INSTITUT TEKNOLOGI NASIONAL MALANG
FAKULTAS TEKNOLOGI INDUSTRI
JURUSAN TEKNIK ELEKTRO S-1
KONSENTRASI TEKNIK ELEKTRONIKA

PERANCANGAN DAN PEMBUATAN ALAT PENTRANSFER DATA ARGOMETER TAKSI BERBASIS MIKROKONTROLLER AT89S8252 YANG BISA DI UPLOAD KE KOMPUTER MELALUI KOMUNIKASI RADIO

SKRIPSI

Disusun Oleh:

CHAIRIL ISKANDAR

0117080

MARET 2006

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LEMBAR PERSETUJUAN

PERANCANGAN DAN PEMBUATAN ALAT PENTRANSFER DATA ARGOMETER TAKSI BERBASIS MIKROKONTROLLER AT89S8252 YANG BISA DI UPLOAD KE KOMPUTER MELALUI KOMUNIKASI RADIO

SKRIPSI

Disusun dan Diajukan Untuk Melengkapi dan Memenuhi Syarat
Guna Mencapai Gelar Sarjana Teknik Elektro Strata Satu (S-1)

Disusun Oleh :

CHAIRIL ISKANDAR
0117080

Mengetahui
Ketua Jurusan Teknik Elektro S-1

(Ir. E. Yudi Limpraptono, MT)
NIP.Y 1039500274

Diperiksa dan Disetujui
Dosen Pembimbing

(Ir.Sidik Noertjahjono,MT)
NIP.Y.1028700167

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BERITA ACARA UJIAN SKRIPSI
FAKULTAS TEKNOLOGI INDUSTRI

Nama : Chairil Iskandar

NIM : 01.17.080

Jurusan : Teknik Elektro S-1

Konsentrasi : Teknik Elektronika

Judul Skripsi : Perencanaan dan Pembuatan Alat Pentransfer Data Argometer Taksi Berbasis Mikrokontroller AT89S8252 Yang Bisa Diupload KeKomputer Melalui Komunikasi Radio

Dipertahankan di hadapan majelis penguji Skripsi jenjang Strata satu (S-1)
pada :

Hari : Rabu

Tanggal : 22 Maret 2006

Dengan Nilai : 79,45 (B+)

Panitia Ujian Skripsi

Ketua

(Ir. Mochtar Asroni, MSME)
NIP.Y.1018100036

Sekretaris

(Ir. F. Yudi Limpraptono, MT)
NIP.Y.1039500274

Anggota Penguji

(Joseph. D. Irawan, ST, MT)
Penguji I

(Setyohadi, ST)
Penguji II

PERSEMBAHAN

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

"Hai orang-orang yang beriman,
bertakwalah kepada Allah dan hemdaklah setiap diri memperhatikan apa yang telah diperbuatnya untuk hari esok, dan bertakwalah kepada Allah Sesungguhnya Allah maha mengetahui apa yang kamu kerjakan"

(Hasyr : 18)

"Hendaknya engkau bersyukur berterima kasih kepada-Ku
Dan kepada kedua orang tuamu"

(Luqman :14)

Kupersembahkan skrisiku ini kepada:

Ayahanda "Drs.Moh.Marsuki, Msi" dan ibundaku "R. Endang Agustina"

makasih atas semua yang telah diberikan dan korbankan buat nanda selama ini. Atas doa cinta dan kasih sayang yang nanda terima tak akan bisa nanda balas sesempurna apa yang nanda terima, Doain dadanx semoga dadanx sukses n bisa bahagiain kalian..... amieeen.

Buat Mas ical & Mbak wiwied-Q yang cantik n adex reesa-Q yang nakal banget smoga klta bisa jadi anak-anak yang berbakti kepada orang tua n yang pasti k ita bisa sukses n bahagiain mereka .buat ponekan kecilku :"Uziela" yang lucu banget smoga kamu bisa jadi kebanggaan kami.

Buat "Jerma-Q "sayang makasih banget buat semua cinta, perhatian, kesabaran dan kesetiaan serta doanya. Kamu yang beri aku semangat dan warna indah dalam hidupku. Thanx banget yach chayanx.....

My Special Thanx to:

- **Base camp** "puskopad C-21", *Adek "**Ferry**" jadi anak yang baek yach..., "**d-wang the reds**" jangan lama-lama yach kuliahnya cepet lulus n jangan lupa cari cewek..., **"dwix n rika"** smoga kalian bisa langgeng yach....., **"mas hasis"** thanx y buat sgalanya, buat **"eko** " q-ta udah lama banget bertemen jadi apapun dirimu sekarang dadanx akan tetap jadi temanmu sorry, buat smua thanx yach udah temenin dadanx selama ini n sorry sering buat kalian repot karena aku.*
- Buat **"Zainul"** *thanx y buat segalanya, dadanx gak akan lupa hari-hari kita bersama, semoga kita bisa selalu bisa bekerjasama dalam hal apapun.Smoga bisa awet yach ma ani aku tunggu undangannya*
- Buat **"Hadaruddin"** *thanx banget yach pinjeman komputernya jangan lupa ma aku yach n aku doain moga cepet lulus d.*
- **Base camp asempayung,** **"Firman"** *my best friend jangan ampe parsahabatan kita hancur, moga kamu sukses y cepet lulus n aku tunggu undangannya ma mila,* **"Wah - yous"** *thanx y atas smua bantuanmu,* **"PIPIEX HADI KARNO & ANDI"** *kalian akan menjadi temanku slamanya.*
- *My old friend* **"Oe-phix"** *kamu adalah saudaraku yang tak akan tergantikan dalam hidupku, thanx y buat doa dan semangatmu, moga kamu sukses baik dalam cinta dan citamu.*
- *Temen-temen elka-01 kompakan slalu yach....., david agus catur n temen2 elka-2 cepet lulus yach. Buat nanang thanx y buat printernya moga kamu sukses yach.....*

ABSTRAKSI

PERANCANGAN DAN PEMBUATAN ALAT PENTRANSFER DATA PADA ARGOMETER TAKSI YANG BERBASIS MIKROKONTROLLER AT89S8252 YANG BISA DI UPLOAD KE KOMPUTER

Sekarang ini bisa dilihat bahwa system penghitungan kilometer pada mobil taksi sudah sedemikian praktisnya yang biasanya diusebut argometer, namun system untuk setoran perhari masih menggunakan atau menggunakan system setor standart harian. Seiring dengan kemajuan teknologi yang semakin canggih saat ini menuntut manusia mencari suatu metode system setor secara komputerisasi yang memudahkan dan meringankan bagi para sopir maupun operator taksi.

Alat ini menggnakan sistem komunikasi tertutup dengan metode half duplex, untuk menjamin keamanannya, selain itu alat ini juga disertai ID yana berbeda untuk setiap taksi. Frekuensi recieve dan trnsmite akan dibuat berbeda,. Laporan harian akan dilakukan jika ada permintaan atau requesting dari operator. Laporan harian ini bisa dilakukan dimana saja asalkan masih dalam jangkauan radio komunikasi pada taksi. Data yang diambil dari mikro pada argometer akan ditransferkan ke operator melalui radio komunikasi pada taksi.Data yang diambil dari mikro akan di modulasi oleh madem agar bisa dimodulasikan pada gelombang radio tersebut.Setelah data yang dimodulasi tadi sampai ke operator akan diubah kembali dengan menggunakan demodulator yang kemudian dimasukkan ke PC operator.

Laporan setoran harian tidak terbatas jarak dan waktu karena melalui gelombang radio selain itu transfer data ke kantor operator taksi lebih cepat. Jarak jangkau tergantung pada jenis dan bentuk antenna dan daya RF masing-masing stasiun radio. Konsumsi daya yang diserap oleh peralatan yang ada ditaksi hanya berkisar 8 watt, dan tegangan catu sesuai dengan tegangan catu daya yang ada di mobil taksi.

KATA PENGANTAR

Dengan mengucap syukur kehadirat ALLAH SWT atas segala rahmat dan hidayatnya .Penulis dapat menyelesaikan laporan skripsi ini dengan judul

PERANCANGAN DAN PEMBUATAN ALAT PENTRANSFER DATA PADA ARGOMETER TAKSI YANG BERBASIS MIKROKONTROLLER AT89S8252 YANG BISA DI UPLOAD KE KOMPUTER

Pada kesempatan ini penyusun ingin menyampaikan dan terima kasih yang sebesar-besarnya kepada pembimbing dan dosen kami

Ir.Sidik Noertjahjono,MT

Yang telah memberikan bimbingan, motivasi dan pengarahan sehingga penulisan skripsi ini dapat diselesaikan. Selain itu penyusun juga ingin menyapaikan terima kasih kepada:

1. Bapak Dr. Ir. Abraham Lomi, MSEE selaku Rektor ITN Malang.
2. Bapak. Ir. Mochtar Asroni, MT selaku Dekan Fakultas Teknik Industi ITN Malang.
3. Bapak Ir. F. Yudi Limpraptono, MT selaku ketua Jurusan Teknik Elektro S-1 ITN Malang.
4. Ibu Ir Mimin Mustikawati selaku Sekretaris Jurusan elektro S-1, Institut Teknologi nasional Malang.

5. Semua pihak yang tidak bisa disebutkan satu per satu dan telah memberikan dukungan kepada penulis atas terselesaikannya penyusunan skripsi ini.

Selanjutnya dengan telah terselesaikannya skripsi ini, maka penyusun sadar bahwa skripsi ini masih perlu disempurnakan, maka berbagai masukan, saran, dan kritik yang sifatnya membangun sangat diharapkan untuk penyusunan skripsi berikutnya

Akhir kata penulis berharap semoga skripsi ini bermanfaat bagi pembaca yang budiman.

Malang,Maret 2006

Penulis

DAFTAR ISI

DAFTAR GAMBAR

DAFTAR TABEL

BAB 1

PENDAHULUAN

1.1 LATAR BELAKANG

Seperti yang telah kita ketahui bersama dalam kehidupan yang serba modern seperti saat ini jalur lalu lintas sangatlah penting dalam kehidupan manusia, ini tidak lepas dari peran angkutan umum yang sangat dibutuhkan dalam kehidupan sehari-hari, salah satu angkutan umum yang paling popular adalah taksi. Karena itu taksi harus terus berkembang sesuai dengan kemajuan teknologi yaitu komputerisasi. Sekarang ini bisa dilihat bahwa system penghitungan kilometer pada mobil taksi sudah sedemikian praktisnya yang biasanya diusebut argometer, namun system untuk setoran perhari masih menggunakan atau menggunakan system setor standart harian. Seiring dengan kemajuan teknologi yang semakin canggih saat ini menuntut manusia mencari suatu metode system setor secara komputerisasi yang memudahkan dan meringankan bagi para sopir maupun operator taksi.

Berlatar belakang hal ini maka dirasakan sangat perlu untuk menciptakan suatu perangkat interface yang menghubungkan perangkat mikrokontroler yang dilengkapi memori yang dapat diupload pada computer.Hal ini sangat menguntungkan baik para sopir taksi maupun para operator taksi sehingga memberikan kemudahan ataupun keringanan pada sopir taksi maupun para operator taksi pada metode penyetoran harian, karena para operator taksi tidak perlu lagi menghitung secara manual storan taksi harian karena laporannya

langsung diupload dan diproses di computer. Selain itu para sopir taksi tidak perlu menghasiskan waktu mereka untuk menunggu giliran untuk penghitungan penyetoran harian.. Karena para sopir taksi bisa melakukan setoran harian dimana saja asal masih dalam jangkaun radio komunikasi yang dimiliki oloeh taksi tersebut. Selain itu alat ini juga telah dilengkapi oleh system komunikasi dengan computer yang berupa radio komunikasi yang tidak lagi memerlukan kabel sehingga alat ini sangatlah praktis dan daya guna.

1.2 PERMASALAHAN

Permasalahan yang akan diangkat dalam laporan ini adalah sebagai berikut:

- Bagaimana mengirimkan data pada argometer ke computer operator taksi melalui radio komunikasi pada taksi. .
- Bagaimana merencanakan dan membuat perangkat lunak untuk penulisan informasi, penyimpanan informasi, dan pengiriman informasi ke bagian penerima (PC) melalui sistem komunikasi radio pada taksi.

1.3 BATASAN MASALAH

Agar perencanaan dan perancangan alat ini dapat dilakukan secara sistematis dan terarah, maka ruang lingkup pembahasan dan perancangan alat dibatasi sebagai berikut:

- Tidak membahas secara mendetail aspek teknis (elektronik) dari radio sebagai system komunikasi antara pc dan mikrokontroller yang

digunakan, melainkan hanya pada antarmuka untuk komunikasi data kedua perangkat tersebut dari/ke sistem mikrokontroler.

- Tidak membahas catu daya dan catu daya dianggap konstan
- Tidak membahas mekanik roda dan perhitungan harga pada taksi melainkan hanya system komunikasi antara mikrokontroller dengan PC

1.4 TUJUAN

Untuk mempelajari, merencanakan dan membuat suatu peralatan interfacing mikrokontroller dengan computer. Diperlukan inisialisasi parameter yang digunakan agar komunikasi data antara computer dengan mikrokontroller melalui radio komunikasi menjadi sinkron.

1.5 KONTRIBUSI PERANCANGAN

Melalui perancangan dan pembuatan alat ini diharapkan dapat memberikan manfaat dalam pengembangan dan pengaplikasian teknologi radio paket dan mikrokomtroller dalam kehidupan sehari-hari.

1.6 SISTEMATIKA PENULISAN

Sistematika penulisan dan gambaran tentang hal-hal yang dibahas dalam setiap bab adalah sebagai berikut:

BAB I PENDAHULUAN

Memuat latar belakang, tujuan, permasalahan, ruang lingkup dan sistematika penulisan.

BAB II DASAR TEORI

Memuat tentang landasan-landasan teori yang diperlukan dalam realisasi pembuatan alat ini.

BAB III PERANCANGAN DAN PEMBUATAN ALAT

Menerangkan tentang perancangan dan pembuatan seluruh sistem peralatan, baik perangkat keras maupun perangkat lunak.

BAB IV ANALISIS DAN PENGUJIAN ALAT

Menerangkan tentang hasil pembuatan dan pengujian yang dilakukan terhadap alat yang telah dibuat serta menampilkan hasil-hasil pengujian.

BAB V PENUTUP

Memuat kesimpulan dan saran dari tema yang di analisa dalam skripsi ini

BAB II

LANDASAN TEORI

2.1. Pendahuluan

Dalam perancangan dan pembuatan alat pentransfer data pada argometer taksi ini di butuhkan beberapa teori yang mejadi landasan, yaitu teori yang berhubungan dengan komponen-komponen yang digunakan dalam perencanaan dan pembuatan sistem ini

2.2. Radio Komunikasi

Pada perancangan dan pembuatan alat pentransfer data pada argometer taksi menggunakan gelombang radio sebagai alat atau media untuk mentransmisikan data dari argometer ke computer operator. Karenanya kami menggunakan HT jenis ICOM 2N sebagai media komunikasinya.

2.3. Mikrokontroler AT89S8252

Mikrokontroler AT89S8252 merupakan versi CHMOS dari AT89S8252 yaitu versi NMOS. NMOS merupakan kependekan dari *N-Channel Metal Oxide Silicon* dan kompatibel dengan MCS-51 mikrokomputer yang merupakan produksi dari ATMEL. Seri AT89S8252 adalah mikrokontroller yang membutuhkan daya rendah, memiliki kemampuan yang tinggi, dan merupakan mikrokomputer 8 bit yang dilengkapi 8K *byte Flash* PEROM (*Programmable and Erasable Read Only Memory*) yaitu ROM yang dapat ditulis ulang atau

dihapus menggunakan sebuah perangkat programmer. Serta terdapat EEPROM *internal* sebesar 2K *Byte*.

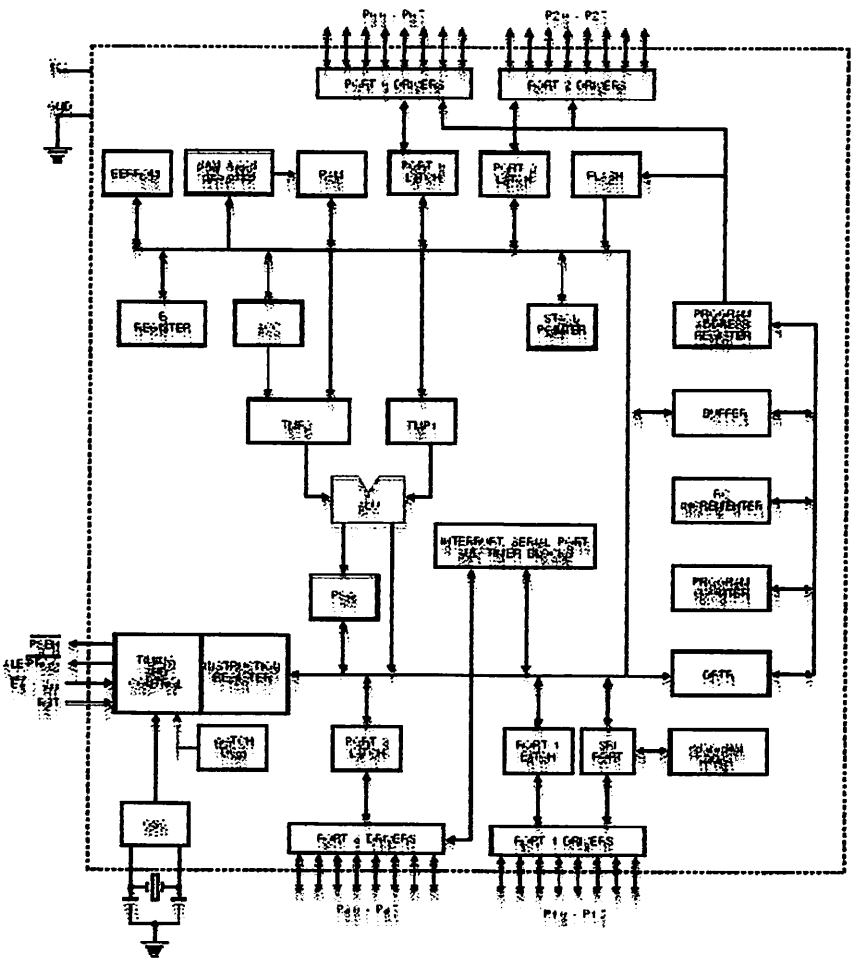
Flash PEROM dalam AT89S8252 menggunakan *Atmel's High-Density Non Volatile Technology* yang mempunyai kemampuan untuk ditulis ulang hingga 1000 kali dan berisikan perintah *standard* MCS-51. Selain itu juga dilengkapi RAM *internal* sebesar 256 *byte*. Dalam sistem Mikrokontroller terdapat dua hal yang mendasar, yaitu: perangkat keras dan perangkat lunak yang keduanya saling terkait dan mendukung. Mikrokontroller ini digunakan untuk beberapa keperluan mulai dari komersial, industri, otomotif, dan militer.

2.3.1. Fitur Mikrokontroller AT89S8252

Fitur Mikrokontroller AT89S8252 adalah sebagai berikut :

- Kompatibel dengan mikrokontroller MCS-51
- 8K byte In-System Programmable Downloadable Flash Memori
  - SPI Serial Interface for Program Downloading
  - Endurance: 1,000 Write/Erase Cycles
- 2K byte EEPROM
  - Edurance: 100,000 Write/Erase Cycles
- 3 Level program memori lock
- Memory 256 x 8 bit *Internal* RAM
- 32 Port I/O Lines yang dapat dipakai semua
- 3 buah Timer/Counter 16 bit
- Nine Interrupt Source

- Programmable UART (serial port)
- SPI Serial Interface
- Programmable Watchdog Timer
- Dual Data Pointer
- Frekuensi kerja 0 sampai 24 MHz
- Tegangan Operasi 4 Volt sampai 6 Volt
- *Power-Off Flag.*



Gambar 2-1. Blok Diagram AT89S8252

Sumber : Datasheet AT89S8252

2.3.2. Arsitektur AT89S8252

Arsitektur Mikrokontroller AT89S8252 adalah sebagai berikut:

- 8 bit CPU (*Central Processing Unit*) dengan register A dan B.
- 16 bit *Program Counter* (PC) dengan *Data Pointer* (DPTR).
- 8 bit program status word (PSW).
- 8 bit stack pointer (SP).
- Internal EPROM dan ROM dari 0 sampai 4 Kb.
- 256 byte *Internal* RAM

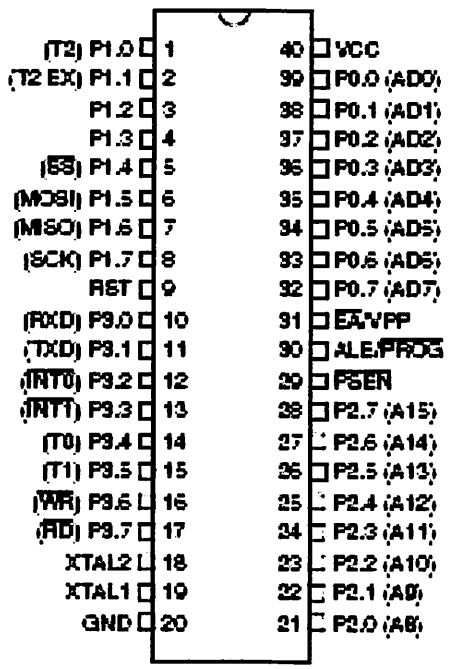
  ⇒ 4 register bank masing-masing 8 register.

  ⇒ 16 byte yang dapat dialamatkan pada *bit level.*

  ⇒ 208 *byte memory general purpose memory data.*
- 32 pin *input/output* tersusun sebagai 4 port masing-masing 8 bit (P0 – P3).
- 3 buah Timer (T0 & T1) dengan masing-masing 16-bit timer/counter.
- Data serial *receiver/transmitter full duplex* yaitu SBUF.
- *Control register* antara lain TCON, TMOD, SCON, PCON, IP dan ME.
- 2 eksternal dan 3 internal sumber *interrupt.*
- Rangkaian *oscillator* dan *clock.*

2.3.3. Konfigurasi Kaki-kaki MCU AT89S8252

Berikut ini adalah bentuk fisik dari AT89S8252:



Gambar 2-2. Bentuk fisik AT89S8252

Sumber : Datasheet AT89S8252

Fungsi-fungsi dari tiap-tiap pin sebagai berikut :

- **Pin 40:Vcc**

  Dihubungkan dengan sumber tegangan + 5 V.

- **Pin 20: GND**

  Dihubungkan dengan Ground rangkaian atau media pentanahan.

- **Pin 32-39 : *Port* 0 (P0.0 – P0.7)**

  Port 0 merupakan *port* I/O 8 bit dua arah. *Port* ini digunakan sebagai multipleks bus alamat rendah dan bus data selama pengaksesan ke memori luar.

➢ **Pin 1-8 : *Port* 1 (P1.0 – P1.7)**

Port 1 dapat difungsikan sebagai masukan atau keluaran dan bekerja baik untuk operasi bit maupun *byte*, tergantung dari pengaturan program yang dibuat.

Tabel 2-1. Fungsi Alternatif Port 1

Port Pin	Fungsi
P1.0	T2 (masukan eksternal untuk Timer/Counter 2)
P1.1	T2EX (Timer/Counter 2 capture/reload trigger dan kontrol arah
P1.2	-
P1.3	-
P1.4	SS (slave port select input)
P1.5	MOSI (master data output, slave data input untuk chanel SPI)
P1.6	MISO (maser data input, slave data output untuk chanel SPI)
P1.7	SCK (master clock output, slave clock input untuk chanel SPI)

➢ **Pin 21-28 : *Port* 2 (P2.0 – P2.7)**

Port 2 merupakan port input-output dengan internal pull-up. *Port ini* dapat digunakan sebagai alamat bus baik *byte* tinggi selama adanya akses ke memori program atau memori data luar.Mengeluarkan address tinggi selama pengambilan (fetching) program memory external. Selama pengaksesan ke external data memory, port 2 mengeluarkan isi P2 SFR. Menerima address dan beberapa control selama pemrograman dan verifikasi.

➢ ***Port* 3 (P3.0 – P3.7)**

Port 3 mempunyai fungsi sebagai I/O juga mempunyai fungsi khusus sebagai berikut :

- RD (P3.7), sinyal pembacaan memori data luar.
- WR (P3.6), sinyal penulisan memori data luar.
- T1 (P3.5), masukan dari pewaktu/pencacah 1.
- T0 (P3.4), masukan dari pewaktu/pencacah 0.
- INT1 (P3.3), masukan interrupt 1.
- INT0 (P3.2), masukan interrupt 0.
- TXD (P3.1), keluaran pengiriman data untuk serial *port* (*asynchronous*) atau sebagai keluaran *clock* (*sybchronous*).
- RXD (P3.0), masukan data serial atau sebagai keluaran data.

➢ **Pin 9 : RST/VPD.**

Merupakan pin input yang aktif jika pin aktif tinggi selama dua siklus mesin maka ketika osilator bekerja akan mereset peralatan.

➢ **Pin 30 : ALE (*Address Latch Enable*).**

Pin ALE (aktif tinggi) mengeluarkan pulsa output untuk menyangga (*latch*) satu byte alamat rendah selama mengakses ke memori eksternal. ALE dapat mengendalikan 8 beban TTL. Pin ini juga merupakan input pulsa program yang aktif rendah selama pemrograman EPROM. Pada operasi normal, ALE dikeluarkan pada suatu kecepatan yang konstan yaitu 1/6 dari frekuensi osilator dan dapat digunakan untuk *timing* eksternal atau untuk tujuan membuat *clock*.

- **Pin 29 : PSEN (*Program Strobe Enable*).**

  Pin ini aktof rendah yang merupakan *strobe* pembacaan ke program memori eksternal.

- **Pin 18-19 : XTA1&XTAL2.**

  Pin XTAL1 merupakan pin input ke penguat osilator pembalik dan XTAL2 merupakan pin output dari penguat osilator pembalik.

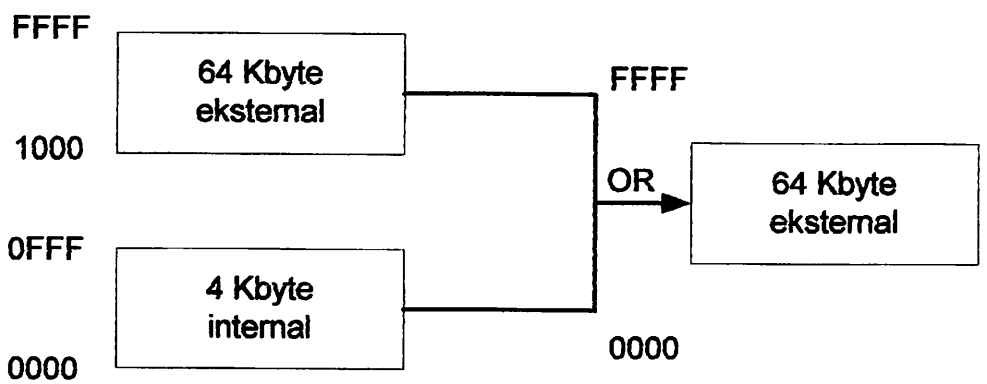
- **Pin 30 : EA,VPP (*External Access/Programming Supply Voltage*).**

  Pin EA di Vcc agar 89S8252 dapat mengakses kode mesin dari program memori.

2.3.4. Organisasi Memori MCU AT89S8252

Mikrokontroler AT89S8252 termasuk keluarga MCS-51 yang memiliki memori program dan memori data yang terpisah. Pemisahan ini dilakukan secara logika sehingga CPU dapat mengakses sampai 64 *Kbyte* memori program dan 64 *Kbyte* memori data. Lebar memori data internal adalah 8 bit dan 16 bit (register PC dan register DPTR).

2.3.4.1. Memori Program



Gambar 2-3. Memori program MCS-51

Sumber : Advanced Microdevices, 1988, 32.

Memori program menggunakan alamat sepanjang 64 *Kbyte* dengan 4 *Kybte* (alamat $0000 sampai dengan $0FFF) yang merupakan memori internal sehingga 60 *Kbyte* merupakan memori eksternal. Dapat menggunakan 64 *Kbyte* memori eksternal sebagaimana yang ditunjukkan pada gambar memori data.

Memori program merupakan tempat penyimpanan data permanen. Memori program lebih dikenal dengan nama *Read Only Memory* (ROM). Data dalam ROM tidak akan terhapus meskipun catu daya dimatikan atau dikenal sebagai sifat *non-volatile*. Karena sifatnya yang demikian ROM dapat digunakan untuk menyimpan program.

Ada beberapa tipe ROM, antara lain :

- ROM (*Read Only Memory*)

  Merupakan memori yang sudah diprogram oleh pabrik (ROM murni).

- PROM (*Programmable Read Only Memory*)

  Merupakan memori yang dapat diprogram oleh pemakai tetapi tidak dapat diprogram ulang.

- EPROM (*Erasable Programmable Read Only Memory*)

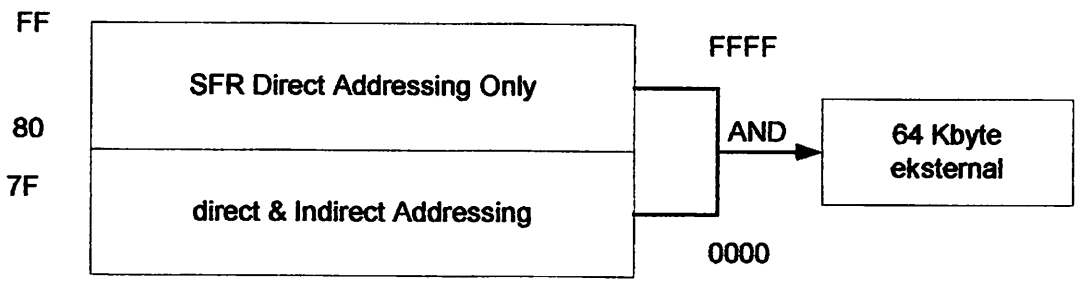
  Merupakan PROM yang dapat diulang. ROM ini juga terdapat pada mikrokontroler 8751, hal ini ditandai dengan adanya jendela kaca pada konstruksi IC 8751 yang digunakan untuk menghapus atau memperbaiki program yang sudah ada.

- EEPROM (*Electrical Erasable Programmable Read Only Memory*)

  Pada prinsipnya hampir sama dengan EPROM, tetapi perbedaaanya terletak pada pengosongan atau penghapusan program. Untuk EPROM

dapat dihapus dengan menggunakan sinar *ultra violet*, sedangkan pada EEPROM pengisian program dapat dilakukan langsung atau menumpuk program lama dengan program yang baru. EEPROM lebih fleksibel dibandingkan EPROM.

2.3.4.2. Memori Data



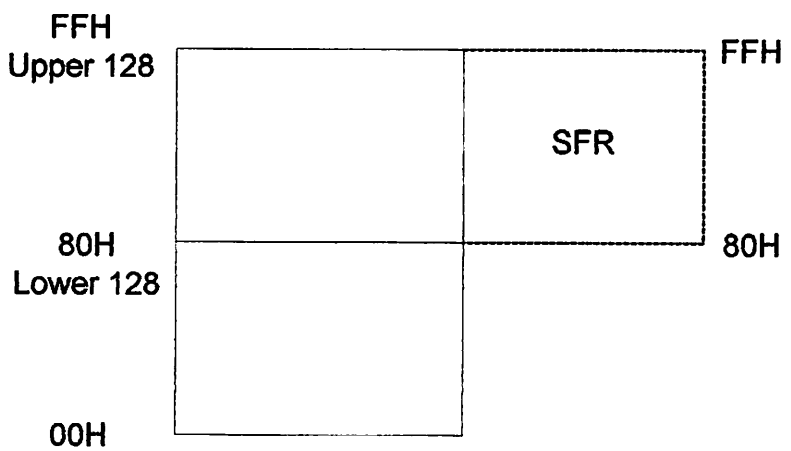
Gambar 2-4. Memori data MCS-51

Sumber : Advanced Microdevices, 1988,33.

Memori data merupakan tempat penyimpanan data yang bersifat sementara atau *volatile*. Dengan kata lain data akan hilang bila tidak dicatu. Memori data lebih dikenal dengan nama RAM (*Random Access Memory*), yaitu dapat dilakukan pembacaan dan penulisan data alamat yang tersedia.

Memori MCS-51 mempunyai 128 *bytes* - 256 *byte* RAM internal ditambah sejumlah register fungsi khusus atau *Special Function Register* (SFR). (*Advanced Mikrodevides*, 1988.1.6). Selain mempunyai memori internal, MCU AT89S8252 mempunyai memori eksternal yang memiliki pengalamatan sampai 64 *Kbytes*.

Pada keluarga mikrokontroler MCS-51, ruang memori data eksternal terbagi menjadi 3 blok yang disebut *lower* 128, *upper* 128 dan ruang SFR, sebagaimana ditunjukkan pada gambar di bawah ini.



Gambar 2-5. Memori Data Eksternal

Sumber : Advanced Microdevices, 1988,16

Pada *lower* 128 lokasi memori dibagi menjadi 3 bagian :

1. Register bank 0 – 3

   Lokasi bank register dimulai dari alamat 00h – 1h yang terdiri dari 32 *bytes*. Register bank ini terdiri dari 4 buah register 8 bit yang dapat dipilih melalui pengaturan *program status word* register.

2. Bit *Addressing*

   Terdiri dari 16 *bytes* yang dimulai dari 20h – 2fh. Masing-masing dari 128 bit lokasi ini dapat dialamati secara langsung yaitu dari $00h sampai $7fh.

3. *Scratch Pad Area*

Lokasi dari alamat $30h sampai $7fh atau sebanyak 80 *bytes* yang dapat digunakan sebagai alamat bagi RAM.

Pada 128 *bytes* atas (*upper* 128) ditempati oleh register yang mempunyai fungsi khusus yang disebut dengan *Special Fuction Register* (SFR). Ruang dari register fungsi khusus ini adalah dari 80h sampai FFh. Berikut ini adalah contoh isi vector alamat pada *Special Function Register.*

- Akumulator (Acc) atau register A dan register B.

  Kedua register tersebut digunakan untuk operasi perkalian dan pembagian.

- *Program Status Word*

  Register ini meliputi bit-bit : CY (*Carry*), AC (*Auxillary Carry*), FO sebagai flag, RS0 dan RS1 untuk pemilih register bank, OV (*Over Flow*), dan *parity flag.*

- *Stack Pointer* (SP)

  SP merupakan register yang digunakan untuk penunjuk alamat. Register ini berguna apabila digunakan suatu *routine* pada program utama.

- *Data Pointer High* (DPH) dan *Data Pointer Lower* (DPL)

  DPTR adalah register yang digunakan untuk pengalamatan tidak langsung. Register ini digunakan untuk mengakses memori program baik internal maupun eksternal. DPTR dikontrol oleh 2 buah register 8 bit yaitu DPH dan DPL.

- *Port 0, Port 1, Port 2, Port 3*

  Pada keluarga 8051 masing-masing *port* dapat dialamati langsung baik secara *byte* atau bit. Masing-masing *port* merupakan *port bi-directional* (*input/output*) :

  1. *Port* 0 digunakan sebagai pengalamatan memori dari luar.
  2. *Port* 1 digunakan sebagai I/O dari mikrokontroler.
  3. *Port* 2 digunakan sebagai pengalamatan memori dari luar.
  4. *Port* 3 berisi sinyal kontrol seperti *interrupt serial*, WR, dan RD.

- *Register Prioritas Interrupt* (*Interrupt Priority Register* /IP).

  Merupakan register yang berisi bit-bit untuk mengaktifkan prioritas dari suatu *interrupt* yang ada pada mikrokontroler pada taraf yang diinginkan.

- *Interrupt Enable Register*

  Merupakan register yang berisi bit-bit untuk menghidupkan atau mematikan sumber-sumber *interrupt*.

- *Timer/Counter Control Register*

  TCON merupakan register yang berisi bit-bit memulai atau menghentikan pencacah atau pewaktu.

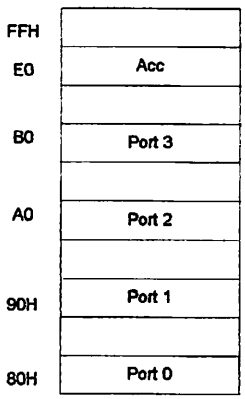
- *Serial Control Buffer*

  Register ini digunakan untuk menampung data masukan (SBUF *in*) atau keluaran (SBUF *out*) dari *serial port.*

Tabel 2-2 Pembagian alamat pada SFR

SYMBOL	NAME	ADDRESS
ACC	ACCUMULATOR	0E0H
B	B REGISTER	0F0H
PSW	PROGRAM STATUS WORD	0D0H
SP	STACK POINTER	81H
DPTR	DATA POINTER 2 BYTE	
DPL	LOW BYTE	82H
DPH	HIGH BYTE	83H
P0	PORT 0	80H
P1	PORT 1	90H
P2	PORT 2	0A0H
P3	PORT 3	080H
IP	INTERRUPT PERIORITY CONTROL	088H
IE	INTERRUPT ENABLE CONTROL	0ABH
TMOD	TIMER/COUNTER MODE CONTROL	89H
TCON	TIMER/COUNTER CONTROL	88H
+TCON	TIMER/COUNTER 2 CONTROL	0CBH
TH0	TIMER/COUNTER 0 HIGH CONTROL	8CH
TL0	TIMER/COUNTER 0 LOW CONTROL	8DH
TH1	TIMER/COUNTER 1 HIGH CONTROL	8DH
TL1	TIMER/COUNTER 1 LOW CONTROL	8CH
TH2	TIMER/COUNTER 2 HIGH CONTROL	0CDH
TL2	TIMER/COUNTER 2 LOW CONTROL	0CCH
RCAP2H	T/C 2 CAPTURE REG. HIGH BYTE	0CBH
+RCAP2L	T/C 2 CAPTURE REG. LOW BYTE	0CAH
SCON	SERIAL CONTROL	98H
SBUF	SERIAL DATA BUFFER	99H
PCON	POWER CONTROL	87H

Adapun diagram blok dari SFR adalah sebagai berikut :



Gambar 2.6. Ruang *Special Function Register*

Sumber : Eksperimen dengan Mikrokontroler, 1999,13

2.3.4.3. SFR Tambahan Pada AT89S8252

Selain memiliki SFR *(Special Function Register)* seperti halnya pada MCS-51, mikrokontroller AT89S8252 memiliki tambahan SFR. Hal ini tak lain karena adanya fitur tambahan pada mikrokontroller AT89S8252.

SFR tambahan ini meliputi : T2CON (Timer 2 Register dengan alamat 0C8H), T2MOD (Timer 2 Mode dengan alamat 0C9H), WMCON (Watchdog and Memory Control Register dengan alamat 96H), SPCR (SPI Control Register dengan alamat D5H), SPSR (SPI Status Register dengan alamat AAH), SPDR (SPI Data Register dengan alamat 86H)

2.3.4.3.1. SFR Untuk Timer 2

Mikrokontroler AT89S8252 terdapat tambahan sebuah Timer/Counter yang diberi nama Timer 2 (sehingga AT89S8252 memiliki 3 Timer/Counter yaitu

Timer/Counter 0, Timer/Counter 1, Timer/Counter 2). Pada Timer/Counter 2 ini dikendalikan oleh SFR yang bernama T2CON (Timer 2 Control), T2MOD (Timer 2 Mode) dan sepasang register RCAP2H, RCAP2L yang merupakan register *capture/reload* untuk Timer 2 dalam 16-bit *capture mode/auto-reload mode.*

2.3.4.3.2. SFR Untuk Watchdog dan Memori

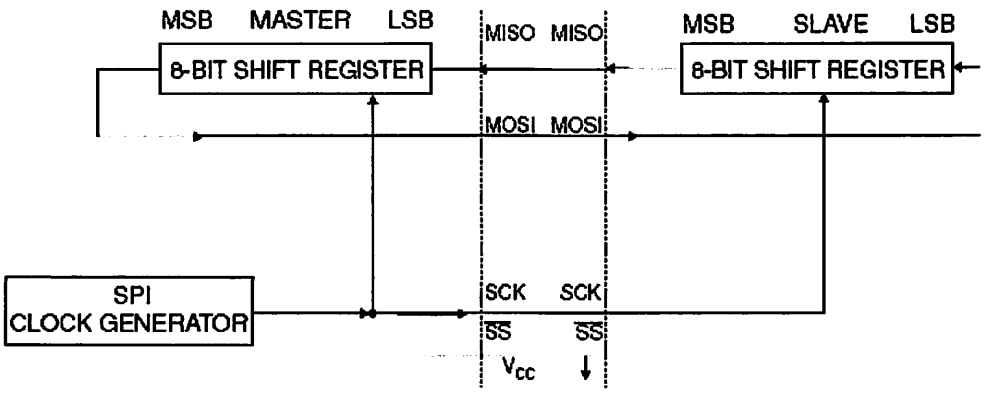
Untuk menggunakan Watchdog Timer/Memori, maka dapat dilakukan dengan mengatur SFR yang bernama WMCON dengan alamat 96_H.

2.3.4.3.3. SFR Pengontrol SPI

Berbeda dengan mikrokontroler MCS-51, AT89S8252 memiliki fasilitas SPI (*Serial Peripheral Interface*). Fasilitas ini memungkinkan transfer data kecepatan tinggi secara sinkron antara mikrokontroler dengan peripheral atau antar mikrokontroler AT89S8252. Fitur ini meliputi :

a. *Full Duplex*, 3 kawat dengan transfer data secara sinkron
b. Operasi Master atau Slave
c. Frekuensi maksimum 6 MHz
d. 4-bit rate terprogram
e. Sistem data transfer MSB dahulu atau LSB
f. Write Collision Flag Protection

Gambar berikut menunjukkan hubungan antara CPU master dan slave.



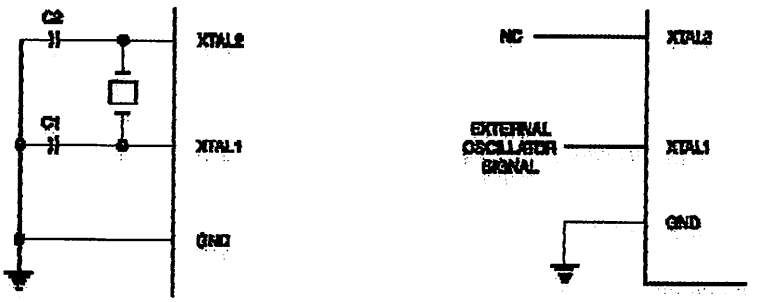
Gambar 2-7. SPI Master-slave Interconnection

Sumber : Datasheet Atmel

2.3.4.3.4. Osilator

Jantung dari AT89S8252 adalah rangkaian yang membangkitkan pulsa clock yang mensinkronkan semua operasi internal. Mikrokontroler AT89S8252 memiliki osilator internal (*on-chip oscilator*) yang dapat digunakan sebagai sumber pewaktu (clock) bagi CPU. Untuk menggunakan osilator internal diperlukan sebuah kristal atau resonator keramik antara pin $XTAL_1$ dan $XTAL_2$ dan sebuah kapasitor ke ground. $XTAL_2$ dan $XTAL_1$ secara berurutan merupakan input dan output dari sebuah inverting amplifier yang dapat dikonfigurasikan penggunaannya sebagai *on-chip oscillator* seperti yang ditunjukkan pada gambar 2.12a.

Untuk memberikan IC AT89S8252 sumber clock eksternal, maka pin $XTAL_2$ dibiarkan tidak berhubungan dengan sumber clock eksternal dan $XTAL_1$ dihubungkan dengan sumber clock eksternal seperti pada gambar 2.12b.



a). *Oscillator Connector* b). *External Clock Drive Configuration*

Gambar 2-8. Karakteristik Osilator

Sumber : Data Sheet AT89S8252

2.3.4.3.5. Timer dan Counter

Dalam mikrokontroler AT89S8252 terdapat 3 buah pewaktu/pencacah (Timer/Counter) 16-bit yang dapat diatur melalui perangkat lunak, yaitu pewaktu/pencacah 0 dan pewaktu/pencacah 1. Timer/Counter ini diatur oleh SFR (*Special Function Register*) yaitu Timer/Counter Control (TCON dengan alamat 88_H) dan Timer/Counter Mode Control (TMOD dengan alamat 89_H). Selain itu nilai byte bawah dan byte atas dari Timer/Counter disimpan dalam register TL dan TH.

Jika difungsikan sebagai Timer, maka akan menggunakan sistem clock sebagai sumber masukan pulsanya. Jika sebagai Counter (pencacah), maka akan menggunakan pulsa dari luar (eksternal) sebagai masukan pulsanya. Pada port 3 terdapat fungsi khusus yaitu T0 (masukan luar untuk Timer/Counter 0) dan T1 (masukan luar untuk Timer/Counter 1). Pemilihan mode Timer/Counter dikontrol oleh register TMOD. Dengan memberikan nilai tertentu pada regiater TMOD,

dapat dipilih mode operasi untuk Timer/Counter 0 dan Timer/Counter 1 seperti terlihat dalam tabel.

Tabel 2-3. Mode Operasi Timer/Counter 0 dan 1

Mode	Timer/Counter 0	Timer/Counter 1
0	13-bit Timer	13-bit Timer
1	16-bit Timer	16-bit Timer
2	8-bit auto-reload	8-bit auto-reload
3	Dua 8-bit Timer	Tidak bekerja

Pada mikrokontroler terdapat tambahan Timer 2. Timer yang lain adalah Timer 0 dan Timer 1. Timer 2 ini merupakan Timer/Counter 16-bit dan memiliki 3 mode operasi yaitu *capture, auto-reload* (*up-down counting*) dan *baund rate generator*. Untuk memilih mode ini dilakukan dengan mengatur bit pada SFR T2CON (Timer 2 Control Register). Timer 2 ini terdiri dari 2 buah Timer 8-bit register yaitu TH2 dan TL2. Pada fungsi Timer, register TL2 dinaikkan (*increament*) tiap siklus mesin. Karena siklus mesin terdiri dari 12 periode osilasi, maka *count rate* menjadi 1/12 dari frekuensi osilator. Sedangkan pada fungsi Counter, register dinaikkan berdasarkan tanggapan adanya transisi tinggi ke rendah pada pin yang bersesuaian (dalam hal ini pin T2 atau P1.0). Tabel berikut menunjukkan mode operasi yang dapat dijalankan pada Timer 2.

Tabel 2-4 Mode Operasi Timer 2

RCLK + TCLK	CP/RL2	TR2	MODE
0	0	1	16-bit auto-reload
0	1	1	16-bit capture
1	X	1	Baund Rate Generator
X	X	0	Off

Keterangan[1] :

RCLK = *Receive Clock Enable.* Jika dieset menyebabkan serial port menggunakan pulsa *overflow* Timer 2 sebagai detak penerimaan pada serial port. Jika RCLK = 0, maka Timer 1 yang digunakan

TCLK = *Transmit Clock Enable.* Jika diset menyebabkan serial port menggunakan pulsa overflow Timer 2 sebagai detak pengiriman. Jika TCLK = 0, maka pulsa *overflow* Timer 1 yang digunakan

CP/RL2 = Pemilihan *Capture/Reload.* Jika diset maka proses *capture* yang terjadi sedangkan jika bit ini diclear maka proses *reload*

2.3.4.3.6. Sistem Interrupt

AT89S8252 memiliki 6 buah sumber interupsi, 2 eksternal interupsi (INT0 dan INT1), 3 Timer interupsi (Timer 0,1 dan 2) dan satu serial port interupsi.

INT0 = interrupt pada P3.2 (kaki 12)

INT1 = interrupt pada P3.3 (kaki 13)

Timer 0 = Timer pada P3.4 (kaki 14)

Timer 1 = Timer pada P3.5 (kaki15)

Port serial = jika pengiriman/penerimaan suatu frame telah lengkap

Saat terjadinya interupsi, mikrokontroler secara otomatis akan menuju *subroutine* pada alamat tersebut. Setelah interupsi servis selesai dikerjakan, mikrokontroler akan mengerjakan program semula. Dua sumber eksternal adalah INT0 dan INT1, kedua interupsi eksternal akan aktif, transisi tergantung isi IT0 dan IT1 pada register TCON. Interrupt T0 dan T1 aktif pada saat Timer yang sesuai mengalami *roll over*. Interupsi serial akan dibangkitkan dengan melakukan operasi OR pada R1 dan T1 tiap-tiap sumber interupsi dapat *enable* atau *disable* secara *software*. Tingkat prioritas semua sumber interupsi dapat diprogram sendiri-sendiri dengan set atau *clear bit* pada SFR IP (*interrupt priority*). Register yang akan berperan dalam mengatur aktif tidaknya interupsi adalah Interrupt Enable Register.

2.4.1 Metode Pengalamatan

Metode pengalamatan yang digunakan pada MCS-51 terbagi menjadi dua jenis, yaitu pengalamatan langsung dan pengalamatan tidak langsung. (Moh. Ibnu Malik, 1997:36)

ϕ *Pengalamatan Tak Langsung*

Operasi pengalamatan tak langsung menunjukkan ke sebuah register yang berisi lokasi alamat memori yang akan digunakan dalam suatu operasi. Lokasi

yang nyata tergantung dari isi register saat instruksi dijalankan. Untuk melakukan pengalamatan tak langsung digunakan simbol @. Misalnya :

- ADD A, @R0 : tambahkan isi R0 dengan Acc dan hasilnya di Acc
- DEC @R1 : kurangi isi dari alamat R1

ϕ *Pengalamatan Langsung*

Pengalamatan langsung dilakukan dengan memberikan nilai ke suatu register secara langsung. Untuk melakukan hal tersebut digunakan tanda #. Misalnya:

- MOV A,#01H : isi Acc dengan data 01H
- MOV DPTR,#19H : isi DPTR dengan data 19H

Pengalamatan data langsung dari 0 sampai 127 akan mengakses RAM internal, sedangkan pengalamatan dari 128 sampai 255 akan mengakses register perangkat keras. Misalnya :

- MOV P3,A : pindahkan isi Acc ke alamat *Port* 3 (B0H)
- INC 50 : naikkan lokasi 50 (desimal) dalam memori

2.4.2 Bahasa Assembler MCS-51

Bahasa assembler digunakan dalam setiap operasi CPU dalam bentuk bahasa simbol yang disusun berurutan dalam pernyataannya. Masing-masing pernyataan akan diterjemahkan ke dalam instruksi bahasa mesin atau sering

disebut *operation code/opcode*. Dalam penulisan bahasa mesin ini, terdapat berbagai macam kelompok instruksi, diantaranya :

- Perpindahan Data

  Instruksi ini digunakan untuk memindahkan data antar register, memori, register-memori, antar muka register dan antar muka memori.

  Contonya: MOV A,R0 : memindahkan isi register R0 ke Acc.

  MOV A,@R0 : memindahkan isi alamat R0 ke Acc.

- Operasi Aritmatika

  Instruksi ini melaksanakan operasi aritmatika yang meliputi penjumlahan, pengurangan, perkalian, maupun pembagian.

  Contohnya: ADD A,#data : menambah Acc dengan data.

  ADC A,#data : menambah Acc dengan data dan carry.

  INC R6 : menambah isi R6 dengan 1.

  DEC R7 : mengurangi isi R7 dengan 1.

  MUL AB : mengalikan isi Acc dengan isi register B.

  DIV AB : membagi isi Acc dengan isi register B.

- Operasi Percabangan

  Instruksi ini mengubah urutan normal pelaksanaan suatu program untuk melaksanakan pada lain tempat yang kita perlukan pada saat itu. Contohnya:

1. CJNE (*Compare Jump Not Equal*)

   Instruksi ini membandingkan isi lokasi memori tertentu dengan isi Acc, jika sama instruksi ini selanjutnya akan dieksekusi. Jika tidak sama eksekusi akan kembali ke alamat kode yang telah ditunjuk.

2. JB (*Jump if Bit Set*)

   Instruksi ini akan menguji suatu alamat bit isi satu, eksekusi akan menuju ke alamat kode dan jika tidak instruksi akan dilanjutkan.

3. JNB (*Jump if Bit Not Set*)

   Instruksi ini menguji suatu alamat bit. Jika berisi 0 maka eksekusi akan menuju ke alamat kode. Jika berisi 1 maka instruksi selanjutnya yang akan dieksekusi.

2.5 Komunikasi Serial

Dalam dunia komunikasi ada dua cara pemindahan data yaitu secara paralel dan serial. Perbedaan dua cara tersebut terletak pada jumlah bit yang dipindahkan. Setiap data merupakan kelompok dari bit-bit tersebut, dikenal dengan istilah *byte* yang merupakan kelompok yang terdiri dari 8 bit, serta *word* yaitu kelompok yang terdiri dari 16 bit.

Pada komunikasi serial terjadi pemindahan data satu bit pada satuan waktu, sedangkan pada komunikasi paralel terjadi pemindahan data secara berurutan dari sekelompok bit pada satuan waktu.

Ditinjau dari arah komunikasi data, dikenal ada tiga cara, yaitu: komunikasi *simplex*, *half duplex* dan *full duplex*.

1. Komunikasi *simplex* adalah sistem komunikasi data yang arah perpindahan datanya satu arah saja.
2. Komunikasi *half duplex* adalah sistem komunikasi data yang arah perpindahan datanya dua arah, namun proses pemindahannya tidak bersamaan.
3. Komunikasi *full duplex* adalah sistem komunikasi yang arah perpindahan datanya dua arah secara bersamaan.

Yang dimaksud dengan komunikasi secara serial adalah komunikasi dengan memanfaatkan hanya satu saluran sinyal untuk pengiriman dan penerimaan data. Untuk data digital yang merupakan serangkaian bit maka data dikirimkan bit per bit. Pengiriman akan dimulai dari LSB (*Least Significant Bit*), dan diakhiri dengan MSB (*Most Significant Bit*). Setiap karakter yang dikirimkan disusun sesuai dengan suatu urutan bit tertentu.

2.6 Metode Transmisi Serial

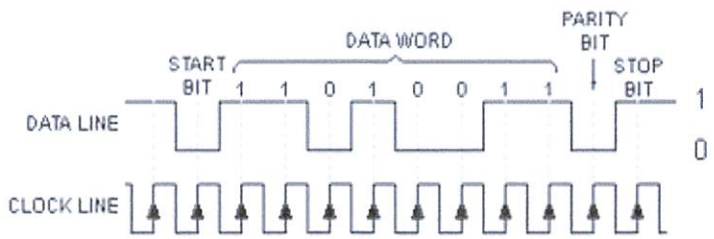
Ada dua metode transmisi serial yang digunakan yaitu:

1. Komunikasi Serial *Sinkron* (*Synchronous Serial Communication*)

Pada komunikasi metode ini, pengiriman dan penerimaan akhir komunikasi adalah secara sinkron atau serempak menggunakan *clock* yang tepat, waktu dalam periode terpisah tiap bit dengan pengeceken *clock* pada penerimaan akhir. Salah satu aspek penting pada metode ini jika akhir dari komunikasi kehilangan sinyal *clock*, maka komunikasi akan *terminasi.*

2. Komunikasi Serial *Asinkron* (*Asynchronous Serial Communication*)

Komunikasi metode ini sinyal *clock* pengirim dan penerima data tidak harus *sinkron* untuk setiap bit data yang ditransmisikan. Karena itu sinyal *clock* tidak perlu dikirimkan. Hal ini bukan berarti tidak ada usaha *sinkronisasi* sama sekali antara pengirim dan penerima data. *Sinkronisasi* dilakukan dengan pengiriman sebuah bit awal *(bit start)* sebelum serangkaian bit data dikirimkan. Agar selama penerimaan data, *clock* penerima tidak melesat jauh, maka jumlah bit data dalam satu kali pengiriman harus dibatasi. Umumnya batasan maksimal 8 bit data (*1 byte*) dalam satu kali pengiriman. Oleh sebab itu komunikasi serial *asinkron* biasanya digunakan pada perangkat yang menghasilkan data dengan laju rendah. Kemudian untuk menjamin adanya transisi sinyal minimal satu kali diantara dua pengiriman rangkaian bit data, maka pengiriman data perlu diakhiri dengan bit penutup *(bit stop)* yang memiliki polaritas yang berbeda dengan bit pembuka.



Gambar 2-9. Asynchronous Serial Data Frame (8E1)

(Sumber: www.google.com)

Bagian penting yang lain pada setiap sinyal serial *asinkronous* adalah *bit rate* pada data yang dikirimkan. Kecepatan data yang diterima didasarkan pada kecepatan minimum 300bps (*bit per second*).

2.7 Perencanaan Perangkat Keras Modulator Demodulator

Sinyal digital pada komputer(data) yang akan dikirimkan atau ditransnisikan secara jarak jauh harus dimadulasikan dengan sinyal analog. Pada dasarnya ada tiga metode atau teknik untuk memodulasi data ke gelombang pembawa, yaitu ASK, FSK dan PSK. Dalam tugas akhir ini kami hanya membahas teknik modulasi dan demodulasi FSK

Modulasi FSK *(Frekuensi Shift Keying)* adalah modulasi yang menyatakan sinyal digital 1 sebagai nilai tegangan dengan frekuensi tertentu (misalnya 1200Hz) sementara sinyal digital 0 dinyatakan sebagai suatu nilai tegangan dengan frekuensi tertentu yang berbeda (misalnya 2200Hz). Sistem FSK ini sangat berguna dan menguntungkan karena pengaruh desah dan interfensi sangatlah kecil.

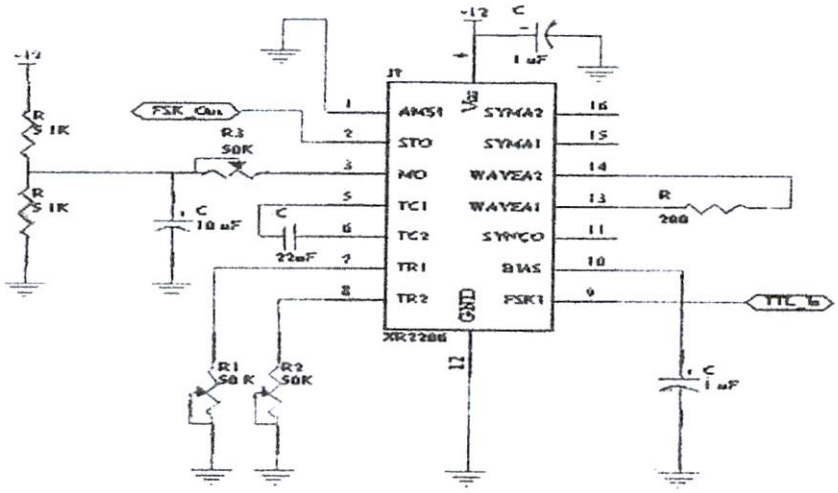
2.7.1 XR-2206 (Modulator FSK)

Rangkaian untuk membangkitkan FSK XR-2206 yang diaplikasikan sebagai FSK generator dengan kecepatan 1200bps menggunakan frekuensi *mark*1200Hz dan *space* 2200Hz dapat bekerja dengan dua buah *timing resistor* R1 dan R2 yang dihubungkan pada pin 7 dan pin 8, dan ditentukan oleh pemilihan kapasitor eksternal yang dihubungkan antara pin 5 dan pin 6. *Timing resistor* ini bekerja bergantian sesuai dengan level tegangan pada pin 9. jika pin 9 diberi tegangan bias $\geq$ 2 V (logika 1), maka hanya R1 yang bekerja. Sebaliknya jika pin 9 diberi tegangan $\leq$ 1 V (logika 0), maka hanya R2 yang bekerja. Sehingga

frekuensi keluaran (pin no.2) berubah-ubah diantara dua frekuensi f1 dan f2. Besarnya f1 dan f2 dapat ditentukan dengan persamaan :

f1 = 1/(R1.C),

f2 = 1/(R2.C)



Gambar 2-10. Komponen modulator XR-2206

(Sumber: www.exar.com)

Frekuensi osilasi fo, ditentukan oleh timing kapasitor yang terhubung dengan pin 5 dan pin 6 serta oleh timing resistor R1 dan R2 yang terhubung dengan pin 7 dan pin 8, dengan ketentuan

$$fo = 1/RC \text{ Hz}$$

Mempertimbangka nilai R yang disarankan antara 4 KΩ – 20 KΩ, diinginkan agar nilai timing resistor R1 dan R2 dengan frekuensi (*mark)* pada f1 = 1200 Hz dan biner 0 (*space*) pada f2 = 2200 Hz dalam jangkauan 10kΩ sampai 50kΩ Nilai kapasitor C diperoleh setelah memasukkan nilai-nilai variable yang

telah diketahui yauitu R1, R2, dan f dengan mempertimbangkan nilai komponen kapasitor yang disarankan pada datasheet dan nilai komponen standart.

