

# ARM Dual-Timer Module (SP804)

Revision: r1p0

## Technical Reference Manual



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## Technical Reference Manual

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### Release Information

Change history		
Date	Issue	Change
31 October 2002	A	First release
26 June 2003	B	Signal name changes and TimerPeriphID2 Register value
14 November 2003	C	Change security to Open Access
23 January 2004	D	Value changed in Example 2-1

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# Contents

## ARM Dual-Timer Module (SP804) Technical Reference Manual

### Preface

About this book .....	x
Feedback .....	xiv

### Chapter 1

#### Introduction

1.1 About the ARM Dual-Timer module (SP804) .....	1-2
1.2 Features .....	1-3
1.3 Programmable parameters .....	1-4

### Chapter 2

#### Functional Overview

2.1 Overview .....	2-2
2.2 Functional description .....	2-4

### Chapter 3

#### Programmer's Model

3.1 Summary of registers .....	3-2
3.2 Register descriptions .....	3-4

### Chapter 4

#### Programmer's Model for Test

4.1 Integration test harness overview .....	4-2
4.2 Scan testing .....	4-3

## Appendix A

A.2 Non-AMBA signals ..... A-3

## List of Tables

# ARM Dual-Timer Module (SP804) Technical Reference Manual

	Change history .....	ii
Table 2-1	Expressions for calculating timer intervals .....	2-13
Table 3-1	Summary of registers .....	3-2
Table 3-2	Control Register bit assignments .....	3-5
Table 3-3	Raw Interrupt Status Register bit assignments .....	3-6
Table 3-4	Masked Interrupt Status Register bit assignments .....	3-7
Table 3-5	Peripheral Identification Register options .....	3-7
Table 3-6	Timer Peripheral ID0 Register bit assignments .....	3-9
Table 3-7	Timer Peripheral ID1 Register bit assignments .....	3-9
Table 3-8	Timer Peripheral ID2 Register bit assignments .....	3-9
Table 3-9	TimerPeripheralID3 register bit assignments .....	3-10
Table 3-10	PrimeCell ID0 Register bit assignments .....	3-11
Table 3-11	PrimeCell ID1 Register bit assignments .....	3-11
Table 3-12	PrimeCell ID2 Register bit assignments .....	3-11
Table 3-13	PrimeCell ID3 Register bit assignments .....	3-12
Table 4-1	Integration Test Control Register bit assignments .....	4-4
Table 4-2	Integration Test Output Set Register bit assignments .....	4-4
Table A-1	AMBA APB signal descriptions .....	A-2
Table A-2	Non-AMBA signals .....	A-3



# List of Figures

## ARM Dual-Timer Module (SP804) Technical Reference Manual

Figure 1-1	Simplified block diagram .....	1-3
Figure 2-1	Dual-Timer module block diagram .....	2-4
Figure 2-2	TIMCLK equals PCLK and TIMCLKENX equals one, clock example .....	2-7
Figure 2-3	TIMCLK equals PCLK and TIMCLKENX is pulsed, clock example .....	2-7
Figure 2-4	TIMCLK is less than PCLK and TIMCLKENX equals one, clock example .....	2-7
Figure 2-5	TIMCLK is less than PCLK and TIMCLKENX is pulsed, clock example .....	2-8
Figure 2-6	Prescale clock enable generation .....	2-8
Figure 2-7	Example timing diagram of prescaler clock enable generation .....	2-9
Figure 2-8	Example interrupt signal timing .....	2-12
Figure 2-9	Raw and masked interrupt status .....	2-12
Figure 3-1	Peripheral identification register bit assignment .....	3-8
Figure 3-2	PrimeCell identification register bit assignments .....	3-10
Figure 4-1	Output integration test harness .....	4-2





# Preface

This preface introduces the Dual-Timer module (SP804) and its reference documentation. It contains the following sections:

- *About this book* on page x
- *Feedback* on page xiv.

## About this book

This document is the *Technical Reference Manual* (TRM) for the ARM Dual-Timer module (SP804).

## Intended audience

This document is intended for hardware and software engineers implementing *System-on-Chip* (SoC) designs.

## Using this book

This book is organized into the following chapters:

### Chapter 1 *Introduction*

Read this chapter for an introduction to the Dual-Timer module and its features.

### Chapter 2 *Functional Overview*

Read this chapter for an overview of the major functional blocks and the operation of the Dual-Timer module.

### Chapter 3 *Programmer's Model*

Read this chapter for a description of the registers and for details of system initialization.

### Chapter 4 *Programmer's Model for Test*

Read this chapter for a description of the additional logic for functional verification and production testing.

### Appendix A *Signal Descriptions*

Read this appendix for a description of the Dual-Timer module signals.

## Product revision status

The *rn*pn identifier indicates the revision status of the product described in this document, where:

**rn** Identifies the major revision of the product.

**pn** Identifies the minor revision or modification status of the product.

## Typographical conventions

The following typographical conventions are used in this book:

<i>italic</i>	Highlights important notes, introduces special terminology, denotes internal cross-references, and citations.
<b>bold</b>	Highlights interface elements, such as menu names. Denotes ARM processor signal names. Also used for terms in descriptive lists, where appropriate.
monospace	Denotes text that can be entered at the keyboard, such as commands, file and program names, and source code.
<u>monospace</u>	Denotes a permitted abbreviation for a command or option. The underlined text can be entered instead of the full command or option name.
<i>monospace italic</i>	Denotes arguments to commands and functions where the argument is to be replaced by a specific value.
<b>monospace bold</b>	Denotes language keywords when used outside example code.

## Other conventions

This document uses other conventions. They are described in the following sections:

- *Signals*
- *Bytes, Halfwords, and Words* on page xii
- *Bits, bytes, k, and M* on page xii
- *Register fields* on page xii.

### Signals

When a signal is described as being asserted, the level depends on whether the signal is active HIGH or active LOW. Asserted means HIGH for active high signals and LOW for active low signals:

<b>Prefix n</b>	Active LOW signals are prefixed by a lowercase n except in the case of AHB or APB reset signals. These are named <b>HRESETn</b> and <b>PRESETn</b> respectively.
<b>Prefix H</b>	AHB signals are prefixed by an upper case H.
<b>Prefix P</b>	APB signals are prefixed by an upper case P.

## Bytes, Halfwords, and Words

<b>Byte</b>	Eight bits.
<b>Halfword</b>	Two bytes (16 bits).
<b>Word</b>	Four bytes (32 bits).
<b>Quadword</b>	16 contiguous bytes (128 bits).

## Bits, bytes, k, and M

<b>Suffix b</b>	Indicates bits.
<b>Suffix B</b>	Indicates bytes.
<b>Suffix K</b>	When used to indicate an amount of memory means 1024. When used to indicate a frequency means 1000.
<b>Suffix M</b>	When used to indicate an amount of memory means $1024^2 = 1\,048\,576$ . When used to indicate a frequency means 1 000 000.

## Register fields

All reserved or unused address locations must not be accessed as this can result in unpredictable behavior of the device.

All reserved or unused bits of registers must be written as zero, and ignored on read unless otherwise stated in the relevant text.

All registers bits are reset to logic 0 by a system reset unless otherwise stated in the relevant text.

Unless otherwise stated in the relevant text, all registers support read and write accesses. A write updates the contents of the register and a read returns the contents of the register.

All registers defined in this document can only be accessed using word reads and word writes, unless otherwise stated in the relevant text.

## Numbers

The conventions used in this document for numbers are:

<b>Prefix b</b>	Binary numbers are prefixed by a lowercase b.
<b>Prefix 0x</b>	Hexadecimal numbers are prefixed by 0x and use a monospace font.

## Further reading

This section lists publications from ARM Limited that provide additional information about ARM devices.

ARM periodically provides updates and corrections to its documentation. See <http://www.arm.com> for current errata sheets and addenda, and also for ARM Frequently Asked Questions.

