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"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	ST6
Core Size	8-Bit
Speed	8MHz
Connectivity	-
Peripherals	LVD, POR, WDT
Number of I/O	20
Program Memory Size	4KB (4K x 8)
Program Memory Type	OTP
EEPROM Size	-
RAM Size	64 x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 6V
Data Converters	A/D 16x8b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	28-SOIC (0.295", 7.50mm Width)
Supplier Device Package	28-SO
Purchase URL	https://www.e-xfl.com/product-detail/stmicroelectronics/st62t25cm6-tr

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2 PIN DESCRIPTION

Figure 2. 28-Pin Package Pinout

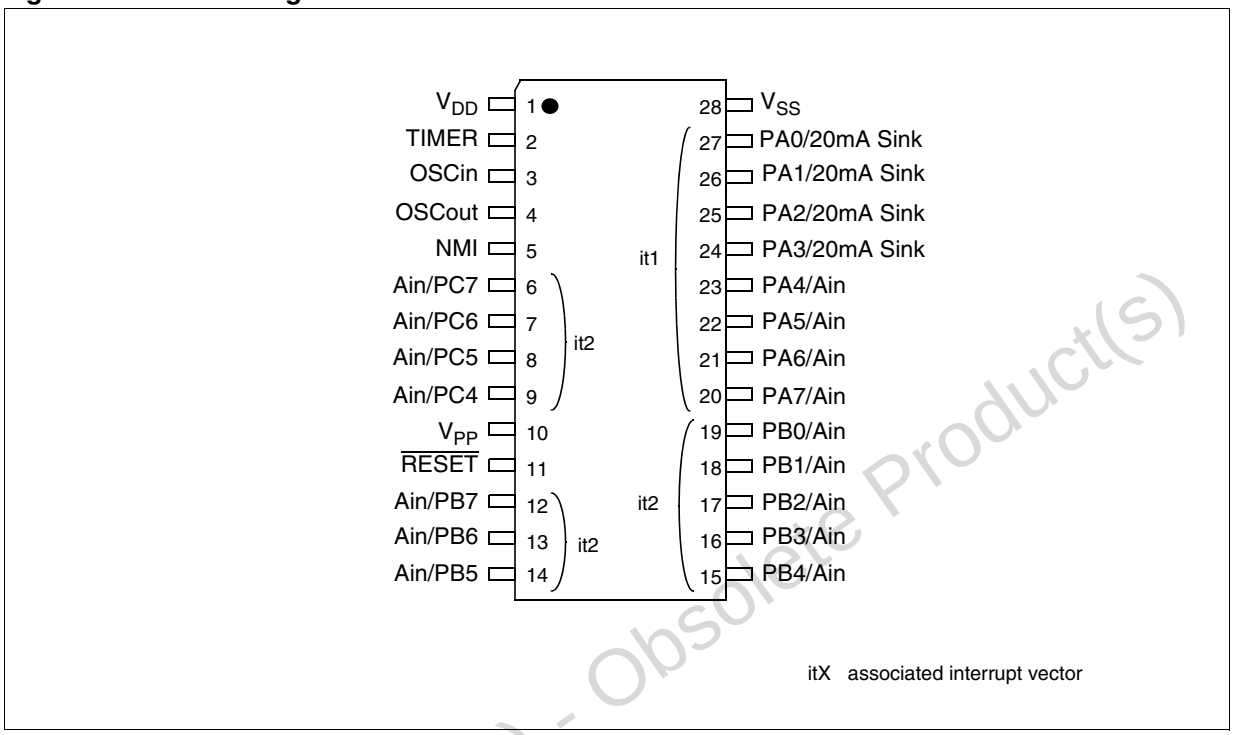


Table 1. Device Pin Description

Pin n°	Pin Name	Type	Main Function (after Reset)	Alternate Function
1	V_{DD}	S	Main power supply	
2	TIMER	I/O	Timer input or output	
3	OSCin	I	External clock input or resonator oscillator inverter input	
4	OSCout	O	Resonator oscillator inverter output or resistor input for RC oscillator	
5	NMI	I	Non maskable interrupt (falling edge sensitive)	
6	PC7/Ain	I/O	Pin C7 (IPU)	Analog input
7	PC6/Ain	I/O	Pin C6 (IPU)	Analog input
8	PC5/Ain	I/O	Pin C5 (IPU)	Analog input
9	PC4/Ain	I/O	Pin C4 (IPU)	Analog input
10	V_{PP}		Must be held at Vss for normal operation, if a 12.5V level is applied to the pin during the reset phase, the device enters EPROM programming mode.	
11	$\overline{\text{RESET}}$	I/O	Top priority non maskable interrupt (active low)	
12	PB7/Ain	I/O	Pin B7 (IPU)	Analog input
13	PB6/Ain	I/O	Pin B6 (IPU)	Analog input

3.3 OPTION BYTES

Each device is available for production in user programmable versions (OTP) as well as in factory coded versions (ROM). OTP devices are shipped to customers with a default content (00h), while ROM factory coded parts contain the code supplied by the customer. This implies that OTP devices have to be configured by the customer using the Option Bytes while the ROM devices are factory-configured.

The two option bytes allow the hardware configuration of the microcontroller to be selected.
The option bytes have no address in the memory map and can be accessed only in programming mode (for example using a standard ST6 programming tool).
In masked ROM devices, the option bytes are fixed in hardware by the ROM code (see Section 12.6.2 "ROM Version" on page 98). It is therefore impossible to read the option bytes.

The option bytes can be only programmed once. It is not possible to change the selected options after they have been programmed.

In order to reach the power consumption value indicated in Section 11.4, the option byte must be programmed to its default value. Otherwise, an over-consumption will occur.

MSB OPTION BYTE

Bits 15:10 = **Reserved**, must be always cleared.

Bit 9 = **EXTCNTL** *External STOP MODE control.*
0: EXTCNTL mode not available. STOP mode is not available with the watchdog active.
1: EXTCNTL mode available. STOP mode is available with the watchdog active by setting NMI pin to one.

Bit 8 = **LVD** *Low Voltage Detector* on/off.
This option bit enable or disable the Low Voltage Detector (LVD) feature.
0: Low Voltage Detector disabled
1: Low Voltage Detector enabled**.**

LSB OPTION BYTE

Bit 7 = **PROTECT** *Readout Protection.*
This option bit enables or disables external access to the internal program memory.
0: Program memory not read-out protected
1: Program memory read-out protected

Bit 6 = **OSC** *Oscillator selection*.
This option bit selects the main oscillator type.
0: Quartz crystal, ceramic resonator or external clock
1: RC network

Bits 5:4 = **Reserved**, must be always cleared.

Bit 3 = **NMI PULL** *NMI Pull-Up* on/off.
This option bit enables or disables the internal pull-up on the NMI pin.
0: Pull-up disabled
1: Pull-up enabled

Bit 2 = **TIM PULL** *TIMER Pull-Up* on/off.
This option bit enables or disables the internal pull-up on the TIMER pin.
0: Pull-up disabled
1: Pull-up enabled

Bit 1 = **WDACT** *Hardware or software watchdog.*
This option bit selects the watchdog type.
0: Software (watchdog to be enabled by software)
1: Hardware (watchdog always enabled)

Bit 0 = **OSGEN** *Oscillator Safeguard* on/off.
This option bit enables or disables the oscillator Safeguard (OSG) feature.
0: Oscillator Safeguard disabled
1: Oscillator Safeguard enabled

	MSB OPTION BYTE								LSB OPTION BYTE							
	15							8	7							0
	Reserved						EXT CTL	LVD	PRO-TECT	OSC	Res.	Res.	NMI PULL	TIM PULL	WD ACT	OSG EN
Default Value	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

4 CENTRAL PROCESSING UNIT

4.1 INTRODUCTION

The CPU Core of ST6 devices is independent of the I/O or Memory configuration. As such, it may be thought of as an independent central processor communicating with on-chip I/O, Memory and Peripherals via internal address, data, and control buses.

4.2 MAIN FEATURES

- 40 basic instructions
- 9 main addressing modes
- Two 8-bit index registers
- Two 8-bit short direct registers
- Low power modes
- Maskable hardware interrupts
- 6-level hardware stack

4.3 CPU REGISTERS

The ST6 Family CPU core features six registers and three pairs of flags available to the programmer. These are described in the following paragraphs.

Accumulator (A). The accumulator is an 8-bit general purpose register used in all arithmetic calculations, logical operations, and data manipulations. The accumulator can be addressed in Data Space as a RAM location at address FFh. Thus the ST6 can manipulate the accumulator just like any other register in Data Space.

