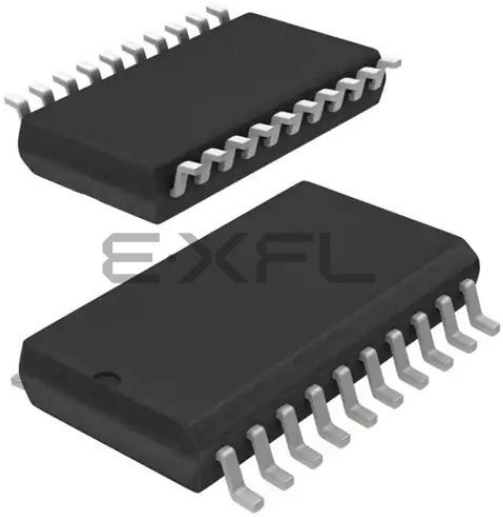

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Not For New Designs
Core Processor	ST7
Core Size	8-Bit
Speed	8MHz
Connectivity	SPI
Peripherals	LVD, POR, PWM, WDT
Number of I/O	17
Program Memory Size	2KB (2K x 8)
Program Memory Type	FLASH
EEPROM Size	128 x 8
RAM Size	256 x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 5.5V
Data Converters	A/D 7x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	20-SOIC (0.295", 7.50mm Width)
Supplier Device Package	20-SO
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/st7flit19bf0m3

Table 2. Hardware Register Map

Address	Block	Register Label	Register Name	Reset Status	Remarks
0000h	Port A	PADR	Port A Data Register	FFh[1)]	R/W
0001h		PADDR	Port A Data Direction Register	00h	R/W
0002h		PAOR	Port A Option Register	40h	R/W
0003h	Port B	PBDR	Port B Data Register	FFh [1)]	R/W
0004h		PBDDR	Port B Data Direction Register	00h	R/W
0005h		PBOR	Port B Option Register	00h	R/W[2)]
0006h	Port C	PCDR	Port C Data Register	0xh	R/W
0007h		PCDDR	Port C Data Direction Register	00h	R/W
0008h	LITE TIMER 2	LTCSR2	Lite Timer Control/Status Register 2	00h	R/W
0009h		LTARR	Lite Timer Auto-reload Register	00h	R/W
000Ah		LTCNTR	Lite Timer Counter Register	00h	Read Only
000Bh		LTCSR1	Lite Timer Control/Status Register 1	0X00 0000b	R/W
000Ch		LTICR	Lite Timer Input Capture Register	00h	Read Only
000Dh	AUTO-RELOAD TIMER 2	ATCSR	Timer Control/Status Register	0X00 0000b	R/W
000Eh		CNTRH	Counter Register High	00h	Read Only
000Fh		CNTRL	Counter Register Low	00h	Read Only
0010h		ATRH	Auto-Reload Register High	00h	R/W
0011h		ATRL	Auto-Reload Register Low	00h	R/W
0012h		PWMCR	PWM Output Control Register	00h	R/W
0013h		PWM0CSR	PWM 0 Control/Status Register	00h	R/W
0014h		PWM1CSR	PWM 1 Control/Status Register	00h	R/W
0015h		PWM2CSR	PWM 2 Control/Status Register	00h	R/W
0016h		PWM3CSR	PWM 3 Control/Status Register	00h	R/W
0017h		DCR0H	PWM 0 Duty Cycle Register High	00h	R/W
0018h		DCR0L	PWM 0 Duty Cycle Register Low	00h	R/W
0019h		DCR1H	PWM 1 Duty Cycle Register High	00h	R/W
001Ah		DCR1L	PWM 1 Duty Cycle Register Low	00h	R/W
001Bh		DCR2H	PWM 2 Duty Cycle Register High	00h	R/W
001Ch		DCR2L	PWM 2 Duty Cycle Register Low	00h	R/W
001Dh		DCR3H	PWM 3 Duty Cycle Register High	00h	R/W
001Eh		DCR3L	PWM 3 Duty Cycle Register Low	00h	R/W
001Fh		ATICRH	Input Capture Register High	00h	Read Only
0020h		ATICRL	Input Capture Register Low	00h	Read Only
0021h		ATCSR2	Timer Control/Status Register 2	03h	R/W
0022h		BREAKCR	Break Control Register	00h	R/W
0023h		ATR2H	Auto-Reload Register 2 High	00h	R/W
0024h		ATR2L	Auto-Reload Register 2 Low	00h	R/W
0025h		DTGR	Dead Time Generation Register	00h	R/W
0026h		BREAKEN	Break Enable Register	03h	R/W
0027h to 002Bh	Reserved area (5 bytes)				
002Ch	Comparator Voltage Reference	VREFCR	Internal Voltage Reference Control Register	00h	R/W
002Dh	Comparator	CMPCR	Comparator and Internal Reference Control Register	00h	R/W
002Eh	WDG	WDGCR	Watchdog Control Register	7Fh	R/W

5 DATA EEPROM

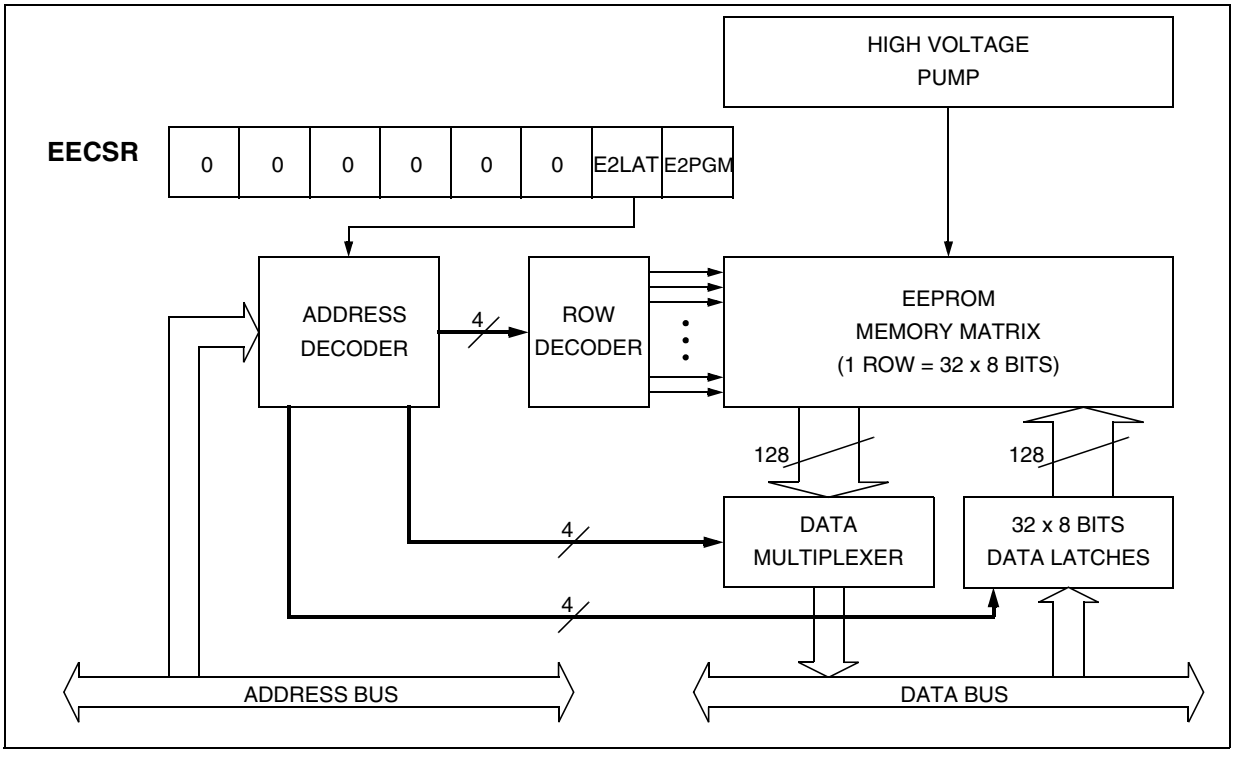
5.1 INTRODUCTION

The Electrically Erasable Programmable Read Only Memory can be used as a non volatile back-up for storing data. Using the EEPROM requires a basic access protocol described in this chapter.

