CYNSE70256 Network Search Engine

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 Overview

Cypress Semiconductor Corporation's (Cypress Semiconductor's) CYNSE70256 network search engine (NSE) incorporates patent-pending Associative Processing Technology™ (APT) and is designed to be a high-performance, pipelined, synchronous, 128K-entry NSE.[1] The CYNSE70256 database entry size can be 72 bits, 144 bits, or 288 bits. In the 72-bit entry mode, the size of the database is 128K entries. In the 144-bit mode, the size of the database is 64K entries, and in the 288-bit mode, the size of the database is 32K entries. The CYNSE70256 is configurable to support multiple databases with different entry sizes. The 36-bit entry table can be implemented using the global mask registers (GMRs), building database size of 256K entries with a single device.

The NSE can sustain 133 million transactions per second when the database is programmed or configured as 72 or 144 bits. When the database is programmed to have an entry size of 36 or 288 bits, the NSE will perform at 66 million transactions per second. Cypress's CYNSE70256 can be used to accelerate network protocols such as Longest-Prefix Match (CIDR), ARP, MPLS, and other layer 2, 3, and 4 protocols.

This high-speed, high-capacity NSE can be deployed in a variety of networking and communications applications. The performance and features of the CYNSE70256 make it attractive in applications such as Enterprise LAN switches and routers, and broadband switching and/or routing equipment that supports multiple data rates at OC–48 and beyond. The NSE is designed to be scalable in order to support network database sizes of up to 7936K entries specifically for environments that require large network policy databases. Figure 2-1 on page 2 shows the block diagram for the CYNSE70256 device.

2.0 Features

- 256K 36-bit entries in a single device
- 128K entries in 72-bit mode, 64K entries in 144-bit mode, 32K entries in 288-bit mode
- 133 million transactions per second in 72- and 144-bit configurations (CFGs)
- 66 million transactions in 36- and 288-bit configurations
- Searches any subfield in a single cycle
- Synchronous pipelined operation
- Up to 31 NSEs can be cascaded
- When cascaded, database entries can range to 7936K 36-bit entries
- Multiple width tables in a single database bank
- Glueless interface to industry-standard SRAMs and/or SSRAMs
- Simple hardware instruction interface
- IEEE 1149.1 test access port
- 1.0V core voltage supply
- 1.8V/2.5V I/O voltage supply
- 352-pin BGA package.

1. All product and company names mentioned in this document are the trademarks of their respective holders. The Cypress Semiconductor Corporation logo, as well as the terms Associative Processing Technology™ (APT), CYNSE70032, CYNSE70064, and CYNSE70128, are trademarks of Cypress Semiconductor.

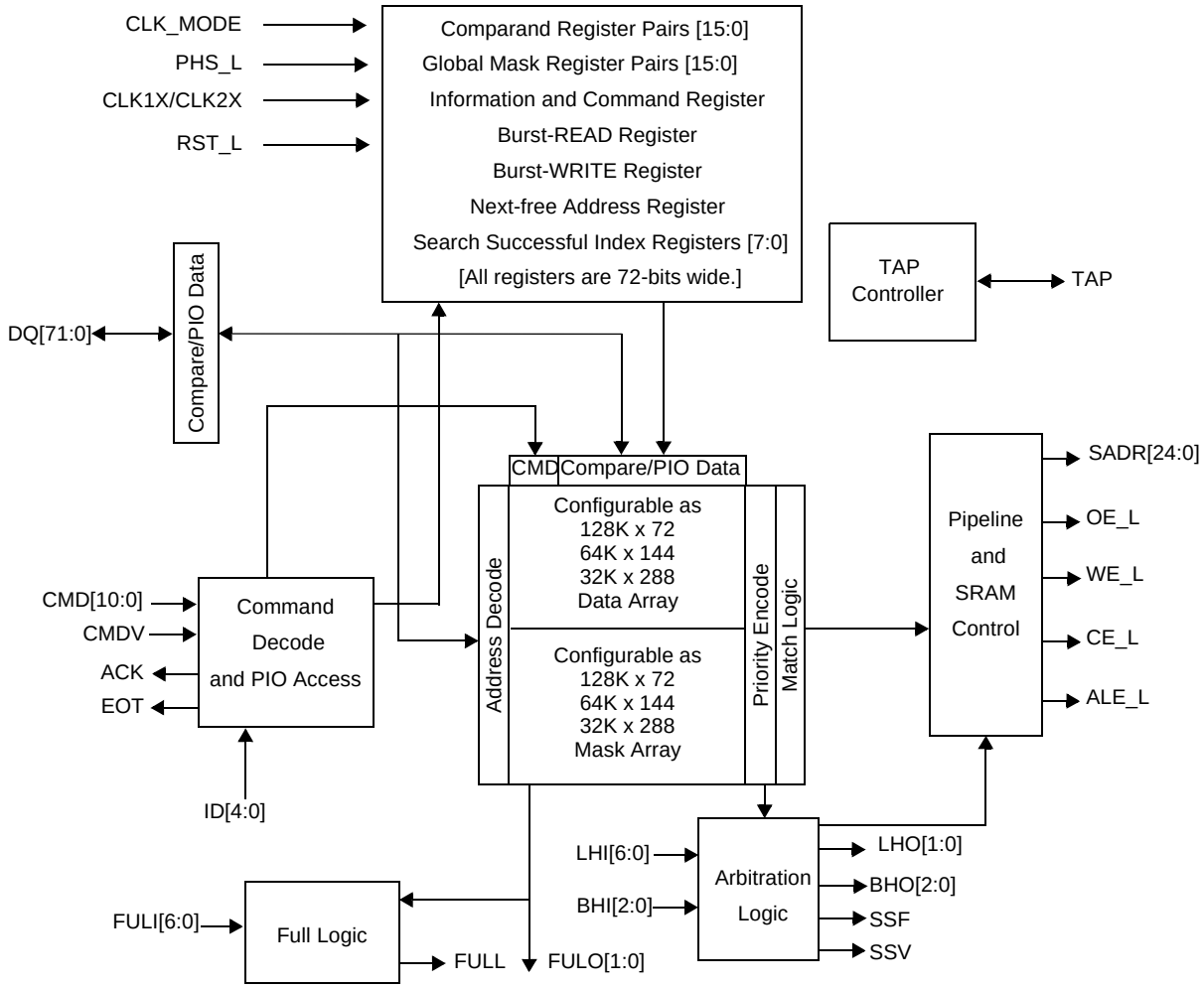


Figure 2-1. CYNSE70256 Block Diagram

3.0 Functional Description

The following subsections contain command (CMD) and DQ bus (command and databus), database entry, arbitration logic, pipeline and SRAM control, and full logic descriptions.

3.1 Command Bus and DQ Bus

CMD[10:0] carries the command and its associated parameter. DQ[71:0] is used for data transfer to and from the database entries, which comprise data and mask fields that are organized as data and mask arrays. The DQ bus carries the SEARCH data (of the data and mask arrays and internal registers) during the SEARCH command as well as the address and data during READ and/or WRITE operations. The DQ bus can also carry address information for the flow-through accesses to the external SRAMs and/or SSRAMs.

3.2 Database Entry (Data and Mask Arrays)

Each database entry comprises data and mask fields. The resultant value of the entry is “1,” “0,” or “X (do not care),” depending on the value in the data mask bit. The on-chip priority encoder selects the first matching entry in the database that is nearest to location 0.

3.3 Arbitration Logic

When multiple NSEs are cascaded to create large databases, the data being searched is presented to all NSEs simultaneously in the cascaded system. If multiple matches occur, arbitration logic on the NSEs will enable the winning device (the one with a matching entry closest to address 0 of the cascaded database) to drive the SRAM bus.

3.4 Pipeline and SRAM Control

Pipeline latency is added to give enough time to a cascaded system's arbitration logic to determine the device that will drive the index of the matching entry on the SRAM bus. Pipeline logic adds latency to both the SRAM access cycles and the search successful flag (SSF) and search successful flag valid (SSV) signals to align them to the host ASIC receiving the associated data.

3.5 Full Logic

Bit[0] in each of the 72-bit entries has a special purpose for the LEARN command (0 = empty, 1 = full). When all the data entries have bit[0] set to 1, the database asserts the FULL flag, indicating that all the NSEs in the depth-cascaded array are full.

4.0 Signal Descriptions

Table 4-1 lists and describes all CYNSE70256 signals.

Table 4-1. CYNSE70256 Signal Description

Symbol	Type[1]	Description
Clocks and Reset		
CLK_MODE	I	**Clock Mode**. This signal allows the selection of clock input to the CLK1X/CLK2X pin. If the CLK_MODE pin is low, CLK2X must be supplied on that pin. PHS_L must also be supplied. If the CLK_MODE pin is high, CLK1X must be supplied on the CLK2X/CLK1X pin, and the PHS_L signal is not required. When the CLK_mode is high, PHS_L is unused and should be externally grounded.
CLK2X/CLK1X	I	**Master Clock**. Depending on the CLK_MODE pin, either the CLK2X or the CLK1X must be supplied. CYNSE70256 samples control and data signals on both edges of CLK1X (if CLK1X is supplied). CYNSE70256 samples all data and control pins on the positive edge of CLK2X (if the CLK2X and PHS_L signals are supplied). All signals are driven out of the device on the rising edge of CLK1X (if CLK1X is supplied), and are driven on the rising edge of CLK2X when PHS_L is low (if CLK2X is supplied).
PHS_L	I	**Phase**. This signal runs at half the frequency of CLK2X and generates an internal CLK from CLK2X. See Section 5.0, "Clocks," on page 6.
TEST_CO	I	**Test Output (for Cypress use only)**. This is test output and will stay unconnected in the application of the device.
TEST	I	**Test Input (for Cypress use only)**. This signal should be connected to ground.
TEST_FM		**Test Input (for Cypress use only)**. This signal should be connected to ground.
RST_L	I	**Reset**. Driving RST_L low initializes the device to a known state.
TEST_PB	I	**Test Input (for Cypress use only)**. This signal should be connected to ground.
CFG_L	I	**Configuration**. When CFG_L is low, CYNSE70256 will operate in backward compatibility mode with CYNSE70064 and CYNSE70128. When CFG_L is low, the CMD[10:9] should be externally grounded. With CFG_L low, the device will behave identically with CYNSE70064 and CYNSE70128, and the new feature added to CYNSE70256 will be disabled. When CFG_L is high, the additional CMD[10:9] can be used and the following additional features will be supported: 1. sixteen pairs of global masks are supported instead of eight; 2. parallel WRITE to the data and mask arrays is supported (see Subsection 10.5, "Parallel WRITE," on page 20); and 3. configuring tables of up to three different widths does not require table identification bits in the data array, thus saving two bits from each 72-bit entry.

Symbol	Type[1]	Description
Command and DQ Bus		
CMD[10:0]	I	**Command Bus**. [1:0] specifies the command; [10:2] contains the command parameters. The descriptions of individual CMDs explains the details of the parameters. The encoding of CMDs based on the [1:0] field are: 00: PIO READ 01: PIO WRITE 10: SEARCH 11: LEARN.
CMDV	I	**Command Valid**. This signal qualifies the command bus: 0: No command 1: Command.
DQ[71:0]	I/O	**Address/Data Bus**. This signal carries the READ and WRITE address and data during register, data, and mask array operations. It carries the compare data during SEARCH operations. It also carries the SRAM address during SRAM PIO accesses.
ACK[2]	T	**READ Acknowledge**. This signal indicates that valid data is available on the DQ bus during register, data, and mask array READ operations, or that the data is available on the SRAM data bus during SRAM READ operations.
EOT[2]	T	**End of Transfer**. This signal indicates the end of burst transfer to the data or mask array during READ or WRITE burst operations.
SSF	T	**Search Successful Flag**. When asserted, this signal indicates that the device is the global winner in a SEARCH operation.
SSV	T	**Search Successful Flag Valid**. When asserted, this signal qualifies the SSF signal.
MULTI_HIT	O	**Multiple Hit Flag**. When asserted, this signal indicates that there is more than one location having a match on the device.
HIGH_SPEED	I	**High Speed**. When this signal is high, the device will run up to 133 MHz and perform 133 million searches per second. However, in this mode, a table size (TLSZ) value of 00 is not supported in a system of a single device. Furthermore, the device will only support a TLSZ of 00 and 01 if more than one device is cascaded to form database tables.
TEST_CT[3][3:0]	I	**TEST_CT [3:0]**. These test pins should be set to logic level 1001.
SRAM Interface		
SADR[24:0]	T	**SRAM Address**. This bus contains address lines to access off-chip SRAMs that contain associative data. See Table 12-1 for the details of the generated SRAM address. In a database of multiple CYNSE70256s, each corresponding SADR bit from all cascaded devices must be connected.
CE_L	T	**SRAM Chip Enable**. This is the chip-enable (CE) control for external SRAMs. In a database of multiple CYNSE70256s, CE_L of all cascaded devices must be connected. This signal is then driven by only one of the devices.
WE_L	T	**SRAM Write Enable**. This is the WRITE-enable control for external SRAMs. In a database of multiple CYNSE70256s, WE_L of all cascaded devices must be connected. This signal is then driven by only one of the devices.
OE_L	T	**SRAM Output Enable**. This is the output-enable (OE) control for external SRAMs. Only the last device drives this signal (with the LRAM bit set).
ALE_L	T	**Address Latch Enable**. When this signal is low, the addresses are valid on the SRAM address bus. In a database of multiple CYNSE70256s, the ALE_L of all cascaded devices must be connected. This signal is then driven by only one of the devices.

Symbol	Type[1]	Description
Cascade Interface		
LHI[6:0]	I	**Local Hit In**. These pins depth-cascade the device to form a larger table. One signal of this bus is connected to the LHO[1] or LHO[0] of each of the upstream devices in a block. All unused LHI pins are connected to a logic 0. For more information, see Section 11.0, “Depth Cascading,” on page 90.
LHO[1:0]	O	**Local Hit Out**. LHO[1] and LHO[0] are the same logical signal. Either the LHO[1] or the LHO[0] is connected to one input on the LHI bus (from up to four downstream devices in a block totalling up to eight). For more information, see Section 11.0, “Depth Cascading,” on page 90.
BHI[2:0]	I	**Block Hit In**. Inputs from the previous block BHO[2:0] are tied to BHI[2:0] of the current device. In a four-block system, the last block can contain only seven devices because the identification code 11111 is used for broadcast access.
BHO[2:0]	O	**Block Hit Out**. These outputs from the last device in a block are connected to the BHI[2:0] inputs of the devices in the downstream blocks.
FULI[6:0]	I	**Full In**. Each signal in this bus is connected to FULO[0] or FULO[1] of an upstream device to generate the FULL flag for the depth-cascaded block.
FULO[1:0]	O	**Full Out**. FULO[1] and FULO[0] are the same logical signal. One of these two signals must be connected to the FULI of up to four downstream devices in a depth-cascaded table. Bit[0] in the data array indicates whether the entry is full (1) or empty (0). This signal is asserted if all bits in the data array are 1s. (Refer to Section 11.0, “Depth Cascading,” on page 90, for information on how to generate the FULL flag.)
FULL	O	**Full Flag**. When asserted, this signal indicates that the table of multiple depth-cascaded devices is full.
Device Identification		
ID[4:0]	I	**Device Identification**. The binary-encoded device identification for a depth-cascaded system starts at 00000 and goes up to 11110. 11111 is reserved for a special broadcast address that selects all cascaded NSEs in the system. On a broadcast READ-only, the device with the LDEV bit set to 1 responds.
Supplies		
V_{DD}	n/a	**Chip Core Supply**: 1.0V.
V_{DDQ}	n/a	**Chip I/O Supply**: 1.8V/2.5V.
Test Access Port		
TDI	I	Test access port’s test data in.
TCK	I	Test access port’s test clock.
TDO	T	Test access port’s test data out.
TMS	I	Test access port’s test mode select.
TRST_L	I	Test access port’s reset.

1. I = Input only, I/O = Input or Output, O = Output only, T = Tristate output.
2. ACK and EOT require a weak external pulldown such as 47KΩ or 100KΩ.
3. In the datasheet for CYNSE70128, these signals were called CLK_TUNE.

5.0 Clocks

If the CLK_MODE pin is low, CYNSE70256 receives the CLK2X and PHS_L signals. It uses the PHS_L signal to divide CLK2X and generate an internal clock (CLK[1]), as shown in Figure 5-1. The CYNSE70256 uses CLK2X and CLK for internal operations.

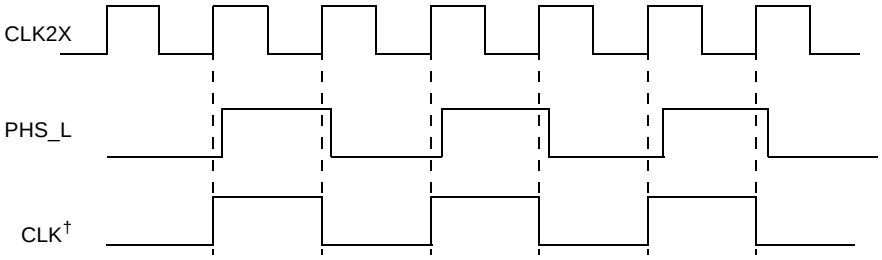


Figure 5-1. CYNSE70256 Clocks (CLK2X and PHS_L)

If the CLK_MODE pin is high, CYNSE70256 receives CLK1X only. CYNSE70256 uses an internal phase-lock loop (PLL) to double the frequency of CLK1X and then divides that clock by two to generate a CLK for internal operations, as shown in Figure 5-2.

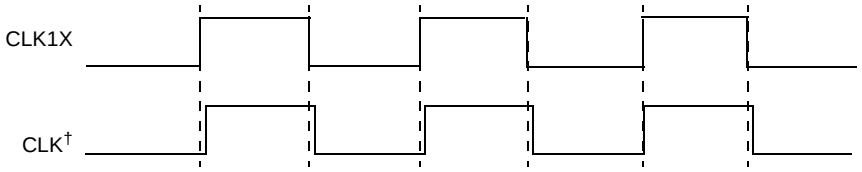


Figure 5-2. CYNSE70256 Clocks (CLK1X)

Note. For the purpose of showing timing diagrams, all such diagrams in this document will be shown in CLK2X mode. For a timing diagram in CLK1X mode, the following substitution can be made (see Figure 5-3).

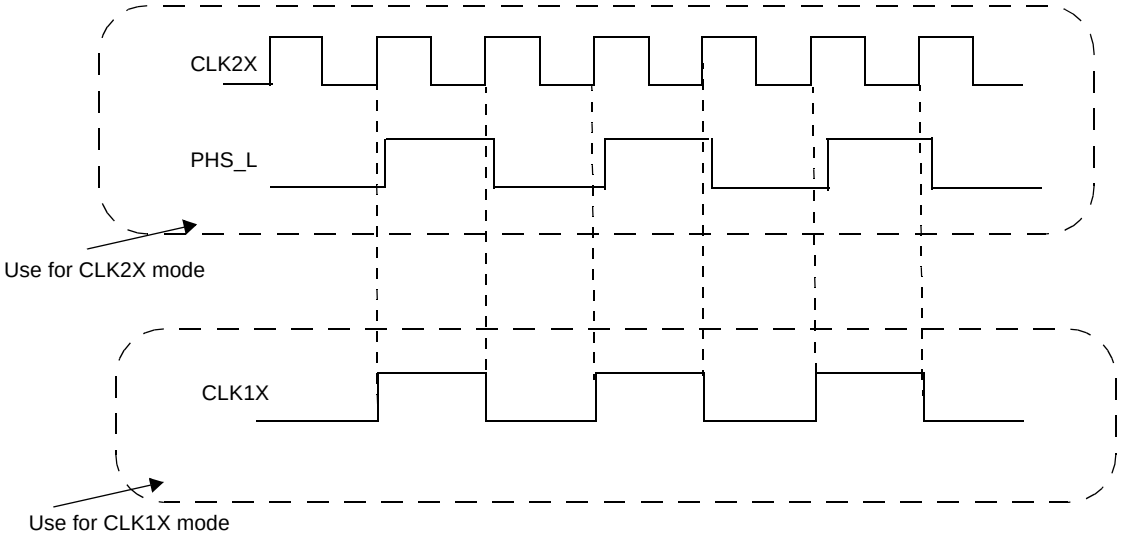


Figure 5-3. CYNSE70256 Clocks for All Timing Diagrams

6.0 Phase-Lock Loop Usage

When the device first powers up, it takes 0.5 ms to lock the internal PLL. During this PLL, the RST_L must be held low for proper initialization of the device. It also takes 32 extra CLK1X cycles in CLK1X mode and 128 extra cycles in CLK2X mode. Setup and hold requirements will change in CLK1X mode if the duty cycle of the CLK1X is varied. All signals to the device in CLK1X mode are sampled by a clock that is generated by multiplying CLK1X by two. Since the PLL has a locking range, the device will only work between the range of frequencies specified in the timing specification wave form section of this datasheet (see Section 16.0, “AC Timing Wave Forms,” on page 108).

1. Any reference to “CLK” cycles means one cycle of CLK.
†. “CLK” is an internal clock signal.

7.0 Registers

All registers in the CYNSE70256 device are 72 bits wide. The CYNSE70256 contains sixteen pairs of comparand storage registers, sixteen pairs of GMRs, eight search successful index registers, and one each of command, information, burst READ, burst WRITE, and next-free address registers. Table 7-1 provides an overview of all the CYNSE70256 registers. The registers are ordered in ascending address order. Each register group is then described in the following subsections.

Table 7-1. Register Overview

Address	Abbreviation	Type	Name
0–31	COMP0–31	R	Sixteen pairs of comparand registers that store comparands from the DQ bus for learning later.
32–47 96–111	MASKS	RW	Sixteen GMR pairs.
48–55	SSR0–7	R	Eight search successful index registers.
56	COMMAND	RW	Command register.
57	INFO	R	Information register.
58	RBURREG	RW	Burst-READ register.
59	WBURREG	RW	Burst-WRITE register.
60	NFA	R	Next-free address register.
61–63	–	–	Reserved.

7.1 Comparand Registers

The device contains 32 72-bit comparand registers (sixteen pairs) dynamically selected in every SEARCH operation to store the comparand presented on the DQ bus. The LEARN command will later use these registers when it is executed. The CYNSE70256 device stores the SEARCH command's cycle A comparand in the even-numbered register and the cycle B comparand in the odd-numbered register, as shown in Figure 7-1.

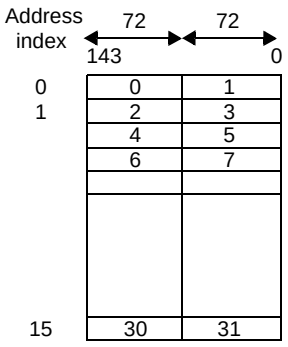
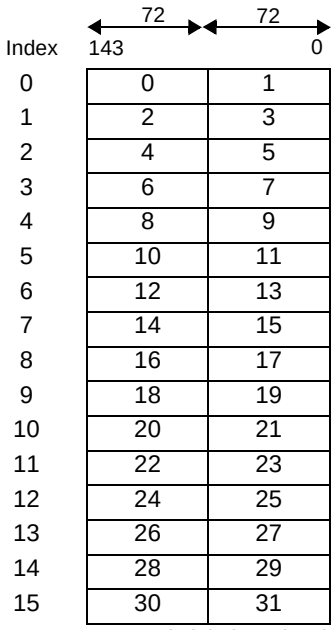


Figure 7-1. Comparand Register Selection during SEARCH and LEARN Instructions

7.2 Mask Registers

The device contains 32 72-bit GMRs (sixteen pairs) dynamically selected in every SEARCH operation to select the SEARCH subfield. The addressing of these registers is explained in Figure 7-2. The 4-bit GMR index supplied on the command bus can apply sixteen pairs of global masks during SEARCH and WRITE operations, as shown below. **Note**. In 72-bit SEARCH and WRITE operations, the host ASIC must program both the even and odd mask registers with the same values.



SEARCH and WRITE command global mask selection.

Figure 7-2. Addressing the GMR Array

Each mask bit in the GMRs is used during SEARCH and WRITE operations. In SEARCH operations, setting the mask bit to 1 enables compares; setting the mask bit to 0 disables compares at the corresponding bit position (forced match). In WRITE operations to the data or mask array, setting the mask bit to 1 enables WRITEs; setting the mask bit to 0 disables WRITEs at the corresponding bit position.

7.3 Search Successful Registers (SSR[0:7])

The device contains eight search successful registers (SSRs) to hold the index of the location at which a successful search occurred. The format of each register is described in Table 7-2. The SEARCH command specifies which SSR stores the index of a specific SEARCH command in cycle B of the SEARCH instruction. Subsequently, the host ASIC can use this register to access that data array, mask array, or external SRAM using the index as part of the indirect access address (see Table 10-3 and Table 10-6).

The device with a valid bit set performs a READ or WRITE operation. All other devices suppress the operation.

Table 7-2. Search Successful Register Description

Field	Range	Initial Value	Description
INDEX	[16:0]	X	**Index**. This is the address of the 72-bit entry where a successful search occurs. The device updates this field only when the search is successful. If a hit occurs in a 144-bit entry-size quadrant, the least-significant bit (LSB) is 0. If a hit occurs in a 288-bit entry-size quadrant, the two LSBs are 00. This index updates if the device is either a local or global winner in a SEARCH operation.
–	[30:17]	0	**Reserved**.
VALID	[31]	0	**Valid**. During SEARCH operation in a depth-cascaded configuration, the device that is a global winner in a match sets this bit to 1. This bit updates only when the device is a global winner in a SEARCH operation.
–	[71:32]	0	**Reserved**.

7.4 Command Register

Table 7-3 describes the command register fields.

Table 7-3. Command Register Description

Field	Range	Initial Value	Description
SRST	[0]	0	**Software Reset**. If 1, this bit resets the device with the same effect as a hardware reset. Internally, it generates a reset pulse lasting for eight CLK cycles. This bit automatically resets to a 0 after the reset has completed.
DEVE	[1]	0	**Device Enable**. If 0, it keeps the SRAM bus (SADR, WE_L, CE_L, OE_L and ALE_L), SSF, and SSV signals in a 3-state condition and forces the cascade interface output signals LHO[1:0] and BHO[2:0] to 0. It also keeps the DQ bus in input mode. The purpose of this bit is to make sure that there are no bus contentions when the devices power up in the system.
TLSZ	[3:2]	01	**Table Size**. The host ASIC must program this field to configure the chips into a table of a certain size. This field affects the pipeline latency of the SEARCH and LEARN operations as well as the READ and WRITE accesses to the SRAM (SADR[24:0], CE_L, OE_L, WE_L, ALE_L, SSV, SSF, and ACK). Once programmed, the SEARCH latency stays constant. Latency in number of CLK cycles with HIGH_SPEED low: 00: One device 4 01: Up to eight devices 5 10: Up to 31 devices 6 11: Reserved. Latency number CLK cycles with HIGH_SPEED high: 00: Not supported 01: One device 5 10: 2–31 devices 6 11: Reserved.
HLAT	[6:4]	000	**Latency of Hit Signals**. This field adds further latency to the SSF and SSV signals during SEARCH, and ACK signal during SRAM READ access by the following number of CLK cycles. 000: 0 100: 4 001: 1 101: 5 010: 2 110: 6 011: 3 111: 7.
LDEV	[7]	0	**Last Device in the Cascade**. When set, this is the last device in the depth-cascaded table and is the default driver for the SSF and SSV signals. In the event of a SEARCH failure, the device with this bit set drives the hit signals as follows: SSF = 0, SSV = 1. During nonSEARCH cycles, the device with this bit set drives the signals as follows: SSF = 0, SSV = 0.
LRAM	[8]	0	**Last Device on the SRAM Bus**. When set, this is the last device on the SRAM bus in the depth-cascaded table and is the default driver for the SADR, CE_L, WE_L, and ALE_L signals. In cycles where no CYNSE70256 device in a depth-cascaded table drives these signals, this device drives the signals as follows: SADR = 24'hFFFFFF, CE_L = 1, WE_L = 1, and ALE_L = 1. OE_L is always driven by the device for which this bit is set.

Field	Range	Initial Value	Description
CFG	[40:9]	00000000000 00000000000 0000000000	**Database Configuration**. The device is divided internally into sixteen partitions of 8K x 72, each of which can be configured as 8K x 72, 4K x 144, or 2K x 288, as follows. 00: 8K x 72 01: 4K x 144 10: 2K x 288 11: low power, partition not used for SEARCH. Bits[10:9] apply to configuring the first partition in the address space. Bits[12:11] apply to configuring the second partition in the address space. Bits[14:13] apply to configuring the third partition in the address space. Bits[16:15] apply to configuring the fourth partition in the address space. Bits[18:17] apply to configuring the fifth partition in the address space. Bits[20:19] apply to configuring the sixth partition in the address space. Bits[22:21] apply to configuring the seventh partition in the address space. Bits[24:23] apply to configuring the eighth partition in the address space. Bits[26:25] apply to configuring the ninth partition in the address space. Bits[28:27] apply to configuring the tenth partition in the address space. Bits[30:29] apply to configuring the eleventh partition in the address space. Bits[32:31] apply to configuring the twelfth partition in the address space. Bits[34:33] apply to configuring the thirteenth partition in the address space. Bits[36:35] apply to configuring the fourteenth partition in the address space. Bits[38:37] apply to configuring the fifteenth partition in the address space. Bits[40:39] apply to configuring the sixteenth partition in the address space.
	[71:41]	0	**Reserved**.

7.5 Information Register

Table 7-4 describes the information register fields.

Table 7-4. Information Register Description

Field	Range	Initial Value	Description
Revision	[3:0]	0001	**Revision Number**. This is the current device revision number. Numbers start at one and increment by one for each revision of the device.
Implementation	[6:4]	001	This is the CYNSE70256 implementation number.
Reserved	[7]	0	**Reserved**.
Device ID	[15:8]	00000101	This is the device identification number.
MFID	[31:16]	1101_1100_0111_1111	**Manufacturer ID**. This field is the same as the manufacturer identification number and continuation bits in the TAP controller.
Reserved	[71:32]		**Reserved**.

7.6 READ Burst Address Register

Table 7-5 shows the READ burst address register (RBURREG) fields that must be programmed before a burst READ.

Table 7-5. READ Burst Register Description

Field	Range	Initial Value	Description
ADR	[16:0]	0	**Address**. This is the starting address of the data or mask array during a burst-READ operation. It automatically increments by one for each successive READ of the data or mask array. Once the operation is complete, the contents of this field must be reinitialized for the next operation.
	[18:17]		**Reserved**.
BLEN	[27:19]	0	**Length of Burst Access**. The device provides the capability to READ from 4–511 locations in a single burst. The BLEN decrements automatically. Once the operation is complete, the contents of this field must be reinitialized for the next operation.
	[71:28]		**Reserved**.

7.7 WRITE Burst Address Register Description

Table 7-6 describes the WRITE burst address register (WBURREG) fields that must be programmed before a burst WRITE.

Table 7-6. Write Burst Register Description

Field	Range	Initial Value	Description
ADR	[16:0]	0	**Address**. This is the starting address of the data or mask array during a burst-WRITE operation. It automatically increments by one for each successive WRITE of the data or mask array. Once the operation is complete, the contents of this field must be reinitialized for the next operation.
	[18:17]		**Reserved**.
BLEN	[27:19]	0	**Length of Burst Access**. The device provides the capability to WRITE from 4–511 locations in a single burst. The BLEN decrements automatically. Once the operation is complete, the contents of this field must be reinitialized for the next operation.
	[71:28]		**Reserved**.

7.8 NFA Register

Bit[0] of each 72-bit data entry is specially designated for use in the operation of the LEARN command. For 72-bit-configured quadrants, this bit indicates whether a location is full (bit set to 1) or empty (bit set to 0). Every WRITE and/or LEARN command loads the address of the first 72-bit location that contains a 0 in the entry's bit[0]. This is stored in the NFA register (see Table 7-7). If all the bits[0] in a device are set to 1, the CYNSE70256 asserts FULO[1:0] to 1.

For 144-bit-configured quadrants, the LSB of the NFA register is always set to 0. The host ASIC must set both bit[0] and bit[72] in a 144-bit word to either 0 or 1 to indicate full or empty status. Both bit[0] and bit[72] must be set to either 0 or 1, (that is, the 10 or 01 settings are invalid).

Table 7-7. NFA Register

Address	71–17	16–0
60	Reserved	Index

8.0 NSE Architecture and Operation Overview

The CYNSE70256 device consists of 64K x 72-bit storage cells referred to as data bits. There is a mask cell corresponding to each data cell. Figure 8-1 shows the three organizations of the device based on the value of the CFG bits in the command register.

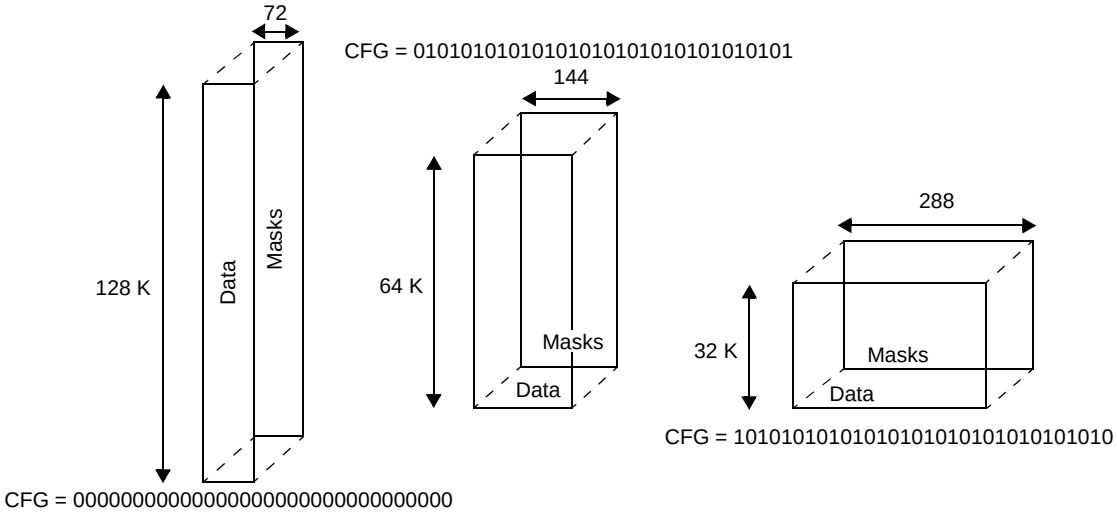


Figure 8-1. CYNSE70256 Database Width Configuration

During a SEARCH operation, the search data bit (S), data array bit (D), mask array bit (M), and global mask bit (G) are used in the following manner to generate a match at that bit position (see Table 8-1). The entry with a match on every bit position results in a successful SEARCH.

Table 8-1. Bit Position Match

G	M	D	S	Match
0	X	X	X	1
1	0	X	X	1
1	1	0	0	1
1	1	1	0	0
1	1	0	1	0
1	1	1	1	1

In order for a successful SEARCH within a device to make the device the local winner, all 72-bit positions must generate a match for a 72-bit entry in 72-bit-configured quadrants, or all 144-bit positions must generate a match for two consecutive even and odd 72-bit entries in quadrants configured as 144 bits, or all 288-bit positions must generate a match for four consecutive entries aligned to four entry-page boundaries of 72-bit entries in quadrants configured as 288 bits.

An arbitration mechanism using a cascade bus determines the global winning device among the local winning devices in a SEARCH cycle. The global winning device drives the SRAM bus, the SSV, and the SSF signals. In case of a SEARCH failure, the device(s) with the LDEV and LRAM bits set drives the SRAM bus, SSF, and SSV signals.

The CYNSE70256 device can be configured to contain tables of different widths, even within the same chip. Figure 8-2 shows a sample configuration of different widths.

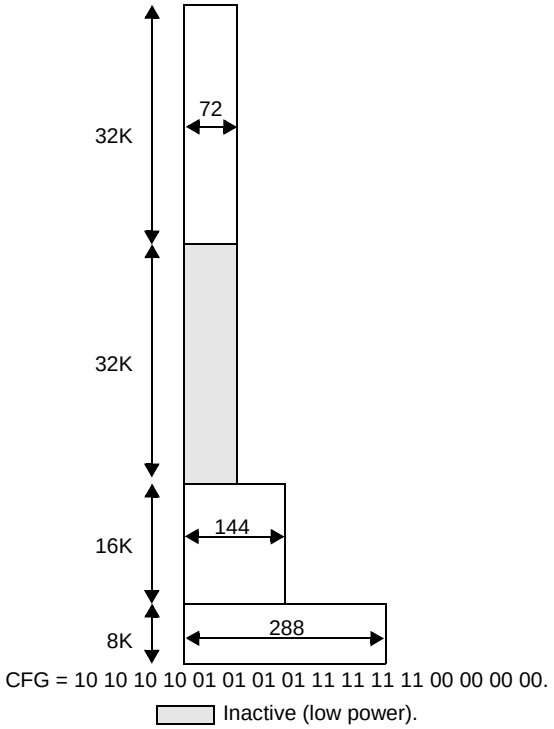


Figure 8-2. Multiwidth Database Configurations Example

9.0 Data and Mask Addressing

Figure 9-1 shows CYNSE70256 data and mask array addressing.

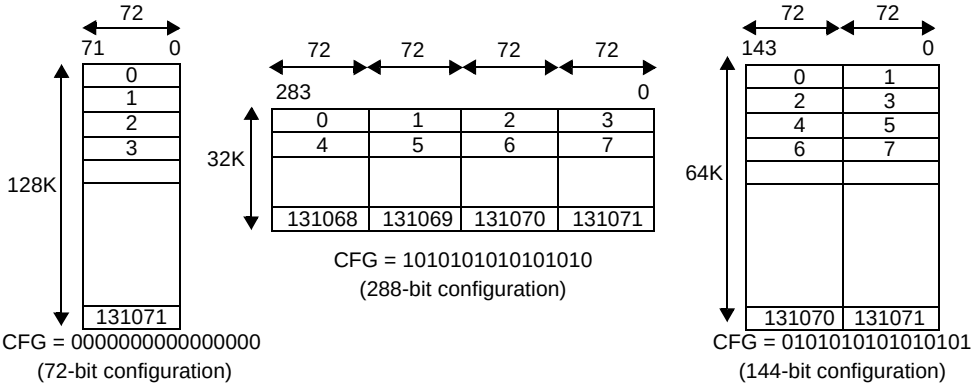


Figure 9-1. Addressing the CYNSE70256 Data and Mask Arrays

10.0 Commands

A master device such as an ASIC controller issues commands to the CYNSE70256 device using the CMDV signal and the command bus. The following subsections describe the operation of these commands.

10.1 Command Codes

The CYNSE70256 device implements four basic commands, as shown in Table 10-1. The command code must be presented to CMD[1:0] while keeping the CMDV signal high for two CLK2X cycles (cycles A and B) when the CLK_MODE pin is low. In CLK2X mode, the controller ASIC must align the instructions using the PHS_L signal. The command code must be presented to CMD[1:0] while keeping the CMDV signal high for one CLK1X cycle when the CLK_MODE pin is high. In CLK1X mode the high phase is cycle A and the low phase is cycle B. The CMD[10:2] field passes command parameters in cycles A and B.

Table 10-1. Command Codes

Command Code	Command	Description
00	READ	Reads one of the following: data array, mask array, device registers, or external SRAM.
01	WRITE	Writes one of the following: data array, mask array, device registers, or external SRAM.
10	SEARCH	Searches the data array for a desired pattern using the specified register from the GMR array and local mask associated with each data cell.
11	LEARN	The device has internal storage for up to sixteen comparands that it can learn. The device controller can insert these entries at the next-free address (as specified by the NFA register) using the LEARN instruction.

10.2 Commands and Command Parameters

Table 10-2 lists the command bus fields that contain the CYNSE70256 command parameters and their respective cycles. Each command is described separately in the subsections that follow.

Table 10-2. Command Parameters

CMD[1,2]	CYC	10	9	8	7	6	5	4	3	2	1	0
READ	A	X	X	SADR[24]	SADR[23]	SADR[22]	0	0	0	0 = Single 1 = Burst	0	0
	B	X	X	0	0	0	0	0	0	0 = Single 1 = Burst	0	0
WRITE	A	GMR Index [3]	0: Normal Write 1: Parallel Write	SADR[24]	SADR[23]	SADR[22]	GMR Index [2:0]			0 = Single 1 = Burst	0	1
	B	GMR Index [3]	0: Normal Write 1: Parallel Write	0	0	0	GMR Index [2:0]			0 = Single 1 = Burst	0	1
SEARCH	A	GMR Index [3]	72 bits: 0 144 bits: 1 288 bits: X	SADR[24]	SADR[23]	SADR[22]	GMR Index 2:0]			72 bits or 144 bits: 0 288 bits: 1 in first cycle 0 in second cycle	1	0
	B	X		SSR Index[2:0]			Comparand Register Index				1	0
LEARN[3]	A	X	X	SADR[24]	SADR[23]	SADR[22]	Comparand Register Index				1	1
	B	X	X	0	0	Mode 0: 72 bits 1: 144 bits	Comparand Register Index				1	1

1. Use CMD[8:0] only and connect CMD[10:9] to ground with CFG_L low.
2. For a description of CMD[9] and CMD[2], see SEARCH 288-bit-configured tables and mixed-size searches with CFG_L high.
3. The 288-bit-configured devices or 288-bit-configured quadrants within devices do not support the LEARN instruction.

10.3 READ Command

The READ can be a single READ of a data array, a mask array, an SRAM, or a register location (CMD[2] = 0). It can be a burst READ of the data (CMD[2] = 1) or mask array locations using an internal auto-incrementing address register (RBURADR). A description of each type is provided in Table 10-3. A single-location READ operation lasts six cycles, as shown in Figure 10-1. The burst READ adds two cycles for each successive READ. The SADR[24:22] bits supplied in READ instruction cycle A drives SADR[24:22] signals during a READ of an SRAM location.

Table 10-3. READ Command Parameters

CMD Parameter CMD[2]	READ Command	Description
0	Single READ	Reads a single location of the data array, mask array, external SRAM, or device registers. All access information is applied on the DQ bus.
1	Burst READ	Reads a block of locations from the data or mask array as a burst. RBURADR specifies the starting address and the length of the data transfer from the data or mask array; it also auto-increments the address for each access. All other access information is applied on the DQ bus. **Note**. The device registers and external SRAM can only be read in single-READ mode.

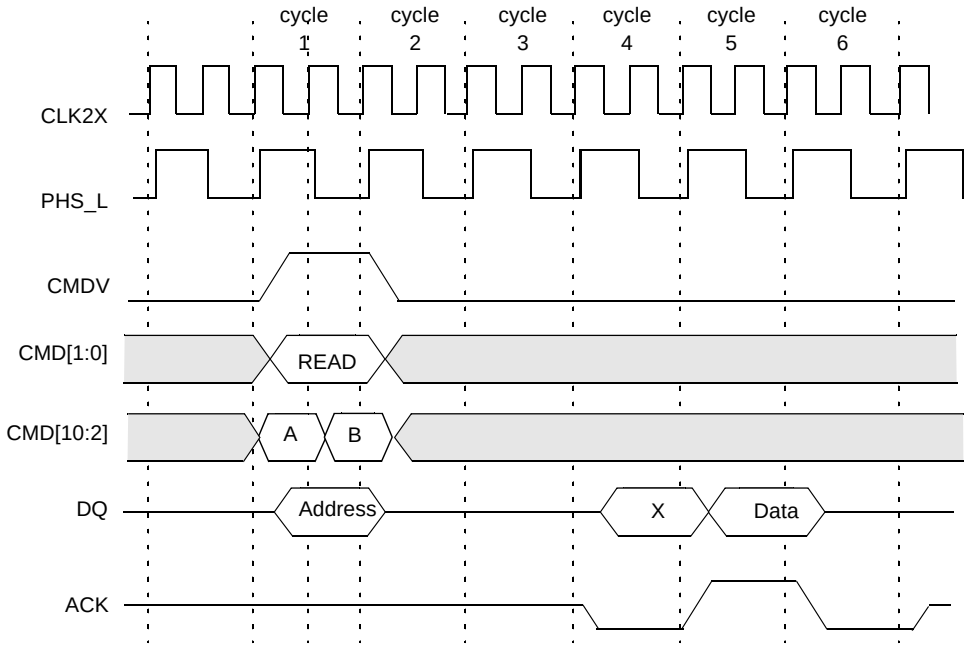


Figure 10-1. Single-Location READ Cycle Timing

The single READ operation takes six CLK cycles that operate in the following sequence.

- **Cycle 1**: The host ASIC applies the READ instruction on CMD[1:0] (CMD[2] = 0) using CMDV = 1, and the DQ bus supplies the address, as shown in Table 10-4 and Table 10-5. The host ASIC selects the CYNSE70256 device for which ID[4:0] matches the DQ[25:21] lines. If DQ[25:21] = 11111, the host ASIC selects the CYNSE70256 with the LDEV bit set. The host ASIC also supplies SADR[24:22] on CMD[8:6] in cycle A of the READ instruction if the READ is directed to the external SRAM.
- **Cycle 2**: The host ASIC floats DQ[71:0] to a 3-state condition.
- **Cycle 3**: The host ASIC keeps DQ[71:0] in a 3-state condition.
- **Cycle 4**: The selected device starts to drive the DQ[71:0] bus and drives the ACK signal from Z to low.
- **Cycle 5**: The selected device drives the READ data from the addressed location on the DQ[71:0] bus, and drives the ACK signal high.
- **Cycle 6**: The selected device floats the DQ[71:0] to a 3-state condition and drives the ACK signal low.

At the termination of cycle 6, the selected device releases the ACK line to a 3-state condition. The READ instruction is complete, and a new operation can begin. **Note**. The latency of the SRAM READ will be different than the one described above (see Subsection 12.1, “SRAM PIO Access,” on page 94). Table 10-4 lists and describes the format of the READ address for a data array, mask array, or SRAM.

Table 10-4. READ Address Format for Data Array, Mask Array, or SRAM

DQ [71:30]	DQ [29]	DQ [28:26]	DQ [25:21]	DQ [20:19]	DQ [18:17]	DQ [16:0]
Reserved	0: Direct 1: Indirect	SSR Index (applicable if DQ[29] is indirect)	ID	00: Data Array	Reserved	If DQ[29] is 0, this field carries the address of the data array location. If DQ[29] is 1, the SSR index specified on DQ[28:26] is used to generate the address of the data array location: {SSR[16:2], SSR[1] | DQ[1], SSR[0] | DQ[0]}.[1]
Reserved	0: Direct 1: Indirect	SSR Index (applicable if DQ[29] is indirect)	ID	01: Mask Array	Reserved	If DQ[29] is 0, this field carries the address of the mask array location. If DQ[29] is 1, the SSR index specified on DQ[28:26] is used to generate the address of the mask array location: {SSR[16:2], SSR[1] | DQ[1], SSR[0] | DQ[0]}.1
Reserved	0: Direct 1: Indirect	SSR Index (applicable if DQ[29] is indirect)	ID	10: External SRAM	Reserved	If DQ[29] is 0, this field carries the address of the SRAM location. If DQ[29] is 1, the SSR index specified on DQ[28:26] is used to generate the address of the SRAM location: {SSR[16:2], SSR[1] | DQ[1], SSR[0] | DQ[0]}.1

1. " | " stands for logical OR operation. "{}" stands for concatenation operator.

Table 10-5 describes the READ address format for the internal registers. Figure 10-2 illustrates the timing diagram for the burst READ of the data or mask array.

Table 10-5. READ Address Format for Internal Registers

DQ[71:26]	DQ[25:21]	DQ[20:19]	DQ[18:7]	DQ[6:0]
Reserved	ID	11: Register	Reserved	Register Address

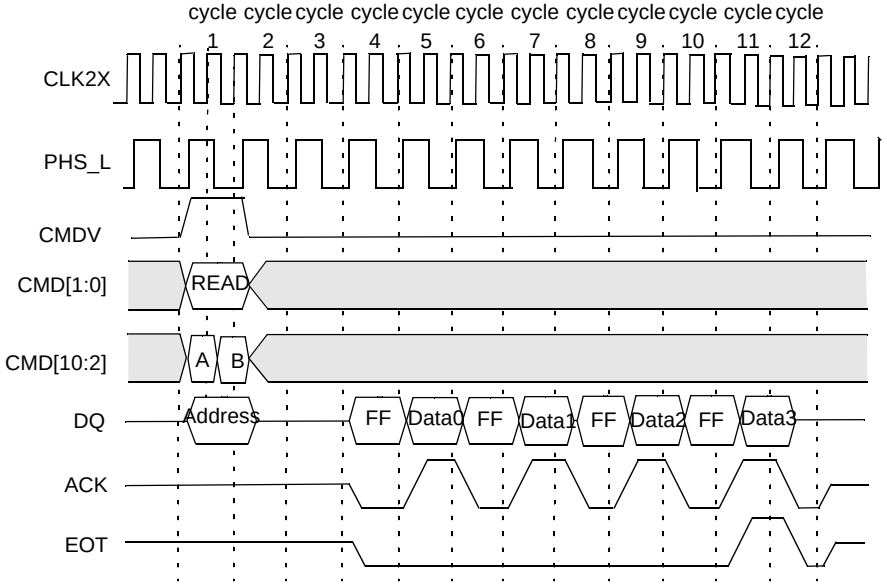


Figure 10-2. Burst READ of the Data and Mask Arrays (BLEN = 4)

The READ operation lasts 4 + 2n CLK cycles (where n is the number of accesses in the burst specified by the BLEN field of the RBURREG) in the sequence shown below. This operation assumes that the host ASIC has programmed the RBURREG with the starting ADR and the BLEN before initiating the burst READ command.

- **Cycle 1**: The host ASIC applies the READ instruction on CMD[1:0] (CMD[2] = 1) using CMDV = 1, and the address supplied on the DQ bus as shown in Table 10-6. The host ASIC selects the CYNSE70256 device where ID[4:0] matches the DQ[25:21] lines. If DQ[25:21] = 11111, the host ASIC selects the CYNSE70256 device with the LDEV bit set.
- **Cycle 2**: The host ASIC floats DQ[71:0] to a 3-state condition.
- **Cycle 3**: The host ASIC keeps DQ[71:0] in a 3-state condition.
- **Cycle 4**: The selected device starts to drive the DQ[71:0] bus and drives ACK and EOT from Z to low.
- **Cycle 5**: The selected device drives the READ data from the address location on the DQ[71:0] bus and drives the ACK signal high.

Cycles 4 and 5 repeat for each additional access until all the accesses specified in the BLEN field of RBURREG are complete. On the last transfer, the CYNSE70256 device drives the EOT signal high.

- **Cycle (4 + 2n)**: The selected device drives the DQ[71:0] to a 3-state condition, and drives the ACK and EOT signals low.

At the termination of cycle (4 + 2n), the selected device floats the ACK line to a 3-state condition. The burst READ instruction is complete, and a new operation can begin. Table 10-6 describes the READ address format for data and mask arrays for burst READ operations.

Table 10-6. READ Address Format for Data and Mask Arrays

DQ[71:26]	DQ[25:21]	DQ[20:19]	DQ[18:17]	DQ[16:0]
Reserved	ID	00: Data Array	Reserved	**Do not care**. These seventeen bits come from the RBURADR, which increments for each access.
Reserved	ID	01: Mask Array	Reserved	**Do not care**. These seventeen bits come from the RBURADR, which increments for each access.

10.4 WRITE Command

The WRITE command can be a single WRITE of a data array, mask array, register, or external SRAM location (CMD[2] = 0). It can be a burst WRITE (CMD[2] = 1) using an internal auto-incrementing address register (WBURADR) of the data or mask array locations. A single-location WRITE is a three-cycle operation, as shown in Figure 10-3. The burst WRITE adds one extra cycle for each successive location WRITE.

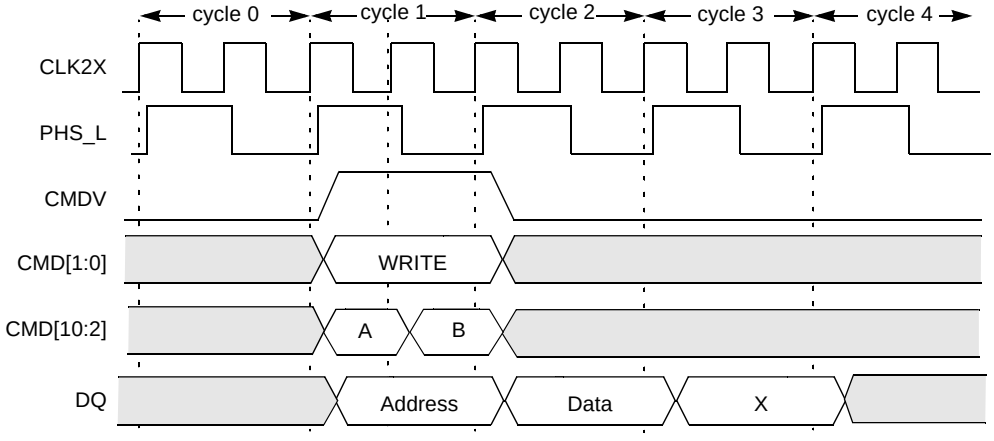


Figure 10-3. Single WRITE Cycle Timing

The following is the WRITE operation sequence. Table 10-7 shows the WRITE address format for the data array, the mask array, or single-WRITE SRAM. Table 10-8 shows the WRITE address format for the internal registers.

- **Cycle 1A**: The host ASIC applies the WRITE instruction to CMD[1:0] (CMD[2] = 0) using CMDV = 1, and the address supplied on the DQ bus. The host ASIC also supplies the GMR index to mask the WRITE to the data or mask array location on {CMD[10], CMD[5:3]}. For SRAM WRITEs, the host ASIC must supply the SADR[24:22] on CMD[8:6]. The host ASIC sets CMD[9] to 0 for a normal WRITE.

- **Cycle 1B**:The host ASIC continues to apply the WRITE instruction to CMD[1:0] (CMD[2] = 0) using CMDV = 1, and the address supplied on the DQ bus. The host ASIC continues to supply the GMR index to mask the WRITE to the data or mask array locations in {CMD[10], CMD[5:3]}. The host ASIC selects the device where ID[4:0] matches the DQ[25:21] lines, or it selects all the devices when DQ[25:21] = 11111.
- **Cycle 2**: The host ASIC drives DQ[71:0] with the data to be written to the data array, mask array, or register location of the selected device.
- **Cycle 3**: Idle cycle.

At the termination of cycle 3, another operation can begin. **Note**. The latency of the SRAM WRITE will be different than the one described above (see Subsection 12.1, “SRAM PIO Access,” on page 94).

Table 10-7. WRITE Address Format for Data Array, Mask Array, or SRAM (Single WRITE)

DQ [71:30]	DQ [29]	DQ [28:26]	DQ [25:21]	DQ [20:19]	DQ [18:17]	DQ [16:0]
Reserved	0: Direct 1: Indirect	SSR (applicable if DQ[29] is indirect)	ID	00: Data Array	Reserved	If DQ[29] is 0, this field carries the address of the data array location. If DQ[29] is 1, the SSR specified on DQ[28:26] is used to generate the address of data array location: {SSR[16:2], SSR[1] | DQ[1], SSR[0] | DQ[0]}.[1]
Reserved	0: Direct 1: Indirect	SSR (applicable if DQ[29] is indirect)	ID	01: Mask Array	Reserved	If DQ[29] is 0, this field carries the address of the mask array location. If DQ[29] is 1, the SSR specified on DQ[28:26] is used to generate the address of the mask array location: {SSR[16:2], SSR[1] | DQ[1], SSR[0] | DQ[0]}.1
Reserved	0: Direct 1: Indirect	SSR (applicable if DQ[29] is indirect)	ID	10: External SRAM	Reserved	If DQ[29] is 0, this field carries the address of the SRAM location. If DQ[29] is 1, the SSR specified on DQ[28:26] is used to generate the address of SRAM location: {SSR[16:2], SSR[1] | DQ[1], SSR[0] | DQ[0]}.1

1. “ | ” stands for logical OR operation. “{}” stands for concatenation operator.

Table 10-8. WRITE Address Format for Internal Registers

DQ[71:26]	DQ[25:21]	DQ[20:19]	DQ[18:7]	DQ[6:0]
Reserved	ID	11: Register	Reserved	Register address

Figure 10-4 shows the timing diagram of a burst WRITE operation of the data or mask array.

