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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	ST7
Core Size	8-Bit
Speed	8MHz
Connectivity	LINbusSCI, SPI
Peripherals	LVD, POR, PWM, WDT
Number of I/O	32
Program Memory Size	32KB (32K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	1.5K x 8
Voltage - Supply (Vcc/Vdd)	3.8V ~ 5.5V
Data Converters	A/D 11x10b
Oscillator Type	External
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	44-LQFP
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/st72f361j6t3

4 FLASH PROGRAM MEMORY

4.1 INTRODUCTION

The ST7 dual voltage High Density Flash (HDFlash) is a non-volatile memory that can be electrically erased as a single block or by individual sectors and programmed on a Byte-by-Byte basis using an external V_{PP} supply.

The HDFlash devices can be programmed and erased off-board (plugged in a programming tool) or on-board using ICP (In-Circuit Programming) or IAP (In-Application Programming).

The array matrix organisation allows each sector to be erased and reprogrammed without affecting other sectors.

4.2 MAIN FEATURES

- 3 Flash programming modes:
  - Insertion in a programming tool. In this mode, all sectors including option bytes can be programmed or erased.
  - ICP (In-Circuit Programming). In this mode, all sectors including option bytes can be programmed or erased without removing the device from the application board.
  - IAP (In-Application Programming) In this mode, all sectors except Sector 0, can be programmed or erased without removing the device from the application board and while the application is running.
- ICT (In-Circuit Testing) for downloading and executing user application test patterns in RAM
- Read-out protection
- Register Access Security System (RASS) to prevent accidental programming or erasing

4.3 STRUCTURE

The Flash memory is organised in sectors and can be used for both code and data storage.

Depending on the overall Flash memory size in the microcontroller device, there are up to three user sectors (see Table 3). Each of these sectors can be erased independently to avoid unnecessary erasing of the whole Flash memory when only a partial erasing is required.

The first two sectors have a fixed size of 4 Kbytes (see Figure 6). They are mapped in the upper part of the ST7 addressing space so the reset and interrupt vectors are located in Sector 0 (F000h-FFFFh).

Table 4. Sectors available in Flash devices

Flash Size (bytes)	Available Sectors
4K	Sector 0
8K	Sectors 0,1
> 8K	Sectors 0,1, 2

4.3.1 Read-out Protection

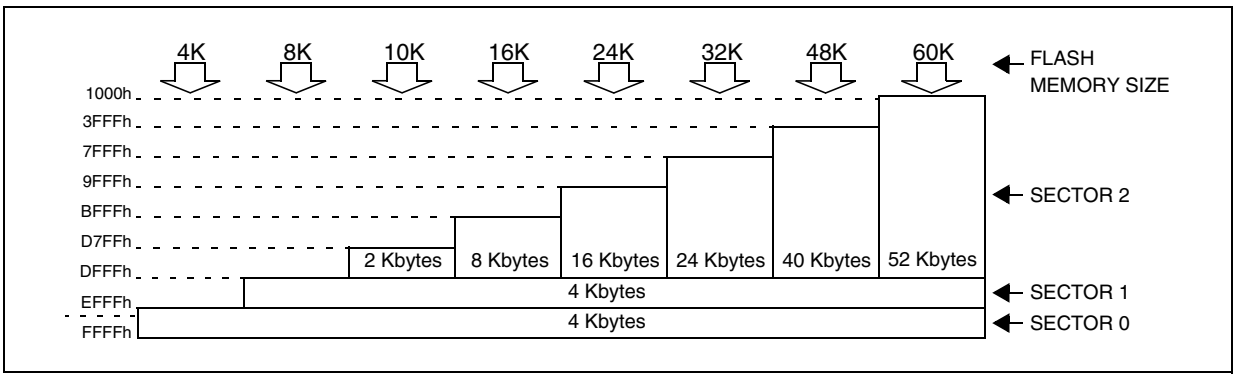
Read-out protection, when selected, provides a protection against Program Memory content extraction and against write access to Flash memory. Even if no protection can be considered as totally unbreakable, the feature provides a very high level of protection for a general purpose microcontroller.

In Flash devices, this protection is removed by reprogramming the option. In this case, the entire program memory is first automatically erased and the device can be reprogrammed.

Read-out protection selection depends on the device type:

- In Flash devices it is enabled and removed through the FMP_R bit in the option byte.
- In ROM devices it is enabled by mask option specified in the Option List.

Figure 6. Memory Map and Sector Address



RESET SEQUENCE MANAGER (Cont'd)

The $\overline{\text{RESET}}$ pin is an asynchronous signal which plays a major role in EMS performance. In a noisy environment, it is recommended to follow the guidelines mentioned in the electrical characteristics section.

6.3.3 External Power-On RESET

If the LVD is disabled by option byte, to start up the microcontroller correctly, the user must ensure by means of an external reset circuit that the reset signal is held low until V_{DD} is over the minimum level specified for the selected f_{OSC} frequency.

A proper reset signal for a slow rising V_{DD} supply can generally be provided by an external RC network connected to the $\overline{\text{RESET}}$ pin.

6.3.4 Internal Low Voltage Detector (LVD) RESET

Two different RESET sequences caused by the internal LVD circuitry can be distinguished:

- Power-On RESET
- Voltage Drop RESET

The device $\overline{\text{RESET}}$ pin acts as an output that is pulled low when $V_{DD} < V_{IT+}$ (rising edge) or $V_{DD} < V_{IT-}$ (falling edge) as shown in Figure 3.

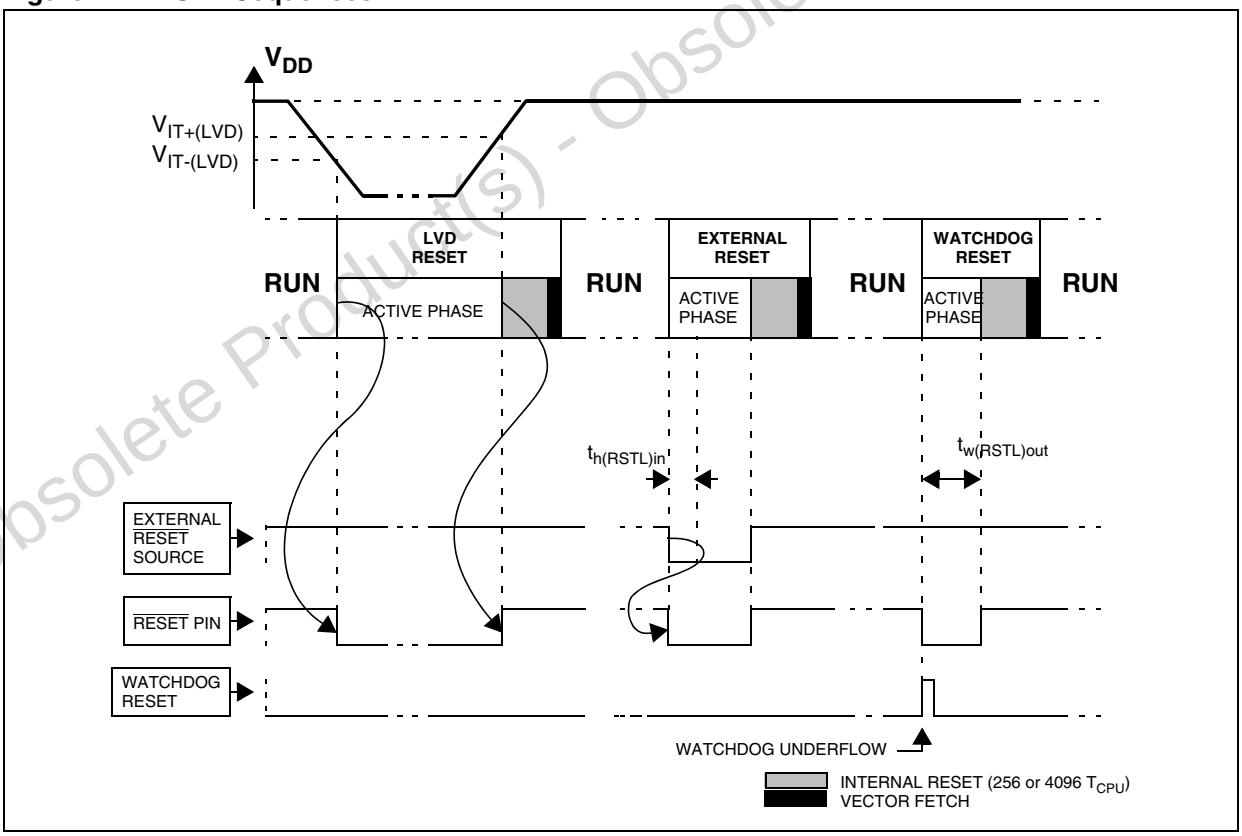
The LVD filters spikes on V_{DD} larger than $t_{g(VDD)}$ to avoid parasitic resets.

