

## 6-PORT 25M ATM PHY LSI

The  $\mu$ PD98408 is an ATM physical layer LSI IC that complies with ATM25 (25.6 Mbps) and which supports TC sublayer and PMD sublayer functions. Interfacing with the ATM layer and AAL layer LSI is implemented at UTOPIA Level 2.

### FEATURES

- Provides a 25.6-Mbps ATM PHY (PMD & TC) function for six circuits
- Conforms to the ATM Forum PHY interface specifications (af-phy-0040.000 November 1995).
- UTOPIA Level 2 V1.0 (af-phy-0039.000 June 1995: max. 8 bits/40 MHz) interface
- Three-cell built-in transmit/receive FIFOs for each circuit
- PMD sublayer functions:
  - (a) Built-in clock recovery.
  - (b) Built-in equalizer.
- TC sublayer functions:
  - (a) NRZI encoder/decoder.
  - (b) Command byte insertion/detection.
  - (c) 4B/5B encoder/decoder.
  - (d) Cell scrambler/descrambler.
  - (e) HEC generation/verification.
- CPU interface: Intel or Motorola can be selected.
- Supports STP and UTP (Categories 3, 4, 5).
- Loopback function: Loopback in the PMD and ATM layers.
- Operation And Maintenance (OAM) functions: Input failure detection, HEC error detection and 4B/5B code error detection.
- Test function: Supports JTAG.
- Power supply voltage: 3.3 V  $\pm$  5 %.

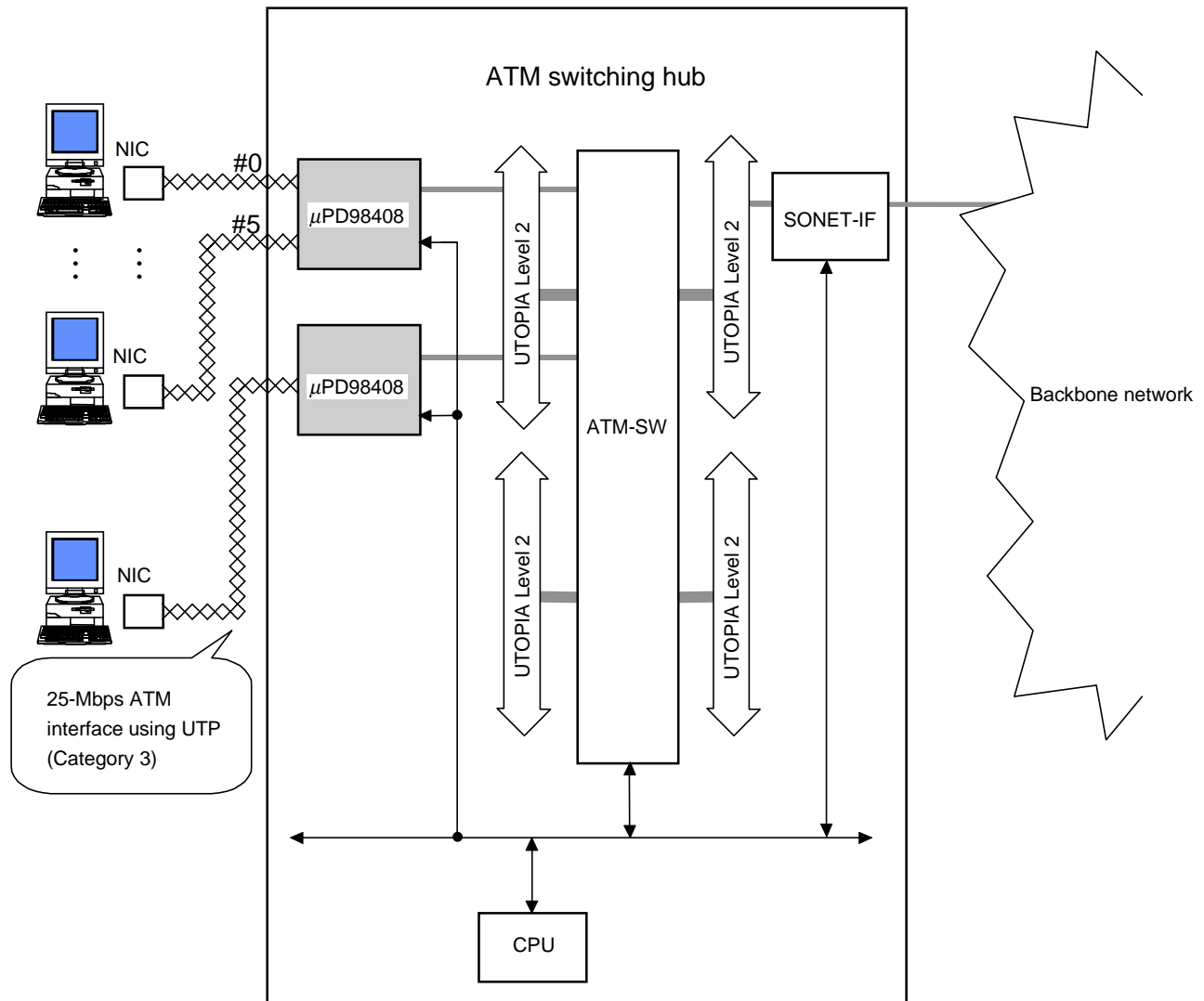
### ORDERING INFORMATION

Part Number	Package
$\mu$ PD98408GD-LML	208-pin plastic QFP (fine pitch) (28 $\times$ 28 mm)

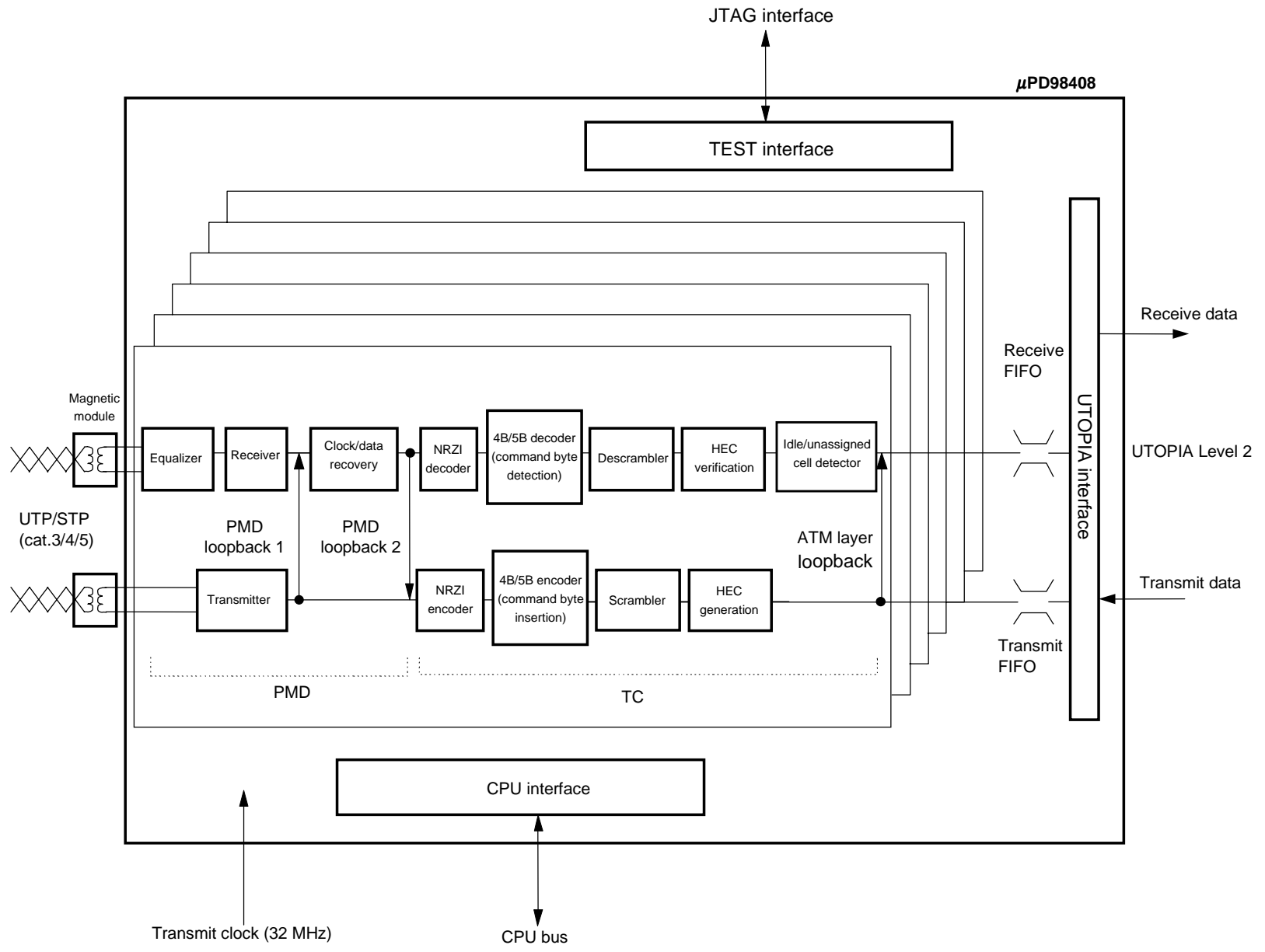
**Remark** This document indicates active low pins in the format of "xxx\_B" (\_B after the pin name).

