

IT8888F

**PCI-to-ISA Bridge Chip
(Code Name: Golden Gate)**

Preliminary Specification V0.9

ITE TECH. INC.

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Revision History

Section	Revision	Page
1	• Added a new feature, "SM Bus".	1
3	• Chapter 4, Pin Configuration, was revised.	7
4	• Table 5-3, Miscellaneous Signals, was revised.	11
	• Table 5-5, Power-On-Strap Settings, was revised.	12
	• Added chapter 6-11, SMB Boot ROM Configuration.	16
10	• Added the following content in the ordering information: "ITE also provides lead-free component. Please mark "-L " at the end of the Part No. when the parts ordered are lead-free."	69

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1. Features

- **PCI Interface**
 - PCI Specification V. 2.1 compliant
 - Supports 32-bit PCI bus & up to 33 MHz PCI bus frequency
 - Supports PERR# & SERR# Error Reporting
 - Supports Delayed Transaction
 - Optional CLKRUN# interface support
- **Programmable PCI Address Decoders**
 - Supports either programmable positive decode or full subtractive decode of PCI cycles
 - Provides 6 positively decoded I/O blocks & 4 positively decoded memory blocks.
 - Optional support ROMCS# fast positive decoder
- **PC/PCI DMA Controller**
 - Comply with Intel Mobile PC/PCI DMA R2.2
 - Supports PPDREQ# and PPDGNT#
 - Provides software transparent capability
- **Distributed DMA Controller**
 - Comply with Distributed DMA R6.0
 - Supports 7 DDMA channels
 - Optional DDMA-Concurrent PCI bus
- **ISA Interface**
 - Supports full ISA compatible functions
 - Supports ISA at ¼ of PCI frequency
 - ISA Bus Master supported
 - Supports 4 ISA slots
- **SM Bus**
 - Comply with System Management Bus Specification R. 1.0
 - Supports single master mode
 - Interface to Serial E²PROM
- **Serial IRQ**
 - Comply with Serialized IRQ Support for PCI system R6.0
 - Supports both continuous and quite modes
 - Auto detect Start Frame width and slot number
 - Encodes all ISA IRQs and IOCHCK#
- **Optional FLASH ROM Interface**
 - Supports up to 1 Mbytes ROM size
 - Positively fast decodes F-segments by power-on strapping
- **Versatile power-on strapping options**
- **Supports NOGO function**

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2. General Description

The IT8888F is a PCI to ISA bridge single function device. The IT8888F serves as a bridge between the PCI bus and ISA bus. The IT8888F's 32-bit PCI bus interface is compliant with PCI Specification V2.1 and supports both PCI Bus Master & Slave. The PCI interface supports both programmable positive and full subtractive decoding schemes.

The IT8888F also integrates two enhanced DMA Slave controllers for achieving PCI DMA cycles: PC/PCI DMA Slave Controller & Distributed DMA Slave Controllers.

The IT8888F also implements the optional fast positive decode of F, E, D, C memory segments. This special feature can provide a direct connection to an FALSH boot ROM.

The NOGO function which is also implemented in the IT8888F for enabling or disabling subtractive decode of PCI interface could be a software controlled output pin from other host controlled devices. The Serial IRQ is also implemented in the device for sending and receiving ISA IRQs & IOCHCK#. The device includes an ISA interface which supports full ISA compatible functions.

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3. Block Diagram

The IT8888F is available in 160-pin QFP package.

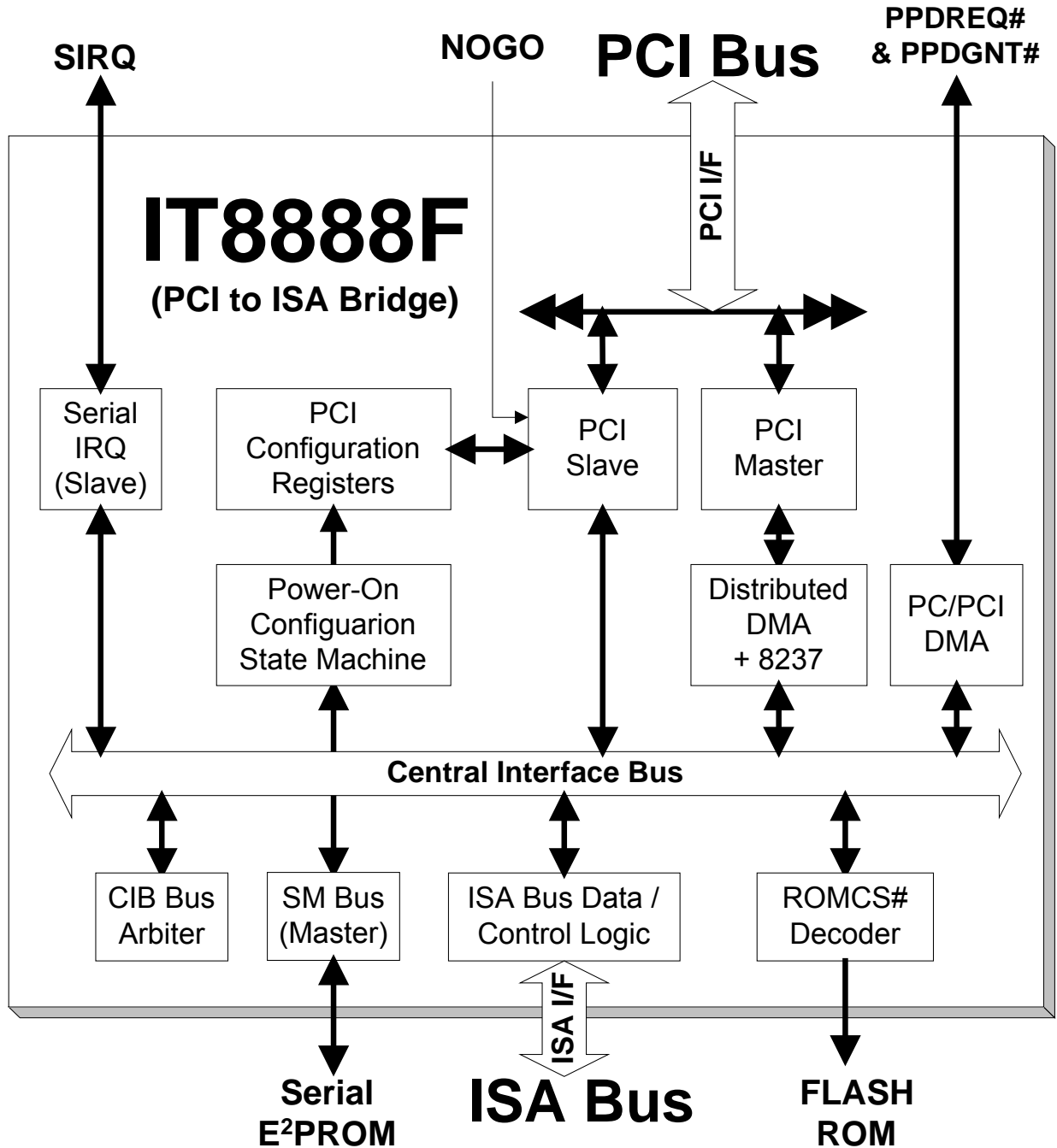


Figure 3-1. IC Block Diagram

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4. Pin Configuration

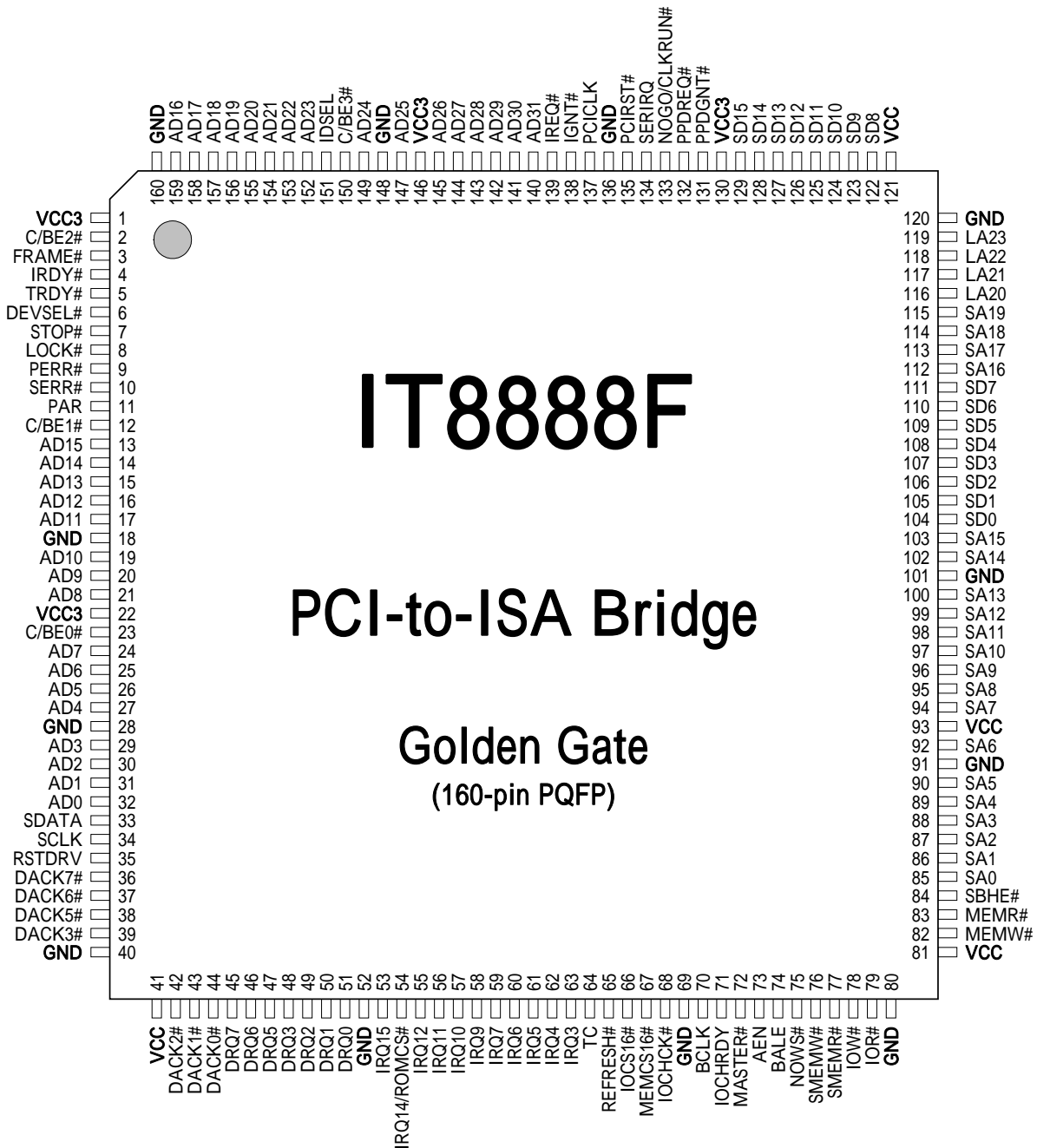


Table 4-1. Pins Listed in Numeric Order

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
1	VCC3	41	VCC	81	VCC	121	VCC
2	C/BE2#	42	DACK2#	82	MEMW#	122	SD8
3	FRAME#	43	DACK1#	83	MEMR#	123	SD9
4	IRDY#	44	DACK0#	84	SBHE#	124	SD10
5	TRDY#	45	DRQ7	85	SA0	125	SD11
6	DEVSEL#	46	DRQ6	86	SA1	126	SD12
7	STOP#	47	DRQ5	87	SA2	127	SD13
8	LOCK#	48	DRQ3	88	SA3	128	SD14
9	PERR#	49	DRQ2	89	SA4	129	SD15
10	SERR#	50	DRQ1	90	SA5	130	VCC3
11	PAR	51	DRQ0	91	GND	131	PPDGNT#
12	C/BE1#	52	GND	92	SA6	132	PPDREQ#
13	AD15	53	IRQ15	93	VCC	133	NOGO/CLKRUN#
14	AD14	54	IRQ14/ROMCS#	94	SA7	134	SERIRQ
15	AD13	55	IRQ12	95	SA8	135	PCIRST#
16	AD12	56	IRQ11	96	SA9	136	GND
17	AD11	57	IRQ10	97	SA10	137	PCICLK
18	GND	58	IRQ9	98	SA11	138	IGNT#
19	AD10	59	IRQ7	99	SA12	139	IREQ#
20	AD9	60	IRQ6	100	SA13	140	AD31
21	AD8	61	IRQ5	101	GND	141	AD30
22	VCC3	62	IRQ4	102	SA14	142	AD29
23	C/BE0#	63	IRQ3	103	SA15	143	AD28
24	AD7	64	TC	104	SD0	144	AD27
25	AD6	65	REFRESH#	105	SD1	145	AD26
26	AD5	66	IOCS16#	106	SD2	146	VCC3
27	AD4	67	MEMCS16#	107	SD3	147	AD25
28	GND	68	IOCHCK#	108	SD4	148	GND
29	AD3	69	GND	109	SD5	149	AD24
30	AD2	70	BCLK	110	SD6	150	C/BE3#
31	AD1	71	IOCHRDY	111	SD7	151	IDSEL
32	AD0	72	MASTER#	112	SA16	152	AD23
33	SDATA	73	AEN	113	SA17	153	AD22
34	SCLK	74	BALE	114	SA18	154	AD21
35	RSTDRV	75	NOWS#	115	SA19	155	AD20
36	DACK7#	76	SMEMW#	116	LA20	156	AD19
37	DACK6#	77	SMEMR#	117	LA21	157	AD18
38	DACK5#	78	IOW#	118	LA22	158	AD17
39	DACK3#	79	IOR#	119	LA23	159	AD16
40	GND	80	GND	120	GND	160	GND

5. IT8888F Pin Descriptions

Table 5-1. PCI Bus Interface Signals

Pin #	Signal	I/O	Description	Level												
140~145, 147, 149, 152~159, 13~17, 19~21, 24~27, 29~32	AD[31:0]	I/O	<p>PCI Multiplexed Address / Data 31 - 0. 32-bit bi-directional address/data multiplexed lines. AD31 is the MSB and AD0 is the LSB. The direction of these pins are defined below:</p> <table border="0"> <tr> <td><u>PHASE</u></td> <td><u>Bus Master</u></td> <td><u>Target</u></td> </tr> <tr> <td>Address Phase</td> <td>Output</td> <td>Input</td> </tr> <tr> <td>Read Data Phase</td> <td>Input</td> <td>Output</td> </tr> <tr> <td>Write Data Phase</td> <td>Output</td> <td>Input</td> </tr> </table>	<u>PHASE</u>	<u>Bus Master</u>	<u>Target</u>	Address Phase	Output	Input	Read Data Phase	Input	Output	Write Data Phase	Output	Input	3.3V
<u>PHASE</u>	<u>Bus Master</u>	<u>Target</u>														
Address Phase	Output	Input														
Read Data Phase	Input	Output														
Write Data Phase	Output	Input														
150, 2, 12, 23	C/BE[3:0]#	I/O	<p>Command/Byte Enable 3 - 0 #. Multiplexed bus command and byte enables.</p>	3.3V												
6	DEVSEL#	I/O	<p>Device Select #. When driven active low, the signal indicates the driving device has decoded its address as the target of the current access. This pin acts as an output pin when the IT8888F (including ISA slave) is the slave of PCI bus cycle transaction. Otherwise, it is an input pin.</p>	3.3V												
5	TRDY#	I/O	<p>Target Ready #. This signal indicates that the target of the current data phase of the transaction is ready to be completed. This pin acts as an output pin when the IT8888F (including ISA slave) is the slave of the PCI bus cycle transaction. Otherwise, it is an input pin.</p>	3.3V												
4	IRDY#	I/O	<p>Initiator Ready #. This signal indicates that the initiator is ready to complete the current data phase of the transaction. This pin acts as an output pin when the IT8888F is the bus master of the PCI bus. Otherwise, it is an input pin.</p>	3.3V												
3	FRAME#	I/O	<p>FRAME #. This signal is driven by the initiator to indicate the beginning and duration of a PCI access.</p>	3.3V												
151	IDSEL	I	<p>Initialization Device Select. This signal is used as a chip select during PCI Configuration read / write transactions.</p>	3.3V												
11	PAR	I/O	<p>Parity This signal is used for the even parity check on both AD[31:0] & C/BE[3:0]# lines. The PAR input/output direction follows the AD[31:0] input/output direction.</p>	3.3V												
9	PERR#	I/O	<p>Parity Error #. This signal is used for reporting data parity errors during all PCI transactions, except in a Special Cycle. PERR# is an output when it detects a parity error in receiving data as a PCI Target or in reading data as a PCI Master.</p>	3.3V												
10	SERR#	I/OD	<p>System Error #. This signal is used for reporting address parity errors, data parity errors on the Special Cycle command, or any other system error where the result will be catastrophic. (input for IC test only)</p>	3.3V												
8	LOCK#	I	<p>Lock #. This signal indicates a Lock Cycle for an atomic operation that may require multiple transactions to complete.</p>	3.3V												
7	STOP#	I/O	<p>Stop #. This signal indicates that the current target is requesting the initiator to stop the current transaction. This pin acts as an output pin when the IT8888F (including ISA slave) is the slave of the PCI bus cycle transaction. Otherwise, it is an input pin.</p>	3.3V												
139	IREQ#	I/O	<p>PCI Bus Request #. This signal is asserted to request the host bridge to allow the</p>	3.3V												