## ARM publications

This document contains information that is specific to the ARM Dual-Timer module. Refer to the following document for other relevant information:

- *AMBA Specification (Rev 2.0)* (ARM IHI 0011).

## Feedback

ARM Limited welcomes feedback on both the Dual-Timer Module (SP804), and its documentation.

### Feedback on the Dual-Timer Module (SP804)

If you have any problems with the Dual-Timer Module (SP804), contact your supplier. To help us provide a rapid and useful response, give:

- details of the release you are using
- details of the platform you are running on, such as the hardware platform, operating system type and version
- a small standalone sample of code that reproduces the problem
- a clear explanation of what you expected to happen, and what actually happened
- the commands you used, including any command-line options
- sample output illustrating the problem
- the version string of the tool, including the version number and date.

### Feedback on this book

If you have any comments on this book, send email to [errata@arm.com](mailto:errata@arm.com) giving:

- the document title
- the document number
- the page number(s) to which your comments apply
- a concise explanation of your comments.

General suggestions for additions and improvements are also welcome.

# Chapter 1

## Introduction

This chapter introduces the Dual-Timer Module (SP804). It contains the following sections:

- *About the ARM Dual-Timer module (SP804)* on page 1-2
- *Features* on page 1-3
- *Programmable parameters* on page 1-4.

## 1.1 About the ARM Dual-Timer module (SP804)

The ARM Dual-Timer module is an *Advanced Microcontroller Bus Architecture* (AMBA) compliant *System-on-Chip* (SoC) peripheral developed, tested and licensed by ARM Limited. For more information, see the *AMBA Specification (Rev 2.0)*.

The module is an AMBA slave module and connects to the *Advanced Peripheral Bus* (APB). The Dual-Timer module consists of two programmable 32/16-bit down counters that can generate interrupts on reaching zero.



## 1.2 Features

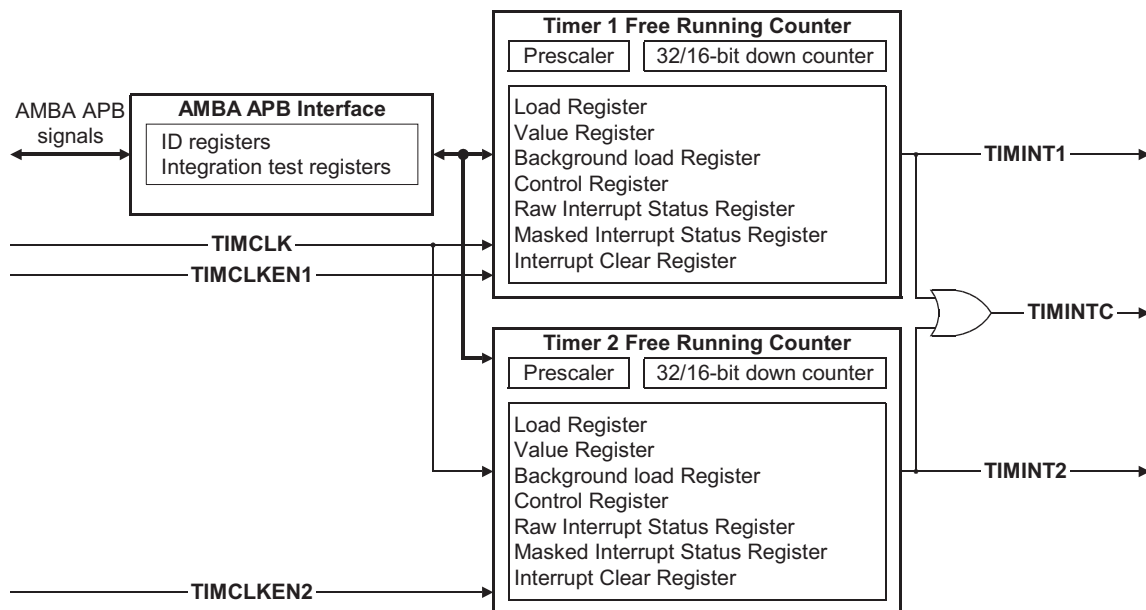
The features of the Dual-Timer module are:

- Compliance to the AMBA Specification (Rev 2.0) for easy integration into an SoC implementation.
- Two 32/16-bit down counters with free-running, periodic and one-shot modes.
- Common clock with separate clock-enables for each timer gives flexible control of the timer intervals.
- Interrupt output generation on timer count reaching zero.
- Identification registers that uniquely identify the Dual-Timer module. These can be used by software to automatically configure itself.

Figure 1-1 shows a simplified block diagram of the module.

**Note**

In Figure 1-1, test logic is not shown for clarity.



**Figure 1-1 Simplified block diagram**

## 1.3 Programmable parameters

The following Dual-Timer module parameters are programmable:

- free-running, periodic, or one-shot timer modes
- 32-bit or 16-bit timer operation
- prescaler divider of 1, 16, or 256
- interrupt generation enable and disable
- interrupt masking.

## Chapter 2

# Functional Overview

This chapter describes the Dual-Timer Module (SP804) operation. It contains the following sections:

- *Overview* on page 2-2
- *Functional description* on page 2-4.

## 2.1 Overview

This section gives a basic overview of the Dual-Timer module operation. See *Functional description* on page 2-4 for a full description of the Dual-Timer module functionality.

The Dual-Timer module consists of two identical programmable *Free Running Counters* (FRCs) that can be configured for 32-bit or 16-bit operation and one of three timer modes;

- free-running
- periodic
- one-shot.

The FRCs operate from a common timer clock, **TIMCLK** with each FRC having its own clock enable input, **TIMCLKEN1** and **TIMCLKEN2**. Each FRC also has a prescaler that can divide down the enabled **TIMCLK** rate by 1, 16, or 256. This enables the count rate for each FRC to be controlled independently using their individual clock enables and prescalers.

**TIMCLK** can be equal to or be a submultiple of the **PCLK** frequency. However, the positive edges of **TIMCLK** and **PCLK** must be synchronous and balanced.

The operation of each Timer module is identical. A Timer module can be programmed for a 32-bit or 16-bit counter size and one of three timer modes using the Control Register. The three timer modes are:

<b>Free-running</b>	The counter operates continuously and wraps around to its maximum value each time that it reaches zero.
<b>Periodic</b>	The counter operates continuously by reloading from the Load Register each time that the counter reaches zero.
<b>One-shot</b>	The counter is loaded with a new value by writing to the Load Register. The counter decrements to zero and then halts until it is reprogrammed.

The timer count is loaded by writing to the Load Register and, if enabled, the timer count decrements at a rate determined by **TIMCLK**, **TIMCLKENX**, and the prescaler setting. When the Timer counter is already running, writing to the Load Register causes the counter to immediately restart from the new value.

An alternative way of loading the Timer count is by writing to the Background Load Register. This has no immediate effect on the current count but the counter continues to decrement. On reaching zero, the Timer count is reloaded from the new load value if it is in periodic mode.

When the Timer count reaches zero an interrupt is generated. The interrupt is cleared by writing to the Interrupt Clear Register. The external interrupt signals can be masked off by the Interrupt Mask Registers.