Adapun perhitungan untuk menetukan nilai komponen eksternal dari modulator FSK sebagai berikut:

Untuk nilai R1=50KΩ dan f1=1200Hz

$$F1= \frac{1}{R1.C}$$

Setelah memperoleh komponen C dengan f2 = 2200 Hz dapat menentukan nilai R2 senagai nerikut

$$R2 = \frac{1}{f2.C}$$

2.7.2 XR-2211 (Demodulator FSK)

Rangkaian demodulator berfungsi mengubah sinyal FSK yang diterima walky talky menjadi data biner. Untuk mendemodulasikan sinyal FSK tersebut digunakan IC XR-2211. XR-2211 adalah sebuah IC *monolithic phase locked loop* yang dirancang untuk komunikasi data khususnya aplikasi modem FSK.

Demodulator FSK dirancang untuk mendemodulasi sinyal FSK dengan frekuensi biner 1 (*mark*) 1200 Hz dan biner 0 (*space*) 2200 Hz dengan kecepatan 1200bps. Untuk mendemodulasi sinyal FSK dengan frekuensi tersebut maka pemilihan nilai-nilai komponen eksternal sntsrs lain:Ro, R1, Co, C1, Cf.

Adapun perhitungan untuk sistem demodulator yang akan dibuat dikemukakan dalam perhitungan berikut:

1. Menetukan PLL counter frekuensi

   $Fo = \sqrt{f1.f2}$

2. Menghitung timing resistor dengan Ro = 10k dan VR Rx = 10k

   $Ro = Ro + \frac{Rx}{2}$

3. Menghitung nilai Co

   $Co = \frac{1}{Ro.Co}$

4. Menghitung nilai R1

   $R1 = \frac{Ro.fo}{(f1 - f2)} 2$

5. menghitung nilai C1

   $C1 = \frac{1250.Co}{R1.^{2}}$

6. Menghitung nilai Rf (paling sedikit 5 kali nilai R1)

   Rf = R1 . 5

7. Menghitung nilai Rb (nilainya paling sedikit 5 kali nilai Rf)

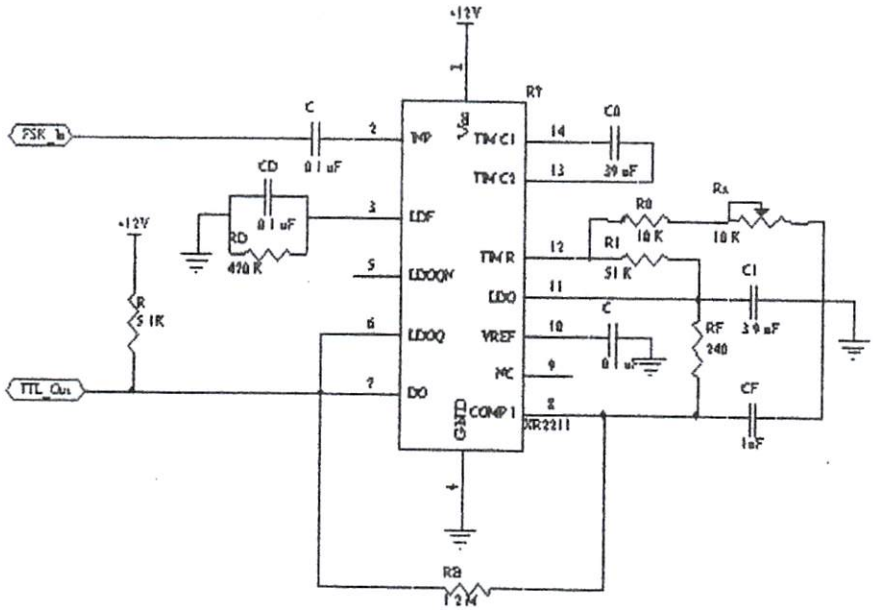
   Rb = Rf . 5

8. Menghitung Rsum

   $Rsum = \frac{(Rf + RI).Rb}{(Rf + R1 + Rb)}$

9. Menghitung nilai Cr

   $Cr = \frac{0{,}25.}{(Rsum.Boudrate}$



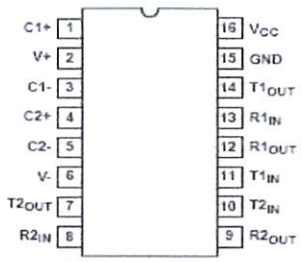
2-11. Komponen Demodulator XR-2211
(Sumber: www.exar.com)

Pada gambar di atas pin no. 2 (*FSK Input*) pada IC XR-2211 merupakan sinyal masukan demodulator yang berasal dari sinyal keluaran HT (*speaker*) dimana pada pin ini sinyal berupa sinyal FSK, dan pin no. 7 (*Data Output*) merupakan sinyal keluaran digital, disini mengalami proses demodulasi (data biner) yang dihubungkan pada komputer atau minimum sistem.

2.8 Interface RS-232

Interface jika diterjemahkan, mungkin akan mengandung arti sebagai antarmuka. Dalam suatu sistem komputer apabila ada alat yang dihubungkan akan dapat mengganggu komputer tersebut. Sinyal-sinyal yang tidak dikenal akan merusak rangkaian komputer. Untuk itu, dibutuhkan suatu *Interface* yang

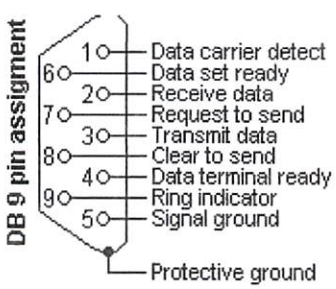
berfungsi sebagai antarmuka dua lingkungan yang berbeda. *Interface* merupakan semacam pintu gerbang dikenal sebagai *I/O Port*.



Gambar 2-12. IC RS 232

a) Konfigurasi Pin

Sebuah komputer atau peralatan lain akan dapat bertukar informasi melalui *Interface port I/O* serial yang disebut *Interface* RS 232. RS 232 merupakan suatu *Interface* antara terminal data dan peralatan komunikasi data yang menggunakan data biner serial sebagai data yang ditransmisikan. RS 232 mengirim dan menerima data dengan kecepatan di atas 120kbps, bahkan kecepatannya mampu mencapai 250 kbps. Salah satu konektor yang biasa digunakan adalah konektor DB 9 seperti ditunjukkan gambar berikut



Gambar 2-13. Konektor DB 9

(Sumber: www.dallas%20semiconductor.com

Pada dasarnya semua pin-pin mimiliki fungsi yang berbeda, tetapi tidak semua digunakan. Fungsi-fungsi pin konektor DB 9 tertera pada tabel 2.1. berikut.

Tabel 2-5. Konfigurasi Pin DB 9

DB-9 Pin	Signal	Function
2	RD	Received data
3	TD	Transmitted data
8	CTS	Clear to send
7	RTS	Request to send
6	DSR	Data set ready
5	SG	Signal ground
4	DTR	Data terminal ready
1	DCD	Data carrier detect

(Sumber: www.google.com)

Sinyal yang dikeluarkan oleh komputer serial secara DCE maupun DTE adalah:

- RTS *(Request To Send)*

  Sinyal ini digunakan oleh PC untuk memberitahu kepada modem bahwa PC akan mengirim data. Apabila modem dalam kondisi siap, maka modem akan memberikan sinyal CTS.

- CTS *(Clear To Send)*

  Sinyal yang dikirimkan modem untuk memberitahu kepada PC bahwa telah dapat dilakukan pengiriman data.

- DTR *(*Data *Terminal Ready)*

  Sinyal yang digunakan oleh PC untuk memberitahu kepada modem bahwa PC siap menerima data dari modem.

- DSR *(*Data *Set Ready)*

  Sinyal yang digunakan modem sebagai tanggapan dari sinyal DTR, dengan sinyal ini PC akan tahu modem dalam kondisi ON.

- RI *(Ring Indication)*

  Sinyal indikator yang digunakan untuk memberitahu pada PC bahwa ada sinyal dering dari line telepon.

- TxD (*Transmitted* Data)

  Sinyal yang digunakan modem untuk memberitahu bahwa data sudah dikirim.

- RxD (*Receive* Data)

  Sinyal yang digunakan modem untuk memberitahu bahwa data sudah diterima.

b) Karakteristik Sinyal Listrik *Interface* RS 232

CCITT telah merekomendasikan karakteristik sinyal listrik pada rangkaian *Interface* V-24 . Karakteristik sinyal listrik yang dimaksudkan adalah batas-batas tegangan yang digunakan. Dalam rekomendasi tersebut dibedakan antara sinyal

data dan sinyal kontrol, sinyal data sebagai logika '0' dan '1', sedangkan sinyal kontrol dinyatakan dengan ON dan OFF. Sinyal-sinyal tersebut mempunyai batas-batas (daerah) tegangan yang ditunjukkan pada tabel 2.2.

Tabel 2-6.Tabel Karakteristik Sinyal Listrik Protokol RS 232

Sinyal	Nilai	Daerah Tegangan
Sinyal data	1	$-3V \geq Vp \geq -15V$
	0	$+3V \leq Vp \leq +15V$
Sinyal control	ON	$+3V \leq Vp \leq +15V$
	OFF	$-3V \geq Vp \geq -15V$

(Sumber : P. C. Den Heijer, R. Tolsma, 1991: 133)

Dalam standar RS232, tegangan antara +3 sampai +15 Volt pada input *Line Receiver* dianggap sebagai *level* tegangan '0', dan tegangan antara –3 sampai –15 Volt dianggap sebagai *level* tegangan '1'.

Untuk mengurangi kemungkinan terjadinya gangguan '*cross talk*' antara kabel saluran sinyal RS 232, kecuraman perubahan tegangan sinyal dibatasi tidak boleh lebih dari 30 Volt/mikro-detik, makin besar kecuraman sinyal, makin besar pula kemungkinan terjadi '*cross talk*'. Di samping itu ditentukan pula kecepatan transmisi data seri tidak boleh lebih besar dari 20 KiloBit/Detik. Impedansi saluran dibatasi antara 3 Kilo-Ohm sampai 7 Kilo-Ohm, dalam standar RS232 yang pertama ditentukan pula panjang kabel tidak boleh lebih dari 15 Meter (50 feet), tapi ketentuan ini sudah di-revisi pada standar RS232 versi 'D'. Dalam ketentuan baru tidak lagi ditentukan panjang kabel maksimum, tapi ditentukan

nilai kapasitan dari kabel tidak boleh lebih besar dari 2500 pF, sehingga dengan menggunakan kabel kualitas baik bisa dicapai jarak yang lebih dari 50 *feet*.

c) Protokol Komunikasi pada RS 232

Beberapa protokol pada *Interface* RS 232 adalah:

- *Start Bits*

  Merupakan sebuah bit dengan logic '0', bit ini yang menandakan bahwa akan ada karakter atau data yang mengikutinya. Bit ini langsung diberikan oleh sinyal *device* tanpa harus mengeset terlebih dahulu.

- *Data Bits*

  Merupakan bit yang mewakili dari karakter yang diikutinya, data bit ini dapat diset sepanjang antara 5 sampai 8 bit.

- *Parity Bits*

  Merupakan bit yang digunakan sebagai *error checking* pada *receiver*. *Parity bit* akan menghitung jumlah data yang berlogika '1' pada data bit. Perhitungan jumlah data bit tersebut tergantung dari jenis *parity* yang diset. Untuk *parity 'even'*, jumlah data bit yang berlogika '1' ditambah dengan *parity bit* akan menghasilkan jumlah yang ganjil. Sedangkan untuk *parity 'mark'*, merupakan *parity bit* yang selalu berlogika '1' begitu pula pada space, *parity* bit selalu berlogika ' 0' dan *parity 'none'* merupakan *parity bit* yang diabaikan.

- *Stop Bits*

  Merupakan bit yang menandakan akhir dari suatu paket data (biasanya 1 *byte* data). Seperti pada data bit, bit ini langsung diberikan dari serial *device*. *Stop bit* ini dapat diset menjadi satu bit, satu setengah dan dua bit.

- *Boud Rate*

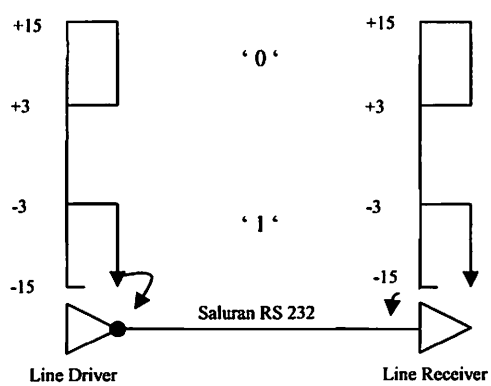
  Baud Rate digunakan untuk menjukkan kecepatan dari transmisi (bits per second)

RS MAX 232 tersusun 2 bagian yaitu : RS 232 line driver yang berfungsi mengubah level tegangan TTL ke level tegangan RS 232 dan RS 232 linereceiver yang berfungsi mengubah tegangan RS 232 ke level tegangan TTL.

Standard RS 232 ditetapkan oleh Electronic Industry Association dan Telecomonication Industry Association pada tahun 1962. Standard ini hanya menyangkut komunikasi data antara komputer (Data terminal Equipment – DTE) deengan alat-alat pelengkap lainnya (Data Circuit – terminating Equipment – DCE).

Ada 3 hal pokok yang diatur standard RS 232, antara lain adalah:

1. Bentuk sinyal dan level tegangan yang dipakai



Level tegangan sinyal RS 232 adalah seperti terlihat pada ganbar. Dalam standard RS 232 ,tegangan antara +3 sampai +15 volt baik pada sinyal input line receiver maupun pada line driver dianggap sebagai tegangan '0', dan tegangan antara -3 sampai-15 volt dianggap sebagai tegangan '1'.

2. Penentuan jenis sinyal dan konektor yang dipakai, serta susunan sinyal pada kaki-kaki di konektor. Jenis-jenis sinyal yang dipakai mengatur pertukaran informasi antara DTE dan DCE, semuanya terdapat 24 jenis sinyal tetapi yang umum dipakai hanyalah 9 jenis sinyal.
3. Penentuan tata cara pertukaran antara computer dan alat-lat pelengkapnya maupun alat-alat digital.

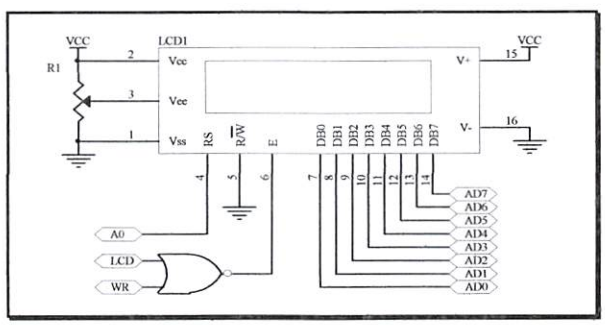
2.9. LCD

Liquid Crystal Display atau LCD merupakan komponen optoelektronik yaitu komponen yang bekerja atau dipengaruhi oleh sinar (optolistrik), komponen pembangkit cahaya (light emiting) dan komponen-komponen yang akan mengubah sinar. LCD terbuat dari bahan kristal cair yang merupakan suatu komponen organik dan mempunyai sifat optik seperti benda padat meskipun bahan tetap cair.

Sel kristal cair terdiri dari selapis bahan kristal cair yang diapit antara dua kaca tipis yang transparan. Antara dua lembar kaca tersebut diberi bahan kristal cair (*liquid crystal)* yang tembus cahaya. Permukaan luar dari masing-masing keping kaca mempunyai lapisan penghantar tembus cahaya seperti oxida timah (*tin oxide)* atau oxida indium (*indium oxide)*. Sel mempunyai ketebalan sekitar 1 x 10^{-5} meter dan diisi dengan kristal cair.

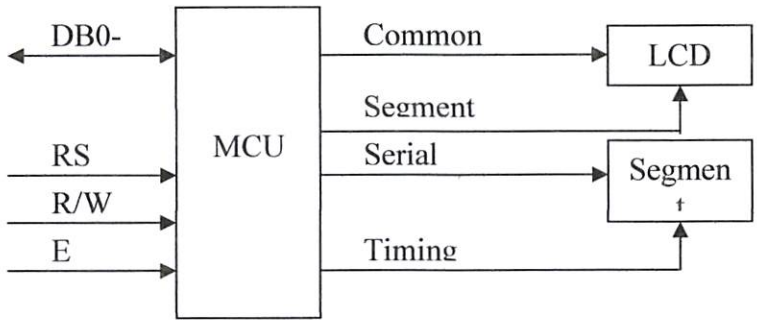
Karena sel-sel kristal cair merefleksikan cahaya dan bukan membangkitkan cahaya maka konsumsi daya yang dibutuhkan relatif rendah. Energi yang dipergunakan hanya untuk mengaktifkan kristal cair. Pada dasarnya LCD bekerja pada tegangan rendah (3 – 15 Vrms), frekuensi rendah (25 – 60 Hz) sinyal AC dan memakai arus listrik yang sangat kecil (25 - 300 μ A). LCD seringkali ditata sebagai tampilan *seven segment* untuk menampilkan angka tetapi juga memiliki keistimewaan lain, yaitu kemampuan untuk menampilkan karakter dan berbagai macam simbol.

Salah satu jenis LCD diantaranya adalah LCD M1632, suatu jenis piranti dengan konsumsi daya yang rendah, disusun dari dot matrik dan dikontrol oleh ROM atau RAM generator karakter dan RAM data display. Pengontrolan utamanya adalah pada ROM generator dan display data RAM yang menghasilkan kode ASCII jika padanya diberikan input ASCII. Untuk dapat difungsikan dengan baik maka perlu diperhatikan proses analisasi yang telah ditentukan oleh pabrik pembuatnya. Timing penganalisasian sangat dipertimbangkan, karena jika meleset sampai ordo *milisecon* maka dapat dipastikan LCD tidak dapat berfungsi.



Gambar 2-14. Konfigurasi Kaki LCD

(Sumber: www.google.com



Gambar 2-15. Blok Diagram LCD

(Sumber: www.google.com)

Adapun karakteristik dari LCD M1632 antara lain :

- Dengan 16 karakter – 2 baris dalam bentuk dotmatrik 5x7 dan cursor
- *Duty ratio* 1/16
- Memiliki ROM pembangkitan karakter untuk 192 jenis karakter
- RAM untuk data display sebanyak 80x8 bit
- Dapat dirangkai dengan MPU 8 bit/4 bit
- RAM data display dan RAM pembangkit karakter dapat dibaca oleh MPU
- Memiliki fungsi instruksi antara lain *display on/off, Cursor on/off, display* karakter *blink, cursor shift* dan *display shift*
- Memiliki rangkaian osilator sendiri
- Catu tegangan tunggal yaitu ± 5 V
- Memiliki rangkaian reset otomatis pada catu daya yang dihidupkan
- Temperatur operasi 0^0 - 50^0

LCD memiliki 16 pin yang masing-masing mempunyai fungsi sebagai berikut :

Tabel 2-7. Fungsi Tiap Pin LCD

No. Pin	Simbol	Level	Fungsi	
1	V_{SS}	-	Power Supply	0 V (GND)
2	V_{CC}	-		5 V ± 10%
3	V_{DD}	-		For LCD Drive
4	RS	H/L	Sinyal seleksi register H ; Data Input [register data (write/read)] L ; Instruction Input [register instruksi (write), busy flag dan address counter (read)]	
5	R/W	H/L	H ; Read L ; Write	
6	E	H	Enable Signal [sinyal penanda mulai operasi, aktif saat operasi write atau read]	
7	DB0	H/L	4 bit bus data lower 2 arah, dapat dibaca atau ditulis terhadap mikrokontroler	
8	DB1	H/L		
9	DB2	H/L		
10	DB3	H/L		
11	DB4	H/L	4 bit bus data upper 2 arah, dapat dibaca atau ditulis terhadap mikrokontroler, DB7 juga sebagai busy flag	
12	DB5	H/L		
13	DB6	H/L		
14	DB7	H/L		
15	V+BL	-	Back Light Supply	4 - 4,2 V 50 – 200 Ma
16	V-BL	-		0 V (GND)

(Sumber: www.google.com)

Instruksi Operasi

Tabel 2-8. Instruksi Pada LCD

Instruksi	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0
Display Clear	0	0	0	0	0	0	0	0	0	1
Cursor Home	0	0	0	0	0	0	0	0	1	*
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S
Display On/Off	0	0	0	0	0	0	1	D	C	B
Cursor Display Shift	0	0	0	0	0	1	S/C	R/L	*	*
Function Set	0	0	0	0	1	DL	1	*	*	*
CG RAM Address Set	0	0	0	1	A_{CG}					
DD RAM Address Set	0	0	1	A_{DD}						
BF/Address Read	0	1	BF	AC						
Data Write to CG RAM	1	0	Write Data							
Data Read from CG RAM	1	1	Read Data							

*Invalid Bit

A_{CG} ; CG RAM Address

A_{DD} ; DD RAM Address

➢ **Operasi Dasar**

- Register

  Kontrol dari LCD memiliki 2 buah register 8 bit yaitu register instruksi (IR) dan register data (DR). IR memiliki instruksi seperti display, clear, cursor shift dan display data (DD RAM) serta karakter (CG RAM). DR menyimpan data untuk ditulis ke DD RAM ataupun membaca data dari DD RAM dan CG RAM. Ketika data ditulis ke DD RAM atau CG RAM maka DR secara otomatis menulis data ke DD RAM atau CG RAM. Ketika data pada CG RAM atau DD RAM akan dibaca maka alamat data

ditulis pada IR. Sedangkan data akan dimasukkan melalui DR sehingga dapat dibaca oleh mikrokontroler.

Tabel 2-9. Pemilihan Register Pada LCD

RS	RW	Operasi
0	0	Seleksi IR, IR Write Display Clear
0	1	Busy Flag (DB7), @ Counter (DB0-DB7) Read
1	0	Seleksi DR, DR Write
1	1	Seleksi DR, DR Read

- Busy Flag

  Busy Flag menunjukkan bahwa modul siap untuk menerima instruksi selanjutnya sebagaimana terlihat pada tabel diatas. Register seleksi sinyal akan melalui DB7 jika RS=0 dan R/W=1. Jika bernilai 1 maka sedang melakukan kerja internal dan instruksi tidak akan dapat diterima, oleh karena itu status dari flag harus diperiksa sebelum melaksanakan instruksi selanjutnya.

- Address Counter (AC)

  AC menunjukkan lokasi memori dalam modul LCD. Pemilihan lokasi alamat lewat Ac diberikan lewat register instruksi (IR) ketika data pada A, maka AC secara otomatis menaikkan atau menurunkan alamat tergantung dari Entry Mode Set.

- Display Data RAM

  Pada LCD, masing-masing line memiliki range alamat tersendiri. Alamat itu diekspresikan dengan bilangan hexadesimal. Untuk line 1 range alamat berkisar antara 40_H-$4F_H$.

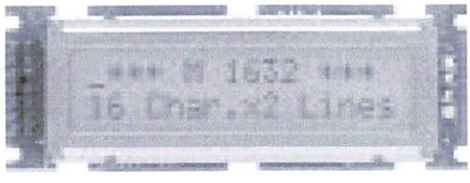
- Character Generator ROM (CG ROM)

  CG ROM memiliki tipe dot matrik 5x7, dimana pada LCD telah tersedian ROM sebagai pembangkit karakter dalam kode ASCII.

- Character Generator RAM (CG RAM)

  CG RAM dipakai untuk pembuatan karakter tersendiri melalui program.

Adapun bentuk fsik dari LCD M1632 adalah pada gambar berikut :



Gambar 2-16. Liquid Crystal Display

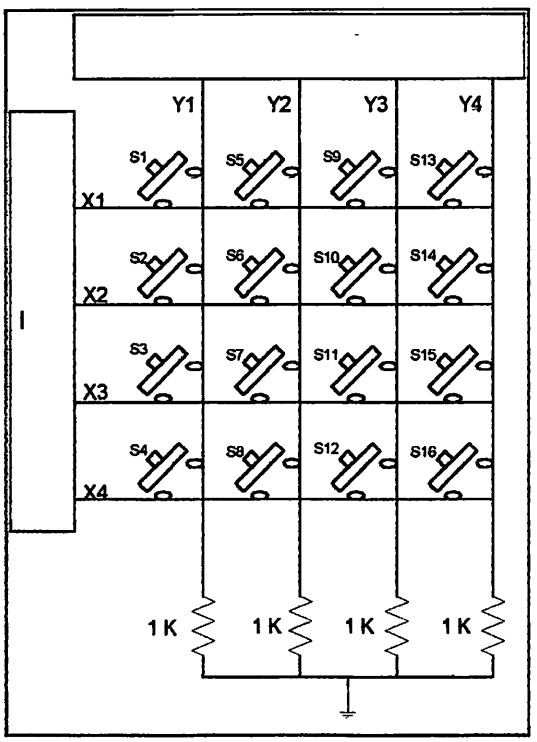
(Sumber: www.google.com)

2.10 Keypad (Papan Tombol)

Papan tombol ini digunakan untuk memasukkan data bila diinginkan. Untuk menterjemahkan informasi yang diterima dari papan tombol, maka keypad dihubungkan dengan port 1.

Papan tombol tersebut mempunayai matrix 3 baris dan 4 kolom. Deretan baris dan kolom dari papan tombol dihubungkan dengan port 1 yang difungsikan sebagai masukan dan keluaran. Deretan kolom dihubungkan dengan ground (berlogika 0) dan port 1 mikrokontroler yang difungsikan sebagai input

mikrokontroler. Sedangkan deretan baris dihubungkan ke port 1 yang telah diberi data 0001 dan secar kontinyu data tersebut begeser satu bit kekiri. Pergeseran data satu bit ini dimaksudkan untuk menentukan posisi tombol yang ditekan dalam satu kolom. Port ini difungsikan sebagai ouput dari mikrokontoler. Dengan demikian kalau tombol tidak ditekan maka masukan port 1 di pin yang terhubung tombol tersebut berlogika 0 dan bila tombol ditekan akan berlogika 1. Rangkaian papan tombol papan tersebut dapat dilihat pada gambar dibawah ini:



Gambar 2-17. Rangkaian Keypad 4x4

(Sumber: www.google.com)

2.10 Pemrograman Visual Basic 6.0

Visual Basic 6.0 merupakan bahasa pemrograman yang cukup populer dan mudah untuk dipelajari. pengguna dapat membuat program dengan aplikasi GUI

(Graphical User Interface) atau program yang memungkinkan pemakai komputer berkomunikasi dengan komputer tersebut dengan menggunakan modus grafik atau gambar.

Visual Basic 6.0 berawal dari bahasa pemrograman BASIC *(Beginners All-purpose Symbolic Instruction Code).* Karena bahasa BASIC cukup mudah dipelajari dan populer maka hampir setiap programmer menguasai bahasa ini.

Tahun 1980-an sistem operasi DOS cukup populer di kalangan pemakai PC karena di dalamnya disertakan bahasa BASIC yang dikenal dengan QBASIC (QuickBasic). Sistem tersebut sekarang sudah jarang digunakan. Di era Windows, Microsoft menciptakan Visual Basic yang terus mengalami penyempurnaan hingga Visual Basic 6.0 ini.

2.11.1 Memulai Visual Basic

Pada bagian ini akan dijelaskan bagaimana cara menjalankan Visual Basic 6.0 pada sistem operasi Windows. Cara pertama yang dapat dilakukan untuk mernulai Microsoft Visual Basic 6.0 adalah:

1. Klik tombol Start pada Taskbar, kemudian pilih Program dari tampilan menu utama
2. Dari tampilan menu yang ada, pilih Visual Basic 6.0. Untuk memudahkan pernahaman. Perhatikan Gambar I. yang menunjukkan proses cara menjalankan Visual Basic 6.0 dengan menggunakan Windows.

2.11.2 Tampilan Awal Visual Basic

Secara otomatis, pada saat pertama kali menjalankan Visual Basic, akan tampil kotak dialog New Project. Pada kotak dialog tersebut terdapat tiga pilihan tabulasi dengan keterangan sebagai berikut:

Tabel 2-10. Pilihan Tabulasi

Tabulasi	Keterangan
New	Pilihan ini digunakan untuk membuat project baru dengan berbagai macam pilihan.
Existing	Pilihan ini digunakan untuk membuka project yang pernah dibuat sebelumnya dengan menentukan folder sekaligus nama file.
Recent	Pilihan ini digunakan untuk membuka project yang telah dibuat dan terakhir kali dibuka.

2.11.3 Komponen Visual Basic

1. Title Bar

Title bar merupakan batang judul dari program Visual Basic 6.0 yang terletak pada bagian paling atas dari jendela program yang berfungsi untuk menampilkan judul atau namajendela. Selain itu title bar juga berfungsi untuk:

a. Memindah posisi jendela dengan menggunakan proses drag and drop pada posisi title bar tersebut.

b. Mengatur ukuran jendela dari ukuran Maximize ke ukuran Restore ataupun sebaliknya dengan melakukan klik ganda pada posisi title bar tersebut.

2. Control Menu

Control Menu merupakan sebuah elemen yang terletak pada bagian sudut kiri atas dari jendela Visual Basic. Dalam sistem operasi Windows, elemen ini tampil dalam bentuk ikon program. Ketika meng-klik Control Menu, akan

tampil daftar menu perintah yang digunakan untuk mengubah ukuran jendela, memindah letak jendela dan juga dapat untuk keluar dari program Microsoft Visual Basic 6.0. Untuk lebih jelasnya, dapat dilihat fungsi dari masing-masing perintah pada tabel di bawah ini:

Tabel 2-11. Fungsi Perintah/Tombol

Tombol	Fungsi
Restore	Mengubah ukuran jendela Visual Basic ke ukuran relatif
Minimize	Mengubah ukuran jendela Visual Basic ke ukuran minimal.
Maximize	Mengubah ukuran jendela Visual Basic ke ukuran maksimal.
Move	Memindah posisi jendela Visual Basic.
Size	Mengatur ukuran jendela Visual Basic.
Close	Keluar dari program Visual Basic.

3. Menu Bar

Menu bar merupakan batang menu yang terletak di bawah title bar yang berfungsi untuk menampilkan pilihan menu atau perintah untuk mengoperasikan program Visual Basic. Saat pertama kali jendela program Visual Basic terbuka, ada tiga belas menu utama, yaitu: File, Edit, View, Project, Format, Debug, Run, Query, Diagram, Tools, Add-Ins, Windows dan Help.

Tampilan pilihan menu dalam program Visual Basic memiliki beberapa variasi yang masing-masing mempunyai pengertian yang berbeda dengan penjelasan sebagai berikut:

a. Menu dengan tanda segitiga yang terletak pada bagian kanan, di mana apabila menu tersebut dipilih maka akan menampilkan submenu pilihan berikutnya.

b. Menu yang secara langsung akan menjalankan suatu perintah yang dipilih.
c. Menu dengan tanda titik tiga pada bagian kanan, apabila dipilih maka akan menampilkan kotak dialog perintah.
d. Menu yang tampil redup yang mengindikasikan bahwa menu tersebut tidak dapat untuk dipilih.
e. Menu dengan gambar ikon di sebelah kirinya yang menandakan bahwa selain dapat dengan menggunakan menu tersebut untuk menjalankan suatu perintah, Anda dapat menekan tombol yang ada di toolbar.
f. Menu dengan Shortcut key di sebelah kanannya yang menandakan bahwa selain dengan menggunakan menu tersebut untuk menjalankan suatu perintah, Anda dapat menekan tombol kombinasi pada keyboard. Misalnya kombinasi antara tombol Shift + F7 untuk mewakili perintah menu View - Object.

4. Toolbar

Toolbar merupakan sebuah batang yang berisi kumpulan tombol yang terletak di bagian bawah menu bar yang dapat digunakan untuk menjalankan suatu perintah. Pada kondisi default program Visual Basic hanya menampilkan toolbar Standard.

Untuk lebih jelasnya tentang fungsi masing-masing tombol pada toolbar standard, perhatikan penjelasan berikut:

Tabel 2-12. Fungsi tombol pada toolbar Standard

Nama Tombol	Fungsi
Add Project	Menambahkan project baru,Dengan pilihan: • Standard EXE • ActiveX EXE • ActiveX DLL • ActiveX Control
Add Form	Menambahkan item, dengan pilthan: • Form • User Control • MDI Form • Property Page • Module • Add File • Class Module • User Document
Menu Editor	Menampilkan kotak dialog Menu Editor.
Open Project	Membuka project yang sudah pernah dibuat ebelumnya.
Save Project Group	Menyimpan project.
Cut	Memotong kontrol yang ada di jendela form atau teks yang ada di jendela code.
Copy	Menyalin kontrol yang ada di jendela form atau teks yang ada di Jendela code.
Paste	Menempelkan kontrol atau teks yang sudah dipotong dengan perintah Cut atau disalin dengan perintah Copy.
Find	Mencari teks pada jendela code.
Undo	Membatalkan suatu perintah an dialankan sebelumn a..
Redo	Mengulangi suatu perintah yang pernah dibatalkan
Start	Menjalankan program.
Break	Menghentikan program yang sedang jalan untuk Sementara.
End	Menghentikan program yang sedang dijalankan.
Project Explorer	Menampilkan jendela ProjectExplorer.
Properties Window	Menampilkan jendela Properties.
	Menampilkan jendela Form
Window	Layout.
Object	Menampilkan jendela Object
Browser	Browser.
Toolbox	Menampilkan jendela Toolbox.

5. Toolbox

Toolbox merupakan kotak perangkat yang berisi kumpulan tombol objek atau kontrol untuk mengatur desain dari aplikasi yang akan dibuat. Pada kondisi default, toolbox menampilkan tabulasi General dengan 21 tombol kontrol yang dapat ditampilkan dengan menggunakan prosedur:

1. Klik tombol Toolbox di bagian Toolbar Standard.
2. Pilih perintah View - Toolbox.

Untuk penjelasan tentang fungsi masing-masing kontrol, perhatikan tabel berikut:

Tabel 2-13. Fungsi masing-masing Kontrol pada Toolbox

Nama Pengontrol	Fungsi
Pointer	Memilih, mengatur ukuran danmemindah posisi kontrol yang terpasang pada bagian form.
PictureBox	Menampilkan file gambar.
Label	Menambahkan label atau teks tambahan.
TextBox	Menambahkan kotak teks.
Frame	Menambahkan control yang dapat diisi dengan kontrol Option Button atau CheckBox.
Command Button	Menambahkan control tombol perintah.
CheckBox	Menambahkan control kotak periksa.
OptionButton	Menambahkan control tombol pilihan.
ComboBox	Menambahkan control kotak combo yang merupakan kontrol gabungan antara TextBox dan ListBox.
ListBox	Menambahkan control daftar pilihan.
HscrollBar	Menambahkan control batang penggulung horisontal.
VscrollBar	Menambahkan control batang penggulung vertikal.
Timer	Menambahkan control sebagai kontrol pencacah waktu.
DriveListBox	Menambahkan control daftar disk drive pada kompuer.
DirListBox	Menambahkan control daftar direktori pada drive aktif.
FileListBox	Menambahkan control daftar file pada direktori aktif.
Shape	Menambahkan control gambar berupa lingkaran, oval, persegi panjang, bujur sangkar dan lain-lain.
Line	Menambahkan control gambar garis lurus.
Image	Menambahkan file gambar dengan pilihan properti yang lebih sedikit dibandingkan kontrol pictureBox.
Data	Menambahkan control yang berupa database
OLE	Menambahkan control yang berhubungan dengan proses relasi antar program aplikasi.

6. Project

Project merupakan suatu kumpulan module atau merupakan program aplikasi itu sendiri. Dalant Visual Basic, file project disimpan dengan nama file berakhiran.VBP, di mana file ini berfungsi untuk menyimpan seluruh komponen program.

Apabila kita membuat suatu program aplikasi baru, maka secara otomatis project tersebut akan diisi dengan objek Form 1. Dalam jendela Project Explorer ditampilkan suatu struktur hirarki dari sebuah project itu sendiri yang berisi semua item yang terkandung di dalamnya. Dengan Project Explorer dapat dipilih objek yang akan dibuat dengan mudah. Untuk Menampilkan jendela Project Explorer, Gunakan Prosedur berikut:

1. Klik tombol Project Explorer pada bagian toolbar Standard.
2. Pilih perintah View-.Project Explorer.
3. Shorcut key Ctrl+R.

Selain menampilkan nama project dan form, pada jendela Project Explorer terdapat tiga tombol dengan penjelasan sebagai berikut:

Tabel 2-14. Tombol pada Project Explorer

Nama Tombol	Fungsi
View Code	Menampilkan jendela Code yang digunakan untuk menulis kode program yang terhubung dengan objek yang terpilib pada jendela form.
View Object	Menampilkan jendela Object untuk item yang terpilih pada form aktif.
Toggle Folders	Menampilkan atau menyembu nyikan folder yang menam pung nama form dari suatu project.

7. Properties Window

Properties Window merupakan sebuah jendela digunakan untuk menampung nama properti dari yang terpilih. Pengaturan properti pada program Basic merupakan hal yang sangat penting membedakan objek yang satu dengan yang lainnya.

Pada jendela properti ditampilkan jenis dan nama objek yang bisa dipilih urut berdasarkan abjad pada tab Alphabetic atau berdasarkan kategori pada tab

Categorized. Untuk menampilkan jendela Properties, dapat menggunakan prosedur berikut:

1. Klik tombol Properties Window pada toolbar Standard.
2. Pilih perintah View - Properties Window.
3. Shorcut key F4.

8. Form Layout Window

Form Layout Window merupakan sebuah jendela yang digunakan untuk mengatur posisi dari form pada form saat program dijalankan. Pada saat mengarahkan pointer mouse ke bagian form, maka pinter mouse akan berubah menjadi anak panah empat arah (pointer pengatur posisi). Untuk memindah posisi form pada layar monitor dapat dilakukan dengan proses drag and drop.

Untuk menampilkan jendela Form Layout, dapat menggunakan prosedur berikut:

1. Klik tombol Form Layout Window pada toolbar Standard.
2. Pilih perintah View - Form Layout Window.

9. Immediate Window

Immediate Window merupakan sebuah jendela yang digunakan untuk mencoba beberapa perintah dengan mengetikkan baris program dan dapat secara langsung melihat hasilnya. Hal tersebut biasa dilakukan dan sangat membantu proses pengujian suatu perintah sebelum dipasang di dalam program.

Untuk menampilkan jendela Immediate, menggunakan prosedur berikut:

1. Pilih perintah View - Immediate Window.

2. Shortcut key Ctrl+G.
3. Klik tombol Immediate Window pada toolbar Debug.

10. Form Window

Form Window merupakan jendela desain dari sebuah program aplikasi. Kita dapat mendesain sebuah program aplikasi dengan menempatkan kontrol-kontrol yang ada di bagian toolbox pada area form.

Pada jendela form juga terdapat beberapa elemen yang dapat digunakan untuk mengatur tampilan. Untuk lebih jelasnya perhatikan Gambar I .29.

11. Code Window

Code Window merupakan sebuah jendela yang digunakan untuk menuliskan kode program dari kontrol yang dipasang pada jendela form dengan cara memilih terlebih dahulu kontrol tersebut pada kotak objek.

12. Event

Event merupakan suatu kejadian yang akan diterirna oleh suatu objek. Event yang diterima oleh objek berfungsi untuk menjalankan kode program yang ada didalam objek tersebut.

13. Method

Method adalah suatu kumpulan perintah yang memiliki kegunaan yang hampir sama dengan suatu fungsi atau prosedur, tetapi penintah-penintah tersebut sudah disesuiakan dalam suatu objek.

Suatu method dapat dipanggil dengan cara menyebutkan narna objek dan diikuti dengan tanda titik dan nama metodenya. Method umumnya digunakan untuk menjalankan perintah khusus pada suatu objek tertentu.

14. Module

Module hampir sama fungsinya dengan form, tetapi module tidak berisi objek dan bentuk standar. Dan module berisi kode program atau prosedur yang dapat digunakan oleh program aplikasi.

2.11.4 Mengolah Toolbox

Pada kondisi default, pada bagian toolbox terdapat satu tabulasi yaitu tabulasi General. Saat menambahkan item kontrol baru secara otomatis akan ditampilkan pada tab yang aktif (General). Kita dapat mengelompokkan item-item yang akan ditambalikan ke bagian toolbox dengan menggunakan tabulasi buatan sendiri. Diharapkan semua item yang ditambahkan ke toolbox dapat terorganisasi sesuai dengan aplikasi yang dibuat.

1. Menambah Tabulasi

Untuk menambahkan tabulasi ke bagian toolbox, dapat menggunakan prosedur berikut:

1. Klik kanan pada bagian toolbox.
2. Pilih perintah Add Tab sehingga akan tampil sebuah kotak dialog.
3. Ketikkan nama tabulasi pada kotak New lab Name dan klik tombol OK.

2. Menghapus Tabulasi

Untuk menghapus tabulasi dari bagian toolbox. Dapat menggunakan prosedur berikut:

1. Klik kanan bagian tabulasi yang ingin dihapus.
2. Pilih perintab Delete Tab.

3. Mengganti Nama Thabulasi

Untuk mengganti nama tabulasi. dapat menggunakan prosedur berikut:

1. Klik kanan pada bagian tabulasi yang ingin diganti namanya.
2. Pilih perintah Rename Tab.
3. Ketikkan nama tabulasi yang baru dan klik tombol OK.

4. Memindah Posisi Tabulasi

Untuk meminndah posisi tabulasi, dapat menggunakan prosedur berikut:

1. Klik kanan pada bagian tabulasi yang ingin Anda pindah posisinya.
2. Pilih perintah Move Up untuk memindah posisi ke atas atau Move Down untuk memindali posisi ke bawah.

5. Menambahkan Item Kontrol

Untuk menambahkan item kontrol, dapat menggunakan prosedur berikut:

1. Aktifkan tabulasi untuk menambahkan item pada bagian kontrol tersebut dengan cara klik.
2. Berikan salah satu perintah berikut:
   a. Pilih perintah Project .Components.
   b. Klik kanan pada bagian tabulasi toolbox dan pilih perintah Components.
   c. Shortcut key Ctrl + y
3. Pada tabulasi Controls, aktifkan kotak periksa dari beberapa pilihan kontrol item yang ingin ditambahkan dan klik tombol Close.

6. Menghapus Item Kontrol

Untuk menghapus item kontrol, dapat menggunakan prosedur berikut:

1. Berikan salah satu perintah berikut:
   a. Pilih perintah Project - Components.
   b. Klik kanan pada bagian tabulasi toolbox dan pilih perintah Components.
   c. Shorcut Key Ctrl + T.
2. Pada tabulasi kontrols, matikan kotak periksa dari beberapa pilihan kontrol item yang akan dihilangkan dari toolbox dan klik tombolo close

BAB III

PERENCANAAN DAN PEMBUATAN ALAT

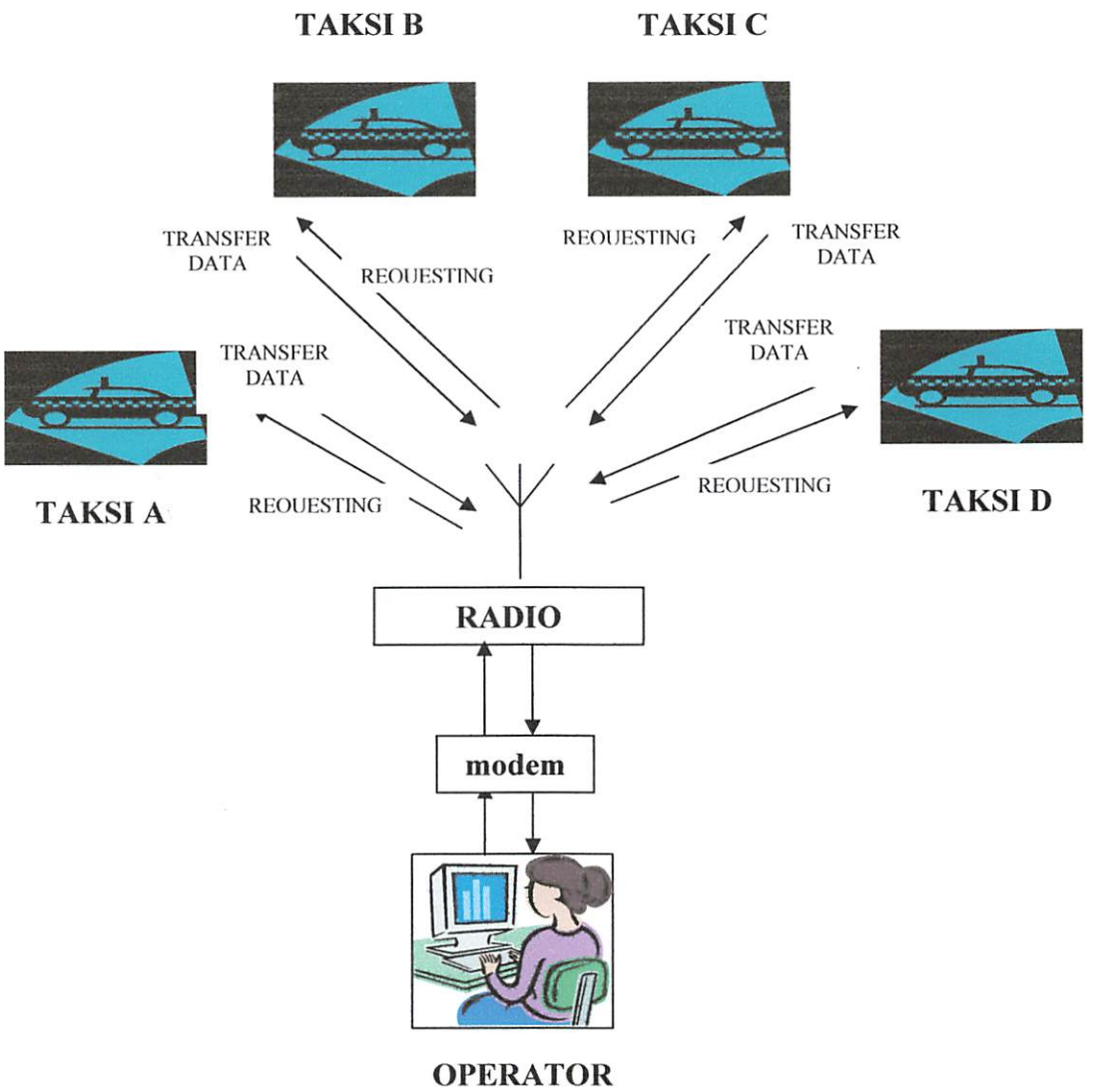
Dalam bab ini akan dijelaskan perencanaan dan pembuatan alat yang meliputi pembuatan perangkat keras dan perangkat lunak. Untuk memudahkan pemahaman pembuatan perangkat keras akan dimulai dengan menjelaskan secara blok diagram terlebih dahulu baru detail dari masing-masing peralatan.

3.1 Gambaran Umum Sistem.

Sistem yang dibuat adalah untuk diaplikasikan pada taksi agat taksi bisa melakukan laposan setoran harian dimanapun asal masih dalam jangkauan radio komunikasi pada taksi kemudian akan dikirimkan ke PC (Personal Computer).

3.2 Blok Diagram

Berikut ini adalah gambar blok perancangan sistem secara keseluruhan :



Gambar 3-1. Block Diagram Sistem

Alat ini menggnakan sistem komunikasi tertutup dengan metode half duplex, untuk menjamin keamanannya, selain itu alat ini juga disertai ID yana berbeda untuk setiap taksi. Frekuensi recieve dan trnsmite akan dibuat berbeda, pada taksi misalnya frekuensi recievenya 150Hz dan transmitenya 151Hz,

sedangkan pada operator frekuensinya merupakan kebalikan dari frekuensi yaitu 151Hz untuk recieve dan 150Hz untuk transmitenya.Dengan demikian apabila operator transmite maka semua taksi akan bisa menerima, sedangkan apabila salah satu taksi transmite maka hanya operator yang bisa menerima. Laporan harian akan dilakukan jika ada permintaan atau requesting dari operator. Laporan harian ini bisa dilakukan dimana saja asalkan masih dalam jangkauan radio komunikasi pada taksi. Data yang diambil dari mikro pada argometer akan ditransferkan ke operator melalui radio komunikasi pada taksi.Data yang diambil dari mikro akan di modulasi oleh madem agar bisa dimodulasikan pada gelombang radio tersebut.Setelah data yang dimodulasi tadi sampai ke operator akan diubah kembali dengan menggunakan demodulator yang kemudian dimasukkan ke PC operator.Karena taksi tidak mungkin hanya satu maka setiap taksi diberikan address yang berbeda agar tidak terjadi kesalahan dalam penyusunan laporan harian.

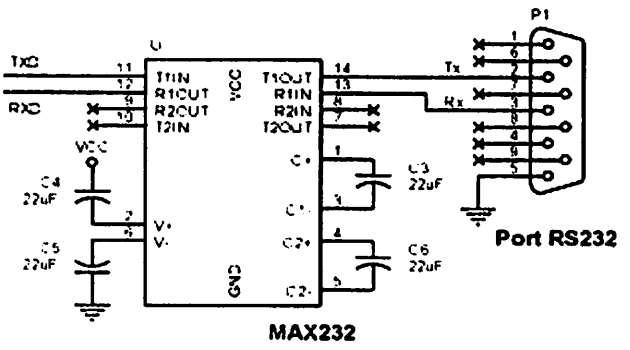
Fungsi masing-masing alat

1. PC operator: alat ini berfungsi untuk menampilkan secara penuh laporan harian taksi.
2. Modem (XR-2211 dan XR-2206) : Alat ini berfungsi sebagai pengubah data yang di ambil dari mikro pada argometer agar bisa di transferkan melaui gelombang radio atau sebaliknya
3. Radio paket: Alat ini berfungsi sebagai alat komunikasi para sopir taksi dengan para operator yang sekaligus merupakan alat yang digunakan sebagai sistem komunikasi yang digunakan untuk mentransfer data

4. Mikrokontroller AT89S8252 karena keunggulan alat ini yang mempunyai EEPROM maka digunakan sebagai penyimpan daftar harga yang nantinya akan ditransferkan ke operator.
5. Display LCD : berfungsi sebagai alat untuk menampilkan jumlah harga,waktu dan jarak yang ditempuh.

3.3 Rangkaian Inerface RS-232

Pada perencanaan hubungan antara komputer dengan modem adalah dipergunakan komunikasi data secara serial yaitu port 1 atau yang sering dikenal dengan COM 1. Adapun kaki atau pin-pin yang dipakai adalah pada pin no. 2 yang berfungsi untuk sambungan *receive data*, pin no. 3 untuk sambungan *transmit data* yang berguna sebagai input data pada modem FSK yang sebelumnya telah disesuaikan dulu level tegangannya dari RS-232 ke level tegangan TTL melalui sebuah IC MAX 232, dan pin no. 5 untuk *singal ground.* Rangkaian interface RS-232 diperlihatkan pada gambar 3.2.



Gambar 3-2. Rangkaian Interface RS-232

Data biner yang berasal dari komputer mempunyai level tegangan antara +3V sampai +15V dan -3V sampai -15V, sebelum masuk pada rangkaian modulator demodulator terlebih dahulu tegangannya melalui sebuah IC MAX 232 dan diubah menjadi tegangan TTL sebesar 0V sampai 5V yang sesuai dengan tegangan untuk mencatu kerja rangkaian modulator demodulator tersebut.

3.4 Perencanaan Perangkat Keras Modulator Demodulator

Sinyal digital pada komputer (data) yang akan dikirimkan atau ditransnisikan secara jarak jauh harus dimadulasikan dengan sinyal analog. Pada dasarnya ada tiga metode atau teknik untuk memodulasi data ke gelombang pembawa, yaitu ASK, FSK dan PSK. Dalam tugas akhir ini kami hanya membahas teknik modulasi dan demodulasi FSK

Modulasi FSK *(Frekuensi Shift Keying)* adalah modulasi yang menyatakan sinyal digital 1 sebagai nilai tegangan dengan frekuensi tertentu (misalnya 1200Hz) sementara sinyal digital 0 dinyatakan sebagai suatu nilai tegangan dengan frekuensi tertentu yang berbeda (misalnya 2200Hz). Sistem FSK ini sangat berguna dan menguntungkan karena pengaruh desah dan interfensi sangatlah kecil.

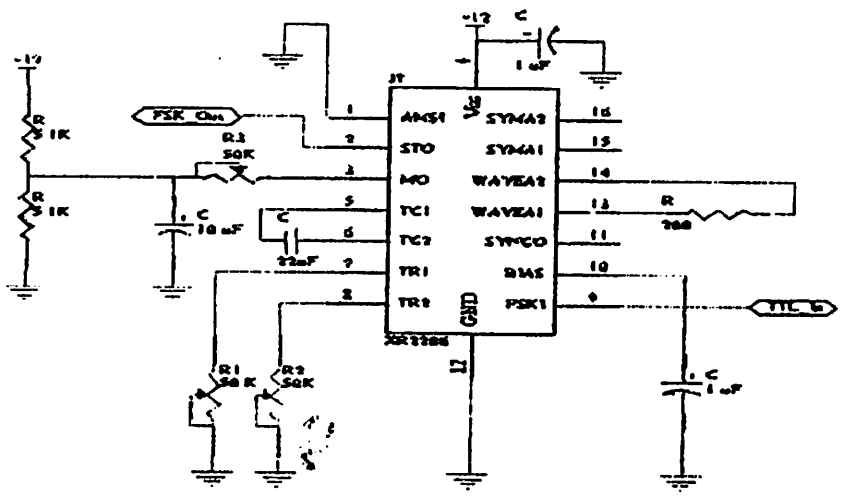
3.4.1 XR-2206 (Modulator FSK)

Rangkaian untuk membangkitkan FSK ditunjukkan dalam gambar 3.3. XR-2206 yang diaplikasikan sebagai FSK generator dengan kecepatan 1200bps menggunakan frekuensi *mark*1200Hz dan *space* 2200Hz dapat bekerja dengan

dua buah *timing resistor* R1 dan R2 yang dihubungkan pada pin 7 dan pin 8, dan ditentukan oleh pemilihan kapasitor eksternal yang dihubungkan antara pin 5 dan pin 6. *Timing resistor* ini bekerja bergantian sesuai dengan level tegangan pada pin 9. jika pin 9 diberi tegangan bias ≥ 2 V (logika 1), maka hanya R1 yang bekerja. Sebaliknya jika pin 9 diberi tegangan ≤ 1 V (logika 0), maka hanya R2 yang bekerja. Sehingga frekuensi keluaran (pin no.2) berubah-ubah diantara dua frekuensi f1 dan f2. Besarnya f1 dan f2 dapat ditentukan dengan persamaan :

f1 = 1/(R1.C),

f2 = 1/(R2.C)



Gambar 3-3. Komponen modulator XR-2206

Frekuensi osilasi fo, ditentukan oleh timing kapasitor yang terhubung dengan pin 5 dan pin 6 serta oleh timing resistor R1 dan R2 yang terhubung dengan pin 7 dan pin 8, dengan ketentuan

$$fo = 1/RC \text{ Hz}$$

Mempertimbangka nilai R yang disarankan antara 4 KΩ – 20 KΩ, diinginkan agar nilai timing resistor R1 dan R2 dengan frekuensi (*mark)* pada f1 = 1200 Hz dan biner 0 (*space*) pada f2 = 2200 Hz dalam jangkauan 10kΩ sampai 50kΩ Nilai kapasitor C diperoleh setelah memasukkan nilai-nilai variable yang telah diketahui yauitu R1, R2, dan f dengan mempertimbangkan nilai komponen kapasitor yang disarankan pada datasheet dan nilai komponen standart.

Adapun perhitungan untuk menetukan nilai komponen eksternal dari modulator FSK sebagai berikut:

Untuk nilai R1=50KΩ dan f1=1200Hz

$$F1 = \frac{1}{R1.C}$$

$$C = \frac{1}{f1, R1} = \frac{1}{1200.50000}$$

$$= 1{,}6666666.\ 10^{-8}\ \text{Farad} = 16\ \text{nF}$$

Setelah memperoleh komponen C dengan f2 = 2200 Hz dapat menentukan nilai R2 senagai nerikut

$$R2 = \frac{1}{f2.C}$$

$$= \frac{1}{2200.16nF}$$

$$= 27272{,}7\ \Omega$$

Hasil perhitungan dapat diperlihatkan dalam table perhitungan nilai komponen eksternal pada table 3-1 berikut

Tabel 3-1. Hasil perhitungan Nilai Komponen Eksternal XR-2206Untuk f1=1200Hz dan f2=2200Hz

R1	R2	C	Nilai komponen yang digunakan
50000ohm	27272,7ohm	16666666869316E-8 Farad	16 nF
47500ohm	25909,1ohm	175438596983213E-8 Farad	17 nf
45000ohm	14545,5ohm	185185182743908E-8 Farad	18 nF
42500ohm	23181,8ohm	196078424608004E-8 Farad	19 nF
40000ohm	21818,2ohm	208333332807342E-8 Farad	20 nF
37500ohm	20454,5ohm	202222222845403E-8 Farad	22 nF
35000ohm	19090,9ohm	2380952324188E-8 Farad	23 nF
32500ohm	17727,3ohm	256410253030026E-8 Farad	25 nF
30000ohm	16363,6ohm	277777782997646E-8 Farad	27 nF
27500ohm	15000,0ohm	303030311954444E-8 Farad	30 nF
25000ohm	16363,6ohm	33333332538632E-8 Farad	33 nF
22500ohm	12292,9ohm	370370365487815E-8 Farad	37 nF
20000ohm	10909,1ohm	416666665614684E-8 Farad	41 nF

Dari hasil simulasi perhitungan diatas, digunakan nilai timing kapasitor C sebesar 22 nF, karena merupakan nilai standart dan umum dipakai dipasaran. Sedangkan nilai R1 dan R2 yang berada pada jangkauan 10kΩ sampai 50kΩ digunakan komponen variable resistor 10kΩ dan 50kΩ.

3.4.2 XR-2211 (Demodulator FSK)

Rangkaian demodulator berfungsi mengubah sinyal FSK yang diterima walky talky menjadi data biner. Untuk mendemodulasikan sinyal FSK tersebut digunakan IC XR-2211. XR-2211 adalah sebuah IC *monolithic phase locked loop* yang dirancang untuk komunikasi data khususnya aplikasi modem FSK.

Demodulator FSK dirancang untuk mendemodulasi sinyal FSK dengan frekuensi biner 1 (*mark*) 1200 Hz dan biner 0 (*space*) 2200 Hz dengan kecepatan 1200bps. Untuk mendemodulasi sinyal FSK dengan frekuensi tersebut maka pemilihan nilai-nilai komponen eksternal sntsrs lain:Ro,R1,Co,C1,Cf.

