A.1. Data Sheet

Features
- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20 MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 4/8/16/32K Bytes of In-System Self-Programmable Flash program memory
    (ATmega48P/88P/168P/328P)
  - 256/512/1K/2K Bytes EEPROM (ATmega48P/88P/168P/328P)
  - 512/1K/2K Bytes Internal SRAM (ATmega48P/88P/168P/328P)
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/100 years at 25°C
  - Optional Boot Code Section with Independent Lock Bits
  - In-System Programming by On-chip Boot Program
  - True Read-While-Write Operation
  - Programming Lock for Software Security
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel 10-bit ADC in TQFP and QFN/MLF package
  - Temperature Measurement
  - 6-channel 10-bit ADC in PDIP Package
  - Programmable Serial UART
  - Master/Slave SPI Serial Interface
  - Byte-oriented 2-wire Serial Interface (Philips i²C compatible)
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage:
  - 1.8 – 5.5V for ATmega48P/88P/168P
  - 2.7 – 5.5V for ATmega48P/88P/168P
  - 1.8 – 5.5V for ATmega328P
- Temperature Range:
  - -40°C to 85°C
- Speed Grade:
  - ATmega48P/88P/168P: 0 – 4 MHz @ 1.8 – 5.5V, 0 – 10 MHz @ 2.7 – 5.5V
  - ATmega48P/88P/168P: 0 – 10 MHz @ 2.7 – 5.5V, 0 – 20 MHz @ 4.5 – 5.5V
  - ATmega328P: 0 – 4 MHz @ 1.8 – 5.5V, 0 – 10 MHz @ 2.7 – 5.5V, 0 – 20 MHz @ 4.5 – 5.5V
- Low Power Consumption at 1 MHz, 1.8V, 25°C for ATmega48P/88P/168P:
  - Active Mode: 0.3 mA
  - Power-down Mode: 0.1 μA
  - Power-save Mode: 0.8 μA (including 32 kHz RTC)

Note: 1. See "Data Retention" on page 7 for details.
1. Pin Configurations

Figure 1-1. Pinout ATmega48P/88P/168P/328P

NOTE: Bottom pad should be soldered to ground.
1.1 Pin Descriptions

1.1.1 VCC
Digital supply voltage.

1.1.2 GND
Ground.

1.1.3 Port B (PB7:0) XTL1/XTAL2/TOSC1/TOSC2
Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Depending on the clock selection fuse settings, PB6 can be used as input to the Inverting Oscillator amplifier and input to the internal clock operating circuit.

Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier.

If the Internal Calibrated RC Oscillator is used as chip clock source, PB7..6 is used as TOSC2..1 Input for the Asynchronous Timer/Counter2 If the AS2 bit in ASSR is set.

The various special features of Port B are elaborated in "Alternate Functions of Port B" on page 82 and "System Clock and Clock Options" on page 25.

1.1.4 Port C (PC5:0)
Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC5..0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

1.1.5 PC6/RESET
If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C.

If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset Input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. The minimum pulse length is given in Table 26-3 on page 320. Shorter pulses are not guaranteed to generate a Reset.

The various special features of Port C are elaborated in "Alternate Functions of Port C" on page 55.

1.1.6 Port D (PD7:0)
Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.
The various special features of Port D are elaborated in "Alternate Functions of Port D" on page 88.

1.7 AVCC

AVCC is the supply voltage pin for the A/D Converter, PC3:0, and ADC7:6. It should be externally connected to VCC even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that PC8..4 use digital supply voltage, VCC.

1.8 AREF

ARF is the analog reference pin for the A/D Converter.

1.9 ADC7:6 (TQFP and QFN/MLF Package Only)

In the TQFP and QFN/MLF package, ADC7:6 serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

2. Overview

The ATmega48P/88P/168P/328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48P/88P/168P/328P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.
2. Overview

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2.1 Block Diagram

Figure 2-1. Block Diagram

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single Instruction executed in one clock cycle. The resulting
architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega48P/88P/168P/328P provides the following features: 4K/8K/16K/32K bytes of In-System Programmable Flash with Read-While-Write capabilities, 256/512/512/1K bytes EEPROM, 512/1K/1K/2K bytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte-oriented 2-wire Serial Interface, an SPI serial port, a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and Interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption.