Pin #	Signal	I/O	Description	Level
			IT8888F to become the PCI bus master. (DDMA) (input for IC test only)	
138	IGNT#	I	PCI Bus Grant #. This signal is asserted from the host bridge allowing the IT8888F to become the PCI bus master. (DDMA)	3.3V
132	PPDREQ#	I/O	PC/PCI DMA (PPDMA) Request #. This signal is used to encode the ISA DMA request information to the host bridge for PPDMA function. (input for IC test only)	3.3V
131	PPDGNT#	I	PC/PCI DMA (PPDMA) Grant #. This signal is asserted from the host bridge to send DACKn# information to IT8888F for PPDMA function.	3.3V
137	PCICLK	I	33 MHz PCI Clock.	3.3V
135	PCIRST#	I	PCI Bus Reset #. PCIRST# is used to reset PCI bus devices.	3.3V

Table 5-2. ISA Bus Interface Signals

Pin #	Signal	I/O	Description	Level
115~112, 103, 102, 100~94, 92, 90~85	SA[19:0]	I/O	ISA Address 19 - 0. SA[19:0] are outputs except during the ISA master cycles.	5V
119 - 116	LA[23:20]	I/O	ISA Latch Address 23 - 20. Latchable Address bus LA23 to LA20 are outputs except during the ISA master cycles.	5V
84	SBHE#	I/O, P/U 50K	System Byte High Enable #. This signal indicates that the high byte on the ISA data bus is valid. SBHE# is an output except during the ISA master cycles	5V
129~122, 111~104	SD[15:0]	I/O, P/U 50K	ISA Data 15 - 0. 16-bit bi-directional data lines. SD15 is the MSB.	5V
79	IOR#	I/O, P/U 50K	I/O Read #. Active low output asserted by the CPU or DMA controller to read data or status information from the ISA device. Acts as input when ISA master cycles.	5V
78	IOW#	I/O, P/U 50K	I/O Write #. Active low output asserted by the CPU or DMA controller to write data or control information to the ISA device. Acts as an input during ISA master cycles.	5V
73	AEN	I/O, P/U 50K	Address Enable. This signal is used to indicate DMA accesses. This signal is also used as power-on strapping select.	5V
83	MEMR#	I/O, P/U 50K	Memory Read #. This signal is an output signal for all cycles except when the ISA master controls the bus.	5V
82	MEMW#	I/O, P/U 50K	Memory Write #. This signal is an output signal for all cycles except when the ISA master controls the bus.	5V
66	IOCS16#	I, P/U 50K	16-bit I/O Access #. This signal indicates that the bus size of current ISA I/O slave is 16 bits.	5V
67	MEMCS16#	I/O, P/U 50K	16-bit Memory Access #. This signal indicates that the bus size of current ISA memory slave is 16 bits. During DMA/MASTER cycles, MCS16# is asserted low when memory target is on the PCI bus.	5V
75	NOWS#	I, P/U 50K	No Wait States #. This signal is asserted by the ISA slave in order to shorten the ISA cycle. The IT8888F samples NOWS# to escape standard wait states from the PCI when the ISA slaves have completed the transfer.	5V
71	IOCHRDY	I/O,	I/O Channel Ready.	5V

Pin #	Signal	I/O	Description	Level
		P/U 50K	IOCHRDY is used by ISA slaves to insert wait states. During the ISA master cycles, IOCHRDY is asserted low by the IT8888F when the slave is on the PCI bus.	
72	MASTER#	I, P/U 50K	16-bit Master #. Indicates that a 16-bit ISA master takes control of the ISA bus.	5V
68	IOCHCK#	I, P/U 50K	I/O Channel Check #. ISA bus error indication	5V
65	REFRESH#	I/O, P/U 50K	System Refresh Control #. Output to ISA bus when converting system timer ticks into a refresh cycle. Input from ISA master is used to refresh on-board and slot DRAM.	5V
45~51	DRQ[7~ 5, 3~0]	I, P/D 50K	DMA Request 7, 6, 5, 3, 2, 1, 0. These active high input signals are used to indicate the DMA service request from DMA devices, or the ISA bus control request from the ISA master.	5V
36~39, 42~44	DACK[7~ 5, 3~0]#	I/O, P/U 50K	DMA Acknowledge 7, 6, 5, 3, 2, 1, 0 #. Active low outputs to acknowledge the corresponding DMA requests. (input for IC test only)	5V
64	TC	I/O, P/U 50K	Terminal Count. This signal is asserted to indicate the end of a DMA transfer. This signal is also used as power-on strapping select.	5V
53	IRQ15	I, P/U 50K	Interrupt Request 15. This pin is the parallel interrupt request line 15.	5V
54	IRQ14/ ROMCS#	I/O, P/U 50K	Interrupt Request 14 /ROM Chip Select # The function selection of this pin is determined by ROM decoding related Configuration register settings. Please refer to section 5.14 Optional FLASH ROM Interface.	5V
55 - 63	IRQ[12~9, 7~3]	I, P/U 50K	Interrupt Request 12, 11, 10, 9, 7, 6, 5, 4, 3. These pins are the parallel interrupt request lines.	5V
35	RSTDRV	O	ISA Reset. A high level on this output resets the ISA bus. This signal asynchronously terminates any activity and places the ISA device in the reset state.	5V
77	SMEMR#	I/O, P/U 50K	System Memory Read #. This signal is an output signal for access under 1MB; otherwise, tri-state. (input for IC test only)	5V
76	SMEMW#	I/O, P/U 50K	System Memory Write #. This signal is an output signal for access under 1MB; otherwise, tri-state. (input for IC test only)	5V
70	BCLK	O	Bus Clock ISA bus clock equals to ¼ of PCI clock.	5V
74	BALE	I/O, P/U 50K	Buffer Address Latch Enable This signal is also used as power-on strapping select.	5V

Table 5-3. Miscellaneous Signals

Pin #	Signal	I/O	Description	Level
133	NOGO/ CLKRUN#	I/O	NOGO / Clock Run # The function selection of this pin is determined by Cfg_54h<20>. When acting as NOGO, it is an input from chipset to disable the subtractive decode of the IT8888F; when acting as CLKRUN#, it is an input/output for the IT8888F to request PCICLK to keep running.	5V
134	SERIRQ	I/O	Serial IRQ This is Serialized IRQ for encoding parallel IRQ lines to one pin.	5V
33	SDATA	I/O, P/U 50K	Serial Bus Data System Management Bus data for Serial E ² PROM.	5V
34	SCLK	I/OD, P/U 50K	Serial Bus Clock System Management Bus clock output for Serial E ² PROM. (input for IC test only)	5V

Table 5-4. Power Signals

Pin #	Signal	I/O	Description	Level
1, 22, 130, 146	VCC3	PWR	PCI Interface Power Pins. Those are connected to 3.3V power supply.	3.3V
41, 81, 93, 121,	VCC	PWR	ISA Interface and chip core power pins. 5V power pins.	5V
18, 28, 40, 52, 69, 80, 91, 101, 120, 136, 148, 160	GND	PWR	Ground pins	0 V

Table 5-5. Power-On-Strap Settings

Signal	Pin #	Jumper	Description
AEN	73	(P/Up)	Reserved for enabling chip test function when PCIRST#=0
		P/Down	IT8888F Normal Function
BALE	74	(P/Up)	Fast DEVSEL# timing for F-segment BIOS (both 000FXXXXh and FFFFXXXXh). It will set Cfg_50h<3>
		P/Down	No response or Subtractive Decode for F-segment access
TC	64	(P/Up)	Enable SM-bus Boot ROM Configuration. It will set Cfg_50h<4>, but will be auto-cleared when finishing download configure code.
		P/Down	Disable SM-bus Boot ROM Configuration

6. Functional Description

The IT8888F provides full ISA interface to hook up on PCI bus, so that the existing legacy ISA devices could be supported in new generation PC chipset architecture without ISA interface. There are some sub-function blocks in the IT8888F as described below.

6.1 PCI Slave Interface

The IT8888F PCI Slave interface provides some positively decode space:

- IT8888F PCI configuration register spaces – positively decode w/ medium DEVSEL# speed on the Type0 PCI configuration cycle, the access space is described in 6.2 Access Configuration Registers on page 6-2.
- Six I/O positively decode spaces – defined in IT8888F Configuration Registers: Cfg_58h ~ Cfg_6Fh.
- Four Memory positively decode spaces – defined in IT8888F Configuration Registers: Cfg_70h ~ Cfg_7Fh.
- Optional I/O Port 80 Write Snooping.
- Optional F-segment BIOS claim w/ Fast DEVSEL# speed.
- ISA Palette decoding (ref: Cfg_50h<7:6>).
- DDMA registers spaces.
- PC/PCI DMA cycle space: I/O addresses of 0000h / 0004h / 00C0h / 00C4h.

The IT8888F supports PCI 2.1 Delayed Transaction feature which can be enabled / disabled by programming Cfg_50h<1>. The benefit of Delayed Transaction is that the PCI bus is still available and can be used by other PCI master, even when there is an ISA PIO cycle in progress behind IT8888F.

When Delayed Transaction is enabled, the IT8888F will retry the PCI-to-ISA cycle claimed by IT8888F and latch those address / command / byte-combination, and issues ISA cycle. When the ISA site is not finished, the PCI Slave interface of IT8888F will still retry any PCI cycle. Once the ISA cycle is finished, the PCI Slave interface will wait the same PCI cycle (same address / command / Byte-enable) and terminate it normally with TRDY# asserted. But before that, the other PCI cycle with different address or command or Byte-enable still will be retried.

If the original PCI bus master after retried never issue the same cycle within the programmed DISCARD Timer, then the IT8888F will discard that ISA transaction, so that the IT8888F is able to respond to other PCI transactions without locking its ISA bus interface. Please refer to the Cfg_54h<15:8> in 6.3.11, the Retry/Discard Timers of the Misc. Control Register on page 6-16 for the setting of Discard Timer. There is an option to report System Error via asserting SERR#.

The IT8888F also supports Exclusive access via LOCK# control. Please refer to PCI Specification Revision 2.1, for more detailed description.

6.2 PCI Master Interface

The IT8888F will issue PCI cycle for ISA bus master cycle and DDMA memory cycle if those accesses are forwarded to PCI bus. The Cfg_50h<23:12> define the decoding spaces for IT8888F to decide forwarding the access of ISA bus master or DDMA controller to PCI bus or not.

When the accessed space is forwarding to PCI bus, the IT8888F will assert IREQ# to PCI bus arbiter if the DACKn# source is DDMA. Once the IGNT# is asserted by PCI arbiter and the PCI bus is in idle state, the PCI Master I/F of IT8888F will issue non-burst PCI Memory Read/Write cycles or PCI I/O Read/Write cycles (if Cfg_50h<23>=1). In the mean time, the IOCHRDY will be de-asserted to insert wait-state until forwarding cycle is finished on PCI site.

When in PC/PCI DMA (PPDMA) cycle, the DACKn# is decoded from PPDGNT#, and the IT8888F will not issue IREQ#. As long as the PPDGNT# and MASTER# signal are asserted and there exist an ISA command issued by ISA master, then the PCI Master I/F of IT8888F will issue a PCI cycle for ISA master if the accessed space is located on PCI bus.

Whenever the PCI Master I/F of IT8888F is retried, it will release PCI bus ownership and re-arbiter and re-issue the same transaction. But if the same retry occurs too many times and exceeds the Retry Timer limitation, then the PCI Master I/F will stop trying and there is an option to report System Error via asserting SERR#. Please refer to Cfg_54h<7:0> in 6.3.11 Retry/Discard Timers, Misc. Control Register on page 6-16 for more detailed Retry Timer setting.

6.3 PCI Parity

The IT8888F, like other standard PCI devices, can handle parity error and other errors. Whenever the IT8888F detects address parity error, it is able to assert SERR# if the SERR# reporting mechanism is enabled in PCI Command/Status register.

Also when IT8888F acts as a PCI slave, it will check the data parity of writing in data; when IT8888F acts as a PCI master, it will check the data parity of reading back data. Once it detects a data parity error, it can report data parity error and assert PERR# if the PERR# reporting mechanism is enabled in PCI Command/Status register.

6.4 Positively Decode Spaces

The six positively decode I/O spaces can be programmed to claim PCI I/O cycle with Fast / Medium / Slow / Subtractive DEVSEL# timing speed. In addition, the ISA I/O aliases can be set to support legacy ISA card with non-fully decoded (only decodes with XA9~0). In other words, when alias is enabled for one I/O space, then the addresses A15~A10 of the PCI access address will be ignored for the enabled I/O space. All I/O spaces are limited under 64KB I/O size. IT8888F only claims I/O access with PCI address A[31:16]=0000h. When programmed to subtractive decoding speed, IT8888F will claim PCI I/O access only when whole chip Subtractive decode function is enabled (Cfg_50h<0>).

The four positively decode Memory spaces can also be programmed to claim PCI Memory cycle with Fast / Medium / Slow / Subtractive DEVSEL# timing speed. The memory space is not limited, i.e., even above ISA 16MB size, if it is fall into IT8888F Memory positive decoding spaces, then it will be forwarded to ISA bus with address A31~A24 ignored. So users must carefully claim memory spaces, since the mechanism can support memory relocation. When programmed to subtractive decoding speed, IT8888F will claim PCI Memory access only when whole chip Subtractive decode function is enabled (Cfg_50h<0>), but the claimed space is restricted under memory space base/size setting, not limited to 16MB size.

6.5 Subtractive Decode

IT8888F supports subtractive decode. In general, the subtractive decode mechanism of PCI-to-PCI Bridge chip is to respond to all non-claimed space. But for IT8888F, avoiding ISA space wrapped, it only responses to the memory space under 16MB size (ISA only has 24-bit addressing ability) when processing subtractive decode, except when the access space is hit to one of four positively decode memory space with slowest DEVSEL# timing speed. And the IT8888F only responds to unclaimed PCI I/O space under 64KB.

6.6 PC/PCI DMA (PPDMA) Slave Controller

The IT8888F, following the “ Mobile PC/PCI DMA Arbitration and Protocols MHPG Architecture Functional Architectures Specification” by Intel Corporation, Revision 2.2, builds a PC/PCI DMA (PPDMA) Slave which supports all 7 ISA DMA channels through a single PPDREQ# / PPDGNT# pair. It provides a very low cost, low pin count mechanism. Please check the waveform for more details.

This protocol works as the followings: the IT8888F encodes the DMA channel request information on the PPDREQ# line and decodes the PPDGNT#, which is output from PPDMA Host (in chipset), to assert the DACKn# of the granted DMA channel to ISA bus.

The PPDMA protocol supports Single DMA, Demand DMA, but not Block DMA, nor software request DMA transfers.

For PPDMA transfer, the PPDMA Host will separate Memory transaction portion from DMA operation, and issues PCI I/O transaction to PPDMA Slave with PPDGNT# asserted and special address listed below:

PCI I/O Address	R/W	IT8888F Operation
00h	R/W	Normal DMA operation without TC
04h	R/W	Normal DMA operation with TC
C0h	R	DMA Verify operation without TC
C4h	R	DMA Verify operation with TC

The IT8888F PPDMA slave controller can handle the PCI Retry while it was granted the bus, it continues to hold DACKn# active to ISA bus even when the PPDGNT# is removed. Also when the PCI Master I/F of IT8888F issues cycle for ISA Master and is retried, PPDMA slave would re-send the PPDREQ# to advise PPDMA Host to process Passive Release.

6.7 Distributed DMA (DDMA) Slave Controller

The IT8888F integrates two DMA controllers (8237) to build a 7-channel DDMA slave for DDMA function, which comply with Distributed DMA Specification R6.0.

There are seven DMA channels in IT8888F. Each channel maps to different ISA DMA channel, i.e. DMA channel 7~5, 3~0. Each channel can be treated as a separate DDMA slave, which has its own DDMA channel base address and can be enabled / disabled separately.

To achieve compatibility with ISA, the DDMA channel 7~5 are fixed at 16-bit transfer width; the DDMA channel 3~0 are fixed at 8-bit transfer width. Each channel supports 24 or 32 bits addressing. That is to say, with IT8888F, the system OS or drivers can perform DMA operation to/from anywhere in 4GB-memory space, and is free from the limit of ISA 16MB memory space. When not using the high page register, the system OS or drivers either write 00h or disable high page for dedicated channel.

In PC system, the DDMA Host is located in chipset, and it converts the address and data of legacy DMA accesses (including transferring base address, word counter register, mode / command / mask / ... registers in I/O port 00h~1Fh, C0h~DFh and page registers in I/O port 8Xh~9Xh). This enables the IT8888F will receive PCI I/O cycles with the address = programming register offset plus pre-configured Base Address of dedicated DDMA slave channel. Please refer to 6.4 DDMA Slave Registers Description on page 6-25 for DDMA Slave Register mapping. For detailed register descriptions of legacy DMA controller, there are numerous manufactures' data books that describe the functionality.

6.8 Type-F DMA Timing

The IT8888F also supports Type F DMA timing. Each DMA channel can be programmed to operate in normal DMA timing or Type-F timing. For normal timing, the DDMA controller issuing I/O and Memory commands or the PPDMA module issuing the DMA I/O command meet the DMA operating timing defined in ISA Specification (IEEE P996 draft). Since the system memory bus is located behind ISA bus in legacy IBM PC/AT architecture, the timing is very loose (slow). But for current PC architecture, the system memory is located on Host bridge chip (or PCI North Bridge), thus DMA cycles can be operated faster to achieve better ISA DMA performance.

6.9 ISA Bus I/O Recovery Time

The recovery time of back to back ISA I/O cycles is 1.5 BCLK (ISA System bus clock). The IT8888F provides different I/O recovery time setting for 8-bit I/O cycles and 16-bit I/O cycles.