Adapun perhitungan untuk sistem demodulator yang akan dibuat dikemukakan dalam perhitungan berikut:

10. Menetukan PLL counter frekuensi

$$Fo = \sqrt{f1.f2}$$

$$= \sqrt{1200.2200}$$

$$= 1624Hz$$

11. Menghitung timing resistor dengan Ro = 10k dan VR Rx = 10k

$$Ro = Ro + \frac{Rx}{2}$$

$$= 10 + \frac{10}{2}$$

$$= 15000 \text{ ohm}$$

12. Menghitung nilai Co

$$Co = \frac{1}{Ro.Co}$$

$$= \frac{1}{15000.1624}$$

$$= 39 \text{ nF}$$

13. Menghitung nilai R1

$$R1 = \frac{Ro.fo}{(f1 - f2)} 2$$

$$= \frac{15000.1624}{(1200 - 2200)} 2$$

$$= 48720$$

$$= 47\ K\Omega$$

14. menghitung nilai C1

$$C1 = \frac{1250.Co}{R1.^{2}}$$

$$= \frac{1250.39nF}{47000.0{,}5^{2}}$$

$$= 4{,}1 \ . \ 10^{-9} = 3{,}9\ nF$$

15. Menghitung nilai Rf (paling sedikit 5 kali nilai R1)

$$Rf = R1 \ . \ 5$$

$$= 47000 \ . \ 5$$

$$= 235000$$

$$= 240\ K\Omega$$

16. Menghitung nilai Rb (nilainya paling sedikit 5 kali nilai Rf)

$$Rb = Rf \ . \ 5$$

$$= 240000 \ . \ 5$$

$$= 1{,}2\ M\Omega$$

17. Menghitung Rsum

$$\text{Rsum} = \frac{(Rf + RI).Rb}{(Rf + R1 + Rb)}$$

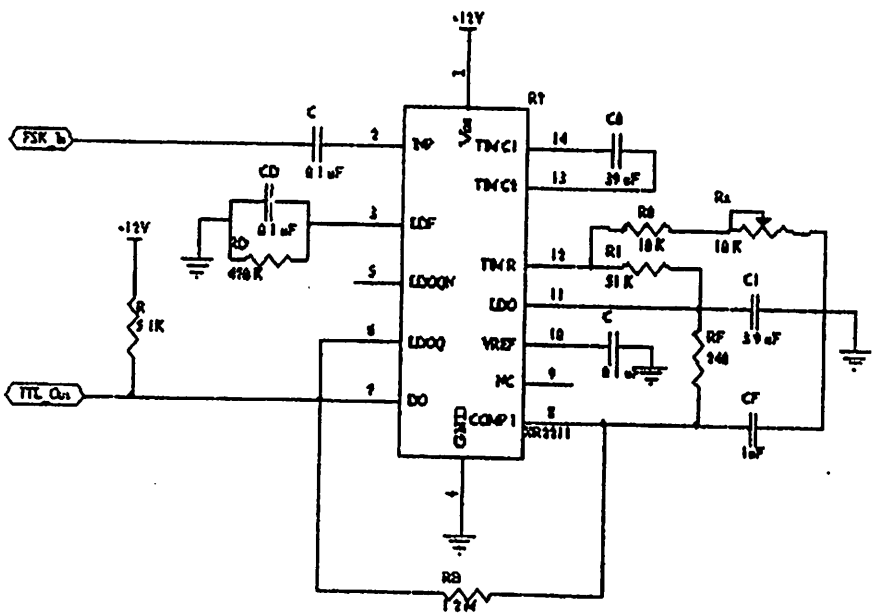
$$= \frac{(24000 + 47000)1200000}{24000 + 47000 + 1200000}$$

$$= 231607\ \Omega$$

18. Menghitung nilai Cr

$$\text{Cr} = \frac{0{,}25.}{(Rsum.Boudrate}$$

$$= \frac{0{,}25}{231607.1200} = 8{,}99 \,.\, 10^{-10} = 1\ \text{nF}$$



Gambar 3-4. Komponen Demodulator XR-2211

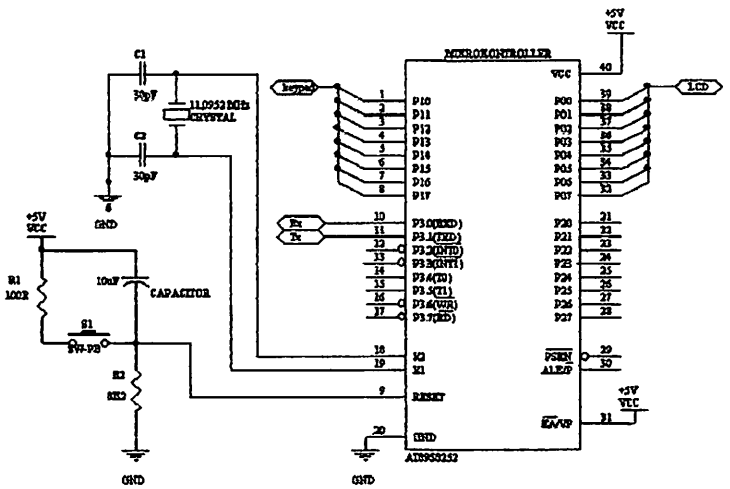
Pada gambar 3-4. di atas pin no. 2 (*FSK Input*) pada IC XR-2211 merupakan sinyal masukan demodulator yang berasal dari sinyal keluaran HT (*speaker*) dimana pada pin ini sinyal berupa sinyal FSK, dan pin no. 7 (*Data Output*) merupakan sinyal keluaran digital, disini mengalami proses demodulasi (data biner) yang dihubungkan pada komputer atau minimum sistem.

3.5 Perancangan Sistem Mikrokontroler

Sistem mikrokontroler terdiri atas mikrokontroler dan komponen-komponen pendukung agar sistem dapat bekerja dengan optimal.

3.5.1 Mikrokontroler 89S8252

Mikrokontroler 89S8252 harus didukung oleh beberapa rangkaian lain agar dapat melakukan prosesnya, yaitu berupa rangkaian clock dan reset. Selain itu juga harus ditentukan penggunaan port-portnya dan sinyal-sinyal yang digunakan untuk mendukung proses yang akan dilakukan.



Gambar 3-5.Skema Rangkaian Minimum Sistem

Mikrokontroler 89S8252 memiliki rangkaian osilator internal yang dapat digunakan sebagai sumber clock bagi CPU. Osilator internal dirancang dengan dua buah kapasitor dan satu kristal, sesuai dengan spesifikasi AT89S8252. Gambar 3.5 menunjukkan rangkaian mikrokontroler dengan osilator internal.

Rangkaian *power-on reset* dipergunakan untuk merseset mikrokontroler secara otomatis setiap awal catu daya dihidupkan. Saat cau daya diaktifkan, rangkaian reset akan menahan logika tinggi dari pin RST dengan jangka waktu tertentu hingga kapasitor terisi muatan hingga jenuh. Saat kapasitor jenuh, pin RST akan berlogika rendah, dan mikrokontroler telah mengalami proses reset.

3.5.2 Pembagian port

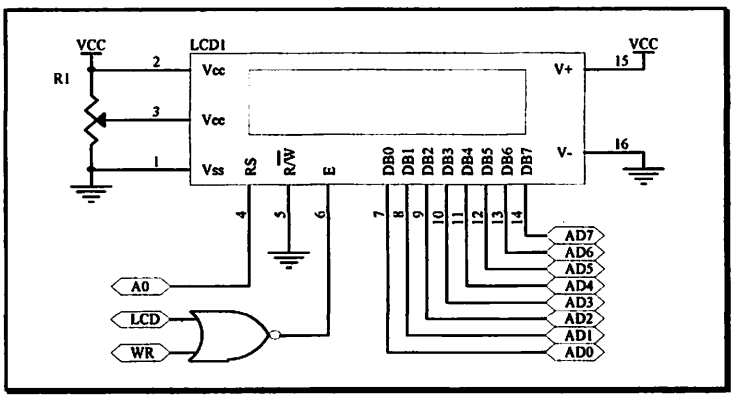
Dalam sistem mikrokontroler 89S8252 ini direncanakan menggunaan port-port yang tersedia. Port 0 digunakan untuk saluran data dan alamat bagian rendah yang dimultiplek (AD0-AD7), dan alamat bagian tinggi dikeluarkan pada port 2 (A8-A15). Karena menggunakan komunikasi serial pada sistem mikrokontrolernya maka beberapa bit port 3 digunakan sebagai pembangkit sinyal kontrol (TxD, RxD, RD dan WR).

3.6 LCD

Pada sistem yang direncanakan akan digunakan LCD (Liquid Crystal Display) sebagai tampilan. LCD yang digunakan adalah jenis TM1632 yang merupakan LCD dua baris dengan tiap barisnya terdiri dari 16 karakter.

LCD ini membutuhkan 3 sinyal kontrol, R/W (*read/write*) untuk menentukan apakah data akan dibaca atau ditulis, E (*Enable*) yang merupakan sinyal untuk meng-enable-kan dan RS (*Register Select*) untuk memilih register yang diakses. LCD TM1632 memiliki 2 register yaitu register data dan register instruksi.

Pin R/W dihubungkan ke *ground* atau selalu berlogika 0 karena dalam perancangan. LCD ini hanya selalu dalam operasi tulis dan pin RS dihubungkan ke pin A0 sistem mikrokontroler. Pengaktifan LCD ini selanjutnya tergantung pada pin E. Dimana pin E ini tergantung dari CS5 dari addres dekoder dan perintah write mikrokontroler. Rangkaian LCD seperti terlihat dalam g*ambar 3.7*

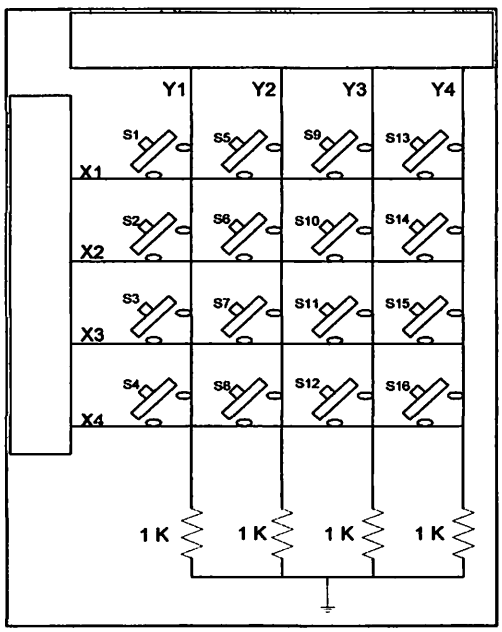


Gambar 3-6. Rangkaian LCD

3.7 Papan Tombol (*Keypad*)

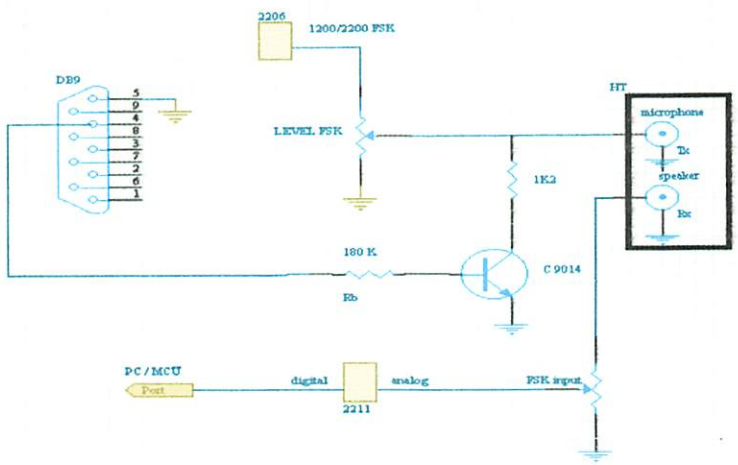
Papan tombol ini digunakan untuk memasukkan data referensi dan mengubah data bila diinginkan. Untuk menterjemahkan informasi yang diterima dari papan tombol, maka *keypad* dihubungkan dengan *port* 1.

Papan tombol tersebut mempunyai matrik 4 baris dan 4 kolom. Deretan baris dan kolom dari papan tombol dihubungkan dengan *port* 1 yang difungsikan sebagai masukan dan keluaran. Deretan kolom dihubungkan dengan *ground* (berlogika 0) dan *port* 1 (P14-P16) yang difungsikan sebagai *input* mikrokontroler. Sedangkan deretan baris dihubungkan ke *port* 1 (P10-P13) yang telah diberi data 0001 dan secara kontinyu data tersebut bergeser satu bit ke kiri. Pergeseran data satu bit ini dimaksudkan untuk menentukan posisi tombol yang ditekan dalam satu kolom. *Port* ini difungsikan sebagai *output* dari mikrokontroler. Dengan demikian kalau tombol tidak ditekan maka masukan *port 1* (P14-P16) di pin yang terhubung tombol tersebut berlogika 0 dan bila tombol ditekan akan berlogika 1.



Gambar 3-7. Rangkaian Keypad

3.8 Koneksi antara modem dengan radio



Gambar 3-8. Rangkaian koneksi modem dengan radio

Transistor berfungsi sebagai saklar yang digunakan untuk memberikan logika high (untuk mengaktifkan PTT dalam proses transmite data) dan low (PTT tidak aktif). Dengan menggunakan transistor NPN 9014 telah cukup untuk menjalankan fungsi saklar pada rangkaian ini. Selain itu transistor 9014 ini harganya murah tetapi dilengkapi dengan mutu yang cukup handal. Ditentukan Vcc= 12 volt dan Rc yang digunakan 1,2 Kohm, pada rangkain ini menggunakan resistansi yang kecil agar nilai Ic yang besar agar dapat arus basis pada transistor.

$$Ic = \frac{Vcc - Vce}{Rc} = \frac{12 - 0}{1.2K} = 10\ mA$$

Bdc = 150 (dari data sheet)

Maka Ib bisa dicari: $Ib = \frac{Ic}{\beta dc} = \frac{10mA}{150} = 66.66uA$

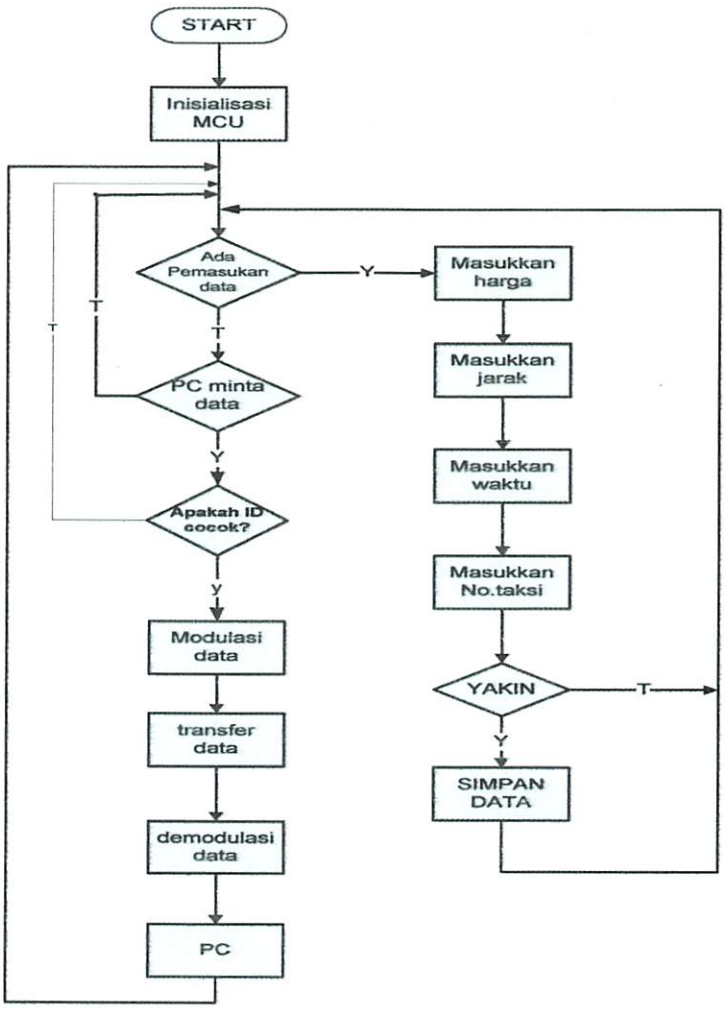
Maka Rb yabg digunakan

$$Rb = \frac{Vcc - Vbe}{Ib} = \frac{12 - 0,7}{66,66uA} = 169,5\ K\Omega$$

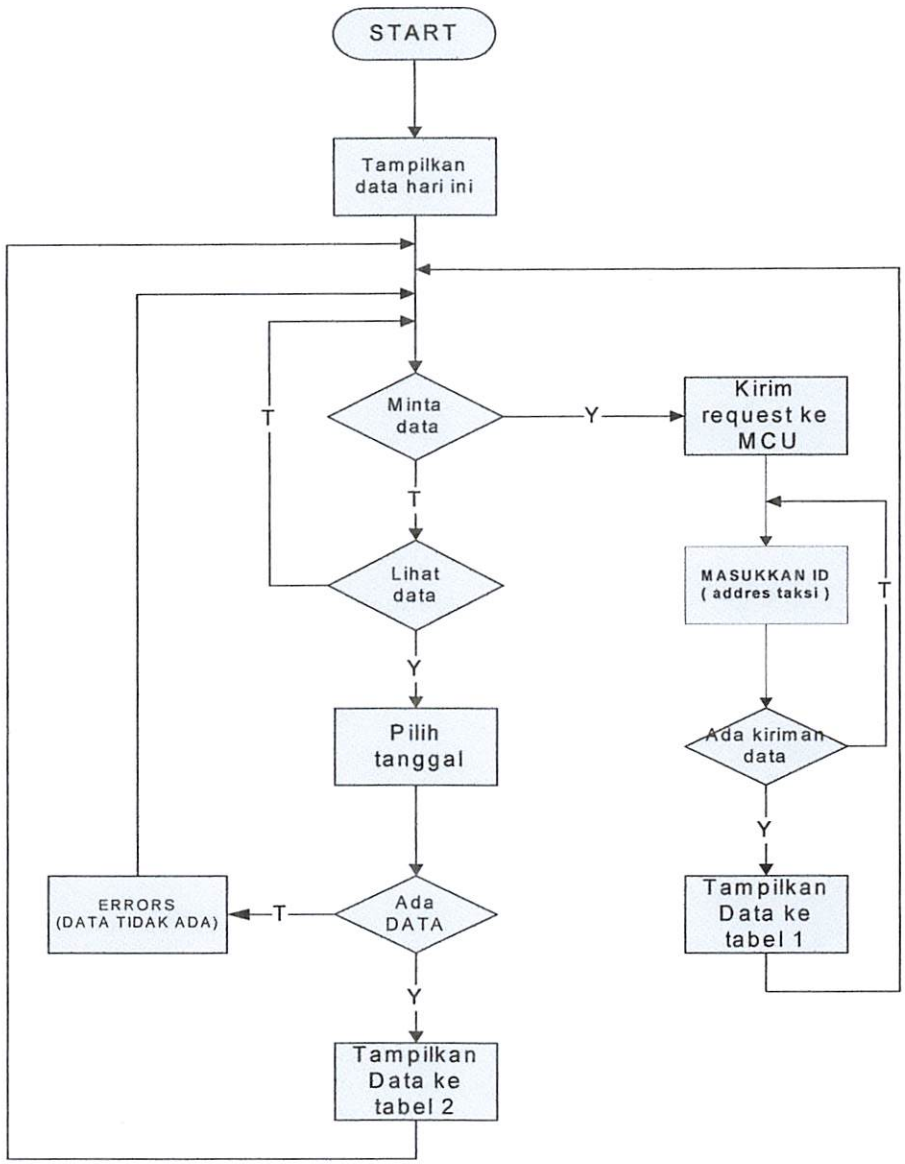
Karena nilai tahanan 169,5 K tidak ada dipasaran maka dapat diganti dengan nilai yang terdekat yaitu 180 KΩ.

3.9 Perencanaan Perangkat lunak

Karena menggunakan mikrokontroller AT89S8252 maka untuk mengontrol prosesnya menggunakan bahasa pemrograman assembly, sedangkan pada pc menggunakan visual basic. Oleh karena itu diperlukan urutan-urutan kerja yang digambarkan pada flowchat dibawah ini



Gambar 3-9. flowchart pada mikrokontroller



Gambar 3-10. flowchart pada PC menggunakan visual basic 6. 0

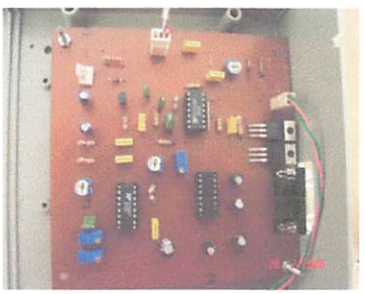
BAB IV

PENGUJIAN DAN ANALISIS

4.1 Tujuan

Bab ini membahas tentang pengujian dan analisis alat yang telah dibuat. Secara umum, pengujian ini bertujuan untuk mengetahui apakah alat yang telah direalisasikan dapat bekerja sesuai dengan spesifikasi perencanaan yang telah ditetapkan. Pengujian alat ini meliputi pengujian perangkat keras dan perangkat lunak.Pengujian dilakukan pada masing-masing blok terlebih dahulu,yang selanjutnya dilakukan pengujian untuk sistem secara keseluruhan.

Gambar 4-1. Gambar alat pada taksi



Gambar 4-2. Gambar alat pada operator

4.2 Pengujian Sistem Mikrokontroller.

- **Tujuan**

  Untuk mengetahui kondisi awal dari mikrokontroler apakah sudah sesuai dengan yang direncanakan

- **Prosedur Pengujian**

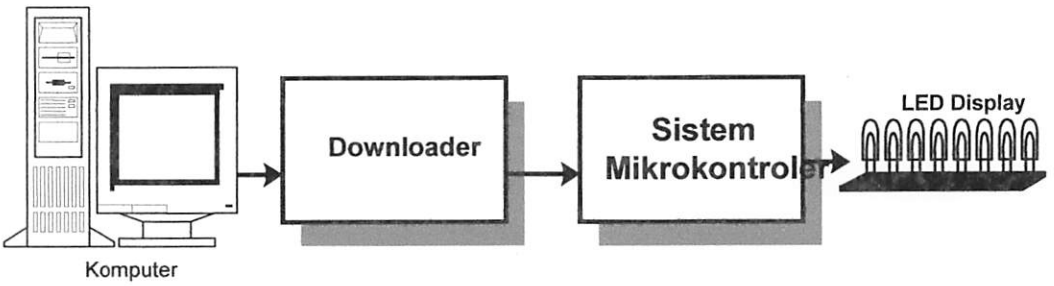
1. Membuat program yang digunakan dalam pengujian mikrokontroler.

   Program yang digunakan dalam pengujian mikrokontroler ini merupakan program sederhana yang meletakkan $0F_H$ dan $F0_H$ pada ACC secara bergantian kemudian memindahkannya pada *Port* 1 AT89S8252. Program yang dibuat adalah sebagai berikut :

```
        ORG   0000H
        JMP   START

START:  MOV   A,#0FH
        MOV   P1,A
        CALL  TUNDA
        MOV   A,#F0H
        MOV   P1,A
        JMP   START
TUNDA:  MOV   R3,#0FFH
TUNDA1: MOV   R2,#0FFH
        DJNZ  R2,$
        MOV   R1,#0FH
        DJNZ  R1,$
        DJNZ  R3,TUNDA1
        RET
        END
```

2. Rangkaian dibuat seperti Gambar 4-3.
3. Memasang catu daya rangkaian sebesar 5 Volt DC
4. Download program diatas .
5. Mengamati keluaran pada LED Display .



Gambar 4-3. Diagram blok Pengujian Mikrokontroler

➢ **Hasil Pengujian**

Hasil pengujian pada sistem mikrokontroller ditunjukkan dalam Tabel 4.1 dibawah ini :

Tabel 4.1 Hasil Pengujian Sistem Mikrokontroler

Kondisi	**Keluaran pada LED Display**							
	Bit 0	**Bit 1**	**Bit 2**	**Bit 3**	**Bit 4**	**Bit 5**	**Bit 6**	**Bit 7**
Satu	0	0	0	0	1	1	1	1
Dua	1	1	1	1	0	0	0	0

➢ **Analisis Pengujian**

Dari hasil pengujian dalam tabel 4-1 dapat dilihat bahwa *port* 1 memberikan logika $0F_H$ dan $F0_H$ secara bergantian sesuai dengan isi program.

4.3 Pengujian Komunikasi Serial

➢ **Tujuan**

Untuk mengetahui apakah data yang dikirim dari MCU ke *PC* dapat diterima dengan benar dengan melakukan simulasi pada komputer.

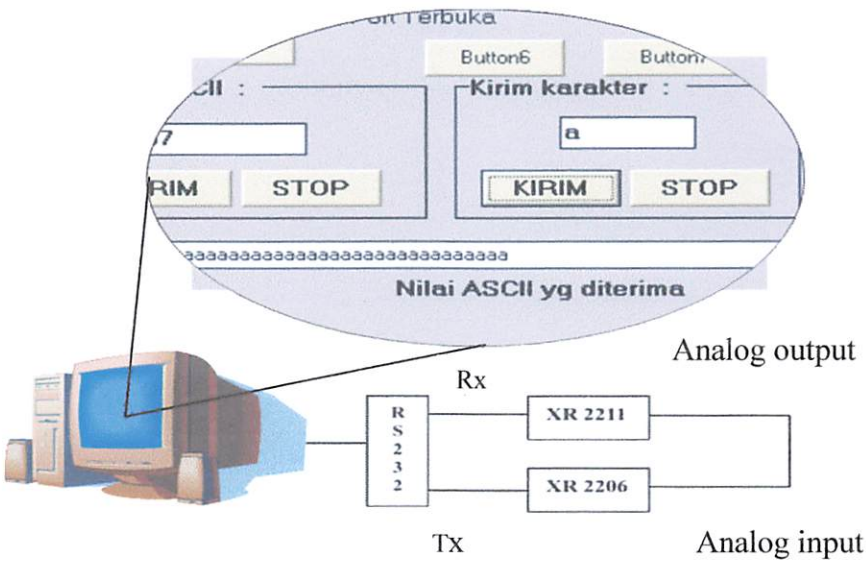
➢ **Peralatan yang digunakan**

- Komputer
- Rangkaian modem (XR 2211 dan XR2206)
- Frekuensi counter
- Catu daya 12 Volt DC
- Sistem mikrokontroller dengan antarmuka RS232.

a. Pengujian Rangkaian modem (XR 2211 dan XR2206)

➢ **Prosedur pengujian**

1 Menyusun rangkaian modem seperti pada gambar 4-4



Gambar 4-4.Rangkaian Pengujian modem

2. Mengaktifkan catu daya
3. Menyetel frekuensi mark (high) dengan frekuensi counter sampai pada 1200 Hz

Gambar 4-5.Tampilan frekuensi FSK pada logika high (mark)

3. Menyetel frekuensi space (low) dengan frekuensi counter pada frekuensi 2200 Hz

Gambar 4-6.Tampilan frekuensi FSK pada logika low(space)

b. Pengujian Sistem mikrokontroller dengan antarmuka RS232.

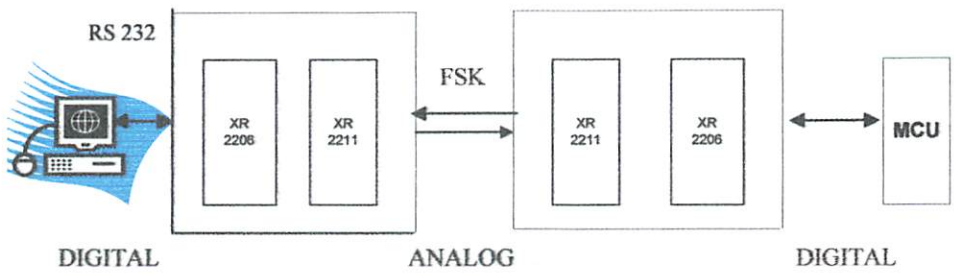
➢ **Prosedur pengujian**

Menyusun rangkaian seperti pada Gambar 4-7

Membuat program transfer data pada sistem mikrokontroller seperti yang ditunjukkan dalam program berikut. Dengan program tersebut komputer mengirim data '1234567890' ke alat dan oleh alat akan dikembalikan lagi ke komputer.

Download program ke Mikrokontroler dan eksekusi program.

Mencatat hasil yang terlihat dalam layar komputer.



Gambar 4-7. Rangkaian Pengujian Transfer Data

➢ Program Uji Komunikasi Data dari Mikrokontroler

```
B2400     EQU    232
MULAI:    CALL   INIT232
          CALL   SERIAL
          JMP    MULAI
PCON      EQU    87H
          ORG    0000H
          JMP    MULAI
          ORG    0023H
SERIAL:   JBC    TI,OUT232
          PUSH   ACC
          MOV    A,SBUF
          MOV    SBUF,A
          POP    ACC
OUT232:   CLR    TI
          CLR    RI
          RETI
INIT232:  MOV    TH1,#B1200
          MOV    TMOD,#22H
          ANL    PCON,#7FH
          MOV    SCON,#50H
          SETB   PS
          SETB   ES
```

Cuplikan program uji komunikasi data di komputer menggunakan program VB 6.0

MSComm1.Output = '1234567890'

Text1.Text = MSComm1.Input

➢ **Hasil Pengujian**

Hasil pengujian transfer data serial ini ditunjukkan Tabel 4 -2 dibawah ini:

Tabel 4-2. Hasil Pengujian Transfer Data Serial

Data yang dikirim komputer	Data yang diterima komputer
1234567890	1234567890

Hasil pengujian dalam Tabel 4-2. menunjukkan bahwa proses pengiriman data serial dengan menggunakan RS 232 ke alat telah benar.

4.4 Pengujian Rangkaian Keypad

➢ **Tujuan**

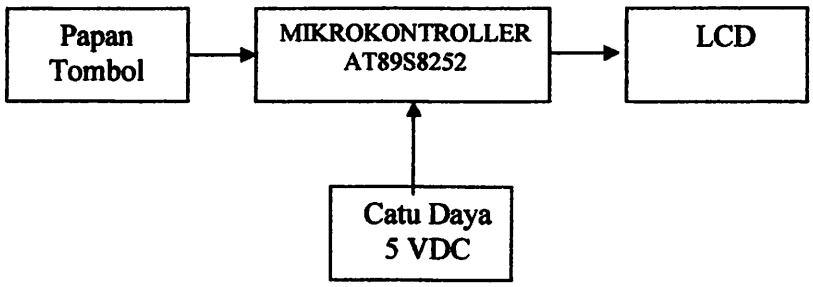
Untuk mengetahui apakah rangkaian ini dapat bekerja dengan baik agar alat yang direncanakan berjalan sesuai dengan yang diharapkan

➢ **Peralatan yang digunakan**

- Papan Tombol (keypad 4x4)
- MCU
- LCD
- Catu daya 5 Volt DC

➢ **Prosedur Pengujian**

1. Peralatan dirangkai seperti pada gambar 4-8
2. Menekan tombol pada papan tombol,mengamati dan mencatat keluaran yang ditampilkan ke LCD



Gambar 4-8. Diagram blok pengujian pengkode papan tombol (keypad)

3.Memasukkan program seperti dibawah ini pada mikro

```
Keypad4x4:

      Mov    keybounc,#100
      Mov    keyport,#0FFh
      Clr    kolom1              ;
;-----------
ul1:
      Jb     baris1,key1
      ;Djnz   keybounc,$
      Mov    keydata,#'1'
      Ret
key1:

      Jb     baris2,key2
;     Djnz   keybounc,$
      Mov    keydata,#'4'
      Ret
key2:
      Jb     baris3,key3
;     Djnz   keybounc,$
      Mov    keydata,#'7'
      Ret
key3:
      Jb     baris4,key4
;     Djnz   keybounc,$
      Mov    keydata,#'*'
      Ret
;-----------
key4:
      Setb   kolom1
      Clr    kolom2
      ;-----------
      Jb     baris1,key5
;     Djnz   keybounc,$
      Mov    keydata,#'2'
      Ret
```

```
key5:
     Jb    baris2,key6
;     Djnz   keybounc,$
     Mov    keydata,#'5'
     Ret
key6:
     Jb    baris3,key7
;     Djnz   keybounc,$
     Mov    keydata,#'8'
     Ret
key7:
     Jb    baris4,key8
;     Djnz   keybounc,$
     Mov    keydata,#'0'
     Ret
;---------------
key8:
     Setb   kolom2
     Clr    kolom3
     ;------------------
     Jb    baris1,key9
;     Djnz   keybounc,$
     Mov    keydata,#'3'
     Ret
key9:
     Jb    baris2,key10
;     Djnz   keybounc,$
     Mov    keydata,#'6'
     Ret
key10:
     Jb    baris3,key11
;     Djnz   keybounc,$
     Mov    keydata,#'9'
     Ret
key11:
     Jb    baris4,key12
;     Djnz   keybounc,$
     Mov    keydata,#'#'
     Ret
key12:
     Mov    keydata,#0FFh
```

- **Hasil pengujian dan analisis**

Hasil pengujian dan pengamatan rangkaian keypad ditunjukkan dalam tabel 4-3

Tabel 4-3. Hasil pengujian papan tombol (keypad)

Tombol	Tampilan LCD
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
*	*
#	#

Berdasarkan hasil pengujian yang diperlihatkan pada tabel 4.3 maka keypad dapat menghasilkan data biner yang berbeda untuk masing-masing tombol. Dengan demikian maka keypad dapat bekerja dengan baik sesuai perencanaan.

4.5 Pengujian Rangkaian LCD

Pengujian rangkaian LCD dilakukan dengan cara merangkainya seperti gambar dibawah kemudian dihubungkan ke rangkaian AT89S8252. Peralatan yang dibutuhkan adalah sebagai berikut:

- LCD M1632
- IC Mikrokontroller AT89S8252
- Supply +5 Volt

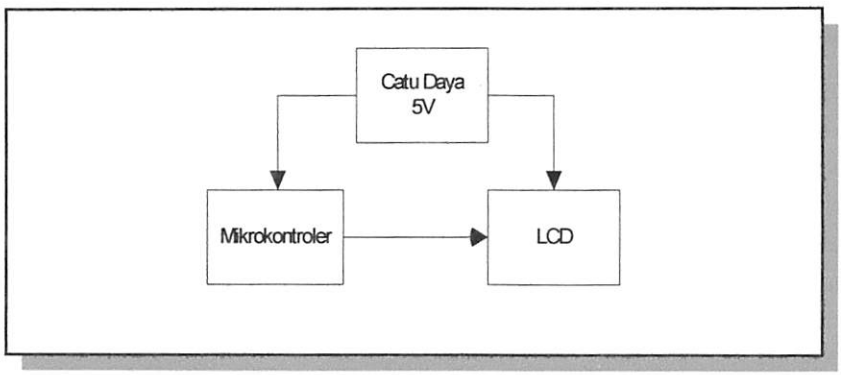
Dengan menggunakan Listing Program dibawah ini, bisa diketahui hasil dari pengujian rangkaian LCD.

Listing Program

```
;-------------------------------------------------------
;Program Demo untuk menjalankan LCD 16 x 2
;               Oleh: chairil iskandar
;-------------------------------------------------------
;
        org     0h
        nop
        ljmp    mulai
;
write_inst:
        mov     P1,#0h;untuk memuliskan
        mov     P0,R1  ;intruksi ke LCD
        setb    P1.1   ;module
        clr     P1.1
        acall   delay
        ret
;
write_data:
        mov     P1,#01;untuk menuliskan
        mov     P0,R1  ;data ke LCD
        setb    P1.1   ;module
        clr     P1.1
        acall   delay
        ret
;
delay:  mov     R0,#0
delay1: mov     R5,#50h
        djnz    R5,$
        djnz    R0,delay1
        ret
;
Ldelay: mov     R2,#030h
Ld1:    acall   delay
        djnz    R2,Ld1
        ret
;
tulis:  mov     R4,#3
        mov     DPTR,#tampil
barisa: mov     R3,#16
        mov     R1,#80h
```

```
        acall   write_inst
tulis1: clr     A
        movc    A,@A+DPTR
        mov     R1,A
        Inc     DPTR
        acall   write_data
        djnz    R3,Tulis1
;
barisb: mov     R3,#16
        mov     R1,#0C0h
        acall   write_inst
tulis2: clr     A
        movc    A,@A+DPTR
        mov     R1,A
        Inc     DPTR
        acall   write_data
        djnz    R3,Tulis2
        acall   Ldelay
        djnz    R4,barisa
        ret
;
mulai:
        mov     R1,#03Fh
        acall   write_inst
        acall   write_inst
        mov     R1,#0Dh
        acall   write_inst
        mov     R1,#06h
        acall   write_inst
        mov     R1,#01h
        acall   write_inst
        mov     R1,#0Ch
        acall   write_inst
        acall   tulis
        sjmp    mulai
;
tampil: DB      ' CHAIRIL ISKANDAR '
        DB      ' - 0117080 - '

;
        End
```



Gambar 4-9. BLOK DIAGRAM PENGUJIAN LCD

- **Analisis Hasil Pengujian**

  Dengan program diatas maka LCD akan menempilkan seperti gambar dibawah ini:

Gambar 4-10. Hasil Pengujian LCD

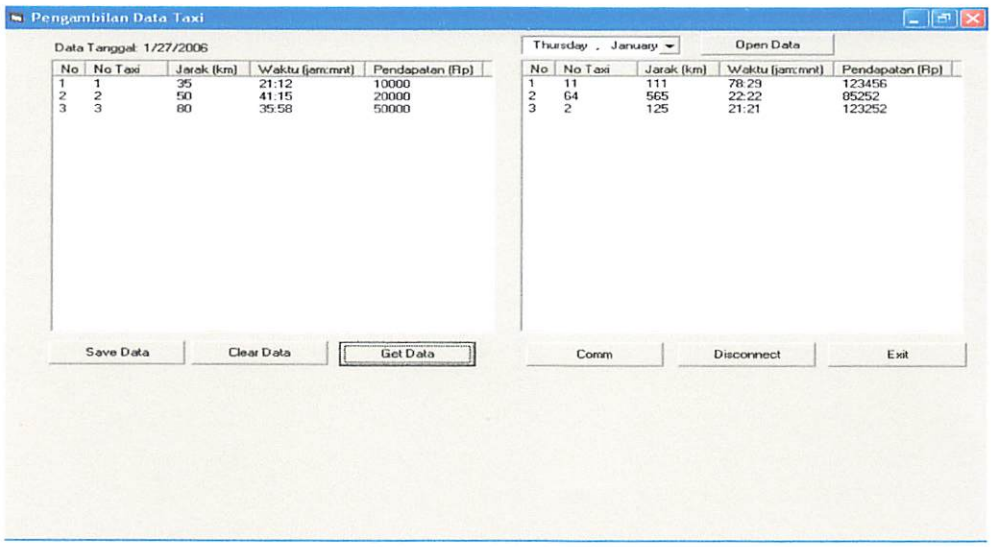
4.6 Pengujian Secara Keseluruhan

Pengujian ini dapat dilakukan setelah semua tahap pengujian perbagian telah dilakukan dengan baik. Adapun prosedur pengujian secara keseluruhan dapat dijelaskan sebagai berikut:

1. Pasang semua piranti perangkat keras.
2. Nyalakan piranti pada bagian taxi.

3. Masukan data-data yang diperlukan melalui keypad. Data meliputi pendapatan, jarak tempuh, waktu operasi, dan nomor lambung taxi.
4. Buka program aplikasi di komputer.
5. Lakukan seting pada port serial.
6. Ambil data
7. Simpan data.

Jika semua langkah telah dilakukan dan tidak terdapat kesalahan maka pengujian secara keseluruhan telah dapat dilakukan dengan baik.



Gambar 4-11. Tampilan Interfacing pada komputer

BAB V

KESIMPULAN

5.1 KESIMPULAN

Kesimpulan yang dapat diambil dari perancangan dan pembuatan alat ini ialah:

a) Transfer data ke kanntor operator taksi lebih cepat
b) Laporan setoran harian tidak terbatas jarak dan waktu karena melalui gelombang radio
c) Jarak jangkau tergantung pada jenis dan bentuk antenna dan daya RF masing-masing stasiun radio.
d) Konsumsi daya yang diserap oleh peralatan yang ada ditaksi hanya berkisar 8 watt, dan tegangan catu sesuai dengan tegangan catu daya yang ada di mobil taksi.

5.2 Saran

Untuk selanjutnya diharapkan adanya perkembangan yang signifikan selain dilengkapi oleh perhitungan harga, juga dilengkapi oleh perhitungan mekanik roda.

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6. Moh. Ibnu Malik, ST, *Belajar Mikrokontroller AT89S8252,* Gaya Media , Edisi Pertama, 2003
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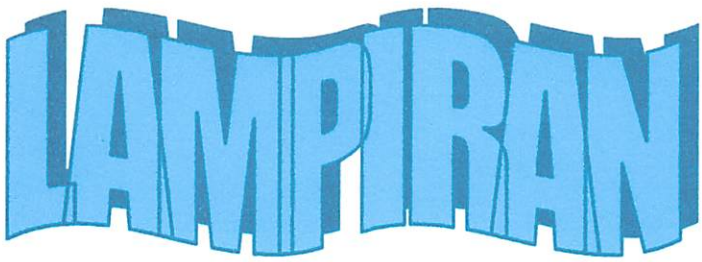
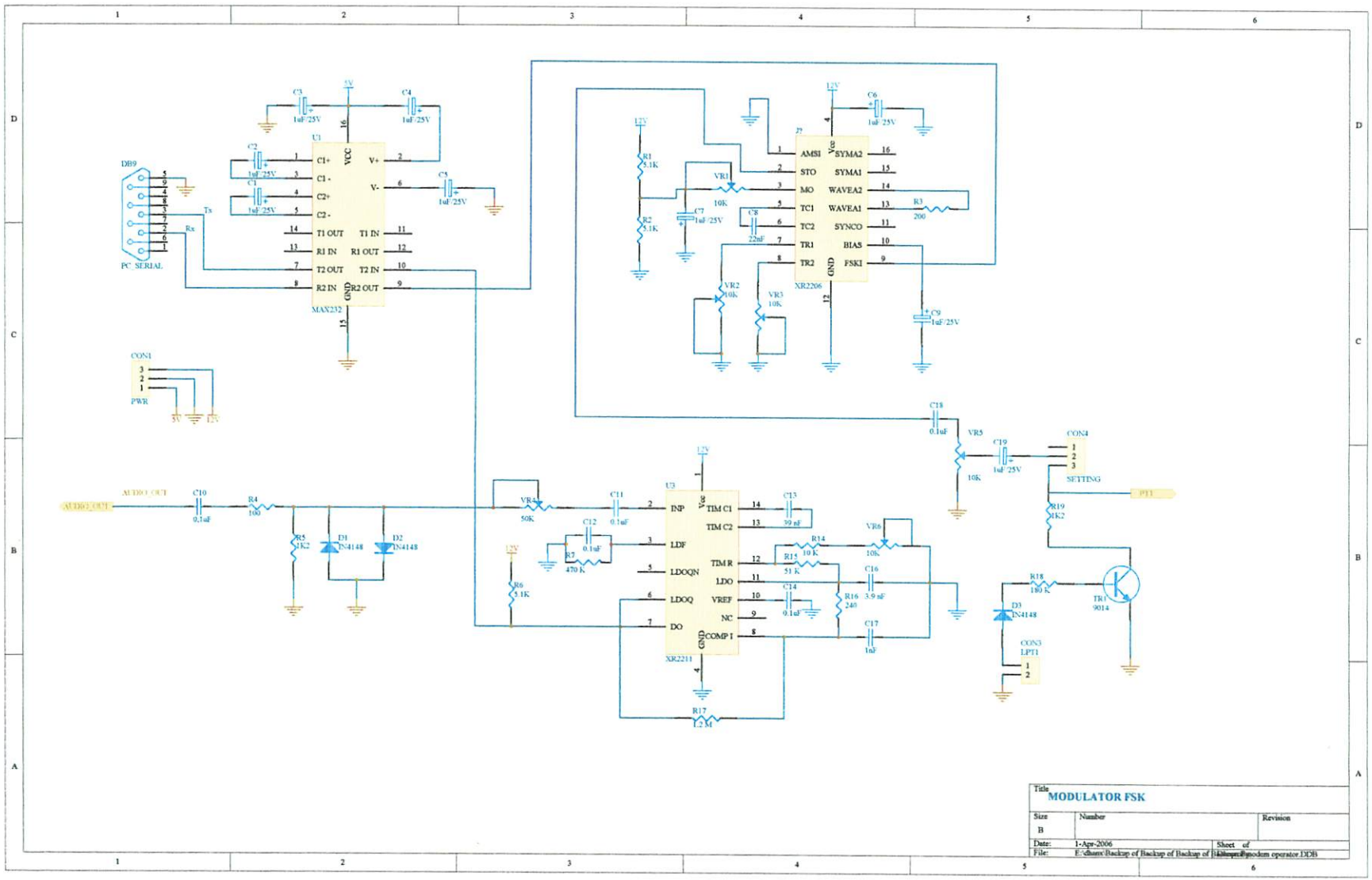
8. http://www.google.com/
9. http://www. maxim-ic.com.pdf


LAMPIRAN


MODULATOR FSK
Size B
Number
Revision
Date: 1-Apr-2006
Sheet of
File: E:\dhani\Backup of Backup of Backup of Dhani\modem operator.DDB
MAX232
XR2206
XR2211
PC SERIAL
PWR
SETTING
PTT
AUDIO_OUT
1N4148
9014

INSTITUT TEKNOLOGI NASIONAL
FAKULTAS TEKNOLOGI INDUSTRI
JURUSAN TEKNIK ELEKTRO S-1
KONSENTRASI TEKNIK ELEKTRONIKA

LEMBAR BIMBINGAN SKRIPSI

Nama	: Chairil Iskandar
NIM	: 01.17.080
Jurusan	: Teknik Elektro S-1
Konsentrasi	: Teknik Elektronika
Judul Skripsi	: Perencanaan dan Pembuatan Alat Pentransfer Data Argometer Taksi Berbasis Mikrokontroller AT89S8252 Yang Bisa Diupload Kekomputer Melalui Komunikasi Radio
Tanggal Pengajuan Skripsi	: 9 Desember 2005
Selesai Penulisan Skripsi	: 20 Maret 2006
Dosen Pembimbing	: Ir. Sidik Noertjahjono, MT
Telah Dievaluasi Dengan Nilai	: 85 (Delapan Puluh Lima)

Mengetahui,
Ketua Jurusan Teknik Elektro S-1

(Ir. F. Yudi Limpraptono, MT)
NIP.Y 1039500274

Diperiksa dan Disetujui,
Dosen Pembimbing

(Ir. Sidik Noertjahjono, MT)
NIP.Y .1028700167

INSTITUT TEKNOLOGI NASIONAL
FAKULTAS TEKNOLOGI INDUSTRI
JURUSAN TEKNIK ELEKTRO

Formulir Perbaikan Ujian Skripsi

Dalam pelaksanaan Ujian Skripsi Janjang Strata 1 Jurusan Teknik Elektro Konsentasi T. Energi Listrik / T. Elektronika, maka perlu adanya perbaikan skripsi untuk mahasiswa :

NAMA : CHRISTIAN ISKANDAR
NIM : 01.17.080
Perbaikan meliputi :

1) RANG. RESET
2) ~~-~~ KONEKSI MODEM } BAB III
3) PENGUJIAN MIKRO
4) RANG. LENGKAP DIPERJELAS
5) Gambar 4-7
6) PENGUJIAN KEYPAD
7) SOFTWARE PENGUJIAN LCD
8) SUMBER BAB II

Malang,

(_____)

INSTITUT TEKNOLOGI NASIONAL
FAKULTAS TEKNOLOGI INDUSTRI
JURUSAN TEKNIK ELEKTRO S-1
KONSENTRASI TEKNIK ELEKTRONIKA

FORMULIR PERBAIKAN SKRIPSI

Nama : Chairil Iskandar

NIM : 01.17.080

Masa Bimbingan : 9 Desember 2005 s/d 9 Mei 2006

Judul : Perencanaan dan Pembuatan Alat Pentransfer Data Argometer Taksi Berbasis Mikrokontroller AT89S8252 Yang Bisa Diupload KeKomputer Melalui Komunikasi Radio

No	Tanggal	Uraian	Paraf
1	22 Maret 2006	Sumber-sumber bab II	
2	22 Maret 2006	Rangkaian Reset dan koneksi Modem	
3	22 Maret 2006	Pengujian Mikrokontroller	
4	22 Maret 2006	Pengujian keypad	
5	22 Maret 2006	Pengujian dan software LCD	
6	22 Maret 2006	Gambar 4.7	
7	22 Maret 2006	Rangkaian keseluruhan	

Disetujui

Penguji I

(Joseph. D. Irawan, ST, MT)

Penguji II

28/3 '06

(Sotyohadi, ST)

Mengetahui,
Dosen Pembimbing

(Ir. Sidik Noertjahjono, MT)
NIP.Y .1028700167

INSTITUT TEKONOLOGI NASIONAL
Jl. Bendungan Sigura-gura No. 2
MALANG

FORMULIR PEMBIMBING SKRIPSI

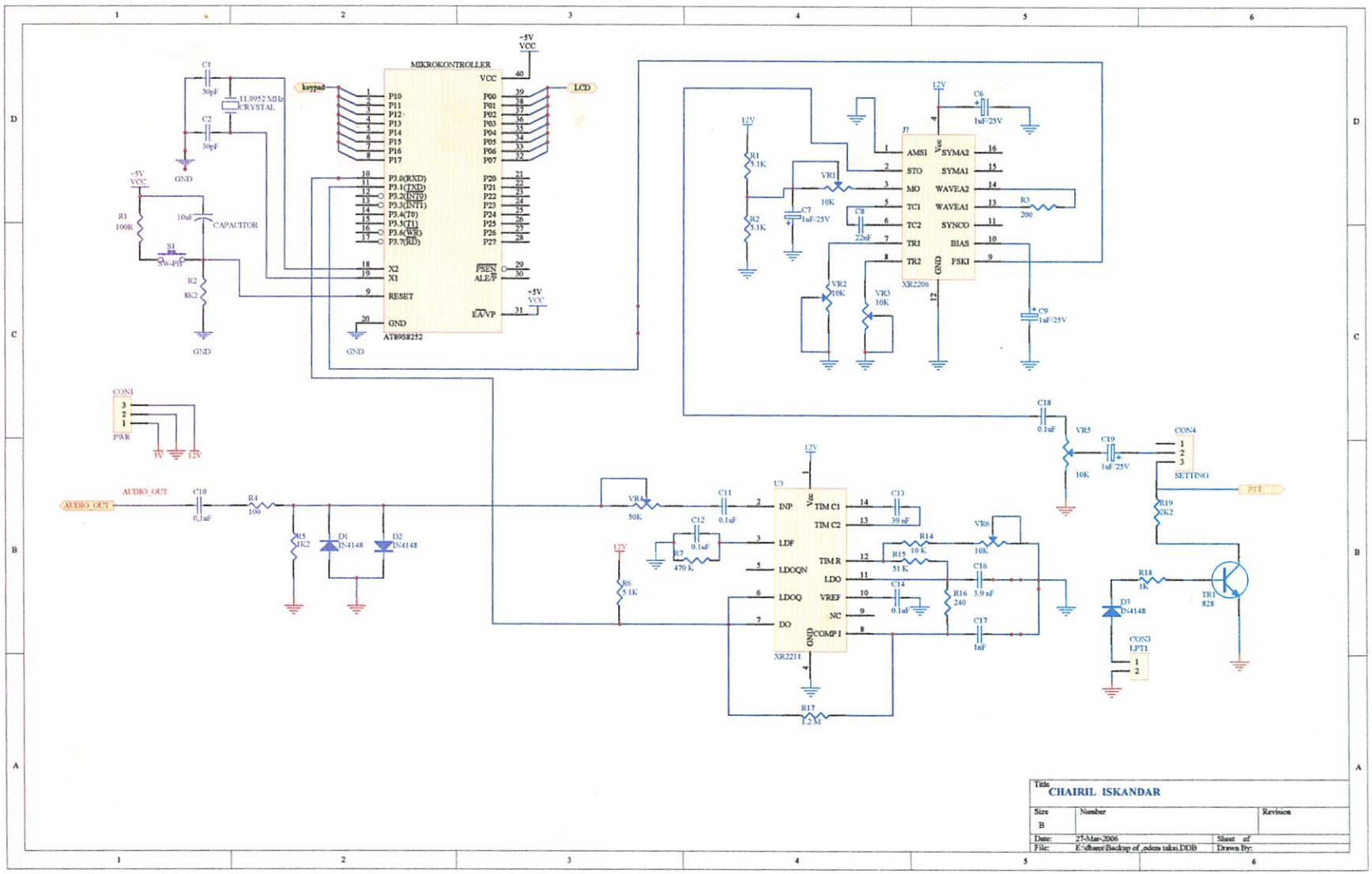
Nama : Chairil Iskandar
Nim : 0117080
Mas Bimbingan : 9 Desember- 10 Mei 2006
Judul Skripsi : PERANCANGAN DAN PEMBUATAN ALAT PENTRANSFER DATA PADA ARGOMETER TAKSI YANG BERBASIS MIKROKONTROLLER AT89S8252 YANG BISA DI UPLOAD KE KOMPUTER

NO	TANGGAL	URAIAN	PARAF
1	10/12 05.	Konsultasi judul & diagram blok	[signature]
2	5/1 06.	Realisasi diagram blok ke rangkaian elektronik	[signature]
3	21/1 06.	Uji modem, test FSK kirim/terima, software	[signature]
4	2/2 06.	Bab IV, uji coba rangk, kesimpulan, tulis Bab V	[signature]
5	12/2 06.	Tulis makalah seminar persiapan.	[signature]
6	28/2 06.	Bab III, pada perencanaan buat routing Request pd. software	[signature]
7	2/3 06.	Bab II, Teori Uji parity bit dan BER.	[signature]
8	10/3 06.	Bab II, rangkaian keypad, Teori Modem, Bab I, Acc.	[signature]
9	17/3 06.	Pd. Abstrak, kurang 3 paragraf, cantumkan d. Bab V.	[signature]
10	20/3 06.	Acc Lap, persiapan ujian	[signature]

Malang,
DOSEN PEMBIMBING

[signature]

Ir.Sidik Noertjahjono,MT
NIP.Y.1028700167


MIKROKONTROLLER
AT89S8252
XR2206
XR2211
CAPACITOR
SW-PB
keypad
LCD
PWR
SETTING
PTT
AUDIO_OUT
CHAIRIL ISKANDAR
Size
B
Number
Revision
Date: 27-Mar-2006
Sheet of
File: E:\dhasr\Backup of ,edem takss.DDB
Drawn By:

LISTING PROGRAM

```
Dim FileName As String
Dim FileName1 As String

Private Sub cmdAmbilData_Click()
Dim a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z
Dim s0, s1, s2, s3, s4, s5, s6, s7, s8, s9
Dim s10, s11, s12, s13, s14, s15, s16, s17, s18, s19
Dim s20, s21, s22, s23, s24, s25, s26, s27, s28, s29
Dim s30, s31, s32, s33, s34, s35, s36, s37, s38, s39
Dim EA As Variant
Dim Rupiah As Long
Dim Km As Long
Dim Waktu As Long
Dim Taxi As Integer

   FileName1 = App.Path & "\" & Replace(DTP1.Value, "/", "_") & ".txt"
   If Dir(FileName1) = "" Then
      MsgBox "Data tidak ditemukan", vbCritical, "Error"
      LV2.ListItems.Clear
      Exit Sub
   End If

   CM1.OpenFile FileName1

   LV2.ListItems.Clear
   If CM1.Text = "" Then Exit Sub

   For i = 0 To CM1.LineCount - 2
      a = CM1.GetLine(i)
      EA = Split(a, ";")
      LV2.ListItems.Add , "A" & Date & Time & i, LV2.ListItems.Count + 1
      LV2.ListItems(LV2.ListItems.Count).SubItems(1) = EA(0)
      LV2.ListItems(LV2.ListItems.Count).SubItems(2) = EA(1)
      LV2.ListItems(LV2.ListItems.Count).SubItems(3) = EA(2)
      LV2.ListItems(LV2.ListItems.Count).SubItems(4) = EA(3)
   Next i

End Sub

Private Sub cmdClearData_Click()
   LV1.ListItems.Clear
End Sub

Private Sub cmdComm_Click()
```

```
    frmProperties.Show vbModal
End Sub

Private Sub cmdConnect_Click()
    If cmdConnect.Caption = "Connect" Then
        MSComm1.PortOpen = True
        cmdConnect.Caption = "Disconnect"
        Proses = Awal
    Else
        MSComm1.PortOpen = False
        cmdConnect.Caption = "Connect"
    End If
End Sub


Private Sub cmdExit_Click()
    Unload Me
End Sub

Private Sub cmdGetData_Click()

    If MSComm1.PortOpen = False Then
        MsgBox "Komunikasi belum diaktifkan", vbCritical, "Error "
        Exit Sub
    End If


    If txtNo.Text = "" Then
        MsgBox "Isi nomor Labung 2 digit", vbCritical, "Error"
        Exit Sub
    End If

    txtTerm.Text = ""

        MSComm1.DTREnable = True
        Sleep 7000

        MSComm1.Output = "RES"

        'DoEvents
        'If txtTerm.Text <> "" Then Exit Do
        'Sleep 100
        'MSComm1.Output = "RES"

        Sleep 100
        MSComm1.Output = txtNo.Text     'Send ID
```

```
    Sleep 500
  'Loop
  MSComm1.DTREnable = False


End Sub

Private Sub cmdSave_Click()
Dim a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z
Dim s0, s1, s2, s3, s4, s5, s6, s7, s8, s9
Dim s10, s11, s12, s13, s14, s15, s16, s17, s18, s19
Dim s20, s21, s22, s23, s24, s25, s26, s27, s28, s29
Dim s30, s31, s32, s33, s34, s35, s36, s37, s38, s39

  If LV1.ListItems.Count = 0 Then
    If MsgBox("Anda yakin menyimpan data kosong?", vbOKCancel,
"Perhatian") = vbCancel Then Exit Sub
  End If

  s30 = App.Path & "\" & Replace(lblTanggal.Caption, "/", "_") & ".txt"

  CM1.Text = ""
  For i = 1 To LV1.ListItems.Count
    a = LV1.ListItems(i).SubItems(1) & ";"
    b = LV1.ListItems(i).SubItems(2) & ";"
    c = LV1.ListItems(i).SubItems(3) & ";"
    d = LV1.ListItems(i).SubItems(4) & ";"
    CM1.Text = CM1.Text & a & b & c & d & vbCrLf
  Next i

  CM1.SaveFile s30, True
  a = a
End Sub


Private Sub Form_Load()
Dim a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z
Dim s0, s1, s2, s3, s4, s5, s6, s7, s8, s9
Dim s10, s11, s12, s13, s14, s15, s16, s17, s18, s19
Dim s20, s21, s22, s23, s24, s25, s26, s27, s28, s29
Dim s30, s31, s32, s33, s34, s35, s36, s37, s38, s39
Dim EA As Variant
Dim Str1 As String
```

```
    Dim CommPort As String, Handshaking As String, Settings As String

    lblTanggal.Caption = Date

    FileName1 = App.Path & "\" & Replace(Date, "/", "_") & ".txt"
    If Dir(FileName1) = "" Then
       LV1.ListItems.Clear
       Exit Sub
    End If

    CM1.OpenFile FileName1

    LV1.ListItems.Clear
    If CM1.Text = "" Then Exit Sub

    For i = 0 To CM1.LineCount - 2
       a = CM1.GetLine(i)
       EA = Split(a, ";")
       LV1.ListItems.Add , "A" & Date & Time & i, LV1.ListItems.Count + 1
       LV1.ListItems(LV1.ListItems.Count).SubItems(1) = EA(0)
       LV1.ListItems(LV1.ListItems.Count).SubItems(2) = EA(1)
       LV1.ListItems(LV1.ListItems.Count).SubItems(3) = EA(2)
       LV1.ListItems(LV1.ListItems.Count).SubItems(4) = EA(3)
    Next i

End Sub

Private Sub MSComm1_OnComm()
    Dim EVMsg$
    Dim ERMsg$

    ' Branch according to the CommEvent property.
    Select Case MSComm1.CommEvent
       ' Event messages.
       Case comEvReceive
          Dim Buffer As Variant
          Buffer = MSComm1.Input
          Debug.Print "Receive - " & StrConv(Buffer, vbUnicode)
          ShowData txtTerm, (StrConv(Buffer, vbUnicode))
       Case comEvSend
       Case comEvCTS
          EVMsg$ = "Change in CTS Detected"
       Case comEvDSR
          EVMsg$ = "Change in DSR Detected"
       Case comEvCD
          EVMsg$ = "Change in CD Detected"
```

```
      Case comEvRing
         EVMsg$ = "The Phone is Ringing"
      Case comEvEOF
         EVMsg$ = "End of File Detected"
      GoTo x1
      ' Error messages.
'     Case comBreak
'        ERMsg$ = "Break Received"
'     Case comCDTO
'        ERMsg$ = "Carrier Detect Timeout"
'     Case comCTSTO
'        ERMsg$ = "CTS Timeout"
'     Case comDCB
'        ERMsg$ = "Error retrieving DCB"
'     Case comDSRTO
'        ERMsg$ = "DSR Timeout"
'     Case comFrame
'        'ERMsg$ = "Framing Error"
'     Case comOverrun
'        ERMsg$ = "Overrun Error"
'     Case comRxOver
'        ERMsg$ = "Receive Buffer Overflow"
'     Case comRxParity
'        ERMsg$ = "Parity Error"
'     Case comTxFull
'        ERMsg$ = "Transmit Buffer Full"
x1:
     Case Else
        Err.Clear
        'ERMsg$ = "Unknown error or event"
   End Select

End Sub
Private Static Sub ShowData(Term As Control, Data As String)
   On Error GoTo Handler
   Const MAXTERMSIZE = 16000
   Dim TermSize As Long, i

   ' Make sure the existing text doesn't get too large.
   TermSize = Len(Term.Text)
   If TermSize > MAXTERMSIZE Then
     Term.Text = Mid$(Term.Text, 4097)
     TermSize = Len(Term.Text)
   End If

   ' Point to the end of Term's data.
```

```
    Term.SelStart = TermSize

    ' Filter/handle BACKSPACE characters.
    Do
      i = InStr(Data, Chr$(8))
      If i Then
        If i = 1 Then
          Term.SelStart = TermSize - 1
          Term.SelLength = 1
          Data = Mid$(Data, i + 1)
        Else
          Data = Left$(Data, i - 2) & Mid$(Data, i + 1)
        End If
      End If
    Loop While i

    ' Eliminate line feeds.
    Do
      i = InStr(Data, Chr$(10))
      If i Then
        Data = Left$(Data, i - 1) & Mid$(Data, i + 1)
      End If
    Loop While i

    ' Make sure all carriage returns have a line feed.
    i = 1
    Do
      i = InStr(i, Data, Chr$(13))
      If i Then
        Data = Left$(Data, i) & Chr$(10) & Mid$(Data, i + 1)
        i = i + 1
      End If
    Loop While i

    ' Add the filtered data to the SelText property.
    Term.SelText = Data

    ' Log data to file if requested.
    Term.SelStart = Len(Term.Text)
Exit Sub

Handler:
    MsgBox Error$
    Resume Next
End Sub
```

```
Private Sub txtTerm_Change()
Dim a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z
Dim s0, s1, s2, s3, s4, s5, s6, s7, s8, s9
Dim s10, s11, s12, s13, s14, s15, s16, s17, s18, s19
Dim s20, s21, s22, s23, s24, s25, s26, s27, s28, s29
Dim s30, s31, s32, s33, s34, s35, s36, s37, s38, s39
Dim Rupiah As Long
Dim Km As Long
Dim Waktu As Long
Dim Taxi As Integer

   If txtTerm.Text = "" Then Exit Sub
   a = InStr(1, txtTerm.Text, "LB")
   If a <> 0 Then
      b = InStrRev(txtTerm.Text, "RP", -1, vbTextCompare)
      If b = 0 Then Exit Sub
      c = InStr(b, txtTerm.Text, "$", vbTextCompare)
      If c = 0 Then Exit Sub
      Rupiah = Mid(txtTerm.Text, b + 2, c - b - 2)
      '---------
      d = InStr(b, txtTerm.Text, "$W", vbTextCompare)
      If d = 0 Then Exit Sub
      e = InStr(d, txtTerm.Text, "&K", vbTextCompare)
      If e = 0 Then Exit Sub
      Waktu = Mid(txtTerm.Text, d + 2, e - d - 2)
      '---------
      b = InStr(d, txtTerm.Text, "&K", vbTextCompare)
      If b = 0 Then Exit Sub
      c = InStr(b, txtTerm.Text, "KM", vbTextCompare)
      If c = 0 Then Exit Sub
      Km = Mid(txtTerm.Text, b + 2, c - b - 2)
      '---------
      b = InStrRev(txtTerm.Text, "LB", -1, vbTextCompare)
      Taxi = Mid(txtTerm.Text, b - 2, 2)

      'LV1.ListItems.Clear
      LV1.ListItems.Add , "A" & Date & Time, LV1.ListItems.Count + 1
      LV1.ListItems(LV1.ListItems.Count).SubItems(1) = Taxi
      LV1.ListItems(LV1.ListItems.Count).SubItems(2) = Km
      LV1.ListItems(LV1.ListItems.Count).SubItems(3) = Mid(Waktu, 1, 2) & ":"
& Right(Waktu, 2)
      LV1.ListItems(LV1.ListItems.Count).SubItems(4) = Rupiah

      txtTerm.Text = ""
   End If
End Sub
```

```
                                    Taxi ITN
olom1           Bit     P1.4    ; kiri (1,4,7,redial)
olom2           Bit     P1.5    ;      (2,5,8,0)
olom3           Bit     P1.6    ;      (3,3,9,#
olom4           Bit     P1.7

aris1           Bit     P1.0    ; atas (1,2,3)
aris2           Bit     P1.1    ;      (4,5,6)
aris3           Bit     P1.2    ;      (7,8,9)
aris4           Bit     P1.3    ;      (*,0,#)

eyport          Equ     P1
elay            Bit     P2.5

cd_rs           Bit     P2.7
cd_ena          Bit     P2.6
cd_Data         Equ     P0

eydata          Data    20h
emp             Data    21h

lagKey          Data    24h

tekantombol     data    30h     30-46// 47,48=stack
mpnilai1        Data    50h     ;50-56

        Clr     EA
        Mov     SP,#80h


        Call    LCD_Inisialisasi
        Call    Serial_Initialization

tart:
        Call    LCD_Inisialisasi
        Call    Serial_Initialization
        Setb    RI

lang:
        Clr     Relay

eyInGetmatrix1:
        Clr     kolom3
        Jnb     baris4,KeyInGetmatrix0

        Jnb     RI,KeyInGetmatrix1

        Call    Serial_Receive

        Cjne    A,#'R',KeyInGetmatrix1

        Call    Serial_Receive
```

```
        Cjne    A,#'E',KeyInGetmatrix1

        Call    Serial_Receive

        Cjne    A,#'S',KeyInGetmatrix1

        Call    Serial_Receive

        Cjne    A,75h,KeyInGetmatrix1

        Call    Serial_Receive

        Cjne    A,#76h,KeyInGetmatrix1

        Setb    Relay
        Call    Delay_Fix_1s

        Call    Outxx

        Call    Delay_Fix_1s
        Clr     Relay

        Jmp     start
eyInGetmatrix0:
        Jmp     Key_masukan

ey_masukan:
        Call    Delay_Fix_1s
        Call    Delay_Fix_100ms
-------------------------------------
etRupiah:
        Call    LCD_Clear
        Call    lcd_line_1
        Mov     DPTR,#txt_setRP
        Call    LCD_TampilKata

        Call    LCD_Line_2
        Mov     DPTR,#txt_setRP1
        Call    LCD_TampilKata

        Call    LCD_Blink_On
        Mov     A,#0C5h
        Call    LCD_Tulis_Inst
        Mov     temp,#6
        Mov     R0,#25h
        Mov     @R0,#'R'
        Inc     R0
        Mov     @R0,#'p'
        Inc     R0
nbilKeypad1:

        Mov     FlagKey,#0
```

```
        Call    Keypad_KeyIn
        ;Mov     B,A

        Mov     @R0,A
        Cjne    A,#'#',AmbilKeypad2
        Mov     @R0,#'$'
        Jmp     Yakinxx
mbilKeypad2:

MBILkEYPAD3:

        Inc     R0
        Djnz    temp,AmbilKeypad1

        Mov     @R0,#'$'
        Jmp     Yakinxx

akinxx:
        Call    LCD_Blink_Off
        Call    Delay_Fix_1s
        ;Jmp     outaa

etWaktu:
        Call    LCD_Clear
        Call    lcd_line_1
        Mov     DPTR,#txt_setwaktu
        Call    LCD_TampilKata
        Call    LCD_Line_2
        Mov     DPTR,#txt_setwaktu1
        Call    LCD_TampilKata

ek_rp:
        Mov     R0,#25h
ek_rp1:
        Mov     A,@R0
        Cjne    A,#'$',Cek_rp2
        Inc     R0
        Jmp     SetWaktu1
ek_rp2:
        Inc     R0
        Jmp     Cek_rp1
etWaktu1:
        Mov     @R0,#'W'
        Inc     R0
        Call    LCD_Blink_On
        ; masukan jam
        Mov     A,#0C4h
        Call    LCD_Tulis_Inst

        Mov     FlagKey,#0
        Call    Keypad_KeyIn
        Mov     @R0,A
```

```
        Inc     R0

        Mov     FlagKey,#0
        Call    Keypad_KeyIn
        Mov     @R0,A
        Inc     R0
        Mov     A,#':'
        Call    LCD_Tulis_Data

        Mov     FlagKey,#0
        Call    Keypad_KeyIn
        Mov     @R0,A
        Inc     R0

        Mov     FlagKey,#0
        Call    Keypad_KeyIn
        Mov     @R0,A
        Inc     R0

        Mov     @R0,#'&'

        Call    LCD_Blink_Off

        Call    Delay_Fix_1s

etKilo:
        Call    LCD_Clear
        Call    lcd_line_1
        Mov     DPTR,#txt_setKM
        Call    LCD_TampilKata

        Call    LCD_Line_2
        Mov     DPTR,#txt_setKM1
        Call    LCD_TampilKata

kwaktu:
        Mov     R0,#25h
kwaktu1:
        Mov     A,@R0
        Cjne    A,#'&',Cekwaktu2
        Inc     R0
        Jmp     Setkilo1
kwaktu2:
        Inc     R0
        Jmp     CekWaktu1

tkilo1:
        Mov     @R0,#'K'
        Inc     R0

        Call    LCD_Blink_On
        Mov     A,#0C2h
```

```
        Call    LCD_Tulis_Inst
        Mov     temp,#3
:tkilo2:
        Mov     FlagKey,#0
        Call    Keypad_KeyIn

        Mov     @R0,A
        Cjne    A,#'#',AmbilKeypad2zz
        Mov     @R0,#'K'
        Inc     R0
        Mov     @R0,#'M'
        Jmp     setNo
ıbilKeypad2zz:
        Inc     R0
        Djnz    temp,Setkilo2

        Mov     @R0,#'K'
        Inc     R0
        Mov     @R0,#'M'

        Jmp     setNo
:tNo:

        Call    LCD_Clear
        Call    lcd_line_1
        Mov     DPTR,#txt_lambung
        Call    LCD_TampilKata

        Call    LCD_Line_2
        Mov     DPTR,#txt_lambung1
        Call    LCD_TampilKata

        Mov     R0,#25h

tNo1:
        Mov     A,@R0
        Cjne    A,#'M',SetNo2
        Inc     R0
        Jmp     Setno3
tNo2:
        Inc     R0
        Jmp     SetNo1

tno3:

        Call    LCD_Blink_On

        Mov     A,#0C4h
        Call    LCD_Tulis_Inst

        Mov     FlagKey,#0
        Call    Keypad_KeyIn
```

```
        Mov     75h,A
        Mov     @R0,A

        Inc     R0

        Mov     FlagKey,#0
        Call    Keypad_KeyIn
        Mov     75h,A
        Mov     @R0,A
        Inc     R0

        Mov     @R0,#'L'

        Inc     R0
        Mov     @R0,#'B'
        Inc     R0

akin1cx:
        Call    LCD_Blink_Off
        Call    Delay_Fix_1s

        Call    LCD_Clear
        Call    lcd_line_1
        Mov     DPTR,#txt_menuyakin
        Call    LCD_TampilKata

        Call    LCD_Line_2
        Mov     DPTR,#txt_menuyakin1
        Call    LCD_TampilKata
akin1C:
        Mov     FlagKey,#0
        Call    Keypad_KeyIn
        Cjne    A,#'1',Yakin2C
        Call    Simpan_data1
        ;Call    Outxx
        Call    Delay_Fix_1s
        Call    Delay_Fix_1s
        Call    LCD_Clear
        Jmp     start

akin2C:
        Cjne    A,#'2',Yakin1C
        Call    LCD_Clear
        Jmp     start

broutine Outxx:
        Call    Delay_Fix_1s
        Call    LCD_Clear

        Mov     R0,#52h
angl:
        Mov     A,@R0
```

```
        Cjne    A,#'B',Tampilkandata
        Call    Serial_Transmit

        Ret
ampilkandata:
        Call    Serial_Transmit
        Inc     R0
        Jmp     ulang1
dSub

================================================
broutine Simpan_data1:

        Call    LCD_Clear
        Call    lcd_line_1
        Mov     DPTR,#txt_simpan
        Call    LCD_TampilKata
        Call    Delay_Fix_1s

        Mov     47h,#25h
        Mov     48h,#52h
impandata2:
        Mov     R0,47h                  ;r0=30h // r0=31h
        Mov     A,@R0                    ;a=30h  // a=31h
        Cjne    A,#'B',SimpanData3
        Mov     R0,48h                   ;r0=52h // r0=53h
        Mov     @R0,A                    ;52h<=30h //53h<=31h

        Ret                     ;start
impanData3:
        Inc     R0                       ;r0=31h //r0=32h
        Mov     47h,R0                   ;40h=31h //40h=32h
        Mov     R0,48h                   ;r0=52h // r0=53h
        Mov     @R0,A                    ;52h<=30h //53h<=31h
        Inc     R0                       ;r0=53  // r0=54h
        Mov     48h,R0                   ;41h=53 //41=54h

        Jmp     Simpandata2
dSub

broutine Conversion_Hexa_BCD:
        Push    B
        Mov     B,#100
        Mov     6,A
        Mov     A,#10
        Add     A,B
        Mov     7,A
        Pop     B
        Ret
dSub

================================
```

```
ubroutine Keypad_KeyIn:
        Push    B                       ; amankan register B
eyInGet1:
        Call    Keypad3x4               ;scan keypad
        Mov     A,keydata               ;isi keydata = data di rutin
eypad
        Cjne    A,#0FFh,KeyInGet0       ;jk isi a # 0ffh ==>lompat
        Jmp     keyInGet1
eyInGet0:
        Mov     B,A                     ;simpan isi a to b
eyInGet:
        Call    Keypad3x4
        Mov     A,keydata
        Cjne    A,B,KeyInOut            ;jk isi A # B lompat
        Jmp     keyInget
eyInOut:
        Cjne    A,#0,KeyInOut1
        Mov     A,B
        Call    LCD_Tulis_Data
        Pop     B
        Ret
eyInOut1:
        Mov     A,B
        Pop     B                       ;idem
ndSub
=====================================
 routine u/ baca keypad 3x4
 output pd keydata(0-9,E=redial,F=#)
=====================================
ubroutine Keypad3x4:

        Mov     keyport,#0FFh
        Clr     kolom1                  ;
------------
l1:
        Jb      baris1,key1
        Mov     keydata,#'1'
        Ret
ey1:

        Jb      baris2,key2
        Mov     keydata,#'4'
        Ret
ey2:
        Jb      baris3,key3
        Mov     keydata,#'7'
        Ret
ey3:
        ;Jb      baris4,key4
        ;Mov     keydata,#'*'
        ;Ret
--------------
```

```
ey4:
        Setb    kolom1
        Clr     kolom2
        ;--------------
        Jb      baris1,key5
        Mov     keydata,#'2'
        Ret
ey5:
        Jb      baris2,key6
        Mov     keydata,#'5'
        Ret
ey6:
        Jb      baris3,key7
        Mov     keydata,#'8'
        Ret
ey7:
        Jb      baris4,key8
        Mov     keydata,#'0'
        Ret
---------------
ey8:
        Setb    kolom2
        Clr     kolom3
        ;-------------------
        Jb      baris1,key9
        Mov     keydata,#'3'
        Ret
ey9:
        Jb      baris2,key10
        Mov     keydata,#'6'
        Ret
ey10:
        Jb      baris3,key11
        Mov     keydata,#'9'
        Ret
ey11:
        Jb      baris4,key12
        Mov     keydata,#'#'
        Ret
y12:
        Mov     keydata,#0FFh

dSub

broutine Serial_Receive:
        Jnb     RI,$
        Clr     RI
        Mov     A,SBUF
        Clr     RI
dSub
broutine Serial_Transmit:
        Mov     SBUF,A
```

```
        Jnb     TI,$
        Clr     TI

        Ret
idSub
ibroutine Serial_Initialization:
        Mov     SCON,#50h
        Mov     TH1,#208        ; BAUDRATE 1200
        Mov     87h,#00h         ; PCON
        Mov     TMOD,#21h
        Mov     TCON,#01010000B ; RUN T1 AND T0
        ;Mov     IE,#10000010B
        ;Mov     IP,#00001000B
idSub

ibroutine LCD_Clear:
        Mov     A,#01h
        Call    LCD_Tulis_Inst
idSub
ibroutine LCD_Blink_Off:
        Push    ACC
        Mov     A,#00001100b    ;
        Lcall   LCD_Tulis_Inst
        Pop     ACC
idSub
ibroutine LCD_Blink_On:
        Push    ACC
        Mov     A,#00001101b    ;
        Lcall   LCD_Tulis_Inst
        Pop     ACC
idSub
ibroutine lcd_line_1:
        Mov     A,#80h
        Call    LCD_Tulis_Inst
idSub
broutine LCD_Line_2:
        Mov     A,#0C0h
        Call    LCD_Tulis_Inst
dSub
broutine LCD_Cursor_Position:
        Push    ACC
        Mov     A,R0    ;15     26
        Anl     A,#0F0h ;10     20
        Cjne    A,#10h,lcd_cursor_position1
        Mov     A,R0    ;15
        Call    LCD_Tulis_Inst
        Jmp     lcd_cursor_position_end
d_cursor_position1:
        Cjne    A,#20h,lcd_cursor_position_end
        Mov     A,R0            ;26
        Call    LCD_Tulis_Inst
d_cursor_position_end:
```

```
        Pop     ACC
ndSub
ubroutine LCD_TampilKata:
        Push    ACC
        Push    DPL
        Push    DPH
ampilKata1:
        Clr     A
        Movc    A,@A+DPTR
        Cjne    A,#0,TampilKata2                ;intinya
        Jmp     out
ampilKata2:
        Inc     DPTR
        Call    LCD_Tulis_Data
        Jmp     TampilKata1
ut:
        Pop     DPH
        Pop     DPL
        Pop     ACC
ndSub

ubroutine LCD_Inisialisasi:
        ;Call    delayL
        Mov     A,#3Fh
        Call    LCD_Tulis_Inst
        Mov     A,#0Ch
        Call    LCD_Tulis_Inst
        Mov     A,#06h
        Call    LCD_Tulis_Inst
        Mov     A,#1Ch
        Call    LCD_Tulis_Inst
        Mov     A,#01h
        Call    LCD_Tulis_Inst
ndSub
ubroutine LCD_Tulis_Inst:
        Clr     Lcd_rs
        Mov     Lcd_Data,A
        Setb    Lcd_ena
        Clr     Lcd_ena
ndSub
ubroutine LCD_Tulis_Data:
        Setb    Lcd_rs
        Mov     Lcd_Data,A
        Setb    Lcd_ena
        Clr     Lcd_ena
ndSub

================ DELAY ================================
ubroutine Delay_Var_1ms:
        Call    Delay_Fix_1ms
        Djnz    R0,Delay_Var_1ms
ndSub
```

```
ubroutine Delay_Var_10ms:
        Call    Delay_Fix_10ms
        Djnz    R0,Delay_Var_10ms
ndSub
ubroutine Delay_Var_100ms:
        Call    Delay_Fix_1ms
        Djnz    R0,Delay_Var_100ms
ndSub
ubroutine Delay_Var_1s:
        Call    Delay_Fix_1s
        Djnz    R0,Delay_Var_1s
ndSub
ubroutine Delay_Var_10s:
        Call    Delay_Fix_10s
        Djnz    R0,Delay_Var_10s
ndSub
ubroutine Delay_Var_10us:
        Call    Delay_Fix_10us
        Djnz    R0,Delay_Var_10us
ndSub
ubroutine Delay_Fix_10us:
        Push    1
        Mov     1,#20
        Djnz    1,$
        Pop     1
ndSub
ubroutine Delay_Fix_10s:
        Push    1
        Mov     1,#10C
elay_fix_10s_1:
        Call    Delay_Fix_100ms
        Djnz    1,delay_fix_10s_1
        Pop     1
ndSub
ubroutine Delay_Fix_1s:
        Push    1
        Mov     1,#100
elay_fix_1000ms_1:
        Call    Delay_Fix_10ms
        Djnz    1,delay_fix_1000ms_1
        Pop     1
ndSub
ubroutine Delay_Fix_100ms:
        Push    1
        Mov     1,#10
elay_fix_100ms_1:
        Call    Delay_Fix_10ms
        Djnz    1,delay_fix_100ms_1
        Pop     1
ndSub
ubroutine Delay_Fix_10ms:
        Mov     TMOD,#00000001b    ; Timer 1 bekerja pada mode 1
```

```
      Mov     TL0,#3Dh    ; siapkan waktu tunda 50 mili-detik
      Mov     TH0,#0BCh
      Clr     TF0                 ; me-nol-kan bit limpahan
      Setb    TR0                 ; timer mulai bekerja
      Jnb     TF0,$               ; tunggu di sini sampai melimpah
      Clr     TR0                 ; timer berhenti kerja
      Ret
dSub
broutine Delay_Fix_1ms:
      Mov     TMOD,#00000001b    ; Timer 1 bekerja pada mode 1
      Mov     TL0,#0EDh    ; siapkan waktu tunda 50 mili-detik
      Mov     TH0,#78h
      Clr     TF0                 ; me-nol-kan bit limpahan
      Setb    TR0                 ; timer mulai bekerja
      Jnb     TF0,$               ; tunggu di sini sampai melimpah
      Clr     TR0                 ; timer berhenti kerja
      Ret
dSub
                        ;'1234567890abcdef'
t_menu1:        Db       '1.Set Nilai',0
t_menu2:        Db       '2.Run',0
t_menu3:        Db       '3.Set Kilo',0
t_menu4:        Db       '4.Run',0
t_menu5:        Db       'Pilih satu',0
t_menu6:        Db       '(1-2-3-4):',0

t_setRP:        Db       'Masukkan Harga',0
t_setRP1:       Db       '  RP.',0
t_setwaktu:     Db       'Masukkan Waktu',0
t_setwaktu1:    Db       '    --:--',0
t_setKM:        Db       'Masukkan KM',0
t_setKM1:       Db       '  --- Km',0
t_menuyakin:    Db       'Yakin ?',0
t_menuyakin1:    Db       '    Y-1,T-2',0
t_menuRP:       Db       '1  Rupiah:',0
t_menuwaktu:    Db       '2. Waktu:',0
t_menuKilo:     Db       '3. Kilo Meter:',0
t_simpan:       Db       'simpan data',0
t_lambung:      Db       'Masukkan No.Taxi',0
t_lambung1:     Db       'No. --',0
```

XR-2206

Monolithic
Function Generator

EXAR ...the analog plus company™

June 1997-3

EATURES

- Low-Sine Wave Distortion, 0.5%, Typical
- Excellent Temperature Stability, 20ppm/°C, Typ.
- Wide Sweep Range, 2000:1, Typical
- Low-Supply Sensitivity, 0.01%V, Typ.
- Linear Amplitude Modulation
- TTL Compatible FSK Controls
- Wide Supply Range, 10V to 26V
- Adjustable Duty Cycle, 1% TO 99%

APPLICATIONS

- Waveform Generation
- Sweep Generation
- AM/FM Generation
- V/F Conversion
- FSK Generation
- Phase-Locked Loops (VCO)

ENERAL DESCRIPTION

e XR-2206 is a monolithic function generator egrated circuit capable of producing high quality sine, uare, triangle, ramp, and pulse waveforms of gh-stability and accuracy. The output waveforms can be th amplitude and frequency modulated by an external ltage. Frequency of operation can be selected ternally over a range of 0.01Hz to more than 1MHz.

The circuit is ideally suited for communications, instrumentation, and function generator applications requiring sinusoidal tone, AM, FM, or FSK generation. It has a typical drift specification of 20ppm/°C. The oscillator frequency can be linearly swept over a 2000:1 frequency range with an external control voltage, while maintaining low distortion.

RDERING INFORMATION

Part No.	Package	Operating Temperature Range
XR-2206M	16 Lead 300 Mil CDIP	-55°C to +125°C
XR-2206P	16 Lead 300 Mil PDIP	–40°C to +85°C
XR-2206CP	16 Lead 300 Mil PDIP	0°C to +70°C
XR-2206D	16 Lead 300 Mil JEDEC SOIC	0°C to +70°C

EXAR Corporation, 48720 Kato Road, Fremont, CA 94538 ◆ (510) 668-7000 ◆ (510) 668-7017

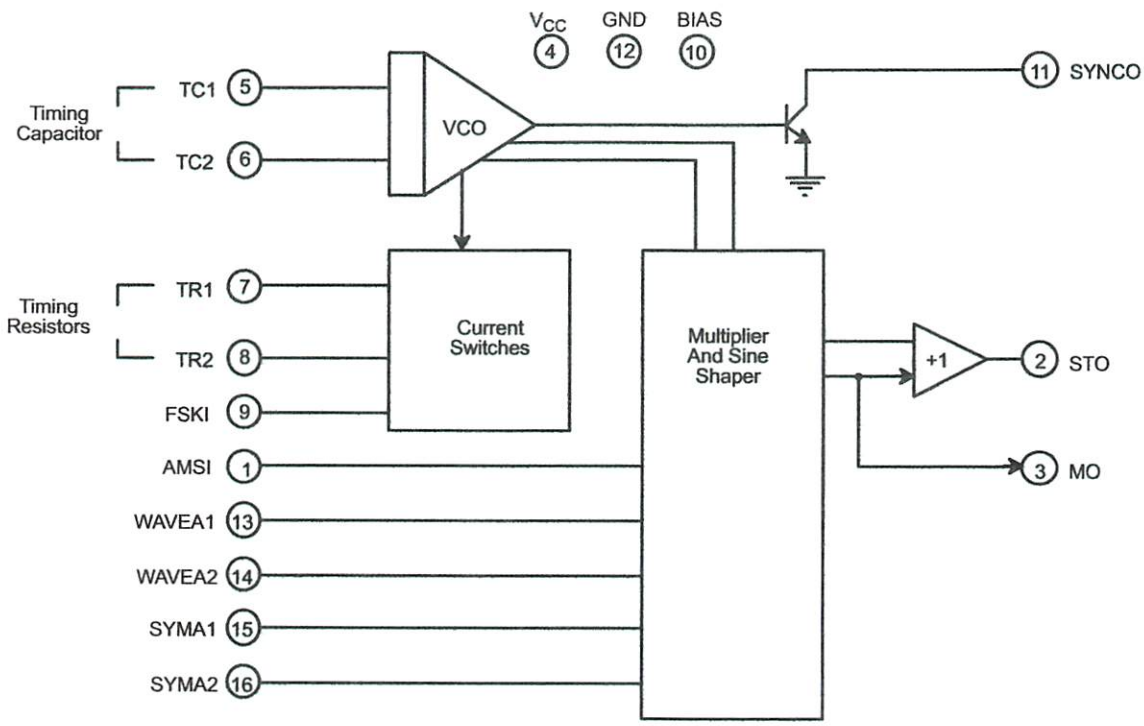
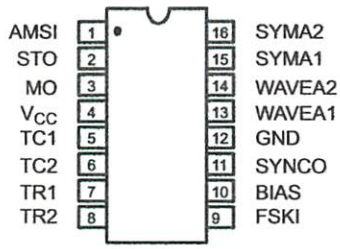
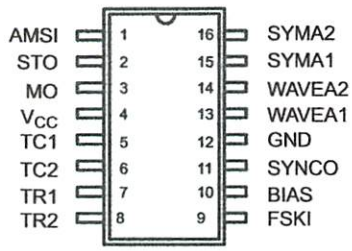


Figure 1. XR-2206 Block Diagram



16 Lead PDIP, CDIP (0.300")



16 Lead SOIC (Jedec, 0.300")

N DESCRIPTION

in #	Symbol	Type	Description
1	AMSI	I	**Amplitude Modulating Signal Input.**
2	STO	O	**Sine or Triangle Wave Output.**
3	MO	O	**Multiplier Output.**
4	V_{CC}		**Positive Power Supply.**
5	TC1	I	**Timing Capacitor Input.**
6	TC2	I	**Timing Capacitor Input.**
7	TR1	O	**Timing Resistor 1 Output.**
8	TR2	O	**Timing Resistor 2 Output.**
9	FSKI	I	**Frequency Shift Keying Input.**
10	BIAS	O	**Internal Voltage Reference.**
11	SYNCO	O	**Sync Output.** This output is a open collector and needs a pull up resistor to V_{CC}.
12	GND		**Ground pin.**
13	WAVEA1	I	**Wave Form Adjust Input 1.**
14	WAVEA2	I	**Wave Form Adjust Input 2.**
15	SYMA1	I	**Wave Symetry Adjust 1.**
16	SYMA2	I	**Wave Symetry Adjust 2.**

C ELECTRICAL CHARACTERISTICS

st Conditions: Test Circuit of *Figure 2* Vcc = 12V, T_A = 25°C, C = 0.01µF, R_1 = 100kΩ, R_2 = 10kΩ, R_3 = 25kΩ
nless Otherwise Specified. S_1 open for triangle, closed for sine wave.

Parameters	XR-2206M/P			XR-2206CP/D			Units	Conditions
	Min.	Typ.	Max.	Min.	Typ.	Max.		
eneral Characteristics								
ingle Supply Voltage	**10**		**26**	10		26	V	
plit-Supply Voltage	**±5**		**±13**	±5		±13	V	
upply Current		12	**17**		14	20	mA	$R_1 \geq 10k\Omega$
scillator Section								
lax. Operating Frequency	**0.5**	1		0.5	1		MHz	C = 1000pF, R_1 = 1kΩ
owest Practical Frequency		0.01			0.01		Hz	C = 50µF, R_1 = 2MΩ
requency Accuracy		±1	**±4**		±2		% of f_o	$f_o = 1/R_1C$
emperature Stability requency		±10	**±50**		±20		ppm/°C	0°C ≤ T_A ≤ 70°C $R_1 = R_2$ = 20kΩ
ine Wave Amplitude Stability[2]		4800			4800		ppm/°C	
upply Sensitivity		0.01	**0.1**		0.01		%/V	V_{LOW} = 10V, V_{HIGH} = 20V, $R_1 = R_2$ = 20kΩ
weep Range	1000:1	2000:1			2000:1		$f_H = f_L$	f_H @ R_1 = 1kΩ f_L @ R_1 = 2MΩ
weep Linearity								
10:1 Sweep		2			2		%	f_L = 1kHz, f_H = 10kHz
1000:1 Sweep		8			8		%	f_L = 100Hz, f_H = 100kHz
FM Distortion		0.1			0.1		%	±10% Deviation
ecommended Timing Components								
Timing Capacitor: C	**0.001**		100	0.001		100	µF	*Figure 5*
Timing Resistors: R_1 & R_2	**1**		2000	1		2000	kΩ	
iangle Sine Wave Output[1]								*Figure 3*
Triangle Amplitude		160			160		mV/kΩ	*Figure 2*, S_1 Open
Sine Wave Amplitude	**40**	60	80		60		mV/kΩ	*Figure 2*, S_1 Closed
Max. Output Swing		6			6		Vp-p	
Output Impedance		600			600		Ω	
Triangle Linearity		1			1		%	
Amplitude Stability		0.5			0.5		dB	For 1000:1 Sweep
ine Wave Distortion								
Without Adjustment		2.5			2.5		%	R_1 = 30kΩ
With Adjustment		0.4	**1.0**		0.5	1.5	%	See *Figure 7* and *Figure 8*

tes
Output amplitude is directly proportional to the resistance, R_3, on Pin 3. See Figure 3.
For maximum amplitude stability, R_3 should be a positive temperature coefficient resistor.
***ld face parameters** are covered by production test and guaranteed over operating temperature range.*

C ELECTRICAL CHARACTERISTICS (CONT'D)

Parameters	XR-2206M/P			XR-2206CP/D			Units	Conditions
	Min.	Typ.	Max.	Min.	Typ.	Max.		
Amplitude Modulation								
Input Impedance	50	100		50	100		kΩ	
Modulation Range		100			100		%	
Carrier Suppression		55			55		dB	
Linearity		2			2		%	For 95% modulation
Square-Wave Output								
Amplitude		12			12		Vp-p	Measured at Pin 11.
Rise Time		250			250		ns	C_L = 10pF
Fall Time		50			50		ns	C_L = 10pF
Saturation Voltage		0.2	**0.4**		0.2	0.6	V	I_L = 2mA
Leakage Current		0.1	**20**		0.1	100	µA	V_{CC} = 26V
FSK Keying Level (Pin 9)	0.8	1.4	**2.4**	0.8	1.4	2.4	V	See section on circuit controls
Reference Bypass Voltage	2.9	3.1	**3.3**	2.5	3	3.5	V	Measured at Pin 10.

Notes

Output amplitude is directly proportional to the resistance, R_3, on Pin 3. See Figure 3.

For maximum amplitude stability, R_3 should be a positive temperature coefficient resistor.

***Bold face parameters** are covered by production test and guaranteed over operating temperature range.*

Specifications are subject to change without notice

ABSOLUTE MAXIMUM RATINGS

Power Supply 26V
Power Dissipation 750mW
Derate Above 25°C ..... 5mW/°C
Total Timing Current 6mA
Storage Temperature ..... -65°C to +150°C

SYSTEM DESCRIPTION

The XR-2206 is comprised of four functional blocks; a voltage-controlled oscillator (VCO), an analog multiplier and sine-shaper; a unity gain buffer amplifier; and a set of current switches.

The VCO produces an output frequency proportional to input current, which is set by a resistor from the timing terminals to ground. With two timing pins, two discrete output frequencies can be independently produced for FSK generation applications by using the FSK input control pin. This input controls the current switches which select one of the timing resistor currents, and routes it to the VCO.

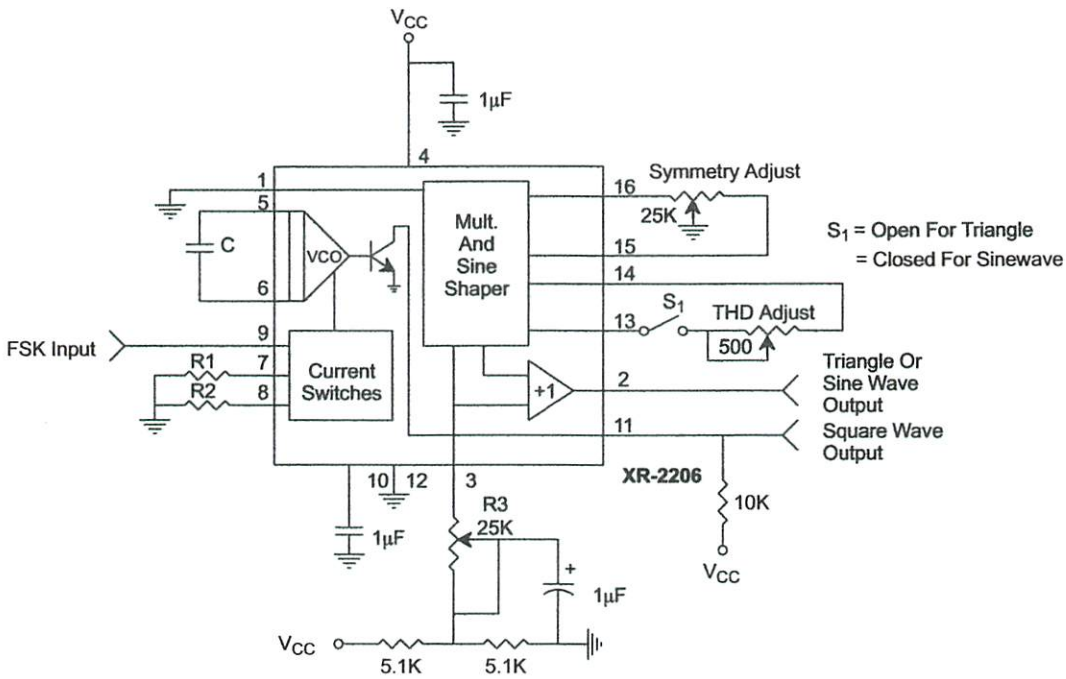


Figure 2. Basic Test Circuit

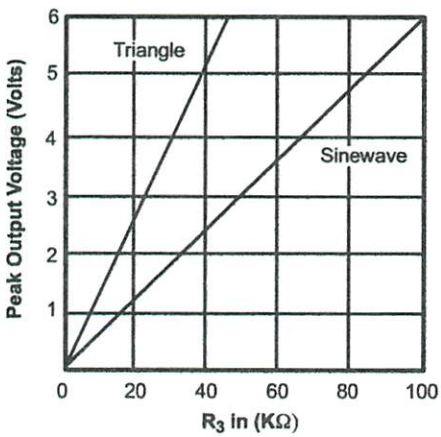


Figure 3. Output Amplitude as a Function of the Resistor, R3, at Pin 3

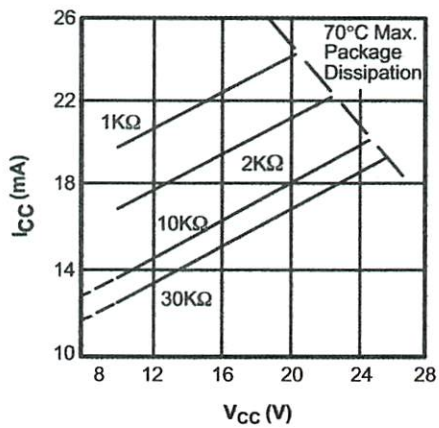


Figure 4. Supply Current vs Supply Voltage, Timing, R

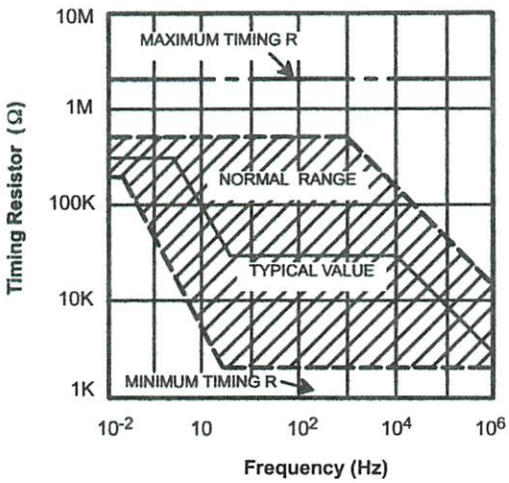


Figure 5. R versus Oscillation Frequency.

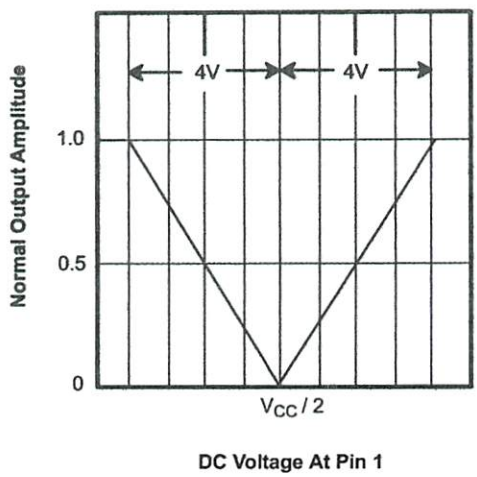


Figure 6. Normalized Output Amplitude versus DC Bias at AM Input (Pin 1)

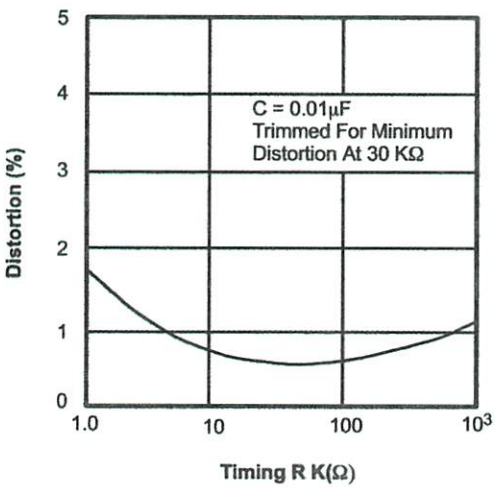


Figure 7. Trimmed Distortion versus Timing Resistor.

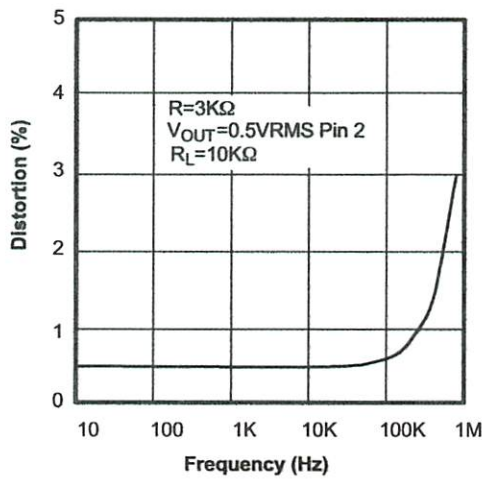


Figure 8. Sine Wave Distortion versus Operating Frequency with Timing Capacitors Varied.

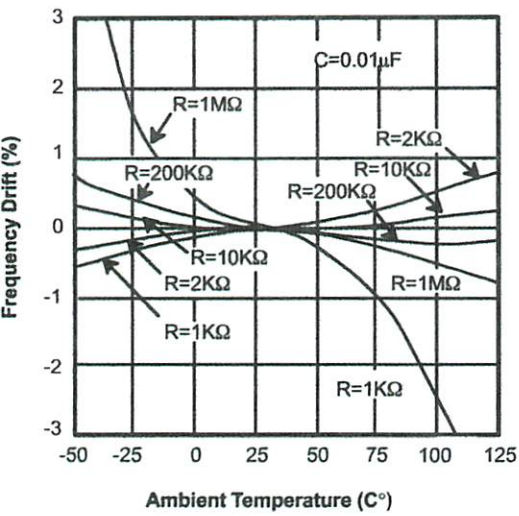


Figure 9. Frequency Drift versus Temperature.

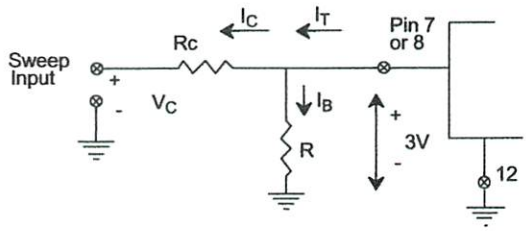


Figure 10. Circuit Connection for Frequency Sweep.

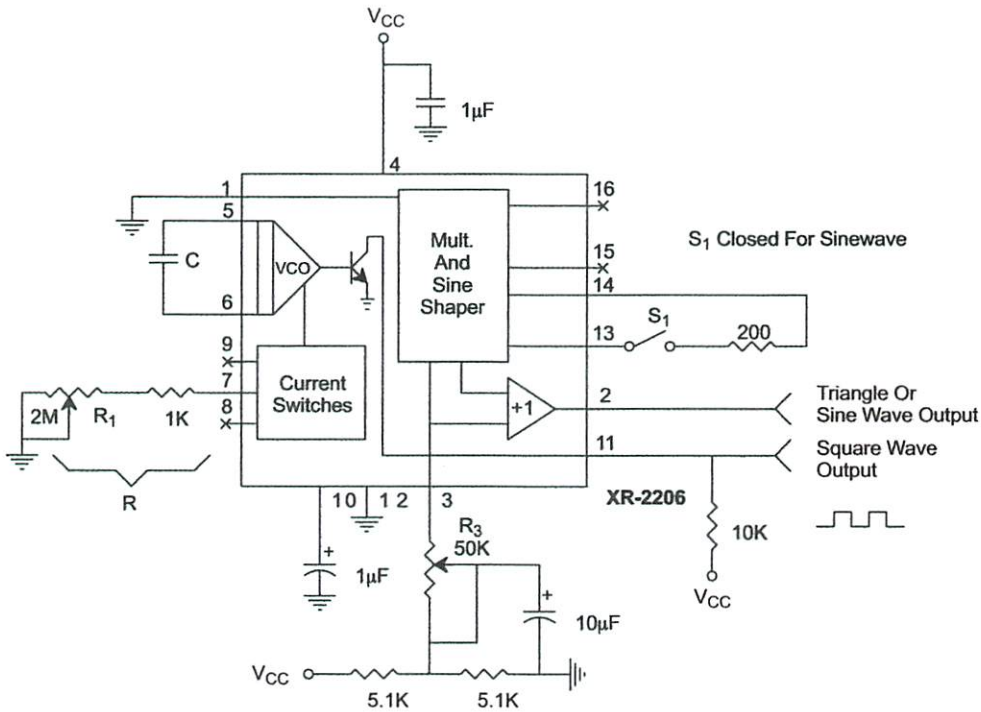


Figure 11. Circuit tor Sine Wave Generation without External Adjustment. (See *Figure 3* for Choice of R_3)

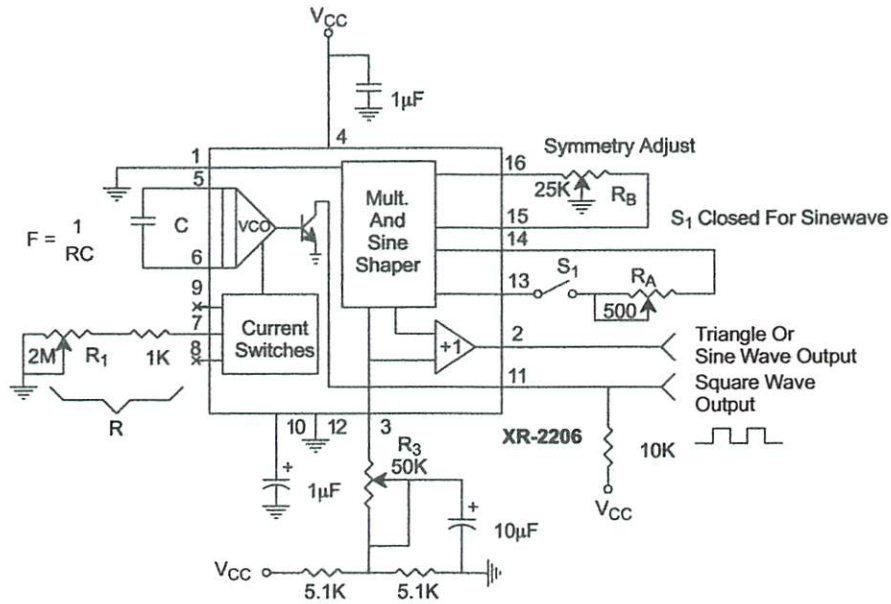


Figure 12. Circuit for Sine Wave Generation with Minimum Harmonic Distortion. (R_3 Determines Output Swing - See *Figure 3*)

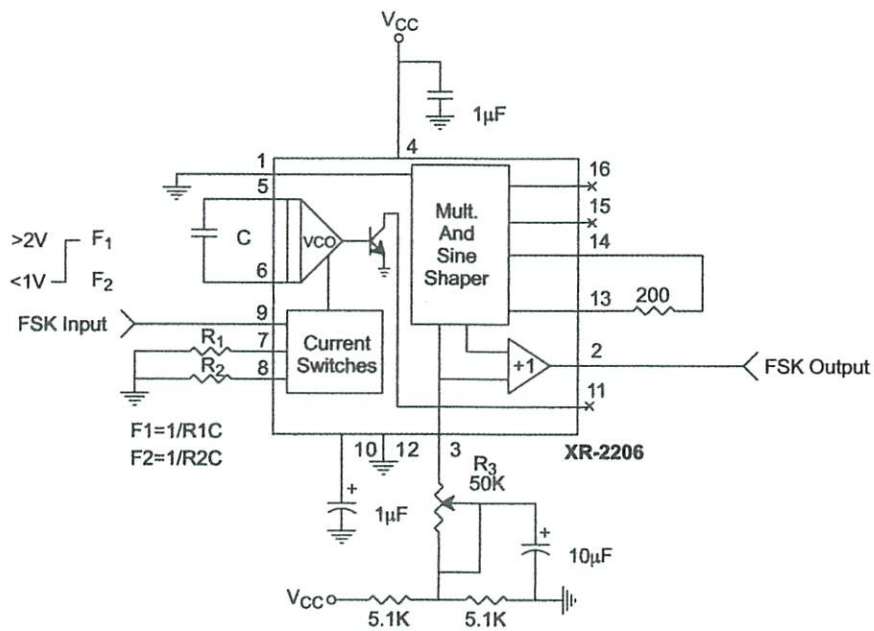


Figure 13. Sinusoidal FSK Generator

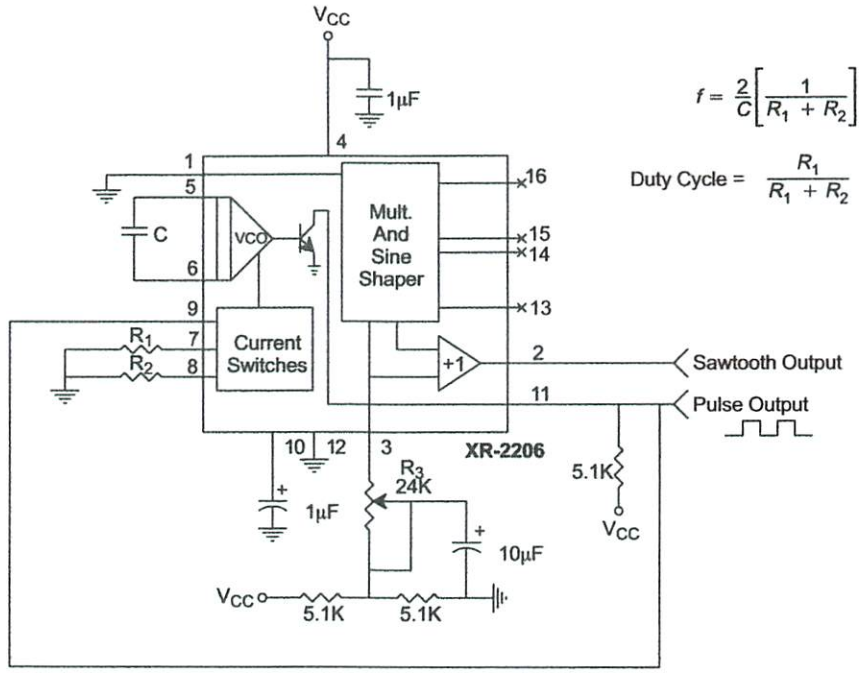


Figure 14. Circuit for Pulse and Ramp Generation.

equency-Shift Keying

e XR-2206 can be operated with two separate timing sistors, R_1 and R_2, connected to the timing Pin 7 and 8, spectively, as shown in *Figure 13*. Depending on the larity of the logic signal at Pin 9, either one or the other these timing resistors is activated. If Pin 9 is en-circuited or connected to a bias voltage $\geq$ 2V, only is activated. Similarly, if the voltage level at Pin 9 is 1V, only R_2 is activated. Thus, the output frequency can keyed between two levels. f_1 and f_2, as:

$= 1/R_1C$ and $f_2 = 1/R_2C$

r split-supply operation, the keying voltage at Pin 9 is ferenced to V^-.

utput DC Level Control

e dc level at the output (Pin 2) is approximately the me as the dc bias at Pin 3. In *Figure 11*, *Figure 12* and *gure 13*, Pin 3 is biased midway between V+ and ound, to give an output dc level of $\approx V^+/2$.

APPLICATIONS INFORMATION

Sine Wave Generation

Without External Adjustment

Figure 11 shows the circuit connection for generating a sinusoidal output from the XR-2206. The potentiometer, R_1 at Pin 7, provides the desired frequency tuning. The maximum output swing is greater than $V^+/2$, and the typical distortion (THD) is < 2.5%. If lower sine wave distortion is desired, additional adjustments can be provided as described in the following section.

The circuit of *Figure 11* can be converted to split-supply operation, simply by replacing all ground connections with V^-. For split-supply operation, R_3 can be directly connected to ground.

ith External Adjustment:

ıe harmonic content of sinusoidal output can be duced to -0.5% by additional adjustments as shown in *gure 12.* The potentiometer, R_A, adjusts the ıe-shaping resistor, and R_B provides the fine ljustment for the waveform symmetry. The adjustment ocedure is as follows:

Set R_B at midpoint and adjust R_A for minimum distortion.

With R_A set as above, adjust R_B to further reduce distortion.

iangle Wave Generation

ıe circuits of *Figure 11* and *Figure 12* can be converted triangle wave generation, by simply open-circuiting Pin and 14 (i.e., S_1 open). Amplitude of the triangle is proximately twice the sine wave output.

SK Generation

gure 13 shows the circuit connection for sinusoidal FSK ınal operation. Mark and space frequencies can be lependently adjusted by the choice of timing resistors, and R_2; the output is phase-continuous during nsitions. The keying signal is applied to Pin 9. The cuit can be converted to split-supply operation by nply replacing ground with V^-.

ılse and Ramp Generation

gure 14 shows the circuit for pulse and ramp waveform neration. In this mode of operation, the FSK keying minal (Pin 9) is shorted to the square-wave output (Pin), and the circuit automatically frequency-shift keys elf between two separate frequencies during the sitive-going and negative-going output waveforms. e pulse width and duty cycle can be adjusted from 1% 99% by the choice of R_1 and R_2. The values of R_1 and should be in the range of 1kΩ to 2MΩ.

PRINCIPLES OF OPERATION

Description of Controls

Frequency of Operation:

The frequency of oscillation, f_o, is determined by the external timing capacitor, C, across Pin 5 and 6, and by the timing resistor, R, connected to either Pin 7 or 8. The frequency is given as:

$$f_0 = \frac{1}{RC}\ Hz$$

and can be adjusted by varying either R or C. The recommended values of R, for a given frequency range, as shown in *Figure 5.* Temperature stability is optimum for 4kΩ < R < 200kΩ. Recommended values of C are from 1000pF to 100μF.

Frequency Sweep and Modulation:

Frequency of oscillation is proportional to the total timing current, I_T, drawn from Pin 7 or 8:

$$f = \frac{320 I_T(mA)}{C(\mu F)}\ Hz$$

Timing terminals (Pin 7 or 8) are low-impedance points, and are internally biased at +3V, with respect to Pin 12. Frequency varies linearly with IT, over a wide range of current values, from 1μA to 3mA. The frequency can be controlled by applying a control voltage, V_C, to the activated timing pin as shown in *Figure 10.* The frequency of oscillation is related to VC as:

$$f = \frac{1}{RC}\left(1 + \frac{R}{R_c}\left(1 - \frac{V_C}{3}\right)\right) Hz$$

where V_C is in volts. The voltage-to-frequency conversion gain, K, is given as:

$$K = \partial f / \partial V_c = -\frac{0.32}{R_c C}\ \ Hz/V$$

CAUTION: *For safety operation of the circuit, I_T should be limited to ≤ 3mA.*

utput Amplitude:

aximum output amplitude is inversely proportional to e external resistor, R_3, connected to Pin 3 (see *gure 3*). For sine wave output, amplitude is proximately 60mV peak per kΩ of R_3; for triangle, the ak amplitude is approximately 160mV peak per kΩ of . Thus, for example, R_3 = 50kΩ would produce proximately 13V sinusoidal output amplitude.

mplitude Modulation:

utput amplitude can be modulated by applying a dc bias d a modulating signal to Pin 1. The internal impedance at Pin 1 is approximately 100kΩ. Output amplitude varies linearly with the applied voltage at Pin 1, for values of dc bias at this pin, within 14 volts of $V_{CC}/2$ as shown in *Figure 6*. As this bias level approaches $V_{CC}/2$, the phase of the output signal is reversed, and the amplitude goes through zero. This property is suitable for phase-shift keying and suppressed-carrier AM generation. Total dynamic range of amplitude modulation is approximately 55dB.

CAUTION: *AM control must be used in conjunction with a well-regulated supply, since the output amplitude now becomes a function of* V_{CC}.

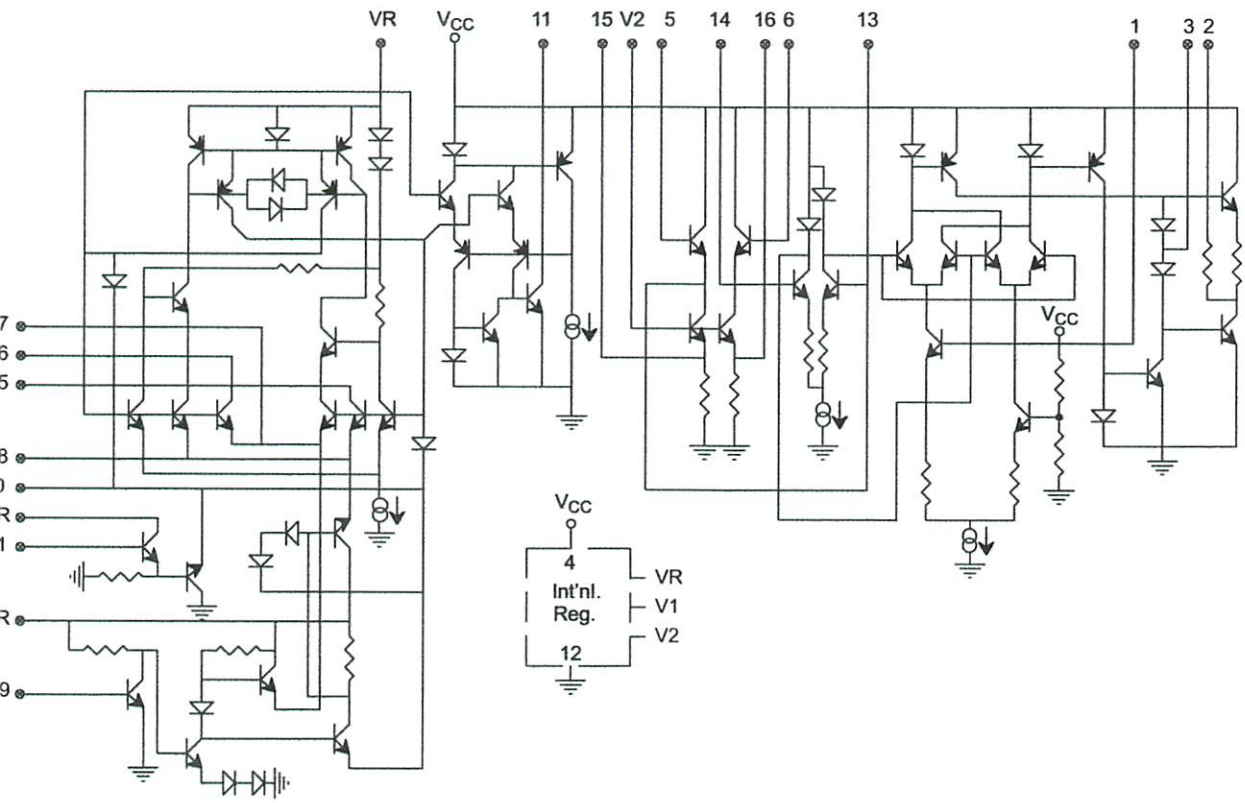
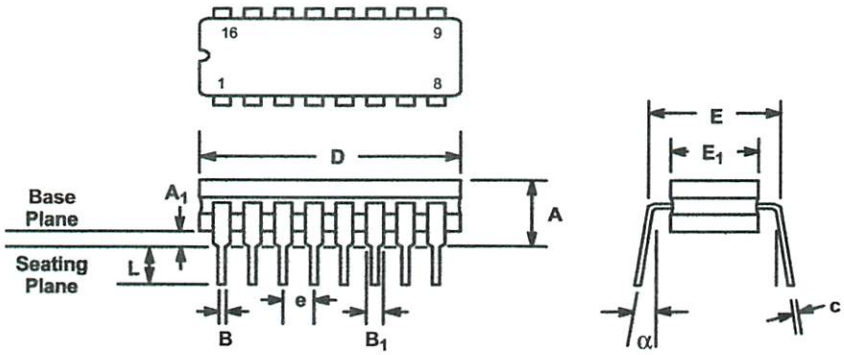


Figure 15. Equivalent Schematic Diagram

16 LEAD CERAMIC DUAL-IN-LINE (300 MIL CDIP)

Rev. 1.00

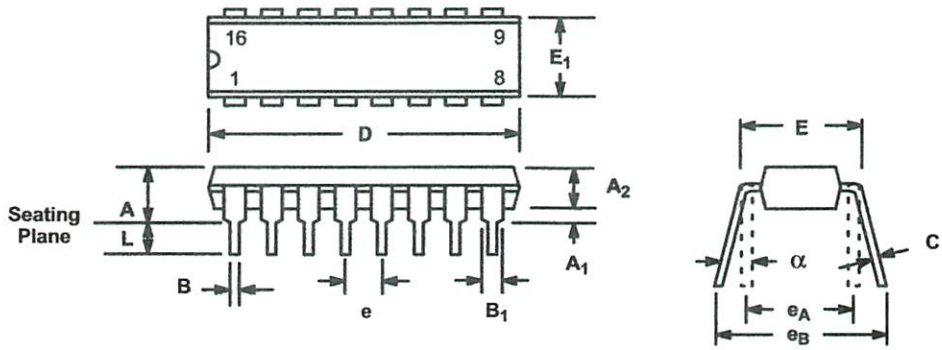


SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.100	0.200	2.54	5.08
A_1	0.015	0.060	0.38	1.52
B	0.014	0.026	0.36	0.66
B_1	0.045	0.065	1.14	1.65
c	0.008	0.018	0.20	0.46
D	0.740	0.840	18.80	21.34
E_1	0.250	0.310	6.35	7.87
E	0.300 BSC		7.62 BSC	
e	0.100 BSC		2.54 BSC	
L	0.125	0.200	3.18	5.08
α	0°	15°	0°	15°

Note: The control dimension is the inch column

16 LEAD PLASTIC DUAL-IN-LINE (300 MIL PDIP)

Rev. 1.00

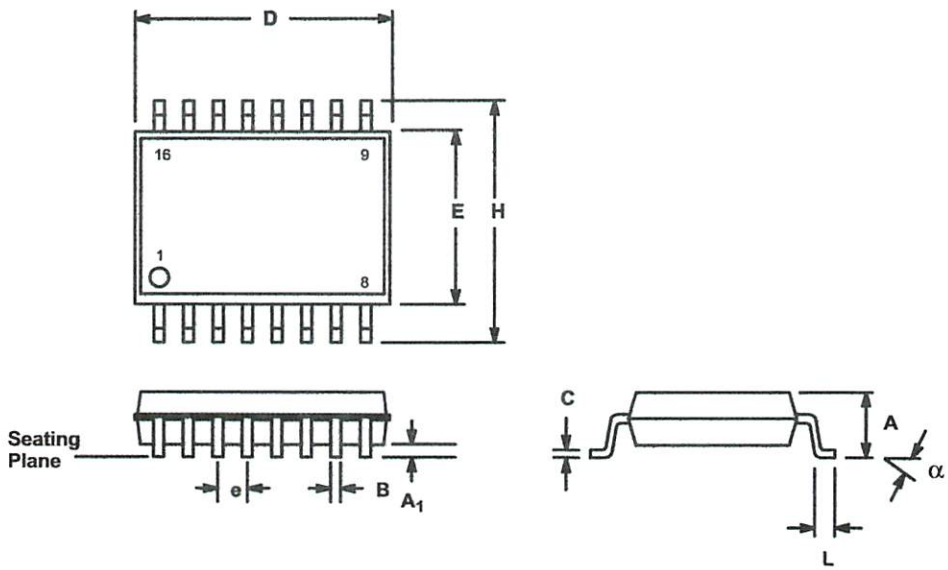


SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.145	0.210	3.68	5.33
A_1	0.015	0.070	0.38	1.78
A_2	0.115	0.195	2.92	4.95
B	0.014	0.024	0.36	0.56
B_1	0.030	0.070	0.76	1.78
C	0.008	0.014	0.20	0.38
D	0.745	0.840	18.92	21.34
E	0.300	0.325	7.62	8.26
E_1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
e_A	0.300 BSC		7.62 BSC	
e_B	0.310	0.430	7.87	10.92
L	0.115	0.160	2.92	4.06
α	0°	15°	0°	15°

Note: The control dimension is the inch column

16 LEAD SMALL OUTLINE (300 MIL JEDEC SOIC)

Rev. 1.00



SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.093	0.104	2.35	2.65
A_1	0.004	0.012	0.10	0.30
B	0.013	0.020	0.33	0.51
C	0.009	0.013	0.23	0.32
D	0.398	0.413	10.10	10.50
E	0.291	0.299	7.40	7.60
e	0.050 BSC		1.27 BSC	
H	0.394	0.419	10.00	10.65
L	0.016	0.050	0.40	1.27
α	0°	8°	0°	8°

Note: The control dimension is the millimeter column

NOTICE

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Datasheet June 1997

tures

- mpatible with MCS-51™ Products
- Bytes of In-System Reprogrammable Downloadable Flash Memory
  - SPI Serial Interface for Program Downloading
  - Endurance: 1,000 Write/Erase Cycles
- Bytes EEPROM
  - Endurance: 100,000 Write/Erase Cycles
- to 6V Operating Range
- ly Static Operation: 0 Hz to 24 MHz
- ree-level Program Memory Lock
- x 8-bit Internal RAM
- Programmable I/O Lines
- ree 16-bit Timer/Counters
- e Interrupt Sources
- grammable UART Serial Channel
- Serial Interface
- w-power Idle and Power-down Modes
- errupt Recovery From Power-down
- grammable Watchdog Timer
- al Data Pointer
- wer-off Flag

scription

AT89S8252 is a low-power, high-performance CMOS 8-bit microcomputer with ytes of downloadable Flash programmable and erasable read only memory and ytes of EEPROM. The device is manufactured using Atmel's high-density nonvol- memory technology and is compatible with the industry-standard 80C51 uction set and pinout. The on-chip downloadable Flash allows the program mem- o be reprogrammed in-system through an SPI serial interface or by a entional nonvolatile memory programmer. By combining a versatile 8-bit CPU downloadable Flash on a monolithic chip, the Atmel AT89S8252 is a powerful ocomputer which provides a highly-flexible and cost-effective solution to many edded control applications.