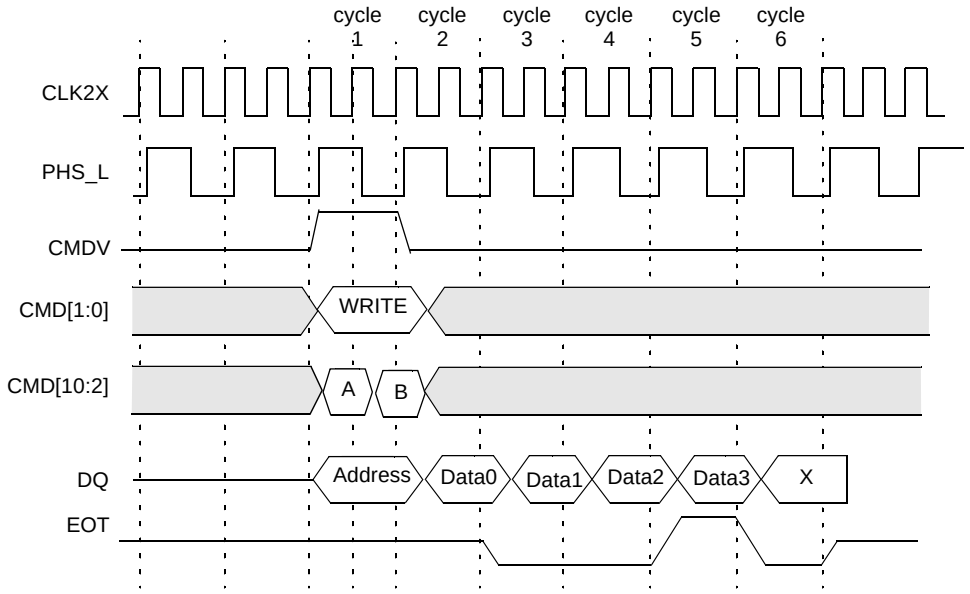


Figure 10-4. BURST Write of the Data and Mask Arrays (BLEN = 4)

The burst WRITE operation lasts for (n + 2) CLK cycles. n signifies the number of accesses in the burst as specified in the BLEN field of the WBURREG register. The following is the block WRITE operation sequence. This operation assumes that the host ASIC has programmed the WBURREG with the starting ADR and BLEN before initiating a burst WRITE command.

- **Cycle 1A**: The host ASIC applies the WRITE instruction to CMD[1:0] (CMD[2] = 1) using CMDV = 1, and the address supplied on the DQ bus as shown in Table 10-9. The host ASIC also supplies the GMR index to mask the WRITE to the data or mask array locations in {CMD[10], CMD[5:3]}. The host ASIC sets CMD[9] to 0 for the normal WRITE.
- **Cycle 1B**: The host ASIC continues to apply the WRITE instruction on CMD[1:0] (CMD[2] = 1) using CMDV = 1, and the address supplied on the DQ bus. The host ASIC continues to supply the GMR index to mask the WRITE to the data or mask array locations in {CMD[10], CMD[5:3]}. The host ASIC selects the device for which ID[4:0] matches the DQ[25:21] lines. It selects all devices when DQ[25:21] = 11111.
- **Cycle 2**: The host ASIC drives the DQ[71:0] with the data to be written to the data or mask array location of the selected device. The CYNSE70256 device writes the data from the DQ[71:0] bus only to the subfield with the corresponding mask bit set to 1 in the GMR that is specified by the index {CMD[10],CMD[5:3]} supplied in cycle 1.
- **Cycles 3 to n + 1**: The host ASIC drives the DQ[71:0] with the data to be written to the next data or mask array location of the selected device (addressed by the auto-increment ADR field of the WBURREG register).

The CYNSE70256 device writes the data on the DQ[71:0] bus only to the subfield that has the corresponding mask bit set to 1 in the GMR specified by the index supplied in cycle 1 {CMD[10],CMD[5:3]}. The CYNSE70256 device drives the EOT signal low from cycle 3 to cycle n; the CYNSE70256 device drives the EOT signal high in cycle n + 1 (n is specified in the BLEN field of the WBURREG).

- **Cycle n + 2**: TheCYNSE70256 device drives the EOT signal low.

At the termination of cycle n + 2, the CYNSE70256 device floats the EOT signal to a 3-state operation, and a new instruction can begin.

Table 10-9. WRITE Address Format for Data and Mask Array (Burst WRITE)

DQ [71:26]	DQ [25:21]	DQ [20:19]	DQ [18:17]	DQ [16:0]
Reserved	ID	00: Data array	Reserved	**Do not care**. These seventeen bits come from WBURADR, which increments with each access.
Reserved	ID	01: Mask array	Reserved	**Do not care**. These seventeen bits come from WBURADR, which increments with each access.

10.5 Parallel WRITE

In order to write the data and mask arrays faster for initialization, testing, or diagnostics, many locations can be written simultaneously in the CYNSE70256 device. When CMD[9] is set in cycles A and B of the WRITE command during a WRITE to the data or mask arrays, the address present on DQ[10:1] that specifies 256 locations in the device is used, and 64 72-bit locations are simultaneously written in either the data or mask array.

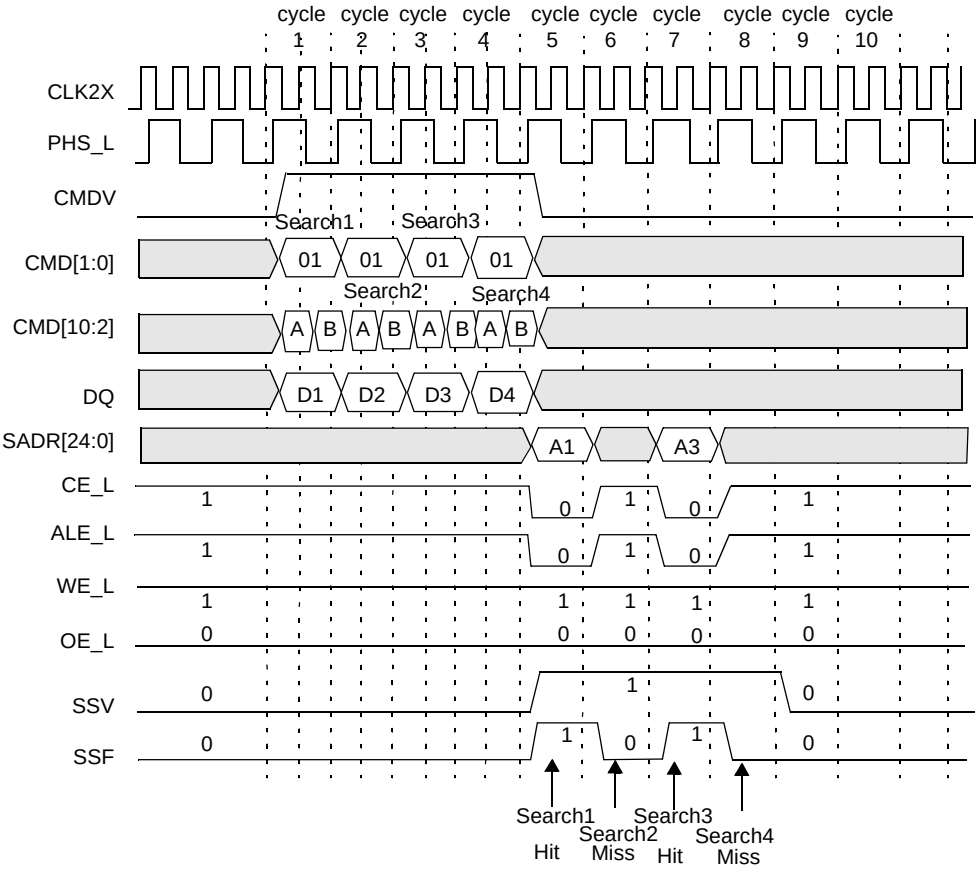
10.6 SEARCH Command

This subsection describes the following.

- 72-bit SEARCH on tables configured as x72 using one device
- 72-bit SEARCH on tables configured as x72 using up to eight devices
- 72-bit SEARCH on tables configured as x72 using up to 31 devices
- 144-bit SEARCH on tables configured as x144 using one device
- 144-bit SEARCH on tables configured as x144 using up to eight devices
- 144-bit SEARCH on tables configured as x144 using up to 31 devices
- 288-bit SEARCH on tables configured as x288 using one device
- 288-bit SEARCH on tables configured as x288 using up to eight devices
- 288-bit SEARCH on tables configured as x288 using up to 31 devices
- Mixed-size SEARCH on tables configured with different widths using an CYNSE70256 with CFG_L low
- Mixed-size SEARCHes on tables configured with different widths using an CYNSE70256 with CFG_L high.

10.6.1 72-bit SEARCH on Tables Configured as x72 using a Single CYNSE70256 Device

Figure 10-5 shows the timing diagram for a SEARCH command in the 72-bit-configured table (CFG = 00000000000000000000000000000000) consisting of a single device for one set of parameters: TLSZ = 00, HLAT = 000, LRAM = 1, and LDEV = 1. The hardware diagram for this search subsystem is shown in Figure 10-6.



CFG = 00000000000000000000000000000000, HLAT = 000, TLSZ = 00, LRAM = 1, LDEV = 1.

Figure 10-5. Timing Diagram for 72-bit SEARCH in x72 Table (One Device)

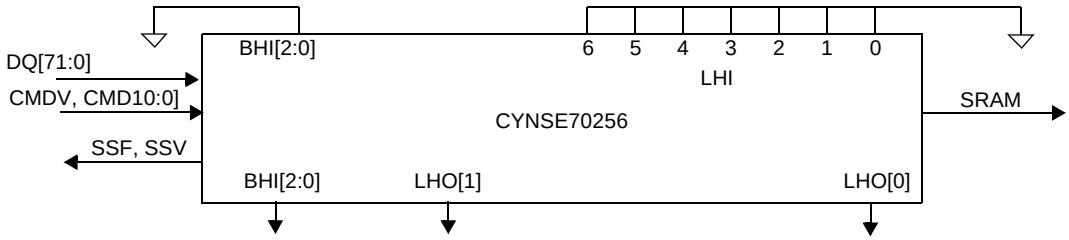


Figure 10-6. Hardware Diagram for a Table with One Device

The following is the sequence of operation for a single 72-bit SEARCH command (also refer to Subsection 10.2, “Commands and Command Parameters,” on page 14).

- **Cycle A**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10], CMD[5:3]} signals must be driven with the index to the GMR pair for use in this SEARCH operation. CMD[8:6] signals must be driven with the same bits that will be driven on SADR[24:22] by this device if it has a hit. DQ[71:0] must be driven with the 72-bit data to be compared. The CMD[2] signal must be driven to logic 0.
- **Cycle B**: The host ASIC continues to drive CMDV high and to apply SEARCH command code (10) on CMD[1:0]. CMD[5:2] must be driven by the index of the comparand register pair for storing the 144-bit word presented on the DQ bus during cycles A and B. CMD[8:6] signals must be driven with the index of the SSR that will be used for storing the address of the matching entry and the hit flag (see page 8 for information on SSR[0:7]). The DQ[71:0] continues to carry the 72-bit data to be compared.

Note. For 72-bit searches, the host ASIC must supply the same 72-bit data on DQ[71:0] during both cycles A and B. The even and odd pair of GMRs selected for the compare must be programmed with the same value.

The logical 72-bit SEARCH operation is shown in Figure 10-7. The entire table consisting of 72-bit entries is compared to a 72-bit word K (presented on the DQ bus in both cycles A and B of the command) using the GMR and local mask bits. The effective GMR is the 72-bit word specified by the identical value in both even and odd GMR pairs selected by the GMR Index in the command’s cycle A. The 72-bit word K (presented on the DQ bus in both cycles A and B of the command) is also stored in both even and odd comparand register pairs selected by the comparand register index in command cycle B. In a x72 configuration, only the even comparand register can subsequently be used by the LEARN command. The word K (presented on the DQ bus in both cycles A and B of the command) is compared with each entry in the table starting at location 0. The first matching entry’s location address L is the winning address that is driven as part of the SRAM address on the SADR[24:0] lines (see Section 12.0, “SRAM Addressing,” on page 93).

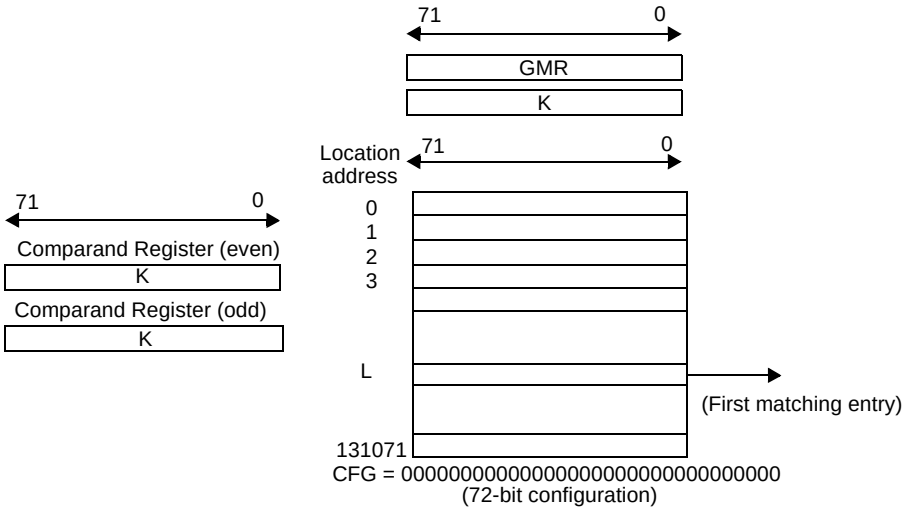


Figure 10-7. x72 Table with One Device

The SEARCH command is a pipelined operation and executes a SEARCH at half the rate of the frequency of CLK2X for 72-bit searches in x72-configured tables. The latency of SADR, CE_L, ALE_L, WE_L, SSV, and SSF from the 72-bit SEARCH command cycle (two CLK2X cycles) is shown in Table 10-10.

Table 10-10. SEARCH Latency from Instruction to SRAM Access Cycle

Number of Devices	Max Table Size	Latency in CLK Cycles
1 (TLSZ = 00)	128K x 72 bits	4
1–8 (TLSZ = 01)	1024K x 72 bits	5
1–31 (TLSZ = 10)	3968K x 72 bits	6

SEARCH latency from command to SRAM access cycle is 4 for a single device in the table with TLSZ = 00. In addition, SSV and SSF shift further to the right for different values of HLAT, as specified in Table 10-11.

Table 10-11. Shift of SSF and SSV from SADR

HLAT	Number of CLK Cycles
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

10.6.2 72-bit SEARCH on Tables Configured as x72 using up to Eight CYNSE70256 Devices

The hardware diagram of the SEARCH subsystem of eight devices is shown in Figure 10-8. The following are the parameters programmed into the eight devices.

- First seven devices (devices 0–6): CFG = 00000000000000000000000000000000, TLSZ = 01, HLAT = 010, LRAM = 0, and LDEV = 0.
- Eighth device (device 7): CFG = 00000000000000000000000000000000, TLSZ = 01, HLAT = 010, LRAM = 1, and LDEV = 1.

Note. All eight devices must be programmed with the same values for TLSZ and HLAT. Only the last device in the table (device number 7 in this case) must be programmed with LRAM = 1 and LDEV = 1. All other upstream devices (devices 0 through 6 in this case) must be programmed with LRAM = 0 and LDEV = 0.

Figure 10-9 shows the timing diagram for a SEARCH command in the 72-bit-configured table of eight devices for device number 0. Figure 10-10 shows the timing diagram for a SEARCH command in the 72-bit-configured table of eight devices for device number 1. Figure 10-11 shows the timing diagram for a SEARCH command in the 72-bit-configured table of eight devices for device number 7 (the last device in this specific table). For these timing diagrams four 72-bit searches are performed sequentially. HIT/MISS assumptions were made as shown below in Table 10-12.

Table 10-12. Hit/Miss Assumptions

SEARCH Number	1	2	3	4
Device 0	Hit	Miss	Hit	Miss
Device 1	Miss	Hit	Hit	Miss
Devices 2–6	Miss	Miss	Miss	Miss
Device 7	Miss	Miss	Hit	Hit

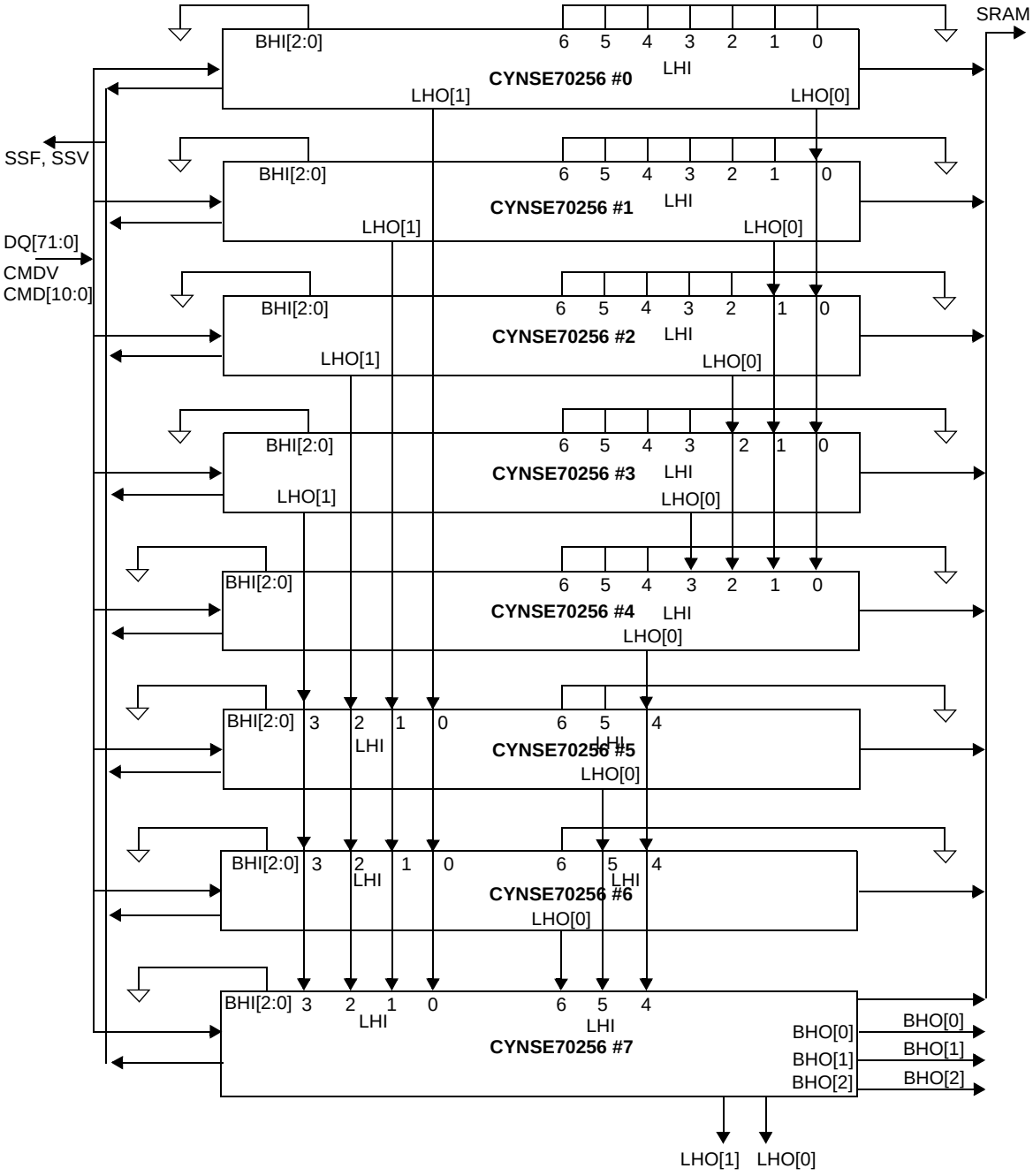
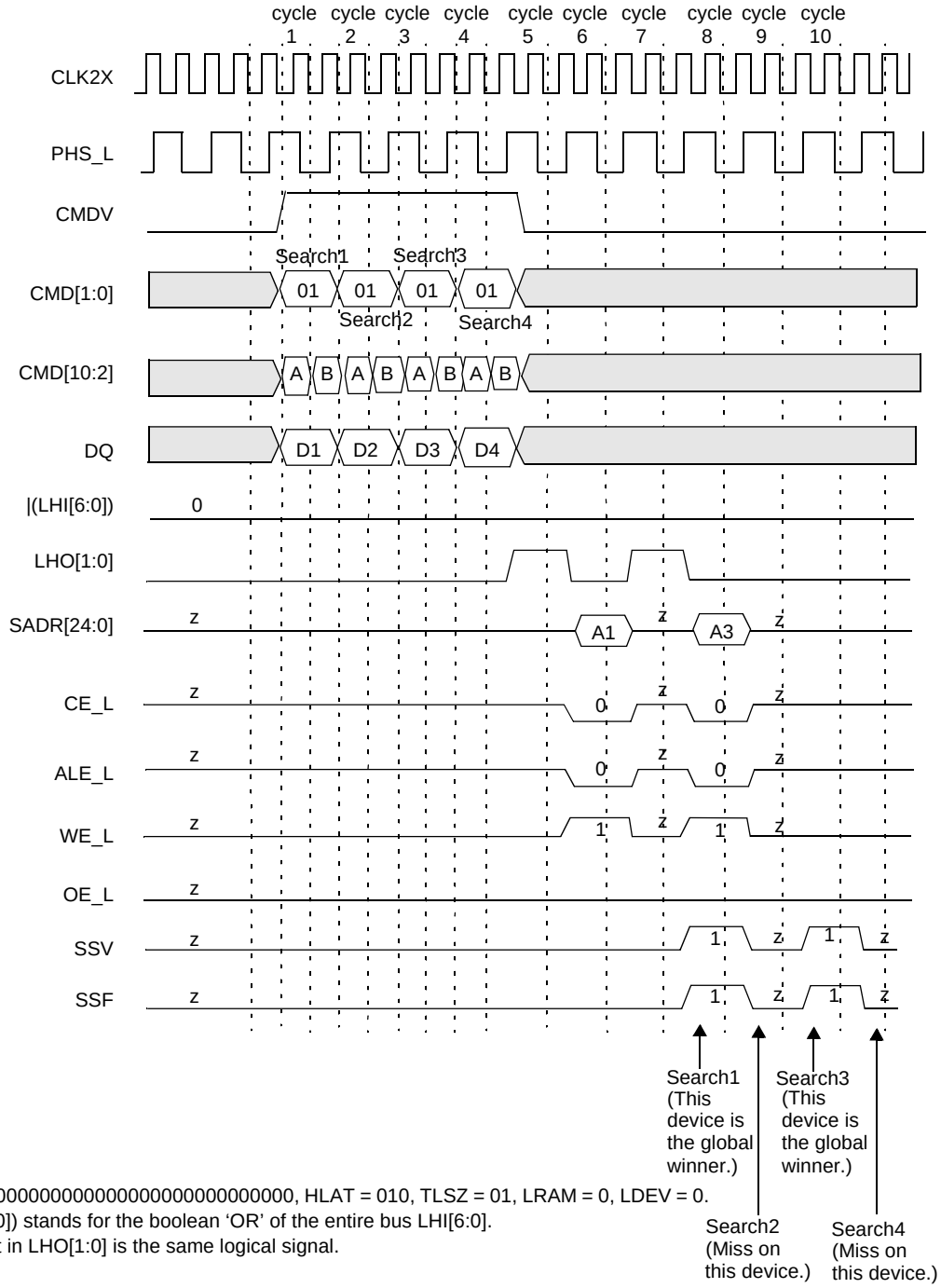
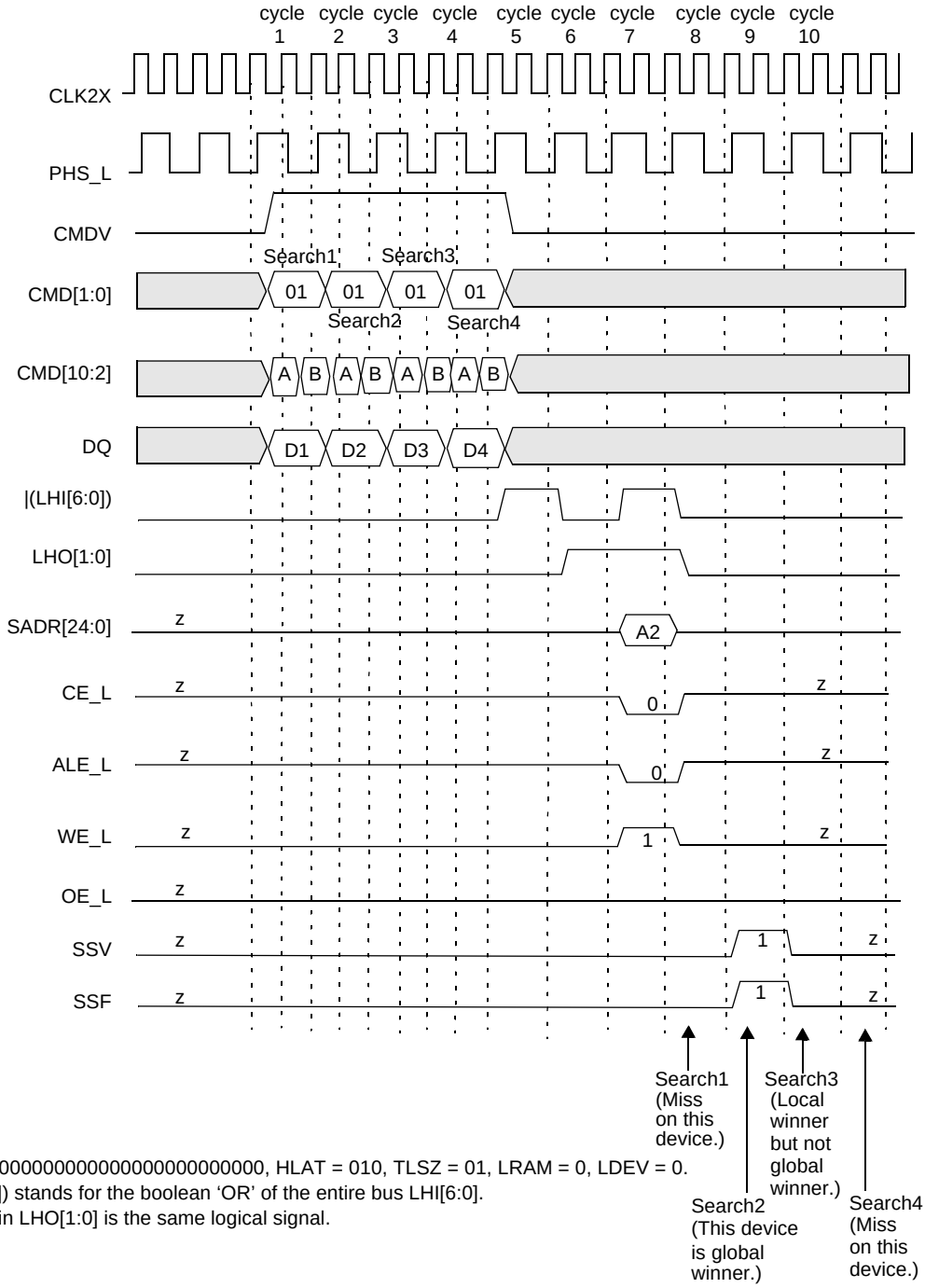


Figure 10-8. Hardware Diagram for a Table with Eight Devices



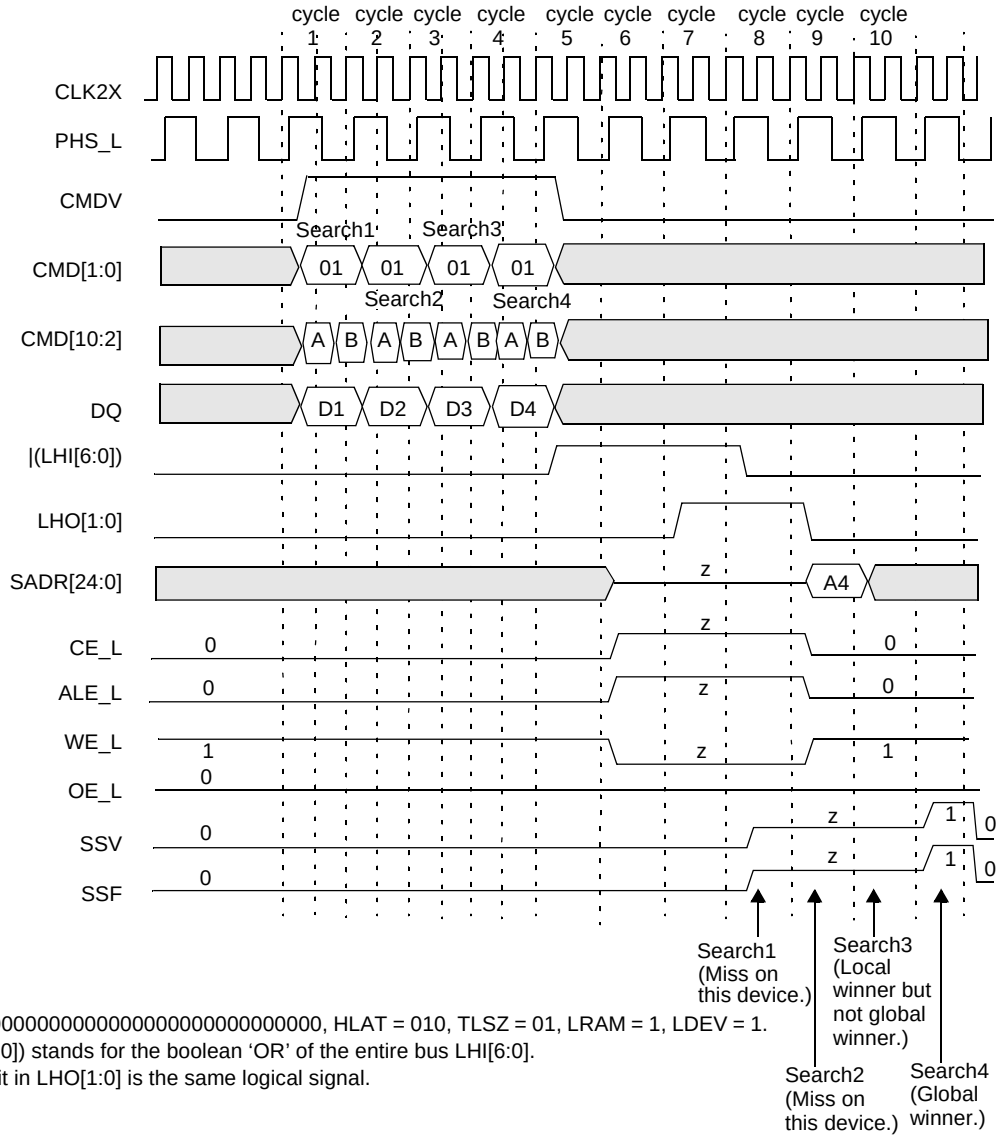
CFG = 00000000000000000000000000000000, HLAT = 010, TLSZ = 01, LRAM = 0, LDEV = 0.
Note: |(LHI[6:0]) stands for the boolean 'OR' of the entire bus LHI[6:0].
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-9. Timing Diagram for 72-bit SEARCH Device Number 0



CFG = 00000000000000000000000000000000, HLAT = 010, TLSZ = 01, LRAM = 0, LDEV = 0.
Note: |(LHI[6:0]) stands for the boolean 'OR' of the entire bus LHI[6:0].
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-10. Timing Diagram for 72-bit SEARCH Device Number 1



CFG = 00000000000000000000000000000000, HLAT = 010, TLSZ = 01, LRAM = 1, LDEV = 1.
Note: |(LHI[6:0]) stands for the boolean 'OR' of the entire bus LHI[6:0].
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-11. Timing Diagram for 72-bit SEARCH Device Number 7 (Last Device)

The following is the sequence of operation for a single 72-bit SEARCH command (also refer to Subsection 10.2, "Commands and Command Parameters," on page 14).

- **Cycle A**: The host ASIC drives CMDV high and applies SEARCH command code (10) to CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair for use in this SEARCH operation. CMD[8:6] signals must be driven with the same bits that will be driven on SADR[24:22] by this device if it has a hit. DQ[71:0] must be driven with the 72-bit data to be compared. The CMD[2] signal must be driven to logic 0.
- **Cycle B**: The host ASIC continues to drive CMDV high and to apply SEARCH command code (10) on CMD[1:0]. CMD[5:2] must be driven by the index of the comparand register pair for storing the 144-bit word presented on the DQ bus during cycles A and B. CMD[8:6] signals must be driven with the index of the SSR that will be used for storing the address of the matching entry and hit flag (see page 8 for a description of SSR[0:7]). The DQ[71:0] continues to carry the 72-bit data to be compared.

Note. For 72-bit searches, the host ASIC must supply the same 72-bit data on DQ[71:0] during both cycles A and B. Also, the even and odd pairs of GMRs selected for the comparison must be programmed with the same value.

The logical 72-bit SEARCH operation is shown in Figure 10-12. The entire table of 72-bit entries (eight devices) is compared to a 72-bit word K (presented on the DQ bus in both cycles A and B of the command) using the GMR and local mask bits. The effective GMR is the 72-bit word specified by the identical value in both even and odd GMR pairs, in each of the eight devices,

and selected by the GMR Index in the command's cycle A. The 72-bit word K (presented on the DQ bus in both cycles A and B of the command) is also stored in both even and odd comparand register pairs (selected by the comparand register index in command cycle B) in each of the eight devices. In the x72 configuration, only the even comparand register can subsequently be used by the LEARN command in one of the devices (the first non-full device only). The word K (presented on the DQ bus in both cycles A and B of the command) is compared with each entry in the table, starting at location 0. The first matching entry's location address L is the winning address that is driven as part of the SRAM address on the SADR[24:0] lines (see Section 12.0, "SRAM Addressing," on page 93). The global winning device will drive the bus in a specific cycle. On a global miss cycle, the device with LRAM = 1 (default driving device for the SRAM bus) and LDEV = 1 (default driving device for SSF and SSV signals) will be the default driver for such missed cycles.

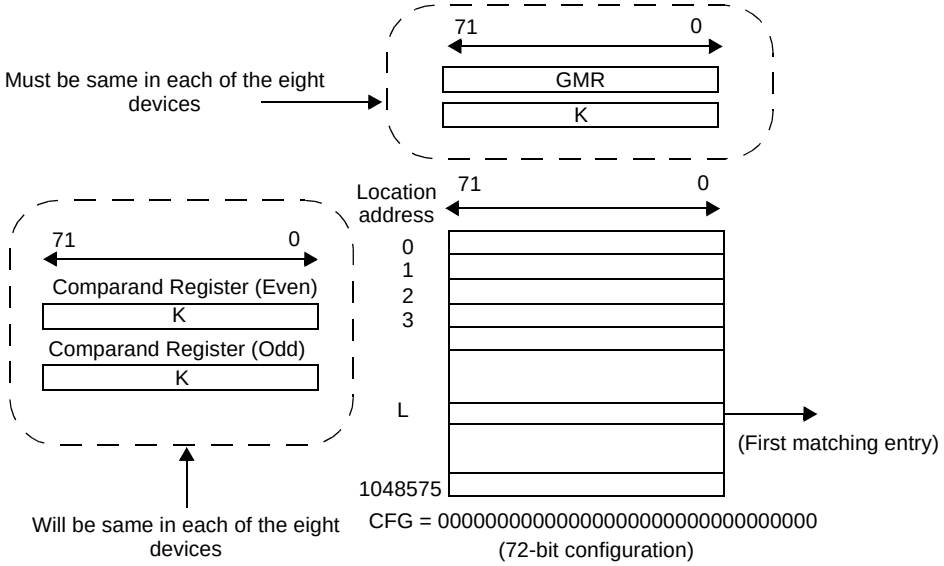


Figure 10-12. x72 Table with Eight Devices

The SEARCH command is a pipelined operation and executes a SEARCH at half the rate of the frequency of CLK2X for 72-bit searches in x72-configured tables. The latency of SADR, CE_L, ALE_L, WE_L, SSV, and SSF from the 72-bit SEARCH command cycle (two CLK2X cycles) is shown in Table 10-13.

Table 10-13. SEARCH Latency from Instruction to SRAM Access Cycle

Number of Devices	Max Table Size	Latency in CLK Cycles
1 (TLSZ = 00)	128K x 72 bits	4
1–8 (TLSZ = 01)	1024K x 72 bits	5
1–31 (TLSZ = 10)	3968K x 72 bits	6

The latency of the SEARCH from command to SRAM access cycle is 5 for up to eight devices in the table (TLSZ = 01). SSV and SSF also shift further to the right for different values of HLAT, as specified in Table 10-14.

Table 10-14. Shift of SSF and SSV from SADR

HLAT	Number of CLK Cycles
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

10.6.3 72-bit SEARCH on Tables Configured as x72 using up to 31 CYNSE70256 Devices

The hardware diagram of the SEARCH subsystem of 31 devices is shown in Figure 10-13. Each of the four blocks in the diagram represents eight CYNSE70256 devices (except the last, which has seven devices). The diagram for a block of eight devices is shown in Figure 10-14. The following are the parameters programmed into the 31 devices.

- First thirty devices (devices 0–29): CFG = 00000000000000000000000000000000, TLSZ = 10, HLAT = 001, LRAM = 0, and LDEV = 0.
- Thirty-first device (device 30): CFG = 00000000000000000000000000000000, TLSZ = 10, HLAT = 001, LRAM = 1, and LDEV = 1.

Note. All 31 devices must be programmed with the same values for TLSZ and HLAT. Only the last device in the table must be programmed with LRAM = 1 and LDEV = 1 (device number 30 in this case). All other upstream devices must be programmed with LRAM = 0 and LDEV = 0 (devices 0 through 29 in this case).

The timing diagrams referred to in this paragraph reference the Hit/Miss assumptions defined in Table 10-15. For the purpose of illustrating the timings, it is further assumed that the there is only one device with a matching entry in each of the blocks. Figure 10-15 shows the timing diagram for a SEARCH command in the 72-bit-configured table of 31 devices for each of the eight devices in block number 0. Figure 10-16 shows the timing diagram for a SEARCH command in the 72-bit-configured table of 31 devices for the all the devices in block number 1 (above the winning device in that block). Figure 10-17 shows the timing diagram for the globally winning device (defined as the final winner within its own and all blocks) in block number 1. Figure 10-18 shows the timing diagram for all the devices below the globally winning device in block number 1. Figure 10-19, Figure 10-20, and Figure 10-21. show the timing diagrams of the devices above the globally winning device, the globally winning device, and the devices below the globally winning device, respectively, for block number 2. Figure 10-22, Figure 10-23, Figure 10-24, and Figure 10-25 show the timing diagrams of the devices above globally winning device, the globally winning device, and the devices below the globally winning device except the last device (device 30), respectively, for block number 3.

The 72-bit SEARCH operation is pipelined and executes as follows. Four cycles from the SEARCH command, each of the devices knows the outcome internal to it for that operation. In the fifth cycle after the SEARCH command, the devices in a block arbitrate for a winner among them (a “block” being defined as less than or equal to eight devices resolving the winner within them using the LHI[6:0] and LHO[1:0] signalling mechanism). In the sixth cycle after the SEARCH command, the blocks (of devices) resolve the winning block through the BHI[2:0] and BHO[2:0] signalling mechanism. The winning device within the winning block is the global winning device for a SEARCH operation.

Table 10-15. Hit/Miss Assumptions

SEARCH Number	1	2	3	4
Block 0	Miss	Miss	Miss	Miss
Block 1	Miss	Miss	Hit	Miss
Block 2	Miss	Hit	Hit	Miss
Block 3	Hit	Hit	Miss	Miss

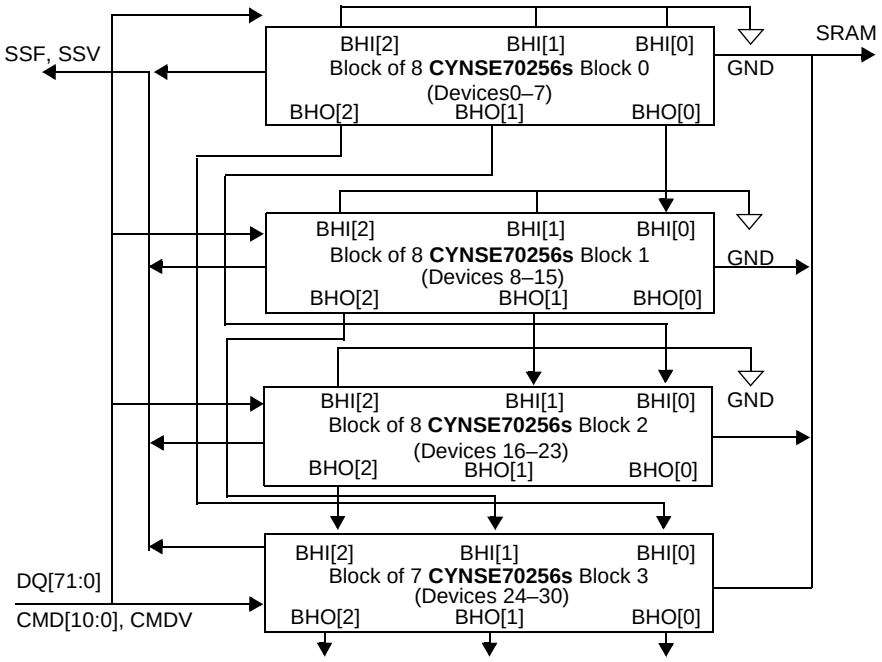


Figure 10-13. Hardware Diagram for a Table with 31 Devices

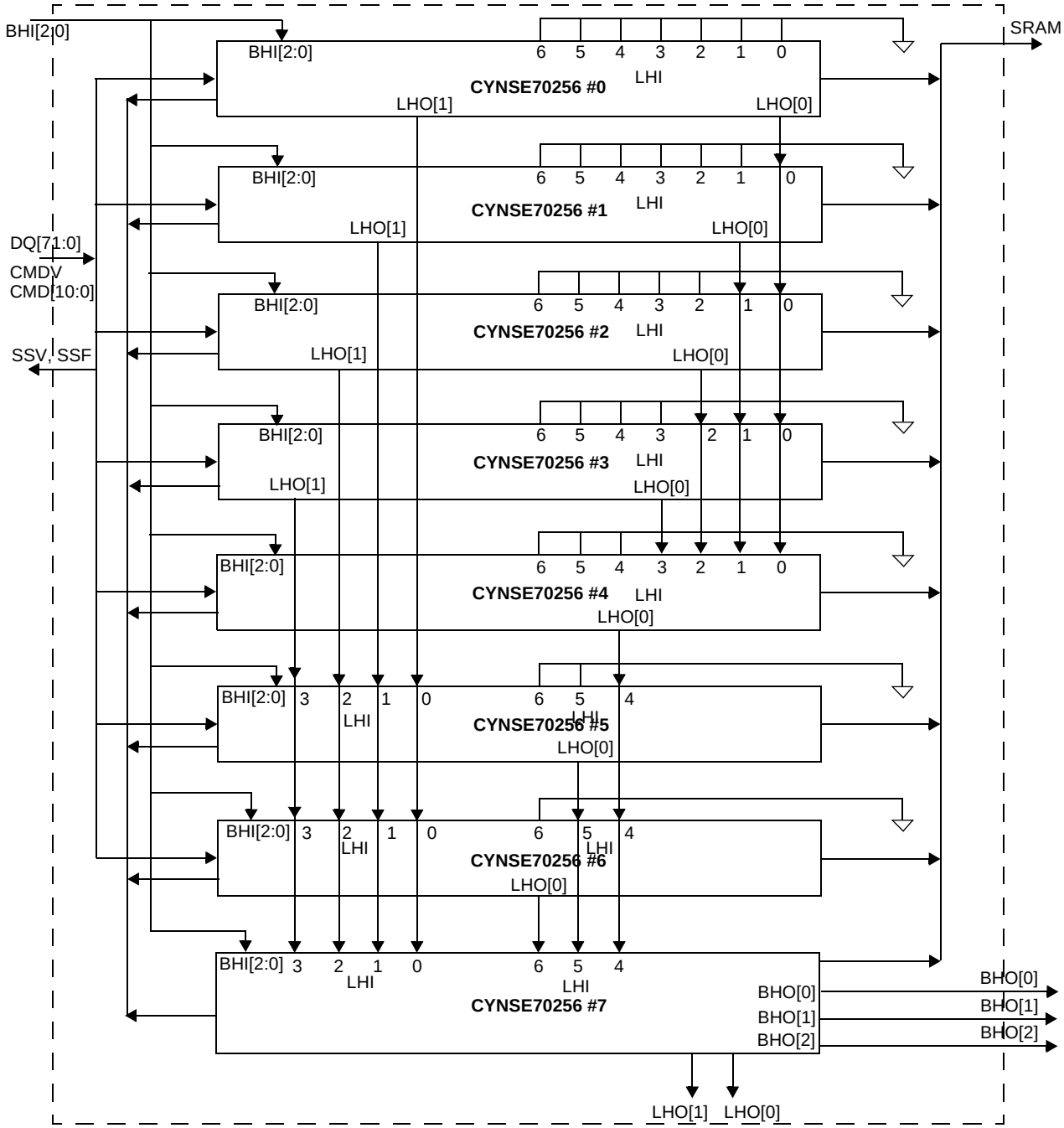
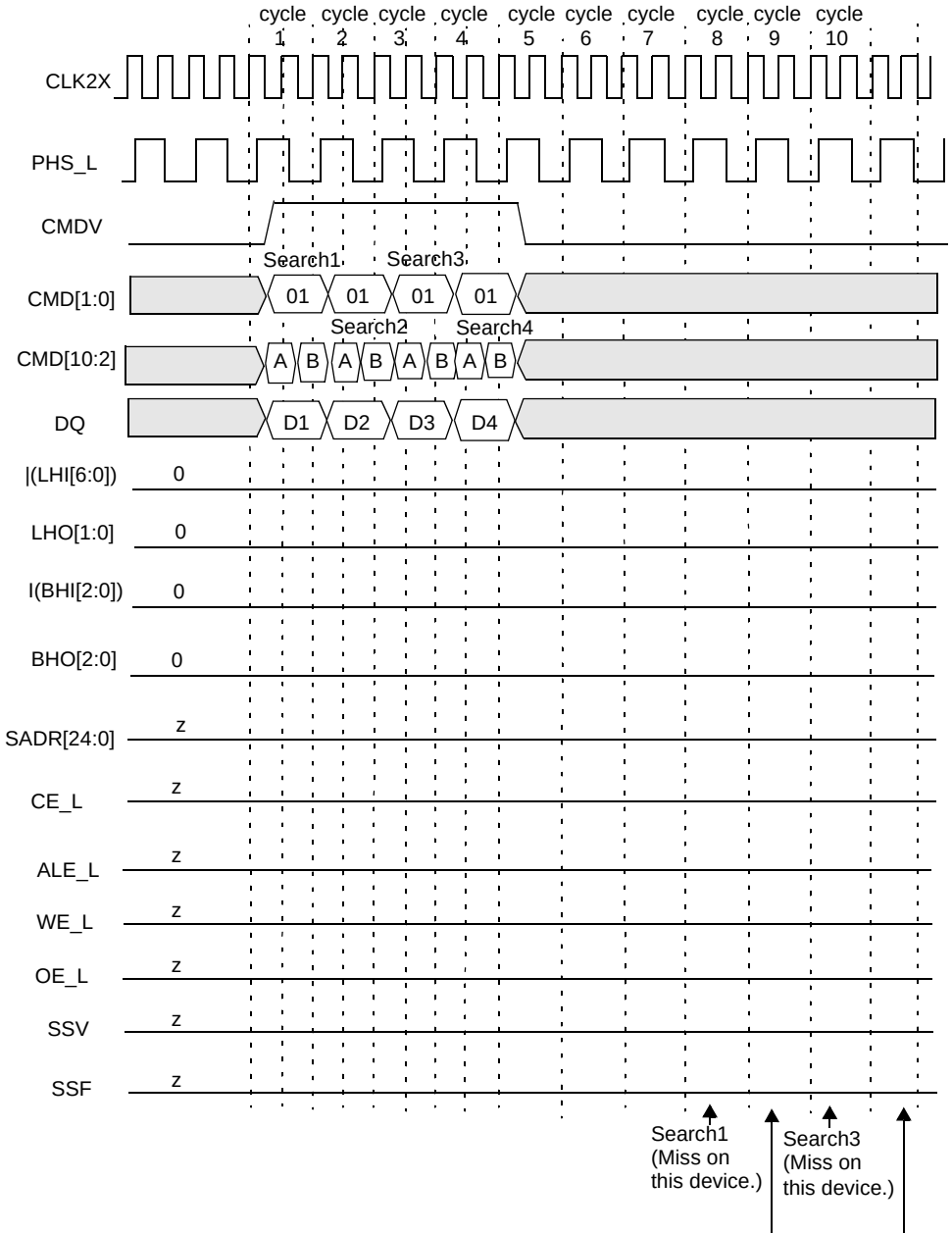
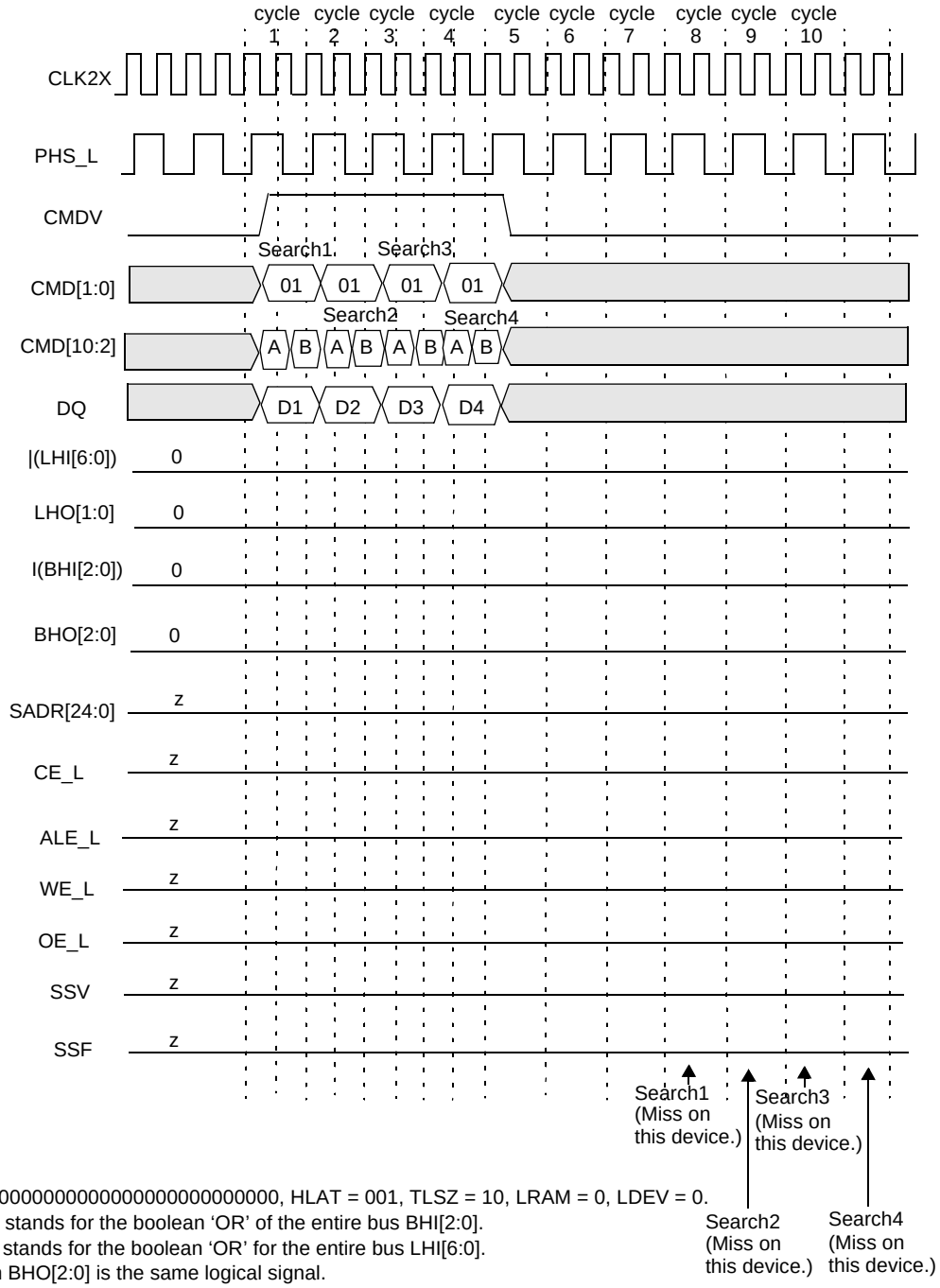


Figure 10-14. Hardware Diagram for a Block of up to Eight Devices



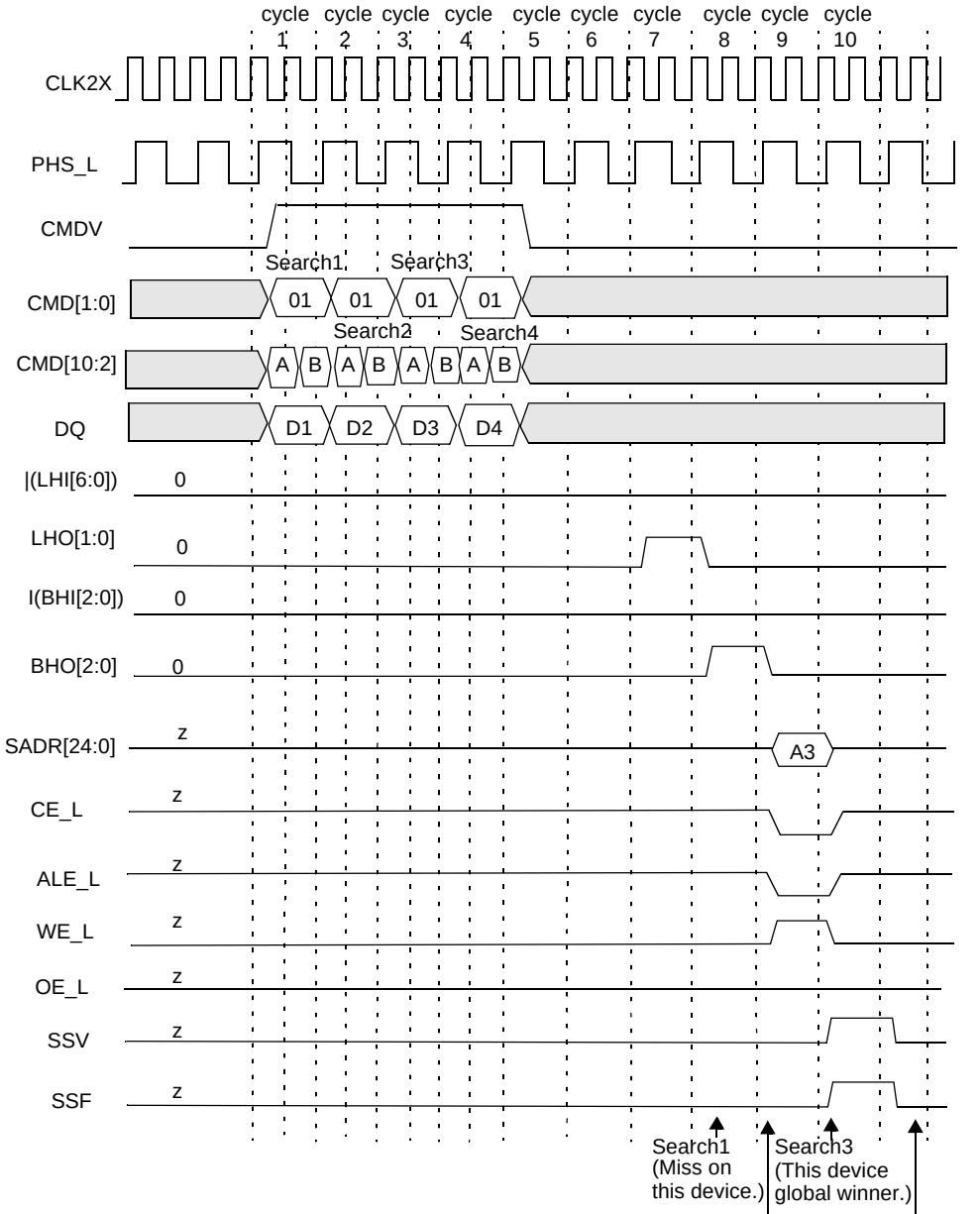
CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-15. Timing Diagram for Each Device in Block Number 0 (Miss on Each Device)



