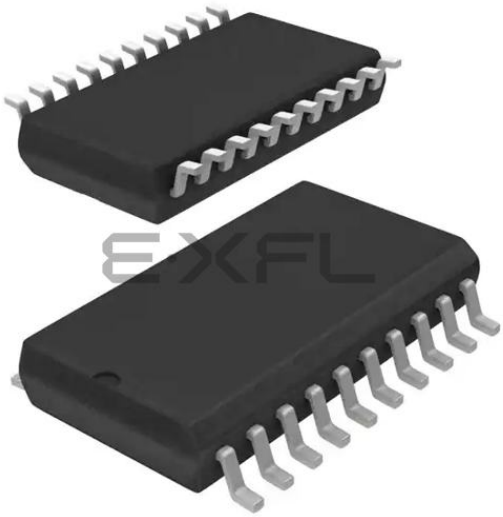

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Applications of "Embedded - Microcontrollers"

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	4KB (4K x 8)
Program Memory Type	FLASH
EEPROM Size	-
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/st7flit15bf1m3

Table of Contents

Address	Block	Register Label	Register Name	Reset Status	Remarks
0002Fh	FLASH	FCSR	Flash Control/Status Register	00h	R/W
00030h	EEPROM	EECSR	Data EEPROM Control/Status Register	00h	R/W
0031h 0032h 0033h	SPI	SPIDR SPICR SPICSR	SPI Data I/O Register SPI Control Register SPI Control Status Register	xxh 0xh 00h	R/W R/W R/W
0034h 0035h 0036h	ADC	ADCCSR ADCDRH ADCDRL	A/D Control Status Register A/D Data Register High A/D Amplifier Control/Data Low Register	00h xxh 0xh	R/W Read Only R/W
0037h	ITC	EICR	External Interrupt Control Register	00h	R/W
0038h	MCC	MCCSR	Main Clock Control/Status Register	00h	R/W
0039h 003Ah	Clock and Reset	RCCR SICSR	RC oscillator Control Register System Integrity Control/Status Register	FFh 0110 0xx0b	R/W R/W
003Bh	PLL clock select	PLLTST	PLL test register	00h	R/W
003Ch	ITC	EISR	External Interrupt Selection Register	0Ch	R/W
003Dh to 0048h	Reserved area (12 bytes)				
0049h 004Ah	AWU	AWUPR AWUCSR	AWU Prescaler Register AWU Control/Status Register	FFh 00h	R/W R/W
004Bh 004Ch 004Dh 004Eh 004Fh 0050h 0051h	DM[3]	DMCR DMSR DMBK1H DMBK1L DMBK2H DMBK2L DMCR2	DM Control Register DM Status Register DM Breakpoint Register 1 High DM Breakpoint Register 1 Low DM Breakpoint Register 2 High DM Breakpoint Register 2 Low DM Control Register 2	00h 00h 00h 00h 00h 00h 00h	R/W R/W R/W R/W R/W R/W R/W
0052h to 007Fh	Reserved area (46 bytes)				

Legend: x=undefined, R/W=read/write

Notes:

1. The contents of the I/O port DR registers are readable only in output configuration. In input configuration, the values of the I/O pins are returned instead of the DR register contents.

2. The bits associated with unavailable pins must always keep their reset value.

3. For a description of the Debug Module registers, see ICC protocol reference manual.

FLASH PROGRAM MEMORY (Cont'd)

4.5 Memory Protection

There are two different types of memory protection: Read Out Protection and Write/Erase Protection which can be applied individually.

4.5.1 Read out Protection

Readout 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. Both program and data E^2 memory are protected.

In flash devices, this protection is removed by reprogramming the option. In this case, both program and data E^2 memory are 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.

4.5.2 Flash Write/Erase Protection

Write/erase protection, when set, makes it impossible to both overwrite and erase program memory. It does not apply to E^2 data. Its purpose is to provide advanced security to applications and prevent any change being made to the memory content.

Warning: Once set, Write/erase protection can never be removed. A write-protected flash device is no longer reprogrammable.

Write/erase protection is enabled through the FMP_W bit in the option byte.

4.6 Related Documentation

For details on Flash programming and ICC protocol, refer to the ST7 Flash Programming Reference Manual and to the ST7 ICC Protocol Reference Manual.

4.7 Register Description

FLASH CONTROL/STATUS REGISTER (FCSR)
Read/Write
Reset Value: 000 0000 (00h)
1st RASS Key: 0101 0110 (56h)
2nd RASS Key: 1010 1110 (AEh)

7							0
0	0	0	0	0	OPT	LAT	PGM

Note: This register is reserved for programming using ICP, IAP or other programming methods. It controls the XFlash programming and erasing operations.

When an EPB or another programming tool is used (in socket or ICP mode), the RASS keys are sent automatically.

7 SUPPLY, RESET AND CLOCK MANAGEMENT

The device includes a range of utility features for securing the application in critical situations (for example in case of a power brown-out), and reducing the number of external components.

Main features

- Clock Management
  - 1 MHz internal RC oscillator (enabled by option byte, available on ST7LITE15B and ST7LITE19B devices only)
  - 1 to 16 MHz External crystal/ceramic resonator (selected by option byte)
  - External Clock Input (enabled by option byte)
  - PLL for multiplying the frequency by 8 or 4 (enabled by option byte)
  - For clock ART counter only: PLL32 for multiplying the 8 MHz frequency by 4 (enabled by option byte). The 8 MHz input frequency is mandatory and can be obtained in the following ways:
    - –1 MHz RC + PLLx8
    - –16 MHz external clock (internally divided by 2)
    - –2 MHz. external clock (internally divided by 2) + PLLx8
    - –Crystal oscillator with 16 MHz output frequency (internally divided by 2)
- Reset Sequence Manager (RSM)
- System Integrity Management (SI)
  - Main supply Low voltage detection (LVD) with reset generation (enabled by option byte)
  - Auxiliary Voltage detector (AVD) with interrupt capability for monitoring the main supply (enabled by option byte)

7.1 INTERNAL RC OSCILLATOR ADJUSTMENT

The device contains an internal RC oscillator with an accuracy of 1% for a given device, temperature and voltage range (4.5V-5.5V). It must be calibrated to obtain the frequency required in the application. This is done by software writing a 10-bit calibration value in the RCCR (RC Control Register) and in the bits 6:5 in the SICSR (SI Control Status Register).

Whenever the microcontroller is reset, the RCCR returns to its default value (FFh), i.e. each time the device is reset, the calibration value must be loaded in the RCCR. Predefined calibration values are stored in EEPROM for 3 and 5V V_{DD} supply voltages at 25°C, as shown in the following table.

RCCR	Conditions	ST7LITE1xB Address
RCCRH0	V_{DD}=5V T_A=25°C f_{RC}=1MHz	DEE0h [1] (CR[9:2])
RCCRL0		DEE1h [1] (CR[1:0])
RCCRH1	V_{DD}=3.3V T_A=25°C f_{RC}=1MHz	DEE2h [1] (CR[9:2])
RCCRL1		DEE3h [1] (CR[1:0])

1. DEE0h, DEE1h, DEE2h and DEE3h addresses are located in a reserved area of non-volatile memory. They are read-only bytes for the application code. This area cannot be erased or programmed by any ICC operation.

For compatibility reasons with the SICSR register, CR[1:0] bits are stored in the 5th and 6th position of DEE1 and DEE3 addresses.