AT89S8252 provides the following standard features: 8K bytes of downloadable , 2K bytes of EEPROM, 256 bytes of RAM, 32 I/O lines, programmable watch- timer, two data pointers, three 16-bit timer/counters, a six-vector two-level upt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In ion, the AT89S8252 is designed with static logic for operation down to zero fre- cy and supports two software selectable power saving modes. The Idle Mode the CPU while allowing the RAM, timer/counters, serial port, and interrupt sys- o continue functioning. The Power-down mode saves the RAM contents but es the oscillator, disabling all other chip functions until the next interrupt or hard- reset.

downloadable Flash can be changed a single byte at a time and is accessible gh the SPI serial interface. Holding RESET active forces the SPI bus into a serial amming interface and allows the program memory to be written to or read from s Lock Bit 2 has been activated.

ATMEL

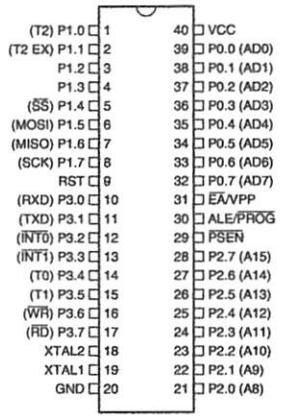
8-bit Microcontroller with 8K Bytes Flash

AT89S8252

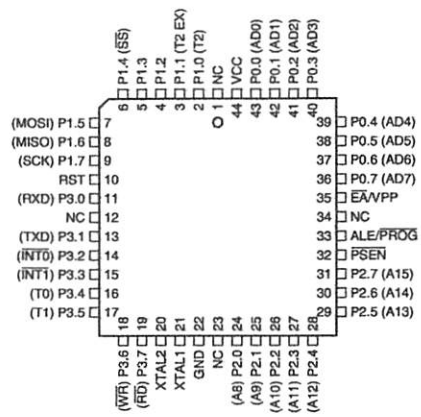
Rev. 0401E–02/00

Configurations

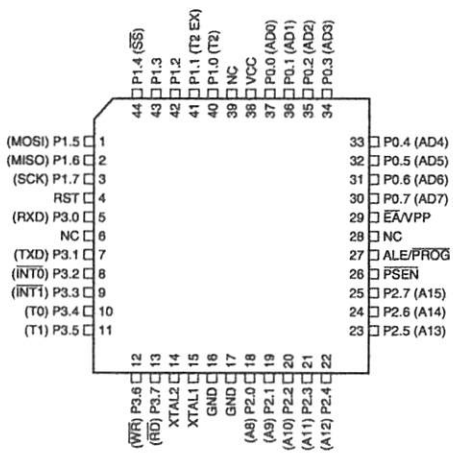
PDIP



PLCC



PQFP/TQFP



Description

ly voltage.

nd.

0

0 is an 8-bit open drain bbi-didirectional I/O port. As an t port, each pin can sink eight TTL inputs. When 1s ritten to port 0 pins, the pins can be used as high- dance inputs.

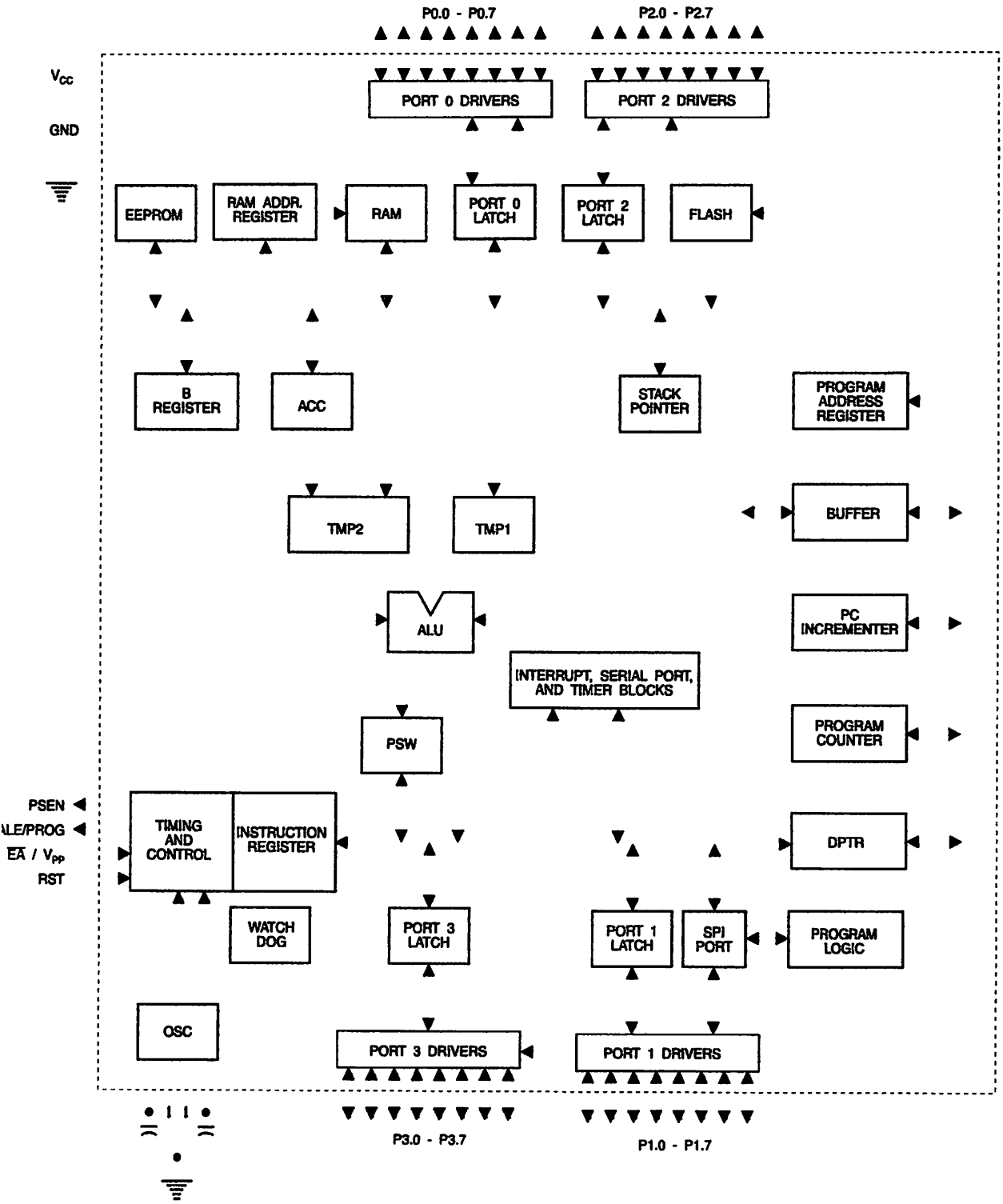
0 can also be configured to be the multiplexed low- address/data bus during accesses to external program and data memory. In this mode, P0 has internal pullups.

Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pullups are required during program verification.

Port 1

Port 1 is an 8-bit bi-directional I/O port with internal pullups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (I_{IL}) because of the internal pullups.

ck Diagram


P0.0 - P0.7
P2.0 - P2.7
VCC
GND
PORT 0 DRIVERS
PORT 2 DRIVERS
EEPROM
RAM ADDR. REGISTER
RAM
PORT 0 LATCH
PORT 2 LATCH
FLASH
B REGISTER
ACC
STACK POINTER
PROGRAM ADDRESS REGISTER
TMP2
TMP1
BUFFER
ALU
PC INCREMENTER
INTERRUPT, SERIAL PORT, AND TIMER BLOCKS
PSW
PROGRAM COUNTER
PSEN
ALE/PROG
EA / VPP
RST
TIMING AND CONTROL
INSTRUCTION REGISTER
DPTR
WATCH DOG
PORT 3 LATCH
PORT 1 LATCH
SPI PORT
PROGRAM LOGIC
OSC
PORT 3 DRIVERS
PORT 1 DRIVERS
P3.0 - P3.7
P1.0 - P1.7

e Port 1 pins provide additional functions. P1.0 and can be configured to be the timer/counter 2 external input (P1.0/T2) and the timer/counter 2 trigger input /T2EX), respectively.

Description

ermore, P1.4, P1.5, P1.6, and P1.7 can be configured e SPI slave port select, data input/output and shift input/output pins as shown in the following table.

Pin	Alternate Functions
	T2 (external count input to Timer/Counter 2), clock-out
	T2EX (Timer/Counter 2 capture/reload trigger and direction control)
	$\overline{SS}$ (Slave port select input)
	MOSI (Master data output, slave data input pin for SPI channel)
	MISO (Master data input, slave data output pin for SPI channel)
	SCK (Master clock output, slave clock input pin for SPI channel)

l also receives the low-order address bytes during programming and verification.

2

2 is an 8-bit bi-directional I/O port with internal pullups. Port 2 output buffers can sink/source four TTL inputs. 1s are written to Port 2 pins, they are pulled high by ternal pullups and can be used as inputs. As inputs, 2 pins that are externally being pulled low will source nt (I_{IL}) because of the internal pullups.

2 emits the high-order address byte during fetches external program memory and during accesses to nal data memory that use 16-bit addresses (MOVX @ t). In this application, Port 2 uses strong internal pul- when emitting 1s. During accesses to external data ory that use 8-bit addresses (MOVX @ RI), Port 2 the contents of the P2 Special Function Register.

2 also receives the high-order address bits and some ol signals during Flash programming and verification.

3

3 is an 8 bit bi-directional I/O port with internal pullups. Port 3 output buffers can sink/source four TTL inputs. 1s are written to Port 3 pins, they are pulled high by ternal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (I_{IL}) because of the pullups.

Port 3 also serves the functions of various special features of the AT89S8252, as shown in the following table.

Port 3 also receives some control signals for Flash programming and verification.

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{INT0}$ (external interrupt 0)
P3.3	$\overline{INT1}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	$\overline{WR}$ (external data memory write strobe)
P3.7	$\overline{RD}$ (external data memory read strobe)

RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

ALE/$\overline{PROG}$

Address Latch Enable is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input ($\overline{PROG}$) during Flash programming.

In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external data memory.

If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

$\overline{PSEN}$

Program Store Enable is the read strobe to external program memory.

When the AT89S8252 is executing code from external program memory, $\overline{PSEN}$ is activated twice each machine cycle, except that two $\overline{PSEN}$ activations are skipped during each access to external data memory.

$\overline{EA}$/VPP

External Access Enable. $\overline{EA}$ must be strapped to GND in order to enable the device to fetch code from external pro-

memory locations starting at 0000H up to FFFFH. however, that if lock bit 1 is programmed, $\overline{EA}$ will be ally latched on reset.

ıould be strapped to V_{CC} for internal program execu-. This pin also receives the 12-volt programming e voltage (V_{PP}) during Flash programming when 12-rogramming is selected.

XTAL1

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2

Output from the inverting oscillator amplifier.

1. AT89S8252 SFR Map and Reset Values

H								0FFH
H	B 00000000							0F7H
H								0EFH
H	ACC 00000000							0E7H
H								0DFH
H	PSW 00000000					SPCR 000001XX		0D7H
H	T2CON 00000000	T2MOD XXXXXX00	RCAP2L 00000000	RCAP2H 00000000	TL2 00000000	TH2 00000000		0CFH
H								0C7H
H	IP XX000000							0BFH
H	P3 11111111							0B7H
H	IE 0X000000		SPSR 00XXXXXX					0AFH
H	P2 11111111							0A7H
H	SCON 00000000	SBUF XXXXXXXX						9FH
H	P1 11111111						WMCON 00000010	97H
H	TCON 00000000	TMOD 00000000	TL0 00000000	TL1 00000000	TH0 00000000	TH1 00000000		8FH
H	P0 11111111	SP 00000111	DP0L 00000000	DP0H 00000000	DP1L 00000000	DP1H 00000000	SPDR XXXXXXXX	PCON 0XXX0000	87H

cial Function Registers

) of the on-chip memory area called the Special Func-egister (SFR) space is shown in Table 1.

hat not all of the addresses are occupied, and unoc-l addresses may not be implemented on the chip. accesses to these addresses will in general return m data, and write accesses will have an indeterminate

software should not write 1s to these unlisted locations, since they may be used in future products to invoke new features. In that case, the reset or inactive values of the new bits will always be 0.

Timer 2 Registers Control and status bits are contained in registers T2CON (shown in Table 2) and T2MOD (shown in Table 9) for Timer 2. The register pair (RCAP2H, RCAP2L) are the Capture/Reload registers for Timer 2 in 16 bit capture mode or 16-bit auto-reload mode.

2. T2CON—Timer/Counter 2 Control Register

)N Address = 0C8H — Reset Value = 0000 0000B

ddressable

TF2	EXF2	RCLK	TCLK	EXEN2	TR2	C/$\overline{T2}$	CP/$\overline{RL2}$
7	6	5	4	3	2	1	0

bol	Function
	Timer 2 overflow flag set by a Timer 2 overflow and must be cleared by software. TF2 will not be set when either RCLK = 1 or TCLK = 1.
?	Timer 2 external flag set when either a capture or reload is caused by a negative transition on T2EX and EXEN2 = 1. When Timer 2 interrupt is enabled, EXF2 = 1 will cause the CPU to vector to the Timer 2 interrupt routine. EXF2 must be cleared by software. EXF2 does not cause an interrupt in up/down counter mode (DCEN = 1).
(	Receive clock enable. When set, causes the serial port to use Timer 2 overflow pulses for its receive clock in serial port Modes 1 and 3. RCLK = 0 causes Timer 1 overflows to be used for the receive clock.
(	Transmit clock enable. When set, causes the serial port to use Timer 2 overflow pulses for its transmit clock in serial port Modes 1 and 3. TCLK = 0 causes Timer 1 overflows to be used for the transmit clock.
N2	Timer 2 external enable. When set, allows a capture or reload to occur as a result of a negative transition on T2EX if Timer 2 is not being used to clock the serial port. EXEN2 = 0 causes Timer 2 to ignore events at T2EX.
	Start/Stop control for Timer 2. TR2 = 1 starts the timer.
	Timer or counter select for Timer 2. C/$\overline{T2}$ = 0 for timer function. C/$\overline{T2}$ = 1 for external event counter (falling edge triggered).
L2	Capture/Reload select. CP/$\overline{RL2}$ = 1 causes captures to occur on negative transitions at T2EX if EXEN2 = 1. CP/$\overline{RL2}$ = 0 causes automatic reloads to occur when Timer 2 overflows or negative transitions occur at T2EX when EXEN2 = 1. When either RCLK or TCLK = 1, this bit is ignored and the timer is forced to auto-reload on Timer 2 overflow.

hdog and Memory Control Register The WMCON ter contains control bits for the Watchdog Timer n in Table 3). The EEMEN and EEMWE bits are used to select the 2K bytes on-chip EEPROM, and to enable byte-write. The DPS bit selects one of two DPTR registers available.

3. WMCON—Watchdog and Memory Control Register

CON Address = 96H — Reset Value = 0000 0010B

PS2	PS1	PS0	EEMWE	EEMEN	DPS	WDTRST	WDTEN
7	6	5	4	3	2	1	0

bol	Function
	Prescaler Bits for the Watchdog Timer. When all three bits are set to "0", the watchdog timer has a nominal period of 16 ms. When all three bits are set to "1", the nominal period is 2048 ms.
WE	EEPROM Data Memory Write Enable Bit. Set this bit to "1" before initiating byte write to on-chip EEPROM with the MOVX instruction. User software should set this bit to "0" after EEPROM write is completed.
EN	Internal EEPROM Access Enable. When EEMEN = 1, the MOVX instruction with DPTR will access on-chip EEPROM instead of external data memory. When EEMEN = 0, MOVX with DPTR accesses external data memory.
	Data Pointer Register Select. DPS = 0 selects the first bank of Data Pointer Register, DP0, and DPS = 1 selects the second bank, DP1
RST /BSY	Watchdog Timer Reset and EEPROM Ready/$\overline{\text{Busy}}$ Flag. Each time this bit is set to "1" by user software, a pulse is generated to reset the watchdog timer. The WDTRST bit is then automatically reset to "0" in the next instruction cycle. The WDTRST bit is Write-Only. This bit also serves as the RDY/$\overline{\text{BSY}}$ flag in a Read-Only mode during EEPROM write. RDY/$\overline{\text{BSY}}$ = 1 means that the EEPROM is ready to be programmed. While programming operations are being executed, the RDY/$\overline{\text{BSY}}$ bit equals "0" and is automatically reset to "1" when programming is completed.
EN	Watchdog Timer Enable Bit. WDTEN = 1 enables the watchdog timer and WDTEN = 0 disables the watchdog timer.

egisters Control and status bits for the Serial Periph- nterface are contained in registers SPCR (shown in 4) and SPSR (shown in Table 5). The SPI data bits ontained in the SPDR register. Writing the SPI data er during serial data transfer sets the Write Collision COL, in the SPSR register. The SPDR is double buff- or writing and the values in SPDR are not changed by .

upt Registers The global interrupt enable bit and the dual interrupt enable bits are in the IE register. In on, the individual interrupt enable bit for the SPI is in PCR register. Two priorities can be set for each of the errupt sources in the IP register.

Dual Data Pointer Registers To facilitate accessing both internal EEPROM and external data memory, two banks of 16 bit Data Pointer Registers are provided: DP0 at SFR address locations 82H-83H and DP1 at 84H-85H. Bit DPS = 0 in SFR WMCON selects DP0 and DPS = 1 selects DP1. The user should always initialize the DPS bit to the appropriate value before accessing the respective Data Pointer Register.

Power Off Flag The Power Off Flag (POF) is located at bit_4 (PCON.4) in the PCON SFR. POF is set to "1" during power up. It can be set and reset under software control and is not affected by RESET.

4. SPCR—SPI Control Register

R Address = D5H

Reset Value = 0000 01XXB

SPIE	SPE	DORD	MSTR	CPOL	CPHA	SPR1	SPR0
7	6	5	4	3	2	1	0

bol	Function
E	SPI Interrupt Enable. This bit, in conjunction with the ES bit in the IE register, enables SPI interrupts: SPIE = 1 and ES = 1 enable SPI interrupts. SPIE = 0 disables SPI interrupts.
	SPI Enable. SPI = 1 enables the SPI channel and connects $\overline{SS}$, MOSI, MISO and SCK to pins P1.4, P1.5, P1.6, and P1.7. SPI = 0 disables the SPI channel.
RD	Data Order. DORD = 1 selects LSB first data transmission. DORD = 0 selects MSB first data transmission.
TR	Master/Slave Select. MSTR = 1 selects Master SPI mode. MSTR = 0 selects Slave SPI mode.
OL	Clock Polarity. When CPOL = 1, SCK is high when idle. When CPOL = 0, SCK of the master device is low when not transmitting. Please refer to figure on SPI Clock Phase and Polarity Control.
HA	Clock Phase. The CPHA bit together with the CPOL bit controls the clock and data relationship between master and slave. Please refer to figure on SPI Clock Phase and Polarity Control.
R0 R1	SPI Clock Rate Select. These two bits control the SCK rate of the device configured as master. SPR1 and SPR0 have no effect on the slave. The relationship between SCK and the oscillator frequency, $F_{osc.}$, is as follows: SPR1SPR0 SCK = $F_{osc.}$ divided by 0 0 4 0 1 16 1 0 64 1 1 128

5. SPSR – SPI Status Register

R Address = AAH

Reset Value = 00XX XXXXB

SPIF	WCOL	–	–	–	–	–	–
7	6	5	4	3	2	1	0

bol	Function
	SPI Interrupt Flag. When a serial transfer is complete, the SPIF bit is set and an interrupt is generated if SPIE = 1 and ES = 1. The SPIF bit is cleared by reading the SPI status register with SPIF and WCOL bits set, and then accessing the SPI data register.
OL	Write Collision Flag. The WCOL bit is set if the SPI data register is written during a data transfer. During data transfer, the result of reading the SPDR register may be incorrect, and writing to it has no effect. The WCOL bit (and the SPIF bit) are cleared by reading the SPI status register with SPIF and WCOL set, and then accessing the SPI data register.

6. SPDR – SPI Data Register

R Address = 86H

Reset Value = unchanged

SPD7	SPD6	SPD5	SPD4	SPD3	SPD2	SPD1	SPD0
7	6	5	4	3	2	1	0

a Memory – EEPROM and RAM

.T89S8252 implements 2K bytes of on-chip EEPROM ata storage and 256 bytes of RAM. The upper 128 of RAM occupy a parallel space to the Special Func-legisters. That means the upper 128 bytes have the addresses as the SFR space but are physically sepa-om SFR space.

an instruction accesses an internal location above ss 7FH, the address mode used in the instruction fies whether the CPU accesses the upper 128 bytes M or the SFR space. Instructions that use direct ssing access SFR space.

xample, the following direct addressing instruction ses the SFR at location 0A0H (which is P2).

```
V 0A0H, #data
```

ctions that use indirect addressing access the upper ytes of RAM. For example, the following indirect ssing instruction, where R0 contains 0A0H, accesses ata byte at address 0A0H, rather than P2 (whose ss is 0A0H).

```
V @R0, #data
```

that stack operations are examples of indirect ssing, so the upper 128 bytes of data RAM are avail-s stack space.

n-chip EEPROM data memory is selected by setting EMEN bit in the WMCON register at SFR address n 96H. The EEPROM address range is from 000H to . The MOVX instructions are used to access the OM. To access off-chip data memory with the MOVX ctions, the EEMEN bit needs to be set to "0".

EMWE bit in the WMCON register needs to be set to fore any byte location in the EEPROM can be written. software should reset EEMWE bit to "0" if no further OM write is required. EEPROM write cycles in the programming mode are self-timed and typically take s. The progress of EEPROM write can be monitored ding the RDY/$\overline{BSY}$ bit (read-only) in SFR WMCON. $\overline{BSY}$ = 0 means programming is still in progress and $\overline{BSY}$ = 1 means EEPROM write cycle is completed nother write cycle can be initiated.

dition, during EEPROM programming, an attempted from the EEPROM will fetch the byte being written ne MSB complemented. Once the write cycle is com-, true data are valid at all bit locations.

grammable Watchdog Timer

rogrammable Watchdog Timer (WDT) operates from lependent oscillator. The prescaler bits, PS0, PS1 S2 in SFR WMCON are used to set the period of the dog Timer from 16 ms to 2048 ms. The available periods are shown in the following table and the actual timer periods (at V_{CC} = 5V) are within ±30% of the nominal.

The WDT is disabled by Power-on Reset and during Power-down. It is enabled by setting the WDTEN bit in SFR WMCON (address = 96H). The WDT is reset by setting the WDTRST bit in WMCON. When the WDT times out without being reset or disabled, an internal RST pulse is generated to reset the CPU.

Table 7. Watchdog Timer Period Selection

WDT Prescaler Bits			
PS2	PS1	PS0	Period (nominal)
0	0	0	16 ms
0	0	1	32 ms
0	1	0	64 ms
0	1	1	128 ms
1	0	0	256 ms
1	0	1	512 ms
1	1	0	1024 ms
1	1	1	2048 ms

Timer 0 and 1

Timer 0 and Timer 1 in the AT89S8252 operate the same way as Timer 0 and Timer 1 in the AT89C51, AT89C52 and AT89C55. For further information, see the October 1995 Microcontroller Data Book, page 2-45, section titled, "Timer/Counters."

Timer 2

Timer 2 is a 16 bit Timer/Counter that can operate as either a timer or an event counter. The type of operation is selected by bit C/$\overline{T2}$ in the SFR T2CON (shown in Table 2). Timer 2 has three operating modes: capture, auto-reload (up or down counting), and baud rate generator. The modes are selected by bits in T2CON, as shown in Table 8.

Timer 2 consists of two 8-bit registers, TH2 and TL2. In the Timer function, the TL2 register is incremented every machine cycle. Since a machine cycle consists of 12 oscillator periods, the count rate is 1/12 of the oscillator frequency.

In the Counter function, the register is incremented in response to a 1-to-0 transition at its corresponding external input pin, T2. In this function, the external input is sampled during S5P2 of every machine cycle. When the samples show a high in one cycle and a low in the next cycle, the count is incremented. The new count value appears in the register during S3P1 of the cycle following the one in which

ansition was detected. Since two machine cycles (24 ator periods) are required to recognize a 1-to-0 transi- the maximum count rate is 1/24 of the oscillator ency. To ensure that a given level is sampled at least before it changes, the level should be held for at least ull machine cycle.

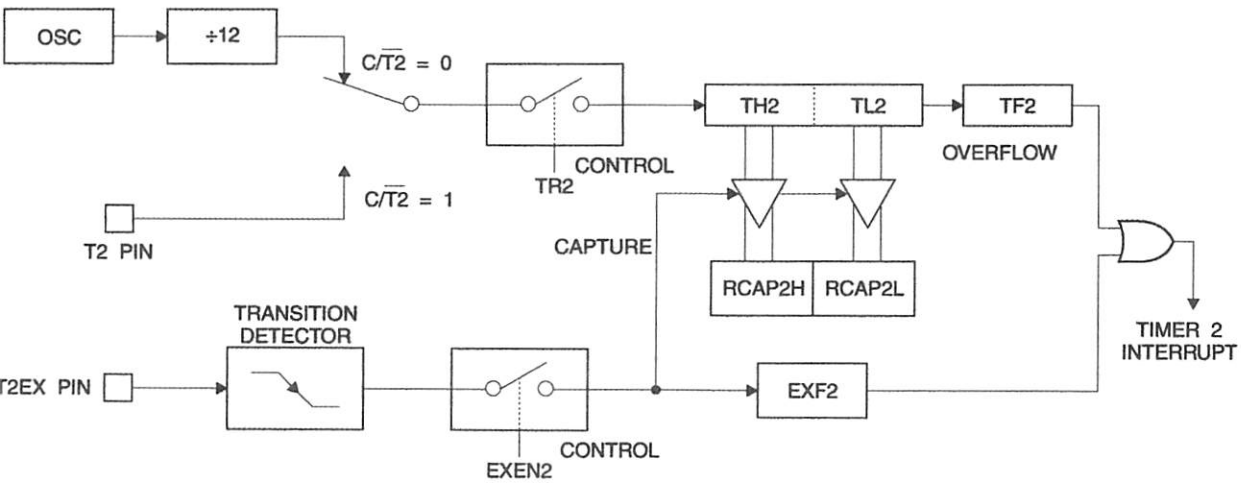
8. Timer 2 Operating Modes

LK + TCLK	CP/$\overline{RL2}$	TR2	MODE
0	0	1	16-bit Auto-reload
0	1	1	16-bit Capture
1	X	1	Baud Rate Generator
X	X	0	(Off)

Capture Mode

In the capture mode, two options are selected by bit EXEN2 in T2CON. If EXEN2 = 0, Timer 2 is a 16 bit timer or counter which upon overflow sets bit TF2 in T2CON. This bit can then be used to generate an interrupt. If EXEN2 = 1, Timer 2 performs the same operation, but a l-to-0 transition at external input T2EX also causes the current value in TH2 and TL2 to be captured into RCAP2H and RCAP2L, respectively. In addition, the transition at T2EX causes bit EXF2 in T2CON to be set. The EXF2 bit, like TF2, can generate an interrupt. The capture mode is illustrated in Figure 1.

e 1. Timer 2 in Capture Mode



-reload (Up or Down Counter)

r 2 can be programmed to count up or down when gured in its 16 bit auto-reload mode. This feature is ed by the DCEN (Down Counter Enable) bit located in FR T2MOD (see Table 9). Upon reset, the DCEN bit to 0 so that timer 2 will default to count up. When N is set, Timer 2 can count up or down, depending on alue of the T2EX pin.

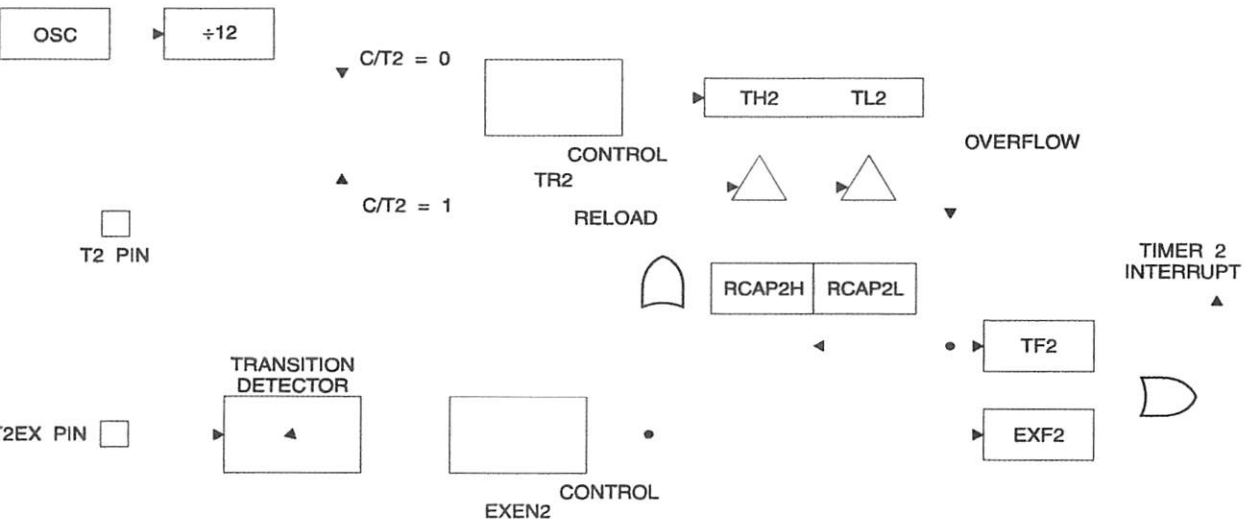
e 2 shows Timer 2 automatically counting up when N = 0. In this mode, two options are selected by bit N2 in T2CON. If EXEN2 = 0, Timer 2 counts up to FFH and then sets the TF2 bit upon overflow. The ow also causes the timer registers to be reloaded with 6 bit value in RCAP2H and RCAP2L. The values in P2H and RCAP2L are preset by software. If EXEN2 = 6 bit reload can be triggered either by an overflow or by a 1-to-0 transition at external input T2EX. This transition also sets the EXF2 bit. Both the TF2 and EXF2 bits can generate an interrupt if enabled.

Setting the DCEN bit enables Timer 2 to count up or down, as shown in Figure 3. In this mode, the T2EX pin controls the direction of the count. A logic 1 at T2EX makes Timer 2 count up. The timer will overflow at 0FFFFH and set the TF2 bit. This overflow also causes the 16 bit value in RCAP2H and RCAP2L to be reloaded into the timer registers, TH2 and TL2, respectively.

A logic 0 at T2EX makes Timer 2 count down. The timer underflows when TH2 and TL2 equal the values stored in RCAP2H and RCAP2L. The underflow sets the TF2 bit and causes 0FFFFH to be reloaded into the timer registers.

The EXF2 bit toggles whenever Timer 2 overflows or underflows and can be used as a 17th bit of resolution. In this operating mode, EXF2 does not flag an interrupt.

e 2. Timer 2 in Auto Reload Mode (DCEN = 0)



9. T2MOD – Timer 2 Mode Control Register

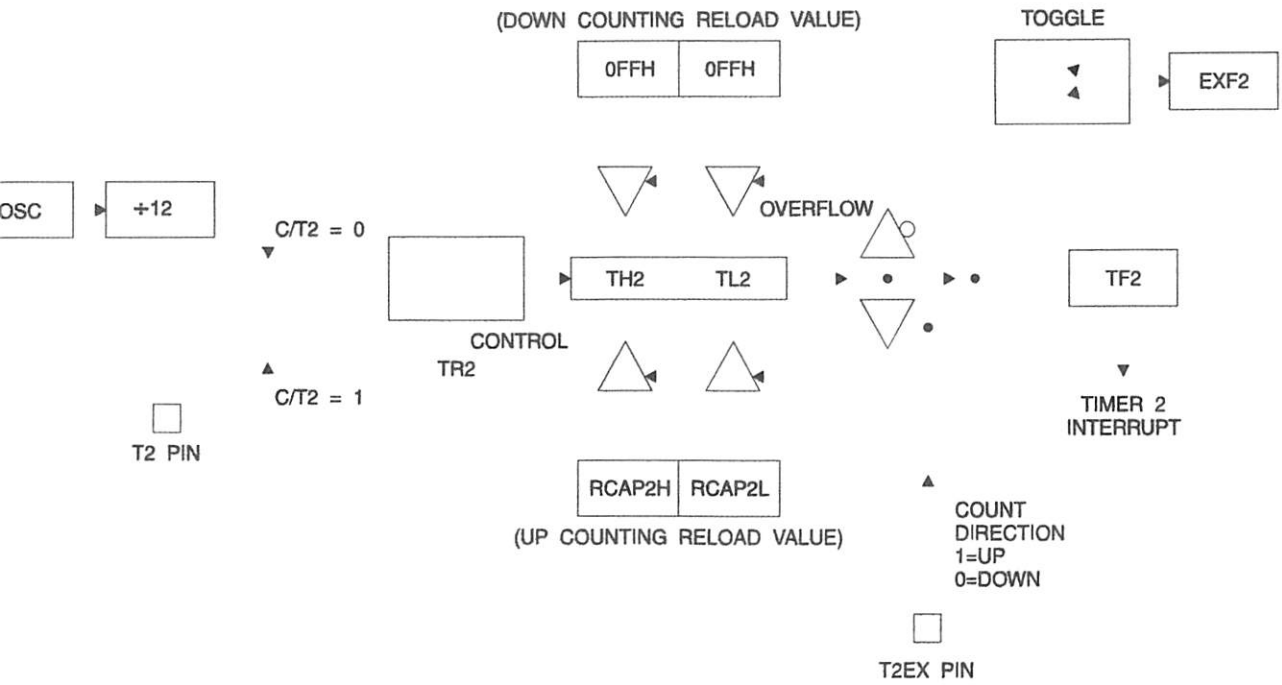
OD Address = 0C9H — Reset Value = XXXX XX00B

Bit Addressable

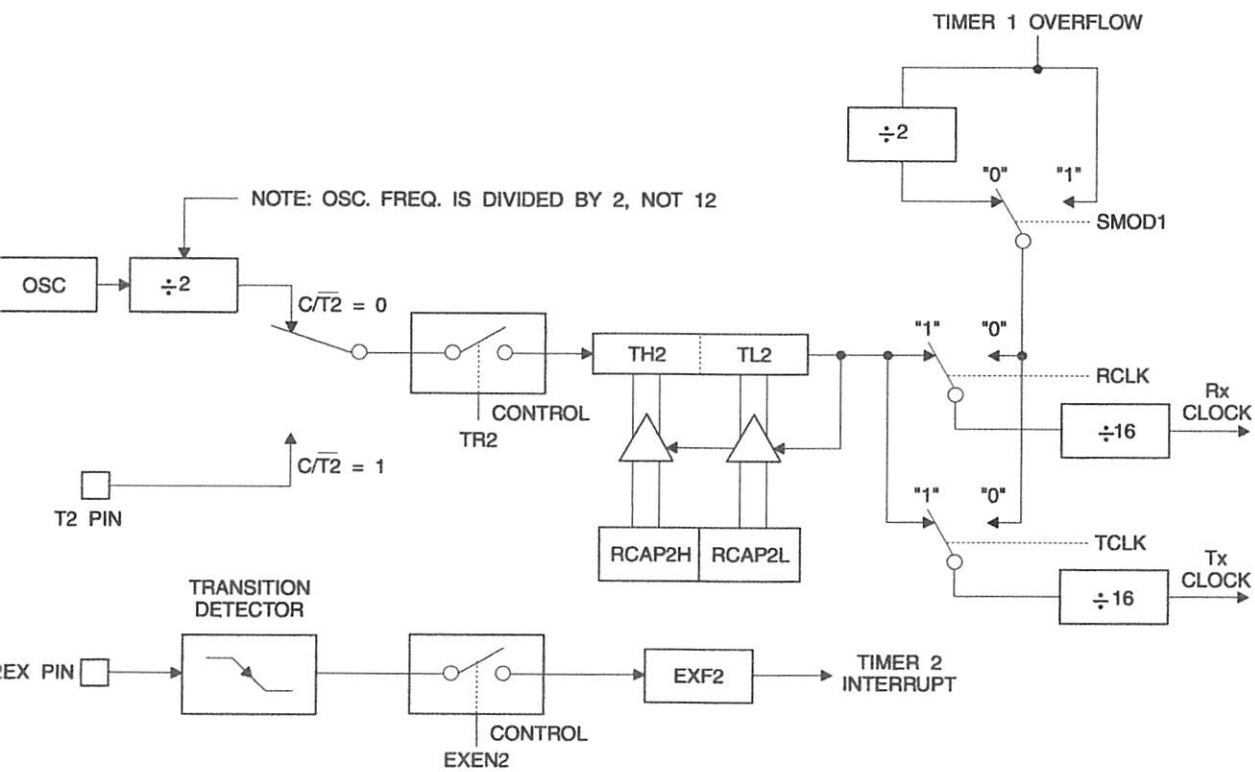
–	–	–	–	–	–	T2OE	DCEN
7	6	5	4	3	2	1	0

bol	Function
	Not implemented, reserved for future use.
E	Timer 2 Output Enable bit.
N	When set, this bit allows Timer 2 to be configured as an up/down counter.

re 3. Timer 2 Auto Reload Mode (DCEN = 1)



re 4. Timer 2 in Baud Rate Generator Mode



ıd Rate Generator

r 2 is selected as the baud rate generator by setting K and/or RCLK in T2CON (Table 2). Note that the rates for transmit and receive can be different if Timer sed for the receiver or transmitter and Timer 1 is used ıe other function. Setting RCLK and/or TCLK puts r 2 into its baud rate generator mode, as shown in Fig-

baud rate generator mode is similar to the auto-reload , in that a rollover in TH2 causes the Timer 2 registers reloaded with the 16 bit value in registers RCAP2H RCAP2L, which are preset by software.

baud rates in Modes 1 and 3 are determined by Timer verflow rate according to the following equation.

$$\text{odes 1 and 3 Baud Rates} = \frac{\text{Timer 2 Overflow Rate}}{16}$$

Timer can be configured for either timer or counter ation. In most applications, it is configured for timer ation ($C/\overline{T2} = 0$). The timer operation is different for r 2 when it is used as a baud rate generator. Normally, timer, it increments every machine cycle (at 1/12 the ator frequency). As a baud rate generator, however, it ments every state time (at 1/2 the oscillator fre-cy). The baud rate formula is given below.

$$\frac{\text{des 1 and 3}}{\text{Baud Rate}} = \frac{\text{Oscillator Frequency}}{32 \times [65536 - (\text{RCAP2H,RCAP2L})]}$$

e (RCAP2H, RCAP2L) is the content of RCAP2H and P2L taken as a 16 bit unsigned integer.

r 2 as a baud rate generator is shown in Figure 4. This e is valid only if RCLK or TCLK = 1 in T2CON. Note rollover in TH2 does not set TF2 and will not generate an interrupt. Note too, that if EXEN2 is set, a 1-to-0 tion in T2EX will set EXF2 but will not cause a reload (RCAP2H, RCAP2L) to (TH2, TL2). Thus when Timer 2 is in use as a baud rate generator, T2EX can be used as an extra external interrupt.

Note that when Timer 2 is running (TR2 = 1) as a timer in the baud rate generator mode, TH2 or TL2 should not be read from or written to. Under these conditions, the Timer is incremented every state time, and the results of a read or write may not be accurate. The RCAP2 registers may be read but should not be written to, because a write might overlap a reload and cause write and/or reload errors. The timer should be turned off (clear TR2) before accessing the Timer 2 or RCAP2 registers.

Programmable Clock Out

A 50% duty cycle clock can be programmed to come out on P1.0, as shown in Figure 5. This pin, besides being a regular I/O pin, has two alternate functions. It can be programmed to input the external clock for Timer/Counter 2 or to output a 50% duty cycle clock ranging from 61 Hz to 4 MHz at a 16 MHz operating frequency.

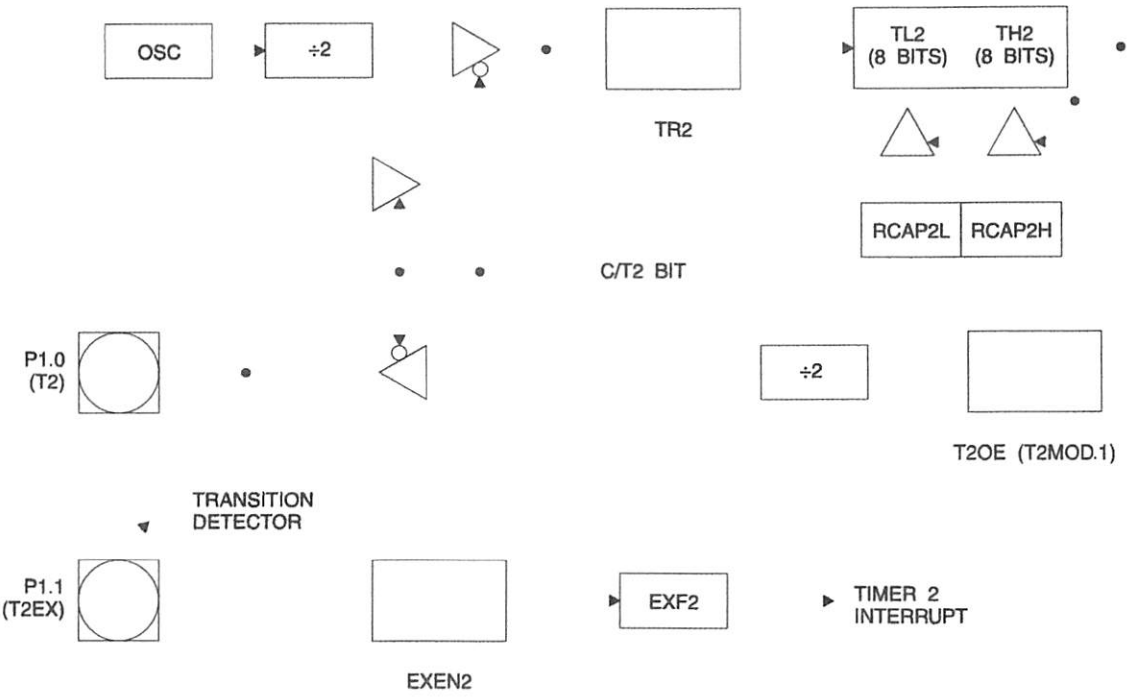
To configure the Timer/Counter 2 as a clock generator, bit $C/\overline{T2}$ (T2CON.1) must be cleared and bit T2OE (T2MOD.1) must be set. Bit TR2 (T2CON.2) starts and stops the timer.

The clock-out frequency depends on the oscillator frequency and the reload value of Timer 2 capture registers (RCAP2H, RCAP2L), as shown in the following equation.

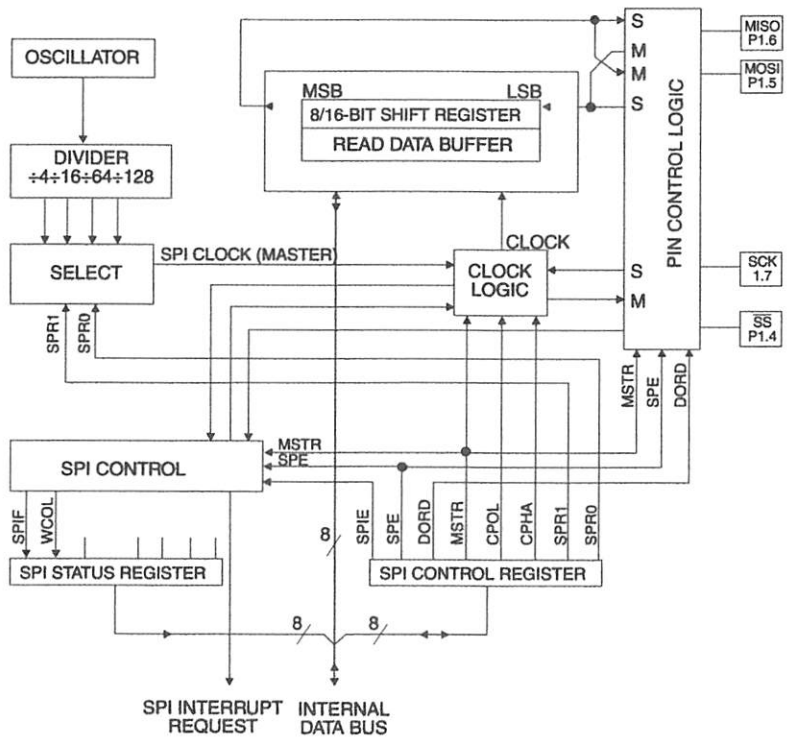
$$\text{Clock Out Frequency} = \frac{\text{Oscillator Frequency}}{4 \times [65536 - (\text{RCAP2H,RCAP2L})]}$$

In the clock-out mode, Timer 2 rollovers will not generate an interrupt. This behavior is similar to when Timer 2 is used as a baud-rate generator. It is possible to use Timer 2 as a baud-rate generator and a clock generator simultaneously. Note, however, that the baud-rate and clock-out frequencies cannot be determined independently from one another since they both use RCAP2H and RCAP2L.

e 5. Timer 2 in Clock-out Mode



e 6. SPI Block Diagram



RT

UART in the AT89S8252 operates the same way as UART in the AT89C51, AT89C52 and AT89C55. For er information, see the October 1995 Microcontroller Book, page 2-49, section titled, "Serial Interface."

ial Peripheral Interface

serial peripheral interface (SPI) allows high-speed syn-nous data transfer between the AT89S8252 and pheral devices or between several AT89S8252 ces. The AT89S8252 SPI features include the ving:

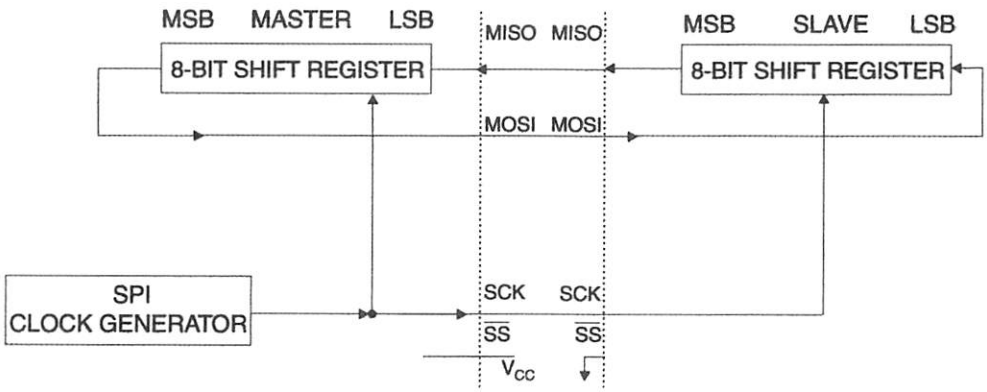
- ll-Duplex, 3-Wire Synchronous Data Transfer
- aster or Slave Operation
- 5 MHz Bit Frequency (max.)
- B First or MSB First Data Transfer
- ur Programmable Bit Rates
- d of Transmission Interrupt Flag
- Write Collision Flag Protection
- Wakeup from Idle Mode (Slave Mode Only)

The interconnection between master and slave CPUs with SPI is shown in the following figure. The SCK pin is the clock output in the master mode but is the clock input in the slave mode. Writing to the SPI data register of the master CPU starts the SPI clock generator, and the data written shifts out of the MOSI pin and into the MOSI pin of the slave CPU. After shifting one byte, the SPI clock generator stops, setting the end of transmission flag (SPIF). If both the SPI interrupt enable bit (SPIE) and the serial port interrupt enable bit (ES) are set, an interrupt is requested.

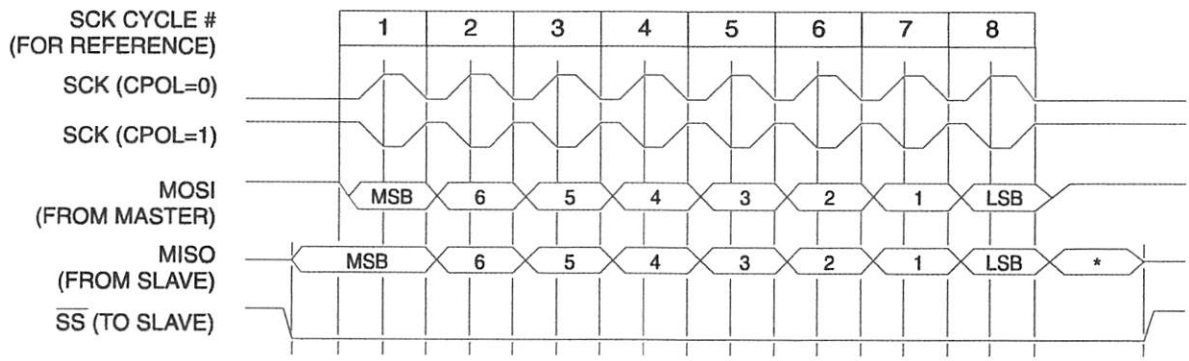
The Slave Select input, $\overline{SS}$/P1.4, is set low to select an individual SPI device as a slave. When $\overline{SS}$/P1.4 is set high, the SPI port is deactivated and the MOSI/P1.5 pin can be used as an input.

There are four combinations of SCK phase and polarity with respect to serial data, which are determined by control bits CPHA and CPOL. The SPI data transfer formats are shown in Figure 8 and Figure 9.

re 7. SPI Master-slave Interconnection

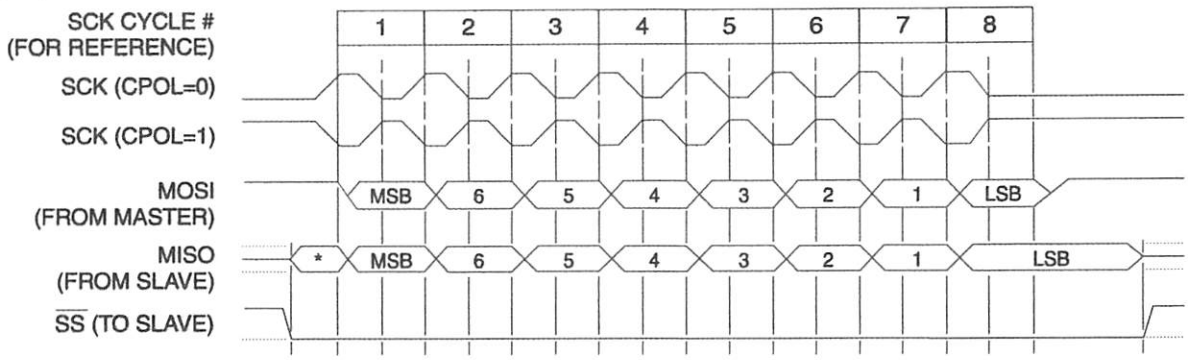


re 8. SPI transfer Format with CPHA = 0



defined but normally MSB of character just received

e 9. SPI Transfer Format with CPHA = 1



defined but normally LSB of previously transmitted character

rrupts

AT89S8252 has a total of six interrupt vectors: two nal interrupts ($\overline{INT0}$ and $\overline{INT1}$), three timer interrupts ers 0, 1, and 2), and the serial port interrupt. These upts are all shown in Figure 10.

of these interrupt sources can be individually enabled abled by setting or clearing a bit in Special Function ter IE. IE also contains a global disable bit, EA, which les all interrupts at once.

that Table 10 shows that bit position IE.6 is unimple-ed. In the AT89C51, bit position IE.5 is also lemented. User software should not write 1s to these sitions, since they may be used in future AT89 cts.

2 interrupt is generated by the logical OR of bits TF2 EXF2 in register T2CON. Neither of these flags is ed by hardware when the service routine is vectored fact, the service routine may have to determine ner it was TF2 or EXF2 that generated the interrupt, nat bit will have to be cleared in software.

Timer 0 and Timer 1 flags, TF0 and TF1, are set at of the cycle in which the timers overflow. The values en polled by the circuitry in the next cycle. However, imer 2 flag, TF2, is set at S2P2 and is polled in the cycle in which the timer overflows.

Table 10. Interrupt Enable (IE) Register

(MSB)(LSB)

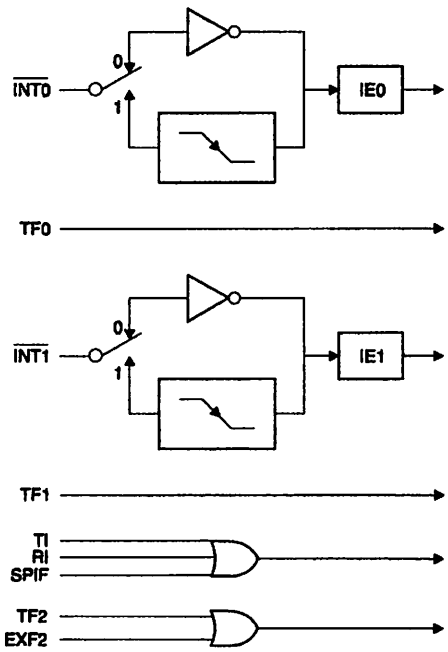
EA	–	ET2	ES	ET1	EX1	ET0	EX0

Enable Bit = 1 enables the interrupt.

Enable Bit = 0 disables the interrupt.

Symbol	Position	Function
EA	IE.7	Disables all interrupts. If EA = 0, no interrupt is acknowledged. If EA = 1, each interrupt source is individually enabled or disabled by setting or clearing its enable bit.
–	IE.6	Reserved.
ET2	IE.5	Timer 2 interrupt enable bit.
ES	IE.4	SPI and UART interrupt enable bit.
ET1	IE.3	Timer 1 interrupt enable bit.
EX1	IE.2	External interrupt 1 enable bit.
ET0	IE.1	Timer 0 interrupt enable bit.
EX0	IE.0	External interrupt 0 enable bit.
User software should never write 1s to unimplemented bits, because they may be used in future AT89 products.		

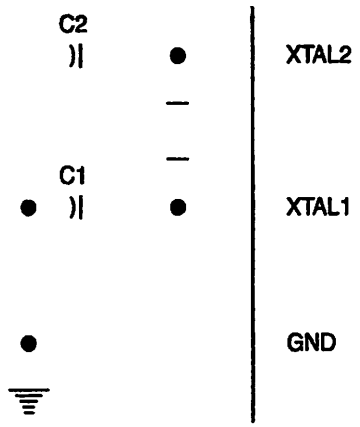
re 10. Interrupt Sources



:illator Characteristics

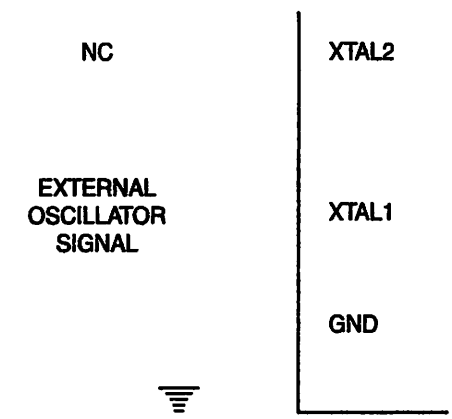
.1 and XTAL2 are the input and output, respectively, inverting amplifier that can be configured for use as ı-chip oscillator, as shown in Figure 11. Either a quartz al or ceramic resonator may be used. To drive the e from an external clock source, XTAL2 should be left nnected while XTAL1 is driven, as shown in Figure 12. ə are no requirements on the duty cycle of the external signal, since the input to the internal clocking circuitry ough a divide-by-two flip-flop, but minimum and maxi- voltage high and low time specifications must be rved.