The device is manufactured using Atmel’s high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core. The Boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega48P/88P/168P/328P is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega48P/88P/168P/328P AVR is supported with a full suite of program and system development tools including: C Compilers, Macro Assemblers, Program Debugger/Simulators, In-Circuit Emulators, and Evaluation kits.

### 2.2 Comparison Between ATmega48P, ATmega88P, ATmega168P, and ATmega328P

The ATmega48P, ATmega88P, ATmega168P, and ATmega328P differ only in memory sizes, boot loader support, and interrupt vector sizes. Table 2-1 summarizes the different memory and interrupt vector sizes for the three devices.

<table>
<thead>
<tr>
<th>Device</th>
<th>Flash</th>
<th>EEPROM</th>
<th>RAM</th>
<th>Interrupt Vector Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATmega48P</td>
<td>4K Bytes</td>
<td>256 Bytes</td>
<td>512 Bytes</td>
<td>1 instruction word/vector</td>
</tr>
<tr>
<td>ATmega88P</td>
<td>8K Bytes</td>
<td>512 Bytes</td>
<td>1K Bytes</td>
<td>1 instruction word/vector</td>
</tr>
<tr>
<td>ATmega168P</td>
<td>16K Bytes</td>
<td>512 Bytes</td>
<td>1K Bytes</td>
<td>2 instruction words/vector</td>
</tr>
<tr>
<td>ATmega328P</td>
<td>32K Bytes</td>
<td>1K Bytes</td>
<td>2K Bytes</td>
<td>2 instruction words/vector</td>
</tr>
</tbody>
</table>

ATmega88P, ATmega168P, and ATmega328P support a real Read-While-Write Self-Programming mechanism. There is a separate Boot Loader Section, and the SPM instruction can only execute from there. In ATmega48P, there is no Read-While-Write support and no separate Boot Loader Section. The SPM instruction can execute from the entire Flash.
3. Resources

A comprehensive set of development tools, application notes and datasheets are available for download on http://www.atmel.com/avr.

4. Data Retention

Reliability Qualification results show that the projected data retention failure rate is much less than 1 PPM over 20 years at 85°C or 100 years at 25°C.
B.1. Listing Program Keseluruhan

```c
#include <SPI.h>
#include <MFRC522.h>  // library MFRC522 yang digunakan untuk menjalankan
                     // fungsi port serial tambahan pada arduino.
#include <Wire.h>     // wire virtual
#include <LiquidCrystal_I2C.h> // library LCD 12C

#define SS_PIN 10     // SDA pin Mifare RC255
#define RST_PIN 9     // Reset pin Mifare RC255
#define LED1 5        // LED
#define LED2 7        // LED
#define doorLock_ON 0  // Relay
#define doorLock_OFF 1 // Relay
#define doorLock_1 6   // Relay

MFRC522 mfrc522(SS_PIN, RST_PIN);  // RFID
int pinBuzzer = 8;   // Buzzer
int doorLock = 6;    // Buzzer

LiquidCrystal_I2C lcd(0x27, 16, 2); // LCD
```
void setup()
{
Serial.begin(9600); // Initiate a serial communication
SPI.begin(); // Initiate SPI bus
mfrc522.PCD_Init(); // Initiate MFRC522
pinMode(LED1, OUTPUT); // mengatur LED 1 sebagai Output
pinMode(LED2, OUTPUT); // mengatur LED 2 sebagai Output
pinMode(pinBuzzer, OUTPUT); // mengatur Buzzer sebagai Output
pinMode(doorLock, OUTPUT); // mengatur Relay sebagai Output
digitalWrite(doorLock, HIGH); // Memeberi Sinyal HIGH pada Relay
digitalWrite(pinBuzzer, HIGH); // Memberi Sinyal HIGH pada Buzzer

// set up the LCD's number of columns and rows:
lcd.begin(); // mengatur LCD 16 x 2
lcd.backlight(); // LCD Clear
delay(250); // Memberi waktu jeda
lcd.noBacklight();
delay(250);
delay(250);
lcd.backlight();

lcd.clear();
lcd.setCursor(0, 1); // Mengatur posisi karakter di LCD
lcd.print(" Tempelkan Kartu"); // Menampilkan Karakter LCD
delay(500); // Memberi Waktu Jeda
lcd.setCursor(0,2);
lcd.print(" ID CARD");
delay(500);

void loop()
{
    lcd.display();
delay(500);

