

LEMBAR PERSETUJUAN



APLIKASI RFID SEBAGAI PENGECEK ID BAGI WARGA PENDATANG KE PULAU BALI MENGGUNAKAN WIRELESS SYSTEM

SKRIPSI

*Disusun Untuk Melengkapi dan Memenuhi Persyaratan
Guna Mencapai Gelar Sarjana Teknik Elektronika Strata Satu (S-1)*

Disusun Oleh :

I MADE HENDRY JAYAMIHARJA

NIM: 03.17.122

Diperiksa dan Disetujui

Dosen Pembimbing I

Dosen Pembimbing II

Joseph Dedy Irawan, ST. MT

NIP. 132315178

I Komang Somawirata, ST. MT

NIP. 1030100361



Mengetahui
Ketua Jurusan Teknik Elektro S-1

Ir. F. Yudi Lipraptano, MT

NIP.P 1039500274

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

2007



BERITA ACARA UJIAN SKRIPSI
FAKULTAS TEKNOLOGI INDUSTRI

NAMA : I MADE HENDRY JAYA.M.
NIM : 03.17.122
JURUSAN : TEKNIK ELEKTRO S-1
KONSENTRASI : ELEKTRONIKA
JUDUL SKRIPSI : APLIKASI RFID SEBAGAI PENGECEK ID BAGI
WARGA PENDATANG KE PULAU BALI
MENGUNAKAN WIRELESS SISTEM.

Dipertahankan dihadapan Majelis Penguji Skripsi Jenjang Strata Satu (S-1), pada:

Hari : Senin
Tanggal : 3 September 2007
Dengan nilai : 86,9(A) *84*



Ir. Mochtar Asroni, MSME
NIP.Y.1018100036

Panitia Ujian Skripsi

Sekretaris

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

Anggota Penguji

Penguji I

Ir. Widodo Pudji Mulyanto, MT
NIP.Y.1028700171

Penguji II

Dr. Cahyo Crysdiان, MSc
NIP.103040412

ABSTRAKSI

APLIKASI RFID SEBAGAI PENGECEK ID BAGI WARGA PENDATANG KE PULAU BALI MENGGUNAKAN WIRELESS SYSTEM

I Made Hendry Jayamiharja
0317122

Jurusan Teknik Elektronika S1- Institut Teknologi Nasional Malang
Jl. Raya karanglo Km.02 Malang, Indonesia
cutes_lc@yahoo.com

Sejak tragedi bom yang terjadi di Bali, setiap pelabuhan di Bali diperketat dengan sistem pemeriksaan KTP bagi para pendatang dengan cara di-*scan*, namun dalam penerapannya sistem ini kurang efisien mengingat banyak pendatang yang tidak memiliki KTP dan tidak ikut turun dari bus saat pemeriksaan KTP. Sementara itu sebuah sistem keamanan identifikasi yang efisien harus memperhatikan hal – hal seperti kemudahan, kecepatan dan keakuratan dalam identifikasi. Untuk mencapai tiga hal tersebut maka teknologi RFID merupakan suatu solusi yang sangat tepat untuk diterapkan.

Pada skripsi ini membahas tentang aplikasi RFID *reader* yang dapat dikomunikasikan secara *wireless* dengan komputer yang berisikan *database* sehingga dapat diaplikasikan untuk mempermudah identifikasi bagi pendatang ke pulau Bali dimana penumpang tidak perlu turun dari kendaraan dan hanya petugas yang masuk ke kendaraan untuk memeriksa identitas pendatang.

Dengan menggunakan sistem ini, identifikasi bagi para pendatang ke pulau Bali dapat dilakukan dengan mudah, cepat dan akurat. Dimana untuk pendatang yang baru pertama ke Bali harus melakukan pendaftaran pada bagian administrasi yang memerlukan waktu sekitar 2 menit untuk mendapatkan *tag* RFID.

KATA PENGANTAR

Puja syukur ke hadirat Ida Sang Hyang Widhi Wasa, Tuhan Yang Maha Esa, karena atas Asung Kerta Wara Nugraha-Nya, tugas akhir yang berjudul Aplikasi RFID Sebagai Pengecek ID Bagi Warga Pendatang Ke Pulau Bali Menggunakan Wireless System ini dapat terselesaikan dengan baik. Tugas akhir ini merupakan salah satu syarat dalam menempuh ujian untuk memperoleh gelar Sarjana Teknik dalam Program S1 Teknik Elektronika, Fakultas Teknologi Industri, Institut Teknologi Nasional Malang.

Proses penyusunan tugas akhir ini tentunya tidak lepas dari bantuan berbagai pihak. Oleh karena itu sebagai rasa wujud syukur atas kesempatan dan kepercayaan yang telah diberikan maka, tidak berlebihan bila penulis mengucapkan terima kasih kepada :

- 1. Bapak Ir. F. Yudi Limpraptono, MT. selaku Kepala Jurusan Teknik Elektronika Insitut Teknologi Nasional Malang.**
- 2. Bapak Joseph Dedy Irawan, ST, MT. selaku pembimbing I dan Bapak I Komang Somawirata, ST.MT selaku pembimbing II yang telah banyak memberikan bimbingan, petunjuk, maupun saran dalam penyusunan tugas akhir ini.**
- 3. Seluruh Dosen, Staf Akademik dan Karyawan di lingkungan Lab. Elektro ITN Malang yang telah banyak membantu kelancaran selama perkuliahan.**
- 4. Semua pihak yang tidak dapat disebutkan satu persatu.**

**Semoga tugas akhir ini dapat memberikan manfaat bagi semua pihak,
khususnya mahasiswa Teknik Elektronika Institut Teknologi Nasional Malang.**

Malang, September 2007

Penulis

LEMBAR PERSEMBAHAN

Om Swastyastu

Puji dan Syukur penyusun panjatkan ke hadirat Ida Sang Hyang Widi Wasa, karena dengan rahmat dan petunjuk-Nya serta usaha yang semaksimal mungkin, penulis mampu menyelesaikan tugas Skripsi ini.

Pada kesempatan ini penulis mengucapkan terima kasih kepada semua pihak yang telah membantu dalam penulisan laporan skripsi ini, diantaranya:

Sang Hyang Aji Saraswati, Ida Betara Guru karena atas sinar sucinya yang selalu memancar dan memberi kekuatan semangat kepada penulis.

Kedua orang tua tercinta I Gd. Muriata dan Ni Made R Sudiadnyani serta kakakku Ni Putu Trisna Hidayati dan adikku I Ketut Adi Suhendra beserta seluruh keluarga besarku yang senantiasa memberi kasih sayang dan dorongan moral dan materi serta doa.

Semeton Bali Enjoy (Antok, Bentir, Dedik, Abonk), Komang John, dan Nani Siswanti yang selalu memberikan semangat dan bantuan.

Temen-temen IMHD baik yang satu angkatan adik tingkat maupun kakak tingkat serta teman-teman @cintya n buat Iefan dan Imron semangat ya...!!!!).

Temen-temen ELKA-S1 2003 semoga semua sukses.

Temen-teman yang baik yang ngak bisa aku sebutin satu persatu, dan maaf pada semua orang yang pernah aku sakitin (sorry yaaa...).

– Thanks for All –

Om Śanti Śanti Śanti Om

DAFTAR ISI

| | Hal |
|-----------------------------------|------------|
| LEMBAR PERSETUJUAN..... | i |
| ABSTRAKSI..... | ii |
| KATA PENGANTAR..... | iii |
| DAFTAR ISI..... | v |
| DAFTAR GAMBAR..... | x |
| DAFTAR TABEL..... | xiii |
| | |
| BAB I PENDAHULUAN | |
| 1.1. Latar Belakang..... | 1 |
| 1.2. Rumusan Masalah..... | 2 |
| 1.3. Batasan Masalah..... | 2 |
| 1.4. Tujuan..... | 3 |
| 1.5. Metodologi..... | 3 |
| 1.6. Sistematika Penulisan..... | 4 |
| | |
| BAB II TEORI DASAR | |
| 2.1. Mikrokontroller AT89S51..... | 6 |
| 2.1.1 Arsitektur AT89S51..... | 6 |
| 2.1.2 Pin Deskripsi..... | 9 |
| 2.1.3 RAM <i>Internal</i> | 16 |
| 2.1.4 Register Fungsi Khusus..... | 21 |
| 2.2. RFID..... | 28 |

| | |
|---------------------------------------------------------|-----------|
| 2.3. LCD (<i>Liquid Crystal Display</i>) | 32 |
| 2.3.1 Konfigurasi LCD | 32 |
| 2.3.2 Intruksi Operasi Dasar | 34 |
| 2.3.2.1 Register | 34 |
| 2.3.2.2 Busy Flag | 35 |
| 2.3.2.3 Address Counter | 35 |
| 2.3.2.4 Display Data RAM (DD RAM) | 36 |
| 2.3.2.5 Character Generator ROM (CG ROM) | 36 |
| 2.3.2.6 Character Generator RAM (CG RAM) | 36 |
| 2.4. BUZZER | 37 |
| 2.5. Komunikasi Serial | 37 |
| 2.5.1. Komunikasi Sinkron | 38 |
| 2.5.2. Komunikasi Asinkron | 39 |
| 2.5.3. Arah Pengiriman Data | 40 |
| 2.6. Serial Port RS – 232 | 40 |
| 2.7. MAX 232 Sebagai Pengubah Tegangan TTL | 43 |
| 2.8. TLP 434 dan RLP 434 | 46 |
| 2.9. Transistor Sebagai Switching | 47 |
| 2.10. IC LM 358 | 49 |
| 2.11. Microsoft SQL Server 2000 | 50 |
| 2.11.1. Interface SQL Server 2000 | 50 |
| 2.11.2. Database | 51 |
| 2.11.3. Tabel | 51 |
| 2.11.4 Primary Key dan Foreign Key | 52 |

| | |
|----------------------------------------------|----|
| 2.12 Bahasa Pemrograman Borland Delphi | 52 |
|----------------------------------------------|----|

| | |
|-----------------------------------------------------------------|----|
| 2.12.1. IDE (Integrated Development Environment) Delphi | 53 |
|-----------------------------------------------------------------|----|

BAB III PERANCANGAN DAN PEMBUATAN ALAT

| | |
|------------------------|----|
| 3.1. Pendahuluan | 59 |
|------------------------|----|

| | |
|---------------------------------------|----|
| 3.2 Perencanaan Perangkat Keras | 63 |
|---------------------------------------|----|

| | |
|-------------------------------------------|----|
| 3.2.1 Sistem Mikrokontroler AT89S51 | 63 |
|-------------------------------------------|----|

| | |
|-------------------------------------------------------|----|
| 3.2.2 Antarmuka RFID Reader dengan modul TLP 434..... | 67 |
|-------------------------------------------------------|----|

| | |
|-------------------------------------------------------|----|
| 3.2.3 Antarmuka modul RLP 434 ke Mikrokontroler | 71 |
|-------------------------------------------------------|----|

| | |
|----------------------------------------------------|----|
| 3.2.4 Antarmuka Mikrokontroller ke modul LCD | 74 |
|----------------------------------------------------|----|

| | |
|----------------------------------------------|----|
| 3.2.5 Antarmuka modul RLP 434 ke RS 232..... | 75 |
|----------------------------------------------|----|

| | |
|-----------------------------------------------|----|
| 3.2.6 Antarmuka RS 232 ke modul TLP 434 | 76 |
|-----------------------------------------------|----|

| | |
|------------------------------------|----|
| 3.2.7 Antarmuka RS 232 ke PC | 77 |
|------------------------------------|----|

| | |
|--------------------------------------------------|----|
| 3.3 Perencanaan Perangkat Lunak / Software | 78 |
|--------------------------------------------------|----|

| | |
|-----------------------------------------------|----|
| 3.3.1 Software di Mikrokontroler (MCU)..... | 78 |
|-----------------------------------------------|----|

| | |
|----------------------------------|----|
| 3.3.2 Perancangan Database | 80 |
|----------------------------------|----|

| | |
|-----------------------------------------------------|----|
| 3.3.3 Perancangan Perangkat Lunak Pada Delphi | 81 |
|-----------------------------------------------------|----|

BAB IV PENGUJIAN ALAT

| | |
|----------------|----|
| 4.1. Umum..... | 89 |
|----------------|----|

| | |
|-------------------------|----|
| 4.2. Pengujian LCD..... | 89 |
|-------------------------|----|

| | |
|----------------------------------|----|
| 4.2.1. Tujuan Pengujian LCD..... | 89 |
|----------------------------------|----|

| | |
|--------------------------------------|----|
| 4.2.2. Peralatan yang digunakan..... | 90 |
|--------------------------------------|----|

| | |
|---------------------------------------------------------------------|-----|
| 4.2.3. Prosedur Pengujian..... | 90 |
| 4.2.4. Hasil Pengujian..... | 92 |
| 1.3. Pengujian Komunikasi Serial | 93 |
| 1.3.1. Tujuan Pengujian Komunikasi Serial..... | 93 |
| 1.3.2. Peralatan yang dibutuhkan | 93 |
| 4.3.3. Prosedur Pengujian Komunikasi Serial..... | 93 |
| 4.3.4 Hasil Pengujian Komunikasi Serial..... | 94 |
| 1.4. Pengujian RFID <i>Reader</i> | 95 |
| 1.4.1. Tujuan Pengujian RFID <i>Reader</i> | 95 |
| 4.4.2. Peralatan Yang Dibutuhkan..... | 95 |
| 4.4.3. Prosedur Pengujian RFID <i>Reader</i> | 95 |
| 4.4.4. Hasil Pengujian dan Analisis..... | 96 |
| 4.5. Pengujian Kondisi <i>Wireless</i> TLP/RLP 434A | 97 |
| 4.5.1. Tujuan Pengujian Kondisi <i>Wireless</i> TLP/RLP 434A..... | 97 |
| 4.5.2. Peralatan Yang Dibutuhkan..... | 97 |
| 4.5.3. Prosedur Pengujian Kondisi <i>Wireless</i> TLP/RLP 434A..... | 97 |
| 4.5.4. Hasil Pengujian Kondisi <i>Wireless</i> TLP/RLP 434A..... | 98 |
| 4.6. Pengujian Sinyal Keluaran TLP/RLP 434..... | 99 |
| 4.6.1. Tujuan Pengujian Sinyal Keluaran TLP/RLP 434 | 99 |
| 4.6.2. Peralatan Yang Dibutuhkan..... | 99 |
| 4.6.3. Prosedur Pengujian Sinyal Keluaran TLP/RLP 434 | 99 |
| 4.6.4. Hasil Pengujian Sinyal Keluaran TLP/RLP 434 | 100 |
| 4.7. Pengujian Frekuensi Pembawa dari TLP/RLP 434A | 101 |
| 4.7.1. Tujuan Pengujian Frekuensi Pembawa dari TLP/RLP 434A..... | 101 |

| | |
|---------------------------------------------------------------------|-----|
| 4.7.2. Peralatan Yang Dibutuhkan..... | 101 |
| 4.7.3. Prosedur Pengujian Frekuensi Pembawa dari TLP/RLP 434A | 101 |
| 4.7.4. Hasil Pengujian Frekuensi Pembawa dari TLP/RLP 434A..... | 102 |
| 4.8. Pengujian Alat Keseluruhan..... | 102 |
| 4.8.1. Tujuan Pengujian Alat Keseluruhan..... | 102 |
| 4.8.2. Peralatan Yang Dibutuhkan..... | 102 |
| 4.8.3. Prosedur Pengujian Alat Keseluruhan..... | 102 |
| 4.8.4. Hasil Pengujian Alat Keseluruhan | 104 |

BAB V PENUTUP

| | |
|----------------------|-----|
| 5.1. Kesimpulan..... | 108 |
| 5.2. Saran..... | 109 |

| | |
|---------------------|-----|
| DAFTAR PUSTAKA..... | 110 |
|---------------------|-----|

LAMPIRAN

DAFTAR GAMBAR

| | | |
|-------------|----------------------------------------------------------------------------------|----|
| Gambar 2-1 | Blok Diagram AT89S51..... | 7 |
| Gambar 2-2 | Pin – Pin AT89S51..... | 9 |
| Gambar 2-3 | Rangkaian Power On Reset..... | 13 |
| Gambar 2-4 | Rangkaian Kristal..... | 14 |
| Gambar 2-5 | Alamat RAM Internal dan Flash PEROM | 15 |
| Gambar 2-6 | Pengalamatan Secara Langsung | 18 |
| Gambar 2-7 | Step – Step Yang Terjadi Pada Pemindahan Data 5 ke Alamat 30H hingga 34H..... | 20 |
| Gambar 2-8 | Bit – Bit Port 1..... | 22 |
| Gambar 2-9 | Diagram Alir Deteksi Bit Ketiga Port 1 | 23 |
| Gambar 2-10 | Komunikasi Antara <i>Reader</i> dan <i>Transmitter (Tag)</i> | 28 |
| Gambar 2-11 | Konfigurasi Pin ID-12 (RFID <i>Reader</i>)..... | 29 |
| Gambar 2-12 | <i>Tag</i> RFID tipe ISO Card GK4001..... | 31 |
| Gambar 2-13 | <i>Tag</i> RFID tipe Alien MPI..... | 32 |
| Gambar 2-14 | Deskripsi pin pada LCD Tipe M1632..... | 33 |
| Gambar 2-15 | Rangkaian <i>Driver Buzzer</i> | 37 |
| Gambar 2-16 | Komunikasi serial dengan Sinyal Sinkronisasi | 38 |
| Gambar 2-17 | Format Sinyal Serial Asinkron | 39 |
| Gambar 2-18 | IC MAX 232..... | 44 |
| Gambar 2-19 | Konektor DB-9..... | 45 |
| Gambar 2-20 | Ultra Small Transmitter (TLP434A)..... | 47 |
| Gambar 2-21 | RLP 434A SAW Based Receiver | 47 |

| | | |
|-------------|-------------------------------------------------------------------|----|
| Gambar 2-22 | Transistor dalam keadaan <i>Saturasi</i> | 48 |
| Gambar 2-23 | Transistor dalam keadaan <i>Cut Off</i> (sumbat)..... | 49 |
| Gambar 2-24 | IC LM 358 (<i>Low Power Dual Operational Amplifier</i>) | 49 |
| Gambar 2-25 | IDE (<i>Integrated Development Enviroment</i>) | 54 |
| Gambar 3-1 | Animasi Perancangan Sistem | 59 |
| Gambar 3-2 | Flowcart alur pengecekan dan pendaftaran penumpang | 60 |
| Gambar 3-3 | Blok Diagram Sistem | 61 |
| Gambar 3-4 | Rangkaian Mikrokontroler AT89S51 | 64 |
| Gambar 3-5 | Rangkaian Pewaktu | 65 |
| Gambar 3-6 | Rangkaian <i>Power On Reset</i> | 66 |
| Gambar 3-7 | Rangkaian dari RFID dan TLP 434 | 68 |
| Gambar 3-8 | Rangkaian modul RLP 434 ke Mikrokontroller | 72 |
| Gambar 3-9 | Rangkaian LCD LM1632..... | 75 |
| Gambar 3-10 | Rangkaian modul RLP 434 ke MAX 232 | 76 |
| Gambar 3-11 | Rangkaian RS 232 ke modul TLP 434..... | 76 |
| Gambar 3-12 | Rangkaian Antarmuka RS 232 ke PC | 77 |
| Gambar 3-13 | Flowchart Perancangan Perangkat Lunak Pada Mikrokontroler..... | 79 |
| Gambar 3-14 | Membuat Tabel Biodata (T_Biodata)..... | 80 |
| Gambar 3-15 | Membuat Tabel Kedatangan (T_Kedatangan) | 81 |
| Gambar 3-16 | Flowchart Perancangan Perangkat Lunak Pada Delphi | 82 |
| Gambar 3-17 | Membuat Koneksi ke <i>Database</i> | 83 |
| Gambar 3-18 | Membuat Koneksi ke <i>Database</i> | 84 |
| Gambar 4-1 | Rangkaian Pengujian LCD..... | 90 |

| | | |
|--------------------|----------------------------------------------------------------------------------|------------|
| Gambar 4-2 | Hasil Pengujian LCD..... | 93 |
| Gambar 4-3 | Rangkaian Pengujian Komunikasi Serial | 93 |
| Gambar 4-4 | Hasil Pengujian Komunikasi Serial..... | 95 |
| Gambar 4-5 | Rangkaian Pengujian RFID Reader | 96 |
| Gambar 4-6 | Hasil Pembacaan RFID Reader..... | 97 |
| Gambar 4-7 | Rangkaian Pengujian Kondisi TLP/RLP 434..... | 98 |
| Gambar 4-8 | Rangkaian Pengujian Sinyal Keluaran TLP/RLP 434 | 99 |
| Gambar 4-9 | Gelombang keluaran dari RLP 434A | 100 |
| Gambar 4-10 | Gelombang keluaran dari RLP 434A setelah melewati rangkaian RC..... | 100 |
| Gambar 4-11 | Gelombang keluaran dari RLP 434A setelah melewati penguatan IC LM358..... | 101 |
| Gambar 4-12 | Gelombang keluaran dari RLP 434A..... | 102 |
| Gambar 4-13 | Skema Pengujian Keseluruhan | 103 |
| Gambar 4-14 | Gambar Pengujian Keseluruhan | 103 |
| Gambar 4-15 | Gambar Pengujian Tampilan Kode Tag RFID..... | 104 |
| Gambar 4-16 | Gambar Tag RFID..... | 104 |
| Gambar 4-17 | Tampilan ‘Belum Terdaftar’ pada LCD..... | 105 |
| Gambar 4-18 | Gambar Pengujian Pendaftaran Pendaftar Baru..... | 105 |
| Gambar 4-19 | Gambar Pengujian Hasil Pendaftaran Pendaftar Baru | 106 |
| Gambar 4-20 | Tampilan nama pada LCD | 106 |

DAFTAR TABEL

| | | |
|-----------|--------------------------------------------------------|-----|
| Tabel 2-1 | Fungsi – Fungsi <i>Alternative Port 1</i> | 10 |
| Tabel 2-2 | Fungsi – Fungsi Alternatif Port 3 | 12 |
| Tabel 2-3 | <i>Datasheet RFID Reader</i> | 30 |
| Tabel 2-4 | Konfigurasi Pin-pin LCD | 34 |
| Tabel 2-5 | Tabel Register Seleksi | 35 |
| Tabel 2-6 | Fungsi Terminal Pada LCD..... | 36 |
| Tabel 2-7 | Nama Pin dan Keterangan dari Port RS – 232 | 42 |
| Tabel 2-8 | Fungsi Pin RS-232 dalam DB-9..... | 45 |
| Tabel 3-1 | Form yang digunakan dalam perancangan..... | 83 |
| Tabel 3-2 | Konfigurasi komponen <i>ADOConnection</i> | 84 |
| Tabel 3-3 | Konfigurasi komponen <i>ADOQuery</i> | 85 |
| Tabel 3-4 | Konfigurasi komponen <i>ADOCommand</i> | 86 |
| Tabel 3-5 | Konfigurasi komponen <i>DataSource</i> | 86 |
| Tabel 3-6 | Konfigurasi komponen <i>Vacomm</i> | 87 |
| Tabel 3-7 | Konfigurasi komponen <i>Timer</i> | 87 |
| Tabel 3-8 | Konfigurasi komponen <i>DBGrid</i> | 88 |
| Tabel 4-1 | Pengujian Jarak Kepekaan <i>RFID Reader</i> | 96 |
| Tabel 4-2 | Hasil pengujian TLP dan RLP 434..... | 98 |
| Tabel 4-3 | Hasil pengujian jarak jangkauan alat keseluruhan | 107 |

BAB I

PENDAHULUAN

1.1 Latar Belakang

Sejak peristiwa Bom Bali I dan Bom Bali II pemerintah propinsi Bali memperketat pemeriksaan KTP untuk pendatang yang masuk ke Bali. Saat ini pemeriksaan Kartu Tanda Penduduk (KTP) bagi pendatang yang masuk ke Bali masih dilakukan dengan cara men-*scan* KTP pendatang, dimana pendatang harus turun dari bus dan berjalan ke arah loket untuk men-*scan* KTPnya. Sistem ini kurangnya efisien mengingat banyak pendatang yang tidak memiliki KTP dan tidak ikut turun dari bus saat pemeriksaan KTP.