Figure 11. Oscillator Connections



Note: Note: C1, C2 = 30 pF ± 10 pF for Crystals
= 40 pF ± 10 pF for Ceramic Resonators

Figure 12. External Clock Drive Configuration



Mode

e mode, the CPU puts itself to sleep while all the on-peripherals remain active. The mode is invoked by are. The content of the on-chip RAM and all the spe-unctions registers remain unchanged during this . The idle mode can be terminated by any enabled upt or by a hardware reset.

that when idle mode is terminated by a hardware , the device normally resumes program execution from where it left off, up to two machine cycles before the internal reset algorithm takes control. On-chip hardware inhibits access to internal RAM in this event, but access to the port pins is not inhibited. To eliminate the possibility of an unexpected write to a port pin when idle mode is terminated by a reset, the instruction following the one that invokes idle mode should not write to a port pin or to external memory.

tus of External Pins During Idle and Power-down Modes

le	Program Memory	ALE	$\overline{PSEN}$	PORT0	PORT1	PORT2	PORT3
	Internal	1	1	Data	Data	Data	Data
	External	1	1	Float	Data	Address	Data
er-down	Internal	0	0	Data	Data	Data	Data
er-down	External	0	0	Float	Data	Data	Data

ver-down Mode

power-down mode, the oscillator is stopped and the ıction that invokes power-down is the last instruction ıted. The on-chip RAM and Special Function Regis-retain their values until the power-down mode is nated. Exit from power-down can be initiated either by dware reset or by an enabled external interrupt. Reset ines the SFRs but does not change the on-chip RAM. eset should not be activated before V_{CC} is restored to ırmal operating level and must be held active long gh to allow the oscillator to restart and stabilize.

dit power-down via an interrupt, the external interrupt be enabled as level sensitive before entering power-. The interrupt service routine starts at 16 ms (nomi-fter the enabled interrupt pin is activated.

Program Memory Lock Bits

The AT89S8252 has three lock bits that can be left unprogrammed (U) or can be programmed (P) to obtain the additional features listed in the following table.

When lock bit 1 is programmed, the logic level at the $\overline{EA}$ pin is sampled and latched during reset. If the device is powered up without a reset, the latch initializes to a random value and holds that value until reset is activated. The latched value of $\overline{EA}$ must agree with the current logic level at that pin in order for the device to function properly.

Once programmed, the lock bits can only be unprogrammed with the Chip Erase operations in either the parallel or serial modes.

k Bit Protection Modes[1][2]

Program Lock Bits			
LB1	LB2	LB3	Protection Type
U	U	U	No internal memory lock feature.
P	U	U	MOVC instructions executed from external program memory are disabled from fetching code bytes from internal memory. $\overline{EA}$ is sampled and latched on reset and further programming of the Flash memory (parallel or serial mode) is disabled.
P	P	U	Same as Mode 2, but parallel or serial verify are also disabled.
P	P	P	Same as Mode 3, but external execution is also disabled.

1. U = Unprogrammed
2. P = Programmed

gramming the Flash and EEPROM

l's AT89S8252 Flash Microcontroller offers 8K bytes system reprogrammable Flash Code memory and 2K of EEPROM Data memory.

AT89S8252 is normally shipped with the on-chip Flash and EEPROM Data memory arrays in the erased (i.e. contents = FFH) and ready to be programmed. device supports a High-voltage (12V) Parallel programming mode and a Low-voltage (5V) Serial ramming mode. The serial programming mode pro- a convenient way to download the AT89S8252 inside ser's system. The parallel programming mode is com- le with conventional third party Flash or EPROM ammers.

Code and Data memory arrays are mapped via sepa- address spaces in the serial programming mode. In arallel programming mode, the two arrays occupy one guous address space: 0000H to 1FFFH for the Code and 2000H to 27FFH for the Data array.

Code and Data memory arrays on the AT89S8252 are ammed byte-by-byte in either programming mode. An erase cycle is provided with the self-timed program- operation in the serial programming mode. There is ed to perform the Chip Erase operation to reprogram nemory location in the serial programming mode s any of the lock bits have been programmed.

parallel programming mode, there is no auto-erase . To reprogram any non-blank byte, the user needs to ne Chip Erase operation first to erase both arrays.

lel Programming Algorithm: To program and verify T89S8252 in the parallel programming mode, the fol- g sequence is recommended:

ower-up sequence:

pply power between V_{CC} and GND pins.

et RST pin to "H".

pply a 3 MHz to 24 MHz clock to XTAL1 pin and wait r at least 10 milliseconds.

et $\overline{PSEN}$ pin to "L"

LE pin to "H"

$\overline{A}$ pin to "H" and all other pins to "H".

pply the appropriate combination of "H" or "L" logic vels to pins P2.6, P2.7, P3.6, P3.7 to select one of ne programming operations shown in the Flash rogramming Modes table.

pply the desired byte address to pins P1.0 to P1.7 nd P2.0 to P2.5.

pply data to pins P0.0 to P0.7 for Write Code peration.

5. Raise $\overline{EA}/V_{PP}$ to 12V to enable Flash programming, erase or verification.
6. Pulse ALE/$\overline{PROG}$ once to program a byte in the Code memory array, the Data memory array or the lock bits. The byte-write cycle is self-timed and typically takes 1.5 ms.
7. To verify the byte just programmed, bring pin P2.7 to "L" and read the programmed data at pins P0.0 to P0.7.
8. Repeat steps 3 through 7 changing the address and data for the entire 2K or 8K bytes array or until the end of the object file is reached.
9. Power-off sequence:

   Set XTAL1 to "L".

   Set RST and $\overline{EA}$ pins to "L".

   Turn V_{CC} power off.

In the parallel programming mode, there is no auto-erase cycle and to reprogram any non-blank byte, the user needs to use the Chip Erase operation first to erase both arrays.

$\overline{Data}$ Polling: The AT89S8252 features $\overline{DATA}$ Polling to indicate the end of a write cycle. During a write cycle in the parallel or serial programming mode, an attempted read of the last byte written will result in the complement of the written datum on P0.7 (parallel mode), and on the MSB of the serial output byte on MISO (serial mode). Once the write cycle has been completed, true data are valid on all outputs, and the next cycle may begin. $\overline{DATA}$ Polling may begin any time after a write cycle has been initiated.

Ready/$\overline{Busy}$: The progress of byte programming in the parallel programming mode can also be monitored by the RDY/$\overline{BSY}$ output signal. Pin P3.4 is pulled Low after ALE goes High during programming to indicate $\overline{BUSY}$. P3.4 is pulled High again when programming is done to indicate READY.

Program Verify: If lock bits LB1 and LB2 have not been programmed, the programmed Code or Data byte can be read back via the address and data lines for verification. The state of the lock bits can also be verified directly in the parallel programming mode. In the serial programming mode, the state of the lock bits can only be verified indirectly by observing that the lock bit features are enabled.

Chip Erase: Both Flash and EEPROM arrays are erased electrically at the same time. In the parallel programming mode, chip erase is initiated by using the proper combination of control signals and by holding ALE/$\overline{PROG}$ low for 10 ms. The Code and Data arrays are written with all "1"s in the Chip Erase operation.

e serial programming mode, a chip erase operation is ed by issuing the Chip Erase instruction. In this mode, erase is self-timed and takes about 16 ms.

ig chip erase, a serial read from any address location turn 00H at the data outputs.

l Programming Fuse: A programmable fuse is avail- to disable Serial Programming if the user needs mum system security. The Serial Programming Fuse nly be programmed or erased in the Parallel Program- Mode.

AT89S8252 is shipped with the Serial Programming enabled.

ling the Signature Bytes: The signature bytes are by the same procedure as a normal verification of ons 030H and 031H, except that P3.6 and P3.7 must lled to a logic low. The values returned are as follows:

030H) = 1EH indicates manufactured by Atmel
031H) = 72H indicates 89S8252

gramming Interface

/ code byte in the Flash and EEPROM arrays can be n, and the entire array can be erased, by using the priate combination of control signals. The write oper- cycle is self-timed and once initiated, will natically time itself to completion.

ajor programming vendors offer worldwide support for tmel microcontroller series. Please contact your local amming vendor for the appropriate software revision.

ial Downloading

the Code and Data memory arrays can be pro- med using the serial SPI bus while RST is pulled to The serial interface consists of pins SCK, MOSI (input) /ISO (output). After RST is set high, the Programming le instruction needs to be executed first before pro- /erase operations can be executed.

ito-erase cycle is built into the self-timed programming ition (in the serial mode ONLY) and there is no need t execute the Chip Erase instruction unless any of the bits have been programmed. The Chip Erase opera- urns the content of every memory location in both the and Data arrays into FFH.

Code and Data memory arrays have separate address es:

0000H to 1FFFH for Code memory and 000H to 7FFH for Data memory.

Either an external system clock is supplied at pin XTAL1 or a crystal needs to be connected across pins XTAL1 and XTAL2. The maximum serial clock (SCK) frequency should be less than 1/40 of the crystal frequency. With a 24 MHz oscillator clock, the maximum SCK frequency is 600 kHz.

Serial Programming Algorithm

To program and verify the AT89S8252 in the serial programming mode, the following sequence is recommended:

1. Power-up sequence:
   Apply power between VCC and GND pins.
   Set RST pin to "H".
   If a crystal is not connected across pins XTAL1 and XTAL2, apply a 3 MHz to 24 MHz clock to XTAL1 pin and wait for at least 10 milliseconds.
2. Enable serial programming by sending the Programming Enable serial instruction to pin MOSI/P1.5. The frequency of the shift clock supplied at pin SCK/P1.7 needs to be less than the CPU clock at XTAL1 divided by 40.
3. The Code or Data array is programmed one byte at a time by supplying the address and data together with the appropriate Write instruction. The selected memory location is first automatically erased before new data is written. The write cycle is self-timed and typically takes less than 2.5 ms at 5V.
4. Any memory location can be verified by using the Read instruction which returns the content at the selected address at serial output MISO/P1.6.
5. At the end of a programming session, RST can be set low to commence normal operation.

Power-off sequence (if needed):
Set XTAL1 to "L" (if a crystal is not used).
Set RST to "L".
Turn V_{CC} power off.

Serial Programming Instruction

The Instruction Set for Serial Programming follows a 3-byte protocol and is shown in the following table:

ruction Set

ruction	Input Format			Operation
	Byte 1	Byte 2	Byte 3	
ramming Enable	1010 1100	0101 0011	xxxx xxxx	Enable serial programming interface after RST goes high.
Erase	1010 1100	xxxx x100	xxxx xxxx	Chip erase both 8K & 2K memory arrays.
d Code Memory	aaaa a001	low addr	xxxx xxxx	Read data from Code memory array at the selected address. The 5 MSBs of the first byte are the high order address bits. The low order address bits are in the second byte. Data are available at pin MISO during the third byte.
e Code Memory	aaaa a010	low addr	data in	Write data to Code memory location at selected address. The address bits are the 5 MSBs of the first byte together with the second byte.
d Data Memory	00aa a101	low addr	xxxx xxxx	Read data from Data memory array at selected address. Data are available at pin MISO during the third byte.
e Data Memory	00aa a110	low addr	data in	Write data to Data memory location at selected address.
e Lock Bits	1010 1100	x x111	xxxx xxxx	Write lock bits. Set LB1, LB2 or LB3 = "0" to program lock bits.

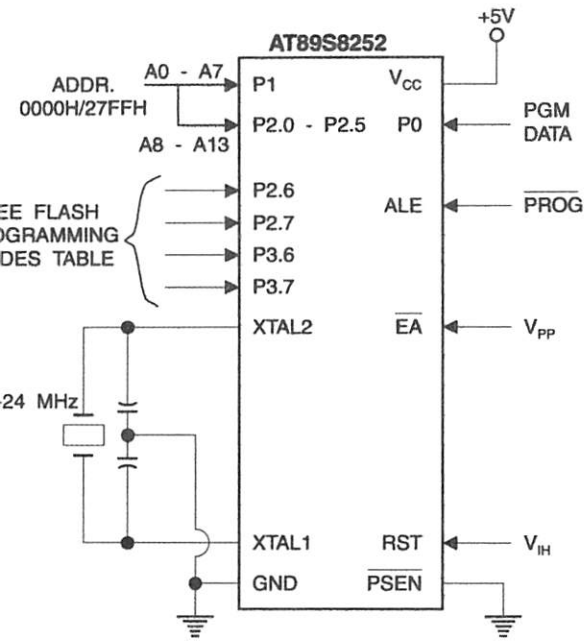
1. DATA polling is used to indicate the end of a write cycle which typically takes less than 2.5 ms at 5V.
2. "aaaaa" = high order address.
3. "x" = don't care.

sh and EEPROM Parallel Programming Modes

e	RST	$\overline{PSEN}$	ALE/$\overline{PROG}$	$\overline{EA}$/V_{PP}	P2.6	P2.7	P3.6	P3.7	Data I/O P0.7:0	Address P2.5:0 P1.7:0
l Prog. Modes	H	h(1)	h(1)	x						
Erase	H	L	(2)	12V	H	L	L	L	X	X
(10K bytes) Memory	H	L		12V	L	H	H	H	DIN	ADDR
d (10K bytes) Memory	H	L	H	12V	L	L	H	H	DOUT	ADDR
Lock Bits:	H	L		12V	H	L	H	L	DIN	X
Bit - 1									P0.7 = 0	X
Bit - 2									P0.6 = 0	X
Bit - 3									P0.5 = 0	X
d Lock Bits:	H	L	H	12V	H	H	L	L	DOUT	X
Bit - 1									@P0.2	X
Bit - 2									@P0.1	X
Bit - 3									@P0.0	X
d Atmel Code	H	L	H	12V	L	L	L	L	DOUT	30H
d Device Code	H	L	H	12V	L	L	L	L	DOUT	31H
l Prog. Enable	H	L	(2)	12V	L	H	L	H	P0.0 = 0	X
l Prog. Disable	H	L	(2)	12V	L	H	L	H	P0.0 = 1	X
d Serial Prog. Fuse	H	L	H	12V	H	H	L	H	@P0.0	X

:
1. "h" = weakly pulled "High" internally.
2. Chip Erase and Serial Programming Fuse require a 10 ms $\overline{PROG}$ pulse. Chip Erase needs to be performed first before reprogramming any byte with a content other than FFH.
3. P3.4 is pulled Low during programming to indicate RDY/$\overline{BSY}$.
4. "X" = don't care

re 13. Programming the Flash/EEPROM Memory



re 14. Verifying the Flash/EEPROM Memory

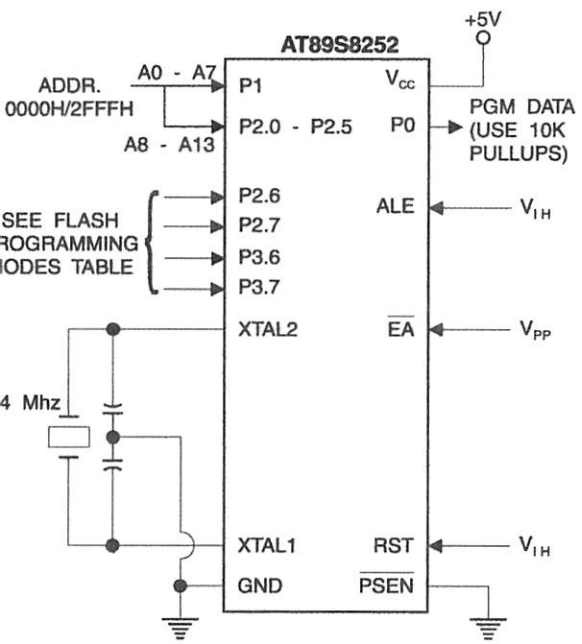
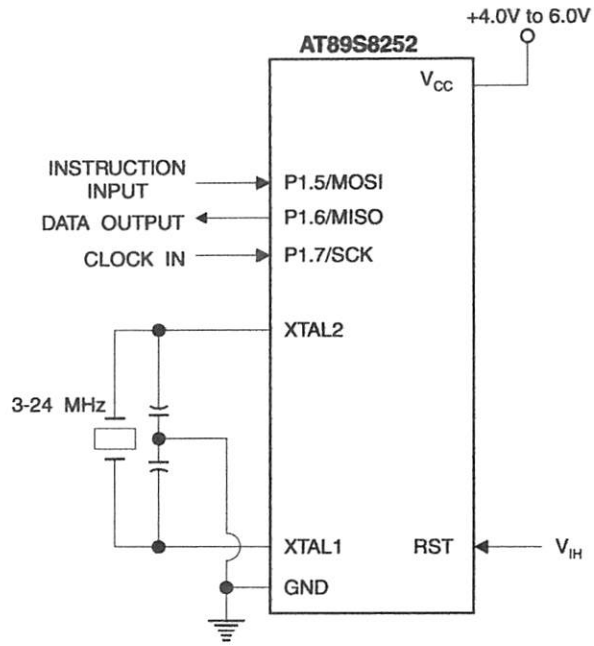


Figure 15. Flash/EEPROM Serial Downloading

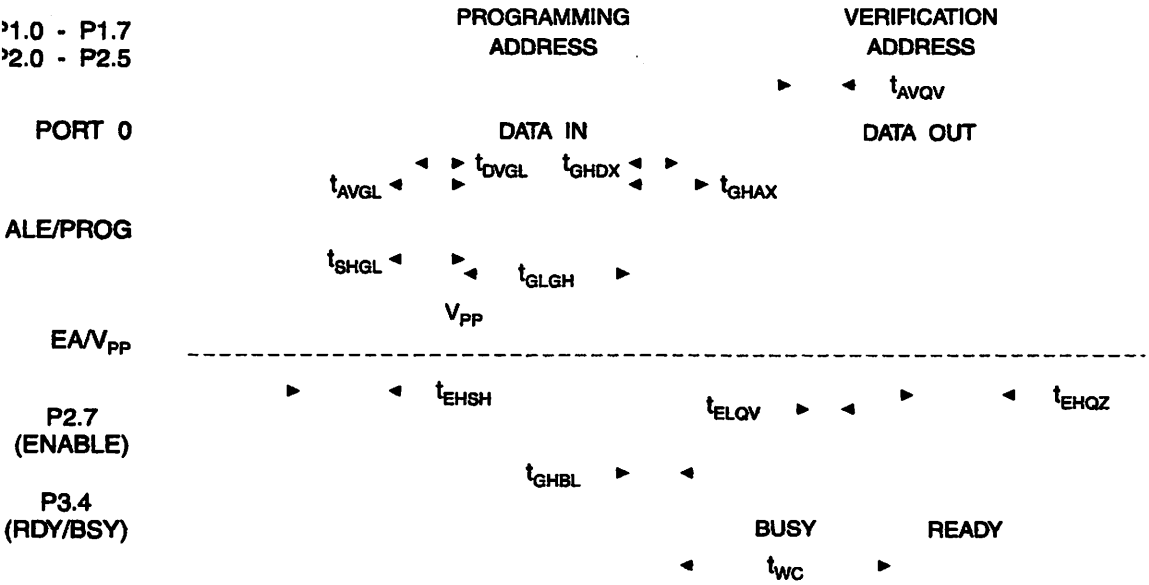


sh Programming and Verification Characteristics – Parallel Mode

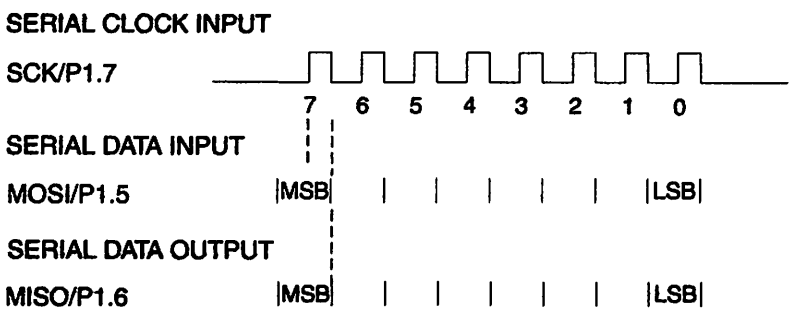
0°C to 70°C, V_{CC} = 5.0V ± 10%

bol	Parameter	Min	Max	Units
	Programming Enable Voltage	11.5	12.5	V
	Programming Enable Current		1.0	mA
CL	Oscillator Frequency	3	24	MHz
	Address Setup to $\overline{PROG}$ Low	$48t_{CLCL}$		
X	Address Hold after $\overline{PROG}$	$48t_{CLCL}$		
	Data Setup to $\overline{PROG}$ Low	$48t_{CLCL}$		
X	Data Hold after $\overline{PROG}$	$48t_{CLCL}$		
H	P2.7 ($\overline{ENABLE}$) High to V_{PP}	$48t_{CLCL}$		
L	V_{PP} Setup to $\overline{PROG}$ Low	10		µs
H	$\overline{PROG}$ Width	1	110	µs
V	Address to Data Valid		$48t_{CLCL}$	
V	$\overline{ENABLE}$ Low to Data Valid		$48t_{CLCL}$	
Z	Data Float after $\overline{ENABLE}$	0	$48t_{CLCL}$	
L	$\overline{PROG}$ High to $\overline{BUSY}$ Low		1.0	µs
	Byte Write Cycle Time		2.0	ms

sh/EEPROM Programming and Verification Waveforms – Parallel Mode



ial Downloading Waveforms



solute Maximum Ratings*

erating Temperature	-55°C to +125°C
rage Temperature	-65°C to +150°C
age on Any Pin Respect to Ground	-1.0V to +7.0V
ximum Operating Voltage	6.6V
Output Current	15.0 mA

*NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Characteristics

values shown in this table are valid for T_A = -40°C to 85°C and V_{CC} = 5.0V ± 20%, unless otherwise noted.

nbol	Parameter	Condition	Min	Max	Units
	Input Low-voltage	(Except $\overline{EA}$)	-0.5	0.2 V_{CC} - 0.1	V
	Input Low-voltage ($\overline{EA}$)		-0.5	0.2 V_{CC} - 0.3	V
	Input Hifh-voltage	(Except XTAL1, RST)	0.2 V_{CC} + 0.9	V_{CC} + 0.5	V
	Input Hifh-voltage	(XTAL1, RST)	0.7 V_{CC}	V_{CC} + 0.5	V
	Output Low-voltage (1) (Ports 1,2,3)	I_{OL} = 1.6 mA		0.5	V
	Output Low-voltage (1) (Port 0, ALE, $\overline{PSEN}$)	I_{OL} = 3.2 mA		0.5	V
	Output Hifh-voltage (Ports 1,2,3, ALE, $\overline{PSEN}$)	I_{OH} = -60 µA, V_{CC} = 5V ± 10%	2.4		V
		I_{OH} = -25 µA	0.75 V_{CC}		V
		I_{OH} = -10 µA	0.9 V_{CC}		V
	Output Hifh-voltage (Port 0 in External Bus Mode)	I_{OH} = -800 µA, V_{CC} = 5V ± 10%	2.4		V
		I_{OH} = -300 µA	0.75 V_{CC}		V
		I_{OH} = -80 µA	0.9 V_{CC}		V
	Logical 0 Input Current (Ports 1,2,3)	V_{IN} = 0.45V		-50	µA
	Logical 1 to 0 Transition Current (Ports 1,2,3)	V_{IN} = 2V, V_{CC} = 5V ± 10%		-650	µA
	Input Leakage Current (Port 0, $\overline{EA}$)	0.45 < V_{IN} < V_{CC}		±10	µA
ST	Reset Pull-down Resistor		50	300	KΩ
	Pin Capacitance	Test Freq. = 1 MHz, T_A = 25°C		10	pF
	Power Supply Current	Active Mode, 12 MHz		25	mA
		Idle Mode, 12 MHz		6.5	mA
	Power-down Mode (2)	V_{CC} = 6V		100	µA
		V_{CC} = 3V		40	µA

1. Under steady state (non-transient) conditions, I_{OL} must be externally limited as follows:
   Maximum I_{OL} per port pin: 10 mA
   Maximum I_{OL} per 8-bit port:
   Port 0: 26 mA
   Ports 1, 2, 3: 15 mA
   Maximum total I_{OL} for all output pins: 71 mA
   If I_{OL} exceeds the test condition, V_{OL} may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test conditions.
2. Minimum V_{CC} for Power-down is 2V

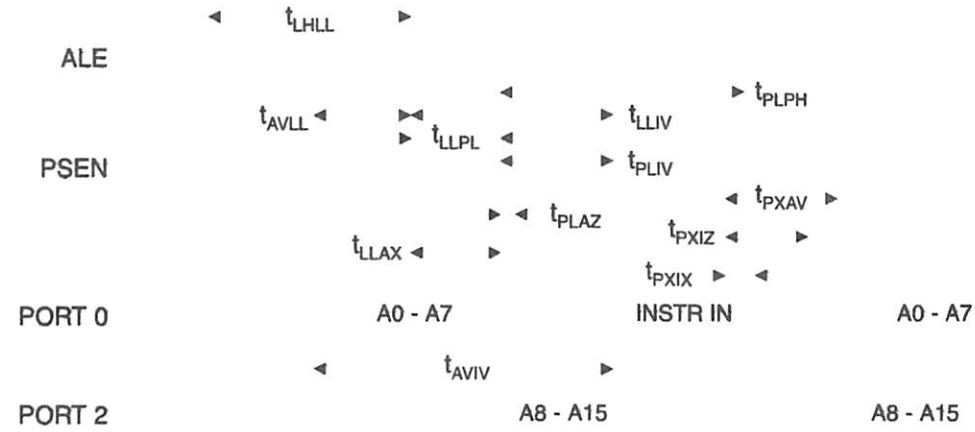
Characteristics

r operating conditions, load capacitance for Port 0, ALE/$\overline{PROG}$, and $\overline{PSEN}$ = 100 pF; load capacitance for all other ts = 80 pF.

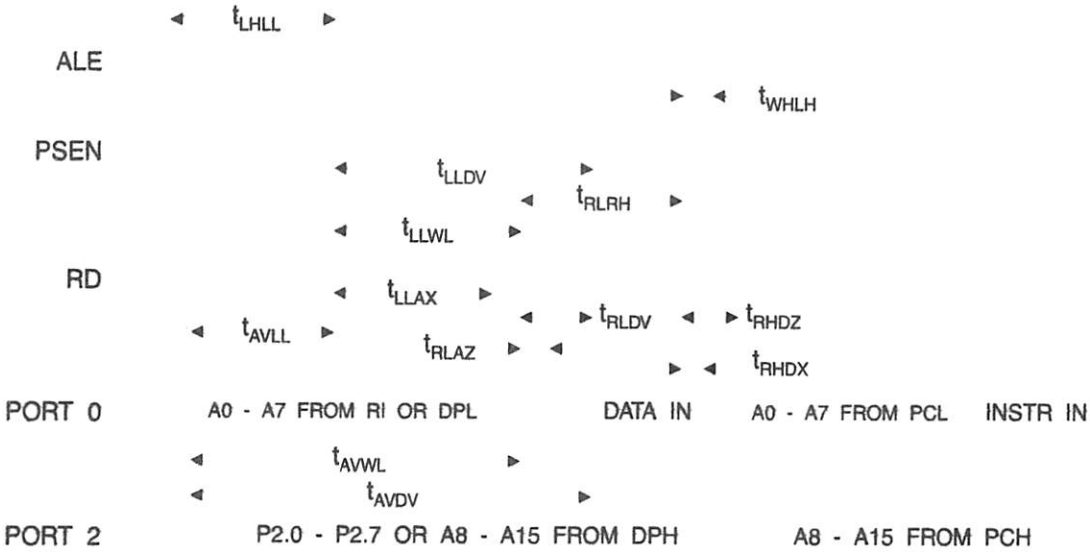
ernal Program and Data Memory Characteristics

bol	Parameter	Variable Oscillator		Units
		Min	Max	
CL	Oscillator Frequency	0	24	MHz
	ALE Pulse Width	$2t_{CLCL}$ - 40		ns
	Address Valid to ALE Low	t_{CLCL} - 13		ns
	Address Hold after ALE Low	t_{CLCL} - 20		ns
	ALE Low to Valid Instruction In		$4t_{CLCL}$ - 65	ns
	ALE Low to $\overline{PSEN}$ Low	t_{CLCL} - 13		ns
	$\overline{PSEN}$ Pulse Width	$3t_{CLCL}$ - 20		ns
	$\overline{PSEN}$ Low to Valid Instruction In		$3t_{CLCL}$ - 45	ns
	Input Instruction Hold after $\overline{PSEN}$	0		ns
	Input Instruction Float after $\overline{PSEN}$		t_{CLCL} - 10	ns
	$\overline{PSEN}$ to Address Valid	t_{CLCL} - 8		ns
	Address to Valid Instruction In		$5t_{CLCL}$ - 55	ns
	$\overline{PSEN}$ Low to Address Float		10	ns
	$\overline{RD}$ Pulse Width	$6t_{CLCL}$ - 100		ns
H	$\overline{WR}$ Pulse Width	$6t_{CLCL}$ - 100		ns
	$\overline{RD}$ Low to Valid Data In		$5t_{CLCL}$ - 90	ns
	Data Hold after $\overline{RD}$	0		ns
	Data Float after $\overline{RD}$		$2t_{CLCL}$ - 28	ns
	ALE Low to Valid Data In		$8t_{CLCL}$ - 150	ns
	Address to Valid Data In		$9t_{CLCL}$ - 165	ns
	ALE Low to $\overline{RD}$ or $\overline{WR}$ Low	$3t_{CLCL}$ - 50	$3t_{CLCL}$ + 50	ns
	Address to $\overline{RD}$ or $\overline{WR}$ Low	$4t_{CLCL}$ - 75		ns
	Data Valid to $\overline{WR}$ Transition	t_{CLCL} - 20		ns
H	Data Valid to $\overline{WR}$ High	$7t_{CLCL}$ - 120		ns
	Data Hold after $\overline{WR}$	t_{CLCL} - 20		ns
	$\overline{RD}$ Low to Address Float		0	ns
	$\overline{RD}$ or $\overline{WR}$ High to ALE High	t_{CLCL} - 20	t_{CLCL} + 25	ns

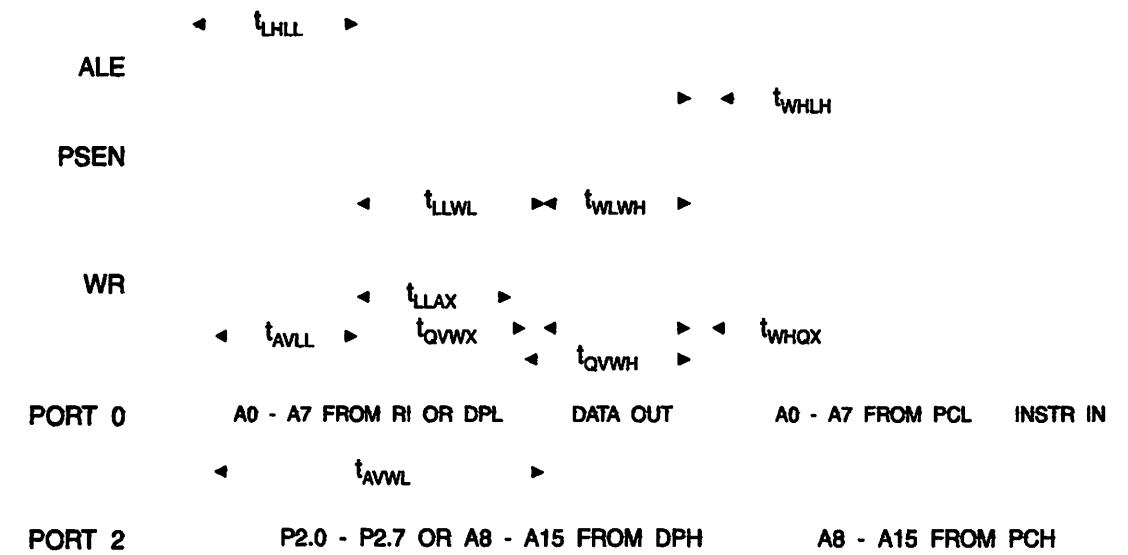
ernal Program Memory Read Cycle



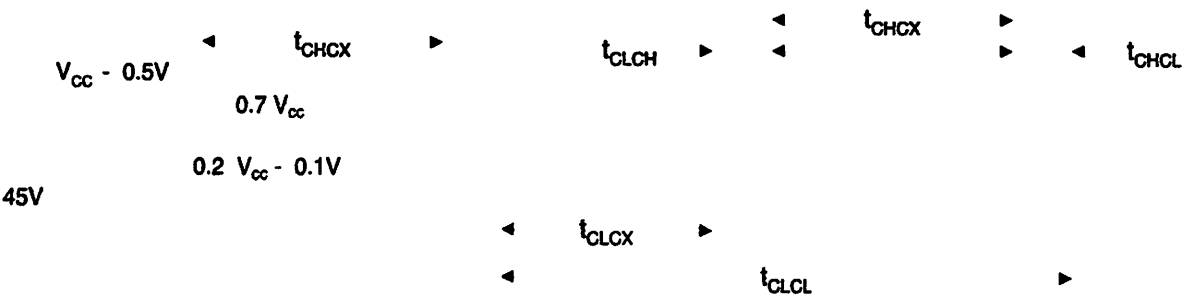
ernal Data Memory Read Cycle



ernal Data Memory Write Cycle



ernal Clock Drive Waveforms



ernal Clock Drive

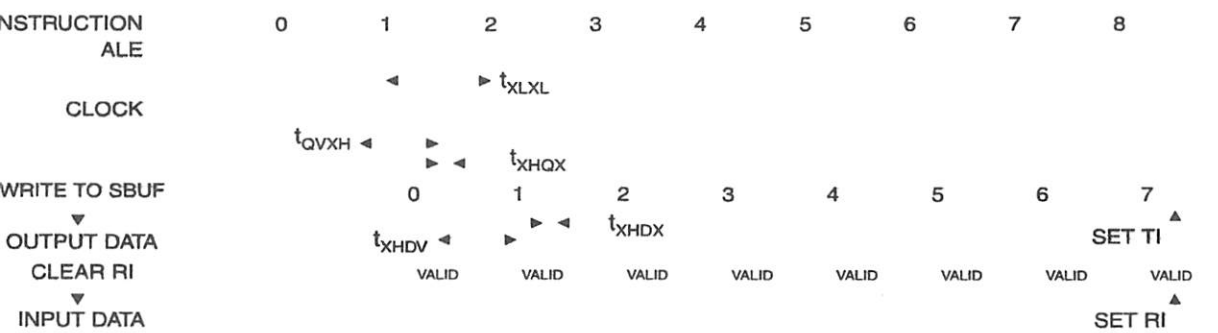
bol	Parameter	V_{CC} = 4.0V to 6.0V		Units
		Min	Max	
CL	Oscillator Frequency	0	24	MHz
	Clock Period	41.6		ns
	High Time	15		ns
	Low Time	15		ns
	Rise Time		20	ns
	Fall Time		20	ns

ial Port Timing: Shift Register Mode Test Conditions

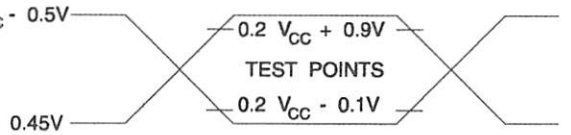
values in this table are valid for V_{CC} = 4.0V to 6V and Load Capacitance = 80 pF.

bol	Parameter	Variable Oscillator		Units
		Min	Max	
	Serial Port Clock Cycle Time	$12t_{CLCL}$		µs
H	Output Data Setup to Clock Rising Edge	$10t_{CLCL}$ - 133		ns
X	Output Data Hold after Clock Rising Edge	$2t_{CLCL}$ - 117		ns
X	Input Data Hold after Clock Rising Edge	0		ns
V	Clock Rising Edge to Input Data Valid		$10t_{CLCL}$ - 133	ns

ft Register Mode Timing Waveforms

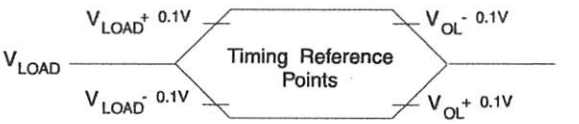


Testing Input/Output Waveforms[1]



: 1. AC Inputs during testing are driven at V_{CC} - 0.5V for a logic 1 and 0.45V for a logic 0. Timing measurements are made at V_{IH} min. for a logic 1 and V_{IL} max. for a logic 0.

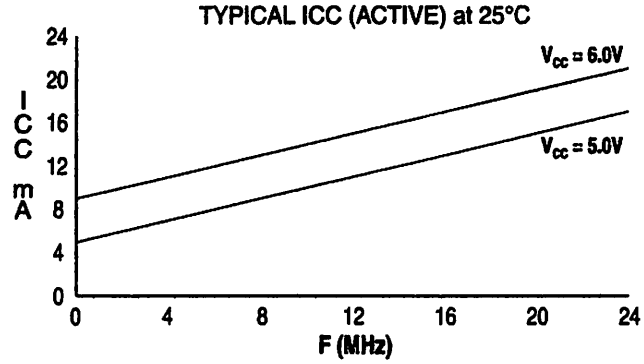
Float Waveforms[1]



Notes: 1. For timing purposes, a port pin is no longer floating when a 100 mV change from load voltage occurs. A port pin begins to float when a 100 mV change from the loaded V_{OH}/V_{OL} level occurs.

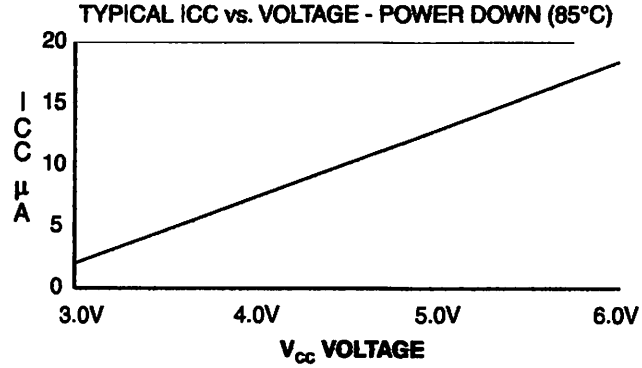
AT89S8252

TYPICAL ICC (ACTIVE) at 25°C



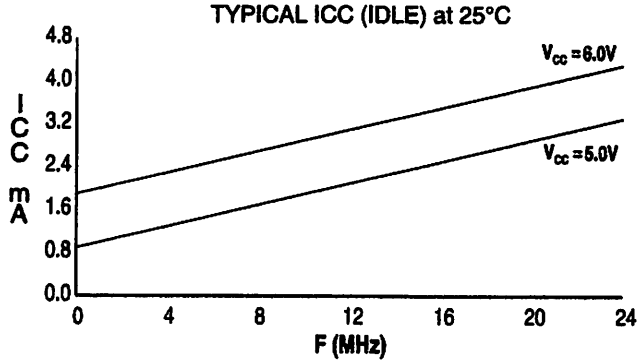
AT89S8252

TYPICAL ICC vs. VOLTAGE - POWER DOWN (85°C)



AT89S8252

TYPICAL ICC (IDLE) at 25°C



Notes: 1. XTAL1 tied to GND for Icc (power-down)
2. Lock bits programmed

lering Information

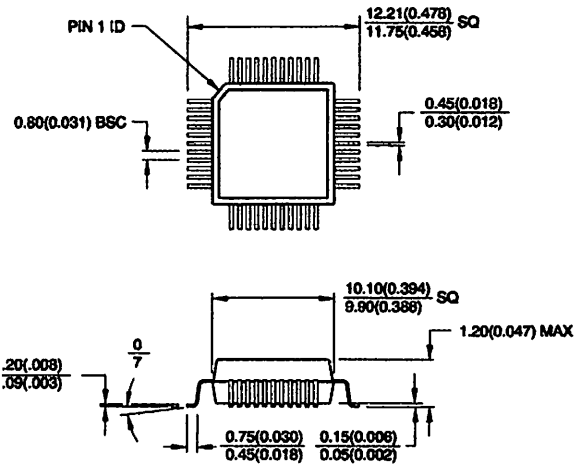
peed /Hz)	Power Supply	Ordering Code	Package	Operation Range
24	4.0V to 6.0V	AT89S8252-24AC AT89S8252-24JC AT89S8252-24PC AT89S8252-24QC	44A 44J 40P6 44Q	Commercial (0°C to 70°C)
	4.0V to 6.0V	AT89S8252-24AI AT89S8252-24JI AT89S8252-24PI AT89S8252-24QI	44A 44J 40P6 44Q	Industrial (-40°C to 85°C)
33	4.5V to 5.5V	AT89S8252-33AC AT89S8252-33JC AT89S8252-33PC AT89S8252-33QC	44A 44J 40P6 44Q	Commercial (0°C to 70°C)

= Preliminary Information

	Package Type
	44-lead, Thin Plastic Gull Wing Quad Flatpack (TQFP)
	44-lead, Plastic J-leaded Chip Carrier (PLCC)
	40-lead, 0.600" Wide, Plastic Dual Inline Package (PDIP)
	44-lead, Plastic Gull Wing Quad Flatpack (PQFP)

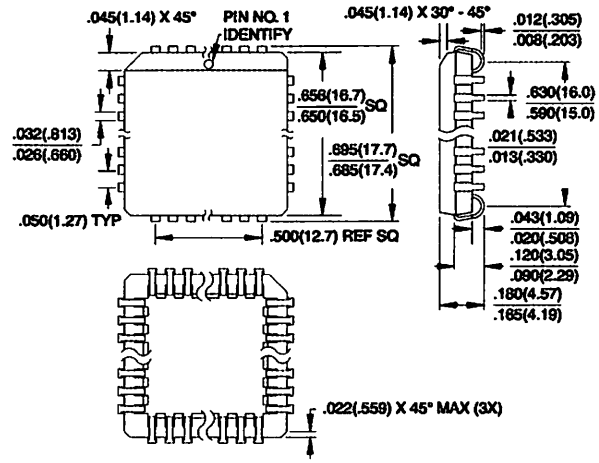
kaging Information

4A, 44-lead, Thin (1.0 mm) Plastic Gull Wing Quad
latpack (TQFP)
imensions in Millimeters and (Inches)*
EDEC STANDARD MS-026 ACB

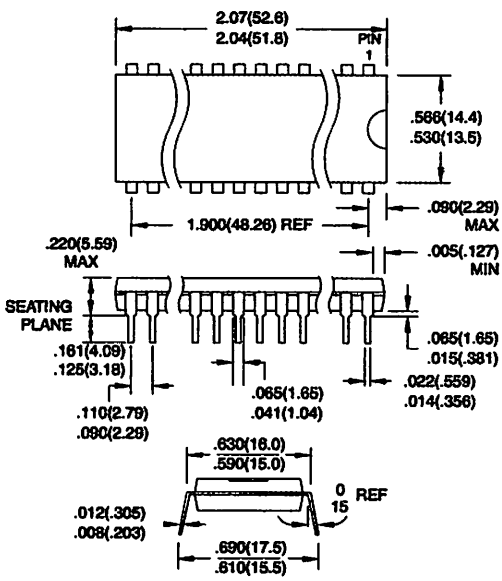


ontrolling dimension: millimeters

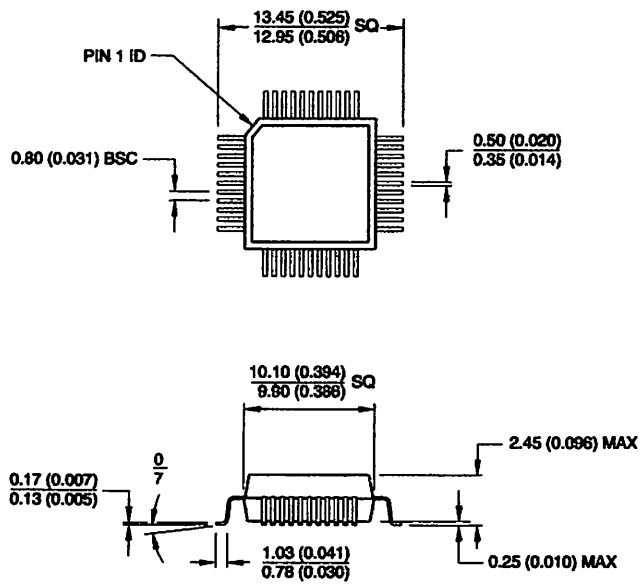
44J, 44-lead, Plastic J-leaded Chip Carrier (PLCC)
Dimensions in Inches and (Millimeters)
JEDEC STANDARD MS-018 AC



0P6, 40-lead, 0.600" Wide, Plastic Dual Inline
ackage (PDIP)
imensions in Inches and (Millimeters)



44Q, 44-lead, Plastic Quad Flat Package (PQFP)
Dimensions in Millimeters and (Inches)*
JEDEC STANDARD MS-022 AB



Controlling dimension: millimeters

ıel Headquarters

ɔorate Headquarters
25 Orchard Parkway
ın Jose, CA 95131
:L (408) 441-0311
\X (408) 487-2600

ɔpe
mel U.K., Ltd.
ɔliseum Business Centre
verside Way
ımberley, Surrey GU15 3YL
ıgland
:L (44) 1276-686-677
\X (44) 1276-686-697

ı
mel Asia, Ltd.
ɔom 1219
ıinachem Golden Plaza
Mody Road Tsimhatsui
ıst Kowloon
ıng Kong
:L (852) 2721-9778
\X (852) 2722-1369

ın
mel Japan K.K.
, Tonetsu Shinkawa Bldg.
24-8 Shinkawa
ıuo-ku, Tokyo 104-0033
pan
:L (81) 3-3523-3551
.X (81) 3-3523-7581

Atmel Operations

Atmel Colorado Springs
1150 E. Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906
TEL (719) 576-3300
FAX (719) 540-1759

Atmel Rousset
Zone Industrielle
13106 Rousset Cedex
France
TEL (33) 4-4253-6000
FAX (33) 4-4253-6001

Fax-on-Demand
North America:
1-(800) 292-8635
International:
1-(408) 441-0732

e-mail
literature@atmel.com

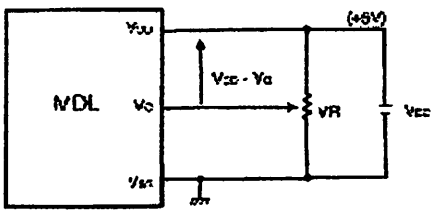
Web Site
http://www.atmel.com

BBS
1-(408) 436-4309

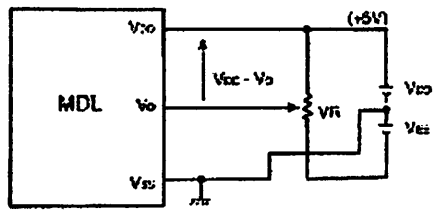
0401E–02/00/xM

ITEM		VALUE	
		MIN	MAX
Power supply for controller	(V_{DD} - V_{SS})	0	7.0V
Power supply for LCD driver	(V_{DD} - V_0)	0	13.5V
Input voltage for data and control signals	¡@	V_{SS}	V_{DD}
Operating temperature	(-LV model)	-5°C	+50°C
Storage temperature	(-LV model)	-20°C	+60°C

POWER SUPPLY FOR SINGLE SUPPLY VOLTAGE TYPES



POWER SUPPLY FOR DUAL SUPPLY VOLTAGE TYPES

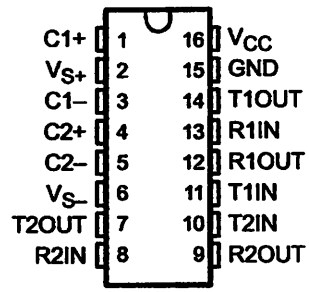


SYMBOL	I/O	FUNCTION
V_{SS}		Ground
V_{DD}		+5 Volt Power Supply
V_0		Negative voltage supply for LCD driver (For non LV models)
RS	I	Register Select: H for data; L for instruction code
R/W	I	Read/Write: H-read from module; L-write into module
E		Enable (No connection for MDL-40466)
DB0 DB1 DB2 DB3	I/O	Data bus lines used only in 8 bit transfer
DB4 DB5 DB6	I/O	Data bus line used for both 4 and 8 bit transfer
DB7	I/O	Data bus lines used for both 4 and 8 bit transfer Also serves as Busy Flag for internal operations
E1	I	Enable for upper two rows
E2	I	Enable for lower two rows
A	¡@	+ve supply input for backlight
K		-ve supply input for backlight

SLLS047H – FEBRUARY 1989 – REVISED FEBRUARY 2002

- Operates With Single 5-V Power Supply
- LinBiCMOS™ Process Technology
- Two Drivers and Two Receivers
- ±30-V Input Levels
- Low Supply Current . . . 8 mA Typical
- Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
- Designed to be Interchangeable With Maxim MAX232
- ESD Protection Exceeds JESD 22
  – 2000-V Human-Body Model (A114-A)
- Applications
  - TIA/EIA-232-F
  - Battery-Powered Systems
  - Terminals
  - Modems
  - Computers
- Package Options Include Plastic Small-Outline (D, DW, NS) Packages and Standard Plastic (N) DIPs

D, DW, N, OR NS PACKAGE
(TOP VIEW)



description

The MAX232 device is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply. Each receiver converts EIA-232 inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V and a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into EIA-232 levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library.

The MAX232 is characterized for operation from 0°C to 70°C. The MAX232I is characterized for operation from –40°C to 85°C.

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES		
	SMALL OUTLINE (D, NS)	SMALL OUTLINE (DW)	PLASTIC DIP (N)
0°C to 70°C	MAX232D MAX232NS	MAX232DW	MAX232N
–40°C to 85°C	MAX232ID	MAX232IDW	MAX232IN

The D and DW packages are available taped and reeled by adding an R to the part number (i.e., MAX232DR). The NS package is only available taped and reeled.

XR-2211

FSK Demodulator/ Tone Decoder

EXAR ...the analog plus company™

June 1997-3

ATURES

Wide Frequency Range, 0.01Hz to 300kHz
Wide Supply Voltage Range, 4.5V to 20V
HCMOS/TTL/Logic Compatibility
FSK Demodulation, with Carrier Detection
Wide Dynamic Range, 10mV to 3V rms
Adjustable Tracking Range, ±1% to 80%
Excellent Temp. Stability, ±50ppm/°C, max.

APPLICATIONS

- Caller Identification Delivery
- FSK Demodulation
- Data Synchronization
- Tone Decoding
- FM Detection
- Carrier Detection

NERAL DESCRIPTION

XR-2211 is a monolithic phase-locked loop (PLL) tem especially designed for data communications lications. It is particularly suited for FSK modem lications. It operates over a wide supply voltage range 1.5 to 20V and a wide frequency range of 0.01Hz to kHz. It can accommodate analog signals between nV and 3V, and can interface with conventional DTL, ., and ECL logic families. The circuit consists of a basic . for tracking an input signal within the pass band, a quadrature phase detector which provides carrier detection, and an FSK voltage comparator which provides FSK demodulation. External components are used to independently set center frequency, bandwidth, and output delay. An internal voltage reference proportional to the power supply is provided at an output pin.

The XR-2211 is available in 14 pin packages specified for military and industrial temperature ranges.

DERING INFORMATION

Part No.	Package	Operating Temperature Range
XR-2211M	14 Pin CDIP (0.300")	-55°C to +125°C
XR-2211N	14 Pin CDIP (0.300")	-40°C to +85°C
XR-2211P	14 Pin PDIP (0.300")	-40°C to +85°C
XR-2211ID	14 Lead SOIC (Jedec, 0.150")	-40°C to +85°C

EXAR Corporation, 48720 Kato Road, Fremont, CA 94538 ◆ (510) 668-7000 ◆ FAX (510) 668-7017

BLOCK DIAGRAM

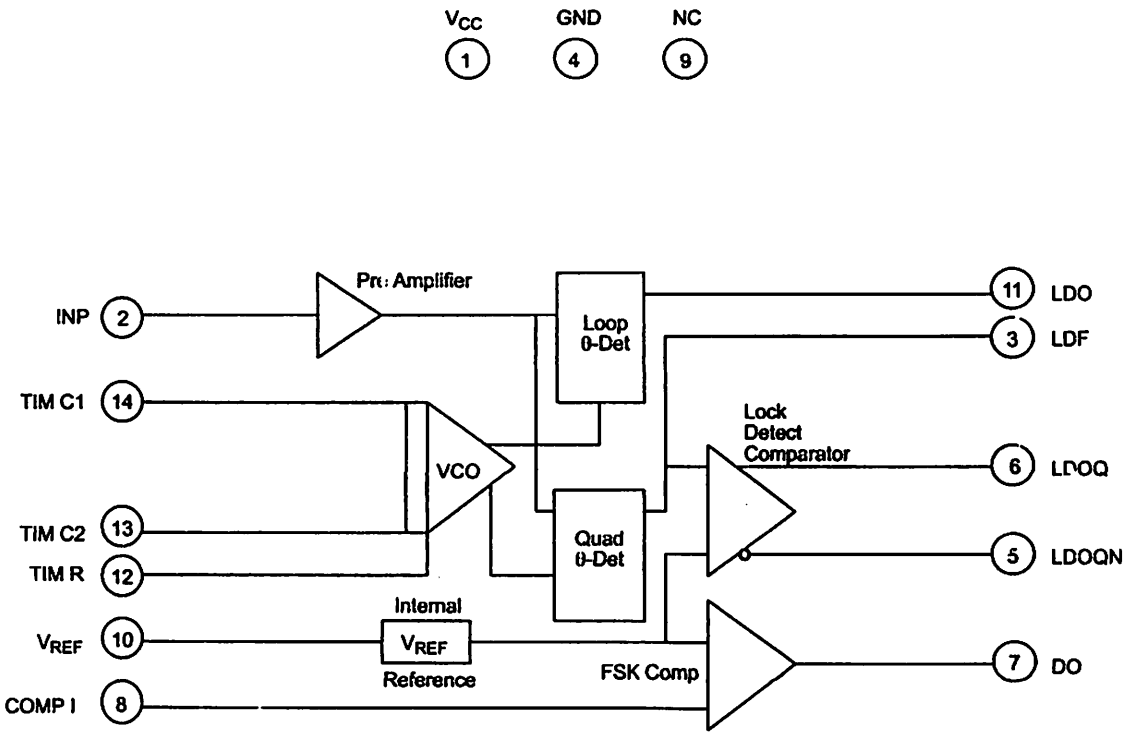
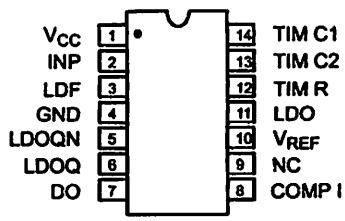
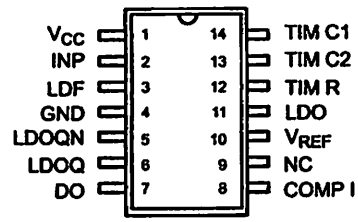


Figure 1. XR-2211 Block Diagram

CONFIGURATION



14 Lead CDIP, PDIP (0.300")



14 Lead SOIC (Jedec, 0.150")

DESCRIPTION

#	Symbol	Type	Description
	V_{CC}		**Positive Power Supply.**
	INP	I	**Receive Analog Input.**
	LDF	O	**Lock Detect Filter.**
	GND		**Ground Pin.**
	LDOQN	O	**Lock Detect Output Not.** This output will be low if the VCO is in the capture range.
	LDOQ	O	**Lock Detect Output.** This output will be high if the VCO is in the capture range.
	DO	O	**Data Output.** Decoded FSK output.
	COMP I	I	**FSK Comparator Input.**
	NC		**Not Connected.**
)	V_{REF}	O	**Internal Voltage Reference.** The value of V_{REF} is $V_{CC}/2$ - 650mV.
	LDO	O	**Loop Detect Output.** This output provides the result of the quadrature phase detection.
2	TIM R	I	**Timing Resistor Input.** This pin connects to the timing resistor of the VCO.
3	TIM C2	I	**Timing Capacitor Input.** The timing capacitor connects between this pin and pin 14.
4	TIM C1	I	**Timing Capacitor Input.** The timing capacitor connects between this pin and pin 13.

CTRICAL CHARACTERISTICS

Conditions: V_{CC} = 12V, T_A = +25°C, R_O = 30KΩ, C_O = 0.033µF, unless otherwise specified.

ımeter	Min.	Typ.	Max.	Unit	Conditions
eral					
ply Voltage	4.5		20	V	
ply Current		4	7	mA	$R_0 \geq$ 10KΩ. See *Figure 4.*
illator Section					
ıuency Accuracy		±1	±3	%	Deviation from $f_O = 1/R_0 C_0$
ıuency Stability					
mperature		±20	±50	ppm/°C	See *Figure 8.*
ower Supply		0.05	0.5	%/V	V_{CC} = 12 ±1V. See *Figure 7.*
		0.2		%/V	V_{CC} = ± 5V. See *Figure 7.*
er Frequency Limit	100	300		kHz	R_0 = 8.2KΩ, C_0 = 400pF
est Practical Operating ıuency			0.01	Hz	R_0 = 2MΩ, C_0 = 50µF
ng Resistor, R_0 - See *ıre 5*					
erating Range	5		2000	KΩ	
commended Range	5			KΩ	See *Figure 7* and *Figure 8.*
p Phase Dectector Section					
k Output Current	±150	±200	±300	µA	Measured at Pin 11
ut Offset Current		1		µA	
ut Impedance		1		MΩ	
imum Swing	±4	± 5		V	Referenced to Pin 10
drature Phase Detector					Measured at Pin 3
k Output Current	100	300		µA	
ut Impedance		1		MΩ	
imum Swing		11		V_{PP}	
t Preampt Section					Measured at Pin 2
t Impedance		20		KΩ	
t Signal					
ltage Required to ause Limiting		2	10	mV rms	

s

meters are guaranteed over the recommended operating conditions, but are not 100% tested in production.
face parameters are covered by production test and guaranteed over operating temperature range.

ELECTRICAL CHARACTERISTICS (CONT'D)

Conditions: V_{CC} = 12V, T_A = +25°C, R_O = 30KΩ, C_O = 0.033µF, unless otherwise specified.

ımeter	Min.	Typ.	Max.	Unit	Conditions
ıge Comparator Section					
t Impedance		2		MΩ	Measured at Pins 3 and 8
t Bias Current		100		nA	
ıge Gain	55	70		dB	R_L = 5.1KΩ
ıut Voltage Low		300	500	mV	I_C = 3mA
ıut Leakage Current		0.01	10	µA	V_O = 20V
rnal Reference					
ıge Level	4.9	5.3	5.7	V	Measured at Pin 10
ıut Impedance		100		Ω	AC Small Signal
imum Source Current		80		µA	

s

neters are guaranteed over the recommended operating conditions, but are not 100% tested in production.
face parameters are covered by production test and guaranteed over operating temperature range.

Specifications are subject to change without notice

OLUTE MAXIMUM RATINGS

ər Supply 20V
: Signal Level ..... 3V rms
ər Dissipation 900mW

Package Power Dissipation Ratings
CDIP 750mW
Derate Above T_A = 25°C ..... 8mW/°C
PDIP 800mW
Derate Above T_A = 25°C ..... 60mW/°C
SOIC 390mW
Derate Above T_A = 25°C ..... 5mW/°C

TEM DESCRIPTION

nain PLL within the XR-2211 is constructed from an preamplifier, analog multiplier used as a phase :tor and a precision voltage controlled oscillator)). The preamplifier is used as a limiter such that signals above typically 10mV rms are amplified to a tant high level signal. The multiplying-type phase :tor acts as a digital exclusive or gate. Its output te:ed) produces sum and difference frequencies of ıput and the VCO output. The VCO is actually a nt controlled oscillator with its normal input current et by a resistor (R_0) to ground and its driving current a resistor (R_1) from the phase detector.

output of the phase detector produces sum and ence of the input and the VCO frequencies (internally connected). When in lock, these frequencies are f_{IN}+ f_{VCO} (2 times f_{IN} when in lock) and f_{IN} - f_{VCO} (0Hz when lock). By adding a capacitor to the phase detector output, the 2 times f_{IN} component is reduced, leaving a DC voltage that represents the phase difference between the two frequencies. This closes the loop and allows the VCO to track the input frequency.

The FSK comparator is used to determine if the VCO is driven above or below the center frequency (FSK comparator). This will produce both active high and active low outputs to indicate when the main PLL is in lock (quadrature phase detector and lock detector comparator).

INCIPLES OF OPERATION

nal Input (Pin 2): Signal is AC coupled to this ninal. The internal impedance at pin 2 is 20KΩ. commended input signal level is in the range of 10mV to 3V rms.

adrature Phase Detector Output (Pin 3): This is the n impedance output of quadrature phase detector and ternally connected to the input of lock detect voltage nparator. In tone detection applications, pin 3 is nected to ground through a parallel combination of R_D C_D (see *Figure 3*) to eliminate the chatter at lock ect outputs. If the tone detect section is not used, pin 3 be left open.

k Detect Output, Q (Pin 6): The output at pin 6 is at " state when the PLL is out of lock and goes to "high" e when the PLL is locked. It is an open collector type put and requires a pull-up resistor, R_L, to V_{CC} for per operation. At "low" state, it can sink up to 5mA of current.

k Detect Complement, (Pin 5): The output at pin 5 is logic complement of the lock detect output at pin 6. output is also an open collector type stage which can 5mA of load current at low or "on" state.

