Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

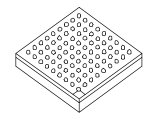
We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

Document Number: MC9328MX21
Rev. 3.4, 07/2010

MC9328MX21



Package Information

(MAPBGA–289)

Ordering Information: See Table 1 on page 3

MC9328MX21

266 MHz

1 Introduction

Freescale's i.MX family of microprocessors has demonstrated leadership in the portable handheld market. Building on the success of the MX (Media Extensions) series, the i.MX21 (MC9328MX21) provides a leap in performance with an ARM926EJ-S™ microprocessor core that provides accelerated Java support in addition to highly integrated system functions. The i.MX21 device specifically addresses the needs of the smartphone and portable product markets with intelligent integrated peripherals, advanced processor core, and power management capabilities.

The i.MX21 features the advanced and power-efficient ARM926EJ-S core operating at speeds up to 266 MHz and is part of a growing family of *Smart Speed* products that offer high performance processing optimized for lowest power consumption. On-chip modules such as a video accelerator module, LCD controller, USB On-The-Go, 1-Wire® interface, CMOS sensor interface, and synchronous serial interfaces offer designers a rich suite of peripherals that can enhance many products seeking to provide a rich multimedia experience.

Contents

1. Introduction 1
2. Signal Descriptions 5
3. Specifications 14
4. Pin Assignment and Package Information 96
5. Document Revision History 99

For cost sensitive applications, the NAND Flash controller allows the use of low-cost NAND Flash devices to be used as primary or secondary non-volatile storage. The on-chip error correction code (ECC) and parity checking circuitry of the NAND Flash controller frees the CPU for other tasks. WLAN, Bluetooth and expansion options are provided through PCMCIA/CF, USB, and MMC/SD host controllers.

The device is packaged in a 289-pin MAPBGA.

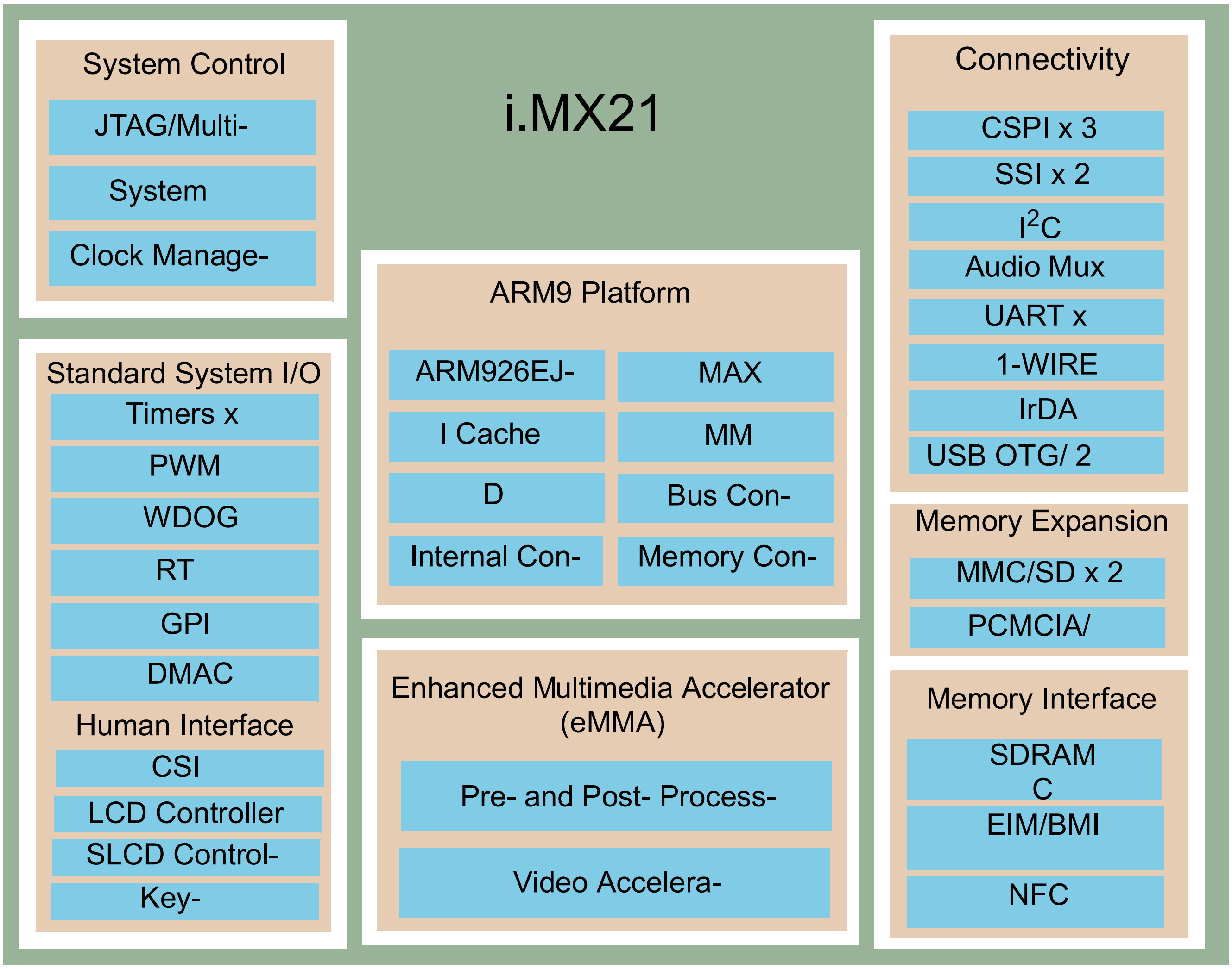


Figure 1. i.MX21 Functional Block Diagram

1.1 Conventions

This document uses the following conventions:

- $\overline{\text{OVERBAR}}$ is used to indicate a signal that is active when pulled low: for example, $\overline{\text{RESET}}$.
- *Logic level one* is a voltage that corresponds to Boolean true (1) state.
- *Logic level zero* is a voltage that corresponds to Boolean false (0) state.
- To *set* a bit or bits means to establish logic level one.
- To *clear* a bit or bits means to establish logic level zero.

- A *signal* is an electronic construct whose state conveys or changes in state convey information.
- A *pin* is an external physical connection. The same pin can be used to connect a number of signals.
- *Asserted* means that a discrete signal is in active logic state.
  — *Active low* signals change from logic level one to logic level zero.
  — *Active high* signals change from logic level zero to logic level one.
- *Negated* means that an asserted discrete signal changes logic state.
  — *Active low* signals change from logic level zero to logic level one.
  — *Active high* signals change from logic level one to logic level zero.
- LSB means *least significant bit* or *bits*, and MSB means *most significant bit* or *bits*. References to low and high bytes or words are spelled out.
- Numbers preceded by a percent sign (%) are binary. Numbers preceded by a dollar sign ($) or *0x* are hexadecimal.

1.2 Target Applications

The i.MX21 is targeted for advanced information appliances, smart phones, Web browsers, digital MP3 audio players, handheld computers based on the popular Palm OS platform, and messaging applications.

1.3 Reference Documentation

The following documents are required for a complete description of the i.MX21 and are necessary to design properly with the device. Especially for those not familiar with the ARM926EJ-S processor the following documents are helpful when used in conjunction with this manual.

ARM Architecture Reference Manual (ARM Ltd., order number ARM DDI 0100)

ARM7TDMI Data Sheet (ARM Ltd., order number ARM DDI 0029)

ARM920T Technical Reference Manual (ARM Ltd., order number ARM DDI 0151C)

MC9328MX21 Product Brief (order number MC9328MX21P)

MC9328MX21 Reference Manual (order number MC9328MX21R*M)*

The Freescale manuals are available on the Freescale Semiconductor Web site at http://www.freescale.com. These documents may be downloaded directly from the Freescale Web site, or printed versions may be ordered. The ARM Ltd. documentation is available from http://www.arm.com.

1.4 Ordering Information

Table 1 provides ordering information for the device.

Table 1. Ordering Information[1]

Part Order Number	Package Size	Package Type	Operating Range
MC9328MX21VK!	289-lead MAPBGA 0.65mm, 14mm x 14mm	Lead-free	0°C–70°C
MC9328MX21VM!	289-lead MAPBGA 0.8mm, 17mm x 17mm	Lead-free	0°C–70°C

Table 1. Ordering Information[1] (Continued)

Part Order Number	Package Size	Package Type	Operating Range
MC9328MX21DVK!	289-lead MAPBGA 0.65mm, 14mm x 14mm	Lead-free	-30°C–70°C
MC9328MX21DVM!	289-lead MAPBGA 0.8mm, 17mm x 17mm	Lead-free	-30°C–70°C
MC9328MX21CVK!	289-lead MAPBGA 0.65mm, 14mm x 14mm	Lead-free	-40°C–85°C
MC9328MX21CVM!	289-lead MAPBGA 0.8mm, 17mm x 17mm	Lead-free	-40°C–85°C
MC9328MX21CJM	289-lead MAPBGA 0.8mm, 17mm x 17mm	Lead-free	-40°C–85°C

1.5 Features

The i.MX21 boasts a robust array of features that can support a wide variety of applications. Below is a brief description of i.MX21 features.