Radio Frequency Identification (RFID) merupakan sebuah teknologi *compact wireless* yang diunggulkan untuk mentransformasi dunia komersial. RFID adalah sebuah teknologi yang memanfaatkan frekuensi radio untuk identifikasi otomatis terhadap obyek-obyek atau manusia.

Sistem RFID merupakan suatu tipe sistem identifikasi otomatis yang bertujuan untuk memungkinkan data ditransmisikan oleh peralatan *portable* yang disebut *tag*, yang dibaca oleh suatu *reader* RFID dan diproses menurut kebutuhan dari aplikasi tertentu. Data yang ditransmisikan oleh *tag* dapat menyediakan informasi identifikasi atau lokasi, atau hal-hal khusus tentang produk-produk ber-*tag*, seperti harga, warna, tanggal pembelian dan lain-lain sehingga *tag* RFID menawarkan solusi identifikasi dengan berbagai macam tingkat keamanan.

Dengan mengacu pada paragraf awal, maka perlu dibuat suatu cara sistem pemeriksaan tanda pengenal yang lebih efisien, yaitu dengan menggabungkan teknologi *database* dan RFID. Metode pengaksesan akan memanfaatkan sistem RFID yang mengkodekan identitas yang akan didisimpan pada *database*. Dengan model sistem seperti ini diharapkan efisiensi pemeriksaan KTP menjadi lebih baik dan bisa dilakukan dengan penumpang hanya duduk di bus dan petugas pemeriksa yang naik ke bus untuk memeriksa dan men-*scan*.

1.2 Rumusan Masalah

Dari sistem yang akan dibuat, dapat disimpulkan beberapa permasalahan yaitu :

1. Bagaimana merencanakan sistem pengecekan identitas pendatang
2. Bagaimana cara pengaturan dan penentuan sistem koneksi antara sistem *database* dan aplikasi yang akan dibangun dengan menggunakan pemrograman *Delphi*.
3. Bagaimana merancang sistem komunikasi *wireless* antara RFID *Reader* dengan komputer, serta antara komputer dengan mikrokontroler.

1.3 Batasan Masalah

Agar permasalahan yang akan dibahas tidak meluas, maka tugas akhir ini dibatasi hanya pada hal – hal sebagai berikut :

1. Alat yang digunakan disesuaikan dengan komponen yang ada dipasaran, maka dalam hal ini pembahasan dimensi dan kebutuhan daya listrik alat diabaikan.

2. Mikrokontroler yang digunakan adalah AT89S51.
3. Tidak membahas antenna
4. Tag RFID yang digunakan adalah jenis ISO Card GK4001
5. Jarak penerimaan dan pengiriman data tidak lebih dari 45 meter

1.4. Tujuan Perancangan

Perancangan dan pembuatan sistem aplikasi pemeriksaan KTP dengan RFID *Reader* yang dihubungkan dengan komputer secara *wireless* sehingga untuk pemeriksaan KTP penumpang tidak perlu turun dari bus atau mendatangi loket pemeriksaan dan hanya petugas pemeriksa yang memeriksa dengan membawa RFID *Reader*. Semua data pendatang ataupun penduduk Bali sendiri disimpan dalam database sehingga sistem ini juga dapat dikembangkan kedepannya untuk pemeriksaan identitas bagi pendatang yang masuk ke mall, cafe, tempat pariwisata, kantor dan lain-lain yang memerlukan pengamanan yang optimal.

1.5. Metodologi

Adapun langkah-langkah yang diambil untuk menyelesaikan perubahan teoritis pada perancangan dan pembuatan alat ini adalah sebagai berikut :

1. Studi literatur, yaitu mengumpulkan data dan bahan – bahan acuan yang dapat digunakan untuk perencanaan dan pembuatan alat.
2. Perencanaan dan pembuatan alat yang digunakan dengan cara pendekatan secara *hardware* dan *software*.
3. Perencanaan blok diagram.

4. Pembuatan alat secara keseluruhan, menyatukan rangkaian dan masing – masing blok diagram untuk mendapatkan rangkaian secara lengkap.
5. Menguji peralatan sebagai unit pemroses.
6. Menyusun naskah skripsi.

1.6. Sistematika Penulisan

Penyusunan laporan skripsi ini secara garis besar terdiri dari lima bab, yang masing – masing bab berisi pembahasan tertentu dengan rincian sebagai berikut :

BAB I : PENDAHULUAN

Berisi latar belakang permasalahan, rumusan masalah, tujuan masalah, batasan masalah, metodologi penulisan dan sistematika penulisan.

BAB II : LANDASAN TEORI

Membahas tentang teori penunjang secara umum yang diperlukan dengan memakai referensi – referensi dari beberapa sumber dimana teori ini merupakan acuan dalam perencanaan dan pembuatan alat.

BAB III : PERENCANAAN DAN PEMBUATAN ALAT

Meliputi penjelasan blok diagram serta perencanaan dan pembuatan *hardware* dan *software*.

BAB IV : PENGUJIAN ALAT

Membahas pengujian peralatan secara keseluruhan dan analisa hasil pengujian.

BAB V : PENUTUP

Berisikan tentang kesimpulan dari pembahasan pada bab – bab sebelumnya.

BAB II

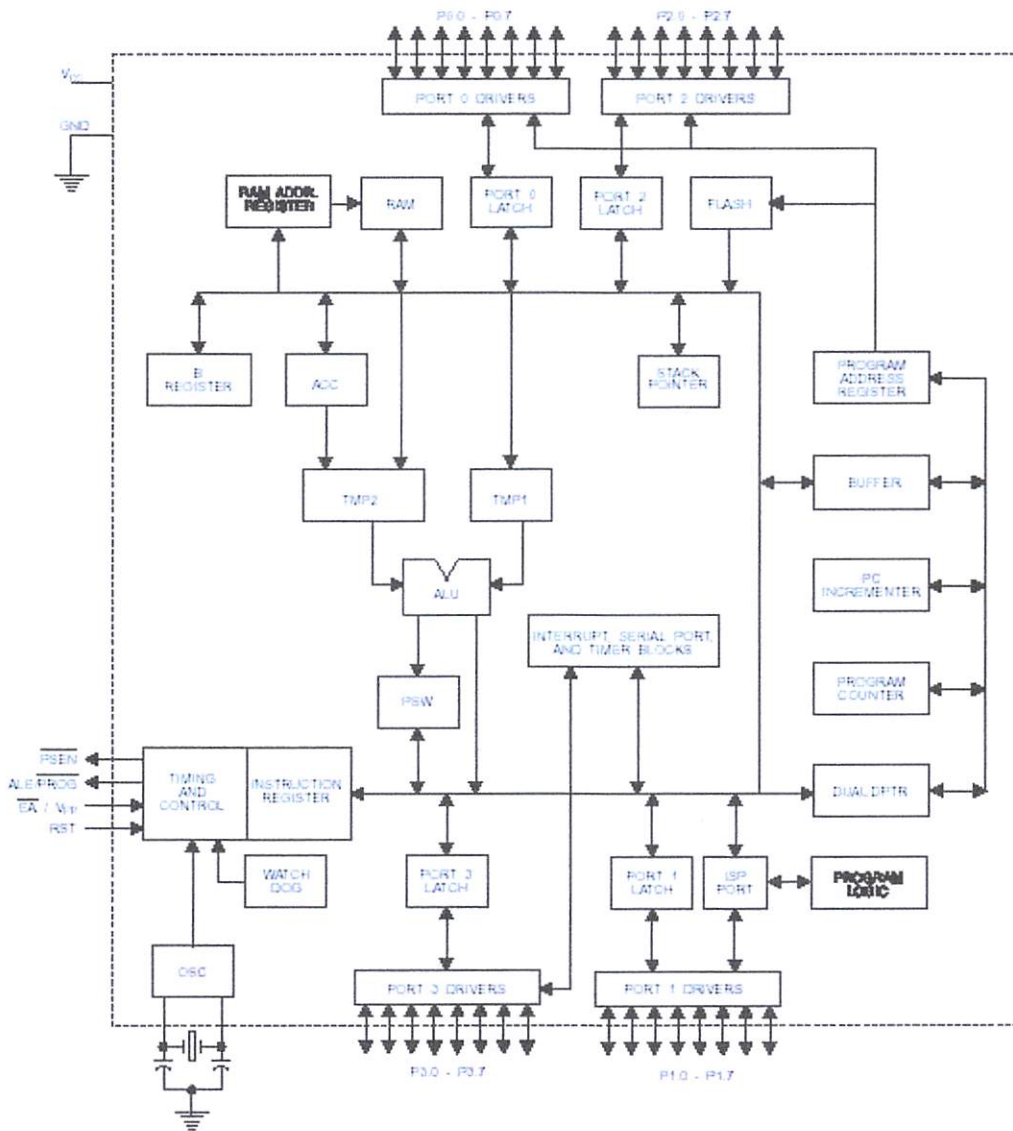
TEORI DASAR

Untuk dapat memahami alat yang akan dirancang, maka dalam bab ini akan dijelaskan mengenai teori dasar yang berkaitan dengan sistem ini.

2.1. Mikrokontroler AT89S51

2.1.1. Arsitektur AT89S51

Mikrokontroler AT89S51 merupakan salah satu anggota keluarga MCS-51, yaitu suatu komponen produksi ATMEL yang berorientasi kontrol (*microcontroller*). Intel mengklarifikasikan dalam kelompok *embedded microcontroller*, yang artinya adalah mikrokontroler yang dapat diprogram ulang (*reprogrammable*). Di dalam *chip* mikrokontroler AT89S51 ini sudah tersedia berbagai macam peralatan pendukung mikroprosesor seperti RAM, *serial port*, *bus - bus* data dan lainnya yang membuat pemakai *chip* ini dapat menekan penambahan komponen pendukung. Spesifikasi perangkat keras dari mikrokontroler AT89S51 adalah sebagai berikut :



Gambar 2 – 1
Blok Diagram AT89S51
(Sumber : Datasheet ATMEL AT89S51)

AT89S51 adalah mikrokontroler keluaran atmel dengan 4K *byte Flash* PEROM (*Programmable and Erasable Read Only Memory*), AT89S51 merupakan memori dengan teknologi *nonvolatile memori*, artinya isi memori tersebut dapat diisi ulang ataupun dihapus berulang kali.

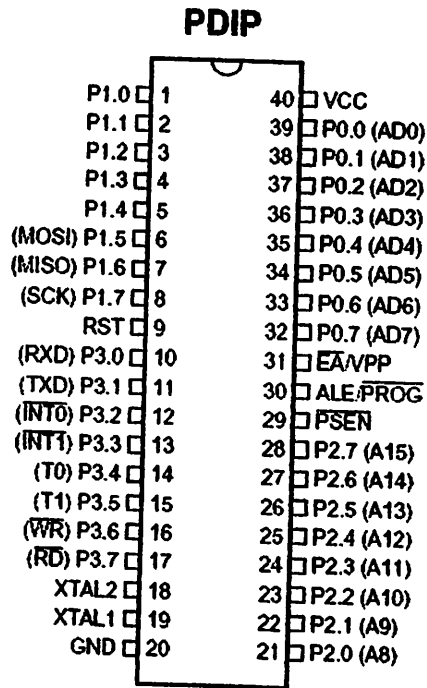
Memori ini biasa digunakan untuk menyimpan instruksi (Perintah) berstandar MCS – 51 code sehingga memungkinkan mikrokontroler ini untuk

bekerja dalam mode *Single Chip Operation* (Mode Operasi Keping Tunggal) yang tidak memerlukan *Eksternal Memori* (Memori luar) untuk menyimpan *source code* tersebut.

IC ATMEL AT89S51 menyediakan standart berikut:

- 4K Bytes memori yang dapat diprogram ulang
- 128 Bytes internal RAM
- 32 jalur I/O (*Input* dan *Output*) yang dapat diprogram
- Sepasang 16 bit *Timer* dan *Counter*
- *Dual data Pointer* (DPTR)
- *Watchdog Timer*
- ISP Port
- Mendukung *serial Port* secara penuh
- Waktu Pemrograman yang singkat

Sebagai tambahan AT89S51 dirancang menggunakan logika yang statis untuk mode pengoperasian yang menuju ke frekuensi dasar dan pendudukan terhadap dua *software*, serta dapat memilih model *power savingnya*. Mode idle akan berhenti ketika CPU sedang menjalankan RAM, *Timer/Counter*, *Serial Port* dan *interrupt system* untuk terus melanjutkan fungsinya. Model *power down* akan menyimpan isi dari RAM tapi akan memberhentikan osilator dan akan menghentikan semua chip lain yang sedang berfungsi sampai terdapat adanya gangguan dari luar atau *hardware* di reset.



Gambar 2 – 2
Pin – Pin AT89S51
 (Sumber : Datasheet ATMEL AT89S51)

2.1.2. Pin Deskripsi

VCC : Power Supply

GND : Ground

Port 0 : *Port 0* berfungsi sebagai 8 bit I/O bertipe *open drain bi-directional*.

Sebagai *port* keluaran masing – masing pin dapat menyerap arus sebesar 8 masukan TTL (sekitar 3,8 mA). Ketika diberikan logika ‘1’ pada pin *port 0* ini maka pin – pin *port 0* ini akan dapat digunakan sebagai inputan berimpedansi tinggi. *Port 0* juga dapat dikonfigurasi pada sebagai bus alamat/data selama proses pengaksesan data memori dan program eksternal. Jika digunakan dalam mode ini *port 0* memiliki internal *Pull Up*.

Port 0 juga menerima kode – kode data yang diberikan padanya selama proses pemrograman dan memberikan kode – kode selama proses verifikasi program yang telah tersimpan didalam memori. Dalam hal ini dibutuhkan eksternal *Pull Up* selama proses verifikasi program.

Port 1 : *Port 1* berfungsi sebagai 8 bit I/O Bi-directional yang dilengkapi dengan internal *Pull Up*. Ketika diberikan logika ‘1’ pin ini akan di *Pull Up* secara internal sehingga dapat digunakan sebagai input. Sebagai inputan jika pin – pin ini dihubungkan ke *ground* maka masing – masing pin ini dapat menghantarkan arus karena di *Pull High* secara internal. *Port 1* juga menerima *Low Order Address Bytes* selama melakukan verifikasi program. Pada *port 1* di AT89S51 pin ini mempunyai alternatif seperti pada tabel berikut ini:

Tabel 2 – 1
Fungsi – Fungsi Alternative Port 1

| Port Pin | Alternate Funtions |
|-----------------|-----------------------------------------------------|
| P1.5 | MOSI (Master Output Slave Input)[*] |
| P1.6 | MISO (Master Input Slave Output)[*] |
| P1.7 | SCK (Serial Clock)[*] |

(Sumber : Datasheet AT89S51)

Port 2 : *Port 2* berfungsi sebagai 8 bit I/O *Bi-directional* yang dilengkapi dengan *internal Pull Up* Penyangga keluaran *port 2* dapat memberikan atau menyerap arus empat masukan TTL (sekitar 1,6 mA).

Jika diberikan logika '1' pada pin – pin *port 2*, maka masing – masing pin akan di *Pull High* secara internal sehingga dapat digunakan sebagai inputan. Sebagai masukan jika pin – pin *port 2* dihubungkan ke *ground* (di *Pull Low*), maka , masing – masing pin dapat menghantarkan arus karena di *Pull High* secara internal.

Port 2 akan memberikan byte alamat bagian tinggi (*High Byte*) selama pengambilan instruksi dari memori program eksternal dan selama pengaksesan memori data eksternal yang menggunakan perintah dengan alamat 16 bit (misalkan *MOVX@DPTR*). Dalam aplikasi ini , jika ingin mengirimkan '1', maka digunakan *Pull Up* internal yang sudah disediakan. Selama pengaksesan memori data eksternal yang menggunakan perintah 8 bit (misalkan *MOVX@RI*), *port 2* akan mengirimkan isi dari SFR *P2* (*Special Function Register Port 2*). *Port 2* juga menerima alamat bagian tinggi (*High Order Address*) selama pemrograman dan verifikasi memori.

Port 3 : *Port 3* sebagai 8 bit I/O *Bi-directional* yang dilengkapi dengan *Pull Up Internal*. Penyangga keluaran *port 3* dapat memberikan atau menyerap arus empat masukan TTL (sekitar 1,6 mA).

Jika diberikan logika '1' pada pin pin *port 3*, maka masing – masing pin akan di *Pull High* oleh *Pull Up internal* sehingga dapat

digunakan sebagai inputan. Sebagai inputan, jika pin – pin *port 3* dihubungkan ke *ground*, maka masing – masing kaki akan memberikan arus karena di *Pull High* secara internal.

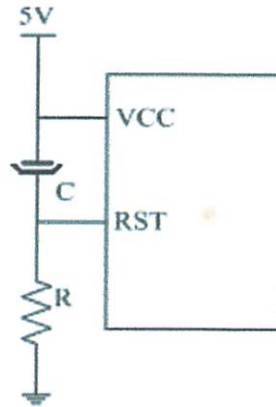
Seperti *Port 1*, *port 3* juga mempunyai fungsi – fungsi alternatif yang diberikan oleh AT89S51 seperti pada tabel berikut ini:

Tabel 2 – 2
Fungsi – Fungsi Alternatif Port 3

| Port Pin | Fungsi Alternatif |
|----------|-----------------------------------------------------------|
| P3.0 | RXD (<i>Serial Input Port</i>) |
| P3.1 | TXD (<i>Serial Output Port</i>) |
| P3.2 | $\overline{\text{INT0}}$ (<i>Eksternal Interrupt 0</i>) |
| P3.3 | $\overline{\text{INT1}}$ (<i>Eksternal Interrupt 1</i>) |
| P3.4 | T0 (<i>Timer 0 Eksternal Input</i>) |
| P3.5 | T1 (<i>Timer 1 Eksternal Input</i>) |
| P3.6 | WR (<i>Eksternal Data Memory Write Strobe</i>) |
| P3.7 | RD (<i>Eksternal Data Memory Read Strobe</i>) |

(Sumber : Datasheet AT89S51)

Reset : Pada saat mikrokontroler pertama kali dihidupkan akan terjadi power on reset yang akan memberikan logika *High* ‘1’ pada pin ini dengan jangka waktu yang ditentukan oleh lamanya pengosongan data muatan kapasitor. Jangka waktu minimal adalah 2 siklus mesin ditambah waktu *start On Osilator*. Untuk reset secara manual membutuhkan waktu minimal 2 kali siklus mesin untuk mereset mikrokontroller.



Gambar 2 - 3
Rangkaian Power On Reset
 (Sumber : www.atmel.com)

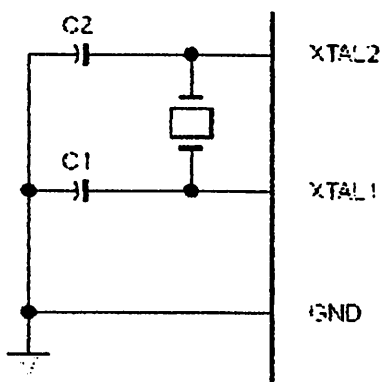
ALE/PROG: Keluaran ALE (*Address Latch Enable*) menghasilkan pulsa – pulsa untuk menutup byte rendah (*Low Byte*) alamat selama mengakses memori eksternal. Pin ini juga berfungsi sebagai inputan pulsa program (*The Program Pulse Input*) atau $\overline{\text{PROG}}$ selama melakukan Flash Program. Pada operasi normal, ALE akan berpulsa dengan laju 1/6 dari frekwensi kristal dan dapat digunakan sebagai pewaktuan (*Timing*) atau pendetakan (*Clocking*) rangkaian eksternal. Sebagai catatan ada sebuah pulsa yang dilewati selama pengaksesan memori data eksternal. Jika dikehendaki operasi ALE dapat di nonaktifkan dengan cara mengatur bit 0 dari SFR (*Special Function Register*) lokasi 8Eh. Jika diberi logika '1' ALE hanya akan aktif selama menemui instruksi **MOVX** atau **MOVC**. Selain itu, pin ini secara perlahan akan di Pull High. Mematikan bit ALE tidak akan ada efeknya jika mikrokontroller mengeksekusi program secara eksternal.

$\overline{\text{PSEN}}$: **$\overline{\text{PSEN}}$** (*Program Store Enable*) merupakan sinyal baca untuk memori program eksternal. Ketika mikrokontroler AT89S51 menjalankan kode dari program eksternal, $\overline{\text{PSEN}}$ akan diaktifkan sebanyak 2 kali per siklusnya, kecuali dua aktivasi $\overline{\text{PSEN}}$ dilompati (*Diabaikan*) saat mengakses memori data eksternal.

$\overline{\text{EA/VPP}}$: **$\overline{\text{EA/VPP}}$** (*External Access Enable*). $\overline{\text{EA}}$ harus selalu dihubungkan ke *Ground* karena digunakan untuk mengakses eksternal memori dengan lokasi 0000H sampai FFFFH. Catatan sekalipun bit '1' sudah terkunci dan terprogram, maka EA akan terkunci pada *reset*. $\overline{\text{EA}}$ juga harus dihubungkan ke *Vcc* untuk melakukan menjalankan program secara internal. Pada saat *Flash Programming*, pin ini mendapatkan tegangan sebesar 12 Volt.

XTAL1 : Merupakan input ke penguat pembalik *osilator* dan ke rangkaian operasi *Clock internal*.

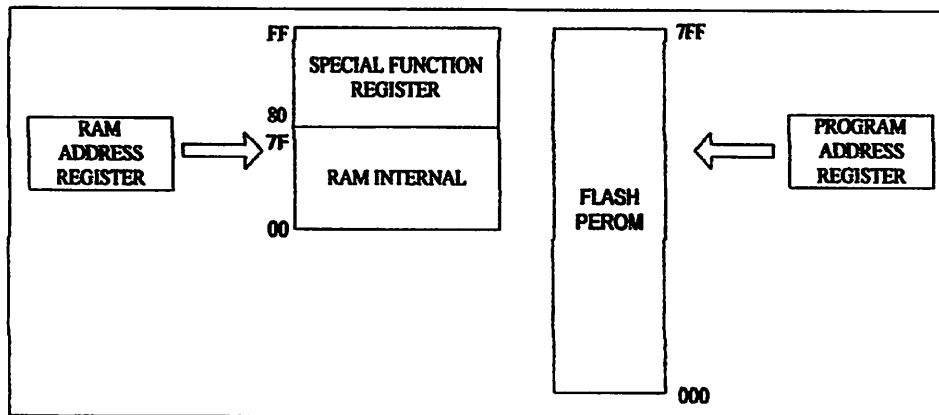
XTAL2 : Keluaran dari penguat pembalik *osilator*.



Gambar 2 – 4
Rangkaian Kristal
(Sumber : *Datasheet AT89S51*)

Mikrokontroler AT89S51 memiliki rangkaian osilator internal dengan mengacu pada frekwensi referensi pada pin XTAL1 dan XTAL2.