The information in this document is subject to change without notice.

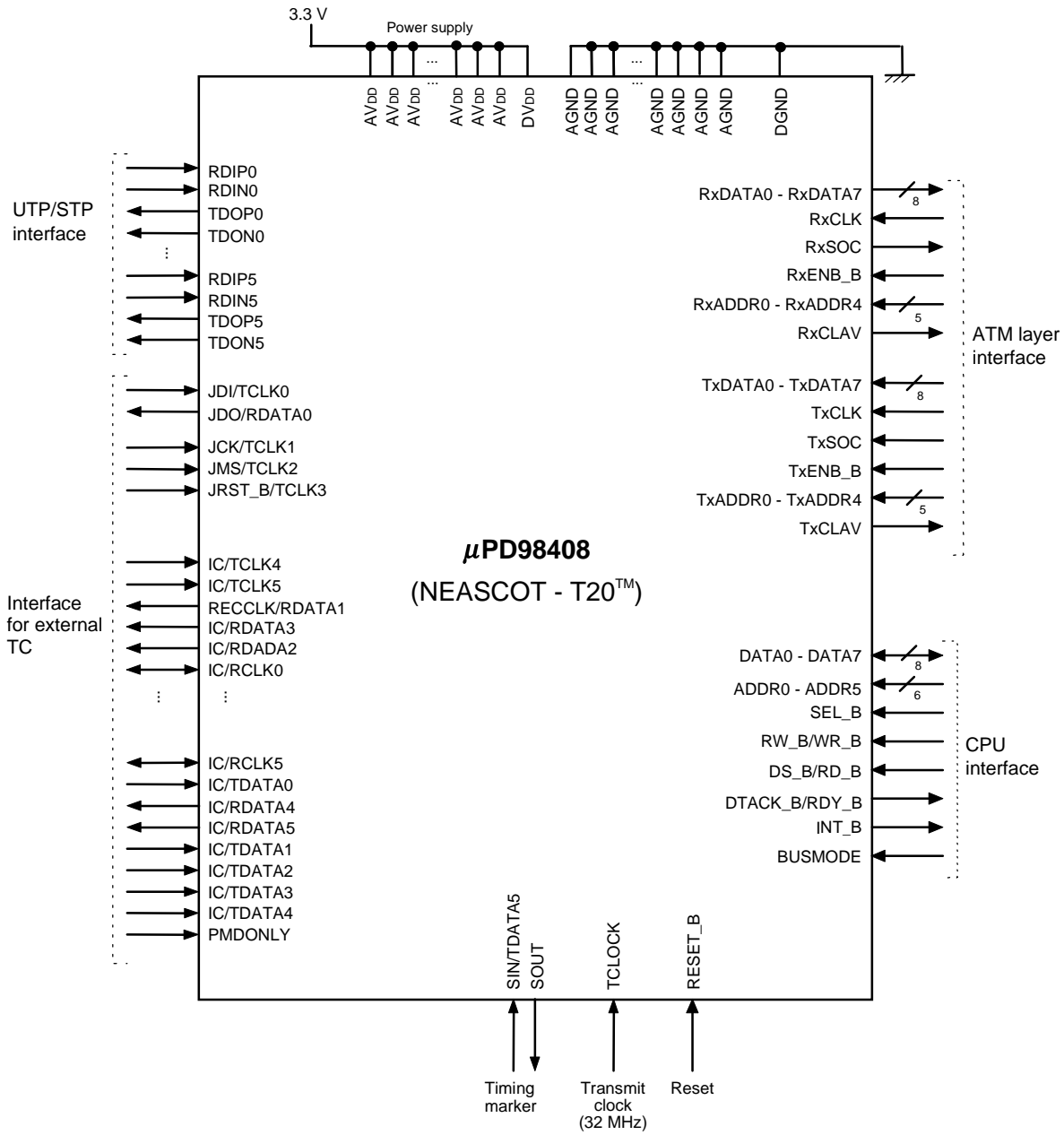
SYSTEM CONFIGURATION EXAMPLE (APPLICATION)



BLOCK DIAGRAM

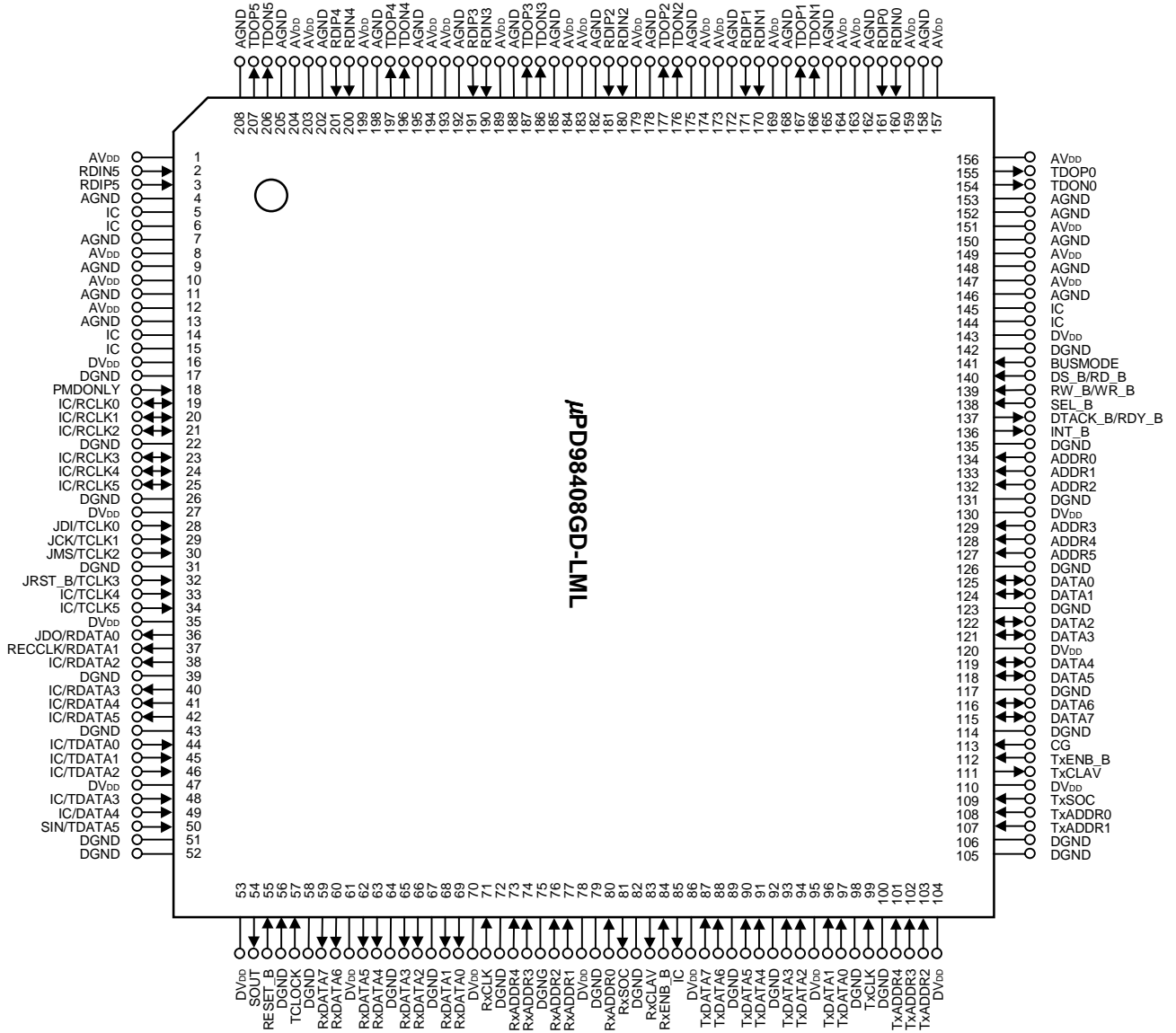


PIN LAYOUT



PIN CONFIGURATION (TOP VIEW)

208-pin plastic QFP (fine pitch) (28 × 28 mm)