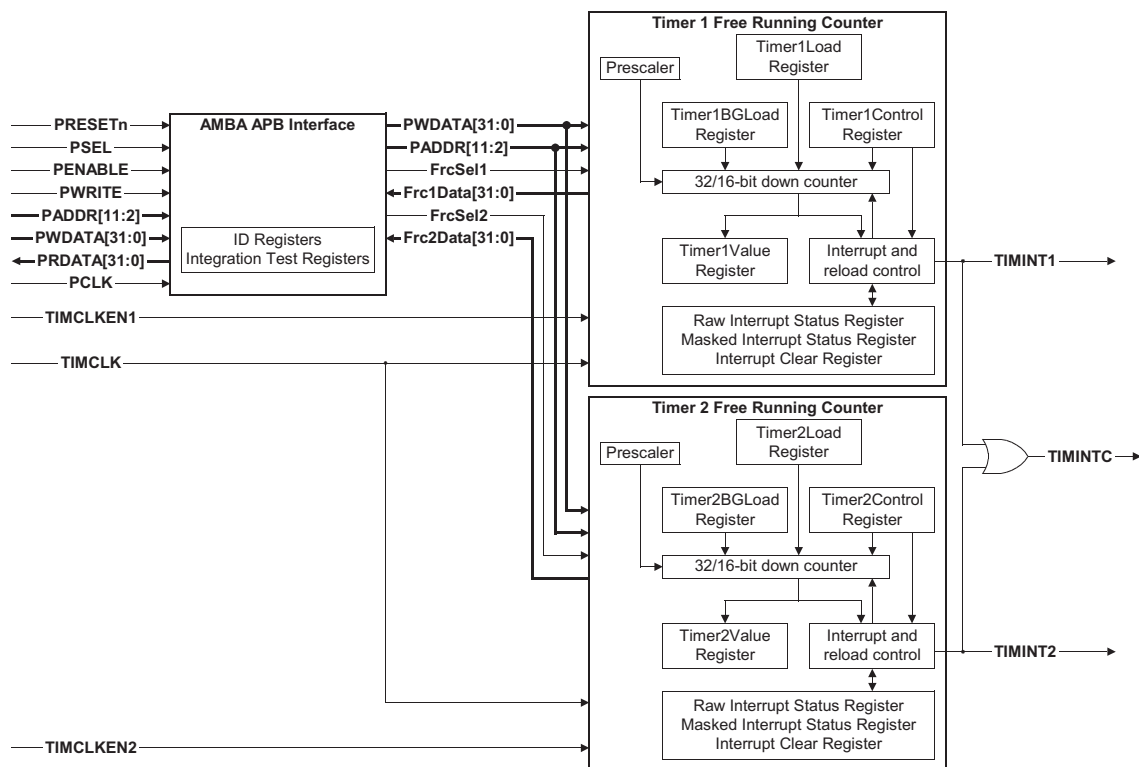
The current counter value can be read from the Value Register at any time.

## 2.2 Functional description

The Dual-Timer module block diagram is shown in Figure 2-1.

### Note

In Figure 2-1, test logic is not shown for clarity.



**Figure 2-1 Dual-Timer module block diagram**

The Dual-Timer module is described in the following sections:

- *AMBA APB Interface* on page 2-5
- *Free-running counter blocks* on page 2-5
- *Interface reset* on page 2-5
- *Clock signals and clock enables* on page 2-6
- *Prescaler operation* on page 2-8

- *Timer operation* on page 2-9
- *Interrupt behavior* on page 2-11
- *Programming the timer interval* on page 2-12
- *Identification Registers* on page 2-14.

### 2.2.1 AMBA APB Interface

The AMBA APB slave interface generates read and write decodes for accesses to all registers in the Dual-Timer module.

### 2.2.2 Free-running counter blocks

The two FRCs are identical and contain the 32/16-bit down counter and interrupt functionality. The counter logic is clocked independently of **PCLK** by **TIMCLK** in conjunction with a clock enable **TIMCLKENX** although there are constraints on the relationship between **PCLK** and **TIMCLK**. See *Clock signals and clock enables* on page 2-6 for details of these constraints.

Although the two FRCs are driven from a common clock, **TIMCLK**, each timer count rate can be independently controlled by their respective clock enables, **TIMCLKEN1** and **TIMCLKEN2**. The prescaler in each FRC gives a further independent control of the count rate of each FRC.

See *Timer operation* on page 2-9 for an operational description of the FRCs.

### 2.2.3 Interface reset

The Dual-Timer module is reset by the global reset signal **PRESETn**.

**PRESETn** can be asserted asynchronously to **PCLK** but must be deasserted synchronously to the rising edge of **PCLK**. **PRESETn** is used to reset the state of the Dual-Timer module registers. The Dual-Timer module requires that **PRESETn** is asserted LOW for at least one period of **PCLK**. The values of the registers after reset are described in Chapter 3 *Programmer's Model*. In summary, the Timer is initialized to the following state after reset:

- the counter is disabled
- free-running mode is selected
- 16-bit counter mode is selected
- prescalers are set to divide by 1
- interrupts are cleared but enabled
- the Load Register is set to zero
- the counter Value is set to 0xFFFFFFFF.

## 2.2.4 Clock signals and clock enables

The Dual-Timer module uses two input clocks:

- **PCLK** is used to time all APB accesses to the Dual-Timer module registers.
- **TIMCLK** is qualified by the clock enables, **TIMCLKEN1** and **TIMCLKEN2**, and used to clock the prescalers, counters and their associated interrupt logic. This qualified **TIMCLK** rate is referred to as the *effective timer clock* rate. The prescaler counter only decrements on a rising edge of **TIMCLK** when **TIMCLKENX** is HIGH. The Timer counter only decrements on a rising edge of **TIMCLK** when **TIMCLKENX** is HIGH and the prescaler counter generates an enable (see *Prescaler operation* on page 2-8).

The relationship between **TIMCLK** and **PCLK** must observe the following constraints:

- the rising edges of **TIMCLK** must be synchronous and balanced with a rising edge of **PCLK**
- **TIMCLK** frequency cannot be greater than **PCLK** frequency.

**TIMCLK**, **TIMCLKEN1**, and **TIMCLKEN2** can be used in the ways described in the following sections:

- *TIMCLK equals PCLK and TIMCLKENX equals one*
- *TIMCLK equals PCLK and TIMCLKENX is pulsed on page 2-7*
- *TIMCLK is less than PCLK and TIMCLKENX equals one on page 2-7*
- *TIMCLK is less than PCLK and TIMCLKENX is pulsed on page 2-8.*

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### Note

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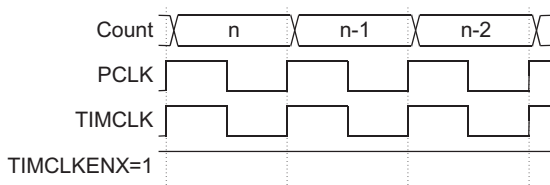
Unless otherwise stated these examples use a prescale setting of divide by 1. The examples apply to either Timer1 or Timer2 in the module. **TIMCLKENX** refers to either **TIMCLKEN1** or **TIMCLKEN2**.

---

### **TIMCLK equals PCLK and TIMCLKENX equals one**

Figure 2-2 on page 2-7 shows the case where **TIMCLK** is identical to **PCLK** and **TIMCLKENX** is permanently enabled. In this case, the counter is decremented on every **TIMCLK** edge.

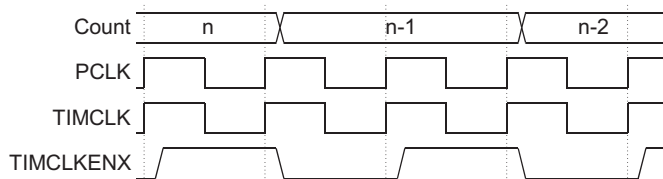




**Figure 2-2 TIMCLK equals PCLK and TIMCLKENX equals one, clock example**

### **TIMCLK equals PCLK and TIMCLKENX is pulsed**

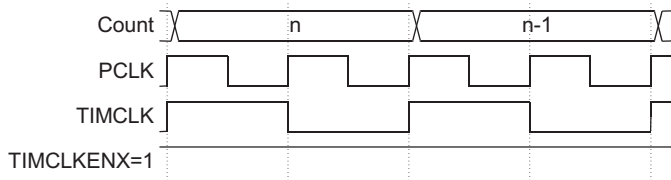
Figure 2-3 shows the case where **TIMCLK** is identical to **PCLK** but **TIMCLKENX** only enables every second **TIMCLK** edge. In this case, the counter is decremented on every second **TIMCLK** rising edge.