Struktur Memori



Gambar 2 – 5

Alamat RAM Internal dan Flash PEROM

(Sumber : *Panduan Praktis Antarmuka & Pemrograman mC AT89s51, Gramedia*)

AT89S51 mempunyai struktur atas memori yang terdiri atas :

- RAM Internal, memori sebesar 128 *byte* yang biasanya digunakan untuk menyimpan variabel atau data yang bersifat sementara.
- *Special Function Register* (Register Fungsi Khusus), memori yang berisi *register – register* yang mempunyai fungsi – fungsi khusus yang disediakan oleh mikrokontroler tersebut, seperti *timer*, serial dan lain – lain.
- *Flash PEROM*, memori yang digunakan untuk menyimpan instruksi – instruksi MCS – 51.

AT89S51 mempunyai struktur memori yang terpisah antara RAM Internal dan Flash PEROM – nya. RAM Internal dialamati oleh *RAM Address Register* (Register Alamat RAM) sedangkan Flash PEROM yang menyimpan perintah – perintah MCS – 51 dialamati oleh *Program Address Register* (Register Alamat Program). Dengan adanya struktur memori yang terpisah tersebut, walaupun RAM Internal dan Flash PEROM, mempunyai alamat awal yang sama, yaitu 00, namun secara fisik kedua memori tersebut tidak saling berhubungan.

2.1.3. RAM Internal

RAM Internal terdiri atas:

⇒ *Register BANKS*

AT89S51 mempunyai delapan buah register yang terdiri atas R0 hingga R7. Kedelapan buah register ini selalu terletak pada alamat 00H hingga 07H pada setiap kali sistem direset. Namun, posisi R0 hingga R7 dapat dipindah ke BANK 1 (08 hingga 0FH), BANK 2 (10H hingga 17H), atau BANK 3 (18H hingga 1FH) dengan mengatur bit RS0 dan RS1.

⇒ *Bit Addressable RAM*

RAM pada alamat 20H hingga 2FH dapat diakses secara pengalamatan bit (*Bit Addressable*) sehingga hanya dengan sebuah instruksi saja setiap bit dalam area ini dapat diset, clear, AND dan OR. Sebagai contoh, pada saat terjadi instruksi *Setb 67H*, hal ini sama dengan menseset bit MSB dari alamat 2C yaitu:

```
MOV    A,2CH      ; Pindahkan data dari alamat 2CH ke Acc A
Orl    A,#1000000B ; Set MSB Acc A
MOV    2CH,A      ; Pindahkan data dari Acc A ke alamat 2CH
```


Dengan adanya sistem *bit addressable* RAM, proses yang seharusnya dijalankan dengan tiga *cycle* seperti listing diatas dapat digantikan dengan sebuah instruksi yang hanya membutuhkan satu instruksi saja.

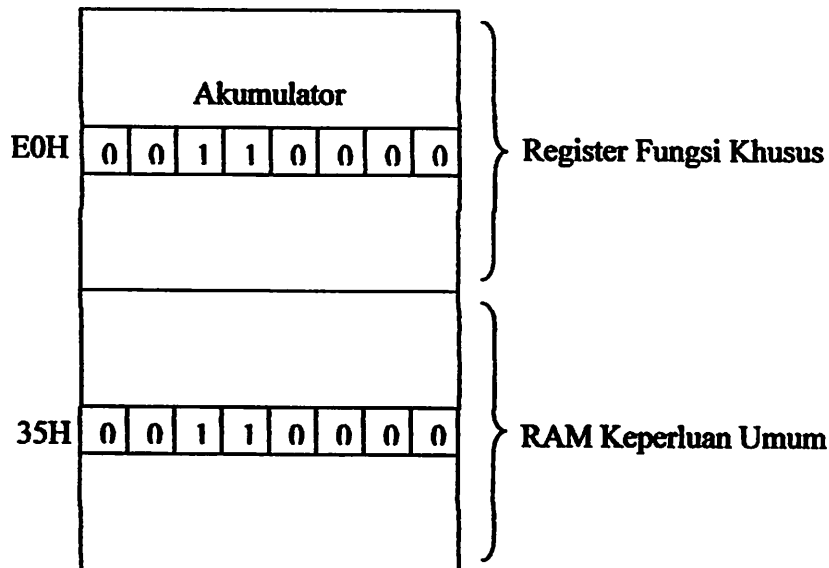
Dalam aplikasinya, lokasi yang dapat diakses dengan pengalamatan bit ini dapat juga digunakan untuk menandai suatu lokasi bit tertentu baik berupa Register Fungsi Khusus yang dapat dialamati secara bit (termasuk *Register I/O*) ataupun lokasi – lokasi tertentu yang dapat dialamati secara bit.

⇒ RAM Keperluan Umum

RAM keperluan umum dapat dimulai dari alamat 30H hingga 7FH dan dapat diakses dengan pengalamatan langsung maupun tak langsung. Pengalamatan langsung dilakukan ketika salah satu operand merupakan bilangan yang menunjukkan lokasi yang dialamati seperti pada contoh berikut:

MOV A,35H ; Baca data dari alamat 35H dan disimpan di *Accumulator*.

Alamat yang ditunjuk langsung



Gambar 2 – 6

Pengalamatan Secara Langsung

(Sumber : *Panduan Praktis Antarmuka & Pemrograman mC AT89s51, Gramedia*)

Sedangkan pengalamatan secara tak langsung pada lokasi dari RAM Internal ini adalah akses dari data memori ketika alamat memori tersebut tersimpan dalam suatu *register* R0 atau R1. R0 dan R1 adalah dua buah *register* pada mikrokontroler berarsitektur MCS – 51 yang dapat digunakan sebagai *pointer* dari sebuah lokasi memori pada RAM Internal. Sebagai Contoh:

```
MOV R0,#35H ; R0 diisi dengan data 35H
MOV A,@R0 ; Baca data di alamat yang diunjuk oleh R0
```

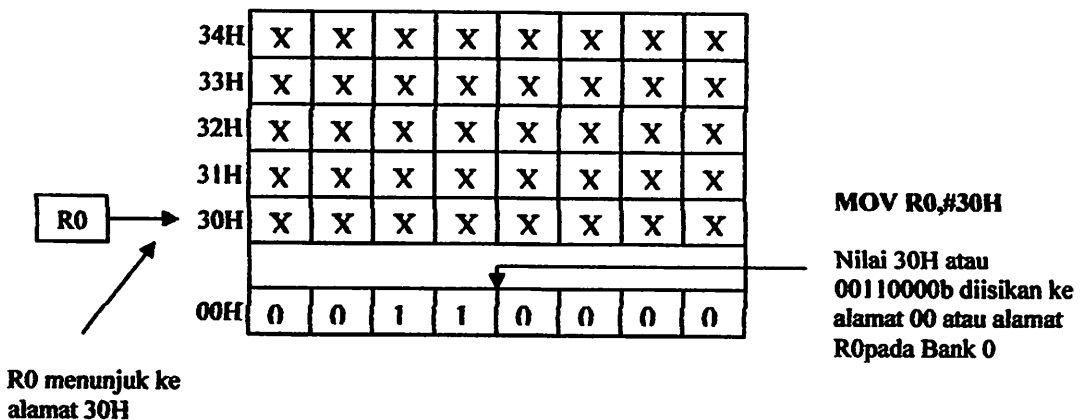
Pengalamatan secara tak langsung biasa digunakan untuk mengakses beberapa lokasi memori dengan letak yang beraturan seperti pada contoh berikut:

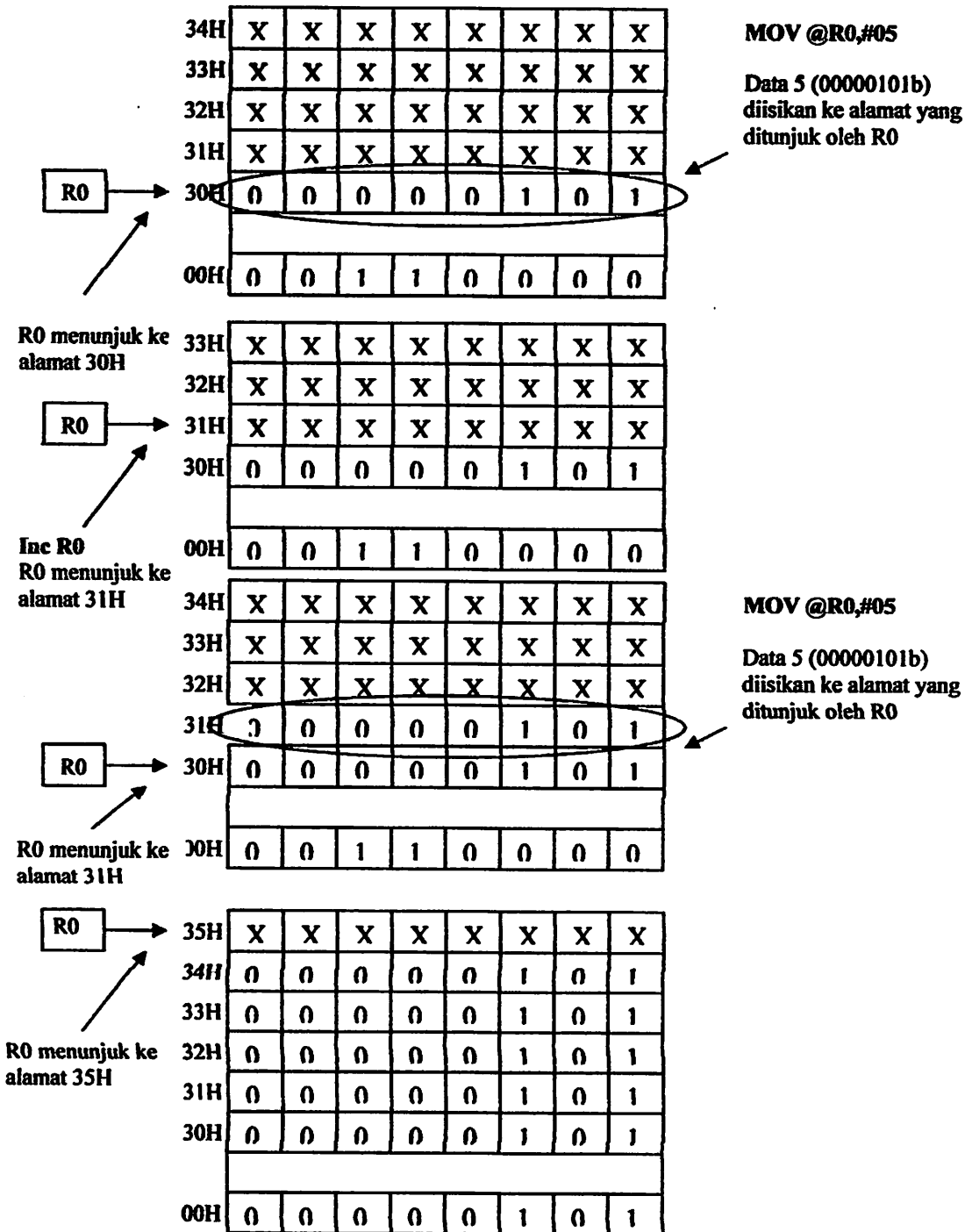
```

MOV      R0,#30H      ; R0 diisi dengan data 30H
Loop:
MOV      @R0,#05      ; Data 5 diisikan ke alamat yang ditunjuk
                        ; oleh R0

Inc      R0            ; R0 menunjuk ke alamat selanjutnya
Cjne     R0,#35H,Loop ; Jika R0 belum mencapai 35H, lompat ke
                        ; label Loop
    
```

Pada gambar 2-7 yang merupakan step – step proses yang terjadi pada contoh program di atas, proses pemindahan data 5 ke alamat – alamat yang ditunjuk oleh R0 dilakukan berulang – ulang hingga R0, register yang berfungsi penyimpan nilai dari alamat yang diakses atau sebagai *pointer* (penunjuk) alamat yang diakses mencapai 35H. Pengalamatan – pengalamatan tersebut juga berlaku pada lokasi yang dapat dialamati secara bit maupun *Register Bank*





Gambar 2 – 7
Step – Step Yang Terjadi Pada Pemindahan Data 5
ke Alamat 30H hingga 34H
 (Sumber : *Panduan Praktis Antarmuka & Pemrograman mC AT89s51, Gramedia*)

2.1.4. Register Fungsi Khusus

AT89S51 mempunyai 21 *Special Function Registers* (Register Fungsi Khusus) yang terletak pada antara alamat 80H hingga FFH. Beberapa dari register – register ini juga bisa dialamati dengan pengalamatan bit sehingga dapat dioperasikan seperti yang ada pada RAM yang lokasinya dapat dialamati dengan pengalamatan bit.

⇒ *Accumulator*

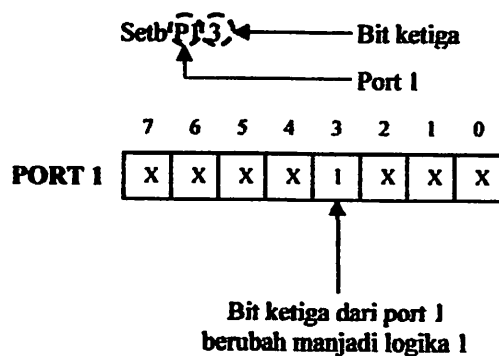
Register ini terletak pada alamat E0H. Hampir semua operasi aritmatik dan operasi logika selalu menggunakan register ini. Untuk proses pengambilan dan pengiriman data ke memori eksternal juga diperlukan register ini.

⇒ *Port*

AT89S51 mempunyai empat buah *Port*, yaitu *Port 0*, *Port 1*, *Port 2* dan *Port 3* yang terletak pada alamat 80H, 90H, A0H dan B0H. Namun, jika digunakan *eksternal memori* ataupun fungsi – fungsi special, seperti *Eksternal Interrupt*, *Serial* ataupun *Eksternal Timer*, *Port 0*, *Port 2* dan *Port 3* tidak dapat digunakan sebagai *Port* dengan fungsi umum. Untuk itu *Port 1* yang dikhususkan untuk *port* dengan fungsi umum.

Semua *Port* ini dapat diakses dengan pengalamatan secara bit sehingga dapat dilakukan perubahan *output* pada tiap – tiap pin dari *port* ini tanpa mempengaruhi *port – port* yang lainnya.

Sebagai contoh, jika dilakukan instruksi Setb P1.3, maka bit ketiga dari port 1 akan berkeadaan *high* (5V) tanpa mempengaruhi bit – bit yang lain pada port ini.



Gambar 2 – 8
Bit – Bit Port 1

(Sumber : *Panduan Praktis Antarmuka & Pemrograman mC AT89s51*,
Gramedia)

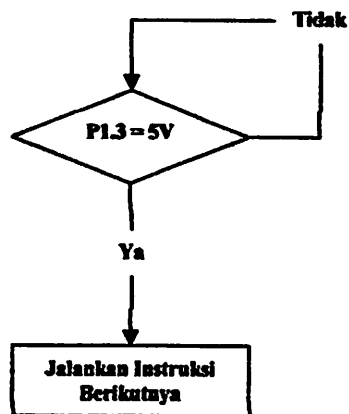
Seperti yang tampak pada gambar 2.7, bit ketiga dari port 1 terletak pada alamat 93H oleh karena itu instruksi Setb P1.3 dapat diganti dengan instruksi Setb 93H.

Port ini digunakan untuk menunggu sinyal yang dikirim oleh komponen lain yang merupakan sinyal positif (5V) misalnya, dengan instruksi berikut ini:

Tunggu:

Jnb P1.3, tunggu

Selama kondisi pada *port 1* pin ketiga masih *low* (0V), program akan terus melompat ke alamat yang ditunjukkan oleh label "tunggu" sehingga dapat diartikan bahwa program berhenti di alamat tersebut hingga terjadi sinyal positif (5V). Setelah sinyal positif (5V) muncul di bit ketiga dari *port 1*; program akan menuju ke alamat yang berikutnya



Gambar 2 – 9
Diagram Alir Deteksi Bit Ketiga Port 1
 (Sumber : *Panduan Praktis Antarmuka, Pemrograman mC AT89s51, Gramedia*)

⇒ PSW (*Program Status Word*)

Program status word atau PSW terletak pada alamat D0H yang terdiri atas beberapa bit sebagai berikut:

| PSW | PSW.7 | PSW.6 | PSW.5 | PSW.4 | PSW.3 | PSW.2 | PSW.1 | PSW.0 |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| D0H | CY | AC | FD | RS1 | RS0 | OV | - | P |

• *Flag Carry*

Flag Carry (terletak pada alamat D7H) mempunyai fungsi sebagai pendeteksi terjadinya kelebihan pada operasi penjumlahan atau terjadi pinjam (*borrow*) pada operasi pengurangan. Misalnya jika data pada *accumulator* adalah FFH dan dijumlahkan dengan bilangan satu atau lebih, akan terjadi kelebihan dan membuat *carry* menjadi Set, sedangkan jika data pada *accumulator* adalah 00H dan dikurangkan dengan bilangan satu atau lebih, akan terjadi pemimjaman dan membuat *carry* juga menjadi set.

- **Flag Auxiliary Carry**

Flag Auxiliary Carry akan selalu Set pada saat proses penjumlahan terjadi carry dari bit ketiga hingga bit keempat.

- **Flag 0**

Flag 0 digunakan untuk tujuan umum bergantung pada kebutuhan pemakai.

- **Bit Pemilih Register Bank**

Register Bank Select Bits (RS0 dan RS1) atau Bit Pemilih *Register Bank* digunakan untuk menentukan lokasi dari *Register Bank* (R0 hingga R7) pada memori. RS0 dan RS1 selalu bernilai nol setiap kali sistem direset sehingga lokasi dari R0 hingga R7 akan berada di alamat 00H hingga 07H.

- **Flag Overflow**

Flag Overflow akan diset jika pada operasi aritmatik menghasilkan bilangan yang lebih besar dari pada 128 atau lebih kecil dari - 128.

Contoh:

```
MOV A,#80h; A = 128
Add  A,#10H    ; A = 128 + 16, A = 144 ATAU 90H
```

Hasil dari operasi aritmatikdi atas adalah lebih besar dari 128, yaitu 144 atau 90H maka *bit Overflow* akan Set.

- **Bit Parity**

Bit Parity akan diset jika jumlah bit 1 dalam *accumulator* adalah ganjil dan akan clear jika jumlah bit 1 dalam *accumulator* genap. Jika data dalam *accumulator* adalah 10101110b atau AEH pariti

akan diset. Data AEH mempunyai lima bit yang berkondisi 1 atau dapat disebut mempunyai bit 1 dalam jumlah yang ganjil. *Bit parity* ini digunakan untuk proses yang berhubungan dengan serial port yaitu sebagai *Check sum*.

⇒ *Register B*

Register B digunakan bersama *accumulator* untuk proses aritmatik selain dapat juga difungsikan sebagai register biasa. *Register* ini juga bersifat *Bit Addressable*.

⇒ *Stack Pointer*

Stack Pointer merupakan sebuah register 8 bit yang terletak di alamat 81H. Isi dari *Stack Pointer* ini merupakan alamat dari data yang disimpan di *stack*. *Stack Pointer* dapat diedit atau dibiarkan saja mengikuti standart sesudah terjadi reset. Jika *Stack Pointer* diisi data 5FH, area untuk proses penyimpanan dan pengambilan data dari dan ke *stack* adalah sebesar 32 *byte*, yaitu antara 60H hingga 7FH karena AT89S51 mempunyai *Internal RAM* sebesar 128 *byte*.

⇒ *Data Pointer Two Byte Register (DPTR)*

Data Pointer Two Byte Register atau *DPTR* merupakan register 16 bit dan terletak pada alamat 82H untuk *DPL (Data Pointer Low)* dan 83H untuk *DPH (Data Pointer High)*. *DPTR* biasa digunakan untuk mengakses *source code* ataupun data yang terletak di memori *eksternal*.

Contoh:

```
MOV A, #01h
MOV DPTR, #2000H
MOVX    @Dptr,A
```

Listing diatas berfungsi untuk menuliskan data 01H ke dalam alamat 2000H. Pertama, data 01H diisikan ke *accumulator*. Kemudian, DPTR yang berfungsi untuk menunjukan alamat penyimpanan data diisi dengan 2000H. terakhir, isi dari *accumulator A* disimpan ke lokasi memori yang ditunjukan oleh DPTR (*Indirect Addressing*).

⇒ *Register Timer*

AT89S51 mempunyai dua buah 16 bit *Timer/Counter*, yaitu *Timer 0* dan *Timer 1*. *Timer 0* terletak pada alamat 8AH untuk TL0 dan 8CH untuk TH0 dan *Timer 1* terletak pada alamat 8BH untuk TL1 dan 8DH untuk TH1.

⇒ *Register Port Serial*

AT89S51 mempunyai sebuah *on chip serial port* (serial port dalam keping) yang dapat digunakan untuk berkomunikasi dengan peralatan lain yang menggunakan serial port juga seperti modem, shift register dan lain – lain.

Penyangga (*Buffer*) untuk proses pengiriman maupun pengambilan data terletak pada register SBUF, yaitu pada alamat 99H. Sedangkan untuk mengatur mode serial dapat dilakukan dengan mengubah isi dari SCON yang terletak pada alamat 98H.

⇒ *Register Interrupt*

AT89S51 mempunyai lima buah interupsi dengan dua level prioritas interupsi. Interupsi akan selalu nonaktif setiap kali sistem di – *reset*. Register – register yang berhubungan dengan interrupt adalah *Interrupt Enable Register (IE)* atau Register Pengaktif Interupsi pada alamat A8H untuk mengatur keaktifan tiap – tiap *interrupt* dan *Interrupt Priority Register (IP)* atau Register Prioritas Interupsi pada alamat B8H.

⇒ *Register CKontrol Power*

Register ini terdiri atas SMOD yang digunakan untuk melipat dua *baud rate* dari port serial, dua buah bit untuk flag fungsi umum pada bit ketiga dan bit kedua, *power Down (PD) bit* dan *idle (IDL) bit*.

Pada mode *idle* hubungan antara CPU dan *internal clock* terputus, namun kondisi port tetap pada kondisi terakhir, ALE dan PSEN menjadi high, timer masih tetap bekerja. Mode idle berakhir pada saat terjadi interupsi, reset atau kondisi – kondisi lain yang mereset IDL bit.

Pada Mode *Power Down oscillator* dan semua fungsi berhenti, RAM tetap pada kondisi terakhir, begitupula dengan port dan ALE maupun PSEN akan berkondisi 0. Mode *Power Down* berakhir pada saat terjadi reset.

⇒ *Time Counter Control (TCON)*

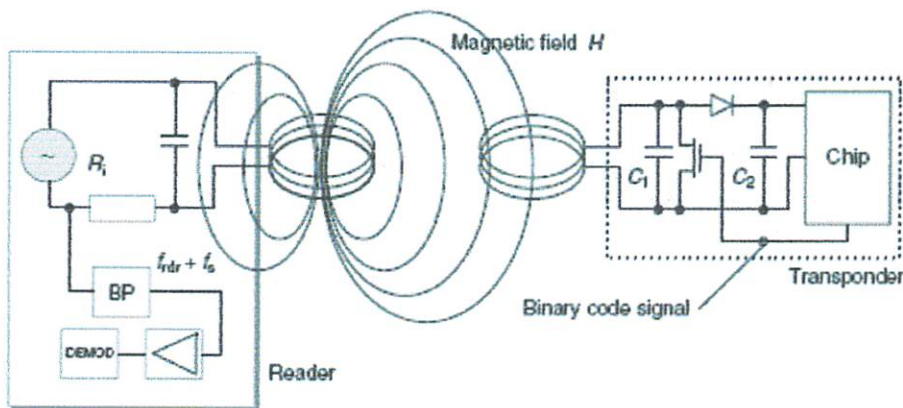
TCON merupakan suatu register yang berisi bit – bit untuk memulai atau menghentikan pencacah/pewaktu.

