PROTOTYPE SMART BATHROOM BERBASIS ARDUINO DENGAN MONITORING PENGGUNAAN AIR MENGGUNAKAN ANDROID

PROYEK AKHIR

Laporan akhir ini dibuat dan diajukan untuk memenuhi salah satu syarat kelulusan Diploma III Politeknik Manufaktur Negeri Bangka Belitung

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POLITEKNIK MANUFAKTUR NEGERI

BANGKA BELITUNG

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LEMBAR PENGESAHAN

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Laporan akhir ini telah disetujui dan disahkan sebagai salah satu syarat kelulusan Program Diploma III Politeknik Manufaktur Negeri Bangka Belitung

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Dengan Judul: *Prototype Smart Bathroom* berbasis *Arduino* dengan monitoring penggunaan air menggunakan *Android*

Menyatakan bahwa laporan akhir ini adalah hasil kerja kami sendiri bukan merupakan plagiat. Pernyataan ini kami buat dengan sebenarnya dan bila ternyata dikemudian hari ternyata melanggar pernyataan ini, kami bersedia diberikansanksi yang berlaku.

Sungailiat, 31Juli 2018

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ABSTRAK

Prototype Smart Bathroom Berbasis Arduino Dengan Monitoring Penggunaan Air Menggunakan Android merupakan alat yang dirancang khusus sebagai simulasi kamar mandi otomatis. Alat ini akan bekerja bila seseorang terdeteksi oleh sensor pada masing-masing komponen kamar mandi. Saat seseorang masuk kamar mandi lampu akan otomatis menyala. Kemudian aktivitas di kloset, kloset akan melakukan pembilasan otomatis. Berikutnya mandi di shower,pengguna kamar mandi cukup mendekat di depan shower, maka air akan mengalir secara otomatis. Selanjutnya aktivitas yang terakhir, yaitu menyikat gigi dan cuci muka di wastafel, pengguna kamar mandi cukup mendekatkan tangan di kran wastafel, maka air akan mengalir secara otomatis. Pengguna kamar mandi selesai aktivitas di kamar mandi dan keluar, kemudian lampu otomatis akan mati. Metode yang digunakan dalam membangun prototype smart bathroom berbasis arduino ini menggunakan metode rancang bangun yang terdiri atas beberapa tahap, yaitu: (1) Identifikasi kebutuhan, (2) Analisis Kebutuhan, (3) Perancangan perangkat keras dan perangkat lunak, (4) Pembuatan alat, (5) Pengujian Alat dan (6) Pengoperasian Alat. Perangkat keras terdiri dari (1) Mikrokontroler arduino Atmega sebagai pengendali utama, (2) Sensor ultrasonic HC-SR04 sebagai pendeteksi jarak tangan di wastafel dan pendeteksi jarak tubuh di shower, (2)Sensor LDR sebagai pendeteksi objek yang masuk di kloset duduk, (3) Solenoid valve DC sebagai system buka tutup aliran air, (4) Relay sebagai saklar dari penggunaan solenoid valve, pompa air DC, actuator, motor DC, dan lampu, (5),Lampu LED sebagai penerangan kamar mandi, (6) Limit switch sebagai sensor minimum dan maksimum pada pintu, (7) NodeMCU untuk mengubungkan dengan Smartphone, (8) Arduino Uno sebagai penghubung ke NodeMCU. Berdasarkan hasil pengujian yang telah dilaksanakan, maka dapat disimpulkan bahwa prototype smart bathroom berbasis arduino ini dapat bekerja dengan baik sesuai dengan fungsinya. Unjuk kerja alat ini diamati dengan melihat kondisi sensor ultrasonic HC-SR04 dan sensor LDR pada wastafel, shower dan kloset duduk. Solenoid valve akan membuka katup coil jika sensor pada tiap komponen kamar mandi mendeteksi objek.

Kata Kunci*: Prototype, Sensor ultrasonic HC-SR04, SensorLDR,Arduino Uno, Arduino Atmega, NodeMCU, Solenoid Valve , Motor DC*

ABSTRAC

Smart Bathroom Based Prototype Arduino With Water Usage Using Android is a specially designed tool for automatic bathroom simulation. This tool will work when someone is detected by the sensor on each. When someone comes in the bathroom will automatically turn on. Then in the closet, the toilet will do an automatic flushing. Next bath in the shower, bathroom users close enough in front of the shower, then the water will flow automatically. Then the last activity, namely brushing and washing face in the sink, bathroom users close enough on the sink taps, then the water will flow automatically. Tub and exit, then the automatic light will turn off . The method used inbuilding prototype arduino intelligent bathroom is using design method consisting of several stages, namely: (1) needs, (2) needs analysis, (3) design of hardware and software, (4) manufacture tools, (5) Testing Tools and (6)Operation Tools. The hardware consists of (1) arduino Atmega microcontroller as the main controller, (2) ultrasonic sensor HC-SR04 as detection of hand spacing at sink and body spacing detector in shower, (2) LDR sensor as detector of incoming object in toilet seat (3) DC solenoid valve as an airflow open system (4) Relay as driver of DC solenoid valve,Actuator Lock , Pump , Lamp and Motor DC (5), LED lamp as bathroom light, (6) Limit switch as LED switch light., (7) NodeMCU for connecting to smartphone, (8) Arduino Uno for connecting to NodeMCU. Based on the results of tests that have been implemented, it can be concluded that the prototype smart bathroom based arduinoAt mega and arduinouno this can work well in accordance with its function. The performance of this tool is observed by looking at the conditions of ultrasonic sensors HC-SR04 and LDR sensors on the sink, shower and toilet seat. The solenoid valve will openthe valve coil if the sensor at each.

***Keywords** : Prototype, Ultrasonic sensors HC-SR04, LDR sensors, Arduino Uno, Arduino Atmega, NodeMCU, Solenoid valve , Motor DC*

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Dalam pembuatan alat dan makalah Proyek Akhir ini penulis mencoba menerapkan ilmu yang telah didapatkan selama 3 tahun menuntut ilmu di Politeknik Manufaktur Negeri Bangka Belitung serta pengalaman yang didapatkan selama melaksanakan Program Praktik Kerja Lapangan. Penulis mengakui bahwa selesainya Proyek Akhir ini tidak lepas dari bantuan banyak pihak yang membantu dan memberi dukungan dalam membuat alat maupun dalam menyelesaikan laporan Proyek Akhir ini. Untuk itu penulis mengucapkan terima kasih kepada :

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Sungailiat, 11 Juli 2018

Penulis

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BAB I
PENDAHULUAN

1.1 Latar Belakang Masalah

Proses penuaan adalah proses alami yang disertai adanya penurunan kondisi fisik, psikologis maupun sosial yang saling berinteraksi satu sama lain (Papalia, 2008) [1]. Penurunan tersebut akan menimbulkan berbagai masalah bagi lansia. Menurut (Hurlock, 2002), terdapat beberapa masalah yang dapat menyertai lansia salah satunya yaitu ketidakberdayaan fisik tubuh lansia yang menyebabkan ketergantungan pada orang lain [2]. Sehingga kebanyakan pada usia tersebut, lansia umumnya akan tinggal bersama keluarganya karena semakin tua seseorang menyebabkan semakin besar hambatan untuk tinggal sendirian. Lansia Indonesia kebanyakan tinggal di rumah sendiri, menurut R. Boedhi Darmojo (2004: 17) mengemukakan bahwa lansia yang tinggal di rumah sendiri 54,7%, tinggal di rumah keluarga 44,4%, dan lansia yang tinggal di tempat lain seperti panti wredha dan rumah sakit hanya 0,9% saja. Sulit melakukan berbagai aktifitas, emosinya pun tidak terkontrol dengan baik [3].

Usia lanjut adalah suatu kejadian yang pasti akan dialami oleh semua orang yang dikaruniai usia panjang, terjadinya tidak bisa dihindari oleh siapapun. Pada usia lanjut akan terjadi berbagai kemunduran pada organ tubuh. Kemunduran ini berlaku pada fungsi motorik dan sensorik. Salah satu contohnya adalah pikun. Faktor pikun ini sendiri bisa menjadi penyebab terjadinya beberapa kelalaian. Salah satunya kelalaian saat berada di tempat yang menjadi bagian dari aktifitas sehari-hari yaitu kamar mandi. Melihat dari permasalahan di atas, penerapan ‘kamar mandi pintar’ mampu mengatasi permasalahan tersebut. Dengan aplikasi ini dapat mempermudah penggunaannya dan mampu memberikan keamanan yang lebih dibandingkan pada kamar mandi biasa. Alat ini juga akan dilengkapi dengan suatu sistem Android yang dapat memonitoring dan mengontrol kapasitas air yang keluar.

Sehingga seseorang dapat mengetahui jumlah pemakaian air pada kamar mandi dalam jangka waktu tertentu.

1.2 Rumusan Masalah

Adapun rumusan masalah dari proyek akhir ini adalah disusun sebagai berikut:

a) Bagaimana merancang dan membuat *hardware* dan *software prototype smart bathroom* berbasis arduino dengan monitoring pemakaian air menggunakan Android?
b) Bagaimana merancang sistem *Flush* otomatis menggunakan sensor *LDR* dan pegas *actuator*?
c) Bagaimana merakit sistem *hardware* dan sistem *software* sebagai kontrol utama dari *prototype smart bathroom* dengan monitoring penggunaan air menggunakan Android?

1.3 Tujuan

Adapun tujuan dari pembuatan tugas akhir dengan judul *Prototype smart bathroom* berbasis arduino dengan monitoring pemakaian air menggunakan Android ini adalah sebagai berikut:

a) Merancang dan membuat sistem *Prototype Smart Bathroom* berbasis Arduino.
b) Merancang sistem monitoring penggunaan air dengan Android.
c) Merakit sistem *hardware* dan sistem *software* sebagai kontrol utama dari *prototype smart bathroom* dengan monitoring penggunaan air menggunakan Android.

BAB II
DASAR TEORI

2.1 Android

Android adalah salah satu *platform* sistem operasi yang digemari masyarakat karena sifatnya yang *open source* sehingga memungkinkan pengguna untuk melakukan pengembangan [4]. Android merupakan generasi baru *platform mobile* berbasis *linux* yang mencakup sistem operasi, *middleware.*

Arsitektektur Android terdiri dari bagian-bagian sebagai berikut:

a) *Applications*dan *Widgets*: *layer* (lapisan) dimana pengguna hanya berhubungan dengan aplikasi saja.
b) *Applications Framework:* lapisan dimana para pengembang melakukan pembuatan aplikasi yang akan dijalankan di sistem operasi Android dengan komponen-komponennya. Meliputi *views, contents provider, resource manager*, *notification manager*, *activity manager*.
c) *Libraries:* lapisan dimana fitur-fitur Android berada, yang berada di atas *kernel* meliputi *library* C/C++ inti seperti Libc dan SSL.
d) Android *Run Time:* lapisan yang membuat aplikasi Android dapat dijalankan dimana dalam prosesnya menggunakan implementasi *Linux* yang terbagi menjadi dua bagian, yaitu *Core Libraries* dan *Dalvik virtual Machine*.
e) *Linux Kernel: layer* yang berisi file-file sistem untuk mengatur *processing*, *memory, resource, driver*, dan sistem operasi Android lainnya.

2.2 Program *Blynk* Pada Pemrograman Android

Blynk adalah sebuah layanan *server* yang digunakan untuk mendukung *project Internet of Things*. Layanan *server* ini memiliki lingkungan *mobile user* baik *Android* maupun *iOS*. Aplikasi *Blynk* sebagai pendukung *IoT* dapat diunduh melalui *Google play*.

Blynk mendukung berbagai macam *hardware* yang dapat digunakan untuk *project Internet of Things*. *Blynk* adalah *dashborad* digital dengan fasilitas antarmuka grafis dalam pembuatan *project* nya. Penambahan komponen pada *Blynk Apps* dengan cara *Drag and Drop* sehingga memudahkan dalam penambahan komponen Input/output tanpa perlu kemampuan pemrograman *Android* maupun *iOS*. *Blynk* diciptakan dengan tujuan untuk *control* dan *monitoring hardware* secara jarak jauh menggunakan komunikasi data internet ataupun intranet (jaringan *LAN*). Kemampuan untuk menyimpan data dan menampilkan data secara visual baik menggunakan angka, warna ataupun grafis semakin memudahkan dalam pembuatan projek dibidang *Internet of Things*.

Terdapat tiga komponen utama *Blynk*, yaitu:

a) *Blynk Apps*

Blynk Apps memungkinkan untuk membuat *project interface* dengan berbagai macam komponen input, output yang mendukung untuk pengiriman maupun penerimaan data serta merepresentasikan data sesuai dengan komponen yang dipilih. Representasi data dapat berbentuk visual angka maupun grafik.

Terdapat lima komponen yang berdapat pada Aplikasi *Blynk:*

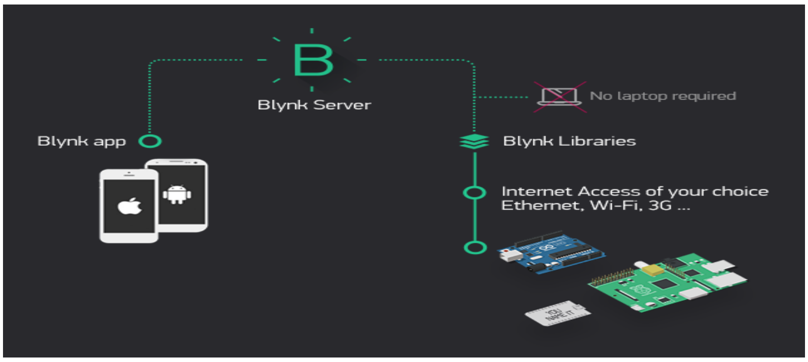
- *Controller* digunakan untuk mengirimkan data atau perintah ke *hardware*
- Display digunakan untuk menampilkan data yang berasal dari *hardware* ke *smartphone*
- *Notification* digunakan untuk mengirim pesan dan notifikasi
- *Interface* pengaturan tampilan pada aplikasi *Blynk* dapat berupa menu ataupun tab
- Beberapa komponen yang tidak masuk dalam tiga kategori sebelumnya di antaranya *Bridge, RTC, Bluetooth.*

b) *Blynk Server*

Blynk server merupakan fasilitas *Backend Service* berbasis *cloud* yang bertanggung jawab untuk mengatur komunikasi antara aplikasi *smart* *phone* dengan lingkungan *hardware*. Kemampun untuk menangani puluhan *hardware* pada saat yang bersamaan semakin memudahkan bagi para pengembang sistem *IoT*. *Blynk* server juga tersedia dalam bentuk *local server* apabila digunakan pada lingkungan tanpa internet. *Blynk server local* bersifat *open source* dan dapat diimplementasikan pada *hardware* Arduino ataupun *Raspberry Pi*.

c) *Blynk Library*

Blynk Library dapat digunakan untuk membantu pengembangan *code*. *Blynk library* tersedia pada banyak *platform* perangkat keras sehingga semakin memudahkan para pengembang *IoT* dengan fleksibilitas *hardware* yang didukung oleh lingkungan *Blynk*. Berikut adalah konsep kerja *Blynk pada gambar* 2.1

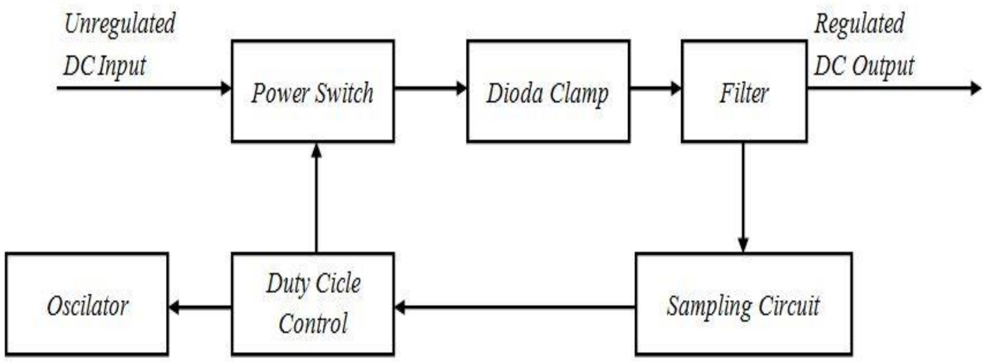


Gambar 2.1 *Blynk Cloud Server* [5]

2.3 *Power Supply*

Power supply atau dalam bahasa Indonesia disebut dengan catu daya adalah suatu alat listrik yang dapat menyediakan energi listrik untuk perangkat listrik ataupun elektronika lainnya. Pada dasarnya *power supply* atau catu daya ini memerlukan sumber energi listrik yang kemudian mengubahnya menjadi energi listrik yang dibutuhkan oleh perangkat elektronika lainnya. Oleh karena itu, *power supply* terkadang disebut juga dengan istilah *Electric Power Converter*. *Supply* utama yang digunakan pada rangkaian alat ini menggunakan catu daya *switching* 12 *Volt* 5 *Ampere*, karena membutuhkan tegangan yang stabil dan baik.

Catu daya *switching* lebih tahan jika digunakan dalam jangka waktu yang panjang karena tidak terpengaruh oleh temperatur, pembagian daya dari catu daya hingga ke komponen. *Switch Mode Power Supply (SMPS)* adalah jenis *power supply* yang langsung menyearahkan *(rectify)* dan menyaring *(filter)* tegangan *Input AC* untuk mendapatkan tegangan *DC*. Tegangan *DC* tersebut kemudian di *switch ON* dan *OFF* pada frekuensi tinggi dengan sirkuit frekuensi tinggi sehingga menghasilkan arus *AC* yang dapat melewati *transformator* frekuensi tinggi. Blok diagramnya dapat dilihat pada gambar 2.2 dan gambar 2.3.



Gambar 2.2 Blok diagram *Power Supply*

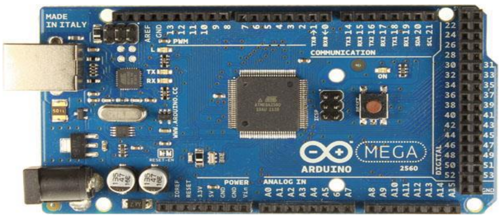
Gambar 2.3 *Power Supply* DC 12 Volt [6]

2.4 Rangkaian *Microcontroller*

Mikrocontroler dibutuhkan dalam tugas akhir ini untuk mengolah data dari masukan yang kemudian diolah untuk mengaktifkan *output*. *Microcontroler* yang digunakan pada pembuatan tugas akhir ini menggunakan arduino mega yang terdiri dari 16 digital *input*/*output* pin, dimana dapat memenuhi kebutuhan untuk mengakses rangkaian yang terhubung dengan beberapa komponen, seperti sensor relay 12 *VDC*, sensor *ultrasonic HC-SR04,* sensor *LDR (Light Dependent Resistor),* sensor *Motion Detector (PIR), Node MCU, solenoid valve,* dan *water flow meter.*

2.4.1 Arduino *Mega*

Komponen utama di dalam papan Arduino adalah sebuah 8 bit dengan merk *ATmega* yang dibuat oleh *Atmel Corporation*. Berbagai papan Arduino menggunakan tipe *ATmega* yang berbeda-beda tergantung dari spesifikasinya, sebagai contoh Arduino *Uno* menggunakan *ATmega328* sedangkan Arduino *Mega2560* yang lebih canggih menggunakan *ATmega2560*. Bentuk fisik Arduino *Mega2560* dapat dilihat pada gambar 2.4



Gambar 2.4 Arduino *Mega2560* [7]

2.4.2 Sumber Tegangan Arduino

Arduino Mega dapat diaktifkan melalui koneksi *USB* atau dengan *catu daya eksternal*. Sumber daya dipilih secara otomatis. Sumber daya *eksternal (non-USB)* dapat berasal baik dari *adaptor AC-DC* atau baterai. *Adaptor* dapat dihubungkan dengan mencolokkan steker 2,1 mm yang bagian tengahnya terminal positif ke sumber tegangan pada papan. Jika tegangan berasal dari baterai dapat langsung dihubungkan melalui *header pin Gnd* dan *pin Vin* dari konektor *power*. Papan Arduino *mega2560* dapat beroperasi dengan pasokan daya eksternal 6 *volt* sampai 20 *volt*. Jika diberi tegangan kurang dari 7 *volt*, maka pin 5 *volt* mungkin akan menghasilkan tegangan kurang dari 5 *volt* dan ini akan membuat papan menjadi tidak stabil. Jika sumber tegangan menggunakan lebih dari 12 *volt, regulator* tegangan akan mengalami panas berlebihan dan bisa merusak papan.

Rentang sumber tegangan yang dianjurkan adalah 7 *volt* sampai 12 *volt*. Sumber tegangan lebih dari 12 *volt*, *regulator* tegangan akan mengalami panas berlebihan dan bisa merusak papan. Jika diberi tegangan kurang dari 7 *volt*, maka pin 5 *volt* mungkin akan menghasilkan tegangan kurang dari 5 *volt* dan ini akan membuat papan menjadi tidak stabil.

Pin tegangan yang tersedia pada papan *arduino* adalah sebagai berikut:

a) *VIN*: Adalah *input* tegangan untuk papan *arduino* ketika menggunakan sumberdaya eksternal (sebagai 'saingan' tegangan 5 *volt* dari koneksi *USB* atau sumber daya ter-*regulator* lainnya). Anda dapat memberikan tegangan melalui pin ini, atau jika memasok tegangan untuk papan melalui *jack power*, kita bisa mengakses/mengambil tegangan melalui pin ini.

b) *5V*: Sebuah pin yang mengeluarkan tegangan ter-*regulator 5 volt*, dari pin ini tegangan sudah diatur (ter-*regulator*) dari r*egulator* yang tersedia (*built-in*) pada papan. Arduino dapat diaktifkan dengan sumber daya baik berasal dari *jack power DC (7-12 volt)*, *konektor USB (5 volt)*, atau pin *VIN* pada *board (7-12 volt)*. Memberikan tegangan melalui pin *5V* atau *3.3V* secara langsung tanpa melewati *regulator* dapat merusak papan *Arduino*.

c) 3V3: Sebuah pin yang menghasilkan tegangan 3,3 Volt. Tegangan ini dihasilkan oleh *regulator* yang terdapat pada papan (*on-board*). Arus maksimum yang dihasilkan adalah 50 mA.

d) *GND: Pin Ground* atau Massa.

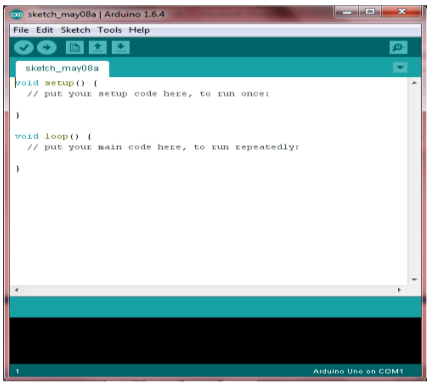
e) *IOREF*: Pin ini pada papan *arduino* berfungsi untuk memberikan referensi

Tegangan yang beroperasi pada *mikrokontroler*. Sebuah perisai (*shield*) dikonfigurasi dengan benar untuk dapat membaca pin tegangan *IOREF* dan memilih sumber daya yang tepat atau mengaktifkan penerjemah tegangan *(voltage translator*) pada *output* untuk bekerja pada tegangan 5 *volt* atau 3,3 *volt*.

2.4.3 *Software* Arduino

Arduino diciptakan untuk para pemula bahkan yang tidak memiliki *basic* bahasa pemrograman sama sekali karena menggunakan bahasa *C++* yang telah dipermudah melalui *library*. Arduino menggunakan *software processing* yang digunakan untuk menulis program ke dalam arduino. *Processing* sendiri merupakan penggabungan antara bahasa *C++* dan *Java*. *Software* arduino ini dapat di-*install* di berbagai *operating system (OS)* seperti: *LINUX, Mac OS, Windows.* Arduino tidak hanya sekedar sebuah alat pengembangan, tetapi kombinasi dari *hardware*, bahasa pemrograman dan *Integrated Development Environment (IDE)*yang canggih. *IDE* adalah sebuah *software* yang sangat berperan untuk menulis program, meng-*compile* menjadi kode *biner* dan meng-*upload* ke dalam *memory microcontroller*. *Software IDE Arduino* terdiri dari 3 (tiga) bagian: Editor program, untuk menulis dan mengedit program dalam bahasa *processing*.

a) *Listing* program pada *Arduino* disebut *sketch. processing*. *Listing* program pada *Arduino* disebut *sketch.*
b) *Compiler*, modul yang berfungsi mengubah bahasa *processing* (kode program) ke dalam kode *biner* karena kode *biner* adalah satu–satunya bahasa program yang dipahami oleh *microcontroller.*
c) *Uploader*, modul yang berfungsi memasukkan kode *biner* ke dalam memori *microcontroller*. Adapun tampilan awal *software arduino* dapat dilihat pada gambar 2.5 di bawah ini.



Gambar 2.5 Tampilan *software* Arduino

2.5 Sensor *Ultrasonic HC-SR04*

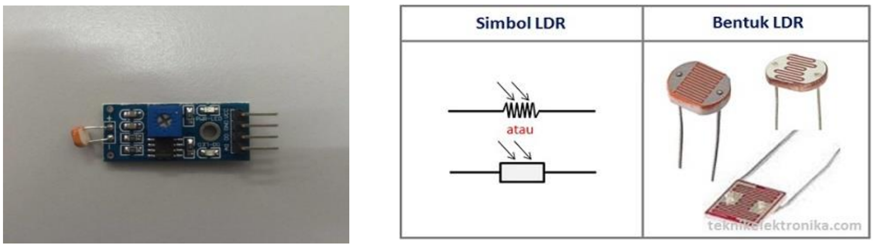
Modul *HC-SR04* merupakan modul sensor *ultrasonik* yang memiliki fungsi utama sebagai pengukur jarak. Modul ini terdiri atas sepasang *transduser* dengan empat pin, yaitu pin suplai tegangan (*Vcc), pin trigger*, *pin echo*, dan *pin ground*. Modul akan memulai pengukuran saat diberi sinyal pulsa *trigger* sepanjang 10 μs, di mana *transmitter* akan mengirimkan gelombang *ultrasonic* yang akan diterima kembali oleh *receiver* saat gelombang tersebut mengenai objek dan memantul. Gelombang *ultrasonic* adalah gelombang mekanis yang mempunyai daerah frekuensi di atas kemampuan manusia atau di atas 20 KHz.

Bunyi *ultrasonic* tidak dapat didengar oleh telinga manusia. Bunyi ultrasonik dapat didengar oleh anjing, kucing, kelelawar, dan lumba-lumba. Bunyi *ultrasonic* bisa merambat melalui zat padat, cair dan gas. Reflektivitas bunyi ultrasonik di permukaan zat padat hampir sama dengan reflektivitas bunyi ultrasonik di permukaan zat cair. Akan tetapi, gelombang bunyi *ultrasonic* akan diserap oleh tekstil dan busa. Sensor ini merupakan sensor *ultrasonic* siap pakai, satu alat yang berfungsi sebagai pengirim, penerima, dan pengontrol gelombang *ultrasonic*. Untuk lebih jelasnya dapat dilihat pada gambar 2.6 berikut.

Gambar 2.6 Bentuk fisik sensor *HC-SR04*

2.6 *LDR* (*Light Dependent Resistor*)

LDR merupakan salah satu jenis resistor yang disebut sebagai *fotoresistor*. Nilai hambatan *LDR* dipengaruhi oleh cahaya yang diterima dari lingkungan sekitar. Resistansi *LDR* dapat berubah-ubah tergantung pada intensitas cahaya yang diterima oleh *LDR* itu sendiri. Gambar 2.7 adalah bentuk fisik dan symbol dari LDR.

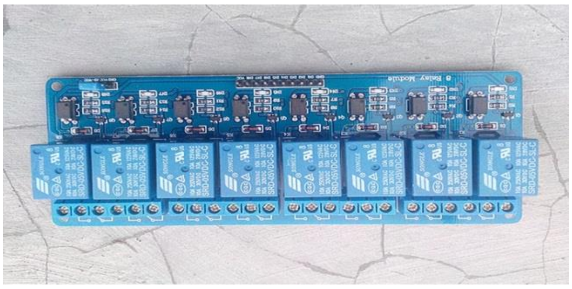


Gambar 2.7 Bentuk fisik dan simbol *LDR* [8]

2.7 *Relay*

Relay adalah sebuah alat yang bekerja secara otomatis mengatur atau memasukan suatu rangkaian listrik (rangkaian *trip*) akibat adanya perubahan rangkaian yang lain. *Relay* pada awalnya berdasarkan dari teknik telegrafi, dimana sebuah *coil* di-*energize* oleh sebuah arus lemah, dan *coil* ini menarik *armature* untuk menutup kontak. Jadi *Relay* dapat disebut juga saklar *elektromagnetis*, karena alat ini bekerja dengan memanfaatkan gaya magnet dari *coil* yang terdapat dalam *relay* karena diberikan tegangan listrik.

Berikut adalah bentuk fisik dari *relay* 8 *channel pada gambar* 2.8.



Gambar 2.8 Bentuk fisik modul *Relay*

2.8 *NodeMCU ESP8266*

NodeMCU ESP8266 merupakan modul turunan pengembangan dari modul *platform IoT (Internet of Things)* keluarga *ESP8266* tipe *ESP-*

12. Secara fungsi modul ini hampir menyerupai *platform* modul Arduino, tetapi yang membedakan yaitu dikhususkan untuk "*Connected to Internet*". Berikut merupakan bentuk fisik *NodeMCU* pada gambar 2.9.

.

Gambar 2.9 Bentuk fisik *NodeMCU* ESP8266 [9]

2.9 *Water Flow* Sensor

Water flow sensor merupakan yang penggunaanya untuk mendeteksi aliran air. Baik itu aliran yang mempunyai *pressure* tertentu, aliran air dengan tekanan sangat kecil serta kecepatan aliran yang minim maupun untuk aliran air di tempat terbuka seperti di parit, sungai atau saluran irigasi. *Water flow s*ensor ini banyak juga yang menyebut dengan istilah meteran air, *flow* meter air atau *water flow meter.* Berikut ini adalah bentuk fisik *water flow sensor pada gambar* 2.10.

Gambar 2.10 Bentuk fisik *Water flow* sensor [10]

2.10 Motor DC

Motor DC adalah motor listrik yang memerlukan *supply* tegangan arus searah pada kumparan medan untuk diubah menjadi energi gerak mekanik. Kumparan medan pada motor DC disebut *stator* (bagian yang tidak berputar) dan kumparan jangkar disebut *rotor* (bagian yang berputar). Motor arus searah, sebagaimana namanya, menggunakan arus langsung yang tidak langsung/*direct-unidirectional*.

Motor DC memiliki tiga komponen utama untuk dapat berputar, yaitu sebagai berikut:

- Kutub medan. Motor DC sederhana memiliki dua kutub medan: kutub utara dan kutub selatan. Garis magnetik energi membesar melintasi ruang terbuka diantara kutub-kutub dari utara ke selatan. Untuk motor yang lebih besar atau lebih *kompleks* terdapat satu atau lebih *elektromagnet.*
- *Current Elektromagnet* atau Dinamo. Dinamo yang berbentuk *silinder*, dihubungkan ke as penggerak untuk menggerakan beban. Untuk kasus motor DC yang kecil, dinamo berputar dalam medan magnet yang dibentuk oleh kutub-kutub, sampai kutub utara dan selatan magnet berganti lokasi.
- *Commutator*. Komponen ini terutama ditemukan dalam motor DC. Kegunaannya adalah untuk transmisi arus antara dinamo dan sumber daya.

Berikut adalah bentuk fisik motor DC pada gambar 2.11

Gambar 2.11 Bentuk fisik Motor DC 12V

2.11 Sensor PIR *(Passive Infra Red)*

Sensor PIR (*Passive Infra Red*) adalah sensor yang berfungsi sebagai pendeteksi gerakan yang bekerja dengan cara mendeteksi adanya perbedaan/perubahan suhu sekarang dan sebelumnya. Sensor gerak menggunakan modul PIR sangat simpel dan mudah diaplikasikan karena

Modul PIR hanya membutuhkan tegangan input DC 5V cukup efektif untuk mendeteksi gerakan hingga jarak 5 meter. Ketika tidak mendeteksi gerakan, keluaran modul adalah *LOW*, dan ketika mendeteksi adanya gerakan, maka keluaran akan berubah menjadi *HIGH*. Adapun lebar pulsa *HIGH* adalah ±0,5 detik. Sensitifitas Modul PIR yang mampu mendeteksi adanya gerakan pada jarak 5 meter memungkinkan tingkat keberhasilan deteksi lebih besar.

Gambar 2.12 Bentuk fisik sensor PIR [11]

2.12 *Step Down LM2596*

LM2596 merupakan sebuah modul pengkonversi tegangan DC ke DC yang dilengkapi dengan *IC* penurun dan penaik tegangan. Pada *LM2596* tegangan di konversi dan bisa disesuaikan dengan cara memutar bagian pengaturan untuk menurunkan atau menaikan tegangan. Modul ini memiliki 4 pin, 2 di kiri dan 2 di kanan untuk arus masuk dan keluar. Berikut ini adalah kegunaan *LM2596* dalam menurunkan tegangan DC, yaitu:

- Kipas pendingin komputer agar tidak terlalu berisik dapat diturunkan *voltage* sampai 9-10V DC dari sumber *input* 12VDC
- Adaptor 12V DC dapat diturunkan menjadi 9V. Misalnya dimanfaatkan untuk *power modem* yang membutuhkan *power* 9V DC sementara hanya tersedia adaptor 12V.
- Adaptor biasa dapat 9V diturunkan ke 5V, misalnya untuk mengisi *smartphone* atau *powerbank*.
- Menyalakan lampu LED 9V dari sumber *powerbank* 5V
- Bahkan untuk mengantikan *power* baterai alat elektronik seperti mobil - mobilan, alat cukur dan lainnya.

Berikut adalah bentuk fisik *step down LM259 pada gambar* 2.13

Gambar 2.13 Bentuk fisik *step down LM259* [12]

2.13 *Solenoid Valve 12V DC*

Solenoid valve merupakan katup yang dikendalikan dengan arus listrik baik AC maupun DC melalui kumparan/*solenoid*. *Solenoid valve* ini merupakan elemen kontrol yang paling sering digunakan dalam sistem *fluida*. Seperti pada sistem *pneumatik*, sistem *hidrolik* ataupun pada sistem kontrol mesin yang membutuhkan elemen kontrol otomatis. Contohnya pada sistem *pneumatik*, *solenoid valve* bertugas untuk mengontrol saluran udara yang bertekanan menuju *aktuator pneumatic (cylinder)*. Atau pada sebuah tandon air yang membutuhkan *solenoid valve* sebagai pengatur pengisian air, sehingga tandon tersebut tidak sampai kosong. *Solenoid valve* akan bekerja bila kumparan/coil mendapatkan tegangan arus listrik yang sesuai dengan tegangan kerja (kebanyakan tegangan kerja *solenoid valve* adalah 100/200VAC dan kebanyakan tegangan kerja pada tegangan DC adalah 12/24VDC). Berikut adalah bentuk fisik *Solenoid Valve pada gambar* 2.14

Gambar 2.14 Bentuk fisik *Solenoid Valve* 12V DC [13]

2.14 *Lock Actuator* (2 Kabel)

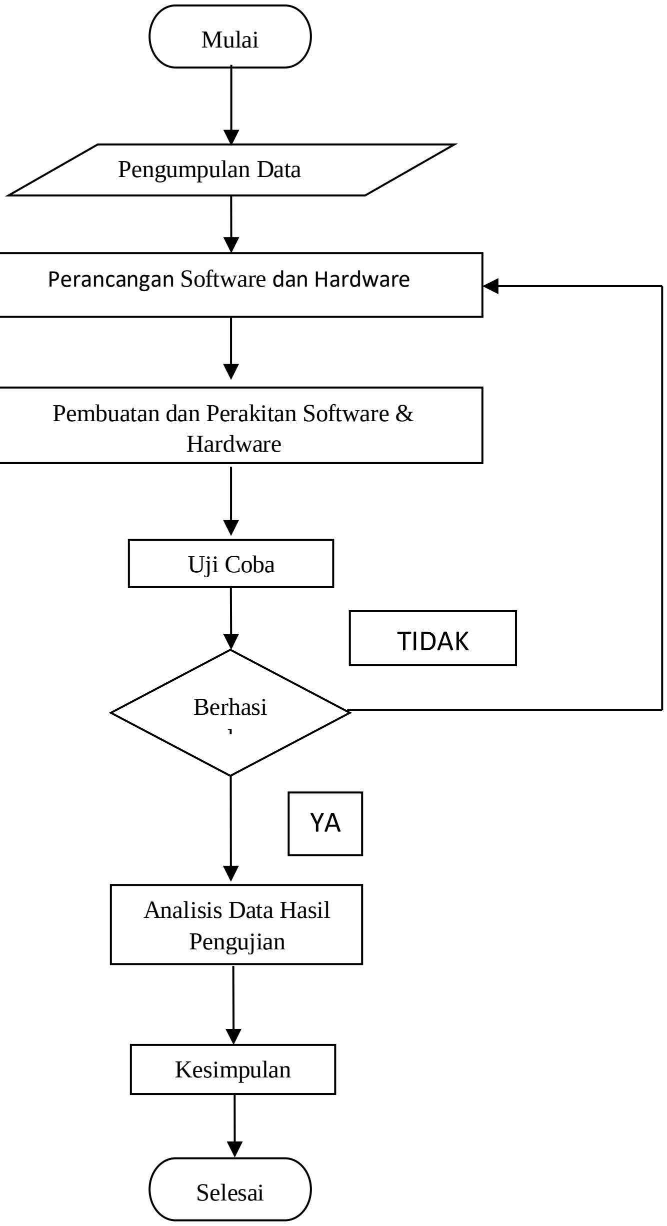
Umumnya hanya memiliki 2 kabel: Hijau dan Biru. Digunakan untuk pintu -pintu atau tutup tangki bensin. *Lock Actuator* memiliki kekuatan dan jarak gerak yang hampir sama, yaitu kekuaatan dan Jarak gerak sekitar 18mm. Berikut bentuk fisik dari *Lock Actuator pada gambar* 2.15

Gambar 2.15 Bentuk fisik *Lock Actuator* [14]

BAB III
METODE PELAKSANAAN

3.1 *Flowchart* Pembuatan *Prototype Smart Bathroom*

Pada gambar 3.1 adalah *flowchart* dari pembuatan *Prototype Smart Bathroom.*



Gambar 3.1 *Flowchart* Metode Pelaksanaan

3.2 Pengumpulan Data

Pengumpulan data berfungsi untuk mengumpulkan data yang diperlukan untuk mendapatkan pengetahuan tentang proyek akhir yang akan dikerjakan. Pengumpulan data dilakukan dengan beberapa cara, antara lain sebagai berikut:

a) Observasi yang dilakukan (pengamatan langsung) ke beberapa rumah yang rata-rata dihuni oleh lansia, untuk lebih mengetahui secara jelas dan detail permasalahan - permasalahan yang berkaitan dengan penggunaan kamar mandi biasa, sehingga penerapan sistem pada *prototype* kamar mandi pintar lebih menekankan terhadap permasalahan yang telah dikumpulkan dari observasi tersebut.
b) Pembuatan simulasi dilakukan agar bisa mengetahui apakah konstruksi yang akan dibuat dapat menyelesaikan permasalahan atau tidak. Permasalahannya adalah konstruksi dapat menggambarkan kondisi yang sebenarnya pada kamar mandi sesungguhnya.
c) Studi Pustaka untuk menunjang pembuatan kamar mandi pintar berbasis arduino sebagai program utama dan Android sebagai monitoring dari jumlah pemakaian air pada *prototype* kamar mandi tersebut. Maka dilakukanlah Studi Pustaka dari berbagai sumber yang terkait dengan masalah-masalah yang akan dibahas. Sumber berasal dari buku-buku referensi, jurnal, serta media internet agar tujuan tersebut tercapai.

3.3 Perancangan *Software* dan *Hardware*

a) Perancangan *Software.* Jika proses pengumpulan data telah selesai, maka dibuatlah rancangan *software* yang bisa dijalankan sesuai sistem yang telah ditentukan serta mudah dalam proses pengoperasiannya.
b) Perancangan *Hardware*. Jika proses pengumpulan data telah selesai, maka dibuatlah rancangan *hardware* dari *prototype smart bathroom* berbasis arduino dengan monitoring pemakaian air menggunakan Android yang dapat menggambarkan bentuk serta fungsinya sesuai dengan kamar mandi sungguhan.

3.4 Pembuatan *Software* dan *Hardware*

a) Pembuatan *Software*

Jika proses perancangan telah selesai, maka proses selanjutnya adalah membuat *software* yang telah ditentukan sesuai dengan fungsi dan sistem pengoperasiannya.

b) Pembuatan *Hardware*

c) Jika proses perancangan telah selesai, maka *hardware* akan dibuat sesuai dengan ukuran dan dimensi dari gambar kerja dan menggunakan bahan yang telah ditentukan pada tahap perancangan.

3.5 Uji Coba

Jika proses pembuatan *software* dan *hardware* telah selesai, maka selanjutnya alat akan diuji coba apakah alat tersebut sudah sesuai dengan apa yang diharapkan atau belum. Jika belum sesuai, maka kembali ke proses perancangan. Jika berhasil maka dibuatkan laporan hasil alat yang telah melalui beberapa tahap pengerjaan hingga uji coba.

3.6 Kesimpulan

Jika semua proses telah dilaksanakan hingga tingkat keberhasilan alat telah diperoleh, maka proses selanjutnya adalah menarik kesimpulan dari hasil tersebut untuk dijadikannya acuan terhadap penyelesaian masalah-masalah dari pengerjaan alat serta cara menyelesaikan permasalahan tersebut.

3.7 Pembuatan Laporan

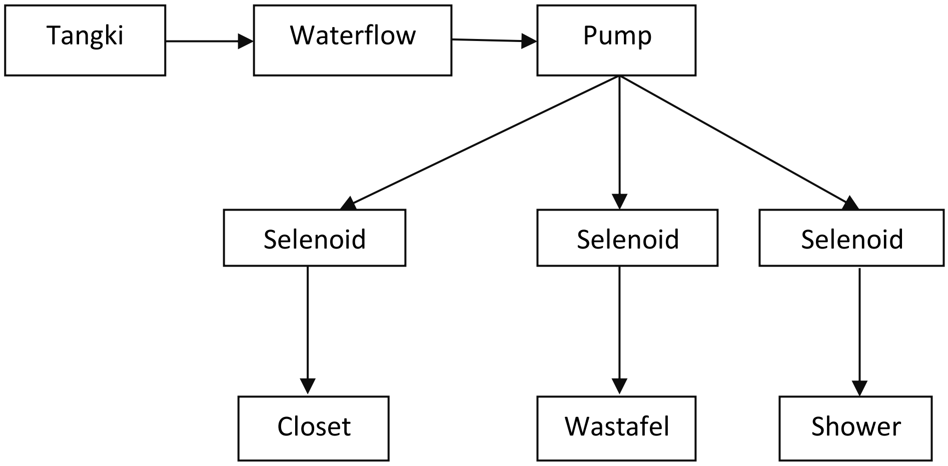
Tahap ini adalah tahap terakhir apabila alat telah memenuhi tuntutan yang ingin dicapai, maka proses pembuatan alat dapat dinyatakan selesai. Dengan selesainya alat, maka penulis akan membuat laporan secara detailtentang proses pembuatan alat dari tahap awal hingga tahap akhir.

BAB IV
PEMBAHASAN

Pada bab ini akan dijelaskan tentang proses pembuatan alat. Dalam proses pembuatan alat ada beberapa tahapan, yaitu: rancangan alat, pembuatan *hardware*, pembuatan *software* dan pengujian alat.

4.1 Perancangan Smart Bathroom

Gambar 4.1 berikut merupakan konsep rancangan *smart bathroom* yang telah disetujui pada proposal proyek akhir.



Gambar 4.1 Konsep rancangan *Smart Bathroom*

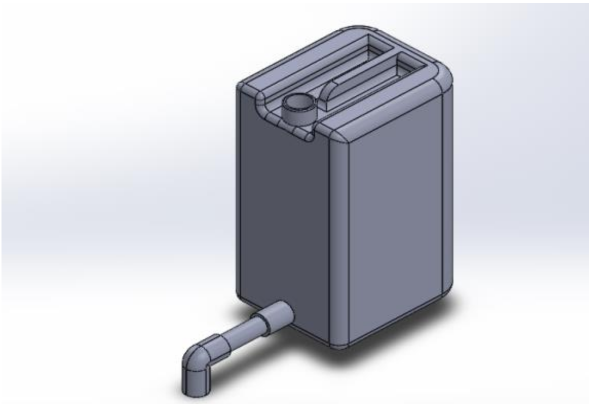
Berdasarkan konsep rancangan yang telah dibuat, proyek akhir ini akan mensimulasikan sistem kontrol air dengan menggunakan setiap sensor pada masing-masing komponen yang ada dikamar mandi.

4.2 Pembuatan Konstruksi Smart Bathroom

Kegiatan ini bertujuan untuk membuat konstruksi dari *smart bathroom* dimana tahapan yang dilakukan meliputi perancangan, pembuatan, perakitan dan pengujian konstruksi mekanik dan *hardware electrical*.

4.2.1 Tangki Penampungan Air

Penampungan air ini terbuat dari bahan plastik dengan massa tangki sebesar 1,5 kg dengan kapasitas penampungan air sebanyak 35L. Penampung air ini telah dimodifikasi dengan tambahan keran yang dibuat sebagai tempat penyaluran air yang akan keluar dari tangki. Tangki diletakan sejajar dengan konstruksi *prototype smart bathroom.* Tangki berfungsi sebagai sumber utama dari air setiap komponen *prototype smart bathroom.* Untuk lebih jelas dapat dilihat pada gambar 4.2 di bawah ini.



Gambar 4.2 Rancangan Tangki Penampungan Air

Pengujian tangki penampung air dilakukan dengan keluarnya air dari tangki ketika keran pada tangki dibuka, yang kemudian air akan mengalir pada masing-masing *solenoid valve* pada setiap komponen. Sebelum melalui *solenoid valve,* air yang keluar dari tangki akan melewati *waterflow* sensor, dimana *waterflow* sensor berfungsi sebagai indikator air yang keluar dari tangki secara keseluruhan untuk penggunaan air pada setiap komponen kamar mandi. Setelah melewati sensor *water flow*, air akan mengalir melalui pompa DC yang siap dialirkan ke masing-masing *solenoid valve* pada *closet, shower,* dan *wastafel* yang siap digunakan. Pada gambar 4.3 adalah hasil pengujian tangki air yang sudah dipasang dari pemipaan sampai ke seluruh komponen yang sudah siap digunakan. Mulai dari *water flow* sensor, *pump,* dan *solenoid valve.*

Untuk melihat hasil pengujian tangki dapat dilihat pada gambar 4.3 di bawah ini.

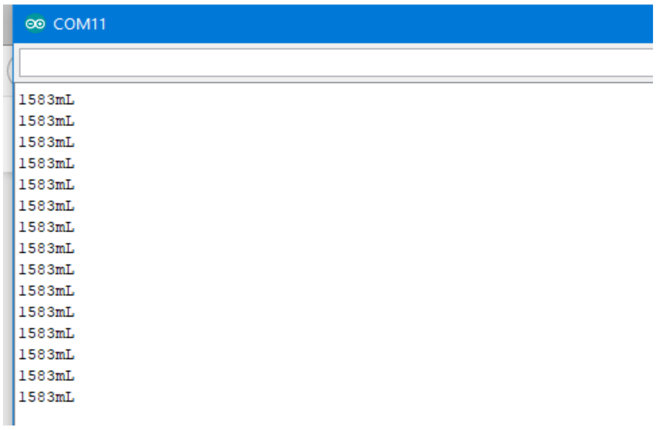
Gambar 4.3 Hasil Pengujian Tangki

4.2.2 *Waterflow* sensor

Waterflow sensor terbuat dari bahan plastic dengan spesifikasi yaitu*:* Tegangan minimum 4.5V, arus maksimal 15mA (DC 5V), tegangan kerja DC 5V-24V, rentang aliran arus 1-30L/menit. Waterflow sensor berfungsi sebagai indikator air yang telah terpakai dari tangki yang digunakan oleh *shower, closet* dan *wastafel. Waterflow* diletakan setelah pipa keran dari tangki, kemudian akan terhubung dengan setiap *solenoid valve* komponen kamar mandi yaitu *shower, closet* dan *wastafel*. Untuk lebih jelas dapat dilihat pada gambar 4.4 di bawah ini.

Gambar 4.4 Rancangan *Waterflow* Sensor

Pengujian *waterflow* sensor dapat dilakukan dengan terpasangnya *waterflow* sensor setelah keran dari tangki terhubung dengan program *waterflow* sensor, dimana setiap air yang telah keluar dari tangki akan ditampilakan di *serial monitor* program *waterflow* sensor. Pengujian pertama dilakukan dengan mengisi wadah air 1500 ml untuk melihat hasil indicator/pembacaan *waterflow* sensor. Untuk hasil pengujian *waterflow* sensor dapat dilihat pada gambar 4.5 dan gambar 4.6 di bawah ini.



Gambar 4.5 Hasil Pembacaan waterflow Sensor

Gambar 4.6 Hasil Pengujian Air yang keluar melalui *Waterflow* sensor

4.2.3 *Solenoid Valve*

Pengujian *solenoid valve* dapat dilakukan dengan terbukanya katup yang ada pada *selenoid valve* sehingga air akan keluar dari tangki ketika diberikan tegangan oleh sumber *relay* yang terhubung pada masing-masing *solenoid valve*. *Solenoid valve* akan terputus apabila tidak diberikan tegangan, dalam hal ini *solenoid* terkontrol oleh masing-masing sensor pada setiap komponen kamar mandi. Untuk gambar hasil pengujian dapat dilihat pada gambar 4.7 dan gambar 4.8 di bawah ini.

Gambar 4.7 Selenoid Valve

Gambar 4.8 Hasil Pengujian Selenoid Valve

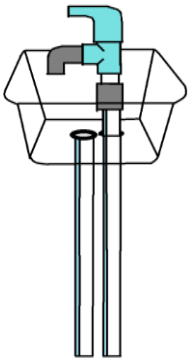
4.2.4 *Pump*

Pump terbuat dari bahan plastic dengan spesifikasi debit air 4.0L/min, daya dorong 0.5mpa, *voltage* DC 12V dan daya/power 60-65W. *Pump* diletakan berurutan sesuai dengan jalur pemipaan air, yaitu setelah keran tangki air. Hal ini berfungsi agar air yang keluar dari tangki memiliki daya dorong yang besar terhadap air yang mengalir ke setiap komponen kamar mandi. Untuk lebih jelas dapat dilihat pada gambar 4.9 di bawah ini.

Gambar 4.9 Perangkaian *Pump*

4.2.5 ***Wastafel***

Wastafel terbuat dari wadah plastik, *wastafel* ini memiliki panjang keseluruhan 17 cm yang terdiri dari kombinasi pipa berdiameter 0,5*inchi* dengan panjang 30 cm untuk pembuangan air *wastafel*. Untuk lebih jelas dapat dilihat pada gambar 4.10 di bawah ini.



Gambar 4.10 Rancangan *Wastafel*

Wastafel dibuat sesuai dengan desain yang telah ditentukan. Pada bagian samping keran air terdapat sensor ultrasonik *HC-SR04* yang berfungsi untuk mendeteksi jarak tanggan pengguna, sementara pada bagian bawah *wastafel* terdapat 1 pipa, dimana jalur tersebut digunakan sebagai pipa pengeluaran air *wastafel*. Untuk lebih jelas dapat dilihat pada gambar 4.11 di bawah ini.

Gambar 4.11 Hasil rancangan *wastafel*

Pengujian *wastafel* meliputi pengujian terhadap air yang keluar dari keran ketika terdapat user atau objek yang terdeteksi oleh sensor *ultrasonic* dengan jarak minimal 5 cm dan maksimal 10 cm dari sensor. Hasil pengujian dapat dilihat pada gambar 4.12 dan gambar 4.13 di bawah ini.

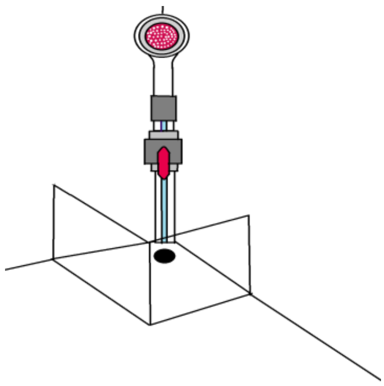
Gambar 4.12 *Wastafel* sebelum diuji

Gambar 4.13 adalah hasil pengujian dari *wastafel* yg sudah diuji.

Gambar 4.13 *Wastafel* setelah diuji

4.2.6 *Shower*

Shower terbuat dari bahan plastik yang dilengkapi dengan keran manual. Shower dilengkapi dengan dinding berbahan akrilik yang akan memudahkan proses deteksifikasi sensor pada saat simulasi. Untuk lebih jelas dapat dilihat pada gambar 4.14 di bawah ini.



Gambar 4.14 Rancangan *shower*

Shower dibuat sesuai dengan desain yang telah ditentukan. Pada bagian samping *shower* terdapat sensor ultrasonik *HC-SR04* yang berfungsi untuk mendeteksi jarak pengguna yang akan menggunakan *shower*. Sementara pada bagian bawah terdapat 1 pipa yang berfungsi sebagai pipa keluaran air *shower*.

Shower side yang telah dibuat dapat dilihat pada gambar 4.15 di bawah ini.

Gambar 4.15 Hasil rancangan *Shower side*

Pengujian *shower* meliputi pengujian terhadap pergerakan air yang keluar apabila terdapat objek atau user yang terdeteksi oleh sensor ultrasonic dengan jarak minimal 10 cm dan jarak maksimal 20 cm dari jarak sensor. *Shower* disertai dengan keran manual berdasarkan tuntutan. Hasil pengujian dapat dilihat pada gambar 4.16 dan gambar 4.17 di bawah ini.

Gambar 4.16 *Shower* sebelum diuji

Gambar 4.17 adalah hasil pengujian *shower* yang sudah diuji.

Gambar 4.17 *Shower* setelah diuji

4.2.7 *Closet*

Closet disusun secara sejajar dengan *shower* dan terbuat dari bahan keramik dengan bentuk dan ukuran yang sesungguhnya, hal ini dikarenakan *closet* yang digunakan adalah *closet* sungguhan sebagai tuntutan tugas akhir. Untuk lebih jelas dapat dilihat pada gambar 4.18 di bawah ini.

Gambar 4.18 Bentuk fisik *closet* sungguhan

Sistem *closet* dibuat sesuai dengan desain yang telah ditentukan. Pada bagaian *flush closet* terdapat *lock actuator* yang pergerakannya dikontrol oleh *relay*. Prinsip kerja *closet* ini adalah *flush* pada *closet* melakukan sistem pembilasan otomatis saat intensitas cahaya melalui sensor *LDR* terpenuhi dan berhenti secara otomatis ketika sistem pembersihan closet telah selesai dengan tidak terdeteksinya cahaya oleh sensor *LDR*. *Closet* yang telah dirakit dapat dilihat pada gambar 4.19 di bawah ini.

Gambar 4.19 Perakitan Sensor *LDR* di Closet

Pengujian *closet* meliputi sistem *flush closet* yang berfungsi otomatis apabila *user* ingin menggunakan *closet* dengan cara membuka tutup *closet* secara manual, maka *actuator* akan aktif dengan ditandai terbuka cahaya teridentifikasi oleh sensor LDR, kemudian pembilasan akan dilakukan secara otomatis dan pada saat tutup closet ditutup kembali maka pembilasan air akan berhenti secara otomatis. Hal ini dikarenakan tidak teridentifkasinya cahaya ke sensor *LDR*. Ketika sensor *LDR* sudah terpenuhi, maka *lock actuatuor* yang berfungsi sebagai penekan *flush closet* tersebut akan aktif. Begitu juga ketika sensor *LDR* tidak terpenuhi cahaya, maka *lock actuator* akan kembali ke posisi awal. Gambar 4.20 dan gambar 4.21 adalah hasil pengujian dari *closet* tersebut.

Hasil pengujiannya dapat dilihat pada gambar 4.20 dan gambar 4.21 di bawah ini.

Gambar 4.20 *Closet* sebelum diuji

Gambar 4.21 *Flush* otomatis pada *closet*

4.2.8 Sistem pintu

Sistem pintu dirancang menggunakan sistem *sliding* dengan menggunakan motor DC 12V. Motor DC yang digunakan sebanyak satu buah yang telah dimodifikasi dan disusun sesuai design pintu yang terbuat dari bahan akrilik.