5.2 MAIN FEATURES

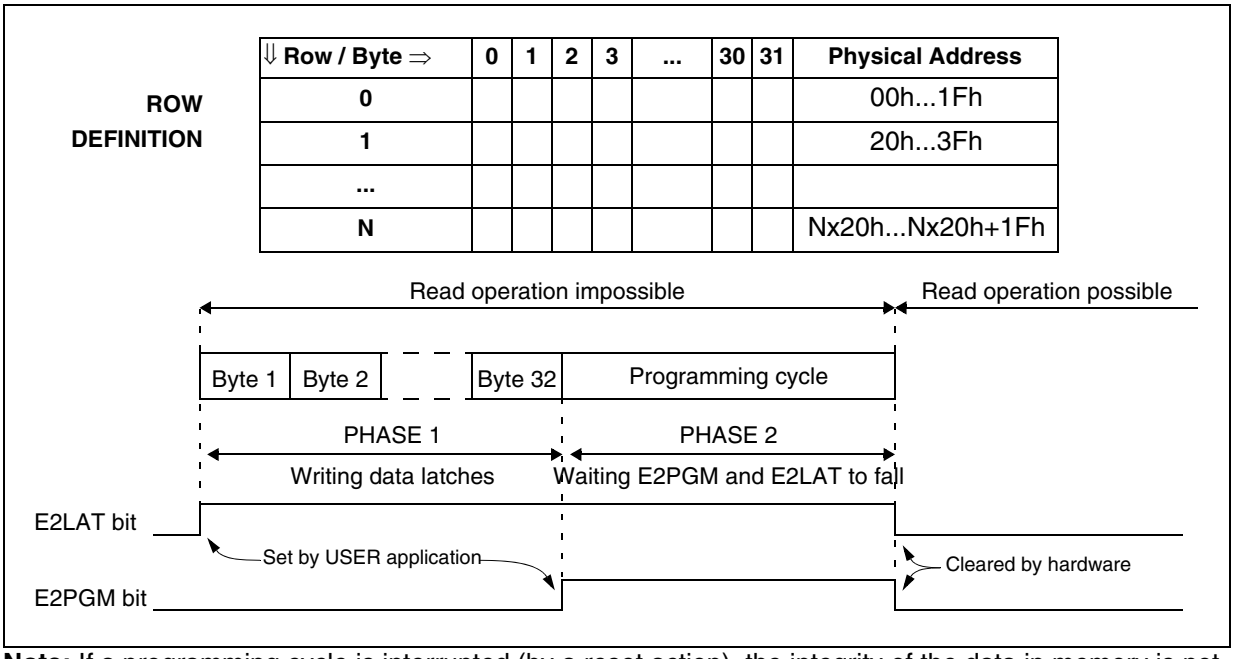
- Up to 32 Bytes programmed in the same cycle
- EEPROM mono-voltage (charge pump)
- Chained erase and programming cycles
- Internal control of the global programming cycle duration
- WAIT mode management
- Readout protection

Figure 7. EEPROM Block Diagram



DATA EEPROM (Cont'd)

Figure 9. Data E^2PROM Write Operation



Note: If a programming cycle is interrupted (by a reset action), the integrity of the data in memory is not guaranteed.

CPU REGISTERS (cont'd)

CONDITION CODE REGISTER (CC)

Read/Write

Reset Value: 111x1xxx

7							0
1	1	1	H	I	N	Z	C

The 8-bit Condition Code register contains the interrupt mask and four flags representative of the result of the instruction just executed. This register can also be handled by the PUSH and POP instructions.

These bits can be individually tested and/or controlled by specific instructions.

Bit 4 = **H** *Half carry*

This bit is set by hardware when a carry occurs between bits 3 and 4 of the ALU during an ADD or ADC instruction. It is reset by hardware during the same instructions.
0: No half carry has occurred.
1: A half carry has occurred.

This bit is tested using the JRH or JRNH instruction. The H bit is useful in BCD arithmetic subroutines.

Bit 3 = **I** *Interrupt mask*

This bit is set by hardware when entering in interrupt or by software to disable all interrupts except the TRAP software interrupt. This bit is cleared by software.
0: Interrupts are enabled.
1: Interrupts are disabled.

This bit is controlled by the RIM, SIM and IRET instructions and is tested by the JRM and JRNM instructions.

Note: Interrupts requested while I is set are latched and can be processed when I is cleared. By default an interrupt routine is not interruptible because the I bit is set by hardware at the start of the routine and reset by the IRET instruction at the end of the routine. If the I bit is cleared by software in the interrupt routine, pending interrupts are serviced regardless of the priority level of the current interrupt routine.

Bit 2 = **N** *Negative*

This bit is set and cleared by hardware. It is representative of the result sign of the last arithmetic, logical or data manipulation. It is a copy of the 7^{th} bit of the result.
0: The result of the last operation is positive or null.
1: The result of the last operation is negative (that is, the most significant bit is a logic 1).

This bit is accessed by the JRMI and JRPL instructions.

Bit 1 = **Z** *Zero*

This bit is set and cleared by hardware. This bit indicates that the result of the last arithmetic, logical or data manipulation is zero.
0: The result of the last operation is different from zero.
1: The result of the last operation is zero.

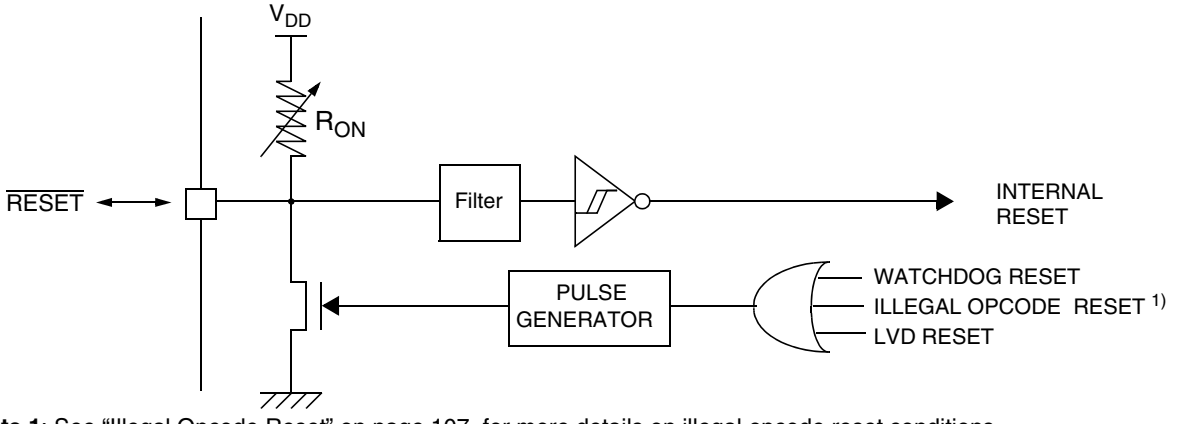
This bit is accessed by the JREQ and JRNE test instructions.

Bit 0 = **C** *Carry/borrow*

This bit is set and cleared by hardware and software. It indicates an overflow or an underflow has occurred during the last arithmetic operation.
0: No overflow or underflow has occurred.
1: An overflow or underflow has occurred.