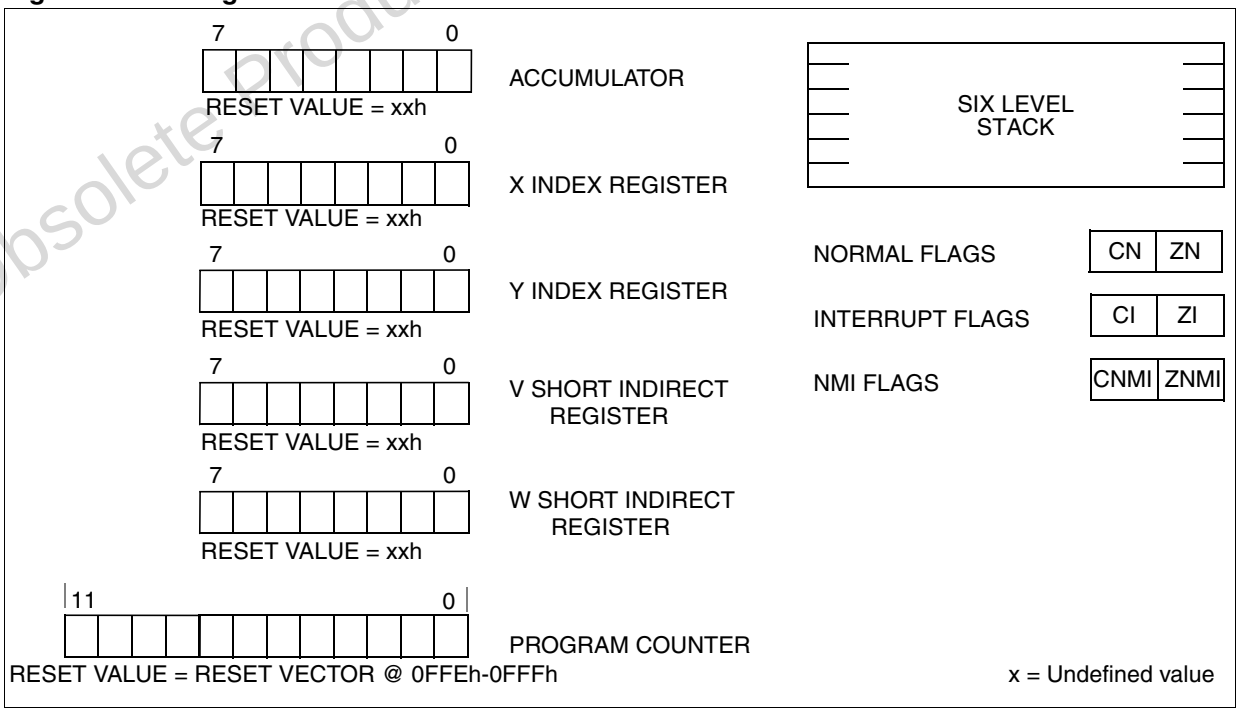
Index Registers (X, Y). These two registers are used in Indirect addressing mode as pointers to memory locations in Data Space. They can also be accessed in Direct, Short Direct, or Bit Direct addressing modes. They are mapped in Data Space at addresses 80h (X) and 81h (Y) and can be accessed like any other memory location.

Short Direct Registers (V, W). These two registers are used in Short Direct addressing mode. This means that the data stored in V or W can be accessed with a one-byte instruction (four CPU cycles). V and W can also be accessed using Direct and Bit Direct addressing modes. They are mapped in Data Space at addresses 82h (V) and 83h (W) and can be accessed like any other memory location.

Note: The X and Y registers can also be used as Short Direct registers in the same way as V and W.

Program Counter (PC). The program counter is a 12-bit register which contains the address of the next instruction to be executed by the core. This ROM location may be an opcode, an operand, or the address of an operand.

Figure 7. CPU Registers



5 CLOCKS, SUPPLY AND RESET

5.1 CLOCK SYSTEM

The main oscillator of the MCU can be driven by any of these clock sources:

– external clock signal

– external AT-cut parallel-resonant crystal

– external ceramic resonator

– external RC network (R_{NET}).

In addition, an on-chip Low Frequency Auxiliary Oscillator (LFAO) is available as a back-up clock system or to reduce power consumption.

An optional Oscillator Safeguard (OSG) filters spikes from the oscillator lines, and switches to the LFAO backup oscillator in the event of main oscillator failure. It also automatically limits the internal clock frequency (f_{INT}) as a function of V_{DD}, in order to guarantee correct operation. These functions are illustrated in Figure 10, and Figure 11.

Table 5 illustrates various possible oscillator configurations using an external crystal or ceramic resonator, an external clock input, an external resistor (R_{NET}), or the lowest cost solution using only the LFAO.

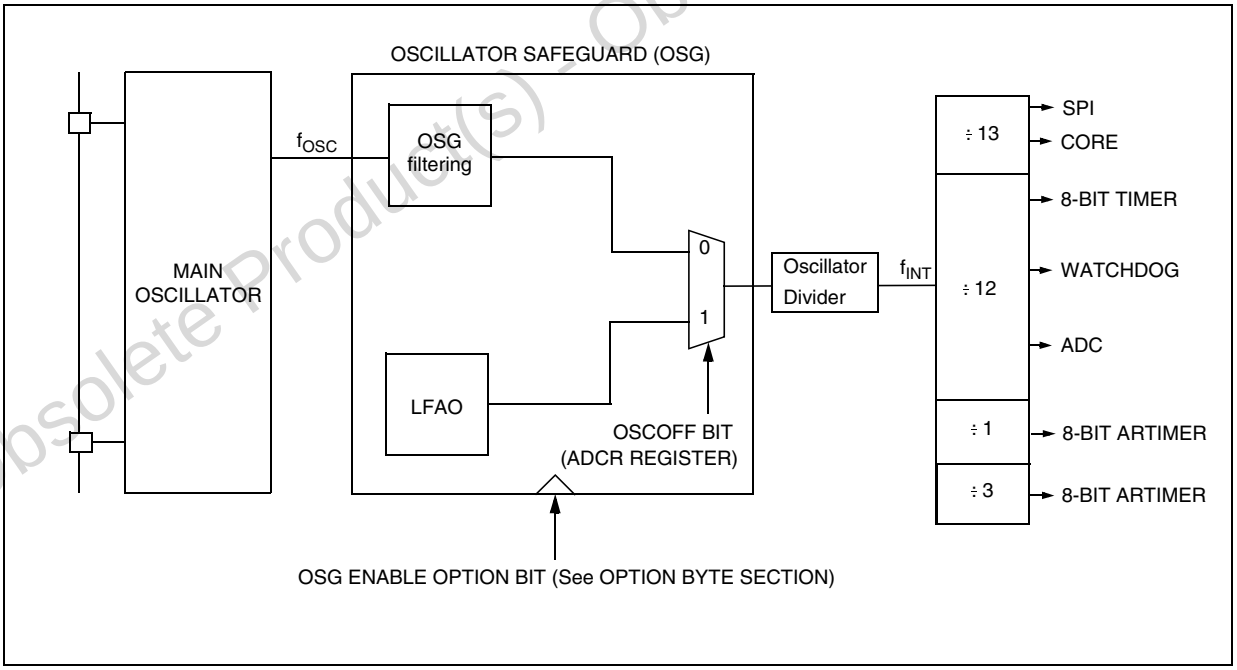
For more details on configuring the clock options, refer to the Option Bytes section of this document.

The internal MCU clock frequency (f_{INT}) is divided by 12 to drive the Timer, the Watchdog timer and the A/D converter, by 13 to drive the CPU core and the SPI and by 1 or 3 to drive the ARTIMER, as shown in Figure 9.

With an 8 MHz oscillator, the fastest CPU cycle is therefore 1.625µs.

A CPU cycle is the smallest unit of time needed to execute any operation (for instance, to increment the Program Counter). An instruction may require two, four, or five CPU cycles for execution.

Figure 9. Clock Circuit Block Diagram



CLOCK SYSTEM (Cont'd)

5.1.3 Low Frequency Auxiliary Oscillator (LFAO)

The Low Frequency Auxiliary Oscillator has three main purposes. Firstly, it can be used to reduce power consumption in non timing critical routines. Secondly, it offers a fully integrated system clock, without any external components. Lastly, it acts as a backup oscillator in case of main oscillator failure.

This oscillator is available when the OSG ENABLED option is selected in the option byte (refer to the Option Bytes section of this document). In this case, it automatically starts one of its periods after the first missing edge of the main oscillator, whatever the reason for the failure (main oscillator defective, no clock circuitry provided, main oscillator switched off...). See Figure 11.