Untuk lebih jelas dapat dilihat pada gambar 4.22

Gambar 4.22 Rancangan Sistem Pintu

Pintu yang digunakan terbuat dari satu buah akrilik yang dimodifikasi sedemikian rupa sehingga sesuai dengan desain yang telah ditentukan. Pintu digerakkan oleh motor DC 12V, sehingga dapat bergerak menutup dan membuka. Selain itu pintu juga dilengkapi dengan sensor *pir* pada bagian atas yang berfungsi untuk mendeteksi *user* agar pintu dapat terbuka dan tertutup secara otomatis. Serta penggunaan *limit switch* yang berfungsi sebagai sensor minimum, maksimum, dan push button untuk menandakan bahwa kamar mandi telah selesai digunkan, dengan ditandai dengan pintu terbuka, dan lampu padam secara otomatis. Pintu yang telah dibuat dapat dilihat pada gambar 4.23 di bawah ini.

Gambar 4.23 Perakitan sistem pintu

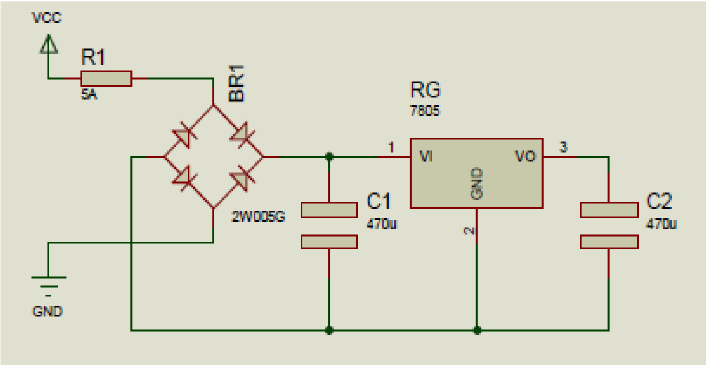
Pengujian pintu meliputi pengujian terhadap pergerakan terbuka dan tertutup otomatis pintu melalui motor DC, apabila terdapat *user* yang terdeteksi oleh sensor *PIR* dengan jarak yang telah ditentukan maka pintu akan melakukan gerakan geser untuk membuka dan menutup. Selanjutnya sensor *PIR* yang ada di dalam mendeteksi *user* yang masuk. Dan apabila ada *user* lain yang ingin menggunakan kamar mandi, *user* dapat mengetahui adanya pengguna di dalam kamar mandi dengan ditandai dengan tidak berfungsinya sensor *PIR* luar, atau dengan kata lain pintu terkunci dari dalam. Hasil pengujian pergerakan pintu dapat dilihat pada gambar 4.24 dan gambar 4.25 di bawah ini.

Gambar 4.24 Pintu bergerak menutup

Gambar 4.25 Pintu bergerak membuka

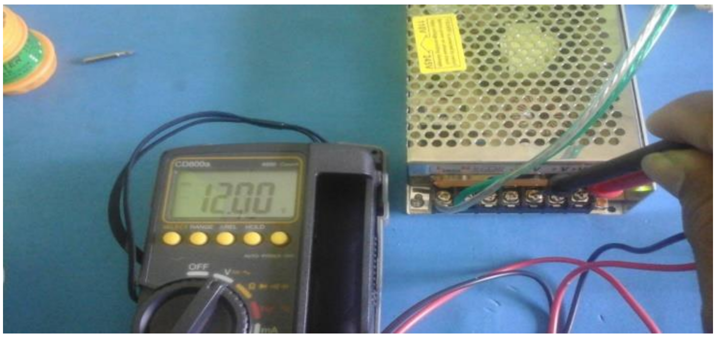
4.2.9 *Power Supply*

Power supply yang digunakan memiliki spesifikasi AC 110V-260V 50Hz-60Hz dan DC 12V/5A. Rangkaian skematik *power supply* dapat dilihat pada gambar 4.26 di bawah ini.



Gambar 4.26 Rangkaian *skematik power supply*

Pengujian yang dilakukan yaitu pengujian tehadap *output* tegangan menggunakan *multitester*. Blok diagram pengujiannya dapat dilihat pada gambar 4.27 di bawah ini. Gambar 4.27 menunjukkan hasil pengukuran tegangan *output* pada *power supply* 12VDC dan hasil pengujian *power supply* 12V dapat dilihat pada tabel 4.1 di bawah ini. Berikut adalah hasil pengukuran *power supply pada gambar* 4.27.



Gambar 4.27 Hasil pengukuran *power supply*

Berikut adalah table hasil pengukuran *IC Regulator* pada table 4.1

Tabel 4.1 Hasil Pengukuran Pada *IC Regulator*

Pengujian ke-	Nilai yang diinginkan	Output yang dihasilkan	Presentase error
1	12V	12V	0%
2	12V	12V	0%
3	12V	12V	0%

Dari data di atas didapat hasil pengukuran *output* tegangan yaitu 4.95 *Volt*.Untuk menentukan persentase *error power supply* dapat dilakukan dengan menggunakan formula sebagai berikut.

$$\left|\frac{Teori-nilai\ yang\ diukur}{Teori}\right| x100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Di bawah ini merupakan perhitungan persantase *error* rangkaian *powersupply* yang telah dibuat:

$$\left|\frac{\mathbf{12-12}}{\mathbf{12}}\right| \boldsymbol{x100}\% = \mathbf{0}\%$$

Nilai *output* yang keluar dari rangkaian *power supply* yang telah dibuat tidak memiliki selisih dari keluaran yang diinginkan, hal ini disebabkan olehproses pengaturan tegangan melalui pemutaran mur yang baik, tingkat *error* yang tidak melebihi 5% pada rangkaian *power supply*, menyebabkan *power supply* ini aman digunakan tanpa merusak rangkaian yang di*supply*-nya.

4.2.10 Arduino

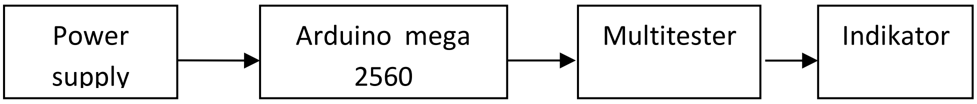
Arduino yang digunakan yaitu Arduino *Mega 2560.* Berfungsi sebagai perangkat kontrol dalam mengontrol sistem kerja kamar mandi pintar. Pada arduino pin digital D2 dan D3 digunakan sebagai *output sensor pir*, D22 dan D23 digunakan untuk *ouput* Motor DC dan D24 digunakan untuk *input*an lampu,, D5 dan D6 sebagai *output* sensor ultrasonic HC SR-04. Pengontrolan sensor *LDR* menggunakan pin digital D4. Pin D10 dan D11 digunakan sebagai *ouput* pintu terbuka dan pintu tertutup, sementara D12 digunakan sebagai *output pushbutton* pintu keluar.

Arduino yang digunakan yaitu *Arduino Mega 2560* karena pada arduino ini terdapat lebih banyak pin yang sesuai dengan kebutuhan proyek akhir. Gambar 4.28 menunjukkan *board* Arduino *Mega 2560* yang siap untuk digunakan

Gambar 4.28 *Board* arduino *Mega 2560*

Untuk mengetahui apakah *board* arduino ini masih berfungsi dengan baik atau tidak dapat dilakukan dengan melakukan pengujian terhadap *port-port* dan pin-pinnya melalui suatu program sederhana. Program sederhana dibuat untuk untuk melakukan pengukuran tegangan tiap-tiap pin dengan cara memberikan *logic* 0 *(low)* dan *logic* 1 *(high)*. Untuk mengetahui apakah rangkaian tersebut bekerjamaka dipergunakan *LED* sebagai indikator.

Untuk melihat hasil pengujian Arduino dapat dilihat pada gambar 4.29 di bawah ini.

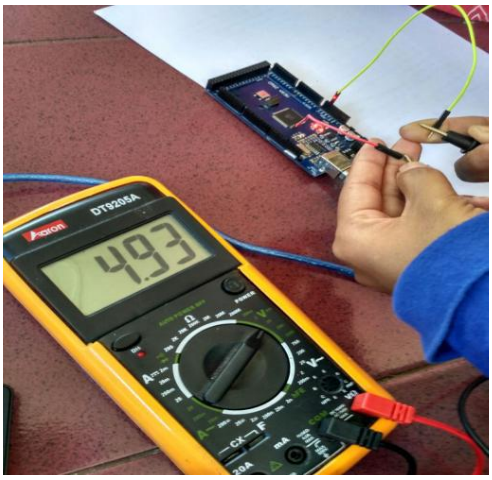


Gambar 4.29 Blok diagram Pengujian *Arduino*

Pengujian pertama untuk mengetahui keluaran pin digital arduino. Hal ini dilakukan dengan cara mengubah *output HIGH* setiap pin digital arduino. Setelah program di*upload*, dilakukan pengukuran dengan menggunakan *multitester*.

Output masing-masing pin digital dihubungkan dengan kaki positif pada *multitester*, sedangkan kaki negatif pada *multitester* dihubungkan pada *ground*. Selanjutnya dilakukan pengujian dengan cara mengubah *output LOW* setiap pin digital *arduino* dengan langkah-langkah yang sama.

Hasil pengukuran tegangan *active high* pin *Arduino Mega 2560* dapat melakukan pengukuran tegangan tiap-tiap pin dengan cara memberikan *logic* 0 dilihat pada gambar 4.30 dan Tabel 4.2 di bawah ini.



Gambar 4.30 Pengukuran tegangan *Active High* Pin 11 Arduino

Berikut adalah hasil pengukuran *Active High* Pin 11 Arduino.

Tabel 4.2 Hasil pengukuran *Active High* Pin 11 Arduino

Pin	Pin arduino mega 2560			
	Percobaanke-1 (V)	Percobaan ke-2 (V)	Percobaan ke-3 (V)	Percobaan ke-4 (V)
D0	4,93	4,93	4,93	1,4%
D1	4,93	4,93	4,93	1,4%
D2	4,93	4,93	4,93	1,4%
D3	4,93	4,93	4,93	1,4%
D4	4,93	4,93	4,93	1,4%
D5	4,93	4,93	4,93	1,4%
D6	4,93	4,93	4,93	1,4%
D7	4,93	4,93	4,93	1,4%
D8	4,93	4,93	4,93	1,4%
D9	4,93	4,93	4,93	1,4%
D10	4,93	4,93	4,93	1,4%
D11	4,93	4,93	4,93	1,4%
D12	4,93	4,93	4,93	1,4%
D13	4,93	4,93	4,93	1,4%
D14	4,93	4,93	4,93	1,4%
D15	4,93	4,93	4,93	1,4%
D16	4,93	4,93	4,93	1,4%
D17	4,93	4,93	4,93	1,4%
D18	4,93	4,93	4,93	1,4%
D19	4,93	4,93	4,93	1,4%
D20	4,93	4,93	4,93	1,4%
D21	4,93	4,93	4,93	1,4%
D22	4,93	4,93	4,93	1,4%
D23	4,93	4,93	4,93	1,4%
D24	4,93	4,93	4,93	1,4%
D25	4,93	4,93	4,93	1,4%
D26	4,93	4,93	4,93	1,4%
D27	4,93	4,93	4,93	1,4%
D28	4,93	4,93	4,93	1,4%

Tegangan yang diinginkan yaitu sebesar 5 *Volt*, namun dari data di atas didapat hasil pengukuran *active high* pin *Arduino Mega 2560* yaitu

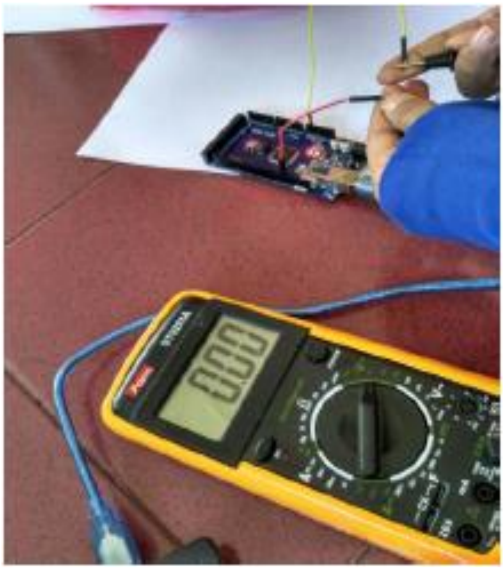
4.93 *Volt*. Untuk menentukan persentase *error*nya dapat dilakukan dengan menggunakan formula sebagai berikut:

$$\left| \frac{Teori - nilai\ yang\ diukur}{Teori} \right| \times 100\% \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Di bawah ini merupakan perhitungan persantase *error* pin *Arduino Mega2560.*

$$\left|\frac{\mathbf{5 - 4.93}}{\mathbf{5}}\right| \times \mathbf{100}\% = \mathbf{1,4}\%$$

Nilai *output* yang keluar dari rangkaian *power supply* yang telah dibuat masih memiliki selisih dari keluaran yang diinginkan namun tingkat *error* yang tidak melebihi 5% mengindikasikan bahwa *board arduino* ini masih baik untuk digunakan. Hasil pengukuran tegangan *active low* pin *Arduino Mega 2560* dapat dilihat pada gambar 4.31 dan Tabel 4.3 di bawah ini.



Gambar 4.31 Hasil Pengukuran *Low Pin* Arduino

Berikut adalah hasil pengukuran *Low High* Pin 11 Arduino.

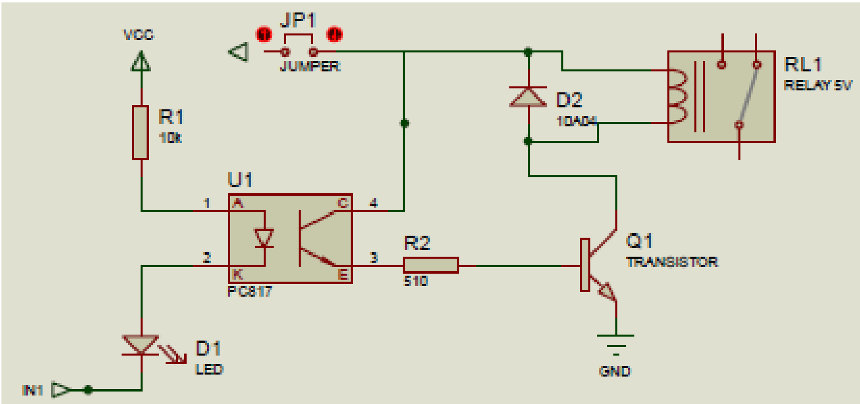
Tabel 4.3 Hasil pengukuran *Low High* Pin 11 Arduino

PIN *Arduino Mega 2560*				
PIN	Percobaan ke-1 (V)	Percobaan ke-2 (V)	Percobaan ke-3 (V)	Persentase *Error*
D29	0	0	0	0%
D30	0	0	0	0%
D31	0	0	0	0%
D32	0	0	0	0%
D33	0	0	0	0%
D34	0	0	0	0%
D35	0	0	0	0%
D36	0	0	0	0%
D37	0	0	0	0%
D38	0	0	0	0%
D39	0	0	0	0%
D40	0	0	0	0%
D41	0	0	0	0%
D42	0	0	0	0%
D43	0	0	0	0%
D44	0	0	0	0%
D45	0	0	0	0%
D46	0	0	0	0%
D47	0	0	0	0%
D48	0	0	0	0%
D49	0	0	0	0%
D50	0	0	0	0%
D51	0	0	0	0%
D52	0	0	0	0%
D53	0	0	0	0%

Tegangan yang diinginkan yaitu sebesar 0 *volt*, dan dari data di atas didapat hasil pengukuran *active low* pin *Arduino Mega 2560* yaitu 0 *volt* juga. Dimana sudah dicoba sebanyak 3 kali uji coba dan hasilnya tetap 0 *volt*. Persentase *error*nya yang 0% mengindikasikan bahwa *Arduino Mega 2560* baik untuk digunakan.

4.2.11 Modul Relay

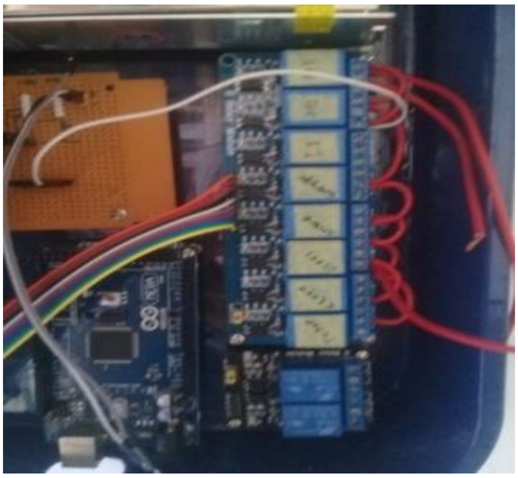
Modul *relay* yang akan digunakan sebanyak Sembilan channel untuk pengontrolan lampu, pintu, *selonoid valve*, *door lock (actuator),*pompa air DC. Rangkaian skematik modul *relay* dapat dilihat pada gambar 4.32 berikut.



Gambar 4.32 Rangkaian Skematik Modul *Relay*

Modul *relay* yang digunakan sebanyak Sembilan channel. Dimana *relay* yang digunakan sebanyak 2 buah, yaitu 1 buah *relay 8 channel*, dan 1 buah *relay 2* channel. Lampu menggunakan modul relay 1. Modul relay pertama digunakan untuk posisi lampu menyala otomatis. Modul *relay* ke dua dan ketiga digunakan untuk motor DC ketika pintu terbuka dan tertutup otomatis. Modul *relay* keempat-keenam digunakan untuk solenoid valve yang berfungsi sebagai kontol kran air yang masuk ke masing-masing komponen kamar mandi, sementara modul relay yang ketujuh-kedelapan digunakan untuk *door lock* pada sistem *flush* closet. Sedangkan modul relay yang kesembilan digunakan untuk pompa air DC. Modul *relay* dibuat berdasarkan rangkaian skematik yang telah dirancang sebelumnya.

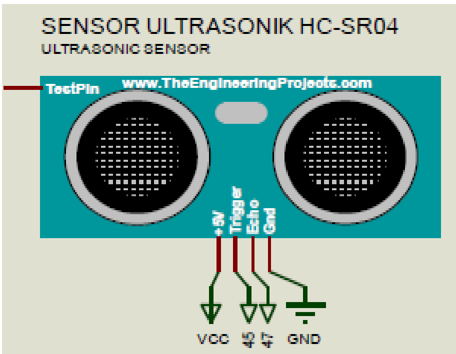
Modul *relay* yang sudah dirangkai dapat dilihat pada gambar 4.33.



Gambar 4.33 *Relay* Yang Sudah Dirangkai

4.2.12 Modul *Ultrasonic HC-SR04*

Modul *Ultrasonic HC-SR04* digunakan untuk mengatur jarak dalam fitur keluaran air otomatis. Rangkaian skematik modul *Ultrasonic HC SR04* dapat dilihat pada gambar 4.34 di bawah ini:



Gambar 4.34 Rangkaian Skematik Ultrasonic HC- SR04

Sensor ultrasonik *HC-SR04* yang digunakan sebanyak 2 buah. Sensor ini dipasang pada beberapa tempat seperti di shower dan di wastafel untuk mendeteksi air yang keluar ketika ada objek yang terdeteksi. Sensor ultrasonik *HC-SR04* yang sudah dipasang dapat dilihat pada gambar 4.35 dan gambar 4.36.

Gambar 4.35 Sensor Ultrasonic *HC-SR04* Pada *Wastafel*

Gambar 4.36 Sensor Ultrasonic *HC-SR04*

Pengujian yang dilakukan adalah pengujian terhadap jarak yang dapatterdeteksi. Sensor ultrasonik *HC-SR04* yang digunakan dalam proyek akhir ini adalah sebanyak 2 buah sehingga diperlukan pengujian satu persatu. Tabel 4.4 dan Tabel 4.5 menunjukkan hasil pengujian jarak sensor ultrasonik *HC-SR04.*

Berikut adalah hasil pengujian sensor ultrasonic pada *wastafel* pada tabel 4.4 dan 4.5.

Tabel 4.4 Hasil Pengujian Sensor Ultrasonik pada Wastafel

No	Jarak(cm)	Kondisi	Presentase Error
1	5	Terdeteksi	0%
2	7	Terdeteksi	0%
3	9	Terdeteksi	0%
4	10	Terdeteksi	0%

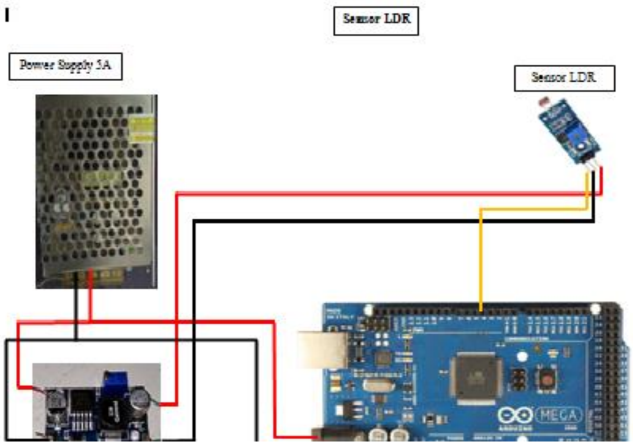
Tabel 4.5 Hasil Pengujian Sensor Ultrasonik pada *Shower*

No	Jarak(cm)	Kondisi	Presentase Error
1	10	Terdeteksi	0%
2	12	Terdeteksi	0%
3	14	Terdeteksi	0%
4	16	Terdeteksi	0%
5	18	Terdeteksi	0%
6	20	Terdeteksi	0%

Hasil dari pendeteksian jarak sangat berpengaruh pada jenis benda yang akan dideteksi yang berhubungan dengan kondisi permukaan benda. Permukaan bentuk *user* yang tidak sama dan tidak rata menyebabkan sensor ultrasonik hanya mendeteksi bagian yang tepat berada di depan sensor tersebut sehingga tidak bisa mendeteksi jarak pada sisi lain dari *user*. Permukaan bentuk *user* yang sering berubah (tidak stabil) apabila bergerak menyebabkan keakuratan pembacaan sensor ultrasonik menjadi berkurang. Untuk memperkecil kemungkinan terjadinya hal ini, maka dilakukan berbagai pengujian terkait penempatan sensor ultrasonik sehingga didapatkan tempat yang cocok dalam menempatkan sensor-sensor ultrasonik ini. Namun berdasarkan hasil pengujian di atas, didapatkan persentase *error*nya 0% sehingga sensor ultrasonik *HC-SR04* masih baik untuk digunakan.

4.2.13 Sensor *LDR*

Modul *LDR* digunakan untuk mengatur sistem pembilasan otomatis sebagai petunjuk adanya objek yang menggunakan *closet* dengan terdeteksinya sumber cahaya oleh sensor LDR. Rangkaian skematik modul *LDR* dapat dilihat pada gambar 4.37.



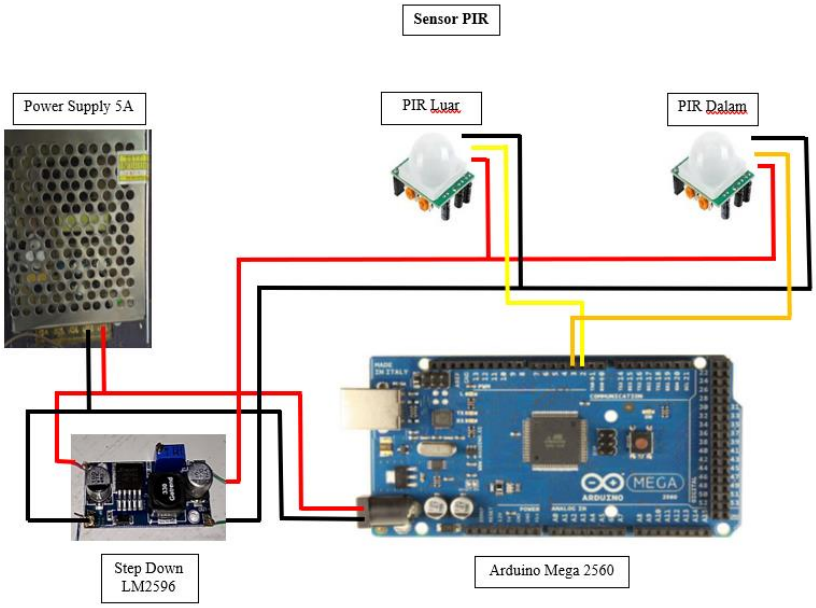
Gambar 4.37 Rangkaian Skematik Sensor *LDR*

Sensor *LDR* yang digunakan sebanyak 1 buah. Sensor ini dipasang pada dudukan closet bagian bawah untuk mendeteksi intensitas cahaya yang dapat didentifikasi oleh sensor *LDR* sehingga sistem akan melakukan pembilasan otomatis di *closet*. Sensor *LDR* yang sudah dipasang dapat dilihat pada gambar 4.38 di bawah ini.


Gambar 4.38 Sensor *LDR* pada *Closet*

4.2.14 Sensor *PIR*

Modul PIR digunakan untuk mengatur sistem pintu otomatis yang bergerak membuka dan menutup pintu sebagai petunjuk adanya objek yang terdeteksi pergerakkannya oleh sumber *infrared*. Rangkaian skematik modul *LDR* dapat dilihat pada gambar 4.39.



Gambar 4.39 Rangkaian Skematik Sensor *PIR*

Sensor *PIR* yang digunakan sebanyak 2 buah. Sensor ini dipasang pada dua sisi pintu, yaitu sisi depan bagian atas yang berguna untuk mengindetifikasi objek bergerak yang akan memasuki kamar mandi, sehingga pintu akan terbuka apabila adanya *motion/*gerakkan manusia. Sementara untuk menutup pintu secara otomatis maka diletakkan sensor *PIR* pada sisi pintu bagian dalam yang berfungsi ketika user teridentifikasi oleh sensor *PIR* maka pintu akan menutup dan menandakan bahwa semua komponen yang ada dikamar mandi dalam kondisi *stand by*. Sensor yang telah dipasang dapat dilihat pada gambar 4.40 dan gambar 4.41 di bawah ini.

Berikut adalah posisi sensor yang telah dipasang pada gambar 4.40 dan gambar 4.41.

Gambar 4.40 Sensor *PIR* di Pintu bagian luar

Gambar 4.41 Sensor *PIR* di pintu bagian dalam

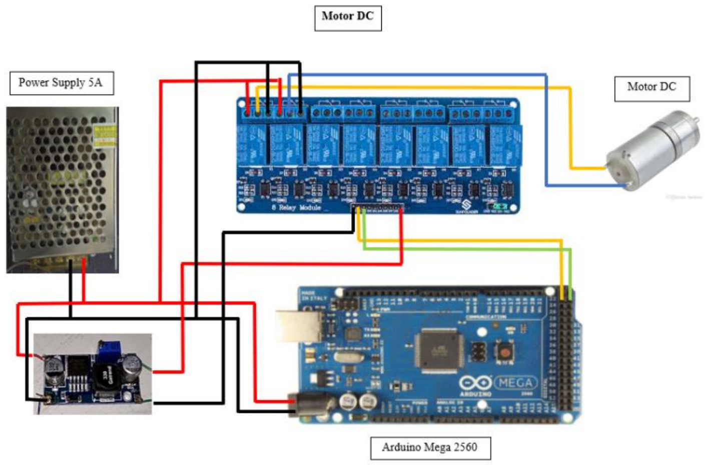
Pengujian sensor *PIR* yang dapat dilakukan adalah dengan memberikan *motion* atau user yang bergerak di depan sensor agar sensor dapat mengetahui adanya pergerakan. Hal ini dikarenakan apabila user dalam kondisi diam atau tidak bergerak, maka sensor tidak dapat melakukan identifikasi, sehingga yang terjadi adalah pintu tidak akan terbuka dan tertutup secara otomatis. Selain itu untuk memicu pintu terbuka dan tertutup secara otomatis, sensor *PIR* juga dipengaruhi jarak user dengan sensor, dimana ketika jarak user tidak mencapai jarak minimal dan jarak maksimal maka pintu tidak akan berfungis sesuai design yang telah direncanakan. Pengujian sensor *PIR* dapat dilihat pada tabel 4.6.

Tabel 4.6 Hasil Pengujian Sensor *PIR*

No	Jarak Objek Dengan Benda (cm)	Waktu Terdeteksi Gerakan (s)
1	10	33
2	20	32
3	30	35
4	40	36
5	50	35
6	60	33
7	70	35
8	80	32
9	90	35
10	100	43
11	110	47

4.2.15 Motor DC

Motor DC yang digunakan yaitu dynamo motor DC12V yang akan ditempatkan pada pintu bagian samping untuk mengontrol pergerakan buka tutupnya. Dinamo motor DC 12V akan ditempatkan pada konstruksi pintu untuk mengontrol pergerakannya. Rangkaian skematik motor dapat dilihat pada gambar 4.42 di bawah ini.



Gambar 4.42 Rangkaian skematik Motor DC

Motor DC yang digunakan yaitu dinamo motor DC 12V sebanyak 1 buahuntuk mengontrol buka - tutup pintu secara otomatis, dimana sistem pintu ini menerapakan pintu yang terbuka secara otomatis dengan gerakan pintu *sliding.* Motor DC yang sudah dipasang berdasarkan rangkaian skematik yang dibuat dapat dilihat pada gambar 4.43 di bawah ini.

Gambar 4.43 Motor DC yang telah dirangkai

Pengujian yang dilakukan adalah pengujian terhadap pergerakan dinamo motor DC 12V yaitu gerakan *sliding* pintu ke kiri dan ke kanan. Dalam pengujian ini, dinamo motor DC 12V masih berada dalam kondisi baik. Gambar 4.44 dan gambar 4.45 adalah gambar kondisi pintu pada saat membuka dan menutup:

Gambar 4.44 Motor bergerak menutup

Gambar 4.45 adalah ketika motor bergerak untuk membuka pintu.

Gambar 4.45 Motor bergerak membuka

Dari data Gambar 4.44 dan gambar 4.45 di atas didapatkan hasil pengujian berupa *input* pergerakan dinamo motor DC 12V yang dikontrol melalui program arduino sama dengan pergerakannya sehingga persentase *error*nya pun adalah 0%. Hasil pengujian tersebut berlaku untuk dinamo motor DC 12V yang akan digunakan sehingga dapat dipastikan bahwa dinamo motor DC 12V dalam keadaan baik.

4.2.16 *Step down*

Pengujian dapat dilakukan dengan cara mengukur dengan menggunakan *multimeter*. Setiap komponen yang akan diukur tegangannnya, apabila hasil pengukuran menunjukan hasil yang sesuai dengan tingkat presisi yang baik maka dapat dikatakan bahwa *step down* berfungsi dengan baik. Hasil pengukuran *step down* dapat dilihat pada gambar 4.46 di bawah ini:

Gambar 4.46 Hasil Percobaan *Step Down*

4.2.17 Modul wifi

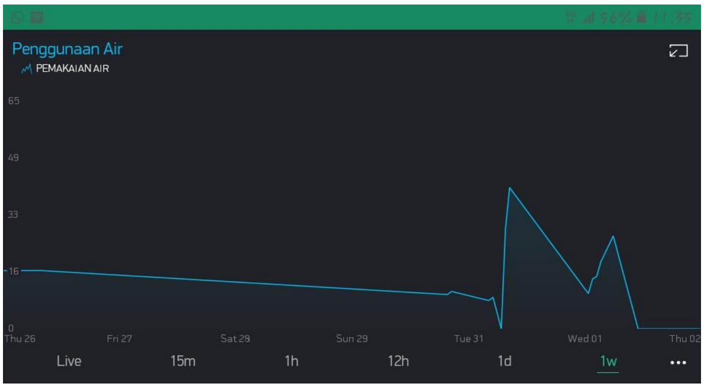
Pemilihan modul *WiFi* yang akan digunakan sebagai pengirim dan penerima data juga sangat diperlukan dan juga harus memenuhi kriteria, modul *WiFi* yang memenuhi kriteria tersebut adalah *NodeMCU ESP8266* atau *ESP-12E*. Meskipun dari segi harga lebih tinggi disbanding dengan yang lainnya, namun *NodeMCU* sangatlah praktis digunakan dan tidak mudah reset, tidak seperti *ESP8266*.

Percobaan pengiriman data dan koneksi internet *NodeMCU* dilakukan dengan pengiriman nilai data sensor *waterflow* dan koneksi ke *WiFi* apakah tersambung atau tidak. Dari percobaan ini, dapat dilihat apakah data yang dikirimkan sesuai dengan nilai data yang didapatkan oleh arduino. Dan dari hasil data yang diperoleh, NodeMCU dapat mengirimkan data dengan baik.

Berikut adalah contoh instruksi yang digunakan pada *board* Arduino Uno dan *board NodeMCU* saat mengirimkan data serial:

```
char auth[] = "9081e84bb5c64161b703fedcfce16eaa";
char ssid[] = "The Anti-Hero";
char pass[] = "sandaimekazekage";
Serial.begin(9600);
Node.begin(9600);
Blynk.begin(auth, ssid, pass);
if (Node.available())
```

Pada bagian awal program di atas pin yang digunakan oleh *NodeMCU* untuk menerima data adalah pin D5 dan pin D6 dengan *setting*-anserial monitor 9600 dan WiFi yang akan digunakan. Pada bagian isi program terdapat instruksi if (Node.available()). Pada instruksi tersebut adalah setiap terjadi komunikasi serial *NodeMCU* maka program akan mengeksekusi perintah di dalamnya. Selanjutnya terdapat perintah val= Node.parseInt();, instruksi ini membaca data serial yang diterima dan data tersebut akan di simpan di *variable* yang telah ditentukan. Berikut adalah gambar hasil pembacaan data komunikasi *Blynk* menggunakan *NodeMCU pada gambar* 4.47.



Gambar 4.47 Hasil pembacaan data komunikasi *Blynk*

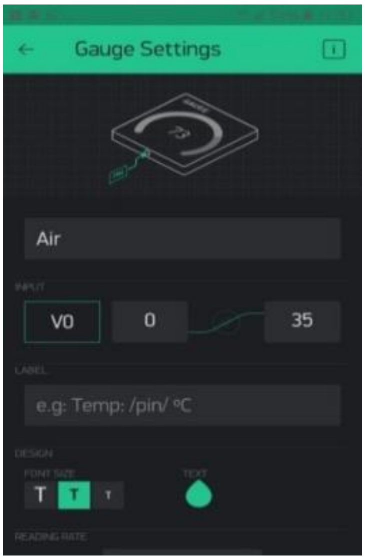
Dari hasil data di atas dapat dilihat bahwa *NodeMCU* menampilkan data penggunaan air yang sama dengan data yang dikirimkan, hal ini dapat disimpulkan bahwa rangkaian *hardware* berfungsi dengan baik.

Untuk mendapatkan aplikasi *Blynk* dapat dengan mengunduh di *play store* pada *handphone* android dan dapat mendaftarkan dengan menggunakan akun *facebook* atau email. Setelah kita mendaftarkan, maka kita akan mendapatkan token yang akan dikirimkan ke akun email yang kita daftarkan, selain itu kita akan mendapatkan *power* sebanyak 2000 *power* secara gratis yang berfungsi untuk membeli komponen yang akan kita gunakan.

Berikut ini adalah *setting*-an monitor pada aplikasi *Blynk*:

a) *Setting* komponen *Gauge*

Pada *setting*-an komponen *monitor gauge* dapat mengisi dengan identitas *title* dan *input*. Disini data yang di monitor menggunakan *gauge* adalah jumlah air yang digunakan. Jadi isi *title* dengan yang kita inginkan. Sementara itu untuk mengisi nilai *input* kita menggunakan pin virtual Vx dengan mengisi nilai minimal dan maksimal pada komponen *gauge*. Gambar 4.48 ini adalah *setting*-an pada komponen *gauge* penggunaan air.



Gambar 4.48 Pengaturan pada *display gauge*

b) *Supper Chart Setting*

Pada salah satu komponen *display* ini adalah berfungsi untuk menampilkan rekaman data selama proses pengambilan data berlangsung. *Setting*-nya cukup sederhana yaitu dengan menambahkan dan meng-*input*-kan *data stream* yang akan kita gunakan. pada gambar di bawah ini menggunakan 1 *data stream* yaitu penggunaan air selama digunakan. *Data stream* dapatdiatur dengan jenis grafik yang diinginkan. Sementara itu untuk acuan waktu rekaman pada grafik sudah ditentukan dalam komponen *display* ini, yaitu live, per 1 jam, per

12 jam, per 1 hari, dan per 1 minggu. Berikut ini adalah gambar pengaturan *super chart* yang kita gunakan. Gambar 4.49 merupakan pengaturan *display super chart.*

Gambar 4.49 Pengaturan pada *diplay super chart*

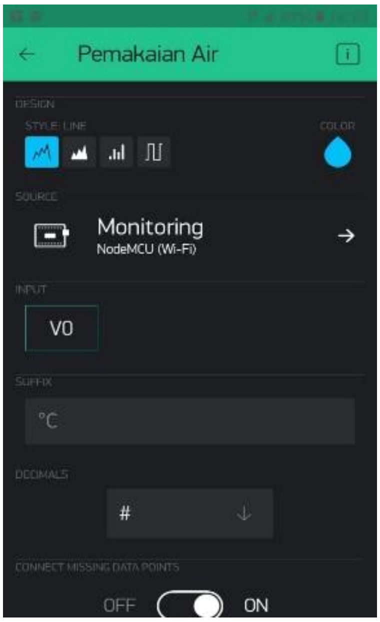
Seperti yang tampak pada pengaturan data *stream,input* nilai yang akan dikirim sesuai dengan virtual data yang dikirimkan pada aplikasi *blynk*, yaitu penggunaan air V0.

c) Uji coba data *logger*

Data *logger* ini berfungsi untuk menyimpan semua data rekaman yang berisikan jumlah air yang terpakai. Dengan menyimpan data tersebut, maka pengguna dapat melihat data pada hari-hari atau jam-jam sebelumnya.

Pada uji coba data *logger* ini memanfaatkan penggunaan grafik pada aplikasi Blynk agar mempermudah *user* dalam melihat data *logger*. Berikut ini adalah gambar pengaturan dan hasil dari uji coba data *logger* pada gambar 4.50, 4.51, 4.52, 4.53, dan 4.54.

Gambar 4.50 adalah pengaturan untuk grafik pada aplikasi *blynk* yang digunakan.



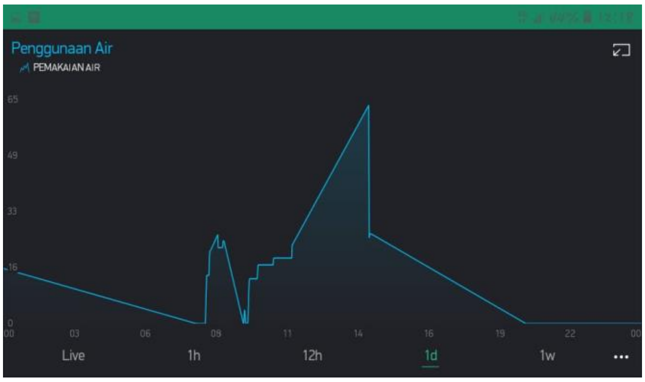
Gambar 4.50 Pengaturan pada *display data*

Gambar 4.51 adalah tampilan grafik dalam per 1 jam.

Gambar 4.51 Tampilan grafik 1 *Hour*

Gambar 4.52, 4.53, dan 4.54 adalah tampilan grafik per 12 jam, 1 hari, dan 1 minggu.

Gambar 4.52 Tampilan grafik 12 *Hour*



Gambar 4.53 Tampilan grafik 1 *day*

Gambar 4.54 Tampilan grafik 1 *week*

4.2.18 Perakitan *Smart Bathroom*

Setelah pembuatan konstruksi mekanik dan *hardware electrical* selesai, Selanjutnya dilakukan proses perakitan bagian-bagian tersebut menjadi satu kesatuan *Smart bathroom*. *Smart Bathroom* yang sudah dirakit dapat dilihat pada gambar 4.55, Gambar 4.56 dan gambar 4.57.

Gambar 4.55 Tampak Depan *Smart Bathroom*

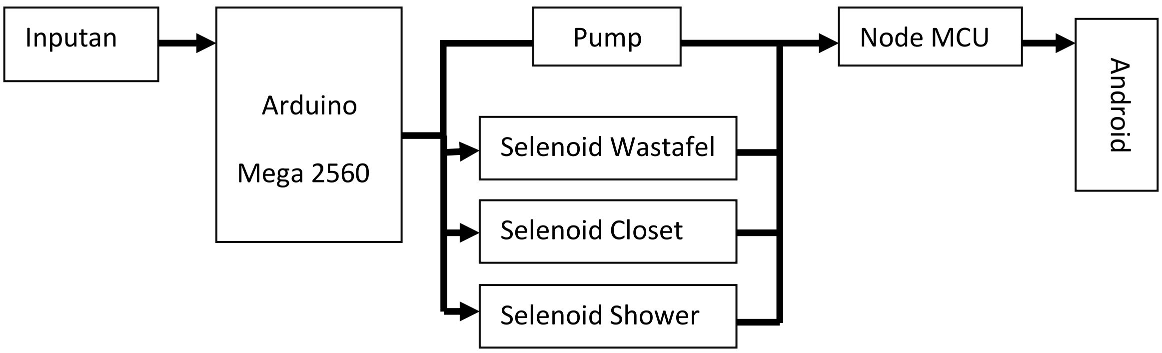
Gambar 4.56 Tampak atas *Smart Bathroom*

Gambar 4.57 adalah tampak samping dari *Smart Bathroom.*

Gambar 4.57 Tampak samping *Smart Bathroom*

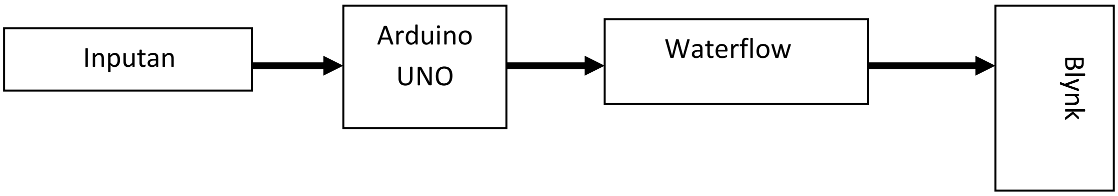
4.2.19 Pembuatan *Software Smart Bathroom*

Perancangan *software* ini bertujuan untuk mengontrol sistem kerja *Smart bathroom*. *Software* yang digunakan pada proyek akhir ini adalah *Arduino IDE Version 1.6.12 dan software Blynk.* Adapun Blok Diagram sistem kerja *smart bathroom* dapat dilihat pada gambar 4.58 dan gambar 4.59 di bawah ini.



Gambar 4.58 Blok diagram rangkaian

Pada gambar 4.59 adalah blok diagram dari rangkaian control Android.



Gambar 4.59 Blok diagram rangkaian kontrol Android

4.2.20 Pembuatan *Hardware Smart Bathroom*

Setelah pembuatan *hardware Smart Bathroom* sesuai dengan desain yang telah ditentukan sebelumnya. Selanjutnya dilakukan pembuatan *software Smart Bathroom*. Pembuatan *software*, meliputi:

- Menyediakan *software Arduino IDE Version 1.6.12* berikut *driver*nya.
- Meng*install software Arduino IDE Version 1.6.12* ke dalam komputer.
- Membuat program untuk mengontrol cara kerja *smart bathroom* sesuai dengan fitur-fitur yang diinginkan. Adapun hal-hal yang dilakukan dalam membuat program yaitu:
- Menyiapkan *libary* untuk komponen-komponen yang *library*nya belum ter*install* otomatis pada *software arduino*, seperti *Node MCU* dan *library Waterflow Sensor.*
- Mulai membuat program untuk menjalankan setiap komponen satu persatu sesuai dengan fungsinya dalam sistem kerja *Smart Bathroom*.
- Ketika program setiap komponen selesai dibuat, selanjutnya menggabungkan program-program tersebut menjadi satu kesatuan sistem kerja *smart bathroom* secara keseluruhan sehingga fungsi *smart bathroom* sesuai dengan tujuan dibuatnya *smart bathroom* ini. Berikut ini adalah contoh program utama dari *smart bathroom:*

```
#define pir1 3 // PIR Inside
#define pir2 2 // PIR Outside
#define LDR 4
#define ls_min 10
```

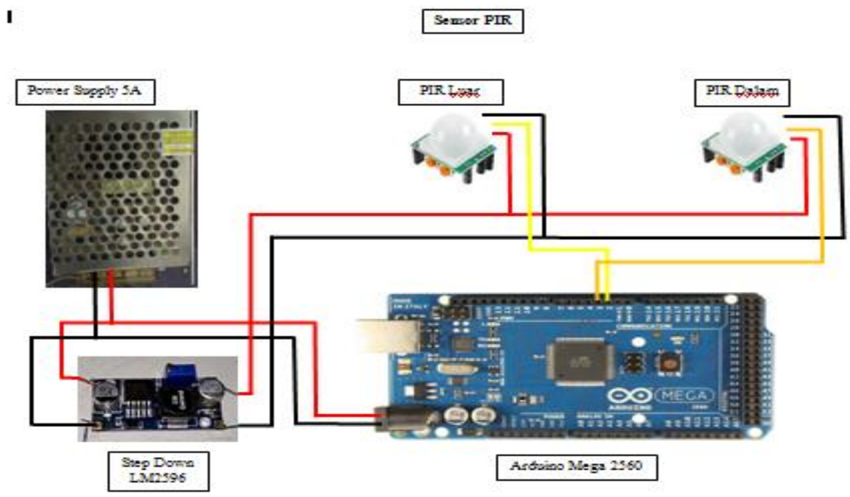
```
#define ls_max 11
#define ls_door 12
#define echo_wstf 6
#define trig_wstf 5
#define echo_shwr 9
#define trig_shwr 8
#define M1 22
#define M2 23
#define Lamp 24
#define Tap_wstf 25
#define Tap_shwr 26
#define Tap_clst1 27
#define Tap_clst2 28
#define Pump 29
#define s_closet 31
byte pir_luar, pir_dalam, pintu_min, pintu_max, buka_pintu, buka, tutup_clst=0, clst, state=0;
float distance_wstf, duration_wstf, distance_shwr, duration_shwr;
```

Untuk program lengkapnya akan dilampirkan pada makalah proyek akhir ini.

4.2.21 Rangkaian Skematik *Smart Bathroom*

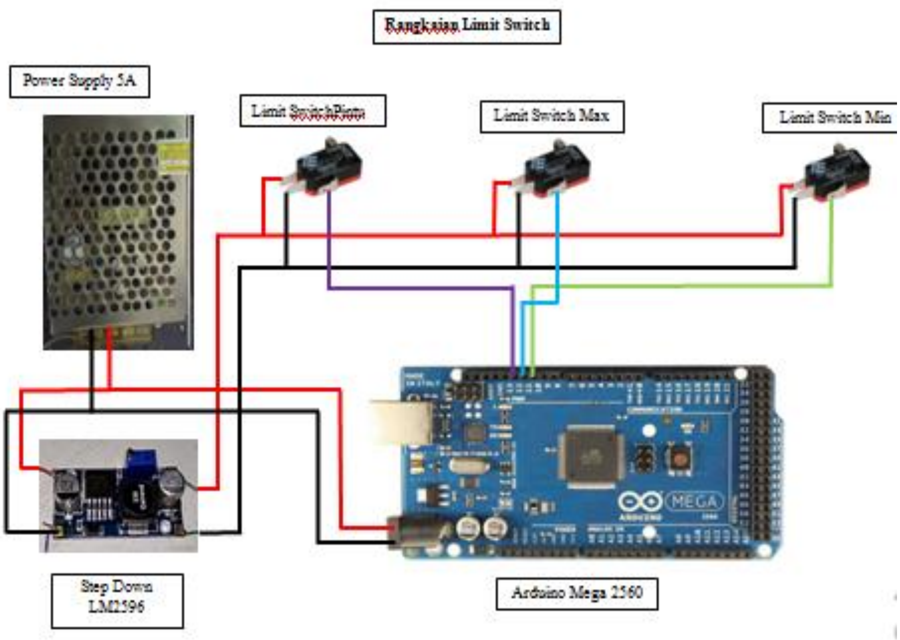
Berikut adalah rangkaian skematik dari kontrol utama pada *smart bathroo*m yang akan dijelaskan pada gambaran skematik pada setiap sensor dan komponen pendukung lainnya. Untuk rangkaian skematik ini akan dijabarkan satu per satu agar lebih mudah dipahami dan di mengerti. untuk memudahkan untuk dipahami. Rangkaian skematik yang akan ditampilkan adalah sensor *PIR, limit switch,* lampu, sensor ultrasonik *HC-SR04,* sensor *LDR, lock actuator, pump,* dan *solenoid valve.*

a) Gambar 4.60 adalah Rangkaian Skematik Sensor *PIR.*



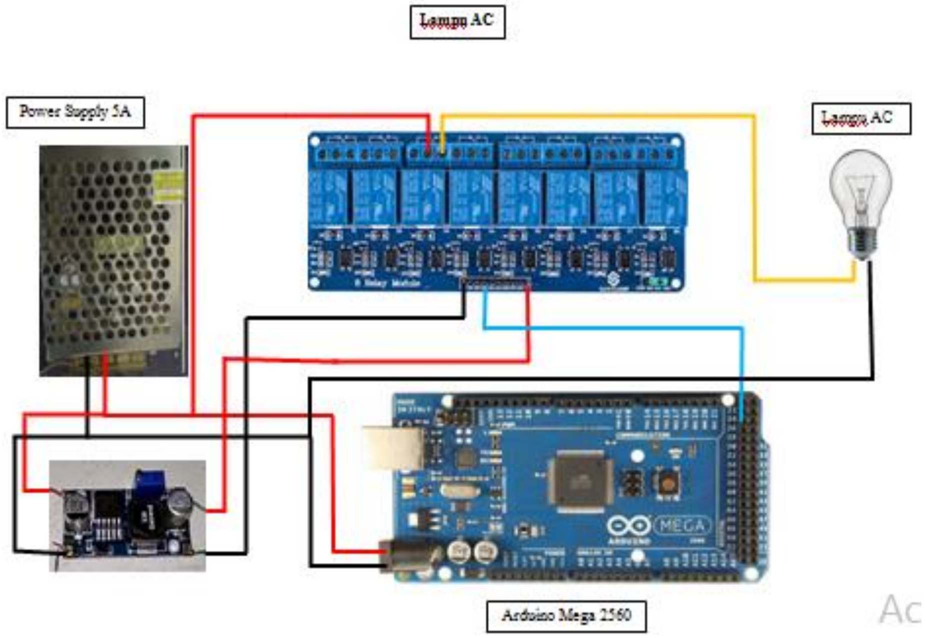
Gambar 4.60 Rangkaian skematik sensor *PI*

b) Gambar 4.61 adalah Rangkaian Skematik *Limit Switch.*



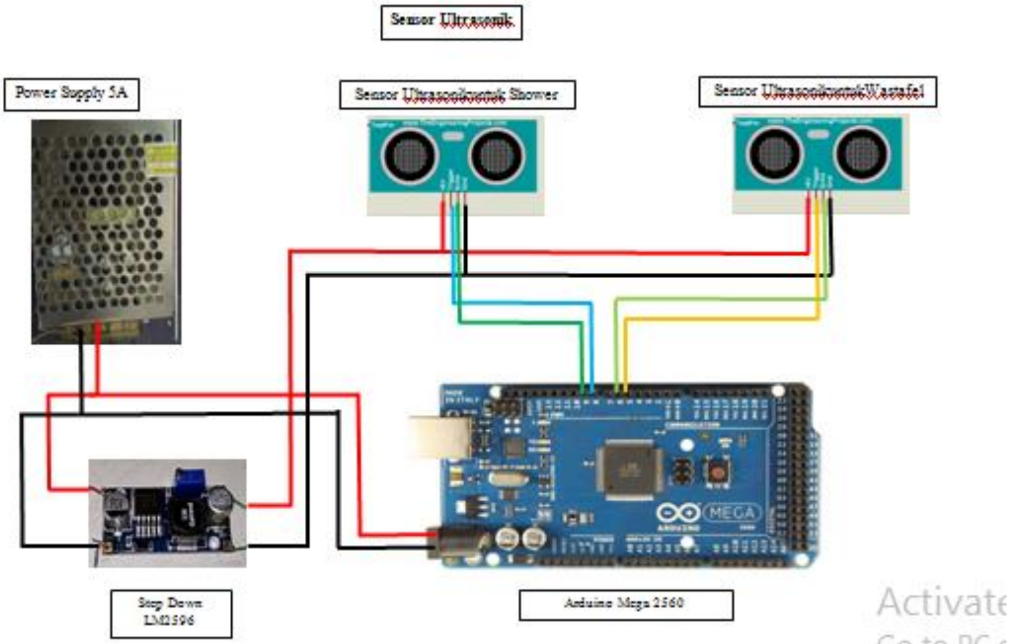
Gambar 4.61 Rangkaian skematik *Limit Switch*

c) Gambar 4.62 adalah Rangkaian Skematik Lampu.



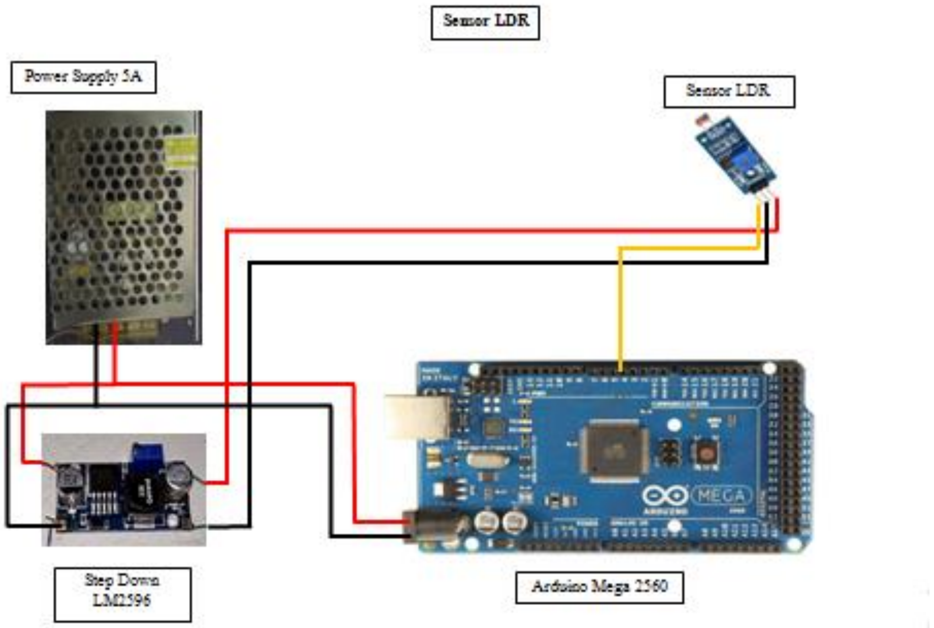
Gambar 4.62 Rangkaian skematik lampu

d) Gambar 4.63 adalah Rangkaian Skematik Sensor *Ultrasonik HC-SR04.*



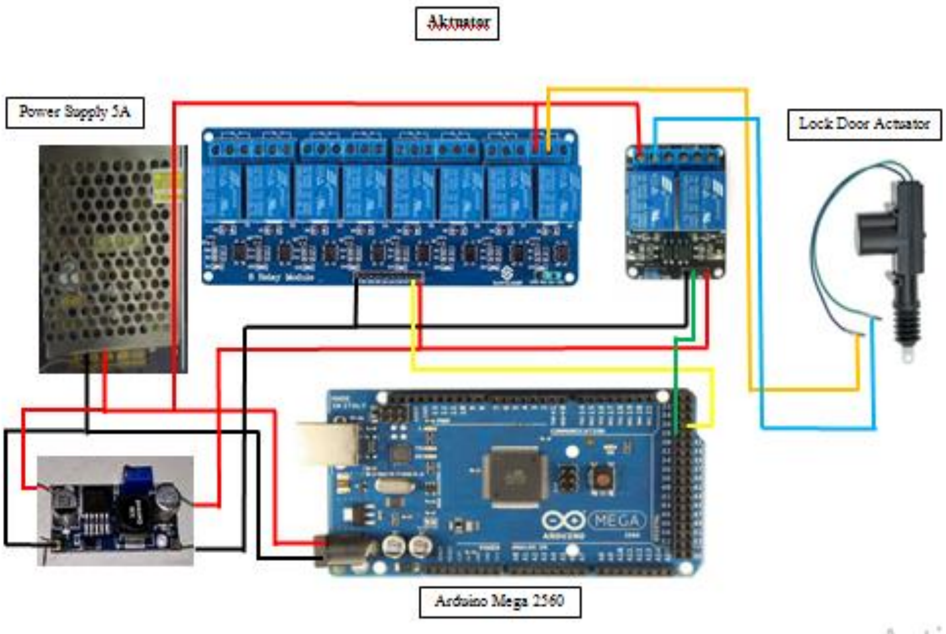
Gambar 4.63 Rangkaian skematik sensor *Ultrasonik HC-SR04*

e) Gambar 4.64 adalah Rangkaian Skematik Sensor *LDR*.