⇒ *Serial Control Buffer (SBUFF)*

Register ini digunakan untuk menampung data masukan (SBUFF IN) ataupun keluaran (SBUFF OUT) dari serial port.

2.2 RFID

RFID adalah proses identifikasi seseorang atau objek dengan menggunakan frekuensi transmisi radio. RFID menggunakan frekuensi radio untuk membaca informasi dari sebuah devais kecil yang disebut tag atau *transponder (Transmitter + Responder)*. Tag RFID akan mengenali diri sendiri ketika mendeteksi sinyal dari devais yang kompatibel, yaitu pembaca RFID (*RFID Reader*) dengan range kisaran pembacaan 12cm serta bekerja pada frekuensi 125 KHz.



Gambar 2-10
Komunikasi Antara Reader dan Transmitter (Tag)

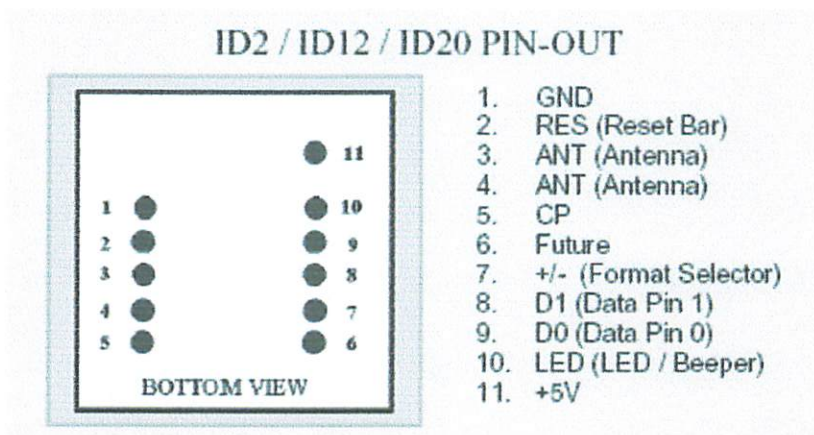
(Sumber: www.digiware.com, RFID)

RFID dapat disediakan dalam devais yang hanya dapat dibaca saja (*Read Only*) atau dapat dibaca dan ditulis (*Read/Write*), tidak memerlukan kontak langsung maupun jalur cahaya untuk dapat beroperasi, dapat berfungsi pada berbagai variasi kondisi lingkungan, dan menyediakan tingkat integritas data yang tinggi. Sebagai tambahan, karena teknologi ini sulit untuk dipalsukan, maka RFID dapat menyediakan tingkat keamanan yang tinggi.

Pada sistem RFID umumnya, tag atau *transponder* ditempelkan pada suatu objek. Setiap tag membawa dapat membawa informasi yang unik, di antaranya: serial number, model, warna, tempat perakitan, dan data lain dari objek tersebut. Ketika tag ini melalui medan yang dihasilkan oleh pembaca RFID yang kompatibel, tag akan mentransmisikan informasi yang ada pada tag kepada pembaca RFID, sehingga proses identifikasi objek dapat dilakukan.

Sistem RFID terdiri dari empat komponen, di antaranya seperti dapat dilihat pada gambar 2-5:

- Tag: Ini adalah devais yang menyimpan informasi untuk identifikasi objek. Tag RFID sering juga disebut sebagai *transponder*. Format dari tag pada perancangan ini adalah EM4001 atau tag kompatibel lainnya.
- Antena: untuk mentransmisikan sinyal frekuensi radio antara pembaca RFID dengan tag RFID.
- Pembaca RFID: adalah devais yang kompatibel dengan tag RFID yang akan berkomunikasi secara *wireless* dengan tag. Digunakan Tipe ID-120 sebagai RFID reader pada perancangan ini.
- Software Aplikasi: adalah aplikasi pada sebuah workstation atau PC yang dapat membaca data dari tag melalui pembaca RFID. Baik tag dan pembaca RFID dilengkapi dengan antena sehingga dapat menerima dan memancarkan gelombang elektromagnetik.



Gambar 2-11
Konfigurasi Pin ID-12 (RFID Reader)
 (Sumber: www.digiware.com, RFID)

Format Pembacaan ASCII

Salah satu tipe dari RFID reader ini yang digunakan pada alat ini adalah ID-12. RFID reader ini memiliki dua bentuk output serial yaitu: ASCII dan *Wiegand 26-bit*. Pada perancangan alat ini digunakan output dengan format ASCII. Berikut ini table dari datasheet RFID Reader.

Tabel 2-3
Datasheet RFID Reader.

| Pin No. | Description | ASCII |
|---------|------------------------------------------|---------------------|
| Pin 1 | Zero Volt and Tuning Capacitor Ground | GND 0 V |
| Pin 2 | Strap to +5 Volt | Reset Bar |
| Pin 3 | To External Antenna and Tuning Capacitor | Antenna |
| Pin 4 | To External Antenna | Antenna |
| Pin 5 | Card Present | No Fuction |
| Pin 6 | Future | Future |
| Pin 7 | Format Selector (+/-) | Strap to GND |
| Pin 8 | Data 1 | CMOS |
| Pin 9 | Data 0 | TTL Data (Inverted) |
| Pin 10 | 3.1 KHz Logic | Beeper / LED |
| Pin 11 | DC Voltage Supply | +5 V |

(Sumber: www.digiware.com, RFID)

Keluaran yang memiliki format ASCII memiliki struktur sebagai berikut:

| | | | | | |
|-----|------------------------|----------|----|----|-----|
| 0 2 | 10 data karakter ASCII | checksum | CR | LF | 0 3 |
|-----|------------------------|----------|----|----|-----|

Checksum merupakan hasil EXOR (*Exclusive OR*) dari 5 biner data *byte*.

Misalnya data output serial (dalam *hexadesimal*) yang kita tangkap adalah sebagai berikut:

| | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| O2 | 30 | 34 | 36 | 32 | 30 | 31 | 44 | 37 | 36 | 43 | 44 | 43 | OD | OA | O3 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

Langkah pertama adalah merubah semua nilai data diatas menjadi karakter ASCII. Misalnya 30H menjadi karakter “0”, 34H menjadi karakter “4”, dst. Langkah kedua adalah menyusun data – data tersebut ke dalam Format Data ASCII seperti tabel 1. Kemudian ambil 10 data karakter ASCII. Dalam contoh ini berarti data tersebut adalah:

| | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|------------|
| 30 | 34 | 36 | 32 | 30 | 31 | 44 | 37 | 36 | 43 | Data Hexsa |
| | | 6 | 2 | 0 | 1 | D | 7 | 6 | C | Data ASCII |

Untuk data dengan angka 30 dan 34 merupakan data untuk jenis-jenis kartu dan tidak digunakan dalam proses konversi, yang akan dipakai disini adalah data yang ke 3 s/d 10. Hasil konversi dari data heksa ke dalam data ASCII adalah “6201D76C”. Gabungkan karakter data ASCII menjadi bilangan Hexadesimal, kemudian konversikan bilangan hexadesimal tsb ke dalam desimal. Hasilnya sebagai berikut: 6201D76C H menjadi 1644287852. angka-angka ini merupakan nomor kartu sebenarnya yang tertera pada badan kartu yang biasa disebut *tag* RFID.

Berikut ini merupakan contoh dari tag RFID :

1644283775 001.51071

Gambar 2-12
Tag RFID tipe ISO Card GK4001
(Sumber: scan tag RFID)



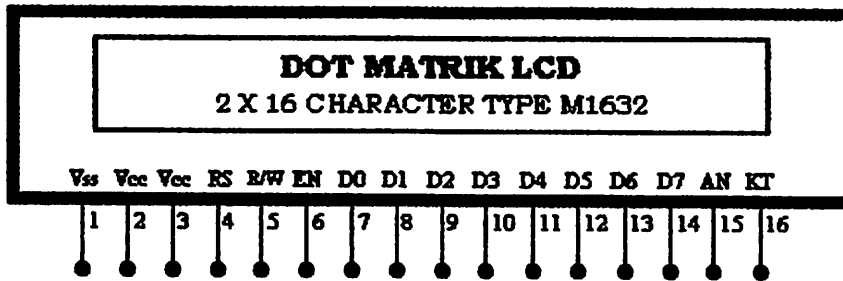
Gambar 2-13
Tag RFID tipe Alien MPI
(Sumber: www.alientechnology.com)

2.3 LCD (*Liquid Crystal Display*)

2.3.1 Konfigurasi LCD

Liquid Crystal Display adalah modul tampilan berkonsumsi daya yang relatif rendah dan terdapat sebuah kontroller CMOS didalamnya. Kontroler tersebut sebagai pembangkit karakter dari ROM/RAM dan *display* data RAM. Semua fungsi tampilan dikontrol oleh suatu intruksi dan modul LCD dapat dengan mudah untuk diinterfacekan dengan mikroprossor/mikrokontroller. Input yang diperlukan untuk mengendalikan modul ini berupa bus data yang termultipleks dengan bus alamat dan 3 bit sinyal kontrol. Pengendali *dot matrik* LCD dilakukan secara internal pada modul LCD sendiri.

LCD merupakan suatu bentuk kristal cair yang akan beremulsi apabila dikenakan tegangan padanya. Tampilannya ini berupa *dot matrik* 5 x LCD sehingga jenis huruf yang dapat ditampilkan akan lebih banyak dan lebih baik resolusinya jika dibandingkan dengan 7 segment.



Gambar 2-14
Deskripsi pin pada LCD Tipe M1632
(Sumber : LCD Manual Book)

LCD tipe M1632 memiliki ciri-ciri sebagai berikut :

- LCD ini terdiri dari 32 karakter dengan 2 baris masing-masing 16 karakter dengan *display dot matrik 5 x 7*
- Karakter generator ROM dengan 192 tipe karakter
- Karakter generator RAM dengan 8 tipe karakter
- 80 x 8 display data RAM
- Dapat diinterfacekan ke MPU 8 atau 4
- Dilengkapi fungsi tambahan : *display clear, cursor home, display ON/OFF, cursor ON/OFF, display character blink, cursor shift, dan display shift.*
- Internal Data
- Internal Otomatis, reset pada saat power ON
- +5 volt PSU Tunggal

Tabel 2-4
Konfigurasi Pin-pin LCD

| NO | SYMBOL | LEVEL | FUNCTION |
|------|-----------|-------|-----------------------------------------------------------|
| 1 | Vss | - | 0 <i>Ground</i> |
| 2 | Vcc | - | 5 V + 10% |
| 3 | Vee | - | LCD <i>Drive</i> |
| 4 | RS | H/L | H : <i>Data Input</i> L : <i>Intruksi Input</i> |
| 5 | R/W | H/L | H : <i>Read</i> L : <i>Write</i> |
| 6 | E | H/L | <i>Enable Signal</i> |
| 7-14 | DB0-DB7 | H/L | <i>Data Bus</i> |
| 15 | Light LCD | - | Menyalakan lampu LCD dengan arus max 112 mA dan V = +4,1V |
| 16 | Light LCD | - | <i>Ground</i> |

(*Sumber : LCD Manual Book*)

2.3.2 Interuksi Operasi Dasar

2.3.2.1 Register

Kontroller dari LCD mempunyai dua buah register 8 bit yaitu register intruksi (IR) dan register data (RD). IR menyimpan intruksi seperti *display clear*, *cursor shift* dan *display data* (DD RAM) serta *character generator* (CG RAM). DR menyimpan data untuk ditulis di DD RAM atau CG RAM atau membaca data dari DD RAM atau CG RAM. Ketika data ditulis ke DD RAM atau CG RAM maka DR akan secara otomatis menulis data ke DD RAM atau CG RAM dan data pada DD RAM atau CG RAM hendak dibaca maka alamat data ditulis pada IR sedangkan data alamat dimasukkan melalui DR dan mikroprosesor membaca data dari DR.

Tabel 2-5
Tabel Register Seleksi

| RS | R/W | OPERASI |
|----|-----|--------------------------------------------------------------|
| 0 | 0 | <i>Seleksi IR, IR Write Display Clear</i> |
| 0 | 0 | <i>Busy Flag (DB7) @counter (DB0-DB7)</i> <i>Read</i> |
| 1 | 0 | <i>Seleksi DR, DR Write</i> |
| 1 | 1 | <i>Seleksi DR, DR Read</i> |

(Sumber : LCD Manual Book)

2.3.2.2 Busy Flag

Busy Flag menunjukkan bahwa modul siap untuk menerima instruksi selanjutnya. Sebagaimana yang terlihat pada table register seleksi sinyal akan melalui DB7. Jika RS = 0 dan R/W = 1. Jika bernilai 1 maka modul sedang melakukan kerja internal dan intruksi tidak dapat diterima. Sehingga status dari *flag* ini harus diperiksa sebelum melaksanakan intruksi selanjutnya.

2.3.2.3 Address Counter

AC menunjukkan lokasi memori dalam modul LCD. Pemilihan lokasi alamat itu diberikan lewat register intruksi (IR). Ketika data ada pada A, maka AC secara otomatis menaikkan atau menurunkan alamat tergantung dari *Entry Mode Set*.

2.3.2.4 Display Data RAM (DD RAM)

Pada LCD masing-masing line mempunyai range alamat tersendiri. Alamat ini diekspresikan dengan bilangan *Hexadecimal*. Untuk itu 1 range alamat berkisar 00H-0FH sedangkan untuk line 2 range alamat berkisar antara 40H-4FH.

2.3.2.5 Character Generator ROM (CG ROM)

CG ROM mempunyai tipe dot matrik 5 x 7 dan data pada LCD telah tersedia ROM sebagai pembangkit *Character* dalam kode ASCII.

2.3.2.6 Character Generator RAM (CG RAM)

CG RAM digunakan untuk pembuatan karakter tersendiri melalui program.

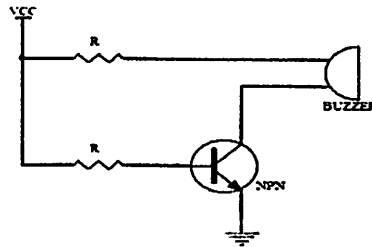
Tabel 2-6
Fungsi Terminal Pada LCD

| Nama Signal | Jml Term | I/O | Tujuan | Fungsi |
|-------------|----------|-----|--------|-------------------------------------------------------------------------------------------------------|
| DB0-DB3 | 4 | I/O | MPU | Sebagai lalu lintas data dan intruksi ke atau dari MPU <i>Low Byte</i> |
| DB4-DB7 | 4 | I/O | MPU | Sebagai lalu lintas data atau intruksi 2 arah <i>upper byte</i> . DB7 sebagai <i>busy flag</i> |
| E | 1 | I | MPU | Sinyal Start (<i>read/write</i>) |
| R/W | 1 | I | MPU | Seleksi Sinyal 0 = <i>write</i> 1 = <i>read</i> |
| RS | 1 | I | MPU | Seleksi Register |
| VLS | 1 | - | PS | 0 = <i>intruksi reg (wr)</i> <i>Busy flag addr counter (rd)</i> 1 = <i>data reg (wr dan rd)</i> |
| 7 | 1 | - | PS | Mengatur Tampilan LCD |
| Vss | 1 | - | PS | +5 volt |

(Sumber : LCD Manual Data Book)

2.4. BUZZER

Perangkat *Buzzer* digunakan untuk menghasilkan bunyi, merupakan komponen resonator Riezoelectric yang digunakan untuk mengadakan isyarat terdengar sebagai *indikator*. *Buzzer* akan aktif dengan cara mengeluarkan sinyal suara (berbunyi) dengan lama waktu sesuai dengan perencanaan nanti.



Gambar 2-15
Rangkaian Driver Buzzer
(Sumber: Perencanaan dan Pembuatan)

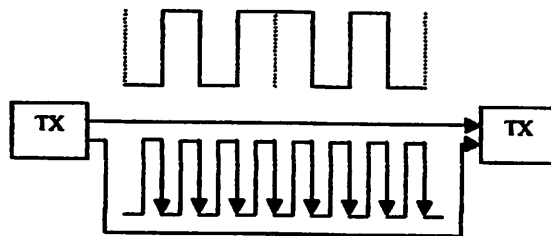
2.5. Komunikasi Serial

Komunikasi serial ialah pengiriman data secara serial (data dikirim satu persatu secara berurutan) sehingga komunikasi serial jauh lebih lambat daripada komunikasi paralel. Kelebihan komunikasi serial ialah jangkauanpanjang kabel yang lebih jauh dibandingkan paralel karena serial *port* mengirimkan logika 1 dengan kisaran tegangan -3 hingga -15 volt dan logika 0 sebagai +3 hingga +15 volt sehingga kehilangan daya karena panjangnya kabel bukan merupakan masalah utama.

Komunikasi serial ada dua macam yaitu *synchronous* dan *asynchronous*. *Synchronous* adalah komunikasi dimana hanya ada satu pihak (pengirim atau penerima yang menghasilkan *clock* dan mengirimkan *clock* tersebut bersama sama dengan data atau dengan kata lain merupakan bentuk transmisi serial yg

mentransmisikan data secara kontinyu. Contoh penggunaan *synchronous* terdapat pada transmisi data *keyboard*. *Asynchronous* adalah komunikasi dimana kedua pihak (pengirim dan penerima) masing-masing menghasilkan *clock* namun hanya data yang ditransmisikan, tanpa *clock*. Agar data yang dikirim sama dengan data yang diterima, maka kedua frekuensi *clock* harus sama dan harus terdapat sinkronisasi. Setelah adanya sinkronisasi, pengirim akan mengirimkan datanya sesuai dengan frekuensi *clock* pengirim dan penerima akan membaca data sesuai dengan frekuensi *clock* penerima.

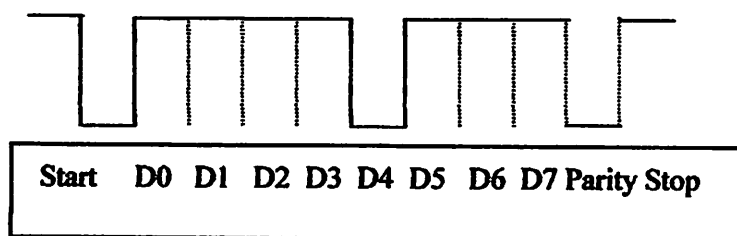
2.5.1. Komunikasi Sinkron



Gambar 2-16
Komunikasi serial dengan Sinyal Sinkronisasi [4]

Setiap TX mengirimkan D_x atau bit ke x dari satu *byte* data akan diikuti dengan sinyal sinkronisasi yang berupa sinyal transisi dari rendah ke tinggi atau tinggi ke rendah. RX akan mengetahui bahwa di jalur data ada data milik D_x . Sesuai dengan banyaknya sinyal sinkronisasi yang diterima, saat sinyal sinkronisasi pertama, berarti data milik D_0 , kedua milik D_1 dan seterusnya.

2.5.2. Komunikasi Asinkron



Gambar 2-17

Format Sinyal Serial Asinkron [4]

Cara kedua dengan komunikasi *asinkron*, yaitu dengan menetapkan kecepatan bit dan menyisipkan beberapa bit protokol, yaitu *bit START*, *PARITY bit* dan *STOP* seperti diperlihatkan pada gambar 2-15 diatas.

- Kecepatan bit disebut sebagai *baud rate* atau pesat bit disingkat *bps (bit per second)*, pada standart komunikasi diantaranya adalah 1200, 4800, 9600 *bps*.
- Makin besar *baud rate*, makin cepat data ditransmisikan, tetapi memerlukan *bandwidth* jalur yang semakin lebar, penggunaan kabel biasa atau kabel telepon kecepatan transmisi data dibatasi oleh *bandwidth* kabel tersebut.
- Setelah *bit start*, diikuti serial data, jumlah data sebanyak 7 atau 8.
- Setelah data – data bit bisa diikuti (jika diperlukan) oleh *parity bit*, Jika dipilih *parity even*, maka *bit parity* akan menggenapkan jumlah bit ‘1’ nya, jika dipilih *parity odd*, maka *bit parity* akan mengganjilkan jumlah bit ‘1’.
- Akhir data adalah *stop bit* yang selalu ‘1’.

2.5.3. Arah Pengiriman Data

Dikenal tiga macam arah pengiriman data, yaitu *Simplex*, *Half Duplex* dan *Full Duplex*.

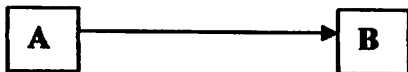
Simplex adalah sistem pemindahan data yang hanya satu arah saja, misalnya dari A ke B, dimana A sebagai pengirim dan B sebagai penerima, dan tidak dapat mengirimkan data dari B ke A.

Half Duplex adalah sistem pemindahan data dua arah, tetapi tidak dapat dilakukan secara bersamaan, harus bergantian.

Full Duplex adalah sistem pemindahan data dua arah dan dapat berlangsung secara bersamaan dalam satu waktu.

Untuk lebih jelasnya, dapat dilihat pada gambar berikut :

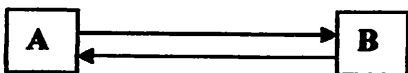
a. Komunikasi data *Simplex*



b. Komunikasi data *Half Duplex*



c. Komunikasi data *Full Duplex*



2.6. Serial Port RS – 232

Dalam komunikasi data komputer terdapat dua terminal (port) komunikasi yaitu *port paralel* (LPT standart) dan *port serial* (RS-232 standart) yang masing-masing memiliki spesifikasi yang berbeda. Biasanya standar serial RS – 232 memiliki dua buah terminal yang sering disebut COM 1 dan COM 2.

DTE (*Data Terminal Equipment*) atau terminal data yang melakukan pertukaran data seri dan menggunakan data biner, dapat menggunakan terminal komunikasi seri RS- 232 yang dibuat oleh EIA (*Electrical industry Association*) dan dikenal dengan standar CCITT V 24. Sebuah DTE adalah perangkat prosesor yang dilengkapi data paralel menjadi serial dan sebaliknya.

Sedang yang dimaksud dengan DCE (*Data Communication Equipment*) adalah perangkat yang mengubah data serial menjadi salah satu bentuk sinyal analog yang dapat ditransformasikan pada saluran transmisi seperti telepon atau radio. Standar RS – 232 ini berisikan karakteristik sinyal listrik, karakteristik mekanik dan cara rangkaian fungsionalnya. Beberapa karakteristik sinyal listrik RS – 232 adalah sebagai berikut :

- Tegangan rangkaian terbuka (*open loop*) tidak boleh lebih dari 25 Volt.
- Keadaan logika “1” (*Mark*) pada driver ditandai dengan tegangan antara –5 sampai –25 Volt.
- Keadaan logika “0”(*Space*) pada driver ditandai dengan tegangan antara +5 sampai +25 Volt.
- *Slew Rate* (perubahan tegangan keluaran perancangan satuan waktu) < 30 V/s. Waktu untuk melewati daerah invalid –3 V hingga +3 V ≤ 1 ms.

Karakteristik mekanik *interface* ditentukan dengan konektor DB – 25 pin atau DB – 9 pin, dimana tiap-tiap kontak konektor memiliki fungsi tertentu seperti tabel 2-7

Tabel 2-7
Nama Pin dan Keterangan dari Port RS – 232

| Nama Sinyal | Arah Sinyal | Nomor kaki konektor | |
|----------------------------------|-------------|---------------------|------|
| | | DB9 | DB25 |
| <i>Signal Common</i> | - | 5 | 7 |
| <i>Transmitted Data (TD)</i> | Ke DCE | 3 | 2 |
| <i>Received Data (RD)</i> | Dari DCE | 2 | 3 |
| <i>Received Data (RTS)</i> | Ke DCE | 7 | 4 |
| <i>Celar to Send (CTS)</i> | Dari DCE | 8 | 5 |
| <i>DCE Ready (DSR)</i> | Dari DCE | 6 | 6 |
| <i>DTE Ready</i> | Ke DCE | 9 | 22 |
| <i>Ring Indicator (RI)</i> | Dari DCE | 9 | 22 |
| <i>Data Carrier Detect (DCD)</i> | Dari DCE | 1 | 8 |

(Sumber: Interfacing Komputer dan Mikrokontroler)

Fungsi pin DB – 9 RS – 232 adalah :

1. Data Carrier Detect (DCD)

Berguna pada DTE untuk tidak memperbolehkan penerimaan data.