User code, normal interrupts, WAIT and STOP instructions, are processed as normal, at the reduced f_{LFAO} frequency. The A/D converter accuracy is decreased, since the internal frequency is below 1.2 MHz.

At power on, until the main oscillator starts, the reset delay counter is driven by the LFAO. If the main oscillator starts before the 2048 cycle delay has elapsed, it takes over.

The Low Frequency Auxiliary Oscillator is automatically switched off as soon as the main oscillator starts.

5.1.4 Register Description

ADC CONTROL REGISTER (ADCR)
Address: 0D1h — Read/Write
Reset value: 0100 0000 (40h)

7							0
ADCR 7	ADCR 6	ADCR 5	ADCR 4	ADCR 3	OSC OFF	ADCR 1	ADCR 0

Bit 7:3, 1:0 = **ADCR[7:3], ADCR[1:0]** *ADC Control Register*.
These bits are used to control the A/D converter (if available on the device) otherwise they are not used.

Bit 2 = **OSCOFF** *Main Oscillator Off.*
0: Main oscillator enabled
1: Main oscillator disabled

Note: The OSG must be enabled using the OSGEN option in the Option Byte, otherwise the OSCOFF setting has no effect.

5.3 RESET

5.3.1 Introduction

The MCU can be reset in three ways:

- A low pulse input on the $\overline{\text{RESET}}$ pin
- Internal Watchdog reset
- Internal Low Voltage Detector (LVD) reset

5.3.2 RESET Sequence

The basic RESET sequence consists of 3 main phases:

- Internal (watchdog or LVD) or external Reset event
- A delay of 2048 clock (f_{INT}) cycles
- RESET vector fetch

The reset delay allows the oscillator to stabilise and ensures that recovery has taken place from the Reset state.

The RESET vector fetch phase duration is 2 clock cycles.

When a reset occurs:

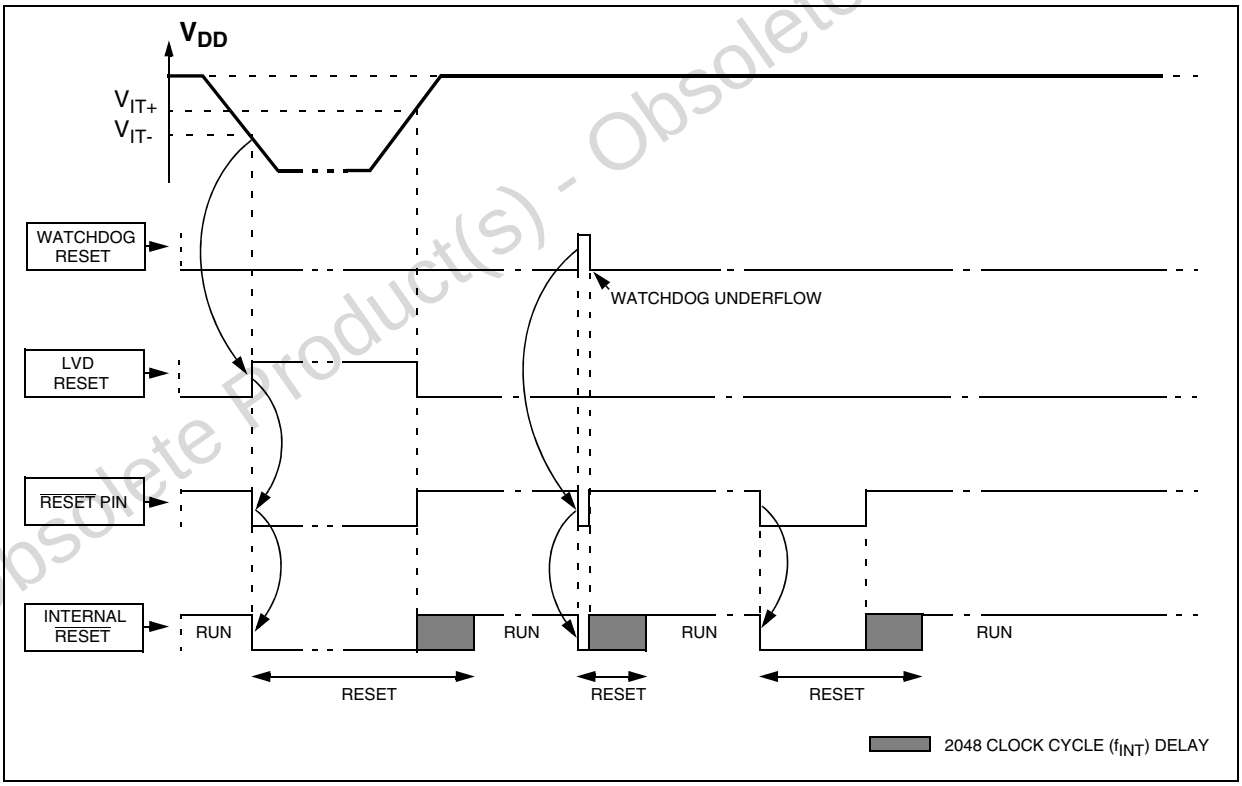
– The stack is cleared

– The PC is loaded with the address of the Reset vector. It is located in program ROM starting at address 0FFEh.

A jump to the beginning of the user program must be coded at this address.

– The interrupt flag is automatically set, so that the CPU is in Non Maskable Interrupt mode. This prevents the initialization routine from being interrupted. The initialization routine should therefore be terminated by a RETI instruction, in order to go back to normal mode.

Figure 13. RESET Sequence



RESET (Cont'd)

5.3.3 RESET Pin

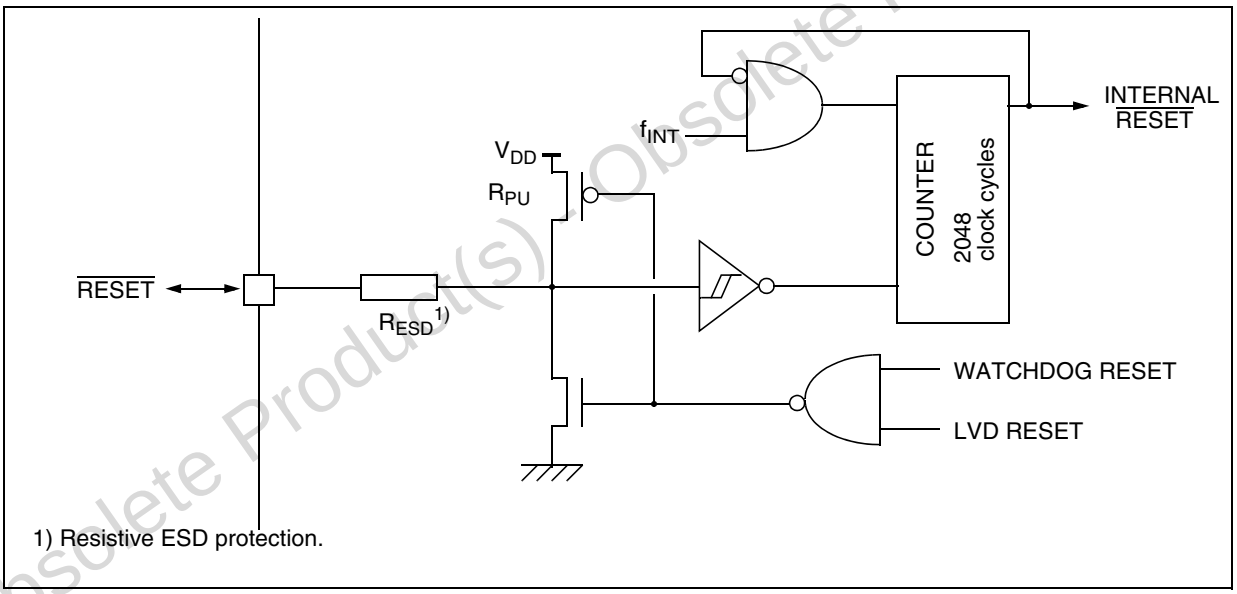
The RESET pin may be connected to a device on the application board in order to reset the MCU if required. The RESET pin may be pulled low in RUN, WAIT or STOP mode. This input can be used to reset the internal state of the MCU and ensure it starts-up correctly. The pin, which is connected to an internal pull-up, is active low and features a Schmitt trigger input. A delay (2048 clock cycles) added to the external signal ensures that even short pulses on the RESET pin are accepted as valid, provided V_{DD} has completed its rising phase and that the oscillator is running correctly (normal RUN or WAIT modes). The MCU is kept in the Reset state as long as the RESET pin is held low.