This bit is driven by the SCF and RCF instructions and tested by the JRC and JRNC instructions. It is also affected by the "bit test and branch", shift and rotate instructions.

Figure 16. Reset Block Diagram



Note 1: See “Illegal Opcode Reset” on page 107. for more details on illegal opcode reset conditions.

8 INTERRUPTS

The ST7 core may be interrupted by one of two different methods: Maskable hardware interrupts as listed in the “interrupt mapping” table and a non-maskable software interrupt (TRAP). The Interrupt processing flowchart is shown in Figure 1.

The maskable interrupts must be enabled by clearing the I bit in order to be serviced. However, disabled interrupts may be latched and processed when they are enabled (see external interrupts subsection).

Note: After reset, all interrupts are disabled.

When an interrupt has to be serviced:

– Normal processing is suspended at the end of the current instruction execution.

– The PC, X, A and CC registers are saved onto the stack.

– The I bit of the CC register is set to prevent additional interrupts.

– The PC is then loaded with the interrupt vector of the interrupt to service and the first instruction of the interrupt service routine is fetched (refer to the Interrupt Mapping table for vector addresses).

The interrupt service routine should finish with the IRET instruction which causes the contents of the saved registers to be recovered from the stack.

Note: As a consequence of the IRET instruction, the I bit is cleared and the main program resumes.

Priority Management

By default, a servicing interrupt cannot be interrupted because the I bit is set by hardware entering in interrupt routine.

In the case when several interrupts are simultaneously pending, an hardware priority defines which one will be serviced first (see the Interrupt Mapping table).

Interrupts and Low Power Mode

All interrupts allow the processor to leave the WAIT low power mode. Only external and specifically mentioned interrupts allow the processor to leave the HALT low power mode (refer to the “Exit from HALT” column in the Interrupt Mapping table).

8.1 NON MASKABLE SOFTWARE INTERRUPT

This interrupt is entered when the TRAP instruction is executed regardless of the state of the I bit. It is serviced according to the flowchart in Figure 1.

8.2 EXTERNAL INTERRUPTS

External interrupt vectors can be loaded into the PC register if the corresponding external interrupt occurred and if the I bit is cleared. These interrupts allow the processor to leave the HALT low power mode.

The external interrupt polarity is selected through the miscellaneous register or interrupt register (if available).

An external interrupt triggered on edge will be latched and the interrupt request automatically cleared upon entering the interrupt service routine.

Caution: The type of sensitivity defined in the Miscellaneous or Interrupt register (if available) applies to the ei source. In case of a NANDed source (as described in the I/O ports section), a low level on an I/O pin, configured as input with interrupt, masks the interrupt request even in case of rising-edge sensitivity.

8.3 PERIPHERAL INTERRUPTS

Different peripheral interrupt flags in the status register are able to cause an interrupt when they are active if both:

– The I bit of the CC register is cleared.

– The corresponding enable bit is set in the control register.

If any of these two conditions is false, the interrupt is latched and thus remains pending.

Clearing an interrupt request is done by:

– Writing “0” to the corresponding bit in the status register or

– Access to the status register while the flag is set followed by a read or write of an associated register.

Note: The clearing sequence resets the internal latch. A pending interrupt (that is, waiting for being enabled) will therefore be lost if the clear sequence is executed.

POWER SAVING MODES (Cont'd)

Figure 27. ACTIVE-HALT Timing Overview

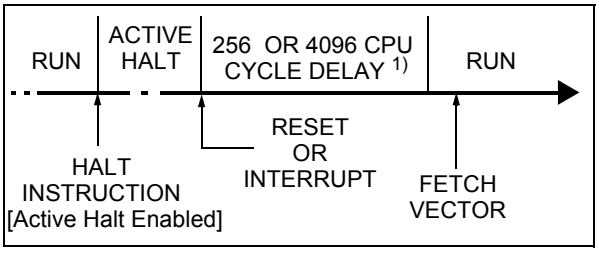
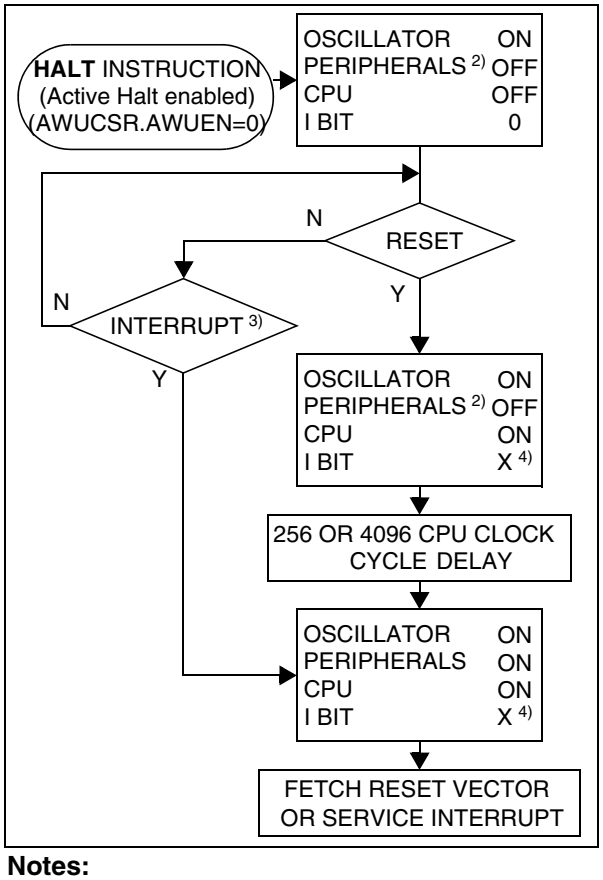


Figure 28. ACTIVE-HALT Mode Flow-chart



Notes:

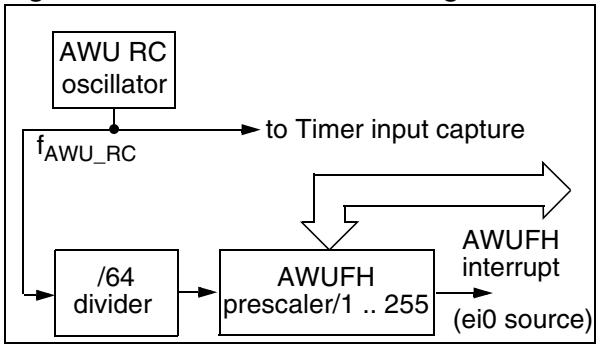
1. This delay occurs only if the MCU exits ACTIVE-HALT mode by means of a RESET.
2. Peripherals clocked with an external clock source can still be active.
3. Only the RTC1 interrupt and some specific interrupts can exit the MCU from ACTIVE-HALT mode. Refer to Table 5, "Interrupt Mapping," on page 37 for more details.
4. Before servicing an interrupt, the CC register is pushed on the stack. The I bit of the CC register is set during the interrupt routine and cleared when the CC register is popped.

9.6 AUTO WAKE UP FROM HALT MODE

Auto Wake Up From Halt (AWUFH) mode is similar to Halt mode with the addition of a specific internal RC oscillator for wake-up (Auto Wake Up from Halt Oscillator). Compared to ACTIVE-HALT mode, AWUFH has lower power consumption (the main clock is not kept running, but there is no accurate realtime clock available.

It is entered by executing the HALT instruction when the AWUEN bit in the AWUCSR register has been set.

