

TahakomAVRLibDoc

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1 Introduction	1
1.1 Library structure	1
1.2 Software setup	1
1.2.1 Linux	2
1.2.2 Windows	2
1.3 Compile and Flash programs	2
1.3.1 Linux	2
1.3.2 Windows	3
1.4 Hardware setup	3
1.5 Applications	3
1.6 Projects	3
1.7 Author	3
1.8 License	3
2 Applications	5
2.1 Blink a Led	5
2.1.1 Hardware	6
2.1.2 Circuit	6
2.1.3 Code	6
2.1.4 Author	7
2.1.5 License	7
2.2 AVR Square-Wave Organ	7
2.2.1 Hardware	8
2.2.2 Circuit	8
2.2.3 Code	8
2.2.4 Author	9
2.2.5 License	9
2.3 AVR Music Box	10
2.3.1 Hardware	10
2.3.2 Circuit	11
2.3.3 Code	11
2.3.4 Author	12
2.3.5 License	12
3 README	13
4 Namespace Index	15
4.1 Namespace List	15
5 Hierarchical Index	17
5.1 Class Hierarchy	17
6 Class Index	19
6.1 Class List	19

7 File Index	21
7.1 File List	21
8 Namespace Documentation	23
8.1 component Namespace Reference	23
8.1.1 Detailed Description	23
8.1.2 Enumeration Type Documentation	23
8.1.2.1 mode	23
8.2 core Namespace Reference	24
8.2.1 Enumeration Type Documentation	25
8.2.1.1 autoTriggerSource	25
8.2.1.2 BODMode	26
8.2.1.3 channel	26
8.2.1.4 clockPrescaler	26
8.2.1.5 clockSource	27
8.2.1.6 compareOutputMode	27
8.2.1.7 operationMode [1/2]	28
8.2.1.8 operationMode [2/2]	28
8.2.1.9 pinChangePort	29
8.2.1.10 referenceVoltage	30
8.2.1.11 resolution	30
8.2.1.12 senseControl	30
8.2.1.13 sleepMode	31
8.2.1.14 timeOut	31
8.3 io Namespace Reference	32
8.3.1 Detailed Description	33
8.3.2 Enumeration Type Documentation	33
8.3.2.1 clockPrescaler	33
8.3.2.2 communicationMode	33
8.3.2.3 dataMode	34
8.3.2.4 dataOrder	34
8.3.2.5 frameSize	35
8.3.2.6 operationMode	35
8.3.2.7 parityMode	36
8.3.2.8 stopBit	36
8.3.2.9 transmissionMode	37
8.3.3 Variable Documentation	37
8.3.3.1 PortB	37
8.3.3.2 PortC	38
8.3.3.3 PortD	38
8.4 utils Namespace Reference	38
8.4.1 Function Documentation	38

8.4.1.1 map()	38
9 Class Documentation	39
9.1 core::ADConverter Class Reference	39
9.1.1 Detailed Description	40
9.1.2 Constructor & Destructor Documentation	40
9.1.2.1 ADConverter() [1/2]	40
9.1.2.2 ~ADConverter()	40
9.1.2.3 ADConverter() [2/2]	41
9.1.3 Member Function Documentation	41
9.1.3.1 conversionComplete()	41
9.1.3.2 conversionCompleteServiceRoutine()	41
9.1.3.3 enableAutoTrigger()	43
9.1.3.4 enableConversionCompleteInterrupt()	43
9.1.3.5 getConversionResult()	44
9.1.3.6 getInstance()	44
9.1.3.7 operator=()	45
9.1.3.8 selectAnalogInput()	45
9.1.3.9 selectAutoTriggerSource()	45
9.1.3.10 selectClockPrescaler()	46
9.1.3.11 selectReferenceVoltage()	46
9.1.3.12 start()	46
9.1.3.13 stop()	46
9.1.4 Member Data Documentation	47
9.1.4.1 __externally_visible__	47
9.1.4.2 __used__	47
9.1.4.3 m_conversionComplete	47
9.1.4.4 m_resolution	47
9.1.4.5 mp_conversionResult	47
9.2 core::AnalogComparator Class Reference	48
9.2.1 Detailed Description	48
9.3 component::Buzzer Class Reference	48
9.3.1 Detailed Description	49
9.3.2 Constructor & Destructor Documentation	49
9.3.2.1 Buzzer()	49
9.3.2.2 ~Buzzer()	50
9.3.3 Member Function Documentation	50
9.3.3.1 buzz() [1/2]	50
9.3.3.2 buzz() [2/2]	50
9.3.3.3 pause()	51
9.3.4 Member Data Documentation	51
9.3.4.1 m_pin	52

9.4 component::DCMotor Class Reference	52
9.4.1 Detailed Description	53
9.4.2 Constructor & Destructor Documentation	53
9.4.2.1 DCMotor()	53
9.4.2.2 ~DCMotor()	53
9.4.3 Member Function Documentation	53
9.4.3.1 connect()	53
9.4.3.2 disconnect()	54
9.4.3.3 off()	54
9.4.3.4 on()	54
9.4.3.5 spin()	54
9.4.3.6 stop()	55
9.4.3.7 toggle()	55
9.4.4 Member Data Documentation	55
9.4.4.1 m_pin	55
9.5 core::ExternInterrupt Class Reference	55
9.5.1 Detailed Description	56
9.5.2 Constructor & Destructor Documentation	56
9.5.2.1 ExternInterrupt() [1/2]	56
9.5.2.2 ~ExternInterrupt()	57
9.5.2.3 ExternInterrupt() [2/2]	57
9.5.3 Member Function Documentation	57
9.5.3.1 enableInt0()	57
9.5.3.2 enableInt1()	57
9.5.3.3 enablePinChange()	58
9.5.3.4 enablePinChangeMaskPortB()	58
9.5.3.5 enablePinChangeMaskPortC()	58
9.5.3.6 enablePinChangeMaskPortD()	59
9.5.3.7 getInstance()	59
9.5.3.8 Int0ServiceRoutine()	59
9.5.3.9 Int1ServiceRoutine()	59
9.5.3.10 operator=()	59
9.5.3.11 pinChangePortBServiceRoutine()	60
9.5.3.12 pinChangePortCServiceRoutine()	60
9.5.3.13 pinChangePortDServiceRoutine()	60
9.5.3.14 setInt0SenseControl()	60
9.5.3.15 setInt1SenseControl()	60
9.5.4 Member Data Documentation	60
9.5.4.1 __externally_visible__	61
9.5.4.2 __used__	61
9.6 component::Led Class Reference	61
9.6.1 Detailed Description	62

9.6.2 Constructor & Destructor Documentation	62
9.6.2.1 Led()	62
9.6.2.2 ~Led()	63
9.6.3 Member Function Documentation	63
9.6.3.1 isOff()	63
9.6.3.2 isOn()	63
9.6.3.3 off()	64
9.6.3.4 on()	64
9.6.3.5 toggle()	64
9.6.4 Member Data Documentation	64
9.6.4.1 m_pin	64
9.7 core::MCU Class Reference	65
9.7.1 Detailed Description	65
9.7.2 Member Function Documentation	65
9.7.2.1 disableBOD()	65
9.7.2.2 enableADC()	65
9.7.2.3 enableSPI()	66
9.7.2.4 enableTimerCounter0()	66
9.7.2.5 enableTimerCounter1()	66
9.7.2.6 enableTimerCounter2()	67
9.7.2.7 enableTWI()	67
9.7.2.8 enableUSART0()	67
9.7.2.9 goToSleep()	68
9.7.2.10 init()	68
9.7.2.11 selectSleepMode()	68
9.7.2.12 sleepEnable()	69
9.8 io::Pin Class Reference	69
9.8.1 Detailed Description	70
9.8.2 Constructor & Destructor Documentation	70
9.8.2.1 Pin()	70
9.8.2.2 ~Pin()	70
9.8.3 Member Function Documentation	71
9.8.3.1 getPinNumber()	71
9.8.3.2 isHigh()	71
9.8.3.3 isLow()	71
9.8.3.4 setHigh()	72
9.8.3.5 setLow()	72
9.8.3.6 toggle()	72
9.8.3.7 toInput()	72
9.8.3.8 toOutput()	73
9.8.4 Member Data Documentation	73
9.8.4.1 m_pinNumber	73

9.8.4.2 mr_portName	73
9.9 io::Port Struct Reference	74
9.9.1 Detailed Description	74
9.9.2 Member Data Documentation	74
9.9.2.1 mp_ddrReg	74
9.9.2.2 mp_pinReg	74
9.9.2.3 mp_portReg	74
9.10 component::PushButton Class Reference	75
9.10.1 Detailed Description	75
9.10.2 Constructor & Destructor Documentation	76
9.10.2.1 PushButton()	76
9.10.2.2 ~PushButton()	76
9.10.3 Member Function Documentation	77
9.10.3.1 getPressedCount()	77
9.10.3.2 isPressed()	77
9.10.3.3 resetPressedCount()	78
9.10.4 Member Data Documentation	78
9.10.4.1 m_buttonPressed	78
9.10.4.2 m_pin	78
9.10.4.3 mr_isActiveLow	78
9.10.4.4 mr_useInternalPullUp	79
9.11 component::ServoMotor Class Reference	79
9.11.1 Detailed Description	80
9.11.2 Constructor & Destructor Documentation	80
9.11.2.1 ServoMotor()	80
9.11.2.2 ~ServoMotor()	80
9.11.3 Member Function Documentation	80
9.11.3.1 computePulseCycleCount()	81
9.11.3.2 computePulseWidthMaxCount()	81
9.11.3.3 computePulseWidthMidCount()	81
9.11.3.4 computePulseWidthMinCount()	81
9.11.3.5 computeRotationAngleCount()	82
9.11.3.6 connect()	82
9.11.3.7 disconnect()	82
9.11.3.8 off()	83
9.11.3.9 on()	83
9.11.3.10 rotate()	83
9.11.3.11 toggle()	83
9.11.4 Member Data Documentation	84
9.11.4.1 m_pin	84
9.11.4.2 m_pulseCycle	84
9.11.4.3 m_pulseWidthMax	84

9.11.4.4 m_pulseWidthMid	84
9.11.4.5 m_pulseWidthMin	85
9.12 io::SPI Class Reference	85
9.12.1 Detailed Description	86
9.12.2 Constructor & Destructor Documentation	86
9.12.2.1 SPI() [1/2]	87
9.12.2.2 ~SPI()	87
9.12.2.3 SPI() [2/2]	87
9.12.3 Member Function Documentation	87
9.12.3.1 enableTransferCompleteInterrupt()	88
9.12.3.2 getInstance()	88
9.12.3.3 masterReceiveByte()	88
9.12.3.4 masterSendByte()	89
9.12.3.5 operator=()	89
9.12.3.6 selectClockPrescaler()	89
9.12.3.7 selectDataMode()	89
9.12.3.8 selectDataOrder()	90
9.12.3.9 selectOperationMode()	90
9.12.3.10 selectSlave()	91
9.12.3.11 slaveReceiveByte()	91
9.12.3.12 transferComplete()	91
9.12.3.13 transferCompleteServiceRoutine()	91
9.12.3.14 writeCollision()	92
9.12.4 Member Data Documentation	92
9.12.4.1 __externally_visible__	92
9.12.4.2 __used__	92
9.12.4.3 m_data	92
9.12.4.4 m_pinMISO	92
9.12.4.5 m_pinMOSI	93
9.12.4.6 m_pinSCK	93
9.12.4.7 m_pinSS	93
9.13 component::StepperMotor Class Reference	93
9.13.1 Detailed Description	94
9.13.2 Constructor & Destructor Documentation	94
9.13.2.1 StepperMotor()	95
9.13.2.2 ~StepperMotor()	95
9.13.3 Member Function Documentation	95
9.13.3.1 computeStepDelay()	95
9.13.3.2 currentPos()	96
9.13.3.3 goalReached()	97
9.13.3.4 setCurrentPos()	97
9.13.3.5 step() [1/3]	97

9.13.3.6 step() [2/3]	98
9.13.3.7 step() [3/3]	99
9.13.3.8 stepDelay()	100
9.13.3.9 stepPulse()	100
9.13.4 Member Data Documentation	101
9.13.4.1 m_accelTime	101
9.13.4.2 m_constSpeedTime	101
9.13.4.3 m_currentPos	102
9.13.4.4 m_decelTime	102
9.13.4.5 m_goalReached	102
9.13.4.6 m_pinCoil1	102
9.13.4.7 m_pinCoil2	102
9.13.4.8 m_pinCoil3	103
9.13.4.9 m_pinCoil4	103
9.13.4.10 stepMode	103
9.14 core::TimerCounter Class Reference	103
9.14.1 Detailed Description	104
9.14.2 Member Function Documentation	104
9.14.2.1 enableOutputCompareMatchInterrupt()	104
9.14.2.2 enableOverflowInterrupt()	104
9.14.2.3 getClockPrescaler()	104
9.14.2.4 getCounter()	105
9.14.2.5 getOutputCompareRegister()	105
9.14.2.6 selectClockSource()	105
9.14.2.7 selectCompareOutputMode()	105
9.14.2.8 selectOperationMode()	105
9.14.2.9 setCounter()	105
9.14.2.10 setOutputCompareRegister()	106
9.14.2.11 start()	106
9.14.2.12 stop()	106
9.15 core::TimerCounter0 Class Reference	106
9.15.1 Detailed Description	108
9.15.2 Constructor & Destructor Documentation	108
9.15.2.1 TimerCounter0() [1/2]	108
9.15.2.2 ~TimerCounter0()	108
9.15.2.3 TimerCounter0() [2/2]	109
9.15.3 Member Function Documentation	109
9.15.3.1 enableOutputCompareMatchInterrupt()	109
9.15.3.2 enableOverflowInterrupt()	110
9.15.3.3 getClockPrescaler()	110
9.15.3.4 getCounter()	110
9.15.3.5 getInstance()	111

9.15.3.6	getOutputCompareRegister()	111
9.15.3.7	operator=()	111
9.15.3.8	outputCompareMatchAServiceRoutine()	111
9.15.3.9	outputCompareMatchBServiceRoutine()	112
9.15.3.10	overflowServiceRoutine()	112
9.15.3.11	selectClockSource()	112
9.15.3.12	selectCompareOutputMode()	113
9.15.3.13	selectOperationMode()	113
9.15.3.14	setCounter()	114
9.15.3.15	setOutputCompareRegister()	114
9.15.3.16	start()	115
9.15.3.17	stop()	115
9.15.4	Member Data Documentation	115
9.15.4.1	__externally_visible__	115
9.15.4.2	__used__	115
9.15.4.3	m_clockPrescaler	116
9.15.4.4	m_clockSource	116
9.16	core::TimerCounter1 Class Reference	116
9.16.1	Detailed Description	118
9.16.2	Constructor & Destructor Documentation	118
9.16.2.1	TimerCounter1() [1/2]	118
9.16.2.2	~TimerCounter1()	118
9.16.2.3	TimerCounter1() [2/2]	118
9.16.3	Member Function Documentation	118
9.16.3.1	enableInputCaptureInterrupt()	119
9.16.3.2	enableOutputCompareMatchInterrupt()	119
9.16.3.3	enableOverflowInterrupt()	120
9.16.3.4	getClockPrescaler()	120
9.16.3.5	getCounter()	120
9.16.3.6	getInputCaptureRegister()	120
9.16.3.7	getInstance()	121
9.16.3.8	getOutputCompareRegister()	121
9.16.3.9	inputCaptureServiceRoutine()	121
9.16.3.10	operator=()	121
9.16.3.11	outputCompareMatchAServiceRoutine()	122
9.16.3.12	outputCompareMatchBServiceRoutine()	122
9.16.3.13	overflowServiceRoutine()	122
9.16.3.14	selectClockSource()	122
9.16.3.15	selectCompareOutputMode()	123
9.16.3.16	selectOperationMode()	123
9.16.3.17	setCounter()	125
9.16.3.18	setInputCaptureRegister()	125

9.16.3.19 setOutputCompareRegister()	125
9.16.3.20 start()	126
9.16.3.21 stop()	126
9.16.4 Member Data Documentation	126
9.16.4.1 __externally_visible__	126
9.16.4.2 __used__	126
9.16.4.3 m_clockPrescaler	127
9.16.4.4 m_clockSource	127
9.17 core::TimerCounter2 Class Reference	127
9.17.1 Detailed Description	128
9.17.2 Constructor & Destructor Documentation	129
9.17.2.1 TimerCounter2() [1/2]	129
9.17.2.2 ~TimerCounter2()	129
9.17.2.3 TimerCounter2() [2/2]	129
9.17.3 Member Function Documentation	129
9.17.3.1 enableOutputCompareMatchInterrupt()	130
9.17.3.2 enableOverflowInterrupt()	130
9.17.3.3 getClockPrescaler()	131
9.17.3.4 getCounter()	131
9.17.3.5 getInstance()	131
9.17.3.6 getOutputCompareRegister()	132
9.17.3.7 operator=()	132
9.17.3.8 outputCompareMatchAServiceRoutine()	132
9.17.3.9 outputCompareMatchBServiceRoutine()	132
9.17.3.10 overflowServiceRoutine()	132
9.17.3.11 selectClockSource()	133
9.17.3.12 selectCompareOutputMode()	133
9.17.3.13 selectOperationMode()	134
9.17.3.14 setCounter()	135
9.17.3.15 setOutputCompareRegister()	135
9.17.3.16 start()	135
9.17.3.17 stop()	136
9.17.4 Member Data Documentation	136
9.17.4.1 __externally_visible__	136
9.17.4.2 __used__	136
9.17.4.3 m_clockPrescaler	136
9.17.4.4 m_clockSource	136
9.18 io::USART0 Class Reference	137
9.18.1 Detailed Description	138
9.18.2 Constructor & Destructor Documentation	138
9.18.2.1 USART0() [1/2]	138
9.18.2.2 ~USART0()	139

9.18.2.3 USART0() [2/2]	139
9.18.3 Member Function Documentation	139
9.18.3.1 dataOverrun()	140
9.18.3.2 dataRegisterEmptyServiceRoutine()	140
9.18.3.3 enableDataRegisterEmptyInterrupt()	140
9.18.3.4 enableReceiveCompleteInterrupt()	141
9.18.3.5 enableTransmitCompleteInterrupt()	141
9.18.3.6 frameError()	142
9.18.3.7 getInstance()	142
9.18.3.8 getNumberBytesReceived()	143
9.18.3.9 getNumberBytesSent()	143
9.18.3.10 operator=()	143
9.18.3.11 parityError()	143
9.18.3.12 ready2Send()	144
9.18.3.13 receiveChar()	144
9.18.3.14 receiveCompleteServiceRoutine()	144
9.18.3.15 receiveFrame()	145
9.18.3.16 receiveString()	145
9.18.3.17 resetNumberBytesReceived()	146
9.18.3.18 sendByte()	146
9.18.3.19 sendChar()	146
9.18.3.20 sendFrame()	147
9.18.3.21 sendLong()	147
9.18.3.22 sendString()	148
9.18.3.23 sendWord()	148
9.18.3.24 setBaudRate()	148
9.18.3.25 setCommunicationMode()	149
9.18.3.26 setFrameSize()	149
9.18.3.27 setParityMode()	150
9.18.3.28 setStopBit()	151
9.18.3.29 setTransmissionMode()	151
9.18.3.30 transmitCompleteServiceRoutine()	152
9.18.4 Member Data Documentation	152
9.18.4.1 __externally_visible__	152
9.18.4.2 __used__	152
9.18.4.3 m_numberBytesReceived	152
9.18.4.4 m_numberBytesSent	153
9.18.4.5 m_ready2Send	153
9.18.4.6 m_sizeData2Receive	153
9.18.4.7 m_sizeData2Send	153
9.18.4.8 m_status	153
9.18.4.9 mp_data2Receive	154

9.18.4.10 mp_data2Send	154
9.19 core::WatchdogTimer Class Reference	154
9.19.1 Detailed Description	155
9.19.2 Constructor & Destructor Documentation	155
9.19.2.1 WatchdogTimer() [1/2]	155
9.19.2.2 ~WatchdogTimer()	155
9.19.2.3 WatchdogTimer() [2/2]	155
9.19.3 Member Function Documentation	155
9.19.3.1 getInstance()	156
9.19.3.2 operator=()	156
9.19.3.3 reset()	156
9.19.3.4 selectTimeOut()	156
9.19.3.5 start() [1/2]	157
9.19.3.6 start() [2/2]	157
9.19.3.7 stop()	157
9.19.3.8 timeOutServiceRoutine()	158
9.19.4 Member Data Documentation	158
9.19.4.1 __externally_visible__	158
9.19.4.2 __used__	158
9.19.4.3 m_operationMode	158
9.19.4.4 m_timeOut	158
10 File Documentation	159
10.1 ADC.cpp File Reference	159
10.2 ADC.cpp	159
10.3 ADC.h File Reference	163
10.3.1 Detailed Description	164
10.4 ADC.h	166
10.5 AnalogComparator.cpp File Reference	167
10.6 AnalogComparator.cpp	167
10.7 AnalogComparator.h File Reference	167
10.7.1 Macro Definition Documentation	168
10.7.1.1 ANALOG_COMARATOR_H	168
10.8 AnalogComparator.h	169
10.9 Buzzer.cpp File Reference	169
10.10 Buzzer.cpp	169
10.11 Buzzer.h File Reference	170
10.12 Buzzer.h	171
10.13 buzzer_pitches_16bit.h File Reference	173
10.13.1 Macro Definition Documentation	175
10.13.1.1 A0	175
10.13.1.2 A1	175

10.13.1.3 A2	175
10.13.1.4 A3	175
10.13.1.5 A4	176
10.13.1.6 A5	176
10.13.1.7 A6	176
10.13.1.8 A7	176
10.13.1.9 Ax0	176
10.13.1.10 Ax1	176
10.13.1.11 Ax2	177
10.13.1.12 Ax3	177
10.13.1.13 Ax4	177
10.13.1.14 Ax5	177
10.13.1.15 Ax6	177
10.13.1.16 Ax7	177
10.13.1.17 B0	178
10.13.1.18 B1	178
10.13.1.19 B2	178
10.13.1.20 B3	178
10.13.1.21 B4	178
10.13.1.22 B5	178
10.13.1.23 B6	179
10.13.1.24 B7	179
10.13.1.25 C0	179
10.13.1.26 C1	179
10.13.1.27 C2	179
10.13.1.28 C3	179
10.13.1.29 C4	180
10.13.1.30 C5	180
10.13.1.31 C6	180
10.13.1.32 C7	180
10.13.1.33 Cx0	180
10.13.1.34 Cx1	180
10.13.1.35 Cx2	181
10.13.1.36 Cx3	181
10.13.1.37 Cx4	181
10.13.1.38 Cx5	181
10.13.1.39 Cx6	181
10.13.1.40 Cx7	181
10.13.1.41 D0	182
10.13.1.42 D1	182
10.13.1.43 D2	182
10.13.1.44 D3	182

10.13.1.45 D4	182
10.13.1.46 D5	182
10.13.1.47 D6	183
10.13.1.48 D7	183
10.13.1.49 Dx0	183
10.13.1.50 Dx1	183
10.13.1.51 Dx2	183
10.13.1.52 Dx3	183
10.13.1.53 Dx4	184
10.13.1.54 Dx5	184
10.13.1.55 Dx6	184
10.13.1.56 Dx7	184
10.13.1.57 E0	184
10.13.1.58 E1	184
10.13.1.59 E2	185
10.13.1.60 E3	185
10.13.1.61 E4	185
10.13.1.62 E5	185
10.13.1.63 E6	185
10.13.1.64 E7	185
10.13.1.65 F0	186
10.13.1.66 F1	186
10.13.1.67 F2	186
10.13.1.68 F3	186
10.13.1.69 F4	186
10.13.1.70 F5	186
10.13.1.71 F6	187
10.13.1.72 F7	187
10.13.1.73 Fx0	187
10.13.1.74 Fx1	187
10.13.1.75 Fx2	187
10.13.1.76 Fx3	187
10.13.1.77 Fx4	188
10.13.1.78 Fx5	188
10.13.1.79 Fx6	188
10.13.1.80 Fx7	188
10.13.1.81 G0	188
10.13.1.82 G1	188
10.13.1.83 G2	189
10.13.1.84 G3	189
10.13.1.85 G4	189
10.13.1.86 G5	189

10.13.1.87 G6	189
10.13.1.88 G7	189
10.13.1.89 Gx0	190
10.13.1.90 Gx1	190
10.13.1.91 Gx2	190
10.13.1.92 Gx3	190
10.13.1.93 Gx4	190
10.13.1.94 Gx5	190
10.13.1.95 Gx6	191
10.13.1.96 Gx7	191
10.14 buzzer_pitches_16bit.h	191
10.15 buzzer_pitches_8bit.h File Reference	192
10.15.1 Macro Definition Documentation	193
10.15.1.1 A0	193
10.15.1.2 A1	193
10.15.1.3 A2	193
10.15.1.4 Ax0	194
10.15.1.5 Ax1	194
10.15.1.6 Ax2	194
10.15.1.7 B0	194
10.15.1.8 B1	194
10.15.1.9 B2	194
10.15.1.10 C1	195
10.15.1.11 C2	195
10.15.1.12 C3	195
10.15.1.13 Cx0	195
10.15.1.14 Cx2	195
10.15.1.15 Cx3	195
10.15.1.16 D1	196
10.15.1.17 D2	196
10.15.1.18 D3	196
10.15.1.19 Dx0	196
10.15.1.20 Dx2	196
10.15.1.21 Dx3	196
10.15.1.22 E1	197
10.15.1.23 E2	197
10.15.1.24 E3	197
10.15.1.25 F1	197
10.15.1.26 F2	197
10.15.1.27 F3	197
10.15.1.28 Fx1	198
10.15.1.29 Fx2	198

10.15.1.30 Fx3	198
10.15.1.31 G1	198
10.15.1.32 G2	198
10.15.1.33 G3	198
10.15.1.34 Gx0	199
10.15.1.35 Gx1	199
10.15.1.36 Gx2	199
10.16 buzzer_pitches_8bit.h	199
10.17 DCMotor.cpp File Reference	200
10.18 DCMotor.cpp	200
10.19 DCMotor.h File Reference	200
10.19.1 Detailed Description	201
10.20 DCMotor.h	203
10.21 ExternInterrupt.cpp File Reference	203
10.22 ExternInterrupt.cpp	204
10.23 ExternInterrupt.h File Reference	205
10.23.1 Detailed Description	206
10.24 ExternInterrupt.h	208
10.25 ha_base.h File Reference	209
10.25.1 Detailed Description	209
10.25.2 Macro Definition Documentation	210
10.25.2.1 STR	210
10.25.2.2 STRx	210
10.26 ha_base.h	210
10.27 ha_m328p.h File Reference	211
10.27.1 Detailed Description	214
10.27.2 Macro Definition Documentation	215
10.27.2.1 ADC_ADJUST_RESULT_LEFT	215
10.27.2.2 ADC_ADJUST_RESULT_RIGHT	215
10.27.2.3 ADC_CONVERSION_COMPLETE_INTERRUPT	215
10.27.2.4 ADC_DISABLE	215
10.27.2.5 ADC_DISABLE_AUTOTRIGGER	216
10.27.2.6 ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT	216
10.27.2.7 ADC_DISABLE_DIGITAL_INPUT_REGISTER	216
10.27.2.8 ADC_ENABLE	216
10.27.2.9 ADC_ENABLE_AUTOTRIGGER	216
10.27.2.10 ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT	216
10.27.2.11 ADC_SELECT_ANALOG_INPUT	217
10.27.2.12 ADC_SELECT_AUTO_TRIGGER_SOURCE	217
10.27.2.13 ADC_SELECT_CLOCK_PRESCALER	217
10.27.2.14 ADC_SELECT_REF_VOLTAGE	217
10.27.2.15 ADC_START_CONVERSION	217

10.27.2.16 ADC_STOP_CONVERSION	217
10.27.2.17 EXT_INT_DISABLE_INT0	218
10.27.2.18 EXT_INT_DISABLE_INT1	218
10.27.2.19 EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT	218
10.27.2.20 EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB	218
10.27.2.21 EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC	218
10.27.2.22 EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD	218
10.27.2.23 EXT_INT_ENABLE_INT0	219
10.27.2.24 EXT_INT_ENABLE_INT1	219
10.27.2.25 EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT	219
10.27.2.26 EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB	219
10.27.2.27 EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC	219
10.27.2.28 EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD	219
10.27.2.29 EXT_INT_INT0_INTERRUPT	220
10.27.2.30 EXT_INT_INT1_INTERRUPT	220
10.27.2.31 EXT_INT_PIN_CHANGE_PORTB_INTERRUPT	220
10.27.2.32 EXT_INT_PIN_CHANGE_PORTC_INTERRUPT	220
10.27.2.33 EXT_INT_PIN_CHANGE_PORTD_INTERRUPT	220
10.27.2.34 EXT_INT_SET_INT0_SENSE_CONTROL	220
10.27.2.35 EXT_INT_SET_INT1_SENSE_CONTROL	221
10.27.2.36 MCU_ADC_DISABLE	221
10.27.2.37 MCU_ADC_ENABLE	221
10.27.2.38 MCU_BOD_DISABLE	221
10.27.2.39 MCU_SELECT_SLEEP_MODE	221
10.27.2.40 MCU_SLEEP_DISABLE	221
10.27.2.41 MCU_SLEEP_ENABLE	222
10.27.2.42 MCU_SPI_DISABLE	222
10.27.2.43 MCU_SPI_ENABLE	222
10.27.2.44 MCU_TIMER0_DISABLE	222
10.27.2.45 MCU_TIMER0_ENABLE	222
10.27.2.46 MCU_TIMER1_DISABLE	222
10.27.2.47 MCU_TIMER1_ENABLE	223
10.27.2.48 MCU_TIMER2_DISABLE	223
10.27.2.49 MCU_TIMER2_ENABLE	223
10.27.2.50 MCU_TWI_DISABLE	223
10.27.2.51 MCU_TWI_ENABLE	223
10.27.2.52 MCU_USART0_DISABLE	223
10.27.2.53 MCU_USART0_ENABLE	224
10.27.2.54 PUSHBUTTON_DEBOUNCE_TIME_US	224
10.27.2.55 PUSHBUTTON_SAMPLING	224
10.27.2.56 SERVOMOTOR_TIMER_ANGLE_COUNT	224
10.27.2.57 SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT	224

10.27.2.58 SPI_CONTROL_REGISTER	225
10.27.2.59 SPI_DATA_REGISTER	225
10.27.2.60 SPI_DISABLE	225
10.27.2.61 SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT	225
10.27.2.62 SPI_ENABLE	225
10.27.2.63 SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT	225
10.27.2.64 SPI_MASTER_MODE	226
10.27.2.65 SPI_SELECT_CLOCK_PRESCALER	226
10.27.2.66 SPI_SELECT_DATA_MODE	226
10.27.2.67 SPI_SELECT_DATA_ORDER	226
10.27.2.68 SPI_SELECT_MASTER_MODE	226
10.27.2.69 SPI_SELECT_SLAVE_MODE	226
10.27.2.70 SPI_STATUS_REGISTER	227
10.27.2.71 SPI_TRANSFER_COMPLETE	227
10.27.2.72 SPI_TRANSFER_COMPLETE_INTERRUPT	227
10.27.2.73 SPI_WRITE_COLLISION	227
10.27.2.74 TIMER0_COM_CHANNEL_A_INTERRUPT	227
10.27.2.75 TIMER0_COM_CHANNEL_B_INTERRUPT	227
10.27.2.76 TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT	228
10.27.2.77 TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT	228
10.27.2.78 TIMER0_DISABLE_OVERFLOW_INTERRUPT	228
10.27.2.79 TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT	228
10.27.2.80 TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT	228
10.27.2.81 TIMER0_ENABLE_OVERFLOW_INTERRUPT	228
10.27.2.82 TIMER0_OVERFLOW_INTERRUPT	229
10.27.2.83 TIMER0_SELECT_CLOCK_SOURCE	229
10.27.2.84 TIMER0_SELECT_COM_CHANNEL_A	229
10.27.2.85 TIMER0_SELECT_COM_CHANNEL_B	229
10.27.2.86 TIMER0_SELECT_OPERATION_MODE	229
10.27.2.87 TIMER0_STOP	229
10.27.2.88 TIMER1_COM_CHANNEL_A_INTERRUPT	230
10.27.2.89 TIMER1_COM_CHANNEL_B_INTERRUPT	230
10.27.2.90 TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT	230
10.27.2.91 TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT	230
10.27.2.92 TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT	230
10.27.2.93 TIMER1_DISABLE_OVERFLOW_INTERRUPT	230
10.27.2.94 TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT	231
10.27.2.95 TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT	231
10.27.2.96 TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT	231
10.27.2.97 TIMER1_ENABLE_OVERFLOW_INTERRUPT	231
10.27.2.98 TIMER1_INPUT_CAPTURE_INTERRUPT	231
10.27.2.99 TIMER1_OVERFLOW_INTERRUPT	231

10.27.2.100	TIMER1_SELECT_CLOCK_SOURCE	232
10.27.2.101	TIMER1_SELECT_COM_CHANNEL_A	232
10.27.2.102	TIMER1_SELECT_COM_CHANNEL_B	232
10.27.2.103	TIMER1_SELECT_OPERATION_MODE	232
10.27.2.104	TIMER1_STOP	232
10.27.2.105	TIMER2_COM_CHANNEL_A_INTERRUPT	232
10.27.2.106	TIMER2_COM_CHANNEL_B_INTERRUPT	233
10.27.2.107	TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT	233
10.27.2.108	TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT	233
10.27.2.109	TIMER2_DISABLE_OVERFLOW_INTERRUPT	233
10.27.2.110	TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT	233
10.27.2.111	TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT	233
10.27.2.112	TIMER2_ENABLE_OVERFLOW_INTERRUPT	234
10.27.2.113	TIMER2_OVERFLOW_INTERRUPT	234
10.27.2.114	TIMER2_SELECT_CLOCK_SOURCE	234
10.27.2.115	TIMER2_SELECT_COM_CHANNEL_A	234
10.27.2.116	TIMER2_SELECT_COM_CHANNEL_B	234
10.27.2.117	TIMER2_SELECT_OPERATION_MODE	234
10.27.2.118	TIMER2_STOP	235
10.27.2.119	USART0_CONTROL_STATUS_REGISTER	235
10.27.2.120	USART0_DATA_OVERRUN	235
10.27.2.121	USART0_DATA_REGISTER	235
10.27.2.122	USART0_DATA_REGISTER_EMPTY_INTERRUPT	235
10.27.2.123	USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT	235
10.27.2.124	USART0_DISABLE_DOUBLE_SPEED_MODE ^[1/2]	236
10.27.2.125	USART0_DISABLE_DOUBLE_SPEED_MODE ^[2/2]	236
10.27.2.126	USART0_DISABLE_PARITY_MODE	236
10.27.2.127	USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT	236
10.27.2.128	USART0_DISABLE_RECEIVER	236
10.27.2.129	USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT	236
10.27.2.130	USART0_DISABLE_TRANSMITTER	237
10.27.2.131	USART0_ENABLE_ASYNC_TRANSMISSION_MODE	237
10.27.2.132	USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT	237
10.27.2.133	USART0_ENABLE_DOUBLE_SPEED_MODE	237
10.27.2.134	USART0_ENABLE_EVEN_PARITY_MODE	237
10.27.2.135	USART0_ENABLE_MASTER_SPI_MODE	237
10.27.2.136	USART0_ENABLE_ODD_PARITY_MODE	238
10.27.2.137	USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT	238
10.27.2.138	USART0_ENABLE_RECEIVER	238
10.27.2.139	USART0_ENABLE_SYNC_TRANSMISSION_MODE	238
10.27.2.140	USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT	238
10.27.2.141	USART0_ENABLE_TRANSMITTER	238

10.27.2.142 USART0_FRAME_ERROR	239
10.27.2.143 USART0_PARITY_ERROR	239
10.27.2.144 USART0_RECEIVE_COMPLETE_INTERRUPT	239
10.27.2.145 USART0_SET_5BIT_FRAME_SIZE	239
10.27.2.146 USART0_SET_6BIT_FRAME_SIZE	239
10.27.2.147 USART0_SET_7BIT_FRAME_SIZE	240
10.27.2.148 USART0_SET_8BIT_FRAME_SIZE	240
10.27.2.149 USART0_SET_9BIT_FRAME_SIZE	240
10.27.2.150 USART0_SET_BAUDRATE_HIGH_REGISTER	240
10.27.2.151 USART0_SET_BAUDRATE_LOW_REGISTER	240
10.27.2.152 USART0_SET_ONE_STOP_BIT	241
10.27.2.153 USART0_SET_TWO_STOP_BITS	241
10.27.2.154 USART0_TRANSMIT_COMPLETE_INTERRUPT	241
10.27.2.155 WATCHDOG_SELECT_TIMEOUT	241
10.27.2.156 WATCHDOG_START	241
10.27.2.157 WATCHDOG_STOP	241
10.27.2.158 WATCHDOG_TIMEOUT_INTERRUPT	242
10.28 ha_m328p.h	242
10.29 LCD.cpp File Reference	246
10.30 LCD.cpp	246
10.31 LCD.h File Reference	246
10.32 LCD.h	246
10.33 Led.cpp File Reference	246
10.34 Led.cpp	246
10.35 Led.h File Reference	247
10.36 Led.h	248
10.37 main.cpp File Reference	248
10.37.1 Detailed Description	249
10.37.2 Macro Definition Documentation	249
10.37.2.1 PIN_NUMBER	249
10.37.2.2 TIMEDELAY	250
10.37.3 Function Documentation	250
10.37.3.1 main()	250
10.38 BlinkLed/main.cpp	250
10.39 main.cpp File Reference	251
10.39.1 Detailed Description	251
10.39.2 Macro Definition Documentation	252
10.39.2.1 BUZZER	252
10.39.2.2 PUSHBUTTON	252
10.39.2.3 SONG_LENGTH	252
10.39.3 Function Documentation	252
10.39.3.1 main()	253

10.40 MusicBox/main.cpp	253
10.41 main.cpp File Reference	254
10.41.1 Detailed Description	255
10.41.2 Macro Definition Documentation	256
10.41.2.1 BUZZER	256
10.41.2.2 NOTE_DURATION	256
10.41.3 Function Documentation	256
10.41.3.1 main()	256
10.42 main.cpp	257
10.43 MCU.cpp File Reference	258
10.44 MCU.cpp	259
10.45 MCU.h File Reference	260
10.45.1 Detailed Description	261
10.46 MCU.h	262
10.47 Pin.cpp File Reference	263
10.48 Pin.cpp	263
10.49 Pin.h File Reference	264
10.50 Pin.h	265
10.51 PushButton.cpp File Reference	266
10.52 PushButton.cpp	266
10.53 PushButton.h File Reference	267
10.54 PushButton.h	268
10.55 README.md File Reference	269
10.56 README.md File Reference	269
10.57 README.md File Reference	269
10.58 README.md File Reference	269
10.59 README.md File Reference	269
10.60 README.md File Reference	269
10.61 ServoMotor.cpp File Reference	269
10.62 ServoMotor.cpp	269
10.63 ServoMotor.h File Reference	271
10.63.1 Detailed Description	272
10.64 ServoMotor.h	274
10.65 SPI.cpp File Reference	275
10.66 SPI.cpp	275
10.67 SPI.h File Reference	277
10.67.1 Detailed Description	278
10.68 SPI.h	279
10.69 StepperMotor.cpp File Reference	280
10.70 StepperMotor.cpp	280
10.71 StepperMotor.h File Reference	285
10.72 StepperMotor.h	286

10.73 TimerCounter.h File Reference	287
10.73.1 Detailed Description	288
10.74 TimerCounter.h	297
10.75 TimerCounter0.cpp File Reference	299
10.76 TimerCounter0.cpp	299
10.77 TimerCounter0.h File Reference	302
10.78 TimerCounter0.h	303
10.79 TimerCounter1.cpp File Reference	304
10.80 TimerCounter1.cpp	305
10.81 TimerCounter1.h File Reference	309
10.82 TimerCounter1.h	310
10.83 TimerCounter2.cpp File Reference	311
10.84 TimerCounter2.cpp	311
10.85 TimerCounter2.h File Reference	314
10.86 TimerCounter2.h	315
10.87 USART0.cpp File Reference	316
10.88 USART0.cpp	317
10.89 USART0.h File Reference	322
10.90 USART0.h	323
10.91 utils_m328p.cpp File Reference	325
10.92 utils_m328p.cpp	325
10.93 utils_m328p.h File Reference	325
10.94 utils_m328p.h	326
10.95 WatchdogTimer.cpp File Reference	326
10.96 WatchdogTimer.cpp	326
10.97 WatchdogTimer.h File Reference	327
10.97.1 Detailed Description	329
10.98 WatchdogTimer.h	330
Index	331

Chapter 1

Introduction

TahakomAVRLib is a C++ library to program Atmel AVR microcontrollers. The library make use of the AVR standard C library and is written for easy usage.

Currently, the classes compile on the **ATmega48P/88P/168P/328P AVR microcontrollers** family.

1.1 Library structure

The library is composed of several classes that abstract the internal elements of a microcontroller and some external components that when hooked up to the chip can perform some actions.

These classes implement all functionalities and are organized into the namespaces:

- core
- io (input/output)
- or components

Several [Applications](#) and [Projects](#) are implemented in order to demonstrate the library usage.

A more detailed description of the code listings can be found in the [library documentation](#) (generated by Doxygen)

1.2 Software setup

Before using the library and start programming and interfacing external peripherals, some software packages need to be installed in your system:

- binutils-avr: for getting tools like assembler, linker, ...
- gcc-avr : AVR GNU C cross-compiler
- avr-libc: AVR C library
- avrdude : driver program for downloading/uploading code and data from/to Atmel AVR microcontrollers

1.2.1 Linux

In Linux (Ubuntu in my case), the software packages can be installed as follows:

```
sudo apt-get update
sudo apt-get install gcc build-essential
sudo apt-get install gcc-avr binutils-avr avr-libc gdb-avr
sudo apt-get install avrdude
```

1.2.2 Windows

In Windows, the software packages can be downloaded and installed as follows:

- AVR toolchain for windows: can be downloaded from the Atmel's website [download](#)
- avrdude: can be downloaded from [download](#)
- make: can be downloaded from [download](#)
- cmake: binary distribution can be downloaded from [download](#)

An alternative, would be to download the precompiled AVR-GCC toolchain from [download](#) that also include avrdude and make utilities but not cmake.

Before using these software tools, you need to update the **PATH** environment variable with the file paths to their executables and restart the system.

1.3 Compile and Flash programs

To compile and flash a program code to the AVR chip via USB port, you need to:

- Install the USB driver for the programmer used
 - Adapt the CMakeLists.txt parameters to your system configuration:
 - **MCU**: AVR chip used
 - **F_CPU**: AVR CPU frequency
 - **BAUD**: Baude rate for serial communication
 - **PROG_TYPE**: Programmer type
 - **AVRFLASH_PORT**: Flash port name
 - Change compiler flags if necessary
- and execute the following steps (shown for the [Blink a Led](#) application):

1.3.1 Linux

```
../BlinkLed$ mkdir build
../BlinkLed$ cd build
../BlinkLed/build$ cmake ..
../BlinkLed/build$ make flash
```

1.3.2 Windows

```
../BlinkLed$ mkdir build
../BlinkLed$ cd build
../BlinkLed/build$ cmake .. -G "Unix Makefiles"
../BlinkLed/build$ make flash
```

1.4 Hardware setup

- AVR chip either barebone or on a development board like an Arduino UNO
- A bunch of Leds, resistors, drivers, sensors and actuators
- A breadboard
- Jumper wires
- An AVR ISPProgrammer (optional)

1.5 Applications

These applications demonstrate the usage of **TahakomAVRLib** in simple examples:

- [Blink a Led](#)
- [AVR Square-Wave Organ](#)

1.6 Projects

These are more complex projects implemented using **TahakomAVRLib**

1.7 Author

- Farid Oubbati
- Date: 12-May-2018
- Copyright (c) 2018

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Chapter 2

Applications

These applications demonstrate the usage of **TahakomAVRLib** in simple examples. Some of the examples are directly inspired from the book *Make: AVR Programming*, [Elliot Williams](#):

- [Blink a Led](#)
- [AVR Square-Wave Organ](#)
- [AVR Music Box](#)

2.1 Blink a Led

This example demonstrates the library usage in a simple blink a Led example. It also shows how to use the Pin and Led abstraction objects.

The pinout of the **ATmega48P/88P/168P/328P AVR microcontrollers** family is illustrated below:

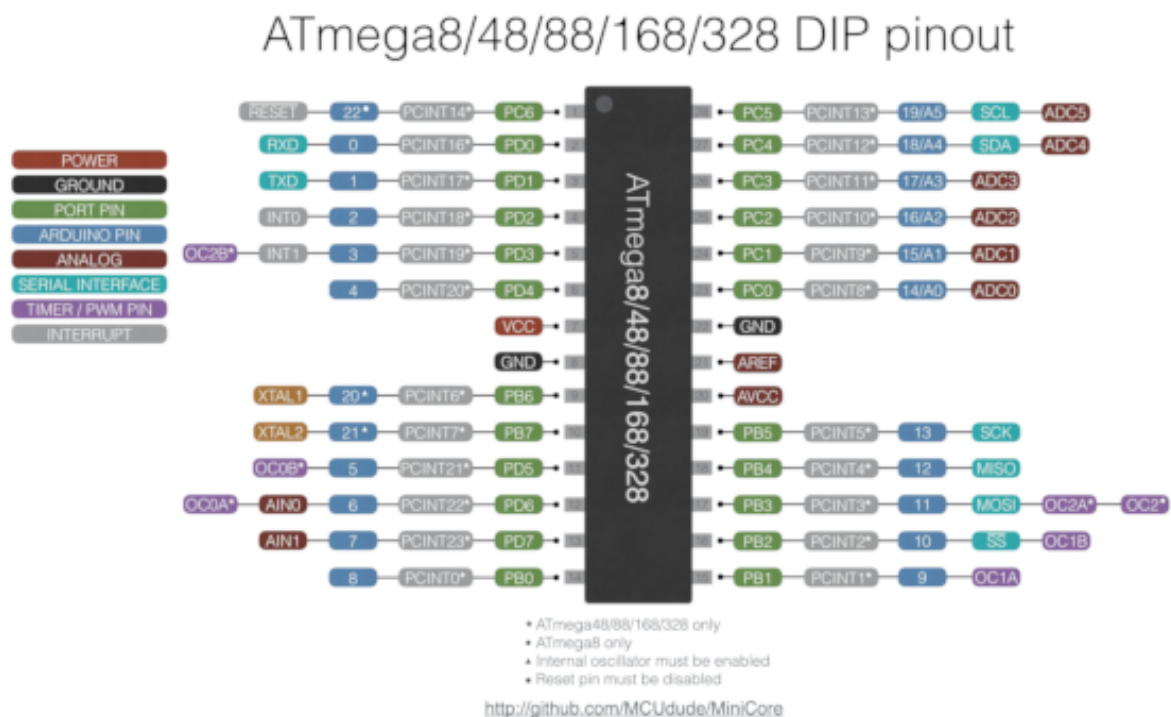


Figure 2.1 Pinout of ATmega48P/88P/168P/328P AVR microcontrollers family

2.1.1 Hardware

- Arduino UNO
- generic Led
- 220 ohm current limiting resistor
- A breadboard

The Led with the current limiting resistor are connected to pin PB0 (digital pin 8 in Arduino UNO).

2.1.2 Circuit

The circuit connection is as follows:

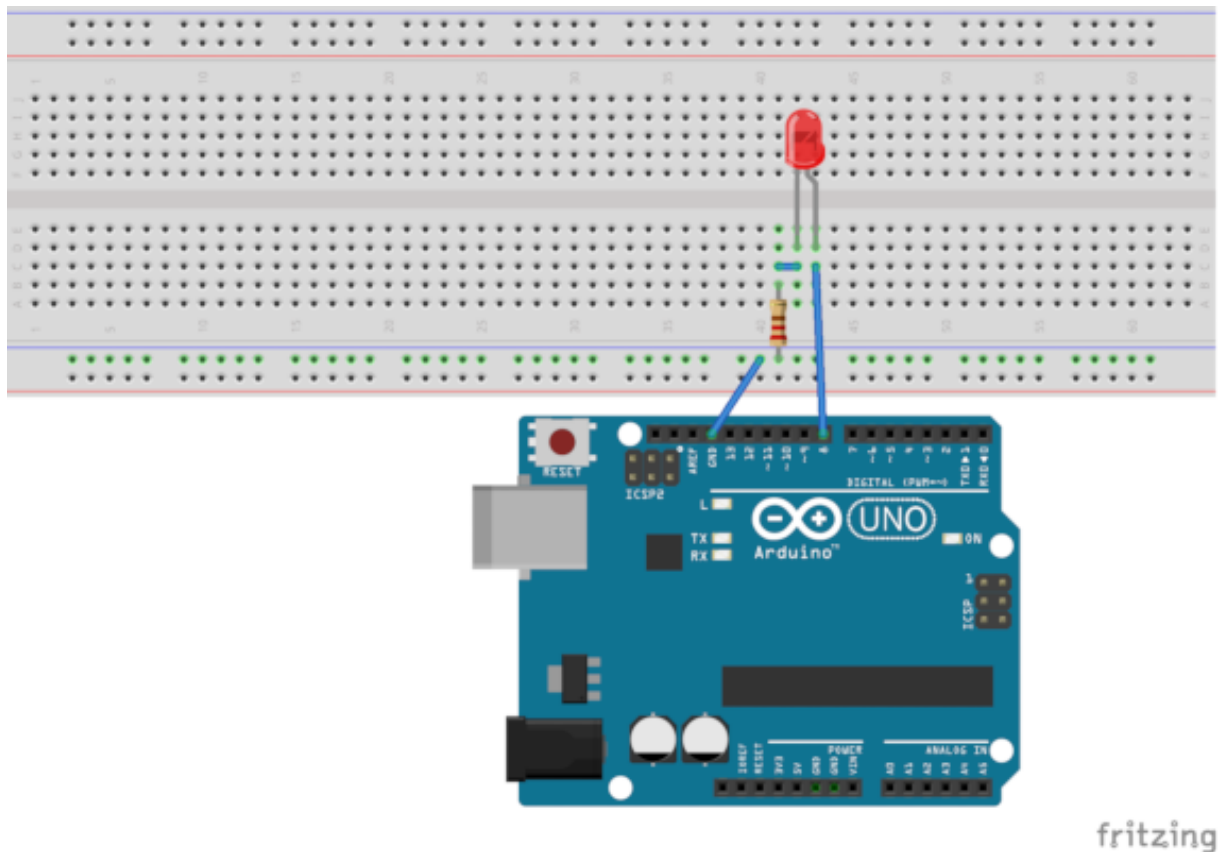


Figure 2.2 Circuit diagram

2.1.3 Code

The following code blinks the Led with a delay of 500 ms:

```
#include "Led.h"
#include <util/delay.h>
#define PIN_NUMBER 0 /**< Led pin number */
#define TIMEDELAY 500 /**< Time delay */
int main(void) {
    // Init
```

```
// Instantiate a Led object
component::Led Led(io::Pin(PIN_NUMBER,io::PortB));
// Mainloop
while (1) {
    Led.on();
    _delay_ms(TIMEDELAY);
    Led.off();
    _delay_ms(TIMEDELAY);
}
return 0;
}
```

2.1.4 Author

- Farid Oubbati
- Date: 12-May-2018
- Copyright (c) 2018

2.1.5 License

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2.2 AVR Square-Wave Organ

This example enables the user to enter a key note via a serial terminal and play the corresponding note in a Buzzer. It also shows how to use the Buzzer and USART0 abstraction objects.

The pinout of the **ATmega48P/88P/168P/328P AVR microcontrollers** family is illustrated below:

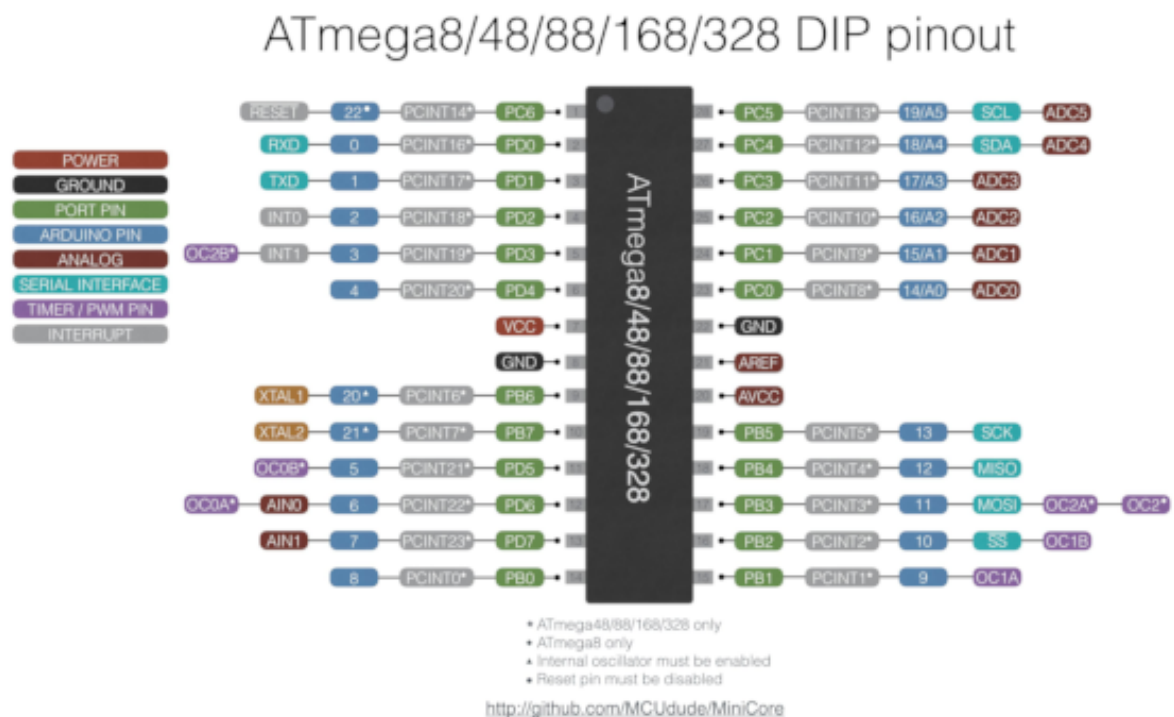


Figure 2.3 Pinout of ATmega48P/88P/168P/328P AVR microcontrollers family

2.2.1 Hardware

- Arduino UNO
- Piezo speaker/Buzzer
- 100 ohm current limiting resistor
- A breadboard

The Buzzer with the current limiting resistor are connected to pin PB0 (digital pin 8 in Arduino UNO).

2.2.2 Circuit

The circuit connection is as follows:

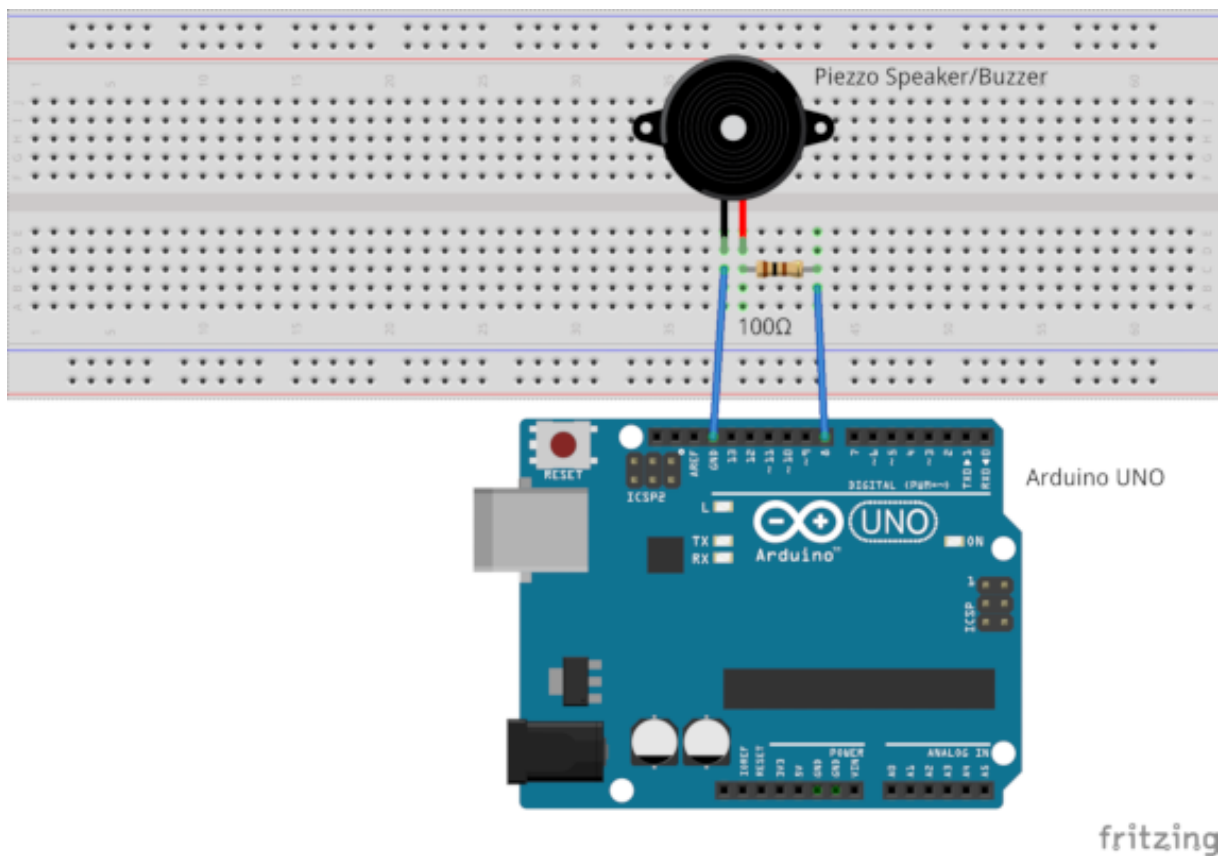


Figure 2.4 Circuit diagram

2.2.3 Code

The following code permits to turn a Buzzer into an Organ that plays notes entered by a user via a serial terminal (GTKTerm serial port terminal is used):

```
#include "Buzzer.h"
#include "USART0.h"
#include "buzzer_pitches_16bit.h"
#define BUZZER 0 /**< Buzzer pin number */
#define NOTE_DURATION 0xF000 /**< Note duration */
```



```

int main(void) {
    // Init
    // Instantiate a Buzzer object
    component::Buzzer Buzzer(io::Pin(BUZZER,io::PortB));
    // Instantiate a USART0 object
    io::USART0 &myUSART0 = io::USART0::getInstance();
    // List of possible keypresses
    const uint8_t l_keys[] = { 'a', 'w', 's', 'e', 'd', 'f', 't',
        'g', 'y', 'h', 'j', 'i', 'k', 'o',
        'l', 'p', ';', '\n'
    };
    // List of the keypresses corresponding pitches
    const uint16_t l_notes[] = { G4, Gx4, A4, Ax4, B4, C5, Cx5,
        D5, Dx5, E5, F5, Fx5, G5, Gx5,
        A5, Ax5, B5, C6
    };
    // Character key from computer serial terminal
    unsigned char l_key;
    // Current note length
    uint16_t l_currentNoteLength = NOTE_DURATION;
    // Check if note key
    uint8_t l_isNote;
    myUSART0.sendString("----- Serial Organ -----\r\n");
    // Mainloop
    while (1) {
        // Send N to signal that AVR chip is ready for next key note input
        myUSART0.sendString("Enter key note\r\n");
        // Wait for key note input
        while (myUSART0.getNumberBytesReceived()==0)
        {
            myUSART0.receiveChar(l_key);
        }
        myUSART0.resetNumberBytesReceived();
        /***** Play key notes *****/
        l_isNote = 0;
        // loop through keys table
        for (uint8_t i = 0; i < sizeof(l_keys); i++) {
            // found match in lookup table
            if (l_key == l_keys[i]) {
                Buzzer.buzz(l_notes[i], l_currentNoteLength);
                // record that we've found a note
                l_isNote = 1;
                break;
            }
        }
        // Handle non-note keys: tempo changes and rests
        if (!l_isNote) {
            if (l_key == '-') {
                // code for short note
                l_currentNoteLength = l_currentNoteLength / 2;
            }
            else if (l_key == '+') {
                // code for long note
                l_currentNoteLength = l_currentNoteLength * 2;
            }
            else {
                // unrecognized, just rest
                Buzzer.pause(l_currentNoteLength);
            }
        }
    }
    return 0;
}

```

2.2.4 Author

- Farid Oubbati
- Date: 12-May-2018
- Copyright (c) 2018

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2.3 AVR Music Box

This example allows the user to play a predefined song in a Buzzer and control its tempo via a PushButton. It also demonstrates the use of the Buzzer and PushButton abstraction objects.

The pinout of the **ATmega48P/88P/168P/328P AVR microcontrollers** family is illustrated below:

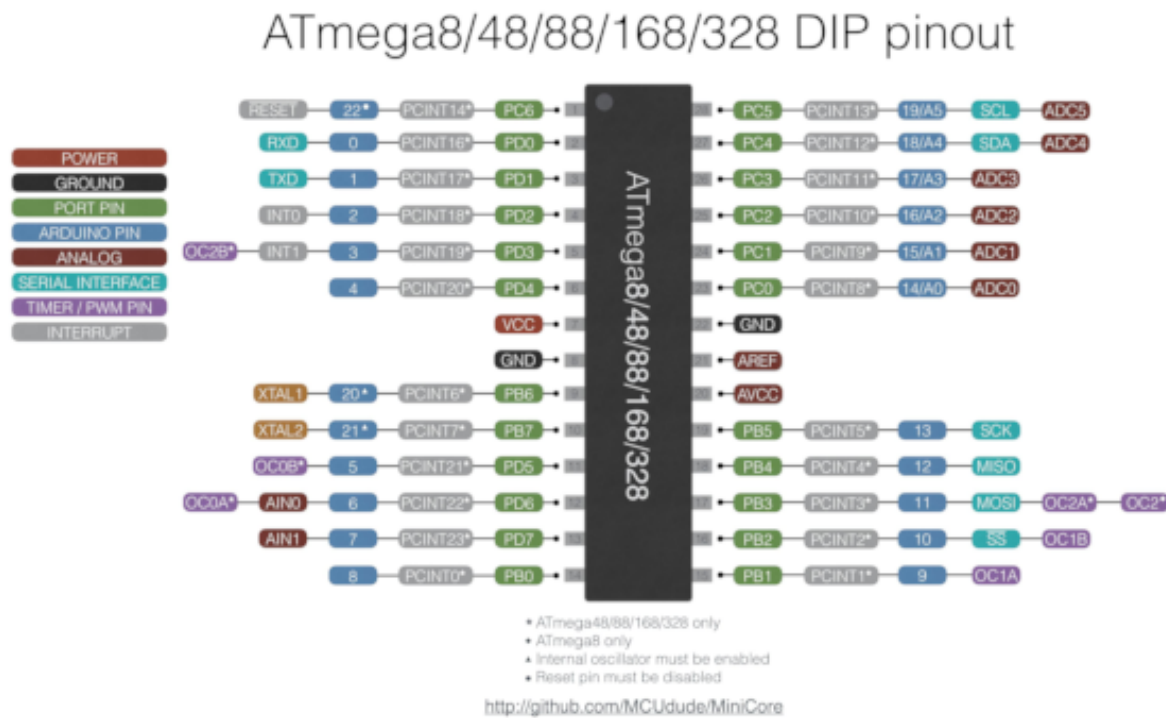


Figure 2.5 Pinout of ATmega48P/88P/168P/328P AVR microcontrollers family

2.3.1 Hardware

- Arduino UNO
- Piezo speaker/Buzzer
- 100 ohm current limiting resistor
- Switch/PushButton
- A breadboard

The Buzzer with the current limiting resistor are connected to pin PB0 (digital pin 8 in Arduino UNO) and the PushButton is connected to PB1 (digital pin 9 in Arduino UNO).

2.3.2 Circuit

The circuit connection is as follows:

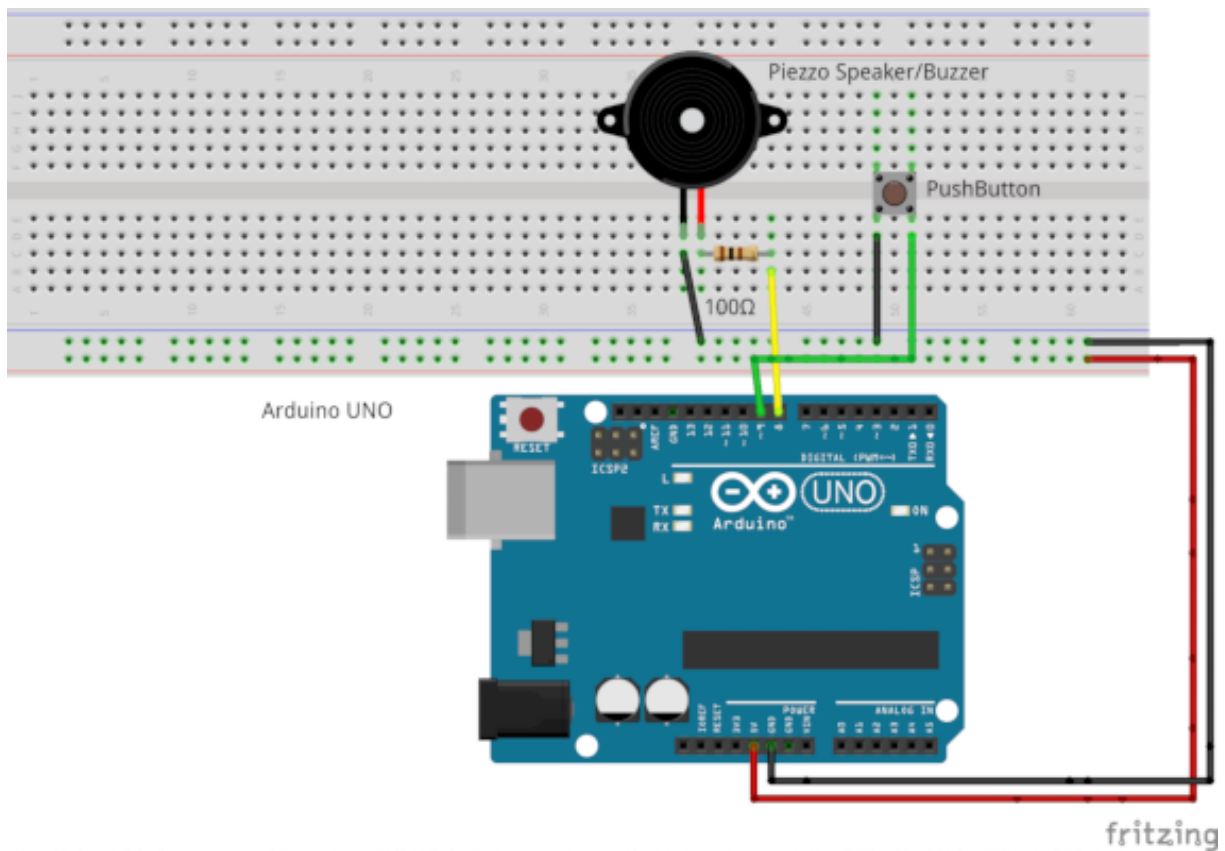


Figure 2.6 Circuit diagram

2.3.3 Code

The following code permits to turn a Buzzer into a Music Box that plays a predefined song which tempo is controlled by a PushButton:

```
#include "Buzzer.h"
#include "PushButton.h"
// Note pitch data
#include "buzzer_pitches_16bit.h"
#define BUZZER 0 /**< Buzzer pin number */
#define PUSHBUTTON 1 /**< PushButton pin number */
#define SONG_LENGTH (sizeof(l_song) / sizeof(uint16_t)) /**< Song length */
int main(void) {
    // Init
    // Instantiate a Buzzer object
    component::Buzzer Buzzer(io::Pin(BUZZER,io::PortB));
    // Instantiate a PushButton object
    component::PushButton PushButton(io::Pin(PUSHBUTTON,io::PortB));
    // Song notes
    const uint16_t l_song[] = {
        E6, E6, E6, C6, E6, G6, G5,
        C6, G5, E5, A5, B5, Ax5, A5,
        G5, E6, G6, A6, F6, G6, E6, C6, D6, B5,
        C6, G5, E5, A5, B5, Ax5, A5,
        G5, E6, G6, A6, F6, G6, E6, C6, D6, B5,
    };
    // Start song at start
    uint8_t l_note = SONG_LENGTH - 1;
    // Initialize PushButton state
    uint8_t l_statePushButton = 0;
```

```
// Mainloop
while (1) {
    // Check if PusbButton is pressed
    if (PushButton.isPressed())
    {
        // Check if a new button press
        if (!l_statePushButton) {
            // play next note
            l_note++;
            // start from start
            if (l_note == SONG_LENGTH) {
                l_note = 0;
            }
            l_statePushButton = 1;
        }
        // Play note
        Buzzer.buzz(l_song[l_note], 1600);
    } else {
        l_statePushButton=0;
    }
}
return 0;
}
```

2.3.4 Author

- Farid Oubbati
- Date: 12-May-2018
- Copyright (c) 2018

2.3.5 License

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Chapter 3

README

Chapter 4

Namespace Index

4.1 Namespace List

Here is a list of all namespaces with brief descriptions:

component	AVR chip external components	23
core	24
io	AVR chip internal i/o components	32
utils	38

Chapter 5

Hierarchical Index

5.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

core::ADConverter	39
core::AnalogComparator	48
component::Buzzer	48
component::DCMotor	52
core::ExternInterrupt	55
component::Led	61
core::MCU	65
io::Pin	69
io::Port	74
component::PushButton	75
component::ServoMotor	79
io::SPI	85
component::StepperMotor	93
core::TimerCounter	103
core::TimerCounter0	106
core::TimerCounter1	116
core::TimerCounter2	127
io::USART0	137
core::WatchdogTimer	154

Chapter 6

Class Index

6.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

core::ADConverter	39
core::AnalogComparator	48
component::Buzzer	
Class for handling a Buzzer component	48
component::DCMotor	52
core::ExternInterrupt	55
component::Led	
Class for handling a Led component	61
core::MCU	65
io::Pin	69
io::Port	
Contains definitions of pointers to the AVR port's registers	74
component::PushButton	
Class for handling a PushButton component	75
component::ServoMotor	79
io::SPI	85
component::StepperMotor	93
core::TimerCounter	103
core::TimerCounter0	106
core::TimerCounter1	116
core::TimerCounter2	127
io::USART0	
Class for handling USART0 component	137
core::WatchdogTimer	154

Chapter 7

File Index

7.1 File List

Here is a list of all files with brief descriptions:

ADC.cpp	159
ADC.h	
Header file of the ADC class	163
AnalogComparator.cpp	167
AnalogComparator.h	167
Buzzer.cpp	169
Buzzer.h	170
buzzer_pitches_16bit.h	173
buzzer_pitches_8bit.h	192
DCMotor.cpp	200
DCMotor.h	
Header file of the DCMotor class	200
ExternInterrupt.cpp	203
ExternInterrupt.h	
Header file of the ExternInterrupt class	205
ha_base.h	
Base header file for the basic hardware abstraction macros	209
ha_m328p.h	
Header file for the hardware abstraction macros of the Atmega328p	211
LCD.cpp	246
LCD.h	246
Led.cpp	246
Led.h	247
BlinkLed/main.cpp	248
MusicBox/main.cpp	251
Organ/main.cpp	254
MCU.cpp	258
MCU.h	
Header file of the MCU class	260
Pin.cpp	263
Pin.h	264
PushButton.cpp	266
PushButton.h	267
ServoMotor.cpp	269
ServoMotor.h	
Header file of the ServoMotor class	271

SPI.cpp	275
SPI.h	
Header file of the SPI class	277
StepperMotor.cpp	280
StepperMotor.h	285
TimerCounter.h	
Header file of the TimerCounter class	287
TimerCounter0.cpp	299
TimerCounter0.h	302
TimerCounter1.cpp	304
TimerCounter1.h	309
TimerCounter2.cpp	311
TimerCounter2.h	314
USART0.cpp	316
USART0.h	322
utils_m328p.cpp	325
utils_m328p.h	325
WatchdogTimer.cpp	326
WatchdogTimer.h	
Header file of the WatchdogTimer class	327

Chapter 8

Namespace Documentation

8.1 component Namespace Reference

AVR chip external components.

Classes

- class [Buzzer](#)
Class for handling a [Buzzer](#) component.
- class [DCMotor](#)
- class [Led](#)
Class for handling a [Led](#) component.
- class [PushButton](#)
Class for handling a [PushButton](#) component.
- class [ServoMotor](#)
- class [StepperMotor](#)

Enumerations

- enum [mode](#) : uint8_t { [mode::fullStep](#) =0, [mode::halfStep](#) }

8.1.1 Detailed Description

AVR chip external components.

The namespace englobes all external components that, when hooked up, allows the AVR chip to interact with the external World

The namespace englobes all external components that, when hooked up, allows the AVR MCU to interact with the external World

8.1.2 Enumeration Type Documentation

8.1.2.1 mode

```
enum component::mode : uint8_t [strong]
```

Enumerator

fullStep	
halfStep	

Definition at line 70 of file [StepperMotor.h](#).

```
00070         : uint8_t {
00071     fullStep=0,
00072     halfStep,
00073 };
```

8.2 core Namespace Reference

Classes

- class [ADConverter](#)
- class [AnalogComparator](#)
- class [ExternInterrupt](#)
- class [MCU](#)
- class [TimerCounter](#)
- class [TimerCounter0](#)
- class [TimerCounter1](#)
- class [TimerCounter2](#)
- class [WatchdogTimer](#)

Enumerations

- enum [resolution](#) : uint8_t {
[resolution::res_8bit](#) =0, [resolution::res_9bit](#), [resolution::res_10bit](#), [resolution::res_11bit](#),
[resolution::res_12bit](#), [resolution::res_13bit](#), [resolution::res_14bit](#), [resolution::res_15bit](#),
[resolution::res_16bit](#) }
- enum [referenceVoltage](#) : uint8_t { [referenceVoltage::AREF](#) =0, [referenceVoltage::AVCC](#), [referenceVoltage::internal](#) }
- enum [clockPrescaler](#) : uint8_t {
[clockPrescaler::PS_2](#) = 1, [clockPrescaler::PS_4](#), [clockPrescaler::PS_8](#), [clockPrescaler::PS_16](#),
[clockPrescaler::PS_32](#), [clockPrescaler::PS_64](#), [clockPrescaler::PS_128](#) }
- enum [autoTriggerSource](#) : uint8_t {
[autoTriggerSource::freeRunning](#), [autoTriggerSource::analogComparator](#), [autoTriggerSource::extInterrupt](#),
[autoTriggerSource::timer0Compare](#),
[autoTriggerSource::timer0Overflow](#), [autoTriggerSource::timer1CompareB](#), [autoTriggerSource::timer1Overflow](#),
[autoTriggerSource::timer1Capture](#) }
- enum [senseControl](#) : uint8_t { [senseControl::lowLevel](#) =0, [senseControl::logicalChange](#), [senseControl::fallingEdge](#),
[senseControl::risingEdge](#) }
- enum [pinChangePort](#) : uint8_t { [pinChangePort::PCINTB](#) =0, [pinChangePort::PCINTC](#), [pinChangePort::PCINTD](#) }
- enum [BODMode](#) : uint8_t { [BODMode::enabled](#) =0, [BODMode::disabled](#) }
- enum [sleepMode](#) : uint8_t {
[sleepMode::Idle](#) =0, [sleepMode::ADC_NoiseReduction](#), [sleepMode::powerDown](#), [sleepMode::powerSave](#),
[sleepMode::standby](#) =6, [sleepMode::extendedStandby](#) }
- enum [channel](#) : uint8_t { [channel::A](#) =0, [channel::B](#) }
- enum [compareOutputMode](#) : uint8_t { [compareOutputMode::normal](#) =0, [compareOutputMode::toggle](#),
[compareOutputMode::clear](#), [compareOutputMode::set](#) }

- enum `operationMode` : `uint8_t` {
`operationMode::normal` =0, `operationMode::PWM_PC`, `operationMode::PWM_PC_8bit`, `operationMode::PWM_PC_9bit`,
`operationMode::PWM_PC_10bit`, `operationMode::PWM_PFC_ICR`, `operationMode::PWM_PFC_OCR`,
`operationMode::PWM_PC_ICR`,
`operationMode::PWM_PC_OCR`, `operationMode::fast_PWM`, `operationMode::fast_PWM_8bit`, `operationMode::fast_PWM_9bit`,
`operationMode::fast_PWM_10bit`, `operationMode::fast_PWM_ICR`, `operationMode::fast_PWM_OCR`,
`operationMode::CTC_OCR`,
`operationMode::CTC_ICR`, `operationMode::interrupt` =1, `operationMode::reset`, `operationMode::interrupt_reset`
}
- enum `clockSource` : `uint16_t` {
`clockSource::noClock` =0, `clockSource::PS_1`, `clockSource::PS_8`, `clockSource::PS_32`,
`clockSource::PS_64`, `clockSource::PS_128`, `clockSource::PS_256`, `clockSource::PS_1024`,
`clockSource::extern_Clock_T0_Falling_Edge`, `clockSource::extern_Clock_T0_Rising_Edge` }
- enum `timeOut` : `uint8_t` {
`timeOut::to_16ms` =0, `timeOut::to_32ms`, `timeOut::to_64ms`, `timeOut::to_125ms`,
`timeOut::to_250ms`, `timeOut::to_500ms`, `timeOut::to_1s`, `timeOut::to_2s`,
`timeOut::to_4s`, `timeOut::to_8s` }
- enum `operationMode` : `uint8_t` {
`operationMode::normal` =0, `operationMode::PWM_PC`, `operationMode::PWM_PC_8bit`, `operationMode::PWM_PC_9bit`,
`operationMode::PWM_PC_10bit`, `operationMode::PWM_PFC_ICR`, `operationMode::PWM_PFC_OCR`,
`operationMode::PWM_PC_ICR`,
`operationMode::PWM_PC_OCR`, `operationMode::fast_PWM`, `operationMode::fast_PWM_8bit`, `operationMode::fast_PWM_9bit`,
`operationMode::fast_PWM_10bit`, `operationMode::fast_PWM_ICR`, `operationMode::fast_PWM_OCR`,
`operationMode::CTC_OCR`,
`operationMode::CTC_ICR`, `operationMode::interrupt` =1, `operationMode::reset`, `operationMode::interrupt_reset`
}

8.2.1 Enumeration Type Documentation

8.2.1.1 autoTriggerSource

```
enum core::autoTriggerSource : uint8_t [strong]
```

Enumerator

<code>freeRunning</code>	
<code>analogComparator</code>	
<code>extInterrupt</code>	
<code>timer0Compare</code>	
<code>timer0Overflow</code>	
<code>timer1CompareB</code>	
<code>timer1Overflow</code>	
<code>timer1Capture</code>	

Definition at line 118 of file [ADC.h](#).

```
00118                                     : uint8_t {
00119     freeRunning,
00120     analogComparator,
00121     extInterrupt,
00122     timer0Compare,
00123     timer0Overflow,
00124     timer1CompareB,
```

```

00125     timer1Overflow,
00126     timer1Capture
00127 };

```

8.2.1.2 BODMode

```
enum core::BODMode : uint8_t [strong]
```

Enumerator

enabled	
disabled	

Definition at line 77 of file [MCU.h](#).

```

00077     : uint8_t {
00078     enabled=0,
00079     disabled,
00080 };

```

8.2.1.3 channel

```
enum core::channel : uint8_t [strong]
```

Enumerator

A	
B	

Definition at line 470 of file [TimerCounter.h](#).

```

00470     : uint8_t {
00471     A=0,
00472     B,
00473 };

```

8.2.1.4 clockPrescaler

```
enum core::clockPrescaler : uint8_t [strong]
```

Enumerator

PS_2	
PS_4	
PS_8	
PS_16	
PS_32	
PS_64	
PS_128	

Definition at line 108 of file [ADC.h](#).

```
00108                                     : uint8_t {
00109     PS_2 = 1,
00110     PS_4,
00111     PS_8,
00112     PS_16,
00113     PS_32,
00114     PS_64,
00115     PS_128
00116 };
```

8.2.1.5 clockSource

```
enum core::clockSource : uint16_t [strong]
```

Enumerator

noClock	
PS_1	
PS_8	
PS_32	
PS_64	
PS_128	
PS_256	
PS_1024	
extern_Clock_T0_Falling_Edge	
extern_Clock_T0_Rising_Edge	

Definition at line 504 of file [TimerCounter.h](#).

```
00504                                     : uint16_t {
00505     noClock=0,
00506     PS_1,
00507     PS_8,
00508     PS_32,
00509     PS_64,
00510     PS_128,
00511     PS_256,
00512     PS_1024,
00513     extern_Clock_T0_Falling_Edge,
00514     extern_Clock_T0_Rising_Edge,
00515 };
```

8.2.1.6 compareOutputMode

```
enum core::compareOutputMode : uint8_t [strong]
```

Enumerator

normal	
toggle	
clear	
set	

Definition at line 476 of file [TimerCounter.h](#).

```

00476                                     : uint8_t {
00477     normal=0,
00478     toggle,
00479     clear,
00480     set,
00481 };

```

8.2.1.7 operationMode [1/2]

```
enum core::operationMode : uint8_t [strong]
```

Enumerator

normal	
PWM_PC	
PWM_PC_8bit	
PWM_PC_9bit	
PWM_PC_10bit	
PWM_PFC_ICR	
PWM_PFC_OCR	
PWM_PC_ICR	
PWM_PC_OCR	
fast_PWM	
fast_PWM_8bit	
fast_PWM_9bit	
fast_PWM_10bit	
fast_PWM_ICR	
fast_PWM_OCR	
CTC_OCR	
CTC_ICR	
interrupt	
reset	
interrupt_reset	

Definition at line 78 of file [WatchdogTimer.h](#).

```

00078                                     : uint8_t {
00079     interrupt=1,
00080     reset,
00081     interrupt_reset,
00082 };

```

8.2.1.8 operationMode [2/2]

```
enum core::operationMode : uint8_t [strong]
```

Enumerator

normal	
PWM_PC	
PWM_PC_8bit	

Enumerator

PWM_PC_9bit	
PWM_PC_10bit	
PWM_PFC_ICR	
PWM_PFC_OCR	
PWM_PC_ICR	
PWM_PC_OCR	
fast_PWM	
fast_PWM_8bit	
fast_PWM_9bit	
fast_PWM_10bit	
fast_PWM_ICR	
fast_PWM_OCR	
CTC_OCR	
CTC_ICR	
interrupt	
reset	
interrupt_reset	

Definition at line 485 of file [TimerCounter.h](#).

```

00485                                     : uint8_t {
00486     normal=0,
00487     PWM_PC,
00488     PWM_PC_8bit,
00489     PWM_PC_9bit,
00490     PWM_PC_10bit,
00491     PWM_PFC_ICR,
00492     PWM_PFC_OCR,
00493     PWM_PC_ICR,
00494     PWM_PC_OCR,
00495     fast_PWM,
00496     fast_PWM_8bit,
00497     fast_PWM_9bit,
00498     fast_PWM_10bit,
00499     fast_PWM_ICR,
00500     fast_PWM_OCR,
00501     CTC_OCR,
00502     CTC_ICR,
00503 };

```

8.2.1.9 pinChangePort

```
enum core::pinChangePort : uint8_t [strong]
```

Enumerator

PCINTB	
PCINTC	
PCINTD	

Definition at line 156 of file [ExternInterrupt.h](#).

```

00156                                     : uint8_t {
00157     PCINTB=0,
00158     PCINTC,
00159     PCINTD,
00160 };

```

8.2.1.10 referenceVoltage

```
enum core::referenceVoltage : uint8_t [strong]
```

Enumerator

AREF	external AREF pin voltage reference, internal 1.1V voltage reference turned off
AVCC	AVCC voltage reference with external capacitor at AREF pin
internal	internal 1.1V voltage reference with external capacitor at AREF pin

Definition at line 100 of file [ADC.h](#).

```
00100                                     : uint8_t {  
00101     AREF=0,  
00102     AVCC,  
00103     internal  
00104 };
```

8.2.1.11 resolution

```
enum core::resolution : uint8_t [strong]
```

Enumerator

res_8bit	
res_9bit	
res_10bit	
res_11bit	
res_12bit	
res_13bit	
res_14bit	
res_15bit	
res_16bit	

Definition at line 87 of file [ADC.h](#).

```
00087                                     : uint8_t {  
00088     res_8bit=0,  
00089     res_9bit,  
00090     res_10bit,  
00091     res_11bit,  
00092     res_12bit,  
00093     res_13bit,  
00094     res_14bit,  
00095     res_15bit,  
00096     res_16bit  
00097 };
```

8.2.1.12 senseControl

```
enum core::senseControl : uint8_t [strong]
```

Enumerator

lowLevel	
logicalChange	
fallingEdge	
risingEdge	

Definition at line 149 of file [ExternInterrupt.h](#).

```
00149             : uint8_t {  
00150     lowLevel=0,  
00151     logicalChange,  
00152     fallingEdge,  
00153     risingEdge  
00154 };
```

8.2.1.13 sleepMode

```
enum core::sleepMode : uint8_t [strong]
```

Enumerator

Idle	
ADC_NoiseReduction	
powerDown	
powerSave	
standby	
extendedStandby	

Definition at line 82 of file [MCU.h](#).

```
00082             : uint8_t {  
00083     Idle=0,  
00084     ADC_NoiseReduction,  
00085     powerDown,  
00086     powerSave,  
00087     standby=6,  
00088     extendedStandby,  
00089 };
```

8.2.1.14 timeOut

```
enum core::timeOut : uint8_t [strong]
```

Enumerator

to_16ms	
to_32ms	
to_64ms	
to_125ms	
to_250ms	
to_500ms	
to_1s	

Enumerator

to_2s	
to_4s	
to_8s	

Definition at line 65 of file [WatchdogTimer.h](#).

```
00065      : uint8_t {
00066      to_16ms=0,
00067      to_32ms,
00068      to_64ms,
00069      to_125ms,
00070      to_250ms,
00071      to_500ms,
00072      to_1s,
00073      to_2s,
00074      to_4s,
00075      to_8s,
00076 };
```

8.3 io Namespace Reference

AVR chip internal i/o components.

