# TahakomAVRLibDoc

1.0

Generated by Doxygen 1.8.17

**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

**3 README** 11

**4 Namespace Index** 13
4.1 Namespace List . . . 13

**5 Hierarchical Index** 15
5.1 Class Hierarchy . . . 15

**6 Class Index** 17
6.1 Class List . . . 17

**7 File Index** 19
7.1 File List . . . 19

**8 Namespace Documentation** 21
8.1 component Namespace Reference . . . 21
8.1.1 Detailed Description . . . 21

8.1.2 Enumeration Type Documentation . . . 21
8.1.2.1 mode . . . 21
8.2 core Namespace Reference . . . 22
8.2.1 Enumeration Type Documentation . . . 23
8.2.1.1 autoTriggerSource . . . 23
8.2.1.2 BODMode . . . 24
8.2.1.3 channel . . . 24
8.2.1.4 clockPrescaler . . . 24
8.2.1.5 clockSource . . . 25
8.2.1.6 compareOutputMode . . . 25
8.2.1.7 operationMode [1/2] . . . 26
8.2.1.8 operationMode [2/2] . . . 26
8.2.1.9 pinChangePort . . . 27
8.2.1.10 referenceVoltage . . . 28
8.2.1.11 resolution . . . 28
8.2.1.12 senseControl . . . 28
8.2.1.13 sleepMode . . . 29
8.2.1.14 timeOut . . . 29
8.3 io Namespace Reference . . . 30
8.3.1 Detailed Description . . . 31
8.3.2 Enumeration Type Documentation . . . 31
8.3.2.1 clockPrescaler . . . 31
8.3.2.2 communicationMode . . . 31
8.3.2.3 dataMode . . . 32
8.3.2.4 dataOrder . . . 32
8.3.2.5 frameSize . . . 33
8.3.2.6 operationMode . . . 33
8.3.2.7 parityMode . . . 34
8.3.2.8 stopBit . . . 34
8.3.2.9 transmissionMode . . . 35
8.3.3 Variable Documentation . . . 35
8.3.3.1 PortB . . . 35
8.3.3.2 PortC . . . 36
8.3.3.3 PortD . . . 36
8.4 utils Namespace Reference . . . 36
8.4.1 Function Documentation . . . 36
8.4.1.1 map() . . . 36

**9 Class Documentation** **37**

9.1 core::ADConverter Class Reference . . . 37
9.1.1 Detailed Description . . . 38
9.1.2 Constructor & Destructor Documentation . . . 38

9.1.2.1 ADConverter() [1/2] . . . 38
9.1.2.2 ~ADConverter() . . . 38
9.1.2.3 ADConverter() [2/2] . . . 39
9.1.3 Member Function Documentation . . . 39
9.1.3.1 conversionComplete() . . . 39
9.1.3.2 conversionCompleteServiceRoutine() . . . 39
9.1.3.3 enableAutoTrigger() . . . 41
9.1.3.4 enableConversionCompleteInterrupt() . . . 41
9.1.3.5 getConversionResult() . . . 42
9.1.3.6 getInstance() . . . 42
9.1.3.7 operator=() . . . 43
9.1.3.8 selectAnalogInput() . . . 43
9.1.3.9 selectAutoTriggerSource() . . . 43
9.1.3.10 selectClockPrescaler() . . . 44
9.1.3.11 selectReferenceVoltage() . . . 44
9.1.3.12 start() . . . 44
9.1.3.13 stop() . . . 44
9.1.4 Member Data Documentation . . . 45
9.1.4.1 __externally_visible__ . . . 45
9.1.4.2 __used__ . . . 45
9.1.4.3 m_conversionComplete . . . 45
9.1.4.4 m_resolution . . . 45
9.1.4.5 mp_conversionResult . . . 45
9.2 core::AnalogComparator Class Reference . . . 46
9.2.1 Detailed Description . . . 46
9.3 component::Buzzer Class Reference . . . 46
9.3.1 Detailed Description . . . 47
9.3.2 Constructor & Destructor Documentation . . . 47
9.3.2.1 Buzzer() . . . 47
9.3.2.2 ~Buzzer() . . . 48
9.3.3 Member Function Documentation . . . 48
9.3.3.1 buzz() [1/2] . . . 48
9.3.3.2 buzz() [2/2] . . . 48
9.3.3.3 pause() . . . 49
9.3.4 Member Data Documentation . . . 49
9.3.4.1 m_pin . . . 50
9.4 component::DCMotor Class Reference . . . 50
9.4.1 Detailed Description . . . 51
9.4.2 Constructor & Destructor Documentation . . . 51
9.4.2.1 DCMotor() . . . 51
9.4.2.2 ~DCMotor() . . . 51
9.4.3 Member Function Documentation . . . 51

9.4.3.1 connect() . . . 51
9.4.3.2 disconnect() . . . 52
9.4.3.3 off() . . . 52
9.4.3.4 on() . . . 52
9.4.3.5 spin() . . . 52
9.4.3.6 stop() . . . 53
9.4.3.7 toggle() . . . 53
9.4.4 Member Data Documentation . . . 53
9.4.4.1 m_pin . . . 53
9.5 core::ExternInterrupt Class Reference . . . 53
9.5.1 Detailed Description . . . 54
9.5.2 Constructor & Destructor Documentation . . . 54
9.5.2.1 ExternInterrupt() [1/2] . . . 54
9.5.2.2 ~ExternInterrupt() . . . 55
9.5.2.3 ExternInterrupt() [2/2] . . . 55
9.5.3 Member Function Documentation . . . 55
9.5.3.1 enableInt0() . . . 55
9.5.3.2 enableInt1() . . . 55
9.5.3.3 enablePinChange() . . . 56
9.5.3.4 enablePinChangeMaskPortB() . . . 56
9.5.3.5 enablePinChangeMaskPortC() . . . 56
9.5.3.6 enablePinChangeMaskPortD() . . . 57
9.5.3.7 getInstance() . . . 57
9.5.3.8 Int0ServiceRoutine() . . . 57
9.5.3.9 Int1ServiceRoutine() . . . 57
9.5.3.10 operator=() . . . 57
9.5.3.11 pinChangePortBServiceRoutine() . . . 58
9.5.3.12 pinChangePortCServiceRoutine() . . . 58
9.5.3.13 pinChangePortDServiceRoutine() . . . 58
9.5.3.14 setInt0SenseControl() . . . 58
9.5.3.15 setInt1SenseControl() . . . 58
9.5.4 Member Data Documentation . . . 58
9.5.4.1 __externally_visible__ . . . 59
9.5.4.2 __used__ . . . 59
9.6 component::Led Class Reference . . . 59
9.6.1 Detailed Description . . . 60
9.6.2 Constructor & Destructor Documentation . . . 60
9.6.2.1 Led() . . . 60
9.6.2.2 ~Led() . . . 61
9.6.3 Member Function Documentation . . . 61
9.6.3.1 isOff() . . . 61
9.6.3.2 isOn() . . . 61

9.6.3.3 off() . . . 62
9.6.3.4 on() . . . 62
9.6.3.5 toggle() . . . 62
9.6.4 Member Data Documentation . . . 62
9.6.4.1 m_pin . . . 62
9.7 core::MCU Class Reference . . . 63
9.7.1 Detailed Description . . . 63
9.7.2 Member Function Documentation . . . 63
9.7.2.1 disableBOD() . . . 63
9.7.2.2 enableADC() . . . 63
9.7.2.3 enableSPI() . . . 64
9.7.2.4 enableTimerCounter0() . . . 64
9.7.2.5 enableTimerCounter1() . . . 64
9.7.2.6 enableTimerCounter2() . . . 65
9.7.2.7 enableTWI() . . . 65
9.7.2.8 enableUSART0() . . . 65
9.7.2.9 goToSleep() . . . 66
9.7.2.10 init() . . . 66
9.7.2.11 selectSleepMode() . . . 66
9.7.2.12 sleepEnable() . . . 67
9.8 io::Pin Class Reference . . . 67
9.8.1 Detailed Description . . . 68
9.8.2 Constructor & Destructor Documentation . . . 68
9.8.2.1 Pin() . . . 68
9.8.2.2 ∼Pin() . . . 68
9.8.3 Member Function Documentation . . . 69
9.8.3.1 getPinNumber() . . . 69
9.8.3.2 isHigh() . . . 69
9.8.3.3 isLow() . . . 69
9.8.3.4 setHigh() . . . 70
9.8.3.5 setLow() . . . 70
9.8.3.6 toggle() . . . 70
9.8.3.7 toInput() . . . 70
9.8.3.8 toOutput() . . . 71
9.8.4 Member Data Documentation . . . 71
9.8.4.1 m_pinNumber . . . 71
9.8.4.2 mr_portName . . . 71
9.9 io::Port Struct Reference . . . 72
9.9.1 Detailed Description . . . 72
9.9.2 Member Data Documentation . . . 72
9.9.2.1 mp_ddrReg . . . 72
9.9.2.2 mp_pinReg . . . 72

9.9.2.3 mp_portReg . . . 72
9.10 component::PushButton Class Reference . . . 73
9.10.1 Detailed Description . . . 73
9.10.2 Constructor & Destructor Documentation . . . 73
9.10.2.1 PushButton() . . . 74
9.10.2.2 ~PushButton() . . . 74
9.10.3 Member Function Documentation . . . 74
9.10.3.1 getPressedCount() . . . 74
9.10.3.2 isPressed() . . . 75
9.10.3.3 resetPressedCount() . . . 75
9.10.4 Member Data Documentation . . . 75
9.10.4.1 m_buttonPressed . . . 75
9.10.4.2 m_pin . . . 76
9.10.4.3 mr_isActiveLow . . . 76
9.10.4.4 mr_useInternalPullUp . . . 76
9.11 component::ServoMotor Class Reference . . . 76
9.11.1 Detailed Description . . . 77
9.11.2 Constructor & Destructor Documentation . . . 77
9.11.2.1 ServoMotor() . . . 77
9.11.2.2 ~ServoMotor() . . . 78
9.11.3 Member Function Documentation . . . 78
9.11.3.1 computePulseCycleCount() . . . 78
9.11.3.2 computePulseWidthMaxCount() . . . 78
9.11.3.3 computePulseWidthMidCount() . . . 78
9.11.3.4 computePulseWidthMinCount() . . . 79
9.11.3.5 computeRotationAngleCount() . . . 79
9.11.3.6 connect() . . . 79
9.11.3.7 disconnect() . . . 80
9.11.3.8 off() . . . 80
9.11.3.9 on() . . . 80
9.11.3.10 rotate() . . . 80
9.11.3.11 toggle() . . . 81
9.11.4 Member Data Documentation . . . 81
9.11.4.1 m_pin . . . 81
9.11.4.2 m_pulseCycle . . . 81
9.11.4.3 m_pulseWidthMax . . . 81
9.11.4.4 m_pulseWidthMid . . . 82
9.11.4.5 m_pulseWidthMin . . . 82
9.12 io::SPI Class Reference . . . 82
9.12.1 Detailed Description . . . 83
9.12.2 Constructor & Destructor Documentation . . . 84
9.12.2.1 SPI() [1/2] . . . 84

9.12.2.2 ~SPI() . . . 84
9.12.2.3 SPI() [2/2] . . . 84
9.12.3 Member Function Documentation . . . 85
9.12.3.1 enableTransferCompleteInterrupt() . . . 85
9.12.3.2 getInstance() . . . 85
9.12.3.3 masterReceiveByte() . . . 85
9.12.3.4 masterSendByte() . . . 86
9.12.3.5 operator=() . . . 86
9.12.3.6 selectClockPrescaler() . . . 86
9.12.3.7 selectDataMode() . . . 86
9.12.3.8 selectDataOrder() . . . 87
9.12.3.9 selectOperationMode() . . . 87
9.12.3.10 selectSlave() . . . 88
9.12.3.11 slaveReceiveByte() . . . 88
9.12.3.12 transferComplete() . . . 88
9.12.3.13 transferCompleteServiceRoutine() . . . 88
9.12.3.14 writeCollision() . . . 89
9.12.4 Member Data Documentation . . . 89
9.12.4.1 __externally_visible__ . . . 89
9.12.4.2 __used__ . . . 89
9.12.4.3 m_data . . . 89
9.12.4.4 m_pinMISO . . . 89
9.12.4.5 m_pinMOSI . . . 90
9.12.4.6 m_pinSCK . . . 90
9.12.4.7 m_pinSS . . . 90
9.13 component::StepperMotor Class Reference . . . 90
9.13.1 Detailed Description . . . 91
9.13.2 Constructor & Destructor Documentation . . . 91
9.13.2.1 StepperMotor() . . . 92
9.13.2.2 ~StepperMotor() . . . 92
9.13.3 Member Function Documentation . . . 92
9.13.3.1 computeStepDelay() . . . 92
9.13.3.2 currentPos() . . . 93
9.13.3.3 goalReached() . . . 94
9.13.3.4 setCurrentPos() . . . 94
9.13.3.5 step() [1/3] . . . 94
9.13.3.6 step() [2/3] . . . 95
9.13.3.7 step() [3/3] . . . 96
9.13.3.8 stepDelay() . . . 97
9.13.3.9 stepPulse() . . . 97
9.13.4 Member Data Documentation . . . 98
9.13.4.1 m_accelTime . . . 98

9.13.4.2 m_constSpeedTime . . . 98
9.13.4.3 m_currentPos . . . 99
9.13.4.4 m_decelTime . . . 99
9.13.4.5 m_goalReached . . . 99
9.13.4.6 m_pinCoil1 . . . 99
9.13.4.7 m_pinCoil2 . . . 99
9.13.4.8 m_pinCoil3 . . . 100
9.13.4.9 m_pinCoil4 . . . 100
9.13.4.10 stepMode . . . 100
9.14 core::TimerCounter Class Reference . . . 100
9.14.1 Detailed Description . . . 101
9.14.2 Member Function Documentation . . . 101
9.14.2.1 enableOutputCompareMatchInterrupt() . . . 101
9.14.2.2 enableOverflowInterrupt() . . . 101
9.14.2.3 getClockPrescaler() . . . 101
9.14.2.4 getCounter() . . . 102
9.14.2.5 getOutputCompareRegister() . . . 102
9.14.2.6 selectClockSource() . . . 102
9.14.2.7 selectCompareOutputMode() . . . 102
9.14.2.8 selectOperationMode() . . . 102
9.14.2.9 setCounter() . . . 102
9.14.2.10 setOutputCompareRegister() . . . 103
9.14.2.11 start() . . . 103
9.14.2.12 stop() . . . 103
9.15 core::TimerCounter0 Class Reference . . . 103
9.15.1 Detailed Description . . . 105
9.15.2 Constructor & Destructor Documentation . . . 105
9.15.2.1 TimerCounter0() [1/2] . . . 105
9.15.2.2 ~TimerCounter0() . . . 105
9.15.2.3 TimerCounter0() [2/2] . . . 106
9.15.3 Member Function Documentation . . . 106
9.15.3.1 enableOutputCompareMatchInterrupt() . . . 106
9.15.3.2 enableOverflowInterrupt() . . . 107
9.15.3.3 getClockPrescaler() . . . 107
9.15.3.4 getCounter() . . . 107
9.15.3.5 getInstance() . . . 108
9.15.3.6 getOutputCompareRegister() . . . 108
9.15.3.7 operator=() . . . 108
9.15.3.8 outputCompareMatchAServiceRoutine() . . . 108
9.15.3.9 outputCompareMatchBServiceRoutine() . . . 109
9.15.3.10 overflowServiceRoutine() . . . 109
9.15.3.11 selectClockSource() . . . 109

9.15.3.12 selectCompareOutputMode() . . . 110
9.15.3.13 selectOperationMode() . . . 110
9.15.3.14 setCounter() . . . 111
9.15.3.15 setOutputCompareRegister() . . . 111
9.15.3.16 start() . . . 112
9.15.3.17 stop() . . . 112
9.15.4 Member Data Documentation . . . 112
9.15.4.1 __externally_visible__ . . . 112
9.15.4.2 __used__ . . . 112
9.15.4.3 m_clockPrescaler . . . 113
9.15.4.4 m_clockSource . . . 113
9.16 core::TimerCounter1 Class Reference . . . 113
9.16.1 Detailed Description . . . 115
9.16.2 Constructor & Destructor Documentation . . . 115
9.16.2.1 TimerCounter1() [1/2] . . . 115
9.16.2.2 ~TimerCounter1() . . . 115
9.16.2.3 TimerCounter1() [2/2] . . . 115
9.16.3 Member Function Documentation . . . 115
9.16.3.1 enableInputCaptureInterrupt() . . . 116
9.16.3.2 enableOutputCompareMatchInterrupt() . . . 116
9.16.3.3 enableOverflowInterrupt() . . . 117
9.16.3.4 getClockPrescaler() . . . 117
9.16.3.5 getCounter() . . . 117
9.16.3.6 getInputCaptureRegister() . . . 117
9.16.3.7 getInstance() . . . 118
9.16.3.8 getOutputCompareRegister() . . . 118
9.16.3.9 inputCaptureServiceRoutine() . . . 118
9.16.3.10 operator=() . . . 118
9.16.3.11 outputCompareMatchAServiceRoutine() . . . 119
9.16.3.12 outputCompareMatchBServiceRoutine() . . . 119
9.16.3.13 overflowServiceRoutine() . . . 119
9.16.3.14 selectClockSource() . . . 119
9.16.3.15 selectCompareOutputMode() . . . 120
9.16.3.16 selectOperationMode() . . . 120
9.16.3.17 setCounter() . . . 122
9.16.3.18 setInputCaptureRegister() . . . 122
9.16.3.19 setOutputCompareRegister() . . . 122
9.16.3.20 start() . . . 123
9.16.3.21 stop() . . . 123
9.16.4 Member Data Documentation . . . 123
9.16.4.1 __externally_visible__ . . . 123
9.16.4.2 __used__ . . . 123

9.16.4.3 m_clockPrescaler . . . 124
9.16.4.4 m_clockSource . . . 124
9.17 core::TimerCounter2 Class Reference . . . 124
9.17.1 Detailed Description . . . 125
9.17.2 Constructor & Destructor Documentation . . . 126
9.17.2.1 TimerCounter2() [1/2] . . . 126
9.17.2.2 ~TimerCounter2() . . . 126
9.17.2.3 TimerCounter2() [2/2] . . . 126
9.17.3 Member Function Documentation . . . 126
9.17.3.1 enableOutputCompareMatchInterrupt() . . . 127
9.17.3.2 enableOverflowInterrupt() . . . 127
9.17.3.3 getClockPrescaler() . . . 128
9.17.3.4 getCounter() . . . 128
9.17.3.5 getInstance() . . . 128
9.17.3.6 getOutputCompareRegister() . . . 129
9.17.3.7 operator=() . . . 129
9.17.3.8 outputCompareMatchAServiceRoutine() . . . 129
9.17.3.9 outputCompareMatchBServiceRoutine() . . . 129
9.17.3.10 overflowServiceRoutine() . . . 129
9.17.3.11 selectClockSource() . . . 130
9.17.3.12 selectCompareOutputMode() . . . 130
9.17.3.13 selectOperationMode() . . . 131
9.17.3.14 setCounter() . . . 132
9.17.3.15 setOutputCompareRegister() . . . 132
9.17.3.16 start() . . . 132
9.17.3.17 stop() . . . 133
9.17.4 Member Data Documentation . . . 133
9.17.4.1 __externally_visible__ . . . 133
9.17.4.2 __used__ . . . 133
9.17.4.3 m_clockPrescaler . . . 133
9.17.4.4 m_clockSource . . . 133
9.18 io::USART0 Class Reference . . . 134
9.18.1 Detailed Description . . . 135
9.18.2 Constructor & Destructor Documentation . . . 135
9.18.2.1 USART0() [1/2] . . . 135
9.18.2.2 ~USART0() . . . 136
9.18.2.3 USART0() [2/2] . . . 136
9.18.3 Member Function Documentation . . . 136
9.18.3.1 dataOverrun() . . . 137
9.18.3.2 dataRegisterEmptyServiceRoutine() . . . 137
9.18.3.3 enableDataRegisterEmptyInterrupt() . . . 137
9.18.3.4 enableReceiveCompleteInterrupt() . . . 138

9.18.3.5 enableTransmitCompleteInterrupt() . . . 138
9.18.3.6 frameError() . . . 139
9.18.3.7 getInstance() . . . 139
9.18.3.8 getNumberBytesReceived() . . . 140
9.18.3.9 getNumberBytesSent() . . . 140
9.18.3.10 operator=() . . . 140
9.18.3.11 parityError() . . . 140
9.18.3.12 ready2Send() . . . 141
9.18.3.13 receiveChar() . . . 141
9.18.3.14 receiveCompleteServiceRoutine() . . . 141
9.18.3.15 receiveFrame() . . . 142
9.18.3.16 receiveString() . . . 142
9.18.3.17 resetNumberBytesReceived() . . . 143
9.18.3.18 sendByte() . . . 143
9.18.3.19 sendChar() . . . 143
9.18.3.20 sendFrame() . . . 144
9.18.3.21 sendLong() . . . 144
9.18.3.22 sendString() . . . 145
9.18.3.23 sendWord() . . . 145
9.18.3.24 setBaudRate() . . . 145
9.18.3.25 setCommunicationMode() . . . 146
9.18.3.26 setFrameSize() . . . 146
9.18.3.27 setParityMode() . . . 147
9.18.3.28 setStopBit() . . . 148
9.18.3.29 setTransmissionMode() . . . 148
9.18.3.30 transmitCompleteServiceRoutine() . . . 149
9.18.4 Member Data Documentation . . . 149
9.18.4.1 __externally_visible__ . . . 149
9.18.4.2 __used__ . . . 149
9.18.4.3 m_numberBytesReceived . . . 149
9.18.4.4 m_numberBytesSent . . . 150
9.18.4.5 m_ready2Send . . . 150
9.18.4.6 m_sizeData2Receive . . . 150
9.18.4.7 m_sizeData2Send . . . 150
9.18.4.8 m_status . . . 150
9.18.4.9 mp_data2Receive . . . 151
9.18.4.10 mp_data2Send . . . 151
9.19 core::WatchdogTimer Class Reference . . . 151
9.19.1 Detailed Description . . . 152
9.19.2 Constructor & Destructor Documentation . . . 152
9.19.2.1 WatchdogTimer() [1/2] . . . 152
9.19.2.2 ~WatchdogTimer() . . . 152

9.19.2.3 WatchdogTimer() [2/2] . . . 152
9.19.3 Member Function Documentation . . . 152
9.19.3.1 getInstance() . . . 153
9.19.3.2 operator=() . . . 153
9.19.3.3 reset() . . . 153
9.19.3.4 selectTimeOut() . . . 153
9.19.3.5 start() [1/2] . . . 154
9.19.3.6 start() [2/2] . . . 154
9.19.3.7 stop() . . . 154
9.19.3.8 timeOutServiceRoutine() . . . 155
9.19.4 Member Data Documentation . . . 155
9.19.4.1 __externally_visible__ . . . 155
9.19.4.2 __used__ . . . 155
9.19.4.3 m_operationMode . . . 155
9.19.4.4 m_timeOut . . . 155

**10 File Documentation** **157**

10.1 ADC.cpp File Reference . . . 157
10.2 ADC.cpp . . . 157
10.3 ADC.h File Reference . . . 161
10.3.1 Detailed Description . . . 162
10.4 ADC.h . . . 164
10.5 AnalogComparator.cpp File Reference . . . 165
10.6 AnalogComparator.cpp . . . 165
10.7 AnalogComparator.h File Reference . . . 165
10.7.1 Macro Definition Documentation . . . 166
10.7.1.1 ANALOG_COMARATOR_H . . . 166
10.8 AnalogComparator.h . . . 167
10.9 Buzzer.cpp File Reference . . . 167
10.10 Buzzer.cpp . . . 167
10.11 Buzzer.h File Reference . . . 168
10.12 Buzzer.h . . . 169
10.13 buzzer_pitches_16bit.h File Reference . . . 171
10.13.1 Macro Definition Documentation . . . 173
10.13.1.1 A0 . . . 173
10.13.1.2 A1 . . . 173
10.13.1.3 A2 . . . 173
10.13.1.4 A3 . . . 173
10.13.1.5 A4 . . . 174
10.13.1.6 A5 . . . 174
10.13.1.7 A6 . . . 174
10.13.1.8 A7 . . . 174

10.13.1.9 Ax0 . . . 174
10.13.1.10 Ax1 . . . 174
10.13.1.11 Ax2 . . . 175
10.13.1.12 Ax3 . . . 175
10.13.1.13 Ax4 . . . 175
10.13.1.14 Ax5 . . . 175
10.13.1.15 Ax6 . . . 175
10.13.1.16 Ax7 . . . 175
10.13.1.17 B0 . . . 176
10.13.1.18 B1 . . . 176
10.13.1.19 B2 . . . 176
10.13.1.20 B3 . . . 176
10.13.1.21 B4 . . . 176
10.13.1.22 B5 . . . 176
10.13.1.23 B6 . . . 177
10.13.1.24 B7 . . . 177
10.13.1.25 C0 . . . 177
10.13.1.26 C1 . . . 177
10.13.1.27 C2 . . . 177
10.13.1.28 C3 . . . 177
10.13.1.29 C4 . . . 178
10.13.1.30 C5 . . . 178
10.13.1.31 C6 . . . 178
10.13.1.32 C7 . . . 178
10.13.1.33 Cx0 . . . 178
10.13.1.34 Cx1 . . . 178
10.13.1.35 Cx2 . . . 179
10.13.1.36 Cx3 . . . 179
10.13.1.37 Cx4 . . . 179
10.13.1.38 Cx5 . . . 179
10.13.1.39 Cx6 . . . 179
10.13.1.40 Cx7 . . . 179
10.13.1.41 D0 . . . 180
10.13.1.42 D1 . . . 180
10.13.1.43 D2 . . . 180
10.13.1.44 D3 . . . 180
10.13.1.45 D4 . . . 180
10.13.1.46 D5 . . . 180
10.13.1.47 D6 . . . 181
10.13.1.48 D7 . . . 181
10.13.1.49 Dx0 . . . 181
10.13.1.50 Dx1 . . . 181

10.13.1.51 Dx2 . . . 181
10.13.1.52 Dx3 . . . 181
10.13.1.53 Dx4 . . . 182
10.13.1.54 Dx5 . . . 182
10.13.1.55 Dx6 . . . 182
10.13.1.56 Dx7 . . . 182
10.13.1.57 E0 . . . 182
10.13.1.58 E1 . . . 182
10.13.1.59 E2 . . . 183
10.13.1.60 E3 . . . 183
10.13.1.61 E4 . . . 183
10.13.1.62 E5 . . . 183
10.13.1.63 E6 . . . 183
10.13.1.64 E7 . . . 183
10.13.1.65 F0 . . . 184
10.13.1.66 F1 . . . 184
10.13.1.67 F2 . . . 184
10.13.1.68 F3 . . . 184
10.13.1.69 F4 . . . 184
10.13.1.70 F5 . . . 184
10.13.1.71 F6 . . . 185
10.13.1.72 F7 . . . 185
10.13.1.73 Fx0 . . . 185
10.13.1.74 Fx1 . . . 185
10.13.1.75 Fx2 . . . 185
10.13.1.76 Fx3 . . . 185
10.13.1.77 Fx4 . . . 186
10.13.1.78 Fx5 . . . 186
10.13.1.79 Fx6 . . . 186
10.13.1.80 Fx7 . . . 186
10.13.1.81 G0 . . . 186
10.13.1.82 G1 . . . 186
10.13.1.83 G2 . . . 187
10.13.1.84 G3 . . . 187
10.13.1.85 G4 . . . 187
10.13.1.86 G5 . . . 187
10.13.1.87 G6 . . . 187
10.13.1.88 G7 . . . 187
10.13.1.89 Gx0 . . . 188
10.13.1.90 Gx1 . . . 188
10.13.1.91 Gx2 . . . 188
10.13.1.92 Gx3 . . . 188

