LAMPIRAN-LAMPIRAN

A1. Data Sheet

1. Data Sheet IC Atmega328P

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
    (Atmega48/PA/88/PA/168/PA/328P)
  - 256/512/1K/2K Bytes EEPROM (Atmega48/PA/88/PA/168/PA/328P)
  - 32/1K/1K/2K Bytes Internal SRAM (Atmega48/PA/88/PA/168/PA/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
  - 8-channel 10-bit ADC in PDIP Package
  - Temperature Measurement
  - Programmable Serial USART
  - 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 Comparer
  - 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 - 3.5V for ATmega48/PA/88/PA/168/PA/328P
- Temperature Range:
  - 40°C to 85°C
- Speed Grade:
  - 0 - 20 MHz @ 1.8 - 5.5V
- Low Power Consumption at 1 MHz, 1.8V, 25°C for ATmega48/PA/88/PA/168/PA/328P:
  - Active Mode: 0.2 mA
  - Power-down Mode: 0.1 μA
  - Power-save Mode: 0.75 μA (including 32 kHz RTC)
1. Pin Configurations

Figure 1-1. Pinout ATmega48PA/88PA/168PA/328P
1.1 Pin Descriptions

1.1.1 VCC
Digital supply voltage.

1.1.2 GND
Ground.

1.1.3 Port B (PB7:0) XTAL1/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 158 and “System Clock and Clock Options” on page 20.

1.1.4 Port C (PC6:0)
Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC6:0 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 RSTC1S1L 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 RSTC1S1L 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 28-3 on page 306. 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 159.

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 "Atmel Functions of Port D" on page 82.

1.1.7 AVcc

AVcc is the supply voltage pin for the A/D Converter, PC0.0, and ADC7:8. 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 PC0..4 use digital supply voltage, Vcc.

1.1.8 AREF

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

1.1.9 ADC7:8 (TQFP and QFN/MLF Package Only)

In the TQFP and QFN/MLF package, ADC7:8 serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit A/D channels.
2. Overview

The ATmega48PA/88PA/168PA/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 ATmega48PA/88PA/168PA/328P achieves throughput approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed.

2.1 Block Diagram

![Block Diagram](image)

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 ATmega48PA/88PA/168PA/328P provides the following features: 4/8/16/32K bytes of In-System Programmable Flash with Read-While-Write capabilities, 256/512/512/1K bytes EEPROM, 512/1K/1K/2K bytes SRAM, 33 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 QFNMLF 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/oscillator 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 ATmega48PA/88PA/168PA/328P is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega48PA/88PA/168PA/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 ATmega48PA, ATmega88PA, ATmega168PA and ATmega328P

The ATmega48PA, ATmega88PA, ATmega168PA 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>ATmega48PA</td>
<td>4K bytes</td>
<td>256 bytes</td>
<td>512 bytes</td>
<td>1 instruction word/vector</td>
</tr>
<tr>
<td>ATmega88PA</td>
<td>8K bytes</td>
<td>512 bytes</td>
<td>1K bytes</td>
<td>1 instruction word/vector</td>
</tr>
<tr>
<td>ATmega168PA</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>

ATmega88PA, ATmega168PA and ATmega328P support a real Read-While-Write Self-Programming mechanism. There is a separate Boot Loader Section, and the SPI instruction can only execute from there. In ATmega48PA, there is no Read-While-Write support and no separate Boot Loader Section. The SPI instruction can execute from the entire Flash.
3. Resources

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

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.
2. Data Sheet MFRC522

MFRC522
Standard 3V MIFARE reader solution
Rev. 3.5 — 17 September 2014

1. Introduction

This document describes the functionality and electrical specifications of the contactless reader/writer MFRC522.

Remark: The MFRC522 supports all variants of the MIFARE Mini, MIFARE 1K, MIFARE 4K, MIFARE Ultralight, MIFARE DESFire EV1 and MIFARE Plus RF identification protocols. To aid readability throughout this data sheet, the MIFARE Mini, MIFARE 1K, MIFARE 4K, MIFARE Ultralight, MIFARE DESFire EV1 and MIFARE Plus products and protocols have the generic name MIFARE.

2. General description

The MFRC522 is a highly integrated reader/writer IC for contactless communication at 13.56 MHz. The MFRC522 reader supports ISO/IEC 14443 A/MIFARE mode.