Notes:

– In 38-pulse ICC mode, the internal RC oscillator is forced as a clock source, regardless of the selection in the option byte. For ST7LITE10B devices which do not support the internal RC oscillator, the “option byte disabled” mode must be used (35-pulse ICC mode entry, clock provided by the tool).

– See “ELECTRICAL CHARACTERISTICS” on page 110. for more information on the frequency and accuracy of the RC oscillator.

– To improve clock stability and frequency accuracy, it is recommended to place a decoupling capacitor, typically 100nF, between the V_{DD} and V_{SS} pins as close as possible to the ST7 device.

– These bytes are systematically programmed by ST, including on FASTROM devices.

Caution: If the voltage or temperature conditions change in the application, the frequency may need to be recalibrated.

Refer to application note AN1324 for information on how to calibrate the RC frequency using an external reference signal.

7.2 PHASE LOCKED LOOP

The PLL can be used to multiply a 1MHz frequency from the RC oscillator or the external clock by 4 or 8 to obtain f_{OSC} of 4 or 8 MHz. The PLL is enabled and the multiplication factor of 4 or 8 is selected by 2 option bits.

– The x4 PLL is intended for operation with V_{DD} in the 2.7V to 3.3V range

7.5 RESET SEQUENCE MANAGER (RSM)

7.5.1 Introduction

The reset sequence manager includes three RESET sources as shown in Figure 16:

- External $\overline{\text{RESET}}$ source pulse
- Internal LVD RESET (Low Voltage Detection)
- Internal WATCHDOG RESET

Note: A reset can also be triggered following the detection of an illegal opcode or prebyte code. Refer to section 12.2.1 on page 107 for further details.

These sources act on the $\overline{\text{RESET}}$ pin and it is always kept low during the delay phase.

The RESET service routine vector is fixed at addresses FFFEh-FFFFh in the ST7 memory map.

The basic RESET sequence consists of 3 phases as shown in Figure 15:

- Active Phase depending on the RESET source
- 256 or 4096 CPU clock cycle delay (see table below)
- RESET vector fetch

Caution: When the ST7 is unprogrammed or fully erased, the Flash is blank and the RESET vector is not programmed. For this reason, it is recommended to keep the RESET pin in low state until programming mode is entered, in order to avoid unwanted behavior.

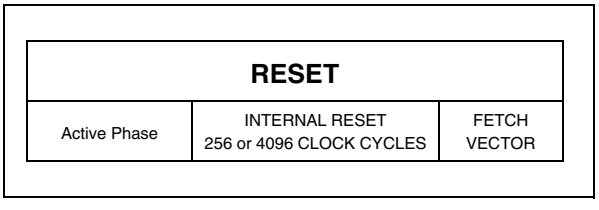
The 256 or 4096 CPU clock cycle delay allows the oscillator to stabilise and ensures that recovery has taken place from the Reset state. The shorter or longer clock cycle delay is automatically selected depending on the clock source chosen by option byte:

The RESET vector fetch phase duration is 2 clock cycles.

Clock Source	CPU clock cycle delay
Internal RC Oscillator	256
External clock (connected to CLKIN pin)	256
External Crystal/Ceramic Oscillator (connected to OSC1/OSC2 pins)	4096

If the PLL is enabled by option byte, it outputs the clock after an additional delay of $t_{STARTUP}$ (see Figure 13).

Figure 15. RESET Sequence Phases



7.5.2 Asynchronous External $\overline{\text{RESET}}$ pin

The $\overline{\text{RESET}}$ pin is both an input and an open-drain output with integrated R_{ON} weak pull-up resistor. This pull-up has no fixed value but varies in accordance with the input voltage. It can be pulled low by external circuitry to reset the device. See Electrical Characteristic section for more details.

A RESET signal originating from an external source must have a duration of at least $t_{h(RSTL)in}$ in order to be recognized (see Figure 17). This detection is asynchronous and therefore the MCU can enter reset state even in HALT mode.

SYSTEM INTEGRITY MANAGEMENT (Cont'd)

7.6.2 Auxiliary Voltage Detector (AVD)

The Voltage Detector function (AVD) is based on an analog comparison between a $V_{IT-(AVD)}$ and $V_{IT+(AVD)}$ reference value and the V_{DD} main supply voltage (V_{AVD}). The $V_{IT-(AVD)}$ reference value for falling voltage is lower than the $V_{IT+(AVD)}$ reference value for rising voltage in order to avoid parasitic detection (hysteresis).

The output of the AVD comparator is directly readable by the application software through a real time status bit (AVDF) in the SICSR register. This bit is read only.

Caution: The AVD functions only if the LVD is enabled through the option byte.

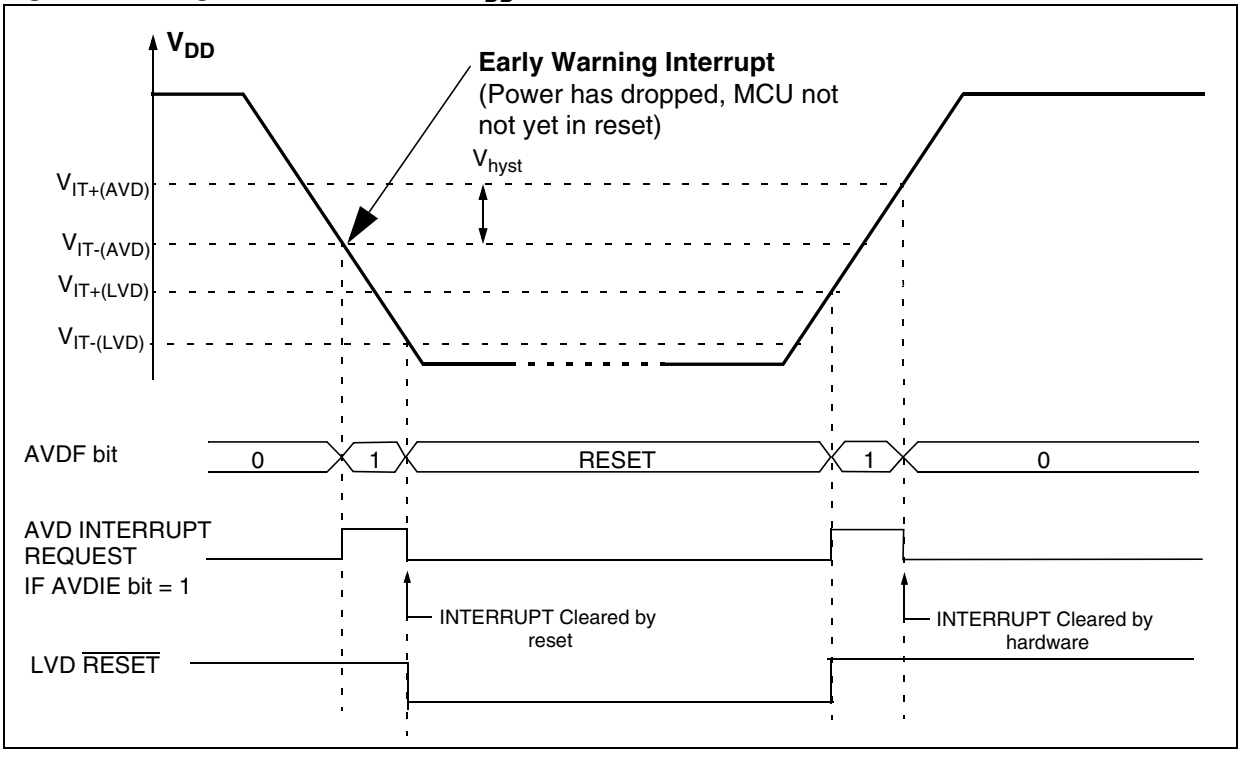
7.6.2.1 Monitoring the V_{DD} Main Supply

The AVD voltage threshold value is relative to the selected LVD threshold configured by option byte (see section 15.1 on page 149).