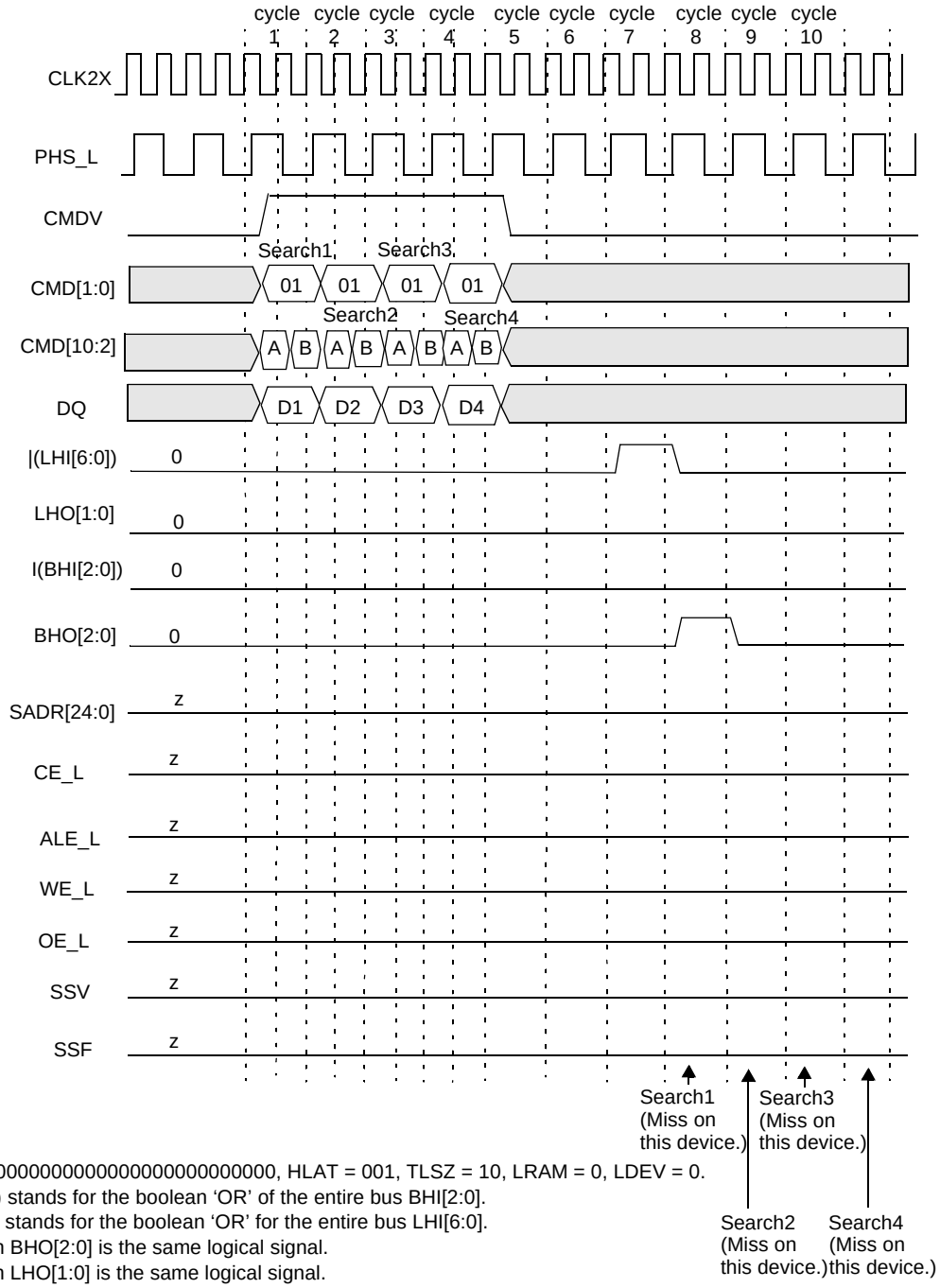
CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0)] stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-16. Timing Diagram for Each Device Above the Winning Device in Block Number 1



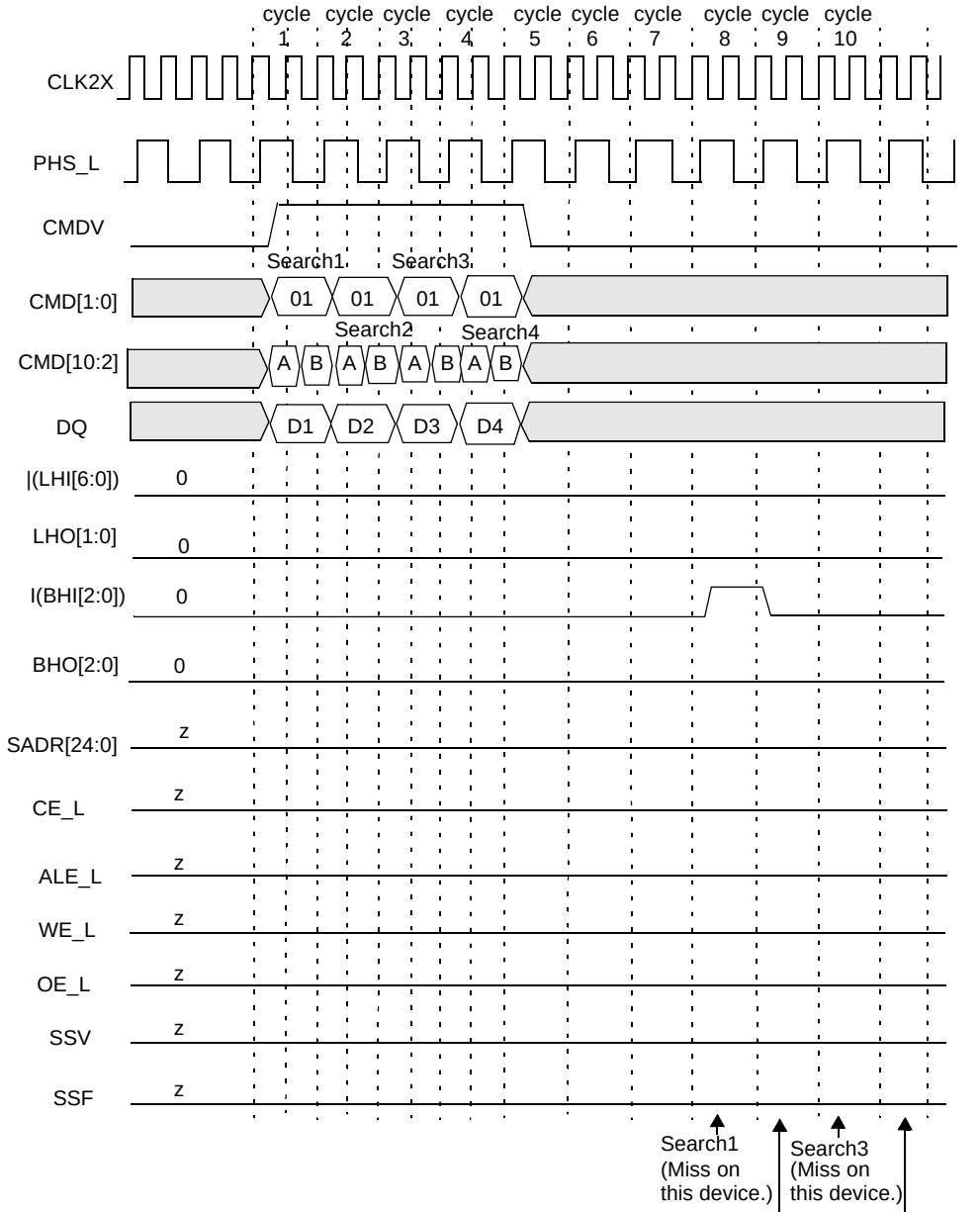
CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-17. Timing Diagram for Globally Winning Device in Block Number 1



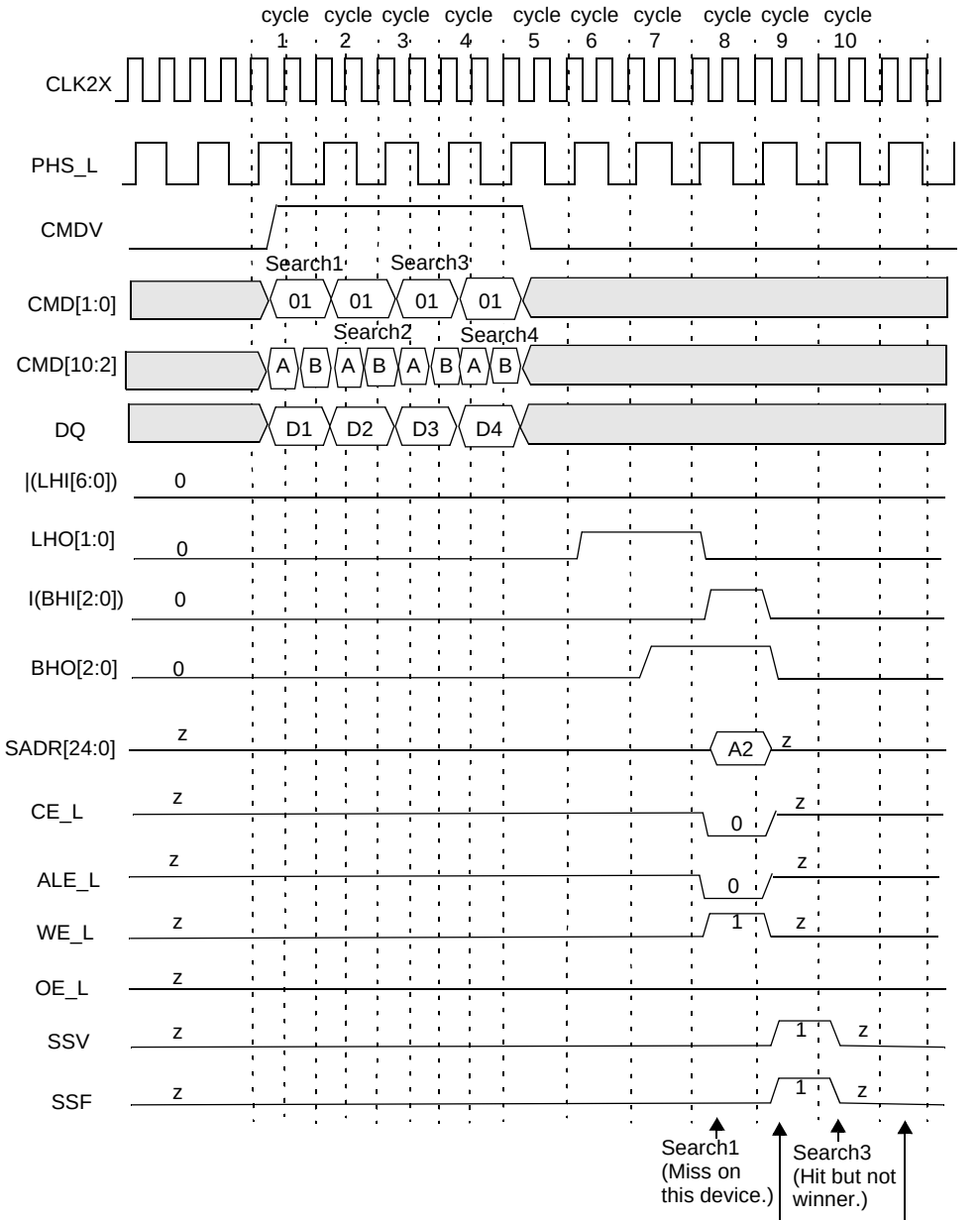
CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-18. Timing Diagram for Devices Below the Winning Device in Block Number 1



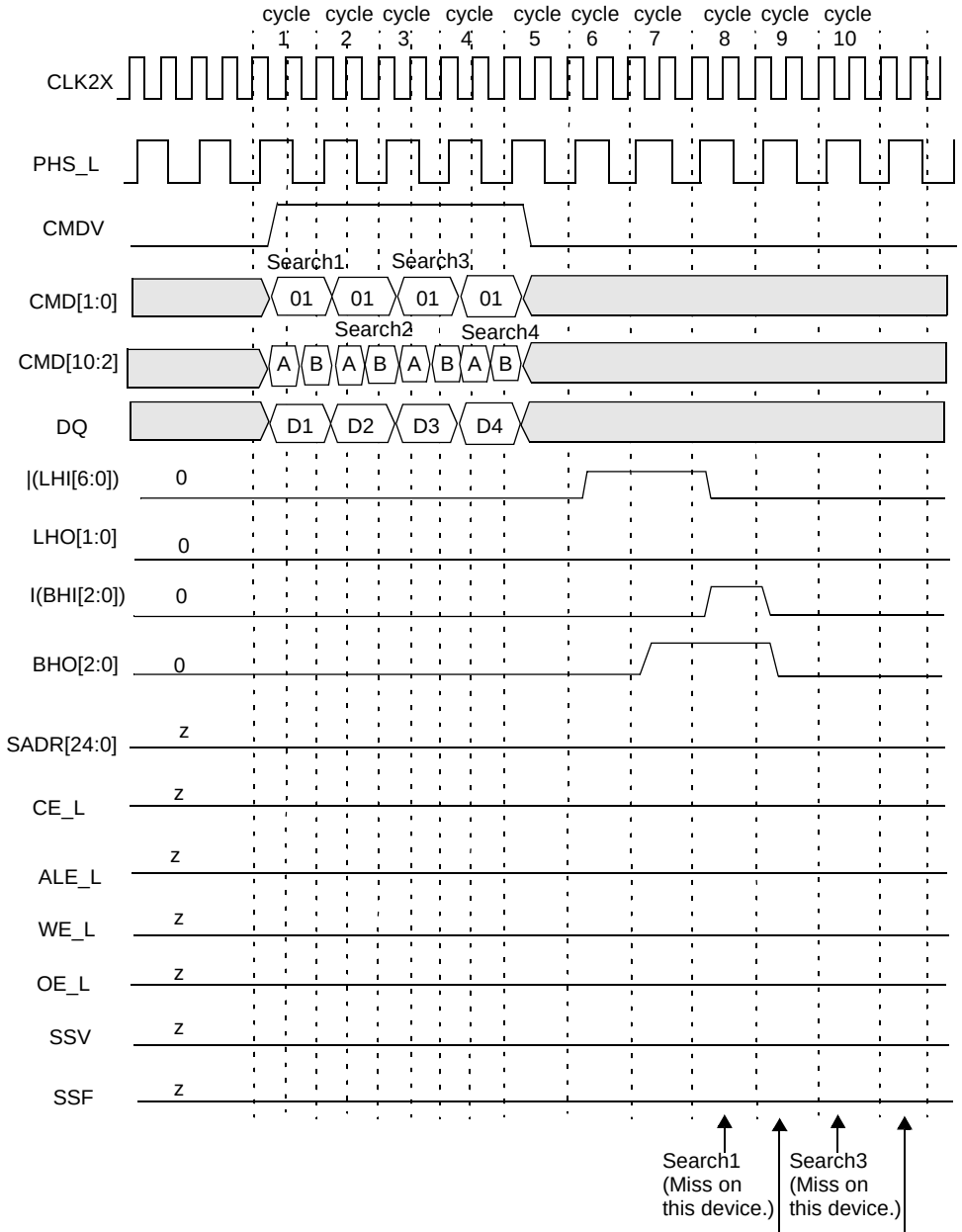
CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-19. Timing Diagram for Devices Above the Winning Device in Block Number 2



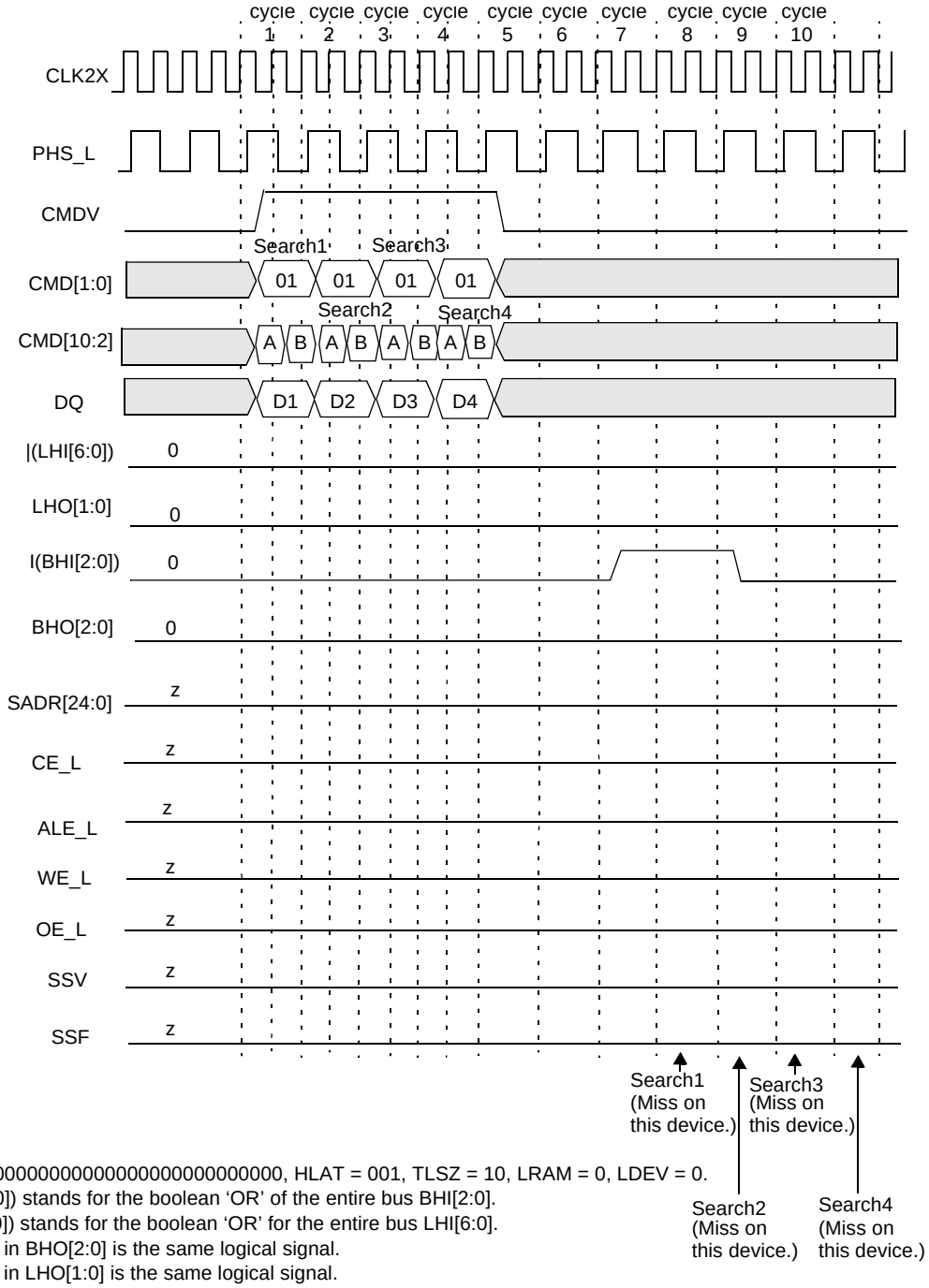
CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-20. Timing Diagram for Globally Winning Device in Block Number 2



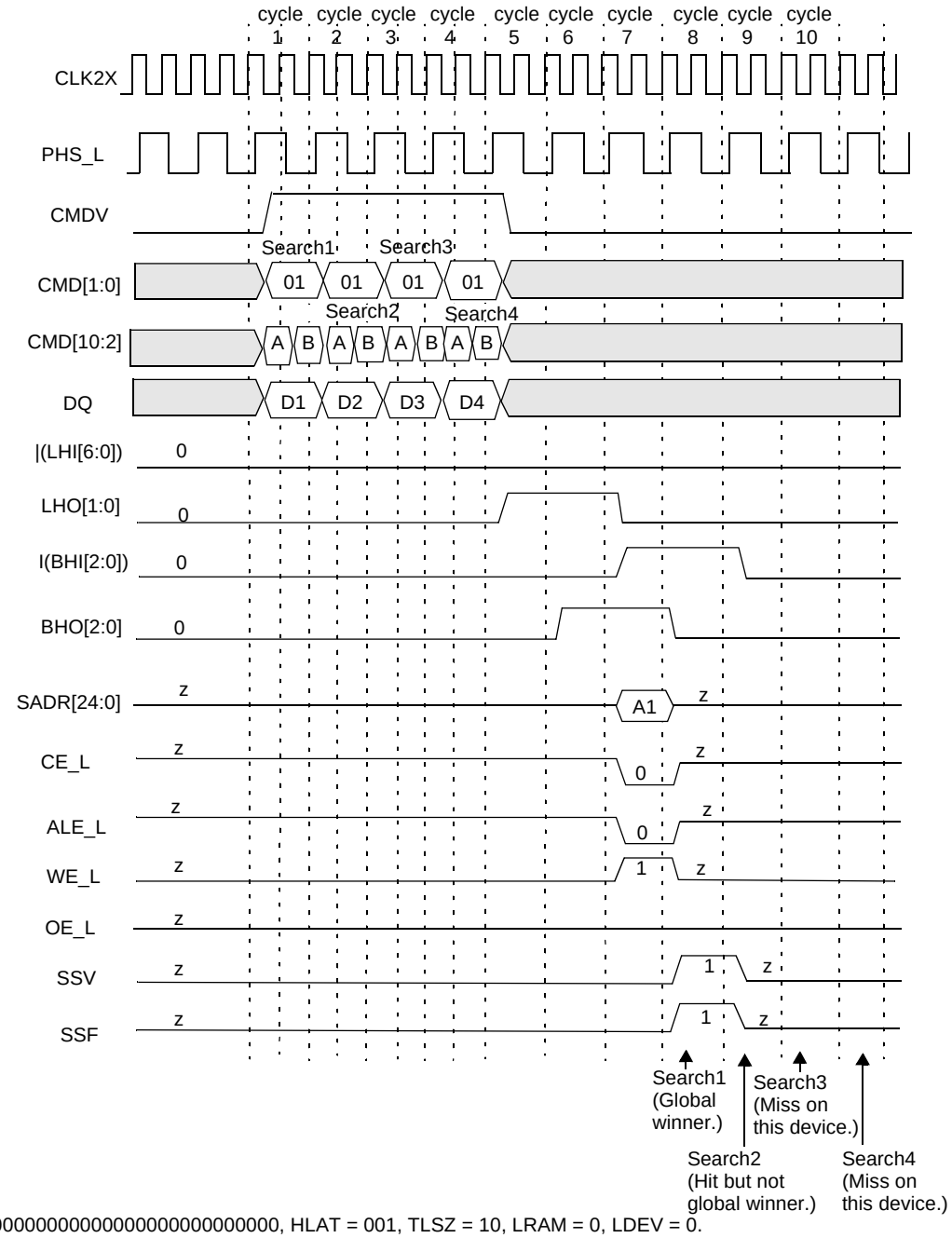
CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-21. Timing Diagram for Devices Below the Winning Device in Block Number 2



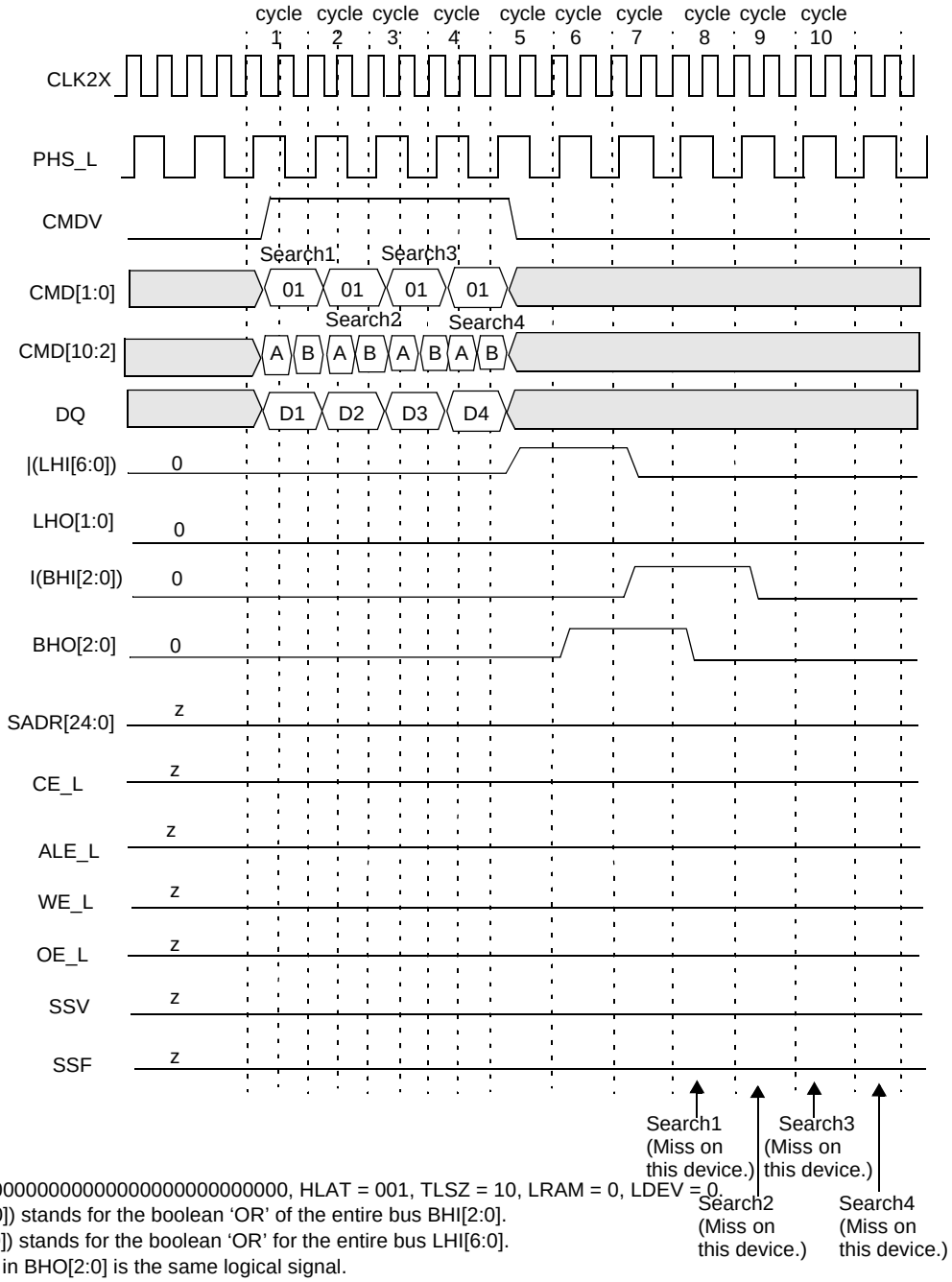
CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-22. Timing Diagram for Devices Above the Winning Device in Block Number 3



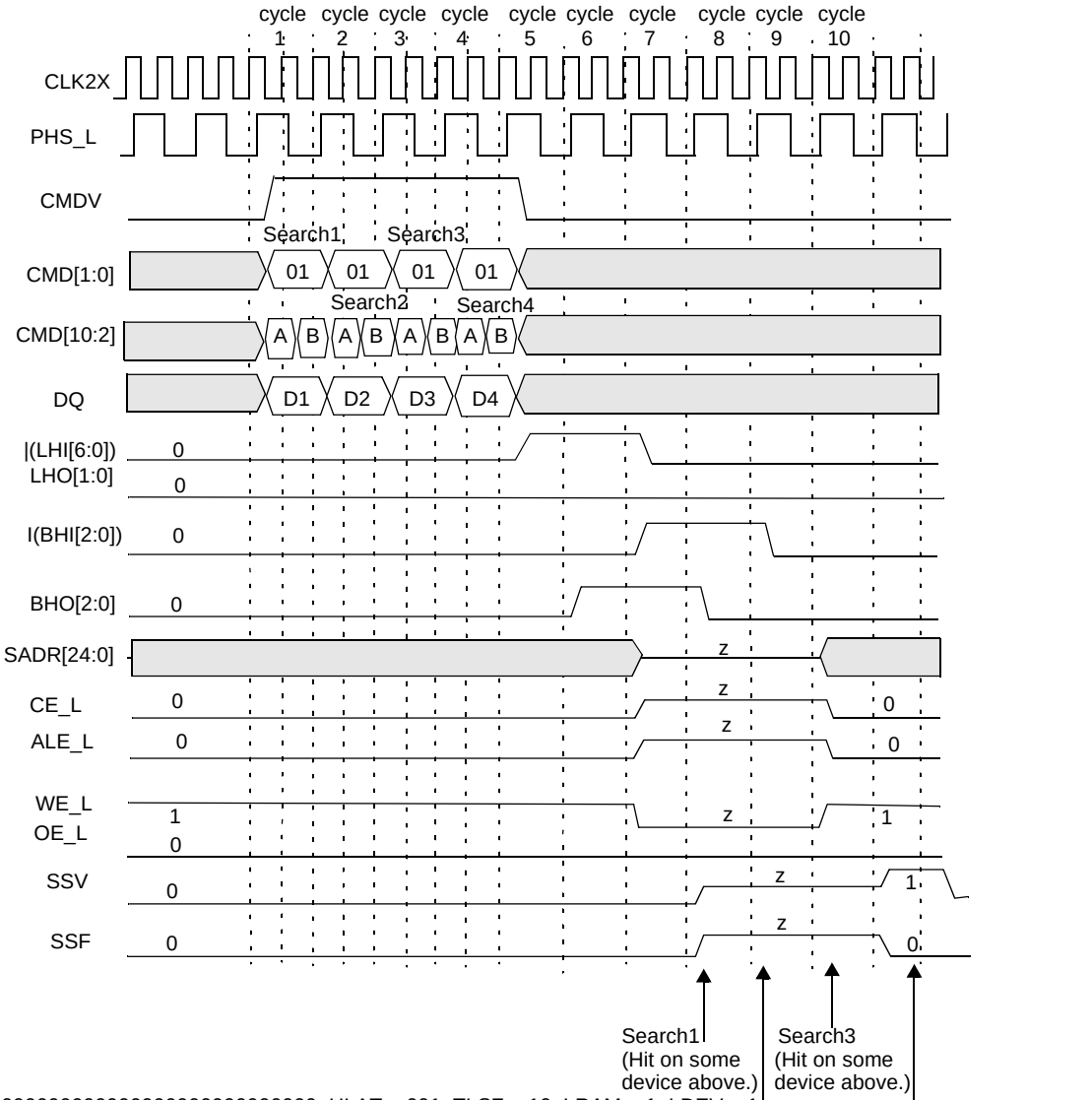
CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-23. Timing Diagram for Globally Winning Device in Block Number 3



CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-24. Timing Diagram for Devices Below the Winning Device in Block Number 3 (Except the Last Device [Device 30])



CFG = 00000000000000000000000000000000, HLAT = 001, TLSZ = 10, LRAM = 1, LDEV = 1

Note: |(BHI[2:0)] stands for the boolean 'OR' of the entire bus BHI[2:0].

Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].

Note: Each bit in BHO[2:0] is the same logical signal.

Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-25. Timing Diagram for Device Number 6 in Block Number 3 (Device 30 in Depth-Cascaded Table)

The following is the sequence of operation for a single 72-bit SEARCH command (also refer to Subsection 10.2, "Commands and Command Parameters," on page 14).

- **Cycle A**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair for use in this SEARCH operation. CMD[8:6] signals must be driven with the same bits that will be driven on SADR[24:22] by this device if it has a hit. DQ[71:0] must be driven with the 72-bit data to be compared. The CMD[2] signal must be driven to a logic 0.
- **Cycle B**: The host ASIC continues to drive CMDV high and applies SEARCH command (10) on CMD[1:0]. CMD[5:2] must be driven by the index of the comparand register pair for storing the 144-bit word presented on the DQ bus during cycles A and B. CMD[8:6] signals must be driven with the index of the SSR that will be used for storing the address of the matching entry and the hit flag (see page 8 for the description of SSR[0:7]). The DQ[71:0] continues to carry the 72-bit data to be compared. **Note**. For 72-bit searches, the host ASIC must supply the same 72-bit data on DQ[71:0] during both cycles A and B. The even and odd pair of GMRs selected for the compare must be programmed with the same value.

The logical 72-bit SEARCH operation is shown in Figure 10-26. The entire table (31 devices of 72-bit entries) is compared to a 72-bit word K (presented on the DQ bus in both cycles A and B of the command) using the GMR and local mask bits. The effective GMR is the 72-bit word specified by the identical value, in both even and odd GMR pairs in each of the eight devices, and selected by the GMR index in the command's cycle A. The 72-bit word K (presented on the DQ bus in both cycles A and B of the command) is also stored in both even and odd comparand register pairs, in each of the eight devices, and selected by the comparand register index in command cycle B. In the x72 configuration, the even comparand register can be subsequently used by the LEARN command only in the first non-full device. The word K (presented on the DQ bus in both cycles A and B of the command) is compared with each entry in the table, starting at location 0. The first matching entry's location address L is the winning address that is driven as part of the SRAM address on the SADR[24:0] lines (see "SRAM Addressing" on page 93). The global winning device will drive the bus in a specific cycle. On global miss cycles, the device with LRAM = 1 and LDEV = 1 will be the default driver for such missed cycles.

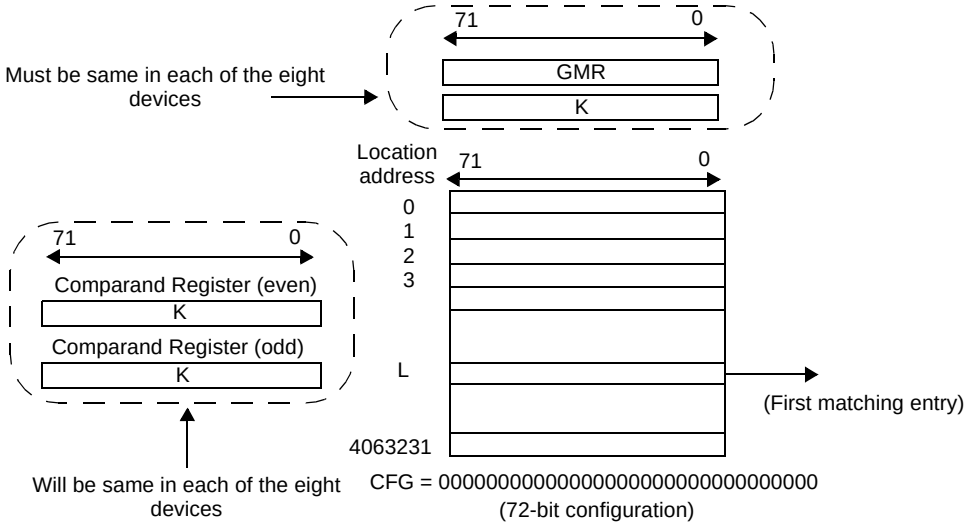


Figure 10-26. x72 Table with 31 Devices

The SEARCH command is a pipelined operation and executes a SEARCH at half the rate of the frequency of CLK2X for 72-bit searches in x72-configured tables. The latency of SADR, CE_L, ALE_L, WE_L, SSV, and SSF from the 72-bit SEARCH command cycle (two CLK2X cycles) is shown in Table 10-16.

Table 10-16. SEARCH Latency from Instruction to SRAM Access Cycle

Number of Devices	Max Table Size	Latency in CLK Cycles
1 (TLSZ = 00)	128K x 72 bits	4
1–8 (TLSZ = 01)	1024K x 72 bits	5
1–31 (TLSZ = 10)	3968K x 72 bits	6

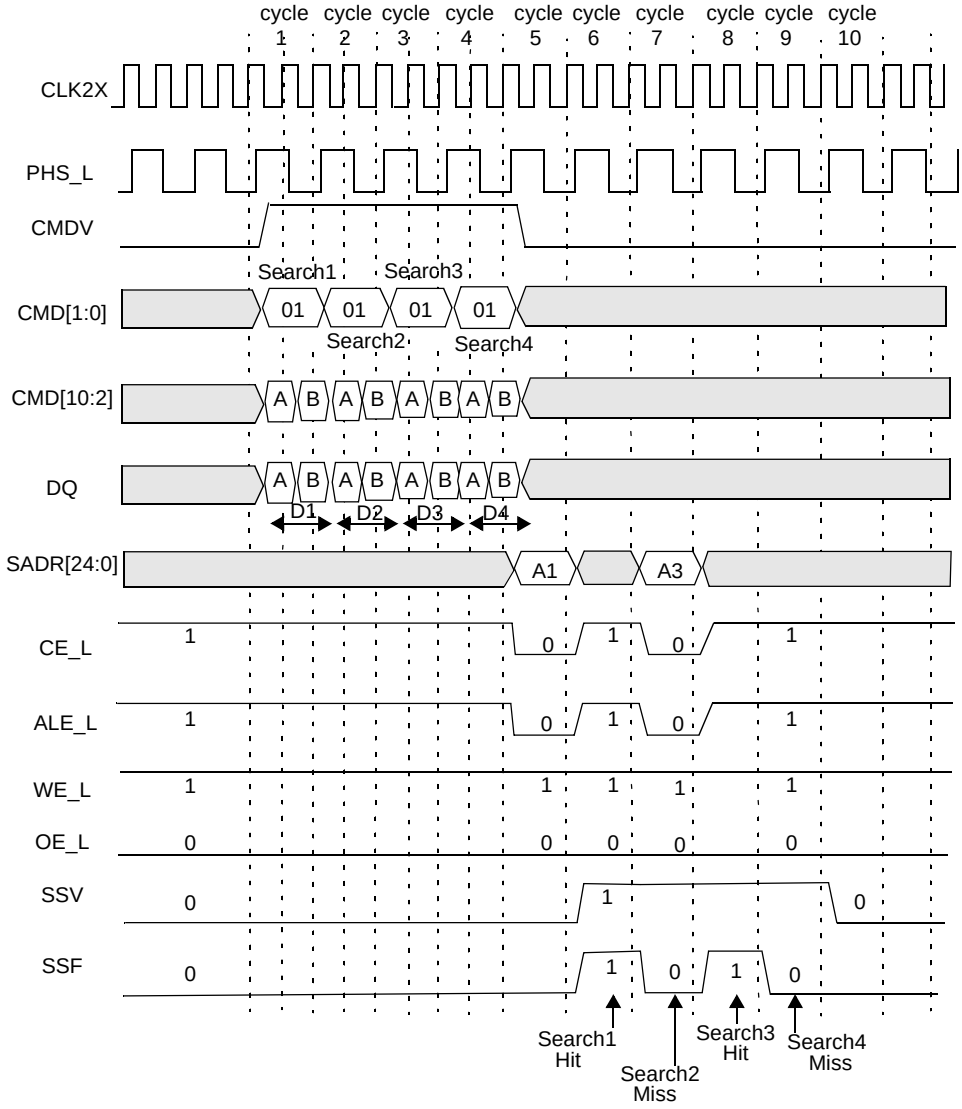
For up to 31 devices in the table (TLSZ = 10), SEARCH latency is 6 from command to SRAM access cycle. In addition, SSV and SSF shift further to the right for different values of HLAT, as specified in Table 10-17.

Table 10-17. Shift of SSF and SSV from SADR

HLAT	Number of CLK Cycles
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

10.6.4 144-bit SEARCH on Tables Configured as x144 using a Single CYNSE70256 Device

Figure 10-27 shows the timing diagram for a SEARCH command in the 144-bit-configured table (CFG = 01010101010101010101010101010101) consisting of a single device for one set of parameters: TLSZ = 00, HLAT = 001, LRAM = 1, and LDEV = 1. The hardware diagram for this SEARCH subsystem is shown in Figure 10-28.



CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 00, LRAM = 1, LDEV = 1.

Figure 10-27. Timing Diagram for 144-bit SEARCH (One Device)

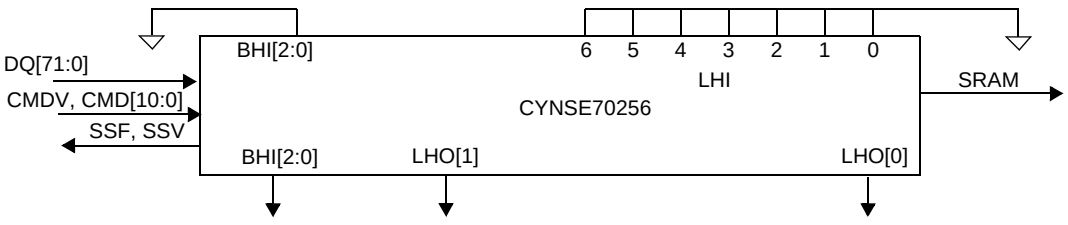


Figure 10-28. Hardware Diagram for a Table with One Device

The following is the operation sequence for a single 144-bit SEARCH command (also refer to Subsection 10.2, “Commands and Command Parameters,” on page 14).

- **Cycle A**: The host ASIC drives CMDV high and applies SEARCH command code (10) to CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index of the GMR pair for use in this SEARCH operation. CMD[8:6] signals must be driven with the same bits that will be driven on SADR[24:22] by this device if it has a hit. DQ[71:0] must be driven with the 72-bit data ([143:72]) to be compared against all even locations. The CMD[2] signal must be driven to logic 0.
- **Cycle B**: The host ASIC continues to drive CMDV high and applies SEARCH command (10) on CMD[1:0]. CMD[5:2] must be driven by the index of the comparand register pair for storing the 144-bit word presented on the DQ bus during cycles A and B. CMD[8:6] signals must be driven with the index of the SSR that will be used for storing the address of the matching entry and hit flag (see page 8 for the description of SSR[0:7]). The DQ[71:0] is driven with 72-bit data ([71:0]), compared to all odd locations.

Note. For 144-bit searches, the host ASIC must supply two distinct 72-bit data words on DQ[71:0] during cycles A and B. The even-numbered GMR of the pair specified by the GMR index is used for masking the word in cycle A. The odd-numbered GMR of the pair specified by the GMR Index is used for masking the word in cycle B.

The logical 144-bit SEARCH operation is shown in Figure 10-29. The entire table of 144-bit entries is compared to a 144-bit word K (presented on the DQ bus in cycles A and B of the command) using the GMR and local mask bits. The GMR is the 144-bit word specified by the even and odd global mask pair selected by the GMR index in the command's cycle A. The 144-bit word K (presented on the DQ bus in cycles A and B of the command) is also stored in both even and odd comparand register pairs selected by the comparand register index in command cycle B. The two comparand registers can subsequently be used by the LEARN command with the even comparand register stored in an even location, and the odd comparand register stored in an adjacent odd location. The word K (presented on the DQ bus in cycles A and B of the command) is compared with each entry in the table, starting at location 0. The first matching entry's location address L (the winning address) is driven as part of the SRAM address on the SADR[24:0] lines (see "SRAM Addressing" on page 93). **Note**. For a 144-bit SEARCH, the matching address is always going to be even.

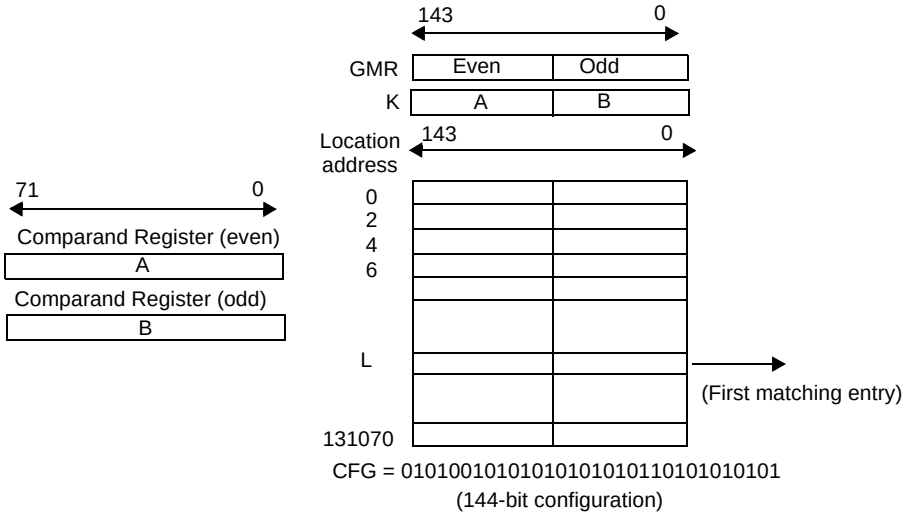


Figure 10-29. x144 Table with One Device

The SEARCH command is a pipelined operation that executes searches at half the rate of the frequency of CLK2X for 144-bit searches in x144-configured tables. The latency of SADR, CE_L, ALE_L, WE_L, SSV, and SSF from the 144-bit SEARCH command cycle (two CLK2X cycles) is shown in Table 10-18.

Table 10-18. SEARCH Latency from Instruction to SRAM Access Cycle

Number of Devices	Max Table Size	Latency in CLK cycles
1 (TLSZ = 00)	64K x 144 bits	4
1–8 (TLSZ = 01)	512K x 144 bits	5
1–31 (TLSZ = 10)	1984K x 144 bits	6

For a single device in the table (with TLSZ = 00), the latency of the SEARCH from command to SRAM access cycle is 4. In addition, SSV and SSF shift further to the right for different values of HLAT, as specified in Table 10-19.

Table 10-19. Shift of SSF and SSV from SADR

HLAT	Number of CLK Cycles
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

10.6.5 144-bit SEARCH on Tables Configured as x144 using up to Eight CYNSE70256 Devices

The hardware diagram of the SEARCH subsystem of eight devices is shown in Figure 10-30. The following are parameters that are programmed into the eight devices.

- First seven devices (devices 0–6): CFG = 010101010101010101010101010101, TLSZ = 01, HLAT = 010, LRAM = 0, and LDEV = 0.
- Eighth device (device 7): CFG = 010101010101010101010101010101, TLSZ = 01, HLAT = 010, LRAM = 1, and LDEV = 1.

Note. All eight devices must be programmed with the same value of TLSZ and HLAT. Only the last device in the table must be programmed with LRAM = 1 and LDEV = 1 (device number 7 in this case). All other upstream devices must be programmed with LRAM = 0 and LDEV = 0 (devices 0 through 6 in this case).

Figure 10-31 shows the timing diagram for a SEARCH command in the 144-bit-configured table of eight devices for device number 0. Figure 10-32 shows the timing diagram for a SEARCH command in the 144-bit-configured table consisting of eight devices for device number 1. Figure 10-33 shows the timing diagram for a SEARCH command in the 144-bit configured table consisting of eight devices for device number 7 (the last device in this specific table). For these timing diagrams, the four 144-bit searches are performed sequentially, and the following Hit/Miss assumptions are made (see Table 10-20).

Table 10-20. Hit/Miss Assumptions

SEARCH Number	1	2	3	4
Device 0	Hit	Miss	Hit	Miss
Device 1	Miss	Hit	Hit	Miss
Devices 2–6	Miss	Miss	Miss	Miss
Device 7	Miss	Miss	Hit	Hit

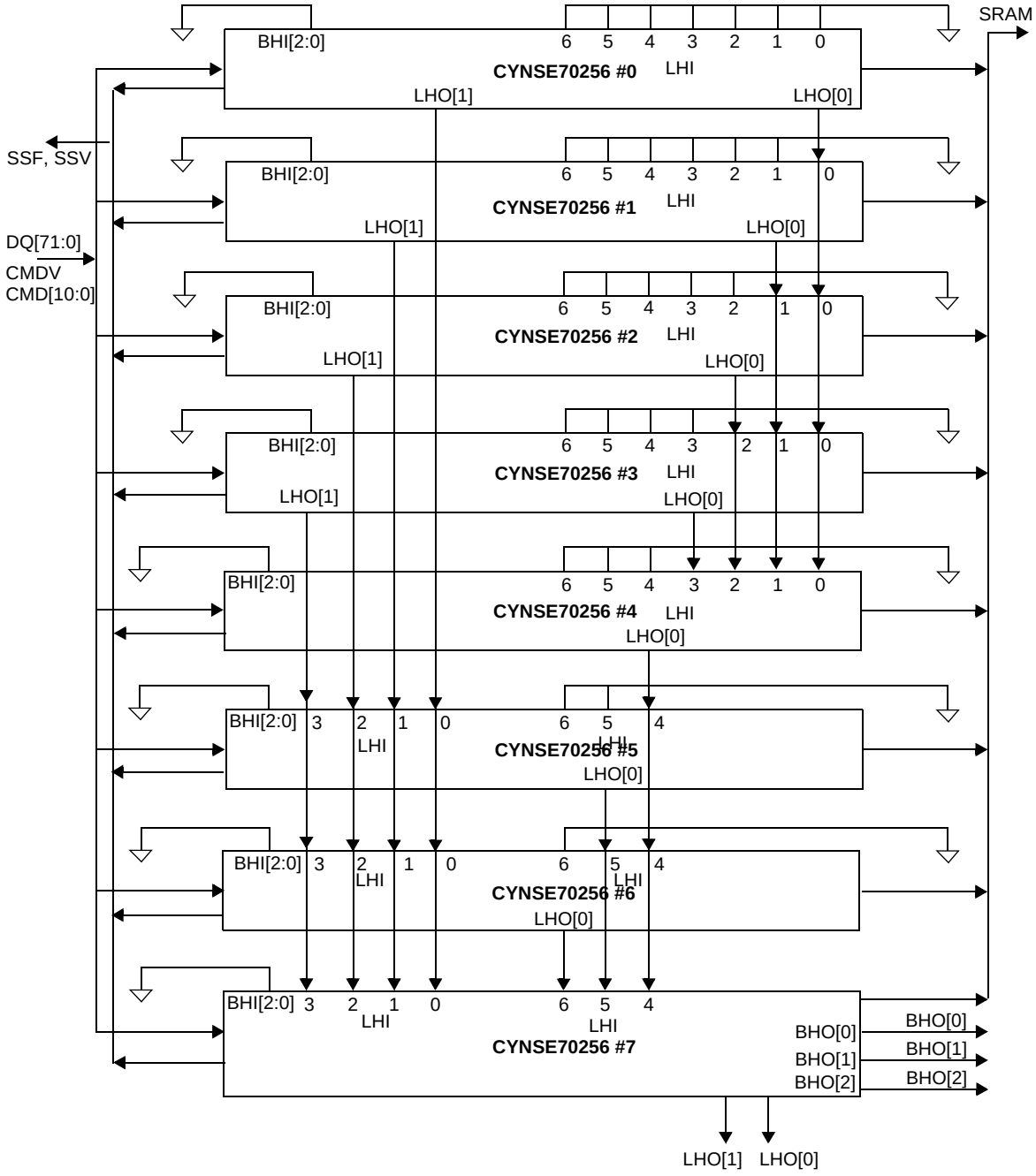
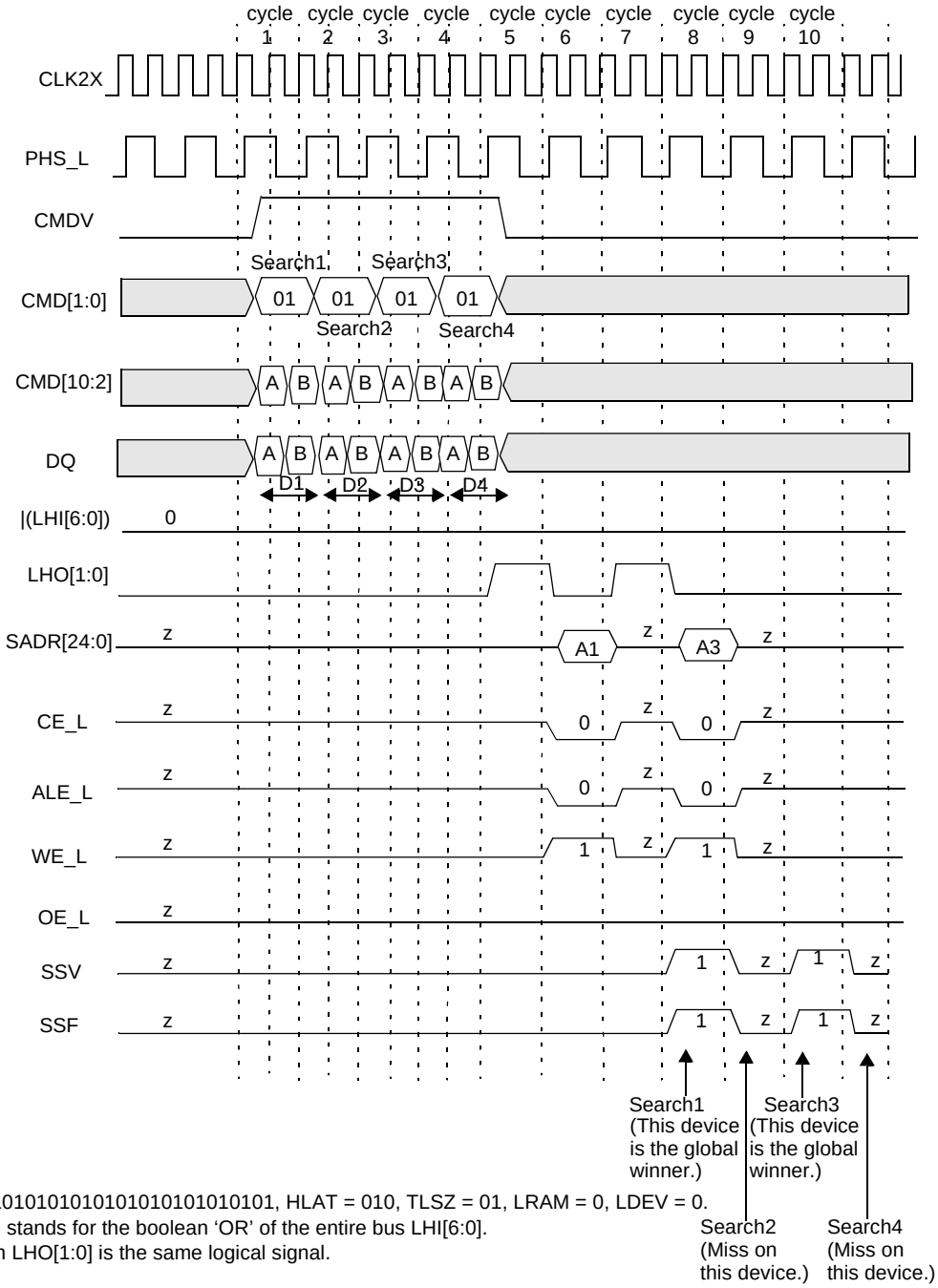
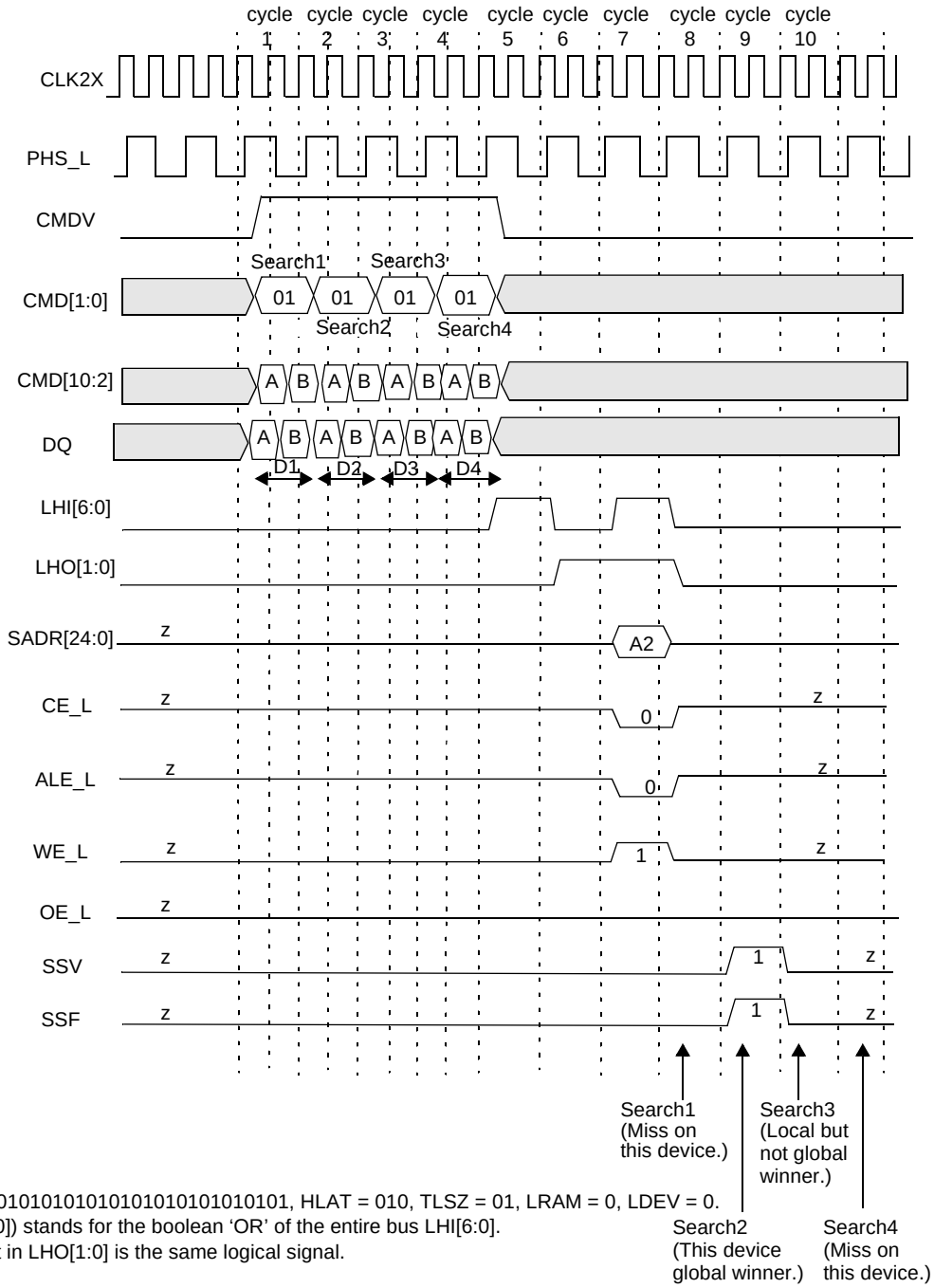


Figure 10-30. Hardware Diagram for a Table with Eight Devices



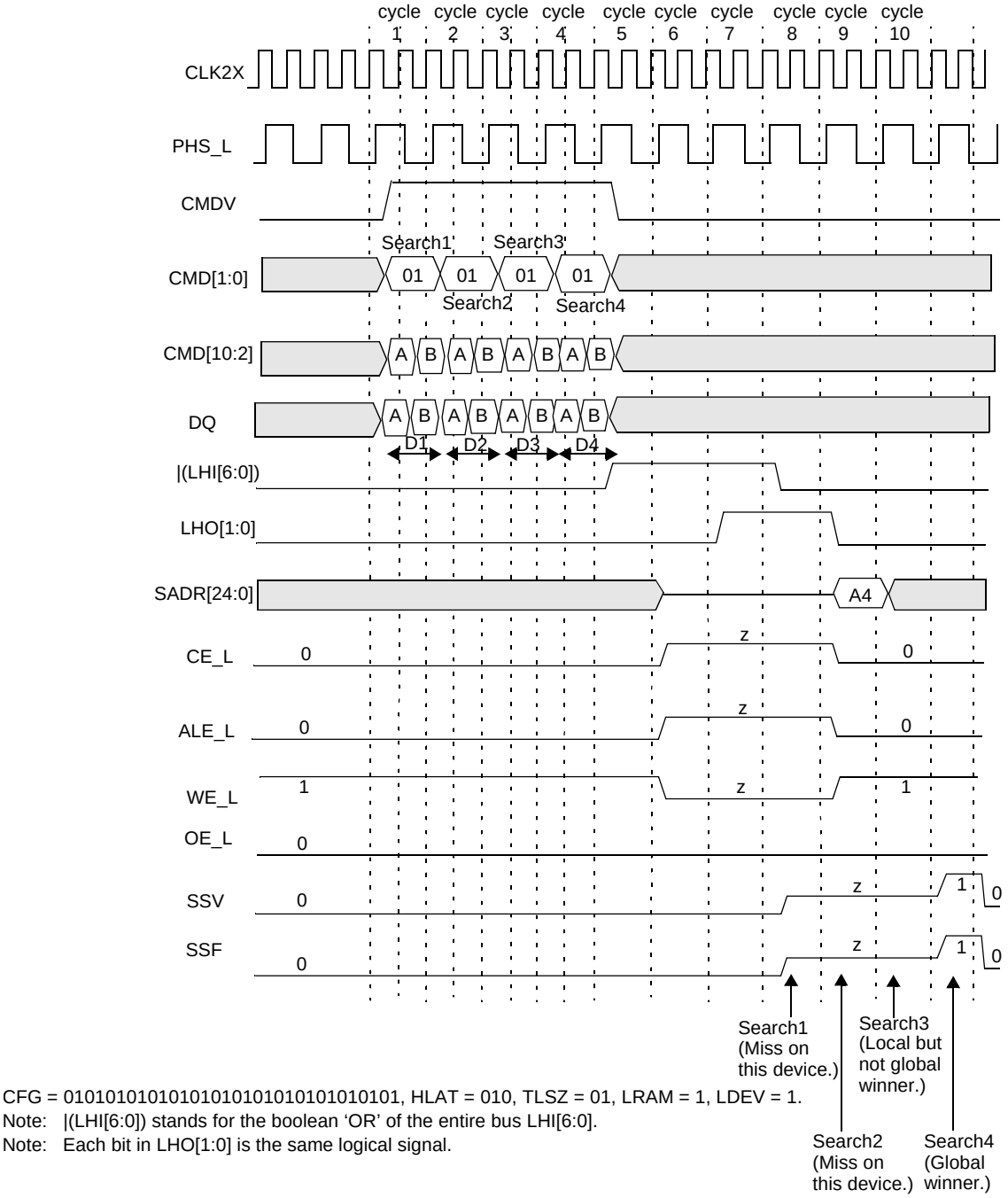
CFG = 01010101010101010101010101010101, HLAT = 010, TLSZ = 01, LRAM = 0, LDEV = 0.
Note: |(LHI[6:0]) stands for the boolean 'OR' of the entire bus LHI[6:0].
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-31. Timing Diagram for 144-bit SEARCH Device Number 0



CFG = 01010101010101010101010101010101, HLAT = 010, TLSZ = 01, LRAM = 0, LDEV = 0.
Note: |(LHI[6:0]) stands for the boolean 'OR' of the entire bus LHI[6:0].
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-32. Timing Diagram for 144-bit SEARCH Device Number 1



CFG = 01010101010101010101010101010101, HLAT = 010, TLSZ = 01, LRAM = 1, LDEV = 1.
Note: |(LHI[6:0]) stands for the boolean 'OR' of the entire bus LHI[6:0].
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-33. Timing Diagram for 144-bit SEARCH Device Number 7 (Last Device)

The following is the sequence of operation for a single 144-bit SEARCH command (also see Subsection 10.2, "Commands and Command Parameters," on page 14).