If the RESET pin is grounded while the MCU is in RUN or WAIT modes, processing of the user program is stopped (RUN mode only), the I/O ports are configured as inputs with pull-up resistors and the main oscillator is restarted. When the level on the RESET pin then goes high, the initialization sequence is executed at the end of the internal delay period.

If the RESET pin is grounded while the MCU is in STOP mode, the oscillator starts up and all the I/O ports are configured as inputs with pull-up resistors. When the RESET pin level then goes high, the initialization sequence is executed at the end of the internal delay period.

A simple external RESET circuitry is shown in Figure 15. For more details, please refer to the application note AN669.

Figure 14. Reset Block Diagram



1) Resistive ESD protection.

WATCHDOG TIMER (Cont'd)

9.1.3 Functional Description

The watchdog activation is selected through an option in the option bytes:

– **HARDWARE** Watchdog option

After reset, the watchdog is permanently active, the C bit in the WDGR is forced high and the user can not change it. However, this bit can be read equally as 0 or 1.

– **SOFTWARE** Watchdog option

After reset, the watchdog is deactivated. The function is activated by setting C bit in the WDGR register. Once activated, it cannot be deactivated. The counter value stored in the WDGR register (bits SR:T0), is decremented every 3072 clock cycles. The length of the timeout period can be programmed by the user in 64 steps of 3072 clock cycles.

If the watchdog is activated (by setting the C bit) and when the SR bit is cleared, the watchdog initiates a reset cycle pulling the reset pin low for typically 500ns.

The application program must write in the WDGR register at regular intervals during normal operation to prevent an MCU reset. The value to be stored in the WDGR register must be between FEh and 02h (see Table 11). To run the watchdog function the following conditions must be true:

– The C bit is set (watchdog activated)

– The SR bit is set to prevent generating an immediate reset

– The T[5:0] bits contain the number of decrements which represent the time delay before the watchdog produces a reset.

Table 11. Watchdog Timing (f_{OSC} = 8 MHz)

	WDGR Register initial value	WDG timeout period (ms)
Max.	FEh	24.576
Min.	02h	0.384

9.1.3.1 Software Reset

The SR bit can be used to generate a software reset by clearing the SR bit while the C bit is set.

9.1.4 Recommendations

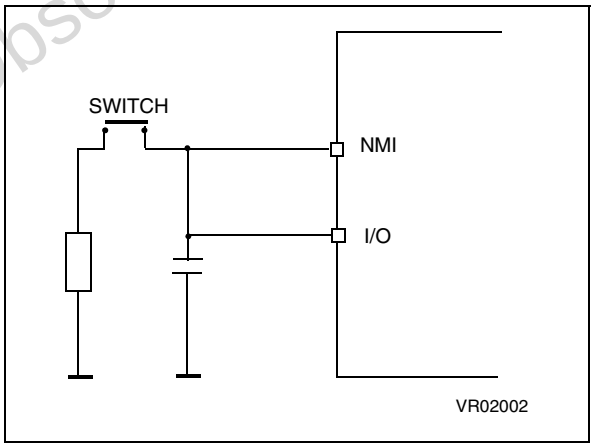
1. The Watchdog plays an important supporting role in the high noise immunity of ST62xx devices, and should be used wherever possible. Watchdog related options should be selected on the basis of a trade-off between application security and STOP mode availability (refer to the description of the WDACT and EXTCNTL bits on the Option Bytes).

When STOP mode is not required, hardware activation without EXTERNAL STOP MODE CONTROL should be preferred, as it provides maximum security, especially during power-on.

When STOP mode is required, hardware activation and EXTERNAL STOP MODE CONTROL should be chosen. NMI should be high by default, to allow STOP mode to be entered when the MCU is idle.

The NMI pin can be connected to an I/O line (see Figure 26) to allow its state to be controlled by software. The I/O line can then be used to keep NMI low while Watchdog protection is required, or to avoid noise or key bounce. When no more processing is required, the I/O line is released and the device placed in STOP mode for lowest power consumption.

Figure 26. A typical circuit making use of the EXERNAL STOP MODE CONTROL feature



2. When software activation is selected (WDACT bit in Option byte) and the Watchdog is not activated, the downcounter may be used as a simple 7-bit timer (remember that the bits are in reverse order).

The software activation option should be chosen only when the Watchdog counter is to be used as a timer. To ensure the Watchdog has not been unexpectedly activated, the following instructions should be executed:

```
jrr 0, WDGR, #+3 ; If C=0,jump to next
ldi WDGR, 0FDH   ; SR=0 -> reset

next :
```

9.2 8-BIT TIMER

9.2.1 Introduction

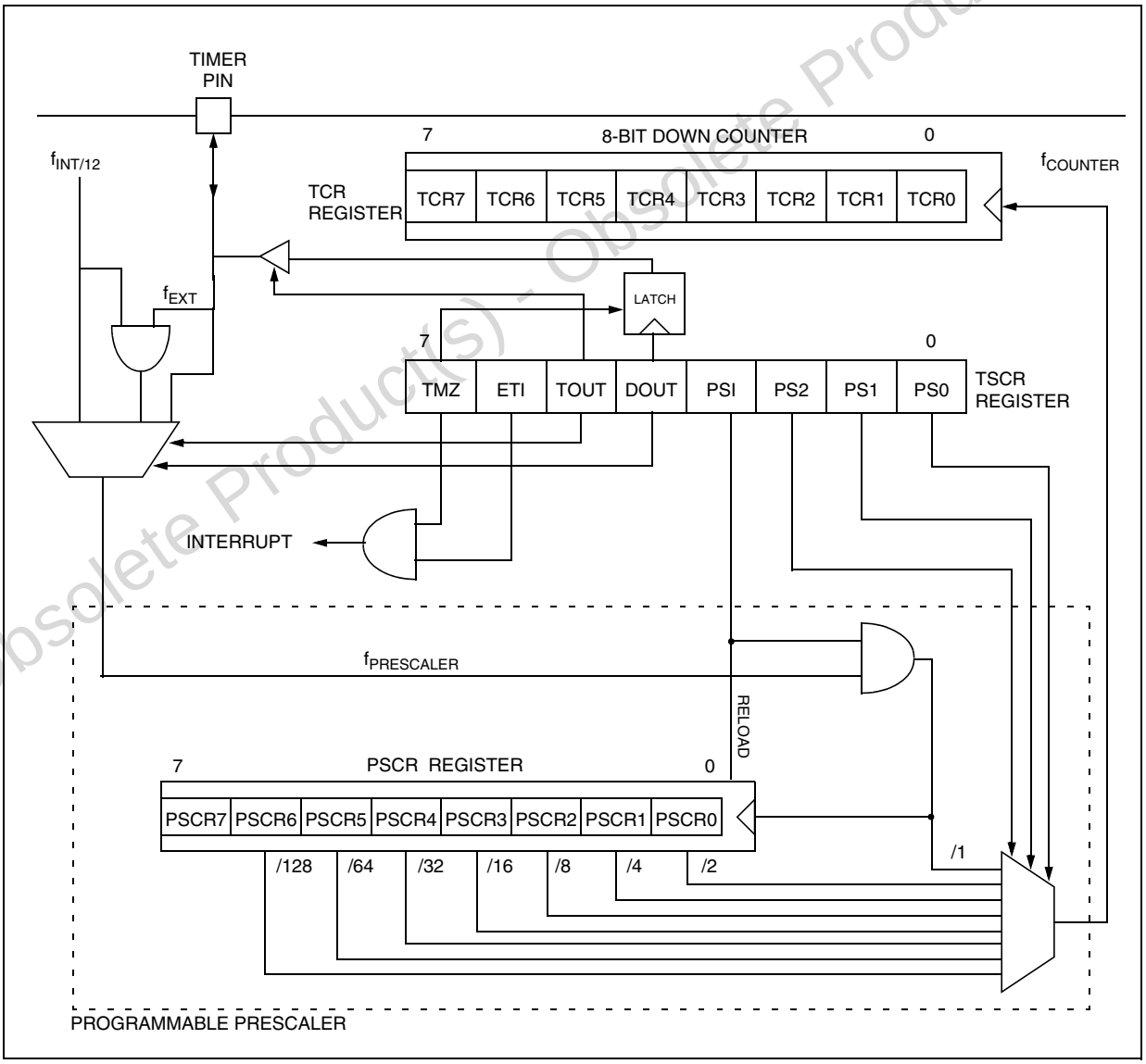
The 8-Bit Timer on-chip peripheral is a free running downcounter based on an 8-bit downcounter with a 7-bit programmable prescaler, giving a maximum count of 2^{15}. The peripheral may be configured in three different operating modes.

