GOWIN
PROGRAMMING FOR THE FUTURE

GW1N series of FPGA Products

Data Sheet

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Revision History

Date	Version	Description
06/08/2018	1.19E	Initial version published.
07/31/2018	1.2E	● PLL Structure diagram updated; ● User Flash timing parameters added; ● The description of systemIO status for blank chips added.
09/12/2018	1.3E	The UG256 package added.
12/10/2018	1.4E	● The BANK0 and BANK2 of GW1N-6 and GW1N-9 support I3C OpenDrain/PushPull conversion; ● Change the step delay of IODELAY from 25ps to 30 ps.
01/09/2019	1.5E	Oscillator frequency updated.
02/14/2019	1.6E	● Power supply for UV devices updated; ● Recommended Operating Conditions for UV devices updated; ● Part naming figures updated.
06/04/2019	1.7E	● Operating temperature changed to Junction temperature; ● GW1N-1S added; ● Power supply restrictions of BANK0/1/3 in GW1N-6/9 added; ● Description of User Flash in GW1N-2/2B/4/4B/6/9 added; ● GW1N-6/9 EQ144 added.
07/08/2019	1.8E	● GW1N-6/9 MG196, UG169, and EQ176 added; ● GW1N-1S CS30 added.
10/10/2019	1.9E	● Packages of GW1N-1 LQ100X-LV and LQ100X-UV added; ● GW1N-1S BSRAM does not support Dual port mode; ● The package size of LQ100 / LQ144 / EQ144 / LQ176 / EQ176 fixed; ● Junction temperature of automotive operation added; ● Power supply ramp rates updated.
11/15/2019	2.0E	● The number of Max. I/O updated; ● Automotive grade description added in 5.1 Part Name; ● IODELAY description added.
01/02/2020	2.1E	● The package name of LQ100X-LV and LQ100X-UV updated; ● GW1N-4 MG132X added; ● CLU description updated.
03/17/2020	2.2E	● GW1N-9 CS81M added; ● The description of PLL CLKIN frequency updated.
04/09/220	2.3E	● GW1N-2/GW1N-2B/GW1N-6 removed; ● CFU view updated;
05/28/2020	2.3.1E	Further description of “C” and “I” in the part name marking added.
09/30/2020	2.4E	● GW1N-2 added; ● GW1N-9 MG100 added; ● GW1N-9 QN48F added.
01/13/2021	2.4.1E	I/O Input/Output type updated.
01/22/2021	2.4.2E	GW1N-2 QN48 and QN48M added.
02/08/2021	2.4.3E	AC/DC parameters added.

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1 About This Guide

1.1 Purpose

This data sheet describes the features, product resources and structure, AC/DC characteristics, timing specifications of the configuration interface, and the ordering information of the GW1N series of FPGA products. It is designed to help you to understand the GW1N series of FPGA products quickly and select and use devices appropriately.

1.2 Related Documents

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

1. UG290, Gowin FPGA Products Programming and Configuration User Guide
2. UG103, GW1N series of FPGA Products Package and Pinout
3. UG107, GW1N-1 Pinout
4. UG167, GW1N-1S Pinout
5. UG171, GW1N-2 Pinout
6. UG105, GW1N-4 Pinout
7. UG114, GW1N-9 Pinout

1.3 Abbreviations and Terminology

The abbreviations and terminologies used in this manual are set out in Table 1-1 below.

Table 1-1 Abbreviations and Terminologies

Abbreviations and Terminology	Name
FPGA	Field Programmable Gate Array
FF	Flip-Flop
CFU	Configurable Function Unit
CLS	Configurable Logic Section
CRU	Configurable Routing Unit

Abbreviations and Terminology	Name
LUT4	4-input Look-up Tables
LUT5	5-input Look-up Tables
LUT6	6-input Look-up Tables
LUT7	7-input Look-up Tables
LUT8	8-input Look-up Tables
REG	Register
ALU	Arithmetic Logic Unit
IOB	Input/Output Block
SSRAM	Shadow Static Random Access Memory
BSRAM	Block Static Random Access Memory
SP	Single Port 16K BSRAM
SDP	Semi Dual Port 16K BSRAM
DP	True Dual Port 16K BSRAM
DSP	Digital Signal Processing
DQCE	Dynamic Quadrant Clock Enable
DCS	Dynamic Clock Selector
PLL	Phase-locked Loop
GPIO	Gowin Programable IO
CS30	WLCSP30
CM64	WLCSP64
CS72	WLCSP72
CS81M	WLCSP81M
QN32	QFN32
QN48	QFN48
QN48M	QFN48M
QN48F	QFN48F
LQ100	LQFP100
LQ100X	LQFP100X
LQ144	LQFP144
EQ144	ELQFP144
LQ176	LQFP176
EQ176	ELQFP176

Abbreviations and Terminology	Name
MG100	MBGA100
MG160	MBGA160
MG196	MBGA196
PG256	PBGA256
PG256M	PBGA256M
UG332	UBGA332
UG169	UBGA169
TDM	Time Division Multiplexing

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 using the information provided below.

Website: www.gowinsemi.com

E-mail: support@gowinsemi.com

2 General Description

The GW1N series of FPGA products are the first generation products in the LittleBee® family. They offer abundant logic resources, multiple I/O standards, embeddedBSRAM, DSP, PLL, and built-in Flash. They are non-volatile FPGA products with low power, instant-start, low-cost, high-security, small size, various packages, and flexible usage.

GOWINSEMI provides a new generation of FPGA hardware development environment through market-oriented independent research and development that supports the GW1N series of FPGA products and applies to FPGA synthesizing, placement and routing, data bitstream generation and download, etc.

2.1 Features

- User Flash (GW1N-1,GW1N-1S)
  - 100,000 write cycles
  - Greater than10 years data retention at +85℃
  - Selectable 8/16/32 bits data-in and data-out
  - Page size: 256 bytes
  - 3 μA standby current
  - Page write time: 8.2 ms
- User Flash (GW1N-2/4/9)
  - 10,000 write cycles
  - Greater than10 years Data Retention at +85℃
  - Data Width: 32
  - GW1N-2/4 capacity: 128 rows x 64 columns x 32 = 256kbits
  - GW1N-9 capacity: 304 rows x 64 columns x 32 = 608kbits
  - Page Erase Capability: 2,048 bytes per page
  - Word Programming Time:≤16 μs
  - Page Erasure Time:≤120 ms
- Lower power consumption
  - 55 nm embedded flash technology

  - LV[1]: Supports 1.2 V core voltage
  - UV: Supports same power supply for V_{CC}/ V_{CCO}/ V_{CCx}

    Note!

    [1] GW1N-1S supports LV Version only.
  - Clock dynamically turns on and off
- Hard Core - MIPI D-PHY RX (GW1N-2)
  - Interfaces to MIPI DSI, RX devices
  - IO Bank6 supports MIPI D-PHY RX
  - MIPI transmission rate up to 1.5Gbps;
  - Supports up to 4 data lanes and one clock lane
- Soft Core - MIPI D-PHY RX/TX (GW1N-2)
  - Interfaces to MIPI CSI2 and DSI, RX and TX devices
  - IO Bank0, IO Bank3, IO Bank4, and IO Bank5 support MIPI D-PHY TX, and the transmission speed can be up to 1.5 Gbps
  - IO Bank2 supports MIPI D-PHY RX, transmission rate can be up to 1.2Gbps
- Multiple I/O Standards
  - LVCMOS33/25/18/15/12; LVTTL33, SSTL33/25/18 I, SSTL33/25/18 II, SSTL15; HSTL18 I, HSTL18 II, HSTL15 I; PCI, LVDS25, RSDS, LVDS25E, BLVDSE

    MLVDSE, LVPECLE, RSDSE
  - Input hysteresis option
  - Supports 4mA,8mA,16mA,24mA,etc. drive options
  - Slew rate option
  - Output drive strength option
  - Individual bus keeper, weak pull-up, weak pull-down, and open drain option
  - Hot socket
  - BANK0/BANK1 of GW1N-1S support MIPI I/O input, and MIPI transmission speed can be up to 1.2Gbps
  - I/Os in the Top layer of GW1N-9 devices support MIPI input, and MIPI transmission speed can be up to 1.2Gbps
  - I/Os in the Bottom layer of GW1N-9 devices support MIPI output, and MIPI transmission speed can be up to 1.2Gbps
  - I/Os in the Top layer and Bottom layer of GW1N-9 devices support I3C OpenDrain/PushPull conversion
- High performance DSP
  - High performance digital signal processing ability
  - Supports 9 x 9,18 x 18,36 x 36 bits multiplier and 54 bits accumulator;
  - Multipliers cascading

  - Registers pipeline and bypass
  - Adaptive filtering through signal feedback
  - Supports barrel shifter
- Abundant slices
  - Four input LUT (LUT4)
  - Double-edge flip-flops
  - Supports shift register and distributed register
- Block SRAM with multiple modes
  - Supports dual port, single port, and semi-dual port
  - Supports bytes write enable
- Flexible PLLs
  - Frequency adjustment (multiply and division) and phase adjustment
  - Supports global clock
- Built-in flash programming
  - Instant-on
  - Supports security bit operation
  - Supports AUTO BOOT and DUAL BOOT
- Configuration
  - JTAG configuration
  - B version/ C version devices support JTAG transparent transmission
  - Offers up to seven GowinCONFIG configuration modes: AUTOBOOT, SSPI, MSPI, CPU, SERIAL, DUAL BOOT, I^2C Slave

2.2 Product Resources

Table 2-1 Product Resources

Device	GW1N-1	GW1N-2	GW1N-4	GW1N-9	GW1N-1S
LUT4	1,152	2304	4,608	8,640	1,152
Flip-Flop (FF)	864	2304(FF+Latch ,where FF: 2016)	3,456	6,480	864
Shadow SRAM Capacity (bits)	0	0	0	17,280	0
Block SRAM Capacity(bits)	72 K	72K	180 K	468 K	72K
Number of BSRAM	4	4	10	26	4
User Flash (bits)	96 K	256K	256 K	608 K	96K
18 x 18 Multiplier	0	0	16	20	0
PLLs	1	1	2	2	1
Total number of I/O banks	4	6[2]	4	4	3
Max. I/O	120	126	218	276	44
Core Voltage (LV)	1.2 V	1.2V	1.2 V	1.2 V	1.2V
Core Voltage (UV)	1.8V/2.5V/3.3V[1]	1.8V/2.5V/3.3V	2.5V/3.3V		–

Note!

- [1] In GW1N-1 series, only package in LQ100X offers both UV and LV version, other packages in GW1N-1 series only offer LV version at present.
- [2] In GW1N-2 seires, the package in CS42 has seven IO banks.

2.3 Package Information

Table 2-2 Package Information and Max. I/O, True LVDS Pairs

Package	Pitch(mm)	Size(mm)	GW1N-1S	GW1N-1	GW1N-2	GW1N-4	GW1N-9
CS30	0.4	2.3 x 2.4	23	24		-	-
QN32	0.5	5 x 5		26	-	24 (3)	-
FN32	0.4	4 x 4	25	-		-	-
CS42	0.4	2.4 x 2.9	-	-	34 (7)	-	-
QN48	0.4	6 x 6	-	41	-	40 (9)	40（12）
QN48M	0.4	6 x 6	-	-	40 (8)	-	-
QN48F	0.4	6 x 6	-				39（11）
CM64	0.5	4.1 x 4.1	-	-		-	55（16）
CS72	0.4	3.6 x 3.3				57 (19)	-

Package	Pitch(mm)	Size(mm)	GW1N-1S	GW1N-1	GW1N-2	GW1N-4	GW1N-9
CS81M	0.4	4.1 x 4.1	-	-		-	55（15）
QN88	0.4	10 x 10	-	-	-	70 (11)	70（19）
LQ100	0.5	14 x 14	-	79	-	79 (13)	79（20）
LQ100X	0.5	14 x 14	-	79	80(15)	-	-
LQ144	0.5	20 x 20	-	116	-	119 (22)	120（28）
LQ144X	0.5	20 x 20	-	-	113 (28)	-	-
EQ144	0.5	20 x 20	-	-	-	-	120（28）
MG100	0.5	5 x 5	-	-	-	-	87（25）
MG132X	0.5	8 x 8	-	-	104 (29)	105(23)	-
MG160	0.5	8 x 8	-	-	-	131 (25)	131（38）
UG169	0.8	11 x 11	-	-	-	-	129（38）
LQ176	0.4	20 x 20	-	-	-	-	147（37）
EQ176	0.4	20 x 20	-	-	-	-	147（37）
MG196	0.5	8 x 8	-	-	-	-	113（35）
PG256	1.0	17 x 17	-	-	-	207（32）	207（36）
PG256M	1.0	17 x 17	-	-	-	207（32）	-
UG256	0.8	14 x 14	-	-	-	-	207（36）
UG332	0.8	17 x 17	-	-	-	-	273（43）

Note!

- JTAGSEL_N and JTAG pins cannot be used as I/O simultaneously. The Max. I/O noted in this table is referred to when the four JTAG pins (TCK, TDI, TDO, and TMS) are used as I/O. When mode [2:0] = 001, JTAGSEL_N and the four JTAG pins (TCK, TDI, TDO, and TMS) can be used as GPIO simultaneously, and the Max. user I/O is increased by one. See *UG103, GW1N series of FPGA Products Package and Pinout* for further details.
- The package types in this data sheet are written with abbreviations. See 5.1Part Name.
- " ⟷ " denotes that the various device pins are compatible when the package types are the same.

3 Architecture

3.1 Architecture Overview

Figure 3-1 Architecture Overview of GW1N series of FPGA Products (GW1N-1/1S/4/9)

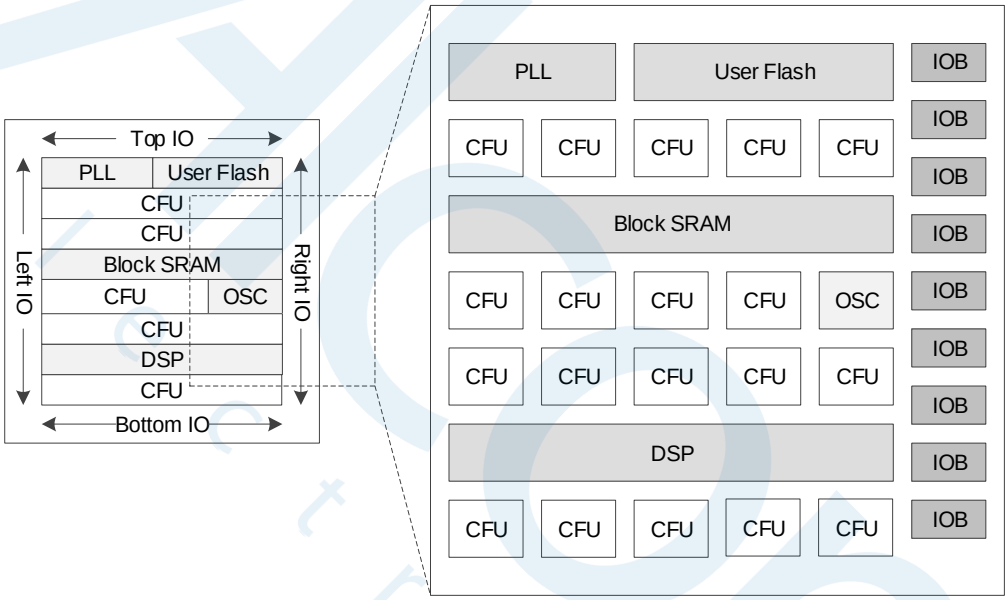
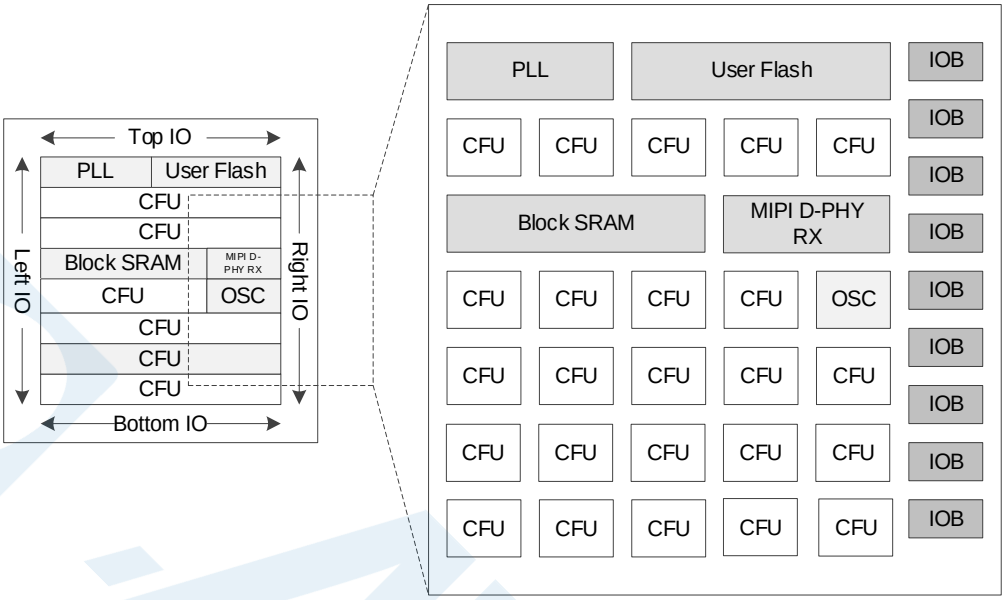


Figure 3-2 Architecture Overview of GW1N-2



As shown in Figure 3-1, the core of GW1N series of FPGA products is CFU. GW1N series of FPGA products also provide BSRAMs, PLLs, User Flash, and on-chip oscillator, and supports Instant-on. Figure 3-2 is the architecture overview of GW1N-2. MIPI D-PHY RX is also embedded in GW1N-2. See Table 2-1 for more detailed information.

Note!

GW1N series of FPGA products include the devices of GW1N-1, GW1N-1S, GW1N-2, GW1N-4, and GW1N-9. In these devices, CFU, BSRAM, GCLK, and on chip crystals are the same, but the other resources, such as DSP, Flash, I/Os, PLL, high-speed clock, etc., are slightly different.

Configurable Function Unit (CFU) is the base cell for the array of GW1N series FPGA Products. Devices with different capacities have different numbers of rows and columns. CFU can be configured as LUT4 mode, ALU mode, and memory mode. Memory mode is supported in GW1N-9. For more detailed information, see 3.2 Configurable Function Unit.

The I/O resources in the GW1N series of FPGA products are arranged around the periphery of the devices in groups referred to as banks[1]. Up to four Banks are supported, including Bank0, Bank1, Bank2, and Bank3. The I/O resources support multiple level standards, and support basic mode, SDR mode, and generic DDR mode. For more detailed information, see 3.3 IOB.

Note!

[1]GW1N-1S includes three Banks, which are Bank0, Bank1, and Bank2 respectively. For further detailed information, please refer to the I/O BANK distribution view in 3.3.1I/O Buffer.

The BSRAM is embedded as a row in the GW1N series of FPGA products. Each BSRAM has 18,432 bits (18 Kbits) and supports multiple configuration modes and operation modes. For more detailed information, see 3.4 Block SRAM (BSRAM).

The User Flash is embedded in the GW1N series of FPGA products, without loss of data, even if powered off. For more detailed information, see 3.5 User Flash (GW1N-1 and GW1N-1S) and 3.6 User Flash (GW1N-2/4/9).

GW1N-4 and GW1N-9 support DSP. DSP blocks are embedded as a row in the FPGA array. Each DSP block contains two Macros, and each Macro contains two pre-adders, two multipliers with 18 by 18 inputs, and a three input ALU54. For more detailed information, see 3.7 DSP.

Note!

GW1N-1 and GW1N-1S do not support DSP currently.

GW1N-1, GW1N-2, and GW1N-1S provide one PLL. GW1N-4 and GW1N-9 provide PLLs. PLL blocks provide the ability to synthesize clock frequencies. Frequency adjustment (multiplication and division), phase adjustment, and duty cycle adjustment can be realized by the configuration of parameters. There is an internal programmable on-chip oscillator in each GW1N series of FPGA product. The on-chip oscillator supports the clock frequencies ranging from 2.5 MHz to 125 MHz, providing the clock resource for the MSPI mode. It also provides a clock resource for user designs with the clock precision reaching ±5%. For more detailed information, see 3.9 Clock, 3.13 On Chip Oscillator.

GW1N-2 provides the hard core MIPI D-PHY RX IP and also the soft core MIPI D-PHY RX TX IP. For further details, please refer to 3.8 MIPI D-PHY.

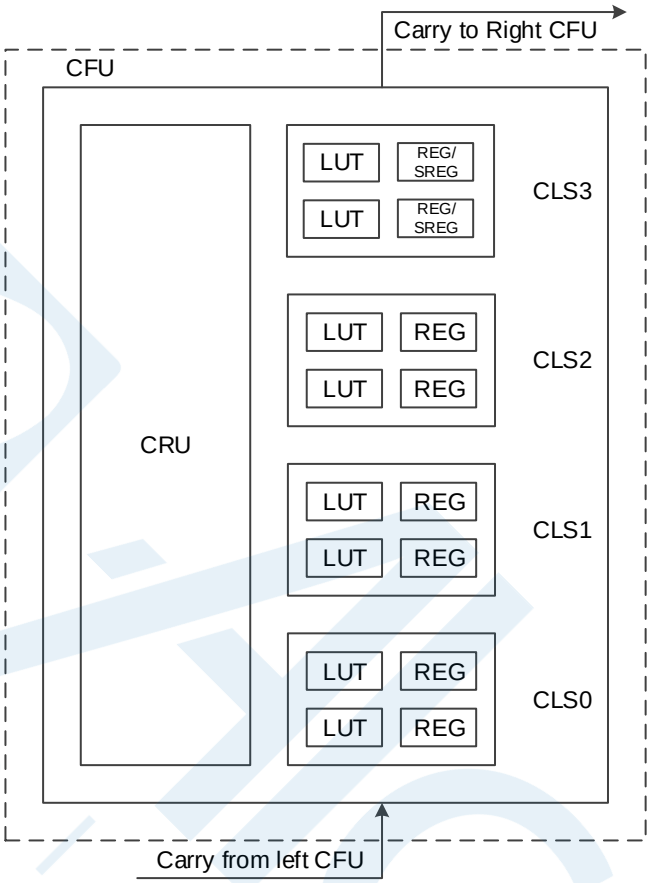
FPGA provides abundant CRUs, connecting all the resources in the FPGA. For example, routing resources distributed in CFU and IOB connect resources in CFU and IOB. Routing resources can automatically be generated by Gowin software. In addition, the GW1N series of FPGA Products also provide abundant GCLKs, long wires (LW), global set/reset (GSR), and programming options, etc. For further detailed information, see 3.9 Clock, 3.10 Long Wire (LW), 3.11 Global Set/Reset (GSR).