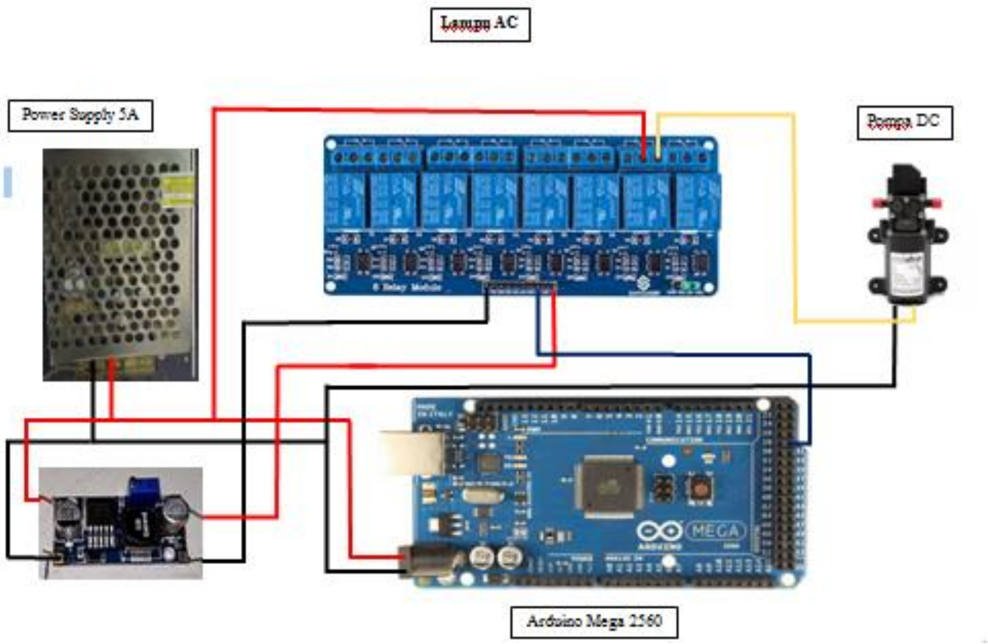
Gambar 4.64 Rangkaian skematik sensor *LDR*

f) Gambar 4.65 adalah rangkaian skematik *Lock Actuator*.



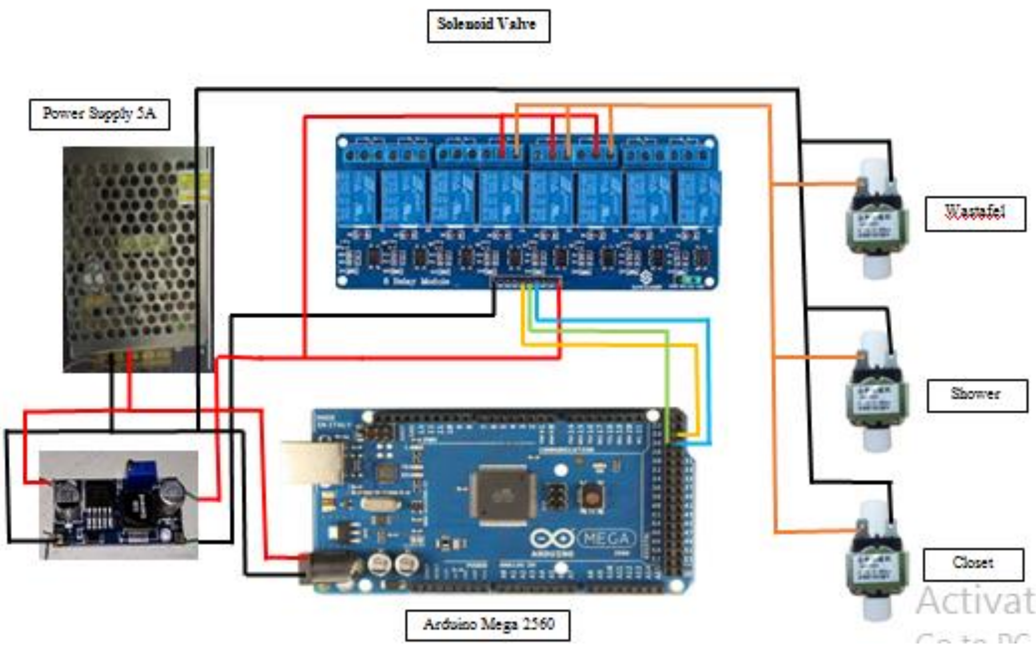
Gambar 4.65 Rangkaian Skematik *Lock Actuator*

g) Gambar 4.66 adalah rangkaian skematik *Pump*.



Gambar 4.66 Rangkaian Skematik *Pump*

h) Gambar 4.67 adalah rangkaian skematik *Selenoid Valve*



Gambar 4.67 Rangkaian Skematik *Selenoid Valve*

4.2.22 Pengujian *Smart Bathroom*

Proses pengujian dilakukan sebagai tolak ukur apakah *smart bathroom* bekerja sesuai dengan fungsi yang diinginkan. Dengan demikian, setiap kekurangan dan kesalahan dalam pembuatannya dapat dievaluasi sedini mungkin. Jika diperlukan, maka apabila sistem kerja *smart bathroom* tidak sesuai dengan yang diinginkan, proses pembuatan dapat dievaluasi kembali, baik perancangan *hardware* dan pemrograman *software*.

Pengujian sistem penggunaan air secara otomatis bertujuan untuk mendapatkan Data berupa air yang terpakai secara keseluruhan pada *smart bathroom*. Pengujian ini dilakukan dengan menggunakan metode *trial and error* dalam pengambilan datanya.

Adapun prosedur pengujian sistem penggunaan air secara otomatis yaitu sebagai berikut:

- Objek terdeteksi oleh sensor *PIR* luar
- Motor berputar ke kiri sehingga pintu terbuka mengenai *limit switch minimum.*
- Ketika *limit switch minimum* tertekan maka lampu menyala dan komponen kamar mandi seperti *closet*, *wastafel* dan *closet* dalam kondisi aktif
- Ketika objek memasuki kamar mandi dan komponen kamar mandi seperti *closet*, *wastafel*, dan *shower* dalam kondisi aktif maka sensor *PIR* bagian dalam akan mendeteksi objek sehingga pintu akan tertutup sampai menekan sensor *limit switch maximum*
- Pada saat objek menggunakan setiap komponen di kamar mandi seperti *wastafel*, *shower* dan *closet* maka masing-masing sensor di komponen tersebut akan mendeteksi sehingga *pump* dan *solenoid valve* akan aktif. Air akan keluar ketika masing-masing sensor komponen mendeteksi objek.

- Setiap air yang keluar dari masing-masing komponen akan dikontrol melalui aplikasi *Blynk* sehingga penggguna dapat melihat penggunaan air dalam kurun waktu perhari,perminggu dan perbulan.

Hasil pengujian sistem monitoring penggunaan air otomatis berbasis android dapat dilihat pada tabel 4.7.

Tabel 4.7 Hasil pengujian sistem *monitoring* penggunaan air secara otomatis berbasis Android

No	Tanggal	Kapasitas air yang digunakan
1.	8 Agustus 2018	25 L
2.	9 Agustus 2018	13 L
3.	10 Agustus 2018	18 L
4.	11 Agustus 2018	14 L
5.	12 Agustus 2018	18 L
6.	13 Agustus 2018	13 L
7.	14 Agustus 2018	3 L
8.	15 Agustus 2018	5 L

Dari data di atas didapatkan hasil pengujian berupa air berdasarkan jumlah yang terdata pada monitoring Android. Hal ini membuktikan bahwa fitur sistem monitoring penggunaan air secara otomatis ini sudah berfungsi sesuai dengan tujuan yang diinginkan.

BAB V
PENUTUP

5.1. Kesimpulan

Berdasarkan hasil pengujian dan analisa fungsi terhadap proyek akhir kami dengan judul “Prototype Smart Bathroom Berbasis Arduino Dengan Monitoring Pengguaan Air Menggunakan Android” ini maka dapat ditarik kesimpulan sebagai berikut :

1. Sistem *software* dan sistem *hardware* dirancang dan dibuat sesuai dengan design yang telah ditentukan. Dari rancangan sistem *software* dan sistem *hardware* yang telah dibuat didapatkan hasil bahwa alat dapat diimplementasikan dan digunakan dengan baik tanpa mengalami kendala. Semua komponen yang digunakan dapat bekerja sesuai dengan fungsinya masing-masing. Sementara untuk monitoring penggunaan air berbasis android didukung oleh aplikasi yang telah dirancang sesuai fungsinya yaitu aplikasi *blynk*
2. Sistem *flush* otomatis dibuat dan dirancang sesuai dengan fungsi serta design yang telah ditentukan. Sistem *flush* menerapkan sistem pegas yang digunakan untuk menekan tombol *flush*. Dalam hal ini sistem pegas yang digunakan adalah sistem pegas yang ada pada l*ock actuator*, lebih tepatnya pengunci otomatis pada mobil. sistem pegas tersebut memiliki banyak keunggulan dibandingkan dengan sistem pegas lainnya salah satunya adalah daya tekan yang besar. Sementara penggunaan sensor *LDR* berfungsi untuk mendeteksi keberadaan objek. Sehinnga sistem *flush* otomatis akan bekerja apabila adanya objek yang terindetifikasi oleh sensor *LDR*.
3. Sistem *software* merupakan rangkaian kontrol utama yang digunakan dalam proses perancangan dan pembuatan *prototype smart bathroom* dengan monitoring penggunaan air menggunakan Android. Sementara sistem *hardware* merupakan konstruksi dan komponen *electrical* lainnya, yang akan dihubungkan dengan sistem *software*, sehingga dari perakitan

kedua sistem tersebut dapat diuji coba dan mengambil kesimpulan apakah sistem *software* dan sistem *hardware* berfungsi sesuai dengan rancangan.

5.2. Saran

Dari keseluruhan proyek akhir yang dikerjakan ini terdapat beberapa saran untuk kedepannya dalam pembuatan proyek akhir ini, antara lain :

1. Mengetahui jenis sensor yang akan kita gunakan agar dapat sesuai dengan fungsinya dengan berbasis "*smartthing*".
2. Penggunaan sensor *water resistant* agar dalam penggunaanya lebih aman dan standar.
3. Proses *wiring* yang rapi pada *prototype* untuk menghindari terjadinya *error* dalam melakukan pengambilan data serta dalam menjalankan sistem utama.

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2002-2007	SDN 87 Kota Jambi
2007-2010	SMPN 19 Kota Jambi
2010-2012	SMA Swasta FerdyFerryPutra Kota Jambi
2015-2018	Politeknik Manufaktur Negeri Bangka Belitung , Kawasan Industri AirKantung, Sungailiat

3. Kemampuan

- Basketball
- Public Speaking
- Microsoft Office
- Bahasa Indonesia (Aktif)

4. Pengalaman Kerja
   - (Internship) PT.Yokogawa Manufacturing Batam sebagai Maintenance Engineering

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2005-2009	SDN 8 ,Sungailiat
2009-2012	SMPN 2, Sungailiat
2012-2015	SMKN 1, Sungailiat

3. Kemampuan

- Teknologi Komputer (Hardware & Software)
- Bahasa Indonesia (Aktif) , Bahasa Inggris (Pasif)

4. Pengalaman Kerja
   - (Internship) PT.Suryaraya Rubberindo Industries , Cileungsi,Bogor sebagai Engineering

Program Utama *Smart Bathroom*

```
/*		Declaration Pin Of PIR (INPUT)		*/
#define pir1 3 // PIR Inside
#define pir2 2 // PIR Outside
/*		Declaration Pin Of LDR (INPUT)		*/
#define LDR 4
/*		Declaration Pin Of Door Limit (INPUT)		*/
#define ls_min 10
#define ls_max 11
#define ls_door 12
/*		Declaration Pin Of HC Wastafel (INPUT)		*/
#define echo_wstf 6
#define trig_wstf 5
/*		Declaration Pin Of HC Shower (INPUT)		*/
#define echo_shwr 9
#define trig_shwr 8
/*		Declaration Pin Of Relay Motor (OUTPUT)		*/
#define M1 22
#define M2 23
/*		Declaration Pin Of Relay Lamp (OUTPUT)		*/
#define Lamp 24
/*		Declaration Pin Of Relay Wastafel (OUTPUT)		*/
#define Tap_wstf 25
/*		Declaration Pin Of Relay Shower (OUTPUT)		*/
#define Tap_shwr 26
```

```
/*              Declaration Pin Of Relay Closet (OUTPUT)          */

#define Tap_clst1 27

#define Tap_clst2 28

/*              Declaration Pin Of Relay Pump (OUTPUT)          */

#define Pump 29

/*              Declaration Pin Of Solenoid closet (OUTPUT)          */

#define s_closet 31

byte pir_luar, pir_dalam, pintu_min, pintu_max, buka_pintu, buka, tutup_clst=0,
clst, state=0;

float distance_wstf, duration_wstf, distance_shwr, duration_shwr;

void setup() {

  // put your setup code here, to run once:

  Serial.begin(9600);

  /*              Setting Pin Pir          */

  pinMode(pir_dalam, INPUT);

  pinMode(pir_luar, INPUT);

  /*              Setting Pin Door Limit          */

  pinMode(ls_min, INPUT);

  pinMode(ls_max, INPUT);

  /*              Setting Pin Motor          */

  pinMode(M1, OUTPUT);

  pinMode(M2, OUTPUT);

  /*              Setting Pin HC Wastafel          */

  pinMode(trig_wstf, OUTPUT);

  pinMode(echo_wstf, INPUT);
```

```
/*		Setting Pin HC Shower		*/
pinMode(trig_shwr, OUTPUT);
pinMode(echo_shwr, INPUT);
/*		Setting Pin s_closet		*/
pinMode(s_closet, OUTPUT);
/*		Setting Pin Pump		*/
pinMode(Pump, OUTPUT);
/*		Setting Pin Lamp		*/
pinMode(Lamp, OUTPUT);
/*		Setting Pin Tap_wstf		*/
pinMode(Tap_wstf, OUTPUT);
/*		Setting Pin Tap_shwr		*/
pinMode(Tap_shwr, OUTPUT);
/*		Setting Pin Tap_clst		*/
pinMode(Tap_clst1, OUTPUT);
pinMode(Tap_clst2, OUTPUT);
/////////////////////////////////////////////
/*		Setting Pin Output		*/
digitalWrite(M1, HIGH);
digitalWrite(M2, HIGH);
digitalWrite(Lamp, HIGH);
digitalWrite(Pump, HIGH);
digitalWrite(s_closet, HIGH);
digitalWrite(Tap_wstf, HIGH);
digitalWrite(Tap_shwr, HIGH);
```

```
  digitalWrite(Tap_clst1, HIGH);
  digitalWrite(Tap_clst2, HIGH);
}
void pir(){
  pir_dalam = digitalRead(pir1);
  pir_luar = digitalRead(pir2);
}
void limit_sw(){
  pintu_min = digitalRead(ls_min);
  pintu_max = digitalRead(ls_max);
  buka_pintu = digitalRead(ls_door);
}
void ldr(){
  clst = digitalRead(LDR);
  Serial.println("Closet: "+String(clst));
}
void jarak_wstf(){
  digitalWrite(trig_wstf, LOW);
  delayMicroseconds(2);
  digitalWrite(trig_wstf, HIGH);
  delayMicroseconds(10);
  digitalWrite(trig_wstf, LOW);
  duration_wstf = pulseIn(echo_wstf, HIGH);

  //Calculate the distance (in cm) based on the speed of sound.
```

```
  distance_wstf = duration_wstf / 53,8;
  if(distance_wstf < 5)distance_wstf=0;
  else if(distance_wstf > 10)distance_wstf=0;
  Serial.println("Wastafel: "+String(distance_wstf));
}
void jarak_shwr(){
  digitalWrite(trig_shwr, LOW);
  delayMicroseconds(2);
  digitalWrite(trig_shwr, HIGH);
  delayMicroseconds(10);
  digitalWrite(trig_shwr, LOW);
  duration_shwr = pulseIn(echo_shwr, HIGH);
  //Calculate the distance (in cm) based on the speed of sound.
  distance_shwr = duration_shwr / 53,8;
  if(distance_shwr < 10)distance_shwr=0;
  else if(distance_shwr > 20)distance_shwr=0;
  Serial.println("Shower: "+String(distance_shwr));
}
void loop() {
  // put your main code here, to run repeatedly:
  awal:
//  Serial.println("System Start! :  "+String(state));
  Serial.println("Pir Dlm! :  "+String(pir_dalam));
  Serial.println("Pir luar! :  "+String(pir_luar));
  digitalWrite(Pump, HIGH);
```

```
  delay(1000);
//  digitalWrite(Tap_clst1, HIGH);
//  digitalWrite(Tap_clst2, LOW);
  pir();
  limit_sw();
  if(buka_pintu == 1){
    delay(500);
    digitalWrite(M1, LOW);
    digitalWrite(M2, HIGH);
    buka = 1;
    Serial.println("Door Open with LS");
   }
   if(pintu_min == 1 && buka == 1){
    digitalWrite(M1, HIGH);
    delay(5000);
    digitalWrite(M2, LOW);
   }
   if(pintu_max == 1 && buka == 1){
    digitalWrite(M2, HIGH);
    digitalWrite(Lamp, HIGH);
    delay(500);
    state=0;
    goto awal;
   }
  else if(pir_luar == 1 && state == 0){                    // START
```

```
  Serial.println("Motion Detect Outside!");
  digitalWrite(M1, LOW); // Door Open
  digitalWrite(M2, HIGH);
  delay(1000);
  state = 1;
  buka = 0;
 }
 else if(state == 1 && pintu_min == 1){                    // DOOR OPEN &&
Sign For All System Ready to Use
  Serial.println("Door Open and Lamp On");
  digitalWrite(M1, HIGH); // Motor OFF
  digitalWrite(M2, HIGH);
  digitalWrite(Lamp, LOW);
  delay(1000);
  state = 2;
 }
 else if(state == 2 && pintu_min == 1 && pir_dalam == 1){
  Serial.println("Door Close Again!");
  digitalWrite(M1, HIGH);
  digitalWrite(M2, LOW);
  digitalWrite(Lamp, LOW);
  delay(1000);
  state = 3;
 }
 else if(state == 3 && pintu_max == 1){
```

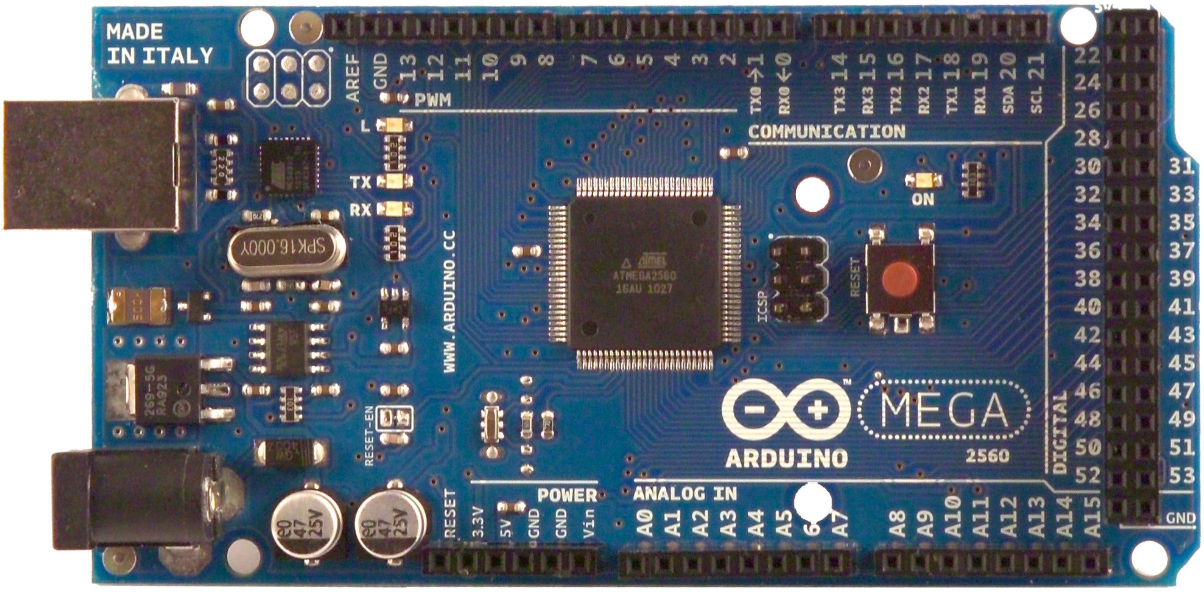
```
  digitalWrite(M1, HIGH); // Motor OFF
  digitalWrite(M2, HIGH);
  delay(1000);
  state = 4;
 }
while(state == 4){
  jarak_wstf();
  jarak_shwr();
  ldr();
  limit_sw();
  Serial.println(tutup_clst);
  if(distance_wstf != 0){
    digitalWrite(Tap_wstf, LOW);
    delay(300);
    digitalWrite(Pump, LOW);
    delay(2000);
  }
  else {digitalWrite(Tap_wstf, HIGH);digitalWrite(Pump, HIGH);}
  if(distance_shwr != 0){
    digitalWrite(Tap_shwr, LOW);
    delay(300);
    digitalWrite(Pump, LOW);
    delay(2000);
  }
  else {digitalWrite(Tap_shwr, HIGH);digitalWrite(Pump, HIGH);}
```

```
if(clst == 0 && tutup_clst == 0){
  digitalWrite(Pump, LOW);
  digitalWrite(s_closet, LOW);
  tutup_clst=1;
  delay(2000);
}
if(clst == 1 && tutup_clst == 1){
  tutup_clst=2;
}
if(clst == 0 && tutup_clst == 2){
  digitalWrite(Tap_clst1, LOW);
  digitalWrite(Tap_clst2, HIGH);
  delay(2000);
  digitalWrite(Tap_clst1, HIGH);
  digitalWrite(Tap_clst2, LOW);
  tutup_clst=3;
}
if(clst == 1 && tutup_clst == 3){
  digitalWrite(Pump, HIGH);
  digitalWrite(s_closet, HIGH);
  tutup_clst=0;
}

if(buka_pintu == 1){
```

```
      delay(500);
      digitalWrite(M1, LOW);
      digitalWrite(M2, HIGH);
      buka = 1;
      Serial.println("Door Open with LS");
    }
    if(pintu_min == 1 && buka == 1){
      digitalWrite(M1, HIGH);
      delay(5000);
      digitalWrite(M2, LOW);
    }
    if(pintu_max == 1 && buka == 1){
      digitalWrite(M2, HIGH);
      digitalWrite(Lamp, HIGH);
      delay(500);
      state=0;
      goto awal;
    }
  }
}
```

Arduino MEGA 2560



Product Overview

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), 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 Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

Index

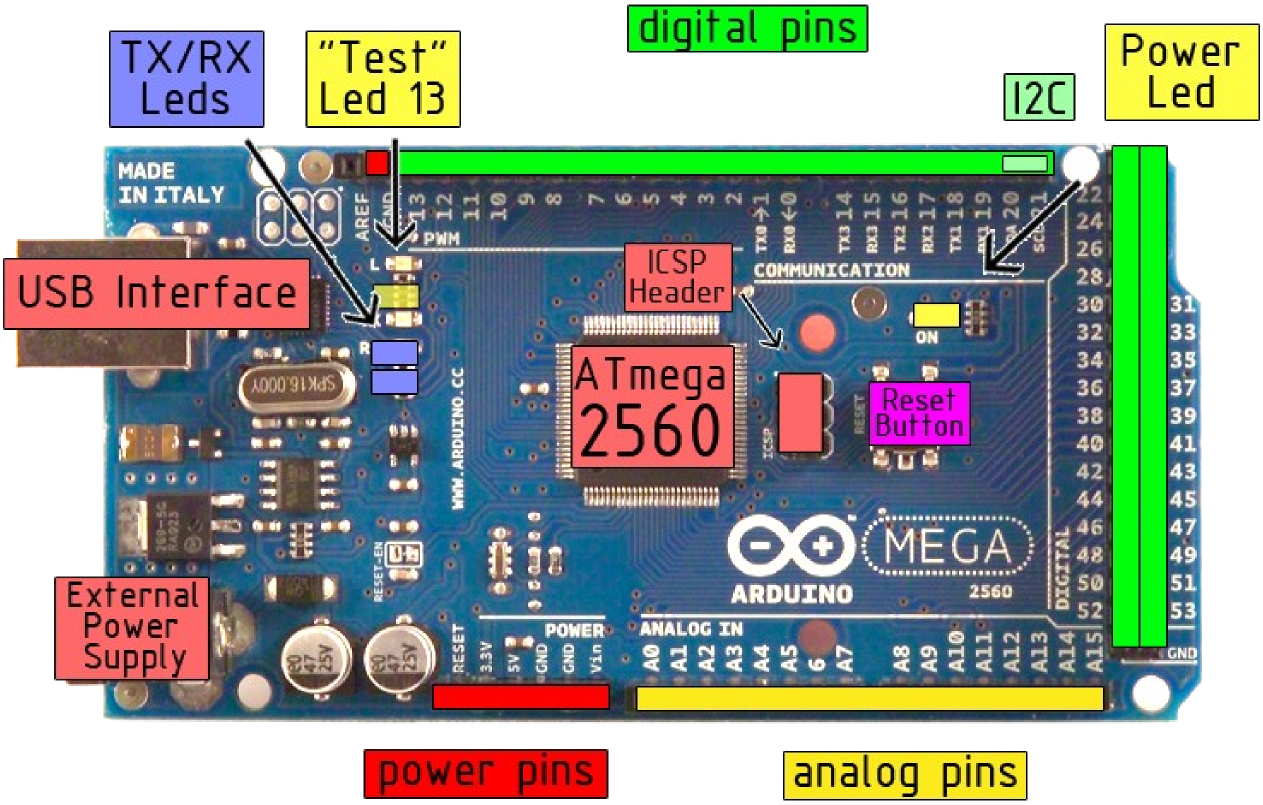
Technical Specification

EAGLE files: arduino-mega2560-reference-design.zip Schematic: arduino-mega2560-schematic.pdf

Summary

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

the board



Power

The Arduino Mega2560 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 Mega2560 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.

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 ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 54 digital pins on the Mega 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); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip .
- **External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2).** 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: 0 to 13.** Provide 8-bit PWM output with the analogWrite() function.
- **SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS).** These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Duemilanove and Diecimila.
- **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.
- **I^2C: 20 (SDA) and 21 (SCL).** Support I^2C (TWI) communication using the Wire library (documentation on the Wiring website). Note that these pins are not in the same location as the I^2C pins on the Duemilanove.

The Mega2560 has 16 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 is it possible to change the upper end of their range using the AREF pin and analogReference() function.

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.

Communication

The Arduino Mega2560 has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega8U2 on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2 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 Mega's digital pins.

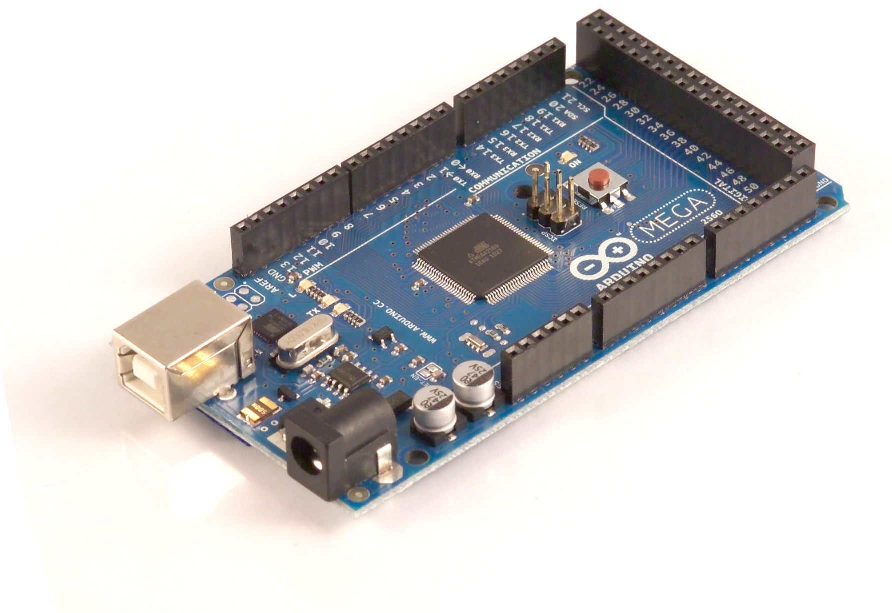
The ATmega2560 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation on the Wiring website for details. To use the SPI communication, please see the ATmega2560 datasheet.

Programming

The Arduino Mega2560 can be programmed with the Arduino software (download). For details, see the reference and tutorials.

The Atmega2560 on the Arduino Mega 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, C header files).

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



Automatic (Software) Reset

Rather then requiring a physical press of the reset button before an upload, the Arduino Mega2560 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 ATmega2560 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 Mega2560 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 Mega2560. 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 Mega 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 Mega 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 and Shield Compatibility

The maximum length and width of the Mega PCB are 4 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.

The Mega is designed to be compatible with most shields designed for the Diecimila or Duemilanove. Digital pins 0 to 13 (and the adjacent AREF and GND pins), analog inputs 0 to 5, the power header, and ICSP header are all in equivalent locations. Further the main UART (serial port) is located on the same pins (0 and 1), as are external interrupts 0 and 1 (pins 2 and 3 respectively). SPI is available through the ICSP header on both the Mega and Duemilanove / Diecimila. **Please note that I^2C is not located on the same pins on the Mega (20 and 21) as the Duemilanove / Diecimila (analog inputs 4 and 5).**

How to use Arduino

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

Arduino is a cross-platoform program. You'll have to follow different instructions for your personal OS. Check on the Arduino site for the latest instructions. *http://arduino.cc/en/Guide/HomePage*

Linux Install

Windows Install

Mac Install

Once you have downloaded/unzipped the arduino IDE, you can Plug the Arduino to your PC via USB cable.

Blink led

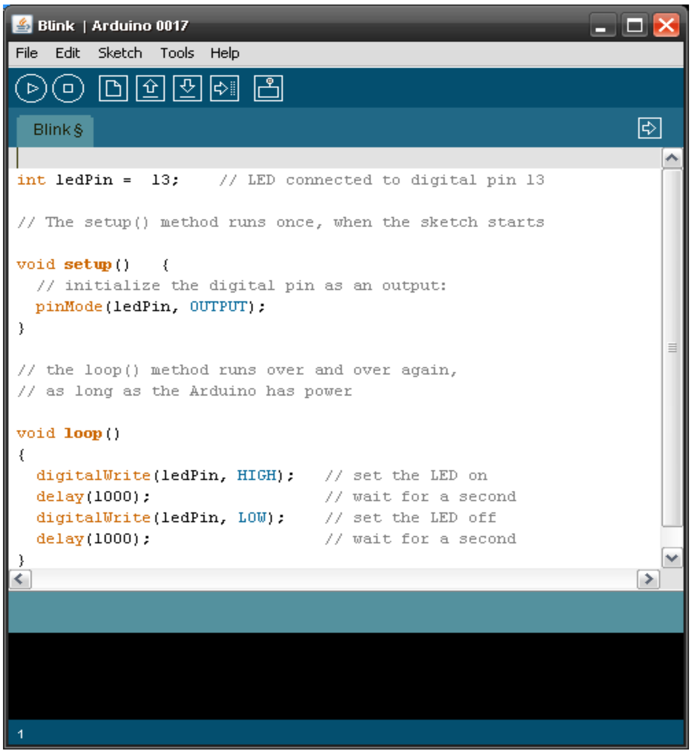
Now you're actually ready to "burn" your first program on the arduino board. To select "blink led", the physical translation of the well known programming "hello world", select

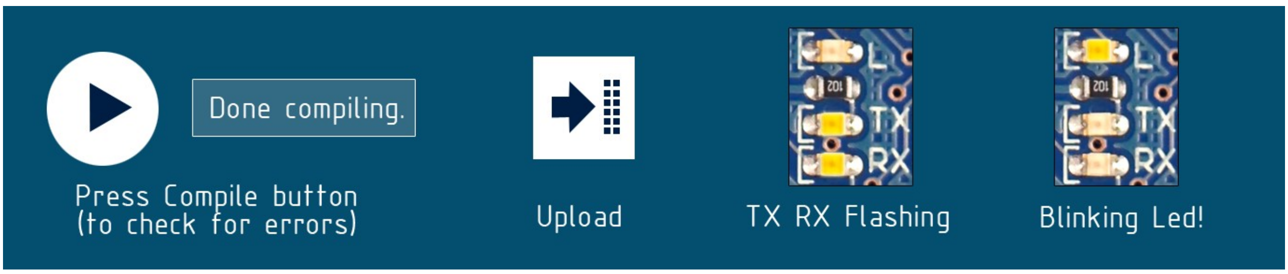
File>Sketchbook>
Arduino-0017>Examples>
Digital>Blink

Once you have your skecth you'll see something very close to the screenshot on the right.

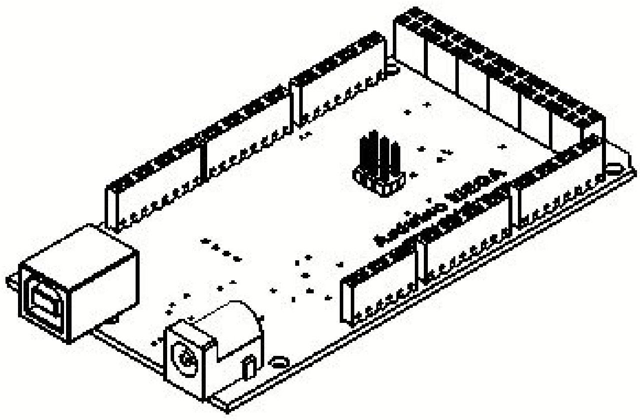
In **Tools>Board** select MEGA

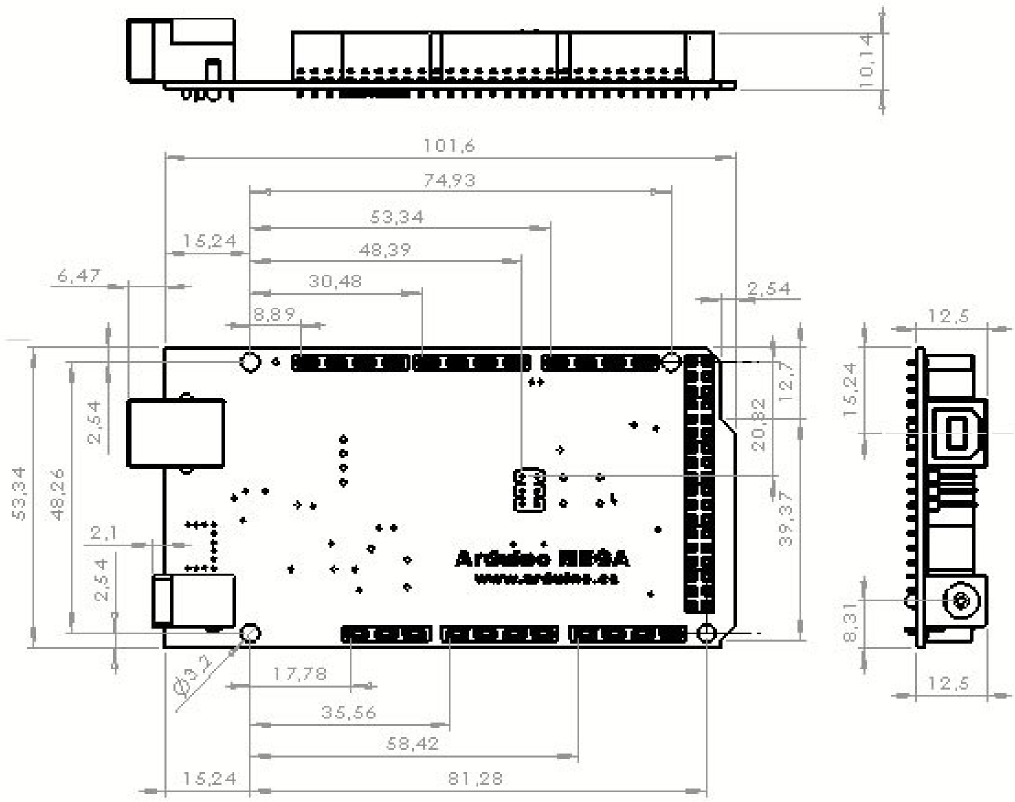
Now you have to go to
Tools>SerialPort
and select the right serial port, the one arduino is attached to.





Dimensioned Drawing





Terms & Conditions

1. Warranties

1.1 The producer warrants that its products will conform to the Specifications. This warranty lasts for one (1) years from the date of the sale. The producer shall not be liable for any defects that are caused by neglect, misuse or mistreatment by the Customer, including improper installation or testing, or for any products that have been altered or modified in any way by a Customer. Moreover, The producer shall not be liable for any defects that result from Customer's design, specifications or instructions for such products. Testing and other quality control techniques are used to the extent the producer deems necessary.

1.2 If any products fail to conform to the warranty set forth above, the producer's sole liability shall be to replace such products. The producer's liability shall be limited to products that are determined by the producer not to conform to such warranty. If the producer elects to replace such products, the producer shall have a reasonable time to replacements. Replaced products shall be warranted for a new full warranty period.

1.3 EXCEPT AS SET FORTH ABOVE, PRODUCTS ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." THE PRODUCER DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING PRODUCTS, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE

1.4 Customer agrees that prior to using any systems that include the producer products, Customer will test such systems and the functionality of the products as used in such systems. The producer may provide technical, applications or design advice, quality characterization, reliability data or other services. Customer acknowledges and agrees that providing these services shall not expand or otherwise alter the producer's warranties, as set forth above, and no additional obligations or liabilities shall arise from the producer providing such services.

1.5 The Arduino™ products are not authorized for use in safety-critical applications where a failure of the product would reasonably be expected to cause severe personal injury or death. Safety-Critical Applications include, without limitation, life support devices and systems, equipment or systems for the operation of nuclear facilities and weapons systems. Arduino™ products are neither designed nor intended for use in military or aerospace applications or environments and for automotive applications or environment. Customer acknowledges and agrees that any such use of Arduino™ products which is solely at the Customer's risk, and that Customer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

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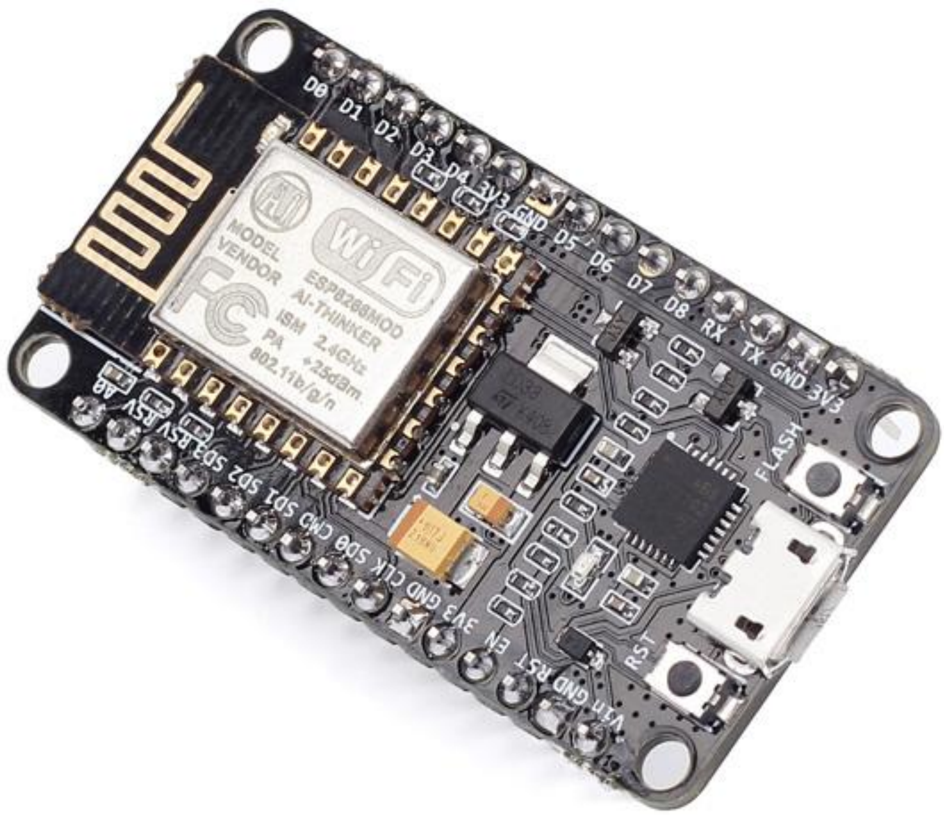
Enviromental Policies

The producer of Arduino™ has joined the Impatto Zero® policy of LifeGate.it. For each Arduino board produced is created / looked after half squared Km of Costa Rica's forest's.

NodeMCU v2



The NodeMcu is an open-source firmware and development kit that helps you to Prototype your IOT product within a few Lua script lines.

Features:

- Open-source
- Interactive
- Programmable
- Low cost
- Simple
- Smart
- WI-FI enabled

Arduino-like hardware IO

Advanced API for hardware IO, which can dramatically reduce the redundant work for configuring and manipulating hardware.
Code like arduino, but interactively in Lua script.

Nodejs style network API

Event-driven API for network applicaitons, which faciliates developers writing code running on a 5mm*5mm sized MCU in Nodejs style.
Greatly speed up your IOT application developing process.

Specification:

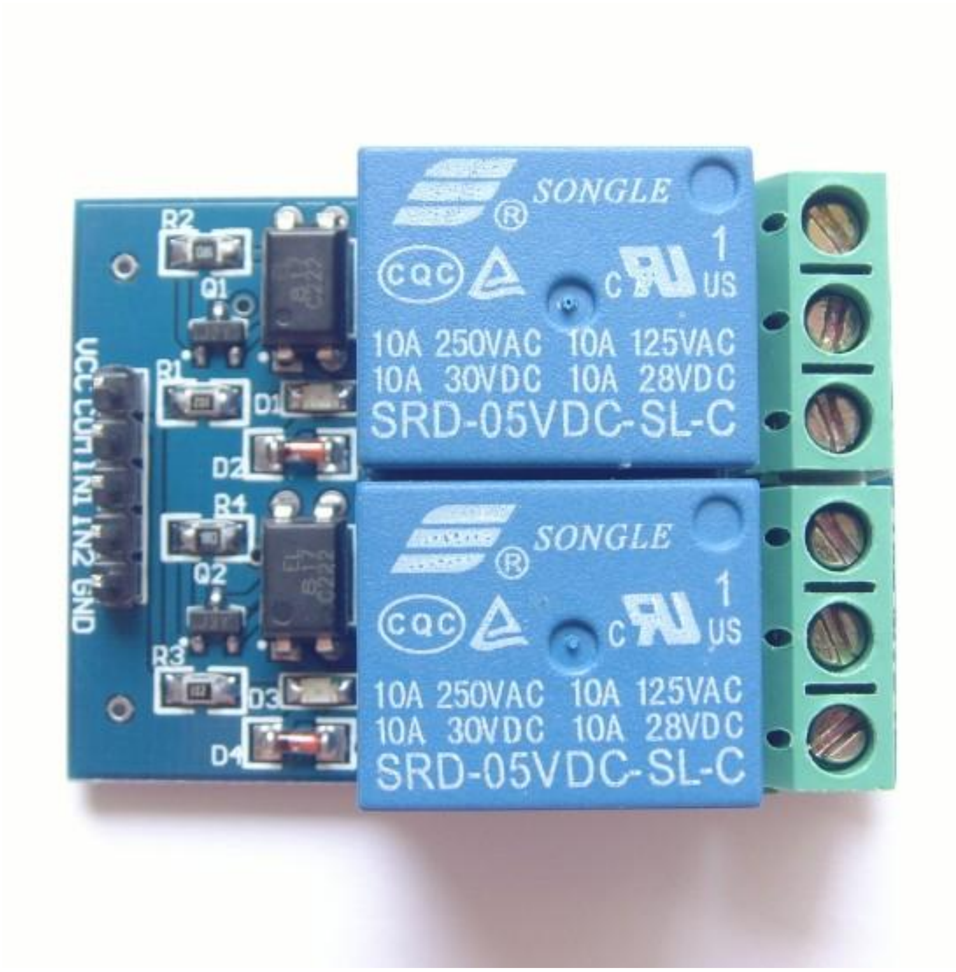
The Development Kit based on ESP8266, integates GPIO, PWM, IIC, 1-Wire and ADC all in one board.
Power your developement in the fastest way combinating with NodeMCU Firmware!

- USB-TTL included, plug&play
- 10 GPIO, every GPIO can be PWM, I2C, 1-wire
- FCC CERTIFIED WI-FI module（Coming soon）
- PCB antenna

Document

Schematic&PCB, Source Code, API Documents

2 CHANNEL 5V 10A RELAY MODULE



Description

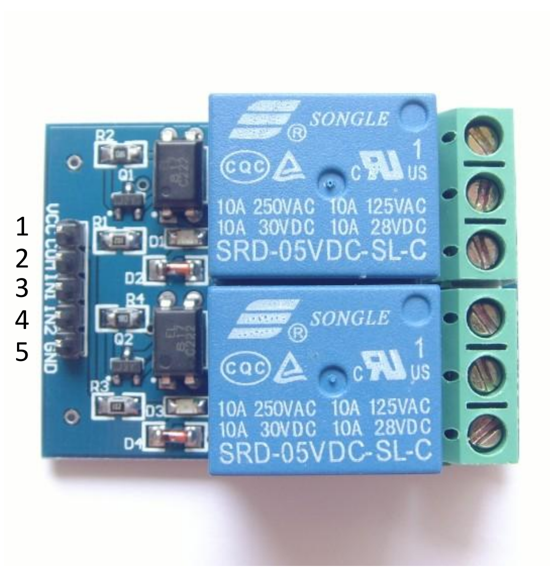
The relay module is an electrically operated switch that allows you to turn on or off a circuit using voltage and/or current much higher than a microcontroller could handle. There is no connection between the low voltage circuit operated by the microcontroller and the high power circuit. The relay protects each circuit from each other.

The each channel in the module has three connections named NC, COM, and NO. Depending on the input signal trigger mode, the jumper cap can be placed at high level effective mode which ‘closes’ the normally open (NO) switch at high level input and at low level effective mode which operates the same but at low level input.

Specifications

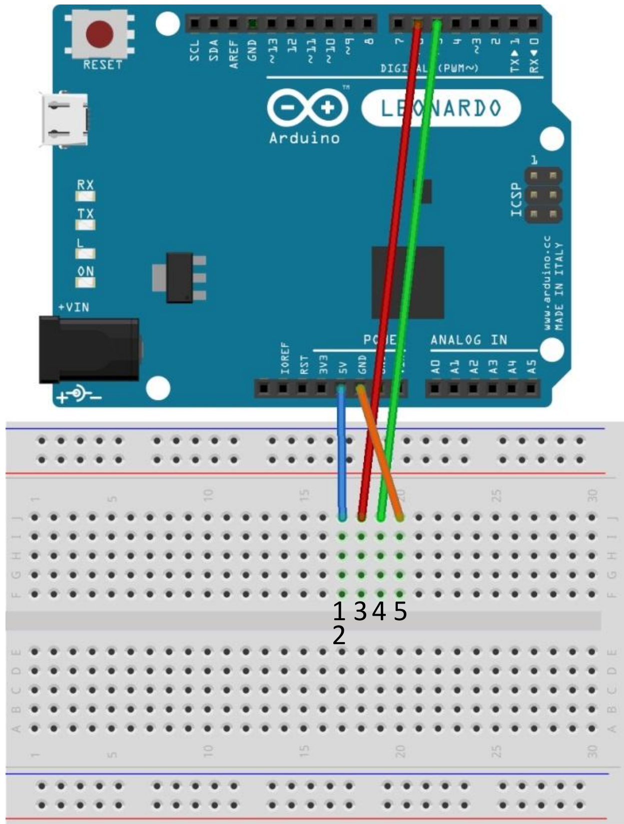
- On-board EL817 photoelectric coupler with photoelectric isolating anti-interference ability strong
- On-board 5V, 10A / 250VAC, 10A / 30VDC relays
- Relay long life can absorb 100000 times in a row
- Module can be directly and MCU I/O link, with the output signal indicator
- Module with diode current protection, short response time
- PCB Size: 45.8mm x 32.4mm

Pin Configuration

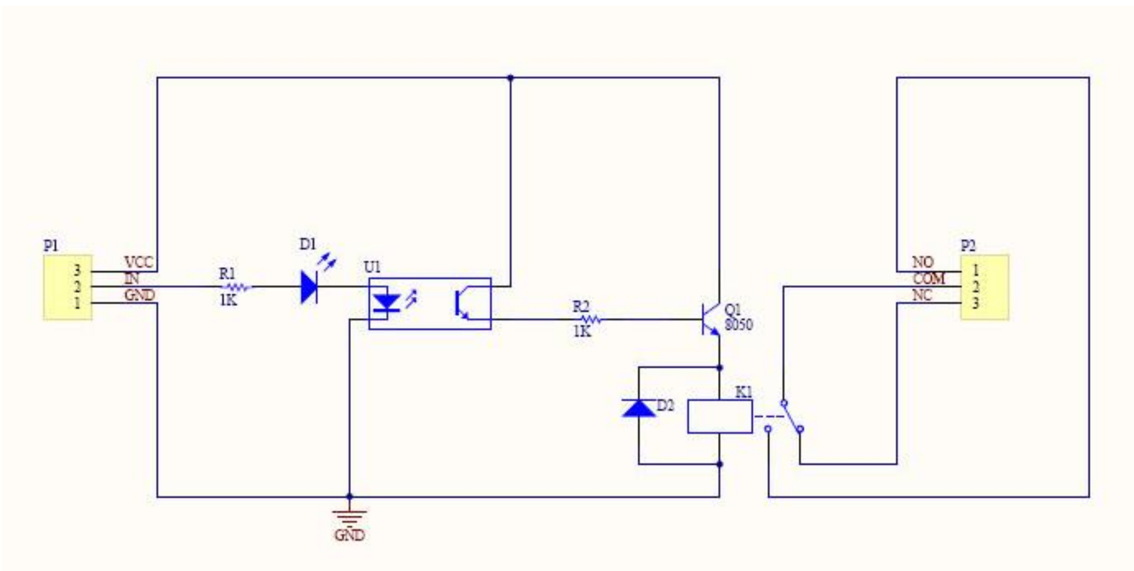


1. VCC: 5V DC
2. COM: 5V DC
3. IN1: high/low output
4. IN2: high/low output
5. GND: ground

Wiring Diagram



Schematic Diagram



Sample Sketch

```
void setup(){
  pinMode(5, OUTPUT);
  pinMode(6, OUTPUT);
}

void loop(){
  digitalWrite(5, LOW);
  digitalWrite(6, HIGH);
  delay(4000);
  digitalWrite(5, HIGH);
  digitalWrite(6, LOW);
  delay(4000);
}
```

How to Test

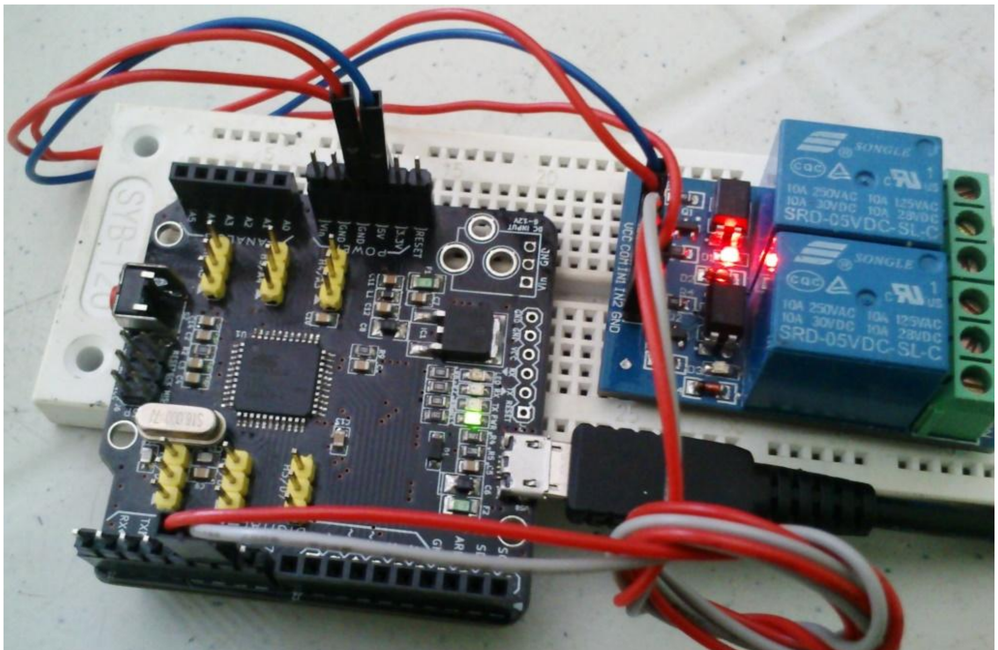
The components to be used are:

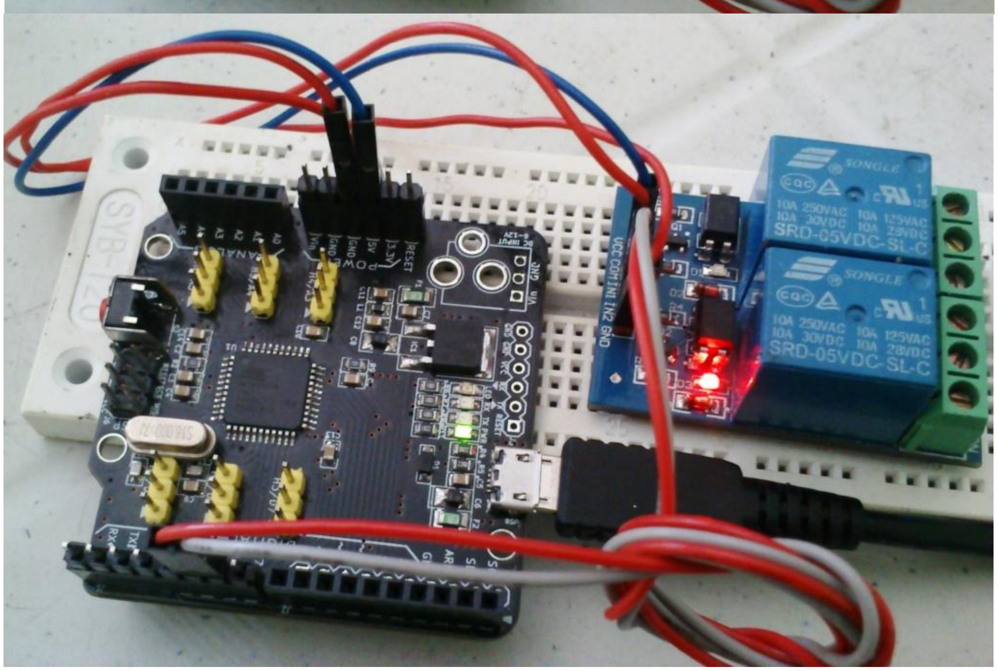
– Microcontroller (any compatible arduino)
– 2 channel 5V 10A relay module
– Pin connectors
– Breadboard
– USB cable

1. Connect the components based on the figure shown in the wiring diagram using pin connectors. VCC and COM pin is connected to the 5V power supply, GND pin is connected to the GND, IN1 and IN2 pins are connected to the digital I/O pin. Pin number will be based on the actual program code.
2. After hardware connection, insert the sample sketch into the Arduino IDE.
3. Using a USB cable, connect the ports from the microcontroller to the computer.
4. Upload the program.

Testing Results

The figures below shows an alternate switching of the two relays every 4 seconds. A tick sound and a red LED would be observed.