If the AVD interrupt is enabled, an interrupt is generated when the voltage crosses the $V_{IT+(LVD)}$ or $V_{IT-(AVD)}$ threshold (AVDF bit is set).

In the case of a drop in voltage, the AVD interrupt acts as an early warning, allowing software to shut down safely before the LVD resets the microcontroller. See Figure 20.

Figure 20. Using the AVD to Monitor V_{DD}



I/O PORTS (Cont'd)

Figure 32. I/O Port General Block Diagram

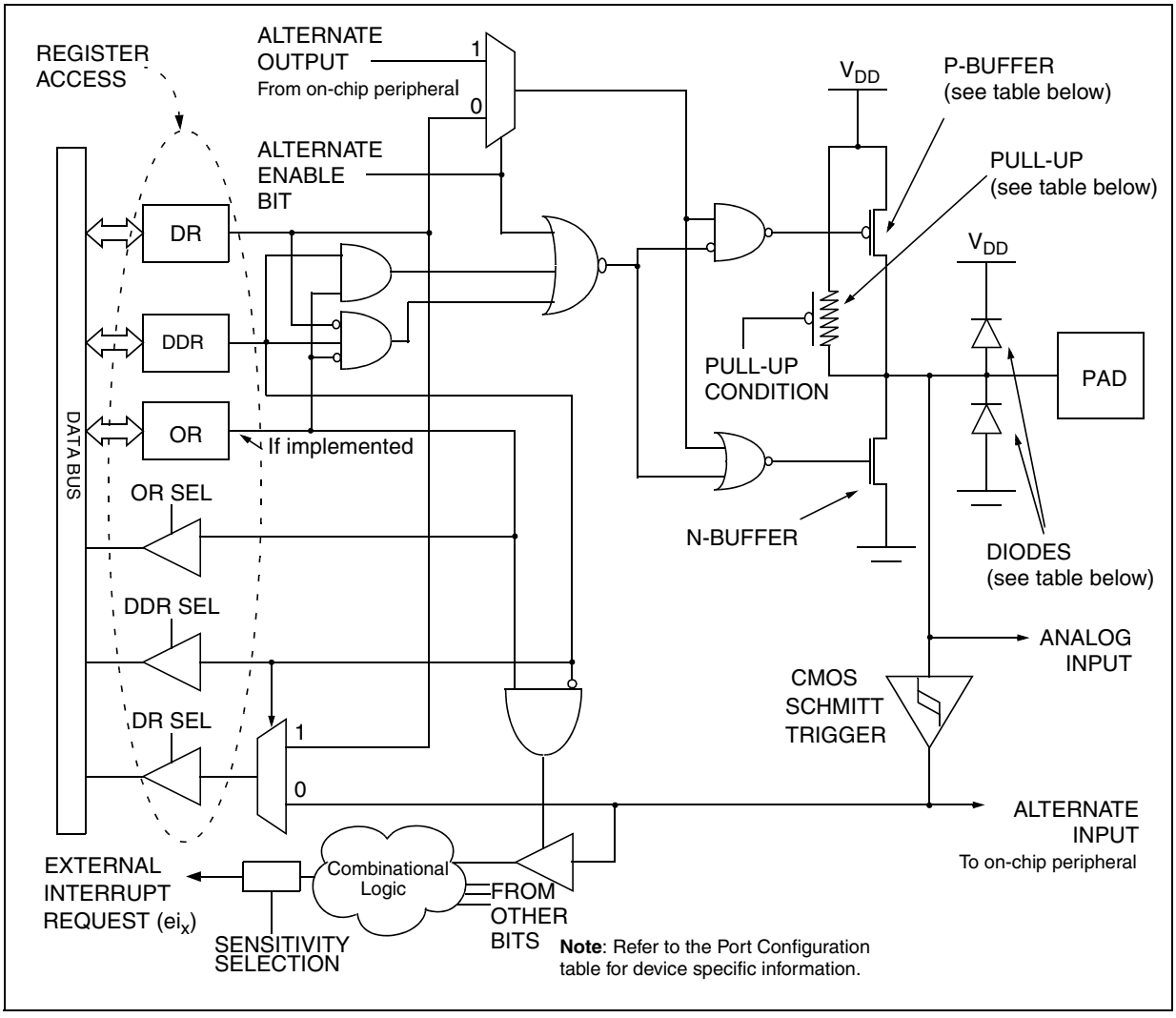


Table 8. I/O Port Mode Options

Configuration Mode		Pull-Up	P-Buffer	Diodes	
				to V_{DD}	to V_{SS}
Input	Floating with/without Interrupt	Off	Off	On	On
	Pull-up with/without Interrupt	On			
Output	Push-pull	Off	On		
	Open Drain (logic level)		Off		

Legend: Off - implemented not activated
On - implemented and activated

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

11.2.3.3 Break Function

The break function can be used to perform an emergency shutdown of the application being driven by the PWM signals.

The break function is activated by the external BREAK pin or internal comparator output. This can be selected by using the BRSEL bit in BREAKCR Register. In order to use the break function it must be previously enabled by software setting the BPEN bit in the BREAKCR register.

The Break active level can be programmed by the BREDGE bit in the BREAKCR register. When an active level is detected on the BREAK pin, the BA bit is set and the break function is activated. In this case, the PWM signals are forced to BREAK value if respective OEx bit is set in PWMCR register.

Software can set the BA bit to activate the break function without using the BREAK pin. The BREN1 and BREN2 bits in the BREAKEN Register are used to enable the break activation on the 2 counters respectively. In Dual Timer Mode, the break for PWM2 and PWM3 is enabled by the BREN2 bit. In Single Timer Mode, the BREN1 bit enables the break for all PWM channels.

When a break function is activated (BA bit =1 and BREN1/BREN2 =1):

– The break pattern (PWM[3:0] bits in the BREAKCR) is forced directly on the PWMx output pins if respective OEx is set. (after the inverter).

– The 12-bit PWM counter CNTR1 is put to its reset value, i.e. 00h (if BREN1 = 1).