Data Output (Pin 7): This output is an open collector stage which requires a pull-up resistor, R_L, to V_{CC} for per operation. It can sink 5mA of load current. When oding FSK signals, FSK data output is at "high" or "off" for low input frequency, and at "low" or "on" state for input frequency. If no input signal is present, the logic at pin 7 is indeterminate.

Comparator Input (Pin 8): This is the high edance input to the FSK voltage comparator. mally, an FSK post-detection or data filter is nected between this terminal and the PLL phase ector output (pin 11). This data filter is formed by R_F C_F (see *Figure 3.*) The threshold voltage of the parator is set by the internal reference voltage, V_{REF}, ilable at pin 10.

erence Voltage, V_{REF} (Pin 10): This pin is internally ed at the reference voltage level, V_{REF}: $V_{REF} = V_{CC}/2$ 0mV. The DC voltage level at this pin forms an internal rence for the voltage levels at pins 5, 8, 11 and 12. Pin 10 must be bypassed to ground with a 0.1µF capacitor for proper operation of the circuit.

Loop Phase Detector Output (Pin 11): This terminal provides a high impedance output for the loop phase detector. The PLL loop filter is formed by R_1 and C_1 connected to pin 11 (see *Figure 3.*) With no input signal, or with no phase error within the PLL, the DC level at pin 11 is very nearly equal to V_{REF}. The peak to peak voltage swing available at the phase detector output is equal to 2 x V_{REF}.

VCO Control Input (Pin 12): VCO free-running frequency is determined by external timing resistor, R_0, connected from this terminal to ground. The VCO free-running frequency, f_O, is:

$$f_O = \frac{1}{R_0 \cdot C_0} \; Hz$$

where C_0 is the timing capacitor across pins 13 and 14. For optimum temperature stability, R_0 must be in the range of 10KΩ to 100KΩ (see *Figure 9.*)

This terminal is a low impedance point, and is internally biased at a DC level equal to V_{REF}. The maximum timing current drawn from pin 12 must be limited to ≤ 3mA for proper operation of the circuit.

VCO Timing Capacitor (Pins 13 and 14): VCO frequency is inversely proportional to the external timing capacitor, C_0, connected across these terminals (see *Figure 6.*) C_0 must be non-polar, and in the range of 200pF to 10µF.

VCO Frequency Adjustment: VCO can be fine-tuned by connecting a potentiometer, R_X, in series with R_0 at pin 12 (see *Figure 10.*)

VCO Free-Running Frequency, f_O: XR-2211 does not have a separate VCO output terminal. Instead, the VCO outputs are internally connected to the phase detector sections of the circuit. For set-up or adjustment purposes, the VCO free-running frequency can be tuned by using the generalized circuit in *Figure 3*, and applying an alternating bit pattern of 0's and 1's at the known mark and space frequencies. By adjusting R_0, the VCO can then be tuned to obtain a 50% duty cycle on the FSK output (pin 7). This will ensure that the VCO f_O value is accurately referenced to the mark and space frequencies.

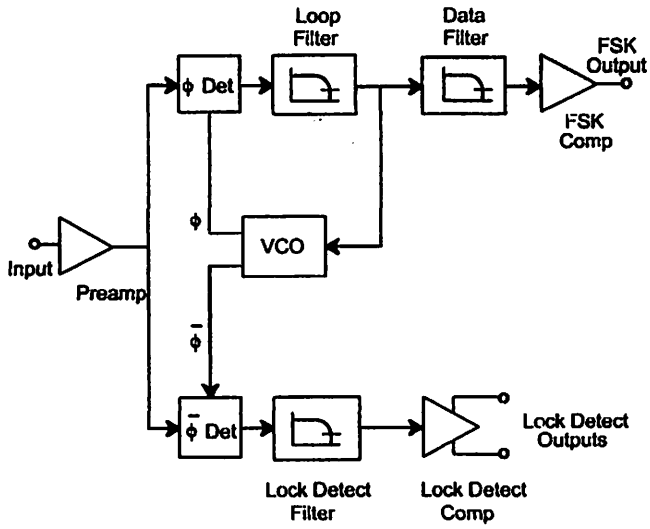


Figure 2. Functional Block Diagram of a Tone and FSK Decoding System Using XR-2211

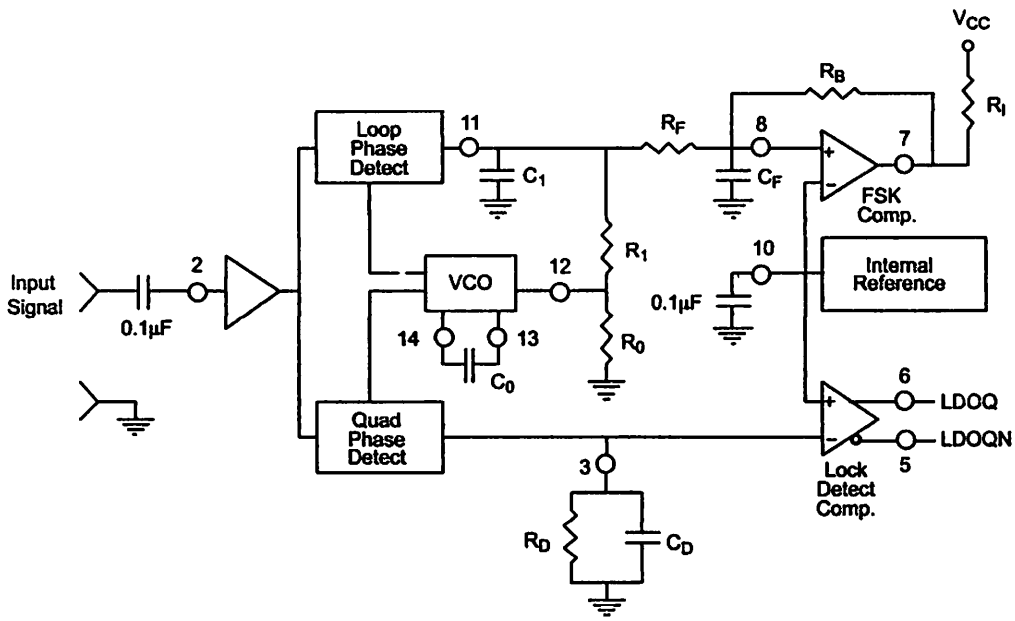


Figure 3. Generalized Circuit Connection for FSK and Tone Detection

SIGN EQUATIONS

resistance in Ω, all frequency in Hz and all capacitance in farads, unless otherwise specified)

e *Figure 3* for definition of components)

VCO Center Frequency, f_O:

$$f_O = \frac{1}{R_0 \cdot C_0}$$

Internal Reference Voltage, V_{REF} (measured at pin 10):

$$V_{REF} = \left(\frac{V_{CC}}{2}\right) - 650mV \text{ in volts}$$

Loop Low-Pass Filter Time Constant, τ:

$$\tau = C_1 \cdot R_{PP} \text{ (seconds)}$$

ere:

$$R_{PP} = \left(\frac{R_1 \cdot R_F}{R_1 + R_F}\right)$$

$_F$ is ∞ or C_F reactance is ∞, then R_{PP} = R1

Loop Damping, ς:

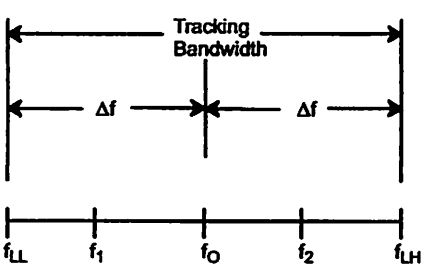
$$\zeta = \sqrt{\left(\frac{1250 \cdot C_0}{R_1 \cdot C_1}\right)}$$

e: For derivation/explanation of this equation, please see TAN-011.

Loop-tracking

idwidth, $\pm = \frac{\Delta f}{f_0}$

$\frac{\Delta f}{f_0} = \frac{R_0}{R_1}$



FSK Data filter time constant, tF:

$$\tau_F = \frac{R_B \cdot R_F}{(R_B + R_F)} \cdot C_F \ (seconds)$$

Loop phase detector conversion gain, Kd: (Kd is the differential DC voltage across pin 10 and pin11, per unit of phase error at phase detector input):

$$K_d = \frac{V_{REF} \cdot R_1}{10,000 \cdot \pi} \left[\frac{volt}{radian}\right]$$

e: *For derivation/explanation of this equation, please see TAN-011.*

VCO conversion gain, Ko: (Ko is the amount of change in VCO frequency, per unit of DC voltage change at pin 11):

$$K_0 = \frac{-2\pi}{V_{REF} \cdot C_0 \cdot R_1} = \left(\frac{radian/second}{volt}\right)$$

The filter transfer function:

$$F(s) = \frac{1}{1 + SR_1 \cdot C_1} \ at\ 0\ Hz. \qquad S = J\omega \ and \ \omega = 0$$

Total loop gain. K_T:

$$K_T = K_O \cdot K_d \cdot F(s) = \left(\frac{R_F}{5,000 \cdot C_0 \cdot (R_1 + R_F)}\right)\left[\frac{1}{seconds}\right]$$

Peak detector current I_A:

$$I_A = \frac{V_{REF}}{20,000} \ (V_{REF} \ in \ volts \ and \ I_A \ in \ amps)$$

e: *For derivation/explanation of this equation, please see TAN-011.*

PLICATIONS INFORMATION

Decoding

ure 10 shows the basic circuit connection for FSK decoding. With reference to *Figure 3* and *Figure 10*, the functions xternal components are defined as follows: R_0 and C_0 set the PLL center frequency, R_1 sets the system bandwidth, C_1 sets the loop filter time constant and the loop damping factor. C_F and R_F form a one-pole post-detection filter for FSK data output. The resistor R_B from pin 7 to pin 8 introduces positive feedback across the FSK comparator to ilitate rapid transition between output logic states.

ign Instructions:

circuit of *Figure 10* can be tailored for any FSK decoding application by the choice of five key circuit components: R_0, C_0, C_1 and C_F. For a given set of FSK mark and space frequencies, f_O and f_1, these parameters can be calculated as ws:

resistance in Ω's, all frequency in Hz and all capacitance in farads, unless otherwise specified)

Calculate PLL center frequency, f_O:

$$f_o = \sqrt{F_1 \cdot F_2}$$

Choose value of timing resistor R_0, to be in the range of 10KΩ to 100KΩ. This choice is arbitrary. The recommended value is R_0 = 20KΩ. The final value of R_0 is normally fine-tuned with the series potentiometer, R_X.

$$R_o = R_o + \frac{R_x}{2}$$

Calculate value of C0 from design equation (1) or from *Figure 7*:

$$C_o = \frac{1}{R_0 \cdot f_0}$$

Calculate R1 to give the desired tracking bandwidth (See design equation 5).

$$R_1 = \frac{R_0 \cdot f_0}{(f_1 - f_2)} \cdot 2$$

Calculate C1 to set loop damping. (See design equation 4):

Normally, $\varsigma = 0.5$ is recommended.

$$C_1 = \frac{1250 \cdot C_0}{R_1 \cdot \varsigma^2}$$

The input to the XR-2211 may sometimes be too sensitive to noise conditions on the input line. *Figure 4* illustrates a method of de-sensitizing the XR-2211 from such noisy line conditions by the use of a resistor, Rx, connected from pin 2 to ground. The value of Rx is chosen by the equation and the desired minimum signal threshold level.

$$V_{IN}\ minimum\ (peak) = V_a - V_b = \Delta V \pm 2.8mV\ offset = V_{REF}\frac{20,000}{(20,000 + R_X)}\ \ or\ R_X = 20,000\left(\frac{V_{REF}}{\Delta V} - 1\right)$$

minimum (peak) input voltage must exceed this value to be detected (equivalent to adjusting V threshold)

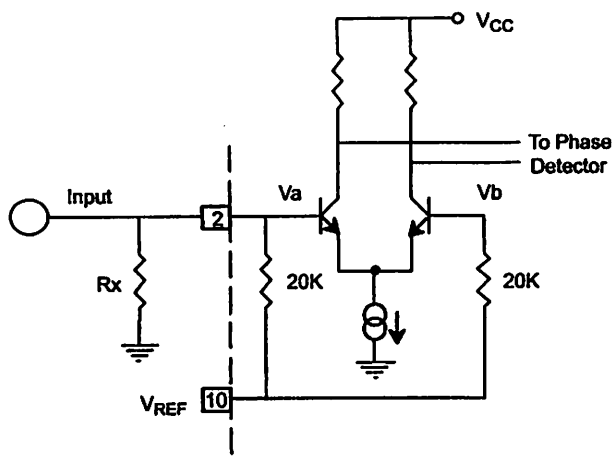


Figure 4. Desensitizing Input Stage

Calculate Data Filter Capacitance, C_F:

$$R_{sum} = \frac{(R_F + R_1)\cdot R_B}{(R_1 + R_F + R_B)}$$

$$C_F = \frac{0.25}{(R_{sum}\cdot Baud\ Rate)} \qquad Baud\ rate\ in\ \frac{1}{seconds}$$

: All values except R_0 can be rounded to nearest standard value.

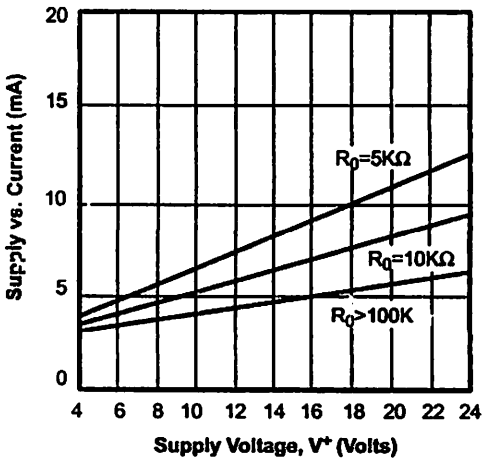


Figure 5. Typical Supply Current vs. V+ (Logic Outputs Open Circuited)

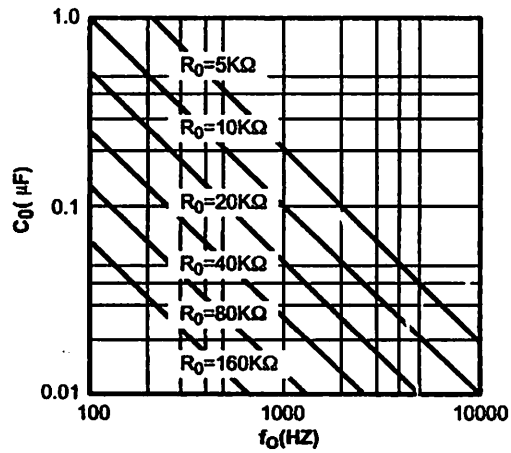


Figure 6. VCO Frequency vs. Timing Resistor

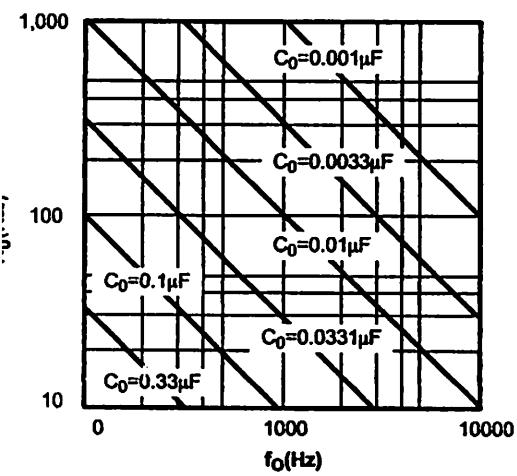


Figure 7. VCO Frequency vs. Timing Capacitor

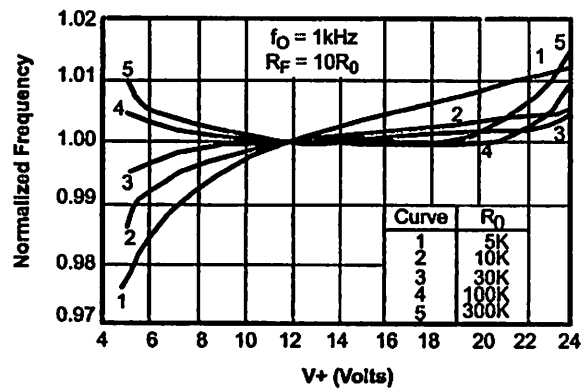


Figure 8. Typical f_O vs. Power Supply Characteristics

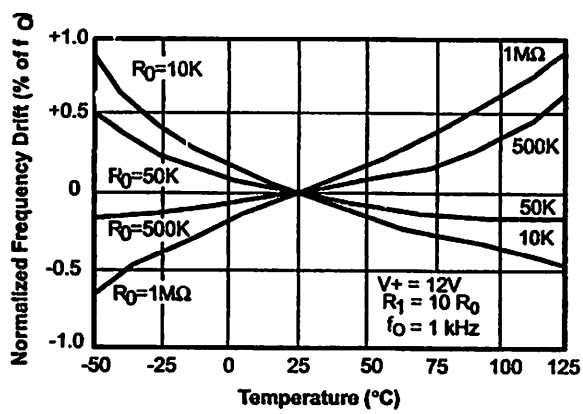


Figure 9. Typical Center Frequency Drift vs. Temperature

ign Example:

Baud FSK demodulator with mark and space frequencies of 1200/2200.

1: Calculate f_O: from design instructions

(a) $f_o = \sqrt{1200 \cdot 2200} = 1624$

2: Calculate R_0 : R_0 =10K with a potentiometer of 10K. (See design instructions (b))

(b) $R_T = 10 + \left(\frac{10}{2}\right) = 15K$

3: Calculate C_0 from design instructions

(c) $C_O = \frac{1}{15000 \cdot 1624} = 39nF$

4: Calculate R_1 : from design instructions

(d) $R_1 = \frac{20000 \cdot 1624 \cdot 2}{(2200-1200)} = 51,000$

5: Calculate C_1 : from design instructions

(e) $C_1 = \frac{1250 \cdot 39nF}{51000 \cdot 0.5^2} = 3.9nF$

6: Calculate R_F : R_F should be at least five times R_1, R_F = 51,000·5 = 255 KΩ

7: Calculate R_B : R_B should be at least five times R_F, R_B = 255,000·5 = 1.2 MΩ

8: Calculate R_{SUM} :

$$R_{SUM} = \frac{(R_F + R_1) \cdot R_B}{(R_F + R_1 + R_B)} = 240K\Omega$$

9: Calculate C_F :

$$C_F = \frac{0.25}{(R_{SUM} \cdot Baud\ Rate)} = 1nF$$

: All values except R_0 can be rounded to nearest standard value.

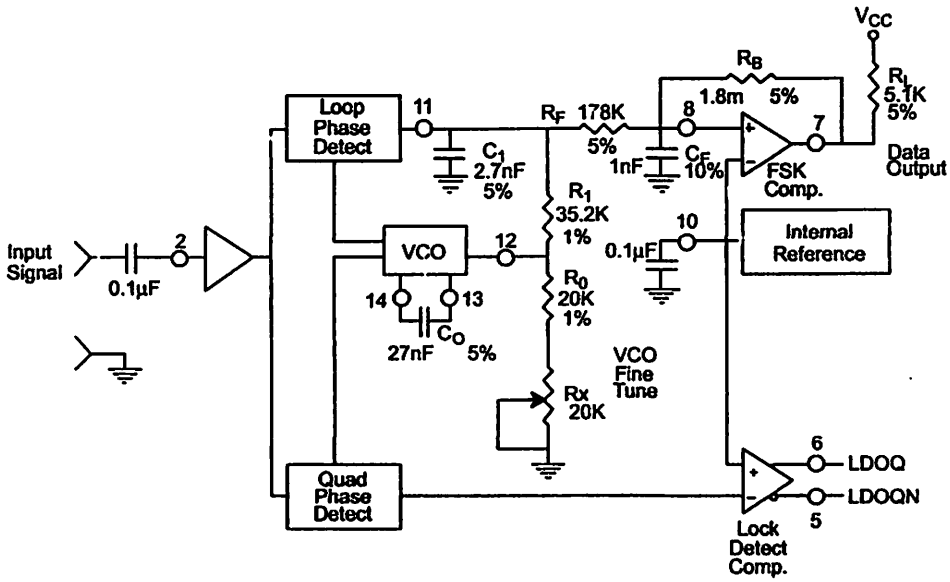


Figure 10. Circuit Connection for FSK Decoding of Caller Identification Signals (Bell 202 Format)

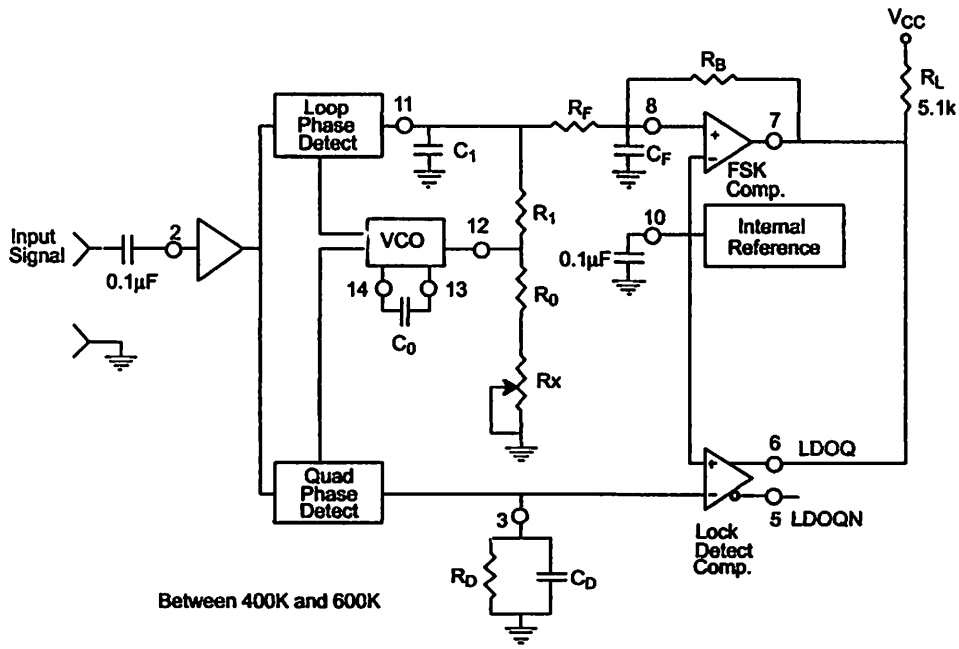


Figure 11. External Connectors for FSK Demodulation with Carrier Detect Capability

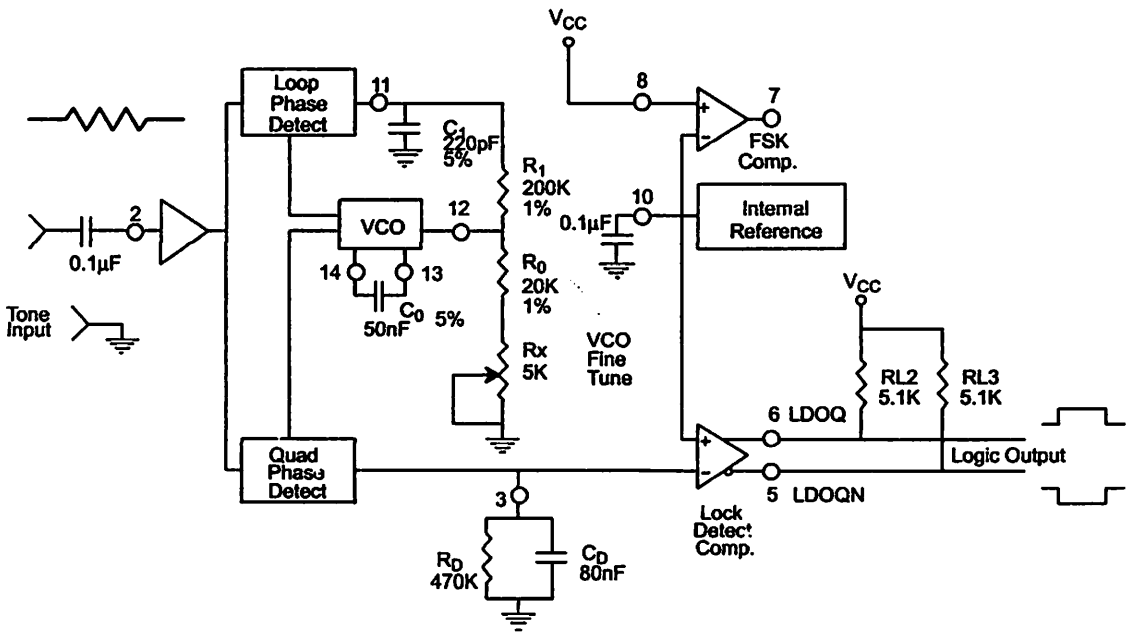


Figure 12. Circuit Connection for Tone Detection

Decoding with Carrier Detect

ock detect section of XR-2211 can be used as a ır detect option for FSK decoding. The ımended circuit connection for this application is n in *Figure 11*. The open collector lock detect output, is shorted to data output (pin 7). Thus, data output ɜ disabled at "low" state, until there is a carrier within ɜtectiorı band of the PLL and the pin 6 output goes ' to enable the data output.

Data Output is "Low" When No Carrier is Present.

ninimum value of the lock detect filter capacitance inversely proportional to the capture range, ±Δfc. s the range of incoming frequencies over which the ɜan acquire lock and is always less than the tracking ɜ. It is further limited by C_1. For most applications, Δfc ɜ. For R_D = 470KΩ, the approximate minimum value can be determined by:

$$C_D > \frac{16}{\Delta f} \quad C \text{ in } \mu F \text{ and } f \text{ in Hz.}$$

in µF and f in Hz.

values of C_D that are too small, chatter can be ved on the lock detect output as an incoming signal frequency approaches the capture bandwidth. Excessively large values of C_D will slow the response time of the lock detect output. For Caller I.D. applications choose C_D = 0.1µF.

Tone Detection

Figure 12 shows the generalized circuit connection for tone detection. The logic outputs, LDOQN and LDOQ at pins 5 and 6 are normally at "high" and "low" logic states, respectively. When a tone is present within the detection band of the PLL, the logic state at these outputs become reversed for the duration of the input tone. Each logic output can sink 5mA of load current.

Both outputs at pins 5 and 6 are open collector type stages, and require external pull-up resistors R_{L2} and R_{L3}, as shown in *Figure 12*.

With reference to *Figure 3* and *Figure 12*, the functions of the external circuit components can be explained as follows: R_0 and C_0 set VCO center frequency; R_1 sets the detection bandwidth; C_1 sets the low pass-loop filter time constant and the loop damping factor.

gn Instructions:

ircuit of *Figure 12* can be optimized for any tone detection application by the choice of the 5 key circuit components: $_1$, C_0, C_1 and C_D. For a given input, the tone frequency, f_S, these parameters are calculated as follows:

esistance in Ω's, all frequency in Hz and all capacitance in farads, unless otherwise specified)

hoose value of timing resistor R_0 to be in the range of 10KΩ to 50KΩ. This choice is dictated by the max./min. urrent that the internal voltage reference can deliver. The recommended value is R_0 = 20KΩ. The final value of R_0 s normally fine-tuned with the series potentiometer, R_X.

alculate value of C_0 from design equation (1) or from *Figure 7* $f_S = f_O$:

$$C_o = \frac{1}{R_0 \cdot fs}$$

alculate R_1 to set the bandwidth ±Δf (See design equation 5):

$$R_1 = \frac{R_0 \cdot f_0 \cdot 2}{\Delta f}$$

The total detection bandwidth covers the frequency range of $f_O \pm \Delta f$

alculate value of C_1 for a given loop damping factor:

lormally, $\varsigma = 0.5$ is recommended.

$$C_1 = \frac{1250 \cdot C_0}{R_1 \cdot \varsigma^2}$$

ncreasing C_1 improves the out-of-band signal rejection, but increases the PLL capture time.

alculate value of the filter capacitor C_D . To avoid chatter at the logic output, with R_D = 470KΩ, C_D must be:

$$C_D > \frac{16}{\Delta f} \quad C \text{ in } \mu F$$

ncreasing C_D slows down the logic output response time.

gn Examples:

detector with a detection band of ± 100Hz:

hoose value of timing resistor R_0 to be in the range of 10KΩ to 50KΩ. This choice is dictated by the max./min. urrent that the internal voltage reference can deliver. The recommended value is R_0 = 20 KΩ. The final value of R_0 s normally fine-tuned with the series potentiometer, R_X.

alculate value of C_0 from design equation (1) or from *Figure 6* $f_S = f_O$:

$$C_0 = \frac{1}{R_0 \cdot f_s} = \frac{1}{20,000 \cdot 1,000} = 50nF$$

Calculate R_1 to set the bandwidth $\pm\Delta f$ (See design equation 5):

$$R_1 = \frac{R_0 \cdot f_O \cdot 2}{\Delta f} = \frac{20,000 \cdot 1,000 \cdot 2}{100} = 400K$$

The total detection bandwidth covers the frequency range of $f_O \pm \Delta f$

Calculate value of C_0 for a given loop damping factor:

Normally, $\varsigma = 0.5$ is recommended.

$$C_1 = \frac{1250 \cdot C_0}{R_1 \cdot \varsigma^2} = \frac{1250 \cdot 50 \cdot 10^{-6}}{400,000 \cdot 0.5^2} = 6.25pF$$

Increasing C_1 improves the out-of-band signal rejection, but increases the PLL capture time.

Calculate value of the filter capacitor C_D . To avoid chatter at the logic output, with R_D = 470KΩ, C_D must be:

$$C_D = \frac{16}{\Delta f} \geq \frac{16}{200} \geq 80nF$$

Increasing C_D slows down the logic output response time.

Fine tune center frequency with 5KΩ potentiometer, R_X.

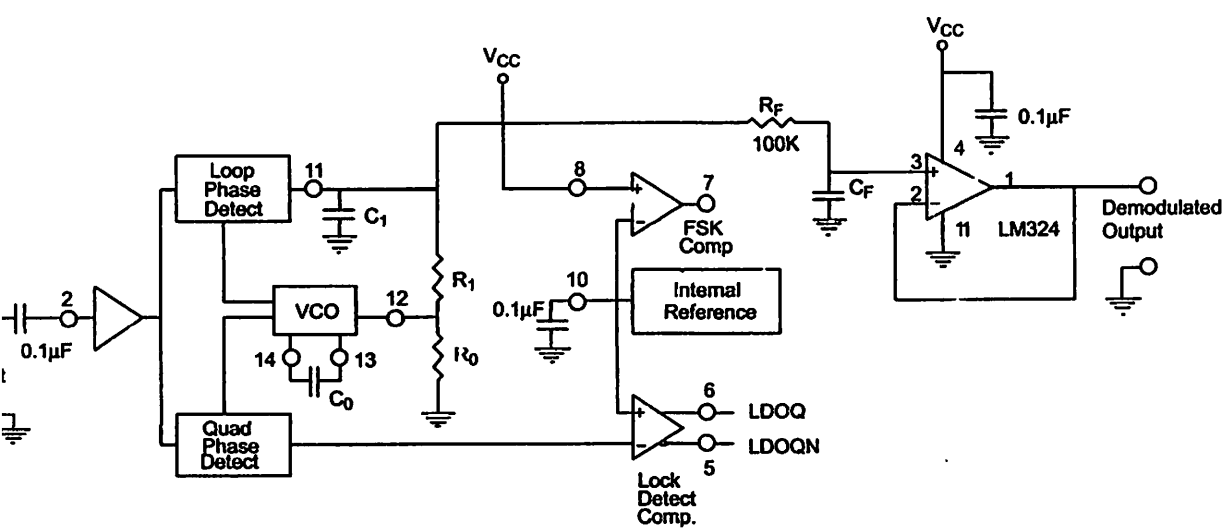


Figure 13. Linear FM Detector Using XR-2211 and an External Op Amp. (See Section on Design Equation for Component Values.)

ır FM Detection

211 can be used as a linear FM detector for a wide of analog communications and telemetry ations. The recommended circuit connection for pplication is shown in *Figure 13*. The demodulated t is taken from the loop phase detector output (pin rough a post-detection filter made up of R_F and C_F, n external buffer amplifier. This buffer amplifier is sary because of the high impedance output at pin rmally, a non-inverting unity gain op amp can be as a buffer amplifier, as shown in *Figure 13*.

The FM detector gain, i.e., the output voltage change per unit of FM deviation can be given as:

$$V_{OUT} = \frac{R_1 \cdot V_{REF}}{100 \cdot R_0}$$

where VR is the internal reference voltage ($V_{REF} = V_{CC}/2 - 650mV$). For the choice of external components R_1, R_0, C_D, C_1 and C_F, see the section on design equations.

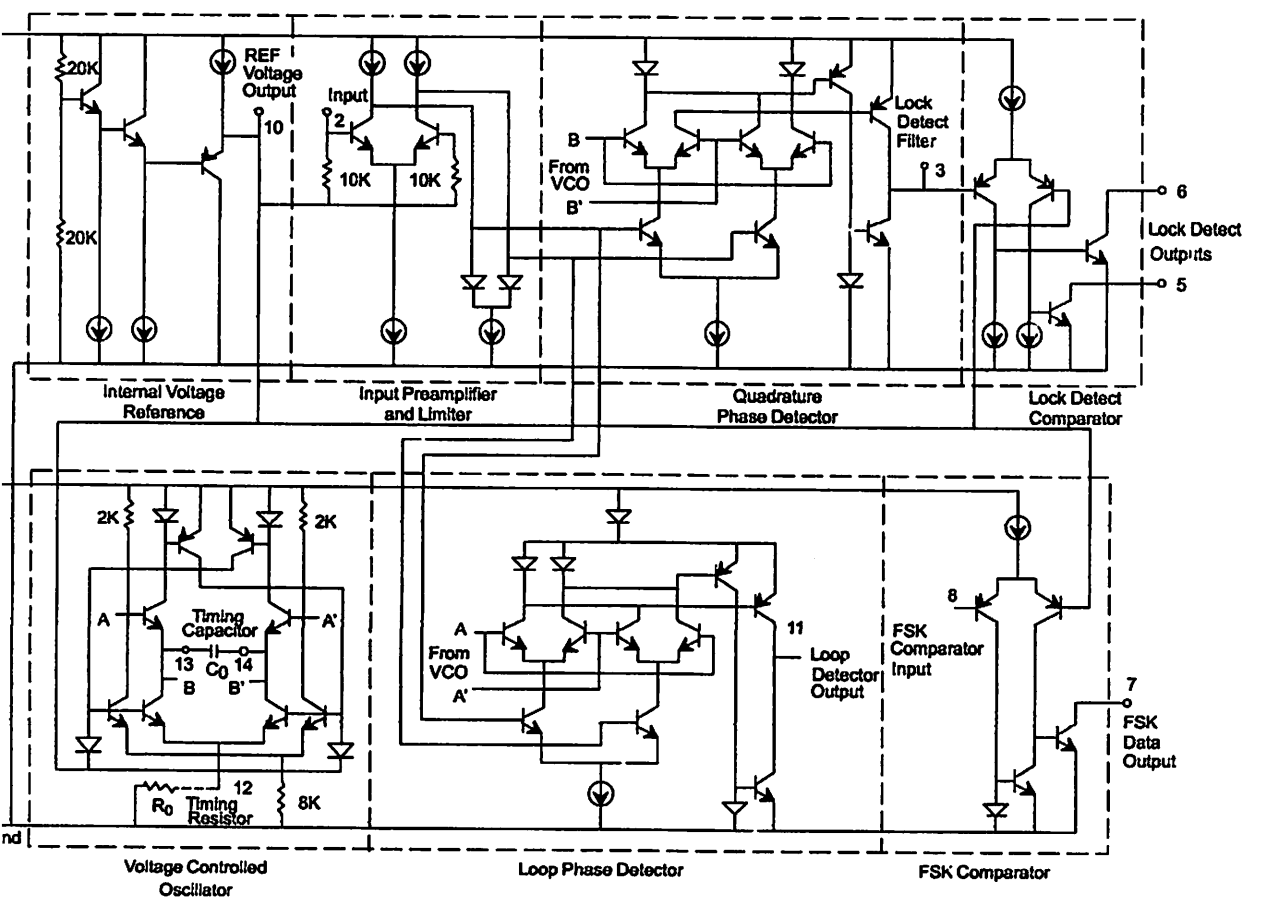
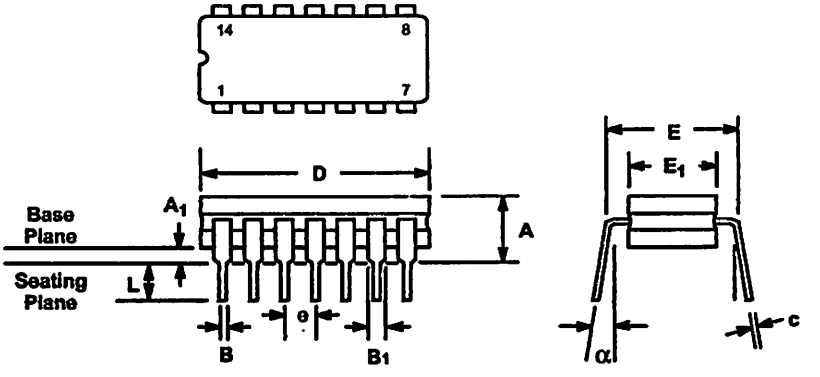


Figure 14. Equivalent Schematic Diagram

14 LEAD CERAMIC DUAL-IN-LINE (300 MIL CDIP)

Rev. 1.00

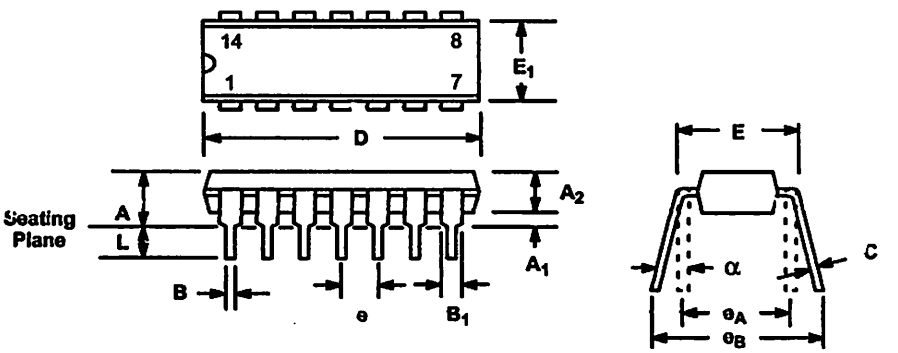


SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.100	0.200	2.54	5.08
A_1	0.015	0.060	0.38	1.52
B	0.014	0.026	0.36	0.66
B_1	0.045	0.065	1.14	1.65
c	0.008	0.018	0.20	0.46
D	0.685	0.785	17.40	19.94
E_1	0.250	0.310	6.35	7.87
E	0.300 BSC		7.62 BSC	
e	0.100 BSC		2.54 BSC	
L	0.125	0.200	3.18	5.08
α	0°	15°	0°	15°

Note: The control dimension is the inch column

14 LEAD PLASTIC DUAL-IN-LINE (300 MIL PDIP)

Rev. 1.00

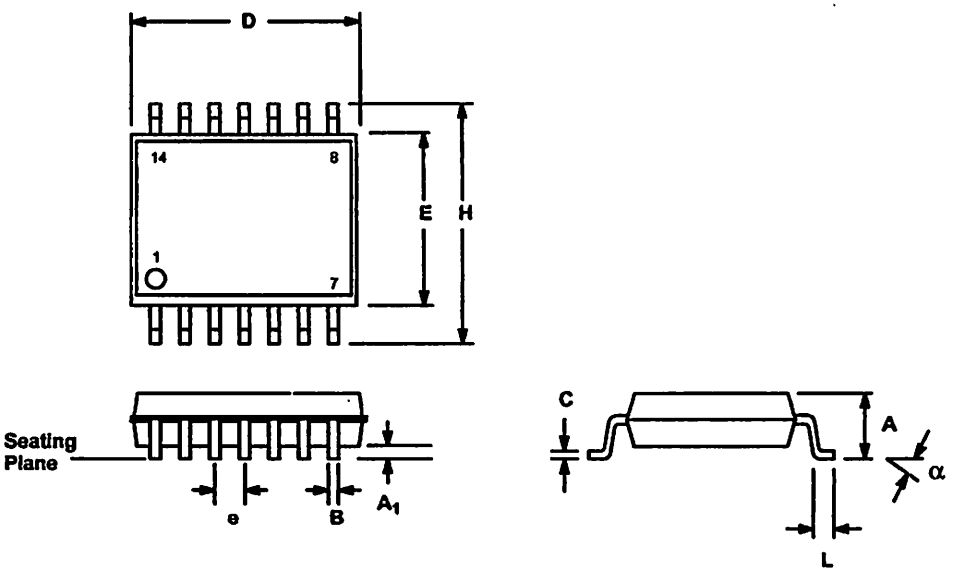


SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.145	0.210	3.68	5.33
A_1	0.015	0.070	0.38	1.78
A_2	0.115	0.195	2.92	4.95
B	0.014	0.024	0.36	0.56
B_1	0.030	0.070	0.76	1.78
C	0.008	0.014	0.20	0.38
D	0.725	0.795	18.42	20.19
E	0.300	0.325	7.62	8.26
E_1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
e_A	0.300 BSC		7.62 BSC	
e_B	0.310	0.430	7.87	10.92
L	0.115	0.160	2.92	4.06
α	0°	15°	0°	15°

Note: The control dimension is the inch column

14 LEAD SMALL OUTLINE (150 MIL JEDEC SOIC)

Rev. 1.00



SYMBOL	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.053	0.069	1.35	1.75
A_1	0.004	0.010	0.10	0.25
B	0.013	0.020	0.33	0.51
C	0.007	0.010	0.19	0.25
D	0.337	0.344	8.55	8.75
E	0.150	0.157	3.80	4.00
e	0.050 BSC		1.27 BSC	
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27
α	0°	8°	0°	8°

Note: The control dimension is the millimeter column

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)atasheet June 1997

FAIRCHILD SEMICONDUCTOR™

October 1987
Revised January 1999

MM74C922 • MM74C923
16-Key Encoder • 20-Key Encoder

General Description

The MM74C922 and MM74C923 CMOS key encoders provide all the necessary logic to fully encode an array of SPST switches. The keyboard scan can be implemented by either an external clock or external capacitor. These encoders also have on-chip pull-up devices which permit switches with up to 50 kΩ on resistance to be used. No diodes in the switch array are needed to eliminate ghost switches. The internal debounce circuit needs only a single external capacitor and can be defeated by omitting the capacitor. A Data Available output goes to a high level when a valid keyboard entry has been made. The Data Available output returns to a low level when the entered key is released, even if another key is depressed. The Data Available will return high to indicate acceptance of the new key after a normal debounce period; this two-key roll-over is provided between any two switches.

An internal register remembers the last key pressed even after the key is released. The 3-STATE outputs provide for easy expansion and bus operation and are LPTTL compatible.

Features

- 50 kΩ maximum switch on resistance
- On or off chip clock
- On-chip row pull-up devices
- 2 key roll-over
- Keybounce elimination with single capacitor
- Last key register at outputs
- 3-STATE output LPTTL compatible
- Wide supply range: 3V to 15V
- Low power consumption

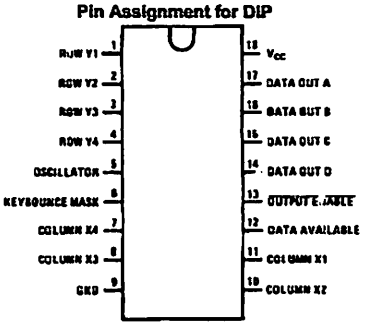
Ordering Code:

Order Number	Package Number	Package Description
MM74C922N	N18A	18-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
MM74C922WM	M20B	20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
MM74C923WM	M20B	20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
MM74C923N	N20A	20-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

Device also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

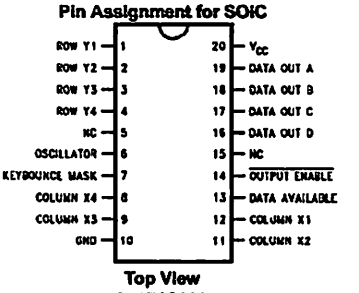
Connection Diagrams

Pin Assignment for DIP



Top View
MM94C922

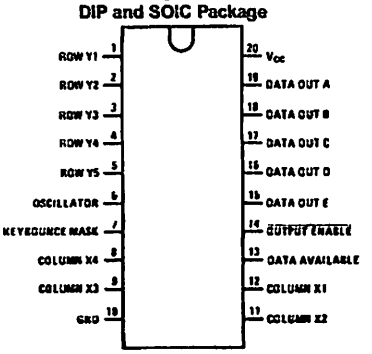
Pin Assignment for SOIC



Top View
MM74C922

Connection Diagrams (Continued)

Pin Assignment for
DIP and SOIC Package



Top View
MM74C923

Truth Tables

(Pins 0 through 11)

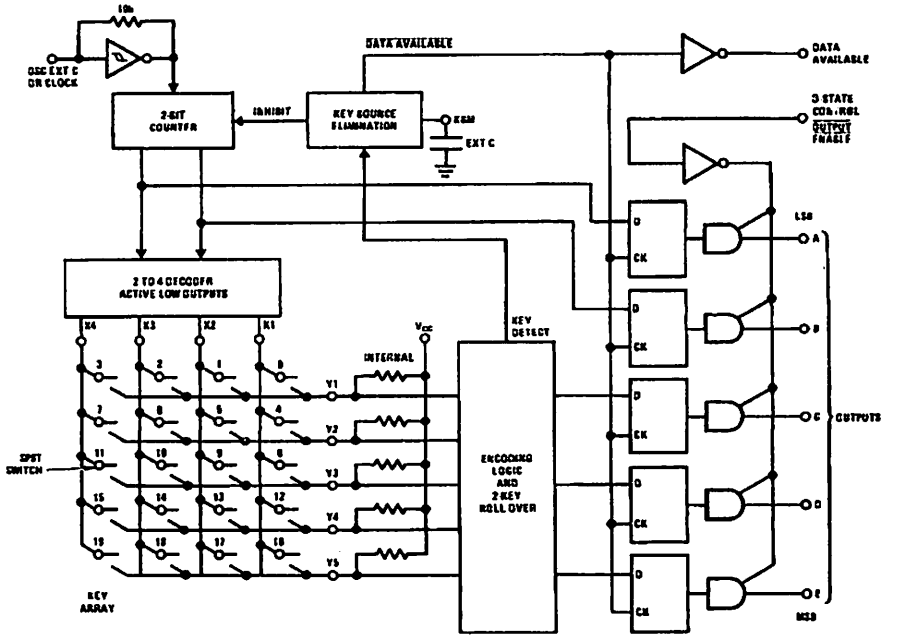
Switch Position		0 Y1,X1	1 Y1,X2	2 Y1,X3	3 Y1,X4	4 Y2,X1	5 Y2,X2	6 Y2,X3	7 Y2,X4	8 Y3,X1	9 Y3,X2	10 Y3,X3	11 Y3,X4
D													
A	A	0	1	0	1	0	1	0	1	0	1	0	1
T	B	0	0	1	1	0	0	1	1	0	0	1	1
A	C	0	0	0	0	1	1	1	1	0	0	0	0
O	D	0	0	0	0	0	0	0	0	1	1	1	1
U	E (Note 1)	0	0	0	0	0	0	0	0	0	0	0	0
T													

(Pins 12 through 19)

Switch Position		12 Y4,X1	13 Y4,X2	14 Y4,X3	15 Y4,X4	16 Y5(Note 1), X1	17 Y5 (Note 1), X2	18 Y5 (Note 1), X3	19 Y5 (Note 1), X4
D									
A	A	0	1	0	1	0	1	0	1
T	B	0	0	1	1	0	0	1	1
A	C	1	1	1	1	0	0	0	0
O	D	1	1	1	1	0	0	0	0
U	E (Note 1)	0	0	0	0	1	1	1	1
T									

Note 1: Omit for MM74C922

Block Diagram



Absolute Maximum Ratings (Note 2)

Voltage at Any Pin	V_{CC} − 0.3V to V_{CC} + 0.3V
Operating Temperature Range	
MM74C922, MM74C923	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Power Dissipation (P_D)	
Dual-In-Line	700 mW
Small Outline	500 mW
Operating V_{CC} Range	3V to 15V
V_{CC}	18V
Lead Temperature	
(Soldering, 10 seconds)	260°C

Note 2: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

DC Electrical Characteristics

Min/Max limits apply across temperature range unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
CMOS TO CMOS						
V_{T+}	Positive-Going Threshold Voltage at Osc and KBM Inputs	V_{CC} = 5V, I_{IN} ≥ 0.7 mA	3.0	3.6	4.3	V
		V_{CC} = 10V, I_{IN} ≥ 1.4 mA	6.0	6.8	8.6	V
		V_{CC} = 15V, I_{IN} ≥ 2.1 mA	9.0	10	12.9	V
V_{T-}	Negative-Going Threshold Voltage at Osc and KBM Inputs	V_{CC} = 5V, I_{IN} ≥ 0.7 mA	0.7	1.4	2.0	V
		V_{CC} = 10V, I_{IN} ≥ 1.4 mA	1.4	3.2	4.0	V
		V_{CC} = 15V, I_{IN} ≥ 2.1 mA	2.1	5	6.0	V
$V_{IN(1)}$	Logical "1" Input Voltage, Except Osc and KBM Inputs	V_{CC} = 5V	3.5	4.5		V
		V_{CC} = 10V	8.0	9		V
		V_{CC} = 15V	12.5	13.5		V
$V_{IN(0)}$	Logical "0" Input Voltage, Except Osc and KBM Inputs	V_{CC} = 5V		0.5	1.5	V
		V_{CC} = 10V		1	2	V
		V_{CC} = 15V		1.5	2.5	V
I_{rp}	Row Pull-Up Current at Y1, Y2, Y3, Y4 and Y5 Inputs	V_{CC} = 5V, V_{IN} = 0.1 V_{CC}		−2	−5	μA
		V_{CC} = 10V		−10	−20	μA
		V_{CC} = 15V		−22	−45	μA
$V_{OUT(1)}$	Logical "1" Output Voltage	V_{CC} = 5V, I_O = −10 μA	4.5			V
		V_{CC} = 10V, I_O = −10 μA	9			V
		V_{CC} = 15V, I_O = −10 μA	13.5			V
$V_{OUT(0)}$	Logical "0" Output Voltage	V_{CC} = 5V, I_O = 10 μA			0.5	V
		V_{CC} = 10V, I_O = 10 μA			1	V
		V_{CC} = 15V, I_O = 10 μA			1.5	V
R_{on}	Column "ON" Resistance at X1, X2, X3 and X4 Outputs	V_{CC} = 5V, V_O = 0.5V		500	1400	Ω
		V_{CC} = 10V, V_O = 1V		300	700	Ω
		V_{CC} = 15V, V_O = 1.5V		200	500	Ω
I_{CC}	Supply Current Osc at 0V, (one Y low)	V_{CC} = 5V		0.55	1.1	mA
		V_{CC} = 10V		1.1	1.9	mA
		V_{CC} = 15V		1.7	2.6	mA
$I_{IN(1)}$	Logical "1" Input Current at $\overline{\text{Output Enable}}$	V_{CC} = 15V, V_{IN} = 15V		0.005	1.0	μA
$I_{IN(0)}$	Logical "0" Input Current at $\overline{\text{Output Enable}}$	V_{CC} = 15V, V_{IN} = 0V	−1.0	−0.005		μA
CMOS/LPTTL INTERFACE						
$V_{IN(1)}$	Except Osc and KBM Inputs	V_{CC} = 4.75V	V_{CC} − 1.5			V
$V_{IN(0)}$	Except Osc and KBM Inputs	V_{CC} = 4.75V			0.8	V
$V_{OUT(1)}$	Logical "1" Output Voltage	I_O = −360 μA, V_{CC} = 4.75V, I_O = −360 μA	2.4			V
$V_{OUT(0)}$	Logical "0" Output Voltage	I_O = −360 μA, V_{CC} = 4.75V, I_O = −360 μA			0.4	V

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
OUTPUT DRIVE (See Family Characteristics Data Sheet) (Short Circuit Current)						
I_{SOURCE}	Output Source Current (P-Channel)	V_{CC} = 5V, V_{OUT} = 0V, T_A = 25°C	−1.75	−3.3		mA
I_{SOURCE}	Output Source Current (P-Channel)	V_{CC} = 10V, V_{OUT} = 0V, T_A = 25°C	−8	−15		mA
I_{SINK}	Output Sink Current (N-Channel)	V_{CC} = 5V, V_{OUT} = V_{CC}, T_A = 25°C	1.75	3.6		mA
I_{SINK}	Output Sink Current (N-Channel)	V_{CC} = 10V, V_{OUT} = V_{CC}, T_A = 25°C	8	16		mA

AC Electrical Characteristics (Note 3)

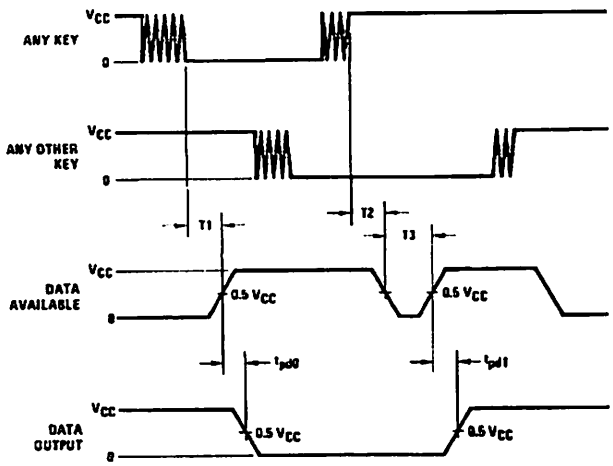
T_A = 25°C, C_L = 50 pF, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{pd0}, t_{pd1}	Propagation Delay Time to Logical "0" or Logical "1" from D.A.	C_L = 50 pF (Figure 1)				
		V_{CC} = 5V		60	150	ns
		V_{CC} = 10V		35	80	ns
		V_{CC} = 15V		25	60	ns
t_{0H}, t_{1H}	Propagation Delay Time from Logical "0" or Logical "1" into High Impedance State	R_L = 10k, C_L = 10 pF (Figure 2)				
		V_{CC} = 5V, R_L = 10k		80	200	ns
		V_{CC} = 10V, C_L = 10 pF		65	150	ns
		V_{CC} = 15V		50	110	ns
t_{H0}, t_{H1}	Propagation Delay Time from High Impedance State to a Logical "0" or Logical "1"	R_L = 10k, C_L = 50 pF (Figure 2)				
		V_{CC} = 5V, R_L = 10k		100	250	ns
		V_{CC} = 10V, C_L = 50 pF		55	125	ns
		V_{CC} = 15V		40	90	ns
C_{IN}	Input Capacitance	Any Input (Note 4)		5	7.5	pF
C_{OUT}	3-STATE Output Capacitance	Any Output (Note 4)		10		pF

Note 3: AC Parameters are guaranteed by DC correlated testing.

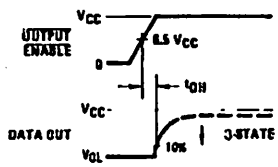
Note 4: Capacitance is guaranteed by periodic testing.

Switching Time Waveforms



T1 = T2 = RC, T3 = 0.7 RC, where R = 10k and C is external capacitor at KBM input.

FIGURE 1.



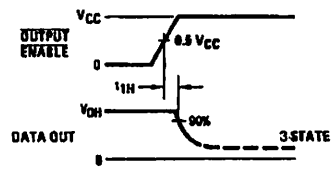
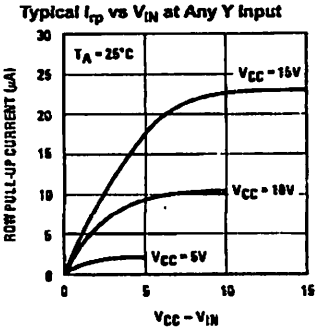


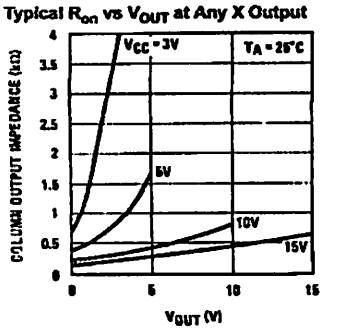
FIGURE 2.

Typical Performance Characteristics

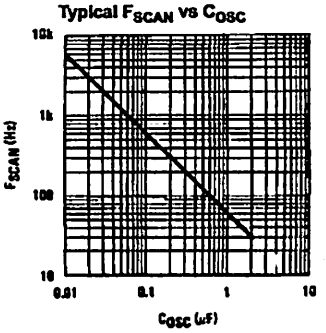
Typical I_{rp} vs V_{IN} at Any Y Input



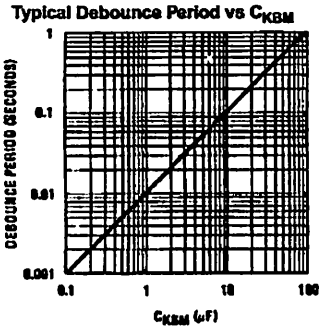
Typical R_{on} vs V_{OUT} at Any X Output



Typical F_{SCAN} vs C_{OSC}

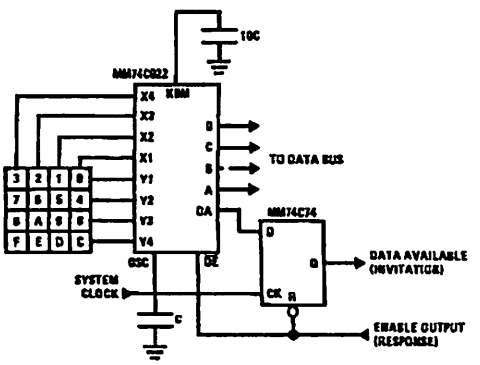


Typical Debounce Period vs C_{KBM}



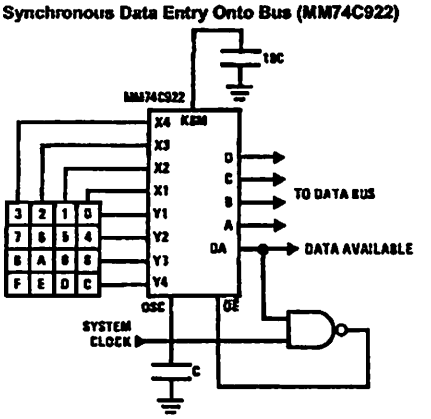
Typical Applications

Synchronous Handshake (MM74C922)



The keyboard may be synchronously scanned by omitting the capacitor at osc. and driving osc. directly if the system clock rate is lower than 10 kHz

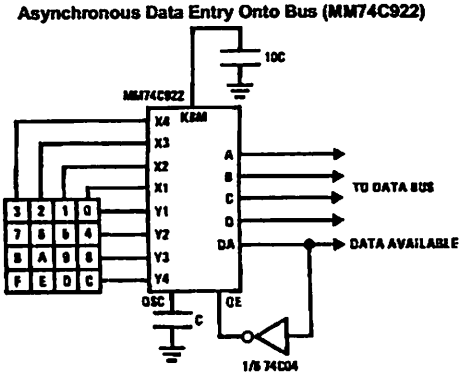
Synchronous Data Entry Onto Bus (MM74C922)



Outputs are enabled when valid entry is made and go into 3-STATE when key is released.

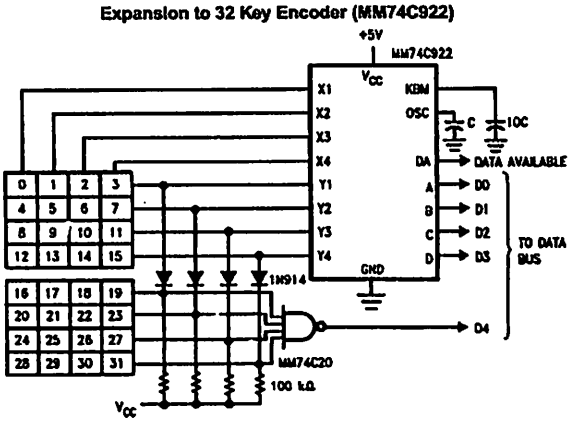
The keyboard may be synchronously scanned by omitting the capacitor at osc. and driving osc. directly if the system clock rate is lower than 10 kHz

Asynchronous Data Entry Onto Bus (MM74C922)



Outputs are in 3-STATE until key is pressed, then data is placed on bus. When key is released, outputs return to 3-STATE.