The configured 8-bit I/O recovery time is inserted after ISA I/F finishes the 8-bit I/O cycle, and the configured 16-bit I/O recovery time is inserted after ISA I/F finishes the 16-bit I/O cycle. No additional recovery time will be inserted due to byte conversion (PCI I/O cycle could be 8/16/24/32 bits, but ISA I/O is only 8/16 bits).

6.10 ISA Bus Arbiter

The IT8888F internal ISA arbiter will handle and exclude DDMA cycle, Refresh cycle and PIO cycle from PCI bus to optimize the ISA bus utilization.

To achieve PCI/ISA concurrency, there are some technologies to improve system performance: Delayed Transaction, Passive Release and the "DDMA-Concurrent" in the IT8888F design.

In legacy PC architecture, the CPU and PCI bus are held throughout the whole DMA operation even when the DMA access space is onto ISA bus or when the forwarded PCI transaction requires just a few PCI clocks to complete. IT8888F provides one option: DDMA-Concurrent cycle when DDMA operation (Cfg_54h<31>). When enabled, the IT8888F will request PCI bus only when DDMA controller or ISA master issued a transaction to be forwarded to PCI bus, and the IT8888F will release PCI bus after it finished PCI bus cycle, even when the DDMA / ISA master still occupies ISA bus.

This is achieved by ISA arbiter, whenever DDMA occupy ISA bus, the PCI Slave will retry all PCI cycles belonging to IT8888F, so that the PCI bus can be used by other PCI transactions.

The ISA Bus Refresh timer requests ISA memory REFRESH operation every 15.36μs which is divided from PCI clocks by 512. The refresh module could be disabled by clearing Cfg_54h<26>.

6.11 SMB Boot ROM Configuration

In addition that the IT8888G configuration can be done by PCI Configuration cycles through system chipset, the IT8888G also offers an optional configuration method via the System Management Bus (SMB, similar to I2C BUS) Boot ROM. As the current version of IT8888G only supports single master mode, users are prohibited to connect the IT8888G SMB interface to other system SMB bus. Only Serial E2PROM can be connected, and the preset slave address is 1010000b.

The Serial E2PROM Data is grouped by each five bytes into the 1st byte, which serves as an index to indicate which PCI Configuration register is. The other 4 bytes are the 32-bits data will be written to the indexed register.

SMB ROM Data format in Serial E²PROM is illustrated below:

ROM Address	ROM Data	IT8888G Operation
top		
5n	Index = AAh	Stop
5m+4	Data	Cfg_50h<31:24>
5m+3	Data	Cfg_50h<23:16>
5m+2	Data	Cfg_50h<15:8>
5m+1	Data	Cfg_50h<7:0>
5m	Index = 50h	Cfg_50h
6	Data	Cfg_XXh<7:0>
5	Index = XXh	Cfg_XXh
4	Data	Cfg_??h<31:24>
3	Data	Cfg_??h<23:16>
2	Data	Cfg_??h<15:8>
1	Data	Cfg_??h<7:0>
0	Index = ??h	Cfg_??h

Whether the chip will execute SMB Boot ROM Configuring Sequence or not is determined by one power-on-strap setting. Please refer to the Table 4-6 Power-On-Strap Settings on page 4-8. If SMB boot ROM Configuration is enabled, the IT8888G will then set the SMB_In_Progress status bit (Cfg_50h<4>) on page 6-12 and begin to issue the I²C Sequential Read Operation. It writes to PCI Configuration Registers after it has finished reading every five bytes from SM ROM. If it reads an Index value as AA_{hex}, then it will stop I²C Sequential Read Operation and clear the SMB_In_Progress status bit. The system BIOS can monitor the status bit to see if SMB is in progress before BIOS can decide to enable some computer system sub-functions. Conversely, if SMB boot ROM Configuration is disabled in power-on-strap setting, the IT8888G will then clear the SMB_In_Progress status bit, and no I²C Sequential Read Operation occurs.

For instance, if users intend to claim a Memory space of 00F3XXXX_n (64KB size) and one I/O space of 02AC_n ~ 02AD_n (2byte size) for a special ISA card (or users try to hook up the ISA device to PCI bus), a Serial E²PROM can be programmed. The resulted data are listed on the next page:

Serial E ² PROM		IT8888G Configuration Register
Address	Data	
top ~ B	XX _h	
A	AA_h	IT8888G SMB I/F Stop
9	C1 _h	Cfg_64h<31:24> Medium DEVSEL#, 2Byte size
8	00 _h	Cfg_64h<23:16> = reserved
7	02 _h	Cfg_64h<15:0> = 02AC _h
6	AC _h	
5	64 _h	Index 64 _h => Cfg_64h
4	A2 _h	Cfg_7Ch<31:24> Slow Medium, 64KB size
3	00 _h	Cfg_7Ch<23:0> = 00F3XXXX _h
2	F3 _h	
1	00 _h	
0	7C _h	Index 7C _h => Cfg_7Ch

In the example above, the IT8888G SMB Configuration block will write the 32-bit data of A200F300_h to Cfg_7Ch when it finishes reading byte 0~4 of Serial E²PROM. It will also write the 32-bit data of C10002AC_h to Cfg_64h when it finishes reading byte 5~9 of Serial E²PROM. After it receives an AA_h in the ROM position of 5xN (i.e. address of 5_d, 10_d, 15_d, .. etc.), the SMB I/F stops fetching more data and clear the SMB_In_Progress status bit. For detailed SMB Configuration operation, please refer to the "IT8888G SMB Configuration Programming Guide".

The SMB Boot Configuring mechanism is patent pending.

6.12 Serialized IRQ

The IT8888F builds a Serialized IRQ slave which complies with Serialized IRQ Support for PCI system R6.0. The Serialized IRQ slave provides signal filtering and encoding logic for all ISA IRQ channels (IRQ [15:14, 12:9, 7:3] and IOCHCK#), which also supports both continuous and quite mode, and auto detect Start Frame width and slot number.

6.13 NOGO and CLKRUN#

The IT8888F also supports NOGO function, which is MUX-ed with the CLKRUN# signal (selected by Cfg_54h<20>).

The NOGO is an input and controlled by chipset to disable the subtractive decode mechanism of the IT8888F, since there is only one subtractive decode device present on PCI bus. For short term, system manufacturers may use GPIO of chipset to control the NOGO pin of the IT8888F to boot up system, but the IT8888F also provides a mechanism to turn on/off the subtractive decode. And it will not be affected by DMA operation, nor by Delayed transaction.

The IT8888F supports CLKRUN# function to reduce system power consumption when no PCI activity in progress. The CLKRUN# function follows the protocol defined in PCI Mobile Design Guide, Revision 1.0. But since the ISA system clock is divided from PCICLK, if some ISA cards still need ISA bus clock all the time, then the user should leave the Cfg_54<27> stay on default value of one. Thus the IT8888F will monitor system CLKRUN# signal and keep PCICLK running; otherwise, the IT8888F will only claim CLKRUN# when ISA Master / DMA requests service or for the DMA service duration, or when the Serialized IRQ module detects the status change on any ISA interrupt requests.

6.14 Optional FLASH ROM Interface

The IT8888F provides ROM decoding and write protect. The ROM chip select can be decoded by programming versatile Cfg_50h<31:24> settings through segments C to F under 1MB and the top 1MB of 4GB. The ROM decoding logic provides ROMCS# signal (which is shared with IRQ14 signal, selected by the internal logic, i.e., when the ROM decoding related Configuration register settings are enabled, the pin 54 will be ROMCS# output automatically; otherwise, it will be IRQ14 input). The PCI Slave I/F needs to claim PCI memory space either by configuring four positively decoding spaces or by setting IT8888F in the subtractive decode mode, except in the power-on-strap settings: F-segment setting (BALE).

If F-segment is set as positively decode, the IT8888F will only do fast DEVSEL# decoding speed and ROMCS# is generated automatically. Its space is F-segment of both 1MB top and 4GB top. Once the ROM is not on ISA interface, the IT8888F will disable F-segment fast decoding itself.

6.15 Testability

The IT8888F provides several test modes, which are aimed for chip testing, not for system testing.

Test Mode	PCIRST#	AEN	DRQ1	DRQ0
Normal Operation	1	X	X	X
	0	0	X	X
	0	1	0	0
Tri-State Test	0	1	0	1
NAND Chain Test	0	1	1	0
Reserved	0	1	1	1

Tri-State Test:

This test mode tri-states all outputs and bi-directional buffers, including the NAND chain outputs, BCLK and RSTDRV.

NAND Chain Test:

The IT8888F builds the NAND Chain test mode. This test mode tri-states all outputs and bi-directional buffers, except for BCLK and RSTDRV, and all the other output buffers are configured as inputs in NAND Chain test mode and are included in the NAND chain. The first input of the NAND chain is DACK2#. The NAND chain is

routed counter-clockwise around the chip (e.g., DACK2#, DACK1#, DACK0#, DREQ7,...). The BCLK is an intermediate output, and the RSTDRV is the final output. PCIRST#, AEN, DRQ1, DRQ0, BCLK and RSTDRV pins are not included in the NAND chain. This testing method can be used to verify chip package connectivity, VIH/VIL DC characteristics.

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7. Register Description

7.1 Configuration Register Map

The IT8888FF PCI header configuration register set complies with Type 00h Configuration Space Header described in the PCI Specification R. 2.1.

Table 7-1. IT8888F Configuration Register Map

31		16 15		00		Index
Device ID (8888h)		Vendor ID (1283h)				00h
Status		Command				04h
Base Class Code (06h)	Sub-class code(01/80h)	Programming I/F (00h)	Revision ID (03h)			08h
Reserved (00h)	Header Type (00h)	Latency Timer (00h)	Cache Line Size (00h)			0Ch
Reserved						10h~2Bh
Subsystem Device ID (0000h)		Subsystem Vendor ID (0000h)				2Ch
Reserved						30~3Fh
DDMA Slave Channel_1 Register		DDMA Slave Channel_0 Register				40h
DDMA Slave Channel_3 Register		DDMA Slave Channel_2 Register				44h
DDMA Slave Channel_5 Register		DMA Type F Timing	PC/PCI DMA Control			48h
DDMA Slave Channel_7 Register		DDMA Slave Channel_6 Register				4Ch
ROMCS#	Master/DMA access	MTOP, I/O Recovery	Timing Control			50h
Misc. Control	Reserved	Discard Timer	Retry Timer			54h
Positively Decoded I/O_Space_0						58h
Positively Decoded I/O_Space_1						5Ch
Positively Decoded I/O_Space_2						60h
Positively Decoded I/O_Space_3						64h
Positively Decoded I/O_Space_4						68h
Positively Decoded I/O_Space_5						6Ch
Positively Decoded Memory_Space_0						70h
Positively Decoded Memory_Space_1						74h
Positively Decoded Memory_Space_2						78h
Positively Decoded Memory_Space_3						7Ch
Reserved						80h~FFh

7.2 Access Configuration Registers

The IT8888F will respond to all PCI Bus Configuration cycles when the IDSEL input is asserted high. Address bits 1-0 of the Configuration cycle are both zeros and address bits 10-8 correspond to internal functions. The Type0 configuration address format is as follows:

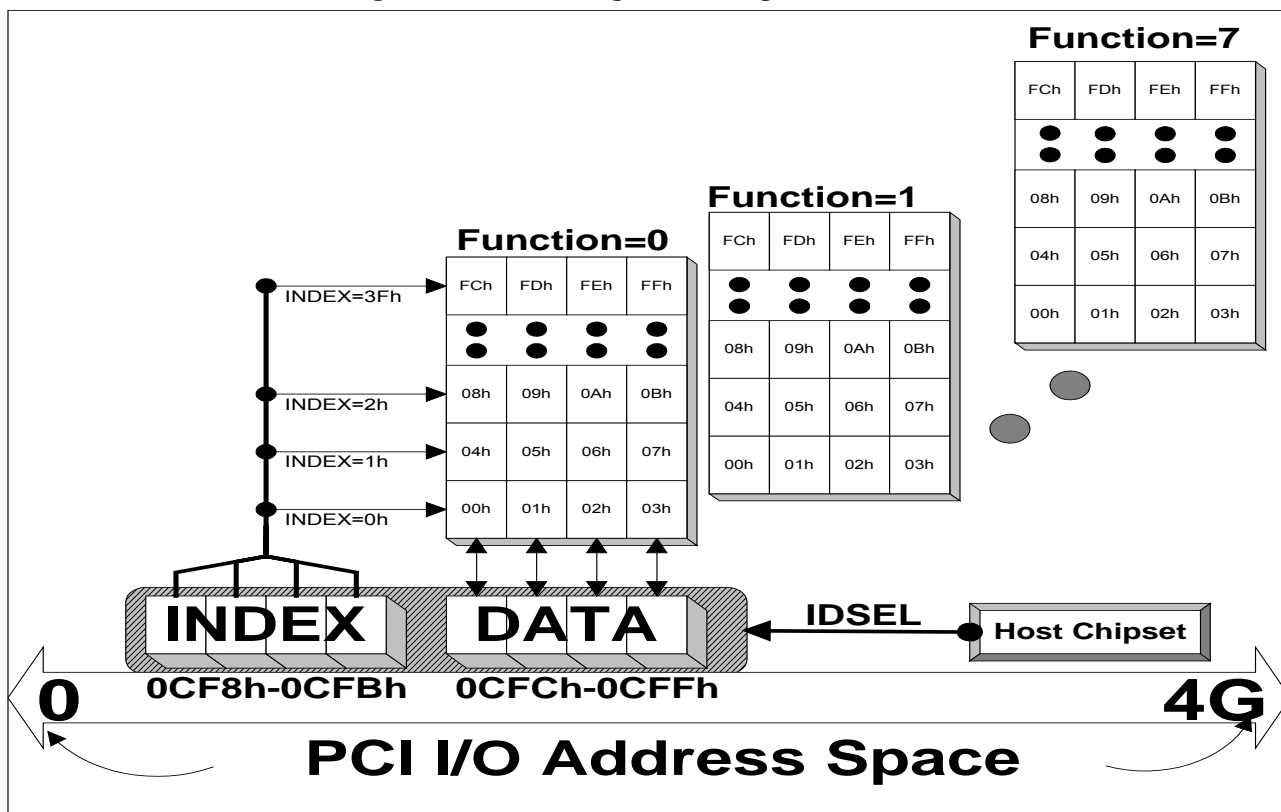
AD31-11	AD10-8	AD7-2	AD1-0	C/BE3-0#
Only one asserted to active IDSEL	Function Select, IT8888F only respond to Function = 000b	Register Select, to select one double-word register	Configuration Type, IT8888F only response to Type = 00b	Byte Select, to select one or more byte in selected double-word register

The configuration registers can be accessed as byte, word (16 bits) or Double-Word (32 bits) quantities or any byte combination. In all of these accesses, only byte enables are used, AD[1:0] is always 00b when accessing the configuration registers. All multi-byte fields use "little-endian" ordering (that is, lower addresses contain the least significant parts of the fields). Registers that are marked "Reserved" will be decoded and return zeros when read. All bits defined as "Reserved" within IT8888F's PCI Configuration Registers will be read as zero and will be unaffected by writes, unless specifically documented otherwise.

The software can use the PCI Configuration Mechanism One to read or write the IT8888F PCI configuration register space. The PCI Configuration Mechanism One utilizes two 32-bit I/O ports located at addresses 0CF8h and 0CFCh. These two ports are:

1. **INDEX Port:** 32-bit wide, occupying I/O address 0CF8h through 0CFBh.
2. **DATA Port:** 32-bit wide, occupying I/O address 0CFCh through 0CFFh.

Figure 7-1. PCI Configuration Register Structure

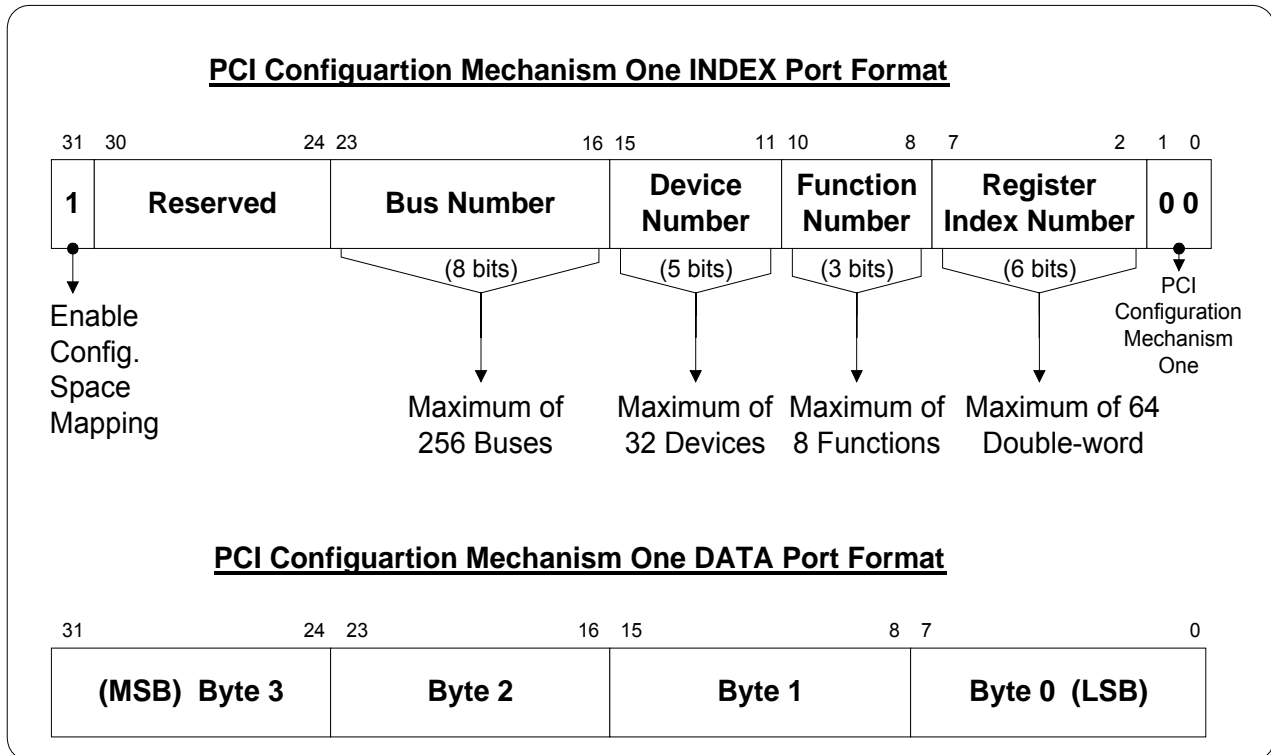


Accessing any PCI configuration register is a two-step process:

Step 1: Perform I/O writes of the bus number, physical device number, function number, and register index number to the PCI Configuration Mechanism One INDEX Port. (The mother board chipset will decode the bus number, device number and then generate the IDSEL signal to select the device. The device then decodes the function number to select which bank of register to be accessed and decodes the register index number to select which double-word register will be accessed.)