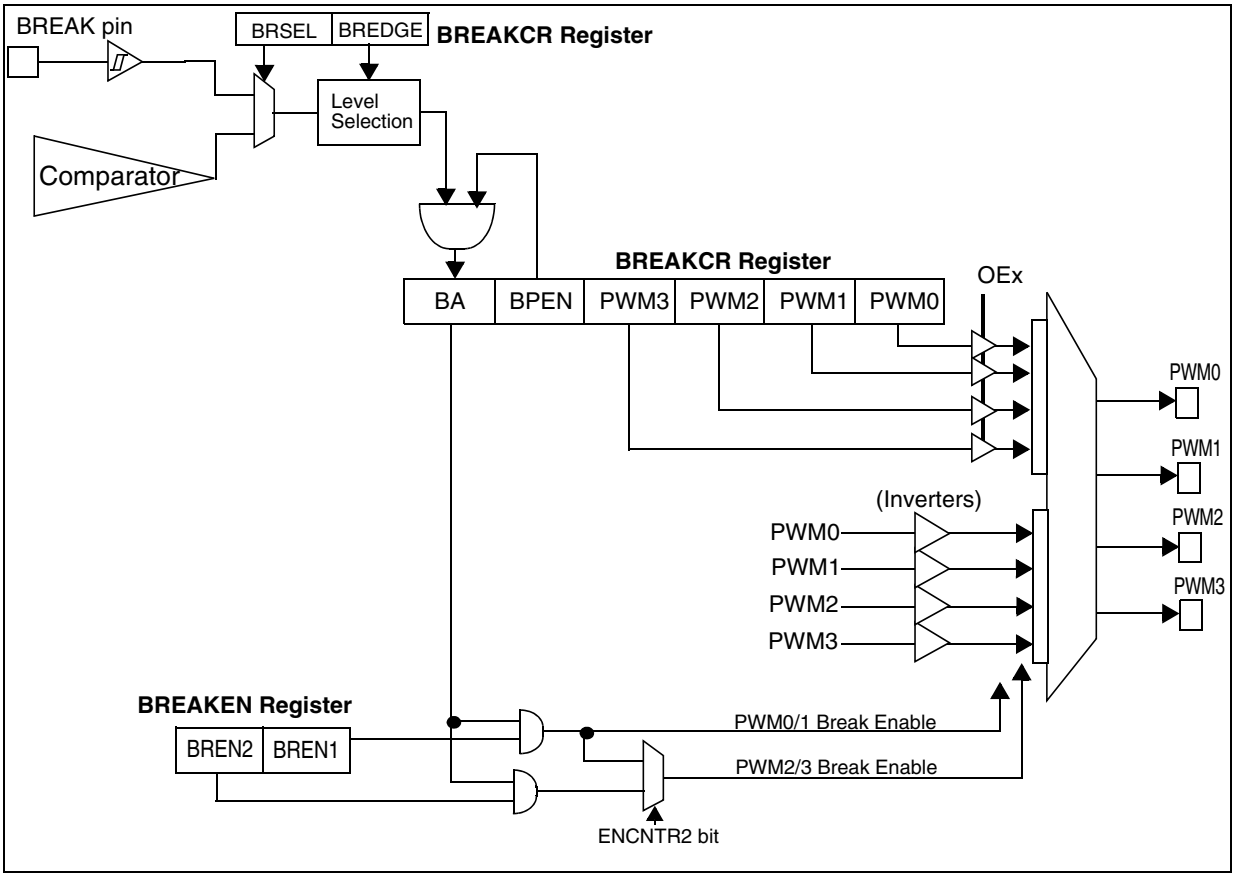
– The 12-bit PWM counter CNTR2 is put to its reset value,i.e. 00h (if BREN2 = 1).

– ATR1, ATR2, Preload and Active DCRx are put to their reset values.

– Counters stop counting.

When the break function is deactivated after applying the break (BA bit goes from 1 to 0 by software), Timer takes the control of PWM ports.

Figure 41. Block Diagram of Break Function



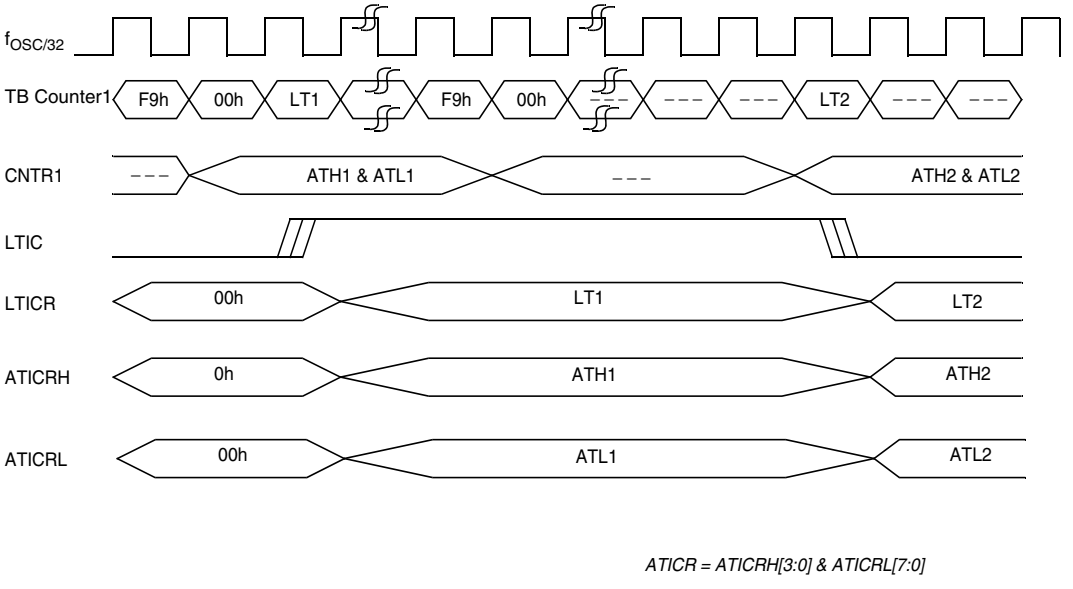
DUAL 12-BIT AUTORELOAD TIMER 4 (Cont'd)

– At the second input capture on the falling edge of the pulse, we assume that the values in the registers are as follows:
LTICR = LT2
ATICRH = ATH2
ATICRL = ATL2
Hence ATICR2 [11:0] = ATH2 & ATL2

Now pulse width P between first capture and second capture will be:

P = decimal (F9 – LT1 + LT2 + 1) * 0.004ms + decimal ((FFF * N) + N + ATICR2 - ATICR1 – 1) * 1ms where N = No of overflows of 12-bit CNTR1.

Figure 46. Long Range Input Capture Timing Diagram



LITE TIMER (Cont'd)

Bit 6 = **ICF** *Input Capture Flag*
This bit is set by hardware and cleared by software by reading the LTICR register. Writing to this bit does not change the bit value.
0: No input capture
1: An input capture has occurred

Note: After an MCU reset, software must initialize the ICF bit by reading the LTICR register

Bit 5 = **TB** *Timebase period selection*
This bit is set and cleared by software.
0: Timebase period = t_{OSC} * 8000 (1ms @ 8 MHz)
1: Timebase period = t_{OSC} * 16000 (2ms @ 8 MHz)

Bit 4 = **TB1IE** *Timebase Interrupt enable*
This bit is set and cleared by software.
0: Timebase (TB1) interrupt disabled
1: Timebase (TB1) interrupt enabled

Bit 3 = **TB1F** *Timebase Interrupt Flag*
This bit is set by hardware and cleared by software reading the LTCSR register. Writing to this bit has no effect.
0: No counter overflow
1: A counter overflow has occurred

Bits 2:0 = Reserved

LITE TIMER INPUT CAPTURE REGISTER (LTICR)
Read only
Reset Value: 0000 0000 (00h)

7							0
ICR7	ICR6	ICR5	ICR4	ICR3	ICR2	ICR1	ICR0

Bits 7:0 = **ICR[7:0]** *Input Capture Value*
These bits are read by software and cleared by hardware after a reset. If the ICF bit in the LTCSR is cleared, the value of the 8-bit up-counter will be captured when a rising or falling edge occurs on the LTIC pin.