2. Transmitted Data (TXD)

Berguna untuk jalur pengiriman data dari DTE ke DCE

3. Received Data (RXD)

Berguna sebagai jalur pengiriman data dari DCE ke DTE

4. Data Terminal Ready (DTR)

Berguna untuk memberitahu DCE bahwa DTE telah aktif dan siap untuk bekerja.

5. Signal Ground (DSR)

Berguna sebagai referensi semua tegangan *interface*.

6. *Data Set Ready (DSR)*

Bekerja untuk memberitahu DTE bahwa DCE telah aktif dan siap untuk bekerja.

7. *Request to Send (RTS)*

Bertugas untuk memberitahu DCE bahwa DTE akan mengirimkan data. RTS merupakan sebuah *protokol hardware* yang mendahului pengiriman data DTE ke DCE.

8. *Clear to Send (CTS)*

Berguna untuk memberitahu DTE bahwa DCE siap untuk menerima data. CTS merupakan sebuah *protokol hardware* yang mendahului pengiriman dari DTE ke DCE.

9. *No Connection (NC)*

Ditinjau dari proses jabatan (*handshaking*) standar RS-232 yaitu pin-pin DTR, DSR, RTS, CTS, dan CD maka perangkat lunak akan mengaktifkan DTR yang menandakan bahwa komputer siap melakukan transmisi atau menerima data dan apabila terminal lain juga dihidupkan serta siap menerima/mengirim data, maka terminal tersebut akan mengirimkan sinyal DSR.

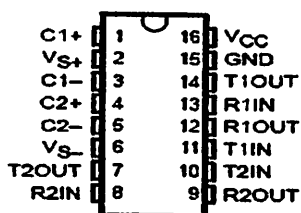
2.7. MAX 232 Sebagai Pengubah Tegangan TTL

Max 232 merupakan pengubah TTL ke level tegangan RS-232. Max 232 memiliki dua *driver* mengkonversikan RS-232 ke level TTL, dan dua penerima yang merubah TTL ke RS-232. Max 232 memiliki 16 pin dan dioperasikan dengan empat buah kapasitor yang memiliki nilai 10uF.

RS-232 merupakan salah satu jenis antar muka (*interface*) dalam proses transfer data antar komputer dalam bentuk *serial transfer*. RS-232 merupakan singkatan dari *Recommbeded Standard number 232*. Alat ini dibuat oleh *Electronic Industry Assosiation*, untuk *Interface* antara peralatan *terminal data* dan peralatan komunikasi data, dengan menggunakan *data binner serial* sebagai data yang ditransmisikan IC MAX 232 ini mempunyai empat buah bagian konverter yaitu dua buah *driver receiver* dan dua buah *driver transmitter*.

Saluran data *pada port seri* PC menggunakan *standard RS-232*, dimana *logic 0 (low)* dinyatakan sebagai tegangan antara +3 volt sampai +15 volt, dan *logic 1 (high)* dinyatakan sebagai tegangan antara -3 volt sampai -15 volt. Level tegangan ini tidak sesuai dengan tegangan *level* tegangan yang dipakai pada port *seri 51 AT* atau *port seri AT89s51* yang menggunakan *Standard TTL (Transistor Transistor Logic)*, yaitu *level* tegangan baku dalam rangkaian – rangkaian *digital*.

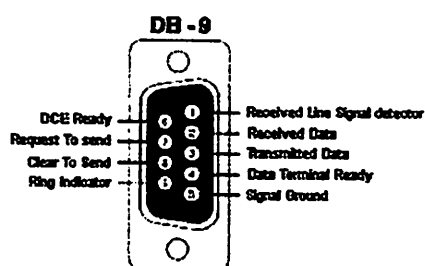
Dalam *standard TTL*, *logic 0 (low)*, dinyatakan sebagai tegangan antara 0 volt sampai 0.8 volt, dan *logic'1 (high)* dinyatakan sebagai tegangan antara 3.5 volt sampai 5 volt. Untuk dua MCU yang dihubungkan secara *serial* pada jarak tertentu maka dibutuhkan IC MAX 232 karena *level* tegangan TTL terlalu kecil untuk ditransfer.



Gambar 2-18
IC MAX 232

(Sumber : www.electroniclab.com DataSheet MAX 232)

Didalam komputer terdapat fasilitas komunikasi *serial* yang menggunakan *Standard RS-232*, yaitu terletak pada COM 1 dan COM 2. Kedua fasilitas ini menggunakan konektor DB-9 atau DB-25. Gambar konektor DB-9 seperti terdapat dalam gambar 2-19.



Gambar 2-19
Konektor DB-9

(Sumber : *Interfacing Komputer dan mikrokontroler*)

Fungsi masing – masing pin pada DB-9 seperti terdapat dalam tabel 2-8

Tabel 2-8
Fungsi Pin RS-232 dalam DB-9

| Pin | Nama | Fungsi |
|-----|---------------------------------------------|-----------------------------------------------------------------|
| 1 | DCD (<i>Data Carrier Detect</i>) | Mendeteksi Sinyal Carrier dari modem lain |
| 2 | RD (<i>Received Data Line</i>) / (RXD) | Pengiriman data serial dari DCE ke DTE |
| 3 | TD (<i>Transmitted Data Line</i>) / (TXD) | Pengiriman data serial dari DTE ke DCE |
| 4 | DTR (<i>Data Terminal Ready</i>) | Memberitahukan DCE bahwa DTE telah aktif dan siap untuk bekerja |
| 5 | Ground | Referensi semua tegangan antar muka |
| 6 | DSR (<i>Data Set Ready</i>) | Memberitahukan DTE bahwa DCE telah aktif dan siap untuk bekerja |
| 7 | RTS (<i>Request To Send</i>) | Memberitahukan DCE bahwa DTE akan mengirim data |
| 8 | CTS (<i>Clear To Send</i>) | Memberitahukan DTE bahwa DCE siap menerima data |
| 9 | RI (<i>Ring Indikator</i>) | Aktif jika <i>modem</i> menerima sinyal ring jalur telepon |

(Sumber : *Interfacing Komputer dan mikrokontroler*)

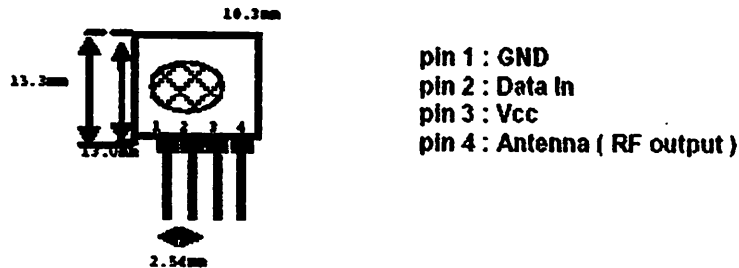
Jalur data (TXD dan RXD) untuk transport data, TXD adalah jalur *output* komputer, data dikirim dari pin ini. Sedangkan RXD adalah penerima untuk komputer, data yang datang akan diterima oleh pin ini. Pin ke empat adalah *output* (RTS) dimana sebuah sinyal akan diberikan pada alat yang dihubungkan dengan maksud meminta kiriman data. CTS adalah sinyal masukan yang menunggu sinyal dari alat yang terhubung ketika alat tersebut menerima sinyal RTS dan bisa menerima data maka ia akan mengirimkan sinyal balik yang merupakan CTS. DTR adalah sinyal keluaran yang memberi tanda bahwa ada alat yang terhubung dan akan mengirimkan data. DSR merupakan sinyal input yang mana jika alat yang terhubung menerima sinyal DTR ia akan memberi sinyal balik kemudian diterima sebagai sinyal DSR.

2.8. TLP 434 dan RLP 434

TLP 434 (pemancar) dan RLP 434 (penerima) merupakan suatu pasangan dalam suatu modul rangkaian yang mempunyai fungsi berbeda, yaitu TLP berfungsi mengirimkan data dan RLP berfungsi menerima sinyal yang dipancarkan dari TLP. Digunakannya TLP434A dan RLP 434A sebagai modul RF (*Radio Frekuensi*) pada skripsi ini karena kemampuannya di dalam pengiriman dan penerimaan data yang cukup baik. Biasanya kedua modul ini dihubungkan dengan mikrokontroler atau peralatan digital yang lainnya. Input data adalah serial dengan level TTL (*Transistor – Transistor Logic*). Jarak pancar maksimum dari modul RF ini adalah 100 meter tanpa halangan dan 30 meter di dalam gedung. Ukuran ini dapat dipengaruhi oleh faktor antena, kebisingan, dan tegangan kerja

dari pemancar. Panjang antena yang digunakan adalah 17 cm, dan terbuat dari kawat besi. Berikut ini merupakan bentuk dari TLP 434 dan RLP 434:

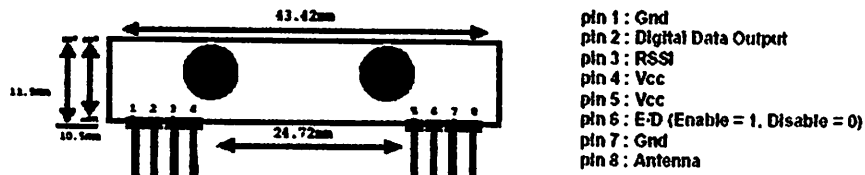
1. Ultra Small Transmitter (TLP434A)



Gambar 2-20

Ultra Small Transmitter (TLP434A)
(Sumber : Datasheet TLP RLP 434A)

2. RLP 434A SAW Based Receiver



Gambar 2-21

RLP 434A SAW Based Receiver
(Sumber : Datasheet TLP RLP 434A)

2.9. Transistor Sebagai *Switching*

Dalam perancangan alat ini digunakan transistor C945 yang berfungsi sebagai saklar. Transistor ini merupakan transistor bipolar dengan tipe NPN.

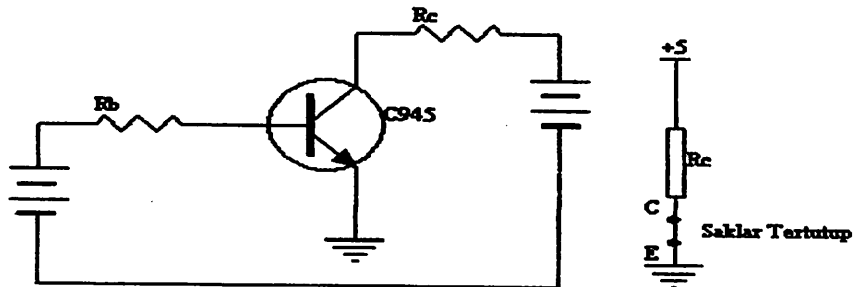
Transistor yang digunakan sebagai saklar harus dikondisikan dalam dua kondisi, yaitu :

1. Transistor dalam keadaan jenuh (saturasi).

Transistor dalam keadaan jenuh (saturasi), maka berlaku :

- Kuat arus (I_c) mencapai maksimum.
- Nilai V_{ce} sama dengan 0 volt.
- Tegangan pada beban sama dengan tegangan sumber ($V_{cc}=V_{Rc}$).

Untuk lebih jelasnya dapat dilihat pada gambar dibawah ini :



Gambar 2-22
Transistor dalam keadaan Saturasi
 (sumber: www.elektroniclub.com)

Untuk menghitung resistansi pada basis menggunakan rumus :

$$V_{cc} - I_c \cdot R_c - V_{ce} = 0$$

Karena keadaan saturasi $V_{ce} = 0$ maka rumusnya menjadi :

$$V_{cc} - I_c \cdot R_c = 0$$

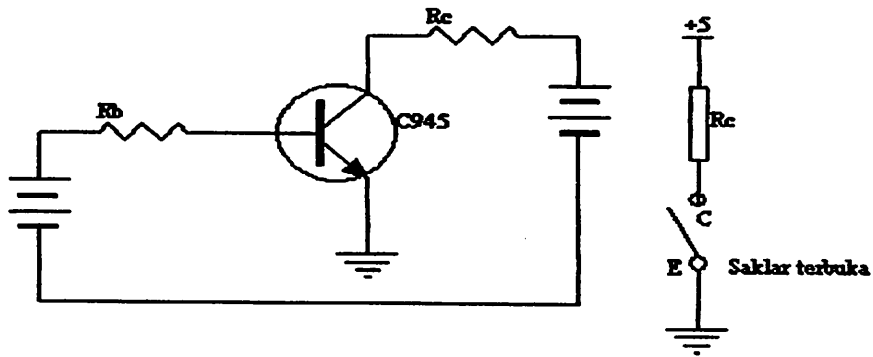
$$I_c = \beta_{dc} \cdot I_b$$

$$I_b = \frac{I_c = V_{cc} - V_{be}}{R_b}$$

2. Transistor dalam keadaan *Cut Off*.

Transistor dalam keadaan cut off (sumbat) berlaku hal – hal sebagai berikut :

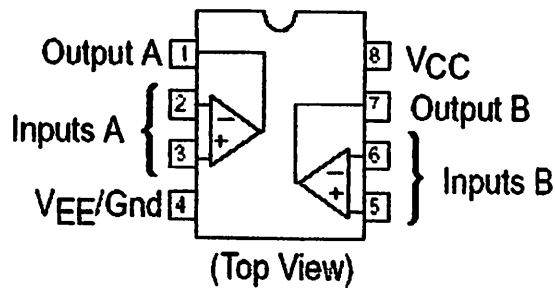
- Nilai arus I_b sama dengan 0 volt.
- Nilai arus I_c sangat kecil sekali sehingga dapat dabaikan.
- Besarnya V_{cc} sama dengan V_{ce} .



Gambar 2-23
Transistor dalam keadaan *Cut Off* (sumbat)
(sumber:www.elektroniclub.com)

2.10. IC LM 358

IC LM 358 ini digunakan untuk penguatan tegangan yang masuk melalui *receiver* RLP 434 karena tegangan yang diterima atau tegangan yang masuk melalui penerima sangat kecil. Namun bentuk gelombang yang dikeluarkan masih kurang bagus dan masih memerlukan penguatan lebih lanjut yang dalam perancangan alat ini menggunakan transistor C945, sehingga gelombang yang dikeluarkan sesuai dengan yang diharapkan. Berikut ini gambar dari IC LM 358 :



Gambar 2-24
IC LM 358 (*Low Power Dual Operational Amplifier*)
(Sumber : Datasheet LM 358)

2.11. Microsoft SQL Server 2000

MS SQL Server adalah salah satu produk *Relational Database Management System* (RDBMS) populer saat ini. Fungsi utamanya adalah sebagai *database server* yang mengatur semua proses penyimpanan data dan transaksi suatu aplikasi. Saat ini versi terbaru adalah *SQL Server 2000*, sedangkan *SQL Server 2005* masih dalam tahap *Beta version*. Versi 2000 memiliki *feature-feature* lengkap untuk membangun aplikasi mulai skala kecil sampai dengan tingkat *enterprise*.

2.11.1 Interface SQL Server 2000

Ada 3 *interface* utama saat Anda bekerja dengan *SQL Server*:

1. Enterprise Manager

Merupakan *interface* utama dan paling sering digunakan oleh administrator *database*. Bagian ini mengandung sebagian besar fungsi-fungsi pokok dalam mengatur *database*. Di dalam folder *database* ditampilkan berbagai *database* yang ada. *Database* master, model, msdb, dan tempdb merupakan default sistem *database* yang diperlukan agar *SQL Server* dapat berfungsi baik. Keempat *database* ini tidak boleh dihapus ataupun dimodifikasi tanpa pengetahuan yang mencukupi tentang sistem *SQL Server*. Sedangkan *NorthWind* dan *pubs* adalah *database* sampel yang dapat digunakan untuk berlatih perintah *SQL* maupun *administration job*.

2. Query Analyser

Tool ini merupakan *interface* utama dalam melakukan pemrograman di *SQL Server*. Bahasa yang digunakan adalah *Transact SQL* (T-SQL). Anda

dapat membuat perintah untuk mengambil data, sortir, manipulasi data serta melakukan perhitungan tertentu terhadap sekumpulan data dalam *database*. *Script* yang telah dibuat dapat disimpan sebagai *View* ataupun *Stored Procedure*, sesuai dengan kebutuhan dalam pembuatan aplikasi.

3. Service Manager

Digunakan untuk mengatur service yang ada di SQL Server, apakah akan dijalankan atau dimatikan. Sebuah service juga dapat disetup agar berjalan otomatis sebagai *Windows service*, atau dijalankan secara manual. Ada 3 service standar dalam setiap instalasi *default* SQL Server::

- *Distributed Transaction Coordinator*
- *SQL Server*
- *SQL Server Agent*

2.11.2 Database

Membuat *Database* baru dilakukan dengan cara : Buka *Enterprise Manager* lalu expand *Microsoft SQL Server > SQL Server Groups*, kemudian dilanjutkan dengan membuka server LOCAL, atau sesuai nama komputer pengguna, lalu buka *folder Database*. Klik kanan folder tersebut dan pilih *New Database* dan kemudian Isikan nama *database* yang akan dibuat.

2.11.3 Tabel

Sebuah *database* terdiri dari satu atau banyak tabel untuk menyimpan data. Untuk membuat tabel, klik kanan nama *database* tersebut lalu pilih *New > Table*. Kemudian diisi nama-nama kolom/*field* untuk tabel tersebut.

Penting untuk diperhatikan bahwa sebuah *field* harus menggunakan tipe data dan ukuran secara tepat, sesuai dengan kebutuhannya. Apalagi tipe data dan

ukurannya terlalu besar, maka *database* akan cepat membengkak dan memakan memori lebih banyak dari yang dibutuhkan.

2.11.4 Primary Key dan Foreign Key

Setiap tabel sebaiknya dilengkapi dengan *primary key* yang merupakan identitas unik dari setiap baris data. Dengan demikian apabila dalam suatu tabel terdapat sekian ribu baris data misalnya, maka setiap barisnya memiliki identitas sendiri berdasarkan *primary key* nya. Salah satu teknik sederhana dan efektif adalah menetapkan field autonumber sebagai *primary key*. Jadi secara otomatis akan ditetapkan angka berurutan dalam setiap barisnya. Anda juga dapat membuat *primary key* dengan tipe data lain (bukan *autonumber*) sesuai dengan kebutuhannya.

2.12 Bahasa Pemrograman Borland Delphi

Delphi adalah perangkat lunak untuk menyusun program aplikasi yang berdasarkan pada bahasa pemrograman bahasa *pascal* dan bekerja dalam lingkungan sistem operasi *Windows*. Dengan *Delphi* diperoleh kemudahan dalam menyusun program aplikasi, karena *Delphi* menggunakan komponen-komponen yang akan menghemat penulisan program dengan fasilitas *VCL (Visual Component Library)*.

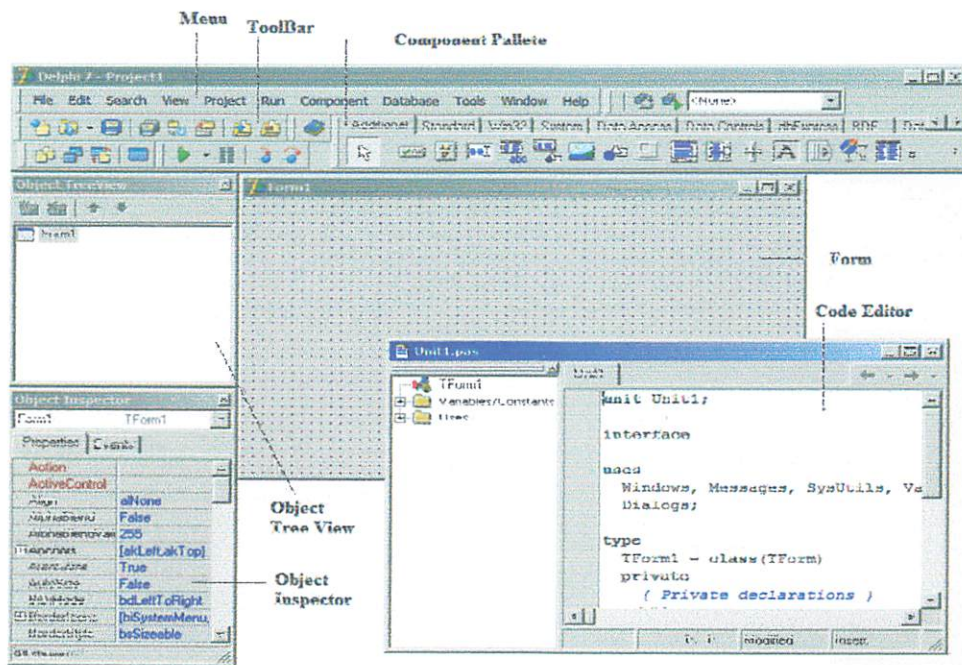
Dalam pembuatan sebuah program, *Delphi* menggunakan sistem yang disebut RAD (*Rapid Application Development*). Sistem ini memanfaatkan bahasa pemrograman visual yang membuat seorang programmer lebih mudah mendesain tampilan program (*User Interface*). Cara ini bermanfaat untuk membuat program

yang bekerja pada sistem *Windows* yang memang tampilan layarnya lebih rumit (sekaligus dapat dilihat dengan indah) dibanding dengan sistem DOS.

Aplikasi dalam tatanan GUI (*Graphical User Interface*) yaitu karakter program aplikasi yang menggunakan sarana perantara grafis dapat dibentuk dengan *Delphi*. Seperti kotak dialog (*dialog box*), tombol (*button, menu*) dan lain sebagainya. Contoh program GUI adalah program-program *Windows*. Dengan *Delphi* sebuah *Windows* yang mengandung tombol-tombol, kotak cek, tombol pilihan panel dan komponen lainnya dapat dengan mudah diciptakan.

2.12.1 IDE (*Integrated Development Environment*) *Delphi*

IDE adalah suatu lingkungan dimana sebuah *tools* yang diperlukan untuk desain, menjalankan dan mengetes sebuah aplikasi disajikan dan terhubung dengan baik sehingga memudahkan pengembangan program. Pada *Delphi*, IDE terdiri dari *main Windows, Component Palette, Toolbar, Form designer, Code Editor, Code Explorer*. Di bawah ini merupakan gambar dari *IDE Delphi*.



Gambar 2-24.

IDE (Integrated Development Enviroment)

(Sumber: Visual Borland Delphi 7, 2004)

e Main Windows (jendela utama)

Main Widows adalah bagian utama dari IDE. *Main Windows* mempunyai semua fungsi utama dari program-program Windows lainnya. *Main Windows* dibagi tiga yaitu menu utama, toolbar, dan component palette.

Menu utama. Seperti program *Windows* lainnya, menu utama dipakai untuk membuat dan menyimpan file memanggil *wizard*, menampilkan jendela lain, mengubah option dan lain sebagainya setiap pilihan pada menu juga dapat dipanggil dengan sebuah tombol pada *toolbar*.

Toolbar. Beberapa operasi pada menu utama dapat dilakukan melalui *toolbar*. Setiap tombol pada *toolbar* mempunyai sebuah *tooltip* yang berisi informasi mengenai fungsi dari tombol tersebut. Selain *component palette*, ada 5 *toolbar* terpisah yaitu *debug*, *desktop*, *standart*, *view*, dan *custom*.

