



TUGAS AKHIR - VE 180626

**PERANCANGAN SISTEM MONITORING TEGANGAN DAN
ARUS BERBASIS ARDUINO UNO DENGAN MEDIA WIFI**

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Surabaya 2020



FINAL PROJECT - VE 180626

***ARDUINO-BASED VOLTAGE AND CURRENT MONITORING
SYSTEM DESIGN WITH WIFI MEDIA***

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PERNYATAAN KEASLIAN TUGAS AKHIR

Dengan ini saya menyatakan bahwa isi sebagian maupun keseluruhan tugas akhir saya dengan judul "**Perancangan Sistem Monitoring Tegangan dan Arus Berbasis Arduino Uno Dengan Media Wifi**" adalah benar-benar hasil karya intelektual mandiri, diselesaikan tanpa menggunakan bahan-bahan yang tidak diijinkan dan bukan merupakan karya pihak lain yang saya akui sebagai karya sendiri.

Semua referensi yang dikutip maupun dirujuk telah ditulis secara lengkap pada daftar pustaka. Apabila ternyata pernyataan ini tidak benar, saya bersedia menerima sanksi sesuai peraturan yang berlaku.

Surabaya, 20 Juli 2020

Argawa Aditya K.
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**PERANCANGAN SISTEM MONITORING TEGANGAN DAN
ARUS BERBASIS ARDUINO UNO DENGAN MEDIA WIFI**

PROYEK AKHIR

Diajukan Guna Memenuhi Sebagian Persyaratan
Untuk Memperoleh Gelar Ahli Madya
Pada
Departemen Teknik Elektro Otomasi
Fakultas Vokasi
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PERANCANGAN SISTEM MONITORING TEGANGAN DAN ARUS BERBASIS ARDUINO UNO DENGAN MEDIA WIFI

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ABSTRAK

Banyak orang belum bisa mengetahui daya yang dipakai pada rumah kita. Untuk mengetahui berapa daya pada rumah kita, kita harus mengukurnya dengan manual yaitu dengan cara melihat langsung pada meteran listrik. Terdapat kode *CL* yang menjadi penanda bagi *PLN* saat memasang daya dirumah pelanggannya. *PLN* membagi meteran listrik dalam beberapa kategori untuk pelanggan non industri dari yang paling rendah hingga paling tinggi.

Judul tugas akhir ini berupa perancangan sistem monitoring tegangan dan arus secara *real time*. Cara kerja alat ini adalah mengawasi kerja suatu beban dan mengambil data arus dan tegangan yang dihasilkan menggunakan sensor. Lalu data dari sensor diproses oleh Arduino dan data yang didapatkan akan dikirim menuju *server* melalui *wifi* dan dapat dilihat di komputer *server*.

Pada perancangan alat ini dapat mengukur tegangan dan arus dari beban. Hasil dari perancangan ini dapat mengukur tegangan dengan rata-rata nilai kesalahan sekitar 0,07% sampai dengan 0,213% dan pengukuran arus yang mempunyai rata-rata nilai kesalahan antara 3,07% sampai dengan 9,04%. Kemudian data yang diterima oleh *arduino* akan dikirimkan ke *LED* yang tiap detiknya akan memperbarui hasil dari nilai daya pada beban yang diukur. Selain itu, hasil dari mengukur daya pada beban bisa di lihat pada aplikasi *xampp-control* yang dimana akan memperlihatkan hasil ukuran dalam bentuk grafik dan tabel.

Kata Kunci : Monitoring, Daya, Arduino, *Wifi*, *Xampp-control*, Sensor

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DESIGN OF NH FUSE MONITORING SYSTEM ON ARDUINO BASED IN LV PANEL WITH WIFI

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ABSTRACT

Many people can not yet know the power used in our homes. To find out how much power is in our house, we have to measure it manually by looking directly at the electricity meter. There is a CL code that is a marker for PLN when installing power at the customer's home. PLN divides electricity meters in several categories for non-industrial customers from the lowest to the highest.

The title of this final project is the design of a voltage and current monitoring system in real time. The way this tool works is to monitor the work of a load and take data current and voltage generated using sensors. Then the data from the sensor is processed by Arduino and the data obtained will be sent to the server via wifi and can be viewed on the server computer.

In the design of this tool can measure the voltage and current of the load. The results of this design can measure the voltage with an average error value of about 0.07% to 0.213% and current measurements which have an average error value between 3.07% to 9.04%. Then the data received by Arduino will be sent to the LED which will update the results every second from the value of the power at the measured load. In addition, the results of measuring power at load can be seen in the xampp-control application which will show the results of measurements in graphical and tabular form.

Keywords : Monitoring, power, Arduino, Wifi, Xampp-control, Sensors

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KATA PENGANTAR

Puji syukur penulis panjatkan kehadirat Allah SWT yang selalu memberikan rahmat dan hidayah-Nya sehingga tugas akhir ini dapat terselesaikan dengan baik. Shalawat serta salam semoga selalu dilimpahkan kepada Rasulullah Muhammad SAW, keluarga, sahabat, dan umat muslim yang senantiasa meneladani beliau.

Tugas akhir ini disusun untuk memenuhi sebagian persyaratan guna menyelesaikan pendidikan Diploma-3 pada Program Studi Elektro Industri, Departemen Teknik Elektro Otomasi, Fakultas Vokasi, Institut Teknologi Sepuluh Nopember Surabaya.

Penulis mengucapkan terima kasih kepada orang tua penulis yang memberikan berbagai bentuk doa serta dukungan tulus tiada henti, Bapak Ir. Joko Susila, M.T dan Bapak Fauzi Imaduddin Adhim, S.ST., M.T atas segala bimbingan ilmu, moral, dan spiritual dari awal hingga terselesaiannya tugas akhir ini. Penulis juga mengucapkan banyak terima kasih kepada semua pihak yang telah membantu baik secara langsung maupun tidak langsung dalam proses penyelesaian tugas akhir ini.

Penulis menyadari dan memohon maaf atas segala kekurangan pada tugas akhir ini. Akhir kata, semoga tugas akhir ini dapat bermanfaat dalam pengembangan keilmuan di kemudian hari.

Surabaya, 20 Juli 2020

Penulis

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BAB I

PENDAHULUAN

1.1 Latar Belakang

Mengacu pada tugas akhir “Perancangan Sistem *Monitoring Kerja NH Fuse pada LV Panel* berbasis Arduino menggunakan media *Wifi*” oleh Rizqi Widya (2015). Menindaklanjuti pentingnya alat ini di dalam pengukuran tegangan dan arus saya mengembangkan alat ini menggunakan metode yang lebih baru dan efisien yaitu menggunakan arduino dengan media *wifi* dan dapat di monitoring lewat *local web*.

Penyebab listrik mati tidak sepenuhnya karena ada gangguan kelistrikan dari pusat. Akan tetapi, bisa disebabkan karena arus listrik padam di area rumah sendiri. Jika arus listrik listrik rumah hanya turun kejadian ini tidak lepas dari beberapa faktor yang menyebabkan listrik turun salah satunya pemakaian listrik melebihi Daya, salah dengan instalasi atau pemasangan kelistrikan dan pemasangan sekring kurang kencang

Sampai saat ini, untuk gangguan pada kelistrikan di rumah belum dapat terdeteksi secara *real time*. kita harus mengukurnya dengan manual yaitu dengan cara melihat langsung pada meteran listrik. Terdapat kode *CL* yang menjadi penanda bagi *PLN* saat memasang daya dirumah pelanggannya. *PLN* membagi meteran listrik dalam beberapa kategori untuk pelanggan non industri dari yang paling rendah hingga paling tinggi.

Menindaklanjuti pentingnya alat ini, diperlukan perhatian khusus pada suatu tegangan dan arus. Perlu suatu *monitoring* kerja sehingga ketika tegangan dan arus mengalami perubahan pennagananya cepat. Dengan menggunakan metode yang lebih baru yaitu menggunakan arduino diharapkan dapat menjalankan sistem *monitoring* dengan baik karena menggunakan teknologi yang lebih baru dan efisien. Dengan dibantunya media pengiriman data menggunakan *wifi* juga akan mendapatkan koneksi yang lebih stabil dalam menganalisa gangguan antara sistem dan juga dapat dilihat melalui *local web* dengan bantuan aplikasi *xampp-control* yang dapat menampilkan pengukuran berupa grafik dan table

1.2 Permasalahan

Permasalahan yang diangkat dari tugas akhir ini adalah karena belum adanya sistem *monitoring* daya pada kelistrikan rumah.

1.3 Batasan Masalah

Pada tugas akhir ini, pengolahan data digital yang digunakan adalah arduino uno, dengan memiliki batasan masalah sebagai berikut:

1. *Monitoring* daya, meliputi *telemetering* arus dan tegangan, indikator *overcurrent* dan mendekati batas arus maksimal, data *monitoring* tidak bisa menampilkan dalam bentuk *history*.
2. Parameter yang diukur adalah tegangan 0-250 Volt, dan arus dari 0-2,5 Ampere.
3. Beban yang dicoba pada telemetering tidak besar sehingga arus yang mengalir tidak sampai maksimal.

1.4 Tujuan

Tujuan saya menuliskan tugas akhir ini adalah:

1. Merancang sistem *monitoring* yang mampu mengukur daya, kemudian mengirim hasil pengukuran melalui *wifi* ke komputer *server* dan menampilkan data yang dapat menganalisa status beban yang diukur di indikator pada tampilan pada *LED* dan *local web*.
2. Membuat *prototype* sistem *monitoring* daya untuk mengetahui status dari beban yang diukur dan dapat mengukur besarnya tegangan dan arus berbasis arduino
3. Mengimplementasikan *monitoring* tegangan dan arus dengan menggunakan aplikasi *xampp-control* yang diharapkan dapat membantu untuk mengetahui berapa nilai daya yang keluar pada kelistrikan rumah.

1.5 Sistematika Laporan

Pembahasan tugas akhir ini akan dibagi menjadi lima Bab dengan sistematika sebagai berikut:

Bab I	Pendahuluan Bab ini meliputi latar belakang, permasalahan, tujuan penelitian, sistematika laporan dan relevansi.
Bab II	Teori Dasar Bab ini menjelaskan tentang tinjauan pustaka dari Arduino, Modul <i>Wifi</i> ISP 12e, LCD 16x2, <i>real time clock</i> , sensor arus ACS 712_05B, sensor tegangan ZNPT 101B, <i>Xampp-control</i> .
Bab III	Perancangan Sistem Bab ini membahas perencanaan dan pembuatan perangkat keras (<i>Hardware</i>) yang meliputi desain alat serta pengimplementasian sensor yang digunakan, pengaturan <i>wifi</i> , dan pembuatan perangkat lunak (<i>Software</i>) yang meliputi program pada Arduino IDE untuk menjalankan alat tersebut.
Bab IV	Pengujian dan Analisis Bab ini memuat tentang pemaparan dan analisis hasil pengujian alat pada keadaan sebenarnya. Seperti pengujian sensor tegangan, dan arus, untuk melihat arus dan tegangan pada beban. Selain itu, dilakukan pengujian <i>wifi</i> dan RTC
Bab V	Penutup Bab ini berisi kesimpulan dan saran dari hasil pembahasan yang telah diperoleh.

1.6 Relevansi

Manfaat atau relevansi tugas akhir ini bisa membantu warga untuk memonitoring suatu beban secara *real time*. Secara tidak langsung juga dapat mengurangi waktu dan biaya yang dihabiskan untuk pengecekan dalam penanganan gangguan sehingga tetap terasa nyaman dan aman.

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BAB II

TEORI DASAR

Bab ini membahas mengenai teori - teori yang berkaitan dengan topic penelitian yang dilaksanakan. Teori yang mendukung penyelesaian tugas akhir ini diantaranya ada pemahaman mengenai Arduino UNO, LCD 16x2, RTC, Modul *Wifi ISP* 12e, sensor arus, sensor tegangan, dan *Xampp-control*.

2.1 Arduino UNO [1]

Arduino adalah *board* mikrokontroler *open source* yang terdiri dari *chip* mikrokontroler yang dapat diprogram melalui komputer dengan program arduino IDE. Arduino memiliki port I/O yang dapat membaca sinyal analog dan dapat menulis sinyal digital dari program yang ditanamkan pada *chip* arduino ini.

Tipe Arduino yang digunakan pada pelaksanaan tugas akhir ini adalah Arduino Uno. Arduino Uno adalah mikrokontroler berbasis ATmega328. Arduino Uno memiliki 14 pin digital *input* dan *output* (dimana 6 dapat digunakan sebagai *output* PWM), 6 *input* analog, resonator keramik 16 MHz, koneksi USB, *jack* listrik, *header* ICSP, dan tombol *reset*. Uno dibangun berdasarkan apa yang diperlukan untuk mendukung mikrokontroler, sumber daya bisa menggunakan power USB (jika terhubung ke komputer dengan kabel USB) dan juga dengan adaptor atau baterai. Pada Tabel 2.4 merupakan spesifikasi dari Arduino Uno. Gambar 2.4 adalah bentuk dari Arduino Uno seperti terlihat pada Gambar 2.1.



Gambar 2.1 Arduino UNO

Tabel 2.1 Spesifikasi Arduino Uno

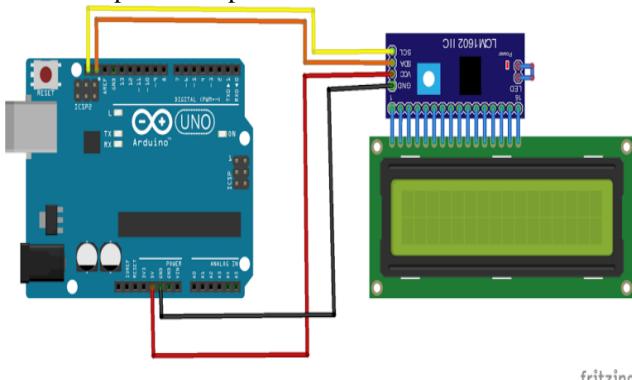
Mikrokontroler	ATmega328
Operasi tegangan	5Volt
Input tegangan	disarankan 7-11Volt
Input tegangan batas	6-20Volt
Pin I/O digital	14 (6 bisa untuk PWM)
Pin Analog	6
Arus DC tiap pin I/O	50mA
Arus DC ketika 3.3V	50mA
Memori flash	32 KB (ATmega328) dan 0,5 KB digunakan oleh <i>bootloader</i>
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Kecepatan clock	16 Hz

2.2 LCD [2]

LCD (*Liquid Crystal Display*) adalah komponen elektronika yang berfungsi untuk menampilkan suatu output berupa nilai atau teks pada mikrokontroler. Sumber cahaya pada LCD adalah lampu neon berwarna putih di bagian belakang susunan cairan kristal cair. Titik cahaya yang jumlahnya puluhan ribu bahkan jutaan ini yang akan membentuk suatu tampilan. Kutub kristal cair yang dilewati arus listrik akan berubah karena pengaruh polarisasi medan magnetik yang timbul dan oleh karenanya hanya beberapa warna diteruskan sedangkan warna lainnya disaring.

Pada tugas akhir ini menggunakan LCD 20x4 dan menggunakan modul I2C LCD. Yang dimaksud modul I2C adalah modul LCD yang dikendalikan secara serial sinkron dengan *protocol I2C/IIC (Inter Integrated Circuit)* atau *TWI (Two Wire Interface)*. I2C hanya membutuhkan 4 port yaitu port SCL (*Serial Clock*), SDA

(*Serial Data*) yang membawa informasi data antara I2C dengan pen-gontrolnya, VCC, dan *ground*. Konfigurasi pin antara LCD I2C dan Arduino Uno dapat dilihat pada Gambar 2.5.