The MFRC522's internal transmitter is able to drive a reader/writer antenna designed to communicate with ISO/IEC 14443 A/MIFARE cards and transponders without additional active circuitry. The receiver module provides a robust and efficient implementation for demodulating and decoding signals from ISO/IEC 14443 A/MIFARE compatible reader/writer transponders. The digital module manages the complete ISO/IEC 14443 A framing and error detection (parity and CRC) functionality.

The MFRC522 supports MF1xxx20, MF1xx370 and MF1xx550 products. The MFRC522 supports contactless communication and uses MIFARE higher transfer speeds up to 848 kbit in both directions.

The following host interfaces are provided:
- Serial Peripheral Interface (SPI)
- Serial UART (similar to RS232 with voltage levels dependent on pin voltage supply)
- I²C-bus interface

2.1 Differences between version 1.0 and 2.0

The MFRC522 is available in two versions:
- MFRC52201HN1, hereafter referred to version 1.0 and
- MFRC52202HN1, hereafter referred to version 2.0.

The MFRC522 version 2.0 is fully compatible to version 1.0 and offers in addition the following features and improvements.
• Increased stability of the reader IC in rough conditions
• An additional timer prescaler, see Section 8.5.
• A corrected CRC handling when RX Multiple is set to 1

This data sheet version covers both versions of the MFRC522 and describes the differences between the versions if applicable.

3. Features and benefits

- Highly integrated analog circuitry to demodulate and decode responses
- Buffered output drivers for connecting an antenna with the minimum number of external components
- Supports ISO/IEC 14443 A/MIFARE
- Typical operating distance in Read/Write mode up to 50 mm depending on the antenna size and tuning
- Supports MF1xxS20, MF1xxS70 and MF1xxS50 encryption in Read/Write mode
- Supports ISO/IEC 14443 A higher transfer speed communication up to 848 kbd
- Supports MFIN/MFOUT
- Additional internal power supply to the smart card IC connected via MFIN/MFOUT
- Supported host interfaces
  - SPI up to 10 Mbits
  - I²C-bus interface up to 400 kbd in Fast mode, up to 3400 kbd in High-speed mode
  - RS232 Serial UART up to 1228.8 kbd, with voltage levels dependant on pin voltage supply
- FIFO buffer handles 94 byte send and receive
- Flexible interrupt modes
- Hard reset with low power function
- Power-down by software mode
- Programmable timer
- Internal oscillator for connection to 27.12 MHz quartz crystal
- 2.5 V to 3.3 V power supply
- CRC coprocessor
- Programmable I/O pins
- Internal self-test
4. Quick reference data

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDDA</td>
<td>analog supply voltage</td>
<td>VDDA = VDDO = VDDIT = VDDITVDD = VDDITPDVDD = 3 V</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>hard power-down, pin NK31PD set LOW</td>
<td></td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>soft power-down, RF level detector on</td>
<td></td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>VDDO</td>
<td>digital supply voltage</td>
<td>VDDA = VDDO = VDDIT = VDDITVDD = VDDITPDVDD = 0 V</td>
<td>2.5</td>
<td>3.3</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>VDDIT</td>
<td>TVDD supply voltage</td>
<td>VDDA = VDDO = VDDIT = VDDITVDD = VDDITPDVDD = 0 V</td>
<td>2.5</td>
<td>3.3</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>VDDITVDD</td>
<td>PVDD supply voltage</td>
<td>VDDA = VDDO = VDDIT = VDDITVDD = VDDITPDVDD = 0 V</td>
<td>1.6</td>
<td>1.8</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>VDDITPDVDD</td>
<td>SVDD supply voltage</td>
<td>VDDA = VDDO = VDDIT = VDDITVDD = VDDITPDVDD = 0 V</td>
<td>1.6</td>
<td>3.6</td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

5. Ordering information

[Notes and explanations provided in the document's text.]