Classes

- class [Pin](#)
- struct [Port](#)
 - Contains definitions of pointers to the AVR port's registers.*
- class [SPI](#)
- class [USART0](#)
 - Class for handling [USART0](#) component.*

Enumerations

- enum [operationMode](#) : uint8_t { [operationMode::master](#) =0, [operationMode::slave](#), [operationMode::submaster](#), [operationMode::disable](#) }
- enum [clockPrescaler](#) : uint8_t { [clockPrescaler::PS_4](#) = 0, [clockPrescaler::PS_16](#), [clockPrescaler::PS_64](#), [clockPrescaler::PS_128](#), [clockPrescaler::PS_2](#), [clockPrescaler::PS_8](#), [clockPrescaler::PS_32](#) }
- enum [dataMode](#) : uint8_t { [dataMode::mode_0](#) = 0, [dataMode::mode_1](#), [dataMode::mode_2](#), [dataMode::mode_3](#) }
- enum [dataOrder](#) : uint8_t { [dataOrder::first_MSB](#) = 0, [dataOrder::first_LSB](#) }
- enum [transmissionMode](#) : uint8_t { [transmissionMode::async](#) =0, [transmissionMode::sync](#), [transmissionMode::masterSPI](#) }
- *USART0 transmission mode.*
- enum [communicationMode](#) : uint8_t { [communicationMode::duplex](#) =0, [communicationMode::transmit](#), [communicationMode::receive](#) }
- *USART0 communication mode.*
- enum [parityMode](#) : uint8_t { [parityMode::noParity](#) =0, [parityMode::evenParity](#), [parityMode::oddParity](#) }
- *USART0 parity mode.*
- enum [frameSize](#) : uint8_t { [frameSize::eightBits](#) =0, [frameSize::fiveBits](#), [frameSize::sixBits](#), [frameSize::sevenBits](#), [frameSize::neineBits](#) }
- *USART0 frame size.*
- enum [stopBit](#) : uint8_t { [stopBit::oneStopBit](#) =0, [stopBit::twoStopBits](#) }
- *USART0 stop bit.*

Variables

- static [io::Port PortB](#) = { &DDRB, &PORTB, &PINB }
- static [io::Port PortC](#) = { &DDRC, &PORTC, &PINC }
- static [io::Port PortD](#) = { &DDRD, &PORTD, &PIND }

8.3.1 Detailed Description

AVR chip internal i/o components.

The namespace englobes all internal input/output components that, when configured, allows the AVR MCU to communicate with the external World

8.3.2 Enumeration Type Documentation

8.3.2.1 clockPrescaler

```
enum io::clockPrescaler : uint8_t [strong]
```

Enumerator

PS_4	
PS_16	
PS_64	
PS_128	
PS_2	
PS_8	
PS_32	

Definition at line 63 of file [SPI.h](#).

```
00063                                     : uint8_t {
00064     PS\_4 = 0,
00065     PS\_16,
00066     PS\_64,
00067     PS\_128,
00068     PS\_2,
00069     PS\_8,
00070     PS\_32
00071 };
```

8.3.2.2 communicationMode

```
enum io::communicationMode : uint8_t [strong]
```

[USART0](#) communication mode.

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Enumerator

duplex	full duplex mode
transmit	transmit mode
receive	receive mode

Definition at line 39 of file [USART0.h](#).

```
00039                                     : uint8_t {
00040     duplex=0,
00041     transmit,
00042     receive,
00044 };
```

8.3.2.3 dataMode

```
enum io::dataMode : uint8_t [strong]
```

Enumerator

mode↔ _0	
mode↔ _1	
mode↔ _2	
mode↔ _3	

Definition at line 73 of file [SPI.h](#).

```
00073                                     : uint8_t {
00074     mode_0 = 0,
00075     mode_1,
00076     mode_2,
00077     mode_3,
00078 };
```

8.3.2.4 dataOrder

```
enum io::dataOrder : uint8_t [strong]
```

Enumerator

first_MSB	
first_LSB	

Definition at line 80 of file [SPI.h](#).

```
00080      : uint8_t {
00081      first_MSB = 0,
00082      first_LSB
00083 };
```

8.3.2.5 frameSize

```
enum io::frameSize : uint8_t [strong]
```

[USART0](#) frame size.

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Enumerator

eightBits	8 bits frame size
fiveBits	5 bits frame size
sixBits	6 bits frame size
sevenBits	7 bits frame size
neineBits	9 bits frame size

Definition at line 68 of file [USART0.h](#).

```
00068      : uint8_t {
00069      eightBits=0,
00070      fiveBits,
00071      sixBits,
00072      sevenBits,
00073      neineBits
00074 };
```

8.3.2.6 operationMode

```
enum io::operationMode : uint8_t [strong]
```

Enumerator

master	
slave	
submaster	
disable	

Definition at line 56 of file [SPI.h](#).

```
00056                                     : uint8_t {  
00057     master=0,  
00058     slave,  
00059     submaster,  
00060     disable,  
00061 };
```

8.3.2.7 parityMode

```
enum io::parityMode : uint8_t [strong]
```

[USART0](#) parity mode.

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Enumerator

noParity	no parity check mode
evenParity	even parity check mode
oddParity	odd parity check mode

Definition at line 54 of file [USART0.h](#).

```
00054                                     : uint8_t {  
00055     noParity=0,  
00056     evenParity,  
00057     oddParity  
00058 };
```

8.3.2.8 stopBit

```
enum io::stopBit : uint8_t [strong]
```

[USART0](#) stop bit.

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Enumerator

oneStopBit	1 stop bit
twoStopBits	2 stop bits

Definition at line 84 of file [USART0.h](#).

```
00084      : uint8_t{
00085      oneStopBit=0,
00086      twoStopBits
00087  };
```

8.3.2.9 transmissionMode

```
enum io::transmissionMode : uint8_t [strong]
```

[USART0](#) transmission mode.

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Enumerator

async	asynchronous mode
sync	synchronous mode
masterSPI	masterSPI mode

Definition at line 25 of file [USART0.h](#).

```
00025      : uint8_t {
00026      async=0,
00027      sync,
00028      masterSPI
00029  };
```

8.3.3 Variable Documentation

8.3.3.1 PortB

```
io::Port io::PortB = { &DDRB, &PORTB, &PINB } [static]
```

global static [Port](#) B object

Definition at line 92 of file [Pin.h](#).

8.3.3.2 PortC

```
io::Port io::PortC = { &DDRC, &PORTC, &PINC } [static]
```

global static [Port](#) C object

Definition at line 93 of file [Pin.h](#).

8.3.3.3 PortD

```
io::Port io::PortD = { &DDRD, &PORTD, &PIND } [static]
```

global static [Port](#) D object

Definition at line 94 of file [Pin.h](#).

8.4 utils Namespace Reference

Functions

- long [map](#) (long x, long in_min, long in_max, long out_min, long out_max)

8.4.1 Function Documentation

8.4.1.1 map()

```
long utils::map (  
    long x,  
    long in_min,  
    long in_max,  
    long out_min,  
    long out_max )
```

Definition at line 3 of file [utils_m328p.cpp](#).

```
00004 {  
00005     return (x - in_min) * (out_max - out_min) / (in_max - in_min) + out_min;  
00006 }
```

Chapter 9

Class Documentation

9.1 core::ADConverter Class Reference

```
#include <ADC.h>
```

Public Member Functions

- void [start](#) ()
- void [stop](#) ()
- void [selectReferenceVoltage](#) (const [referenceVoltage](#) &ar_refVoltage)
- void [selectAnalogInput](#) ([io::Pin](#) a_pin)
- void [selectClockPrescaler](#) (const [clockPrescaler](#) &ar_clockPrescaler)
- void [enableConversionCompleteInterrupt](#) (const uint8_t a_enable)
- void [enableAutoTrigger](#) (const uint8_t a_enable)
- void [selectAutoTriggerSource](#) (const [autoTriggerSource](#) &ar_autoTriggerSource)
- uint8_t [conversionComplete](#) ()
- void [getConversionResult](#) (uint16_t *ap_resultData, const [resolution](#) &ar_resolution=[resolution::res_10bit](#))

Static Public Member Functions

- static [ADConverter](#) & [getInstance](#) (const [referenceVoltage](#) &ar_refVoltage=[referenceVoltage::AVCC](#), const [clockPrescaler](#) &ar_clockPrescaler=[clockPrescaler::PS_128](#), const [autoTriggerSource](#) &ar_autoTriggerSource=[autoTriggerSource::freeRunning](#), const [io::Pin](#) &ar_pin=[io::Pin](#)(0, [io::PortC](#)))
- static void [conversionCompleteServiceRoutine](#) () __asm__([STR\(ADC_CONVERSION_COMPLETE_INTERRUPT\)](#))
__attribute__((__signal__

Public Attributes

- static void [__used__](#)
- static void [__externally_visible__](#)

Private Member Functions

- [ADConverter](#) (const [referenceVoltage](#) &ar_refVoltage, const [clockPrescaler](#) &ar_clockPrescaler, const [autoTriggerSource](#) &ar_autoTriggerSource, const [io::Pin](#) &ar_pin)
- [~ADConverter](#) ()
- [ADConverter](#) (const [ADConverter](#) &)
- const [ADConverter](#) & [operator=](#) (const [ADConverter](#) &)

Static Private Attributes

- static volatile uint16_t * [mp_conversionResult](#) = nullptr
- static uint8_t [m_resolution](#) = 10
- static volatile uint8_t [m_conversionComplete](#) = 0

9.1.1 Detailed Description

Definition at line 129 of file [ADC.h](#).

9.1.2 Constructor & Destructor Documentation

9.1.2.1 [ADConverter\(\)](#) [1/2]

```
core::ADConverter::ADConverter (
    const referenceVoltage & ar_refVoltage,
    const clockPrescaler & ar_clockPrescaler,
    const autoTriggerSource & ar_autoTriggerSource,
    const io::Pin & ar_pin ) [private]
```

Definition at line 23 of file [ADC.cpp](#).

```
00027 {
00028     core::MCU::enableADC(1);
00029     selectAnalogInput(ar_pin);
00030     selectReferenceVoltage(ar_refVoltage);
00031     selectClockPrescaler(ar_clockPrescaler);
00032     enableAutoTrigger(1);
00033     selectAutoTriggerSource(ar_autoTriggerSource);
00034     sei();
00035     enableConversionCompleteInterrupt(1);
00036
00037
00038 }
```

References [core::MCU::enableADC\(\)](#).

9.1.2.2 [~ADConverter\(\)](#)

```
core::ADConverter::~~ADConverter ( ) [private]
```

Destructor.

Definition at line 41 of file [ADC.cpp](#).

```
00042 {
00043
00044 }
```


9.1.2.3 ADConverter() [2/2]

```
core::ADConverter::ADConverter (
    const ADConverter & ) [private]
```

Overried Copy constructor.

9.1.3 Member Function Documentation

9.1.3.1 conversionComplete()

```
uint8_t core::ADConverter::conversionComplete ( )
```

Definition at line 255 of file [ADC.cpp](#).

```
00256 {
00257     return m_conversionComplete;
00258 }
00259 }
```

9.1.3.2 conversionCompleteServiceRoutine()

```
void core::ADConverter::conversionCompleteServiceRoutine ( ) [static]
```

Definition at line 109 of file [ADC.cpp](#).

```
00110 {
00111
00112     static uint32_t l_resultData = 0;
00113     static uint16_t l_resultDataIndex = 0;
00114
00115     m_conversionComplete = 0;
00116     switch (m_resolution)
00117     {
00118     case 8:
00119     {
00120         *mp_conversionResult = ADC >> 8;
00121         m_conversionComplete = 1;
00122         break;
00123     }
00124     case 9:
00125     {
00126         *mp_conversionResult = ADC >> 7;
00127         m_conversionComplete = 1;
00128         break;
00129     }
00130     case 10:
00131     {
00132         *mp_conversionResult = ADC;
00133         m_conversionComplete = 1;
00134         break;
00135     }
00136     case 11:
00137     {
00138
00139         if (l_resultDataIndex < 4)
00140         {
00141             l_resultData += ADC;
00142             l_resultDataIndex++;
00143         }
00144         else
00145         {
00146             *mp_conversionResult = l_resultData >> 1;
00147             l_resultData = 0;
00148         }
00149     }
00150     }
```

```
00149         l_resultDataIndex = 0;
00150         m_conversionComplete = 1;
00151     }
00152 }
00153
00154     break;
00155 }
00156 case 12:
00157 {
00158     if (l_resultDataIndex < 16)
00159     {
00160         l_resultData += ADC;
00161         l_resultDataIndex++;
00162     }
00163     else
00164     {
00165         *mp_conversionResult = l_resultData > 2;
00166         l_resultData = 0;
00167         l_resultDataIndex = 0;
00168         m_conversionComplete = 1;
00169     }
00170 }
00171     break;
00172 }
00173
00174 case 13:
00175 {
00176     if (l_resultDataIndex < 64)
00177     {
00178         l_resultData += ADC;
00179         l_resultDataIndex++;
00180     }
00181     else
00182     {
00183         *mp_conversionResult = l_resultData > 3;
00184         l_resultData = 0;
00185         l_resultDataIndex = 0;
00186         m_conversionComplete = 1;
00187     }
00188 }
00189     break;
00190 }
00191
00192 case 14:
00193 {
00194     if (l_resultDataIndex < 256)
00195     {
00196         l_resultData += ADC;
00197         l_resultDataIndex++;
00198     }
00199     else
00200     {
00201         *mp_conversionResult = l_resultData > 4;
00202         l_resultData = 0;
00203         l_resultDataIndex = 0;
00204         m_conversionComplete = 1;
00205     }
00206 }
00207     break;
00208 }
00209
00210 case 15:
00211 {
00212     if (l_resultDataIndex < 1024)
00213     {
00214         l_resultData += ADC;
00215         l_resultDataIndex++;
00216     }
00217     else
00218     {
00219         *mp_conversionResult = l_resultData > 5;
00220         l_resultData = 0;
00221         l_resultDataIndex = 0;
00222         m_conversionComplete = 1;
00223     }
00224 }
00225     break;
00226 }
00227
00228 case 16:
00229 {
00230     if (l_resultDataIndex < 4096)
00231     {
00232         l_resultData += ADC;
00233         l_resultDataIndex++;
00234     }
00235 }
```

```

00236         }
00237         else
00238         {
00239             *mp_conversionResult = l_resultData >> 6;
00240             l_resultData = 0;
00241             l_resultDataIndex = 0;
00242             m_conversionComplete = 1;
00243         }
00244         break;
00245     }
00246 }
00247
00248 }
00249
00250
00251
00252
00253 }

```

9.1.3.3 enableAutoTrigger()

```

void core::ADConverter::enableAutoTrigger (
    const uint8_t a_enable )

```

Definition at line 73 of file [ADC.cpp](#).

```

00074 {
00075     if (a_enable) {
00076         ADC_ENABLE_AUTOTRIGGER;
00077     } else {
00078         ADC_DISABLE_AUTOTRIGGER;
00079     }
00080 }
00081
00082 }

```

References [ADC_DISABLE_AUTOTRIGGER](#), and [ADC_ENABLE_AUTOTRIGGER](#).

9.1.3.4 enableConversionCompleteInterrupt()

```

void core::ADConverter::enableConversionCompleteInterrupt (
    const uint8_t a_enable )

```

Definition at line 84 of file [ADC.cpp](#).

```

00085 {
00086     if (a_enable) {
00087         ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT;
00088     } else {
00089         ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT;
00090     }
00091 }
00092
00093 }

```

References [ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT](#), and [ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT](#).

9.1.3.5 getConversionResult()

```
void core::ADConverter::getConversionResult (
    uint16_t * ap_resultData,
    const resolution & ar_resolution = resolution::res_10bit )
```

Definition at line 262 of file [ADC.cpp](#).

```
00263 {
00264     mp_conversionResult = ap_resultData;
00265
00266     switch (ar_resolution)
00267     {
00268         case core::resolution::res_8bit:
00269         {
00270             ADC_ADJUST_RESULT_LEFT;
00271             m_resolution = 8;
00272             break;
00273         }
00274         case core::resolution::res_9bit:
00275         {
00276             ADC_ADJUST_RESULT_LEFT;
00277             m_resolution = 9;
00278             break;
00279         }
00280         case core::resolution::res_10bit:
00281         {
00282             ADC_ADJUST_RESULT_RIGHT;
00283             m_resolution = 10;
00284             break;
00285         }
00286         case core::resolution::res_11bit:
00287         {
00288             m_resolution = 11;
00289             break;
00290         }
00291         case core::resolution::res_12bit:
00292         {
00293             m_resolution = 12;
00294             break;
00295         }
00296         case core::resolution::res_13bit:
00297         {
00298             m_resolution = 13;
00299             break;
00300         }
00301         case core::resolution::res_14bit:
00302         {
00303             m_resolution = 14;
00304             break;
00305         }
00306         case core::resolution::res_15bit:
00307         {
00308             m_resolution = 15;
00309             break;
00310         }
00311         case core::resolution::res_16bit:
00312         {
00313             m_resolution = 16;
00314             break;
00315         }
00316     }
00317 }
00318
00319
00320 }
```

References [ADC_ADJUST_RESULT_LEFT](#), [ADC_ADJUST_RESULT_RIGHT](#), [core::res_10bit](#), [core::res_11bit](#), [core::res_12bit](#), [core::res_13bit](#), [core::res_14bit](#), [core::res_15bit](#), [core::res_16bit](#), [core::res_8bit](#), and [core::res_9bit](#).

9.1.3.6 getInstance()

```
core::ADConverter & core::ADConverter::getInstance (
    const referenceVoltage & ar_refVoltage = referenceVoltage::AVCC,
```

```

const clockPrescaler & ar_clockPrescaler = clockPrescaler::PS_128,
const autoTriggerSource & ar_autoTriggerSource = autoTriggerSource::freeRunning,
const io::Pin & ar_pin = io::Pin(0, io::PortC) ) [static]

```

Definition at line 9 of file [ADC.cpp](#).

```

00013 {
00014
00015     static ADConverter l_instance(ar_refVoltage,
00016                                   ar_clockPrescaler,
00017                                   ar_autoTriggerSource,
00018                                   ar_pin);
00019
00020     return l_instance;
00021 }

```

9.1.3.7 operator=()

```

const ADConverter& core::ADConverter::operator= (
    const ADConverter & ) [private]

```

Override assign operator.

9.1.3.8 selectAnalogInput()

```

void core::ADConverter::selectAnalogInput (
    io::Pin a_pin )

```

Definition at line 53 of file [ADC.cpp](#).

```

00054 {
00055     a_pin.toInput(0);
00056     ADC_SELECT_ANALOG_INPUT(a_pin.getPinNumber());
00057     ADC_DISABLE_DIGITAL_INPUT_REGISTER(a_pin.getPinNumber());
00058
00059 }

```

References [ADC_DISABLE_DIGITAL_INPUT_REGISTER](#), [ADC_SELECT_ANALOG_INPUT](#), [io::Pin::getPinNumber\(\)](#), and [io::Pin::toInput\(\)](#).

9.1.3.9 selectAutoTriggerSource()

```

void core::ADConverter::selectAutoTriggerSource (
    const autoTriggerSource & ar_autoTriggerSource )

```

Definition at line 102 of file [ADC.cpp](#).

```

00103 {
00104     ADC_SELECT_AUTO_TRIGGER_SOURCE(static_cast<uint8_t>(ar_autoTriggerSource));
00105
00106
00107 }

```

References [ADC_SELECT_AUTO_TRIGGER_SOURCE](#).

9.1.3.10 selectClockPrescaler()

```
void core::ADConverter::selectClockPrescaler (
    const clockPrescaler & ar_clockPrescaler )
```

Definition at line 95 of file [ADC.cpp](#).

```
00096 {
00097     ADC_SELECT_CLOCK_PRESCALER(static_cast<uint8_t>(ar_clockPrescaler));
00098
00099 }
```

References [ADC_SELECT_CLOCK_PRESCALER](#).

9.1.3.11 selectReferenceVoltage()

```
void core::ADConverter::selectReferenceVoltage (
    const referenceVoltage & ar_refVoltage )
```

Definition at line 47 of file [ADC.cpp](#).

```
00048 {
00049     ADC_SELECT_REF_VOLTAGE(static_cast<uint8_t>(ar_refVoltage));
00050
00051 }
```

References [ADC_SELECT_REF_VOLTAGE](#).

9.1.3.12 start()

```
void core::ADConverter::start ( )
```

Definition at line 61 of file [ADC.cpp](#).

```
00062 {
00063     ADC_ENABLE;
00064     ADC_START_CONVERSION;
00065 }
```

References [ADC_ENABLE](#), and [ADC_START_CONVERSION](#).

9.1.3.13 stop()

```
void core::ADConverter::stop ( )
```

Definition at line 67 of file [ADC.cpp](#).

```
00068 {
00069     ADC_STOP_CONVERSION;
00070     ADC_DISABLE;
00071 }
```

References [ADC_DISABLE](#), and [ADC_STOP_CONVERSION](#).

9.1.4 Member Data Documentation

9.1.4.1 `__externally_visible__`

```
void core::ADConverter::__externally_visible__
```

Definition at line 160 of file [ADC.h](#).

9.1.4.2 `__used__`

```
void core::ADConverter::__used__
```

Definition at line 160 of file [ADC.h](#).

9.1.4.3 `m_conversionComplete`

```
volatile uint8_t core::ADConverter::m_conversionComplete = 0 [static], [private]
```

ready to receive flag

Definition at line 192 of file [ADC.h](#).

9.1.4.4 `m_resolution`

```
uint8_t core::ADConverter::m_resolution = 10 [static], [private]
```

pointer to receiver buffer

Definition at line 190 of file [ADC.h](#).

9.1.4.5 `mp_conversionResult`

```
volatile uint16_t * core::ADConverter::mp_conversionResult = nullptr [static], [private]
```

pointer to receiver buffer

Definition at line 187 of file [ADC.h](#).

9.2 core::AnalogComparator Class Reference

```
#include <AnalogComparator.h>
```

9.2.1 Detailed Description

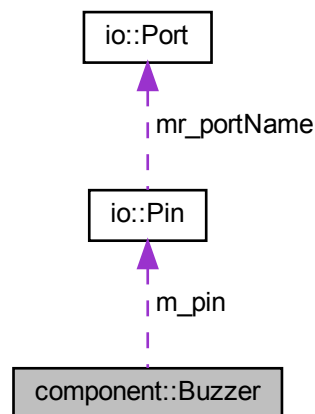
Definition at line 24 of file [AnalogComparator.h](#).

9.3 component::Buzzer Class Reference

Class for handling a [Buzzer](#) component.

```
#include <Buzzer.h>
```

Collaboration diagram for component::Buzzer:



Public Member Functions

- [Buzzer](#) (const [io::Pin](#) &ar_pin)
- [~Buzzer](#) ()
- void [buzz](#) (const uint16_t &ar_period_us, const uint16_t &ar_duration_us)
- void [pause](#) (uint16_t a_duration_us)
- template<typename TC >
void [buzz](#) (TC &ar_timerCounter, const uint16_t &ar_period_us, uint16_t &ar_duration_ms, const [core::channel](#) &ar_channel=[core::channel::A](#), const [core::clockSource](#) &ar_clockSource=[core::clockSource::PS_64](#))

Private Attributes

- [io::Pin](#) m_pin

9.3.1 Detailed Description

Class for handling a [Buzzer](#) component.

The class implements [Buzzer](#) component operations

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Definition at line [74](#) of file [Buzzer.h](#).

9.3.2 Constructor & Destructor Documentation

9.3.2.1 Buzzer()

```
component::Buzzer::Buzzer (
    const io::Pin & ar_pin )
```

Constructor

Initializes the [Buzzer](#) object

Parameters

ar_pin	Defines a Pin object
------------------------	----------------------

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

- See [Buzzer.h](#) for a description of this code

Definition at line [13](#) of file [Buzzer.cpp](#).

```
00014         : m_pin(ar_pin)
00015 {
00016     m_pin.toOutput();
00017
00018 }
```

References [m_pin](#), and [io::Pin::toOutput\(\)](#).

9.3.2.2 ~Buzzer()

```
component::Buzzer::~Buzzer ( )
```

Destructor

Definition at line 20 of file [Buzzer.cpp](#).

```
00021 {
00022
00023 }
```

9.3.3 Member Function Documentation

9.3.3.1 buzz() [1/2]

```
void component::Buzzer::buzz (
    const uint16_t & ar_period_us,
    const uint16_t & ar_duration_us )
```

Generate a [Buzzer](#) signal

Parameters

<i>ar_period_us</i>	Defines period of Buzzer signal
<i>ar_duration_us</i>	Defines duration of Buzzer signal

Definition at line 25 of file [Buzzer.cpp](#).

```
00026 {
00027
00028     for (uint16_t i = 0; i < ar_duration_us; i += ar_period_us)
00029     {
00030         // for loop with variable delay selects the pitch
00031         for (uint16_t j = 0; j < ar_period_us; j++)
00032         {
00033             _delay_us(1);
00034         }
00035         m_pin.toggle();
00036     }
00037     m_pin.setLow();
00038
00039 }
```

9.3.3.2 buzz() [2/2]

```
template<typename TC >
void component::Buzzer::buzz (
    TC & ar_timerCounter,
    const uint16_t & ar_period_us,
    uint16_t & ar_duration_ms,
    const core::channel & ar_channel = core::channel::A,
    const core::clockSource & ar_clockSource = core::clockSource::PS\_64 ) [inline]
```

Generate a [Buzzer](#) signal

Template Parameters

<i>TC</i>	Type Defines a TimerCounter object
-----------	------------------------------------

Parameters

<i>ar_period_us</i>	Defines period of Buzzer signal
<i>ar_duration_ms</i>	Defines duration of Buzzer signal
<i>ar_channel</i>	Defines TimerCounter channel
<i>ar_clockSource</i>	Defines TimerCounter clock source

Definition at line 114 of file [Buzzer.h](#).

```

00120     {
00121         ar_timerCounter.selectOperationMode(core::operationMode::CTC_OCR);
00122         ar_timerCounter.selectCompareOutputMode(ar_channel, core::compareOutputMode::toggle);
00123         ar_timerCounter.setCounter(0);
00124         ar_timerCounter.setOutputCompareRegister(ar_channel, ar_period_us);
00125         // start timer
00126         ar_timerCounter.start();
00127         // wait for the pitch duration
00128         while (ar_duration_ms) {
00129             _delay_ms(1);
00130             ar_duration_ms--;
00131         }
00132         // no buzz
00133         ar_timerCounter.selectCompareOutputMode(ar_channel, core::compareOutputMode::normal);
00134         ar_timerCounter.stop();
00135     }

```

References [core::CTC_OCR](#), [core::normal](#), and [core::toggle](#).

9.3.3.3 pause()

```

void component::Buzzer::pause (
    uint16_t a_duration_us )

```

Generate a time break

Parameters

<i>a_duration_us</i>	Defines duration of time break
----------------------	--------------------------------

Definition at line 42 of file [Buzzer.cpp](#).

```

00043 {
00044     do {
00045         _delay_us(1);
00046     } while (--a_duration_us);
00047 }

```

9.3.4 Member Data Documentation

9.3.4.1 m_pin

```
io::Pin component::Buzzer::m_pin [private]
```

Pin object

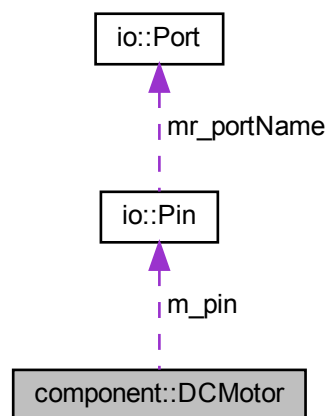
Definition at line 142 of file [Buzzer.h](#).

Referenced by [Buzzer\(\)](#).

9.4 component::DCMotor Class Reference

```
#include <DCMotor.h>
```

Collaboration diagram for component::DCMotor:



Public Member Functions

- `DCMotor` (const `io::Pin` &ar_pin)
- `~DCMotor` ()
- void `on` ()
- void `off` ()
- void `toggle` ()
- template<typename TC >
void `spin` (TC &ar_timerCounter, const uint16_t &ar_speed, const `core::channel` &ar_channel=`core::channel::A`)
- template<typename TC >
void `stop` (TC &ar_timerCounter)
- template<typename TC >
void `connect` (TC &ar_timerCounter, const `core::channel` &ar_channel=`core::channel::A`)
- template<typename TC >
void `disconnect` (TC &ar_timerCounter, const `core::channel` &ar_channel=`core::channel::A`)

Private Attributes

- [io::Pin m_pin](#)

9.4.1 Detailed Description

Definition at line 126 of file [DCMotor.h](#).

9.4.2 Constructor & Destructor Documentation

9.4.2.1 DCMotor()

```
component::DCMotor::DCMotor (
    const io::Pin & ar_pin )
```

Definition at line 3 of file [DCMotor.cpp](#).

```
00004         : m_pin(ar_pin)
00005 {
00006     m_pin.toOutput();
00007
00008 }
```

References [m_pin](#), and [io::Pin::toOutput\(\)](#).

9.4.2.2 ~DCMotor()

```
component::DCMotor::~DCMotor ( )
```

Definition at line 11 of file [DCMotor.cpp](#).

```
00012 {
00013
00014 }
```

9.4.3 Member Function Documentation

9.4.3.1 connect()

```
template<typename TC >
void component::DCMotor::connect (
    TC & ar_timerCounter,
    const core::channel & ar_channel = core::channel::A ) [inline]
```

Definition at line 164 of file [DCMotor.h](#).

```
00166     {
00167         ar_timerCounter.selectOperationMode(core::operationMode::fast_PWM);
00168         ar_timerCounter.selectCompareOutputMode(ar_channel, core::compareOutputMode::clear);
00169         ar_timerCounter.setCounter(0);
00170
00171     }
```

References [core::clear](#), and [core::fast_PWM](#).

9.4.3.2 disconnect()

```
template<typename TC >
void component::DCMotor::disconnect (
    TC & ar_timerCounter,
    const core::channel & ar_channel = core::channel::A ) [inline]
```

Definition at line 174 of file [DCMotor.h](#).

```
00176     {
00177         ar_timerCounter.selectCompareOutputMode(ar_channel, core::compareOutputMode::normal);
00178         ar_timerCounter.stop();
00179     }
```

References [core::normal](#).

9.4.3.3 off()

```
void component::DCMotor::off ( )
```

Turn servo motor Off.

Definition at line 21 of file [DCMotor.cpp](#).

```
00022 {
00023     m_pin.setLow();
00024 }
```

9.4.3.4 on()

```
void component::DCMotor::on ( )
```

Turn servo motor On.

Definition at line 16 of file [DCMotor.cpp](#).

```
00017 {
00018     m_pin.setHigh();
00019 }
```

9.4.3.5 spin()

```
template<typename TC >
void component::DCMotor::spin (
    TC & ar_timerCounter,
    const uint16_t & ar_speed,
    const core::channel & ar_channel = core::channel::A ) [inline]
```

Definition at line 144 of file [DCMotor.h](#).

```
00148     {
00149
00150         ar_timerCounter.setOutputCompareRegister(ar_channel, ar_speed);
00151         ar_timerCounter.start();
00152
00153
00154     }
```

9.4.3.6 stop()

```
template<typename TC >
void component::DCMotor::stop (
    TC & ar_timerCounter ) [inline]
```

Definition at line 156 of file [DCMotor.h](#).

```
00157     {
00158         ar_timerCounter.stop();
00159     }
00160
00161 }
```

9.4.3.7 toggle()

```
void component::DCMotor::toggle ( )
```

Toggle servo motor state.

Definition at line 26 of file [DCMotor.cpp](#).

```
00027 {
00028     m_pin.toggle();
00029 }
00030 }
```

9.4.4 Member Data Documentation

9.4.4.1 m_pin

```
io::Pin component::DCMotor::m_pin [private]
```

pin object

Definition at line 185 of file [DCMotor.h](#).

Referenced by [DCMotor\(\)](#).

9.5 core::ExternInterrupt Class Reference

```
#include <ExternInterrupt.h>
```

Public Member Functions

- void [setInt0SenseControl](#) (const [senseControl](#) &ar_senseControl)
- void [setInt1SenseControl](#) (const [senseControl](#) &ar_senseControl)
- void [enableInt0](#) (const uint8_t a_enable)
- void [enableInt1](#) (const uint8_t a_enable)
- void [enablePinChange](#) (const [pinChangePort](#) &ar_pinChangePort, const uint8_t a_enable)
- void [enablePinChangeMaskPortB](#) (const uint8_t a_pinNumber, const uint8_t a_enable)
- void [enablePinChangeMaskPortC](#) (const uint8_t a_pinNumber, const uint8_t a_enable)
- void [enablePinChangeMaskPortD](#) (const uint8_t a_pinNumber, const uint8_t a_enable)

Static Public Member Functions

- static [ExternInterrupt](#) & [getInstance](#) ()
- static void [Int0ServiceRoutine](#) () __asm__(STR(EXT_INT_INT0_INTERRUPT)) __attribute__((__signal__
- static void [Int1ServiceRoutine](#) () __asm__(STR(EXT_INT_INT1_INTERRUPT)) __attribute__((__signal__
- static void [pinChangePortBServiceRoutine](#) () __asm__(STR(EXT_INT_PIN_CHANGE_PORTB_INTERRUPT)) __attribute__((__signal__
- static void [pinChangePortCServiceRoutine](#) () __asm__(STR(EXT_INT_PIN_CHANGE_PORTC_INTERRUPT)) __attribute__((__signal__
- static void [pinChangePortDServiceRoutine](#) () __asm__(STR(EXT_INT_PIN_CHANGE_PORTD_INTERRUPT)) __attribute__((__signal__

Public Attributes

- static void [__used__](#)
- static void [__externally_visible__](#)

Private Member Functions

- [ExternInterrupt](#) ()
- [~ExternInterrupt](#) ()
- [ExternInterrupt](#) (const [ExternInterrupt](#) &)
- const [ExternInterrupt](#) & [operator=](#) (const [ExternInterrupt](#) &)

9.5.1 Detailed Description

Definition at line 162 of file [ExternInterrupt.h](#).

9.5.2 Constructor & Destructor Documentation

9.5.2.1 ExternInterrupt() [1/2]

```
core::ExternInterrupt::ExternInterrupt ( ) [private]
```

Definition at line 11 of file [ExternInterrupt.cpp](#).

```
00012 {
00013     sei();
00014
00015 }
```


9.5.2.2 ~ExternInterrupt()

```
core::ExternInterrupt::~~ExternInterrupt ( ) [private]
```

Destructor.

Definition at line 17 of file [ExternInterrupt.cpp](#).

```
00018 {  
00019  
00020 }
```

9.5.2.3 ExternInterrupt() [2/2]

```
core::ExternInterrupt::ExternInterrupt (  
    const ExternInterrupt & ) [private]
```

Overried Copy constructor.

9.5.3 Member Function Documentation

9.5.3.1 enableInt0()

```
void core::ExternInterrupt::enableInt0 (  
    const uint8_t a_enable )
```

Definition at line 34 of file [ExternInterrupt.cpp](#).

```
00035 {  
00036     if (a_enable) {  
00037         EXT\_INT\_ENABLE\_INT0;  
00038     } else {  
00039         EXT\_INT\_DISABLE\_INT0;  
00040     }  
00041 }  
00042  
00043 }
```

References [EXT_INT_DISABLE_INT0](#), and [EXT_INT_ENABLE_INT0](#).

9.5.3.2 enableInt1()

```
void core::ExternInterrupt::enableInt1 (  
    const uint8_t a_enable )
```

Definition at line 45 of file [ExternInterrupt.cpp](#).

```
00046 {  
00047     if (a_enable) {  
00048         EXT\_INT\_ENABLE\_INT1;  
00049     } else {  
00050         EXT\_INT\_DISABLE\_INT1;  
00051     }  
00052 }  
00053 }
```

References [EXT_INT_DISABLE_INT1](#), and [EXT_INT_ENABLE_INT1](#).

9.5.3.3 enablePinChange()

```
void core::ExternInterrupt::enablePinChange (
    const pinChangePort & ar_pinChangePort,
    const uint8_t a_enable )
```

Definition at line 56 of file [ExternInterrupt.cpp](#).

```
00057 {
00058     if (a_enable) {
00059         EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT(static_cast<uint8_t>(ar_pinChangePort));
00060     } else {
00061         EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT(static_cast<uint8_t>(ar_pinChangePort));
00062     }
00063 }
00064
00065 }
```

References [EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT](#), and [EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT](#).

9.5.3.4 enablePinChangeMaskPortB()

```
void core::ExternInterrupt::enablePinChangeMaskPortB (
    const uint8_t a_pinNumber,
    const uint8_t a_enable )
```

Definition at line 67 of file [ExternInterrupt.cpp](#).

```
00068 {
00069     if (a_enable) {
00070         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(a_pinNumber);
00071     } else {
00072         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(a_pinNumber);
00073     }
00074 }
00075
00076 }
```

References [EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB](#).

9.5.3.5 enablePinChangeMaskPortC()

```
void core::ExternInterrupt::enablePinChangeMaskPortC (
    const uint8_t a_pinNumber,
    const uint8_t a_enable )
```

Definition at line 79 of file [ExternInterrupt.cpp](#).

```
00080 {
00081     if (a_enable) {
00082         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(a_pinNumber);
00083     } else {
00084         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(a_pinNumber);
00085     }
00086 }
00087
00088 }
```

References [EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC](#).

9.5.3.6 enablePinChangeMaskPortD()

```
void core::ExternInterrupt::enablePinChangeMaskPortD (
    const uint8_t a_pinNumber,
    const uint8_t a_enable )
```

Definition at line 90 of file [ExternInterrupt.cpp](#).

```
00091 {
00092     if (a_enable) {
00093         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(a_pinNumber);
00094     } else {
00095         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(a_pinNumber);
00096     }
00097 }
00098 }
```

References [EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD](#).

9.5.3.7 getInstance()

```
core::ExternInterrupt & core::ExternInterrupt::getInstance ( ) [static]
```

Definition at line 3 of file [ExternInterrupt.cpp](#).

```
00004 {
00005     static ExternInterrupt l_instance;
00006     return l_instance;
00007 }
00008 }
```

9.5.3.8 Int0ServiceRoutine()

```
static void core::ExternInterrupt::Int0ServiceRoutine ( ) [static]
```

9.5.3.9 Int1ServiceRoutine()

```
static void core::ExternInterrupt::Int1ServiceRoutine ( ) [static]
```

9.5.3.10 operator=()

```
const ExternInterrupt& core::ExternInterrupt::operator= (
    const ExternInterrupt & ) [private]
```

Override assign operator.

9.5.3.11 pinChangePortBServiceRoutine()

```
static void core::ExternInterrupt::pinChangePortBServiceRoutine ( ) [static]
```

9.5.3.12 pinChangePortCServiceRoutine()

```
static void core::ExternInterrupt::pinChangePortCServiceRoutine ( ) [static]
```

9.5.3.13 pinChangePortDServiceRoutine()

```
static void core::ExternInterrupt::pinChangePortDServiceRoutine ( ) [static]
```

9.5.3.14 setInt0SenseControl()

```
void core::ExternInterrupt::setInt0SenseControl (
    const senseControl & ar_senseControl )
```

Definition at line 22 of file [ExternInterrupt.cpp](#).

```
00023 {
00024     EXT\_INT\_SET\_INT0\_SENSE\_CONTROL(static_cast<uint8_t>(ar_senseControl));
00025
00026 }
```

References [EXT_INT_SET_INT0_SENSE_CONTROL](#).

9.5.3.15 setInt1SenseControl()

```
void core::ExternInterrupt::setInt1SenseControl (
    const senseControl & ar_senseControl )
```

Definition at line 28 of file [ExternInterrupt.cpp](#).

```
00029 {
00030     EXT\_INT\_SET\_INT1\_SENSE\_CONTROL(static_cast<uint8_t>(ar_senseControl));
00031
00032 }
```

References [EXT_INT_SET_INT1_SENSE_CONTROL](#).

9.5.4 Member Data Documentation

9.5.4.1 `__externally_visible__`

```
static void core::ExternInterrupt::__externally_visible__
```

Definition at line 185 of file [ExternInterrupt.h](#).

9.5.4.2 `__used__`

```
static void core::ExternInterrupt::__used__
```

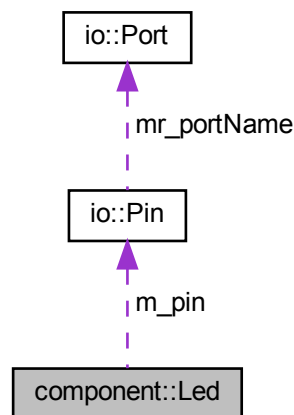
Definition at line 185 of file [ExternInterrupt.h](#).

9.6 component::Led Class Reference

Class for handling a [Led](#) component.

```
#include <Led.h>
```

Collaboration diagram for component::Led:



Public Member Functions

- [Led](#) (const [io::Pin](#) &ar_pin)
- [~Led](#) ()
- void [on](#) ()
- void [off](#) ()
- void [toggle](#) ()
- uint8_t [isOn](#) ()
- uint8_t [isOff](#) ()

Private Attributes

- [io::Pin m_pin](#)

9.6.1 Detailed Description

Class for handling a [Led](#) component.

The class implements [Led](#) component operations

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Definition at line [26](#) of file [Led.h](#).

9.6.2 Constructor & Destructor Documentation

9.6.2.1 Led()

```
component::Led::Led (
    const io::Pin & ar_pin )
```

Constructor

Initializes the [Led](#) object

Parameters

<i>ar_pin</i>	Defines a Pin object
---------------	----------------------

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

- See [Led.h](#) for a description of this code

Definition at line 12 of file [Led.cpp](#).

```
00013         : m_pin(ar_pin)
00014 {
00015     m_pin.toOutput();
00016 }
```

References [m_pin](#), and [io::Pin::toOutput\(\)](#).

9.6.2.2 ~Led()

```
component::Led::~~Led ( )
```

Destructor

Definition at line 18 of file [Led.cpp](#).

```
00019 {
00020
00021 }
```

9.6.3 Member Function Documentation

9.6.3.1 isOff()

```
uint8_t component::Led::isOff ( )
```

Is [Led](#) Off

Returns

[Led](#) status

Definition at line 50 of file [Led.cpp](#).

```
00051 {
00052     return m_pin.isLow();
00053
00054 }
```

9.6.3.2 isOn()

```
uint8_t component::Led::isOn ( )
```

Is [Led](#) On

Returns

[Led](#) status

Definition at line 43 of file [Led.cpp](#).

```
00044 {
00045     return m_pin.isHigh();
00046
00047 }
```

9.6.3.3 off()

```
void component::Led::off ( )
```

Turn [Led](#) Off

Definition at line 30 of file [Led.cpp](#).

```
00031 {  
00032     m_pin.setLow();  
00033  
00034 }
```

9.6.3.4 on()

```
void component::Led::on ( )
```

Turn [Led](#) On

Definition at line 24 of file [Led.cpp](#).

```
00025 {  
00026     m_pin.setHigh();  
00027  
00028 }
```

9.6.3.5 toggle()

```
void component::Led::toggle ( )
```

Toggle [Led](#) state

Definition at line 37 of file [Led.cpp](#).

```
00038 {  
00039     m_pin.toggle();  
00040  
00041 }
```

9.6.4 Member Data Documentation

9.6.4.1 m_pin

```
io::Pin component::Led::m_pin [private]
```

Pin object

Definition at line 68 of file [Led.h](#).

Referenced by [Led\(\)](#).

9.7 core::MCU Class Reference

```
#include <MCU.h>
```

Static Public Member Functions

- static void [init](#) ()
- static void [selectSleepMode](#) (const [sleepMode](#) &a_sleepMode)
- static void [goToSleep](#) (const [BODMode](#) &a_BODMode)
- static void [sleepEnable](#) (const uint8_t a_enable)
- static void [enableUSART0](#) (const uint8_t a_enable)
- static void [enableTimerCounter0](#) (const uint8_t a_enable)
- static void [enableTimerCounter1](#) (const uint8_t a_enable)
- static void [enableTimerCounter2](#) (const uint8_t a_enable)
- static void [enableTWI](#) (const uint8_t a_enable)
- static void [enableSPI](#) (const uint8_t a_enable)
- static void [enableADC](#) (const uint8_t a_enable)
- static void [disableBOD](#) ()

9.7.1 Detailed Description

Definition at line 91 of file [MCU.h](#).

9.7.2 Member Function Documentation

9.7.2.1 [disableBOD\(\)](#)

```
void core::MCU::disableBOD ( ) [static]
```

Definition at line 126 of file [MCU.cpp](#).

```
00127 {
00128     MCU\_BOD\_DISABLE;
00129 }
```

References [MCU_BOD_DISABLE](#).

9.7.2.2 [enableADC\(\)](#)

```
void core::MCU::enableADC (
    const uint8_t a_enable ) [static]
```

Definition at line 117 of file [MCU.cpp](#).

```
00118 {
00119     if (a_enable) {
00120         MCU\_ADC\_ENABLE;
00121     } else {
00122         MCU\_ADC\_DISABLE;
00123     }
00124 }
```

References [MCU_ADC_DISABLE](#), and [MCU_ADC_ENABLE](#).

Referenced by [core::ADConverter::ADConverter\(\)](#), and [init\(\)](#).

9.7.2.3 enableSPI()

```
void core::MCU::enableSPI (
    const uint8_t a_enable ) [static]
```

Definition at line 107 of file [MCU.cpp](#).

```
00108 {
00109     if (a_enable) {
00110         MCU_SPI_ENABLE;
00111     } else {
00112         MCU_SPI_DISABLE;
00113     }
00114 }
00115 }
```

References [MCU_SPI_DISABLE](#), and [MCU_SPI_ENABLE](#).

Referenced by [init\(\)](#), and [io::SPI::SPI\(\)](#).

9.7.2.4 enableTimerCounter0()

```
void core::MCU::enableTimerCounter0 (
    const uint8_t a_enable ) [static]
```

Definition at line 67 of file [MCU.cpp](#).

```
00068 {
00069     if (a_enable) {
00070         MCU_TIMER0_ENABLE;
00071     } else {
00072         MCU_TIMER0_DISABLE;
00073     }
00074 }
00075 }
```

References [MCU_TIMER0_DISABLE](#), and [MCU_TIMER0_ENABLE](#).

Referenced by [init\(\)](#), and [core::TimerCounter0::TimerCounter0\(\)](#).

9.7.2.5 enableTimerCounter1()

```
void core::MCU::enableTimerCounter1 (
    const uint8_t a_enable ) [static]
```

Definition at line 77 of file [MCU.cpp](#).

```
00078 {
00079     if (a_enable) {
00080         MCU_TIMER1_ENABLE;
00081     } else {
00082         MCU_TIMER1_DISABLE;
00083     }
00084 }
00085 }
```

References [MCU_TIMER1_DISABLE](#), and [MCU_TIMER1_ENABLE](#).

Referenced by [init\(\)](#), and [core::TimerCounter1::TimerCounter1\(\)](#).

9.7.2.6 enableTimerCounter2()

```
void core::MCU::enableTimerCounter2 (
    const uint8_t a_enable ) [static]
```

Definition at line 87 of file [MCU.cpp](#).

```
00088 {
00089     if (a_enable) {
00090         MCU_TIMER2_ENABLE;
00091     } else {
00092         MCU_TIMER2_DISABLE;
00093     }
00094
00095 }
```

References [MCU_TIMER2_DISABLE](#), and [MCU_TIMER2_ENABLE](#).

Referenced by [init\(\)](#), and [core::TimerCounter2::TimerCounter2\(\)](#).

9.7.2.7 enableTWI()

```
void core::MCU::enableTWI (
    const uint8_t a_enable ) [static]
```

Definition at line 97 of file [MCU.cpp](#).

```
00098 {
00099     if (a_enable) {
00100         MCU_TWI_ENABLE;
00101     } else {
00102         MCU_TWI_DISABLE;
00103     }
00104
00105 }
```

References [MCU_TWI_DISABLE](#), and [MCU_TWI_ENABLE](#).

Referenced by [init\(\)](#).

9.7.2.8 enableUSART0()

```
void core::MCU::enableUSART0 (
    const uint8_t a_enable ) [static]
```

Definition at line 57 of file [MCU.cpp](#).

```
00058 {
00059     if (a_enable) {
00060         MCU_USART0_ENABLE;
00061     } else {
00062         MCU_USART0_DISABLE;
00063     }
00064
00065 }
```

References [MCU_USART0_DISABLE](#), and [MCU_USART0_ENABLE](#).

Referenced by [init\(\)](#), and [io::USART0::USART0\(\)](#).

9.7.2.9 goToSleep()

```
void core::MCU::goToSleep (
    const BODMode & a_BODMode ) [static]
```

Definition at line 21 of file [MCU.cpp](#).

```
00022 {
00023     cli();
00024     switch (a_BODMode)
00025     {
00026         case core::BODMode::enabled:
00027         {
00028             sleepEnable(1);
00029             sei();
00030             sleep_cpu();
00031             sleepEnable(0);
00032             break;
00033         }
00034         case core::BODMode::disabled:
00035         {
00036             sleepEnable(1);
00037             disableBOD();
00038             sei();
00039             sleep_cpu();
00040             sleepEnable(0);
00041             break;
00042         }
00043     }
00044 }
00045 }
```

References [core::disabled](#), and [core::enabled](#).

9.7.2.10 init()

```
void core::MCU::init ( ) [static]
```

Definition at line 3 of file [MCU.cpp](#).

```
00004 {
00005     enableUSART0(0);
00006     enableTimerCounter0(0);
00007     enableTimerCounter1(0);
00008     enableTimerCounter2(0);
00009     enableTWI(0);
00010     enableSPI(0);
00011     enableADC(0);
00012 }
00013 }
```

References [enableADC\(\)](#), [enableSPI\(\)](#), [enableTimerCounter0\(\)](#), [enableTimerCounter1\(\)](#), [enableTimerCounter2\(\)](#), [enableTWI\(\)](#), and [enableUSART0\(\)](#).

9.7.2.11 selectSleepMode()

```
void core::MCU::selectSleepMode (
    const sleepMode & a_sleepMode ) [static]
```

Definition at line 15 of file [MCU.cpp](#).

```
00016 {
00017     MCU_SELECT_SLEEP_MODE(static_cast<uint8_t>(a_sleepMode));
00018 }
00019 }
```

References [MCU_SELECT_SLEEP_MODE](#).

9.7.2.12 sleepEnable()

```
void core::MCU::sleepEnable (
    const uint8_t ar_enable ) [static]
```

Definition at line 47 of file [MCU.cpp](#).

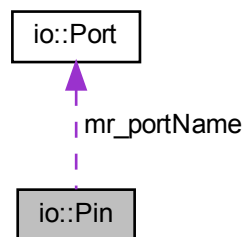
```
00048 {
00049     if (a_enable) {
00050         MCU_SLEEP_ENABLE;
00051     } else {
00052         MCU_SLEEP_DISABLE;
00053     }
00054 }
00055 }
```

References [MCU_SLEEP_DISABLE](#), and [MCU_SLEEP_ENABLE](#).

9.8 io::Pin Class Reference

```
#include <Pin.h>
```

Collaboration diagram for io::Pin:



Public Member Functions

- [Pin](#) (const uint8_t a_pinNumber, const [Port](#) &ar_portName)
- [~Pin](#) ()
- void [toOutput](#) ()
- void [toInput](#) (const uint8_t &ar_useInternalPullUp)
- void [setLow](#) ()
- void [setHigh](#) ()
- void [toggle](#) ()
- uint8_t [isHigh](#) ()
- uint8_t [isLow](#) ()
- uint8_t [getPinNumber](#) ()

Private Attributes

- const [Port](#) & [mr_portName](#)
- const uint8_t [m_pinNumber](#)

9.8.1 Detailed Description

Definition at line 28 of file [Pin.h](#).

9.8.2 Constructor & Destructor Documentation

9.8.2.1 Pin()

```
io::Pin::Pin (
    const uint8_t a_pinNumber,
    const Port & mr_portName )
```

Constructor

Initializes the pin object

Parameters

<i>ar_portName</i>	Defines the Port name in the AVR chip
<i>a_pinNumber</i>	Defines the Pin number in the AVR chip

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

- See [Pin.h](#) for a description of this code

Definition at line 12 of file [Pin.cpp](#).

```
00013         : mr_portName(mr_portName), m_pinNumber(a_pinNumber)
00014 {
00015
00016 }
```

9.8.2.2 ~Pin()

```
io::Pin::~~Pin ( )
```

Destructor

Definition at line 19 of file [Pin.cpp](#).

```
00021 {
00022
00023 }
```

9.8.3 Member Function Documentation

9.8.3.1 getPinNumber()

```
uint8_t io::Pin::getPinNumber ( )
```

Get [Pin](#) number

Returns

[Pin](#) number

Definition at line 81 of file [Pin.cpp](#).

```
00082 {  
00083     return m_pinNumber;  
00084 }
```

Referenced by [core::ADConverter::selectAnalogInput\(\)](#).

9.8.3.2 isHigh()

```
uint8_t io::Pin::isHigh ( )
```

Check if [Pin](#) is logic high

Returns

[Pin](#) status

Definition at line 71 of file [Pin.cpp](#).

```
00072 {  
00073     return *mr_portName.mp_pinReg & (1 << m_pinNumber);  
00074 }
```

9.8.3.3 isLow()

```
uint8_t io::Pin::isLow ( )
```

Check if [Pin](#) is logic low

Returns

[Pin](#) status

Definition at line 76 of file [Pin.cpp](#).

```
00077 {  
00078     return !(*mr_portName.mp_pinReg & (1 << m_pinNumber));  
00079 }
```

9.8.3.4 setHigh()

```
void io::Pin::setHigh ( )
```

Set [Pin](#) to logic high

Definition at line 55 of file [Pin.cpp](#).

```
00056 {
00057     if (*mr_portName.mp_ddrReg & (1 << m_pinNumber))
00058     {
00059         *mr_portName.mp_portReg |= (1 << m_pinNumber);
00060     }
00061 }
```

9.8.3.5 setLow()

```
void io::Pin::setLow ( )
```

Set [Pin](#) to logic low

Definition at line 47 of file [Pin.cpp](#).

```
00048 {
00049     if (*mr_portName.mp_ddrReg & (1 << m_pinNumber))
00050     {
00051         *mr_portName.mp_portReg &= ~(1 << m_pinNumber);
00052     }
00053 }
```

9.8.3.6 toggle()

```
void io::Pin::toggle ( )
```

Toggle [Pin](#) state

Definition at line 63 of file [Pin.cpp](#).

```
00064 {
00065     if (*mr_portName.mp_ddrReg & (1 << m_pinNumber))
00066     {
00067         *mr_portName.mp_portReg ^= 1 << m_pinNumber;
00068     }
00069 }
```

9.8.3.7 toInput()

```
void io::Pin::toInput (
    const uint8_t & ar_useInternalPullUp )
```

Configures [Pin](#) to input

Parameters

<i>ar_useInternalPullUp</i>	Indicates if internal pull up resistor is used
-----------------------------	--

Definition at line 30 of file [Pin.cpp](#).

```
00031 {
00032     if (ar_useInternalPullUp)
00033     {
00034         *mr_portName.mp_portReg |= (1 << m_pinNumber);
00035         *mr_portName.mp_ddrReg  &= ~(1 << m_pinNumber);
00036     }
00037 }
00038 else
00039 {
00040     *mr_portName.mp_portReg &= ~(1 << m_pinNumber);
00041     *mr_portName.mp_ddrReg  &= ~(1 << m_pinNumber);
00042 }
00043 }
00044 }
00045 }
```

Referenced by [component::PushButton::PushButton\(\)](#), and [core::ADConverter::selectAnalogInput\(\)](#).

9.8.3.8 toOutput()

```
void io::Pin::toOutput ( )
```

Configures [Pin](#) to output

Definition at line 25 of file [Pin.cpp](#).

```
00026 {
00027     *mr_portName.mp_ddrReg |= (1 << m_pinNumber);
00028 }
```

Referenced by [component::Buzzer::Buzzer\(\)](#), [component::DCMotor::DCMotor\(\)](#), [component::Led::Led\(\)](#), [component::ServoMotor::ServoMotor\(\)](#), and [component::StepperMotor::StepperMotor\(\)](#).

9.8.4 Member Data Documentation

9.8.4.1 m_pinNumber

```
const uint8_t io::Pin::m_pinNumber [private]
```

[Pin](#) number

Definition at line 86 of file [Pin.h](#).

9.8.4.2 mr_portName

```
const Port& io::Pin::mr_portName [private]
```

[Port](#) object

Definition at line 85 of file [Pin.h](#).

9.9 io::Port Struct Reference

Contains definitions of pointers to the AVR port's registers.

```
#include <Pin.h>
```

Public Attributes

- volatile uint8_t * [mp_ddrReg](#)
- volatile uint8_t * [mp_portReg](#)
- volatile uint8_t * [mp_pinReg](#)

9.9.1 Detailed Description

Contains definitions of pointers to the AVR port's registers.

Definition at line 19 of file [Pin.h](#).

9.9.2 Member Data Documentation

9.9.2.1 mp_ddrReg

```
volatile uint8_t* io::Port::mp_ddrReg
```

Pointer to the data direction register

Definition at line 21 of file [Pin.h](#).

9.9.2.2 mp_pinReg

```
volatile uint8_t* io::Port::mp_pinReg
```

Pointer to the pin register

Definition at line 25 of file [Pin.h](#).

9.9.2.3 mp_portReg

```
volatile uint8_t* io::Port::mp_portReg
```

Pointer to the port register

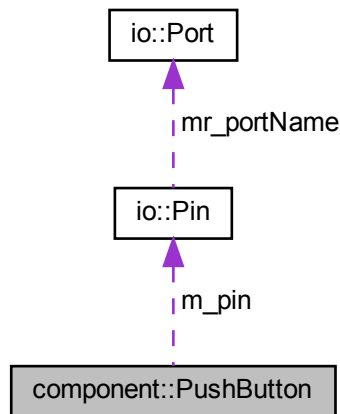
Definition at line 23 of file [Pin.h](#).

9.10 component::PushButton Class Reference

Class for handling a [PushButton](#) component.

```
#include <PushButton.h>
```

Collaboration diagram for component::PushButton:



Public Member Functions

- [PushButton](#) (const [io::Pin](#) &ar_pin, const uint8_t &ar_useInternalPullUp=1, const uint8_t &ar_isActiveLow=1)
- [~PushButton](#) ()
- uint8_t [isPressed](#) ()
- uint8_t [getPressedCount](#) () const
- void [resetPressedCount](#) ()

Private Attributes

- [io::Pin](#) m_pin
- const uint8_t & [mr_isActiveLow](#)
- const uint8_t & [mr_useInternalPullUp](#)
- uint8_t [m_buttonPressed](#)

9.10.1 Detailed Description

Class for handling a [PushButton](#) component.

The class implements [PushButton](#) component operations

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Definition at line 26 of file [PushButton.h](#).

9.10.2 Constructor & Destructor Documentation

9.10.2.1 PushButton()

```
component::PushButton::PushButton (
    const io::Pin & ar_pin,
    const uint8_t & ar_useInternalPullUp = 1,
    const uint8_t & ar_isActiveLow = 1 )
```

Constructor.

Initializes The [PushButton](#) object

Parameters

<i>ar_pin</i>	Defines a Pin object
<i>ar_useInternalPullUp</i>	Defines if internal pull up resistor is used
<i>ar_isActiveLow</i>	Defines if input is active low or active high

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

- See [PushButton.h](#) for a description of this code

Definition at line 12 of file [PushButton.cpp](#).

```
00013         : m_pin(ar_pin),
00014           mr_isActiveLow(ar_isActiveLow),
00015           mr_useInternalPullUp(ar_useInternalPullUp)
00016
00017
00018 {
00019     m_pin.toInput(mr_useInternalPullUp);
00020     m_buttonPressed = 0;
00021 }
```

References [m_buttonPressed](#), [m_pin](#), [mr_useInternalPullUp](#), and [io::Pin::toInput\(\)](#).

9.10.2.2 ~PushButton()

```
component::PushButton::~~PushButton ( )
```

Destructor

Definition at line 23 of file [PushButton.cpp](#).

```
00024 {
00025
00026 }
```

9.10.3 Member Function Documentation

9.10.3.1 getPressedCount()

```
uint8_t component::PushButton::getPressedCount ( ) const
```

Get pushbutton pressed count

Returns

[PushButton](#) press count

Definition at line 55 of file [PushButton.cpp](#).

```
00056 {  
00057  
00058     return m_buttonPressed;  
00059  
00060 }
```

9.10.3.2 isPressed()

```
uint8_t component::PushButton::isPressed ( )
```

Is pushbutton pressed

Returns

[PushButton](#) status

Definition at line 29 of file [PushButton.cpp](#).

```
00030 {  
00031     if (mr_isActiveLow || mr_useInternalPullUp) {  
00032         if (m_pin.isLow()) {  
00033             _delay_us(PUSHBUTTON_DEBOUNCE_TIME_US);  
00034             if (m_pin.isLow()) {  
00035                 ++m_buttonPressed;  
00036                 return 1;  
00037             }  
00038         }  
00039     } else {  
00040  
00041         if (m_pin.isHigh()) {  
00042             _delay_us(PUSHBUTTON_DEBOUNCE_TIME_US);  
00043             if (m_pin.isHigh()) {  
00044                 ++m_buttonPressed;  
00045                 return 1;  
00046             }  
00047         }  
00048     }  
00049 }  
00050  
00051 return 0;  
00052  
00053 }
```

References [PUSHBUTTON_DEBOUNCE_TIME_US](#).

9.10.3.3 resetPressedCount()

```
void component::PushButton::resetPressedCount ( )
```

Reset pushbutton pressed count

Definition at line 62 of file [PushButton.cpp](#).

```
00063 {  
00064     m_buttonPressed = 0;  
00065  
00066 }
```

9.10.4 Member Data Documentation

9.10.4.1 m_buttonPressed

```
uint8_t component::PushButton::m_buttonPressed [private]
```

[PushButton](#) pressed count

Definition at line 67 of file [PushButton.h](#).

Referenced by [PushButton\(\)](#).

9.10.4.2 m_pin

```
io::Pin component::PushButton::m_pin [private]
```

Pin object

Definition at line 64 of file [PushButton.h](#).

Referenced by [PushButton\(\)](#).

9.10.4.3 mr_isActiveLow

```
const uint8_t& component::PushButton::mr_isActiveLow [private]
```

Input active state

Definition at line 65 of file [PushButton.h](#).

9.10.4.4 mr_useInternalPullUp

```
const uint8_t& component::PushButton::mr_useInternalPullUp [private]
```

Internal pullup resistor use

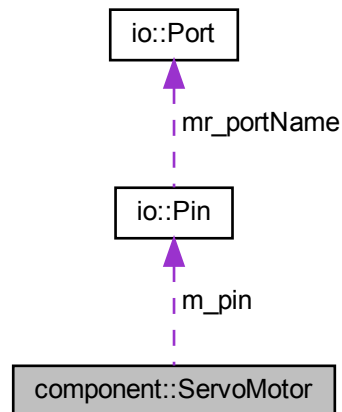
Definition at line 66 of file [PushButton.h](#).

Referenced by [PushButton\(\)](#).

9.11 component::ServoMotor Class Reference

```
#include <ServoMotor.h>
```

Collaboration diagram for component::ServoMotor:



Public Member Functions

- [ServoMotor](#) (const [io::Pin](#) &ar_pin, const uint16_t &ar_pulseCycle=0, const uint16_t &ar_pulseWidthMin=0, const uint16_t &ar_pulseWidthMid=0, const uint16_t &ar_pulseWidthMax=0)
- [~ServoMotor](#) ()
- void [on](#) ()
- void [off](#) ()
- void [toggle](#) ()
- uint16_t [computePulseCycleCount](#) (const uint16_t &ar_clockPrescaler)
- uint16_t [computePulseWidthMinCount](#) (const uint16_t &ar_clockPrescaler)
- uint16_t [computePulseWidthMidCount](#) (const uint16_t &ar_clockPrescaler)
- uint16_t [computePulseWidthMaxCount](#) (const uint16_t &ar_clockPrescaler)
- uint16_t [computeRotationAngleCount](#) (const uint8_t &ar_angle_deg, const uint16_t &ar_clockPrescaler)
- void [rotate](#) (core::TimerCounter1 &ar_timerCounter1, const uint8_t &ar_angle_deg, const [core::channel](#) &ar_channel=[core::channel::A](#))
- void [connect](#) (core::TimerCounter1 &ar_timerCounter1, const [core::channel](#) &ar_channel=[core::channel::A](#))
- void [disconnect](#) (core::TimerCounter1 &ar_timerCounter1, const [core::channel](#) &ar_channel=[core::channel::A](#))

Private Attributes

- [io::Pin](#) `m_pin`
- `uint16_t` `m_pulseCycle`
- `uint16_t` `m_pulseWidthMin`
- `uint16_t` `m_pulseWidthMid`
- `uint16_t` `m_pulseWidthMax`

9.11.1 Detailed Description

Definition at line 138 of file [ServoMotor.h](#).

9.11.2 Constructor & Destructor Documentation

9.11.2.1 ServoMotor()

```
component::ServoMotor::ServoMotor (
    const io::Pin & ar_pin,
    const uint16_t & ar_pulseCycle = 0,
    const uint16_t & ar_pulseWidthMin = 0,
    const uint16_t & ar_pulseWidthMid = 0,
    const uint16_t & ar_pulseWidthMax = 0 )
```

Definition at line 5 of file [ServoMotor.cpp](#).

```
00010 : m_pin(ar_pin),
00011     m_pulseCycle(ar_pulseCycle),
00012     m_pulseWidthMin(ar_pulseWidthMin),
00013     m_pulseWidthMid(ar_pulseWidthMid),
00014     m_pulseWidthMax(ar_pulseWidthMax)
00015 {
00016     m_pin.toOutput();
00017
00018 }
```

References [m_pin](#), and [io::Pin::toOutput\(\)](#).

9.11.2.2 ~ServoMotor()

```
component::ServoMotor::~~ServoMotor ( )
```

Definition at line 20 of file [ServoMotor.cpp](#).

```
00021 {
00022
00023 }
```

9.11.3 Member Function Documentation

9.11.3.1 computePulseCycleCount()

```
uint16_t component::ServoMotor::computePulseCycleCount (
    const uint16_t & ar_clockPrescaler )
```

Definition at line 44 of file [ServoMotor.cpp](#).

```
00045 {
00046     return SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(m_pulseCycle,ar_clockPrescaler);
00047 }
```

References [SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT](#).

9.11.3.2 computePulseWidthMaxCount()

```
uint16_t component::ServoMotor::computePulseWidthMaxCount (
    const uint16_t & ar_clockPrescaler )
```

Definition at line 54 of file [ServoMotor.cpp](#).

```
00055 {
00056     return SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(m_pulseWidthMax,ar_clockPrescaler);
00057 }
```

References [SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT](#).

9.11.3.3 computePulseWidthMidCount()

```
uint16_t component::ServoMotor::computePulseWidthMidCount (
    const uint16_t & ar_clockPrescaler )
```

Definition at line 59 of file [ServoMotor.cpp](#).

```
00060 {
00061     return SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(m_pulseWidthMid,ar_clockPrescaler);
00062 }
```

References [SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT](#).

9.11.3.4 computePulseWidthMinCount()

```
uint16_t component::ServoMotor::computePulseWidthMinCount (
    const uint16_t & ar_clockPrescaler )
```

Definition at line 49 of file [ServoMotor.cpp](#).

```
00050 {
00051     return SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(m_pulseWidthMin,ar_clockPrescaler);
00052 }
```

References [SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT](#).

9.11.3.5 computeRotationAngleCount()

```
uint16_t component::ServoMotor::computeRotationAngleCount (
    const uint8_t & ar_angle_deg,
    const uint16_t & ar_clockPrescaler )
```

Definition at line 64 of file [ServoMotor.cpp](#).

```
00065 {
00066     return
00067     static_cast<uint16_t> (SERVOMOTOR_TIMER_ANGLE_COUNT (ar_angle_deg, static_cast<long> (computePulseWidthMinCount (ar_clockPr
```

References [SERVOMOTOR_TIMER_ANGLE_COUNT](#).

9.11.3.6 connect()

```
void component::ServoMotor::connect (
    core::TimerCounter1 & ar_timerCounter1,
    const core::channel & ar_channel = core::channel::A )
```

Definition at line 85 of file [ServoMotor.cpp](#).

```
00087 {
00088
00089
00090     ar_timerCounter1.setInputCaptureRegister (computePulseCycleCount (ar_timerCounter1.getClockPrescaler ()));
00091     ar_timerCounter1.selectOperationMode (core::operationMode::fast_PWM_ICR);
00092     ar_timerCounter1.selectCompareOutputMode (ar_channel, core::compareOutputMode::clear);
00093     ar_timerCounter1.setCounter (0);
00094
00095 }
```

References [core::clear](#), [core::fast_PWM_ICR](#), [core::TimerCounter1::getClockPrescaler\(\)](#), [core::TimerCounter1::selectCompareOutputMode\(\)](#), [core::TimerCounter1::selectOperationMode\(\)](#), [core::TimerCounter1::setCounter\(\)](#), and [core::TimerCounter1::setInputCaptureRegister\(\)](#).

9.11.3.7 disconnect()

```
void component::ServoMotor::disconnect (
    core::TimerCounter1 & ar_timerCounter1,
    const core::channel & ar_channel = core::channel::A )
```

Definition at line 97 of file [ServoMotor.cpp](#).

```
00099 {
00100     ar_timerCounter1.selectCompareOutputMode (ar_channel, core::compareOutputMode::normal);
00101     // stop timer
00102     ar_timerCounter1.stop ();
00103 }
```

References [core::normal](#), [core::TimerCounter1::selectCompareOutputMode\(\)](#), and [core::TimerCounter1::stop\(\)](#).

9.11.3.8 off()

```
void component::ServoMotor::off ( )
```

Turn servo motor Off.

Definition at line 33 of file [ServoMotor.cpp](#).

```
00034 {  
00035     m_pin.setLow();  
00036 }
```

9.11.3.9 on()

```
void component::ServoMotor::on ( )
```

Turn servo motor On.

Definition at line 28 of file [ServoMotor.cpp](#).

```
00029 {  
00030     m_pin.setHigh();  
00031 }
```

9.11.3.10 rotate()

```
void component::ServoMotor::rotate (  
    core::TimerCounter1 & ar_timerCounter1,  
    const uint8_t & ar_angle_deg,  
    const core::channel & ar_channel = core::channel::A )
```

Definition at line 71 of file [ServoMotor.cpp](#).

```
00074 {  
00075  
00076     ar_timerCounter1.setOutputCompareRegister(ar_channel,  
        computeRotationAngleCount(ar_angle_deg, ar_timerCounter1.getClockPrescaler()));  
00077  
00078     // start timer  
00079     ar_timerCounter1.start();  
00080  
00081  
00082 }
```

References [core::TimerCounter1::getClockPrescaler\(\)](#), [core::TimerCounter1::setOutputCompareRegister\(\)](#), and [core::TimerCounter1::start\(\)](#).

9.11.3.11 toggle()

```
void component::ServoMotor::toggle ( )
```

Toggle servo motor state.

Definition at line 38 of file [ServoMotor.cpp](#).

```
00039 {  
00040     m_pin.toggle();  
00041  
00042 }
```

9.11.4 Member Data Documentation

9.11.4.1 m_pin

```
io::Pin component::ServoMotor::m_pin [private]
```

pin object

Definition at line 188 of file [ServoMotor.h](#).

Referenced by [ServoMotor\(\)](#).

9.11.4.2 m_pulseCycle

```
uint16_t component::ServoMotor::m_pulseCycle [private]
```

pulse cycle [us]

Definition at line 190 of file [ServoMotor.h](#).

9.11.4.3 m_pulseWidthMax

```
uint16_t component::ServoMotor::m_pulseWidthMax [private]
```

pulse width max [us]

Definition at line 196 of file [ServoMotor.h](#).

9.11.4.4 m_pulseWidthMid

```
uint16_t component::ServoMotor::m_pulseWidthMid [private]
```

pulse width mid [us]

Definition at line 194 of file [ServoMotor.h](#).

9.11.4.5 m_pulseWidthMin

```
uint16_t component::ServoMotor::m_pulseWidthMin [private]
```

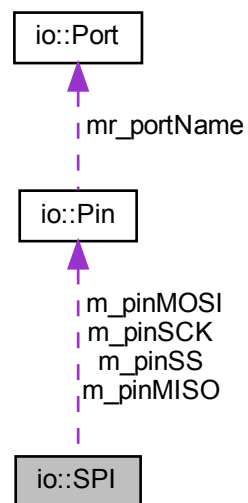
pulse width min [us]

Definition at line 192 of file [ServoMotor.h](#).

9.12 io::SPI Class Reference

```
#include <SPI.h>
```

Collaboration diagram for io::SPI:



Public Member Functions

- void [selectDataMode](#) (const [dataMode](#) &ar_dataMode)
- void [selectDataOrder](#) (const [dataOrder](#) &ar_dataOrder)
- void [selectOperationMode](#) (const [operationMode](#) &ar_operationMode)
- void [selectClockPrescaler](#) (const [clockPrescaler](#) &ar_clockPrescaler)
- void [selectSlave](#) (const uint8_t a_select)
- uint8_t [writeCollision](#) ()
- uint8_t [transferComplete](#) ()
- void [masterSendByte](#) (const uint8_t &ar_byte)
- void [masterReceiveByte](#) (uint8_t &ar_byte)
- void [slaveReceiveByte](#) (uint8_t &ar_byte)

Static Public Member Functions

- static [SPI](#) & [getInstance](#) (const [io::Pin](#) &ar_pinSCK, const [io::Pin](#) &ar_pinMISO, const [io::Pin](#) &ar_pinMOSI, const [io::Pin](#) &ar_pinSS)
- static void [enableTransferCompleteInterrupt](#) (const uint8_t a_enable)
- static void [transferCompleteServiceRoutine](#) () __asm__(STR(SPI_TRANSFER_COMPLETE_INTERRUPT))
__attribute__((__signal__

Public Attributes

- static void [__used__](#)
- static void [__externally_visible__](#)

Private Member Functions

- [SPI](#) (const [io::Pin](#) &ar_pinSCK, const [io::Pin](#) &ar_pinMISO, const [io::Pin](#) &ar_pinMOSI, const [io::Pin](#) &ar_pinSS)
- [~SPI](#) ()
- [SPI](#) (const [SPI](#) &)
- const [SPI](#) & [operator=](#) (const [SPI](#) &)

Private Attributes

- [io::Pin](#) m_pinSCK
- [io::Pin](#) m_pinMISO
- [io::Pin](#) m_pinMOSI
- [io::Pin](#) m_pinSS

Static Private Attributes

- static volatile uint8_t [m_data](#) = 0

9.12.1 Detailed Description

Definition at line 86 of file [SPI.h](#).

9.12.2 Constructor & Destructor Documentation

9.12.2.1 SPI() [1/2]

```
io::SPI::SPI (
    const io::Pin & ar_pinSCK,
    const io::Pin & ar_pinMISO,
    const io::Pin & ar_pinMOSI,
    const io::Pin & ar_pinSS ) [private]
```

Constructor. Initializes the [USART0](#) object

@param ar_transMode defines transmission mode
 @param ar_comMode defines communication mode
 @param ar_frameSize defines data frame size
 @param ar_stopBit defines number of stop bits
 @param ar_parityMode defines parity mode

Definition at line 22 of file [SPI.cpp](#).

```
00026         : m_pinSCK(ar_pinSCK),
00027           m_pinMISO(ar_pinMISO),
00028           m_pinMOSI(ar_pinMOSI),
00029           m_pinSS(ar_pinSS)
00030 {
00031     core::MCU::enableSPI(1);
00032     sei();
00033     enableTransferCompleteInterrupt(1);
00034 }
00035 }
```

References [core::MCU::enableSPI\(\)](#), and [enableTransferCompleteInterrupt\(\)](#).

9.12.2.2 ~SPI()

```
io::SPI::~~SPI ( ) [private]
```

Destructor.

Definition at line 37 of file [SPI.cpp](#).

```
00038 {
00039
00040 }
```

9.12.2.3 SPI() [2/2]

```
io::SPI::SPI (
    const SPI & ) [private]
```

Overried Copy constructor.

9.12.3 Member Function Documentation

9.12.3.1 enableTransferCompleteInterrupt()

```
void io::SPI::enableTransferCompleteInterrupt (
    const uint8_t a_enable ) [static]
```

Definition at line 110 of file [SPI.cpp](#).

```
00111 {
00112     if (a_enable) {
00113         SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT;
00114     } else {
00115         SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT;
00116     }
00117 }
```

References [SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT](#), and [SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT](#).

Referenced by [SPI\(\)](#).

9.12.3.2 getInstance()

```
io::SPI & io::SPI::getInstance (
    const io::Pin & ar_pinSCK,
    const io::Pin & ar_pinMISO,
    const io::Pin & ar_pinMOSI,
    const io::Pin & ar_pinSS ) [static]
```

Definition at line 8 of file [SPI.cpp](#).

```
00012 {
00013     static SPI l_instance(ar_pinSCK,
00014                          ar_pinMISO,
00015                          ar_pinMOSI,
00016                          ar_pinSS);
00017
00018     return l_instance;
00019
00020 }
```

9.12.3.3 masterReceiveByte()

```
void io::SPI::masterReceiveByte (
    uint8_t & ar_byte )
```

Definition at line 147 of file [SPI.cpp](#).

```
00148 {
00149     masterSendByte(0);
00150     ar_byte = m_data;
00151
00152 }
```


9.12.3.4 masterSendByte()

```
void io::SPI::masterSendByte (
    const uint8_t & ar_byte )
```

Definition at line 135 of file [SPI.cpp](#).

```
00136 {
00137
00138     SPI_DATA_REGISTER = ar_byte;
00139     selectSlave(1);
00140     while(!transferComplete()){};
00141     selectSlave(0);
00142
00143
00144
00145 }
```

References [SPI_DATA_REGISTER](#).

9.12.3.5 operator=()

```
const SPI& io::SPI::operator= (
    const SPI & ) [private]
```

Override assign operator.

9.12.3.6 selectClockPrescaler()

```
void io::SPI::selectClockPrescaler (
    const clockPrescaler & ar_clockPrescaler )
```

Definition at line 53 of file [SPI.cpp](#).

```
00054 {
00055     SPI_SELECT_CLOCK_PRESCALER(static_cast<uint8_t>(ar_clockPrescaler));
00056
00057 }
```

References [SPI_SELECT_CLOCK_PRESCALER](#).

9.12.3.7 selectDataMode()

```
void io::SPI::selectDataMode (
    const dataMode & ar_dataMode )
```

Definition at line 99 of file [SPI.cpp](#).

```
00100 {
00101     SPI_SELECT_DATA_MODE(static_cast<uint8_t>(ar_dataMode));
00102 }
```

References [SPI_SELECT_DATA_MODE](#).

9.12.3.8 selectDataOrder()

```
void io::SPI::selectDataOrder (
    const dataOrder & ar_dataOrder )
```

Definition at line 104 of file [SPI.cpp](#).

```
00105 {
00106     SPI\_SELECT\_DATA\_ORDER(static\_cast<uint8_t>(ar_dataOrder));
00107 }
00108 }
```

References [SPI_SELECT_DATA_ORDER](#).