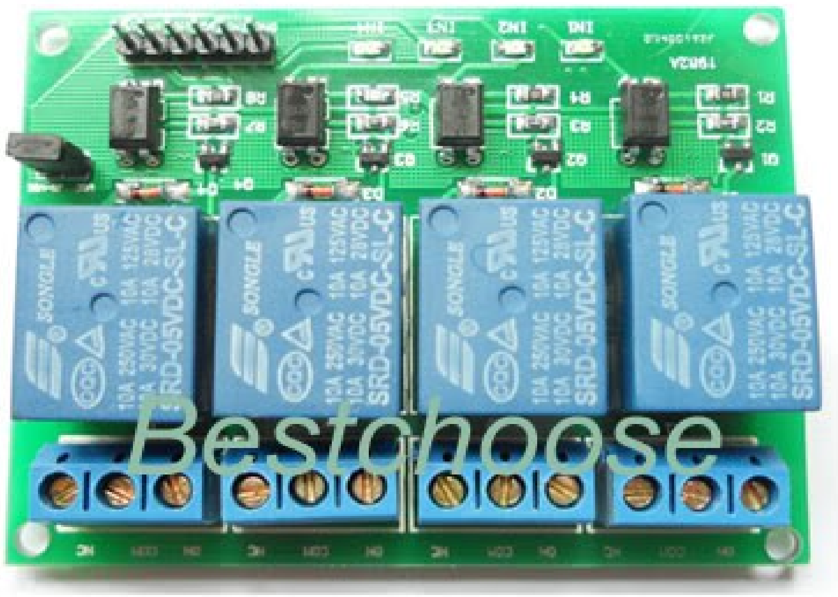


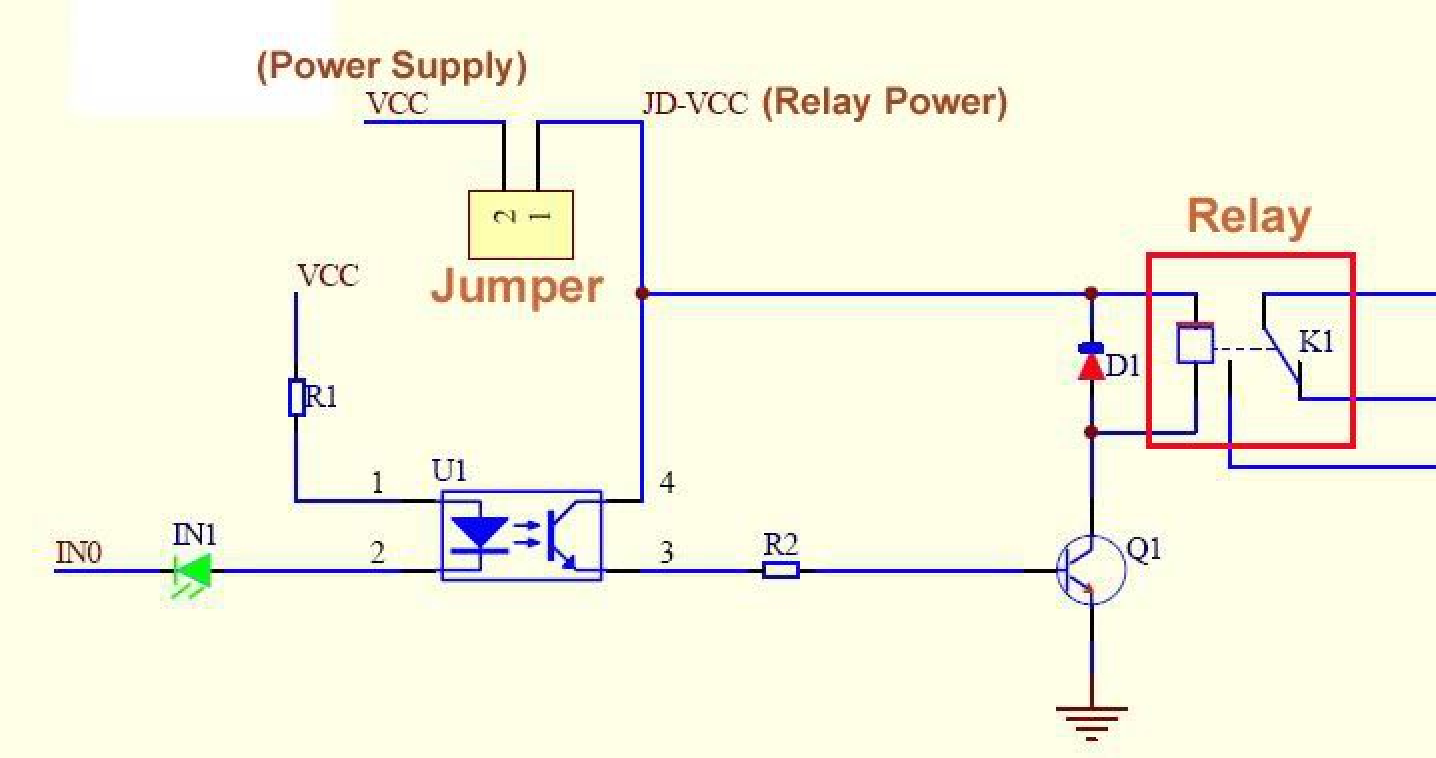


4-Channel 5V Relay Module for Arduino PIC ARM AVR DSP
Product Description

This is a 5V 4-Channel Relay interface board, Be able to control various appliances, and other equipments with large current. It can be controlled directly by Microcontroller(Arduino , 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic) .

1、5V 4-Channel Relay interface board, and each one needs 15-20mA Driver Current
2、Equiped with high-current relay, AC250V ; DC30V
3、Standard interface that can be controlled directly by microcontroller (Arduino , 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic)
4、Indication LED’s for Relay output status





(Power Supply)
VCC
JD-VCC
(Relay Power)
2 1
Jumper
VCC
R1
Relay
D1
K1
1
U1
4
IN0
IN1
2
3
R2
Q1

LM2596

3.0 A, Step-Down Switching Regulator

The LM2596 regulator is monolithic integrated circuit ideally suited for easy and convenient design of a step−down switching regulator (buck converter). It is capable of driving a 3.0 A load with excellent line and load regulation. This device is available in adjustable output version and it is internally compensated to minimize the number of external components to simplify the power supply design.

Since LM2596 converter is a switch−mode power supply, its efficiency is significantly higher in comparison with popular three−terminal linear regulators, especially with higher input voltages.

The LM2596 operates at a switching frequency of 150 kHz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators. Available in a standard 5−lead TO−220 package with several different lead bend options, and D^2PAK surface mount package.

The other features include a guaranteed ±4% tolerance on output voltage within specified input voltages and output load conditions, and ±15% on the oscillator frequency. External shutdown is included, featuring 80 μA (typical) standby current. Self protection features include switch cycle−by−cycle current limit for the output switch, as well as thermal shutdown for complete protection under fault conditions.

Features

- Adjustable Output Voltage Range 1.23 V − 37 V
- Guaranteed 3.0 A Output Load Current
- Wide Input Voltage Range up to 40 V
- 150 kHz Fixed Frequency Internal Oscillator
- TTL Shutdown Capability
- Low Power Standby Mode, typ 80 μA
- Thermal Shutdown and Current Limit Protection
- Internal Loop Compensation
- Moisture Sensitivity Level (MSL) Equals 1
- Pb−Free Packages are Available

Applications

- Simple High−Efficiency Step−Down (Buck) Regulator
- Efficient Pre−Regulator for Linear Regulators
- On−Card Switching Regulators
- Positive to Negative Converter (Buck−Boost)
- Negative Step−Up Converters
- Power Supply for Battery Chargers

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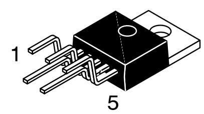
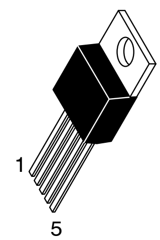


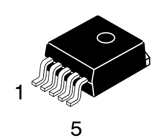
TO−220
TV SUFFIX
CASE 314B

Heatsink surface connected to Pin 3



TO−220
T SUFFIX
CASE 314D

Pin
1. V_{in}
2. Output
3. Ground
4. Feedback
5. $\overline{\text{ON}}$/OFF



D^2PAK
D2T SUFFIX
CASE 936A

Heatsink surface (shown as terminal 6 in case outline drawing) is connected to Pin 3

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 23 of this data sheet.

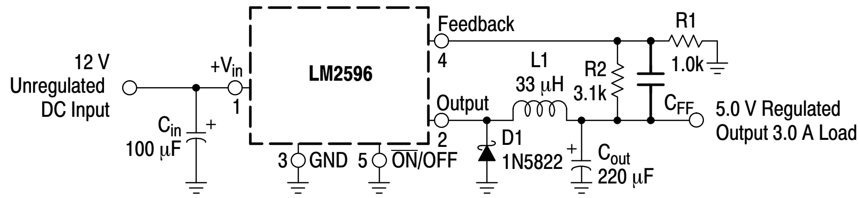
DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 23 of this data sheet.

November, 2008 − Rev. 0

Publication Order Number:
LM2596/D

Typical Application (Adjustable Output Voltage Version)



Block Diagram

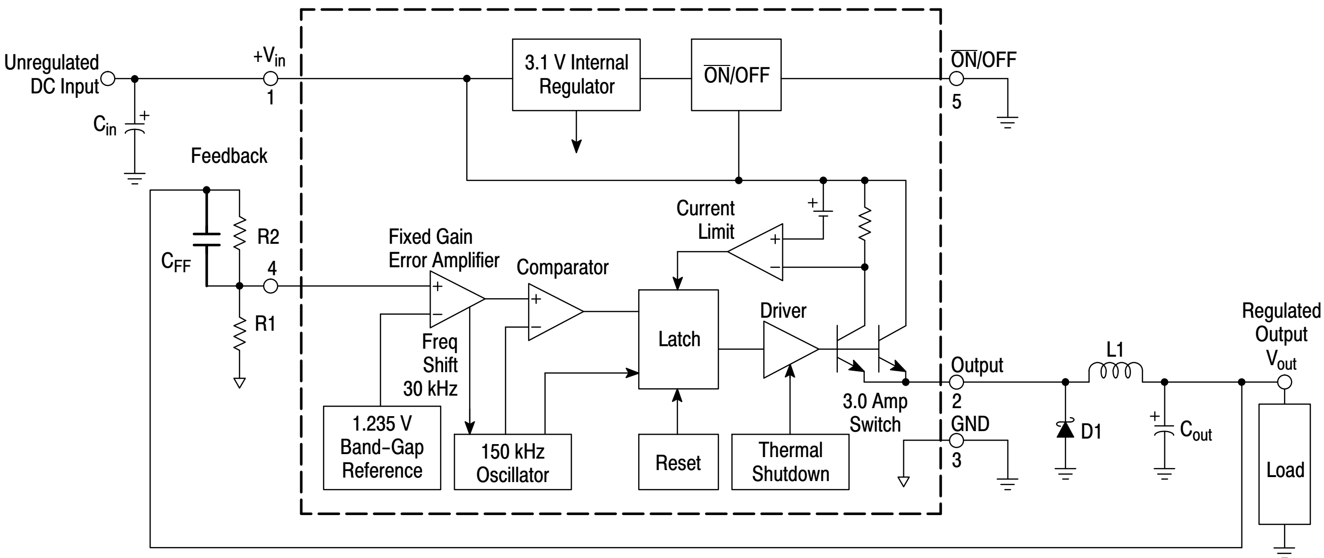


Figure 1. Typical Application and Internal Block Diagram

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Maximum Supply Voltage	V_{in}	45	V
$\overline{ON}$/OFF Pin Input Voltage	–	$-0.3\ V \le V \le +V_{in}$	V
Output Voltage to Ground (Steady−State)	–	−1.0	V
Power Dissipation			
Case 314B and 314D (TO−220, 5−Lead)	P_D	Internally Limited	W
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	65	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	5.0	°C/W
Case 936A (D^2PAK)	P_D	Internally Limited	W
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	70	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	5.0	°C/W
Storage Temperature Range	T_{stg}	−65 to +150	°C
Minimum ESD Rating (Human Body Model: C = 100 pF, R = 1.5 kΩ)	–	2.0	kV
Lead Temperature (Soldering, 10 seconds)	–	260	°C
Maximum Junction Temperature	T_J	150	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

PIN FUNCTION DESCRIPTION

Pin	Symbol	Description (Refer to Figure 1)
1	V_{in}	This pin is the positive input supply for the LM2596 step−down switching regulator. In order to minimize voltage transients and to supply the switching currents needed by the regulator, a suitable input bypass capacitor must be present (C_{in} in Figure 1).
2	Output	This is the emitter of the internal switch. The saturation voltage V_{sat} of this output switch is typically 1.5 V. It should be kept in mind that the PCB area connected to this pin should be kept to a minimum in order to minimize coupling to sensitive circuitry.
3	GND	Circuit ground pin. See the information about the printed circuit board layout.
4	Feedback	This pin is the direct input of the error amplifier and the resistor network R2, R1 is connected externally to allow programming of the output voltage.
5	$\overline{ON}$/OFF	It allows the switching regulator circuit to be shut down using logic level signals, thus dropping the total input supply current to approximately 80 μA. The threshold voltage is typically 1.6 V. Applying a voltage above this value (up to $+V_{in}$) shuts the regulator off. If the voltage applied to this pin is lower than 1.6 V or if this pin is left open, the regulator will be in the “on” condition.

OPERATING RATINGS (Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.)

Rating	Symbol	Value	Unit
Operating Junction Temperature Range	T_J	−40 to +125	°C
Supply Voltage	V_{in}	4.5 to 40	V

SYSTEM PARAMETERS

ELECTRICAL CHARACTERISTICS Specifications with standard type face are for T_J = 25°C, and those with boldface type apply over full Operating Temperature Range −40°C to +125°C

Characteristics	Symbol	Min	Typ	Max	Unit
LM2596 (Note 1, Test Circuit Figure 15)					
Feedback Voltage (V_{in} = 12 V, I_{Load} = 0.5 A, V_{out} = 5.0 V,)	V_{FB_nom}		1.23		V
Feedback Voltage (8.5 V ≤ V_{in} ≤ 40 V, 0.5 A ≤ I_{Load} ≤ 3.0 A, V_{out} = 5.0 V)	V_{FB}	1.193 **1.18**		1.267 **1.28**	V
Efficiency (V_{in} = 12 V, I_{Load} = 3.0 A, V_{out} = 5.0 V)	η	–	73	–	%
Characteristics	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Feedback Bias Current (V_{out} = 5.0 V)	I_b		25	100 **200**	nA
Oscillator Frequency (Note 2)	f_{osc}	135 **120**	150	165 **180**	kHz
Saturation Voltage (I_{out} = 3.0 A, Notes 3 and 4)	V_{sat}		1.5	1.8 **2.0**	V
Max Duty Cycle "ON" (Note 4)	DC		95		%
Current Limit (Peak Current, Notes 2 and 3)	I_{CL}	4.2 **3.5**	5.6	6.9 **7.5**	A
Output Leakage Current (Notes 5 and 6) Output = 0 V Output = −1.0 V	I_L		 0.5 6.0	 2.0 20	mA
Quiescent Current (Note 5)	I_Q		5.0	10	mA
Standby Quiescent Current ($\overline{ON}$/OFF Pin = 5.0 V ("OFF")) (Note 6)	I_{stby}		80	200 **250**	μA
$\overline{ON}$/OFF PIN LOGIC INPUT					
Threshold Voltage			1.6		V
V_{out} = 0 V (Regulator OFF)	V_{IH}	2.2 **2.4**			V
V_{out} = Nominal Output Voltage (Regulator ON)	V_{IL}			1.0 **0.8**	V
$\overline{ON}$/OFF Pin Input Current					
$\overline{ON}$/OFF Pin = 5.0 V (Regulator OFF)	I_{IH}	–	15	30	μA
$\overline{ON}$/OFF Pin = 0 V (regulator ON)	I_{IL}	–	0.01	5.0	μA

1. External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the LM2596 is used as shown in the Figure 15 test circuit, system performance will be as shown in system parameters section.
2. The oscillator frequency reduces to approximately 30 kHz in the event of an output short or an overload which causes the regulated output voltage to drop approximately 40% from the nominal output voltage. This self protection feature lowers the average dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%.
3. No diode, inductor or capacitor connected to output (Pin 2) sourcing the current.
4. Feedback (Pin 4) removed from output and connected to 0 V.
5. Feedback (Pin 4) removed from output and connected to +12 V to force the output transistor "off".
6. V_{in} = 40 V.

TYPICAL PERFORMANCE CHARACTERISTICS (Circuit of Figure 15)

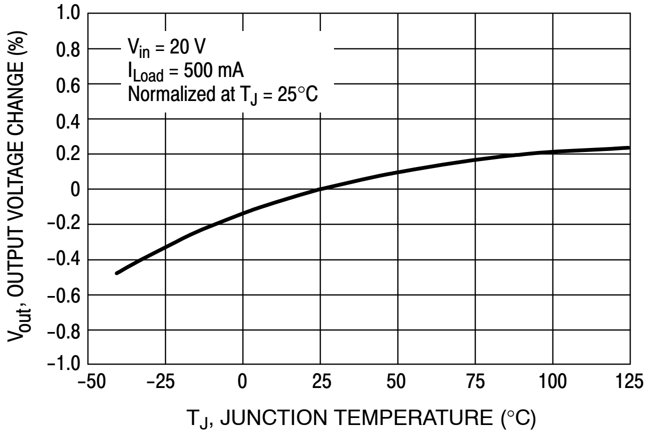


Figure 2. Normalized Output Voltage

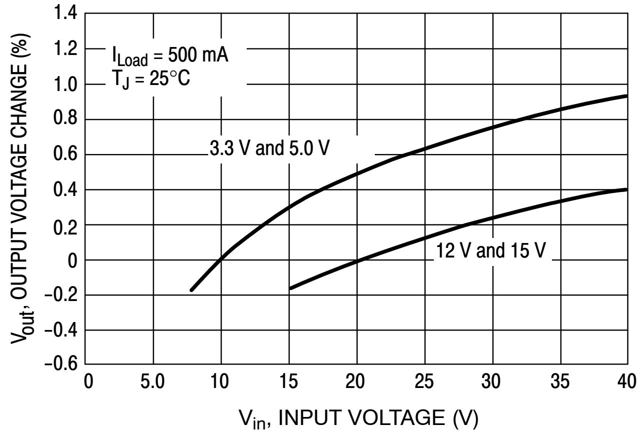


Figure 3. Line Regulation

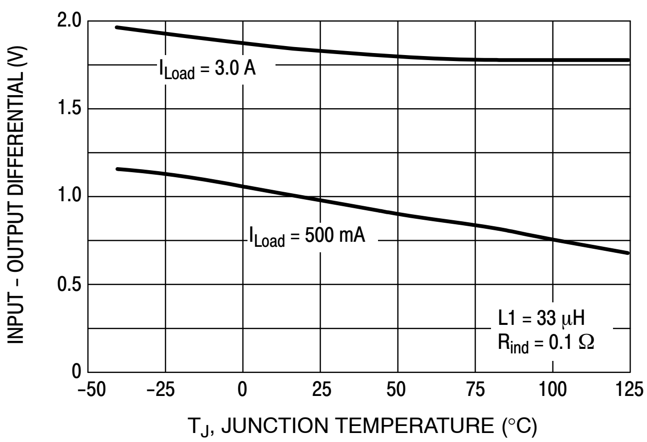


Figure 4. Dropout Voltage

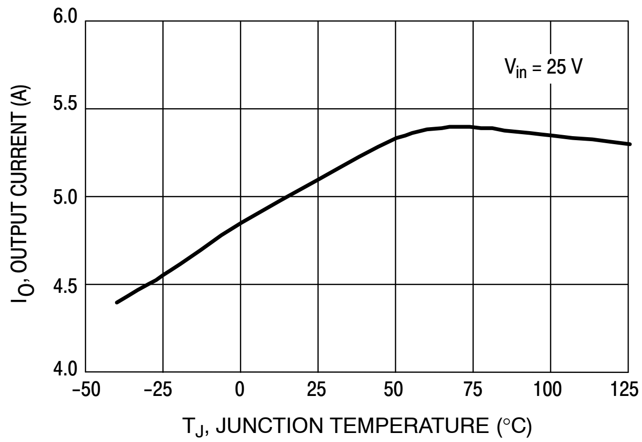


Figure 5. Current Limit

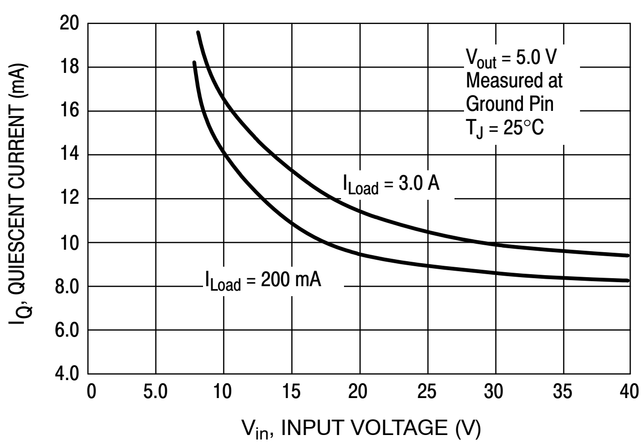


Figure 6. Quiescent Current

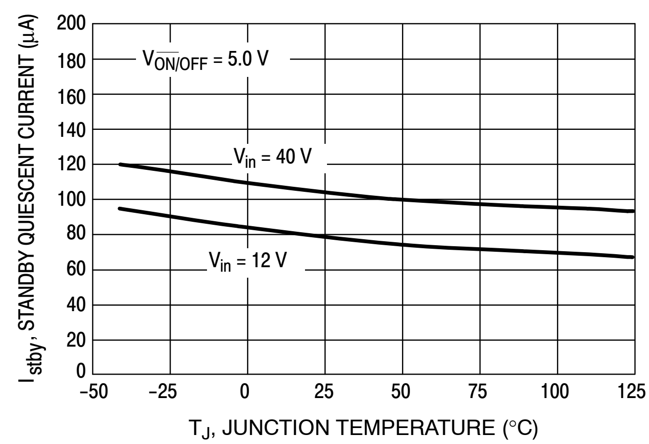


Figure 7. Standby Quiescent Current

TYPICAL PERFORMANCE CHARACTERISTICS (Circuit of Figure 15)

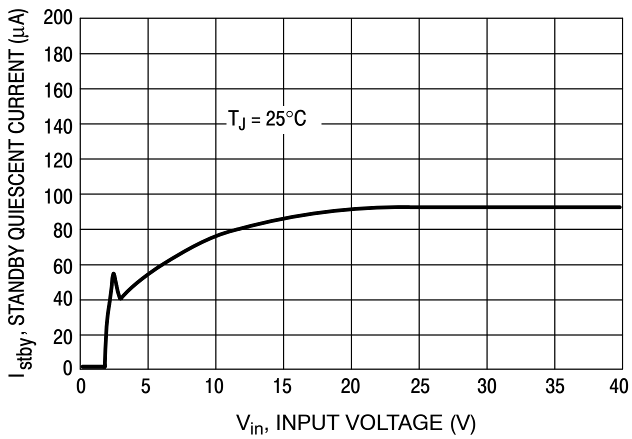


Figure 8. Standby Quiescent Current

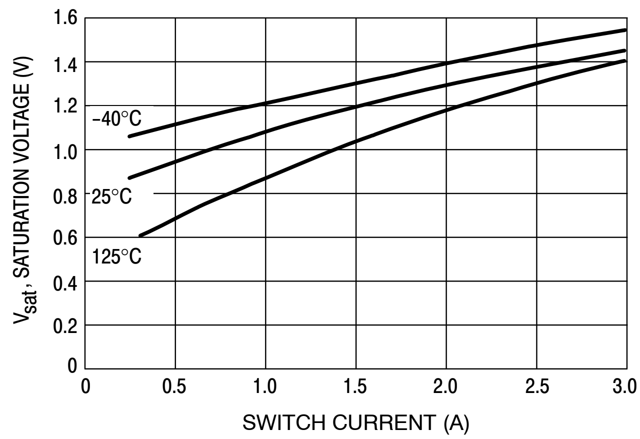


Figure 9. Switch Saturation Voltage

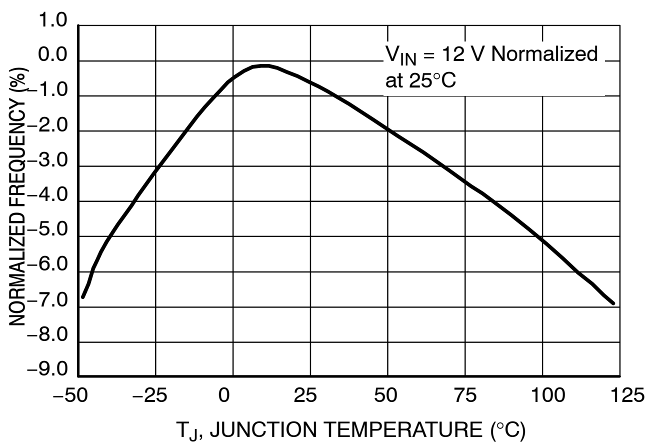


Figure 10. Switching Frequency

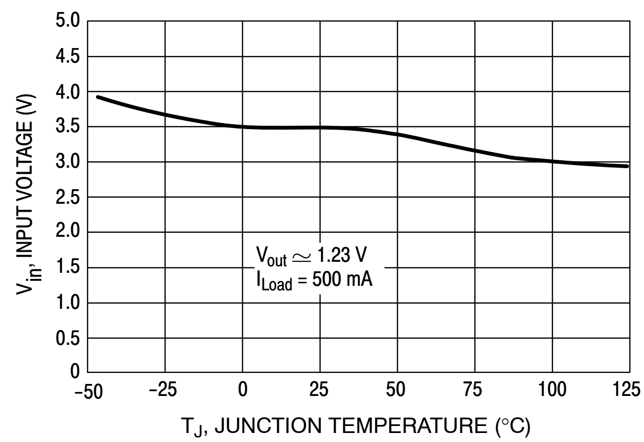


Figure 11. Minimum Supply Operating Voltage

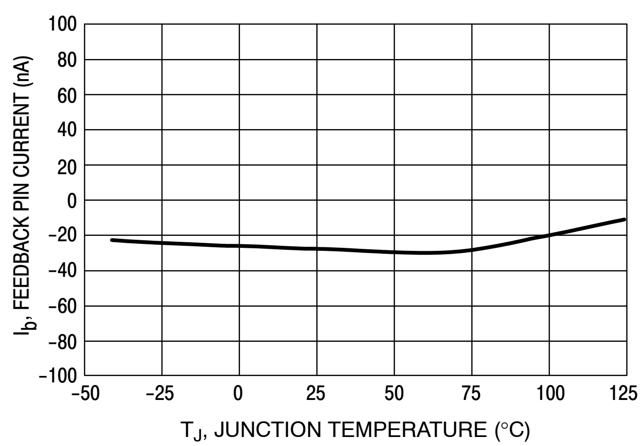


Figure 12. Feedback Pin Current

TYPICAL PERFORMANCE CHARACTERISTICS (Circuit of Figure 15)

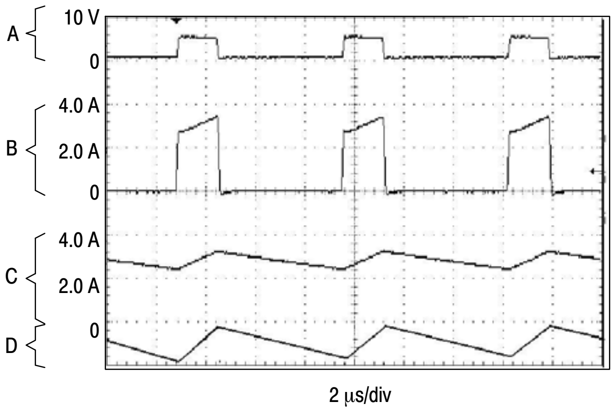


Figure 13. Switching Waveforms

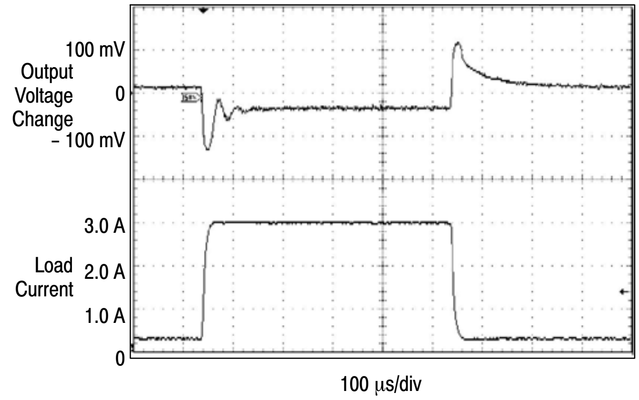
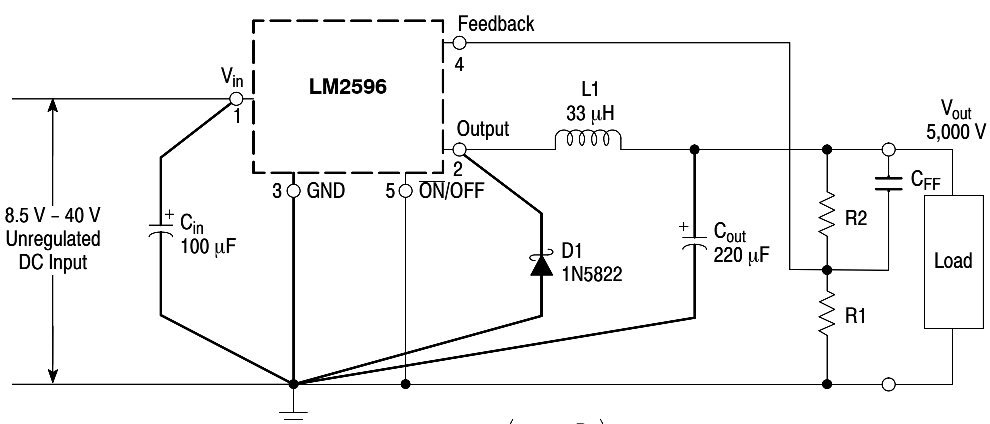


Figure 14. Load Transient Response

Vout = 5 V
A: Output Pin Voltage, 10 V/div
B: Switch Current, 2.0 A/div
C: Inductor Current, 2.0 A/div, AC−Coupled
D: Output Ripple Voltage, 50 mV/div, AC−Coupled

Horizontal Time Base: 5.0 µs/div

Adjustable Output Voltage Versions



$$V_{out} = V_{ref}\left(1.0 + \frac{R2}{R1}\right)$$

$$R2 = R1\left(\frac{V_{out}}{V_{ref}}\ 1.0\right)$$

Where V_{ref} = 1.23 V, R1 between 1.0 k and 5.0 k

Figure 15. Typical Test Circuit

PCB LAYOUT GUIDELINES

As in any switching regulator, the layout of the printed circuit board is very important. Rapidly switching currents associated with wiring inductance, stray capacitance and parasitic inductance of the printed circuit board traces can generate voltage transients which can generate electromagnetic interferences (EMI) and affect the desired operation. As indicated in the Figure 15, to minimize inductance and ground loops, the length of the leads indicated by heavy lines should be kept as short as possible.

For best results, single−point grounding (as indicated) or ground plane construction should be used.

On the other hand, the PCB area connected to the Pin 2 (emitter of the internal switch) of the LM2596 should be kept to a minimum in order to minimize coupling to sensitive circuitry.

Another sensitive part of the circuit is the feedback. It is important to keep the sensitive feedback wiring short. To assure this, physically locate the programming resistors near to the regulator, when using the adjustable version of the LM2596 regulator.

DESIGN PROCEDURE

Buck Converter Basics

The LM2596 is a "Buck" or Step−Down Converter which is the most elementary forward−mode converter. Its basic schematic can be seen in Figure 16.

The operation of this regulator topology has two distinct time periods. The first one occurs when the series switch is on, the input voltage is connected to the input of the inductor.

The output of the inductor is the output voltage, and the rectifier (or catch diode) is reverse biased. During this period, since there is a constant voltage source connected across the inductor, the inductor current begins to linearly ramp upwards, as described by the following equation:

$$I_{L(on)} = \frac{(V_{IN} - V_{OUT})t_{on}}{L}$$

During this "on" period, energy is stored within the core material in the form of magnetic flux. If the inductor is properly designed, there is sufficient energy stored to carry the requirements of the load during the "off" period.

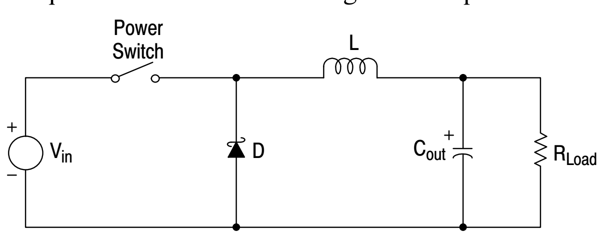


Figure 16. Basic Buck Converter

The next period is the "off" period of the power switch. When the power switch turns off, the voltage across the inductor reverses its polarity and is clamped at one diode voltage drop below ground by the catch diode. The current now flows through the catch diode thus maintaining the load current loop. This removes the stored energy from the inductor. The inductor current during this time is:

$$I_{L(off)} = \frac{(V_{OUT} - V_D)t_{off}}{L}$$

This period ends when the power switch is once again turned on. Regulation of the converter is accomplished by varying the duty cycle of the power switch. It is possible to describe the duty cycle as follows:

$$d = \frac{t_{on}}{T}, \text{ where T is the period of switching.}$$

For the buck converter with ideal components, the duty cycle can also be described as:

$$d = \frac{V_{out}}{V_{in}}$$

Figure 17 shows the buck converter, idealized waveforms of the catch diode voltage and the inductor current.

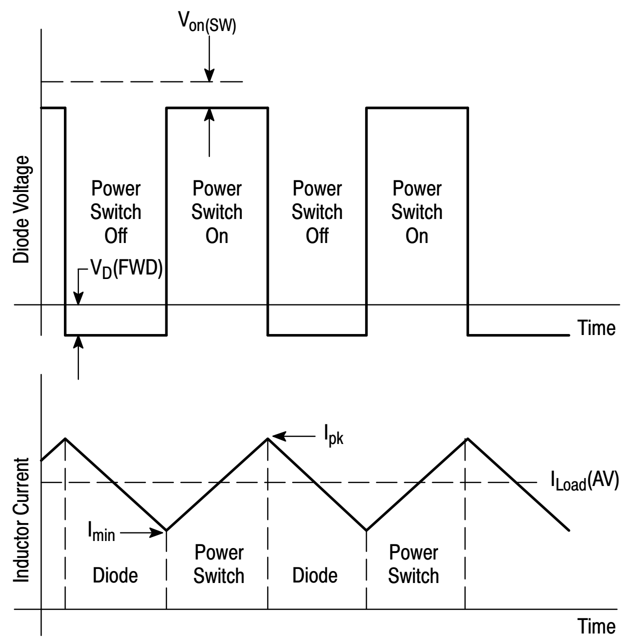


Figure 17. Buck Converter Idealized Waveforms

PROCEDURE (ADJUSTABLE OUTPUT VERSION: LM2596)

Procedure	Example
Given Parameters: V_{out} = Regulated Output Voltage $V_{in(max)}$ = Maximum DC Input Voltage $I_{Load(max)}$ = Maximum Load Current	**Given Parameters:** V_{out} = 5.0 V $V_{in(max)}$ = 12 V $I_{Load(max)}$ = 3.0 A
1. Programming Output Voltage To select the right programming resistor R1 and R2 value (see Figure 1) use the following formula: $V_{out} = V_{ref}\left(1.0 + \frac{R2}{R1}\right)$ where V_{ref} = 1.23 V Resistor R1 can be between 1.0 k and 5.0 kΩ. (For best temperature coefficient and stability with time, use 1% metal film resistors). $R2 = R1\left(\frac{V_{out}}{V_{ref}} - 1.0\right)$	**1. Programming Output Voltage** (selecting R1 and R2) Select R1 and R2: $V_{out} = 1.23\left(1.0 + \frac{R2}{R1}\right)$ Select R1 = 1.0 kΩ $R2 = R1\left(\frac{V_{out}}{V_{ref}} - 1.0\right) = \left(\frac{5\ V}{1.23\ V} - 1.0\right)$ R2 = 3.0 kΩ, choose a 3.0k metal film resistor.
2. Input Capacitor Selection (C_{in}) To prevent large voltage transients from appearing at the input and for stable operation of the converter, an aluminium or tantalum electrolytic bypass capacitor is needed between the input pin $+V_{in}$ and ground pin GND This capacitor should be located close to the IC using short leads. This capacitor should have a low ESR (Equivalent Series Resistance) value**.** For additional information see input capacitor section in the “Application Information” section of this data sheet.	**2. Input Capacitor Selection (C_{in})** A 100 μF, 50 V aluminium electrolytic capacitor located near the input and ground pin provides sufficient bypassing.
3. Catch Diode Selection (D1) **A.** Since the diode maximum peak current exceeds the regulator maximum load current the catch diode current rating must be at least 1.2 times greater than the maximum load current. For a robust design, the diode should have a current rating equal to the maximum current limit of the LM2596 to be able to withstand a continuous output short. **B.** The reverse voltage rating of the diode should be at least 1.25 times the maximum input voltage.	**3. Catch Diode Selection (D1)** **A.** For this example, a 3.0 A current rating is adequate. **B.** For robust design use a 30 V 1N5824 Schottky diode or any suggested fast recovery diode in the Table 2.

PROCEDURE (ADJUSTABLE OUTPUT VERSION: LM2596) (CONTINUED)

Procedure	Example
4. Inductor Selection (L1) **A.** Use the following formula to calculate the inductor Volt x microsecond [V x µs] constant: $E \times T = \left(V_{IN} - V_{OUT} - V_{SAT}\right) \times \frac{V_{OUT} + V_D}{V_{IN} - V_{SAT} + V_D} \times \frac{1000}{150\ kHz} (V \times \mu s)$ **B.** Match the calculated E x T value with the corresponding number on the vertical axis of the Inductor Value Selection Guide shown in Figure 18. This E x T constant is a measure of the energy handling capability of an inductor and is dependent upon the type of core, the core area, the number of turns, and the duty cycle. **C.** Next step is to identify the inductance region intersected by the E x T value and the maximum load current value on the horizontal axis shown in Figure 18. **D.** Select an appropriate inductor from Table 3. The inductor chosen must be rated for a switching frequency of 150 kHz and for a current rating of 1.15 x I_{Load}. The inductor current rating can also be determined by calculating the inductor peak current: $I_{p(max)} = I_{Load(max)} + \frac{\left(V_{in} - V_{out}\right) t_{on}}{2L}$ where t_{on} is the "on" time of the power switch and $t_{on} = \frac{V_{out}}{V_{in}} \times \frac{1.0}{f_{osc}}$	**4. Inductor Selection (L1)** **A.** Calculate E x T [V x µs] constant: $E \times T = (12 - 5 - 1.5) \times \frac{5 + 0.5}{12 - 5 + 0.5} \times \frac{1000}{150\ kHz} (V \times \mu s)$ $E \times T = (5.5) \times \frac{5.5}{7.5} \times 6.6 (V \times \mu s)$ **B.** E x T = 27 [V x µs] **C.** $I_{Load(max)}$ = 3.0 A Inductance Region = L40 **D.** Proper inductor value = 33 µH Choose the inductor from Table 3.
5. Output Capacitor Selection (C_{out}) **A.** Since the LM2596 is a forward−mode switching regulator with voltage mode control, its open loop has 2−pole−1−zero frequency characteristic. The loop stability is determined by the output capacitor (capacitance, ESR) and inductance values. For stable operation use recommended values of the output capacitors in Table 1. Low ESR electrolytic capacitors between 220uFand 1500uF provide best results. **B.** The capacitors voltage rating should be at least 1.5 times greater than the output voltage, and often much higher voltage rating is needed to satisfy low ESR requirement	**5. Output Capacitor Selection (C_{out})** **A.** In this example is recommended Nichicon PM capacitors: 470 µF/35 V or 220 µF/35 V
6. Feedforward Capacitor (C_{FF}) It provides additional stability mainly for higher input voltages. For Cff selection use Table 1. The compensation capacitor between 0.6 nF and 40 nF is wired in parallel with the output voltage setting resistor R2, The capacitor type can be ceramic, plastic, etc..	**6. Feedforward Capacitor (C_{FF})** In this example is recommended feedforward capacitor 15 nF or 5 nF.

LM2596 Series Buck Regulator Design Procedures (continued)

Table 1. RECOMMENDED VALUES OF THE OUTPUT CAPACITOR AND FEEDFORWARD CAPACITOR
(I_{load} = 3 A)

Nichicon PM Capacitors								
V_{in} (V)	**Capacity/Voltage Range/ESR (μF/V/mΩ)**							
40	1500/35/24	1000/35/29	1000/35/29	680/35/36	560/25/55	560/25/55	470/35/46	470/35/46
26	1200/35/26	820/35	680/35/36	560/35/41	470/25/65	470/25/65	330/35/60	
22	1000/35/29	680/35/36	560/35/41	330/25/85	330/25/85	220/35/85		
20	820/35/32	470/35/46	470/25/65	330/25/85	330/25/85	220/35/85		
18	820/35/32	470/35/46	470/25/65	330/25/85	330/25/85	220/35/85		
12	820/35/32	470/35/46	220/35/85	220/25/111				
10	820/35/32	470/35/46	220/35/85					
V_{out} (V)	2	4	6	9	12	15	24	28
C_{FF} (nF]	**40**	**15**	**5**	**2**	**1.5**	**1**	**0.6**	**0.6**

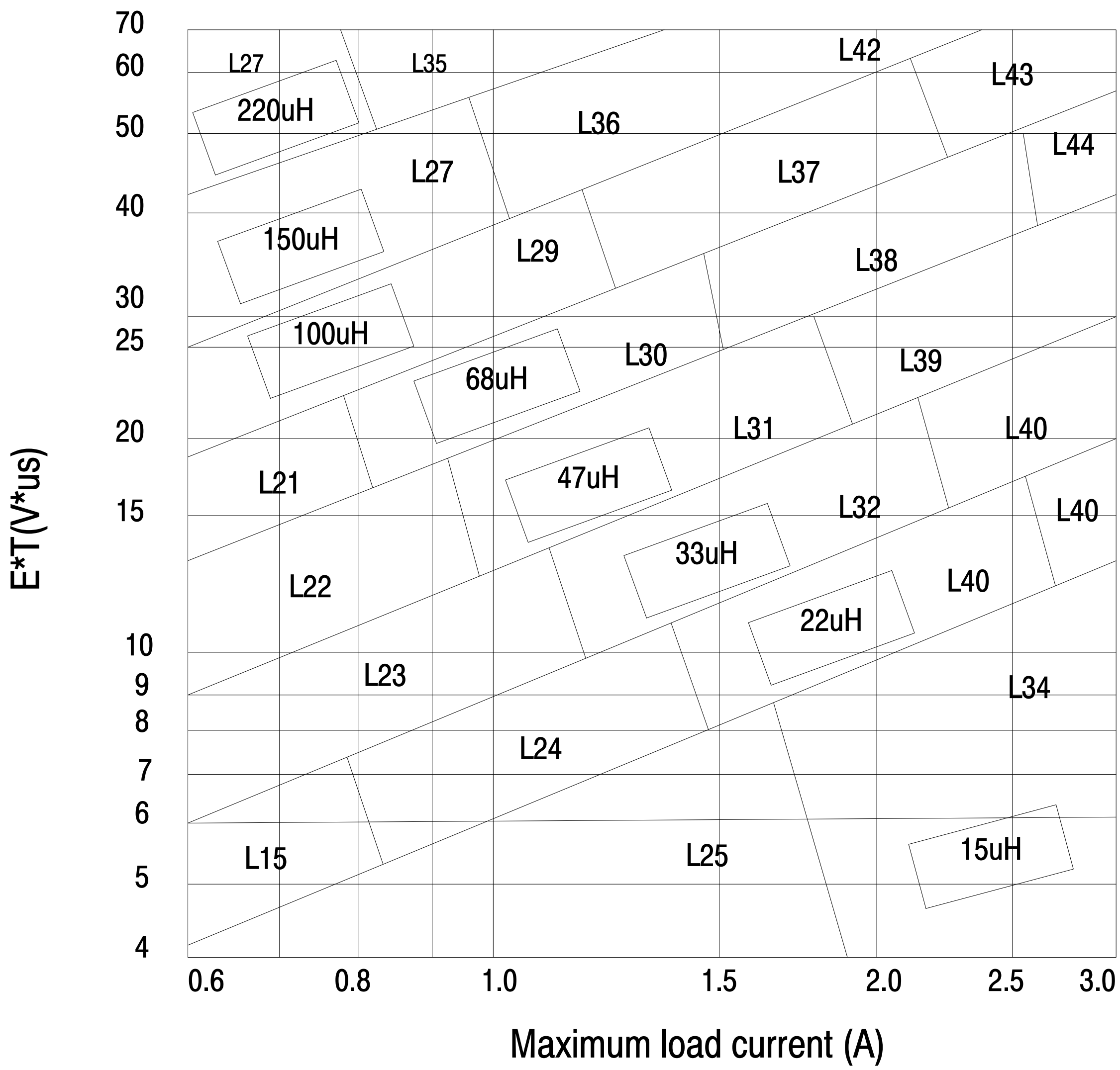


Figure 18. Inductor Value Selection Guides (For Continuous Mode Operation)

Table 2. DIODE SELECTION

V_R	Schottky				Fast Recovery			
	3.0 A		4.0 – 6.0 A		3.0 A		4.0 – 6.0 A	
	Through Hole	Surface Mount	Through Hole	Surface Mount	Through Hole	Surface Mount	Through Hole	Surface Mount
20 V	**1N5820** MBR320P SR302	SK32	**1N5823** SR502 SB520		MUR320 31DF1 HER302 (all diodes rated to at least 100 V)	**MURS320T3** **MURD320** 30WF10 (all diodes rated to at least 100 V)	**MUR420** HER602 (all diodes rated to at least 100 V)	**MURD620CT** 50WF10 (all diodes rated to at least 100 V)
30 V	**1N5821** MBR330 SR303 31DQ03	SK33 30WQ03	**1N5824** SR503 SB530	50WQ03				
40 V	**1N5822** **MBR340** SR304 31DQ04	SK34 30WQ04 **MBRS340T3** **MBRD340**	**1N5825** SR504 SB540	**MBRD640CT** 50WQ04				
50 V	MBR350 31DQ05 SR305	SK35 30WQ05	SB550	50WQ05				
60 V	**MBR360** DQ06 SR306	**MBRS360T3** **MBRD360**	50SQ080	**MBRD660CT**				

NOTE: Diodes listed in bold are available from ON Semiconductor.

Table 3. INDUCTOR MANUFACTURERS PART NUMBERS

	Inductance (μH)	Current (A)	Schott		Renco		Pulse Engineering		Coilcraft
			Through Hole	Surface Mount	Through Hole	Surface Mount	Through Hole	Surface Mount	Surface Mount
L15	22	0.99	67148350	67148460	RL−1284−22−43	RL1500−22	PE−53815	PE−53815−S	DO3308−223
L21	68	0.99	67144070	67144450	RL−5471−5	RL1500−68	PE−53821	PE−53821−S	DO3316−683
L22	47	1.17	67144080	67144460	RL−5471−6	–	PE−53822	PE−53822−S	DO3316−473
L23	33	1.40	67144090	67144470	RL−5471−7	–	PE−53823	PE−53823−S	DO3316−333
L24	22	1.70	67148370	67148480	RL−1283−22−43	–	PE−53824	PE−53825−S	DO3316−223
L25	15	2.10	67148380	67148490	RL−1283−15−43	–	PE−53825	PE−53824−S	DO3316−153
L26	330	0.80	67144100	67144480	RL−5471−1	–	PE−53826	PE−53826−S	DO5022P−334
L27	220	1.00	67144110	67144490	RL−5471−2	–	PE−53827	PE−53827−S	DO5022P−224
L28	150	1.20	67144120	67144500	RL−5471−3	–	PE−53828	PE−53828−S	DO5022P−154
L29	100	1.47	67144130	67144510	RL−5471−4	–	PE−53829	PE−53829−S	DO5022P−104
L30	68	1.78	67144140	67144520	RL−5471−5	–	PE−53830	PE−53830−S	DO5022P−683
L31	47	2.20	67144150	67144530	RL−5471−6	–	PE−53831	PE−53831−S	DO5022P−473
L32	33	2.50	67144160	67144540	RL−5471−7	–	PE−53932	PE−53932−S	DO5022P−333
L33	22	3.10	67148390	67148500	RL−1283−22−43	–	PE−53933	PE−53933−S	DO5022P−223
L34	15	3.40	67148400	67148790	RL−1283−15−43	–	PE−53934	PE−53934−S	DO5022P−153
L35	220	1.70	67144170	–	RL−5473−1	–	PE−53935	PE−53935−S	–
L36	150	2.10	67144180	–	RL−5473−4	–	PE−54036	PE−54036−S	–
L37	100	2.50	67144190	–	RL−5472−1	–	PE−54037	PE−54037−S	–
L38	68	3.10	67144200	–	RL−5472−2	–	PE−54038	PE−54038−S	DO5040H−683ML
L39	47	3.50	67144210	–	RL−5472−3	–	PE−54039	PE−54039−S	DO5040H−473ML
L40	33	3.50	67144220	67148290	RL−5472−4	–	PE−54040	PE−54040−S	DO5040H−333ML
L41	22	3.50	67144230	67148300	RL−5472−5	–	PE−54041	PE−54041−S	DO5040H−223ML
L42	150	2.70	67148410	–	RL−5473−4	–	PE−54042	PE−54042−S	–
L43	100	3.40	67144240	–	RL−5473−2	–	PE−54043		-
L44	68	3.40	67144250	–	RL−5473−3	–	PE−54044		DO5040H−683ML

APPLICATION INFORMATION

EXTERNAL COMPONENTS

Input Capacitor (C_{in})

The Input Capacitor Should Have a Low ESR

For stable operation of the switch mode converter a low ESR (Equivalent Series Resistance) aluminium or solid tantalum bypass capacitor is needed between the input pin and the ground pin, to prevent large voltage transients from appearing at the input. It must be located near the regulator and use short leads. With most electrolytic capacitors, the capacitance value decreases and the ESR increases with lower temperatures. For reliable operation in temperatures below −25°C larger values of the input capacitor may be needed. Also paralleling a ceramic or solid tantalum capacitor will increase the regulator stability at cold temperatures.

RMS Current Rating of C_{in}

The important parameter of the input capacitor is the RMS current rating. Capacitors that are physically large and have large surface area will typically have higher RMS current ratings. For a given capacitor value, a higher voltage electrolytic capacitor will be physically larger than a lower voltage capacitor, and thus be able to dissipate more heat to the surrounding air, and therefore will have a higher RMS current rating. The consequence of operating an electrolytic capacitor beyond the RMS current rating is a shortened operating life. In order to assure maximum capacitor operating lifetime, the capacitor's RMS ripple current rating should be:

$$I_{rms} > 1.2 \times d \times I_{Load}$$

where d is the duty cycle, for a buck regulator

$$d = \frac{t_{on}}{T} = \frac{V_{out}}{V_{in}}$$

and $d = \frac{t_{on}}{T} = \frac{|V_{out}|}{|V_{out}| + V_{in}}$ for a buck–boost regulator.

Output Capacitor (C_{out})

For low output ripple voltage and good stability, low ESR output capacitors are recommended. An output capacitor has two main functions: it filters the output and provides regulator loop stability. The ESR of the output capacitor and the peak−to−peak value of the inductor ripple current are the main factors contributing to the output ripple voltage value. Standard aluminium electrolytics could be adequate for some applications but for quality design, low ESR types are recommended.

An aluminium electrolytic capacitor's ESR value is related to many factors such as the capacitance value, the voltage rating, the physical size and the type of construction. In most cases, the higher voltage electrolytic capacitors have lower ESR value. Often capacitors with much higher voltage ratings may be needed to provide low ESR values that, are required for low output ripple voltage.

Feedfoward Capacitor

(Adjustable Output Voltage Version)

This capacitor adds lead compensation to the feedback loop and increases the phase margin for better loop stability. For C_{FF} selection, see the design procedure section.

The Output Capacitor Requires an ESR Value That Has an Upper and Lower Limit

As mentioned above, a low ESR value is needed for low output ripple voltage, typically 1% to 2% of the output voltage. But if the selected capacitor's ESR is extremely low (below 0.05 Ω), there is a possibility of an unstable feedback loop, resulting in oscillation at the output. This situation can occur when a tantalum capacitor, that can have a very low ESR, is used as the only output capacitor.

At Low Temperatures, Put in Parallel Aluminium Electrolytic Capacitors with Tantalum Capacitors

Electrolytic capacitors are not recommended for temperatures below −25°C. The ESR rises dramatically at cold temperatures and typically rises 3 times at −25°C and as much as 10 times at −40°C. Solid tantalum capacitors have much better ESR spec at cold temperatures and are recommended for temperatures below −25°C. They can be also used in parallel with aluminium electrolytics. The value of the tantalum capacitor should be about 10% or 20% of the total capacitance. The output capacitor should have at least 50% higher RMS ripple current rating at 150 kHz than the peak−to−peak inductor ripple current.

Catch Diode

Locate the Catch Diode Close to the LM2596

The LM2596 is a step−down buck converter; it requires a fast diode to provide a return path for the inductor current when the switch turns off. This diode must be located close to the LM2596 using short leads and short printed circuit traces to avoid EMI problems.

Use a Schottky or a Soft Switching Ultra−Fast Recovery Diode

Since the rectifier diodes are very significant sources of losses within switching power supplies, choosing the rectifier that best fits into the converter design is an important process. Schottky diodes provide the best performance because of their fast switching speed and low forward voltage drop.

They provide the best efficiency especially in low output voltage applications (5.0 V and lower). Another choice could be Fast−Recovery, or Ultra−Fast Recovery diodes. It has to be noted, that some types of these diodes with an abrupt turnoff characteristic may cause instability or EMI troubles.

A fast−recovery diode with soft recovery characteristics can better fulfill some quality, low noise design requirements. Table 2 provides a list of suitable diodes for the LM2596 regulator. Standard 50/60 Hz rectifier diodes, such as the 1N4001 series or 1N5400 series are **NOT** suitable.

Inductor

The magnetic components are the cornerstone of all switching power supply designs. The style of the core and the winding technique used in the magnetic component's design has a great influence on the reliability of the overall power supply.

Using an improper or poorly designed inductor can cause high voltage spikes generated by the rate of transitions in current within the switching power supply, and the possibility of core saturation can arise during an abnormal operational mode. Voltage spikes can cause the semiconductors to enter avalanche breakdown and the part can instantly fail if enough energy is applied. It can also cause significant RFI (Radio Frequency Interference) and EMI (Electro−Magnetic Interference) problems.

Continuous and Discontinuous Mode of Operation

The LM2596 step−down converter can operate in both the continuous and the discontinuous modes of operation. The regulator works in the continuous mode when loads are relatively heavy, the current flows through the inductor continuously and never falls to zero. Under light load conditions, the circuit will be forced to the discontinuous mode when inductor current falls to zero for certain period of time (see Figure 19 and Figure 20). Each mode has distinctively different operating characteristics, which can affect the regulator performance and requirements. In many cases the preferred mode of operation is the continuous mode. It offers greater output power, lower peak currents in the switch, inductor and diode, and can have a lower output ripple voltage. On the other hand it does require larger inductor values to keep the inductor current flowing continuously, especially at low output load currents and/or high input voltages.

To simplify the inductor selection process, an inductor selection guide for the LM2596 regulator was added to this data sheet (Figure 18). This guide assumes that the regulator is operating in the continuous mode, and selects an inductor that will allow a peak−to−peak inductor ripple current to be a certain percentage of the maximum design load current. This percentage is allowed to change as different design load currents are selected. For light loads (less than approximately 300 mA) it may be desirable to operate the regulator in the discontinuous mode, because the inductor value and size can be kept relatively low. Consequently, the percentage of inductor peak−to−peak current increases. This discontinuous mode of operation is perfectly acceptable for this type of switching converter. Any buck regulator will be forced to enter discontinuous mode if the load current is light enough.

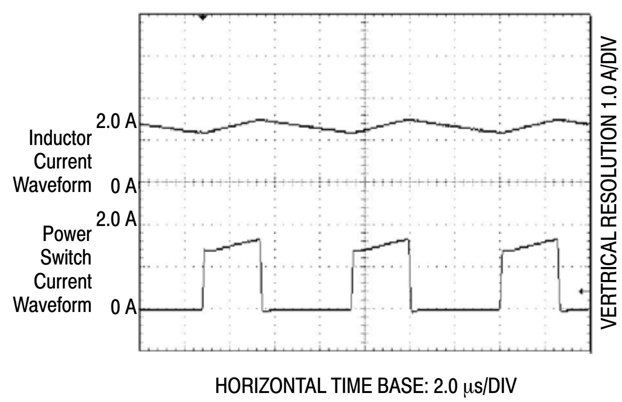


Figure 19. Continuous Mode Switching Current Waveforms

Selecting the Right Inductor Style

Some important considerations when selecting a core type are core material, cost, the output power of the power supply, the physical volume the inductor must fit within, and the amount of EMI (Electro−Magnetic Interference) shielding that the core must provide. The inductor selection guide covers different styles of inductors, such as pot core, E−core, toroid and bobbin core, as well as different core materials such as ferrites and powdered iron from different manufacturers.

For high quality design regulators the toroid core seems to be the best choice. Since the magnetic flux is contained within the core, it generates less EMI, reducing noise problems in sensitive circuits. The least expensive is the bobbin core type, which consists of wire wound on a ferrite rod core. This type of inductor generates more EMI due to the fact that its core is open, and the magnetic flux is not contained within the core.

When multiple switching regulators are located on the same printed circuit board, open core magnetics can cause interference between two or more of the regulator circuits, especially at high currents due to mutual coupling. A toroid, pot core or E−core (closed magnetic structure) should be used in such applications.

Do Not Operate an Inductor Beyond its Maximum Rated Current

Exceeding an inductor's maximum current rating may cause the inductor to overheat because of the copper wire losses, or the core may saturate. Core saturation occurs when the flux density is too high and consequently the cross sectional area of the core can no longer support additional lines of magnetic flux.