3.2 Configurable Function Unit

The configurable function unit and the configurable logic unit are two basic units for FPGA core of GOWINSEMI. As shown in Figure 3-3, each unit consists of four configurable logic sections and its configurable routing unit. Each of the three configurable logic sections contains two 4-input LUTs and two registers, and the other one only contians two 4-input LUTs.

Configurable logical sections in CLU cannot be configured as SRAM, but as basic logic, ALU, and ROM. The configurable logic sections in the CFU can be configured as basic logic, ALU, SRAM, and ROM depending on the applications. This section takes CFU as an example to introduce CFU and CLU.

Figure 3-3 CFU View



Note!

- SREG needs special patch supporting. Please contact Gowin technical support or local Office for this patch.
- In GW1N-2, the CLK, CE, and SR of CLS3 and CLS2 are driven by the same source.

3.2.1 CLU

The CLU supports three operation modes: basic logic mode, ALU mode, and memory mode.

- Basic Logic Mode

Each LUT can be configured as one four input LUT. A higher input number of LUT can be formed by combining LUT4 together.

  - Each CLS can form one five input LUT5.
  - Two CLSs can form one six input LUT6.
  - Four CLSs can form one seven input LUT7.
  - Eight CLSs (two CLUs) can form one eight input LUT8.

- ALU Mode

When combined with carry chain logic, the LUT can be configured as the ALU mode to implement the following functions.

  - Adder and subtractor
  - Up/down counter

- Comparator, including greater-than, less-than, and not-equal-to
- MULT

- Memory mode

GW1N-9 supports memory mode. In this mode, a 16 x 4 SSRAM or ROM can be constructed by using CLSs.

This SSRAM can be initialized during the device configuration stage. The initialization data can be generated in the bit stream file from Gowin software.

Register

There are two registers in each configurable logic section (CLS0~CLS2), as shown in Figure 3-4 below.

Figure 3-4 Register in CLS

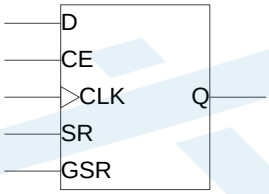


Table 3-1 Register Description in CLS

Signal	I/O	Description
D	I	Data input[1]
CE	I	CLK enable, can be high or low effective[2]
CLK	I	Clock, can be rising edge or falling edge trigging [2]
SR	I	Set/Reset, can be configured as [2]: ● Synchronized reset ● Synchronized set ● Asynchronous reset ● Asynchronous set ● Non
GSR[3],[4]	I	Global Set/Reset, can be configured as[4]: ● Asynchronous reset ● Asynchronous set ● Non
Q	O	Register output

Note!

- [1] The source of the signal D can be the output of a LUT, or the input of the CRU; as such, the register can be used alone when LUTs are in use.
- [2] CE/CLK/SR in CFU is independent.
- [3] In the GW1N series of FPGA products, GSR has its own dedicated network.
- [4] When both SR and GSR are effective, GSR has higher priority.

3.2.2 CRU

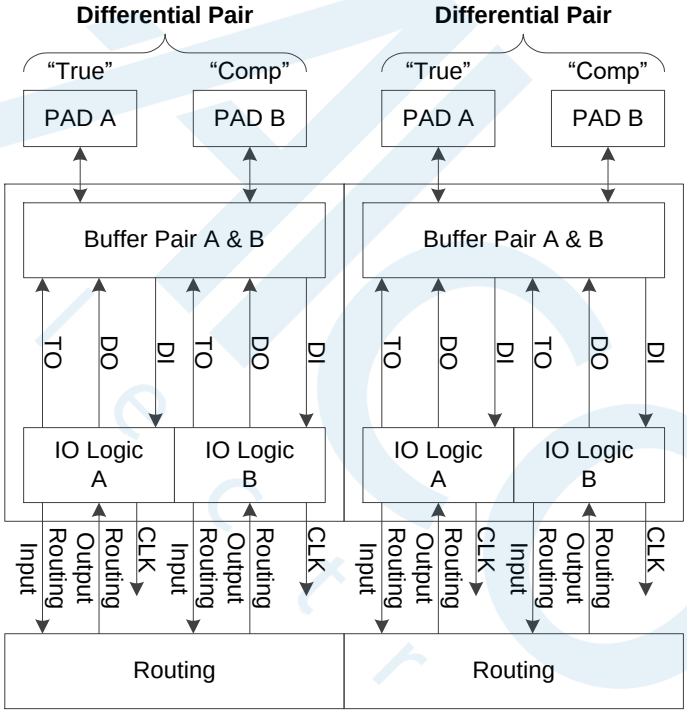
The main functions of the CRU are as follows:

- Input selection: Select input signals for the CFU.
- Configurable routing: Connect the input and output of the CFUs, including inside the CFU, CFU to CFU, and CFU to other functional blocks in FPGA.

3.3 IOB

The IOB in the GW1N series of FPGA products includes I/O buffer, I/O logic, and its routing unit. As shown in Figure 3-5, each IOB connects to two pins (Marked A and B). They can be used as a differential pair or as two single-ended input/output.

Figure 3-5 IOB Structure View



IOB Features:

- V_{CCO} supplied with each bank
- LVCMOS, PCI, LVTTL, LVDS, SSTL, and HSTL (true LVDS not supported in GW1N-1 and GW1N-1S)
- Input hysteresis option
- Output drive strength option
- Slew rate option
- Individual bus keeper, weak pull-up, weak pull-down, and open drain option
- Hot socket
- IO logic supports basic mode, SRD mode, and generic DDR mode
- I/Os in the top layer of GW1N-1S and GW1N-9 devices support MIPI

input

- I/Os in the bottom layer of GW1N-9 devices support MIPI output
- I/Os in the Top layer and Bottom layer of GW1N-9 devices support I3C

Note!

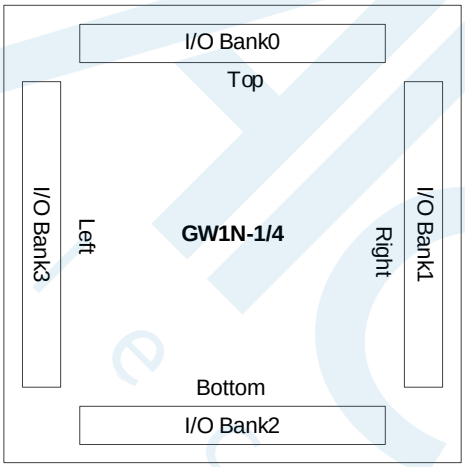
GW1N-1 and GW1N-1S do not support true LVDS output.

3.3.1 I/O Buffer

Each Bank supports single power supply and has independent I/O power supply V_{CCO}. To support SSTL, HSTL, etc., each bank also provides one independent voltage source (V_{REF}) as referenced voltage. The user can choose from the internal reference voltage of the bank (0.5 x V_{CCO}) or the external reference voltage using any IO from the bank.

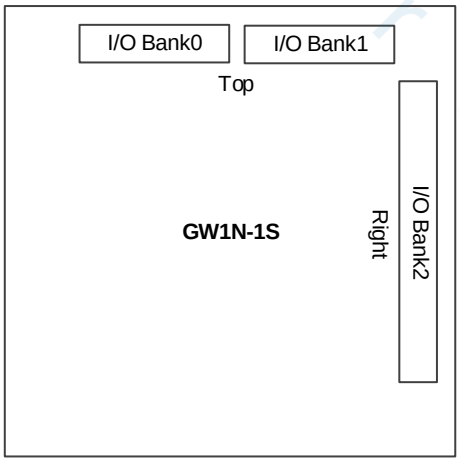
There are four IO Banks in the GW1N-1/4 products, as shown in Figure 3-6.

Figure 3-6 I/O Bank Distribution View of GW1N-1/4



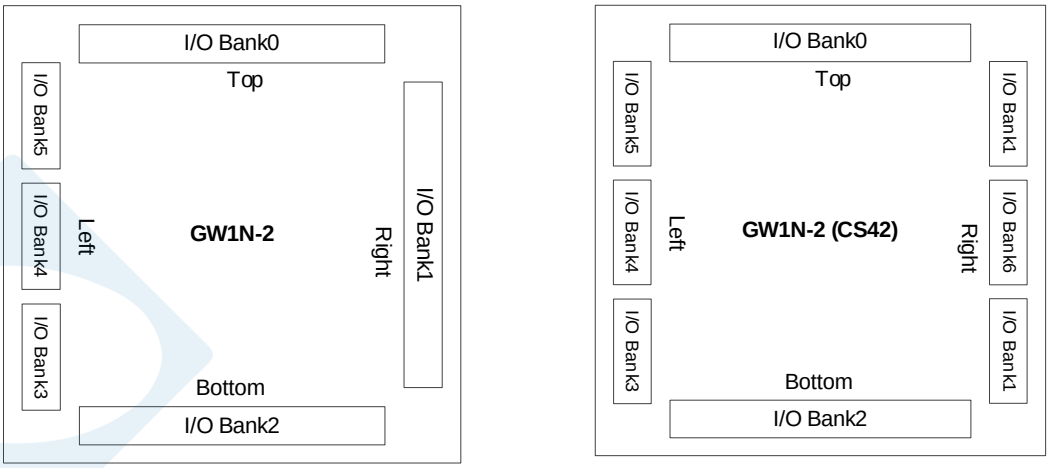
GW1N-1S includes three IO Banks, as shown in Figure 3-7.

Figure 3-7 I/O Bank Distribution View of GW1N-1S



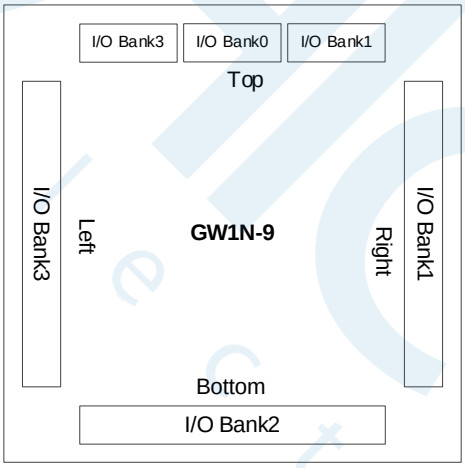
GW1N-2 includes six IO Banks, and the package in CS42 of GW1N-2 includes seven IO Banks, as shown in Figure 3-8.

Figure 3-8 I/O Bank Distribution View of GW1N-2



There are four IO Banks in the GW1N-9 product, as shown in Figure 3-9.

Figure 3-9 I/O Bank Distribution View of GW1N-9



The GW1N series of FPGA products support LV, and UV, among which GW1N-1S supports LV version.

LV devices support 1.2 V V_{CC} to meet users' low power needs.

V_{CCO} can be set as 1.2 V, 1.5 V, 1.8 V, 2.5 V, or 3.3 V according to requirements[1].

GW1N-1S does not support V_{CCX}. V_{CCX} of the other devices supports 2.5 V or 3.3 V power supply.

UV devices support 1.8V, 2.5 V, and 3.3 V, and linear voltage regulator is integrated to facilitate single power supply.

BANK0/BANK1 of GW1N-1S supports MIPI I/O input. The top I/Os of GW1N-9 supports MIPI input and the bottom I/Os support MIPI output. I/Os of both the top and bottom layer in GW1N-9 support I3C.

Note!

- By default, the Gowin Programmable IO is tri-stated weak pull-up.

- For the recommended operating conditions of different devices, please refer to 4.1Operating Conditions;
- When the I/O of GW1N-1S is used as MIPI input, V_{CCO0}/ V_{CCO1} needs to be supplied with 2.5V power supply,
- When the I/O in Top layer of GW1N-9 is used as MIPI input, V_{CCO0} needs to be supplied with 1.2V power supply.
- When the I/O in Bottom layer of GW1N-9 is used as MIPI output, V_{CCO2} needs to be supplied with 1.2V power supply.
- The I/O power supply restrictions of BANK0, BANK1, BANK3 in GW1N-9 are as follows:
  - When V_{CCO0} is greater than or equal to 1.8V, V_{CCO1} and V_{CCO3} support 1.2V, 1.5V, 1.8V, 2.5V, and 3.3V.
  - When V_{CCO0} is 1.5V, V_{CCO1} and V_{CCO3} support 1.2V, 1.5V, 1.8V, and 2.5V.
  - When V_{CCO0} is 1.2V, V_{CCO1} and V_{CCO3} support 1.2V, 1.5V, and 1.8V.

For the V_{CCO} requirements of different I/O standards, see Table 3-2 and Table 3-3.

Table 3-2 Output I/O Standards and Configuration Options

I/O Type (Output)	Single/Differ	Bank V_{CCO} (V)	Drive Strength (mA)
MIPI[1]	Differ (TLVDS)	1.2	8
LVDS25[2]	Differ (TLVDS)	2.5/3.3	3.5/2.5/2/1.25
RSDS[2]	Differ (TLVDS)	2.5/3.3	2
MINILVDS[2]	Differ (TLVDS)	2.5/3.3	2
PPLVDS[2]	Differ (TLVDS)	2.5/3.3	3.5
LVDS25E	Differ	2.5	8
BLVDS25E	Differ	2.5	16
MLVDS25E	Differ	2.5	16
RSDS25E	Differ	2.5	8
LVPECL33E	Differ	3.3	16
HSTL18D_I	Differ	1.8	8
HSTL18D_II	Differ	1.8	8
HSTL15D_I	Differ	1.5	8
SSTL15D	Differ	1.5	8
SSTL18D_I	Differ	1.8	8
SSTL18D_II	Differ	1.8	8
SSTL25D_I	Differ	2.5	8
SSTL25D_II	Differ	2.5	8
SSTL33D_I	Differ	3.3	8
SSTL33D_II	Differ	3.3	8

I/O Type (Output)	Single/Differ	Bank V_{CCO} (V)	Drive Strength (mA)
LVCMOS12D	Differ	1.2	6/2
LVCMOS15D	Differ	1.5	8/4
LVCMOS18D	Differ	1.8	8/12/4
LVCMOS25D	Differ	2.5	8/16/12/4
LVCMOS33D	Differ	3.3	8/16/12/4
HSTL15_I	Single	1.5	8
HSTL18_I	Single	1.8	8
HSTL18_II	Single	1.8	8
SSTL15	Single	1.5	8
SSTL18_I	Single	1.8	8
SSTL18_II	Single	1.8	8
SSTL25_I	Single	2.5	8
SSTL25_II	Single	2.5	8
SSTL33_I	Single	3.3	8
SSTL33_II	Single	3.3	8
LVCMOS12	Single	1.2	4,8
LVCMOS15	Single	1.5	4,8
LVCMOS18	Single	1.8	4,8,12
LVCMOS25	Single	2.5	4,8,12,16
LVCMOS33/ LVTTL33	Single	3.3	4,8,12,16,24
PCI33	Single	3.3	N/A

Note!

- [1] GW1N-2 Bank0/Bank3/Bank4/Bank5 supports MIPI I/O output; GW1N-9 Bank2 supports MIPI I/O output.
- [2] GW1N-1/GW1N-1S does not support this I/O type.

Table 3-3 Input I/O Standards and Configuration Options

I/O Type (Input)	Single/Differ	Bank V_{CCO} (V)	HYSTERESIS	Need V_{REF}
MIPI[1]	Differ (TLVDS)	1.2	No	No
LVDS25[2]	Differ (TLVDS)	2.5/3.3	No	No
RSDS[2]	Differ (TLVDS)	2.5/3.3	No	No
MINILVDS[2]	Differ (TLVDS)	2.5/3.3	No	No
PPLVDS[2]	Differ (TLVDS)	2.5/3.3	No	No
LVDS25E	Differ	2.5/3.3	No	No

I/O Type (Input)	Single/Differ	Bank V_{CCO} (V)	HYSTERESIS	Need V_{REF}
BLVDS25E	Differ	2.5/3.3	No	No
MLVDS25E	Differ	2.5/3.3	No	No
RSDS25E	Differ	2.5/3.3	No	No
LVPECL33E	Differ	3.3	No	No
HSTL18D_I	Differ	1.8/2.5/3.3	No	No
HSTL18D_II	Differ	1.8/2.5/3.3	No	No
HSTL15D_I	Differ	1.5/1.8/2.5/3.3	No	No
SSTL15D	Differ	1.5/1.8/2.5/3.3	No	No
SSTL18D_I	Differ	1.8/2.5/3.3	No	No
SSTL18D_II	Differ	1.8/2.5/3.3	No	No
SSTL25D_I	Differ	2.5/3.3	No	No
SSTL25D_II	Differ	2.5/3.3	No	No
SSTL33D_I	Differ	3.3	No	No
SSTL33D_II	Differ	3.3	No	No
LVCMOS12D	Differ	1.2/1.5/1.8/2.5/3.3	No	No
LVCMOS15D	Differ	1.5/1.8/2.5/3.3	No	No
LVCMOS18D	Differ	1.8/2.5/3.3	No	No
LVCMOS25D	Differ	2.5/3.3	No	No
LVCMOS33D	Differ	3.3	No	No
HSTL15_I	Single	1.5 or 1.5/1.8/2.5/3.3[3]	No	Yes
HSTL18_I	Single	1.8 or 1.8/2.5/3.3[4]	No	Yes
HSTL18_II	Single	1.8 or 1.8/2.5/3.3[4]	No	Yes
SSTL15	Single	1.5 or 1.5/1.8/2.5/3.3[3]	No	Yes
SSTL18_I	Single	1.8 or 1.8/2.5/3.3[4]	No	Yes
SSTL18_II	Single	1.8 or 1.8/2.5/3.3[4]	No	Yes
SSTL25_I	Single	2.5 or 2.5/3.3[5]	No	Yes
SSTL25_II	Single	2.5 or 2.5/3.3[5]	No	Yes
SSTL33_I	Single	3.3	No	Yes
SSTL33_II	Single	3.3	No	Yes
LVCMOS12	Single	1.2/1.5/1.8/2.5/3.3	Yes	No
LVCMOS15	Single	1.2/1.5/1.8/2.5/3.3	Yes	No
LVCMOS18	Single	1.2/1.5/1.8/2.5/3.3	Yes	No

I/O Type (Input)	Single/Differ	Bank V_{CCO} (V)	HYSTERESIS	Need V_{REF}
LVCMOS25	Single	1.2/1.5/1.8/2.5/3.3	Yes	No
LVCMOS33/ LVTTL33	Single	1.2/1.5/1.8/2.5/3.3	Yes	No
PCI33	Single	3.3	Yes	No
LVCMOS33OD25	Single	2.5	No	No
LVCMOS33OD18	Single	1.8	No	No
LVCMOS33OD15	Single	1.5	No	No
LVCMOS25OD18	Single	1.8	No	No
LVCMOS25OD15	Single	1.5	No	No
LVCMOS18OD15	Single	1.5	No	No
LVCMOS15OD12	Single	1.2	No	No
LVCMOS25UD33	Single	3.3	No	No
LVCMOS18UD25	Single	2.5	No	No
LVCMOS18UD33	Single	3.3	No	No
LVCMOS15UD18	Single	1.8	No	No
LVCMOS15UD25	Single	2.5	No	No
LVCMOS15UD33	Single	3.3	No	No
LVCMOS12UD15	Single	1.5	No	No
LVCMOS12UD18	Single	1.8	No	No
LVCMOS12UD25	Single	2.5	No	No
LVCMOS12UD33	Single	3.3	No	No

Note!

- [1] GW1N-2 Bank2, GW1N-2 Bank6 (Hard core), GW1N-9 Bank0, and GW1N-1S Bank0/ Bank1 support MIPI I/O input.
- [2] GW1N-1S does not support this I/O type.
- [3] When VREF is INTERNAL, the V_{CCO} of this I/O type is 1.5V; when VREF is VREF1_LOAD, the V_{CCO} of this I/O type is 1.5 V/1.8 V/2.5 V/3.3 V.
- [4] When VREF is INTERNAL, the V_{CCO} of this I/O type is 1.8 V; when VREF is VREF1_LOAD, the V_{CCO} of this I/O type is 1.8 V /2.5 V /3.3 V.
- [5] When VREF is INTERNAL, the V_{CCO} of this I/O type is 2.5 V; when VREF is VREF1_LOAD, the V_{CCO} of this I/O type is 2.5 V /3.3 V.

3.3.2 True LVDS Design

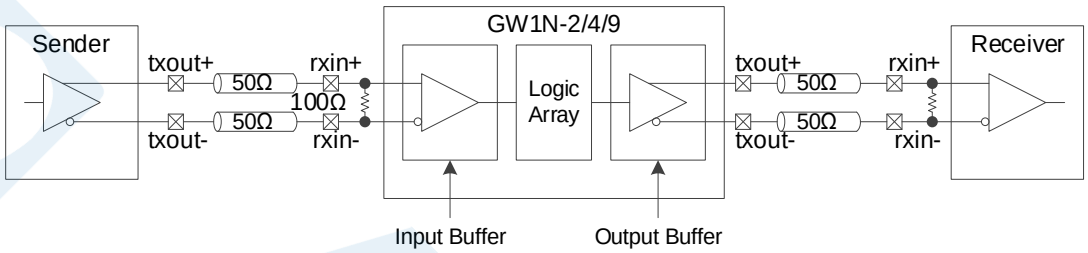
Except GW1N-1 / GW1N-1S, the other devices of GW1N series products support true LVDS output, but do not support internal 100Ω input differential matched resistance. The Bank that does not support True LVDS output supports internal 100Ω input differential matched resistance. GW1N series of FPGA products also support LVDS25E, MLVDS25E, BLVDS25E,

etc. For more detailed information about different levels, please refer to UG289, *Gowin Programable IO User Guide*.