9.12.3.9 selectOperationMode()

```
void io::SPI::selectOperationMode (
    const operationMode & ar_operationMode )
```

Definition at line 59 of file [SPI.cpp](#).

```
00060 {
00061     switch (ar_operationMode)
00062     {
00063         case operationMode::master:
00064         {
00065             m\_pinMOSI.toOutput();
00066             m\_pinSCK.toOutput();
00067             m\_pinMISO.toInput(1);
00068             m\_pinSS.toOutput();
00069             m\_pinSS.setHigh();
00070             SPI\_SELECT\_MASTER\_MODE;
00071             SPI\_ENABLE;
00072             break;
00073         }
00074         case operationMode::slave:
00075         {
00076             m\_pinMISO.toOutput();
00077             SPI\_SELECT\_SLAVE\_MODE;
00078             SPI\_ENABLE;
00079             break;
00080         }
00081         case operationMode::submaster:
00082         {
00083             m\_pinMOSI.toOutput();
00084             m\_pinSCK.toOutput();
00085             m\_pinMISO.toInput(1);
00086             m\_pinSS.toInput(1);
00087             SPI\_SELECT\_MASTER\_MODE;
00088             SPI\_ENABLE;
00089             break;
00090         }
00091         case operationMode::disable:
00092         {
00093             SPI\_DISABLE;
00094             break;
00095         }
00096     }
00097 }
```

References [io::disable](#), [io::master](#), [io::slave](#), [SPI_DISABLE](#), [SPI_ENABLE](#), [SPI_SELECT_MASTER_MODE](#), [SPI_SELECT_SLAVE_MODE](#), and [io::submaster](#).

9.12.3.10 selectSlave()

```
void io::SPI::selectSlave (
    const uint8_t a_select )
```

Definition at line 119 of file [SPI.cpp](#).

```
00120 {
00121     if (a_select) {
00122         m_pinSS.setLow();
00123     } else {
00124         m_pinSS.setHigh();
00125     }
00126 }
00127
00128 }
```

9.12.3.11 slaveReceiveByte()

```
void io::SPI::slaveReceiveByte (
    uint8_t & ar_byte )
```

Definition at line 154 of file [SPI.cpp](#).

```
00155 {
00156     ar_byte = m_data;
00157 }
00158 }
```

9.12.3.12 transferComplete()

```
uint8_t io::SPI::transferComplete ( )
```

Is serial transfer complete.

Definition at line 48 of file [SPI.cpp](#).

```
00049 {
00050     return (SPI_STATUS_REGISTER & (1 << SPI_TRANSFER_COMPLETE));
00051 }
```

References [SPI_STATUS_REGISTER](#), and [SPI_TRANSFER_COMPLETE](#).

9.12.3.13 transferCompleteServiceRoutine()

```
void io::SPI::transferCompleteServiceRoutine ( ) [static]
```

Serial transfer complete ISR.

Definition at line 129 of file [SPI.cpp](#).

```
00130 {
00131
00132     m_data = SPI_DATA_REGISTER;
00133 }
```

References [SPI_DATA_REGISTER](#).

9.12.3.14 writeCollision()

```
uint8_t io::SPI::writeCollision ( )
```

Is there write collision.

Definition at line 42 of file [SPI.cpp](#).

```
00043 {  
00044     return (SPI_STATUS_REGISTER & (1 « SPI_WRITE_COLLISION));  
00045 }
```

References [SPI_STATUS_REGISTER](#), and [SPI_WRITE_COLLISION](#).

9.12.4 Member Data Documentation

9.12.4.1 __externally_visible__

```
void io::SPI::__externally_visible__
```

Definition at line 124 of file [SPI.h](#).

9.12.4.2 __used__

```
void io::SPI::__used__
```

Definition at line 124 of file [SPI.h](#).

9.12.4.3 m_data

```
volatile uint8_t io::SPI::m_data = 0 [static], [private]
```

Definition at line 154 of file [SPI.h](#).

9.12.4.4 m_pinMISO

```
io::Pin io::SPI::m_pinMISO [private]
```

pin object

Definition at line 157 of file [SPI.h](#).

9.12.4.5 m_pinMOSI

```
io::Pin io::SPI::m_pinMOSI [private]
```

pin object

Definition at line 158 of file [SPI.h](#).

9.12.4.6 m_pinSCK

```
io::Pin io::SPI::m_pinSCK [private]
```

pin object

Definition at line 156 of file [SPI.h](#).

9.12.4.7 m_pinSS

```
io::Pin io::SPI::m_pinSS [private]
```

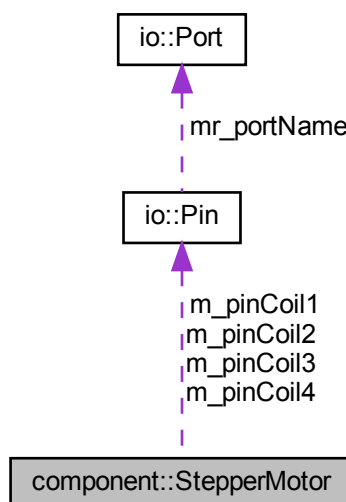
pin object

Definition at line 159 of file [SPI.h](#).

9.13 component::StepperMotor Class Reference

```
#include <StepperMotor.h>
```

Collaboration diagram for component::StepperMotor:



Public Member Functions

- [StepperMotor](#) (const [mode](#) &ar_mode, const [io::Pin](#) &ar_pinCoil1, const [io::Pin](#) &ar_pinCoil2, const [io::Pin](#) &ar_pinCoil3, const [io::Pin](#) &ar_pinCoil4)
- [~StepperMotor](#) ()
- void [step](#) (const int16_t a_step, const uint16_t a_speed)
- void [step](#) (const int16_t a_step, const uint16_t a_speed, const float a_stepAngle)
- void [step](#) (const int16_t a_step, const uint16_t a_speed, const uint16_t a_accel, const uint16_t a_decel)
- void [stepPulse](#) (const uint8_t a_stepPulse)
- void [stepDelay](#) (uint8_t a_stepDelay)
- uint8_t [goalReached](#) ()
- void [setCurrentPos](#) (uint16_t a_currentPos)
- uint16_t [currentPos](#) ()
- uint8_t [computeStepDelay](#) (uint16_t a_step, const uint16_t a_speed, const uint16_t a_accel, const uint16_t a_decel)

Public Attributes

- uint16_t [m_accelTime](#)
- uint16_t [m_decelTime](#)
- uint16_t [m_constSpeedTime](#)

Private Attributes

- [io::Pin](#) [m_pinCoil1](#)
- [io::Pin](#) [m_pinCoil2](#)
- [io::Pin](#) [m_pinCoil3](#)
- [io::Pin](#) [m_pinCoil4](#)
- [mode](#) [stepMode](#)
- uint8_t [m_goalReached](#)
- uint16_t [m_currentPos](#)

9.13.1 Detailed Description

Definition at line 75 of file [StepperMotor.h](#).

9.13.2 Constructor & Destructor Documentation

9.13.2.1 StepperMotor()

```
component::StepperMotor::StepperMotor (
    const mode & ar_mode,
    const io::Pin & ar_pinCoil1,
    const io::Pin & ar_pinCoil2,
    const io::Pin & ar_pinCoil3,
    const io::Pin & ar_pinCoil4 )
```

Definition at line 8 of file [StepperMotor.cpp](#).

```
00013 : m_pinCoil1(ar_pinCoil1),
00014     m_pinCoil2(ar_pinCoil2),
00015     m_pinCoil3(ar_pinCoil3),
00016     m_pinCoil4(ar_pinCoil4),
00017     stepMode(ar_mode)
00018 {
00019
00020     m_pinCoil1.toOutput();
00021     m_pinCoil2.toOutput();
00022     m_pinCoil3.toOutput();
00023     m_pinCoil4.toOutput();
00024     m_goalReached = 0;
00025     m_currentPos = 0;
00026
00027
00028 }
```

References [m_currentPos](#), [m_goalReached](#), [m_pinCoil1](#), [m_pinCoil2](#), [m_pinCoil3](#), [m_pinCoil4](#), and [io::Pin::toOutput\(\)](#).

9.13.2.2 ~StepperMotor()

```
component::StepperMotor::~~StepperMotor ( )
```

Definition at line 30 of file [StepperMotor.cpp](#).

```
00031 {
00032
00033 }
```

9.13.3 Member Function Documentation

9.13.3.1 computeStepDelay()

```
uint8_t component::StepperMotor::computeStepDelay (
    uint16_t a_step,
    const uint16_t a_speed,
    const uint16_t a_accel,
    const uint16_t a_decel )
```

Definition at line 127 of file [StepperMotor.cpp](#).

```
00131 {
00132
00133
00134     uint32_t l_accelTime= (1000UL*a_speed/a_accel);
00135     uint16_t l_decelTime = (1000UL*a_speed/a_decel);
00136     int16_t l_constSpeedTime=((1000UL*a_step/a_speed)-(l_accelTime/2)-(l_decelTime/2));
00137     static uint32_t l_time=0;
00138     static uint32_t l_speed=0;
00139     static uint64_t l_speed_time_product=0;
```

```

00140     static uint64_t l_current_position=0;
00141
00142
00143
00144
00145
00146
00147
00148     if (l_constSpeedTime<0)
00149     {
00150         l_constSpeedTime=0;
00151         l_accelTime = static_cast<uint32_t>(1000UL*sqrtf(a_step/a_accel));
00152         a_speed=l_accelTime*a_accel/1000UL;
00153         l_decelTime = 1000UL*a_speed/a_decel;
00154
00155     }
00156
00157
00158
00159
00160     if (l_time<=l_accelTime)
00161     {
00162         l_speed=a_accel*l_time;
00163
00164     }
00165     else if ((l_time>l_accelTime) && (l_time<=(l_accelTime+l_constSpeedTime)))
00166     {
00167         l_speed=1000UL*a_speed;
00168
00169     }
00170     else if
00171     ((l_time>(l_accelTime+l_constSpeedTime)) && (l_time<=l_accelTime+l_constSpeedTime+l_decelTime))
00172     {
00173         l_speed= (1000UL*a_speed)-a_decel*(l_time-l_accelTime-l_constSpeedTime);
00174
00175     }
00176
00177
00178     l_time=l_time+1;
00179
00180
00181     l_speed_time_product = l_speed_time_product+l_speed;
00182
00183     if (l_speed_time_product - l_current_position >= 1000000UL)
00184     {
00185         l_current_position=l_current_position+1000000UL;
00186         return 1;
00187     }
00188     else
00189     {
00190         stepDelay(1);
00191         return 0;
00192     }
00193
00194
00195
00196
00197
00198 }

```

9.13.3.2 currentPos()

uint16_t component::StepperMotor::currentPos ()

Definition at line 40 of file [StepperMotor.cpp](#).

```

00041 {
00042     return m_currentPos;
00043 }

```


9.13.3.3 goalReached()

```
uint8_t component::StepperMotor::goalReached ( )
```

Definition at line 403 of file [StepperMotor.cpp](#).

```
00404 {
00405     return m_goalReached;
00406
00407 }
```

9.13.3.4 setCurrentPos()

```
void component::StepperMotor::setCurrentPos (
    uint16_t a_currentPos )
```

Definition at line 35 of file [StepperMotor.cpp](#).

```
00036 {
00037     m_currentPos = a_currentPos;
00038 }
```

9.13.3.5 step() [1/3]

```
void component::StepperMotor::step (
    const int16_t a_step,
    const uint16_t a_speed )
```

Turn servo motor On.

Definition at line 201 of file [StepperMotor.cpp](#).

```
00202 {
00203     static int16_t l_stepNumber = 0;
00204     static uint8_t l_stepDelay_ms = static_cast<uint8_t>(1000UL/a_speed);
00205
00206     if (a_step<=0)
00207     {
00208         if (l_stepNumber== -a_step)
00209         {
00210             m_goalReached = 1;
00211         } else {
00212             l_stepNumber++;
00213             m_currentPos++;
00214         }
00215     }
00216
00217     } else {
00218
00219         if (l_stepNumber == -a_step)
00220         {
00221             m_goalReached = 1;
00222         } else {
00223             l_stepNumber--;
00224             m_currentPos--;
00225         }
00226     }
00227
00228     }
00229
00230
00231
00232     if (m_goalReached == 0)
00233     {
00234
00235         switch (stepMode)
00236         {
00237             case mode::fullStep:
```

```

00238         {
00239             // equivalent to l_stepNumber % 4
00240             // 1 3 5 7 <->
00241             stepPulse(2*(l_stepNumber & 3)+1);
00242             break;
00243         }
00244
00245         case mode::halfStep:
00246         {
00247             // equivalent to l_stepNumber % 8
00248             // 0 1 2 3 4 5 6 7 <->
00249             stepPulse(l_stepNumber & 7);
00250             break;
00251         }
00252     }
00253
00254     stepDelay(l_stepDelay_ms);
00255
00256 }
00257 }

```

References [component::fullStep](#), and [component::halfStep](#).

9.13.3.6 step() [2/3]

```

void component::StepperMotor::step (
    const int16_t a_step,
    const uint16_t a_speed,
    const float a_stepAngle )

```

Definition at line 259 of file [StepperMotor.cpp](#).

```

00260 {
00261     static int16_t l_stepNumber = 0;
00262     static uint8_t l_stepDelay_ms = static_cast<uint8_t>(1000UL*a_stepAngle/a_speed);
00263
00264     if (a_step<=0)
00265     {
00266         if (l_stepNumber== -a_step)
00267         {
00268             m_goalReached = 1;
00269         } else {
00270             l_stepNumber++;
00271             m_currentPos++;
00272         }
00273     }
00274
00275     } else {
00276         if (l_stepNumber == -a_step)
00277         {
00278             m_goalReached = 1;
00279         } else {
00280             l_stepNumber--;
00281             m_currentPos--;
00282         }
00283     }
00284
00285     if (m_goalReached == 0)
00286     {
00287         switch (stepMode)
00288         {
00289             case mode::fullStep:
00290             {
00291                 // equivalent to l_stepNumber % 4
00292                 // 1 3 5 7 <->
00293                 stepPulse(2*(l_stepNumber & 3)+1);
00294                 break;
00295             }
00296
00297             case mode::halfStep:
00298             {
00299
00300
00301
00302
00303
00304

```

```

00305             // equivalent to l_stepNumber % 8
00306             // 0 1 2 3 4 5 6 7 <->
00307             stepPulse(l_stepNumber & 7);
00308             break;
00309         }
00310     }
00311
00312     stepDelay(l_stepDelay_ms);
00313
00314 }
00315
00316
00317 }

```

References [component::fullStep](#), and [component::halfStep](#).

9.13.3.7 step() [3/3]

```

void component::StepperMotor::step (
    const int16_t a_step,
    const uint16_t a_speed,
    const uint16_t a_accel,
    const uint16_t a_decel )

```

Definition at line 47 of file [StepperMotor.cpp](#).

```

00051 {
00052     static int16_t l_stepNumber = 0;
00053     uint8_t l_stepDelay_ms = 0;
00054     uint16_t l_step=0;
00055
00056     if (a_step<=0)
00057     {
00058         l_step = -a_step;
00059     } else
00060     {
00061         l_step = a_step;
00062     }
00063
00064     l_stepDelay_ms = computeStepDelay(l_step,
00065                                     a_speed,
00066                                     a_accel,
00067                                     a_decel);
00068
00069     if (l_stepDelay_ms>0)
00070     {
00071
00072         if (a_step<=0)
00073         {
00074             if (l_stepNumber== -a_step)
00075             {
00076                 m_goalReached = 1;
00077             } else {
00078                 l_stepNumber++;
00079                 m_currentPos++;
00080             }
00081         }
00082
00083     } else {
00084
00085         if (l_stepNumber == -a_step)
00086         {
00087             m_goalReached = 1;
00088         } else {
00089             l_stepNumber--;
00090             m_currentPos--;
00091         }
00092     }
00093
00094 }
00095
00096
00097
00098     if (m_goalReached == 0)
00099     {
00100
00101         switch (stepMode)

```

```

00102     {
00103         case mode::fullStep:
00104         {
00105             // equivalent to l_stepNumber % 4
00106             // 1 3 5 7 <->
00107             stepPulse(2*(l_stepNumber & 3)+1);
00108             break;
00109         }
00110
00111         case mode::halfStep:
00112         {
00113             // equivalent to l_stepNumber % 8
00114             // 0 1 2 3 4 5 6 7 <->
00115             stepPulse(l_stepNumber & 7);
00116             break;
00117         }
00118     }
00119     stepDelay(l_stepDelay_ms);
00120 }
00121 }
00122 }
00123 }
00124 }
00125 }

```

References [component::fullStep](#), and [component::halfStep](#).

9.13.3.8 stepDelay()

```

void component::StepperMotor::stepDelay (
    uint8_t a_stepDelay )

```

Definition at line 395 of file [StepperMotor.cpp](#).

```

00396 {
00397     while(a_stepDelay-->0)
00398     {
00399         _delay_ms(1);
00400     }
00401 }

```

9.13.3.9 stepPulse()

```

void component::StepperMotor::stepPulse (
    const uint8_t a_stepPulse )

```

Definition at line 320 of file [StepperMotor.cpp](#).

```

00321 {
00322
00323     switch (a_stepPulse) {
00324     case 0: // 1000
00325     {
00326         m_pinCoil1.setHigh();
00327         m_pinCoil2.setLow();
00328         m_pinCoil3.setLow();
00329         m_pinCoil4.setLow();
00330         break;
00331     }
00332     case 1: // 1100
00333     {
00334         m_pinCoil1.setHigh();
00335         m_pinCoil2.setHigh();
00336         m_pinCoil3.setLow();
00337         m_pinCoil4.setLow();
00338         break;
00339     }
00340     case 2: // 0100
00341     {
00342         m_pinCoil1.setLow();

```

```

00343         m_pinCoil2.setHigh();
00344         m_pinCoil3.setLow();
00345         m_pinCoil4.setLow();
00346         break;
00347     }
00348     case 3:        //0110
00349     {
00350         m_pinCoil1.setLow();
00351         m_pinCoil2.setHigh();
00352         m_pinCoil3.setHigh();
00353         m_pinCoil4.setLow();
00354         break;
00355     }
00356     case 4:        //0010
00357     {
00358         m_pinCoil1.setLow();
00359         m_pinCoil2.setLow();
00360         m_pinCoil3.setHigh();
00361         m_pinCoil4.setLow();
00362         break;
00363     }
00364     case 5:        //0011
00365     {
00366         m_pinCoil1.setLow();
00367         m_pinCoil2.setLow();
00368         m_pinCoil3.setHigh();
00369         m_pinCoil4.setHigh();
00370         break;
00371     }
00372     case 6:        //0001
00373     {
00374         m_pinCoil1.setLow();
00375         m_pinCoil2.setLow();
00376         m_pinCoil3.setLow();
00377         m_pinCoil4.setHigh();
00378         break;
00379     }
00380     case 7:        //1001
00381     {
00382         m_pinCoil1.setHigh();
00383         m_pinCoil2.setLow();
00384         m_pinCoil3.setLow();
00385         m_pinCoil4.setHigh();
00386         break;
00387     }
00388 }
00389
00390
00391 }

```

9.13.4 Member Data Documentation

9.13.4.1 m_accelTime

uint16_t component::StepperMotor::m_accelTime

pulse delay in ms

Definition at line 118 of file [StepperMotor.h](#).

9.13.4.2 m_constSpeedTime

uint16_t component::StepperMotor::m_constSpeedTime

pulse delay in ms

Definition at line 120 of file [StepperMotor.h](#).

9.13.4.3 m_currentPos

`uint16_t component::StepperMotor::m_currentPos [private]`

pulse delay in ms

Definition at line 139 of file [StepperMotor.h](#).

Referenced by [StepperMotor\(\)](#).

9.13.4.4 m_decelTime

`uint16_t component::StepperMotor::m_decelTime`

pulse delay in ms

Definition at line 119 of file [StepperMotor.h](#).

9.13.4.5 m_goalReached

`uint8_t component::StepperMotor::m_goalReached [private]`

Definition at line 138 of file [StepperMotor.h](#).

Referenced by [StepperMotor\(\)](#).

9.13.4.6 m_pinCoil1

`io::Pin component::StepperMotor::m_pinCoil1 [private]`

pin object

Definition at line 132 of file [StepperMotor.h](#).

Referenced by [StepperMotor\(\)](#).

9.13.4.7 m_pinCoil2

`io::Pin component::StepperMotor::m_pinCoil2 [private]`

pin object

Definition at line 133 of file [StepperMotor.h](#).

Referenced by [StepperMotor\(\)](#).

9.13.4.8 m_pinCoil3

`io::Pin` component::StepperMotor::m_pinCoil3 [private]

pin object

Definition at line 134 of file [StepperMotor.h](#).

Referenced by [StepperMotor\(\)](#).

9.13.4.9 m_pinCoil4

`io::Pin` component::StepperMotor::m_pinCoil4 [private]

pin object

Definition at line 135 of file [StepperMotor.h](#).

Referenced by [StepperMotor\(\)](#).

9.13.4.10 stepMode

`mode` component::StepperMotor::stepMode [private]

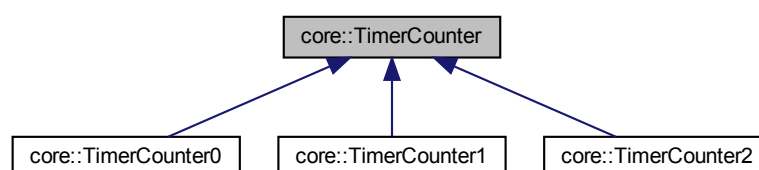
steps per revolution

Definition at line 137 of file [StepperMotor.h](#).

9.14 core::TimerCounter Class Reference

```
#include <TimerCounter.h>
```

Inheritance diagram for core::TimerCounter:



Public Member Functions

- virtual void [selectOperationMode](#) (const [operationMode](#) &ar_operationMode)=0
- virtual void [start](#) ()=0
- virtual void [stop](#) ()=0
- virtual void [selectClockSource](#) (const [clockSource](#) &ar_clockSource)=0
- virtual void [selectCompareOutputMode](#) (const [channel](#) &ar_channel, const [compareOutputMode](#) &ar_↔compareOutputMode)=0
- virtual void [setCounter](#) (const uint16_t &ar_dataBuffer)=0
- virtual uint16_t [getCounter](#) () const =0
- virtual void [setOutputCompareRegister](#) (const [channel](#) &ar_channel, const uint16_t &ar_dataBuffer)=0
- virtual uint16_t [getOutputCompareRegister](#) (const [channel](#) &ar_channel) const =0
- virtual void [enableOutputCompareMatchInterrupt](#) (const [channel](#) &ar_channel, const uint8_t a_enable)=0
- virtual void [enableOverflowInterrupt](#) (const uint8_t a_enable)=0
- virtual uint16_t [getClockPrescaler](#) ()=0

9.14.1 Detailed Description

Definition at line 517 of file [TimerCounter.h](#).

9.14.2 Member Function Documentation

9.14.2.1 [enableOutputCompareMatchInterrupt\(\)](#)

```
virtual void core::TimerCounter::enableOutputCompareMatchInterrupt (
    const channel & ar_channel,
    const uint8_t a_enable ) [pure virtual]
```

Implemented in [core::TimerCounter1](#), [core::TimerCounter0](#), and [core::TimerCounter2](#).

9.14.2.2 [enableOverflowInterrupt\(\)](#)

```
virtual void core::TimerCounter::enableOverflowInterrupt (
    const uint8_t a_enable ) [pure virtual]
```

Implemented in [core::TimerCounter1](#), [core::TimerCounter0](#), and [core::TimerCounter2](#).

9.14.2.3 [getClockPrescaler\(\)](#)

```
virtual uint16_t core::TimerCounter::getClockPrescaler ( ) [pure virtual]
```

Implemented in [core::TimerCounter1](#), [core::TimerCounter0](#), and [core::TimerCounter2](#).

9.14.2.4 getCounter()

```
virtual uint16_t core::TimerCounter::getCounter ( ) const [pure virtual]
```

Implemented in [core::TimerCounter1](#), [core::TimerCounter0](#), and [core::TimerCounter2](#).

9.14.2.5 getOutputCompareRegister()

```
virtual uint16_t core::TimerCounter::getOutputCompareRegister (
    const channel & ar_channel ) const [pure virtual]
```

Implemented in [core::TimerCounter1](#), [core::TimerCounter0](#), and [core::TimerCounter2](#).

9.14.2.6 selectClockSource()

```
virtual void core::TimerCounter::selectClockSource (
    const clockSource & ar_clockSource ) [pure virtual]
```

Implemented in [core::TimerCounter0](#), [core::TimerCounter1](#), and [core::TimerCounter2](#).

9.14.2.7 selectCompareOutputMode()

```
virtual void core::TimerCounter::selectCompareOutputMode (
    const channel & ar_channel,
    const compareOutputMode & ar_compareOutputMode ) [pure virtual]
```

Implemented in [core::TimerCounter1](#), [core::TimerCounter0](#), and [core::TimerCounter2](#).

9.14.2.8 selectOperationMode()

```
virtual void core::TimerCounter::selectOperationMode (
    const operationMode & ar_operationMode ) [pure virtual]
```

Implemented in [core::TimerCounter0](#), [core::TimerCounter1](#), and [core::TimerCounter2](#).

9.14.2.9 setCounter()

```
virtual void core::TimerCounter::setCounter (
    const uint16_t & ar_dataBuffer ) [pure virtual]
```

Implemented in [core::TimerCounter1](#), [core::TimerCounter0](#), and [core::TimerCounter2](#).

9.14.2.10 setOutputCompareRegister()

```
virtual void core::TimerCounter::setOutputCompareRegister (
    const channel & ar_channel,
    const uint16_t & ar_dataBuffer ) [pure virtual]
```

Implemented in [core::TimerCounter1](#), [core::TimerCounter0](#), and [core::TimerCounter2](#).

9.14.2.11 start()

```
virtual void core::TimerCounter::start ( ) [pure virtual]
```

Implemented in [core::TimerCounter0](#), [core::TimerCounter1](#), and [core::TimerCounter2](#).

9.14.2.12 stop()

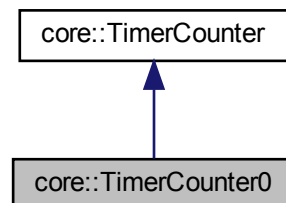
```
virtual void core::TimerCounter::stop ( ) [pure virtual]
```

Implemented in [core::TimerCounter0](#), [core::TimerCounter1](#), and [core::TimerCounter2](#).

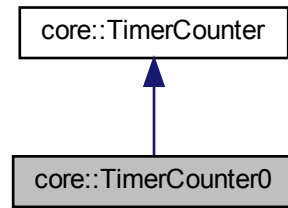
9.15 core::TimerCounter0 Class Reference

```
#include <TimerCounter0.h>
```

Inheritance diagram for core::TimerCounter0:



Collaboration diagram for core::TimerCounter0:



Public Member Functions

- void [selectOperationMode](#) (const [operationMode](#) &ar_operationMode) override
- void [start](#) () override
- void [stop](#) () override
- void [selectClockSource](#) (const [clockSource](#) &ar_clockSource) override
- void [selectCompareOutputMode](#) (const [channel](#) &ar_channel, const [compareOutputMode](#) &ar_compareOutputMode) override
- void [setCounter](#) (const uint16_t &ar_dataBuffer) override
- uint16_t [getCounter](#) () const override
- void [setOutputCompareRegister](#) (const [channel](#) &ar_channel, const uint16_t &ar_dataBuffer) override
- uint16_t [getOutputCompareRegister](#) (const [channel](#) &ar_channel) const override
- void [enableOutputCompareMatchInterrupt](#) (const [channel](#) &ar_channel, const uint8_t a_enable) override
- void [enableOverflowInterrupt](#) (const uint8_t a_enable) override
- uint16_t [getClockPrescaler](#) () override

Static Public Member Functions

- static [TimerCounter0](#) & [getInstance](#) (const [channel](#) &ar_channel=[channel::A](#), const [operationMode](#) &ar_operationMode=[operationMode::normal](#), const [clockSource](#) &ar_clockSource=[clockSource::noClock](#), const [compareOutputMode](#) &ar_compareOutputMode=[compareOutputMode::normal](#))
- static void [outputCompareMatchAServiceRoutine](#) () __asm__(STR(TIMERO0_COM_CHANNEL_A_INTERRUPT)) __attribute__((__signal__))
- static void [outputCompareMatchBServiceRoutine](#) () __asm__(STR(TIMERO0_COM_CHANNEL_B_INTERRUPT)) __attribute__((__signal__))
- static void [overflowServiceRoutine](#) () __asm__(STR(TIMERO0_OVERFLOW_INTERRUPT)) __attribute__((__signal__))

Public Attributes

- static void [__used__](#)
- static void [__externally_visible__](#)

Private Member Functions

- [TimerCounter0](#) (const [channel](#) &ar_channel, const [operationMode](#) &ar_operationMode, const [clockSource](#) &ar_clockSource, const [compareOutputMode](#) &ar_compareOutputMode)
- [~TimerCounter0](#) ()
- [TimerCounter0](#) (const [TimerCounter0](#) &)
- const [TimerCounter0](#) & [operator=](#) (const [TimerCounter0](#) &)

Private Attributes

- uint16_t [m_clockPrescaler](#)
- uint8_t [m_clockSource](#)

9.15.1 Detailed Description

Definition at line 279 of file [TimerCounter0.h](#).

9.15.2 Constructor & Destructor Documentation

9.15.2.1 TimerCounter0() [1/2]

```
core::TimerCounter0::TimerCounter0 (
    const channel & ar_channel,
    const operationMode & ar_operationMode,
    const clockSource & ar_clockSource,
    const compareOutputMode & ar_compareOutputMode ) [private]
```

Definition at line 20 of file [TimerCounter0.cpp](#).

```
00024 {
00025     core::MCU::enableTimerCounter0(1);
00026     stop();
00027     selectOperationMode(ar_operationMode);
00028     selectClockSource(ar_clockSource);
00029     selectCompareOutputMode(ar_channel, ar_compareOutputMode);
00030
00031
00032
00033 }
```

References [core::MCU::enableTimerCounter0\(\)](#).

9.15.2.2 ~TimerCounter0()

```
core::TimerCounter0::~~TimerCounter0 ( ) [private]
```

Definition at line 34 of file [TimerCounter0.cpp](#).

```
00035 {
00036
00037 }
```

9.15.2.3 TimerCounter0() [2/2]

```
core::TimerCounter0::TimerCounter0 (
    const TimerCounter0 & ) [private]
```

Overried Copy constructor.

9.15.3 Member Function Documentation

9.15.3.1 enableOutputCompareMatchInterrupt()

```
void core::TimerCounter0::enableOutputCompareMatchInterrupt (
    const channel & ar_channel,
    const uint8_t a_enable ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 216 of file [TimerCounter0.cpp](#).

```
00217 {
00218     switch (ar_channel)
00219     {
00220         case core::channel::A:
00221         {
00222             if (a_enable) {
00223                 TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT;
00224             } else {
00225                 TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT;
00226             }
00227             break;
00228         }
00229         case core::channel::B:
00230         {
00231             if (a_enable) {
00232                 TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT;
00233             } else {
00234                 TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT;
00235             }
00236             break;
00237         }
00238     }
00239 }
```

References [core::A](#), [core::B](#), [TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT](#), [TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT](#), [TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT](#), and [TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT](#).

9.15.3.2 enableOverflowInterrupt()

```
void core::TimerCounter0::enableOverflowInterrupt (
    const uint8_t a_enable ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 251 of file [TimerCounter0.cpp](#).

```
00252 {
00253
00254     if (a_enable) {
00255
00256         TIMER0_ENABLE_OVERFLOW_INTERRUPT;
00257
00258     } else {
00259
00260         TIMER0_DISABLE_OVERFLOW_INTERRUPT;
00261     }
00262
00263 }
```

References [TIMER0_DISABLE_OVERFLOW_INTERRUPT](#), and [TIMER0_ENABLE_OVERFLOW_INTERRUPT](#).

9.15.3.3 getClockPrescaler()

```
uint16_t core::TimerCounter0::getClockPrescaler ( ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 141 of file [TimerCounter0.cpp](#).

```
00142 {
00143     return m_clockPrescaler;
00144 }
```

9.15.3.4 getCounter()

```
uint16_t core::TimerCounter0::getCounter ( ) const [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 176 of file [TimerCounter0.cpp](#).

```
00177 {
00178     return TCNT0;
00179 }
```

9.15.3.5 getInstance()

```
core::TimerCounter0 & core::TimerCounter0::getInstance (
    const channel & ar_channel = channel::A,
    const operationMode & ar_operationMode = operationMode::normal,
    const clockSource & ar_clockSource = clockSource::noClock,
    const compareOutputMode & ar_compareOutputMode = compareOutputMode::normal )
[static]
```

Definition at line 5 of file [TimerCounter0.cpp](#).

```
00009 {
00010     static TimerCounter0 l_instance(ar_channel,
00011                                     ar_operationMode,
00012                                     ar_clockSource,
00013                                     ar_compareOutputMode);
00014
00015     return l_instance;
00016
00017
00018 }
```

9.15.3.6 getOutputCompareRegister()

```
uint16_t core::TimerCounter0::getOutputCompareRegister (
    const channel & ar_channel ) const [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 201 of file [TimerCounter0.cpp](#).

```
00202 {
00203     switch (ar_channel)
00204     {
00205         case core::channel::A:
00206         {
00207             return OCR0A;
00208         }
00209         case core::channel::B:
00210         {
00211             return OCR0B;
00212         }
00213     }
00214 }
```

References [core::A](#), and [core::B](#).

9.15.3.7 operator=()

```
const TimerCounter0& core::TimerCounter0::operator= (
    const TimerCounter0 & ) [private]
```

Override assign operator.

9.15.3.8 outputCompareMatchAServiceRoutine()

```
static void core::TimerCounter0::outputCompareMatchAServiceRoutine ( ) [static]
```

9.15.3.9 outputCompareMatchBServiceRoutine()

```
static void core::TimerCounter0::outputCompareMatchBServiceRoutine ( ) [static]
```

9.15.3.10 overflowServiceRoutine()

```
static void core::TimerCounter0::overflowServiceRoutine ( ) [static]
```

9.15.3.11 selectClockSource()

```
void core::TimerCounter0::selectClockSource (
    const clockSource & ar_clockSource ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 39 of file [TimerCounter0.cpp](#).

```
00040 {
00041     switch (ar_clockSource)
00042     {
00043         case core::clockSource::noClock:
00044         {
00045             m_clockPrescaler=0;
00046             m_clockSource=0;
00047             break;
00048         }
00049         case core::clockSource::PS_1:
00050         {
00051             m_clockPrescaler=1;
00052             m_clockSource=1;
00053             break;
00054         }
00055         case core::clockSource::PS_8:
00056         {
00057             m_clockPrescaler=8;
00058             m_clockSource=2;
00059             break;
00060         }
00061         case core::clockSource::PS_64:
00062         {
00063             m_clockPrescaler=64;
00064             m_clockSource=3;
00065             break;
00066         }
00067         case core::clockSource::PS_256:
00068         {
00069             m_clockPrescaler=256;
00070             m_clockSource=4;
00071             break;
00072         }
00073         case core::clockSource::PS_1024:
00074         {
00075             m_clockPrescaler=1024;
00076             m_clockSource=5;
00077             break;
00078         }
00079         case core::clockSource::extern_Clock_T0_Falling_Edge:
00080         {
00081             m_clockPrescaler=0;
00082             m_clockSource=6;
00083             break;
00084         }
00085         case core::clockSource::extern_Clock_T0_Rising_Edge:
00086         {
00087             m_clockPrescaler=0;
00088             m_clockSource=7;
00089             break;
00090         }
00091     }
```



```
00092
00093
00094 }
```

References [core::extern_Clock_T0_Falling_Edge](#), [core::extern_Clock_T0_Rising_Edge](#), [core::noClock](#), [core::PS_1](#), [core::PS_1024](#), [core::PS_256](#), [core::PS_64](#), and [core::PS_8](#).

9.15.3.12 selectCompareOutputMode()

```
void core::TimerCounter0::selectCompareOutputMode (
    const channel & ar_channel,
    const compareOutputMode & ar_compareOutputMode ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 152 of file [TimerCounter0.cpp](#).

```
00153 {
00154     switch (ar_channel)
00155     {
00156         case core::channel::A:
00157         {
00158             TIMER0_SELECT_COM_CHANNEL_A(static_cast<uint8_t>(ar_compareOutputMode));
00159             break;
00160         }
00161         case core::channel::B:
00162         {
00163             TIMER0_SELECT_COM_CHANNEL_B(static_cast<uint8_t>(ar_compareOutputMode));
00164             break;
00165         }
00166     }
00167 }
```

References [core::A](#), [core::B](#), [TIMER0_SELECT_COM_CHANNEL_A](#), and [TIMER0_SELECT_COM_CHANNEL_B](#).

9.15.3.13 selectOperationMode()

```
void core::TimerCounter0::selectOperationMode (
    const operationMode & ar_operationMode ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 96 of file [TimerCounter0.cpp](#).

```
00097 {
00098     switch (ar_operationMode)
00099     {
00100         case core::operationMode::normal:
00101         {
00102             TIMER0_SELECT_OPERATION_MODE(0);
00103             break;
00104         }
00105         case core::operationMode::PWM_PC:
00106         {
00107             TIMER0_SELECT_OPERATION_MODE(1);
00108             break;
00109         }
00110         case core::operationMode::CTC_OCR:
00111         {
00112             TIMER0_SELECT_OPERATION_MODE(2);
00113             break;
00114         }
00115         case core::operationMode::fast_PWM:
00116         {
00117             TIMER0_SELECT_OPERATION_MODE(3);
00118             break;
00119         }
00120     }
00121 }
```

```

00119     }
00120     case core::operationMode::PWM_PC_OCR:
00121     {
00122         TIMER0_SELECT_OPERATION_MODE(5);
00123         break;
00124     }
00125     case core::operationMode::fast_PWM_OCR:
00126     {
00127         TIMER0_SELECT_OPERATION_MODE(7);
00128         break;
00129     }
00130
00131 }
00132
00133 }

```

References [core::CTC_OCR](#), [core::fast_PWM](#), [core::fast_PWM_OCR](#), [core::normal](#), [core::PWM_PC](#), [core::PWM_PC_OCR](#), and [TIMER0_SELECT_OPERATION_MODE](#).

9.15.3.14 setCounter()

```

void core::TimerCounter0::setCounter (
    const uint16_t & ar_dataBuffer ) [override], [virtual]

```

Implements [core::TimerCounter](#).

Definition at line 171 of file [TimerCounter0.cpp](#).

```

00172 {
00173     TCNT0 = static_cast<uint8_t>(ar_dataBuffer);
00174 }

```

9.15.3.15 setOutputCompareRegister()

```

void core::TimerCounter0::setOutputCompareRegister (
    const channel & ar_channel,
    const uint16_t & ar_dataBuffer ) [override], [virtual]

```

Implements [core::TimerCounter](#).

Definition at line 181 of file [TimerCounter0.cpp](#).

```

00182 {
00183     switch (ar_channel)
00184     {
00185         case core::channel::A:
00186         {
00187             OCR0A = static_cast<uint8_t>(ar_dataBuffer);
00188             break;
00189         }
00190         case core::channel::B:
00191         {
00192             OCR0B = static_cast<uint8_t>(ar_dataBuffer);
00193             break;
00194         }
00195     }
00196 }
00197 }

```

References [core::A](#), and [core::B](#).

9.15.3.16 start()

```
void core::TimerCounter0::start ( ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 136 of file [TimerCounter0.cpp](#).

```
00137 {  
00138     TIMER0_SELECT_CLOCK_SOURCE(m_clockSource);  
00139 }
```

References [TIMER0_SELECT_CLOCK_SOURCE](#).

9.15.3.17 stop()

```
void core::TimerCounter0::stop ( ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 146 of file [TimerCounter0.cpp](#).

```
00147 {  
00148     TIMER0_STOP;  
00149 }
```

References [TIMER0_STOP](#).

9.15.4 Member Data Documentation

9.15.4.1 __externally_visible__

```
static void core::TimerCounter0::__externally_visible__
```

Definition at line 313 of file [TimerCounter0.h](#).

9.15.4.2 __used__

```
static void core::TimerCounter0::__used__
```

Definition at line 313 of file [TimerCounter0.h](#).

9.15.4.3 m_clockPrescaler

```
uint16_t core::TimerCounter0::m_clockPrescaler [private]
```

Definition at line 340 of file [TimerCounter0.h](#).

9.15.4.4 m_clockSource

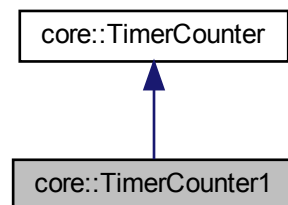
```
uint8_t core::TimerCounter0::m_clockSource [private]
```

Definition at line 342 of file [TimerCounter0.h](#).

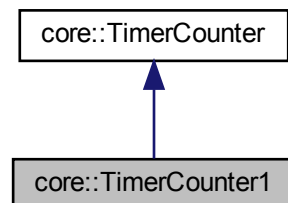
9.16 core::TimerCounter1 Class Reference

```
#include <TimerCounter1.h>
```

Inheritance diagram for core::TimerCounter1:



Collaboration diagram for core::TimerCounter1:



Public Member Functions

- void [selectOperationMode](#) (const [operationMode](#) &ar_operationMode) override
- void [start](#) () override
- void [stop](#) () override
- void [selectClockSource](#) (const [clockSource](#) &ar_clockSource) override
- void [selectCompareOutputMode](#) (const [channel](#) &ar_channel, const [compareOutputMode](#) &ar_compareOutputMode) override
- void [setCounter](#) (const uint16_t &ar_dataBuffer) override
- uint16_t [getCounter](#) () const override
- void [setOutputCompareRegister](#) (const [channel](#) &ar_channel, const uint16_t &ar_dataBuffer) override
- uint16_t [getOutputCompareRegister](#) (const [channel](#) &ar_channel) const override
- void [setInputCaptureRegister](#) (const uint16_t &ar_dataBuffer)
- uint16_t [getInputCaptureRegister](#) () const
- void [enableOutputCompareMatchInterrupt](#) (const [channel](#) &ar_channel, const uint8_t a_enable) override
- void [enableOverflowInterrupt](#) (const uint8_t a_enable) override
- void [enableInputCaptureInterrupt](#) (const uint8_t a_enable)
- uint16_t [getClockPrescaler](#) () override

Static Public Member Functions

- static [TimerCounter1](#) & [getInstance](#) (const [channel](#) &ar_channel=[channel::A](#), const [operationMode](#) &ar_operationMode=[operationMode::normal](#), const [clockSource](#) &ar_clockSource=[clockSource::noClock](#), const [compareOutputMode](#) &ar_compareOutputMode=[compareOutputMode::normal](#))
- static void [outputCompareMatchAServiceRoutine](#) () __asm__(STR(TIMER1_COM_CHANNEL_A_INTERRUPT)) __attribute__((__signal__))
- static void [outputCompareMatchBServiceRoutine](#) () __asm__(STR(TIMER1_COM_CHANNEL_B_INTERRUPT)) __attribute__((__signal__))
- static void [overflowServiceRoutine](#) () __asm__(STR(TIMER1_OVERFLOW_INTERRUPT)) __attribute__((__signal__))
- static void [inputCaptureServiceRoutine](#) () __asm__(STR(TIMER1_INPUT_CAPTURE_INTERRUPT)) __attribute__((__signal__))

Public Attributes

- static void [__used__](#)
- static void [__externally_visible__](#)

Private Member Functions

- [TimerCounter1](#) (const [channel](#) &ar_channel, const [operationMode](#) &ar_operationMode, const [clockSource](#) &ar_clockSource, const [compareOutputMode](#) &ar_compareOutputMode)
- [~TimerCounter1](#) ()
- [TimerCounter1](#) (const [TimerCounter1](#) &)
- const [TimerCounter1](#) & [operator=](#) (const [TimerCounter1](#) &)

Private Attributes

- uint16_t [m_clockPrescaler](#)
- uint8_t [m_clockSource](#)

9.16.1 Detailed Description

Definition at line 279 of file [TimerCounter1.h](#).

9.16.2 Constructor & Destructor Documentation

9.16.2.1 TimerCounter1() [1/2]

```
core::TimerCounter1::TimerCounter1 (
    const channel & ar_channel,
    const operationMode & ar_operationMode,
    const clockSource & ar_clockSource,
    const compareOutputMode & ar_compareOutputMode ) [private]
```

Definition at line 20 of file [TimerCounter1.cpp](#).

```
00024 {
00025     core::MCU::enableTimerCounter1(1);
00026     stop();
00027     selectOperationMode(ar_operationMode);
00028     selectClockSource(ar_clockSource);
00029     selectCompareOutputMode(ar_channel,ar_compareOutputMode);
00030
00031
00032 }
```

References [core::MCU::enableTimerCounter1\(\)](#).

9.16.2.2 ~TimerCounter1()

```
core::TimerCounter1::~~TimerCounter1 ( ) [private]
```

Definition at line 33 of file [TimerCounter1.cpp](#).

```
00034 {
00035
00036 }
```

9.16.2.3 TimerCounter1() [2/2]

```
core::TimerCounter1::TimerCounter1 (
    const TimerCounter1 & ) [private]
```

Overried Copy constructor.

9.16.3 Member Function Documentation

9.16.3.1 enableInputCaptureInterrupt()

```
void core::TimerCounter1::enableInputCaptureInterrupt (
    const uint8_t a_enable )
```

Definition at line 309 of file [TimerCounter1.cpp](#).

```
00310 {
00311     if (a_enable) {
00312         TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT;
00313     } else {
00314         TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT;
00315     }
00316 }
```

References [TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT](#), and [TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT](#).

9.16.3.2 enableOutputCompareMatchInterrupt()

```
void core::TimerCounter1::enableOutputCompareMatchInterrupt (
    const channel & ar_channel,
    const uint8_t a_enable ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 260 of file [TimerCounter1.cpp](#).

```
00261 {
00262     switch (ar_channel)
00263     {
00264         case core::channel::A:
00265         {
00266             if (a_enable) {
00267                 TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT;
00268             } else {
00269                 TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT;
00270             }
00271             break;
00272         }
00273         case core::channel::B:
00274         {
00275             if (a_enable) {
00276                 TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT;
00277             } else {
00278                 TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT;
00279             }
00280             break;
00281         }
00282     }
00283 }
```

References [core::A](#), [core::B](#), [TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT](#), [TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT](#), [TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT](#), and [TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT](#).

9.16.3.3 enableOverflowInterrupt()

```
void core::TimerCounter1::enableOverflowInterrupt (
    const uint8_t a_enable ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 295 of file [TimerCounter1.cpp](#).

```
00296 {
00297
00298     if (a_enable) {
00299
00300         TIMER1_ENABLE_OVERFLOW_INTERRUPT;
00301
00302     } else {
00303
00304         TIMER1_DISABLE_OVERFLOW_INTERRUPT;
00305     }
00306 }
00307 }
```

References [TIMER1_DISABLE_OVERFLOW_INTERRUPT](#), and [TIMER1_ENABLE_OVERFLOW_INTERRUPT](#).

9.16.3.4 getClockPrescaler()

```
uint16_t core::TimerCounter1::getClockPrescaler ( ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 186 of file [TimerCounter1.cpp](#).

```
00187 {
00188     return m_clockPrescaler;
00189 }
```

Referenced by [component::ServoMotor::connect\(\)](#), and [component::ServoMotor::rotate\(\)](#).

9.16.3.5 getCounter()

```
uint16_t core::TimerCounter1::getCounter ( ) const [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 221 of file [TimerCounter1.cpp](#).

```
00222 {
00223     return TCNT1;
00224 }
```

9.16.3.6 getInputCaptureRegister()

```
uint16_t core::TimerCounter1::getInputCaptureRegister ( ) const
```

Definition at line 327 of file [TimerCounter1.cpp](#).

```
00328 {
00329     return ICR1;
00330 }
```


9.16.3.7 getInstance()

```
core::TimerCounter1 & core::TimerCounter1::getInstance (
    const channel & ar_channel = channel::A,
    const operationMode & ar_operationMode = operationMode::normal,
    const clockSource & ar_clockSource = clockSource::noClock,
    const compareOutputMode & ar_compareOutputMode = compareOutputMode::normal )
[static]
```

Definition at line 5 of file [TimerCounter1.cpp](#).

```
00009 {
00010     static TimerCounter1 l_instance(ar_channel,
00011                                     ar_operationMode,
00012                                     ar_clockSource,
00013                                     ar_compareOutputMode);
00014
00015     return l_instance;
00016
00017
00018 }
```

9.16.3.8 getOutputCompareRegister()

```
uint16_t core::TimerCounter1::getOutputCompareRegister (
    const channel & ar_channel ) const [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 245 of file [TimerCounter1.cpp](#).

```
00246 {
00247     switch (ar_channel)
00248     {
00249         case core::channel::A:
00250         {
00251             return OCR1A;
00252         }
00253         case core::channel::B:
00254         {
00255             return OCR1B;
00256         }
00257     }
00258 }
```

References [core::A](#), and [core::B](#).

9.16.3.9 inputCaptureServiceRoutine()

```
static void core::TimerCounter1::inputCaptureServiceRoutine ( ) [static]
```

9.16.3.10 operator=()

```
const TimerCounter1& core::TimerCounter1::operator= (
    const TimerCounter1 & ) [private]
```

Override assign operator.

9.16.3.11 outputCompareMatchAServiceRoutine()

```
static void core::TimerCounter1::outputCompareMatchAServiceRoutine ( ) [static]
```

9.16.3.12 outputCompareMatchBServiceRoutine()

```
static void core::TimerCounter1::outputCompareMatchBServiceRoutine ( ) [static]
```

9.16.3.13 overflowServiceRoutine()

```
static void core::TimerCounter1::overflowServiceRoutine ( ) [static]
```

9.16.3.14 selectClockSource()

```
void core::TimerCounter1::selectClockSource (
    const clockSource & ar_clockSource ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 38 of file [TimerCounter1.cpp](#).

```
00039 {
00040     switch (ar_clockSource)
00041     {
00042         case core::clockSource::noClock:
00043         {
00044             m_clockPrescaler=0;
00045             m_clockSource=0;
00046             break;
00047         }
00048         case core::clockSource::PS_1:
00049         {
00050             m_clockPrescaler=1;
00051             m_clockSource=1;
00052             break;
00053         }
00054         case core::clockSource::PS_8:
00055         {
00056             m_clockPrescaler=8;
00057             m_clockSource=2;
00058             break;
00059         }
00060         case core::clockSource::PS_64:
00061         {
00062             m_clockPrescaler=64;
00063             m_clockSource=3;
00064             break;
00065         }
00066         case core::clockSource::PS_256:
00067         {
00068             m_clockPrescaler=256;
00069             m_clockSource=4;
00070             break;
00071         }
00072         case core::clockSource::PS_1024:
00073         {
00074             m_clockPrescaler=1024;
00075             m_clockSource=5;
00076             break;
00077         }
00078         case core::clockSource::extern_Clock_T0_Falling_Edge:
```

```

00079     {
00080         m_clockPrescaler=0;
00081         m_clockSource=6;
00082         break;
00083     }
00084     case core::clockSource::extern_Clock_T0_Rising_Edge:
00085     {
00086         m_clockPrescaler=0;
00087         m_clockSource=7;
00088         break;
00089     }
00090 }
00091
00092
00093 }
```

References [core::extern_Clock_T0_Falling_Edge](#), [core::extern_Clock_T0_Rising_Edge](#), [core::noClock](#), [core::PS_1](#), [core::PS_1024](#), [core::PS_256](#), [core::PS_64](#), and [core::PS_8](#).

9.16.3.15 selectCompareOutputMode()

```

void core::TimerCounter1::selectCompareOutputMode (
    const channel & ar_channel,
    const compareOutputMode & ar_compareOutputMode ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 197 of file [TimerCounter1.cpp](#).

```

00198 {
00199     switch (ar_channel)
00200     {
00201         case core::channel::A:
00202         {
00203             TIMER1_SELECT_COM_CHANNEL_A(static_cast<uint8_t>(ar_compareOutputMode));
00204             break;
00205         }
00206         case core::channel::B:
00207         {
00208             TIMER1_SELECT_COM_CHANNEL_B(static_cast<uint8_t>(ar_compareOutputMode));
00209             break;
00210         }
00211     }
00212 }
00213 }
```

References [core::A](#), [core::B](#), [TIMER1_SELECT_COM_CHANNEL_A](#), and [TIMER1_SELECT_COM_CHANNEL_B](#).

Referenced by [component::ServoMotor::connect\(\)](#), and [component::ServoMotor::disconnect\(\)](#).

9.16.3.16 selectOperationMode()

```

void core::TimerCounter1::selectOperationMode (
    const operationMode & ar_operationMode ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 95 of file [TimerCounter1.cpp](#).

```

00096 {
00097     switch (ar_operationMode)
00098     {
00099         case core::operationMode::normal:
00100         {
00101             TIMER1_SELECT_OPERATION_MODE(0);
```

```

00102         break;
00103     }
00104     case core::operationMode::PWM_PC_8bit:
00105     {
00106         TIMER1_SELECT_OPERATION_MODE(1);
00107         break;
00108     }
00109     case core::operationMode::PWM_PC_9bit:
00110     {
00111         TIMER1_SELECT_OPERATION_MODE(2);
00112         break;
00113     }
00114     case core::operationMode::PWM_PC_10bit:
00115     {
00116         TIMER1_SELECT_OPERATION_MODE(3);
00117         break;
00118     }
00119     case core::operationMode::CTC_OCR:
00120     {
00121         TIMER1_SELECT_OPERATION_MODE(4);
00122         break;
00123     }
00124     case core::operationMode::fast_PWM_8bit:
00125     {
00126         TIMER1_SELECT_OPERATION_MODE(5);
00127         break;
00128     }
00129     case core::operationMode::fast_PWM_9bit:
00130     {
00131         TIMER1_SELECT_OPERATION_MODE(6);
00132         break;
00133     }
00134     case core::operationMode::fast_PWM_10bit:
00135     {
00136         TIMER1_SELECT_OPERATION_MODE(7);
00137         break;
00138     }
00139     case core::operationMode::PWM_PFC_ICR:
00140     {
00141         TIMER1_SELECT_OPERATION_MODE(8);
00142         break;
00143     }
00144     case core::operationMode::PWM_PFC_OCR:
00145     {
00146         TIMER1_SELECT_OPERATION_MODE(9);
00147         break;
00148     }
00149     case core::operationMode::PWM_PC_ICR:
00150     {
00151         TIMER1_SELECT_OPERATION_MODE(10);
00152         break;
00153     }
00154     case core::operationMode::PWM_PC_OCR:
00155     {
00156         TIMER1_SELECT_OPERATION_MODE(11);
00157         break;
00158     }
00159     case core::operationMode::CTC_ICR:
00160     {
00161         TIMER1_SELECT_OPERATION_MODE(12);
00162         break;
00163     }
00164     case core::operationMode::fast_PWM_ICR:
00165     {
00166         TIMER1_SELECT_OPERATION_MODE(14);
00167         break;
00168     }
00169     case core::operationMode::fast_PWM_OCR:
00170     {
00171         TIMER1_SELECT_OPERATION_MODE(15);
00172         break;
00173     }
00174 }
00175 }
00176
00177
00178 }

```

References [core::CTC_ICR](#), [core::CTC_OCR](#), [core::fast_PWM_10bit](#), [core::fast_PWM_8bit](#), [core::fast_PWM_9bit](#), [core::fast_PWM_ICR](#), [core::fast_PWM_OCR](#), [core::normal](#), [core::PWM_PC_10bit](#), [core::PWM_PC_8bit](#), [core::PWM_PC_9bit](#), [core::PWM_PC_ICR](#), [core::PWM_PC_OCR](#), [core::PWM_PFC_ICR](#), [core::PWM_PFC_OCR](#), and [TIMER1_SELECT_OPERATION_MODE](#).

Referenced by [component::ServoMotor::connect\(\)](#).

9.16.3.17 setCounter()

```
void core::TimerCounter1::setCounter (
    const uint16_t & ar_dataBuffer ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 216 of file [TimerCounter1.cpp](#).

```
00217 {
00218     TCNT1 = ar_dataBuffer;
00219 }
```

Referenced by [component::ServoMotor::connect\(\)](#).

9.16.3.18 setInputCaptureRegister()

```
void core::TimerCounter1::setInputCaptureRegister (
    const uint16_t & ar_dataBuffer )
```

Definition at line 321 of file [TimerCounter1.cpp](#).

```
00322 {
00323     ICR1 = ar_dataBuffer;
00324 }
```

Referenced by [component::ServoMotor::connect\(\)](#).

9.16.3.19 setOutputCompareRegister()

```
void core::TimerCounter1::setOutputCompareRegister (
    const channel & ar_channel,
    const uint16_t & ar_dataBuffer ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 226 of file [TimerCounter1.cpp](#).

```
00227 {
00228     switch (ar_channel)
00229     {
00230         case core::channel::A:
00231         {
00232             OCR1A = ar_dataBuffer;
00233             break;
00234         }
00235         case core::channel::B:
00236         {
00237             OCR1B = ar_dataBuffer;
00238             break;
00239         }
00240     }
00241 }
```

References [core::A](#), and [core::B](#).

Referenced by [component::ServoMotor::rotate\(\)](#).

9.16.3.20 start()

```
void core::TimerCounter1::start ( ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 181 of file [TimerCounter1.cpp](#).

```
00182 {  
00183     TIMER1\_SELECT\_CLOCK\_SOURCE(m_clockSource);  
00184 }
```

References [TIMER1_SELECT_CLOCK_SOURCE](#).

Referenced by [component::ServoMotor::rotate\(\)](#).

9.16.3.21 stop()

```
void core::TimerCounter1::stop ( ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 191 of file [TimerCounter1.cpp](#).

```
00192 {  
00193     TIMER1\_STOP;  
00194 }
```

References [TIMER1_STOP](#).

Referenced by [component::ServoMotor::disconnect\(\)](#).

9.16.4 Member Data Documentation

9.16.4.1 __externally_visible__

```
static void core::TimerCounter1::__externally_visible__
```

Definition at line 320 of file [TimerCounter1.h](#).

9.16.4.2 __used__

```
static void core::TimerCounter1::__used__
```

Definition at line 320 of file [TimerCounter1.h](#).

9.16.4.3 m_clockPrescaler

```
uint16_t core::TimerCounter1::m_clockPrescaler [private]
```

Definition at line 349 of file [TimerCounter1.h](#).

9.16.4.4 m_clockSource

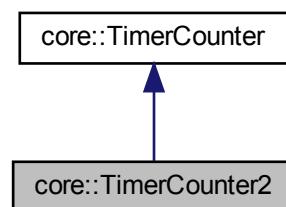
```
uint8_t core::TimerCounter1::m_clockSource [private]
```

Definition at line 351 of file [TimerCounter1.h](#).

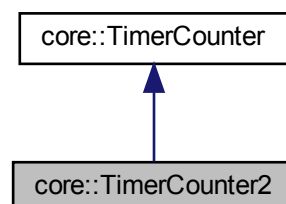
9.17 core::TimerCounter2 Class Reference

```
#include <TimerCounter2.h>
```

Inheritance diagram for core::TimerCounter2:



Collaboration diagram for core::TimerCounter2:



Public Member Functions

- void [selectOperationMode](#) (const [operationMode](#) &ar_operationMode) override
- void [start](#) () override
- void [stop](#) () override
- void [selectClockSource](#) (const [clockSource](#) &ar_clockSource) override
- void [selectCompareOutputMode](#) (const [channel](#) &ar_channel, const [compareOutputMode](#) &ar_compareOutputMode) override
- void [setCounter](#) (const uint16_t &ar_dataBuffer) override
- uint16_t [getCounter](#) () const override
- void [setOutputCompareRegister](#) (const [channel](#) &ar_channel, const uint16_t &ar_dataBuffer) override
- uint16_t [getOutputCompareRegister](#) (const [channel](#) &ar_channel) const override
- void [enableOutputCompareMatchInterrupt](#) (const [channel](#) &ar_channel, const uint8_t a_enable) override
- void [enableOverflowInterrupt](#) (const uint8_t a_enable) override
- uint16_t [getClockPrescaler](#) () override

Static Public Member Functions

- static [TimerCounter2](#) & [getInstance](#) (const [channel](#) &ar_channel=[channel::A](#), const [operationMode](#) &ar_operationMode=[operationMode::normal](#), const [clockSource](#) &ar_clockSource=[clockSource::noClock](#), const [compareOutputMode](#) &ar_compareOutputMode=[compareOutputMode::normal](#))
- static void [outputCompareMatchAServiceRoutine](#) () __asm__(STR(TIMER2_COM_CHANNEL_A_INTERRUPT)) __attribute__((__signal__))
- static void [outputCompareMatchBServiceRoutine](#) () __asm__(STR(TIMER2_COM_CHANNEL_B_INTERRUPT)) __attribute__((__signal__))
- static void [overflowServiceRoutine](#) () __asm__(STR(TIMER2_OVERFLOW_INTERRUPT)) __attribute__((__signal__))

Public Attributes

- static void [__used__](#)
- static void [__externally_visible__](#)

Private Member Functions

- [TimerCounter2](#) (const [channel](#) &ar_channel, const [operationMode](#) &ar_operationMode, const [clockSource](#) &ar_clockSource, const [compareOutputMode](#) &ar_compareOutputMode)
- [~TimerCounter2](#) ()
- [TimerCounter2](#) (const [TimerCounter2](#) &)
- const [TimerCounter2](#) & [operator=](#) (const [TimerCounter2](#) &)

Private Attributes

- uint16_t [m_clockPrescaler](#)
- uint8_t [m_clockSource](#)

9.17.1 Detailed Description

Definition at line 279 of file [TimerCounter2.h](#).

9.17.2 Constructor & Destructor Documentation

9.17.2.1 TimerCounter2() [1/2]

```
core::TimerCounter2::TimerCounter2 (
    const channel & ar_channel,
    const operationMode & ar_operationMode,
    const clockSource & ar_clockSource,
    const compareOutputMode & ar_compareOutputMode ) [private]
```

Definition at line 20 of file [TimerCounter2.cpp](#).

```
00024 {
00025     core::MCU::enableTimerCounter2(1);
00026     stop();
00027     selectOperationMode(ar_operationMode);
00028     selectClockSource(ar_clockSource);
00029     selectCompareOutputMode(ar_channel, ar_compareOutputMode);
00030
00031 }
```

References [core::MCU::enableTimerCounter2\(\)](#).

9.17.2.2 ~TimerCounter2()

```
core::TimerCounter2::~~TimerCounter2 ( ) [private]
```

Definition at line 32 of file [TimerCounter2.cpp](#).

```
00033 {
00034
00035 }
```

9.17.2.3 TimerCounter2() [2/2]

```
core::TimerCounter2::TimerCounter2 (
    const TimerCounter2 & ) [private]
```

Overried Copy constructor.

9.17.3 Member Function Documentation

9.17.3.1 enableOutputCompareMatchInterrupt()

```
void core::TimerCounter2::enableOutputCompareMatchInterrupt (
    const channel & ar_channel,
    const uint8_t a_enable ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 215 of file [TimerCounter2.cpp](#).

```
00216 {
00217     switch (ar_channel)
00218     {
00219         case core::channel::A:
00220         {
00221             if (a_enable) {
00222
00223                 TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT;
00224
00225             } else {
00226
00227                 TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT;
00228
00229             }
00230             break;
00231         }
00232         case core::channel::B:
00233         {
00234             if (a_enable) {
00235
00236                 TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT;
00237
00238             } else {
00239
00240                 TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT;
00241
00242             }
00243             break;
00244         }
00245     }
00246 }
```

References [core::A](#), [core::B](#), [TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT](#), [TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT](#), [TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT](#), and [TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT](#).

9.17.3.2 enableOverflowInterrupt()

```
void core::TimerCounter2::enableOverflowInterrupt (
    const uint8_t a_enable ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 250 of file [TimerCounter2.cpp](#).

```
00251 {
00252
00253     if (a_enable) {
00254
00255         TIMER2_ENABLE_OVERFLOW_INTERRUPT;
00256
00257     } else {
00258
00259         TIMER2_DISABLE_OVERFLOW_INTERRUPT;
00260     }
00261 }
00262 }
```

References [TIMER2_DISABLE_OVERFLOW_INTERRUPT](#), and [TIMER2_ENABLE_OVERFLOW_INTERRUPT](#).

9.17.3.3 getClockPrescaler()

```
uint16_t core::TimerCounter2::getClockPrescaler ( ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 138 of file [TimerCounter2.cpp](#).

```
00139 {  
00140     return m_clockPrescaler;  
00141 }
```

9.17.3.4 getCounter()

```
uint16_t core::TimerCounter2::getCounter ( ) const [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 176 of file [TimerCounter2.cpp](#).

```
00177 {  
00178     return TCNT2;  
00179 }
```

9.17.3.5 getInstance()

```
core::TimerCounter2 & core::TimerCounter2::getInstance (  
    const channel & ar_channel = channel::A,  
    const operationMode & ar_operationMode = operationMode::normal,  
    const clockSource & ar_clockSource = clockSource::noClock,  
    const compareOutputMode & ar_compareOutputMode = compareOutputMode::normal )  
[static]
```

Definition at line 5 of file [TimerCounter2.cpp](#).

```
00009 {  
00010     static TimerCounter2 l_instance(ar_channel,  
00011                                     ar_operationMode,  
00012                                     ar_clockSource,  
00013                                     ar_compareOutputMode);  
00014  
00015     return l_instance;  
00016  
00017  
00018 }
```

9.17.3.6 getOutputCompareRegister()

```
uint16_t core::TimerCounter2::getOutputCompareRegister (
    const channel & ar_channel ) const [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 199 of file [TimerCounter2.cpp](#).

```
00200 {
00201     switch (ar_channel)
00202     {
00203         case core::channel::A:
00204         {
00205             return OCR2A;
00206         }
00207         case core::channel::B:
00208         {
00209             return OCR2B;
00210         }
00211     }
00212 }
00213 }
```

References [core::A](#), and [core::B](#).

9.17.3.7 operator=()

```
const TimerCounter2& core::TimerCounter2::operator= (
    const TimerCounter2 & ) [private]
```

Override assign operator.

9.17.3.8 outputCompareMatchAServiceRoutine()

```
static void core::TimerCounter2::outputCompareMatchAServiceRoutine ( ) [static]
```

9.17.3.9 outputCompareMatchBServiceRoutine()

```
static void core::TimerCounter2::outputCompareMatchBServiceRoutine ( ) [static]
```

9.17.3.10 overflowServiceRoutine()

```
static void core::TimerCounter2::overflowServiceRoutine ( ) [static]
```

9.17.3.11 selectClockSource()

```
void core::TimerCounter2::selectClockSource (
    const clockSource & ar_clockSource ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 37 of file [TimerCounter2.cpp](#).

```
00038 {
00039     switch (ar_clockSource)
00040     {
00041         case core::clockSource::noClock:
00042         {
00043             m_clockPrescaler=0;
00044             m_clockSource=0;
00045             break;
00046         }
00047         case core::clockSource::PS_1:
00048         {
00049             m_clockPrescaler=1;
00050             m_clockSource=1;
00051             break;
00052         }
00053         case core::clockSource::PS_8:
00054         {
00055             m_clockPrescaler=8;
00056             m_clockSource=2;
00057             break;
00058         }
00059         case core::clockSource::PS_32:
00060         {
00061             m_clockPrescaler=32;
00062             m_clockSource=3;
00063             break;
00064         }
00065         case core::clockSource::PS_64:
00066         {
00067             m_clockPrescaler=64;
00068             m_clockSource=4;
00069             break;
00070         }
00071         case core::clockSource::PS_128:
00072         {
00073             m_clockPrescaler=128;
00074             m_clockSource=5;
00075             break;
00076         }
00077         case core::clockSource::PS_256:
00078         {
00079             m_clockPrescaler=256;
00080             m_clockSource=6;
00081             break;
00082         }
00083         case core::clockSource::PS_1024:
00084         {
00085             m_clockPrescaler=1024;
00086             m_clockSource=7;
00087             break;
00088         }
00089     }
00090 }
00091 }
```

References [core::noClock](#), [core::PS_1](#), [core::PS_1024](#), [core::PS_128](#), [core::PS_256](#), [core::PS_32](#), [core::PS_64](#), and [core::PS_8](#).

9.17.3.12 selectCompareOutputMode()

```
void core::TimerCounter2::selectCompareOutputMode (
    const channel & ar_channel,
    const compareOutputMode & ar_compareOutputMode ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 150 of file [TimerCounter2.cpp](#).

```
00151 {
00152     switch (ar_channel)
00153     {
00154         case core::channel::A:
00155         {
00156             TIMER2_SELECT_COM_CHANNEL_A(static_cast<uint8_t>(ar_compareOutputMode));
00157             break;
00158         }
00159         case core::channel::B:
00160         {
00161             TIMER2_SELECT_COM_CHANNEL_B(static_cast<uint8_t>(ar_compareOutputMode));
00162             break;
00163         }
00164     }
00165 }
00166
00167 }
```

References [core::A](#), [core::B](#), [TIMER2_SELECT_COM_CHANNEL_A](#), and [TIMER2_SELECT_COM_CHANNEL_B](#).

9.17.3.13 selectOperationMode()

```
void core::TimerCounter2::selectOperationMode (
    const operationMode & ar_operationMode ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 93 of file [TimerCounter2.cpp](#).

```
00094 {
00095     switch (ar_operationMode)
00096     {
00097         case core::operationMode::normal:
00098         {
00099             TIMER2_SELECT_OPERATION_MODE(0);
00100             break;
00101         }
00102         case core::operationMode::PWM_PC:
00103         {
00104             TIMER2_SELECT_OPERATION_MODE(1);
00105             break;
00106         }
00107         case core::operationMode::CTC_OCR:
00108         {
00109             TIMER2_SELECT_OPERATION_MODE(2);
00110             break;
00111         }
00112         case core::operationMode::fast_PWM:
00113         {
00114             TIMER2_SELECT_OPERATION_MODE(3);
00115             break;
00116         }
00117         case core::operationMode::PWM_PC_OCR:
00118         {
00119             TIMER2_SELECT_OPERATION_MODE(5);
00120             break;
00121         }
00122         case core::operationMode::fast_PWM_OCR:
00123         {
00124             TIMER2_SELECT_OPERATION_MODE(7);
00125             break;
00126         }
00127     }
00128 }
00129
00130 }
```

References [core::CTC_OCR](#), [core::fast_PWM](#), [core::fast_PWM_OCR](#), [core::normal](#), [core::PWM_PC](#), [core::PWM_PC_OCR](#), and [TIMER2_SELECT_OPERATION_MODE](#).

9.17.3.14 setCounter()

```
void core::TimerCounter2::setCounter (
    const uint16_t & ar_dataBuffer ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 171 of file [TimerCounter2.cpp](#).

```
00172 {
00173     TCNT2 = static_cast<uint8_t>(ar_dataBuffer);
00174 }
```

9.17.3.15 setOutputCompareRegister()

```
void core::TimerCounter2::setOutputCompareRegister (
    const channel & ar_channel,
    const uint16_t & ar_dataBuffer ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 181 of file [TimerCounter2.cpp](#).

```
00182 {
00183     switch (ar_channel)
00184     {
00185         case core::channel::A:
00186         {
00187             OCR2A = static_cast<uint8_t>(ar_dataBuffer);
00188             break;
00189         }
00190         case core::channel::B:
00191         {
00192             OCR2B = static_cast<uint8_t>(ar_dataBuffer);
00193             break;
00194         }
00195     }
00196 }
```

References [core::A](#), and [core::B](#).

9.17.3.16 start()

```
void core::TimerCounter2::start ( ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 133 of file [TimerCounter2.cpp](#).

```
00134 {
00135     TIMER2_SELECT_CLOCK_SOURCE(m_clockSource);
00136 }
```

References [TIMER2_SELECT_CLOCK_SOURCE](#).

9.17.3.17 stop()

```
void core::TimerCounter2::stop ( ) [override], [virtual]
```

Implements [core::TimerCounter](#).

Definition at line 144 of file [TimerCounter2.cpp](#).

```
00145 {  
00146     TIMER2_STOP;  
00147 }
```

References [TIMER2_STOP](#).

9.17.4 Member Data Documentation

9.17.4.1 __externally_visible__

```
static void core::TimerCounter2::__externally_visible__
```

Definition at line 313 of file [TimerCounter2.h](#).

9.17.4.2 __used__

```
static void core::TimerCounter2::__used__
```

Definition at line 313 of file [TimerCounter2.h](#).

9.17.4.3 m_clockPrescaler

```
uint16_t core::TimerCounter2::m_clockPrescaler [private]
```

Definition at line 338 of file [TimerCounter2.h](#).

9.17.4.4 m_clockSource

```
uint8_t core::TimerCounter2::m_clockSource [private]
```

Definition at line 340 of file [TimerCounter2.h](#).

9.18 io::USART0 Class Reference

Class for handling [USART0](#) component.

```
#include <USART0.h>
```

Public Member Functions

- void [setBaudRate](#) ()
- void [setTransmissionMode](#) (const [transmissionMode](#) &ar_transMode)
- void [setCommunicationMode](#) (const [communicationMode](#) &ar_comMode)
- void [setParityMode](#) (const [parityMode](#) &ar_parityMode)
- void [setFrameSize](#) (const [frameSize](#) &ar_frameSize)
- void [setStopBit](#) (const [stopBit](#) &ar_stopBit)
- void [sendFrame](#) (const uint8_t *ap_dataBuffer, const uint8_t a_size)
- void [sendString](#) (const char *ap_string)
- void [receiveString](#) (const char *ap_string)
- void [sendChar](#) (const uint8_t &ar_char)
- void [sendByte](#) (const uint8_t &ar_byte)
- void [sendWord](#) (const uint16_t &ar_word)
- void [sendLong](#) (const uint32_t &ar_long)
- void [receiveChar](#) (uint8_t &ar_char)
- void [receiveFrame](#) (uint8_t *ap_dataBuffer, const uint8_t a_size)
- void [enableTransmitCompleteInterrupt](#) (const uint8_t a_enable)
- void [enableReceiveCompleteInterrupt](#) (const uint8_t a_enable)
- uint8_t [frameError](#) ()
- uint8_t [dataOverrun](#) ()
- uint8_t [parityError](#) ()
- uint16_t [getNumberBytesReceived](#) ()
- uint16_t [getNumberBytesSent](#) ()
- uint8_t [ready2Send](#) ()
- void [resetNumberBytesReceived](#) ()

Static Public Member Functions

- static [USART0](#) & [getInstance](#) (const [transmissionMode](#) &ar_transMode=[transmissionMode::async](#), const [communicationMode](#) &ar_comMode=[communicationMode::duplex](#), const [frameSize](#) &ar_frameSize=[frameSize::eightBits](#), const [stopBit](#) &ar_stopBit=[stopBit::oneStopBit](#), const [parityMode](#) &ar_parityMode=[parityMode::noParity](#))
- static void [enableDataRegisterEmptyInterrupt](#) (const uint8_t a_enable)
- static void [receiveCompleteServiceRoutine](#) () __asm__(STR(USART0_RECEIVE_COMPLETE_INTERRUPT)) __attribute__((__signal__))
- static void [dataRegisterEmptyServiceRoutine](#) () __asm__(STR(USART0_DATA_REGISTER_EMPTY_INTERRUPT)) __attribute__((__signal__))
- static void [transmitCompleteServiceRoutine](#) () __asm__(STR(USART0_TRANSMIT_COMPLETE_INTERRUPT)) __attribute__((__signal__))

Public Attributes

- static void [__used__](#)
- static void [__externally_visible__](#)

Private Member Functions

- `USART0` (const `transmissionMode` &ar_transMode, const `communicationMode` &ar_comMode, const `frameSize` &ar_frameSize, const `stopBit` &ar_stopBit, const `parityMode` &ar_parityMode)
- `~USART0` ()
- `USART0` (const `USART0` &)
- const `USART0` & `operator=` (const `USART0` &)

Static Private Attributes

- static volatile uint8_t `m_status` = 0
- static const uint8_t * `mp_data2Send` = nullptr
- static uint8_t * `mp_data2Receive` = nullptr
- static uint16_t `m_sizeData2Send` = 0
- static uint16_t `m_sizeData2Receive` = 0
- static volatile uint16_t `m_numberBytesReceived` = 0
- static volatile uint16_t `m_numberBytesSent` = 0
- static volatile uint8_t `m_ready2Send` = 1

9.18.1 Detailed Description

Class for handling `USART0` component.

The class implements `USART0` component operations

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Definition at line 98 of file `USART0.h`.

9.18.2 Constructor & Destructor Documentation

9.18.2.1 `USART0()` [1/2]

```
io::USART0::USART0 (
    const transmissionMode & ar_transMode,
    const communicationMode & ar_comMode,
    const frameSize & ar_frameSize,
    const stopBit & ar_stopBit,
    const parityMode & ar_parityMode ) [private]
```

Constructor.

Initializes the `USART0` object

Parameters

<i>ar_transMode</i>	defines transmission mode
<i>ar_comMode</i>	defines communication mode
<i>ar_frameSize</i>	defines data frame size
<i>ar_stopBit</i>	defines number of stop bits
<i>ar_parityMode</i>	defines parity mode

Definition at line 43 of file [USART0.cpp](#).

```

00049 {
00050     core::MCU::enableUSART0(1);
00051     setBaudRate();
00052     setTransmissionMode(ar_transMode);
00053     setCommunicationMode(ar_comMode);
00054     setParityMode(ar_parityMode);
00055     setFrameSize(ar_frameSize);
00056     setStopBit(ar_stopBit);
00057     sei();
00058     enableReceiveCompleteInterrupt(1);
00059 }
```

References [core::MCU::enableUSART0\(\)](#).

9.18.2.2 ~USART0()

```
io::USART0::~~USART0 ( ) [private]
```

Destructor.

Definition at line 61 of file [USART0.cpp](#).

```

00062 {
00063
00064 }
```

9.18.2.3 USART0() [2/2]

```
io::USART0::USART0 (
    const USART0 & ) [private]
```

Overried Copy constructor.

9.18.3 Member Function Documentation

9.18.3.1 dataOverrun()

```
uint8_t io::USART0::dataOverrun ( )
```

Is there data overrun in received data

Returns

Status of received data

Definition at line 204 of file [USART0.cpp](#).

```
00205 {
00206     return (m_status & (1 << USART0_DATA_OVERRUN));
00207
00208 }
```

References [USART0_DATA_OVERRUN](#).

9.18.3.2 dataRegisterEmptyServiceRoutine()

```
void io::USART0::dataRegisterEmptyServiceRoutine ( ) [static]
```

Data register empty ISR

Definition at line 340 of file [USART0.cpp](#).

```
00341 {
00342
00343     if (m_sizeData2Send)
00344     {
00345         m_ready2Send = 0;
00346         USART0_DATA_REGISTER = *mp_data2Send++;
00347         m_sizeData2Send--;
00348         m_numberBytesSent++;
00349     }
00350
00351     else
00352     {
00353         enableDataRegisterEmptyInterrupt (0);
00354         m_numberBytesSent = 0;
00355         m_ready2Send = 1;
00356     }
00357 }
00358
00359 }
```

References [USART0_DATA_REGISTER](#).

9.18.3.3 enableDataRegisterEmptyInterrupt()

```
void io::USART0::enableDataRegisterEmptyInterrupt (
    const uint8_t a_enable ) [static]
```

Enable data register empty interrupt

Parameters

<i>ar_enable</i>	Indicates if interrupt is enabled
------------------	-----------------------------------

Definition at line 383 of file [USART0.cpp](#).

```
00384 {
00385     if (a_enable) {
00386         USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT;
00387     } else {
00388         USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT;
00389     }
00390 }
00391
00392 }
```

References [USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT](#), and [USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT](#).

9.18.3.4 enableReceiveCompleteInterrupt()

```
void io::USART0::enableReceiveCompleteInterrupt (
    const uint8_t a_enable )
```

Enable receive complete interrupt

Parameters

<i>ar_enable</i>	Indicates if interrupt is enabled
------------------	-----------------------------------

Definition at line 372 of file [USART0.cpp](#).

```
00373 {
00374     if (a_enable) {
00375         USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT;
00376     } else {
00377         USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT;
00378     }
00379 }
00380
00381 }
```

References [USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT](#), and [USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT](#).

9.18.3.5 enableTransmitCompleteInterrupt()

```
void io::USART0::enableTransmitCompleteInterrupt (
    const uint8_t a_enable )
```

Enable transmit complete interrupt

Parameters

<i>ar_enable</i>	Indicates if interrupt is enabled
------------------	-----------------------------------

Definition at line 362 of file [USART0.cpp](#).

```
00363 {
00364     if (a_enable) {
00365         USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT;
00366     } else {
00367         USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT;
00368     }
00369 }
```

```
00370 }
```

References [USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT](#), and [USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT](#)

9.18.3.6 frameError()

```
uint8_t io::USART0::frameError ( )
```

Is there frame error in received data

Returns

Status of received data

Definition at line 198 of file [USART0.cpp](#).

```
00199 {
00200     return (m_status & (1 << USART0_FRAME_ERROR));
00201
00202 }
```

References [USART0_FRAME_ERROR](#).

9.18.3.7 getInstance()

```
io::USART0 & io::USART0::getInstance (
    const transmissionMode & ar_transMode = transmissionMode::async,
    const communicationMode & ar_comMode = communicationMode::duplex,
    const frameSize & ar_frameSize = frameSize::eightBits,
    const stopBit & ar_stopBit = stopBit::oneStopBit,
    const parityMode & ar_parityMode = parityMode::noParity ) [static]
```

Create a single instance of the [USART0](#) object

Parameters

<i>ar_transMode</i>	Defines transmission mode
<i>ar_comMode</i>	Defines communication mode
<i>ar_frameSize</i>	Defines data frame size
<i>ar_stopBit</i>	Defines number of stop bits
<i>ar_parityMode</i>	Defines parity mode

Definition at line 26 of file [USART0.cpp](#).

```
00031 {
00032     static USART0 l_instance(ar_transMode,
00033                             ar_comMode,
00034                             ar_frameSize,
00035                             ar_stopBit,
00036                             ar_parityMode);
00037
00038     return l_instance;
00039 }
```

9.18.3.8 getNumberBytesReceived()

```
uint16_t io::USART0::getNumberBytesReceived ( )
```

Get number of bytes received

Returns

Number of received bytes

Definition at line 404 of file [USART0.cpp](#).

```
00405 {  
00406     return m_numberBytesReceived;  
00407 }
```

9.18.3.9 getNumberBytesSent()

```
uint16_t io::USART0::getNumberBytesSent ( )
```

Get number of bytes sent

Returns

Number of transmitted bytes

Definition at line 399 of file [USART0.cpp](#).

```
00400 {  
00401     return m_numberBytesSent;  
00402 }
```

9.18.3.10 operator=()

```
const USART0& io::USART0::operator= (  
    const USART0 & ) [private]
```

Override assign operator.

9.18.3.11 parityError()

```
uint8_t io::USART0::parityError ( )
```

Is there parity error in received data

Returns

Status of received data

Definition at line 210 of file [USART0.cpp](#).

```
00211 {  
00212     return (m_status & (1 << USART0_PARITY_ERROR));  
00213 }  
00214 }
```

References [USART0_PARITY_ERROR](#).

9.18.3.12 ready2Send()

```
uint8_t io::USART0::ready2Send ( )
```

Is ready to send

Returns

Sender status

Definition at line 414 of file [USART0.cpp](#).

```
00415 {
00416     return m_ready2Send;
00417 }
00418 }
```

9.18.3.13 receiveChar()

```
void io::USART0::receiveChar (
    uint8_t & ar_char )
```

Receive character

Parameters

<i>ar_char</i>	Defines charcter to be received
----------------	---------------------------------

Definition at line 293 of file [USART0.cpp](#).