9.2.2 Main Features

- Time-out downcounting mode with up to 15-bit accuracy
- External counter clock source (valid also in STOP mode)
- Interrupt capability on counter underflow
- Output signal generation
- External pulse length measurement
- Event counter

The timer can be used in WAIT and STOP modes to wake up the MCU.

Figure 27. Timer Block Diagram



INSTRUCTION SET (Cont'd)

Arithmetic and Logic. These instructions are used to perform arithmetic calculations and logic operations. In AND, ADD, CP, SUB instructions one operand is always the accumulator while, depending on the addressing mode, the other can be either a data space memory location or an immediate value. In CLR, DEC, INC instructions the operand can be any of the 256 data space addresses. In COM, RLC, SLA the operand is always the accumulator.

Table 17. Arithmetic & Logic Instructions

Instruction	Addressing Mode	Bytes	Cycles	Flags	
				Z	C
ADD A, (X)	Indirect	1	4	Δ	Δ
ADD A, (Y)	Indirect	1	4	Δ	Δ
ADD A, rr	Direct	2	4	Δ	Δ
ADDI A, #N	Immediate	2	4	Δ	Δ
AND A, (X)	Indirect	1	4	Δ	Δ
AND A, (Y)	Indirect	1	4	Δ	Δ
AND A, rr	Direct	2	4	Δ	Δ
ANDI A, #N	Immediate	2	4	Δ	Δ
CLR A	Short Direct	2	4	Δ	Δ
CLR r	Direct	3	4	*	*
COM A	Inherent	1	4	Δ	Δ
CP A, (X)	Indirect	1	4	Δ	Δ
CP A, (Y)	Indirect	1	4	Δ	Δ
CP A, rr	Direct	2	4	Δ	Δ
CPI A, #N	Immediate	2	4	Δ	Δ
DEC X	Short Direct	1	4	Δ	*
DEC Y	Short Direct	1	4	Δ	*
DEC V	Short Direct	1	4	Δ	*
DEC W	Short Direct	1	4	Δ	*
DEC A	Direct	2	4	Δ	*
DEC rr	Direct	2	4	Δ	*
DEC (X)	Indirect	1	4	Δ	*
DEC (Y)	Indirect	1	4	Δ	*
INC X	Short Direct	1	4	Δ	*
INC Y	Short Direct	1	4	Δ	*
INC V	Short Direct	1	4	Δ	*
INC W	Short Direct	1	4	Δ	*
INC A	Direct	2	4	Δ	*
INC rr	Direct	2	4	Δ	*
INC (X)	Indirect	1	4	Δ	*
INC (Y)	Indirect	1	4	Δ	*
RLC A	Inherent	1	4	Δ	Δ
SLA A	Inherent	2	4	Δ	Δ
SUB A, (X)	Indirect	1	4	Δ	Δ
SUB A, (Y)	Indirect	1	4	Δ	Δ
SUB A, rr	Direct	2	4	Δ	Δ
SUBI A, #N	Immediate	2	4	Δ	Δ

Notes:
X,Y Index Registers
V, W Short Direct Registers
Δ Affected
Immediate data (stored in ROM memory)
* Not Affected
rr Data space register

CLOCK AND TIMING CHARACTERISTICS (Cont'd)

11.5.4 RC Oscillator

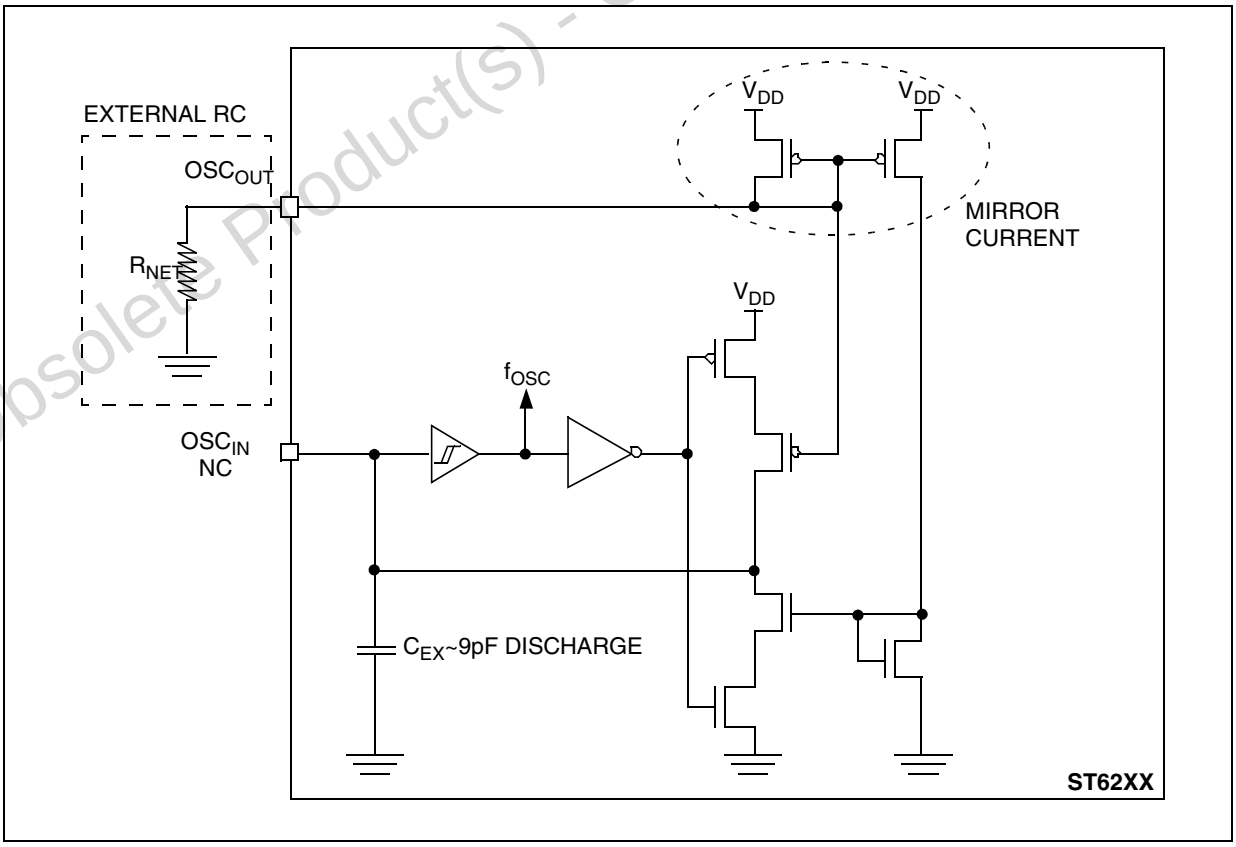
The ST6 internal clock can be supplied with an external RC oscillator. Depending on the R_{NET} value, the accuracy of the frequency is about 20%, so it may not be suitable for some applications.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
f_{OSC}	RC oscillator frequency [1]	$4.5V \le V_{DD} \le 6.0V$	R_{NET}=22 kΩ	7.2	8.6	10	MHz
			R_{NET}=47 kΩ	5.1	5.7	6.5	
			R_{NET}=100 kΩ	3.2	3.4	3.8	
			R_{NET}=220 kΩ	1.8	1.9	2	
			R_{NET}=470 kΩ	0.9	0.95	1.1	
		$3V \le V_{DD} \le 3.6V$	R_{NET}=22 kΩ	3.7	4.3	4.9	
			R_{NET}=47 kΩ	2.8	3	3.3	
			R_{NET}=100 kΩ	1.8	1.9	2	
			R_{NET}=220 kΩ	1	1.1	1.2	
			R_{NET}=470 kΩ	0.5	0.55	0.6	
R_{NET}	RC Oscillator external resistor [2]		see Figure 52 & Figure 53	22		870	kΩ

Notes:

1. Data based on characterization results, not tested in production. These measurements were done with the OSCin pin unconnected (only soldered on the PCB).
2. R_{NET} must have a positive temperature coefficient (ppm/°C), carbon resistors should therefore not be used.