For more detailed information about true LVDS, please refer to *UG171, GW1N-2 Pinout*, *UG105, GW1N-4 Pinout,* and *UG114, GW1N-9 Pinout*.

True LVDS input I/O needs external 100Ω terminal resistance for matching. See Figure 3-10 for the true LVDS design.

Figure 3-10 True LVDS Design



For more detailed information about LVDS25E, MLVDS25E, and BLVDS25E on IO terminal matched resistance, please refer to UG289, *Gowin Programable IO User Guide*.

3.3.3 I/O Logic

Figure 3-11 shows the I/O logic output of the GW1N series of FPGA products.

Figure 3-11 I/O Logic Output

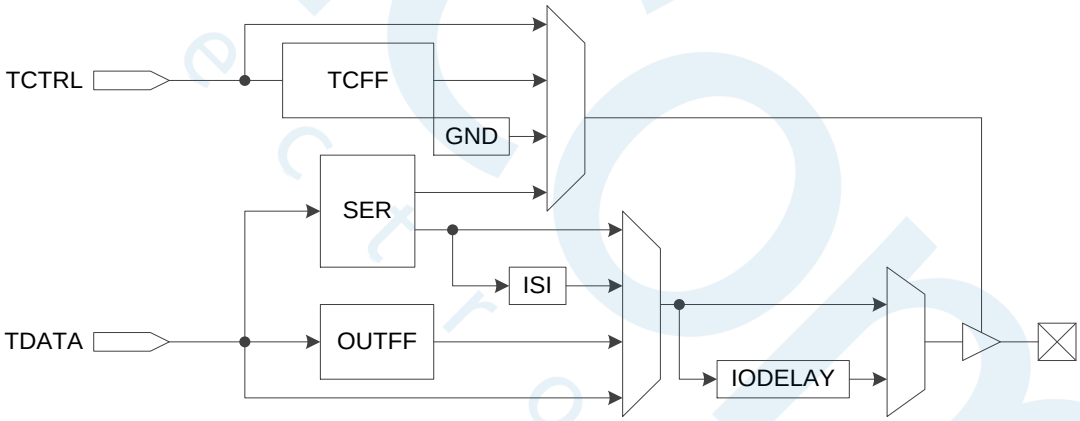
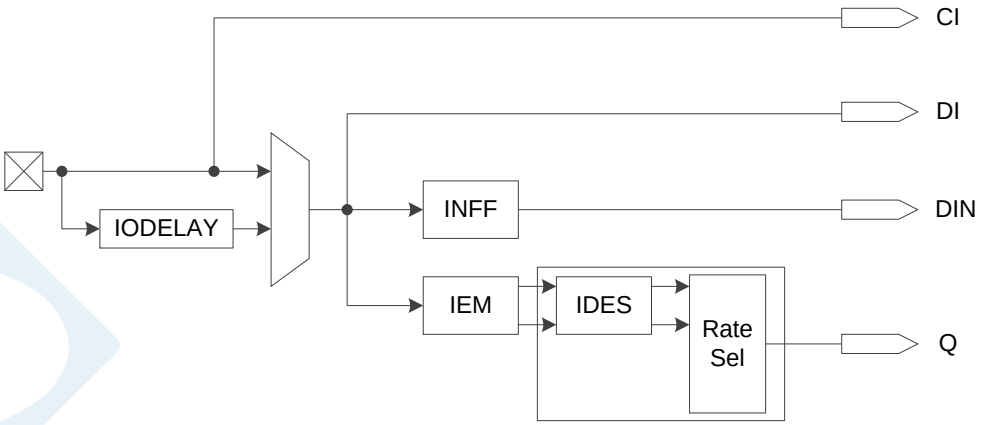


Figure 3-12 shows the I/O logic input of the GW1N series of FPGA products.

Figure 3-12 I/O Logic Input

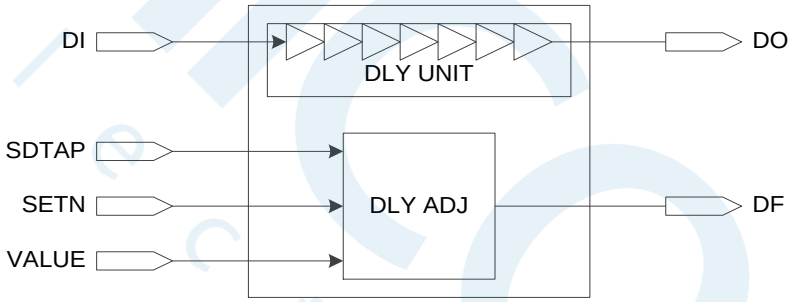


A description of the I/O logic modules of the GW1N series FPGA products is presented below.

IODELAY

See Figure 3-13 for an overview of the IODELAY. Each I/O of the GW1N series of FPGA products has an IODELAY cell. A total of 128(0~127) step delay is provided, with one-step delay time of about 30ps.

Figure 3-13 IODELAY



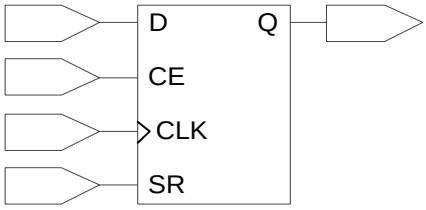
There are two ways to control the delay cell:

- Static control:
- Dynamic control: Usually used to sample delay window together with IEM. The IODELAY cannot be used for both input and output at the same time

I/O Register

See Figure 3-14 for I/O register in the GW1N series of FPGA products. Each I/O provides one input register, INFF, one output register, OUTFF, and a tristate register, TCFF.

Figure 3-14 Register Structure in I/O Logic



Note!

- CE can be either active low (0: enable)or active high (1: enable).
- CLK can be either rising edge trigger or falling edge trigger.
- SR can be either synchronous/asynchronous SET or RESET or disable.
- The register can be programmed as register or latch.

IEM

IEM is for sampling clock edge and is used in the generic DDR mode. See Figure 3-15 for the IEM structure.

Figure 3-15 IEM Structure

De-serializer DES

The GW1N series of FPGA products provide a simple De-serializer DES for each output I/O to support advanced I/O protocols.

Serializer SER

The GW1N series of FPGA products provide a simple Serializer SER for each output I/O to support advanced I/O protocols.

3.3.4 I/O Logic Modes

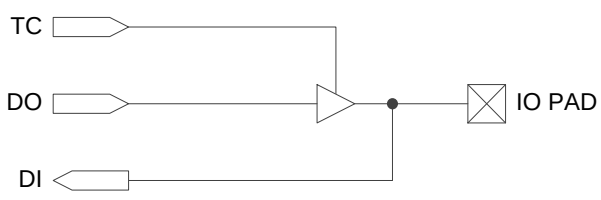
The I/O Logic in the GW1N series of FPGA products supports several operations. In each operation, the I/O (or I/O differential pair) can be configured as output, input, and INOUT or tristate output (output signal with tristate control).

GW1N-1S, GW1N-2, and GW1N-9 pins support IO logic. The GW1N-1 pins IOL6 (A, B,C….J) and IOR6 (A,B,C….J) do not support IO logic. The other pins of GW1N-1 support IO logic. The GW1N-4 pins IOL10 (A,B,C….J) and IOR10(A,B,C….J) do not support IO logic. The other pins of GW1N-4 support IO logic.

Basic Mode

In basic mode, the I/O logic is as shown in Figure 3-16, and the TC, DO, and DI signals are connected to the internal cores directly through CRU.

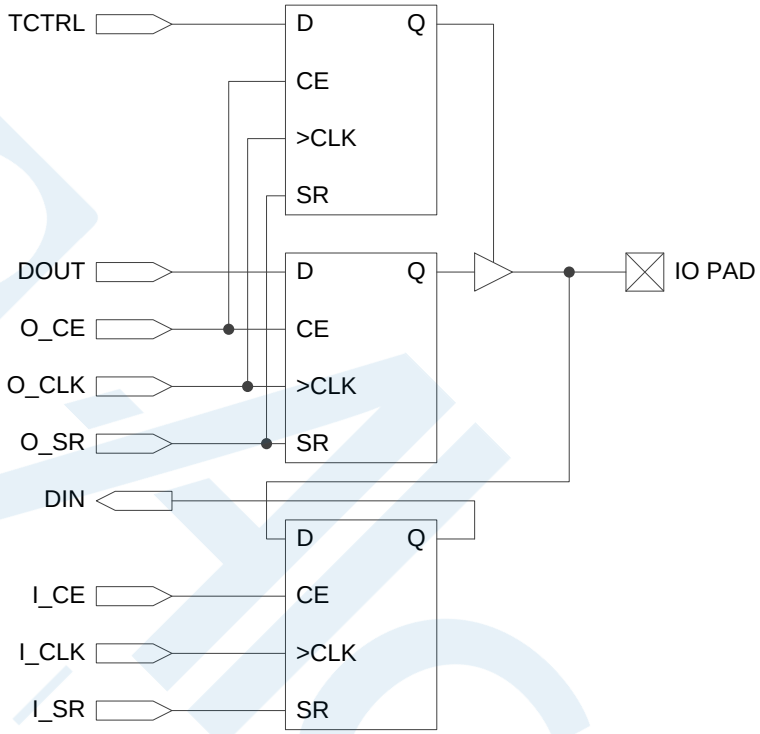
Figure 3-16 I/O Logic in Basic Mode



SDR Mode

In comparison with the basic mode, SDR utilizes the IO register, as shown in Figure 3-17. This can effectively improve IO timing.

Figure 3-17 I/O Logic in SDR Mode



Note!

- CLK enable O_CE and I_CE can be configured as active high or active low;
- O_CLK and I_CLK can be either rising edge trigger or falling edge trigger;
- Local set/reset signal O_SR and I_SR can be either synchronized reset, synchronized set, asynchronous reset, asynchronous set, or no-function;
- I/O registers in SDR mode can be configured as basic registers or latches.

Generic DDR Mode

Higher speed IO protocols can be supported in generic DDR mode.

GW1N-1S and GW1N-9 devices support IDES16 mode and OSER16 mode. The other devices do not support.

Figure 3-18 shows the generic DDR input, with a speed ratio of the internal logic to PAD 1:2.

Figure 3-18 I/O Logic in DDR Input Mode

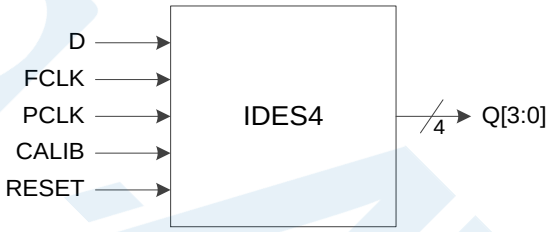
Figure 3-19 shows generic DDR output, with a speed ratio of PAD to FPGA internal logic 2:1.

Figure 3-19 I/O Logic in DDR Output Mode

IDES4 Mode

In IDES4 mode, the speed ratio of the PAD to FPGA internal logic is 1:4.

Figure 3-20 I/O Logic in IDES4 Mode



OSER4 Mode

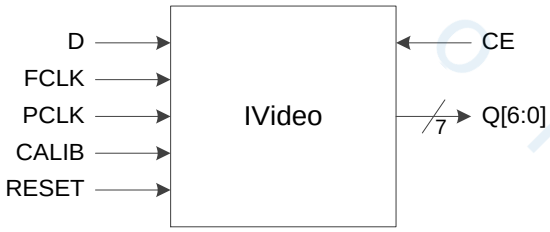
In OSER4 mode, the speed ratio of the PAD to FPGA internal logic is 4:1.

Figure 3-21 I/O Logic in OSER4 Mode

IVideo Mode

In IVideo mode, the speed ratio of the PAD to FPGA internal logic is 1:7.

Figure 3-22 I/O Logic in IVideo Mode



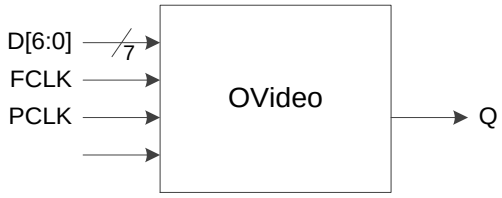
Note!

IVideo and IDES8/10 will occupy the neighboring I/O logic. If the I/O logic of a single port is occupied, the pin can only be programmed in SDR or BASIC mode.

OVideo Mode

In OVideo mode, the speed ratio of the PAD to FPGA internal logic is 7:1.

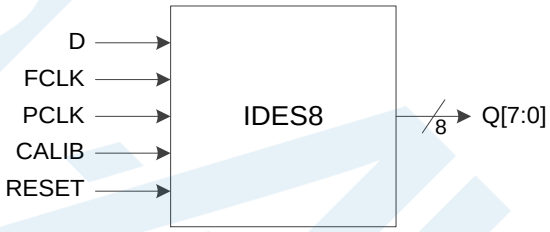
Figure 3-23 I/O Logic in OVideo Mode



IDES8 Mode

In IDES8 mode, the speed ratio of the PAD to FPGA internal logic is 1:8.

Figure 3-24 I/O Logic in IDES8 Mode



OSER8 Mode

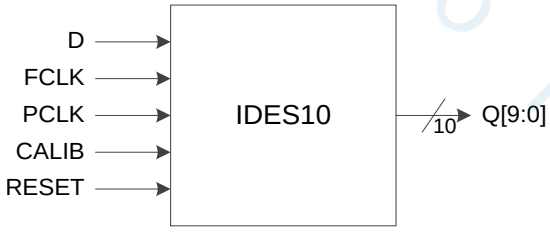
In OSER8 mode, the speed ratio of the PAD to FPGA internal logic is 8:1.

Figure 3-25 I/O Logic in OSER8 Mode

IDES10 Mode

In IDES10 mode, the speed ratio of the PAD to FPGA internal logic is 1:10.

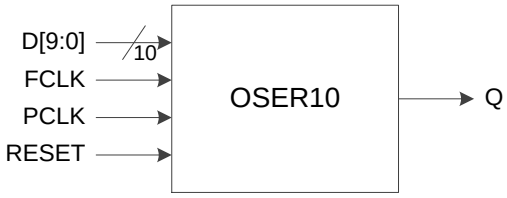
Figure 3-26 I/O Logic in IDES10 Mode



OSER10 Mode

In OSER10 mode, the speed ratio of the PAD to FPGA internal logic is 10:1.

Figure 3-27 I/O Logic in OSER10 Mode



IDES16 Mode

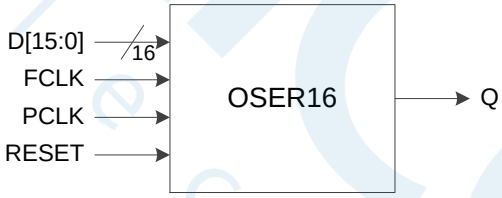
Only GW1N-1S and GW1N-9 devices support this mode. In IDES16 mode, the speed ratio of the PAD to FPGA internal logic is 1:16.

Figure 3-28 I/O Logic in IDES16 Mode

OSER16 Mode

Only GW1N-1S and GW1N-9 devices support this mode. In OSER16 mode, the speed ratio of the PAD to FPGA internal logic is 16:1.

Figure 3-29 I/O Logic in OSER16 Mode



3.4 Block SRAM (BSRAM)

3.4.1 Introduction

The GW1N series of FPGA products provide abundant BSRAMs. The Block SRAM (BSRAM) is embedded as a row in the FPGA array and is different from SSRAM (Shadow SRAM). Each BSRAM has 18,432 bits (18Kbits). There are four operation modes: Single Port, Dual Port, Semi Dual Port, and ROM. The signals and functional descriptions of BSRAM are listed in Table 3-4.

An abundance of BSRAM resources provide a guarantee for the user's high-performance design. BSRAM features include the following:

- Max.18,432 bits per BSRAM
- BSRAM itself can run at 190 MHz at max
- Single Port
- Dual Port
- Semi Dual Port
- Parity bits

- ROM
- Data width from 1 to 36 bits
- Mixed clock mode
- Mixed data width mode
- Enable Byte operation for double byte or above
- Normal Read and Write Mode
- Read-before-write Mode
- Write-through Mode

Table 3-4 BSRAM Signals

Port Name	I/O	Description
DIA	I	Port A data input
DIB	I	Port B data input
ADA	I	Port A address
ADB	I	Port B address
CEA	I	Clock enable, Port A
CEB	I	Clock enable, Port B
RESETA	I	Register reset, Port A
RESETB	I	Register reset, Port B
WREA	I	Read/write enable, Port A
WREB	I	Read/write enable, Port B
BLKSELA, BLKSELB	I	Block select
CLKA	I	Read/write cycle clock for Port A input registers
CLKB	I	Read/write cycle clock for Port B input registers
OCEA	I	Clock enable for Port A output registers
OCEB	I	Clock enable for Port B output registers
DOA	O	Port A data output
DOB	O	Port B data output

3.4.2 Configuration Mode

The BSRAM mode in the GW1N series of FPGA products supports different data bus widths. See Table 3-5.

Table 3-5 Memory Size Configuration

Single Port Mode	Dual Port Mode[1]	Semi-Dual Port Mode	Read Only
16 K x 1	16 K x 1	16 K x 1	16K x 1
8K x 2	8K x 2	8K x 2	8K x 2
4K x 4	4K x 4	4K x 4	4K x 4
2K x 8	2K x 8	2K x 8	2K x 8
1K x 16	1K x 16	1K x 16	1K x 16
512 x 32	-	512 x 32	512 x 32
2K x 9	2K x 9	2K x 9	2K x 9
1K x 18	1K x 18	1K x 18	1K x 18
512 x 36	-	512 x 36	512 x 36

Note!

[1]GW1N-9 and GW1N-1S do not support Dual Port Mode.

Single Port Mode

In the single port mode, BSRAM can write to or read from one port at one clock edge. During the write operation, the data can show up at the output of BSRAM. Normal-Write Mode and Write–through Mode can be supported. When the output register is bypassed, the new data will show at the same write clock rising edge.

Dual Port Mode

BSRAM support dual port mode. The applicable operations are as follows:

- Two independent read
- Two independent write
- An independent read and an independent write at different clock frequencies

For further information about Dual Port Block Memory ports and the related description, please refer to *UG285E, Gowin BSRAM&SSRAM User Guide*.

Semi-Dual Port Mode

Semi-Dual Port supports read and write at the same time on different ports, but it is not possible to write and read to the same port at the same time. The system only supports write on Port A, read on Port B.

For further information about Semi-Dual Port Block Memory ports and the related description, please refer to *UG285E, Gowin BSRAM&SSRAM*

User Guide.

Read Only

BSRAM can be configured as ROM. The ROM can be initialized during the device configuration stage, and the ROM data needs to be provided in the initialization file. Initialization completes during the device power-on process.

Each BSRAM can be configured as one 16 Kbits ROM. For further information about Read Only Port Block Memory ports and the related description, please refer to *UG285E, Gowin BSRAM&SSRAM User Guide*.

3.4.3 Mixed Data Bus Width Configuration

The BSRAM in the GW1N series of FPGA products supports mixed data bus width operation. In the dual port and semi-dual port modes, the data bus width for read and write can be different. For the configuration options that are available, please see Table 3-6 and Table 3-7 below.

Table 3-6 Dual Port Mixed Read/Write Data Width Configuration[1],[2]

Read Port	Write Port						
	16K x 1	8K x 2	4K x 4	2K x 8	1K x 16	2K x 9	1K x 18
16K x 1	*	*	*	*	*		
8K x 2	*	*	*	*	*		
4K x 4	*	*	*	*	*		
2K x 8	*	*	*	*	*		
1K x 16	*	*	*	*	*		
2K x 9						*	*
1K x 18						*	*

Note!

- [1] GW1N-1S does not support Dual Port Mode;
- [2] "*" denotes the modes supported.

Table 3-7 Semi Dual Port Mixed Read/Write Data Width Configuration

Read Port	Write Port								
	16K x 1	8K x 2	4K x 4	2K x 8	1K x 16	512 x 32	2K x 9	1K x 18	512 x 36
16K x 1	*	*	*	*	*	*			
8K x 2	*	*	*	*	*	*			
4K x 4	*	*	*	*	*	*			
2K x 8	*	*	*	*	*	*			
1K x 16	*	*	*	*	*	*			
512 x 32	*	*	*	*	*	*			
2K x 9							*	*	*

Read Port	Write Port								
	16K x 1	8K x 2	4K x 4	2K x 8	1K x 16	512 x 32	2K x 9	1K x 18	512 x 36
1K x 18							*	*	*

Note!

"*"denotes the modes supported.

3.4.4 Byte-enable

The BSRAM in the GW1N series of FPGA products supports byte-enable. For data longer than a byte, the additional bits can be blocked, and only the selected portion can be written into. The blocked bits will be retained for future operation. Read/write enable ports (WREA, WREB), and byte-enable parameter options can be used to control the BSRAM write operation.

3.4.5 Parity Bit

There are parity bits in BSRAMs. The 9th bit in each byte can be used as a parity bit to check the correctness of data transmission. It can also be used for data storage.

3.4.6 Synchronous Operation

- All the input registers of BSRAM support synchronous write;
- The output registers can be used as pipeline registers to improve design performance;
- The output registers are bypass-able.

3.4.7 Power up Conditions

BSRAM initialization is supported when powering up. During the power-up process, BSRAM is in standby mode, and all the data outputs are "0". This also applies in ROM mode.

3.4.8 BSRAM Operation Modes

BSRAM supports five different operations, including two read operations (Bypass Mode and Pipeline Read Mode) and three write operations (Normal Write Mode, Write-through Mode, and Read-before-write Mode).

Read Mode

Read data from the BSRAM via output registers or without using the output registers.