```
00294 {
00295     m_sizeData2Receive = 1;
00296     mp_data2Receive = &ar_char;
00297 }
```

9.18.3.14 receiveCompleteServiceRoutine()

```
void io::USART0::receiveCompleteServiceRoutine ( ) [static]
```

Receive complete ISR

Definition at line 315 of file [USART0.cpp](#).

```
00316 {
00317     static volatile uint8_t *lp_dataReceived = mp_data2Receive;
00318     static uint16_t l_dataSize = m_sizeData2Receive;
00319     m_status = USART0_CONTROL_STATUS_REGISTER;
00320
00321     if (l_dataSize)
00322     {
00323         *lp_dataReceived++ = USART0_DATA_REGISTER;
00324         l_dataSize--;
00325         m_numberBytesReceived++;
00326     }
00327 }
```



```

00332         else
00333         {
00334             l_dataSize = m_sizeData2Receive;
00335             lp_dataReceived = mp_data2Receive;
00336         }
00337
00338     }

```

References [USART0_CONTROL_STATUS_REGISTER](#), and [USART0_DATA_REGISTER](#).

9.18.3.15 receiveFrame()

```

void io::USART0::receiveFrame (
    uint8_t * ap_dataBuffer,
    const uint8_t a_size )

```

Receive data frame

Parameters

<i>ap_dataBuffer</i>	Defines pointer to receiver buffer
<i>a_size</i>	Defines size of receiver buffer
<i>a_ready2Receive</i>	Indicates if chip ready to receive data

Definition at line 300 of file [USART0.cpp](#).

```

00301 {
00302     m_sizeData2Receive = a_size;
00303     mp_data2Receive = ap_dataBuffer;
00304     // TODO: to be implemented
00305
00306
00307 }

```

9.18.3.16 receiveString()

```

void io::USART0::receiveString (
    const char * ap_string )

```

Receive string

Parameters

<i>ap_string</i>	Defines pointer to string
------------------	---------------------------

Definition at line 309 of file [USART0.cpp](#).

```

00310 {
00311     // TODO: to be implemented
00312 }

```

9.18.3.17 resetNumberBytesReceived()

```
void io::USART0::resetNumberBytesReceived ( )
```

Reset number of bytes received

Definition at line 409 of file [USART0.cpp](#).

```
00410 {
00411     m_numberBytesReceived = 0;
00412 }
```

9.18.3.18 sendByte()

```
void io::USART0::sendByte (
    const uint8_t & ar_byte )
```

Transmit byte

Parameters

<i>ar_byte</i>	Defines byte to be sent
----------------	-------------------------

Definition at line 235 of file [USART0.cpp](#).

```
00236 {
00237     static uint8_t l_byte2Send[3];
00238     l_byte2Send[0] = '0' + (ar_byte / 100);
00239     l_byte2Send[1] = '0' + ((ar_byte / 10) % 10);
00240     l_byte2Send[2] = '0' + (ar_byte % 10);
00241
00242     while (!ready2Send()){};
00243     m_sizeData2Send = 3;
00244     mp_data2Send = l_byte2Send;
00245     enableDataRegisterEmptyInterrupt(1);
00246
00247 }
```

9.18.3.19 sendChar()

```
void io::USART0::sendChar (
    const uint8_t & ar_char )
```

Transmit character

Parameters

<i>ar_char</i>	Defines character to be sent
----------------	------------------------------

Definition at line 284 of file [USART0.cpp](#).

```
00285 {
00286     while (!ready2Send()){};
00287     m_sizeData2Send = 1;
00288     mp_data2Send = &ar_char;
00289     enableDataRegisterEmptyInterrupt(1);
00290 }
```

```
00291 }
```

9.18.3.20 sendFrame()

```
void io::USART0::sendFrame (
    const uint8_t * ap_dataBuffer,
    const uint8_t a_size )
```

Transmit data frame

Parameters

<i>ap_dataBuffer</i>	Defines pointer to transmitter buffer
<i>a_size</i>	Defines size of transmitter buffer

Definition at line 216 of file [USART0.cpp](#).

```
00217 {
00218     while (!ready2Send()){};
00219     m_sizeData2Send = a_size;
00220     mp_data2Send = ap_dataBuffer;
00221     enableDataRegisterEmptyInterrupt(1);
00222 }
```

9.18.3.21 sendLong()

```
void io::USART0::sendLong (
    const uint32_t & ar_long )
```

Transmit long word

Parameters

<i>ar_long</i>	Defines long word to be sent
----------------	------------------------------

Definition at line 248 of file [USART0.cpp](#).

```
00249 {
00250     static uint8_t l_word2Send[10];
00251     l_word2Send[0] = '0' + (ar_long / 1000000000);
00252     l_word2Send[1] = '0' + ((ar_long / 100000000) % 10);
00253     l_word2Send[2] = '0' + ((ar_long / 10000000) % 10);
00254     l_word2Send[3] = '0' + ((ar_long / 1000000) % 10);
00255     l_word2Send[4] = '0' + ((ar_long / 100000) % 10);
00256     l_word2Send[5] = '0' + ((ar_long / 10000) % 10);
00257     l_word2Send[6] = '0' + ((ar_long / 1000) % 10);
00258     l_word2Send[7] = '0' + ((ar_long / 100) % 10);
00259     l_word2Send[8] = '0' + ((ar_long / 10) % 10);
00260     l_word2Send[9] = '0' + (ar_long % 10);
00261
00262     while (!ready2Send()){};
00263     m_sizeData2Send = 10;
00264     mp_data2Send = l_word2Send;
00265     enableDataRegisterEmptyInterrupt(1);
00266
00267 }
```

9.18.3.22 sendString()

```
void io::USART0::sendString (
    const char * ap_string )
```

Transmit string

Parameters

<i>ap_string</i>	Defines pointer to string
------------------	---------------------------

Definition at line 225 of file [USART0.cpp](#).

```
00226 {
00227     while (!ready2Send()){};
00228     m_sizeData2Send = strlen(ap_string);
00229     mp_data2Send = reinterpret_cast<const uint8_t*>(ap_string);
00230     enableDataRegisterEmptyInterrupt(1);
00231
00232 }
```

9.18.3.23 sendWord()

```
void io::USART0::sendWord (
    const uint16_t & ar_word )
```

Transmit word

Parameters

<i>ar_word</i>	Defines word to be sent
----------------	-------------------------

Definition at line 268 of file [USART0.cpp](#).

```
00269 {
00270     static uint8_t l_word2Send[5];
00271     l_word2Send[0] = '0' + (ar_word / 10000);
00272     l_word2Send[1] = '0' + ((ar_word / 1000) % 10);
00273     l_word2Send[2] = '0' + ((ar_word / 100) % 10);
00274     l_word2Send[3] = '0' + ((ar_word / 10) % 10);
00275     l_word2Send[4] = '0' + (ar_word % 10);
00276
00277     while (!ready2Send()){};
00278     m_sizeData2Send = 5;
00279     mp_data2Send = l_word2Send;
00280     enableDataRegisterEmptyInterrupt(1);
00281
00282 }
```

9.18.3.24 setBaudRate()

```
void io::USART0::setBaudRate ( )
```

Set baud rate.

Definition at line 66 of file [USART0.cpp](#).

```
00067 {
```

```

00068     USART0_SET_BAUDRATE_HIGH_REGISTER;
00069     USART0_SET_BAUDRATE_LOW_REGISTER;
00070
00071 }

```

References [USART0_SET_BAUDRATE_HIGH_REGISTER](#), and [USART0_SET_BAUDRATE_LOW_REGISTER](#).

9.18.3.25 setCommunicationMode()

```

void io::USART0::setCommunicationMode (
    const communicationMode & ar_comMode )

```

Set communication mode

Parameters

<i>ar_comMode</i>	Defines communication mode
-------------------	----------------------------

Definition at line 98 of file [USART0.cpp](#).

```

00099 {
00100     switch (ar_comMode)
00101     {
00102         case communicationMode::duplex:
00103         {
00104             USART0_ENABLE_TRANSMITTER;
00105             USART0_ENABLE_RECEIVER;
00106             break;
00107         }
00108         case communicationMode::receive:
00109         {
00110             USART0_ENABLE_RECEIVER;
00111             USART0_DISABLE_TRANSMITTER;
00112             break;
00113         }
00114         case communicationMode::transmit:
00115         {
00116             USART0_ENABLE_TRANSMITTER;
00117             USART0_DISABLE_RECEIVER;
00118             break;
00119         }
00120     }
00121
00122 }

```

References [io::duplex](#), [io::receive](#), [io::transmit](#), [USART0_DISABLE_RECEIVER](#), [USART0_DISABLE_TRANSMITTER](#), [USART0_ENABLE_RECEIVER](#), and [USART0_ENABLE_TRANSMITTER](#).

9.18.3.26 setFrameSize()

```

void io::USART0::setFrameSize (
    const frameSize & ar_frameSize )

```

Set data frame size

Parameters

<i>ar_frameSize</i>	Defines data frame size
---------------------	-------------------------

Definition at line 147 of file USART0.cpp.

```
00148 {
00149     switch (ar_frameSize)
00150     {
00151         case frameSize::eightBits:
00152         {
00153             USART0_SET_8BIT_FRAME_SIZE;
00154             break;
00155         }
00156         case frameSize::sevenBits:
00157         {
00158             USART0_SET_7BIT_FRAME_SIZE;
00159             break;
00160         }
00161         case frameSize::sixBits:
00162         {
00163             USART0_SET_6BIT_FRAME_SIZE;
00164             break;
00165         }
00166         case frameSize::fiveBits:
00167         {
00168             USART0_SET_5BIT_FRAME_SIZE;
00169             break;
00170         }
00171         case frameSize::neineBits:
00172         {
00173             USART0_SET_9BIT_FRAME_SIZE;
00174             break;
00175         }
00176     }
00177 }
00178 }
```

References [io::eightBits](#), [io::fiveBits](#), [io::neineBits](#), [io::sevenBits](#), [io::sixBits](#), [USART0_SET_5BIT_FRAME_SIZE](#), [USART0_SET_6BIT_FRAME_SIZE](#), [USART0_SET_7BIT_FRAME_SIZE](#), [USART0_SET_8BIT_FRAME_SIZE](#), and [USART0_SET_9BIT_FRAME_SIZE](#).

9.18.3.27 setParityMode()

```
void io::USART0::setParityMode (
    const parityMode & ar_parityMode )
```

Set parity mode in data frame

Parameters

<i>ar_parityMode</i>	Defines parity mode
----------------------	---------------------

Definition at line 124 of file USART0.cpp.

```
00125 {
00126     switch (ar_parityMode)
00127     {
00128         case parityMode::noParity:
00129         {
00130             USART0_DISABLE_PARITY_MODE;
00131             break;
00132         }
00133         case parityMode::evenParity:
00134         {
00135             USART0_ENABLE_EVEN_PARITY_MODE;
00136             break;
00137         }
00138         case parityMode::oddParity:
00139         {
00140             USART0_ENABLE_ODD_PARITY_MODE;
00141             break;
00142         }
00143     }
00144 }
00145 }
```

References [io::evenParity](#), [io::noParity](#), [io::oddParity](#), [USART0_DISABLE_PARITY_MODE](#), [USART0_ENABLE_EVEN_PARITY_MODE](#) and [USART0_ENABLE_ODD_PARITY_MODE](#).

9.18.3.28 setStopBit()

```
void io::USART0::setStopBit (
    const stopBit & ar_stopBit )
```

Set number of stop bits in data frame

Parameters

<i>ar_stopBit</i>	Defines number of stop bits
-------------------	-----------------------------

Definition at line 179 of file [USART0.cpp](#).

```
00180 {
00181     switch (ar_stopBit)
00182     {
00183         case stopBit::oneStopBit:
00184         {
00185             USART0_SET_ONE_STOP_BIT;
00186             break;
00187         }
00188         case stopBit::twoStopBits:
00189         {
00190             USART0_SET_TWO_STOP_BITS;
00191             break;
00192         }
00193     }
00194 }
00195 }
```

References [io::oneStopBit](#), [io::twoStopBits](#), [USART0_SET_ONE_STOP_BIT](#), and [USART0_SET_TWO_STOP_BITS](#).

9.18.3.29 setTransmissionMode()

```
void io::USART0::setTransmissionMode (
    const transmissionMode & ar_transMode )
```

Set transmission mode

Parameters

<i>ar_transMode</i>	Defines transmission mode
---------------------	---------------------------

Definition at line 73 of file [USART0.cpp](#).

```
00074 {
00075     switch (ar_transMode)
00076     {
00077         case transmissionMode::async:
00078         {
00079             USART0_ENABLE_ASYNC_TRANSMISSION_MODE;
00080             break;
00081         }
00082         case transmissionMode::sync:
00083         {
```

```

00084         USART0_DISABLE_DOUBLE_SPEED_MODE;
00085         USART0_ENABLE_SYNC_TRANSMISSION_MODE;
00086         break;
00087     }
00088     case transmissionMode::masterSPI:
00089     {
00090         USART0_ENABLE_MASTER_SPI_MODE;
00091         break;
00092     }
00093 }
00094
00095
00096 }
```

References [io::async](#), [io::masterSPI](#), [io::sync](#), [USART0_DISABLE_DOUBLE_SPEED_MODE](#), [USART0_ENABLE_ASYNC_TRANSMISSION_MODE](#), [USART0_ENABLE_MASTER_SPI_MODE](#), and [USART0_ENABLE_SYNC_TRANSMISSION_MODE](#).

9.18.3.30 transmitCompleteServiceRoutine()

```
void io::USART0::transmitCompleteServiceRoutine ( ) [static]
```

Transmit complete ISR

Definition at line 394 of file [USART0.cpp](#).

```

00395 {
00396
00397 }
```

9.18.4 Member Data Documentation

9.18.4.1 __externally_visible__

```
static void io::USART0::__externally_visible__
```

Definition at line 283 of file [USART0.h](#).

9.18.4.2 __used__

```
static void io::USART0::__used__
```

Definition at line 283 of file [USART0.h](#).

9.18.4.3 m_numberBytesReceived

```
volatile uint16_t io::USART0::m_numberBytesReceived = 0 [static], [private]
```

Nnumber of received bytes

Definition at line 338 of file [USART0.h](#).

9.18.4.4 m_numberBytesSent

```
volatile uint16_t io::USART0::m_numberBytesSent = 0 [static], [private]
```

Number of trasnmitted bytes

Definition at line 340 of file [USART0.h](#).

9.18.4.5 m_ready2Send

```
volatile uint8_t io::USART0::m_ready2Send = 1 [static], [private]
```

Ready to send flag

Definition at line 342 of file [USART0.h](#).

9.18.4.6 m_sizeData2Receive

```
uint16_t io::USART0::m_sizeData2Receive = 0 [static], [private]
```

Size of data to be received

Definition at line 336 of file [USART0.h](#).

9.18.4.7 m_sizeData2Send

```
uint16_t io::USART0::m_sizeData2Send = 0 [static], [private]
```

Size of data to be transmitted

Definition at line 334 of file [USART0.h](#).

9.18.4.8 m_status

```
volatile uint8_t io::USART0::m_status = 0 [static], [private]
```

Status of received data

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

See [USART0.h](#) for a description of this code

Definition at line 328 of file [USART0.h](#).

9.18.4.9 mp_data2Receive

```
uint8_t * io::USART0::mp_data2Receive = nullptr [static], [private]
```

Pointer to receiver buffer

Definition at line 332 of file [USART0.h](#).

9.18.4.10 mp_data2Send

```
const uint8_t * io::USART0::mp_data2Send = nullptr [static], [private]
```

Pointer to transmitter buffer

Definition at line 330 of file [USART0.h](#).

9.19 core::WatchdogTimer Class Reference

```
#include <WatchdogTimer.h>
```

Public Member Functions

- void [selectTimeOut](#) (const [timeOut](#) &ar_timeOut)
- void [reset](#) ()
- void [start](#) (const [operationMode](#) &ar_operationMode)
- void [start](#) (const [operationMode](#) &ar_operationMode, const [timeOut](#) &ar_timeOut)
- void [stop](#) ()

Static Public Member Functions

- static [WatchdogTimer](#) & [getInstance](#) ()
- static void [timeOutServiceRoutine](#) () __asm__(STR(WATCHDOG_TIMEOUT_INTERRUPT)) __attribute__((__signal__

Public Attributes

- static void [__used__](#)
- static void [__externally_visible__](#)

Private Member Functions

- [WatchdogTimer](#) ()
- [~WatchdogTimer](#) ()
- [WatchdogTimer](#) (const [WatchdogTimer](#) &)
- const [WatchdogTimer](#) & [operator=](#) (const [WatchdogTimer](#) &)

Private Attributes

- `uint8_t m_timeOut`
- `uint8_t m_operationMode`

9.19.1 Detailed Description

Definition at line 84 of file [WatchdogTimer.h](#).

9.19.2 Constructor & Destructor Documentation

9.19.2.1 WatchdogTimer() [1/2]

```
core::WatchdogTimer::WatchdogTimer ( ) [private]
```

Definition at line 11 of file [WatchdogTimer.cpp](#).

```
00012 {  
00013     sei();  
00014     stop();  
00015 }
```

9.19.2.2 ~WatchdogTimer()

```
core::WatchdogTimer::~~WatchdogTimer ( ) [private]
```

Destructor.

Definition at line 17 of file [WatchdogTimer.cpp](#).

```
00018 {  
00019  
00020 }
```

9.19.2.3 WatchdogTimer() [2/2]

```
core::WatchdogTimer::WatchdogTimer (  
    const WatchdogTimer & ) [private]
```

Overried Copy constructor.

9.19.3 Member Function Documentation

9.19.3.1 getInstance()

```
core::WatchdogTimer & core::WatchdogTimer::getInstance ( ) [static]
```

Definition at line 4 of file [WatchdogTimer.cpp](#).

```
00005 {  
00006     static WatchdogTimer l_instance;  
00007     return l_instance;  
00008  
00009 }
```

9.19.3.2 operator=()

```
const WatchdogTimer& core::WatchdogTimer::operator= (  
    const WatchdogTimer & ) [private]
```

Override assign operator.

9.19.3.3 reset()

```
void core::WatchdogTimer::reset ( )
```

Definition at line 33 of file [WatchdogTimer.cpp](#).

```
00034 {  
00035     wdt_reset();  
00036  
00037 }
```

9.19.3.4 selectTimeOut()

```
void core::WatchdogTimer::selectTimeOut (  
    const timeOut & ar_timeOut )
```

Definition at line 22 of file [WatchdogTimer.cpp](#).

```
00023 {  
00024     m_timeOut = static_cast<uint8_t>(ar_timeOut);  
00025     m_timeOut = static_cast<uint8_t>((m_timeOut & 7) | ((m_timeOut & 8) << 2));  
00026     cli();  
00027     wdt_reset();  
00028     WATCHDOG_SELECT_TIMEOUT(m_timeOut);  
00029     sei();  
00030  
00031 }
```

References [WATCHDOG_SELECT_TIMEOUT](#).

9.19.3.5 start() [1/2]

```
void core::WatchdogTimer::start (
    const operationMode & ar_operationMode )
```

Definition at line 39 of file [WatchdogTimer.cpp](#).

```
00040 {
00041     m\_operationMode = static\_cast<uint8_t>(ar_operationMode);
00042     m\_operationMode = static\_cast<uint8_t>(((m\_operationMode & 1) << 6) | ((m\_operationMode & 2) << 3
    ));
00043     cli();
00044     wdt_reset();
00045     WATCHDOG\_START(m\_operationMode,m\_timeOut);
00046     sei();
00047 }
00048 }
```

References [WATCHDOG_START](#).

9.19.3.6 start() [2/2]

```
void core::WatchdogTimer::start (
    const operationMode & ar_operationMode,
    const timeOut & ar_timeOut )
```

Definition at line 50 of file [WatchdogTimer.cpp](#).

```
00051 {
00052     m\_timeOut = static\_cast<uint8_t>(ar_timeOut);
00053     m\_timeOut = static\_cast<uint8_t>((m\_timeOut & 7) | ((m\_timeOut & 8) << 2));
00054     m\_operationMode = static\_cast<uint8_t>(ar_operationMode);
00055     m\_operationMode = static\_cast<uint8_t>(((m\_operationMode & 1) << 6) | ((m\_operationMode & 2) << 3
    ));
00056     cli();
00057     wdt_reset();
00058     WATCHDOG\_START(m\_operationMode,m\_timeOut);
00059     sei();
00060 }
00061 }
```

References [WATCHDOG_START](#).

9.19.3.7 stop()

```
void core::WatchdogTimer::stop ( )
```

Definition at line 63 of file [WatchdogTimer.cpp](#).

```
00064 {
00065     cli();
00066     wdt_reset();
00067     WATCHDOG\_STOP;
00068     sei();
00069 }
00070 }
```

References [WATCHDOG_STOP](#).

9.19.3.8 timeOutServiceRoutine()

```
static void core::WatchdogTimer::timeOutServiceRoutine ( ) [static]
```

9.19.4 Member Data Documentation

9.19.4.1 __externally_visible__

```
void core::WatchdogTimer::__externally_visible__
```

Definition at line 102 of file [WatchdogTimer.h](#).

9.19.4.2 __used__

```
void core::WatchdogTimer::__used__
```

Definition at line 102 of file [WatchdogTimer.h](#).

9.19.4.3 m_operationMode

```
uint8_t core::WatchdogTimer::m_operationMode [private]
```

Definition at line 125 of file [WatchdogTimer.h](#).

9.19.4.4 m_timeOut

```
uint8_t core::WatchdogTimer::m_timeOut [private]
```

Definition at line 123 of file [WatchdogTimer.h](#).

Chapter 10

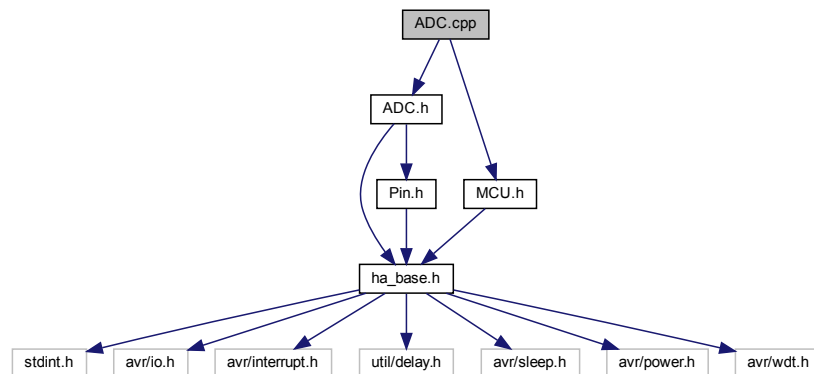
File Documentation

10.1 ADC.cpp File Reference

```
#include "ADC.h"
```

```
#include "MCU.h"
```

Include dependency graph for ADC.cpp:



10.2 ADC.cpp

```
00001 #include "ADC.h"
00002 #include "MCU.h"
00003
00004 volatile uint16_t* core::ADConverter::mp_conversionResult = nullptr;
00005 volatile uint8_t core::ADConverter::m_conversionComplete = 0;
00006 uint8_t core::ADConverter::m_resolution = 10;
00007
00008
00009 core::ADConverter& core::ADConverter::getInstance(const referenceVoltage &ar_refVoltage,
00010                                                    const clockPrescaler& ar_clockPrescaler,
00011                                                    const autoTriggerSource& ar_autoTriggerSource,
00012                                                    const io::Pin &ar_pin)
00013 {
00014
00015     static ADConverter l_instance(ar_refVoltage,
00016                                   ar_clockPrescaler,
00017                                   ar_autoTriggerSource,
00018                                   ar_pin);
```

```

00019
00020     return l_instance;
00021 }
00022
00023 core::ADConverter::ADConverter(const referenceVoltage& ar_refVoltage,
00024                               const clockPrescaler& ar_clockPrescaler,
00025                               const autoTriggerSource& ar_autoTriggerSource,
00026                               const io::Pin &ar_pin)
00027 {
00028     core::MCU::enableADC(1);
00029     selectAnalogInput(ar_pin);
00030     selectReferenceVoltage(ar_refVoltage);
00031     selectClockPrescaler(ar_clockPrescaler);
00032     enableAutoTrigger(1);
00033     selectAutoTriggerSource(ar_autoTriggerSource);
00034     sei();
00035     enableConversionCompleteInterrupt(1);
00036 }
00037
00038 }
00039
00040
00041 core::ADConverter::~ADConverter()
00042 {
00043 }
00044 }
00045
00046
00047 void core::ADConverter::selectReferenceVoltage(const referenceVoltage& ar_refVoltage)
00048 {
00049     ADC_SELECT_REF_VOLTAGE(static_cast<uint8_t>(ar_refVoltage));
00050 }
00051 }
00052
00053 void core::ADConverter::selectAnalogInput(io::Pin a_pin)
00054 {
00055     a_pin.toInput(0);
00056     ADC_SELECT_ANALOG_INPUT(a_pin.getPinNumber());
00057     ADC_DISABLE_DIGITAL_INPUT_REGISTER(a_pin.getPinNumber());
00058 }
00059 }
00060
00061 void core::ADConverter::start()
00062 {
00063     ADC_ENABLE;
00064     ADC_START_CONVERSION;
00065 }
00066
00067 void core::ADConverter::stop()
00068 {
00069     ADC_STOP_CONVERSION;
00070     ADC_DISABLE;
00071 }
00072
00073 void core::ADConverter::enableAutoTrigger(const uint8_t a_enable)
00074 {
00075     if (a_enable) {
00076         ADC_ENABLE_AUTOTRIGGER;
00077     } else {
00078         ADC_DISABLE_AUTOTRIGGER;
00079     }
00080 }
00081
00082 }
00083
00084 void core::ADConverter::enableConversionCompleteInterrupt(const uint8_t a_enable)
00085 {
00086     if (a_enable) {
00087         ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT;
00088     } else {
00089         ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT;
00090     }
00091 }
00092
00093 }
00094
00095 void core::ADConverter::selectClockPrescaler(const clockPrescaler& ar_clockPrescaler)
00096 {
00097     ADC_SELECT_CLOCK_PRESCALER(static_cast<uint8_t>(ar_clockPrescaler));
00098 }
00099 }
00100
00101
00102 void core::ADConverter::selectAutoTriggerSource(const autoTriggerSource& ar_autoTriggerSource)
00103 {
00104     ADC_SELECT_AUTO_TRIGGER_SOURCE(static_cast<uint8_t>(ar_autoTriggerSource));
00105 }

```



```
00106
00107 }
00108
00109 void core::ADConverter::conversionCompleteServiceRoutine()
00110 {
00111
00112     static uint32_t l_resultData = 0;
00113     static uint16_t l_resultDataIndex = 0;
00114
00115     m_conversionComplete = 0;
00116     switch (m_resolution)
00117     {
00118     case 8:
00119     {
00120         *mp_conversionResult = ADC » 8;
00121         m_conversionComplete = 1;
00122         break;
00123     }
00124     case 9:
00125     {
00126         *mp_conversionResult = ADC » 7;
00127         m_conversionComplete = 1;
00128         break;
00129     }
00130     case 10:
00131     {
00132         *mp_conversionResult = ADC;
00133         m_conversionComplete = 1;
00134         break;
00135     }
00136     case 11:
00137     {
00138
00139         if (l_resultDataIndex < 4)
00140         {
00141             l_resultData += ADC;
00142             l_resultDataIndex++;
00143         }
00144         else
00145         {
00146             *mp_conversionResult = l_resultData » 1;
00147             l_resultData = 0;
00148             l_resultDataIndex = 0;
00149             m_conversionComplete = 1;
00150         }
00151     }
00152     }
00153     break;
00154 }
00155 case 12:
00156 {
00157     if (l_resultDataIndex < 16)
00158     {
00159         l_resultData += ADC;
00160         l_resultDataIndex++;
00161     }
00162     else
00163     {
00164         *mp_conversionResult = l_resultData » 2;
00165         l_resultData = 0;
00166         l_resultDataIndex = 0;
00167         m_conversionComplete = 1;
00168     }
00169 }
00170 break;
00171 }
00172 case 13:
00173 {
00174     if (l_resultDataIndex < 64)
00175     {
00176         l_resultData += ADC;
00177         l_resultDataIndex++;
00178     }
00179     else
00180     {
00181         *mp_conversionResult = l_resultData » 3;
00182         l_resultData = 0;
00183         l_resultDataIndex = 0;
00184         m_conversionComplete = 1;
00185     }
00186 }
00187 break;
00188 }
00189 case 14:
```

```

00193     {
00194         if (l_resultDataIndex < 256)
00195         {
00196             l_resultData += ADC;
00197             l_resultDataIndex++;
00198         }
00199     }
00200     else
00201     {
00202         *mp_conversionResult = l_resultData » 4;
00203         l_resultData = 0;
00204         l_resultDataIndex = 0;
00205         m_conversionComplete = 1;
00206     }
00207     break;
00208 }
00209 case 15:
00210 {
00211     if (l_resultDataIndex < 1024)
00212     {
00213         l_resultData += ADC;
00214         l_resultDataIndex++;
00215     }
00216     else
00217     {
00218         *mp_conversionResult = l_resultData » 5;
00219         l_resultData = 0;
00220         l_resultDataIndex = 0;
00221         m_conversionComplete = 1;
00222     }
00223     break;
00224 }
00225 case 16:
00226 {
00227     if (l_resultDataIndex < 4096)
00228     {
00229         l_resultData += ADC;
00230         l_resultDataIndex++;
00231     }
00232     else
00233     {
00234         *mp_conversionResult = l_resultData » 6;
00235         l_resultData = 0;
00236         l_resultDataIndex = 0;
00237         m_conversionComplete = 1;
00238     }
00239     break;
00240 }
00241 }
00242 }
00243 }
00244 }
00245 }
00246 }
00247 }
00248 }
00249 }
00250 }
00251 }
00252 }
00253 }
00254 }
00255 uint8_t core::ADConverter::conversionComplete()
00256 {
00257     return m_conversionComplete;
00258 }
00259 }
00260 }
00261 }
00262 void core::ADConverter::getConversionResult(uint16_t *ap_resultData, const resolution& ar_resolution)
00263 {
00264     mp_conversionResult = ap_resultData;
00265     switch (ar_resolution)
00266     {
00267     case core::resolution::res_8bit:
00268     {
00269         ADC_ADJUST_RESULT_LEFT;
00270         m_resolution = 8;
00271         break;
00272     }
00273     case core::resolution::res_9bit:
00274     {
00275         ADC_ADJUST_RESULT_LEFT;
00276         m_resolution = 9;
00277         break;
00278     }
00279     }

```

```

00280     case core::resolution::res_10bit:
00281     {
00282         ADC_ADJUST_RESULT_RIGHT;
00283         m_resolution = 10;
00284         break;
00285     }
00286     case core::resolution::res_11bit:
00287     {
00288
00289         m_resolution = 11;
00290         break;
00291     }
00292     case core::resolution::res_12bit:
00293     {
00294         m_resolution = 12;
00295         break;
00296     }
00297     case core::resolution::res_13bit:
00298     {
00299         m_resolution = 13;
00300         break;
00301     }
00302     case core::resolution::res_14bit:
00303     {
00304         m_resolution = 14;
00305         break;
00306     }
00307     case core::resolution::res_15bit:
00308     {
00309         m_resolution = 15;
00310         break;
00311     }
00312     case core::resolution::res_16bit:
00313     {
00314         m_resolution = 16;
00315         break;
00316     }
00317 }
00318
00319
00320 }

```

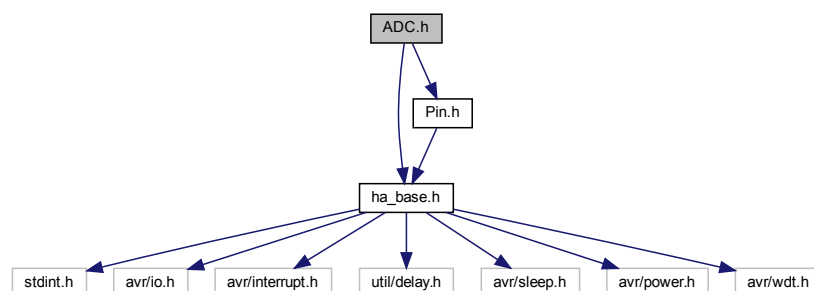
10.3 ADC.h File Reference

Header file of the ADC class.

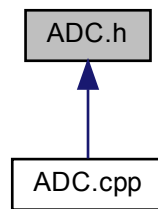
```
#include "ha_base.h"
```

```
#include "Pin.h"
```

Include dependency graph for ADC.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [core::ADConverter](#)

Namespaces

- [core](#)

Enumerations

- enum [core::resolution](#) : uint8_t {
[core::resolution::res_8bit](#) =0, [core::resolution::res_9bit](#), [core::resolution::res_10bit](#), [core::resolution::res_11bit](#),
[core::resolution::res_12bit](#), [core::resolution::res_13bit](#), [core::resolution::res_14bit](#), [core::resolution::res_15bit](#),
[core::resolution::res_16bit](#) }
- enum [core::referenceVoltage](#) : uint8_t { [core::referenceVoltage::AREF](#) =0, [core::referenceVoltage::AVCC](#),
[core::referenceVoltage::internal](#) }
- enum [core::clockPrescaler](#) : uint8_t {
[core::clockPrescaler::PS_2](#) = 1, [core::clockPrescaler::PS_4](#), [core::clockPrescaler::PS_8](#), [core::clockPrescaler::PS_16](#),
[core::clockPrescaler::PS_32](#), [core::clockPrescaler::PS_64](#), [core::clockPrescaler::PS_128](#) }
- enum [core::autoTriggerSource](#) : uint8_t {
[core::autoTriggerSource::freeRunning](#), [core::autoTriggerSource::analogComparator](#), [core::autoTriggerSource::extInterrupt](#),
[core::autoTriggerSource::timer0Compare](#),
[core::autoTriggerSource::timer0Overflow](#), [core::autoTriggerSource::timer1CompareB](#), [core::autoTriggerSource::timer1Overflow](#),
[core::autoTriggerSource::timer1Capture](#) }

10.3.1 Detailed Description

Header file of the ADC class.

Basic class for abstraction of the Analog to Digital Converter.

Usage example: `#include "ADC.h" #include "USART0.h"`

```
#define TRANSMIT_BUFFER_SIZE 7
```

```
int main(void) {
```

```
Init
```

instantiate the USART0 object `io::USART0` &myUSART0 = `io::USART0::getInstance()`; transmit data buffer char `l_data2Send[TRANSMIT_BUFFER_SIZE]`;

instantiate the ADC object `core::ADConverter` &myADC = `core::ADConverter::getInstance()`;

select analog input `myADC.selectAnalogInput(io::Pin(0,io::PortC))`;

variable to hold conversion result `uint16_t l_conversionResult = 0`;

enable and start conversion `myADC.start()`;

```
----- Event loop ----- // while (1) {
```

```
    myADC.getConversionResult(&l_conversionResult, core::resolution::RES_16bit);

    if (myADC.conversionComplete())
    {
        l_data2Send[0] = '0' + (l_conversionResult / 10000);
        l_data2Send[1] = '0' + ((l_conversionResult / 1000) % 10);
        l_data2Send[2] = '0' + ((l_conversionResult / 100) % 10);
        l_data2Send[3] = '0' + ((l_conversionResult / 10) % 10);
        l_data2Send[4] = '0' + (l_conversionResult % 10);
        l_data2Send[5] = '\n';
        l_data2Send[6] = '\r';

        if (myUSART0.ready2Send())
        {
            myUSART0.sendFrame(reinterpret_cast<uint8_t*>(l_data2Send), TRANSMIT_BUFFER_SIZE);
        }
    }
}
return 0;
}
```

```
uint16_t value = 12345; char lo = value & 0xFF; char hi = value >> 8;
```

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Definition in file [ADC.h](#).

10.4 ADC.h

```

00001
00078 #ifndef ADC_H
00079 #define ADC_H
00080 #include "ha_base.h"
00081 #include "Pin.h"
00082
00083
00084 namespace core
00085 {
00086
00087 enum class resolution : uint8_t {
00088     res_8bit=0,
00089     res_9bit,
00090     res_10bit,
00091     res_11bit,
00092     res_12bit,
00093     res_13bit,
00094     res_14bit,
00095     res_15bit,
00096     res_16bit
00097 };
00098
00099
00100 enum class referenceVoltage : uint8_t {
00101     AREF=0,
00102     AVCC,
00103     internal
00104 };
00105
00106
00107
00108 enum class clockPrescaler : uint8_t {
00109     PS_2 = 1,
00110     PS_4,
00111     PS_8,
00112     PS_16,
00113     PS_32,
00114     PS_64,
00115     PS_128
00116 };
00117
00118 enum class autoTriggerSource : uint8_t {
00119     freeRunning,
00120     analogComparator,
00121     extInterrupt,
00122     timer0Compare,
00123     timer0Overflow,
00124     timer1CompareB,
00125     timer1Overflow,
00126     timer1Capture
00127 };
00128
00129 class ADConverter
00130 {
00131 public:
00132
00133     static ADConverter& getInstance(const referenceVoltage& ar_refVoltage = referenceVoltage::AVCC,
00134                                     const clockPrescaler& ar_clockPrescaler = clockPrescaler::PS_128,
00135                                     const autoTriggerSource& ar_autoTriggerSource =
00136                                         autoTriggerSource::freeRunning,
00137                                     const io::Pin &ar_pin = io::Pin(0,io::PortC));
00138
00139     void start();
00140
00141     void stop();
00142
00143     void selectReferenceVoltage(const referenceVoltage& ar_refVoltage);
00144
00145     void selectAnalogInput(io::Pin a_pin);
00146
00147     void selectClockPrescaler(const clockPrescaler& ar_clockPrescaler);
00148
00149     void enableConversionCompleteInterrupt(const uint8_t a_enable);
00150
00151     void enableAutoTrigger(const uint8_t a_enable);
00152
00153     void selectAutoTriggerSource(const autoTriggerSource& ar_autoTriggerSource);
00154
00155     uint8_t conversionComplete();
00156
00157     void getConversionResult(uint16_t *ap_resultData, const resolution& ar_resolution =
00158         resolution::res_10bit);
00159

```

```

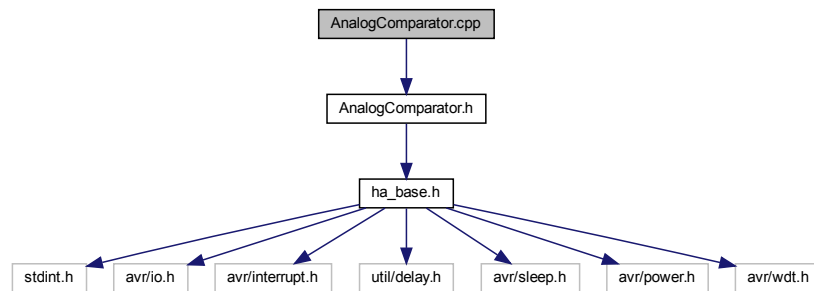
00160     static void conversionCompleteServiceRoutine() __asm__(STR(ADC_CONVERSION_COMPLETE_INTERRUPT))
    __attribute__((__signal__, __used__, __externally_visible__));
00161
00162
00163 protected:
00164
00165
00166
00167 private:
00168
00169     ADConverter(const referenceVoltage& ar_refVoltage,
00170                const clockPrescaler& ar_clockPrescaler,
00171                const autoTriggerSource &ar_autoTriggerSource,
00172                const io::Pin &ar_pin);
00173
00174     ~ADConverter();
00175
00176     ADConverter(const ADConverter&);
00177
00178     const ADConverter& operator=(const ADConverter&);
00179
00180
00181     static volatile uint16_t *mp_conversionResult;
00182     static uint8_t m_resolution;
00183     static volatile uint8_t m_conversionComplete;
00184 };
00185
00186 #endif

```

10.5 AnalogComparator.cpp File Reference

```
#include "AnalogComparator.h"
```

Include dependency graph for AnalogComparator.cpp:



10.6 AnalogComparator.cpp

```

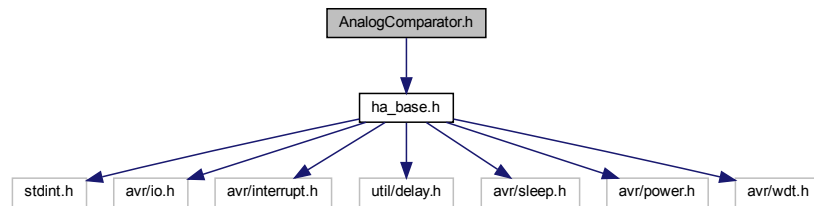
00001 #include "AnalogComparator.h"
00002
00003

```

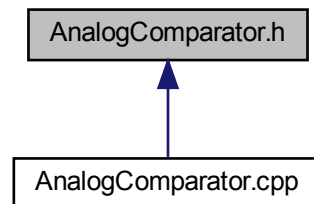
10.7 AnalogComparator.h File Reference

```
#include "ha_base.h"
```

Include dependency graph for AnalogComparator.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [core::AnalogComparator](#)

Namespaces

- [core](#)

Macros

- #define [ANALOG_COMARATOR_H](#)

10.7.1 Macro Definition Documentation

10.7.1.1 ANALOG_COMARATOR_H

```
#define ANALOG_COMARATOR_H
```

Definition at line 13 of file [AnalogComparator.h](#).

10.8 AnalogComparator.h

```

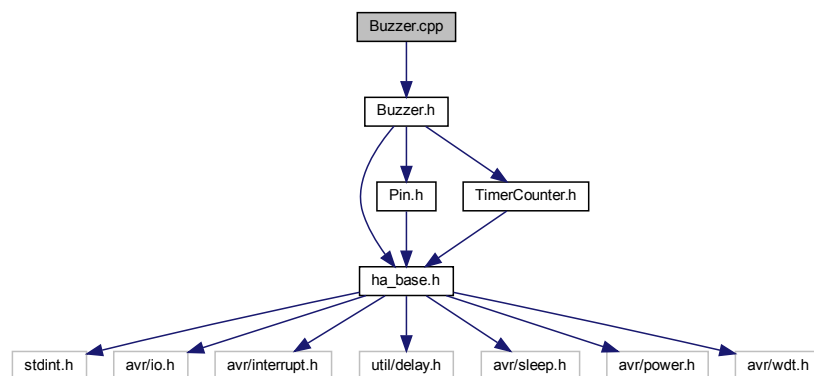
00001
00012 #ifndef ANALOG_COMPARATOR_H
00013 #define ANALOG_COMARATOR_H
00014 #include "ha_base.h"
00015
00016
00017
00018 namespace core
00019 {
00020
00021
00022
00023
00024 class AnalogComparator
00025 {
00026
00027 public:
00028
00029
00030
00031
00032 protected:
00033
00034 private:
00035
00036
00037
00038 };
00039
00040 }
00041
00042
00043 #endif

```

10.9 Buzzer.cpp File Reference

```
#include "Buzzer.h"
```

Include dependency graph for Buzzer.cpp:



10.10 Buzzer.cpp

```

00001
00010 #include "Buzzer.h"
00011
00012
00013 component::Buzzer::Buzzer(const io::Pin &ar_pin)
00014     : m_pin(ar_pin)
00015 {

```

```

00016     m_pin.toOutput();
00017
00018 }
00019
00020 component::Buzzer::~Buzzer()
00021 {
00022 }
00023 }
00024
00025 void component::Buzzer::buzz(const uint16_t &ar_period_us , const uint16_t &ar_duration_us)
00026 {
00027
00028     for (uint16_t i = 0; i < ar_duration_us; i += ar_period_us)
00029     {
00030         // for loop with variable delay selects the pitch
00031         for (uint16_t j = 0; j < ar_period_us; j++)
00032         {
00033             _delay_us(1);
00034         }
00035         m_pin.toggle();
00036     }
00037     m_pin.setLow();
00038 }
00039 }
00040
00041
00042 void component::Buzzer::pause(uint16_t a_duration_us)
00043 {
00044     do {
00045         _delay_us(1);
00046     } while (--a_duration_us);
00047 }

```

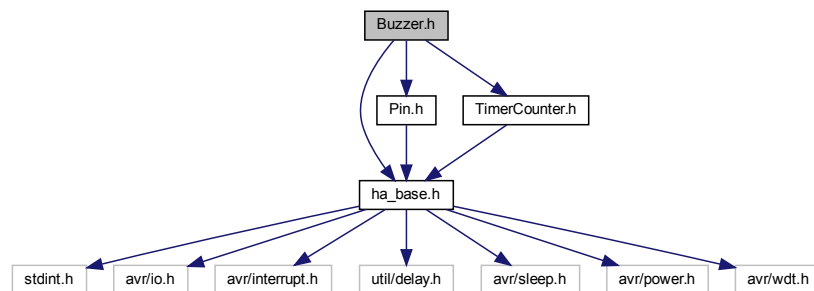
10.11 Buzzer.h File Reference

```

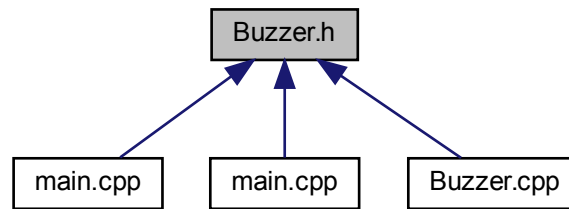
#include "ha_base.h"
#include "Pin.h"
#include "TimerCounter.h"

```

Include dependency graph for Buzzer.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `component::Buzzer`
Class for handling a *Buzzer* component.

Namespaces

- `component`
AVR chip external components.

10.12 Buzzer.h

```

00001
00002 // #include "Buzzer.h"
00003 // #include "TimerCounter0.h"
00004 // #include "buzzer_pitches_8bit.h"
00005
00006
00007 // #define BUZZER 6
00008
00009
00010 // int main(void) {
00011
00012 //     // Init
00013 //     // instantiate the Buzzer object
00014 //     component::Buzzer Buzzer(io::Pin(BUZZER,io::PortD));
00015
00016
00017 //     // instantiate the TimerCounter0 object
00018 //     core::TimerCounter0 &myTimerCounter0 = core::TimerCounter0::getInstance();
00019
00020 //     // notes in the melody:
00021 //     const uint16_t notes[] = {C2, E2, G2, C3};
00022
00023
00024 //     for (uint8_t i = 0; i < sizeof (notes)/sizeof (uint16_t); i++)
00025 //     {
00026
00027 //         Buzzer.buzz(notes[i],200);
00028
00029 //     }
00030
00031 //     _delay_ms(1000);
00032 //     _delay_ms(1000);
00033 //     _delay_ms(1000);
00034
00035 //     for (uint8_t i = 0; i < sizeof (notes)/sizeof (uint16_t); i++)
00036 //     {
00037 //         Buzzer.buzz(myTimerCounter0,notes[i],200);

```

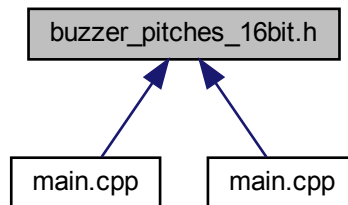
```

00038 //    }
00039
00040
00041 //    // ----- Event loop ----- //
00042 //    while (1) {
00043
00044
00045 //    }
00046 //    return 0;
00047 // }
00048
00049 #ifndef BUZZER_H
00050 #define BUZZER_H
00051 #include "ha_base.h"
00052 #include "Pin.h"
00053 #include "TimerCounter.h"
00054
00063 namespace component
00064 {
00065
00074 class Buzzer
00075 {
00076
00077 public:
00085     Buzzer(const io::Pin &ar_pin);
00089     ~Buzzer();
00090
00096     void buzz(const uint16_t &ar_period_us , const uint16_t &ar_duration_us);
00097
00102     void pause(uint16_t a_duration_us);
00103
00113     template<typename TC>
00114     void buzz(TC &ar_timerCounter,
00115               const uint16_t &ar_period_us,
00116               uint16_t &ar_duration_ms,
00117               const core::channel &ar_channel=core::channel::A,
00118               const core::clockSource &ar_clockSource= core::clockSource::PS_64
00119               )
00120     {
00121         ar_timerCounter.selectOperationMode(core::operationMode::CTC_OCR);
00122         ar_timerCounter.selectCompareOutputMode(ar_channel, core::compareOutputMode::toggle);
00123         ar_timerCounter.setCounter(0);
00124         ar_timerCounter.setOutputCompareRegister(ar_channel, ar_period_us);
00125         // start timer
00126         ar_timerCounter.start();
00127         // wait for the pitch duration
00128         while (ar_duration_ms) {
00129             _delay_ms(1);
00130             ar_duration_ms--;
00131         }
00132         // no buzz
00133         ar_timerCounter.selectCompareOutputMode(ar_channel, core::compareOutputMode::normal);
00134         ar_timerCounter.stop();
00135     }
00136
00137
00138 protected:
00139
00140 private:
00141
00142     io::Pin m_pin;
00145 };
00146 }
00147
00148
00149 #endif

```

10.13 buzzer_pitches_16bit.h File Reference

This graph shows which files directly or indirectly include this file:



Macros

- #define C0 25000
- #define Cx0 23597
- #define D0 22272
- #define Dx0 21022
- #define E0 19843
- #define F0 18729
- #define Fx0 17678
- #define G0 16685
- #define Gx0 15749
- #define A0 14865
- #define Ax0 14031
- #define B0 13243
- #define C1 12500
- #define Cx1 11798
- #define D1 11136
- #define Dx1 10511
- #define E1 9921
- #define F1 9364
- #define Fx1 8839
- #define G1 8343
- #define Gx1 7875
- #define A1 7433
- #define Ax1 7015
- #define B1 6622
- #define C2 6250
- #define Cx2 5899
- #define D2 5568
- #define Dx2 5256
- #define E2 4961
- #define F2 4682
- #define Fx2 4419
- #define G2 4171
- #define Gx2 3937

- #define [A2](#) 3716
- #define [Ax2](#) 3508
- #define [B2](#) 3311
- #define [C3](#) 3125
- #define [Cx3](#) 2950
- #define [D3](#) 2784
- #define [Dx3](#) 2628
- #define [E3](#) 2480
- #define [F3](#) 2341
- #define [Fx3](#) 2210
- #define [G3](#) 2086
- #define [Gx3](#) 1969
- #define [A3](#) 1858
- #define [Ax3](#) 1754
- #define [B3](#) 1655
- #define [C4](#) 1562
- #define [Cx4](#) 1474
- #define [D4](#) 1392
- #define [Dx4](#) 1313
- #define [E4](#) 1240
- #define [F4](#) 1170
- #define [Fx4](#) 1105
- #define [G4](#) 1043
- #define [Gx4](#) 984
- #define [A4](#) 929
- #define [Ax4](#) 877
- #define [B4](#) 827
- #define [C5](#) 781
- #define [Cx5](#) 737
- #define [D5](#) 696
- #define [Dx5](#) 657
- #define [E5](#) 620
- #define [F5](#) 585
- #define [Fx5](#) 552
- #define [G5](#) 521
- #define [Gx5](#) 492
- #define [A5](#) 464
- #define [Ax5](#) 438
- #define [B5](#) 414
- #define [C6](#) 390
- #define [Cx6](#) 368
- #define [D6](#) 347
- #define [Dx6](#) 328
- #define [E6](#) 310
- #define [F6](#) 292
- #define [Fx6](#) 276
- #define [G6](#) 260
- #define [Gx6](#) 246
- #define [A6](#) 232
- #define [Ax6](#) 219
- #define [B6](#) 207
- #define [C7](#) 195
- #define [Cx7](#) 184
- #define [D7](#) 174
- #define [Dx7](#) 164

- `#define E7` 155
- `#define F7` 146
- `#define Fx7` 138
- `#define G7` 130
- `#define Gx7` 123
- `#define A7` 116
- `#define Ax7` 109
- `#define B7` 103

10.13.1 Macro Definition Documentation

10.13.1.1 A0

```
#define A0 14865
```

Definition at line 21 of file [buzzer_pitches_16bit.h](#).

10.13.1.2 A1

```
#define A1 7433
```

Definition at line 33 of file [buzzer_pitches_16bit.h](#).

10.13.1.3 A2

```
#define A2 3716
```

Definition at line 45 of file [buzzer_pitches_16bit.h](#).

10.13.1.4 A3

```
#define A3 1858
```

Definition at line 57 of file [buzzer_pitches_16bit.h](#).

10.13.1.5 A4

```
#define A4 929
```

Definition at line 69 of file [buzzer_pitches_16bit.h](#).

10.13.1.6 A5

```
#define A5 464
```

Definition at line 81 of file [buzzer_pitches_16bit.h](#).

10.13.1.7 A6

```
#define A6 232
```

Definition at line 93 of file [buzzer_pitches_16bit.h](#).

10.13.1.8 A7

```
#define A7 116
```

Definition at line 105 of file [buzzer_pitches_16bit.h](#).

10.13.1.9 Ax0

```
#define Ax0 14031
```

Definition at line 22 of file [buzzer_pitches_16bit.h](#).

10.13.1.10 Ax1

```
#define Ax1 7015
```

Definition at line 34 of file [buzzer_pitches_16bit.h](#).

10.13.1.11 Ax2

```
#define Ax2 3508
```

Definition at line 46 of file [buzzer_pitches_16bit.h](#).

10.13.1.12 Ax3

```
#define Ax3 1754
```

Definition at line 58 of file [buzzer_pitches_16bit.h](#).

10.13.1.13 Ax4

```
#define Ax4 877
```

Definition at line 70 of file [buzzer_pitches_16bit.h](#).

10.13.1.14 Ax5

```
#define Ax5 438
```

Definition at line 82 of file [buzzer_pitches_16bit.h](#).

10.13.1.15 Ax6

```
#define Ax6 219
```

Definition at line 94 of file [buzzer_pitches_16bit.h](#).

10.13.1.16 Ax7

```
#define Ax7 109
```

Definition at line 106 of file [buzzer_pitches_16bit.h](#).

10.13.1.17 B0

```
#define B0 13243
```

Definition at line [23](#) of file [buzzer_pitches_16bit.h](#).

10.13.1.18 B1

```
#define B1 6622
```

Definition at line [35](#) of file [buzzer_pitches_16bit.h](#).

10.13.1.19 B2

```
#define B2 3311
```

Definition at line [47](#) of file [buzzer_pitches_16bit.h](#).

10.13.1.20 B3

```
#define B3 1655
```

Definition at line [59](#) of file [buzzer_pitches_16bit.h](#).

10.13.1.21 B4

```
#define B4 827
```

Definition at line [71](#) of file [buzzer_pitches_16bit.h](#).

10.13.1.22 B5

```
#define B5 414
```

Definition at line [83](#) of file [buzzer_pitches_16bit.h](#).

10.13.1.23 B6

```
#define B6 207
```

Definition at line 95 of file [buzzer_pitches_16bit.h](#).

10.13.1.24 B7

```
#define B7 103
```

Definition at line 107 of file [buzzer_pitches_16bit.h](#).

10.13.1.25 C0

```
#define C0 25000
```

Definition at line 12 of file [buzzer_pitches_16bit.h](#).

10.13.1.26 C1

```
#define C1 12500
```

Definition at line 24 of file [buzzer_pitches_16bit.h](#).

10.13.1.27 C2

```
#define C2 6250
```

Definition at line 36 of file [buzzer_pitches_16bit.h](#).

10.13.1.28 C3

```
#define C3 3125
```

Definition at line 48 of file [buzzer_pitches_16bit.h](#).

10.13.1.29 C4

```
#define C4 1562
```

Definition at line 60 of file [buzzer_pitches_16bit.h](#).

10.13.1.30 C5

```
#define C5 781
```

Definition at line 72 of file [buzzer_pitches_16bit.h](#).

10.13.1.31 C6

```
#define C6 390
```

Definition at line 84 of file [buzzer_pitches_16bit.h](#).

10.13.1.32 C7

```
#define C7 195
```

Definition at line 96 of file [buzzer_pitches_16bit.h](#).

10.13.1.33 Cx0

```
#define Cx0 23597
```

Definition at line 13 of file [buzzer_pitches_16bit.h](#).

10.13.1.34 Cx1

```
#define Cx1 11798
```

Definition at line 25 of file [buzzer_pitches_16bit.h](#).

10.13.1.35 Cx2

```
#define Cx2 5899
```

Definition at line 37 of file [buzzer_pitches_16bit.h](#).

10.13.1.36 Cx3

```
#define Cx3 2950
```

Definition at line 49 of file [buzzer_pitches_16bit.h](#).

10.13.1.37 Cx4

```
#define Cx4 1474
```

Definition at line 61 of file [buzzer_pitches_16bit.h](#).

10.13.1.38 Cx5

```
#define Cx5 737
```

Definition at line 73 of file [buzzer_pitches_16bit.h](#).

10.13.1.39 Cx6

```
#define Cx6 368
```

Definition at line 85 of file [buzzer_pitches_16bit.h](#).

10.13.1.40 Cx7

```
#define Cx7 184
```

Definition at line 97 of file [buzzer_pitches_16bit.h](#).

10.13.1.41 D0

```
#define D0 22272
```

Definition at line 14 of file [buzzer_pitches_16bit.h](#).

10.13.1.42 D1

```
#define D1 11136
```

Definition at line 26 of file [buzzer_pitches_16bit.h](#).

10.13.1.43 D2

```
#define D2 5568
```

Definition at line 38 of file [buzzer_pitches_16bit.h](#).

10.13.1.44 D3

```
#define D3 2784
```

Definition at line 50 of file [buzzer_pitches_16bit.h](#).

10.13.1.45 D4

```
#define D4 1392
```

Definition at line 62 of file [buzzer_pitches_16bit.h](#).

10.13.1.46 D5

```
#define D5 696
```

Definition at line 74 of file [buzzer_pitches_16bit.h](#).

10.13.1.47 D6

```
#define D6 347
```

Definition at line 86 of file [buzzer_pitches_16bit.h](#).

10.13.1.48 D7

```
#define D7 174
```

Definition at line 98 of file [buzzer_pitches_16bit.h](#).

10.13.1.49 Dx0

```
#define Dx0 21022
```

Definition at line 15 of file [buzzer_pitches_16bit.h](#).

10.13.1.50 Dx1

```
#define Dx1 10511
```

Definition at line 27 of file [buzzer_pitches_16bit.h](#).

10.13.1.51 Dx2

```
#define Dx2 5256
```

Definition at line 39 of file [buzzer_pitches_16bit.h](#).

10.13.1.52 Dx3

```
#define Dx3 2628
```

Definition at line 51 of file [buzzer_pitches_16bit.h](#).

10.13.1.53 Dx4

```
#define Dx4 1313
```

Definition at line 63 of file [buzzer_pitches_16bit.h](#).

10.13.1.54 Dx5

```
#define Dx5 657
```

Definition at line 75 of file [buzzer_pitches_16bit.h](#).

10.13.1.55 Dx6

```
#define Dx6 328
```

Definition at line 87 of file [buzzer_pitches_16bit.h](#).

10.13.1.56 Dx7

```
#define Dx7 164
```

Definition at line 99 of file [buzzer_pitches_16bit.h](#).

10.13.1.57 E0

```
#define E0 19843
```

Definition at line 16 of file [buzzer_pitches_16bit.h](#).

10.13.1.58 E1

```
#define E1 9921
```

Definition at line 28 of file [buzzer_pitches_16bit.h](#).

10.13.1.59 E2

```
#define E2 4961
```

Definition at line 40 of file [buzzer_pitches_16bit.h](#).

10.13.1.60 E3

```
#define E3 2480
```

Definition at line 52 of file [buzzer_pitches_16bit.h](#).

10.13.1.61 E4

```
#define E4 1240
```

Definition at line 64 of file [buzzer_pitches_16bit.h](#).

10.13.1.62 E5

```
#define E5 620
```

Definition at line 76 of file [buzzer_pitches_16bit.h](#).

10.13.1.63 E6

```
#define E6 310
```

Definition at line 88 of file [buzzer_pitches_16bit.h](#).

10.13.1.64 E7

```
#define E7 155
```

Definition at line 100 of file [buzzer_pitches_16bit.h](#).

10.13.1.65 F0

```
#define F0 18729
```

Definition at line 17 of file [buzzer_pitches_16bit.h](#).

10.13.1.66 F1

```
#define F1 9364
```

Definition at line 29 of file [buzzer_pitches_16bit.h](#).

10.13.1.67 F2

```
#define F2 4682
```

Definition at line 41 of file [buzzer_pitches_16bit.h](#).

10.13.1.68 F3

```
#define F3 2341
```

Definition at line 53 of file [buzzer_pitches_16bit.h](#).

10.13.1.69 F4

```
#define F4 1170
```

Definition at line 65 of file [buzzer_pitches_16bit.h](#).

10.13.1.70 F5

```
#define F5 585
```

Definition at line 77 of file [buzzer_pitches_16bit.h](#).

10.13.1.71 F6

```
#define F6 292
```

Definition at line 89 of file [buzzer_pitches_16bit.h](#).

10.13.1.72 F7

```
#define F7 146
```

Definition at line 101 of file [buzzer_pitches_16bit.h](#).

10.13.1.73 Fx0

```
#define Fx0 17678
```

Definition at line 18 of file [buzzer_pitches_16bit.h](#).

10.13.1.74 Fx1

```
#define Fx1 8839
```

Definition at line 30 of file [buzzer_pitches_16bit.h](#).

10.13.1.75 Fx2

```
#define Fx2 4419
```

Definition at line 42 of file [buzzer_pitches_16bit.h](#).

10.13.1.76 Fx3

```
#define Fx3 2210
```

Definition at line 54 of file [buzzer_pitches_16bit.h](#).

10.13.1.77 Fx4

```
#define Fx4 1105
```

Definition at line 66 of file [buzzer_pitches_16bit.h](#).

10.13.1.78 Fx5

```
#define Fx5 552
```

Definition at line 78 of file [buzzer_pitches_16bit.h](#).

10.13.1.79 Fx6

```
#define Fx6 276
```

Definition at line 90 of file [buzzer_pitches_16bit.h](#).

10.13.1.80 Fx7

```
#define Fx7 138
```

Definition at line 102 of file [buzzer_pitches_16bit.h](#).

10.13.1.81 G0

```
#define G0 16685
```

Definition at line 19 of file [buzzer_pitches_16bit.h](#).

10.13.1.82 G1

```
#define G1 8343
```

Definition at line 31 of file [buzzer_pitches_16bit.h](#).

10.13.1.83 G2

```
#define G2 4171
```

Definition at line 43 of file [buzzer_pitches_16bit.h](#).

10.13.1.84 G3

```
#define G3 2086
```

Definition at line 55 of file [buzzer_pitches_16bit.h](#).

10.13.1.85 G4

```
#define G4 1043
```

Definition at line 67 of file [buzzer_pitches_16bit.h](#).

10.13.1.86 G5

```
#define G5 521
```

Definition at line 79 of file [buzzer_pitches_16bit.h](#).

10.13.1.87 G6

```
#define G6 260
```

Definition at line 91 of file [buzzer_pitches_16bit.h](#).

10.13.1.88 G7

```
#define G7 130
```

Definition at line 103 of file [buzzer_pitches_16bit.h](#).

10.13.1.89 Gx0

```
#define Gx0 15749
```

Definition at line 20 of file [buzzer_pitches_16bit.h](#).

10.13.1.90 Gx1

```
#define Gx1 7875
```

Definition at line 32 of file [buzzer_pitches_16bit.h](#).

10.13.1.91 Gx2

```
#define Gx2 3937
```

Definition at line 44 of file [buzzer_pitches_16bit.h](#).

10.13.1.92 Gx3

```
#define Gx3 1969
```

Definition at line 56 of file [buzzer_pitches_16bit.h](#).

10.13.1.93 Gx4

```
#define Gx4 984
```

Definition at line 68 of file [buzzer_pitches_16bit.h](#).

10.13.1.94 Gx5

```
#define Gx5 492
```

Definition at line 80 of file [buzzer_pitches_16bit.h](#).

10.13.1.95 Gx6

```
#define Gx6 246
```

Definition at line 92 of file [buzzer_pitches_16bit.h](#).

10.13.1.96 Gx7

```
#define Gx7 123
```

Definition at line 104 of file [buzzer_pitches_16bit.h](#).

10.14 buzzer_pitches_16bit.h

```
00001 /* Scale in the key of 1/25000 */
00002 /*
00003  * These are 1/2 periods (us) -- if you delay this long,
00004  * then toggle the speaker pin, you'll get approximate
00005  * pitches.
00006  *
00007  * This is the 16-bit version. The pitches get less accurate
00008  * as they get higher.
00009  */
00010 */
00011
00012 #define C0      25000 // freq = 1000000/ (2*25000) = 20hz
00013 #define Cx0     23597
00014 #define D0      22272
00015 #define Dx0     21022
00016 #define E0      19843
00017 #define F0      18729
00018 #define Fx0     17678
00019 #define G0      16685
00020 #define Gx0     15749
00021 #define A0      14865
00022 #define Ax0     14031
00023 #define B0      13243
00024 #define C1      12500
00025 #define Cx1     11798
00026 #define D1      11136
00027 #define Dx1     10511
00028 #define E1       9921
00029 #define F1       9364
00030 #define Fx1      8839
00031 #define G1       8343
00032 #define Gx1      7875
00033 #define A1       7433
00034 #define Ax1      7015
00035 #define B1       6622
00036 #define C2       6250
00037 #define Cx2      5899
00038 #define D2       5568
00039 #define Dx2      5256
00040 #define E2       4961
00041 #define F2       4682
00042 #define Fx2      4419
00043 #define G2       4171
00044 #define Gx2      3937
00045 #define A2       3716
00046 #define Ax2      3508
00047 #define B2       3311
00048 #define C3       3125
00049 #define Cx3      2950
00050 #define D3       2784
00051 #define Dx3      2628
00052 #define E3       2480
00053 #define F3       2341
00054 #define Fx3      2210
00055 #define G3       2086
00056 #define Gx3      1969
00057 #define A3       1858
00058 #define Ax3      1754
```

```

00059 #define B3      1655
00060 #define C4      1562
00061 #define Cx4     1474
00062 #define D4      1392
00063 #define Dx4     1313
00064 #define E4      1240
00065 #define F4      1170
00066 #define Fx4     1105
00067 #define G4      1043
00068 #define Gx4     984
00069 #define A4      929
00070 #define Ax4     877
00071 #define B4      827
00072 #define C5      781
00073 #define Cx5     737
00074 #define D5      696
00075 #define Dx5     657
00076 #define E5      620
00077 #define F5      585
00078 #define Fx5     552
00079 #define G5      521
00080 #define Gx5     492
00081 #define A5      464
00082 #define Ax5     438
00083 #define B5      414
00084 #define C6      390
00085 #define Cx6     368
00086 #define D6      347
00087 #define Dx6     328
00088 #define E6      310
00089 #define F6      292
00090 #define Fx6     276
00091 #define G6      260
00092 #define Gx6     246
00093 #define A6      232
00094 #define Ax6     219
00095 #define B6      207
00096 #define C7      195
00097 #define Cx7     184
00098 #define D7      174
00099 #define Dx7     164
00100 #define E7      155
00101 #define F7      146
00102 #define Fx7     138
00103 #define G7      130
00104 #define Gx7     123
00105 #define A7      116
00106 #define Ax7     109
00107 #define B7      103 // freq = 1000000/ (2*103) = 4.85 khz

```

10.15 buzzer_pitches_8bit.h File Reference

Macros

- #define Gx0 252
- #define A0 238
- #define Ax0 224
- #define B0 212
- #define C1 200
- #define Cx0 189
- #define D1 178
- #define Dx0 168
- #define E1 159
- #define F1 150
- #define Fx1 141
- #define G1 133
- #define Gx1 126
- #define A1 119
- #define Ax1 112
- #define B1 106

- #define [C2](#) 100
- #define [Cx2](#) 94
- #define [D2](#) 89
- #define [Dx2](#) 84
- #define [E2](#) 79
- #define [F2](#) 75
- #define [Fx2](#) 71
- #define [G2](#) 67
- #define [Gx2](#) 63
- #define [A2](#) 59
- #define [Ax2](#) 56
- #define [B2](#) 53
- #define [C3](#) 50
- #define [Cx3](#) 47
- #define [D3](#) 44
- #define [Dx3](#) 42
- #define [E3](#) 40
- #define [F3](#) 37
- #define [Fx3](#) 35
- #define [G3](#) 33

10.15.1 Macro Definition Documentation

10.15.1.1 A0

```
#define A0 238
```

Definition at line [14](#) of file [buzzer_pitches_8bit.h](#).

10.15.1.2 A1

```
#define A1 119
```

Definition at line [26](#) of file [buzzer_pitches_8bit.h](#).

10.15.1.3 A2

```
#define A2 59
```

Definition at line [38](#) of file [buzzer_pitches_8bit.h](#).

10.15.1.4 Ax0

```
#define Ax0 224
```

Definition at line 15 of file [buzzer_pitches_8bit.h](#).

10.15.1.5 Ax1

```
#define Ax1 112
```

Definition at line 27 of file [buzzer_pitches_8bit.h](#).

10.15.1.6 Ax2

```
#define Ax2 56
```

Definition at line 39 of file [buzzer_pitches_8bit.h](#).

10.15.1.7 B0

```
#define B0 212
```

Definition at line 16 of file [buzzer_pitches_8bit.h](#).

10.15.1.8 B1

```
#define B1 106
```

Definition at line 28 of file [buzzer_pitches_8bit.h](#).

10.15.1.9 B2

```
#define B2 53
```

Definition at line 40 of file [buzzer_pitches_8bit.h](#).

10.15.1.10 C1

```
#define C1 200
```

Definition at line 17 of file [buzzer_pitches_8bit.h](#).

10.15.1.11 C2

```
#define C2 100
```

Definition at line 29 of file [buzzer_pitches_8bit.h](#).

10.15.1.12 C3

```
#define C3 50
```

Definition at line 41 of file [buzzer_pitches_8bit.h](#).

10.15.1.13 Cx0

```
#define Cx0 189
```

Definition at line 18 of file [buzzer_pitches_8bit.h](#).

10.15.1.14 Cx2

```
#define Cx2 94
```

Definition at line 30 of file [buzzer_pitches_8bit.h](#).

10.15.1.15 Cx3

```
#define Cx3 47
```

Definition at line 42 of file [buzzer_pitches_8bit.h](#).

10.15.1.16 D1

```
#define D1 178
```

Definition at line 19 of file [buzzer_pitches_8bit.h](#).

10.15.1.17 D2

```
#define D2 89
```

Definition at line 31 of file [buzzer_pitches_8bit.h](#).

10.15.1.18 D3

```
#define D3 44
```

Definition at line 43 of file [buzzer_pitches_8bit.h](#).

10.15.1.19 Dx0

```
#define Dx0 168
```

Definition at line 20 of file [buzzer_pitches_8bit.h](#).

10.15.1.20 Dx2

```
#define Dx2 84
```

Definition at line 32 of file [buzzer_pitches_8bit.h](#).

10.15.1.21 Dx3

```
#define Dx3 42
```

Definition at line 44 of file [buzzer_pitches_8bit.h](#).

10.15.1.22 E1

```
#define E1 159
```

Definition at line 21 of file [buzzer_pitches_8bit.h](#).

10.15.1.23 E2

```
#define E2 79
```

Definition at line 33 of file [buzzer_pitches_8bit.h](#).

10.15.1.24 E3

```
#define E3 40
```

Definition at line 45 of file [buzzer_pitches_8bit.h](#).

10.15.1.25 F1

```
#define F1 150
```

Definition at line 22 of file [buzzer_pitches_8bit.h](#).

10.15.1.26 F2

```
#define F2 75
```

Definition at line 34 of file [buzzer_pitches_8bit.h](#).

10.15.1.27 F3

```
#define F3 37
```

Definition at line 46 of file [buzzer_pitches_8bit.h](#).

10.15.1.28 Fx1

```
#define Fx1 141
```

Definition at line 23 of file [buzzer_pitches_8bit.h](#).

10.15.1.29 Fx2

```
#define Fx2 71
```

Definition at line 35 of file [buzzer_pitches_8bit.h](#).

10.15.1.30 Fx3

```
#define Fx3 35
```

Definition at line 47 of file [buzzer_pitches_8bit.h](#).

10.15.1.31 G1

```
#define G1 133
```

Definition at line 24 of file [buzzer_pitches_8bit.h](#).

10.15.1.32 G2

```
#define G2 67
```

Definition at line 36 of file [buzzer_pitches_8bit.h](#).

10.15.1.33 G3

```
#define G3 33
```

Definition at line 48 of file [buzzer_pitches_8bit.h](#).

10.15.1.34 Gx0

```
#define Gx0 252
```

Definition at line 13 of file [buzzer_pitches_8bit.h](#).

10.15.1.35 Gx1

```
#define Gx1 126
```

Definition at line 25 of file [buzzer_pitches_8bit.h](#).

10.15.1.36 Gx2

```
#define Gx2 63
```

Definition at line 37 of file [buzzer_pitches_8bit.h](#).

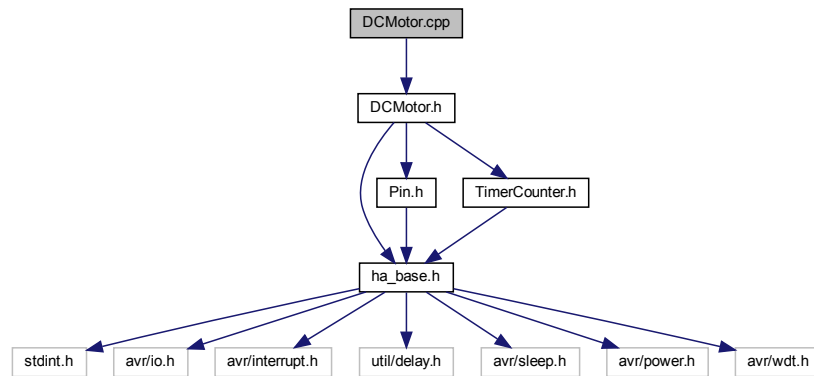
10.16 buzzer_pitches_8bit.h

```
00001 /* Scale in the key of 1/200 */
00002
00003 /*
00004     These are 1/2 periods (us) -- if you delay this long,
00005     then toggle the speaker pin, you'll get approximate
00006     pitches.
00007
00008     This is the 8-bit version. The pitches get less accurate
00009     as they get higher.
00010
00011 */
00012
00013 #define Gx0 252 // freq = 1000000/ (2*252) = 1.98 khz
00014 #define A0 238
00015 #define Ax0 224
00016 #define B0 212
00017 #define C1 200
00018 #define Cx0 189
00019 #define D1 178
00020 #define Dx0 168
00021 #define E1 159
00022 #define F1 150
00023 #define Fx1 141
00024 #define G1 133
00025 #define Gx1 126
00026 #define A1 119
00027 #define Ax1 112
00028 #define B1 106
00029 #define C2 100
00030 #define Cx2 94
00031 #define D2 89
00032 #define Dx2 84
00033 #define E2 79
00034 #define F2 75
00035 #define Fx2 71
00036 #define G2 67
00037 #define Gx2 63
00038 #define A2 59
00039 #define Ax2 56
00040 #define B2 53
00041 #define C3 50
00042 #define Cx3 47
00043 #define D3 44
00044 #define Dx3 42
00045 #define E3 40
00046 #define F3 37
00047 #define Fx3 35
00048 #define G3 33 // freq = 1000000/ (2*33) = 15.15 khz
```

10.17 DCMotor.cpp File Reference

```
#include "DCMotor.h"
```

Include dependency graph for DCMotor.cpp:



10.18 DCMotor.cpp

```

00001 #include "DCMotor.h"
00002
00003 component::DCMotor::DCMotor(const io::Pin &ar_pin)
00004     : m_pin(ar_pin)
00005 {
00006     m_pin.toOutput();
00007 }
00008
00009
00010
00011 component::DCMotor::~DCMotor()
00012 {
00013 }
00014
00015
00016 void component::DCMotor::on()
00017 {
00018     m_pin.setHigh();
00019 }
00020
00021 void component::DCMotor::off()
00022 {
00023     m_pin.setLow();
00024 }
00025
00026 void component::DCMotor::toggle()
00027 {
00028     m_pin.toggle();
00029 }
00030 }
  
```

10.19 DCMotor.h File Reference

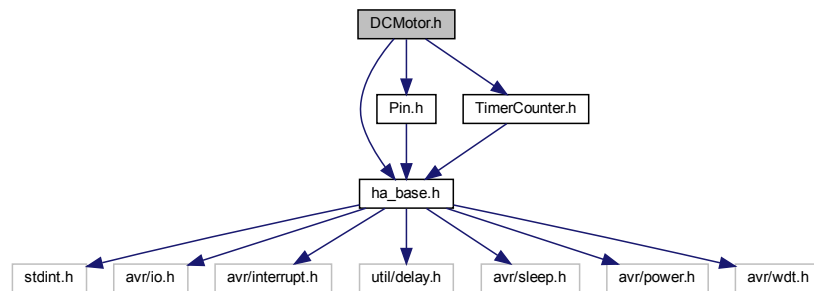
Header file of the DCMotor class.

```
#include "ha_base.h"
#include "Pin.h"
```

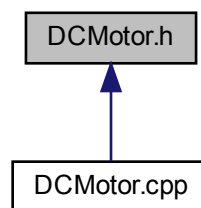


```
#include "TimerCounter.h"
```

Include dependency graph for DCMotor.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [component::DCMotor](#)

Namespaces

- [component](#)
AVR chip external components.

10.19.1 Detailed Description

Header file of the DCMotor class.

Usage example (test): `#include "MCU.h" #include "TimerCounter0.h" #include "DCMotor.h"`

```
#define DCMOTOR_NUMBER 6
```

```
int main(void) {
```

```

Init initialize MCU core::MCU::init();

instantiate the TimerCounter0 object core::TimerCounter0 &myTimerCounter0 = core::TimerCounter0::getInstance();
myTimerCounter0.selectClockSource(core::clockSource::PS_1024);

instantiate a DCMotor object component::DCMotor myDCMotor(io::Pin(DCMOTOR_NUMBER,io::PortD));

myDCMotor.connect(myTimerCounter0);

myDCMotor.spin(myTimerCounter0,0); _delay_ms(5000);

myDCMotor.spin(myTimerCounter0,75); _delay_ms(5000);

myDCMotor.spin(myTimerCounter0,190); _delay_ms(5000);

myDCMotor.spin(myTimerCounter0,200); _delay_ms(5000);

myDCMotor.disconnect(myTimerCounter0);

Mainloop while (1) {

} return 0; } Usage example (H Bridge):

#include "MCU.h" #include "TimerCounter0.h" #include "DCMotor.h"

#define DCMOTOR_NUMBER 6 #define DCMOTOR_BACKWARD 0 #define DCMOTOR_FORWARD 1

int main(void) {

Init initialize MCU core::MCU::init();

instantiate the TimerCounter0 object core::TimerCounter0 &myTimerCounter0 = core::TimerCounter0::getInstance();
myTimerCounter0.selectClockSource(core::clockSource::PS_256);

instantiate a DCMotor object component::DCMotor myDCMotor(io::Pin(DCMOTOR_NUMBER,io::PortD));

instantiate direction pins objects

io::Pin myPinForward = io::Pin(DCMOTOR_FORWARD,io::PortB); myPinForward.toOutput();

io::Pin myPinBackward = io::Pin(DCMOTOR_BACKWARD,io::PortB); myPinBackward.toOutput();

myDCMotor.connect(myTimerCounter0);

myPinForward.setHigh(); myPinBackward.setLow(); myDCMotor.spin(myTimerCounter0,30); _delay_ms(5000);

myPinForward.setLow(); myPinBackward.setHigh(); myDCMotor.spin(myTimerCounter0,30); _delay_ms(5000);

myDCMotor.disconnect(myTimerCounter0);

Mainloop while (1) {

} return 0; }

```

Basic class for IO abstraction of Pin and Port

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Definition in file [DCMotor.h](#).

10.20 DCMotor.h

```

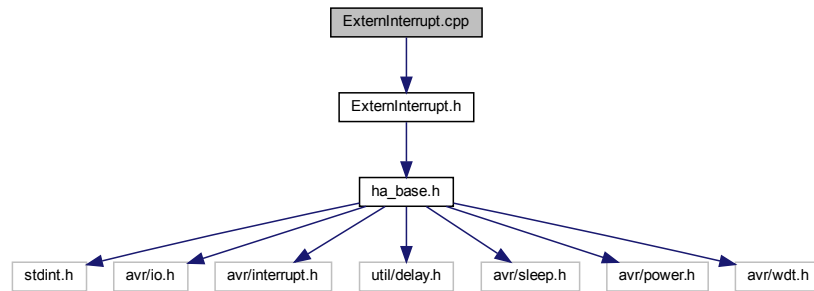
00001
00117 #ifndef DCMOTOR_H
00118 #define DCMOTOR_H
00119 #include "ha_base.h"
00120 #include "Pin.h"
00121 #include "TimerCounter.h"
00122
00123 namespace component
00124 {
00125
00126 class DCMotor
00127 {
00128 public:
00129     DCMotor(const io::Pin &ar_pin);
00130
00131     ~DCMotor();
00132
00133     void on();
00134     void off();
00135     void toggle();
00136
00137     template<typename TC>
00138     void spin(TC &ar_timerCounter,
00139              //const uint8_t &ar_dir,
00140              const uint16_t &ar_speed,
00141              const core::channel &ar_channel=core::channel::A)
00142     {
00143         ar_timerCounter.setOutputCompareRegister(ar_channel, ar_speed);
00144         ar_timerCounter.start();
00145     }
00146
00147     template<typename TC>
00148     void stop(TC &ar_timerCounter)
00149     {
00150         ar_timerCounter.stop();
00151     }
00152
00153     template<typename TC>
00154     void connect(TC &ar_timerCounter,
00155                 const core::channel &ar_channel=core::channel::A)
00156     {
00157         ar_timerCounter.selectOperationMode(core::operationMode::fast_PWM);
00158         ar_timerCounter.selectCompareOutputMode(ar_channel, core::compareOutputMode::clear);
00159         ar_timerCounter.setCounter(0);
00160     }
00161
00162     template<typename TC>
00163     void disconnect(TC &ar_timerCounter,
00164                    const core::channel &ar_channel=core::channel::A)
00165     {
00166         ar_timerCounter.selectCompareOutputMode(ar_channel, core::compareOutputMode::normal);
00167         ar_timerCounter.stop();
00168     }
00169
00170 private:
00171     io::Pin m_pin;
00172 };
00173
00174 #endif // DCMOTOR_H

```

10.21 ExternInterrupt.cpp File Reference

```
#include "ExternInterrupt.h"
```

Include dependency graph for ExternInterrupt.cpp:



10.22 ExternInterrupt.cpp

```

00001 #include "ExternInterrupt.h"
00002
00003 core::ExternInterrupt& core::ExternInterrupt::getInstance()
00004 {
00005     static ExternInterrupt l_instance;
00006     return l_instance;
00007 }
00008
00009
00010
00011 core::ExternInterrupt::ExternInterrupt()
00012 {
00013     sei();
00014 }
00015
00016
00017 core::ExternInterrupt::~ExternInterrupt()
00018 {
00019 }
00020
00021
00022 void core::ExternInterrupt::setInt0SenseControl(const senseControl& ar_senseControl)
00023 {
00024     EXT_INT_SET_INT0_SENSE_CONTROL(static_cast<uint8_t>(ar_senseControl));
00025 }
00026
00027
00028 void core::ExternInterrupt::setInt1SenseControl(const senseControl& ar_senseControl)
00029 {
00030     EXT_INT_SET_INT1_SENSE_CONTROL(static_cast<uint8_t>(ar_senseControl));
00031 }
00032
00033
00034 void core::ExternInterrupt::enableInt0(const uint8_t a_enable)
00035 {
00036     if (a_enable) {
00037         EXT_INT_ENABLE_INT0;
00038     } else {
00039         EXT_INT_DISABLE_INT0;
00040     }
00041 }
00042
00043
00044
00045 void core::ExternInterrupt::enableInt1(const uint8_t a_enable)
00046 {
00047     if (a_enable) {
00048         EXT_INT_ENABLE_INT1;
00049     } else {
00050         EXT_INT_DISABLE_INT1;
00051     }
00052 }
00053
00054
00055
00056 void core::ExternInterrupt::enablePinChange(const pinChangePort& ar_pinChangePort, const uint8_t
a_enable)
  
```

```

00057 {
00058     if (a_enable) {
00059         EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT(static_cast<uint8_t>(ar_pinChangePort));
00060     } else {
00061         EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT(static_cast<uint8_t>(ar_pinChangePort));
00062     }
00063 }
00064
00065 }
00066
00067 void core::ExternInterrupt::enablePinChangeMaskPortB(const uint8_t a_pinNumber, const uint8_t
a_enable)
00068 {
00069     if (a_enable) {
00070         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(a_pinNumber);
00071     } else {
00072         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(a_pinNumber);
00073     }
00074 }
00075
00076 }
00077
00078
00079 void core::ExternInterrupt::enablePinChangeMaskPortC(const uint8_t a_pinNumber, const uint8_t
a_enable)
00080 {
00081     if (a_enable) {
00082         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(a_pinNumber);
00083     } else {
00084         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(a_pinNumber);
00085     }
00086 }
00087
00088 }
00089
00090 void core::ExternInterrupt::enablePinChangeMaskPortD(const uint8_t a_pinNumber, const uint8_t
a_enable)
00091 {
00092     if (a_enable) {
00093         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(a_pinNumber);
00094     } else {
00095         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(a_pinNumber);
00096     }
00097 }
00098 }

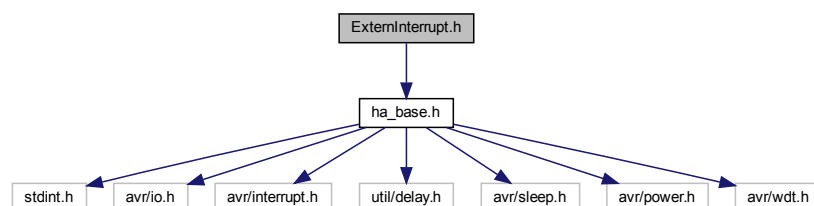
```

10.23 ExternInterrupt.h File Reference

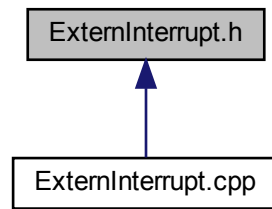
Header file of the ExternInterrupt class.