6.3.5 Internal Watchdog RESET

The RESET sequence generated by a internal Watchdog counter overflow is shown in Figure 3.

Starting from the Watchdog counter underflow, the device $\overline{\text{RESET}}$ pin acts as an output that is pulled low during at least $t_{w(RSTL)out}$.

Figure 14. RESET Sequences



10 ON-CHIP PERIPHERALS

10.1 WINDOW WATCHDOG (WWDG)

10.1.1 Introduction

The Window Watchdog is used to detect the occurrence of a software fault, usually generated by external interference or by unforeseen logical conditions, which causes the application program to abandon its normal sequence. The Watchdog circuit generates an MCU reset on expiry of a programmed time period, unless the program refreshes the contents of the downcounter before the T6 bit becomes cleared. An MCU reset is also generated if the 7-bit downcounter value (in the control register) is refreshed before the downcounter has reached the window register value. This implies that the counter must be refreshed in a limited window.

10.1.2 Main Features

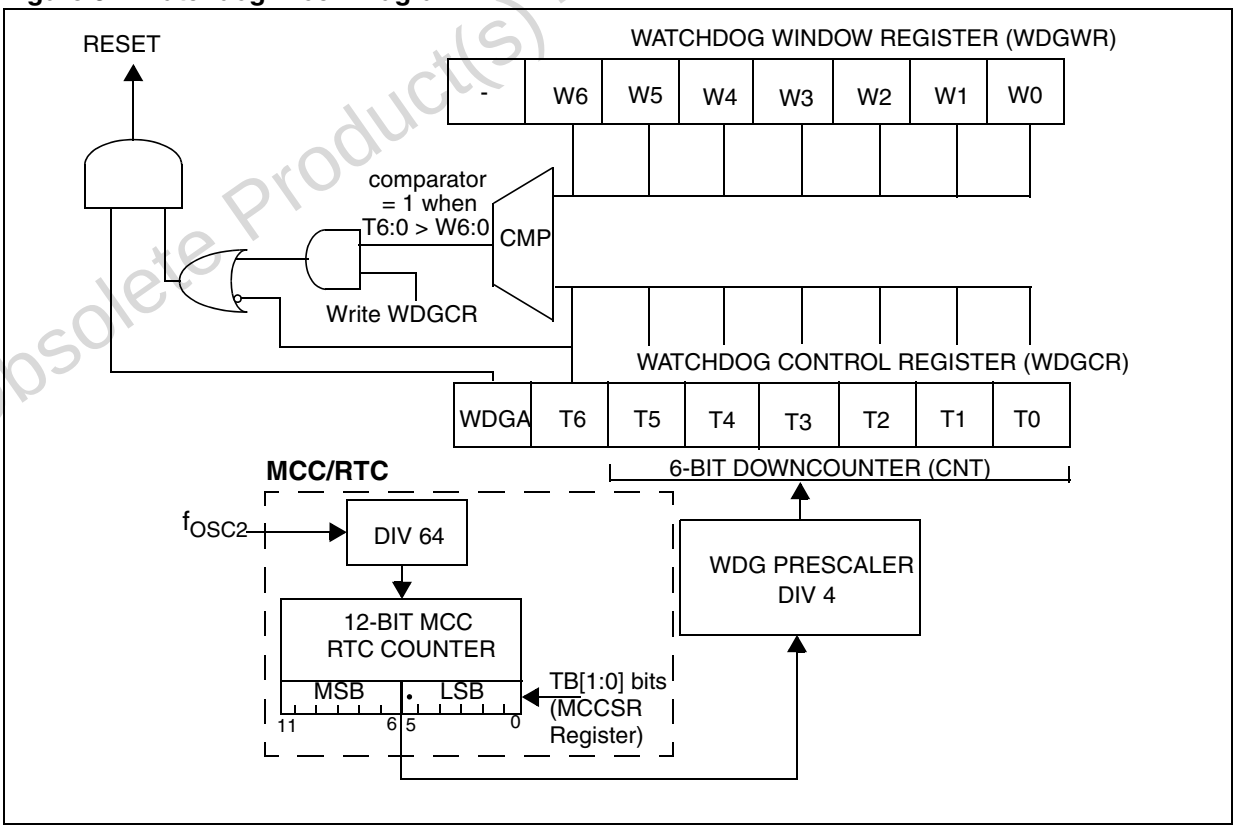
- Programmable free-running downcounter
- Conditional reset
  - Reset (if watchdog activated) when the downcounter value becomes less than 40h
  - Reset (if watchdog activated) if the downcounter is reloaded outside the window (see Figure 4)
- Hardware/Software Watchdog activation (selectable by option byte)
- Optional reset on HALT instruction (configurable by option byte)

10.1.3 Functional Description

The counter value stored in the WDGCR register (bits T[6:0]), is decremented every 16384 f_{OSC2} cycles (approx.), and the length of the timeout period can be programmed by the user in 64 increments.

If the watchdog is activated (the WDGA bit is set) and when the 7-bit downcounter (T[6:0] bits) rolls over from 40h to 3Fh (T6 becomes cleared), it initiates a reset cycle pulling low the reset pin for typically 30µs. If the software reloads the counter while the counter is greater than the value stored in the window register, then a reset is generated.