MFRC522 Standard 3V MIFARE reader solution
5. Ordering information

Table 2. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFRC52201H1/TRA01</td>
<td>HVQFN24</td>
<td>plastic thermal enhanced very thin quad flat package; no leads;</td>
<td>SCOT617-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32 terminal; body 5 x 5 x 0.85 mm</td>
<td></td>
</tr>
<tr>
<td>MFRC52201H1/TRA02</td>
<td>HVQFN32</td>
<td>plastic thermal enhanced very thin quad flat package; no leads;</td>
<td>SCOT617-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32 terminal; body 5 x 5 x 0.85 mm</td>
<td></td>
</tr>
<tr>
<td>MFRC52202H1/TRA01</td>
<td>HVQFN32</td>
<td>plastic thermal enhanced very thin quad flat package; no leads;</td>
<td>SCOT617-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32 terminal; body 5 x 5 x 0.85 mm</td>
<td></td>
</tr>
<tr>
<td>MFRC52202H1/TRA02</td>
<td>HVQFN32</td>
<td>plastic thermal enhanced very thin quad flat package; no leads;</td>
<td>SCOT617-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32 terminal; body 5 x 5 x 0.85 mm</td>
<td></td>
</tr>
</tbody>
</table>

[1] Delivered in one tray.

6. Block diagram

The analog interface handles the modulation and demodulation of the analog signals.

The contactless UART manages the protocol requirements for the communication protocols in cooperation with the host. The FIFO buffer ensures fast and convenient data transfer to and from the host and the contactless UART and vice versa.

Various host interfaces are implemented to meet different customer requirements.

![Simplified block diagram of the MFRC522](image)
# 7. Pinning information

![Diagram](image)

**Fig 3. Pinning configuration HVQFN32 (SOT617-1)**

## 7.1 Pin description

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I2C</td>
<td>I</td>
<td>PC-bus enable inputC</td>
</tr>
<tr>
<td>2</td>
<td>PVD0</td>
<td>P</td>
<td>pin power supply</td>
</tr>
<tr>
<td>3</td>
<td>DVS0</td>
<td>P</td>
<td>digital power supply</td>
</tr>
<tr>
<td>4</td>
<td>DVS0</td>
<td>G</td>
<td>digital groundG</td>
</tr>
<tr>
<td>5</td>
<td>PVSS</td>
<td>G</td>
<td>pin power supply ground</td>
</tr>
<tr>
<td>6</td>
<td>NRSTPD</td>
<td>I</td>
<td>reset and power-down input: power-down: enabled when LOW; internal current sinks are switched off, the oscillator is inhibited and the input pins are disconnected from the outside world reset: enabled by a positive edge</td>
</tr>
<tr>
<td>7</td>
<td>MFIN</td>
<td>I</td>
<td>MIFARE signal input</td>
</tr>
<tr>
<td>8</td>
<td>MFCUT</td>
<td>O</td>
<td>MIFARE signal output</td>
</tr>
<tr>
<td>9</td>
<td>SVDD</td>
<td>P</td>
<td>MFIN and MFCUT pin power supply</td>
</tr>
<tr>
<td>10</td>
<td>TVSS</td>
<td>G</td>
<td>transmitter output stage 1 ground</td>
</tr>
<tr>
<td>11</td>
<td>TX1</td>
<td>O</td>
<td>transmitter 1 modulated 13.56 MHz energy carrier output</td>
</tr>
<tr>
<td>12</td>
<td>TVDD</td>
<td>P</td>
<td>transmitter power supply: supplies the output stage of transmitters 1 and 2</td>
</tr>
<tr>
<td>13</td>
<td>TX2</td>
<td>O</td>
<td>transmitter 2 modulated 13.56 MHz energy carrier output</td>
</tr>
<tr>
<td>14</td>
<td>TVSS</td>
<td>G</td>
<td>transmitter output stage 2 ground</td>
</tr>
<tr>
<td>15</td>
<td>AVDD</td>
<td>P</td>
<td>analog power supply</td>
</tr>
</tbody>
</table>
3. Data Sheet Sensor Ultrasonik (HC-SR04)

Ultrasonic Ranging Module HC - SR04

Product features:

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The module includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

1) Using IO trigger for at least 10us high level signal.
2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
3) If the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time * velocity of sound (340M/S) ) / 2.