- **Cycle A**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair for use in this SEARCH operation. CMD[8:6] signals must be driven with the same bits that will be driven by this device on SADR[24:22] if it has a hit. DQ[71:0] must be driven with the 72-bit data ([143:72]) in order to be compared against all even locations. The CMD[2] signal must be driven to logic 0.

- **Cycle B**: The host ASIC continues to drive CMDV high and to apply SEARCH command code (10) on CMD[1:0]. CMD[5:2] must be driven by the index of the comparand register pair for storing the 144-bit word presented on the DQ bus during cycles A and B. CMD[8:6] signals must be driven with the SSR index that will be used for storing the address of the matching entry and the hit flag (see page 8 for the description of SSR[0:7]). The DQ[71:0] is driven with 72-bit data ([71:0]) compared against all odd locations.

The logical 144-bit SEARCH operation is shown in Figure 10-34. The entire table (eight devices of 144-bit entries) is compared to a 144-bit word K (presented on the DQ bus in cycles A and B of the command) using the GMR and local mask bits. The GMR is the 144-bit word specified by the even and odd global mask pair selected by the GMR index in the command's cycle A. The 144-bit word K (presented on the DQ bus in cycles A and B of the command) is also stored in the even and odd comparand registers specified by the comparand register index in command cycle B. In x144 configurations, the even and odd comparand registers can be subsequently used by the LEARN command in only one of the devices (the first non-full device). The word K (presented on the DQ bus in cycles A and B of the command) is compared to each entry in the table starting at location 0. The first matching entry's location, address L, is the winning address that is driven as part of the SRAM address on the SADR[24:0] lines (see "SRAM Addressing" on page 93). The global winning device will drive the bus in a specific cycle. On global miss cycles the device with LRAM = 1 (the default driving device for the SRAM bus) and LDEV = 1 (the default driving device for SSF and SSV signals) will be the default driver for such missed cycles. **Note**. During 144-bit searches of 144-bit-configured tables, the SEARCH hit will always be at an even address.

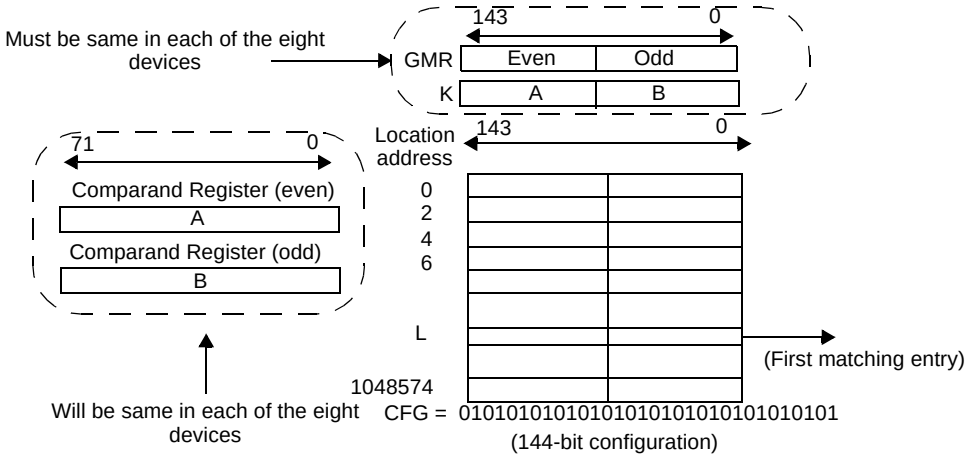


Figure 10-34. x144 Table with Eight Devices

The SEARCH command is a pipelined operation and executes a SEARCH at half the rate of the frequency of CLK2X for 144-bit searches in x144-configured tables. The latency of SADR, CE_L, ALE_L, WE_L, SSV, and SSF from the 144-bit SEARCH command cycle (two CLK2X cycles) is shown in Table 10-21.

Table 10-21. SEARCH Latency from Instruction to SRAM Access Cycle

Number of Devices	Max Table Size	Latency in CLK Cycles
1 (TLSZ = 00)	64K x 144 bits	4
1–8 (TLSZ = 01)	512K x 144 bits	5
1–31 (TLSZ = 10)	1984K x 144 bits	6

For one to eight devices in the table and TLSZ = 01, SEARCH latency from command to SRAM access cycle is 5. In addition, SSV and SSF shift further to the right for different values of HLAT, as specified in Table 10-22.

Table 10-22. Shift of SSF and SSV from SADR

HLAT	Number of CLK Cycles
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

10.6.6 144-bit SEARCH on Tables Configured as x144 using up to 31 CYNSE70256 Devices

The hardware diagram of the SEARCH subsystem of 31 devices is shown in Figure 10-35. Each of the four blocks in the diagram represents a block of eight CYNSE70256 devices (except the last, which has seven devices). The diagram for a block of eight devices is shown in Figure 10-36. The following are the parameters programmed into the 31 devices.

- First thirty devices (devices 0–29): CFG = 01010101010101010101010101010101, TLSZ = 10, HLAT = 001, LRAM = 0, and LDEV = 0.
- Thirty-first device (device 30): CFG = 01010101010101010101010101010101, TLSZ = 10, HLAT = 001, LRAM = 1, and LDEV = 1.

Note. All 31 devices must be programmed with the same value of TLSZ and HLAT. Only the last device in the table must be programmed with LRAM = 1 and LDEV = 1 (device number 30 in this case). All other upstream devices must be programmed with LRAM = 0 and LDEV = 0 (devices 0 through 29 in this case).

The timing diagrams referred to in this paragraph reference the Hit/Miss assumptions defined in Table 10-23. For the purpose of illustrating the timings, it is further assumed that the there is only one device with a matching entry in each of the blocks. Figure 10-37 shows the timing diagram for a SEARCH command in the 144-bit-configured table (31 devices) for each of the eight devices in block number 0. Figure 10-38 shows the timing diagram for a SEARCH command in the 72-bit-configured table (31 devices) for all the devices above the winning device in block number 1. Figure 10-39 shows the timing diagram for the globally winning device (the final winner within its own and all blocks) in block number 1. Figure 10-40 shows the timing diagram for all the devices below the globally winning device in block number 1. Figure 10-41, Figure 10-42, and Figure 10-43 show the timing diagrams of the devices above globally winning device, the globally winning device, and the devices below the globally winning device, respectively, for block number 2. Figure 10-44, Figure 10-45, Figure 10-46, and Figure 10-47 show, respectively, the timing diagrams of the devices above the globally winning device, the globally winning device, and devices below the globally winning device except the last device (device 30), and then the last device (device 30) for block number 3.

The 144-bit SEARCH operation is pipelined and executes as follows. Four cycles from the SEARCH command, each of the devices knows the outcome internal to it for that operation. In the fifth cycle after the SEARCH command, the devices in a block (being less than or equal to eight devices resolving the winner within them using the LHI[6:0] and LHO[1:0] signalling mechanism) arbitrate for a winner among them. In the sixth cycle after the SEARCH command, the blocks (of devices) resolve the winning block through the BHI[2:0] and BHO[2:0] signalling mechanism. The winning device in the winning block is the global winning device for a SEARCH operation.

Table 10-23. Hit/Miss Assumptions

SEARCH Number	1	2	3	4
Block 0	Miss	Miss	Miss	Miss
Block 1	Miss	Miss	Hit	Miss
Block 2	Miss	Hit	Hit	Miss
Block 3	Hit	Hit	Miss	Miss

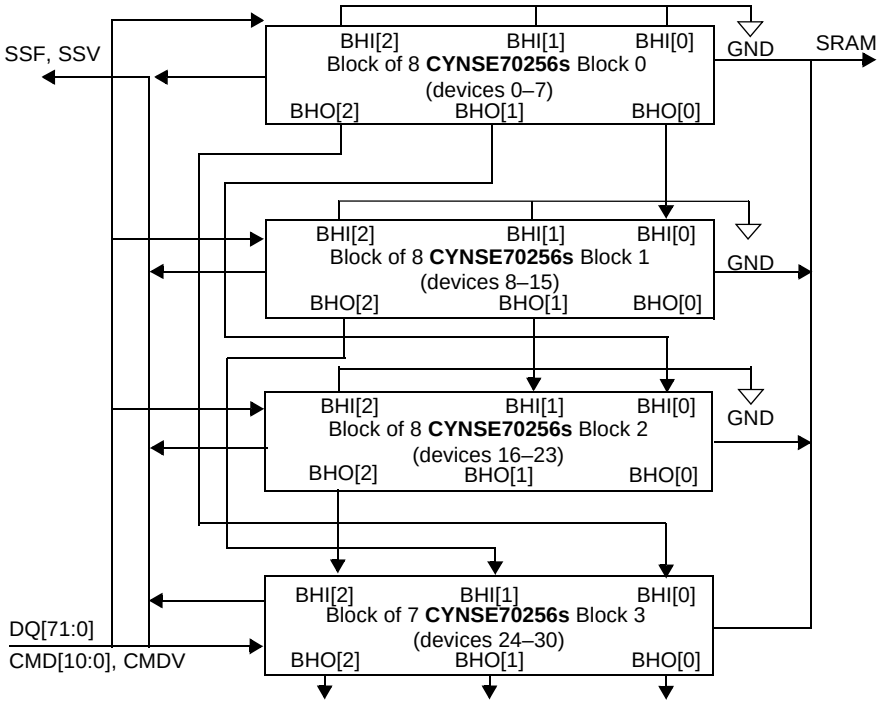


Figure 10-35. Hardware Diagram for a Table with 31 Devices

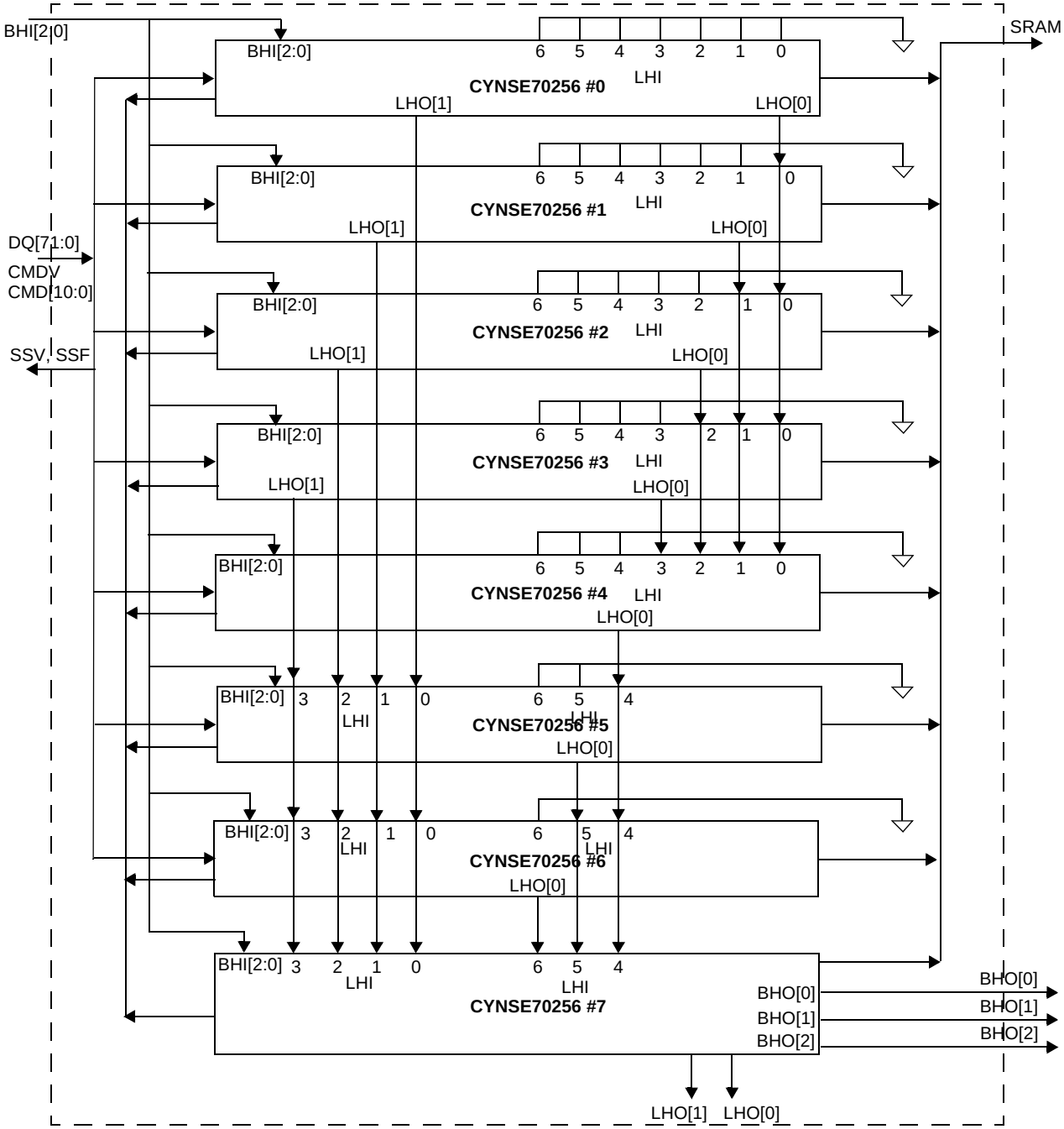
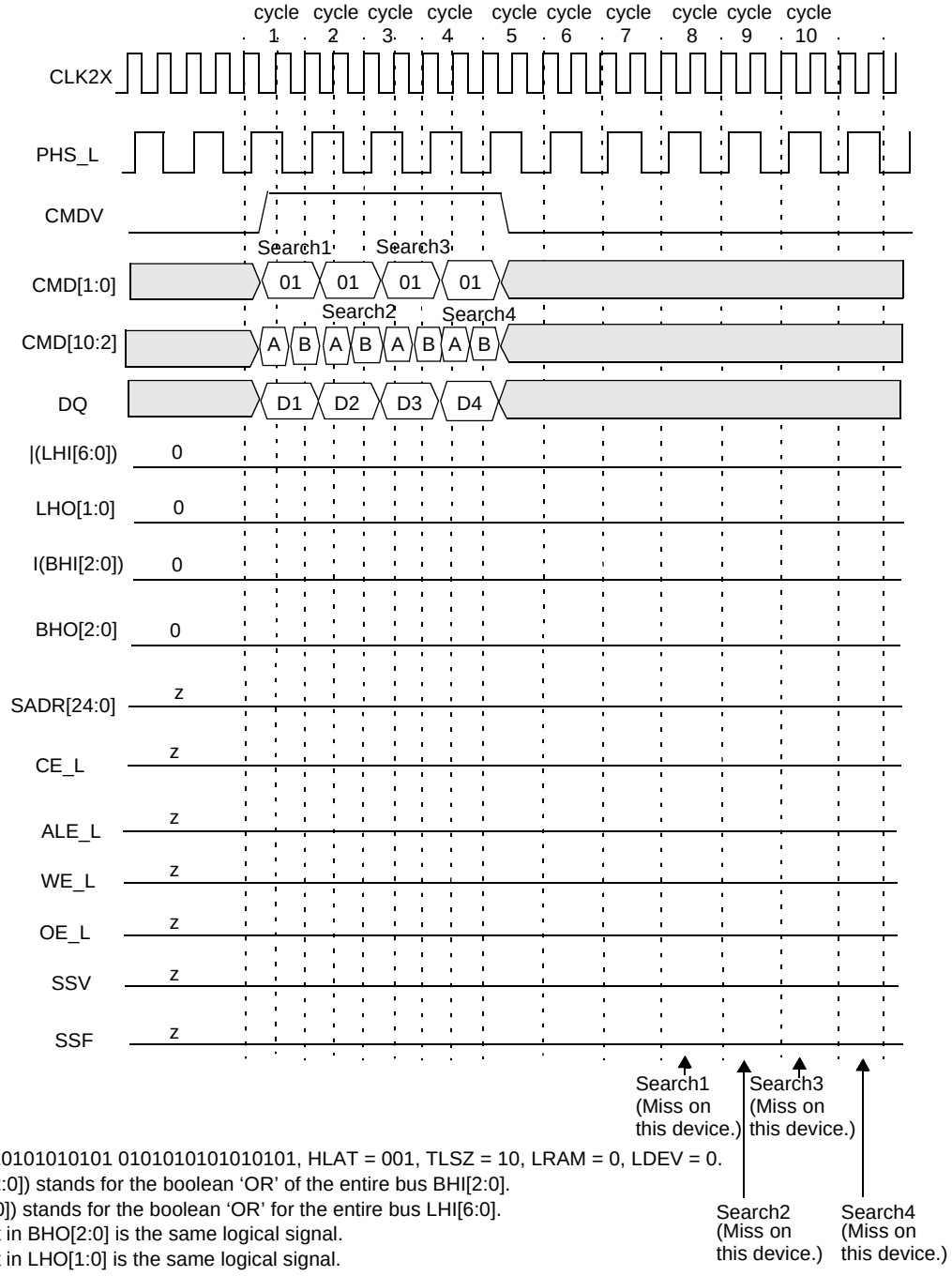
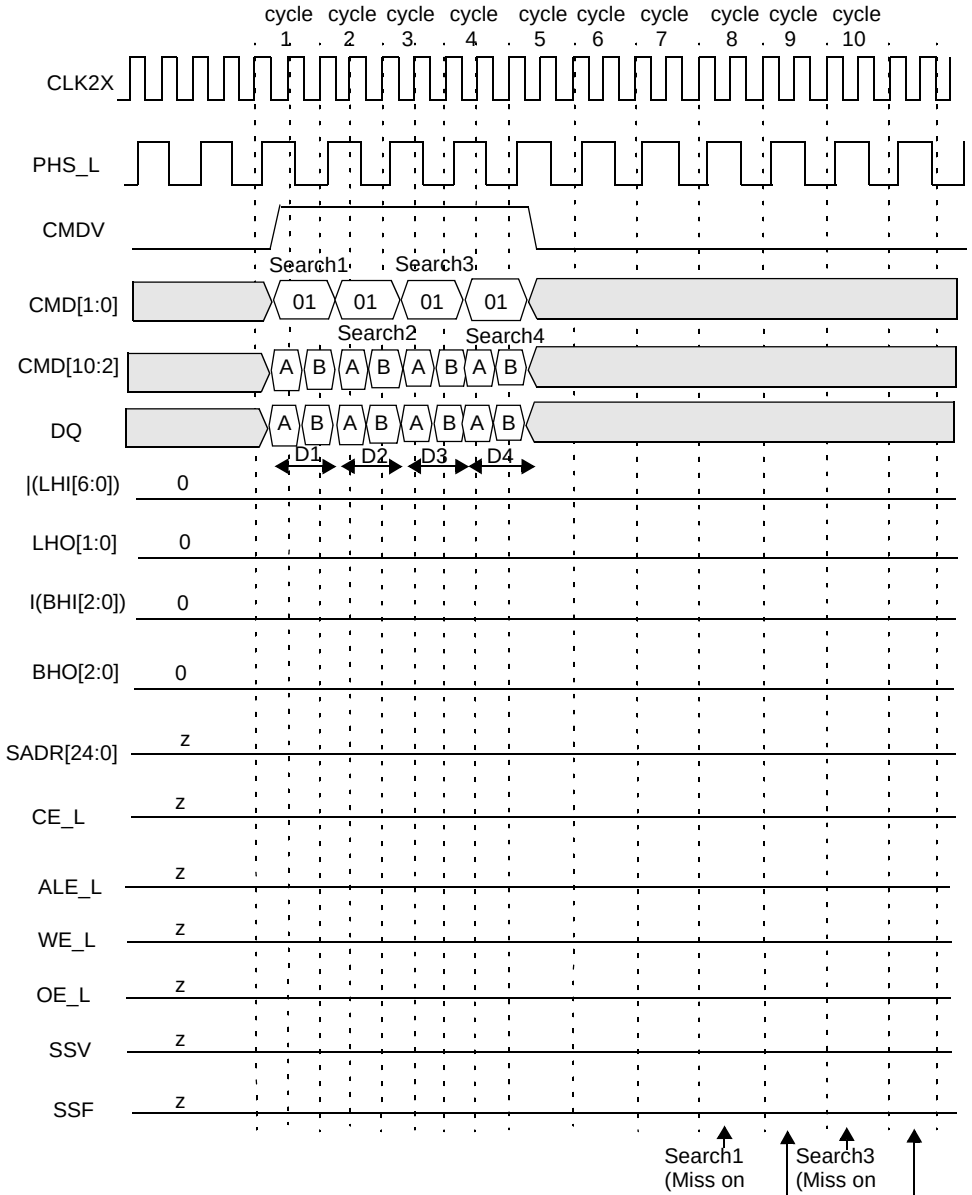


Figure 10-36. Hardware Diagram for a Block of up to Eight Devices



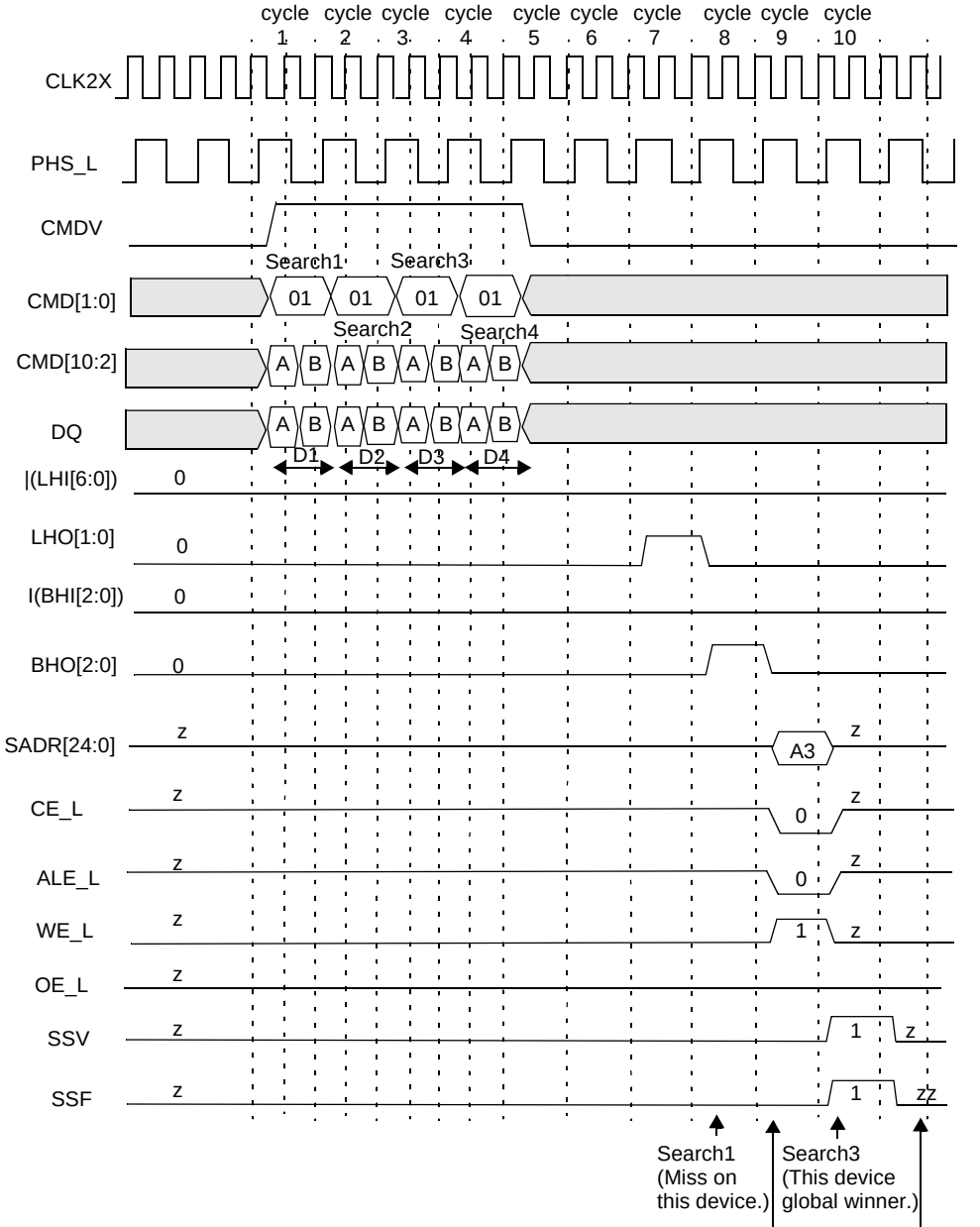
CFG =0101010101010101 0101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-37. Timing Diagram for Each Device in Block Number 0 (Miss on Each Device)



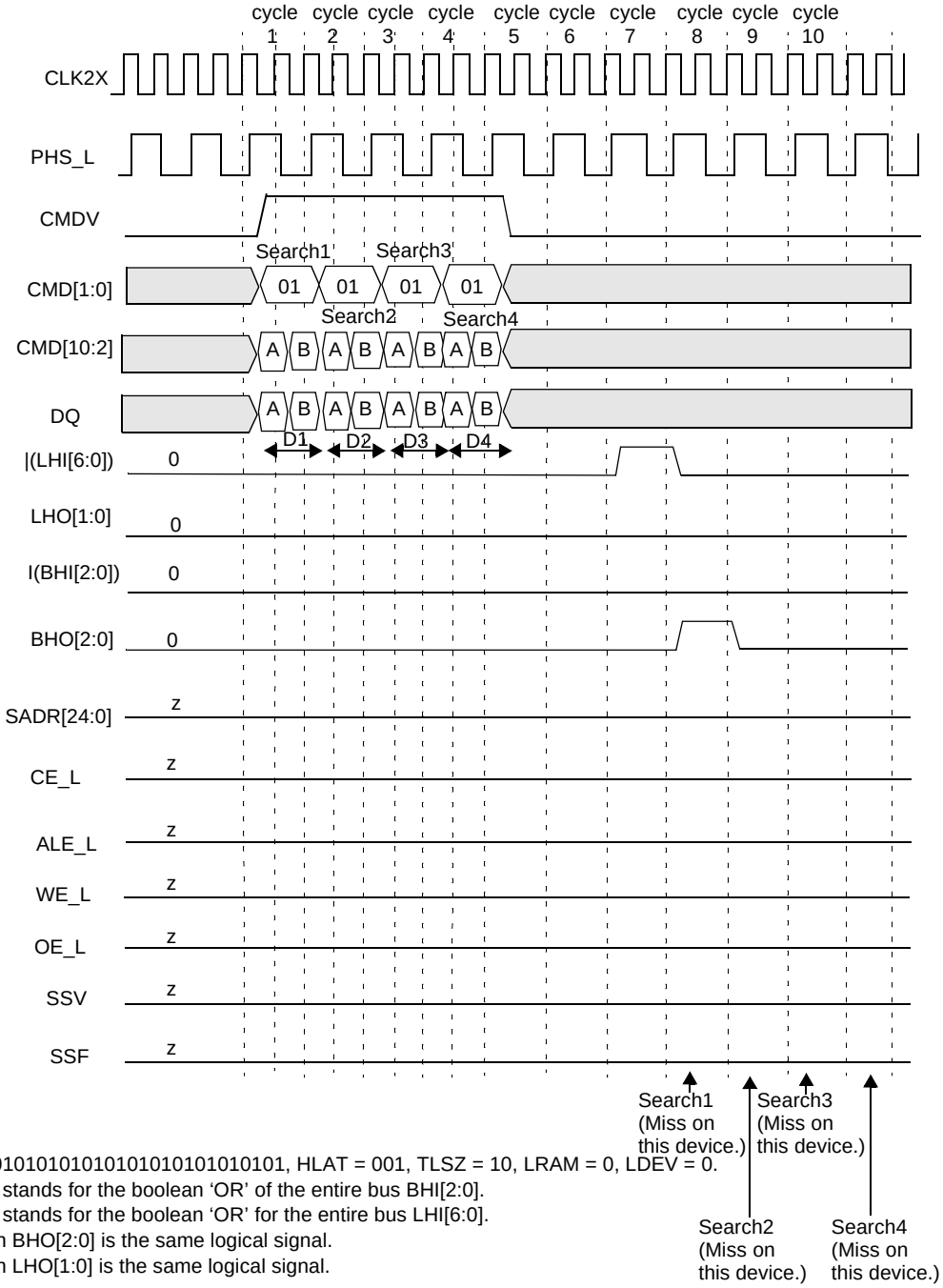
CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-38. Timing Diagram for Each Device Above the Winning Device in Block Number 1



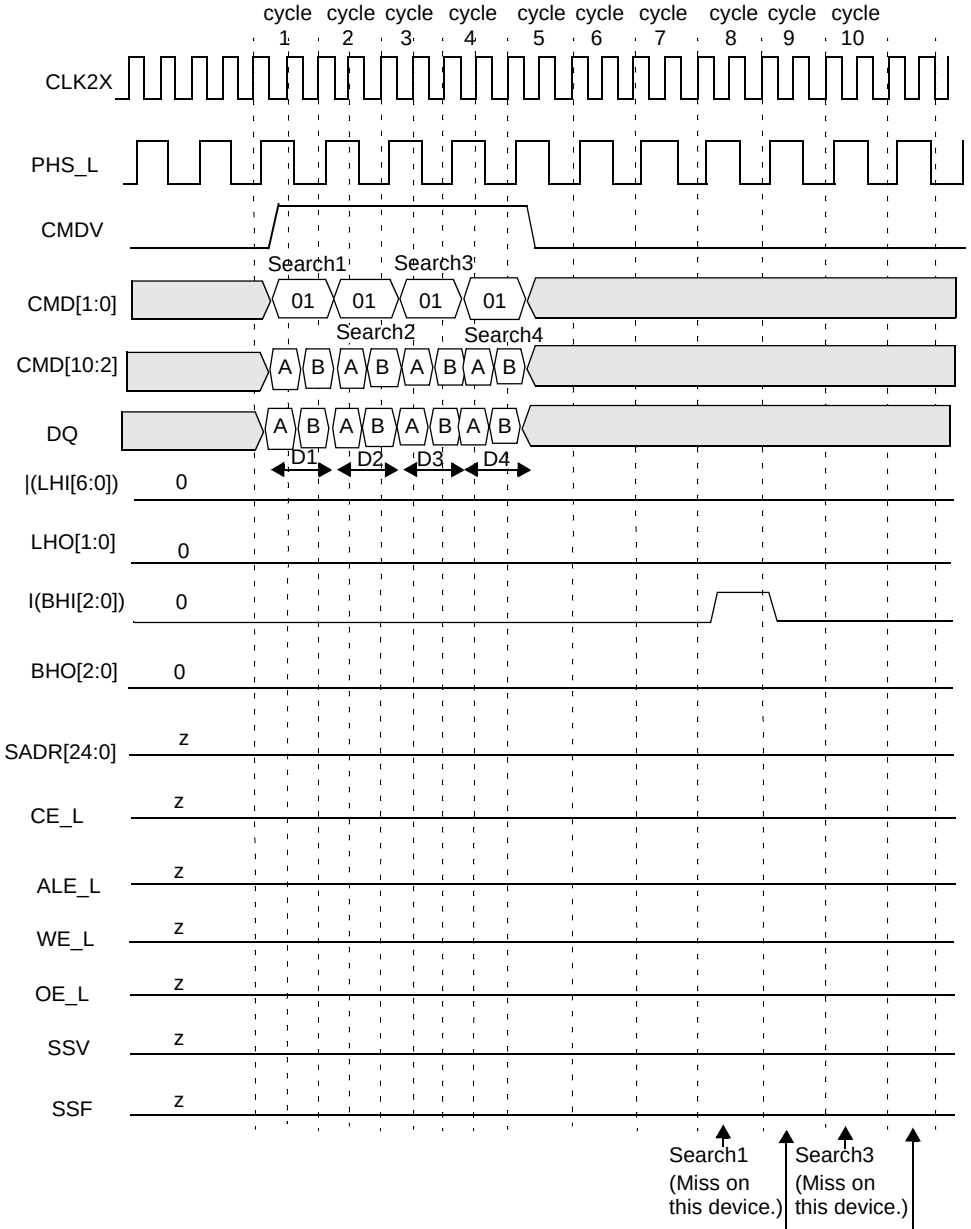
CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-39. Timing Diagram for Globally Winning Device in Block Number 1



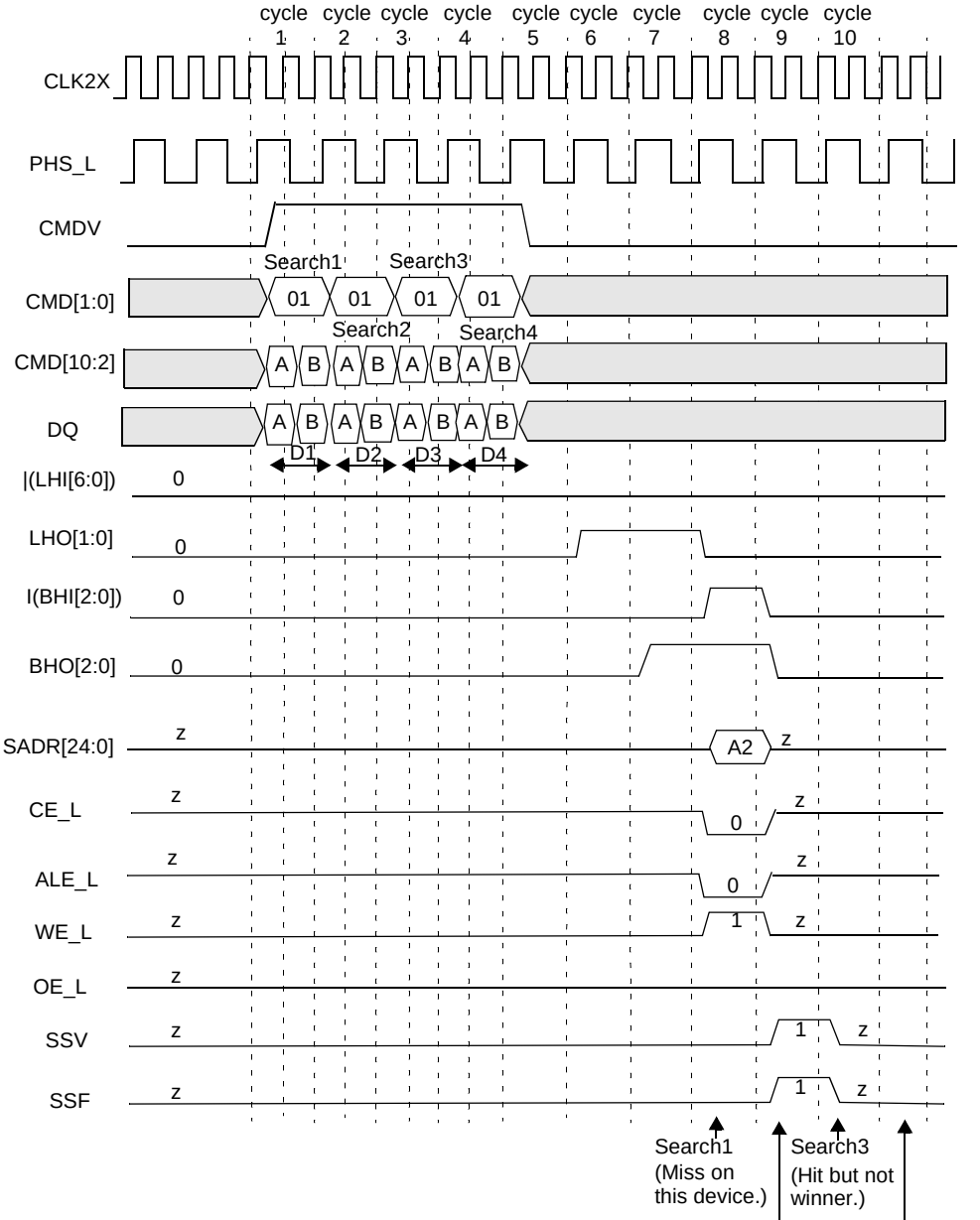
CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0] stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI(6:0) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-40. Timing Diagram for Devices Below the Winning Device in Block Number 1



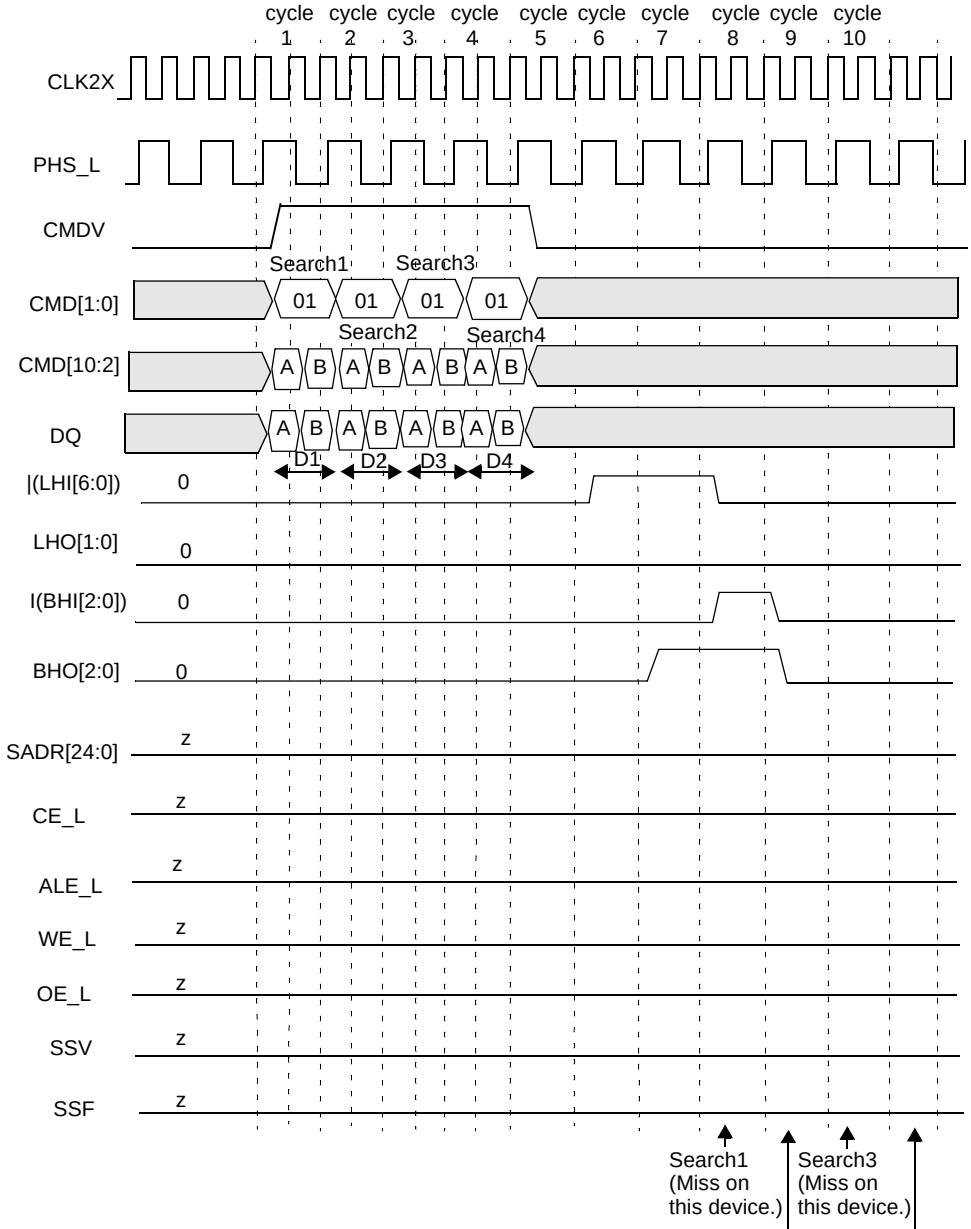
CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-41. Timing Diagram for Devices Above the Winning Device in Block Number 2



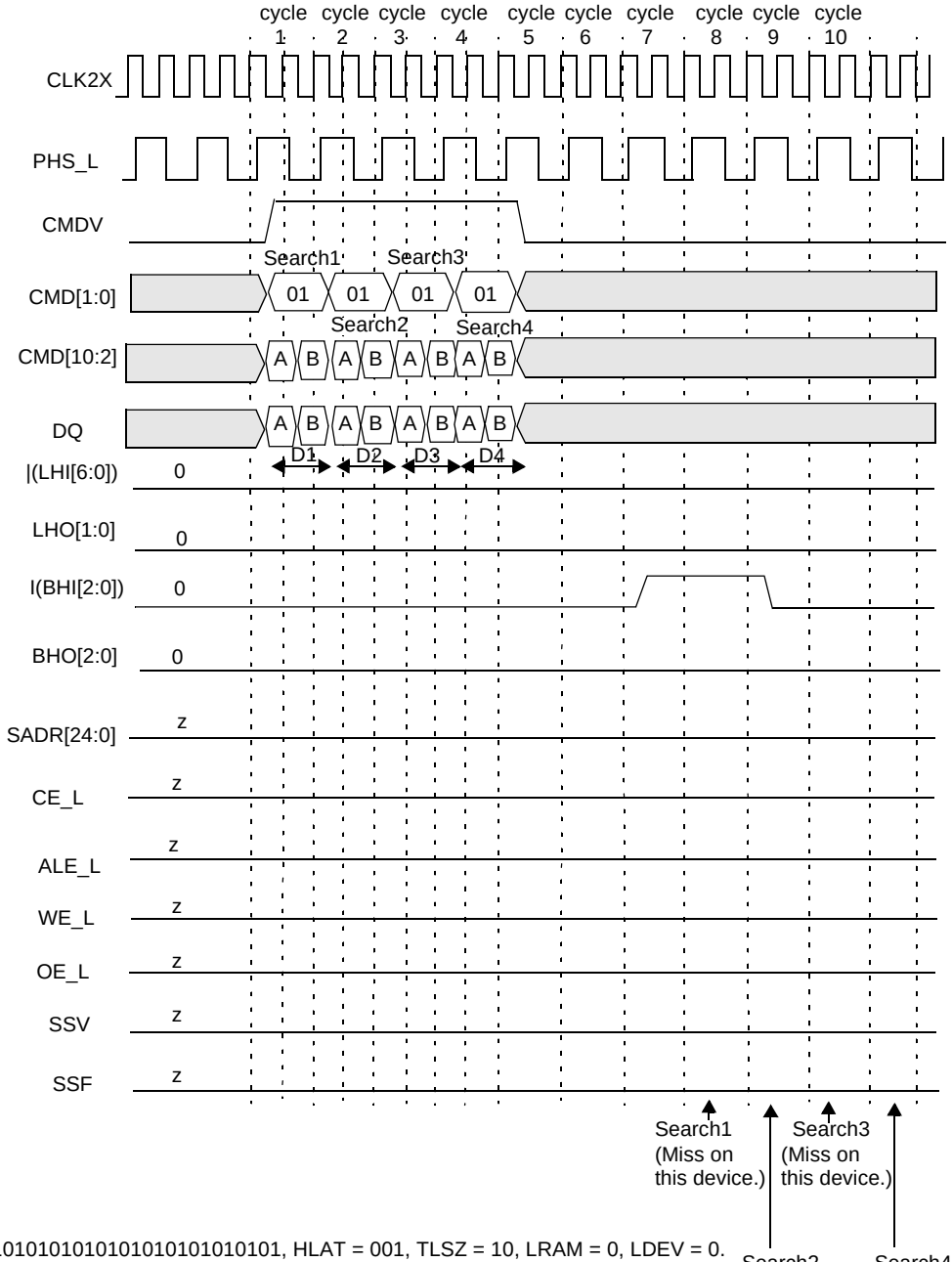
CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-42. Timing Diagram for Globally Winning Device in Block Number 2



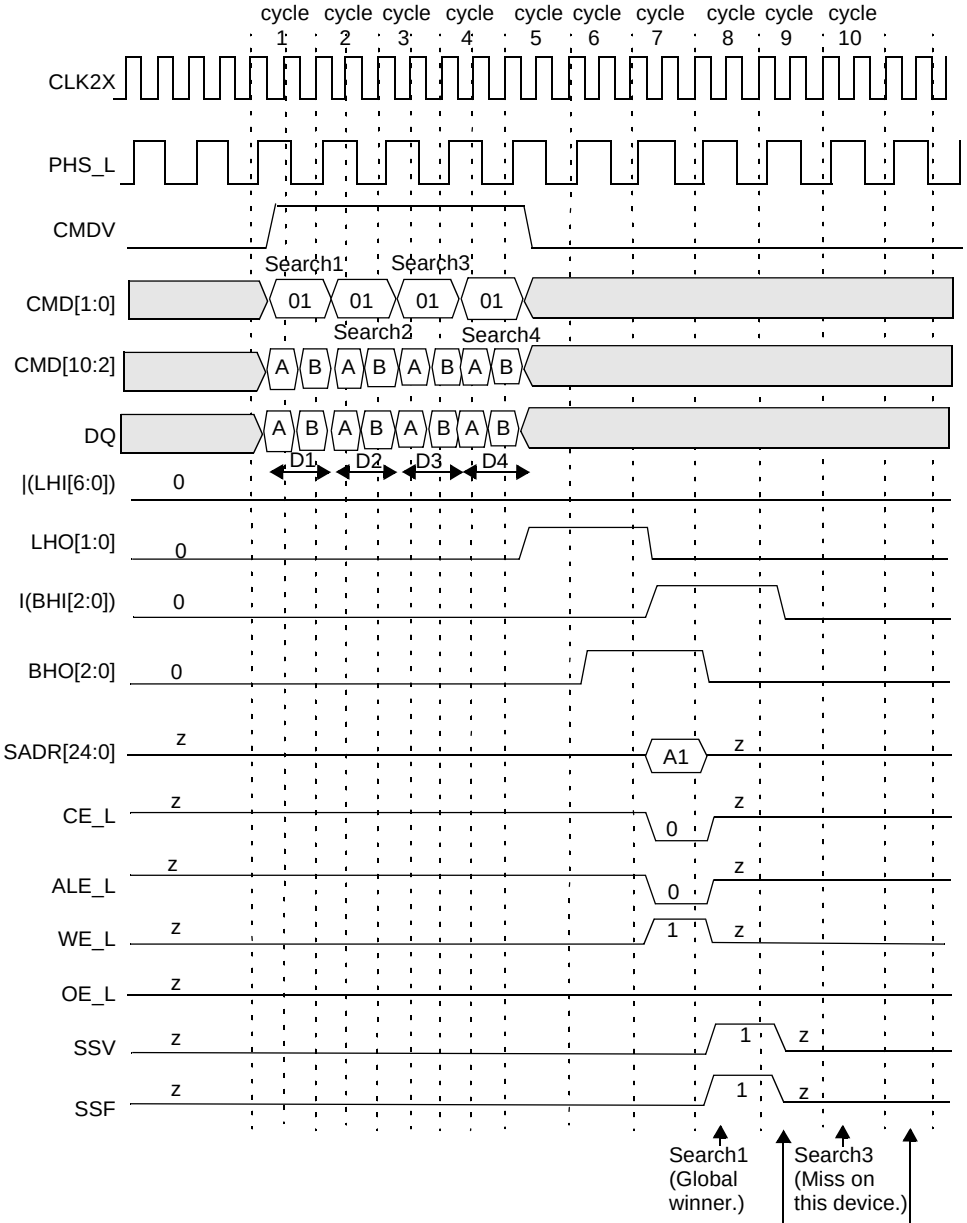
CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-43. Timing Diagram for Devices Below the Winning Device in Block Number 2



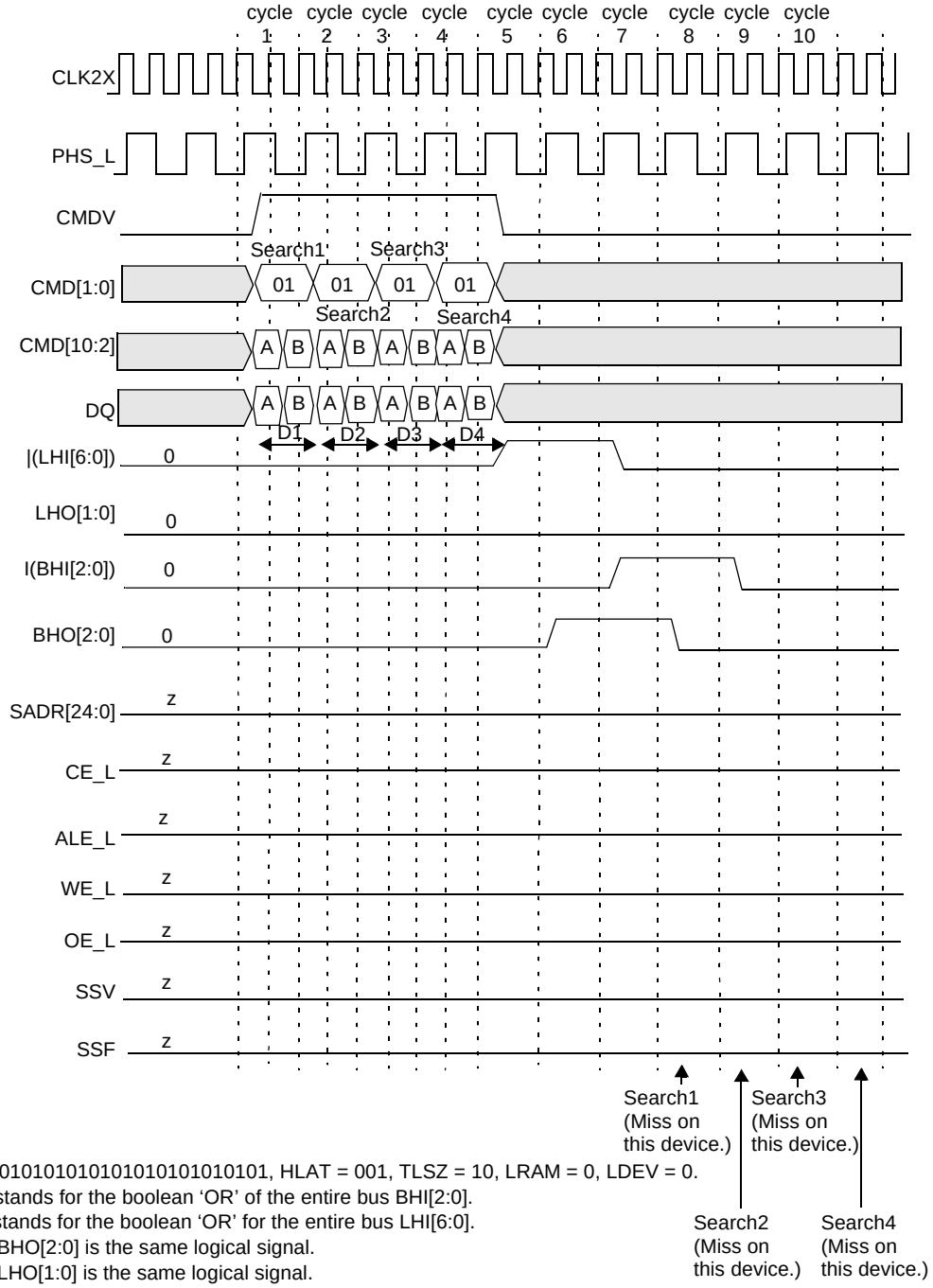
CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-44. Timing Diagram for Devices Above the Winning Device in Block Number 3



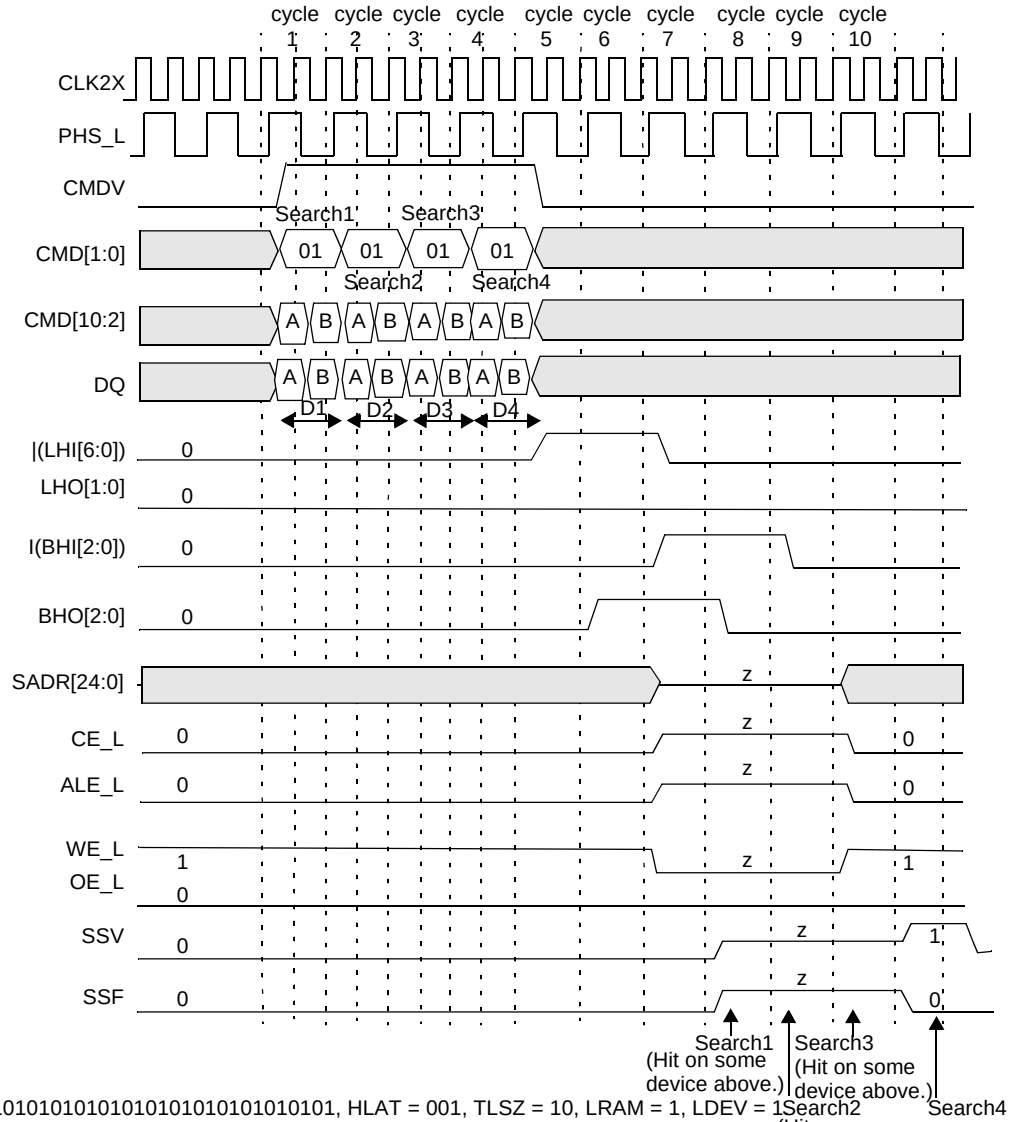
CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-45. Timing Diagram for Globally Winning Device in Block Number 3



CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-46. Timing Diagram for Devices Below the Winning Device in Block Number 3 Except Device 30 (the Last Device)



CFG = 01010101010101010101010101010101, HLAT = 001, TLSZ = 10, LRAM = 1, LDEV = 1
Note: |(BHI[2:0)] stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-47. Timing Diagram for Device Number 6 in Block Number 3 (Device 30 in a Depth-Cascaded Table)

The following is the sequence of operation for a single 144-bit SEARCH command (also refer to "Command and Command Parameters," Section 10.2 on page 14).