```
#include "ha_base.h"
```

Include dependency graph for ExternInterrupt.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [core::ExternInterrupt](#)

Namespaces

- [core](#)

Enumerations

- enum [core::senseControl](#) : uint8_t { [core::senseControl::lowLevel](#) =0, [core::senseControl::logicalChange](#), [core::senseControl::fallingEdge](#), [core::senseControl::risingEdge](#) }
- enum [core::pinChangePort](#) : uint8_t { [core::pinChangePort::PCINTB](#) =0, [core::pinChangePort::PCINTC](#), [core::pinChangePort::PCINTD](#) }

10.23.1 Detailed Description

Header file of the ExternInterrupt class.

class to handle externally triggered interrupts.

Usage example (external interrupt):

```
#include "PushButton.h" #include "Led.h" #include "ExternInterrupt.h"
```

```
#define PUSHBUTTON_NUMBER 2 #define MAIN_LED_NUMBER 0 #define INTERRUPT_LED_NUMBER 1 #define DELAYTIME 1000
```

```
instantiate a Led object declaration of global variables (shut up warning) extern component::Led MainLed; extern component::Led InterruptLed; component::Led MainLed(io::Pin(MAIN_LED_NUMBER,io::PortB)); component::Led InterruptLed(io::Pin(INTERRUPT_LED_NUMBER,io::PortB));
```

```
instantiate a Led object declaration of global variable (shut up warning) extern component::PushButton PushButton; component::PushButton PushButton(io::Pin(PUSHBUTTON_NUMBER,io::PortD));
```

```
int main(void) {
```

Init

```

instantiate the external interrupt manager core::ExternInterrupt &myExternInterrupt = core::ExternInterrupt::getInstance();
myExternInterrupt.enableInt0(1); myExternInterrupt.setInt0SenseControl(core::senseControl::logicalChange);

```

Mainloop while (1) {

```

MainLed.toggle(); _delay_ms(DELAYTIME);

```

} return 0; }

```

void core::ExternInterrupt::Int0ServiceRoutine() { if (PushButton.isPressed()) { InterruptLed.on(); } else { InterruptLed.off(); }
}

```

Usage example (pin change interrupt):

```

#include "PushButton.h" #include "Led.h" #include "ExternInterrupt.h"

```

```

#define PUSHBUTTON_1_NUMBER 2 #define PUSHBUTTON_2_NUMBER 3 #define MAIN_LED_NUMBER 0
#define INTERRUPT_LED_1_NUMBER 1 #define INTERRUPT_LED_2_NUMBER 2 #define DELAYTIME 1000

```

```

instantiate a Led objects declaration of global variables (shut up warning) extern component::Led MainLed; extern component::Led InterruptLed1; extern component::Led InterruptLed2; component::Led MainLed(io::Pin(MAIN_LED_NUMBER,io::PortB)); component::Led InterruptLed1(io::Pin(INTERRUPT_LED_1_NUMBER,io::PortB)); component::Led InterruptLed2(io::Pin(INTERRUPT_LED_2_NUMBER,io::PortB));

```

```

instantiate a PushButton objects declaration of global variable (shut up warning) extern component::PushButton PushButton1; extern component::PushButton PushButton2; component::PushButton PushButton1(io::Pin(PUSHBUTTON_1_NUMBER,io::PortD)); component::PushButton PushButton2(io::Pin(PUSHBUTTON_2_NUMBER,io::PortB));

```

```

int main(void) {

```

Init

```

instantiate the external interrupt manager core::ExternInterrupt &myExternInterrupt = core::ExternInterrupt::getInstance();
myExternInterrupt.enablePinChange(core::pinChangePort::PCINTD,1); myExternInterrupt.enablePinChange(core::pinChangePort::PCINTB,1); myExternInterrupt.enablePinChangeMaskPortD(PUSHBUTTON_1_NUMBER,1);
myExternInterrupt.enablePinChangeMaskPortB(PUSHBUTTON_2_NUMBER,1);

```

Mainloop while (1) {

```

MainLed.toggle(); _delay_ms(DELAYTIME);

```

} return 0; }

```

void core::ExternInterrupt::pinChangePortDServiceRoutine() { if (PushButton1.isPressed()) { InterruptLed1.on();

```

```

} else { InterruptLed1.off();

```

```

} } void core::ExternInterrupt::pinChangePortBServiceRoutine() { if (PushButton2.isPressed()) { InterruptLed2.on();
} else { InterruptLed2.off(); }

```

}

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Definition in file `ExternInterrupt.h`.

10.24 ExternInterrupt.h

```

00001
00140 #ifndef EXTERN_INTERRUPTS_H
00141 #define EXTERN_INTERRUPTS_H
00142 #include "ha_base.h"
00143
00144
00145
00146 namespace core
00147 {
00148
00149 enum class senseControl : uint8_t {
00150     lowLevel=0,
00151     logicalChange,
00152     fallingEdge,
00153     risingEdge
00154 };
00155
00156 enum class pinChangePort : uint8_t {
00157     PCINTB=0,
00158     PCINTC,
00159     PCINTD,
00160 };
00161
00162 class ExternInterrupt
00163 {
00164
00165 public:
00166
00167     static ExternInterrupt& getInstance();
00168
00169     void setInt0SenseControl(const senseControl& ar_senseControl);
00170
00171     void setInt1SenseControl(const senseControl& ar_senseControl);
00172
00173     void enableInt0(const uint8_t a_enable);
00174
00175     void enableInt1(const uint8_t a_enable);
00176
00177     void enablePinChange(const pinChangePort& ar_pinChangePort, const uint8_t a_enable);
00178
00179     void enablePinChangeMaskPortB(const uint8_t a_pinNumber, const uint8_t a_enable);
00180
00181     void enablePinChangeMaskPortC(const uint8_t a_pinNumber, const uint8_t a_enable);
00182
00183     void enablePinChangeMaskPortD(const uint8_t a_pinNumber, const uint8_t a_enable);
00184
00185     static void Int0ServiceRoutine() __asm__(STR(EXT_INT_INT0_INTERRUPT)) __attribute__((__signal__,
00186         __used__, __externally_visible__));
00187
00188     static void Int1ServiceRoutine() __asm__(STR(EXT_INT_INT1_INTERRUPT)) __attribute__((__signal__,
00189         __used__, __externally_visible__));
00190
00191     static void pinChangePortBServiceRoutine() __asm__(STR(EXT_INT_PIN_CHANGE_PORTB_INTERRUPT))
00192         __attribute__((__signal__, __used__, __externally_visible__));
00193
00194     static void pinChangePortCServiceRoutine() __asm__(STR(EXT_INT_PIN_CHANGE_PORTC_INTERRUPT))
00195         __attribute__((__signal__, __used__, __externally_visible__));
00196
00197     static void pinChangePortDServiceRoutine() __asm__(STR(EXT_INT_PIN_CHANGE_PORTD_INTERRUPT))
00198         __attribute__((__signal__, __used__, __externally_visible__));
00199
00200 protected:
00201
00202 private:
00203
00204     ExternInterrupt();
00205
00206     ~ExternInterrupt();
00207
00208     ExternInterrupt(const ExternInterrupt&);
00209
00210     const ExternInterrupt& operator=(const ExternInterrupt&);
00211
00212 };
00213
00214 }
00215
00216
00217
00218
00219
00220 #endif

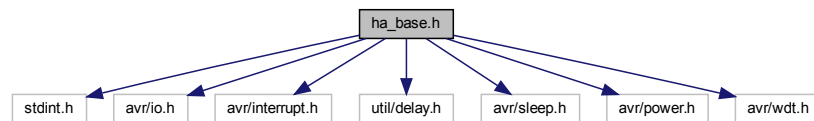
```


10.25 ha_base.h File Reference

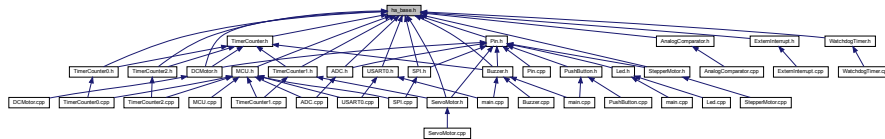
Base header file for the basic hardware abstraction macros.

```
#include <stdint.h>
#include <avr/io.h>
#include <avr/interrupt.h>
#include <util/delay.h>
#include <avr/sleep.h>
#include <avr/power.h>
#include <avr/wdt.h>
```

Include dependency graph for ha_base.h:



This graph shows which files directly or indirectly include this file:



Macros

- #define STRx(s) #s
- #define STR(s) STRx(s)

10.25.1 Detailed Description

Base header file for the basic hardware abstraction macros.

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Definition in file [ha_base.h](#).

10.25.2 Macro Definition Documentation

10.25.2.1 STR

```
#define STR(  
    s ) STRx(s)
```

Definition at line 16 of file [ha_base.h](#).

10.25.2.2 STRx

```
#define STRx(  
    s ) #s
```

Definition at line 15 of file [ha_base.h](#).

10.26 ha_base.h

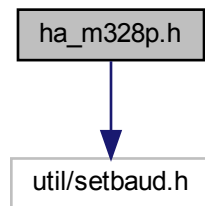
```
00001  
00009 #ifndef HABASE_H  
00010 #define HABASE_H  
00011  
00012 /*  
00013  * Helper construct to get interrupt numbers from names  
00014  */  
00015 #define STRx(s) #s  
00016 #define STR(s) STRx(s)  
00017  
00018 /*  
00019  * Any class needs these includes from avr-libc  
00020  */  
00021 #include <stdint.h>  
00022 #include <avr/io.h>  
00023 #include <avr/interrupt.h>  
00024 #include <util/delay.h>  
00025 #include <avr/sleep.h>  
00026 #include <avr/power.h>  
00027 #include <avr/wdt.h>  
00028  
00029  
00030 /*  
00031  * Include hardware abstraction the Atmega328p  
00032  */  
00033 #if defined(__AVR_ATmega328P__)  
00034  
00035     #include "ha_m328p.h"  
00036     #include "utils_m328p.h"  
00037  
00038 #endif  
00039  
00040  
00041 #endif
```

10.27 ha_m328p.h File Reference

Header file for the hardware abstraction macros of the Atmega328p.

```
#include <util/setbaud.h>
```

Include dependency graph for ha_m328p.h:



Macros

- `#define PUSHBUTTON_DEBOUNCE_TIME_US 1000`
- `#define PUSHBUTTON_SAMPLING 12`
- `#define USART0_SET_BAUDRATE_HIGH_REGISTER UBRR0H = UBRRH_VALUE`
- `#define USART0_SET_BAUDRATE_LOW_REGISTER UBRR0L = UBRL_VALUE`
- `#define USART0_ENABLE_ASYNC_TRANSMISSION_MODE UCSR0C &= ~((1 << UMSEL01) | (1 << UMSEL00))`
- `#define USART0_ENABLE_SYNC_TRANSMISSION_MODE UCSR0C = (UCSR0C & ~(1 << UMSEL01)) | (1 << UMSEL00)`
- `#define USART0_ENABLE_MASTER_SPI_MODE UCSR0C |= (1 << UMSEL01) | (1 << UMSEL00)`
- `#define USART0_ENABLE_DOUBLE_SPEED_MODE`
- `#define USART0_DISABLE_DOUBLE_SPEED_MODE`
- `#define USART0_DISABLE_DOUBLE_SPEED_MODE UCSR0A &= ~(1 << U2X0)`
- `#define USART0_ENABLE_EVEN_PARITY_MODE UCSR0C = (1 << UPM01) | (UCSR0C & ~(1 << UPM00))`
- `#define USART0_ENABLE_ODD_PARITY_MODE UCSR0C |= ((1 << UPM01) | (1 << UPM00))`
- `#define USART0_DISABLE_PARITY_MODE UCSR0C &= ~((1 << UPM01) | (1 << UPM00))`
- `#define USART0_SET_ONE_STOP_BIT UCSR0C &= ~(1 << USBS0)`
- `#define USART0_SET_TWO_STOP_BITS UCSR0C |= (1 << USBS0)`
- `#define USART0_SET_9BIT_FRAME_SIZE`
- `#define USART0_SET_8BIT_FRAME_SIZE`
- `#define USART0_SET_7BIT_FRAME_SIZE`
- `#define USART0_SET_6BIT_FRAME_SIZE`
- `#define USART0_SET_5BIT_FRAME_SIZE`
- `#define USART0_ENABLE_TRANSMITTER UCSR0B |= 1 << TXEN0`
- `#define USART0_DISABLE_TRANSMITTER UCSR0B &= ~(1 << TXEN0)`
- `#define USART0_ENABLE_RECEIVER UCSR0B |= 1 << RXEN0`
- `#define USART0_DISABLE_RECEIVER UCSR0B &= ~(1 << RXEN0)`
- `#define USART0_CONTROL_STATUS_REGISTER UCSR0A`
- `#define USART0_DATA_REGISTER UDR0`
- `#define USART0_FRAME_ERROR FE0`

- #define USART0_DATA_OVERRUN DOR0
- #define USART0_PARITY_ERROR UPE0
- #define USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT UCSRB |= 1 << UDRIE0
- #define USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT UCSRB &= ~(1 << UDRIE0)
- #define USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT UCSRB |= 1 << RXCIE0
- #define USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT UCSRB &= ~(1 << RXCIE0)
- #define USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT UCSRB |= 1 << TXCIE0
- #define USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT UCSRB &= ~(1 << TXCIE0)
- #define USART0_RECEIVE_COMPLETE_INTERRUPT USART_RX_vect
- #define USART0_TRANSMIT_COMPLETE_INTERRUPT USART_TX_vect
- #define USART0_DATA_REGISTER_EMPTY_INTERRUPT USART_UDRE_vect
- #define ADC_SELECT_REF_VOLTAGE(refVoltage) ADMUX &= 0x3F; ADMUX |= refVoltage << 6
- #define ADC_ADJUST_RESULT_LEFT ADMUX |= 1 << ADLAR
- #define ADC_ADJUST_RESULT_RIGHT ADMUX &= ~(1 << ADLAR)
- #define ADC_SELECT_ANALOG_INPUT(pinNumber) ADMUX &= 0xF0; ADMUX |= pinNumber
- #define ADC_DISABLE_DIGITAL_INPUT_REGISTER(pinNumber) DIDR0 &= 0xC0; DIDR0 |= pinNumber
- #define ADC_ENABLE ADCSRA |= 1 << ADEN
- #define ADC_DISABLE ADCSRA &= ~(1 << ADEN)
- #define ADC_START_CONVERSION ADCSRA |= 1 << ADSC
- #define ADC_STOP_CONVERSION ADCSRA &= ~(1 << ADSC)
- #define ADC_ENABLE_AUTOTRIGGER ADCSRA |= 1 << ADIF
- #define ADC_DISABLE_AUTOTRIGGER ADCSRA &= ~(1 << ADIF)
- #define ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT ADCSRA |= 1 << ADIF
- #define ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT ADCSRA &= ~(1 << ADIF)
- #define ADC_SELECT_CLOCK_PRESCALER(clockPrescaler) ADCSRA &= 0xF8; ADCSRA |= clockPrescaler
- #define ADC_SELECT_AUTO_TRIGGER_SOURCE(triggerSource) ADCSRB &= 0xF8; ADCSRB |= triggerSource
- #define ADC_CONVERSION_COMPLETE_INTERRUPT ADC_vect
- #define EXT_INT_SET_INT0_SENSE_CONTROL(senseControl) EICRA &= 0xFC; EICRA |= senseControl
- #define EXT_INT_SET_INT1_SENSE_CONTROL(senseControl) EICRA &= 0xF3; EICRA |= senseControl
- #define EXT_INT_ENABLE_INT0 EIMSK |= 1 << INT0
- #define EXT_INT_DISABLE_INT0 EIMSK &= ~(1 << INT0)
- #define EXT_INT_ENABLE_INT1 EIMSK |= 1 << INT1
- #define EXT_INT_DISABLE_INT1 EIMSK &= ~(1 << INT1)
- #define EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT(pinChangePort) PCICR |= 1 << pinChangePort
- #define EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT(pinChangePort) PCICR &= ~(1 << pinChangePort)
- #define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(pinChangePin) PCMSK0 |= 1 << pinChangePin
- #define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB(pinChangePin) PCMSK0 &= ~(1 << pinChangePin)
- #define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(pinChangePin) PCMSK1 |= 1 << pinChangePin
- #define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC(pinChangePin) PCMSK1 &= ~(1 << pinChangePin)
- #define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(pinChangePin) PCMSK2 |= 1 << pinChangePin
- #define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD(pinChangePin) PCMSK2 &= ~(1 << pinChangePin)
- #define EXT_INT_INT0_INTERRUPT INT0_vect
- #define EXT_INT_INT1_INTERRUPT INT1_vect
- #define EXT_INT_PIN_CHANGE_PORTB_INTERRUPT PCINT0_vect
- #define EXT_INT_PIN_CHANGE_PORTC_INTERRUPT PCINT1_vect
- #define EXT_INT_PIN_CHANGE_PORTD_INTERRUPT PCINT2_vect

- `#define TIMER0_STOP` TCCR0B &= 0xF8
- `#define TIMER1_STOP` TCCR1B &= 0xF8
- `#define TIMER2_STOP` TCCR2B &= 0xF8
- `#define TIMER0_SELECT_CLOCK_SOURCE`(clockSource) TCCR0B &= 0xF8; TCCR0B |= clockSource
- `#define TIMER1_SELECT_CLOCK_SOURCE`(clockSource) TCCR1B &= 0xF8; TCCR1B |= clockSource
- `#define TIMER2_SELECT_CLOCK_SOURCE`(clockSource) TCCR2B &= 0xF8; TCCR2B |= clockSource
- `#define TIMER0_SELECT_OPERATION_MODE`(operationMode) TCCR0A &= 0xFC; TCCR0A |= (operationMode & 3); TCCR0B &= 0xF7; TCCR0B |= (operationMode & 12) << 1
- `#define TIMER1_SELECT_OPERATION_MODE`(operationMode) TCCR1A &= 0xFC; TCCR1A |= (operationMode & 3); TCCR1B &= 0xE7; TCCR1B |= (operationMode & 12) << 1
- `#define TIMER2_SELECT_OPERATION_MODE`(operationMode) TCCR2A &= 0xFC; TCCR2A |= (operationMode & 3); TCCR2B &= 0xF7; TCCR2B |= (operationMode & 12) << 1
- `#define TIMER0_SELECT_COM_CHANNEL_A`(compareOutputMode) TCCR0A &= 0x3F; TCCR0A |= compareOutputMode << 6
- `#define TIMER0_SELECT_COM_CHANNEL_B`(compareOutputMode) TCCR0A &= 0xCF; TCCR0A |= compareOutputMode << 4
- `#define TIMER1_SELECT_COM_CHANNEL_A`(compareOutputMode) TCCR1A &= 0x3F; TCCR1A |= compareOutputMode << 6
- `#define TIMER1_SELECT_COM_CHANNEL_B`(compareOutputMode) TCCR1A &= 0xCF; TCCR1A |= compareOutputMode << 4
- `#define TIMER2_SELECT_COM_CHANNEL_A`(compareOutputMode) TCCR2A &= 0x3F; TCCR2A |= compareOutputMode << 6
- `#define TIMER2_SELECT_COM_CHANNEL_B`(compareOutputMode) TCCR2A &= 0xCF; TCCR2A |= compareOutputMode << 4
- `#define TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT` TIMSK0 |= 1 << OCIE0A
- `#define TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT` TIMSK0 &= ~(1 << OCIE0A)
- `#define TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT` TIMSK0 |= 1 << OCIE0B
- `#define TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT` TIMSK0 &= ~(1 << OCIE0B)
- `#define TIMER0_ENABLE_OVERFLOW_INTERRUPT` TIMSK0 |= 1 << TOIE0
- `#define TIMER0_DISABLE_OVERFLOW_INTERRUPT` TIMSK0 &= ~(1 << TOIE0)
- `#define TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT` TIMSK1 |= 1 << OCIE1A
- `#define TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT` TIMSK1 &= ~(1 << OCIE1A)
- `#define TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT` TIMSK1 |= 1 << OCIE1B
- `#define TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT` TIMSK1 &= ~(1 << OCIE1B)
- `#define TIMER1_ENABLE_OVERFLOW_INTERRUPT` TIMSK1 |= 1 << TOIE1
- `#define TIMER1_DISABLE_OVERFLOW_INTERRUPT` TIMSK1 &= ~(1 << TOIE1)
- `#define TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT` TIMSK1 |= 1 << ICIE1
- `#define TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT` TIMSK1 &= ~(1 << ICIE1)
- `#define TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT` TIMSK2 |= 1 << OCIE2A
- `#define TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT` TIMSK2 &= ~(1 << OCIE2A)
- `#define TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT` TIMSK2 |= 1 << OCIE2B
- `#define TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT` TIMSK2 &= ~(1 << OCIE2B)
- `#define TIMER2_ENABLE_OVERFLOW_INTERRUPT` TIMSK2 |= 1 << TOIE2
- `#define TIMER2_DISABLE_OVERFLOW_INTERRUPT` TIMSK2 &= ~(1 << TOIE2)
- `#define TIMER0_COM_CHANNEL_A_INTERRUPT` TIMER0_COMPA_vect
- `#define TIMER0_COM_CHANNEL_B_INTERRUPT` TIMER0_COMPB_vect
- `#define TIMER0_OVERFLOW_INTERRUPT` TIMER0_OVF_vect
- `#define TIMER1_COM_CHANNEL_A_INTERRUPT` TIMER1_COMPA_vect
- `#define TIMER1_COM_CHANNEL_B_INTERRUPT` TIMER1_COMPB_vect
- `#define TIMER1_OVERFLOW_INTERRUPT` TIMER1_OVF_vect
- `#define TIMER1_INPUT_CAPTURE_INTERRUPT` TIMER1_CAPT_vect
- `#define TIMER2_COM_CHANNEL_A_INTERRUPT` TIMER2_COMPA_vect
- `#define TIMER2_COM_CHANNEL_B_INTERRUPT` TIMER2_COMPB_vect
- `#define TIMER2_OVERFLOW_INTERRUPT` TIMER2_OVF_vect

- #define WATCHDOG_SELECT_TIMEOUT(timeOut) WDTCSR |= (1<<WDCE) | (1<<WDE); WDTCSR = (0<<WDIE) | (0<<WDE) | timeOut;
- #define WATCHDOG_START(operationMode, timeOut) MCUSR &= ~(1<<WDRF); WDTCSR |= (1<<WDCE) | (1<<WDE); WDTCSR = operationMode | timeOut;
- #define WATCHDOG_STOP MCUSR &= ~(1<<WDRF); WDTCSR |= (1<<WDCE) | (1<<WDE); WDTCSR = 0x00;
- #define WATCHDOG_TIMEOUT_INTERRUPT WDT_vect
- #define MCU_SELECT_SLEEP_MODE(sleepMode) SMCR &= 0xF1; SMCR |= sleepMode << 1
- #define MCU_SLEEP_ENABLE SMCR |= 1 << SE
- #define MCU_SLEEP_DISABLE SMCR &= ~(1 << SE)
- #define MCU_TWI_ENABLE PRR &= ~(1 << PRTWI)
- #define MCU_TWI_DISABLE PRR |= 1 << PRTWI
- #define MCU_TIMER2_ENABLE PRR &= ~(1 << PRTIM2)
- #define MCU_TIMER2_DISABLE PRR |= 1 << PRTIM2
- #define MCU_TIMER1_ENABLE PRR &= ~(1 << PRTIM1)
- #define MCU_TIMER1_DISABLE PRR |= 1 << PRTIM1
- #define MCU_TIMER0_ENABLE PRR &= ~(1 << PRTIM0)
- #define MCU_TIMER0_DISABLE PRR |= 1 << PRTIM0
- #define MCU_SPI_ENABLE PRR &= ~(1 << PRSPI)
- #define MCU_SPI_DISABLE PRR |= 1 << PRSPI
- #define MCU_USART0_ENABLE PRR &= ~(1 << PRUSART0)
- #define MCU_USART0_DISABLE PRR |= 1 << PRUSART0
- #define MCU_ADC_ENABLE PRR &= ~(1 << PRADC)
- #define MCU_ADC_DISABLE PRR |= 1 << PRADC
- #define MCU_BOD_DISABLE MCUCR |= (1<<BODSE) | (1<<BODS); MCUCR &= ~(1<<BODSE);
- #define SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(pulseWidth, clockPrescaler) ((F_CPU/1000000UL) * (pulseWidth/ clockPrescaler))
- #define SERVOMOTOR_TIMER_ANGLE_COUNT(angle, out_min, out_mid, out_max) (((out_min*(angle - 90L))*(angle - 180L))/16200L + (angle*out_max*(angle - 90L))/16200L - (angle*out_mid*(angle - 180L))/8100L))
- #define SPI_ENABLE SPCR |= 1 << SPE
- #define SPI_DISABLE SPCR &= ~(1 << SPE)
- #define SPI_SELECT_MASTER_MODE SPCR |= 1 << MSTR
- #define SPI_SELECT_SLAVE_MODE SPCR &= ~(1 << MSTR)
- #define SPI_SELECT_DATA_MODE(dataMode) SPCR &= 0xF3; SPCR |= dataMode << 2
- #define SPI_SELECT_CLOCK_PRESCALER(clockPrescaler) SPCR &= 0xFC; SPCR |= (clockPrescaler & 3); SPSR &= 0xFE; SPSR |= (clockPrescaler & 4) >> 2
- #define SPI_SELECT_DATA_ORDER(dataOrder) SPCR &= 0xDF; SPCR |= dataOrder << 5
- #define SPI_WRITE_COLLISION WCOL
- #define SPI_TRANSFER_COMPLETE SPIF
- #define SPI_MASTER_MODE MSTR
- #define SPI_CONTROL_REGISTER SPCR
- #define SPI_DATA_REGISTER SPDR
- #define SPI_STATUS_REGISTER SPSR
- #define SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT SPCR |= 1 << SPIE
- #define SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT SPCR &= ~(1 << SPIE)
- #define SPI_TRANSFER_COMPLETE_INTERRUPT SPI_STC_vect

10.27.1 Detailed Description

Header file for the hardware abstraction macros of the Atmega328p.

Author

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Date

March 2020

Definition in file [ha_m328p.h](#).

10.27.2 Macro Definition Documentation

10.27.2.1 ADC_ADJUST_RESULT_LEFT

```
#define ADC_ADJUST_RESULT_LEFT ADMUX |= 1 << ADLAR
```

Definition at line 126 of file [ha_m328p.h](#).

10.27.2.2 ADC_ADJUST_RESULT_RIGHT

```
#define ADC_ADJUST_RESULT_RIGHT ADMUX &= ~(1 << ADLAR)
```

Definition at line 127 of file [ha_m328p.h](#).

10.27.2.3 ADC_CONVERSION_COMPLETE_INTERRUPT

```
#define ADC_CONVERSION_COMPLETE_INTERRUPT ADC_vect
```

Definition at line 151 of file [ha_m328p.h](#).

10.27.2.4 ADC_DISABLE

```
#define ADC_DISABLE ADCSRA &= ~(1 << ADEN)
```

Definition at line 134 of file [ha_m328p.h](#).

10.27.2.5 ADC_DISABLE_AUTOTRIGGER

```
#define ADC_DISABLE_AUTOTRIGGER ADCSRA &= ~(1 << ADATE)
```

Definition at line 140 of file [ha_m328p.h](#).

10.27.2.6 ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT

```
#define ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT ADCSRA &= ~(1 << ADIE)
```

Definition at line 143 of file [ha_m328p.h](#).

10.27.2.7 ADC_DISABLE_DIGITAL_INPUT_REGISTER

```
#define ADC_DISABLE_DIGITAL_INPUT_REGISTER(  
    pinNumber ) DIDR0 &= 0xC0; DIDR0 |= pinNumber
```

Definition at line 130 of file [ha_m328p.h](#).

10.27.2.8 ADC_ENABLE

```
#define ADC_ENABLE ADCSRA |= 1 << ADEN
```

Definition at line 133 of file [ha_m328p.h](#).

10.27.2.9 ADC_ENABLE_AUTOTRIGGER

```
#define ADC_ENABLE_AUTOTRIGGER ADCSRA |= 1 << ADATE
```

Definition at line 139 of file [ha_m328p.h](#).

10.27.2.10 ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT

```
#define ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT ADCSRA |= 1 << ADIE
```

Definition at line 142 of file [ha_m328p.h](#).

10.27.2.11 ADC_SELECT_ANALOG_INPUT

```
#define ADC_SELECT_ANALOG_INPUT(  
    pinNumber ) ADMUX &= 0xF0; ADMUX |= pinNumber
```

Definition at line 129 of file [ha_m328p.h](#).

10.27.2.12 ADC_SELECT_AUTO_TRIGGER_SOURCE

```
#define ADC_SELECT_AUTO_TRIGGER_SOURCE(  
    triggerSource ) ADCSRB &= 0xF8; ADCSRB |= triggerSource
```

Definition at line 148 of file [ha_m328p.h](#).

10.27.2.13 ADC_SELECT_CLOCK_PRESCALER

```
#define ADC_SELECT_CLOCK_PRESCALER(  
    clockPrescaler ) ADCSRA &= 0xF8; ADCSRA |= clockPrescaler
```

Definition at line 145 of file [ha_m328p.h](#).

10.27.2.14 ADC_SELECT_REF_VOLTAGE

```
#define ADC_SELECT_REF_VOLTAGE(  
    refVoltage ) ADMUX &= 0x3F; ADMUX |= refVoltage << 6
```

Definition at line 124 of file [ha_m328p.h](#).

10.27.2.15 ADC_START_CONVERSION

```
#define ADC_START_CONVERSION ADCSRA |= 1 << ADSC
```

Definition at line 136 of file [ha_m328p.h](#).

10.27.2.16 ADC_STOP_CONVERSION

```
#define ADC_STOP_CONVERSION ADCSRA &= ~(1 << ADSC)
```

Definition at line 137 of file [ha_m328p.h](#).

10.27.2.17 EXT_INT_DISABLE_INT0

```
#define EXT_INT_DISABLE_INT0 EIMSK &= ~(1 << INT0)
```

Definition at line 159 of file [ha_m328p.h](#).

10.27.2.18 EXT_INT_DISABLE_INT1

```
#define EXT_INT_DISABLE_INT1 EIMSK &= ~(1 << INT1)
```

Definition at line 162 of file [ha_m328p.h](#).

10.27.2.19 EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT

```
#define EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT(  
    pinChangePort ) PCICR &= ~(1 << pinChangePort)
```

Definition at line 166 of file [ha_m328p.h](#).

10.27.2.20 EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB

```
#define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB(  
    pinChangePin ) PCMSK0 &= ~(1 << pinChangePin)
```

Definition at line 170 of file [ha_m328p.h](#).

10.27.2.21 EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC

```
#define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC(  
    pinChangePin ) PCMSK1 &= ~(1 << pinChangePin)
```

Definition at line 173 of file [ha_m328p.h](#).

10.27.2.22 EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD

```
#define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD(  
    pinChangePin ) PCMSK2 &= ~(1 << pinChangePin)
```

Definition at line 176 of file [ha_m328p.h](#).

10.27.2.23 EXT_INT_ENABLE_INT0

```
#define EXT_INT_ENABLE_INT0 EIMSK |= 1 << INT0
```

Definition at line 158 of file [ha_m328p.h](#).

10.27.2.24 EXT_INT_ENABLE_INT1

```
#define EXT_INT_ENABLE_INT1 EIMSK |= 1 << INT1
```

Definition at line 161 of file [ha_m328p.h](#).

10.27.2.25 EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT

```
#define EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT(  
    pinChangePort ) PCICR |= 1 << pinChangePort
```

Definition at line 165 of file [ha_m328p.h](#).

10.27.2.26 EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB

```
#define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(  
    pinChangePin ) PCMSK0 |= 1 << pinChangePin
```

Definition at line 169 of file [ha_m328p.h](#).

10.27.2.27 EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC

```
#define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(  
    pinChangePin ) PCMSK1 |= 1 << pinChangePin
```

Definition at line 172 of file [ha_m328p.h](#).

10.27.2.28 EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD

```
#define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(  
    pinChangePin ) PCMSK2 |= 1 << pinChangePin
```

Definition at line 175 of file [ha_m328p.h](#).

10.27.2.29 EXT_INT_INT0_INTERRUPT

```
#define EXT_INT_INT0_INTERRUPT INT0_vect
```

Definition at line 179 of file [ha_m328p.h](#).

10.27.2.30 EXT_INT_INT1_INTERRUPT

```
#define EXT_INT_INT1_INTERRUPT INT1_vect
```

Definition at line 180 of file [ha_m328p.h](#).

10.27.2.31 EXT_INT_PIN_CHANGE_PORTB_INTERRUPT

```
#define EXT_INT_PIN_CHANGE_PORTB_INTERRUPT PCINT0_vect
```

Definition at line 182 of file [ha_m328p.h](#).

10.27.2.32 EXT_INT_PIN_CHANGE_PORTC_INTERRUPT

```
#define EXT_INT_PIN_CHANGE_PORTC_INTERRUPT PCINT1_vect
```

Definition at line 183 of file [ha_m328p.h](#).

10.27.2.33 EXT_INT_PIN_CHANGE_PORTD_INTERRUPT

```
#define EXT_INT_PIN_CHANGE_PORTD_INTERRUPT PCINT2_vect
```

Definition at line 184 of file [ha_m328p.h](#).

10.27.2.34 EXT_INT_SET_INT0_SENSE_CONTROL

```
#define EXT_INT_SET_INT0_SENSE_CONTROL(  
    senseControl ) EICRA &= 0xFC; EICRA |= senseControl
```

Definition at line 155 of file [ha_m328p.h](#).

10.27.2.35 EXT_INT_SET_INT1_SENSE_CONTROL

```
#define EXT_INT_SET_INT1_SENSE_CONTROL(  
    senseControl ) EICRA &= 0xF3; EICRA |= senseControl
```

Definition at line 156 of file [ha_m328p.h](#).

10.27.2.36 MCU_ADC_DISABLE

```
#define MCU_ADC_DISABLE PRR |= 1 << PRADC
```

Definition at line 286 of file [ha_m328p.h](#).

10.27.2.37 MCU_ADC_ENABLE

```
#define MCU_ADC_ENABLE PRR &= ~(1 << PRADC)
```

Definition at line 285 of file [ha_m328p.h](#).

10.27.2.38 MCU_BOD_DISABLE

```
#define MCU_BOD_DISABLE MCUCR |= (1<<BODSE) | (1<<BODS); MCUCR &= ~(1<<BODSE);
```

Definition at line 288 of file [ha_m328p.h](#).

10.27.2.39 MCU_SELECT_SLEEP_MODE

```
#define MCU_SELECT_SLEEP_MODE(  
    sleepMode ) SMCR &= 0xF1; SMCR |= sleepMode << 1
```

Definition at line 262 of file [ha_m328p.h](#).

10.27.2.40 MCU_SLEEP_DISABLE

```
#define MCU_SLEEP_DISABLE SMCR &= ~(1 << SE)
```

Definition at line 265 of file [ha_m328p.h](#).

10.27.2.41 MCU_SLEEP_ENABLE

```
#define MCU_SLEEP_ENABLE SMCR |= 1 << SE
```

Definition at line 264 of file [ha_m328p.h](#).

10.27.2.42 MCU_SPI_DISABLE

```
#define MCU_SPI_DISABLE PRR |= 1 << PRSPI
```

Definition at line 280 of file [ha_m328p.h](#).

10.27.2.43 MCU_SPI_ENABLE

```
#define MCU_SPI_ENABLE PRR &= ~(1 << PRSPI)
```

Definition at line 279 of file [ha_m328p.h](#).

10.27.2.44 MCU_TIMER0_DISABLE

```
#define MCU_TIMER0_DISABLE PRR |= 1 << PRTIM0
```

Definition at line 277 of file [ha_m328p.h](#).

10.27.2.45 MCU_TIMER0_ENABLE

```
#define MCU_TIMER0_ENABLE PRR &= ~(1 << PRTIM0)
```

Definition at line 276 of file [ha_m328p.h](#).

10.27.2.46 MCU_TIMER1_DISABLE

```
#define MCU_TIMER1_DISABLE PRR |= 1 << PRTIM1
```

Definition at line 274 of file [ha_m328p.h](#).

10.27.2.47 MCU_TIMER1_ENABLE

```
#define MCU_TIMER1_ENABLE PRR &= ~(1 << PRTIM1)
```

Definition at line 273 of file [ha_m328p.h](#).

10.27.2.48 MCU_TIMER2_DISABLE

```
#define MCU_TIMER2_DISABLE PRR |= 1 << PRTIM2
```

Definition at line 271 of file [ha_m328p.h](#).

10.27.2.49 MCU_TIMER2_ENABLE

```
#define MCU_TIMER2_ENABLE PRR &= ~(1 << PRTIM2)
```

Definition at line 270 of file [ha_m328p.h](#).

10.27.2.50 MCU_TWI_DISABLE

```
#define MCU_TWI_DISABLE PRR |= 1 << PRTWI
```

Definition at line 268 of file [ha_m328p.h](#).

10.27.2.51 MCU_TWI_ENABLE

```
#define MCU_TWI_ENABLE PRR &= ~(1 << PRTWI)
```

Definition at line 267 of file [ha_m328p.h](#).

10.27.2.52 MCU_USART0_DISABLE

```
#define MCU_USART0_DISABLE PRR |= 1 << PRUSART0
```

Definition at line 283 of file [ha_m328p.h](#).

10.27.2.53 MCU_USART0_ENABLE

```
#define MCU_USART0_ENABLE PRR &= ~(1 << PRUSART0)
```

Definition at line 282 of file [ha_m328p.h](#).

10.27.2.54 PUSHBUTTON_DEBOUNCE_TIME_US

```
#define PUSHBUTTON_DEBOUNCE_TIME_US 1000
```

Definition at line 16 of file [ha_m328p.h](#).

10.27.2.55 PUSHBUTTON_SAMPLING

```
#define PUSHBUTTON_SAMPLING 12
```

Definition at line 17 of file [ha_m328p.h](#).

10.27.2.56 SERVOMOTOR_TIMER_ANGLE_COUNT

```
#define SERVOMOTOR_TIMER_ANGLE_COUNT(  
    angle,  
    out_min,  
    out_mid,  
    out_max ) (((out_min*(angle - 90L)*(angle - 180L))/16200L + (angle*out_max*(angle  
- 90L))/16200L - (angle*out_mid*(angle - 180L))/8100L))
```

Definition at line 295 of file [ha_m328p.h](#).

10.27.2.57 SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT

```
#define SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(  
    pulseWidth,  
    clockPrescaler ) ((F_CPU/1000000UL) * (pulseWidth/ clockPrescaler))
```

Definition at line 293 of file [ha_m328p.h](#).

10.27.2.58 SPI_CONTROL_REGISTER

```
#define SPI_CONTROL_REGISTER SPCR
```

Definition at line 313 of file [ha_m328p.h](#).

10.27.2.59 SPI_DATA_REGISTER

```
#define SPI_DATA_REGISTER SPDR
```

Definition at line 314 of file [ha_m328p.h](#).

10.27.2.60 SPI_DISABLE

```
#define SPI_DISABLE SPCR &= ~(1 << SPE)
```

Definition at line 300 of file [ha_m328p.h](#).

10.27.2.61 SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT

```
#define SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT SPCR &= ~(1 << SPIE)
```

Definition at line 318 of file [ha_m328p.h](#).

10.27.2.62 SPI_ENABLE

```
#define SPI_ENABLE SPCR |= 1 << SPE
```

Definition at line 299 of file [ha_m328p.h](#).

10.27.2.63 SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT

```
#define SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT SPCR |= 1 << SPIE
```

Definition at line 317 of file [ha_m328p.h](#).

10.27.2.64 SPI_MASTER_MODE

```
#define SPI_MASTER_MODE MSTR
```

Definition at line 312 of file [ha_m328p.h](#).

10.27.2.65 SPI_SELECT_CLOCK_PRESCALER

```
#define SPI_SELECT_CLOCK_PRESCALER(  
    clockPrescaler ) SPCR &= 0xFC; SPCR |= (clockPrescaler & 3); SPSR &= 0xFE; SPSR |=  
(clockPrescaler & 4) >> 2
```

Definition at line 306 of file [ha_m328p.h](#).

10.27.2.66 SPI_SELECT_DATA_MODE

```
#define SPI_SELECT_DATA_MODE(  
    dataMode ) SPCR &= 0xF3; SPCR |= dataMode << 2
```

Definition at line 305 of file [ha_m328p.h](#).

10.27.2.67 SPI_SELECT_DATA_ORDER

```
#define SPI_SELECT_DATA_ORDER(  
    dataOrder ) SPCR &= 0xDF; SPCR |= dataOrder << 5
```

Definition at line 307 of file [ha_m328p.h](#).

10.27.2.68 SPI_SELECT_MASTER_MODE

```
#define SPI_SELECT_MASTER_MODE SPCR |= 1 << MSTR
```

Definition at line 301 of file [ha_m328p.h](#).

10.27.2.69 SPI_SELECT_SLAVE_MODE

```
#define SPI_SELECT_SLAVE_MODE SPCR &= ~(1 << MSTR)
```

Definition at line 302 of file [ha_m328p.h](#).

10.27.2.70 SPI_STATUS_REGISTER

```
#define SPI_STATUS_REGISTER SPSR
```

Definition at line 315 of file [ha_m328p.h](#).

10.27.2.71 SPI_TRANSFER_COMPLETE

```
#define SPI_TRANSFER_COMPLETE SPIF
```

Definition at line 310 of file [ha_m328p.h](#).

10.27.2.72 SPI_TRANSFER_COMPLETE_INTERRUPT

```
#define SPI_TRANSFER_COMPLETE_INTERRUPT SPI_STC_vect
```

Definition at line 321 of file [ha_m328p.h](#).

10.27.2.73 SPI_WRITE_COLLISION

```
#define SPI_WRITE_COLLISION WCOL
```

Definition at line 309 of file [ha_m328p.h](#).

10.27.2.74 TIMER0_COM_CHANNEL_A_INTERRUPT

```
#define TIMER0_COM_CHANNEL_A_INTERRUPT TIMER0_COMPA_vect
```

Definition at line 239 of file [ha_m328p.h](#).

10.27.2.75 TIMER0_COM_CHANNEL_B_INTERRUPT

```
#define TIMER0_COM_CHANNEL_B_INTERRUPT TIMER0_COMPB_vect
```

Definition at line 240 of file [ha_m328p.h](#).

10.27.2.76 TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT

```
#define TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT TIMSK0 &= ~(1 << OCIE0A)
```

Definition at line 210 of file [ha_m328p.h](#).

10.27.2.77 TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT

```
#define TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT TIMSK0 &= ~(1 << OCIE0B)
```

Definition at line 213 of file [ha_m328p.h](#).

10.27.2.78 TIMER0_DISABLE_OVERFLOW_INTERRUPT

```
#define TIMER0_DISABLE_OVERFLOW_INTERRUPT TIMSK0 &= ~(1 << TOIE0)
```

Definition at line 216 of file [ha_m328p.h](#).

10.27.2.79 TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT

```
#define TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT TIMSK0 |= 1 << OCIE0A
```

Definition at line 209 of file [ha_m328p.h](#).

10.27.2.80 TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT

```
#define TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT TIMSK0 |= 1 << OCIE0B
```

Definition at line 212 of file [ha_m328p.h](#).

10.27.2.81 TIMER0_ENABLE_OVERFLOW_INTERRUPT

```
#define TIMER0_ENABLE_OVERFLOW_INTERRUPT TIMSK0 |= 1 << TOIE0
```

Definition at line 215 of file [ha_m328p.h](#).

10.27.2.82 TIMER0_OVERFLOW_INTERRUPT

```
#define TIMER0_OVERFLOW_INTERRUPT TIMER0_OVF_vect
```

Definition at line 241 of file [ha_m328p.h](#).

10.27.2.83 TIMER0_SELECT_CLOCK_SOURCE

```
#define TIMER0_SELECT_CLOCK_SOURCE(  
    clockSource ) TCCR0B &= 0xF8; TCCR0B |= clockSource
```

Definition at line 192 of file [ha_m328p.h](#).

10.27.2.84 TIMER0_SELECT_COM_CHANNEL_A

```
#define TIMER0_SELECT_COM_CHANNEL_A(  
    compareOutputMode ) TCCR0A &= 0x3F; TCCR0A |= compareOutputMode << 6
```

Definition at line 200 of file [ha_m328p.h](#).

10.27.2.85 TIMER0_SELECT_COM_CHANNEL_B

```
#define TIMER0_SELECT_COM_CHANNEL_B(  
    compareOutputMode ) TCCR0A &= 0xCF; TCCR0A |= compareOutputMode << 4
```

Definition at line 201 of file [ha_m328p.h](#).

10.27.2.86 TIMER0_SELECT_OPERATION_MODE

```
#define TIMER0_SELECT_OPERATION_MODE(  
    operationMode ) TCCR0A &= 0xFC; TCCR0A |= (operationMode & 3); TCCR0B &= 0xF7;  
TCCR0B |= (operationMode & 12) << 1
```

Definition at line 196 of file [ha_m328p.h](#).

10.27.2.87 TIMER0_STOP

```
#define TIMER0_STOP TCCR0B &= 0xF8
```

Definition at line 188 of file [ha_m328p.h](#).

10.27.2.88 TIMER1_COM_CHANNEL_A_INTERRUPT

```
#define TIMER1_COM_CHANNEL_A_INTERRUPT TIMER1_COMPA_vect
```

Definition at line 243 of file [ha_m328p.h](#).

10.27.2.89 TIMER1_COM_CHANNEL_B_INTERRUPT

```
#define TIMER1_COM_CHANNEL_B_INTERRUPT TIMER1_COMPB_vect
```

Definition at line 244 of file [ha_m328p.h](#).

10.27.2.90 TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT

```
#define TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT TIMSK1 &= ~(1 << OCIE1A)
```

Definition at line 219 of file [ha_m328p.h](#).

10.27.2.91 TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT

```
#define TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT TIMSK1 &= ~(1 << OCIE1B)
```

Definition at line 222 of file [ha_m328p.h](#).

10.27.2.92 TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT

```
#define TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT TIMSK1 &= ~(1 << ICIE1)
```

Definition at line 228 of file [ha_m328p.h](#).

10.27.2.93 TIMER1_DISABLE_OVERFLOW_INTERRUPT

```
#define TIMER1_DISABLE_OVERFLOW_INTERRUPT TIMSK1 &= ~(1 << TOIE1)
```

Definition at line 225 of file [ha_m328p.h](#).

10.27.2.94 TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT

```
#define TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT TIMSK1 |= 1 << OCIE1A
```

Definition at line 218 of file [ha_m328p.h](#).

10.27.2.95 TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT

```
#define TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT TIMSK1 |= 1 << OCIE1B
```

Definition at line 221 of file [ha_m328p.h](#).

10.27.2.96 TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT

```
#define TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT TIMSK1 |= 1 << ICIE1
```

Definition at line 227 of file [ha_m328p.h](#).

10.27.2.97 TIMER1_ENABLE_OVERFLOW_INTERRUPT

```
#define TIMER1_ENABLE_OVERFLOW_INTERRUPT TIMSK1 |= 1 << TOIE1
```

Definition at line 224 of file [ha_m328p.h](#).

10.27.2.98 TIMER1_INPUT_CAPTURE_INTERRUPT

```
#define TIMER1_INPUT_CAPTURE_INTERRUPT TIMER1_CAPT_vect
```

Definition at line 246 of file [ha_m328p.h](#).

10.27.2.99 TIMER1_OVERFLOW_INTERRUPT

```
#define TIMER1_OVERFLOW_INTERRUPT TIMER1_OVF_vect
```

Definition at line 245 of file [ha_m328p.h](#).

10.27.2.100 TIMER1_SELECT_CLOCK_SOURCE

```
#define TIMER1_SELECT_CLOCK_SOURCE(  
    clockSource ) TCCR1B &= 0xF8; TCCR1B |= clockSource
```

Definition at line 193 of file [ha_m328p.h](#).

10.27.2.101 TIMER1_SELECT_COM_CHANNEL_A

```
#define TIMER1_SELECT_COM_CHANNEL_A(  
    compareOutputMode ) TCCR1A &= 0x3F; TCCR1A |= compareOutputMode << 6
```

Definition at line 203 of file [ha_m328p.h](#).

10.27.2.102 TIMER1_SELECT_COM_CHANNEL_B

```
#define TIMER1_SELECT_COM_CHANNEL_B(  
    compareOutputMode ) TCCR1A &= 0xCF; TCCR1A |= compareOutputMode << 4
```

Definition at line 204 of file [ha_m328p.h](#).

10.27.2.103 TIMER1_SELECT_OPERATION_MODE

```
#define TIMER1_SELECT_OPERATION_MODE(  
    operationMode ) TCCR1A &= 0xFC; TCCR1A |= (operationMode & 3); TCCR1B &= 0xE7;  
TCCR1B |= (operationMode & 12) << 1
```

Definition at line 197 of file [ha_m328p.h](#).

10.27.2.104 TIMER1_STOP

```
#define TIMER1_STOP TCCR1B &= 0xF8
```

Definition at line 189 of file [ha_m328p.h](#).

10.27.2.105 TIMER2_COM_CHANNEL_A_INTERRUPT

```
#define TIMER2_COM_CHANNEL_A_INTERRUPT TIMER2_COMPA_vect
```

Definition at line 248 of file [ha_m328p.h](#).

10.27.2.106 TIMER2_COM_CHANNEL_B_INTERRUPT

```
#define TIMER2_COM_CHANNEL_B_INTERRUPT TIMER2_COMPB_vect
```

Definition at line 249 of file [ha_m328p.h](#).

10.27.2.107 TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT

```
#define TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT TIMSK2 &= ~(1 << OCIE2A)
```

Definition at line 231 of file [ha_m328p.h](#).

10.27.2.108 TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT

```
#define TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT TIMSK2 &= ~(1 << OCIE2B)
```

Definition at line 234 of file [ha_m328p.h](#).

10.27.2.109 TIMER2_DISABLE_OVERFLOW_INTERRUPT

```
#define TIMER2_DISABLE_OVERFLOW_INTERRUPT TIMSK2 &= ~(1 << TOIE2)
```

Definition at line 237 of file [ha_m328p.h](#).

10.27.2.110 TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT

```
#define TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT TIMSK2 |= 1 << OCIE2A
```

Definition at line 230 of file [ha_m328p.h](#).

10.27.2.111 TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT

```
#define TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT TIMSK2 |= 1 << OCIE2B
```

Definition at line 233 of file [ha_m328p.h](#).

10.27.2.112 TIMER2_ENABLE_OVERFLOW_INTERRUPT

```
#define TIMER2_ENABLE_OVERFLOW_INTERRUPT TIMSK2 |= 1 << TOIE2
```

Definition at line 236 of file [ha_m328p.h](#).

10.27.2.113 TIMER2_OVERFLOW_INTERRUPT

```
#define TIMER2_OVERFLOW_INTERRUPT TIMER2_OVF_vect
```

Definition at line 250 of file [ha_m328p.h](#).

10.27.2.114 TIMER2_SELECT_CLOCK_SOURCE

```
#define TIMER2_SELECT_CLOCK_SOURCE(  
    clockSource ) TCCR2B &= 0xF8; TCCR2B |= clockSource
```

Definition at line 194 of file [ha_m328p.h](#).

10.27.2.115 TIMER2_SELECT_COM_CHANNEL_A

```
#define TIMER2_SELECT_COM_CHANNEL_A(  
    compareOutputMode ) TCCR2A &= 0x3F; TCCR2A |= compareOutputMode << 6
```

Definition at line 206 of file [ha_m328p.h](#).

10.27.2.116 TIMER2_SELECT_COM_CHANNEL_B

```
#define TIMER2_SELECT_COM_CHANNEL_B(  
    compareOutputMode ) TCCR2A &= 0xCF; TCCR2A |= compareOutputMode << 4
```

Definition at line 207 of file [ha_m328p.h](#).

10.27.2.117 TIMER2_SELECT_OPERATION_MODE

```
#define TIMER2_SELECT_OPERATION_MODE(  
    operationMode ) TCCR2A &= 0xFC; TCCR2A |= (operationMode & 3); TCCR2B &= 0xF7;  
TCCR2B |= (operationMode & 12) << 1
```

Definition at line 198 of file [ha_m328p.h](#).

10.27.2.118 TIMER2_STOP

```
#define TIMER2_STOP TCCR2B &= 0xF8
```

Definition at line 190 of file [ha_m328p.h](#).

10.27.2.119 USART0_CONTROL_STATUS_REGISTER

```
#define USART0_CONTROL_STATUS_REGISTER UCSR0A
```

Definition at line 91 of file [ha_m328p.h](#).

10.27.2.120 USART0_DATA_OVERRUN

```
#define USART0_DATA_OVERRUN DOR0
```

Definition at line 99 of file [ha_m328p.h](#).

10.27.2.121 USART0_DATA_REGISTER

```
#define USART0_DATA_REGISTER UDR0
```

Definition at line 92 of file [ha_m328p.h](#).

10.27.2.122 USART0_DATA_REGISTER_EMPTY_INTERRUPT

```
#define USART0_DATA_REGISTER_EMPTY_INTERRUPT USART_UDRE_vect
```

Definition at line 119 of file [ha_m328p.h](#).

10.27.2.123 USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT

```
#define USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT UCSR0B &= ~(1 << UDRIE0)
```

Definition at line 105 of file [ha_m328p.h](#).

10.27.2.124 USART0_DISABLE_DOUBLE_SPEED_MODE [1/2]

```
#define USART0_DISABLE_DOUBLE_SPEED_MODE
```

Definition at line 40 of file [ha_m328p.h](#).

10.27.2.125 USART0_DISABLE_DOUBLE_SPEED_MODE [2/2]

```
#define USART0_DISABLE_DOUBLE_SPEED_MODE UCSRA &= ~(1 << U2X0)
```

Definition at line 40 of file [ha_m328p.h](#).

10.27.2.126 USART0_DISABLE_PARITY_MODE

```
#define USART0_DISABLE_PARITY_MODE UCSRC &= ~((1 << UPM01) | (1 << UPM00))
```

Definition at line 45 of file [ha_m328p.h](#).

10.27.2.127 USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT

```
#define USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT UCSRB &= ~(1 << RXCIE0)
```

Definition at line 108 of file [ha_m328p.h](#).

10.27.2.128 USART0_DISABLE_RECEIVER

```
#define USART0_DISABLE_RECEIVER UCSRB &= ~(1 << RXEN0)
```

Definition at line 87 of file [ha_m328p.h](#).

10.27.2.129 USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT

```
#define USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT UCSRB &= ~(1 << TXCIE0)
```

Definition at line 111 of file [ha_m328p.h](#).

10.27.2.130 USART0_DISABLE_TRANSMITTER

```
#define USART0_DISABLE_TRANSMITTER UCSR0B &= ~(1 << TXEN0)
```

Definition at line 82 of file [ha_m328p.h](#).

10.27.2.131 USART0_ENABLE_ASYNC_TRANSMISSION_MODE

```
#define USART0_ENABLE_ASYNC_TRANSMISSION_MODE UCSR0C &= ~((1 << UMSEL01) | (1 << UMSEL00))
```

Definition at line 26 of file [ha_m328p.h](#).

10.27.2.132 USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT

```
#define USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT UCSR0B |= 1 << UDRIE0
```

Definition at line 104 of file [ha_m328p.h](#).

10.27.2.133 USART0_ENABLE_DOUBLE_SPEED_MODE

```
#define USART0_ENABLE_DOUBLE_SPEED_MODE
```

Definition at line 31 of file [ha_m328p.h](#).

10.27.2.134 USART0_ENABLE_EVEN_PARITY_MODE

```
#define USART0_ENABLE_EVEN_PARITY_MODE UCSR0C = (1 << UPM01) | (UCSR0C & ~(1 << UPM00))
```

Definition at line 43 of file [ha_m328p.h](#).

10.27.2.135 USART0_ENABLE_MASTER_SPI_MODE

```
#define USART0_ENABLE_MASTER_SPI_MODE UCSR0C |= (1 << UMSEL01) | (1 << UMSEL00)
```

Definition at line 28 of file [ha_m328p.h](#).

10.27.2.136 USART0_ENABLE_ODD_PARITY_MODE

```
#define USART0_ENABLE_ODD_PARITY_MODE UCSR0C |= ((1 << UPM01) | (1 << UPM00))
```

Definition at line 44 of file [ha_m328p.h](#).

10.27.2.137 USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT

```
#define USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT UCSR0B |= 1 << RXCIE0
```

Definition at line 107 of file [ha_m328p.h](#).

10.27.2.138 USART0_ENABLE_RECEIVER

```
#define USART0_ENABLE_RECEIVER UCSR0B |= 1 << RXEN0
```

Definition at line 86 of file [ha_m328p.h](#).

10.27.2.139 USART0_ENABLE_SYNC_TRANSMISSION_MODE

```
#define USART0_ENABLE_SYNC_TRANSMISSION_MODE UCSR0C = (UCSR0C & ~(1 << UMSEL01)) | (1 << UMSEL00)
```

Definition at line 27 of file [ha_m328p.h](#).

10.27.2.140 USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT

```
#define USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT UCSR0B |= 1 << TXCIE0
```

Definition at line 110 of file [ha_m328p.h](#).

10.27.2.141 USART0_ENABLE_TRANSMITTER

```
#define USART0_ENABLE_TRANSMITTER UCSR0B |= 1 << TXEN0
```

Definition at line 81 of file [ha_m328p.h](#).

10.27.2.142 USART0_FRAME_ERROR

```
#define USART0_FRAME_ERROR FE0
```

Definition at line 97 of file [ha_m328p.h](#).

10.27.2.143 USART0_PARITY_ERROR

```
#define USART0_PARITY_ERROR UPE0
```

Definition at line 101 of file [ha_m328p.h](#).

10.27.2.144 USART0_RECEIVE_COMPLETE_INTERRUPT

```
#define USART0_RECEIVE_COMPLETE_INTERRUPT USART_RX_vect
```

Definition at line 115 of file [ha_m328p.h](#).

10.27.2.145 USART0_SET_5BIT_FRAME_SIZE

```
#define USART0_SET_5BIT_FRAME_SIZE
```

Value:

```
do { \
    UCSR0C &= ~( (1 << UCSZ01) | (1 << UCSZ00)); \
    UCSR0B &= ~(1 << UCSZ02); \
} while (0)
```

Definition at line 74 of file [ha_m328p.h](#).

10.27.2.146 USART0_SET_6BIT_FRAME_SIZE

```
#define USART0_SET_6BIT_FRAME_SIZE
```

Value:

```
do { \
    UCSR0C = (UCSR0C & ~(1 << UCSZ01)) | (1 << UCSZ00); \
    UCSR0B &= ~(1 << UCSZ02); \
} while (0)
```

Definition at line 69 of file [ha_m328p.h](#).

10.27.2.147 USART0_SET_7BIT_FRAME_SIZE

```
#define USART0_SET_7BIT_FRAME_SIZE
```

Value:

```
do { \
    UCSR0C = (1 « UCSZ01) | (UCSR0C & ~(1 « UCSZ00)); \
    UCSR0B &= ~(1 « UCSZ02); \
} while (0)
```

Definition at line 64 of file [ha_m328p.h](#).

10.27.2.148 USART0_SET_8BIT_FRAME_SIZE

```
#define USART0_SET_8BIT_FRAME_SIZE
```

Value:

```
do { \
    UCSR0C |= ((1 « UCSZ01) | (1 « UCSZ00)); \
    UCSR0B &= ~(1 « UCSZ02); \
} while (0)
```

Definition at line 58 of file [ha_m328p.h](#).

10.27.2.149 USART0_SET_9BIT_FRAME_SIZE

```
#define USART0_SET_9BIT_FRAME_SIZE
```

Value:

```
do { \
    UCSR0C |= ((1 « UCSZ01) | (1 « UCSZ00)); \
    UCSR0B |= (1 « UCSZ02); \
} while (0)
```

Definition at line 52 of file [ha_m328p.h](#).

10.27.2.150 USART0_SET_BAUDRATE_HIGH_REGISTER

```
#define USART0_SET_BAUDRATE_HIGH_REGISTER UBRR0H = UBRRH_VALUE
```

Definition at line 23 of file [ha_m328p.h](#).

10.27.2.151 USART0_SET_BAUDRATE_LOW_REGISTER

```
#define USART0_SET_BAUDRATE_LOW_REGISTER UBRR0L = UBRL_VALUE
```

Definition at line 24 of file [ha_m328p.h](#).

10.27.2.152 USART0_SET_ONE_STOP_BIT

```
#define USART0_SET_ONE_STOP_BIT UCSR0C &= ~(1 << USBS0)
```

Definition at line 48 of file [ha_m328p.h](#).

10.27.2.153 USART0_SET_TWO_STOP_BITS

```
#define USART0_SET_TWO_STOP_BITS UCSR0C |= (1 << USBS0)
```

Definition at line 49 of file [ha_m328p.h](#).

10.27.2.154 USART0_TRANSMIT_COMPLETE_INTERRUPT

```
#define USART0_TRANSMIT_COMPLETE_INTERRUPT USART_TX_vect
```

Definition at line 117 of file [ha_m328p.h](#).

10.27.2.155 WATCHDOG_SELECT_TIMEOUT

```
#define WATCHDOG_SELECT_TIMEOUT(  
    timeOut ) WDTCSR |= (1<<WDCE) | (1<<WDE); WDTCSR = (0<<WDIE) | (0<<WDE) | timeOut;  
Out;
```

Definition at line 254 of file [ha_m328p.h](#).

10.27.2.156 WATCHDOG_START

```
#define WATCHDOG_START(  
    operationMode,  
    timeOut ) MCUSR &= ~(1<<WDRF); WDTCSR |= (1<<WDCE) | (1<<WDE); WDTCSR = operationMode | timeOut;
```

Definition at line 255 of file [ha_m328p.h](#).

10.27.2.157 WATCHDOG_STOP

```
#define WATCHDOG_STOP MCUSR &= ~(1<<WDRF); WDTCSR |= (1<<WDCE) | (1<<WDE); WDTCSR = 0x00;
```

Definition at line 256 of file [ha_m328p.h](#).

10.27.2.158 WATCHDOG_TIMEOUT_INTERRUPT

```
#define WATCHDOG_TIMEOUT_INTERRUPT WDT_vect
```

Definition at line 257 of file [ha_m328p.h](#).

10.28 ha_m328p.h

```
00001
00008 #ifndef HAM329P_H
00009 #define HAM329P_H
00010
00011 #ifndef HABASE_H
00012     #error "don't use this file directly! Please include only ha_base.h!"
00013 #endif
00014
00015 // PushButton defines
00016 #define PUSHBUTTON_DEBOUNCE_TIME_US 1000 // microseconds to wait for next check
00017 #define PUSHBUTTON_SAMPLING 12 // number of times a push button must be pressed
00018
00019
00020 // USART defines
00021 #include <util/setbaud.h>
00022
00023 #define USART0_SET_BAUDRATE_HIGH_REGISTER UBRR0H = UBRRH_VALUE
00024 #define USART0_SET_BAUDRATE_LOW_REGISTER UBRR0L = UBRL_VALUE
00025
00026 #define USART0_ENABLE_ASYNC_TRANSMISSION_MODE UCSR0C &= ~(1 << UMSEL01) | (1 << UMSEL00)
00027 #define USART0_ENABLE_SYNC_TRANSMISSION_MODE UCSR0C = (UCSR0C & ~(1 << UMSEL01)) | (1 << UMSEL00)
00028 #define USART0_ENABLE_MASTER_SPI_MODE UCSR0C |= (1 << UMSEL01) | (1 << UMSEL00)
00029
00030
00031 #define USART0_ENABLE_DOUBLE_SPEED_MODE
00032 #define USART0_DISABLE_DOUBLE_SPEED_MODE
00033
00034 #if USE_2X
00035     #undef USART0_ENABLE_DOUBLE_SPEED_MODE
00036     #define USART0_ENABLE_DOUBLE_SPEED_MODE UCSR0A |= (1 << U2X0)
00037     #warning "double speed operation activated"
00038 #else
00039     #undef USART0_DISABLE_DOUBLE_SPEED_MODE
00040     #define USART0_DISABLE_DOUBLE_SPEED_MODE UCSR0A &= ~(1 << U2X0)
00041 #endif
00042
00043 #define USART0_ENABLE_EVEN_PARITY_MODE UCSR0C = (1 << UPM01) | (UCSR0C & ~(1 << UPM00))
00044 #define USART0_ENABLE_ODD_PARITY_MODE UCSR0C |= ((1 << UPM01) | (1 << UPM00))
00045 #define USART0_DISABLE_PARITY_MODE UCSR0C &= ~(1 << UPM01) | (1 << UPM00)
00046
00047
00048 #define USART0_SET_ONE_STOP_BIT UCSR0C &= ~(1 << USBS0)
00049 #define USART0_SET_TWO_STOP_BITS UCSR0C |= (1 << USBS0)
00050
00051
00052 #define USART0_SET_9BIT_FRAME_SIZE \
00053     do { \
00054         UCSR0C |= ((1 << UCSZ01) | (1 << UCSZ00)); \
00055         UCSR0B |= (1 << UCSZ02); \
00056     } while (0)
00057
00058 #define USART0_SET_8BIT_FRAME_SIZE \
00059     do { \
00060         UCSR0C |= ((1 << UCSZ01) | (1 << UCSZ00)); \
00061         UCSR0B &= ~(1 << UCSZ02); \
00062     } while (0)
00063
00064 #define USART0_SET_7BIT_FRAME_SIZE \
00065     do { \
00066         UCSR0C = (1 << UCSZ01) | (UCSR0C & ~(1 << UCSZ00)); \
00067         UCSR0B &= ~(1 << UCSZ02); \
00068     } while (0)
00069 #define USART0_SET_6BIT_FRAME_SIZE \
00070     do { \
00071         UCSR0C = (UCSR0C & ~(1 << UCSZ01)) | (1 << UCSZ00); \
00072         UCSR0B &= ~(1 << UCSZ02); \
00073     } while (0)
00074 #define USART0_SET_5BIT_FRAME_SIZE \
00075     do { \
00076         UCSR0C &= ~(1 << UCSZ01) | (1 << UCSZ00); \
00077         UCSR0B &= ~(1 << UCSZ02); \
00078     } while (0)
```

```

00079
00080
00081 #define USART0_ENABLE_TRANSMITTER UCSRB |= 1 < TXEN0
00082 #define USART0_DISABLE_TRANSMITTER UCSRB &= ~(1 < TXEN0)
00083
00084
00085
00086 #define USART0_ENABLE_RECEIVER UCSRB |= 1 < RXEN0
00087 #define USART0_DISABLE_RECEIVER UCSRB &= ~(1 < RXEN0)
00088
00089
00090
00091 #define USART0_CONTROL_STATUS_REGISTER UCSRA
00092 #define USART0_DATA_REGISTER UDRO
00093
00094
00095
00096
00097 #define USART0_FRAME_ERROR FE0
00098
00099 #define USART0_DATA_OVERRUN DOR0
00100
00101 #define USART0_PARITY_ERROR UPE0
00102
00103
00104 #define USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT UCSRB |= 1 < UDRIE0
00105 #define USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT UCSRB &= ~(1 < UDRIE0)
00106
00107 #define USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT UCSRB |= 1 < RXCIE0
00108 #define USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT UCSRB &= ~(1 < RXCIE0)
00109
00110 #define USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT UCSRB |= 1 < TXCIE0
00111 #define USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT UCSRB &= ~(1 < TXCIE0)
00112
00113
00114
00115 #define USART0_RECEIVE_COMPLETE_INTERRUPT USART_RX_vect
00116
00117 #define USART0_TRANSMIT_COMPLETE_INTERRUPT USART_TX_vect
00118
00119 #define USART0_DATA_REGISTER_EMPTY_INTERRUPT USART_UDRE_vect
00120
00121
00122 // ADC defines
00123
00124 #define ADC_SELECT_REF_VOLTAGE(refVoltage) ADMUX &= 0x3F; ADMUX |= refVoltage < 6
00125
00126 #define ADC_ADJUST_RESULT_LEFT ADMUX |= 1 < ADLAR
00127 #define ADC_ADJUST_RESULT_RIGHT ADMUX &= ~(1 < ADLAR)
00128
00129 #define ADC_SELECT_ANALOG_INPUT(pinNumber) ADMUX &= 0xF0; ADMUX |= pinNumber
00130 #define ADC_DISABLE_DIGITAL_INPUT_REGISTER(pinNumber) DIDR0 &= 0xC0; DIDR0 |= pinNumber
00131
00132
00133 #define ADC_ENABLE ADCSRA |= 1 < ADEN
00134 #define ADC_DISABLE ADCSRA &= ~(1 < ADEN)
00135
00136 #define ADC_START_CONVERSION ADCSRA |= 1 < ADSC
00137 #define ADC_STOP_CONVERSION ADCSRA &= ~(1 < ADSC)
00138
00139 #define ADC_ENABLE_AUTOTRIGGER ADCSRA |= 1 < ADIFSC
00140 #define ADC_DISABLE_AUTOTRIGGER ADCSRA &= ~(1 < ADIFSC)
00141
00142 #define ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT ADCSRA |= 1 < ADIF
00143 #define ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT ADCSRA &= ~(1 < ADIF)
00144
00145 #define ADC_SELECT_CLOCK_PRESCALER(clockPrescaler) ADCSRA &= 0xF8; ADCSRA |= clockPrescaler
00146
00147
00148 #define ADC_SELECT_AUTO_TRIGGER_SOURCE(triggerSource) ADCSRB &= 0xF8; ADCSRB |=
    triggerSource
00149
00150
00151 #define ADC_CONVERSION_COMPLETE_INTERRUPT ADC_vect
00152
00153 // Externally Triggered Interrupts defines
00154
00155 #define EXT_INT_SET_INT0_SENSE_CONTROL(senseControl) EICRA &= 0xFC; EICRA |= senseControl
00156 #define EXT_INT_SET_INT1_SENSE_CONTROL(senseControl) EICRA &= 0xF3; EICRA |= senseControl
00157
00158 #define EXT_INT_ENABLE_INT0 EIMSK |= 1 < INT0
00159 #define EXT_INT_DISABLE_INT0 EIMSK &= ~(1 < INT0)
00160
00161 #define EXT_INT_ENABLE_INT1 EIMSK |= 1 < INT1
00162 #define EXT_INT_DISABLE_INT1 EIMSK &= ~(1 < INT1)
00163
00164

```

```

00165 #define EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT(pinChangePort)    PCICR |= 1 « pinChangePort
00166 #define EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT(pinChangePort)    PCICR &= ~(1 « pinChangePort)
00167
00168
00169 #define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(pinChangePin)      PCMSK0 |= 1 « pinChangePin
00170 #define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB(pinChangePin)    PCMSK0 &= ~(1 « pinChangePin)
00171
00172 #define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(pinChangePin)      PCMSK1 |= 1 « pinChangePin
00173 #define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC(pinChangePin)    PCMSK1 &= ~(1 « pinChangePin)
00174
00175 #define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(pinChangePin)      PCMSK2 |= 1 « pinChangePin
00176 #define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD(pinChangePin)    PCMSK2 &= ~(1 « pinChangePin)
00177
00178
00179 #define EXT_INT_INT0_INTERRUPT    INT0_vect
00180 #define EXT_INT_INT1_INTERRUPT    INT1_vect
00181
00182 #define EXT_INT_PIN_CHANGE_PORTB_INTERRUPT    PCINT0_vect
00183 #define EXT_INT_PIN_CHANGE_PORTC_INTERRUPT    PCINT1_vect
00184 #define EXT_INT_PIN_CHANGE_PORTD_INTERRUPT    PCINT2_vect
00185
00186 // Timers/Counters defines
00187
00188 #define TIMER0_STOP TCCR0B &= 0xF8
00189 #define TIMER1_STOP TCCR1B &= 0xF8
00190 #define TIMER2_STOP TCCR2B &= 0xF8
00191
00192 #define TIMER0_SELECT_CLOCK_SOURCE(clockSource) TCCR0B &= 0xF8; TCCR0B |= clockSource
00193 #define TIMER1_SELECT_CLOCK_SOURCE(clockSource) TCCR1B &= 0xF8; TCCR1B |= clockSource
00194 #define TIMER2_SELECT_CLOCK_SOURCE(clockSource) TCCR2B &= 0xF8; TCCR2B |= clockSource
00195
00196 #define TIMER0_SELECT_OPERATION_MODE(operationMode) TCCR0A &= 0xFC; TCCR0A |= (operationMode & 3);
00197 #define TIMER1_SELECT_OPERATION_MODE(operationMode) TCCR1A &= 0xFC; TCCR1A |= (operationMode & 3);
00198 #define TIMER2_SELECT_OPERATION_MODE(operationMode) TCCR2A &= 0xFC; TCCR2A |= (operationMode & 3);
00199 #define TCCR0B &= 0xF7; TCCR0B |= (operationMode & 12) « 1
00200 #define TCCR1B &= 0xE7; TCCR1B |= (operationMode & 12) « 1
00201 #define TCCR2B &= 0xF7; TCCR2B |= (operationMode & 12) « 1
00202
00203 #define TIMER0_SELECT_COM_CHANNEL_A(compareOutputMode) TCCR0A &= 0x3F; TCCR0A |= compareOutputMode « 6
00204 #define TIMER0_SELECT_COM_CHANNEL_B(compareOutputMode) TCCR0A &= 0xCF; TCCR0A |= compareOutputMode « 4
00205
00206 #define TIMER1_SELECT_COM_CHANNEL_A(compareOutputMode) TCCR1A &= 0x3F; TCCR1A |= compareOutputMode « 6
00207 #define TIMER1_SELECT_COM_CHANNEL_B(compareOutputMode) TCCR1A &= 0xCF; TCCR1A |= compareOutputMode « 4
00208
00209 #define TIMER2_SELECT_COM_CHANNEL_A(compareOutputMode) TCCR2A &= 0x3F; TCCR2A |= compareOutputMode « 6
00210 #define TIMER2_SELECT_COM_CHANNEL_B(compareOutputMode) TCCR2A &= 0xCF; TCCR2A |= compareOutputMode « 4
00211
00212 #define TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT TIMSK0 |= 1 « OCIE0A
00213 #define TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT TIMSK0 &= ~(1 « OCIE0A)
00214
00215 #define TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT TIMSK0 |= 1 « OCIE0B
00216 #define TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT TIMSK0 &= ~(1 « OCIE0B)
00217
00218 #define TIMER0_ENABLE_OVERFLOW_INTERRUPT TIMSK0 |= 1 « TOIE0
00219 #define TIMER0_DISABLE_OVERFLOW_INTERRUPT TIMSK0 &= ~(1 « TOIE0)
00220
00221 #define TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT TIMSK1 |= 1 « OCIE1A
00222 #define TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT TIMSK1 &= ~(1 « OCIE1A)
00223
00224 #define TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT TIMSK1 |= 1 « OCIE1B
00225 #define TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT TIMSK1 &= ~(1 « OCIE1B)
00226
00227 #define TIMER1_ENABLE_OVERFLOW_INTERRUPT TIMSK1 |= 1 « TOIE1
00228 #define TIMER1_DISABLE_OVERFLOW_INTERRUPT TIMSK1 &= ~(1 « TOIE1)
00229
00230 #define TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT TIMSK1 |= 1 « ICIE1
00231 #define TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT TIMSK1 &= ~(1 « ICIE1)
00232
00233 #define TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT TIMSK2 |= 1 « OCIE2A
00234 #define TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT TIMSK2 &= ~(1 « OCIE2A)
00235
00236 #define TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT TIMSK2 |= 1 « OCIE2B
00237 #define TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT TIMSK2 &= ~(1 « OCIE2B)
00238
00239 #define TIMER2_ENABLE_OVERFLOW_INTERRUPT TIMSK2 |= 1 « TOIE2
00240 #define TIMER2_DISABLE_OVERFLOW_INTERRUPT TIMSK2 &= ~(1 « TOIE2)
00241
00242 #define TIMER0_COM_CHANNEL_A_INTERRUPT    TIMER0_COMPA_vect
00243 #define TIMER0_COM_CHANNEL_B_INTERRUPT    TIMER0_COMPB_vect
00244 #define TIMER0_OVERFLOW_INTERRUPT         TIMER0_OVF_vect
00245 #define TIMER1_COM_CHANNEL_A_INTERRUPT    TIMER1_COMPA_vect
00246 #define TIMER1_COM_CHANNEL_B_INTERRUPT    TIMER1_COMPB_vect
00247 #define TIMER1_OVERFLOW_INTERRUPT         TIMER1_OVF_vect
00248 #define TIMER1_INPUT_CAPTURE_INTERRUPT    TIMER1_CAPT_vect
00249 #define TIMER2_COM_CHANNEL_A_INTERRUPT    TIMER2_COMPA_vect

```

```

00249 #define    TIMER2_COM_CHANNEL_B_INTERRUPT    TIMER2_COMPB_vect
00250 #define    TIMER2_OVERFLOW_INTERRUPT    TIMER2_OVF_vect
00251
00252 // Watchdog Timer defines
00253
00254 #define WATCHDOG_SELECT_TIMEOUT(timeOut) WDTCSR |= (1<<WDCE) | (1<<WDE); WDTCSR = (0<<WDIE) | (0<<WDE) |
    timeOut;
00255 #define WATCHDOG_START(operationMode,timeOut) MCUSR &= ~(1<<WDRF); WDTCSR |= (1<<WDCE) | (1<<WDE); WDTCSR
    = operationMode | timeOut;
00256 #define WATCHDOG_STOP MCUSR &= ~(1<<WDRF); WDTCSR |= (1<<WDCE) | (1<<WDE); WDTCSR = 0x00;
00257 #define WATCHDOG_TIMEOUT_INTERRUPT    WDT_vect
00258
00259 // MCU defines
00260
00261
00262 #define MCU_SELECT_SLEEP_MODE(sleepMode) SMCR &= 0xF1; SMCR |= sleepMode << 1
00263
00264 #define MCU_SLEEP_ENABLE SMCR |= 1 << SE
00265 #define MCU_SLEEP_DISABLE SMCR &= ~(1 << SE)
00266
00267 #define MCU_TWI_ENABLE PRR &= ~(1 << PRTWI)
00268 #define MCU_TWI_DISABLE PRR |= 1 << PRTWI
00269
00270 #define MCU_TIMER2_ENABLE PRR &= ~(1 << PRTIM2)
00271 #define MCU_TIMER2_DISABLE PRR |= 1 << PRTIM2
00272
00273 #define MCU_TIMER1_ENABLE PRR &= ~(1 << PRTIM1)
00274 #define MCU_TIMER1_DISABLE PRR |= 1 << PRTIM1
00275
00276 #define MCU_TIMER0_ENABLE PRR &= ~(1 << PRTIM0)
00277 #define MCU_TIMER0_DISABLE PRR |= 1 << PRTIM0
00278
00279 #define MCU_SPI_ENABLE PRR &= ~(1 << PRSPI)
00280 #define MCU_SPI_DISABLE PRR |= 1 << PRSPI
00281
00282 #define MCU_USART0_ENABLE PRR &= ~(1 << PRUSART0)
00283 #define MCU_USART0_DISABLE PRR |= 1 << PRUSART0
00284
00285 #define MCU_ADC_ENABLE PRR &= ~(1 << PRADC)
00286 #define MCU_ADC_DISABLE PRR |= 1 << PRADC
00287
00288 #define MCU_BOD_DISABLE MCUCR |= (1<<BODSE) | (1<<BODS); MCUCR &= ~(1<<BODSE);
00289
00290
00291 // ServoMotor defines
00292
00293 #define SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(pulseWidth,clockPrescaler) ((F_CPU/1000000UL) *
    (pulseWidth/ clockPrescaler))
00294
00295 #define SERVOMOTOR_TIMER_ANGLE_COUNT(angle,out_min,out_mid,out_max) (((out_min*(angle - 90L)*(angle -
    180L))/16200L + (angle*out_max*(angle - 90L))/16200L - (angle*out_mid*(angle - 180L))/8100L))
00296
00297 // SPI defines
00298
00299 #define    SPI_ENABLE                SPCR |= 1 << SPE
00300 #define    SPI_DISABLE                SPCR &= ~(1 << SPE)
00301 #define    SPI_SELECT_MASTER_MODE    SPCR |= 1 << MSTR
00302 #define    SPI_SELECT_SLAVE_MODE    SPCR &= ~(1 << MSTR)
00303
00304
00305 #define    SPI_SELECT_DATA_MODE(dataMode) SPCR &= 0xF3; SPCR |= dataMode << 2
00306 #define    SPI_SELECT_CLOCK_PRESCALER(clockPrescaler) SPCR &= 0xFC; SPCR |= (clockPrescaler & 3); SPSR
    &= 0xFE; SPSR |= (clockPrescaler & 4) >> 2
00307 #define    SPI_SELECT_DATA_ORDER(dataOrder) SPCR &= 0xDF; SPCR |= dataOrder << 5
00308
00309 #define    SPI_WRITE_COLLISION    WCOL
00310 #define    SPI_TRANSFER_COMPLETE    SPIF
00311
00312 #define    SPI_MASTER_MODE    MSTR
00313 #define    SPI_CONTROL_REGISTER    SPCR
00314 #define    SPI_DATA_REGISTER    SPDR
00315 #define    SPI_STATUS_REGISTER    SPSR
00316
00317 #define    SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT    SPCR |= 1 << SPIE
00318 #define    SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT    SPCR &= ~(1 << SPIE)
00319
00320
00321 #define    SPI_TRANSFER_COMPLETE_INTERRUPT    SPI_STC_vect
00322
00323 // StepperMotor defines
00324
00325
00326
00327
00328
00329
00330 #endif

```

00331

10.29 LCD.cpp File Reference

10.30 LCD.cpp

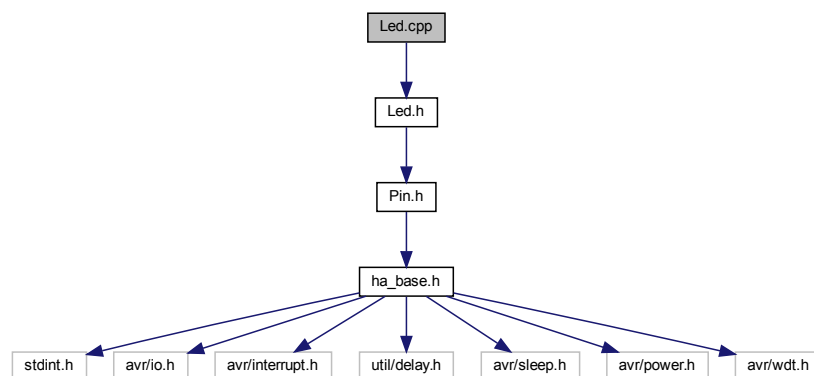
10.31 LCD.h File Reference

10.32 LCD.h

10.33 Led.cpp File Reference

```
#include "Led.h"
```

Include dependency graph for Led.cpp:



10.34 Led.cpp

```

00001
00010 #include "Led.h"
00011
00012 component::Led::Led(const io::Pin &ar_pin)
00013     : m_pin(ar_pin)
00014 {
00015     m_pin.toOutput();
00016 }
00017
00018 component::Led::~Led()
00019 {
00020 }
00021 }
00022
00023
00024 void component::Led::on()
00025 {
00026     m_pin.setHigh();
00027 }
00028 }
00029
  
```

```

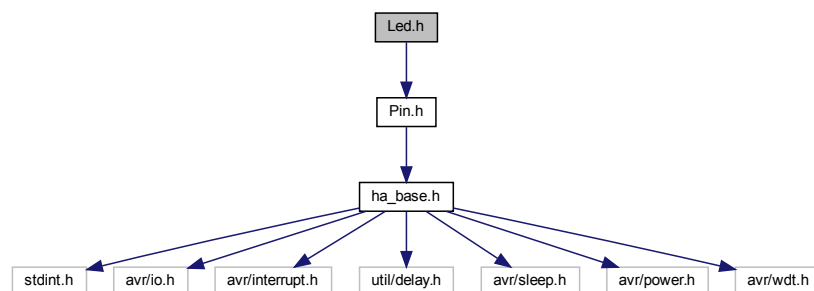
00030 void component::Led::off()
00031 {
00032     m_pin.setLow();
00033 }
00034 }
00035
00036
00037 void component::Led::toggle()
00038 {
00039     m_pin.toggle();
00040 }
00041 }
00042
00043 uint8_t component::Led::isOn()
00044 {
00045     return m_pin.isHigh();
00046 }
00047 }
00048
00049
00050 uint8_t component::Led::isOff()
00051 {
00052     return m_pin.isLow();
00053 }
00054 }
00055

```

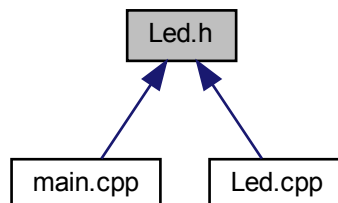
10.35 Led.h File Reference

```
#include "Pin.h"
```

Include dependency graph for Led.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `component::Led`
Class for handling a `Led` component.

Namespaces

- `component`
AVR chip external components.

10.36 Led.h

```

00001 #ifndef LED_H
00002 #define LED_H
00003 #include "Pin.h"
00004
00014 namespace component
00015 {
00016
00026 class Led
00027 {
00028
00029 public:
00037     Led(const io::Pin &ar_pin);
00041     ~Led();
00044     void on();
00047     void off();
00050     void toggle();
00056     uint8_t isOn();
00062     uint8_t isOff();
00063
00064 protected:
00065
00066 private:
00067     io::Pin m_pin;
00072 };
00073
00074 }
00075
00076
00077 #endif

```

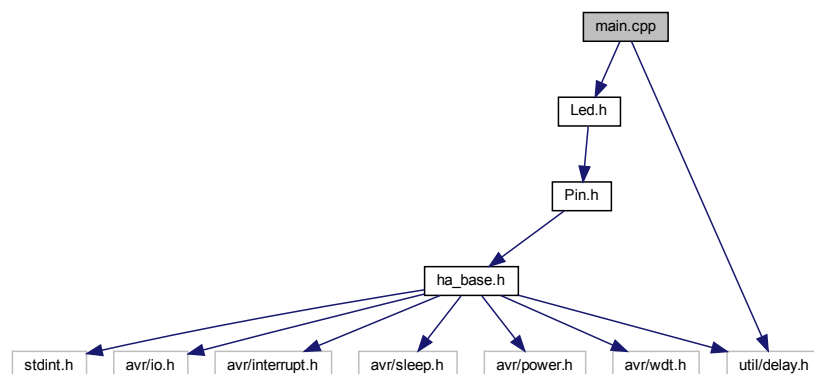
10.37 main.cpp File Reference

```

#include "Led.h"
#include <util/delay.h>

```

Include dependency graph for BlinkLed/main.cpp:



Macros

- `#define PIN_NUMBER 0`
- `#define TIMEDELAY 500`

Functions

- `int main (void)`

10.37.1 Detailed Description

Demo example: Blink a Led

Usage demonstration of the TahakomAVRLib in a simple blink a Led example. This example demonstrates the use of the `component::Led()` and `io::Pin()` abstraction objects.

- Compiler: avr-gcc (GCC) 5.4.0
- Supported devices: The example compiles on the ATmega48P/88P/168P/328P AVR family

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Definition in file [BlinkLed/main.cpp](#).

10.37.2 Macro Definition Documentation

10.37.2.1 PIN_NUMBER

```
#define PIN_NUMBER 0
```

Led pin number

Definition at line 20 of file [BlinkLed/main.cpp](#).

10.37.2.2 TIMEDELAY

```
#define TIMEDELAY 500
```

Time delay

Definition at line 22 of file [BlinkLed/main.cpp](#).

10.37.3 Function Documentation

10.37.3.1 main()

```
int main (
    void )
```

Definition at line 24 of file [BlinkLed/main.cpp](#).

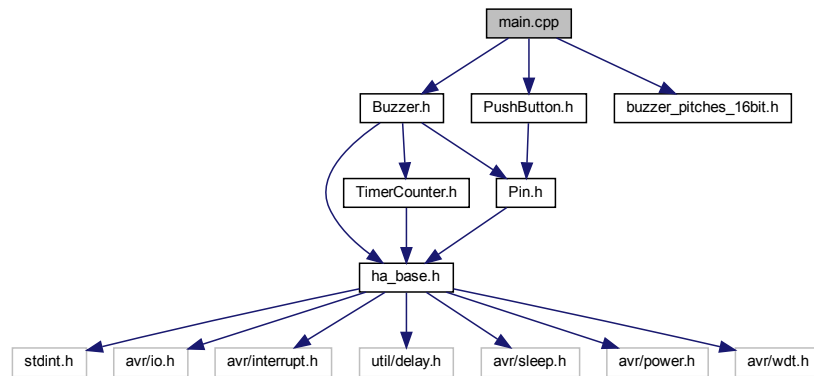
```
00024     {
00025
00026     // Init
00027
00028     // Instantiate a Led object
00029     component::Led Led(io::Pin(PIN_NUMBER,io::PortB));
00030
00031     // Mainloop
00032     while (1) {
00033
00034         Led.on();
00035         _delay_ms(TIMEDELAY);
00036
00037         Led.off();
00038         _delay_ms(TIMEDELAY);
00039     }
00040     return 0;
00041 }
```

10.38 BlinkLed/main.cpp

```
00001
00017 #include "Led.h"
00018 #include <util/delay.h>
00019
00020 #define PIN_NUMBER 0
00022 #define TIMEDELAY 500
00024 int main(void) {
00025
00026     // Init
00027
00028     // Instantiate a Led object
00029     component::Led Led(io::Pin(PIN_NUMBER,io::PortB));
00030
00031     // Mainloop
00032     while (1) {
00033
00034         Led.on();
00035         _delay_ms(TIMEDELAY);
00036
00037         Led.off();
00038         _delay_ms(TIMEDELAY);
00039     }
00040     return 0;
00041 }
```

10.39 main.cpp File Reference

```
#include "Buzzer.h"
#include "PushButton.h"
#include "buzzer_pitches_16bit.h"
Include dependency graph for MusicBox/main.cpp:
```



Macros

- `#define BUZZER 0`
- `#define PUSHBUTTON 1`
- `#define SONG_LENGTH (sizeof(l_song) / sizeof(uint16_t))`

Functions

- `int main (void)`

10.39.1 Detailed Description

Demo example: AVR Music Box

Usage demonstration of the TahakomAVRLib in an AVR based Music Box. The example allows the user to play a predefined song in a Buzzer and control its tempo via a PushButton This example demonstrates the use of the `component::Buzzer()` and `component::PushButton()` abstraction objects.

- Compiler: avr-gcc (GCC) 5.4.0
- Supported devices: The example compiles on the ATmega48P/88P/168P/328P AVR family

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Definition in file [MusicBox/main.cpp](#).

10.39.2 Macro Definition Documentation

10.39.2.1 BUZZER

```
#define BUZZER 0
```

Buzzer pin number

Definition at line 24 of file [MusicBox/main.cpp](#).

10.39.2.2 PUSHBUTTON

```
#define PUSHBUTTON 1
```

PushButton pin number

Definition at line 26 of file [MusicBox/main.cpp](#).

10.39.2.3 SONG_LENGTH

```
#define SONG_LENGTH (sizeof(l_song) / sizeof(uint16_t))
```

Song length

Definition at line 28 of file [MusicBox/main.cpp](#).

10.39.3 Function Documentation

10.39.3.1 main()

```
int main (
    void )
```

Definition at line 30 of file [MusicBox/main.cpp](#).