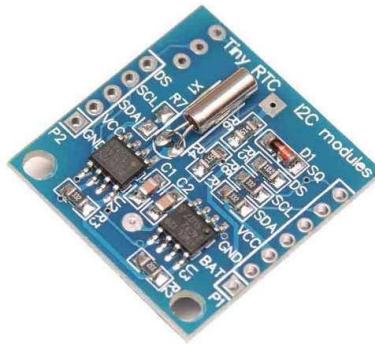
Gambar 2.2 Konfigurasi Pin LCD I2C

fritzing

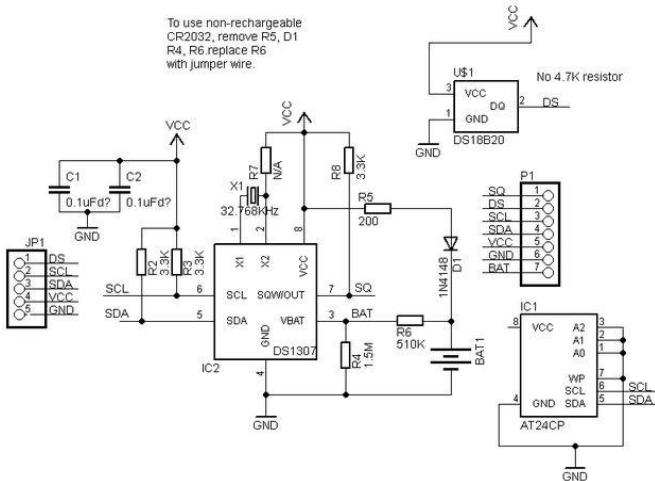
2.3 RTC [3]

RTC (*Real time clock*) adalah jam elektronik berupa *chip* yang dapat menghitung waktu (mulai detik hingga tahun) dengan akurat dan menjaga/menyimpan data waktu tersebut secara *real time*. Karena jam tersebut bekerja *real time*, maka setelah proses hitung waktu dilakukan *output* datanya langsung disimpan atau dikirim ke *device* lain melalui sistem antarmuka.

RTC yang digunakan pada tugas akhir ini adalah RTC DS1307. RTC ini memiliki *supply* alternatif sehingga dapat terus menjaga waktu saat sumber daya dari Arduino tidak ada. *Supply* alternatif ini berasal dari baterai *lithium*. Gambar dari Gambar 2.3 adalah modul RTC DS1307 yang digunakan. Gambar 2.4 adalah rangkaian dari RTC DS1307.



Gambar 2.3 Modul RTC DS1307



Gambar 2.4 Rangkaian RTC DS1307

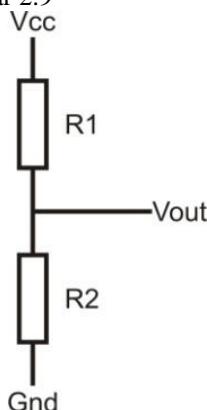
2.4 Sensor

Sensor adalah komponen elektronika yang digunakan untuk mengukur ataupun mendeteksi suatu perubahan fisik atau kimia. Variabel keluaran yang dihasilkan sensor yang dirubah menjadi besaran listrik disebut transduser.

Pada tugas akhir ini, ada dua sensor yang digunakan yaitu sensor tegangan dan sensor arus.

2.4.1 Sensor Tegangan [4]

Sinyal tegangan yang akan diukur dengan menurunkan tegangan input menggunakan *transformator step down* dan rangkaian pembagi tegangan dimana resistor disusun secara seri. Prinsip dari rangkaian pembagi tegangan sesuai dengan hukum *kirchoff* tegangan yang menyatakan bahwa “Tegangan dalam rangkaian tertutup sama dengan jumlah semua tegangan di seluruh rangkaian”. Dari Gambar 2.8, R1 dan R2 dipasang secara seri, di mana tegangan keluaran (V_{out}) adalah tegangan R2. Gambar rangkaian pembagi tegangan ditunjukkan pada Gambar 2.9



Gambar 2.5 Rangkaian Pembagi Tegangan

Berdasarkan Gambar 2.9 dapat diperoleh persamaan sebagai berikut:

$$V_{out} = \frac{R_2}{R_1+R_2} \times V_{in} \quad \dots \dots \dots \quad (2.1)$$

Dimana R2 dan R1 merupakan kombinasi resistor yang membagi tegangan input (V_{in}) dan V_{out} merupakan tegangan keluar pada R2. [6]

2.4.2 Sensor Arus [5]

Suatu rangkaian elektronik terdapat tegangan, arus dan hambatan yang saling berhubungan. Untuk itulah pada tugas akhir kali ini sensor arus berperan penting sekali untuk berjalannya sistem *prototype* ini. Sensor arus adalah perangkat elektronika yang dapat

mengukur arus dari suatu rangkaian listrik dengan dipasangkan seri denga rangkaian yang akan diukur.

Sensor arus yang digunakan pada tugas akhir ini adalah sensor arus ACS712. Sensor ini dapat mengukur arus hingga 30 Ampere. Sensor arus ACS712 membutuhkan 3 pin pada Arduino yaitu VCC, pin *input* analog, dan *ground*. Gambar 2.10 adalah gambar dari ACS712.



Gambar 2.6 Modul Sensor Arus ACS712

2.5 Xampp-control [6]

XAMPP adalah perangkat lunak bebas, yang mendukung banyak sistem operasi, merupakan kompilasi dari beberapa program. Fungsinya adalah sebagai server yang berdiri sendiri, yang terdiri atas program Apache HTTP Server, MySQL database, dan penjerjema bahasa yang ditulis dengan bahasa pemrograman PHP dan Perl. Gambar 2.11 adalah tampilan *start up xampp-control*



Gambar 2.7 Tampilan Aplikasi Xampp-control

2.6 Arduino IDE [7]

IDE merupakan kependekan dari *Integrated Development Environment*, atau secara bahasa mudahnya merupakan lingkungan terintegrasi yang digunakan untuk melakukan pengembangan. Disebut sebagai lingkungan karena melalui *software* inilah Arduino dilakukan pemrograman untuk melakukan fungsi-fungsi yang dibenamkan melalui sintaks pemrograman. Arduino menggunakan bahasa pemrograman sendiri yang menyerupai bahasa C. bahasa pemrograman Arduino (*sketch*) sudah dilakukan perubahan untuk memudahkan pemula dalam melakukan pemrograman dari bahasa aslinya. Sebelum dijual ke pasaran IC mikrokontroler Arduino telah ditanamkan suatu program bernama bernama *bootloader* yang berfungsi sebagai penengah antara *compiler* Arduino dengan mikrokontroler. Arduino IDE dibuat dari bahasa pemrograman JAVA.

Arduino IDE juga dilengkapi dengan *library* C/C++ yang biasa disebut *Wiring* yang membuat operasi *input* dan *output* menjadi lebih mudah. Arduino IDE ini dikembangkan dari *software Processing* yang dirombak menjadi Arduino IDE khusus untuk pemrograman dengan Arduino. Gambar 2.8 adalah tampilan *start up* dari Arduino IDE.



Gambar 2.8 Arduino IDE

2.7 Modul Wifi ESP12e

merupakan modul wifi yang berfungsi sebagai perangkat tambahan mikrokontroler seperti **Arduino** agar dapat terhubung langsung dengan wifi dan membuat koneksi TCP/IP.

Modul ini membutuhkan daya sekitar 3.3v dengan memiliki tiga mode wifi yaitu Station, Access Point dan Both (Keduanya). Modul ini juga dilengkapi dengan prosesor, memori dan GPIO dimana jumlah pin bergantung dengan jenis **ESP8266** yang kita gunakan. Sehingga modul ini bisa berdiri sendiri tanpa menggunakan mikrokontroler apapun karena sudah memiliki perlengkapan layaknya mikrokontroler.

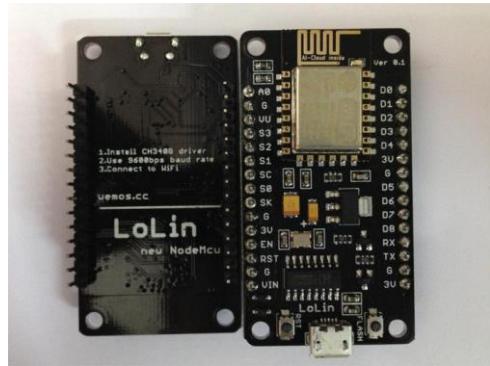
Firmware default yang digunakan oleh perangkat ini menggunakan AT Command, selain itu ada beberapa Firmware SDK yang digunakan oleh perangkat ini berbasis opensource yang diantaranya adalah sebagai berikut :

- **NodeMCU** dengan menggunakan basic programming lua
- **MicroPython** dengan menggunakan basic programming python
- **AT Command** dengan menggunakan perintah perintah AT command.

Untuk pemrogramannya sendiri kita bisa menggunakan **ESPlorer** untuk Firmware berbasis **NodeMCU** dan menggunakan putty sebagai terminal control untuk AT Command.

Selain itu kita bisa memprogram perangkat ini menggunakan **Arduino IDE**. Dengan menambahkan **library ESP8266** pada board manager kita dapat dengan mudah memprogram dengan basic program arduino.

Ditambah lagi dengan harga yang cukup terjangkau, kamu dapat membuat berbagai projek dengan modul ini. Maka dari itu banyak orang yang menggunakannya modul ini untuk membuat projek Internet of Thinking (IoT)



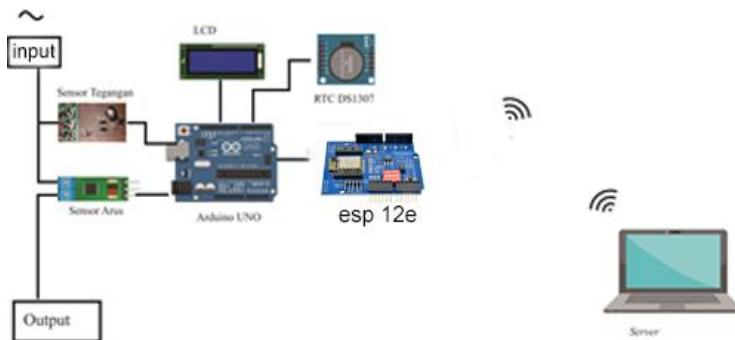
Gambar 2.9 Modul WiFi ESP8266 Lolin

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BAB III

PERANCANGAN HARDWARE DAN SOFTWARE

Pada perancangan dan pembuatan alat ini terdiri dari pembuatan *hardware* dan *software* yang akan digunakan di rancang bangun *prototype* ini. Bab ini membahas tentang tahapan yang dilakukan terhadap perancangan dan pembuatan *prototype* Tugas Akhir yang berjudul Perancangan Sistem Monitoring tegangan dan arus Berbasis Arduino Uno Dengan Media Wifi. Pada pembuatan *hardware* ini meliputi perangkaian antara beberapa komponen penting yang diperlukan, seperti Arduino Uno, Modul Wifi ESP12e , sensor tegangan, sensor arus ACS712, RTC DS1307, dan LCD I6x2



Gambar 3.1 Diagram Fungsional Sistem

Berikut penjelasan mengenai diagram fungsional sistem pada Gambar 3.1 yaitu Arduino Uno sebagai mikrokontroler. Pertama-tama saat diberi input, sensor tegangan akan menerima tegangan yang sudah diubah ke DC oleh *transformator step down* dan rangkaian *signal conditioner* member data berupa sinyal analog menuju ke pin *input* analog Arduino. Begitu pula sensor arus ACS712, saat sensor arus dialiri oleh arus sensor akan membaca nilai arus yang diterima dengan mengirim sinyal analog ke arduino. Setelah Arduino membaca nilai ADC dari masing- masing sensor dan memproses data untuk ditampilkan ke LCD dan mengirim data ADC ke *server* melalui Modul Wifi ESP 12e. Data yang diterima

oleh server akan ditampilkan pada *local web* melalui aplikasi *xampp-control*.

3.1 Perancangan Hardware

Pada perancangan *hardware* dibagi menjadi beberapa sub bab yang akan dijelaskan per sub bab nya, antara lain :

1. Rangkaian Arduino Uno
2. Sensor tegangan dan rangkaian
3. Sensor Arus ACS712
4. RTC (*Real Time Clock*) DS1302
5. LCD I2C
6. Modul *Wifi* ESP12e

3.1.1 Perancangan Rangkaian Arduino Uno

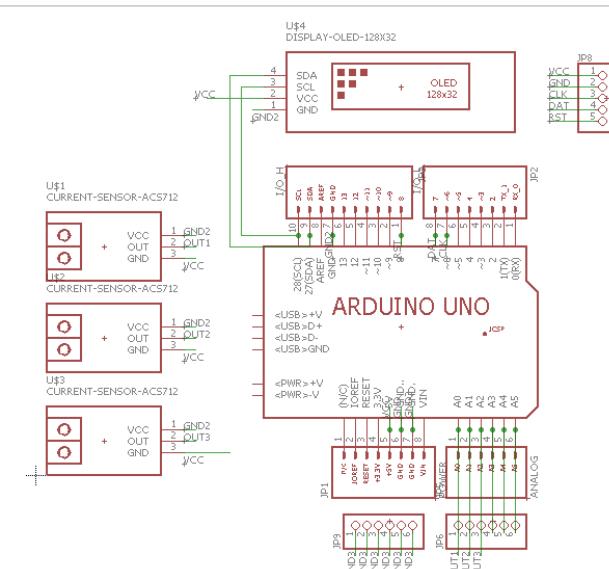
Pada perancangan rangkaian kontroler ini menggunakan Arduino Uno untuk menerima data dari sensor arus dan tegangan dan akan dikirim melalui Modul *Wifi* ESP12e. Pada rangkaian ini ditambahkan sebuah *shield* untuk sensor tegangan, sensor arus, LCD, dan *real time clock*. Pada *shield* ini terdapat *port* VCC, GND, *port* analog dan *port* digital yang dihubungkan dengan *port* pada arduino. Arduino sebagai mikrokontroler diprogram agar dapat mengontrol, besar nilai tegangan dan arus beban serta mengirimnya ke *server* melalui Modul *Wifi* ESP12e secara *real time*. Berikut ini pada Tabel 3.1 merupakan tabel untuk penggunaan pin pada *shield* Arduino yang akan dibuat :

Tabel 3.1 Mapping Pin Analog/Digital yang digunakan

No.	Modul	Pin Analog/Digital
1.	LCD 16X2	GND GND VCC VCC A4 : SDA A5 : SCL
2.	RTC	GND GND VCC VCC SDA : SDA SCL : SCL
3.	Sensor Arus ACS712	GND GND VCC VCC A0 A.OUT

No.	Modul	Pin Analog/Digital
4.	Sensor Tegangan	GND GND GND GND VCC VCC
5.	Modul WiFi ESP12e	GND GND VCC VIN TX RX RX TX

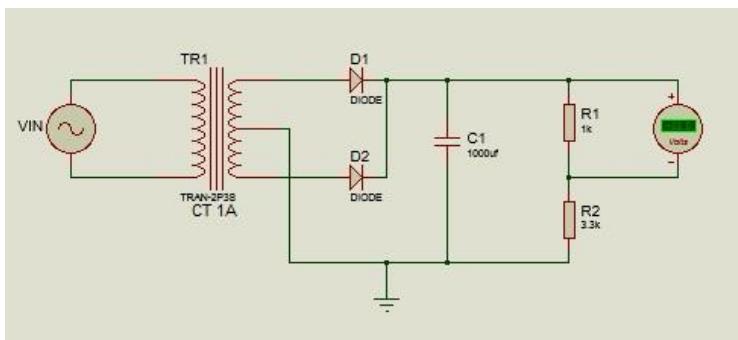
Berikut adalah rangkaian modul *shield* Arduino Uno yang diperlukan untuk alat ini. Modul *shield* ini digunakan untuk mempermudah koneksi antar modul-modul yang digunakan dengan Arduino, selain itu dengan adanya modul ini dapat mengurangi jumlah *wiring* pada alat ini. Untuk lebih jelasnya terdapat pada Gambar 3.2 yang merupakan skematik dari rangkaian modul *shield* Arduino Uno. Hasil dari pembuatan alat *shield* Arduino Uno dapat dilihat pada Gambar 3.3



Gambar 3.2 Rangkaian Modul Shield Arduino Uno

3.1.2 Sensor Tegangan

Sensor tegangan merupakan komponen untuk mendeteksi besar tegangan yang masuk. Sensor yang dipakai adalah *transformator step down* dengan penyearah gelombang penuh kombinasi rangkaian pembagi tegangan. Rangkaian pembagi tegangan ini menggunakan prinsip hukum kirchoff tegangan, memakai resistor yang dipasang secara seri. Skema rangkaian sensor tegangan untuk 1 fasa-nya dapat dilihat pada Gambar 3.4 dan hasil bentuk sensornya dapat dilihat pada Gambar 3.3.