Wire connecting direct as following:

- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- GND Ground

Electric Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Voltage</td>
<td>DC 5 V</td>
</tr>
<tr>
<td>Working Current</td>
<td>15mA</td>
</tr>
<tr>
<td>Working Frequency</td>
<td>40Hz</td>
</tr>
<tr>
<td>Max Range</td>
<td>4m</td>
</tr>
<tr>
<td>Min Range</td>
<td>2cm</td>
</tr>
<tr>
<td>Measuring Angle</td>
<td>±5 degree</td>
</tr>
<tr>
<td>Trigger Input Signal</td>
<td>30us TTL pulse</td>
</tr>
<tr>
<td>Echo Output Signal</td>
<td>Input TTL  level signal and the range is proportion</td>
</tr>
<tr>
<td>Dimension</td>
<td>45<em>20</em>15mm</td>
</tr>
</tbody>
</table>
Timing diagram

The Timing diagram is shown below. You only need to supply a short 10μS pulse to the trigger input to start the ranging, and then the module will send out an 8-cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distance object that is pulse width and the range in proportion. You can calculate the range through the time interval between sending trigger signal and receiving echo signal. Formula: μS / 58 = centimeters or μS / 148 = inches; or: the range = high level time * velocity (340M/S) / 2; we suggest to use over 60ns measurement cycle, in order to prevent trigger signal to the echo signal.
4. Data Sheet Modul I2C

Description:
This LCD0034 is a great I2C interface for 2x16 and 4x08 LCD displays. With the limited pin resources, your project may be out of resources using normal LCD shield. With this I2C interface LCD module, you only need 2 lines (I2C) to display the information. If you already have I2C devices in your project, this LCD module actually cost no more resources at all. Fantastic for Arduino based projects.

Specification:
- Compatible with 16x2 and 20x4 LCD’s
- Default I2C Address = 0x27
- Address selectable - Range 0x20 to 0x27

Board Layout:

![Board Layout Image]
The LCD2004 board utilized the PCF8574 I/O expander. This nifty little chip provides eight bits of parallel I/O addressability by a I2C bus address – 0x00 to 0x27. SainSmart tied all address leads to Vcc, so the LCD2004 board's I2C address is permanently fixed at hex 27. This is rather limiting since no additional LCD2004s can be added to the bus. Anyway, you simply address the board and write an eight bit value which is then presented on the output pins of the PCF8574, which, in this case, are connected to the HD44780 based LCD screen.

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>I2C SLAVE ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>A1</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

H = Open Jumper  L = Close Jumper
5. Data Sheet Motor Stepper 28BYJ-48

28BYJ-48 – 5V Stepper Motor

The 28BYJ-48 is a small stepper motor suitable for a large range of applications.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>5VDC</td>
</tr>
<tr>
<td>Number of Phase</td>
<td>4</td>
</tr>
<tr>
<td>Speed Variation Ratio</td>
<td>1/64</td>
</tr>
<tr>
<td>Stobe Angle</td>
<td>5.85°±64</td>
</tr>
<tr>
<td>Frequency</td>
<td>100kHz</td>
</tr>
<tr>
<td>DC resistance</td>
<td>550Ω±%(25°C)</td>
</tr>
<tr>
<td>Idle In-Induction Frequency</td>
<td>&gt; 600Hz</td>
</tr>
<tr>
<td>Idle Out-Induction Frequency</td>
<td>&gt; 1000Hz</td>
</tr>
<tr>
<td>In-Induction Torque</td>
<td>&lt;5.3 mN.m (150mA)</td>
</tr>
<tr>
<td>Self-positioning Torque</td>
<td>&gt;34.3mN.m</td>
</tr>
<tr>
<td>Friction torque</td>
<td>600-1200 gf.cm</td>
</tr>
<tr>
<td>Pull in torque</td>
<td>500 gf.cm</td>
</tr>
<tr>
<td>Insulated resistance</td>
<td>&gt;106MΩ(500VDC)</td>
</tr>
<tr>
<td>Insulated electricity power</td>
<td>600VAC/1mA/1s</td>
</tr>
<tr>
<td>Insulation grade</td>
<td>A</td>
</tr>
<tr>
<td>Rise in Temperature</td>
<td>&lt;20K (120Hz)</td>
</tr>
<tr>
<td>Noise</td>
<td>&lt;25db(120Hz, no load, 10cm)</td>
</tr>
<tr>
<td>Model</td>
<td>28BYJ-48 – 5V</td>
</tr>
</tbody>
</table>

![Motor Diagram](image-url)
6. Data Sheet Motor Driver ULN2003

ULN2001A-ULN2002A
ULN2003A-ULN2004A

SEVEN DARLINGTON ARRAYS

- Seven Darlington transistors per package
- Output current: 500mA per driver (600mA peak)
- Output voltage: 50V
- Integrated suppression diodes for inductive loads
- Outputs can be paralleled for higher current
- TTL/CMOS/PWM/DTL compatible inputs
- Inputs pinned opposite outputs to simplify layout

DESCRIPTION

The ULN2001A, ULN2002A, ULN2003, and ULN2004A are high voltage, high current Darlington arrays each containing seven open collector Darlington pairs with common emitters. Each channel is rated at 500mA and can withstand peak currents of 600mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout.