## PIN NAMES

ADDR0-ADDR5	: Address	RxADDR0-RxADDR4:	Receive address
AGND	: Analog ground	RxCLAV	: Receive cell available
AV <sub>DD</sub>	: Analog supply voltage	RxCLOCK	: Receive data clock
BUSMODE	: Bus mode	RxDATA0- RxDATA7	: Receive data
CG	: Connect GND	RxENB_B	: Receive enable
DATA0-DATA7	: Data	RxSOC	: Receive start address of ATM cell
DGND	: Digital ground	SEL_B	: Selector
DS_B/RD_B	: Data strove/read	SIN/TDATA5	: Signal in/transmit data
DTACK_B/RDY_B	: Data acknowledge/ready	SOUT	: Signal out
DV <sub>DD</sub>	: Digital supply voltage	TCLOCK	: Transmit clock
IC	: Internal connect	TDON0-TDON5	: Transmit data output negative
IC/RCLK0-IC/RCLK5	: Internal connect/receive clock	TDOP0-TDOP5	: Transmit data output positive
IC/RDATA2-IC/RDATA5:	Internal connect/receive data	TxADDR0- TxADDR4	: Transmit address
IC/TCLK4, IC/TCLK5	: Internal connect/transmit clock	TxCLAV	: Transmit cell available
IC/TDATA0-IC/TDATA4	: Internal connect/transmit data	TxCLOCK	: Transmit data clock
INT_B	: Interrupt	TxDATA0-TxDATA7:	Transmit data
JCK/TCLK1	: JTAG test clock/transmit clock	TxENB_B	: Transmit enable
JDI/TCLK0	: JTAG test data input/transmit clock	TxSOC	: Transmit start address of ATM cell
JDO/RDATA0	: JTAG test data output/recieve data		
JMS/TCLK2	: JTAG test mode select/transmit clock		
JRST_B/TCLK3	: JTAG test reset/transmit clock		
PMDONLY	: PMD only		
RDIN0-RDIN5	: Receive data input negative		
RDIP0-RDIP5	: Receive data input positive		
RECCLK/RDATA1	: Recovery clock/receive data		
RESET_B	: Reset		
RW_B/WR_B	: Read write/write		

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## 1. PIN FUNCTIONS

### 1.1 Power Supply

Pin Name	Pin No.	I/O	Active Level	Function
AV <sub>DD</sub>	1, 8, 10, 12, 147, 149, 151, 156, 157, 159, 163, 164, 169, 173, 174, 179, 183, 184, 189, 193, 194, 199, 203, 204	–	–	+3.3-V power supply pins for analog circuits.
DV <sub>DD</sub>	16, 27, 35, 47, 53, 61, 70, 78, 86, 95, 104, 110, 120, 130, 143	–	–	+3.3-V power supply pins for digital circuits.
AGND	4, 7, 9, 11, 13, 146, 148, 150, 152, 153, 158, 162, 165, 168, 172, 175, 178, 182, 185, 188, 192, 195, 198, 202, 205, 208	–	–	Analog circuit grounding pins.
DGND	17, 22, 26, 31, 39, 43, 51, 52, 56, 58, 64, 67, 72, 75, 79, 82, 89, 92, 98, 100, 105, 106, 114, 117, 123, 126, 131, 135, 142	–		Digital circuit grounding pins.

**Caution** On the PC board layout, AGND and DGND should be connected to the same, wide plane.  
On the PC board layout, AV<sub>DD</sub> and DV<sub>DD</sub> should be connected to the same, wide plane.  
For details, refer to the User's Manual (S11409E).



## 1.2 UTP/STP Interface

Pin Name	Pin No.	I/O	Active Level	Function
RDIP0	161	I	–	Receive data inputs from circuit #0 (analog balanced signal inputs).
RDIN0	160	I	–	
TDOP0	155	O	–	Transmit data outputs to circuit #0 (analog balanced signal outputs).
TDON0	154	O	–	
RDIP1	171	I	–	Receive data inputs from circuit #1 (analog balanced signal inputs).
RDIN1	170	I	–	
TDOP1	167	O	–	Transmit data outputs to circuit #1 (analog balanced signal outputs).
TDON1	166	O	–	
RDIP2	181	I	–	Receive data inputs from circuit #2 (analog balanced signal inputs).
RDIN2	180	I	–	
TDOP2	177	O	–	Transmit data outputs to circuit #2 (analog balanced signal outputs).
TDON2	176	O	–	
RDIP3	191	I	–	Receive data inputs from circuit #3 (analog balanced signal inputs).
RDIN3	190	I	–	
TDOP3	187	O	–	Transmit data outputs to circuit #3 (analog balanced signal outputs).
TDON3	186	O	–	
RDIP4	201	I	–	Receive data inputs from circuit #4 (analog balanced signal inputs).
RDIN4	200	I	–	
TDOP4	197	O	–	Transmit data outputs to circuit #4 (analog balanced signal outputs).
TDON4	196	O	–	
RDIP5	3	I	–	Receive data inputs from circuit #5 (analog balanced signal inputs).
RDIN5	2	I	–	
TDOP5	207	O	–	Transmit data outputs to circuit #5 (analog balanced signal outputs).
TDON5	206	O	–	

## 1.3 UTOPIA Interface

Pin Name	Pin No.	I/O	Active Level	Function
RxDATA0- RxDATA7	69, 68, 66, 65, 63, 62, 60, 59	O Tristate	–	8-bit data bus used for receive data output to the ATM layer device. Data is output in sync with the positive-going edge of RxCLK.
RxCLK	71	I	–	Input pin of the clock for receive data transfer to the ATM layer device.
RxSOC	81	O Tristate	H	Receive cell start address signal output, which outputs the signal for informing the ATM layer device of the start byte position of the receive cell. The start byte position is that position where RxSOC = 1.
RxENB_B	84	I	L	RxDATA0-RxDATA7 and RxSOC output enable signal input. When 0 is input, outputs RxDATA0-RxDATA7 and RxSOC are enabled.
RxADDR0- RxADDR4	80, 77, 76, 74, 73	I	–	Input pins for the signal indicating the address of the μPD98408.
RxCLAV	83	O Tristate	H	Cell receive available signal output. Becomes 1 when the μPD98408 has an output cell.
TxDATA0- TxDATA7	97, 96, 94, 93, 91, 90, 88, 87	I	–	8-bit data bus used for transmit data input to the ATM layer device. Data is input in sync with the positive-going edge of TxCLK.
TxCLK	99	I	–	Input pin of the clock for the transmit data transfer to the ATM layer device
TxSOC	109	I	H	Transmit cell start address signal input, which inputs the signal indicating the start byte position of the transmit cell input from the ATM layer device. The start byte position is that position where TxSOC = 1.
TxENB_B	112	I	L	Transmit enable signal input, which inputs a signal indicating that the ATM layer device is outputting valid transmit data at TxDATA0-TxDATA7. 0 for enable and 1 for disable.
TxADDR0- TxADDR4	108, 107, 103, 102, 101	I	–	Input pins of the signal indicating the address of the μPD98408 which transmits data
TxCLAV	111	O Tristate	H	Cell transmit available signal output. Goes to 1 when the μPD98408 is ready to receive a cell.

## 1.4 CPU Interface

Pin Name	Pin No.	I/O	Active Level	Function
BUSMODE	141	I	–	Selects the CPU interface operation mode. 0: <DS_B, RW_B, DTACK_B> style (Motorola compatible) 1: <RD_B, WR_B, RDY_B> style (Intel compatible)
DATA0-DATA7	125, 124, 122, 121, 119, 118, 116, 115	I/O	–	Used to transfer data between the CPU and an internal register (8-bit). The MSB is DATA7.
ADDR0-ADDR5	134, 133, 132, 129, 128, 127	I	–	Used to set the address of an internal register (6-bit).
SEL_B	138	I	L	Register access enable signal. 0 for enable.
DS_B/RD_B	140	I	L/L	<ul style="list-style-type: none"> <li>When BUSMODE = 0, becomes the data strobe signal (DS_B) of the Motorola-compatible interface. In read cycle: DS_B = 0 for read data enable. In write cycle: DS_B = 0 for write data strobe.</li> <li>When BUSMODE = 1, becomes the read instruction signal of the Intel-compatible interface. RD_B = 0 for read instruction.</li> </ul>
RW_B/WR_B	139	I	L/L	<ul style="list-style-type: none"> <li>When BUSMODE = 0, becomes the read/write control signal (RW_B) of the Motorola-compatible interface. 0: Write cycle 1: Read cycle</li> <li>When BUSMODE = 1, becomes the write instruction signal of the Intel-compatible interface. WR_B = 0 for write instruction.</li> </ul>
DTACK_B/ RDY_B	137	O	L/L	<ul style="list-style-type: none"> <li>When BUSMODE = 0, becomes the data acknowledge signal (DTACK_B) of the Motorola-compatible interface. This signal indicates the completion of data transmission over the data bus. DTACK_B is set to 0 upon the completion of data transmission.</li> <li>When BUSMODE = 1, becomes the ready signal (RDY_B) of the Intel-compatible interface. This signal indicates the completion of data transmission over the data bus. RDY_B is set to 0 upon the completion of data transmission.</li> </ul>
INT_B	136	O	L	Notifies the CPU of the occurrence of an interrupt factor.