10.13.1.93 Gx4 . . . 188
10.13.1.94 Gx5 . . . 188
10.13.1.95 Gx6 . . . 189
10.13.1.96 Gx7 . . . 189
10.14 buzzer_pitches_16bit.h . . . 189
10.15 buzzer_pitches_8bit.h File Reference . . . 190
10.15.1 Macro Definition Documentation . . . 191
10.15.1.1 A0 . . . 191
10.15.1.2 A1 . . . 191
10.15.1.3 A2 . . . 191
10.15.1.4 Ax0 . . . 192
10.15.1.5 Ax1 . . . 192
10.15.1.6 Ax2 . . . 192
10.15.1.7 B0 . . . 192
10.15.1.8 B1 . . . 192
10.15.1.9 B2 . . . 192
10.15.1.10 C1 . . . 193
10.15.1.11 C2 . . . 193
10.15.1.12 C3 . . . 193
10.15.1.13 Cx0 . . . 193
10.15.1.14 Cx2 . . . 193
10.15.1.15 Cx3 . . . 193
10.15.1.16 D1 . . . 194
10.15.1.17 D2 . . . 194
10.15.1.18 D3 . . . 194
10.15.1.19 Dx0 . . . 194
10.15.1.20 Dx2 . . . 194
10.15.1.21 Dx3 . . . 194
10.15.1.22 E1 . . . 195
10.15.1.23 E2 . . . 195
10.15.1.24 E3 . . . 195
10.15.1.25 F1 . . . 195
10.15.1.26 F2 . . . 195
10.15.1.27 F3 . . . 195
10.15.1.28 Fx1 . . . 196
10.15.1.29 Fx2 . . . 196
10.15.1.30 Fx3 . . . 196
10.15.1.31 G1 . . . 196
10.15.1.32 G2 . . . 196
10.15.1.33 G3 . . . 196
10.15.1.34 Gx0 . . . 197
10.15.1.35 Gx1 . . . 197

10.15.1.36 Gx2 . . . 197
10.16 buzzer_pitches_8bit.h . . . 197
10.17 DCMotor.cpp File Reference . . . 198
10.18 DCMotor.cpp . . . 198
10.19 DCMotor.h File Reference . . . 198
10.19.1 Detailed Description . . . 199
10.20 DCMotor.h . . . 201
10.21 ExternInterrupt.cpp File Reference . . . 201
10.22 ExternInterrupt.cpp . . . 202
10.23 ExternInterrupt.h File Reference . . . 203
10.23.1 Detailed Description . . . 204
10.24 ExternInterrupt.h . . . 206
10.25 ha_base.h File Reference . . . 207
10.25.1 Detailed Description . . . 207
10.25.2 Macro Definition Documentation . . . 208
10.25.2.1 STR . . . 208
10.25.2.2 STRx . . . 208
10.26 ha_base.h . . . 208
10.27 ha_m328p.h File Reference . . . 209
10.27.1 Detailed Description . . . 212
10.27.2 Macro Definition Documentation . . . 213
10.27.2.1 ADC_ADJUST_RESULT_LEFT . . . 213
10.27.2.2 ADC_ADJUST_RESULT_RIGHT . . . 213
10.27.2.3 ADC_CONVERSION_COMPLETE_INTERRUPT . . . 213
10.27.2.4 ADC_DISABLE . . . 213
10.27.2.5 ADC_DISABLE_AUTOTRIGGER . . . 214
10.27.2.6 ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT . . . 214
10.27.2.7 ADC_DISABLE_DIGITAL_INPUT_REGISTER . . . 214
10.27.2.8 ADC_ENABLE . . . 214
10.27.2.9 ADC_ENABLE_AUTOTRIGGER . . . 214
10.27.2.10 ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT . . . 214
10.27.2.11 ADC_SELECT_ANALOG_INPUT . . . 215
10.27.2.12 ADC_SELECT_AUTO_TRIGGER_SOURCE . . . 215
10.27.2.13 ADC_SELECT_CLOCK_PRESCALER . . . 215
10.27.2.14 ADC_SELECT_REF_VOLTAGE . . . 215
10.27.2.15 ADC_START_CONVERSION . . . 215
10.27.2.16 ADC_STOP_CONVERSION . . . 215
10.27.2.17 EXT_INT_DISABLE_INT0 . . . 216
10.27.2.18 EXT_INT_DISABLE_INT1 . . . 216
10.27.2.19 EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT . . . 216
10.27.2.20 EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB . . . 216
10.27.2.21 EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC . . . 216

10.27.2.22 EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD . . . 216
10.27.2.23 EXT_INT_ENABLE_INT0 . . . 217
10.27.2.24 EXT_INT_ENABLE_INT1 . . . 217
10.27.2.25 EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT . . . 217
10.27.2.26 EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB . . . 217
10.27.2.27 EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC . . . 217
10.27.2.28 EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD . . . 217
10.27.2.29 EXT_INT_INT0_INTERRUPT . . . 218
10.27.2.30 EXT_INT_INT1_INTERRUPT . . . 218
10.27.2.31 EXT_INT_PIN_CHANGE_PORTB_INTERRUPT . . . 218
10.27.2.32 EXT_INT_PIN_CHANGE_PORTC_INTERRUPT . . . 218
10.27.2.33 EXT_INT_PIN_CHANGE_PORTD_INTERRUPT . . . 218
10.27.2.34 EXT_INT_SET_INT0_SENSE_CONTROL . . . 218
10.27.2.35 EXT_INT_SET_INT1_SENSE_CONTROL . . . 219
10.27.2.36 MCU_ADC_DISABLE . . . 219
10.27.2.37 MCU_ADC_ENABLE . . . 219
10.27.2.38 MCU_BOD_DISABLE . . . 219
10.27.2.39 MCU_SELECT_SLEEP_MODE . . . 219
10.27.2.40 MCU_SLEEP_DISABLE . . . 219
10.27.2.41 MCU_SLEEP_ENABLE . . . 220
10.27.2.42 MCU_SPI_DISABLE . . . 220
10.27.2.43 MCU_SPI_ENABLE . . . 220
10.27.2.44 MCU_TIMER0_DISABLE . . . 220
10.27.2.45 MCU_TIMER0_ENABLE . . . 220
10.27.2.46 MCU_TIMER1_DISABLE . . . 220
10.27.2.47 MCU_TIMER1_ENABLE . . . 221
10.27.2.48 MCU_TIMER2_DISABLE . . . 221
10.27.2.49 MCU_TIMER2_ENABLE . . . 221
10.27.2.50 MCU_TWI_DISABLE . . . 221
10.27.2.51 MCU_TWI_ENABLE . . . 221
10.27.2.52 MCU_USART0_DISABLE . . . 221
10.27.2.53 MCU_USART0_ENABLE . . . 222
10.27.2.54 PUSHBUTTON_DEBOUNCE_TIME_US . . . 222
10.27.2.55 PUSHBUTTON_SAMPLING . . . 222
10.27.2.56 SERVOMOTOR_TIMER_ANGLE_COUNT . . . 222
10.27.2.57 SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT . . . 222
10.27.2.58 SPI_CONTROL_REGISTER . . . 223
10.27.2.59 SPI_DATA_REGISTER . . . 223
10.27.2.60 SPI_DISABLE . . . 223
10.27.2.61 SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT . . . 223
10.27.2.62 SPI_ENABLE . . . 223
10.27.2.63 SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT . . . 223

10.27.2.64 SPI_MASTER_MODE . . . 224
10.27.2.65 SPI_SELECT_CLOCK_PRESCALER . . . 224
10.27.2.66 SPI_SELECT_DATA_MODE . . . 224
10.27.2.67 SPI_SELECT_DATA_ORDER . . . 224
10.27.2.68 SPI_SELECT_MASTER_MODE . . . 224
10.27.2.69 SPI_SELECT_SLAVE_MODE . . . 224
10.27.2.70 SPI_STATUS_REGISTER . . . 225
10.27.2.71 SPI_TRANSFER_COMPLETE . . . 225
10.27.2.72 SPI_TRANSFER_COMPLETE_INTERRUPT . . . 225
10.27.2.73 SPI_WRITE_COLLISION . . . 225
10.27.2.74 TIMER0_COM_CHANNEL_A_INTERRUPT . . . 225
10.27.2.75 TIMER0_COM_CHANNEL_B_INTERRUPT . . . 225
10.27.2.76 TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT . . . 226
10.27.2.77 TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT . . . 226
10.27.2.78 TIMER0_DISABLE_OVERFLOW_INTERRUPT . . . 226
10.27.2.79 TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT . . . 226
10.27.2.80 TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT . . . 226
10.27.2.81 TIMER0_ENABLE_OVERFLOW_INTERRUPT . . . 226
10.27.2.82 TIMER0_OVERFLOW_INTERRUPT . . . 227
10.27.2.83 TIMER0_SELECT_CLOCK_SOURCE . . . 227
10.27.2.84 TIMER0_SELECT_COM_CHANNEL_A . . . 227
10.27.2.85 TIMER0_SELECT_COM_CHANNEL_B . . . 227
10.27.2.86 TIMER0_SELECT_OPERATION_MODE . . . 227
10.27.2.87 TIMER0_STOP . . . 227
10.27.2.88 TIMER1_COM_CHANNEL_A_INTERRUPT . . . 228
10.27.2.89 TIMER1_COM_CHANNEL_B_INTERRUPT . . . 228
10.27.2.90 TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT . . . 228
10.27.2.91 TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT . . . 228
10.27.2.92 TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT . . . 228
10.27.2.93 TIMER1_DISABLE_OVERFLOW_INTERRUPT . . . 228
10.27.2.94 TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT . . . 229
10.27.2.95 TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT . . . 229
10.27.2.96 TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT . . . 229
10.27.2.97 TIMER1_ENABLE_OVERFLOW_INTERRUPT . . . 229
10.27.2.98 TIMER1_INPUT_CAPTURE_INTERRUPT . . . 229
10.27.2.99 TIMER1_OVERFLOW_INTERRUPT . . . 229
10.27.2.100 TIMER1_SELECT_CLOCK_SOURCE . . . 230
10.27.2.101 TIMER1_SELECT_COM_CHANNEL_A . . . 230
10.27.2.102 TIMER1_SELECT_COM_CHANNEL_B . . . 230
10.27.2.103 TIMER1_SELECT_OPERATION_MODE . . . 230
10.27.2.104 TIMER1_STOP . . . 230
10.27.2.105 TIMER2_COM_CHANNEL_A_INTERRUPT . . . 230

10.27.2.106 TIMER2_COM_CHANNEL_B_INTERRUPT . . . 231
10.27.2.107 TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT . . . 231
10.27.2.108 TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT . . . 231
10.27.2.109 TIMER2_DISABLE_OVERFLOW_INTERRUPT . . . 231
10.27.2.110 TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT . . . 231
10.27.2.111 TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT . . . 231
10.27.2.112 TIMER2_ENABLE_OVERFLOW_INTERRUPT . . . 232
10.27.2.113 TIMER2_OVERFLOW_INTERRUPT . . . 232
10.27.2.114 TIMER2_SELECT_CLOCK_SOURCE . . . 232
10.27.2.115 TIMER2_SELECT_COM_CHANNEL_A . . . 232
10.27.2.116 TIMER2_SELECT_COM_CHANNEL_B . . . 232
10.27.2.117 TIMER2_SELECT_OPERATION_MODE . . . 232
10.27.2.118 TIMER2_STOP . . . 233
10.27.2.119 USART0_CONTROL_STATUS_REGISTER . . . 233
10.27.2.120 USART0_DATA_OVERRUN . . . 233
10.27.2.121 USART0_DATA_REGISTER . . . 233
10.27.2.122 USART0_DATA_REGISTER_EMPTY_INTERRUPT . . . 233
10.27.2.123 USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT . . . 233
10.27.2.124 USART0_DISABLE_DOUBLE_SPEED_MODE [1/2] . . . 234
10.27.2.125 USART0_DISABLE_DOUBLE_SPEED_MODE [2/2] . . . 234
10.27.2.126 USART0_DISABLE_PARITY_MODE . . . 234
10.27.2.127 USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT . . . 234
10.27.2.128 USART0_DISABLE_RECEIVER . . . 234
10.27.2.129 USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT . . . 234
10.27.2.130 USART0_DISABLE_TRANSMITTER . . . 235
10.27.2.131 USART0_ENABLE_ASYNC_TRANSMISSION_MODE . . . 235
10.27.2.132 USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT . . . 235
10.27.2.133 USART0_ENABLE_DOUBLE_SPEED_MODE . . . 235
10.27.2.134 USART0_ENABLE_EVEN_PARITY_MODE . . . 235
10.27.2.135 USART0_ENABLE_MASTER_SPI_MODE . . . 235
10.27.2.136 USART0_ENABLE_ODD_PARITY_MODE . . . 236
10.27.2.137 USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT . . . 236
10.27.2.138 USART0_ENABLE_RECEIVER . . . 236
10.27.2.139 USART0_ENABLE_SYNC_TRANSMISSION_MODE . . . 236
10.27.2.140 USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT . . . 236
10.27.2.141 USART0_ENABLE_TRANSMITTER . . . 236
10.27.2.142 USART0_FRAME_ERROR . . . 237
10.27.2.143 USART0_PARITY_ERROR . . . 237
10.27.2.144 USART0_RECEIVE_COMPLETE_INTERRUPT . . . 237
10.27.2.145 USART0_SET_5BIT_FRAME_SIZE . . . 237
10.27.2.146 USART0_SET_6BIT_FRAME_SIZE . . . 237
10.27.2.147 USART0_SET_7BIT_FRAME_SIZE . . . 238

10.27.2.148 USART0_SET_8BIT_FRAME_SIZE . . . 238
10.27.2.149 USART0_SET_9BIT_FRAME_SIZE . . . 238
10.27.2.150 USART0_SET_BAUDRATE_HIGH_REGISTER . . . 238
10.27.2.151 USART0_SET_BAUDRATE_LOW_REGISTER . . . 238
10.27.2.152 USART0_SET_ONE_STOP_BIT . . . 239
10.27.2.153 USART0_SET_TWO_STOP_BITS . . . 239
10.27.2.154 USART0_TRANSMIT_COMPLETE_INTERRUPT . . . 239
10.27.2.155 WATCHDOG_SELECT_TIMEOUT . . . 239
10.27.2.156 WATCHDOG_START . . . 239
10.27.2.157 WATCHDOG_STOP . . . 239
10.27.2.158 WATCHDOG_TIMEOUT_INTERRUPT . . . 240
10.28 ha_m328p.h . . . 240
10.29 LCD.cpp File Reference . . . 244
10.30 LCD.cpp . . . 244
10.31 LCD.h File Reference . . . 244
10.32 LCD.h . . . 244
10.33 Led.cpp File Reference . . . 244
10.34 Led.cpp . . . 244
10.35 Led.h File Reference . . . 245
10.36 Led.h . . . 246
10.37 main.cpp File Reference . . . 246
10.37.1 Detailed Description . . . 247
10.37.2 Macro Definition Documentation . . . 247
10.37.2.1 PIN_NUMBER . . . 247
10.37.2.2 TIMEDELAY . . . 248
10.37.3 Function Documentation . . . 248
10.37.3.1 main() . . . 248
10.38 BlinkLed/main.cpp . . . 248
10.39 main.cpp File Reference . . . 249
10.39.1 Detailed Description . . . 249
10.39.2 Macro Definition Documentation . . . 250
10.39.2.1 BUZZER . . . 250
10.39.2.2 NOTE_DURATION . . . 250
10.39.3 Function Documentation . . . 250
10.39.3.1 main() . . . 250
10.40 main.cpp . . . 251
10.41 MCU.cpp File Reference . . . 252
10.42 MCU.cpp . . . 253
10.43 MCU.h File Reference . . . 254
10.43.1 Detailed Description . . . 255
10.44 MCU.h . . . 256
10.45 Pin.cpp File Reference . . . 257

10.46 Pin.cpp . . . 257
10.47 Pin.h File Reference . . . 258
10.48 Pin.h . . . 259
10.49 PushButton.cpp File Reference . . . 260
10.50 PushButton.cpp . . . 260
10.51 PushButton.h File Reference . . . 261
10.51.1 Detailed Description . . . 262
10.52 PushButton.h . . . 263
10.53 README.md File Reference . . . 264
10.54 README.md File Reference . . . 264
10.55 README.md File Reference . . . 264
10.56 README.md File Reference . . . 264
10.57 README.md File Reference . . . 264
10.58 ServoMotor.cpp File Reference . . . 264
10.59 ServoMotor.cpp . . . 264
10.60 ServoMotor.h File Reference . . . 266
10.60.1 Detailed Description . . . 267
10.61 ServoMotor.h . . . 269
10.62 SPI.cpp File Reference . . . 269
10.63 SPI.cpp . . . 270
10.64 SPI.h File Reference . . . 272
10.64.1 Detailed Description . . . 273
10.65 SPI.h . . . 274
10.66 StepperMotor.cpp File Reference . . . 275
10.67 StepperMotor.cpp . . . 275
10.68 StepperMotor.h File Reference . . . 280
10.69 StepperMotor.h . . . 281
10.70 TimerCounter.h File Reference . . . 282
10.70.1 Detailed Description . . . 283
10.71 TimerCounter.h . . . 292
10.72 TimerCounter0.cpp File Reference . . . 294
10.73 TimerCounter0.cpp . . . 294
10.74 TimerCounter0.h File Reference . . . 297
10.75 TimerCounter0.h . . . 298
10.76 TimerCounter1.cpp File Reference . . . 299
10.77 TimerCounter1.cpp . . . 300
10.78 TimerCounter1.h File Reference . . . 304
10.79 TimerCounter1.h . . . 305
10.80 TimerCounter2.cpp File Reference . . . 306
10.81 TimerCounter2.cpp . . . 306
10.82 TimerCounter2.h File Reference . . . 309
10.83 TimerCounter2.h . . . 310

10.84 USART0.cpp File Reference . . . 311
10.85 USART0.cpp . . . 312
10.86 USART0.h File Reference . . . 317
10.87 USART0.h . . . 318
10.88 utils_m328p.cpp File Reference . . . 320
10.89 utils_m328p.cpp . . . 320
10.90 utils_m328p.h File Reference . . . 320
10.91 utils_m328p.h . . . 321
10.92 WatchdogTimer.cpp File Reference . . . 321
10.93 WatchdogTimer.cpp . . . 321
10.94 WatchdogTimer.h File Reference . . . 322
10.94.1 Detailed Description . . . 324
10.95 WatchdogTimer.h . . . 325

**Index** **327**

# 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** environement 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`

## 1.6 Projects

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

## 1.7 Author

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

## 1.8 License

This project is licensed under the MIT License - see the `LICENSE.txt` file for more details

# Chapter 2

# Applications

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

- Blink a Led
- AVR Square-Wave Organ

## 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 bellow:

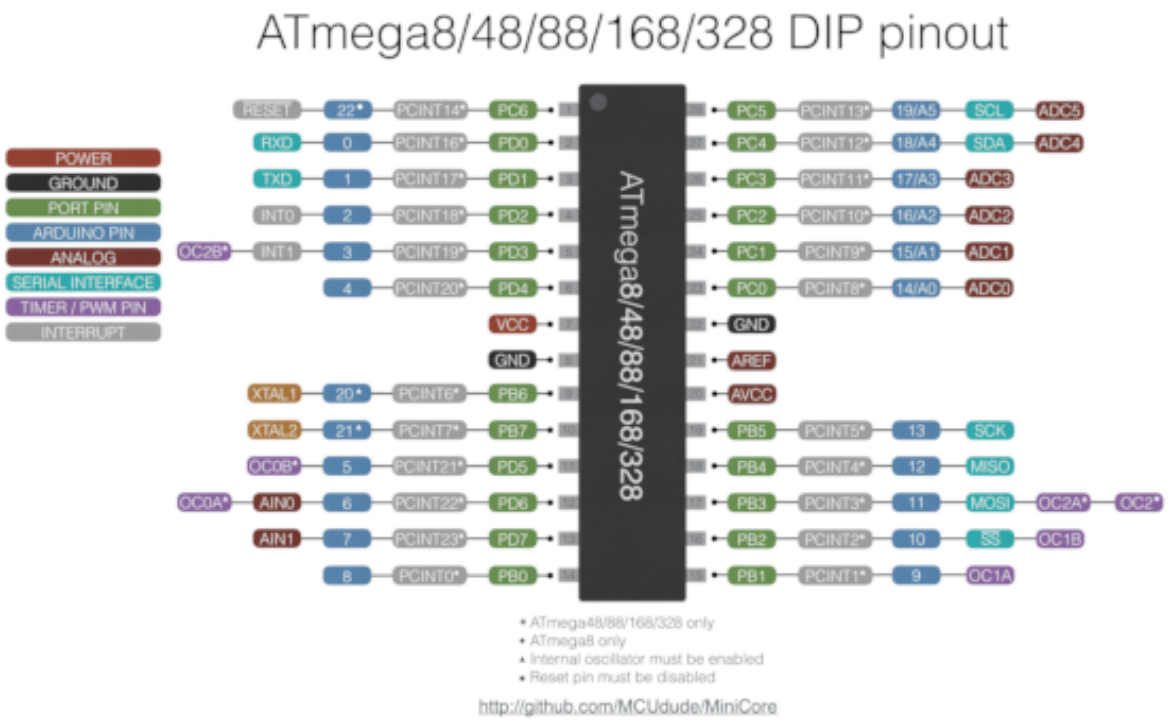



**Figure 2.1 Pinout of ATmega48P/88P/168P/328P AVR microcontrollers family**

### 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:

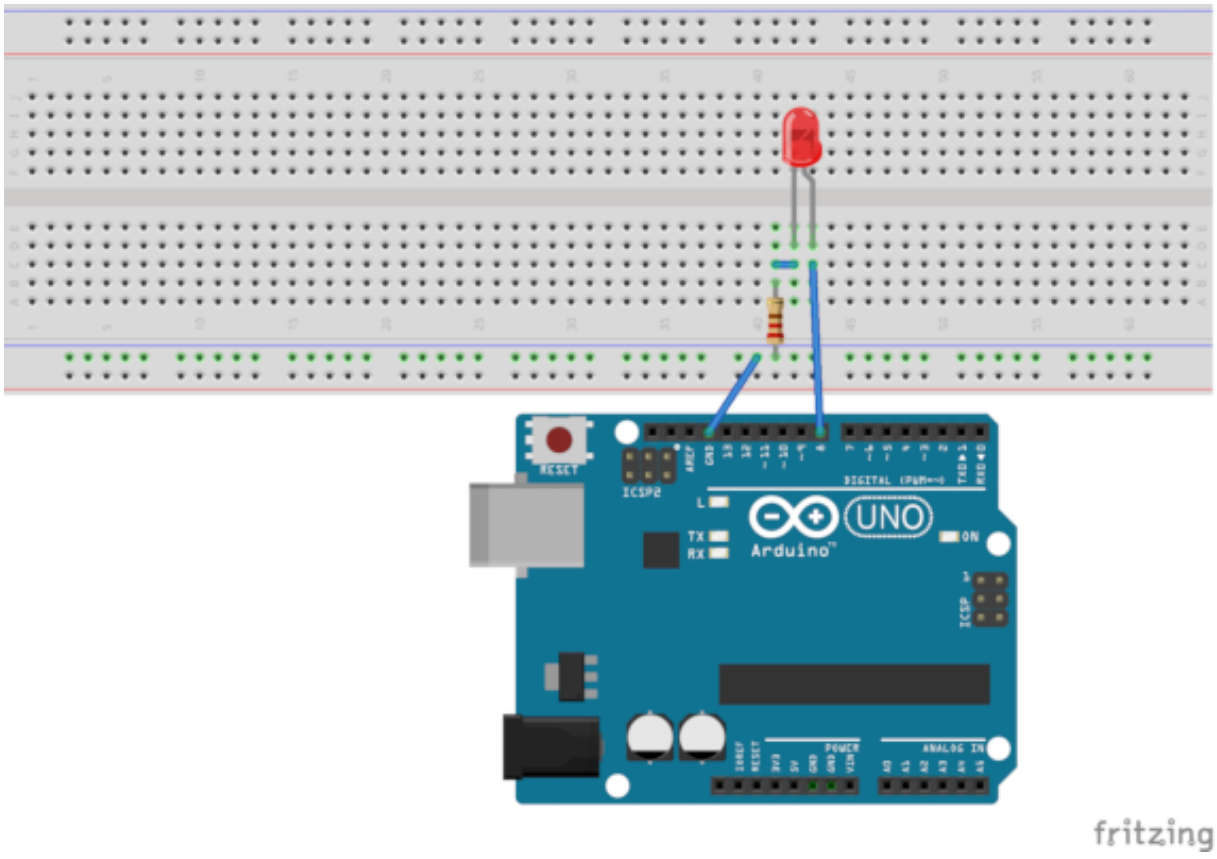



**Figure 2.2 Circuit diagram**

### 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

This project is licensed under the MIT License - see the `LICENSE.txt` file for more details