**Figure 2-3 TIMCLK equals PCLK and TIMCLKENX is pulsed, clock example**

### **TIMCLK is less than PCLK and TIMCLKENX equals one**

Figure 2-4 shows the case where **TIMCLK** frequency is a submultiple of the **PCLK** frequency but the rising edges of **TIMCLK** are synchronous and balanced with **PCLK** edges. **TIMCLKENX** is permanently enabled. In this case, the counter is decremented on every **TIMCLK** rising edge.



**Figure 2-4 TIMCLK is less than PCLK and TIMCLKENX equals one, clock example**

### TIMCLK is less than PCLK and TIMCLKENX is pulsed

Figure 2-5 shows the case where **TIMCLK** frequency is a submultiple of the **PCLK** frequency but the rising edges of **TIMCLK** are synchronous and balanced with **PCLK** edges. **TIMCLKENX** only enables every second **TIMCLK** edge. In this case, the counter is decremented on every second **TIMCLK** rising edge.

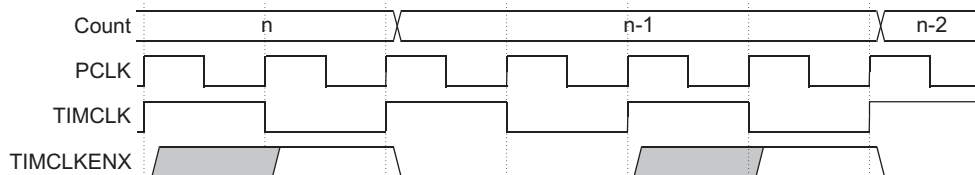


Figure 2-5 TIMCLK is less than PCLK and TIMCLKENX is pulsed, clock example

## 2.2.5 Prescaler operation

The prescaler generates a timer clock enable that is used to enable the decrementing of the timer counter at one of the following rates:

- the effective timer clock rate where **TIMCLK** is qualified by **TIMCLKENX**
- the effective timer clock rate divided by 16
- the effective timer clock rate divided by 256.

Figure 2-6 shows how the timer clock enable is generated by the prescaler.

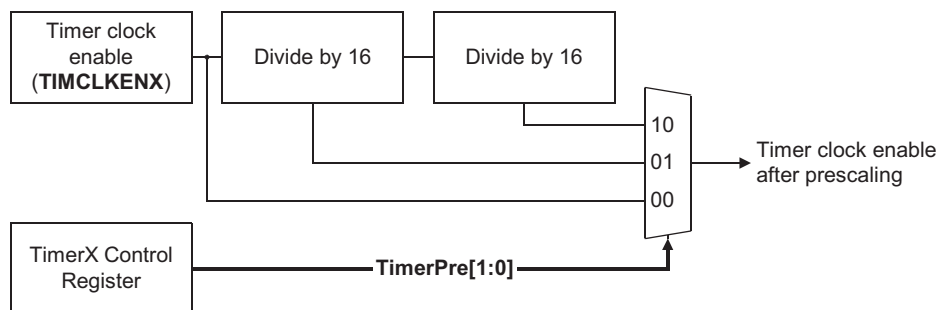
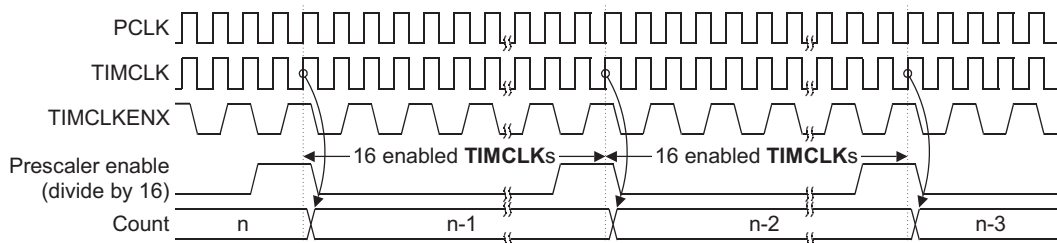


Figure 2-6 Prescale clock enable generation

Figure 2-7 on page 2-9 shows an example of how the prescaler generates the timer clock enable for a prescaler setting of divide by 16.



**Figure 2-7 Example timing diagram of prescaler clock enable generation**

## 2.2.6 Timer operation

After the initial application and release of **PRESETn**, the Timer state is initialized as follows:

- the counter is disabled, **TimerEn**=0
- free-running mode is selected, **TimerMode**=0 and **OneShot**=0
- 16-bit counter mode is selected, **TimerSize**=0
- prescalers are set to divide by 1, **TimerPre**=0x0
- interrupts are cleared but enabled, **IntEnable**=1
- the Load Register is set to zero
- the counter Value is set to 0xFFFFFFFF.

The operation in each of the three Timer modes is described in:

- *Free-running mode*
- *Periodic mode* on page 2-10
- *One-shot mode* on page 2-11.

### Free-running mode

Free-running mode is selected by setting the following bits in the **TimerControl Register**:

- set **TimerMode** bit to 1
- set **OneShot** bit to 0.

The 32-bit or 16-bit counter operation is selected by setting the **TimerSize** bit appropriately in the **TimerControl Register**.

On reset the timer value is initialized to 0xFFFFFFFF and if the counter is enabled then the count decrements by one for each **TIMCLK** positive edge when **TIMCLKENX** is HIGH and the prescaler generates an enable pulse. Alternatively, a new initial counter value can be loaded by writing to the TimerXLoad Register and the counter starts decrementing from this value if the counter is enabled.

In 32-bit mode, when the count reaches zero, 0x00000000, an interrupt is generated and the counter wraps around to 0xFFFFFFFF irrespective of the value in the TimerXLoad Register. The counter starts to decrement again and this whole cycle repeats for as long as the counter is enabled.

In 16-bit mode, only the least significant 16-bits of the counter are decremented and when the count reaches 0x0000, an interrupt is generated and the counter wraps round to 0xFFFF irrespective of the value in the TimerXLoad Register.

If the counter is disabled by clearing the TimerEn bit in the TimerControl Register, the counter halts and holds its current value. If the counter is re-enabled again then the counter continues decrementing from the current value.

The counter value can be read at any time by reading the TimerXValue Register.

### Periodic mode

Periodic mode is selected by setting the following bits in the TimerControl Register:

- set TimerMode bit to 0
- set OneShot bit to 0.

The 32-bit or 16-bit counter operation is selected by setting the TimerSize bit appropriately in the TimerControl Register.

An initial counter value can be loaded by writing to the TimerXLoad Register and the counter starts decrementing from this value if the counter is enabled.

In 32-bit mode, the full 32 bits of the counter are decremented and when the count reaches zero, 0x00000000, an interrupt is generated and the counter reloads with the value in the TimerXLoad Register. The counter starts to decrement again and this whole cycle repeats for as long as the counter is enabled.

In 16-bit mode, only the least significant 16-bits of the counter are decremented and when the count reaches 0x0000, an interrupt is generated and the counter reloads with the value in the TimerXLoad Register. The counter starts to decrement again and this whole cycle repeats for as long as the counter is enabled.

If a new value is loaded into the counter by writing to the TimerXLoad Register while the counter is running then the counter values changes to the new load value on the next **TIMCLK** when **TIMCLKENX** is HIGH.

If a new value is written to the Background Load Register, **TimerXBGLoad**, while the counter is running then the **TimerXLoad** Register is also updated with the same load value but the counter continues to decrement to zero. When it reaches zero, the counter reloads with the new load value and uses this new load value for each subsequent reload for as long as the timer is enabled in periodic mode.

If the counter is disabled by clearing the **TimerEn** bit in the **TimerControl** Register, the counter halts and holds its current value. If the counter is re-enabled again then the counter continues decrementing from the current value.

### One-shot mode

One-shot timer mode is selected by setting the **OneShot** bit in the **TimerControl** Register to 1. The **TimerMode** bit has no effect in one-shot mode.

The 32-bit or 16-bit counter operation is selected by setting the **TimerSize** bit appropriately in the **TimerControl** Register.