The four versions interface to all common logic families:

<table>
<thead>
<tr>
<th>Version</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULN2001A</td>
<td>General Purpose, DTL, TTL, PMOS, CMOS</td>
</tr>
<tr>
<td>ULN2002A</td>
<td>14-25V PMOS</td>
</tr>
<tr>
<td>ULN2003A</td>
<td>5V TTL, CMOS</td>
</tr>
<tr>
<td>ULN2004A</td>
<td>6-15V CMOS, PMOS</td>
</tr>
</tbody>
</table>

These versatile devices are useful for driving a wide range of loads including solenoids, relays, DC motors, LED displays, filament lamps, thermal print-heads and high power buffers.

SCHEMATIC DIAGRAM

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V0</td>
<td>Output Voltage</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>IC</td>
<td>Continuous Collector Current</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>IB</td>
<td>Continuous Base Current</td>
<td>25</td>
<td>mA</td>
</tr>
<tr>
<td>Tamb</td>
<td>Operating Ambient Temperature Range</td>
<td>-20 to 85</td>
<td>°C</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature Range</td>
<td>-55 to 150</td>
<td>°C</td>
</tr>
<tr>
<td>TJ</td>
<td>Junction Temperature</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

THERMAL DATA

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>DIP16</th>
<th>SO16</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rth(J-A)</td>
<td>Thermal Resistance Junction-ambient</td>
<td>Max.</td>
<td></td>
<td>°C/W</td>
</tr>
</tbody>
</table>
## ELECTRICAL CHARACTERISTICS (T_{\text{amb}} = 25^\circ\text{C} unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Fig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{\text{CEO}}</td>
<td>Output Leakage Current</td>
<td>V_{\text{CE}} = 50V; T_{\text{amb}} = 70^\circ\text{C}; V_{\text{EE}} = 50V</td>
<td>50</td>
<td>100</td>
<td>µA</td>
<td>1a</td>
<td>1a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T_{\text{amb}} = 70^\circ\text{C} for ULN2002A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{\text{CE}} = 50V; V_{\text{L}} = 6V for ULN2003A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{\text{CE}} = 50V; V_{\text{L}} = 1V for ULN2004A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{\text{CEO(max)}}</td>
<td>Collector-emitter Saturation Voltage</td>
<td>I_{C} = 100mA, I_{E} = 250µA</td>
<td>0.6</td>
<td>1.1</td>
<td>V</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_{C} = 200mA, I_{E} = 350µA</td>
<td>1.1</td>
<td>1.3</td>
<td>V</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_{C} = 300mA, I_{E} = 500µA</td>
<td>1.3</td>
<td>1.6</td>
<td>V</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>I_{\text{IN}}</td>
<td>Input Current</td>
<td>for ULN2002A, V_{\text{I}} = 17V</td>
<td>0.82</td>
<td>1.25</td>
<td>mA</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for ULN2003A, V_{\text{I}} = 3.68V</td>
<td>0.99</td>
<td>1.36</td>
<td>mA</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for ULN2004A, V_{\text{I}} = 5V</td>
<td>0.35</td>
<td>0.5</td>
<td>mA</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{\text{I}} = 12V</td>
<td>1</td>
<td>1.45</td>
<td>mA</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>I_{\text{IN}}</td>
<td>Input Current</td>
<td>T_{\text{amb}} = 70^\circ\text{C}; I_{C} = 500µA</td>
<td>50</td>
<td>65</td>
<td>µA</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>V_{\text{CBO}}</td>
<td>Input Voltage</td>
<td>V_{\text{CC}} = 2V</td>
<td>V</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for ULN2002A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_{C} = 300mA</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for ULN2003A</td>
<td>I_{C} = 200mA</td>
<td>2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I_{C} = 250mA</td>
<td>2.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I_{C} = 300mA</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for ULN2004A</td>
<td>I_{C} = 125mA</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I_{C} = 200mA</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I_{C} = 250mA</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I_{C} = 350mA</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{\text{VE}}</td>
<td>DC Forward Current Gain</td>
<td>for ULN2001A</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{\text{CC}} = 2V, I_{C} = 350mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{\text{I}}</td>
<td>Input Capacitance</td>
<td>15</td>
<td>25</td>
<td>pF</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>t_{\text{PLH}}</td>
<td>Turn-on Delay Time</td>
<td>0.5 V_{\text{IL}} to 0.5 V_{\text{OH}}</td>
<td>0.25</td>
<td>1</td>
<td>µs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t_{\text{PHL}}</td>
<td>Turn-off Delay Time</td>
<td>0.5 V_{\text{IL}} to 0.5 V_{\text{OH}}</td>
<td>0.25</td>
<td>1</td>
<td>µs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{\text{T}}</td>
<td>Clamp Diode Leakage Current</td>
<td>V_{\text{CC}} = 50V</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>T_{\text{amb}} = 70^\circ\text{C}; V_{\text{IN}} = 60V</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{\text{F}}</td>
<td>Clamp Diode Forward Voltage</td>
<td>I_{C} = 350mA</td>
<td>1.7</td>
<td>2</td>
<td>V</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
TEST CIRCUITS