Figure 29. AWUFH Mode Block Diagram



As soon as HALT mode is entered, and if the AWUEN bit has been set in the AWUCSR register, the AWU RC oscillator provides a clock signal (f_{AWU_RC}). Its frequency is divided by a fixed divider and a programmable prescaler controlled by the AWUPR register. The output of this prescaler provides the delay time. When the delay has elapsed the AWUF flag is set by hardware and an interrupt wakes-up the MCU from Halt mode. At the same time the main oscillator is immediately turned on and a 256 or 4096 cycle delay is used to stabilize it. After this start-up delay, the CPU resumes operation by servicing the AWUFH interrupt. The AWU flag and its associated interrupt are cleared by software reading the AWUCSR register.

To compensate for any frequency dispersion of the AWU RC oscillator, it can be calibrated by measuring the clock frequency f_{AWU_RC} and then calculating the right prescaler value. Measurement mode is enabled by setting the AWUM bit in the AWUCSR register in Run mode. This connects f_{AWU_RC} to the input capture of the 12-bit Auto-Reload timer, allowing the f_{AWU_RC} to be measured using the main oscillator clock as a reference timebase.

DUAL 12-BIT AUTORELOAD TIMER 4 (Cont'd)

11.2.3.2 Dead Time Generation

A dead time can be inserted between PWM0 and PWM1 using the DTGR register. This is required for half-bridge driving where PWM signals must not be overlapped. The non-overlapping PWM0/ PWM1 signals are generated through a programmable dead time by setting the DTE bit.

Dead time value = DT[6:0] x Tcounter1

DTGR[7:0] is buffered inside so as to avoid deforming the current PWM cycle. The DTGR effect will take place only after an overflow.

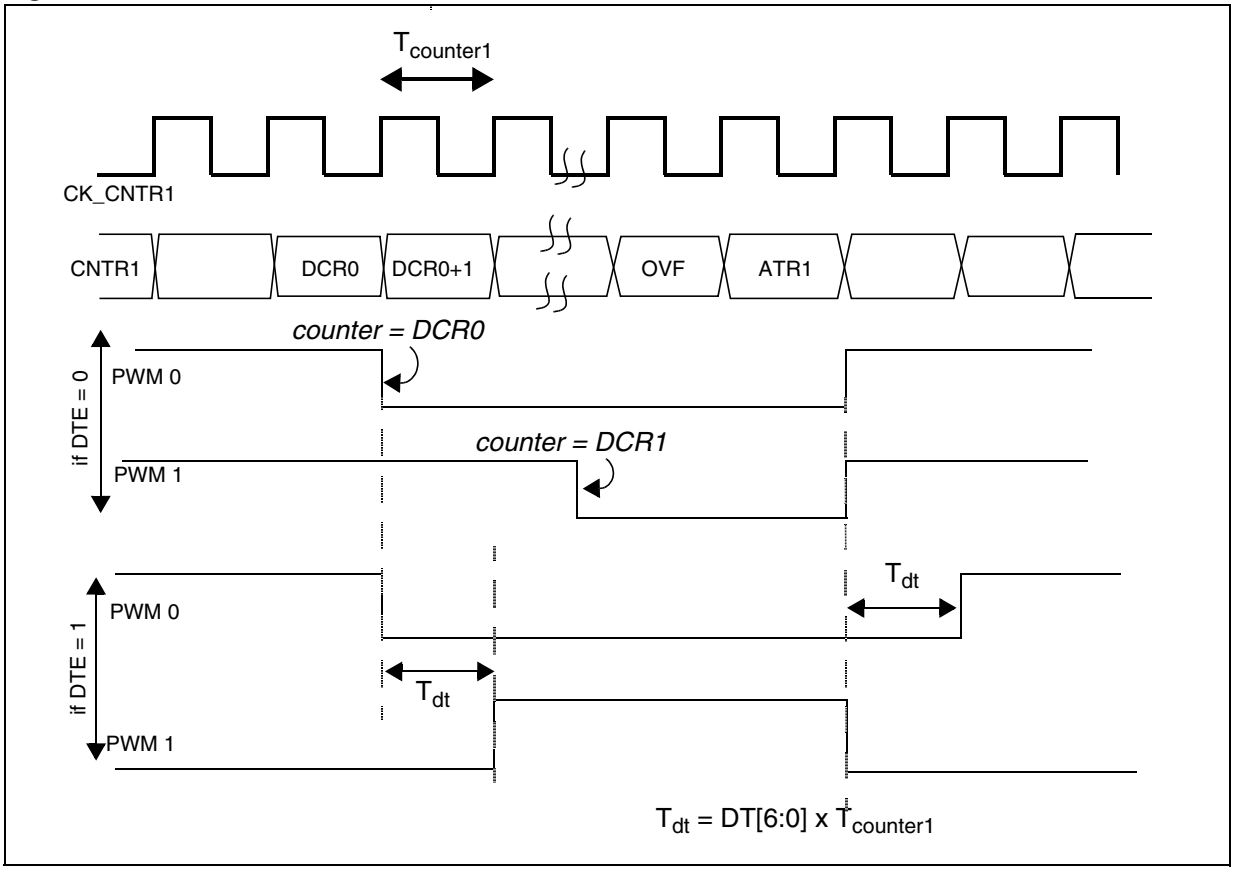
Notes:

1. Dead time is generated only when DTE=1 and DT[6:0] $\neq$ 0. If DTE is set and DT[6:0]=0, PWM output signals will be at their reset state.

2. Half Bridge driving is possible only if polarities of PWM0 and PWM1 are not inverted, i.e. if OP0 and OP1 are not set. If polarity is inverted, overlapping PWM0/PWM1 signals will be generated.

3. Dead Time generation does not work at 1 ms timebase.

Figure 40. Dead Time Generation



In the above example, when the DTE bit is set:

– PWM goes low at DCR0 match and goes high at ATR1+Tdt

– PWM1 goes high at DCR0+Tdt and goes low at ATR match.

With this programmable delay (Tdt), the PWM0 and PWM1 signals which are generated are not overlapped.

DUAL 12-BIT AUTORELOAD TIMER 4 (Cont'd)

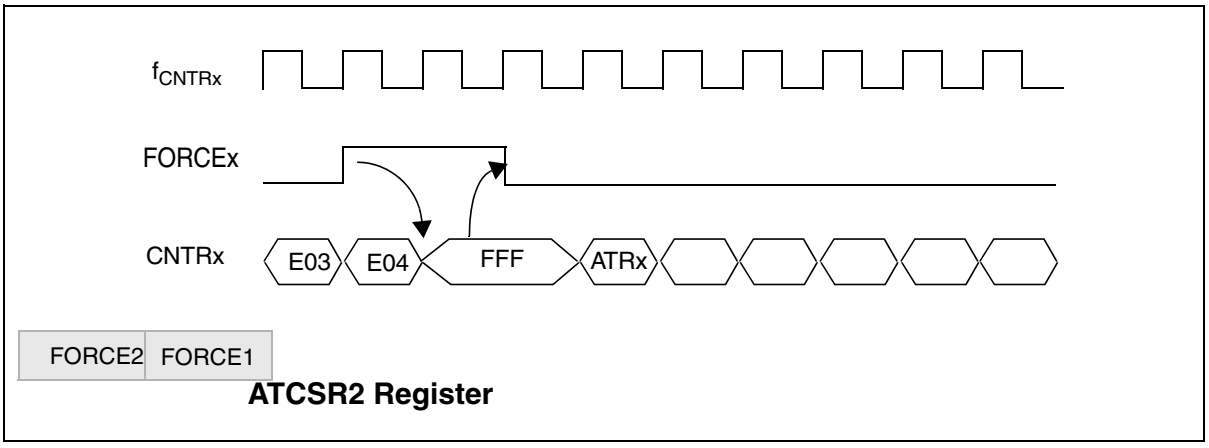
11.2.3.7 Force Update

In order not to wait for the counter$_x$ overflow to load the value into active DCRx registers, a programmable counter$_x$ overflow is provided. For both counters, a separate bit is provided which when set, make the counters start with the overflow value, i.e. FFFh. After overflow, the counters start counting from their respective auto reload register values.