- ARM926EJ-S Core Complex
- enhanced Multimedia Accelerator (eMMA)
- Display and Video Modules
  - LCD Controller (LCDC)
  - Smart LCD Controller (SLCDC)
  - CMOS Sensor Interface (CSI)
- Bus Master Interface (BMI)
- Wireless Connectivity
  - Fast Infra-Red Interface (FIRI)
- Wired Connectivity
  - USB On-The-Go (USBOTG) Controller
  - Four Universal Asynchronous Receiver/Transmitters (UART*x*)
  - Three Configurable Serial Peripheral Interfaces (CSPI*x*) for High Speed Data Transfer
  - Inter-IC (I^2C) Bus Module
  - Two Synchronous Serial Interfaces (SSI) with Inter-IC Sound (I^2S)
  - Digital Audio Mux
  - One-Wire Controller
  - Keypad Interface
- Memory Expansion and I/O Card Support
  - Two Multimedia Card and Secure Digital (MMC/SD) Host Controller Modules

- Memory Interface
  - — External Interface Module (EIM)
  - — SDRAM Controller (SDRAMC)
  - — NAND Flash Controller (NFC)
  - — PCMCIA/CF Interface
- Standard System Resources
  - — Clock Generation Module (CGM) and Power Control Module
  - — Three General-Purpose 32-Bit Counters/Timers
  - — Watchdog Timer
  - — Real-Time Clock/Sampling Timer (RTC)
  - — Pulse-Width Modulator (PWM) Module
  - — Direct Memory Access Controller (DMAC)
  - — General-Purpose I/O (GPIO) Ports
  - — Debug Capability

2 Signal Descriptions

Table 2 identifies and describes the i.MX21 signals. Pin assignment is provided in Section 4, "Pin Assignment and Package Information" and in the "Signal Multiplexing Scheme" table within the reference manual.

The connections of the pins in Table 2 depends solely upon the user application, however there are a few factory test signals that are not used in a normal application. Following is a list of these signals and how they are to be terminated for proper operation of the i.MX21 processor:

- CLKMODE[1:0]: To ensure proper operation, leave these signals as no connects.
- OSC26M_TEST: To ensure proper operation, leave this signal as no connect.
- EXT_48M: To ensure proper operation, connect this signal to ground.
- EXT_266M: To ensure proper operation, connect this signal to ground.
- TEST_WB[2:0]: These signals are also multiplexed with GPIO PORT E as well as alternate keypad signals. If not utilizing these signals for GPIO functionality or for their other multiplexed function, then configure as GPIO input with pull up enabled, and leave as a no connect.
- TEST_WB[4:3]: To ensure proper operation, leave these signals as no connects.

Table 2. i.MX21 Signal Descriptions

Signal Name	Function/Notes
External Bus/Chip Select (EIM)	
A [25:0]	Address bus signals
D [31:0]	Data bus signals
$\overline{\text{EB0}}$	MSB Byte Strobe—Active low external enable byte signal that controls D [31:24], shared with SDRAM DQM0.

Table 2. i.MX21 Signal Descriptions (Continued)

Signal Name	Function/Notes
EB1	Byte Strobe—Active low external enable byte signal that controls D [23:16], shared with SDRAM DQM1.
EB2	Byte Strobe—Active low external enable byte signal that controls D [15:8], shared with SDRAM DQM2 and PCMCIA PC_REG.
EB3	LSB Byte Strobe—Active low external enable byte signal that controls D [7:0], shared with SDRAM DQM3 and PCMCIA PC_IORD.
OE	Memory Output Enable—Active low output enables external data bus, shared with PCMCIA PC_IOWR.
CS [5:0]	Chip Select—The chip select signals CS [3:2] are multiplexed with CSD [1:0] and are selected by the Function Multiplexing Control Register (FMCR) in the System Control chapter. By default CSD [1:0] is selected. DTACK is multiplexed with CS4.
ECB	Active low input signal sent by flash device to the EIM whenever the flash device must terminate an on-going burst sequence and initiate a new (long first access) burst sequence.
LBA	Active low signal sent by flash device causing the external burst device to latch the starting burst address.
BCLK	Clock signal sent to external synchronous memories (such as burst flash) during burst mode.
RW	RW signal—Indicates whether external access is a read (high) or write (low) cycle. This signal is also shared with the PCMCIA PC_WE.
DTACK	DTACK signal—External input data acknowledge signal, multiplexed with CS4.
Bootstrap	
BOOT [3:0]	System Boot Mode Select—The operational system boot mode upon system reset is determined by the settings of these pins. To hardwire these inputs low, terminate with a 1 KΩ resister to ground. For a logic high, terminate with a 1 KΩ resistor to VDDA. Do not change the state of these inputs after power-up. Boot 3 should always be tied to logic low.
SDRAM Controller	
SDBA [4:0]	SDRAM non-interleave mode bank address signals. These signals are multiplexed with address signals A[20:16].
SDIBA [3:0]	SDRAM interleave addressing mode bank address signals. These signals are multiplexed with address signals A[24:21].
MA [11:0]	SDRAM address signals. MA[9:0] are multiplexed with address signals A[10:1].
DQM [3:0]	SDRAM data qualifier mask multiplexed with EB[3:0]. DQM3 corresponds to D[31:24], DQM2 corresponds to D[23:16], DQM1 corresponds to D[15:8], and DQM0 corresponds to D[7:0].
CSD0	SDRAM Chip Select signal. This signal is multiplexed with the CS2 signal. This signal is selectable by programming the Function Multiplexing Control Register in the System Control chapter.
CSD1	SDRAM Chip Select signal. This signal is multiplexed with the CS3 signal. This signal is selectable by programming the Function Multiplexing Control Register in the System Control chapter.
RAS	SDRAM Row Address Select signal.
CAS	SDRAM Column Address Select signal
SDWE	SDRAM Write Enable signal
SDCKE0	SDRAM Clock Enable 0
SDCKE1	SDRAM Clock Enable 1
SDCLK	SDRAM Clock

Table 2. i.MX21 Signal Descriptions (Continued)

Signal Name	Function/Notes
Clocks and Resets	
EXTAL26M	Crystal input (26MHz), or a 16 MHz to 32 MHz oscillator (or square-wave) input when the internal oscillator circuit is shut down. When using an external signal source, feed this input with a square wave signal switching from GND to VDDA.
XTAL26M	Oscillator output to external crystal. When using an external signal source, float this output.
EXTAL32K	32 kHz or 32.768 kHz crystal input. When using an external signal source, feed this input with a square wave signal switching from GND to QVDD5.
XTAL32K	Oscillator output to external crystal. When using an external signal source, float this output.
CLKO	Clock Out signal selected from internal clock signals. Please refer to clock controller for internal clock selection.
EXT_48M	This is a special factory test signal. To ensure proper operation, connect this signal to ground.
EXT_266M	This is a special factory test signal. To ensure proper operation, connect this signal to ground.
RESET_IN	Master Reset—External active low Schmitt trigger input signal. When this signal goes active, all modules (except the reset module, SDRAMC module, and the clock control module) are reset.
RESET_OUT	Reset Out—Internal active low output signal from the Watchdog Timer module and is asserted from the following sources: Power-on reset, External reset (RESET_IN), and Watchdog time-out.
POR	Power On Reset—Active low Schmitt trigger input signal. The POR signal is normally generated by an external RC circuit designed to detect a power-up event.
CLKMODE[1:0]	These are special factory test signals. To ensure proper operation, leave these signals as no connects.
OSC26M_TEST	This is a special factory test signal. To ensure proper operation, leave this signal as a no connect.
TEST_WB[2:0]	These are special factory test signals. However, these signals are also multiplexed with GPIO PORT E as well as alternate keypad signals. If not using these signals for GPIO functions or for other multiplexed functions, then configure as GPIO input with pull-up enabled, and leave as a no connect.
TEST_WB[4:3]	These are special factory test signals. To ensure proper operation, leave these signals as no connects.
WKGD	Battery indicator input used to qualify the walk-up process. Also multiplexed with TIN.
JTAG For termination recommendations, see the Table “*JTAG pinouts*” in the *Multi-ICE® User Guide* from ARM® Limited.	
TRST	Test Reset Pin—External active low signal used to asynchronously initialize the JTAG controller.
TDO	Serial Output for test instructions and data. Changes on the falling edge of TCK.
TDI	Serial Input for test instructions and data. Sampled on the rising edge of TCK.
TCK	Test Clock to synchronize test logic and control register access through the JTAG port.
TMS	Test Mode Select to sequence the JTAG test controller’s state machine. Sampled on the rising edge of TCK.
JTAG_CTRL	JTAG Controller select signal—JTAG_CTRL is sampled during the rising edge of TRST. Must be pulled to logic high for proper JTAG interface to debugger. Pulling JTAG_CRTL low is for internal test purposes only.
RTCK	JTAG Return Clock used to enhance stability of JTAG debug interface devices. This signal is multiplexed with 1-Wire, therefore using 1-Wire renders RTCK unusable and vice versa.
CMOS Sensor Interface	
CSI_D [7:0]	Sensor port data
CSI_MCLK	Sensor port master clock

Table 2. i.MX21 Signal Descriptions (Continued)