Pipeline Mode

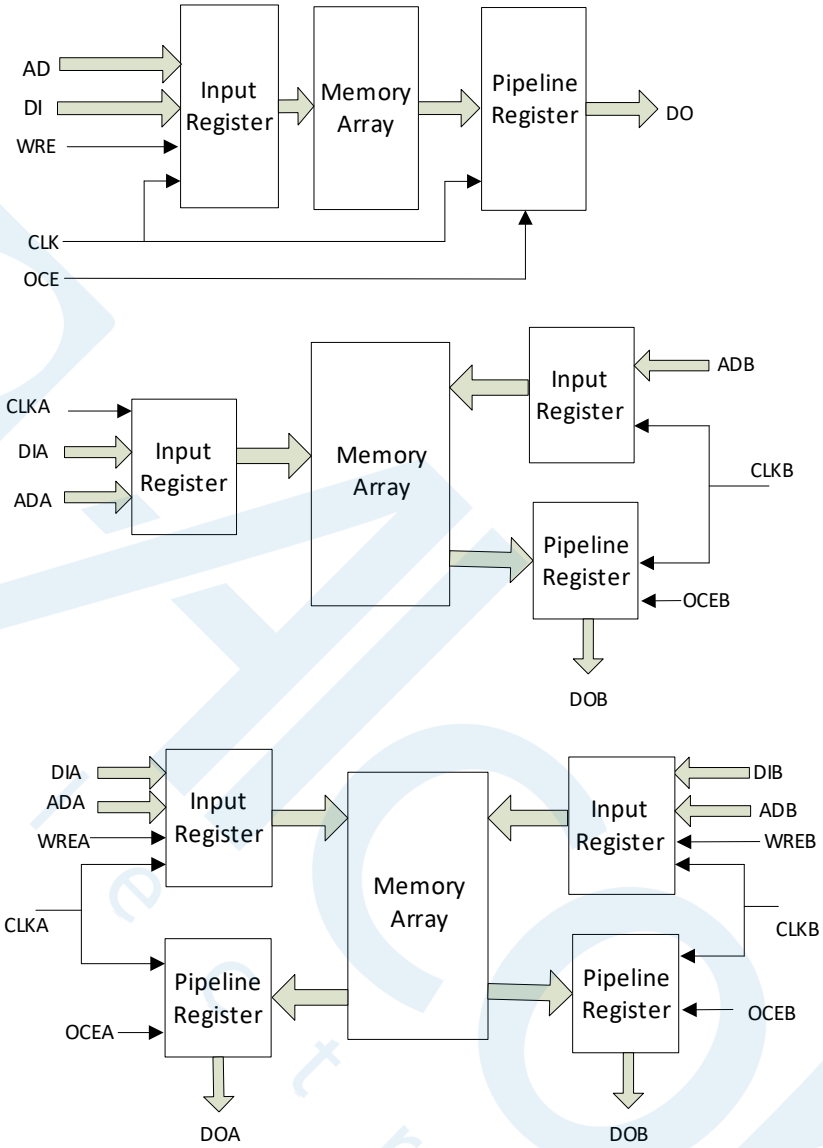
When a synchronous write cycles into a memory array with pipeline registers enabled, the data can be read from pipeline registers in the next clock cycle. The data bus can be up to 36 bits in this mode.

Bypass Mode

When a synchronous write cycles into a memory array with pipeline

registers bypassed, the outputs are registered at the memory array.

Figure 3-30 Pipeline Mode in Single Port, Dual Port and Semi Dual Port



Write Mode

NORMAL WRITE MODE

In this mode, when the user writes data to one port, and the output data of this port does not change. The data written in will not appear at the read port.

WRITE-THROUGH MODE

In this mode, when the user writes data to one port, and the data written in will also appear at the output of this port.

READ-BEFORE-WRITE MODE

In this mode, when the user writes data to one port, and the data written in will be stored in the memory according to the address. The original data in this address will appear at the output of this port.

3.4.9 Clock Operations

Table 3-8 lists the clock operations in different BSRAM modes:

Table 3-8 Clock Operations in Different BSRAM Modes

Clock Operations	Dual Port Mode	Semi-Dual Port Mode	Single Port Mode
Independent Clock Mode	Yes	No	No
Read/Write Clock Mode	Yes	Yes	No
Single Port Clock Mode	No	No	Yes

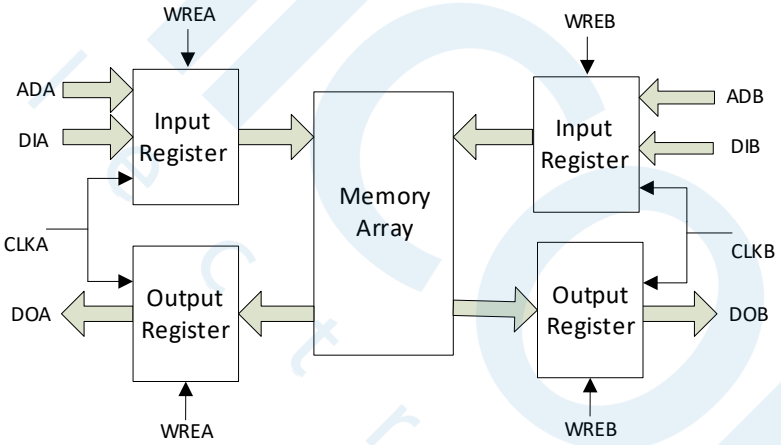
Note!

GW1N-1S does not support Dual Port Mode.

Independent Clock Mode

Figure 3-31 shows the independent clocks in the dual port mode with each port with one clock. CLKA controls all the registers at Port A; CLKB controls all the registers at Port B.

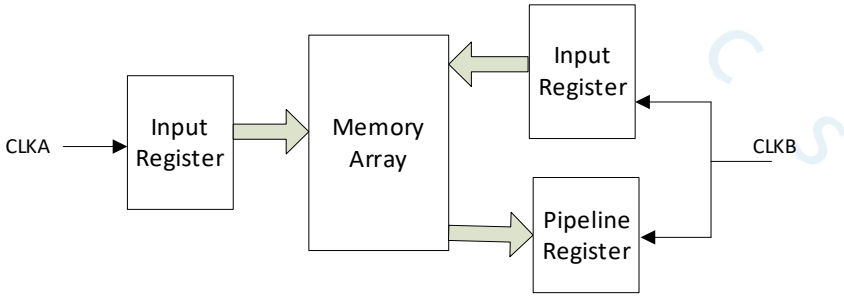
Figure 3-31 Independent Clock Mode



Read/Write Clock Operation

Figure 3-32 shows the read/write clock operations in the semi-dual port mode with one clock at each port. The write clock (CLKA) controls Port A data inputs, write address and read/write enable signals. The read clock (CLKB) controls Port B data output, read address, and read enable signals.

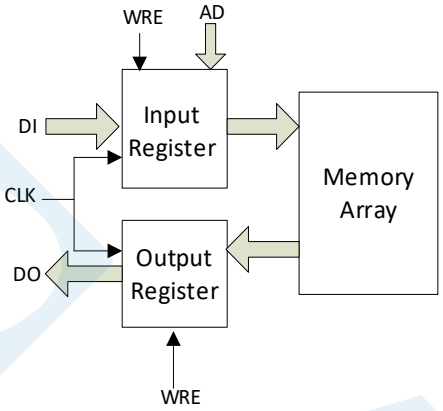
Figure 3-32 Read/Write Clock Mode



Single Port Clock Mode

Figure 3-33 shows the clock operation in single port mode.

Figure 3-33 Single Port Clock Mode



3.5 User Flash (GW1N-1 and GW1N-1S)

3.5.1 Introduction

GW1N-1 and GW1N-1S devices support User Flash with 12 Kbytes (48 page x 256 Bytes). The features are as following:

- 100,000 write cycles
- Greater than10 years Data Retention at +85 ℃
- Selectable 8/16/32 bits data-in and data-out
- Page size: 256 Bytes
- 3 μA standby current
- Page Write Time: 8.2 ms

3.5.2 Port Signal

See Figure 3-34 for GW1N-1 and GW1N-1S user flash:

Figure 3-34 GW1N-1/GW1N-1S User Flash Ports

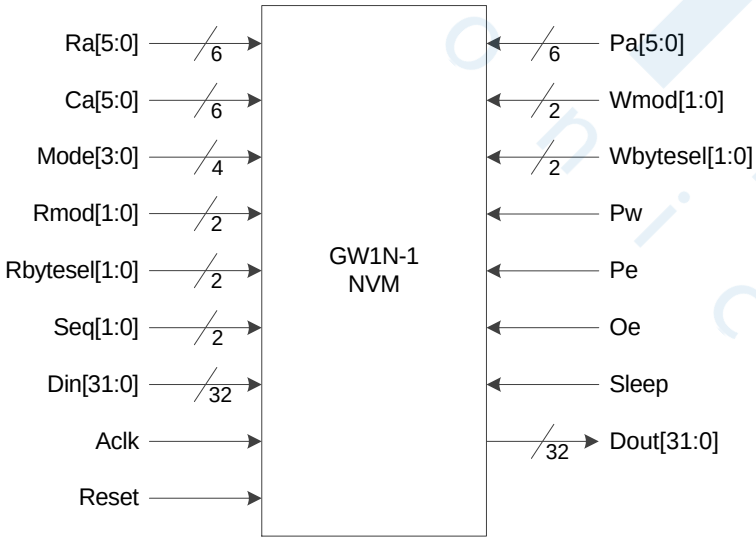


Table 3-9 Flash Module Signal Description

Pin name[1]	I/O	Description
Ra[5:0]	I	X address bus, used to select one row within memory block.
Ca[5:0]	I	Y address bus, used to select one column within memory block.
Pa[5:0][2]	I	I
Mode[3:0]	I	Select operation mode.
Seq[1:0]	I	Control operation sequence.
Aclk	I	Synchronize clock for read-write operations.
Rmod[1:0]	I	Read data bit width selection.
Wmod[1:0]	I	Write data bit width selection.
Rbytesel[1:0]	I	Read data byte selection.
Wbytesel[1:0]	I	Write data byte selection.
Pw	I	Write Page latch clock.
Reset[3]	I	Reset signal, active-high.
Pe	I	Charge pump enable.
Oe	I	Data output enable.
Sleep[4]	I	Sleep mode, active-high.
Din[31:0]	I	Data input bus.
Dout[31:0]	O	Data output bus.

Note!

- [1] Port names of Control, address, and data signals.
- [2] Pa signal has the same function as Ca signal, except that Pa signal is used for programming operation of page latch data, and Ca signal is used for other operations related to column selection in Flash.
- [3] The high-level effective time of reset signal is not less than 20ns. Wait for 6μs after that the reset signal changes to low-level, and then move on.
- [4] Save power through flash memory resources entering into sleep mode. Wait for 6μs after that the sleep signal changes to low-level, and then move on.

3.5.3 Data Output Bit Selection

Change data I/O bit width by Rmod/Wmod and Rbytesel/ Wbytesel. The correspondence between data bit width and control signal is shown in Table 3-10 and Table 3-11.

Table 3-10 Data Output Bit Selection

Rmod[1:0]	Rbytesel		Dout			
	[1]	[0]	[31:24]	[23:16]	[15:8]	[7:0]
00	√	√	×	×	×	√
01	√	×	×	×	√	√
1X	×	×	√	√	√	√

Table 3-11 Data Input Bit Selection

Wmod[1:0]	Wbytesel		Din			
	[1]	[0]	[31:24]	[23:16]	[15:8]	[7:0]
00	√	√	×	×	×	√
01	√	×	×	×	√	√
1X	×	×	√	√	√	√

Note!

"√" means valid input; "×"means invalid input.

3.5.4 Operation Mode

User can set Mode [3: 0] to select different operation modes, as shown in Table 3-12.

Table 3-12 Operation Modes Selection

Mode[3:0]	Description
0000	Normal read operation and page latch write operation
0001	Set pre-program and clear after any program cycle automatically
0100	Clear page latches
1000	Erase Page (or row)
1100	Program Page (or row)

3.5.5 Read Operation

When the Mode input is set as "0000", the User Flash enters into read operation mode at the rising edge of Aclk. Seq [1: 0] should be "00" for read operation mode. When the data access time (<= 38ns) is met, the data would be available on the output pin Dout.

3.5.6 Write Operation

The write operation of User Flash memory module includes five steps:

1. Clear page latches
2. Write data into the page latches;
3. Preprogram the selected memory location to pseudo "1";
4. Erase the selected memory location;
5. Program page latch contents into memory location.

After being erased, the data would be "0"; and after being programmed, the data would be "1". An erased location "0" can be programmed to "1", but a programmed location"1" cannot be programmed to "0", so erasing is always needed for a new write operation.

Write page latches

Page latch can be regarded as one page of SRAM that will be written into Flash memory. The operation of writing into page latches is controlled by Pw signal, independent of Aclk. Pa (Page Addresses) are used for addressing page latches.

Clear page latches should be done before writing. Write Page latches one by one, set Mode value as "0000", and Seq [1: 0] as "00". Write page latch and data read operation are completely independent.

Clear page latches

Unlike write page latches, clear page latches is controlled by Aclk. When the Mode input is set as "0100", the user flash enters into clear page latch mode at the rising edge of Aclk. In this mode, Seq [1: 0] should be "00" and page latch data will be cleared in one Aclk cycle.

Erase and Programming

Erase and Programming operation has to go through Seq sequence 1> 2> 3> 0, which are long operations requiring milliseconds. It is forbidden to program the same page twice after an erasure operation.

Before erasing and programming, pre-program all the selected memory locations to pseudo "1". To execute pre-program operation, set PEP (pre-program) first (Mode "0001"), and then program (Mode "1100") the selected locations with high-level duration in time of hundreds of microseconds.

3.6 User Flash (GW1N-2/4/9)

3.6.1 Introduction

GW1N-2/4/9 offers User Flash. The capacity of the User Flash in GW1N-2/4 is 256Kbits. The capacity of the User Flash in GW1N-9 is 608Kbits. The user Flash memory is composed of row memory and column memory. One row memory is composed of 64 column memories. The capacity of one column memory is 32 bits, and the capacity of one row memory is 64*32=2048 bits. Page erase is supported, and one page capacity is 2048 bytes, i.e., one page includes 8 rows. The features are shown below:

- 10,000 write cycles
- Greater than10 years Data Retention at +85 ℃
- Data Width: 32
- GW1N-2/4 capacity: 128 rows x 64 columns x 32 = 256kbits
- GW1N-9 capacity: 304 rows x 64 columns x 32 = 608kbits
- Page Erase Capability: 2,048 bytes per page
- Fast Page Erasure/Word Programming Operation
- Clock frequency: 40 MHz
- Word Programming Time:≤16 μs
- Page Erasure Time:≤120 ms
- Electric current
  - Read current/duration:2.19 mA/25 ns (V_{CC}) & 0.5 mA/25 ns (V_{CCX}) (MAX)
  - Program/Erase operation: 12/12 mA(MAX)

3.6.2 Port Signal

See Figure 3-35 for GW1N-2/4/9 user flash:

Figure 3-35 GW1N-2/4/9 Flash Port Signal

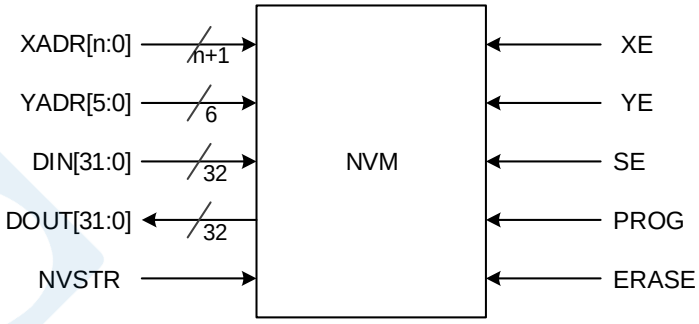


Table 3-13 Flash Module Signal Description

Pin name[1]	I/O	Description
XADR[5:0][2]	I	X address bus, used to access row address. XADR[n:3] is used to select one page; XADR[2:0] is used to select one row on one page. One page is composed of eight rows, and one row is composed of 64 columns. GW1N-2/4: 128 rows in all, n=6 GW1N-9: 304 rows in all, n=8
YADR[5:0][2]	I	Y address bus, used to select one column within a row of memory block. One row consists of 64 columns.
DIN[31:0]	I	Data input bus.
DOUT[31:0]	O	Data output bus.
XE[2]	I	X address enable signal, if XE is 0, all of the row addresses are not enabled.
YE[2]	I	Y address enable signal, if YE is 0, all of the column addresses are not enabled.
SE[2]	I	Detect amplifier enable signal, active high.
ERASE	I	Erase port, active-high.
PROG	I	Programming port, active-high.
NVSTR	I	Flash data storage port, active-high.

Note!

- [1] Port names of Control, address, and data signals.
- [2] The read operation is valid only if XE = YE = V_{CC} and SE meets the pulse timing requirements (T_{pws}, T_{nws}). The address of read data is determined by XADR [5: 0] and YADR [5: 0].

3.6.3 Operation Mode

Table 3-14 Truth Table in User Mode

Mode	XE	YE	SE	PROG	ERASE	NVSTR
Read Mode	H	H	H	L	L	L
Programming Mode	H	H	L	H	L	H
Page Erasure Mode	H	L	L	L	H	H

Note!

"H" and "L" means high level and low level of VCC.

3.7 DSP

3.7.1 Introduction

GW1N-4/9 devices offer abundant DSP modules. Gowin DSP solutions can meet user demands for high performance digital signal processing design, such as FIR, FFT, etc. DSP blocks have the advantages of stable timing performance, high-usage, and low-power.

DSP offers the following functions:

- Multiplier with three widths: 9-bit, 18-bit, 36-bit
- 54-bit ALU
- Multipliers cascading to support wider data
- Barrel shifter
- Adaptive filtering through signal feedback
- Computing with options to round to a positive number or a prime number
- Supports pipeline mode and bypass mode.

Macro

DSP blocks are embedded as rows in the FPGA array. Each DSP occupies nine CFU columns. Each DSP block contains two Macros, and each Macro contains two pre-adders, two 18 x 18 bit multipliers, and one three-input ALU.

Figure 3-36 shows the structure of one Macro.

Figure 3-36 DSP Macro

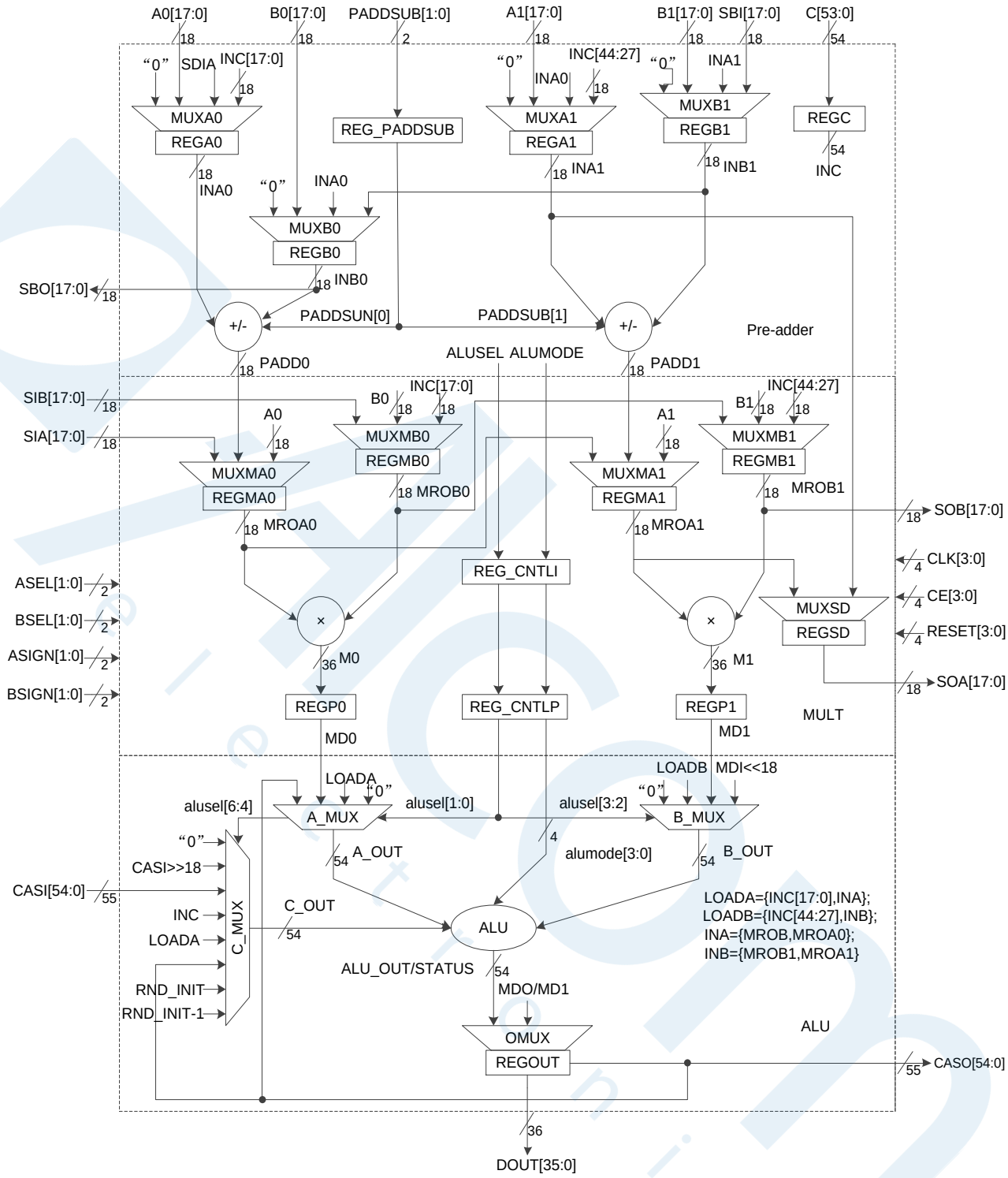


Table 3-15 shows DSP ports description. Table 3-16 shows internal registers.