Step 2: Perform an I/O read from or write to the PCI Configuration Mechanism One DATA Port. The PCI Configuration Mechanism One INDEX & Data Port format is illustrated below:

Figure 7-2. PCI Configuration Access Mechanism #1



Cfg_04h		Status / Command Register	
<15:10>	RO	Reserved	all zero
<9>	RO	Fast back-to-back control. IT8888F will not perform FBTB access to the target on PCI bus.	0b
<8>	R/W	SERR# drives low enable. A value of 1 enables IT8888F to drive SERR#. A value of 0 disables SERR# signal.	0b
<7>	RO	AD bus stepping. IT8888F does not perform AD stepping.	0b
<6>	R/W	Parity error response. When the bit is 0, IT8888F will ignore any parity error, which is detected on PCI bus interface.	0b
<5:3>	RO	Reserved	000b
<2>	RO	Enable IT8888F to act as a master on primary interface.	1b
<1>	RO	Downstream memory transaction enabling.	1b
<0>	RO	Downstream I/O transaction enabling.	1b

•Status (STS) Register

Address Offset: 06h - 07h

Default Value: 0280h

Access: Read Only, Write-1-to-Clear,

Size: 16 bits

The status register is used to record status information for PCI bus related events. Reads to this register behave normally. Some bits with access attribute of W1C (Write-1-to Clear) means when writes to this register with a '1' to the corresponding bit location cause that bit to be reset.

Cfg_04h		Status / Command Register	
<31>	R/W1C	Set by IT8888F whenever it detects a parity error on PCI bus.	0b
<30>	R/W1C	Set by IT8888F whenever it asserts SERR#.	0b
<29>	R/W1C	Set by IT8888F whenever it, as a PCI bus master, terminates a transaction by signaling a Master Abort.	0b
<28>	R/W1C	Set by IT8888F whenever it, as a master, terminates a transaction by receiving a Target Abort.	0b
<27>	R/W1C	Set by IT8888F whenever it, as a target, terminates a transaction by signaling a Target Abort.	0b
<26:25>	R/L	Medium DEVSEL# timing for IT8888F as a target to respond to an access on PCI bus.	01b
<24>	R/W1C	Set by IT8888F when three conditions are met: 1) asserting PERR# itself or observing PERR# being asserted; 2) IT8888F acts as a bus master for the operation in which an error occurs; 3) Cfg_04h<6> is set.	0b
<23>	RO	Fast back-to-back capability (when IT8888F acts as a target).	1b
<22:16>	RO	Reserved	all zero

7.3.8 DDMA Slave Channel_5 Register / DMA Type-F Timing / PPD Register

•PPD Register

Address Offset: 48h Default Value: FFh
 Access: Read/Write Size: 8bits
 This register is used to enable the PC/PCI DMA engine and each channel.

Cfg_48h		DDMA Slave Channel_5 Register / DMA Type-F Timing / PPD Register	
<7:5>	R/W	PPD DREQ Enable bits for Channel_[7:5]. 0= Masked, 1= Enabled.	111b
<4>	R/W	PPD Global Enable bit. 0b: Disable PPDREQ#/PPDGNT# coding 1b: Enable PPDREQ#/PPDGNT# coding	1b
<3:0>	R/W	PPD DREQ Enable bits for Channel_[3:0]. 0=Masked, 1= Enabled.	1111b

•DMA Type-F Timing

Address Offset: 49h Default Value: 00h
 Access: Read/Write Size: 8bits
 This register is used to control DMA Type F timing which applies to both DDMA and PPD. The Type F DMA timing is not ISA compatible timing.

Cfg_48h		DDMA Slave Channel_5 Register / DMA Type-F Timing / PPD Register	
<15:8>	R/W	Type F DMA Timing Enable for each channel (apply to both DDMA and PPD, user should aware that, the Type F DMA Timing is not ISA compatible timing). 0= Disabled, 1=Enabled.	00h

•DDMA Slave Channel 5 Register

Address Offset: 4Ah – 4Bh Default Value: 0002h
 Access: Read/Write, Read-only Size: 16bits
 This register is used for DDMA Channel 5 base address assignment, data width status and enable control.

Cfg_48h		DDMA Slave Channel_5 Register / DMA Type-F Timing / PPD Register	
<31:20>	R/W	DDMA Slave Channel_5 Base Address A[15:4]	000h
<19>	R/W	DDMA Slave Channel_5 Non-Legacy Extended addressing Enable. If disabled, then the Base Address A[31:24] register of Channel_5 will be always reset to 00h for memory access under 16MB. 0=Disabled, 1=Enabled.	0b
<18:17>	RO	DDMA Slave Channel_5 Transfer Data width. 00=8 bits, 01=16 bits, 10=32 bits, 11=Reserved.	01b
<16>	R/W	DDMA Slave Channel_5 Enable. 0= Disabled, 1=Enabled.	0b

7.4 DDMA Slave Registers Description

Only one register Base address is dedicated to each DDMA slave channel, and unique 16-byte register spaces are allocated for each DDMA Slave channel. Below is the DDMA slave register description:

DDMA Slave Address	R/W	Register Name	IT8888F Operation
Channel_N Base Address + 0h	W	Transfer Base Address[7:0]	Write to 8237_8 or 8237_16 Base address register of Channel_N
Channel_N Base Address + 0h	R	Current Transfer Address[7:0]	Read from 8237_8 or 8237_16 Current address register of Channel_N
Channel_N Base Address + 1h	W	Transfer Base Address[15:8]	Write to 8237_8 or 8237_16 Base address register of Channel_N ¹
Channel_N Base Address + 1h	R	Current Transfer Address[15:8]	Read from 8237_8 or 8237_16 Current address register of Channel_N
Channel_N Base Address + 2h	W	Transfer Base Address[23:16]	Write to Low Page register of Channel_N
Channel_N Base Address + 2h	R	Current Transfer Address[23:16]	Read from Low Page register of Channel_N
Channel_N Base Address + 3h	W	Transfer Base Address[31:24]	Write to High Page register of Channel_N
Channel_N Base Address + 3h	R	Current Transfer Address[31:24]	Read from High Page register of Channel_N
Channel_N Base Address + 4h	W	Base Word Count[7:0]	Write to 8237_8 or 8237_16 Base Word Count register of Channel_N
Channel_N Base Address + 4h	R	Current Word Count[7:0]	Read from 8237_8 or 8237_16 Current Word Count register of Channel_N
Channel_N Base Address + 5h	W	Base Word Count[15:8]	Write to 8237_8 or 8237_16 Base Word Count register of Channel_N
Channel_N Base Address + 5h	R	Current Word Count[15:8]	Read from 8237_8 or 8237_16 Current Word Count register of Channel_N
Channel_N Base Address + 6h	W	Base Word Count[23:16]	No Operation
Channel_N Base Address + 6h	R	Current Word Count[23:16]	Read 00h
Channel_N Base Address + 7h	N/A	Reserved	No Operation

¹ DDMA Host should handle Byte-Flip-Flop pointer.

DDMA Slave Registers Description (continued)

DDMA Slave Address	R/W	Register Name	IT8888F Operation
Channel_N Base Address + 8h	W	Command	Write to 8237_8 or 8237_16 Command register
Channel_N Base Address + 8h	R	Status	Read from 8237_8or 8237_16 Status register and convert / duplicate data bits, depending on Channel_N information.
Channel_N Base Address + 9h	W	S/W DMA Request	Write to 8237_8 or 8237_16 Request register
Channel_N Base Address + 9h	R	Reserved	Read Data Undefined
Channel_N Base Address + Ah	N/A	Reserved	Ignore Write; Read Data Undefined
Channel_N Base Address + Bh	W	Mode	Write to 8237_8 or 8237_16 Mode register
Channel_N Base Address + Bh	R	Reserved	Read Data Undefined
Channel_N Base Address + Ch	N/A	Reserved	Ignore Write; Read Data Undefined
Channel_N Base Address + Dh	W	Master Clear	Write to 8237_8 or 8237_16 Master Clear register
Channel_N Base Address + Dh	R	Reserved	Read Data Undefined
Channel_N Base Address + Eh	N/A	Reserved	Ignore Write; Read Data Undefined
Channel_N Base Address + Fh	W	Multi-Channel Mask	Write to 8237_8 or 8237_16 Single Channel Mask register w/ shifting data bit<0> to bit<2> and converting Channel_N information to bit<1:0>
Channel_N Base Address + Fh	R	Multi-Channel Mask	Read from 8237_8or 8237_16 Single Channel Mask register and convert / duplicate data bits, depending on Channel_N information.

8. DC Characteristics

Absolute Maximum Ratings*

Applied Voltage (V_{CC}).....	-0.3V to 6.0V
Input Voltage (V_I).....	-0.3V to $V_{CC}+0.3V$
Output Voltage (V_O).....	-0.3V to $V_{CC}+0.3V$
Storage Temperature (T_{STG}).....	-40°C to 125°C

*Comments

Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in “Recommended Operating Conditions” is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 8-1. Recommended Operating Conditions

Symbol	Parameter	Min.	Typical	Max.	Units
VCC3	Power Supply	3.0	3.3	3.6	V
VCC	Power Supply	4.75	5.0	5.25	V
V _{IN}	Input Voltage	0		VCC / VCC3	V
T _{OPT}	Operating Temperature	0	25	70	°C

8.1 DC Electrical Characteristics

Table 8-2. General DC Characteristics

Symbol	Parameter	Conditions	Min.	Typical	Max.	Units
I _{IL}	Input Low Current	no P/D or P/U	-1		1	μA
I _{IH}	Input High Current	no P/D or P/U	-1		1	μA
I _{OZ}	Tri-state Leakage Current		-10		10	μA
I _{CC}	Operating Current	from VCC source				mA
I _{CC3}	Operating Current	from VCC3 source				mA
C _{IN}	Input Capacitance			3		pF
C _{OUT}	Output Capacitance			3 to 6		pF
C _{BID}	Bi-directional buffer Capacitance			3 to 6		pF

Table 8-3. DC Electrical Characteristics

(T_{OPT}=0°C~70°C, VCC3=3.0~3.6V, VCC=4.75~5.25V)

Symbol	Parameter	Conditions	Min.	Typical	Max.	Units
V _{IL}	Input Low Voltage for 5V cell	TTL			0.8	V
V _{IL}	Input Low Voltage for 3.3V cell	CMOS			0.3*VCC3	V
V _{IL}	Schmitt Input Low Voltage	TTL		1.10		V
V _{IH}	Input High Voltage for 5V cell	TTL	2.2			V
V _{IH}	Input High Voltage for 3.3V cell	CMOS	0.7*VCC3			V
V _{IH}	Schmitt Input High Voltage	TTL		1.87		V
V _{OL}	Output Low Voltage for 5V cell				0.4	V
V _{OL}	Output Low Voltage for 3.3V cell				0.4	V
V _{OH}	Output High Voltage for 5V cell		3.5			V
V _{OH}	Output High Voltage for 3.3V cell		2.3			V

8.2 AC Characteristics

Table 8-4. AC Characteristics of PCI Interface Timing

(VCC=5.0V±5%, VCC3=3.3V±5%, T_a=0°C~70°C, C_L=50pF²) unit: ns

Symbol	Parameter	Min.	Typical	Max.	Notes
t _{VALID_PCI}	Valid output delay time				
t _{SETUP_PCI}	Input setup time				
t _{HOLD_PCI}	Input hold time				
t _{ON_PCI}	Float to Active				
t _{OFF_PCI}	Active to Float				

² All the pads loading are based on 50pF for Typical simulated values.

Table 8-5. AC Characteristics of ISA Interface Timing (PIO Cycle)

 (Measured in Design Simulation) unit: 1T=1 PCICLK period \geq 30ns

In the following parameters, the LA[23:20] signals are replaced by SA[23:20] to simplify descriptions.

Symbol	Parameter	Typical	Notes
t_{BCLK}	BCLK frequency	≤ 8.25	MHz (=PCICLK/4)
t_{L_BCLK}	BCLK low period	$\geq 2T$	1T=1 PCICLK period
t_{H_BCLK}	BCLK high period	2T	
t_{H_BALE}	BALE high period in PIO mode	2T	
$t_{OS_LA_BALE}$	SA[23:2] valid to BALE de-asserted	$\geq 4T$	
$t_{OS_LA_M}$	SA[23:2] valid to MEMR#/MEMW# asserted	$\geq 4T$	16-bit memory access
		$\geq 6T$	8-bit memory access
$t_{OS_LA_IO}$	SA[23:2] valid to IOR#/IOW# asserted	$\geq 6T$	16-/8-bit I/O access
$t_{OS_SA_M}$	SA[1:0], SBHE# valid to MEMR#/MEMW# asserted	2T	16-bit memory access
		4T	8-bit memory access
$t_{OS_SA_IO}$	SA[1:0], SBHE# valid to IOR#/IOW# asserted	4T	16-/8-bit I/O access
t_{OH_A}	SA[23:0], SBHE# hold after command de-asserted	$\geq 2T$	all PIO access
t_{W_M}	MEMR#/MEMW# low width	8T	16-bit access w/o NOWS#
		18T	8-bit access w/o NOWS#
		$\geq 4T$	16-bit access w/ NOWS#
		$\geq 6T$	8-bit access w/ NOWS#
t_{W_IO}	IOR#/IOW# low width	6T	16-bit access
		18T	8-bit access w/o NOWS#
		$\geq 6T$	8-bit access w/ NOWS#
t_{OS_SD}	SD[15:0] valid to MEMW#/IOW# asserted	0T	16-bit memory write
		2T	else
t_{OH_SD}	SD[15:0] hold/float after MEMW#/IOW# de-asserted	2T	all PIO write access
t_{OH_CMD}	command hold from IOCHRDY	$\geq 4T$	all PIO write access

Table 8-6. AC Characteristics of ISA Interface Timing (DMA Cycle)(Measured in Design Simulation) unit: 1T=1 PCICLK period \geq 30ns

In the following parameters, the LA[23:20] signals are replaced by SA[23:20] to simplify descriptions.