## 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 bellow:

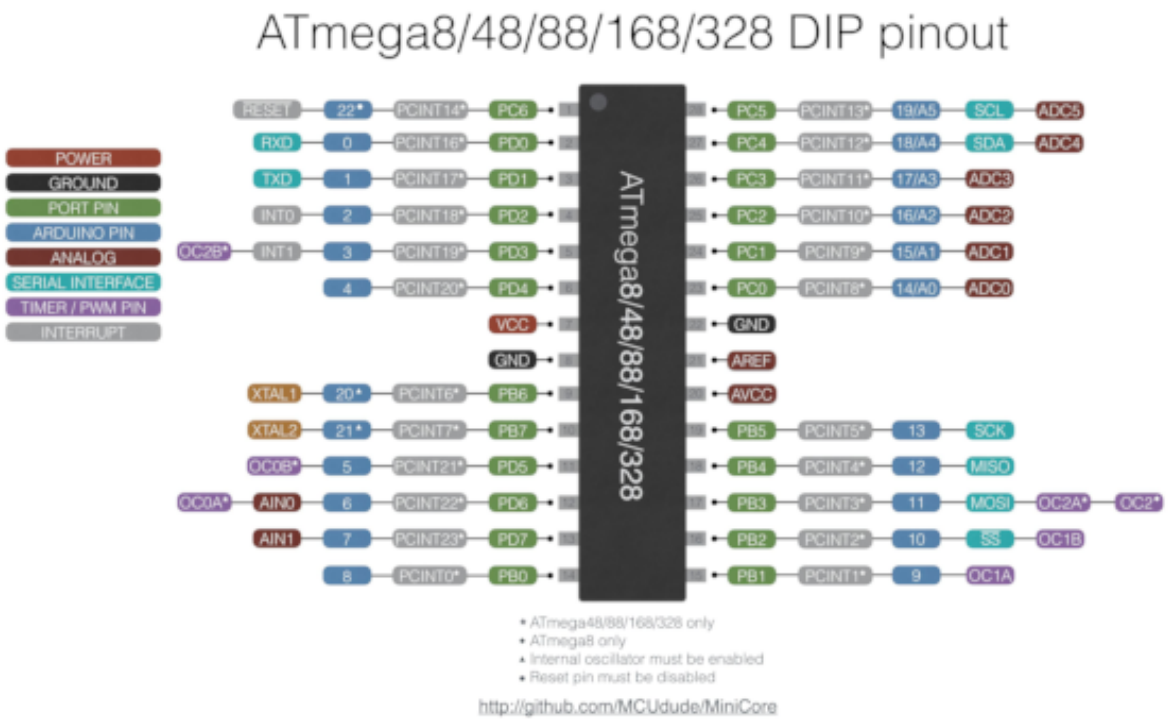



**Figure 2.3 Pinout of ATmega48P/88P/168P/328P AVR microcontrollers family**

### 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:

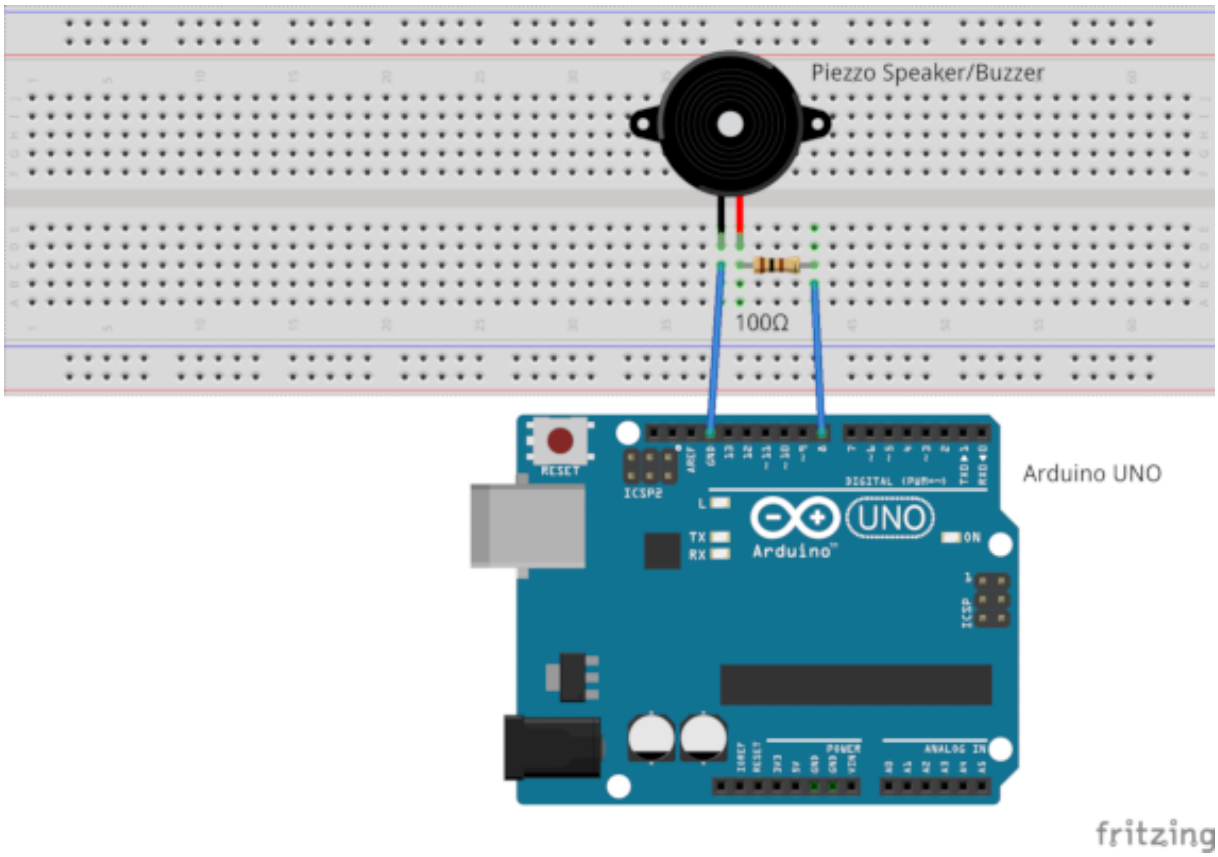



**Figure 2.4 Circuit diagram**

### 2.2.3 Code

The following code permits to turn a Buzzer to 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', ';', '\"
  };
  // 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

### 2.2.5 License

This project is licensed under the MIT License - see the `LICENSE.txt` file for more details

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 . . . . . 21
core . . . . . 22
io
    AVR chip internal i/o components . . . . . 30
utils . . . . . 36

# Chapter 5

# Hierarchical Index

## 5.1 Class Hierarchy

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


core::ADConverter . . . 37
core::AnalogComparator . . . 46
component::Buzzer . . . 46
component::DCMotor . . . 50
core::ExternInterrupt . . . 53
component::Led . . . 59
core::MCU . . . 63
io::Pin . . . 67
io::Port . . . 72
component::PushButton . . . 73
component::ServoMotor . . . 76
io::SPI . . . 82
component::StepperMotor . . . 90
core::TimerCounter . . . 100
    core::TimerCounter0 . . . 103
    core::TimerCounter1 . . . 113
    core::TimerCounter2 . . . 124
io::USART0 . . . 134
core::WatchdogTimer . . . 151

# Chapter 6

# Class Index

## 6.1 Class List

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


core::ADConverter . . . 37
core::AnalogComparator . . . 46
component::Buzzer
    Class for handling a Buzzer component . . . 46
component::DCMotor . . . 50
core::ExternInterrupt . . . 53
component::Led
    Class for handling a Led component . . . 59
core::MCU . . . 63
io::Pin . . . 67
io::Port
    Contains defintions of pointers to the AVR port's registers . . . 72
component::PushButton . . . 73
component::ServoMotor . . . 76
io::SPI . . . 82
component::StepperMotor . . . 90
core::TimerCounter . . . 100
core::TimerCounter0 . . . 103
core::TimerCounter1 . . . 113
core::TimerCounter2 . . . 124
io::USART0
    Class for handling USART0 component . . . 134
core::WatchdogTimer . . . 151

# Chapter 7

# File Index

## 7.1 File List

Here is a list of all files with brief descriptions:


ADC.cpp . . . 157
ADC.h
    Header file of the ADC class . . . 161
AnalogComparator.cpp . . . 165
AnalogComparator.h . . . 165
Buzzer.cpp . . . 167
Buzzer.h . . . 168
buzzer_pitches_16bit.h . . . 171
buzzer_pitches_8bit.h . . . 190
DCMotor.cpp . . . 198
DCMotor.h
    Header file of the DCMotor class . . . 198
ExternInterrupt.cpp . . . 201
ExternInterrupt.h
    Header file of the ExternInterrupt class . . . 203
ha_base.h
    Base header file for the basic hardware abstraction macros . . . 207
ha_m328p.h
    Header file for the hardware abstraction macros of the Atmega328p . . . 209
LCD.cpp . . . 244
LCD.h . . . 244
Led.cpp . . . 244
Led.h . . . 245
BlinkLed/main.cpp . . . 246
Organ/main.cpp . . . 249
MCU.cpp . . . 252
MCU.h
    Header file of the MCU class . . . 254
Pin.cpp . . . 257
Pin.h . . . 258
PushButton.cpp . . . 260
PushButton.h
    Header file of the Push Button class . . . 261
ServoMotor.cpp . . . 264
ServoMotor.h
    Header file of the ServoMotor class . . . 266

SPI.cpp . . . 269
SPI.h
Header file of the SPI class . . . 272
StepperMotor.cpp . . . 275
StepperMotor.h . . . 280
TimerCounter.h
Header file of the TimerCounter class . . . 282
TimerCounter0.cpp . . . 294
TimerCounter0.h . . . 297
TimerCounter1.cpp . . . 299
TimerCounter1.h . . . 304
TimerCounter2.cpp . . . 306
TimerCounter2.h . . . 309
USART0.cpp . . . 311
USART0.h . . . 317
utils_m328p.cpp . . . 320
utils_m328p.h . . . 320
WatchdogTimer.cpp . . . 321
WatchdogTimer.h
Header file of the WatchdogTimer class . . . 322

# 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 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**

| | |
|---|---|
| freeRunning | |
| analogComparator | |
| extInterrupt | |
| timer0Compare | |
| timer0Overflow | |
| timer1CompareB | |
| timer1Overflow | |
| timer1Capture | |

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 defintions 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_autoTrigger↩ Source=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             }
00145             else
00146             {
00147                 *mp_conversionResult = l_resultData » 1;
00148                 l_resultData = 0;
```

```
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             }
00164             else
00165             {
00166                 *mp_conversionResult = l_resultData » 2;
00167                 l_resultData = 0;
00168                 l_resultDataIndex = 0;
00169                 m_conversionComplete = 1;
00170
00171             }
00172             break;
00173         }
00174         case 13:
00175         {
00176             if (l_resultDataIndex < 64)
00177             {
00178                 l_resultData += ADC;
00179                 l_resultDataIndex++;
00180
00181             }
00182             else
00183             {
00184                 *mp_conversionResult = l_resultData » 3;
00185                 l_resultData = 0;
00186                 l_resultDataIndex = 0;
00187                 m_conversionComplete = 1;
00188
00189             }
00190             break;
00191         }
00192         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             }
00208             break;
00209         }
00210         case 15:
00211         {
00212             if (l_resultDataIndex < 1024)
00213             {
00214                 l_resultData += ADC;
00215                 l_resultDataIndex++;
00216
00217             }
00218             else
00219             {
00220                 *mp_conversionResult = l_resultData » 5;
00221                 l_resultData = 0;
00222                 l_resultDataIndex = 0;
00223                 m_conversionComplete = 1;
00224
00225             }
00226             break;
00227         }
00228         case 16:
00229         {
00230             if (l_resultDataIndex < 4096)
00231             {
00232
00233                 l_resultData += ADC;
00234                 l_resultDataIndex++;
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             }
00245             break;
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 
00078     } else {
00079         ADC_DISABLE_AUTOTRIGGER;
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 
00089     } else {
00090         ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT;
00091     }
00092 
00093 }
```

References ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT, and ADC_ENABLE_CONVERSION_COMPLETE_INTERR

#### 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
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 }
```

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

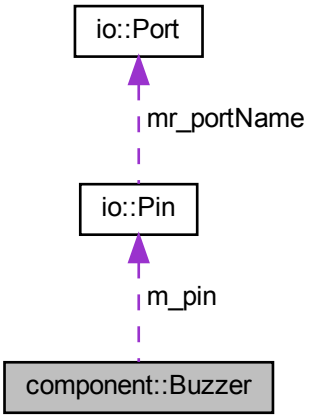
Definition at line 24 of file AnalogComparator.h.

## 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

Initalizes 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**

| | |
|---|---|
| *ar_period_us* | Defines period of Buzzer signal |
| *ar_duration_us* | 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**

| | |
|---|---|
| *TC* | Type Defines a TimerCounter object |

**Parameters**

| | |
|---|---|
| *ar_period_us* | Defines period of Buzzer signal |
| *ar_duration_ms* | Defines duration of Buzzer signal |
| *ar_channel* | Defines TimerCounter channel |
| *ar_clockSource* | 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**

| | |
|---|---|
| *a_duration_us* | 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

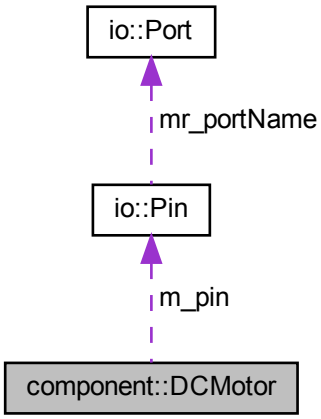
Definition at line 142 of file Buzzer.h.

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
00039     } else {
00040         EXT_INT_DISABLE_INT0;
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
00050     } else {
00051         EXT_INT_DISABLE_INT1;
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
00061     } else {
00062         EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT(static_cast<uint8_t>(ar_pinChangePort));
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
00072     } else {
00073         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(a_pinNumber);
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
00084     } else {
00085         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(a_pinNumber);
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 
00095     } else {
00096         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(a_pinNumber);
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__
```

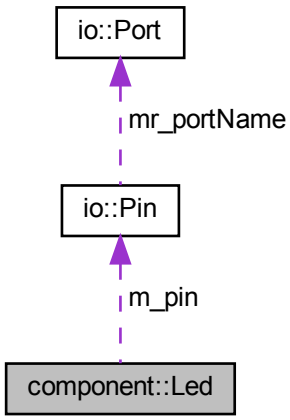
Definition at line 185 of file ExternInterrupt.h.

## 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

Initalizes the Led object

**Parameters**

| | |
|---|---|
| *ar_pin* | 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 ar_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.

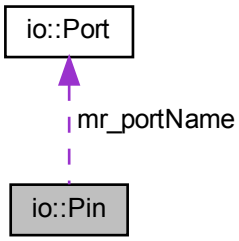
```
00048 {
00049     if (a_enable) {
00050         MCU_SLEEP_ENABLE;
00051     } else {
00052         MCU_SLEEP_DISABLE;
00053     }
00054
00055 }
```

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

Initalizes the pin object

**Parameters**

| | |
|---|---|
| *ar_portName* | Defines the Port name in the AVR chip |
| *a_pinNumber* | 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**

| | |
|---|---|
| *ar_useInternalPullUp* | 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     }
00039     else
00040     {
00041         *mr_portName.mp_portReg &= ~(1 << m_pinNumber);
00042         *mr_portName.mp_ddrReg  &= ~(1 << m_pinNumber);
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::Ser
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 defintions 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 defintions 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`

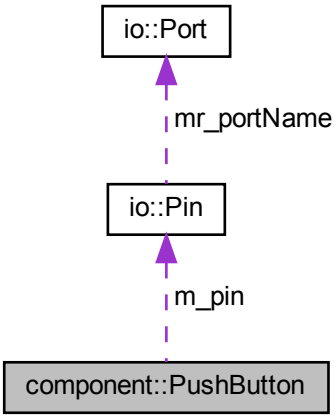
Pointer to the port register

Definition at line 23 of file Pin.h.

## 9.10 component::PushButton Class Reference

`#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

Definition at line 95 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 pushbutton object

```
@param ar_pin pin object
@param ar_useInternalPullUp indicates if internal pull up resistor used
```

Definition at line 3 of file PushButton.cpp.

```
00004                                   : m_pin(ar_pin),
00005                                     mr_isActiveLow(ar_isActiveLow),
00006                                     mr_useInternalPullUp(ar_useInternalPullUp)
00007
00008
00009 {
00010     m_pin.toInput(mr_useInternalPullUp);
00011     m_buttonPressed = 0;
00012 }
```

References m_buttonPressed, m_pin, mr_useInternalPullUp, and io::Pin::toInput().

#### 9.10.2.2 ~PushButton()

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

Destructor.

Definition at line 14 of file PushButton.cpp.

```
00015 {
00016
00017 }
```

### 9.10.3 Member Function Documentation

#### 9.10.3.1 getPressedCount()

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

Get pushbutton pressed count.

Definition at line 46 of file PushButton.cpp.

```
00047 {
00048
00049     return m_buttonPressed;
00050
00051 }
```

#### 9.10.3.2 isPressed()

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

Is pushbutton pressed.

Definition at line 20 of file PushButton.cpp.

```
00021 {
00022     if (mr_isActiveLow || mr_useInternalPullUp) {
00023         if (m_pin.isLow()) {
00024             _delay_us(PUSHBUTTON_DEBOUNCE_TIME_US);
00025             if (m_pin.isLow()) {
00026                 ++m_buttonPressed;
00027                 return 1;
00028             }
00029         }
00030     } else {
00031
00032         if (m_pin.isHigh()) {
00033             _delay_us(PUSHBUTTON_DEBOUNCE_TIME_US);
00034             if (m_pin.isHigh()) {
00035                 ++m_buttonPressed;
00036                 return 1;
00037             }
00038         }
00039
00040     }
00041     m_buttonPressed = 0;
00042     return 0;
00043
00044 }
```

References PUSHBUTTON_DEBOUNCE_TIME_US.

#### 9.10.3.3 resetPressedCount()

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

Reset pushbutton pressed count.

Definition at line 53 of file PushButton.cpp.

```
00054 {
00055     m_buttonPressed = 0;
00056
00057 }
```

### 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 125 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 122 of file PushButton.h.

Referenced by PushButton().

#### 9.10.4.3 mr_isActiveLow

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

indicates led active state

Definition at line 123 of file PushButton.h.

#### 9.10.4.4 mr_useInternalPullUp

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

indicates if internal pullup resistor used

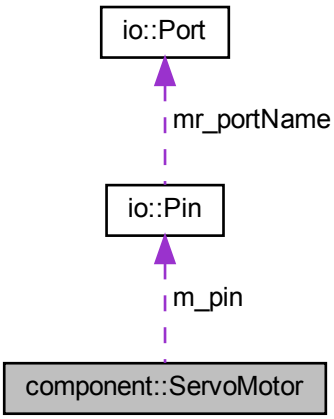
Definition at line 124 of file PushButton.h.

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
      static_cast<uint16_t>(SERVOMOTOR_TIMER_ANGLE_COUNT(ar_angle_deg,static_cast<long>(computePulseWidthMinCount(ar_clockPre
00067 }
```

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::selectCompareOutpu
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]
```

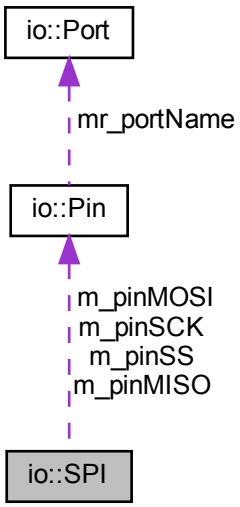
pulse width min [us]

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. Initalizes 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 
00124     } else {
00125         m_pinSS.setHigh();
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]
```

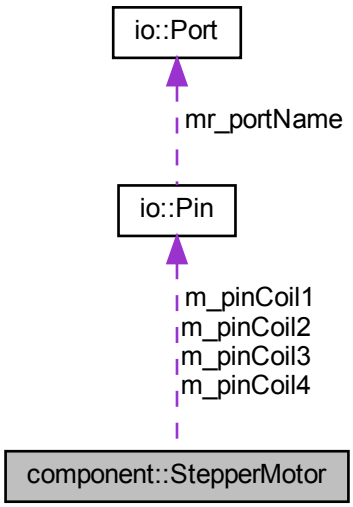
pin object

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
      ((l_time>(l_accelTime+l_constSpeedTime))&&(l_time<=l_accelTime+l_constSpeedTime+l_decelTime))
00171    {
00172        l_speed= (1000UL*a_speed)-a_decel*(l_time-l_accelTime-l_constSpeedTime);
00173
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
00212         } else {
00213             l_stepNumber++;
00214             m_currentPos++;
00215         }
00216
00217
00218     } else {
00219
00220         if (l_stepNumber == -a_step)
00221         {
00222             m_goalReached = 1;
00223
00224         } else {
00225             l_stepNumber--;
00226             m_currentPos--;
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 
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 }
```

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
00078         } else {
00079             l_stepNumber++;
00080             m_currentPos++;
00081         }
00082
00083
00084     } else {
00085
00086         if (l_stepNumber == -a_step)
00087         {
00088             m_goalReached = 1;
00089
00090         } else {
00091             l_stepNumber--;
00092             m_currentPos--;
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 }
```

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--)
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]
```

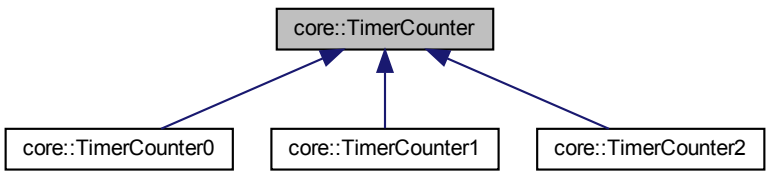
steps per revolution

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()

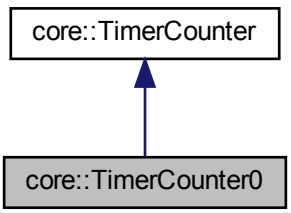
```
virtual void core::TimerCounter::stop ( )  [pure virtual]
```

Implemented in core::TimerCounter0, core::TimerCounter1, and core::TimerCounter2.

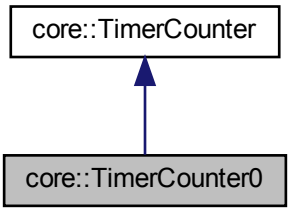
## 9.15 core::TimerCounter0 Class Reference

```
#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_compare↩ OutputMode) 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(TIMER0_COM_CHANNEL_A_INTERRUPT)) __attribute__((__signal__
- static void outputCompareMatchBServiceRoutine () __asm__(STR(TIMER0_COM_CHANNEL_B_INTERRUPT)) __attribute__((__signal__
- static void overflowServiceRoutine () __asm__(STR(TIMER0_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 
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             }
00243             break;
00244         }
00245     }
00246 
00247 }
```

References core::A, core::B, TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT, TIMER0_DISABLE_COM_CHANNEL_B_INTERF
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         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

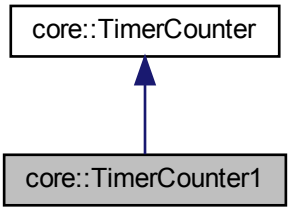
```
uint8_t core::TimerCounter0::m_clockSource  [private]
```

Definition at line 342 of file TimerCounter0.h.

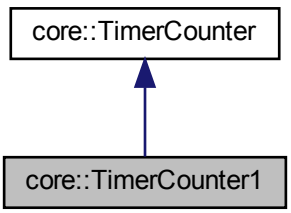
## 9.16 core::TimerCounter1 Class Reference

```
#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_compare↩ OutputMode) 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
00313         TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT;
00314
00315     } else {
00316
00317         TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT;
00318     }
00319 }
```

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
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             }
00287             break;
00288         }
00289     }
00290
00291 }
```

References core::A, core::B, TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT, TIMER1_DISABLE_COM_CHANNEL_B_INTERF
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

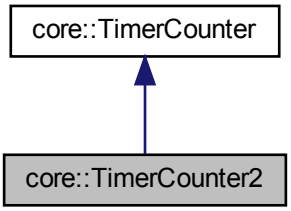
```
uint8_t core::TimerCounter1::m_clockSource  [private]
```

Definition at line 351 of file TimerCounter1.h.

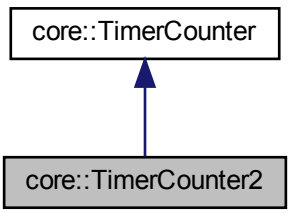
## 9.17 core::TimerCounter2 Class Reference

```
#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_compare↩ OutputMode) 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             break;
00230         }
00231         case core::channel::B:
00232         {
00233             if (a_enable) {
00234 
00235                 TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT;
00236 
00237             } else {
00238 
00239                 TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT;
00240 
00241             }
00242             break;
00243         }
00244     }
00245 
00246 }
```

References core::A, core::B, TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT, TIMER2_DISABLE_COM_CHANNEL_B_INTEF
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_frame↩ Size=frameSize::eightBits, const stopBit &ar_stopBit=stopBit::oneStopBit, const parityMode &ar_parity↩ Mode=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.

Initalizes the USART0 object

**Parameters**

| | |
|---|---|
| *ar_transMode* | defines transmission mode |
| *ar_comMode* | defines communication mode |
| *ar_frameSize* | defines data frame size |
| *ar_stopBit* | defines number of stop bits |
| *ar_parityMode* | 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**

| | |
|---|---|
| *ar_enable* | 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 
00388     } else {
00389         USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT;
00390     }
00391 
00392 }
```

References USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT, and USART0_ENABLE_DATA_REGISTER_EMPTY_IN

#### 9.18.3.4 enableReceiveCompleteInterrupt()

```
void io::USART0::enableReceiveCompleteInterrupt (
            const uint8_t a_enable )
```

Enable receive complete interrupt

**Parameters**

| | |
|---|---|
| *ar_enable* | 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 
00377     } else {
00378         USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT;
00379     }
00380 
00381 }
```

References USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT, and USART0_ENABLE_RECEIVE_COMPLETE_INTERRUP

#### 9.18.3.5 enableTransmitCompleteInterrupt()

```
void io::USART0::enableTransmitCompleteInterrupt (
            const uint8_t a_enable )
```

Enable transmit complete interrupt

**Parameters**

| | |
|---|---|
| *ar_enable* | 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_INTERR

#### 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**

| | |
|---|---|
| *ar_transMode* | Defines transmission mode |
| *ar_comMode* | Defines communication mode |
| *ar_frameSize* | Defines data frame size |
| *ar_stopBit* | Defines number of stop bits |
| *ar_parityMode* | 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 partity 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**

| | |
|---|---|
| *ar_char* | 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
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 }
```

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**

| | |
|---|---|
| *ap_dataBuffer* | Defines pointer to receiver buffer |
| *a_size* | Defines size of receiver buffer |
| *a_ready2Receive* | 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**

| | |
|---|---|
| *ap_string* | 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**

| | |
|---|---|
| *ar_byte* | 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**

| | |
|---|---|
| *ar_char* | 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**

| | |
|---|---|
| *ap_dataBuffer* | Defines pointer to transmitter buffer |
| *a_size* | 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**

| | |
|---|---|
| *ar_long* | 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**

| | |
|---|---|
| *ap_string* | 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**

| | |
|---|---|
| *ar_word* | 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**

| | |
|---|---|
| *ar_comMode* | 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**

| | |
|---|---|
| *ar_frameSize* | 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**

| | |
|---|---|
| *ar_parityMode* | 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_MOD
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**

| | |
|---|---|
| *ar_stopBit* | 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 transnmission mode

**Parameters**

| | |
|---|---|
| *ar_transMode* | 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_TRANSM
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.

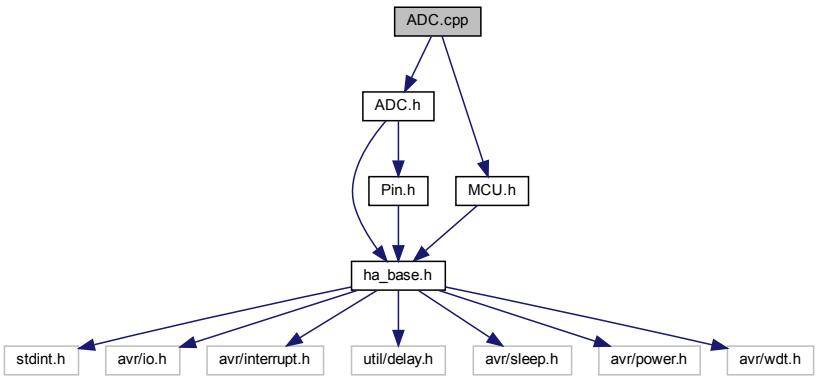
# Chapter 10

# 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
00078     } else {
00079         ADC_DISABLE_AUTOTRIGGER;
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
00089     } else {
00090         ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT;
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             }
00145             else
00146             {
00147                 *mp_conversionResult = l_resultData » 1;
00148                 l_resultData = 0;
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             }
00164             else
00165             {
00166                 *mp_conversionResult = l_resultData » 2;
00167                 l_resultData = 0;
00168                 l_resultDataIndex = 0;
00169                 m_conversionComplete = 1;
00170
00171             }
00172             break;
00173         }
00174         case 13:
00175         {
00176             if (l_resultDataIndex < 64)
00177             {
00178                 l_resultData += ADC;
00179                 l_resultDataIndex++;
00180
00181             }
00182             else
00183             {
00184                 *mp_conversionResult = l_resultData » 3;
00185                 l_resultData = 0;
00186                 l_resultDataIndex = 0;
00187                 m_conversionComplete = 1;
00188
00189             }
00190             break;
00191         }
00192         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             }
00208             break;
00209         }
00210         case 15:
00211         {
00212             if (l_resultDataIndex < 1024)
00213             {
00214                 l_resultData += ADC;
00215                 l_resultDataIndex++;
00216 
00217             }
00218             else
00219             {
00220                 *mp_conversionResult = l_resultData » 5;
00221                 l_resultData = 0;
00222                 l_resultDataIndex = 0;
00223                 m_conversionComplete = 1;
00224 
00225             }
00226             break;
00227         }
00228         case 16:
00229         {
00230             if (l_resultDataIndex < 4096)
00231             {
00232 
00233                 l_resultData += ADC;
00234                 l_resultDataIndex++;
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             }
00245             break;
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 
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         }
```

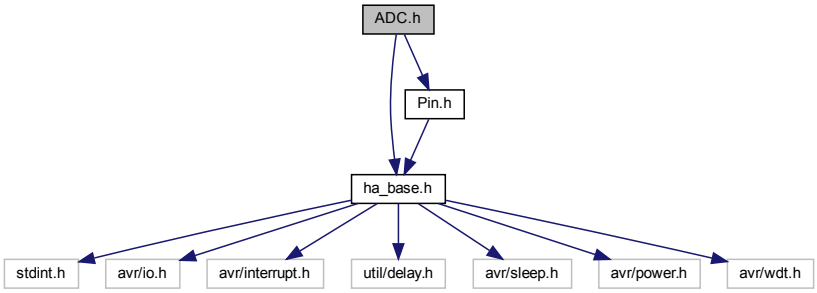
```
00280         case core::resolution::res_10bit:
00281         {
00282             ADC_ADJUST_RESULT_RIGHT;
00283             m_resolution = 10;
00284             break;
00285         }
00286         case core::resolution::res_11bit:
00287         {
00288
00289             m_resolution = 11;
00290             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

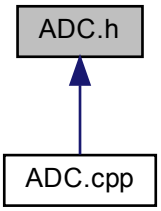
Header file of the ADC class.