Figure 1a.

Figure 1b.

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6.

Figure 7.
<table>
<thead>
<tr>
<th>DIM</th>
<th>mm</th>
<th>inch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MIN</td>
<td>TYP</td>
</tr>
<tr>
<td>a1</td>
<td>0.51</td>
<td>0.020</td>
</tr>
<tr>
<td>B</td>
<td>0.77</td>
<td>1.65</td>
</tr>
<tr>
<td>b</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>b1</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>2.54</td>
<td></td>
</tr>
<tr>
<td>e3</td>
<td>17.78</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>1.27</td>
<td>0.050</td>
</tr>
</tbody>
</table>

OUTLINE AND MECHANICAL DATA

DIP16
B1. Listing Program Keseluruhan

#include <SPI.h> // serial peripheral interface
#include <MFRC522.h> // library rfid
#include <Wire.h> // wire virtual
#include <LiquidCrystal_I2C.h> //library lcd i2c
#include <Stepper.h> // library motor stepper

#define SS_PIN 10 // menetapkan pin rfid dengan pin 10 arduino
#define RST_PIN 9 // menetapkan pin rfid dengan pin 9 arduino
#define LED_ACCESS_PIN 7 // pin 7 led pada arduino

#define motorSteps 64 // step dari motor stepper
#define motorPin1 6 // pin IN1 motor driver ULN2003
#define motorPin2 5 // pin IN2 motor driver ULN2003
#define motorPin3 4 // pin IN3 motor driver ULN2003
#define motorPin4 3 // pin IN4 motor driver ULN2003
#define button 8

const int step_ = 1600; //putaran motor stepper
int trigPin = A0; //pin sensor hc-sr04 di A0 arduino
int echoPin = A1; //pin sensor hc-sr04 di A0 arduino
int button1 = 0; //push button
// initialize of the Stepper library:
Stepper myStepper(motorSteps, motorPin4, motorPin2, motorPin3, motorPin1);
LiquidCrystal_I2C lcd(0x27, 16, 2); // alamat modul i2c
MFRC522 mfrc522(SS_PIN, RST_PIN); // jarak dari modul mfrc522

void setup() // fungsi yang berjalan sekali
{
    myStepper.setSpeed(100); // kecepatan motor stepper

    // initialize the Serial port:
    Serial.begin(9600); // Initiate a serial communication
    lcd.begin(); //lcd 16x2
    lcd.setCursor(1,0); // posisi text pada lcd
    lcd.clear(); //hapus text pada lcd
    SPI.begin(); // Initiate SPI bus
    mfrc522.PCD_Init(); // Initiate MFRC522
    Serial.println("PLEASE TAG YOUR E-KTP CARD to the READER TAG...");
    Serial.println();
    pinMode(LED_ACCESS_PIN, OUTPUT); // pin led sebagai output
    pinMode(echoPin, INPUT); // pin echo sebagai input
    pinMode(trigPin, OUTPUT); // pin trig sebagai output
    pinMode(button, INPUT_PULLUP); // pin push button sebagai input
}