    // Look for new cards
    if ( ! mfrc522.PICC_IsNewCardPresent())
    {
        return;
    }

    //Select one of the cards
    if ( ! mfrc522.PICC_ReadCardSerial())
    {
        return;
    }

    //Show UID on serial monitor
lcd.setCursor(0,0);
Serial.print("UID tag :");
lcd.print("UID:");
String content= "";
byte letter;
for (byte i = 0; i < mfrc522.uid.size; i++)
{
    Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
    Serial.print(mfrc522.uid.uidByte[i], HEX);
    lcd.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
    lcd.print(mfrc522.uid.uidByte[i], HEX);
    content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));     
    content.concat(String(mfrc522.uid.uidByte[i], HEX));
}
lcd.print(" Message :");
content.toUpperCase();
if (content.substring(1) =="47 C2 E7 35") //ubah UID nya disini sesuai ID card yang boleh di access
{
    lcd.clear();
lcd.setCursor(0,1);
lcd.print(" Tempelkan Kartu ");
delay(500);
lcd.setCursor(0,1);
lcd.print(" Selamat Datang ");
lcd.setCursor(0,2);
lcd.print(" Silahkan Masuk ");
delay(0);
digitalWrite(LED1,HIGH);
digitalWrite(LED2,LOW);
digitalWrite(pinBuzzer, LOW);
delay(500);
digitalWrite(pinBuzzer, HIGH);
delay(500);
digitalWrite(doorLock,HIGH);
delay(5000);
lcd.clear();
lcd.setCursor (0,1);
lcd.print(F(" Silahkan Masuk "));
lcd.setCursor (0,2);
lcd.print(F(" AutoLock after "));
for(int i=5; i>0; i--)
{
    lcd.setCursor (17,2); lcd.print(i);
delay (1000);
}
digitalWrite(doorLock,LOW);
delay(5000);
digitalWrite(pinBuzzer, HIGH);
lcd.clear();
lcd.setCursor(0,1);
lcd.print(" * Tugas Akhir *");
delay(300);
lcd.setCursor(0,2);
lcd.print(" ID CARD");
delay(500);
}

else {
  lcd.setCursor(0,2);
lcd.clear();
lcd.print(" Akses Ditolak ");
delay(500);
digitalWrite(pinBuzzer, HIGH);
delay(300);
digitalWrite(pinBuzzer, LOW);
delay(300);
digitalWrite(pinBuzzer, HIGH);
delay(300);
digitalWrite(pinBuzzer, LOW);
delay(300);
digitalWrite(pinBuzzer, HIGH);
delay(300);
digitalWrite(pinBuzzer, LOW);
delay(300);
digitalWrite(pinBuzzer, HIGH);
delay(1000);
digitalWrite(LED2, HIGH);
digitalWrite(LED1, LOW);
lcd.clear();
lcd.setCursor(0,1);
lcd.print(" Tempelkan Kartu");
delay(500);
lcd.setCursor(0,2);
lcd.print(" ID CARD");
delay(500);
}
C.1. Skema Rangkaian Keseluruhan
### D.1. Daftar Komponen dan Daftar Harga

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<thead>
<tr>
<th>NO.</th>
<th>Nama Komponen</th>
<th>Harga(Rp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(1pcs) Arduino Uno</td>
<td>90.000,-</td>
</tr>
<tr>
<td>2</td>
<td>(1pcs) LCD</td>
<td>25.000,-</td>
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<tr>
<td>3</td>
<td>(1pcs) Mifare RFID RC522</td>
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<td>4</td>
<td>(1pcs) Modul Buzzer</td>
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<td>6</td>
<td>(1pcs) 12 C LCD</td>
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<td>7</td>
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<td>8</td>
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<td>10</td>
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<td>(4pcs) Dioda</td>
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<td>12</td>
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<td>13</td>
<td>(3pcs) LED</td>
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<td>14</td>
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<td>15</td>
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<td></td>
<td><strong>Jumlah</strong></td>
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</table>
E.1. PCB Layout
F.1. Foto Alat

Foto Alat Keamanan Pintu

Foto RFID
Foto Arduino Uno

Foto LCD
Foto Solenoid

Foto Adaptor