11.4.8 Register Description

SPI CONTROL REGISTER (SPICR)

Read/Write

Reset Value: 0000 xxxx (0xh)

7							0
SPIE	SPE	SPR2	MSTR	CPOL	CPHA	SPR1	SPR0

Bit 7 = **SPIE** *Serial Peripheral Interrupt Enable*
This bit is set and cleared by software.
0: Interrupt is inhibited
1: An SPI interrupt is generated whenever an End of Transfer event, Master Mode Fault or Overrun error occurs (SPIF = 1, MODF = 1 or OVR = 1 in the SPICSR register)

Bit 6 = **SPE** *Serial Peripheral Output Enable*
This bit is set and cleared by software. It is also cleared by hardware when, in master mode, $\overline{SS}$ = 0 (see Section 0.1.5.1 Master Mode Fault (MODF)). The SPE bit is cleared by reset, so the SPI peripheral is not initially connected to the external pins.
0: I/O pins free for general purpose I/O
1: SPI I/O pin alternate functions enabled

Bit 5 = **SPR2** *Divider Enable*
This bit is set and cleared by software and is cleared by reset. It is used with the SPR[1:0] bits to set the baud rate. Refer to Table 1 SPI Master Mode SCK Frequency.
0: Divider by 2 enabled
1: Divider by 2 disabled

Note: This bit has no effect in slave mode.

Bit 4 = **MSTR** *Master Mode*
This bit is set and cleared by software. It is also cleared by hardware when, in master mode, $\overline{SS}$ = 0 (see Section 0.1.5.1 Master Mode Fault (MODF)).
0: Slave mode
1: Master mode. The function of the SCK pin changes from an input to an output and the functions of the MISO and MOSI pins are reversed.

Bit 3 = **CPOL** *Clock Polarity*
This bit is set and cleared by software. This bit determines the idle state of the serial Clock. The CPOL bit affects both the master and slave modes.
0: SCK pin has a low level idle state
1: SCK pin has a high level idle state

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

Bit 2 = **CPHA** *Clock Phase*
This bit is set and cleared by software.
0: The first clock transition is the first data capture edge.
1: The second clock transition is the first capture edge.

Note: The slave must have the same CPOL and CPHA settings as the master.

Bits 1:0 = **SPR[1:0]** *Serial Clock Frequency*
These bits are set and cleared by software. Used with the SPR2 bit, they select the baud rate of the SPI serial clock SCK output by the SPI in master mode.

Note: These 2 bits have no effect in slave mode.

Table 16. SPI Master Mode SCK Frequency

Serial Clock	SPR2	SPR1	SPR0
$f_{CPU}/4$	1	0	0
$f_{CPU}/8$	0		
$f_{CPU}/16$			1
$f_{CPU}/32$	1	1	0
$f_{CPU}/64$	0		
$f_{CPU}/128$			1

ANALOG COMPARATOR (Cont'd)

Figure 61. Analog Comparator and Internal Voltage Reference

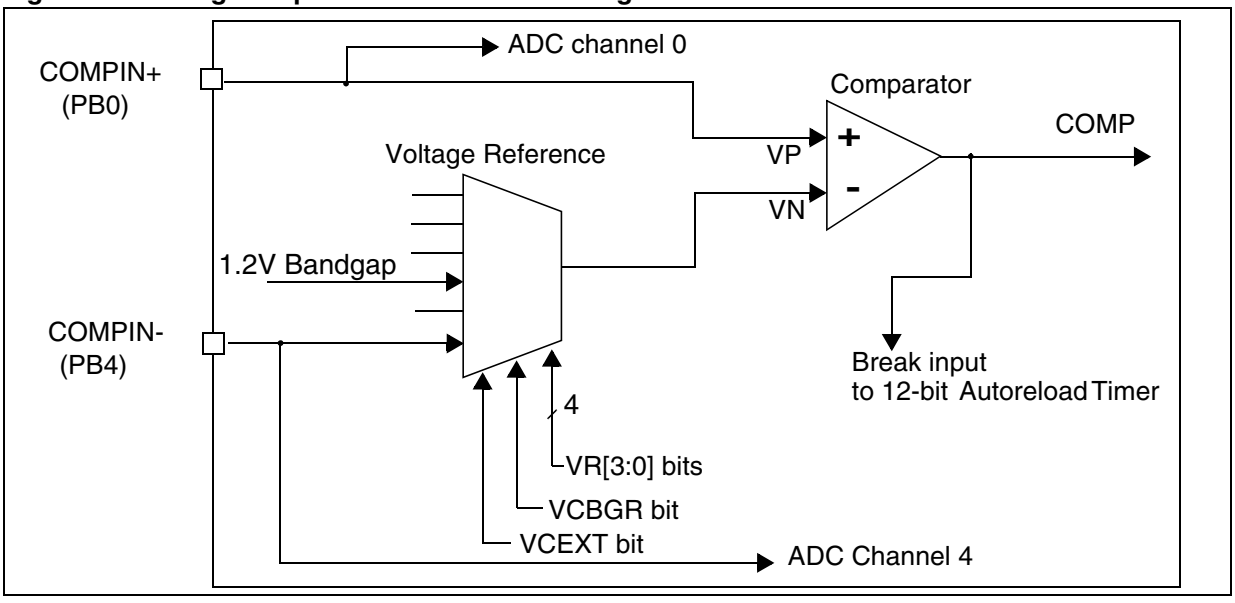
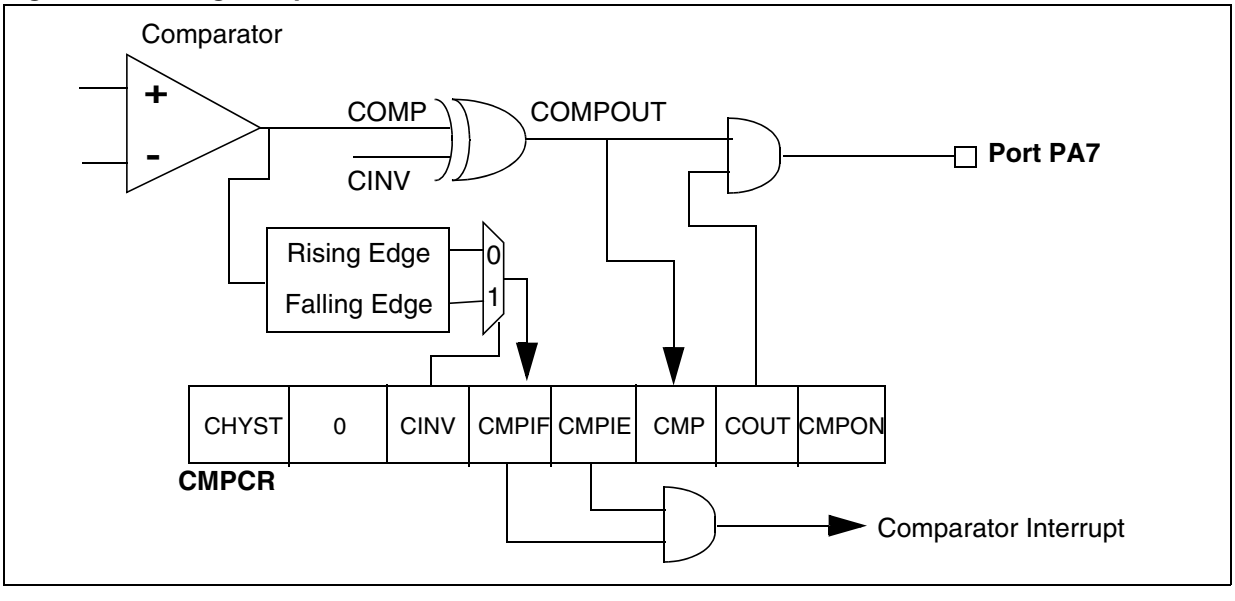


Figure 62. Analog Comparator



13.3 OPERATING CONDITIONS

13.3.1 General Operating Conditions: Suffix 6 Devices

T_A = -40 to +85°C unless otherwise specified.