This causes the permeability of the core to drop, the inductance value decreases rapidly and the inductor begins to look mainly resistive. It has only the DC resistance of the winding. This can cause the switch current to rise very rapidly and force the LM2596 internal switch into cycle−by−cycle current limit, thus reducing the DC output load current. This can also result in overheating of the inductor and/or the LM2596. Different inductor types have different saturation characteristics, and this should be kept in mind when selecting an inductor.

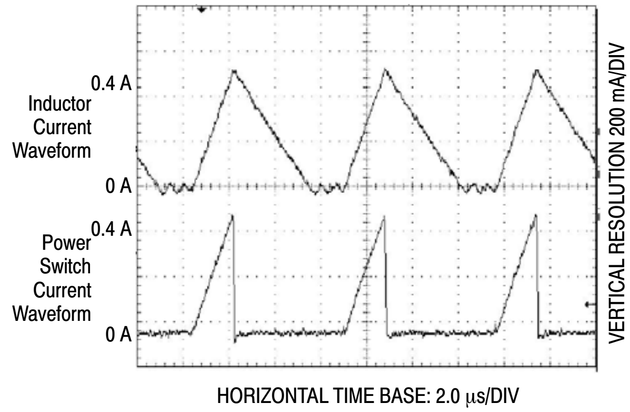


Figure 20. Discontinuous Mode Switching Current Waveforms

GENERAL RECOMMENDATIONS

Output Voltage Ripple and Transients

Source of the Output Ripple

Since the LM2596 is a switch mode power supply regulator, its output voltage, if left unfiltered, will contain a sawtooth ripple voltage at the switching frequency. The output ripple voltage value ranges from 0.5% to 3% of the output voltage. It is caused mainly by the inductor sawtooth ripple current multiplied by the ESR of the output capacitor.

Short Voltage Spikes and How to Reduce Them

The regulator output voltage may also contain short voltage spikes at the peaks of the sawtooth waveform (see Figure 21). These voltage spikes are present because of the fast switching action of the output switch, and the parasitic inductance of the output filter capacitor. There are some other important factors such as wiring inductance, stray capacitance, as well as the scope probe used to evaluate these transients, all these contribute to the amplitude of these spikes. To minimize these voltage spikes, low inductance capacitors should be used, and their lead lengths must be kept short. The importance of quality printed circuit board layout design should also be highlighted.

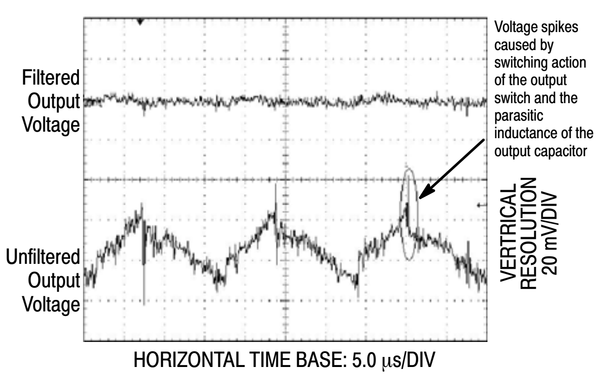


Figure 21. Output Ripple Voltage Waveforms

Minimizing the Output Ripple

In order to minimize the output ripple voltage it is possible to enlarge the inductance value of the inductor L1 and/or to use a larger value output capacitor. There is also another way to smooth the output by means of an additional LC filter (20 μH, 100 μF), that can be added to the output (see Figure 30) to further reduce the amount of output ripple and transients. With such a filter it is possible to reduce the output ripple voltage transients 10 times or more. Figure 21 shows the difference between filtered and unfiltered output waveforms of the regulator shown in Figure 30.

The lower waveform is from the normal unfiltered output of the converter, while the upper waveform shows the output ripple voltage filtered by an additional LC filter.

Heatsinking and Thermal Considerations

The Through−Hole Package TO−220

The LM2596 is available in two packages, a 5−pin TO−220(T, TV) and a 5−pin surface mount D^2PAK(D2T). Although the TO−220(T) package needs a heatsink under most conditions, there are some applications that require no heatsink to keep the LM2596 junction temperature within the allowed operating range. Higher ambient temperatures require some heat sinking, either to the printed circuit (PC) board or an external heatsink.

The Surface Mount Package D^2PAK and its Heatsinking

The other type of package, the surface mount D^2PAK, is designed to be soldered to the copper on the PC board. The copper and the board are the heatsink for this package and the other heat producing components, such as the catch diode and inductor. The PC board copper area that the package is soldered to should be at least 0.4 in^2 (or 260 mm^2) and ideally should have 2 or more square inches (1300 mm^2) of 0.0028 inch copper. Additional increases of copper area beyond approximately 6.0 in^2 (4000 mm^2) will not improve heat dissipation significantly. If further thermal improvements are needed, double sided or multilayer PC boards with large copper areas should be considered. In order to achieve the best thermal performance, it is highly recommended to use wide copper traces as well as large areas of copper in the printed circuit board layout. The only exception to this is the OUTPUT (switch) pin, which should not have large areas of copper (see page 8 'PCB Layout Guideline').

Thermal Analysis and Design

The following procedure must be performed to determine whether or not a heatsink will be required. First determine:

1. $P_{D(max)}$ maximum regulator power dissipation in the application.
2. $T_{A(max)}$ maximum ambient temperature in the application.
3. $T_{J(max)}$ maximum allowed junction temperature (125°C for the LM2596). For a conservative design, the maximum junction temperature should not exceed 110°C to assure safe operation. For every additional +10°C temperature rise that the junction must withstand, the estimated operating lifetime of the component is halved.
4. $R_{\theta JC}$ package thermal resistance junction−case.
5. $R_{\theta JA}$ package thermal resistance junction−ambient.

(Refer to Maximum Ratings on page 2 of this data sheet or $R_{\theta JC}$ and $R_{\theta JA}$ values).

The following formula is to calculate the approximate total power dissipated by the LM2596:

$$P_D = (V_{in} \times I_Q) + d \times I_{Load} \times V_{sat}$$

where d is the duty cycle and for buck converter

$$d = \frac{t_{on}}{T} = \frac{V_O}{V_{in}},$$

I_Q (quiescent current) and V_{sat} can be found in the LM2596 data sheet,

V_{in} is minimum input voltage applied,

V_O is the regulator output voltage,

I_{Load} is the load current.

The dynamic switching losses during turn−on and turn−off can be neglected if proper type catch diode is used.

Packages Not on a Heatsink (Free−Standing)

For a free−standing application when no heatsink is used, the junction temperature can be determined by the following expression:

$$T_J = (R_{\theta JA})(P_D) + T_A$$

where $(R_{\theta JA})(P_D)$ represents the junction temperature rise caused by the dissipated power and T_A is the maximum ambient temperature.

Packages on a Heatsink

If the actual operating junction temperature is greater than the selected safe operating junction temperature determined in step 3, than a heatsink is required. The junction temperature will be calculated as follows:

$$T_J = P_D (R_{\theta JA} + R_{\theta CS} + R_{\theta SA}) + T_A$$

where $R_{\theta JC}$ is the thermal resistance junction−case,
$R_{\theta CS}$ is the thermal resistance case−heatsink,
$R_{\theta SA}$ is the thermal resistance heatsink−ambient.

If the actual operating temperature is greater than the selected safe operating junction temperature, then a larger heatsink is required.

Some Aspects That can Influence Thermal Design

It should be noted that the package thermal resistance and the junction temperature rise numbers are all approximate, and there are many factors that will affect these numbers, such as PC board size, shape, thickness, physical position, location, board temperature, as well as whether the surrounding air is moving or still.

Other factors are trace width, total printed circuit copper area, copper thickness, single− or double−sided, multilayer board, the amount of solder on the board or even color of the traces.

The size, quantity and spacing of other components on the board can also influence its effectiveness to dissipate the heat.

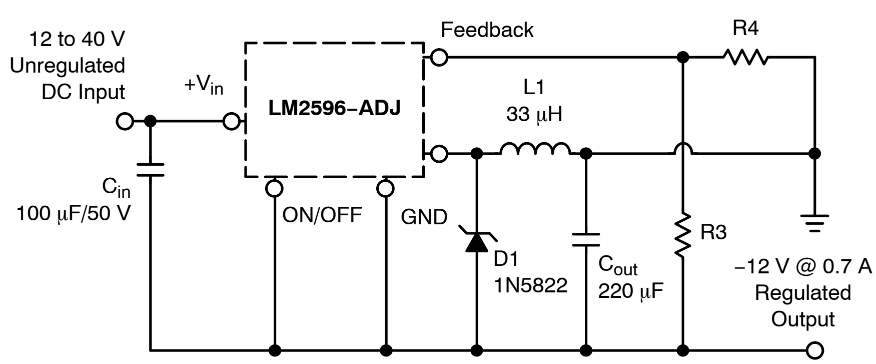


Figure 22. Inverting Buck−Boost Develops −12 V

ADDITIONAL APPLICATIONS

Inverting Regulator

An inverting buck−boost regulator using the LM2596−ADJ is shown in Figure 22. This circuit converts a positive input voltage to a negative output voltage with a common ground by bootstrapping the regulators ground to the negative output voltage. By grounding the feedback pin, the regulator senses the inverted output voltage and regulates it.

In this example the LM2596−12 is used to generate a −12 V output. The maximum input voltage in this case cannot exceed +28 V because the maximum voltage appearing across the regulator is the absolute sum of the input and output voltages and this must be limited to a maximum of 40 V.

This circuit configuration is able to deliver approximately 0.7 A to the output when the input voltage is 12 V or higher. At lighter loads the minimum input voltage required drops to approximately 4.7 V, because the buck−boost regulator topology can produce an output voltage that, in its absolute value, is either greater or less than the input voltage.

Since the switch currents in this buck−boost configuration are higher than in the standard buck converter topology, the available output current is lower.

This type of buck−boost inverting regulator can also require a larger amount of startup input current, even for light loads. This may overload an input power source with a current limit less than 5.0 A.

Such an amount of input startup current is needed for at least 2.0 ms or more. The actual time depends on the output voltage and size of the output capacitor.

Because of the relatively high startup currents required by this inverting regulator topology, the use of a delayed startup or an undervoltage lockout circuit is recommended.

Using a delayed startup arrangement, the input capacitor can charge up to a higher voltage before the switch−mode regulator begins to operate.

The high input current needed for startup is now partially supplied by the input capacitor C_{in}.

It has been already mentioned above, that in some situations, the delayed startup or the undervoltage lockout features could be very useful. A delayed startup circuit applied to a buck−boost converter is shown in Figure 27. Figure 29 in the “Undervoltage Lockout” section describes an undervoltage lockout feature for the same converter topology.

Design Recommendations:

The inverting regulator operates in a different manner than the buck converter and so a different design procedure has to be used to select the inductor L1 or the output capacitor C_{out}.

The output capacitor values must be larger than what is normally required for buck converter designs. Low input voltages or high output currents require a large value output capacitor (in the range of thousands of μF).

The recommended range of inductor values for the inverting converter design is between 68 μH and 220 μH. To select an inductor with an appropriate current rating, the inductor peak current has to be calculated.

The following formula is used to obtain the peak inductor current:

$$I_{peak} \approx \frac{I_{Load}\,(V_{in} + |V_O|)}{V_{in}} + \frac{V_{in} \times t_{on}}{2L_1}$$

$$\text{where } t_{on} = \frac{|V_O|}{V_{in} + |V_O|} \times \frac{1.0}{f_{osc}}, \text{ and } f_{osc} = 52\text{ kHz.}$$

Under normal continuous inductor current operating conditions, the worst case occurs when V_{in} is minimal.

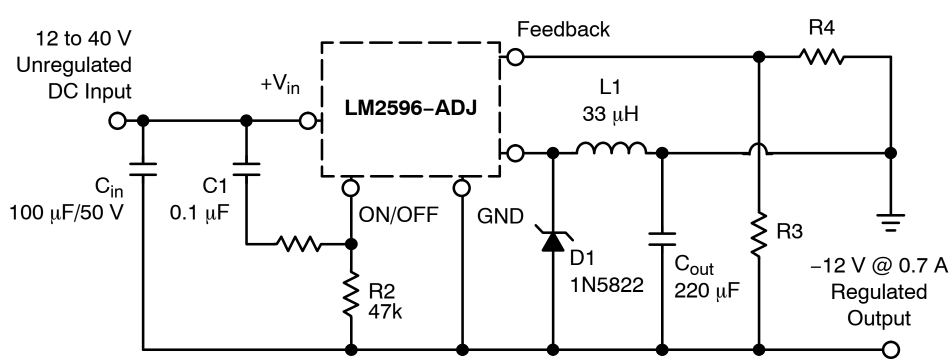
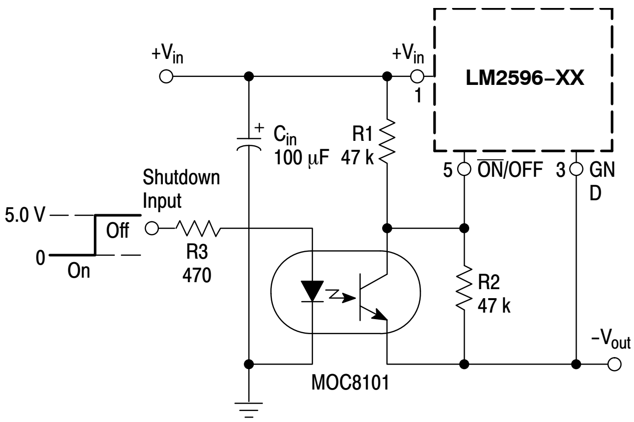
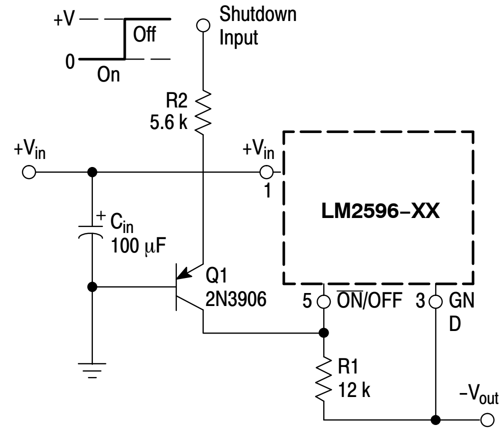


Figure 23. Inverting Buck−Boost Develops −12 V



NOTE: This picture does not show the complete circuit.

Figure 24. Inverting Buck−Boost Regulator Shutdown Circuit Using an Optocoupler



NOTE: This picture does not show the complete circuit.

Figure 25. Inverting Buck−Boost Regulator Shutdown Circuit Using a PNP Transistor

With the inverting configuration, the use of the $\overline{ON}$/OFF pin requires some level shifting techniques. This is caused by the fact, that the ground pin of the converter IC is no longer at ground. Now, the $\overline{ON}$/OFF pin threshold voltage (1.3 V approximately) has to be related to the negative output voltage level. There are many different possible shut down methods, two of them are shown in Figures 24 and 25.

Negative Boost Regulator

This example is a variation of the buck−boost topology and it is called negative boost regulator. This regulator experiences relatively high switch current, especially at low input voltages. The internal switch current limiting results in lower output load current capability.

The circuit in Figure 26 shows the negative boost configuration. The input voltage in this application ranges from −5.0 V to −12 V and provides a regulated −12 V output. If the input voltage is greater than −12 V, the output will rise above −12 V accordingly, but will not damage the regulator.

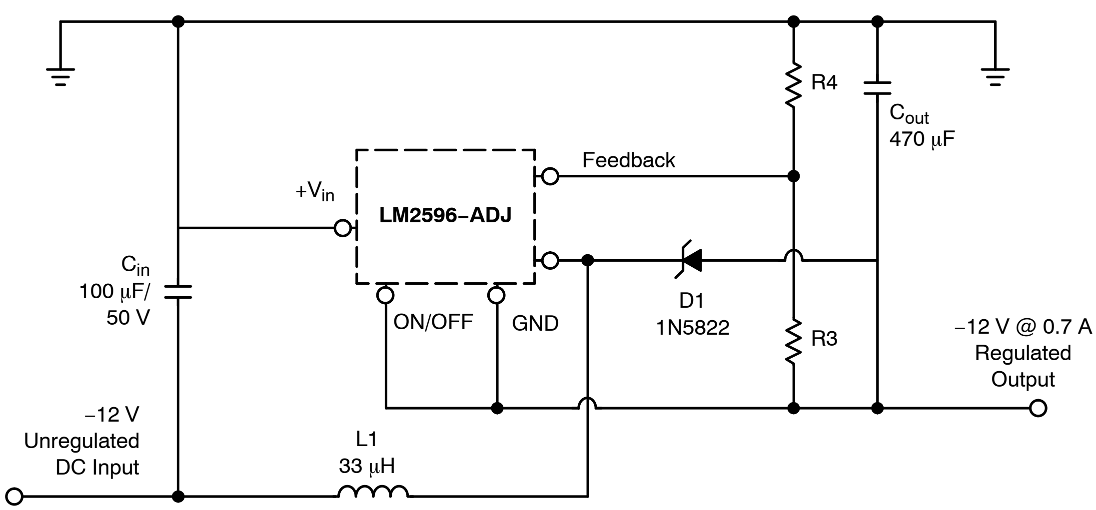


Figure 26. Negative Boost Regulator

Design Recommendations:

The same design rules as for the previous inverting buck−boost converter can be applied. The output capacitor C_{out} must be chosen larger than would be required for a what standard buck converter. Low input voltages or high output currents require a large value output capacitor (in the range of thousands of μF). The recommended range of inductor values for the negative boost regulator is the same as for inverting converter design.

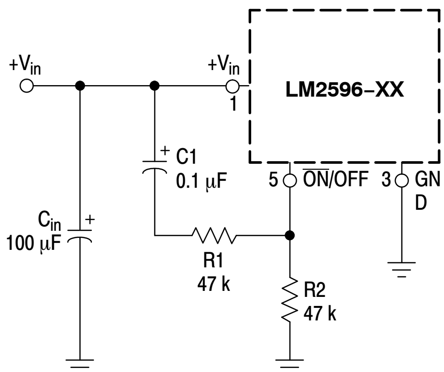
Another important point is that these negative boost converters cannot provide current limiting load protection in the event of a short in the output so some other means, such as a fuse, may be necessary to provide the load protection.

Delayed Startup

There are some applications, like the inverting regulator already mentioned above, which require a higher amount of startup current. In such cases, if the input power source is limited, this delayed startup feature becomes very useful.

To provide a time delay between the time when the input voltage is applied and the time when the output voltage comes up, the circuit in Figure 27 can be used. As the input voltage is applied, the capacitor C1 charges up, and the voltage across the resistor R2 falls down. When the voltage on the $\overline{\text{ON}}$/OFF pin falls below the threshold value 1.3 V, the regulator starts up. Resistor R1 is included to limit the maximum voltage applied to the $\overline{\text{ON}}$/OFF pin. It reduces the power supply noise sensitivity, and also limits the capacitor C1 discharge current, but its use is not mandatory.

When a high 50 Hz or 60 Hz (100 Hz or 120 Hz respectively) ripple voltage exists, a long delay time can cause some problems by coupling the ripple into the $\overline{\text{ON}}$/OFF pin, the regulator could be switched periodically on and off with the line (or double) frequency.



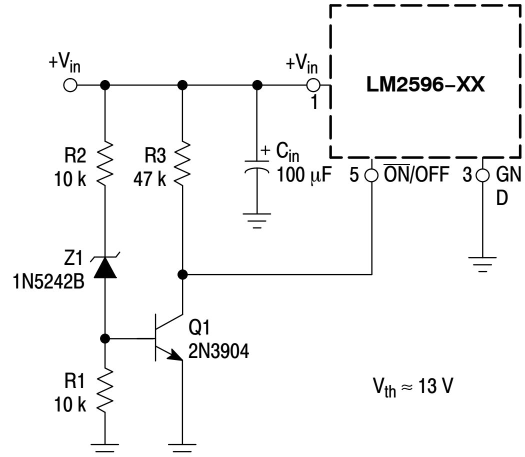
NOTE: This picture does not show the complete circuit.

Figure 27. Delayed Startup Circuitry

Undervoltage Lockout

Some applications require the regulator to remain off until the input voltage reaches a certain threshold level. Figure 28 shows an undervoltage lockout circuit applied to a buck regulator. A version of this circuit for buck−boost converter is shown in Figure 29. Resistor R3 pulls the $\overline{\text{ON}}$/OFF pin high and keeps the regulator off until the input voltage reaches a predetermined threshold level with respect to the ground Pin 3, which is determined by the following expression:

$$V_{th} \approx V_{Z1} + \left(1.0 + \frac{R2}{R1}\right) V_{BE}\ (Q1)$$



NOTE: This picture does not show the complete circuit.

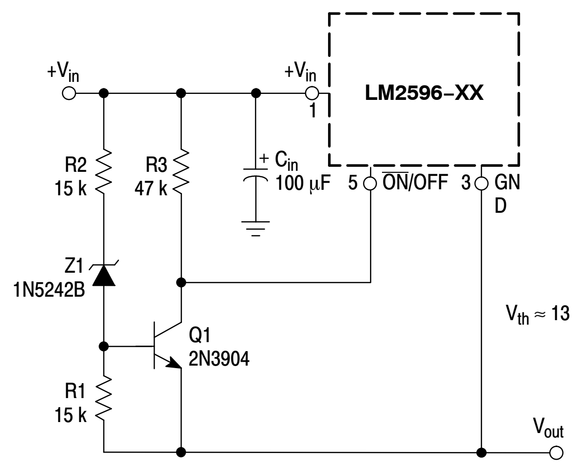
Figure 28. Undervoltage Lockout Circuit for Buck Converter

The following formula is used to obtain the peak inductor current:

$$I_{peak} \approx \frac{I_{Load}\,(V_{in} + |V_O|)}{V_{in}} + \frac{V_{in} \times t_{on}}{2L_1}$$

$$\text{where } t_{on} = \frac{|V_O|}{V_{in} + |V_O|} \times \frac{1.0}{f_{osc}},\ \text{and } f_{osc} = 52\ \text{kHz.}$$

Under normal continuous inductor current operating conditions, the worst case occurs when V_{in} is minimal.



NOTE: This picture does not show the complete circuit.

Figure 29. Undervoltage Lockout Circuit for Buck−Boost Converter

Adjustable Output, Low−Ripple Power Supply

A 3.0 A output current capability power supply that features an adjustable output voltage is shown in Figure 30.

This regulator delivers 3.0 A into 1.2 V to 35 V output. The input voltage ranges from roughly 3.0 V to 40 V. In order to achieve a 10 or more times reduction of output ripple, an additional L−C filter is included in this circuit.

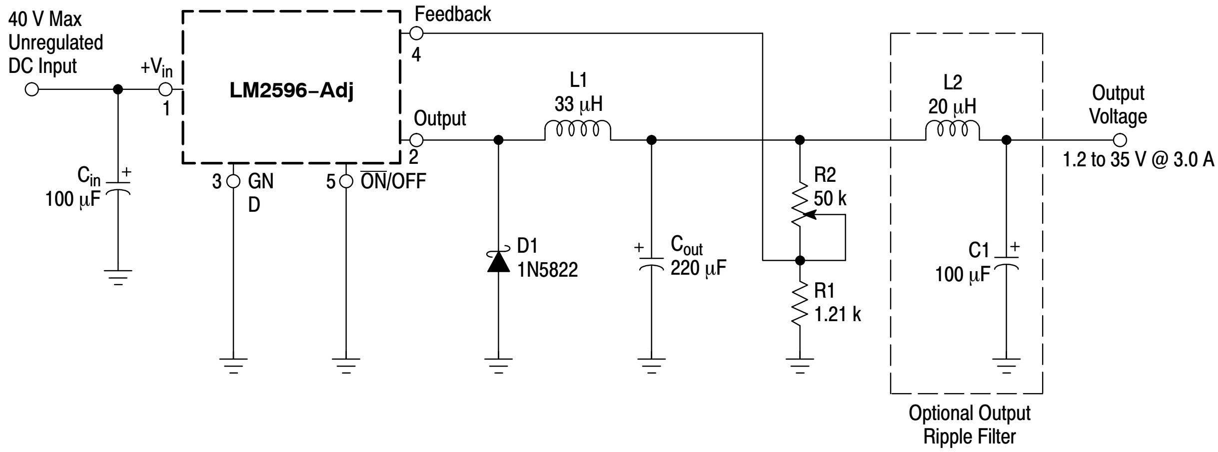
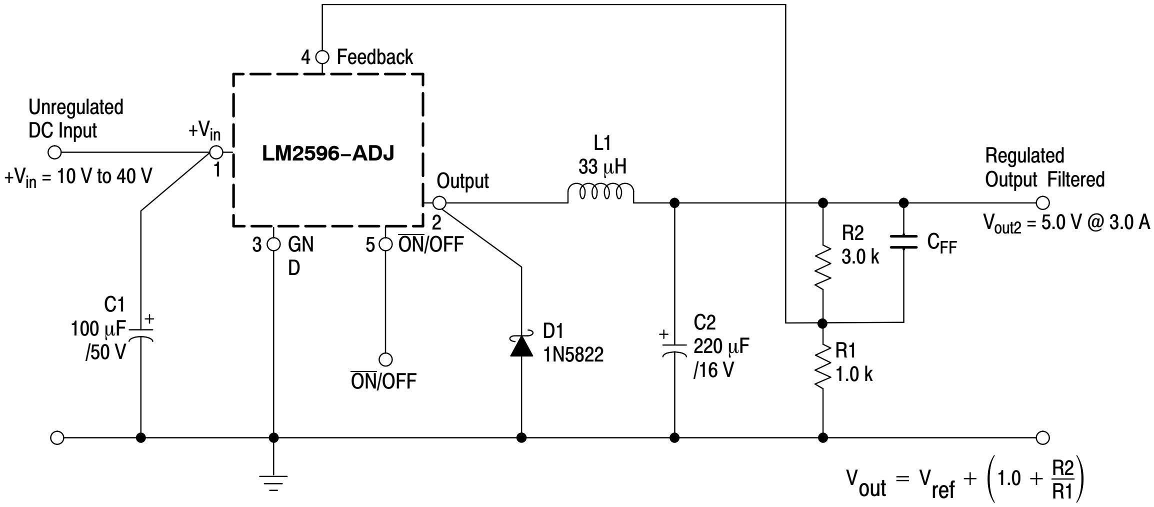


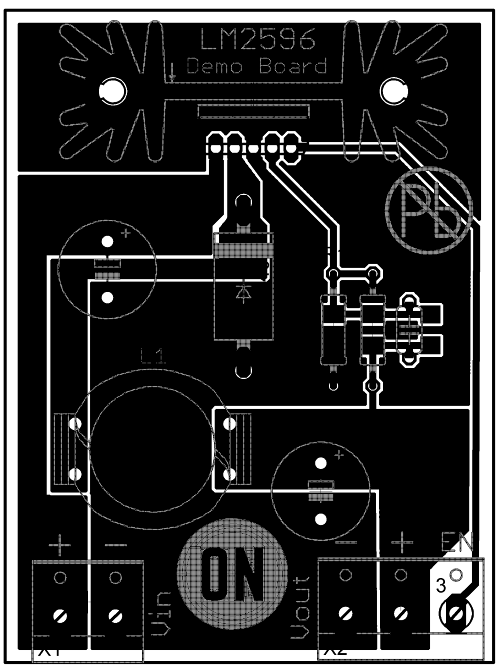
Figure 30. 1.2 to 35 V Adjustable 3.0 A Power Supply with Low Output Ripple

THE LM2596 STEP−DOWN VOLTAGE REGULATOR WITH 5.0 V @ 3.0 A OUTPUT POWER CAPABILITY. TYPICAL APPLICATION WITH THROUGH−HOLE PC BOARD LAYOUT



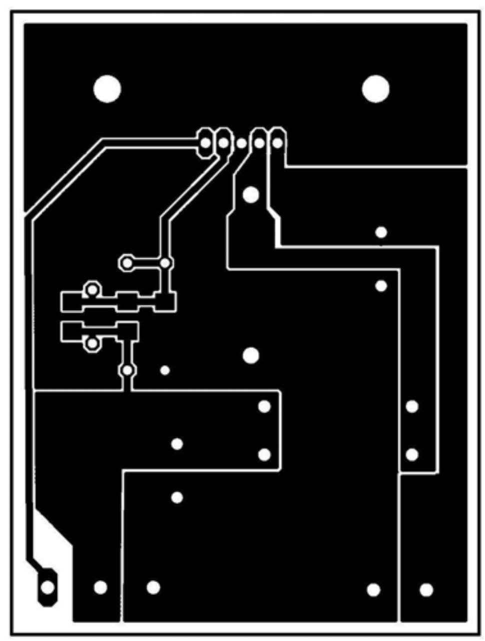
C1 – 100 µF, 50 V, Aluminium Electrolytic
C2 – 220 µF, 25 V, Aluminium Electrolytic
D1 – 3.0 A, 40 V, Schottky Rectifier, 1N5822
L1 – 33 µH, DO5040H, Coilcraft
R1 – 1.0 kΩ, 0.25 W
R2 – 3.0 kΩ, 0.25 W

Figure 31. Schematic Diagram of the 5.0 V @ 3.0 A Step−Down Converter Using the LM2596−ADJ



NOTE: Not to scale.

Figure 32. Printed Circuit Board Layout Component Side



NOTE: Not to scale.

Figure 33. Printed Circuit Board Layout Copper Side

References

- National Semiconductor LM2596 Data Sheet and Application Note
- National Semiconductor LM2595 Data Sheet and Application Note
- Marty Brown “Practical Switching Power Supply Design”, Academic Press, Inc., San Diego 1990
- Ray Ridley “High Frequency Magnetics Design”, Ridley Engineering, Inc. 1995

ORDERING INFORMATION

Device	Package	Shipping†
LM2596TADJG	TO−220 (Pb−Free)	50 Units / Rail
LM2596TVADJG	TO−220 (F) (Pb−Free)	50 Units / Rail
LM2596DSADJG	D^2PAK (Pb−Free)	50 Units / Rail
LM2596DSADJR4G	D^2PAK (Pb−Free)	800 / Tape & Reel

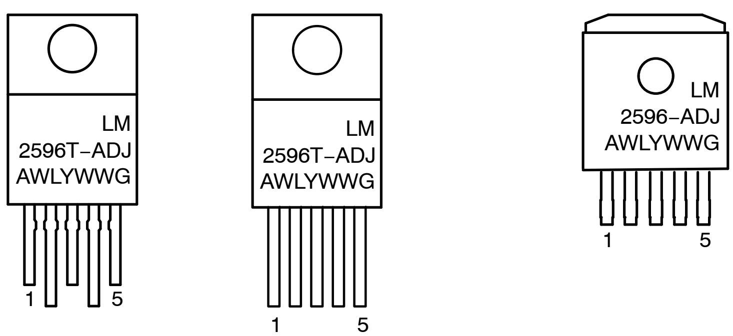
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

MARKING DIAGRAMS

TO−220
TV SUFFIX
CASE 314B

TO−220
T SUFFIX
CASE 314D

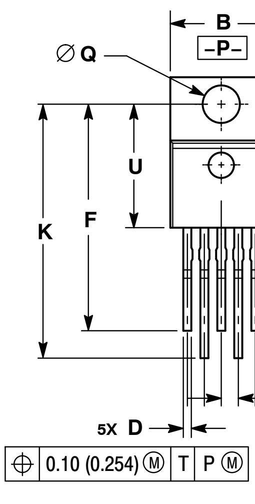
D^2PAK
DS SUFFIX
CASE 936A

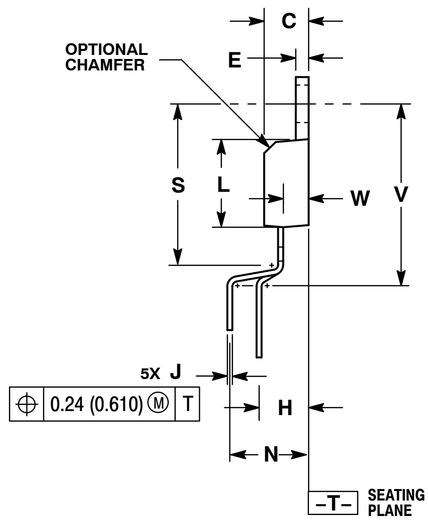


A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week
G = Pb−Free Package

PACKAGE DIMENSIONS

TO−220
TV SUFFIX
CASE 314B−05
ISSUE L

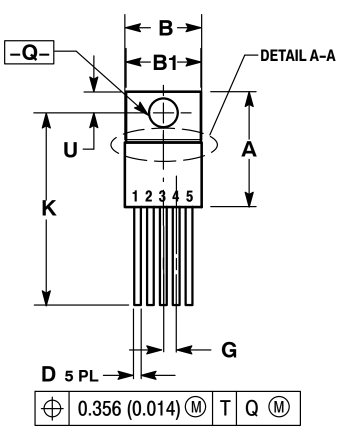


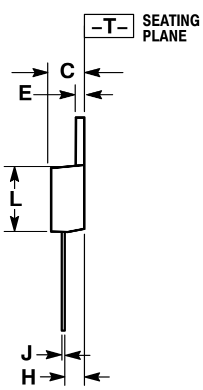


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION D DOES NOT INCLUDE INTERCONNECT BAR (DAMBAR) PROTRUSION. DIMENSION D INCLUDING PROTRUSION SHALL NOT EXCEED 0.043 (1.092) MAXIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.572	0.613	14.529	15.570
B	0.390	0.415	9.906	10.541
C	0.170	0.180	4.318	4.572
D	0.025	0.038	0.635	0.965
E	0.048	0.055	1.219	1.397
F	0.850	0.935	21.590	23.749
G	0.067 BSC		1.702 BSC	
H	0.166 BSC		4.216 BSC	
J	0.015	0.025	0.381	0.635
K	0.900	1.100	22.860	27.940
L	0.320	0.365	8.128	9.271
N	0.320 BSC		8.128 BSC	
Q	0.140	0.153	3.556	3.886
S	---	0.620	---	15.748
U	0.468	0.505	11.888	12.827
V	---	0.735	---	18.669
W	0.090	0.110	2.286	2.794

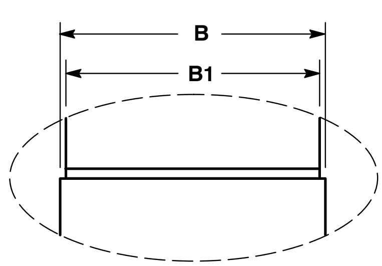
TO−220
T SUFFIX
CASE 314D−04
ISSUE F





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION D DOES NOT INCLUDE INTERCONNECT BAR (DAMBAR) PROTRUSION. DIMENSION D INCLUDING PROTRUSION SHALL NOT EXCEED 10.92 (0.043) MAXIMUM.

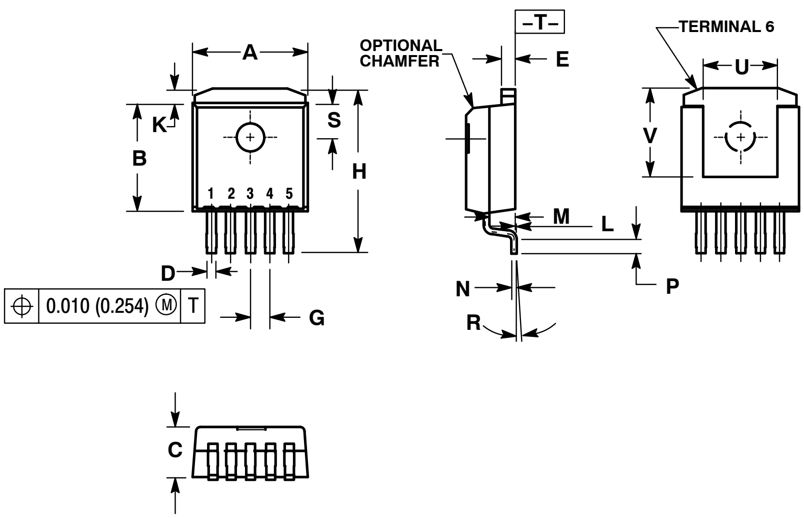
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.572	0.613	14.529	15.570
B	0.390	0.415	9.906	10.541
B1	0.375	0.415	9.525	10.541
C	0.170	0.180	4.318	4.572
D	0.025	0.038	0.635	0.965
E	0.048	0.055	1.219	1.397
G	0.067 BSC		1.702 BSC	
H	0.087	0.112	2.210	2.845
J	0.015	0.025	0.381	0.635
K	0.977	1.045	24.810	26.543
L	0.320	0.365	8.128	9.271
Q	0.140	0.153	3.556	3.886
U	0.105	0.117	2.667	2.972



DETAIL A−A

PACKAGE DIMENSIONS

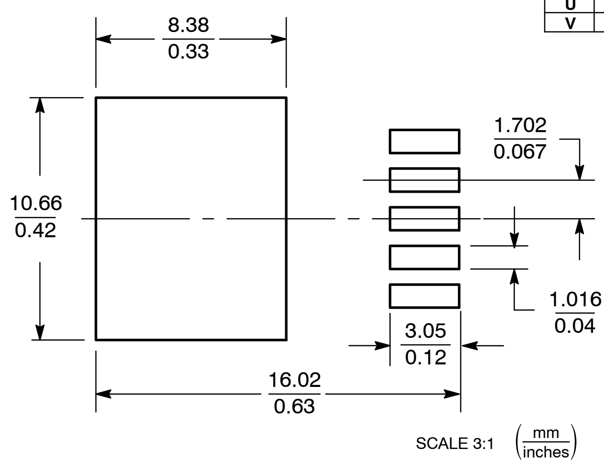
D²PAK
D2T SUFFIX
CASE 936A−02
ISSUE C



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. TAB CONTOUR OPTIONAL WITHIN DIMENSIONS A AND K.
4. DIMENSIONS U AND V ESTABLISH A MINIMUM MOUNTING SURFACE FOR TERMINAL 6.
5. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH OR GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.025 (0.635) MAXIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.386	0.403	9.804	10.236
B	0.356	0.368	9.042	9.347
C	0.170	0.180	4.318	4.572
D	0.026	0.036	0.660	0.914
E	0.045	0.055	1.143	1.397
G	0.067 BSC		1.702 BSC	
H	0.539	0.579	13.691	14.707
K	0.050 REF		1.270 REF	
L	0.000	0.010	0.000	0.254
M	0.088	0.102	2.235	2.591
N	0.018	0.026	0.457	0.660
P	0.058	0.078	1.473	1.981
R	5° REF		5° REF	
S	0.116 REF		2.946 REF	
U	0.200 MIN		5.080 MIN	
V	0.250 MIN		6.350 MIN	

SOLDERING FOOTPRINT*



*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

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ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative

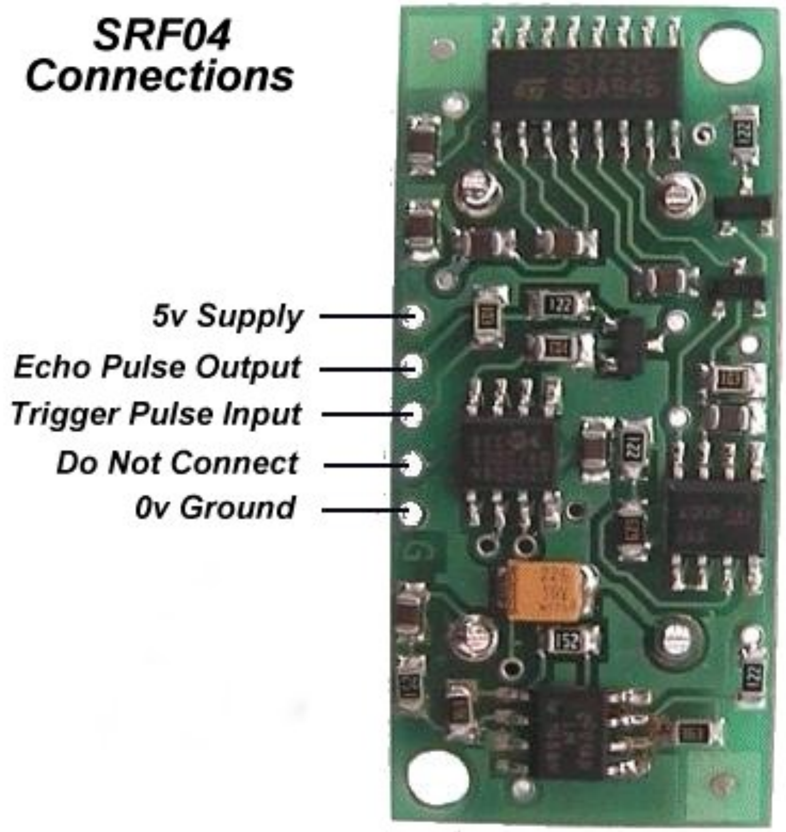
SRF04 - Ultra-Sonic Ranger

Technical Specification

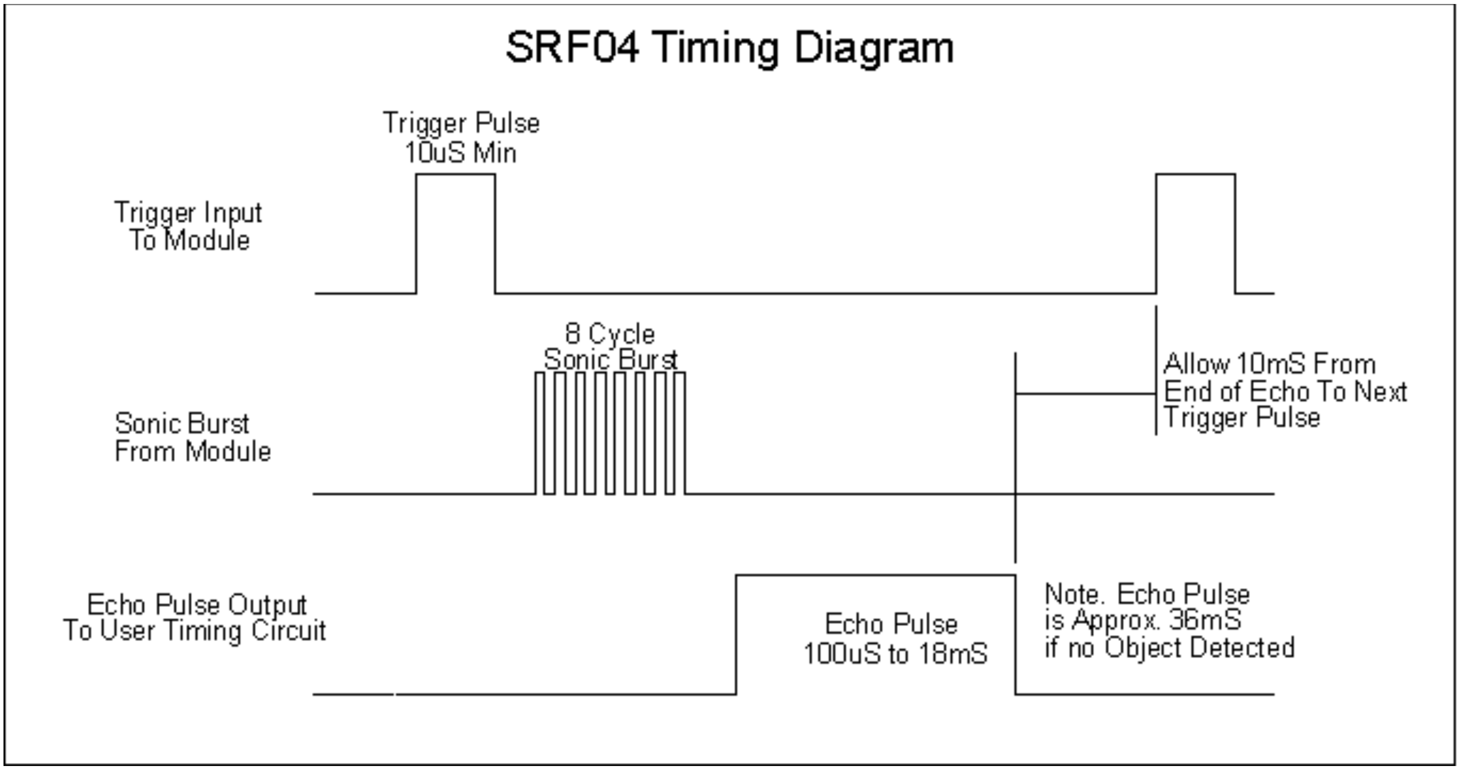
This project started after I looked at the Polaroid Ultrasonic Ranging module. It has a number of disadvantages for use in small robots etc.

1. The maximum range of 10.7 metre is far more than is normally required, and as a result
2. The current consumption, at 2.5 Amps during the sonic burst is truly horrendous.
3. The 150mA quiescent current is also far too high.
4. The minimum range of 26cm is useless. 1-2cm is more like it.
5. The module is quite large to fit into small systems, and
6. It's EXPENSIVE.

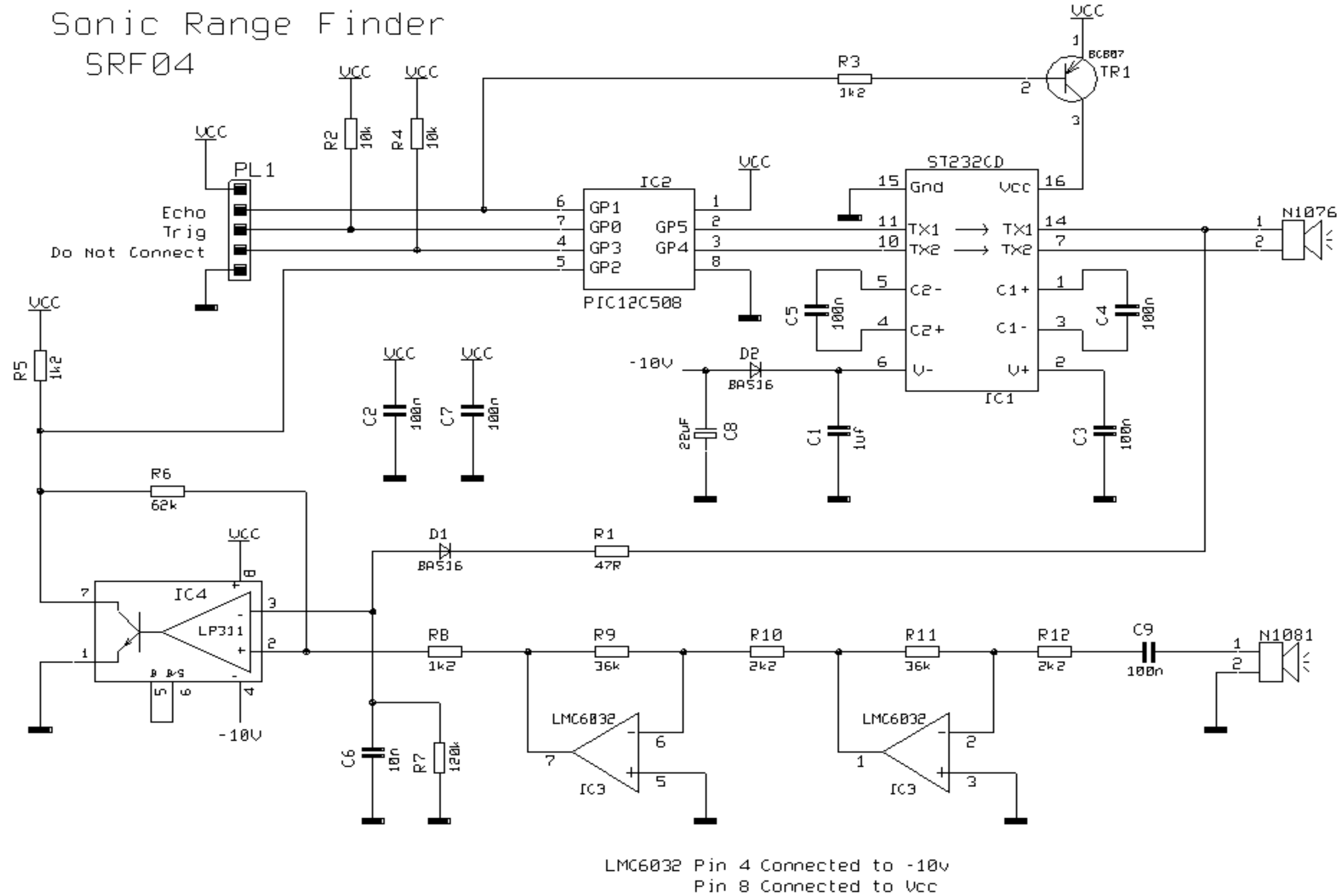
The SRF04 was designed to be just as easy to use as the Polaroid sonar, requiring a short trigger pulse and providing an echo pulse. Your controller only has to time the length of this pulse to find the range. The connections to the SRF04 are shown below:



The SRF04 Timing diagram is shown below. You only need to supply a short 10uS pulse to the trigger input to start the ranging. The SRF04 will send out an 8 cycle burst of ultrasound at 40khz and raise its echo line high. It then listens for an echo, and as soon as it detects one it lowers the echo line again. The echo line is therefore a pulse whose width is proportional to the distance to the object. By timing the pulse it is possible to calculate the range in inches/centimeters or anything else. If nothing is detected then the SRF04 will lower its echo line anyway after about 36mS.



Here is the schematic, You can download a better quality pdf (161k) version srf1.pdf



The circuit is designed to be low cost. It uses a PIC12C508 to perform the control functions and standard 40khz piezo transducers. The drive to the transmitting transducer could be simplest driven directly from the PIC. The 5v drive can give a useful range for large objects, but can be problematic detecting smaller objects. The transducer can handle 20v of drive, so I decided to get up close to this level. A MAX232 IC, usually used for RS232 communication makes and ideal driver, providing about 16v of drive.

The receiver is a classic two stage op-amp circuit. The input capacitor C8 blocks some residual DC which always seems to be present. Each gain stage is set to 24 for a total gain of 576-ish. This is close the 25 maximum gain available using the LM1458. The gain bandwidth product for the LM1458 is 1Mhz. The maximum gain at 40khz is 1000000/40000 = 25. The output of the amplifier is fed into an LM311 comparator. A small amount of positive feedback provides some hysterisis to give a clean stable output.

The problem of getting operation down to 1-2cm is that the receiver will pick up direct coupling from the transmitter, which is right next to it. To make matters worse the piezo transducer is a mechanical object that keeps resonating some time after the drive has been removed. Up to 1mS depending on when you decide it has stopped. It is much harder to tell the difference between this direct coupled ringing and a returning echo, which is why many designs, including the Polaroid module, simply blank out this period. Looking at the returning echo on an oscilloscope shows that it is much larger in magnitude at close quarters than the cross-coupled signal. I therefore adjust the detection threshold during this time so that only the echo is detectable. The 100n capacitor C10 is charged to about –6v during the burst. This discharges quite quickly through the

10k resistor R6 to restore sensitivity for more distant echo's.

A convenient negative voltage for the op-amp and comparator is generated by the MAX232. Unfortunately, this also generates quite a bit of high frequency noise. I therefore shut it down whilst listening for the echo. The 10uF capacitor C9 holds the negative rail just long enough to do this.

In operation, the processor waits for an active low trigger pulse to come in. It then generates just eight cycles of 40khz. The echo line is then raised to signal the host processor to start timing. The raising of the echo line also shuts of the MAX232. After a while – no more than 10-12mS normally, the returning echo will be detected and the PIC will lower the echo line. The width of this pulse represents the flight time of the sonic burst. If no echo is detected then it will automatically time out after about 30mS (Its two times the WDT period of the PIC). Because the MAX232 is shut down during echo detection, you must wait at least 10mS between measurement cycles for the +/- 10v to recharge.

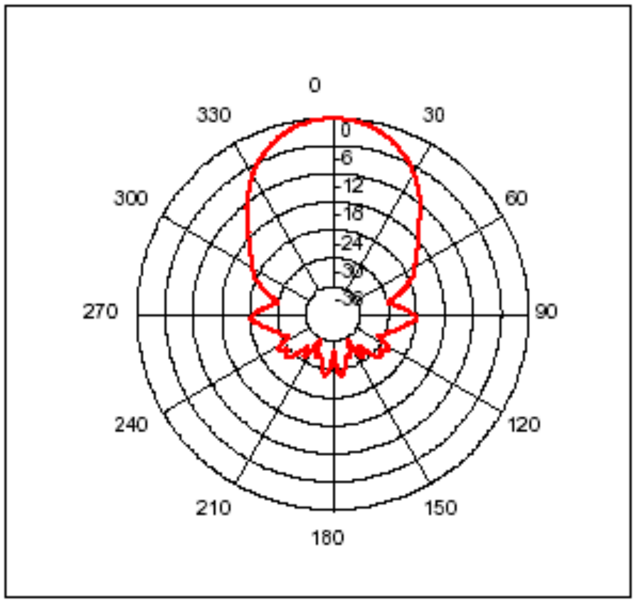
Performance of this design is, I think, quite good. It will reliably measure down to 3cm and will continue detecting down to 1cm or less but after 2-3cm the pulse width doesn't get any smaller.

Maximum range is a little over 3m. As and example of the sensitivity of this design, it will detect a 1inch thick plastic broom handle at 2.4m.
Average current consumption is reasonable at less than 50mA and typically about 30mA.

Download the source code and a ready assembled hex file.

Calculating the Distance
The SRF04 provides an echo pulse proportional to distance. If the width of the pulse is measured in uS, then dividing by 58 will give you the distance in cm, or dividing by 148 will give the distance in inches. uS/58=cm or uS/148=inches.

Changing beam pattern and beam width
You can't! This is a question which crops up regularly, however there is no easy way to reduce or change the beam width that I'm aware of. The beam pattern of the SRF04 is conical with the width of the beam being a function of the surface area of the transducers and is fixed. The beam pattern of the transducers used on the SRF04, taken from the manufacturers data sheet, is shown below.



There is more information in the sonar faq.

Update - May 2003
Since the original design of the SRF04 was published, there have been incremental improvements to improve performance and manufacturing reliability. The op-amp is now an LMC6032 and the comparator is an LP311. The 10uF capacitor is now 22uF and a few resistor values have been tweaked. These changes have happened over a period of time.

All SRF04's manufactured after May 2003 have new software implementing an optional timing control input using the "do not connect" pin. This connection is the PIC's Vpp line used to program the chip after assembly. After programming its just an unused input with a pull-up resistor. When left unconnected the SRF04 behaves exactly as it always has and is described above. When the "do not connect" pin is connected to ground (0v), the timing is changed slightly to allow the SRF04 to work with the slower controllers such as the Picaxe. The SRF04's "do not connect" pin now acts as a timing control. **This pin is pulled high by default and when left unconnected, the timing remains exactly as before.** With the timing pin pulled low (grounded) a 300uS delay is added between the end of the trigger pulse and transmitting the sonic burst. Since the echo output is not raised until the burst is completed, there is no change to the range timing, but the 300uS delay gives the Picaxe time to sort out which pin to look at and start doing so. The new code has shipped in all SRF04's since the end of April 2003. The new code is also useful when connecting the SRF04 to the slower Stamps such as the BS2. Although the SRF04 works with the BS2, the echo line needs to be connected to the lower numbered input pins. This is because the Stamps take progressively longer to look at the higher numbered pins and can miss the rising edge of the echo signal. In this case you can connect the "do not connect" pin to ground and give it an extra 300uS to get there.

Water Flow Sensor

HZ21WA

SIZE:G1/2",58*38*38(L*W*H)mm

The principle of operation

The main water flow sensor by copper body and plastic forming, water flow rotor components, steady flow components and hall components. It into water dispenser, coffee machine and household appliances the water used for measuring the water flow.

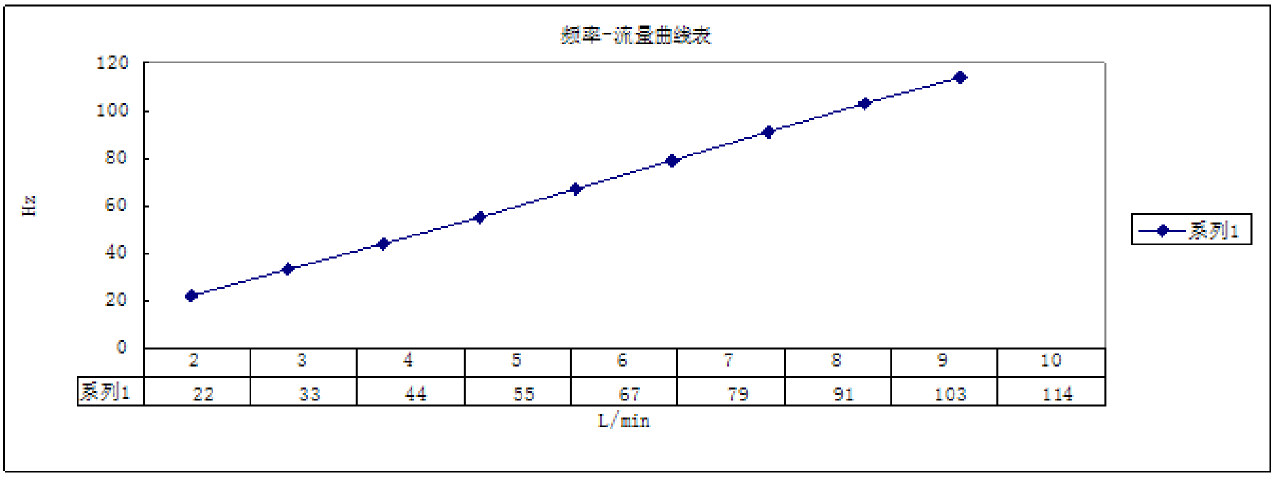
When water flows through the rotor components, magnetic rotor rotating, and speed along with the flow of a linear change. Hall element output corresponding pulse signal feedback to the controller, the size of the flow of water by controller judgment, adjust proportional valve control of electric current.