- **Cycle A**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair for use in this SEARCH operation. CMD[8:6] signals must be driven with the bits that will be driven on SADR[24:22] by this device if it has a hit. DQ[71:0] must be driven with the 72-bit data ([143:72]) in order to be compared against all even locations. The CMD[2] signal must be driven to logic 0.
- **Cycle B**: The host ASIC continues to drive CMDV high and to apply SEARCH command code (10) on CMD[1:0]. CMD[5:2] must be driven by the index of the comparand register pair for storing the 144-bit word presented on the DQ bus during cycles A and B. CMD[8:6] signals must be driven with the index of the SSR that will be used for storing the address of the matching entry and the hit flag (see page 8 for the description of SSR[0:7]). The DQ[71:0] is driven with 72-bit data ([71:0]) to be compared against all odd locations.

The logical 144-bit SEARCH operation is shown in Figure 10-48. The entire table of 31 devices (consisting of 144-bit entries) is compared against a 144-bit word K that is presented on the DQ bus in cycles A and B of the command using the GMR and local mask bits. The GMR is the 144-bit word specified by the even and odd global mask pair selected by the GMR Index in the command's cycle A.

The 144-bit word K that is presented on the DQ bus in cycles A and B of the command is also stored in the even and odd comparand registers specified by the comparand register index in command cycle B. In x144 configurations, the even and odd comparand registers can subsequently be used by the LEARN command in only the first non-full device. **Note**. The LEARN command is supported for only one of the blocks consisting of up to eight devices in a depth-cascaded table of more than one block. The word K that is presented on the DQ bus in cycles A and B of the command is compared with each entry in the table, starting at location 0. The first matching entry's location address L is the winning address that is driven as part of the SRAM address on the SADR[24:0] lines (see Section 12.0, "SRAM Addressing," on page 93). The global winning device will drive the bus in a specific cycle. On global miss cycles the device with LRAM = 1 (the default driving device for the SRAM bus) and LDEV = 1 (the default driving device for SSF and SSV signals) will be the default driver for such missed cycles. **Note**. During 144-bit searches of 144-bit-configured tables, the SEARCH hit will always be at an even address.

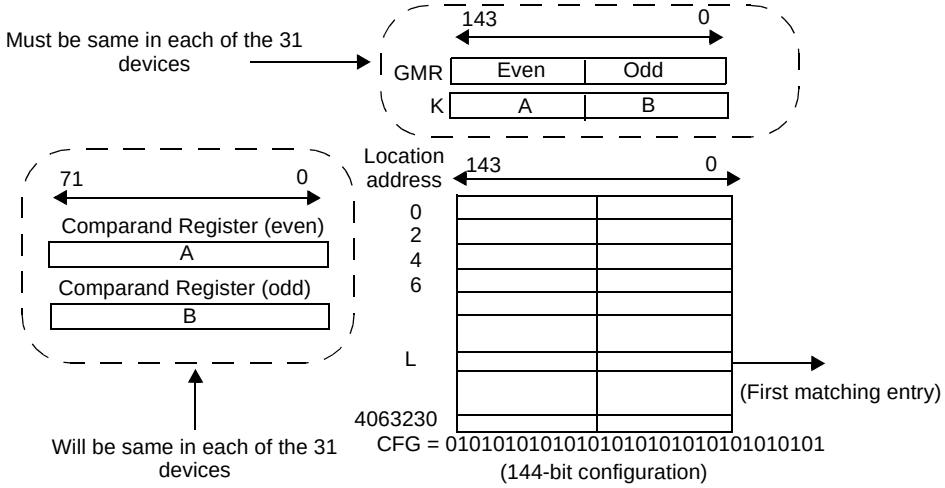


Figure 10-48. x144 table with 31 devices

The SEARCH command is a pipelined operation. It executes a SEARCH at half the rate of the frequency of CLK2X for 144-bit searches in x144-configured tables. The latency of SADR, CE_L, ALE_L, WE_L, SSV, and SSF from the 144-bit SEARCH command cycle (two CLK2X cycles) is shown in Table 10-24.

Table 10-24. SEARCH Latency from Instruction to SRAM Access Cycle

Number of Devices	Max Table Size	Latency in CLK Cycles
1 (TLSZ = 00)	64K x 144 bits	4
1–8 (TLSZ = 01)	512K x 144 bits	5
1–31 (TLSZ = 10)	1984K x 144 bits	6

SEARCH latency from command to the SRAM access cycle is 6 for 1–31 devices in the table and TLSZ = 10. In addition, SSV and SSF shift further to the right for different values of HLAT, as specified in Table 10-25.

Table 10-25. Shift of SSF and SSV from SADR

HLAT	Number of CLK Cycles
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

10.6.7 288-bit SEARCH on Tables Configured as x288 using a Single CYNSE70256 Device

Figure 10-49 shows the timing diagram for a SEARCH command in a 288-bit-configured table (CFG = 10101010101010101010101010101010) consisting of a single device for one set of parameters: TLSZ = 00, HLAT = 001, LRAM = 1, and LDEV = 1. The hardware diagram for this SEARCH subsystem is shown in Figure 10-50.

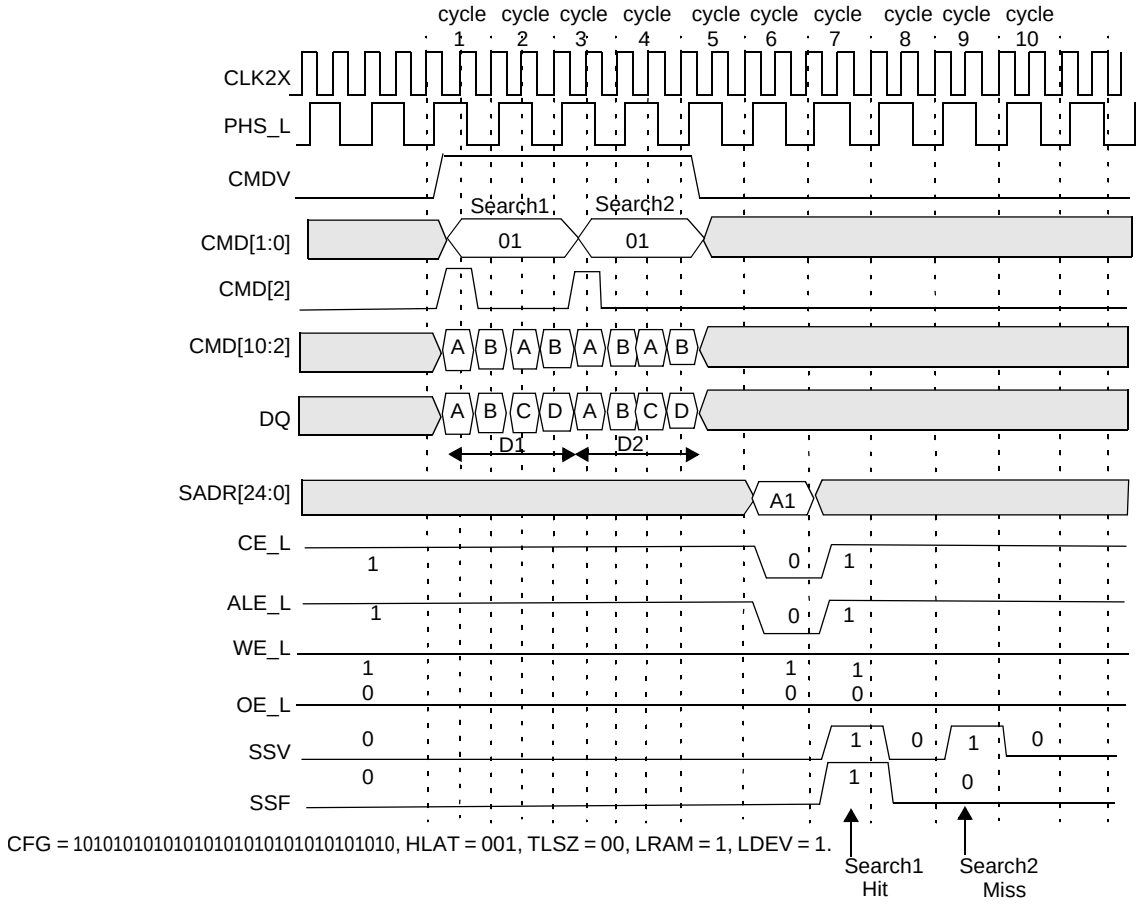


Figure 10-49. Timing Diagram for 288-bit SEARCH (One Device)

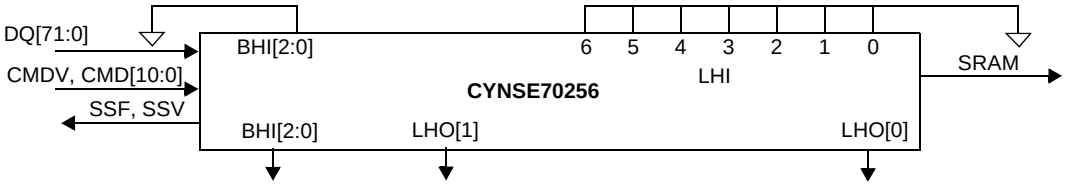


Figure 10-50. Hardware Diagram for a Table with One Device

The following is the sequence of operation for a single 144-bit SEARCH command (also refer to Subsection 10.2, “Commands and Command Parameters,” on page 14).

- **Cycle A**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair used for bits [287:144] of the data being searched. DQ[71:0] must be driven with the 72-bit data ([287:216]) to be compared to all locations 0 in the four 72-bits-word page. The CMD[2] signal must be driven to logic 1. **Note**. CMD[2] = 1 signals that the SEARCH is a x288-bit search. CMD[8:3] in this cycle is ignored.
- **Cycle B**: The host ASIC continues to drive CMDV high and to apply SEARCH command code (10) on CMD[1:0]. The DQ[71:0] is driven with the 72-bit data ([215:144]) to be compared to all locations 1 in the four 72-bits-word pages.
- **Cycle C**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair used for bits [143:0] of the data being searched. CMD[8:6] signals must be driven with the bits that will be driven on SADR[24:22] by this device if it has a hit.

DQ[71:0] must be driven with the 72-bit data ([143:72]) to be compared to all locations 2 in the four 72-bits-word page. The CMD[2] signal must be driven to logic 0.

- **Cycle D**: The host ASIC continues to drive CMDV high and applies SEARCH command code (10) on CMD[1:0]. CMD[8:6] signals must be driven with the index of the SSR that will be used for storing the address of the matching entry and the hit flag (see page 8 for the description of SSR[0:7]). The DQ[71:0] is driven with the 72-bit data ([71:0]) to be compared to all locations 3 in the four 72-bits-word page. CMD[5:2] is ignored because the LEARN instruction is not supported for x288 tables.

Note. For 288-bit searches, the host ASIC must supply four distinct 72-bit data words on DQ[71:0] during cycles A, B, C, and D. The GMR index in cycle A selects a pair of GMRs that apply to DQ data in cycles A and B. The GMR index in cycle C selects a pair of GMRs that apply to DQ data in cycles C and D.

The logical 288-bit SEARCH operation is shown in Figure 10-51. The entire table of 288-bit entries is compared to a 288-bit word K that is presented on the DQ bus in cycles A, B, C, and D of the command using the GMR and local mask bits. The GMR is the 288-bit word specified by the two pairs of GMRs selected by the GMR indexes in command cycles A and C. The 288-bit word K that is presented on the DQ bus in cycles A, B, C and D of the command is compared with each entry in the table starting at location 0. The first matching entry's location address L is the winning address that is driven as part of the SRAM address on SADR[24:0] lines (Section 12.0, "SRAM Addressing," on page 93). **Note**. The matching address is always going to be location 0 in a four-entry page for a 288-bit SEARCH (two LSBs of the matching index will be 00).

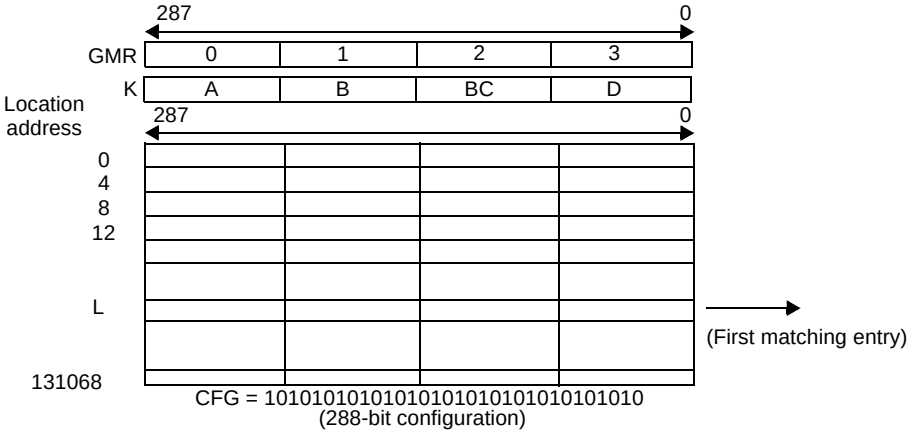


Figure 10-51. x288 Table with One Device

The SEARCH command is a pipelined operation and executes at one-fourth the rate of the frequency of CLK2X for 288-bit searches in x288-configured tables. The latency of SADR, CE_L, ALE_L, WE_L, SSV, and SSF from the 288-bit SEARCH command (measured in CLK cycles) from the CLK2X cycle containing C and D cycles is shown in Table 10-26.

Table 10-26. SEARCH Latency from Instruction to SRAM Access Cycle

Number of Devices	Max Table Size	Latency in CLK Cycles
1 (TLSZ = 00)	32K x 288 bits	4
1–8 (TLSZ = 01)	256K x 288 bits	5
1–31 (TLSZ = 10)	992K x 288 bits	6

SEARCH latency from command to SRAM access cycle is 4 for a single device in the table and TLSZ = 00. In addition, SSV and SSF shift further to the right for different values of HLAT, as specified in Table 10-27.

Table 10-27. Shift of SSF and SSV from SADR

HLAT	Number of CLK Cycles
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

10.6.8 288-bit SEARCH on x288-configured Tables using up to Eight CYNSE70256 Devices

The hardware diagram of the SEARCH subsystem of eight devices is shown in Figure 10-52. The following are the parameters programmed into the eight devices.

- First seven devices (devices 0–6): CFG = 10101010101010101010101010101010, TLSZ = 01, HLAT = 000, LRAM = 0, and LDEV = 0.
- Eighth device (device 7): CFG = 10101010101010101010101010101010, TLSZ = 01, HLAT = 000, LRAM = 1, and LDEV = 1.

Note. All eight devices must be programmed with the same values of TLSZ and HLAT. Only the last device in the table must be programmed with LRAM = 1 and LDEV = 1 (device number 7 in this case). All other upstream devices must be programmed with LRAM = 0 and LDEV = 0 (devices 0 through 6 in this case).

Figure 10-53 shows the timing diagram for a SEARCH command in the 288-bit-configured table of eight devices for device number 0. Figure 10-54 shows the timing diagram for a SEARCH command in the 288-bit-configured table of eight devices for device number 1. Figure 10-55 shows the timing diagram for a SEARCH command in the 288-bit-configured table of eight devices for device number 7 (the last device in this table). In these timing diagrams, three 288-bit searches are performed sequentially. The Hit/Miss assumptions were made as shown in Table 10-28.

Table 10-28. Hit/Miss Assumptions

SEARCH Number	1	2	3
Device 0	Hit	Miss	Miss
Device 1	Miss	Hit	Miss
Devices 2–6	Miss	Miss	Miss
Device 7	Miss	Miss	Miss

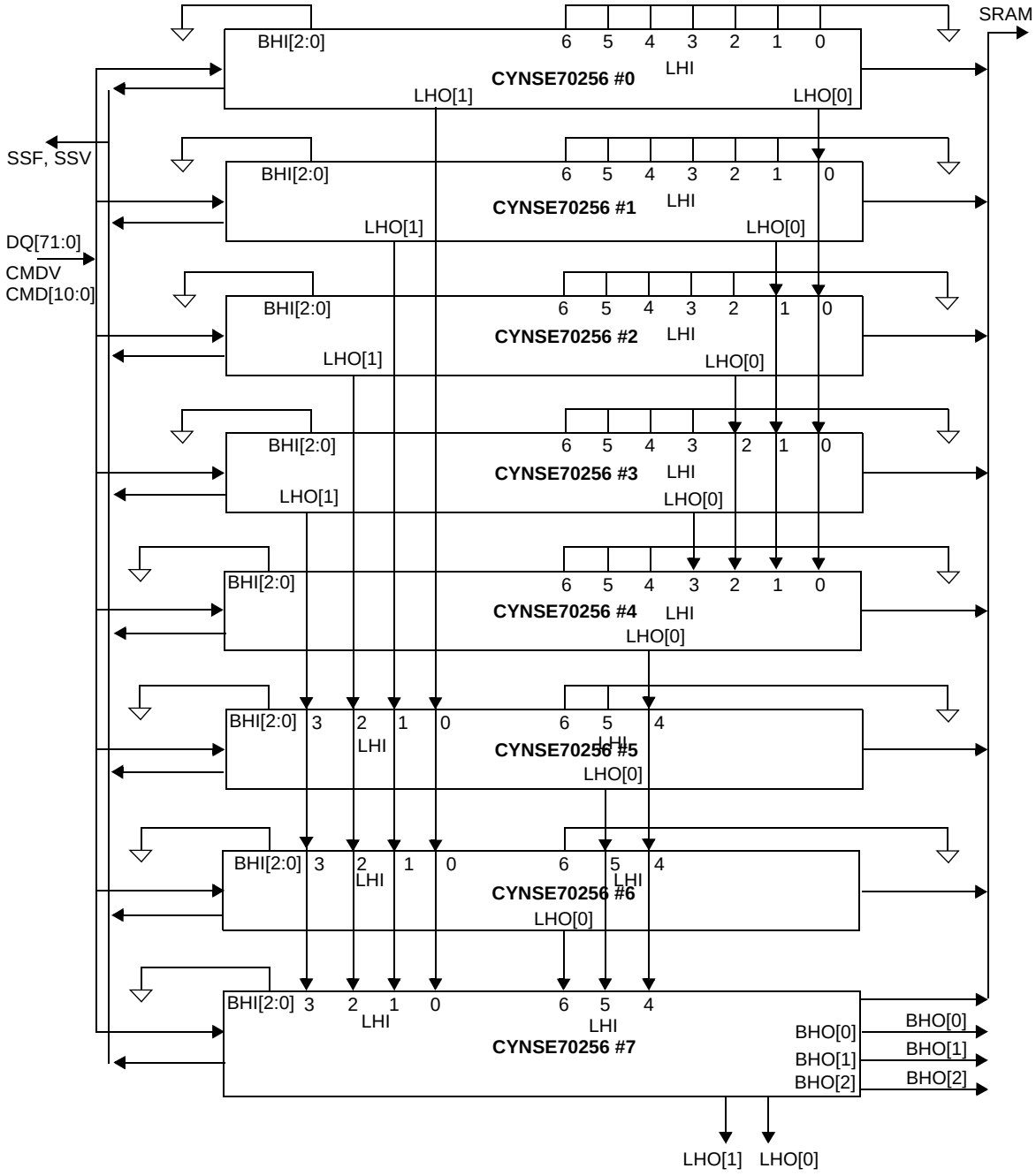
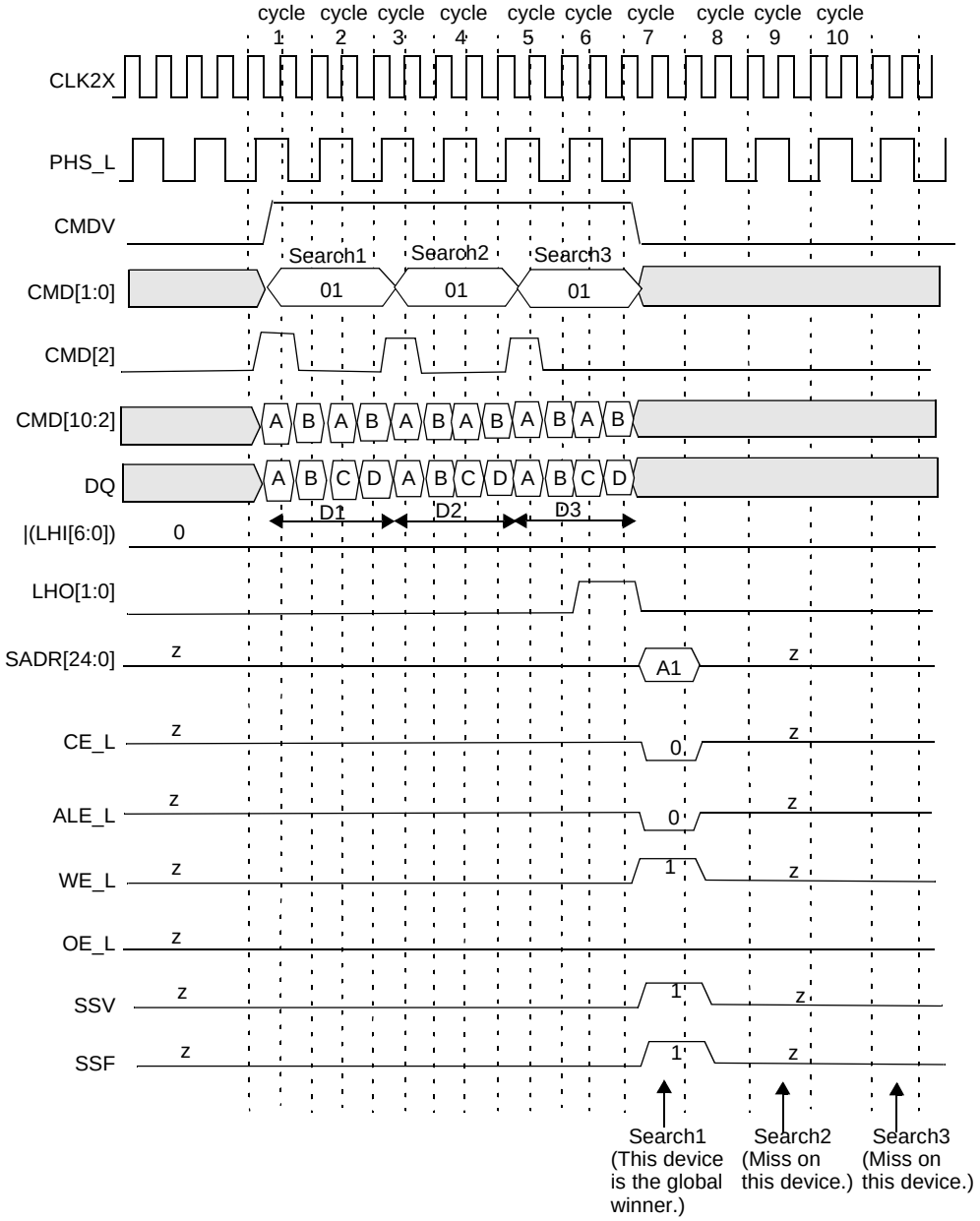
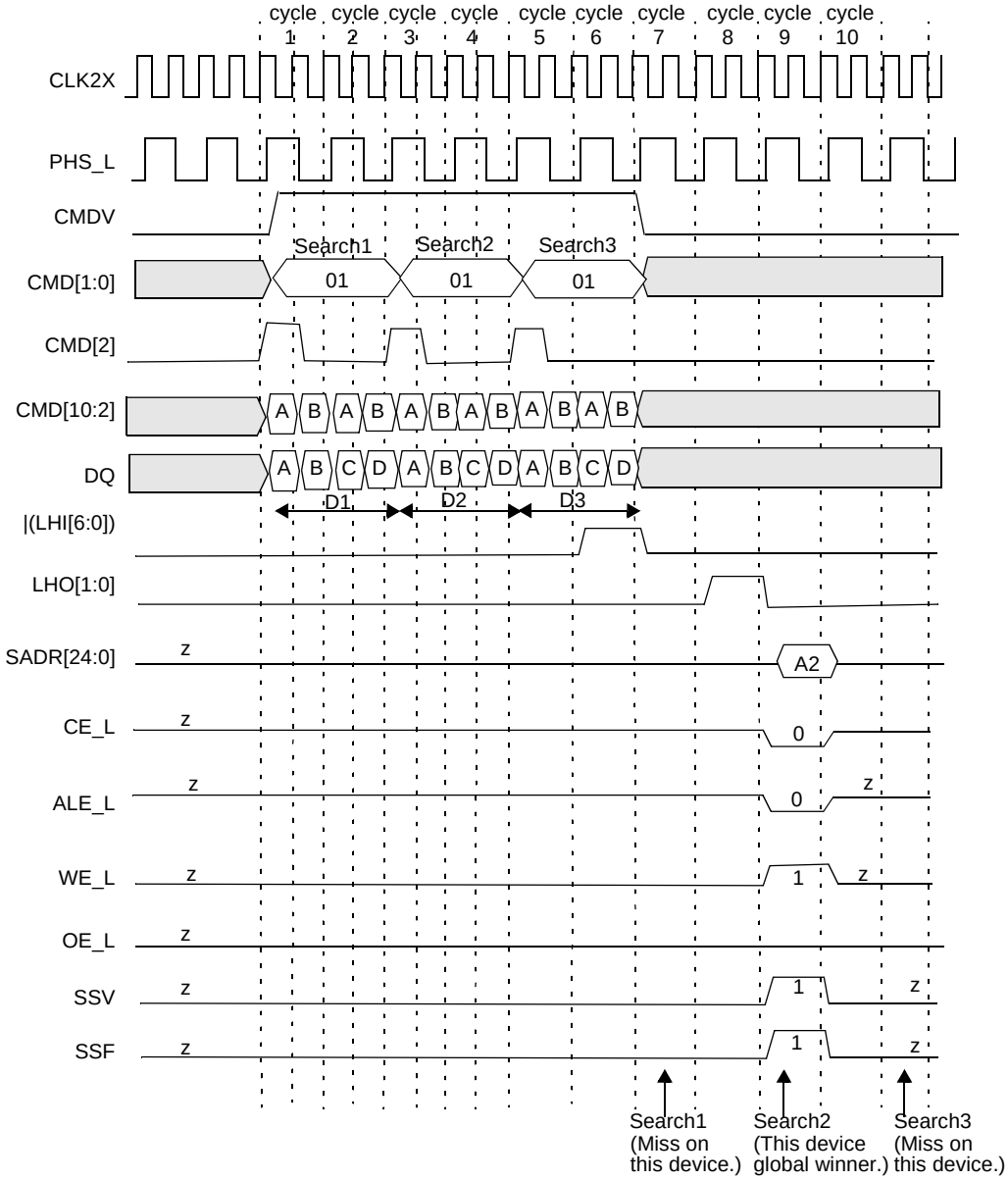


Figure 10-52. Hardware Diagram for a Table with Eight Devices



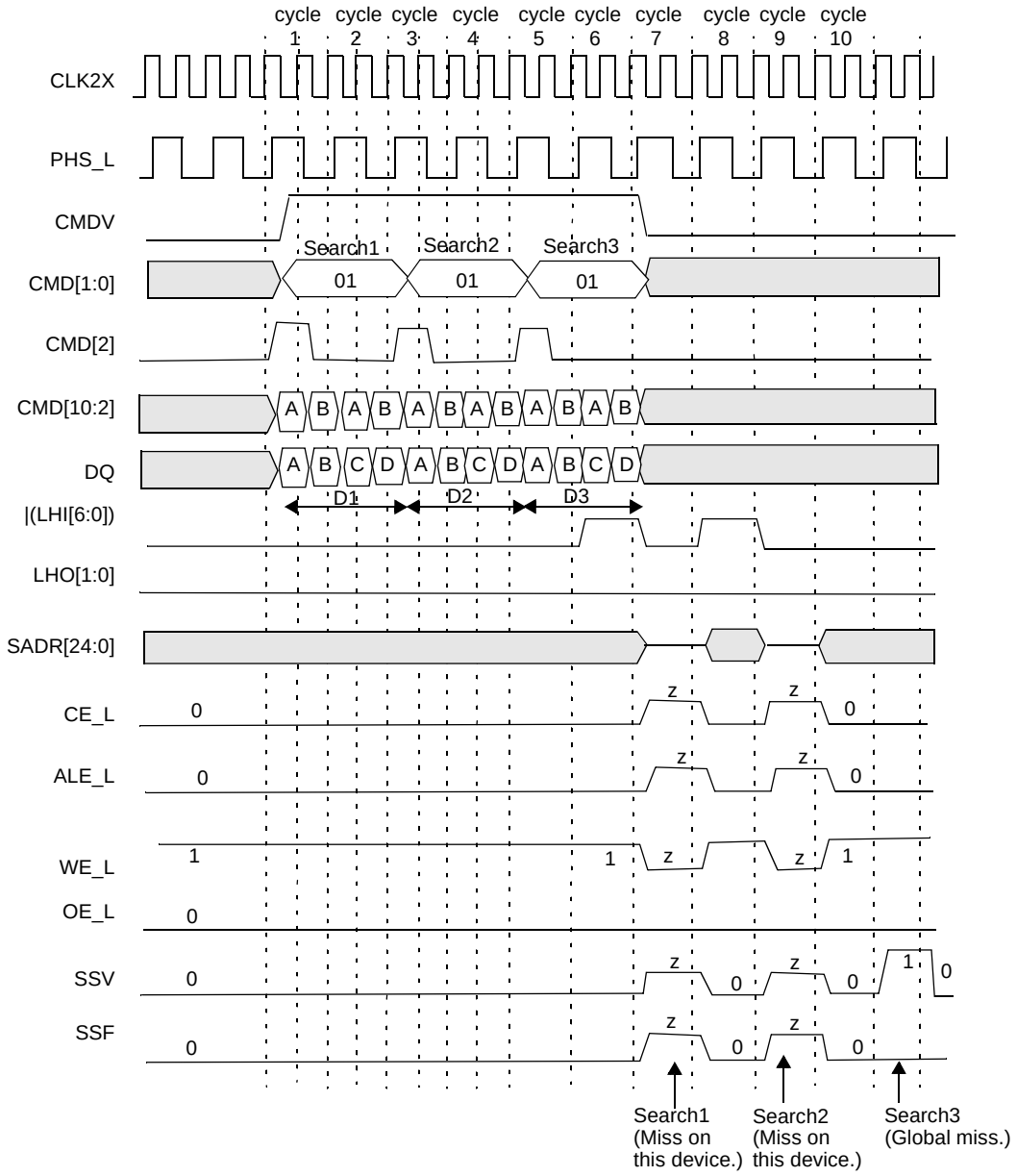
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 01, LRAM = 0, LDEV = 0.
Note: |(LHI[6:0]) stands for the boolean 'OR' of the entire bus LHI[6:0].
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-53. Timing Diagram for 288-bit SEARCH Device Number 0



CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 01, LRAM = 0, LDEV = 0.
Note: |(LHI[6:0]) stands for the boolean 'OR' of the entire bus LHI[6:0].
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-54. Timing Diagram for 288-bit SEARCH Device Number 1



CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 01, LRAM = 1, LDEV = 1.
Note: |(LHI[6:0]) stands for the boolean 'OR' of the entire bus LHI[6:0].
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-55. Timing Diagram for 288-bit SEARCH Device Number 7 (Last Device)

The following is the sequence of operation for a single 288-bit SEARCH command (see also Subsection 10.2, "Commands and Command Parameters," on page 14).

- **Cycle A**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair used for bits [287:144] of the data being searched in this operation. DQ[71:0] must be driven with the 72-bit data ([287:216]) to be compared against all locations 0 in the four-word 72-bit page. The CMD[2] signal must be driven to logic 1. **Note**. CMD[2] = 1 signals that the SEARCH is a 288-bit search. CMD[8:3] in this cycle is ignored.
- **Cycle B**: The host ASIC continues to drive CMDV high and applies SEARCH command code (10) on CMD[1:0]. The DQ[71:0] is driven with the 72-bit data ([215:144]) to be compared against all locations 1 in the four 72-bits-word pages.

- **Cycle C**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair used for bits [143:0] of the data being searched. CMD[8:6] signals must be driven with the bits that will be driven on SADR[24:22] by this device if it has a hit. DQ[71:0] must be driven with the 72-bit data ([143:72]) to be compared against all locations 2 in the four 72-bits-word page. The CMD[2] signal must be driven to logic 0.
- **Cycle D**: The host ASIC continues to drive CMDV high and applies SEARCH command code (10) on CMD[1:0]. CMD[8:6] signals must be driven with the index of the SSR that will be used for storing the address of the matching entry and the hit flag (see page 8 for the description of SSR[0:7]). The DQ[71:0] is driven with the 72-bit data ([71:0]) to be compared to all locations 3 in the four 72-bits-word pages. CMD[5:2] is ignored because the LEARN instruction is not supported for x288 tables.

Note. For 288-bit searches, the host ASIC must supply four distinct 72-bit data words on DQ[71:0] during cycles A, B, C, and D. The GMR index in cycle A selects a pair of GMRs in each of the eight devices that apply to DQ data in cycles A and B. The GMR index in cycle C selects a pair of GMRs in each of the eight devices that apply to DQ data in cycles C and D.

The logical 288-bit SEARCH operation is shown in Figure 10-56. The entire table of 288-bit entries is compared to a 288-bit word K that is presented on the DQ bus in cycles A, B, C, and D of the command using the GMR and the local mask bits. The GMR is the 288-bit word specified by the two pairs of GMRs selected by the GMR indexes in command cycles A and C in each of the eight devices. The 288-bit word K that is presented on the DQ bus in cycles A, B, C, and D of the command is compared to each entry in the table starting at location 0. The first matching entry's location address L is the winning address that is driven as part of the SRAM address on the SADR[24:0] lines (Section 12.0, "SRAM Addressing," on page 93). **Note**. The matching address is always going to be location 0 in a four-entry page for 288-bit SEARCH (two LSBs of the matching index will be 00).

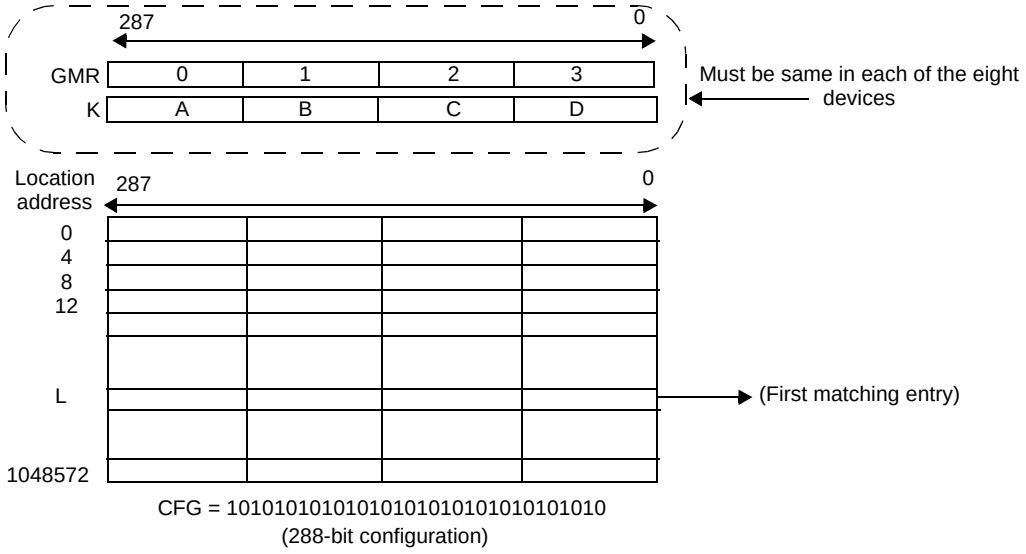


Figure 10-56. x288 Table with Eight Devices

The SEARCH command is a pipelined operation and executes a SEARCH at one-fourth the rate of the frequency of CLK2X for 288-bit searches in x288-configured tables. The latency of SADR, CE_L, ALE_L, WE_L, SSV, and SSF from the 288-bit SEARCH command (measured in CLK cycles) from the CLK2X cycle that contains the C and D cycles is shown in Table 10-29.

Table 10-29. Search Latency from Instruction to SRAM Access Cycle

Number of Devices	Max Table Size	Latency in CLK Dycles
1 (TLSZ = 00)	32K x 288 bits	4
1–8 (TLSZ = 01)	256K x 288 bits	5
1–31 (TLSZ = 10)	992K x 288 bits	6

SEARCH latency from command to SRAM access cycle is 5 for only a single device in the table and TLSZ = 01. In addition, SSV and SSF shift further to the right for different values of HLAT, as specified in Table 10-30.

Table 10-30. Shift of SSF and SSV from SADR

HLAT	Number of CLK Cycles
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

10.6.9 288-bit SEARCH on Tables Configured as x288 using up to 31 CYNSE70256 Devices

The hardware diagram of the SEARCH subsystem of 31 devices is shown in Figure 10-57. Each of the four blocks in the diagram represents a block of eight CYNSE70256 devices except the last, which has seven devices.The diagram for a block of eight devices is shown in Figure 10-58. The following are the parameters programmed into the 31 devices.

- First thirty devices (devices 0–29): CFG = 10101010101010101010101010101010, TLSZ = 10, HLAT = 000, LRAM = 0, and LDEV = 0.
- Thirty-first device (device 30): CFG = 10101010101010101010101010101010, TLSZ = 10, HLAT = 000, LRAM = 1, and LDEV = 1.

Note. All 31 devices must be programmed with the same value for TLSZ and HLAT. Only the last device in the table must be programmed with LRAM = 1 and LDEV = 1 (device number 30 in this case). All other upstream devices must be programmed with LRAM = 0 and LDEV = 0 (devices 0 through 29 in this case).

The timing diagrams referred to in this paragraph reference the Hit/Miss assumptions defined in Table 10-31. For the purpose of illustrating the timings, it is further assumed that there is only one device with the matching entry in each block. Figure 10-59 shows the timing diagram for a SEARCH command in the 288-bit-configured table of 31 devices for each of the eight devices in block number 0. Figure 10-60 shows the timing diagram for a SEARCH command in the 288-bit-configured table of 31 devices for all devices above the winning device in block number 1. Figure 10-61 shows the timing diagram for the globally winning device (the final winner within its own and all blocks) in block number 1. Figure 10-62 shows the timing diagram for the devices below the globally winning device in block number 1. Figure 10-63, Figure 10-64, and Figure 10-65, respectively, show the timing diagrams of the devices above the globally winning device, the globally winning device, and the devices below the globally winning device in block number 2. Figure 10-66, Figure 10-67, Figure 10-68, and Figure 10-69, respectively, show the timing diagrams of the devices above the globally winning device, the globally winning device, the devices below the globally winning device (except device 30), and the last device (device 30) in block number 3.

The 288-bit SEARCH operation is pipelined and executes as follows. Four cycles from the last cycle of the SEARCH command, each of the devices knows the outcome internal to it for that operation. In the fifth cycle from the SEARCH command, the devices in a block (less than or equal to eight devices resolving the winner among them using LHI[6:0] and LHO[1:0] signalling mechanisms) arbitrate for a winner. In the sixth cycle after the SEARCH command, the blocks of devices resolve the winning block through BHI[2:0] and BHO[2:0] signalling mechanisms. The winning device within the winning block is the global winning device for the SEARCH operation.

Table 10-31. Hit/Miss Assumptions

SEARCH Number	1	2	3
Block 0	Miss	Miss	Miss
Block 1	Miss	Miss	Hit
Block 2	Miss	Hit	Hit
Block 3	Hit	Hit	Miss

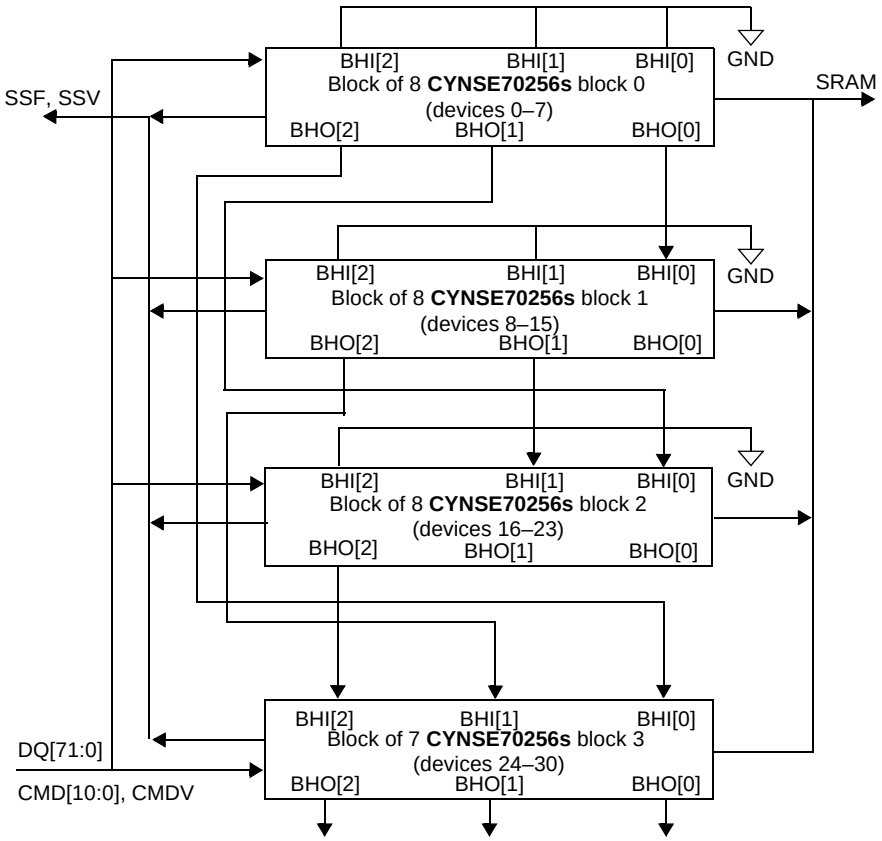


Figure 10-57. Hardware Diagram for a Table with 31 Devices

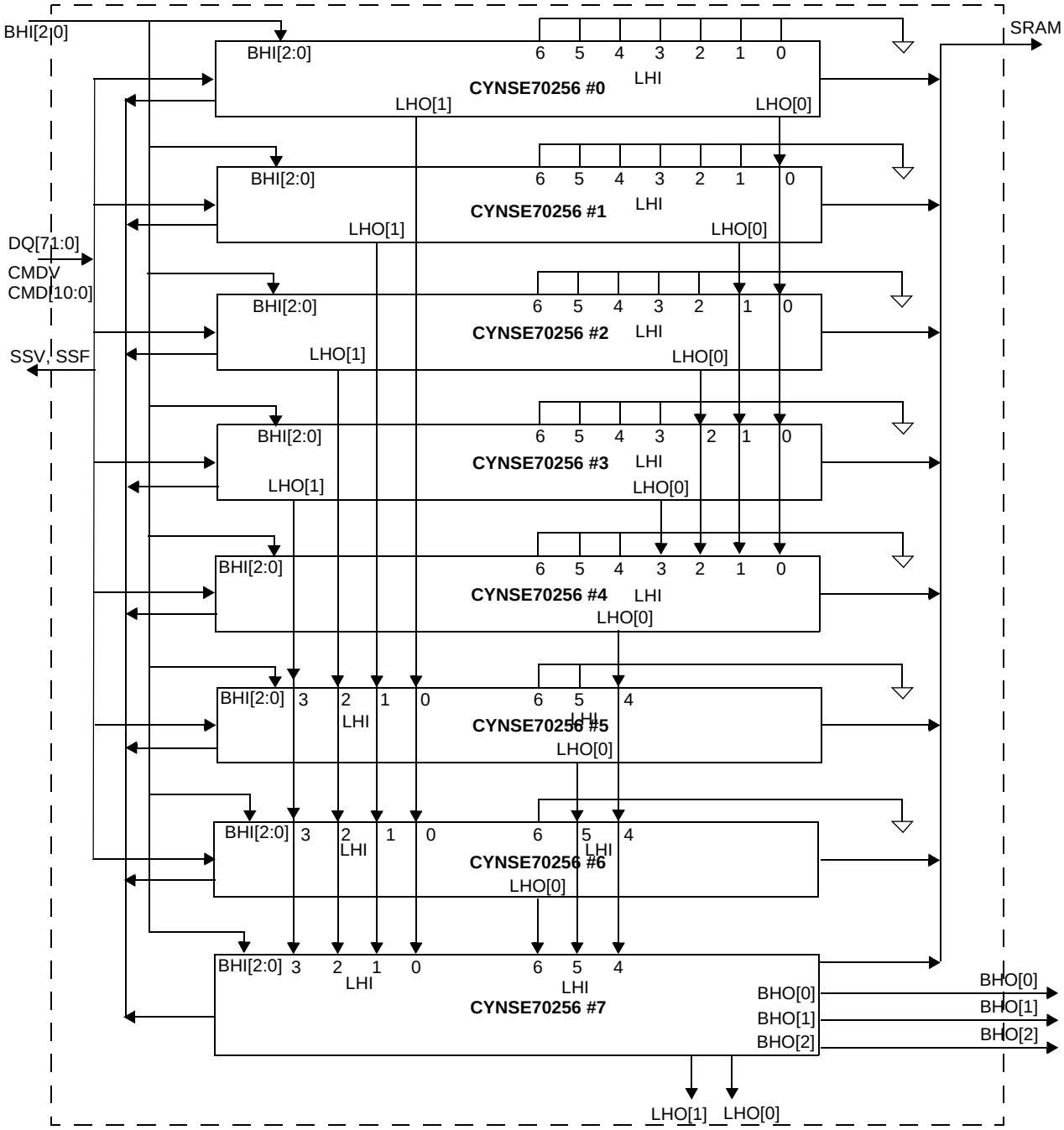
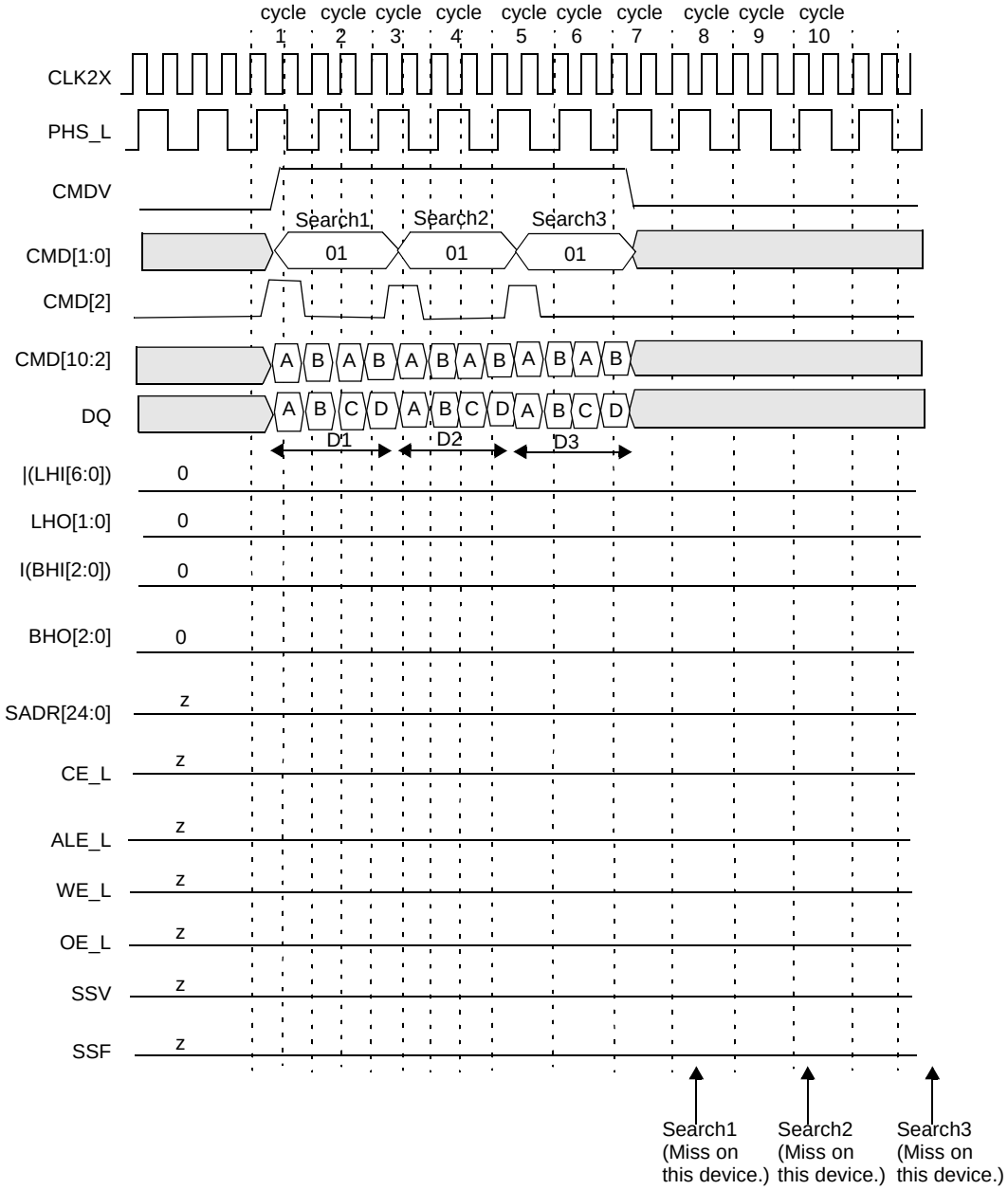
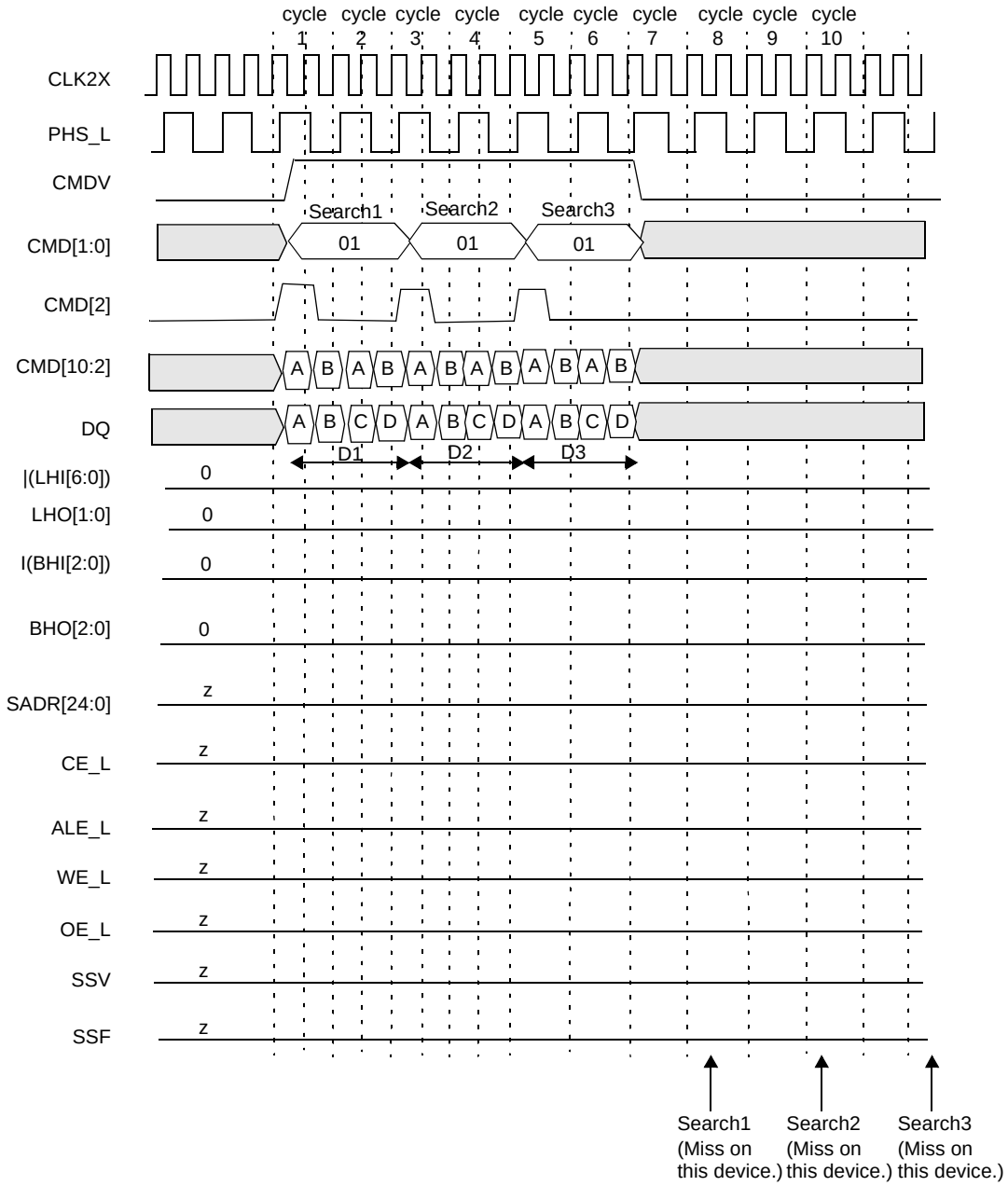