Figure 51. Typical Application with RC Oscillator



CLOCK AND TIMING CHARACTERISTICS (Cont'd)

Figure 52. Typical RC Oscillator frequency vs. V_{DD}

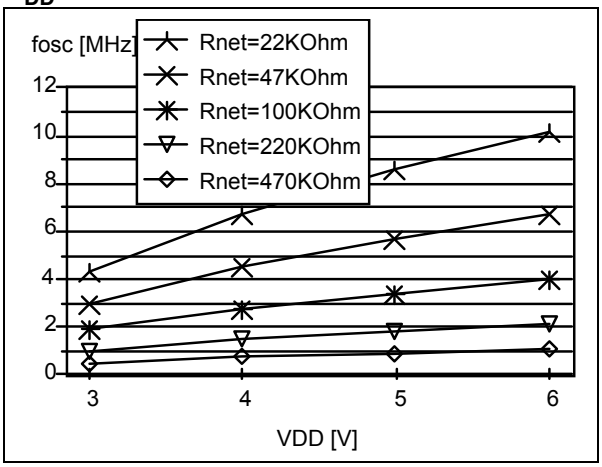
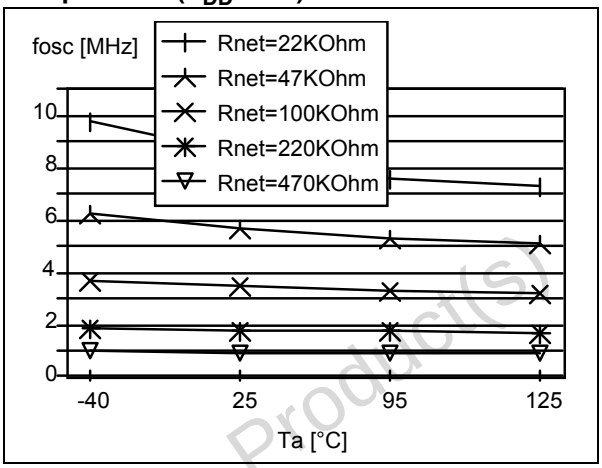


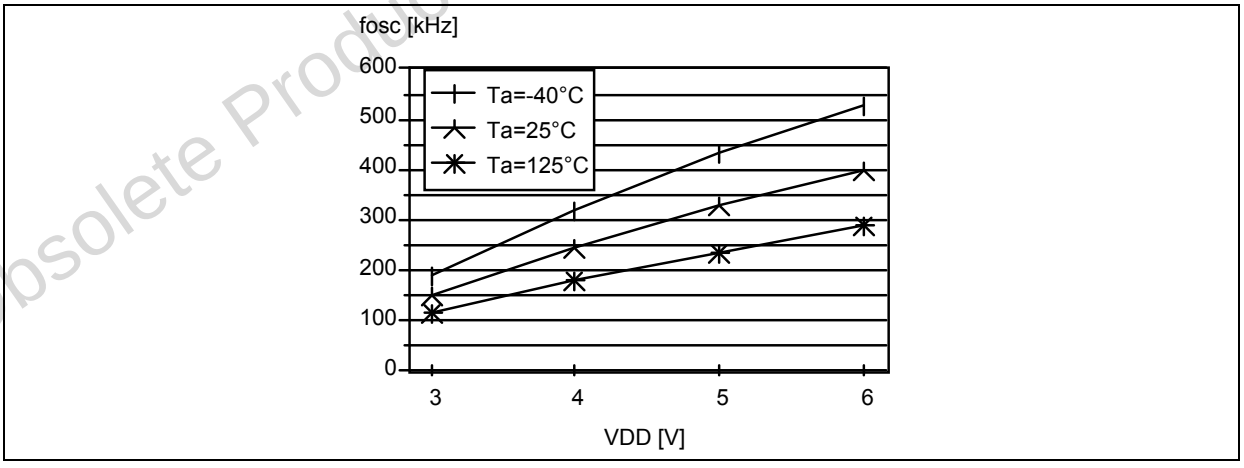
Figure 53. Typical RC Oscillator frequency vs. Temperature (V_{DD} = 5V)



11.5.5 Oscillator Safeguard (OSG) and Low Frequency Auxiliary Oscillator (LFAO)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{LFAO}	Low Frequency Auxiliary Oscillator Frequency [1]	T_A=25° C, V_{DD}=5.0 V	200	350	800	kHz
		T_A=25° C, V_{DD}=3.3 V	86	150	340	
f_{OSG}	Internal Frequency with OSG enabled	T_A=25° C, V_{DD}=4.5 V	4			MHz
		T_A=25° C, V_{DD}=3.3 V	2			

Figure 54. Typical LFAO Frequencies



Note:
1. Data based on characterization results.

EMC CHARACTERISTICS (Cont'd)

11.7.2.2 Static and Dynamic Latch-Up

- **LU**: 3 complementary static tests are required on 10 parts to assess the latch-up performance. A supply overvoltage (applied to each power supply pin), a current injection (applied to each input, output and configurable I/O pin) and a power supply switch sequence are performed on each sample. This test conforms to the EIA/JESD 78 IC latch-up standard. For more details, refer to the AN1181 application note.
- **DLU**: Electro-Static Discharges (one positive then one negative test) are applied to each pin of 3 samples when the micro is running to assess the latch-up performance in dynamic mode. Power supplies are set to the typical values, the oscillator is connected as near as possible to the pins of the micro and the component is put in reset mode. This test conforms to the IEC1000-4-2 and SAEJ1752/3 standards and is described in Figure 58. For more details, refer to the AN1181 application note.

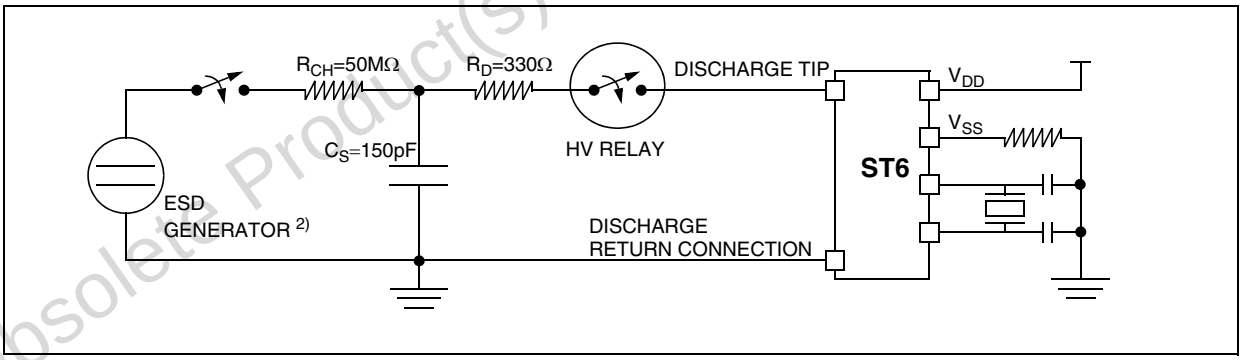
Electrical Sensitivities

Symbol	Parameter	Conditions	Class [1]
LU	Static latch-up class	T_A=+25°C T_A=+85°C	A A
DLU	Dynamic latch-up class	V_{DD}=5V, f_{OSC}=4MHz, T_A=+25°C	A

Notes:

1. Class description: A Class is an STMicroelectronics internal specification. All its limits are higher than the JEDEC specifications, that means when a device belongs to Class A it exceeds the JEDEC standard. B Class strictly covers all the JEDEC criteria (international standard).
2. Schaffner NSG435 with a pointed test finger.

Figure 58. Simplified Diagram of the ESD Generator for DLU



I/O PORT PIN CHARACTERISTICS (Cont'd)

11.8.2 Output Driving Current

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{OL} 1)	Output low level voltage for a standard I/O pin (see Figure 63 and Figure 66)	V_{DD}=5V	I_{IO}=+10µA, $T_A \le 125°C$		0.1	V
			I_{IO}=+3mA, $T_A \le 125°C$		0.8	
			I_{IO}=+5mA, $T_A \le 85°C$		0.8	
			I_{IO}=+10mA, $T_A \le 85°C$		1.2	
	Output low level voltage for a high sink I/O pin (see Figure 64 and Figure 67)		I_{IO}=+10µA, $T_A \le 125°C$		0.1	
			I_{IO}=+7mA, $T_A \le 125°C$		0.8	
			I_{IO}=+10mA, $T_A \le 85°C$		0.8	
			I_{IO}=+15mA, $T_A \le 125°C$		1.3	
			I_{IO}=+20mA, $T_A \le 85°C$		1.3	
			I_{IO}=+30mA, $T_A \le 85°C$		2	
V_{OH} 2)	Output high level voltage for an I/O pin (see Figure 65 and Figure 68)		I_{IO}=-10µA, $T_A \le 125°C$	V_{DD}-0.1		
			I_{IO}=-3mA, $T_A \le 125°C$	V_{DD}-1.5		
			I_{IO}=-5mA, $T_A \le 85°C$	V_{DD}-1.5		

Notes:

1. The I_{IO} current sunk must always respect the absolute maximum rating specified in Section 11.2.2 and the sum of I_{IO} (I/O ports and control pins) must not exceed I_{VSS}.
2. The I_{IO} current source must always respect the absolute maximum rating specified in Section 11.2.2 and the sum of I_{IO} (I/O ports and control pins) must not exceed I_{VDD}. True open drain I/O pins does not have V_{OH}.