Water flow sensor fundamentally solve the differential water-gas valve flap type high pressure and start water valve easy misoperation appear dry and shortcomings.
It has reflected sensitive, long service life, action quick, safe and reliable, joins convenient traffic advantages such as the start low, deeply the general user affection.

The main components of turbine rotor flow switch shell, magnetic rotor, brake ring composition. Use water flow switch mode, its performance than the mechanical differential pressure plate structure, and decrease the size. As the water through the turbine switch shell, promote magnetic rotor, different pole near the hall element hall element when conduction, and leave the hall componets disconnect. Thus, can measure the rotor speed. According to the measured data of the rotor speed and water flow, the output signal (voltage) curve, can be sure water dispenser, coffee machine and household appliances start water pressure, hydraulic pressure and startup corresponding start the flow of water and rotor The start of the speed.

Electrical characteristic

NO	Item	Examination requirement
1	Appearance	Clean and beautiful, smooth without burr, without off color
2	Water pressure resistance performance	1.75 MPa pressure has no slack phenomenon, and parts no crack, relaxation, inflation, and deformation anomaly
3	Operating voltage range	DC3-18V
4	Maximum operating current	15mA
5	The output pulse high level	In 5 V rated voltage, the output of the high level requirements in 4.5 V above
6	The output pulse low level	In 5 V rated voltage, the output of the low level requirements in 0.5 V the following
7	The output pulse duty ratio	In the rated voltage, the output pulse occupies emptiescompared to 50%-10%
8	Flow pulse characteristics	［4.1Q］±10%
9	Insulating property	Dielectric resistance＞100MΩ
10	Electrical strength	AC500V 50Hz(Don't breakdown or flash winding)
11	Electrical strength(100℃)	In 100 ℃ temperature placed in 72 hours, in the environmental temperature back after 1 hour the accuracy of measurement requirements within the plus or minus 5%
12	Cold resistance(-20℃)	In 20 ℃ temperature placed in-72 hours, in the environmental temperature back after 1 hour the accuracy of measurement requirements within the plus or minus 5%
13	Mode of connection	Red: the positive, black: negative, yellow: pulse signal



Installation instructions

1、When magnetic materials or to flow switch a magnetic force materials near water flow switch, its characteristics may change.

2、In order to avoid particles, sundry into the flow switch, in the inlet must install screen pack.

3、In the use of the water flow switch before please read the parameters that if there are still questions please to our factory technical personnel consultation.

4、In the process of installation and use must cooperate relays (power in 3 W below), lest because of switch power small and dry reed pipe burn out.

5、The water flow switch installation use environment to avoid strong vibration and shaking place, in order to avoid water flow switch produce false action.

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Document: Datasheet Date: 28-Jul-08 Model #: 3190 Product's Page: www.sunrom.com/p-510.html

Light Dependent Resistor - LDR

Two cadmium sulphide(cds) photoconductive cells with spectral responses similar to that of the human eye. The cell resistance falls with increasing light intensity. Applications include smoke detection, automatic lighting control, batch counting and burglar alarm systems.

Applications

Photoconductive cells are used in many different types of circuits and applications.

Analog Applications

- Camera Exposure Control
- Auto Slide Focus - dual cell
- Photocopy Machines - density of toner
- Colorimetric Test Equipment
- Densitometer
- Electronic Scales - dual cell
- Automatic Gain Control – modulated light source
- Automated Rear View Mirror

Digital Applications

- Automatic Headlight Dimmer
- Night Light Control
- Oil Burner Flame Out
- Street Light Control
- Absence / Presence (beam breaker)
- Position Sensor

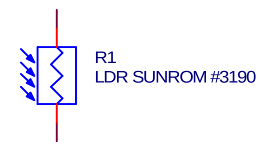
Electrical Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Cell resistance	1000 LUX 10 LUX	- -	400 9	- -	Ohm K Ohm
Dark Resistance	-	-	1	-	M Ohm
Dark Capacitance	-	-	3.5	-	pF
Rise Time	1000 LUX 10 LUX	- -	2.8 18	- -	ms ms
Fall Time	1000 LUX 10 LUX	- -	48 120	- -	ms ms
Voltage AC/DC Peak		-	-	320	V max
Current		-	-	75	mA max
Power Dissipation				100	mW max
Operating Temperature		-60	-	+75	Deg. C

Guide to source illuminations

Light source Illumination	LUX
Moonlight	0.1
60W Bulb at 1m	50
1W MES Bulb at 0.1m	100
Fluorescent Lighting	500
Bright Sunlight	30,000

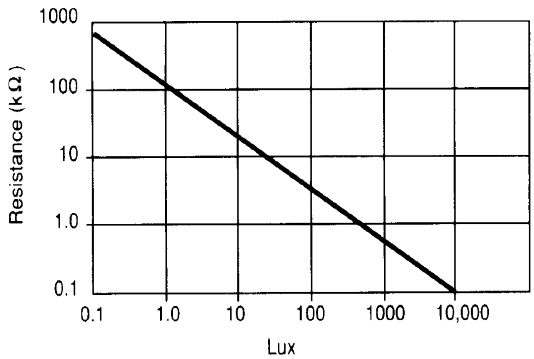
FIGURE 1 CIRCUIT SYMBOL



Sensitivity

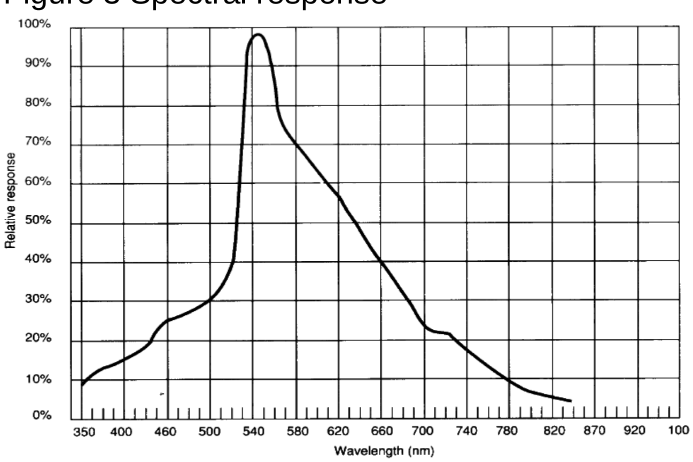
The sensitivity of a photodetector is the relationship between the light falling on the device and the resulting output signal. In the case of a photocell, one is dealing with the relationship between the incident light and the corresponding resistance of the cell.

FIGURE 2 RESISTANCE AS FUNCTION OF ILLUMINATION



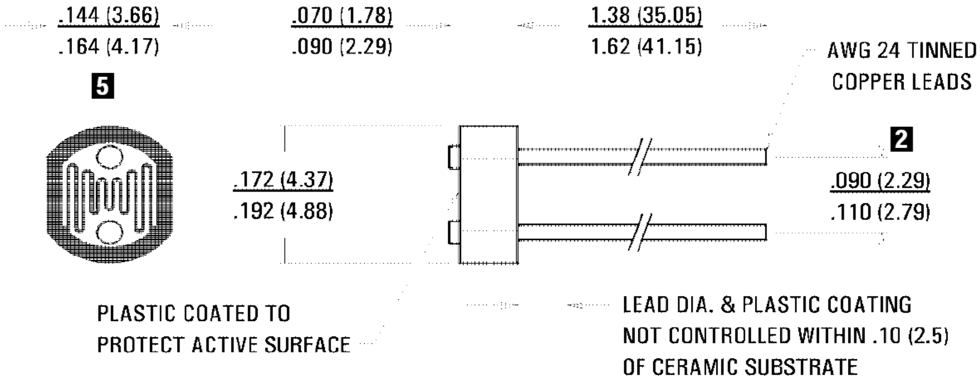
Spectral Response

Figure 3 Spectral response



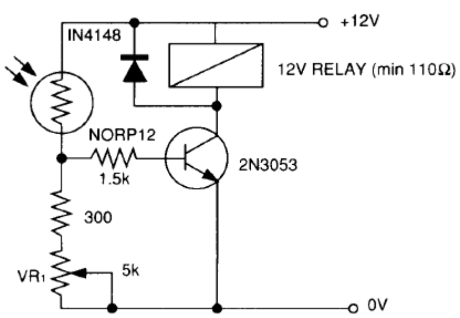
Like the human eye, the relative sensitivity of a photoconductive cell is dependent on the wavelength (color) of the incident light. Each photoconductor material type has its own unique spectral response curve or plot of the relative response of the photocell versus wavelength of light.

Dimensions



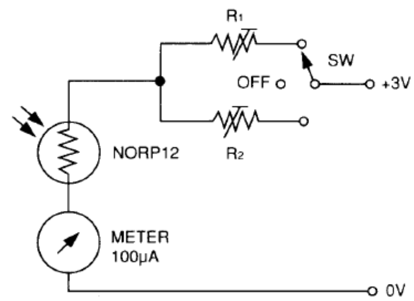
Typical Application Circuits

Figure 6 Sensitive light operated relay



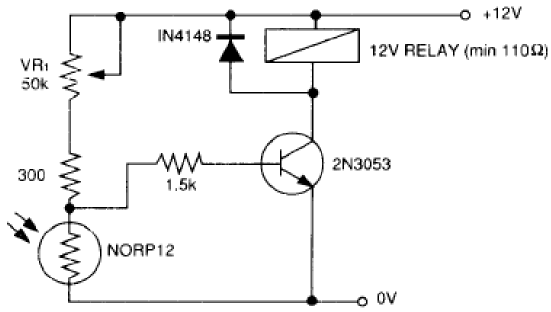
Relay energised when light level increases above the level set by VR_1

Figure 9 Logarithmic law photographic light meter



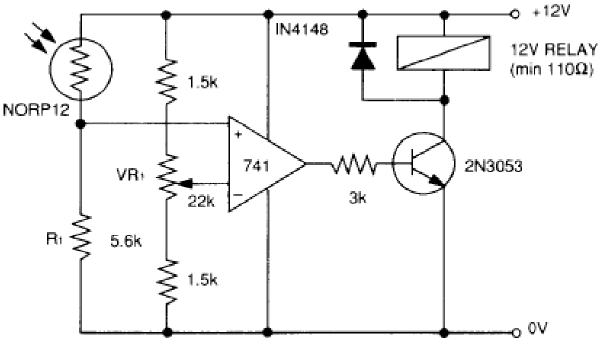
Typical value $R^1 = 100k\Omega$
$R^2 = 200k\Omega$ preset to give two overlapping ranges.
(Calibration should be made against an accurate meter.)

Figure 7 Light interruption detector



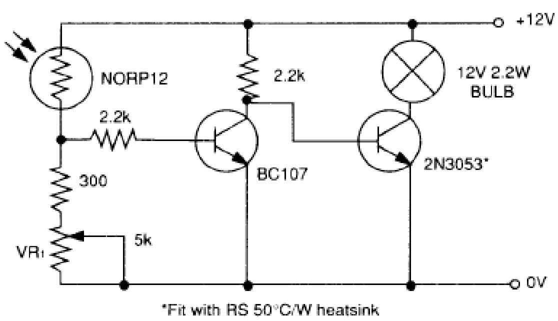
As Figure 6 relay energised when light level drops below the level set by VR_1

Figure 10 Extremely sensitive light operated relay



(Relay energised when light exceeds preset level.) Incorporates a balancing bridge and op-amp. R_1 and NORP12 may be interchanged for the reverse function.

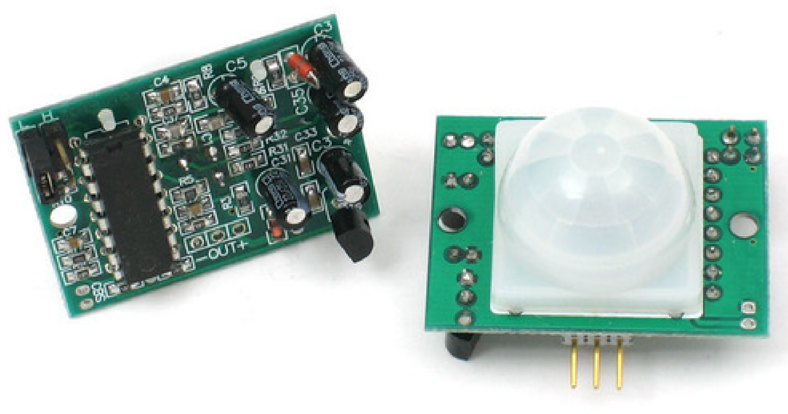
Figure 8 Automatic light circuit



adafruit learning system

PIR Motion Sensor

Created by lady ada



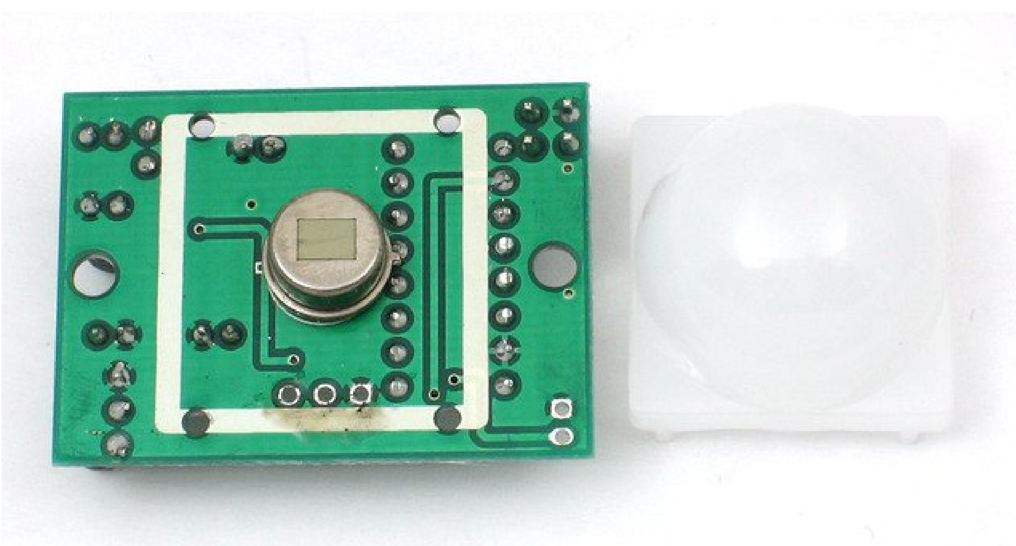
Last updated on 2018-06-17 08:04:51 PM UTC

Guide Contents

Overview

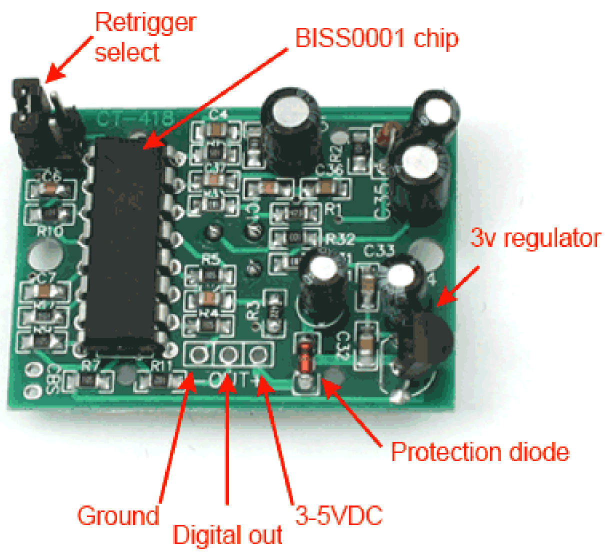
PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

PIRs are basically made of a pyroelectric sensor (https://adafru.it/aKh) (which you can see below as the round metal can with a rectangular crystal in the center), which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low.

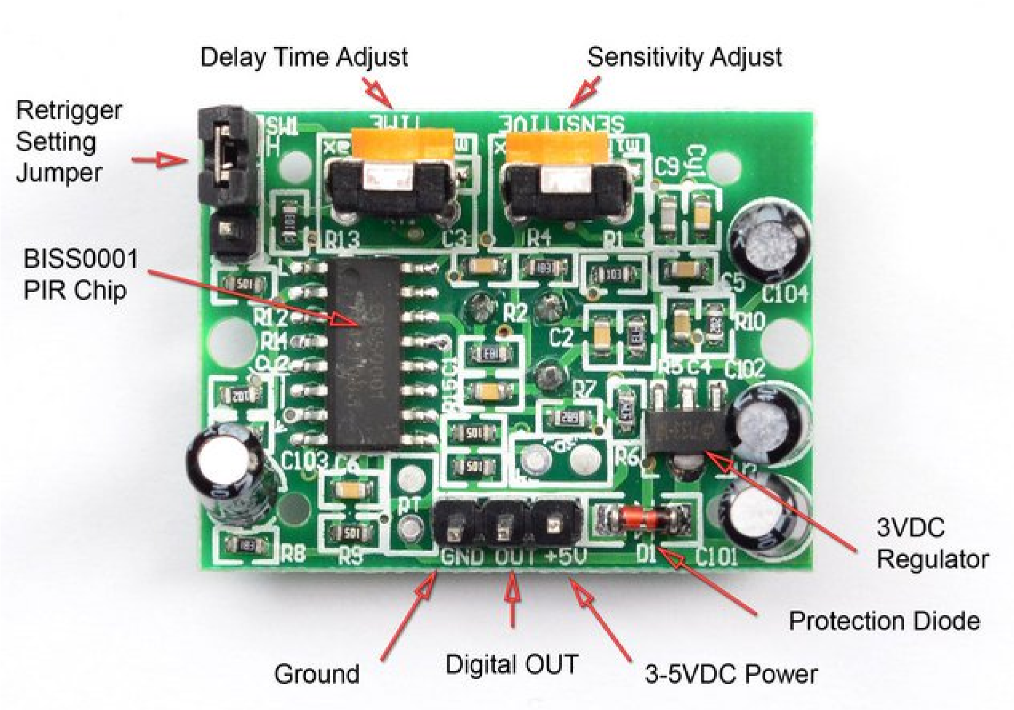


Along with the pyroelectic sensor is a bunch of supporting circuitry, resistors and capacitors. It seems that most small hobbyist sensors use the BISS0001 ("Micro Power PIR Motion Detector IC") (https://adafru.it/clR), undoubtedly a very inexpensive chip. This chip takes the output of the sensor and does some minor processing on it to emit a digital output pulse from the analog sensor.

Our older PIRs looked like this:



Our new PIRs have more adjustable settings and have a header installed in the 3-pin ground/out/power pads



For many basic projects or products that need to detect when a person has left or entered the area, or has approached, PIR sensors are great. They are low power and low cost, pretty rugged, have a wide lens range, and are easy to interface with. Note that PIRs won't tell you how many people are around or how close they are to the sensor, the lens is often fixed to a certain sweep and distance (although it can be hacked somewhere) and they are also sometimes set off by housepets. Experimentation is key!

Some Basic Stats

These stats are for the PIR sensor in the Adafruit shop which is very much like the Parallax one (https://adafru.it/aKj) . Nearly all PIRs will have slightly different specifications, although they all pretty much work the same. If there's a datasheet, you'll want to refer to it

- **Size:** Rectangular
- **Price:** $10.00 at the Adafruit shop (https://adafru.it/aIH)
- **Output:** Digital pulse high (3V) when triggered (motion detected) digital low when idle (no motion detected). Pulse lengths are determined by resistors and capacitors on the PCB and differ from sensor to sensor.
- **Sensitivity range:** up to 20 feet (6 meters) 110° x 70° detection range
- **Power supply:** 5V-12V input voltage for most modules (they have a 3.3V regulator), but 5V is ideal in case the regulator has different specs
- **BIS0001 Datasheet (https://adafru.it/clR)** (the decoder chip used)
- **RE200B datasheet (https://adafru.it/clS)** (most likely the PIR sensing element used)
- **NL11NH datasheet (https://adafru.it/clT)** (equivalent lens used)
- **Parallax Datasheet on their version of the sensor (https://adafru.it/clU)**

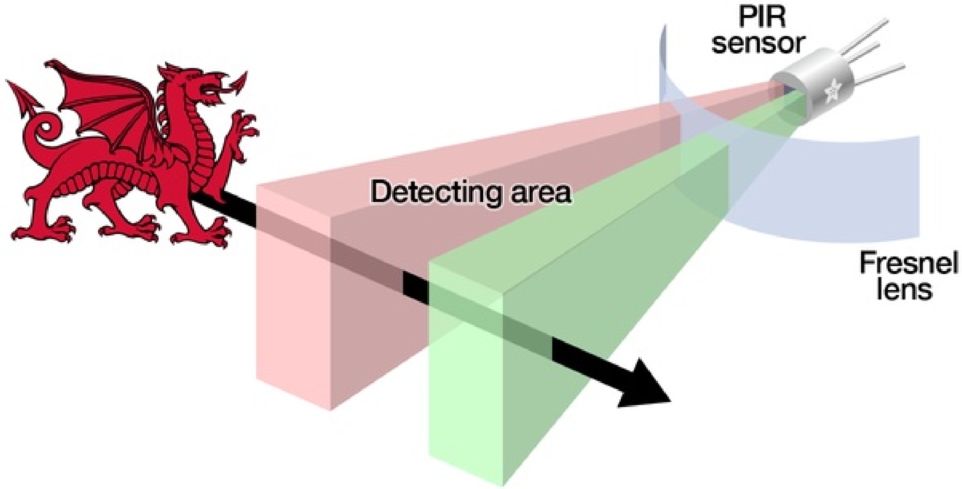
More links!

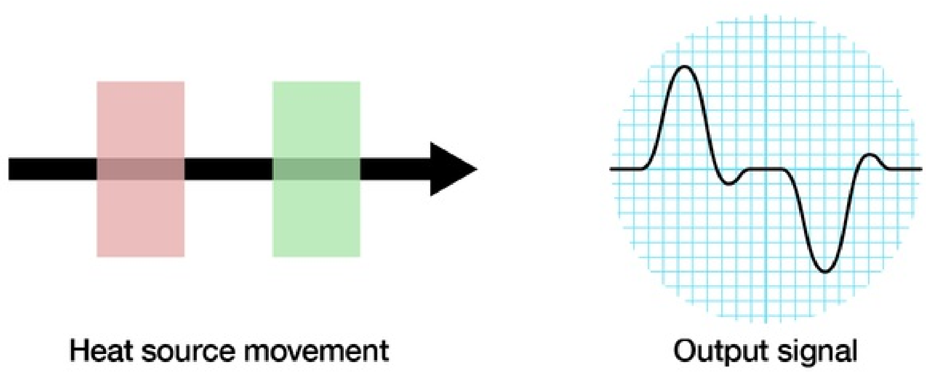
- A great page on PIR sensors from GLOLAB \\ (https://adafru.it/aKn)

How PIRs Work

PIR sensors are more complicated than many of the other sensors explained in these tutorials (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. To begin explaining how a basic sensor works, we'll use this rather nice diagram

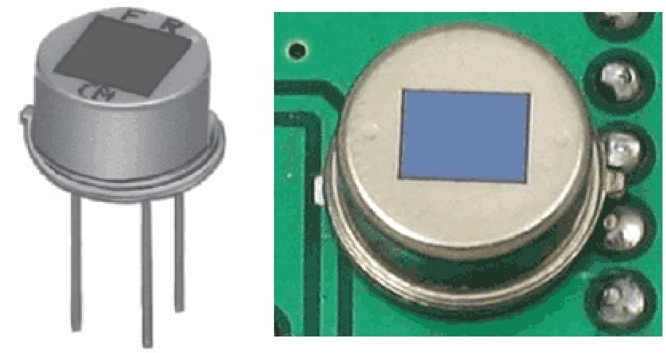
The PIR sensor itself has two slots in it, each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and so we see that the two slots can 'see' out past some distance (basically the sensitivity of the sensor). When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a *positive differential* change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.





The PIR Sensor

The IR sensor itself is housed in a hermetically sealed metal can to improve noise/temperature/humidity immunity. There is a window made of IR-transmissive material (typically coated silicon since that is very easy to come by) that protects the sensing element. Behind the window are the two balanced sensors.



Left image from Murata datasheet (https://adafru.it/cm5)

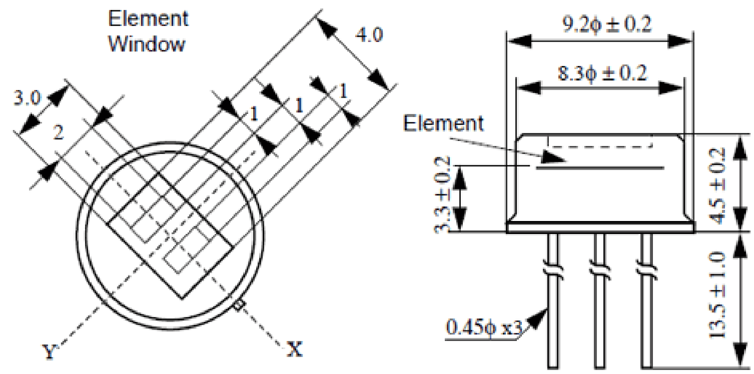


Image from RE200B datasheet (https://adafru.it/clS)

You can see above the diagram showing the element window, the two pieces of sensing material

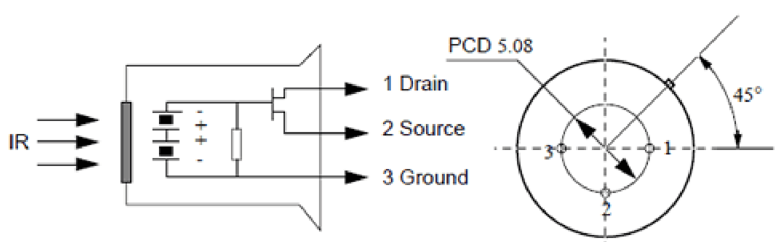


Image from RE200B datasheet (https://adafru.it/clS)

This image shows the internal schematic. There is actually a JFET inside (a type of transistor) which is very low-noise and buffers the extremely high impedence of the sensors into something a low-cost chip (like the BIS0001) can sense.

Lenses

PIR sensors are rather generic and for the most part vary only in price and sensitivity. Most of the real magic happens with the optics. This is a pretty good idea for manufacturing: the PIR sensor and circuitry is fixed and costs a few dollars. The lens costs only a few cents and can change the breadth, range, sensing pattern, very easily.

In the diagram up top, the lens is just a piece of plastic, but that means that the detection area is just two rectangles. Usually we'd like to have a detection area that is much larger. To do that, we use a simple lens (https://adafru.it/aKq) such as those found in a camera: they condenses a large area (such as a landscape) into a small one (on film or a CCD sensor). For reasons that will be apparent soon, we would like to make the PIR lenses small and thin and moldable from cheap plastic, even though it may add distortion. For this reason the sensors are actually Fresnel lenses (https://adafru.it/aKr):

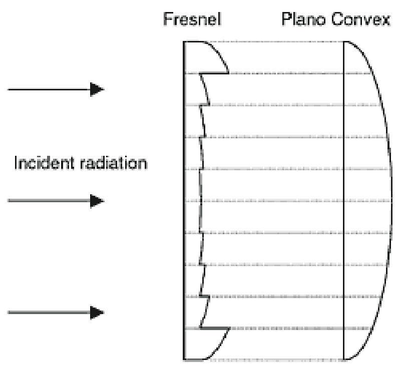


Image from Sensors Magazine (https://adafru.it/aKs)

The Fresnel lens condenses light, providing a larger range of IR to the sensor.

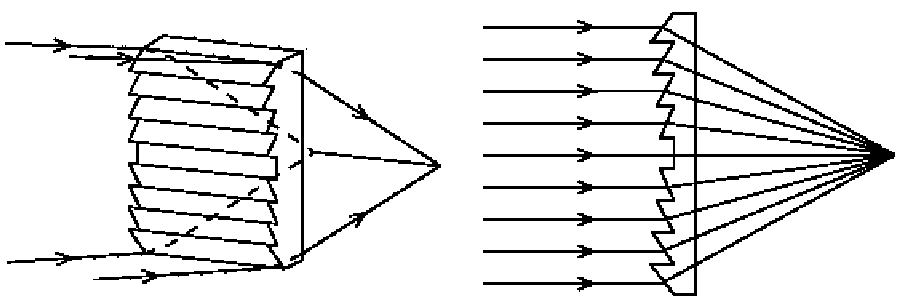


Image from BHlens.com (https://adafru.it/aKt)

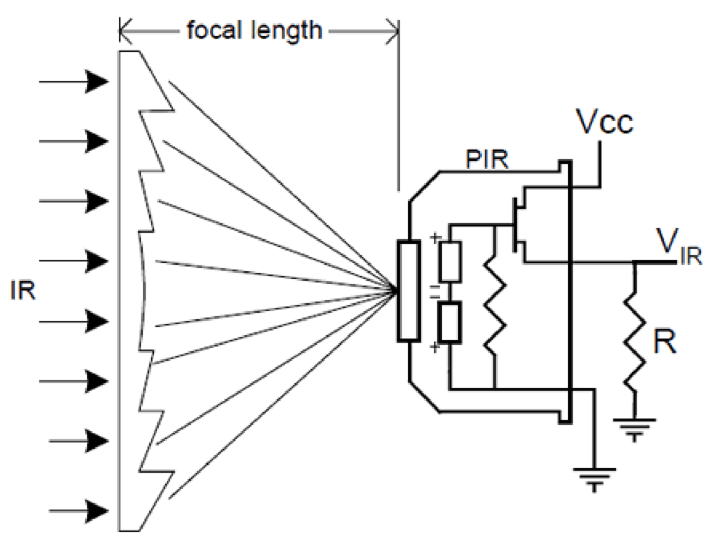
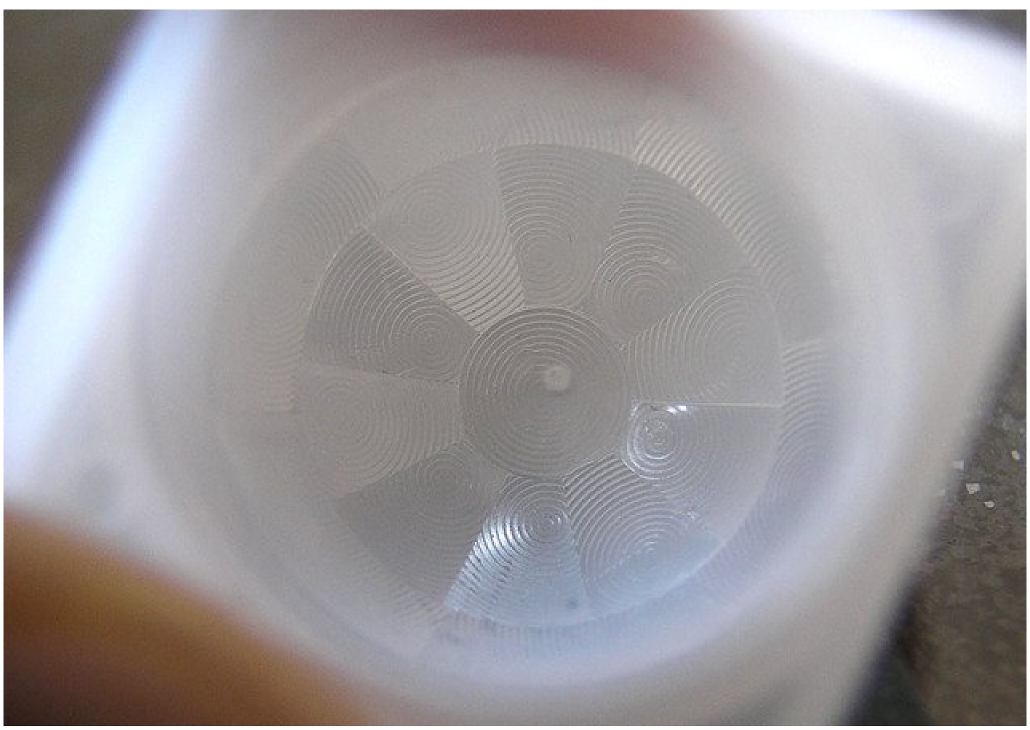


Image from Cypress appnote 2105 (https://adafru.it/cm6)

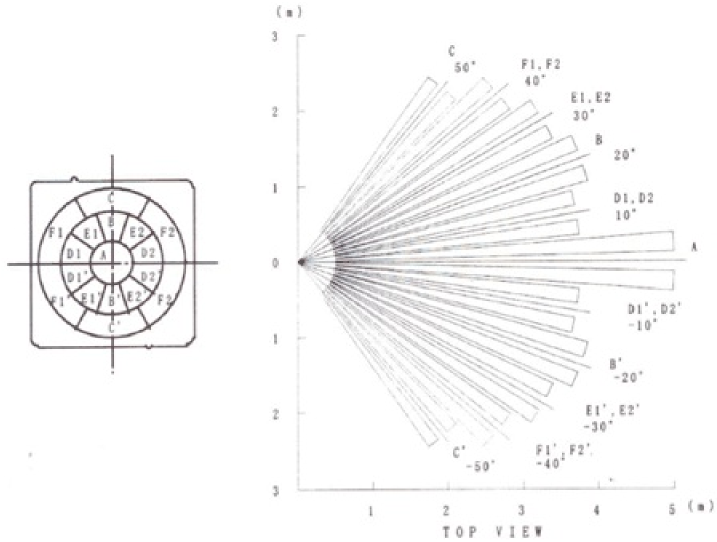
OK, so now we have a much larger range. However, remember that we actually have two sensors, and more importantly we dont want two really big sensing-area rectangles, but rather a scattering of multiple small areas. So what we do is split up the lens into multiple section, each section of which is a fresnel lens.

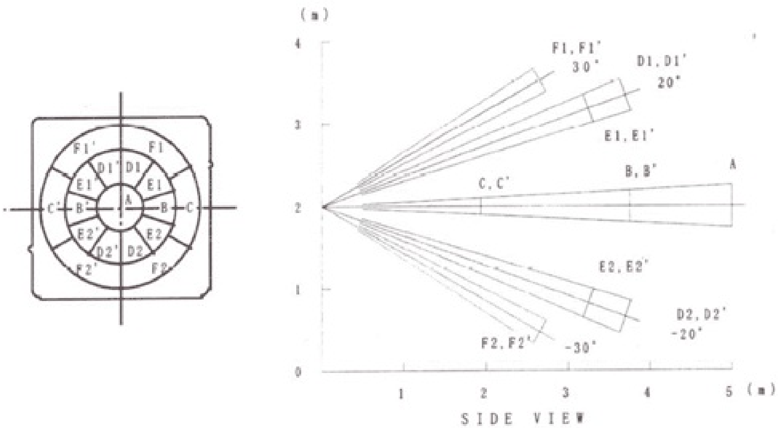
Here you can see the multiple facet-sections



This macro shot shows the different Fresnel lenses in each facet!

The different faceting and sub-lenses create a range of detection areas, interleaved with each other. That's why the lens centers in the facets above are 'inconsistent' - every other one points to a different half of the PIR sensing element





Images from NL11NH datasheet (https://adafru.it/clT)

Here is another image, more qualitative but not as quantitative. (Note that the sensor in the Adafruit shop is 110° not 90°)

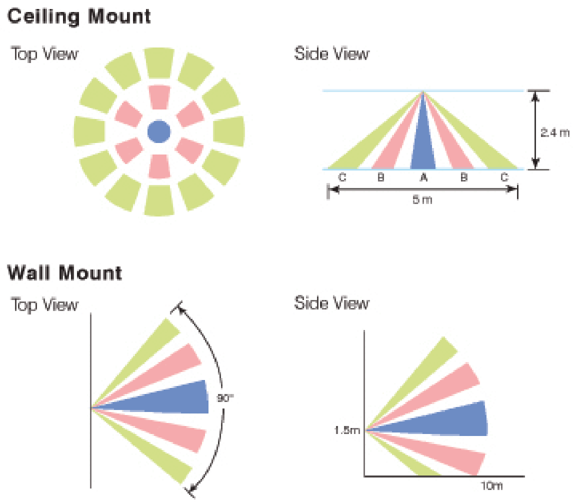
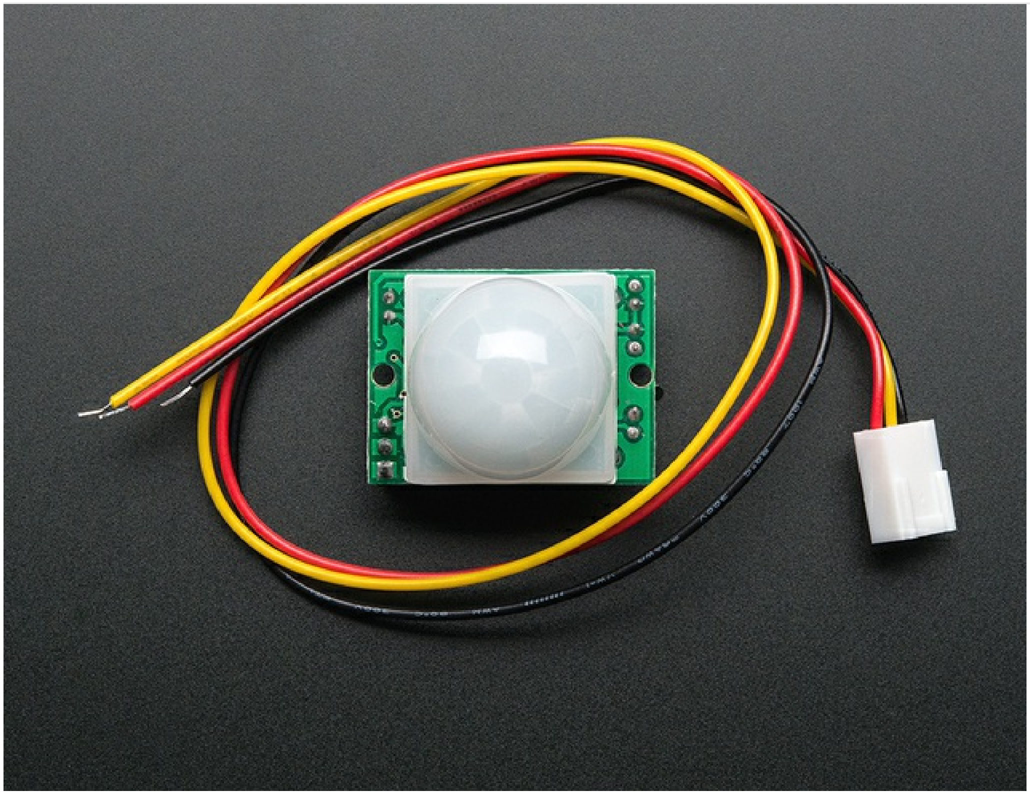


Image from IR-TEC (https://adafru.it/aKv)

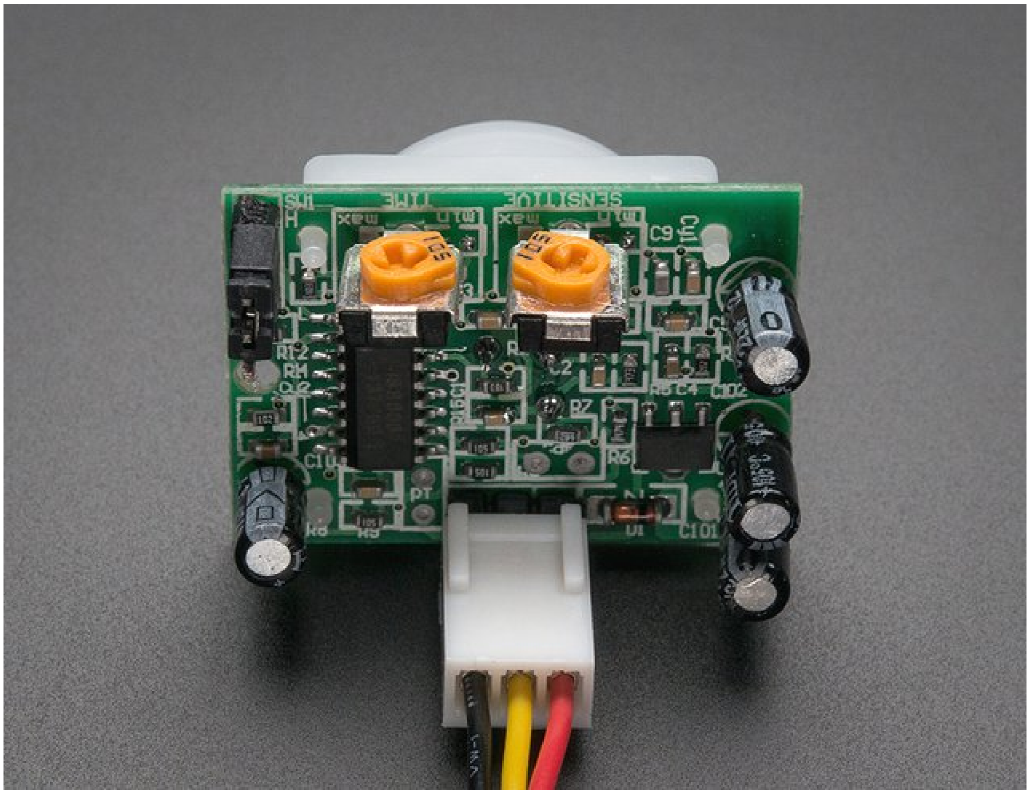
Connecting to a PIR



Most PIR modules have a 3-pin connection at the side or bottom. The pinout may vary between modules so triple-check the pinout! It's often silkscreened on right next to the connection (at least, ours is!) One pin will be ground, another will be signal and the final one will be power. Power is usually 3-5VDC input but may be as high as 12V. Sometimes larger modules don't have direct output and instead just operate a relay in which case there is ground, power and the two switch connections.

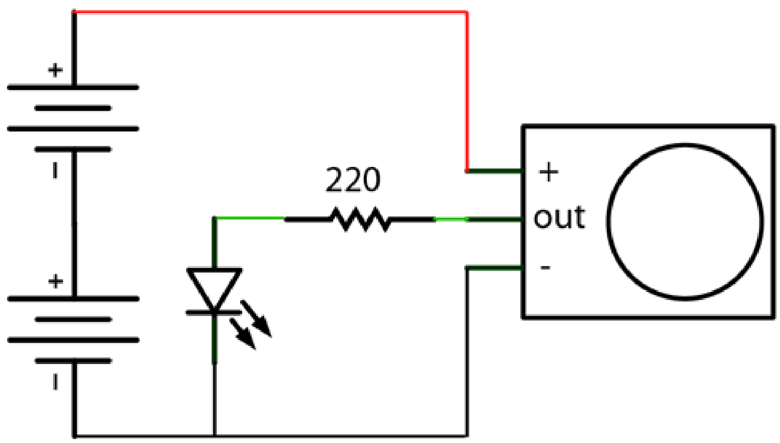
The output of some relays may be 'open collector' - that means it requires a pullup resistor. If you're not getting a variable output be sure to try attaching a 10K pullup between the signal and power pins.

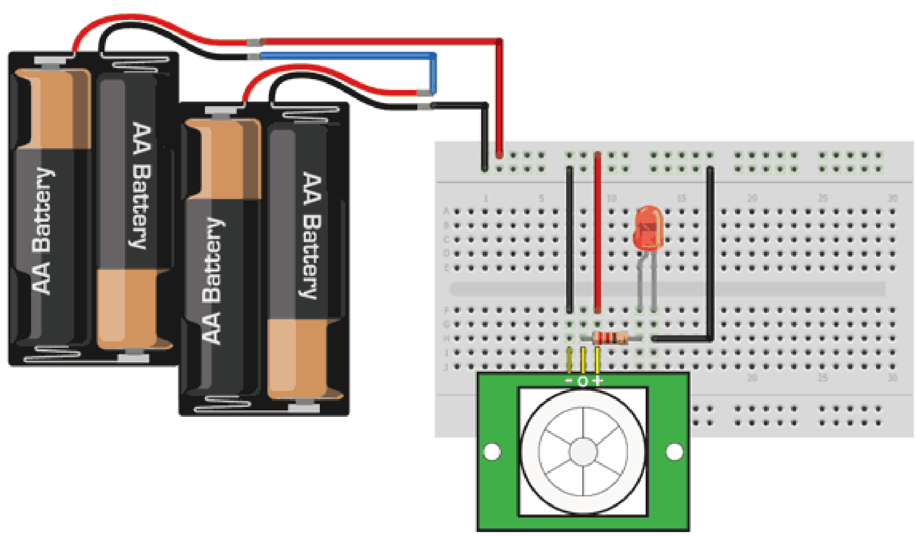
An easy way of prototyping with PIR sensors is to connect it to a breadboard since the connection port is 0.1" spacing. Some PIRs come with header on them already, the one's from adafruit have a straight 3-pin header on them for connecting a cable



For our PIR's the red cable is + voltage power, black cable is - ground power and yellow is the signal out. Just make sure you plug the cable in as shown above! If you get it backwards you won't damage the PIR but it won't work.

Testing a PIR





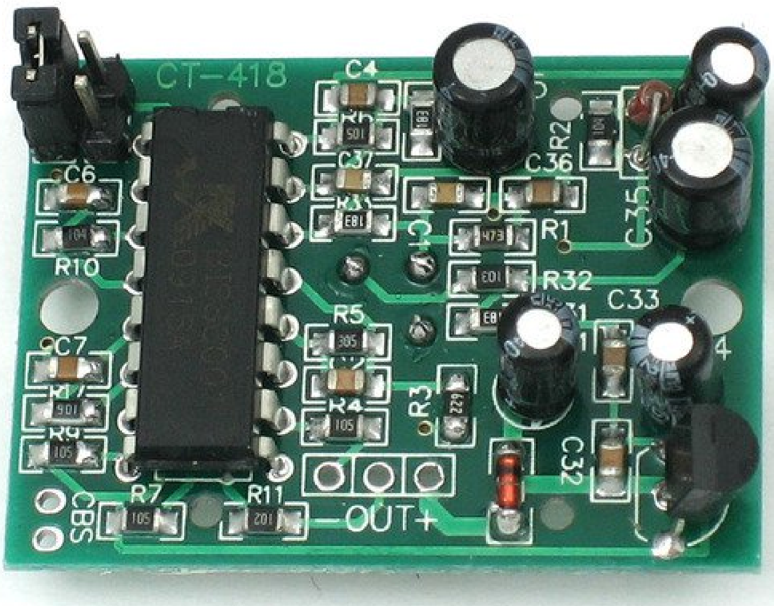
Now when the PIR detects motion, the output pin will go "high" to 3.3V and light up the LED!

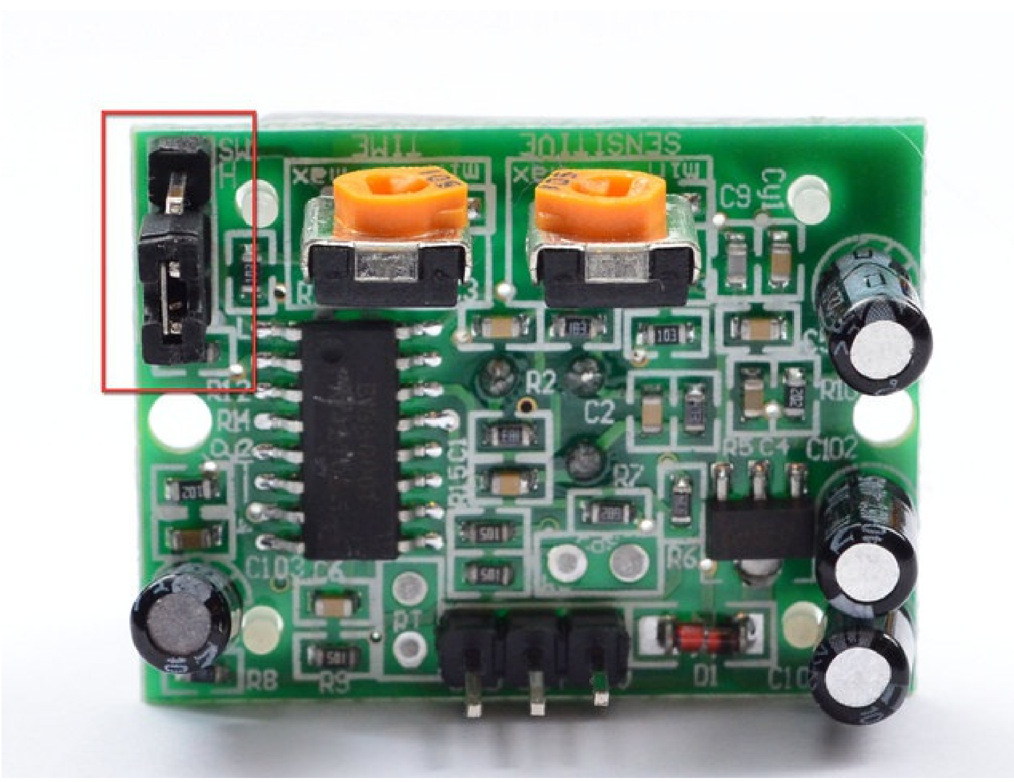
Once you have the breadboard wired up, insert batteries and wait 30-60 seconds for the PIR to 'stabilize'. During that time the LED may blink a little. Wait until the LED is off and then move around in front of it, waving a hand, etc, to see the LED light up!

Retriggering

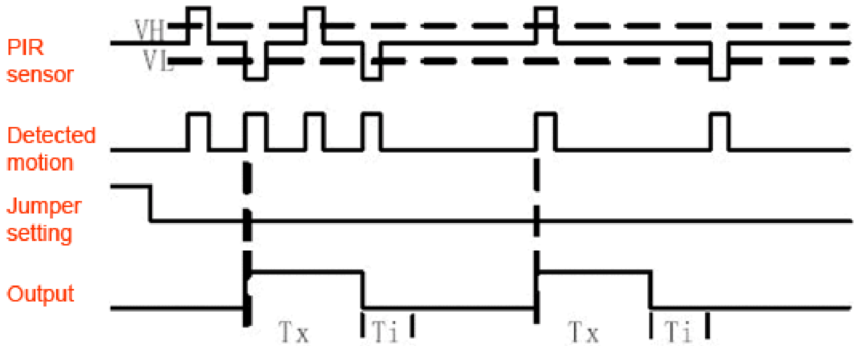
There's a couple options you may have with your PIR. First up we'll explore the 'Retriggering' option.

Once you have the LED blinking, look on the back of the PIR sensor and make sure that the jumper is placed in the **L** position as shown below.

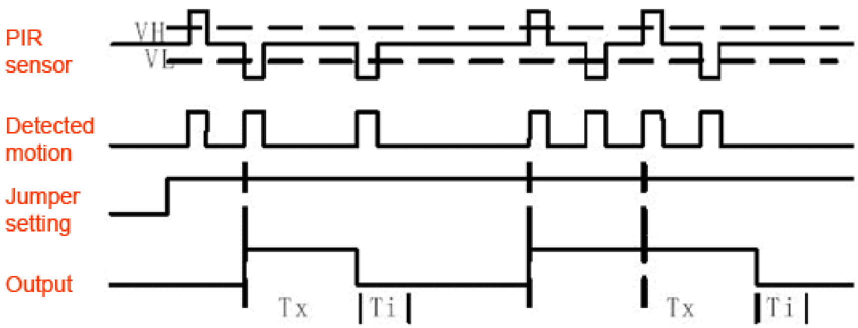




Now set up the testing board again. You may notice that when connecting up the PIR sensor as above, the LED does not stay on when moving in front of it but actually turns on and off every second or so. That is called "non-retriggering".

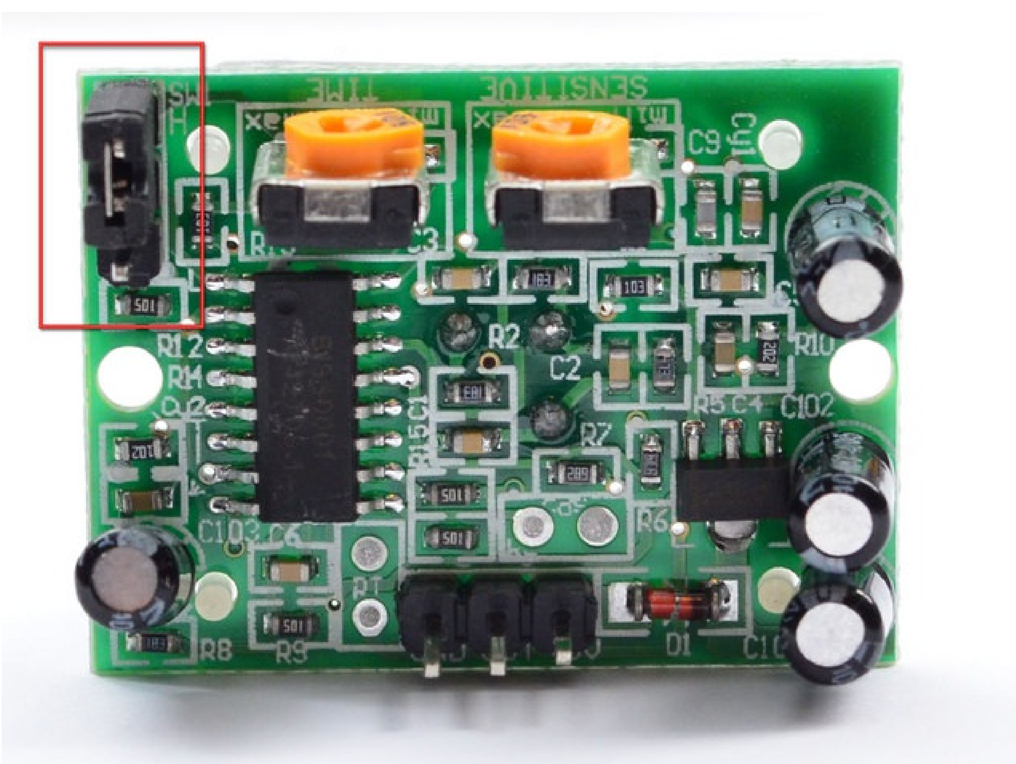


Now change the jumper so that it is in the **H** position. If you set up the test, you will notice that now the LED *does* stay on the entire time that something is moving. That is called "retriggering".



(The graphs above are from the BISS0001 datasheet, they kinda suck)

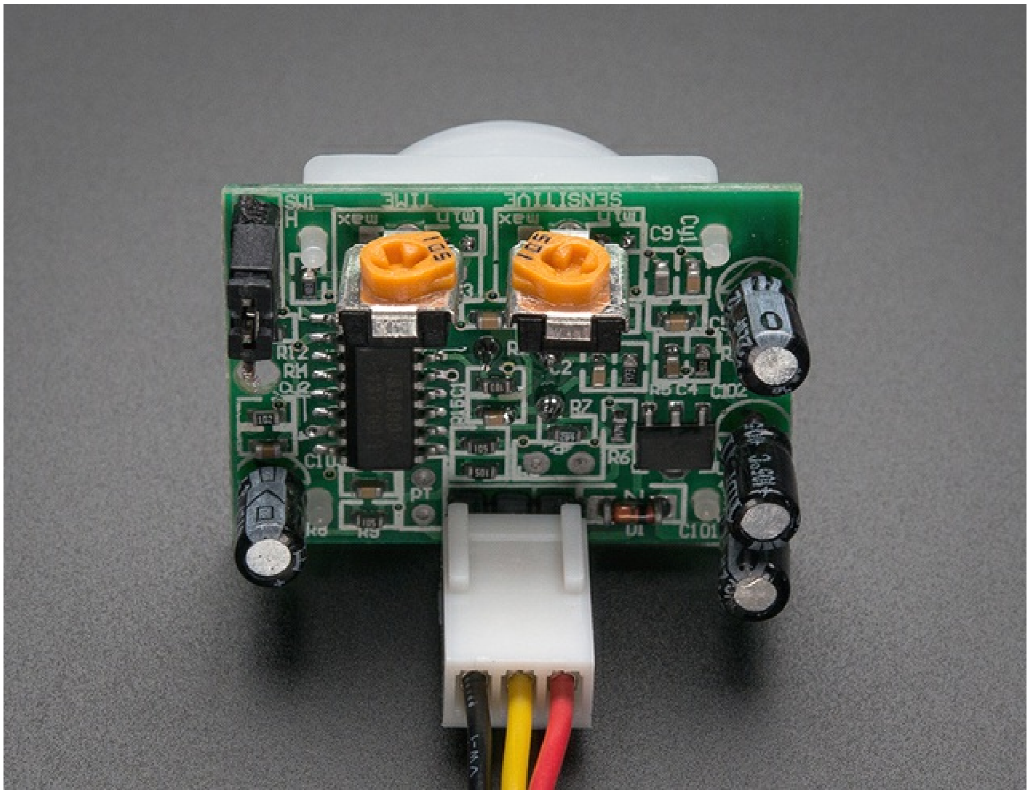
For most applications, "retriggering" (jumper in H position as shown below) mode is a little nicer.