Figure 10-58. Hardware Diagram for a Block of up to Eight Devices



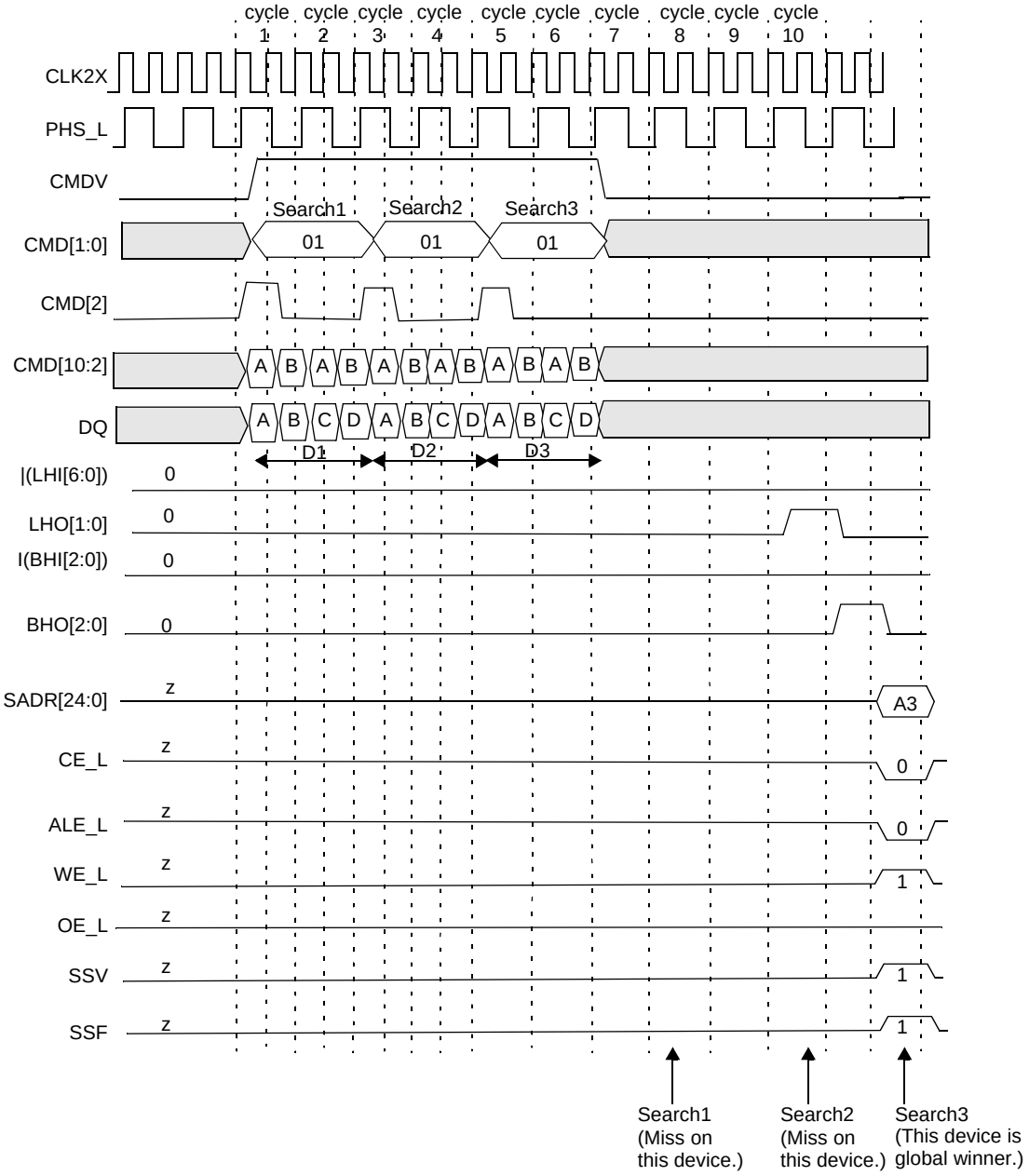
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-59. Timing Diagram for Each Device in Block Number 0 (Miss on Each Device)



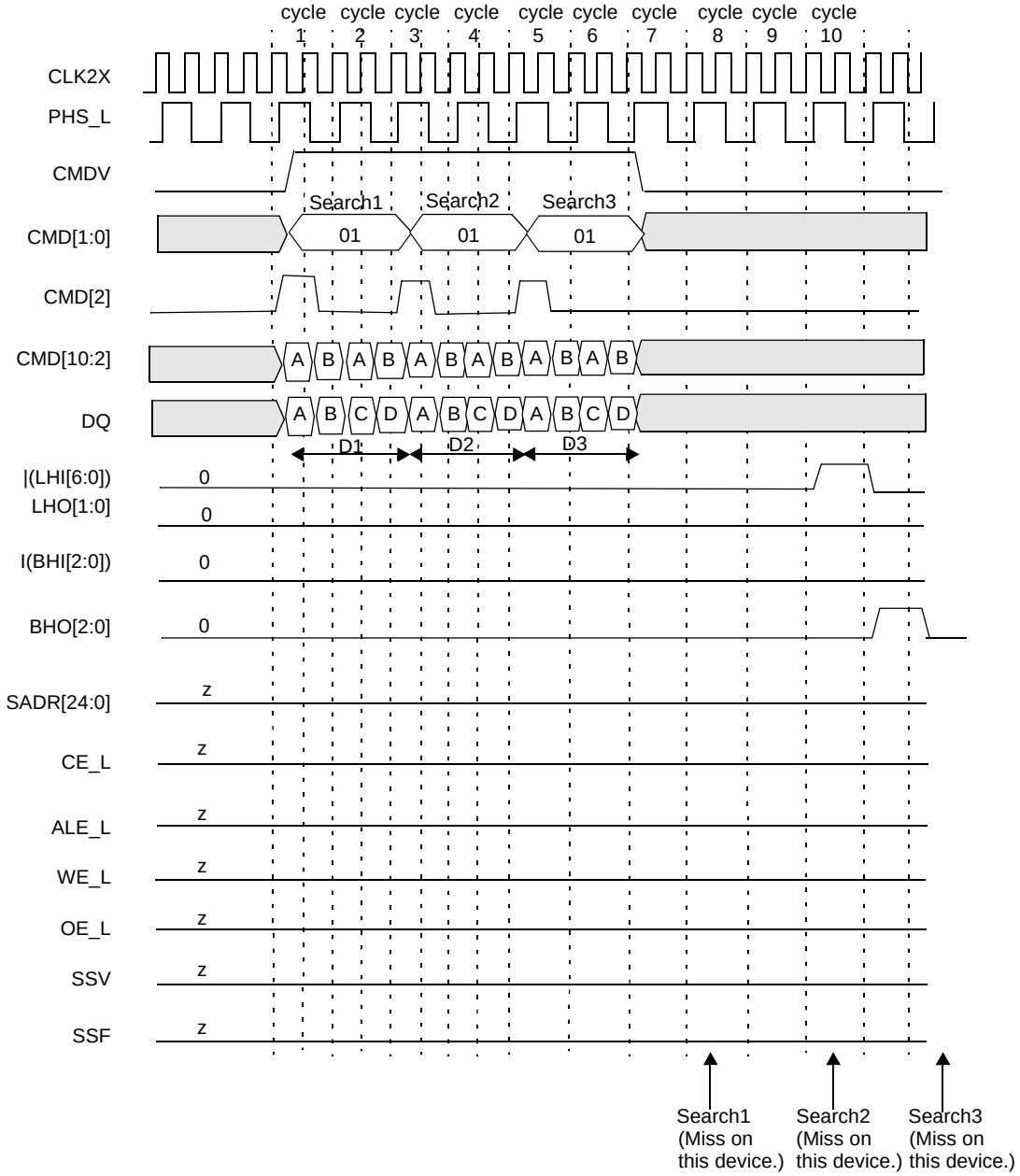
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-60. Timing Diagram for Each Device Above the Winning Device in Block Number 1



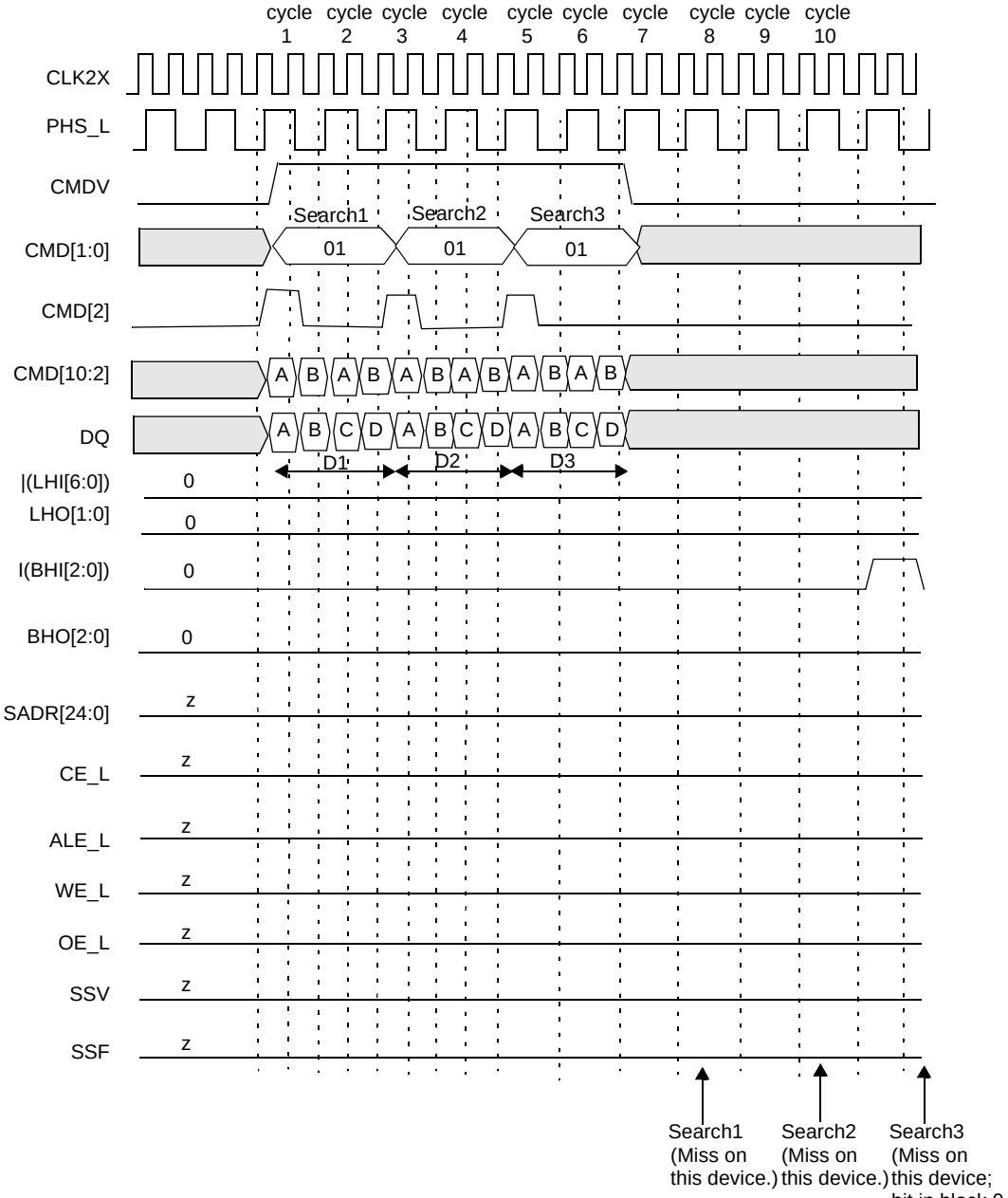
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-61. Timing Diagram for Globally Winning Device in Block Number 1



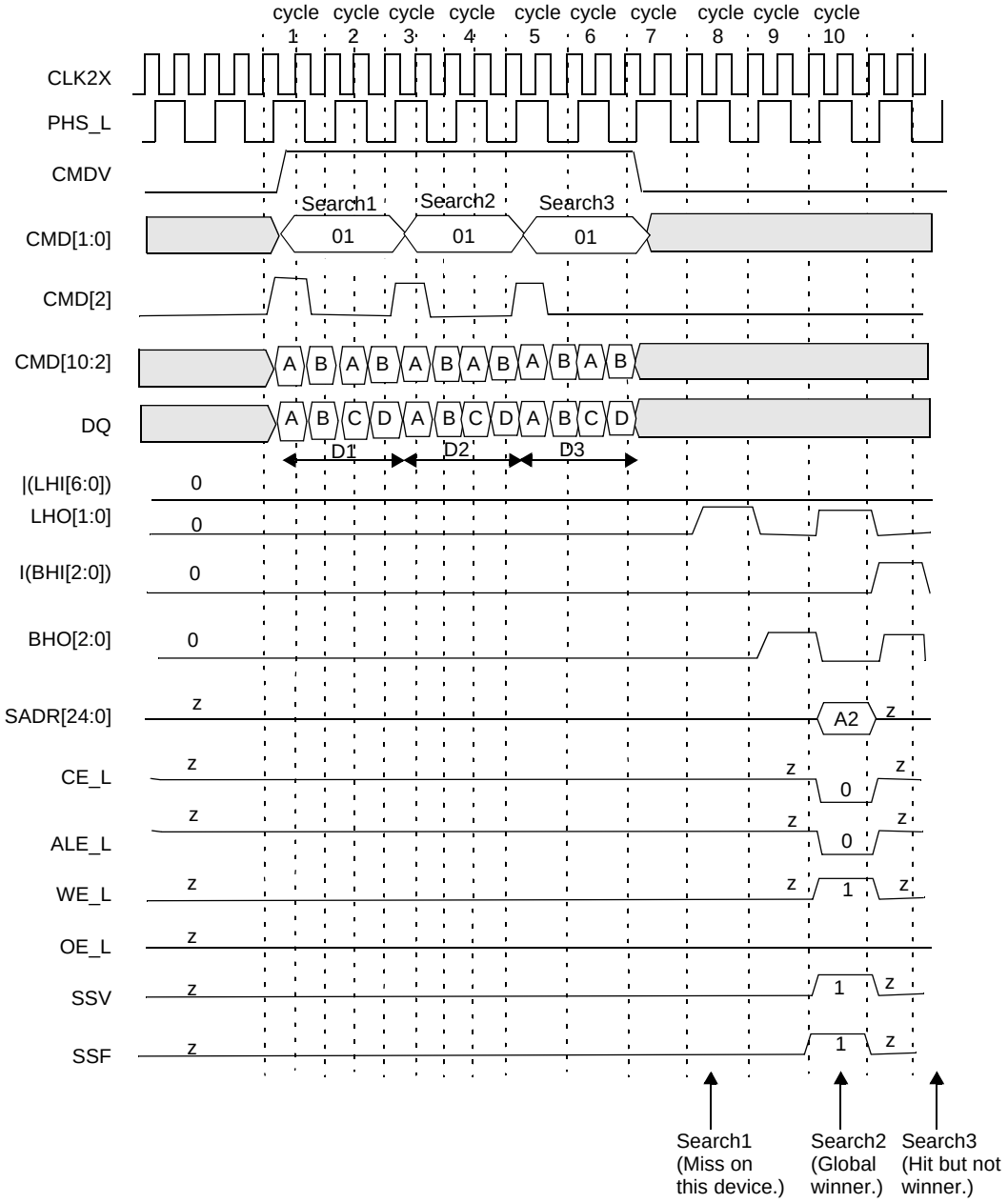
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-62. Timing Diagram for Devices Below the Winning Device in Block Number 1



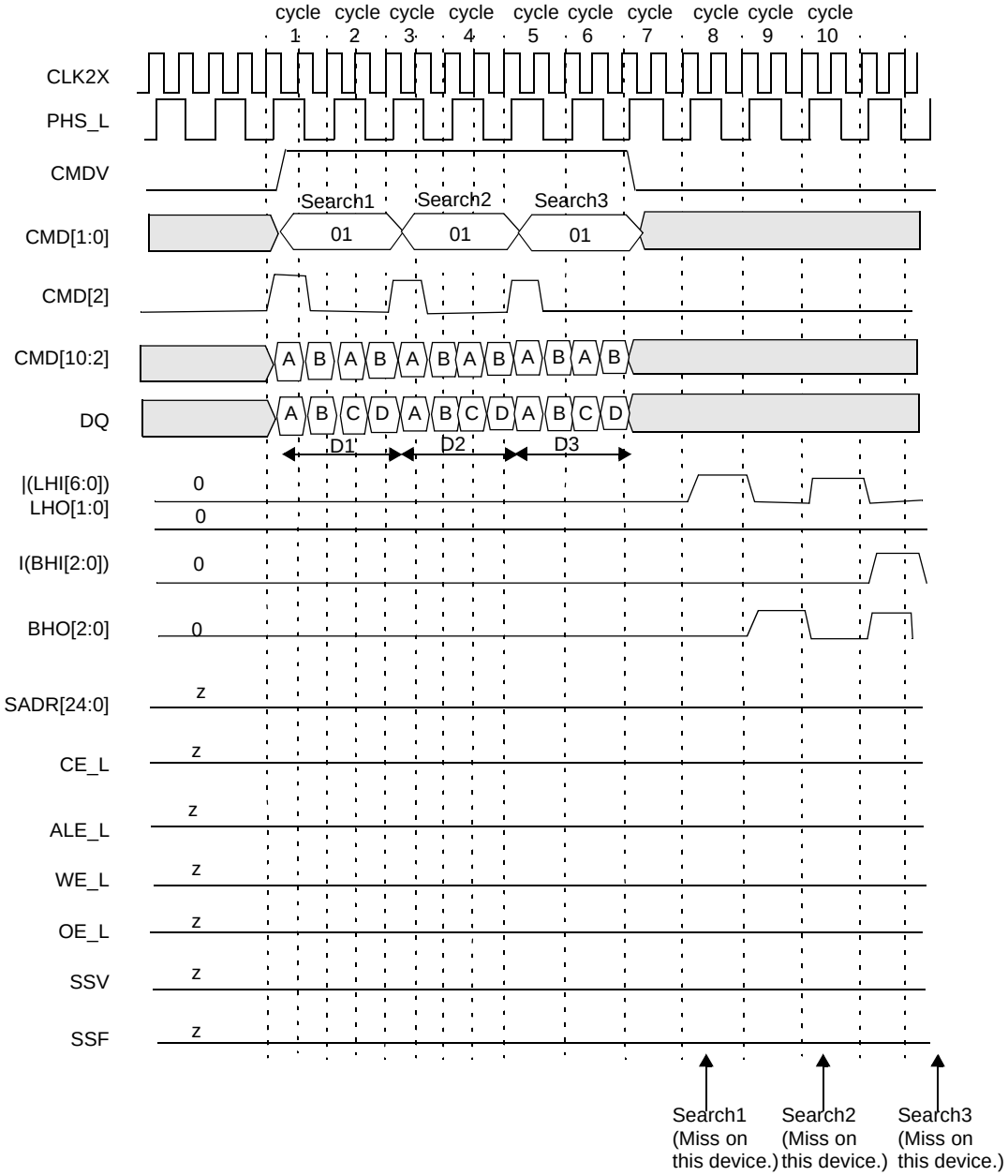
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-63. Timing Diagram for Devices Above the Winning Device in Block Number 2



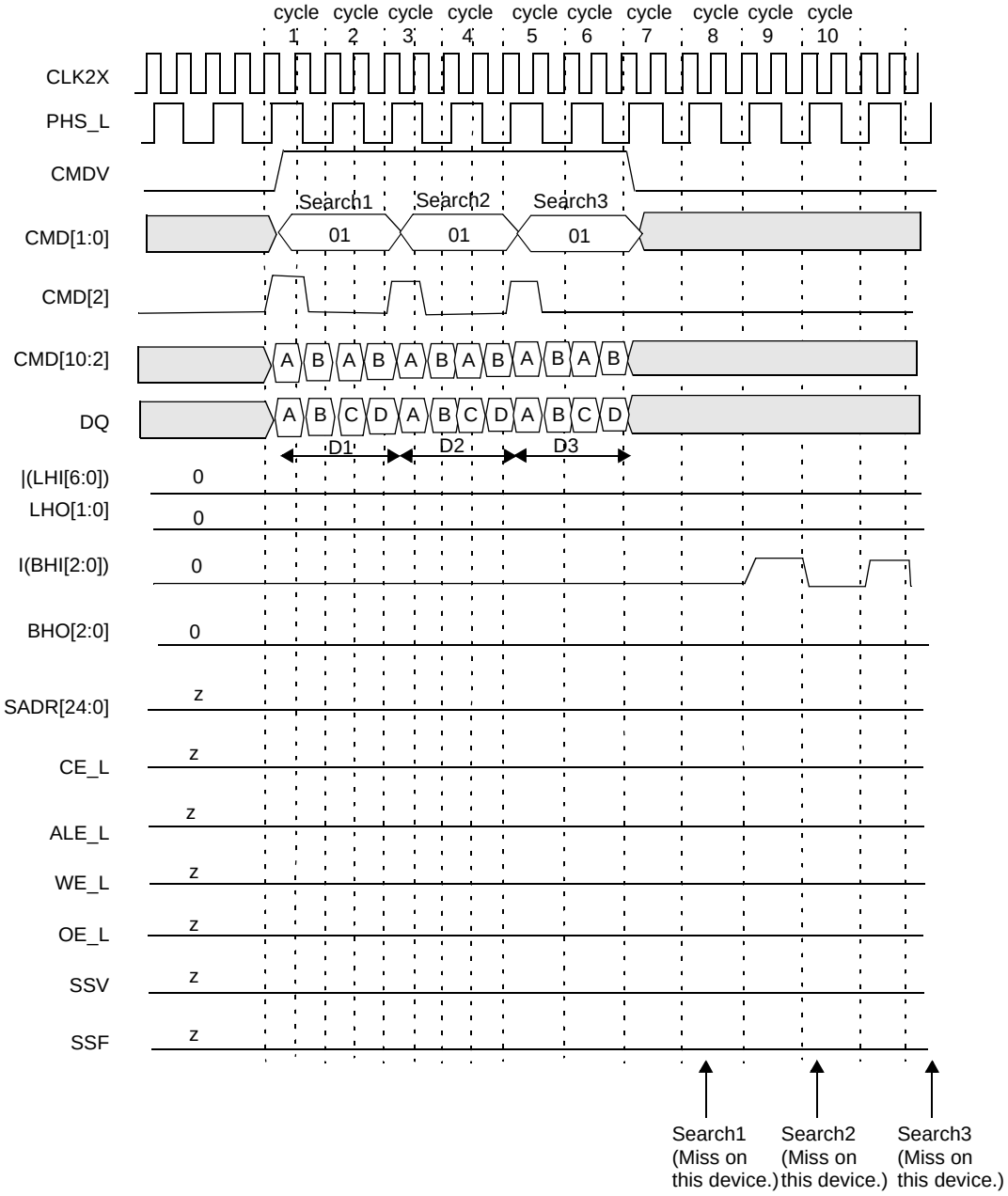
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-64. Timing Diagram for Globally Winning Device in Block Number 2



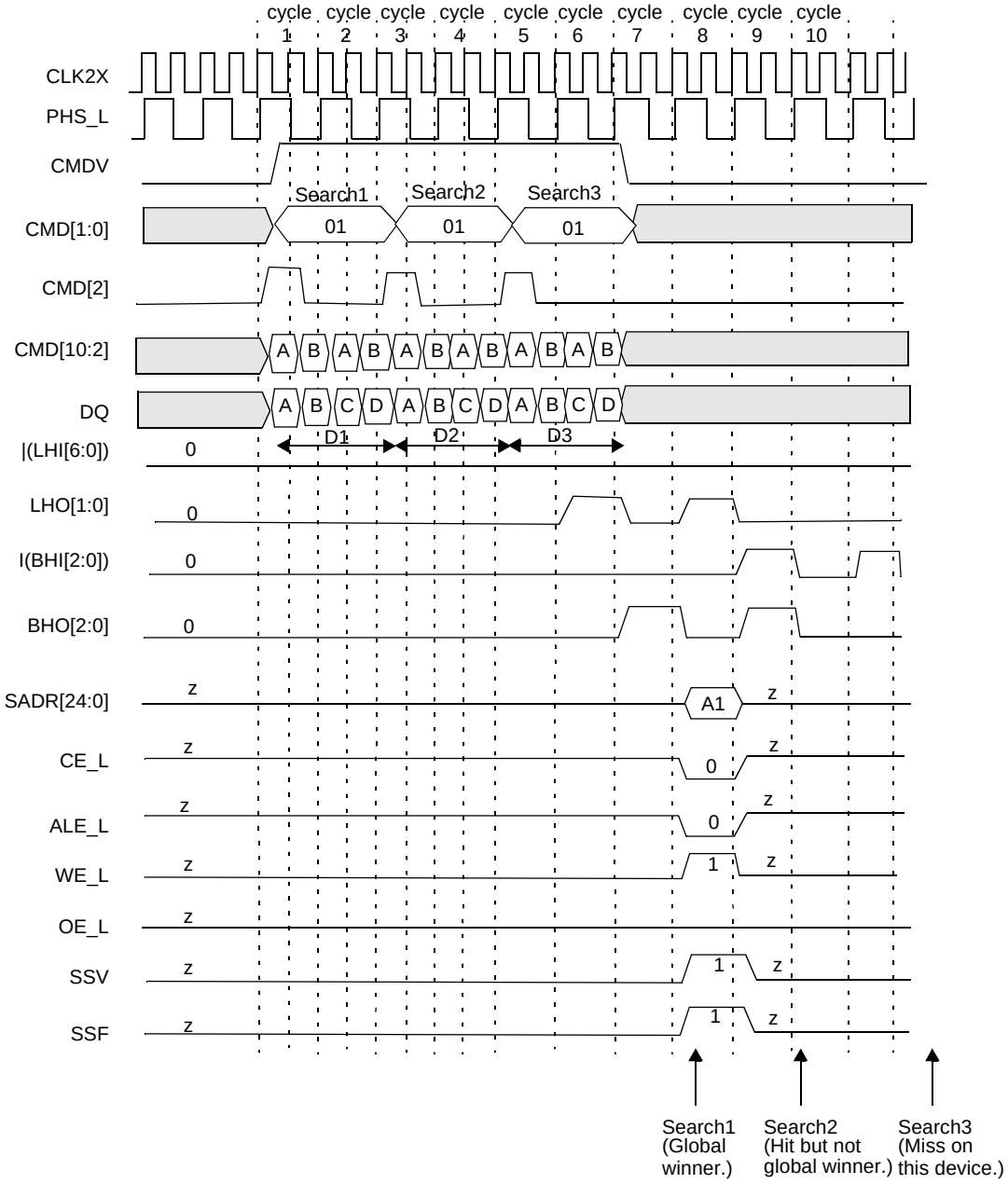
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-65. Timing Diagram for Devices Below the Winning Device in Block Number 2



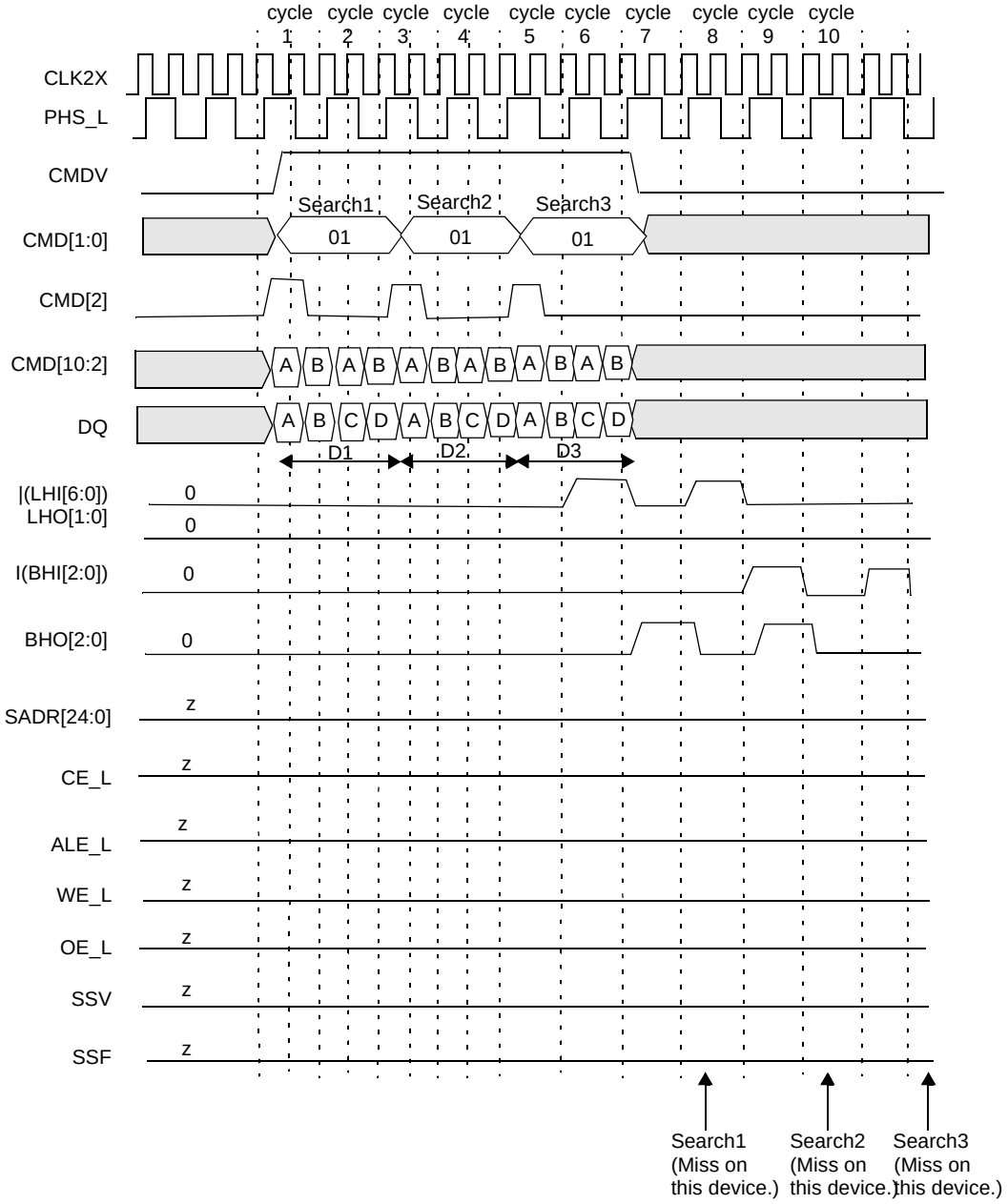
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-66. Timing Diagram for Devices Above the Winning Device in Block Number 3



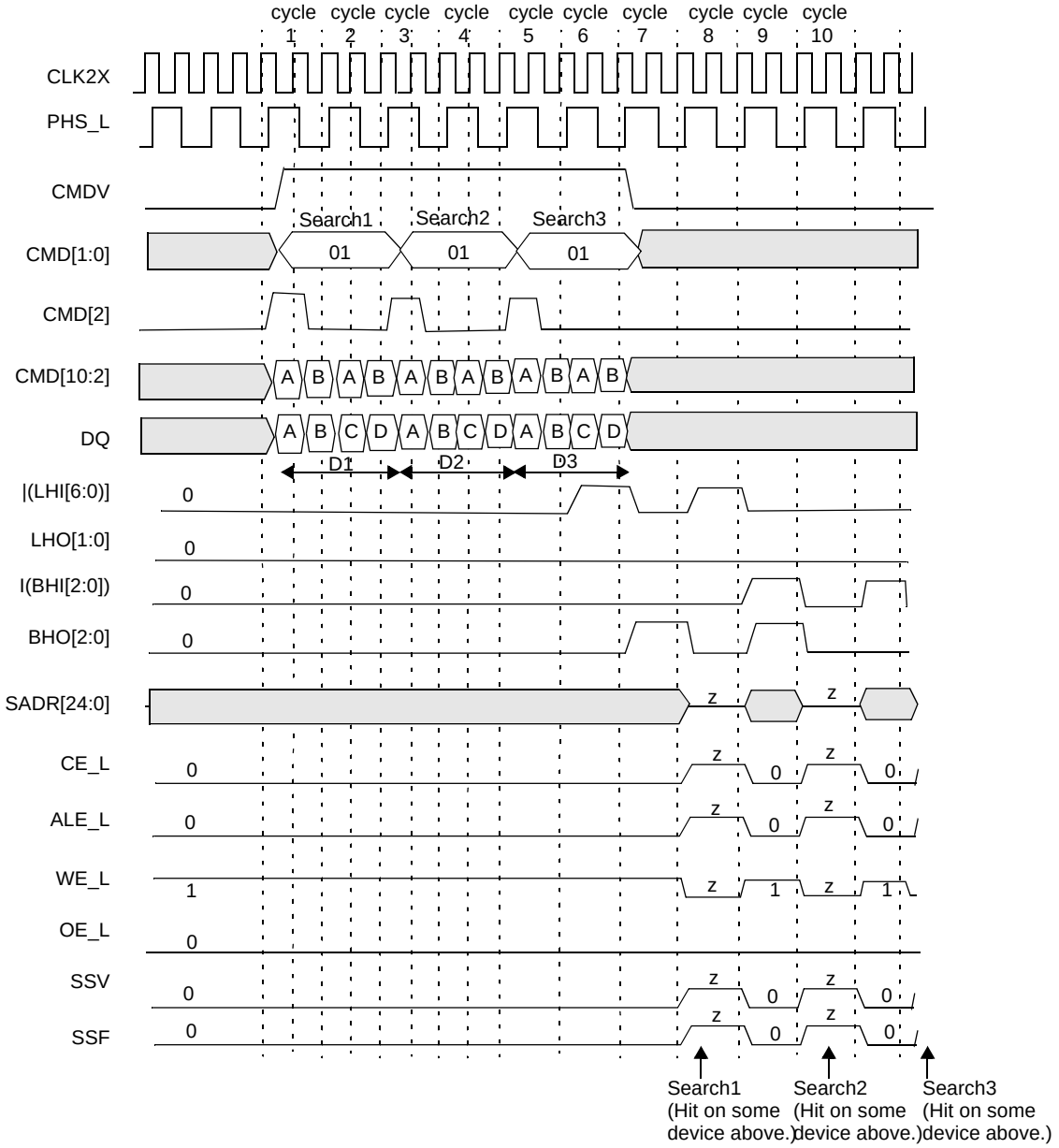
CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-67. Timing Diagram for Globally Winning Device in Block Number 3



CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 0, LDEV = 0.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-68. Timing Diagram for Devices Below the Winning Device in Block Number 3 Except Device 30 (Last Device)



CFG = 10101010101010101010101010101010, HLAT = 000, TLSZ = 10, LRAM = 1, LDEV = 1.
Note: |(BHI[2:0]) stands for the boolean 'OR' of the entire bus BHI[2:0].
Note: |(LHI[6:0]) stands for the boolean 'OR' for the entire bus LHI[6:0].
Note: Each bit in BHO[2:0] is the same logical signal.
Note: Each bit in LHO[1:0] is the same logical signal.

Figure 10-69. Timing Diagram of the Last Device in Block Number 3 (Device 30 in the Table)

The following is the sequence of operation for a single 288-bit SEARCH command (see also Subsection 10.2, "Commands and Command Parameters," on page 14).

- **Cycle A**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair used for bits [287:144] of the data being searched. DQ[71:0] must be driven with the 72-bit data ([287:216]) to be compared to all locations 0 in the four 72-bits-word page. The CMD[2] signal must be driven to logic 1. **Note**. CMD[2] = 1 signals that the SEARCH is a x288-bit SEARCH. CMD[8:6] is ignored in this cycle.

- **Cycle B**: The host ASIC continues to drive CMDV high and to apply SEARCH command (10) on CMD[1:0]. The DQ[71:0] is driven with the 72-bit data ([215:144]) to be compared to all locations 1 in the four 72-bits-word pages.
- **Cycle C**: The host ASIC drives CMDV high and applies SEARCH command code (10) on CMD[1:0] signals. {CMD[10],CMD[5:3]} signals must be driven with the index to the GMR pair used for the bits [143:0] of the data being searched. CMD[8:6] signals must be driven with the bits that will be driven by this device on SADR[24:22] if it has a hit. DQ[71:0] must be driven with the 72-bit data ([143:72]) to be compared to all locations 2 in the four 72-bits-word pages. The CMD[2] signal must be driven to logic 0.
- **Cycle D**: The host ASIC continues to drive CMDV high and to apply SEARCH command code (10) on CMD[1:0]. CMD[8:6] signals must be driven with the index of the SSR that will be used for storing the address of the matching entry and the hit flag (see page 8 for a description of SSR[0:7]). The DQ[71:0] is driven with the 72-bit data ([71:0]) to be compared to all locations 3 in the four 72-bits-word pages. CMD[5:2] is ignored because the LEARN instruction is not supported for x288 tables.

Note. For 288-bit searches, the host ASIC must supply four distinct 72-bit data words on DQ[71:0] during cycles A, B, C, and D. The GMR index in cycle A selects a pair of GMRs in each of the 31 devices that apply to DQ data in cycles A and B. The GMR index in cycle C selects a pair of GMRs in each of the 31 devices that apply to DQ data in cycles C and D.

The logical 288-bit SEARCH operation is shown in Figure 10-70. The entire table of 288-bit entries is compared to a 288-bit word K that is presented on the DQ bus in cycles A, B, C, and D of the command using the GMR and local mask bits. The GMR is the 288-bit word specified by the two pairs of GMRs selected by the GMR Indexes in command cycles A and C in each of the 31 devices. The 288-bit word K that is presented on the DQ bus in cycles A, B, C, and D of the command is compared to each entry in the table starting at location 0. The first matching entry's location address L is the winning address that is driven as part of the SRAM address on the SADR[24:0] lines (see "SRAM Addressing" on page 93). **Note**. The matching address is always going to be location 0 in a four-entry page for 288-bit search (two LSBs of the matching index will be 00).

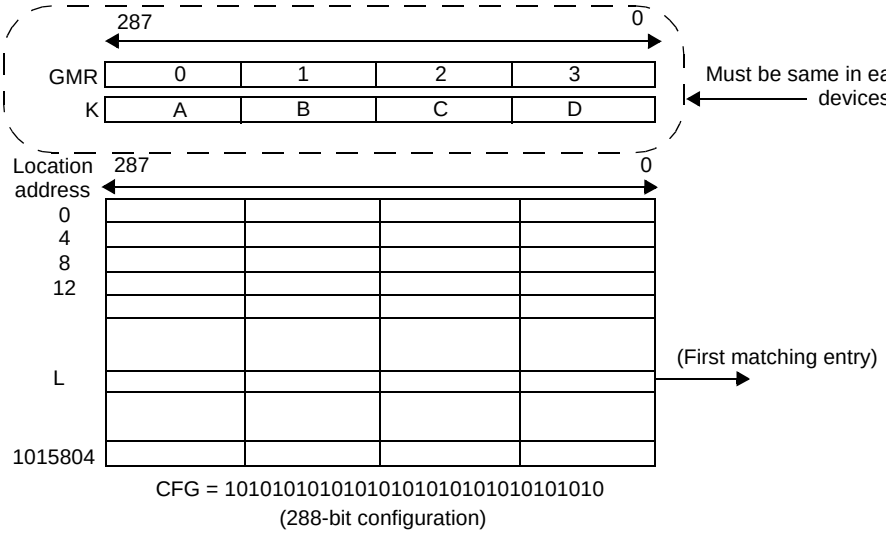


Figure 10-70. x288 Table with 31 Devices

The SEARCH command is a pipelined operation and executes a SEARCH at one-fourth the rate of the frequency of CLK2X for 288-bit searches in x288-configured tables. The latency of SADR, CE_L, ALE_L, WE_L, SSV, and SSF from the 288-bit SEARCH command (measured in CLK cycles) from the CLK2X cycle that contains the C and D cycles is shown in Table 10-32.

Table 10-32. SEARCH Latency from Instruction to SRAM Access Cycle

Number of Devices	Max Table Size	Latency in CLK Cycles
1 (TLSZ = 00)	32K x 288 bits	4
1–8 (TLSZ = 01)	256K x 288 bits	5
1–31 (TLSZ = 10)	992K x 288 bits	6

SEARCH latency from command to SRAM access cycle is 6 for a single device in the table and TLSZ = 10. In addition, SSV and SSF shift further to the right for different values of HLAT, as specified in Table 10-33.

Table 10-33. Shift of SSF and SSV from SADR

HLAT	Number of CLK Cycles
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

10.6.10 Mixed-size Searches on Tables Configured with Different Widths using an CYNSE70256 With CFG_L LOW

This subsection will cover mixed searches (x72, x144, and x288) with tables of different widths (x72, x144, x288). The sample operation shown is for a single device with CFG = 10101010010101010000000000000000 that contains three tables of x72, x144, and x288 widths. The operation can be generalized to a block of 8–31 devices using four blocks; the timing and pipeline operation is the same as described previously for fixed searches on a table of one-width size.

Figure 10-71 shows three sequential searches: first, a 72-bit SEARCH on a x72-configured table; a 144-bit SEARCH on a x144-configured table; finally, a 288-bit SEARCH on a x288-configured table that each results in a hit. **Note**. The DQ[71:70] will be 00 in each of the two A and B cycles of the x72-bit SEARCH (Search1). DQ[71:70] is 01 in each of the A and B cycles of the x144-bit SEARCH (Search2). DQ[71:70] is 10 in each of the A, B, C, and D cycles of the x288-bit SEARCH (Search3). By having table designation bits, the CYNSE70256 device enables the creation of many tables in a bank of NSEs of different widths.

Figure 10-72 shows the sample table. Two bits in each 72-bit entry will need to designated as the table number bits. One choice can be the 00 values for the table configured as x72, 01 values for tables configured as x144, and 10 values for tables configured as x288. For the above explanation, it is further assumed that bits [71:70] for each entry will be designed as such table designation bits.

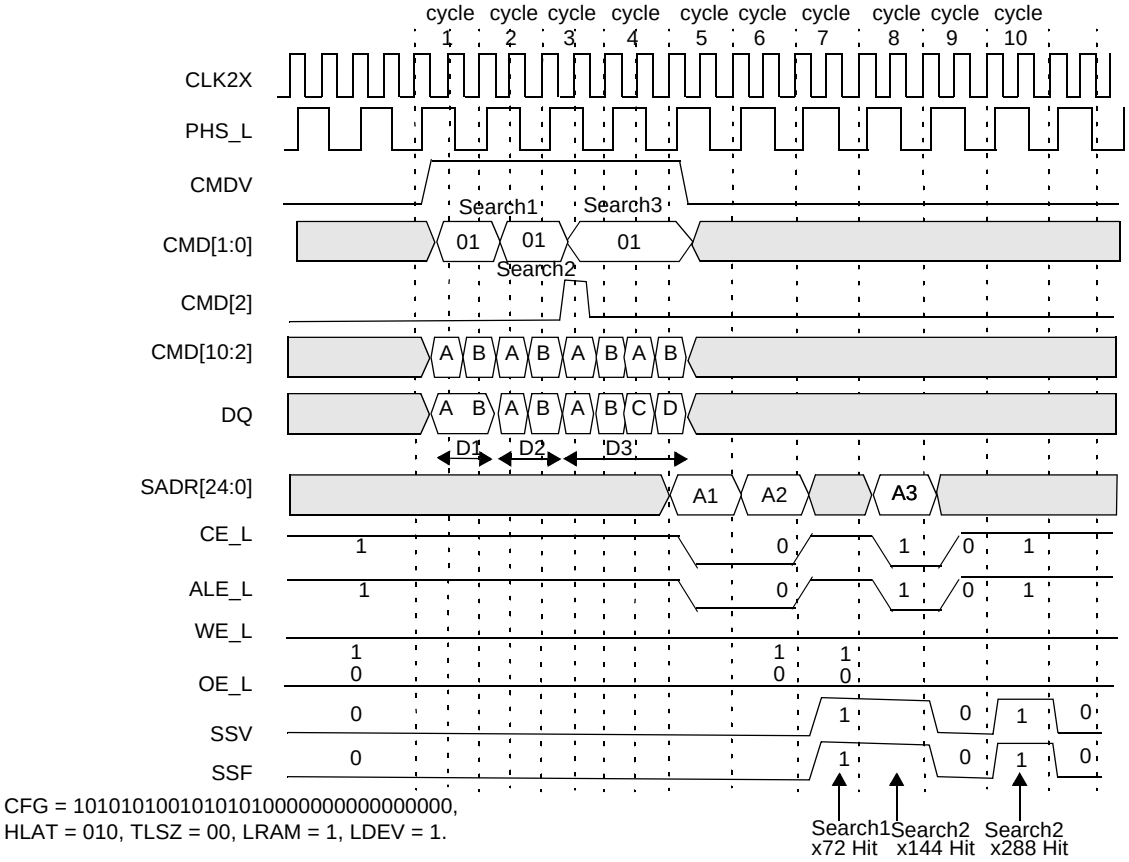


Figure 10-71. Timing Diagram for Mixed Search (One Device)

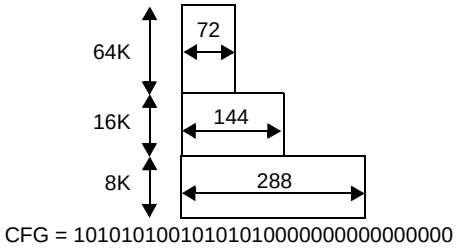


Figure 10-72. Multiwidth Configurations Example

10.6.11 Mixed-size Searches on Tables Configured to Different Widths using a CYNSE70256 Device with CFG_L High

This subsection will cover the mixed-size searches (x72, x144 and x288) with tables of different widths (x72, x144, x288) with CFG_L set high. The previous subsection described searches on tables of different widths using table designation bits in the data array, which can be wasteful. In order to avoid the waste of these bits and yet support up to three tables of x72, x144 and x288 widths, CMD[2] and CMD[9] (in CFG_L high mode) in cycle A of the command can be used as shown in Table 10-34.

Table 10-34. Searches with CFG_L Set High

CMD[9]	CMD[2]	SEARCH
0	0	SEARCH 72-bit-configured partitions only.
1	0	SEARCH 144-bit-configured partitions only.
X	1	Cycles A and B for searching 288-bit-configured partitions.
X	0	Cycles C and D for searching 288-bit-configured partitions.

10.7 LRAM and LDEV Description

When NSEs are cascaded using multiple CYNSE70256 devices, the SADR, CE_L, and WE_L (3-state signals) are all tied together. In order to eliminate external pull-up and pull downs, one device in a bank is designated the default driver. For nonSEARCH or nonLEARN cycles (see Subsection 10.8, “LEARN Command”) or SEARCH cycles with a global miss, the SADR, CE_L, and WE_L signals are driven by the device with the LRAM bit set. It is important that only one device in a bank of cascaded NSEs have this bit set. Failure to do so will cause contention on the SADR, CE_L, and WE_L, and can potentially cause damage to the device(s).

Similarly, when NSEs using multiple CYNSE70256 devices are cascaded, SSF and SSV (also 3-state signals) are tied together. In order to eliminate external pull-up and pull downs, one device in a bank is designated as the default driver. For nonSEARCH cycles or SEARCH cycles with a global miss, the SSF and SSV signals are driven by the device with the LDEV bit set. It is important that only one device in a bank of cascaded NSEs have this bit set. Failure to do so will cause contention on the SSV and SSF, and can potentially cause damage to the device(s).

10.8 LEARN Command

Bit[0] of each 72-bit data location specifies whether an entry in the database is occupied. If all the entries in a device are occupied, the device asserts FULO signal to inform the downstream devices that it is full. The result of this communication between depth-cascaded devices determines the global FULL signal for the entire table. The FULL signal in the last device determines the fullness of the depth-cascaded table.

The device contains sixteen pairs of internal 72-bit-wide comparand registers that store the comparands as the device executes searches. On a miss by the SEARCH that is signalled to the ASIC through the SSV and SSF signals (SSV = 1, SSF = 0), the host ASIC can apply the LEARN command to learn the entry from a comparand register as to the next-free location (see Subsection 7.8, “NFA Register,” on page 11). The NFA register is updated with the new next-free location information following each WRITE or LEARN command.

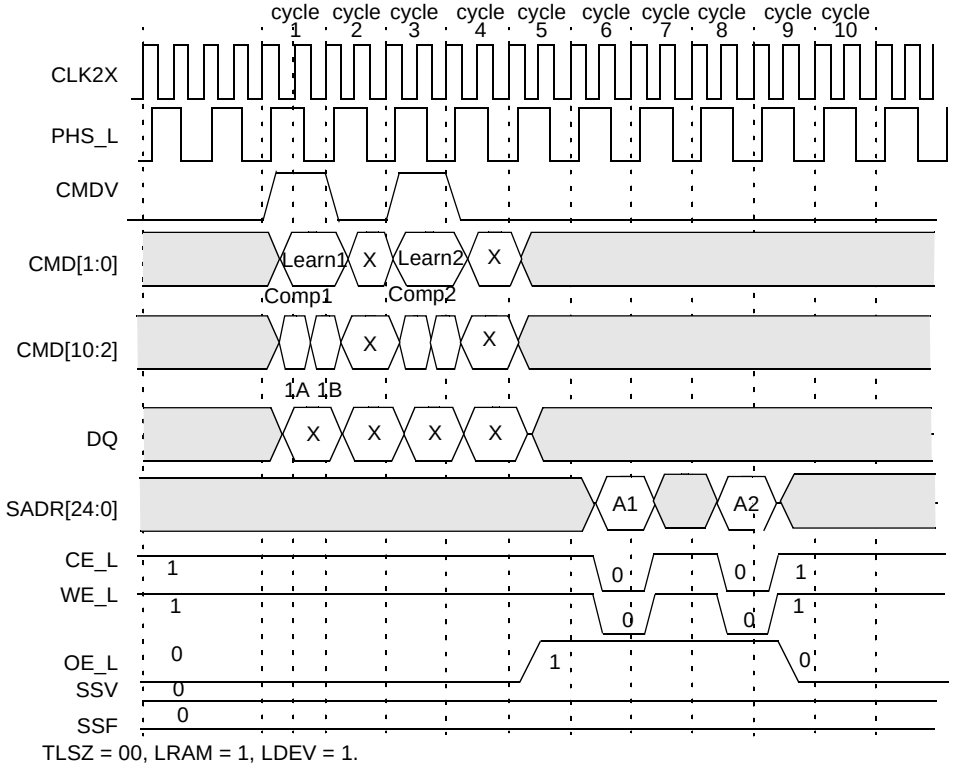
In a depth-cascaded table, only a single device will LEARN the entry through the application of a LEARN instruction. The determination as to which device will LEARN is based on the FULI and FULO signals between the devices. The first non-full device learns the entry by storing the contents of the specified comparand registers to the location(s) pointed to by the NFA register.

In a x72-configured table, the LEARN command writes a single 72-bit location. In a x144-configured table, the LEARN command writes the next even and odd 72-bit locations. In 144-bit mode, bit[0] of the even and odd 72-bit locations is 0, indicating that they are cascaded empty, or 1, indicating that they are occupied.

The global FULL signal indicates to the table controller (the host ASIC) that all entries within a block are occupied and that no more entries can be learned. The CYNSE70256 device updates the signal after each WRITE or LEARN command to a data array. The LEARN command generates a WRITE cycle to the external SRAM, also using the NFA register as part of the SRAM address (see Section 12.0, “SRAM Addressing,” on page 93).

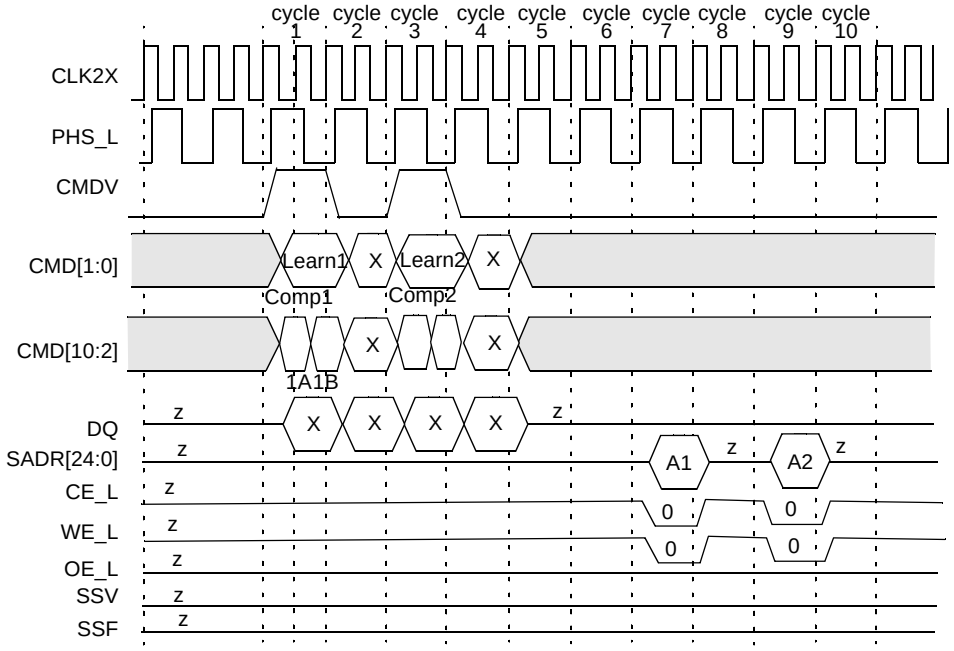
The LEARN command is supported on a single block containing up to eight devices if the table is configured either as x72 or x144. The LEARN command is not supported for x288-configured tables.

The LEARN command is a pipelined operation and lasts for two CLK cycles, as shown in Figure 10-73 where TLSZ = 00, and Figure 10-74 and Figure 10-75 where TLSZ = 01. Figure 10-74 and Figure 10-75 assume that the device performing the LEARN operation is not the last device in the table and will therefore have its LRAM bit set to 0. **Note**. The OE_L for the device with the LRAM bit set goes high for two cycles for each LEARN (one during the SRAM WRITE cycle and one during the cycle before). The SRAM WRITE cycle latency from the second cycle of the instruction is shown in Table 10-35.



TLSZ = 00, LRAM = 1, LDEV = 1.

Figure 10-73. Timing Diagram of LEARN (TLSZ = 00)



TLSZ = 01, LRAM = 0, LDEV = 0.

Figure 10-74. Timing Diagram of LEARN (Except on the Last Device [TLSZ = 01])

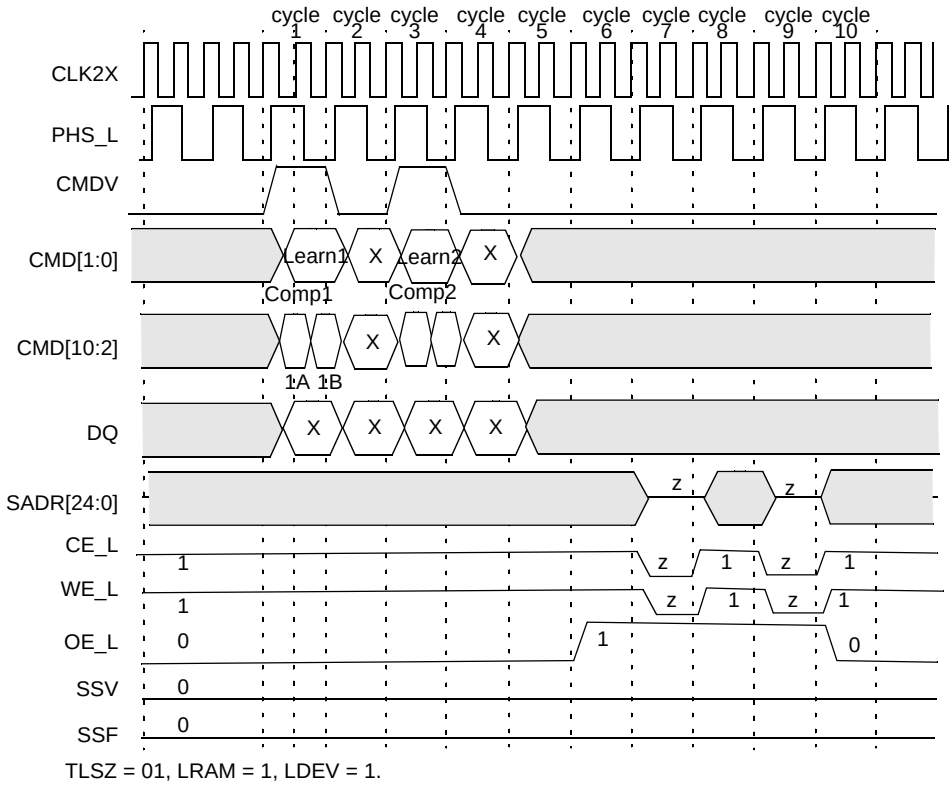


Figure 10-75. Timing Diagram of LEARN on Device Number 7 (TLSZ = 01)

Table 10-35. SRAM WRITE Cycle Latency from Second Cycle of LEARN Instruction

Number of Devices	Latency in CLK Cycles
1 (TLSZ = 00)	4
1–8 (TLSZ = 01)	5
1–31 (TLSZ = 10)	6

The LEARN operation lasts two CLK cycles. The sequence of operation is as follows.

- **Cycle 1A**: The host ASIC applies the LEARN instruction on CMD[1:0] using CMDV = 1. The CMD[5:2] field specifies the index of the comparand register pair that will be written in the data array in the 144-bit-configured table. For a LEARN in a 72-bit-configured table, the even-numbered comparand specified by this index will be written. CMD[8:6] carries the bits that will be driven on SADR[24:22] in the SRAM WRITE cycle.
- **Cycle 1B**: The host ASIC continues to drive CMDV to 1, CMD[1:0] to 11, and CMD[5:2] with the comparand pair index. CMD[6] must be set to 0 if the LEARN is being performed on a 72-bit-configured table, and to 1 if the LEARN is being performed on a 144-bit-configured table.
- **Cycle 2**: The host ASIC drives CMDV to 0.

At the end of cycle 2, a new instruction can begin. SRAM WRITE latency is the same as the SEARCH to the SRAM READ cycle. It is measured from the second cycle of the LEARN instruction.

11.0 Depth Cascading

The NSE application can depth-cascade the devices to various table sizes of different widths (72 bits, 144 bits, or 288 bits). The devices perform all the necessary arbitration to decide which device will drive the SRAM bus. SEARCH latency increases as the table size increases; the SEARCH rate itself remains constant.

11.1 Depth Cascading up to Eight Devices (One Block)

Figure 11-1 shows that up to eight devices can be cascaded to form 512K x 72, 256K x 144, or 128K x 288 tables. It also shows the interconnection between devices for depth cascading. Each NSE asserts the LHO[1] and LHO[0] signals to inform downstream devices of its result. LHI[6:0] signals for a device are connected to LHO signals of the upstream devices. The host ASIC must program the TLSZ to 01 for each of up to eight devices in a block. Only a single device drives the SRAM bus in any single cycle.