Gambar 3.3 Rangkaian Sensor Tegangan

Pada sensor tegangan Tugas Akhir ini keluaran sensor adalah 0-4 Volt DC. Karena Arduino hanya dapat menerima tegangan DC antara 0-5 Volt. Untuk mendapatkan sinyal DC menggunakan rangkaian penyearah gelombang penuh ditambah kapasitor sebagai penyetabil tegangan keluaran, sehingga didapat Vrs sebesar 12Volt DC dengan ditetapkan R2 sebesar 3,3KΩ. Dengan menggunakan rumus dari persamaan 2.1, didapatkan perhitungan untuk menentukan besar R1 adalah sebagai berikut:

$$4 = \frac{R1}{R1+3,3k} \times 12$$

$$4R1 + 13,2 = 12 R1$$

$$13,2 = 8 R1$$

$$R1 = 1,6k\Omega$$

(pakai 1kΩ karena di pasaran ada 1 atau 2kΩ, jika menggunakan yang 2kΩ Vout yang dikeluarkan lebih dari 4 Volt)

Adapun komponen yang digunakan pada sensor tegangan adalah:

Vinp : Sumber AC 220Volt (PLN)

TR1 : Trafo CT 1A

D1, D2: Dioda 1A

C1 : Kapasitor 1000uF

R1 : Resistor 1k Ω

R2 : Resistor 3,3k Ω

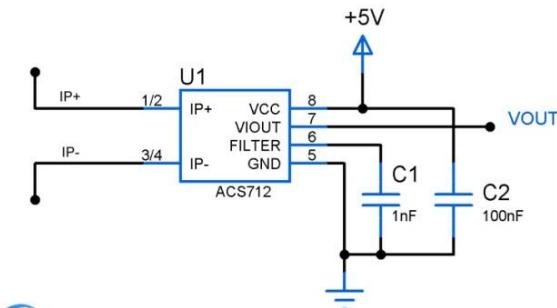
Hasil dari pembuatan rangkaian sensor tegangan dapat dilihat pada Gambar 3.4.



Gambar 3.4 Tampilan rangkaian sensor Tegangan

3.1.3 Sensor Arus

Sensor arus merupakan komponen untuk mendeteksi besar arus beban yang mengalir pada *NH fuse*. Sensor arus yang digunakan adalah sensor arus ACS712 30 Ampere. Sensor ini sudah berbentuk modul yang siap dipakai. Berikut adalah skema rangkaian dari modul ACS712 30 Ampere yang dapat dilihat pada Gambar 3.6.



Gambar 3.5 Skema Rangkaian ACS712 30 Ampere

Modul sensor ini membutuhkan tegangan *supply* tegangan sebesar 5 Volt. Keluaran sensor ini adalah 0-5 Volt DC, karena Arduino dapat menerima tegangan 0-5 Volt.

3.1.4 RealTime Clock (RTC) DS1307

Pemakaian RTC dalam alat ini digunakan untuk menampilkan tanggal dan waktu di sistem ini. RTC DS1307 ini memiliki beberapa fitur antara lain:

- Penghitung secara real time untuk detik, menit, jam, hari, tanggal, bulan, dan tahun (valid sampai tahun 2100)
- Format waktu dapat disetting ke dalam format 12 jam (AM/PM) atau 24 jam
- Memiliki kemampuan penyesuaian jumlah hari/bulan terhadap tahun kabisat
- 31 x 8 *Battery-Backed General-Purpose RAM*
- Menggunakan antarmuka i2c (Serial Data dan Serial Clock)
- Menggunakan tegangan *input* kerja 5 VoltDC
- Harus memakai baterai *back-up* dengan range 2-5 VoltDC
- Konsumsi arus pada baterai back-up yaitu hanya 200nA
- Range suhu kerja optimal antara -40°C sampai +85°C

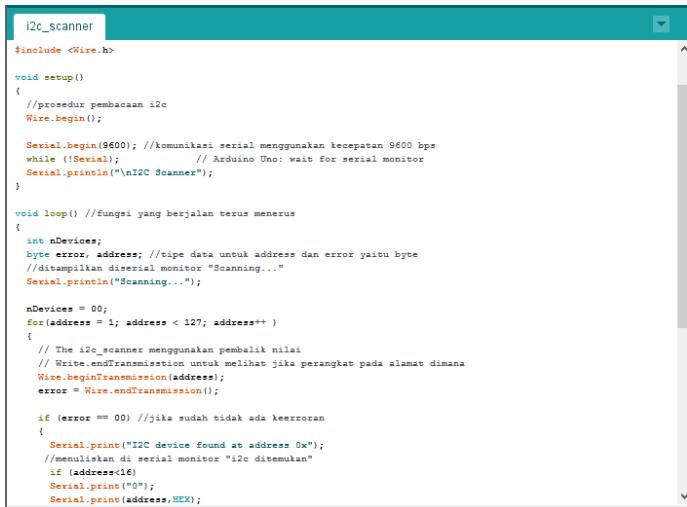
RTC DS1307 ini menggunakan 4 pin di antaranya:

- VCC ↔ +5V
- GND ↔ GND

- SCL ↔ SCL
- SDA ↔ SDA

3.1.5 LCD 16x2

LCD yang digunakan disini adalah LCD 16x2 warna biru dengan tambahan modul I2C. Modul I2C berguna sekali karena hanya menggunakan 4 pin yaitu pin VCC, GND, SDA, dan SCL. I2C memiliki *address* tersendiri untuk mengakses dengan Arduino. Pada LCD I2C 16x2 ini *address*-nya adalah 0X3F. cara mencari *address* LCD pertama kali kita harus memasukkan program yang bernama I2C *scanner*. Saat menjalankan program ini kita dapat mengetahui *address* LCD I2C yang akan dipakai. Program I2C *scanner* dapat dilihat pada Gambar 3.6.



```

i2c_scanner
#include <Wire.h>

void setup()
{
    //prosedur pembacaan i2c
    Wire.begin();

    Serial.begin(9600); //komunikasi serial menggunakan kecepatan 9600 bps
    while (!Serial); // Arduino Uno: wait for serial monitor
    Serial.println("\nI2C Scanner");
}

void loop() //fungsi yang berjalan terus menerus
{
    int nDevices;
    byte error, address; //tipe data untuk address dan error yaitu byte
    //ditampilkan di serial monitor "Scanning..."
    Serial.print("Scanning...");

    nDevices = 0;
    for(address = 1; address < 127; address++ )
    {
        // The i2c_scanner menggunakan pembalik nilai
        // Write.endTransmission untuk melihat jika perangkat pada alamat dimana
        Wire.beginTransmission(address);
        error = Wire.endTransmission(); 

        if (error == 0) //jika sudah tidak ada keerrroran
        {
            Serial.print("I2C device found at address ");
            //menuliskan di serial monitor "i2c ditemukan"
            if (address<16)
                Serial.print("0");
            Serial.print(address,HEX);
        }
    }
}

```

Gambar 3.6 Program I2C *Scanner*

3.2 Perancangan *Software*

Pada perancangan *software* untuk alat ini berupa pemrograman Arduino Uno di Arduino IDE dan pembuatan tampilan di *website* melalui aplikasi *Xampp-control* pada komputer *server*

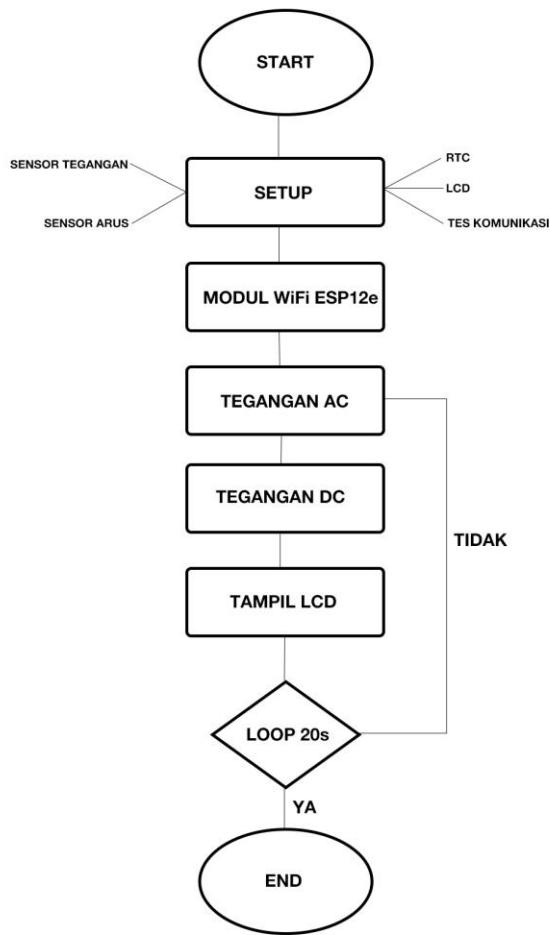
3.2.1 Perancangan Program Arduino

Perancangan program pada arduino ini berkaitan dengan pembuatan program untuk sub-sub sistem yang berupa sensor-sensor, modul wifi esp12e, RTC, LCD. Langkah awal dalam suatu pemrograman adalah deklarasi variabel dan tipe data yang digunakan. Variabel dan tipe data ini digunakan untuk memudahkan dalam memrogram perangkat apa saja yang ingin diprogram. Untuk sensor pertama adalah mendeklarasi pin *input* A0-A6 untuk sensor arus dan tegangan. Untuk pin A0 s/d A2 digunakan untuk sensor arus ACS712, sedangkan pin A3 s/d A6 digunakan untuk sensor tegangan. Program deklarasi untuk sensor dapat dilihat pada Gambar 3.10.

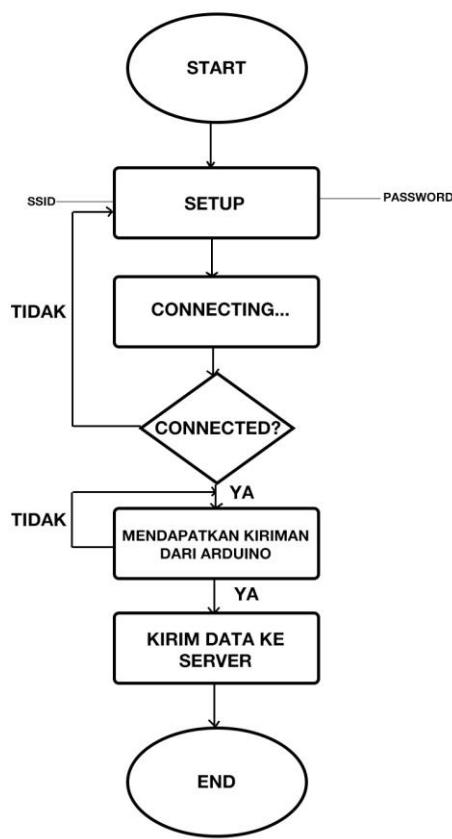
```
int I1=analogRead(A0);
int I2=analogRead(A1);
int I3=analogRead(A2);
int V1=analogRead(A3);
int V2=analogRead(A4);
int V3=analogRead(A5);

float ArusR = 0.00;
float ArusS = 0.00;
float ArusT = 0.00;
float TeganganR = 0.00;
float TeganganS = 0.00;
float TeganganT = 0.00;
```

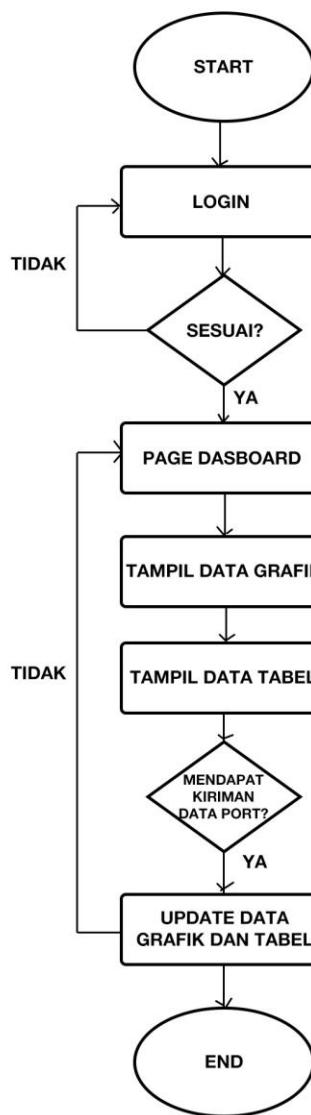
Gambar 3.7 Program Deklarasi Pin pada Arduino IDE



Gambar 3.8 Flowchart Sistem pada Prototype



Gambar 3.9 Flowchart Sistem pada Modul WiFi ESP8266



Gambar 3.10 Flowcart Sistem pada Website

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BAB IV

PENGUJIAN DAN ANALISA DATA

Pada bab ini akan membahas tentang hasil dari pengujian dan analisa atas pembuatan alat untuk “Perancangan Sistem Monitoring Tegangan dan Arus Berbasis Arduino Dengan Media Wifi”. Data pengujian diperlukan untuk implementasi dalam dunia nyata. Kinerja suatu sistem sangat dipengaruhi oleh kinerja tiap bagian dari suatu sistem tersebut.

Untuk mengetahui apakah tujuan-tujuan dari pembuatan alat ini telah terlaksana atau tidak, perlu dilakukan pengujian dan analisa terhadap alat yang dibuat. setelah dilakukan pengujian, dilakukan analisa terhadap bagian-bagian alat yang telah diuji. Kesesuaian sistem dengan perencanaan dapat dilihat dari hasil yang dicapai pada pengujian sistem. Pengujian ini juga bertujuan untuk mencari kelebihan dan kekurangan dari sistem yang telah dibuat. Hasil pengujian tersebut akan dianalisa untuk mengetahui penyebab terjadinya kekurangan atau kesalahan dalam sistem.

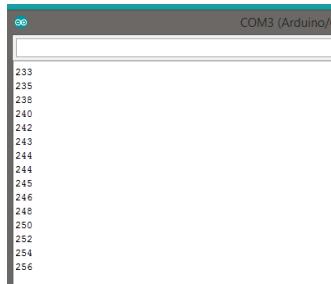
4.1 Pengujian Arduino Uno

Pengujian pada Arduino Uno bertujuan untuk mengetahui apakah mikrokontroller bekerja baik atau tidak. Pengujian dilakukan dengan memasukkan sebuah program pembacaan data Analog input Arduino. Program untuk percobaan analog *read* bisa dilihat pada Gambar 4.1 berikut :

```
// the setup routine runs once when you press reset:  
void setup() {  
    // initialize serial communication at 9600 bits per second:  
    Serial.begin(9600);  
}  
  
// the loop routine runs over and over again forever:  
void loop() {  
    // read the input on analog pin 0:  
    int sensorValue = analogRead(A0);  
    // print out the value you read:  
    Serial.println(sensorValue);  
    delay(100);          // delay in between reads for stability  
}
```

Gambar 4.1 Program Analog Read Arduino

Selanjutnya, untuk mengetahui apakah Arduino dapat bekerja bisa dilihat pada *serial monitor*. Hasil dari pengujian ini bisa dilihat pada Gambar 4.2.

A screenshot of the Arduino Serial Monitor window titled "COM3 (Arduino/G)". The window shows a list of numbers ranging from 233 to 256, each on a new line, representing analog read values.