```
#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

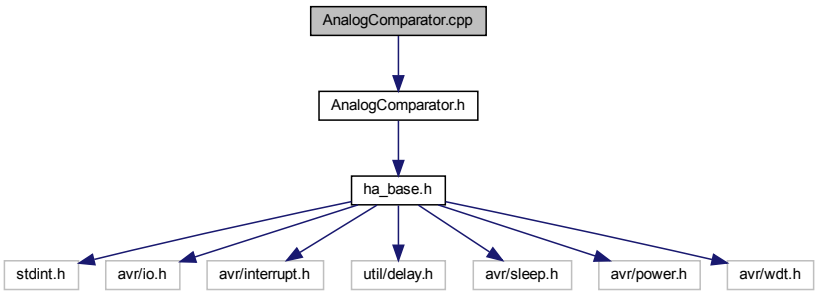
```
00001
00078 #ifndef ADC_H
00079 #define ADC_H
00080 #include "ha_base.h"
00081 #include "Pin.h"
00082
00083
00084 namespace core
00085 {
00086
00087 enum class resolution : uint8_t {
00088     res_8bit=0,
00089     res_9bit,
00090     res_10bit,
00091     res_11bit,
00092     res_12bit,
00093     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 =
      autoTriggerSource::freeRunning,
00136                                     const io::Pin &ar_pin = io::Pin(0,io::PortC));
00137
00138     void start();
00139
00140     void stop();
00141
00142     void selectReferenceVoltage(const referenceVoltage& ar_refVoltage);
00143
00144     void selectAnalogInput(io::Pin a_pin);
00145
00146     void selectClockPrescaler(const clockPrescaler& ar_clockPrescaler);
00147
00148     void enableConversionCompleteInterrupt(const uint8_t a_enable);
00149
00150     void enableAutoTrigger(const uint8_t a_enable);
00151
00152     void selectAutoTriggerSource(const autoTriggerSource& ar_autoTriggerSource);
00153
00154     uint8_t conversionComplete();
00155
00156
00157     void getConversionResult(uint16_t *ap_resultData, const resolution& ar_resolution =
      resolution::res_10bit);
00158
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
00176     ~ADConverter();
00177
00180     ADConverter(const ADConverter&);
00181
00184     const ADConverter& operator=(const ADConverter&);
00185
00186
00187     static volatile uint16_t *mp_conversionResult;
00190     static uint8_t m_resolution;
00192     static volatile uint8_t m_conversionComplete;
00199 };
00200
00201
00202
00203
00204
00205 }
00206 #endif
```

## 10.5 AnalogComparator.cpp File Reference

`#include "AnalogComparator.h"`

Include dependency graph for AnalogComparator.cpp:



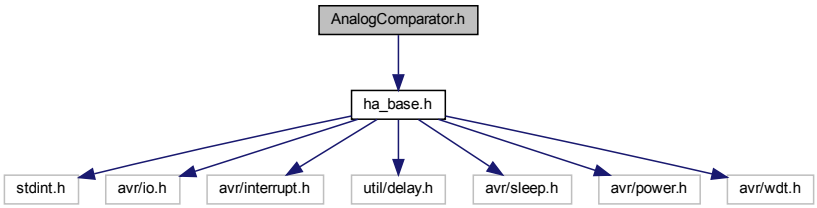

## 10.6 AnalogComparator.cpp

```
00001 #include "AnalogComparator.h"
00002
00003
```

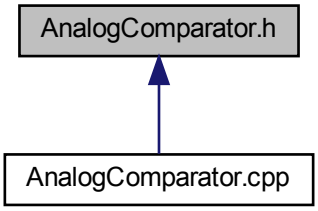
## 10.7 AnalogComparator.h File Reference

`#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
```

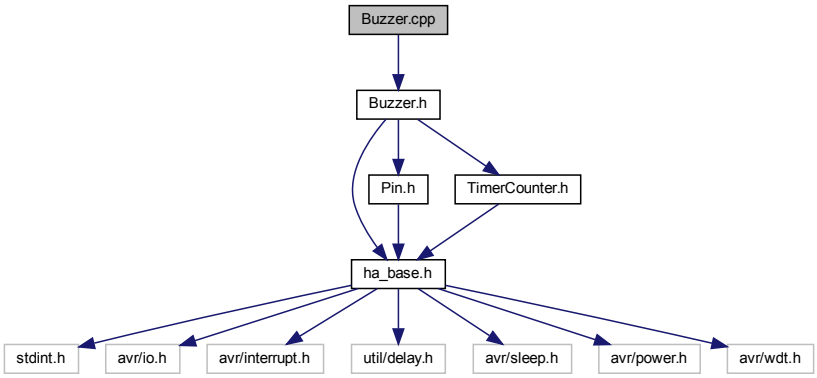
Definition at line 13 of file AnalogComparator.h.

## 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

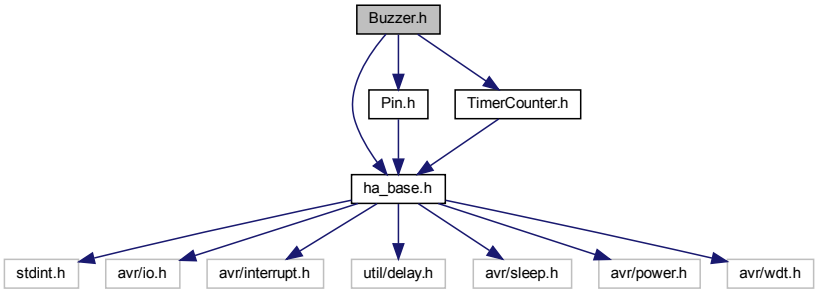
```
00001
00010 #include "Buzzer.h"
00011
00012
00013 component::Buzzer::Buzzer(const io::Pin &ar_pin)
00014                 : m_pin(ar_pin)
00015 {
```

```
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 }
```

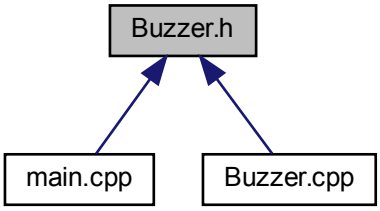
## 10.11 Buzzer.h File Reference

```
#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.*

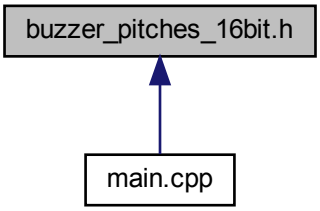
# 10.12 Buzzer.h

```
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.

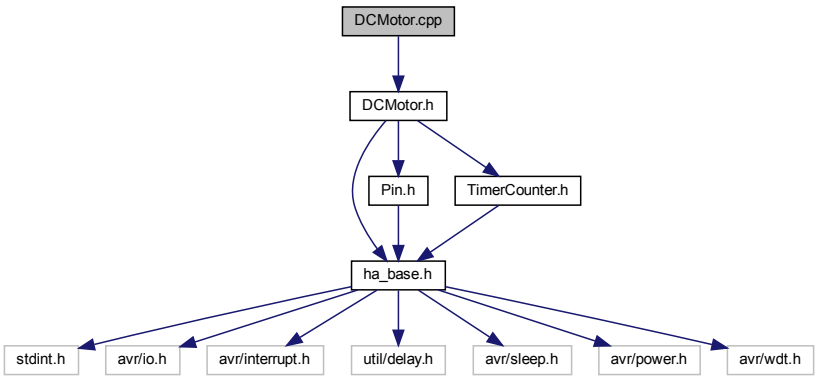
## 10.16 buzzer_pitches_8bit.h

```
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

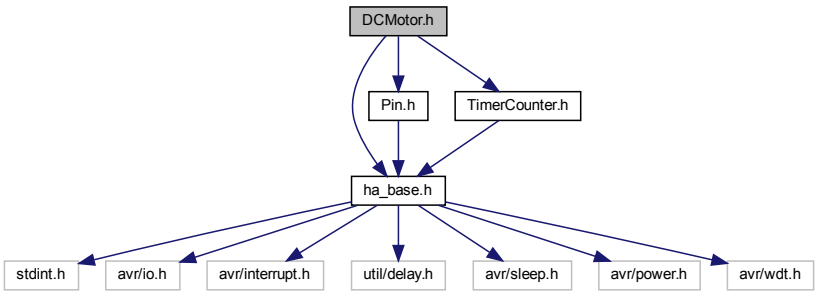
```
00001 #include "DCMotor.h"
00002
00003 component::DCMotor::DCMotor(const io::Pin &ar_pin)
00004         : m_pin(ar_pin)
00005 {
00006     m_pin.toOutput();
00007
00008 }
00009
00010
00011 component::DCMotor::~DCMotor()
00012 {
00013
00014 }
00015
00016 void component::DCMotor::on()
00017 {
00018     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

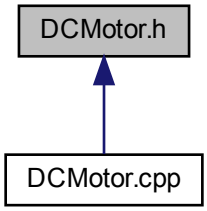
Header file of the DCMotor class.

```
#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.

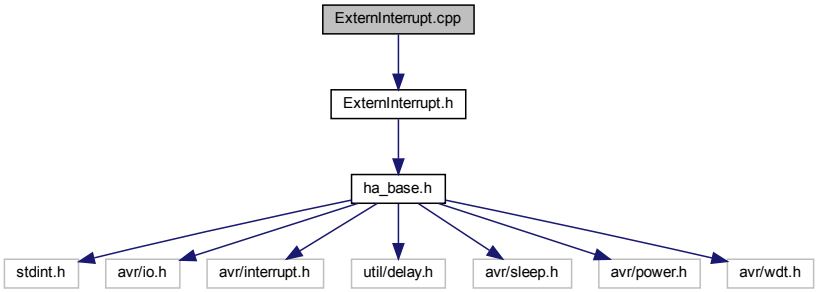
## 10.20 DCMotor.h

```
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
00135     void on();
00138     void off();
00141     void toggle();
00142
00143     template<typename TC>
00144     void spin(TC &ar_timerCounter,
00145               //const uint8_t &ar_dir,
00146               const uint16_t &ar_speed,
00147               const core::channel &ar_channel=core::channel::A)
00148     {
00149
00150         ar_timerCounter.setOutputCompareRegister(ar_channel, ar_speed);
00151         ar_timerCounter.start();
00152
00153
00154     }
00155     template<typename TC>
00156     void stop(TC &ar_timerCounter)
00157     {
00158         ar_timerCounter.stop();
00159
00160
00161     }
00162
00163     template<typename TC>
00164     void connect(TC &ar_timerCounter,
00165                  const core::channel &ar_channel=core::channel::A)
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     }
00172
00173     template<typename TC>
00174     void disconnect(TC &ar_timerCounter,
00175                     const core::channel &ar_channel=core::channel::A)
00176     {
00177         ar_timerCounter.selectCompareOutputMode(ar_channel, core::compareOutputMode::normal);
00178         ar_timerCounter.stop();
00179     }
00180
00181
00182
00183 private:
00184
00185     io::Pin m_pin;
00187 };
00188
00189 }
00190 #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
00039     } else {
00040         EXT_INT_DISABLE_INT0;
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
00050     } else {
00051         EXT_INT_DISABLE_INT1;
00052     }
00053 }
00054
00055
00056 void core::ExternInterrupt::enablePinChange(const pinChangePort& ar_pinChangePort, const uint8_t
      a_enable)
```

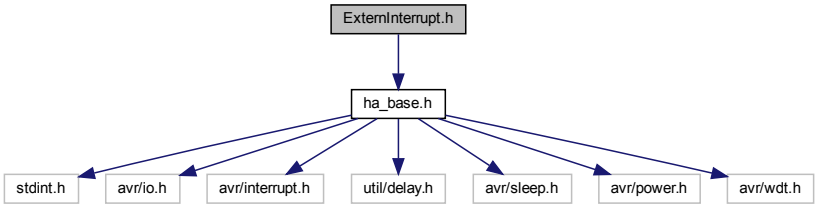
```
00057 {
00058     if (a_enable) {
00059         EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT(static_cast<uint8_t>(ar_pinChangePort));
00060 
00061     } else {
00062         EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT(static_cast<uint8_t>(ar_pinChangePort));
00063     }
00064 
00065 }
00066 
00067 void core::ExternInterrupt::enablePinChangeMaskPortB(const 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 
00072     } else {
00073         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(a_pinNumber);
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 
00084     } else {
00085         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(a_pinNumber);
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 
00095     } else {
00096         EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(a_pinNumber);
00097     }
00098 }
```

## 10.23 ExternInterrupt.h File Reference

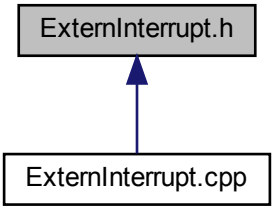
Header file of the ExternInterrupt class.

```
#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 { Interrupt↩ Led.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(M↩ AIN_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(PUSH↩ BUTTON_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

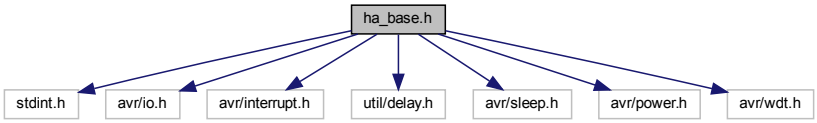
```
00001
00140 #ifndef EXTERN_INTERRUPTS_H
00141 #define EXTERN_INTERRUPTS_H
00142 #include "ha_base.h"
00143
00144
00145
00146 namespace core
00147 {
00148
00149 enum class senseControl : uint8_t {
00150     lowLevel=0,
00151     logicalChange,
00152     fallingEdge,
00153     risingEdge
00154 };
00155
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__,
      __used__, __externally_visible__));
00186
00187     static void Int1ServiceRoutine() __asm__(STR(EXT_INT_INT1_INTERRUPT)) __attribute__((__signal__,
      __used__, __externally_visible__));
00188
00189     static void pinChangePortBServiceRoutine() __asm__(STR(EXT_INT_PIN_CHANGE_PORTB_INTERRUPT))
      __attribute__((__signal__, __used__, __externally_visible__));
00190
00191     static void pinChangePortCServiceRoutine() __asm__(STR(EXT_INT_PIN_CHANGE_PORTC_INTERRUPT))
      __attribute__((__signal__, __used__, __externally_visible__));
00192
00193     static void pinChangePortDServiceRoutine() __asm__(STR(EXT_INT_PIN_CHANGE_PORTD_INTERRUPT))
      __attribute__((__signal__, __used__, __externally_visible__));
00194
00195
00196 protected:
00197
00198 private:
00199
00200     ExternInterrupt();
00201
00204     ~ExternInterrupt();
00205
00208     ExternInterrupt(const ExternInterrupt&);
00209
00212     const ExternInterrupt& operator=(const ExternInterrupt&);
00213
00214 };
00215 }
00216
00217
00218
00219
00220 #endif
```

# 10.25 ha_base.h File Reference

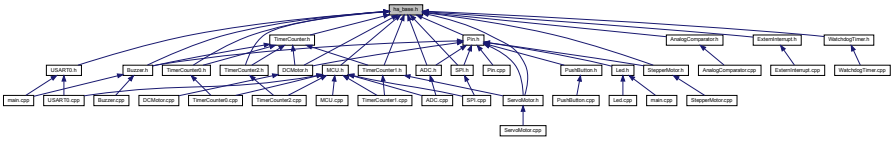
Base header file for the basic hardware abstraction macros.

```
#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

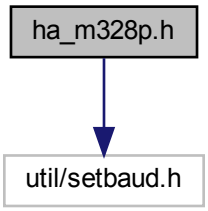
```
00001
00009 #ifndef HABASE_H
00010 #define HABASE_H
00011
00012 /*
00013  *  Helper construct to get interrupt numbers from names
00014  */
00015 #define STRx(s)  #s
00016 #define STR(s)   STRx(s)
00017
00018 /*
00019  *  Any class needs these includes from avr-libc
00020  */
00021 #include <stdint.h>
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 = UBRRL_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 << U↩ PM00))
- #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 UCSR0B |= 1 << UDRIE0
- #define USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT UCSR0B &= ~(1 << UDRIE0)
- #define USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT UCSR0B |= 1 << RXCIE0
- #define USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT UCSR0B &= ~(1 << RXCIE0)
- #define USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT UCSR0B |= 1 << TXCIE0
- #define USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT UCSR0B &= ~(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 << ADATE
- #define ADC_DISABLE_AUTOTRIGGER ADCSRA &= ~(1 << ADATE)
- #define ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT ADCSRA |= 1 << ADIE
- #define ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT ADCSRA &= ~(1 << ADIE)
- #define ADC_SELECT_CLOCK_PRESCALER(clockPrescaler) ADCSRA &= 0xF8; ADCSRA |= clock↩ Prescaler
- #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 << pinChange↩ Port)
- #define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB(pinChangePin) PCMSK0 |= 1 << pinChange↩ Pin
- #define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB(pinChangePin) PCMSK0 &= ~(1 << pin↩ ChangePin)
- #define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC(pinChangePin) PCMSK1 |= 1 << pinChange↩ Pin
- #define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC(pinChangePin) PCMSK1 &= ~(1 << pin↩ ChangePin)
- #define EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD(pinChangePin) PCMSK2 |= 1 << pinChange↩ Pin
- #define EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD(pinChangePin) PCMSK2 &= ~(1 << pin↩ ChangePin)
- #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<<W↩ DCE) | (1<<WDE); WDTCSR = operationMode | timeOut;
- #define WATCHDOG_STOP MCUSR &= ~(1<<WDRF); WDTCSR |= (1<<WDCE) | (1<<WDE); WDT↩ CSR = 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/1000000↩ UL) * (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**

Farid Oubbati ( https://github.com/faroub)

**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 UCSR0A &= ~(1 << U2X0)
```

Definition at line 40 of file ha_m328p.h.

#### 10.27.2.126 USART0_DISABLE_PARITY_MODE

```
#define USART0_DISABLE_PARITY_MODE UCSR0C &= ~((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 UCSR0B &= ~(1 << RXCIE0)
```

Definition at line 108 of file ha_m328p.h.

#### 10.27.2.128 USART0_DISABLE_RECEIVER

```
#define USART0_DISABLE_RECEIVER UCSR0B &= ~(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 UCSR0B &= ~(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 << UM↩
SEL00)
```

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 = UBRRL_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) | time↩
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 = operation↩
Mode | 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 = UBRRL_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      UCSR0B |=   1 « TXEN0
00082 #define   USART0_DISABLE_TRANSMITTER     UCSR0B &= ~(1 « TXEN0)
00083
00084
00085
00086 #define   USART0_ENABLE_RECEIVER         UCSR0B |=   1 « RXEN0
00087 #define   USART0_DISABLE_RECEIVER        UCSR0B &= ~(1 « RXEN0)
00088
00089
00090
00091 #define   USART0_CONTROL_STATUS_REGISTER UCSR0A
00092 #define   USART0_DATA_REGISTER           UDR0
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   UCSR0B |=   1 « UDRIE0
00105 #define   USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT  UCSR0B &= ~(1 « UDRIE0)
00106
00107 #define   USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT   UCSR0B |=   1 « RXCIE0
00108 #define   USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT  UCSR0B &= ~(1 « RXCIE0)
00109
00110 #define   USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT   UCSR0B |=   1 « TXCIE0
00111 #define   USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT  UCSR0B &= ~(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 « ADATE
00140 #define   ADC_DISABLE_AUTOTRIGGER        ADCSRA &= ~(1 « ADATE)
00141
00142 #define   ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT   ADCSRA |=   1 « ADIE
00143 #define   ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT  ADCSRA &= ~(1 « ADIE)
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);
       TCCR0B &= 0xF7; TCCR0B |= (operationMode & 12) « 1
00197 #define TIMER1_SELECT_OPERATION_MODE(operationMode) TCCR1A &= 0xFC; TCCR1A |= (operationMode & 3);
       TCCR1B &= 0xE7; TCCR1B |= (operationMode & 12) « 1
00198 #define TIMER2_SELECT_OPERATION_MODE(operationMode) TCCR2A &= 0xFC; TCCR2A |= (operationMode & 3);
       TCCR2B &= 0xF7; TCCR2B |= (operationMode & 12) « 1
00199
00200 #define TIMER0_SELECT_COM_CHANNEL_A(compareOutputMode) TCCR0A &= 0x3F; TCCR0A |= compareOutputMode « 6
00201 #define TIMER0_SELECT_COM_CHANNEL_B(compareOutputMode) TCCR0A &= 0xCF; TCCR0A |= compareOutputMode « 4
00202
00203 #define TIMER1_SELECT_COM_CHANNEL_A(compareOutputMode) TCCR1A &= 0x3F; TCCR1A |= compareOutputMode « 6
00204 #define TIMER1_SELECT_COM_CHANNEL_B(compareOutputMode) TCCR1A &= 0xCF; TCCR1A |= compareOutputMode « 4
00205
00206 #define TIMER2_SELECT_COM_CHANNEL_A(compareOutputMode) TCCR2A &= 0x3F; TCCR2A |= compareOutputMode « 6
00207 #define TIMER2_SELECT_COM_CHANNEL_B(compareOutputMode) TCCR2A &= 0xCF; TCCR2A |= compareOutputMode « 4
00208
00209 #define TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT TIMSK0 |=  1 « OCIE0A
00210 #define TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT TIMSK0 &= ~(1 « OCIE0A)
00211
00212 #define TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT TIMSK0 |=  1 « OCIE0B
00213 #define TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT TIMSK0 &= ~(1 « OCIE0B)
00214
00215 #define TIMER0_ENABLE_OVERFLOW_INTERRUPT TIMSK0 |=  1 « TOIE0
00216 #define TIMER0_DISABLE_OVERFLOW_INTERRUPT TIMSK0 &= ~(1 « TOIE0)
00217
00218 #define TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT TIMSK1 |=  1 « OCIE1A
00219 #define TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT TIMSK1 &= ~(1 « OCIE1A)
00220
00221 #define TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT TIMSK1 |=  1 « OCIE1B
00222 #define TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT TIMSK1 &= ~(1 « OCIE1B)
00223
00224 #define TIMER1_ENABLE_OVERFLOW_INTERRUPT TIMSK1 |=  1 « TOIE1
00225 #define TIMER1_DISABLE_OVERFLOW_INTERRUPT TIMSK1 &= ~(1 « TOIE1)
00226
00227 #define TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT TIMSK1 |=  1 « ICIE1
00228 #define TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT TIMSK1 &= ~(1 « ICIE1)
00229
00230 #define TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT TIMSK2 |=  1 « OCIE2A
00231 #define TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT TIMSK2 &= ~(1 « OCIE2A)
00232
00233 #define TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT TIMSK2 |=  1 « OCIE2B
00234 #define TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT TIMSK2 &= ~(1 « OCIE2B)
00235
00236 #define TIMER2_ENABLE_OVERFLOW_INTERRUPT TIMSK2 |=  1 « TOIE2
00237 #define TIMER2_DISABLE_OVERFLOW_INTERRUPT TIMSK2 &= ~(1 « TOIE2)
00238
00239 #define   TIMER0_COM_CHANNEL_A_INTERRUPT  TIMER0_COMPA_vect
00240 #define   TIMER0_COM_CHANNEL_B_INTERRUPT  TIMER0_COMPB_vect
00241 #define   TIMER0_OVERFLOW_INTERRUPT  TIMER0_OVF_vect
00242
00243 #define   TIMER1_COM_CHANNEL_A_INTERRUPT  TIMER1_COMPA_vect
00244 #define   TIMER1_COM_CHANNEL_B_INTERRUPT  TIMER1_COMPB_vect
00245 #define   TIMER1_OVERFLOW_INTERRUPT  TIMER1_OVF_vect
00246 #define   TIMER1_INPUT_CAPTURE_INTERRUPT  TIMER1_CAPT_vect
00247
00248 #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

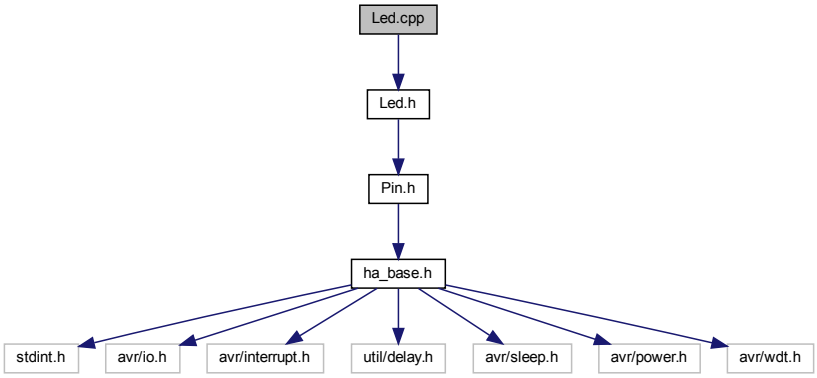
## 10.31 LCD.h File Reference

## 10.32 LCD.h

## 10.33 Led.cpp File Reference

```
#include "Led.h"
```

Include dependency graph for Led.cpp:




## 10.34 Led.cpp

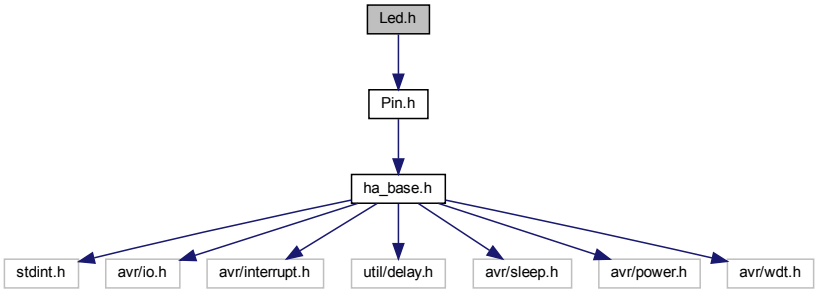
```
00001
00010 #include "Led.h"
00011
00012 component::Led::Led(const io::Pin &ar_pin)
00013          : m_pin(ar_pin)
00014 {
00015     m_pin.toOutput();
00016 }
00017
00018 component::Led::~Led()
00019 {
00020
00021 }
00022
00023
00024 void component::Led::on()
00025 {
00026     m_pin.setHigh();
00027
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
```

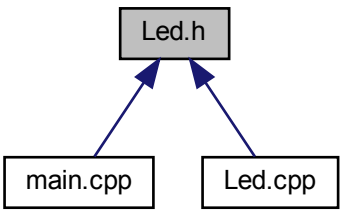
## 10.35 Led.h File Reference

`#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.*

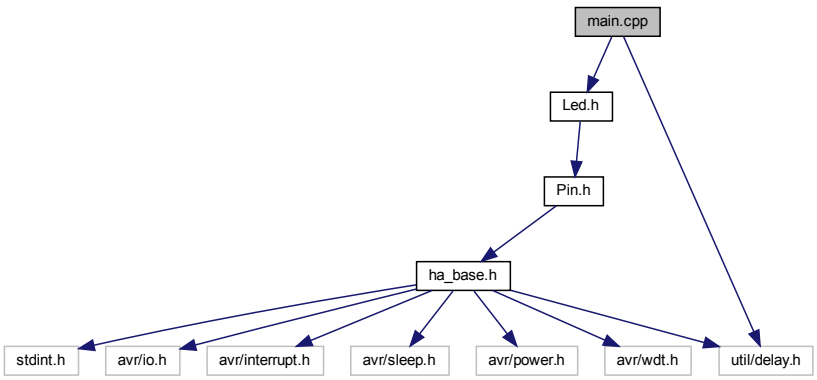
## 10.36 Led.h

```
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
00068     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 }
```