Signal Name	Function/Notes
CSI_VSYNC	Sensor port vertical sync
CSI_HSYNC	Sensor port horizontal sync
CSI_PIXCLK	Sensor port data latch clock
LCD Controller	
LD [17:0]	LCD Data Bus—All LCD signals are driven low after reset and when LCD is off. LD[15:0] signals are multiplexed with SLCDC1_DAT[15:0] from SLCDC1 and BMI_D[15:0]. LD[17] signal is multiplexed with BMI_WRITE of BMI. LD[16] is multiplexed with BMI_READ_REQ of BMI and EXT_DMAGRANT.
FLM_VSYNC (or simply referred to as VSYNC)	Frame Sync or Vsync—This signal also serves as the clock signal output for gate driver (dedicated signal SPS for Sharp panel HR-TFT). This signal is multiplexed with BMI_RXF_FULL and BMI_WAIT of the BMI.
LP_HSYNC (or simply referred to as HSYNC)	Line Pulse or HSync
LSCLK	Shift Clock. This signal is multiplexed with the BMI_CLK_CS from BMI.
OE_ACD	Alternate Crystal Direction/Output Enable.
CONTRAST	This signal is used to control the LCD bias voltage as contrast control. This signal is multiplexed with the BMI_READ from BMI.
SPL_SPR	Sampling start signal for left and right scanning. This signal is multiplexed with the SLCDC1_CLK.
PS	Control signal output for source driver (Sharp panel dedicated signal). This signal is multiplexed with the SLCDC1_CS.
CLS	Start signal output for gate driver. This signal is invert version of PS (Sharp panel dedicated signal). This signal is multiplexed with the SLCDC1_RS.
REV	Signal for common electrode driving signal preparation (Sharp panel dedicated signal). This signal is multiplexed with SLCDC1_D0.
Smart LCD Controller	
SLCDC1_CLK	SLCDC Clock output signal. This signal is multiplexed and available at 2 alternate locations. These are SPL_SPR and SD2_CLK signals of LCDC and SD2, respectively.
SLCDC1_CS	SLCDC Chip Select output signal. This signal is multiplexed and available at 2 alternate signal locations. These are PS and SD2_CMD signals of LCDC and SD2, respectively.
SLCDC1_RS	SLCDC Register Select output signal. This signal is multiplexed and available at 2 alternate signal locations. These are CLS and SD2_D3 signals of LCDC and SD2, respectively.
SLCDC1_D0	SLCDC serial data output signal. This signal is multiplexed and available at 2 alternate signal locations. These are and REV and SD2_D2 signals of LCDC and SD2, respectively. This signal is inactive when a parallel data interface is used.
SLCDC1_DAT[15:0]	SLCDC Data output signals for connection to a parallel SLCD panel interface. These signals are multiplexed with LD[15:0] while an alternate 8-bit SLCD muxing is available on LD[15:8]. Further alternate muxing of these signals are available on some of the USB OTG and USBH1 signals.
SLCDC2_CLK	SLCDC Clock input signal for pass through to SLCD device. This signal is multiplexed with SSI3_CLK signal from SSI3.
SLCDC2_CS	SLCDC Chip Select input signal for pass through to SLCD device. This signal is multiplexed with SSI3_TXD signal from SSI3.
SLCDC2_RS	SLCDC Register Select input signal for pass through to SLCD device. This signal is multiplexed with SSI3_RXD signal from SSI3.

Table 2. i.MX21 Signal Descriptions (Continued)

Signal Name	Function/Notes
SLCDC2_D0	SLCD Data input signal for pass through to SLCD device. This signal is multiplexed with SSI3_FS signal from SSI3.
Bus Master Interface (BMI)	
BMI_D[15:0]	BMI bidirectional data bus. Bus width is programmable between 8-bit or 16-bit.These signals are multiplexed with LD[15:0] and SLCDC_DAT[15:0].
BMI_CLK_CS	BMI bidirectional clock or chip select signal.This signal is multiplexed with LSCLK of LCDC.
BMI_WRITE	BMI bidirectional signal to indicate read or write access. This is an input signal when the BMI is a slave and an output signal when BMI is the master of the interface. BMI_WRITE is asserted for write and negated for read.This signal is muxed with LD[17] of LCDC.
BMI_READ	BMI output signal to enable data read from external slave device. This signal is not used and driven high when BMI is slave.This signal is multiplexed with CONTRAST signal of LCDC.
BMI_READ_REQ	BMI Read request output signal to external bus master. This signal is active when the data in the TXFIFO is larger or equal to the data transfer size of a single external BMI access.This signal is muxed with LD[16] of LCDC.
BMI_RXF_FULL	BMI Receive FIFO full active high output signal to reflect if the RxFIFO reaches water mark value.This signal is muxed with VSYNC of the LCDC.
BMI_WAIT	BMI Wait—Active low signal to wait for data ready (read cycle) or accepted (write_cycle). Also multiplexed with VSYNC.
External DMA	
EXT_DMAREQ	External DMA Request input signal. This signal is multiplexed with CSPI1_RDY.
EXT_DMAGRANT	External DMA Grant output signal. This signal is multiplexed with LD[16] of LCDC and CSPI1_SS1 of CSPI1.
NAND Flash Controller	
NF_CLE	NAND Flash Command Latch Enable output signal. Multiplexed with PC_POE of PCMCIA.
NF_CE	NAND Flash Chip Enable output signal. This signal is multiplexed with PC_CE1 of PCMCIA.
NF_WP	NAND Flash Write Protect output signal. This signal is multiplexed with PC_CE2 of PCMCIA.
NF_ALE	NAND Flash Address Latch Enable output signal. This signal is multiplexed with PC_OE of PCMCIA.
NF_RE	NAND Flash Read Enable output signal. This signal is multiplexed with PC_RW of PCMCIA.
NF_WE	NAND Flash Write Enable output signal. This signal is multiplexed with and PC_BVD2 of PCMCIA.
NF_RB	NAND Flash Ready Busy input signal. This signal is multiplexed with PC_RST of PCMCIA.
NF_IO[15:0]	NAND Flash Data input and output signals. NF_IO[15:7] signals are multiplexed with A[25:21] and A[15:13]. NF_IO[7:0] signals are multiplexed with several PCMCIA signals.
PCMCIA Controller	
PC_A[25:0]	PCMCIA Address signals. These signals are multiplexed with A[25:0].
PC_D[15:0]	PCMCIA Data input and output signals. These signals are multiplexed with D[15:0].
PC_CD1	PCMCIA Card Detect1 input signal. This signal is multiplexed with NFIO[7] signal of NF.
PC_CD2	PCMCIA Card Detect2 input signal. This signal is multiplexed with NFIO[6] signal of NF.
PC_WAIT	PCMCIA Wait input signal to extend current access. This signal is multiplexed with NFIO[5] signal of NF.
PC_READY	PCMCIA Ready input signal indicates card is ready for access. Multiplexed with NFIO[4] signal of NF.

Table 2. i.MX21 Signal Descriptions (Continued)

Signal Name	Function/Notes
PC_RST	PCMCIA Reset output signal. This signal is multiplexed with NFRB signal of NF.
PC_OE	PCMCIA Memory Read Enable output signal asserted during common or attribute memory read cycles. This signal is multiplexed with NFALE signal of NF.
PC_WE	PCMCIA Memory Write Enable output signal asserted during common or attribute memory cycles. This signal is shared with RW of the EIM.
PC_VS1	PCMCIA Voltage Sense1 input signal. This signal is multiplexed with NFIO[2] signal of NF.
PC_VS2	PCMCIA Voltage Sense2 input signal. This signal is multiplexed with NFIO[1] signal of NF.
PC_BVD1	PCMCIA Battery Voltage Detect1 input signal. This signal is multiplexed with NFIO[0] signal of NF.
PC_BVD2	PCMCIA Battery Voltage Detect2 input signal. This signal is multiplexed with NF_WE signal of NF.
PC_SPKOUT	PCMCIA Speaker Out output signal. This signal is multiplexed with PWMO signal.
PC_REG	PCMCIA Register Select output signal. This signal is shared with EB2 of EIM.
PC_CE1	PCMCIA Card Enable1 output signal. This signal is multiplexed with NFCE signal of NF.
PC_CE2	PCMCIA Card Enable2 output signal. This signal is multiplexed with NFWP signal of NF.
PC_IORD	PCMCIA IO Read output signal. This signal is shared with EB3 of EIM.
PC_IOWR	PCMCIA IO Write output signal. This signal is shared with OE signal of EIM.
PC_WP	PCMCIA Write Protect input signal. This signal is multiplexed with NFIO[3] signal of NF.
PC_POE	PCMCIA Output Enable signal to enable voltage translation buffers and transceivers. This signal is multiplexed with NFCLE signal of NF.
PC_RW	PCMCIA Read Write output signal to control external transceiver direction. Asserted high for read access and negated low for write access. This signal is multiplexed with NFRE signal of NF.
PC_PWRON	PCMCIA input signal to indicate that the card power has been applied and stabilized.
CSPI	
CSPI1_MOSI	Master Out/Slave In signal
CSPI1_MISO	Master In/Slave Out signal
CSPI1_SS[2:0]	Slave Select (Selectable polarity) signal. CSPI1_SS2 is also multiplexed with USBG_RXDAT and CSPI1_SS1 is multiplexed with EXT_DMAGRANT.
CSPI1_SCLK	Serial Clock signal
CSPI1_RDY	Serial Data Ready signal. Also multiplexed with EXT_DMAREQ.
CSPI2_MOSI	Master Out/Slave In signal. This signal is multiplexed with USBH2_TXDP signal of USB OTG.
CSPI2_MISO	Master In/Slave Out signal. This signal is multiplexed with USBH2_TXDM signal of USB OTG.
CSPI2_SS[2:0]	Slave Select (Selectable polarity) signals. These signals are multiplexed with USBH2_FS, USBH2_RXDP and USBH2_RXDM signal of USB OTG
CSPI2_SCLK	Serial Clock signal. This signal is multiplexed with USBH2_OE signal of USB OTG
CSPI3_MOSI	Master Out/Slave In signal. This signal is multiplexed with SD1_CMD.
CSPI3_MISO	Master In/Slave Out signal. This signal is multiplexed with SD1_D0.
CSPI3_SS	Slave Select (Selectable polarity) signal multiplexed with SD1_D3.
CSPI3_SCLK	Serial Clock signal. This signal is multiplexed with SD1_CLK.