These bits are FORCE1 and FORCE2 in the ATCSR2 register. FORCE1 is used to force an overflow on Counter 1 and, FORCE2 is used for Counter 2. These bits are set by software and reset by hardware after the respective counter overflow event has occurred.

This feature can be used at any time. All related features such as PWM generation, Output Compare, Input Capture, One-pulse (refer to Figure 15. Dynamic DCR2/3 update in One Pulse Mode) can be used this way.

Figure 50. Force Overflow Timing Diagram



DUAL 12-BIT AUTORELOAD TIMER 4 (Cont'd)

11.2.6 Register Description

TIMER CONTROL STATUS REGISTER (ATCSR)
Read / Write
Reset Value: 0x00 0000 (x0h)

7							0
0	ICF	ICIE	CK1	CK0	OVF1	OVFIE1	CMPIE

Bit 7 = Reserved.

Bit 6 = **ICF** *Input Capture Flag.*
This bit is set by hardware and cleared by software by reading the ATICR register (a read access to ATICRH or ATICRL will clear this flag). Writing to this bit does not change the bit value.
0: No input capture
1: An input capture has occurred

Bit 5 = **ICIE** *IC Interrupt Enable.*
This bit is set and cleared by software.
0: Input capture interrupt disabled
1: Input capture interrupt enabled

Bits 4:3 = **CK[1:0]** *Counter Clock Selection.*
These bits are set and cleared by software and cleared by hardware after a reset. They select the clock frequency of the counter.

Counter Clock Selection	CK1	CK0
OFF	0	0
32 MHz	1	1
f_{LTIMER} (1 ms timebase @ 8 MHz)	0	1
f_{CPU}	1	0

Bit 2 = **OVF1** *Overflow Flag.*
This bit is set by hardware and cleared by software by reading the ATCSR register. It indicates the transition of the counter1 CNTR1 from FFFh to ATR1 value.
0: No counter overflow occurred
1: Counter overflow occurred

Bit 1 = **OVFIE1** *Overflow Interrupt Enable.*
This bit is read/write by software and cleared by hardware after a reset.
0: Overflow interrupt disabled.
1: Overflow interrupt enabled.

Bit 0 = **CMPIE** *Compare Interrupt Enable*.
This bit is read/write by software and cleared by hardware after a reset. It can be used to mask the interrupt generated when any of the CMPFx bit is set.
0: Output compare interrupt disabled.
1: Output Compare interrupt enabled.

COUNTER REGISTER 1 HIGH (CNTR1H)
Read only
Reset Value: 0000 0000 (00h)

15							8
0	0	0	0	CNTR1_11	CNTR1_10	CNTR1_9	CNTR1_8

COUNTER REGISTER 1 LOW (CNTR1L)
Read only
Reset Value: 0000 0000 (00h)

7							0
CNTR1_7	CNTR1_6	CNTR1_5	CNTR1_4	CNTR1_3	CNTR1_2	CNTR1_1	CNTR1_0

Bits 15:12 = Reserved.

Bits 11:0 = **CNTR1[11:0]** *Counter Value*.
This 12-bit register is read by software and cleared by hardware after a reset. The counter CNTR1 increments continuously as soon as a counter clock is selected. To obtain the 12-bit value, software should read the counter value in two consecutive read operations. As there is no latch, it is recommended to read LSB first. In this case, CNTR1H can be incremented between the two read operations and to have an accurate result when $f_{timer}=f_{CPU}$, special care must be taken when CNTR1L values close to FFh are read.
When a counter overflow occurs, the counter restarts from the value specified in the ATR1 register.

ON-CHIP PERIPHERALS (cont'd)

11.4 SERIAL PERIPHERAL INTERFACE (SPI)

11.4.1 Introduction

The Serial Peripheral Interface (SPI) allows full-duplex, synchronous, serial communication with external devices. An SPI system may consist of a master and one or more slaves or a system in which devices may be either masters or slaves.

11.4.2 Main Features

- Full duplex synchronous transfers (on three lines)
- Simplex synchronous transfers (on two lines)
- Master or slave operation
- 6 master mode frequencies (f_{CPU}/4 max.)
- f_{CPU}/2 max. slave mode frequency (see note)
- $\overline{SS}$ Management by software or hardware
- Programmable clock polarity and phase
- End of transfer interrupt flag
- Write collision, Master Mode Fault and Overrun flags

Note: In slave mode, continuous transmission is not possible at maximum frequency due to the software overhead for clearing status flags and to initiate the next transmission sequence.

11.4.3 General Description

Figure 1 on page 3 shows the serial peripheral interface (SPI) block diagram. There are three registers:

- SPI Control Register (SPICR)
- SPI Control/Status Register (SPICSR)
- SPI Data Register (SPIDR)

The SPI is connected to external devices through four pins:

- MISO: Master In / Slave Out data
- MOSI: Master Out / Slave In data
- SCK: Serial Clock out by SPI masters and input by SPI slaves
- $\overline{SS}$: Slave select:
  This input signal acts as a 'chip select' to let the SPI master communicate with slaves individually and to avoid contention on the data lines. Slave $\overline{SS}$ inputs can be driven by standard I/O ports on the master Device.

SERIAL PERIPHERAL INTERFACE (cont'd)

11.4.3.1 Functional Description

A basic example of interconnections between a single master and a single slave is illustrated in Figure 2.

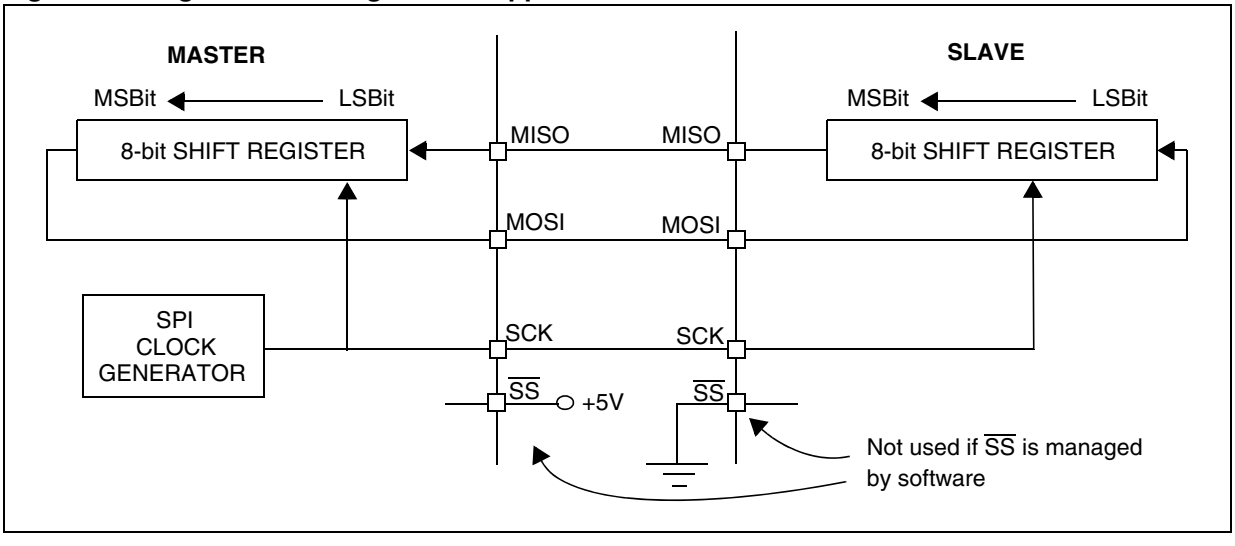
The MOSI pins are connected together and the MISO pins are connected together. In this way data is transferred serially between master and slave (most significant bit first).