Figure 34. Watchdog Block Diagram



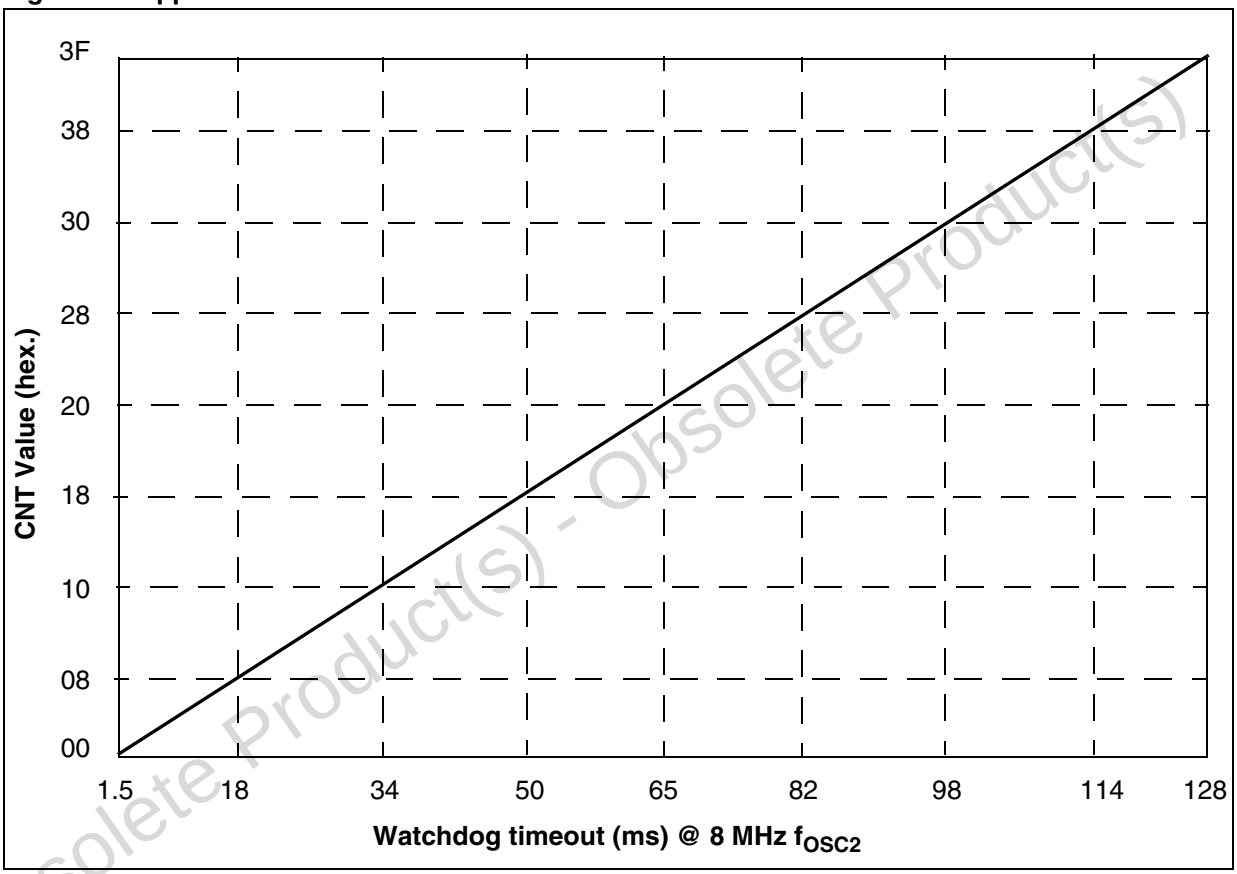
WINDOW WATCHDOG (Cont'd)

10.1.5 How to Program the Watchdog Timeout

Figure 2 shows the linear relationship between the 6-bit value to be loaded in the Watchdog Counter (CNT) and the resulting timeout duration in milliseconds. This can be used for a quick calculation without taking the timing variations into account. If more precision is needed, use the formulae in Figure 3.

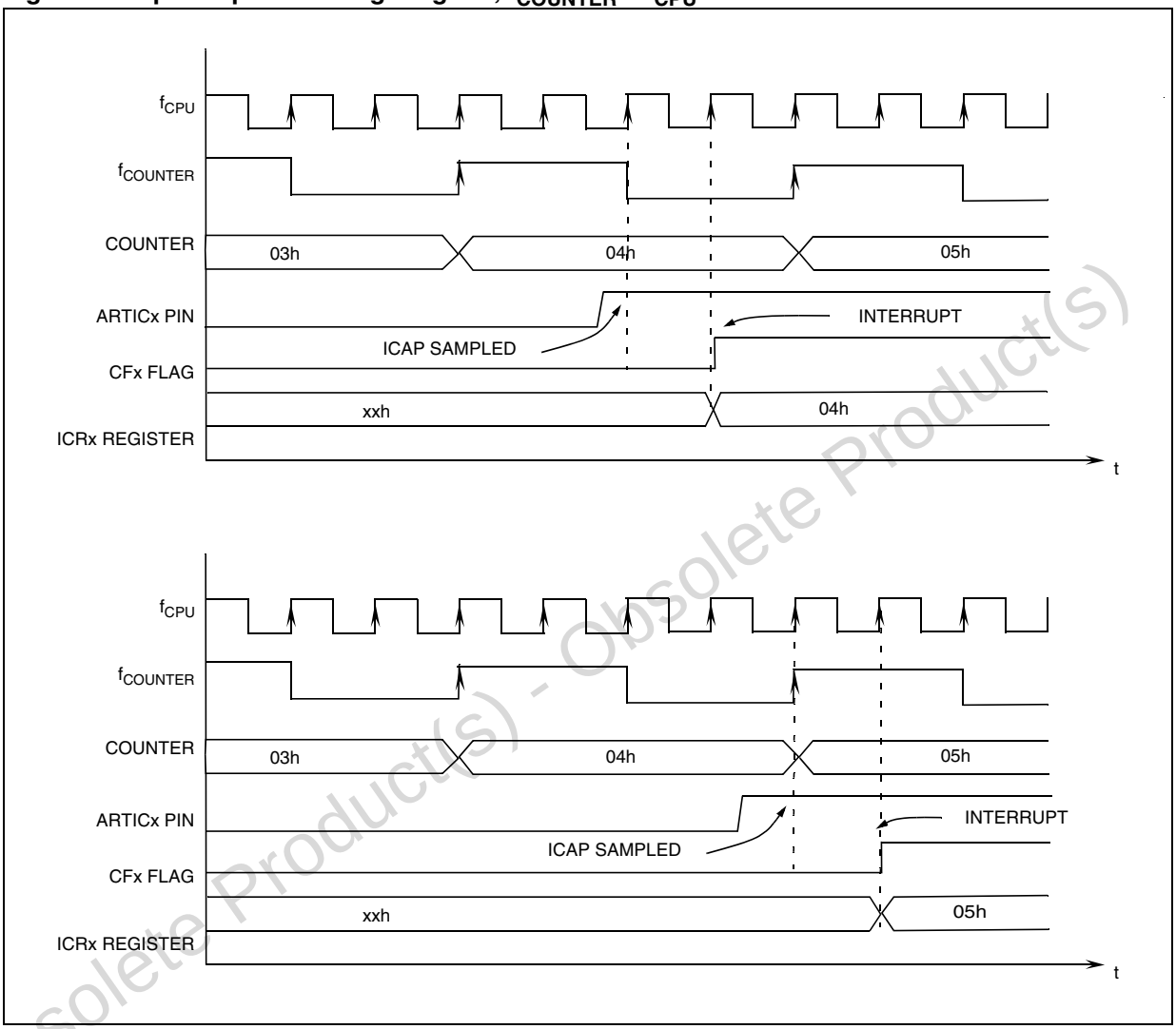
Caution: When writing to the WDGCR register, always write 1 in the T6 bit to avoid generating an immediate reset.

Figure 35. Approximate Timeout Duration



PWM AUTO-RELOAD TIMER (Cont'd)

Figure 46. input Capture Timing Diagram, $f_{COUNTER} = f_{CPU} / 4$



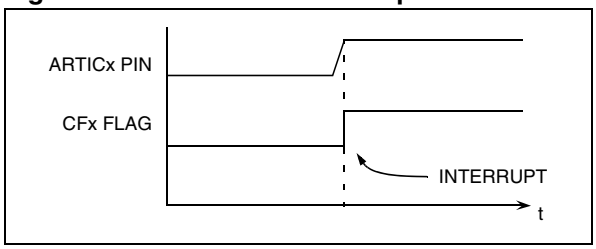
External Interrupt Capability

This mode allows the Input capture capabilities to be used as external interrupt sources. The interrupts are generated on the edge of the ARTICx signal.

The edge sensitivity of the external interrupts is programmable (CSx bit of ARTICCSR register) and they are independently enabled through CIEx bits of the ARTICCSR register. After fetching the interrupt vector, the CFx flags can be read to identify the interrupt source.

During HALT mode, the external interrupts can be used to wake up the micro (if the CIEx bit is set). In this case, the interrupt synchronization is done directly on the ARTICx pin edge (Figure 47).

Figure 47. ART External Interrupt in Halt Mode



ON-CHIP PERIPHERALS (Cont'd)

INPUT CAPTURE CONTROL / STATUS REGISTER (ARTICCSR)

Read/Write

Reset Value: 0000 0000 (00h)

7							0
0	0	CS2	CS1	CIE2	CIE1	CF2	CF1

Bit 7:6 = Reserved, always read as 0.

Bit 5:4 = **CS[2:1]** *Capture Sensitivity*
These bits are set and cleared by software. They determine the trigger event polarity on the corresponding input capture channel.
0: Falling edge triggers capture on channel x.
1: Rising edge triggers capture on channel x.