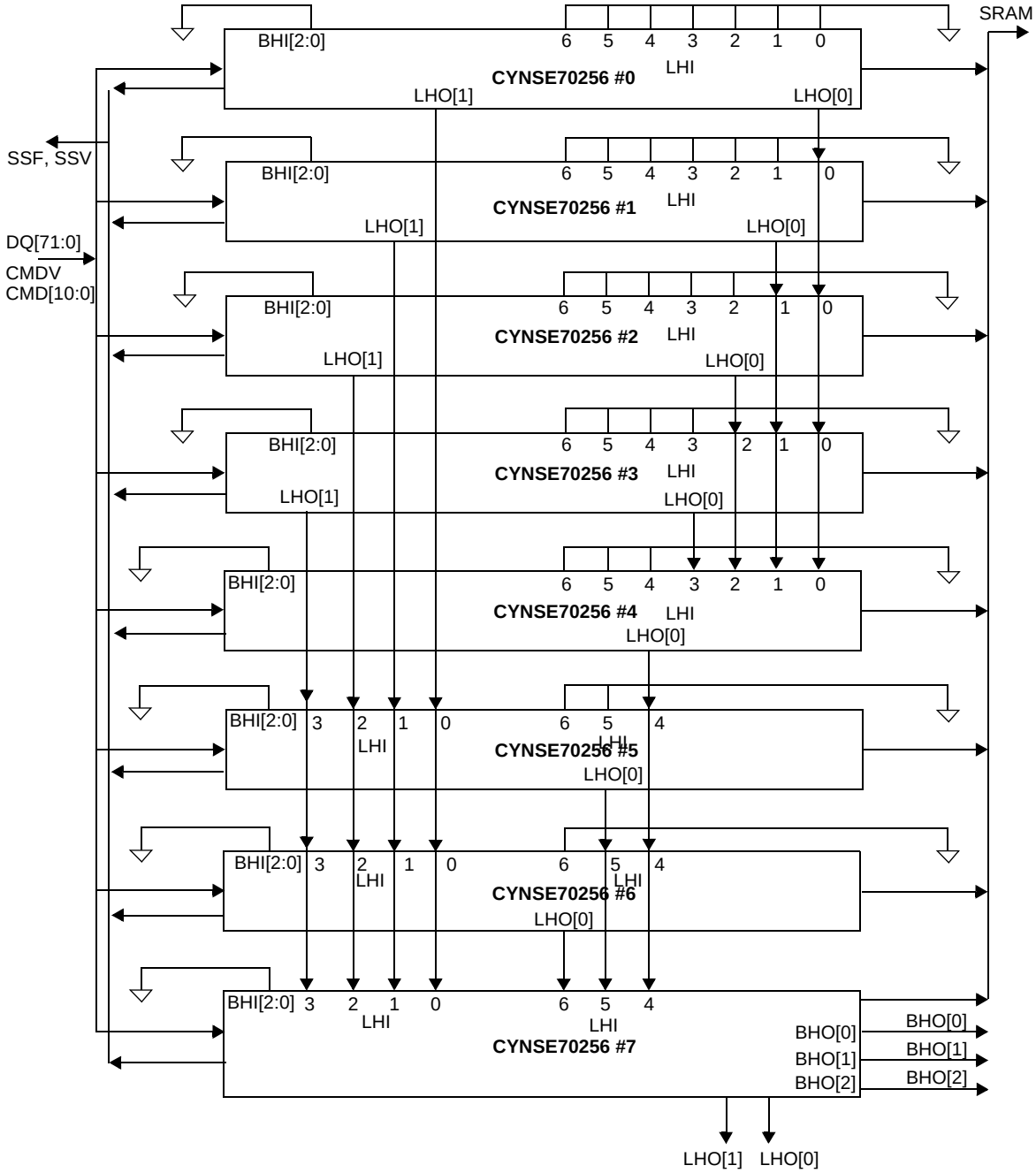


Figure 11-1. Depth Cascading to Form a Single Block

11.2 Depth Cascading up to 31 Devices (Four Blocks)

Figure 11-2 shows the cascading of up to four blocks. Each block except the last contains up to eight CYNSE70256 devices, and the interconnection within each with the cascading of up to eight devices in a block was shown in the previous subsection. **Note**. The interconnection between blocks for depth cascading is important. For each SEARCH, a block asserts BHO[2], BHO[1], and BHO[0]. The BHO[2:0] signals for a block are taken only from the last device in that block. For all other devices within that block, these signals stay open and floating. The host ASIC must program TLSZ to 10 in each of the devices for cascading up to 31 devices (in up to four blocks).

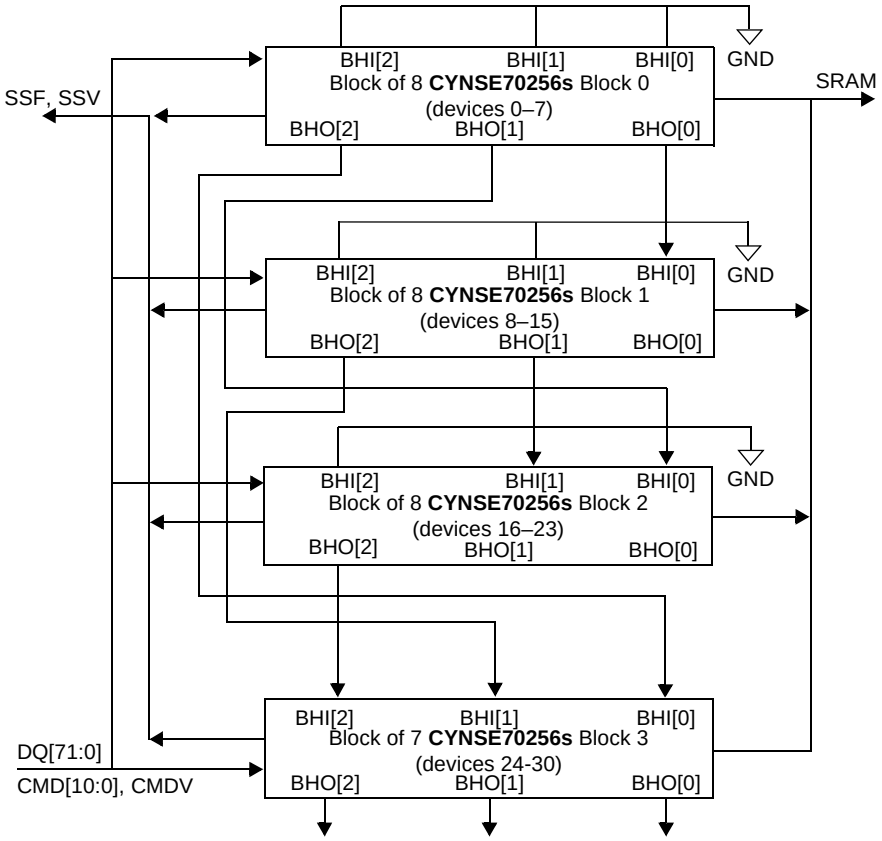


Figure 11-2. Depth Cascading four Blocks

11.3 Depth Cascading for a FULL Signal

Bit[0] of each of the 72-bit entries is designated as a special bit (1 = occupied, 0 = empty). For each LEARN or PIO WRITE to the data array, each device asserts FULO[1] or FULO[0] depending on whether or not it has any empty locations within it (see Figure 11-3). Each device combines the FULO signals from the devices above it with its own full status to generate a FULL signal that gives the full status of the table up to the device asserting the FULL signal. Figure 11-3 shows the hardware connection diagram for generating the FULL signal that goes back to the ASIC. In a depth-cascaded block of up to eight devices, the FULL signal from the last device should be fed back to the ASIC controller to indicate the fullness of the table. The FULL signal of the other devices should be left open. **Note**. The LEARN instruction is supported for only up to eight devices, whereas FULL cascading is allowed only for one block in tables containing more than eight devices. In tables for which a LEARN instruction is not going to be used, the bit[0] of each 72-bit entry should always be set to 1.

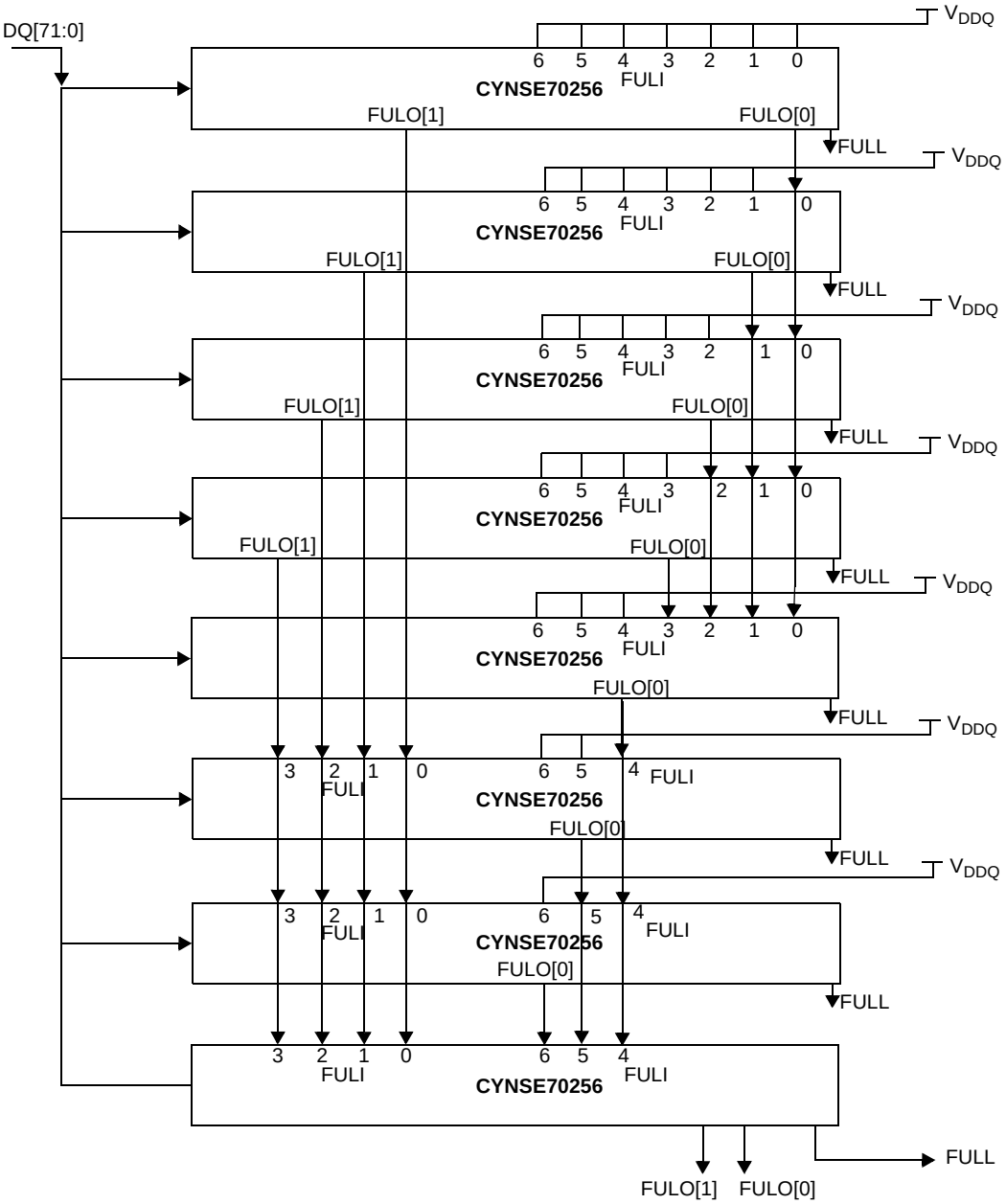


Figure 11-3. FULL Signal Generation in a Cascaded Table

12.0 SRAM Addressing

Table 12-1 describes the commands used to generate addresses on the SRAM address bus. The index [16:0] field contains the address of a 72-bit entry that results in a hit in 72-bit-configured quadrant. It is the address of the 72-bit entry that lies at the 144-bit page, and the 288-bit page boundaries in 144-bit- and 288-bit-configured quadrants, respectively.

Section 7.0, “Registers,” on page 7 of this datasheet describes the NFA and SSR registers. ADR[16:0] contains the address supplied on the DQ bus during PIO access to the CYNSE70256. Command bits 8, 7, and 6 {CMD[8:6]} are passed from the command to the SRAM address bus. See Section 10.0, “Commands,” on page 13, for more information. ID[4:0] is the ID of the device driving the SRAM bus (see Section 17.0, “Pinout Descriptions and Package Diagrams,” on page 112, for more information).

Table 12-1. SRAM Bus Address

Command	SRAM Operation	24	23	22	[21:17]	[16:0]
SEARCH	READ	C8	C7	C6	ID[4:0]	Index[16:0]
LEARN	WRITE	C8	C7	C6	ID[4:0]	NFA[16:0]
PIO READ	READ	C8	C7	C6	ID[4:0]	ADR16:0]
PIO WRITE	WRITE	C8	C7	C6	ID[4:0]	ADR[16:0]
Indirect Access	WRITE/READ	C8	C7	C6	ID[4:0]	SSR[16:0]

12.1 SRAM PIO Access

The remainder of Section 12.0 describes SRAM READ and WRITE operations.

SRAM READ enables READ access to the off-chip SRAM containing associative data. The latency from the issuance of the READ instruction to the appearance of the address on the SRAM bus is the same as the SEARCH instruction latency, and will depend on the value programmed for the TLSZ parameter in the device configuration register. The latency of the ACK from the READ instruction is the same as that from the SEARCH instruction to the SRAM address latency, plus the HLAT programmed in the configuration register. **Note**. SRAM READ is a blocking operation—no new instruction can begin until the ACK is returned by the selected device performing the access.

SRAM WRITE enables WRITE access to the off-chip SRAM containing associative data. The latency from the second cycle of the WRITE instruction to the appearance of the address on the SRAM bus is the same as the SEARCH instruction latency, and will depend on the TLSZ value parameter programmed in the device configuration register. **Note**. SRAM WRITE is a pipelined operation—new instruction can begin right after the previous command has ended.

12.2 SRAM READ with a Table of One Device

SRAM READ enables READ access to the off-chip SRAM containing associative data. The latency from the issuance of the READ instruction to the appearance of the address on the SRAM bus is the same as SEARCH instruction latency, and will depend on the TLSZ value parameter programmed into the device configuration register. ACK latency from the READ instruction is the same as that from the SEARCH instruction to the SRAM address, plus the HLAT programmed in the configuration register. The following explains the SRAM READ operation in a table with only one device that has the following parameters: TLSZ = 00, HLAT = 000, LRAM = 1, and LDEV = 1. Figure 12-1 shows the associated timing diagram. For the following description, the selected device refers to the only device in the table because it is the only device to be accessed.

- **Cycle 1A**: The host ASIC applies the READ instruction on CMD[1:0] using CMDV = 1. The DQ bus supplies the address, with DQ[20:19] set to 10, to select the SRAM address. The host ASIC selects the device for which ID[4:0] matches the DQ[25:21] lines. During this cycle, the host ASIC also supplies SADR[24:22] on CMD[8:6].
- **Cycle 1B**: The host ASIC continues to apply the READ instruction on CMD[1:0] using CMDV = 1. The DQ bus supplies the address with DQ[20:19] set to 10 to select the SRAM address.
- **Cycle 2**: The host ASIC floats DQ[71:0] to a 3-state condition.
- **Cycle 3**: The host ASIC keeps DQ[71:0] in a 3-state condition.
- **Cycle 4**: The selected device starts to drive DQ[71:0] and drives ACK from high-Z to low.
- **Cycle 5**: The selected device drives the READ address on SADR[24:0] and drives ACK high, CE_L low, and ALE_L low.
- **Cycle 6**: The selected device drives CE_L high, ALE_L high, the SADR bus, the DQ bus in a 3-state condition, and ACK low.

At the end of cycle 6, the selected device floats ACK in a 3-state condition, and a new command can begin.

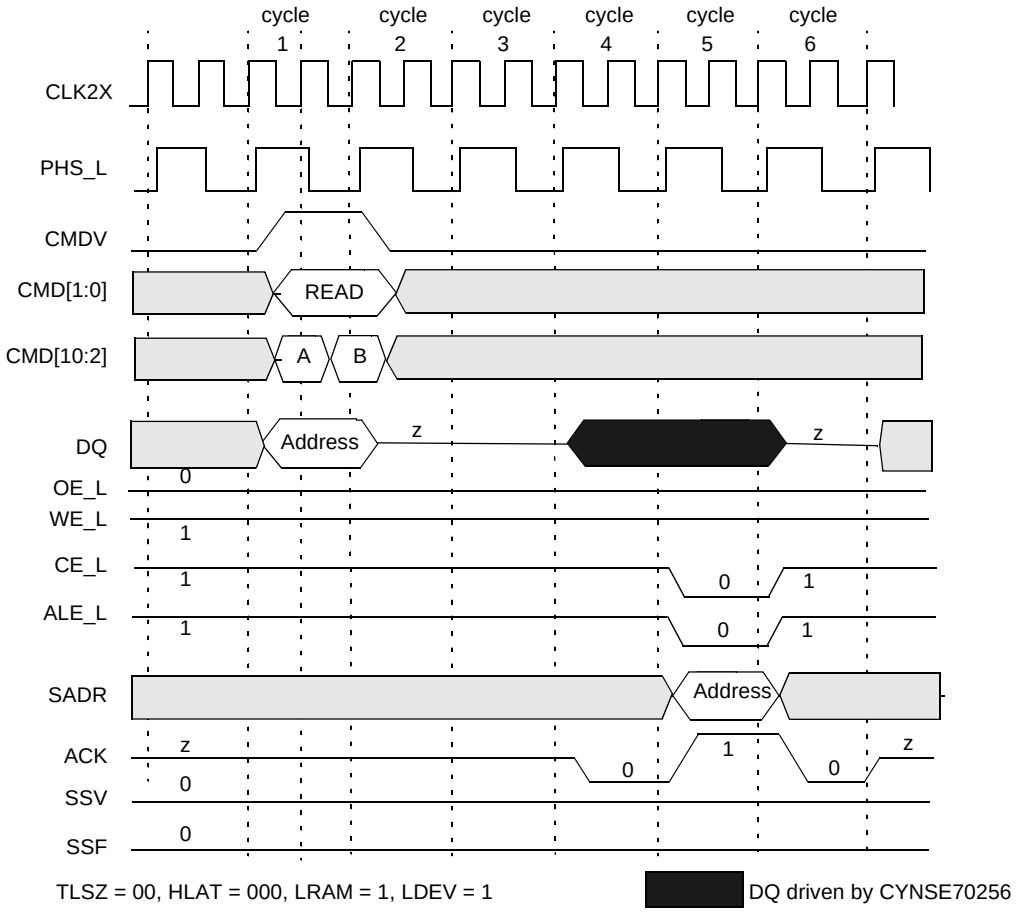


Figure 12-1. SRAM READ Access (TLSZ = 00, HLAT = 000, LRAM = 1, LDEV = 1)

12.3 SRAM READ with a Table of up to Eight Devices

The following explains the SRAM READ operation completed through a table of up to eight devices using the following parameter: TLSZ = 01. Figure 12-2 diagrams a block of eight devices. The following assumes that SRAM access is successfully achieved through CYNSE70256 device number 0. Figure 12-3 and Figure 12-4 show timing diagrams for device number 0 and device number 7, respectively.

- **Cycle 1A**: The host ASIC applies the READ instruction on CMD[1:0] using CMDV = 1. The DQ bus supplies the address, with DQ[20:19] set to 10, to select the SRAM address. The host ASIC selects the device for which ID[4:0] matches the DQ[25:21] lines. During this cycle the host ASIC also supplies SADR[24:22] on CMD[8:6].
- **Cycle 1B**: The host ASIC continues to apply the READ instruction on CMD[1:0], using CMDV = 1. The DQ bus supplies the address, with DQ[20:19] set to 10, to select the SRAM address.
- **Cycle 2**: The host ASIC floats DQ[71:0] to a 3-state condition.
- **Cycle 3**: The host ASIC keeps DQ[71:0] in a 3-state condition.
- **Cycle 4**: The selected device starts to drive DQ[71:0].
- **Cycle 5**: The selected device continues to drive DQ[71:0] and drives ACK from high-Z to low.
- **Cycle 6**: The selected device drives the READ address on SADR[24:0], and drives ACK high, CE_L low, WE_L high, and ALE_L low.
- **Cycle 7**: The selected device drives CE_L , ALE_L, WE_L, and the DQ bus in a 3-state condition. It continues to drive ACK low.

At the end of cycle 7, the selected device floats ACK in a 3-state condition. A new command can begin.

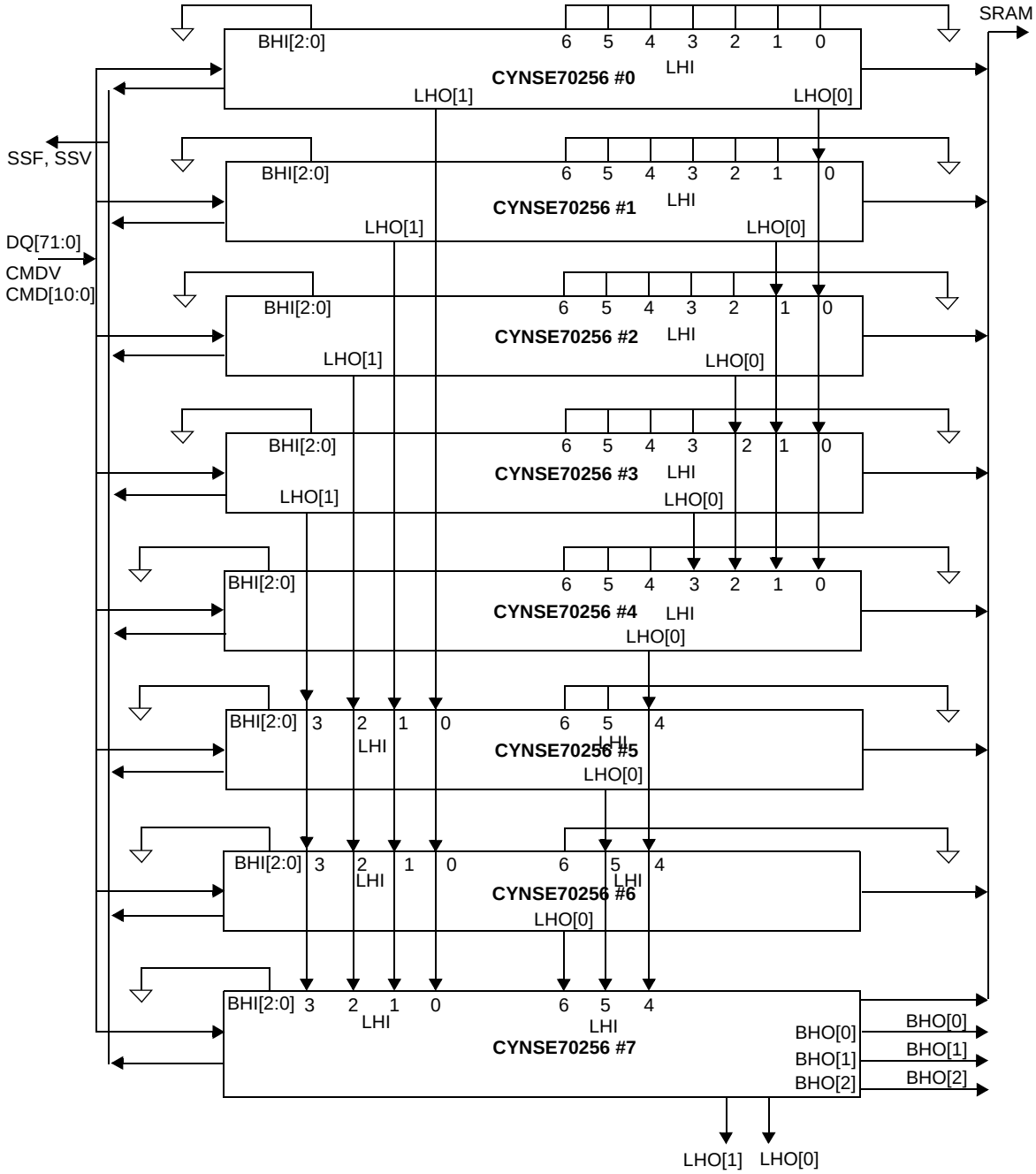


Figure 12-2. Hardware Diagram of a Block of Eight Devices

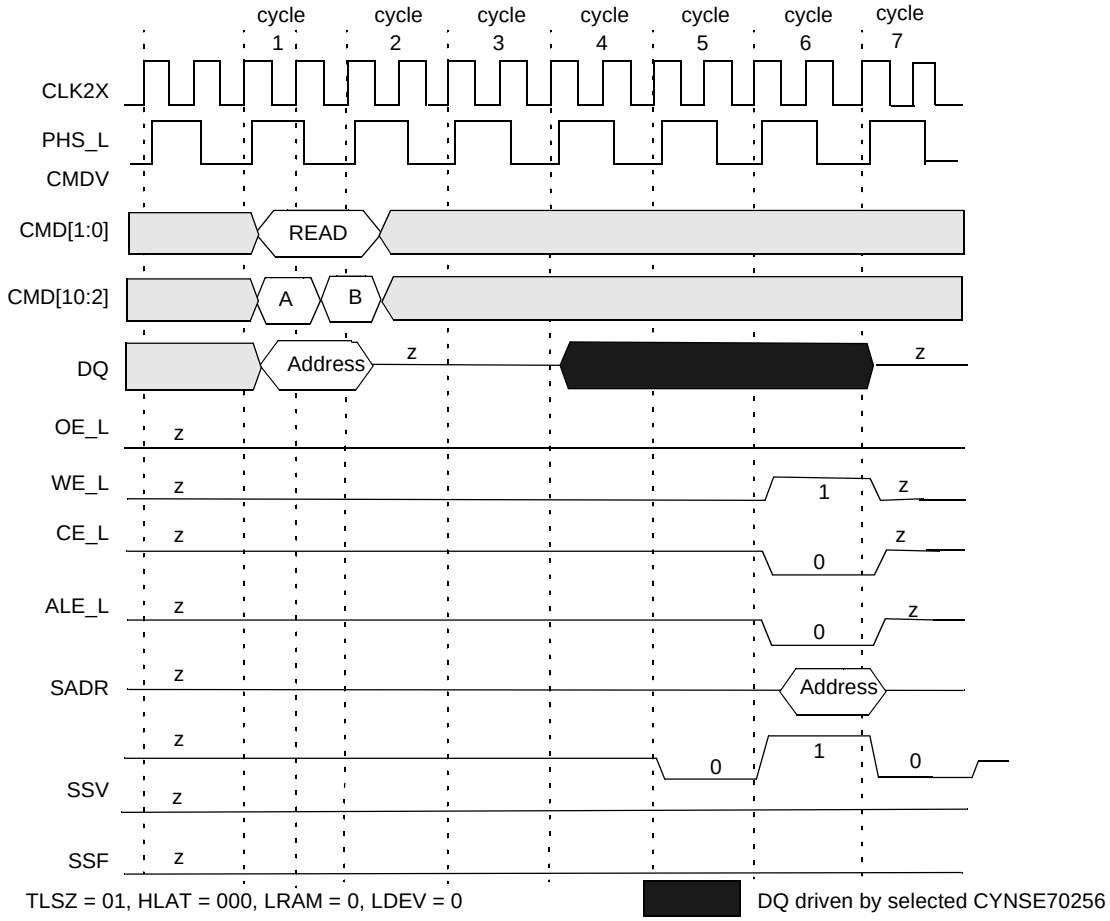
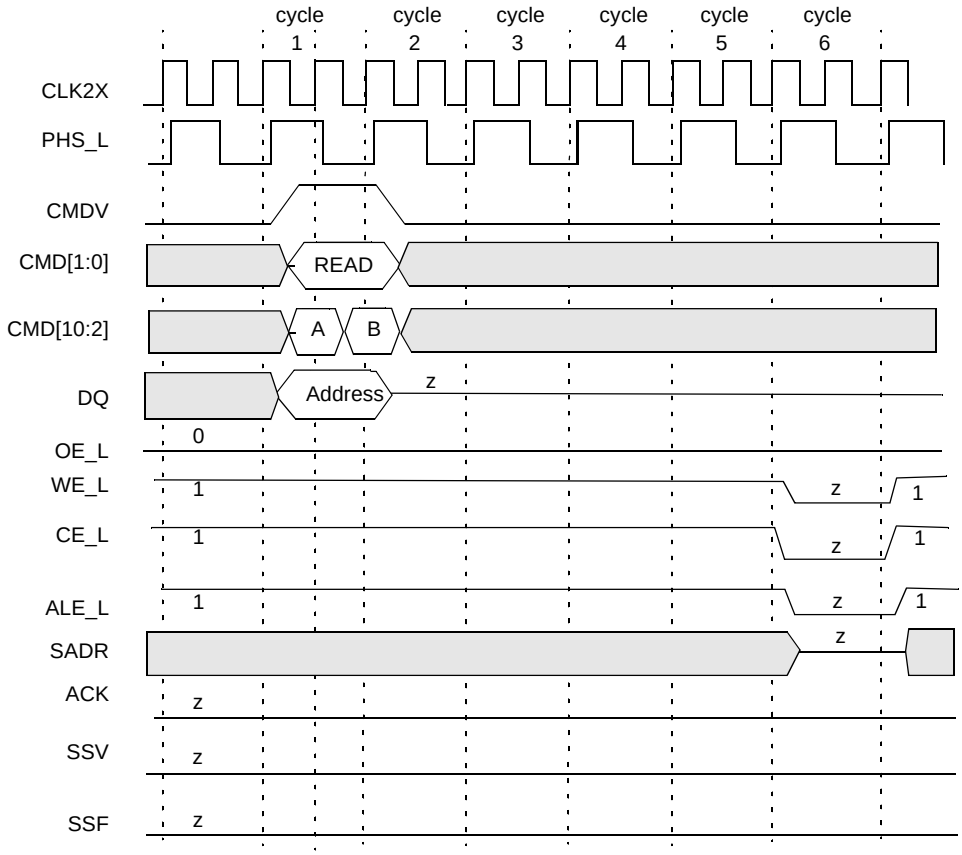


Figure 12-3. SRAM READ Through Device Number 0 in a Block of Eight Devices



TLSZ = 01, HLAT = 000, LRAM = 1, LDEV = 1

Figure 12-4. SRAM READ Timing for Device Number 7 in a Block of Eight Devices

12.4 SRAM READ with a Table of up to 31 Devices

The following explains the SRAM READ operation accomplished through a table of up to 31 devices, using the following parameter: TLSZ = 10. The hardware diagram is shown in Figure 12-5. The following assumes that SRAM access is being accomplished through CYNSE70256 device number 0, and that device number 0 is the selected device. Figure 12-6 and Figure 12-7 show the timing diagrams for device number 0 and device number 30, respectively.

- **Cycle 1A**: The host ASIC applies the READ instruction to CMD[1:0] using CMDV = 1. The DQ bus supplies the address, with DQ[20:19] set to 10, to select the SRAM address. The host ASIC selects the device for which the ID[4:0] matches the DQ[25:21] lines. During this cycle, the host ASIC also supplies SADR[24:22] on CMD[8:6].
- **Cycle 1B**: The host ASIC continues to apply the READ instruction to CMD[1:0], using CMDV = 1. The DQ bus supplies the address, with DQ[20:19] set to 10, to select the SRAM address.
- **Cycle 2**: The host ASIC floats DQ[71:0] to a 3-state condition.
- **Cycle 3**: The host ASIC keeps DQ[71:0] in a 3-state condition.
- **Cycle 4**: The selected device starts to drive DQ[71:0].
- **Cycles 5 to 6**: The selected device continues to drive DQ[71:0].
- **Cycle 7**: The selected device continues to drive DQ[71:0], and drives an SRAM READ cycle.
- **Cycle 8**: The selected device drives ACL from Z to low.
- **Cycle 9**: The selected device drives ACK to high.
- **Cycle 10**: The selected device drives ACK from high to low.

At the end of cycle 10, the selected device floats ACK in a 3-state condition.

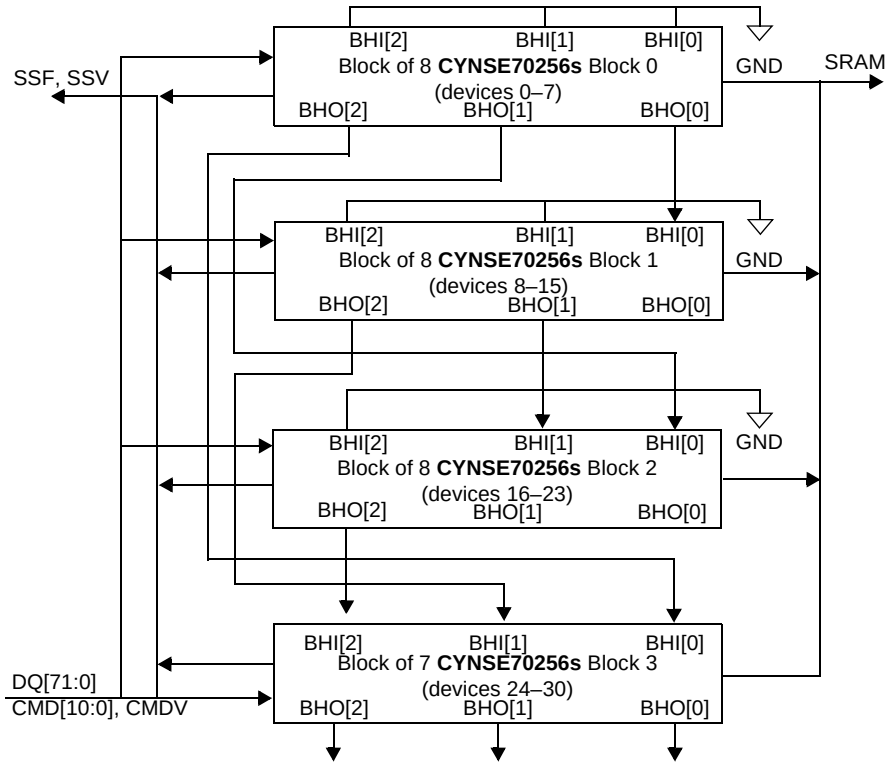


Figure 12-5. Hardware Diagram of 31 Devices Using Four Blocks

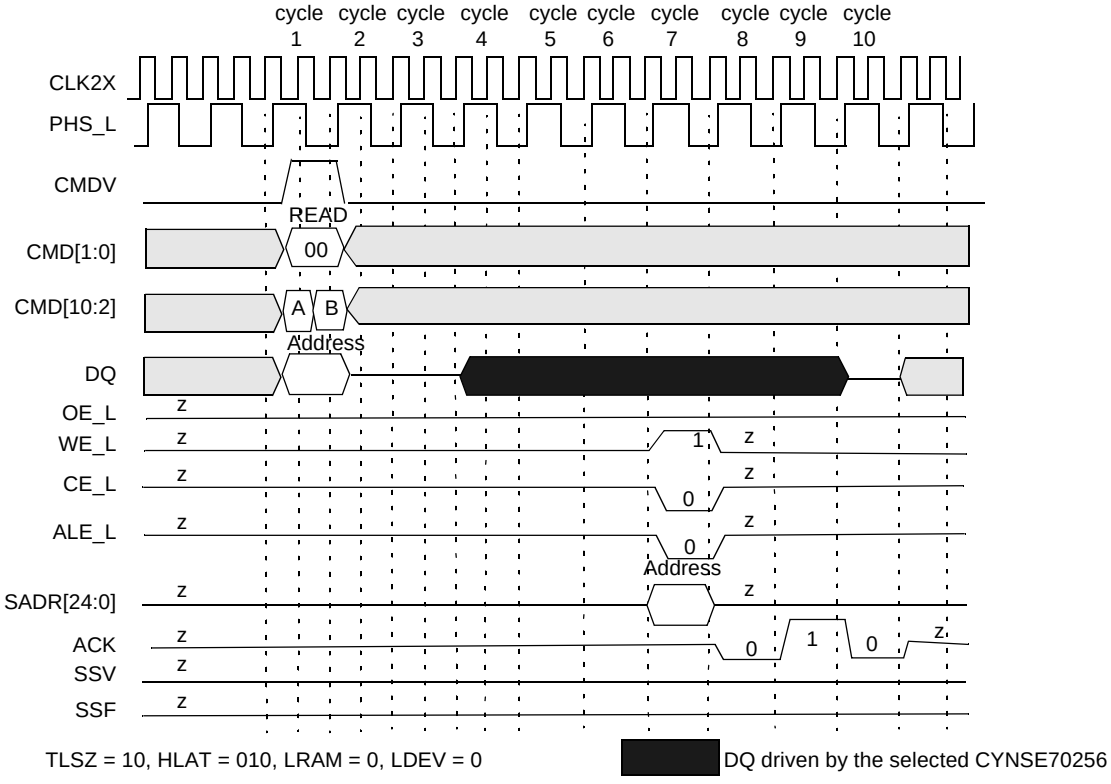


Figure 12-6. SRAM READ Through Device Number 0 in a Bank of 31 Devices (Device Number 0 Timing)

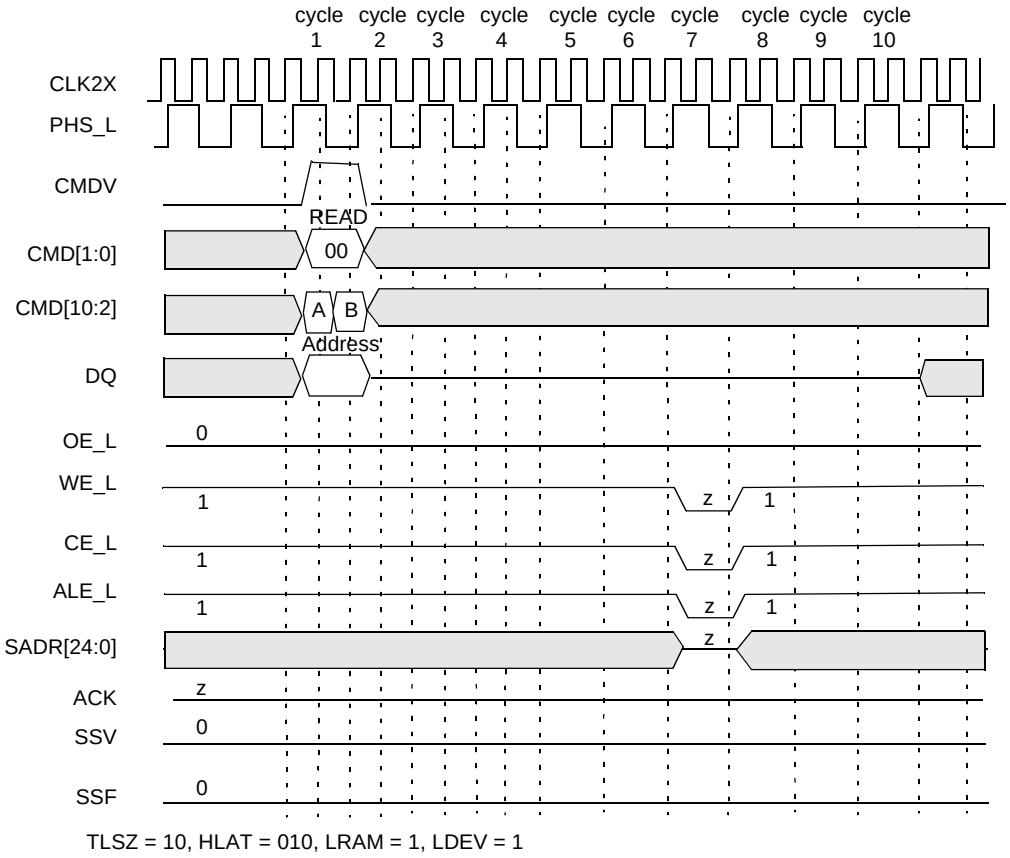


Figure 12-7. SRAM READ Through Device Number 0 in a Bank of 31 Devices (Device Number 30 Timing)

12.5 SRAM WRITE with a Table of One Device

SRAM WRITE enables WRITE access to the off-chip SRAM containing associative data. The latency from the second cycle of the WRITE instruction to the appearance of the address on the SRAM bus is the same as SEARCH instruction latency, and will depend on the TLSZ value parameter programmed in the device configuration register. The following explains the SRAM WRITE operation accomplished through a table of only one device with the following parameters: TLSZ = 00, HLAT = 000, LRAM = 1, and LDEV = 1. Figure 12-8 shows the timing diagram. For the following description, the selected device refers to the only device in the table because it is the only device that will be accessed.

- **Cycle 1A**: The host ASIC applies the WRITE instruction on CMD[1:0] using CMDV = 1. The DQ bus supplies the address with DQ[20:19] set to 10 to select the SRAM address. The host ASIC selects the device for which the ID[4:0] matches the DQ[25:21] lines. The host ASIC also supplies SADR[24:22] on CMD[8:6] in this cycle. **Note**. CMD[2] must be set to 0 for SRAM WRITE because burst WRITEs into the SRAM are not supported.
- **Cycle 1B**: The host ASIC continues to apply the WRITE instruction on CMD[1:0] using CMDV = 1. The DQ bus supplies the address with DQ[20:19] set to 10 to select the SRAM address. **Note**. CMD[2] must be set to 0 for SRAM WRITE because burst WRITEs into the SRAM are not supported.
- **Cycle 2**: The host ASIC continues to drive DQ[71:0]. The data in this cycle is not used by the CYNSE70256 device.
- **Cycle 3**: The host ASIC continues to drive DQ[71:0]. The data in this cycle is not used by the CYNSE70256 device.

At the end of cycle 3, a new command can begin. The WRITE is a pipelined operation; the WRITE cycle appears at the SRAM bus, however, with the same latency as the SEARCH instruction, as measured from the second cycle of the WRITE command.

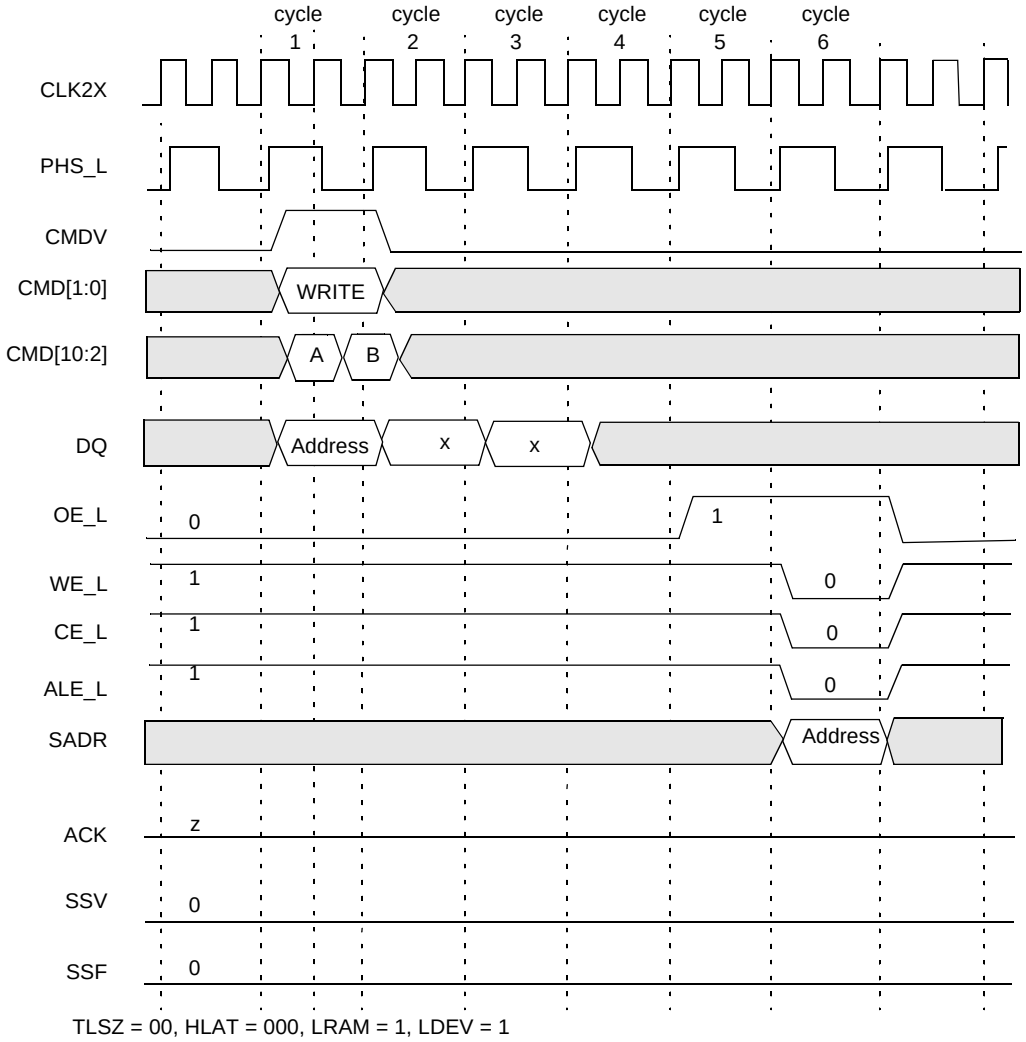


Figure 12-8. SRAM WRITE Access (TLSZ = 00, HLAT = 000, LRAM = 1, LDEV = 1)

12.6 SRAM WRITE with a Table of up to Eight Devices

The following explains the SRAM WRITE operation accomplished through a table(s) of up to eight devices with the following parameters (TLSZ = 01). The hardware diagram for this table is shown in Figure 12-9. The following assumes that SRAM access is achieved through CYNSE70256 device number 0. Figure 12-10 and Figure 12-11 show the timing diagram for device number 0 and device number 7 respectively.

- **Cycle 1A**: The host ASIC applies the WRITE instruction on CMD[1:0] using CMDV = 1. The DQ bus supplies the address with DQ[20:19] set to 10 to select the SRAM address. The host ASIC selects the device for which the ID[4:0] matches the DQ[25:21] lines. The host ASIC also supplies SADR[24:22] on CMD[8:6] in this cycle. **Note**. CMD[2] must be set to 0 for SRAM WRITE because burst WRITEs into the SRAM are not supported.
- **Cycle 1B**: The host ASIC continues to apply the WRITE instruction on CMD[1:0] using CMDV = 1. The DQ bus supplies the address with DQ[20:19] set to 10 to select the SRAM address. **Note**. CMD[2] must be set to 0 for SRAM WRITE because burst WRITEs into the SRAM are not supported.
- **Cycle 2**: The host ASIC continues to drive DQ[71:0]. The data in this cycle is not used by the CYNSE70256 device.
- **Cycle 3**: The host ASIC continues to drive DQ[71:0]. The data in this cycle is not used by the CYNSE70256 device.

At the end of cycle 3, a new command can begin. WRITE is a pipelined operation, but the WRITE cycle appears at the SRAM bus with the same latency as that of a SEARCH instruction, as measured from the second cycle of the WRITE command.

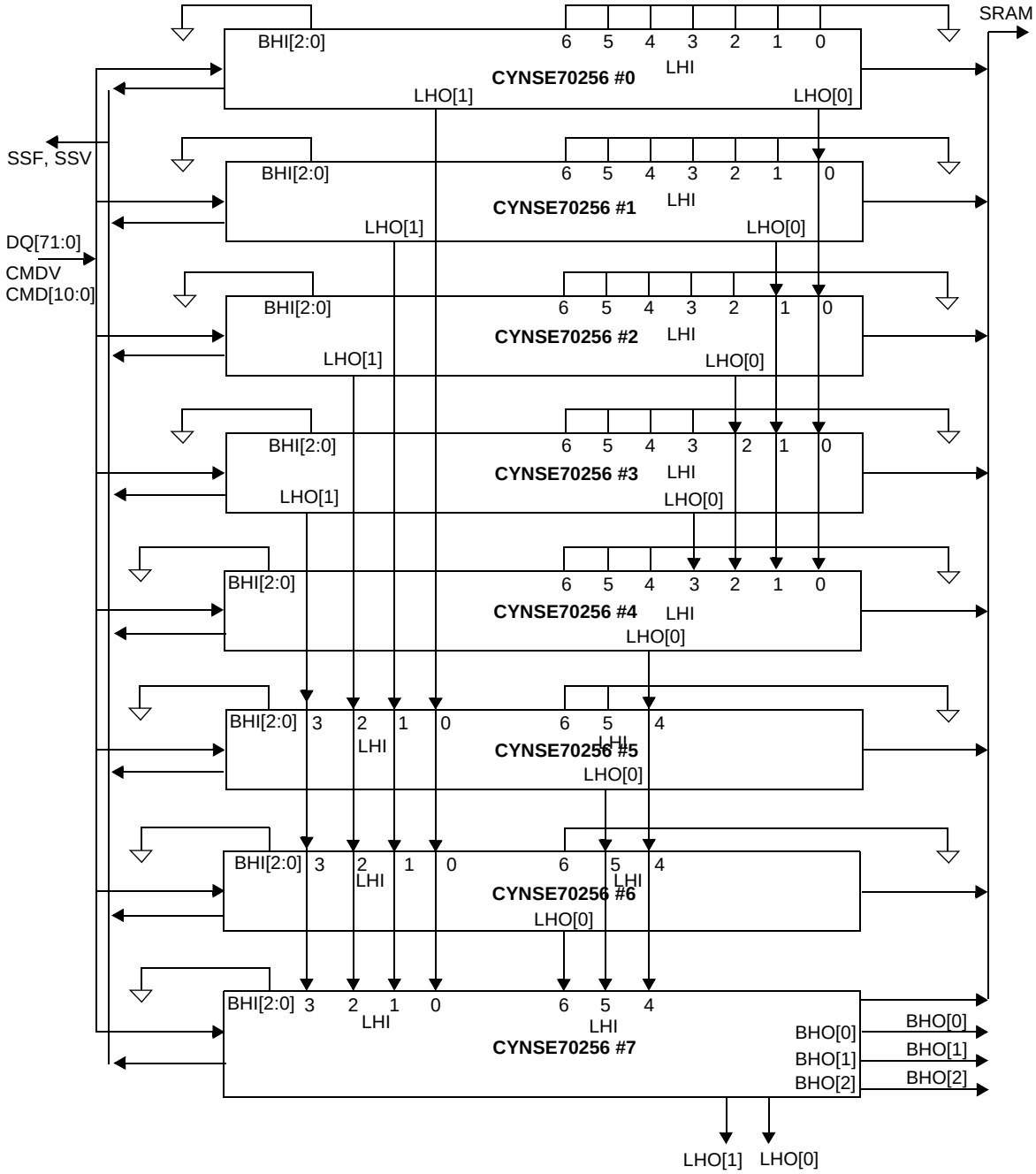


Figure 12-9. Hardware Diagram of a Block of Eight Devices

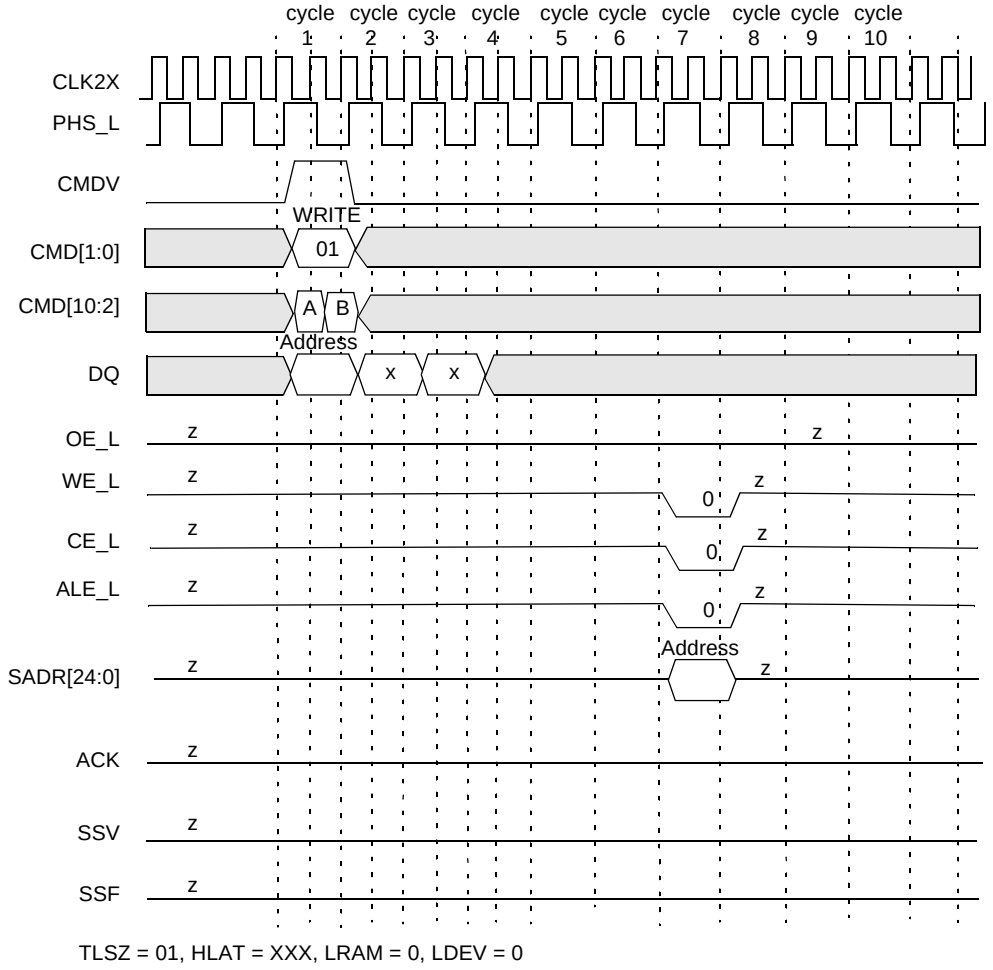


Figure 12-10. SRAM WRITE Through Device Number 0 in a Block of Eight Devices

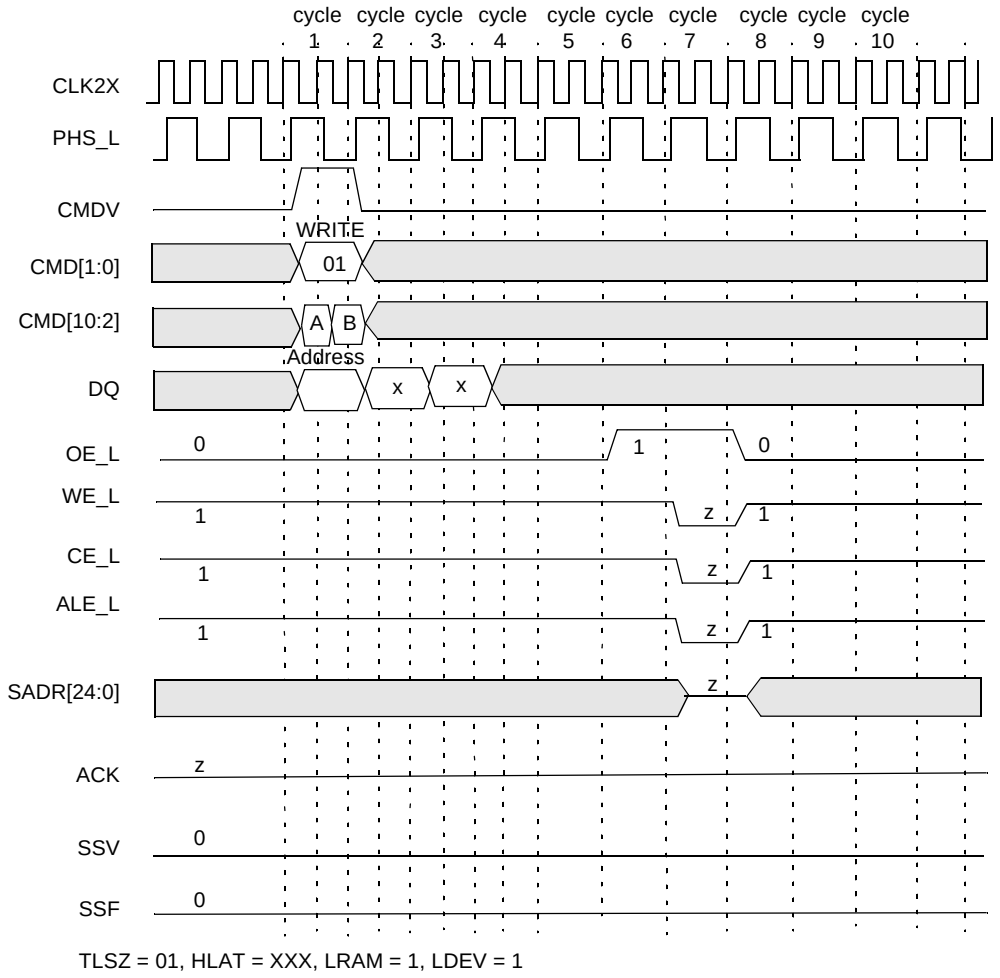


Figure 12-11. SRAM WRITE Timing for Device Number 7 in Block of Eight Devices

12.7 SRAM WRITE with Table(s) Consisting of up to 31 Devices

The following explains the SRAM WRITE operation accomplished through a table of up to 31 devices with the following parameter: TLSZ = 10. The hardware diagram is shown in Figure 12-12. The following assumes that SRAM access is accomplished through CYNSE70256 device number 0—the selected device. Figure 12-13 and Figure 12-14 show timing diagrams for device number 0 and device number 30, respectively.