```
00030     {
00031
00032     // Init
00033
00034     // Instantiate a Buzzer object
00035     component::Buzzer Buzzer(io::Pin(BUZZER,io::PortB));
00036
00037     // Instantiate a PushButton object
00038     component::PushButton PushButton(io::Pin(PUSHBUTTON,io::PortB));
00039
00040     // Song notes
00041     const uint16_t l_song[] = {
00042     E6, E6, E6, C6, E6, G6, G5,
00043     C6, G5, E5, A5, B5, Ax5, A5,
00044     G5, E6, G6, A6, F6, G6, E6, C6, D6, B5,
00045     C6, G5, E5, A5, B5, Ax5, A5,
00046     G5, E6, G6, A6, F6, G6, E6, C6, D6, B5,
00047     };
00048
00049     // Start song at start
00050     uint8_t l_note = SONG_LENGTH - 1;
00051
00052     // Initialize PushButton state
00053     uint8_t l_statePushButton = 0;
00054
00055
00056     // Mainloop
00057     while (1) {
00058         // Check if PusgButton is pressed
00059         if (PushButton.isPressed())
00060         {
00061             // Check if a new button press
00062             if (!l_statePushButton) {
00063                 // play next note
00064                 l_note++;
00065                 // start from start
00066                 if (l_note == SONG_LENGTH) {
00067
00068                     l_note = 0;
00069
00070                 }
00071
00072                 l_statePushButton = 1;
00073
00074             }
00075             // Play note
00076             Buzzer.buzz(l_song[l_note], 1600);
00077
00078         } else {
00079
00080             l_statePushButton=0;
00081
00082         }
00083
00084     }
00085     return 0;
00086 }
```

10.40 MusicBox/main.cpp

```
00001
00018 #include "Buzzer.h"
00019 #include "PushButton.h"
00020 // Note pitch data
00021 #include "buzzer_pitches_16bit.h"
00022
00023
00024 #define BUZZER 0
00026 #define PUSHBUTTON 1
00028 #define SONG_LENGTH (sizeof(l_song) / sizeof(uint16_t))
00030 int main(void) {
00031
00032     // Init
00033
```

```

00034 // Instantiate a Buzzer object
00035 component::Buzzer Buzzer(io::Pin(BUZZER,io::PortB));
00036
00037 // Instantiate a PushButton object
00038 component::PushButton PushButton(io::Pin(PUSHBUTTON,io::PortB));
00039
00040 // Song notes
00041 const uint16_t l_song[] = {
00042     E6, E6, E6, C6, E6, G6, G5,
00043     C6, G5, E5, A5, B5, Ax5, A5,
00044     G5, E6, G6, A6, F6, G6, E6, C6, D6, B5,
00045     C6, G5, E5, A5, B5, Ax5, A5,
00046     G5, E6, G6, A6, F6, G6, E6, C6, D6, B5,
00047 };
00048
00049 // Start song at start
00050 uint8_t l_note = SONG_LENGTH - 1;
00051
00052 // Initialize PushButton state
00053 uint8_t l_statePushButton = 0;
00054
00055
00056 // Mainloop
00057 while (1) {
00058     // Check if PusgButton is pressed
00059     if (PushButton.isPressed())
00060     {
00061         // Check if a new button press
00062         if (!l_statePushButton) {
00063             // play next note
00064             l_note++;
00065             // start from start
00066             if (l_note == SONG_LENGTH) {
00067
00068                 l_note = 0;
00069
00070             }
00071
00072             l_statePushButton = 1;
00073
00074         }
00075         // Play note
00076         Buzzer.buzz(l_song[l_note], 1600);
00077     } else {
00078
00079         l_statePushButton=0;
00080
00081     }
00082
00083 }
00084 }
00085 return 0;
00086 }

```

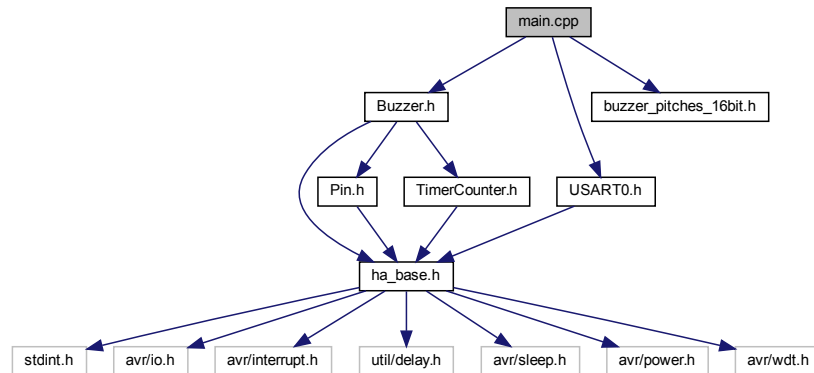
10.41 main.cpp File Reference

```

#include "Buzzer.h"
#include "USART0.h"
#include "buzzer_pitches_16bit.h"

```

Include dependency graph for Organ/main.cpp:



Macros

- `#define BUZZER 0`
- `#define NOTE_DURATION 0xF000`

Functions

- `int main (void)`

10.41.1 Detailed Description

Demo example: AVR Square-Wave Organ

Usage demonstration of the TahakomAVRLib in a Buzzer based and serial driven Square-Wave Organ. The example enables the user to enter a key note via serial terminal from the keyboard and play the corresponding note in a Buzzer. This example demonstrates the use of the `component::Buzzer()` and `io::USART0()` abstraction objects.

- Compiler: avr-gcc (GCC) 5.4.0
- Supported devices: The example compiles on the ATmega48P/88P/168P/328P AVR family

Author

Farid Oubbati (farid.oubbati@outlook.com)

Date

March 2018

Definition in file [Organ/main.cpp](#).

10.41.2 Macro Definition Documentation

10.41.2.1 BUZZER

```
#define BUZZER 0
```

Buzzer pin number

Definition at line 24 of file [Organ/main.cpp](#).

10.41.2.2 NOTE_DURATION

```
#define NOTE_DURATION 0xF000
```

Note duration

Definition at line 26 of file [Organ/main.cpp](#).

10.41.3 Function Documentation

10.41.3.1 main()

```
int main (
    void )
```

Definition at line 28 of file [Organ/main.cpp](#).

```
00028         {
00029
00030     // Init
00031
00032     // Instantiate a Buzzer object
00033     component::Buzzer Buzzer(io::Pin(BUZZER,io::PortB));
00034
00035     // Instantiate a USART0 object
00036     io::USART0 &myUSART0 = io::USART0::getInstance();
00037
00038     // List of possible keypresses
00039     const uint8_t l_keys[] = { 'a', 'w', 's', 'e', 'd', 'f', 't',
00040                               'g', 'y', 'h', 'j', 'i', 'k', 'o',
00041                               'l', 'p', ';', '\n'
00042     };
00043
00044     // List of the keypresses corresponding pitches
00045     const uint16_t l_notes[] = { G4, Gx4, A4, Ax4, B4, C5, Cx5,
00046                                 D5, Dx5, E5, Fx5, G5, Gx5,
00047                                 A5, Ax5, B5, C6
00048     };
00049
00050     // Character key from computer serial terminal
00051     unsigned char l_key;
00052
00053     // Current note length
00054     uint16_t l_currentNoteLength = NOTE_DURATION;
00055 }
```



```

00056 // Check if note key
00057 uint8_t l_isNote;
00058
00059 myUSART0.sendString("----- Serial Organ -----\r\n");
00060
00061 // Mainloop
00062 while (1) {
00063
00064     // Send N to signal that AVR chip is ready for next key note input
00065     myUSART0.sendString("Enter key note\r\n");
00066
00067     // Wait for key note input
00068     while (myUSART0.getNumberBytesReceived()==0)
00069     {
00070         myUSART0.receiveChar(l_key);
00071     }
00072     myUSART0.resetNumberBytesReceived();
00073
00074     /***** Play key notes *****/
00075
00076     l_isNote = 0;
00077     // Loop through keys table
00078     for (uint8_t i = 0; i < sizeof(l_keys); i++) {
00079         // Found match in lookup table
00080         if (l_key == l_keys[i]) {
00081             Buzzer.buzz(l_notes[i], l_currentNoteLength);
00082             // Record that we've found a note
00083             l_isNote = 1;
00084             break;
00085         }
00086     }
00087
00088     // Handle non-note keys: tempo changes and rests
00089     if (!l_isNote) {
00090         if (l_key == '-') {
00091             // Code for short note
00092             l_currentNoteLength = l_currentNoteLength / 2;
00093         }
00094         else if (l_key == '+') {
00095             // Code for long note
00096             l_currentNoteLength = l_currentNoteLength * 2;
00097         }
00098         else {
00099             // Unrecognized, just rest
00100             Buzzer.pause(l_currentNoteLength);
00101         }
00102     }
00103 }
00104
00105 }
00106 return 0;
00107 }

```

10.42 main.cpp

```

00001
00018 #include "Buzzer.h"
00019 #include "USART0.h"
00020 // Note pitch data
00021 #include "buzzer_pitches_16bit.h"
00022
00023
00024 #define BUZZER 0
00026 #define NOTE_DURATION 0xF000
00028 int main(void) {
00029
00030     // Init
00031
00032     // Instantiate a Buzzer object
00033     component::Buzzer Buzzer(io::Pin(BUZZER, io::PortB));
00034
00035     // Instantiate a USART0 object
00036     io::USART0 &myUSART0 = io::USART0::getInstance();
00037
00038     // List of possible keypresses
00039     const uint8_t l_keys[] = { 'a', 'w', 's', 'e', 'd', 'f', 't',
00040                               'g', 'y', 'h', 'j', 'i', 'k', 'o',
00041                               'l', 'p', ';', '\n'
00042     };
00043
00044     // List of the keypresses corresponding pitches
00045     const uint16_t l_notes[] = { G4, Gx4, A4, Ax4, B4, C5, Cx5,
00046                                 D5, Dx5, E5, F5, Fx5, G5, Gx5,

```

```

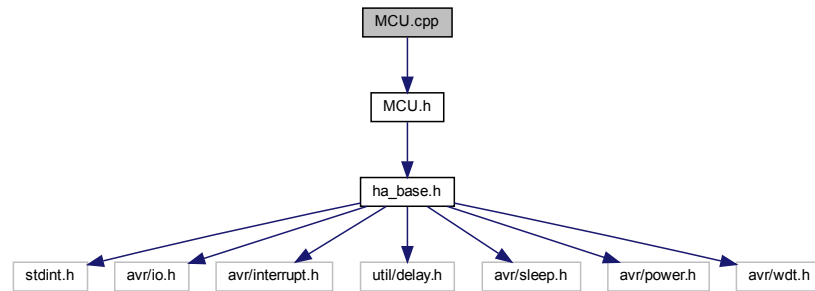
00047     A5, Ax5, B5, C6
00048 };
00049
00050 // Character key from computer serial terminal
00051 unsigned char l_key;
00052
00053 // Current note length
00054 uint16_t l_currentNoteLength = NOTE_DURATION;
00055
00056 // Check if note key
00057 uint8_t l_isNote;
00058
00059 myUSART0.sendString("----- Serial Organ -----\r\n");
00060
00061 // Mainloop
00062 while (1) {
00063
00064     // Send N to signal that AVR chip is ready for next key note input
00065     myUSART0.sendString("Enter key note\r\n");
00066
00067     // Wait for key note input
00068     while (myUSART0.getNumberBytesReceived()==0)
00069     {
00070         myUSART0.receiveChar(l_key);
00071     }
00072     myUSART0.resetNumberBytesReceived();
00073
00074     /***** Play key notes *****/
00075
00076     l_isNote = 0;
00077     // Loop through keys table
00078     for (uint8_t i = 0; i < sizeof(l_keys); i++) {
00079         // Found match in lookup table
00080         if (l_key == l_keys[i]) {
00081             Buzzer.buzz(l_notes[i], l_currentNoteLength);
00082             // Record that we've found a note
00083             l_isNote = 1;
00084             break;
00085         }
00086     }
00087
00088     // Handle non-note keys: tempo changes and rests
00089     if (!l_isNote) {
00090         if (l_key == '-' ) {
00091             // Code for short note
00092             l_currentNoteLength = l_currentNoteLength / 2;
00093         }
00094         else if (l_key == '+' ) {
00095             // Code for long note
00096             l_currentNoteLength = l_currentNoteLength * 2;
00097         }
00098         else {
00099             // Unrecognized, just rest
00100             Buzzer.pause(l_currentNoteLength);
00101         }
00102     }
00103 }
00104
00105 }
00106 return 0;
00107 }

```

10.43 MCU.cpp File Reference

```
#include "MCU.h"
```

Include dependency graph for MCU.cpp:



10.44 MCU.cpp

```

00001 #include "MCU.h"
00002
00003 void core::MCU::init()
00004 {
00005     enableUSART0(0);
00006     enableTimerCounter0(0);
00007     enableTimerCounter1(0);
00008     enableTimerCounter2(0);
00009     enableTWI(0);
00010     enableSPI(0);
00011     enableADC(0);
00012 }
00013
00014
00015 void core::MCU::selectSleepMode(const sleepMode &a_sleepMode)
00016 {
00017     MCU_SELECT_SLEEP_MODE(static_cast<uint8_t>(a_sleepMode));
00018 }
00019
00020
00021 void core::MCU::goToSleep(const BODMode &a_BODMode)
00022 {
00023     cli();
00024     switch (a_BODMode)
00025     {
00026     case core::BODMode::enabled:
00027     {
00028         sleepEnable(1);
00029         sei();
00030         sleep_cpu();
00031         sleepEnable(0);
00032         break;
00033     }
00034     case core::BODMode::disabled:
00035     {
00036         sleepEnable(1);
00037         disableBOD();
00038         sei();
00039         sleep_cpu();
00040         sleepEnable(0);
00041         break;
00042     }
00043     }
00044 }
00045
00046
00047 void core::MCU::sleepEnable(const uint8_t a_enable)
00048 {
00049     if (a_enable) {
00050         MCU_SLEEP_ENABLE;
00051     } else {
00052         MCU_SLEEP_DISABLE;
00053     }
00054 }
00055
00056
00057 void core::MCU::enableUSART0(const uint8_t a_enable)

```

```

00058 {
00059     if (a_enable) {
00060         MCU_USART0_ENABLE;
00061     } else {
00062         MCU_USART0_DISABLE;
00063     }
00064 }
00065 }
00066
00067 void core::MCU::enableTimerCounter0(const uint8_t a_enable)
00068 {
00069     if (a_enable) {
00070         MCU_TIMER0_ENABLE;
00071     } else {
00072         MCU_TIMER0_DISABLE;
00073     }
00074 }
00075 }
00076
00077 void core::MCU::enableTimerCounter1(const uint8_t a_enable)
00078 {
00079     if (a_enable) {
00080         MCU_TIMER1_ENABLE;
00081     } else {
00082         MCU_TIMER1_DISABLE;
00083     }
00084 }
00085 }
00086
00087 void core::MCU::enableTimerCounter2(const uint8_t a_enable)
00088 {
00089     if (a_enable) {
00090         MCU_TIMER2_ENABLE;
00091     } else {
00092         MCU_TIMER2_DISABLE;
00093     }
00094 }
00095 }
00096
00097 void core::MCU::enableTWI(const uint8_t a_enable)
00098 {
00099     if (a_enable) {
00100         MCU_TWI_ENABLE;
00101     } else {
00102         MCU_TWI_DISABLE;
00103     }
00104 }
00105 }
00106
00107 void core::MCU::enableSPI(const uint8_t a_enable)
00108 {
00109     if (a_enable) {
00110         MCU_SPI_ENABLE;
00111     } else {
00112         MCU_SPI_DISABLE;
00113     }
00114 }
00115 }
00116
00117 void core::MCU::enableADC(const uint8_t a_enable)
00118 {
00119     if (a_enable) {
00120         MCU_ADC_ENABLE;
00121     } else {
00122         MCU_ADC_DISABLE;
00123     }
00124 }
00125 }
00126 void core::MCU::disableBOD()
00127 {
00128     MCU_BOD_DISABLE;
00129 }

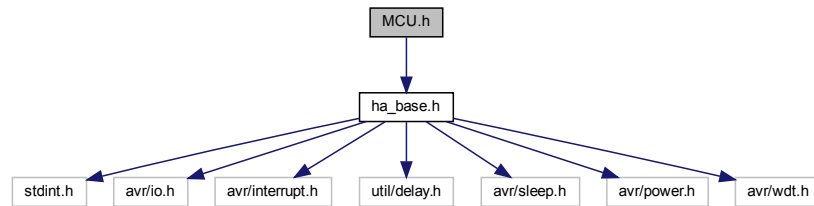
```

10.45 MCU.h File Reference

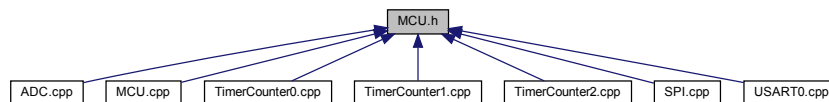
Header file of the MCU class.

```
#include "ha_base.h"
```

Include dependency graph for MCU.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [core::MCU](#)

Namespaces

- [core](#)

Enumerations

- enum [core::BODMode](#) : uint8_t { [core::BODMode::enabled](#) =0, [core::BODMode::disabled](#) }
- enum [core::sleepMode](#) : uint8_t { [core::sleepMode::Idle](#) =0, [core::sleepMode::ADC_NoiseReduction](#), [core::sleepMode::powerDown](#), [core::sleepMode::powerSave](#), [core::sleepMode::standby](#) =6, [core::sleepMode::extendedStandby](#) }

10.45.1 Detailed Description

Header file of the MCU class.

Basic class abstraction of the MCU.

Usage example (test):

```
#include "PushButton.h" #include "Led.h" #include "ExternInterrupt.h" #include "MCU.h"
```

```
#define PUSHBUTTON_NUMBER 2 #define LED_NUMBER 0
```

```

int main(void) {

Init initialize MCU core::MCU::init();

instantiate a Led object component::Led Led(io::Pin(LED_NUMBER,io::PortB));

instantiate a Led object component::PushButton PushButton(io::Pin(PUSHBUTTON_NUMBER,io::PortD));

instantiate the external interrupt manager core::ExternInterrupt &myExternInterrupt = core::ExternInterrupt::getInstance();
myExternInterrupt.enableInt0(1); myExternInterrupt.setInt0SenseControl(core::senseControl::logicalChange);

set sleep mode core::MCU::selectSleepMode(core::sleepMode::powerDown);

Mainloop while (1) {

flash the LED for (uint8_t i=0;i<10;i++) { Led.on(); _delay_ms(100); Led.off(); _delay_ms(100); } _delay_ms(5000);
Led.on(); _delay_ms(100); Led.off(); core::MCU::goToSleep(core::BODMode::enabled);

} return 0; }

void core::ExternInterrupt::Int0ServiceRoutine() {

}

```

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Definition in file [MCU.h](#).

10.46 MCU.h

```

00001
00069 #ifndef MCU_H
00070 #define MCU_H
00071 #include "ha_base.h"
00072
00073
00074 namespace core
00075 {
00076
00077 enum class BODMode : uint8_t {
00078     enabled=0,
00079     disabled,
00080 };
00081
00082 enum class sleepMode : uint8_t {
00083     Idle=0,
00084     ADC_NoiseReduction,
00085     powerDown,
00086     powerSave,
00087     standby=6,
00088     extendedStandby,
00089 };
00090
00091 class MCU
00092 {
00093 public:
00094
00095     static void init();
00096
00097     static void selectSleepMode(const sleepMode &a_sleepMode);

```

```

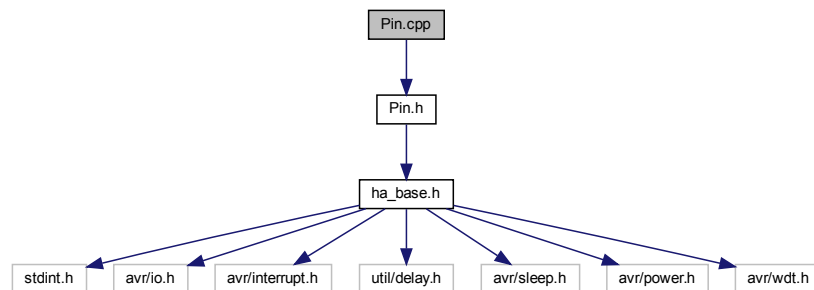
00098
00099     static void goToSleep(const BODMode &a_BODMode);
00100
00101     static void sleepEnable(const uint8_t ar_enable);
00102
00103     static void enableUSART0(const uint8_t a_enable);
00104
00105     static void enableTimerCounter0(const uint8_t a_enable);
00106
00107     static void enableTimerCounter1(const uint8_t a_enable);
00108
00109     static void enableTimerCounter2(const uint8_t a_enable);
00110
00111     static void enableTWI(const uint8_t a_enable);
00112
00113     static void enableSPI(const uint8_t a_enable);
00114
00115     static void enableADC(const uint8_t a_enable);
00116
00117     static void disableBOD();
00118
00119
00120
00121
00122
00123 protected:
00124
00125
00126
00127 private:
00128
00129
00130
00131
00132
00133
00134
00135 };
00136
00137
00138
00139
00140
00141 }
00142 #endif

```

10.47 Pin.cpp File Reference

```
#include "Pin.h"
```

Include dependency graph for Pin.cpp:



10.48 Pin.cpp

```
00001
```

```

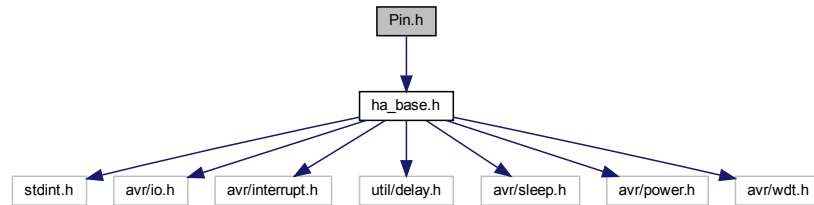
00009 #include "Pin.h"
00010
00011
00012 io::Pin::Pin(const uint8_t a_pinNumber, const Port &mr_portName)
00013     : mr_portName(mr_portName), m_pinNumber(a_pinNumber)
00014 {
00015 }
00016 }
00017
00018
00019 io::Pin::~~Pin()
00020 {
00021 }
00022 }
00023 }
00024
00025 void io::Pin::toOutput()
00026 {
00027     *mr_portName.mp_ddrReg |= (1 « m_pinNumber);
00028 }
00029
00030 void io::Pin::toInput(const uint8_t &ar_useInternalPullUp)
00031 {
00032     if (ar_useInternalPullUp)
00033     {
00034         *mr_portName.mp_portReg |= (1 « m_pinNumber);
00035         *mr_portName.mp_ddrReg &= ~(1 « m_pinNumber);
00036     }
00037 }
00038 }
00039 else
00040 {
00041     *mr_portName.mp_portReg &= ~(1 « m_pinNumber);
00042     *mr_portName.mp_ddrReg &= ~(1 « m_pinNumber);
00043 }
00044 }
00045 }
00046
00047 void io::Pin::setLow()
00048 {
00049     if (*mr_portName.mp_ddrReg & (1 « m_pinNumber))
00050     {
00051         *mr_portName.mp_portReg &= ~(1 « m_pinNumber);
00052     }
00053 }
00054
00055 void io::Pin::setHigh()
00056 {
00057     if (*mr_portName.mp_ddrReg & (1 « m_pinNumber))
00058     {
00059         *mr_portName.mp_portReg |= (1 « m_pinNumber);
00060     }
00061 }
00062
00063 void io::Pin::toggle()
00064 {
00065     if (*mr_portName.mp_ddrReg & (1 « m_pinNumber))
00066     {
00067         *mr_portName.mp_portReg ^= 1 « m_pinNumber;
00068     }
00069 }
00070
00071 uint8_t io::Pin::isHigh()
00072 {
00073     return *mr_portName.mp_pinReg & (1 « m_pinNumber);
00074 }
00075
00076 uint8_t io::Pin::isLow()
00077 {
00078     return !(*mr_portName.mp_pinReg & (1 « m_pinNumber));
00079 }
00080
00081 uint8_t io::Pin::getPinNumber()
00082 {
00083     return m_pinNumber;
00084 }

```

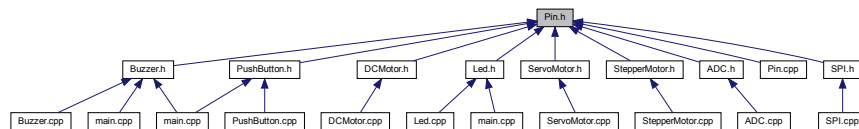
10.49 Pin.h File Reference

```
#include "ha_base.h"
```


Include dependency graph for Pin.h:



This graph shows which files directly or indirectly include this file:



Classes

- struct `io::Port`
Contains definitions of pointers to the AVR port's registers.
- class `io::Pin`

Namespaces

- `io`
AVR chip internal i/o components.

Variables

- static `io::Port io::PortB = { &DDRB, &PORTB, &PINB }`
- static `io::Port io::PortC = { &DDRC, &PORTC, &PINC }`
- static `io::Port io::PortD = { &DDRD, &PORTD, &PIND }`

10.50 Pin.h

```

00001 #ifndef PIN_H
00002 #define PIN_H
00003 #include "ha_base.h"
00012 namespace io
00013 {
00014
00019 struct Port
00020 {
00021     volatile uint8_t* mp_ddrReg;
00023     volatile uint8_t* mp_portReg;
00025     volatile uint8_t* mp_pinReg;
00026 };
  
```

```

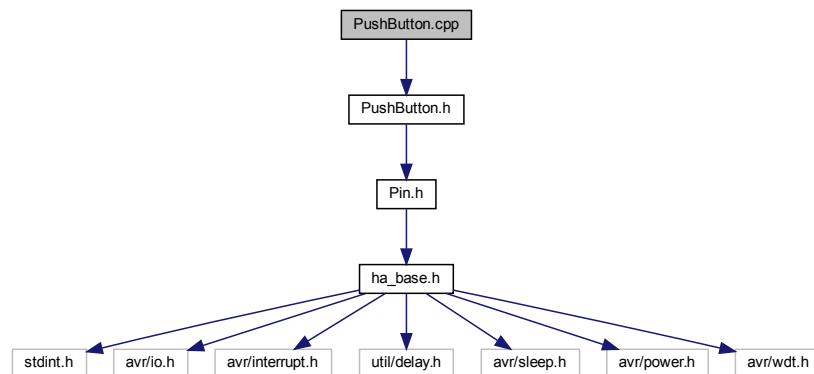
00027
00028 class Pin
00029 {
00030
00031 public:
00032     Pin(const uint8_t a_pinNumber, const Port &ar_portName);
00033     ~Pin();
00034     void toOutput();
00035     void toInput(const uint8_t &ar_useInternalPullUp);
00036     void setLow();
00037     void setHigh();
00038
00039     void toggle();
00040     uint8_t isHigh();
00041     uint8_t isLow();
00042     uint8_t getPinNumber();
00043
00044 protected:
00045
00046 private:
00047     const Port &mr_portName;
00048     const uint8_t m_pinNumber;
00049 };
00050
00051 static io::Port PortB = { &DDRB, &PORTB, &PINB };
00052 static io::Port PortC = { &DDRC, &PORTC, &PINC };
00053 static io::Port PortD = { &DDRD, &PORTD, &PIND };
00054
00055 #endif

```

10.51 PushButton.cpp File Reference

```
#include "PushButton.h"
```

Include dependency graph for PushButton.cpp:



10.52 PushButton.cpp

```

00001
00010 #include "PushButton.h"
00011
00012 component::PushButton::PushButton(const io::Pin& ar_pin, const uint8_t &ar_useInternalPullUp, const
    uint8_t &ar_isActiveLow)
00013     : m_pin(ar_pin),
00014       mr_isActiveLow(ar_isActiveLow),
00015       mr_useInternalPullUp(ar_useInternalPullUp)
00016

```

```

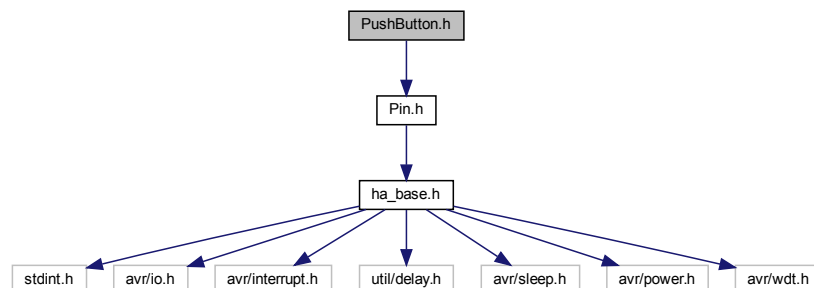
00017
00018 {
00019     m_pin.toInput(mr_useInternalPullUp);
00020     m_buttonPressed = 0;
00021 }
00022
00023 component::PushButton::~PushButton()
00024 {
00025
00026 }
00027
00028
00029 uint8_t component::PushButton::isPressed()
00030 {
00031     if (mr_isActiveLow || mr_useInternalPullUp) {
00032         if (m_pin.isLow()) {
00033             _delay_us(PUSHBUTTON_DEBOUNCE_TIME_US);
00034             if (m_pin.isLow()) {
00035                 ++m_buttonPressed;
00036                 return 1;
00037             }
00038         }
00039     } else {
00040
00041         if (m_pin.isHigh()) {
00042             _delay_us(PUSHBUTTON_DEBOUNCE_TIME_US);
00043             if (m_pin.isHigh()) {
00044                 ++m_buttonPressed;
00045                 return 1;
00046             }
00047         }
00048     }
00049 }
00050
00051 return 0;
00052
00053 }
00054
00055 uint8_t component::PushButton::getPressedCount() const
00056 {
00057
00058     return m_buttonPressed;
00059 }
00060
00061
00062 void component::PushButton::resetPressedCount()
00063 {
00064     m_buttonPressed = 0;
00065 }
00066 }

```

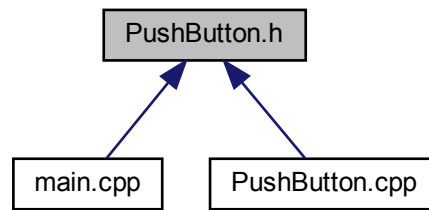
10.53 PushButton.h File Reference

#include "Pin.h"

Include dependency graph for PushButton.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `component::PushButton`
Class for handling a `PushButton` component.

Namespaces

- `component`
AVR chip external components.

10.54 PushButton.h

```

00001 #ifndef PUSHBUTTON_H
00002 #define PUSHBUTTON_H
00003 #include "Pin.h"
00004
00014 namespace component
00015 {
00016
00026 class PushButton
00027 {
00028 public:
00037     PushButton(const io::Pin &ar_pin, const uint8_t &ar_useInternalPullUp=1, const uint8_t
        &ar_isActiveLow=1);
00041     ~PushButton();
00047     uint8_t isPressed();
00053     uint8_t getPressedCount() const;
00058     void resetPressedCount();
00059
00060
00061 protected:
00062
00063 private:
00064     io::Pin m_pin;
00065     const uint8_t &mr_isActiveLow;
00066     const uint8_t &mr_useInternalPullUp;
00067     uint8_t m_buttonPressed;
00071 };
00072 }
00073
00074
00075
00076
00077 #endif
  
```

10.55 README.md File Reference

10.56 README.md File Reference

10.57 README.md File Reference

10.58 README.md File Reference

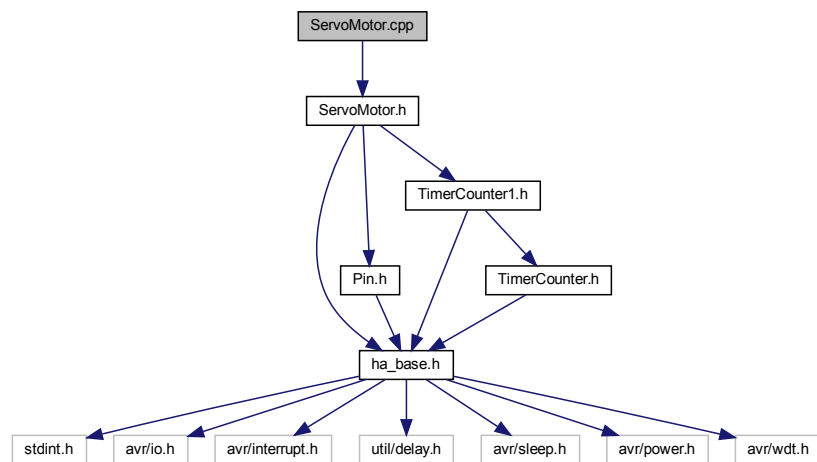
10.59 README.md File Reference

10.60 README.md File Reference

10.61 ServoMotor.cpp File Reference

```
#include "ServoMotor.h"
```

Include dependency graph for ServoMotor.cpp:



10.62 ServoMotor.cpp

```

00001 #include "ServoMotor.h"
00002
00003
00004
00005 component::ServoMotor::ServoMotor(const io::Pin &ar_pin,
00006                                     const uint16_t &ar_pulseCycle,
00007                                     const uint16_t &ar_pulseWidthMin,
00008                                     const uint16_t &ar_pulseWidthMid,
00009                                     const uint16_t &ar_pulseWidthMax)
00010 : m_pin(ar_pin),
00011   m_pulseCycle(ar_pulseCycle),
00012   m_pulseWidthMin(ar_pulseWidthMin),
00013   m_pulseWidthMid(ar_pulseWidthMid),

```

```

00014             m_pulseWidthMax(ar_pulseWidthMax)
00015 {
00016     m_pin.toOutput();
00017 }
00018 }
00019
00020 component::ServoMotor::~ServoMotor()
00021 {
00022 }
00023 }
00024
00025
00026
00027
00028 void component::ServoMotor::on()
00029 {
00030     m_pin.setHigh();
00031 }
00032
00033 void component::ServoMotor::off()
00034 {
00035     m_pin.setLow();
00036 }
00037
00038 void component::ServoMotor::toggle()
00039 {
00040     m_pin.toggle();
00041 }
00042 }
00043
00044 uint16_t component::ServoMotor::computePulseCycleCount(const uint16_t &ar_clockPrescaler)
00045 {
00046     return SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(m_pulseCycle, ar_clockPrescaler);
00047 }
00048
00049 uint16_t component::ServoMotor::computePulseWidthMinCount(const uint16_t &ar_clockPrescaler)
00050 {
00051     return SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(m_pulseWidthMin, ar_clockPrescaler);
00052 }
00053
00054 uint16_t component::ServoMotor::computePulseWidthMaxCount(const uint16_t &ar_clockPrescaler)
00055 {
00056     return SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(m_pulseWidthMax, ar_clockPrescaler);
00057 }
00058
00059 uint16_t component::ServoMotor::computePulseWidthMidCount(const uint16_t &ar_clockPrescaler)
00060 {
00061     return SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT(m_pulseWidthMid, ar_clockPrescaler);
00062 }
00063
00064 uint16_t component::ServoMotor::computeRotationAngleCount(const uint8_t &ar_angle_deg, const uint16_t
&ar_clockPrescaler)
00065 {
00066     return
static_cast<uint16_t>{SERVOMOTOR_TIMER_ANGLE_COUNT(ar_angle_deg, static_cast<long>(computePulseWidthMinCount(ar_clockPrescaler)));
00067 }
00068
00069
00070
00071 void component::ServoMotor::rotate(core::TimerCounter1 &ar_timerCounter1,
const uint8_t &ar_angle_deg,
const core::channel &ar_channel)
00072 {
00073     ar_timerCounter1.setOutputCompareRegister(ar_channel,
computeRotationAngleCount(ar_angle_deg, ar_timerCounter1.getClockPrescaler()));
00074 }
00075
00076     ar_timerCounter1.setOutputCompareRegister(ar_channel,
computeRotationAngleCount(ar_angle_deg, ar_timerCounter1.getClockPrescaler()));
00077
00078     // start timer
00079     ar_timerCounter1.start();
00080 }
00081
00082 }
00083
00084
00085 void component::ServoMotor::connect(core::TimerCounter1 &ar_timerCounter1,
const core::channel &ar_channel)
00086 {
00087 }
00088
00089
00090
00091     ar_timerCounter1.setInputCaptureRegister(computePulseCycleCount(ar_timerCounter1.getClockPrescaler()));
00092     ar_timerCounter1.selectOperationMode(core::operationMode::fast_PWM_ICR);
00093     ar_timerCounter1.selectCompareOutputMode(ar_channel, core::compareOutputMode::clear);
00094     ar_timerCounter1.setCounter(0);
00095 }
00096

```

```

00097 void component::ServoMotor::disconnect(core::TimerCounter1 &ar_timerCounter1,
00098                                         const core::channel &ar_channel)
00099 {
00100     ar_timerCounter1.selectCompareOutputMode(ar_channel, core::compareOutputMode::normal);
00101     // stop timer
00102     ar_timerCounter1.stop();
00103 }

```

10.63 ServoMotor.h File Reference

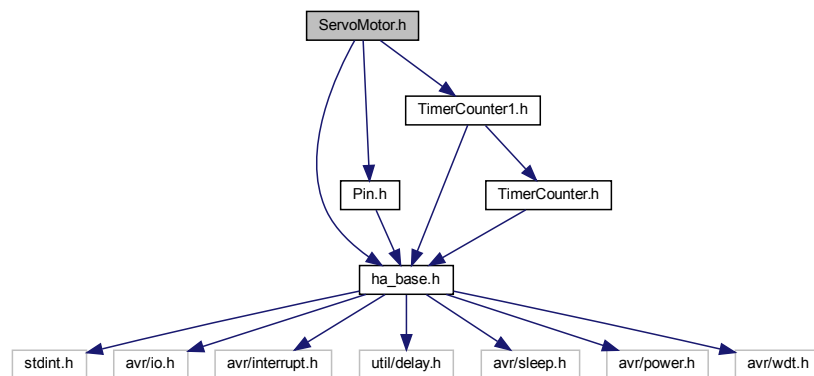
Header file of the ServoMotor class.

```

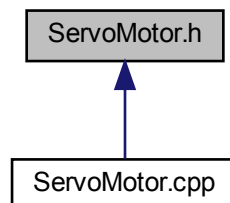
#include "ha_base.h"
#include "Pin.h"
#include "TimerCounter1.h"

```

Include dependency graph for ServoMotor.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `component::ServoMotor`

Namespaces

- [component](#)

AVR chip external components.

10.63.1 Detailed Description

Header file of the ServoMotor class.

Header file of the StepperMotor class.

Usage example (separate): #include "MCU.h" #include "ServoMotor.h" #include "TimerCounter1.h"

```
#define SERVOMOTOR_NUMBER 1 #define SERVOMOTOR_PULSE_CYCLE 30000 // pulse cycle [us] #define
SERVOMOTOR_PULSE_WIDTH_MIN 500// pulse width min [us] #define SERVOMOTOR_PULSE_WIDTH_MID
1520 // pulse width mid [us] #define SERVOMOTOR_PULSE_WIDTH_MAX 3000 // pulse width max [us]
```

```
int main(void) {
```

```
Init initialize MCU core::MCU::init();
```

```
instantiate the TimerCounter0 object core::TimerCounter1 &myTimerCounter1 = core::TimerCounter1::getInstance();
myTimerCounter1.selectClockSource(core::clockSource::PS_8); myTimerCounter1.selectOperationMode(core::
::operationMode::fast_PWM_ICR); myTimerCounter1.selectCompareOutputMode(core::channel::A, core::
::compareOutputMode::clear);
```

```
instantiate the Buzzer object component::ServoMotor myServoMotor(io::Pin(SERVOMOTOR_NUMBER,io::PortB),
SERVOMOTOR_PULSE_CYCLE, SERVOMOTOR_PULSE_WIDTH_MIN, SERVOMOTOR_PULSE_WIDTH_MID, SERVOMOTOR_PULSE_WIDTH_MAX);
```

```
myTimerCounter1.setInputCaptureRegister(myServoMotor.computePulseCycleCount(myTimerCounter1.getClockPrescaler())); myTimerCounter1.setOutputCompareRegister(core::channel::A, myServoMotor.computeRotationAngleCount(0,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); myTimerCounter1.setOutputCompareRegister(core::channel::A, myServoMotor.computeRotationAngleCount(45,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); myTimerCounter1.setOutputCompareRegister(core::channel::A, myServoMotor.computeRotationAngleCount(90,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); myTimerCounter1.setOutputCompareRegister(core::channel::A, myServoMotor.computeRotationAngleCount(135,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); myTimerCounter1.setOutputCompareRegister(core::channel::A, myServoMotor.computeRotationAngleCount(180,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); myTimerCounter1.setOutputCompareRegister(core::channel::A, myServoMotor.computeRotationAngleCount(0,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000);
```

```
Mainloop while (1) {
```

```
} return 0; } Usage example (TimerCounter1): #include "MCU.h" #include "ServoMotor.h" #include "TimerCounter1.h"
```

```
#define SERVOMOTOR_NUMBER 1 #define SERVOMOTOR_PULSE_CYCLE 30000 // pulse cycle [us] #define
SERVOMOTOR_PULSE_WIDTH_MIN 500// pulse width min [us] #define SERVOMOTOR_PULSE_WIDTH_MID
1520 // pulse width mid [us] #define SERVOMOTOR_PULSE_WIDTH_MAX 3000 // pulse width max [us]
```

```
int main(void) {
```

```
Init initialize MCU core::MCU::init();
```


instantiate the TimerCounter1 object `core::TimerCounter1` &myTimerCounter1 = `core::TimerCounter1::getInstance()`;
myTimerCounter1.selectClockSource(core::clockSource::PS_8);

instantiate the Buzzer object `component::ServoMotor` myServoMotor(`io::Pin(SERVOMOTOR_NUMBER,io::PortB)`,
SERVOMOTOR_PULSE_CYCLE, SERVOMOTOR_PULSE_WIDTH_MIN, SERVOMOTOR_PULSE_WIDTH_M↵
ID, SERVOMOTOR_PULSE_WIDTH_MAX);

myServoMotor.connect(myTimerCounter1);

myServoMotor.rotate(myTimerCounter1,0); _delay_ms(2000); myServoMotor.rotate(myTimerCounter1,45); _↵
delay_ms(2000); myServoMotor.rotate(myTimerCounter1,90); _delay_ms(2000); myServoMotor.rotate(myTimer↵
Counter1,135); _delay_ms(2000); myServoMotor.rotate(myTimerCounter1,180); _delay_ms(2000); myServo↵
Motor.rotate(myTimerCounter1,0); _delay_ms(2000);

myServoMotor.disconnect(myTimerCounter1);

Mainloop while (1) {

```
}
return 0;
```

```
}
```

class to control a servo motor

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

The StepperMotor class is implemented and tested for the 28BYJ-48 Stepper Motor Usage example (basic):

```
#include "StepperMotor.h"
```

```
#define StepperMotor_Pin_1 0 #define StepperMotor_Pin_2 1 #define StepperMotor_Pin_3 2 #define Stepper↵  
Motor_Pin_4 3
```

```
#define STEP_ANGLE_FULL_STEP 0.176 #define STEP_ANGLE_HALF_STEP 0.0879
```

```
int main(void) {
```

instantiate the StepperMotor object `component::StepperMotor` myStepperMotor(`component::mode::halfStep`,
`io::Pin(StepperMotor_Pin_1,io::PortB)`, `io::Pin(StepperMotor_Pin_2,io::PortB)`, `io::Pin(StepperMotor_Pin_3,io::PortB)`,
`io::Pin(StepperMotor_Pin_4,io::PortB)`);

```
int16_t l_angle = -180; int16_t l_step = static_cast<int16_t>(l_angle / STEP_ANGLE_HALF_STEP);
```

set speed [steps/s] full step: max speed: 500p/s half step: max speed: 1000p/s

set speed [%/s] full step: max speed: 40%/s half step: max speed: 80%/s

Mainloop while (1) {

```
while (!myStepperMotor.goalReached())
{
```

```
set motor steps myStepperMotor.step(l_step,1000); myStepperMotor.step(l_step,80,STEP_ANGLE_HALF_STEP);
```

```
}
```

```
} return 0; }
```

class to control a servo motor

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Definition in file [ServoMotor.h](#).

10.64 ServoMotor.h

```

00001
00126 #ifndef SERVOMOTOR_H
00127 #define SERVOMOTOR_H
00128 #include "ha_base.h"
00129 #include "Pin.h"
00130 #include "TimerCounter1.h"
00131
00132
00133
00134 namespace component
00135 {
00136
00137
00138 class ServoMotor
00139 {
00140 public:
00141
00142     ServoMotor(const io::Pin &ar_pin,
00143               const uint16_t &ar_pulseCycle=0,
00144               const uint16_t &ar_pulseWidthMin=0,
00145               const uint16_t &ar_pulseWidthMid=0,
00146               const uint16_t &ar_pulseWidthMax=0);
00147
00148     ~ServoMotor();
00149
00150     void on();
00151     void off();
00152     void toggle();
00153
00154     uint16_t computePulseCycleCount(const uint16_t &ar_clockPrescaler);
00155
00156     uint16_t computePulseWidthMinCount(const uint16_t &ar_clockPrescaler);
00157
00158     uint16_t computePulseWidthMidCount(const uint16_t &ar_clockPrescaler);
00159
00160     uint16_t computePulseWidthMaxCount(const uint16_t &ar_clockPrescaler);
00161
00162     uint16_t computeRotationAngleCount(const uint8_t &ar_angle_deg, const uint16_t
&ar_clockPrescaler);
00163
00164
00165     void rotate(core::TimerCounter1 &ar_timerCounter1,
00166               const uint8_t &ar_angle_deg,
00167               const core::channel &ar_channel=core::channel::A);
00168
00169     void connect(core::TimerCounter1 &ar_timerCounter1,
00170               const core::channel &ar_channel=core::channel::A);
00171
00172     void disconnect(core::TimerCounter1 &ar_timerCounter1,
00173               const core::channel &ar_channel=core::channel::A);
00174
00175
00176
00177
00178
00179
00180
00181
00182
00183 protected:
00184
00185 private:
00186
00187
00188     io::Pin m_pin;
00189     uint16_t m_pulseCycle;
00190     uint16_t m_pulseWidthMin;
00191     uint16_t m_pulseWidthMid;
00192     uint16_t m_pulseWidthMax;
00203 };
00204
00205
00206
00207

```

```

00208 }
00209
00210
00211
00212 #endif

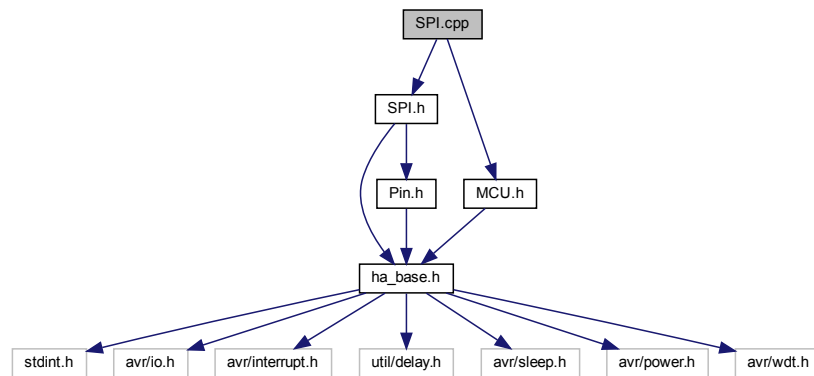
```

10.65 SPI.cpp File Reference

```
#include "SPI.h"
```

```
#include "MCU.h"
```

Include dependency graph for SPI.cpp:



10.66 SPI.cpp

```

00001 #include "SPI.h"
00002 #include "MCU.h"
00003
00004 volatile uint8_t io::SPI::m_data = 0;
00005
00006
00007
00008 io::SPI& io::SPI::getInstance(const Pin &ar_pinSCK,
00009                               const Pin &ar_pinMISO,
00010                               const Pin &ar_pinMOSI,
00011                               const Pin &ar_pinSS)
00012 {
00013     static SPI l_instance(ar_pinSCK,
00014                           ar_pinMISO,
00015                           ar_pinMOSI,
00016                           ar_pinSS);
00017
00018     return l_instance;
00019
00020 }
00021
00022 io::SPI::SPI(const Pin &ar_pinSCK,
00023              const Pin &ar_pinMISO,
00024              const Pin &ar_pinMOSI,
00025              const Pin &ar_pinSS)
00026     : m_pinSCK(ar_pinSCK),
00027       m_pinMISO(ar_pinMISO),
00028       m_pinMOSI(ar_pinMOSI),
00029       m_pinSS(ar_pinSS)
00030 {
00031     core::MCU::enableSPI(1);
00032     sei();
00033     enableTransferCompleteInterrupt(1);
00034 }
00035
00036

```

```

00037 io::SPI::~SPI()
00038 {
00039
00040 }
00041
00042 uint8_t io::SPI::writeCollision()
00043 {
00044     return (SPI_STATUS_REGISTER & (1 << SPI_WRITE_COLLISION));
00045 }
00046
00047
00048 uint8_t io::SPI::transferComplete()
00049 {
00050     return (SPI_STATUS_REGISTER & (1 << SPI_TRANSFER_COMPLETE));
00051 }
00052
00053 void io::SPI::selectClockPrescaler(const clockPrescaler& ar_clockPrescaler)
00054 {
00055     SPI_SELECT_CLOCK_PRESCALER(static_cast<uint8_t>(ar_clockPrescaler));
00056 }
00057
00058
00059 void io::SPI::selectOperationMode(const operationMode& ar_operationMode)
00060 {
00061     switch (ar_operationMode)
00062     {
00063     case operationMode::master:
00064     {
00065         m_pinMOSI.toOutput();
00066         m_pinSCK.toOutput();
00067         m_pinMISO.toInput(1);
00068         m_pinSS.toOutput();
00069         m_pinSS.setHigh();
00070         SPI_SELECT_MASTER_MODE;
00071         SPI_ENABLE;
00072         break;
00073     }
00074     case operationMode::slave:
00075     {
00076         m_pinMISO.toOutput();
00077         SPI_SELECT_SLAVE_MODE;
00078         SPI_ENABLE;
00079         break;
00080     }
00081     case operationMode::submaster:
00082     {
00083         m_pinMOSI.toOutput();
00084         m_pinSCK.toOutput();
00085         m_pinMISO.toInput(1);
00086         m_pinSS.toInput(1);
00087         SPI_SELECT_MASTER_MODE;
00088         SPI_ENABLE;
00089         break;
00090     }
00091     case operationMode::disable:
00092     {
00093         SPI_DISABLE;
00094         break;
00095     }
00096     }
00097 }
00098
00099 void io::SPI::selectDataMode(const dataMode& ar_dataMode)
00100 {
00101     SPI_SELECT_DATA_MODE(static_cast<uint8_t>(ar_dataMode));
00102 }
00103
00104 void io::SPI::selectDataOrder(const dataOrder& ar_dataOrder)
00105 {
00106     SPI_SELECT_DATA_ORDER(static_cast<uint8_t>(ar_dataOrder));
00107 }
00108
00109
00110 void io::SPI::enableTransferCompleteInterrupt(const uint8_t a_enable)
00111 {
00112     if (a_enable) {
00113         SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT;
00114     } else {
00115         SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT;
00116     }
00117 }
00118
00119 void io::SPI::selectSlave(const uint8_t a_select)
00120 {
00121     if (a_select) {
00122         m_pinSS.setLow();
00123     }

```

```

00124     } else {
00125         m_pinSS.setHigh();
00126     }
00127 }
00128 }
00129 void io::SPI::transferCompleteServiceRoutine()
00130 {
00131     m_data = SPI_DATA_REGISTER;
00132 }
00133 }
00134 }
00135 void io::SPI::masterSendByte(const uint8_t &ar_byte)
00136 {
00137     SPI_DATA_REGISTER = ar_byte;
00138     selectSlave(1);
00139     while(!transferComplete()){};
00140     selectSlave(0);
00141 }
00142 }
00143 }
00144 }
00145 }
00146 }
00147 void io::SPI::masterReceiveByte(uint8_t &ar_byte)
00148 {
00149     masterSendByte(0);
00150     ar_byte = m_data;
00151 }
00152 }
00153 }
00154 void io::SPI::slaveReceiveByte(uint8_t &ar_byte)
00155 {
00156     ar_byte = m_data;
00157 }
00158 }

```

10.67 SPI.h File Reference

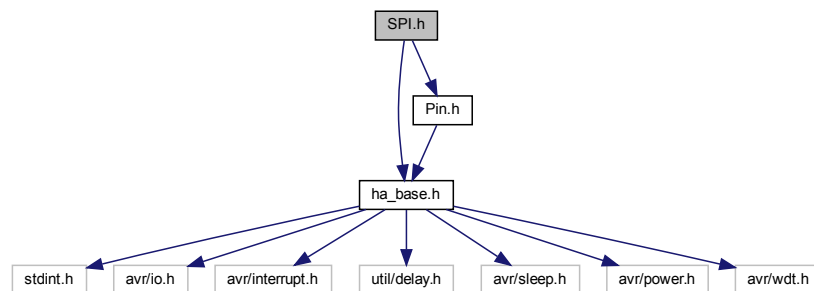
Header file of the SPI class.

```

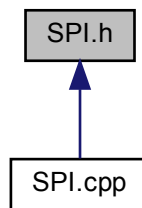
#include "ha_base.h"
#include "Pin.h"

```

Include dependency graph for SPI.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [io::SPI](#)

Namespaces

- [io](#)

AVR chip internal i/o components.

Enumerations

- enum [io::operationMode](#) : `uint8_t` { [io::operationMode::master](#) = 0, [io::operationMode::slave](#), [io::operationMode::submaster](#), [io::operationMode::disable](#) }
- enum [io::clockPrescaler](#) : `uint8_t` { [io::clockPrescaler::PS_4](#) = 0, [io::clockPrescaler::PS_16](#), [io::clockPrescaler::PS_64](#), [io::clockPrescaler::PS_128](#), [io::clockPrescaler::PS_2](#), [io::clockPrescaler::PS_8](#), [io::clockPrescaler::PS_32](#) }
- enum [io::dataMode](#) : `uint8_t` { [io::dataMode::mode_0](#) = 0, [io::dataMode::mode_1](#), [io::dataMode::mode_2](#), [io::dataMode::mode_3](#) }
- enum [io::dataOrder](#) : `uint8_t` { [io::dataOrder::first_MSB](#) = 0, [io::dataOrder::first_LSB](#) }

10.67.1 Detailed Description

Header file of the SPI class.

Usage example (test): `#include "MCU.h" #include "SPI.h"`

```
#define SPI_SCK 5 #define SPI_MISO 4 #define SPI_MOSI 3 #define SPI_SS 2
```

```
int main(void) {
```

```
    Init initialize MCU core::MCU::init\(\); instantiate a SPI object io::SPI &myISP = io::SPI::getInstance\(io::Pin\(SPI\_SCK,io::PortB\),  
io::Pin\(SPI\_MISO,io::PortB\), io::Pin\(SPI\_MOSI,io::PortB\), io::Pin\(SPI\_SS,io::PortB\)\);
```

```
    myISP.selectClockPrescaler(io::clockPrescaler::PS\_128); myISP.selectDataMode(io::dataMode::mode\_0); myISP.  
P.selectDataOrder(io::dataOrder::first\_LSB); myISP.selectOperationMode(io::operationMode::master);
```

```
    myISP.masterSendByte(0x03);
```

```
    Mainloop while (1) {
```

```
    } return 0; }
```

Basic class for IO abstraction of Pin and Port

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Definition in file [SPI.h](#).

10.68 SPI.h

```
00001
00048 #ifndef SPI_H
00049 #define SPI_H
00050 #include "ha_base.h"
00051 #include "Pin.h"
00052
00053 namespace io
00054 {
00055
00056 enum class operationMode : uint8_t {
00057     master=0,
00058     slave,
00059     submaster,
00060     disable,
00061 };
00062
00063 enum class clockPrescaler : uint8_t {
00064     PS_4 = 0,
00065     PS_16,
00066     PS_64,
00067     PS_128,
00068     PS_2,
00069     PS_8,
00070     PS_32
00071 };
00072
00073 enum class dataMode : uint8_t {
00074     mode_0 = 0,
00075     mode_1,
00076     mode_2,
00077     mode_3,
00078 };
00079
00080 enum class dataOrder : uint8_t {
00081     first_MSB = 0,
00082     first_LSB
00083 };
00084
00085
00086 class SPI
00087 {
00088 public:
00090     static SPI& getInstance(const io::Pin &ar_pinSCK,
00091                             const io::Pin &ar_pinMISO,
00092                             const io::Pin &ar_pinMOSI,
00093                             const io::Pin &ar_pinSS);
00094
00095     void selectDataMode(const dataMode& ar_dataMode);
00096
00097     void selectDataOrder(const dataOrder& ar_dataOrder);
00098
00099     void selectOperationMode(const operationMode& ar_operationMode);
00100
00101     void selectClockPrescaler(const clockPrescaler& ar_clockPrescaler);
00102
00103     void selectSlave(const uint8_t a_select);
00104
00107     uint8_t writeCollision();
00108
00111     uint8_t transferComplete();
00112
00113
00114     static void enableTransferCompleteInterrupt(const uint8_t a_enable);
00115
00116     void masterSendByte(const uint8_t &ar_byte);
```

```

00117
00118     void masterReceiveByte(uint8_t &ar_byte);
00119
00120     void slaveReceiveByte(uint8_t &ar_byte);
00121
00124     static void transferCompleteServiceRoutine() __asm__(STR(SPI_TRANSFER_COMPLETE_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00125
00126
00127
00128 private:
00137     SPI(const io::Pin &ar_pinSCK,
00138         const io::Pin &ar_pinMISO,
00139         const io::Pin &ar_pinMOSI,
00140         const io::Pin &ar_pinSS);
00141
00144     ~SPI();
00145
00148     SPI(const SPI&);
00149
00152     const SPI& operator=(const SPI&);
00153
00154     static volatile uint8_t m_data;
00155
00156     io::Pin m_pinSCK;
00157     io::Pin m_pinMISO;
00158     io::Pin m_pinMOSI;
00159     io::Pin m_pinSS;
00167 };
00168
00169 }
00170 #endif // SPI_H

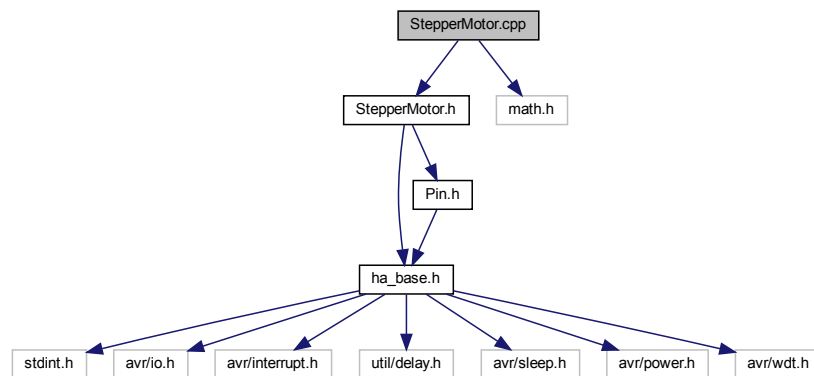
```

10.69 StepperMotor.cpp File Reference

```
#include "StepperMotor.h"
```

```
#include <math.h>
```

Include dependency graph for StepperMotor.cpp:



10.70 StepperMotor.cpp

```

00001 #include "StepperMotor.h"
00002 #include <math.h>
00003
00004 // TODO: steps to angle
00005 // TODO: maximum speed
00006 // TODO: speed and acceleration profiles
00007
00008 component::StepperMotor::StepperMotor(const mode &ar_mode,
00009                                         const io::Pin &ar_pinCoill,

```



```

00010                                     const io::Pin &ar_pinCoil2,
00011                                     const io::Pin &ar_pinCoil3,
00012                                     const io::Pin &ar_pinCoil4)
00013     : m_pinCoil1(ar_pinCoil1),
00014       m_pinCoil2(ar_pinCoil2),
00015       m_pinCoil3(ar_pinCoil3),
00016       m_pinCoil4(ar_pinCoil4),
00017       stepMode(ar_mode)
00018 {
00019     m_pinCoil1.toOutput();
00020     m_pinCoil2.toOutput();
00021     m_pinCoil3.toOutput();
00022     m_pinCoil4.toOutput();
00023     m_goalReached = 0;
00024     m_currentPos = 0;
00025
00026
00027
00028 }
00029
00030 component::StepperMotor::~StepperMotor()
00031 {
00032
00033 }
00034
00035 void component::StepperMotor::setCurrentPos(uint16_t a_currentPos)
00036 {
00037     m_currentPos = a_currentPos;
00038 }
00039
00040 uint16_t component::StepperMotor::currentPos()
00041 {
00042     return m_currentPos;
00043 }
00044
00045
00046
00047 void component::StepperMotor::step(const int16_t a_step,
00048                                     const uint16_t a_speed,
00049                                     const uint16_t a_accel,
00050                                     const uint16_t a_decel)
00051 {
00052     static int16_t l_stepNumber = 0;
00053     uint8_t l_stepDelay_ms = 0;
00054     uint16_t l_step=0;
00055
00056     if (a_step<=0)
00057     {
00058         l_step = -a_step;
00059     } else
00060     {
00061         l_step = a_step;
00062     }
00063
00064     l_stepDelay_ms = computeStepDelay(l_step,
00065                                     a_speed,
00066                                     a_accel,
00067                                     a_decel);
00068
00069     if (l_stepDelay_ms>0)
00070     {
00071
00072         if (a_step<=0)
00073         {
00074             if (l_stepNumber== -a_step)
00075             {
00076                 m_goalReached = 1;
00077
00078             } else {
00079                 l_stepNumber++;
00080                 m_currentPos++;
00081             }
00082
00083         } else {
00084
00085             if (l_stepNumber == -a_step)
00086             {
00087                 m_goalReached = 1;
00088
00089             } else {
00090                 l_stepNumber--;
00091                 m_currentPos--;
00092             }
00093
00094         }
00095     }
00096

```

```

00097
00098     if (m_goalReached == 0)
00099     {
00100
00101         switch (stepMode)
00102         {
00103             case mode::fullStep:
00104             {
00105                 // equivalent to l_stepNumber % 4
00106                 // 1 3 5 7 <->
00107                 stepPulse(2*(l_stepNumber & 3)+1);
00108                 break;
00109             }
00110
00111             case mode::halfStep:
00112             {
00113                 // equivalent to l_stepNumber % 8
00114                 // 0 1 2 3 4 5 6 7 <->
00115                 stepPulse(l_stepNumber & 7);
00116                 break;
00117             }
00118         }
00119
00120         stepDelay(l_stepDelay_ms);
00121
00122     }
00123 }
00124
00125 }
00126
00127 uint8_t component::StepperMotor::computeStepDelay(uint16_t a_step,
00128             uint16_t a_speed,
00129             uint16_t a_accel,
00130             uint16_t a_decel)
00131 {
00132
00133
00134     uint32_t l_accelTime= (1000UL*a_speed/a_accel);
00135     uint16_t l_decelTime = (1000UL*a_speed/a_decel);
00136     int16_t l_constSpeedTime=((1000UL*a_step/a_speed)-(l_accelTime/2)-(l_decelTime/2));
00137     static uint32_t l_time=0;
00138     static uint32_t l_speed=0;
00139     static uint64_t l_speed_time_product=0;
00140     static uint64_t l_current_position=0;
00141
00142
00143
00144
00145
00146
00147
00148     if (l_constSpeedTime<0)
00149     {
00150         l_constSpeedTime=0;
00151         l_accelTime = static_cast<uint32_t>(1000UL*sqrtf(a_step/a_accel));
00152         a_speed=l_accelTime*a_accel/1000UL;
00153         l_decelTime = 1000UL*a_speed/a_decel;
00154     }
00155
00156
00157
00158
00159
00160     if (l_time<=l_accelTime)
00161     {
00162         l_speed=a_accel*l_time;
00163     }
00164
00165     else if ((l_time>l_accelTime) && (l_time<=(l_accelTime+l_constSpeedTime)))
00166     {
00167         l_speed=1000UL*a_speed;
00168     }
00169
00170     else if
00171     ((l_time>(l_accelTime+l_constSpeedTime)) && (l_time<=l_accelTime+l_constSpeedTime+l_decelTime))
00172     {
00173         l_speed= (1000UL*a_speed)-a_decel*(l_time-l_accelTime-l_constSpeedTime);
00174     }
00175
00176
00177
00178     l_time=l_time+1;
00179
00180
00181     l_speed_time_product = l_speed_time_product+l_speed;
00182

```

```

00183     if (l_speed_time_product - l_current_position >= 1000000UL)
00184     {
00185         l_current_position=l_current_position+1000000UL;
00186         return 1;
00187     }
00188     else
00189     {
00190         stepDelay(1);
00191         return 0;
00192     }
00193
00194
00195
00196
00197
00198 }
00199
00200
00201 void component::StepperMotor::step(const int16_t a_step, const uint16_t a_speed)
00202 {
00203     static int16_t l_stepNumber = 0;
00204     static uint8_t l_stepDelay_ms = static_cast<uint8_t>(1000UL/a_speed);
00205
00206     if (a_step<=0)
00207     {
00208         if (l_stepNumber== -a_step)
00209         {
00210             m_goalReached = 1;
00211
00212         } else {
00213             l_stepNumber++;
00214             m_currentPos++;
00215         }
00216
00217     } else {
00218
00219         if (l_stepNumber == -a_step)
00220         {
00221             m_goalReached = 1;
00222
00223         } else {
00224             l_stepNumber--;
00225             m_currentPos--;
00226
00227         }
00228     }
00229
00230
00231
00232     if (m_goalReached == 0)
00233     {
00234
00235         switch (stepMode)
00236         {
00237             case mode::fullStep:
00238             {
00239                 // equivalent to l_stepNumber % 4
00240                 // 1 3 5 7 <->
00241                 stepPulse(2*(l_stepNumber & 3)+1);
00242                 break;
00243             }
00244
00245             case mode::halfStep:
00246             {
00247                 // equivalent to l_stepNumber % 8
00248                 // 0 1 2 3 4 5 6 7 <->
00249                 stepPulse(l_stepNumber & 7);
00250                 break;
00251             }
00252         }
00253
00254         stepDelay(l_stepDelay_ms);
00255     }
00256 }
00257
00258
00259 void component::StepperMotor::step(const int16_t a_step, const uint16_t a_speed, const float
a_stepAngle)
00260 {
00261     static int16_t l_stepNumber = 0;
00262     static uint8_t l_stepDelay_ms = static_cast<uint8_t>(1000UL*a_stepAngle/a_speed);
00263
00264     if (a_step<=0)
00265     {
00266         if (l_stepNumber== -a_step)
00267         {
00268             m_goalReached = 1;

```

```

00269
00270     } else {
00271         l_stepNumber++;
00272         m_currentPos++;
00273     }
00274
00275
00276     } else {
00277
00278         if (l_stepNumber == -a_step)
00279         {
00280             m_goalReached = 1;
00281
00282         } else {
00283             l_stepNumber--;
00284             m_currentPos--;
00285         }
00286     }
00287 }
00288
00289
00290 if (m_goalReached == 0)
00291 {
00292
00293     switch (stepMode)
00294     {
00295         case mode::fullStep:
00296         {
00297             // equivalent to l_stepNumber % 4
00298             // 1 3 5 7 <->
00299             stepPulse(2*(l_stepNumber & 3)+1);
00300             break;
00301         }
00302
00303         case mode::halfStep:
00304         {
00305             // equivalent to l_stepNumber % 8
00306             // 0 1 2 3 4 5 6 7 <->
00307             stepPulse(l_stepNumber & 7);
00308             break;
00309         }
00310     }
00311
00312     stepDelay(l_stepDelay_ms);
00313
00314 }
00315
00316
00317 }
00318
00319
00320 void component::StepperMotor::stepPulse(const uint8_t a_stepPulse)
00321 {
00322
00323     switch (a_stepPulse) {
00324         case 0: // 1000
00325         {
00326             m_pinCoil1.setHigh();
00327             m_pinCoil2.setLow();
00328             m_pinCoil3.setLow();
00329             m_pinCoil4.setLow();
00330             break;
00331         }
00332         case 1: // 1100
00333         {
00334             m_pinCoil1.setHigh();
00335             m_pinCoil2.setHigh();
00336             m_pinCoil3.setLow();
00337             m_pinCoil4.setLow();
00338             break;
00339         }
00340         case 2: // 0100
00341         {
00342             m_pinCoil1.setLow();
00343             m_pinCoil2.setHigh();
00344             m_pinCoil3.setLow();
00345             m_pinCoil4.setLow();
00346             break;
00347         }
00348         case 3: // 0110
00349         {
00350             m_pinCoil1.setLow();
00351             m_pinCoil2.setHigh();
00352             m_pinCoil3.setHigh();
00353             m_pinCoil4.setLow();
00354             break;
00355     }

```

```

00356     case 4:      //0010
00357     {
00358         m_pinCoil1.setLow();
00359         m_pinCoil2.setLow();
00360         m_pinCoil3.setHigh();
00361         m_pinCoil4.setLow();
00362         break;
00363     }
00364     case 5:      //0011
00365     {
00366         m_pinCoil1.setLow();
00367         m_pinCoil2.setLow();
00368         m_pinCoil3.setHigh();
00369         m_pinCoil4.setHigh();
00370         break;
00371     }
00372     case 6:      //0001
00373     {
00374         m_pinCoil1.setLow();
00375         m_pinCoil2.setLow();
00376         m_pinCoil3.setLow();
00377         m_pinCoil4.setHigh();
00378         break;
00379     }
00380     case 7:      //1001
00381     {
00382         m_pinCoil1.setHigh();
00383         m_pinCoil2.setLow();
00384         m_pinCoil3.setLow();
00385         m_pinCoil4.setHigh();
00386         break;
00387     }
00388 }
00389
00390
00391 }
00392
00393
00394
00395 void component::StepperMotor::stepDelay(uint8_t a_stepDelay)
00396 {
00397     while(a_stepDelay-->0)
00398     {
00399         _delay_ms(1);
00400     }
00401 }
00402
00403 uint8_t component::StepperMotor::goalReached()
00404 {
00405     return m_goalReached;
00406 }
00407 }

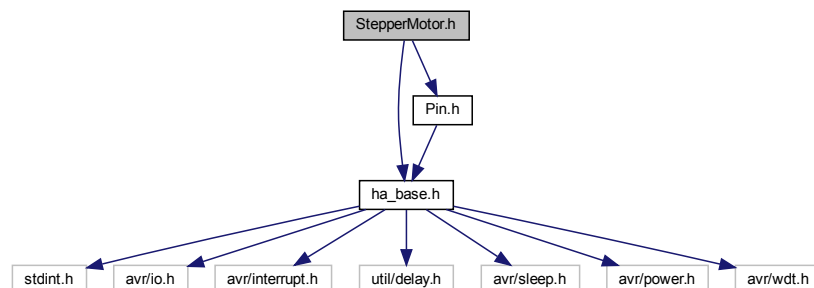
```

10.71 StepperMotor.h File Reference

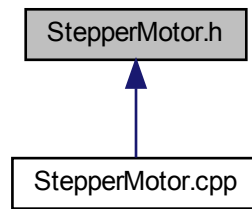
```
#include "ha_base.h"
```

```
#include "Pin.h"
```

Include dependency graph for StepperMotor.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `component::StepperMotor`

Namespaces

- `component`
AVR chip external components.

Enumerations

- enum `component::mode` : `uint8_t` { `component::mode::fullStep` =0, `component::mode::halfStep` }

10.72 StepperMotor.h

```

00001
00062 #ifndef STEPPERMOTOR_H
00063 #define STEPPERMOTOR_H
00064 #include "ha_base.h"
00065 #include "Pin.h"
00066
00067 namespace component
00068 {
00069
00070 enum class mode : uint8_t {
00071     fullStep=0,
00072     halfStep,
00073 };
00074
00075 class StepperMotor
00076 {
00077 public:
00078
00079     StepperMotor(const mode &ar_mode,
00080                 const io::Pin &ar_pinCoil1,
00081                 const io::Pin &ar_pinCoil2,
00082                 const io::Pin &ar_pinCoil3,
00083                 const io::Pin &ar_pinCoil4);
00084
00085     ~StepperMotor();
00086
00090     void step(const int16_t a_step,
00091              const uint16_t a_speed);
00092
00093     void step(const int16_t a_step,
00094              const uint16_t a_speed,
  
```

```

00095         const float a_stepAngle);
00096
00097 void step(const int16_t a_step,
00098          const uint16_t a_speed,
00099          const uint16_t a_accel,
00100          const uint16_t a_decel);
00101
00102 void stepPulse(const uint8_t a_stepPulse);
00103
00104 void stepDelay(uint8_t a_stepDelay);
00105
00106 uint8_t goalReached();
00107
00108 void setCurrentPos(uint16_t a_currentPos);
00109
00110 uint16_t currentPos();
00111
00112
00113 uint8_t computeStepDelay(uint16_t a_step,
00114                          const uint16_t a_speed,
00115                          const uint16_t a_accel,
00116                          const uint16_t a_decel);
00117
00118 uint16_t m_accelTime;
00119 uint16_t m_decelTime;
00120 uint16_t m_constSpeedTime;
00124 private:
00125
00126 //      uint8_t computeStepDelay(int16_t a_step,
00127 //                               const uint16_t a_speed,
00128 //                               const uint16_t a_accel,
00129 //                               const uint16_t a_decel);
00130
00131
00132 io::Pin m_pinCoil1;
00133 io::Pin m_pinCoil2;
00134 io::Pin m_pinCoil3;
00135 io::Pin m_pinCoil4;
00137 mode stepMode;
00138 uint8_t m_goalReached;
00139 uint16_t m_currentPos;
00144 };
00145
00146 }
00147 #endif // STEPPERMOTOR_H

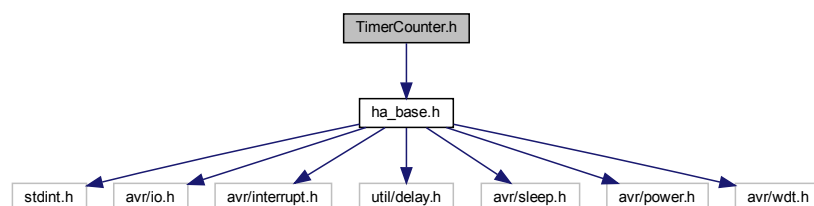
```

10.73 TimerCounter.h File Reference

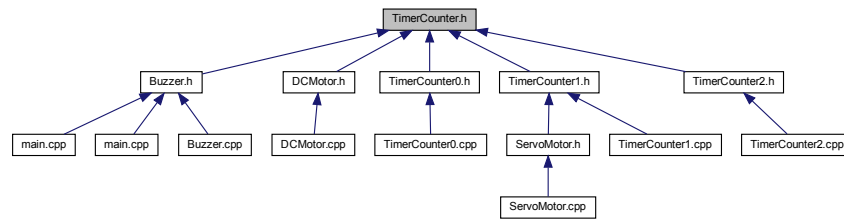
Header file of the TimerCounter class.