Table 2. i.MX21 Signal Descriptions (Continued)

Signal Name	Function/Notes
General Purpose Timers	
TIN	Timer Input Capture or Timer Input Clock—The signal on this input is applied to all 3 timers simultaneously. This signal is muxed with the Walk-up Guard Mode WKGD signal in the PLL, Clock, and Reset Controller module.
TOUT1 (or simply TOUT)	Timer Output signal from General Purpose Timer1 (GPT1). This signal is multiplexed with SYS_CLK1 and SYS_CLK2 signal of SSI1 and SSI2. The pin name of this signal is simply TOUT.
TOUT2	Timer Output signal from General Purpose Timer1 (GPT2). This signal is multiplexed with PWMO.
TOUT3	Timer Output signal from General Purpose Timer1 (GPT3). This signal is multiplexed with PWMO.
USB On-The-Go	
USB_BYP	USB Bypass input active low signal. This signal can only be used for USB function, not for GPIO.
USB_PWR	USB Power output signal
USB_OC	USB Over current input signal. This signal can only be used for USB function, not for GPIO.
USBG_RXDP	USB OTG Receive Data Plus input signal. This signal is muxed with SLCDC1_DAT15.
USBG_RXDM	USB OTG Receive Data Minus input signal. This signal is muxed with SLCDC1_DAT14.
USBG_TXDP	USB OTG Transmit Data Plus output signal. This signal is muxed with SLCDC1_DAT13.
USBG_TXDM	USB OTG Transmit Data Minus output signal. This signal is muxed with SLCDC1_DAT12.
USBG_RXDAT	USB OTG Transceiver differential data receive signal. Multiplexed with CSPI1_SS2.
USBG_OE	USB OTG Output Enable signal. This signal is muxed with SLCDC1_DAT11.
USBG_ON	USB OTG Transceiver ON output signal. This signal is muxed with SLCDC1_DAT9.
USBG_FS	USB OTG Full Speed output signal. This signal is multiplexed with external transceiver USBG_TXR_INT signal of USB OTG. This signal is muxed with SLCDC1_DAT10.
USBH1_RXDP	USB Host1 Receive Data Plus input signal. This signal is multiplexed with UART4_RXD and SLCDC1_DAT6. It also provides an alternative multiplex for UART4_RTS, where this signal is selectable by programming the Function Multiplexing Control Register in the System Control chapter.
USBH1_RXDM	USB Host1 Receive Data Minus input signal. This signal is muxed with SLCDC1_DAT5. It also provides an alternative multiplex for UART4_CTS.
USBH1_TXDP	USB Host1 Transmit Data Plus output signal. This signal is multiplexed with UART4_CTS and SLCDC1_DAT4. It also provides an alternative multiplex for UART4_RXD, where this signal is selectable by programming the Function Multiplexing Control Register in the System Control chapter.
USBH1_TXDM	USB Host1 Transmit Data Minus output signal. Multiplexed with UART4_TXD and SLCDC1_DAT3.
USBH1_RXDAT	USB Host1 Transceiver differential data receive signal. Multiplexed with USBH1_FS.
USBH1_OE	USB Host1 Output Enable signal. This signal is muxed with SLCDC1_DAT2.
USBH1_FS	USB Host1 Full Speed output signal. Multiplexed with UART4_RTS and SLCDC1_DAT1 and USBH1_RXDAT.
USBH_ON	USB Host transceiver ON output signal. This signal is muxed with SLCDC1_DAT0.
USBH2_RXDP	USB Host2 Receive Data Plus input signal. This signal is multiplexed with CSPI2_SS[1] of CSPI2.
USBH2_RXDM	USB Host2 Receive Data Minus input signal. This signal is multiplexed with CSPI2_SS[2] of CSPI2.
USBH2_TXDP	USB Host2 Transmit Data Plus output signal. This signal is multiplexed with CSPI2_MOSI of CSPI2.
USBH2_TXDM	USB Host2 Transmit Data Minus output signal. This signal is multiplexed with CSPI2_MISO of CSPI2.
USBH2_OE	USB Host2 Output Enable signal. This signal is multiplexed with CSPI2_SCLK of CSPI2.

Table 2. i.MX21 Signal Descriptions (Continued)

Signal Name	Function/Notes
USBH2_FS	USB Host2 Full Speed output signal. This signal is multiplexed with CSPI2_SS[0] of CSPI2.
USBG_SCL	USB OTG I^2C Clock input/output signal. This signal is multiplexed with SLCDC1_DAT8.
USBG_SDA	USB OTG I^2C Data input/output signal. This signal is multiplexed with SLCDC1_DAT7.
USBG_TXR_INT	USB OTG transceiver interrupt input. Multiplexed with USBG_FS.
Secure Digital Interface	
SD1_CMD	SD Command bidirectional signal—If the system designer does not want to make use of the internal pull-up, via the Pull-up enable register, a 4.7k–69k external pull-up resistor must be added. This signal is multiplexed with CSPI3_MOSI.
SD1_CLK	SD Output Clock. This signal is multiplexed with CSPI3_SCLK.
SD1_D[3:0]	SD Data bidirectional signals—If the system designer does not want to make use of the internal pull-up, via the Pull-up enable register, a 50k–69k external pull-up resistor must be added. SD1_D[3] is muxed with CSPI3_SS while SD1_D[0] is muxed with CSPI3_MISO.
SD2_CMD	SD Command bidirectional signal. This signal is multiplexed with SLCDC1_CS signal from SLCDC1.
SD2_CLK	SD Output Clock signal. This signal is multiplexed with SLCDC1_CLK signal from SLCDC1.
SD2_D[3:0]	SD Data bidirectional signals. SD2_D[3:2] are multiplexed with SLCDC1_RS and SLCDC_D0 signals from SLCDC1.
UARTs – IrDA/Auto-Bauding	
UART1_RXD	Receive Data input signal
UART1_TXD	Transmit Data output signal
UART1_RTS	Request to Send input signal
UART1_CTS	Clear to Send output signal
UART2_RXD	Receive Data input signal. This signal is multiplexed with KP_ROW6 signal from KPP.
UART2_TXD	Transmit Data output signal. This signal is multiplexed with KP_COL6 signal from KPP.
UART2_RTS	Request to Send input signal. This signal is multiplexed with KP_ROW7 signal from KPP.
UART2_CTS	Clear to Send output signal. This signal is multiplexed with KP_COL7 signal from KPP.
UART3_RXD	Receive Data input signal. This signal is multiplexed with IR_RXD from FIRI.
UART3_TXD	Transmit Data output signal. This signal is multiplexed with IR_TXD from FIRI.
UART3_RTS	Request to Send input signal
UART3_CTS	Clear to Send output signal
UART4_RXD	Receive Data input signal which is multiplexed with USBH1_RXDP and USBH1_TXDP.
UART4_TXD	Transmit Data output signal which is multiplexed with USBH1_TXDM.
UART4_RTS	Request to Send input signal which is multiplexed with USBH1_FS and USBH1_RXDP.
UART4_CTS	Clear to Send output signal which is multiplexed with USBH1_TXDP and USBH1_RXDM.
Serial Audio Port – SSI (configurable to I^2S protocol and AC97)	
SSI1_CLK	Serial clock signal which is output in master or input in slave
SSI1_TXD	Transmit serial data
SSI1_RXD	Receive serial data
SSI1_FS	Frame Sync signal which is output in master and input in slave

Table 2. i.MX21 Signal Descriptions (Continued)