Gambar 4.2 Hasil Analog Read Arduino

4.2 Pengujian Koneksi Modul *Wifi* ESP8266

Pengujian Modul *Wifi* ESP8266 dilakukan agar mengetahui kerja baik atau tidak, karena Modul *Wifi* ESP8266 berperan penting dalam pengiriman data ke *server*. Pengujian dilakukan dengan memasukan program ke dalam Arduino. Modul *Wifi* ESP8266 disambungkan dengan kabel usb 2.0 untuk mengetes koneksi dengan *wifi* antara Arduino dengan komputer. Kemudian terdapat tiga perintah untuk penyesuaian nomor *ip* pada koneksi yang dipakai dengan laptop agar dapat memunculkan hasil monitoring ke *local website*. Adapun programnya dapat dilihat pada Gambar 4.3.

```
#include <ESP8266WiFi.h>
#include <WiFiClient.h>
#include <ESP8266WebServer.h>
#include <ESP8266HTTPClient.h>

int Led_OnBoard = 2; // Initialize the Led_OnBoard

//-----

const char* ssid = "Thetering"; //Setting 1
const char* password = "prudential"; //Setting 2

void setup() {
  delay(1000);
  pinMode(Led_OnBoard, OUTPUT);
  Serial.begin(9600);
  WiFi.mode(WIFI_OFF); //Prevents reconnection issue (taking too long to connect)
  delay(1000);
  WiFi.mode(WIFI_STA); //This line hides the viewing of ESP as wifi hotspot

  WiFi.begin(ssid, password); //Connect to your WiFi router
  Serial.println("");
  Serial.print("Connecting");
```

Gambar 4.3 Program IoT dengan menginput nama *Thetering*

```

#include <WiFiClient.h>
#include <ESP8266WebServer.h>
#include <ESP8266HTTPClient.h>

int Led_OnBoard = 2;           // Initialize the Led_OnBoard
//-----

const char* ssid = "AlwaysListeningAlwaysUnlistening";           //Setting 1
const char* password = "prudential"; //Setting 2

void setup() {
  delay(1000);
  pinMode(Led_OnBoard, OUTPUT);
  Serial.begin(9600);
  WiFi.mode(WIFI_OFF);      //Prevents reconnection issue (taking too long to connect)
  delay(1000);
  WiFi.mode(WIFI_STA);      //This line hides the viewing of ESP as wifi hotspot

  WiFi.begin(ssid, password); //Connect to your WiFi router
  Serial.println("");
  Serial.print("Connecting");
  while (WiFi.status() != WL_CONNECTED) {
    //-----
```

Gambar 4.4 Program IoT dengan menginput *password wifi*

```

}
}

String PostData(String Voltage, String Current){
  // put your main code here, to run repeatedly:
  HTTPClient http; //Declare object of class HTTPClient

  //-----to send data to the database
  String postData = "voltageval=" + Voltage + "ampereval=" + Current;

  http.begin("http://192.168.43.72/iothbase/admin/dataFromArduino.php"); //Setting 3 IPCONFIG
  http.addHeader("Content-Type", "application/x-www-form-urlencoded"); //Specify content-type

  int httpCode = http.POST(postData); //Send the request
  String payload = http.getString(); //Get the response payload
  //-----
```

- //Serial.println(httpCode); //Print HTTP return code
- http.end(); //Close connection
- //Serial.println(payload); //Print request response payload
- //Serial.println("Tegangan= " + Voltage + " Arus= " + Current);
- return String(httpCode);

}

Gambar 4.5 Program IoT dengan menginput nomor *ip wifi*

4.3 Pengujian Arduino pada *Hardware*

Pengujian ini bertujuan untuk mengaktifkan semua program yang sudah terprogram pada Arduino agar semua rangkaian bisa berjalan dengan semestinya. Berikut program Arduino *final* bisa dilihat pada gambar 4.6

```

#include <Filters.h> //Easy library to do the calculations
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <ds3231.h>
#include "ACS712.h"

ACS712 CurrentSensor(ACS712_05B, A0);

//Setup Tegangan
float testFrequency = 50; // test signal frequency (Hz)
float windowLength = 40.0/testFrequency; // how long to average the signal, for statistist

int Sensor = 0; //Sensor analog input, here it's A0

float intercept = -0.04; // to be adjusted based on calibration testing
//float slope = 0.0405; // to be adjusted based on calibration testing
float slope = 0.0368; // to be adjusted based on calibration testing
float current_Volts; // Voltage
float VoltageRMS = 0;

unsigned long printPeriod = 1000; //Refresh rate
unsigned long previousMillis = 0;

struct ts t;
// Set the LCD address to 0x27 for a 16 chars and 2 line display
LiquidCrystal_I2C lcd(0x3F, 16, 2);
//0x3F untuk i2c standart

```

Gambar 4.6 Program arduino *final* pada *Hardware*

4.4 Pengujian Sensor Tegangan dan Arus

Pada pengujian sensor tegangan dimana sensor yang dipakai adalah modul sensor tegangan ZNPT 101B yang diperlihatkan pada Gambar 4.7.

Pengujian sensor tegangan menggunakan VariAC milik Laboratorium Elektronika Dasar Departemen Teknik Elektro Otomasi. VariAC dapat memberikan *input* tegangan yang dapat diubah-ubah mulai dari 0-250 Volt. Data yang diambil mengambil range tegangan mulai dari 200 Volt sampai dengan 240 Volt dengan selisih tiap data 1 Volt. Nilai tegangan yang keluar tidak selalu akurat dengan nilai yang diharapkan dikarenakan perputaran knopnya yang susah dan faktor dari kondisi VariAC yang sudah lama. Berikut adalah dokumentasi dari pengambilan data untuk sensor tegangan yang dapat dilihat pada Gambar 4.7, gambar 4.8, dan gambar 4.9.



Gambar 4.7 Pengambilan Data Sensor Tegangan pada *Heat Gun*



Gambar 4.8 Pengambilan Data Sensor Arus pada *Heat Gun*



Gambar 4.9 Tampilan hasil pengambilan data pada LCD

Pengambilan data sensor berupa data tegangan dan arus yang tampil pada LCD 16x2 seperti pada Gambar 4.10 agar dapat mengetahui data dengan lebih jelas. Data yang diperoleh dapat dilihat pada Tabel 4.1.

Tabel 4.1 Hasil Pengukuran Sensor Tegangan pada *Heat Gun*

No	Input Tegangan (V)	Tegangan Terukur (V) pada Voltmeter	Tampilan Tegangan (V) pada LCD
1	200	202,1	210,8
2	201	205,4	213,5
3	202	207	215,1
4	203	210,3	218,7
5	204	215,7	223,4
6	205	216	224,1
7	206	216,6	225,4
8	207	219,1	227,5
9	208	222,4	230,9
10	209	224,1	232,9

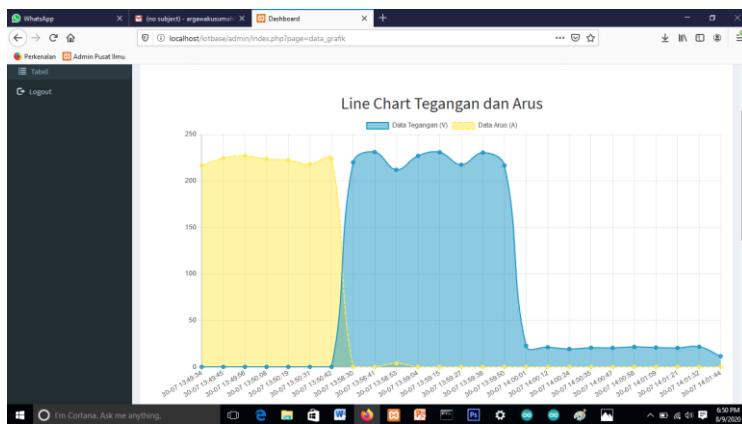
Tabel 4.2 Hasil Pengukuran Sensor Arus pada *Heat Gun*

No	Input Tegangan (V)	Arus Terukur (A) pada Voltmeter	Tampilan Arus pada LCD (A)
1	200	0,42	0,63
2	201	0,86	1,08
3	202	1,39	1,61
4	203	2,12	2,34
5	204	2,46	2,50
6	205	2,98	3,22
7	206	3,27	3,51
8	207	3,81	3,94
9	208	4,17	4,29
10	209	4,23	4,30

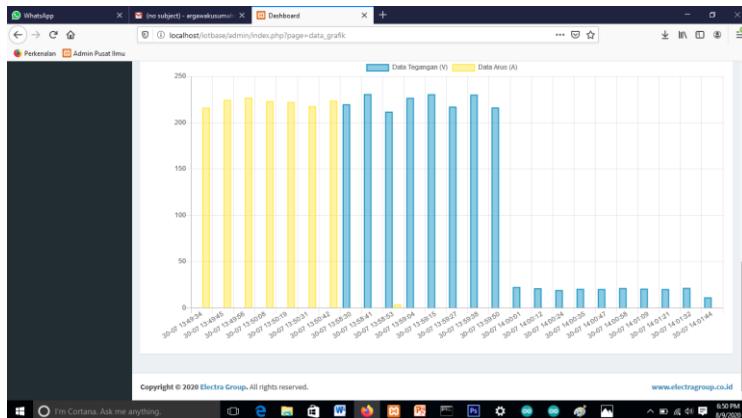
4.5 Pengujian pada website dan aplikasi *Xampp-control*

Data yang diambil dari percobaan ini yaitu melalui hasil dari pengukuran sensor tegangan dan arus pada rangkaian alat perancangan sistem *monitoring* tegangan dan arus berbasis arduino uno menggunakan *wifi*. Kemudian data ditransfer melalui modul *wifi* ESP12e dengan bantuan kabel USB 2.0.

Data pada website akan muncul di *localhost* yang sudah dibuat. Tampilan pada website berupa tabel dan grafik, serta dapat menampilkan waktu terkini sesuai Waktu Indonesia Barat. berikut gambar bisa dilihat pada gambar 4.11, gambar 4.12, dan gambar 4.13 hasil atau tampilan pada website dengan bantuan aplikasi *Xampp-control*.



Gambar 4.10 Tampilan data Sensor Tegangan dan Arus pada website berupa grafik



Gambar 4.11 Tampilan data Sensor Tegangan dan Arus pada website berupa grafik balok

The screenshot shows a Windows desktop environment with a browser window open to a local host address. The browser title bar reads "localhost/fortbase/admin/index.php?page=data_tabel". The main content area has two tabs: "Data Grafik" and "Data Tabel". The "Data Tabel" tab is active, displaying a table titled "Database Tegangan dan Arus". The table has columns: No, Tegangan, Arus, Tanggal, and Jam. It contains 10 rows of data. The data is as follows:

No	Tegangan	Arus	Tanggal	Jam
1	11.58	0.1	2020-07-30	14:01:44
2	21.74	0.09	2020-07-30	14:01:32
3	20.52	0.11	2020-07-30	14:01:21
4	20.9	0.1	2020-07-30	14:01:09
5	21.61	0.11	2020-07-30	14:00:58
6	20.55	0.1	2020-07-30	14:00:47
7	20.68	0.1	2020-07-30	14:00:35
8	19.39	0.1	2020-07-30	14:00:24
9	21.29	0.12	2020-07-30	14:00:12
10	22.72	0.1	2020-07-30	14:00:01

Gambar 4.12 Tampilan data Sensor Tegangan dan Arus pada website berupa tabel

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BAB V

PENUTUP

5.1 Kesimpulan

Pada penelitian kali ini, dapat diambil kesimpulan antara lain sebagai berikut:

1. Dalam pengujian ditemukan % *error* untuk tegangan dengan rata – rata 10v.
2. Dalam pengujian ditemukan % *error* untuk arus dengan rata – rata 4A.
3. Komunikasi antara *device* dan *website* tergantung stabilitas jaringan.
4. Proses *sharing* data ke *website* tidak bisa *realtime* karena harus berbagi proses dengan *task* yang lain. Sehingga waktu *sharing* data optimal adalah per 10 *second*.

5.2 Saran

Saran untuk penelitian selanjutnya yaitu diharapkan dapat menggunakan perangkat sensor dengan kelinieran yang lebih baik. Lalu disarankan untuk menambahkan *supply* tambahan agar saat terjadi gangguan Arduino dan *website* masih berfungsi dan dapat mengirim data ke *server*.

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DAFTAR PUSTAKA

- [1] Farizka, Elviena, “Perancangan Sistem *Monitoring* Kerja *NH Fuse* pada *LV Panel* Menggunakan Mikrokontroler dengan Media Modem GSM”, *Tugas Akhir*, Program D3 Teknik Elektro FTI-ITS, Surabaya, 2013
- [2] Moch Fajar Wicaksono dkk, ***Mudah Belajar Mikrokontroller Arduino***, Penerbit Informatika, Bandung, 2017
- [3]***LCD I2C***, pembahasan tentang LCD dan I2C, <https://mikroavr.com/arduino-lcd-i2c/>
- [4] Farrah Fadilah, “Telemetering Kebocoran Pipa pada Distribusi Air dengan Komunikasi Ethernet”, *Tugas Akhir*, Program D3 Teknik Elektro FTI-ITS, Surabaya, 2017
- [5]***Sensor Arus ACS712***, pembahasan tentang sensor arus acs 712, <https://depokinstruments.com/tag/belajar-sensor-arus-listrik/> (diakses pada tanggal 14 Mei 2018)

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LAMPIRAN A

A.1. Program Arduino

```
#include <Filters.h> //Easy library to do the calculations
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <ds3231.h>
#include "ACS712.h"

ACS712 CurrentSensor(ACS712_05B, A0);

//Setup Tegangan
float testFrequency = 50; // test signal frequency
(Hz)
float windowLength = 40.0/testFrequency; // how long to
average the signal, for statistist

int Sensor = 0; //Sensor analog input, here it's A0

float intercept = -0.04; // to be adjusted based on calibration
testing
//float slope = 0.0405; // to be adjusted based on calibration
testing
float slope = 0.0368; // to be adjusted based on calibration test-
ing
float current_Volts; // Voltage
float VoltageRMS = 0;

unsigned long printPeriod = 1000; //Refresh rate
unsigned long previousMillis = 0;

struct ts t;
// Set the LCD address to 0x27 for a 16 chars and 2 line display
LiquidCrystal_I2C lcd(0x3F, 16, 2);
//0x3F untuk i2c standart

void setup() {
  Serial.begin(9600);
  Wire.begin();
```

```

DS3231_init(DS3231_CONTROL_INTCN);

CurrentSensor.calibrate();

/*
-----
-- In order to synchronise your clock module, insert timetable
values below !
-----
*/
//t.hour=14;
//t.min=8;
//t.sec=40;
//t.mday=24;
//t.mon=7;
//t.year=2020;

//DS3231_set(t);

// initialize the LCD
lcd.begin();

// Turn on the blacklight and print a message.
lcd.backlight();
lcd.clear();
}

void loop() {
    RunningStatistics inputStats;           //Easy life lines, actual
calculation of the RMS requires a load of coding
    inputStats.setWindowSecs( windowLength );

    unsigned long SystemLoop=0;
    unsigned long DisplayLoop=0;
    float Current = 0;
    while( true ) {
        Sensor = analogRead(A1); // read the analog in value:
        inputStats.input(Sensor); // log to Stats function
}

```

```

if((unsigned long)(millis() - previousMillis) >= printPeriod)
{
    previousMillis = millis(); // update time every second

    //Serial.print( "\n" );

    current_Volts = intercept + slope * inputStats.sigma();
    //Calibartions for offset and amplitude
    current_Volts = current_Volts*(40.3231);
    //Further calibrations for the amplitude

    VoltageRMS = current_Volts*0.707;//Hasil Akhir
    //Serial.print( "\tVoltage (Vp): " );
    //Serial.print(current_Volts); //Calculation and Value dis-
    play is done the rest is if you're using an OLED display
    //Serial.print( " \| Voltage (RMS): " );
    //Serial.print(VoltageRMS); //Calculation and Value dis-
    play is done the rest is if you're using an OLED display
}

//SISTEM LOOP
if (SystemLoop >= 10){ //Setiap 50 detik kirim data ke serv-
er
    SystemLoop = 0;
    String myString = String(VoltageRMS) + "#" +
String(Current) + "$";
    Serial.print(myString);
} else if (DisplayLoop >= 1000){
    DisplayLoop=0;
    SystemLoop++;
}

//ARUS
Current = CurrentSensor.getCurrentAC();

DS3231_get(&t);

//TAMPIL DATA LCD
lcd.clear();

```

```

lcd.setCursor(0,0);
lcd.print(t.mday);
lcd.print("/");
lcd.print(t.mon);
//lcd.print("/");
//lcd.print(t.year);
lcd.print(" A:");
lcd.print(Current);
lcd.print(" ");
lcd.print(SystemLoop);

lcd.setCursor(0,1);
lcd.print(t.hour);
lcd.print(":");
lcd.print(t.min);
//lcd.print(":");
//lcd.print(t.sec);
lcd.print(" V:");
lcd.print(VoltageRMS);
}
else {
    DisplayLoop++;
    //delay(1); //Refresh Rate
}
}
}

```

A.2. Program Modul *WiFi ESP12e*

```

#include <ESP8266WiFi.h>
#include <WiFiClient.h>
#include <ESP8266WebServer.h>
#include <ESP8266HTTPClient.h>

int Led_OnBoard = 2;           // Initialize the Led_OnBoard

//-----

```

```

const char* ssid = "AlwaysListeningAlwaysUndrtning";
//Setting 1
const char* password = "prudential"; //Setting 2

void setup() {
  delay(1000);
  pinMode(Led_OnBoard, OUTPUT);
  Serial.begin(9600);
  WiFi.mode(WIFI_OFF);      //Prevents reconnection issue (taking
  too long to connect)
  delay(1000);
  WiFi.mode(WIFI_STA);      //This line hides the viewing of ESP
  as wifi hotspot

  WiFi.begin(ssid, password); //Connect to your WiFi router
  Serial.println("");

  Serial.print("Connecting");
  while (WiFi.status() != WL_CONNECTED) {
    digitalWrite(Led_OnBoard, LOW);
    delay(250);
    Serial.print(".");
    digitalWrite(Led_OnBoard, HIGH);
    delay(250);
  }

  digitalWrite(Led_OnBoard, HIGH);
  //If connection successful show IP address in serial monitor
  Serial.println("");
  Serial.println("Connected to Network/SSID");
  Serial.print("IP address: ");
  Serial.println(WiFi.localIP()); //IP address assigned to your ESP
}

void loop() {
  if(Serial.available() > 0)
  {
    String Voltage = Serial.readStringUntil('#');
    String Current = Serial.readStringUntil('$');

```

```

if (Voltage != "" && Current != ""){
    Serial.print(PostData(Voltage , Current));

    digitalWrite(Led_OnBoard, LOW); delay(1000);
    digitalWrite(Led_OnBoard, HIGH); delay(1000);
}

digitalWrite(Led_OnBoard, LOW); delay(1000);
digitalWrite(Led_OnBoard, HIGH); delay(1000);
}

String PostData(String Voltage, String Current){
    // put your main code here, to run repeatedly:
    HttpClient http; //Declare object of class HttpClient

    //-----to send data to the database
    String postData = "voltageval=" + Voltage + "&ampereval=" +
    Current;

    http.begin("http://192.168.43.72/iotbase/admin/dataFromArduino.ph
p"); //Setting 3 IP CONFIG      //Specify request destination
    http.addHeader("Content-Type",           "application/x-www-form-
urlencoded"); //Specify content-type header

    int httpCode = http.POST(postData); //Send the request
    String payload = http.getString(); //Get the response payload
    //-----

    //Serial.println(httpCode); //Print HTTP return code
    http.end(); //Close connection

    //Serial.println(payload); //Print request response payload
    //Serial.println("Tegangan= " + Voltage + " Arus= " + Current);
    return String(httpCode);
}

```

LAMPIRAN B

B.1 Datasheet Arduino UNO



Product Overview

The Arduino Uno is a microcontroller board based on the ATmega328 ([datasheet](#)). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the [Index of Arduino boards](#).