Table 3-15 DSP Ports Description

Port Name	I/O	Description
A0[17:0]	I	18-bit data input A0

Port Name	I/O	Description
B0[17:0]	I	18-bit data input B0
A1[17:0]	I	18-bit data input A1
B1[17:0]	I	18-bit data input B1
C[53:0]	I	54-bit data input C
SIA[17:0]	I	Shift data input A, used for CASCADE connection. The input signal SIA is directly connected to the output signal SOA of previously adjacent DSP and the delay from SIA to SOA inside a DSP is one clock cycle.
SIB[17:0]	I	Shift data input B, used for CASCADE connection. The input signal SIB is directly connected to the output signal SOB of previously adjacent DSP and the delay from SIB to SOB inside a DSP is one clock cycle.
SBI[17:0]	I	Pre-adder logic shift input, backward direction.
CASI[54:0]	I	ALU input from previous DSP block, used for cascade connection.
ASEL[1:0]	I	Source select for Multiplier or pre-adder input A
BSEL[1:0]	I	Source select for Multiplier input B
ASIGN[1:0]	I	Sign bit for input A
BSIGN[1:0]	I	Sign bit for input B
PADDSUB[1:0]	I	Operation control signals of pre-adder, used for pre-adder logic add/subtract selection
CLK[3:0]	I	Clock input
CE[3:0]	I	Clock Enable
RESET[3:0]	I	Reset input, synchronous or asynchronous
SOA[17:0]	O	Shift data output A
SOB[17:0]	O	Shift data output B
SBO[17:0]	O	Pre-adder logic shift output, backward direction.
DOUT[35:0]	O	DSP output data
CASO[54:0]	O	ALU output to next DSP block for cascade connection, the highest bit is sign extended.

Table 3-16 Internal Registers Description

Register	Description and Associated Attributes
A0 register	Registers for A0 input
A1 register	Registers for A1 input
B0 register	Registers for B0 input
B1 register	Registers for B1 input
C register	Registers for C input
P1_A0 register	Registers for A0 input of left multiplier
P1_A1 register	Registers for A1 input of right multiplier
P1_B0 register	Registers for B0 input of left multiplier
P1_B1 register	Registers for B1 input of right multiplier

Register	Description and Associated Attributes
P2_0 register	Registers for pipeline of left multiplier
P2_1 register	Registers for pipeline of right multiplier
OUT register	Registers for DOUT output
OPMODE register	Registers for operation mode control
SOA register	Registers for shift output at port SOA

PADD

Each DSP macro features two units of pre-adders to implement pre-add, pre-subtraction, and shifting.

PADD locates at the first stage with two inputs.,

- Parallel 18-bit input B or SBI;
- Parallel 18-bit input A or SIA.

Note!

Each input end supports pipeline mode and bypass mode.

GOWINSEMI PADD can be used as a function block independently, which supports 9-bit and 18-bit width.

MULT

Multipliers locate after the pre-adder. Multipliers can be configured as 9 x 9, 18 x 18, 36 x 18 or 36 x 36. Register mode and bypass mode are supported both in input and output ports. The configuration modes that a macro supports include:

- One 18 x 36 multiplier
- Two 18 x 18 multipliers
- Four 9 x 9 multipliers

Note!

Two adjacent DSP macros can form a 36 x 36 multiplier.

ALU

Each Macro has one 54 bits ALU54, which can further enhance MULT's functions. The register mode and bypass mode are supported both in input and output ports. The functions are as following:

- Multiplier output data / 0, addition/subtraction operations for data A and data B;
- Multiplier output data / 0, addition/subtraction operations for data B and bit C;
- Addition/subtraction operations for data A, data B, and bit C;

3.7.2 DSP Operations

- Multiplier
- Accumulator
- MULTADDALU

3.8 MIPI D-PHY (GW1N-2)

Hard Core - MIPI D-PHY RX

GW1N-2 provides the hard core - MIPI D-PHY RX IP. This IP applies to the display serial interface (DSI), which is designed to receive and send image data or video data. MIPI D-PHY provides a physical layer definition.

Features are as follows:

- Supports MIPI Alliance Standard for D-PHY Specification, version 2.1;
- Interfaces to MIPI DSI, RX devices;
- Supports unidirectional High-speed (HS) mode;
- Supports bidirectional Low-power operation mode;
- Deserializes serial high-speed data into byte data packets;
- Supports MIPI D-PHY RX 1:8 mode and 1:16 mode;
- Supports MIPI IO;
- In HS mode, MIPI transmission speed can be up to 1.5 Gbps;
- In LP mode, the data transmission speed is 10Mbps;
- Supports up to 4 data lanes and one clock lane;
- IO Bank6 supports MIPI D-PHY RX.

Soft Core - MIPI D-PHY RX/TX

GW1N-2 also provides the soft core - MIPI D-PHY RX/TX IP. This IP applies to the display serial interface (DSI) and the camera serial interface (CSI), which are designed to receive and send image data or video data. MIPI D-PHY provides a physical layer definition.

Features are as follows:

- Supports MIPI Alliance Standard for D-PHY Specification, version 1.2;
- Interfaces to MIPI CSI2 and DSI, RX and TX devices;
- Supports unidirectional High-speed (HS) mode;
- Supports bidirectional Low-power operation mode;
- Deserializes serial high-speed data into byte data packets;
- Supports MIPI D-PHY RX 1:8 mode and 1:16 mode;
- Supports IO Types of ELVDS, TLVDS, and MIPI IO;
- IO Bank0, IO Bank3, IO Bank4, and IO Bank5 supports MIPI D-PHY TX, and the transmission speed can be up to 1.5 Gbps;
- IO Bank2 supports MIPI D-PHY RX, transmission speed can be up to 1.2Gbps;
- Supports up to 4 data lanes and one clock lane.

For further detailed information, please refer to *IPUG112, Gowin MIPI D-PHY RX TX user guide*.

3.9 Clock

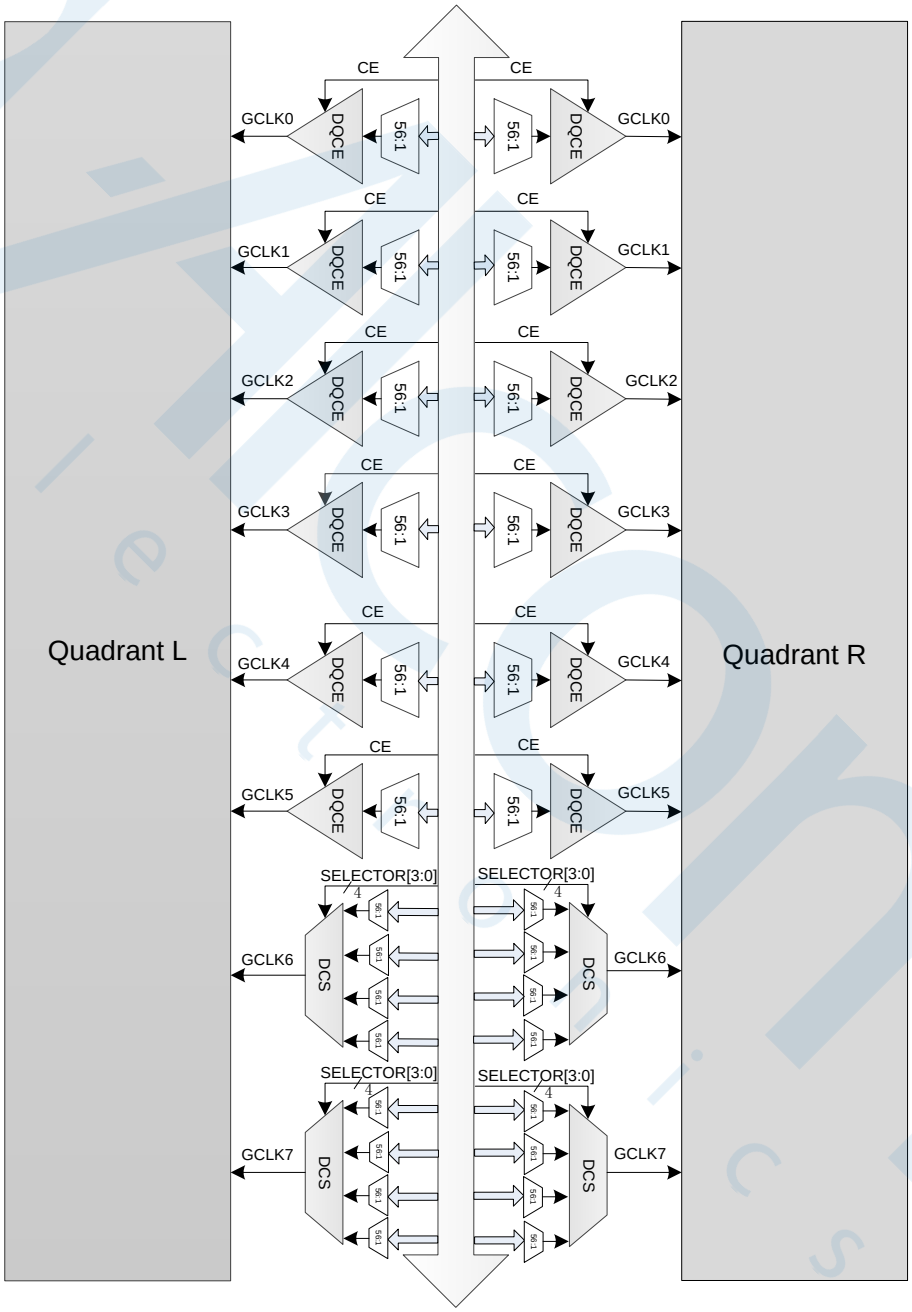
The clock resources and routing are critical to high-performance

applications in FPGA. The GW1N series of FPGA products provide the global clock network (GCLK) that is connected to all the registers directly. Besides the global clock network, the GW1N series of FPGA products provide high-speed clock HCLK, PLLs, etc.

3.9.1 Global Clock

The GCLK is distributed in GW1N-1 as two quadrants, L and R. Each quadrant provides eight GCLKs. The optional clock resources of GCLK can be pins or CRU. Users can employ dedicated pins as clock resources to achieve better timing.

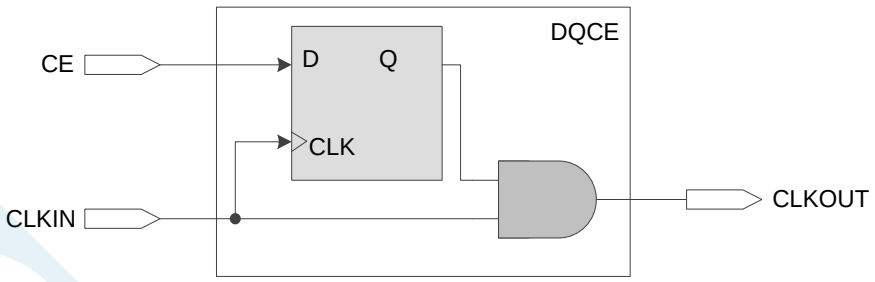
Figure 3-37 GCLK Quadrant Distribution



GCLK0~GCLK5 can be turned on or off by Dynamic Quadrant Clock Enable (DQCE). When GCLK0~GCLK5 in the quadrant is off, all the logic

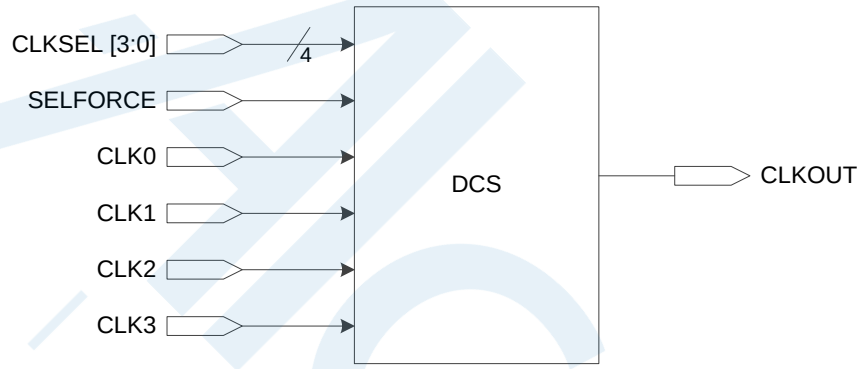
driven by it will not toggle; therefore, lower power can be achieved.

Figure 3-38 DQCE Concept



GCLK6~GCLK7 of each quadrant is controlled by the DCS, as shown in Figure 3-39. Select dynamically between CLK0~CLK3 by CRU, and output a glitch-free clock.

Figure 3-39 DCS Concept

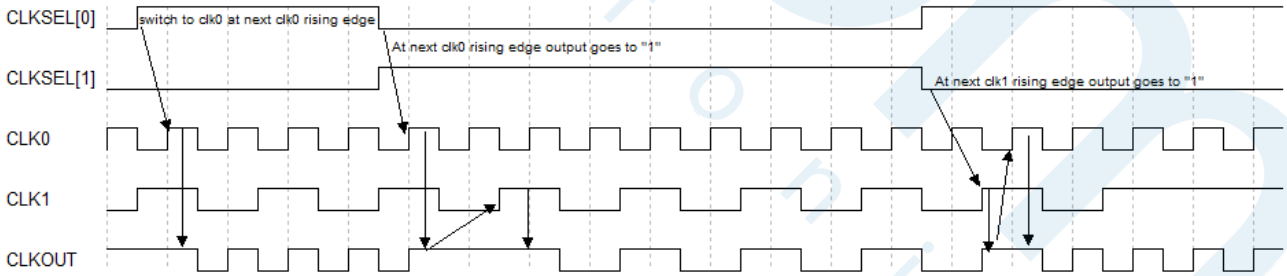


DCS can be configured into the following modes:

1. DCS Rising Edge

Stay as 1 after the rising edge of the currently selected clock, and the new clock will be effective after its first rising edge, as shown in Figure 3-40.

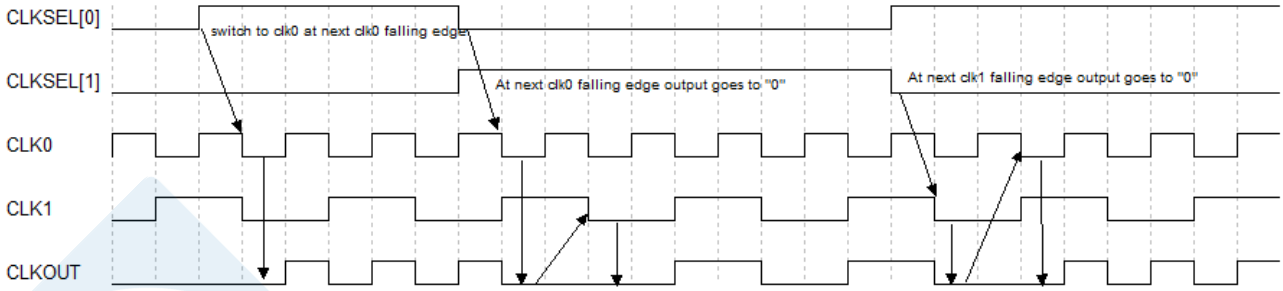
Figure 3-40 DCS Rising Edge



2. DCS Falling Edge

Stay as 0 after the falling edge of the currently selected clock, and the new clock will be effective after its first falling edge, as shown in Figure 3-41.

Figure 3-41 DCS Falling Edge



3. Clock Buffer Mode

In this mode, DCS acts as a clock buffer.

3.9.2 PLL

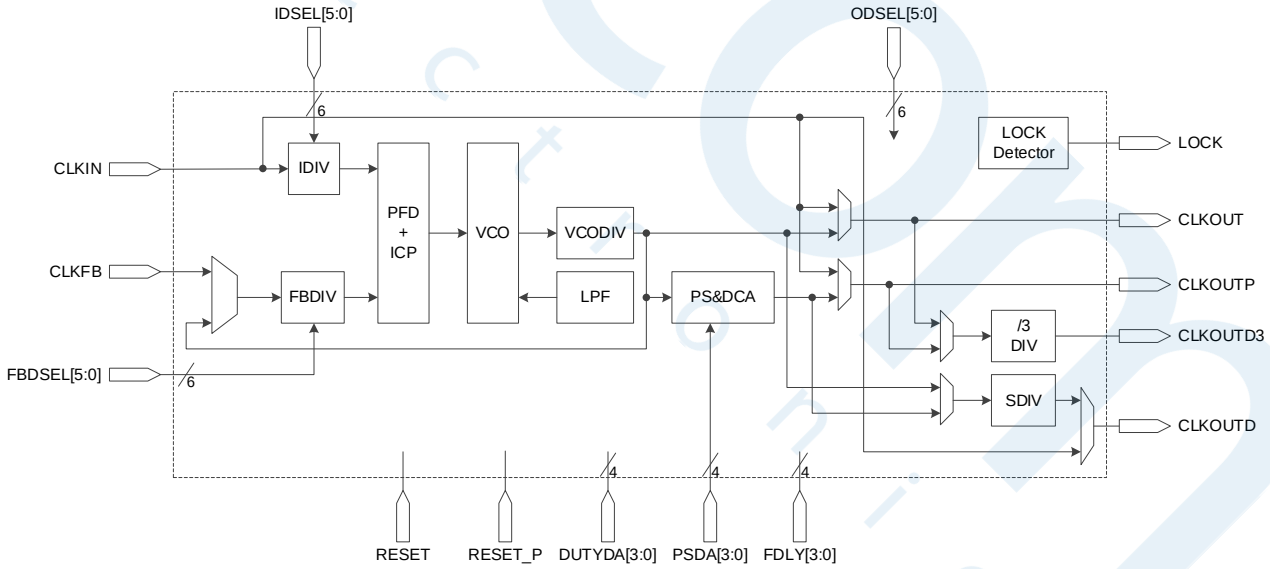
Phase-locked Loop (PLL) is a feedback control circuit. The frequency and phase of the internal oscillator signal are controlled by the external input reference clock.

GW1N PLL blocks in the GW1N series of FPGA products provide the ability to synthesize clock frequencies. Frequency adjustment (multiplication and division), phase adjustment, and duty cycle adjustment can be realized by parameters configuration.

GW1N-1/GW1N-1S/GW1N-4/GW1N-9

See Figure 3-42 for the PLL structure of GW1N-1 / GW1N-1S / GW1N-4 / GW1N-9.

Figure 3-42 PLL Structure (GW1N-1/GW1N-1S/GW1N-4/GW1N-9)



See Table 3-17 for a definition of the PLL ports.

Table 3-17 PLL Ports Definition

Port Name	Signal	Description
CLKIN	I	Reference clock input

Port Name	Signal	Description
CLKFB	I	Feedback clock input
RESET	I	PLL reset
RESET_P	I	PLL Power Down
IDSEL [5:0]	I	Dynamic IDIV control: 1~64
FBDSEL [5:0]	I	Dynamic FBDIV control:1~64
PSDA [3:0]	I	Dynamic phase control (rising edge effective)
DUTYDA [3:0]	I	Dynamic duty cycle control (falling edge effective)
FDLY[3:0]	I	CLKOUTP dynamic delay control
CLKOUT	O	Clock output with no phase and duty cycle adjustment
CLKOUTP	O	Clock output with phase and duty cycle adjustment
CLKOUTD	O	Clock divider from CLKOUT and CLKOUTP (controlled by SDIV)
CLKOUTD3	O	clock divider from CLKOUT and CLKOUTP (controlled by DIV3 with the constant division value 3)
LOCK	O	PLL lock status: 1: locked, 0: unlocked

The PLL reference clock source can come from an external PLL pin or from internal routing GCLK, HCLK, or general data signal. PLL feedback signal can come from the external PLL feedback input or from internal routing GCLK, HCLK, or general data signal.

For PLL features of GW1N-1/4/9/1S, please refer to Table 4-21 PLL Parameters.

PLL can adjust the frequency of the input clock CLKIN (multiplication and division). The formulas for doing so are as follows:

1. fCLKOUT = (fCLKIN*FBDIV)/IDIV
2. fVCO = fCLKOUT*ODIV
3. fCLKOUTD = fCLKOUT/SDIV
4. fPFD = fCLKIN/IDIV = fCLKOUT/FBDIV

Note!

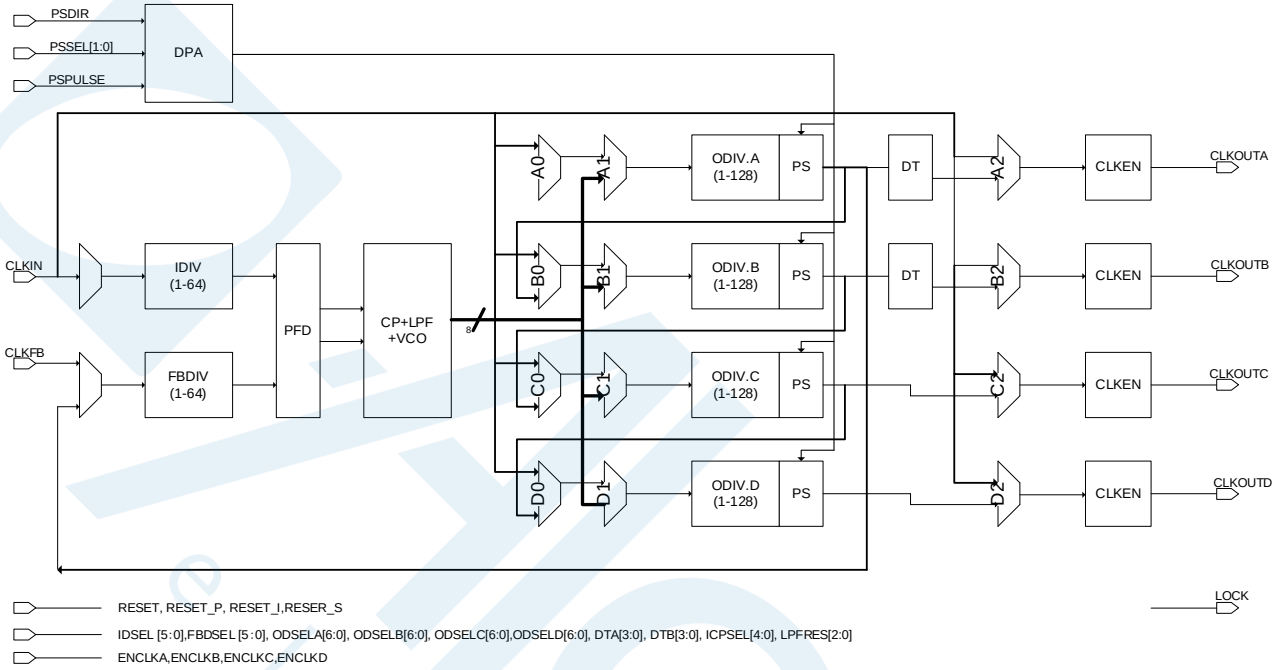
- fCLKIN: The frequency of the input clock CLKIN
- fCLKOUT: The clock frequency of CLKOUT and CLKOUTP
- fCLKOUTD: The clock frequency of CLKOUTD, and CLKOUTD is the clock CLKOUT after division
- fPFD: PFD Phase Comparison Frequency, and the minimum value of fPFD should be no less than 3MHz.