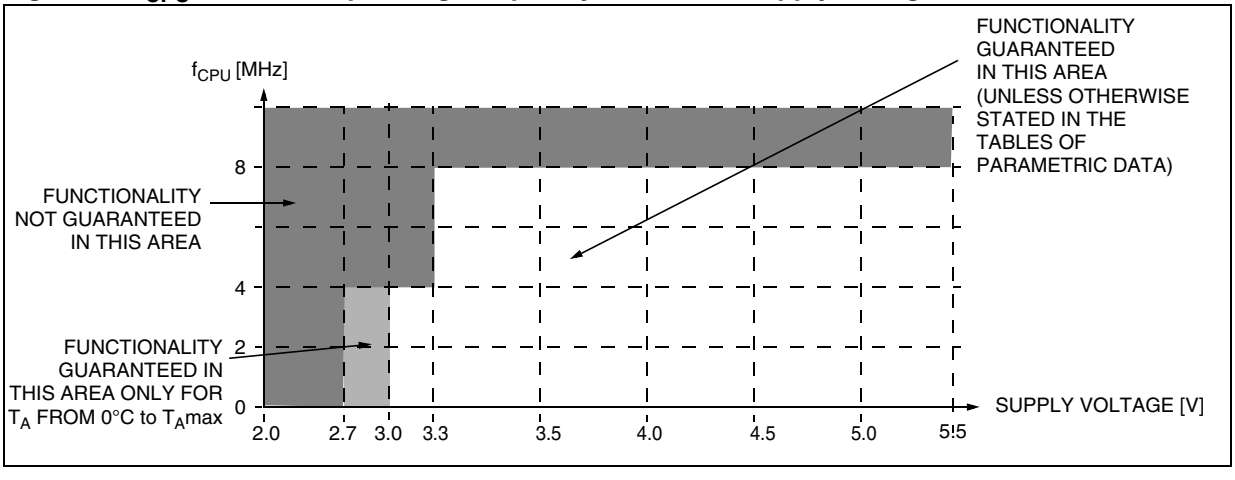
Symbol	Parameter	Conditions	Min	Max	Unit
V_{DD}	Supply voltage	f_{CPU} = 4 MHz. max., T_A = 0 to 85°C	2.7	5.5	V
		f_{CPU} = 4 MHz. max.,T_A = -40 to 85°C	3.0	5.5	
		f_{CPU} = 8 MHz. max.	3.3	5.5	
f_{CPU}	CPU clock frequency	$V_{DD} \geq 3.3V$	up to 8		MHz
		$2.7V \leq V_{DD} < 3.3V$	up to 4		

13.3.2 General Operating Conditions: Suffix 3 Devices

T_A = -40 to +125°C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DD}	Supply voltage	f_{CPU} = 4 MHz. max., T_A = 0 to 125°C	2.7	5.5	V
		f_{CPU} = 4 MHz. max.,T_A = -40 to 125°C	3.0	5.5	
		f_{CPU} = 8 MHz. max.	3.3	5.5	
f_{CPU}	CPU clock frequency	$V_{DD} \geq 3.3V$	up to 8		MHz
		$2.7V \leq V_{DD} < 3.3V$	up to 4		

Figure 65. f_{CPU} Maximum Operating Frequency Versus V_{DD} Supply Voltage



OPERATING CONDITIONS (Cont'd)

The RC oscillator and PLL characteristics are temperature-dependent and are grouped in four tables.

13.3.5.1 Devices with '"6" or "3"order code suffix (tested for T_A = -40 to +125°C) @ V_{DD} = 5V

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{RC}	Internal RC oscillator frequency [1]	RCCR = FF (reset value), T_A=25°C,V_{DD}=5V		700		kHz
		RCCR = RCCR0[2],T_A=25°C,V_{DD}=5V	992	1000	1008	
ACC_{RC}	Accuracy of Internal RC oscillator with RCCR=RCCR0[2]	T_A=25°C,V_{DD}=5V	-0.8		+0.8	%
		T_A=25°C, V_{DD}=4.5 to 5.5V[3]	-1		+1	%
		T_A=25°C to +85°C,V_{DD}=5V	-3		+3	%
		T_A=25°C to +85°C,V_{DD}=4.5 to 5.5V[3]	-3.5		+3.5	%
		T_A=85°C to +125°C,V_{DD}=5V	-3.5		+5	%
		T_A=85°C to +125°C,V_{DD}=4.5 to 5.5V[3]	-3.5		+6	%
		T_A=-40 to +25°C, V_{DD}=5V[3]	-3		+7	%
$I_{DD(RC)}$	RC oscillator current consumption	T_A=25°C,V_{DD}=5V		600[3]		µA
$t_{su(RC)}$	RC oscillator setup time	T_A=25°C,V_{DD}=5V			10[2]	µs
f_{PLL}	x8 PLL input clock			1[3]		MHz
t_{LOCK}	PLL Lock time[5]			2		ms
t_{STAB}	PLL Stabilization time[5]			4		ms
ACC_{PLL}	x8 PLL Accuracy	f_{RC} = 1MHz@T_A=25°C,V_{DD}=4.5 to 5.5V		0.1[4]		%
		f_{RC} = 1MHz@T_A=-40 to +85°C,V_{DD}=5V		0.1[4]		%
$t_{w(JIT)}$	PLL jitter period [6]	f_{RC} = 1MHz		120		µs
JIT_{PLL}	PLL jitter ($\Delta f_{CPU}/f_{CPU}$)			1[7]		%
$I_{DD(PLL)}$	PLL current consumption	T_A=25°C		600[3]		µA

Notes:

1. If the RC oscillator clock is selected, to improve clock stability and frequency accuracy, it is recommended to place a decoupling capacitor, typically 100nF, between the V_{DD} and V_{SS} pins as close as possible to the ST7 device.

2. See "INTERNAL RC OSCILLATOR ADJUSTMENT" on page 23

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

4. Averaged over a 4ms period. After the LOCKED bit is set, a period of t_{STAB} is required to reach ACC_{PLL} accuracy.

5. After the LOCKED bit is set ACC_{PLL} is max. 10% until t_{STAB} has elapsed. See Figure 13 on page 24.

6. This period is the phase servo loop period. During this period, the frequency remains unchanged.

7. Guaranteed by design.

OPERATING CONDITIONS (Cont'd)

13.3.5.2 Devices with '"6" or "3" order code suffix (tested for T_A = -40 to +125°C) @ V_{DD} = 3.0 to 3.6V

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{RC}	Internal RC oscillator frequency [1]	RCCR = FF (reset value), T_A=25°C, V_{DD}= 3.3V		700		kHz
		RCCR=RCCR1[2] ,T_A=25°C,V_{DD}= 3.3V	992	1000	1008	
ACC_{RC}	Accuracy of Internal RC oscillator when calibrated with RCCR=RCCR1[2]	T_A=25°C,V_{DD}=3.3V	-0.8		+0.8	%
		T_A=25°C,V_{DD}=3.0 to 3.6V [3]	-1		+1	%
		T_A=25 to +85°C,V_{DD}=3.3V	-3		+3	%
		T_A=25 to +85°C,V_{DD}=3.0 to 3.6V [3]	-3.5		+3.5	%
		T_A=25 to +125°C,V_{DD}=3.0 to 3.6V [3]	-5		+6.5	%
		T_A=-40 to +25°C,V_{DD}=3.0 to 3.6V [3]	-3.5		+4	%
$I_{DD(RC)}$	RC oscillator current consumption	T_A=25°C,V_{DD}=3.3V		400[3]		µA
$t_{su(RC)}$	RC oscillator setup time	T_A=25°C,V_{DD}=3.3V			10[2]	µs
f_{PLL}	x4 PLL input clock			0.7[3]		MHz
t_{LOCK}	PLL Lock time[5]			2		ms
t_{STAB}	PLL Stabilization time[5]			4		ms
ACC_{PLL}	x4 PLL Accuracy	f_{RC} = 1MHz@T_A=25°C, V_{DD}=2.7 to 3.3V		0.1[4]		%
		f_{RC} = 1MHz@T_A=40 to +85°C, V_{DD}= 3.3V		0.1[4]		%
$t_{w(JIT)}$	PLL jitter period [6]	f_{RC} = 1MHz		120		µs
JIT_{PLL}	PLL jitter ($\Delta f_{CPU}/f_{CPU}$)			1[7]		%
$I_{DD(PLL)}$	PLL current consumption	T_A=25°C		190[3]		µA