To initiate a count down sequence in one-shot mode, write a new load value to the **TimerXLoad** Register and the counter starts decrementing from this value if enabled.

In 32-bit mode, the full 32-bits of the counter are decremented and when the count reaches zero, **0x00000000**, an interrupt is generated and the counter halts.

In 16-bit mode, only the least significant 16-bits of the counter are decremented and when the count reaches **0x0000**, an interrupt is generated and the counter halts.

One-shot mode can be retrIGGERED by writing a new value to the **TimerXLoad** Register. The counter values changes to the new load value on the next **TIMCLK** when **TIMCLKENX** is HIGH.

## 2.2.7 Interrupt behavior

An interrupt is generated if **IntEnable**=1 and the counter reaches **0x00000000** in 32-bit mode or **0xFFFF0000** in 16-bit mode. The most significant 16 bits of the counter are ignored in 16-bit mode.

When the Timer module raises an interrupt by asserting **TIMINTX**, the timing of this signal is generated from a rising clock edge of **TIMCLK** enabled by **TIMCLKENX**. When the interrupt is cleared by a write to the **Interrupt Clear Register**, **TimerXIntClr**, the **TIMINTX** signal is deasserted immediately in the **PCLK** domain rather than waiting for the next enabled **TIMCLK** rising edge.

Figure 2-8 on page 2-12 illustrates an example of the timing for an interrupt being raised and cleared.



Figure 2-8 Example interrupt

The interrupt signals generated by the timer module are masked by setting the **TIMINT1** and **TIMINT2** bits in the **TimerXControl Register**. The interrupt status prior to the interrupt is masked by setting the **TIMXRIS** bit in the **TimerXRIS Register**. For more information on how the raw and masked interrupt status is generated, see the **TimerXMIS Register**. For more information on how the raw and masked interrupt status is generated, see the **TimerXMIS Register**.

Figure 2-8 Example interrupt

The interrupt signals generated by the timer module, **TIMINT1** and **TIMINT2**, are masked by setting the **TIMINT1** and **TIMINT2** bits in the **TimerXControl Register**. The interrupt status prior to the interrupt is masked by setting the **TIMXRIS** bit in the **TimerXRIS Register**. For more information on how the raw and masked interrupt status is generated, see the **TimerXMIS Register**. For more information on how the raw and masked interrupt status is generated, see the **TimerXMIS Register**.

Figure 2-9 Raw and masked interrupt

Programming the timer interval

Table 2-1 on page 2-13 shows the equations used to generate the timer interval for each timer mode in terms of **TIMCLK**.

- **TIMCLK<sub>FREQ</sub>** is the frequency of **TIMCLK**.

- **TIMCLKENX<sub>DIV</sub>** is the effective division of the **TIMCLK** rate by the clock enable, **TIMCLKENX**. For example, if **TIMCLKENX** enables every fourth **TIMCLK** edge then **TIMCLKENX<sub>DIV</sub>**=4.
- **PRESCALE<sub>DIV</sub>** is the prescaler division factor of 1, 16, or 256. Derived from Control Register bits[3:2].
- **TimerXLoad** is the value in the Load Register.

**Table 2-1 Expressions for calculating timer intervals**

Mode	Interval
Free-running 32-bit	$\left[ \frac{\text{TIMCLKENX}_{\text{DIV}} \times \text{PRESCALE}_{\text{DIV}}}{\text{TIMCLK}_{\text{FREQ}}} \right] \times 2^{32}$
Free-running 16-bit	$\left[ \frac{\text{TIMCLKENX}_{\text{DIV}} \times \text{PRESCALE}_{\text{DIV}}}{\text{TIMCLK}_{\text{FREQ}}} \right] \times 2^{16}$
Periodic and One-shot	$\left[ \frac{\text{TIMCLKENX}_{\text{DIV}} \times \text{PRESCALE}_{\text{DIV}}}{\text{TIMCLK}_{\text{FREQ}}} \right] \times \text{TimerXLoad}$

For example, the **TimerXLoad** value required for a 1ms periodic interval with **TIMCLK**=100MHz, **TIMCLKENX<sub>DIV</sub>**=1, and **PRESCALE<sub>DIV</sub>**=1 is calculated as shown in Example 2-1.

**Example 2-1 Calculating the TimerXLoad value**

$$\text{TimerXLoad} = \left[ \frac{\text{Interval} \times \text{TIMCLK}_{\text{FREQ}}}{\text{TIMCLKENX}_{\text{DIV}} \times \text{PRESCALE}_{\text{DIV}}} \right]$$

$$\text{TimerXLoad} = \left[ \frac{1\text{ms} \times 100\text{MHz}}{1 \times 1} \right] = 10^5 = 0\text{x}000186\text{A}0$$

---

**Note**

---

The minimum valid value for **TimerXLoad** is 1. If **TimerXload** is set to 0 then an interrupt is generated immediately.

---

### 2.2.9 Identification Registers

The Dual-Timer module contains a set of read-only Identification Registers that can be used by software to identify the timer peripheral type and revision. Software can use this information to automatically configure itself.

See Chapter 3 *Programmer's Model* for details of the Identification Registers.



# Chapter 3

## Programmer's Model

This chapter describes the registers of the Dual-Timer Module (SP804). It contains the following sections:

- *Summary of registers* on page 3-2
- *Register descriptions* on page 3-4.

### 3.1 Summary of registers

A summary of the registers is provided in Table 3-1.

**Table 3-1 Summary of registers**

Address	Type	Width	Reset value	Name	Description
Base+0x00	Read/write	32	0x00000000	Timer1Load	See <i>Load Register, TimerXLoad</i> on page 3-4
Base+0x04	Read	32	0xFFFFFFFF	Timer1Value	See <i>Current Value Register, TimerXValue</i> on page 3-5
Base+0x08	Read/write	8	0x20	Timer1Control	See <i>Control Register, TimerXControl</i> on page 3-5
Base+0x0C	Write	-	-	Timer1IntClr	See <i>Interrupt Clear Register, TimerXIntClr</i> on page 3-6
Base+0x10	Read	1	0x0	Timer1RIS	See <i>Raw Interrupt Status Register, TimerXRIS</i> on page 3-6
Base+0x14	Read	1	0x0	Timer1MIS	See <i>Masked Interrupt Status Register, TimerXMIS</i> on page 3-7
Base+0x18	Read/write	32	0x00000000	Timer1BGLoad	See <i>Background Load Register, TimerXBGLoad</i> on page 3-7
Base+0x20	Read/write	32	0x00000000	Timer2Load	See <i>Load Register, TimerXLoad</i> on page 3-4
Base+0x24	Read	32	0xFFFFFFFF	Timer2Value	See <i>Current Value Register, TimerXValue</i> on page 3-5
Base+0x28	Read/write	8	0x20	Timer2Control	See <i>Control Register, TimerXControl</i> on page 3-5
Base+0x2C	Write	-	-	Timer2IntClr	See <i>Interrupt Clear Register, TimerXIntClr</i> on page 3-6
Base+0x30	Read	1	0x0	Timer2RIS	See <i>Raw Interrupt Status Register, TimerXRIS</i> on page 3-6
Base+0x34	Read	1	0x0	Timer2MIS	See <i>Masked Interrupt Status Register, TimerXMIS</i> on page 3-7
Base+0x38	Read/write	32	0x00000000	Timer2BGLoad	See <i>Background Load Register, TimerXBGLoad</i> on page 3-7
0x40-0xEFC	-	-	-	-	Reserved for future expansion

Table 3-1 Summary of registers (continued)