Component Palette adalah *toolbar* dengan ketinggian ganda, yaitu berisi page kontrol dengan semua komponennya. Urutan dan tampilan dari page dan komponen pada komponen *palette* dapat diatur dengan klik kanan atau dengan memilih menu *component configure component* dari menu utama.

- **Form designer**

Diawali dengan jendela kosong yang memungkinkan untuk merancang aplikasi *Windows*. Dari sini dapat ditentukan tampilan aplikasi sesuai dengan yang diinginkan. Berinteraksi dengan *form designer* dengan cara memilih komponen *palette* dan meletakkannya ke dalam *form*, posisi dan ukuran dapat diubah-ubah dengan menggunakan *mouse*. Untuk mengubah tampilan dan perilaku komponen maka digunakan *object inspector* dan *code editor*.

- **Object Editor**

Object Editor terdiri dari dua tab yaitu *tab properties* dan *tab events*. *Tab properties* memberi fasilitas untuk melihat dan mengubah property dari setiap item. Klik pada sebuah form kosong, dan perhatikan atribut-atribut yang ada. Jika terdapat tanda + disamping property maka property tersebut berarti mempunyai *sub property*. Contohnya *property*

font, jika diklik ganda pada *property font* maka akan ditampilkan *sub property*nya seperti *color*, *height*, *name* dan lain-lain. *Tab Event* berisi event-event yang dapat direspon oleh sebuah obyek. Klik tab event disebelah kanan tab *properties*. Misalnya ingin sesuatu dikerjakan pada saat *form* ditutup, maka tindakan tersebut (berupa sebuah *procedure*) pada *Onclose*.

- **Struktur Menu *Delphi***

Struktur menu *Delphi* memberikan tools untuk mengakses lingkungan *Delphi*.

- ***File***

Menu *file* adalah menu paling penting dan akan dijabarkan pada bagian berikut:

New. Digunakan untuk memulai obyek baru.

New Application. Dengan memilih menu ini, berarti akan membuat project baru. Jika belum membuka sebuah *project* atau *object* yang dibuka sudah disimpan ke disk. *Delphi* akan menutup *project* tersebut dan akan membuat *project* baru, termasuk membuat jendela *editor* baru dengan nama file *UNIT.PAS*, *form baru* (form 1) dan menampilkan *object inspector*.

New Form. Menu ini dipakai untuk membuat form baru.

New frame. Untuk membuat frame kosong dan menambahkannya ke dalam *project*.

Open. Menyatakan pada *Delphi* bahwa akan dibuka sebuah *object* dapat berupa sebuah program atau seluruh *project*.

Open Project. Untuk membuka sebuah *project*.

Reopen. Menu ini dipakai untuk membuka *object favorit* yang sudah pernah dibuka.

Save. Menu ini dipakai untuk menyimpan *module* yang sedang aktif.

Save as. Dipakai untuk menyimpan *module* dengan nama lain.

Save project as. Menu ini dipakai untuk menyimpan *project* dengan nama baru.

Save all. Menyimpan sebuah *object* yang dibuka.

Close. Untuk menutup module program dengan *formnya*. Jika module tersebut belum disimpan, saat menutup maka *Delphi* akan menanyakan apakah modul tersebut akan disimpan.

Close all. Menutup *project*.

Use Unit. *Delphi* akan menambahkan *kluda uses* pada program yang dibuat. Artinya sebuah unit akan dipakai dalam *project*.

Print. Mencetak item *Delphi* yang telah dipilih.

Exit. Keluar dari aplikasi Delphi.

➤ **Edit**

Dipakai untuk menyunting program.

➤ **Search**

Dipakai untuk mencari dan mengganti kata-kata pada saat menyunting program.

➤ **View**

Dipakai untuk menampilkan atau menyembunyikan jendela-jendela tertentu, misalnya *object inspector*, *code explorer*, *debug* dan lain-lain.

➤ **Project**

Dipakai untuk mengelola *project*. *Form* dapat ditambah dan sibuang dari *object*, mengkompilasi *project* dan lain-lain.

➤ **Run**

Menu ini dipakai untuk menjalankan program dan memantau jalannya program. Pada saat di *run*, apabila terjadi salah tulis akan dapat diketahui.

➤ **Component**

Dengan menu ini komponen baru dapat ditambah atau diinstal.

(Sumber: Teknik Antarmuka Mikrokontroler Dengan Komputer Berbasis Delphi, 2006)

BAB III

PERANCANGAN DAN PEMBUATAN ALAT

3.1. Pendahuluan

Pada bab III ini akan diuraikan mengenai perencanaan dan pembuatan alat Aplikasi RFID Sebagai Pengecek ID Bagi Warga Pendatang Ke Pulau Bali Menggunakan *Wireless System*. Adapun animasi dari sistem ini adalah sebagai berikut :



Gambar 3 - 1
Animasi Perancangan Sistem

Dari animasi perancangan sistem diatas dapat dijelaskan dari masing – masing sebagai berikut :

1. Penumpang

Dalam perancangan sistem ini, penumpang yang berada di dalam kendaraan tidak perlu turun meninggalkan kendaraan untuk men-*scan* KTP-nya. Penumpang hanya duduk di dalam kendaraan dan hanya menunjukkan KTP yang telah ditempelkan dengan *tag* RFID.

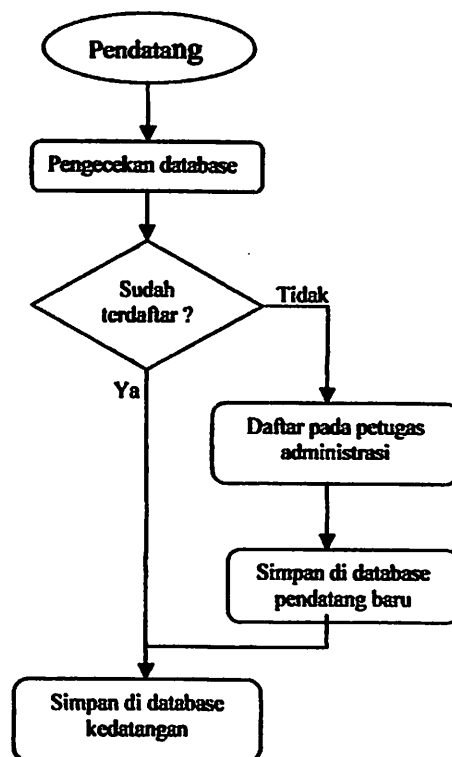
2. Operator (Petugas pengecekan)

Operator atau petugas pengecekan mempunyai tugas mengecek kebenaran kartu identitas yang dibawa oleh penumpang dengan cara mendekatkan *Reader* dengan *tag* RFID sehingga nama dari pendatang akan ditampilkan di LCD dan mewajibkan bagi para pendatang yang belum mempunyai kartu identitas dalam bentuk *tag* RFID untuk mendaftarkan diri pada bagian Administrasi

3. Petugas Administrasi

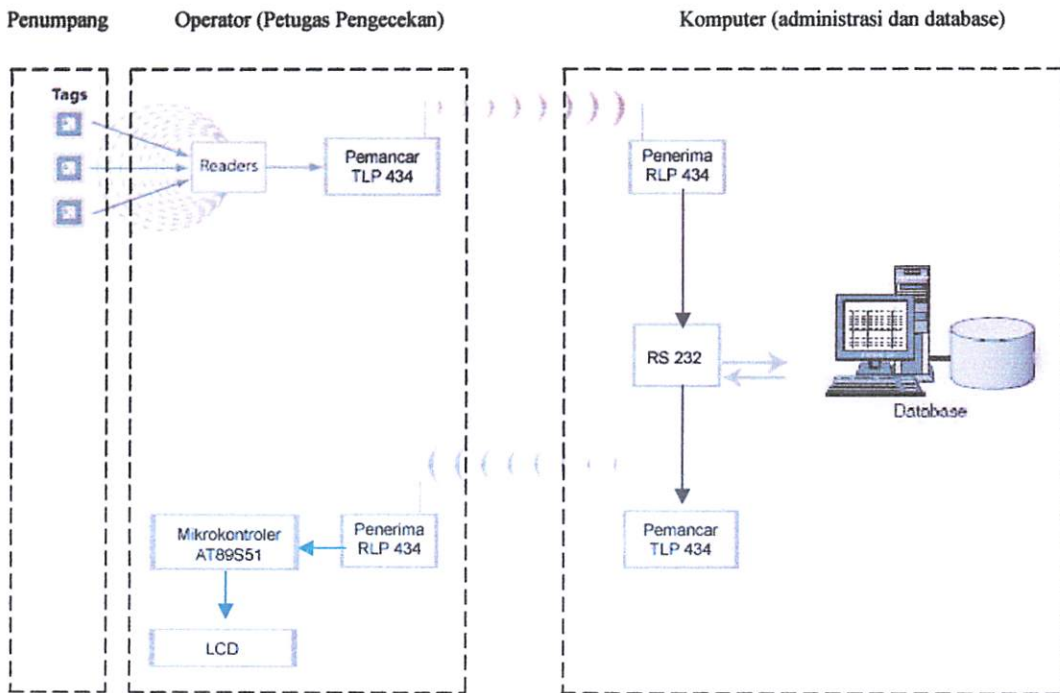
Petugas administrasi mempunyai tugas mendaftarkan identitas pendatang baru.

Flowcart alur pengecekan dan pendaftaran penumpang



Gambar 3 - 2
Flowcart alur pengecekan dan pendaftaran penumpang

Untuk memperjelas pemahaman dari animasi perancangan sistem diatas diperlihatkan pada blok diagram berikut:



Gambar 3 - 3
Blok Diagram Sistem

Berdasarkan blok diagram diatas, untuk menampilkan data identitas pendatang pada komputer yang dihubungkan secara *wireless* dengan RFID *Reader*, dalam perancangan diperlukan :

- a. *Tag* RFID yang berisi data identitas penduduk

Tag RFID yang digunakan disini adalah jenis EM4001

- b. RFID *Reader* : Sebagai pembaca *tag* RFID.

RFID *Reader* yang digunakan disini adalah ID12 yang mempunyai jarak pembacaan kurang lebih 12 cm.

Rangkaian pemancar dan penerima sebagai tatap muka antara komputer dengan RFID *Reader*. Rangkaian pemancar menggunakan TLP 434 dan rangkaian penerima menggunakan RLP 434.

- c. Mikrokontroler AT89S51 sebagai minimum sistem untuk mengatur tampilan status/informasi pada LCD.
- d. LCD sebagai penampil status/informasi.

LCD yang digunakan disini adalah LCD tipe LM1632 yaitu sebuah LCD dot matrix 16 x 2 baris dengan konsumsi daya rendah.

- e. Antena pemancar dan penerima.

- f. Komputer (administrasi dan *database*)

Komputer merupakan tempat penyimpanan *database* dari identitas penduduk, kedatangan dan juga sebagai tempat pendaftaran.

Prinsip kerja sistem :

Dalam perancangan penyelesaian tugas akhir ini terdiri dari dua perangkat yaitu *software* dan *hardware*. Untuk *hardware* digunakan RFID *Reader* yang dirangkai sehingga dapat dikomunikasikan secara *wireless* dengan komputer. Sedangkan untuk *software* disusun dalam bahasa pemrograman yang digunakan sebagai *user interface* dan digunakan juga untuk membandingkan data atau menyimpan data pada *database*.

Prinsip kerja dari aplikasi yang dibuat adalah RFID *Reader* membaca data pada *tag* RFID dan membandingkannya dengan *database* pada komputer yang dihubungkan secara *wireless*. Data yang dibaca oleh RFID *Reader* dikirim ke komputer, komputer akan membandingkannya dengan *database*, jika data tersebut

sudah ada di *database* (sudah pernah terdaftar) maka komputer akan mengirimkan informasi yang berupa nama ke mikrokontroler yang akan ditampilkan ke LCD sehingga petugas yang membawa RFID *Reader* akan mengetahui identitas dari pendatang. Jika data pendatang tidak ditemukan di *database* maka komputer akan mengirimkan status 'Belum Terdaftar' yang selanjutnya akan ditampilkan di LCD. Dan pengunjung diwajibkan untuk mendaftar di loket dan dikenakan biaya tertentu untuk mendapatkan *tag* RFID.

3.2 Perencanaan Perangkat Keras

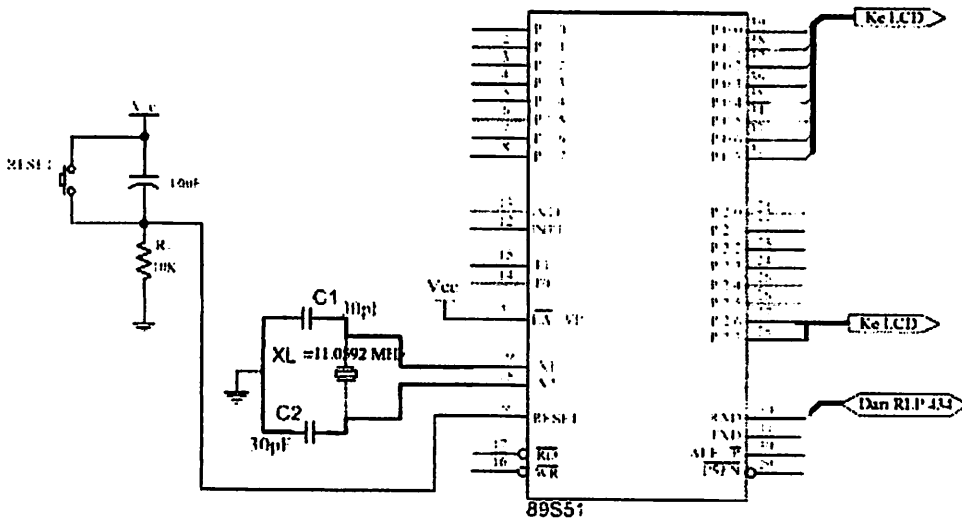
Bagian ini menguraikan perencanaan perangkat keras yang meliputi perencanaan :

1. Sistem Mikrokontroler AT89S51
2. Antarmuka RFID *Reader* dengan modul TLP 434
3. Antarmuka modul RLP 434 ke Mikrokontroler
4. Antarmuka Mikrokontroler ke modul LCD
5. Antarmuka modul RLP 434 ke RS 232
6. Antarmuka RS 232 ke modul TLP 434
7. Antarmuka RS 232 ke PC

3.2.1 Sistem Mikrokontroler AT89S51

Mikrokontroler AT 89S51 harus didukung oleh beberapa rangkaian lain agar dapat melakukan prosesnya, yaitu berupa rangkaian *clock* dan *reset*. Selain itu juga harus ditentukan dalam penggunaan port – portnya dan sinyal – sinyal yang digunakan mendukung proses yang dilakukan. Rangkaian mikrokontroler AT89S51 yang akan diantarmukakan dengan modul RLP 434 dan modul LCD.

Pada masing – masing blok memiliki rangkaian yang sama. Berikut adalah gambar 3 – 4 rangkaian mikrokontroler adalah sebagai berikut :



Gambar 3 - 4
Rangkaian Mikrokontroler AT89S51

Dalam sistem mikrokontroler ini direncanakan penggunaan port yang tersedia sebagai berikut :

1. *Port* 0.0 –0.7 sebagai jalur untuk LCD.
2. *Port* 2.6 –2.7 sebagai jalur data untuk pembaca dan menulis modul LCD.
3. *Port* 3.0 (RXD) sebagai jalur komunikasi serial dari modul RLP 434.

Hal – hal itu adalah sebagai berikut :

- ***Clock***

Kecepatan proses yang dilakukan oleh mikrokontroler ditentukan oleh sumber *clock* (pewaktuan) yang mengendalikan mikrokontroler tersebut. Sistem yang dirancang ini akan menggunakan osilator internal yang sudah tersedia di dalam chip AT89S51. Untuk menentukan frekuensi osilatornya, cukup dengan cara menghunungkan kristal pada pin XTAL1 dan XTAL2

serta dua buah kapasitor ke *ground*. Dengan menggunakan *crystal* diatas maka dapat dihitung waktu yang diperlukan untuk satu siklus mesin.

$$f = 11.0592 \text{ Mhz}$$

$$\text{sehingga } T = \frac{1}{f}$$

$$T = \frac{1}{11.0592 \text{ Mhz}} = 0.09042 \mu\text{s}$$

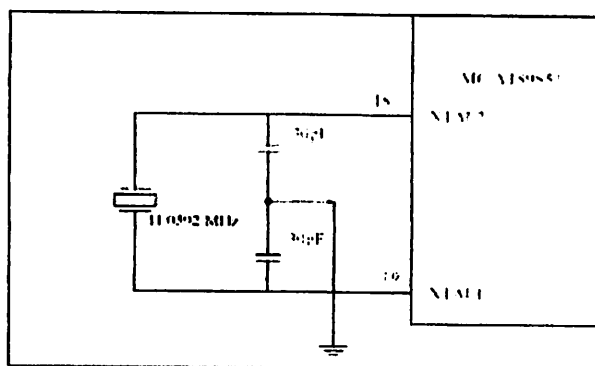
Maka untuk satu siklus mesin dari mikrokontroler besarnya adalah :

$$T_{me} = 12 \times T$$

$$T_{me} = 12 \times 0.09042 \mu\text{s}$$

$$T_{me} = 1,085 \mu\text{s}$$

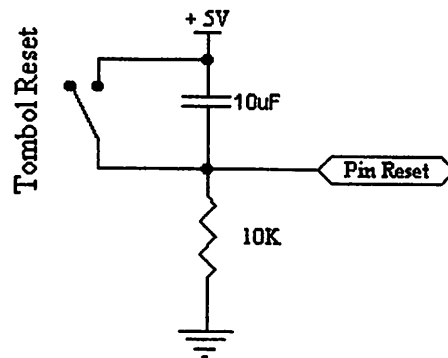
Besar *Crystal* disesuaikan dengan kecepatan yang diharapkan untuk transfer data melalui pin *serial interface* AT89S51 tersebut. Sistem ini dirancang untuk memiliki kemampuan *baud rate* sebesar 9600bps, sehinggalan dipilih kristal dengan nilai 11.0592 MHz sesuai dengan spesifikasi dalam Gambar 3 -5. memperlihatkan rangkaian rangkaian pewaktu yang digunakan.



Gambar 3 – 5
Rangkaian Pewaktu

- **Rangkaian Reset**

Reset pada mikrokontroler merupakan masukkan aktif High '1' Pulsa transisi dari rendah '0' ke tinggi '1' akan mereset mikrokontroler menuju alamat 0000H. Pin *reset* dihubungkan dengan rangkaian *power on reset* seperti pada gambar 3 – 6.



Gambar 3 – 6
Rangkaian *Power On Reset*

Rangkaian reset bertujuan agar mikrokontroler dapat menjalankan proses dari awal. Rangkaian *reset* untuk mikrokontroler dirancang agar mempunyai kemampuan *power on reset*, yaitu *reset* yang terjadi pada saat sistem dinyalakan untuk pertama kalinya. *Reset* juga dapat dilakukan secara manual dengan menekan tombol reset yang berupa *switch push button*.

Rangkaian *Reset* terbentuk oleh komponen R dan C. Nilai R yang dipakai adalah 10 kΩ dan C 10 µF.

Sedangkan untuk mencari frekuensi dari reset tersebut dengan menggunakan rumus sebagai berikut :

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

Sehingga dengan komponen *resistor* dengan nilai 10 Kohm serta kapasitor dengan nilai 47 uF akan dihasilkan frekuensi.

$$f_o = \frac{1}{1,1.RC}$$

$$= \frac{1}{1,1 \times 10^3 \times 10^{-6}} = 9,09 \text{ Hz}$$

Maka Periode Clock $T = \frac{1}{f_o}$

$$T = \frac{1}{9,09 \text{ Hz}} = 0,11 \text{ detik} = 110 \text{ ms}$$

Berarti dengan waktu 110ms mikrokontroller sudah dapat direset karena waktu minimal yang dibutuhkan untuk power on reset adalah 2 kali siklus mesin ditambah power on osilator yaitu $(1,085 \mu\text{s} \times 2) + 10 \text{ ms}$. Dan untuk reset secara manual diperlukan waktu minimal 2 kali siklus mesin yaitu $1,085 \mu\text{s} \times 2$.

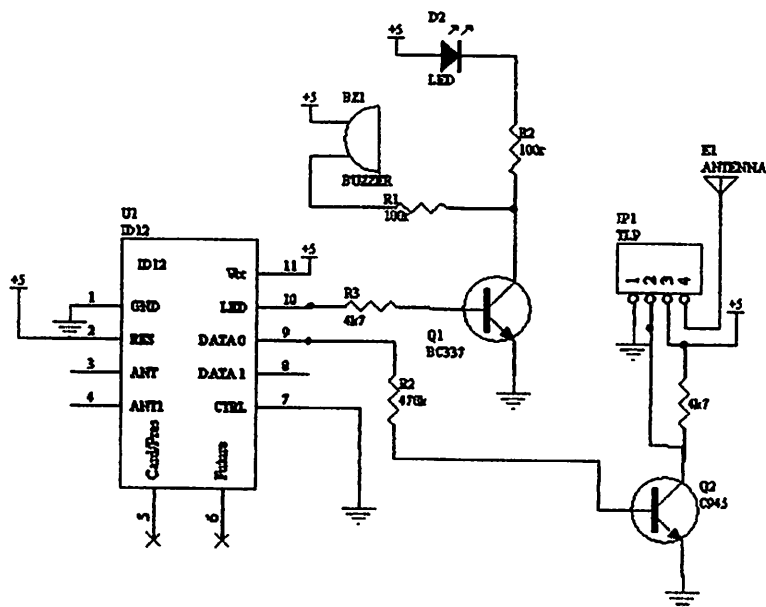
- **Pembagian Port**

Mikrokontroler AT89S51 mempunyai 4 buah port yaitu *port 0* (P0), *port 1* (P1), *port 2* (P2) dan *port 3* (P3). Pada *port 2* yaitu P2.6 dihubungkan dengan EN dan P2.7 dihubungkan dengan CS pada LCD, sedangkan untuk bit kontrol Rx terletak pada komunikasi serial sistem mikrokontroler digunakan sebagai masukan data dari modul RLP 434.

3.2.2 Antarmuka RFID Reader dengan modul TLP 434

Kartu RFID / *tag* yang telah ditempel pada KTP digunakan sebagai ID agar bisa dibaca oleh RFID *reader* dan bisa dikirim ke komputer penerima yang selanjutnya di cari di *database*. RFID *Reader* langsung dihubungkan ke TLP 434 untuk dikirim ke penerima RLP434 yang terhubung dengan komputer. Karena

inputan yang harus masuk ke TLP 434 adalah inputan TTL maka pada RFID reader dihubungkan dengan pin DATA 0. Gambar 3-7 dibawah ini adalah rangkaian dari RFID dan TLP 434.



Gambar 3 – 7
Rangkaian dari RFID dan TLP 434

Perhitungan untuk Rangkaian TLP 434A

Keluaran dari pin 9 RFID pada saat *tag* tidak didekatkan dengan *reader* adalah high (5 Volt) sehingga agar TLP434A tidak mengirimkan logika *high* secara terus menerus maka digunakan transistor yang berfungsi sebagai saklar.