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How to use Arduino Programming Environment, Basic Tutorials	Page 6
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Technical Specification

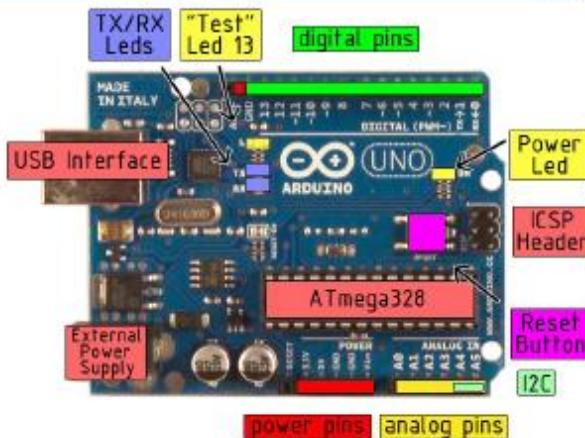


EAGLE file: [arduino-duemilanove-uno-design.eagle](#) Schematic: [arduino-uno-schematic.pdf](#)

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

the board.



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Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the [EEPROM library](#)).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using [pinMode\(\)](#), [digitalWrite\(\)](#), and [digitalRead\(\)](#) functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial:** 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts:** 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the [attachInterrupt\(\)](#) function for details.
- **PWM:** 3, 5, 6, 8, 9, 10, and 11. Provide 8-bit PWM output with the [analogWrite\(\)](#) function.
- **SPI:** 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- **LED:** 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.



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The Uno has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though it is possible to change the upper end of their range using the AREF pin and the [analogReference\(\)](#) function. Additionally, some pins have specialized functionality:

- PC: 4 (ADA) and 6 (ACL). Support I^C (TWI) communication using the [Wire library](#).

There are a couple of other pins on the board:

- AREF. Reference voltage for the analog inputs. Used with [analogReference\(\)](#).
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the [mapping between Arduino pins and Atmega328 ports](#).

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an ".inf" file is required..

The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A [SoftwareSerial library](#) allows for serial communication on any of the Uno's digital pins.

The ATmega328 also supports I^C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I^C bus; see the [documentation](#) for details. To use the SPI communication, please see the ATmega328 datasheet.

Programming

The Arduino Uno can be programmed with the Arduino software ([download](#)). Select "Arduino Uno w/ ATmega328" from the Tools > Board menu (according to the microcontroller on your board). For details, see the [reference](#) and [tutorials](#).

The ATmega328 on the Arduino Uno comes preburned with a [bootloader](#) that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol ([reference](#), [G-Header file](#)).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see [these instructions](#) for details.

The ATmega8U2 firmware source code is available. The ATmega8U2 is loaded with a DFU bootloader, which can be activated by connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. You can then use [Atmel's FLIP software](#) (Windows) or the [DFU programmer](#) (Mac OS X and Linux) to load a new firmware. Or you can use the ICSP header with an external programmer (overwriting the DFU bootloader).



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Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see [this forum thread](#) for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.



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B.2 Datasheet Modul Wifi ESP8266

1. Preambles

ESP-01 WiFi module is developed by Ai-thinker Team. core processor ESP8266 in smaller sizes of the module encapsulates Tensilica L106 integrates industry-leading ultra low power 32-bit MCU micro, with the 16-bit short mode, Clock speed support 80 MHz, 160 MHz, supports the RTOS, integrated Wi-Fi MAC/BB/RF/PA/LNA, on-board antenna.

The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller.

ESP8266 is high integration wireless SoCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement.

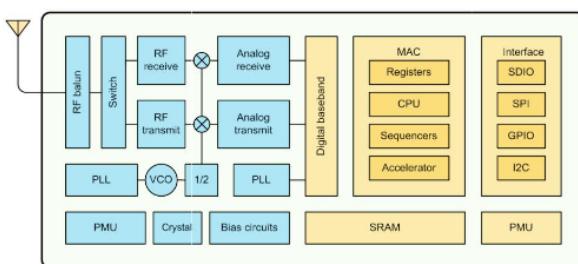


Figure 1 ESP8266EX Block Diagram

1.2. Parameters

Table 1 below describes the major parameters.

Table 1 Parameters

Categories	Items	Values
WiFi Parameters	WiFi Protocols	802.11 b/g/n
	Frequency Range	2.4GHz-2.5GHz (2400M-2483.5M)
Hardware Parameters	Peripheral Bus	UART/HSPI/I2C/I2S/Ir Remote Control
	GPIO/PWM	
	Operating Voltage	3.0~3.6V
	Operating Current	Average value: 80mA
	Operating Temperature Range	-40°~125°
	Ambient Temperature Range	Normal temperature
	Package Size	14.3mm*24.8mm*3mm
	External Interface	N/A
Software Parameters	Wi-Fi mode	station/softAP/SoftAP+station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware Upgrade	UART Download / OTA (via network) / download and write firmware via host
	Software Development	Supports Cloud Server Development / SDK for custom firmware development
	Network Protocols	IPv4, TCP/UDP/HTTP/FTP
	User Configuration	AT Instruction Set, Cloud Server, Android/iOS App

Table 2 Pin Descriptions

NO.	Pin Name	Function
1	GND	GND
2	GPIO2	GPIO,Internal Pull-up
3	GPIO0	GPIO,Internal Pull-up
4	RXD	UART0,data received pin RXD
5	VCC	3.3V power supply (VDD)
6	RST	1] External reset pin, active low 2] Can loft or external MCU
7	CH_PD	Chip enable pin. Active high
8	TXD	UART0,data send pin RXD

Table 2 Pin Descriptions

NO.	Pin Name	Function
1	GND	GND
2	GPIO2	GPIO,Internal Pull-up
3	GPIO0	GPIO,Internal Pull-up
4	RXD	UART0,data received pin RXD
5	VCC	3.3V power supply (VDD)
6	RST	1] External reset pin, active low 2] Can loft or external MCU
7	CH_PD	Chip enable pin. Active high
8	TXD	UART0,data send pin RXD

Table 3 Pin Mode

Mode	GPIO15	GPIO0	GPIO2
UART	Low	Low	High
Flash Boot	Low	High	High

Table 4 Receiver Sensitivity

Parameters	Min	Typical	Max	Unit
Input frequency	2412		2484	MHz
Input impedance		50		Ω
Input reflection			-10	dB
Output power of PA for 72.2Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b mode	19.5	20.5	21.5	dBm
Sensitivity				
DSSS, 1Mbps		-98		dBm
CCK, 11Mbps		-91		dBm
6Mbps (1/2 BPSK)		-93		dBm
54Mbps (3/4 64-QAM)		-75		dBm
HT20, MCS7 (65Mbps, 72.2Mbps)		-72		dBm
Adjacent Channel Rejection				
OFDM, 6Mbps		37		dB
OFDM, 54Mbps		21		dB
HT20, MCS0		37		dB
HT20, MCS7		20		dB

3. Packaging and Dimension

The external size of the module is 14.3mm*24.8mm*3mm, as is illustrated in Figure 3 below. The type of flash integrated in this module is an SPI flash, the capacity of which is 1 MB, and the package size of which is SOP-210mil. The antenna applied on this module is a 3DBi PCB-on-board antenna.

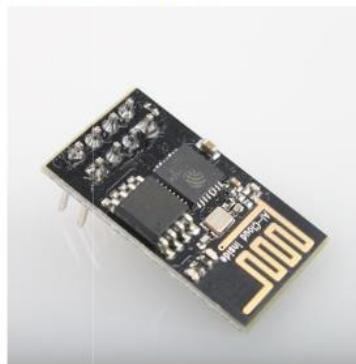


Figure 3 [Module Pin Counts, 8 pin, 14.3 mm *24.8 mm *3.0 mm]

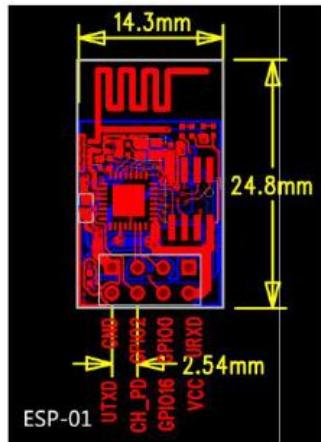


Figure 4 Top View of ESP-01 WiFi Module

Table 5 Dimension of ESP-01 WiFi Module

Length	Width	Height	PAD Size(Bottom)	Pin Pitch
14.3 mm	24.8 mm	3 mm	0.9 mm x 1.7 mm	2.54 mm

4. Functional Descriptions

4.1. MCU

ESP8266EX is embedded with Tensilica L106 32-bit micro controller (MCU), which features extra low power consumption and 16-bit RSIC. The CPU clock speed is 80MHz. It can also reach a maximum value of 160MHz. ESP8266EX is often integrated with external sensors and other specific devices through its GPIOs; codes for such applications are provided in examples in the SDK.

4.2. Memory Organization

4.2.1. Internal SRAM and ROM

ESP8266EX WiFi SoC is embedded with memory controller, including SRAM and ROM. MCU can visit the memory units through I_{BUS}, d_{BUS}, and AHB interfaces. All memory units can be visited upon request, while a memory arbiter will decide the running sequence according to the time when these requests are received by the processor.

According to our current version of SDK provided, SRAM space that is available to users is assigned as below:
 • RAM size < 36kB, that is to say, when ESP8266EX is working under the station mode and is connected to the router, programmable space accessible to user in heap and data section is around 36kB.
 • There is no programmable ROM in the SoC, therefore, user program must be stored in an external SPI flash.

4.2.2. External SPI Flash

This module is mounted with an 1 MB external SPI flash to store user programs. If larger definable storage space is required, a SPI flash with larger memory size is preferred. Theoretically speaking, up to 16 MB memory capacity can be supported.

Suggested SPI Flash memory capacity:

• OTA is disabled: the minimum flash memory that can be supported is 512 kB;

• OTA is enabled: the minimum flash memory that can be supported is 1 MB.

Several SPI modes can be supported, including Standard SPI, Dual SPI, and Quad SPI.

Therefore, please choose the correct SPI mode when you are downloading into the flash, otherwise firmwares/programs that you downloaded may not work in the right way.

4.3. Crystal

Currently, the frequency of crystal oscillators supported include 40MHz, 26MHz and 24MHz. The accuracy of crystal oscillators applied should be $\pm 10\text{PPM}$, and the operating temperature range should be between -20°C and 85°C.

When using the downloading tools, please remember to select the right crystal oscillator type. In circuit design, capacitors C1 and C2, which are connected to the earth, are added to the input and output terminals of the crystal oscillator respectively. The values of the two capacitors can be flexible, ranging from 6pF to 22pF; however, the specific capacitive values of C1 and C2 depend on further testing and adjustment on the overall performance of the whole circuit. Normally, the capacitive values of C1 and C2 are within 10pF if the crystal oscillator frequency is 26MHz, while the values of C1 and C2 are 10pF<C1, C2<22pF if the crystal oscillator frequency is 40MHz.

4.4. Interfaces

Table 6 Descriptions of Interfaces

Interface	Pin Name	Description
HSPI	IO12(MISO) IO13(MOSI) IO14(CLK) IO15(CS)	SPI Flash 2, display screen, and MCU can be connected using HSPI interface.
PWM	IO12(R) IO15(G) IO13(B)	Currently the PWM interface has four channels, but users can extend the channels according to their own needs. PWM interface can be used to control LED lights, buzzers, relays, electronic machines, and so on.
IR Remote Control	IO14(IR_T) IO5(IR_R)	The functionality of Infrared remote control interface can be implemented via software programming. NEC coding, modulation, and demodulation are used by this interface. The frequency of modulated carrier signal is 38KHz.
ADC	TOUT	ESP8266EX integrates a 10-bit analog ADC. It can be used to test the power-supply voltage of VDD3P3 (Pin3 and Pin4) and the input power voltage of TOUT (Pin 6). However, these two functions cannot be used simultaneously. This interface is typically used in sensor products.
I2C	IO14(SCL) IO2(SDA)	I2C interface can be used to connect external sensor products and display screens, etc.

Interface	Pin Name	Description
UART	UART0: TXD (U0TXD) RXD (U0RXD) IO15 (RTS) IO13 (CTS) UART1: IO2(TXD)	Devices with UART interfaces can be connected with the module. Downloading: U0TXD+U0RXD or GPIO2+U0RXD Communicating: UART0: U0TXD, U0RXD, MTD0 (U0RTS), MTCK (U0CTS) Debugging: UART1_TXD (GPIO2) can be used to print debugging information.
I2S	I2S Input: IO12 (I2S1_DATA); IO13 (I2S1_BCK); I2S Output: IO14 (I2S1_WS); IO15 (I2S0_BCK); IO3 (I2S0_DATA); IO2 (I2S0_WS).	By default, UART0 will output some printed information when the device is powered on and is booting up. If this issue exerts influence on some specific applications, users can exchange the inner pins of UART when initializing, that is to say, exchange U0TXD, U0RXD with U0RTS, U0CTS. I2S interface is mainly used for collecting, processing, and transmission of audio data.

4.5. Absolute Maximum Ratings

Table 7 Absolute Maximum Ratings

Rating	Condition	Value	Unit
Storage Temperature		-40 to 125	°C
Maximum Soldering Temperature		260	°C
Supply Voltage	IPC/JEDEC J-STD-020	+3.0 to +3.6	V

4.6. Recommended Operating Conditions

Table 8 Recommended Operating Conditions

Operating Condition	Symbol	Min	Typ	Max	Unit
Operating Temperature		-40	20	125	°C
Supply voltage	VDD	3.0	3.3	3.6	V

4.7. Digital Terminal Characteristics

Table 9 Digital Terminal Characteristics

Terminals	Symbol	Min	Typ	Max	Unit
Input logic level low	V _{IL}	>0.3		0.25VDD	V
Input logic level high	V _{IH}	0.75VDD		VDD+0.3	V
Output logic level low	V _{OL}	N		0.1VDD	V
Output logic level high	V _{OH}	0.8VDD		N	V

Note: Test conditions: VDD = 3.3V, Temperature = 20 °C, if nothing special is stated.