Address	Type	Width	Reset value	Name	Description
Base+0xF00	Read/write	1	0x0	TimerITCR	See <i>Integration Test Control Register, TimerITCR</i> on page 4-4
Base+0xF04	Write	2	0x0	TimerITOP	See <i>Integration Test Control Register, TimerITCR</i> on page 4-4
0xF08-0xFDC	-	-	-	-	Reserved for future expansion
Base+0xFE0	Read-only	8	0x04	TimerPeriphID0	See <i>Timer Peripheral ID0 Register, TimerPeriphID0</i> on page 3-9
Base+0xFE4	Read-only	8	0x18	TimerPeriphID1	See <i>Timer Peripheral ID1 Register, TimerPeriphID1</i> on page 3-9
Base+0xFE8	Read-only	8	0x14	TimerPeriphID2	See <i>Timer Peripheral ID2 Register, TimerPeriphID2</i> on page 3-9
Base+0xFEC	Read-only	8	0x00	TimerPeriphID3	See <i>Timer Peripheral ID3 Register, TimerPeriphID3</i> on page 3-10
Base+0xFF0	Read-only	8	0x0D	TimerPCellID0	See <i>PrimeCell ID0 Register, TimerPCellID0</i> on page 3-11
Base+0xFF4	Read-only	8	0xF0	TimerPCellID1	See <i>PrimeCell ID1 Register, TimerPCellID1</i> on page 3-11
Base+0xFF8	Read-only	8	0x05	TimerPCellID2	See <i>PrimeCell ID2 Register, TimerPCellID2</i> on page 3-11
Base+0xFFC	Read-only	8	0xB1	TimerPCellID3	See <i>PrimeCell ID3 Register, TimerPCellID3</i> on page 3-12

## 3.2 Register descriptions

This section describes the dual Timer module registers:

- *Load Register, TimerXLoad*
- *Current Value Register, TimerXValue* on page 3-5
- *Control Register, TimerXControl* on page 3-5
- *Interrupt Clear Register, TimerXIntClr* on page 3-6
- *Raw Interrupt Status Register, TimerXRIS* on page 3-6
- *Masked Interrupt Status Register, TimerXMIS* on page 3-7
- *Background Load Register, TimerXBGLoad* on page 3-7
- *Peripheral Identification Registers, TimerPeriphID0-3* on page 3-7
- *PrimeCell Identification Registers, TimerPCellID0-3* on page 3-10.

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### Note

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The letter X used in register names means a register in either FRC1 or FRC2.

---

### 3.2.1 Load Register, TimerXLoad

The TimerXLoad Register is a 32-bit register that contains the value from which the counter is to decrement. This is the value used to reload the counter when Periodic mode is enabled, and the current count reaches zero.

When this register is written to directly, the current count immediately resets to the new value at the next rising edge of **TIMCLK** which is enabled by **TIMCLKENX**.

---

### Note

---

The minimum valid value for **TimerXLoad** is 1. If **TimerXload** is set to 0 then an interrupt is generated immediately.

---

The value in this register is also over-written if the TimerXBGLoad Register is written to, but the current count is not immediately affected.

If values are written to both the TimerXLoad and TimerXBGLoad Registers before an enabled rising edge on **TIMCLK**, then on the next enabled **TIMCLK** edge the value written to the TimerXLoad value replaces the current count value. After that, each time the counter reaches zero the current count value resets to the value written to TimerXBGLoad.

Reading from the TimerXLoad Register at any time after the two writes have occurred retrieves the value written to TimerXBGLoad. That is, the value read from TimerXLoad is always the value that takes effect for Periodic mode after the next time the counter reaches zero.

3.2.2 Current Value Register, TimerXValue

The TimerXValue Register is a 32-bit read-only register that gives the current value of the decrementing counter.

After a load operation has taken place by writing a new load value to TimerXLoad, the TimerXValue register reflects the new load value immediately in the **PCLK** clock domain without waiting for the next **TIMCLK** edge qualified by **TIMCLKENX**.

————— **Note** —————

The most significant 16 bits of the 32-bit TimerXValue Register are not automatically set to 0 when in 16-bit timer mode. If the timer is in 16-bit mode then the most significant 16 bits of the TimerXValue Register might have a non-zero value if the timer was previously in 32-bit mode and a write to the TimerXLoad Register has not occurred since the change to 16-bit mode.

3.2.3 Control Register, TimerXControl

The bit assignments of the Control Register are listed in Table 3-2.

**Table 3-2 Control Register bit assignments**

Bits	Name	Type	Function
[31:8]	-	-	Reserved bits, do not modify, and ignore on read
[7]	TimerEn	Read/write	Enable bit: 0 = Timer module disabled (default) 1 = Timer module enabled.
[6]	TimerMode	Read/write	Mode bit: 0 = Timer module is in free-running mode (default) 1 = Timer module is in periodic mode.
[5]	IntEnable	Read/write	Interrupt Enable bit: 0 = Timer module Interrupt disabled 1 = Timer module Interrupt enabled (default).
[4]	-	-	Reserved bit, do not modify, and ignore on read

Table 3-2 Control Register bit assignments (continued)

Bits	Name	Type	Function
[3:2]	TimerPre	Read/write	Prescale bits: 00 = 0 stages of prescale, clock is divided by 1 (default) 01 = 4 stages of prescale, clock is divided by 16 10 = 8 stages of prescale, clock is divided by 256 11 = Undefined, do not use.
[1]	TimerSize	Read/write	Selects 16/32 bit counter operation: 0 = 16-bit counter (default) 1 = 32-bit counter.
[0]	OneShot	Read/write	Selects one-shot or wrapping counter mode: 0 = wrapping mode (default) 1 = one-shot mode.

**Caution**

The counter mode, size or prescale settings must not be changed while the Timer module is running. If a new configuration is required then the Timer module must be disabled and then the new configuration values written to the appropriate registers. The Timer module must then be re-enabled after the configuration changes are complete. Failure to follow this procedure can result in unpredictable behavior of the device.

3.2.4 Interrupt Clear Register. TimerXIntClr

Any write to this register, clears the interrupt output from the counter.

3.2.5 Raw Interrupt Status Register, TimerXRIS

The TimerXRIS Register indicates the raw interrupt status from the counter. The bit assignment is listed in Table 3-3.

Table 3-3 Raw Interrupt Status Register bit assignments

Bits	Name	Type	Function
[31:1]	-	-	Reserved bits, do not modify, and ignore on read
[0]	TimerXRIS	Read	Raw interrupt status from the counter

### 3.2.6 Masked Interrupt Status Register, TimerXMIS

The TimerXMIS Register indicates the masked interrupt status from the counter. This value is the logical AND of the raw interrupt status with the Timer Interrupt Enable bit from the control register, and is the same value which is passed to the interrupt output pin, **TIMINTX**. The bit assignment is listed in Table 3-4.

**Table 3-4 Masked Interrupt Status Register bit assignments**

Bits	Name	Type	Function
[31:1]	-	-	Reserved bits, do not modify, and ignore on read
[0]	TimerXMIS	Read	Enabled interrupt status from the counter

### 3.2.7 Background Load Register, TimerXBGLoad

The TimerXBGLoad Register is a 32-bit register that contains the value from which the counter is to decrement. This is the value used to reload the counter when Periodic mode is enabled, and the current count reaches zero.

This provides an alternative method of accessing the TimerXLoad Register. The difference is that writes to TimerXBGLoad do not cause the counter to restart from the new value immediately.

Reading from this register returns the same value returned from TimerXLoad. See *Load Register, TimerXLoad* on page 3-4 for more information.

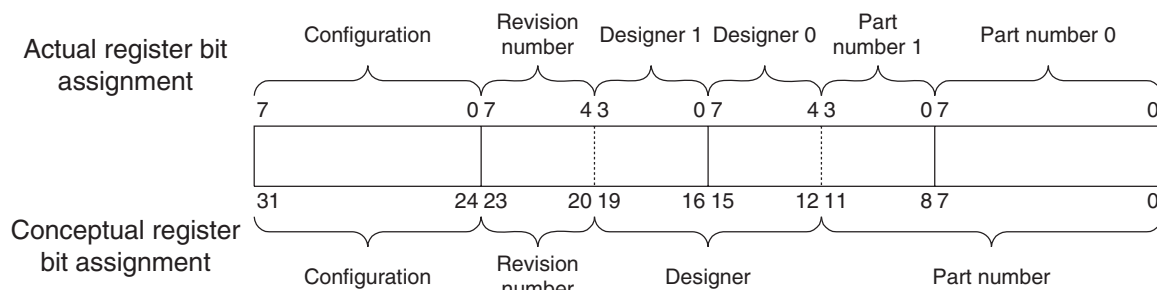
### 3.2.8 Peripheral Identification Registers, TimerPeriphID0-3

The TimerPeriphID0-3 Registers are four 8-bit registers, that span address locations 0xFE0 - 0xFEC. The registers can conceptually be treated as a 32-bit register. The read-only registers provide the peripheral options listed in Table 3-5.