Notes:

1. If the RC oscillator clock is selected, to improve clock stability and frequency accuracy, it is recommended to place a decoupling capacitor, typically 100nF, between the V_{DD} and V_{SS} pins as close as possible to the ST7 device.

2. See "INTERNAL RC OSCILLATOR ADJUSTMENT" on page 23.

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

4. Averaged over a 4ms period. After the LOCKED bit is set, a period of t_{STAB} is required to reach ACC_{PLL} accuracy

5. After the LOCKED bit is set ACC_{PLL} is max. 10% until t_{STAB} has elapsed. See Figure 13 on page 24.

6. This period is the PLL servoing period. During this period, the frequency remains unchanged.

7. Guaranteed by design.

13.7 EMC CHARACTERISTICS

Susceptibility tests are performed on a sample basis during product characterization.

13.7.1 Functional EMS (Electro Magnetic Susceptibility)

Based on a simple running application on the product (toggling 2 LEDs through I/O ports), the product is stressed by two electro magnetic events until a failure occurs (indicated by the LEDs).

- **ESD**: Electro-Static Discharge (positive and negative) is applied on all pins of the device until a functional disturbance occurs. This test conforms with the IEC 1000-4-2 standard.
- **FTB**: A Burst of Fast Transient voltage (positive and negative) is applied to V_{DD} and V_{SS} through a 100pF capacitor, until a functional disturbance occurs. This test conforms with the IEC 1000-4-4 standard.

A device reset allows normal operations to be resumed. The test results are given in the table below based on the EMS levels and classes defined in application note AN1709.

13.7.1.1 Designing hardened software to avoid noise problems

EMC characterization and optimization are performed at component level with a typical application environment and simplified MCU software. It should be noted that good EMC performance is highly dependent on the user application and the software in particular.

Therefore it is recommended that the user applies EMC software optimization and prequalification tests in relation with the EMC level requested for his application.

Software recommendations:

The software flowchart must include the management of runaway conditions such as:

– Corrupted program counter

– Unexpected reset

– Critical Data corruption (control registers...)

Prequalification trials:

Most of the common failures (unexpected reset and program counter corruption) can be reproduced by manually forcing a low state on the RESET pin or the Oscillator pins for 1 second.

To complete these trials, ESD stress can be applied directly on the device, over the range of specification values. When unexpected behaviour is detected, the software can be hardened to prevent unrecoverable errors occurring (see application note AN1015).

Symbol	Parameter	Conditions	Level/ Class
V_{FESD}	Voltage limits to be applied on any I/O pin to induce a functional disturbance	V_{DD}=5V, T_A=+25°C, f_{OSC}=8MHz conforms to IEC 1000-4-2	2B
V_{FFTB}	Fast transient voltage burst limits to be applied through 100pF on V_{DD} and V_{SS} pins to induce a functional disturbance	V_{DD}=5V, T_A=+25°C, f_{OSC}=8MHz conforms to IEC 1000-4-4	3B

13.7.2 Electro Magnetic Interference (EMI)

Based on a simple application running on the product (toggling 2 LEDs through the I/O ports), the product is monitored in terms of emission. This emission test is in line with the norm SAE J 1752/3 which specifies the board and the loading of each pin.

Symbol	Parameter	Conditions	Monitored Frequency Band	Max vs. [f_{OSC}/f_{CPU}]		Unit
				8/4MHz	16/8MHz	
S_{EMI}	Peak level	V_{DD}=5V, T_A=+25°C, SO20 package, conforming to SAE J 1752/3	0.1MHz to 30MHz	15	21	dBµV
			30MHz to 130MHz	22	29	
			130MHz to 1GHz	17	22	
			SAE EMI Level	3.5	3.5	-

Note:

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

I/O PORT PIN CHARACTERISTICS (Cont'd)

13.8.2 Output Driving Current

Subject to general operating conditions for V_{DD}, f_{CPU}, 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 when 8 pins are sunk at same time (see Figure 83)	V_{DD}=5V	I_{IO}=+5mA $T_A \leq 125°C$		1.0	V
			I_{IO}=+2mA $T_A \leq 125°C$		0.4	
	Output low level voltage for a high sink I/O pin when 4 pins are sunk at same time (see Figure 89)		I_{IO}=+20mA,$T_A \leq 125°C$		1.3	
			I_{IO}=+8mA $T_A \leq 125°C$		0.75	
V_{OH} 2)	Output high level voltage for an I/O pin when 4 pins are sourced at same time (see Figure 95)		I_{IO}=-5mA, $T_A \leq 125°C$	V_{DD}-1.5		
			I_{IO}=-2mA $T_A \leq 125°C$	V_{DD}-0.8		
V_{OL} 1)3)	Output low level voltage for a standard I/O pin when 8 pins are sunk at same time (see Figure 82)	V_{DD}=3.3V	I_{IO}=+2mA $T_A \leq 125°C$		0.5	
	Output low level voltage for a high sink I/O pin when 4 pins are sunk at same time		I_{IO}=+8mA $T_A \leq 125°C$		0.5	
V_{OH} 2)3)	Output high level voltage for an I/O pin when 4 pins are sourced at same time (Figure 94)		I_{IO}=-2mA $T_A \leq 125°C$	V_{DD}-0.8		
V_{OL} 1)3)	Output low level voltage for a standard I/O pin when 8 pins are sunk at same time (see Figure 87)	V_{DD}=2.7V	I_{IO}=+2mA $T_A \leq 125°C$		0.6	
	Output low level voltage for a high sink I/O pin when 4 pins are sunk at same time		I_{IO}=+8mA $T_A \leq 125°C$		0.6	
V_{OH} 2)3)	Output high level voltage for an I/O pin when 4 pins are sourced at same time (see Figure 101)		I_{IO}=-2mA $T_A \leq 125°C$	V_{DD}-0.9		

Notes:

1. The I_{IO} current sunk must always respect the absolute maximum rating specified in Section 13.2.2 and the sum of I_{IO} (I/O ports and control pins) must not exceed I_{VSS}.

2. The I_{IO} current sourced must always respect the absolute maximum rating specified in Section 13.2.2 and the sum of I_{IO} (I/O ports and control pins) must not exceed I_{VDD}.