If you need to connect the sensor to something edge-triggered, you'll want to set it to "non-retriggering" (jumper in L position).

Changing sensitivity

The Adafruit PIR has a trimpot on the back for adjusting sensitivity. You can adjust this if your PIR is too sensitive or not sensitive enough - clockwise makes it more sensitive.



Changing Pulse Time and Timeout Length

There are two 'timeouts' associated with the PIR sensor. One is the "**Tx**" timeout: how long the LED is lit after it detects movement - this is easy to adjust on Adafruit PIR's because there's a potentiometer.

The second is the "**Ti**" timeout which is how long the LED is guaranteed to be off when there is no movement. This one is not *easily* changed but if you're handy with a soldering iron it is within reason.

First, lets take a look at the BISS datasheet again

Tx = The time duration during which the output pin (Vo) remains high after triggering.
Ti = During this time period, triggering is inhibited. See timing charts for details.

Tx ≈ 24576 xR10 x C6; **Ti** ≈ 24 x R9 x C7。 (ref to schematic)

On Adafruit PIR sensors, there's a little trim potentiometer labeled **TIME.** This is a 1 Megaohm adjustable resistor which is added to a 10K series resistor. And **C6** is 0.01uF so

> Tx = **24576 x (10K + Rtime) x 0.01uF**

If the Rtime potentiometer is turned all the way down counter-clockwise (to 0 ohms) then

> **Tx** = **24576 x (10K) x 0.01uF = 2.5** seconds (approx)

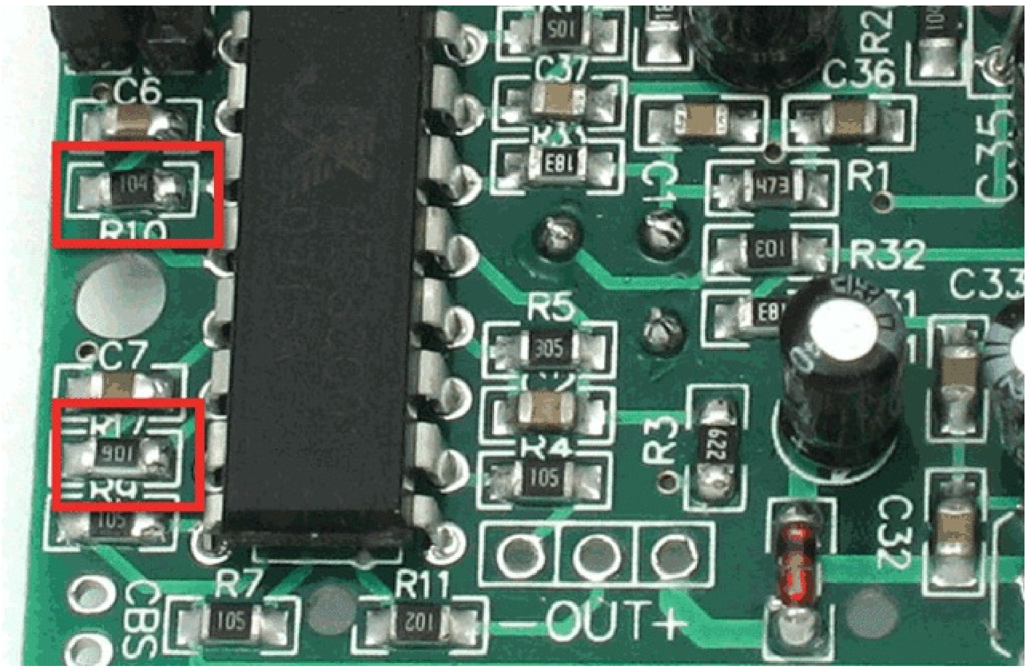
If the Rtime potentiometer is turned all the way up clockwise to 1 Megaohm then

> **Tx** = **24576 x (1010K) x 0.01uF = 250** seconds (approx)

If RTime is in the middle, that'd be about 120 seconds (two minutes) so you can tweak it as necessary. For example if you want motion from someone to turn on a fan for a minimum of 1 minute, set the Rtime potentiometer to about 1/4 the way around.

For older/other PIR sensors

If you have a PIR sensor from somewhere else that does not have a potentiometer adjust, you can trace out the adjustment resistors this way:



Determining R10 and R9 isnt too tough. Unfortunately this PIR sensor is mislabeled (it looks like they swapped R9 R17). You can trace the pins by looking at the BISS001 datasheet and figuring out what pins they are - R10 connects to pin 3 and R9 connects to pin 7. the capacitors are a little tougher to determine, but you can 'reverse engineer' them from timing the sensor and solving!

For example:

> **Tx is = 24576 * R10 * C6 = ~1.2 seconds**
> **R10** = 4.7K and **C6** = 10nF

Likewise,

> **Ti = 24 * R9 * C7 = ~1.2 seconds**
> **R9** = 470K and **C7** = 0.1uF

You can change the timing by swapping different resistors or capacitors. For a nice tutorial on this, see Keith's PIR hacking page (https://adafru.it/aKw).

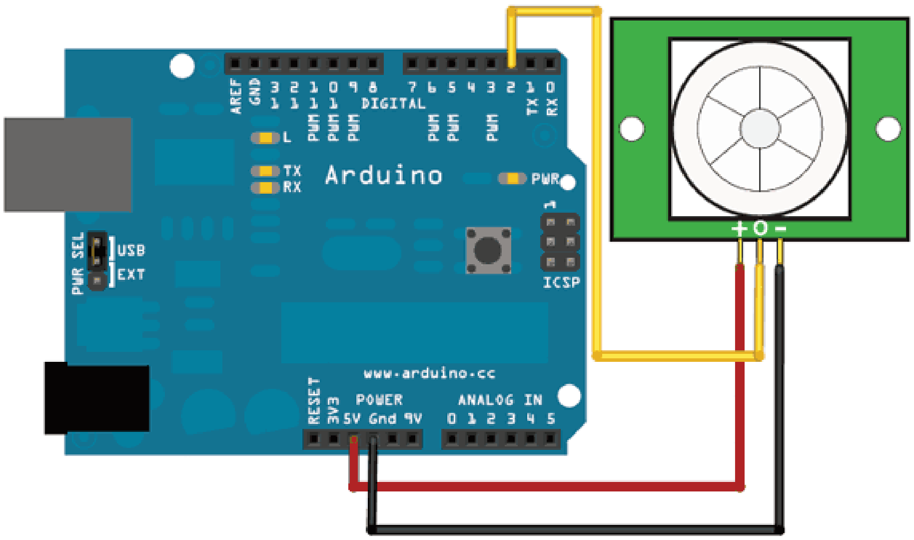
Using a PIR w/Arduino

Reading PIR Sensors

Connecting PIR sensors to a microcontroller is really simple. The PIR acts as a digital output, it can be high voltage or low voltage, so all you need to do is listen for the pin to flip high (detected) or low (not detected) by listening on a digital input on your Arduino

Its likely that you'll want reriggering, so be sure to put the jumper in the **H** position!

Power the PIR with 5V and connect ground to ground. Then connect the output to a digital pin. In this example we'll use pin 2.



The code is very simple, and is basically just keeps track of whether the input to pin 2 is high or low. It also tracks the *state* of the pin, so that it prints out a message when motion has started and stopped.

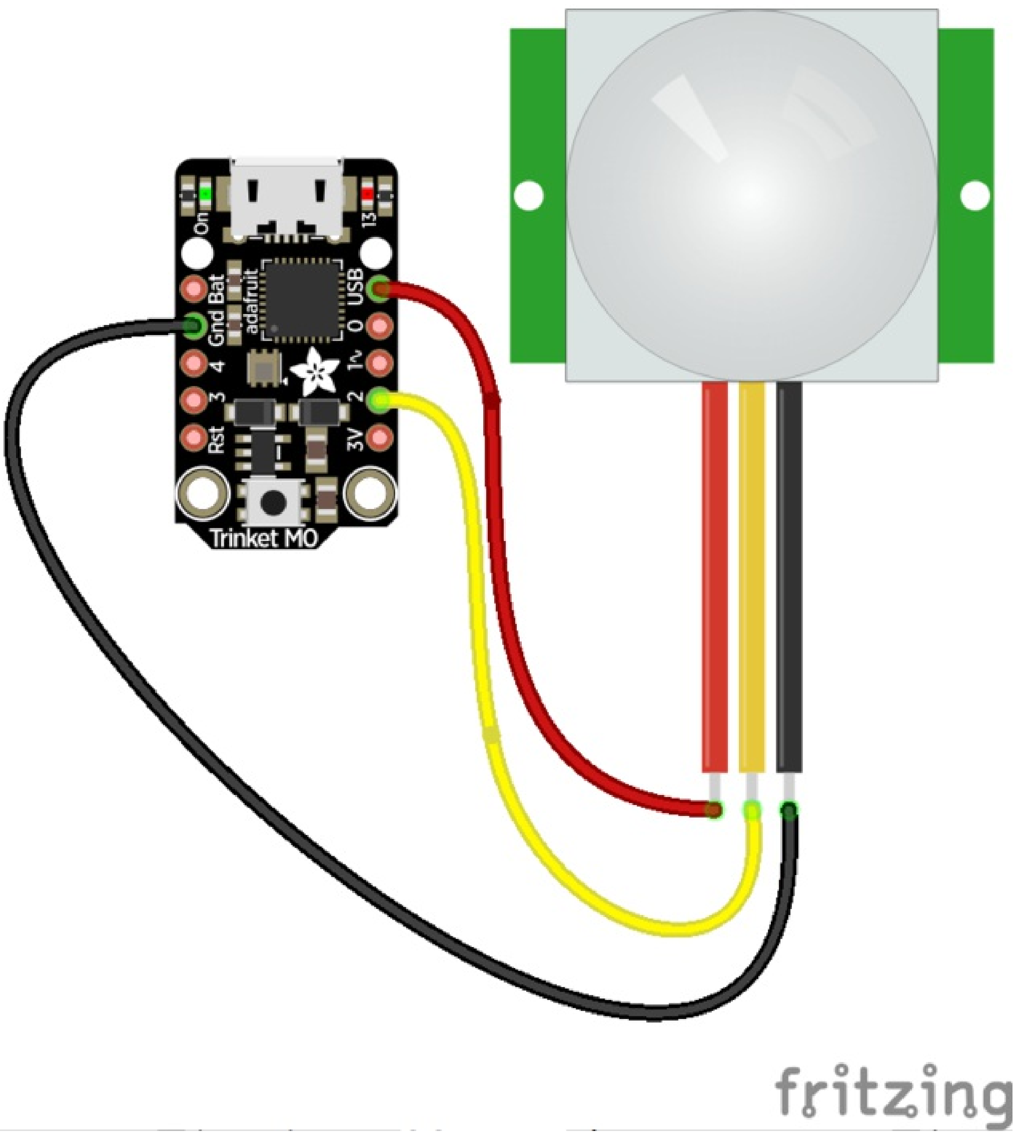
```
/*
 * PIR sensor tester
 */

int ledPin = 13;                // choose the pin for the LED
int inputPin = 2;               // choose the input pin (for PIR sensor)
int pirState = LOW;             // we start, assuming no motion detected
int val = 0;                    // variable for reading the pin status

void setup() {
  pinMode(ledPin, OUTPUT);      // declare LED as output
  pinMode(inputPin, INPUT);     // declare sensor as input

  Serial.begin(9600);
}

void loop(){
  val = digitalRead(inputPin);  // read input value
  if (val == HIGH) {            // check if the input is HIGH
    digitalWrite(ledPin, HIGH);  // turn LED ON
    if (pirState == LOW) {
      // we have just turned on
      Serial.println("Motion detected!");
      // We only want to print on the output change, not state
      pirState = HIGH;
    }
  } else {
    digitalWrite(ledPin, LOW); // turn LED OFF
    if (pirState == HIGH){
      // we have just turned of
      Serial.println("Motion ended!");
      // We only want to print on the output change, not state
      pirState = LOW;
    }
  }
}
```

Don't forget that there are some times when you don't need a microcontroller. A PIR sensor can be connected to a relay (perhaps with a transistor buffer) without a micro!

CircuitPython Code

It's easy to use a PIR sensor with CircuitPython using simple digital inputs. The PIR sensor looks and acts kind of like a button or switch, i.e. it's only ever a high or low logic level, so you don't need any special libraries or other code to read one from Python. It will help to familiarize yourself with CircuitPython digital inputs and outputs (https://adafru.it/BBl) before continuing though!

First make sure your PIR sensor is wired to your board as shown in the previous page. There's no difference wiring a PIR sensor to an Arduino vs. CircuitPython board. You must connect the power, ground, and sensor output to your board. The sensor output should be connected to any digital I/O line on your board. In this example we'll use pin D2 on a Trinket M0.



https://adafru.it/A0n

https://adafru.it/A0n

Next connect to the board's serial REPL (https://adafru.it/pMf) so you are at the CircuitPython >>> prompt.

Run the following code to import the **board** and **digitalio** modules which lets you read digital inputs:

```
import board
import digitalio
```

Then create a simple digital input for the PIR. Remember to use the right board pin for how you've wired your sensor to your board. This example is using pin D2 on a Trinket M0:

```
pir = digitalio.DigitalInOut(board.D2)
pir.direction = digitalio.Direction.INPUT
```

At this point you can read the state of the sensor by reading the value property. If the value is at a low logic level, or False, the sensor sees no movement. If it's at a high logic level, or True, the sensor is detecting movement!

Note you'll likely want the sensor's jumper in the H position for retriggering mode as mentioned on the previous page.

For example with no movement in front of the sensor you might see:

```
pir.value
```

Then wave your hand in front of the sensor, and as you wave it run the same command again. Notice you get a True result!

```
pir.value
```

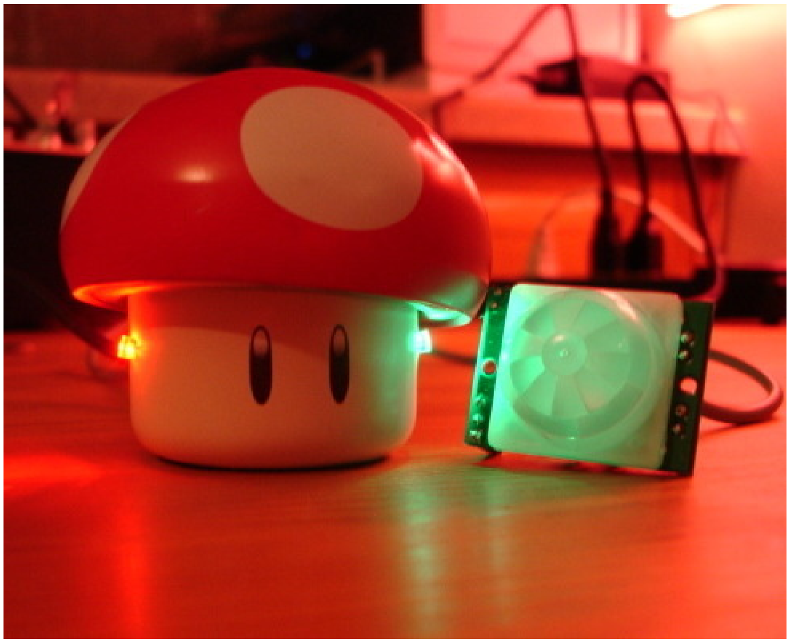
That's all there is to using a PIR sensor with CircuitPython!

Here's a complete example just like from the previous page where movement from the PIR sensor will turn on the board's LED and print a message. This is a direct port of the previous page's Arduino example to CircuitPython. Try saving it as a **main.py** on your board and connecting to the serial terminal to see the output as it runs! (be sure to change the board pin numbers to your sensor and LED wiring!)

```
import board
import digitalio

LED_PIN = board.D13  # Pin number for the board's built in LED.
PIR_PIN = board.D2   # Pin number connected to PIR sensor output wire.

# Setup digital input for PIR sensor:
pir = digitalio.DigitalInOut(PIR_PIN)
pir.direction = digitalio.Direction.INPUT

# Setup digital output for LED:
led = digitalio.DigitalInOut(LED_PIN)
led.direction = digitalio.Direction.OUTPUT

# Main loop that will run forever:
old_value = pir.value
while True:
    pir_value = pir.value
    if pir_value:
        # PIR is detecting movement! Turn on LED.
        led.value = True
        # Check if this is the first time movement was
        # detected and print a message!
        if not old_value:
            print('Motion detected!')
    else:
        # PIR is not detecting movement. Turn off LED.
        led.value = False
        # Again check if this is the first time movement
        # stopped and print a message.
        if old_value:
            print('Motion ended!')
    old_value = pir_value
```

Example Projects

A simple room greeter that plays the super mario brothers theme music when triggered by a PIR in a hacked airwick freshener unit.

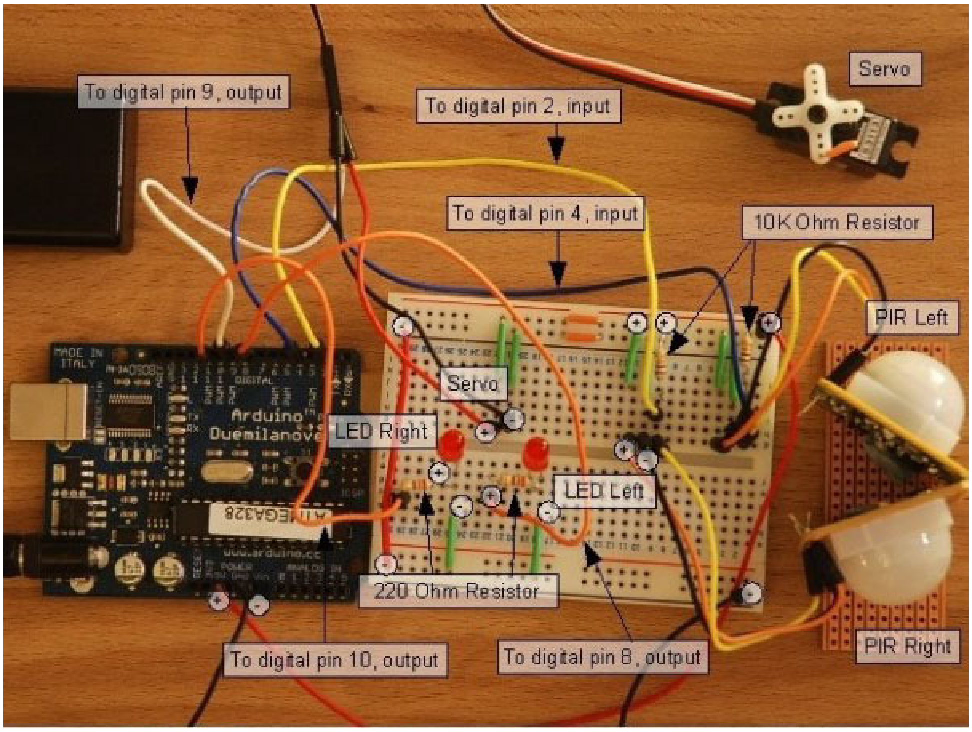


A USB-powered singing and blinking Mario mushroom (there's a video on the site!)(https://adafru.it/aKx)

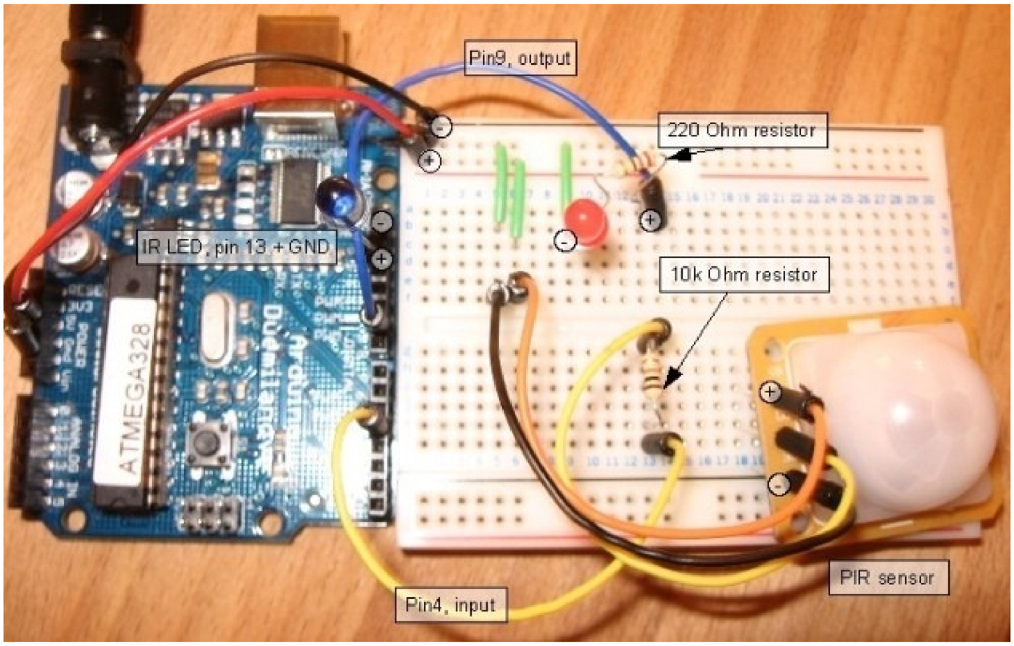
Rain Umbrellas (https://adafru.it/aKy)

A home-made security system using PIR sensors (which is built into a Start Trek panel!)

PIR sensor + Arduino + Servo = automatic cat door!



A 2-PIR motion tracker (https://adafru.it/aKz) by Lucky Larry



A PIR-based remote camera trigger (also by Lucky Larry!) (https://adafru.it/aKA)

An interesting hack whereby the PIR sensor is used 'raw' to track movement.

Buy a PIR Motion Sensor

Buy a PIR Motion Sensor (http://adafru.it/189)

PS-601250
PS 12V/5A enclosed switch mode power supply

Edition: 9 from 27.05.2014
Supercedes edition: 8 from 07.03.2013

EN

Features of the power supply unit:

- power output 5A/12÷15VDC*
- universal AC input voltage range 85÷264V
- high efficiency 80%
- LED optical signalisation
- protections:
  - SCP short-circuit protection
  - overvoltage OVP
  - overvoltage protection
  - overload (OLP)
- warranty – 2 year from the production date

1. Technical description.

1.1.General description.

The power supply unit is intended for the feeding of alarm system equipments, which require 12V DC supply voltage and current load **I=5A**. The design enables simple changing of the output voltage, within the range of 12V÷15V DC, using a potentiometer. The power supply unit is protected against short-circuit, overload and overvoltage.

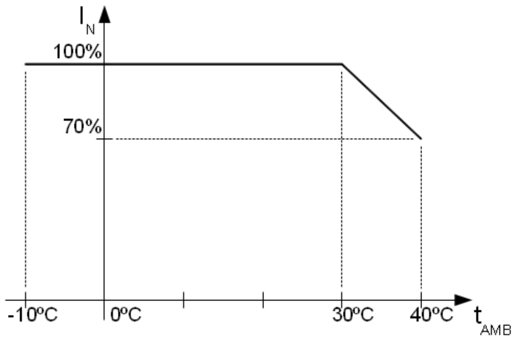
1.2. Technical parameters.

Supply voltage	85 ÷ 264 V AC, 120 ÷ 370 V DC
Current consumption	0,6A@230VAC max.
Supply power	60W max.
Efficiency	80%
Output voltage	12V DC
Output current t_{AMB}<30°C	**5A - see graph 1.**
Output current t_{AMB}=40°C	**3,5 A - see graph 1.**
Voltage adjustment range	12 V ÷ 15V DC
Ripple voltage	100mV p-p max.
Short-circuit protection SCP	electronic, automatic recovery
Overload protection OLP	105-150% of power supply, automatic recovery
Surge protection	varistors
Overvoltage protection OVP	>16V (automatic return)
Optical signalisation	green LED – presence of DC voltage
Operation conditions	2-nd enviromental class, temperature: -10 °C÷40 °C relative humidity 20%...90%, without condensation
Dimensions (LxWxH)	159 x 97 x 38 [mm]
Net/gross weight	0,48kg / 0,51kg
Protection class PN-EN 60950-1:2007	I (first) – requires a protective conductor (PE)
Connectors	power-supply:Φ0,63-2,50 (AWG 22-10) outputs : Φ0,63-2,50 (AWG 22-10)
Electrical strength of insulation: - between input (network) circuit and output circuits of power-supply (I/PO/P) - between input circuit and PE protection circuit (I/P-FG) - between output circuit and PE protection circuit (O/P-FG)	 3000 V/AC min. 1500 V/AC min. 500 V/AC min.
Insulation resistance: - between input circuit and output or protection circuit	 100 MΩ, 500V/DC
Storage temperature	-20ºC...+60ºC
Vibrations and impulse waves during transport	according to PN-83/T-42106

* In order to extend the life of the power supply, the load current of 3,5A is recommended.

* See graph 1.

1.3. Output current vs temperature.



Graph 1.
Allowable output current from the power supply depending on ambient temperature (instantaneous load).

2. Installation.

2.1. Requirements.

The power supply shall be mounted by the qualified installer having appropriate (required and necessary for a given country) permissions and qualifications for connecting (operating) low-voltage installations. The unit shall be mounted in closed rooms, according to the environment class II, of the normal air humidity (RH=90% max. without condensation) and the temperature within the range from -10°C to +40°C.

The power supply shall be mounted in a close casing (a cubicle, a terminal device) and in order to fulfill LVD and EMC requirements the rules for power-supply, encasing and shielding shall be observed according to application.

Due to the power supply design, the PE wire has to be connected to the corresponding connector of the supply unit. Operation without proper grounding of the power supply is not allowed!

2.2. Installation procedure.

1. Prior to installation of the power supply unit, make sure that power leads have been disconnected from the 230VAC mains.
2. Install the unit in the previously selected place.
3. Connect the 230VAC power leads. Connect the PE cable (yellow-green) to an appropriate terminal on the power supply unit (marked with ⏚).

The circuit of the shock protection shall be performed with a particular care, i.e. the yellow and green protection wire of the power cable shall be connected from one side to the terminal marked by the symbol of ⏚ in the casing of the power-supply. Operation of the power-supply without the properly made and fully operational circuit of the shock protection is
UNACCEPTABLE!
It can result in failure of devices and electric shock.

---

4. Connect load/loads to proper output connectors of the power supply (positive end is marked as +V, negative end as -V).
5. Upon the completion of tests and trial activation, close the housing, cabinet etc.

2.3. Description of terminal.

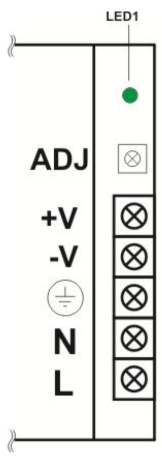


Fig.1. Description of terminal.

Elements/connectors [Fig.1]	Description
L, N, ⏚	**L-N** - input voltage connectors 230 V AC, ⏚– protective conductor connector
-V	Power supply output (0V)
+V	Power supply output (+12V)
LED1	LED signals the presence of voltage at the unit's output
ADJ	Potentiometer - output voltage adjust

2.4. Dimensions and fitting of the PS-601250 power supply.

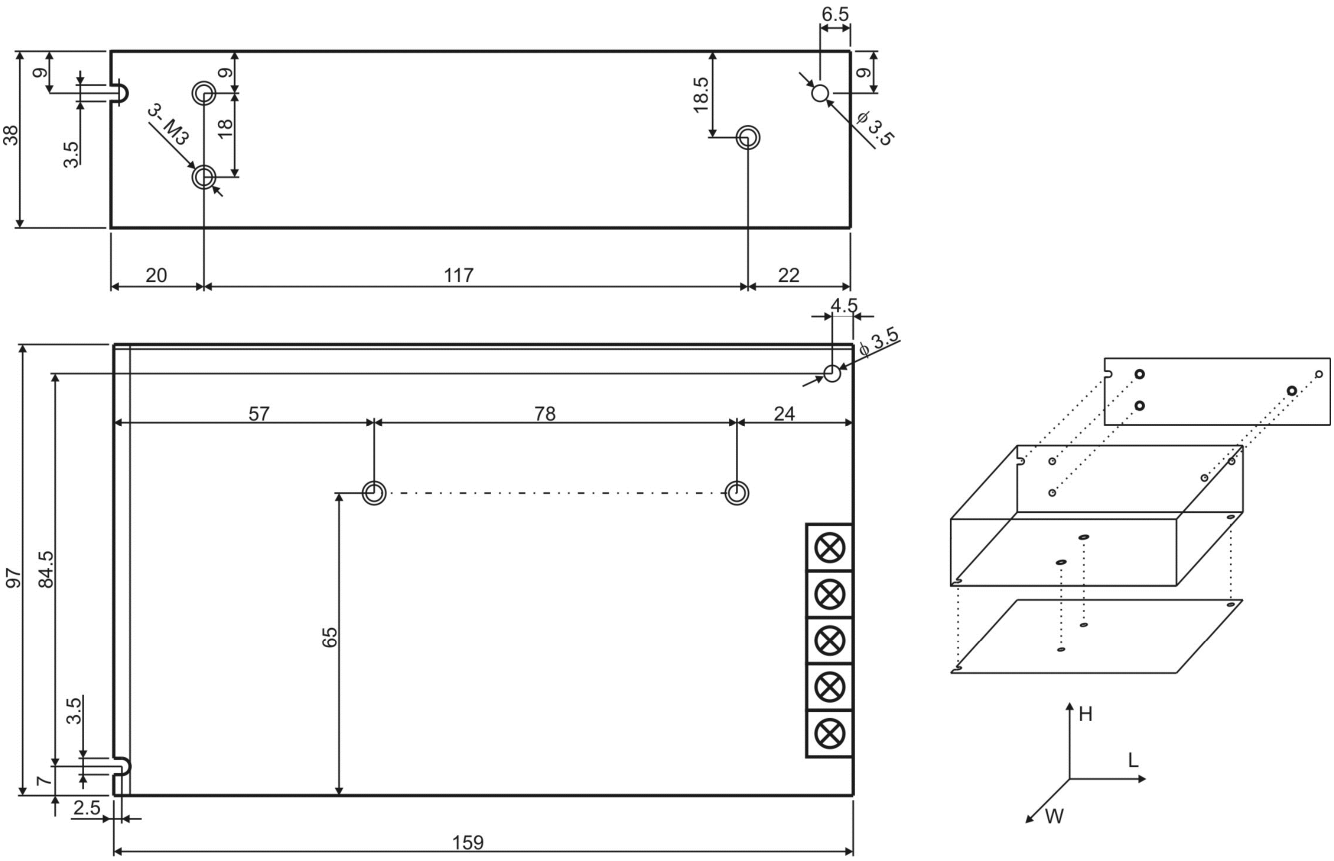


Fig.2. Dimensions of power supply.

3. Maintenance.

All maintenance procedures can be performed after the disconnection of the power supply from the electrical grid. The power supply does not require any special maintenance procedures, but in the case of significant dust accumulation, dusting using compressed air is recommended.

WEEE designation

The waste electric and electronic equipment worn out may not be disposed of together with standard household waste. According to the WEEE directive, applicable in the EU, the separate neutralization methods should be used for electric and electronic equipment.

GENERAL WARRANTY CONDITIONS

1. Pulsar K. Bogusz Sp.j. (the manufacturer) grants a two-year warranty for the equipment, , counted from the device's production date.
2. The warranty includes free-of-charge repair or replacement with an appropriate equivalent (the selection is at the manufacturer's discretion) if the malfunction is due to the manufacturer, includes manufacturing or material defects, unless such defects have been reported within the warranty period (item 1).
3. The equipment subject to warranty is to be brought to the place where it was purchased, or directly to the main office of the manufacturer.
4. The warranty applies to complete equipment, accompanied by a properly filled warranty claim with a description of the defect.
5. Should the claim be accepted, the manufacturer is obliged to provide warranty repairs, at the earliest convenienve, however not later that within 14 days from the delivery to the service centre of the manufacturer.
6. The repair period mentioned in item 5 may be prolonged, if there are no technical possibilities to carry out the repairs, or if the equipment has been conditionally accepted, due to the breaking warranty terms by the claimant.
7. All the services rendered by force of the warranty arecarried out at the service centre of the manufacturer, exclusively.
8. The warranty does not cover the defects of the equipment, resulting from:
- reasons beyond the manufacturer's control,
- mechanical damage,
- improper storage and transport,
- use that violates the operation manual or equipment's intended use
- fortuitous events, including lightning discharges, power failures, fire, flood, high temperatures and chemical agents,
- improper installation and configuration (in defiance with the manual),
9. The warranty is void in any of the following circumstances:
- construction changes
- repairs carried out by any unauthorized service center
- damage or removal of warranty labels
- modifications of the serial number
10. The liability of the manufacturer towards the buyer is limited to the value of the equipment, determined according to the wholesale prices suggested by the manufacturer on the day of purchase.
11. The manufacturer takes no reponsibility for the defects that result from:
- the damaging, malfunctioning or inability to operate the equipment
- defects that result from using the equipment outside its stated specifications and operating parameters failing to abide by the recommendations and requirements contained in the manual, or the use of the equipment.

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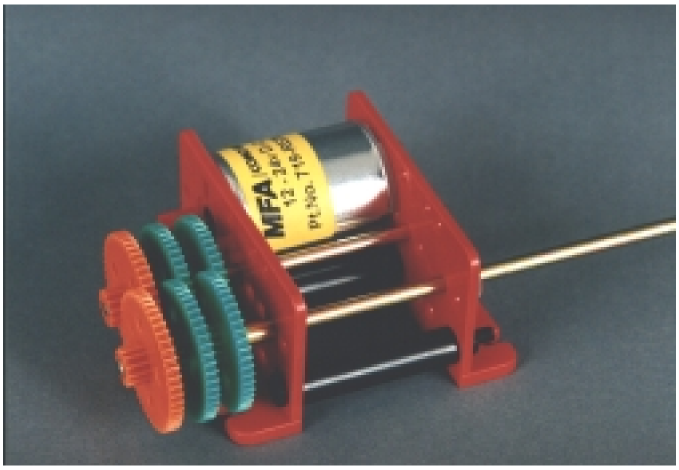
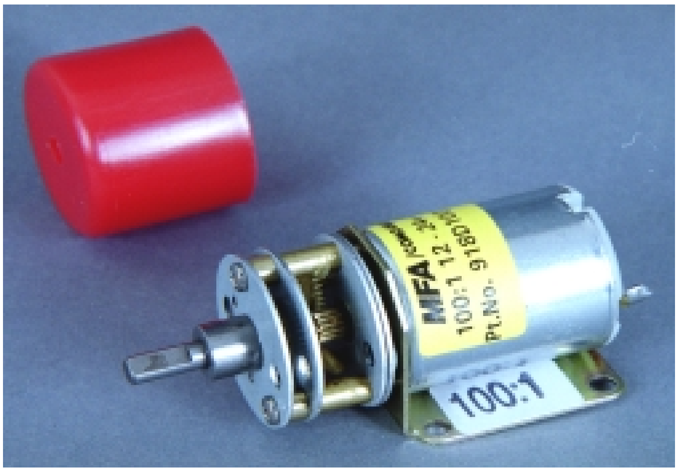
e-mail: biuro@pulsar.pl, sales@pulsar.pl
http:// www.pulsar.pl, www.zasilacze.pl

LOW VOLTAGE D.C. MOTORS & GEARBOX UNITS





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MFA/COMO DRILLS

918D SERIES SINGLE RATIO METAL GEARBOX (RE280 MOTOR/RE 280/1 MOTOR)

NEW!

WITH 2mm OUTPUT SHAFT (15:1 ONLY)

WITH 4mm OUTPUT SHAFT (ALL RATIOS)

RATIOS NOW AVAILABLE AS EX-STOCK ITEMS.

918D151 (1.5v - 3v) WITH RE 280 MOTOR (RATIO 15:1). 2mm SHAFT

918D151/1 (1.5v - 3v) WITH RE 280 MOTOR (RATIO 15:1). 4mm SHAFT
918D301/1 (1.5v - 3v) WITH RE 280 MOTOR (RATIO 30:1). 4mm SHAFT
918D1001/1 (1.5v - 3v) WITH RE 280 MOTOR (RATIO 100:1). 4mm SHAFT

918D15112 (12v - 24v) WITH RE 280/1 MOTOR (RATIO 15:1). 2mm SHAFT

918D15112/1 (12v - 24v) WITH RE 280/1 MOTOR (RATIO 15:1). 4mm SHAFT
918D30112/1 (12v - 24v) WITH RE 280/1 MOTOR (RATIO 30:1). 4mm SHAFT
918D100112/1 (12v - 24v) WITH RE 280/1 MOTOR (RATIO 100:1). 4mm SHAFT

This miniature gearbox is of steel and brass construction with brass gears and is mounted on a 1mm thickness steel bracket. It incorporates a high quality three pole motor with sintered-bronze bearings. The design and construction of the unit make it suitable for a host of model and light industrial applications.

MOTOR DATA. (RE-280 & RE-280/1)

MODEL	VOLTAGE		NO LOAD		AT MAXIMUM EFFICIENCY						STALL TORQUE	
	OPERATING RANGE	NOMINAL	SPEED	CURRENT	SPEED	CURRENT	TORQUE		OUTPUT	EFF		
			R.P.M.	A	R.P.M.	A	oz - in	g - cm	W	%	oz - in	g - cm
RE - 280	1.5 - 3 .0	1.5v CONSTANT	4600	0.120	3750	0.53	0.160	11.53	0.44	56.2	0.86	62.0
RE - 280	1.5 - 3.0	3.0v CONSTANT	9200	0.155	7800	0.85	0.278	20.00	1.60	62.3	1.81	130.0
RE - 280/1	12 - 24	12v CONSTANT	8400	0.10	6300	0.30	0.347	25.0	1.62	44.87	1.389	100

REDUCTION TABLE. R.P.M.

SUPPLY VOLTAGE	1.5v	3.0v	6v	12v	18v	24v
918D151	306	613				
918D15112			280	560	840	1120
918D301	153	306				
918D30112			140	280	420	560
918D1001	46	92				
918D100112			42	84	126	168

WEIGHT	
918D151	72g
918D15112	72g
918D301	72g
918D30112	72g
918D1001	72g
918D100112	72g

TORQUE TABLE (g.cm). (Theoretical rating for motor & gearbox combined).

	AT MAXIMUM EFFICIENCY			STALL TORQUE		
	1.5V	3V	12V	1.5V	3V	12V
RE 280 (15:1)	173	300		930	1950	
RE 280/1 (15:1)			375			1500
RE 280 (30:1)	346	600		1860	3900	
RE 280/1 (30:1)			750			3000
RE 280 (100:1)	1153	2000		6200	13000	
RE 280/1 (100:1)			2500			10000

IMPORTANT NOTICE
Due to the wide range of applications for this product it is the users responsibility to establish the products suitability for their individual purpose(s).

NOTE: To establish Torque Rating in nM divide g.cm by 10,197.0

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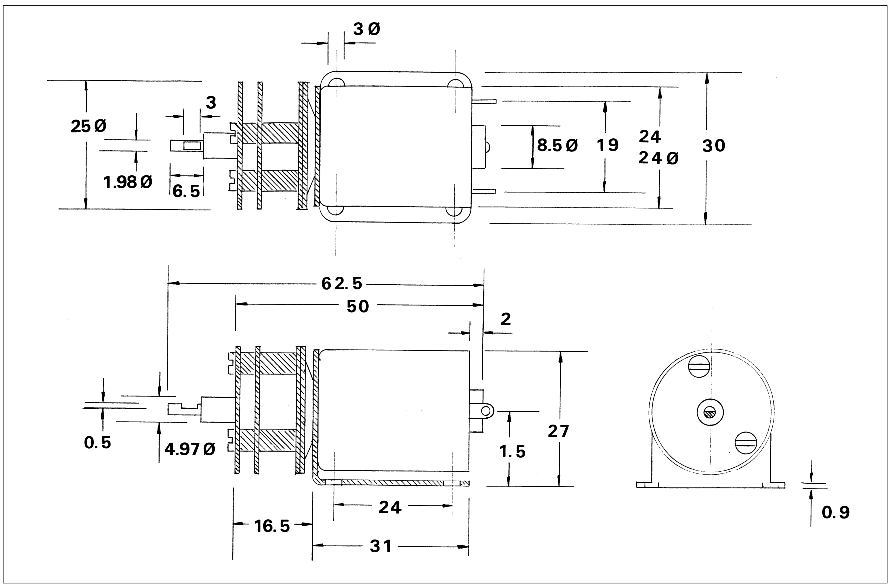
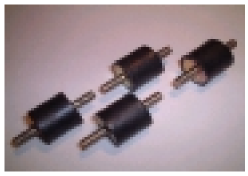
918D SERIES SINGLE RATIO METAL GEARBOX

GEARBOX DIMENSIONS.

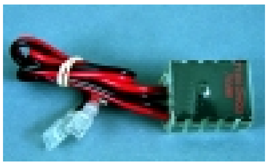




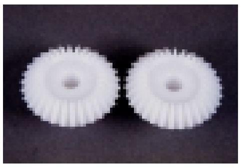
Part No. 1071. Anti vibration mount. M3

Part No. 918D8. Steel Shaft. 4mm OD x 150mm

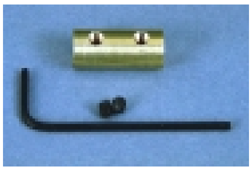
ACCESSORIES FOR 918D SERIES GEARBOX.



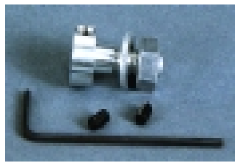
Part No. 917D9. Voltage Regulator. (6-15v DC Input, 3v, 1.5amp output)
Part No. 917D10. Voltage Regulator. (6-15v DC Input. 1.5v, 1.5amp output)
Part No. 917D11. Voltage Regulator. (6-15v DC Input. 4.5v, 1.5amp output)
(Above for 280 motor only)



Part No. 918D7. Nylon Bevel Gears (1:1). O.D. 17.2mm. 4mm I.D.

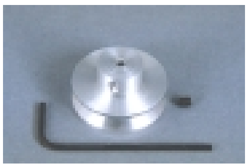


Part No. 918D1. In-Line Coupling. 2mm - 3mm. (Dia. 8mm x 18.4mm)
Part No. 918D1/1. In-Line Coupling 4mm - 4mm. (Dia. 8mm x 18.4mm)

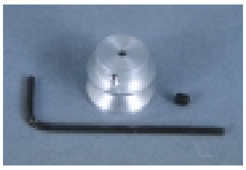


Part No. 918D4. Gear Adapter. 2mm I.D.
Part No. 918D4/1 Gear Adapter. 4mm I.D.

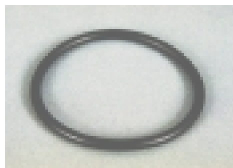
Part No. 917D2458. Pinions (Plastic) 12 tooth. 1.9mm I.D.



Part No. 918D2. Pulley. 2mm I.D. (25mm dia. x 14.75mm) (Aluminium)
Part No. 918D2/1. Pulley 4mm I.D. (25mm dia. x 14.75mm) (Aluminium)



Part No. 918D3. Pulley. 2mm I.D. (16mm dia. x 13.6mm) (Aluminium)
Part No. 918D3/1. Pulley 4mm I.D. (16mm dia x 13.6mm((Aluminium)



Part No. 917D2515. "O" Ring 70mm x 5mm Dia.

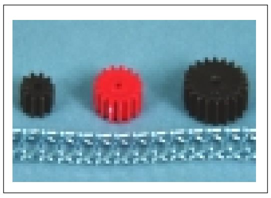
Subject to minimum order quantities of 250 units, the following ratios are also available with a six week lead-time. The physical dimensions of these other gearboxes may vary from the data as illustrated above. Details of individual gearboxes are available upon request.

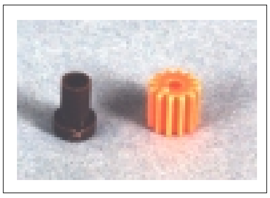
GEARBOX 21:1 with RE280 motor (1.5v - 3v)	GEARBOX 21:1 with RE280/1 motor (12v - 24v)
GEARBOX 44:1 with RE280 motor (1.5v - 3v)	GEARBOX 44:1 with RE280/1 motor (12v - 24v)
GEARBOX 60:1 with RE280 motor (1.5v - 3v)	GEARBOX 60:1 with RE280/1 motor (12v - 24v)
GEARBOX 112:1 with RE280 motor (1.5v - 3v)	GEARBOX 112:1 with RE280/1 motor (12v - 24v)
GEARBOX 150:1 with RE280 motor (1.5v - 3v)	GEARBOX 150:1 with RE280/1 motor (12v - 24v)
GEARBOX 200:1 with RE280 motor (1.5v - 3v)	GEARBOX 200:1 with RE280/1 motor (12v - 24v)
GEARBOX 250:1 with RE280 motor (1.5v - 3v)	GEARBOX 250:1 with RE280/1 motor (12v - 24v)
GEARBOX 320:1 with RE280 motor (1.5v - 3v)	GEARBOX 320:1 with RE280/1 motor (12v - 24v)
GEARBOX 360:1 with RE 280 motor (1.5v - 3v)	GEARBOX 360:1 with RE280/1 motor (12v - 24v)
GEARBOX 1024:1 with RE 280 motor (1.5v - 3v)	GEARBOX 1024:1 with RE 280/1 motor (12v - 24v)

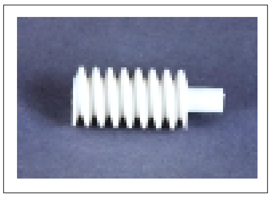
MFA/COMO DRILLS

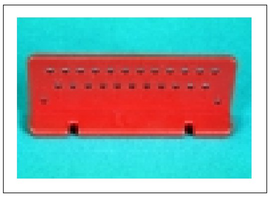
MULTI RATIO GEARBOX

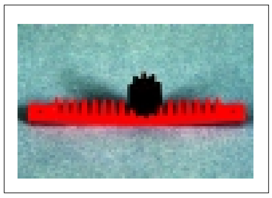
MULTI RATIO GEARBOX ACCESSORIES. (917D, 917D/A, 920D, 920D/A, 927D, 927D/A.)

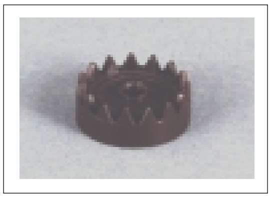

Pt.No.917D2401,2402,2403 2404,2449/1

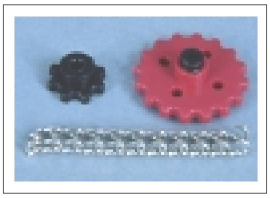

Pt.No.917D2417,2458

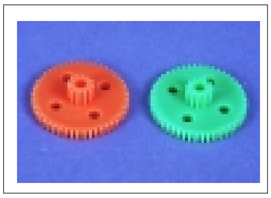

Pt.No.917D2420

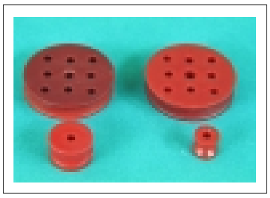

Pt.No. 917D2425

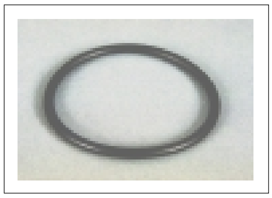

Pt.No. 917D2401
Pt.No. 917D2430
(Set: 917D/1)


Pt.No. 917D2440


Pt.No.917D2445,2446,2449


Pt.No.917D2452,2456


Pt.No.917D2460,2461,2462,2463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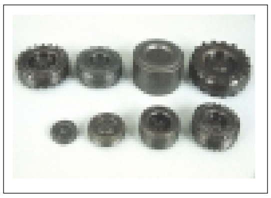
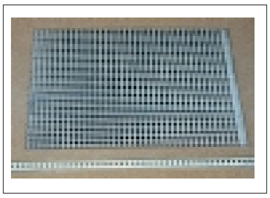
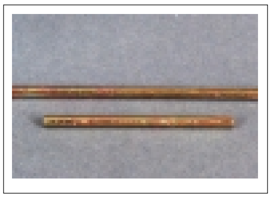
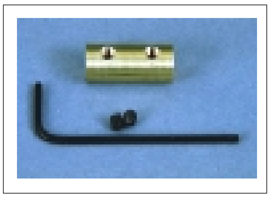
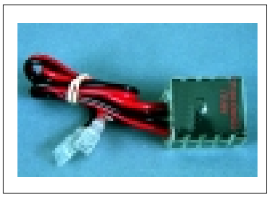

Pt.No.917D2501,2502,2504, 2505,2506,2507,2509, 2513


Pt.No.917D2531,2540


Pt.No.917D2551,2553


Pt.No. 917D8


Pt.No.917D9,D10,D11

Part No. 917D8.	Inline Coupling. 3mm - 3mm. (7.9mm x 20mm)
Part No. 917D9.	Voltage regulator. 6-15v DC Input.3v1.5amp output. (31mm x 26mm x 15.5mm)
Part No. 917D10.	Voltage regulator.6-15v DC Input. 1.5v,1.5amp output. (31mm x 26mm x 15.5mm)
Part No. 917D11.	Voltage regulator. 6-15v DC Input. 4.5v,1.5amp output. (31mm x 26mm x 15.5mm)
Part No. 917D2401.	Gear. 10 tooth. 2.9mm bore. (Dia. 11.2mm x 5.8mm)(pkt 10)
Part No. 917D2402	Gear. 15 tooth. 2.9mm bore. (Dia. 16.2mm x 5.8mm)(pkt 10)
Part No. 917D2403.	Gear. 20 tooth. 2.9mm bore. (Dia. 22mm x 6.3mm)(pkt 10)
Part No. 917D2404.	Gear. 40 tooth. 2.9mm bore. (Dia. 41.3mm x 6.3mm)(pkt 10)
Part No. 917D2415.	Stop Rings.(pkt 10)
Part No. 917D2417.	Micro-Switch operating pins. (Dia. 3.9mm/5.7mm x 8mm)(pkt 10)
Part No. 917D2420.	Worm Drive. (Dia. 11.94mm x 32mm)(pkt 10)
Part No. 917D2425.	Custom gearbox bracket. (69.8mm x 27.9mm x 2.0mm)(pkt 2)
Part No. 917D2426.	Gearbox Brackets. (52.8mm x 30.0mm x 2.0mm)(pkt 2)
Part No. 917D2430.	Rack. (70.5mm x 4.7mm x 5.13mm)(pkt 10)
Part No. 917D2440.	Crown Gear. (OD 16.4mm x 6.9mm high)(pkt 10)
Part No. 917D2445.	Chain Sprocket. 8 tooth 2.9mm bore. (OD 13.9mm)(pkt 10)
Part No. 917D2446.	Chain Sprocket.16 tooth 2.9mm bore. (OD 26.7mm)(pkt 10)
Part No. 917D2449.	Chain in 1m length approx. (7.1mm wide) For gears 917D2445, 2446.
Part No. 917D2449/1	Chain in 1m length approx. (10.8mm Wide) For gears 917D2401,2402, 2403 & 2404.
Part No. 917D2452.	Double Gear. 48/12. 2.9mm bore. (OD24.57mm/OD6.72mm)(pkt 10
Part No. 917D2456.	Double Gear. 48/12. 3.1mm bore. (OD24.57mm/OD6.72mm)(pkt 10
Part No. 917D2458.	Pinion. 12 tooth (for motor) 1.9mm Bore. (OD6.92mm)(pkt 10)
Part No. 917D2460.	Pulley. 14/10mm dia. 2.9mm bore.(pkt 10)
Part No. 917D2461.	Pulley. 30/25mm dia. 2.9mm bore.(pkt 10)
Part No. 917D2462.	Pulley. 30/25mm dia. 3.9mm bore with brass sleeve.(pkt 10)
Part No. 917D2463.	Pulley. 8/5.5m dia. 2.9mm bore. (pkt 10)
Part No. 917D2501.	Robotic Wheels - 25mm x 10mm. 2.6mm bore.(pkt 4)
Part No. 917D2502.	Robotic Wheels - 35mm x 7mm. 2.6mm bore.(pkt 4)
Part No. 917D2504.	Robotic Wheels - 51mm x 16mm. 2.6mm bore.(pkt 4)
Part No. 917D2505.	Robotic Wheels - 68mm x 20mm. 3.5mm bore.
Part No. 917D2506.	Robotic Wheels - 37mm x 16mm. 2.6mm bore.(pkt 4)
Part No. 917D2507.	Robotic Wheels - 44mm x 16mm. 2.6mm bore.(pkt 4)
Part No. 917D2509.	Robotic Wheels - 56mm x 16mm. 2.6mm bore.(pkt 4)
Part No. 917D2513.	Robotic Wheels - 54mm x 30mm. 2.6mm bore.
Part No. 917D2515.	'O' Ring 70mm x 5mm dia.
Part No. 917D2531.	Perforated Metal Strip. (305mm x 8.75mm x 0.5mm)(pkt 5)
Part No. 917D2540.	Perforated Metal Sheet. (200mm x 110mm x 0.6mm)
Part No. 917D2551.	Shaft 3mm dia (long for output). (3mm x 110mm)(pkt 10)
Part No. 917D2553.	Shaft 3mm dia (short for intermediate). (3mm x 60mm)(pkt 10)
Part No. 917D2682.	Spacers (25mm).(pkt 10)
Part No. 917D2683.	Spacers (30mm).(pkt 10)

RACK & PINION SET. PT.NO. 917D/1.
Consisting of: 1 Rack (917D2430), 1 Pinion (917D2401) and Mounting Screws.

GEAR SET. PT.NO. 917D/2.
Consisting of:4 gears(917D2456),2 gears (917D2452) and 1 Pinion (917D2458).

CHAIN & SPROCKET SET. PT.NO. 917D/3.
Consisting of:2 Sprockets(917D2445),2 Sprockets(917D2446) & 1m approx Chain(917D2449)

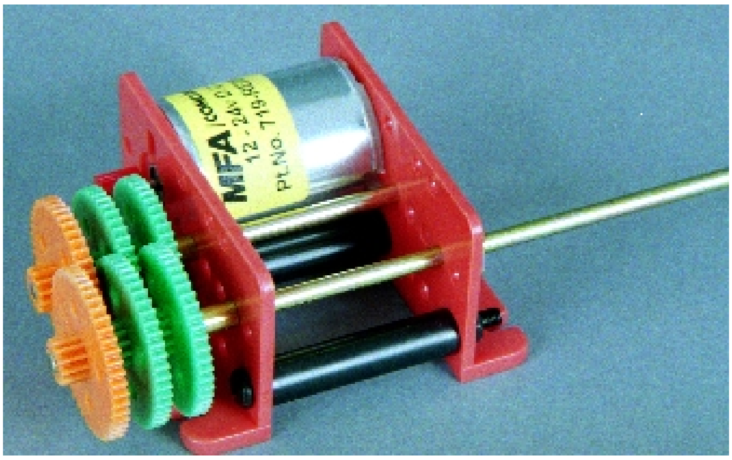
WORM DRIVE SET. PT.NO. 917D/4.
Consisting of:1 Worm drive(917D2420),& 1 Spur Gear(917D2404).

CROWN WHEEL & PINION SET. PT.NO. 917D/5.
Consisting of: 1 Crown Wheel (917D2440) & 1 Pinion (917D2401).

SPUR GEAR SET. PT.NO. 917D/6.
Consisting of: 1 each Spur Gear (917D2403, 917D2401 & 917D2404).

PULLEY SET. PT. NO. 917D/7.
Consisting of: 1 each of Pulley (917D2460, 917D2461, 917D2462, 917D2463) Micro Switch operating Pin. (917D2417), & "O" Ring (917D2515).