void distance1()
{
    long duration, distance; //fungsi jarak sensor hc-sr04
    digitalWrite(trigPin, HIGH); //pin trig aktif
delayMicroseconds(1000); //delay waktu
digitalWrite(trigPin, LOW);
duration=pulseIn(echoPin, HIGH);
distance =(duration/2)/29.1;
Serial.print(distance);
Serial.println("CM");
if(distance<=10) //jika jarak kuang dari 10cm, sensor bekerja
{
  myStepper.step(0); // motor stepper berhenti ketika sensor hc-sr04 memdeteksi jarak yang sesuai
  delay(2000); //delay 2detik
digitalWrite(LED_ACCESS_PIN, HIGH); //led menyala
  lcd.clear(); //hapus text
  lcd.setBacklight(HIGH);
  lcd.setCursor(1,0);
  lcd.print("ADA OBJEK!"); //text pada lcd
digitalWrite(LED_ACCESS_PIN, HIGH); //led menyala
delay(1000);
digitalWrite(LED_ACCESS_PIN, LOW); // led mati
  lcd.clear();
  Serial.println("TRUE"); //teks pada serial monitor Arduino IDE
  return distance1(); //kembali mendeteksi jarak sensor hc-sr04
}
void button0(){ //fungsi dari push button
  button1 = digitalRead(button); //membaca push button
if (button1 == LOW) { //jika button di tekan, maka proses akan berjalan
    Serial.println("Authorized Access"); //teks di serial monitor
    Serial.println();
lcd.setCursor(1, 0);
    lcd.println("ACCESS GRANTED"); //teks di lcd ketika akses diijinkan oleh rfid
    lcd.println();
lcd.clear();
lcd.setBacklight(HIGH);
lcd.setCursor(4, 0); // intruksi menentukan kursor
    lcd.print("Sky Hunter"); //intruksi menulis string/karakter pada lcd 16x2
    lcd.setCursor(4, 1);
    lcd.print("Project");
    Serial.println("BUKA"); // intruksi menulis string/ karakter pada serial monitor
delay(3000);
digitalWrite(7, HIGH); // intruksi pin led 7 di Arduino agar menyala
myStepper.step(step_); // intruksi motor stepper berjalan
    lcd.clear();
lcd.setBacklight(HIGH);
lcd.setCursor(2, 0);
lcd.print("PASS THE DOOR");
lcd.setCursor(0, 1);
lcd.print("Welcome to Home");
    Serial.println("PASS THE DOOR");
digitalWrite(7, LOW);
delay(6000);
distance1(); // variabel sensor hc-sr04
delay(6000);
lcd.clear();
lcd.setBacklight(HIGH);
lcd.setCursor(4, 0);
lcd.print("CLOSING");
lcd.setCursor(2, 1);
lcd.print("See You ^_^");
Serial.println("CLOSING");
digitalWrite(7, HIGH);
delay(3000);
myStepper.step(-step_);
Serial.println("TUTUP");
digitalWrite(7, LOW);
delay(3000);
lcd.clear();
myStepper.step(-step_); // intruksi motor stepper untuk menutup pagar
Serial.println("TUTUP");
digitalWrite(7, LOW);
delay(3000);
lcd.clear();
}
void loop() {
    lcd.setCursor(4, 0);

    // Print at cursor Location:
    lcd.print("ASSALAMUALAIKUM");

    //goto column 2 and second line
    lcd.setCursor(0, 1);
    lcd.print("Sky Hunter Team ");
    buttoon();

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

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

    //Show UID on serial monitor
    Serial.print("UID tag:");