3. Not tested in production, based on characterization results.

I/O PORT PIN CHARACTERISTICS (Cont'd)

Figure 93. Typical V_{DD}-V_{OH} at V_{DD}=2.7V

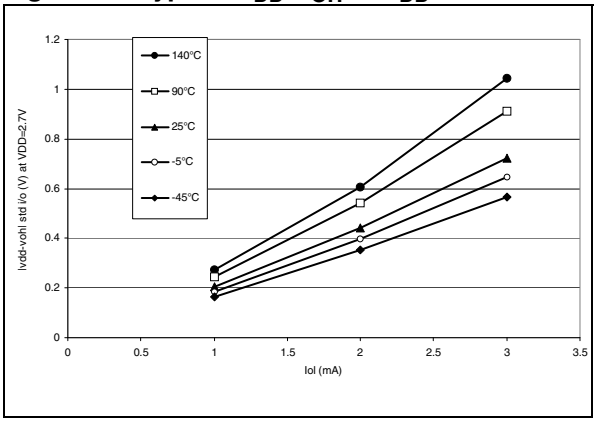


Figure 94. Typical V_{DD}-V_{OH} at V_{DD}=3.3V

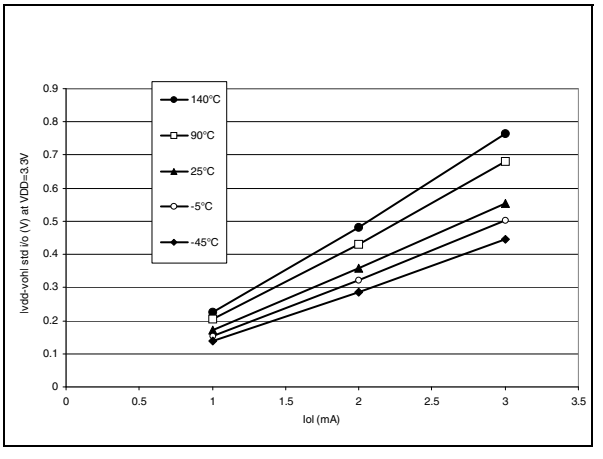


Figure 95. Typical V_{DD}-V_{OH} at V_{DD}=5V

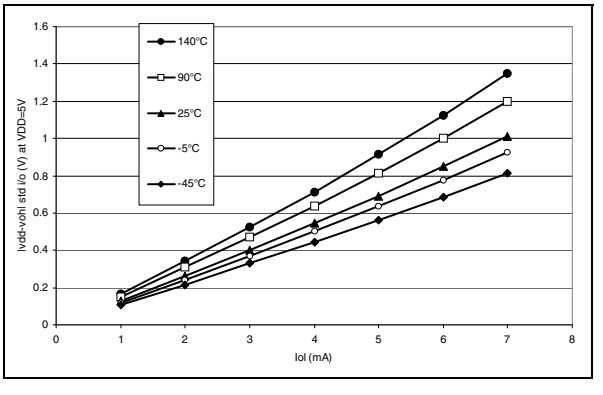


Figure 96. Typical V_{DD}-V_{OH} at V_{DD}=2.7V (HS)

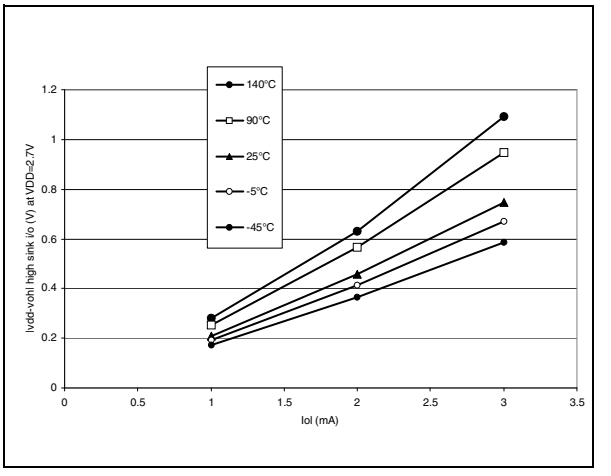


Figure 97. Typical V_{DD}-V_{OH} at V_{DD}=3.3V (HS)

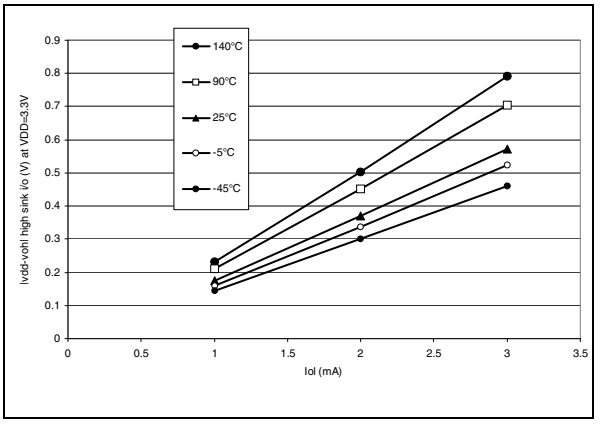
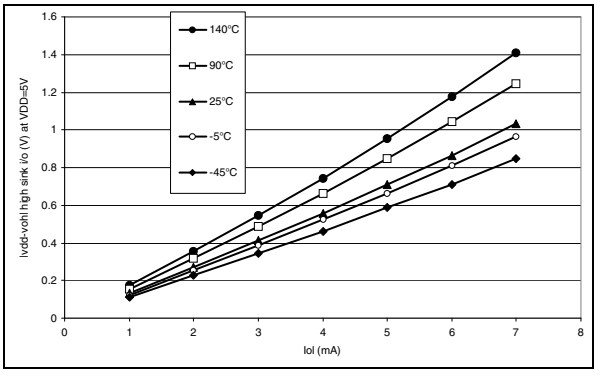


Figure 98. Typical V_{DD}-V_{OH} at V_{DD}=5V (HS)



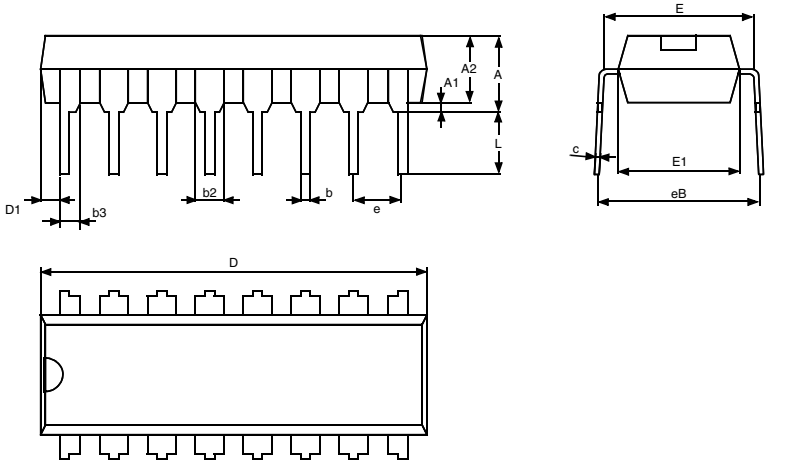
14 PACKAGE CHARACTERISTICS

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label.

ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

14.1 PACKAGE MECHANICAL DATA

Figure 113. 16-Pin Plastic Dual In-Line Package, 300-mil Width



Dim.	mm			inches[1]		
	Min	Typ	Max	Min	Typ	Max
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
b3	0.76	0.99	1.14	0.030	0.039	0.045
c	0.20	0.25	0.36	0.008	0.010	0.014
D	18.67	19.18	19.69	0.735	0.755	0.775
D1	0.13			0.005		
e		2.54			0.100	
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
L	2.92	3.30	3.81	0.115	0.130	0.150
eB			10.92			0.430
	Number of Pins					
N	16					

Note . Values in inches are converted from mm and rounded to 3 decimal digits.

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