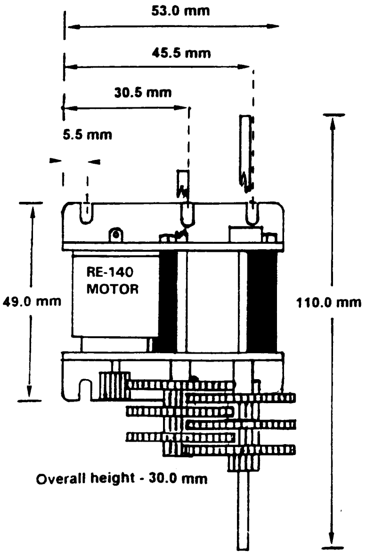
MULTI RATIO GEARBOX



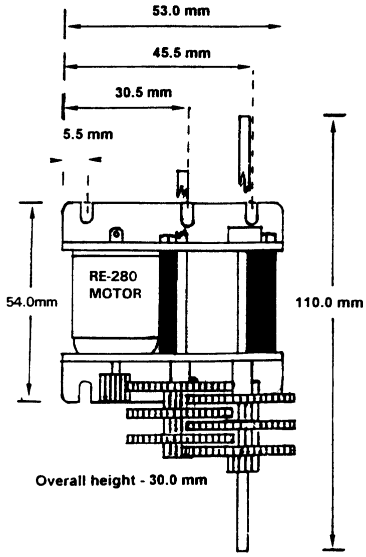
MULTI RATIO GEARBOX

917D KIT FORM (RE 140 MOTOR)
917D/A ASSEMBLED VERSION (RE 140 MOTOR)
920D KIT FORM (RE 280 MOTOR)
920D/A ASSEMBLED VERSION (RE 280 MOTOR)
927D KIT FORM (RE 280/1 MOTOR)
927D/A ASSEMBLED VERSION (RE 280/1 MOTOR)

GEARBOX DIMENSIONS.
(917D)



(920D & 927D)



***PROVIDES 6 DIFFERENT RATIOS AND 18 SPEEDS.* RUGGED AND COMPACT DESIGN AND CONSTRUCTION.* IDEAL FOR MODELS, CDT (CRAFT,DESIGN AND TECHNOLOGY) PROJECTS.* OPERATES FROM 1.5 - 3v (RE140 &, WITH THE HIGHER TORQUE MOTOR,RE280) AND 12 - 24v (RE280/1) D.C.SUPPLIES. * EXTENSIVE RANGE OF ACCESSORIES AVAILABLE.**

The unit operates on 1.5 - 3v (917D & 917D/A, also with higher torque motor 920D & 920D/A), or 12-24v (927D & 927D/A) D.C. power sources, either battery or suitable transformer. Its simple versatile design and sturdy construction make it suitable for a host of uses from powering models and robots to teaching the principles of mechanics. Current consumption depends on eventual load but is within the range 0.2 to 0.8n amps. The output shaft is 3mm diameter.

WEIGHT	
917D	54g
920D	76g
927D	76g

IMPORTANT NOTICE
Due to the wide range of applications for this product it is the users responsibility to establish the products suitability for their individual purpose(s).

MOTOR DATA. (RE-140, RE-280 & RE-280/1)

MODEL	VOLTAGE		NO LOAD		AT MAXIMUM EFFICIENCY						STALL TORQUE	
	OPERATING RANGE	NOMINAL	SPEED R.P.M.	CURRENT A	SPEED R.P.M.	CURRENT A	TORQUE oz - in	TORQUE g - cm	OUTPUT W	EFF %	oz - in	g - cm
RE - 140	1.5 - 3.0	3.0v CONSTANT	14800	0.300	11500	1.05	0.152	10.92	1.29	41.03	0.68	49.0
RE - 280	1.5 - 3.0	1.5v CONSTANT	4600	0.120	3750	0.53	0.160	11.53	0.44	56.20	0.86	62.0
RE - 280	1.5 - 3.0	3.0v CONSTANT	9200	0.155	7800	0.85	0.278	20.00	1.60	62.30	1.81	130.0
RE - 280/1	12 - 24	12V CONSTANT	8400	0.100	6300	0.30	0.347	25.00	1.62	44.87	1.389	100.0

REDUCTION TABLE R.P.M. (917D)

	1.5V	3.0V
4:1	1850	3700
16:1	462	925
64:1	115	231
256:1	29	57
1024:1	7	14
4096:1	2	4

REDUCTION TABLE R.P.M. (920D)

	1.5V	3.0V
4:1	1150	2300
16.1	287	575
64.1	72	144
256:1	18	36
1024:1	4	9
4096:1	1	2

REDUCTION TABLE R.P.M. (927D)

	12V	15V	18V	24V
4:1	2100	2625	3150	4199
16:1	525	656	787	1050
64:1	131	164	196	261
256:1	33	42	50	67
1024:1	8	10	12	16
4096:1	2	2	3	4

MFA/COMO DRILLS FELDERLAND LANE. WORTH. DEAL. KENT. CT14 OBT
TEL: 01304 612132. FAX: 01304 614696
E-MAIL: MFA_COMO_DRILLS@COMPUSERVE.COM. www.comodrills.com

919D SERIES SINGLE RATIO METAL GEARBOX (RE 540/1 MOTOR)

IMPORTANT NOTICE
Due to the wide range of applications for this product it is the users responsibility to establish the products suitability for their individual purpose(s).

RATIOS NOW AVAILABLE AS EX-STOCK ITEMS.

NEW!	919D2.51	(4.5v - 15v)	WITH RE 540/1 MOTOR.	RATIO 2.5:1
	919D61	(4.5v - 15v)	WITH RE 540/1 MOTOR.	RATIO 6:1
	919D111	(4.5v - 15v)	WITH RE 540/1 MOTOR.	RATIO 11:1
	919D501	(4.5v - 15v)	WITH RE 540/1 MOTOR.	RATIO 50:1
	919D1481	(4.5v - 15v)	WITH RE 540/1 MOTOR.	RATIO 148:1
	919D8101	(4.5v - 15v)	WITH RE 540/1 MOTOR.	RATIO 810:1
NEW!	919D30001	(4.5v - 15v)	WITH RE 540/1 MOTOR.	RATIO 3000:1

Designed for heavy-duty industrial and model applications this robust unit boasts a powerful high quality, three pole motor with sintered bronze bearings. The all steel gearbox incorporates bronze output bearings, enabling the high torque transfer from the motor to be transmitted through the gearbox. The unit is mounted on a 1mm thick plated steel bracket.

MOTOR DATA. (RE-540/1)

MODEL	VOLTAGE		NO LOAD		AT MAXIMUM EFFICIENCY						STALL TORQUE	
	OPERATING RANGE	NOMINAL	SPEED R.P.M.	CURRENT A	SPEED R.P.M.	CURRENT A	TORQUE oz - in	TORQUE g - cm	OUTPUT W	EFF %	oz - in	g - cm
RE - 540/1	4.5 - 15.0	6.0v CONSTANT	7500	0.45	6180	2.1	1.64	118.2	7.49	59.4	9.31	670
		12.0v CONSTANT	15800	0.52	13360	2.85	2.14	154.4	21.2	61.9	13.9	1000

REDUCTION TABLE. R.P.M.

SUPPLY VOLTAGE	4.5v	6.0v	9.0v	12.0v	15.0v
919D2.51	2250	3000	4500	6300	7900
919D61	990	1316	1975	2633	3295
919D111	540	718	1077	1436	1800
919D501	120	158	237	316	395
919D1481	40	53	80	106	132
919D8101	8	10	15	20	25
919D30001	1.5	2	3	5	6

WEIGHT	
919D2.51	240g
919D61	234g
919D111	238g
919D501	246g
919D1481	255g
919D8101	255g
919D30001	262g

TORQUE TABLE (g.cm). (Theoretical rating for motor & gearbox combined).

	AT MAXIMUM EFFICIENCY 6V	12V	STALL TORQUE 6V	12V
RE 540/1 (2.5)	295	386	1675	2500
RE 540/1 (6:1)	709	926	4020	6000
RE 540/1 (11:1)	1300	1698	7370	11000
RE 540/1 (50:1)	5910	7720	33500	50000
RE 540/1 (148:1)	17493	22851	99160	148000
RE 540/1 (810:1)	95742	125064	542700	810000
RE540/1(3000:1)	354600	463200	2010000	3000000

NOTE: To establish Torque Rating in nM divide g.cm by 10,197.0

**24 volt versions are available for this range of motor-gearboxes. Performance data is similar to 12 volt versions. This version also has an extended 10mm rear shaft to accommodate motor encoders. When ordering please use 12v version part number suffixed with 24V.
I.E. 919D111 will be 919D11124V**

MFA/COMO DRILLS FELDERLAND LANE. WORTH. DEAL. KENT. CT14 OBT
TEL: 01304 612132. FAX: 01304 614696
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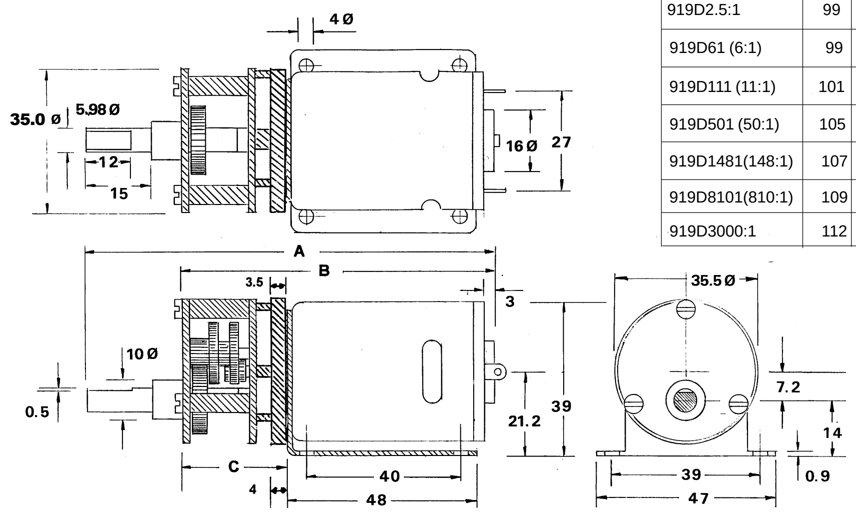
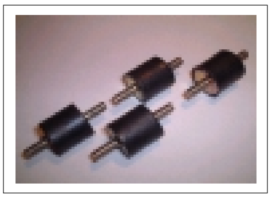
919D SERIES SINGLE RATIO METAL GEARBOX (RE 540/1 MOTOR)

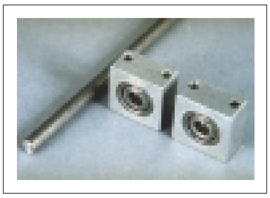
GEARBOX DIMENSIONS



GEARBOX REF.	A	B	C
919D2.5:1	99	73	20
919D61 (6:1)	99	73	20
919D111 (11:1)	101	76	22
919D501 (50:1)	105	80	26
919D1481(148:1)	107	82	28
919D8101(810:1)	109	94	30
919D3000:1	112	97	33



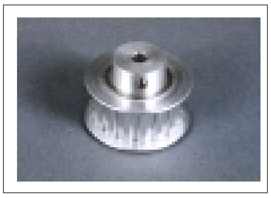
Part No. 1071. Anti vibration mount. M3

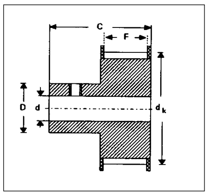


Part No. 919D30
Bearing Blocks. 5mm I.D.

Part No. 919D26
Steel shaft 5mmOD x 150mm

TIMING PULLEYS

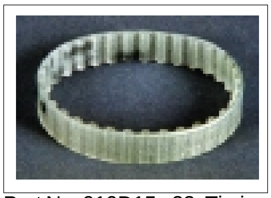




Part No. 919D7 - 14. Timing Pulleys.

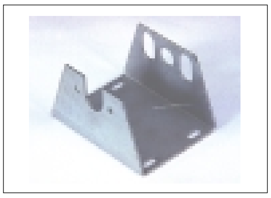
Pt. No.	No. of teeth	d	dk	F	C	D
919D7	14	6	21.45	12	21.0	12
919D8	16	6	24.60	12	21.0	15
919D9	20	6	31.00	12	21.0	15
919D10	25	6	39.00	12	21.0	15
919D11	30	6	46.95	12	21.0	15
919D12	35	6	54.85	12	21.0	15
919D13	40	6	62.85	12	21.0	15
919D14	44	6	69.20	12	21.0	15

TIMING BELTS

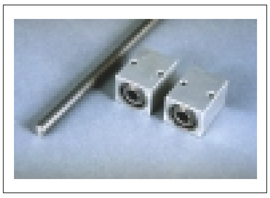


Part No. 919D15 - 23. Timing Belts.

Pt. No.	Length (Circum)	Width
919D15	165	9.8
919D16	185	9.8
919D17	200	9.8
919D18	305	9.8
919D19	390	9.8
919D20	455	9.8
919D21	545	9.8
919D22	630	9.8
919D23	840	9.8

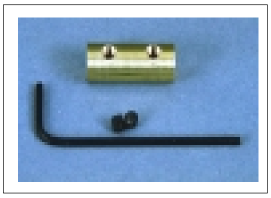


Part No. 919D29
Double ended motor mount.

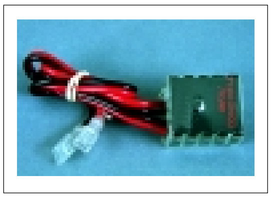


Part No. 919D30/1
Bearing Blocks. 6mm I.D.

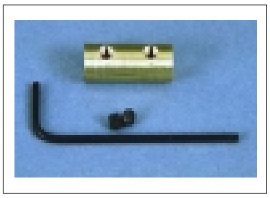
Part No. 919D26/1
Steel Shaft 6mmOD x 150mm



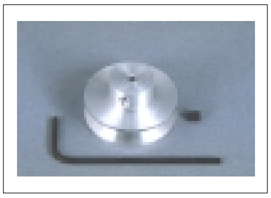
Pt No. 919D1. In-Line Coupling. 6mm - 6mm.(Dia. 12.67mm x 24.8mm)



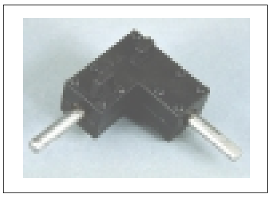
Pt No. 919D2. Voltage Regulator.(6-15v DC Input. 4v-12v output). 26mm x 31mm x 15.5mm



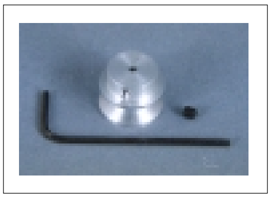
Pt No. 919D3. In-line Coupling. 6mm-8swg (Meccano) Dia. 12.67mm x 24.8mm



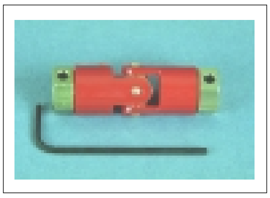
Pt No. 919D4. Pulley 25mm dia. (Aluminium)



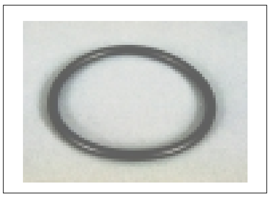
Pt.No.919D24. Bevel Gearbox. (Right Angle)



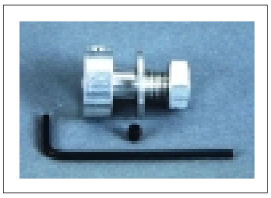
Pt No. 919D5. Pulley 16mm dia. (Aluminium)



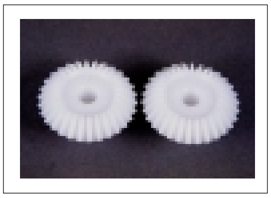
Pt No. 919D6. Universal Coupling. 6mm - 6mm.



Pt No. 917D2515. "O" Ring 70mm x 5mm Dia.



Pt No. 919D27. Gear Adapter.



Pt No. 919D25. Nylon Bevel Gears 1:1. OD30.7mm ID 6mm

Subject to minimum order quantities of 250 units, the following ratios are also available with a six week lead-time. The physical dimensions of these other gearboxes may vary from the data as illustrated above. Details of individual gearboxes are available upon request.

GEARBOX 18:1 WITH 540/1 MOTOR.
GEARBOX 70:1 WITH 540/1 MOTOR.
GEARBOX 100:1 WITH 540/1 MOTOR
GEARBOX 200:1 WITH 540/1 MOTOR
GEARBOX 350:1 WITH 540/1 MOTOR
GEARBOX 500:1 WITH 540/1 MOTOR
GEARBOX 900:1 WITH 540/1 MOTOR
GEARBOX 30:1 WITH 540/1 MOTOR.
GEARBOX 75:1 WITH 540/1 MOTOR.
GEARBOX 120:1 WITH 540/1 MOTOR
GEARBOX 250:1 WITH 540/1 MOTOR
GEARBOX 400:1 WITH 540/1 MOTOR
GEARBOX 600:1 WITH 540/1 MOTOR
GEARBOX 1000:1 WITH 540/1 MOTOR
GEARBOX 60:1 WITH 540/1 MOTOR
GEARBOX 90:1 WITH 540/1 MOTOR.
GEARBOX 180:1 WITH 540/1 MOTOR
GEARBOX 300:1 WITH 540/1 MOTOR
GEARBOX 450:1 WITH 540/1 MOTOR
GEARBOX 700:1 WITH 540/1 MOTOR
GEARBOX 1500:1 WITH 540/1 MOTOR

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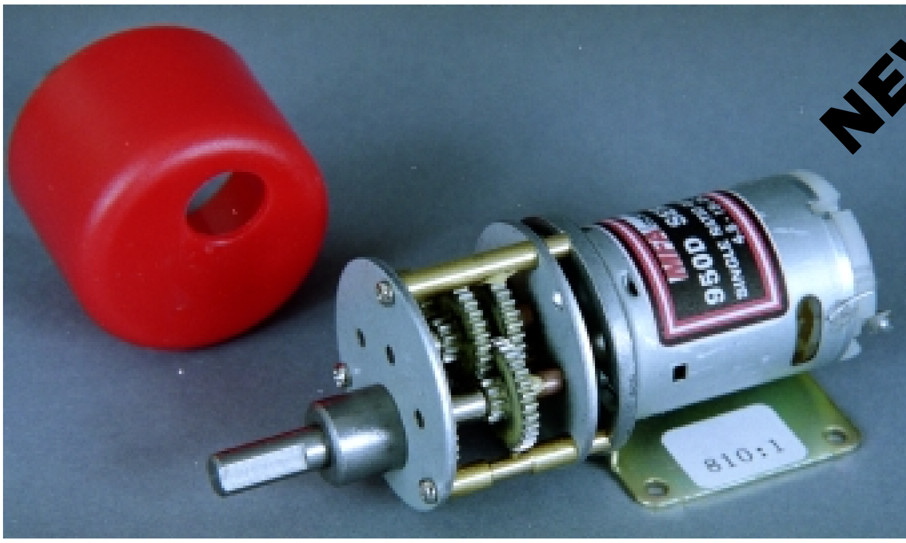
MFA/COMO DRILLS

950D SERIES SINGLE RATIO METAL GEARBOX (RE 385 MOTOR)



IMPORTANT NOTICE
Due to the wide range of applications for this product it is the users responsibility to establish the products suitability for their individual purpose(s).

RATIOS NOW AVAILABLE AS EX-STOCK ITEMS.

950D2.51	(4.5v - 15v)	WITH RE 385 MOTOR. RATIO 2.5:1
950D61	(4.5v - 15v)	WITH RE 385 MOTOR. RATIO 6:1
950D111	(4.5v - 15v)	WITH RE 385 MOTOR. RATIO 11:1
950D501	(4.5v - 15v)	WITH RE 385 MOTOR. RATIO 50:1
950D1481	(4.5v - 15v)	WITH RE 385 MOTOR. RATIO 148:1
950D8101	(4.5v - 15v)	WITH RE 385 MOTOR. RATIO 810:1
950D30001	(4.5v - 15v)	WITH RE 385 MOTOR. RATIO 3000:1

Designed for heavy-duty industrial and model applications this robust unit boasts a powerful high quality, five pole motor with sintered bronze bearings. The all steel gearbox incorporates bronze output bearings, enabling the high torque transfer from the motor to be transmitted through the gearbox. The unit is mounted on a 1mm thick plated steel bracket.

MOTOR DATA. (RE-385)

MODEL	VOLTAGE		NO LOAD		AT MAXIMUM EFFICIENCY						STALL TORQUE	
	OPERATING RANGE	NOMINAL	SPEED	CURRENT	SPEED	CURRENT	TORQUE		OUTPUT	EFF		
			R.P.M.	A	R.P.M.	A	oz - in	g - cm	W	%	oz - in	g - cm
RE - 385	6.0 - 15.0	12v CONSTANT	11000	0.155	9281	0.837		65.3	6.21	61.85		417.6

REDUCTION TABLE. R.P.M.

SUPPLY VOLTAGE	4.5v	6.0v	9.0v	12.0v	15.0v
950D2.51	1890	2520	3375	5040	6300
950D61	787	1050	1575	2100	2625
950D111	429	572	858	1145	1430
950D501	94	126	189	252	315
950D1481	32	42	64	85	106
950D8101	5	7	11	15	18
950D30001	1.5	2	3	4	5

WEIGHT	
950D2.51	146g
950D6	144g
950D111	146g
950D501	156g
950D1481	162g
950D8101	164g
950D30001	168g

TORQUE TABLE (g.cm). (Theoretical rating for motor & gearbox combined).

	AT MAXIMUM EFFICIENCY 12V	STALL TORQUE 12V
RE 385 (2.5)	165	1044
RE 385 (6:1)	392	2506
RE 385 (11:1)	718	4594
RE 385 (50:1)	3625	20880
RE 385 (148:1)	9664	61805
RE 385 (810:1)	52893	338256
RE 385 (3000:1)	195900	1252800

24 volt versions are available for this range of motor-gearboxes. Performance data is similar to 12 volt versions. This version also has an extended 10mm rear shaft to accommodate motor encoders. When ordering please use 12v version part number suffixed with 24V.
I.E. 950D111 will be 950D11124V

NOTE: To establish Torque Rating in nM divide g.cm by 10,197.0

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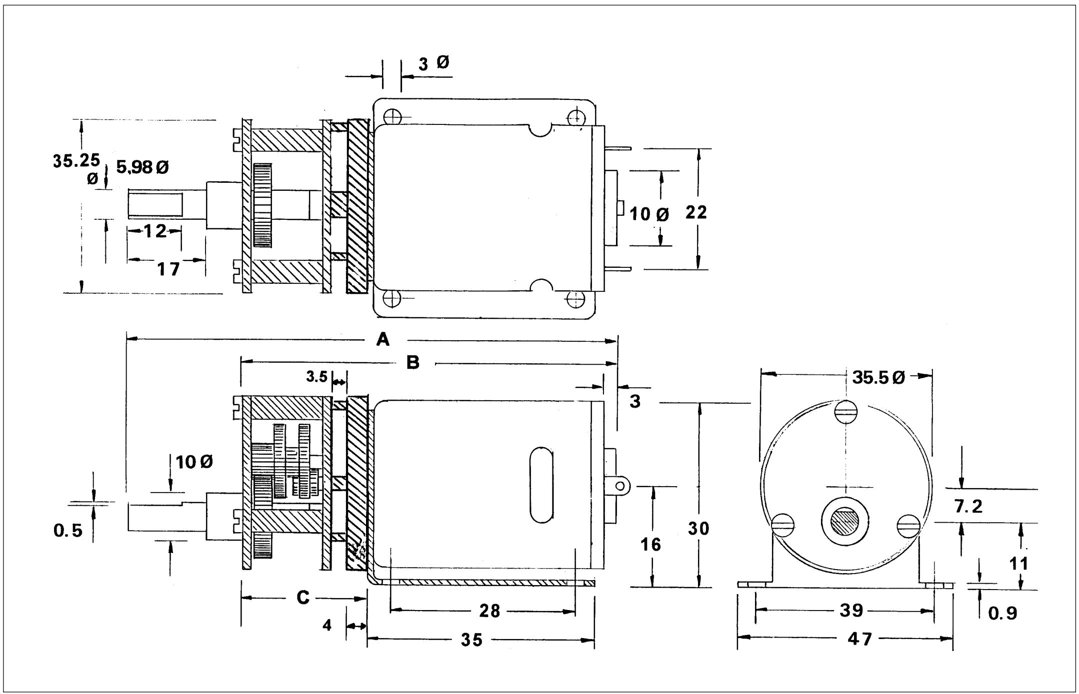
950D SERIES SINGLE RATIO METAL GEARBOX (RE 385 MOTOR)

GEARBOX DIMENSIONS



GEARBOX REF.	A	B	C
950D2.5:1	85	60	19
950D61 (6:1)	85	60	19
950D111 (11:1)	85	60	19
950D501 (50:1)	90	65	24
950D1481 (148:1)	92	67	26
950D8101 (810:1)	95	70	29
950D3000:1	102	87	31

FOR ACCESSORIES TO FIT THIS SERIES GEARBOX, REFER TO 919D SERIES PAGE.

Subject to minimum order quantities of 250 units, the following ratios are also available with a six week lead-time. The physical dimensions of these other gearboxes may vary from the data as illustrated above. Details of individual gearboxes are available upon request.

GEARBOX 18:1 WITH 385 MOTOR.
GEARBOX 70:1 WITH 385 MOTOR.
GEARBOX 100:1 WITH 385 MOTOR
GEARBOX 200:1 WITH 385 MOTOR
GEARBOX 350:1 WITH 385 MOTOR
GEARBOX 500:1 WITH 385 MOTOR
GEARBOX 900:1 WITH 385 MOTOR
GEARBOX 3000:1 WITH 385 MOTOR

GEARBOX 30:1 WITH 385 MOTOR.
GEARBOX 75:1 WITH 385 MOTOR.
GEARBOX 120:1 WITH 385 MOTOR
GEARBOX 250:1 WITH 385 MOTOR
GEARBOX 400:1 WITH 385 MOTOR
GEARBOX 600:1 WITH 385 MOTOR
GEARBOX 1000:1 WITH 385 MOTOR

GEARBOX 60:1 WITH 385 MOTOR
GEARBOX 90:1 WITH 385 MOTOR.
GEARBOX 180:1 WITH 385 MOTOR
GEARBOX 300:1 WITH 385 MOTOR
GEARBOX 450:1 WITH 385 MOTOR
GEARBOX 700:1 WITH 385 MOTOR
GEARBOX 1500:1 WITH 385 MOTOR

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941D SERIES PLANETRY (EPICYCLIC) SUB MINIATURE METAL GEARBOX

NEW!

IMPORTANT NOTICE
Due to the wide range of applications for this product it is the users responsibility to establish the products suitability for their individual purpose(s).

RATIOS NOW AVAILABLE AS EX-STOCK ITEMS.

941D41	(1.5v - 12v)	RATIO 4:1
941D621	(1.5v - 12v)	RATIO 62:1
941D2311	(1.5v - 12v)	RATIO 231:1

Designed for heavy-duty industrial and model applications this robust unit boasts a powerful high quality motor with sintered bronze bearings. The all metal gearbox incorporates bronze output bearings, enabling the high torque transfer from the motor to be transmitted through the gearbox.

MOTOR DATA.

MODEL	VOLTAGE		NO LOAD		MAX EFFICIENCY						STALL TORQUE	
	OPERATING RANGE	NOMINAL	SPEED	CURRENT	SPEED	CURRENT	TORQUE		OUTPUT	EFF		
			R.P.M.	mA	R.P.M	mA	oz - in	g - cm	W	%		g - cm
(941D)	1.5 - 12.0	12.0v CONSTANT	8000	19	5881	70		8.68	0.5	63.26		26

REDUCTION TABLE. R.P.M.

SUPPLY VOLTAGE		3.0v	6.0v	9.0v	12.0v
941D41		350	800	1300	1800
941D621		18	50	82	119
941D2311		5	14	23	32

WEIGHT	
941D41	37g
941D621	45g
941D2311	49g

NOTE: It is not recommended to run the motor/gearbox combination at 1.5v

TORQUE TABLE (g.cm). (Theoretical rating for motor & gearbox combined).

	AT MAXIMUM EFFICIENCY 12V	STALL TORQUE 12V
941D4:1 (4:1)	31	94
941D621 (62:1)	484	1451
941D2311 (231:1)	1805	5405

NOTE: To establish Torque Rating in nM divide g.cm by 10,197.0

**24 volt versions are available for this range of motor-gearboxes. Performance data is similar to 12 volt versions. This version also has an extended 10mm rear shaft to accommodate motor encoders. When ordering please use 12v version part number suffixed with 24V.
I.E. 941D621 will be 941D62124V**

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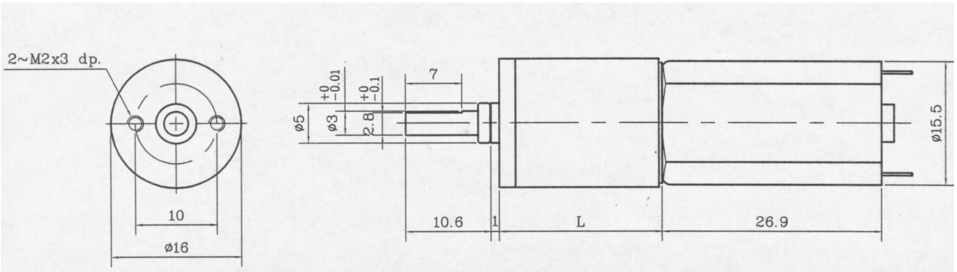
941D SERIES PLANETRY (EPICYCLIC) SUB MINIATURE METAL GEARBOX

GEARBOX DIMENSIONS



GEARBOX REF.	L
941D41 (4:1)	15
941D621 (62:1)	22.2
941D2311 (231:1)	25.8

FOR ACCESSORIES TO FIT THIS SERIES GEARBOX, REFER TO 917D SERIES PAGE.

ADVANTAGES OF PLANETARY GEARBOXES.

EFFICIENCY:	Efficiencies of planetary gearboxes can be above 90% while some other types of transmission can be 50% or less. This allows the use of smaller motors.
SIZE:	Planetary gearboxes can be half the size of conventional boxes.
WEIGHT:	Weight savings can be as high as 60%, allowing smaller, lighter support structures.
MAINTENANCE:	Other than routine oil changes, no maintenance is required, eliminating the need to hold spares.
REVERSIBLE:	Planetary gears can be equally efficient in either direction. This is an advantage for use in running machinery in both clockwise and anti-clockwise directions.
COAXIAL:	The coaxial configuration of input and output shafts allows planetary gears to be installed in line with a motor and a machine.

Subject to minimum order quantities of 100 units, the following ratios are also available with a six week lead-time. The physical dimensions of these other gearboxes may vary from the data as illustrated above. Details of individual gearboxes are available upon request.

GEARBOX 14:1 WITH MOTOR
GEARBOX 84:1 WITH MOTOR
GEARBOX 316:1 WITH MOTOR
GEARBOX 455:1 WITH MOTOR
GEARBOX 1621:1 WITH MOTOR

GEARBOX 19:1 WITH MOTOR
GEARBOX 104:1 WITH MOTOR
GEARBOX 370:1 WITH MOTOR
GEARBOX 1014:1 WITH MOTOR
GEARBOX 1996:1 WITH MOTOR

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940D SERIES PLANETRY (EPICYCLIC) METAL GEARBOX

(RE 385 MOTOR)

NEW!

IMPORTANT NOTICE
Due to the wide range of applications for this product it is the users responsibility to establish the products suitability for their individual purpose(s).

RATIOS NOW AVAILABLE AS EX-STOCK ITEMS.

940D51	(4.5v - 15v)	RATIO 5:1
940D1001	(4.5v - 15v)	RATIO 100:1
940D5161	(4.5v - 15v)	RATIO 516:1

Designed for heavy-duty industrial and model applications this robust unit boasts a powerful high quality, five pole motor with sintered bronze bearings. The all metal gearbox incorporates bronze output bearings, enabling the high torque transfer from the motor to be transmitted through the gearbox.

MOTOR DATA. (RE-385)

MODEL	VOLTAGE		NO LOAD		AT MAXIMUM EFFICIENCY						STALL TORQUE	
	OPERATING RANGE	NOMINAL	SPEED R.P.M.	CURRENT A	SPEED R.P.M.	CURRENT A	TORQUE oz - in	TORQUE g - cm	OUTPUT W	EFF %	oz - in	g - cm
RE - 385	6.0 - 15.0	12v CONSTANT	11000	0.155	9281	0.837		65.3	6.21	61.85		417.6

REDUCTION TABLE. R.P.M.

SUPPLY VOLTAGE	4.5v	6.0v	9.0v	12.0v	15.0v
940D51	700	1000	1600	2150	2800
940D1001	35	50	77	103	134
940D5161	6	8.5	14	19	25

WEIGHT	
940D51	167g
940D1001	214g
940D5161	239g

TORQUE TABLE (g.cm). (Theoretical rating for motor & gearbox combined).

	AT MAXIMUM EFFICIENCY 12V	STALL TORQUE 12V
940D51 (5:1)	326.5	2008
940D1001 (100:1)	6530.0	41760
940D5161 (516:1)	33695.0	215482

NOTE: To establish Torque Rating in Nm divide g.cm by 10,197.0

24 volt versions are available for this range of motor-gearboxes. Performance data is similar to 12 volt versions. This version also has an extended 10mm rear shaft to accommodate motor encoders. When ordering please use 12v version part number suffixed with 24V.
I.E. 940D1001 will be 940D100124V

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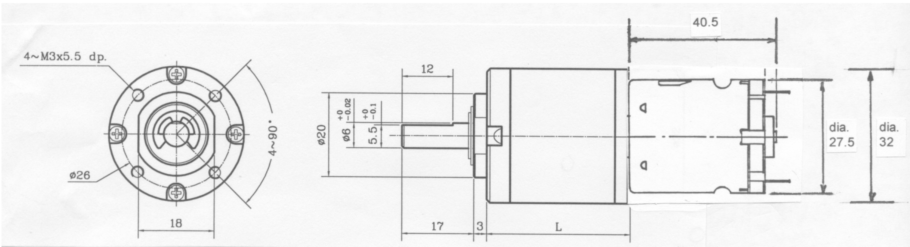
940D SERIES PLANETRY (EPICYCLIC) METAL GEARBOX

GEARBOX DIMENSIONS



GEARBOX REF.	L
940D51 (5:1)	20.4
940D1001 (100:1)	33.2
940D5161 (516:1)	39.6

FOR ACCESSORIES TO FIT THIS SERIES GEARBOX, REFER TO 919D SERIES PAGE.

ADVANTAGES OF PLANETARY GEARBOXES.

EFFICIENCY:	Efficiencies of planetary gearboxes can be above 90% while some other types of transmission can be 50% or less. This allows the use of smaller motors.
SIZE:	Planetary gearboxes can be half the size of conventional boxes.
WEIGHT:	Weight savings can be as high as 60%, allowing smaller, lighter support structures.
MAINTENANCE:	Other than routine oil changes, no maintenance is required, eliminating the need to hold spares.
REVERSIBLE:	Planetary gears can be equally efficient in either direction. This is an advantage for use in running machinery in both clockwise and anti-clockwise directions.
COAXIAL:	The coaxial configuration of input and output shafts allows planetary gears to be installed in line with a motor and a machine.

Subject to minimum order quantities of 100 units, the following ratios are also available with a six week lead-time. The physical dimensions of these other gearboxes may vary from the data as illustrated above. Details of individual gearboxes are available upon request.

GEARBOX 19:1 WITH 385 MOTOR.
GEARBOX 71:1 WITH 385 MOTOR.
GEARBOX 264:1 WITH 385 MOTOR

GEARBOX 27:1 WITH 385 MOTOR.
GEARBOX 139:1 WITH 385 MOTOR
GEARBOX 721:1 WITH 385 MOTOR

960D & 965D SERIES BELT DRIVE REDUCTION UNITS

Part No. 960D2.11 (RE 800 Motor)
Part No. 965D2.11 (RE 850 Motor)
Part No. 966D2.11 (Without motor)

This unit has been developed to meet a requirement for heavy duty high torque applications combined with relatively low power consumption.

The unit is powered by MFA/Como Drills 800 or MFA/Como Drills 850 series 12v d.c. 3 pole motors, with heavy duty carbon brush gear and double ended 6mm drive shaft. The motor is mounted on a rugged 1.5mm steel right angle bracket. The 2.1:1 reduction is achieved via two precision aluminium timing pulleys utilising a high quality toothed timing belt. The final drive is delivered through two block mounted precision ballraces with a 6mm keyed steel output shaft.

The RE800 motor version will deliver around 1229 g.cm torque (0.12 Nm) running at maximum efficiency.
The RE850 motor version will deliver around 1380 g.cm torque (0.14 Nm) running at maximum efficiency.

MOTOR DATA. (RE 800)

MODEL	VOLTAGE		NO LOAD		AT MAXIMUM EFFICIENCY						STALL TORQUE	
	OPERATING RANGE	NOMINAL	SPEED	CURRENT	SPEED	CURRENT	TORQUE		OUTPUT	EFF		
			R.P.M.	A	R.P.M.	A	oz - in	mN-m	W	%	oz - in	mN-m
RE - 800	12.0v	12.0v CONSTANT	5167	1.058	4289	5.28		82.08	36.84	58.2		482.8

MOTOR DATA. (RE 850)

MODEL	VOLTAGE		NO LOAD		AT MAXIMUM EFFICIENCY						STALL TORQUE	
	OPERATING RANGE	NOMINAL	SPEED	CURRENT	SPEED	CURRENT	TORQUE		OUTPUT	EFF		
			R.P.M.	A	R.P.M.	A	oz - in	mN-m	W	%	oz - in	mN-m
RE - 850	12.0v	12.0v CONSTANT	9778	1.90	8311	10.82		92.13	157	61.74		614

942D SERIES PLANETRY (EPICYCLIC) METAL GEARBOX (RE 540/1 MOTOR)

IMPORTANT NOTICE
Due to the wide range of applications for this product it is the users responsibility to establish the products suitability for their individual purpose(s).

RATIOS NOW AVAILABLE AS EX-STOCK ITEMS.

942D51	(4.5v - 15v)	RATIO 5:1
942D1001	(4.5v - 15v)	RATIO 100:1
942D5161	(4.5v - 15v)	RATIO 516:1

Designed for heavy-duty industrial and model applications this robust unit boasts a powerful high quality motor with sintered bronze bearings. The all metal gearbox incorporates bronze output bearings, enabling the high torque transfer from the motor to be transmitted through the gearbox.

MOTOR DATA.

MODEL	VOLTAGE		NO LOAD		MAX EFFICIENCY						STALL TORQUE	
	OPERATING RANGE	NOMINAL	SPEED	CURRENT	SPEED	CURRENT	TORQUE		OUTPUT	EFF		
			R.P.M.	A	R.P.M	A	oz - in	g - cm	W	%		g - cm
540/1	4.5 - 15.0	12.0v CONSTANT	15,800	0.52	13360	2.85	2.14	154.4	21.2	61.9	13.9	1000

REDUCTION TABLE. R.P.M.

SUPPLY VOLTAGE	4.5v	6.0v	9.0v	12.0v	15.0v
942D51	1082	1502	2287	3090	3640
942D1001	51	71	108	146	172
942D5161	9.5	13	20	27	32

WEIGHT	
942D51	g
942D1001	g
942D5161	g

TORQUE TABLE (g.cm). (Theoretical rating for motor & gearbox combined).

	AT MAXIMUM EFFICIENCY 12V	STALL TORQUE 12V
942D51 (5:1)	772	5000
942D1001 (100:1)	15440	100,000
942D5161 (516:1)	79670	516,000

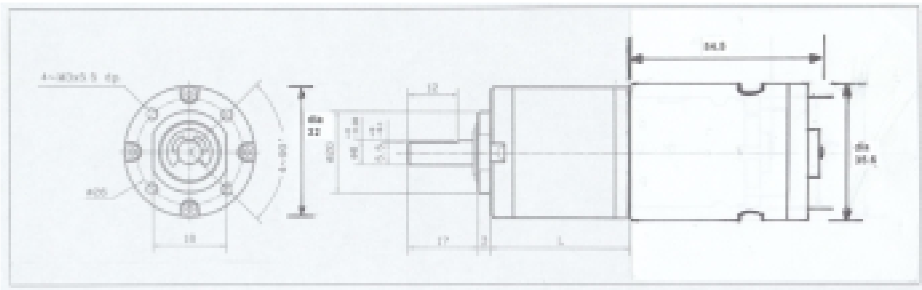
NOTE: To establish Torque Rating in Nm divide g.cm by 10,197.0

24 volt versions are available for this range of motor-gearboxes. Performance data is similar to 12 volt versions. This version also has an extended 10mm rear shaft to accommodate motor encoders. When ordering please use 12v version part number suffixed with 24V.
I.E. 942D1001 will be 942D100124V

MFA/COMO DRILLS FELDERLAND LANE. WORTH. DEAL. KENT. CT14 OBT
TEL: 01304 612132. FAX: 01304 614696
E-MAIL: MFA_COMO_DRILLS@COMPUSERVE.COM. www.comodrills.com

942D SERIES PLANETRY (EPICYCLIC) METAL GEARBOX

GEARBOX DIMENSIONS



GEARBOX REF.	L
942D51 (5:1)	20.4
942D1001 (100:1)	33.2
942D5161 (516:1)	39.6

FOR ACCESSORIES TO FIT THIS SERIES GEARBOX, REFER TO 919D SERIES PAGE.

ADVANTAGES OF PLANETARY GEARBOXES.

EFFICIENCY:	Efficiencies of planetary gearboxes can be above 90% while some other types of transmission can be 50% or less. This allows the use of smaller motors.
SIZE:	Planetary gearboxes can be half the size of conventional boxes.
WEIGHT:	Weight savings can be as high as 60%, allowing smaller, lighter support structures.
MAINTENANCE:	Other than routine oil changes, no maintenance is required, eliminating the need to hold spares.
REVERSIBLE:	Planetary gears can be equally efficient in either direction. This is an advantage for use in running machinery in both clockwise and anti-clockwise directions.
COAXIAL:	The coaxial configuration of input and output shafts allows planetary gears to be installed in line with a motor and a machine.

Subject to minimum order quantities of 100 units, the following ratios are also available with a six week lead-time. The physical dimensions of these other gearboxes may vary from the data as illustrated above. Details of individual gearboxes are available upon request.

GEARBOX 19:1 WITH 540/1 MOTOR.
GEARBOX 71:1 WITH 540/1 MOTOR.
GEARBOX 264:1 WITH 540/1 MOTOR
GEARBOX 27:1 WITH 540/1 MOTOR.
GEARBOX 139:1 WITH 540/1 MOTOR
GEARBOX 721:1 WITH 540/1 MOTOR

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Singflo®

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Tel:86-592-5612511 Fax:86-592-5626361
E-mail:sales@singflo.com

FLO Small Water Pressure Pump

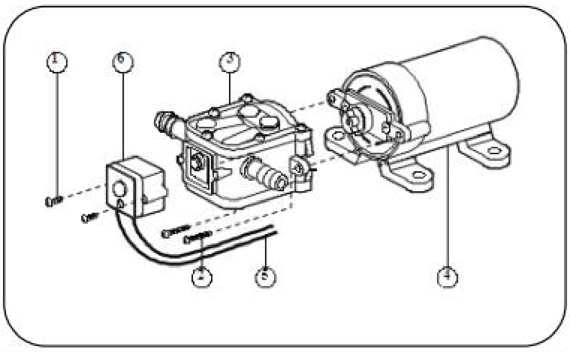
Specifications

Motor

Type:12V/24V DC, Permanent magnet,totally enclosed,non-ventilated
Leads:16 AWG
Duty cycle: Work intermittent

Pump

Type:2-chamber positive displacement
Liquid Temperature:140ºF(60°C)Maximum
Priming Capabilities:3feet(0.9m)suction lift
Pump able to run dry without damage
CHECK VALVE: (1-Way Operation) Prevents Reverse



Key	DESCRIPITON	Key	DESCRIPTION
1	Switch cover screw	4	Motor
2	Pump head screws	5	Lead wire
3	Pump head	6	Pressure Switch

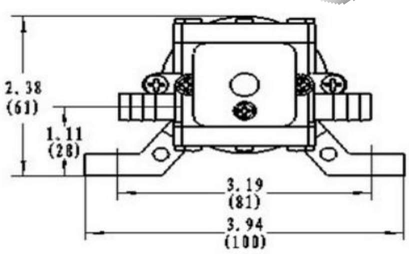
Material of Contruction

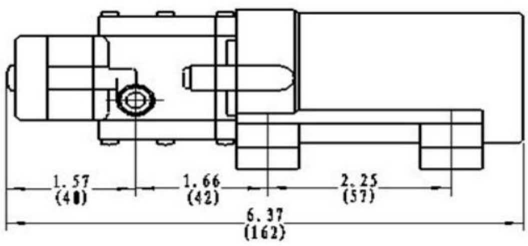
Motor Housing: PA66
Pump Housing: Polypropylene
Valves: Viton or EPDM
Diaphragm: Santoprene
Ports Size: 3/8'' Hose Barb

Weight &Size

Dimension:18.5*11*6.5cm
Net weight:0.67kgs
Packing:50pcs/CTN
Ctn size:58*37*37cm
N.W.:34kgs, G.W.:36kgs

Technical Data					
Model	Volt	Flow LPM(GPM)	Pressure PSI(BAR)	Amp Draw(A)	BYPASS
FLO-2201	12	2(0.52)	55(3.79)	1.8	YES
FLO-2202	12	3.8(1.0)	35(2.41)	3	YES
FLO-2202	12	4.3(1.13)	35(2.41)	3.5	YES
FLO-2203	12	2.6(0.68)	70(4.83)	2.1	YES
FLO-2203-1	12	3.1(0.82)	70(4.83)	2.2	YES
FLO-2202A	12	4(1.05)	80(5.52)	2.6	YES
FLO-2401	24	2(0.53)	55(3.79)	0.9	YES
FLO-2402	24	3.8(1.0)	35(2.41)	1.5	YES
FLO-2403	24	2.6(0.68)	70(4.83)	1	YES
FLO-2402A	24	4(1.05)	80(5.52)	1.3	YES





DP High Pressure Water Pump

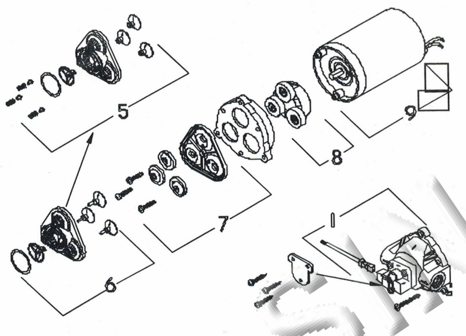
Specifications

Motor

Type: Permanent magnet,Thermally Protected
Leads:16 AWG,
Duty cycle: Work intermittent

Pump

Type:3-chamber positive displacement
Liquid Temperature:140ºF(60°C)Maximum
Priming Capabilities:6feet(1.8m)suction lift
Pump able to run dry without damage
CHECK VALVE: (1-Way Operation) Prevents Reverse Flow



KEY#	DESCRIPTION
1	Complete assembled pump head
2	Pressure switch assembly
3	Check valve components
4	Upper housing
5	Bypass valve and discharge valve assembly
6	Valve plate assembly
7	Diaphragm and piston components
8	Drive assembly
9	Motor assembly (less base plate)

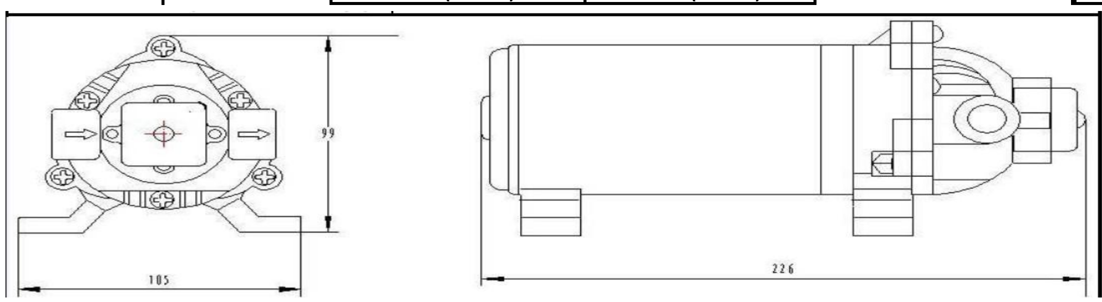
Material of Contruction

Motor Housing: Cast Iron
Pump Housing: Polypropylene
Valves: Viton or EPDM
Check valve spring Stainless steel
Diaphragm: Santoprene
Ports Size: 3/8'' Female thread
Fittings: 3/8''hose barb x2,
1/4''BSPT male thread x 2

Weight &Size

Dimension/PC:26.5x12x10.5cm
Net weight:2.60kgs(DC)   Net weight:3.15kgs(AC)
Packing:10pcs/CTN
Ctn size:64x29x22cm(DC) 63x39x22.5cm (AC)
N.W.:26kgs,G.W.:27kgs N.W.:31kgs, G.W.:33kgs

Model	Volt	Flow LPM(GPM)	Pressure PSI(BAR)	Amp Draw(A)	BYPASS
DP-60	12	4.6(1.21)	60(4.14)	7	YES
DP-60B	24	4.5(1.18)	60(4.14)	4	YES
DP-80	12	5.5(1.45)	80(5.52)	8	YES
DP-100	12	5.5(1.45)	100(6.90)	9	YES
DP-120	12	5.5(1.45)	120(8.28)	9.5	YES
DP-120B	24	5.5(1.45)	120(8.28)	4.5	YES
DP-160	12	5.5(1.45)	160(11.0)	10.5	YES
DP-160B	24	5.5(1.45)	160(11.0)	4.2	YES
DP-100M	230	5.5(1.45)	100(6.90)	0.6	YES
DP-160S	120	5.5(1.45)	160(11.0)	1	YES
DP-120M	220	5.5(1.45)	120(8.28)	0.5	YES
DP-160M	220	5.5(1.45)	160(11.0)	0.55	YES



Singflo®

FL High Flow Water Pump

Specifications

Motor

Type:12V/24V DC,115V,230V AC Permanent magnet

Leads:16 AWG,

Duty cycle: Work intermittent

Pump

Type:4-chamber positive displacement

Liquid Temperature:140ºF(60°C)Maximum

Priming Capabilities:6feet(1.8m)suction lift

Pump able to run dry without damage

Material of Contruction

Motor Housing: Cast Iron

Pump Housing: Polypropylene

Valves: Viton or EPDM

Check valve spring Stainless steel

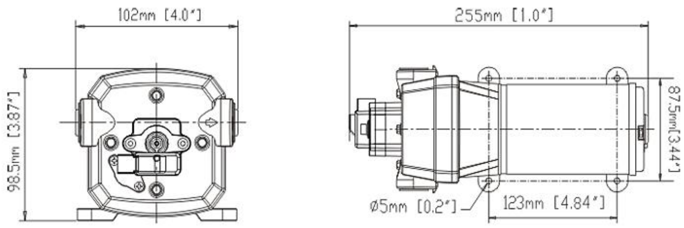
Diaphragm: Santoprene

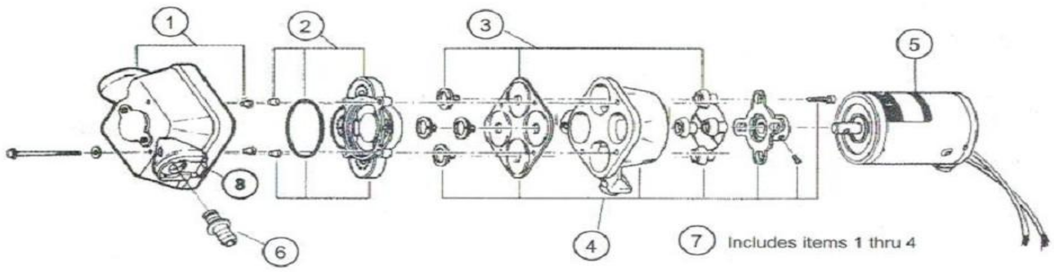
Ports Size: 1/2'' Snap–in Port Fittings

Fittings: 3/4''male thread,1/2''BSPT hose barb

1/2''elbow hose barb,1/2'' filter

Typical Application





TECHNICAL DATA OF DC VOLTAGE					
Model	Volt	Flow LPM(GPM)	Pressure PSI(bar)	Amp Draw(A)	BYPASS
FL-30	12	10(2.63)	17(1.17)	2.2	NO
FL-31	24	10(2.63)	17(1.17)	1.5	NO
FL-35	12	12.5(3.29)	35(2.41)	7	NO
FL-34	24	12.5(3.29)	35(2.41)	4	NO
FL-40	12	17(4.47)	40(2.76)	9.2	NO
FL-44	24	17(4.47)	40(2.76)	5.6	NO
TECHNICAL DATA OF AC VOLTAGE					
Model	Volt	FLow(L/Min)	Pressure PSI(Bar)	Amp Draw(A)	BYPASS
FL-33	115	12.5(3.29)	35(2.41)	0.5	NO
FL-32	220	12.5(3.29)	35(2.41)	0.4	NO
FL-41	115	17(4.47)	40(2.76)	0.5	NO
FL-43	220	17(4.47)	40(2.76)	0.8	NO

FLO High Pressure Water Pump

Specifications

Motor

Type:12V/24V DC, Permanent magnet,totally enclosed,non-ventilated
Leads:16 AWG
Duty cycle: Work intermittent

Pump

Type:2-chamber positive displacement
Liquid Temperature:140ºF(60°C)Maximum
Priming Capabilities:3feet(0.9m)suction lift
Pump able to run dry without damage
CHECK VALVE: (1-Way Operation) Prevents Reverse Flow

Material of Contruction

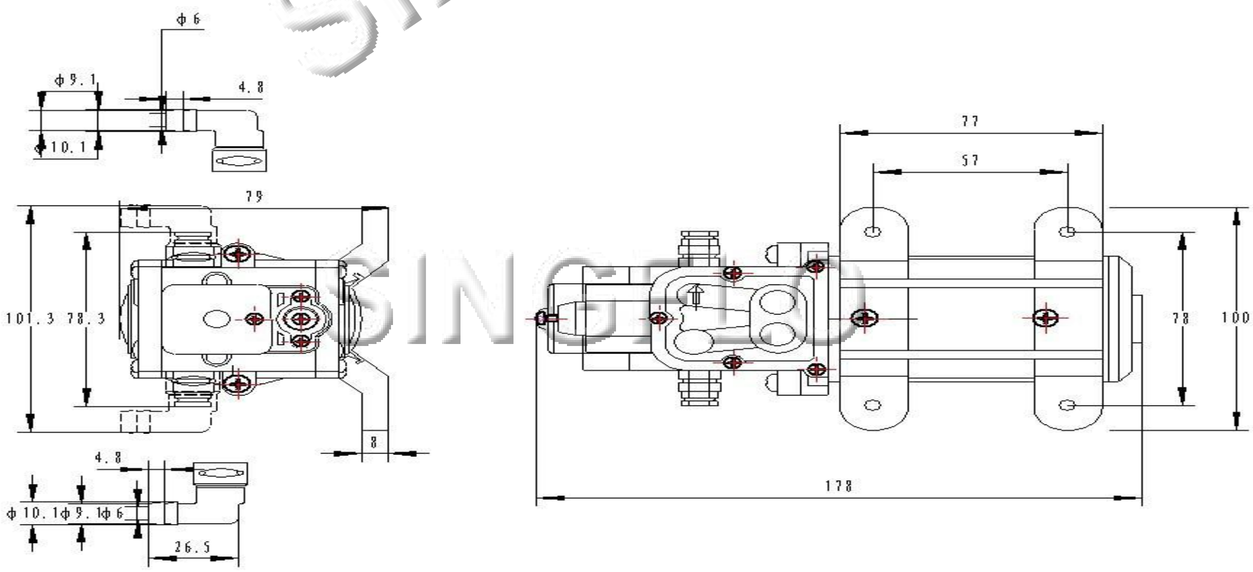
Motor Housing: PA66
Pump Housing: Polypropylene
Valves: Viton or EPDM
Diaphragm: Santoprene
Ports Size: 3/8'' Hose Barb with O-ring

Weight &Size

Dimension:
Net weight:1.21kgs
Packing:30pcs/CTN
Ctn size:55*40*28cm
N.W.:38kgs, G.W.:40kgs

Technical Data

Model	Volt	Flow LPM(GPM)	Pressure PSI(BAR)	Amp Draw(A)	BYPASS
FL-3202	12	5.0(1.32)	80(5.51)	4.5	YES
FL-3402	24	5.0(1.32)	80(5.51)	2.8	YES
FL-3206	12	5.0(1.32)	60(4.14)	4	YES
FL-3406	24	5.0(1.32)	60(4.14)	2.5	YES
FL-3203	12	5.0(1.32)	100(6.90)	5	YES
FL-3403	24	5.0(1.32)	100(6.90)	3	YES



FL-200 High Pressure Water Pump

Specifications

Motor

Type:12V/24V DC, Permanent magnet,totally enclosed,non-ventilated

Leads:14 AWG

Duty cycle: Work intermittent

Pump

Type: 5-chamber positive displacement

Liquid Temperature:140ºF(60°C)Maximum

Priming Capabilities:6feet(1.8m)suction lift

Pump able to run dry without damage

CHECK VALVE: (1-Way Operation) Prevents Reverse Flow

Material of Contruction

Motor Housing: PA66

Pump Housing: Polypropylene

Valves: Viton or EPDM

Diaphragm: Santoprene

Ports Size: 1/2'' Hose Barb

Technical Data					
Model	Volt	Flow LPM(GPM)	Pressure PSI(BAR)	Amp Draw(A)	BYPASS
FL-200	12	10.0(2.63)	200(13.79)	15	NO
FL-200B	24	10.0(2.63)	200(13.79)	8	NO
FL-55	12	20.0(5.26)	55(3.79)	16	NO
FL-55B	24	20.0(5.26)	55(3.79)	9	NO