```
#include "ha_base.h"
```

Include dependency graph for TimerCounter.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `core::TimerCounter`

Namespaces

- `core`

Enumerations

- enum `core::channel` : `uint8_t` { `core::channel::A` =0, `core::channel::B` }
- enum `core::compareOutputMode` : `uint8_t` { `core::compareOutputMode::normal` =0, `core::compareOutputMode::toggle`, `core::compareOutputMode::clear`, `core::compareOutputMode::set` }
- enum `core::operationMode` : `uint8_t` { `core::operationMode::normal` =0, `core::operationMode::PWM_PC`, `core::operationMode::PWM_PC_8bit`, `core::operationMode::PWM_PC_9bit`, `core::operationMode::PWM_PC_10bit`, `core::operationMode::PWM_PFC_ICR`, `core::operationMode::PWM_PFC_OCR`, `core::operationMode::PWM_PC_ICR`, `core::operationMode::PWM_PC_OCR`, `core::operationMode::fast_PWM`, `core::operationMode::fast_PWM_8bit`, `core::operationMode::fast_PWM_9bit`, `core::operationMode::fast_PWM_10bit`, `core::operationMode::fast_PWM_ICR`, `core::operationMode::fast_PWM_OCR`, `core::operationMode::CTC_OCR`, `core::operationMode::CTC_ICR`, `core::operationMode::interrupt` =1, `core::operationMode::reset`, `core::operationMode::interrupt` }
- enum `core::clockSource` : `uint16_t` { `core::clockSource::noClock` =0, `core::clockSource::PS_1`, `core::clockSource::PS_8`, `core::clockSource::PS_32`, `core::clockSource::PS_64`, `core::clockSource::PS_128`, `core::clockSource::PS_256`, `core::clockSource::PS_1024`, `core::clockSource::extern_Clock_T0_Falling_Edge`, `core::clockSource::extern_Clock_T0_Rising_Edge` }

10.73.1 Detailed Description

Header file of the TimerCounter class.

Basic class for abstraction of the TimerCounter peripherals.

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Basic class for abstraction of the TimerCounter peripherals.

Usage example (Reaction Timer): #include "TimerCounter.h" #include "USART0.h" #include "PushButton.h" #include "Led.h"

```
void randomDelay(void); void printWord(uint16_t word);
```

```
instantiate the Counter object extern core::TimerCounter core::TimerCounter &myCounter = core::TimerCounter<--
::getInstanceTimerCounter0();
```

```
instantiate the USART0 object extern io::USART0 io::USART0 &myUSART0 = io::USART0::getInstance();
```

```
#define BUFFER_SIZE 1 #define LED_NUMBER 0 #define PUSHBUTTON_NUMBER 2
```

```
int main(void) {
```

```
    Init uint16_t timerValue;
```

```
    char l_receiverBuffer[BUFFER_SIZE];
```

```
    myCounter.selectClockSource(core::timerCounter::timerCounter1, core::clockSource::PS_1024);
```

```
    / instantiate a Led object component::Led Led(io::Pin(LED_NUMBER,io::PortB));
```

```
    instantiate a Led object component::PushButton PushButton(io::Pin(PUSHBUTTON_NUMBER,io::PortD));
```

```
    ready to send flag uint8_t l_ready2Send = 1;
```

```
    if (myUSART0.ready2Send()) { myUSART0.sendString("Reaction Timer:\r\n"); }
```

```
    wait to send next string while (!myUSART0.ready2Send());}
```

```
    if (myUSART0.ready2Send()) { myUSART0.sendString("-----\r\n"); }
```

```
    wait to send next string while (!myUSART0.ready2Send());}
```

```
    if (myUSART0.ready2Send()) { myUSART0.sendString("Press any key to start.\r\n"); }
```

```
    Mainloop while (1) {
```

```
        myUSART0.receiveFrame(reinterpret_cast<uint8_t*>(l_receiverBuffer),BUFFER_SIZE);
```

```
        wait for a key press while (!myUSART0.getNumberBytesReceived()) {
```

```
    }
```

```
    reset number of bytes after extracting the received data myUSART0.resetNumberBytesReceived();
```

```
    wait to send next string while (!myUSART0.ready2Send());}
```

```
    if (myUSART0.ready2Send()) { myUSART0.sendString("\r\nGet ready..."); }
```

```
    randomDelay();
```

```

wait to send next string while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send()) { myUSART0.sendString("\nGo!\n"); }

Led.on();

myCounter.setCounter(core::timerCounter::timerCounter1,0);

if (PushButton.isPressed()) { wait to send next string while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send()) { myUSART0.sendString("You're only cheating yourself.\n"); }

} else {

wait for a button press while (!PushButton.isPressed()) {

} get counter value myCounter.getCounter(core::timerCounter::timerCounter1, &timerValue); bit shift divide by 16 =
2^4 to convert from micro to milliseconds timerValue = timerValue >> 4; print response time printWord(timerValue);
}

Led.off();

while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send()) { myUSART0.sendString("\nPress any key to try again.\n"); }

} return 0; }

void randomDelay(void) {

Waits for a "random" delay from 1 - 3.5 sec Requires timer 1 initialized and running It's not really random, but very
hard to control –like coin-flipping.

uint16_t counter;
_delay_ms(1000);

myCounter.getCounter(core::timerCounter::timerCounter1, &counter);
uint8_t randomTime = static_cast<uint8_t>(counter);

```

type-casting the 16-bit TCNT1 as an 8-bit number keeps only the 8 least-significant (fastest-changing) bits

```

while (--randomTime) {
    _delay_ms(10);
}

void printWord(uint16_t word) {

while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send())
{
    myUSART0.sendByte('0' + (word / 10000));
}

while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send())
{
    myUSART0.sendByte('0' + ((word / 1000) % 10));
}

```

```
while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send())
{
    myUSART0.sendByte('0' + ((word / 100) % 10));
}

while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send())
{
    myUSART0.sendByte('0' + ((word / 10) % 10));
}

while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send())
{
    myUSART0.sendByte('0' + (word % 10));
}

}
void printWord(uint16_t word) {
    char timerValue = '0' + (word / 10000);
    while (!myUSART0.ready2Send()){};
    if (myUSART0.ready2Send())
    {
        myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
    }
    timerValue = '0' + ((word / 1000) % 10);
    while (!myUSART0.ready2Send()){};

    if (myUSART0.ready2Send())
    {
        myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
    }
    timerValue = '0' + ((word / 100) % 10);
    while (!myUSART0.ready2Send()){};

    if (myUSART0.ready2Send())
    {
        myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
    }
    timerValue = '0' + ((word / 10) % 10);
    while (!myUSART0.ready2Send()){};

    if (myUSART0.ready2Send())
    {
        myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
    }
    timerValue = '0' + (word % 10);
    while (!myUSART0.ready2Send()){};
```

```

if (myUSART0.ready2Send())
{
    myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
}
}

```

Usage example (PWM):

```
#include "Led.h" #include "USART0.h" #include "TimerCounter1.h" #include "TimerCounter2.h"
```

```
uint8_t getNumber(const char *ap_receive);
```

```
#define LED_1 1 #define LED_2 2 #define LED_3 3 #define BUFFER_SIZE 4
```

```
int main(void) {
```

```
    Init receiver buffer char l_receiverBuffer[BUFFER_SIZE];
```

```
    instantiate Led objects component::Led Led1(io::Pin(LED_1,io::PortB)); component::Led Led2(io::Pin(LED_2,io::PortB)); component::Led Led3(io::Pin(LED_3,io::PortB));
```

```
    instantiate USART0 object io::USART0 &myUSART0 = io::USART0::getInstance();
```

```
    instantiate Timer1 object core::TimerCounter1 &myTimerCounter1 = core::TimerCounter1::getInstance(); myTimerCounter1.selectOperationMode(core::operationMode::Fast_PWM_8bit); myTimerCounter1.selectCompareOutputMode(core::channel::A,core::compareOutputMode::Clear); myTimerCounter1.selectCompareOutputMode(core::channel::B,core::compareOutputMode::Clear); instantiate Timer2 object core::TimerCounter2 &myTimerCounter2 = core::TimerCounter2::getInstance(); myTimerCounter2.selectOperationMode(core::operationMode::Fast_PWM); myTimerCounter2.selectCompareOutputMode(core::channel::A,core::compareOutputMode::Clear);
```

```
    if (myUSART0.ready2Send()) { myUSART0.sendString("-- LED PWM Demo --\r\n"); } wait to send next string while (!myUSART0.ready2Send()){}

```

```
    myTimerCounter1.start(core::clockSource::PS_64); myTimerCounter2.start(core::clockSource::PS_64);
```

```
    ----- Event loop ----- // while (1) {
```

```
        if (myUSART0.ready2Send())
        {
            myUSART0.sendString("\r\nEnter (0-255) for PWM duty cycle: ");
        }

```

```
        myUSART0.receiveFrame(reinterpret_cast<uint8_t*>(l_receiverBuffer), BUFFER_SIZE);
```

```
        wait for a key press while (myUSART0.getNumberBytesReceived()<4){}

```

```
        reset number of bytes after extracting the received data myUSART0.resetNumberBytesReceived();

```

```
        send back the received character if (myUSART0.ready2Send()) { myUSART0.sendFrame(reinterpret_cast<uint8_t*>(l_receiverBuffer), BUFFER_SIZE); }

```

```
        while (!myUSART0.ready2Send()){} myTimerCounter2.setOutputCompareRegister(core::channel::A,myTimerCounter1.getOutputCompareRegister(core::channel::B)); myTimerCounter1.setOutputCompareRegister(core::channel::B,myTimerCounter1.getOutputCompareRegister(core::channel::A)); myTimerCounter1.setOutputCompareRegister(core::channel::A,getNumber(l_receiverBuffer));
    }
}

```

```

}
return 0;

```

```

}

```

```

uint8_t getNumber(const char *ap_receive) { Gets a numerical 0-255 from the serial port. Converts from string to
number. char hundreds = '0'; char tens = '0'; char ones = '0'; char thisChar = '0'; do { hundreds = tens; tens = ones;
ones = thisChar; thisChar = *ap_receive; ap_receive++;

```

```

} while (*ap_receive != '\r'); return (100 * (hundreds - '0') + 10 * (tens - '0') + ones - '0'); }

```

Usage example (PWM on Any Pin):

```

#include "TimerCounter0.h" #include "Led.h"

```

```

#define LED_0 0 #define LED_1 1 #define LED_2 2 #define LED_3 3

```

```

instantiate Timer0 object extern core::TimerCounter0 core::TimerCounter0 &myTimerCounter0 = core::TimerCounter0::getInstance();

```

```

instantiate Led objects extern component::Led Led0; component::Led Led0(io::Pin(LED_0,io::PortB)); ex-
tern component::Led Led1; component::Led Led1(io::Pin(LED_1,io::PortB)); extern component::Led Led2;
component::Led Led2(io::Pin(LED_2,io::PortB)); extern component::Led Led3; component::Led Led3(io::Pin(LED_3,io::PortB));

```

```

#define DELAYTIME 3

```

```

volatile uint8_t l_brightnessA; volatile uint8_t l_brightnessB;

```

```

int main(void) {

```

```

    Init uint8_t i;

```

```

    sei();

```

```

    myTimerCounter0.enableOutputCompareMatchInterrupt(core::channel::A,1); myTimerCounter0.enableOutputCompareMatchInterrupt(core::channel::B,1); myTimerCounter0.enableOverflowInterrupt(1); myTimerCounter0.start(core::clockSource::PS_1024);

```

```

    ----- Event loop ----- // while (1) {

```

```

        for (i = 0; i < 255; i++) {
            _delay_ms(DELAYTIME);
            l_brightnessA = i;
            l_brightnessB = 255 - i;
        }
        for (i = 254; i > 0; i--) {
            _delay_ms(DELAYTIME);
            l_brightnessA = i;
            l_brightnessB = 255 - i;
        }

```

```

    } return 0; }

```

```

void core::TimerCounter0::overflowServiceRoutine()
{
    Led0.on();
    Led1.on();
    Led2.on();
    Led3.on();
    myTimerCounter0.setOutputCompareRegister(core::channel::A, l_brightnessA);
    myTimerCounter0.setOutputCompareRegister(core::channel::B, l_brightnessB);
}

void core::TimerCounter0::outputCompareMatchAServiceRoutine()
{
    Led0.off();
    Led1.off();
    Led2.on();
    Led3.on();
}
void core::TimerCounter0::outputCompareMatchBServiceRoutine()
{
    Led0.on();
    Led1.on();
    Led2.off();
    Led3.off();
}

```

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Basic class for abstraction of the TimerCounter peripherals.

Usage example (Reaction Timer): #include "TimerCounter.h" #include "USART0.h" #include "PushButton.h" #include "Led.h"

```
void randomDelay(void); void printWord(uint16_t word);
```

instantiate the Counter object extern `core::TimerCounter core::TimerCounter` &myCounter = core::TimerCounter↵
::getInstanceTimerCounter0();

instantiate the USART0 object extern `io::USART0 io::USART0` &myUSART0 = io::USART0::getInstance();

```
#define BUFFER_SIZE 1 #define LED_NUMBER 0 #define PUSHBUTTON_NUMBER 2
```

```
int main(void) {
```

```
    Init uint16_t timerValue;
```

```
    char l_receiverBuffer[BUFFER_SIZE];
```

```
    myCounter.selectClockSource(core::timerCounter::timerCounter1, core::clockSource::PS_1024);
```

```

/ instantiate a Led object component::Led Led(io::Pin(LED_NUMBER,io::PortB));

instantiate a Led object component::PushButton PushButton(io::Pin(PUSHBUTTON_NUMBER,io::PortD));

ready to send flag uint8_t I_ready2Send = 1;

if (myUSART0.ready2Send()) { myUSART0.sendString("Reaction Timer:\r\n"); }

wait to send next string while (!myUSART0.ready2Send());

if (myUSART0.ready2Send()) { myUSART0.sendString("-----\r\n"); }

wait to send next string while (!myUSART0.ready2Send());

if (myUSART0.ready2Send()) { myUSART0.sendString("Press any key to start.\r\n"); }

Mainloop while (1) {

myUSART0.receiveFrame(reinterpret_cast<uint8_t*>(&I_receiverBuffer),BUFFER_SIZE);

wait for a key press while (!myUSART0.getNumberBytesReceived()) {

}

reset number of bytes after extracting the received data myUSART0.resetNumberBytesReceived();

wait to send next string while (!myUSART0.ready2Send());

if (myUSART0.ready2Send()) { myUSART0.sendString("\r\nGet ready..."); }

randomDelay();

wait to send next string while (!myUSART0.ready2Send());

if (myUSART0.ready2Send()) { myUSART0.sendString("\r\nGo!\r\n"); }

Led.on();

myCounter.setCounter(core::timerCounter::timerCounter1,0);

if (PushButton.isPressed()) { wait to send next string while (!myUSART0.ready2Send()); }

if (myUSART0.ready2Send()) { myUSART0.sendString("You're only cheating yourself.\r\n"); }

} else {

wait for a button press while (!PushButton.isPressed()) {

} get counter value myCounter.getCounter(core::timerCounter::timerCounter1, &timerValue); bit shift divide by 16 =
2^4 to convert from micro to milliseconds timerValue = timerValue >> 4; print response time printWord(timerValue);
}

Led.off();

while (!myUSART0.ready2Send());

if (myUSART0.ready2Send()) { myUSART0.sendString("\r\nPress any key to try again.\r\n"); }

} return 0; }

void randomDelay(void) {

Waits for a "random" delay from 1 - 3.5 sec Requires timer 1 initialized and running It's not really random, but very
hard to control –like coin-flipping.

```

```
uint16_t counter;
_delay_ms(1000);

myCounter.getCounter(core::timerCounter::timerCounter1, &counter);
uint8_t randomTime = static_cast<uint8_t>(counter);
```

type-casting the 16-bit TCNT1 as an 8-bit number keeps only the 8 least-significant (fastest-changing) bits

```
while (--randomTime) {
    _delay_ms(10);
}

void printWord(uint16_t word) {

    while (!myUSART0.ready2Send()){};

    if (myUSART0.ready2Send())
    {
        myUSART0.sendByte('0' + (word / 10000));
    }

    while (!myUSART0.ready2Send()){};

    if (myUSART0.ready2Send())
    {
        myUSART0.sendByte('0' + ((word / 1000) % 10));
    }

    while (!myUSART0.ready2Send()){};

    if (myUSART0.ready2Send())
    {
        myUSART0.sendByte('0' + ((word / 100) % 10));
    }

    while (!myUSART0.ready2Send()){};

    if (myUSART0.ready2Send())
    {
        myUSART0.sendByte('0' + ((word / 10) % 10));
    }

    while (!myUSART0.ready2Send()){};

    if (myUSART0.ready2Send())
    {
        myUSART0.sendByte('0' + (word % 10));
    }

}

void printWord(uint16_t word) {

    char timerValue = '0' + (word / 10000);

    while (!myUSART0.ready2Send()){};

    if (myUSART0.ready2Send())
    {
        myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
    }

    timerValue = '0' + ((word / 1000) % 10);

    while (!myUSART0.ready2Send()){};
```



```

if (myUSART0.ready2Send())
{
    myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
}

timerValue = '0' + ((word / 100) % 10);

while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send())
{
    myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
}

timerValue = '0' + ((word / 10) % 10);

while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send())
{
    myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
}

timerValue = '0' + (word % 10);

while (!myUSART0.ready2Send()){};

if (myUSART0.ready2Send())
{
    myUSART0.sendFrame(reinterpret_cast<uint8_t*>(&timerValue), BUFFER_SIZE);
}

}

```

Usage example (Reaction Timer):

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Definition in file [TimerCounter.h](#).

10.74 TimerCounter.h

```

00001
00039
00461 #ifndef TIMER_COUNTER_H
00462 #define TIMER_COUNTER_H
00463 #include "ha_base.h"
00464
00465
00466 namespace core
00467 {
00468
00469
00470 enum class channel : uint8_t {
00471     A=0,

```

```

00472     B,
00473 };
00474
00475
00476 enum class compareOutputMode : uint8_t {
00477     normal=0,
00478     toggle,
00479     clear,
00480     set,
00481 };
00482
00483
00484
00485 enum class operationMode : uint8_t {
00486     normal=0,
00487     PWM_PC,
00488     PWM_PC_8bit,
00489     PWM_PC_9bit,
00490     PWM_PC_10bit,
00491     PWM_PFC_ICR,
00492     PWM_PFC_OCR,
00493     PWM_PC_ICR,
00494     PWM_PC_OCR,
00495     fast_PWM,
00496     fast_PWM_8bit,
00497     fast_PWM_9bit,
00498     fast_PWM_10bit,
00499     fast_PWM_ICR,
00500     fast_PWM_OCR,
00501     CTC_OCR,
00502     CTC_ICR,
00503 };
00504 enum class clockSource : uint16_t {
00505     noClock=0,
00506     PS_1,
00507     PS_8,
00508     PS_32,
00509     PS_64,
00510     PS_128,
00511     PS_256,
00512     PS_1024,
00513     extern_Clock_T0_Falling_Edge,
00514     extern_Clock_T0_Rising_Edge,
00515 };
00516
00517 class TimerCounter
00518 {
00519
00520 public:
00521
00522
00523     virtual void selectOperationMode(const operationMode &ar_operationMode) = 0;
00524
00525     virtual void start() = 0;
00526
00527     virtual void stop() = 0;
00528
00529     virtual void selectClockSource(const clockSource &ar_clockSource) = 0;
00530
00531     virtual void selectCompareOutputMode(const channel &ar_channel, const compareOutputMode
&ar_compareOutputMode) = 0;
00532
00533     virtual void setCounter(const uint16_t &ar_dataBuffer) = 0;
00534
00535     virtual uint16_t getCounter() const = 0;
00536
00537     virtual void setOutputCompareRegister(const channel &ar_channel, const uint16_t &ar_dataBuffer) =
0;
00538
00539     virtual uint16_t getOutputCompareRegister(const channel &ar_channel) const = 0;
00540
00541     virtual void enableOutputCompareMatchInterrupt(const channel &ar_channel, const uint8_t a_enable)
= 0;
00542
00543     virtual void enableOverflowInterrupt(const uint8_t a_enable) = 0;
00544
00545     virtual uint16_t getClockPrescaler() = 0;
00546
00547 protected:
00548
00549 private:
00550
00551
00552
00553
00554 };
00555

```

```

00556 }
00557
00558
00559 #endif

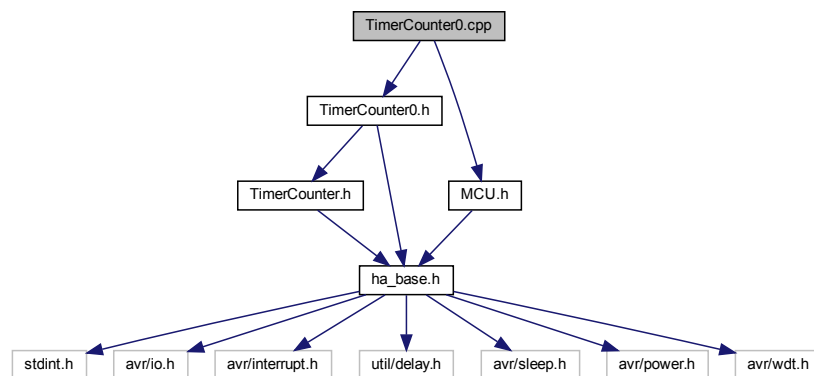
```

10.75 TimerCounter0.cpp File Reference

```
#include "TimerCounter0.h"
```

```
#include "MCU.h"
```

Include dependency graph for TimerCounter0.cpp:



10.76 TimerCounter0.cpp

```

00001 #include "TimerCounter0.h"
00002 #include "MCU.h"
00003
00004
00005 core::TimerCounter0& core::TimerCounter0::getInstance(const channel &ar_channel,
00006                                                         const operationMode &ar_operationMode,
00007                                                         const clockSource &ar_clockSource,
00008                                                         const compareOutputMode &ar_compareOutputMode)
00009 {
00010     static TimerCounter0 l_instance(ar_channel,
00011                                     ar_operationMode,
00012                                     ar_clockSource,
00013                                     ar_compareOutputMode);
00014
00015     return l_instance;
00016 }
00017
00018 }
00019
00020 core::TimerCounter0::TimerCounter0(const channel &ar_channel,
00021                                     const operationMode &ar_operationMode,
00022                                     const clockSource &ar_clockSource,
00023                                     const compareOutputMode& ar_compareOutputMode)
00024 {
00025     core::MCU::enableTimerCounter0(1);
00026     stop();
00027     selectOperationMode(ar_operationMode);
00028     selectClockSource(ar_clockSource);
00029     selectCompareOutputMode(ar_channel, ar_compareOutputMode);
00030
00031
00032
00033 }
00034 core::TimerCounter0::~TimerCounter0()
00035 {
00036
00037 }

```

```
00038
00039 void core::TimerCounter0::selectClockSource(const clockSource &ar_clockSource)
00040 {
00041     switch (ar_clockSource)
00042     {
00043         case core::clockSource::noClock:
00044         {
00045             m_clockPrescaler=0;
00046             m_clockSource=0;
00047             break;
00048         }
00049         case core::clockSource::PS_1:
00050         {
00051             m_clockPrescaler=1;
00052             m_clockSource=1;
00053             break;
00054         }
00055         case core::clockSource::PS_8:
00056         {
00057             m_clockPrescaler=8;
00058             m_clockSource=2;
00059             break;
00060         }
00061         case core::clockSource::PS_64:
00062         {
00063             m_clockPrescaler=64;
00064             m_clockSource=3;
00065             break;
00066         }
00067         case core::clockSource::PS_256:
00068         {
00069             m_clockPrescaler=256;
00070             m_clockSource=4;
00071             break;
00072         }
00073         case core::clockSource::PS_1024:
00074         {
00075             m_clockPrescaler=1024;
00076             m_clockSource=5;
00077             break;
00078         }
00079         case core::clockSource::extern_Clock_T0_Falling_Edge:
00080         {
00081             m_clockPrescaler=0;
00082             m_clockSource=6;
00083             break;
00084         }
00085         case core::clockSource::extern_Clock_T0_Rising_Edge:
00086         {
00087             m_clockPrescaler=0;
00088             m_clockSource=7;
00089             break;
00090         }
00091     }
00092 }
00093
00094 }
00095
00096 void core::TimerCounter0::selectOperationMode(const operationMode &ar_operationMode)
00097 {
00098     switch (ar_operationMode)
00099     {
00100         case core::operationMode::normal:
00101         {
00102             TIMER0_SELECT_OPERATION_MODE(0);
00103             break;
00104         }
00105         case core::operationMode::PWM_PC:
00106         {
00107             TIMER0_SELECT_OPERATION_MODE(1);
00108             break;
00109         }
00110         case core::operationMode::CTC_OCR:
00111         {
00112             TIMER0_SELECT_OPERATION_MODE(2);
00113             break;
00114         }
00115         case core::operationMode::fast_PWM:
00116         {
00117             TIMER0_SELECT_OPERATION_MODE(3);
00118             break;
00119         }
00120         case core::operationMode::PWM_PC_OCR:
00121         {
00122             TIMER0_SELECT_OPERATION_MODE(5);
00123             break;
00124         }
00125     }
00126 }
```

```

00125         case core::operationMode::fast_PWM_OCR:
00126         {
00127             TIMER0_SELECT_OPERATION_MODE(7);
00128             break;
00129         }
00130
00131     }
00132
00133 }
00134
00135
00136 void core::TimerCounter0::start()
00137 {
00138     TIMER0_SELECT_CLOCK_SOURCE(m_clockSource);
00139 }
00140
00141 uint16_t core::TimerCounter0::getClockPrescaler()
00142 {
00143     return m_clockPrescaler;
00144 }
00145
00146 void core::TimerCounter0::stop()
00147 {
00148     TIMER0_STOP;
00149 }
00150
00151
00152 void core::TimerCounter0::selectCompareOutputMode(const channel &ar_channel, const compareOutputMode
&ar_compareOutputMode)
00153 {
00154     switch (ar_channel)
00155     {
00156         case core::channel::A:
00157         {
00158             TIMER0_SELECT_COM_CHANNEL_A(static_cast<uint8_t>(ar_compareOutputMode));
00159             break;
00160         }
00161         case core::channel::B:
00162         {
00163             TIMER0_SELECT_COM_CHANNEL_B(static_cast<uint8_t>(ar_compareOutputMode));
00164             break;
00165         }
00166     }
00167 }
00168
00169
00170
00171 void core::TimerCounter0::setCounter(const uint16_t &ar_dataBuffer)
00172 {
00173     TCNT0 = static_cast<uint8_t>(ar_dataBuffer);
00174 }
00175
00176 uint16_t core::TimerCounter0::getCounter() const
00177 {
00178     return TCNT0;
00179 }
00180
00181 void core::TimerCounter0::setOutputCompareRegister(const channel &ar_channel, const uint16_t
&ar_dataBuffer)
00182 {
00183     switch (ar_channel)
00184     {
00185         case core::channel::A:
00186         {
00187             OCR0A = static_cast<uint8_t>(ar_dataBuffer);
00188             break;
00189         }
00190         case core::channel::B:
00191         {
00192             OCR0B = static_cast<uint8_t>(ar_dataBuffer);
00193             break;
00194         }
00195     }
00196 }
00197
00198
00199
00200
00201 uint16_t core::TimerCounter0::getOutputCompareRegister(const channel &ar_channel) const
00202 {
00203     switch (ar_channel)
00204     {
00205         case core::channel::A:
00206         {
00207             return OCR0A;
00208         }
00209         case core::channel::B:

```

```

00210     {
00211         return OCR0B;
00212     }
00213 }
00214 }
00215
00216 void core::TimerCounter0::enableOutputCompareMatchInterrupt(const channel &ar_channel, const uint8_t
a_enable)
00217 {
00218     switch (ar_channel)
00219     {
00220         case core::channel::A:
00221         {
00222             if (a_enable) {
00223
00224                 TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT;
00225
00226             } else {
00227
00228                 TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT;
00229             }
00230             break;
00231         }
00232         case core::channel::B:
00233         {
00234             if (a_enable) {
00235
00236                 TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT;
00237
00238             } else {
00239
00240                 TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT;
00241             }
00242             break;
00243         }
00244     }
00245 }
00246
00247 }
00248
00249
00250
00251 void core::TimerCounter0::enableOverflowInterrupt(const uint8_t a_enable)
00252 {
00253
00254     if (a_enable) {
00255
00256         TIMER0_ENABLE_OVERFLOW_INTERRUPT;
00257
00258     } else {
00259
00260         TIMER0_DISABLE_OVERFLOW_INTERRUPT;
00261     }
00262 }
00263 }

```

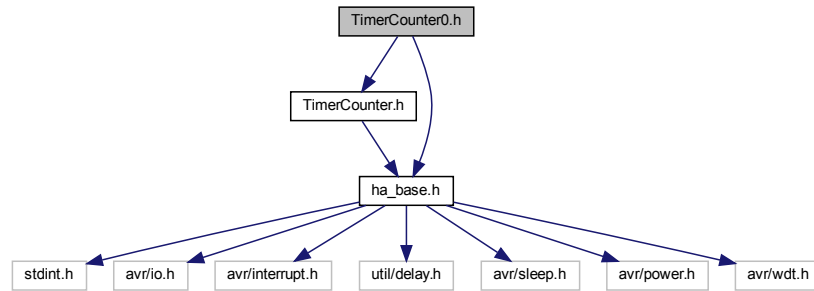
10.77 TimerCounter0.h File Reference

```

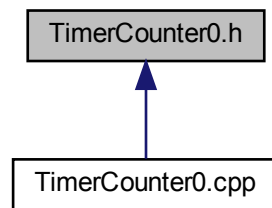
#include "TimerCounter.h"
#include "ha_base.h"

```

Include dependency graph for TimerCounter0.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [core::TimerCounter0](#)

Namespaces

- [core](#)

10.78 TimerCounter0.h

```

00001
00039
00268 #ifndef TIMER_COUNTER0_H
00269 #define TIMER_COUNTER0_H
00270 #include "TimerCounter.h"
00271 #include "ha_base.h"
00272
00273
00274
00275 namespace core
00276 {
00277
00278
00279 class TimerCounter0 : public TimerCounter

```

```

00280 {
00281
00282 public:
00283
00284     static TimerCounter0& getInstance(const channel &ar_channel = channel::A,
00285                                     const operationMode &ar_operationMode = operationMode::normal,
00286                                     const clockSource &ar_clockSource= clockSource::noClock,
00287                                     const compareOutputMode& ar_compareOutputMode =
compareOutputMode::normal);
00288
00289     void selectOperationMode(const operationMode &ar_operationMode) override;
00290
00291     void start() override;
00292
00293     void stop() override;
00294
00295     void selectClockSource(const clockSource &ar_clockSource) override;
00296
00297     void selectCompareOutputMode(const channel &ar_channel, const compareOutputMode
&ar_compareOutputMode) override;
00298
00299     void setCounter(const uint16_t &ar_dataBuffer) override;
00300
00301     uint16_t getCounter() const override;
00302
00303     void setOutputCompareRegister(const channel &ar_channel, const uint16_t &ar_dataBuffer) override;
00304
00305     uint16_t getOutputCompareRegister(const channel &ar_channel) const override;
00306
00307     void enableOutputCompareMatchInterrupt(const channel &ar_channel, const uint8_t a_enable)
override;
00308
00309     void enableOverflowInterrupt(const uint8_t a_enable) override;
00310
00311     uint16_t getClockPrescaler() override;
00312
00313     static void outputCompareMatchAServiceRoutine() __asm__(STR(TIMERO_COM_CHANNEL_A_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00314
00315     static void outputCompareMatchBServiceRoutine() __asm__(STR(TIMERO_COM_CHANNEL_B_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00316
00317     static void overflowServiceRoutine() __asm__(STR(TIMERO_OVERFLOW_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00318
00319
00320
00321 protected:
00322
00323 private:
00324
00325     TimerCounter0(const channel &ar_channel,
00326                  const operationMode &ar_operationMode,
00327                  const clockSource &ar_clockSource,
00328                  const compareOutputMode& ar_compareOutputMode);
00329
00330     ~TimerCounter0();
00331
00332     TimerCounter0(const TimerCounter0&);
00333
00334     const TimerCounter0& operator=(const TimerCounter0&);
00335
00336     uint16_t m_clockPrescaler;
00337
00338     uint8_t m_clockSource;
00339
00340 };
00341
00342
00343
00344
00345
00346 };
00347
00348 }
00349
00350
00351 #endif

```

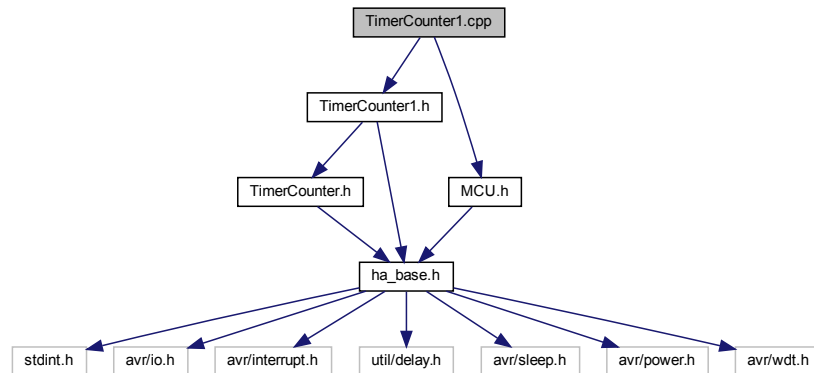
10.79 TimerCounter1.cpp File Reference

```

#include "TimerCounter1.h"
#include "MCU.h"

```


Include dependency graph for TimerCounter1.cpp:



10.80 TimerCounter1.cpp

```

00001 #include "TimerCounter1.h"
00002 #include "MCU.h"
00003
00004
00005 core::TimerCounter1& core::TimerCounter1::getInstance(const channel &ar_channel,
00006                                                         const operationMode &ar_operationMode,
00007                                                         const clockSource &ar_clockSource,
00008                                                         const compareOutputMode& ar_compareOutputMode)
00009 {
00010     static TimerCounter1 l_instance(ar_channel,
00011                                     ar_operationMode,
00012                                     ar_clockSource,
00013                                     ar_compareOutputMode);
00014
00015     return l_instance;
00016 }
00017
00018 }
00019
00020 core::TimerCounter1::TimerCounter1(const channel &ar_channel,
00021                                     const operationMode &ar_operationMode,
00022                                     const clockSource &ar_clockSource,
00023                                     const compareOutputMode& ar_compareOutputMode)
00024 {
00025     core::MCU::enableTimerCounter1(1);
00026     stop();
00027     selectOperationMode(ar_operationMode);
00028     selectClockSource(ar_clockSource);
00029     selectCompareOutputMode(ar_channel, ar_compareOutputMode);
00030 }
00031
00032 }
00033 core::TimerCounter1::~TimerCounter1()
00034 {
00035 }
00036 }
00037
00038 void core::TimerCounter1::selectClockSource(const clockSource &ar_clockSource)
00039 {
00040     switch (ar_clockSource)
00041     {
00042     case core::clockSource::noClock:
00043     {
00044         m_clockPrescaler=0;
00045         m_clockSource=0;
00046         break;
00047     }
00048     case core::clockSource::PS_1:
00049     {
00050         m_clockPrescaler=1;
00051         m_clockSource=1;
00052         break;
00053     }
  
```

```

00054         case core::clockSource::PS_8:
00055         {
00056             m_clockPrescaler=8;
00057             m_clockSource=2;
00058             break;
00059         }
00060         case core::clockSource::PS_64:
00061         {
00062             m_clockPrescaler=64;
00063             m_clockSource=3;
00064             break;
00065         }
00066         case core::clockSource::PS_256:
00067         {
00068             m_clockPrescaler=256;
00069             m_clockSource=4;
00070             break;
00071         }
00072         case core::clockSource::PS_1024:
00073         {
00074             m_clockPrescaler=1024;
00075             m_clockSource=5;
00076             break;
00077         }
00078         case core::clockSource::extern_Clock_T0_Falling_Edge:
00079         {
00080             m_clockPrescaler=0;
00081             m_clockSource=6;
00082             break;
00083         }
00084         case core::clockSource::extern_Clock_T0_Rising_Edge:
00085         {
00086             m_clockPrescaler=0;
00087             m_clockSource=7;
00088             break;
00089         }
00090     }
00091 }
00092
00093 }
00094
00095 void core::TimerCounter1::selectOperationMode(const operationMode &ar_operationMode)
00096 {
00097     switch (ar_operationMode)
00098     {
00099         case core::operationMode::normal:
00100         {
00101             TIMER1_SELECT_OPERATION_MODE(0);
00102             break;
00103         }
00104         case core::operationMode::PWM_PC_8bit:
00105         {
00106             TIMER1_SELECT_OPERATION_MODE(1);
00107             break;
00108         }
00109         case core::operationMode::PWM_PC_9bit:
00110         {
00111             TIMER1_SELECT_OPERATION_MODE(2);
00112             break;
00113         }
00114         case core::operationMode::PWM_PC_10bit:
00115         {
00116             TIMER1_SELECT_OPERATION_MODE(3);
00117             break;
00118         }
00119         case core::operationMode::CTC_OCR:
00120         {
00121             TIMER1_SELECT_OPERATION_MODE(4);
00122             break;
00123         }
00124         case core::operationMode::fast_PWM_8bit:
00125         {
00126             TIMER1_SELECT_OPERATION_MODE(5);
00127             break;
00128         }
00129         case core::operationMode::fast_PWM_9bit:
00130         {
00131             TIMER1_SELECT_OPERATION_MODE(6);
00132             break;
00133         }
00134         case core::operationMode::fast_PWM_10bit:
00135         {
00136             TIMER1_SELECT_OPERATION_MODE(7);
00137             break;
00138         }
00139         case core::operationMode::PWM_PFC_ICR:
00140         {

```

```

00141         TIMER1_SELECT_OPERATION_MODE(8);
00142         break;
00143     }
00144     case core::operationMode::PWM_PFC_OCR:
00145     {
00146         TIMER1_SELECT_OPERATION_MODE(9);
00147         break;
00148     }
00149     case core::operationMode::PWM_PC_ICR:
00150     {
00151         TIMER1_SELECT_OPERATION_MODE(10);
00152         break;
00153     }
00154     case core::operationMode::PWM_PC_OCR:
00155     {
00156         TIMER1_SELECT_OPERATION_MODE(11);
00157         break;
00158     }
00159     case core::operationMode::CTC_ICR:
00160     {
00161         TIMER1_SELECT_OPERATION_MODE(12);
00162         break;
00163     }
00164     case core::operationMode::fast_PWM_ICR:
00165     {
00166         TIMER1_SELECT_OPERATION_MODE(14);
00167         break;
00168     }
00169     case core::operationMode::fast_PWM_OCR:
00170     {
00171         TIMER1_SELECT_OPERATION_MODE(15);
00172         break;
00173     }
00174 }
00175 }
00176
00177
00178 }
00179
00180
00181 void core::TimerCounter1::start()
00182 {
00183     TIMER1_SELECT_CLOCK_SOURCE(m_clockSource);
00184 }
00185
00186 uint16_t core::TimerCounter1::getClockPrescaler()
00187 {
00188     return m_clockPrescaler;
00189 }
00190
00191 void core::TimerCounter1::stop()
00192 {
00193     TIMER1_STOP;
00194 }
00195
00196
00197 void core::TimerCounter1::selectCompareOutputMode(const channel &ar_channel, const compareOutputMode
&ar_compareOutputMode)
00198 {
00199     switch (ar_channel)
00200     {
00201         case core::channel::A:
00202         {
00203             TIMER1_SELECT_COM_CHANNEL_A(static_cast<uint8_t>(ar_compareOutputMode));
00204             break;
00205         }
00206         case core::channel::B:
00207         {
00208             TIMER1_SELECT_COM_CHANNEL_B(static_cast<uint8_t>(ar_compareOutputMode));
00209             break;
00210         }
00211     }
00212 }
00213 }
00214
00215
00216 void core::TimerCounter1::setCounter(const uint16_t &ar_dataBuffer)
00217 {
00218     TCNT1 = ar_dataBuffer;
00219 }
00220
00221 uint16_t core::TimerCounter1::getCounter() const
00222 {
00223     return TCNT1;
00224 }
00225
00226 void core::TimerCounter1::setOutputCompareRegister(const channel &ar_channel, const uint16_t

```

```

        &ar_dataBuffer)
00227 {
00228     switch (ar_channel)
00229     {
00230         case core::channel::A:
00231         {
00232             OCR1A = ar_dataBuffer;
00233             break;
00234         }
00235         case core::channel::B:
00236         {
00237             OCR1B = ar_dataBuffer;
00238             break;
00239         }
00240     }
00241 }
00242
00243
00244
00245 uint16_t core::TimerCounter1::getOutputCompareRegister(const channel &ar_channel) const
00246 {
00247     switch (ar_channel)
00248     {
00249         case core::channel::A:
00250         {
00251             return OCR1A;
00252         }
00253         case core::channel::B:
00254         {
00255             return OCR1B;
00256         }
00257     }
00258 }
00259
00260 void core::TimerCounter1::enableOutputCompareMatchInterrupt(const channel &ar_channel, const uint8_t
a_enable)
00261 {
00262     switch (ar_channel)
00263     {
00264         case core::channel::A:
00265         {
00266             if (a_enable) {
00267
00268                 TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT;
00269
00270             } else {
00271
00272                 TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT;
00273             }
00274             break;
00275         }
00276         case core::channel::B:
00277         {
00278             if (a_enable) {
00279
00280                 TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT;
00281
00282             } else {
00283
00284                 TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT;
00285             }
00286             break;
00287         }
00288     }
00289 }
00290
00291 }
00292
00293
00294
00295 void core::TimerCounter1::enableOverflowInterrupt(const uint8_t a_enable)
00296 {
00297     if (a_enable) {
00298
00299         TIMER1_ENABLE_OVERFLOW_INTERRUPT;
00300
00301     } else {
00302
00303         TIMER1_DISABLE_OVERFLOW_INTERRUPT;
00304     }
00305 }
00306
00307 }
00308
00309 void core::TimerCounter1::enableInputCaptureInterrupt(const uint8_t a_enable)
00310 {
00311     if (a_enable) {

```

```

00312
00313     TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT;
00314
00315 } else {
00316
00317     TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT;
00318 }
00319 }
00320
00321 void core::TimerCounter1::setInputCaptureRegister(const uint16_t &ar_dataBuffer)
00322 {
00323     ICR1 = ar_dataBuffer;
00324 }
00325
00326
00327 uint16_t core::TimerCounter1::getInputCaptureRegister() const
00328 {
00329     return ICR1;
00330 }

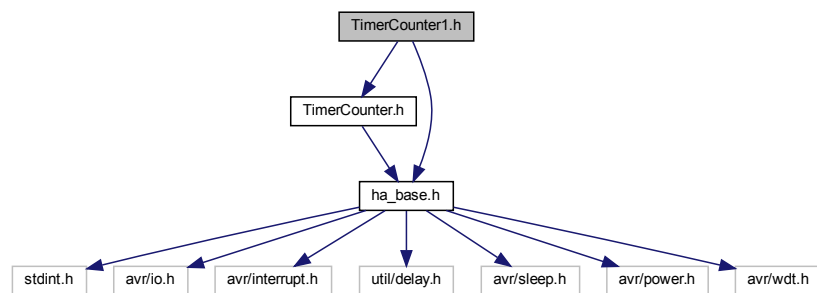
```

10.81 TimerCounter1.h File Reference

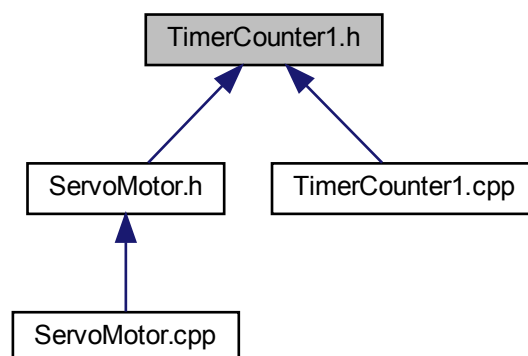
```
#include "TimerCounter.h"
```

```
#include "ha_base.h"
```

Include dependency graph for TimerCounter1.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [core::TimerCounter1](#)

Namespaces

- [core](#)

10.82 TimerCounter1.h

```

00001
00039
00268 #ifndef TIMER_COUNTER1_H
00269 #define TIMER_COUNTER1_H
00270 #include "TimerCounter.h"
00271 #include "ha_base.h"
00272
00273
00274
00275 namespace core
00276 {
00277
00278
00279 class TimerCounter1 : public TimerCounter
00280 {
00281
00282 public:
00283
00284     static TimerCounter1& getInstance(const channel &ar_channel = channel::A,
00285                                     const operationMode &ar_operationMode = operationMode::normal,
00286                                     const clockSource &ar_clockSource= clockSource::noClock,
00287                                     const compareOutputMode& ar_compareOutputMode =
00288                                     compareOutputMode::normal);
00289
00289     void selectOperationMode(const operationMode &ar_operationMode) override;
00290
00291     void start() override;
00292
00293     void stop() override;
00294
00295     void selectClockSource(const clockSource &ar_clockSource) override;
00296
00297
00298     void selectCompareOutputMode(const channel &ar_channel, const compareOutputMode
&ar_compareOutputMode) override;
00299
00300     void setCounter(const uint16_t &ar_dataBuffer) override;
00301
00302     uint16_t getCounter() const override;
00303
00304     void setOutputCompareRegister(const channel &ar_channel, const uint16_t &ar_dataBuffer) override;
00305
00306     uint16_t getOutputCompareRegister(const channel &ar_channel) const override;
00307
00308     void setInputCaptureRegister(const uint16_t &ar_dataBuffer);
00309
00310     uint16_t getInputCaptureRegister() const;
00311
00312     void enableOutputCompareMatchInterrupt(const channel &ar_channel, const uint8_t a_enable)
override;
00313
00314     void enableOverflowInterrupt(const uint8_t a_enable) override;
00315
00316     void enableInputCaptureInterrupt(const uint8_t a_enable);
00317
00318     uint16_t getClockPrescaler() override;
00319
00320     static void outputCompareMatchAServiceRoutine() __asm__(STR(TIMER1_COM_CHANNEL_A_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00321
00322     static void outputCompareMatchBServiceRoutine() __asm__(STR(TIMER1_COM_CHANNEL_B_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00323
00324     static void overflowServiceRoutine() __asm__(STR(TIMER1_OVERFLOW_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00325
00326     static void inputCaptureServiceRoutine() __asm__(STR(TIMER1_INPUT_CAPTURE_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));

```

```

00327
00328
00329
00330 protected:
00331
00332 private:
00333
00334     TimerCounter1(const channel &ar_channel,
00335                  const operationMode &ar_operationMode,
00336                  const clockSource &ar_clockSource,
00337                  const compareOutputMode& ar_compareOutputMode);
00338
00339     ~TimerCounter1();
00340
00341     TimerCounter1(const TimerCounter1&);
00342
00343     const TimerCounter1& operator=(const TimerCounter1&);
00344
00345     uint16_t m_clockPrescaler;
00346
00347     uint8_t m_clockSource;
00348
00349 };
00350
00351 #endif

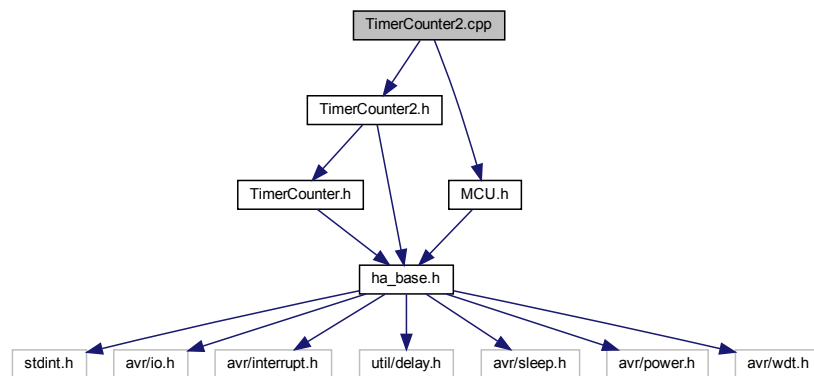
```

10.83 TimerCounter2.cpp File Reference

```
#include "TimerCounter2.h"
```

```
#include "MCU.h"
```

Include dependency graph for TimerCounter2.cpp:



10.84 TimerCounter2.cpp

```

00001 #include "TimerCounter2.h"
00002 #include "MCU.h"
00003
00004
00005 core::TimerCounter2& core::TimerCounter2::getInstance(const channel &ar_channel,
00006                                                         const operationMode &ar_operationMode,
00007                                                         const clockSource &ar_clockSource,
00008                                                         const compareOutputMode& ar_compareOutputMode)
00009 {
00010     static TimerCounter2 l_instance(ar_channel,
00011                                     ar_operationMode,
00012                                     ar_clockSource,
00013                                     ar_compareOutputMode);

```

```

00014
00015     return l_instance;
00016
00017
00018 }
00019
00020 core::TimerCounter2::TimerCounter2(const channel &ar_channel,
00021                                     const operationMode &ar_operationMode,
00022                                     const clockSource &ar_clockSource,
00023                                     const compareOutputMode& ar_compareOutputMode)
00024 {
00025     core::MCU::enableTimerCounter2(1);
00026     stop();
00027     selectOperationMode(ar_operationMode);
00028     selectClockSource(ar_clockSource);
00029     selectCompareOutputMode(ar_channel, ar_compareOutputMode);
00030
00031 }
00032 core::TimerCounter2::~TimerCounter2()
00033 {
00034
00035 }
00036
00037 void core::TimerCounter2::selectClockSource(const clockSource &ar_clockSource)
00038 {
00039     switch (ar_clockSource)
00040     {
00041         case core::clockSource::noClock:
00042         {
00043             m_clockPrescaler=0;
00044             m_clockSource=0;
00045             break;
00046         }
00047         case core::clockSource::PS_1:
00048         {
00049             m_clockPrescaler=1;
00050             m_clockSource=1;
00051             break;
00052         }
00053         case core::clockSource::PS_8:
00054         {
00055             m_clockPrescaler=8;
00056             m_clockSource=2;
00057             break;
00058         }
00059         case core::clockSource::PS_32:
00060         {
00061             m_clockPrescaler=32;
00062             m_clockSource=3;
00063             break;
00064         }
00065         case core::clockSource::PS_64:
00066         {
00067             m_clockPrescaler=64;
00068             m_clockSource=4;
00069             break;
00070         }
00071         case core::clockSource::PS_128:
00072         {
00073             m_clockPrescaler=128;
00074             m_clockSource=5;
00075             break;
00076         }
00077         case core::clockSource::PS_256:
00078         {
00079             m_clockPrescaler=256;
00080             m_clockSource=6;
00081             break;
00082         }
00083         case core::clockSource::PS_1024:
00084         {
00085             m_clockPrescaler=1024;
00086             m_clockSource=7;
00087             break;
00088         }
00089     }
00090
00091 }
00092
00093 void core::TimerCounter2::selectOperationMode(const operationMode &ar_operationMode)
00094 {
00095     switch (ar_operationMode)
00096     {
00097         case core::operationMode::normal:
00098         {
00099             TIMER2_SELECT_OPERATION_MODE(0);
00100             break;

```



```

00101     }
00102     case core::operationMode::PWM_PC:
00103     {
00104         TIMER2_SELECT_OPERATION_MODE(1);
00105         break;
00106     }
00107     case core::operationMode::CTC_OCR:
00108     {
00109         TIMER2_SELECT_OPERATION_MODE(2);
00110         break;
00111     }
00112     case core::operationMode::fast_PWM:
00113     {
00114         TIMER2_SELECT_OPERATION_MODE(3);
00115         break;
00116     }
00117     case core::operationMode::PWM_PC_OCR:
00118     {
00119         TIMER2_SELECT_OPERATION_MODE(5);
00120         break;
00121     }
00122     case core::operationMode::fast_PWM_OCR:
00123     {
00124         TIMER2_SELECT_OPERATION_MODE(7);
00125         break;
00126     }
00127 }
00128 }
00129 }
00130 }
00131 }
00132 }
00133 void core::TimerCounter2::start()
00134 {
00135     TIMER2_SELECT_CLOCK_SOURCE(m_clockSource);
00136 }
00137 }
00138 uint16_t core::TimerCounter2::getClockPrescaler()
00139 {
00140     return m_clockPrescaler;
00141 }
00142 }
00143 }
00144 void core::TimerCounter2::stop()
00145 {
00146     TIMER2_STOP;
00147 }
00148 }
00149 }
00150 void core::TimerCounter2::selectCompareOutputMode(const channel &ar_channel, const compareOutputMode
&ar_compareOutputMode)
00151 {
00152     switch (ar_channel)
00153     {
00154         case core::channel::A:
00155         {
00156             TIMER2_SELECT_COM_CHANNEL_A(static_cast<uint8_t>(ar_compareOutputMode));
00157             break;
00158         }
00159         case core::channel::B:
00160         {
00161             TIMER2_SELECT_COM_CHANNEL_B(static_cast<uint8_t>(ar_compareOutputMode));
00162             break;
00163         }
00164     }
00165 }
00166 }
00167 }
00168 }
00169 }
00170 }
00171 void core::TimerCounter2::setCounter(const uint16_t &ar_dataBuffer)
00172 {
00173     TCNT2 = static_cast<uint8_t>(ar_dataBuffer);
00174 }
00175 }
00176 uint16_t core::TimerCounter2::getCounter() const
00177 {
00178     return TCNT2;
00179 }
00180 }
00181 void core::TimerCounter2::setOutputCompareRegister(const channel &ar_channel, const uint16_t
&ar_dataBuffer)
00182 {
00183     switch (ar_channel)
00184     {
00185         case core::channel::A:

```

```

00186         {
00187             OCR2A = static_cast<uint8_t>(ar_dataBuffer);
00188             break;
00189         }
00190         case core::channel::B:
00191         {
00192             OCR2B = static_cast<uint8_t>(ar_dataBuffer);
00193             break;
00194         }
00195     }
00196 }
00197
00198
00199 uint16_t core::TimerCounter2::getOutputCompareRegister(const channel &ar_channel) const
00200 {
00201     switch (ar_channel)
00202     {
00203         case core::channel::A:
00204         {
00205             return OCR2A;
00206         }
00207         case core::channel::B:
00208         {
00209             return OCR2B;
00210         }
00211     }
00212 }
00213 }
00214
00215 void core::TimerCounter2::enableOutputCompareMatchInterrupt(const channel &ar_channel, const uint8_t
a_enable)
00216 {
00217     switch (ar_channel)
00218     {
00219         case core::channel::A:
00220         {
00221             if (a_enable) {
00222                 TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT;
00223             } else {
00224                 TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT;
00225             }
00226             break;
00227         }
00228         case core::channel::B:
00229         {
00230             if (a_enable) {
00231                 TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT;
00232             } else {
00233                 TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT;
00234             }
00235             break;
00236         }
00237     }
00238 }
00239
00240 void core::TimerCounter2::enableOverflowInterrupt(const uint8_t a_enable)
00241 {
00242     if (a_enable) {
00243         TIMER2_ENABLE_OVERFLOW_INTERRUPT;
00244     } else {
00245         TIMER2_DISABLE_OVERFLOW_INTERRUPT;
00246     }
00247 }
00248
00249
00250 void core::TimerCounter2::enableOverflowInterrupt(const uint8_t a_enable)
00251 {
00252     if (a_enable) {
00253         TIMER2_ENABLE_OVERFLOW_INTERRUPT;
00254     } else {
00255         TIMER2_DISABLE_OVERFLOW_INTERRUPT;
00256     }
00257 }
00258
00259 void core::TimerCounter2::enableOverflowInterrupt(const uint8_t a_enable)
00260 {
00261     if (a_enable) {
00262         TIMER2_ENABLE_OVERFLOW_INTERRUPT;
00263     } else {
00264         TIMER2_DISABLE_OVERFLOW_INTERRUPT;
00265     }
00266 }

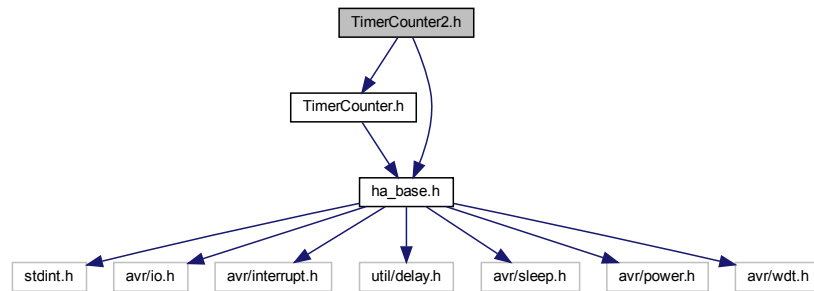
```

10.85 TimerCounter2.h File Reference

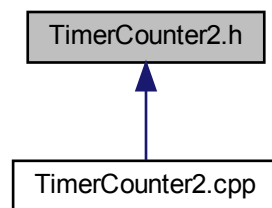
```
#include "TimerCounter.h"
```

```
#include "ha_base.h"
```

Include dependency graph for TimerCounter2.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `core::TimerCounter2`

Namespaces

- `core`

10.86 TimerCounter2.h

```

00001
00039
00268 #ifndef TIMER_COUNTER2_H
00269 #define TIMER_COUNTER2_H
00270 #include "TimerCounter.h"
00271 #include "ha_base.h"
00272
00273
00274
00275 namespace core
00276 {
00277

```

```

00278
00279 class TimerCounter2 : public TimerCounter
00280 {
00281
00282 public:
00283
00284     static TimerCounter2& getInstance(const channel &ar_channel = channel::A,
00285                                     const operationMode &ar_operationMode = operationMode::normal,
00286                                     const clockSource &ar_clockSource= clockSource::noClock,
00287                                     const compareOutputMode& ar_compareOutputMode =
compareOutputMode::normal);
00288
00289     void selectOperationMode(const operationMode &ar_operationMode) override;
00290
00291     void start() override;
00292
00293     void stop() override;
00294
00295     void selectClockSource(const clockSource &ar_clockSource) override;
00296
00297     void selectCompareOutputMode(const channel &ar_channel, const compareOutputMode
&ar_compareOutputMode) override;
00298
00299     void setCounter(const uint16_t &ar_dataBuffer) override;
00300
00301     uint16_t getCounter() const override;
00302
00303     void setOutputCompareRegister(const channel &ar_channel, const uint16_t &ar_dataBuffer) override;
00304
00305     uint16_t getOutputCompareRegister(const channel &ar_channel) const override;
00306
00307     void enableOutputCompareMatchInterrupt(const channel &ar_channel, const uint8_t a_enable)
override;
00308
00309     void enableOverflowInterrupt(const uint8_t a_enable) override;
00310
00311     uint16_t getClockPrescaler() override;
00312
00313     static void outputCompareMatchAServiceRoutine() __asm__(STR(TIMER2_COM_CHANNEL_A_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00314
00315     static void outputCompareMatchBServiceRoutine() __asm__(STR(TIMER2_COM_CHANNEL_B_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00316
00317     static void overflowServiceRoutine() __asm__(STR(TIMER2_OVERFLOW_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00318
00319 protected:
00320
00321 private:
00322
00323     TimerCounter2(const channel &ar_channel,
00324                  const operationMode &ar_operationMode,
00325                  const clockSource &ar_clockSource,
00326                  const compareOutputMode& ar_compareOutputMode);
00327
00328     ~TimerCounter2();
00329
00330     TimerCounter2(const TimerCounter2&);
00331
00332     const TimerCounter2& operator=(const TimerCounter2&);
00333
00334     uint16_t m_clockPrescaler;
00335
00336     uint8_t m_clockSource;
00337
00338 };
00339
00340
00341
00342 };
00343
00344 }
00345
00346
00347 #endif

```

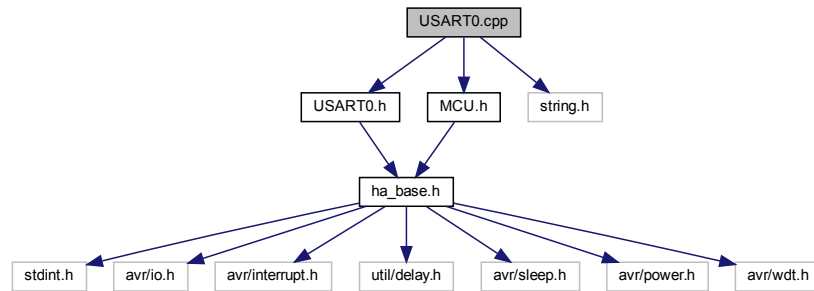
10.87 USART0.cpp File Reference

```

#include "USART0.h"
#include "MCU.h"
#include <string.h>

```

Include dependency graph for USART0.cpp:



10.88 USART0.cpp

```

00001
00010 #include "USART0.h"
00011 #include "MCU.h"
00012 #include <string.h>
00013
00014 volatile uint8_t io::USART0::m_status = 0;
00015 const uint8_t* io::USART0::mp_data2Send = nullptr;
00016 uint8_t* io::USART0::mp_data2Receive = nullptr;
00017 uint16_t io::USART0::m_sizeData2Send = 0;
00018 uint16_t io::USART0::m_sizeData2Receive = 0;
00019 volatile uint16_t io::USART0::m_numberBytesReceived = 0;
00020 volatile uint16_t io::USART0::m_numberBytesSent = 0;
00021 volatile uint8_t io::USART0::m_ready2Send = 1;
00022
00023
00024
00025
00026 io::USART0& io::USART0::getInstance(const transmissionMode& ar_transMode,
00027                                     const communicationMode& ar_comMode,
00028                                     const frameSize& ar_frameSize,
00029                                     const stopBit& ar_stopBit,
00030                                     const parityMode& ar_parityMode)
00031 {
00032     static USART0 l_instance(ar_transMode,
00033                             ar_comMode,
00034                             ar_frameSize,
00035                             ar_stopBit,
00036                             ar_parityMode);
00037
00038     return l_instance;
00039 }
00040
00041
00042
00043 io::USART0::USART0(const transmissionMode& ar_transMode,
00044                   const communicationMode& ar_comMode,
00045                   const frameSize& ar_frameSize,
00046                   const stopBit& ar_stopBit,
00047                   const parityMode& ar_parityMode)
00048 {
00049     {
00050         core::MCU::enableUSART0(1);
00051         setBaudRate();
00052         setTransmissionMode(ar_transMode);
00053         setCommunicationMode(ar_comMode);
00054         setParityMode(ar_parityMode);
00055         setFrameSize(ar_frameSize);
00056         setStopBit(ar_stopBit);
00057         sei();
00058         enableReceiveCompleteInterrupt(1);
00059     }
00060
00061     io::USART0::~~USART0()
00062     {
00063     }
00064 }
00065

```

```
00066 void io::USART0::setBaudRate()
00067 {
00068     USART0_SET_BAUDRATE_HIGH_REGISTER;
00069     USART0_SET_BAUDRATE_LOW_REGISTER;
00070 }
00071 }
00072
00073 void io::USART0::setTransmissionMode(const transmissionMode& ar_transMode)
00074 {
00075     switch (ar_transMode)
00076     {
00077         case transmissionMode::async:
00078         {
00079             USART0_ENABLE_ASYNC_TRANSMISSION_MODE;
00080             break;
00081         }
00082         case transmissionMode::sync:
00083         {
00084             USART0_DISABLE_DOUBLE_SPEED_MODE;
00085             USART0_ENABLE_SYNC_TRANSMISSION_MODE;
00086             break;
00087         }
00088         case transmissionMode::masterSPI:
00089         {
00090             USART0_ENABLE_MASTER_SPI_MODE;
00091             break;
00092         }
00093     }
00094 }
00095
00096 }
00097
00098 void io::USART0::setCommunicationMode(const communicationMode &ar_comMode)
00099 {
00100     switch (ar_comMode)
00101     {
00102         case communicationMode::duplex:
00103         {
00104             USART0_ENABLE_TRANSMITTER;
00105             USART0_ENABLE_RECEIVER;
00106             break;
00107         }
00108         case communicationMode::receive:
00109         {
00110             USART0_ENABLE_RECEIVER;
00111             USART0_DISABLE_TRANSMITTER;
00112             break;
00113         }
00114         case communicationMode::transmit:
00115         {
00116             USART0_ENABLE_TRANSMITTER;
00117             USART0_DISABLE_RECEIVER;
00118             break;
00119         }
00120     }
00121 }
00122 }
00123
00124 void io::USART0::setParityMode(const parityMode& ar_parityMode)
00125 {
00126     switch (ar_parityMode)
00127     {
00128         case parityMode::noParity:
00129         {
00130             USART0_DISABLE_PARITY_MODE;
00131             break;
00132         }
00133         case parityMode::evenParity:
00134         {
00135             USART0_ENABLE_EVEN_PARITY_MODE;
00136             break;
00137         }
00138         case parityMode::oddParity:
00139         {
00140             USART0_ENABLE_ODD_PARITY_MODE;
00141             break;
00142         }
00143     }
00144 }
00145 }
00146
00147 void io::USART0::setFrameSize(const frameSize& ar_frameSize)
00148 {
00149     switch (ar_frameSize)
00150     {
00151         case frameSize::eightBits:
00152         {
```

```

00153         USART0_SET_8BIT_FRAME_SIZE;
00154         break;
00155     }
00156     case frameSize::sevenBits:
00157     {
00158         USART0_SET_7BIT_FRAME_SIZE;
00159         break;
00160     }
00161     case frameSize::sixBits:
00162     {
00163         USART0_SET_6BIT_FRAME_SIZE;
00164         break;
00165     }
00166     case frameSize::fiveBits:
00167     {
00168         USART0_SET_5BIT_FRAME_SIZE;
00169         break;
00170     }
00171     case frameSize::neineBits:
00172     {
00173         USART0_SET_9BIT_FRAME_SIZE;
00174         break;
00175     }
00176 }
00177
00178 }
00179 void io::USART0::setStopBit(const stopBit& ar_stopBit)
00180 {
00181     switch (ar_stopBit)
00182     {
00183         case stopBit::oneStopBit:
00184         {
00185             USART0_SET_ONE_STOP_BIT;
00186             break;
00187         }
00188         case stopBit::twoStopBits:
00189         {
00190             USART0_SET_TWO_STOP_BITS;
00191             break;
00192         }
00193     }
00194 }
00195 }
00196
00197
00198 uint8_t io::USART0::frameError()
00199 {
00200     return (m_status & (1 << USART0_FRAME_ERROR));
00201 }
00202 }
00203
00204 uint8_t io::USART0::dataOverrun()
00205 {
00206     return (m_status & (1 << USART0_DATA_OVERRUN));
00207 }
00208 }
00209
00210 uint8_t io::USART0::parityError()
00211 {
00212     return (m_status & (1 << USART0_PARITY_ERROR));
00213 }
00214 }
00215
00216 void io::USART0::sendFrame(const uint8_t* ap_dataBuffer, const uint8_t a_size)
00217 {
00218     while (!ready2Send()){};
00219     m_sizeData2Send = a_size;
00220     mp_data2Send = ap_dataBuffer;
00221     enableDataRegisterEmptyInterrupt(1);
00222 }
00223
00224
00225 void io::USART0::sendString(const char* ap_string)
00226 {
00227     while (!ready2Send()){};
00228     m_sizeData2Send = strlen(ap_string);
00229     mp_data2Send = reinterpret_cast<const uint8_t*>(ap_string);
00230     enableDataRegisterEmptyInterrupt(1);
00231 }
00232 }
00233
00234
00235 void io::USART0::sendByte(const uint8_t &ar_byte)
00236 {
00237     static uint8_t l_byte2Send[3];
00238     l_byte2Send[0] = '0' + (ar_byte / 100);
00239     l_byte2Send[1] = '0' + ((ar_byte / 10) % 10);

```

```

00240     l_byte2Send[2] = '0' + (ar_byte % 10);
00241
00242     while (!ready2Send()){};
00243     m_sizeData2Send = 3;
00244     mp_data2Send = l_byte2Send;
00245     enableDataRegisterEmptyInterrupt(1);
00246 }
00247 }
00248 void io::USART0::sendLong(const uint32_t &ar_long)
00249 {
00250     static uint8_t l_word2Send[10];
00251     l_word2Send[0] = '0' + (ar_long / 1000000000);
00252     l_word2Send[1] = '0' + ((ar_long / 100000000) % 10);
00253     l_word2Send[2] = '0' + ((ar_long / 10000000) % 10);
00254     l_word2Send[3] = '0' + ((ar_long / 1000000) % 10);
00255     l_word2Send[4] = '0' + ((ar_long / 100000) % 10);
00256     l_word2Send[5] = '0' + ((ar_long / 10000) % 10);
00257     l_word2Send[6] = '0' + ((ar_long / 1000) % 10);
00258     l_word2Send[7] = '0' + ((ar_long / 100) % 10);
00259     l_word2Send[8] = '0' + ((ar_long / 10) % 10);
00260     l_word2Send[9] = '0' + (ar_long % 10);
00261
00262     while (!ready2Send()){};
00263     m_sizeData2Send = 10;
00264     mp_data2Send = l_word2Send;
00265     enableDataRegisterEmptyInterrupt(1);
00266 }
00267 }
00268 void io::USART0::sendWord(const uint16_t &ar_word)
00269 {
00270     static uint8_t l_word2Send[5];
00271     l_word2Send[0] = '0' + (ar_word / 10000);
00272     l_word2Send[1] = '0' + ((ar_word / 1000) % 10);
00273     l_word2Send[2] = '0' + ((ar_word / 100) % 10);
00274     l_word2Send[3] = '0' + ((ar_word / 10) % 10);
00275     l_word2Send[4] = '0' + (ar_word % 10);
00276
00277     while (!ready2Send()){};
00278     m_sizeData2Send = 5;
00279     mp_data2Send = l_word2Send;
00280     enableDataRegisterEmptyInterrupt(1);
00281 }
00282 }
00283
00284 void io::USART0::sendChar(const uint8_t &ar_char)
00285 {
00286     while (!ready2Send()){};
00287     m_sizeData2Send = 1;
00288     mp_data2Send = &ar_char;
00289     enableDataRegisterEmptyInterrupt(1);
00290 }
00291 }
00292
00293 void io::USART0::receiveChar(uint8_t &ar_char)
00294 {
00295     m_sizeData2Receive = 1;
00296     mp_data2Receive = &ar_char;
00297 }
00298
00299
00300 void io::USART0::receiveFrame(uint8_t *ap_dataBuffer, const uint8_t a_size)
00301 {
00302     m_sizeData2Receive = a_size;
00303     mp_data2Receive = ap_dataBuffer;
00304     // TODO: to be implemented
00305 }
00306
00307 }
00308
00309 void io::USART0::receiveString(const char *ap_string)
00310 {
00311     // TODO: to be implemented
00312 }
00313
00314
00315 void io::USART0::receiveCompleteServiceRoutine()
00316 {
00317     static volatile uint8_t *lp_dataReceived = mp_data2Receive;
00318     static uint16_t l_dataSize = m_sizeData2Receive;
00319
00320     m_status = USART0_CONTROL_STATUS_REGISTER;
00321
00322
00323
00324     if (l_dataSize)
00325     {
00326

```



```

00327         *lp_dataReceived++ = USART0_DATA_REGISTER;
00328         l_dataSize--;
00329         m_numberBytesReceived++;
00330     }
00331 }
00332 else
00333 {
00334     l_dataSize = m_sizeData2Receive;
00335     lp_dataReceived = mp_data2Receive;
00336 }
00337 }
00338 }
00339
00340 void io::USART0::dataRegisterEmptyServiceRoutine()
00341 {
00342     if (m_sizeData2Send)
00343     {
00344         m_ready2Send = 0;
00345         USART0_DATA_REGISTER = *mp_data2Send++;
00346         m_sizeData2Send--;
00347         m_numberBytesSent++;
00348     }
00349 }
00350 else
00351 {
00352     enableDataRegisterEmptyInterrupt(0);
00353     m_numberBytesSent = 0;
00354     m_ready2Send = 1;
00355 }
00356 }
00357 }
00358 }
00359 }
00360
00361
00362 void io::USART0::enableTransmitCompleteInterrupt(const uint8_t a_enable)
00363 {
00364     if (a_enable) {
00365         USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT;
00366     } else {
00367         USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT;
00368     }
00369 }
00370 }
00371
00372 void io::USART0::enableReceiveCompleteInterrupt(const uint8_t a_enable)
00373 {
00374     if (a_enable) {
00375         USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT;
00376     } else {
00377         USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT;
00378     }
00379 }
00380 }
00381 }
00382
00383 void io::USART0::enableDataRegisterEmptyInterrupt(const uint8_t a_enable)
00384 {
00385     if (a_enable) {
00386         USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT;
00387     } else {
00388         USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT;
00389     }
00390 }
00391 }
00392 }
00393
00394 void io::USART0::transmitCompleteServiceRoutine()
00395 {
00396 }
00397 }
00398
00399 uint16_t io::USART0::getNumberBytesSent()
00400 {
00401     return m_numberBytesSent;
00402 }
00403
00404 uint16_t io::USART0::getNumberBytesReceived()
00405 {
00406     return m_numberBytesReceived;
00407 }
00408
00409 void io::USART0::resetNumberBytesReceived()
00410 {
00411     m_numberBytesReceived = 0;
00412 }
00413

```

```

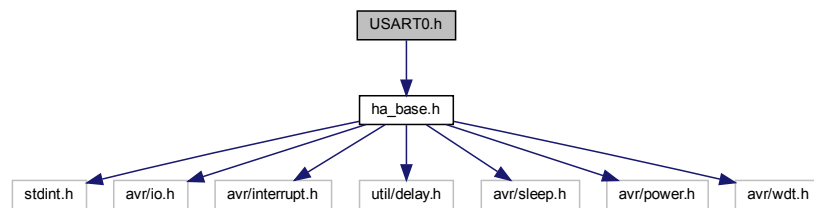
00414 uint8_t io::USART0::ready2Send()
00415 {
00416     return m_ready2Send;
00417 }
00418 }
00419

```

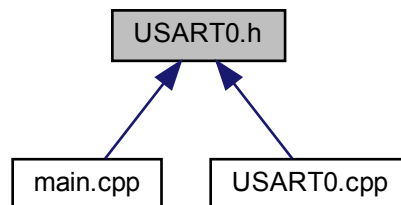
10.89 USART0.h File Reference

```
#include "ha_base.h"
```

Include dependency graph for USART0.h:



This graph shows which files directly or indirectly include this file:



Classes

- class `io::USART0`
Class for handling `USART0` component.

Namespaces

- `io`
AVR chip internal i/o components.

Enumerations

- enum `io::transmissionMode` : `uint8_t` { `io::transmissionMode::async` =0, `io::transmissionMode::sync`, `io::transmissionMode::masterSPI` }
USART0 transmission mode.
- enum `io::communicationMode` : `uint8_t` { `io::communicationMode::duplex` =0, `io::communicationMode::transmit`, `io::communicationMode::receive` }
USART0 communication mode.
- enum `io::parityMode` : `uint8_t` { `io::parityMode::noParity` =0, `io::parityMode::evenParity`, `io::parityMode::oddParity` }
USART0 parity mode.
- enum `io::frameSize` : `uint8_t` { `io::frameSize::eightBits` =0, `io::frameSize::fiveBits`, `io::frameSize::sixBits`, `io::frameSize::sevenBits`, `io::frameSize::neineBits` }
USART0 frame size.
- enum `io::stopBit` : `uint8_t` { `io::stopBit::oneStopBit` =0, `io::stopBit::twoStopBits` }
USART0 stop bit.

10.90 USART0.h

```

00001 #ifndef USART_H
00002 #define USART_H
00003 #include "ha_base.h"
00004
00013 namespace io
00014 {
00015
00016
00025 enum class transmissionMode : uint8_t {
00026     async=0,
00027     sync,
00028     masterSPI
00029 };
00030
00039 enum class communicationMode : uint8_t {
00040     duplex=0,
00041     transmit,
00042     receive,
00044 };
00045
00054 enum class parityMode : uint8_t {
00055     noParity=0,
00056     evenParity,
00057     oddParity
00058 };
00059
00068 enum class frameSize : uint8_t {
00069     eightBits=0,
00070     fiveBits,
00071     sixBits,
00072     sevenBits,
00073     neunBits
00074 };
00075
00084 enum class stopBit : uint8_t {
00085     oneStopBit=0,
00086     twoStopBits
00087 };
00088
00098 class USART0
00099 {
00100
00101 public:
00102
00103
00113 static USART0& getInstance(const transmissionMode& ar_transMode = transmissionMode::async,
00114                             const communicationMode& ar_comMode = communicationMode::duplex,
00115                             const frameSize& ar_frameSize = frameSize::eightBits,
00116                             const stopBit& ar_stopBit = stopBit::oneStopBit,
00117                             const parityMode& ar_parityMode = parityMode::noParity);
00122 void setBaudRate();
00128 void setTransmissionMode(const transmissionMode& ar_transMode);
00134 void setCommunicationMode(const communicationMode& ar_comMode);

```

```

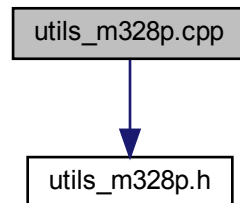
00140     void setParityMode(const parityMode& ar_parityMode);
00146     void setFrameSize(const frameSize& ar_frameSize);
00152     void setStopBit(const stopBit& ar_stopBit);
00159     void sendFrame(const uint8_t *ap_dataBuffer, const uint8_t a_size);
00160
00166     void sendString(const char *ap_string);
00167
00173     void receiveString(const char *ap_string);
00174
00180     void sendChar(const uint8_t &ar_char);
00181
00187     void sendByte(const uint8_t &ar_byte);
00188
00194     void sendWord(const uint16_t &ar_word);
00195
00201     void sendLong(const uint32_t &ar_long);
00202
00208     void receiveChar(uint8_t &ar_char);
00209
00217     void receiveFrame(uint8_t *ap_dataBuffer, const uint8_t a_size);
00218
00224     void enableTransmitCompleteInterrupt(const uint8_t a_enable);
00225
00231     void enableReceiveCompleteInterrupt(const uint8_t a_enable);
00232
00238     static void enableDataRegisterEmptyInterrupt(const uint8_t a_enable);
00239
00245     uint8_t frameError();
00246
00252     uint8_t dataOverrun();
00253
00259     uint8_t parityError();
00265     uint16_t getNumberBytesReceived();
00271     uint16_t getNumberBytesSent();
00277     uint8_t ready2Send();
00280     void resetNumberBytesReceived();
00283     static void receiveCompleteServiceRoutine() __asm__(STR(USART0_RECEIVE_COMPLETE_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00286     static void dataRegisterEmptyServiceRoutine() __asm__(STR(USART0_DATA_REGISTER_EMPTY_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00289     static void transmitCompleteServiceRoutine() __asm__(STR(USART0_TRANSMIT_COMPLETE_INTERRUPT))
__attribute__((__signal__, __used__, __externally_visible__));
00290
00291 protected:
00292
00293
00294
00295
00296 private:
00297     USART0(const transmissionMode& ar_transMode,
00308           const communicationMode& ar_comMode,
00309           const frameSize& ar_frameSize,
00310           const stopBit& ar_stopBit,
00311           const parityMode& ar_parityMode);
00312
00313     ~USART0();
00316
00317     USART0(const USART0&);
00321
00322     const USART0& operator=(const USART0&);
00326
00327
00328     static volatile uint8_t m_status;
00330     static const uint8_t *mp_data2Send;
00332     static uint8_t *mp_data2Receive;
00334     static uint16_t m_sizeData2Send;
00336     static uint16_t m_sizeData2Receive;
00338     static volatile uint16_t m_numberBytesReceived;
00340     static volatile uint16_t m_numberBytesSent;
00342     static volatile uint8_t m_ready2Send;
00345 };
00346
00347
00348
00349 }
00350
00351
00352
00353
00354
00355
00356
00357
00358
00359
00360
00361 #endif

```

10.91 utils_m328p.cpp File Reference

```
#include "utils_m328p.h"
```

Include dependency graph for utils_m328p.cpp:

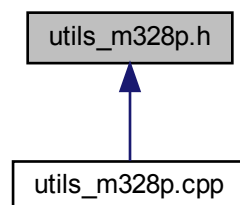


10.92 utils_m328p.cpp

```
00001 #include "utils_m328p.h"
00002
00003 long utils::map(long x, long in_min, long in_max, long out_min, long out_max)
00004 {
00005     return (x - in_min) * (out_max - out_min) / (in_max - in_min) + out_min;
00006 }
```

10.93 utils_m328p.h File Reference

This graph shows which files directly or indirectly include this file:



Namespaces

- [utils](#)

Functions

- long [utils::map](#) (long x, long in_min, long in_max, long out_min, long out_max)

10.94 utils_m328p.h

```

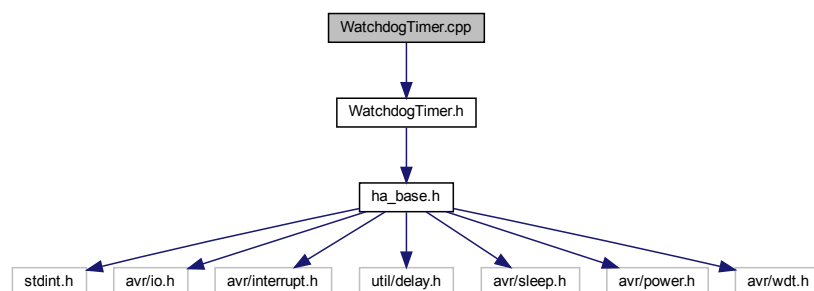
00001 #ifndef UTILSM329P_H
00002 #define UTILSM329P_H
00003 namespace utils
00004 {
00005
00006
00007 // delay functions
00008
00009
00010
00011 // multiplication / division operations bit-shift divide multiply
00012
00013
00014 // clock division (set prescaler)
00015
00016 // clock power saving through macros
00017
00018
00019 // mapping values
00020
00021 long map(long x, long in_min, long in_max, long out_min, long out_max);
00022
00023
00024 }
00025 #endif

```

10.95 WatchdogTimer.cpp File Reference

```
#include "WatchdogTimer.h"
```

Include dependency graph for WatchdogTimer.cpp:



10.96 WatchdogTimer.cpp

```

00001 #include "WatchdogTimer.h"
00002
00003
00004 core::WatchdogTimer& core::WatchdogTimer::getInstance()
00005 {
00006     static WatchdogTimer l_instance;
00007     return l_instance;
00008 }
00009
00010

```

```

00011 core::WatchdogTimer::WatchdogTimer()
00012 {
00013     sei();
00014     stop();
00015 }
00016
00017 core::WatchdogTimer::~WatchdogTimer()
00018 {
00019
00020 }
00021
00022 void core::WatchdogTimer::selectTimeOut(const timeOut &ar_timeOut)
00023 {
00024     m_timeOut = static_cast<uint8_t>(ar_timeOut);
00025     m_timeOut = static_cast<uint8_t>((m_timeOut & 7) | ((m_timeOut & 8) << 2));
00026     cli();
00027     wdt_reset();
00028     WATCHDOG_SELECT_TIMEOUT(m_timeOut);
00029     sei();
00030 }
00031
00032
00033 void core::WatchdogTimer::reset()
00034 {
00035     wdt_reset();
00036 }
00037
00038
00039 void core::WatchdogTimer::start(const operationMode &ar_operationMode)
00040 {
00041     m_operationMode = static_cast<uint8_t>(ar_operationMode);
00042     m_operationMode = static_cast<uint8_t>((m_operationMode & 1) << 6) | ((m_operationMode & 2) << 3
00043 ));
00044     cli();
00045     wdt_reset();
00046     WATCHDOG_START(m_operationMode,m_timeOut);
00047     sei();
00048 }
00049
00050 void core::WatchdogTimer::start(const operationMode &ar_operationMode, const timeOut &ar_timeOut)
00051 {
00052     m_timeOut = static_cast<uint8_t>(ar_timeOut);
00053     m_timeOut = static_cast<uint8_t>((m_timeOut & 7) | ((m_timeOut & 8) << 2));
00054     m_operationMode = static_cast<uint8_t>(ar_operationMode);
00055     m_operationMode = static_cast<uint8_t>((m_operationMode & 1) << 6) | ((m_operationMode & 2) << 3
00056 ));
00057     cli();
00058     wdt_reset();
00059     WATCHDOG_START(m_operationMode,m_timeOut);
00060     sei();
00061 }
00062
00063 void core::WatchdogTimer::stop()
00064 {
00065     cli();
00066     wdt_reset();
00067     WATCHDOG_STOP;
00068     sei();
00069 }
00070
00071

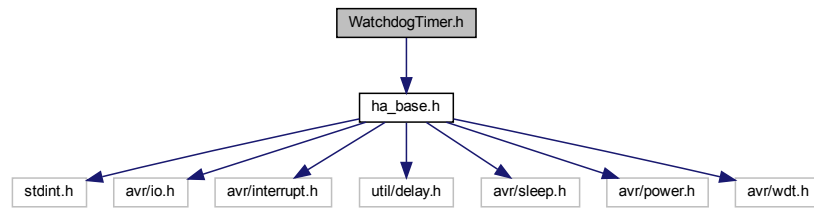
```

10.97 WatchdogTimer.h File Reference

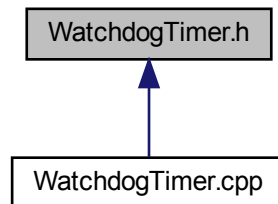
Header file of the WatchdogTimer class.