1.5 Other Pins

(1/3)

Pin Name	Pin No.	I/O	Active Level	Function
JDI/TCLK0	28	I	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (JDI): JTAG test data input pin.</li> <li>When PMDONLY = 1 (TCLK0): Input pin for transmit clock for the PMD transmitter (Circuit 0).</li> </ul>
JDO/RDATA0	36	O	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (JDO): JTAG test data output pin.</li> <li>When PMDONLY = 1 (RDATA0): Output pin for data received from the PMD receiver (Circuit 0).</li> </ul>
JCK/TCLK1	29	I	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (JCK): JTAG test clock input pin.</li> <li>When PMDONLY = 1 (TCLK1): Input pin for transmit clock for the PMD transmitter (Circuit 1).</li> </ul>
JMS/TCLK2	30	I	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (JMS): JTAG test mode input pin.</li> <li>When PMDONLY = 1 (TCLK2): Input pin for transmit clock for the PMD transmitter (Circuit 2).</li> </ul>
JRST_B/TCLK3	32	I	L/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (JRST_B): JTAG test reset signal input pin.</li> <li>When PMDONLY = 1 (TCLK3): Input pin for transmit clock for the PMD transmitter (Circuit 3).</li> </ul>
IC/TCLK4	33	I (with pull-down resistor)	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (TCLK4): Input pin for transmit clock for the PMD transmitter (Circuit 4).</li> </ul>
IC/TCLK5	34	I (with pull-down resistor)	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (TCLK5): Input pin for transmit clock for the PMD transmitter (Circuit 5).</li> </ul>

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Pin Name	Pin No.	I/O	Active Level	Function
RECCLK/ RDATA1	37	O	—/—	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (RECCLK): Output pin for the recovery clock on the receive data. The recovery clock of circuit 0 is output.</li> <li>When PMDONLY = 1 (RDATA1): Output pin for data received from the PMD receiver (Circuit 1).</li> </ul>
IC/RDATA3	40	O	—/—	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (RDATA3): Output pin for data received from the PMD receiver (Circuit 3).</li> </ul>
IC/RDATA2	38	O	—/—	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (RDATA2): Output pin for data received from the PMD receiver (Circuit 2).</li> </ul>
IC/ RCLK0- RCLK5	19, 20, 21, 23, 24, 25	O/I (with pull- down resistor)	—/—	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to these pins.</li> <li>When PMDONLY = 1 (RCLK0-RCLK5): Output pins for the clock received from the PMD receiver (Circuits 0 to 5).</li> </ul>
IC/TDATA0	44	I (with pull- down resistor)	—/—	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (TDATA0): Input pin for transmit data for the PMD transmitter (Circuit 0).</li> </ul>
IC/RDATA4	41	O	—/—	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (RDATA4): Output pin for the data received from the PMD receiver (Circuit 4).</li> </ul>

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Pin Name	Pin No.	I/O	Active Level	Function
IC/RDATA5	42	O	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (RDATA5): Output pin for the data received from the PMD receiver (Circuit 5).</li> </ul>
IC/TDATA1	45	I (with pull-down resistor)	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (TDATA1): Input pin for transmit data for the PMD transmitter (Circuit 1).</li> </ul>
IC/TDATA2	46	I (with pull-down resistor)	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (TDATA2): Input pin for transmit data for the PMD transmitter (Circuit 2).</li> </ul>
IC/TDATA3	48	I (with pull-down resistor)	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (TDATA3): Input pin for transmit data for the PMD transmitter (Circuit 3).</li> </ul>
IC/TDATA4	49	I (with pull-down resistor)	–/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (IC): No signal should be connected to this pin.</li> <li>When PMDONLY = 1 (TDATA4): Input pin for transmit data for the PMD transmitter (Circuit 4).</li> </ul>
SIN/TDATA5	50	I (with pull-down resistor)	H/–	Two pin functions can be selected according to the level of the PMDONLY pin. <ul style="list-style-type: none"> <li>When PMDONLY = 0 (SIN): X_8 command transmit timing signal input pin.</li> <li>When PMDONLY = 1 (TDATA5): Input pin for transmit data for the PMD transmitter (Circuit 5).</li> </ul>
SOUT	54	O	H	X_8 command receive timing signal output pin.
PMDONLY	18	I (with pull-down resistor)	–	Specifies the mode of the μPD98408: whether it is operated as PMD + TC or as PMD only. <ul style="list-style-type: none"> <li>0: Operation as PMD + TC.</li> <li>1: Operation as PMD only.</li> </ul>
TCLOCK	57	I	–	Transmit clock (32 MHz) input pin
RESET_B	55	I	L	Input pin for the reset signal for the entire μPD98408.
IC	5, 6, 14, 15, 85, 144, 145	–	–	No signal should be connected to these pins.
CG	113	I	–	Should be connected to GND for normal use.

## 1.6 Handling Unused Pins

Pin Name	I/O	Recommended Connection When Not in Use
RDIP0-RDIP5	I	Pull up with a resistor (1 kΩ).
RDIN0-RDIN5	I	Pull up with a resistor (1 kΩ).
TDOP0-TDOP5	O	Open.
TDON0-TDON5	O	Open.
JDI/TCLK0	I	Pull up with a resistor.
JDO/RDATA0	O	Open.
JCK/TCLK1	I	Pull up with a resistor.
JMS/TCLK2	I	Pull up with a resistor.
JRST_B/TCLK3	I	Pull up with a resistor.
IC/TCLK4	I (with pull-down resistor)	Open.
IC/TCLK5	I (with pull-down resistor)	Open.
RECCLK/RDATA1	O	Open.
IC/RDATA3	O	Open.
IC/RDATA2	O	Open.
IC/RCLK0-IC/RCLK5	I/O (with pull-down resistor)	Open.
IC/TDATA0	I (with pull-down resistor)	Open.
IC/RDATA4	O	Open.
IC/RDATA5	O	Open.
IC/TDATA1	I (with pull-down resistor)	Open.
IC/TDATA2	I (with pull-down resistor)	Open.
IC/TDATA3	I (with pull-down resistor)	Open.
IC/TDATA4	I (with pull-down resistor)	Open.
SIN/TDATA5	I (with pull-down resistor)	Open.
SOUT	O	Open.
PMDONLY	I (with pull-down resistor)	Open.

## 1.7 Pin States at Reset

Pin Name	I/O	Pin States at Reset
TDOP0-TDOP5	O	Not defined
TDON0-TDON5	O	Not defined
RxDATA0-RxDATA7	Tristate O	Hi-Z
RxSOC	Tristate O	Hi-Z
RxCLAV	Tristate O	Hi-Z
TxCLAV	Tristate O	Hi-Z
DATA0-DATA7	I/O	Hi-Z
DTACK_B/RDY_B	O	High level
INT_B	O	High level
JDO/RDATA0	O	Not defined
RECCLK/RDATA1	O	Not defined
SOUT	O	Low level



2. ELECTRIC CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Rating	Unit
Power supply voltage	$V_{DD}$		-0.5 to +4.6	V
Input voltage	$V_I$		-0.5 to +6.6	V
Output voltage	$V_O$		-0.5 to +6.6	V
Output current	$I_{O1}$	<b>Note 1</b>	10	mA
	$I_{O2}$	<b>Note 2</b>	30	mA
Storage temperature	$T_{stg}$		-65 to +150	°C

**Caution** Absolute maximum ratings are rated values beyond which physical damage will be caused to the product; if the rated value of any of the parameters in the above table is exceeded, even momentarily, the quality of the product may deteriorate. Always use the product within its rated values.