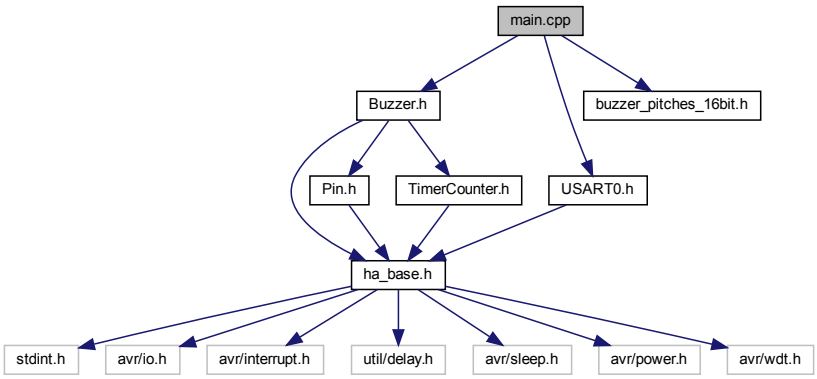
## 10.38 BlinkLed/main.cpp

```
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 "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)

### 10.39.1 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.

## 10.39.2 Macro Definition Documentation

### 10.39.2.1 BUZZER

```
#define BUZZER 0
```

Buzzer pin number

Definition at line 24 of file Organ/main.cpp.

### 10.39.2.2 NOTE_DURATION

```
#define NOTE_DURATION 0xF000
```

Note duration

Definition at line 26 of file Organ/main.cpp.

## 10.39.3 Function Documentation

### 10.39.3.1 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', ';', '\"
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       }
00073       myUSART0.resetNumberBytesReceived();
00074
00075       /********** Play key notes ***********/
00076
00077       l_isNote = 0;
00078       // loop through keys table
00079       for (uint8_t i = 0; i < sizeof(l_keys); i++) {
00080           // found match in lookup table
00081           if (l_key == l_keys[i]) {
00082               Buzzer.buzz(l_notes[i], l_currentNoteLength);
00083               // record that we've found a note
00084               l_isNote = 1;
00085               break;
00086           }
00087       }
00088
00089       // Handle non-note keys: tempo changes and rests
00090       if (!l_isNote) {
00091           if (l_key == '-') {
00092               // code for short note
00093               l_currentNoteLength = l_currentNoteLength / 2;
00094           }
00095           else if (l_key == '+') {
00096               // code for long note
00097               l_currentNoteLength = l_currentNoteLength * 2;
00098           }
00099           else {
00100               // unrecognized, just rest
00101               Buzzer.pause(l_currentNoteLength);
00102           }
00103       }
00104
00105   }
00106   return 0;
00107 }
```

# 10.40 main.cpp

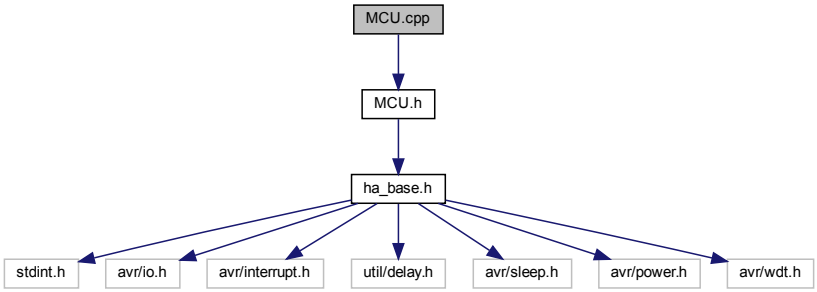
```
00001
00018 #include "Buzzer.h"
00019 #include "USART0.h"
00020 // Note pitch data
00021 #include "buzzer_pitches_16bit.h"
00022
00023
00024 #define BUZZER 0
00026 #define NOTE_DURATION  0xF000
00028 int main(void) {
00029
00030   // Init
00031
00032   // Instantiate a Buzzer object
00033   component::Buzzer 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', ';', '\"
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       }
00073       myUSART0.resetNumberBytesReceived();
00074
00075       /********** Play key notes ***********/
00076
00077       l_isNote = 0;
00078       // loop through keys table
00079       for (uint8_t i = 0; i < sizeof(l_keys); i++) {
00080           // found match in lookup table
00081           if (l_key == l_keys[i]) {
00082               Buzzer.buzz(l_notes[i], l_currentNoteLength);
00083               // record that we've found a note
00084               l_isNote = 1;
00085               break;
00086           }
00087       }
00088
00089       // Handle non-note keys: tempo changes and rests
00090       if (!l_isNote) {
00091           if (l_key == '-') {
00092               // code for short note
00093               l_currentNoteLength = l_currentNoteLength / 2;
00094           }
00095           else if (l_key == '+') {
00096               // code for long note
00097               l_currentNoteLength = l_currentNoteLength * 2;
00098           }
00099           else {
00100               // unrecognized, just rest
00101               Buzzer.pause(l_currentNoteLength);
00102           }
00103       }
00104
00105   }
00106   return 0;
00107 }
```

## 10.41 MCU.cpp File Reference

```
#include "MCU.h"
```

Include dependency graph for MCU.cpp:




## 10.42 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)
```

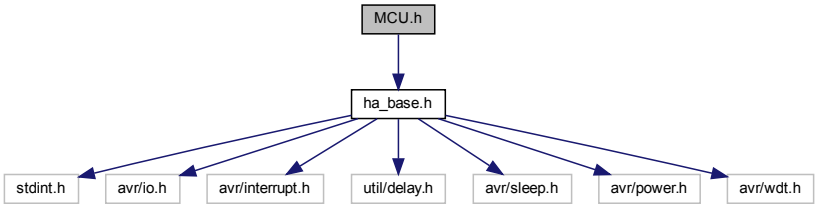
```
00058 {
00059     if (a_enable) {
00060         MCU_USART0_ENABLE;
00061     } else {
00062         MCU_USART0_DISABLE;
00063     }
00064 
00065 }
00066 
00067 void core::MCU::enableTimerCounter0(const uint8_t a_enable)
00068 {
00069     if (a_enable) {
00070         MCU_TIMER0_ENABLE;
00071     } 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 }
```

## 10.43 MCU.h File Reference

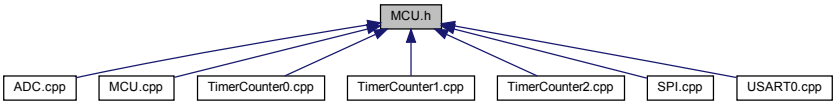
Header file of the MCU class.

```
#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::powerSav
  core::sleepMode::standby =6, core::sleepMode::extendedStandby }

### 10.43.1 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.

## 10.44 MCU.h

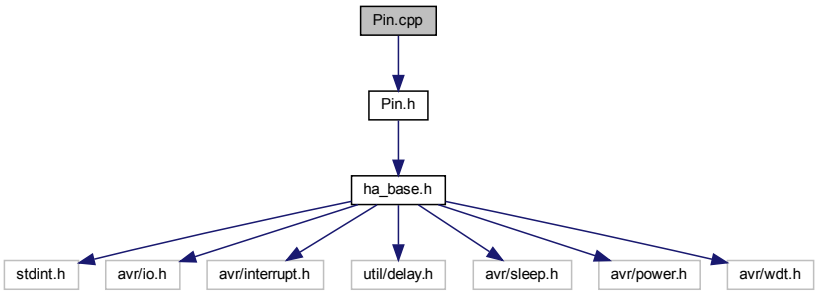
```
00001
00069 #ifndef MCU_H
00070 #define MCU_H
00071 #include "ha_base.h"
00072
00073
00074 namespace core
00075 {
00076
00077 enum class BODMode : uint8_t {
00078     enabled=0,
00079     disabled,
00080 };
00081
00082 enum class sleepMode : uint8_t {
00083     Idle=0,
00084     ADC_NoiseReduction,
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
```

## 10.45 Pin.cpp File Reference

`#include "Pin.h"`

Include dependency graph for Pin.cpp:




## 10.46 Pin.cpp

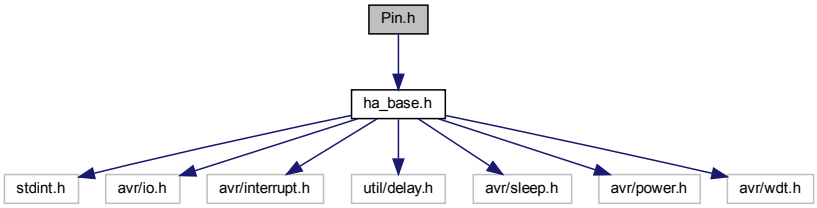
```
00001
```

```
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 }
```

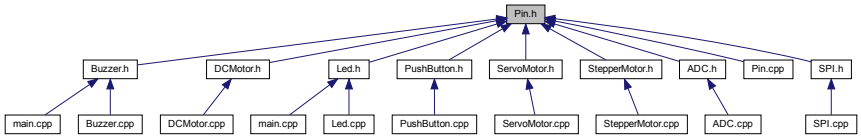
## 10.47 Pin.h File Reference

```
#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 defintions 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 }

# 10.48 Pin.h

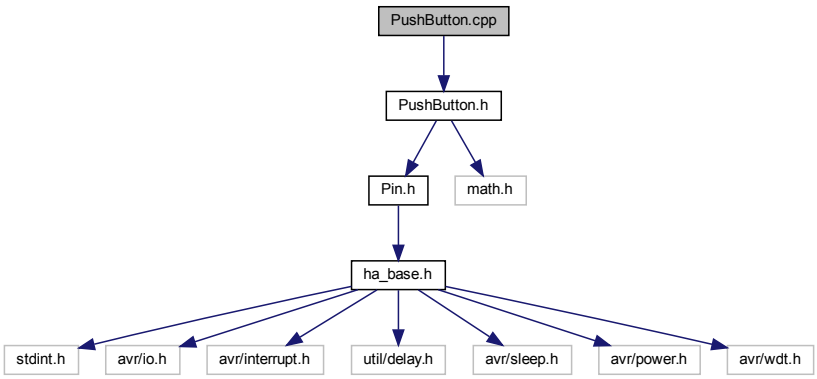
```
00001 #ifndef PIN_H
00002 #define PIN_H
00003 #include "ha_base.h"
00012 namespace io
00013 {
00014
00019 struct Port
00020 {
00021   volatile uint8_t* mp_ddrReg;
00023   volatile uint8_t* mp_portReg;
00025   volatile uint8_t* mp_pinReg;
```

```
00026 };
00027
00028 class Pin
00029 {
00030
00031 public:
00039     Pin(const uint8_t a_pinNumber, const Port &ar_portName);
00042     ~Pin();
00045     void toOutput();
00050     void toInput(const uint8_t &ar_useInternalPullUp);
00053     void setLow();
00056     void setHigh();
00057
00060     void toggle();
00066     uint8_t isHigh();
00072     uint8_t isLow();
00078     uint8_t getPinNumber();
00079
00080 protected:
00081
00082
00083 private:
00084
00085      const Port &mr_portName;
00086      const uint8_t m_pinNumber;
00090 };
00091
00092 static io::Port PortB = { &DDRB, &PORTB, &PINB };
00093 static io::Port PortC = { &DDRC, &PORTC, &PINC };
00094 static io::Port PortD = { &DDRD, &PORTD, &PIND };
00096 }
00097
00098
00099 #endif
```

## 10.49 PushButton.cpp File Reference

`#include "PushButton.h"`

Include dependency graph for PushButton.cpp:




## 10.50 PushButton.cpp

```
00001 #include "PushButton.h"
00002
00003 component::PushButton::PushButton(const io::Pin& ar_pin, const uint8_t &ar_useInternalPullUp, const
       uint8_t &ar_isActiveLow)
00004                                 : m_pin(ar_pin),
00005                                   mr_isActiveLow(ar_isActiveLow),
00006                                   mr_useInternalPullUp(ar_useInternalPullUp)
00007
```

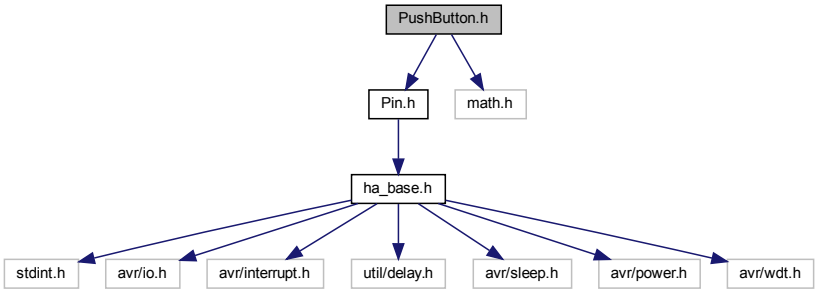
```
00008
00009 {
00010     m_pin.toInput(mr_useInternalPullUp);
00011     m_buttonPressed = 0;
00012 }
00013
00014 component::PushButton::~PushButton()
00015 {
00016
00017 }
00018
00019
00020 uint8_t component::PushButton::isPressed()
00021 {
00022     if (mr_isActiveLow || mr_useInternalPullUp) {
00023         if (m_pin.isLow()) {
00024             _delay_us(PUSHBUTTON_DEBOUNCE_TIME_US);
00025             if (m_pin.isLow()) {
00026                 ++m_buttonPressed;
00027                 return 1;
00028             }
00029         }
00030     } else {
00031
00032         if (m_pin.isHigh()) {
00033             _delay_us(PUSHBUTTON_DEBOUNCE_TIME_US);
00034             if (m_pin.isHigh()) {
00035                 ++m_buttonPressed;
00036                 return 1;
00037             }
00038         }
00039
00040     }
00041     m_buttonPressed = 0;
00042     return 0;
00043
00044 }
00045
00046 uint8_t component::PushButton::getPressedCount() const
00047 {
00048
00049     return m_buttonPressed;
00050
00051 }
00052
00053 void component::PushButton::resetPressedCount()
00054 {
00055     m_buttonPressed = 0;
00056
00057 }
```

## 10.51 PushButton.h File Reference

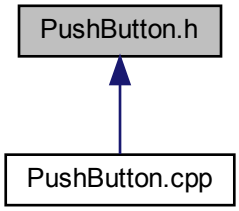
Header file of the Push Button class.

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

Include dependency graph for PushButton.h:



This graph shows which files directly or indirectly include this file:




## Classes

- class component::PushButton

## Namespaces

- component

  *AVR chip external components.*

### 10.51.1 Detailed Description

Header file of the Push Button class.

class to monitor a Push Button

Usage example (current state):

#include "PushButton.h" #include "Led.h"

#define PUSHBUTTON_NUMBER 1 #define LED_NUMBER 0

int main(void) {

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::PortB));

Mainloop while (1) {

if (PushButton.isPressed()) { Led.on(); } else { Led.off(); }

} return 0; }

Usage example (changing state):

#include "PushButton.h" #include "Led.h"

#define PUSHBUTTON_NUMBER 1 #define LED_NUMBER 0

int main(void) {

Init

uint8_t l_statePushButton = 0;

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::PortB));

Mainloop while (1) {

if (PushButton.isPressed()) { if (l_statePushButton == 0) {

```
Led.toggle();
l_statePushButton = 1;
```

} } else { l_statePushButton = 0; }

} return 0; }

**Author**

Farid Oubbati ( https://github.com/faroub)

**Date**

March 2020

Definition in file PushButton.h.

## 10.52 PushButton.h

```
00001
00085 #ifndef PUSHBUTTON_H
00086 #define PUSHBUTTON_H
00087 #include "Pin.h"
00088 #include <math.h>
00089
00090 // TODO: check the use PUSHBUTTON_SAMPLING in ha_m328p.h
00091
00092
00093 namespace component
00094 {
00095 class PushButton
00096 {
00097 public:
00104     PushButton(const io::Pin &ar_pin, const uint8_t &ar_useInternalPullUp=1, const uint8_t
       &ar_isActiveLow=1);
00107     ~PushButton();
00110     uint8_t isPressed();
00113     uint8_t getPressedCount() const;
00116     void resetPressedCount();
00117
00118
00119 protected:
00120
00121 private:
00122     io::Pin m_pin;
00123     const uint8_t &mr_isActiveLow;
00124     const uint8_t &mr_useInternalPullUp;
00125     uint8_t m_buttonPressed;
00129 };
00130 }
00131
00132
00133
00134
00135 #endif
```

## 10.53 README.md File Reference

## 10.54 README.md File Reference

## 10.55 README.md File Reference

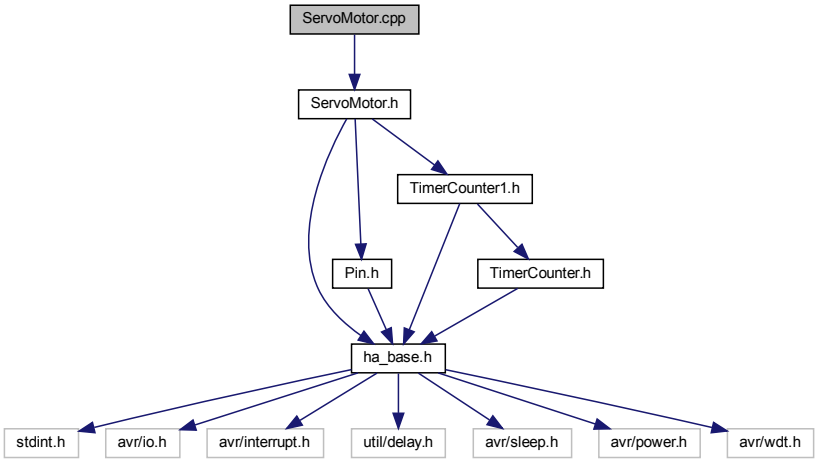
## 10.56 README.md File Reference

## 10.57 README.md File Reference

## 10.58 ServoMotor.cpp File Reference

```
#include "ServoMotor.h"
```

Include dependency graph for ServoMotor.cpp:




## 10.59 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_clockPre
00067 }
00068
00069
00070
00071 void component::ServoMotor::rotate(core::TimerCounter1 &ar_timerCounter1,
00072                                    const uint8_t &ar_angle_deg,
00073                                    const core::channel &ar_channel)
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,
00086              const core::channel &ar_channel)
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 }
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
```

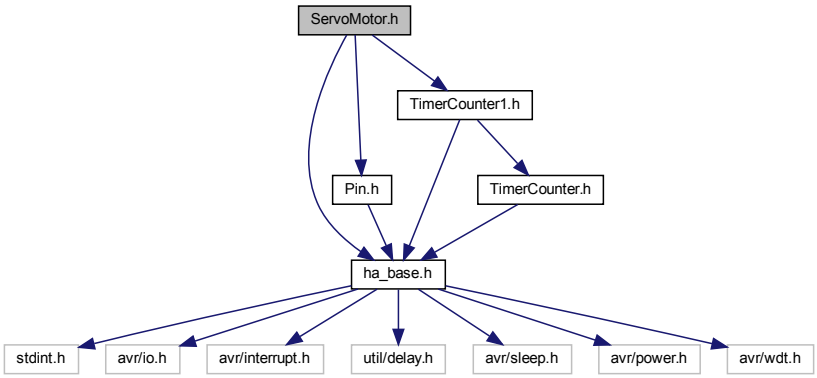
```
00102     ar_timerCounter1.stop();
00103 }
```

## 10.60 ServoMotor.h File Reference

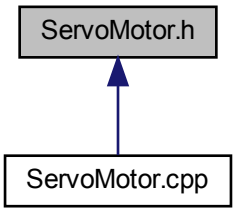
Header file of the ServoMotor class.

```
#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.*

### 10.60.1 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_M↩ ID, SERVOMOTOR_PULSE_WIDTH_MAX);

myTimerCounter1.setInputCaptureRegister(myServoMotor.computePulseCycleCount(myTimerCounter1.get↩ ClockPrescaler())); myTimerCounter1.setOutputCompareRegister(core::channel::A, myServoMotor.compute↩ RotationAngleCount(0,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); my↩ TimerCounter1.setOutputCompareRegister(core::channel::A, myServoMotor.computeRotationAngleCount(45,my↩ TimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); myTimerCounter1.set↩ OutputCompareRegister(core::channel::A, myServoMotor.computeRotationAngleCount(90,myTimerCounter1.↩ getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); myTimerCounter1.setOutputCompare↩ Register(core::channel::A, myServoMotor.computeRotationAngleCount(135,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); myTimerCounter1.setOutputCompareRegister(core::channel::A, my↩ ServoMotor.computeRotationAngleCount(180,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000); myTimerCounter1.setOutputCompareRegister(core::channel::A, myServoMotor.compute↩ RotationAngleCount(0,myTimerCounter1.getClockPrescaler())); myTimerCounter1.start(); _delay_ms(2000);

Mainloop while (1) {

} return 0; } Usage example (TimerCounter1): #include "MCU.h" #include "ServoMotor.h" #include "Timer↩ Counter1.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.

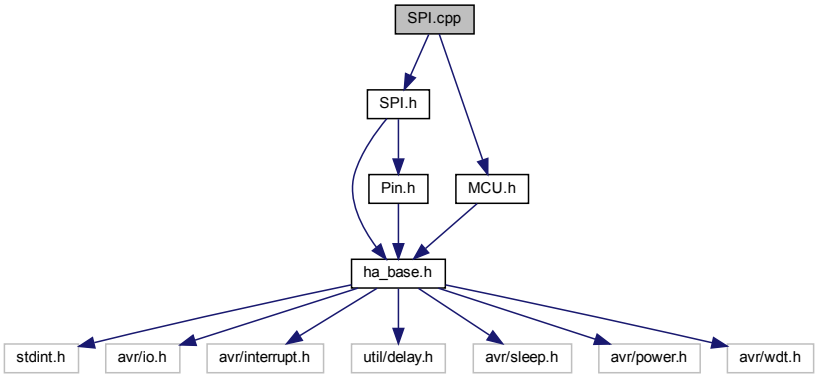
## 10.61 ServoMotor.h

```
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
00152     void on();
00155     void off();
00158     void toggle();
00159
00160     uint16_t computePulseCycleCount(const uint16_t &ar_clockPrescaler);
00161
00162     uint16_t computePulseWidthMinCount(const uint16_t &ar_clockPrescaler);
00163
00164     uint16_t computePulseWidthMidCount(const uint16_t &ar_clockPrescaler);
00165
00166     uint16_t computePulseWidthMaxCount(const uint16_t &ar_clockPrescaler);
00167
00168     uint16_t computeRotationAngleCount(const uint8_t &ar_angle_deg, const uint16_t
       &ar_clockPrescaler);
00169
00170
00171     void rotate(core::TimerCounter1 &ar_timerCounter1,
00172                 const uint8_t &ar_angle_deg,
00173                 const core::channel &ar_channel=core::channel::A);
00174
00175     void connect(core::TimerCounter1 &ar_timerCounter1,
00176                  const core::channel &ar_channel=core::channel::A);
00177
00178     void disconnect(core::TimerCounter1 &ar_timerCounter1,
00179                     const core::channel &ar_channel=core::channel::A);
00180
00181
00182
00183 protected:
00184
00185 private:
00186
00187
00188     io::Pin m_pin;
00190     uint16_t m_pulseCycle;
00192     uint16_t m_pulseWidthMin;
00194     uint16_t m_pulseWidthMid;
00196     uint16_t m_pulseWidthMax;
00205 };
00206
00207
00208 }
00209
00210
00211
00212 #endif
```

## 10.62 SPI.cpp File Reference

```
#include "SPI.h"
#include "MCU.h"
```

Include dependency graph for SPI.cpp:




## 10.63 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
00132         m_data = SPI_DATA_REGISTER;
00133 }
00134
00135 void io::SPI::masterSendByte(const uint8_t &ar_byte)
00136 {
00137
00138     SPI_DATA_REGISTER = ar_byte;
00139     selectSlave(1);
00140     while(!transferComplete()){};
```

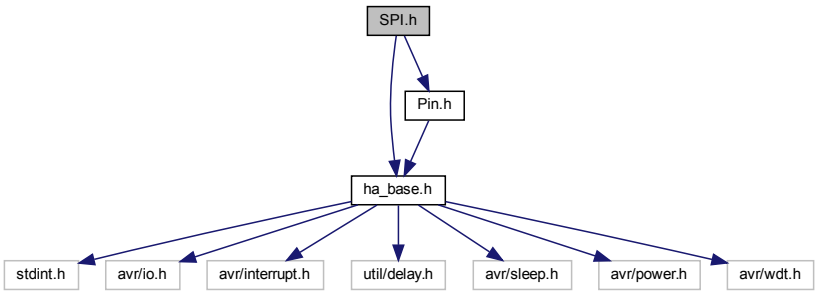
```
00141     selectSlave(0);
00142
00143
00144
00145 }
00146
00147 void io::SPI::masterReceiveByte(uint8_t &ar_byte)
00148 {
00149     masterSendByte(0);
00150     ar_byte = m_data;
00151
00152 }
00153
00154 void io::SPI::slaveReceiveByte(uint8_t &ar_byte)
00155 {
00156     ar_byte = m_data;
00157
00158 }
```

## 10.64 SPI.h File Reference

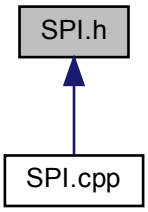
Header file of the SPI class.

```
#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 }

### 10.64.1 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.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.

## 10.65 SPI.h

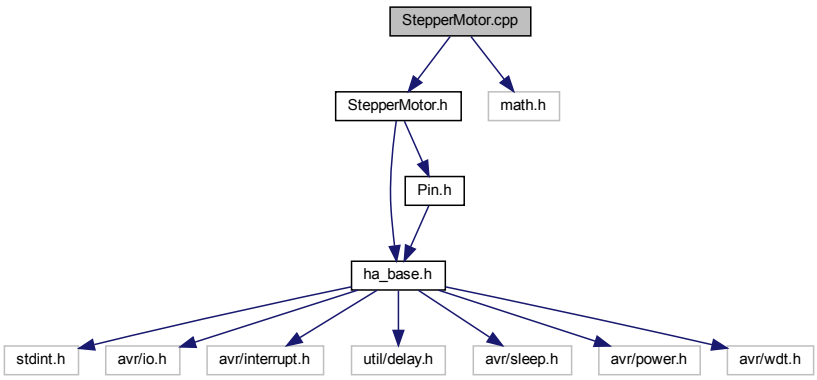
```
00001
00048 #ifndef SPI_H
00049 #define SPI_H
00050 #include "ha_base.h"
00051 #include "Pin.h"
00052
00053 namespace io
00054 {
00055
00056 enum class operationMode : uint8_t {
00057     master=0,
00058     slave,
00059     submaster,
00060     disable,
00061 };
00062
00063 enum class clockPrescaler : 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
00089 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
```

## 10.66 StepperMotor.cpp File Reference

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

Include dependency graph for StepperMotor.cpp:




## 10.67 StepperMotor.cpp

```
00001 #include "StepperMotor.h"
00002 #include <math.h>
00003
00004 // TODO: steps to angle
00005 // TODO: maximum speed
00006 // TODO: speed and accelleration profiles
00007
00008 component::StepperMotor::StepperMotor(const mode &ar_mode,
00009                                       const io::Pin &ar_pinCoil1,
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
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 }
```

```
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
00084     } else {
00085
00086         if (l_stepNumber == -a_step)
00087         {
00088             m_goalReached = 1;
00089
00090         } else {
00091             l_stepNumber--;
00092             m_currentPos--;
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
      ((l_time>(l_accelTime+l_constSpeedTime))&&(l_time<=l_accelTime+l_constSpeedTime+l_decelTime))
00171    {
00172        l_speed= (1000UL*a_speed)-a_decel*(l_time-l_accelTime-l_constSpeedTime);
00173 
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 
00218     } else {
00219 
00220         if (l_stepNumber == -a_step)
00221         {
00222             m_goalReached = 1;
00223 
00224         } else {
00225             l_stepNumber--;
00226             m_currentPos--;
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     }
```

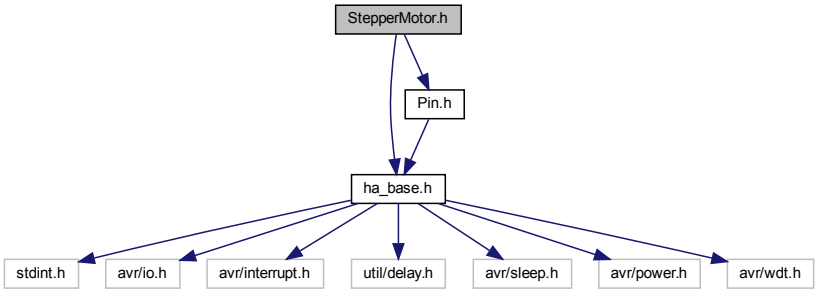
```
00288
00289
00290     if (m_goalReached == 0)
00291     {
00292
00293         switch (stepMode)
00294         {
00295             case mode::fullStep:
00296             {
00297                 // equivalent to l_stepNumber % 4
00298                 // 1 3 5 7 <->
00299                 stepPulse(2*(l_stepNumber & 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--)
00398     {
00399         _delay_ms(1);
00400     }
00401 }
00402
00403 uint8_t component::StepperMotor::goalReached()
00404 {
00405     return m_goalReached;
00406
00407 }
```

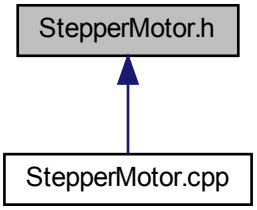
## 10.68 StepperMotor.h File Reference

```
#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 }

# 10.69 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,
```

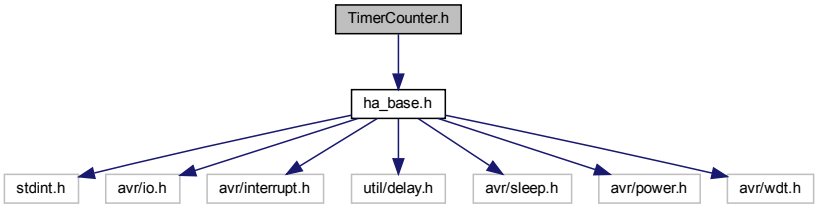
```
00095               const float a_stepAngle);
00096
00097     void step(const int16_t a_step,
00098               const uint16_t a_speed,
00099               const uint16_t a_accel,
00100               const uint16_t a_decel);
00101
00102     void stepPulse(const uint8_t a_stepPulse);
00103
00104     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
```

## 10.70 TimerCounter.h File Reference

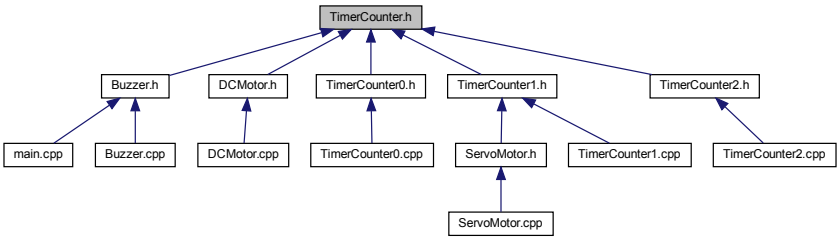
Header file of the TimerCounter class.