```
#include "ha_base.h"
```

Include dependency graph for WatchdogTimer.h:



This graph shows which files directly or indirectly include this file:



Classes

- class [core::WatchdogTimer](#)

Namespaces

- [core](#)

Enumerations

- enum [core::timeOut](#) : `uint8_t` {
[core::timeOut::to_16ms](#) =0, [core::timeOut::to_32ms](#), [core::timeOut::to_64ms](#), [core::timeOut::to_125ms](#),
[core::timeOut::to_250ms](#), [core::timeOut::to_500ms](#), [core::timeOut::to_1s](#), [core::timeOut::to_2s](#),
[core::timeOut::to_4s](#), [core::timeOut::to_8s](#) }
- enum [core::operationMode](#) : `uint8_t` {
[core::operationMode::normal](#) =0, [core::operationMode::PWM_PC](#), [core::operationMode::PWM_PC_8bit](#),
[core::operationMode::PWM_PC_9bit](#),
[core::operationMode::PWM_PC_10bit](#), [core::operationMode::PWM_PFC_ICR](#), [core::operationMode::PWM_PFC_OCR](#),
[core::operationMode::PWM_PC_ICR](#),
[core::operationMode::PWM_PC_OCR](#), [core::operationMode::fast_PWM](#), [core::operationMode::fast_PWM_8bit](#),
[core::operationMode::fast_PWM_9bit](#),
[core::operationMode::fast_PWM_10bit](#), [core::operationMode::fast_PWM_ICR](#), [core::operationMode::fast_PWM_OCR](#),
[core::operationMode::CTC_OCR](#),
[core::operationMode::CTC_ICR](#), [core::operationMode::interrupt](#) =1, [core::operationMode::reset](#), [core::operationMode::interrupt](#),
}

10.97.1 Detailed Description

Header file of the WatchdogTimer class.

Basic class abstraction of the WatchdogTimer peripheral

Usage example (test):

```
#include "WatchdogTimer.h" #include "Led.h" instantiate a Led object extern component::Led Led; component::Led
Led(io::Pin(1,io::PortB)); extern component::Led LedStart; component::Led LedStart(io::Pin(2,io::PortB));
```

```
int main(void) {
```

```
Init instantiate a Watchdog object core::WatchdogTimer &myWatchdog = core::WatchdogTimer::getInstance(); my
Watchdog.selectTimeOut(core::timeOut::to_8s); LedStart.on(); _delay_ms(5000); LedStart.off(); myWatchdog.
start(core::operationMode::reset); ----- Event loop ----- // while (1) {
```

```
Led.on();
_delay_ms(1000);
Led.off();
_delay_ms(1000);
```

```
} return 0; }
```

```
void core::WatchdogTimer::timeOutServiceRoutine() { for (uint8_t i=0;i<10;i++) { Led.on(); _delay_ms(100); Led.
off(); _delay_ms(100);
```

```
}
```

```
}
```

Author

Farid Oubbati (<https://github.com/faroub>)

Date

March 2020

Definition in file [WatchdogTimer.h](#).

10.98 WatchdogTimer.h

```

00001
00057 #ifndef WATCHDOG_TIMER_H
00058 #define WATCHDOG_TIMER_H
00059 #include "ha_base.h"
00060
00061
00062
00063 namespace core
00064 {
00065     enum class timeOut : uint8_t {
00066         to_16ms=0,
00067         to_32ms,
00068         to_64ms,
00069         to_125ms,
00070         to_250ms,
00071         to_500ms,
00072         to_1s,
00073         to_2s,
00074         to_4s,
00075         to_8s,
00076     };
00077
00078     enum class operationMode : uint8_t {
00079         interrupt=1,
00080         reset,
00081         interrupt_reset,
00082     };
00083
00084     class WatchdogTimer
00085     {
00086     public:
00087         static WatchdogTimer& getInstance();
00088
00089         void selectTimeOut(const timeOut &ar_timeOut);
00090
00091         void reset();
00092
00093         void start(const operationMode &ar_operationMode);
00094
00095         void start(const operationMode &ar_operationMode, const timeOut &ar_timeOut);
00096
00097         void stop();
00098
00099         static void timeOutServiceRoutine() __asm__(STR(WATCHDOG_TIMEOUT_INTERRUPT))
00100         __attribute__((__signal__, __used__, __externally_visible__));
00101
00102     protected:
00103
00104     private:
00105         WatchdogTimer();
00106
00107         ~WatchdogTimer();
00108
00109         WatchdogTimer(const WatchdogTimer&);
00110
00111         const WatchdogTimer& operator=(const WatchdogTimer&);
00112
00113         uint8_t m_timeOut;
00114
00115         uint8_t m_operationMode;
00116     };
00117 }
00118
00129 }
00130
00131
00132 #endif

```

Index

- `__externally_visible__`
 - `core::ADConverter`, [47](#)
 - `core::ExternInterrupt`, [60](#)
 - `core::TimerCounter0`, [115](#)
 - `core::TimerCounter1`, [126](#)
 - `core::TimerCounter2`, [136](#)
 - `core::WatchdogTimer`, [158](#)
 - `io::SPI`, [92](#)
 - `io::USART0`, [152](#)
- `__used__`
 - `core::ADConverter`, [47](#)
 - `core::ExternInterrupt`, [61](#)
 - `core::TimerCounter0`, [115](#)
 - `core::TimerCounter1`, [126](#)
 - `core::TimerCounter2`, [136](#)
 - `core::WatchdogTimer`, [158](#)
 - `io::SPI`, [92](#)
 - `io::USART0`, [152](#)
- `~ADConverter`
 - `core::ADConverter`, [40](#)
- `~Buzzer`
 - `component::Buzzer`, [49](#)
- `~DCMotor`
 - `component::DCMotor`, [53](#)
- `~ExternInterrupt`
 - `core::ExternInterrupt`, [56](#)
- `~Led`
 - `component::Led`, [63](#)
- `~Pin`
 - `io::Pin`, [70](#)
- `~PushButton`
 - `component::PushButton`, [76](#)
- `~SPI`
 - `io::SPI`, [87](#)
- `~ServoMotor`
 - `component::ServoMotor`, [80](#)
- `~StepperMotor`
 - `component::StepperMotor`, [95](#)
- `~TimerCounter0`
 - `core::TimerCounter0`, [108](#)
- `~TimerCounter1`
 - `core::TimerCounter1`, [118](#)
- `~TimerCounter2`
 - `core::TimerCounter2`, [129](#)
- `~USART0`
 - `io::USART0`, [139](#)
- `~WatchdogTimer`
 - `core::WatchdogTimer`, [155](#)

A

- `core`, [26](#)
- A0
 - `buzzer_pitches_16bit.h`, [175](#)
 - `buzzer_pitches_8bit.h`, [193](#)
- A1
 - `buzzer_pitches_16bit.h`, [175](#)
 - `buzzer_pitches_8bit.h`, [193](#)
- A2
 - `buzzer_pitches_16bit.h`, [175](#)
 - `buzzer_pitches_8bit.h`, [193](#)
- A3
 - `buzzer_pitches_16bit.h`, [175](#)
- A4
 - `buzzer_pitches_16bit.h`, [175](#)
- A5
 - `buzzer_pitches_16bit.h`, [176](#)
- A6
 - `buzzer_pitches_16bit.h`, [176](#)
- A7
 - `buzzer_pitches_16bit.h`, [176](#)
- ADC.cpp, [159](#)
- ADC.h, [163](#), [166](#)
- ADC_ADJUST_RESULT_LEFT
 - `ha_m328p.h`, [215](#)
- ADC_ADJUST_RESULT_RIGHT
 - `ha_m328p.h`, [215](#)
- ADC_CONVERSION_COMPLETE_INTERRUPT
 - `ha_m328p.h`, [215](#)
- ADC_DISABLE
 - `ha_m328p.h`, [215](#)
- ADC_DISABLE_AUTOTRIGGER
 - `ha_m328p.h`, [215](#)
- ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT
 - `ha_m328p.h`, [216](#)
- ADC_DISABLE_DIGITAL_INPUT_REGISTER
 - `ha_m328p.h`, [216](#)
- ADC_ENABLE
 - `ha_m328p.h`, [216](#)
- ADC_ENABLE_AUTOTRIGGER
 - `ha_m328p.h`, [216](#)
- ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT
 - `ha_m328p.h`, [216](#)
- ADC_NoiseReduction
 - `core`, [31](#)
- ADC_SELECT_ANALOG_INPUT
 - `ha_m328p.h`, [216](#)
- ADC_SELECT_AUTO_TRIGGER_SOURCE
 - `ha_m328p.h`, [217](#)
- ADC_SELECT_CLOCK_PRESCALER

- ha_m328p.h, [217](#)
- ADC_SELECT_REF_VOLTAGE
 - ha_m328p.h, [217](#)
- ADC_START_CONVERSION
 - ha_m328p.h, [217](#)
- ADC_STOP_CONVERSION
 - ha_m328p.h, [217](#)
- ADConverter
 - core::ADConverter, [40](#)
- ANALOG_COMARATOR_H
 - AnalogComparator.h, [168](#)
- analogComparator
 - core, [25](#)
- AnalogComparator.cpp, [167](#)
- AnalogComparator.h, [167](#), [169](#)
 - ANALOG_COMARATOR_H, [168](#)
- AREF
 - core, [30](#)
- async
 - io, [37](#)
- autoTriggerSource
 - core, [25](#)
- AVCC
 - core, [30](#)
- Ax0
 - buzzer_pitches_16bit.h, [176](#)
 - buzzer_pitches_8bit.h, [193](#)
- Ax1
 - buzzer_pitches_16bit.h, [176](#)
 - buzzer_pitches_8bit.h, [194](#)
- Ax2
 - buzzer_pitches_16bit.h, [176](#)
 - buzzer_pitches_8bit.h, [194](#)
- Ax3
 - buzzer_pitches_16bit.h, [177](#)
- Ax4
 - buzzer_pitches_16bit.h, [177](#)
- Ax5
 - buzzer_pitches_16bit.h, [177](#)
- Ax6
 - buzzer_pitches_16bit.h, [177](#)
- Ax7
 - buzzer_pitches_16bit.h, [177](#)
- B
 - core, [26](#)
- B0
 - buzzer_pitches_16bit.h, [177](#)
 - buzzer_pitches_8bit.h, [194](#)
- B1
 - buzzer_pitches_16bit.h, [178](#)
 - buzzer_pitches_8bit.h, [194](#)
- B2
 - buzzer_pitches_16bit.h, [178](#)
 - buzzer_pitches_8bit.h, [194](#)
- B3
 - buzzer_pitches_16bit.h, [178](#)
- B4
 - buzzer_pitches_16bit.h, [178](#)
- B5
 - buzzer_pitches_16bit.h, [178](#)
- B6
 - buzzer_pitches_16bit.h, [178](#)
- B7
 - buzzer_pitches_16bit.h, [179](#)
- BlinkLed/main.cpp
 - main, [250](#)
 - PIN_NUMBER, [249](#)
 - TIMEDELAY, [249](#)
- BODMode
 - core, [26](#)
- buzz
 - component::Buzzer, [50](#)
- BUZZER
 - MusicBox/main.cpp, [252](#)
 - Organ/main.cpp, [256](#)
- Buzzer
 - component::Buzzer, [49](#)
- Buzzer.cpp, [169](#)
- Buzzer.h, [170](#), [171](#)
- buzzer_pitches_16bit.h, [173](#), [191](#)
 - A0, [175](#)
 - A1, [175](#)
 - A2, [175](#)
 - A3, [175](#)
 - A4, [175](#)
 - A5, [176](#)
 - A6, [176](#)
 - A7, [176](#)
 - Ax0, [176](#)
 - Ax1, [176](#)
 - Ax2, [176](#)
 - Ax3, [177](#)
 - Ax4, [177](#)
 - Ax5, [177](#)
 - Ax6, [177](#)
 - Ax7, [177](#)
 - B0, [177](#)
 - B1, [178](#)
 - B2, [178](#)
 - B3, [178](#)
 - B4, [178](#)
 - B5, [178](#)
 - B6, [178](#)
 - B7, [179](#)
 - C0, [179](#)
 - C1, [179](#)
 - C2, [179](#)
 - C3, [179](#)
 - C4, [179](#)
 - C5, [180](#)
 - C6, [180](#)
 - C7, [180](#)
 - Cx0, [180](#)
 - Cx1, [180](#)
 - Cx2, [180](#)
 - Cx3, [181](#)

- Cx4, [181](#)
- Cx5, [181](#)
- Cx6, [181](#)
- Cx7, [181](#)
- D0, [181](#)
- D1, [182](#)
- D2, [182](#)
- D3, [182](#)
- D4, [182](#)
- D5, [182](#)
- D6, [182](#)
- D7, [183](#)
- Dx0, [183](#)
- Dx1, [183](#)
- Dx2, [183](#)
- Dx3, [183](#)
- Dx4, [183](#)
- Dx5, [184](#)
- Dx6, [184](#)
- Dx7, [184](#)
- E0, [184](#)
- E1, [184](#)
- E2, [184](#)
- E3, [185](#)
- E4, [185](#)
- E5, [185](#)
- E6, [185](#)
- E7, [185](#)
- F0, [185](#)
- F1, [186](#)
- F2, [186](#)
- F3, [186](#)
- F4, [186](#)
- F5, [186](#)
- F6, [186](#)
- F7, [187](#)
- Fx0, [187](#)
- Fx1, [187](#)
- Fx2, [187](#)
- Fx3, [187](#)
- Fx4, [187](#)
- Fx5, [188](#)
- Fx6, [188](#)
- Fx7, [188](#)
- G0, [188](#)
- G1, [188](#)
- G2, [188](#)
- G3, [189](#)
- G4, [189](#)
- G5, [189](#)
- G6, [189](#)
- G7, [189](#)
- Gx0, [189](#)
- Gx1, [190](#)
- Gx2, [190](#)
- Gx3, [190](#)
- Gx4, [190](#)
- Gx5, [190](#)
- Gx6, [190](#)
- Gx7, [191](#)
- buzzer_pitches_8bit.h, [192](#), [199](#)
 - A0, [193](#)
 - A1, [193](#)
 - A2, [193](#)
 - Ax0, [193](#)
 - Ax1, [194](#)
 - Ax2, [194](#)
 - B0, [194](#)
 - B1, [194](#)
 - B2, [194](#)
 - C1, [194](#)
 - C2, [195](#)
 - C3, [195](#)
 - Cx0, [195](#)
 - Cx2, [195](#)
 - Cx3, [195](#)
 - D1, [195](#)
 - D2, [196](#)
 - D3, [196](#)
 - Dx0, [196](#)
 - Dx2, [196](#)
 - Dx3, [196](#)
 - E1, [196](#)
 - E2, [197](#)
 - E3, [197](#)
 - F1, [197](#)
 - F2, [197](#)
 - F3, [197](#)
 - Fx1, [197](#)
 - Fx2, [198](#)
 - Fx3, [198](#)
 - G1, [198](#)
 - G2, [198](#)
 - G3, [198](#)
 - Gx0, [198](#)
 - Gx1, [199](#)
 - Gx2, [199](#)
- C0
 - buzzer_pitches_16bit.h, [179](#)
- C1
 - buzzer_pitches_16bit.h, [179](#)
 - buzzer_pitches_8bit.h, [194](#)
- C2
 - buzzer_pitches_16bit.h, [179](#)
 - buzzer_pitches_8bit.h, [195](#)
- C3
 - buzzer_pitches_16bit.h, [179](#)
 - buzzer_pitches_8bit.h, [195](#)
- C4
 - buzzer_pitches_16bit.h, [179](#)
- C5
 - buzzer_pitches_16bit.h, [180](#)
- C6
 - buzzer_pitches_16bit.h, [180](#)
- C7
 - buzzer_pitches_16bit.h, [180](#)

- channel
 - core, 26
- clear
 - core, 27
- clockPrescaler
 - core, 26
 - io, 33
- clockSource
 - core, 27
- communicationMode
 - io, 33
- compareOutputMode
 - core, 27
- component, 23
 - fullStep, 24
 - halfStep, 24
 - mode, 23
- component::Buzzer, 48
 - ~Buzzer, 49
 - buzz, 50
 - Buzzer, 49
 - m_pin, 51
 - pause, 51
- component::DCMotor, 52
 - ~DCMotor, 53
 - connect, 53
 - DCMotor, 53
 - disconnect, 53
 - m_pin, 55
 - off, 54
 - on, 54
 - spin, 54
 - stop, 54
 - toggle, 55
- component::Led, 61
 - ~Led, 63
 - isOff, 63
 - isOn, 63
 - Led, 62
 - m_pin, 64
 - off, 63
 - on, 64
 - toggle, 64
- component::PushButton, 75
 - ~PushButton, 76
 - getPressedCount, 77
 - isPressed, 77
 - m_buttonPressed, 78
 - m_pin, 78
 - mr_isActiveLow, 78
 - mr_useInternalPullUp, 78
 - PushButton, 76
 - resetPressedCount, 77
- component::ServoMotor, 79
 - ~ServoMotor, 80
 - computePulseCycleCount, 80
 - computePulseWidthMaxCount, 81
 - computePulseWidthMidCount, 81
 - computePulseWidthMinCount, 81
 - computeRotationAngleCount, 81
 - connect, 82
 - disconnect, 82
 - m_pin, 84
 - m_pulseCycle, 84
 - m_pulseWidthMax, 84
 - m_pulseWidthMid, 84
 - m_pulseWidthMin, 84
 - off, 82
 - on, 83
 - rotate, 83
 - ServoMotor, 80
 - toggle, 83
- component::StepperMotor, 93
 - ~StepperMotor, 95
 - computeStepDelay, 95
 - currentPos, 96
 - goalReached, 96
 - m_accelTime, 101
 - m_constSpeedTime, 101
 - m_currentPos, 101
 - m_decelTime, 102
 - m_goalReached, 102
 - m_pinCoil1, 102
 - m_pinCoil2, 102
 - m_pinCoil3, 102
 - m_pinCoil4, 103
 - setCurrentPos, 97
 - step, 97–99
 - stepDelay, 100
 - stepMode, 103
 - StepperMotor, 94
 - stepPulse, 100
- computePulseCycleCount
 - component::ServoMotor, 80
- computePulseWidthMaxCount
 - component::ServoMotor, 81
- computePulseWidthMidCount
 - component::ServoMotor, 81
- computePulseWidthMinCount
 - component::ServoMotor, 81
- computeRotationAngleCount
 - component::ServoMotor, 81
- computeStepDelay
 - component::StepperMotor, 95
- connect
 - component::DCMotor, 53
 - component::ServoMotor, 82
- conversionComplete
 - core::ADConverter, 41
- conversionCompleteServiceRoutine
 - core::ADConverter, 41
- core, 24
 - A, 26
 - ADC_NoiseReduction, 31
 - analogComparator, 25
 - AREF, 30

autoTriggerSource, 25
 AVCC, 30
 B, 26
 BODMode, 26
 channel, 26
 clear, 27
 clockPrescaler, 26
 clockSource, 27
 compareOutputMode, 27
 CTC_ICR, 28, 29
 CTC_OCR, 28, 29
 disabled, 26
 enabled, 26
 extendedStandby, 31
 extern_Clock_T0_Falling_Edge, 27
 extern_Clock_T0_Rising_Edge, 27
 extInterrupt, 25
 fallingEdge, 31
 fast_PWM, 28, 29
 fast_PWM_10bit, 28, 29
 fast_PWM_8bit, 28, 29
 fast_PWM_9bit, 28, 29
 fast_PWM_ICR, 28, 29
 fast_PWM_OCR, 28, 29
 freeRunning, 25
 Idle, 31
 internal, 30
 interrupt, 28, 29
 interrupt_reset, 28, 29
 logicalChange, 31
 lowLevel, 31
 noClock, 27
 normal, 27, 28
 operationMode, 28
 PCINTB, 29
 PCINTC, 29
 PCINTD, 29
 pinChangePort, 29
 powerDown, 31
 powerSave, 31
 PS_1, 27
 PS_1024, 27
 PS_128, 26, 27
 PS_16, 26
 PS_2, 26
 PS_256, 27
 PS_32, 26, 27
 PS_4, 26
 PS_64, 26, 27
 PS_8, 26, 27
 PWM_PC, 28
 PWM_PC_10bit, 28, 29
 PWM_PC_8bit, 28
 PWM_PC_9bit, 28, 29
 PWM_PC_ICR, 28, 29
 PWM_PC_OCR, 28, 29
 PWM_PFC_ICR, 28, 29
 PWM_PFC_OCR, 28, 29
 referenceVoltage, 30
 res_10bit, 30
 res_11bit, 30
 res_12bit, 30
 res_13bit, 30
 res_14bit, 30
 res_15bit, 30
 res_16bit, 30
 res_8bit, 30
 res_9bit, 30
 reset, 28, 29
 resolution, 30
 risingEdge, 31
 senseControl, 30
 set, 27
 sleepMode, 31
 standby, 31
 timeOut, 31
 timer0Compare, 25
 timer0Overflow, 25
 timer1Capture, 25
 timer1CompareB, 25
 timer1Overflow, 25
 to_125ms, 31
 to_16ms, 31
 to_1s, 31
 to_250ms, 31
 to_2s, 32
 to_32ms, 31
 to_4s, 32
 to_500ms, 31
 to_64ms, 31
 to_8s, 32
 toggle, 27
 core::ADConverter, 39
 __externally_visible__, 47
 __used__, 47
 ~ADConverter, 40
 ADConverter, 40
 conversionComplete, 41
 conversionCompleteServiceRoutine, 41
 enableAutoTrigger, 43
 enableConversionCompleteInterrupt, 43
 getConversionResult, 43
 getInstance, 44
 m_conversionComplete, 47
 m_resolution, 47
 mp_conversionResult, 47
 operator=, 45
 selectAnalogInput, 45
 selectAutoTriggerSource, 45
 selectClockPrescaler, 45
 selectReferenceVoltage, 46
 start, 46
 stop, 46
 core::AnalogComparator, 48
 core::ExternInterrupt, 55
 __externally_visible__, 60

- `__used__`, 61
- `~ExternInterrupt`, 56
- `enableInt0`, 57
- `enableInt1`, 57
- `enablePinChange`, 57
- `enablePinChangeMaskPortB`, 58
- `enablePinChangeMaskPortC`, 58
- `enablePinChangeMaskPortD`, 58
- `ExternInterrupt`, 56, 57
- `getInstance`, 59
- `Int0ServiceRoutine`, 59
- `Int1ServiceRoutine`, 59
- `operator=`, 59
- `pinChangePortBServiceRoutine`, 59
- `pinChangePortCServiceRoutine`, 60
- `pinChangePortDServiceRoutine`, 60
- `setInt0SenseControl`, 60
- `setInt1SenseControl`, 60
- `core::MCU`, 65
 - `disableBOD`, 65
 - `enableADC`, 65
 - `enableSPI`, 65
 - `enableTimerCounter0`, 66
 - `enableTimerCounter1`, 66
 - `enableTimerCounter2`, 66
 - `enableTWI`, 67
 - `enableUSART0`, 67
 - `goToSleep`, 67
 - `init`, 68
 - `selectSleepMode`, 68
 - `sleepEnable`, 68
- `core::TimerCounter`, 103
 - `enableOutputCompareMatchInterrupt`, 104
 - `enableOverflowInterrupt`, 104
 - `getClockPrescaler`, 104
 - `getCounter`, 104
 - `getOutputCompareRegister`, 105
 - `selectClockSource`, 105
 - `selectCompareOutputMode`, 105
 - `selectOperationMode`, 105
 - `setCounter`, 105
 - `setOutputCompareRegister`, 105
 - `start`, 106
 - `stop`, 106
- `core::TimerCounter0`, 106
 - `__externally_visible__`, 115
 - `__used__`, 115
 - `~TimerCounter0`, 108
 - `enableOutputCompareMatchInterrupt`, 109
 - `enableOverflowInterrupt`, 109
 - `getClockPrescaler`, 110
 - `getCounter`, 110
 - `getInstance`, 110
 - `getOutputCompareRegister`, 111
 - `m_clockPrescaler`, 115
 - `m_clockSource`, 116
 - `operator=`, 111
 - `outputCompareMatchAServiceRoutine`, 111
 - `outputCompareMatchBServiceRoutine`, 111
 - `overflowServiceRoutine`, 112
 - `selectClockSource`, 112
 - `selectCompareOutputMode`, 113
 - `selectOperationMode`, 113
 - `setCounter`, 114
 - `setOutputCompareRegister`, 114
 - `start`, 114
 - `stop`, 115
 - `TimerCounter0`, 108
- `core::TimerCounter1`, 116
 - `__externally_visible__`, 126
 - `__used__`, 126
 - `~TimerCounter1`, 118
 - `enableInputCaptureInterrupt`, 118
 - `enableOutputCompareMatchInterrupt`, 119
 - `enableOverflowInterrupt`, 119
 - `getClockPrescaler`, 120
 - `getCounter`, 120
 - `getInputCaptureRegister`, 120
 - `getInstance`, 120
 - `getOutputCompareRegister`, 121
 - `inputCaptureServiceRoutine`, 121
 - `m_clockPrescaler`, 126
 - `m_clockSource`, 127
 - `operator=`, 121
 - `outputCompareMatchAServiceRoutine`, 121
 - `outputCompareMatchBServiceRoutine`, 122
 - `overflowServiceRoutine`, 122
 - `selectClockSource`, 122
 - `selectCompareOutputMode`, 123
 - `selectOperationMode`, 123
 - `setCounter`, 125
 - `setInputCaptureRegister`, 125
 - `setOutputCompareRegister`, 125
 - `start`, 125
 - `stop`, 126
 - `TimerCounter1`, 118
- `core::TimerCounter2`, 127
 - `__externally_visible__`, 136
 - `__used__`, 136
 - `~TimerCounter2`, 129
 - `enableOutputCompareMatchInterrupt`, 129
 - `enableOverflowInterrupt`, 130
 - `getClockPrescaler`, 130
 - `getCounter`, 131
 - `getInstance`, 131
 - `getOutputCompareRegister`, 131
 - `m_clockPrescaler`, 136
 - `m_clockSource`, 136
 - `operator=`, 132
 - `outputCompareMatchAServiceRoutine`, 132
 - `outputCompareMatchBServiceRoutine`, 132
 - `overflowServiceRoutine`, 132
 - `selectClockSource`, 132
 - `selectCompareOutputMode`, 133
 - `selectOperationMode`, 134
 - `setCounter`, 134

- setOutputCompareRegister, [135](#)
 - start, [135](#)
 - stop, [135](#)
 - TimerCounter2, [129](#)
- core::WatchdogTimer, [154](#)
 - __externally_visible__, [158](#)
 - __used__, [158](#)
 - ~WatchdogTimer, [155](#)
 - getInstance, [155](#)
 - m_operationMode, [158](#)
 - m_timeOut, [158](#)
 - operator=, [156](#)
 - reset, [156](#)
 - selectTimeOut, [156](#)
 - start, [156](#), [157](#)
 - stop, [157](#)
 - timeOutServiceRoutine, [157](#)
 - WatchdogTimer, [155](#)
- CTC_ICR
 - core, [28](#), [29](#)
- CTC_OCR
 - core, [28](#), [29](#)
- currentPos
 - component::StepperMotor, [96](#)
- Cx0
 - buzzer_pitches_16bit.h, [180](#)
 - buzzer_pitches_8bit.h, [195](#)
- Cx1
 - buzzer_pitches_16bit.h, [180](#)
- Cx2
 - buzzer_pitches_16bit.h, [180](#)
 - buzzer_pitches_8bit.h, [195](#)
- Cx3
 - buzzer_pitches_16bit.h, [181](#)
 - buzzer_pitches_8bit.h, [195](#)
- Cx4
 - buzzer_pitches_16bit.h, [181](#)
- Cx5
 - buzzer_pitches_16bit.h, [181](#)
- Cx6
 - buzzer_pitches_16bit.h, [181](#)
- Cx7
 - buzzer_pitches_16bit.h, [181](#)
- D0
 - buzzer_pitches_16bit.h, [181](#)
- D1
 - buzzer_pitches_16bit.h, [182](#)
 - buzzer_pitches_8bit.h, [195](#)
- D2
 - buzzer_pitches_16bit.h, [182](#)
 - buzzer_pitches_8bit.h, [196](#)
- D3
 - buzzer_pitches_16bit.h, [182](#)
 - buzzer_pitches_8bit.h, [196](#)
- D4
 - buzzer_pitches_16bit.h, [182](#)
- D5
 - buzzer_pitches_16bit.h, [182](#)
- D6
 - buzzer_pitches_16bit.h, [182](#)
- D7
 - buzzer_pitches_16bit.h, [183](#)
- dataMode
 - io, [34](#)
- dataOrder
 - io, [34](#)
- dataOverrun
 - io::USART0, [139](#)
- dataRegisterEmptyServiceRoutine
 - io::USART0, [140](#)
- DCMotor
 - component::DCMotor, [53](#)
- DCMotor.cpp, [200](#)
- DCMotor.h, [200](#), [203](#)
- disable
 - io, [35](#)
- disableBOD
 - core::MCU, [65](#)
- disabled
 - core, [26](#)
- disconnect
 - component::DCMotor, [53](#)
 - component::ServoMotor, [82](#)
- duplex
 - io, [34](#)
- Dx0
 - buzzer_pitches_16bit.h, [183](#)
 - buzzer_pitches_8bit.h, [196](#)
- Dx1
 - buzzer_pitches_16bit.h, [183](#)
- Dx2
 - buzzer_pitches_16bit.h, [183](#)
 - buzzer_pitches_8bit.h, [196](#)
- Dx3
 - buzzer_pitches_16bit.h, [183](#)
 - buzzer_pitches_8bit.h, [196](#)
- Dx4
 - buzzer_pitches_16bit.h, [183](#)
- Dx5
 - buzzer_pitches_16bit.h, [184](#)
- Dx6
 - buzzer_pitches_16bit.h, [184](#)
- Dx7
 - buzzer_pitches_16bit.h, [184](#)
- E0
 - buzzer_pitches_16bit.h, [184](#)
- E1
 - buzzer_pitches_16bit.h, [184](#)
 - buzzer_pitches_8bit.h, [196](#)
- E2
 - buzzer_pitches_16bit.h, [184](#)
 - buzzer_pitches_8bit.h, [197](#)
- E3
 - buzzer_pitches_16bit.h, [185](#)
 - buzzer_pitches_8bit.h, [197](#)
- E4

- buzzer_pitches_16bit.h, 185
- E5
 - buzzer_pitches_16bit.h, 185
- E6
 - buzzer_pitches_16bit.h, 185
- E7
 - buzzer_pitches_16bit.h, 185
- eightBits
 - io, 35
- enableADC
 - core::MCU, 65
- enableAutoTrigger
 - core::ADConverter, 43
- enableConversionCompleteInterrupt
 - core::ADConverter, 43
- enabled
 - core, 26
- enableDataRegisterEmptyInterrupt
 - io::USART0, 140
- enableInputCaptureInterrupt
 - core::TimerCounter1, 118
- enableInt0
 - core::ExternInterrupt, 57
- enableInt1
 - core::ExternInterrupt, 57
- enableOutputCompareMatchInterrupt
 - core::TimerCounter, 104
 - core::TimerCounter0, 109
 - core::TimerCounter1, 119
 - core::TimerCounter2, 129
- enableOverflowInterrupt
 - core::TimerCounter, 104
 - core::TimerCounter0, 109
 - core::TimerCounter1, 119
 - core::TimerCounter2, 130
- enablePinChange
 - core::ExternInterrupt, 57
- enablePinChangeMaskPortB
 - core::ExternInterrupt, 58
- enablePinChangeMaskPortC
 - core::ExternInterrupt, 58
- enablePinChangeMaskPortD
 - core::ExternInterrupt, 58
- enableReceiveCompleteInterrupt
 - io::USART0, 141
- enableSPI
 - core::MCU, 65
- enableTimerCounter0
 - core::MCU, 66
- enableTimerCounter1
 - core::MCU, 66
- enableTimerCounter2
 - core::MCU, 66
- enableTransferCompleteInterrupt
 - io::SPI, 87
- enableTransmitCompleteInterrupt
 - io::USART0, 141
- enableTWI
 - core::MCU, 67
- enableUSART0
 - core::MCU, 67
- evenParity
 - io, 36
- EXT_INT_DISABLE_INT0
 - ha_m328p.h, 217
- EXT_INT_DISABLE_INT1
 - ha_m328p.h, 218
- EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT
 - ha_m328p.h, 218
- EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB
 - ha_m328p.h, 218
- EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC
 - ha_m328p.h, 218
- EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD
 - ha_m328p.h, 218
- EXT_INT_ENABLE_INT0
 - ha_m328p.h, 218
- EXT_INT_ENABLE_INT1
 - ha_m328p.h, 219
- EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT
 - ha_m328p.h, 219
- EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB
 - ha_m328p.h, 219
- EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC
 - ha_m328p.h, 219
- EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD
 - ha_m328p.h, 219
- EXT_INT_INT0_INTERRUPT
 - ha_m328p.h, 219
- EXT_INT_INT1_INTERRUPT
 - ha_m328p.h, 220
- EXT_INT_PIN_CHANGE_PORTB_INTERRUPT
 - ha_m328p.h, 220
- EXT_INT_PIN_CHANGE_PORTC_INTERRUPT
 - ha_m328p.h, 220
- EXT_INT_PIN_CHANGE_PORTD_INTERRUPT
 - ha_m328p.h, 220
- EXT_INT_SET_INT0_SENSE_CONTROL
 - ha_m328p.h, 220
- EXT_INT_SET_INT1_SENSE_CONTROL
 - ha_m328p.h, 220
- extendedStandby
 - core, 31
- extern_Clock_T0_Falling_Edge
 - core, 27
- extern_Clock_T0_Rising_Edge
 - core, 27
- ExternInterrupt
 - core::ExternInterrupt, 56, 57
- ExternInterrupt.cpp, 203, 204
- ExternInterrupt.h, 205, 208
- extInterrupt
 - core, 25
- F0
 - buzzer_pitches_16bit.h, 185
- F1

- buzzer_pitches_16bit.h, [186](#)
 - buzzer_pitches_8bit.h, [197](#)
- F2
 - buzzer_pitches_16bit.h, [186](#)
 - buzzer_pitches_8bit.h, [197](#)
- F3
 - buzzer_pitches_16bit.h, [186](#)
 - buzzer_pitches_8bit.h, [197](#)
- F4
 - buzzer_pitches_16bit.h, [186](#)
- F5
 - buzzer_pitches_16bit.h, [186](#)
- F6
 - buzzer_pitches_16bit.h, [186](#)
- F7
 - buzzer_pitches_16bit.h, [187](#)
- fallingEdge
 - core, [31](#)
- fast_PWM
 - core, [28](#), [29](#)
- fast_PWM_10bit
 - core, [28](#), [29](#)
- fast_PWM_8bit
 - core, [28](#), [29](#)
- fast_PWM_9bit
 - core, [28](#), [29](#)
- fast_PWM_ICR
 - core, [28](#), [29](#)
- fast_PWM_OCR
 - core, [28](#), [29](#)
- first_LSB
 - io, [35](#)
- first_MSB
 - io, [35](#)
- fiveBits
 - io, [35](#)
- frameError
 - io::USART0, [142](#)
- frameSize
 - io, [35](#)
- freeRunning
 - core, [25](#)
- fullStep
 - component, [24](#)
- Fx0
 - buzzer_pitches_16bit.h, [187](#)
- Fx1
 - buzzer_pitches_16bit.h, [187](#)
 - buzzer_pitches_8bit.h, [197](#)
- Fx2
 - buzzer_pitches_16bit.h, [187](#)
 - buzzer_pitches_8bit.h, [198](#)
- Fx3
 - buzzer_pitches_16bit.h, [187](#)
 - buzzer_pitches_8bit.h, [198](#)
- Fx4
 - buzzer_pitches_16bit.h, [187](#)
- Fx5
 - buzzer_pitches_16bit.h, [188](#)
- Fx6
 - buzzer_pitches_16bit.h, [188](#)
- Fx7
 - buzzer_pitches_16bit.h, [188](#)
- G0
 - buzzer_pitches_16bit.h, [188](#)
- G1
 - buzzer_pitches_16bit.h, [188](#)
 - buzzer_pitches_8bit.h, [198](#)
- G2
 - buzzer_pitches_16bit.h, [188](#)
 - buzzer_pitches_8bit.h, [198](#)
- G3
 - buzzer_pitches_16bit.h, [189](#)
 - buzzer_pitches_8bit.h, [198](#)
- G4
 - buzzer_pitches_16bit.h, [189](#)
- G5
 - buzzer_pitches_16bit.h, [189](#)
- G6
 - buzzer_pitches_16bit.h, [189](#)
- G7
 - buzzer_pitches_16bit.h, [189](#)
- getClockPrescaler
 - core::TimerCounter, [104](#)
 - core::TimerCounter0, [110](#)
 - core::TimerCounter1, [120](#)
 - core::TimerCounter2, [130](#)
- getConversionResult
 - core::ADConverter, [43](#)
- getCounter
 - core::TimerCounter, [104](#)
 - core::TimerCounter0, [110](#)
 - core::TimerCounter1, [120](#)
 - core::TimerCounter2, [131](#)
- getInputCaptureRegister
 - core::TimerCounter1, [120](#)
- getInstance
 - core::ADConverter, [44](#)
 - core::ExternInterrupt, [59](#)
 - core::TimerCounter0, [110](#)
 - core::TimerCounter1, [120](#)
 - core::TimerCounter2, [131](#)
 - core::WatchdogTimer, [155](#)
 - io::SPI, [88](#)
 - io::USART0, [142](#)
- getNumberBytesReceived
 - io::USART0, [142](#)
- getNumberBytesSent
 - io::USART0, [143](#)
- getOutputCompareRegister
 - core::TimerCounter, [105](#)
 - core::TimerCounter0, [111](#)
 - core::TimerCounter1, [121](#)
 - core::TimerCounter2, [131](#)
- getPinNumber
 - io::Pin, [71](#)

- getPressedCount
 - component::PushButton, [77](#)
- goalReached
 - component::StepperMotor, [96](#)
- goToSleep
 - core::MCU, [67](#)
- Gx0
 - buzzer_pitches_16bit.h, [189](#)
 - buzzer_pitches_8bit.h, [198](#)
- Gx1
 - buzzer_pitches_16bit.h, [190](#)
 - buzzer_pitches_8bit.h, [199](#)
- Gx2
 - buzzer_pitches_16bit.h, [190](#)
 - buzzer_pitches_8bit.h, [199](#)
- Gx3
 - buzzer_pitches_16bit.h, [190](#)
- Gx4
 - buzzer_pitches_16bit.h, [190](#)
- Gx5
 - buzzer_pitches_16bit.h, [190](#)
- Gx6
 - buzzer_pitches_16bit.h, [190](#)
- Gx7
 - buzzer_pitches_16bit.h, [191](#)
- ha_base.h, [209](#), [210](#)
 - STR, [210](#)
 - STRx, [210](#)
- ha_m328p.h, [211](#), [242](#)
 - ADC_ADJUST_RESULT_LEFT, [215](#)
 - ADC_ADJUST_RESULT_RIGHT, [215](#)
 - ADC_CONVERSION_COMPLETE_INTERRUPT, [215](#)
 - ADC_DISABLE, [215](#)
 - ADC_DISABLE_AUTOTRIGGER, [215](#)
 - ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT, [216](#)
 - ADC_DISABLE_DIGITAL_INPUT_REGISTER, [216](#)
 - ADC_ENABLE, [216](#)
 - ADC_ENABLE_AUTOTRIGGER, [216](#)
 - ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT, [216](#)
 - ADC_SELECT_ANALOG_INPUT, [216](#)
 - ADC_SELECT_AUTO_TRIGGER_SOURCE, [217](#)
 - ADC_SELECT_CLOCK_PRESCALER, [217](#)
 - ADC_SELECT_REF_VOLTAGE, [217](#)
 - ADC_START_CONVERSION, [217](#)
 - ADC_STOP_CONVERSION, [217](#)
 - EXT_INT_DISABLE_INT0, [217](#)
 - EXT_INT_DISABLE_INT1, [218](#)
 - EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT, [218](#)
 - EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB, [218](#)
 - EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC, [218](#)
 - EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD, [218](#)
 - EXT_INT_ENABLE_INT0, [218](#)
 - EXT_INT_ENABLE_INT1, [219](#)
 - EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT, [219](#)
 - EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB, [219](#)
 - EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC, [219](#)
 - EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD, [219](#)
 - EXT_INT_INT0_INTERRUPT, [219](#)
 - EXT_INT_INT1_INTERRUPT, [220](#)
 - EXT_INT_PIN_CHANGE_PORTB_INTERRUPT, [220](#)
 - EXT_INT_PIN_CHANGE_PORTC_INTERRUPT, [220](#)
 - EXT_INT_PIN_CHANGE_PORTD_INTERRUPT, [220](#)
 - EXT_INT_SET_INT0_SENSE_CONTROL, [220](#)
 - EXT_INT_SET_INT1_SENSE_CONTROL, [220](#)
 - MCU_ADC_DISABLE, [221](#)
 - MCU_ADC_ENABLE, [221](#)
 - MCU_BOD_DISABLE, [221](#)
 - MCU_SELECT_SLEEP_MODE, [221](#)
 - MCU_SLEEP_DISABLE, [221](#)
 - MCU_SLEEP_ENABLE, [221](#)
 - MCU_SPI_DISABLE, [222](#)
 - MCU_SPI_ENABLE, [222](#)
 - MCU_TIMER0_DISABLE, [222](#)
 - MCU_TIMER0_ENABLE, [222](#)
 - MCU_TIMER1_DISABLE, [222](#)
 - MCU_TIMER1_ENABLE, [222](#)
 - MCU_TIMER2_DISABLE, [223](#)
 - MCU_TIMER2_ENABLE, [223](#)
 - MCU_TWI_DISABLE, [223](#)
 - MCU_TWI_ENABLE, [223](#)
 - MCU_USART0_DISABLE, [223](#)
 - MCU_USART0_ENABLE, [223](#)
 - PUSHBUTTON_DEBOUNCE_TIME_US, [224](#)
 - PUSHBUTTON_SAMPLING, [224](#)
 - SERVOMOTOR_TIMER_ANGLE_COUNT, [224](#)
 - SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT, [224](#)
 - SPI_CONTROL_REGISTER, [224](#)
 - SPI_DATA_REGISTER, [225](#)
 - SPI_DISABLE, [225](#)
 - SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT, [225](#)
 - SPI_ENABLE, [225](#)
 - SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT, [225](#)
 - SPI_MASTER_MODE, [225](#)
 - SPI_SELECT_CLOCK_PRESCALER, [226](#)
 - SPI_SELECT_DATA_MODE, [226](#)
 - SPI_SELECT_DATA_ORDER, [226](#)
 - SPI_SELECT_MASTER_MODE, [226](#)

- SPI_SELECT_SLAVE_MODE, [226](#)
- SPI_STATUS_REGISTER, [226](#)
- SPI_TRANSFER_COMPLETE, [227](#)
- SPI_TRANSFER_COMPLETE_INTERRUPT, [227](#)
- SPI_WRITE_COLLISION, [227](#)
- TIMER0_COM_CHANNEL_A_INTERRUPT, [227](#)
- TIMER0_COM_CHANNEL_B_INTERRUPT, [227](#)
- TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT, [227](#)
- TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT, [228](#)
- TIMER0_DISABLE_OVERFLOW_INTERRUPT, [228](#)
- TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT, [228](#)
- TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT, [228](#)
- TIMER0_ENABLE_OVERFLOW_INTERRUPT, [228](#)
- TIMER0_OVERFLOW_INTERRUPT, [228](#)
- TIMER0_SELECT_CLOCK_SOURCE, [229](#)
- TIMER0_SELECT_COM_CHANNEL_A, [229](#)
- TIMER0_SELECT_COM_CHANNEL_B, [229](#)
- TIMER0_SELECT_OPERATION_MODE, [229](#)
- TIMER0_STOP, [229](#)
- TIMER1_COM_CHANNEL_A_INTERRUPT, [229](#)
- TIMER1_COM_CHANNEL_B_INTERRUPT, [230](#)
- TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT, [230](#)
- TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT, [230](#)
- TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT, [230](#)
- TIMER1_DISABLE_OVERFLOW_INTERRUPT, [230](#)
- TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT, [230](#)
- TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT, [231](#)
- TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT, [231](#)
- TIMER1_ENABLE_OVERFLOW_INTERRUPT, [231](#)
- TIMER1_INPUT_CAPTURE_INTERRUPT, [231](#)
- TIMER1_OVERFLOW_INTERRUPT, [231](#)
- TIMER1_SELECT_CLOCK_SOURCE, [231](#)
- TIMER1_SELECT_COM_CHANNEL_A, [232](#)
- TIMER1_SELECT_COM_CHANNEL_B, [232](#)
- TIMER1_SELECT_OPERATION_MODE, [232](#)
- TIMER1_STOP, [232](#)
- TIMER2_COM_CHANNEL_A_INTERRUPT, [232](#)
- TIMER2_COM_CHANNEL_B_INTERRUPT, [232](#)
- TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT, [233](#)
- TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT, [233](#)
- TIMER2_DISABLE_OVERFLOW_INTERRUPT, [233](#)
- TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT, [233](#)
- TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT, [233](#)
- TIMER2_ENABLE_OVERFLOW_INTERRUPT, [233](#)
- TIMER2_OVERFLOW_INTERRUPT, [234](#)
- TIMER2_SELECT_CLOCK_SOURCE, [234](#)
- TIMER2_SELECT_COM_CHANNEL_A, [234](#)
- TIMER2_SELECT_COM_CHANNEL_B, [234](#)
- TIMER2_SELECT_OPERATION_MODE, [234](#)
- TIMER2_STOP, [234](#)
- USART0_CONTROL_STATUS_REGISTER, [235](#)
- USART0_DATA_OVERRUN, [235](#)
- USART0_DATA_REGISTER, [235](#)
- USART0_DATA_REGISTER_EMPTY_INTERRUPT, [235](#)
- USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT, [235](#)
- USART0_DISABLE_DOUBLE_SPEED_MODE, [235](#), [236](#)
- USART0_DISABLE_PARITY_MODE, [236](#)
- USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT, [236](#)
- USART0_DISABLE_RECEIVER, [236](#)
- USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT, [236](#)
- USART0_DISABLE_TRANSMITTER, [236](#)
- USART0_ENABLE_ASYNC_TRANSMISSION_MODE, [237](#)
- USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT, [237](#)
- USART0_ENABLE_DOUBLE_SPEED_MODE, [237](#)
- USART0_ENABLE_EVEN_PARITY_MODE, [237](#)
- USART0_ENABLE_MASTER_SPI_MODE, [237](#)
- USART0_ENABLE_ODD_PARITY_MODE, [237](#)
- USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT, [238](#)
- USART0_ENABLE_RECEIVER, [238](#)
- USART0_ENABLE_SYNC_TRANSMISSION_MODE, [238](#)
- USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT, [238](#)
- USART0_ENABLE_TRANSMITTER, [238](#)
- USART0_FRAME_ERROR, [238](#)
- USART0_PARITY_ERROR, [239](#)
- USART0_RECEIVE_COMPLETE_INTERRUPT, [239](#)
- USART0_SET_5BIT_FRAME_SIZE, [239](#)
- USART0_SET_6BIT_FRAME_SIZE, [239](#)
- USART0_SET_7BIT_FRAME_SIZE, [239](#)
- USART0_SET_8BIT_FRAME_SIZE, [240](#)
- USART0_SET_9BIT_FRAME_SIZE, [240](#)
- USART0_SET_BAUDRATE_HIGH_REGISTER, [240](#)
- USART0_SET_BAUDRATE_LOW_REGISTER, [240](#)

- USART0_SET_ONE_STOP_BIT, [240](#)
- USART0_SET_TWO_STOP_BITS, [241](#)
- USART0_TRANSMIT_COMPLETE_INTERRUPT, [241](#)
- WATCHDOG_SELECT_TIMEOUT, [241](#)
- WATCHDOG_START, [241](#)
- WATCHDOG_STOP, [241](#)
- WATCHDOG_TIMEOUT_INTERRUPT, [241](#)
- halfStep
 - component, [24](#)
- Idle
 - core, [31](#)
- init
 - core::MCU, [68](#)
- inputCaptureServiceRoutine
 - core::TimerCounter1, [121](#)
- Int0ServiceRoutine
 - core::ExternInterrupt, [59](#)
- Int1ServiceRoutine
 - core::ExternInterrupt, [59](#)
- internal
 - core, [30](#)
- interrupt
 - core, [28](#), [29](#)
- interrupt_reset
 - core, [28](#), [29](#)
- io, [32](#)
 - async, [37](#)
 - clockPrescaler, [33](#)
 - communicationMode, [33](#)
 - dataMode, [34](#)
 - dataOrder, [34](#)
 - disable, [35](#)
 - duplex, [34](#)
 - eightBits, [35](#)
 - evenParity, [36](#)
 - first_LSB, [35](#)
 - first_MSB, [35](#)
 - fiveBits, [35](#)
 - frameSize, [35](#)
 - master, [35](#)
 - masterSPI, [37](#)
 - mode_0, [34](#)
 - mode_1, [34](#)
 - mode_2, [34](#)
 - mode_3, [34](#)
 - neineBits, [35](#)
 - noParity, [36](#)
 - oddParity, [36](#)
 - oneStopBit, [37](#)
 - operationMode, [35](#)
 - parityMode, [36](#)
 - PortB, [37](#)
 - PortC, [37](#)
 - PortD, [38](#)
 - PS_128, [33](#)
 - PS_16, [33](#)
 - PS_2, [33](#)
 - PS_32, [33](#)
 - PS_4, [33](#)
 - PS_64, [33](#)
 - PS_8, [33](#)
 - receive, [34](#)
 - sevenBits, [35](#)
 - sixBits, [35](#)
 - slave, [35](#)
 - stopBit, [36](#)
 - submaster, [35](#)
 - sync, [37](#)
 - transmissionMode, [37](#)
 - transmit, [34](#)
 - twoStopBits, [37](#)
- io::Pin, [69](#)
 - ~Pin, [70](#)
 - getPinNumber, [71](#)
 - isHigh, [71](#)
 - isLow, [71](#)
 - m_pinNumber, [73](#)
 - mr_portName, [73](#)
 - Pin, [70](#)
 - setHigh, [71](#)
 - setLow, [72](#)
 - toggle, [72](#)
 - toInput, [72](#)
 - toOutput, [73](#)
- io::Port, [74](#)
 - mp_ddrReg, [74](#)
 - mp_pinReg, [74](#)
 - mp_portReg, [74](#)
- io::SPI, [85](#)
 - __externally_visible__, [92](#)
 - __used__, [92](#)
 - ~SPI, [87](#)
 - enableTransferCompleteInterrupt, [87](#)
 - getInstance, [88](#)
 - m_data, [92](#)
 - m_pinMISO, [92](#)
 - m_pinMOSI, [92](#)
 - m_pinSCK, [93](#)
 - m_pinSS, [93](#)
 - masterReceiveByte, [88](#)
 - masterSendByte, [88](#)
 - operator=, [89](#)
 - selectClockPrescaler, [89](#)
 - selectDataMode, [89](#)
 - selectDataOrder, [89](#)
 - selectOperationMode, [90](#)
 - selectSlave, [90](#)
 - slaveReceiveByte, [91](#)
 - SPI, [86](#), [87](#)
 - transferComplete, [91](#)
 - transferCompleteServiceRoutine, [91](#)
 - writeCollision, [91](#)
- io::USART0, [137](#)
 - __externally_visible__, [152](#)
 - __used__, [152](#)

- ~USART0, [139](#)
- dataOverrun, [139](#)
- dataRegisterEmptyServiceRoutine, [140](#)
- enableDataRegisterEmptyInterrupt, [140](#)
- enableReceiveCompleteInterrupt, [141](#)
- enableTransmitCompleteInterrupt, [141](#)
- frameError, [142](#)
- getInstance, [142](#)
- getNumberBytesReceived, [142](#)
- getNumberBytesSent, [143](#)
- m_numberBytesReceived, [152](#)
- m_numberBytesSent, [152](#)
- m_ready2Send, [153](#)
- m_sizeData2Receive, [153](#)
- m_sizeData2Send, [153](#)
- m_status, [153](#)
- mp_data2Receive, [153](#)
- mp_data2Send, [154](#)
- operator=, [143](#)
- parityError, [143](#)
- ready2Send, [143](#)
- receiveChar, [144](#)
- receiveCompleteServiceRoutine, [144](#)
- receiveFrame, [145](#)
- receiveString, [145](#)
- resetNumberBytesReceived, [145](#)
- sendByte, [146](#)
- sendChar, [146](#)
- sendFrame, [147](#)
- sendLong, [147](#)
- sendString, [147](#)
- sendWord, [148](#)
- setBaudRate, [148](#)
- setCommunicationMode, [149](#)
- setFrameSize, [149](#)
- setParityMode, [150](#)
- setStopBit, [151](#)
- setTransmissionMode, [151](#)
- transmitCompleteServiceRoutine, [152](#)
- USART0, [138](#), [139](#)
- isHigh
 - io::Pin, [71](#)
- isLow
 - io::Pin, [71](#)
- isOff
 - component::Led, [63](#)
- isOn
 - component::Led, [63](#)
- isPressed
 - component::PushButton, [77](#)
- LCD.cpp, [246](#)
- LCD.h, [246](#)
- Led
 - component::Led, [62](#)
- Led.cpp, [246](#)
- Led.h, [247](#), [248](#)
- logicalChange
 - core, [31](#)
- lowLevel
 - core, [31](#)
- m_accelTime
 - component::StepperMotor, [101](#)
- m_buttonPressed
 - component::PushButton, [78](#)
- m_clockPrescaler
 - core::TimerCounter0, [115](#)
 - core::TimerCounter1, [126](#)
 - core::TimerCounter2, [136](#)
- m_clockSource
 - core::TimerCounter0, [116](#)
 - core::TimerCounter1, [127](#)
 - core::TimerCounter2, [136](#)
- m_constSpeedTime
 - component::StepperMotor, [101](#)
- m_conversionComplete
 - core::ADConverter, [47](#)
- m_currentPos
 - component::StepperMotor, [101](#)
- m_data
 - io::SPI, [92](#)
- m_decelTime
 - component::StepperMotor, [102](#)
- m_goalReached
 - component::StepperMotor, [102](#)
- m_numberBytesReceived
 - io::USART0, [152](#)
- m_numberBytesSent
 - io::USART0, [152](#)
- m_operationMode
 - core::WatchdogTimer, [158](#)
- m_pin
 - component::Buzzer, [51](#)
 - component::DCMotor, [55](#)
 - component::Led, [64](#)
 - component::PushButton, [78](#)
 - component::ServoMotor, [84](#)
- m_pinCoil1
 - component::StepperMotor, [102](#)
- m_pinCoil2
 - component::StepperMotor, [102](#)
- m_pinCoil3
 - component::StepperMotor, [102](#)
- m_pinCoil4
 - component::StepperMotor, [103](#)
- m_pinMISO
 - io::SPI, [92](#)
- m_pinMOSI
 - io::SPI, [92](#)
- m_pinNumber
 - io::Pin, [73](#)
- m_pinSCK
 - io::SPI, [93](#)
- m_pinSS
 - io::SPI, [93](#)
- m_pulseCycle
 - component::ServoMotor, [84](#)

- m_pulseWidthMax
 - component::ServoMotor, [84](#)
- m_pulseWidthMid
 - component::ServoMotor, [84](#)
- m_pulseWidthMin
 - component::ServoMotor, [84](#)
- m_ready2Send
 - io::USART0, [153](#)
- m_resolution
 - core::ADConverter, [47](#)
- m_sizeData2Receive
 - io::USART0, [153](#)
- m_sizeData2Send
 - io::USART0, [153](#)
- m_status
 - io::USART0, [153](#)
- m_timeOut
 - core::WatchdogTimer, [158](#)
- main
 - BlinkLed/main.cpp, [250](#)
 - MusicBox/main.cpp, [252](#)
 - Organ/main.cpp, [256](#)
- main.cpp, [248](#), [250](#), [251](#), [253](#), [254](#)
- map
 - utils, [38](#)
- master
 - io, [35](#)
- masterReceiveByte
 - io::SPI, [88](#)
- masterSendByte
 - io::SPI, [88](#)
- masterSPI
 - io, [37](#)
- MCU.cpp, [258](#), [259](#)
- MCU.h, [260](#), [262](#)
- MCU_ADC_DISABLE
 - ha_m328p.h, [221](#)
- MCU_ADC_ENABLE
 - ha_m328p.h, [221](#)
- MCU_BOD_DISABLE
 - ha_m328p.h, [221](#)
- MCU_SELECT_SLEEP_MODE
 - ha_m328p.h, [221](#)
- MCU_SLEEP_DISABLE
 - ha_m328p.h, [221](#)
- MCU_SLEEP_ENABLE
 - ha_m328p.h, [221](#)
- MCU_SPI_DISABLE
 - ha_m328p.h, [222](#)
- MCU_SPI_ENABLE
 - ha_m328p.h, [222](#)
- MCU_TIMER0_DISABLE
 - ha_m328p.h, [222](#)
- MCU_TIMER0_ENABLE
 - ha_m328p.h, [222](#)
- MCU_TIMER1_DISABLE
 - ha_m328p.h, [222](#)
- MCU_TIMER1_ENABLE
 - ha_m328p.h, [222](#)
- MCU_TIMER2_DISABLE
 - ha_m328p.h, [223](#)
- MCU_TIMER2_ENABLE
 - ha_m328p.h, [223](#)
- MCU_TWI_DISABLE
 - ha_m328p.h, [223](#)
- MCU_TWI_ENABLE
 - ha_m328p.h, [223](#)
- MCU_USART0_DISABLE
 - ha_m328p.h, [223](#)
- MCU_USART0_ENABLE
 - ha_m328p.h, [223](#)
- mode
 - component, [23](#)
- mode_0
 - io, [34](#)
- mode_1
 - io, [34](#)
- mode_2
 - io, [34](#)
- mode_3
 - io, [34](#)
- mp_conversionResult
 - core::ADConverter, [47](#)
- mp_data2Receive
 - io::USART0, [153](#)
- mp_data2Send
 - io::USART0, [154](#)
- mp_ddrReg
 - io::Port, [74](#)
- mp_pinReg
 - io::Port, [74](#)
- mp_portReg
 - io::Port, [74](#)
- mr_isActiveLow
 - component::PushButton, [78](#)
- mr_portName
 - io::Pin, [73](#)
- mr_useInternalPullUp
 - component::PushButton, [78](#)
- MusicBox/main.cpp
 - BUZZER, [252](#)
 - main, [252](#)
 - PUSHBUTTON, [252](#)
 - SONG_LENGTH, [252](#)
- neineBits
 - io, [35](#)
- noClock
 - core, [27](#)
- noParity
 - io, [36](#)
- normal
 - core, [27](#), [28](#)
- NOTE_DURATION
 - Organ/main.cpp, [256](#)
- oddParity

- io, 36
- off
 - component::DCMotor, 54
 - component::Led, 63
 - component::ServoMotor, 82
- on
 - component::DCMotor, 54
 - component::Led, 64
 - component::ServoMotor, 83
- oneStopBit
 - io, 37
- operationMode
 - core, 28
 - io, 35
- operator=
 - core::ADConverter, 45
 - core::ExternInterrupt, 59
 - core::TimerCounter0, 111
 - core::TimerCounter1, 121
 - core::TimerCounter2, 132
 - core::WatchdogTimer, 156
 - io::SPI, 89
 - io::USART0, 143
- Organ/main.cpp
 - BUZZER, 256
 - main, 256
 - NOTE_DURATION, 256
- outputCompareMatchAServiceRoutine
 - core::TimerCounter0, 111
 - core::TimerCounter1, 121
 - core::TimerCounter2, 132
- outputCompareMatchBServiceRoutine
 - core::TimerCounter0, 111
 - core::TimerCounter1, 122
 - core::TimerCounter2, 132
- overflowServiceRoutine
 - core::TimerCounter0, 112
 - core::TimerCounter1, 122
 - core::TimerCounter2, 132
- parityError
 - io::USART0, 143
- parityMode
 - io, 36
- pause
 - component::Buzzer, 51
- PCINTB
 - core, 29
- PCINTC
 - core, 29
- PCINTD
 - core, 29
- Pin
 - io::Pin, 70
- Pin.cpp, 263
- Pin.h, 264, 265
- PIN_NUMBER
 - BlinkLed/main.cpp, 249
- pinChangePort
 - core, 29
- pinChangePortBServiceRoutine
 - core::ExternInterrupt, 59
- pinChangePortCServiceRoutine
 - core::ExternInterrupt, 60
- pinChangePortDServiceRoutine
 - core::ExternInterrupt, 60
- PortB
 - io, 37
- PortC
 - io, 37
- PortD
 - io, 38
- powerDown
 - core, 31
- powerSave
 - core, 31
- PS_1
 - core, 27
- PS_1024
 - core, 27
- PS_128
 - core, 26, 27
 - io, 33
- PS_16
 - core, 26
 - io, 33
- PS_2
 - core, 26
 - io, 33
- PS_256
 - core, 27
- PS_32
 - core, 26, 27
 - io, 33
- PS_4
 - core, 26
 - io, 33
- PS_64
 - core, 26, 27
 - io, 33
- PS_8
 - core, 26, 27
 - io, 33
- PUSHBUTTON
 - MusicBox/main.cpp, 252
- PushButton
 - component::PushButton, 76
- PushButton.cpp, 266
- PushButton.h, 267, 268
- PUSHBUTTON_DEBOUNCE_TIME_US
 - ha_m328p.h, 224
- PUSHBUTTON_SAMPLING
 - ha_m328p.h, 224
- PWM_PC
 - core, 28
- PWM_PC_10bit
 - core, 28, 29

- PWM_PC_8bit
 - core, [28](#)
- PWM_PC_9bit
 - core, [28](#), [29](#)
- PWM_PC_ICR
 - core, [28](#), [29](#)
- PWM_PC_OCR
 - core, [28](#), [29](#)
- PWM_PFC_ICR
 - core, [28](#), [29](#)
- PWM_PFC_OCR
 - core, [28](#), [29](#)
- README.md, [269](#)
- ready2Send
 - io::USART0, [143](#)
- receive
 - io, [34](#)
- receiveChar
 - io::USART0, [144](#)
- receiveCompleteServiceRoutine
 - io::USART0, [144](#)
- receiveFrame
 - io::USART0, [145](#)
- receiveString
 - io::USART0, [145](#)
- referenceVoltage
 - core, [30](#)
- res_10bit
 - core, [30](#)
- res_11bit
 - core, [30](#)
- res_12bit
 - core, [30](#)
- res_13bit
 - core, [30](#)
- res_14bit
 - core, [30](#)
- res_15bit
 - core, [30](#)
- res_16bit
 - core, [30](#)
- res_8bit
 - core, [30](#)
- res_9bit
 - core, [30](#)
- reset
 - core, [28](#), [29](#)
 - core::WatchdogTimer, [156](#)
- resetNumberBytesReceived
 - io::USART0, [145](#)
- resetPressedCount
 - component::PushButton, [77](#)
- resolution
 - core, [30](#)
- risingEdge
 - core, [31](#)
- rotate
 - component::ServoMotor, [83](#)
- selectAnalogInput
 - core::ADConverter, [45](#)
- selectAutoTriggerSource
 - core::ADConverter, [45](#)
- selectClockPrescaler
 - core::ADConverter, [45](#)
 - io::SPI, [89](#)
- selectClockSource
 - core::TimerCounter, [105](#)
 - core::TimerCounter0, [112](#)
 - core::TimerCounter1, [122](#)
 - core::TimerCounter2, [132](#)
- selectCompareOutputMode
 - core::TimerCounter, [105](#)
 - core::TimerCounter0, [113](#)
 - core::TimerCounter1, [123](#)
 - core::TimerCounter2, [133](#)
- selectDataMode
 - io::SPI, [89](#)
- selectDataOrder
 - io::SPI, [89](#)
- selectOperationMode
 - core::TimerCounter, [105](#)
 - core::TimerCounter0, [113](#)
 - core::TimerCounter1, [123](#)
 - core::TimerCounter2, [134](#)
 - io::SPI, [90](#)
- selectReferenceVoltage
 - core::ADConverter, [46](#)
- selectSlave
 - io::SPI, [90](#)
- selectSleepMode
 - core::MCU, [68](#)
- selectTimeOut
 - core::WatchdogTimer, [156](#)
- sendByte
 - io::USART0, [146](#)
- sendChar
 - io::USART0, [146](#)
- sendFrame
 - io::USART0, [147](#)
- sendLong
 - io::USART0, [147](#)
- sendString
 - io::USART0, [147](#)
- sendWord
 - io::USART0, [148](#)
- senseControl
 - core, [30](#)
- ServoMotor
 - component::ServoMotor, [80](#)
- ServoMotor.cpp, [269](#)
- ServoMotor.h, [271](#), [274](#)
- SERVOMOTOR_TIMER_ANGLE_COUNT
 - ha_m328p.h, [224](#)
- SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT
 - ha_m328p.h, [224](#)
- set

- core, 27
- setBaudRate
 - io::USART0, 148
- setCommunicationMode
 - io::USART0, 149
- setCounter
 - core::TimerCounter, 105
 - core::TimerCounter0, 114
 - core::TimerCounter1, 125
 - core::TimerCounter2, 134
- setCurrentPos
 - component::StepperMotor, 97
- setFrameSize
 - io::USART0, 149
- setHigh
 - io::Pin, 71
- setInputCaptureRegister
 - core::TimerCounter1, 125
- setInt0SenseControl
 - core::ExternInterrupt, 60
- setInt1SenseControl
 - core::ExternInterrupt, 60
- setLow
 - io::Pin, 72
- setOutputCompareRegister
 - core::TimerCounter, 105
 - core::TimerCounter0, 114
 - core::TimerCounter1, 125
 - core::TimerCounter2, 135
- setParityMode
 - io::USART0, 150
- setStopBit
 - io::USART0, 151
- setTransmissionMode
 - io::USART0, 151
- sevenBits
 - io, 35
- sixBits
 - io, 35
- slave
 - io, 35
- slaveReceiveByte
 - io::SPI, 91
- sleepEnable
 - core::MCU, 68
- sleepMode
 - core, 31
- SONG_LENGTH
 - MusicBox/main.cpp, 252
- SPI
 - io::SPI, 86, 87
- SPI.cpp, 275
- SPI.h, 277, 279
- SPI_CONTROL_REGISTER
 - ha_m328p.h, 224
- SPI_DATA_REGISTER
 - ha_m328p.h, 225
- SPI_DISABLE
 - ha_m328p.h, 225
- SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT
 - ha_m328p.h, 225
- SPI_ENABLE
 - ha_m328p.h, 225
- SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT
 - ha_m328p.h, 225
- SPI_MASTER_MODE
 - ha_m328p.h, 225
- SPI_SELECT_CLOCK_PRESCALER
 - ha_m328p.h, 226
- SPI_SELECT_DATA_MODE
 - ha_m328p.h, 226
- SPI_SELECT_DATA_ORDER
 - ha_m328p.h, 226
- SPI_SELECT_MASTER_MODE
 - ha_m328p.h, 226
- SPI_SELECT_SLAVE_MODE
 - ha_m328p.h, 226
- SPI_STATUS_REGISTER
 - ha_m328p.h, 226
- SPI_TRANSFER_COMPLETE
 - ha_m328p.h, 227
- SPI_TRANSFER_COMPLETE_INTERRUPT
 - ha_m328p.h, 227
- SPI_WRITE_COLLISION
 - ha_m328p.h, 227
- spin
 - component::DCMotor, 54
- standby
 - core, 31
- start
 - core::ADConverter, 46
 - core::TimerCounter, 106
 - core::TimerCounter0, 114
 - core::TimerCounter1, 125
 - core::TimerCounter2, 135
 - core::WatchdogTimer, 156, 157
- step
 - component::StepperMotor, 97–99
- stepDelay
 - component::StepperMotor, 100
- stepMode
 - component::StepperMotor, 103
- StepperMotor
 - component::StepperMotor, 94
- StepperMotor.cpp, 280
- StepperMotor.h, 285, 286
- stepPulse
 - component::StepperMotor, 100
- stop
 - component::DCMotor, 54
 - core::ADConverter, 46
 - core::TimerCounter, 106
 - core::TimerCounter0, 115
 - core::TimerCounter1, 126
 - core::TimerCounter2, 135
 - core::WatchdogTimer, 157

- stopBit
 - io, [36](#)
- STR
 - ha_base.h, [210](#)
- STRx
 - ha_base.h, [210](#)
- submaster
 - io, [35](#)
- sync
 - io, [37](#)
- TIMEDELAY
 - BlinkLed/main.cpp, [249](#)
- timeOut
 - core, [31](#)
- timeOutServiceRoutine
 - core::WatchdogTimer, [157](#)
- TIMER0_COM_CHANNEL_A_INTERRUPT
 - ha_m328p.h, [227](#)
- TIMER0_COM_CHANNEL_B_INTERRUPT
 - ha_m328p.h, [227](#)
- TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT
 - ha_m328p.h, [227](#)
- TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT
 - ha_m328p.h, [228](#)
- TIMER0_DISABLE_OVERFLOW_INTERRUPT
 - ha_m328p.h, [228](#)
- TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT
 - ha_m328p.h, [228](#)
- TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT
 - ha_m328p.h, [228](#)
- TIMER0_ENABLE_OVERFLOW_INTERRUPT
 - ha_m328p.h, [228](#)
- TIMER0_OVERFLOW_INTERRUPT
 - ha_m328p.h, [228](#)
- TIMER0_SELECT_CLOCK_SOURCE
 - ha_m328p.h, [229](#)
- TIMER0_SELECT_COM_CHANNEL_A
 - ha_m328p.h, [229](#)
- TIMER0_SELECT_COM_CHANNEL_B
 - ha_m328p.h, [229](#)
- TIMER0_SELECT_OPERATION_MODE
 - ha_m328p.h, [229](#)
- TIMER0_STOP
 - ha_m328p.h, [229](#)
- timer0Compare
 - core, [25](#)
- timer0Overflow
 - core, [25](#)
- TIMER1_COM_CHANNEL_A_INTERRUPT
 - ha_m328p.h, [229](#)
- TIMER1_COM_CHANNEL_B_INTERRUPT
 - ha_m328p.h, [230](#)
- TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT
 - ha_m328p.h, [230](#)
- TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT
 - ha_m328p.h, [230](#)
- TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT
 - ha_m328p.h, [230](#)
- TIMER1_DISABLE_OVERFLOW_INTERRUPT
 - ha_m328p.h, [230](#)
- TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT
 - ha_m328p.h, [230](#)
- TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT
 - ha_m328p.h, [231](#)
- TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT
 - ha_m328p.h, [231](#)
- TIMER1_ENABLE_OVERFLOW_INTERRUPT
 - ha_m328p.h, [231](#)
- TIMER1_INPUT_CAPTURE_INTERRUPT
 - ha_m328p.h, [231](#)
- TIMER1_OVERFLOW_INTERRUPT
 - ha_m328p.h, [231](#)
- TIMER1_SELECT_CLOCK_SOURCE
 - ha_m328p.h, [231](#)
- TIMER1_SELECT_COM_CHANNEL_A
 - ha_m328p.h, [232](#)
- TIMER1_SELECT_COM_CHANNEL_B
 - ha_m328p.h, [232](#)
- TIMER1_SELECT_OPERATION_MODE
 - ha_m328p.h, [232](#)
- TIMER1_STOP
 - ha_m328p.h, [232](#)
- timer1Capture
 - core, [25](#)
- timer1CompareB
 - core, [25](#)
- timer1Overflow
 - core, [25](#)
- TIMER2_COM_CHANNEL_A_INTERRUPT
 - ha_m328p.h, [232](#)
- TIMER2_COM_CHANNEL_B_INTERRUPT
 - ha_m328p.h, [232](#)
- TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT
 - ha_m328p.h, [233](#)
- TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT
 - ha_m328p.h, [233](#)
- TIMER2_DISABLE_OVERFLOW_INTERRUPT
 - ha_m328p.h, [233](#)
- TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT
 - ha_m328p.h, [233](#)
- TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT
 - ha_m328p.h, [233](#)
- TIMER2_ENABLE_OVERFLOW_INTERRUPT
 - ha_m328p.h, [233](#)
- TIMER2_OVERFLOW_INTERRUPT
 - ha_m328p.h, [234](#)
- TIMER2_SELECT_CLOCK_SOURCE
 - ha_m328p.h, [234](#)
- TIMER2_SELECT_COM_CHANNEL_A
 - ha_m328p.h, [234](#)
- TIMER2_SELECT_COM_CHANNEL_B
 - ha_m328p.h, [234](#)
- TIMER2_SELECT_OPERATION_MODE
 - ha_m328p.h, [234](#)
- TIMER2_STOP
 - ha_m328p.h, [234](#)

TimerCounter.h, [287](#), [297](#)
TimerCounter0
 core::TimerCounter0, [108](#)
TimerCounter0.cpp, [299](#)
TimerCounter0.h, [302](#), [303](#)
TimerCounter1
 core::TimerCounter1, [118](#)
TimerCounter1.cpp, [304](#), [305](#)
TimerCounter1.h, [309](#), [310](#)
TimerCounter2
 core::TimerCounter2, [129](#)
TimerCounter2.cpp, [311](#)
TimerCounter2.h, [314](#), [315](#)
to_125ms
 core, [31](#)
to_16ms
 core, [31](#)
to_1s
 core, [31](#)
to_250ms
 core, [31](#)
to_2s
 core, [32](#)
to_32ms
 core, [31](#)
to_4s
 core, [32](#)
to_500ms
 core, [31](#)
to_64ms
 core, [31](#)
to_8s
 core, [32](#)
toggle
 component::DCMotor, [55](#)
 component::Led, [64](#)
 component::ServoMotor, [83](#)
 core, [27](#)
 io::Pin, [72](#)
toInput
 io::Pin, [72](#)
toOutput
 io::Pin, [73](#)
transferComplete
 io::SPI, [91](#)
transferCompleteServiceRoutine
 io::SPI, [91](#)
transmissionMode
 io, [37](#)
transmit
 io, [34](#)
transmitCompleteServiceRoutine
 io::USART0, [152](#)
twoStopBits
 io, [37](#)

USART0
 io::USART0, [138](#), [139](#)
USART0.cpp, [316](#), [317](#)

USART0.h, [322](#), [323](#)
USART0_CONTROL_STATUS_REGISTER
 ha_m328p.h, [235](#)
USART0_DATA_OVERRUN
 ha_m328p.h, [235](#)
USART0_DATA_REGISTER
 ha_m328p.h, [235](#)
USART0_DATA_REGISTER_EMPTY_INTERRUPT
 ha_m328p.h, [235](#)
USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT
 ha_m328p.h, [235](#)
USART0_DISABLE_DOUBLE_SPEED_MODE
 ha_m328p.h, [235](#), [236](#)
USART0_DISABLE_PARITY_MODE
 ha_m328p.h, [236](#)
USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT
 ha_m328p.h, [236](#)
USART0_DISABLE_RECEIVER
 ha_m328p.h, [236](#)
USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT
 ha_m328p.h, [236](#)
USART0_DISABLE_TRANSMITTER
 ha_m328p.h, [236](#)
USART0_ENABLE_ASYNC_TRANSMISSION_MODE
 ha_m328p.h, [237](#)
USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT
 ha_m328p.h, [237](#)
USART0_ENABLE_DOUBLE_SPEED_MODE
 ha_m328p.h, [237](#)
USART0_ENABLE_EVEN_PARITY_MODE
 ha_m328p.h, [237](#)
USART0_ENABLE_MASTER_SPI_MODE
 ha_m328p.h, [237](#)
USART0_ENABLE_ODD_PARITY_MODE
 ha_m328p.h, [237](#)
USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT
 ha_m328p.h, [238](#)
USART0_ENABLE_RECEIVER
 ha_m328p.h, [238](#)
USART0_ENABLE_SYNC_TRANSMISSION_MODE
 ha_m328p.h, [238](#)
USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT
 ha_m328p.h, [238](#)
USART0_ENABLE_TRANSMITTER
 ha_m328p.h, [238](#)
USART0_FRAME_ERROR
 ha_m328p.h, [238](#)
USART0_PARITY_ERROR
 ha_m328p.h, [239](#)
USART0_RECEIVE_COMPLETE_INTERRUPT
 ha_m328p.h, [239](#)
USART0_SET_5BIT_FRAME_SIZE
 ha_m328p.h, [239](#)
USART0_SET_6BIT_FRAME_SIZE
 ha_m328p.h, [239](#)
USART0_SET_7BIT_FRAME_SIZE
 ha_m328p.h, [239](#)
USART0_SET_8BIT_FRAME_SIZE

- ha_m328p.h, [240](#)
- USART0_SET_9BIT_FRAME_SIZE
 - ha_m328p.h, [240](#)
- USART0_SET_BAUDRATE_HIGH_REGISTER
 - ha_m328p.h, [240](#)
- USART0_SET_BAUDRATE_LOW_REGISTER
 - ha_m328p.h, [240](#)
- USART0_SET_ONE_STOP_BIT
 - ha_m328p.h, [240](#)
- USART0_SET_TWO_STOP_BITS
 - ha_m328p.h, [241](#)
- USART0_TRANSMIT_COMPLETE_INTERRUPT
 - ha_m328p.h, [241](#)
- utils, [38](#)
 - map, [38](#)
- utils_m328p.cpp, [325](#)
- utils_m328p.h, [325](#), [326](#)

- WATCHDOG_SELECT_TIMEOUT
 - ha_m328p.h, [241](#)
- WATCHDOG_START
 - ha_m328p.h, [241](#)
- WATCHDOG_STOP
 - ha_m328p.h, [241](#)
- WATCHDOG_TIMEOUT_INTERRUPT
 - ha_m328p.h, [241](#)
- WatchdogTimer
 - core::WatchdogTimer, [155](#)
- WatchdogTimer.cpp, [326](#)
- WatchdogTimer.h, [327](#), [330](#)
- writeCollision
 - io::SPI, [91](#)