Karena $V_{cc} = 5V$ dan I_c yang diinginkan untuk dapat mengaktifkan transistor sebesar 1 mA ($V_{be} = 0,65 V$), maka dapat dicari R_c :

$$R_c = \frac{V_{cc}}{I_c}$$

$$R_c = \frac{5V}{1mA}$$

$$R_c = 5K\Omega$$

Diinginkan Hfe dari transistor adalah 100 dan karena keluaran dari pin 9 RFID adalah 5V maka untuk dapat mengaktifkan transistor diperlukan resistor (Rb) :

$$I_b = \frac{I_c}{\beta_{dc}}$$

$$I_b = \frac{1mA}{100}$$

$$I_b = 10\mu A$$

Dari nilai Ib yang sudah diketahui maka nilai Rb adalah :

$$R_b = \frac{V_{bb} - V_{be}}{I_b}$$

$$R_b = \frac{5 - 0,65}{10\mu A}$$

$$R_b = 435 K\Omega$$

Oleh karena resistor dengan nilai 5K Ω dan 453K Ω tidak terdapat di pasaran maka digunakan resistor pengganti yaitu senilai 4K7 Ω dan 470K Ω . Dan dengan karakteristik transistor yang diinginkan seperti diatas maka digunakanlah transistor C945.

Perhitungan untuk rangkaian LED dan Buzzer

Frekuensi keluaran dari pin 10 RFID reader adalah 3,1 KHz dan tegangan keluaran pada saat tag RFID didekatkan dengan reader adalah 5 volt. Untuk mengaktifkan LED dan buzzer akan digunakan transistor BC337 yang mempunyai karakteristik Ib = 100mA dan Hfe = 100. Karena Vcc adalah 5 volt dan Vled adalah 2,7V dan arus yang dibutuhkan led adalah 20mA maka perlu dicari resistansi yang akan digunakan :

Tahanan untuk LED :

$$\begin{aligned} R_{led} &= \frac{V_{cc} - V_{led}}{I_c} \\ &= \frac{5V - 2,7V}{20mA} \\ &= \frac{2,3V}{20mA} \\ &= 115 \Omega \end{aligned}$$

Karena resistor 115 Ω tidak terdapat dipasaran maka digunakan resistor sebesar 100 Ω .

Tahanan untuk buzzer :

$$\begin{aligned} I_{buz} &= I_c - I_{led} \\ &= 100mA - 20mA \\ &= 80mA \\ R_{buz} &= \frac{V_{cc}}{80mA} \\ &= \frac{5V}{80mA} \\ &= 62,5 \Omega \end{aligned}$$

Karena resistor 62,5 Ω tidak terdapat dipasaran maka digunakan resistor sebesar 100 Ω .

Karena tegangan keluaran pin 10 RFID adalah 5 volt maka untuk mengaktifkan transistor BC337 maka perlu diberi tahanan sebesar :

$$\begin{aligned} I_b &= \frac{I_c}{\beta_{dc}} \\ &= \frac{100mA}{100} = 1mA \end{aligned}$$

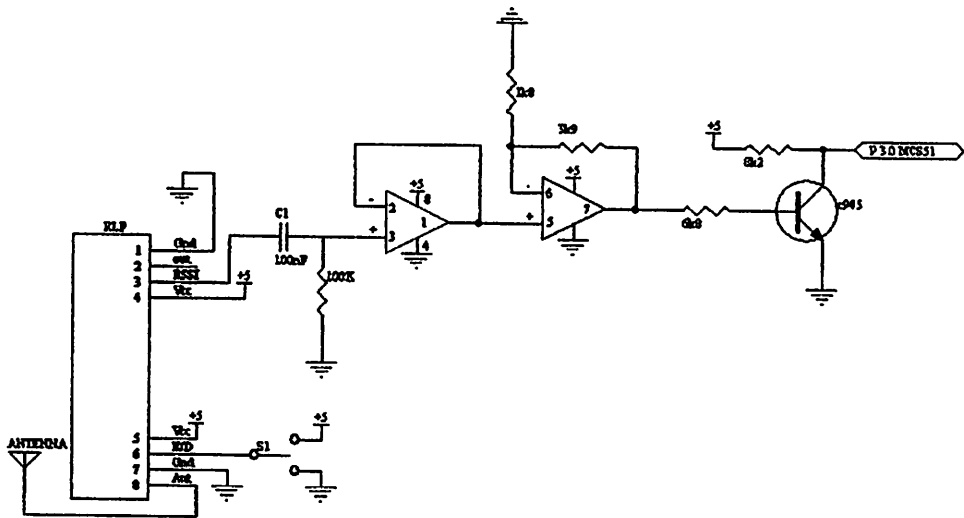
$$\begin{aligned}
 R_b &= \frac{V_{bb} - V_{be}}{I_b} \\
 &= \frac{5V - 0,7V}{1mA} \\
 &= 4300 \Omega \\
 &= 4,3 \text{ k}\Omega
 \end{aligned}$$

Karena resistor 4,3 k Ω tidak terdapat dipasaran maka digunakan resistor sebesar 4,7 k Ω .

3.2.3 Antarmuka modul RLP 434 ke Mikrokontroler

Sinyal data dari komputer yang dikirimkan oleh rangkaian pengirim (TLP) akan diterima oleh modul penerima yaitu RLP 434. Modul ini bekerja pada frekwensi 434 MHZ.

Keluaran dari rangkaian RLP (sudah berupa digital) selanjutnya dikuatkan tegangannya dengan rangkaian LM358 sehingga dapat mengaktifkan transistor SC945 untuk disesuaikan dengan tegangan mikrokontroler. Adapun gambar rangkaian dari RLP 434 adalah sebagai berikut:



Gambar 3 – 8
Rangkaian modul RLP 434 ke Mikrokontroller

Pada saat RLP menerima data High =0.5V pada pengukuran menggunakan oscilloscope dapat dilihat bahwa gelombang keluaran dari RLP belum berada di level 0 volt hal ini disebabkan oleh adanya tegangan DC. Kapasitor 100nF dan resistor 100K berfungsi menghilangkan sinyal dc dan digunakan untuk menurunkan level tersebut sehingga berada pada level 0 volt pada pengukuran oscilloscope. RLP dihubungkan dengan rangkaian Buffer (IC LM 358) sebagai penyangga dan kemudian tegangan dikuatkan pada penguat non inverting sehingga tegangan tersebut dapat mengaktifkan transistor C945, maka dilakukan perhitungan :

Perhitungan rangkaian buffer :

$$V_{in} = V_{out}(\text{buffer}) = 0,5V$$

Rangkaian ini (buffer) berfungsi untuk menstabilkan frekuensi dan atau amplitude akibat dari pembebanan tingkat selanjutnya.

Perhitungan pada rangkaian penguat *non inverting*

$$V_{out} = \left(1 + \frac{R_2}{R_1}\right) \times V_{in}$$

$$V_{out} = \left(1 + \frac{3K9}{1K8}\right) \times 0,5V$$

$$V_{out} = (1 + 2,16) \times 0,5V$$

$$V_{out} = 1,58 V$$

Perhitungan pada transistor :

Besar I_c diasumsikan sama dengan I mikrokontroler, dari datasheet arus untuk perubahan logika 1 ke 0 pada mikrokontroler sebesar $650\mu A$ begitu pula pada RS 232 diasumsikan sama, dan dengan tegangan sumber sebesar 5 volt maka dapat dicari R_c .

$$R_c = \frac{V_{sumber}}{I_c}$$

$$R_c = \frac{5V}{650\mu A}$$

$$R_c = 7,69 K\Omega$$

Karena nilai tahanan $7,69 K\Omega$ tidak ada dipasaran maka dapat diganti dengan nilai yang terdekat yaitu $8K2 \Omega$.

Dengan I_c sebesar $650\mu A$, dan H_{fe} dari transistor C945 sebesar 90 maka dapat dicari I_b .

$$I_b = \frac{I_c}{\beta_{dc}}$$

$$I_b = \frac{650\mu A}{90}$$

$$I_b = 7,2\mu A$$

Untuk membuat rangkaian ini bekerja lebih sensitive maka tegangan *basis* (V_{bb}) harus sedikit lebih besar dari tegangan V_{be} , dengan asumsi perancangan bahwa V_{bb} sebesar 0,7 V transistor C945 sudah mulai saturasi.

Diketahui bahwa besar V_{be} dari transistor C945 sebesar 0,65 V.

$$R_b = \frac{V_{bb} - V_{be}}{I_b}$$

$$R_b = \frac{0,7V - 0,65V}{7,2\mu A}$$

$$R_b = 6K9 \Omega$$

Karena nilai tahanan 6K9 Ω tidak ada di pasaran maka dapat diganti dengan nilai yang mendekati yaitu 6K8 Ω .

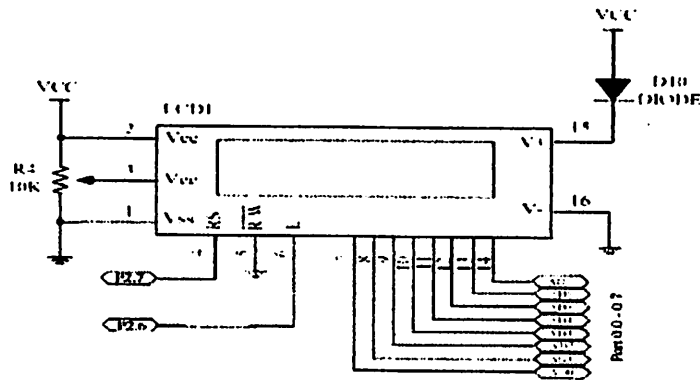
3.2.4 Antarmuka Mikrokontroler ke modul LCD

Pada sistem yang direncanakan akan digunakan LCD (*Liquid Crystal Display*) sebagai tampilan. LCD yang digunakan adalah jenis LM1632 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 LM1632 memiliki 2 register yaitu register data dan register instruksi.

Dalam sistem ini, LCD menempati ruang alamat A000H-A001H. 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 port 2.7 sistem mikrokontroler. Pengaktifan LCD ini selanjutnya tergantung pada pin E.

Dimana pin E ini tergantung dari P2.6 dari mikrokontroler. Rangkaian LCD seperti terlihat dalam gambar 3 - 9.

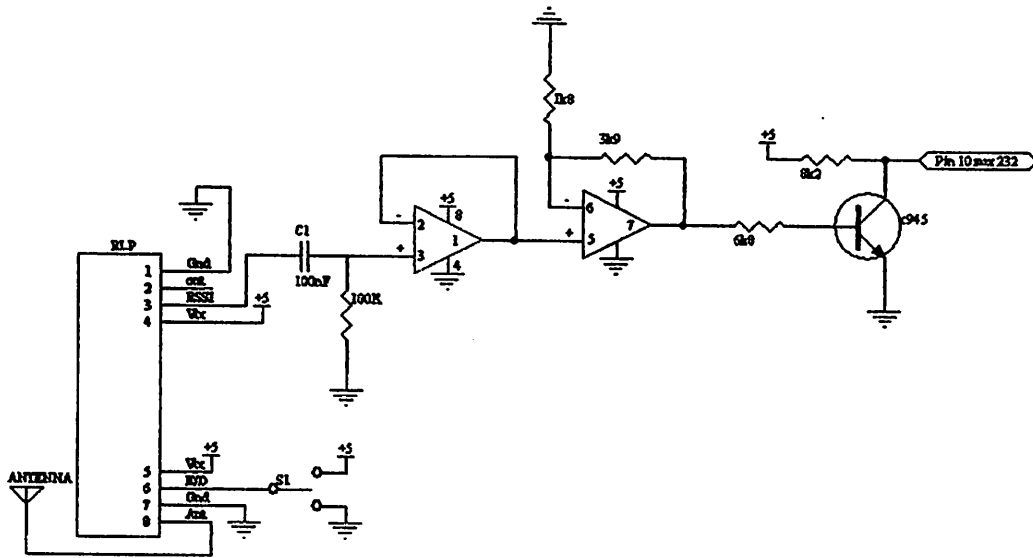


Gambar 3 – 9
Rangkaian LCD LM1632

3.2.5 Antarmuka modul RLP 434 ke RS 232

Sinyal data dari RFID *Reader* yang dikirimkan oleh rangkaian pengirim (TLP) akan diterima oleh modul penerima yaitu RLP 434. Modul ini bekerja pada frekwensi 434 MHZ.

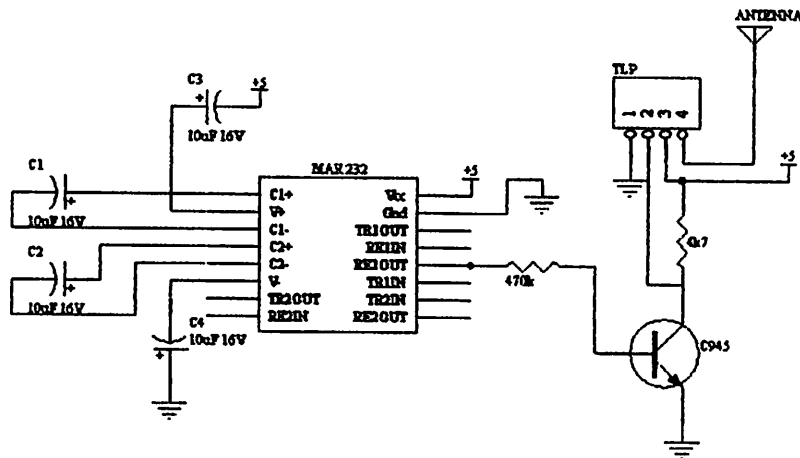
Keluaran dari rangkaian RLP (sudah berupa digital) selanjutnya dikuatkan tegangannya dengan rangkaian LM358 sehingga dapat mengaktifkan transistor SC945 untuk disesuaikan dengan tegangan mikrokontroller. Adapun gambar rangkaian dari RLP 434 adalah sebagai berikut:



Gambar 3 – 10
Rangkaian modul RLP 434 ke MAX 232

3.2.6 Antarmuka RS 232 ke modul TLP 434

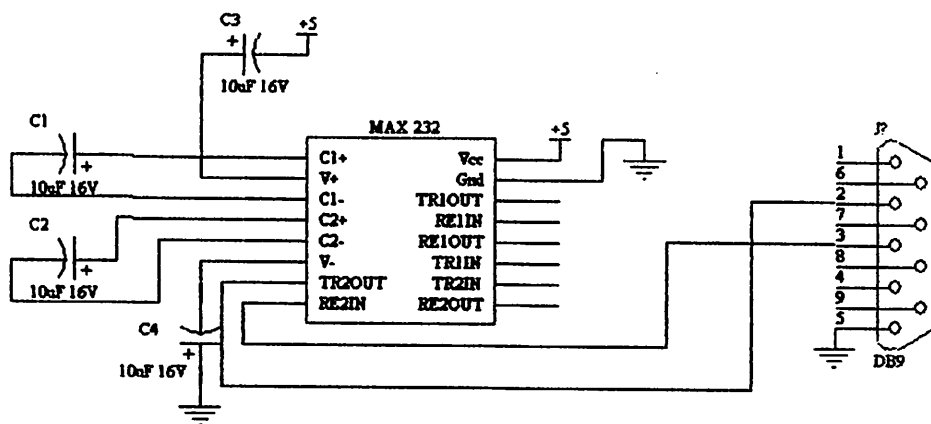
Data yang dikirim oleh PC melalui RS232 akan ditransmisikan secara *wireless* dengan menggunakan modul TLP434. Gambar 3-11 dibawah ini adalah rangkaian RS 232 ke modul TLP 434



Gambar 3 – 11
Rangkaian RS 232 ke modul TLP 434

3.2.7 Antarmuka RS 232 ke PC

Data yang keluar masuk port serial komputer menggunakan standar komunikasi serial RS232. Pada standart komunikasi serial sesuai dengan spesifikasi standart RS 232-C, level tegangan yang digunakan adalah level tegangan yang berkisar antara -3 volt hingga -15 volt untuk kondisi logika '1' atau yang disebut dengan keadaan *mark* dan antara +3 volt hingga +15 volt untuk kondisi logika '0' atau disebut dengan keadaan *space* atau dengan kata lain standart RS 232-C menggunakan logika negatif/terbalik. Untuk dapat digunakan pada RS485, dalam membentuk jaringan komunikasi data antara komputer sentral dengan PPDS, level tegangan RS232 dari komputer harus diubah menjadi level tegangan TTL karena masukan DI (*driver input*) RS485 menggunakan level tegangan TTL. Begitu pula jika RS485 akan menyampaikan data ke komputer, maka level tegangan data tersebut harus diubah dulu sesuai standart RS232. Nilai kapasitor yang digunakan telah ditentukan sebesar 10 uF. Rangkaian untuk *Interface Unit RS232* ditunjukkan pada gambar 3 -12.



Gambar 3 – 12
Rangkaian Antarmuka RS 232 ke PC

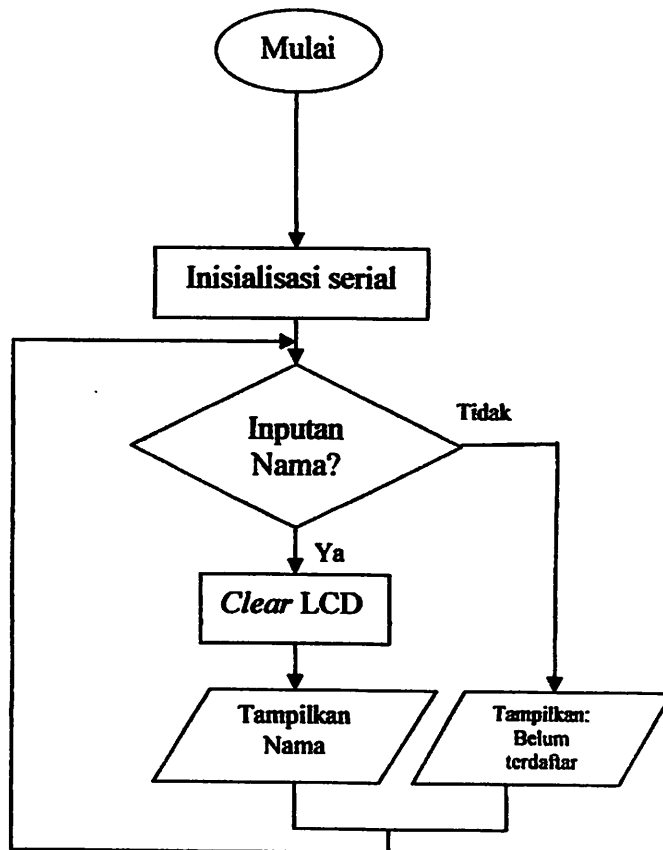
3.3 Perencanaan Perangkat Lunak / Software

3.3.1 Software di Mikrokontroler (MCU)

Untuk pemakaian mikrokontroler di dalam suatu sistem, perlu direncanakan perangkat lunak mikrokontroler yang dapat mengatur sistem tersebut. Perangkat lunak disini adalah susunan perintah-perintah (program) di dalam memori yang harus dilaksanakan oleh mikrokontroler. Di dalam suatu mikrokontroler memori merupakan suatu fasilitas utama karena disini disimpan perintah-perintah yang harus dijalankan. Memori disini dapat dibedakan menurut fungsinya menjadi memori program dan memori data.

Perencanaan perangkat lunak (*software*) didasarkan perencanaan perangkat keras yang telah dibuat sebelumnya, untuk mendapatkan sistem kerja yang diharapkan. *Software* dari alat tersebut terdapat dibagian lampiran.

Pada bagian alat yang dibawa petugas terdapat mikrokontroler yang berfungsi menampilkan status pada LCD dan menerima masukan data serial yang berupa nama, karakter '-' yang berfungsi membersihkan layar LCD dan karakter '/' yang berfungsi menampilkan status 'Belum Terdaftar'. Jika setelah dibandingkan di *database* ternyata terdapat data penduduk, maka *software Delphi* akan mengirimkan data berupa nama yang diawali dengan karakter '-' kemudian data nama. Karakter '-' ini oleh mikrokontroller difungsikan untuk membersihkan LCD kemudian data berupa nama ditampilkan di LCD. Jika masukan data serial merupakan karakter '/' maka mikrokontroler akan menampilkan status 'Belum Terdaftar' pada LCD. Dan gambar *flowchart* dari program mikrokontroler pada sistem ini adalah sebagai berikut :



Gambar 3 – 13
Flowchart Perancangan Perangkat Lunak Pada Mikrokontroler

Didalam proses komunikasi serial antara MCU dengan PC terlebih dahulu ditentukan *baud rate* yang digunakan. *Baud rate* yang dibangkitkan *Timer1* dengan *Timer2* (8 bit *auto reload*) yang hanya menggunakan register TH1. Pada sistem ini digunakan *baudrate* sebesar 9600 dengan $SMOD = 0$ dengan menggunakan $Frekuensi_osilator = 11.0592\text{ MHz}$.

$$Baud\ rate = \frac{2^{SMOD}}{32} \times \frac{Frekuensi_osilator}{12 \times [256 - (TH1)]}$$

$$9600 = \frac{2^0}{32} \times \frac{11.059 \times 10^6}{12 \times [256 - (TH1)]}$$

$$[256-(TH1)] = \frac{1}{32} \times \frac{11.059 \times 10^6}{12 \times 9600}$$

$$[256-(TH1)] = 3$$

$$TH1 = 256 - 3 = 253_D = 0xFD_H$$

3.3.2 Perancangan Database

Perancangan *database* pada sistem ini menggunakan *Microsoft SQL Server 2000* agar sistem ini dapat dikembangkan dengan aplikasi *clien-server*. Data yang disimpan dalam *database Microsoft SQL Server 2000* merupakan data yang sama dengan data pada kartu tanda penduduk (KTP). Yaitu : N.I.K, Nama, Jenis kelamin, Kelahiran, Alamat, Agama dan Kewarganegaraan.

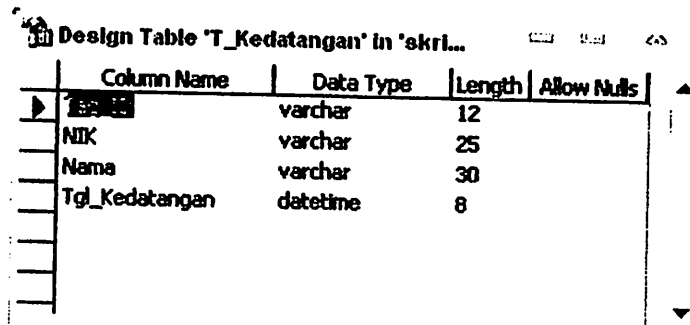
Pembuatan *database* dilakukan dengan cara membuat *database* baru pada *SQL Server Enterprise Manager* dengan nama *database* yaitu "skripsi". Tabel yang dibuat sebanyak 2 tabel, yaitu Table Biodata (T_Biodata) dan Table Kedatangan (T_Kedatangan).

Di bawah ini merupakan perancangan *database* dari Table Biodata (T_Biodata).

| Column Name | Data Type | Length | Allow Nulls |
|-----------------|-----------|--------|-------------|
| NIK | varchar | 12 | |
| Nama | varchar | 30 | |
| Jns_Kelamin | varchar | 10 | |
| Tpt_Lahir | varchar | 30 | |
| Tol_Lahir | datetime | 8 | ✓ |
| Alamat | varchar | 50 | ✓ |
| Agama | char | 10 | ✓ |
| Kewarganegaraan | varchar | 10 | ✓ |

Gambar 3 – 14
Membuat Tabel Biodata (T_Biodata)

Dan berikut ini merupakan perancangan *database* dari Tabel Kedatangan (T_Kedatangan).