- Notes**
1. Applies to pins JDO/RDATA0, RECCLK/RDATA1, IC/RDATA2, IC/RDATA3, IC/RDATA4, IC/RDATA5, SOUT, and IC/RCLK0-IC/RCLK5.
  2. Applies to pins RxDATA0-RxDATA7, RxSOC, RxCLAV, TxCLAV, INT\_B, DTACK\_B/RDY\_B, and DATA0-DATA7.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Power supply voltage	$V_{DD}$		3.135	3.3	3.465	V
High-level input voltage	$V_{IH}$		2.0	–	5.5	V
Low-level input voltage	$V_{IL}$		0	–	0.8	V
Operating ambient temperature	$T_A$		-40	–	+85	°C



DC CHARACTERISTICS (T<sub>A</sub> = -40 to +85 °C, V<sub>DD</sub> = 3.3 V ± 5 %)

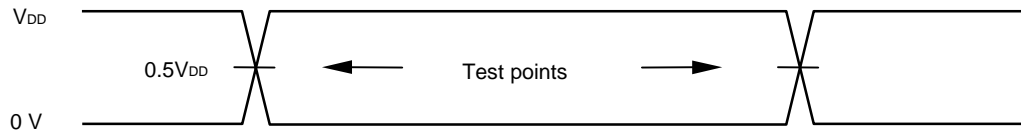
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input leakage current	I <sub>L</sub>	V <sub>I</sub> = V <sub>DD</sub> or GND	–	–	2	μA
★ High-level output current	I <sub>OH1</sub>	V <sub>OH</sub> = 2.4 V <b>Note 1</b>	-3.0	–	–	mA
	I <sub>OH2</sub>	V <sub>OH</sub> = 2.4 V <b>Note 2</b>	-8.0	–	–	mA
Low-level output current	I <sub>OL1</sub>	V <sub>OL</sub> = 0.4 V <b>Note 1</b>	3.0	–	–	mA
	I <sub>OL2</sub>	V <sub>OL</sub> = 0.4 V <b>Note 2</b>	9.0	–	–	mA
★ High-level output voltage	V <sub>OH1</sub>	I <sub>OH</sub> = 0 mA <b>Note 3</b>	V <sub>DD</sub> - 0.4	–	–	V
	V <sub>OH2</sub>	I <sub>OH</sub> = 0 mA When <b>Note 3</b> is not applied	V <sub>DD</sub> - 0.2	–	–	V
Low-level output voltage	V <sub>OL</sub>	I <sub>OL</sub> = 0 mA	–	–	0.1	V
Supply current	I <sub>DD</sub>	In operation	–	180	280	mA

- Notes**
1. Applies to pins JDO/RDATA0, RECCLK/RDATA1, IC/RDATA2, IC/RDATA3, IC/RDATA4, IC/RDATA5, SOUT, and IC/RCLK0-IC/RCLK5.
  2. Applies to pins RxDATA0-RxDATA7, RxSOC, RxCLAV, TxCLAV, INT\_B, DTACK\_B/RDY\_B, and DATA0-DATA7.
  3. Applies to pins IC/RCLK0-IC/RCLK5 only when 1 is input to the PMDONLY pin (only PMD operates).

**CAPACITANCE**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input capacitance	C <sub>i</sub>	Frequency = 1 MHz	–	10	20	pF
Output capacitance	C <sub>o</sub>	Frequency = 1 MHz	–	10	20	pF
I/O capacitance	C <sub>io</sub>	Frequency = 1 MHz	–	10	20	pF

**AC Test I/O Waveform**

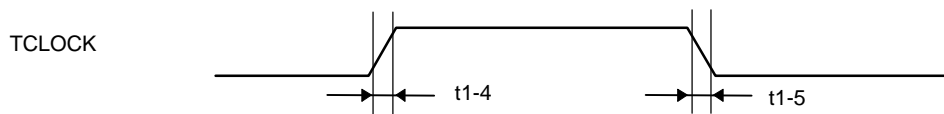
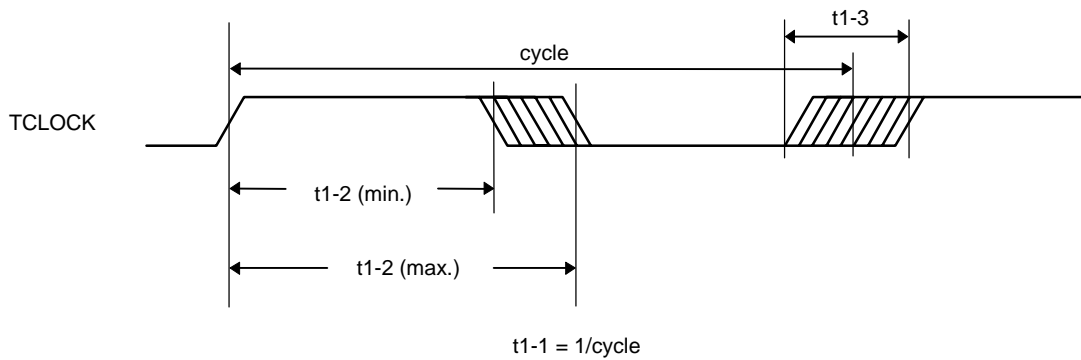


**AC CHARACTERISTICS (T<sub>A</sub> = -40 to +85 °C, V<sub>DD</sub> = 3.3 V ± 5 %)**

**TCLOCK**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
TCLOCK frequency	t1-1		–	32	–	MHz
TCLOCK duty	t1-2		40	–	60	%
TCLOCK frequency accuracy	t1-3		–	–	100	ppm
★ TCLOCK rise time	t1-4	Measurement of 10 to 90 % transition time	–	–	5	ns
★ TCLOCK fall time	t1-5	Measurement of 10 to 90 % transition time	–	–	5	ns

**TCLOCK Input**

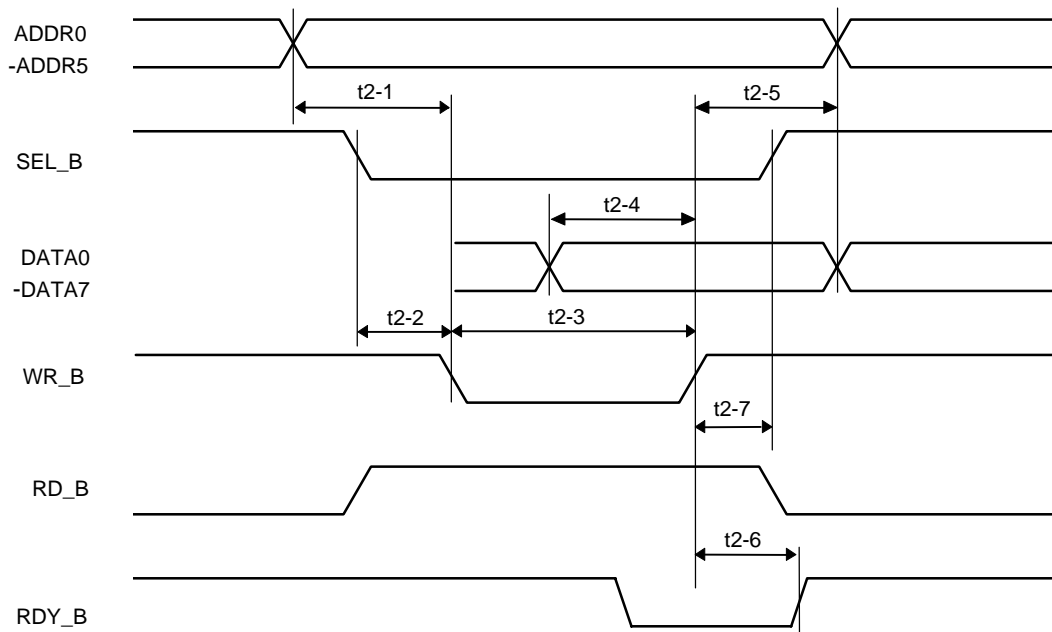


CPU INTERFACE

(1) Write operation (when BUSMODE = 1)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
ADDR setup time (referred to WR_B↓)	t2-1		10	–	–	ns
SEL_B setup time (referred to WR_B↓)	t2-2		5	–	–	ns
WR_B pulse width	t2-3		50	–	–	ns
DATA setup time (referred to WR_B↑)	t2-4		16	–	–	ns
ADDR/DATA hold time (referred to WR_B↑)	t2-5		4	–	–	ns
RDY_B disable time (referred to WR_B↑)	t2-6		–	–	10	ns
SEL_B hold time (referred to WR_B↑)	t2-7		0	–	–	ns

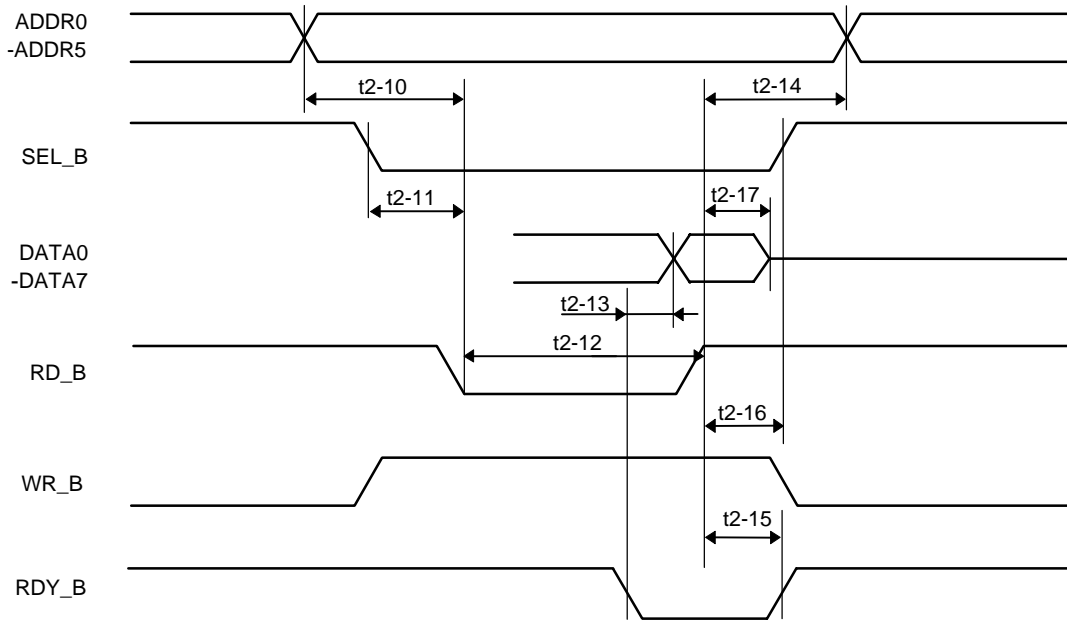
CPU Interface Write Operation (BUSMODE = 1)