Adjust IDIV, FBDIV, ODIV, and SDIV to achieve the required clock frequency.

GW1N-2

SeeFigure 3-44 for the PLL structure of GW1N-2.

Figure 3-43 PLL Structure (GW1N-2)



See Table 3-18 for a definition of the PLL ports.

Table 3-18 PLL Ports Definition

Port Name	Signal	Description
CLKIN	I	Reference clock input
CLKFB	I	Feedback clock input
RESET	I	PLL reset
RESET_P	I	PLL Power Down
RESET_I	I	PLL with IDIV reset
RESET_S	I	Only Channel B/C/D reset
IDSEL [5:0]	I	Dynamic IDIV control: 1~64
FBDSEL [5:0]	I	Dynamic FBDIV control:1~64
ODSELA[6:0]	I	Dynamic ODIVA control:1~128
ODSELB[6:0]	I	Dynamic ODIVB control:1~128
ODSELC[6:0]	I	Dynamic ODIVC control:1~128
ODSELD[6:0]	I	Dynamic ODIVD control:1~128
DTA[3:0]	I	Dynamic control of CLKOUTA dutycycle

Port Name	Signal	Description
DTB[3:0]	I	Dynamic control of CLKOUTB dutycycle
ICPSEL[4:0]	I	Dynamic control of ICP size
LPFRES[2:0]	I	Dynamic control LPFRES size
PSDIR	I	Dynamic control of phase shift direction
PSSEL[1:0]	I	Dynamic control of phase shift channel selection
PSPULSE	I	Dynamic control of phase shift clock
ENCLKA ENCLKB ENCLKC ENCLKD	O	Dynamic control of clock output enable
CLKOUTA	O	Clock output of Channel A (by default)
CLKOUTB	O	Clock output of Channel B (by default)
CLKOUTC	O	Clock output of Channel C (by default)
CLKOUTD	O	Clock output of Channel D (by default)

The PLL reference clock source can come from an external PLL pin or from internal routing GCLK, HCLK, or general data signal. PLL feedback signal can come from the external PLL feedback input or from internal routing GCLK, HCLK, or general data signal.

For PLL features of GW1N-2, please refer to Table 4-21 PLL Parameters.

PLL can adjust the frequency of the input clock CLKIN (multiplication and division). The formulas for doing so are as follows:

1. **fCLKOUTA = (fCLKIN*FBDIV)/IDIV**
2. **fVCO = fCLKOUTA*ODIVA**
3. **fCLKOUTx = fIN_ODIVx/ODIVx**
4. **fPFD = fCLKIN/IDIV=fCLKOUTA/FBDIV**

Note!

- fCLKIN: The frequency of the input clock CLKIN
- fCLKOUTx: The output clock frequency of channel X, x=A/B/C/D.
- ODIVx: The Output frequency division coefficient of channel X, x=A/B/C/D.
- fIN_ODIVx: The input clock frequency of ODIVx, x=A/B/C/D, and fvco is defaulted. It's determined by the actual circuit if the Chanel is cascaded.
- fPFD: PFD Phase Comparison Frequency, and the minimum value of fPFD should be no less than 3MHz.

Adjust IDIV, FBDIV, and ODIV to achieve the required clock frequency.

3.9.3 HCLK

HCLK is the high-speed clock in the GW1N series of FPGA products, which can support high-speed data transfer and is mainly suitable for

source synchronous data transfer protocols. See Figure 3-44, Figure 3-45, Figure 3-46, Figure 3-47, and Figure 3-48.

Note!

The features of the HCLK in GW1N-1 and GW1N-4 are the same; the features of the HCLK in GW1N-1S and GW1N-9 are slightly different.

Figure 3-44 GW1N-1 HCLK Distribution

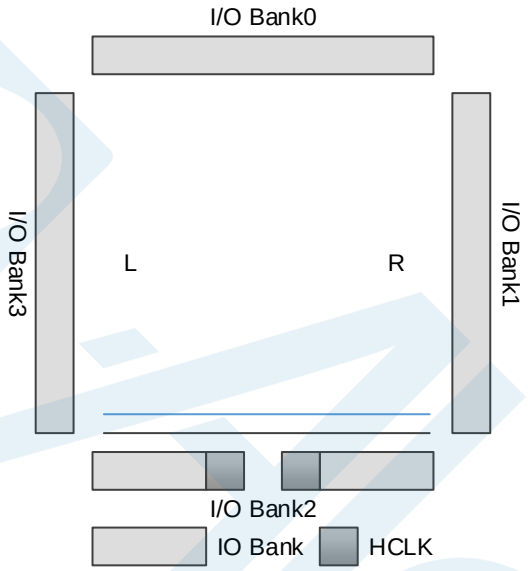


Figure 3-45 GW1N-2 HCLK Distribution

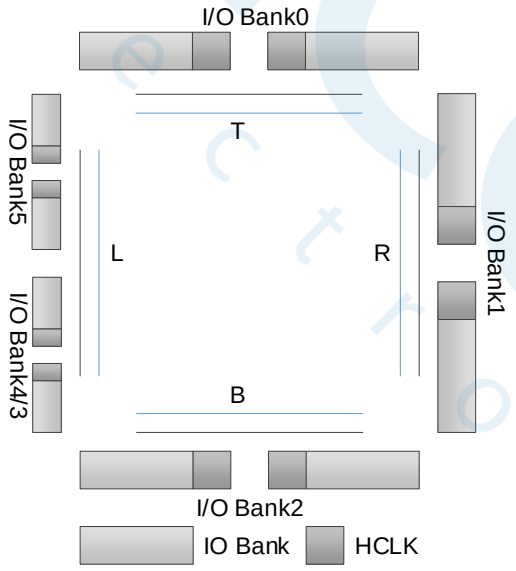


Figure 3-46 GW1N-4 HCLK Distribution

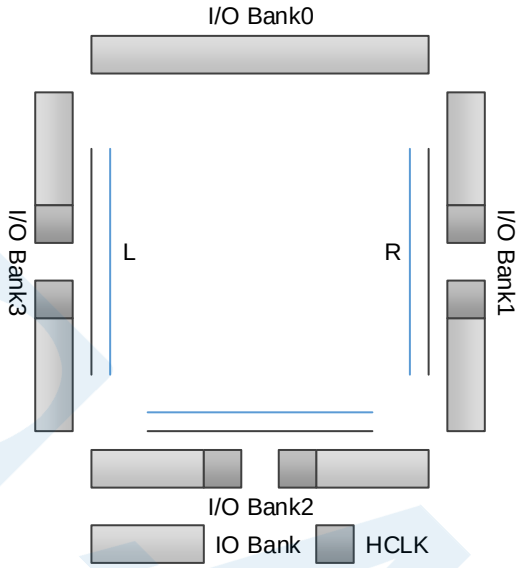


Figure 3-47 GW1N-9 HCLK Distribution

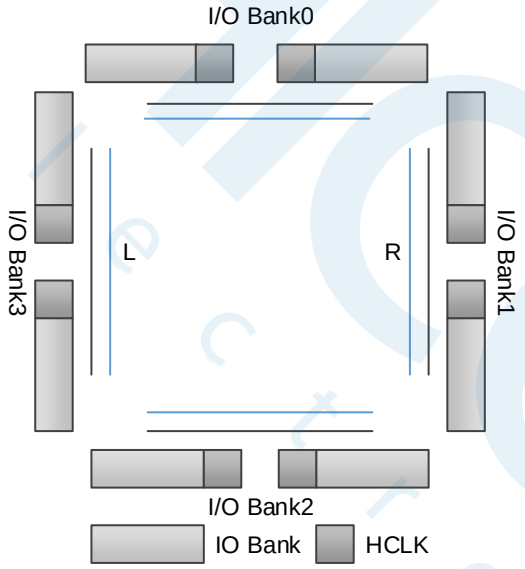
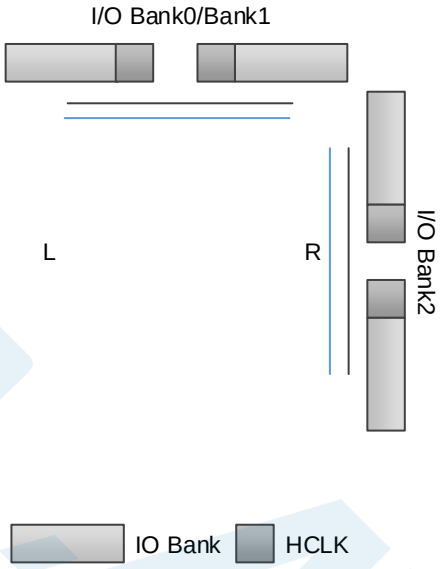


Figure 3-48 GW1N-1S HCLK Distribution



3.10 Long Wire (LW)

As a supplement to CRU, the GW1N series of FPGA products provide another routing resource- Long Wire, which is suitable for clock, clock enable, set/reset, or other high fan out signals.

3.11 Global Set/Reset (GSR)

A global set/rest (GSR) network is built in the GW1N series of FPGA product. There is a direct connection to core logic. It can be used as asynchronous/synchronous set or asynchronous/synchronous reset. The registers in CFU and I/O can be individually configured to use GSR.

3.12 Programming Configuration

The GW1N series of FPGA products support SRAM and Flash. The Flash programming mode supports on-chip Flash and off-chip Flash. The GW1N series of FPGA products support DUAL BOOT, providing a selection for users to backup data to off-chip Flash according to requirements.

Besides JTAG, the GW1N series of FPGA products also support GOWINSEMI own configuration mode: GowinCONFIG (AUTO BOOT, SSPI, MSPI, DUAL BOOT, SERIAL, CPU, and I2C Slave. All the devices support JTAG and AUTO BOOT. For more detailed information, please refer to UG290, *Gowin FPGA Products Programming and Configuration User Guide*.

3.12.1 SRAM Configuration

When you adopt SRAM to configure the device, and each time the device is powered on, it needs to download the bit stream file to configure.

3.12.2 Flash Configuration

The Flash configuration data is stored in the on-chip flash. Each time the device is powered on, the configuration data is transferred from the

Flash to the SRAM, which controls the working of the device. This mode can complete configuration within a few ms, and is referred to as “Quick Start”.

B version of GW1N devices has the feature of transparent transmission. That is to say, the B version device can program the on-chip Flash or off-chip Flash via the JTAG interface without affecting the current working state. During programming, the B version device works according to the previous configuration. After programming, provide one low pulse for RECONFIG_N to complete the online upgrade. This feature applies to the applications with long online time and irregular upgrades.

The GW1N series of FPGA products also support off-chip Flash configuration and dual-boot. Please refer to UG290, *Gowin FPGA Products Programming and Configuration User Guide* for more detailed information.

3.13 On Chip Oscillator

There is an internal oscillator in each of the GW1N series of FPGA product. The on-chip oscillator supports the clock frequencies ranging from 2.5 MHz to 125MHz. It provides programmable user clock with clock precision ±5%. During the configuration process, it can provide a clock for MSPI mode.

The on-chip oscillator also provides a clock resource for user designs. Up to 64 clock frequencies can be obtained by setting the parameters.

The following formula is used to get GW1N-1/1S/2/9 output clock frequency: fout=250MHz/Param.

The following formula is used to get GW1N-4 output clock frequency: fout=210MHz/Param

Note!

“Param” is the configuration parameter with a range of 2~128. It supports even numbers only.

See Table 3-19 for GW1N-1/1S/2/9 output frequency; see Table 3-20 for GW1N-4 output frequency.

Table 3-19 GW1N-4 Oscillator Output Frequency Options

Mode	Frequency	Mode	Frequency	Mode	Frequency
0	2.1MHz[1]	8	6.6MHz	16	13.1MHz
1	4.6MHz	9	7MHz	17	15MHz
2	4.8MHz	10	7.5MHz	18	17.5MHz
3	5MHz	11	8.1MHz	19	21MHz
4	5.3MHz	12	8.8MHz	20	26.3MHz
5	5.5MHz	13	9.5MHz	21	35MHz
6	5.8MHz	14	10.5MHz	22	52.5MHz
7	6.2MHz	15	11.7MHz	23	105MHz[2]

Table 3-20 GW1N-1/1S/2/9 Oscillator Output Frequency Options

Mode	Frequency	Mode	Frequency	Mode	Frequency
0	2.5MHz[1]	8	7.8MHz	16	15.6MHz
1	5.4MHz	9	8.3MHz	17	17.9MHz
2	5.7MHz	10	8.9MHz	18	21MHz
3	6.0MHz	11	9.6MHz	19	25MHz
4	6.3MHz	12	10.4MHz	20	31.3MHz
5	6.6MHz	13	11.4MHz	21	41.7MHz
6	6.9MHz	14	12.5MHz	22	62.5MHz
7	7.4MHz	15	13.9MHz	23	125MHz[2]

Note!

- [1] Default frequency
- [2] 125MHz is not suitable for MSPI.

4 AC/DC Characteristic

Note!

Please ensure that you use GOWINSEMI devices within the recommended operating conditions and range. Data beyond the working conditions and range are for reference only. GOWINSEMI does not guarantee that all devices will operate normally beyond the operating conditions and range.

4.1 Operating Conditions

4.1.1 Absolute Max. Ratings

Table 4-1 Absolute Max. Ratings

Name	Description	Min.	Max.
V_{CC}	LV: Core Power	-0.5V	1.32V
	UV: Core Power	-0.5V	3.75V
V_{CCO}	I/O Bank Power	-0.5V	3.75V
V_{CCX}	Auxiliary voltage	-0.5V	3.75V
Storage Temperature	Storage Temperature	-65℃	+150℃
Junction Temperature	Junction Temperature	-40℃	+125℃

4.1.2 Recommended Operating Conditions

Table 4-2 Recommended Operating Conditions

Name	Description	Min.	Max.
V_{CC}	LV: Core Power	1.14V	1.26V
	UV: Core Power	1.71V	3.465V
V_{CCO}	I/O Bank Power	1.14V	3.465V
V_{CCX}	Auxiliary voltage	2.375V	3.465V
T_{JCOM}	Junction temperature (Commercial operation)	0℃	+85℃
T_{JIND}	Junction temperature (Industrial operation)	-40℃	+100℃
T_{JAUT}	Junction temperature (Automotive operation)	-40℃	+105℃

Note!

- For some packages, V_{CCO} and V_{CCX} may share one pin. In this case, V_{CCX} requirements must be met first.
- For further power supply info, please refer to *UG107, GW1N-1 Pinout, UG169, GW1N-1S Pinout*, *UG171, GW1N-2 Pinout*, *UG105, GW1N-4 Pinout,* and *UG114, GW1N-9 Pinout.*

4.1.3 Power Supply Ramp Rate

Table 4-3 GW1N-1/GW1N-1S Power Supply Ramp Rate

名称	描述	器件	最小值	典型值	最大值
T_{RAMP}	Power supply ramp rates for core voltage	GW1N-1/GW1N-1S	1.2mV/μs	-	40mV/μs
		GW1N-2/4/9	0.6mV/μs	-	6mV/μs
T_{RAMP_VCCx}	Power supply ramp rates for VCCX	GW1N	0.6mV/μs	-	10mV/us
T_{RAMP_VCCIO}	Power supply ramp rates for VCCIO	GW1N	0.6mV/μs	-	10mV/us

4.1.4 Hot Socket Specifications

Table 4-4 Hot Socket Specifications

Name	Description	Condition	I/O Type	Max.
I_{HS}	Input or I/O leakage current	$0<V_{IN}<V_{IH}(MAX)$	I/O	150uA
I_{HS}	Input or I/O leakage current	$0<V_{IN}<V_{IH}(MAX)$	TDI,TDO, TMS,TCK	120uA

4.1.5 POR Feature

Table 4-5 POR Voltage

Name	Description	Name	Min.	Max.
POR Voltage	Power on reset voltage of Vcc	VCC	0.75	1
		VCCX	1.8	2
		VCCIO	0.85	0.98

4.2 ESD

Table 4-6 GW1N ESD - HBM

Device	GW1N-1	GW1N-2	GW1N-4	GW1N-9	GW1N-1S
LQ100	HBM>1,000V	-	HBM>1,000V	HBM>1,000V	-
LQ100X	HBM>1,000V	HBM>1,000V	-	-	-
LQ144	-	-	-	-	-
LQ144X	-	HBM>1,000V	-	-	-
EQ144	HBM>1,000V	-	HBM>1,000V	HBM>1,000V	-
LQ176	-	-	-	HBM>1,000V	-
EQ176	-	-	-	HBM>1,000V	-
MG100	-	-	-	HBM>1,000V	-
MG132X	-	HBM>1,000V	HBM>1,000V	-	-
MG160	-	-	HBM>1,000V	HBM>1,000V	-
MG196	-	-	-	HBM>1,000V	-
PG256	-	-	HBM>1,000V	HBM>1,000V	-
PG256M	-	-	HBM>1,000V	-	-
UG169	-	-	-	HBM>1,000V	-
UG256	-	-	-	HBM>1,000V	-
UG332	-	-	-	HBM>1,000V	-
QN32	HBM>1,000V	-	HBM>1,000V	-	-
QN48	HBM>1,000V	-	HBM>1,000V	HBM>1,000V	-
QN48M	-	HBM>1,000V	-	-	-
QN48F	-	-	-	HBM>1,000V	-
CS30	HBM>1,000V	-	-	-	-
CS42	-	HBM>1,000V	-	-	-
CS72	-	-	HBM>1,000V	-	-
CS81M	-	-	-	HBM>1,000V	

Device	GW1N-1	GW1N-2	GW1N-4	GW1N-9	GW1N-1S
QN88	-	-	HBM>1,000V	HBM>1,000V	-
FN32	-	-	-	-	HBM>1,000V

Table 4-7 GW1N ESD - CDM

Device	GW1N-1	GW1N-2	GW1N-4	GW1N-9	GW1N-1S
LQ100	CDM>500V	-	CDM>500V	CDM>500V	-
LQ100X	CDM>500V	CDM>500V	-	-	-
LQ144	CDM>500V	-	CDM>500V	CDM>500V	-
LQ144X	-	CDM>500V	-	-	-
EQ144	CDM>500V	-	CDM>500V	CDM>500V	-
LQ176	-	-	-	CDM>500V	-
EQ176	-	-	-	CDM>500V	-
MG100	-	-	-	CDM>500V	-
MG132X	-	CDM>500V	CDM>500V	-	-
MG160	-	-	CDM>500V	CDM>500V	-
MG196	-	-	-	CDM>500V	-
PG256	-	-	CDM>500V	CDM>500V	-
PG256M	-	-	CDM>500V	-	-
UG169				CDM>500V	
UG256	-	-	-	CDM>500V	-
UG332	-	-	-	CDM>500V	-
QN32	CDM>500V	-	-	-	-
QN48	CDM>500V	-	CDM>500V	CDM>500V	-
QN48M	-	CDM>500V	-	-	-
QN48F	-	-	-	CDM>500V	-
CS30	CDM>500V		-	-	-
CS42	-	CDM>500V	-	-	-
CS72	-	-	CDM>500V	-	-
CS81M	-	-	-	CDM>500V	-
QN88	-	-	CDM>500V	CDM>500V	-
FN32	-	-	-	-	CDM>500V

4.3 DC Characteristic

4.3.1 DC Electrical Characteristics over Recommended Operating Conditions

Table 4-8 DC Electrical Characteristics over Recommended Operating Conditions

Name	Description	Condition	Min.	Typ.	Max.
I_{IL},I_{IH}	Input or I/O leakage	$V_{CCO}<V_{IN}<V_{IH}$ (MAX)	-	-	210 µA
		$0V<V_{IN}<V_{CCO}$	-	-	10 µA
I_{PU}	I/O Active Pull-up Current	$0<V_{IN}<0.7V_{CCO}$	-30 µA	-	-150 µA
I_{PD}	I/O Active Pull-down Current	V_{IL} (MAX)$<V_{IN}<V_{CCO}$	30 µA	-	150 µA
I_{BHLS}	Bus Hold Low Sustaining Current	$V_{IN}=V_{IL}$ (MAX)	30 µA	-	-
I_{BHHS}	Bus Hold High Sustaining Current	$V_{IN}=0.7V_{CCO}$	-30 µA	-	-
I_{BHLO}	Bus Hold Low Overdrive Current	$0\le V_{IN}\le V_{CCO}$	-	-	150 µA
I_{BHHO}	Bus Hold High Overdrive Current	$0\le V_{IN}\le V_{CCO}$	-	-	-150 µA
V_{BHT}	Bus hold trip points		V_{IL} (MAX)	-	V_{IH} (MIN)
C1	I/O Capacitance			5 pF	8 pF
V_{HYST}	Hysteresis for Schmitt Trigger inputs	V_{CCO}=3.3V, Hysteresis= Large	-	482mV	-
		V_{CCO}=2.5V, Hysteresis= Large	-	302mV	-
		V_{CCO}=1.8V, Hysteresis= Large	-	152mV	-
		V_{CCO}=1.5V, Hysteresis= Large	-	94mV	-
		V_{CCO}=3.3V, Hysteresis= Small	-	240mV	-
		V_{CCO}=2.5V, Hysteresis= Small	-	150mV	-
		V_{CCO}=1.8V, Hysteresis= Small	-	75mV	-
		V_{CCO}=1.5V, Hysteresis= Small	-	47mV	-

4.3.2 Static Current

Table 4-9 Static Current

Device	Name	Description	LV/UV	Typ. (mA)	Max.(mA)
GW1N-1	I_{CC}	Core 电源电流(V_{CC}=1.2V)	LV	1.8	–
	I_{CCX}	V_{CCX} 电源电流(V_{CCX}=3.3V)	LV	1	–
	I_{CCO}	I/O Bank 电源电流(V_{CCO}=2.5V)	LV	0.8	–