- **Cycle 1A**: The host ASIC applies the WRITE instruction on CMD[1:0] using CMDV = 1. The DQ bus supplies the address with DQ[20:19] set to 10 to select the SRAM address. The host ASIC selects the device for which the ID[4:0] matches the DQ[25:21] lines. The host ASIC also supplies SADR[24:22] on CMD[8:6] in this cycle. **Note**. CMD[2] must be set to 0 for SRAM WRITE because burst WRITEs into the SRAM are not supported.
- **Cycle 1B**: The host ASIC continues to apply the WRITE instruction on CMD[1:0] using CMDV = 1. The DQ bus supplies the address with DQ[20:19] set to 10 to select the SRAM address. **Note**. CMD[2] must be set to 0 for SRAM WRITE because burst WRITEs into the SRAM are not supported.
- **Cycle 2**: The host ASIC continues to drive DQ[71:0]. The data in this cycle is not used by the CYNSE70256 device.
- **Cycle 3**: The host ASIC continues to drive DQ[71:0]. The data in this cycle is not used by the CYNSE70256 device.

At the end of cycle 3, a new command can begin. The WRITE is a pipelined operation, but the WRITE cycle appears at the SRAM bus with the same latency as that of a SEARCH instruction, as measured from the second cycle of the WRITE command.

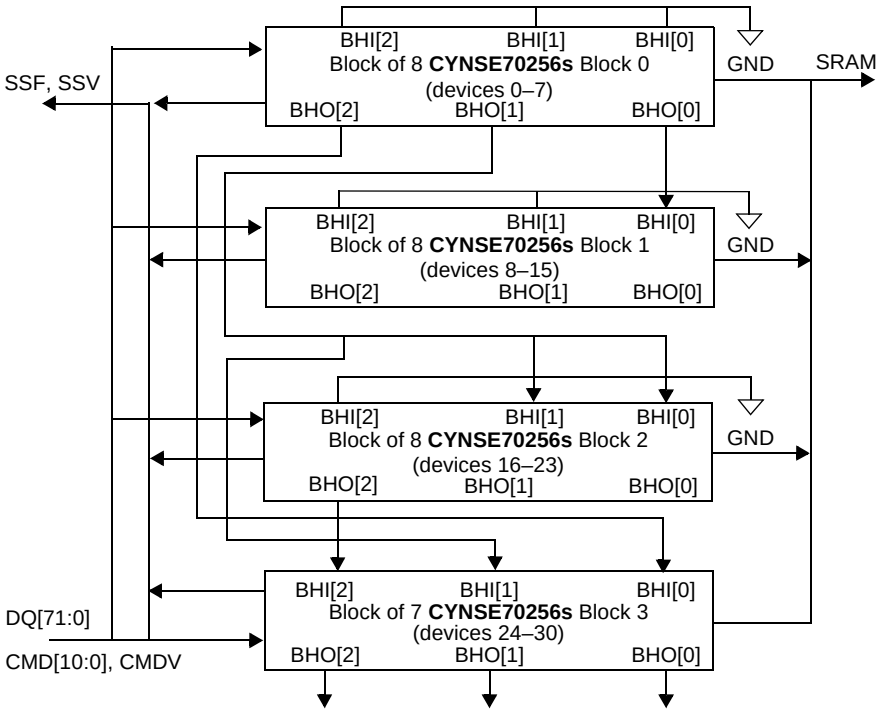


Figure 12-12. Table of 31 Devices (four BLOCKS)

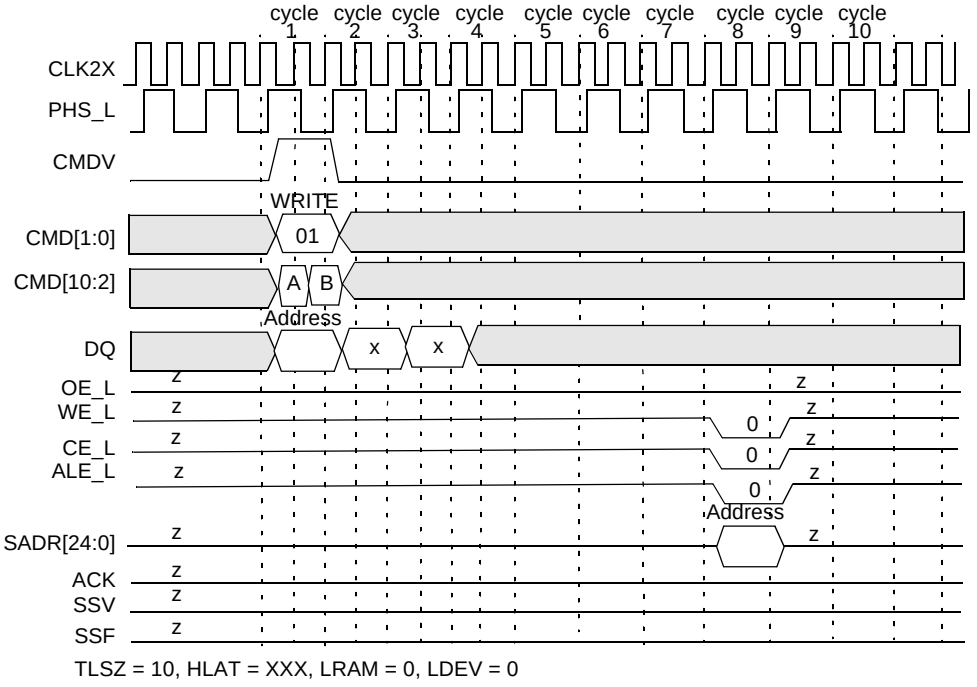


Figure 12-13. SRAM WRITE Through Device Number 0 in Bank of 31 Devices (Device 0 Timing)

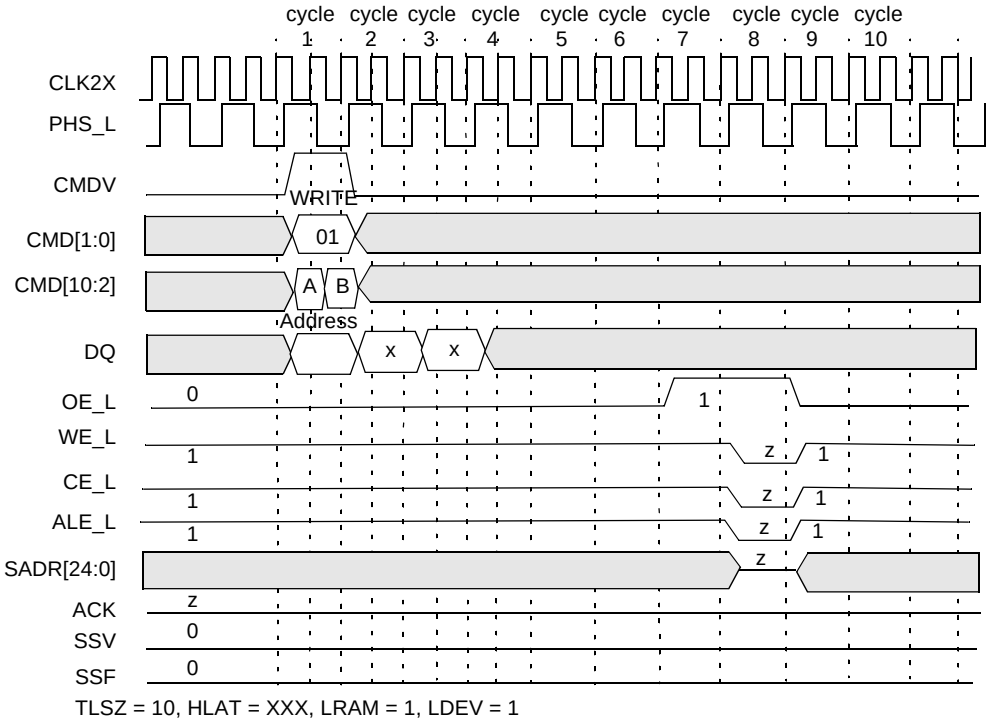


Figure 12-14. SRAM WRITE Through Device Number 0 in Bank of 31 CYNSE70256 Devices (Device Number 30 Timing)

13.0 Application

Figure 13-1 shows how an NSE subsystem can be formed using a host ASIC and a CYNSE70256 bank. It also shows how this NSE subsystem is integrated in a switch or router. The CYNSE70256 device can access synchronous and asynchronous SRAMs by allowing the host ASIC to set the same HLAT parameter in all NSEs within a bank of NSEs.

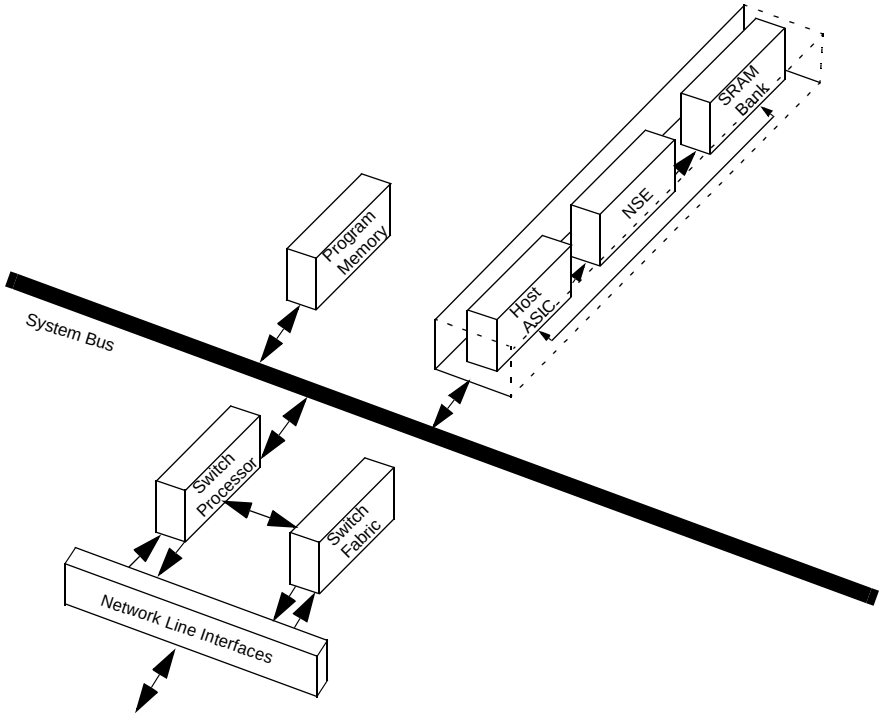


Figure 13-1. Sample Switch/Router Using the CYNSE70256 Device

14.0 JTAG (1149.1) Testing

The CYNSE70256 device supports the Test Access Port and Boundary Scan Architecture as specified in IEEE JTAG Standard Number 1149.1. The pin interface to the chip consists of five signals with the standard definitions: TCK, TMS, TDI, TDO, and TRST_L. Table 14-1 describes the operations that the test access port controller supports, and Table 14-2 describes the TAP Device ID Register. **Note**. To disable JTAG functionality, connect the TCK, TMS, and TDI pins to ground, and TRST_L to V_{DD}.

Table 14-1. Supported Operations

Instruction	Type	Description
SAMPLE/PRELOAD	Mandatory	**Sample/Preload**. This operation loads the values of signals going to and from I/O pins into the boundary scan shift register to provide a snapshot of the normal functional operation.
EXTEST	Mandatory	**External Test**. This operation uses boundary scan values shifted in from the TAP to test connectivity external to the device.
INTEST	Optional	**Internal Test**. This operation allows slow-speed functional testing of the device using the boundary scan register to provide I/O values.

Table 14-2. TAP Device ID Register

Field	Range	Initial Value	Description
Revision	[31:28]	0001	**Revision Number**. This is the current device revision number. Numbers start from one and increment by one for each revision of the device.
Part Number	[27:12]	0000 0000 0000 0101	This is the part number for the device.
MFID	[11:1]	000_1101_1100	**Manufacturer ID**. This field is the same as the manufacturer ID used in the TAP controller.
LSB	[0]	1	Least significant bit.

15.0 Electrical Specifications

This section describes the electrical specifications, capacitance, operating conditions, DC characteristics, and AC timing parameters for the CYNSE70256 device (see Table 15-1 and Table 15-2).

Table 15-1. DC Electrical Characteristics for CYNSE70256

Symbol	Parameter	Conditions	Min	Max	Unit
I_{LI}	Input leakage current	V_{DDQ} = V_{DDQ} Max, V_{IN}= 0 to V_{DDQ} Max	-10	10	µA
I_{LO}	Output leakage current	V_{DDQ} = V_{DDQ} Max, V_{IN}=0 to V_{DDQ} Max	-10	10	µA
V_{IL}	Input low voltage (1.8V)		TBD	TBD	V
V_{IH}	Input high voltage (1.8V)		TBD	TBD	V
V_{OL}	Output low voltage (1.8V)	V_{DDQ} = V_{DDQ} Min, I_{OL} = 8mA	TBD	TBD	V
V_{OH}	Output high voltage (1.8V)	V_{DDQ} = V_{DDQ} Min, I_{OH} = 8mA	TBD	TBD	V
V_{IL}	Input low voltage (2.5V)		-0.3	0.7	V
V_{IH}	Input high voltage (2.5V)		1.7	V_{DDQ} + 0.3	V
V_{OL}	Output low voltage (2.5V)	V_{DDQ} = V_{DDQ} Min, I_{OL} = 8mA		0.4	V
V_{OH}	Output high voltage (2.5V)	V_{DDQ} = V_{DDQ} Min, I_{OH} = 8mA	2.0		V
I_{DD2}	2.5V supply current at V_{DD} Max	133 MHz search rate, I_{OUT} = 0mA		TBD	mA
I_{DD2}	2.5V supply current at V_{DD} Max	100 MHz search rate, I_{OUT} = 0mA		TBD	mA
I_{DD2}	2.5V supply current at V_{DD} Max	83 MHz search rate, I_{OUT} = 0mA		TBD	mA
I_{DDI}	1.5V supply current at V_{DD} Max	133 MHz search rate		TBD	A
I_{DDI}	1.5V supply current at V_{DD} Max	100 MHz search rate		TBD	A
I_{DDI}	1.5V supply current at V_{DD} Max	83 MHz search rate		TBD	A

Symbol	Parameter	Max	Unit
C_{IN}	Input capacitance	6	pF[1]
C_{OUT}	Output capacitance	6	pF[2]

1. f = 1 MHz, V_{IN} = 0 V.
2. f = 1 MHz, V_{OUT} = 0 V.

Table 15-2. Operating Conditions for CYNSE70256

Symbol	Parameter	Min	Max	Unit
V_{DDQ} = 2.5V	Operating voltage for I/O	2.375	2.625	V
V_{DDQ} = 1.8V	Operating voltage for I/O	TBD	TBD	V
V_{DD}	Operating supply voltage	1.425	1.575	V
V_{IH}	Input high voltage[1] (1.8V)	TBD	TBD	V
V_{IL}	Input low voltage[2] (1.8V)	TBD	TBD	V
V_{IH}	Input high voltage[3] (2.5V)	1.7	V_{DDQ}+ 0.3	V
V_{IL}	Input low voltage[4] (2.5V)	-0.3	0.7	V
T_A	Ambient operating temperature	0	70	°C
	Supply voltage tolerance	–5%	+5%	

1. Maximum allowable applies to overshoot only (V_{DDQ} is 1.8V supply).
2. Minimum allowable applies to undershoot only.
3. Maximum allowable applies to overshoot only (V_{DDQ} is 2.5V supply).
4. Minimum allowable applies to undershoot only.

16.0 AC Timing Wave Forms

Table 16-1 and Table 16-2 show the AC timing parameters for the CYNSE70256 device. Table 16-3 shows the same parameters, but for 2.5V. Figure 16-1 shows the input wave form for the CYNSE70256 device. Figure 16-2 and Figure 16-3 show the output load and output load equivalent of the CYNSE70256 device. Figure 16-4 shows timing wave form diagrams for CLK2X. Figure 16-5 details timing wave form diagrams for CLK1X.

Table 16-1. AC Timing Parameters with CLK2X

Row	Symbol	CYNSE70256-083		CYNSE70256-100		CYNSE70256-133		Unit	Description
		Min	Max	Min	Max	Min	Max		
1	f_{CLOCK}	40	166	40	200	40	266	MHz	CLK2X frequency.
2	t_{CLOK}		0.5		0.5		0.5	ms	PLL lock time.
3	tT_{CKHI}	2.4		2.0		1.5		ns	CLK2X high pulse.[1]
4	t_{CKLO}	2.4		2.0		1.5		ns	CLK2X low pulse.[1]
5	t_{ISCH}	1.8		1.5		TBD		ns	Input setup time to CLK2X rising edge.[1]
6	t_{IHCH}	0.6		0.5		TBD		ns	Input hold time to CLK2X rising edge.[1]
7	t_{ICSCH}	3.5		3.0		TBD		ns	Cascaded input setup time to CLK2X rising edge.[1]
8	t_{ICHCH}	0.6		0.5		TBD		ns	Cascaded input hold time to CLK2X rising edge.[1]
9	t_{CKHOV}		7.0		6.5		TBD	ns	Rising edge of CLK2X to LHO, FULO, BHO, FULL valid.[2]
10	t_{CKHDV}		7.5		7.0		TBD	ns	Rising edge of CLK2X to DQ valid.[2]
11	t_{CKHDZ}		7.0		6.5		TBD	ns	Rising edge of CLK2X to DQ high-Z.[3]
12	t_{CKHSV}		7.5		7.0		TBD	ns	Rising edge of CLK2X to SRAM bus valid.[2]
13	t_{CKHSHZ}		6.0		5.5		TBD	ns	Rising edge of CLK2X to SRAM bus high-Z.[3]
14	t_{CKHSLZ}	6.5		6.0		TBD		ns	Rising edge of CLK2X to SRAM bus low-Z.[3]

1. Values are based on 50% signal levels.
2. Based on an AC load of CL = 30pF (see Figure 16-1, Figure 16-2, and Figure 16-3).
3. These parameters are sampled but not 100% tested, and are based on an AC load of 5pF.

Table 16-2. AC Timing Parameters with CLK1X

Row	Symbol	CYNSE70256 -083		CYNSE70256 -100		CYNSE70256 -133		Unit	Description
		Min	Max	Min	Max	Min	Max		
1	f_{CLOCK}	20	83	20	100	20	133	MHz	CLK1X frequency.
2	t_{CLOK}		0.5		0.5		0.5	ms	PLL lock time.
3	t_{CKHI}	5.4		4.5		3.4		ns	CLK1X high pulse; worst-case duty cycle.[1]
4	t_{CKLO}	5.4		4.5		3.4		ns	CLK1X low pulse; worst-case duty cycle.1
5	t_{ISCH}	1.5		1.5		TBD		ns	Input setup time to CLK1X edge.1
6	t_{IHCH}	0.5		0.5		TBD		ns	Input hold time to CLK1X edge.1
7	t_{ICSCH}	3.5		3.0		TBD		ns	Cascaded input setup time to CLK1X rising edge.1
8	t_{ICHCH}	0.5		0.5		TBD		ns	Cascaded input hold time to CLK1X rising edge.1
9	t_{CKHOV}		7.0		6.5		TBD	ns	Rising edge of CLK1X to LHO, FULO, BHO, FULL valid.[2]
10	t_{CKHDV}		7.5		7.0		TBD	ns	Rising edge of CLK1X to DQ valid.[2]
11	t_{CKHDZ}		7.0		6.5		TBD	ns	Rising edge of CLK1X to DQ high-Z.[3]
12	t_{CKHSV}		7.5		7.0		TBD	ns	Rising edge of CLK1X to SRAM bus valid.[2]
13	t_{CKHSHZ}		6.0		5.5		TBD	ns	Rising edge of CLK1X to SRAM bus high-Z.[3]
14	t_{CKHSLZ}	6.5		6.0		TBD		ns	Rising edge of CLK1X to SRAM bus low-Z.[3]

1. Values are based on 50% signal levels and a 50%/50% duty cycle of CLK1X.
2. Based on an AC load of CL = 30pF (see Figure 16-1, Figure 16-2, and Figure 16-3).
3. These parameters are sampled but not 100% tested, and are based on an AC load of 5pF.

Table 16-3. 2.5V AC Table for Test Condition of CYNSE70256

Conditions	Results
Input pulse levels	GND to 2.5V
Input rise and fall times measured at 0.25V and 2.25V	≤ 2 ns (see Figure 16-1)
Input timing reference levels (2.5V / 1.8V)	1.25V / 0.9V
Output reference levels (2.5V / 1.8V)	1.25V / 0.9V
Output load	See Figure 16-2 and Figure 16-3

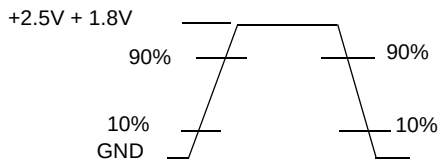


Figure 16-1. Input Wave Form for CYNSE70256

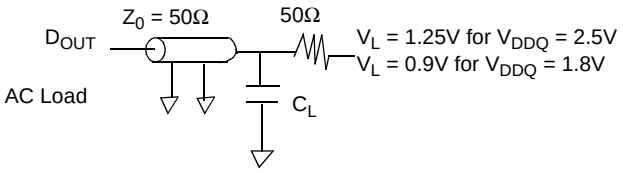


Figure 16-2. Output Load for CYNSE70256

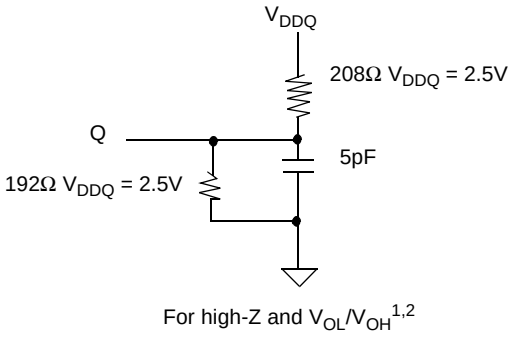
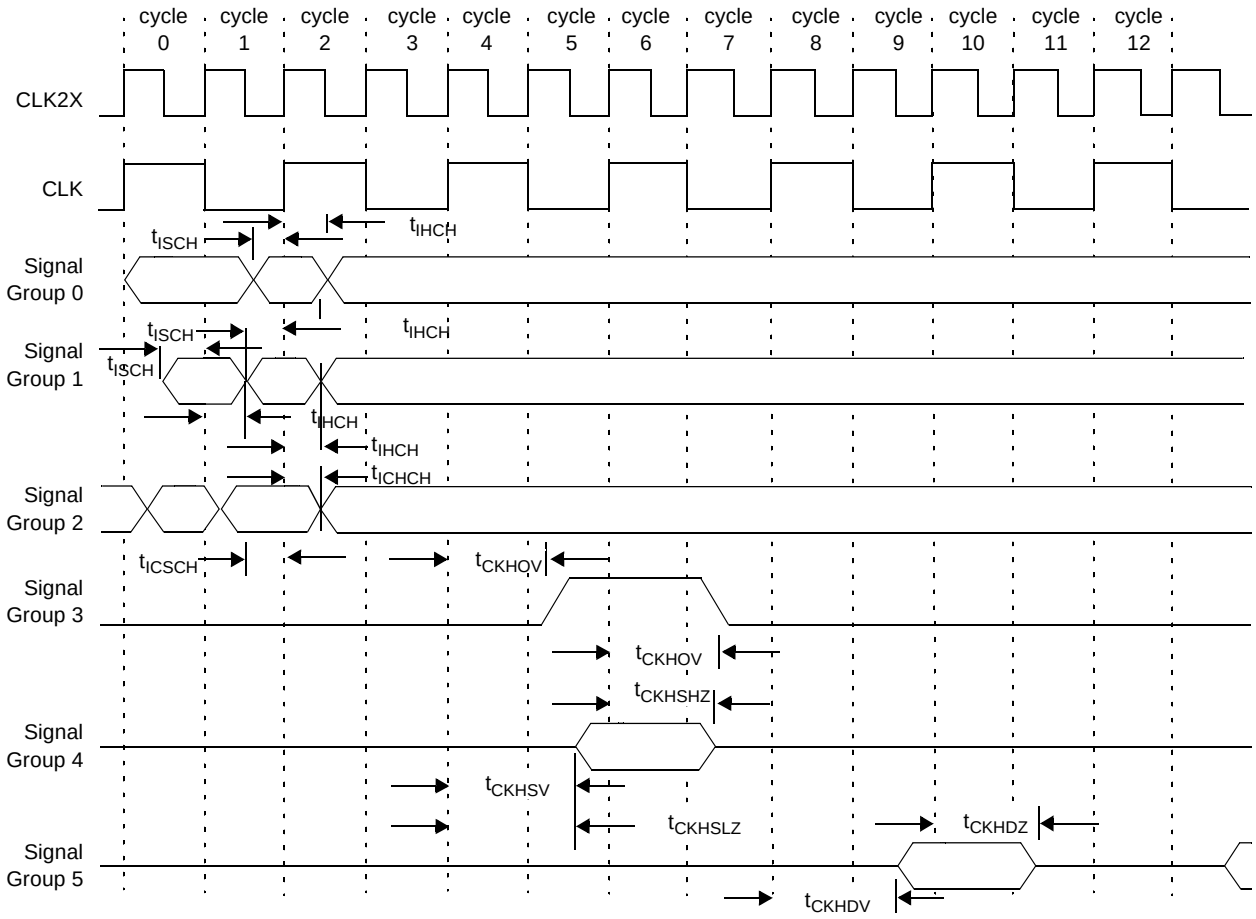


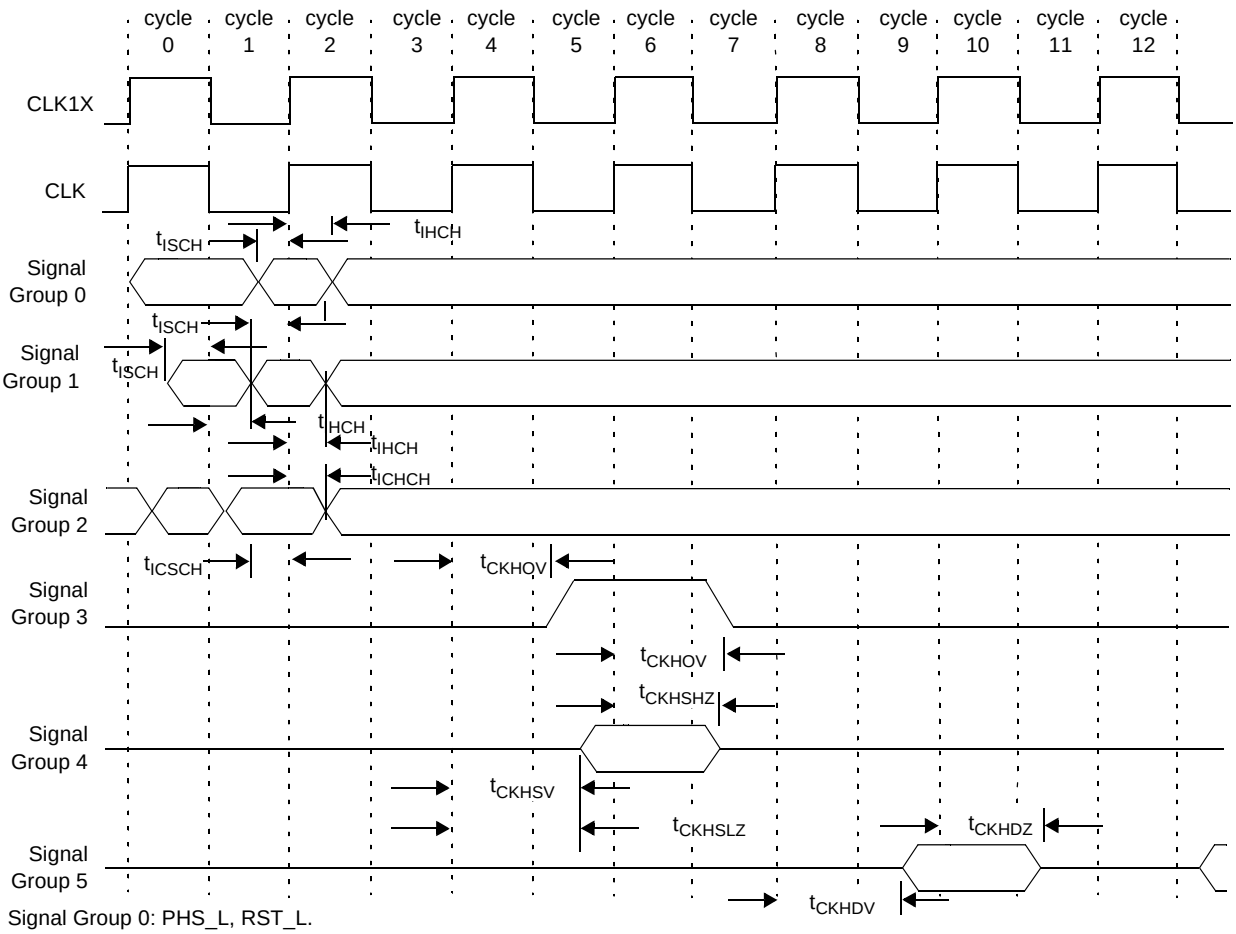
Figure 16-3. 2.5 I/O Output Load Equivalent for CYNSE70256

1. Output loading is specified with CL = 5pF as in Figure 16-3. Transition is measured at ± 200 mV from steady state voltage.
2. The load used for V_{OH}, V_{OL} testing is shown in Figure 16-3.



Signal Group 0: PHS_L, RST_L.
Signal Group 1: DQ, CMD, CMDV.
Signal Group 2: LHI, BHI, FULI.
Signal Group 3: LHO, BHO, FULO, FULL.
Signal Group 4: SADR, CE_L, OE_L, WE_L, ALE_L, SSF, SSV.
Signal Group 5: DQ, ACK, EOT.

Figure 16-4. AC Timing Wave Forms with CLK2X



Signal Group 0: PHS_L, RST_L.
Signal Group 1: DQ, CMD, CMDV.
Signal Group 2: LHI, BHI, FULI.
Signal Group 3: LHO, BHO, FULO, FULL.
Signal Group 4: SADR, CE_L, OE_L, WE_L, ALE_L, SSF, SSV.
Signal Group 5: DQ, ACK, EOT.

Figure 16-5. AC Timing Wave Forms with CLK1X

17.0 Pinout Descriptions and Package Diagrams

In the following figures and tables the CYNSE70256 device pinout descriptions and package diagrams are shown. Figure 17-1 shows the pinout diagram, Table 17-1 lists descriptions for the pinout diagram, and Figure 17-2, Figure 17-3, and Figure 17-4 illustrate the package from various views.

	AF	AE	AD	AC	AB	AA	Y	W	V	U	T	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
1	TEST_CO	TEST	RST_L	V_{SS}	FULL	FULO1	FULI6	V_{DDQ}	FULI2	FULI0	BHO2	V_{DDQ}	BHO0	BHI1	V_{DDQ}	LHO0	LHI6	LHI2	LHI0	ID3	ID1	ID0	TRST_L	TCK	TDI	TEST_CT	1
2	TEST_CT	V_{SS}	V_{DDQ}	EOT	ACK	V_{DDQ}	FULO0	FULI5	FULI3	V_{DDQ}	V_{SS}	BHO1	MULTI_HIT	BHI2	BHI0	LHO1	LHI4	LHI3	LHI1	ID4	ID2	V_{DDQ}	TDO	TMS	V_{SS}	DQ71	2
3	DQ68	DQ70	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	NC2	FULI4	FULI1	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	LHI5	V_{DDQ}	NC1	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	DQ69	V_{DDQ}	3
4	DQ66	V_{DDQ}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	DQ65	DQ67	4
5	DQ62	DQ64	V_{DD}	V_{SS}																			V_{SS}	V_{DD}	DQ61	DQ63	5
6	V_{DDQ}	DQ60	V_{DD}	V_{SS}																			V_{SS}	V_{DD}	DQ59	V_{DDQ}	6
7	DQ56	DQ58	V_{DD}	V_{SS}																			V_{SS}	V_{DD}	DQ55	DQ57	7
8	DQ52	DQ54	NC3	V_{SS}																			V_{SS}	NC8	V_{DDQ}	DQ53	8
9	DQ48	DQ50	V_{DDQ}	V_{SS}																			V_{SS}	DQ49	DQ47	DQ51	9
10	V_{DDQ}	DQ44	DQ46	V_{SS}																			V_{SS}	V_{DDQ}	DQ45	DQ43	10
11	DQ40	DQ42	V_{DD}	V_{DD}																			V_{DD}	V_{DD}	DQ39	DQ41	11
12	DQ36	DQ38	V_{DD}	V_{DD}																			V_{DD}	V_{DD}	V_{DDQ}	DQ37	12
13	DQ34	V_{DDQ}	V_{DD}	V_{DD}																			V_{DD}	V_{DD}	DQ33	DQ35	13
14	DQ30	DQ32	V_{DD}	V_{DD}																			V_{DD}	V_{DD}	DQ29	DQ31	14
15	V_{DDQ}	DQ28	V_{DD}	V_{DD}																			V_{DD}	V_{DD}	DQ27	V_{DDQ}	15
16	DQ24	DQ26	V_{DD}	V_{DD}																			V_{DD}	V_{DD}	DQ23	DQ25	16
17	DQ22	V_{DDQ}	DQ20	V_{SS}																			V_{SS}	DQ19	V_{DDQ}	DQ21	17
18	DQ14	DQ18	DQ16	V_{SS}																			V_{SS}	DQ13	DQ15	DQ17	18
19	V_{DDQ}	DQ12	NC4	V_{SS}																			V_{SS}	NC7	DQ11	V_{DDQ}	19
20	DQ08	DQ10	V_{DD}	V_{SS}																			V_{SS}	V_{DD}	DQ07	DQ09	20
21	DQ04	DQ06	V_{DD}	V_{SS}																			V_{SS}	V_{DD}	V_{DDQ}	DQ05	21
22	DQ02	V_{DDQ}	V_{DD}	V_{SS}																			V_{SS}	V_{DD}	DQ01	DQ03	22
23	SSV	DQ00	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD}	TEST_PB	TEST_FM	23
24	SSF	V_{DDQ}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	SADR[24]	CE_L	OE_L	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	SADR13	SADR11	NC6	V_{DD}	V_{DD}	V_{DD}	V_{DD}	V_{DD}	CFG_L	V_{DDQ}	24
25	CMD10	V_{SS}	CMD8	CMD6	CMD5	CMD3	CMD1	CMDV	V_{DDQ}	PHS_L	CLK_MODE	SADR22	SADR21	SADR19	V_{DDQ}	SADR15	V_{DDQ}	SADR12	V_{DDQ}	SADR08	SADR06	SADR05	SADR03	SADR01	V_{SS}	HIGH_SPEED	25
26	CMD9	TEST_CT	CMD7	V_{DDQ}	CMD4	CMD2	CMD0	ALE_L	WE_L	CLK1X/CLK2X	SADR23	V_{DDQ}	SADR20	SADR18	SADR17	SADR16	SADR14	SADR10	SADR09	SADR07	V_{DDQ}	SADR04	SADR02	V_{DDQ}	SADR00	TEST_CT	26
	AF	AE	AD	AC	AB	AA	Y	W	V	U	T	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	

Figure 17-1. Pinout Diagram

Table 17-1. Pinout Descriptions for Pinout Diagram

Package Ball Number	Signal Name	Signal Type	Package Ball Number	Signal Name	Signal Type
A1	TEST_CT[1]	Note 1	AA26	CMD[2]	Input
A10	DQ[43]	I/O	AA3	V_{DD}	1.0V
A11	DQ[41]	I/O	AA4	V_{SS}	Ground
A12	DQ[37]	I/O	AB1	FULL	Output-T
A13	DQ[35]	I/O	AB2	ACK	Output-T
A14	DQ[31]	I/O	AB23	VSS	Ground
A15	V_{DDQ}[2]	1.8V/2.5V	AB24	V_{DD}	1.0V
A16	DQ[25]	I/O	AB25	CMD[5]	Input
A17	DQ[21]	I/O	AB26	CMD[4]	Input
A18	DQ[17]	I/O	AB3	V_{DD}	1.0V
A19	V_{DDQ}	1.8V/2.5V	AB4	V_{SS}	Ground
A2	DQ[71]	I/O	AC1	V_{SS}	Ground
A20	DQ[09]	I/O	AC10	V_{SS}	Ground
A21	DQ[05]	I/O	AC11	V_{DD}	1.0V
A22	DQ[03]	I/O	AC12	V_{DD}	1.0V
A23	TEST_FM	Ground	AC13	V_{DD}	1.0V
A24	V_{DDQ}	1.8V/2.5V	AC14	V_{DD}	1.0V
A25	HIGH_SPEED	Input	AC15	V_{DD}	1.0V
A26	TEST_CT	Note 1	AC16	V_{DD}	1.0V
A3	V_{DDQ}	1.8V/2.5V	AC17	V_{SS}	Ground
A4	DQ[67]	I/O	AC18	V_{SS}	Ground
A5	DQ[63]	I/O	AC19	V_{SS}	Ground
A6	V_{DDQ}	1.8V/2.5V	AC2	EOT	Output-T
A7	DQ[57]	I/O	AC20	V_{SS}	Ground
A8	DQ[53]	I/O	AC21	V_{SS}	Ground
A9	DQ[51]	I/O	AC22	V_{SS}	Ground
AA1	FULO[1]	Output-T	AC23	V_{SS}	Ground
AA2	V_{DDQ}	1.8V/2.5V	AC24	V_{DD}	1.0V
AA23	VSS	Ground	AC25	CMD[6]	Input
AA24	V_{DD}	1.0V	AC26	V_{DDQ}	1.8V/2.5V
AA25	CMD[3]	Input	AC3	V_{DD}	1.0V
AC4	V_{SS}	Ground	AE10	DQ[44]	I/O
AC5	V_{SS}	Ground	AE11	DQ[42]	I/O
AC6	V_{SS}	Ground	AE12	DQ[38]	I/O
AC7	V_{SS}	Ground	AE13	V_{DDQ}	1.8V/2.5V
AC8	V_{SS}	Ground	AE14	DQ[32]	I/O
AC9	V_{SS}	Ground	AE15	DQ[28]	I/O
AD1	RST_L	Input	AE16	DQ[26]	I/O
AD10	DQ[46]	I/O	AE17	V_{DDQ}	1.8V/2.5V
AD11	V_{DD}	1.0V	AE18	DQ[18]	I/O
AD12	V_{DD}	1.0V	AE19	DQ[12]	I/O
AD13	V_{DD}	1.0V	AE2	V_{SS}	Ground
AD14	V_{DD}	1.0V	AE20	DQ[10]	I/O
AD15	V_{DD}	1.0V	AE21	DQ[06]	I/O
AD16	V_{DD}	1.0V	AE22	V_{DDQ}	1.8V/2.5V
AD17	DQ[20]	I/O	AE23	DQ[00]	I/O

Package Ball Number	Signal Name	Signal Type	Package Ball Number	Signal Name	Signal Type
AD18	DQ[16]	I/O	AE24	V_{DDQ}	1.8V/2.5V
AD19	NC4	No Connect	AE25	V_{SS}	Ground
AD2	V_{DDQ}	1.8V/2.5V	AE26	TEST_CT	Note 1
AD20	V_{DD}	1.0V	AE3	DQ[70]	I/O
AD21	V_{DD}	1.0V	AE4	V_{DDQ}	1.8V/2.5V
AD22	V_{DD}	1.0V	AE5	DQ[64]	I/O
AD23	V_{DD}	1.0V	AE6	DQ[60]	I/O
AD24	V_{DD}	1.0V	AE7	DQ[58]	I/O
AD25	CMD[8]	Input	AE8	DQ[54]	I/O
AD26	CMD[7]	Input	AE9	DQ[50]	I/O
AD3	V_{DD}	1.0V	AF1	TEST_CO	No Connect
AD4	V_{DD}	1.0V	AF10	V_{DDQ}	1.8V/2.5V
AD5	V_{DD}	1.0V	AF11	DQ[40]	I/O
AD6	V_{DD}	1.0V	AF12	DQ[36]	I/O
AD7	V_{DD}	1.0V	AF13	DQ[34]	I/O
AD8	NC3	No Connect	AF14	DQ[30]	I/O
AD9	V_{DDQ}	1.8V/2.5V	AF15	V_{DDQ}	1.8V/2.5V
AE1	TEST	Ground	AF16	DQ[24]	I/O
AF17	DQ[22]	I/O	B23	TEST_PB	Input
AF18	DQ[14]	I/O	B24	CFG_L	Input
AF19	V_{DDQ}	1.8V/2.5V	B25	V_{SS}	Ground
AF2	TEST_CT	Note 1	B26	SADR[00]	Output
AF20	DQ[08]	I/O	B3	DQ[69]	I/O
AF21	DQ[04]	I/O	B4	DQ[65]	I/O
AF22	DQ[02]	I/O	B5	DQ[61]	I/O
AF23	SSV	Output-T	B6	DQ[59]	I/O
AF24	SSF	Output-T	B7	DQ[55]	I/O
AF25	CMD[10]	Input	B8	V_{DDQ}	1.8V/2.5V
AF26	CMD[9]	Input	B9	DQ[47]	I/O
AF3	DQ[68]	I/O	C1	TCK	Input
AF4	DQ[66]	I/O	C10	V_{DDQ}	1.8V/2.5V
AF5	DQ[62]	I/O	C11	V_{DD}	1.0V
AF6	V_{DDQ}	1.8V/2.5V	C12	V_{DD}	1.0V
AF7	DQ[56]	I/O	C13	V_{DD}	1.0V
AF8	DQ[52]	I/O	C14	V_{DD}	1.0V
AF9	DQ[48]	I/O	C15	V_{DD}	1.0V
B1	TDI	Input	C16	V_{DD}	1.0V
B10	DQ[45]	I/O	C17	DQ[19]	I/O
B11	DQ[39]	I/O	C18	DQ[13]	I/O
B12	V_{DDQ}	1.8V/2.5V	C19	NC7	No Connect
B13	DQ[33]	I/O	C2	TMS	Input
B14	DQ[29]	I/O	C20	V_{DD}	1.0V
B15	DQ[27]	I/O	C21	V_{DD}	1.0V
B16	DQ[23]	I/O	C22	V_{DD}	1.0V
B17	V_{DDQ}	1.8V/2.5V	C23	V_{DD}	1.0V
B18	DQ[15]	I/O	C24	V_{DD}	1.0V
B19	DQ[11]	I/O	C25	SADR[01]	Output

Package Ball Number	Signal Name	Signal Type	Package Ball Number	Signal Name	Signal Type
B2	V_{SS}	Ground	C26	V_{DDQ}	1.8V/2.5V
B20	DQ[07]	I/O	C3	V_{DD}	1.0V
B21	V_{DDQ}	1.8V/2.5V	C4	V_{DD}	1.0V
B22	DQ[01]	I/O	C5	V_{DD}	1.0V
C6	V_{DD}	1.0V	E24	V_{DD}	1.0V
C7	V_{DD}	1.0V	E25	SADR[05]	Output
C8	NC8	No Connect	E26	SADR[04]	Output
C9	DQ[49]	I/O	E3	V_{DD}	1.0V
D1	TRST_L	Input	E4	V_{SS}	Ground
D10	VSS	Ground	F1	ID[1]	Input
D11	V_{DD}	1.0V	F2	ID[2]	Input
D12	V_{DD}	1.0V	F23	V_{SS}	Ground
D13	V_{DD}	1.0V	F24	V_{DD}	1.0V
D14	V_{DD}	1.0V	F25	SADR[06]	Output
D15	V_{DD}	1.0V	F26	V_{DDQ}	1.8V/2.5V
D16	V_{DD}	1.0V	F3	V_{DD}	1.0V
D17	V_{SS}	Ground	F4	V_{SS}	Ground
D18	V_{SS}	Ground	G1	ID[3]	Input
D19	V_{SS}	Ground	G2	ID[4]	Input
D2	TDO	Output-T	G23	V_{SS}	Ground
D20	V_{SS}	Ground	G24	V_{DD}	1.0V
D21	V_{SS}	Ground	G25	SADR[08]	Output
D22	V_{SS}	Ground	G26	SADR[07]	Output
D23	V_{SS}	Ground	G3	V_{DD}	1.0V
D24	V_{DD}	1.0V	G4	V_{SS}	Ground
D25	SADR[03]	Output	H1	LHI[0]	Input
D26	SADR[02]	Output	H2	LHI[1]	Input
D3	V_{DD}	1.0V	H23	V_{SS}	Ground
D4	V_{SS}	Ground	H24	NC6	No Connect
D5	V_{SS}	Ground	H25	V_{DDQ}	1.8V/2.5V
D6	V_{SS}	Ground	H26	SADR[09]	Output
D7	V_{SS}	Ground	H3	NC1	No Connect
D8	V_{SS}	Ground	H4	V_{SS}	Ground
D9	V_{SS}	Ground	J1	LHI[2]	Input
E1	ID[0]	Input	J2	LHI[3]	Input
E2	V_{DDQ}	1.8V/2.5V	J23	V_{SS}	Ground
E23	V_{SS}	Ground	J24	SADR[11]	Output
J25	SADR[12]	Output	M2	BHI[0]	Input
J26	SADR[10]	Output	M23	V_{DD}	1.0V
J3	V_{DDQ}	1.8V/2.5V	M24	V_{DD}	1.0V
J4	V_{SS}	Ground	M25	V_{DDQ}	1.8V/2.5V
K1	LHI[6]	Input	M26	SADR[17]	Output
K2	LHI[4]	Input	M3	V_{DD}	1.0V
K23	V_{SS}	Ground	M4	V_{DD}	1.0V
K24	SADR[13]	Output	N1	BHI[1]	Input
K25	V_{DDQ}	1.8V/2.5V	N11	V_{SS}	Ground
K26	SADR[14]	Output	N12	V_{SS}	Ground

Package Ball Number	Signal Name	Signal Type	Package Ball Number	Signal Name	Signal Type
K3	LHI[5]	Input	N13	V_{SS}	Ground
K4	V_{SS}	Ground	N14	V_{SS}	Ground
L1	LHO[0]	Output-T	N15	V_{SS}	Ground
L11	V_{SS}	Ground	N16	V_{SS}	Ground
L12	V_{SS}	Ground	N2	BHI[2]	Input
L13	V_{SS}	Ground	N23	V_{DD}	1.0V
L14	V_{SS}	Ground	N24	V_{DD}	1.0V
L15	V_{SS}	Ground	N25	SADR[19]	Output
L16	V_{SS}	Ground	N26	SADR[18]	Output
L2	LHO[1]	Output-T	N3	V_{DD}	1.0V
L23	V_{DD}	1.0V	N4	V_{DD}	1.0V
L24	V_{DD}	1.0V	P1	BHO[0]	Output-T
L25	SADR[15]	Output	P11	V_{SS}	Ground
L26	SADR[16]	Output	P12	V_{SS}	Ground
L3	V_{DD}	1.0V	P13	V_{SS}	Ground
L4	V_{DD}	1.0V	P14	V_{SS}	Ground
M1	V_{DDQ}	1.8V/2.5V	P15	V_{SS}	Ground
M11	V_{SS}	Ground	P16	V_{SS}	Ground
M12	V_{SS}	Ground	P2	MULTI_HIT	Output-T
M13	V_{SS}	Ground	P23	V_{DD}	1.0V
M14	V_{SS}	Ground	P24	V_{DD}	1.0V
M15	V_{SS}	Ground	P25	SADR[21]	Output
M16	V_{SS}	Ground	P26	SADR[20]	Output
P3	V_{DD}	1.0V	U24	OE_L	Output-T
P4	V_{DD}	1.0V	U25	PHS_L	Input
R1	V_{DDQ}	1.8V/2.5V	U26	CLK1X/CLK2X	Input
R11	V_{SS}	Ground	U3	FULI[1]	Input
R12	V_{SS}	Ground	U4	V_{SS}	Ground
R13	V_{SS}	Ground	V1	FULI[2]	Input
R14	V_{SS}	Ground	V2	FULI[3]	Input
R15	V_{SS}	Ground	V23	V_{SS}	Ground
R16	V_{SS}	Ground	V24	CE_L	Output-T
R2	BHO[1]	Output-T	V25	V_{DDQ}	1.8V/2.5V
R23	V_{DD}	1.0V	V26	WE_L	Output-T
R24	V_{DD}	1.0V	V3	FULI[4]	Input
R25	SADR[22]	Output	V4	V_{SS}	Ground
R26	V_{DDQ}	1.8V/2.5V	W1	V_{DDQ}	1.8V/2.5V
R3	V_{DD}	1.0V	W2	FULI[5]	Input
R4	V_{DD}	1.0V	W23	V_{SS}	Ground
T1	BHO[2]	Output-T	W24	SADR[24]	Output-T
T11	V_{SS}	Ground	W25	CMDV	Input
T12	V_{SS}	Ground	W26	ALE_L	Output-T
T13	V_{SS}	Ground	W3	NC2	No Connect
T14	V_{SS}	Ground	W4	V_{SS}	Ground
T15	V_{SS}	Ground	Y1	FULI[6]	Input
T16	V_{SS}	Ground	Y2	FULO[0]	Output-T
T2	V_{SS}	Ground	Y23	V_{SS}	Ground

Package Ball Number	Signal Name	Signal Type	Package Ball Number	Signal Name	Signal Type
T23	V_{DD}	1.0V	Y24	V_{DD}	1.0V
T24	V_{DD}	1.0V	Y25	CMD[1]	Input
T25	CLK_MODE	Input	Y26	CMD[0]	Input
T26	SADR[23]	Output	Y3	V_{DD}	1.0V
T3	V_{DD}	1.0V	Y4	V_{SS}	Ground
T4	V_{DD}	1.0V			
U1	FULI[0]	Input			
U2	V_{DDQ}	1.8V/2.5V			
U23	V_{SS}	Ground			

1. CLK_TUNE[3:0] should be programmed to 100%.
2. All V_{DDQ} pins should be set to either 2.5V or 3.3V.

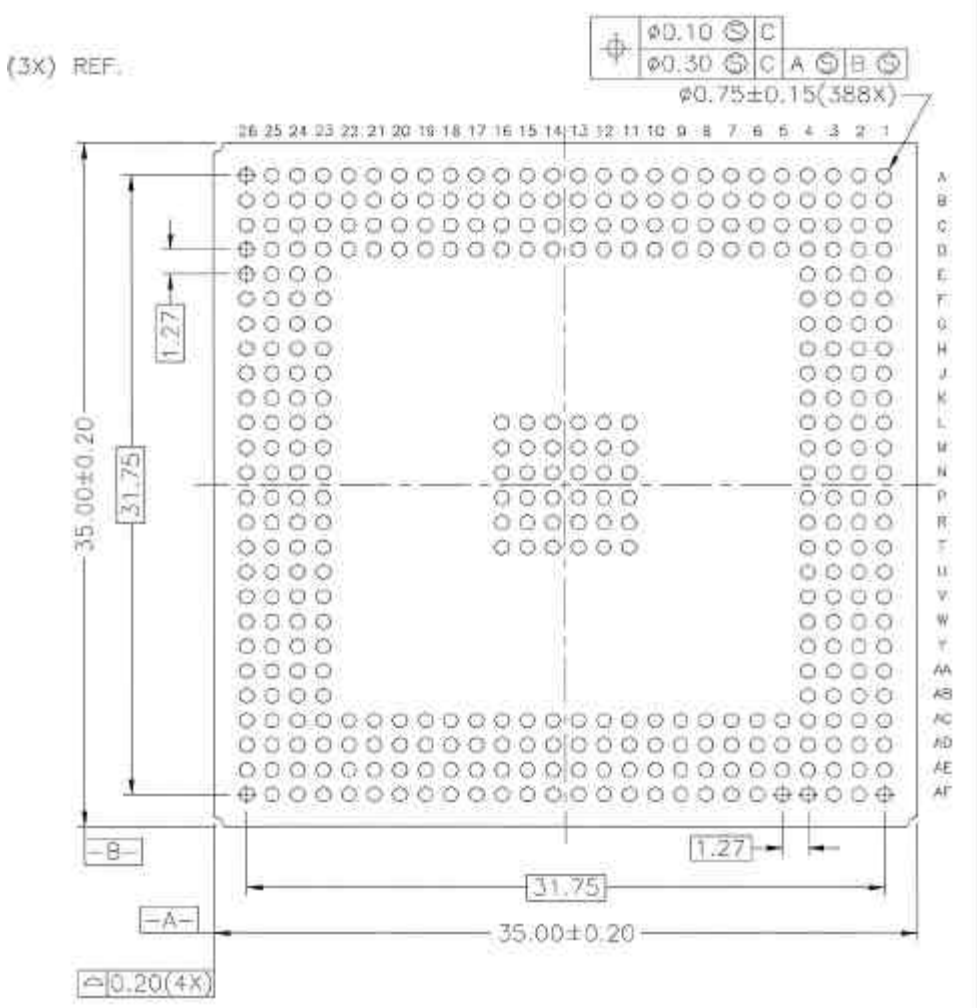


Figure 17-2. Package: Bottom View

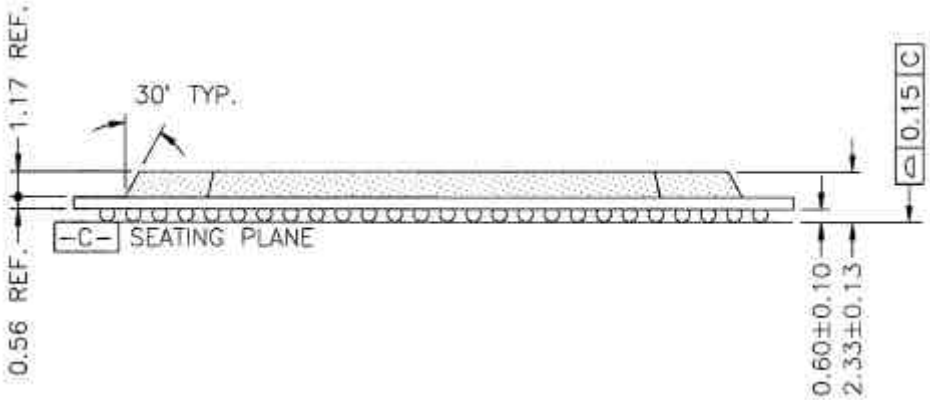


Figure 17-3. Package: Side view

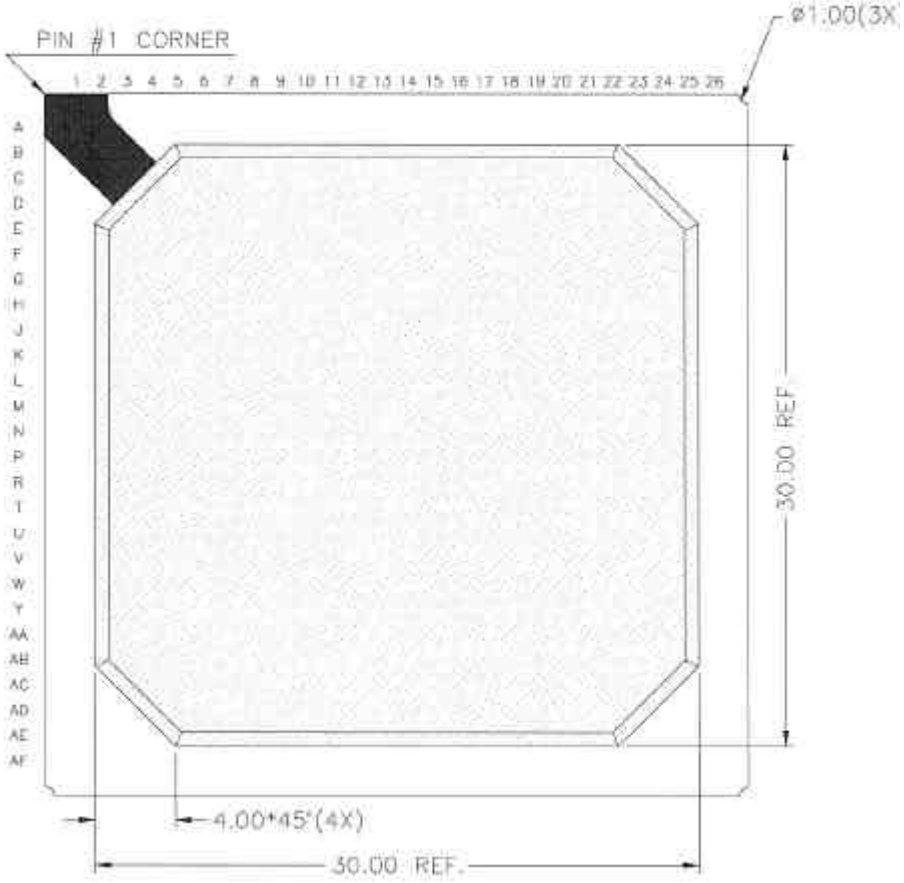


Figure 17-4. Package: Top View

18.0 Ordering Information

Table 18-1 provides ordering information.

Table 18-1. Ordering Information

Part Number	Description	I/O Voltage	Frequency	Temperature Range
CYNSE70256–066	NSE	1.8V/2.5V	66 MHz	Commercial
CYNSE70256–083	NSE	1.8V/2.5V	83 MHz	Commercial
CYNSE70256–100	NSE	1.8V/2.5V	100 MHz	Commercial