**Table 3-5 Peripheral Identification Register options**

Bits	Function
PartNumber[11:0]	This is used to identify the peripheral. The three digits product code 0x804 is used.
Designer ID[19:12]	This is the identification of the designer. ARM Limited is 0x41 (ASCII A).
Revision[23:20]	This is the revision number of the peripheral. The revision number starts from 0.
Configuration[31:24]	This is the configuration option of the peripheral. The configuration value is 0.

Figure 3-1 on page 3-8 shows the bit assignments for the registers.



**Figure 3-1 Peripheral identification register bit assignment**

**Note**

When you design a system memory map you must remember that the peripheral has a 4KB-memory footprint. The 4-bit revision number is implemented by instantiating a component called RevAnd four times with its inputs tied off as appropriate, and the output sent to the read multiplexor. All memory accesses to the peripheral identification registers must be 32-bit, using the LDR instructions.

The four, 8-bit peripheral identification registers are described in the following subsections:

- *Timer Peripheral ID0 Register; TimerPeriphID0* on page 3-9
- *Timer Peripheral ID1 Register; TimerPeriphID1* on page 3-9
- *Timer Peripheral ID2 Register; TimerPeriphID2* on page 3-9
- *Timer Peripheral ID3 Register; TimerPeriphID3* on page 3-10.



### Timer Peripheral ID0 Register, TimerPeriphID0

The TimerPeriphID0 Register is hard-coded and the fields in the register determine the reset value. Table 3-6 lists the bit assignments of the register.

**Table 3-6 Timer Peripheral ID0 Register bit assignments**

Bit	Name	Description
[31:8]	-	Reserved, read undefined must be written as zeros
[7:0]	PartNumber0	These bits read back as 0x04

### Timer Peripheral ID1 Register, TimerPeriphID1

The TimerPeriphID1 Register is hard-coded and the fields in the register determine the reset value. Table 3-7 lists the bit assignments of the register.

**Table 3-7 Timer Peripheral ID1 Register bit assignments**

Bit	Name	Description
[31:8]	-	Reserved, read undefined, must be written as zeros
[7:4]	Designer0	These bits read back as 0x1
[3:0]	PartNumber1	These bits read back as 0x8

### Timer Peripheral ID2 Register, TimerPeriphID2

The TimerPeriphID2 register is hard-coded and the fields in the register determine the reset value. Table 3-8 lists the bit assignment of the register.

**Table 3-8 Timer Peripheral ID2 Register bit assignments**

Bit	Name	Description
[31:8]	-	Reserved, read undefined, must be written as zeros
[7:4]	Revision	These bits read back as 0x1
[3:0]	Designer1	These bits read back as 0x4

Timer Peripheral ID3 Register, TimerPeriphID3

The TimerPeriphID3 register is hard-coded and the fields in the register determine the reset value. Table 3-9 shows the bit assignments of the register.

Table 3-9 TimerPeriphID3 register bit assignments

Bit	Name	Description
[31:8]	-	Reserved, read undefined, must be written as zeros
[7:0]	Configuration	These bits read back as 0x00

3.2.9 PrimeCell Identification Registers, TimerPCellID0-3

The TimerPCellID0-3 Registers are four 8-bit registers, that span address locations 0xFF0-0xFFC. The read-only registers can conceptually be treated as a 32-bit register. The register is used as a standard cross-peripheral identification system. The TimerPCellID Register is set to 0xB105F00D. Figure 3-2 shows the bit assignment for the registers.

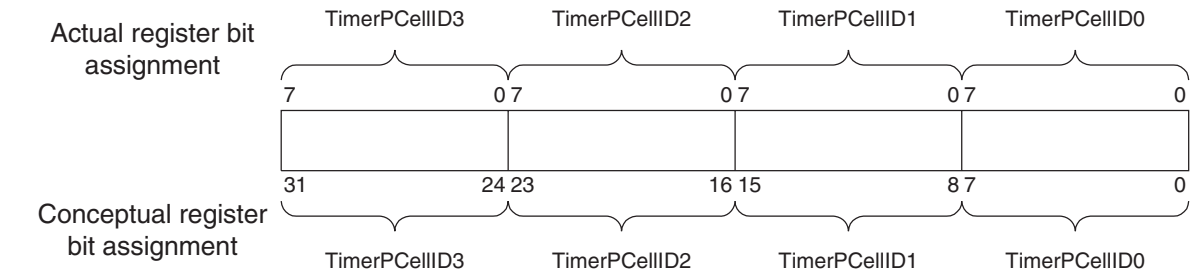


Figure 3-2 PrimeCell identification register bit assignments

The four, 8-bit PrimeCell identification registers are described in the following subsections:

- PrimeCell ID0 Register, TimerPCellID0 on page 3-11
- PrimeCell ID1 Register, TimerPCellID1 on page 3-11
- PrimeCell ID2 Register, TimerPCellID2 on page 3-11
- PrimeCell ID3 Register, TimerPCellID3 on page 3-12.

### PrimeCell ID0 Register, TimerPCellID0

The TimerPCellID0 register is hard-coded and the fields in the register determine the reset value. Table 3-10 shows the bit assignments of the register.

**Table 3-10 PrimeCell ID0 Register bit assignments**

Bit	Name	Description
[31:8]	-	Reserved, read undefined, must be written as zeros
[7:0]	TimerPCellID0	These bits read back as 0x00

### PrimeCell ID1 Register, TimerPCellID1

The TimerPCellID1 register is hard-coded and the fields in the register determine the reset value. Table 3-11 shows the bit assignment of the register.

**Table 3-11 PrimeCell ID1 Register bit assignments**

Bit	Name	Description
[31:8]	-	Reserved, read undefined, must be written as zeros
[7:0]	TimerPCellID1	These bits read back as 0xF0

### PrimeCell ID2 Register, TimerPCellID2

The TimerPCellID2 register is hard-coded and the fields in the register determine the reset value. Table 3-12 shows the bit assignment of the TimerPCellID2 register.

**Table 3-12 PrimeCell ID2 Register bit assignments**

Bit	Name	Description
[31:8]	-	Reserved, read undefined, must be written as zeros
[7:0]	TimerPCellID2	These bits read back as 0x05

**PrimeCell ID3 Register, TimerPCellID3**

The TimerPCellID3 register is hard-coded and the fields in the register determine the reset value. Table 3-13 shows the bit assignment of the TimerPCellID3 register.

**Table 3-13 PrimeCell ID3 Register bit assignments**

Bit	Name	Description
[31:8]	-	Reserved, read undefined, must be written as zeros
[7:0]	TimerPCellID3	These bits read back as 0xB1

# Chapter 4

## Programmer's Model for Test

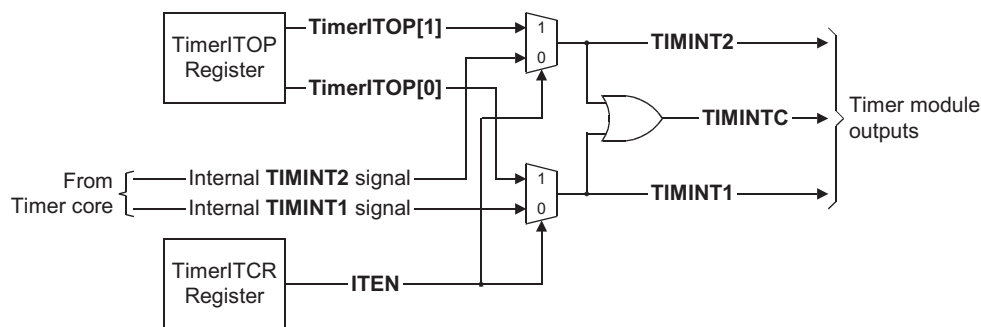
This chapter describes the additional logic for functional verification and production testing. It contains the following sections:

- *Integration test harness overview* on page 4-2
- *Scan testing* on page 4-3
- *Test registers* on page 4-4.