GW1N-4	I_{CC}	Core 电源电流 (VCC=1.2V)	LV/UV	2.8	–
	I_{CCX}	V_{CCX} 电源电流(V_{CCX}=3.3V)	LV/UV	1.15	–
	I_{CCO}	I/O Bank 电源电流(V_{CCO}=2.5V)	LV/UV	0.55	–
GW1N-9	I_{CC}	Core 电源电流(VCC=1.2V)	LV/UV	3.5	–
	I_{CCX}	V_{CCX} 电源电流(V_{CCX}=3.3V)	LV/UV	5	–
	I_{CCO}	I/O Bank 电源电流(V_{CCO}=2.5V)	LV/UV	2	–

4.3.3 Programming Current

Table 4-10 Programming Current

Device	Description	LV/UV	Typ. (mA)	Max.(mA)
GW1N-1	Core current when programming Flash (V_{CC}=1.2V)	LV	–	1.9
	V_{CCX} current when programming Flash (V_{CCX}=3.3V)	LV	–	2.74
	I/O Bank current when programming Flash (V_{CCO}=2.5V)	LV	0.06	–
GW1N-4	Core current when programming Flash (V_{CC}=1.2V)	LV	–	–
	V_{CCX} current when programming Flash (V_{CCX}=3.3V)	LV	–	–
	I/O Bank current when programming Flash (V_{CCO}=2.5V)	LV	–	–
GW1N-9	Core current when programming Flash (V_{CC}=1.2V)	LV		–
	V_{CCX} current when programming Flash (V_{CCX}=3.3V)	LV	–	–
	I/O Bank current when programming Flash (V_{CCO}=2.5V)	LV	–	–

4.3.4 I/O Operating Conditions Recommended

Table 4-11 I/O Operating Conditions Recommended

Name	Output V_{CCO} (V)			Input V_{REF} (V)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
LVTTL33	3.135	3.3	3.465	-	-	-
LVCMOS33	3.135	3.3	3.465	-	-	-
LVCMOS25	2.375	2.5	2.625	-	-	-
LVCMOS18	1.71	1.8	1.89	-	-	-
LVCMOS15	1.425	1.5	1.575	-	-	-
LVCMOS12	1.14	1.2	1.26	-	-	-
SSTL15	1.425	1.5	1.575	0.68	0.75	0.9
SSTL18_I	1.71	1.8	1.89	0.833	0.9	0.969

Name	Output V_{CCO} (V)			Input V_{REF} (V)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
SSTL18_II	1.71	1.8	1.89	0.833	0.9	0.969
SSTL25_I	2.375	2.5	2.645	1.15	1.25	1.35
SSTL25_II	2.375	2.5	2.645	1.15	1.25	1.35
SSTL33_I	3.135	3.3	3.465	1.3	1.5	1.7
SSTL33_II	3.135	3.3	3.465	1.3	1.5	1.7
HSTL18_I	1.71	1.8	1.89	0.816	0.9	1.08
HSTL18_II	1.71	1.8	1.89	0.816	0.9	1.08
HSTL15	1.425	1.5	1.575	0.68	0.75	0.9
PCI33	3.135	3.3	3.465	-	-	-
LVPECL33E	3.135	3.3	3.465	-	-	-
MLVDS25E	2.375	2.5	2.625	-	-	-
BLVDS25E	2.375	2.5	2.625	-	-	-
RSDS25E	2.375	2.5	2.625	-	-	-
LVDS25E	2.375	2.5	2.625	-	-	-
SSTL15D	1.425	1.5	1.575	-	-	-
SSTL18D_I	1.71	1.8	1.89	-	-	-
SSTL18D_II	1.71	1.8	1.89	-	-	-
SSTL25D_I	2.375	2.5	2.625	-	-	-
SSTL25D_II	2.375	2.5	2.625	-	-	-
SSTL33D_I	3.135	3.3	3.465	-	-	-
SSTL33D_II	3.135	3.3	3.465	-	-	-
HSTL15D	1.425	1.575	1.89	-	-	-
HSTL18D_I	1.71	1.8	1.89	-	-	-
HSTL18D_II	1.71	1.8	1.89	-	-	-

4.3.5 IOB Single - Ended DC Electrical Characteristic

Table 4-12 IOB Single - Ended DC Electrical Characteristic

Name	V_{IL}		V_{IH}		V_{OL} (Max)	V_{OH} (Min)	I_{OL} (mA)	I_{OH} (mA)
	Min	Max	Min	Max				
LVCMOS33 LVTTL33	-0.3V	0.8V	2.0V	3.6V	0.4V	V_{CCO}-0.4V	4	-4
							8	-8
							12	-12

Name	V_{IL}		V_{IH}		V_{OL} (Max)	V_{OH} (Min)	I_{OL} (mA)	I_{OH} (mA)
	Min	Max	Min	Max				
							16	-16
							24	-24
					0.2V	V_{CCO}-0.2V	0.1	-0.1
LVCMOS25	-0.3V	0.7V	1.7V	3.6V	0.4V	V_{CCO}-0.4V	4	-4
							8	-8
							12	-12
							16	-16
					0.2V	V_{CCO}-0.2V	0.1	-0.1
LVCMOS18	-0.3V	0.35 x V_{CCO}	0.65 x V_{CCO}	3.6V	0.4V	V_{CCO}0.4V	4	-4
							8	-8
							12	-12
					0.2V	V_{CCO}-0.2V	0.1	-0.1
LVCMOS15	-0.3V	0.35 x V_{CCO}	0.65 x V_{CCO}	3.6V	0.4V	V_{CCO}-0.4V	4	-4
							8	-8
					0.2V	V_{CCO}-0.2V	0.1	-0.1
LVCMOS12	-0.3V	0.35 x V_{CCO}	0.65 x V_{CCO}	3.6V	0.4V	V_{CCO}-0.4V	2	-2
							6	-6
					0.2V	V_{CCO}-0.2V	0.1	-0.1
PCI33	-0.3V	0.3 x V_{CCO}	0.5 x V_{CCO}	3.6V	0.1 x V_{CCO}	0.9 x V_{CCO}	1.5	-0.5
SSTL33_I	-0.3V	V_{REF}-0.2V	V_{REF}+0.2V	3.6V	0.7	V_{CCO}-1.1V	8	-8
SSTL25_I	-0.3V	V_{REF}-0.18V	V_{REF}+0.18V	3.6V	0.54V	V_{CCO}-0.62V	8	-8
SSTL25_II	-0.3V	V_{REF}-0.18V	V_{REF}+0.18V	3.6V	NA	NA	NA	NA
SSTL18_II	-0.3V	V_{REF}-0.125V	V_{REF}+0.125V	3.6V	NA	NA	NA	NA
SSTL18_I	-0.3V	V_{REF}-0.125V	V_{REF}+0.125V	3.6V	0.40V	V_{CCO}-0.40V	8	-8
SSTL15	-0.3V	V_{REF}-0.1V	V_{REF}+ 0.1V	3.6V	0.40V	V_{CCO}-0.40V	8	-8
HSTL18_I	-0.3V	V_{REF}-0.1V	V_{REF}+ 0.1V	3.6V	0.40V	V_{CCO}-0.40V	8	-8
HSTL18_II	-0.3V	V_{REF}-0.1V	V_{REF}+ 0.1V	3.6V	NA	NA	NA	NA
HSTL15_I	-0.3V	V_{REF}-0.1V	V_{REF}+ 0.1V	3.6V	0.40V	V_{CCO}-0.40V	8	-8
HSTL15_II	-0.3V	V_{REF}-0.1V	V_{REF}+ 0.1V	3.6V	NA	NA	NA	NA

4.3.6 IOB Differential Electrical Characteristics

Table 4-13 IOB Differential Electrical Characteristics

Name	Description	Condition	Min.	Typ.	Max.	Unit
V_{INA},V_{INB}	Input Voltage		0	-	2.4	V
V_{CM}	Input Common Mode Voltage	Half the Sum of the Two Inputs	0.05	-	2.35	V
V_{THD}	Differential Input Threshold	Difference Between the Two Inputs	±100	-	-	mV
I_{IN}	Input Current	Power On or Power Off	-	-	± 10	μA
V_{OH}	Output High Voltage for V_{OP} or V_{OM}	R_T = 100Ω	-	-	1.60	V
V_{OL}	Output Low Voltage for V_{OP} or V_{OM}	R_T = 100Ω	0.9	-	-	V
V_{OD}	Output Voltage Differential	(V_{OP} - V_{OM}), R_T = 100Ω	250	350	450	mV
ΔV_{OD}	Change in V_{OD} Between High and Low		-	-	50	mV
V_{OS}	Output Voltage Offset	(V_{OP} + V_{OM})/2, R_T = 100Ω	1.125	1.20	1.375	V
ΔV_{OS}	Change in V_{OS} Between High and Low		-	-	50	mV
I_S	Short-circuit current	V_{OD} = 0V output short-circuit	-	-	15	mA

4.4 Switching Characteristic

4.4.1 Internal Switching Characteristics

Table 4-14 CFU Block Internal Timing Parameters

Name	Description	Speed Grade		Unit
		Min	Max	
t_{LUT4_CFU}	LUT4 delay	-	0.674	ns
t_{LUT5_CFU}	LUT5 delay	-	1.388	ns
t_{LUT6_CFU}	LUT6 delay	-	2.01	ns
t_{LUT7_CFU}	LUT7 delay	-	2.632	ns
t_{LUT8_CFU}	LUT8 delay	-	3.254	ns
t_{SR_CFU}	Set/Reset to Register output	-	1.86	ns
t_{CO_CFU}	Clock to Register output	-	0.76	ns

4.4.2 BSRAM Switching Characteristics

Table 4-15 BSRAM Internal Timing Parameters

Name	Description	Speed Grade		Unit
		Min	Max	
t_{COAD_BSRAM}	Clock to output time of read address/data	-	5.10	ns
t_{COOR_BSRAM}	Clock to output time of output register	-	0.56	ns

4.4.3 DSP Switching Characteristics

Table 4-16 DSP Internal Timing Parameters

Name	Description	Speed Grade		Unit
		Min.	Max.	
t_{COIR_DSP}	Clock to output time of input register	-	4.80	ns
t_{COPR_DSP}	Clock to output time of pipeline register	-	2.40	ns
t_{COOR_DSP}	Clock to output time of output register	-	0.84	ns

4.4.4 Gearbox Switching Characteristics

Table 4-17 Gearbox Internal Timing Parameters

Device	Name	Description	Min.	Unit
GW1N-1/4	$FMAX_{IDDR}$	2:1 Gearbox maximum input serial rate	1000	Mbps
	$FMAX_{IDES4}$	4:1 Gearbox maximum input serial rate	500	Mbps
	$FMAX_{IDESx}$	7:1/8:1/10:1 Gearbox maximum input serial rate	1000	Mbps
	$FMAX_{ODDR}$	1:2 Gearbox maximum input serial rate	1000	Mbps
	$FMAX_{OSER4}$	1:4 Gearbox maximum output serial rate	500	Mbps
	$FMAX_{OSERx}$	1:7/1:8/1:10 Gearbox maximum output serial rate	1000	Mbps
GW1N-9	$FMAX_{IDDR}$	2:1 Gearbox maximum input serial rate	1200	Mbps
	$FMAX_{IDES4}$	4:1 Gearbox maximum input serial rate	600	Mbps
	$FMAX_{IDESx}$	7:1/8:1/10:1/16:1 Gearbox maximum input serial rate	1200	Mbps
	$FMAX_{ODDR}$	1:2 Gearbox maximum output serial rate	1200	Mbps
	$FMAX_{OSER4}$	1:4 Gearbox maximum output serial rate	600	Mbps
	$FMAX_{OSERx}$	1:7/1:8/1:10/1:16 Gearbox maximum output serial rate	1200	Mbps

Note!

LVDS IO speed can be up to 1Gbps, but note that for 1:4 Gearbox and 1:2 Gearbox, the internal core may not reach the corresponding speed.

Table 4-18 Single-ended IO Fmax

Name	Fmax	
	Min. Value(Mhz)	
	DriverStrength = 4mA	DriverStrength > 4mA
LVTTL33	150	300
LVCMOS33	150	300
LVCMOS25	150	300
LVCMOS18	150	300
LVCMOS15	150	200
LVCMOS12	150	150

Note!

The test loading is 30pF capacitor.

4.4.5 Clock and I/O Switching Characteristics

Table 4-19 External Switching Characteristics

Name	Description	Device	-5		-6		Unit
			Min	Max	Min	Max	
HCLK Tree delay	TBD	TBD	TBD	TBD	TBD	TBD	
PCLK Tree delay	TBD	TBD	TBD	TBD	TBD	TBD	
Pin-LUT-Pin Delay	TBD	TBD	TBD	TBD	TBD	TBD	
IO Buffer delay	TBD	TBD	TBD	TBD	TBD	TBD	

4.4.6 On chip Oscillator Switching Characteristics

Table 4-20 On chip Oscillator Output Frequency

Name	Description		Min.	Typ.	Max.
f_{MAX}	On chip Oscillator Output Frequency (0 ~ +85℃)	GW1N-4	99.75MHz	105MHz	110.25MHz
		GW1N-1/1S/2/9	118.75MHz	125MHz	131.25MHz
	On chip Oscillator Output Frequency (-40 ~ +100℃)	GW1N-4	94.5MHz	105MHz	115.5MHz
		GW1N-1/1S/2/9	112.5MHz	125MHz	137.5MHz
t_{DT}	Clock Duty Cycle		43%	50%	57%
t_{OPJIT}	Clock Period Jitter		0.01 UIPP	0.012 UIPP	0.02 UIPP

4.4.7 PLL Switching Characteristics

Table 4-21 PLL Parameters

Name	Description	Parameter	Min.	Max.
GW1N-1	C7/I6	CLKIN	3MHZ	400MHZ
	C6/I5	PFD	3MHZ	400MHZ

Name	Description	Parameter	Min.	Max.
		VCO	400MHZ	900MHZ
		CLKOUT	3.125MHZ	450MHZ
	C5/I4	CLKIN	3MHZ	320MHZ
		PFD	3MHZ	320MHZ
		VCO	320MHZ	720MHZ
		CLKOUT	2.5MHZ	360MHZ
GW1N-1S	C7/I6 C6/I5	CLKIN	3MHZ	400MHZ
		PFD	3MHZ	400MHZ
		VCO	400MHZ	1200MHZ
		CLKOUT	3.125MHZ	600MHZ
	C5/I4	CLKIN	3MHZ	320MHZ
		PFD	3MHZ	320MHZ
		VCO	320MHZ	960MHZ
		CLKOUT	2.5MHZ	480MHZ
GW1N-4 GW1N-9	C7/I6 C6/I5	CLKIN	3MHZ	400MHZ
		PFD	3MHZ	400MHZ
		VCO	400MHZ	1000MHZ
		CLKOUT	3.125MHZ	500MHZ
	C5/I4	CLKIN	3MHZ	320MHZ
		PFD	3MHZ	320MHZ
		VCO	320MHZ	800MHZ
		CLKOUT	2.5MHZ	400MHZ
GW1N-2	C7/I6	CLKIN	3MHZ	400MHZ
		PFD	3MHZ	400MHZ
		VCO	400MHZ	800MHZ
		CLKOUT	3.125MHZ[1]	800MHZ

Note!

[1]The min. output frequency for different channels may be different. The min. output frequency for channel A is VCO/128, which is 3.125MHZ/2.5MHZ; Channel B/C/D needs to be judged according to whether it is cascaded (parameter). If it is not cascaded, it is the same as channel A; if it is cascaded, it needs to be divided by 128 again.

4.5 User Flash Characteristics

4.5.1 DC Characteristics [1]

(T_J = -40~+100℃, V_{CC} = 0.95~1.05V, V_{CCX} = 1.7~3.45V, V_{SS} = 0V)

Table 4-22 GW1N-1/ GW1N-1S User Flash DC Characteristic

Name	Description	Spec.			Unit
		Min.	Normal	Max.	
Ta	Environmental temperature	-40	25	85	℃
Tj	Junction Temperature	-40	25	100	℃
Ilkg	Leakage current	-	-	1	μA
Isb	Standby current	-	-	3（Ta=25）	μA
		-	-	20（Ta=85）	
Icc0	Idle current	-	-	1.3	mA
Icc1	Read operation current	-	-	2（Rmod=00）	mA
		-	-	2.5（Rmod=01）	mA
		-	-	3（Rmod=00）	mA
Icc2	Page write current	-	-	2	mA
Icc3	programming/ erasing current	-	-	3	mA

Table 4-23 GW1N-2/4/9 User Flash DC Characteristic

Name	Param-eter	Max.		Unit	Wake-up Time	Condition
		V_{CC}[3]	V_{CCX}			
Read mode (w/I 25ns)[1]	I_{CC1}[2]	2.19	0.5	mA	NA	Min. Clock period, duty cycle 100%, VIN = "1/0"
Write mode		0.1	12	mA	NA	
Erase mode		0.1	12	mA	NA	
Page Erasure Mode		0.1	12	mA	NA	
Read mode static current (25-50ns)	I_{CC2}	980	25	μA	NA	XE=YE=SE="1",between T=Tacc and T=50ns, I/O=0mA; later than T=50ns, read mode is turned off, and I/O current is the current of standby mode.
Standby mode	I_{SB}	5.2	20	μA	0	V_{SS}, V_{CCX}, and V_{CC}

Note!

- [1] Means the average current, and the peak value is higher than the average one.
- [2] Calculated in different T_{new} clock periods.
  - $T_{new} < T_{acc}$ is not allowed
  - $T_{new} = T_{acc}$
  - $T_{acc} < T_{new}$ - 50ns: I_{CC1} (new) = $(I_{CC1} - I_{CC2})(T_{acc}/T_{new}) + I_{CC2}$
  - T_{new}>50ns: I_{CC1} (new) = $(I_{CC1} - I_{CC2})(T_{acc}/T_{new})$ + 50ns x I_{CC2}/T_{new} + I_{SB}
  - t > 50ns, $I_{CC2} = I_{SB}$
- [3] V_{CC} must be greater than 1.08V from the zero wake-up time.

4.5.2 Timing Parameters[1],[5],[6]

(T_J = -40~+100℃, V_{CC} = 0.95~1.05V, V_{CCX} = 1.7~3.45V, V_{SS} = 0V)

Table 4-24 GW1N-1/GW1N-1S User Flash Timing Parameters

Name	Description	Spec.			Unit
		Min.	Normal	Max.	
Taa	Data acquisition time	-	-	38	ns
Tcy	Read cycle	43	-	-	ns
Taw	Aclk high-level time	10	-	-	ns
Tawl	Aclk low-level time	10	-	-	ns
Tas	Setup time	3	-	-	ns
Tah	Hold-up time	3	-	-	ns
Toz	Oe down to high resistance	-	-	2	ns
Toe	Oe up to Dout	-	-	2	ns
Twcy	Write cycle	40	-	-	ns

Name	Description	Spec.			Unit
		Min.	Normal	Max.	
Tpw	Pw high-level time	16	–	–	ns
Tpwl	Pw low-level time	16	–	–	ns
Tpas	Page address set up time	3	–	–	ns
Tpah	Page address hold-up time	3	–	–	ns
Tds	Data set up time	16	–	–	ns
Tdh	Data hold-up time	3	–	–	ns
Ts0	Seq0 cycle	6	–	–	μs
Ts1	Seq1 cycle	15	–	–	μs
Ts2p	Set up time from Aclk to Pe rising edge	5	–	10	μs
Ts3	Seq3 cycle	5	–	10	μs
Tps3	Set up time from Pe falling edge to Aclk	60	–	–	μs
Tpe	Mode=1000 erasure time	5.7	6	6.3	ms
	Mode=1100 programming time	1.9	2	2.1	ms
	Mode=11xx preprogramming time	190	200	210	us

Table 4-25 GW1N-2/4/9User Flash Timing Parameters

User Modes	Parameter	Name	Min.	Max.	Unit
Access time[2]	WC1	T_{acc}[3]	-	25	ns
	TC		-	22	ns
	BC		-	21	ns
	LT		-	21	ns
	WC		-	25	ns
Program/Erase to data storage		T_{nvs}	5	-	μs
Data storage hold time		T_{nvh}	5	-	μs
Data storage hold time (Overall erase)		T_{nvh1}	100	-	μs
Time from data storage to program setup		T_{pgs}	10	-	μs
Program hold time		T_{pgh}	20	-	ns
Write time		T_{prog}	8	16	μs
Write ready time		T_{wpr}	>0	-	ns
Erase hold time		T_{whd}	>0	-	ns
Time from control signal to write/Erase setup		T_{cps}	-10	-	ns
Time from SE to read setup		T_{as}	0.1	-	ns
SE pulse high level time		T_{pws}	5	-	ns

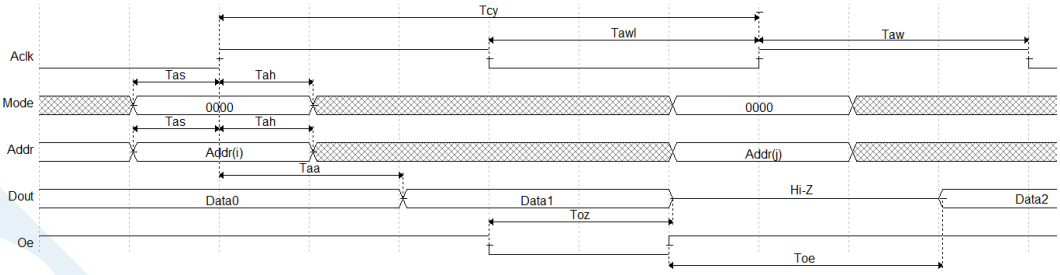
User Modes	Parameter	Name	Min.	Max.	Unit
Address/data setup time		T_{ads}	20	-	ns
Address/data hold time		T_{adh}	20	-	ns
Data hold-up time		T_{dh}	0.5	-	ns
Read mode address hold time[3]	WC1	T_{ah}	25	-	ns
	TC	-	22	-	ns
	BC	-	21	-	ns
	LT	-	21	-	ns
	WC	-	25	-	ns
SE pulse low level time		T_{nws}	2	-	ns
Recovery time		T_{rcv}	10	-	μs
Data storage time		T_{hv}[4]	-	6	ms
Erasure time		T_{erase}	100	120	ms
Overall erase time		T_{me}	100	120	ms
Wake-up time from power down to standby mode		T_{wk_pd}	7	-	μs
Standby hold time		T_{sbh}	100	-	ns
V_{CC} setup time		T_{ps}	0	-	ns
V_{CCX} hold time		T_{ph}	0	-	ns

Note!