Signal Name	Function/Notes
SYS_CLK1	SSI1 master clock. Multiplexed with TOUT.
SSI2_CLK	Serial clock signal which is output in master or input in slave.
SSI2_TXD	Transmit serial data signal
SSI2_RXD	Receive serial data
SSI2_FS	Frame Sync signal which is output in master and input in slave.
SYS_CLK2	SSI2 master clock. Multiplexed with TOUT.
SSI3_CLK	Serial clock signal which is output in master or input in slave. Multiplexed with SLCDC2_CLK
SSI3_TXD	Transmit serial data signal which is multiplexed with SLCDC2_CS
SSI3_RXD	Receive serial data which is multiplexed with SLCDC2_RS
SSI3_FS	Frame Sync signal which is output in master and input in slave. Multiplexed with SLCDC2_D0.
SAP_CLK	Serial clock signal which is output in master or input in slave.
SAP_TXD	Transmit serial data
SAP_RXD	Receive serial data
SAP_FS	Frame Sync signal which is output in master and input in slave.
I^{2}C	
I2C_CLK	I^{2}C Clock
I2C_DATA	I^{2}C Data
1-Wire	
OWIRE	1-Wire input and output signal. This signal is multiplexed with JTAG RTCK.
PWM	
PWMO	PWM Output. This signal is multiplexed with PC_SPKOUT of PCMCIA, as well as TOUT2 and TOUT3 of the General Purpose Timer module.
General Purpose Input/Output	
PF[16]	Dedicated GPIO. When unused, program this signal as an input with the on-chip pull-up resistor enabled.
Keypad	
KP_COL[7:0]	Keypad Column selection signals. KP_COL[7:6] are multiplexed with UART2_CTS and UART2_TXD respectively. Alternatively, KP_COL6 is also available on the internal factory test signal TEST_WB2. The Function Multiplexing Control Register in the System Control chapter must be used in conjunction with programming the GPIO multiplexing (to select the alternate signal multiplexing) to choose which signal KP_COL6 is available.
KP_ROW[7:0]	Keypad Row selection signals. KP_ROW[7:6] are multiplexed with UART2_RTS and UART2_RXD signals respectively. Alternatively, KP_ROW7 and KP_ROW6 are available on the internal factory test signals TEST_WB0 and TEST_WB1 respectively. The Function Multiplexing Control Register in the System Control chapter must be used in conjunction with programming the GPIO multiplexing (to select the alternate signal multiplexing) to choose which signals KP_ROW6 and KP_ROW7 are available.
Noisy Supply Pins	
NVDD	Noisy Supply for the I/O pins. There are six (6) I/O voltages, NVDD1 through NVDD6.
NVSS	Noisy Ground for the I/O pins

Table 2. i.MX21 Signal Descriptions (Continued)

Signal Name	Function/Notes
Supply Pins – Analog Modules	
VDDA	Supply for analog blocks
QVSS (internally connected to AVSS)	Quiet GND for analog blocks (QVSS and AVSS are synonymous)
Internal Power Supplies	
QVDD	Power supply pins for silicon internal circuitry
QVSS	Quiet GND pins for silicon internal circuitry
QVDDX	Power supply pin for the ARM core. Externally connect directly to QVDD

3 Specifications

This section contains the electrical specifications and timing diagrams for the i.MX21 processor.

3.1 Maximum Ratings

Table 3 provides the maximum ratings.

CAUTION

Stresses beyond those listed under "Maximum Ratings," (Table 3) may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated under "266 MHz Recommended Operating Range" (Table 4) is not implied. Exposure to maximum-rated conditions for extended periods may affect device reliability.

Table 3. Maximum Ratings

Ref. Num	Parameter	Symbol	Min	Max	Units
1	Supply Voltage	$QVDD_{max}$, $QVDDX_{max}$	-0.3	2.1	V
		$NVDD_{max}$, $VDDA_{max}$	-0.3	3.3	V
2	Input Voltage Range	V_{Imax}	-0.3	VDD + 0.3[1]	V
3	Storage Temperature Range	$T_{storage}$	-55	150	°C

1. VDD is the supply voltage associated with the input. See *Signal Multiplexing Scheme* table in the reference manual.

3.2 Recommended Operating Range

Table 4 provides the recommended operating ranges. The device has multiple pairs of VDD and VSS power supply and return pins. QVDD, QVDDx, and QVSS pins are used for internal logic. All other VDD and VSS pins are for the I/O pads voltage supply, and each pair of VDD and VSS provides power to the enclosed I/O pads. This design allows different peripheral supply voltage levels in a system.

Because VDDA pins are supply voltages to the analog pads, it is recommended to isolate and noise-filter the VDDA pins from other VDD pins.

For more information about I/O pads grouping per VDD, please refer to Table 4.

Table 4. 266 MHz Recommended Operating Range

Rating		Symbol	Minimum	Maximum	Unit
Operating temperature range	**Part No. Suffix**				
	VK, VM	T_A	0	70	°C
	DVK, DVM	T_A	-30	70	°C
	CVK, CVM	T_A	- 40	85	°C
I/O supply voltage NVDD 1–6		$NVDD_x$	1.70	3.30	V
Internal supply voltage (Core = 266 MHz)		QVDD, QVDDx	1.45	1.65	V
Analog supply voltage		VDDA	1.70	3.30	V

3.3 DC Electrical Characteristics

Table 5 contains the DC characteristics of the i.MX21.

Table 5. DC Characteristics

Parameter	Symbol	Test Conditions	Min	Typ[1]	Max	Units
High-level input voltage	V_{IH}	–	0.7NVDD	–	NVDD	
Low-level Input voltage	V_{IL}	–	O	–	0.3NVDD	
High-level output voltage	V_{OH}	I_{OH} = spec'ed Drive	0.8NVDD	–	–	V
Low-level output voltage	V_{OL}	I_{OL} = spec'ed Drive	–	–	0.2NVDD	V
High-level output current, slow I/O	I_{OH_S}	V_{out}=0.8NVDD DSCR[2] = 000 DSCR = 001 DSCR = 011 DSCR = 111	 -2 -4 -8 -12	–	–	mA
High-level output current, fast I/O	I_{OH_F}	V_{out}=0.8NVDD1 DSCR[2] = 000 DSCR = 001 DSCR = 011 DSCR = 111	 -3.5 -4.5 -5.5 -6.5	–	–	mA
Low-level output current, slow I/O	I_{OL_S}	V_{out}=0.2NVDD DSCR[2] = 000 DSCR = 001 DSCR = 011 DSCR = 111	 2 4 8 12	–	–	mA
Low-level output current, fast I/O	I_{OL_F}	V_{out}=0.2NVDD1 DSCR[2] = 000 DSCR = 001 DSCR = 011 DSCR = 111	 3.5 4.5 5.5 6.5	–	–	mA
Schmitt trigger Positive–input threshold	V_T +	–	–	–	2.15	V
Schmitt trigger Negative–input threshold	V_T -		0.75	–	–	V
Hysteresis	V_{HYS}	–	–	0.3	–	V

Table 5. DC Characteristics (Continued)

Parameter	Symbol	Test Conditions	Min	Typ[1]	Max	Units
Input leakage current (no pull-up or pull-down)	I_{in}	V_{in} = 0 or NVDD	–	–	±1	µA
I/O leakage current	I_{OZ}	$V_{I/O}$ = NVDD or 0 I/O = High impedance state	–	–	±5	µA

1. Data labeled Typical is not guaranteed, but is intended as an indication of the IC's potential performance.
2. For DSCR definition refer to the System Control chapter in the reference manual.

Table 6 shows the input and output capacitance for the device.

Table 6. Input/Output Capacitance

Parameter	Symbol	Min	Typ	Max	Units
Input capacitance	C_i	–	–	5	pF
Output capacitance	C_o	–	–	5	pF

Table 7 shows the power consumption for the device.

Table 7. Power Consumption

ID	Parameter	Conditions	Symbol	Typ	Max	Units
1	Run Current	QVDD = QVDDX = 1.65 V, NVDD1 = 1.8 V. NVDD2 through NVDD6 = VDDA = 3.1V. Core = 266 MHz, System = 133 MHz. MPEG4 Playback (QVGA) from MMC/SD card, 30fps, 44.1kHz audio.	$I_{QVDD} + I_{QVDDX}$	120	–	mA
			I_{NVDD1}	8	–	mA
			I_{NVDD2} through $I_{NVDD6} + I_{VDDA}$	6.6	–	mA
2	Sleep Current	Standby current with Well Biasing System enabled. Well Bias Control Register (WBCR) must be set as follows: WBCR: CRM_WBS bits = 01 CRM_WBFA bit = 1 CRM_WBM bits = 001 CRM_SPA_SEL bit = 1 FMCR bit = 1 For WBCR definition refer to System Control Chapter in the reference manual.	**I_{STBY}**			
			QVDD = QVDDX = 1.65V, TA[1]	–	3.0	mA
			QVDD = QVDDX = 1.65V, 25°	–	700	µA
			QVDD = QVDDX = 1.55V, 25°	320	–	µA

1. TA = 70°C for suffixes VK, VM, DVK, DVM, and SVK. TA = 85°C for suffixes CVK, CVM, and SCVK.

3.4 AC Electrical Characteristics

The AC characteristics consist of output delays, input setup and hold times, and signal skew times. All signals are specified relative to an appropriate edge of other signals. All timing specifications are specified at a system operating frequency (HCLK) from 0 MHz to 133 MHz (core operating frequency 266 MHz) with an operating supply voltage from $V_{DD\ min}$ to $V_{DD\ max}$ under an operating temperature from T_L to T_H.

All timing is measured at 30 pF loading with the exception of fast I/O signals as discussed below. Refer to the reference manual's System Control Chapter for details on drive strength settings.

Table 8 provides the maximum loading guidelines that can be tolerated on a memory I/O signal (also known as Fast I/O) to achieve 133 MHz operation. These critical signals include the SDRAM Clock (SDCLK), Data Bus signals (D[31:0]), lower order address signals such as A0-A10, MA10, MA11, and other signals required to meet 133 MHz timing.

The values shown in Table 8 apply over the recommended operating temperature range. Care must be taken to minimize parasitic capacitance of associated printed circuit board traces.