The communication is always initiated by the master. When the master device transmits data to a slave device via MOSI pin, the slave device responds by sending data to the master device via the MISO pin. This implies full duplex communication with both data out and data in synchronized with the same clock signal (which is provided by the master device via the SCK pin).

To use a single data line, the MISO and MOSI pins must be connected at each node (in this case only simplex communication is possible).

Four possible data/clock timing relationships may be chosen (see Figure 5 on page 7) but master and slave must be programmed with the same timing mode.

Figure 54. Single Master/ Single Slave Application



SERIAL PERIPHERAL INTERFACE (cont'd)

11.4.4 Clock Phase and Clock Polarity

Four possible timing relationships may be chosen by software, using the CPOL and CPHA bits (See Figure 5).

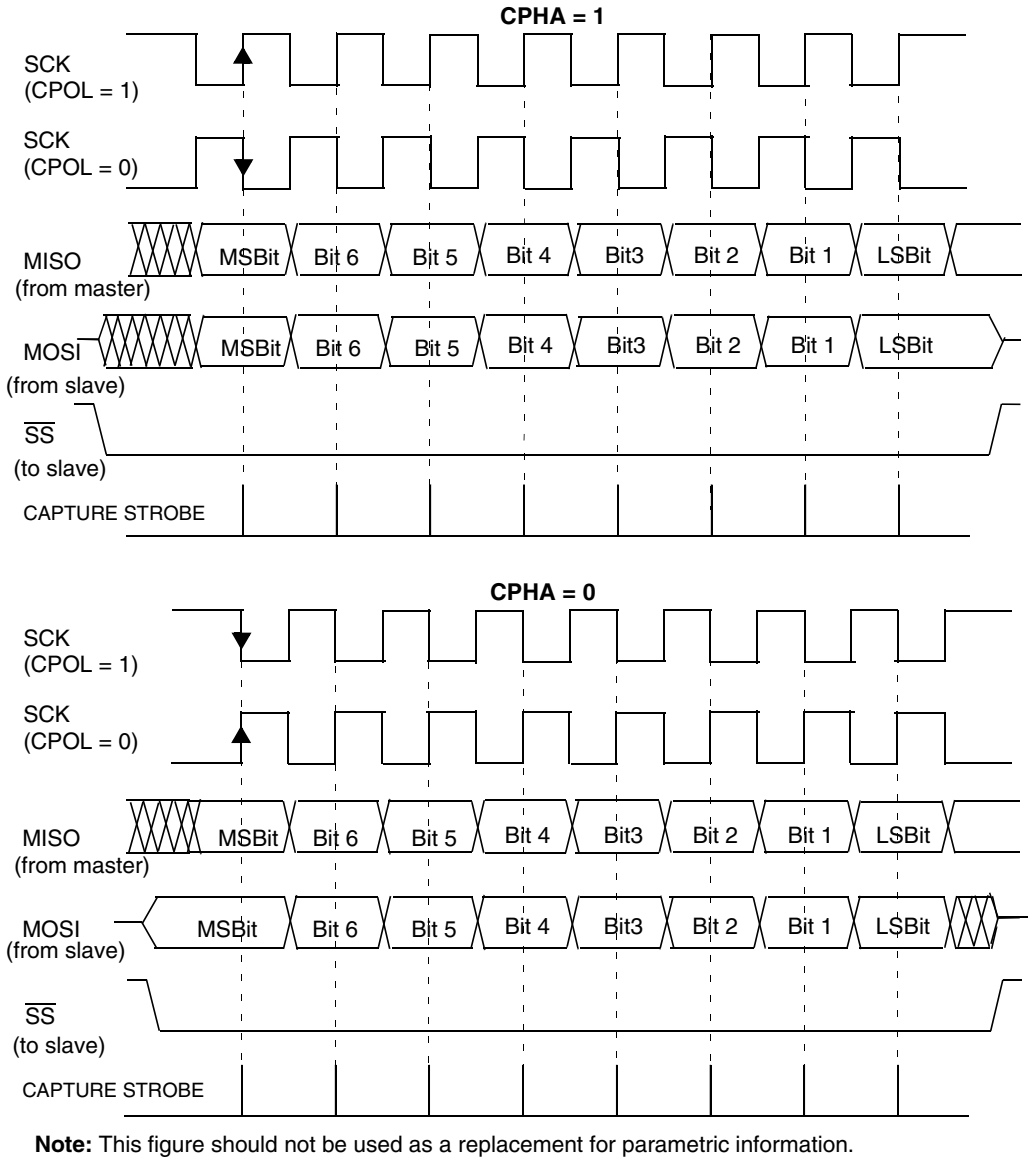
Note: The idle state of SCK must correspond to the polarity selected in the SPICSR register (by pulling up SCK if CPOL = 1 or pulling down SCK if CPOL = 0).

The combination of the CPOL clock polarity and CPHA (clock phase) bits selects the data capture clock edge.

Figure 5 shows an SPI transfer with the four combinations of the CPHA and CPOL bits. The diagram may be interpreted as a master or slave timing diagram where the SCK pin, the MISO pin and the MOSI pin are directly connected between the master and the slave device.

Note: If CPOL is changed at the communication byte boundaries, the SPI must be disabled by resetting the SPE bit.

Figure 57. Data Clock Timing Diagram



Note: This figure should not be used as a replacement for parametric information. Refer to the Electrical Characteristics chapter.

SERIAL PERIPHERAL INTERFACE (cont'd)

11.4.5 Error Flags

11.4.5.1 Master Mode Fault (MODF)

Master mode fault occurs when the master device's $\overline{SS}$ pin is pulled low.

When a Master mode fault occurs:

– The MODF bit is set and an SPI interrupt request is generated if the SPIE bit is set.

– The SPE bit is reset. This blocks all output from the device and disables the SPI peripheral.

– The MSTR bit is reset, thus forcing the device into slave mode.

Clearing the MODF bit is done through a software sequence:

1. A read access to the SPICSR register while the MODF bit is set.

2. A write to the SPICR register.

Notes: To avoid any conflicts in an application with multiple slaves, the $\overline{SS}$ pin must be pulled high during the MODF bit clearing sequence. The SPE and MSTR bits may be restored to their original state during or after this clearing sequence.

Hardware does not allow the user to set the SPE and MSTR bits while the MODF bit is set except in the MODF bit clearing sequence.

In a slave device, the MODF bit can not be set, but in a multimaster configuration the device can be in slave mode with the MODF bit set.

The MODF bit indicates that there might have been a multimaster conflict and allows software to handle this using an interrupt routine and either perform a reset or return to an application default state.

11.4.5.2 Overrun Condition (OVR)

An overrun condition occurs when the master device has sent a data byte and the slave device has not cleared the SPIF bit issued from the previously transmitted byte.

When an Overrun occurs:

– The OVR bit is set and an interrupt request is generated if the SPIE bit is set.

In this case, the receiver buffer contains the byte sent after the SPIF bit was last cleared. A read to the SPIDR register returns this byte. All other bytes are lost.

The OVR bit is cleared by reading the SPICSR register.

11.4.5.3 Write Collision Error (WCOL)

A write collision occurs when the software tries to write to the SPIDR register while a data transfer is taking place with an external device. When this happens, the transfer continues uninterrupted and the software write will be unsuccessful.

Write collisions can occur both in master and slave mode. See also Section 0.1.3.2 Slave Select Management.