    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);
content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
content.concat(String(mfrc522.uid.uidByte[i], HEX));
}
Serial.println();
Serial.print("Message : ");
content.toUpperCase()
if (content.substring(1) == "04 28 5D 4A F9 2C 80") // nomor tag kartu yang mendapat akses
{
Serial.println("Authorized access");
Serial.println();
lcd.setCursor(1, 0);
lcd.println("ACCESS GRANTED");
lcd.println();
lcd.clear();
lcd.setBacklight(HIGH);
lcd.setCursor(4, 0);
lcd.print("OPENING");
lcd.setCursor(4, 1);
lcd.print("GARAGE");
Serial.println("BUKA");
delay(3000);
digitalWrite(7, HIGH);
myStepper.step(step_);
lcd.clear();
lcd.setBacklight(HIGH);
lcd.setCursor(2, 0);
lcd.print("PASSED");
lcd.setCursor(0, 1);
lcd.print("Welcome to Home");
Serial.println("PASSED");
digitalWrite(7, LOW);
delay(6000);
distance1();
delay(6000);
lcd.clear();
lcd.setBacklight(HIGH);
lcd.setCursor(4, 0);
lcd.print("CLOSING");
lcd.setCursor(2, 1);
lcd.print("See You ^_^");
Serial.println("CLOSING");
digitalWrite(7, HIGH);
delay(3000);
myStepper.step(-step_);
Serial.println("TUTUP");
digitalWrite(7, LOW);
delay(3000);

lcd.clear();

myStepper.step(-step_);

Serial.println("TUTUP");
digitalWrite(7, LOW);
delay(3000);
lcd.clear();
}

Else //jika kartu di tolak maka tidak ada proses berjalan
{
    Serial.println("ACCESS DENIED"); //keluaran teks di serial monitor ketika akses ditolak
digitalWrite(7, HIGH);
delay(100);
digitalWrite(7, LOW);
delay(100);
digitalWrite(7, HIGH);
delay(100);
digitalWrite(7, LOW);
delay(100);
digitalWrite(7, HIGH);
delay(100);
digitalWrite(7, LOW);
delay(100);
digitalWrite(7, LOW);
delay(100);
Serial.println(" Access denied");
Serial.println();
lcd.clear();
lcd.setBacklight(HIGH);
lcd.setCursor(1, 0);
lcd.print("Access Denied");
delay(3000);
lcd.clear();
}

}
C1. Skema Rangkaian Keseluruhan
D1. Daftar Komponen dan Daftar Harga

<table>
<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>Rp. 95.000,-</td>
</tr>
<tr>
<td>2</td>
<td>(1pcs) Sensor HC-SR 04</td>
<td>Rp. 30.000,-</td>
</tr>
<tr>
<td>3</td>
<td>(1pcs) Modul I2C</td>
<td>Rp. 25.000,-</td>
</tr>
<tr>
<td>4</td>
<td>(1pcs) Buzzer</td>
<td>Rp. 7.500,-</td>
</tr>
<tr>
<td>5</td>
<td>(40pcs) Kabel Male – Female</td>
<td>Rp. 40.000,-</td>
</tr>
<tr>
<td>6</td>
<td>(1pcs) PCB 10x20cm</td>
<td>Rp. 7.000,-</td>
</tr>
<tr>
<td>7</td>
<td>(5pcs) LED</td>
<td>Rp. 1500,-</td>
</tr>
<tr>
<td>8</td>
<td>(1pcs) Resistor</td>
<td>Rp. 100,-</td>
</tr>
<tr>
<td>9</td>
<td>(1pcs) Kabel Jumper</td>
<td>Rp. 2.000,-</td>
</tr>
<tr>
<td>10</td>
<td>(1pcs) Modul RFID MFRC522</td>
<td>Rp. 35.000,-</td>
</tr>
<tr>
<td>11</td>
<td>(1pcs) BreadBoard</td>
<td>Rp. 10.000,-</td>
</tr>
<tr>
<td>12</td>
<td>(1pcs) Motor Driver ULN2003</td>
<td>Rp. 25000,-</td>
</tr>
<tr>
<td>13</td>
<td>(4pcs) Push Button</td>
<td>Rp. 2000,-</td>
</tr>
</tbody>
</table>

Total Harga Rp. 280.100,-
E1. Foto Alat
F1. Tampilan Serial Monitor Arduino IDE

1. Tampilan Serial Monitor

   - Tampilan Serial monitor saat akses kartu diijinkan dan memulai proses

   ![Tampilan Serial Monitor diijinkan](image1)

   - Tampilan Serial Monitor saat akses kartu ditolak.

   ![Tampilan Serial Monitor ditolak](image2)

   a). Tampilan Serial monitor saat – akses kartu diijinkan dan memulai proses

   b). Tampilan Serial Monitor- saat akses kartu di tolak.
c). Tampilan Serial Monitor- saat sensor HC-SR04 mendeteksi objek ketika ada objek yang berhenti saat pagar sedang menutup