Symbol	Parameter	Typical	Notes
DDMA Mode			
$t_{DD_AEN_DACK}$	AEN asserted to DACKn# asserted	0T	DACK[7:5]#
		4T	DACK[3:0]#
$t_{DD_DACK_AEN}$	DACKn# de-asserted to AEN de-asserted	0T	DACK[7:5]#
		4T	DACK[3:0]#
$t_{DD_DACK_IOR}$	DACKn# asserted to IOR# asserted	6T	
$t_{DD_DACK_IOW}$	DACKn# asserted to IOW# asserted	14T	
$t_{DD_DACK_M}$	DACKn# asserted to MEMR#/MEMW# asserted	14T	Memory space on ISA
$t_{DD_PAGE_M}$	Page Address valid to MEMR#/MEMW# asserted	14T	SA[23:17/16]
$t_{DD_SA_M}$	Base Address valid to MEMR#/MEMW# asserted	10T	SA[16/15:0]
$t_{DD_M_SA}$	Address hold after MEMR#/MEMW# de-asserted	4T	SA[23:0]
$t_{DD_W_R}$	IOR#/MEMR# hold after MEMW#/IOW# de-asserted	2T	
$t_{DD_OS_SD}$	SD[15:0] setup to IOW# de-asserted	8T	Memory space on PCI
$t_{DD_OH_SD}$	SD[15:0] hold/float after MEMW#/IOW# de-asserted	4T	
$t_{DD_W_IOR}$	IOR# width	\geq 26T	Memory space on PCI
		30T	Memory space on ISA
$t_{DD_W_IOW}$	IOW# width	\geq 16T	Memory space on PCI
		24T	Memory space on ISA
$t_{DD_W_MEMR}$	MEMR# width	26T	Memory space on ISA
$t_{DD_W_MEMW}$	MEMW# width	20T	Memory space on ISA
$t_{DD_OS_TC}$	TC valid to IOR#/IOW# de-asserted	22/28T	
$t_{DD_OH_TC}$	TC hold after IOR#/IOW# de-asserted	4/6T	
$t_{PP_SU_IOR}$	PPDMA I/O cycle start to IOR# asserted	\geq 7T	
$t_{PP_SU_IOW}$	PPDMA I/O cycle start to IOW# asserted	\geq 13/9T	Normal/Type-F DMA
$t_{PP_HD_IOR}$	IOR# de-asserted to PPDMA I/O cycle end	6T	DACKn#/AEN hold until PPDGNT# de-asserted
$t_{PP_HD_IOW}$	IOW# de-asserted to PPDMA I/O cycle end	8T	
$t_{PP_OS_SD}$	SD[15:0] setup to IOW# asserted (falling edge)	8/4T	Normal/Type-F DMA
$t_{PP_OH_SD}$	SD[15:0] hold/float after IOW# de-asserted	8T	
$t_{PP_W_IOR}$	IOR# width	26/6T	Normal/Type-F DMA
$t_{PP_W_IOW}$	IOW# width	18/6T	Normal/Type-F DMA
$t_{PP_OSR_TC}$	TC valid to IOR # de-asserted	28/8T	Normal/Type-F DMA
$t_{PP_OSW_TC}$	TC valid to IOW# de-asserted	26/10T	Normal/Type-F DMA
$t_{PP_OH_TC}$	TC hold after IOR#/IOW# de-asserted	4/6T	

Table 8-7. AC Characteristics of SMB Interface Timing

Symbol	Parameter	Typical	Notes
t_{SCLK}	SCLK frequency	≤ 86.8	KHz (= PCICLK/384)
t_{L_SCLK}	SCLK low period	5.76	μs (= 192 PCI clocks)
t_{H_SCLK}	SCLK high period	5.76	μs
t_{SU_STA}	Start condition setup time	5.76	μs
t_{HD_STA}	Start condition hold time	5.76	μs
t_{SU_STOP}	Stop condition setup time	5.76	μs
t_{OS_SDATA}	SDATA output setup time	2.38	μs (= 96 PCI clocks)
t_{OH_SDATA}	SDATA output hold time	2.38	μs
t_{IS_SDATA}	SDATA input setup time	-2.3	μs
t_{IH_SDATA}	SDATA input hold time	-2.3	μs

8.3 Waveforms

In the following waveforms, the LA[23:20] signals symbol are replaced by SA[23:20] to simplify drawings.