Bit 3:2 = **CIE[2:1]** *Capture Interrupt Enable*
These bits are set and cleared by software. They enable or disable the Input capture channel interrupts independently.
0: Input capture channel x interrupt disabled.
1: Input capture channel x interrupt enabled.

Bit 1:0 = **CF[2:1]** *Capture Flag*
These bits are set by hardware and cleared by software reading the corresponding ARTICRx register. Each CFx bit indicates that an input capture x has occurred.
0: No input capture on channel x.
1: An input capture has occurred on channel x.

INPUT CAPTURE REGISTERS (ARTICRx)

Read only

Reset Value: 0000 0000 (00h)

7							0
IC7	IC6	IC5	IC4	IC3	IC2	IC1	IC0

Bit 7:0 = **IC[7:0]** *Input Capture Data*

These read only bits are set and cleared by hardware. An ARTICRx register contains the 8-bit auto-reload counter value transferred by the input capture channel x event.

8-BIT TIMER (Cont'd)

CONTROL REGISTER 2 (CR2)

Read/Write

Reset Value: 0000 0000 (00h)

7							0
OC1E	OC2E	OPM	PWM	CC1	CC0	IEDG2	0

Bit 7 = **OC1E** *Output Compare 1 Pin Enable.*
This bit is used only to output the signal from the timer on the OCMP1 pin (OLV1 in Output Compare mode, both OLV1 and OLV2 in PWM and one-pulse mode). Whatever the value of the OC1E bit, the Output Compare 1 function of the timer remains active.
0: OCMP1 pin alternate function disabled (I/O pin free for general-purpose I/O).
1: OCMP1 pin alternate function enabled.

Bit 6 = **OC2E** *Output Compare 2 Pin Enable.*
This bit is used only to output the signal from the timer on the OCMP2 pin (OLV2 in Output Compare mode). Whatever the value of the OC2E bit, the Output Compare 2 function of the timer remains active.
0: OCMP2 pin alternate function disabled (I/O pin free for general-purpose I/O).
1: OCMP2 pin alternate function enabled.

Bit 5 = **OPM** *One Pulse Mode.*
0: One Pulse Mode is not active.
1: One Pulse Mode is active, the ICAP1 pin can be used to trigger one pulse on the OCMP1 pin; the active transition is given by the IEDG1 bit. The length of the generated pulse depends on the contents of the OC1R register.

Bit 4 = **PWM** *Pulse Width Modulation.*
0: PWM mode is not active.
1: PWM mode is active, the OCMP1 pin outputs a programmable cyclic signal; the length of the pulse depends on the value of OC1R register; the period depends on the value of OC2R register.

Bit 3, 2 = **CC[1:0]** *Clock Control.*

The timer clock mode depends on these bits:

Table 20. Clock Control Bits

Timer Clock	CC1	CC0
f_{CPU} / 4	0	0
f_{CPU} / 2	0	1
f_{CPU} / 8	1	0
f_{OSC2} / 8000*	1	1

* Not available in Slow mode in ST72F561.

Bit 1 = **IEDG2** *Input Edge 2.*
This bit determines which type of level transition on the ICAP2 pin will trigger the capture.
0: A falling edge triggers the capture.
1: A rising edge triggers the capture.

Bit 0 = Reserved, must be kept at 0.

LINSCI™ SERIAL COMMUNICATION INTERFACE (LIN Mode) (cont'd)

CONTROL REGISTER 2 (SCICR2)
Read/Write
Reset Value: 0000 0000 (00h)

7							0
TIE	TCIE	RIE	ILIE	TE	RE	RWU	SBK

Bits 7:2 Same function as in SCI mode; please refer to Section 0.1.8 SCI Mode Register Description.

Bit 1 = **RWU** *Receiver wake-up.*
This bit determines if the SCI is in mute mode or not. It is set and cleared by software and can be cleared by hardware when a wake-up sequence is recognized.
0: Receiver in active mode
1: Receiver in mute mode

Notes:

– Mute mode is recommended for detecting only the Header and avoiding the reception of any other characters. For more details, please refer to Section 0.1.9.3 LIN Reception.

– In LIN slave mode, when RDRF is set, the software can not set or clear the RWU bit.

Bit 0 = **SBK** *Send break.*
This bit set is used to send break characters. It is set and cleared by software.
0: No break character is transmitted
1: Break characters are transmitted

Note: If the SBK bit is set to "1" and then to "0", the transmitter will send a BREAK word at the end of the current word.

CONTROL REGISTER 3 (SCICR3)
Read/Write
Reset Value: 0000 0000 (00h)

7							0
LDUM	LINE	LSLV	LASE	LHDM	LHIE	LHDF	LSF

Bit 7 = **LDUM** *LIN Divider Update Method.*
This bit is set and cleared by software and is also cleared by hardware (when RDRF = 1). It is only used in LIN Slave mode. It determines how the LIN Divider can be updated by software.
0: LDIV is updated as soon as LPR is written (if no Auto Synchronization update occurs at the same time).
1: LDIV is updated at the next received character (when RDRF = 1) after a write to the LPR register

Notes:

- If no write to LPR is performed between the setting of LDUM bit and the reception of the next character, LDIV will be updated with the old value.

- After LDUM has been set, it is possible to reset the LDUM bit by software. In this case, LDIV can be modified by writing into LPR / LPFR registers.

Bits 6:5 = **LINE, LSLV** *LIN Mode Enable Bits.*
These bits configure the LIN mode:

LINE	LSLV	Meaning
0	x	LIN mode disabled
1	0	LIN Master Mode
	1	LIN Slave Mode

The LIN Master configuration enables:

The capability to send LIN Synch Breaks (13 low bits) using the SBK bit in the SCICR2 register.

The LIN Slave configuration enables:

– The LIN Slave Baud Rate generator. The LIN Divider (LDIV) is then represented by the LPR and LPFR registers. The LPR and LPFR registers are read/write accessible at the address of the SCIBRR register and the address of the SCIETPR register

– Management of LIN Headers.

– LIN Synch Break detection (11-bit dominant).

– LIN Wake-Up method (see LHDM bit) instead of the normal SCI Wake-Up method.

– Inhibition of Break transmission capability (SBK has no effect)

– LIN Parity Checking (in conjunction with the PCE bit)

Bit 4 = **LASE** *LIN Auto Synch Enable.*
This bit enables the Auto Synch Unit (ASU). It is set and cleared by software. It is only usable in LIN Slave mode.

0: Auto Synch Unit disabled
1: Auto Synch Unit enabled.

Bit 3 = **LHDM** *LIN Header Detection Method*
This bit is set and cleared by software. It is only usable in LIN Slave mode. It enables the Header Detection Method. In addition if the RWU bit in the

LINSCI™ SERIAL COMMUNICATION INTERFACE (LIN Mode) (cont'd)

LIN PRESCALER FRACTION REGISTER (LPFR)

Read/Write

Reset Value: 0000 0000 (00h)

7							0
0	0	0	0	LPFR 3	LPFR 2	LPFR 1	LPFR 0

Bits 7:4 = Reserved.

Bits 3:0 = **LPFR[3:0]** *Fraction of LDIV*

These 4 bits define the fraction of the LIN Divider (LDIV):

LPFR[3:0]	Fraction (LDIV)
0h	0
1h	1/16
...	...
Eh	14/16
Fh	15/16

1. When initializing LDIV, the LPFR register must be written first. Then, the write to the LPR register will effectively update LDIV and so the clock generation.
2. In LIN Slave mode, if the LPR[7:0] register is equal to 00h, the transceiver and receiver input clocks are switched off.