```
#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 }

### 10.70.1 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("\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 millseconds 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 (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(); my↩
TimerCounter1.selectOperationMode(core::operationMode::Fast_PWM_8bit); myTimerCounter1.selectCompare↩
OutputMode(core::channel::A,core::compareOutputMode::Clear); myTimerCounter1.selectCompareOutput↩
Mode(core::channel::B,core::compareOutputMode::Clear); instantiate Timer2 object core::TimerCounter2 &my↩
TimerCounter2 = core::TimerCounter2::getInstance(); myTimerCounter2.selectOperationMode(core::operation↩
Mode::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,myTimer↩
Counter1.getOutputCompareRegister(core::channel::B)); myTimerCounter1.setOutputCompareRegister(core::channel::B,my↩
TimerCounter1.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)); extern 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.enableOutput↩ CompareMatchInterrupt(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 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("\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 millseconds 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.

## 10.71 TimerCounter.h

```
00001
00039
00461 #ifndef TIMER_COUNTER_H
00462 #define TIMER_COUNTER_H
00463 #include "ha_base.h"
00464
00465
00466
00467 namespace core
00468 {
00469
00470 enum class channel : uint8_t {
00471     A=0,
```

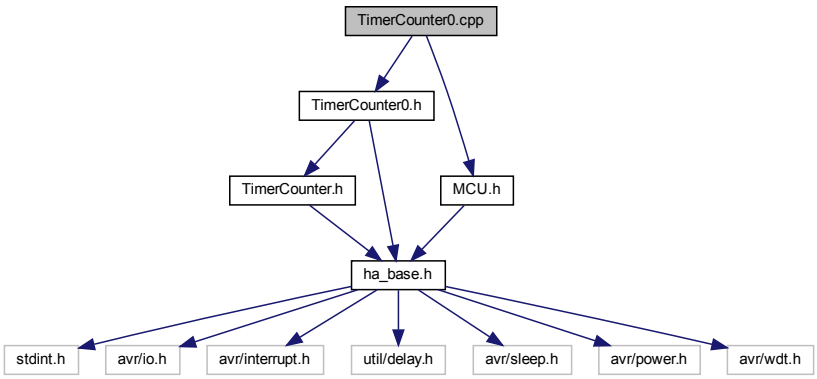
```
00472     B,
00473 };
00474
00475
00476 enum class compareOutputMode : uint8_t {
00477     normal=0,
00478     toggle,
00479     clear,
00480     set,
00481 };
00482
00483
00484
00485 enum class operationMode : uint8_t {
00486     normal=0,
00487     PWM_PC,
00488     PWM_PC_8bit,
00489     PWM_PC_9bit,
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
```

## 10.72 TimerCounter0.cpp File Reference

```
#include "TimerCounter0.h"
#include "MCU.h"
```

Include dependency graph for TimerCounter0.cpp:




## 10.73 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         }
```

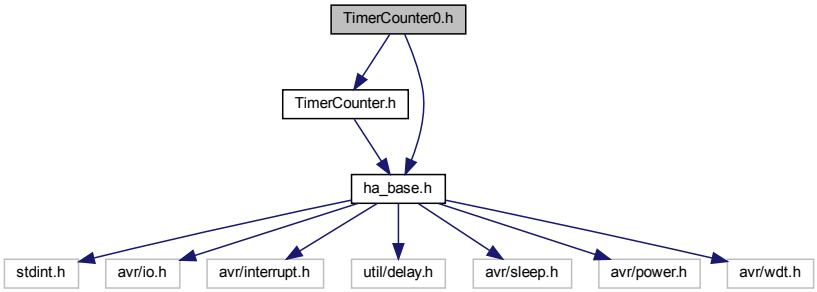
```
00125         case core::operationMode::fast_PWM_OCR:
00126         {
00127             TIMER0_SELECT_OPERATION_MODE(7);
00128             break;
00129         }
00130
00131     }
00132
00133 }
00134
00135
00136 void core::TimerCounter0::start()
00137 {
00138     TIMER0_SELECT_CLOCK_SOURCE(m_clockSource);
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             }
00243             break;
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 }
```

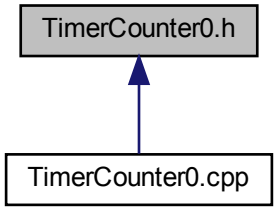
## 10.74 TimerCounter0.h File Reference

```
#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

# 10.75 TimerCounter0.h

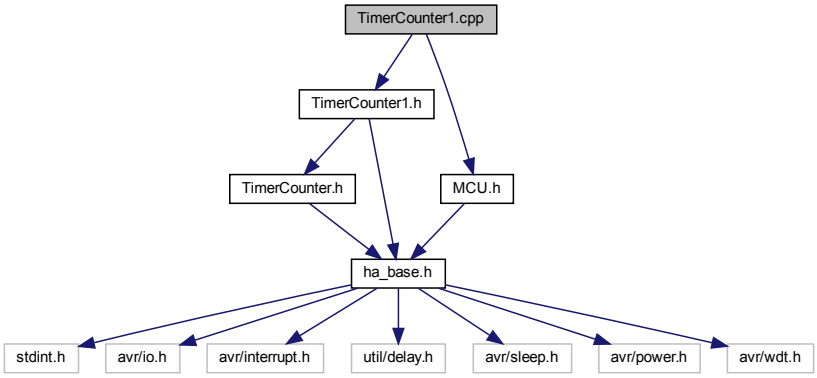
```
00001
00039
00268 #ifndef TIMER_COUNTER0_H
00269 #define TIMER_COUNTER0_H
00270 #include "TimerCounter.h"
00271 #include "ha_base.h"
00272
00273
00274
00275 namespace core
00276 {
00277
00278
00279 class TimerCounter0 : public TimerCounter
```

```
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(TIMER0_COM_CHANNEL_A_INTERRUPT))
      __attribute__((__signal__, __used__, __externally_visible__));
00314
00315     static void outputCompareMatchBServiceRoutine() __asm__(STR(TIMER0_COM_CHANNEL_B_INTERRUPT))
      __attribute__((__signal__, __used__, __externally_visible__));
00316
00317     static void overflowServiceRoutine() __asm__(STR(TIMER0_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
00334     TimerCounter0(const TimerCounter0&);
00335
00338     const TimerCounter0& operator=(const TimerCounter0&);
00339
00340     uint16_t m_clockPrescaler;
00341
00342     uint8_t m_clockSource;
00343
00344
00345
00346 };
00347
00348 }
00349
00350
00351 #endif
```

## 10.76 TimerCounter1.cpp File Reference

```
#include "TimerCounter1.h"
#include "MCU.h"
```

Include dependency graph for TimerCounter1.cpp:




## 10.77 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
```

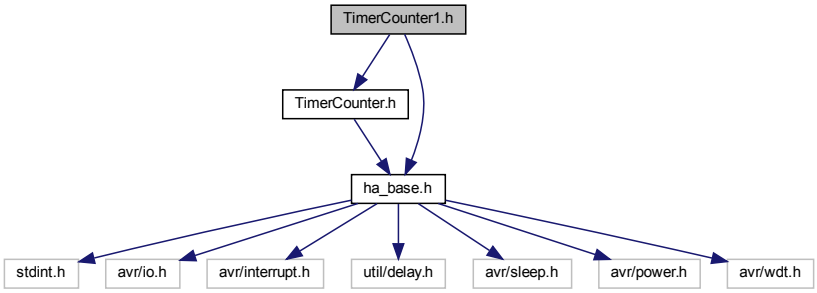
```
      &ar_dataBuffer)
00227 {
00228     switch (ar_channel)
00229     {
00230         case core::channel::A:
00231         {
00232             OCR1A = ar_dataBuffer;
00233             break;
00234         }
00235         case core::channel::B:
00236         {
00237             OCR1B = ar_dataBuffer;
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             }
00287             break;
00288         }
00289     }
00290
00291 }
00292
00293
00294
00295 void core::TimerCounter1::enableOverflowInterrupt(const uint8_t a_enable)
00296 {
00297
00298     if (a_enable) {
00299
00300         TIMER1_ENABLE_OVERFLOW_INTERRUPT;
00301
00302     } else {
00303
00304         TIMER1_DISABLE_OVERFLOW_INTERRUPT;
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 }
```

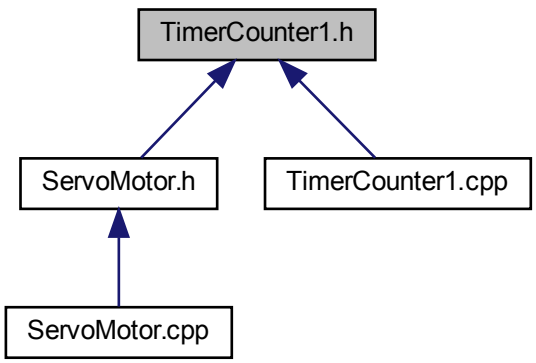
## 10.78 TimerCounter1.h File Reference

```
#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

# 10.79 TimerCounter1.h

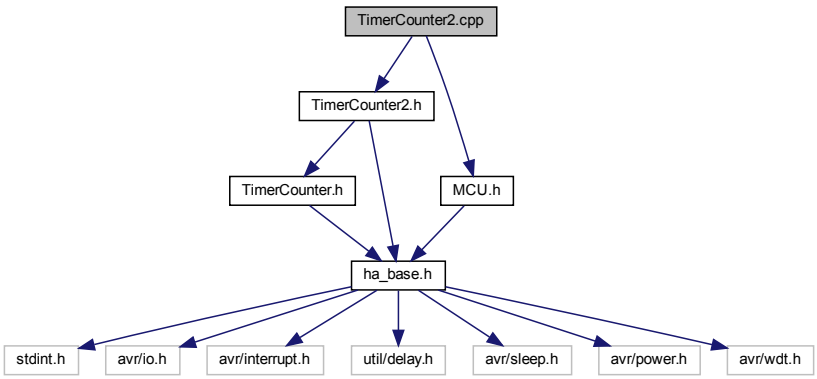
```
00001
00039
00268 #ifndef TIMER_COUNTER1_H
00269 #define TIMER_COUNTER1_H
00270 #include "TimerCounter.h"
00271 #include "ha_base.h"
00272
00273
00274
00275 namespace core
00276 {
00277
00278
00279 class TimerCounter1 : public TimerCounter
00280 {
00281
00282 public:
00283
00284     static TimerCounter1& 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 =
      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
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
00343     TimerCounter1(const TimerCounter1&);
00344
00347     const TimerCounter1& operator=(const TimerCounter1&);
00348
00349     uint16_t m_clockPrescaler;
00350
00351     uint8_t m_clockSource;
00352
00353 };
00354
00355 }
00356
00357
00358 #endif
```

## 10.80 TimerCounter2.cpp File Reference

```
#include "TimerCounter2.h"
#include "MCU.h"
```

Include dependency graph for TimerCounter2.cpp:




## 10.81 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:
```

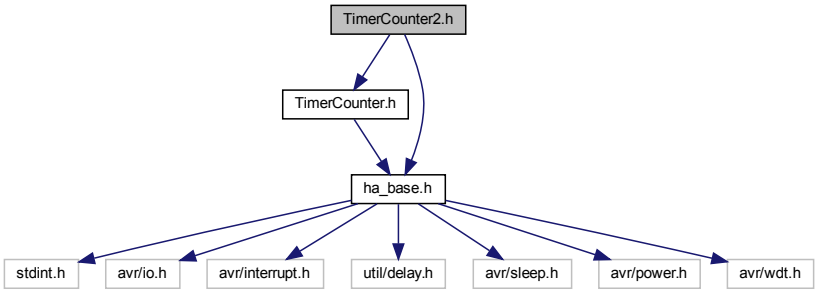
```
00186         {
00187             OCR2A = static_cast<uint8_t>(ar_dataBuffer);
00188             break;
00189         }
00190         case core::channel::B:
00191         {
00192             OCR2B = static_cast<uint8_t>(ar_dataBuffer);
00193             break;
00194         }
00195     }
00196 }
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
00223                 TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT;
00224
00225             } else {
00226
00227                 TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT;
00228             }
00229             break;
00230         }
00231         case core::channel::B:
00232         {
00233             if (a_enable) {
00234
00235                 TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT;
00236
00237             } else {
00238
00239                 TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT;
00240
00241             }
00242             break;
00243         }
00244     }
00245
00246 }
00247
00248
00249
00250 void core::TimerCounter2::enableOverflowInterrupt(const uint8_t a_enable)
00251 {
00252
00253     if (a_enable) {
00254
00255         TIMER2_ENABLE_OVERFLOW_INTERRUPT;
00256
00257     } else {
00258
00259         TIMER2_DISABLE_OVERFLOW_INTERRUPT;
00260     }
00261
00262 }
```

## 10.82 TimerCounter2.h File Reference

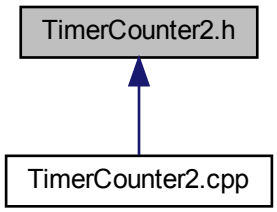
```
#include "TimerCounter.h"
```

```
#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

# 10.83 TimerCounter2.h

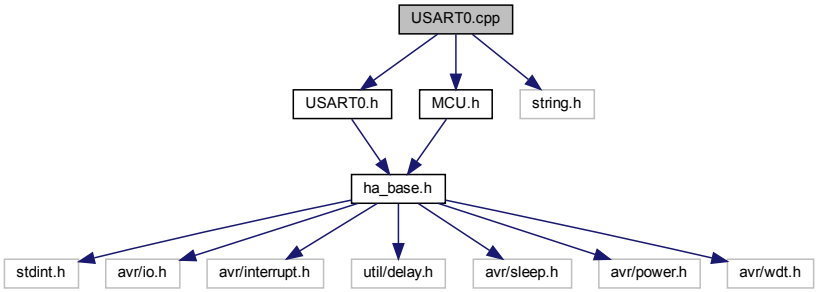
```
00001
00039
00268 #ifndef TIMER_COUNTER2_H
00269 #define TIMER_COUNTER2_H
00270 #include "TimerCounter.h"
00271 #include "ha_base.h"
00272
00273
00274
00275 namespace core
00276 {
00277
```

```
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
00332     TimerCounter2(const TimerCounter2&);
00333
00336     const TimerCounter2& operator=(const TimerCounter2&);
00337
00338     uint16_t m_clockPrescaler;
00339
00340     uint8_t m_clockSource;
00341
00342 };
00343
00344 }
00345
00346
00347 #endif
```

## 10.84 USART0.cpp File Reference

```
#include "USART0.h"
#include "MCU.h"
#include <string.h>
```

Include dependency graph for USART0.cpp:




## 10.85 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);
```

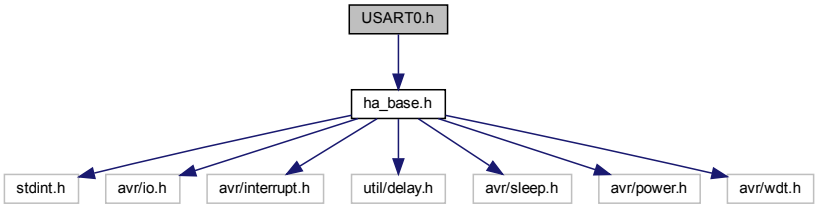
```
00240     l_byte2Send[2] = '0' + (ar_byte % 10);
00241
00242     while (!ready2Send()){};
00243     m_sizeData2Send = 3;
00244     mp_data2Send = l_byte2Send;
00245     enableDataRegisterEmptyInterrupt(1);
00246
00247 }
00248 void io::USART0::sendLong(const uint32_t &ar_long)
00249 {
00250     static 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 
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 }
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 
00377     } else {
00378         USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT;
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 
00388     } else {
00389         USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT;
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 
```

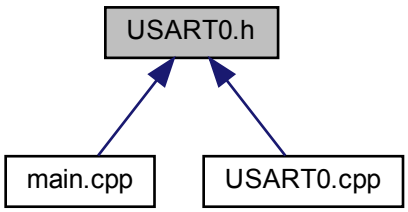
```
00414 uint8_t io::USART0::ready2Send()
00415 {
00416     return m_ready2Send;
00417
00418 }
00419
```

# 10.86 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.*

## 10.87 USART0.h

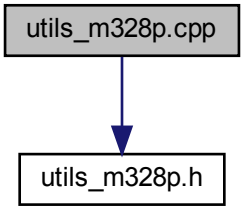
```
00001 #ifndef USART_H
00002 #define USART_H
00003 #include "ha_base.h"
00004
00013 namespace io
00014 {
00015
00016
00025 enum class transmissionMode : uint8_t {
00026     async=0,
00027     sync,
00028     masterSPI
00029 };
00030
00039 enum class communicationMode : uint8_t {
00040     duplex=0,
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     neineBits
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
00292 protected:
00293
00294
00295
00296
00297 private:
00308     USART0(const transmissionMode& ar_transMode,
00309            const communicationMode& ar_comMode,
00310            const frameSize& ar_frameSize,
00311            const stopBit& ar_stopBit,
00312            const parityMode& ar_parityMode);
00313
00316     ~USART0();
00317
00321     USART0(const USART0&);
00322
00326     const USART0& operator=(const USART0&);
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
```

## 10.88 utils_m328p.cpp File Reference

```
#include "utils_m328p.h"
```

Include dependency graph for utils_m328p.cpp:

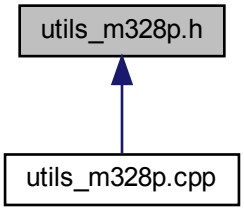



## 10.89 utils_m328p.cpp

```
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 }
```

## 10.90 utils_m328p.h File Reference

This graph shows which files directly or indirectly include this file:




### Namespaces

- utils

### Functions

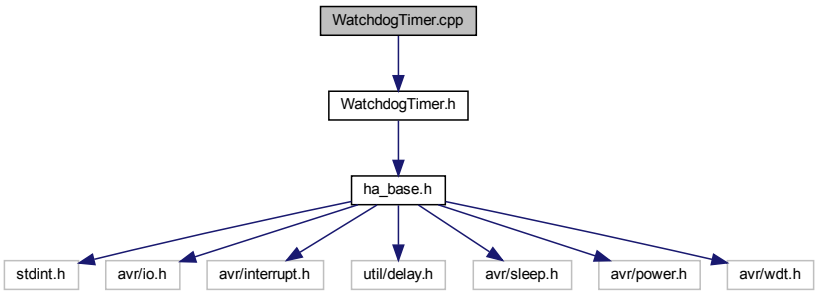
- long utils::map (long x, long in_min, long in_max, long out_min, long out_max)

## 10.91 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 devide 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
```

## 10.92 WatchdogTimer.cpp File Reference

`#include "WatchdogTimer.h"`
Include dependency graph for WatchdogTimer.cpp:




## 10.93 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
```

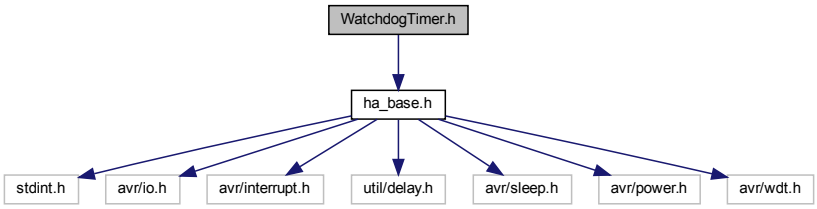
```
00011 core::WatchdogTimer::WatchdogTimer()
00012 {
00013     sei();
00014     stop();
00015 }
00016
00017 core::WatchdogTimer::~WatchdogTimer()
00018 {
00019
00020 }
00021
00022 void core::WatchdogTimer::selectTimeOut(const timeOut &ar_timeOut)
00023 {
00024     m_timeOut = static_cast<uint8_t>(ar_timeOut);
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     cli();
00044     wdt_reset();
00045     WATCHDOG_START(m_operationMode,m_timeOut);
00046     sei();
00047
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     cli();
00057     wdt_reset();
00058     WATCHDOG_START(m_operationMode,m_timeOut);
00059     sei();
00060
00061 }
00062
00063 void core::WatchdogTimer::stop()
00064 {
00065     cli();
00066     wdt_reset();
00067     WATCHDOG_STOP;
00068     sei();
00069
00070 }
00071
```

## 10.94 WatchdogTimer.h File Reference

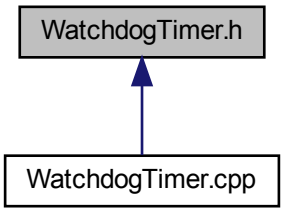
Header file of the WatchdogTimer class.

```
#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
  }

### 10.94.1 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(); myWatchdog.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.