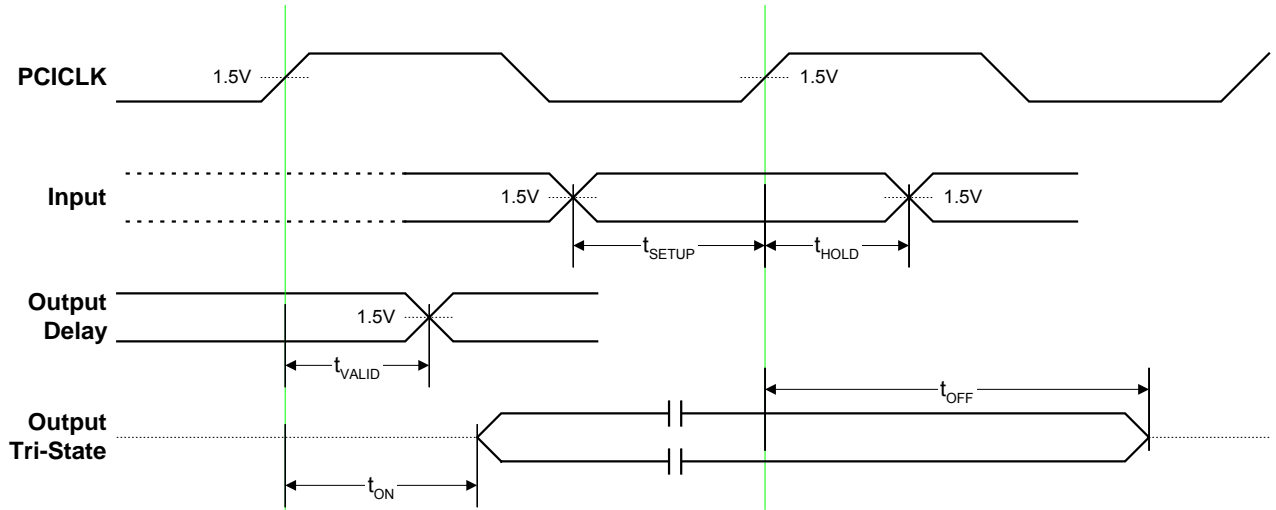


Figure 8-1. PCI Bus Interface Timing

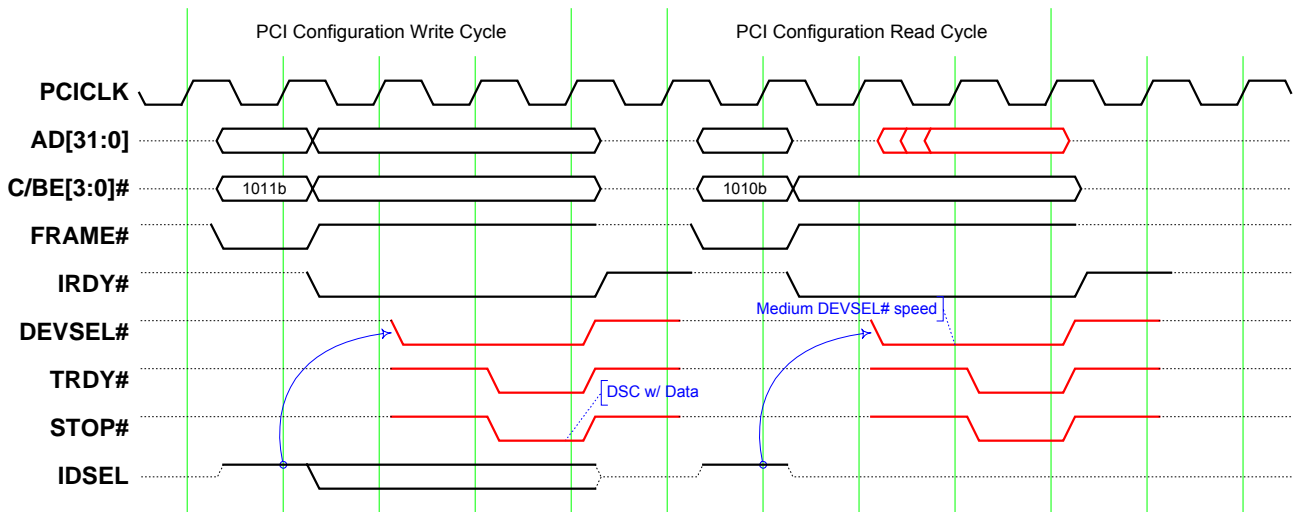


Figure 8-2. PCI Configuration Write / Read Cycle

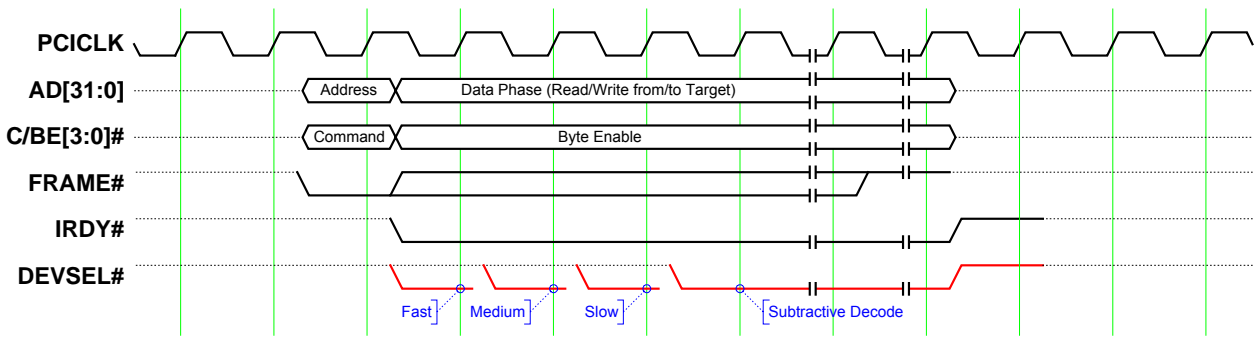


Figure 8-3. DEVSEL# Decoding Speed

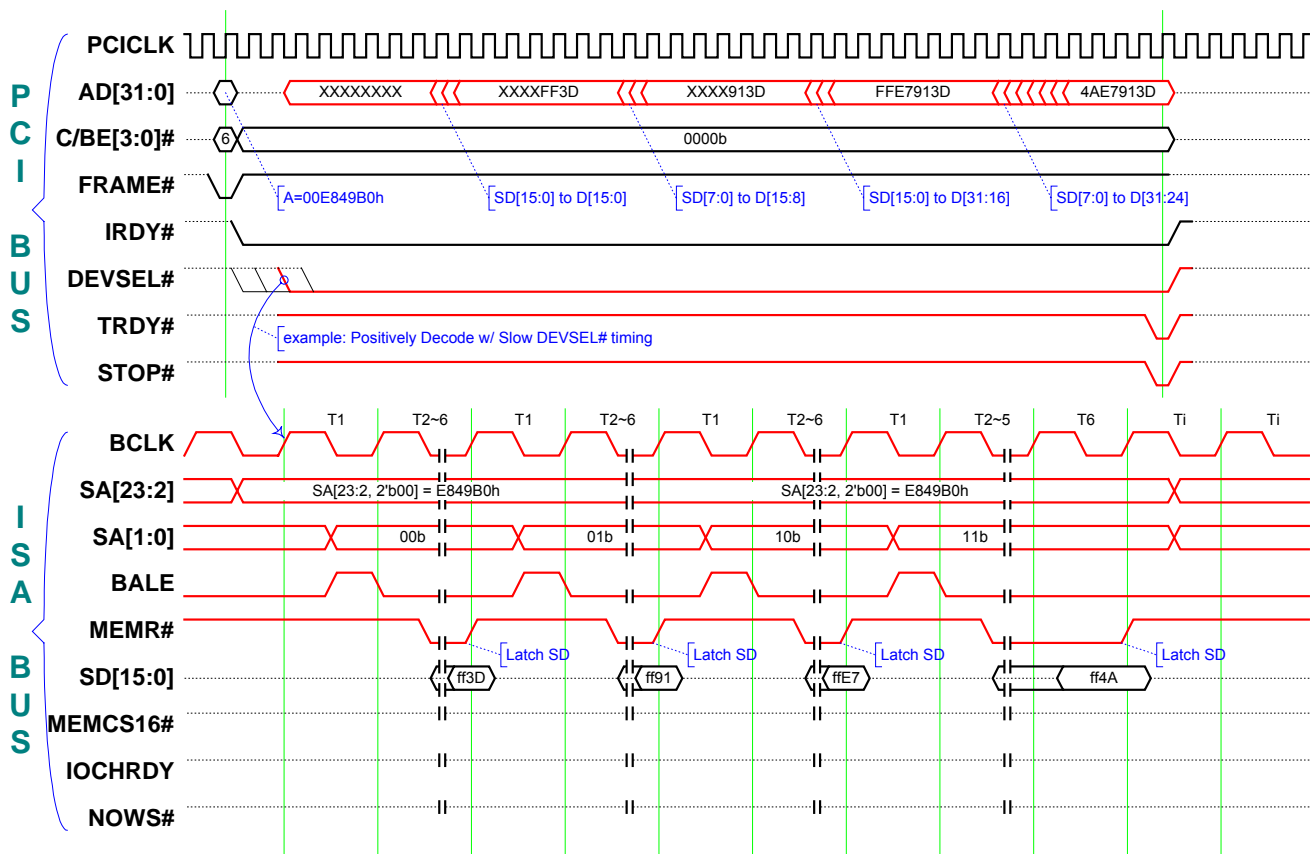


Figure 8-4. PCI Memory Read from ISA Device when Delayed Transaction is disabled

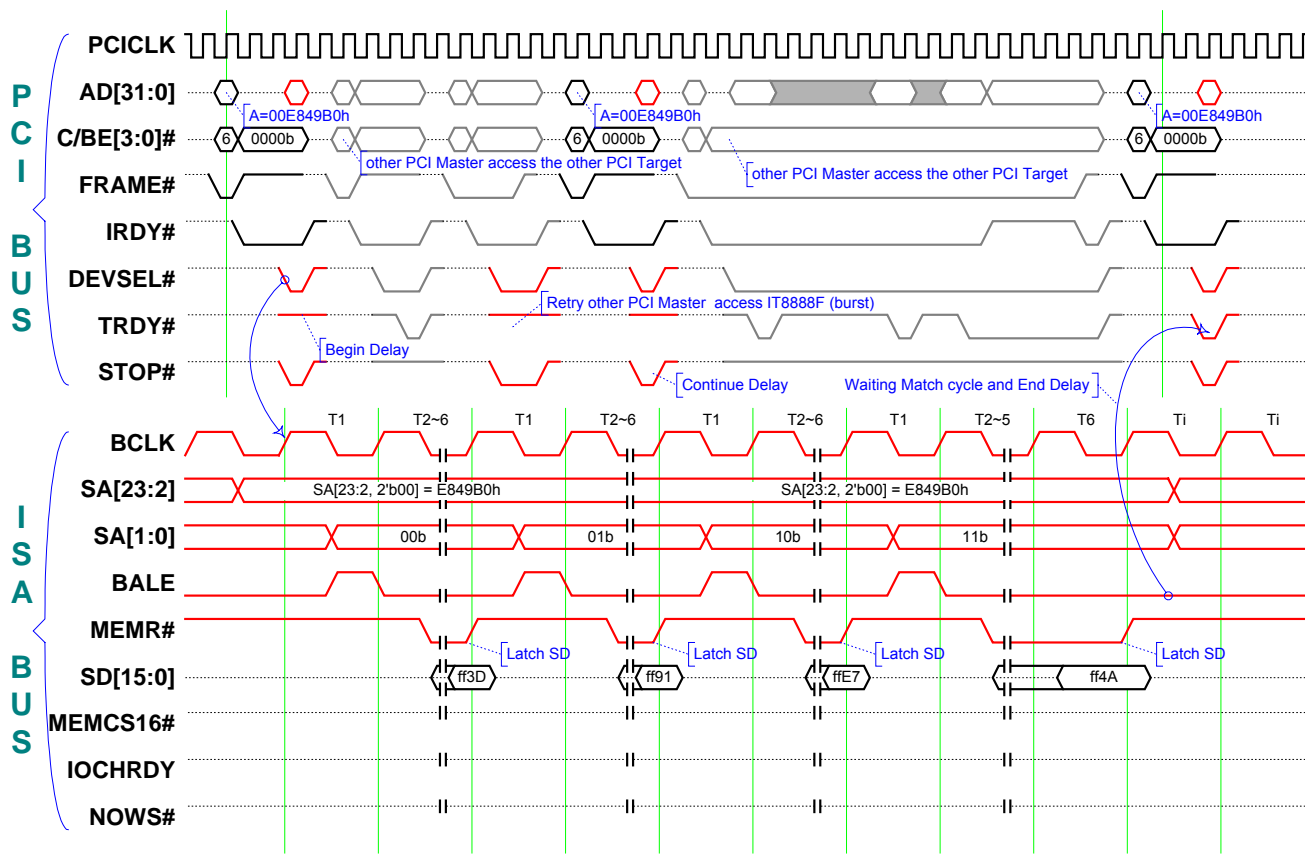


Figure 8-5. PCI Memory Read from ISA Device when Delayed Transaction is enabled

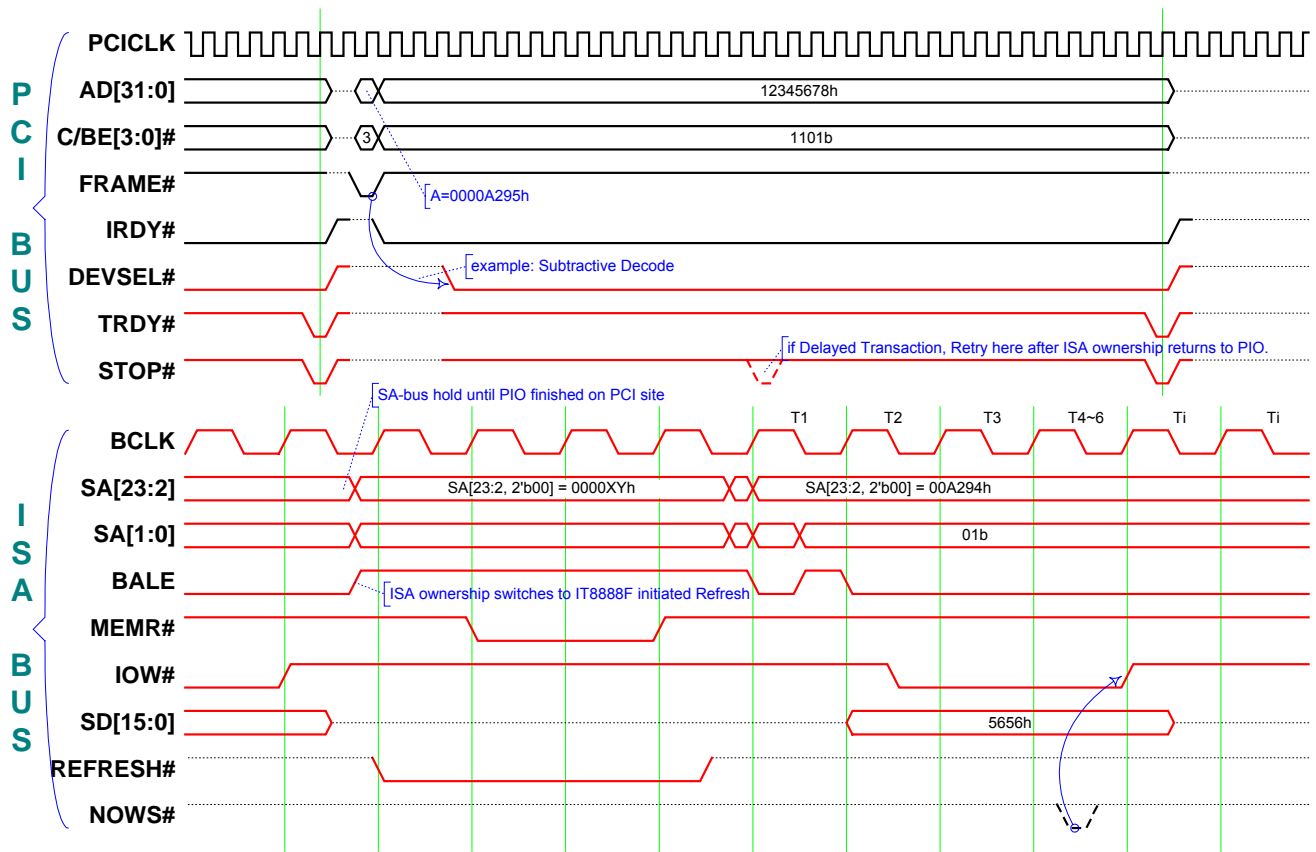


Figure 8-6. IT8888F Initiated Refresh Cycle

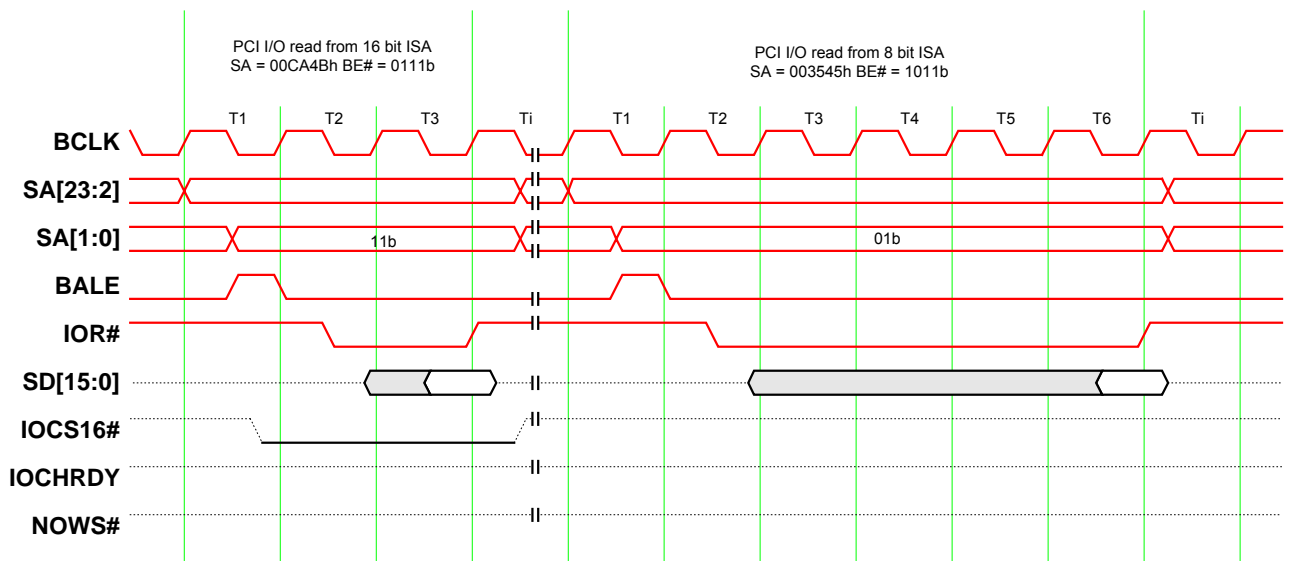


Figure 8-7. PCI I/O Read from ISA device

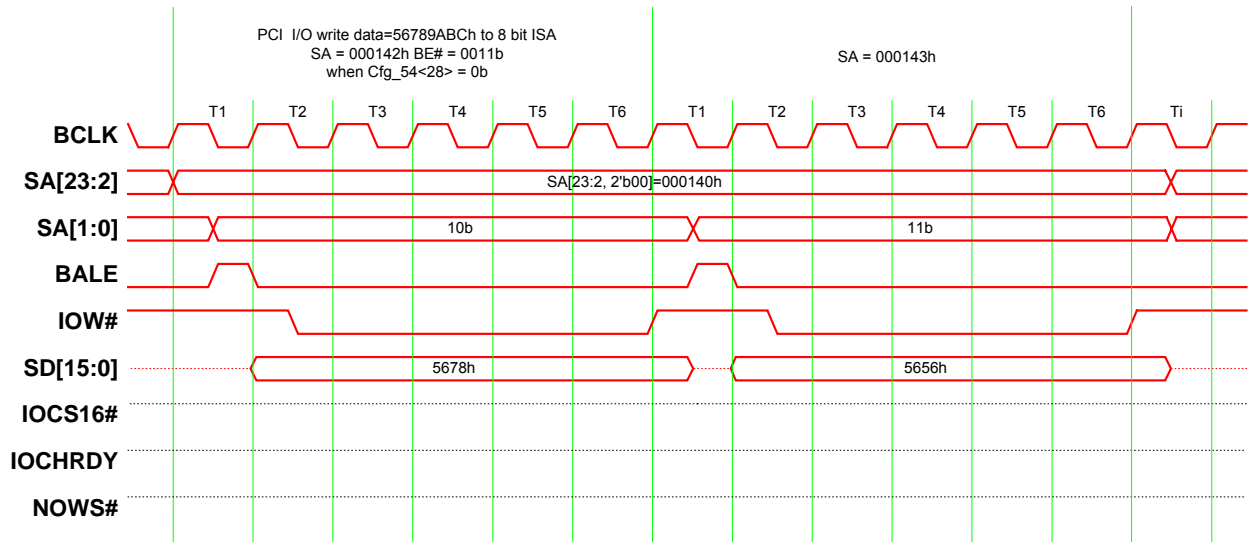


Figure 8-8. PCI I/O Write to 8-bit ISA Device when Cfg_54<28>=0b

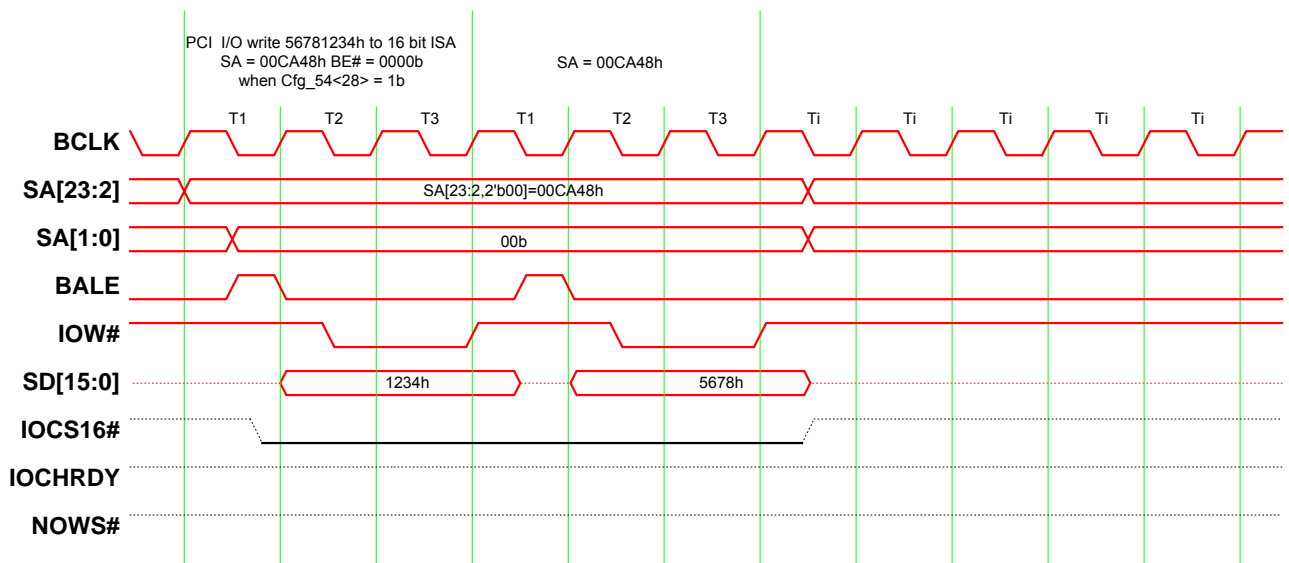


Figure 8-9. PCI I/O Write to 16-bit ISA Device when Cfg_54<28>=1b

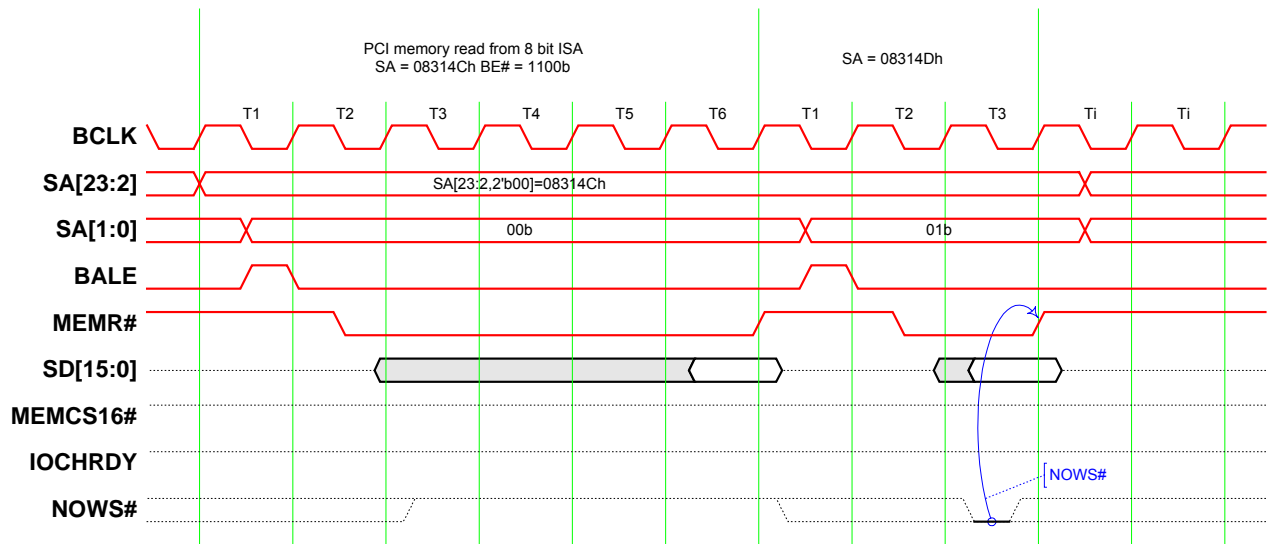


Figure 8-10. PCI Memory Read from 8-bit ISA Device