5. RF Performance

Description	Min.	Typ.	Max	Unit
Input frequency	2400		2483.5	MHz
Input impedance		50		ohm
Input reflection			-10	dB
Output power of PA for 72.2Mbps	15.5	16.5	17.5	dBM
Output power of PA for 11b mode	19.5	20.5	21.5	dBM
Sensitivity				
CCK, 1Mbps		-98		dBM
CCK, 11Mbps		-91		dBM
6Mbps (1/2 BPSK)		-93		dBM
54Mbps (3/4 64-QAM)		-75		dBM
HT20, MCS7 (65Mbps, 72.2Mbps)		-72		dBM
Adjacent Channel Rejection				
OFDM, 6Mbps		37		dB
OFDM, 54Mbps		21		dB
HT20, MCS0		37		dB
HT20, MCS7		20		dB

Table 10 RF Performance

6. Power Consumption

Parameters	Min	Typical	Max	Unit
Tx802.11b, CCK 11Mbps, P OUT=+17dBM		170		mA
Tx 802.11g, OFDM 54Mbps, P OUT =+15dBM		140		mA
Tx 802.11n, MCS7, P OUT =+13dBM		120		mA
Rx 802.11b, 1024 bytes packet length, +80dBM		50		mA
Rx 802.11g, 1024 bytes packet length, -70dBM		56		mA
Rx 802.11n, 1024 bytes packet length, -65dBM		56		mA
Modem-Sleep①		15		mA
Light-Sleep②		0.9		mA
Deep-Sleep③		10		uA

Table 11 Power Consumption

① Modem-Sleep requires the CPU to be working, as in PWM or I2S applications. According to 802.11 standards (like U-APSD), it saves power to shut down the Wi-Fi Modem circuit while maintaining a Wi-Fi connection with no data transmission. E.g. in DTIM3, to maintain a sleep 300ms-wake 3ms cycle to receive AP's Beacon packages, the current is about 15mA.

② During Light-Sleep, the CPU may be suspended in applications like Wi-Fi switch. Without data transmission, the Wi-Fi Modem circuit can be turned off and CPU suspended to save power according to the 802.11 standard (U-APSD). E.g. in DTIM3, to maintain a sleep 300ms-wake 3ms cycle to receive AP's Beacon packages, the current is about 0.9mA.

③ Deep-Sleep does not require Wi-Fi connection to be maintained. For application with long time lags between data transmission, e.g. a temperature sensor that checks the temperature every 100s, sleep 300s and waking up to connect to the AP (taking about 0.3~1s), the overall average current is less than 1mA.

7. Reflow Profile

Table 12 Instructions

T _s max to T _L (Ramp-up Rate)	3°C/second max
Preheat	
Temperature Min.(T _s Min.)	150°C
Temperature Typical.(T _s Typ.)	175°C
Temperature Min.(T _s Max.)	200°C
Time(T _s)	60~180 seconds
Ramp-up rate (T _L to T _F)	3°C/second max
Time Maintained Above: -Temperature(T _U)/Time(T _U)	217°C/60~150 seconds
Peak Temperature(T _F)	260°C max. for 10 seconds
Target Peak Temperature (T _F Target)	260°C +0/-5°C
Time within 5°C of actual peak(t _s)	20~40 seconds
T _s max to T _L (Ramp-down Rate)	6°C/second max
Tune 25°C to Peak Temperature (t _s)	8 minutes max

8. Schematics

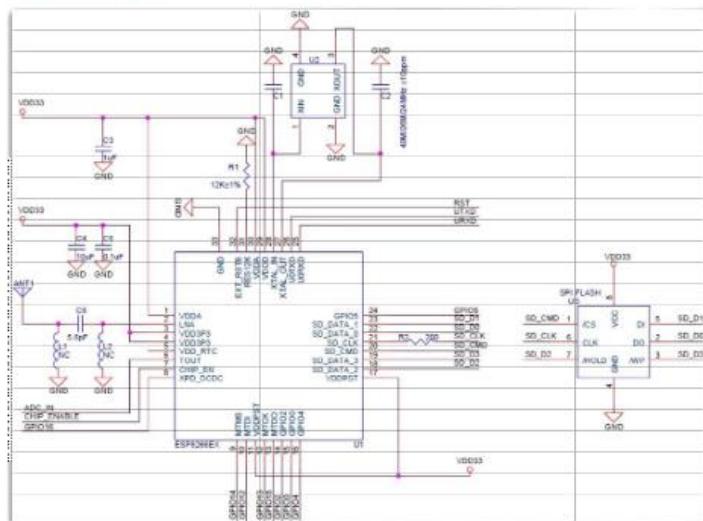


Figure 4 Schematics of Esp-01 WiFi Module

B.3 Datasheet RTC DS1307



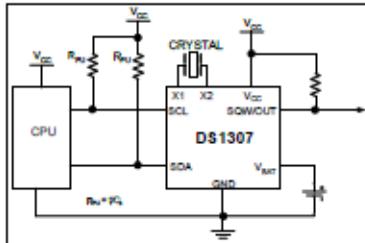
maxim
integrated.[™]

DS1307
64 x 8, Serial, I²C Real-Time Clock

GENERAL DESCRIPTION

The DS1307 serial real-time clock (RTC) is a low-power, full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially through an I²C, bidirectional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power-sense circuit that detects power failures and automatically switches to the backup supply. Timekeeping operation continues while the part operates from the backup supply.

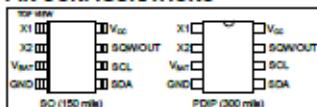
TYPICAL OPERATING CIRCUIT



BENEFITS AND FEATURES

- Completely Manages All Timekeeping Functions
 - Real-Time Clock Counts Seconds, Minutes, Hours, Date of the Month, Month, Day of the Week, and Year with Leap-Year Compensation Valid Up to 2100
 - 56-Byte, Battery-Backed, General-Purpose RAM with Unlimited Writes
 - Programmable Square-Wave Output Signal
- Simple Serial Port Interfaces to Most Microcontrollers
 - I²C Serial Interface
- Low Power Operation Extends Battery Backup Run Time
 - Consumes Less than 500nA in Battery-Backup Mode with Oscillator Running
 - Automatic Power-Fail Detect and Switch Circuitry
- 8-Pin DIP and 8-Pin SO Minimizes Required Space
- Optional Industrial Temperature Range: -40°C to +85°C Supports Operation in a Wide Range of Applications
- Underwriters Laboratories® (UL) Recognized

PIN CONFIGURATIONS



ORDERING INFORMATION

PART	TEMP RANGE	VOLTAGE (V)	PIN-PACKAGE	TOP MARK*
DS1307	0°C to +70°C	5.0	8 PDIP (300 mils)	DS1307
DS1307N+	-40°C to +85°C	5.0	8 PDIP (300 mils)	DS1307N
DS1307Z	0°C to +70°C	5.0	8 SO (150 mils)	DS1307
DS1307ZN+	-40°C to +85°C	5.0	8 SO (150 mils)	DS1307N
DS1307Z+T&R	0°C to +70°C	5.0	8 SO (150 mils) Tape and Reel	DS1307
DS1307ZN+T&R	-40°C to +85°C	5.0	8 SO (150 mils) Tape and Reel	DS1307N

*Denotes a lead-free/RoHS-compliant package.

*A “+” anywhere on the top mark indicates a lead-free package. An “N” anywhere on the top mark indicates an industrial temperature range device. Underwriters Laboratories, Inc. is a registered certification mark of Underwriters Laboratories, Inc.

ABSOLUTE MAXIMUM RATINGS

Voltage Range on Any Pin Relative to Ground	-0.5V to +7.0V
Operating Temperature Range (Noncondensing)	
Commercial	0°C to +70°C
Industrial	-40°C to +85°C
Storage Temperature Range	-55°C to +125°C
Soldering Temperature (DIP, leads)	+260°C for 10 seconds
Soldering Temperature (surface mount)	Refer to the JPC/JEDEC J-STD-020 Specification.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED DC OPERATING CONDITIONS

(T_A = 0°C to +70°C, T_A = -40°C to +85°C.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V _{CC}		4.5	5.0	5.5	V
Logic 1 Input	V _H		2.2		V _{CC} + 0.3	V
Logic 0 Input	V _L		-0.3		+0.8	V
V _{BAT} Battery Voltage	V _{BAT}		2.0	3	3.5	V

DC ELECTRICAL CHARACTERISTICS

(V_{CC} = 4.5V to 5.5V; T_A = 0°C to +70°C, T_A = -40°C to +85°C.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Leakage (SCL)	I _U		-1		1	µA
I/O Leakage (SDA, SQW/OUT)	I _O		-1		1	µA
Logic 0 Output (I _{OL} = 5mA)	V _{OL}				0.4	V
Active Supply Current (f _{SCL} = 100kHz)	I _{SSC}				1.5	mA
Standby Current	I _{SCS}	(Note 3)			200	µA
V _{BAT} Leakage Current	I _{BATLKG}			5	50	nA
Power-Fail Voltage (V _{BAT} = 3.0V)	V _{PF}		1.216 x V _{BAT}	1.25 x V _{BAT}	1.284 x V _{BAT}	V

DC ELECTRICAL CHARACTERISTICS

(V_{CC} = 0V, V_{BAT} = 3.0V; T_A = 0°C to +70°C, T_A = -40°C to +85°C.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
V _{BAT} Current (OSC ON); SQW/OUT OFF	I _{BAT1}			300	500	nA
V _{BAT} Current (OSC ON); SQW/OUT ON (32kHz)	I _{BAT2}			480	800	nA
V _{BAT} Data-Retention Current (Oscillator Off)	I _{BATOR}			10	100	nA

WARNING: Negative undershoots below -0.3V while the part is in battery-backed mode may cause loss of data.

AC ELECTRICAL CHARACTERISTICS(V_{CC} = 4.5V to 5.5V; T_A = 0°C to +70°C, T_A = -40°C to +85°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SCL Clock Frequency	t _{SCL}		0	100	kHz	
Bus Free Time Between a STOP and START Condition	t _{BF}		4.7			μs
Hold Time (Repeated) START Condition	t _{HOLDSTA}	(Note 4)	4.0			μs
LOW Period of SCL Clock	t _{LOW}		4.7			μs
HIGH Period of SCL Clock	t _{HIGH}		4.0			μs
Setup Time for a Repeated START Condition	t _{SUSTA}		4.7			μs
Data Hold Time	t _{HDAT}		0			μs
Data Setup Time	t _{UDAT}	(Notes 5, 6)	250			ns
Rise Time of Both SDA and SCL Signals	t _R			1000		ns
Fall Time of Both SDA and SCL Signals	t _F			300		ns
Setup Time for STOP Condition	t _{SUSTO}		4.7			μs

CAPACITANCE(T_A = +25°C)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Pin Capacitance (SDA, SCL)	C _{IO}			10		pF
Capacitance Load for Each Bus Line	C _B	(Note 7)		400		pF

Note 1: All voltages are referenced to ground.

Note 2: Limits at -40°C are guaranteed by design and are not production tested.

Note 3: t_{SDA} specified with V_{DD} = 5.0V and SDA, SCL = 5.0V.

Note 4: After this period, the first clock pulse is generated.

Note 5: A device must internally provide a hold time of at least 300ns for the SDA signal (referred to the V_{HIGH} of the SCL signal) to bridge the undefined region of the falling edge of SCL.Note 6: The maximum t_{UDAT} only has to be met if the device does not stretch the LOW period (t_{LOW}) of the SCL signal.Note 7: C_B—total capacitance of one bus line in pF.

TIMING DIAGRAM

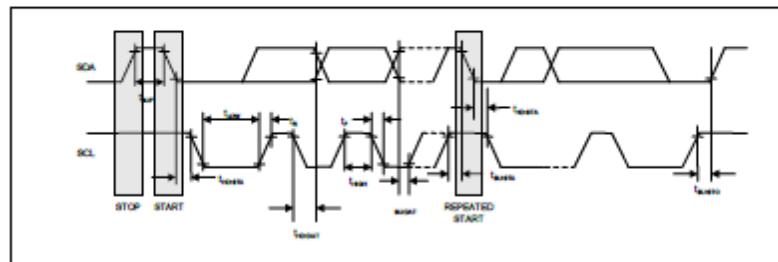
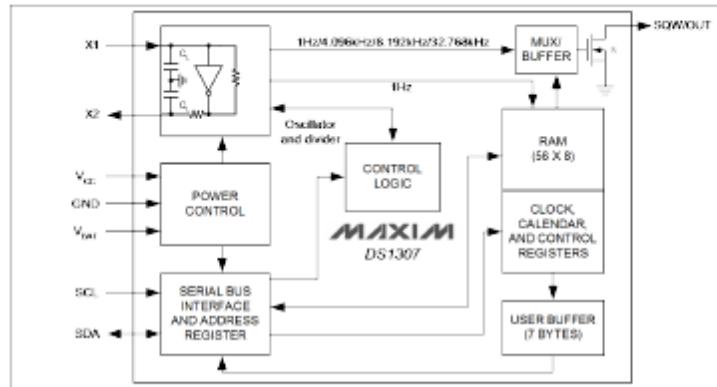
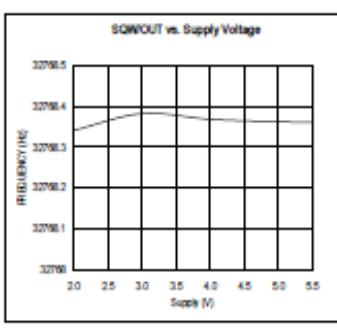
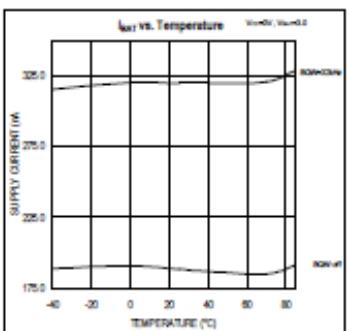
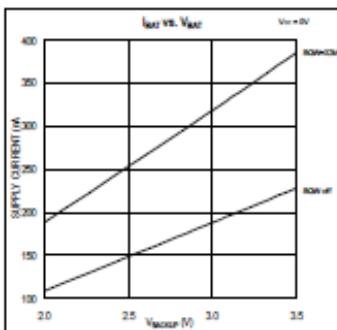
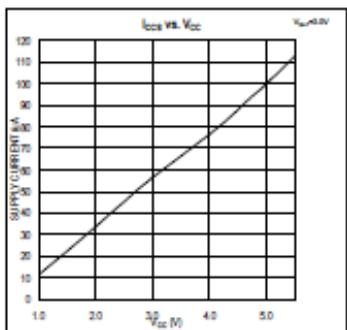


Figure 1. Block Diagram



TYPICAL OPERATING CHARACTERISTICS
 (V_{CC} = 5.0V, T_A = +25°C, unless otherwise noted.)



PIN DESCRIPTION

PIN	NAME	FUNCTION
1	X1	Connections for Standard 32.768kHz Quartz Crystal. The internal oscillator circuitry is designed for operation with a crystal having a specified load capacitance (C_L) of 12.5pF. X1 is the input to the oscillator and can optionally be connected to an external 32.768kHz oscillator. The output of the internal oscillator, X2, is floated if an external oscillator is connected to X1.
2	X2	Note: For more information on crystal selection and crystal layout considerations, refer to Application Note 58: Crystal Considerations with Dallas Real-Time Clocks.
3	V _{BAT}	Backup Supply Input for Any Standard 3V Lithium Cell or Other Energy Source. Battery voltage must be held between the minimum and maximum limits for proper operation. Diodes in series between the battery and the V _{BAT} pin may prevent proper operation. If a backup supply is not required, V _{BAT} must be grounded. The nominal power-fail trip point (V _{TP}) voltage at which access to the RTC and user RAM is denied is set by the internal circuitry as 1.25 x V _{BAT} nominal. A lithium battery with 48mAh or greater will back up the DS1307 for more than 10 years in the absence of power at +25°C. UL recognized to ensure against reverse charging current when used with a lithium battery. Go to: www.maxim-ic.com/ga/info/ul .
4	GND	Ground
5	SDA	Serial Data Input/Output. SDA is the data input/output for the I ^C serial interface. The SDA pin is open drain and requires an external pullup resistor. The pullup voltage can be up to 5.5V regardless of the voltage on V _{CC} .
6	SCL	Serial Clock Input. SCL is the clock input for the I ^C interface and is used to synchronize data movement on the serial interface. The pullup voltage can be up to 5.5V regardless of the voltage on V _{CC} .
7	SQW/OUT	Square Wave/Output Driver. When enabled, the SQWE bit set to 1, the SQW/OUT pin outputs one of four square-wave frequencies (1Hz, 4kHz, 8kHz, 32kHz). The SQW/OUT pin is open drain and requires an external pullup resistor. SQW/OUT operates with either V _{CC} or V _{BAT} applied. The pullup voltage can be up to 5.5V regardless of the voltage on V _{CC} . If not used, this pin can be left floating.
8	V _{CC}	Primary Power Supply. When voltage is applied within normal limits, the device is fully accessible and data can be written and read. When a backup supply is connected to the device and V _{CC} is below V _{TP} , read and writes are inhibited. However, the timekeeping function continues unaffected by the lower input voltage.