## 4.1 Integration test harness overview

The Dual-Timer module contains an integration test harness to enable the direct control of the non-AMBA module outputs for test purposes. The test harness is controlled by Integration Test Registers, **TIMERITCR** and **TIMERITOP**. This enables the connectivity of the **TIMINT1**, **TIMINT2**, and **TIMINTC** output signals to other modules in a SoC device to be easily verified using only transfers from the APB bus.

Figure 3-1 shows a block diagram of the output integration test harness and how **TIMINT1**, **TIMINT2**, and **TIMINTC** are controlled in integration test mode.



**Figure 4-1** Output integration test harness

## 4.2 Scan testing

The Dual-Timer module has been designed to simplify:

- insertion of scan test cells
- use of *Automatic Test Pattern Generation* (ATPG).

This is the recommended method of manufacturing test.

The Dual-Timer module includes placeholder signals to aid the scan insertion process. These are:

- **SCANENABLE**
- **SCANINPCLK**
- **SCANOUTPCLK.**

### 4.3 Test registers

The following registers are described:

- *Integration Test Control Register, TimerITCR*
- *Integration Test Output Set Register, TimerITOP.*

#### 4.3.1 Integration Test Control Register, TimerITCR

This is a single-bit register used to enable integration test mode. When in this mode, the masked interrupt outputs are directly controlled by the integration test output set register. The bit assignments are listed in Table 4-1.

Table 4-1 Integration Test Control Register bit assignments

Bits	Name	Type	Function
[31:1]	-	-	Reserved, read undefined, must be written as zeros
[0]	ITEN	Read/write	Integration test enable. When this bit is 1 the Dual-Timer module is placed in Integration Test Mode, otherwise it is in normal mode.

#### 4.3.2 Integration Test Output Set Register, TimerITOP

When in integration test mode, the enabled interrupt outputs are driven directly from the values in this register. The combined interrupt output **TIMINTC** then becomes the logical OR of the bits set in the integration test output set register. The bit assignments are listed in Table 4-2.

Table 4-2 Integration Test Output Set Register bit assignments

Bits	Name	Type	Function
[31:2]	-	-	Reserved, read undefined, must be written as zeros
[1]	TIMINT2	Write	Value output on <b>TIMINT2</b> when in Integration Test Mode
[0]	TIMINT1	Write	Value output on <b>TIMINT1</b> when in Integration Test Mode



# Appendix A

## Signal Descriptions

This chapter describes the signals that interface with the Dual-Timer Module (SP804). It contains the following sections:

- *AMBA APB signals* on page A-2
- *Non-AMBA signals* on page A-3.

A.1 AMBA APB signals

The Dual-Timer module is connected to the AMBA APB as a bus slave. Table A-1 describes the APB interface signals.

Table A-1 AMBA APB signal descriptions

Name	Type	Source/Destination	Description
PADDR[11:2]	Input	APB bridge	Subset of the AMBA APB address bus.
PCLK	Input	Clock generator	AMBA APB clock.
PENABLE	Input	APB bridge	AMBA APB enable signal. <b>PENABLE</b> is asserted HIGH for one cycle of <b>PCLK</b> to enable a bus transfer.
PRDATA[31:0]	Output	APB bridge	Unidirectional AMBA APB read data bus.
PRESETn	Input	Reset controller	APB bus reset signal, active LOW.
PSEL	Input	APB bridge	Timer module select signal from the decoder within the APB bridge. When HIGH this signal indicates the slave device is selected by the APB bridge, and that a data transfer is required.
PWDATA[31:0]	Input	APB bridge	Unidirectional AMBA APB write data bus.
PWRITE	Input	APB bridge	AMBA APB transfer direction signal, indicates a write access when HIGH, read access when LOW.

## A.2 Non-AMBA signals

Table A-2 describes the Dual-Timer module non-AMBA signals.

**Table A-2 Non-AMBA signals**

<b>Name</b>	<b>Type</b>	<b>Source/Destination</b>	<b>Description</b>
<b>TIMCLK</b>	Input	Clock generator	Timer clock
<b>TIMCLKEN1</b>	Input	Clock generator	Timer1 clock enable
<b>TIMCLKEN2</b>	Input	Clock generator	Timer2 clock enable
<b>TIMINT1</b>	Output	Interrupt controller	Timer1 interrupt, active HIGH
<b>TIMINT2</b>	Output	Interrupt controller	Timer2 interrupt, active HIGH
<b>TIMINTC</b>	Output	Interrupt controller	Combined interrupt, active HIGH
<b>SCANENABLE</b>	Input	Test controller	Placeholder for Dual-Timer module scan enable signal
<b>SCANINPCLK</b>	Input	Test controller	Placeholder for Dual-Timer module input scan signal
<b>SCANOUTPCLK</b>	Output	Test controller	Placeholder Dual-Timer module output scan signal



# Index

## A

About the module 1-2  
AMBA 1-3  
APB 2-5  
APB signals A-2

## B

Background Load Register 3-7

## C

Clock  
  enable 2-6  
  signals 2-6  
Control Register 3-5  
Conventions  
  numerical xii  
  register fields xii  
  signal xi

word length xii  
Current Value Register 3-5

## F

FRC 2-2  
Free running counter 2-2, 2-5  
Functional description 2-4  
Functional overview 2-2

## I

Identification Registers 1-3, 2-14, 3-7, 3-10  
Integration Test Control Register 4-4  
Integration test harness 4-2  
Integration Test Output Set Register 4-4  
Interface reset 2-5  
Interrupt 1-3  
  behavior 2-11

generation 1-4  
masking 1-4  
Interrupt Clear Register 3-6  
Interrupt Status Register 3-7

## L

Load Register 3-4

## M

Mode 1-4  
  free-running 2-2, 2-9  
  one-shot 2-2, 2-11  
  periodic 2-2, 2-10

## N

Non-AMBA signals A-3  
Numerical conventions xii

## P

Peripheral Identification Registers 3-7  
 Prescaler 1-4  
   operation 2-8  
 PrimeCell Identification Registers 3-10  
 Product revision status x  
 Programmable parameters 1-4

## R

Raw Interrupt Status Register 3-6  
 Register descriptions 3-4  
   Background Load Register 3-7  
   Control Register 3-5  
   Current Value Register 3-5  
   Interrupt Clear Register 3-6  
   Load Register 3-4  
   Masked Interrupt Status Register 3-7  
   Peripheral Identification Registers 3-7  
   PrimeCell Identification Registers 3-10  
   Raw Interrupt Status Register 3-6  
 Register field conventions xii  
 Reset signal 2-5  
 Revision status x

## S

Scan testing 4-3  
 Signal conventions xi  
 Signals  
   APB A-2  
   non-AMBA A-3  
 Summary of registers 3-2

## T

Test registers  
   Integration Test Control Register 4-4  
   Integration Test Output Set Register 4-4

Timer interval  
   programming 2-12  
 TimerITCR 4-4  
 TimerITOP 4-4  
 TimerPCellID0-3 3-10  
 TimerPeriphID0-3 3-7  
 TimerXBGLoad 3-7  
 TimerXControl 3-5  
 TimerXIntClr 3-6  
 TimerXLoad 3-4  
 TimerXMIS 3-7  
 TimerXRIS 3-6  
 TimerXValue 3-5

## W

Word length conventions xii