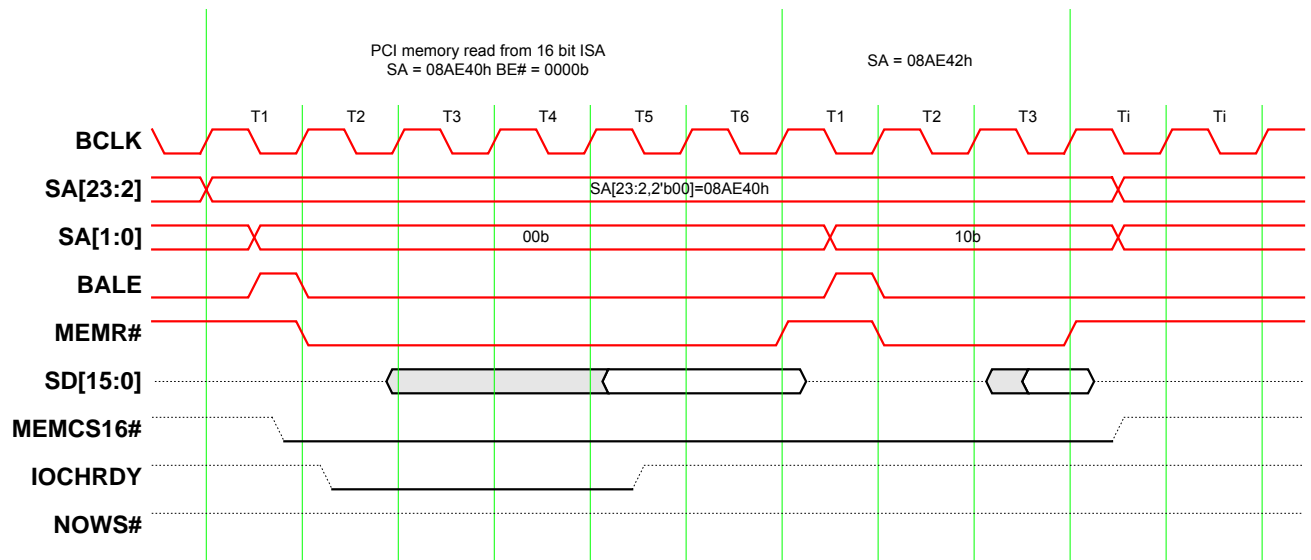


Figure 8-11. PCI Memory Read from 16-bit ISA Device

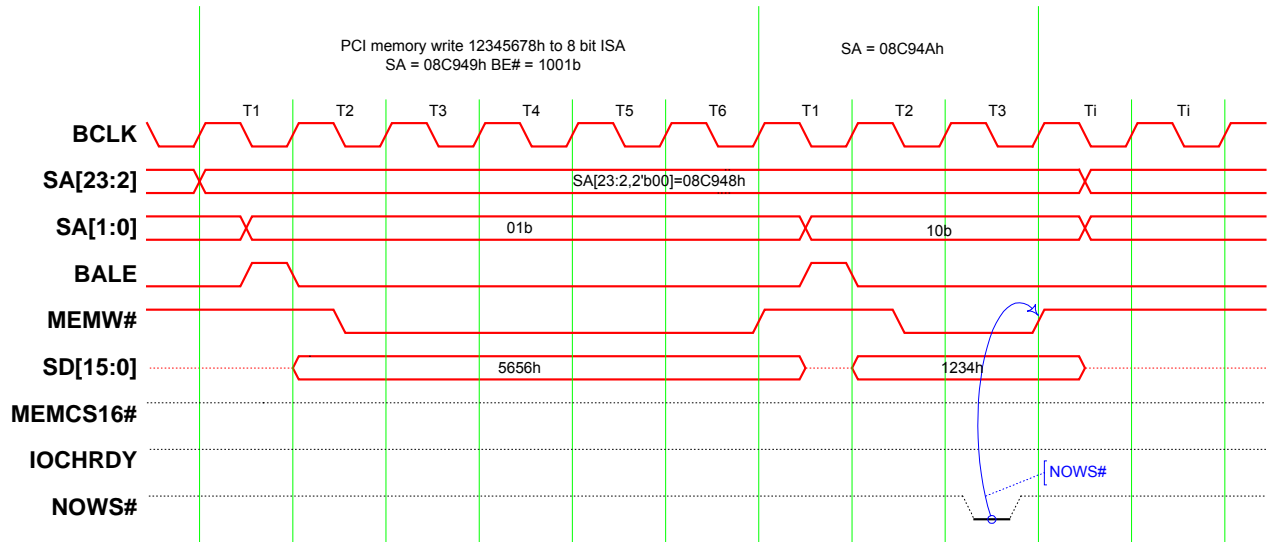


Figure 8-12. PCI Memory Write to 8-bit ISA Device

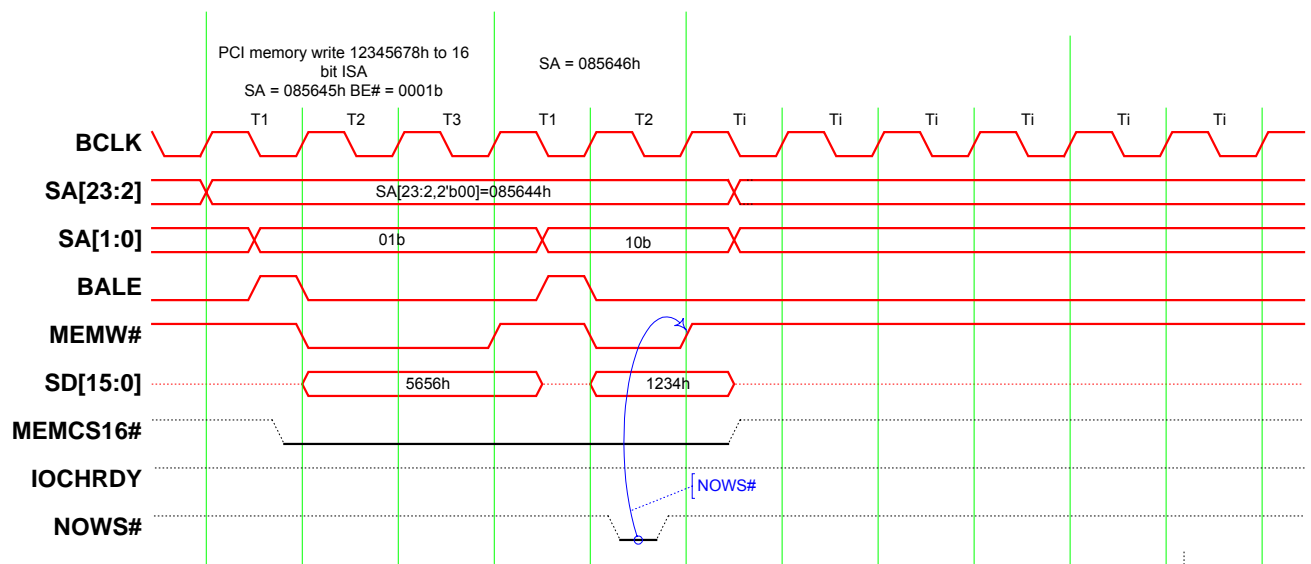


Figure 8-13. PCI Memory Write to 16-bit ISA Device

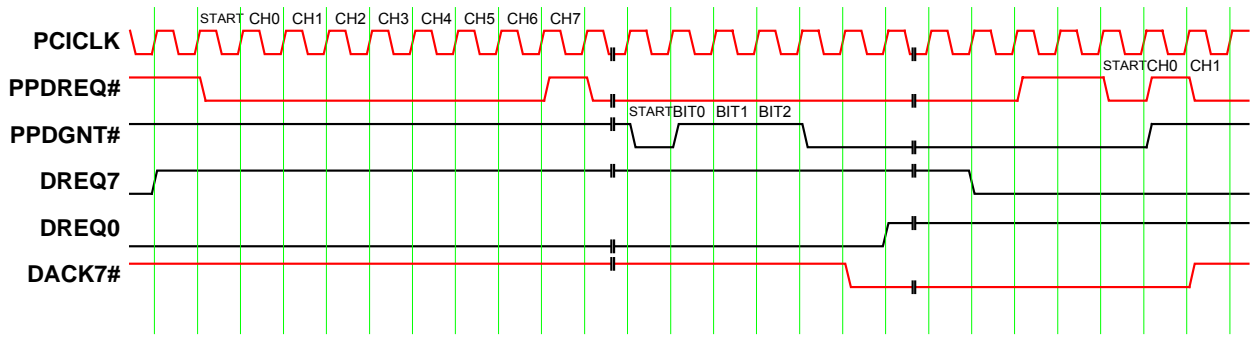


Figure 8-14. DREQn/DACKn# Coding in PC/PCI DMA Function

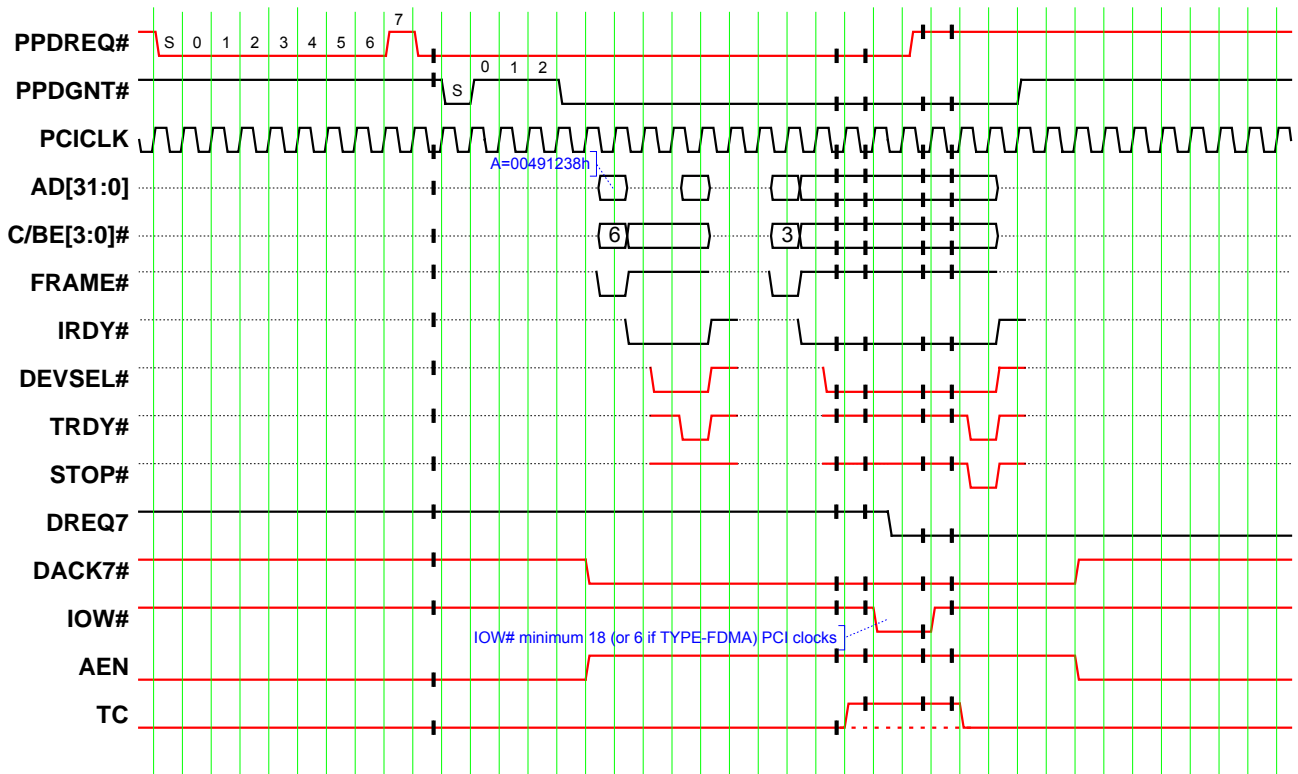


Figure 8-15. DMA Read Operation in PC/PCI DMA (Memory Access to PCI with TC)

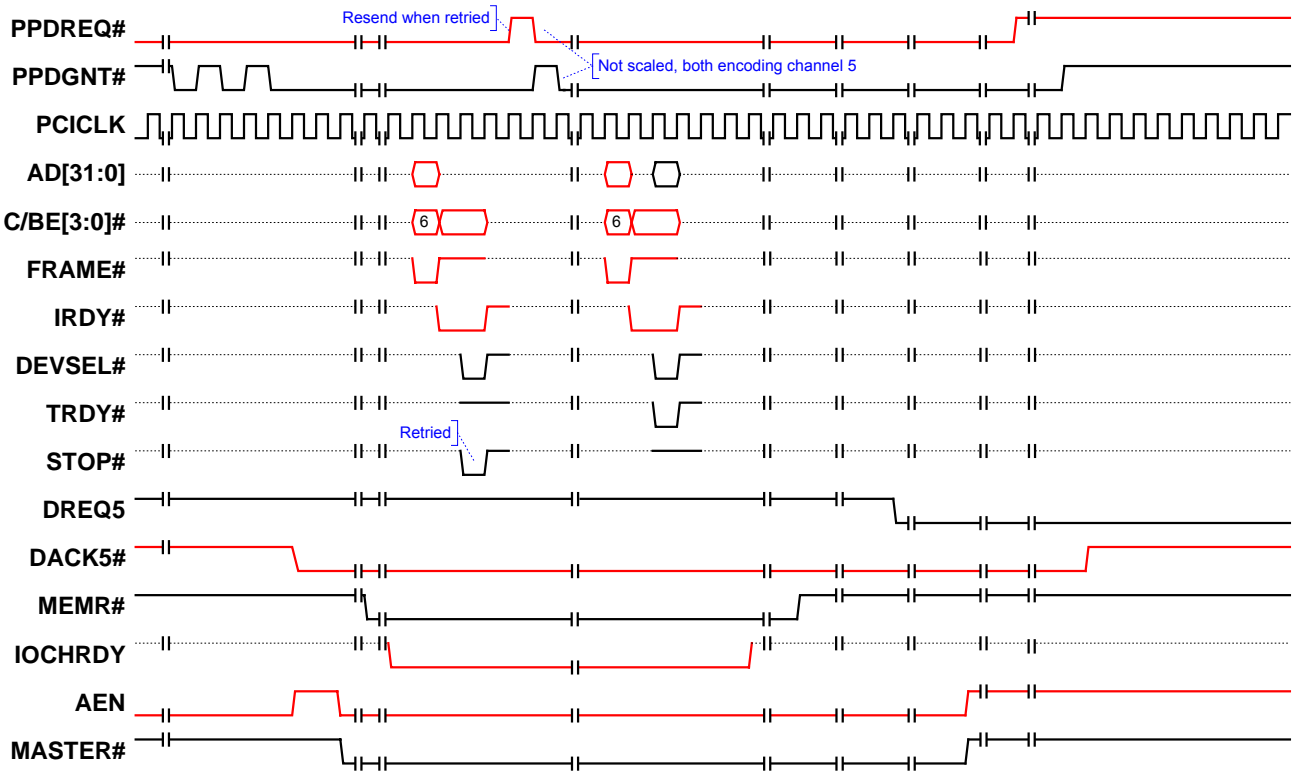


Figure 8-16. ISA Master Memory Read from PCI in PC/PCI DMA (Retried and Normal Termination)

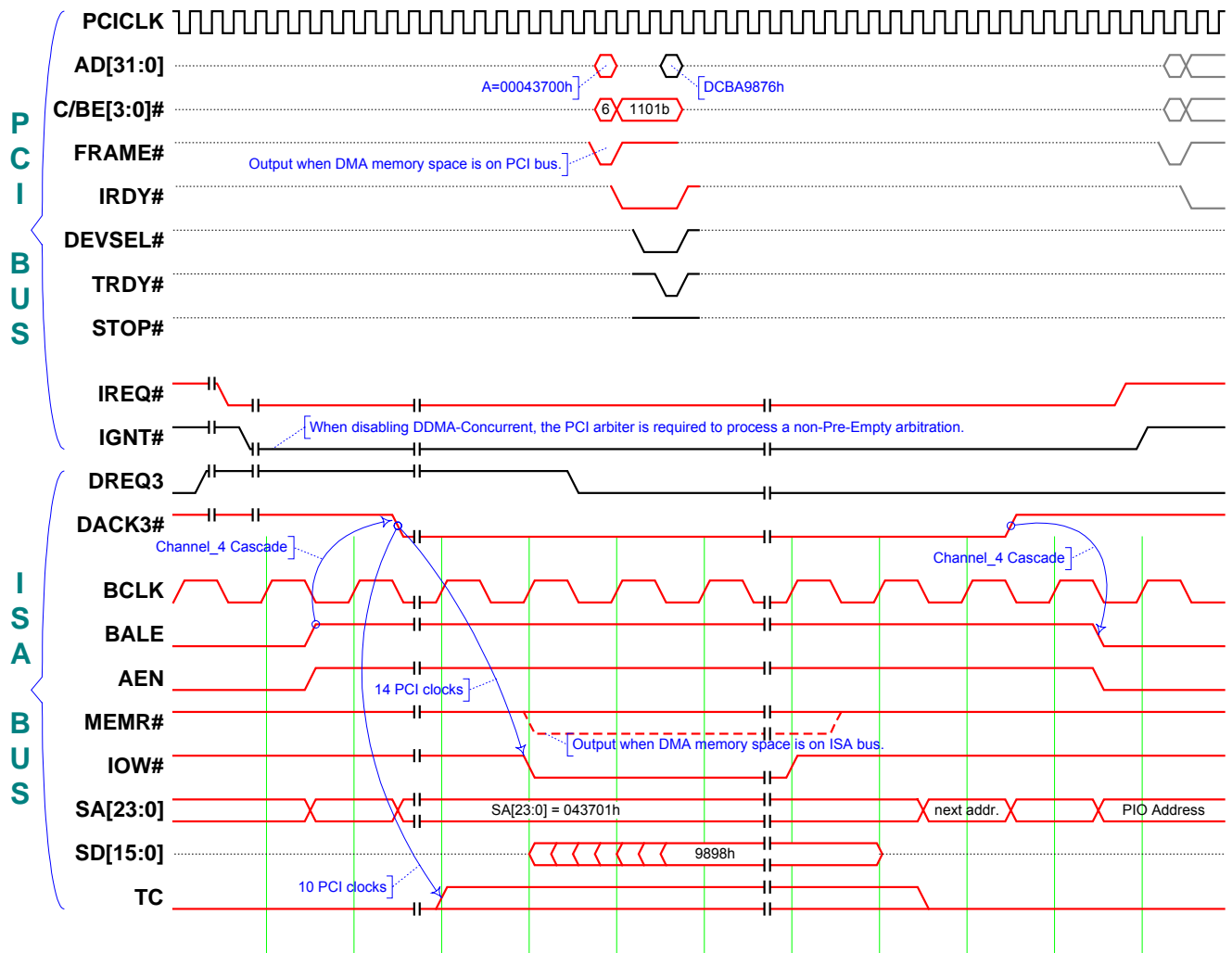


Figure 8-17. DMA Read Operation in DDMA (Memory Access to PCI when DDMA-Concurrent is disabled.)

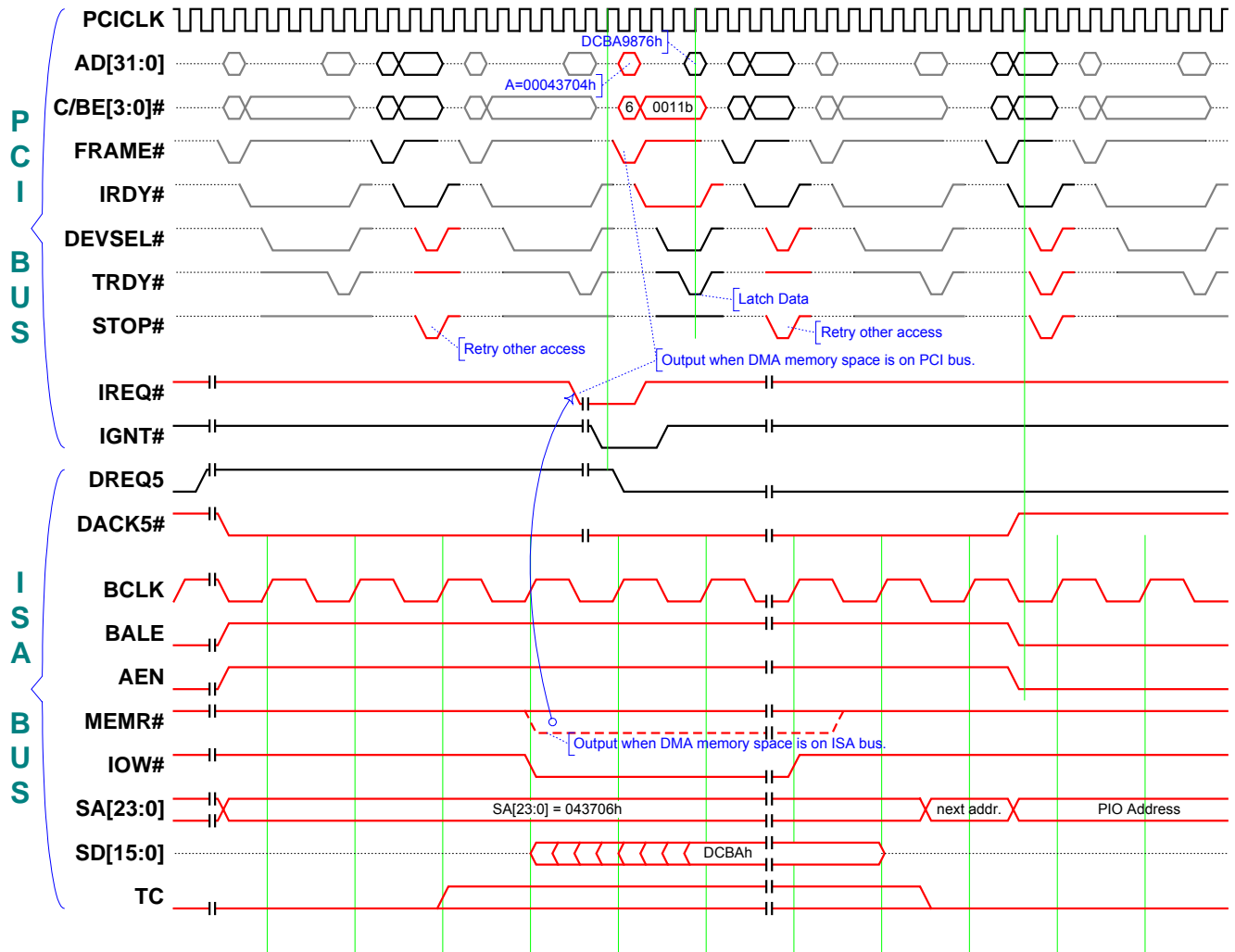


Figure 8-18. DMA Read Operation in DDMA (Memory Access to PCI when both Delayed-Transaction and DDMA-Concurrent are enabled.)