Examples of LDIV coding:

Example 1: LPR = 27d and LPFR = 12d

This leads to:

Mantissa (LDIV) = 27d

Fraction (LDIV) = 12/16 = 0.75d

Therefore LDIV = 27.75d

Example 2: LDIV = 25.62d

This leads to:

LPFR = rounded(16*0.62d)

= rounded(9.92d) = 10d = Ah

LPR = mantissa (25.620d) = 25d = 1Bh

Example 3: LDIV = 25.99d

This leads to:

LPFR = rounded(16*0.99d)

= rounded(15.84d) = 16d

LINSCI™ SERIAL COMMUNICATION INTERFACE (LIN Mode) (cont'd)

LIN HEADER LENGTH REGISTER (LHLR)
Read Only
Reset Value: 0000 0000 (00h).

7							0
LHL7	LHL6	LHL5	LHL4	LHL3	LHL2	LHL1	LHL0

Note: In LIN Slave mode when LASE = 1 or LHDM = 1, the LHLR register is accessible at the address of the SCIERPR register.

Otherwise this register is always read as 00h.

Bits 7:0 = **LHL[7:0]** *LIN Header Length.*

This is a read-only register, which is updated by hardware if one of the following conditions occurs:
- After each break detection, it is loaded with "FFh".
- If a timeout occurs on T_{HEADER}, it is loaded with 00h.
- After every successful LIN Header reception (at the same time than the setting of LHDF bit), it is loaded with a value (LHL) which gives access to the number of bit times of the LIN header length (T_{HEADER}). The coding of this value is explained below:

LHL Coding:

T_{HEADER_MAX} = 57
LHL(7:2) represents the mantissa of (57 - T_{HEADER})
LHL(1:0) represents the fraction (57 - T_{HEADER})

LHL[7:2]	Mantissa (57 - T_{HEADER})	Mantissa (T_{HEADER})
0h	0	57
1h	1	56
...	...	...
39h	56	1
3Ah	57	0
3Bh	58	Never Occurs
...	...	...
3Eh	62	Never Occurs
3Fh	63	Initial value

LHL[1:0]	Fraction (57 - T_{HEADER})
0h	0
1h	1/4
2h	1/2
3h	3/4

Example of LHL coding:

Example 1: LHL = 33h = 001100 11b
LHL(7:3) = 1100b = 12d
LHL(1:0) = 11b = 3d
This leads to:
Mantissa (57 - T_{HEADER}) = 12d
Fraction (57 - T_{HEADER}) = 3/4 = 0.75
Therefore:
(57 - T_{HEADER}) = 12.75d
and T_{HEADER} = 44.25d

Example 2:
57 - T_{HEADER} = 36.21d
LHL(1:0) = rounded(4*0.21d) = 1d
LHL(7:2) = Mantissa (36.21d) = 36d = 24h
Therefore LHL(7:0) = 10010001 = 91h

Example 3:
57 - T_{HEADER} = 36.90d
LHL(1:0) = rounded(4*0.90d) = 4d
The carry must be propagated to the matissa:
LHL(7:2) = Mantissa (36.90d) + 1 = 37d =
Therefore LHL(7:0) = 10110000 = A0h

10.8 LINSCI SERIAL COMMUNICATION INTERFACE (LIN Master Only)

10.8.1 Introduction

The Serial Communications Interface (SCI) offers a flexible means of full-duplex data exchange with external equipment requiring an industry standard NRZ asynchronous serial data format. The SCI offers a very wide range of baud rates using two baud rate generator systems.

10.8.2 Main Features

- Full duplex, asynchronous communications
- NRZ standard format (Mark/Space)
- Dual baud rate generator systems
- Independently programmable transmit and receive baud rates up to 500K baud.
- Programmable data word length (8 or 9 bits)
- Receive buffer full, Transmit buffer empty and End of Transmission flags
- 2 receiver wake-up modes:
  - Address bit (MSB)
  - Idle line
- Muting function for multiprocessor configurations
- Separate enable bits for Transmitter and Receiver
- 4 error detection flags:
  - Overrun error
  - Noise error
  - Frame error
  - Parity error
- 5 interrupt sources with flags:
  - Transmit data register empty
  - Transmission complete
  - Receive data register full
  - Idle line received
  - Overrun error detected
- Transmitter clock output
- Parity control:
  - Transmits parity bit
  - Checks parity of received data byte
- Reduced power consumption mode
- LIN Synch Break send capability

10.8.3 General Description

The interface is externally connected to another device by three pins (see Figure 88 on page 153). Any SCI bidirectional communication requires a minimum of two pins: Receive Data In (RDI) and Transmit Data Out (TDO):

– SCLK: Transmitter clock output. This pin outputs the transmitter data clock for synchronous transmission (no clock pulses on start bit and stop bit, and a software option to send a clock pulse on the last data bit). This can be used to control peripherals that have shift registers (e.g. LCD drivers). The clock phase and polarity are software programmable.

– TDO: Transmit Data Output. When the transmitter is disabled, the output pin returns to its I/O port configuration. When the transmitter is enabled and nothing is to be transmitted, the TDO pin is at high level.

– RDI: Receive Data Input is the serial data input. Oversampling techniques are used for data recovery by discriminating between valid incoming data and noise.

Through these pins, serial data is transmitted and received as frames comprising:

– An Idle Line prior to transmission or reception

– A start bit

– A data word (8 or 9 bits) least significant bit first

– A Stop bit indicating that the frame is complete.

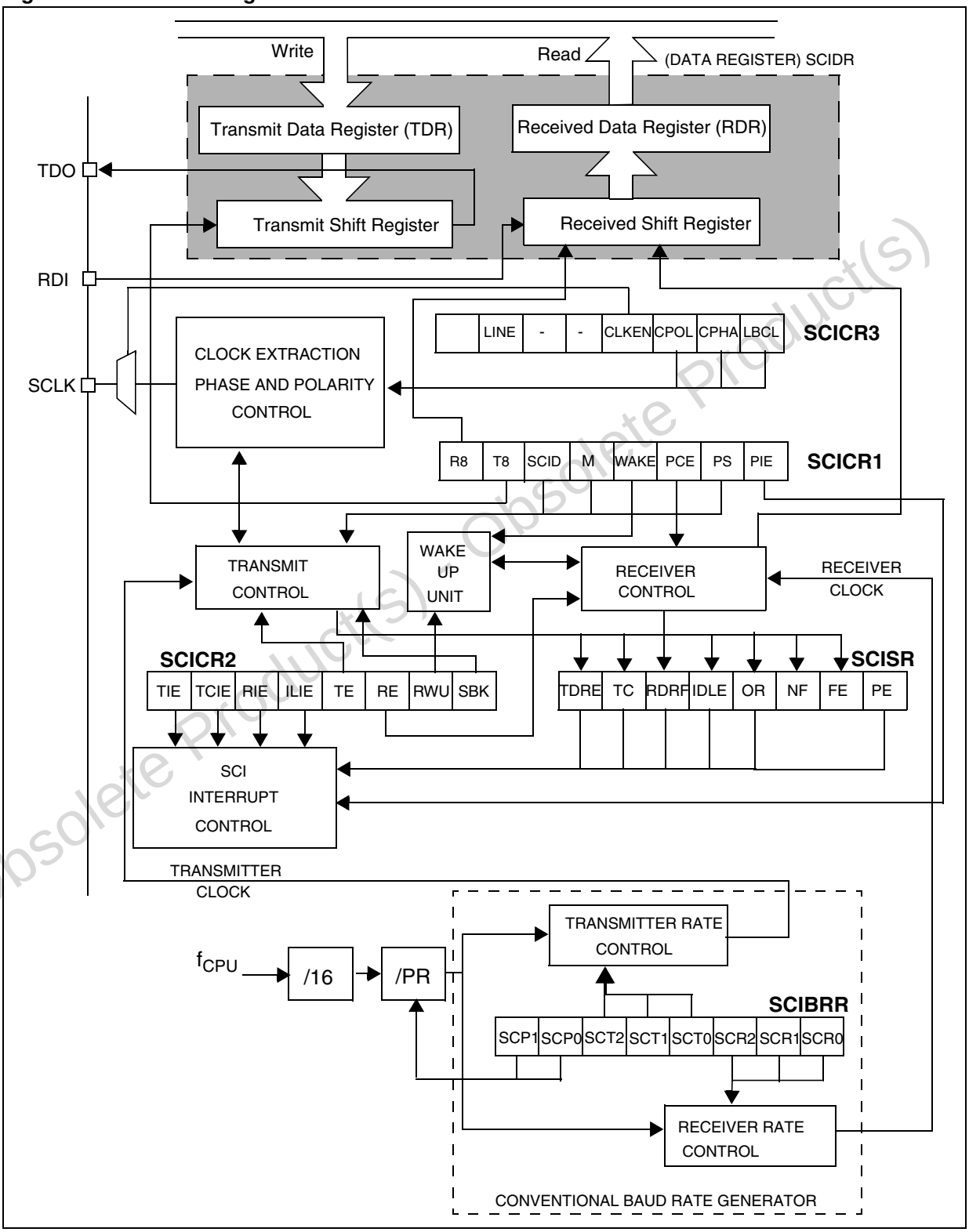
This interface uses two types of baud rate generator:

– A conventional type for commonly-used baud rates,

– An extended type with a prescaler offering a very wide range of baud rates even with non-standard oscillator frequencies.