Table 8. Loading Guidelines for Fast IO Signals to Achieve 133 MHz Operation

Drive Strength Setting (DSCR2–DSCR12)	Maximum I/O Loading at 1.8 V	Maximum I/O Loading at 3.0 V
000: 3.5 mA	9 pF	12 pF
001: 4.5 mA	12 pF	16 pF
011: 5.5 mA	15 pF	21 pF
111: 6.5 mA	19 pF	26 pF

Table 9. 32k/26M Oscillator Signal Timing

Parameter	Minimum	RMS	Maximum	Unit
EXTAL32k input jitter (peak to peak) for both System PLL and MCUPLL	–	5	20	ns
EXTAL32k input jitter (peak to peak) for MCUPLL only	–	5	100	ns
EXTAL32k startup time	800	–	–	ms

Table 10. CLKO Rise/Fall Time (at 30pF Loaded)

	Best Case	Typical	Worst Case	Units
Rise Time	0.80	1.00	1.40	ns
Fall Time	0.74	1.08	1.67	ns

3.5 DPLL Timing Specifications

Parameters of the DPLL are given in Table 11. In this table, T_{ref} is a reference clock period after the predivider and T_{dck} is the output double clock period.

Table 11. DPLL Specifications

Parameter	Test Conditions	Minimum	Typical	Maximum	Unit
Reference clock frequency range	Vcc = 1.5V	16	–	320	MHz
Pre-divider output clock frequency range	Vcc = 1.5V	16	–	32	MHz
Double clock frequency range	Vcc = 1.5V	220	–	560	MHz
Pre-divider factor (PD)	–	1	–	16	–
Total multiplication factor (MF)	Includes both integer and fractional parts	5	–	15	–

Table 11. DPLL Specifications (Continued)

Parameter	Test Conditions	Minimum	Typical	Maximum	Unit
MF integer part	–	5	–	15	–
MF numerator	Should be less than the denominator	0	–	1022	–
MF denominator	–	1	–	1023	–
Frequency lock-in time after full reset	FOL mode for non-integer MF (does not include pre-multi lock-in time)	350	400	450	T_{ref}
Frequency lock-in time after partial reset	FOL mode for non-integer MF (does not include pre-multi lock-in time)	220	280	330	T_{ref}
Phase lock-in time after full reset	FPL mode and integer MF (does not include pre-multi lock-in time)	480	530	580	T_{ref}
Phase lock-in time after partial reset	FPL mode and integer MF (does not include pre-multi lock-in time)	360	410	460	T_{ref}
Frequency jitter (p-p)	–	–	0.02	0.03	2•T_{dck}
Phase jitter (p-p)	Integer MF, FPL mode, Vcc=1.7V	–	1.0	1.5	ns
Power dissipation	FOL mode, integer MF, f_{dck} = 560 MHz, Vcc = 1.5V	–	1.5	–	mW (Avg)

3.6 Reset Module

The timing relationships of the Reset module with the $\overline{\text{POR}}$ and $\overline{\text{RESET\_IN}}$ are shown in Figure 2 and Figure 3. Be aware that NVDD must ramp up to at least 1.7V for NVDD1 and 2.7V for NVDD2-6 before QVDD is powered up to prevent forward biasing.

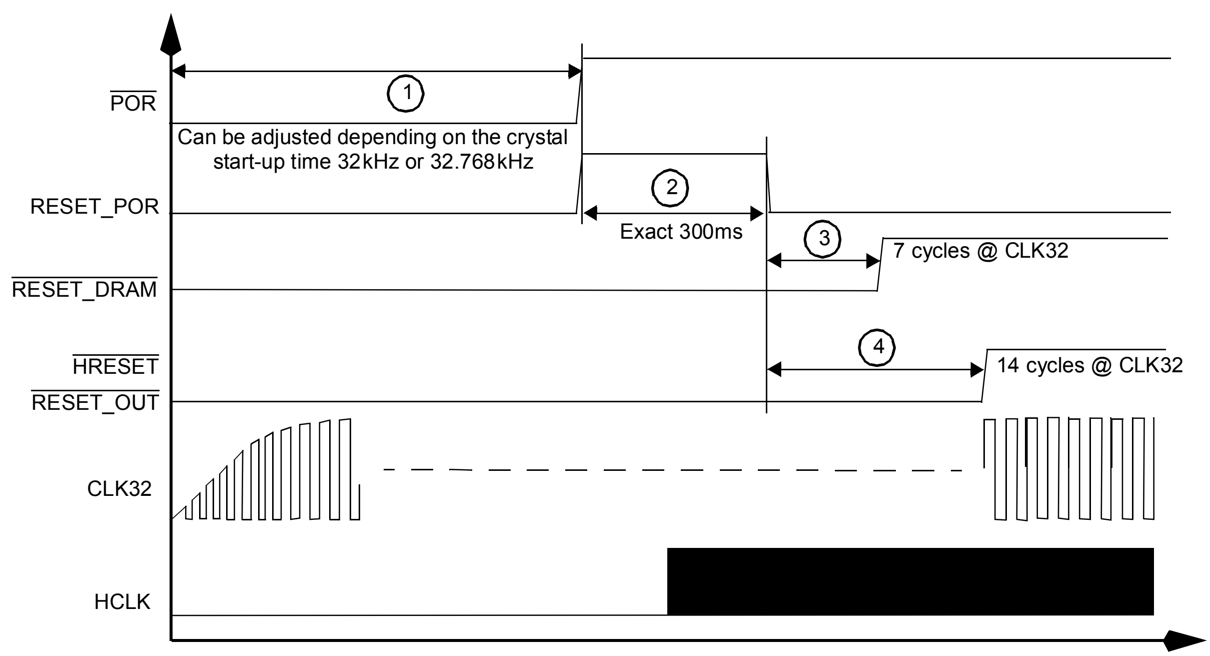


Figure 2. Timing Relationship with $\overline{\text{POR}}$

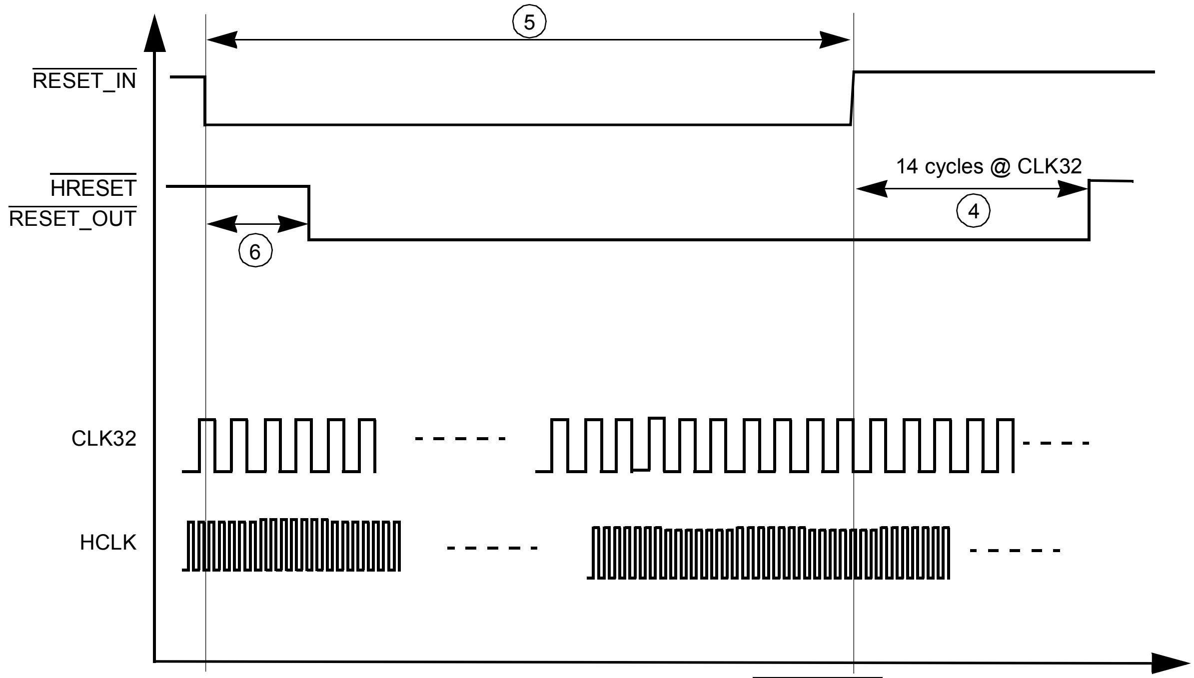


Figure 3. Timing Relationship with RESET_IN

Table 12. Reset Module Timing Parameters

Ref No.	Parameter	1.8 V ± 0.10 V		3.0 V ± 0.30 V		Unit
		Min	Max	Min	Max	
1	Width of input POWER_ON_RESET	800	–	800	–	ms
2	Width of internal POWER_ON_RESET (CLK32 at 32 kHz)	300	300	300	300	ms
3	7k to 32k-cycle stretcher for SDRAM reset	7	7	7	7	Cycles of CLK32
4	14k to 32k-cycle stretcher for internal system reset HRESERT and output reset at pin RESET_OUT	14	14	14	14	Cycles of CLK32
5	Width of external hard-reset RESET_IN	4	–	4	–	Cycles of CLK32
6	4k to 32k-cycle qualifier	4	4	4	4	Cycles of CLK32

3.7 External DMA Request and Grant

The External DMA request is an active low signal to be used by devices external to i.MX21 processor to request the DMAC for data transfer.

