



# **DDR DQ Window Check Method and Result Analysis**

**Issue**            **00B02**

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# About This Document

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## Related Versions

The following table lists the product versions related to this document.

| Product Name | Version |
|--------------|---------|
| Hi3516C      | V500    |
| Hi3516D      | V300    |
| Hi3516A      | V300    |
| Hi3559       | V200    |
| Hi3556       | V200    |

## Intended Audience

This document is intended for:

- Technical support engineers
- Software development engineers

## Change History

Changes between document issues are cumulative. The latest document issue contains all changes made in previous issues.

### Issue 00B02 (2019-02-28)

This issue is the second draft release.

The description of Hi3516A V300 is added.

### Issue 00B01 (2018-11-20)

This issue is the first draft release.



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# 1 DDR DQ Window Check Method and Result Analysis

## 1.1 Check Method

### 1.1.1 Procedure

- Step 1** Prepare a board which can start normally, and connect the serial port of the board with the PC to enable proper communication.
- Step 2** Enable the board to stay under U-Boot, and run the **mw** command to configure the registers to enable DDR training. The configuration depends on the actual DDR specifications used by the board. The following table describes the switch configurations of the DDR training registers.

| Register Address | Register Description      | Register Value | Configurations                        |
|------------------|---------------------------|----------------|---------------------------------------|
| 0x120200a0       | Training control register | 0x0            | Enable training for PHY 0 and PHY 1.  |
|                  |                           | 0x1            | Enable training for PHY 1 only.       |
|                  |                           | 0x2            | Enable training for PHY 0 only.       |
|                  |                           | 0xffffffff     | Disable training for PHY 0 and PHY 1. |

- Step 3** Run the **ddr dataeye** command to view the DDR DQ window.

----End

### 1.1.2 Examples

#### Window Check Example for DDR3 SDRAM

Use the DDR3 as an example. You only need to input the following commands in U-Boot:



mw 0x120200a0 0x2 //Enable PHY0 training.

ddr dataeye //Check the DQ window.

#### NOTE

- The chip has only one PHY (that is, PHY0). During window check, the control bit for PHY1 cannot be enabled.
- The command for window check is irrelevant to the DDR3, LPDDR3, or DDR4.

## NOTICE

The preceding operations are all performed in U-Boot.

No modules except the CPU can access the DDR SDRAM in U-Boot; otherwise, the check result becomes inaccurate.

## 1.2 Result Analysis

The window check results are displayed in the read and write directions. The window size is focused.

### 1.2.1 Write Window

The write window has following features:

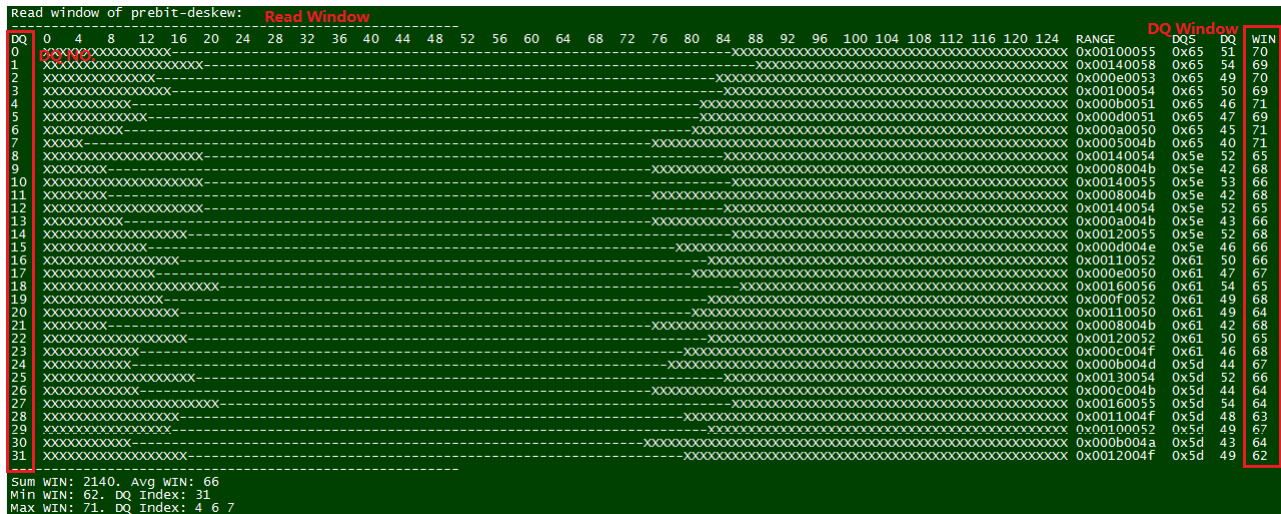
- The flag of write window is shown at the top of the print result.
- The DQ sequence numbers are displayed on the left.
- The window size of each DQ is listed on the right.
- The DQ statistics result is provided at the bottom, including the minimum value, the maximum value, and the average value.