DETAILED DESCRIPTION

The DS1307 is a low-power clock/calendar with 56 bytes of battery-backed SRAM. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The date at the end of the month is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The DS1307 operates as a slave device on the I^C bus. Access is obtained by implementing a START condition and providing a device identification code followed by a register address. Subsequent registers can be accessed sequentially until a STOP condition is executed. When V_{CC} falls below 1.25 x V_{BAT}, the device terminates an access in progress and resets the device address counter. Inputs to the device will not be recognized at this time to prevent erroneous data from being written to the device from an out-of-tolerance system. When V_{CC} falls below V_{BAT}, the device switches into a low-current battery-backup mode. Upon power-up, the device switches from battery to V_{CC} when V_{CC} is greater than V_{BAT} +0.2V and recognizes inputs when V_{CC} is greater than 1.25 x V_{BAT}. The block diagram in Figure 1 shows the main elements of the serial RTC.

B.4 Datasheet LCD 16x2

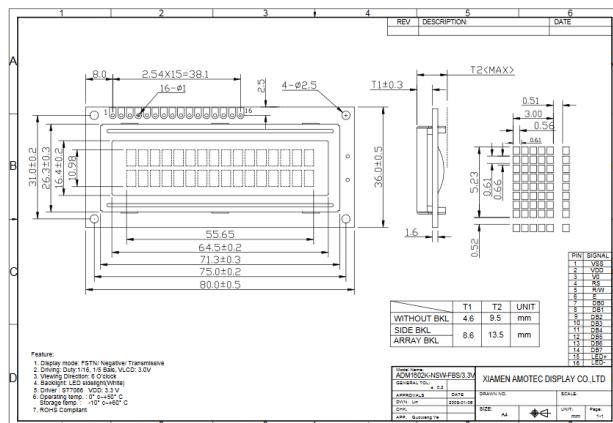
1. Features

1. 5x8 dots with cursor
2. 16characters *2lines display
3. 4-bit or 8-bit MPU interfaces
4. Built-in controller (ST7066 or equivalent)
5. Display Mode & Backlight Variations
6. ROHS Compliant

LCD type	OTN		
	<input type="checkbox"/> FSTN	<input checked="" type="checkbox"/> FSTN Negative	
View direction	DSTN Yellow Green	DSTN Gray	DSTN Blue Negative
Rear Polarizer	<input type="checkbox"/> Reflective	<input type="checkbox"/> Transflective	<input checked="" type="checkbox"/> Transmissive
Backlight Type	<input checked="" type="checkbox"/> LED	<input type="checkbox"/> DEL	<input type="checkbox"/> Internal Power
		<input type="checkbox"/> CCFL	<input checked="" type="checkbox"/> External Power
Backlight Color	<input checked="" type="checkbox"/> White	<input type="checkbox"/> Blue	<input type="checkbox"/> Amber
Temperature Range	<input type="checkbox"/> Normal	<input type="checkbox"/> Wide	<input type="checkbox"/> Super Wide
DC to DC circuit	<input type="checkbox"/> Build-in	<input checked="" type="checkbox"/> Not Build-in	
Touch screen	<input type="checkbox"/> With	<input checked="" type="checkbox"/> Without	
Font type	<input checked="" type="checkbox"/> English-Japanese	<input type="checkbox"/> English-Europe	<input type="checkbox"/> English-Russian
		<input type="checkbox"/>	Other

2. MECHANICAL SPECIFICATIONS

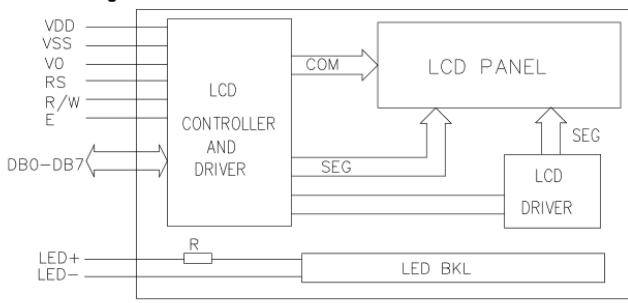
Module size	80.0mm(L)*36.0mm(W)* Max13.5(H)mm
Viewing area	64.5mm(L)*16.4mm(W)
Character size	3.00mm(L)*5.23mm(W)
Character pitch	3.51mm(L)*5.75mm(W)
Weight	Approx.



4. Absolute maximum ratings

Item	Symbol	Standard		Unit
Power voltage	$V_{DD}-V_{SS}$	0	-	7.0
Input voltage	V_{IN}	VSS	-	VDD
Operating temperature range	V_{OP}	0	-	+50
Storage temperature range	V_{ST}	-10	-	+60

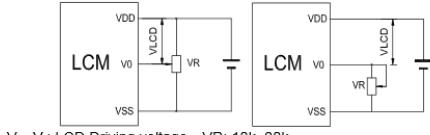
5. Block diagram



6. Interface pin description

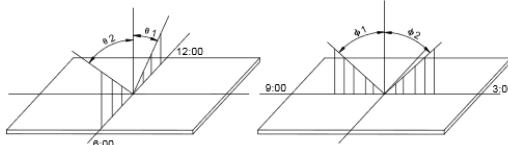
Pin no.	Symbol	External connection	Function
1	V_{SS}	Power supply	Signal ground for LCM
2	V_{DD}		Power supply for logic for LCM
3	V_0		Contrast adjust
4	RS	MPU	Register select signal
5	R/W	MPU	Read/write select signal
6	E	MPU	Operation (data read/write) enable signal
7~10	DB0~DB3	MPU	Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCM. These four are not used during 4-bit operation.
11~14	DB4~DB7	MPU	Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU
15	LED+	LED BKL power supply	Power supply for BKL
16	LED-	LED BKL power supply	Power supply for BKL

7. Contrast adjust



$V_{DD}-V_0$: LCD Driving voltage VR: 10k~20k

8. Optical characteristics



STN type display module ($T_a=25^\circ C$, $V_{DD}=3.3V$)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing angle	θ_1	$C_r \geq 3$	-	20	-	deg
	θ_2		-	40	-	
	Φ_1		-	35	-	
	Φ_2		-	35	-	
Contrast ratio	C_r	-	-	10	-	-
Response time (rise)	T_r	-	-	200	250	ms
Response time (fall)	T_r	-	-	300	350	

9. Electrical characteristics

DC characteristics

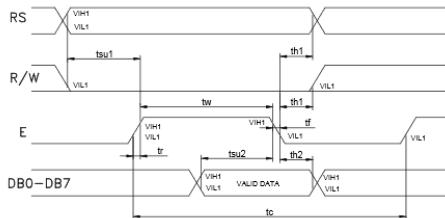
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage for LCD	$V_{DD}-V_0$	$T_a=25^\circ C$	-	3.0	-	V
Input voltage	V_{DD}	-	3.1	3.3	3.5	
Supply current	I_{DD}	$T_a=25^\circ C$, $V_{DD}=3.3V$	-	1.5	2.5	mA
Input leakage current	I_{LKG}	-	-	-	1.0	uA
"H" level input voltage	V_{IH}	-	2.2	-	V_∞	
"L" level input voltage	V_{IL}	Twice initial value or less	0	-	0.6	
"H" level output voltage	V_{OH}	$LOH=-0.25mA$	2.4	-	-	
"L" level output voltage	V_{OL}	$LOH=1.6mA$	-	-	0.4	V
Backlight supply voltage	V_F	-	-	3.0	-	
Backlight supply current	I_{LED}	$V_{LED}=3.3V$ $R=25\Omega$	-	-	16	mA

10. Timing Characteristics

Write cycle ($T_a=25^\circ\text{C}$, $VDD=3.3\text{V}$)

Parameter	Symbol	Test pin	Min.	Typ.	Max.	Unit
Enable cycle time	t_c	E	500	-	-	ns
Enable pulse width	t_w		300	-	-	
Enable rise/fall time	t_r, t_f		-	-	25	
RS; R/W setup time	$tsu1$		100	-	-	
RS; R/W address hold time	t_h1		10	-	-	
Read data output delay	$tsu2$		60	-	-	
Read data hold time	t_h2		10	-	-	

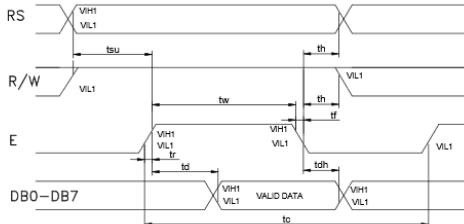
Write mode timing diagram



Read cycle ($T_a=25^\circ\text{C}$, $VDD=3.3\text{V}$)

Parameter	Symbol	Test pin	Min.	Typ.	Max.	Unit
Enable cycle time	t_c	E	500	-	-	ns
Enable pulse width	t_w		300	-	-	
Enable rise/fall time	t_r, t_f		-	-	25	
RS; R/W setup time	tsu		100	-	-	
RS; R/W address hold time	t_h		10	-	-	
Read data output delay	td		60	-	90	
Read data hold time	t_{dh}	DBO~DB7	20	-	-	

Read mode timing diagram



11. FUNCTION DESCRIPTION

11.1 System Interface

This chip has all two kinds of interface type with MPU : 4-bit bus and 8-bit bus. 4-bit bus and 8-bit bus is selected by DL bit in the instruction register.

11.2 Busy Flag (BF)

When BF = "High", it indicates that the internal operation is being processed. So during this time the next instruction cannot be accepted. BF can be read, when RS = Low and R/W = High (Read Instruction Operation), through DB7 port. Before executing the next instruction, be sure that BF is not high.

11.3 Address Counter (AC)

Address Counter (AC) stores DDRAM/CGRAM address, transferred from IR. After writing into (reading from) DDRAM/CGRAM, AC is automatically increased (decreased) by 1. When RS = "Low" and R/W = "High", AC can be read through DB0 – DB6 ports.

11.4 Display Data RAM (DDRAM)

DDRAM stores display data of maximum 80 x 8 bits (80 characters). DDRAM address is set in the address counter (AC) as a hexadecimal number.

Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DDRAM address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
DDRAM address	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

11.5 CGROM (Character Generator ROM)

CGROM has a 5×8 dots 204 characters pattern and a 5×10 dots 32 characters pattern. CGROM has 204 character patterns of 5×8 dots.

11.6 CGRAM (Character Generator RAM)

CGRAM has up to 5 dot, 8 characters. By writing font data to CGRAM, user defined characters can be used.

Relationship between CGRAM Addresses, Character Codes (DDRAM) and Character patterns (CGRAM Data)

Notes:

1. Character code bits 0 to 2 correspond to CGRAM address bits 3 to 5 (3 bits: 8 types).
 2. CGRAM address bits 0 to 2 designate the character pattern line position. The 8th line is the cursor position.

and its display is formed by a logical OR with the cursor. Maintain the 8th line data, corresponding to the cursor display position, at 0 as the cursor display. If the 8th line data is 1, 1 bit will light up the 8th line regardless of the cursor presence.

3. Character pattern row positions correspond to CGRAM data bits 0 to 4 (bit 4 being at the left).

4. As shown Table, CGRAM character patterns are selected when character code bits 4 to 7 are all 0. However, since character code bit 3 has no effect, the R display example above can be selected by either character code 0DH or 08H.

5. 1 for CGRAM data corresponds to display selection and 0 to non-selection.

"-": Indicates no effect.

11.7 Cursor/Blink Control Circuit

It controls cursor/blink ON/OFF at cursor position.

11.8 Outline

To overcome the speed difference between the internal clock of ST7066 and the MPU clock, ST7066 performs internal operations by storing control information to IR or DR. The internal operation is determined according to the signal from MPU, composed of read/write and data bus (Refer to Table7).

Instructions can be divided largely into four groups:

- 1) ST7066 function set instructions (set display methods, set data length, etc.)
- 2) Address set instructions to internal RAM
- 3) Data transfer instructions with internal RAM
- 4) Others

The address of the internal RAM is automatically increased or decreased by 1.

Note: during internal operation, busy flag (DB7) is read "High".

Busy flag check must be preceded by the next instruction.

11.9 Instruction Table

Instruction	Instruction code										Description	Execution time (fosc= 270 KHz)
	RS	R/M	DB ₅	DB ₄	DB ₃	DB ₂	DB ₁	DB ₀	I/D	SH		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DRA and set DDRAM address to "00H" from AC.	1.53ms
Return Home	0	0	0	0	0	0	0	0	1	-	Set DDRAM address to "00H". From AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.53ms
Entry mode Set	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction And blinking of entire display	39us
Display ON/OFF control	0	0	0	0	0	0	1	D	C	B	Set display (D), cursor (C), and Blinking of cursor (B) on/off Control bit.	
Cursor or Display shift	0	0	0	0	0	1	S/C	R/L	-	-	Set cursor moving and display Shift control bit, and the Direction, without changing of DDRAM data	39us
Function set	0	0	0	0	1	DL	N	F	-	-	Set interface data length (DL: 8 or 9bit), numbers of display Line (N: 2-line/1-line) and, Display font type (F: 5x11/5x8)	39us
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address Counter.	39us
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address Counter.	39us
Read busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal Operation or not can be known By reading BF. The contents of Address counter can also be read.	0us
Write data to Address	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43us
Read data From RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43us

NOTE:

When an MPU program with checking the busy flag (DB7) is made, it must be necessary 1/2fosc is necessary for executing the next instruction by the falling edge of the "E" signal after the busy flag (DB7) goes to "Low".

11.3Contents

- 1) Clear display

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1

Clear all the display data by writing "20H" (space code) to all DDRAM address, and set DDRAM address to "00H" into AC (address counter).

Return cursor to the original status, namely, bring the cursor to the left edge on the fist line of the display.

Make the entry mode increment (I/D="High").

- 2) Return home

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	-

Return home is cursor return home instruction.

Set DDRAM address to "00H" into the address counter.

Return cursor to its original site and return display to its original status, if shifted.

Contents of DDRAM does not change.

- 3) Entry mode set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	I/D	SH

Set the moving direction of cursor and display.

I/D: increment / decrement of DDRAM address (cursor or blink)

When I/D="high", cursor/blink moves to right and DDRAM address is increased by 1.

When I/D="Low", cursor/blink moves to left and DDRAM address is increased by 1.

*CGRAM operates the same way as DDRAM, when reading from or writing to CGRAM.

SH: shift of entire display

When DDRAM read (CGRAM read/write) operation or SH="Low", shifting of entire display is not performed. If SH ="High" and DDRAM write operation, shift of entire display is performed according to I/D value. (I/D="high": shift left, I/D="Low": Shift right).

- 4) Display ON/OFF control

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	D	C	B

Control display/cursor/blink ON/OFF 1 bit register.

D: Display ON/OFF control bit

When D="High", entire display is turned on.

When D="Low", display is turned off, but display data remains in DDRAM.

C: cursor ON/OFF control bit

When D="High", cursor is turned on.

When D="Low", cursor is disappeared in current display, but I/D register preserves its data.

B: Cursor blink ON/OFF control bit

When B="High", cursor blink is on, which performs alternately between all the "High" data and display characters at the cursor position.

When B="Low", blink is off.

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Set CGRAM address to AC.

The instruction makes CGRAM data available from MPU.

- 8) Set DDRAM address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0

Set DDRAM address to AC.

This instruction makes DDRAM data available form MPU.

When 1-line display mode (N=LOW), DDRAM address is form "00H" to "4FH". In 2-line display mode (N=High), DDRAM address in the 1st line form "00H" to "27H", and DDRAM address in the 2nd line is from "40H" to "67H".

- 9) Read busy flag & address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0

This instruction shows whether SPLC780D is in internal operation or not.

If the resultant BF is 'High', internal operation is in progress and should wait BF is to be LOW, which by then the next instruction can be performed. In this instruction you can also read the value of the address counter.

5) Cursor or display shift

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	S/C	R/L	-	-

Shifting of right/left cursor position or display without writing or reading of display data.

This instruction is used to correct or search display data.

During 2-line mode display, cursor moves to the 2nd line after the 40th digit of the 1st line.

Note that display shift is performed simultaneously in all the lines.