# 10.95 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
00087 public:
00088
00089     static WatchdogTimer& getInstance();
00090
00091     void selectTimeOut(const timeOut &ar_timeOut);
00092
00093     void reset();
00094
00095     void start(const operationMode &ar_operationMode);
00096
00097     void start(const operationMode &ar_operationMode, const timeOut &ar_timeOut);
00098
00099
00100     void stop();
00101
00102     static void timeOutServiceRoutine() __asm__(STR(WATCHDOG_TIMEOUT_INTERRUPT))
      __attribute__((__signal__, __used__, __externally_visible__));
00103
00104
00105 protected:
00106
00107 private:
00108
00109     WatchdogTimer();
00110
00113     ~WatchdogTimer();
00114
00117     WatchdogTimer(const WatchdogTimer&);
00118
00121     const WatchdogTimer& operator=(const WatchdogTimer&);
00122
00123     uint8_t m_timeOut;
00124
00125     uint8_t m_operationMode;
00126
00127 };
00128
00129 }
00130
00131
00132 #endif
```

# Index


__externally_visible__
core::ADConverter, 45
core::ExternInterrupt, 58
core::TimerCounter0, 112
core::TimerCounter1, 123
core::TimerCounter2, 133
core::WatchdogTimer, 155
io::SPI, 89
io::USART0, 149
__used__
core::ADConverter, 45
core::ExternInterrupt, 59
core::TimerCounter0, 112
core::TimerCounter1, 123
core::TimerCounter2, 133
core::WatchdogTimer, 155
io::SPI, 89
io::USART0, 149
~ADConverter
core::ADConverter, 38
~Buzzer
component::Buzzer, 47
~DCMotor
component::DCMotor, 51
~ExternInterrupt
core::ExternInterrupt, 54
~Led
component::Led, 61
~Pin
io::Pin, 68
~PushButton
component::PushButton, 74
~SPI
io::SPI, 84
~ServoMotor
component::ServoMotor, 77
~StepperMotor
component::StepperMotor, 92
~TimerCounter0
core::TimerCounter0, 105
~TimerCounter1
core::TimerCounter1, 115
~TimerCounter2
core::TimerCounter2, 126
~USART0
io::USART0, 136
~WatchdogTimer
core::WatchdogTimer, 152

A
core, 24
A0
buzzer_pitches_16bit.h, 173
buzzer_pitches_8bit.h, 191
A1
buzzer_pitches_16bit.h, 173
buzzer_pitches_8bit.h, 191
A2
buzzer_pitches_16bit.h, 173
buzzer_pitches_8bit.h, 191
A3
buzzer_pitches_16bit.h, 173
A4
buzzer_pitches_16bit.h, 173
A5
buzzer_pitches_16bit.h, 174
A6
buzzer_pitches_16bit.h, 174
A7
buzzer_pitches_16bit.h, 174
ADC.cpp, 157
ADC.h, 161, 164
ADC_ADJUST_RESULT_LEFT
ha_m328p.h, 213
ADC_ADJUST_RESULT_RIGHT
ha_m328p.h, 213
ADC_CONVERSION_COMPLETE_INTERRUPT
ha_m328p.h, 213
ADC_DISABLE
ha_m328p.h, 213
ADC_DISABLE_AUTOTRIGGER
ha_m328p.h, 213
ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT
ha_m328p.h, 214
ADC_DISABLE_DIGITAL_INPUT_REGISTER
ha_m328p.h, 214
ADC_ENABLE
ha_m328p.h, 214
ADC_ENABLE_AUTOTRIGGER
ha_m328p.h, 214
ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT
ha_m328p.h, 214
ADC_NoiseReduction
core, 29
ADC_SELECT_ANALOG_INPUT
ha_m328p.h, 214
ADC_SELECT_AUTO_TRIGGER_SOURCE
ha_m328p.h, 215
ADC_SELECT_CLOCK_PRESCALER

ha_m328p.h, 215
ADC_SELECT_REF_VOLTAGE
ha_m328p.h, 215
ADC_START_CONVERSION
ha_m328p.h, 215
ADC_STOP_CONVERSION
ha_m328p.h, 215
ADConverter
core::ADConverter, 38
ANALOG_COMARATOR_H
AnalogComparator.h, 166
analogComparator
core, 23
AnalogComparator.cpp, 165
AnalogComparator.h, 165, 167
ANALOG_COMARATOR_H, 166
AREF
core, 28
async
io, 35
autoTriggerSource
core, 23
AVCC
core, 28
Ax0
buzzer_pitches_16bit.h, 174
buzzer_pitches_8bit.h, 191
Ax1
buzzer_pitches_16bit.h, 174
buzzer_pitches_8bit.h, 192
Ax2
buzzer_pitches_16bit.h, 174
buzzer_pitches_8bit.h, 192
Ax3
buzzer_pitches_16bit.h, 175
Ax4
buzzer_pitches_16bit.h, 175
Ax5
buzzer_pitches_16bit.h, 175
Ax6
buzzer_pitches_16bit.h, 175
Ax7
buzzer_pitches_16bit.h, 175

B
core, 24
B0
buzzer_pitches_16bit.h, 175
buzzer_pitches_8bit.h, 192
B1
buzzer_pitches_16bit.h, 176
buzzer_pitches_8bit.h, 192
B2
buzzer_pitches_16bit.h, 176
buzzer_pitches_8bit.h, 192
B3
buzzer_pitches_16bit.h, 176
B4
buzzer_pitches_16bit.h, 176
B5
buzzer_pitches_16bit.h, 176
B6
buzzer_pitches_16bit.h, 176
B7
buzzer_pitches_16bit.h, 177
BlinkLed/main.cpp
main, 248
PIN_NUMBER, 247
TIMEDELAY, 247
BODMode
core, 24
buzz
component::Buzzer, 48
BUZZER
Organ/main.cpp, 250
Buzzer
component::Buzzer, 47
Buzzer.cpp, 167
Buzzer.h, 168, 169
buzzer_pitches_16bit.h, 171, 189
A0, 173
A1, 173
A2, 173
A3, 173
A4, 173
A5, 174
A6, 174
A7, 174
Ax0, 174
Ax1, 174
Ax2, 174
Ax3, 175
Ax4, 175
Ax5, 175
Ax6, 175
Ax7, 175
B0, 175
B1, 176
B2, 176
B3, 176
B4, 176
B5, 176
B6, 176
B7, 177
C0, 177
C1, 177
C2, 177
C3, 177
C4, 177
C5, 178
C6, 178
C7, 178
Cx0, 178
Cx1, 178
Cx2, 178
Cx3, 179
Cx4, 179

Cx5, 179
Cx6, 179
Cx7, 179
D0, 179
D1, 180
D2, 180
D3, 180
D4, 180
D5, 180
D6, 180
D7, 181
Dx0, 181
Dx1, 181
Dx2, 181
Dx3, 181
Dx4, 181
Dx5, 182
Dx6, 182
Dx7, 182
E0, 182
E1, 182
E2, 182
E3, 183
E4, 183
E5, 183
E6, 183
E7, 183
F0, 183
F1, 184
F2, 184
F3, 184
F4, 184
F5, 184
F6, 184
F7, 185
Fx0, 185
Fx1, 185
Fx2, 185
Fx3, 185
Fx4, 185
Fx5, 186
Fx6, 186
Fx7, 186
G0, 186
G1, 186
G2, 186
G3, 187
G4, 187
G5, 187
G6, 187
G7, 187
Gx0, 187
Gx1, 188
Gx2, 188
Gx3, 188
Gx4, 188
Gx5, 188
Gx6, 188
Gx7, 189
buzzer_pitches_8bit.h, 190, 197
A0, 191
A1, 191
A2, 191
Ax0, 191
Ax1, 192
Ax2, 192
B0, 192
B1, 192
B2, 192
C1, 192
C2, 193
C3, 193
Cx0, 193
Cx2, 193
Cx3, 193
D1, 193
D2, 194
D3, 194
Dx0, 194
Dx2, 194
Dx3, 194
E1, 194
E2, 195
E3, 195
F1, 195
F2, 195
F3, 195
Fx1, 195
Fx2, 196
Fx3, 196
G1, 196
G2, 196
G3, 196
Gx0, 196
Gx1, 197
Gx2, 197

C0
buzzer_pitches_16bit.h, 177
C1
buzzer_pitches_16bit.h, 177
buzzer_pitches_8bit.h, 192
C2
buzzer_pitches_16bit.h, 177
buzzer_pitches_8bit.h, 193
C3
buzzer_pitches_16bit.h, 177
buzzer_pitches_8bit.h, 193
C4
buzzer_pitches_16bit.h, 177
C5
buzzer_pitches_16bit.h, 178
C6
buzzer_pitches_16bit.h, 178
C7
buzzer_pitches_16bit.h, 178
channel

core, 24
clear
core, 25
clockPrescaler
core, 24
io, 31
clockSource
core, 25
communicationMode
io, 31
compareOutputMode
core, 25
component, 21
fullStep, 22
halfStep, 22
mode, 21
component::Buzzer, 46
~Buzzer, 47
buzz, 48
Buzzer, 47
m_pin, 49
pause, 49
component::DCMotor, 50
~DCMotor, 51
connect, 51
DCMotor, 51
disconnect, 51
m_pin, 53
off, 52
on, 52
spin, 52
stop, 52
toggle, 53
component::Led, 59
~Led, 61
isOff, 61
isOn, 61
Led, 60
m_pin, 62
off, 61
on, 62
toggle, 62
component::PushButton, 73
~PushButton, 74
getPressedCount, 74
isPressed, 74
m_buttonPressed, 75
m_pin, 75
mr_isActiveLow, 76
mr_useInternalPullUp, 76
PushButton, 73
resetPressedCount, 75
component::ServoMotor, 76
~ServoMotor, 77
computePulseCycleCount, 78
computePulseWidthMaxCount, 78
computePulseWidthMidCount, 78
computePulseWidthMinCount, 78
computeRotationAngleCount, 79
connect, 79
disconnect, 79
m_pin, 81
m_pulseCycle, 81
m_pulseWidthMax, 81
m_pulseWidthMid, 81
m_pulseWidthMin, 82
off, 80
on, 80
rotate, 80
ServoMotor, 77
toggle, 80
component::StepperMotor, 90
~StepperMotor, 92
computeStepDelay, 92
currentPos, 93
goalReached, 93
m_accelTime, 98
m_constSpeedTime, 98
m_currentPos, 98
m_decelTime, 99
m_goalReached, 99
m_pinCoil1, 99
m_pinCoil2, 99
m_pinCoil3, 99
m_pinCoil4, 100
setCurrentPos, 94
step, 94–96
stepDelay, 97
stepMode, 100
StepperMotor, 91
stepPulse, 97
computePulseCycleCount
component::ServoMotor, 78
computePulseWidthMaxCount
component::ServoMotor, 78
computePulseWidthMidCount
component::ServoMotor, 78
computePulseWidthMinCount
component::ServoMotor, 78
computeRotationAngleCount
component::ServoMotor, 79
computeStepDelay
component::StepperMotor, 92
connect
component::DCMotor, 51
component::ServoMotor, 79
conversionComplete
core::ADConverter, 39
conversionCompleteServiceRoutine
core::ADConverter, 39
core, 22
A, 24
ADC_NoiseReduction, 29
analogComparator, 23
AREF, 28
autoTriggerSource, 23

AVCC, 28
B, 24
BODMode, 24
channel, 24
clear, 25
clockPrescaler, 24
clockSource, 25
compareOutputMode, 25
CTC_ICR, 26, 27
CTC_OCR, 26, 27
disabled, 24
enabled, 24
extendedStandby, 29
extern_Clock_T0_Falling_Edge, 25
extern_Clock_T0_Rising_Edge, 25
extInterrupt, 23
fallingEdge, 29
fast_PWM, 26, 27
fast_PWM_10bit, 26, 27
fast_PWM_8bit, 26, 27
fast_PWM_9bit, 26, 27
fast_PWM_ICR, 26, 27
fast_PWM_OCR, 26, 27
freeRunning, 23
Idle, 29
internal, 28
interrupt, 26, 27
interrupt_reset, 26, 27
logicalChange, 29
lowLevel, 29
noClock, 25
normal, 25, 26
operationMode, 26
PCINTB, 27
PCINTC, 27
PCINTD, 27
pinChangePort, 27
powerDown, 29
powerSave, 29
PS_1, 25
PS_1024, 25
PS_128, 24, 25
PS_16, 24
PS_2, 24
PS_256, 25
PS_32, 24, 25
PS_4, 24
PS_64, 24, 25
PS_8, 24, 25
PWM_PC, 26
PWM_PC_10bit, 26, 27
PWM_PC_8bit, 26
PWM_PC_9bit, 26, 27
PWM_PC_ICR, 26, 27
PWM_PC_OCR, 26, 27
PWM_PFC_ICR, 26, 27
PWM_PFC_OCR, 26, 27
referenceVoltage, 28
res_10bit, 28
res_11bit, 28
res_12bit, 28
res_13bit, 28
res_14bit, 28
res_15bit, 28
res_16bit, 28
res_8bit, 28
res_9bit, 28
reset, 26, 27
resolution, 28
risingEdge, 29
senseControl, 28
set, 25
sleepMode, 29
standby, 29
timeOut, 29
timer0Compare, 23
timer0Overflow, 23
timer1Capture, 23
timer1CompareB, 23
timer1Overflow, 23
to_125ms, 29
to_16ms, 29
to_1s, 29
to_250ms, 29
to_2s, 30
to_32ms, 29
to_4s, 30
to_500ms, 29
to_64ms, 29
to_8s, 30
toggle, 25
core::ADConverter, 37
__externally_visible__, 45
__used__, 45
~ADConverter, 38
ADConverter, 38
conversionComplete, 39
conversionCompleteServiceRoutine, 39
enableAutoTrigger, 41
enableConversionCompleteInterrupt, 41
getConversionResult, 41
getInstance, 42
m_conversionComplete, 45
m_resolution, 45
mp_conversionResult, 45
operator=, 43
selectAnalogInput, 43
selectAutoTriggerSource, 43
selectClockPrescaler, 43
selectReferenceVoltage, 44
start, 44
stop, 44
core::AnalogComparator, 46
core::ExternInterrupt, 53
__externally_visible__, 58
__used__, 59

~ExternInterrupt, 54
enableInt0, 55
enableInt1, 55
enablePinChange, 55
enablePinChangeMaskPortB, 56
enablePinChangeMaskPortC, 56
enablePinChangeMaskPortD, 56
ExternInterrupt, 54, 55
getInstance, 57
Int0ServiceRoutine, 57
Int1ServiceRoutine, 57
operator=, 57
pinChangePortBServiceRoutine, 57
pinChangePortCServiceRoutine, 58
pinChangePortDServiceRoutine, 58
setInt0SenseControl, 58
setInt1SenseControl, 58
core::MCU, 63
disableBOD, 63
enableADC, 63
enableSPI, 63
enableTimerCounter0, 64
enableTimerCounter1, 64
enableTimerCounter2, 64
enableTWI, 65
enableUSART0, 65
goToSleep, 65
init, 66
selectSleepMode, 66
sleepEnable, 66
core::TimerCounter, 100
enableOutputCompareMatchInterrupt, 101
enableOverflowInterrupt, 101
getClockPrescaler, 101
getCounter, 101
getOutputCompareRegister, 102
selectClockSource, 102
selectCompareOutputMode, 102
selectOperationMode, 102
setCounter, 102
setOutputCompareRegister, 102
start, 103
stop, 103
core::TimerCounter0, 103
__externally_visible__, 112
__used__, 112
~TimerCounter0, 105
enableOutputCompareMatchInterrupt, 106
enableOverflowInterrupt, 106
getClockPrescaler, 107
getCounter, 107
getInstance, 107
getOutputCompareRegister, 108
m_clockPrescaler, 112
m_clockSource, 113
operator=, 108
outputCompareMatchAServiceRoutine, 108
outputCompareMatchBServiceRoutine, 108
overflowServiceRoutine, 109
selectClockSource, 109
selectCompareOutputMode, 110
selectOperationMode, 110
setCounter, 111
setOutputCompareRegister, 111
start, 111
stop, 112
TimerCounter0, 105
core::TimerCounter1, 113
__externally_visible__, 123
__used__, 123
~TimerCounter1, 115
enableInputCaptureInterrupt, 115
enableOutputCompareMatchInterrupt, 116
enableOverflowInterrupt, 116
getClockPrescaler, 117
getCounter, 117
getInputCaptureRegister, 117
getInstance, 117
getOutputCompareRegister, 118
inputCaptureServiceRoutine, 118
m_clockPrescaler, 123
m_clockSource, 124
operator=, 118
outputCompareMatchAServiceRoutine, 118
outputCompareMatchBServiceRoutine, 119
overflowServiceRoutine, 119
selectClockSource, 119
selectCompareOutputMode, 120
selectOperationMode, 120
setCounter, 122
setInputCaptureRegister, 122
setOutputCompareRegister, 122
start, 122
stop, 123
TimerCounter1, 115
core::TimerCounter2, 124
__externally_visible__, 133
__used__, 133
~TimerCounter2, 126
enableOutputCompareMatchInterrupt, 126
enableOverflowInterrupt, 127
getClockPrescaler, 127
getCounter, 128
getInstance, 128
getOutputCompareRegister, 128
m_clockPrescaler, 133
m_clockSource, 133
operator=, 129
outputCompareMatchAServiceRoutine, 129
outputCompareMatchBServiceRoutine, 129
overflowServiceRoutine, 129
selectClockSource, 129
selectCompareOutputMode, 130
selectOperationMode, 131
setCounter, 131
setOutputCompareRegister, 132

start, 132
stop, 132
TimerCounter2, 126
core::WatchdogTimer, 151
__externally_visible__, 155
__used__, 155
~WatchdogTimer, 152
getInstance, 152
m_operationMode, 155
m_timeOut, 155
operator=, 153
reset, 153
selectTimeOut, 153
start, 153, 154
stop, 154
timeOutServiceRoutine, 154
WatchdogTimer, 152
CTC_ICR
core, 26, 27
CTC_OCR
core, 26, 27
currentPos
component::StepperMotor, 93
Cx0
buzzer_pitches_16bit.h, 178
buzzer_pitches_8bit.h, 193
Cx1
buzzer_pitches_16bit.h, 178
Cx2
buzzer_pitches_16bit.h, 178
buzzer_pitches_8bit.h, 193
Cx3
buzzer_pitches_16bit.h, 179
buzzer_pitches_8bit.h, 193
Cx4
buzzer_pitches_16bit.h, 179
Cx5
buzzer_pitches_16bit.h, 179
Cx6
buzzer_pitches_16bit.h, 179
Cx7
buzzer_pitches_16bit.h, 179

D0
buzzer_pitches_16bit.h, 179
D1
buzzer_pitches_16bit.h, 180
buzzer_pitches_8bit.h, 193
D2
buzzer_pitches_16bit.h, 180
buzzer_pitches_8bit.h, 194
D3
buzzer_pitches_16bit.h, 180
buzzer_pitches_8bit.h, 194
D4
buzzer_pitches_16bit.h, 180
D5
buzzer_pitches_16bit.h, 180
D6
buzzer_pitches_16bit.h, 180
D7
buzzer_pitches_16bit.h, 181
dataMode
io, 32
dataOrder
io, 32
dataOverrun
io::USART0, 136
dataRegisterEmptyServiceRoutine
io::USART0, 137
DCMotor
component::DCMotor, 51
DCMotor.cpp, 198
DCMotor.h, 198, 201
disable
io, 33
disableBOD
core::MCU, 63
disabled
core, 24
disconnect
component::DCMotor, 51
component::ServoMotor, 79
duplex
io, 32
Dx0
buzzer_pitches_16bit.h, 181
buzzer_pitches_8bit.h, 194
Dx1
buzzer_pitches_16bit.h, 181
Dx2
buzzer_pitches_16bit.h, 181
buzzer_pitches_8bit.h, 194
Dx3
buzzer_pitches_16bit.h, 181
buzzer_pitches_8bit.h, 194
Dx4
buzzer_pitches_16bit.h, 181
Dx5
buzzer_pitches_16bit.h, 182
Dx6
buzzer_pitches_16bit.h, 182
Dx7
buzzer_pitches_16bit.h, 182

E0
buzzer_pitches_16bit.h, 182
E1
buzzer_pitches_16bit.h, 182
buzzer_pitches_8bit.h, 194
E2
buzzer_pitches_16bit.h, 182
buzzer_pitches_8bit.h, 195
E3
buzzer_pitches_16bit.h, 183
buzzer_pitches_8bit.h, 195
E4
buzzer_pitches_16bit.h, 183

E5
buzzer_pitches_16bit.h, 183
E6
buzzer_pitches_16bit.h, 183
E7
buzzer_pitches_16bit.h, 183
eightBits
io, 33
enableADC
core::MCU, 63
enableAutoTrigger
core::ADConverter, 41
enableConversionCompleteInterrupt
core::ADConverter, 41
enabled
core, 24
enableDataRegisterEmptyInterrupt
io::USART0, 137
enableInputCaptureInterrupt
core::TimerCounter1, 115
enableInt0
core::ExternInterrupt, 55
enableInt1
core::ExternInterrupt, 55
enableOutputCompareMatchInterrupt
core::TimerCounter, 101
core::TimerCounter0, 106
core::TimerCounter1, 116
core::TimerCounter2, 126
enableOverflowInterrupt
core::TimerCounter, 101
core::TimerCounter0, 106
core::TimerCounter1, 116
core::TimerCounter2, 127
enablePinChange
core::ExternInterrupt, 55
enablePinChangeMaskPortB
core::ExternInterrupt, 56
enablePinChangeMaskPortC
core::ExternInterrupt, 56
enablePinChangeMaskPortD
core::ExternInterrupt, 56
enableReceiveCompleteInterrupt
io::USART0, 138
enableSPI
core::MCU, 63
enableTimerCounter0
core::MCU, 64
enableTimerCounter1
core::MCU, 64
enableTimerCounter2
core::MCU, 64
enableTransferCompleteInterrupt
io::SPI, 85
enableTransmitCompleteInterrupt
io::USART0, 138
enableTWI
core::MCU, 65
enableUSART0
core::MCU, 65
evenParity
io, 34
EXT_INT_DISABLE_INT0
ha_m328p.h, 215
EXT_INT_DISABLE_INT1
ha_m328p.h, 216
EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT
ha_m328p.h, 216
EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB
ha_m328p.h, 216
EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC
ha_m328p.h, 216
EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD
ha_m328p.h, 216
EXT_INT_ENABLE_INT0
ha_m328p.h, 216
EXT_INT_ENABLE_INT1
ha_m328p.h, 217
EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT
ha_m328p.h, 217
EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB
ha_m328p.h, 217
EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC
ha_m328p.h, 217
EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD
ha_m328p.h, 217
EXT_INT_INT0_INTERRUPT
ha_m328p.h, 217
EXT_INT_INT1_INTERRUPT
ha_m328p.h, 218
EXT_INT_PIN_CHANGE_PORTB_INTERRUPT
ha_m328p.h, 218
EXT_INT_PIN_CHANGE_PORTC_INTERRUPT
ha_m328p.h, 218
EXT_INT_PIN_CHANGE_PORTD_INTERRUPT
ha_m328p.h, 218
EXT_INT_SET_INT0_SENSE_CONTROL
ha_m328p.h, 218
EXT_INT_SET_INT1_SENSE_CONTROL
ha_m328p.h, 218
extendedStandby
core, 29
extern_Clock_T0_Falling_Edge
core, 25
extern_Clock_T0_Rising_Edge
core, 25
ExternInterrupt
core::ExternInterrupt, 54, 55
ExternInterrupt.cpp, 201, 202
ExternInterrupt.h, 203, 206
extInterrupt
core, 23

F0
buzzer_pitches_16bit.h, 183
F1
buzzer_pitches_16bit.h, 184

buzzer_pitches_8bit.h, 195
F2
buzzer_pitches_16bit.h, 184
buzzer_pitches_8bit.h, 195
F3
buzzer_pitches_16bit.h, 184
buzzer_pitches_8bit.h, 195
F4
buzzer_pitches_16bit.h, 184
F5
buzzer_pitches_16bit.h, 184
F6
buzzer_pitches_16bit.h, 184
F7
buzzer_pitches_16bit.h, 185
fallingEdge
core, 29
fast_PWM
core, 26, 27
fast_PWM_10bit
core, 26, 27
fast_PWM_8bit
core, 26, 27
fast_PWM_9bit
core, 26, 27
fast_PWM_ICR
core, 26, 27
fast_PWM_OCR
core, 26, 27
first_LSB
io, 33
first_MSB
io, 33
fiveBits
io, 33
frameError
io::USART0, 139
frameSize
io, 33
freeRunning
core, 23
fullStep
component, 22
Fx0
buzzer_pitches_16bit.h, 185
Fx1
buzzer_pitches_16bit.h, 185
buzzer_pitches_8bit.h, 195
Fx2
buzzer_pitches_16bit.h, 185
buzzer_pitches_8bit.h, 196
Fx3
buzzer_pitches_16bit.h, 185
buzzer_pitches_8bit.h, 196
Fx4
buzzer_pitches_16bit.h, 185
Fx5
buzzer_pitches_16bit.h, 186
Fx6
buzzer_pitches_16bit.h, 186
Fx7
buzzer_pitches_16bit.h, 186
G0
buzzer_pitches_16bit.h, 186
G1
buzzer_pitches_16bit.h, 186
buzzer_pitches_8bit.h, 196
G2
buzzer_pitches_16bit.h, 186
buzzer_pitches_8bit.h, 196
G3
buzzer_pitches_16bit.h, 187
buzzer_pitches_8bit.h, 196
G4
buzzer_pitches_16bit.h, 187
G5
buzzer_pitches_16bit.h, 187
G6
buzzer_pitches_16bit.h, 187
G7
buzzer_pitches_16bit.h, 187
getClockPrescaler
core::TimerCounter, 101
core::TimerCounter0, 107
core::TimerCounter1, 117
core::TimerCounter2, 127
getConversionResult
core::ADConverter, 41
getCounter
core::TimerCounter, 101
core::TimerCounter0, 107
core::TimerCounter1, 117
core::TimerCounter2, 128
getInputCaptureRegister
core::TimerCounter1, 117
getInstance
core::ADConverter, 42
core::ExternInterrupt, 57
core::TimerCounter0, 107
core::TimerCounter1, 117
core::TimerCounter2, 128
core::WatchdogTimer, 152
io::SPI, 85
io::USART0, 139
getNumberBytesReceived
io::USART0, 139
getNumberBytesSent
io::USART0, 140
getOutputCompareRegister
core::TimerCounter, 102
core::TimerCounter0, 108
core::TimerCounter1, 118
core::TimerCounter2, 128
getPinNumber
io::Pin, 69
getPressedCount

component::PushButton, 74
goalReached
component::StepperMotor, 93
goToSleep
core::MCU, 65
Gx0
buzzer_pitches_16bit.h, 187
buzzer_pitches_8bit.h, 196
Gx1
buzzer_pitches_16bit.h, 188
buzzer_pitches_8bit.h, 197
Gx2
buzzer_pitches_16bit.h, 188
buzzer_pitches_8bit.h, 197
Gx3
buzzer_pitches_16bit.h, 188
Gx4
buzzer_pitches_16bit.h, 188
Gx5
buzzer_pitches_16bit.h, 188
Gx6
buzzer_pitches_16bit.h, 188
Gx7
buzzer_pitches_16bit.h, 189

ha_base.h, 207, 208
STR, 208
STRx, 208
ha_m328p.h, 209, 240
ADC_ADJUST_RESULT_LEFT, 213
ADC_ADJUST_RESULT_RIGHT, 213
ADC_CONVERSION_COMPLETE_INTERRUPT, 213
ADC_DISABLE, 213
ADC_DISABLE_AUTOTRIGGER, 213
ADC_DISABLE_CONVERSION_COMPLETE_INTERRUPT, 214
ADC_DISABLE_DIGITAL_INPUT_REGISTER, 214
ADC_ENABLE, 214
ADC_ENABLE_AUTOTRIGGER, 214
ADC_ENABLE_CONVERSION_COMPLETE_INTERRUPT, 214
ADC_SELECT_ANALOG_INPUT, 214
ADC_SELECT_AUTO_TRIGGER_SOURCE, 215
ADC_SELECT_CLOCK_PRESCALER, 215
ADC_SELECT_REF_VOLTAGE, 215
ADC_START_CONVERSION, 215
ADC_STOP_CONVERSION, 215
EXT_INT_DISABLE_INT0, 215
EXT_INT_DISABLE_INT1, 216
EXT_INT_DISABLE_PIN_CHANGE_INTERRUPT, 216
EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTB, 216
EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTC, 216
EXT_INT_DISABLE_PIN_CHANGE_MASK_PORTD, 216
EXT_INT_ENABLE_INT0, 216
EXT_INT_ENABLE_INT1, 217
EXT_INT_ENABLE_PIN_CHANGE_INTERRUPT, 217
EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTB, 217
EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTC, 217
EXT_INT_ENABLE_PIN_CHANGE_MASK_PORTD, 217
EXT_INT_INT0_INTERRUPT, 217
EXT_INT_INT1_INTERRUPT, 218
EXT_INT_PIN_CHANGE_PORTB_INTERRUPT, 218
EXT_INT_PIN_CHANGE_PORTC_INTERRUPT, 218
EXT_INT_PIN_CHANGE_PORTD_INTERRUPT, 218
EXT_INT_SET_INT0_SENSE_CONTROL, 218
EXT_INT_SET_INT1_SENSE_CONTROL, 218
MCU_ADC_DISABLE, 219
MCU_ADC_ENABLE, 219