Figure 63. Typical V_{OL} at V_{DD} = 5V (standard)

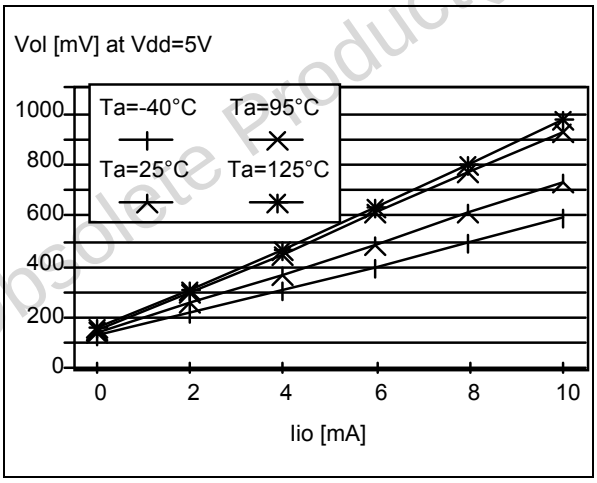
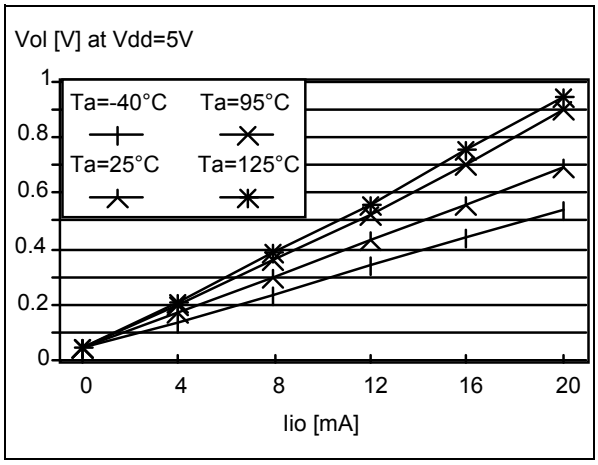


Figure 64. Typical V_{OL} at V_{DD} = 5V (high-sink)



I/O PORT PIN CHARACTERISTICS (Cont'd)

Figure 65. Typical V_{OH} at V_{DD} = 5V

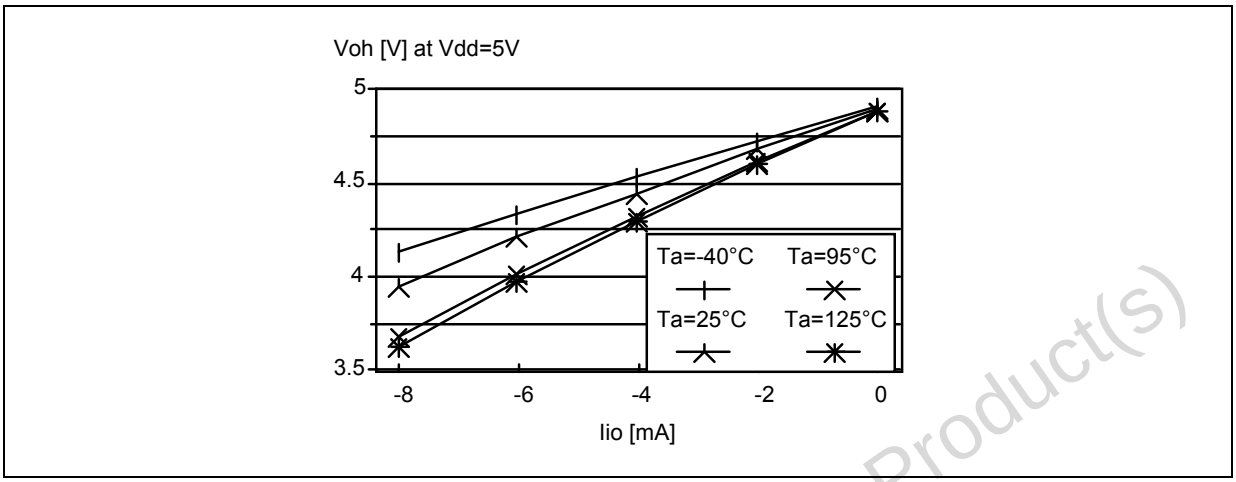


Figure 66. Typical V_{OL} vs V_{DD} (standard I/Os)

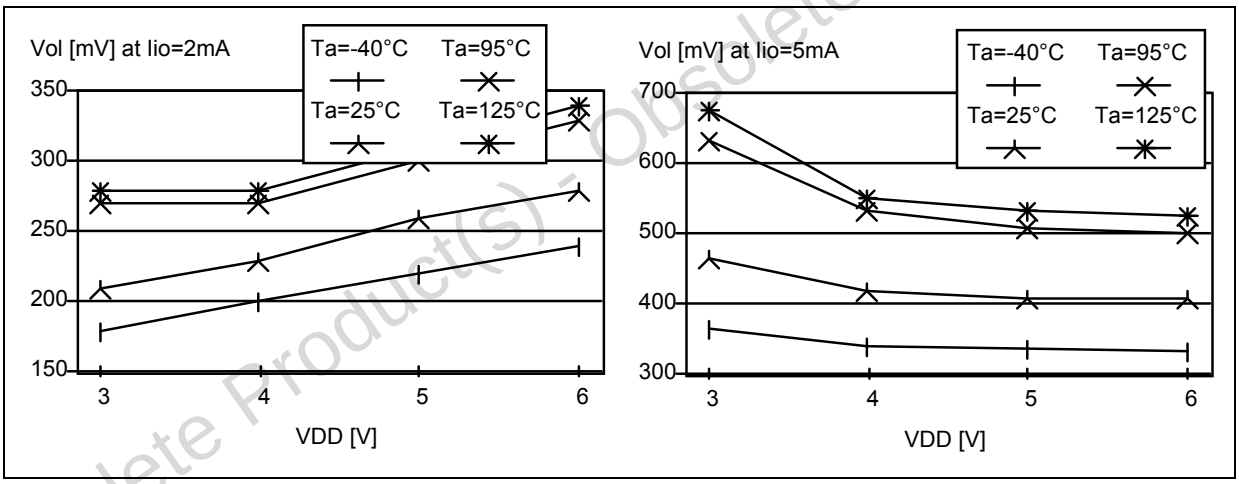
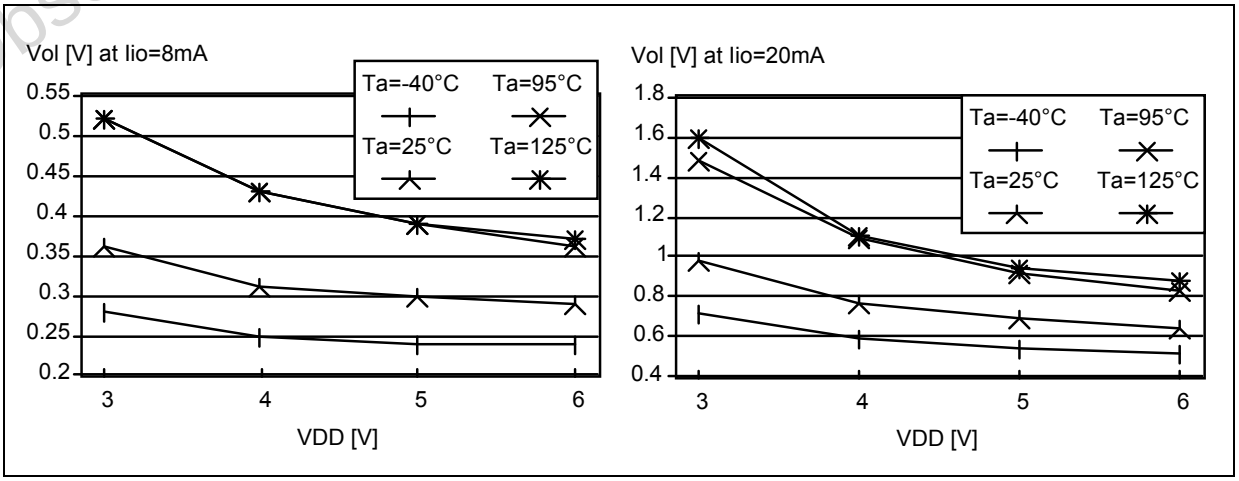
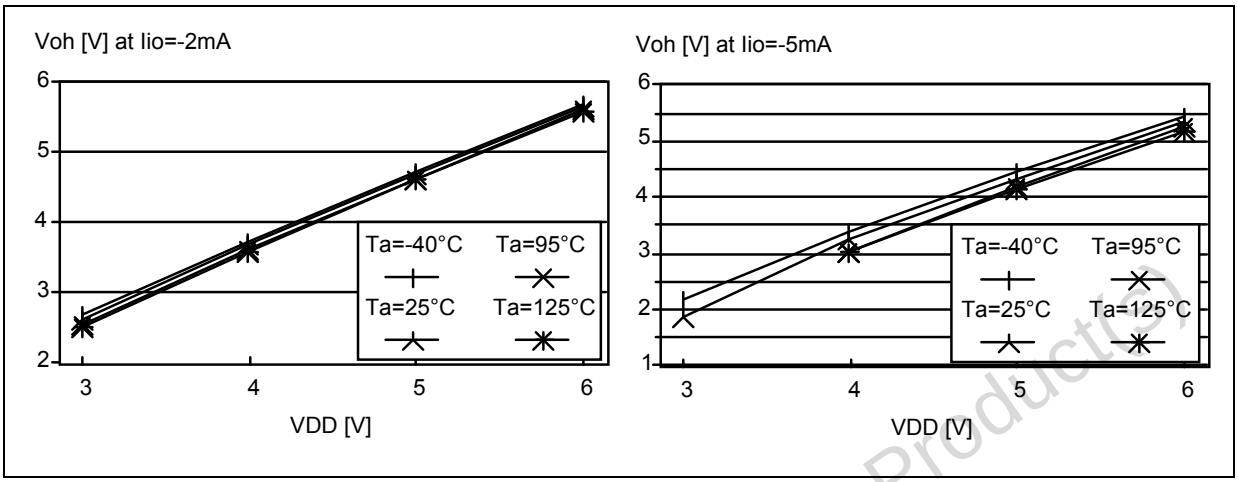