(2) Read operation (when BUSMODE = 1)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
ADDR setup time (referred to RD_B↓)	t2-10		10	–	–	ns
SEL_B setup time (referred to RD_B↓)	t2-11		5	–	–	ns
RD_B pulse width	t2-12		50	–	–	ns
DATA fixed time (referred to RDY_B↓)	t2-13		–	–	10	ns
ADDR hold time (referred to RD_B↑)	t2-14		4	–	–	ns
RDY_B disable time (referred to RD_B↑)	t2-15		–	–	10	ns
SEL_B hold time (referred to RD_B↑)	t2-16		0	–	–	ns
DATA invalid/tristate time (referred to RD_B↑)	t2-17		0	–	–	ns

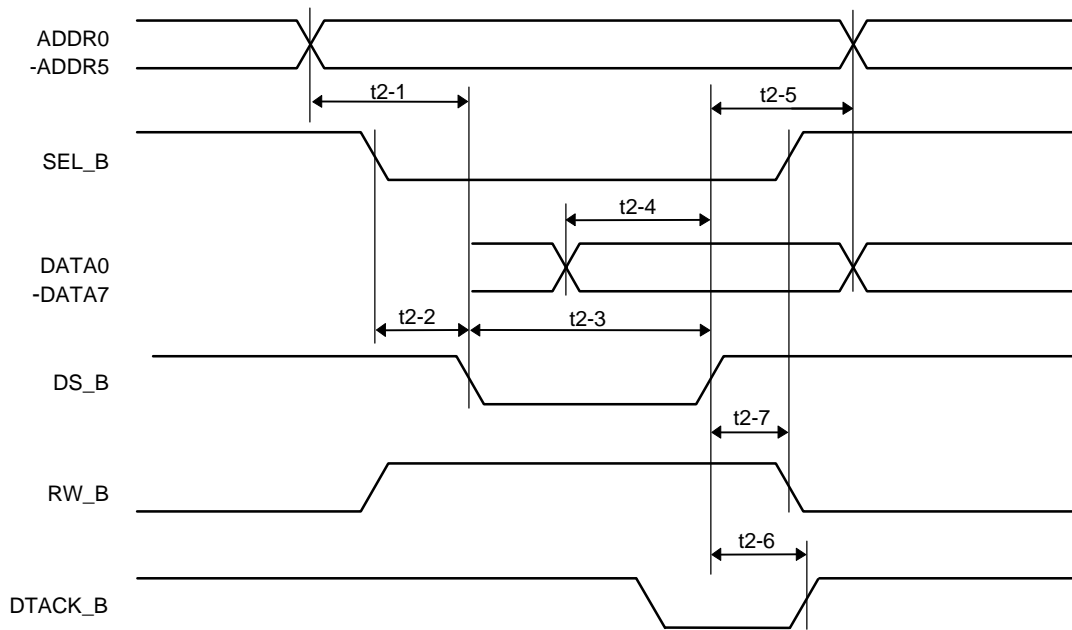
CPU Interface Read Operation (BUSMODE = 1)



**(3) Write operation (when BUSMODE = 0)**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
ADDR setup time (referred to DS_B↓)	t2-1		10	–	–	ns
SEL_B or RW_B setup time (referred to DS_B↓)	t2-2		5	–	–	ns
DS_B pulse width	t2-3		50	–	–	ns
DATA setup time (referred to DS_B↑)	t2-4		15	–	–	ns
ADDR/DATA hold time (referred to DS_B↑)	t2-5		4	–	–	ns
DTACK_B disable time (referred to DS_B↑)	t2-6		–	–	10	ns
SEL_B or RW_B hold time (referred to DS_B↑)	t2-7		0	–	–	ns

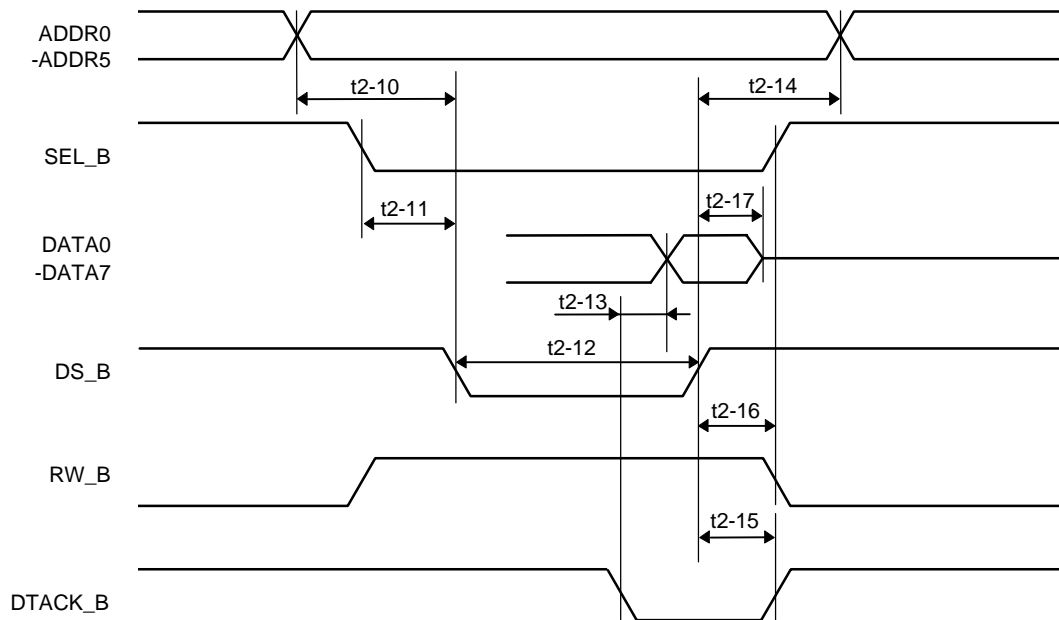
**CPU Interface Write Operation (BUSMODE = 0)**



**(4) Read operation (when BUSMODE = 0)**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
ADDR setup time (referred to DS_B↓)	t2-10		10	–	–	ns
SEL_B or RW_B setup time (referred to DS_B↓)	t2-11		5	–	–	ns
DS_B pulse width	t2-12		50	–	–	ns
DATA fixed time (referred to DTACK_B↓)	t2-13		–	–	10	ns
ADDR hold time (referred to DS_B↑)	t2-14		4	–	–	ns
DTACK_B disable time (referred to DS_B↑)	t2-15		–	–	10	ns
SEL_B or RW_B hold time (referred to DS_B↑)	t2-16		0	–	–	ns
DATA invalid/tristate time (referred to DS_B↑)	t2-17		0	–	–	ns

**CPU Interface Read Operation (BUSMODE = 0)**



## UTOPIA INTERFACE

## (1) Transmission

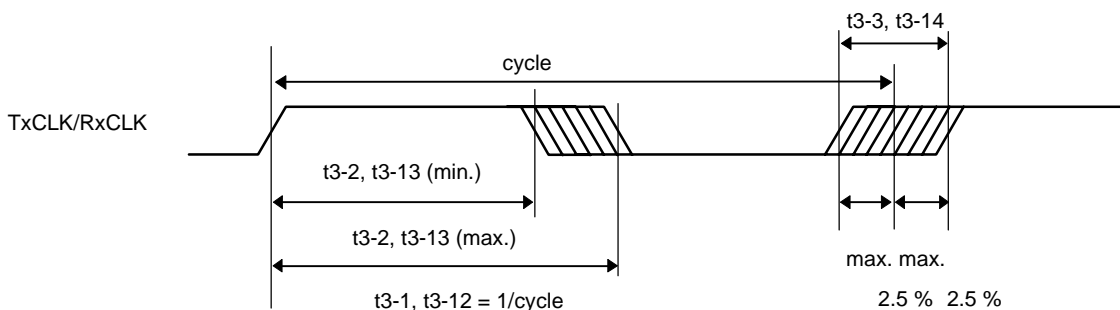
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
TxCLK frequency	t3-1		0	–	40	MHz
TxCLK duty cycle	t3-2		40	–	60	%
TxCLK jitter (peak to peak)	t3-3		–	–	5	%
TxCLK rise time	t3-4	Measurement of 10 to 90 % transition time	–	–	3	ns
TxCLK fall time	t3-5	Measurement of 10 to 90 % transition time	–	–	3	ns
TxDATA[7:0], TxSOC, TxENB_B, or TxADDR[4:0] setup time	t3-6		8	–	–	ns
TxDATA[7:0], TxSOC, TxENB_B, or TxADDR[4:0] hold time	t3-7		1	–	–	ns
TxCLAV low-impedance delay time (referred to TxCLK↑)	t3-8		8	–	–	ns
TxCLAV high-impedance delay time (referred to TxCLK↑)	t3-9		0	–	–	ns
TxCLAV low-impedance delay time (referred to TxCLK↑)	t3-10		1	–	–	ns
TxCLAV high-impedance delay time (referred to TxCLK↑)	t3-11		1	–	–	ns