After assertion of External DMA request the DMA burst will start when the channel on which the External request is the source (as per the RSSR settings) becomes the current highest priority channel. The external device using the External DMA request should keep its request asserted until it is serviced by the DMAC. One External DMA request will initiate one DMA burst.

The output External Grant signal from the DMAC is an active-low signal.When the following conditions are true, the External DMA Grant signal is asserted with the initiation of the DMA burst.

- The DMA channel for which the DMA burst is ongoing has request source as external DMA Request
  (as per source select register setting).
- REN and CEN bit of this channel are set.
- External DMA Request is asserted.

After the grant is asserted, the External DMA request will not be sampled until completion of the DMA burst. As the external request is synchronized, the request synchronization will not be done during this period. The priority of the external request becomes low for the next consecutive burst, if another DMA request signal is asserted.

Worst case—that is, the smallest burst (1 byte read/write) timing diagrams are shown in Figure 4 and Figure 5. Minimum and maximum timings for the External request and External grant signals are present in Table 13.

Figure 4 shows the minimum time for which the External Grant signal remains asserted when an External DMA request is de-asserted immediately after sensing grant signal active.

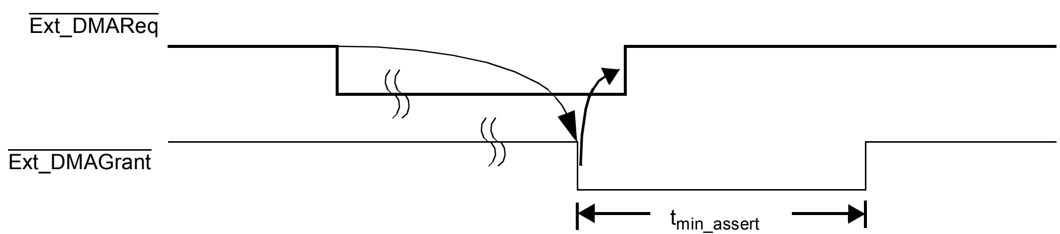
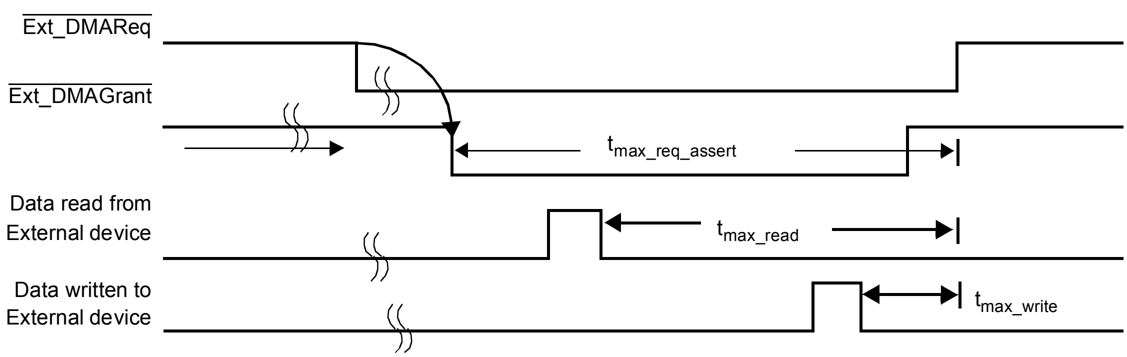


Figure 4. Assertion of DMA External Grant Signal

Figure 5 shows the safe maximum time for which External DMA request can be kept asserted, after sensing grant signal active such that a new burst is not initiated.



NOTE: Assuming in worst case the data is read/written from/to External device as per the above waveform.

Figure 5. Safe Maximum Timings for External Request De-Assertion

Table 13. DMA External Request and Grant Timing Parameters

Parameter	Description	3.0 V		1.8 V		Unit
		WCS	BCS	WCS	BCS	
t_{min_assert}	Minimum assertion time of External Grant signal	8 hclk + 8.6	8 hclk + 2.74	8 hclk + 7.17	8 hclk + 3.25	ns
$t_{max\_req\_assert}$	Maximum External request assertion time after assertion of Grant signal	9 hclk - 20.66	9 hclk - 6.7	9 hclk - 17.96	9 hclk - 8.16	ns
t_{max_read}	Maximum External request assertion time after first read completion	8 hclk - 6.21	8 hclk - 0.77	8 hclk - 5.84	8 hclk - 0.66	ns
t_{max_write}	Maximum External request assertion time after completion of first write	3 hclk - 15.87	3 hclk - 8.83	3 hclk - 15.9	3 hclk - 9.12	ns

3.8 BMI Interface Timing Diagram

3.8.1 Connecting BMI to ATI MMD Devices

3.8.1.1 ATI MMD Devices Drive the BMI_CLK/CS

In this mode MMD_MODE_SEL bit is set and MMD_CLKOUT bit is cleared. $\overline{\text{BMI\_WRITE}}$ and BMI_CLK/CS are input signals to BMI driving by ATI MMD chip set. Output signal BMI_READ_REQ can be used as interrupt signal to inform MMD that data is ready in BMI TxFIFO for read access. MMD can write data to BMI RxFIFO anytime as CPU or DMA can move data out from RxFIFO much faster than the BMI interface. Overflow interrupt is generated if RxFIFO overflow is detected. Once this happens, the new coming data is ignored.

3.8.1.1.1 MMD Read BMI Timing

Figure 6 shows the MMD read BMI timing when the MMD drives clock.

On each rising edge of BMI_CLK/CS BMI checks the $\overline{\text{BMI\_WRITE}}$ logic level to determine if the current cycle is a read cycle. It puts data into the data bus and enables the data out on the rising edge of BMI_CLK/CS if BMI_WRITE is logic high. The BMI_READ_REQ is negated one hclk cycle after the BMI_CLK/CS rising edge of last data read. The MMD cannot issues read command when BMI_READ_REQ is low (no data in TxFIFO).

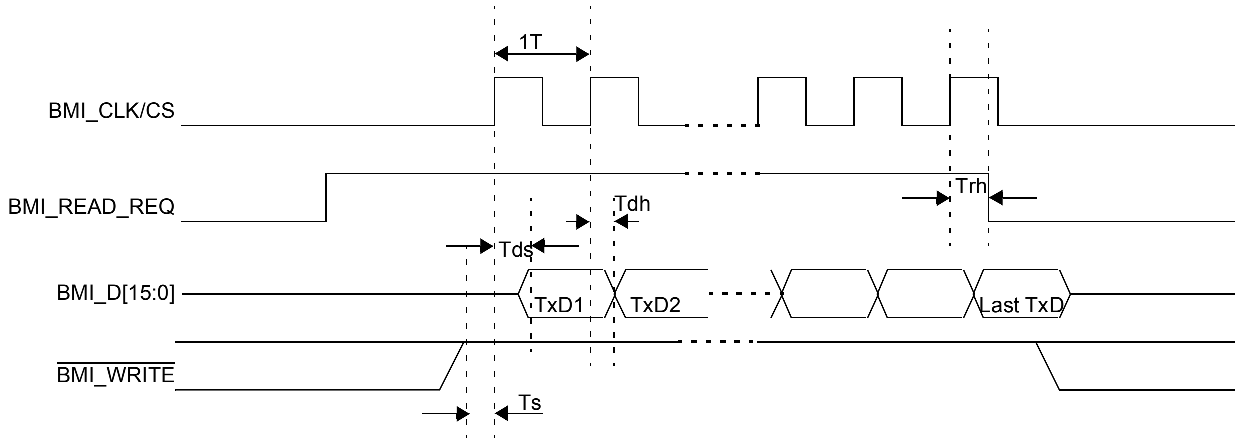


Figure 6. MMD (ATI) Drives Clock, MMD Read BMI Timing (MMD_MODE_SEL=1, MASTER_MODE_SEL=0,MMD_CLKOUT=0)

Table 14. MMD Read BMI Timing Table when MMD Drives Clock

Item	Symbol	Minimum	Typical	Maximum	Unit
Clock period	1T	33.3	–	–	ns
write setup time	Ts	11	–	–	ns
read_req hold time	Trh	6	–	24	ns
transfer data setup time	Tds	6	–	14	ns
transfer data hold time	Tdh	6	-	14	ns

Note: All the timings assume that the hclk is running at 133 MHz.

Note: The MIN period of the 1T is assumed that MMD latch data at falling edge.

Note: If the MMD latch data at next rising edge, the ideally max clock can be as much as double, but because the BMI data pads are slow pads and it max frequency can only up to 18MHz, the max clock frequency can only up to 36 MHz.

3.8.1.1.2 MMD Write BMI Timing

Figure 7 shows the MMD write BMI timing when MMD drives clock. On each falling edge of BMI_CLK/CS BMI checks the BMI_WRITE logic level to determine if the current cycle is a write cycle. If the BMI_WRITE is logic low, it latches data into the RxFIFO on each falling edge of BMI_CLK/CS signal.