LINSCI™ SERIAL COMMUNICATION INTERFACE (LIN Master Only) (Cont'd)

Figure 88. SCI Block Diagram



LINSCI™ SERIAL COMMUNICATION INTERFACE (LIN Master Only) (Cont'd)

10.8.4.7 Parity control

Parity control (generation of parity bit in transmission and parity checking in reception) can be enabled by setting the PCE bit in the SCICR1 register. Depending on the frame length defined by the M bit, the possible SCI frame formats are as listed in Table 24.

Table 25. Frame Formats

M bit	PCE bit	SCI frame
0	0	| SB | 8 bit data | STB |
	1	| SB | 7-bit data | PB | STB |
1	0	| SB | 9-bit data | STB |
	1	| SB | 8-bit data PB | STB |

Legend:

SB: Start Bit

STB: Stop Bit

PB: Parity Bit

Note: In case of wake up by an address mark, the MSB bit of the data is taken into account and not the parity bit

Even parity: The parity bit is calculated to obtain an even number of "1s" inside the frame made of the 7 or 8 LSB bits (depending on whether M is equal to 0 or 1) and the parity bit.

Example: data = 00110101; 4 bits set => parity bit is 0 if even parity is selected (PS bit = 0).

Odd parity: The parity bit is calculated to obtain an odd number of "1s" inside the frame made of the 7 or 8 LSB bits (depending on whether M is equal to 0 or 1) and the parity bit.

Example: data = 00110101; 4 bits set => parity bit is 1 if odd parity is selected (PS bit = 1).

Transmission mode: If the PCE bit is set then the MSB bit of the data written in the data register is not transmitted but is changed by the parity bit.

Reception mode: If the PCE bit is set then the interface checks if the received data byte has an even number of "1s" if even parity is selected (PS = 0) or an odd number of "1s" if odd parity is selected (PS = 1). If the parity check fails, the PE flag is set in the SCISR register and an interrupt is generated if PIE is set in the SCICR1 register.

10.8.5 Low Power Modes

Mode	Description
WAIT	No effect on SCI. SCI interrupts cause the device to exit from Wait mode.
HALT	SCI registers are frozen. In Halt mode, the SCI stops transmitting/receiving until Halt mode is exited.

10.8.6 Interrupts

Interrupt Event	Event Flag	Enable Control Bit	Exit from Wait	Exit from Halt
Transmit Data Register Empty	TDRE	TIE	Yes	No
Transmission Complete	TC	TCIE		
Received Data Ready to be Read	RDRF	RIE		
Overrun Error Detected	OR			
Idle Line Detected	IDLE	ILIE		
Parity Error	PE	PIE		

The SCI interrupt events are connected to the same interrupt vector.

These events generate an interrupt if the corresponding Enable Control Bit is set and the interrupt mask in the CC register is reset (RIM instruction).

LINSCI™ SERIAL COMMUNICATION INTERFACE (LIN Master Only) (Cont'd)

CONTROL REGISTER 2 (SCICR2)

Read/Write

Reset Value: 0000 0000 (00h)

7							0
TIE	TCIE	RIE	ILIE	TE	RE	RWU	SBK

Bit 7 = **TIE** *Transmitter interrupt enable*.
This bit is set and cleared by software.
0: Interrupt is inhibited
1: An SCI interrupt is generated whenever TDRE = 1 in the SCISR register

Bit 6 = **TCIE** *Transmission complete interrupt enable*
This bit is set and cleared by software.
0: Interrupt is inhibited
1: An SCI interrupt is generated whenever TC = 1 in the SCISR register

Bit 5 = **RIE** *Receiver interrupt enable*.
This bit is set and cleared by software.
0: Interrupt is inhibited
1: An SCI interrupt is generated whenever OR = 1 or RDRF = 1 in the SCISR register

Bit 4 = **ILIE** *Idle line interrupt enable.*
This bit is set and cleared by software.
0: Interrupt is inhibited
1: An SCI interrupt is generated whenever IDLE = 1 in the SCISR register.

Bit 3 = **TE** *Transmitter enable.*
This bit enables the transmitter. It is set and cleared by software.
0: Transmitter is disabled
1: Transmitter is enabled

Notes:

– During transmission, a "0" pulse on the TE bit ("0" followed by "1") sends a preamble (idle line) after the current word.

– When TE is set there is a 1 bit-time delay before the transmission starts.

Bit 2 = **RE** *Receiver enable.*
This bit enables the receiver. It is set and cleared by software.
0: Receiver is disabled
1: Receiver is enabled and begins searching for a start bit

Bit 1 = **RWU** *Receiver wake-up.*
This bit determines if the SCI is in mute mode or not. It is set and cleared by software and can be cleared by hardware when a wake-up sequence is recognized.
0: Receiver in active mode
1: Receiver in mute mode

Notes:

– Before selecting Mute mode (by setting the RWU bit) the SCI must first receive a data byte, otherwise it cannot function in Mute mode with wake-up by Idle line detection.

– In Address Mark Detection Wake-Up configuration (WAKE bit = 1) the RWU bit cannot be modified by software while the RDRF bit is set.

Bit 0 = **SBK** *Send break.*
This bit set is used to send break characters. It is set and cleared by software.
0: No break character is transmitted
1: Break characters are transmitted

Note: If the SBK bit is set to "1" and then to "0", the transmitter sends a BREAK word at the end of the current word.

10-BIT A/D CONVERTER (ADC) (Cont'd)

10.9.6 Register Description

CONTROL/STATUS REGISTER (ADCCSR)

Read/Write (Except bit 7 read only)

Reset Value: 0000 0000 (00h)

7							0
EOC	SPEED	ADON	SLOW	CH3	CH2	CH1	CH0

Bit 7 = **EOC** *End of Conversion*
This bit is set by hardware. It is cleared by software reading the ADCDRH register or writing to any bit of the ADCCSR register.
0: Conversion is not complete
1: Conversion complete

Bit 6 = **SPEED** *A/D clock selection*
This bit is set and cleared by software.

Table 29. A/D Clock Selection

f_{ADC}	SLOW	SPEED
$f_{CPU}/2$	0	0
f_{CPU} (where f_{CPU} <= 4 MHz)	0	1
$f_{CPU}/4$	1	0
$f_{CPU}/2$ (same frequency as SLOW=0, SPEED=0)	1	1

Bit 5 = **ADON** *A/D Converter on*
This bit is set and cleared by software.
0: Disable ADC and stop conversion
1: Enable ADC and start conversion

Bit 4 = **SLOW** *A/D Clock Selection*
This bit is set and cleared by software. It works together with the SPEED bit. Refer to Table 29.

Bits 3:0 = **CH[3:0]** *Channel Selection*
These bits are set and cleared by software. They select the analog input to convert.

*The number of channels is device dependent. Refer to the device pinout description.