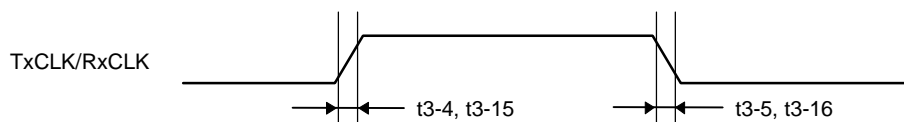
(2) Reception

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
RxCLK frequency	t3-12		0	–	40	MHz
RxCLK duty cycle	t3-13		40	–	60	%
RxCLK jitter (peak to peak)	t3-14		–	–	5	%
RxCLK rise time	t3-15	Measurement of 10 to 90 % transition time	–	–	3	ns
RxCLK fall time	t3-16	Measurement of 10 to 90 % transition time	–	–	3	ns
RxENB_B or RxADDR[4:0] setup time	t3-17		8	–	–	ns
RxENB_B or RxADDR[4:0] hold time	t3-18		1	–	–	ns
RxDATA[7:0], RxSOC, or RxCLAV low-impedance delay time (referred to RxCLK↑)	t3-19		8	–	–	ns
RxDATA[7:0], RxSOC, or RxCLAV high-impedance delay time (referred to RxCLK↑)	t3-20		0	–	–	ns
RxDATA[7:0], RxSOC, or RxCLAV low-impedance delay time (referred to RxCLK↑)	t3-21		1	–	–	ns
RxDATA[7:0], RxSOC, or RxCLAV high-impedance delay time (referred to RxCLK↑)	t3-22		1	–	–	ns

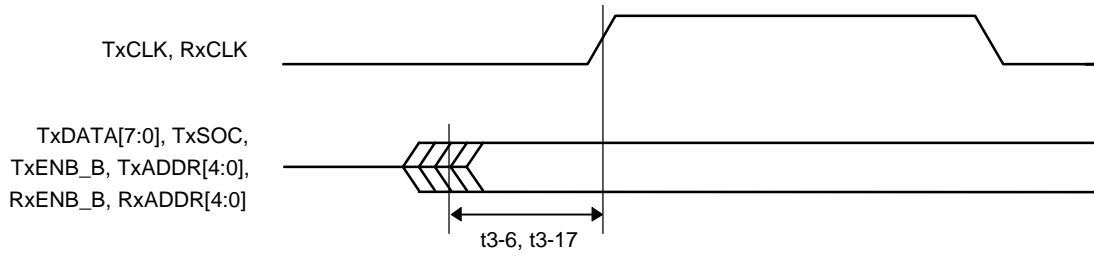
TxCLK or RxCLK Timing - 1



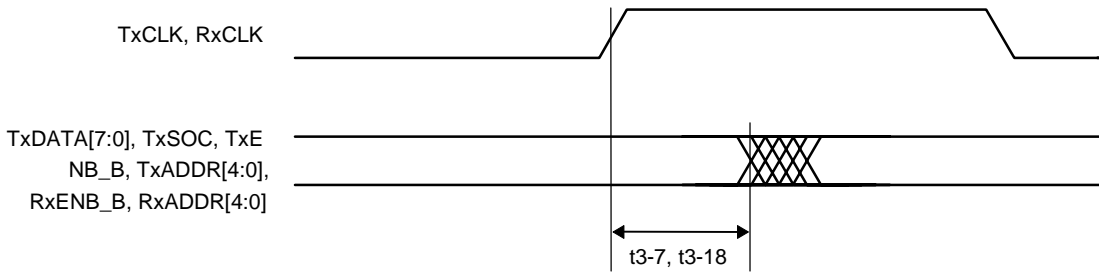
TxCLK or RxCLK Timing - 2



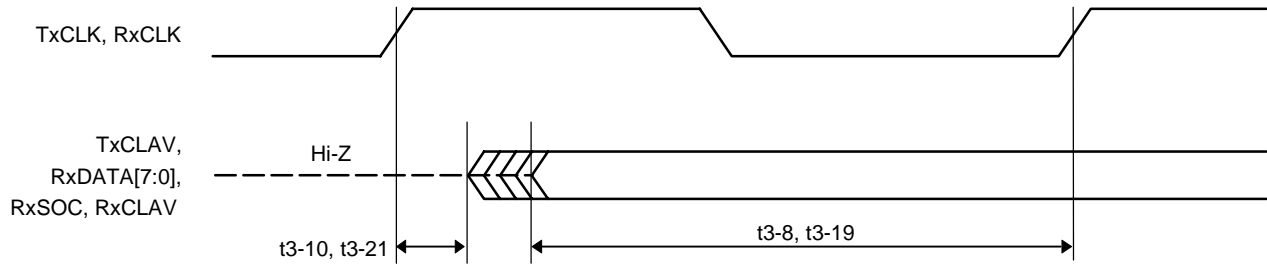
**Input Signal Setup Timing**



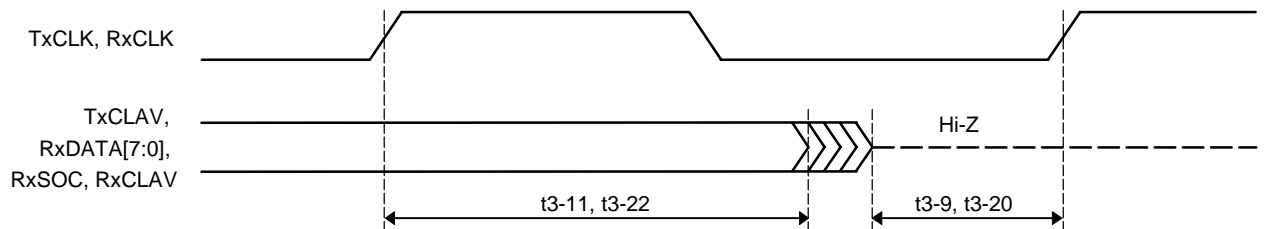
**Input Signal Hold Timing**



**Output Delay Time - 1**



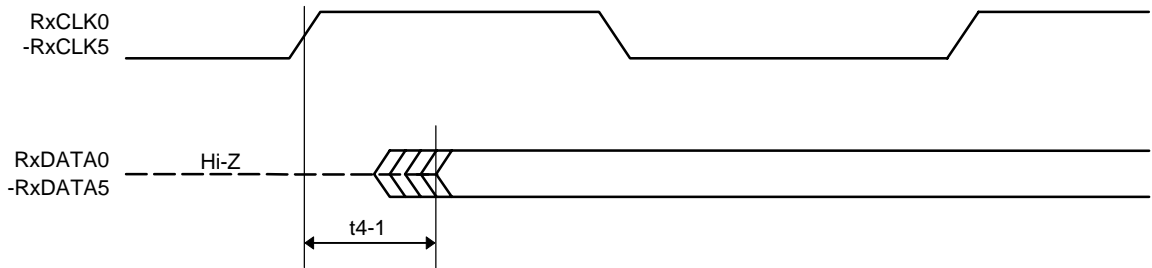
**Output Delay Time - 2**



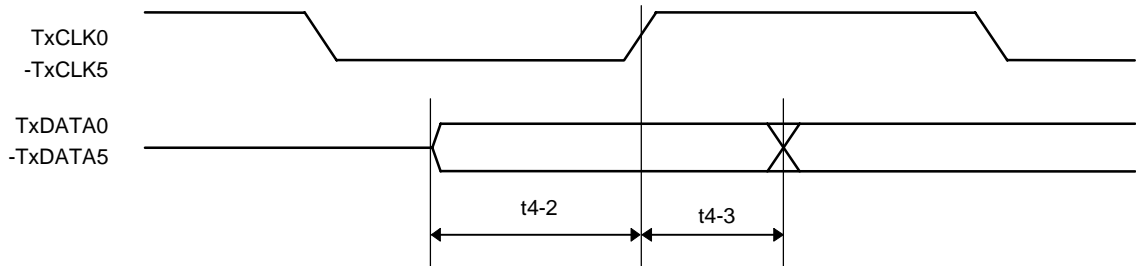
**PMDONLY MODE**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
RxDATA delay time (referred to RxCLK↑)	t4-1		0.5	–	15.0	ns
TxDATA setup time (referred to TxCLK↑)	t4-2		8.0	–	–	ns
TxDATA hold time (referred to TxCLK↑)	t4-3		0.5	–	–	ns