- [1] The parameter values may change;
- [2] The values are simulation data only.
- [3]After XADR, YADR, XE, and YE are valid, T_{acc} start time is SE rising edge. DOUT is kept until the next valid read operation;
- [4]T_{hv} is the time between write and the next erasure. The same address cannot be written twice before erasure, so does the same register. This limitation is for safety;
- [5]Both the rising edge time and falling edge time for all waveform is 1ns;
- [6] TX, YADR, XE, and YE hold time need to be T_{acc} at least, and T_{acc} starts from SE rising edge.

4.5.3 Operation Timing Diagrams (GW1N-1/ GW1N-1S)

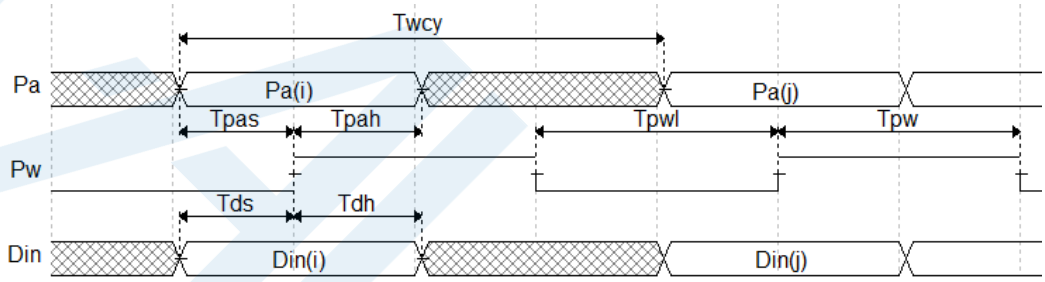
Figure 4-1 Read Mode



Note!

Read operation cycle Seq=0, Addr signal contains Ra, Ca, Rmod, and Rbytesel.

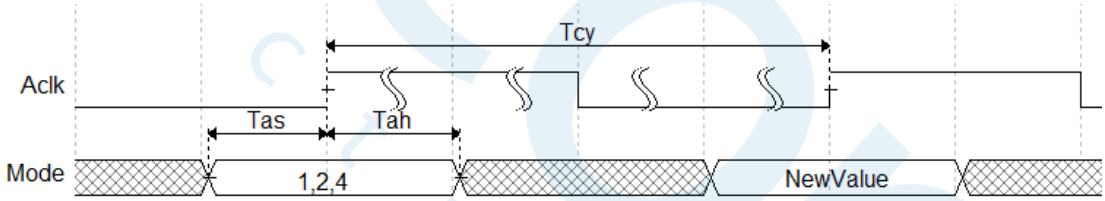
Figure 4-2 Write Page Latches Mode



Note!

Write Page Latches Cycle Seq=0, Mode=0000.

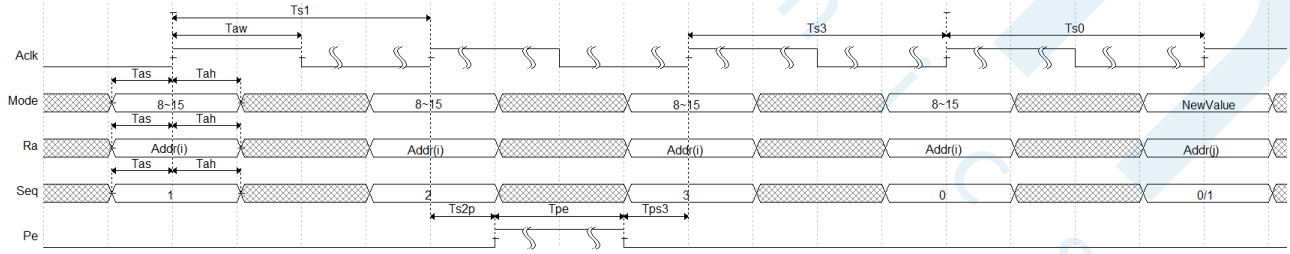
Figure 4-3 Clear Page Latches Mode



Note!

The timing parameters of Setting PEP, writing to all pages, and clearing page latches are all the same. The MODE values are different.

Figure 4-4 High Level Cycle



4.5.4 Operation Timing Diagrams (GW1N-2/4/9)

Figure 4-5 User Flash Read Operation

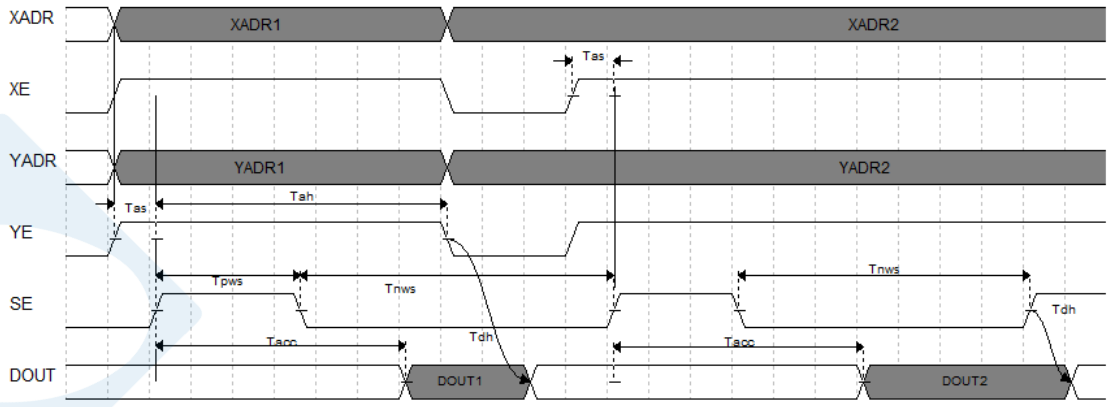


Figure 4-6 User Flash Program Operation

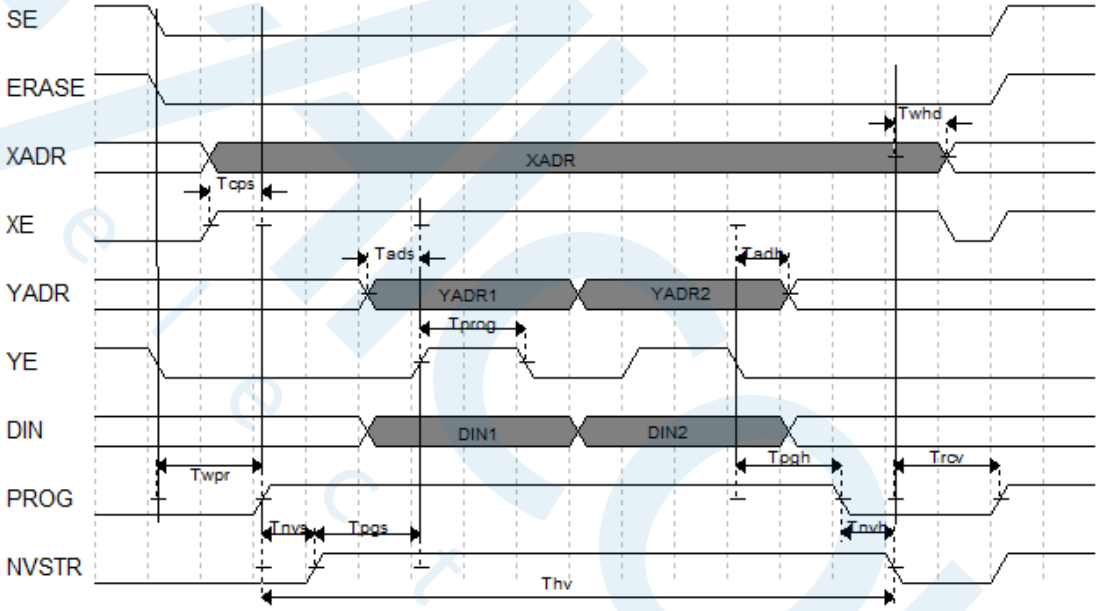
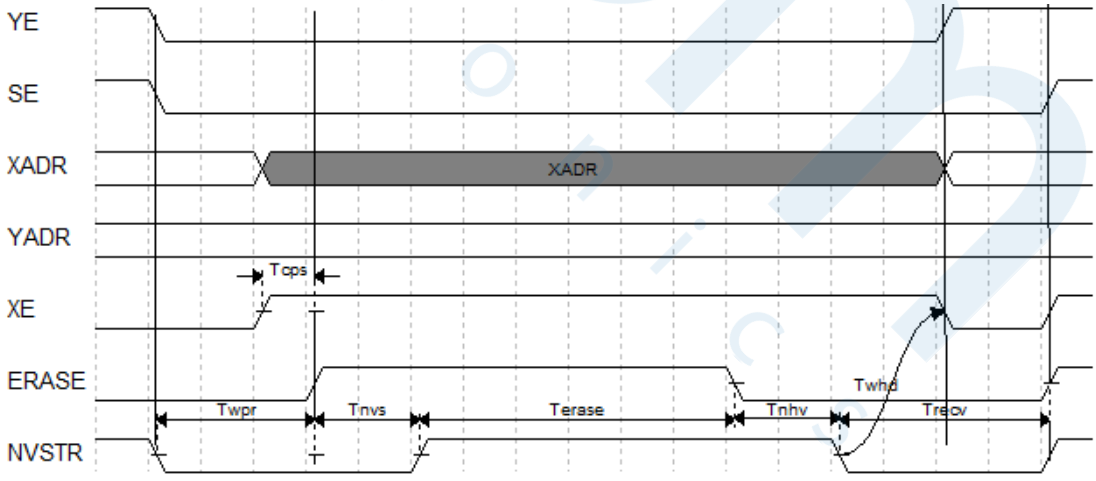


Figure 4-7 User Flash Erase Operation



4.6 Configuration Interface Timing Specification

The GW1N series of FPGA products GowinCONFIG support seven configuration modes: AUTO BOOT, SSPI, MSPI, DUAL BOOT, SERIAL, CPU, and I^2C Slave. For more detailed information, please refer to UG290, *Gowin FPGA Products Programming and Configuration* User Guide.

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5 Ordering Information

5.1 Part Name

Note!

- GW1N-1S parts support LV only;
- For the further detailed information about the package information, please refer to 2.2 Product Resources and 2.3 Package Information.

Figure 5-1 Part Naming–ES

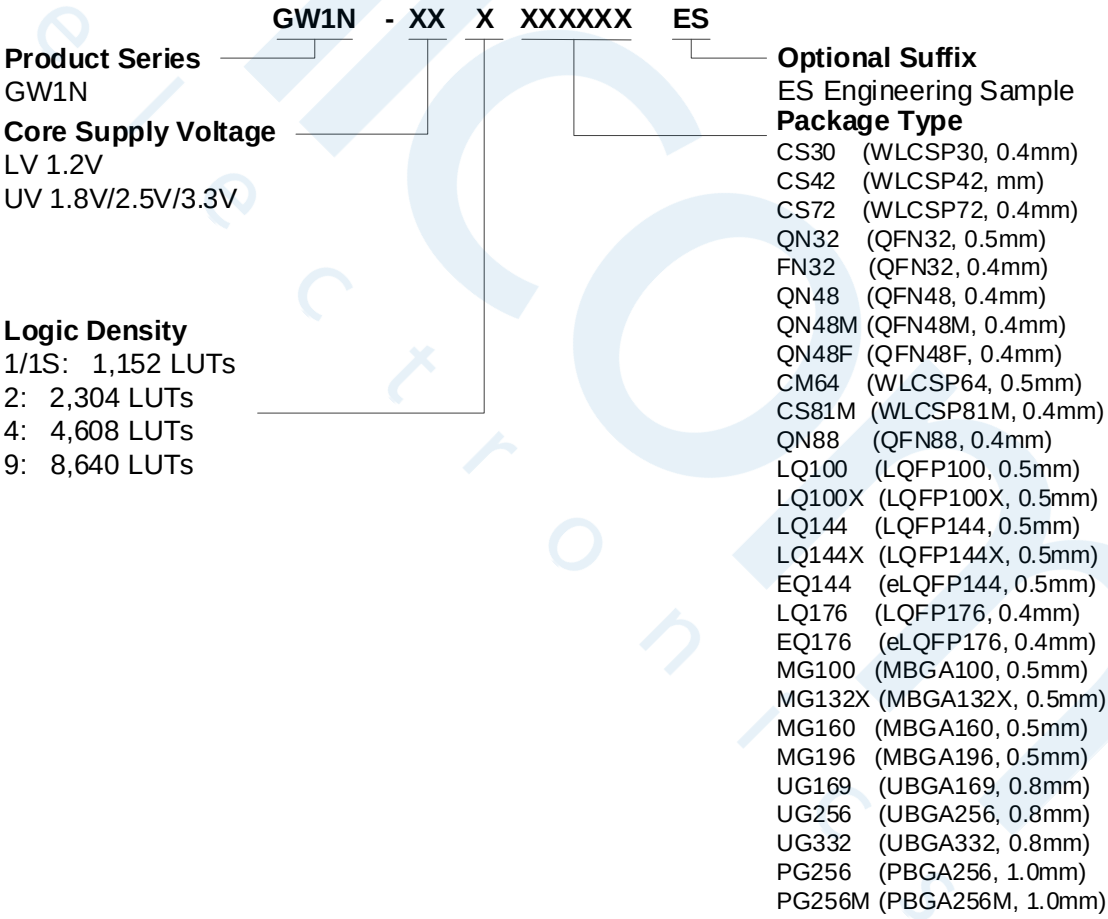
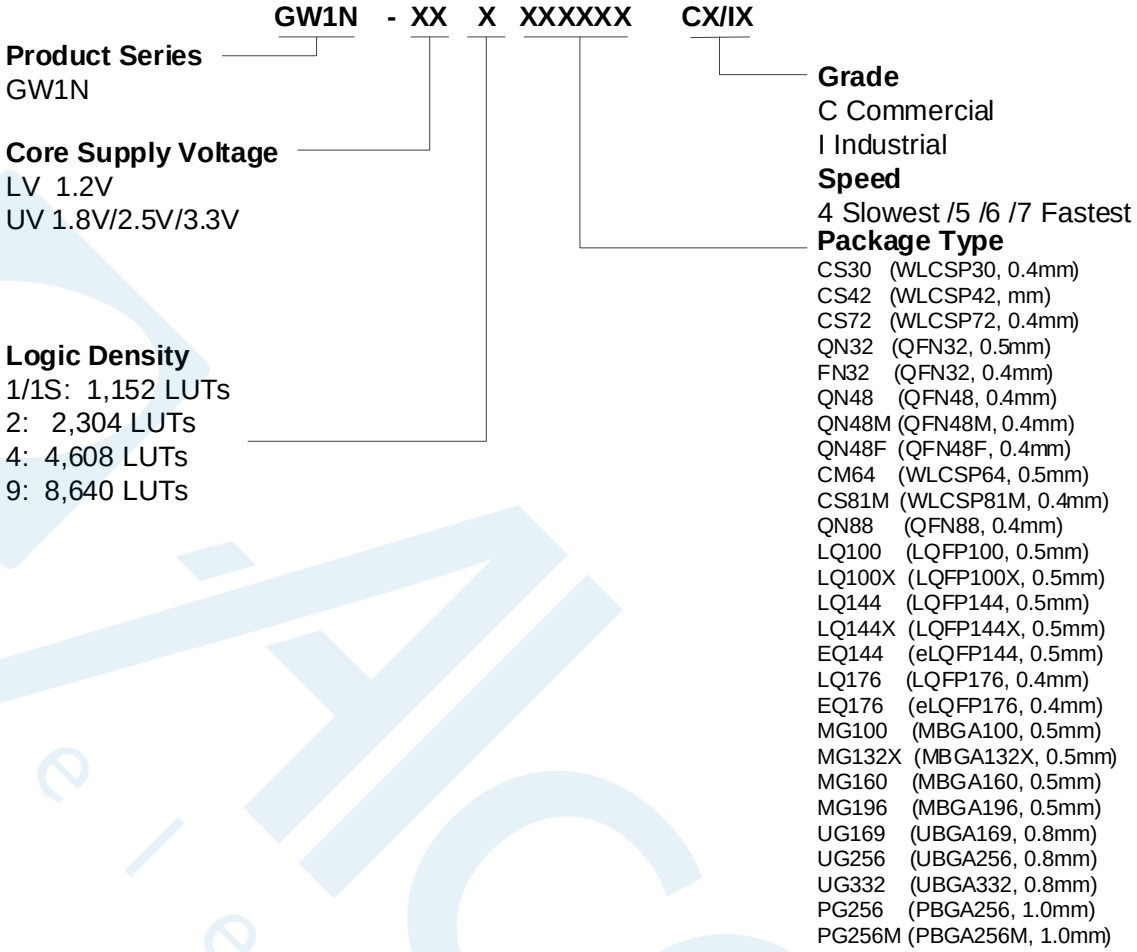


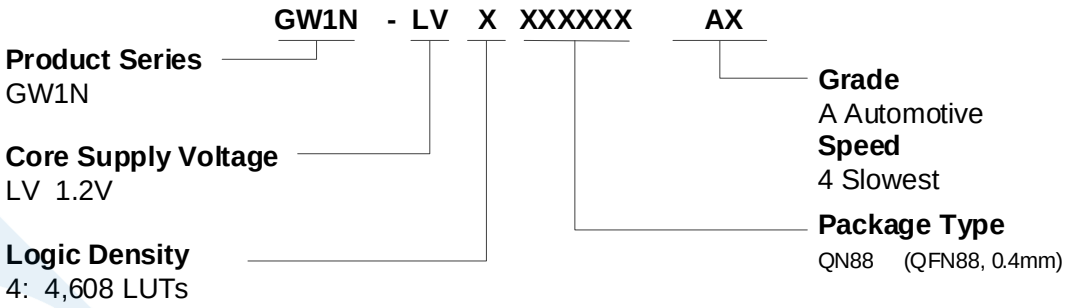
Figure 5-2 Part Naming–Production



Note!

- The LittleBee® family devices and Arora family devices of the same speed grade have different speeds.
- Both "C" and "I" are used in GOWIN part name marking for one device. GOWIN devices are screened using industrial standards, so one same device can be used for both industrial (I) and commercial (C) applications. The maximum temperature of the industrial grade is 100℃, and the maximum temperature of the commercial grade is 85℃. Therefore, if the same chip meets the speed grade 7 in the commercial grade application, the speed grade is 6 in the industrial grade application.

Figure 5-3 Part Naming–Production



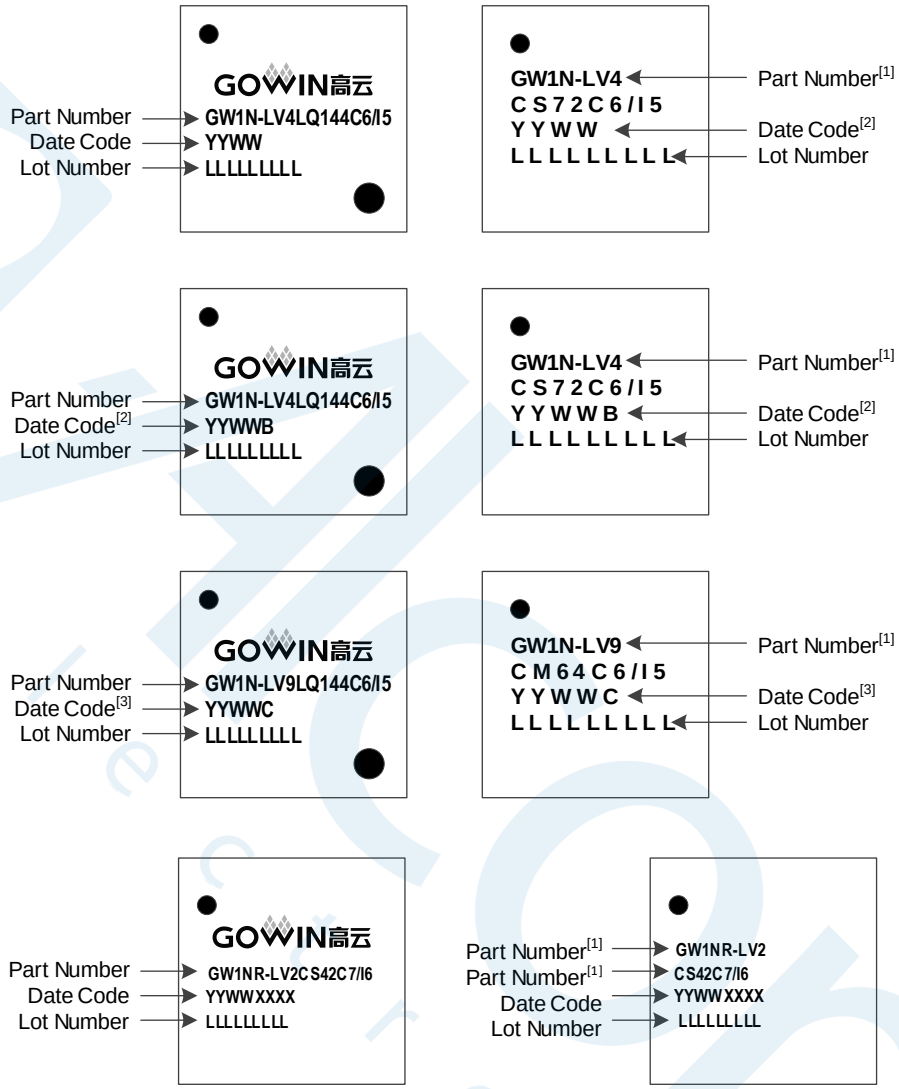
Note!

The LittleBee® family devices and Arora family devices of the same speed grade have different speeds.

5.2 Package Mark

The device information is marked on the chip surface, as shown in Figure 5-4.

Figure 5-4 Package Mark



Note!

- [1]The first two lines in the right figure above are the "Part Number"
- [2] The Data Code is followed by a "B" for B version devices.
- [3] The Data Code is followed by a "C" for C version devices.

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