MCU_BOD_DISABLE, 219
MCU_SELECT_SLEEP_MODE, 219
MCU_SLEEP_DISABLE, 219
MCU_SLEEP_ENABLE, 219
MCU_SPI_DISABLE, 220
MCU_SPI_ENABLE, 220
MCU_TIMER0_DISABLE, 220
MCU_TIMER0_ENABLE, 220
MCU_TIMER1_DISABLE, 220
MCU_TIMER1_ENABLE, 220
MCU_TIMER2_DISABLE, 221
MCU_TIMER2_ENABLE, 221
MCU_TWI_DISABLE, 221
MCU_TWI_ENABLE, 221
MCU_USART0_DISABLE, 221
MCU_USART0_ENABLE, 221
PUSHBUTTON_DEBOUNCE_TIME_US, 222
PUSHBUTTON_SAMPLING, 222
SERVOMOTOR_TIMER_ANGLE_COUNT, 222
SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT, 222
SPI_CONTROL_REGISTER, 222
SPI_DATA_REGISTER, 223
SPI_DISABLE, 223
SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT, 223
SPI_ENABLE, 223
SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT, 223
SPI_MASTER_MODE, 223
SPI_SELECT_CLOCK_PRESCALER, 224
SPI_SELECT_DATA_MODE, 224
SPI_SELECT_DATA_ORDER, 224
SPI_SELECT_MASTER_MODE, 224
SPI_SELECT_SLAVE_MODE, 224
SPI_STATUS_REGISTER, 224

SPI_TRANSFER_COMPLETE, 225
SPI_TRANSFER_COMPLETE_INTERRUPT, 225
SPI_WRITE_COLLISION, 225
TIMER0_COM_CHANNEL_A_INTERRUPT, 225
TIMER0_COM_CHANNEL_B_INTERRUPT, 225
TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT, 225
TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT, 226
TIMER0_DISABLE_OVERFLOW_INTERRUPT, 226
TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT, 226
TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT, 226
TIMER0_ENABLE_OVERFLOW_INTERRUPT, 226
TIMER0_OVERFLOW_INTERRUPT, 226
TIMER0_SELECT_CLOCK_SOURCE, 227
TIMER0_SELECT_COM_CHANNEL_A, 227
TIMER0_SELECT_COM_CHANNEL_B, 227
TIMER0_SELECT_OPERATION_MODE, 227
TIMER0_STOP, 227
TIMER1_COM_CHANNEL_A_INTERRUPT, 227
TIMER1_COM_CHANNEL_B_INTERRUPT, 228
TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT, 228
TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT, 228
TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT, 228
TIMER1_DISABLE_OVERFLOW_INTERRUPT, 228
TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT, 228
TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT, 229
TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT, 229
TIMER1_ENABLE_OVERFLOW_INTERRUPT, 229
TIMER1_INPUT_CAPTURE_INTERRUPT, 229
TIMER1_OVERFLOW_INTERRUPT, 229
TIMER1_SELECT_CLOCK_SOURCE, 229
TIMER1_SELECT_COM_CHANNEL_A, 230
TIMER1_SELECT_COM_CHANNEL_B, 230
TIMER1_SELECT_OPERATION_MODE, 230
TIMER1_STOP, 230
TIMER2_COM_CHANNEL_A_INTERRUPT, 230
TIMER2_COM_CHANNEL_B_INTERRUPT, 230
TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT, 231
TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT, 231
TIMER2_DISABLE_OVERFLOW_INTERRUPT, 231
TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT, 231
TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT, 231
TIMER2_ENABLE_OVERFLOW_INTERRUPT, 231
TIMER2_OVERFLOW_INTERRUPT, 232
TIMER2_SELECT_CLOCK_SOURCE, 232
TIMER2_SELECT_COM_CHANNEL_A, 232
TIMER2_SELECT_COM_CHANNEL_B, 232
TIMER2_SELECT_OPERATION_MODE, 232
TIMER2_STOP, 232
USART0_CONTROL_STATUS_REGISTER, 233
USART0_DATA_OVERRUN, 233
USART0_DATA_REGISTER, 233
USART0_DATA_REGISTER_EMPTY_INTERRUPT, 233
USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT, 233
USART0_DISABLE_DOUBLE_SPEED_MODE, 233, 234
USART0_DISABLE_PARITY_MODE, 234
USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT, 234
USART0_DISABLE_RECEIVER, 234
USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT, 234
USART0_DISABLE_TRANSMITTER, 234
USART0_ENABLE_ASYNC_TRANSMISSION_MODE, 235
USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT, 235
USART0_ENABLE_DOUBLE_SPEED_MODE, 235
USART0_ENABLE_EVEN_PARITY_MODE, 235
USART0_ENABLE_MASTER_SPI_MODE, 235
USART0_ENABLE_ODD_PARITY_MODE, 235
USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT, 236
USART0_ENABLE_RECEIVER, 236
USART0_ENABLE_SYNC_TRANSMISSION_MODE, 236
USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT, 236
USART0_ENABLE_TRANSMITTER, 236
USART0_FRAME_ERROR, 236
USART0_PARITY_ERROR, 237
USART0_RECEIVE_COMPLETE_INTERRUPT, 237
USART0_SET_5BIT_FRAME_SIZE, 237
USART0_SET_6BIT_FRAME_SIZE, 237
USART0_SET_7BIT_FRAME_SIZE, 237
USART0_SET_8BIT_FRAME_SIZE, 238
USART0_SET_9BIT_FRAME_SIZE, 238
USART0_SET_BAUDRATE_HIGH_REGISTER, 238
USART0_SET_BAUDRATE_LOW_REGISTER, 238
USART0_SET_ONE_STOP_BIT, 238
USART0_SET_TWO_STOP_BITS, 239

USART0_TRANSMIT_COMPLETE_INTERRUPT, 239
WATCHDOG_SELECT_TIMEOUT, 239
WATCHDOG_START, 239
WATCHDOG_STOP, 239
WATCHDOG_TIMEOUT_INTERRUPT, 239
halfStep
component, 22

Idle
core, 29
init
core::MCU, 66
inputCaptureServiceRoutine
core::TimerCounter1, 118
Int0ServiceRoutine
core::ExternInterrupt, 57
Int1ServiceRoutine
core::ExternInterrupt, 57
internal
core, 28
interrupt
core, 26, 27
interrupt_reset
core, 26, 27
io, 30
async, 35
clockPrescaler, 31
communicationMode, 31
dataMode, 32
dataOrder, 32
disable, 33
duplex, 32
eightBits, 33
evenParity, 34
first_LSB, 33
first_MSB, 33
fiveBits, 33
frameSize, 33
master, 33
masterSPI, 35
mode_0, 32
mode_1, 32
mode_2, 32
mode_3, 32
neineBits, 33
noParity, 34
oddParity, 34
oneStopBit, 35
operationMode, 33
parityMode, 34
PortB, 35
PortC, 35
PortD, 36
PS_128, 31
PS_16, 31
PS_2, 31
PS_32, 31
PS_4, 31
PS_64, 31
PS_8, 31
receive, 32
sevenBits, 33
sixBits, 33
slave, 33
stopBit, 34
submaster, 33
sync, 35
transmissionMode, 35
transmit, 32
twoStopBits, 35
io::Pin, 67
~Pin, 68
getPinNumber, 69
isHigh, 69
isLow, 69
m_pinNumber, 71
mr_portName, 71
Pin, 68
setHigh, 69
setLow, 70
toggle, 70
toInput, 70
toOutput, 71
io::Port, 72
mp_ddrReg, 72
mp_pinReg, 72
mp_portReg, 72
io::SPI, 82
__externally_visible__, 89
__used__, 89
~SPI, 84
enableTransferCompleteInterrupt, 85
getInstance, 85
m_data, 89
m_pinMISO, 89
m_pinMOSI, 89
m_pinSCK, 90
m_pinSS, 90
masterReceiveByte, 85
masterSendByte, 85
operator=, 86
selectClockPrescaler, 86
selectDataMode, 86
selectDataOrder, 86
selectOperationMode, 87
selectSlave, 87
slaveReceiveByte, 88
SPI, 84
transferComplete, 88
transferCompleteServiceRoutine, 88
writeCollision, 88
io::USART0, 134
__externally_visible__, 149
__used__, 149
~USART0, 136
dataOverrun, 136

dataRegisterEmptyServiceRoutine, 137
enableDataRegisterEmptyInterrupt, 137
enableReceiveCompleteInterrupt, 138
enableTransmitCompleteInterrupt, 138
frameError, 139
getInstance, 139
getNumberBytesReceived, 139
getNumberBytesSent, 140
m_numberBytesReceived, 149
m_numberBytesSent, 149
m_ready2Send, 150
m_sizeData2Receive, 150
m_sizeData2Send, 150
m_status, 150
mp_data2Receive, 150
mp_data2Send, 151
operator=, 140
parityError, 140
ready2Send, 140
receiveChar, 141
receiveCompleteServiceRoutine, 141
receiveFrame, 142
receiveString, 142
resetNumberBytesReceived, 142
sendByte, 143
sendChar, 143
sendFrame, 144
sendLong, 144
sendString, 144
sendWord, 145
setBaudRate, 145
setCommunicationMode, 146
setFrameSize, 146
setParityMode, 147
setStopBit, 148
setTransmissionMode, 148
transmitCompleteServiceRoutine, 149
USART0, 135, 136
isHigh
io::Pin, 69
isLow
io::Pin, 69
isOff
component::Led, 61
isOn
component::Led, 61
isPressed
component::PushButton, 74

LCD.cpp, 244
LCD.h, 244
Led
component::Led, 60
Led.cpp, 244
Led.h, 245, 246
logicalChange
core, 29
lowLevel
core, 29

m_accelTime
component::StepperMotor, 98
m_buttonPressed
component::PushButton, 75
m_clockPrescaler
core::TimerCounter0, 112
core::TimerCounter1, 123
core::TimerCounter2, 133
m_clockSource
core::TimerCounter0, 113
core::TimerCounter1, 124
core::TimerCounter2, 133
m_constSpeedTime
component::StepperMotor, 98
m_conversionComplete
core::ADConverter, 45
m_currentPos
component::StepperMotor, 98
m_data
io::SPI, 89
m_decelTime
component::StepperMotor, 99
m_goalReached
component::StepperMotor, 99
m_numberBytesReceived
io::USART0, 149
m_numberBytesSent
io::USART0, 149
m_operationMode
core::WatchdogTimer, 155
m_pin
component::Buzzer, 49
component::DCMotor, 53
component::Led, 62
component::PushButton, 75
component::ServoMotor, 81
m_pinCoil1
component::StepperMotor, 99
m_pinCoil2
component::StepperMotor, 99
m_pinCoil3
component::StepperMotor, 99
m_pinCoil4
component::StepperMotor, 100
m_pinMISO
io::SPI, 89
m_pinMOSI
io::SPI, 89
m_pinNumber
io::Pin, 71
m_pinSCK
io::SPI, 90
m_pinSS
io::SPI, 90
m_pulseCycle
component::ServoMotor, 81
m_pulseWidthMax
component::ServoMotor, 81

m_pulseWidthMid
component::ServoMotor, 81
m_pulseWidthMin
component::ServoMotor, 82
m_ready2Send
io::USART0, 150
m_resolution
core::ADConverter, 45
m_sizeData2Receive
io::USART0, 150
m_sizeData2Send
io::USART0, 150
m_status
io::USART0, 150
m_timeOut
core::WatchdogTimer, 155
main
BlinkLed/main.cpp, 248
Organ/main.cpp, 250
main.cpp, 246, 248, 249
map
utils, 36
master
io, 33
masterReceiveByte
io::SPI, 85
masterSendByte
io::SPI, 85
masterSPI
io, 35
MCU.cpp, 252, 253
MCU.h, 254, 256
MCU_ADC_DISABLE
ha_m328p.h, 219
MCU_ADC_ENABLE
ha_m328p.h, 219
MCU_BOD_DISABLE
ha_m328p.h, 219
MCU_SELECT_SLEEP_MODE
ha_m328p.h, 219
MCU_SLEEP_DISABLE
ha_m328p.h, 219
MCU_SLEEP_ENABLE
ha_m328p.h, 219
MCU_SPI_DISABLE
ha_m328p.h, 220
MCU_SPI_ENABLE
ha_m328p.h, 220
MCU_TIMER0_DISABLE
ha_m328p.h, 220
MCU_TIMER0_ENABLE
ha_m328p.h, 220
MCU_TIMER1_DISABLE
ha_m328p.h, 220
MCU_TIMER1_ENABLE
ha_m328p.h, 220
MCU_TIMER2_DISABLE
ha_m328p.h, 221
MCU_TIMER2_ENABLE
ha_m328p.h, 221
MCU_TWI_DISABLE
ha_m328p.h, 221
MCU_TWI_ENABLE
ha_m328p.h, 221
MCU_USART0_DISABLE
ha_m328p.h, 221
MCU_USART0_ENABLE
ha_m328p.h, 221
mode
component, 21
mode_0
io, 32
mode_1
io, 32
mode_2
io, 32
mode_3
io, 32
mp_conversionResult
core::ADConverter, 45
mp_data2Receive
io::USART0, 150
mp_data2Send
io::USART0, 151
mp_ddrReg
io::Port, 72
mp_pinReg
io::Port, 72
mp_portReg
io::Port, 72
mr_isActiveLow
component::PushButton, 76
mr_portName
io::Pin, 71
mr_useInternalPullUp
component::PushButton, 76

neineBits
io, 33
noClock
core, 25
noParity
io, 34
normal
core, 25, 26
NOTE_DURATION
Organ/main.cpp, 250

oddParity
io, 34
off
component::DCMotor, 52
component::Led, 61
component::ServoMotor, 80
on
component::DCMotor, 52
component::Led, 62

component::ServoMotor, 80
oneStopBit
io, 35
operationMode
core, 26
io, 33
operator=
core::ADConverter, 43
core::ExternInterrupt, 57
core::TimerCounter0, 108
core::TimerCounter1, 118
core::TimerCounter2, 129
core::WatchdogTimer, 153
io::SPI, 86
io::USART0, 140
Organ/main.cpp
BUZZER, 250
main, 250
NOTE_DURATION, 250
outputCompareMatchAServiceRoutine
core::TimerCounter0, 108
core::TimerCounter1, 118
core::TimerCounter2, 129
outputCompareMatchBServiceRoutine
core::TimerCounter0, 108
core::TimerCounter1, 119
core::TimerCounter2, 129
overflowServiceRoutine
core::TimerCounter0, 109
core::TimerCounter1, 119
core::TimerCounter2, 129

parityError
io::USART0, 140
parityMode
io, 34
pause
component::Buzzer, 49
PCINTB
core, 27
PCINTC
core, 27
PCINTD
core, 27
Pin
io::Pin, 68
Pin.cpp, 257
Pin.h, 258, 259
PIN_NUMBER
BlinkLed/main.cpp, 247
pinChangePort
core, 27
pinChangePortBServiceRoutine
core::ExternInterrupt, 57
pinChangePortCServiceRoutine
core::ExternInterrupt, 58
pinChangePortDServiceRoutine
core::ExternInterrupt, 58
PortB
io, 35
PortC
io, 35
PortD
io, 36
powerDown
core, 29
powerSave
core, 29
PS_1
core, 25
PS_1024
core, 25
PS_128
core, 24, 25
io, 31
PS_16
core, 24
io, 31
PS_2
core, 24
io, 31
PS_256
core, 25
PS_32
core, 24, 25
io, 31
PS_4
core, 24
io, 31
PS_64
core, 24, 25
io, 31
PS_8
core, 24, 25
io, 31
PushButton
component::PushButton, 73
PushButton.cpp, 260
PushButton.h, 261, 263
PUSHBUTTON_DEBOUNCE_TIME_US
ha_m328p.h, 222
PUSHBUTTON_SAMPLING
ha_m328p.h, 222
PWM_PC
core, 26
PWM_PC_10bit
core, 26, 27
PWM_PC_8bit
core, 26
PWM_PC_9bit
core, 26, 27
PWM_PC_ICR
core, 26, 27
PWM_PC_OCR
core, 26, 27
PWM_PFC_ICR
core, 26, 27

PWM_PFC_OCR
core, 26, 27

README.md, 264
ready2Send
io::USART0, 140
receive
io, 32
receiveChar
io::USART0, 141
receiveCompleteServiceRoutine
io::USART0, 141
receiveFrame
io::USART0, 142
receiveString
io::USART0, 142
referenceVoltage
core, 28
res_10bit
core, 28
res_11bit
core, 28
res_12bit
core, 28
res_13bit
core, 28
res_14bit
core, 28
res_15bit
core, 28
res_16bit
core, 28
res_8bit
core, 28
res_9bit
core, 28
reset
core, 26, 27
core::WatchdogTimer, 153
resetNumberBytesReceived
io::USART0, 142
resetPressedCount
component::PushButton, 75
resolution
core, 28
risingEdge
core, 29
rotate
component::ServoMotor, 80

selectAnalogInput
core::ADConverter, 43
selectAutoTriggerSource
core::ADConverter, 43
selectClockPrescaler
core::ADConverter, 43
io::SPI, 86
selectClockSource
core::TimerCounter, 102
core::TimerCounter0, 109
core::TimerCounter1, 119
core::TimerCounter2, 129
selectCompareOutputMode
core::TimerCounter, 102
core::TimerCounter0, 110
core::TimerCounter1, 120
core::TimerCounter2, 130
selectDataMode
io::SPI, 86
selectDataOrder
io::SPI, 86
selectOperationMode
core::TimerCounter, 102
core::TimerCounter0, 110
core::TimerCounter1, 120
core::TimerCounter2, 131
io::SPI, 87
selectReferenceVoltage
core::ADConverter, 44
selectSlave
io::SPI, 87
selectSleepMode
core::MCU, 66
selectTimeOut
core::WatchdogTimer, 153
sendByte
io::USART0, 143
sendChar
io::USART0, 143
sendFrame
io::USART0, 144
sendLong
io::USART0, 144
sendString
io::USART0, 144
sendWord
io::USART0, 145
senseControl
core, 28
ServoMotor
component::ServoMotor, 77
ServoMotor.cpp, 264
ServoMotor.h, 266, 269
SERVOMOTOR_TIMER_ANGLE_COUNT
ha_m328p.h, 222
SERVOMOTOR_TIMER_PULSE_WIDTH_COUNT
ha_m328p.h, 222
set
core, 25
setBaudRate
io::USART0, 145
setCommunicationMode
io::USART0, 146
setCounter
core::TimerCounter, 102
core::TimerCounter0, 111
core::TimerCounter1, 122

core::TimerCounter2, 131
setCurrentPos
component::StepperMotor, 94
setFrameSize
io::USART0, 146
setHigh
io::Pin, 69
setInputCaptureRegister
core::TimerCounter1, 122
setInt0SenseControl
core::ExternInterrupt, 58
setInt1SenseControl
core::ExternInterrupt, 58
setLow
io::Pin, 70
setOutputCompareRegister
core::TimerCounter, 102
core::TimerCounter0, 111
core::TimerCounter1, 122
core::TimerCounter2, 132
setParityMode
io::USART0, 147
setStopBit
io::USART0, 148
setTransmissionMode
io::USART0, 148
sevenBits
io, 33
sixBits
io, 33
slave
io, 33
slaveReceiveByte
io::SPI, 88
sleepEnable
core::MCU, 66
sleepMode
core, 29
SPI
io::SPI, 84
SPI.cpp, 269, 270
SPI.h, 272, 274
SPI_CONTROL_REGISTER
ha_m328p.h, 222
SPI_DATA_REGISTER
ha_m328p.h, 223
SPI_DISABLE
ha_m328p.h, 223
SPI_DISABLE_TRANSFER_COMPLETE_INTERRUPT
ha_m328p.h, 223
SPI_ENABLE
ha_m328p.h, 223
SPI_ENABLE_TRANSFER_COMPLETE_INTERRUPT
ha_m328p.h, 223
SPI_MASTER_MODE
ha_m328p.h, 223
SPI_SELECT_CLOCK_PRESCALER
ha_m328p.h, 224
SPI_SELECT_DATA_MODE
ha_m328p.h, 224
SPI_SELECT_DATA_ORDER
ha_m328p.h, 224
SPI_SELECT_MASTER_MODE
ha_m328p.h, 224
SPI_SELECT_SLAVE_MODE
ha_m328p.h, 224
SPI_STATUS_REGISTER
ha_m328p.h, 224
SPI_TRANSFER_COMPLETE
ha_m328p.h, 225
SPI_TRANSFER_COMPLETE_INTERRUPT
ha_m328p.h, 225
SPI_WRITE_COLLISION
ha_m328p.h, 225
spin
component::DCMotor, 52
standby
core, 29
start
core::ADConverter, 44
core::TimerCounter, 103
core::TimerCounter0, 111
core::TimerCounter1, 122
core::TimerCounter2, 132
core::WatchdogTimer, 153, 154
step
component::StepperMotor, 94–96
stepDelay
component::StepperMotor, 97
stepMode
component::StepperMotor, 100
StepperMotor
component::StepperMotor, 91
StepperMotor.cpp, 275
StepperMotor.h, 280, 281
stepPulse
component::StepperMotor, 97
stop
component::DCMotor, 52
core::ADConverter, 44
core::TimerCounter, 103
core::TimerCounter0, 112
core::TimerCounter1, 123
core::TimerCounter2, 132
core::WatchdogTimer, 154
stopBit
io, 34
STR
ha_base.h, 208
STRx
ha_base.h, 208
submaster
io, 33
sync
io, 35

TIMEDELAY

BlinkLed/main.cpp, 247
timeOut
core, 29
timeOutServiceRoutine
core::WatchdogTimer, 154
TIMER0_COM_CHANNEL_A_INTERRUPT
ha_m328p.h, 225
TIMER0_COM_CHANNEL_B_INTERRUPT
ha_m328p.h, 225
TIMER0_DISABLE_COM_CHANNEL_A_INTERRUPT
ha_m328p.h, 225
TIMER0_DISABLE_COM_CHANNEL_B_INTERRUPT
ha_m328p.h, 226
TIMER0_DISABLE_OVERFLOW_INTERRUPT
ha_m328p.h, 226
TIMER0_ENABLE_COM_CHANNEL_A_INTERRUPT
ha_m328p.h, 226
TIMER0_ENABLE_COM_CHANNEL_B_INTERRUPT
ha_m328p.h, 226
TIMER0_ENABLE_OVERFLOW_INTERRUPT
ha_m328p.h, 226
TIMER0_OVERFLOW_INTERRUPT
ha_m328p.h, 226
TIMER0_SELECT_CLOCK_SOURCE
ha_m328p.h, 227
TIMER0_SELECT_COM_CHANNEL_A
ha_m328p.h, 227
TIMER0_SELECT_COM_CHANNEL_B
ha_m328p.h, 227
TIMER0_SELECT_OPERATION_MODE
ha_m328p.h, 227
TIMER0_STOP
ha_m328p.h, 227
timer0Compare
core, 23
timer0Overflow
core, 23
TIMER1_COM_CHANNEL_A_INTERRUPT
ha_m328p.h, 227
TIMER1_COM_CHANNEL_B_INTERRUPT
ha_m328p.h, 228
TIMER1_DISABLE_COM_CHANNEL_A_INTERRUPT
ha_m328p.h, 228
TIMER1_DISABLE_COM_CHANNEL_B_INTERRUPT
ha_m328p.h, 228
TIMER1_DISABLE_INPUT_CAPTURE_INTERRUPT
ha_m328p.h, 228
TIMER1_DISABLE_OVERFLOW_INTERRUPT
ha_m328p.h, 228
TIMER1_ENABLE_COM_CHANNEL_A_INTERRUPT
ha_m328p.h, 228
TIMER1_ENABLE_COM_CHANNEL_B_INTERRUPT
ha_m328p.h, 229
TIMER1_ENABLE_INPUT_CAPTURE_INTERRUPT
ha_m328p.h, 229
TIMER1_ENABLE_OVERFLOW_INTERRUPT
ha_m328p.h, 229
TIMER1_INPUT_CAPTURE_INTERRUPT
ha_m328p.h, 229
TIMER1_OVERFLOW_INTERRUPT
ha_m328p.h, 229
TIMER1_SELECT_CLOCK_SOURCE
ha_m328p.h, 229
TIMER1_SELECT_COM_CHANNEL_A
ha_m328p.h, 230
TIMER1_SELECT_COM_CHANNEL_B
ha_m328p.h, 230
TIMER1_SELECT_OPERATION_MODE
ha_m328p.h, 230
TIMER1_STOP
ha_m328p.h, 230
timer1Capture
core, 23
timer1CompareB
core, 23
timer1Overflow
core, 23
TIMER2_COM_CHANNEL_A_INTERRUPT
ha_m328p.h, 230
TIMER2_COM_CHANNEL_B_INTERRUPT
ha_m328p.h, 230
TIMER2_DISABLE_COM_CHANNEL_A_INTERRUPT
ha_m328p.h, 231
TIMER2_DISABLE_COM_CHANNEL_B_INTERRUPT
ha_m328p.h, 231
TIMER2_DISABLE_OVERFLOW_INTERRUPT
ha_m328p.h, 231
TIMER2_ENABLE_COM_CHANNEL_A_INTERRUPT
ha_m328p.h, 231
TIMER2_ENABLE_COM_CHANNEL_B_INTERRUPT
ha_m328p.h, 231
TIMER2_ENABLE_OVERFLOW_INTERRUPT
ha_m328p.h, 231
TIMER2_OVERFLOW_INTERRUPT
ha_m328p.h, 232
TIMER2_SELECT_CLOCK_SOURCE
ha_m328p.h, 232
TIMER2_SELECT_COM_CHANNEL_A
ha_m328p.h, 232
TIMER2_SELECT_COM_CHANNEL_B
ha_m328p.h, 232
TIMER2_SELECT_OPERATION_MODE
ha_m328p.h, 232
TIMER2_STOP
ha_m328p.h, 232
TimerCounter.h, 282, 292
TimerCounter0
core::TimerCounter0, 105
TimerCounter0.cpp, 294
TimerCounter0.h, 297, 298
TimerCounter1
core::TimerCounter1, 115
TimerCounter1.cpp, 299, 300
TimerCounter1.h, 304, 305
TimerCounter2
core::TimerCounter2, 126

TimerCounter2.cpp, 306
TimerCounter2.h, 309, 310
to_125ms
core, 29
to_16ms
core, 29
to_1s
core, 29
to_250ms
core, 29
to_2s
core, 30
to_32ms
core, 29
to_4s
core, 30
to_500ms
core, 29
to_64ms
core, 29
to_8s
core, 30
toggle
component::DCMotor, 53
component::Led, 62
component::ServoMotor, 80
core, 25
io::Pin, 70
toInput
io::Pin, 70
toOutput
io::Pin, 71
transferComplete
io::SPI, 88
transferCompleteServiceRoutine
io::SPI, 88
transmissionMode
io, 35
transmit
io, 32
transmitCompleteServiceRoutine
io::USART0, 149
twoStopBits
io, 35

USART0
io::USART0, 135, 136
USART0.cpp, 311, 312
USART0.h, 317, 318
USART0_CONTROL_STATUS_REGISTER
ha_m328p.h, 233
USART0_DATA_OVERRUN
ha_m328p.h, 233
USART0_DATA_REGISTER
ha_m328p.h, 233
USART0_DATA_REGISTER_EMPTY_INTERRUPT
ha_m328p.h, 233
USART0_DISABLE_DATA_REGISTER_EMPTY_INTERRUPT
ha_m328p.h, 233
USART0_DISABLE_DOUBLE_SPEED_MODE
ha_m328p.h, 233, 234
USART0_DISABLE_PARITY_MODE
ha_m328p.h, 234
USART0_DISABLE_RECEIVE_COMPLETE_INTERRUPT
ha_m328p.h, 234
USART0_DISABLE_RECEIVER
ha_m328p.h, 234
USART0_DISABLE_TRANSMIT_COMPLETE_INTERRUPT
ha_m328p.h, 234
USART0_DISABLE_TRANSMITTER
ha_m328p.h, 234
USART0_ENABLE_ASYNC_TRANSMISSION_MODE
ha_m328p.h, 235
USART0_ENABLE_DATA_REGISTER_EMPTY_INTERRUPT
ha_m328p.h, 235
USART0_ENABLE_DOUBLE_SPEED_MODE
ha_m328p.h, 235
USART0_ENABLE_EVEN_PARITY_MODE
ha_m328p.h, 235
USART0_ENABLE_MASTER_SPI_MODE
ha_m328p.h, 235
USART0_ENABLE_ODD_PARITY_MODE
ha_m328p.h, 235
USART0_ENABLE_RECEIVE_COMPLETE_INTERRUPT
ha_m328p.h, 236
USART0_ENABLE_RECEIVER
ha_m328p.h, 236
USART0_ENABLE_SYNC_TRANSMISSION_MODE
ha_m328p.h, 236
USART0_ENABLE_TRANSMIT_COMPLETE_INTERRUPT
ha_m328p.h, 236
USART0_ENABLE_TRANSMITTER
ha_m328p.h, 236
USART0_FRAME_ERROR
ha_m328p.h, 236
USART0_PARITY_ERROR
ha_m328p.h, 237
USART0_RECEIVE_COMPLETE_INTERRUPT
ha_m328p.h, 237
USART0_SET_5BIT_FRAME_SIZE
ha_m328p.h, 237
USART0_SET_6BIT_FRAME_SIZE
ha_m328p.h, 237
USART0_SET_7BIT_FRAME_SIZE
ha_m328p.h, 237
USART0_SET_8BIT_FRAME_SIZE
ha_m328p.h, 238
USART0_SET_9BIT_FRAME_SIZE
ha_m328p.h, 238
USART0_SET_BAUDRATE_HIGH_REGISTER
ha_m328p.h, 238
USART0_SET_BAUDRATE_LOW_REGISTER
ha_m328p.h, 238
USART0_SET_ONE_STOP_BIT
ha_m328p.h, 238
USART0_SET_TWO_STOP_BITS
ha_m328p.h, 239

USART0_TRANSMIT_COMPLETE_INTERRUPT
ha_m328p.h, 239
utils, 36
map, 36
utils_m328p.cpp, 320
utils_m328p.h, 320, 321

WATCHDOG_SELECT_TIMEOUT
ha_m328p.h, 239
WATCHDOG_START
ha_m328p.h, 239
WATCHDOG_STOP
ha_m328p.h, 239
WATCHDOG_TIMEOUT_INTERRUPT
ha_m328p.h, 239
WatchdogTimer
core::WatchdogTimer, 152
WatchdogTimer.cpp, 321
WatchdogTimer.h, 322, 325
writeCollision
io::SPI, 88