Channel Pin*	CH3	CH2	CH1	CH0
AIN0	0	0	0	0
AIN1	0	0	0	1
AIN2	0	0	1	0
AIN3	0	0	1	1
AIN4	0	1	0	0
AIN5	0	1	0	1
AIN6	0	1	1	0
AIN7	0	1	1	1
AIN8	1	0	0	0
AIN9	1	0	0	1
AIN10	1	0	1	0
AIN11	1	0	1	1
AIN12	1	1	0	0
AIN13	1	1	0	1
AIN14	1	1	1	0
AIN15	1	1	1	1

DATA REGISTER (ADCDRH)

Read Only

Reset Value: 0000 0000 (00h)

7							0
D9	D8	D7	D6	D5	D4	D3	D2

Bits 7:0 = **D[9:2]** *MSB of Analog Converted Value*

DATA REGISTER (ADCDRL)

Read Only

Reset Value: 0000 0000 (00h)

7							0
0	0	0	0	0	0	D1	D0

Bits 7:2 = Reserved. Forced by hardware to 0.

Bits 1:0 = **D[1:0]** *LSB of Analog Converted Value*

INSTRUCTION SET OVERVIEW (Cont'd)

11.1.6 Indirect Indexed (Short, Long)

This is a combination of indirect and short indexed addressing modes. The operand is referenced by its memory address, which is defined by the unsigned addition of an index register value (X or Y) with a pointer value located in memory. The pointer address follows the opcode.

The indirect indexed addressing mode consists of two submodes:

Indirect Indexed (Short)

The pointer address is a byte, the pointer size is a byte, thus allowing 00 - 1FE addressing space, and requires 1 byte after the opcode.

Indirect Indexed (Long)

The pointer address is a byte, the pointer size is a word, thus allowing 64 Kbyte addressing space, and requires 1 byte after the opcode.

Table 32. Instructions Supporting Direct, Indexed, Indirect and Indirect Indexed Addressing Modes

Long and Short Instructions	Function
LD	Load
CP	Compare
AND, OR, XOR	Logical Operations
ADC, ADD, SUB, SBC	Arithmetic Additions/Substractions operations
BCP	Bit Compare

Short Instructions Only	Function
CLR	Clear
INC, DEC	Increment/Decrement
TNZ	Test Negative or Zero
CPL, NEG	1 or 2 Complement
BSET, BRES	Bit Operations
BTJT, BTJF	Bit Test and Jump Operations
SLL, SRL, SRA, RLC, RRC	Shift and Rotate Operations
SWAP	Swap Nibbles
CALL, JP	Call or Jump subroutine

11.1.7 Relative mode (Direct, Indirect)

This addressing mode is used to modify the PC register value, by adding an 8-bit signed offset to it.

Available Relative Direct/Indirect Instructions	Function
JRxx	Conditional Jump
CALLR	Call Relative

The relative addressing mode consists of two submodes:

Relative (Direct)

The offset is following the opcode.

Relative (Indirect)

The offset is defined in memory, which address follows the opcode.

I/O PORT PIN CHARACTERISTICS (Cont'd)

Figure 103. Connecting Unused I/O Pins

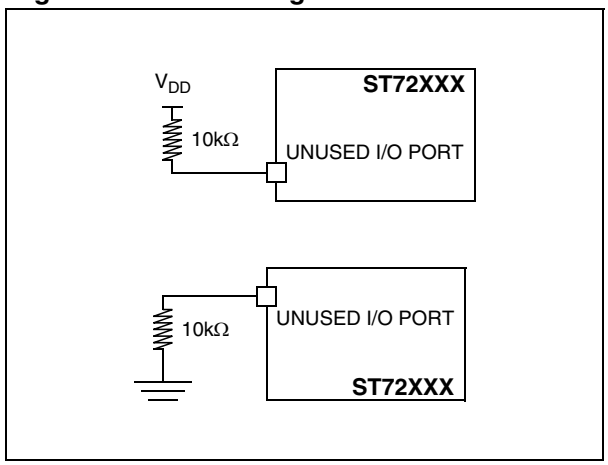


Figure 104. R_{PU} vs V_{DD} with $V_{IN} = V_{SS}$

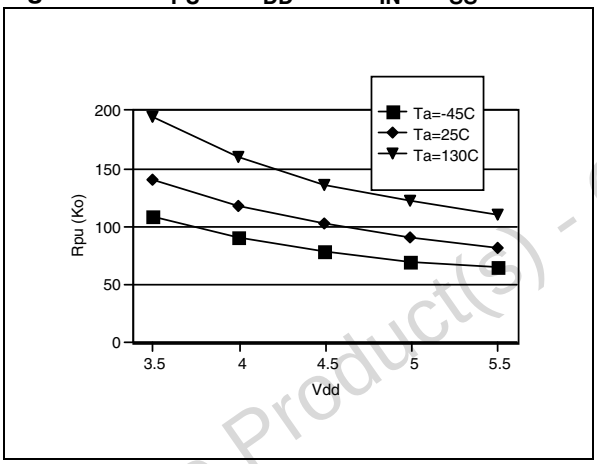
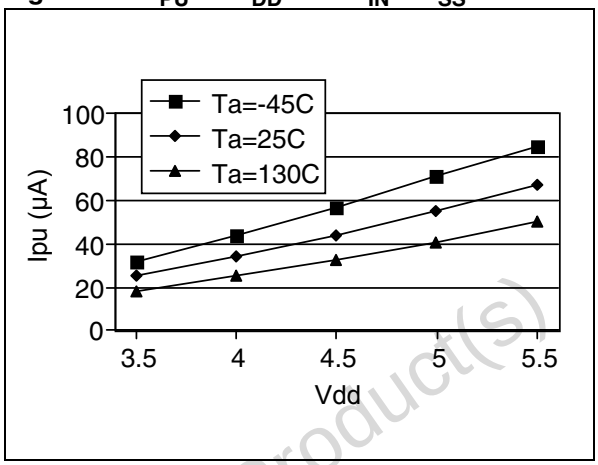


Figure 105. I_{PU} vs V_{DD} with $V_{IN} = V_{SS}$



12.12 COMMUNICATION INTERFACE CHARACTERISTICS

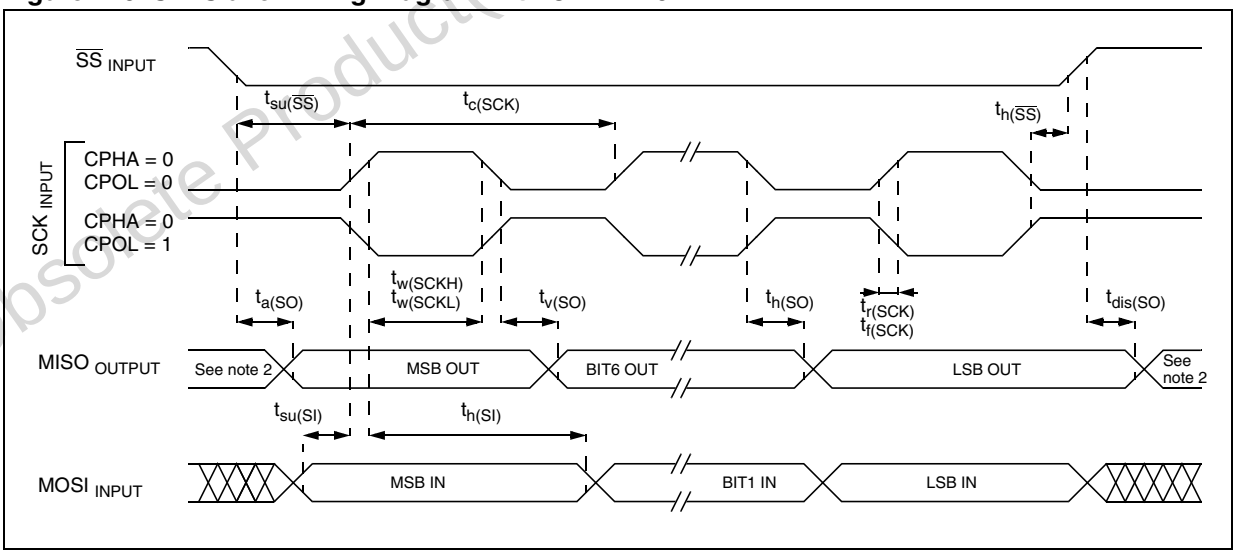
12.12.1 SPI - Serial Peripheral Interface

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

Refer to I/O port characteristics for more details on the input/output alternate function characteristics ($\overline{SS}$, SCK, MOSI, MISO).