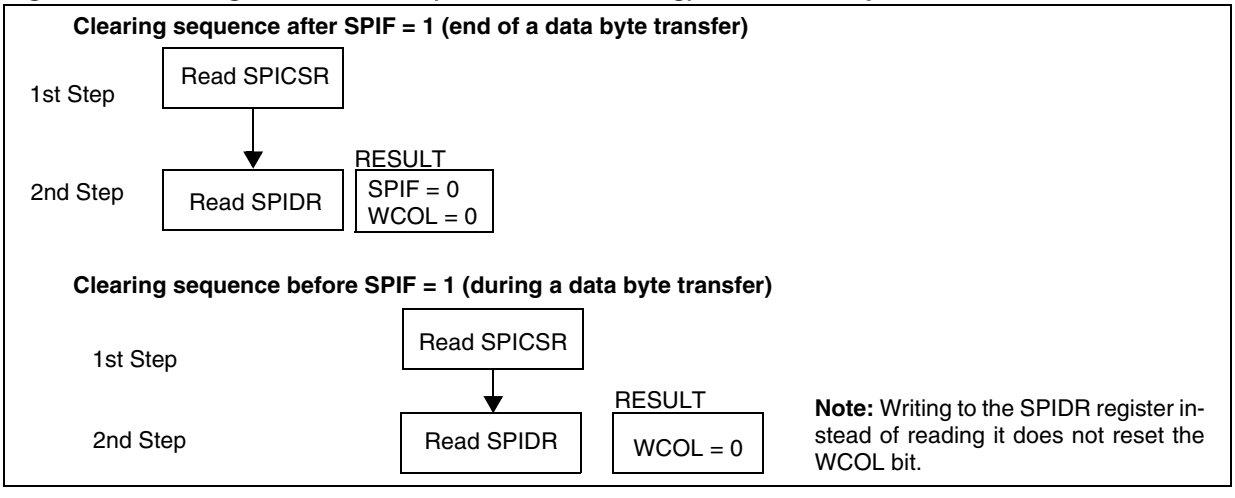
Note: A "read collision" will never occur since the received data byte is placed in a buffer in which access is always synchronous with the CPU operation.

The WCOL bit in the SPICSR register is set if a write collision occurs.

No SPI interrupt is generated when the WCOL bit is set (the WCOL bit is a status flag only).

Clearing the WCOL bit is done through a software sequence (see Figure 6).

Figure 58. Clearing the WCOL Bit (Write Collision Flag) Software Sequence



12 INSTRUCTION SET

12.1 ST7 ADDRESSING MODES

The ST7 Core features 17 different addressing modes which can be classified in seven main groups:

Addressing Mode	Example
Inherent	nop
Immediate	ld A,#$55
Direct	ld A,$55
Indexed	ld A,($55,X)
Indirect	ld A,([$55],X)
Relative	jrne loop
Bit operation	bset byte,#5

The ST7 Instruction set is designed to minimize the number of bytes required per instruction: To do so, most of the addressing modes may be subdivided in two submodes called long and short:

– Long addressing mode is more powerful because it can use the full 64 Kbyte address space, however it uses more bytes and more CPU cycles.

– Short addressing mode is less powerful because it can generally only access page zero (0000h - 00FFh range), but the instruction size is more compact, and faster. All memory to memory instructions use short addressing modes only (CLR, CPL, NEG, BSET, BRES, BTJT, BTJF, INC, DEC, RLC, RRC, SLL, SRL, SRA, SWAP)

The ST7 Assembler optimizes the use of long and short addressing modes.

Table 22. ST7 Addressing Mode Overview

Mode			Syntax	Destination/ Source	Pointer Address (Hex.)	Pointer Size (Hex.)	Length (Bytes)
Inherent			nop				+ 0
Immediate			ld A,#$55				+ 1
Short	Direct		ld A,$10	00..FF			+ 1
Long	Direct		ld A,$1000	0000..FFFF			+ 2
No Offset	Direct	Indexed	ld A,(X)	00..FF			+ 0 (with X register) + 1 (with Y register)
Short	Direct	Indexed	ld A,($10,X)	00..1FE			+ 1
Long	Direct	Indexed	ld A,($1000,X)	0000..FFFF			+ 2
Short	Indirect		ld A,[$10]	00..FF	00..FF	byte	+ 2
Long	Indirect		ld A,[$10.w]	0000..FFFF	00..FF	word	+ 2
Short	Indirect	Indexed	ld A,([$10],X)	00..1FE	00..FF	byte	+ 2
Long	Indirect	Indexed	ld A,([$10.w],X)	0000..FFFF	00..FF	word	+ 2
Relative	Direct		jrne loop	PC-128/PC+127[1)]			+ 1
Relative	Indirect		jrne [$10]	PC-128/PC+127[1)]	00..FF	byte	+ 2
Bit	Direct		bset $10,#7	00..FF			+ 1
Bit	Indirect		bset [$10],#7	00..FF	00..FF	byte	+ 2
Bit	Direct	Relative	btjt $10,#7,skip	00..FF			+ 2
Bit	Indirect	Relative	btjt [$10],#7,skip	00..FF	00..FF	byte	+ 3

Note:
1. At the time the instruction is executed, the Program Counter (PC) points to the instruction following JRxx.

13 ELECTRICAL CHARACTERISTICS

13.1 PARAMETER CONDITIONS

Unless otherwise specified, all voltages are referred to V_{SS}.

13.1.1 Minimum and Maximum values

Unless otherwise specified the minimum and maximum values are guaranteed in the worst conditions of ambient temperature, supply voltage and frequencies by tests in production on 100% of the devices with an ambient temperature at T_A=25°C and T_A=$T_A$max (given by the selected temperature range).

Data based on characterization results, design simulation and/or technology characteristics are indicated in the table footnotes and are not tested in production. Based on characterization, the minimum and maximum values refer to sample tests and represent the mean value plus or minus three times the standard deviation (mean±3Σ).

13.1.2 Typical values

Unless otherwise specified, typical data are based on T_A=25°C, V_{DD}=5V (for the 4.5V≤V_{DD}≤5.5V voltage range) and V_{DD}=3.3V (for the 3V≤V_{DD}≤3.6V voltage range). They are given only as design guidelines and are not tested.

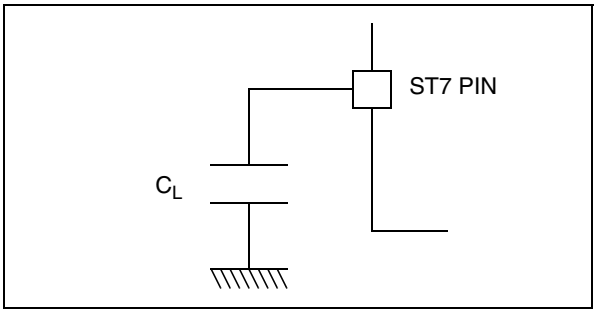
13.1.3 Typical curves

Unless otherwise specified, all typical curves are given only as design guidelines and are not tested.

13.1.4 Loading capacitor

The loading conditions used for pin parameter measurement are shown in Figure 63.

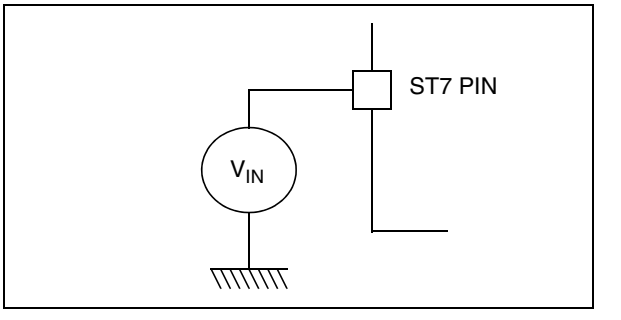
Figure 63. Pin loading conditions



13.1.5 Pin input voltage

The input voltage measurement on a pin of the device is described in Figure 64.