Expansion to 32 Key Encoder (MM74C922)



Theory of Operation

The MM74C922/MM74C923 Keyboard Encoders implement all the logic necessary to interface a 16 or 20 SPST key switch matrix to a digital system. The encoder will convert a key switch closer to a 4(MM74C922) or 5(MM74C923) bit nibble. The designer can control both the keyboard scan rate and the key debounce period by altering the oscillator capacitor, C_{OSE}, and the key bounce mask capacitor, C_{MSK}. Thus, the MM74C922/MM74C923's performance can be optimized for many keyboards.

The keyboard encoders connect to a switch matrix that is 4 rows by 4 columns (MM74C922) or 5 rows by 4 columns (MM74C923). When no keys are depressed, the row inputs are pulled high by internal pull-ups and the column outputs sequentially output a logic "0". These outputs are open drain and are therefore low for 25% of the time and otherwise off. The column scan rate is controlled by the oscillator input, which consists of a Schmitt trigger oscillator, a 2-bit counter, and a 2–4-bit decoder.

When a key is depressed, key 0, for example, nothing will happen when the X1 input is off, since Y1 will remain high. When the X1 column is scanned, X1 goes low and Y1 will go low. This disables the counter and keeps X1 low. Y1 going low also initiates the key bounce circuit timing and locks out the other Y inputs. The key code to be output is a combination of the frozen counter value and the decoded Y inputs. Once the key bounce circuit times out, the data is latched, and the Data Available (DAV) output goes high.

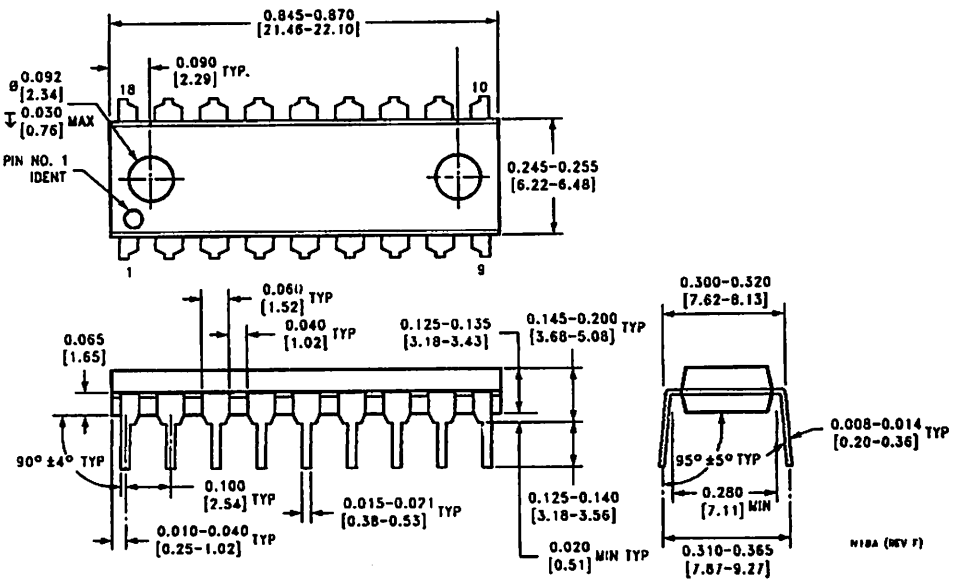
If, during the key closure the switch bounces, Y1 input will go high again, restarting the scan and resetting the key bounce circuitry. The key may bounce several times, but as soon as the switch stays low for a debounce period, the closure is assumed valid and the data is latched.

A key may also bounce when it is released. To ensure that the encoder does not recognize this bounce as another key closure, the debounce circuit must time out before another closure is recognized.

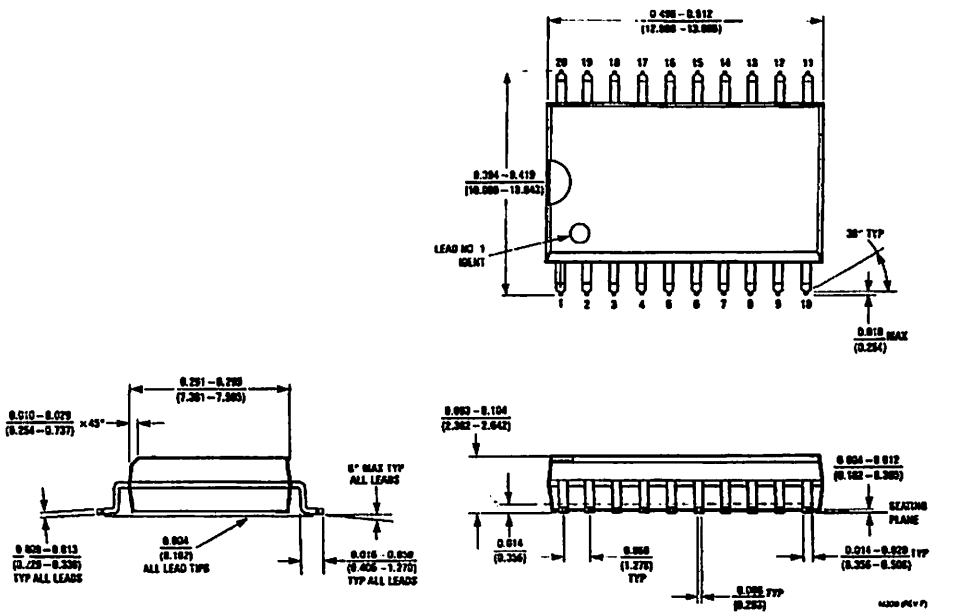
The two-key roll-over feature can be illustrated by assuming a key is depressed, and then a second key is depressed. Since all scanning has stopped, and all other Y inputs are disabled, the second key is not recognized until the first key is lifted and the key bounce circuitry has reset.

The output latches feed 3-STATE, which is enabled when the Output Enable ($\overline{OE}$) input is taken low.

Physical Dimensions inches (millimeters) unless otherwise noted

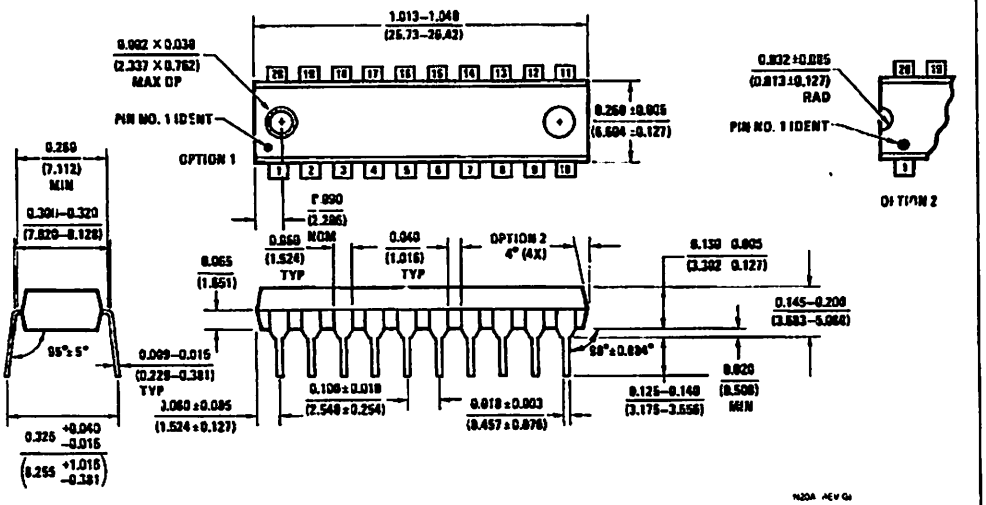


18-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
Package Number N18A



20-Lead Plastic Small Outline I.C. Package (M)
Package Number M20B

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



20-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
Package Number N20A

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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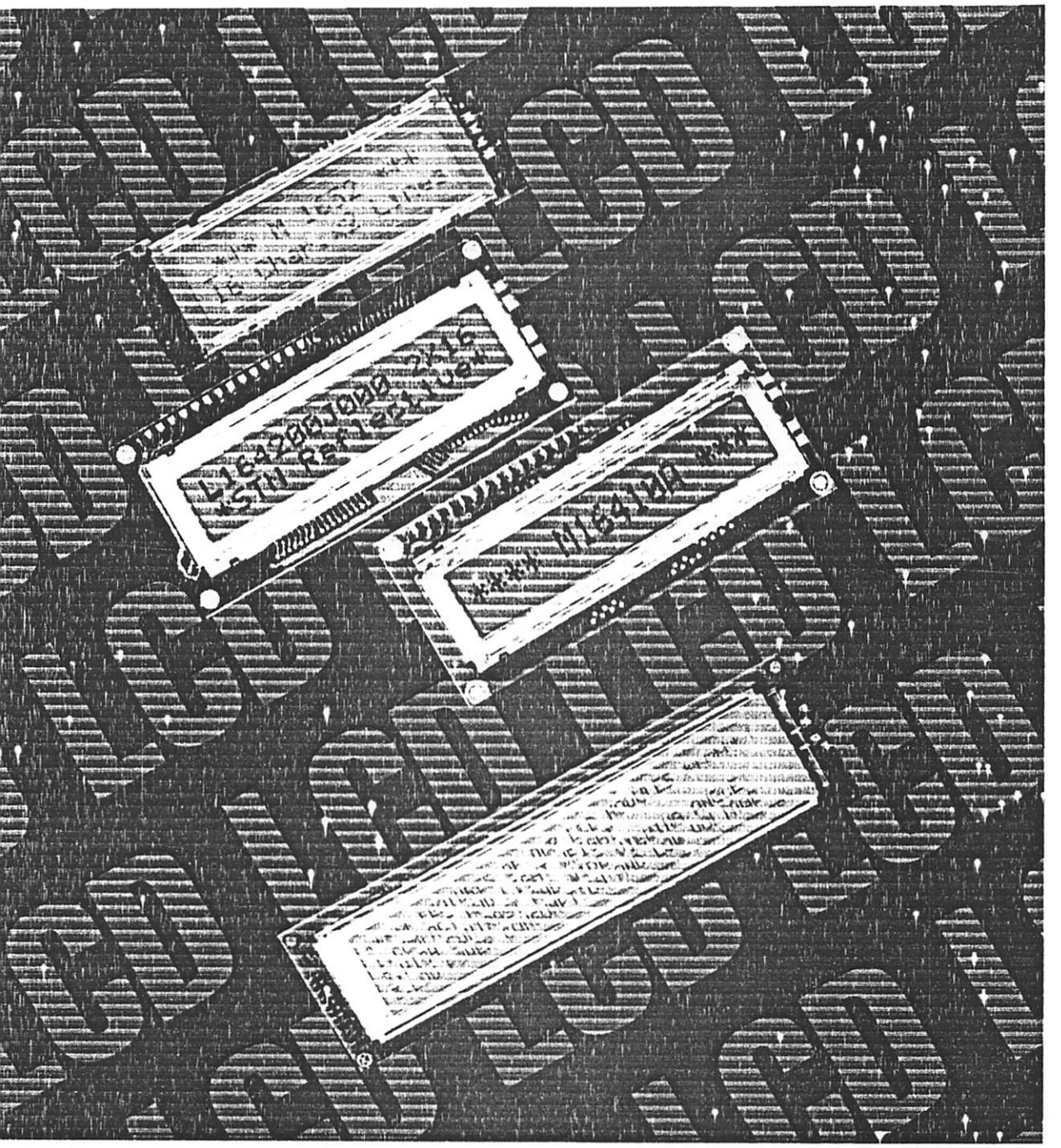
LCM

Liquid Crystal Display Modules

Seiko Instruments GmbH



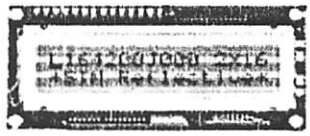
Dot Matrix Liquid Crystal Display Modules

CHARACTER TYPE

• FEATURES :

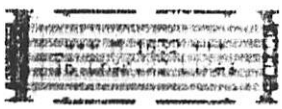
- Slim, light weight and low power consumption
- High contrast and wide viewing angle
- Built-in controller for easy interfacing
- LCD modules with built-in EL or LED backlight

M1641

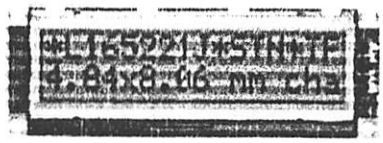


L1642

L1614



M1632



L1652

L2012

• SPECIFICATIONS :

: Standard products : Products of optional specification

Character Format (character x line)		16 x 1	16 x 2	16 x 2	16 x 2	16 x 4	20 x 2
Model		M1641	M1632	L1642	L1652	L1614	L2012
Reflective		M16410AS	M16320AS	L164200J000S	L165200J200S	L161400J000S	L201200J000S
EL backlight		M16419DWS	M16329DWS	L164221J000S	L165221J200S	L161421J000S	L201221J000S
LED backlight		M16417DYS	M16327DYS	L1642B1J000S	L1652B1J200S	L1614B1J000S	L2012B1J000S
Reflective (wide temp)		M16410CS	M16320CS	L164200L000S	L165200L200S	L161400L000S	L201200L000S
LED backlight (wide temp)		M16417JYS	M16327JYS	L1642B1L000S	L1652B1L200S	L1614B1L000S	L2012B1L000S
Character font		5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor
Module size (HxVxT) mm	Reflective	80,0 x 36,0 x 11,3	85,0 x 30,0 x 10,1	80,0 x 36,0 x 11,3	122,0 x 44,0 x 11,3	87,0 x 60,0 x 11,6	116,0 x 37,0 x 11,3
	EL backlight	80,0 x 36,0 x 11,3	85,0 x 30,0 x 10,1	80,0 x 36,0 x 11,3	122,0 x 44,0 x 11,3	87,0 x 60,0 x 11,6	116,0 x 37,0 x 11,3
	LED backlight	80,0 x 36,0 x 15,8	85,0 x 30,0 x 15,8	80,0 x 36,0 x 15,8	122,0 x 44,0 x 15,8	87,0 x 60,0 x 15,8	116,0 x 37,0 x 15,8
Viewing area (HxV) mm		64,5 x 13,8	62,0 x 16,0	64,5 x 13,8	99,0 x 24,0	61,8 x 25,2	83,0 x 18,6
Character size (HxV) mm *1		3,07 x 5,73	2,78 x 4,27	2,95 x 3,80	4,84 x 8,06	2,95 x 4,15	3,20 x 4,85
Dot size (HxV) mm		0,55 x 0,75	0,50 x 0,55	0,50 x 0,55	0,92 x 1,10	0,55 x 0,55	0,60 x 0,65
Power supply voltage (VDD-VSS) V		+ 5 V	+ 5 V	+ 5 V	+ 5 V	+ 5 V	+ 5 V
Current consumption (mA,typ)	IDD	1,5	2,0	1,6	2,0	2,7	2,0
	ILC *4	0,2	0,2	0,3	0,4	1,1	0,4
Driving method (duty)		1/16	1/16	1/16	1/16	1/16	1/16
Built-in LSI		KS0066 or equivalent	KS0066 MSM5839 or equivalent	KS0066 MSM5839 or equivalent	KS0066 MSM5839 or equivalent	KS0066 KS0063 or equivalent	KS0066 KS0063 or equivalent
Operating temperature (°C)	normal temp.	0 to + 50	0 to + 50	0 to + 50	0 to + 50	0 to + 50	0 to + 50
	wide temp. *2	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70
Storage temperature (°C)	normal temp.	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60
	wide temp.	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80
Weight (g, typ.)	Reflective	25	25	25	50	50	40
	EL backlight	30	30	30	55	55	45
	LED backlight	35	40	35	65	65	60
Inverters for EL	Model	5S	5S	5S	5C	5A	5A
	Power supply (V)	+ 5.0	+ 5.0	+ 5.0	+ 5.0	+ 5.0	+ 5.0
	current consumption (mA) *3	10	10	10	35	45	45
LED backlight	Forward current consumption (mA)	100	112	100	240	200	154
	Forward input voltage (V,typ.)	+ 4,1	+ 4,1	+ 4,1	+ 4,1	+ 4,1	+ 4,1

*1 : Excluding cursor

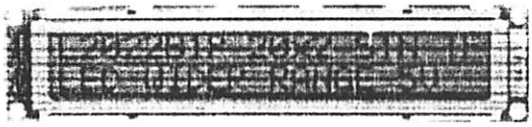
H : Horizontal V : Vertical T : Thickness (max)

*2 : With external temperature compensation

*3 : Including EL backlight

*4 : Based on normal temperature range

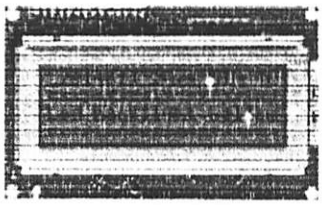
Since our policy is one of continues improvements we reserve the right to change the specifications for the products in the catalogue without notice.



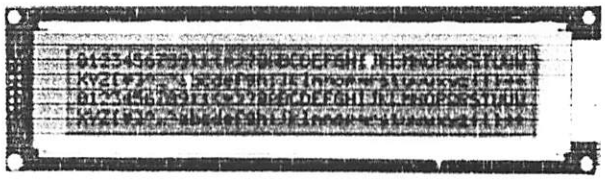
L2022

L2432

L4042



L2014



M4024

• SPECIFICATIONS :

[ ] : Standard products [ ] : Products of optional specification

Character Format (character x line)			20 x 2	20 x 4	24 x 2	40 x 2	40 x 4
Model			L2022	L2014	L2432	L4042	M4024
Reflective			-	L201400J000S	L243200J000S	L404200J000S	M40240AS
EL backlight			-	L201421J000S	L243221J000S	L404221J000S	M40249DWS
LED backlight			-	L2014B1J000S	L2432B1J000S	L4042B1J000S	M40247DYS
Reflective (wide temp)			L202200P000S	L201400L000S	L243200L000S	L404200L000S	M40240CS
LED backlight (wide temp)			L2022B1P000S	L2014B1L000S	L2432B1L000S	L4042B1L000S	M40247JYS
Character font			5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor	5x7 dots + cursor
Module size (HxVxT) mm	Reflective		180,0 x 40,0 x 10,5	98,0 x 60,0 x 11,6	118,0 x 36,0 x 11,3	182,0 x 33,5 x 11,3	190,0 x 54,0 x 10,1
	EL backlight		180,0 x 40,0 x 10,5	98,0 x 60,0 x 11,6	118,0 x 36,0 x 11,3	182,0 x 33,5 x 11,3	190,0 x 54,0 x 10,1
	LED backlight		180,0 x 40,0 x 14,8	98,0 x 60,0 x 15,8	118,0 x 36,0 x 15,8	182,0 x 33,5 x 16,3	190,0 x 54,0 x 10,3
Viewing area (HxV) mm			149,0 x 23,0	76,0 x 25,2	94,5 x 17,8	154,4 x 15,8	147,0 x 29,5
Character size (HxV) mm *1			6,00 x 9,66	2,95 x 4,15	3,20 x 4,85	3,20 x 4,85	2,78 x 4,27
Dot size (HxV) mm			1,12 x 1,12	0,55 x 0,55	0,60 x 0,65	0,60 x 0,65	0,50 x 0,55
Power supply voltage (VDD-VSS) V			+ 5 V	+ 5 V	+ 5 V	+ 5 V	+ 5 V
Current consumption (mA,typ)		IDD	4,2	2,9	2,5	3,0	8,0
		ILC *4	2,6	1,2	0,5	1,0	3,0
Driving method (duty)			1/16	1/16	1/16	1/16	1/16
Built-in LSI			KS0066 KS0063 or equivalent	KS0066 MSM5839 or equivalent	KS0066 KS0063 or equivalent	KS0066 KS0063 or equivalent	KS0066 MSM5839 or equivalent
Operating temperature (°C)		normal temp.	-	0 to + 50	0 to + 50	0 to + 50	0 to + 50
		wide temp. *2	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70	- 20 to + 70
Storage temperature (°C)		normal temp.	-	- 20 to + 60	- 20 to + 60	- 20 to + 60	- 20 to + 60
		wide temp.	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80	- 30 to + 80
Weight (g, typ.)	Reflective		80	55	40	70	90
	EL backlight		-	60	45	75	105
	LED backlight		110	70	60	95	140
Inverters for EL	Model		-	5A	5A	5C	5D
	Power supply (V)		+ 5.0	+ 5.0	+ 5.0	+ 5.0	+ 5.0
	current consumption (mA) *3		-	45	45	25	80
LED backlight	Forward current consumption (mA)		320	240	150	260	480
	Forward input voltage (V,typ.)		+ 4,1	+ 4,1	+ 4,1	+ 4,1	+ 4,1

*1 : Excluding cursor

*2 : With external temperature compensation

*3 : Including EL backlight

*4 : Based on normal temperature range

H : Horizontal V : Vertical T : Thickness (max)

Dot Matrix Liquid Crystal Display Modules

GRAPHIC TYPE

- **FEATURES :**
  - •Wide viewing angle and high contrast
  - •Full dot configuration fits any application
  - •Slim, light weight and low power consumption
  - •Available in STN and FSTN

- **SPECIFICATIONS :**

Dot format (HxV,dot)			97 x 32	128 x 32	128 x 64	128 x 64
Model			Y97031	G1213	G1216	G1226
STN type (Gray mode)	Reflective	built-in RAM	-	-	-	-
	Reflective wide temp.	built-in RAM	-	G121300N000S	G121600N000S	-
	LED backlight	built-in RAM	-	-	-	G122681J000S
	LED backlight wide temp	built-in RAM	-	G1213B1N000S	G1216B1N000S	-
FSTN type (B&W mode)	Transmissive	-	-	-	-	-
	with CFL backlight	built-in controller	-	-	-	-
	Transflective	built-in RAM	Y97031LF60W	-	-	-
Module size (H x V x T) mm	Reflective (no backlight)		47,5 x 65,4 x 2,1	75,0 x 41,5 x 6,8	75,0 x 52,7 x 6,8	-
	LED backlight		-	75,0 x 41,5 x 8,9	75,0 x 52,7 x 8,9	93,0 x 70,0 x 11,4
	CFL backlight		-	-	-	-
Viewing area (HxV) mm			43,5 x 23,9	60,0 x 21,3	60,0 x 32,5	70,7 x 38,8
Dot size (H x V) mm			0,35 x 0,48	0,40 x 0,48	0,40 x 0,40	0,44 x 0,44
Dot pitch (H x V) mm			0,39 x 0,52	0,43 x 0,51	0,43 x 0,43	0,48 x 0,48
Power supply voltage (V)		(VDD - VSS)	+5,0	+5,0	+5,0	+5,0
		(VLC - VSS)	-	- 8,0	- 8,1	-8,2
Current consumption (mA, typ.)		IDD	0,10	2,0	2,0	3,0
		IDD (built-in controlle)	-	-	-	-
		ILC	-	1,8	1,8	2,0
Driving method (duty)			1/33	1/64	1/64	1/64
Built-in LSI		Driver	SED1530 or equivalent	HD61202 HD61203 or equivalent	HD61202 HD61203 or equivalent	KS0107 KS0108 or equivalent
		Controller	-	-	-	-
Operating temperature range (°C)			- 20 to + 70	- 20 to + 70	- 20 to + 70	0 to + 50
Storage temperature range (°C)			- 30 to + 80	- 30 to + 80	- 30 to + 80	- 20 to + 60
Weight (g. typ.)	Reflective (Transflective no backlight)		10	23	35	-
	LED backlight		-	35	45	72
	CFL backlight		-	-	-	-
LED backlight	Forward current consumption (mA)		-	40	90	125
	Forward input voltage (V, typ.)		-	3,8	4,1	4,1
Inverter for CFL	Mode		-	-	-	-
	Power supply voltage (V)		-	-	-	-
	Current consumption (mA, typ.)		-	-	-	-

*1 : built-in DC/DC converter (single power source)

*2 : Use with external temperature compensation circuit

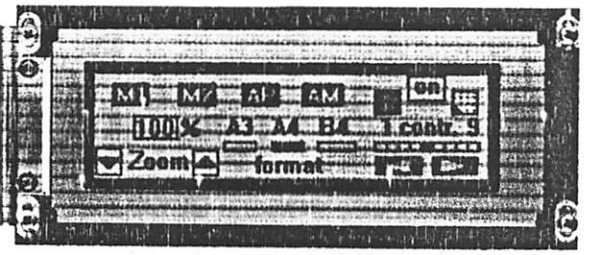
Since our policy is one of continues improvements we reserve the right to change the specifications of the products in the catalogue without notice.

Dot format (HxV,dot)			240 x 64	240 x 128	320 x 200	320 x 240	640 x 200
Model			G2446	G242C	G321D	G324E	G649D
STN type (Gray mode)	Reflective	built-in RAM	-	-	-	-	-
	Reflective wide temp.	built-in RAM	-	-	-	-	-
	LED backlight	built-in RAM	-	-	-	-	-
	LED backlight wide temp	built-in RAM	-	-	-	-	-
FSTN type (B&W mode)	Transmissive	-	G2446X5R1A0S	G242CX5R1A0S	G321DX5R1A0S	G324EX5R1A0S	G649DX5R0105
	with CFL backlight	built-in controller	G2446X5R1ACS	G242CX5R1A0S	G321DX5R1ACS	G324EX5R1ACS	-
	Transflective	built-in RAM	-	-	-	-	-
Module size (H x V x T) mm	Reflective (no backlight)			-	-	-	-
	LED backlight			-	-	-	-
	CFL backlight		191,0 x 79,0 x 15,1	180,0 x 110,0 x 15,1	186,0 x 134,0 x 15,1	186,0 x 134,0 x 15,1	260,0 x 122,0 x 15,7
Viewing area (HxV) mm			134,0 x 41,0	134,0 x 76,0	126,0 x 110,0	126,0 x 110,0	216,0 x 83,0
Dot size (H x V) mm			0,49 x 0,49	0,47 x 0,47	0,34 x 0,48	0,32 x 0,39	0,30 x 0,36
Dot pitch (H x V) mm			0,53 x 0,53	0,51 x 0,51	0,38 x 0,52	0,36 x 0,43	0,33 x 0,39
Power supply voltage (V)		(VDD - VSS)*1	+5,0	+5,0	+5,0	+5,0	+5,0
		(VLC - VSS)	*1	*1	-24,0	-24,0	-24,0
Current consumption (mA, typ.)		IDD	12	30	8	7,5	11
		IDD (built-in controller)	15	40	23	23	-
		ILC	-	-	6	6,5	9
Driving method (duty)			1/64	1/128	1/200	1/240	1/200
Built-in LSI		Driver	MSM5298 MSM5299 or equivalent	KS0103 KS0104 or equivalent	MSM5298 MSM5299 or equivalent	HD66204 HD66205 or equivalent	MSM5298 MSM5299 or equivalent
		Controller	SED1330FB	SED1330FB	SED1330FB	SED1330FB	-
Operating temperature range (°C)			0 to +50	0 to +50	0 to +50	0 to +50	0 to +50
Storage temperature range (°C)			-20 to +60	-20 to +60	-20 to +60	-20 to +60	-20 to +60
Weight (g, typ.)	Reflective (Transflective no backlight)		-	-	-	-	-
	LED backlight		-	-	-	-	-
	CFL backlight		200	280	350	350	420
LED backlight	Forward current consumption (mA)		-	-	-	-	-
	Forward input voltage (V, typ.)		-	-	-	-	-
Inverter for CFL	Mode		4800210	4800210	4800210	4800210	4800120
	Power supply voltage (V)		+5,0	+5,0	+5,0	+5,0	+12,0
	Current consumption (mA, typ.)		250	350	365	365	390

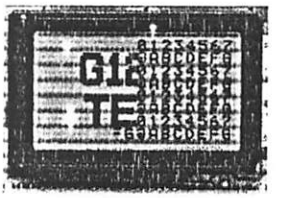
*1 : built-in DC/DC converter (single power source)

*2 : Use with external temperature compensation

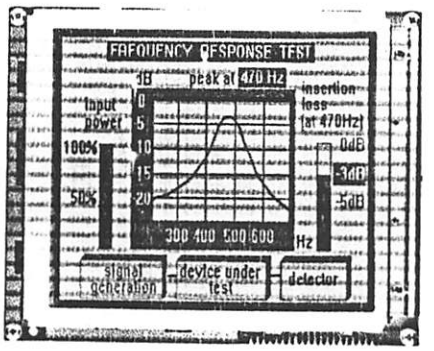
Since our policy is one of continous improvemets, we reserve the right to change the specifications of the products in the catalogue without notice.



G2446

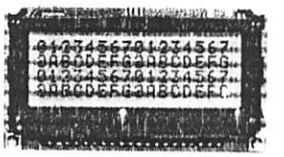


G1226

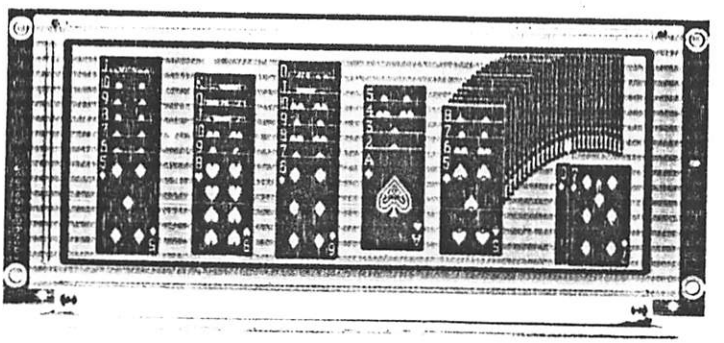


G321D

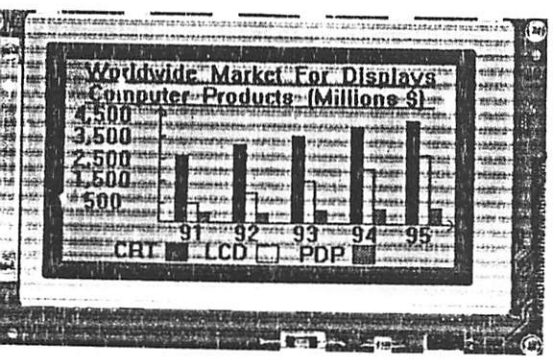
G1216



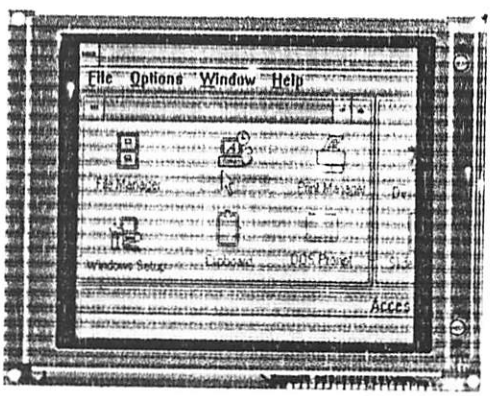
G1213



G649D



G242C



G324E

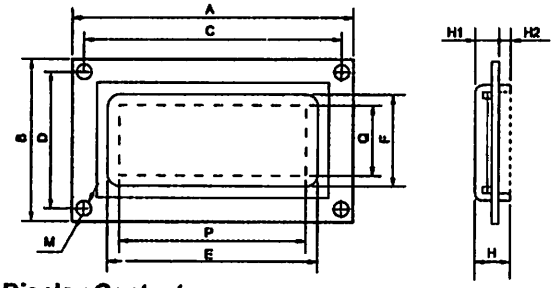
CHECK LIST FOR CUSTOM DESIGNED LCD MODULE

1. Company_____ **2. Application**_____ **3. Customer Specified Part No.**_____

4. Design

☐ New ☐ Modified : Manufacturer_____, Part No._____, Remarks _____
☐ Equivalent: Manufacturer_____, Part No._____, Remarks _____

5. LCM Dimensions



A x B : Module size_____ x _____ mm
E x F : Viewing area_____ x _____ mm
P x Q : Active display area_____ x _____ mm
C : Length between mounting holes_____ mm
D : Length between mounting holes_____ mm
M : Diameter of mounting hole_____ mm
H : Total thickness_____ mm
H1 : Upper thickness_____ mm
H2 : Lower thickness_____ mm

6. Display Contents

☐ Character type:_____ characters_____ lines
Character font_____ x _____ dots + cursor
Character pitch_____ x _____ mm
Dot pitch_____ x _____ mm
Dot size_____ x _____ mm
☐ Graphics (Full dot) type:_____ x _____ dots
Dot pitch_____ x _____ mm
Dot size_____ x _____ mm
☐ Segment type: _____ digits_____ lines
☐ Others _____

7. LCD Panel

Viewing angle: ☐ 6 o'clock ☐ 12 o'clock ☐ ____ o'clock
Type: ☐ TN ☐ FSTN (Black and white)
☐ STN (☐ Yellow green ☐ Gray ☐ Blue)
Chromaticity coordinates
(_____ ≤ x ≤ _____ , _____ ≤ y ≤ _____)
☐ Positive type ☐ Negative type
☐ Reflective ☐ Transflective ☐ Transmissive
☐ Others _____
Gray scale: ☐ Yes_____ gray scale ☐ No
Preferential specifications:
☐ Response time t_{on} ____ ms (____ °C) t_{off} ____ ms (____ °C)
☐ Viewing angle ____ deg. (____ °C) ☐ Contrast ____ (____ °C)
☐ Others _____
LCD surface finishing:
☐ Normal ☐ Anti-glare ☐ _____
Polarizer color: ☐ Normal (neutral gray) ☐ Red
☐ Green ☐ Blue ☐ _____

8. Driving Method

Multiplexing: 1/_____ duty, 1/_____ bias
Frame frequency: _____ Hz

9. IC

LCD driver: ☐ Specified ☐ Unspecified
Segment driver _____ (Manufacturer _____)
Common driver _____ (Manufacturer _____)
Controller: ☐ Internal ☐ External
Type No._____ (Manufacturer _____)
MPU: ☐ Internal ☐ External
Type No._____ (Manufacturer _____)
RAM: ☐ Internal ☐ External
Type No. /Memory size_____ (Kbit) (Manufacturer _____)

10. Power Supply

☐ Single power supply: ☐ 5V ☐ _____ V
☐ 2 power supplies
For logic: (V_{DD}-V_{SS}) : ☐ 5V ☐ _____ V
For LC drive: (V_{LC}-V_{SS}) : ☐ _____ V

11. Temperature Compensation Circuit

☐ Internal ☐ External ☐ Unnecessary
Compensation range: ☐ 0°C to 50°C ☐ ___°C to ___°C

12. Current Consumption

For logic: typ._____ mA, max._____ mA
For LC drive: typ._____ mA, max._____ mA
Others ( ) : typ._____ mA, max._____ mA

13. Contrast Adjustment

☐ Internal ☐ External ☐ Unnecessary
Method: ☐ Temp. compensation circuit ☐ Volume ☐ ____

14. Temperature Range

Operating temperature range: ☐ 0°C to 50°C ☐ ____ °C to ____ °C
Storage temperature range: ☐ - 20°C to 60°C ☐ ____ °C to ____ °C

15. Input/Output Terminals

Specifying allocation: ☐ Yes ☐ No
Specifying position: ☐ Yes ☐ No

16. Weight

typ._____ g, max._____ g

17. Connector

☐ Internal ☐ External ☐ Unnecessary
Type No._____ (Manufacturer _____)

18. Backlight

☐ Internal ☐ External ☐ Unnecessary
☐ EL: ☐ Green ☐ White ☐ _____
☐ LED: ☐ Yellow green ☐ Amber ☐ _____
☐ CFL: ☐ White ☐ _____
☐ Incandescent lamp ☐ Others _____
☐ Backlight type ☐ Edge backlight type
Brightness:_____ cd/m²
Inverter: ☐ Internal ☐ External ☐ Unnecessary
Power supply voltage_____ V
Current consumption (backlight included)_____ mA
Brightness control: ☐ Yes ☐ No

19. Others

_____
_____
_____

20. Schedule

Estimate:_____
Sample: Delivery_____, Quantity:_____ pcs
Mass production: Target price: _____
Delivery _____, Total quantity:_____ pcs
Quantity per month_____ pcs

iquid Crystal Displays

HECK LIST FOR CUSTOM DESIGNED LCD

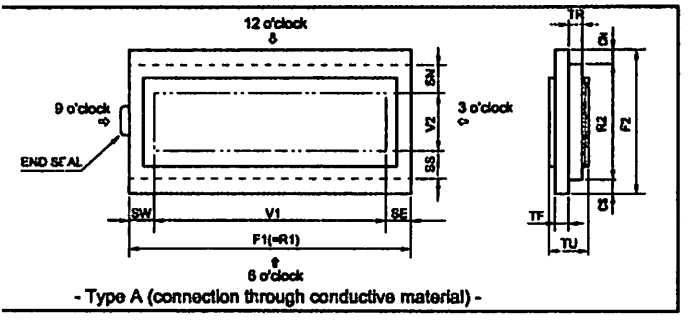
Company_____ **2. Application**_____ **3. Customer Specified Part No.**_____

Dasign

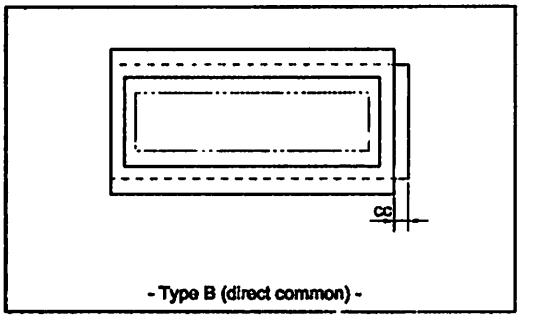
☐New ☐Modified: Manufacturer _____ , Part No._____ , Remarks_____

☐Equivalent: Manufacturer_____ , Part No._____ , Remarks_____

Panel Dimensions



- Type A (connection through conductive material) -

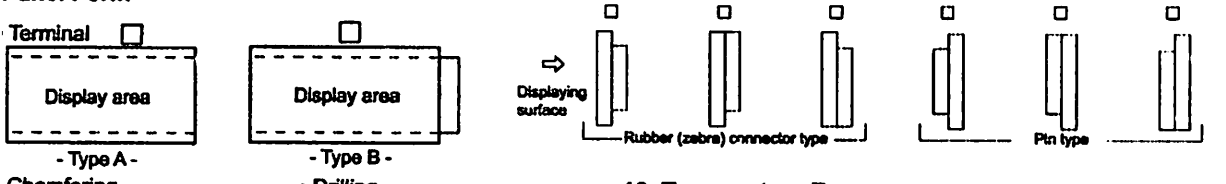


- Type B (direct common) -

: Horizontal length of upper glass _____ mm
: Vertical length of upper glass_____ mm
: Horizontal length of lower glass_____ the same as F1
*: Vertical length of lower glass_____ mm
R2 is generally longer than F2 when terminals are with pin.
, TR***: Thickness of glass_____ mm
*Standard type: 1.1 mm or 0.7 mm
: Thickness of LCD_____ mm
d seal: ☐Right ☐Left ☐Right or Left

V1 :Horizontal length of viewing area _____ mm
V2 :Vertical length of viewing area _____ mm
CN**: Terminal length_____ mm
CS**:Terminal length_____ mm
**CN or CS=0 in case of one side terminal type.
CC: Terminal length_____ mm
SE,SW,SN,SS : Seal width
(According to design or manufacturing condition:
about 2.0 mm to 4.0 mm)

Panel Form



Chamfering ☐ Yes ☐ No

• Drilling ☐ Yes ☐ No

Display Mode

Viewing angle : ☐6 o'clock ☐12 o'clock ☐_____o'clock
Type: ☐TN ☐FSTN (Black and white)
☐STN: (☐ Yellow green ☐ Gray ☐ Blue)
Chromaticity coordinates (____≦x≦____, ____≦y≦____)
☐Positive type ☐Negative type
☐Reflective ☐Transflective ☐Transmissive
Preferential specifications:
☐Response time t_{on} ____ ms (____ °C) t_{off} ____ ms (____ °C)
☐Viewing angle ____ deg. (____ °C) ☐Contrast____ (____ °C)
☐Others_____

Polarizer

Surface finishing: ☐Normal ☐Anti-glare ☐_____
Color: ☐Normal (neutral gray) ☐Red ☐Green
☐Blue ☐_____
Front polarizer : ☐ Attached type ☐ Separate type
Rear polarizer : ☐ Attached type ☐ Separate type

Driving Method

Static ☐ Multiplexing: (1/_____duty, 1/_____bias)
Operating voltage (V_{opr}) :_____V
Frame frequency:_____ Hz
Driving IC:_____(Manufacturer_____)
Current consumption:_____ μA

10. Temperature Range

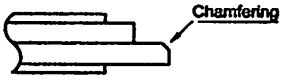
Operating temperature range
☐With temperature compensation circuit (or volume)
(☐ 0°C to 50°C ☐_____°C to_____°C)
☐Without temperature compensation circuit
(☐ 0°C to 50°C ☐_____°C to_____°C)
Storage temperature range
(☐ - 20°C to 60°C ☐_____°C to_____°C)

11. Terminal Connecting Method

☐Rubber connector (Zebra rubber)
☐Pin: ☐DIL ☐SIL ☐_____
Pitch (☐2.54 ☐_____mm) Length (_____mm)
☐Heat seal: ☐Equipped ☐Unnecessary

12. Others

Print (Characters, lines, masks etc.) : ☐Yes ☐No
Protective film:
☐Yes (Color: ☐ Red ☐Translucent ☐Transparent) ☐No
Chamfering (for heat-seal connector) :
☐Yes (Position:_____)
(Quantity:_____)
☐No



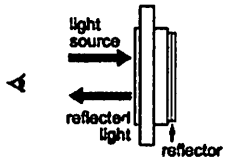
13. Schedule

Estimate :_____
Sample : Delivery_____ , Quantity :_____pcs
Mass production : Target price : _____
Delivery _____ , Total quantity:_____pcs
Quantity per month:_____pcs

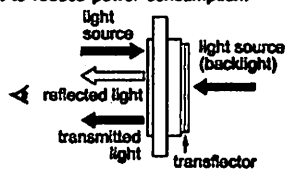
.iquid Crystal Display Modules

REFLECTIVE/TRANSFLECTIVE/TRANSMISSIVE LCD

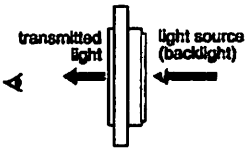
Reflective LCD
Reflector bonded to the rear polarizer reflects the incoming ambient light. Low power consumption because no backlight is required.



Transflective LCD
Transflector bonded to the rear polarizer reflects light from the front as well as enabling lights to pass through the back. Used with backlight off in bright light and with it on in low light to reduce power consumption.



Transmissive LCD
Without reflector or transflector bonded to the rear polarizer. Backlight required. Most common is transmissive negative image.



POSITIVE/NEGATIVE MODE

Positive type		Negative type		Negative type (inverse image) (when data is inverted)	

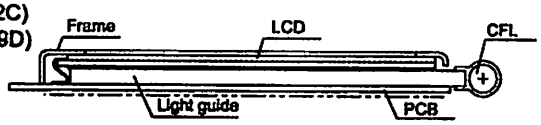
TN TYPE/STN TYPE/FSTN TYPE

TN	(Background/dot color) Gray/Black	TN(Twisted Nematic) type is most conventional and economical. It is used for static drive LCD and low-duty drive LCD (watch,calculator, etc.)
STN	Yellowgreen/Dark blue Gray/Dark blue White/Blue	STN (Super Twisted Nematic) type has a higher twist angle, and thus provides clear visibility and wider viewing angle. This is suitable especially for high-duty drive LCD.
FSTN	White/Black	FSTN (Film Super Twisted Nematic) type utilizes RCF (Retardation Control Film) to remove the coloring of STN LCD. Thus FSTN type provides easy-to-read black-and-white display.

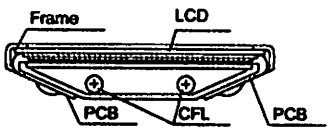
STRUCTURE AND FEATURE OF LCD MODULE WITH BACKLIGHT

CFL (Cold Cathode Fluorescent Lamp) backlight
Features: high brightness, long service life, inverter required

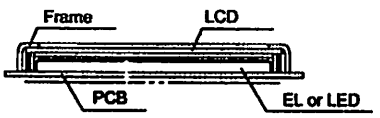
- Edge backlight type
  (G2446,G242C)
  (G321D,G649D)



- Backlight type

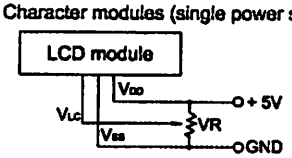


EL (Electroluminescent Lamp) backlight
LED (Light Emitting Diode) backlight
Features: EL: thin, inverter required
LED: long service life, low voltage driving, no inverter required

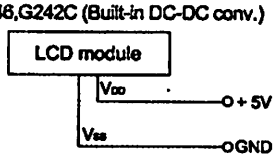


POWER SUPPLY

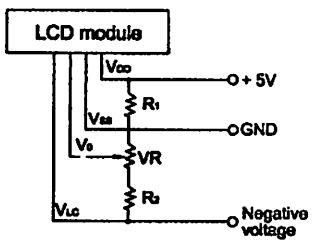
- Character modules (single power supply)



- G2446,G242C (Built-in DC-DC conv.)

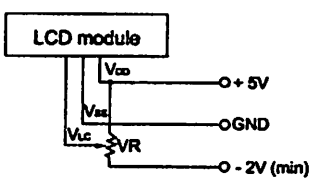


- G321D, G324E and G649D

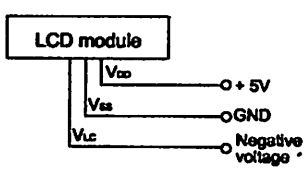


Note 1:Contrast can be adjusted by VR.
Note 2:For module with backlight, power supply for backlight is necessary.

- Character Modules(Dual power supply)



- Y1206 and G1226



·Negative voltage should be variable for contrast adjustment.

Precautions

Safety Instructions

- If the LCD panel is damaged, be careful not to get the liquid crystal in your mouth and not to be injured by crushed glasses.
- If you should swallow the liquid crystal, first, wash your mouth thoroughly with water, then, drink a lot of water and induce vomiting, and then, consult a physician.
- If the liquid crystal should get in your eye, flush your eye with running water for at least fifteen minutes.
- If the liquid crystal touches your skin or clothes, remove it and wash the affected part of your skin or clothes with soap and running water.
- EL or CFL backlight is driven by a high voltage with an inverter. Do not touch the connection part or the wiring pattern of the inverter.
- Do not use inverters without a load or in the short-circuit mode.
- Use the LCD module within the rated voltage to prevent overheating and/or damage. Also, take steps to ensure that the connector does not come off.

Handling Precautions

- Since the LCD panel has glass substrate, avoid applying mechanical shock or pressure on the module. Do not drop, bend, twist or press the module.
- Do not soil or damage LCD panel terminals.
- Since the polarizer is made of easily-scratched material, be careful not to touch or place objects on the display surface.
- Keep the display surface clean. Do not touch it with your skin.
- CMOS LSI is used in the LCD module. Be careful of static electricity.
- Do not disassemble the module or remove the liquid crystal panel or the panel frame.
- Do not damage the film surface of the EL lamp; otherwise the lamp will be damaged by humidity.
- To set an EL lamp in an LCD module, push the EL lamp with its emitting side up, without pushing the rubber connectors too hard. If you damage them, the LCD module may not work properly.

Mounting and Designing

- To protect the polarizer and the LCD panel, cover the display surface with a transparent plate (e.g., acrylic or glass) with a small gap between the transparent plate and the display surface.
- Keep the module dry. Avoid condensation to prevent the transparent electrodes from being damaged.
- Drive LCD panel with AC waveform in which DC element is not included to prevent deterioration in the LCD panel.
- Contrast of LCD varies depending on the ambient temperature. To offer the optimum contrast, LC drive voltage should be adjusted. LCD driven in a high duty ratio must be provided with drive voltage adjustment method.
- Mount a LCD module with the specified mounting part/ holes.
- Design the equipment so that input signal is not applied to the LCD module while power supply voltage is not applied to it.
- Do not locate the CFL tube and the lamp lead wire close to a metal plate or a plated part inside the equipment. Otherwise stray capacity causes a drop in voltage, decreasing the brightness and the ability to start-up.

Cleaning

- Do not wipe the polarizer with a dry cloth, as it may scratch the surface.
- Wipe the LCD panel gently with a soft cloth soaked with a petroleum benzine.
- Do not use ketonic solvents (ketone and acetone)or aromatic solvents (toluene and xylene), as they may damage the polarizer.

Storing

- Store the LCD panel in a dark place, where the temperature is 25°C±10°C and the relative humidity below 65%. If possible, store the LCD panel in the packaging situation when it was delivered.
- Do not store the module near organic solvents or corrosive gases.
- Keep the module (including accessories) safe from vibration, shock and pressure.
- Use an LCD module with built-in EL backlight within six months of delivery.
- EL backlight is easily affected by environmental conditions such as temperature and humidity; the quality may deteriorate if stored for an extended period of time. Contact Seiko Instruments GmbH for details.
- Some parts of the backlight and the inverter generate heat. Take care so that the heat does not affect the liquid crystal or any other parts.
- Dust particles attached to the surface of the LCD or the surface of the backlight degrade the display quality. Be careful to keep dust out in designing the structure as well as in handling the module.
- Black or white air-bubbles may be produced if the LCD panel is stored for long time in the lower temperature or mechanical shocks are applied onto the LCD panel.

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olute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Input supply voltage range, V_{CC} (see Note 1) ..... –0.3 V to 6 V
Positive output supply voltage range, V_{S+} ..... V_{CC} –0.3 V to 15 V
Negative output supply voltage range, V_{S-} ..... –0.3 V to –15 V
Input voltage range, V_I: Driver ..... –0.3 V to V_{CC} + 0.3 V
Receiver ..... ±30 V
Output voltage range, V_O: T1OUT, T2OUT ..... V_{S-} –0.3 V to V_{S+} + 0.3 V
R1OUT, R2OUT ..... –0.3 V to V_{CC} + 0.3 V
Short-circuit duration: T1OUT, T2OUT ..... Unlimited
Package thermal impedance, θ_{JA} (see Note 2): D package ..... 73°C/W
DW package ..... 57°C/W
N package ..... 67°C/W
NS package ..... 64°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ..... 260°C
Storage temperature range, T_{stg} ..... –65°C to 150°C

sses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and tional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not ied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
: 1: All voltage values are with respect to network ground terminal.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

mmended operating conditions

			MIN	NOM	MAX	UNIT
	Supply voltage		4.5	5	5.5	V
	High-level input voltage (T1IN,T2IN)		2			V
	Low-level input voltage (T1IN, T2IN)				0.8	V
I, R2IN	Receiver input voltage				±30	V
	Operating free-air temperature	MAX232	0		70	°C
		MAX232I	–40		85	

lectrical characteristics over recommended ranges of supply voltage and operating free-air emperature range (unless otherwise noted)

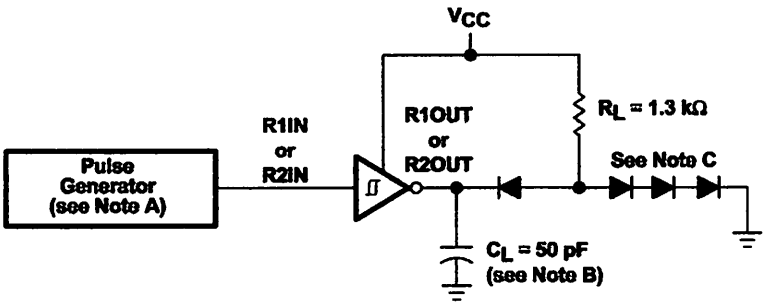
PARAMETER			TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{OH}	High-level output voltage	T1OUT, T2OUT	R_L = 3 kΩ to GND		5	7		V
		R1OUT, R2OUT	I_{OH} = –1 mA		3.5			
V_{OL}	Low-level output voltage‡	T1OUT, T2OUT	R_L = 3 kΩ to GND			–7	–5	V
		R1OUT, R2OUT	I_{OL} = 3.2 mA				0.4	
VIT+	Receiver positive-going input threshold voltage	R1IN, R2IN	V_{CC} = 5 V,	T_A = 25°C		1.7	2.4	V
VIT–	Receiver negative-going input threshold voltage	R1IN, R2IN	V_{CC} = 5 V,	T_A = 25°C	0.8	1.2		V
Vhys	Input hysteresis voltage	R1IN, R2IN	V_{CC} = 5 V		0.2	0.5	1	V
ri	Receiver input resistance	R1IN, R2IN	V_{CC} = 5,	T_A = 25°C	3	5	7	kΩ
ro	Output resistance	T1OUT, T2OUT	V_{S+} = V_{S-} = 0,	V_O = ± 2 V	300			Ω
IOS§	Short-circuit output current	T1OUT, T2OUT	V_{CC} = 5.5 V,	V_O = 0		±10		mA
IIS	Short-circuit input current	T1IN, T2IN	V_I = 0				200	µA
ICC	Supply current		V_{CC} = 5.5 V, T_A = 25°C	All outputs open,		8	10	mA

All typical values are at V_{CC} = 5 V, T_A = 25°C.
The algebraic convention, in which the least positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
Not more than one output should be shorted at a time.

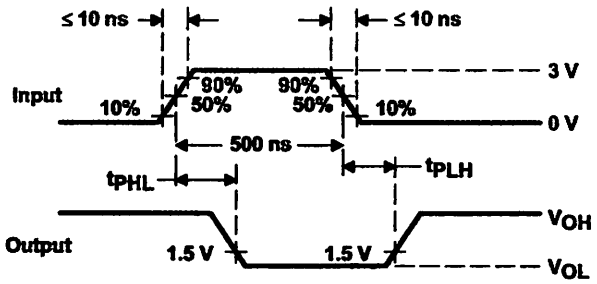
witching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH(R)}$	Receiver propagation delay time, low- to high-level output	See Figure 1		500		ns
$t_{PHL(R)}$	Receiver propagation delay time, high- to low-level output	See Figure 1		500		ns
SR	Driver slew rate	R_L = 3 kΩ to 7 kΩ, See Figure 2			30	V/µs
SR(tr)	Driver transition region slew rate	See Figure 3		3		V/µs

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

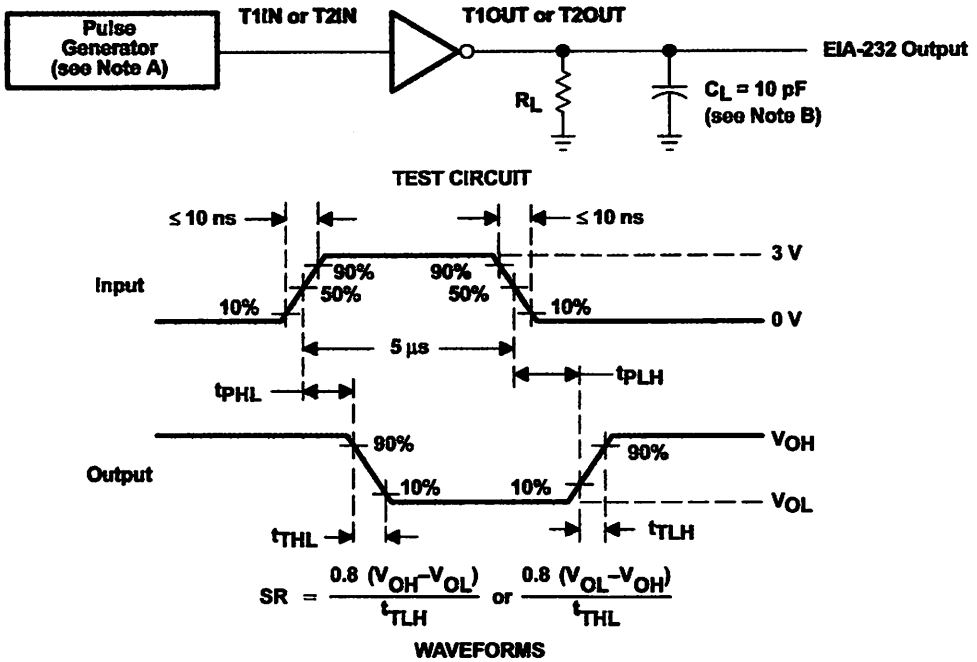


WAVEFORMS

NOTES: A. The pulse generator has the following characteristics: Z_O = 50 Ω, duty cycle ≤ 50%.
B. C_L includes probe and jig capacitance.
C. All diodes are 1N3064 or equivalent.

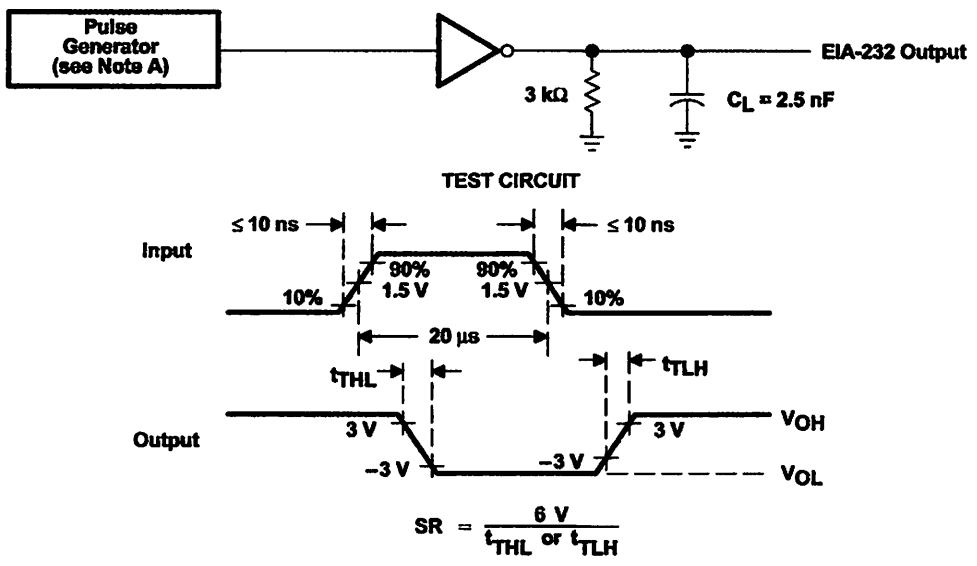
Figure 1. Receiver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements

PARAMETER MEASUREMENT INFORMATION



NOTES: A. The pulse generator has the following characteristics: Z_O = 50 Ω, duty cycle ≤ 50%.
B. C_L includes probe and jig capacitance.

Figure 2. Driver Test Circuit and Waveforms for t_{PHL} and t_{PLH} Measurements (5-µs input)



NOTE A: The pulse generator has the following characteristics: Z_O = 50 Ω, duty cycle ≤ 50%.

Figure 3. Test Circuit and Waveforms for t_{THL} and t_{TLH} Measurements (20-µs input)

APPLICATION INFORMATION

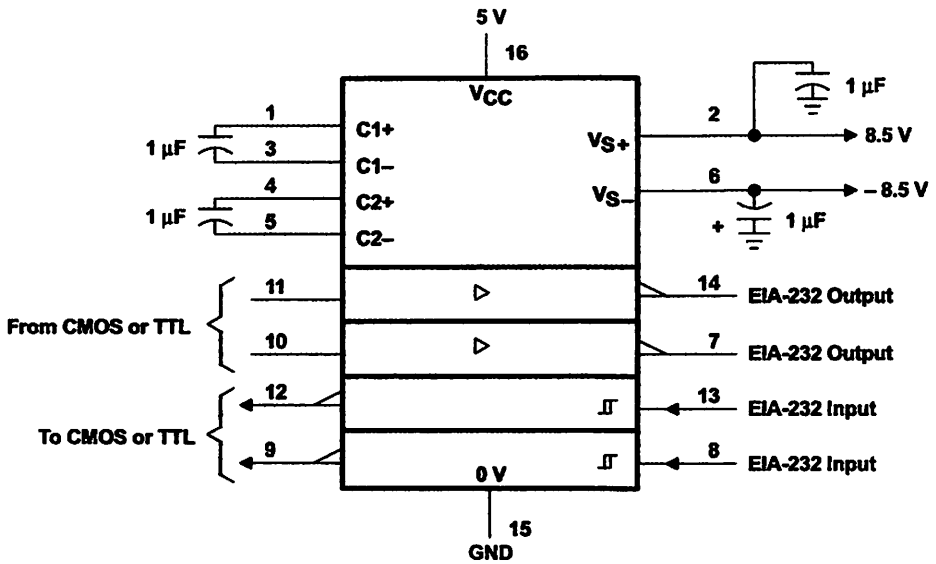


Figure 4. Typical Operating Circuit

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Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265