Figure 67. Typical V_{OL} vs V_{DD} (high-sink I/Os)



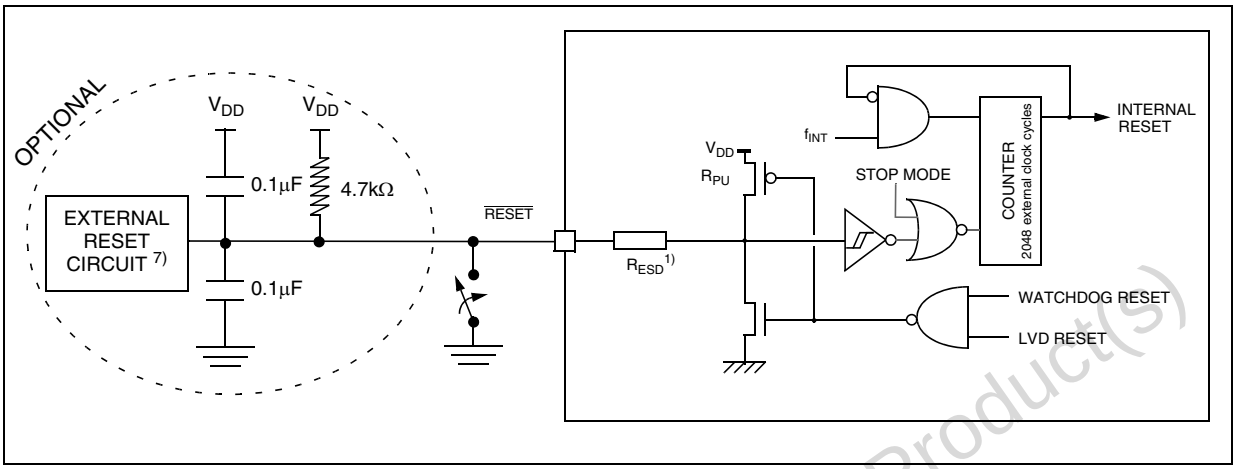
I/O PORT PIN CHARACTERISTICS (Cont'd)

Figure 68. Typical V_{OH} vs V_{DD}



CONTROL PIN CHARACTERISTICS (Cont'd)

Figure 70. Typical Application with $\overline{\text{RESET}}$ pin [8)]



11.9.2 NMI Pin

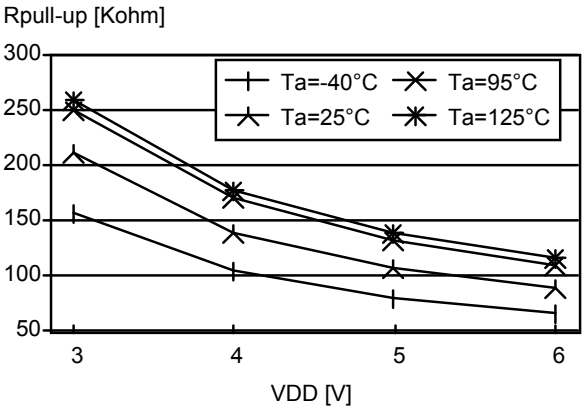
Subject to general operating conditions for V_{DD}, f_{OSC}, and T_A unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ [1)]	Max	Unit
V_{IL}	Input low level voltage [2)]					$0.3xV_{DD}$	V
V_{IH}	Input high level voltage [2)]			$0.7xV_{DD}$			
V_{hys}	Schmitt trigger voltage hysteresis [3)]			200	400		mV
$R_{pull-up}$	Weak pull-up equivalent resistor [4)]	$V_{IN}=V_{SS}$	V_{DD}=5V	40	100	350	kΩ
			V_{DD}=3.3V	80	200	700	

Notes:

1. Unless otherwise specified, typical data are based on T_A=25°C and V_{DD}=5V.
2. Data based on characterization results, not tested in production.
3. Hysteresis voltage between Schmitt trigger switching levels. Based on characterization results, not tested.
4. The $R_{pull-up}$ equivalent resistor is based on a resistive transistor. This data is based on characterization results, not tested in production.

Figure 71. Typical $R_{pull-up}$ vs. V_{DD} with $V_{IN}=V_{SS}$



12.4 PACKAGE/SOCKET FOOTPRINT PROPOSAL

Table 22. Suggested List of DIP28 Socket Types

Package / Probe	Adaptor / Socket Reference		Same Footprint	Socket Type
DIP28	TEXTOOL	228-60-23	X	Textool

Table 23. Suggested List of SO28 Socket Types

Package / Probe	Adaptor / Socket Reference		Same Footprint	Socket Type
SO28	ENPLAS	OTS-28-1.27-04		Open Top
	YAMAICHI	IC51-0282-334-1		Clamshell
EMU PROBE	Adapter from SO28 to DIP28 footprint (delivered with emulator)		X	SMD to DIP
Programming Adapter	Logical Systems	PA28SO1-08-6	X	Open Top

Table 24. Suggested List of SSOP28 Socket Types

Package / Probe	Adaptor / Socket Reference		Same Footprint	Socket Type
SSOP28	ENPLAS	OTS-28-0.65-01		Open Top
EMU PROBE	Adapter from SSOP28 to DIP28 footprint (sales type: ST626X-P/SSOP28)		X	DIP to SMD
Programming Adapter	Logical Systems	PA28SS-OT-6	X	Open Top

IDENTIFICATION	DESCRIPTION
AN913	PWM GENERATION WITH ST62 16-BIT AUTO-RELOAD TIMER
AN914	USING ST626X SPI AS UART
AN1016	ST6 USING THE ST623XB/ST628XB UART
AN1050	ST6 INPUT CAPTURE WITH ST62 16-BIT AUTO-RELOAD TIMER
AN1127	USING THE ST62T6XC/5XC SPI IN MASTER MODE
GENERAL	
AN683	MCUS - 8/16-BIT MICROCONTROLLERS (MCUS) APPLICATION NOTES ABSTRACTS BY TOPICS
AN886	SELECTING BETWEEN ROM AND OTP FOR A MICROCONTROLLER
AN887	MAKING IT EASY WITH MICROCONTROLLERS
AN898	EMC GENERAL INFORMATION
AN899	SOLDERING RECOMMENDATIONS AND PACKAGING INFORMATION
AN900	INTRODUCTION TO SEMICONDUCTOR TECHNOLOGY
AN901	EMC GUIDE-LINES FOR MICROCONTROLLER - BASED APPLICATIONS
AN902	QUALITY AND RELIABILITY INFORMATION
AN912	A SIMPLE GUIDE TO DEVELOPMENT TOOLS
AN1181	ELECTROSTATIC DISHARGE SENSITIVITY MEASUREMENT