Symbol	Parameter	Conditions	Min	Max	Unit
$f_{SCK} = 1 / t_{c(SCK)}$	SPI clock frequency	Master, f_{CPU} = 8 MHz	$f_{CPU} / 128 = 0.0625$	$f_{CPU} / 4 = 2$	MHz
		Slave, f_{CPU} = 8 MHz	0	$f_{CPU} / 2 = 4$	
$t_{r(SCK)}$	SPI clock rise and fall time		See I/O port pin description		
$t_{f(SCK)}$					
$t_{su(\overline{SS})}$ [1]	$\overline{SS}$ setup time[4]	Slave	$(4 \times T_{CPU}) + 50$		ns
$t_{h(\overline{SS})}$ [1]	$\overline{SS}$ hold time		120		
$t_{w(SCKH)}$ [1]	SCK high and low time	Master	100		
$t_{w(SCKL)}$ [1]		Slave	90		
$t_{su(MI)}$ [1]	Data input setup time	Master	100		
$t_{su(SI)}$ [1]		Slave			
$t_{h(MI)}$ [1]	Data input hold time	Master			
$t_{h(SI)}$ [1]		Slave			
$t_{a(SO)}$ [1]	Data output access time	Slave	0	120	
$t_{dis(SO)}$ [1]	Data output disable time			240	
$t_{v(SO)}$ [1]	Data output valid time	Slave (after enable edge)		90	
$t_{h(SO)}$ [1]	Data output hold time		0		
$t_{v(MO)}$ [1]	Data output valid time	Master (after enable edge)		120	
$t_{h(MO)}$ [1]	Data output hold time		0		

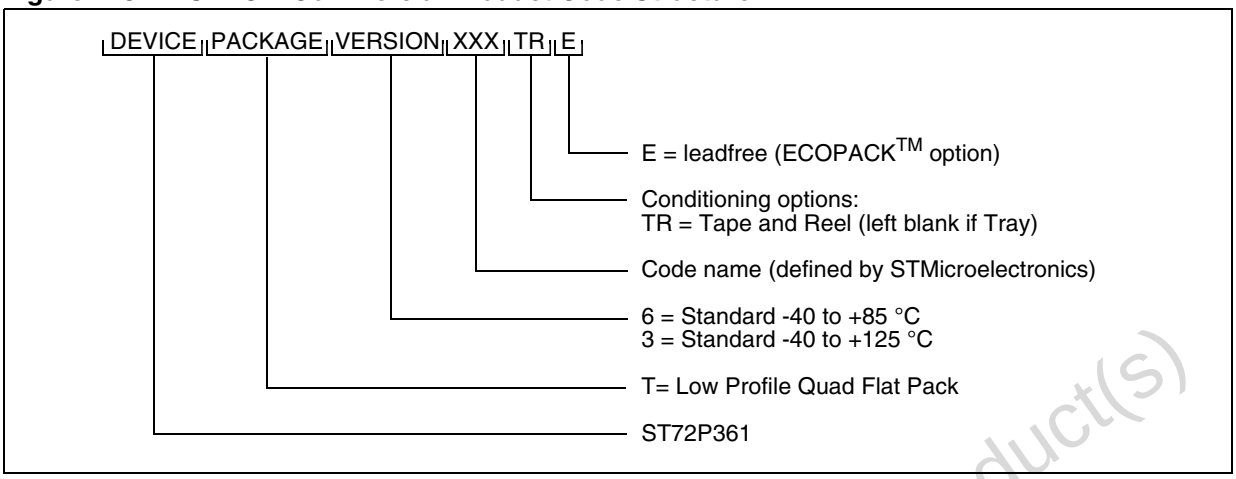
Figure 116. SPI Slave Timing Diagram with CPHA = 0[3]



Notes:

1. Data based on design simulation and/or characterization results, not tested in production.
2. When no communication is on-going the data output line of the SPI (MOSI in master mode, MISO in slave mode) has its alternate function capability released. In this case, the pin status depends on the I/O port configuration.
3. Measurement points are done at CMOS levels: 0.3 x V_{DD} and 0.7 x V_{DD}.
4. Depends on f_{CPU}. For example, if f_{CPU} = 8 MHz, then $T_{CPU} = 1 / f_{CPU}$ = 125ns and $t_{su(\overline{SS})}$ = 550ns.

Figure 128. FASTROM Commercial Product Code Structure



15 DEVELOPMENT TOOLS

Development tools for the ST7 microcontrollers include a complete range of hardware systems and software tools from STMicroelectronics and third-party tool suppliers. The range of tools includes solutions to help you evaluate microcontroller peripherals, develop and debug your application, and program your microcontrollers.

15.0.1 Evaluation Tools and Starter Kits

ST offers complete, affordable **starter kits** and full-featured **evaluation boards** that allow you to evaluate microcontroller features and quickly start developing ST7 applications. Starter kits are complete, affordable hardware/software tool packages that include features and samples to help you quickly start developing your application. ST evaluation boards are open-design, embedded systems, which are developed and documented to serve as references for your application design. They include sample application software to help you demonstrate, learn about and implement your ST7's features.

15.0.2 Development and Debugging Tools

Application development for ST7 is supported by fully optimizing **C Compilers** and the **ST7 Assembler-Linker** toolchain, which are all seamlessly integrated in the ST7 integrated development environments in order to facilitate the debugging and fine-tuning of your application. The Cosmic C Compiler is available in a free version that outputs up to 16K of code.

The range of hardware tools includes cost effective **ST7-DVP3 series emulators**. These tools are supported by the **ST7 Toolset** from STMicroelectronics, which includes the STVD7 integrated development environment (IDE) with high-level language debugger, editor, project manager and integrated programming interface.

15.0.3 Programming Tools

During the development cycle, the **ST7-DVP3** and **ST7-EMU3 series emulators** and the **RLink** provide in-circuit programming capability for programming the Flash microcontroller on your application board.

ST also provides dedicated a low-cost dedicated in-circuit programmer, the **ST7-STICK**, as well as **ST7 Socket Boards** which provide all the sockets required for programming any of the devices in a specific ST7 sub-family on a platform that can be used with any tool with in-circuit programming capability for ST7.

For production programming of ST7 devices, ST's third-party tool partners also provide a complete range of gang and automated programming solutions, which are ready to integrate into your production environment.

For additional ordering codes for spare parts, accessories and tools available for the ST7 (including from third party manufacturers), refer to the online product selector at www.st.com.

15.0.4 Order Codes for ST72361 Development Tools

Table 37. Development Tool Order Codes for the ST72361 Family

MCU	In-circuit Debugger	Emulator	Programming Tool	
	Starter Kit with Demo Board		In-circuit Programmer	ST7 Socket Board[6]
ST72361	ST72F36X-SK/RAIS[1]	ST7MDT25-DVP3[2]	ST7-STICK[3][4] STX-RLINK[5]	ST7SB25[3]

Notes:

1. In-circuit programming only. In-circuit debugging is not yet supported for HDFlash devices without debug module such as the ST72F36x.
2. Requires optional connection kit. See "How to order and EMU or DVP" for connection kit ordering information in ST product and tool selection guide
3. Add suffix /EU, /UK or /US for the power supply for your region
4. Parellel port connection to PC
5. USB connection to PC
6. Socket boards complement any tool with ICC capabilities (ST7-STICK, InDART, RLINK, DVP3, EMU3, etc.)