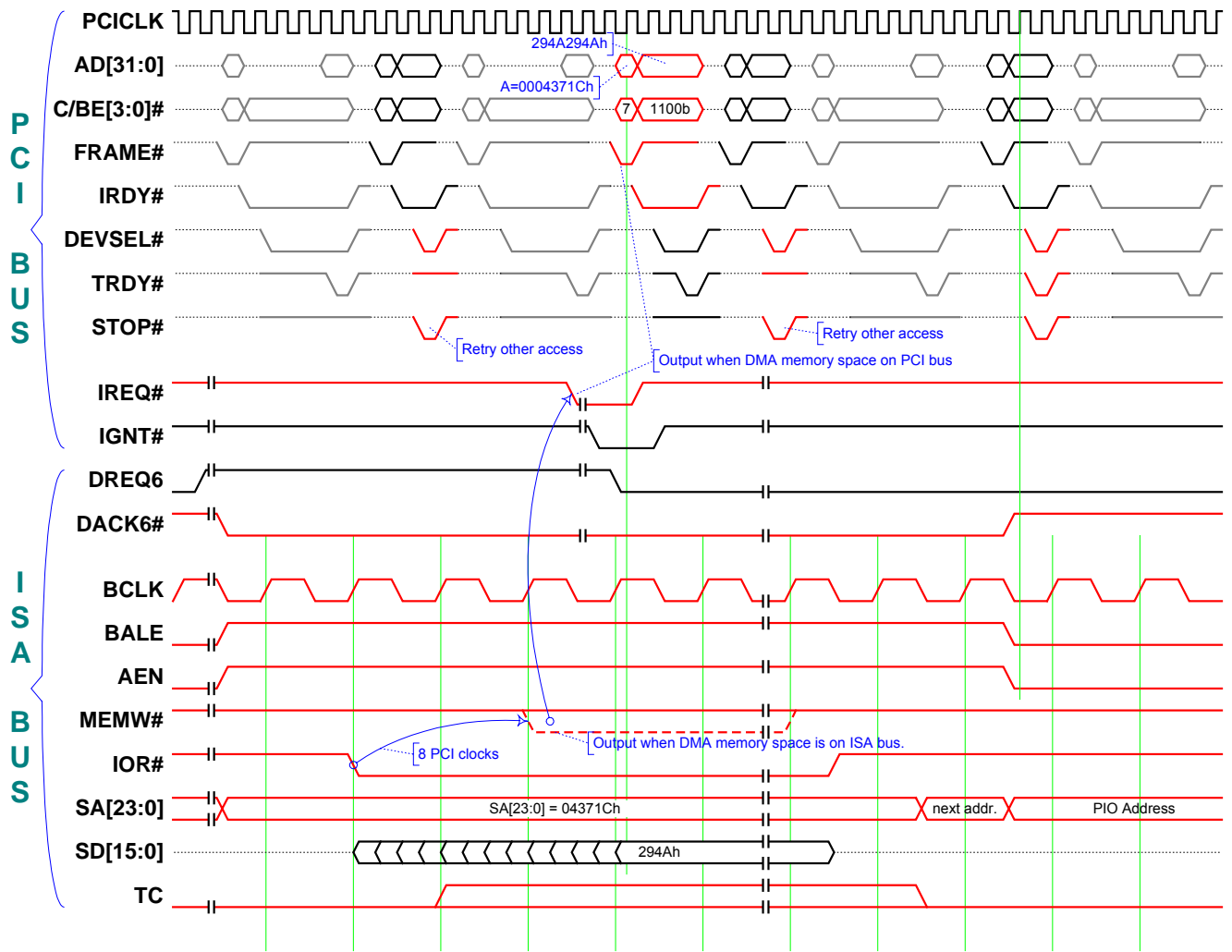


Figure 8-19. DMA Write Operation in DDMA (Memory Access to PCI when both Delayed-Transaction and DDMA-Concurrent are enabled.)

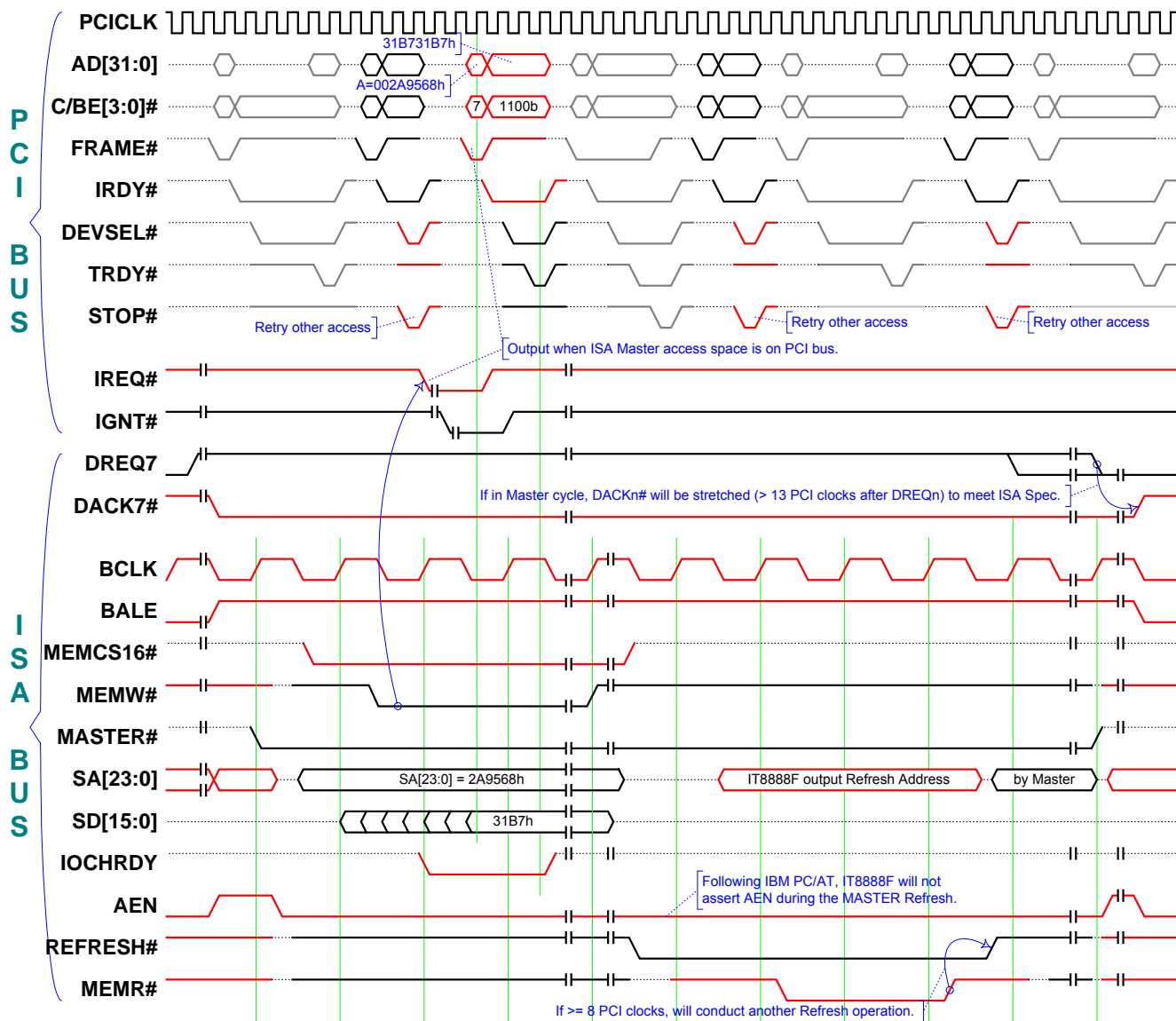


Figure 8-20. ISA Master Write and Master-Initiated-Refresh Operation in DDMA (Memory Access to PCI when both Delayed-Transaction and DDMA-Concurrent are enabled.)

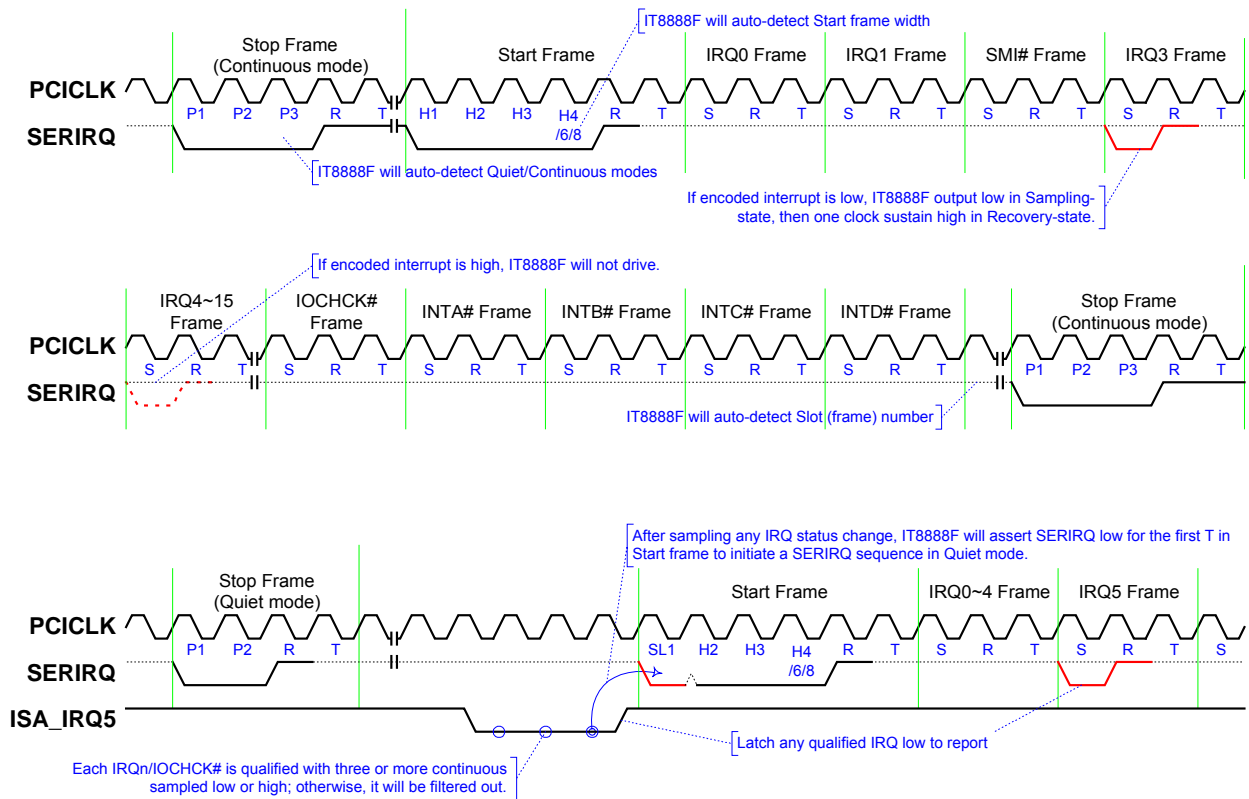


Figure 8-21. Serialized IRQ Coding

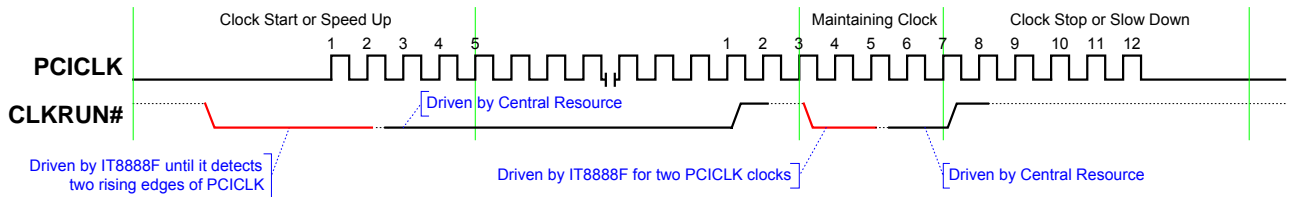


Figure 8-22. CLKRUN# Operation

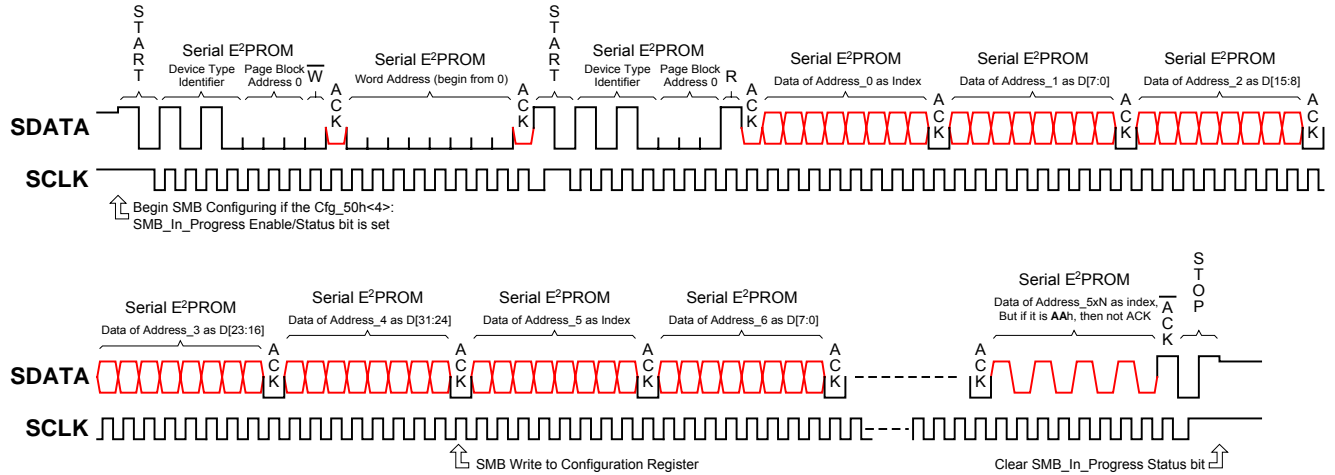


Figure 8-23. SMB Serial E²PROM Configuration Programming

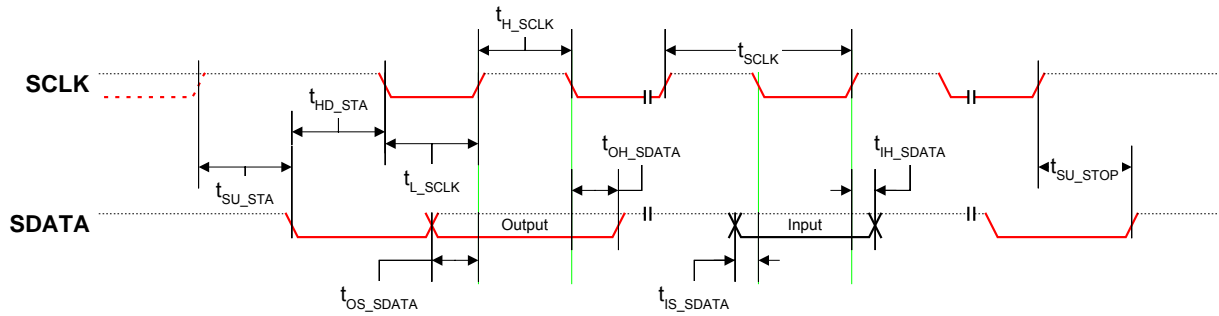


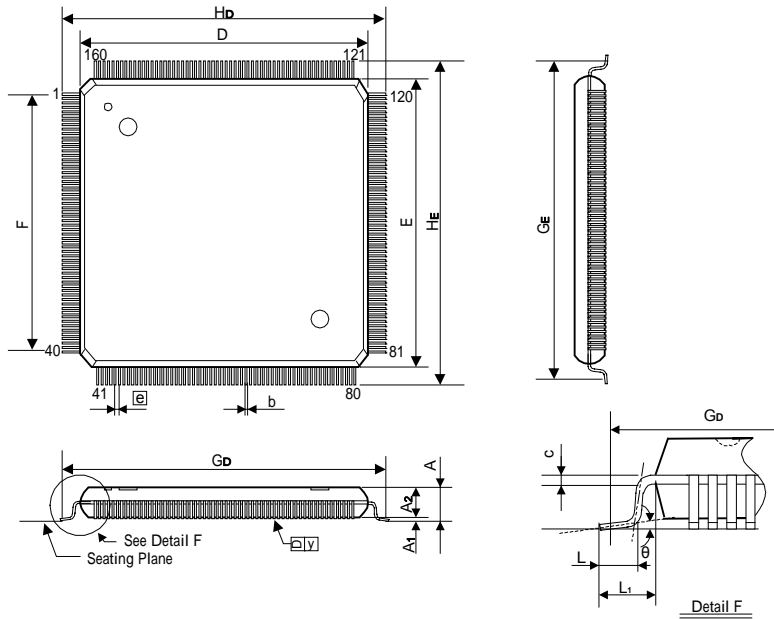
Figure 8-24. SMB Serial E²PROM Interface Timing

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9. Package Information

QFP 160L Outline Dimensions

unit: inches/mm



Symbol	Dimensions in inches	Dimensions in mm
A	0.145 Max.	3.68 Max.
A ₁	0.004 Min.	0.10 Min.
A ₂	0.127±0.005	3.23±0.13
b	0.012 ^{+0.004} -0.002	0.30 ^{+0.10} -0.05
c	0.006 ^{+0.004} -0.002	0.15 ^{+0.10} -0.05
D	1.102±0.005	28.00±0.13
E	1.102±0.005	28.00±0.13
<u>e</u>	0.026±0.006	0.65±0.15
F	0.998 NOM.	25.35 NOM.
G _D	1.197 NOM.	30.40 NOM.
G _E	1.197 NOM.	30.40 NOM.
H _D	1.228±0.012	31.20±0.30
H _E	1.228±0.012	31.20±0.30
L	0.031±0.008	0.80±0.20
L ₁	0.063±0.008	1.60±0.20
y	0.004 Max.	0.10 Max.
θ	0°~ 10°	0°~ 10°

Notes:

1. The dimensions D & E don't include resin fins.
2. Dimensions F, G_D, G_E are for PC Board surface mount pad pitch design reference only.
3. All dimensions are based on metric system.

DI-QFP160(28*28)v1

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10. Ordering Information

Part No.	Package
IT8888F	160 QFP

ITE also provides lead-free component. Please mark "-L" at the end of the Part No. when the parts ordered are lead-free.