| write window of prebit-deskew: Write Window |            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |            | DQ Window |    |     |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---------------------------------------------|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|------------|-----------|----|-----|--|--|--|--|--|--|--|--|--|--|--|--|--|
| DQ                                          | 8          | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 | 64 | 68 | 72 | 76 | 80 | 84 | 88 | 92 | 96 | 100 | 104 | 108 | 112 | 116 | 120 | 124 | RANGE      | DQPH      | DQ | WIN |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0                                           | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000d0056 | 0xc       | 50 | 74  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1                                           | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000e0055 | 0xc       | 50 | 72  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2                                           | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00090053 | 0xc       | 46 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3                                           | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000c0054 | 0xc       | 48 | 73  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4                                           | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00090053 | 0xc       | 46 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5                                           | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000a0053 | 0xc       | 47 | 74  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6                                           | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00090053 | 0xc       | 46 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7                                           | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x0008004f | 0xc       | 44 | 72  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8                                           | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00080053 | 0xd       | 46 | 76  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9                                           |            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00000045 | 0xd       | 35 | 70  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000a0054 | 0xd       | 47 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11                                          |            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00000047 | 0xd       | 36 | 72  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00080053 | 0xd       | 46 | 76  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13                                          |            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x0000004b | 0xd       | 38 | 76  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00090055 | 0xd       | 47 | 77  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15                                          |            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x0000004b | 0xd       | 38 | 76  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x0011005b | 0xd       | 54 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 17                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000d0057 | 0xd       | 50 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 18                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x0011005a | 0xd       | 54 | 74  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 19                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000c0054 | 0xd       | 48 | 73  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 20                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00100059 | 0xd       | 53 | 74  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 21                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000c0053 | 0xd       | 48 | 72  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 22                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x0012005a | 0xd       | 54 | 73  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 23                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000c0057 | 0xd       | 50 | 76  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 24                                          | XXXX       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x0004004e | 0xd       | 41 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000d0057 | 0xd       | 50 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 26                                          | XXXX       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x0006004f | 0xd       | 43 | 74  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 27                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000e0058 | 0xd       | 51 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 28                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000b0053 | 0xd       | 47 | 73  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 29                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x00070050 | 0xd       | 44 | 74  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 30                                          | XXXX       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x0004004e | 0xd       | 41 | 75  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 31                                          | XXXXXXXXXX |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     | 0x000a0053 | 0xd       | 48 | 76  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Sum WIN: 2377. Avg WIN: 74                  |            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |            |           |    |     |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Min WIN: 70. DQ Index: 9                    |            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |            |           |    |     |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Max WIN: 77. DQ Index: 14                   |            |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |     |     |     |            |           |    |     |  |  |  |  |  |  |  |  |  |  |  |  |  |

### 1.2.2 Read Window

The read window has following features:

- The flag of read window is shown at the top of the print result.
- The DQ sequence numbers are displayed on the left.
- The window size of each DQ is listed on the right.
- The DQ statistics result is provided at the bottom, including the minimum value, the maximum value, and the average value.



### 1.2.3 Window Judgment Standard

Table 1-1 describes the standard levels of the write and read windows based on the test result of the demo board. If the standard requirements are not met, the DDR SDRAM may have unstable factors.

### Table 1-1 Standard levels

| DDR         | Standard Levels  |
|-------------|------------------|
| 1600 Mbit/s | $\geq 52$ levels |
| 1800 Mbit/s | $\geq 48$ levels |
| 2133 Mbit/s | $\geq 45$ levels |

Statement: The DDR DQ window results serve as the data and methods that are provided for you to analyze DDR problems. Even if the standards are satisfied, the DDR performance cannot be ensured. You need to verify the DDR reliability according to your own test standards.