When display data is shifted repeatedly, each line is shifted individually.

When display shift is performed, the contents of the address counter are not changed.

Shift patterns according to S/C and R/L bits

S/C	R/L	Operation
0	0	Shift cursor to the left, AC is decreased by 1
0	1	Shift cursor to the right, AC is increased by 1
1	0	Shift all the display to the left, cursor moves according to the display
1	1	Shift all the display to the right, cursor moves according to the display

6) Function set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	N	F	-	-

DL: Interface data length control bit

When DL="High", it means 8-bit bus mode with MPU.

When DL="Low", it means 4-bit bus mode with MPU. Hence, DL is a signal to select 8-bit or 4-bit bus mode.

When 4-bit bus mode, it needs to transfer 4-bit data twice.

N: Display line number control bit

When N="Low", 1-line display mode is set.

When N="High", 2-line display mode is set.

F: Display line number control bit

When F="Low", 5x8 dots format display mode is set.

When F="High", 5x11 dots format display mode.

7) Set CGRAM address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Set CGRAM address to AC.

The instruction makes CGRAM data available from MPU.

8) Set DDRAM address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0

Set DDRAM address to AC.

This instruction makes DDRAM data available from MPU.

When 1-line display mode (N=LOW), DDRAM address is form "00H" to "4FH". In 2-line display mode (N=High), DDRAM address in the 1st line form "00H" to "27H", and DDRAM address in the 2nd line is from "40H" to "67H".

9) Read busy flag & address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0

This instruction shows whether SPLC780D is in internal operation or not.

If the resultant BF is "High", internal operation is in progress and should wait BF is to be LOW, which by then the next instruction can be performed. In this instruction you can also read the value of the address counter.

10) Write data to RAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	D7	D6	D5	D4	D3	D2	D1	D0

Write binary 8-bit data to DDRAM/CGRAM.

The selection of RAM from DDRAM, and CGRAM, is set by the previous address set instruction (DDRAM address set, CGRAM address set).

RAM set instruction can also determine the AC direction to RAM.

After write operation. The address is automatically increased/decreased by 1, according to the entry mode.

11) Read data from RAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	D7	D6	D5	D4	D3	D2	D1	D0

Read binary 8-bit data from DDRAM/CGRAM.

The selection of RAM is set by the previous address set instruction. If the address set instruction of RAM is not performed before this instruction, the data that has been read first is invalid, as the direction of AC is not yet determined. If RAM data is read several times without RAM address instructions set before, read operation, the correct RAM data can be obtained from the second. But the first data would be incorrect, as there is no time margin to transfer RAM data.

In case of DDRAM read operation, cursor shift instruction plays the same role as DDRAM address set

instruction, it also transfers RAM data to output data register.

After read operation, address counter is automatically increased/decreased by 1 according to the entry mode.

After CGRAM read operation, display shift may not be executed correctly.

NOTE: In case of RAM write operation, AC is increased/decreased by 1 as in read operation.

At this time, AC indicates next address position, but only the previous data can be read by the read instruction.

B.5 Datasheet ACS712



ACS712

Fully Integrated, Hall Effect-Based Linear Current Sensor IC
with 2.1 kVRMS Isolation and a Low-Resistance Current Conductor

Features and Benefits

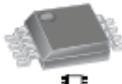
- Low-noise analog signal path
- Device bandwidth is set via the new FILTER pin
- 5 µs output rise time in response to step input current
- 80 kHz bandwidth
- Total output error 1.5% at $T_A = 25^\circ\text{C}$
- Small footprint, low-profile SOIC8 package
- 1.2 mΩ internal conductor resistance
- 2.1 kVRMS minimum isolation voltage from pins 1-4 to pins 5-8
- 5.0 V, single supply operation
- 66 to 185 mV/A output sensitivity
- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis
- Ratiometric output from supply voltage



TDV America
Certificate Number
ULV 005 SK014 010



Package: 8 Lead SOIC (suffix LC)



Approximate Scale 1:1

Description

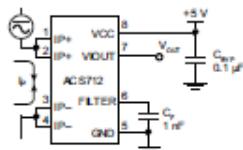
The Allegro™ ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switch-mode power supplies, and overcurrent fault protection. The device is not intended for automotive applications.

The device consists of a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which the Hall IC converts into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging.

The output of the device has a positive slope ($\sim V_{OUT/Q}$) when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sampling. This internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of

Continued on the next page...

Typical Application



Application 1. The ACS712 outputs an analog signal, V_{OUT} , that varies linearly with the uni- or bi-directional AC or DC primary sampled current, I_p , within the range specified. C_p is recommended for noise management, with values that depend on the application.

ACS712

Fully Integrated, Hall Effect-Based Linear Current Sensor IC with 2.1 kVRMS Isolation and a Low-Resistance Current Conductor

Description (continued)

the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the signal leads (pins 5 through 8). This allows the ACS712 to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The ACS712 is provided in a small, surface mount SOIC8 package. The leadframe is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free, except for flip-chip high-temperature Pb-based solder balls, currently exempt from RoHS. The device is fully calibrated prior to shipment from the factory.

Selection Guide

Part Number	Packing*	T _A (°C)	Optimized Range, I _P (A)	Sensitivity, S _{NS} (Typ) (mV/A)
ACS712ELCTR-25B-T	Tape and reel, 3000 pieces/reel	-40 to 85	±5	185
ACS712ELCTR-20A-T	Tape and reel, 3000 pieces/reel	-40 to 85	±20	100
ACS712ELCTR-30A-T	Tape and reel, 3000 pieces/reel	-40 to 85	±30	66

*Contact Allegro for additional packing options.

Absolute Maximum Ratings

Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	V _{DD}		8	V
Reverse Supply Voltage	V _{RECC}		-0.1	V
Output Voltage	V _{OUT}		8	V
Reverse Output Voltage	V _{ROUT}		-0.1	V
Output Current Source	I _{OUT(PULSE)}		3	mA
Output Current Sink	I _{OUT(SINK)}		10	mA
Overcurrent Transient Tolerance	I _P	1 pulse, 100 ms	100	A
Nominal Operating Ambient Temperature	T _A	Range E	-40 to 85	°C
Maximum Junction Temperature	T _{J(max)}		185	°C
Storage Temperature	T _{STG}		-65 to 170	°C

Isolation Characteristics

Characteristic	Symbol	Notes	Rating	Unit
Dielectric Strength Test Voltage*	V _{ISO}	Agency type-tested for 60 seconds per UL standard 60950-1, 1st Edition	2100	VAC
Working Voltage for Basic Isolation	V _{WRI}	For basic (single) isolation per UL standard 60950-1, 1st Edition	354	VDC or V _{pk}
Working Voltage for Reinforced Isolation	V _{WRRI}	For reinforced (double) isolation per UL standard 60950-1, 1st Edition	184	VDC or V _{pk}

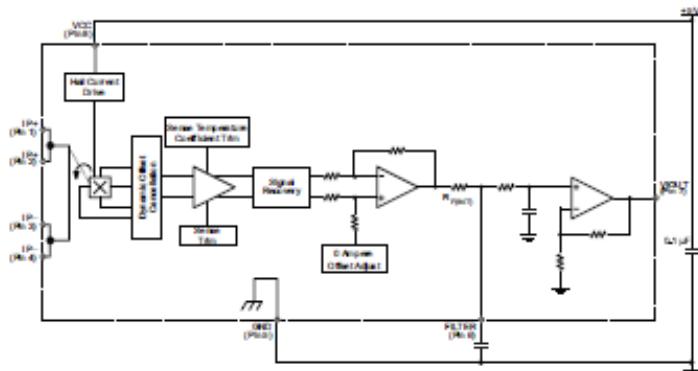
* Allegro does not conduct 60-second testing. It is done only during the UL certification process.

Parameter	Specification
Fire and Electric Shock	CAN/CSA-C22.2 No. 60950-1-03 UL 60950-1:2003 EN 60950-1:2001

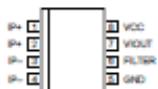


Allegro MicroSystems, LLC
115 Northwest Court
Worcester, Massachusetts 01615-0036 U.S.A.
1.508.853.5000; www.allegromicro.com

Functional Block Diagram



Pin-out Diagram



Terminal List Table

Number	Name	Description
1 and 2	IP+	Terminals for current being sampled; fused internally
3 and 4	IP-	Terminals for current being sampled; fused internally
5	GND	Signal ground terminal
6	FILTER	Terminal for external capacitor that sets bandwidth
7	VOUT	Analog output signal
8	VCC	Device power supply terminal

ACS712

Fully Integrated, Hall Effect-Based Linear Current Sensor IC with 2.1 kVRMS Isolation and a Low-Resistance Current Conductor

COMMON OPERATING CHARACTERISTICS¹ over full range of T_A , $C_F = 1 \text{ nF}$, and $V_{CC} = 5 \text{ V}$, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
ELECTRICAL CHARACTERISTICS						
Supply Voltage	V_{CC}		4.5	5.0	5.5	V
Supply Current	I_{CC}	$V_{CC} = 5.0 \text{ V}$, output open	-	10	13	mA
Output Capacitance Load	C_{LOAD}	V_{OUT} to GND	-	-	10	nF
Output Resistive Load	R_{LOAD}	V_{OUT} to GND	4.7	-	-	kΩ
Primary Conductor Resistance	$R_{PRIMARY}$	$T_A = 25^\circ\text{C}$	-	1.2	-	mΩ
Rise Time	t_r	$I_p = I_p(\text{max})$, $T_A = 25^\circ\text{C}$, C_{LOAD} open	-	3.5	-	μs
Frequency Bandwidth	f	-3 dB, $T_A = 25^\circ\text{C}$, I_p is 10 A peak-to-peak	-	80	-	kHz
Nonlinearity	E_{LIN}	Over full range of I_p	-	1.5	-	%
Symmetry	E_{SYMM}	Over full range of I_p	98	100	102	%
Zero Current Output Voltage	$V_{OUT(0)}$	Bidirectional, $I_p = 0 \text{ A}$, $T_A = 25^\circ\text{C}$	-	$V_{CC}/0.5$	-	V
Power-On Time	t_{PO}	Output reaches 90% of steady-state level, $T_J = 25^\circ\text{C}$, 20 A present on leadframe	-	35	-	μs
Magnetic Coupling ²			-	12	-	GA
Internal Filter Resistance ³	R_{FILTER}			-	1.7	kΩ

¹Device may be operated at higher primary current levels, I_p , and ambient, T_A , and internal leadframe temperatures, T_A , provided that the Maximum Junction Temperature, $T_J(\text{max})$, is not exceeded.

²1G = 0.1 mT.

³ R_{FILTER} forms an RC circuit via the FILTER pin.

COMMON THERMAL CHARACTERISTICS¹

Characteristic	T_A	E range	Min.	Typ.	Max.	Units
Operating Internal Leadframe Temperature	T_A	E range	-40	-	85	°C
Junction-to-Lead Thermal Resistance ²	R_{JL}	Mounted on the Allegro ASEK 712 evaluation board	-	Value	Units	
Junction-to-Ambient Thermal Resistance	R_{JA}	Mounted on the Allegro 85-0322 evaluation board, includes the power consumed by the board	5	23	°C/W	

¹Additional thermal information is available on the Allegro website.

²The Allegro evaluation board has 1500 mm² of 2 oz. copper on each side, connected to pins 1 and 2, and to pins 3 and 4, with thermal vias connecting the layers. Performance values include the power consumed by the PCB. Further details on the board are available from the Frequently Asked Questions document on our website. Further information about board design and thermal performance also can be found in the Applications Information section of this datasheet.



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ACS712

Fully Integrated, Hall Effect-Based Linear Current Sensor IC with 2.1 kVRMS Isolation and a Low-Resistance Current Conductor

x05B PERFORMANCE CHARACTERISTICS¹ $T_A = -40^\circ\text{C}$ to 85°C , $C_p = 1 \text{ nF}$, and $V_{DD} = 5 \text{ V}$, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Optimized Accuracy Range	I_p		-5	-	5	A
Sensitivity	Sens	Over full range of I_p , $T_A = 25^\circ\text{C}$	180	185	190	mV/A
Noise	$V_{NOISE(pp)}$	Peak-to-peak, $T_A = 25^\circ\text{C}$, 165 mV/A programmed Sensitivity, $C_p = 47 \text{ nF}$, $C_{OUT} = \text{open}$, 2 kHz bandwidth	-	21	-	mV
Zero Current Output Slope	$\Delta V_{OUT(pp)}$	$T_A = -40^\circ\text{C}$ to 25°C	-	-0.26	-	mV/°C
		$T_A = 25^\circ\text{C}$ to 150°C	-	-0.08	-	mV/°C
Sensitivity Slope	$\Delta SENS$	$T_A = -40^\circ\text{C}$ to 25°C	-	0.054	-	mV/A/°C
		$T_A = 25^\circ\text{C}$ to 150°C	-	-0.008	-	mV/A/°C
Total Output Error ²	E_{TOT}	$I_p = \pm 5 \text{ A}$, $T_A = 25^\circ\text{C}$	-	±1.5	-	%

¹Device may be operated at higher primary current levels, I_p , and ambient temperatures, T_A , provided that the Maximum Junction Temperature, $T_J(max)$, is not exceeded.

²Percentage of I_p , with $I_p = 5 \text{ A}$. Output filtered.

x20A PERFORMANCE CHARACTERISTICS¹ $T_A = -40^\circ\text{C}$ to 85°C , $C_p = 1 \text{ nF}$, and $V_{DD} = 5 \text{ V}$, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Optimized Accuracy Range	I_p		-20	-	20	A
Sensitivity	Sens	Over full range of I_p , $T_A = 25^\circ\text{C}$	96	100	104	mV/A
Noise	$V_{NOISE(pp)}$	Peak-to-peak, $T_A = 25^\circ\text{C}$, 100 mV/A programmed Sensitivity, $C_p = 47 \text{ nF}$, $C_{OUT} = \text{open}$, 2 kHz bandwidth	-	11	-	mV
Zero Current Output Slope	$\Delta V_{OUT(pp)}$	$T_A = -40^\circ\text{C}$ to 25°C	-	-0.34	-	mV/°C
		$T_A = 25^\circ\text{C}$ to 150°C	-	-0.07	-	mV/°C
Sensitivity Slope	$\Delta SENS$	$T_A = -40^\circ\text{C}$ to 25°C	-	0.017	-	mV/A/°C
		$T_A = 25^\circ\text{C}$ to 150°C	-	-0.004	-	mV/A/°C
Total Output Error ²	E_{TOT}	$I_p = \pm 20 \text{ A}$, $T_A = 25^\circ\text{C}$	-	±1.5	-	%

¹Device may be operated at higher primary current levels, I_p , and ambient temperatures, T_A , provided that the Maximum Junction Temperature, $T_J(max)$, is not exceeded.

²Percentage of I_p , with $I_p = 20 \text{ A}$. Output filtered.

x30A PERFORMANCE CHARACTERISTICS¹ $T_A = -40^\circ\text{C}$ to 85°C , $C_p = 1 \text{ nF}$, and $V_{DD} = 5 \text{ V}$, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Optimized Accuracy Range	I_p		-30	-	30	A
Sensitivity	Sens	Over full range of I_p , $T_A = 25^\circ\text{C}$	63	66	69	mV/A
Noise	$V_{NOISE(pp)}$	Peak-to-peak, $T_A = 25^\circ\text{C}$, 66 mV/A programmed Sensitivity, $C_p = 47 \text{ nF}$, $C_{OUT} = \text{open}$, 2 kHz bandwidth	-	7	-	mV
Zero Current Output Slope	$\Delta V_{OUT(pp)}$	$T_A = -40^\circ\text{C}$ to 25°C	-	-0.35	-	mV/°C
		$T_A = 25^\circ\text{C}$ to 150°C	-	-0.08	-	mV/°C
Sensitivity Slope	$\Delta SENS$	$T_A = -40^\circ\text{C}$ to 25°C	-	0.007	-	mV/A/°C
		$T_A = 25^\circ\text{C}$ to 150°C	-	-0.002	-	mV/A/°C
Total Output Error ²	E_{TOT}	$I_p = \pm 30 \text{ A}$, $T_A = 25^\circ\text{C}$	-	±1.5	-	%

¹Device may be operated at higher primary current levels, I_p , and ambient temperatures, T_A , provided that the Maximum Junction Temperature, $T_J(max)$, is not exceeded.

²Percentage of I_p , with $I_p = 30 \text{ A}$. Output filtered.



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