**Reception Data Output Delay Time**



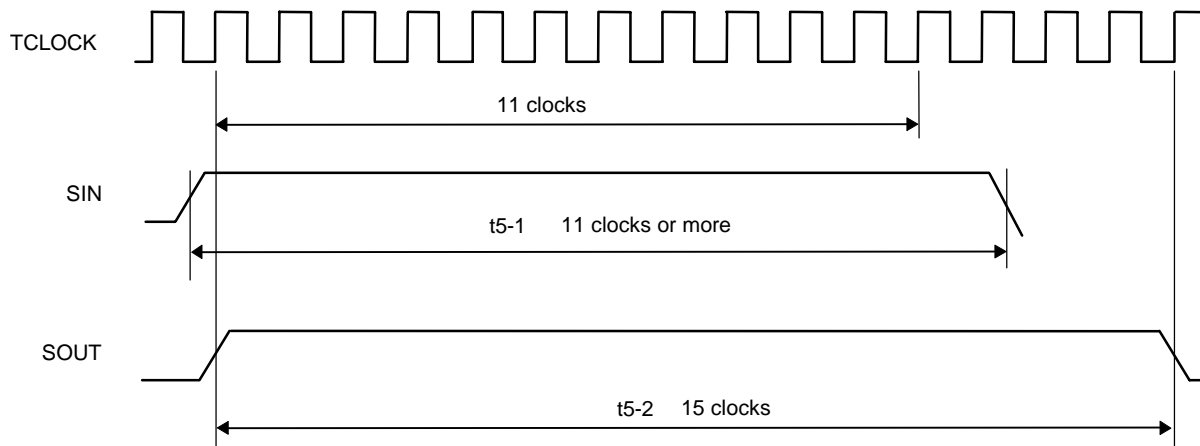
**Transmission Data Setup/Hold Time**



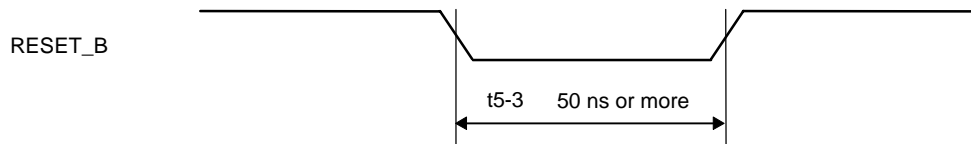
OTHERS

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
SIN pulse width	t5-1		11	–	–	TCLOCK clock
SOUT pulse width	t5-2		–	15	–	TCLOCK clock
RESET_B pulse width	t5-3		50	–	–	ns

SIN and SOUT Timings

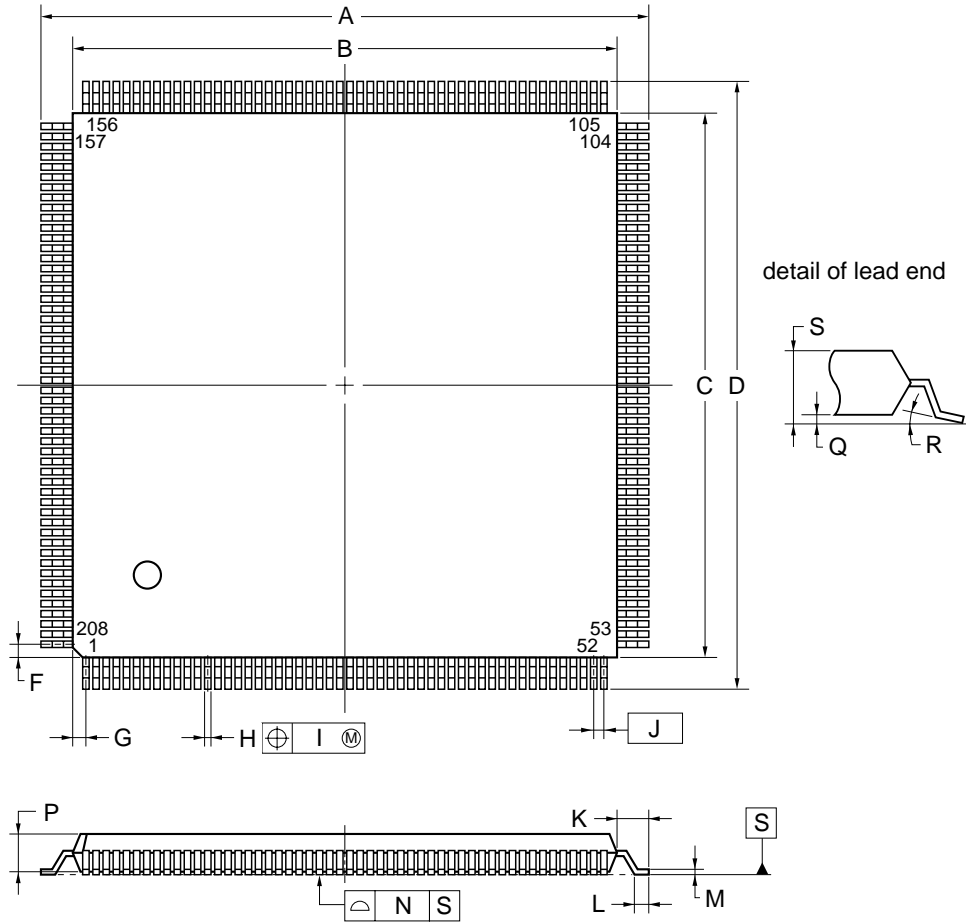


RESET\_B Timing



3. PACKAGE DRAWING

208 PIN PLASTIC QFP (FINE PITCH) (28x28)



NOTE

- 1. Each lead centerline is located within 0.12 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	30.6±0.2
B	28.0±0.2
C	28.0±0.2
D	30.6±0.2
F	1.25
G	1.25
H	0.22 <sup>+0.05</sup> <sub>-0.04</sub>
I	0.10
J	0.5 (T.P.)
K	1.3±0.2
L	0.5±0.2
M	0.17 <sup>+0.03</sup> <sub>-0.07</sub>
N	0.10
P	3.2±0.1
Q	0.4±0.1
R	5°±5°
S	3.8 MAX.

P208GD-50-LML, MML, SML-5

**4. RECOMMENDED SOLDERING CONDITIONS**

The conditions listed below shall be met when soldering the μPD98408.

For details of the recommended soldering conditions, refer to our document **Semiconductor Device Mounting Technology Manual (C10535E)**.

Please consult with our sales offices in case any other soldering process is used, or in case soldering is done under different conditions.

**Surface-Mount Type**

- μPD98408GD-LML: 208-pin plastic QFP (fine pitch) (28 × 28 mm)

Soldering Process	Soldering Conditions	Symbol
Infrared ray reflow	Peak package's surface temperature: 235 °C Reflow time: 30 seconds or less (210 °C or more) Maximum allowable number of reflow processes: 2 Exposure limit: 7 days <sup>Note</sup> (36 hours of pre-baking is required at 125 °C afterward) <Caution> Non-heat-resistant trays, such as magazine and taping trays, cannot be baked before unpacking.	IR35-367-2
VPS	Peak package's surface temperature: 215 °C Reflow time: 40 seconds or less (200 °C or more) Maximum allowable number of reflow processes: 2 Exposure limit: 7 days <sup>Note</sup> (36 hours of pre-baking is required at 125 °C afterward) <Caution> Non-heat-resistant trays, such as magazine and taping trays, cannot be baked before unpacking.	VP15-367-2
Partial heating method	Terminal temperature: 300 °C or less Heat time: 3 seconds or less (for one side of a device)	—

**Note** Maximum number of days during which the product can be stored at a temperature of 25 °C and a relative humidity of 65 % or less after dry-pack package is opened.

**Caution** Do not apply two or more different soldering methods to one chip (except for partial heating method for terminal sections).

## NOTES FOR CMOS DEVICES

### ① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

**Note:** Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

### ② HANDLING OF UNUSED INPUT PINS FOR CMOS

**Note:** No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to  $V_{DD}$  or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

### ③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

**Note:** Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

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While NEC Corporation has been making continuous effort to enhance the reliability of its semiconductor devices, the possibility of defects cannot be eliminated entirely. To minimize risks of damage or injury to persons or property arising from a defect in an NEC semiconductor device, customers must incorporate sufficient safety measures in its design, such as redundancy, fire-containment, and anti-failure features.

NEC devices are classified into the following three quality grades:

"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

**Standard:** Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

**Special:** Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

**Specific:** Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.

Anti-radioactive design is not implemented in this product.