Figure 64. Pin input voltage



13.3.6 Operating conditions with ADC

T_A = -40 to 125°C, unless otherwise specified

Symbol	Parameter	Typ	Unit
$I_{INJ(ANA)}$ [1]	Injected current on any analog pin	0	mA

Note:
1. Current injection (negative or positive) not allowed on any analog pin.

13.5 CLOCK AND TIMING CHARACTERISTICS

Subject to general operating conditions for V_{DD}, f_{OSC}, and T_A.

13.5.1 General Timings

Symbol	Parameter [1]	Conditions	Min	Typ [2]	Max	Unit
$t_{c(INST)}$	Instruction cycle time	f_{CPU}=8MHz	2	3	12	t_{CPU}
			250	375	1500	ns
$t_{v(IT)}$	Interrupt reaction time [3] $t_{v(IT)} = \Delta t_{c(INST)} + 10$	f_{CPU}=8MHz	10		22	t_{CPU}
			1.25		2.75	µs

Notes:

1. Guaranteed by Design. Not tested in production.

2. Data based on typical application software.

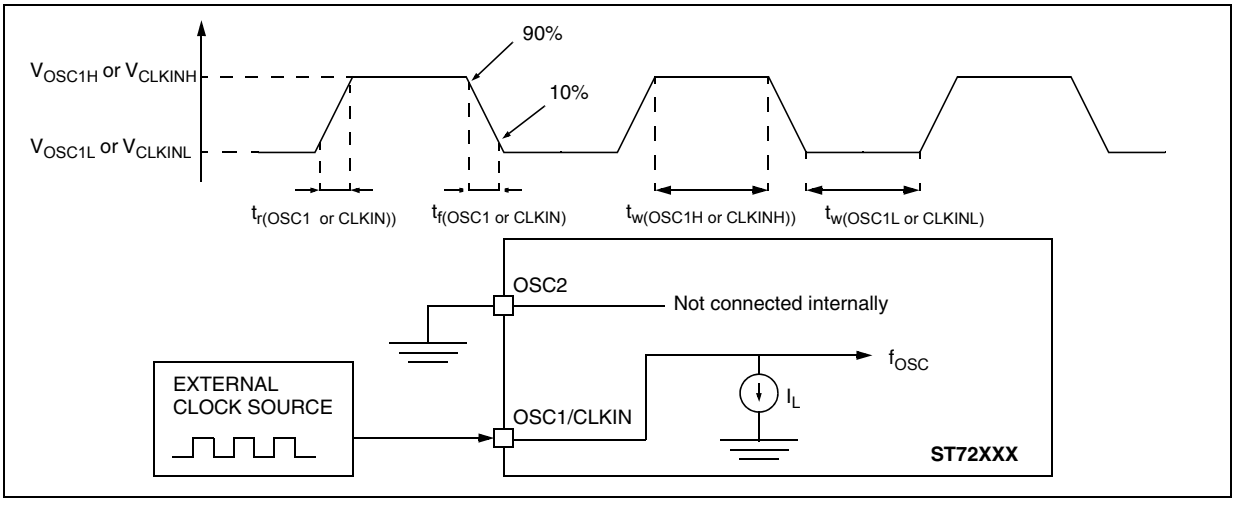
3. Time measured between interrupt event and interrupt vector fetch. $\Delta t_{c(INST)}$ is the number of t_{CPU} cycles needed to finish the current instruction execution.

4. Data based on design simulation and/or technology characteristics, not tested in production.

13.5.2 External Clock Source

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OSC1H} or V_{CLKIN_H}	OSC1/CLKIN input pin high level voltage	see Figure 78	0.7xV_{DD}		V_{DD}	V
V_{OSC1L} or V_{CLKIN_L}	OSC1/CLKIN input pin low level voltage		V_{SS}		0.3xV_{DD}	
$t_{w(OSC1H)}$ or $t_{w(CLKINH)}$ $t_{w(OSC1L)}$ or $t_{w(CLKINL)}$	OSC1/CLKIN high or low time [4]		15			ns
$t_{r(OSC1)}$ or $t_{r(CLKIN)}$ $t_{f(OSC1)}$ or $t_{f(CLKIN)}$	OSC1/CLKIN rise or fall time [4]				15	
I_L	OSCx/CLKIN Input leakage current	$V_{SS} \le V_{IN} \le V_{DD}$			±1	µA

Figure 78. Typical Application with an External Clock Source



13.5.3 Auto Wakeup from Halt Oscillator (AWU)

Symbol	Parameter [1]	Conditions	Min	Typ	Max	Unit
f_{AWU}	AWU Oscillator Frequency		50	125	250	kHz
t_{RCSRT}	AWU Oscillator startup time				50	µs

Note: 1. Guaranteed by Design. Not tested in production.

EMC CHARACTERISTICS (Cont'd)

13.7.3 Absolute Maximum Ratings (Electrical Sensitivity)

Based on two different tests (ESD and LU) using specific measurement methods, the product is stressed in order to determine its performance in terms of electrical sensitivity. For more details, refer to the application note AN1181.

13.7.3.1 Electro-Static Discharge (ESD)

Electro-Static Discharges (a positive then a negative pulse separated by 1 second) are applied to the pins of each sample according to each pin combination. The sample size depends on the number of supply pins in the device (3 parts*(n+1) supply pin). Two models can be simulated: Human Body Model and Machine Model. This test conforms to the JESD22-A114A/A115A standard.

Absolute Maximum Ratings

Symbol	Ratings	Conditions	Maximum value [1]	Unit
$V_{ESD(HBM)}$	Electro-static discharge voltage (Human Body Model)	T_A=+25°C	8000	V
$V_{ESD(MM)}$	Electro-static discharge voltage (Machine Model)	T_A=+25°C	400	

Note:

1. Data based on characterization results, not tested in production.

13.7.3.2 Static Latch-Up

- **LU**: 3 complementary static tests are required on 6 parts to assess the latch-up performance. A supply overvoltage (applied to each power supply pin) and a current injection (applied to each input, output and configurable I/O pin) are performed on each sample. This test conforms to the EIA/JESD 78 IC latch-up standard. For more details, refer to the application note AN1181.

Electrical Sensitivities

Symbol	Parameter	Conditions	Class
LU	Static latch-up class	T_A=+25°C T_A=+85°C	A A

Date	Revision	Main changes
27-Nov-06	4	Added QFN20 pinout with new mechanical data (Figure 3 on page 5 and Figure 117 on page 145) Added ST7FLI19BY1M3TR sales type in Table 1, “Supported Flash part numbers,” Modifed “DEVELOPMENT TOOLS” on page 153
23-April-07	5	Added note 1 to Table 1 on page 7 Modified note 1 in section 7.1 on page 23 Added caution to section 7.5.1 on page 28 Modified section 11.2.3.6 on page 67 Modified title of Figure 48 on page 68 and added note 1 Modified Figure 49 on page 69 Modified section 11.5.3.4 on page 97 and added section 11.5.3.5 on page 97 Modified EOC bit description in section 11.5.6 on page 98 Modified V_{FFTB} parameter in section 13.7.1 on page 127 Modified Table 28 on page 153
17-June-08	6	Modified first page Added note 2 in Table 1, “Device Pin Description,” on page 7 Modified WDGRF bit description in section 7.6.4 on page 35 Modified note 1 in section 11.2.3.6 on page 67 Added section 13.3.6 on page 120 Modified CLKSEL option bits description in section 15.1 on page 149 Modified section 15.2 on page 151 and option list