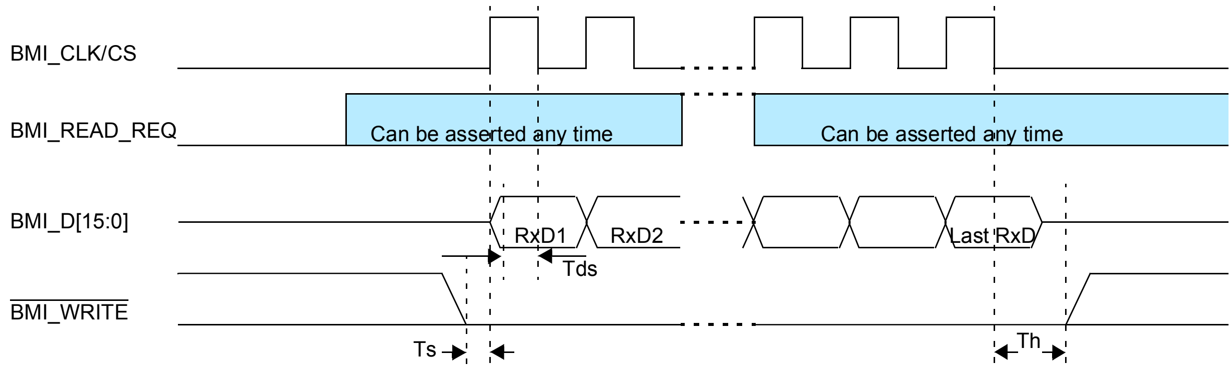


Figure 7. MMD (ATI) Drives Clock, MMD Write BMI Timing (MMD_MODE_SEL=1, MASTER_MODE_SEL=0, MMD_CLKOUT=0)

Table 15. MMD Write BMI Timing

Item	Symbol	Minimum	Typical	Maximum	Unit
write setup time	Ts	11	–	–	ns
write old ime h t	Th	0	–	–	ns
receive data setup time	Tds	5	–	–	ns

Note: All timings assume that the hclk is running at 133 MHz.

Note: At this mode, the maximum frequency of the BMI_CLK/CS can be up to 36 MHz (doubles as maximum data pad speed).

3.8.1.2 BMI Drives the BMI_CLK/CS

In this mode MMD_MODE_SEL and MMD_CLKOUT are both set. The software must know which mode it is now (READ or WRITE). When the BMI_WRITE is high, BMI drives BMI_CLK/CS out if the TxFIFO is not emptied. When BMI_WRITE is low, user can write a 1 to READ bit of control register1 to issue a write cycle (MMD write BMI).

3.8.1.3 MMD Read BMI Timing

Figure 13 shows the MMD read BMI timing when BMI drives the BMI_CLK/CS. When the BMI_WRITE is high, the BMI drives BMI_CLK/CS out if data is written to TxFIFO (BMI_READ_REQ become high), BMI puts data into data bus and enable data out on the rising edge of BMI_CLK/CS. The MMD devices can latch the data on each falling edge of BMI_CLK/CS.

It is recommended that the MMD do not change the BMI_WRITE signal from high to low when the BMI_READ_REQ is asserted. If user writes data to the TxFIFO when the BMI_WRITE is low, the BMI will drive BMI_CLK/CS out once the BMI_WRITE is changed from low to high.

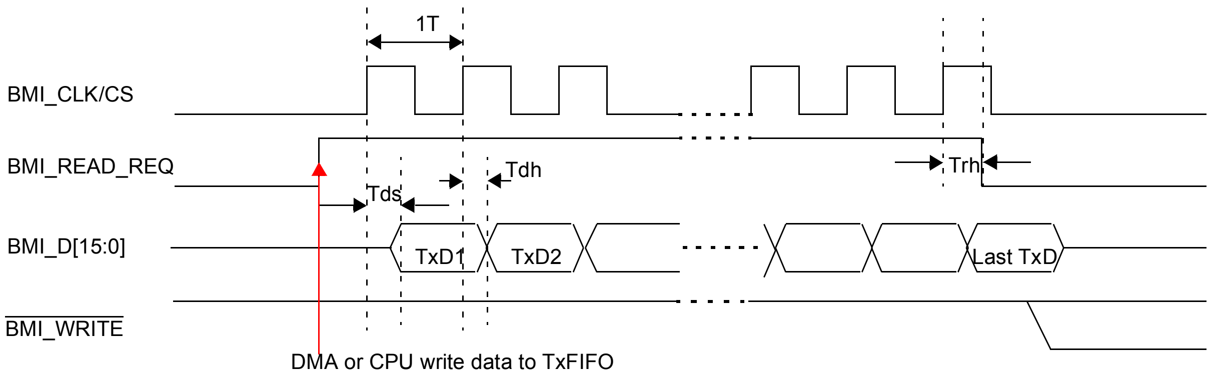


Figure 8. BMI Drives Clock, MMD Read BMI Timing (MASTER_MODE_SEL=0, MMD_MODE_SEL=1, MMD_CLKOUT=1)

Table 16. MMD Read BMI Timing Table when BMI Drives Clock

Item	Symbol	Minimum	Typical	Maximum	Unit
Transfer data setup time	Tds	2	–	8	ns
Transfer data hold time	Tdh	2	–	8	ns
Read_req hold time	Trh	2	–	18	ns

Note: In this mode, the max frequency of the BMI_CLK/CS can be up to 36MHz (double as max data pad speed).
Note: The BMI_CLK/CS can only be divided by 2,4,8,16 from HCLK.

3.8.1.4 MMD Write BMI Timing

Figure 9 shows the MMD write BMI timing when BMI drives BMI_CLK/CS.

When the BMI_WRITE signal is asserted, the BMI can write a 1 to READ bit of control register to issue a WRITE cycle. This bit is cleared automatically when the WRITE operation is completed. In a WRITE burst the MMD will write COUNT+1 data to the BMI. The user can issue another WRITE operation if the MMD still has data to write after the first operation completed.

The BMI can latch the data either at falling edge or the next rising edge of the BMI_CLK/CS according to the DATA_LATCH bit. When the DATA_LATCH bit is set, the BMI latch data at the next rising edge and latch the last data using the internal clock.

BMI_WRITE signal can not be negated when the WRITE operation is proceeding.

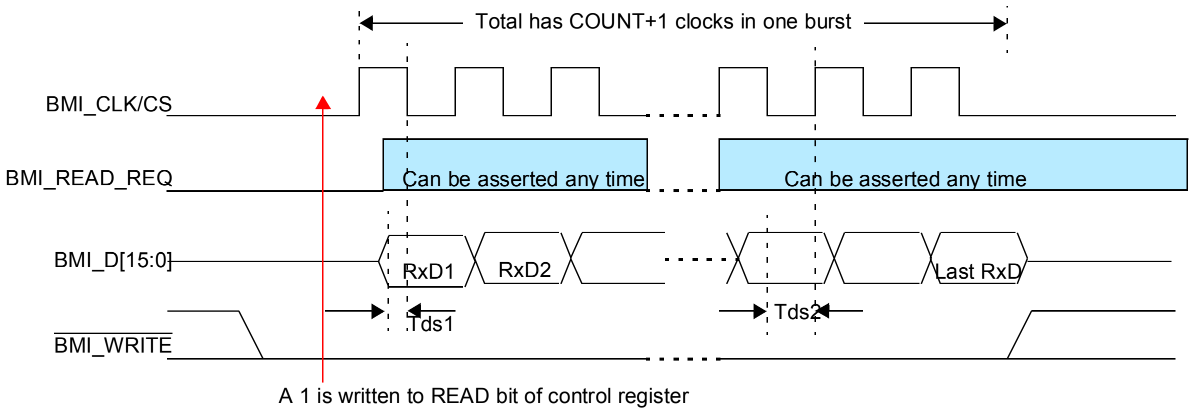


Figure 9. BMI Drives Clock, MMD Write BMI Timing (MASTER_MODE_SEL=0, MMD_MODE_SEL=1, MMD_CLKOUT=1)

Table 17. MMD Write BMI Timing Table when BMI Drives Clock

Item	Symbol	Minimum	Typical	Maximum	Unit
Receive data setup time1	Tds1	14	–	–	ns
Receive data setup time2	Tds2	14	–	–	ns

Note: The BMI_CLK/CS can only be up to 30MHz if BMI latch data at the falling edge and can be up to 36MHz (double as max data pad speed) if BMI latch data at the next rising edge.

Note: Tds1 is the receive data setup time when BMI latch data at the falling edge.

Note: Tds2 is the receive data setup time when BMI latch data at the next rising edge.

3.8.2 Connecting BMI to External Bus Master Devices

In this mode both MASTER_SEL bit and MMD_MODE_SEL bit are cleared and the MMD_CLKOUT bit is no useful. BMI_WRITE and BMI_CLK/CS are input signals driving by the external bus master. The Output signal BMI_READ_REQ can be used as an interrupt signal to inform external bus master that data is ready in the BMI TxFIFO for a read access. The external bus master can write data to the BMI RxFIFO anytime since the CPU or DMA can move data out from RxFIFO much faster than the BMI interface. An overflow interrupt is generated if RxFIFO overflow is detected. Once this happens, the new coming data is ignored.

Each falling edge of BMI_CLK/CS will determine if the current cycle is read or write cycle. It drives data and enables data out if BMI_WRITE is logic high. The D_EN signal remains active only while BMI_CLK/CS is logic low and BMI_WRITE is logic high.

Each rising edge of BMI_CLK/CS will determine if data should be latched to RxFIFO from the data bus.