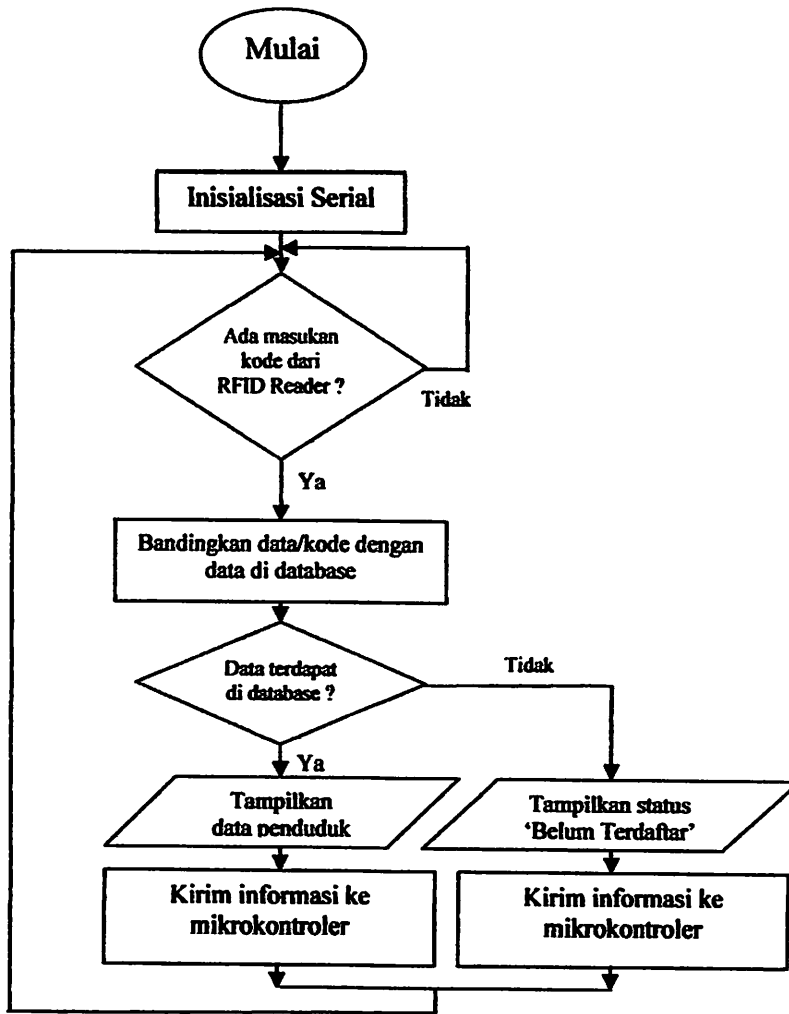


| Column Name | Data Type | Length | Allow Nulls |
|----------------|-----------|--------|-------------|
| ID_Kedatangan | varchar | 12 | |
| NIK | varchar | 25 | |
| Nama | varchar | 30 | |
| Tgl_Kedatangan | datetime | 8 | |

Gambar 3 – 15
Membuat Tabel Kedatangan (T_Kedatangan)

3.3.3 Perancangan Perangkat Lunak Pada *Delphi*

Delphi merupakan program aplikasi berbasis *Windows*. Dalam sistem yang telah dibuat, *Delphi* disini digunakan untuk tampilan layar monitor komputer (tampilan Visual), mengakses *database* menggunakan *ADOConnection* dan memerintahkan pengiriman data melalui serial COM. Dan gambar *flowchart* dari program *Delphi* pada sistem ini adalah sebagai berikut :



Gambar 3 – 16
Flowchart Perancangan Perangkat Lunak Pada Delphi

Adapun komponen-komponen yang digunakan dalam perancangan *software Delphi* antara lain :

- **Form**

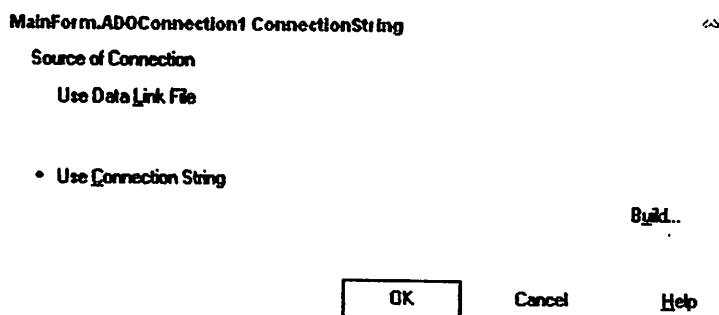
Dalam perancangan *software Delphi* digunakan 5 buah *form* dengan konfigurasi sebagai berikut:

Tabel 3 - 1
Form yang digunakan dalam perancangan

| Komponen | Properti | Isi |
|----------|-----------------|-------------------------------------|
| Form1 | Name Caption | MainForm Monitoring Pendetang |
| Form1 | Name Caption | Form1 Pencarian Biodata |
| Form2 | Name Caption | Form2 Pendaftaran Pendetang Baru |
| Form3 | Name Caption | Form3 Edit Biodata |
| Form4 | Name Caption | Form4 Pencarian Kedatangan |

- **ADOConnection**

Komponen ini berfungsi menghubungkan program *Delphi* dengan *database Microsoft SQL Server 2000*. Pada properties dari *ADOConnection1* pada kolom *ConnectionString* diset sebagai berikut :



Gambar 3 – 17
Membuat Koneksi ke Database

Data Link Properties

Provider Connection Advanced All

Specify the following to connect to SQL Server data:

1. Select or enter a server name:

mudrix

Refresh

2. Enter information to log on to the server:

Use Windows NT Integrated security

• Use a specific user name and password:

User name: sa

Password: *****

Blank password Allow saving password

3. • Select the database on the server:

skripsi

Attach a database file as a database name:

Test Connection

OK

Cancel

Help

Gambar 3 – 18
Membuat Koneksi ke *Database*

Isi dari *property ADOConnection* adalah

Tabel 3 - 2
Konfigurasi komponen *ADOConnection*

| Komponen | Properti | Isi |
|---------------|------------------|--------------------------|
| ADOConnection | Name | ADO Connection1 |
| | ConnectionString | Diisi dengan cara diatas |
| | LoginPrompt | False |
| | Connected | True |

- **ADOQuery**

ADOQuery berfungsi untuk mengambil data, sortir, manipulasi data serta melakukan perhitungan tertentu terhadap sekumpulan data dalam *database*.

Dalam perancangan *software Delphi* digunakan 4 buah komponen *ADOQuery* dengan konfigurasi sebagai berikut:

Tabel 3 - 3
Konfigurasi komponen *ADOQuery*

| Form | Komponen | Properti | Isi |
|----------|-----------|-------------------------------------|-------------------------------------------------------------------------|
| MainForm | ADOQuery1 | Name Connection SQL Active | ADOQuery1 ADOConnection1 Select * From T_Biodata True |
| | ADOQuery2 | Name Connection SQL Active | ADOQuery2 ADOConnection1 Select * From T_Kedatangan True |
| Form1 | ADOQuery1 | Name Connection SQL Active | ADOQuery1 Mainform.ADOConnection1 Select * From T_Biodata True |
| Form4 | ADOQuery1 | Name Connection SQL Active | ADOQuery1 Mainform.ADOConnection1 Select * From T_Biodata True |

- ***ADOCommand***

ADOCommand berfungsi untuk melakukan *Insert*, *Update* dan *Delete* dari isi tabel.

Adapun konfigurasi dari *ADOCommand* adalah sebagai berikut:

Tabel 3 - 4
Konfigurasi komponen *ADOCommand*

| Komponen | Properti | Isi |
|-------------|---------------|----------------|
| ADOCommand1 | Name | ADOCommand1 |
| | ADOConnection | ADOConnection1 |

- ***DataSource***

DataSource berfungsi sebagai penghubung antara *ADOQuery* dengan *DBGrid*.

Adapun konfigurasi dari *DataSource* adalah sebagai berikut:

Tabel 3 - 5
Konfigurasi komponen *DataSource*

| Form | Komponen | Properti | Isi |
|----------|-------------|----------|--------------------|
| MainForm | DataSource1 | Name | DataSource1 |
| | | DataSet | ADOQuery1 |
| | DataSource2 | Name | DataSource2 |
| | | DataSet | ADOQuery2 |
| Form1 | DataSource1 | Name | DataSource1 |
| | | DataSet | ADOQuery1 |
| Form4 | DataSource1 | Name | DataSource1 |
| | | DataSet | MainForm.ADOQuery2 |

- **Vacomm**

Komponen *Vacomm* berfungsi menghubungkan program *Delphi* dengan COM pada komputer (sebagai komunikasi serial).

Adapun konfigurasi dari konmponen *Vacomm* adalah sebagai berikut:

Tabel 3 - 6
Konfigurasi komponen *Vacomm*

| Komponen | Properti | Isi |
|----------|------------|----------|
| Vacomm1 | Name | Vacomm1 |
| | Baudrate | 9600 bps |
| | DeviceName | COM1 |
| | Parity | paNone |
| | StopBits | sb |

- **Timer**

Timer berfungsi sebagai pewaktu.

Adapun konfigurasi dari konmponen *Timer* adalah sebagai berikut:

Tabel 3 - 7
Konfigurasi komponen *Timer*

| Komponen | Properti | Events | Isi |
|----------|----------|---------|-------------|
| Timer | Name | | Timer1 |
| | Enable | | True |
| | Interval | | 1000 |
| | | OnTimer | Timer1Timer |

- **DBGrid**

DBGrid berfungsi menampilkan table dari *database*.

Adapun konfigurasi dari konmponen DBGrid adalah sebagai berikut:

Tabel 3 - 8
Konfigurasi komponen *DBGrid*

| Form | Komponen | Properti | Isi |
|----------|------------|--------------------|---------------------------|
| Mainform | suiDBGrid1 | Name DataSource | suiDBGrid1 DataSource1 |
| | suiDBGrid2 | Name DataSource | suiDBGrid2 DataSource2 |
| Form1 | suiDBGrid1 | Name DataSource | suiDBGrid1 DataSource1 |
| Form4 | suiDBGrid1 | Name DataSource | suiDBGrid1 DataSource1 |

Selain dari komponen-komponen diatas, dalam perancangan program ini digunakan komponen tambahan yaitu *suiPack* dan *AlphaLite* yang berfungsi sebagai *Skin* dari tampilan program.

BAB IV

PENGUJIAN ALAT

4.1. Umum

Pada bab ini membahas tentang pengujian alat yang telah dibuat. Secara umum, pengujian ini bertujuan untuk mengetahui apakah alat dapat bekerja sesuai dengan spesifikasi perencanaan yang telah ditetapkan. Pengujian dilakukan dengan cara menguji system yang dibuat secara per – blok. Dengan demikian dapat diketahui kepresisian kerja dari alat yang direncanakan dan dibuat. Secara umum tujuan dari pengujian alat tersebut adalah sebagai berikut :

1. Mengetahui proses kerja dari masing-masing rangkaian.
2. Memudahkan pendataan spesifikasi alat.
3. Mengetahui hasil dari suatu perencanaan yang telah dibuat.
4. Memudahkan perawatan dan perbaikan apabila sewaktu waktu terjadi kerusakan.

4.2. Pengujian LCD

4.2.1. Tujuan Pengujian LCD

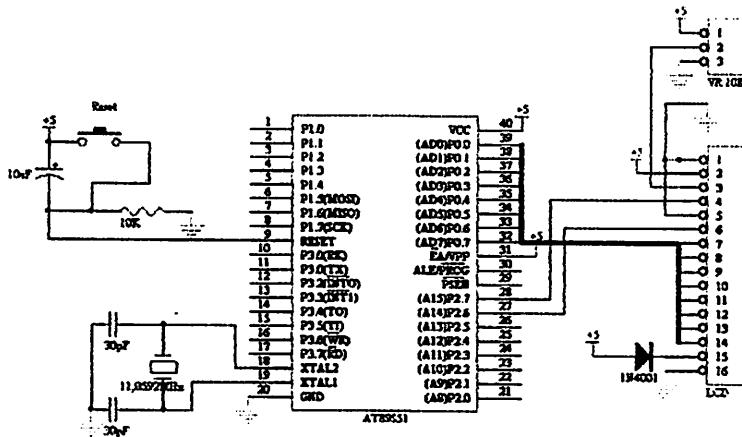
Untuk mengetahui kemampuan rangkaian tampilan yang sudah dibuat apakah dapat mendukung sistem yang direncanakan untuk menampilkan data pada *LCD*.

4.2.2. Peralatan yang digunakan :

1. *Personal Computer.*
2. Minimum sistem mikrokontroler AT89S51.
3. Catu daya 5V DC.

4.2.3. Prosedur Pengujian

1. Merangkai peralatan seperti dalam Gambar 4 - 1.



Gambar 4 – 1
Rangkaian Pengujian LCD

2. Membuat program *assembler* yang digunakan dalam pengujian LCD ini merupakan program yang menampilkan Nama dan NIM pada LCD.

Program yang dibuat adalah sebagai berikut :

```
LCD_RS bit P2.7
LCD_CS bit P2.6
org 0h
mulai: call inisialisasi
mov dptr,#tulis_atas
mov r3,#16
mov a,#80h
call write_inst
tulis: clr a
movc a,@a+dptr
inc dptr
call write_data
```

```

djnz r3,tulis
mov dptr,#tulis_bawah
mov r3,#16
mov a,#0C0h
call write_inst
tulis1: clr a
movc a,@a+dptr
inc dptr
call write_data
djnz r3,tulis1
jmp mulai

```

: Inisialisasi LCD

```

inisialisasi:
mov A,#03Fh
call write_inst
call write_inst
mov A,#0Dh
call write_inst
mov A,#06h
call write_inst
mov A,#01h
call write_inst
mov A,#0Fh
call write_inst
ret

```

: Routine untuk menulis instruksi ke LCD

```

write_inst:
clr LCD_RS
setb LCD_CS
mov P0,A ;instruksi ke LCD
clr LCD_CS ;module
setb LCD_CS
call delay
ret

```

: Routine untuk menulis data ke LCD

```

write_data:
setb LCD_RS
setb LCD_CS

```

```

mov P0,A ;data ke LCD
clr LCD_CS ;module
setb LCD_CS
call delay
ret

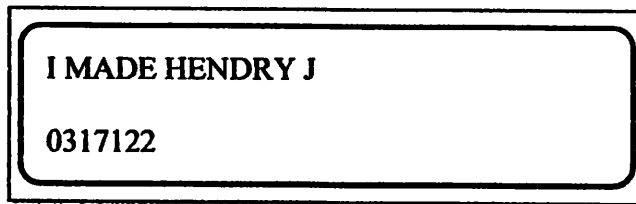
;
; Routine penghasil delay
;
delay: mov R0,#0FFh
delay1: mov R5,#0
djmp R5,$
djmp R0,delay1
ret
;
Ldelay: mov R2,#010h
Ld1: call delay
djmp R2,Ld1
ret
;
tulis_atas:
db 'I MADE HENDRY J'
tulis_bawah:
db '0317122'
end

```

3. Memasang catu daya rangkaian sebesar 5 volt
4. Mendownload program diatas
5. Mengamati keluaran pada LCD.

4.2.4. Hasil Pengujian

Dari hasil pengujian didapatkan bahwa rangkaian LCD dapat menampilkan karakter-karakter, sesuai dengan data yang dikirimkan oleh EPROM *Emulator*. Tampilan penampil kristal cair terdiri atas 2 baris yang masing-masing mempunyai 16 karakter.



Gambar 4 – 2
Hasil Pengujian LCD

4.3. Pengujian Komunikasi Serial

4.3.1. Tujuan Pengujian Komunikasi Serial

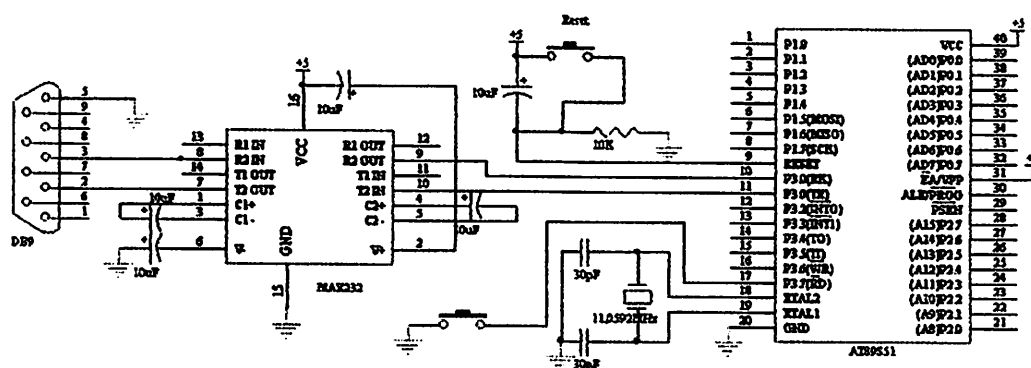
Untuk mengetahui apakah data yang dikirimkan secara serial sudah sesuai dengan yang diterima.

4.3.2. Peralatan yang dibutuhkan

1. Komputer (PC).
2. rangkaian Penerima (RS232).
3. Rangkaian Pengirim (Mikrokontroler)
4. Power suplay

4.3.3. Prosedur Pengujian Komunikasi Serial

1. Merangkai peralatan yang digunakan sesuaigamba di bawah ini.



Gambar 4 – 3
Rangkaian Pengujian Komunikasi Serial

2. Membuat program yang digunakan dalam pengujian komunikasi serial.

Program yang digunakan dalam pengujian ini merupakan program sederhana yang mengirimkan huruf A secara kontinyu dari mikrokontroller ke PC dengan menggunakan Hyperterminal. Program yang dibuat adalah sebagai berikut :

```
mulai:   setb EA
         mov TMOD,#20h
         mov TH1,#0FDH
         setb TR1
         mov SCON,#50h
```

```
tulis:
next_1:  JB P3.7,tulis
         kirim:
         mov  a,#41h
         clr  ES
         mov  sbuf,a
         jnb  ti,$
         clr  ti
         setb ES
         jmp  tulis
         end
```

3. Memasang catu daya rangkaian sebesar 5 volt
4. Mendownload program diatas
5. Menekan tombol *push button*
6. Mengamati tampilan pada Hyper Terminal .

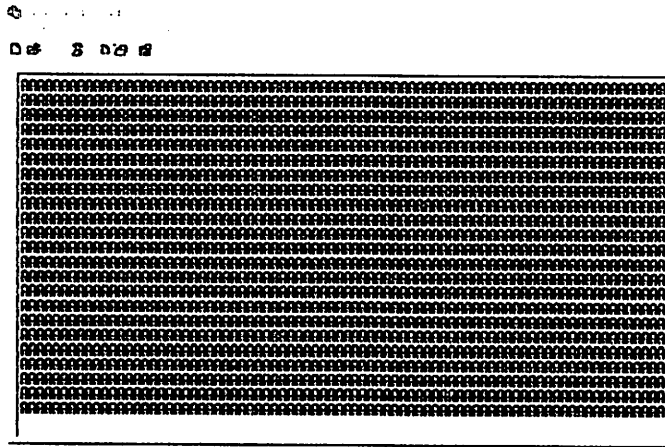
4.3.4 Hasil Pengujian Komunikasi Serial

Hasil pengujian komunikasi serial ditunjukkan dalam table berikut :

| Data Mikrokontroler | Tampilan pada Hyper Terminal |
|-----------------------|------------------------------|
| AAAAAAAAAAAAAAAA..... | AAAAAAAAAAAAAAAA..... |

Dalam melakukan pengujian komunikasi serial pada PC, data diterima dan ditampilkan menggunakan Hyper Terminal yang telah disediakan oleh Windows.

Hasil penerimaan data pada Hyper Terminal dapat dilihat pada gambar berikut :



Gambar 4 – 4
Hasil Pengujian Komunikasi Serial

4.4. Pengujian RFID Reader

4.4.1. Tujuan Pengujian RFID Reader

Untuk mengetahui apakah RFID reader dapat membaca Tag (kartu) atau tidak dan mengetahui keluaran data dari kartu yang dibaca oleh RFID Reader.

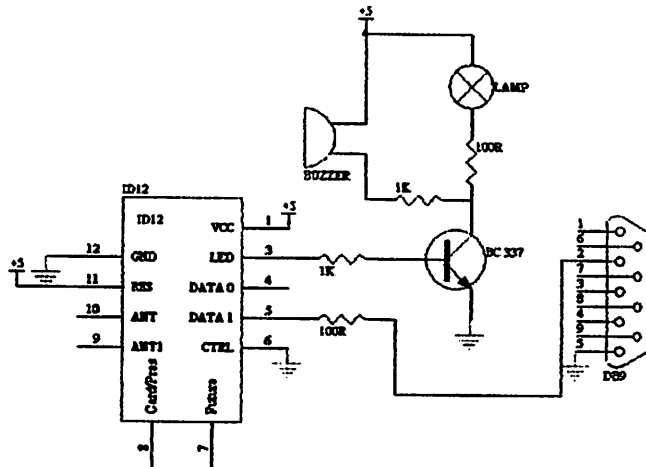
4.4.2. Peralatan Yang Dibutuhkan

1. Komputer (PC)
2. Sistem Mikrokontroler dan LCD
3. Tag (kartu) RFID dan RFID reader

4.4.3. Prosedur Pengujian RFID Reader

1. Menyusun rangkaian seperti gambar 4-5.
2. Memasang catu daya rangkaian sebesar 5 volt.
3. Membuka program Hiper Terminal.

4. Mendekatkan *tag* pada *RFID reader*
5. Mengamati jarak *Reader* dengan kartu dan melihat tampilan pada *Hiper Terminal*.



Gambar 4-5
Rangkaian Pengujian RFID Reader

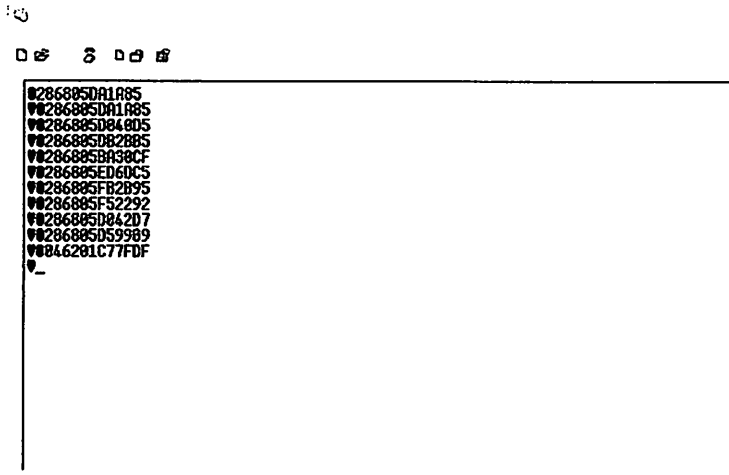
4.4.4. Hasil Pengujian dan Analisis

Hasil Pengujian menunjukkan bahwa *RFID reader* dapat membaca *tag* (kartu) *RFID* dan kartu dapat diakses oleh *reader* hanya sampai sejauh 5cm dan walaupun ada halangan *reader* dapat membaca *RFID* dengan baik. Dengan demikian *RFID* untuk digunakan sebagai kartu debit telah bekerja dengan baik.

Tabel 4-1
Pengujian Jarak Kepekaan RFID Reader

| Jarak jangkauan | Kepekaan reader |
|-----------------|-----------------|
| 1 Cm | Sangat peka |
| 2 Cm | Sangat Peka |
| 3 Cm | Sangat Peka |
| 4 Cm | Sangat Peka |
| 5 Cm | Peka |
| 6 Cm | Kurang Peka |

| | |
|-------|-------------|
| 7 Cm | Kurang Peka |
| 8 Cm | Kurang Peka |
| 9 Cm | Kurang Peka |
| 10 Cm | Kurang Peka |



Gambar 4-7
Hasil Pembacaan RFID Reader

4.6. Pengujian Kondisi *Wireless* TLP/RLP 434A

4.6.1. Tujuan Pengujian Kondisi *Wireless* TLP/RLP 434A

Untuk mengetahui apakah modul TLP dan RLP dapat bekerja dengan baik.

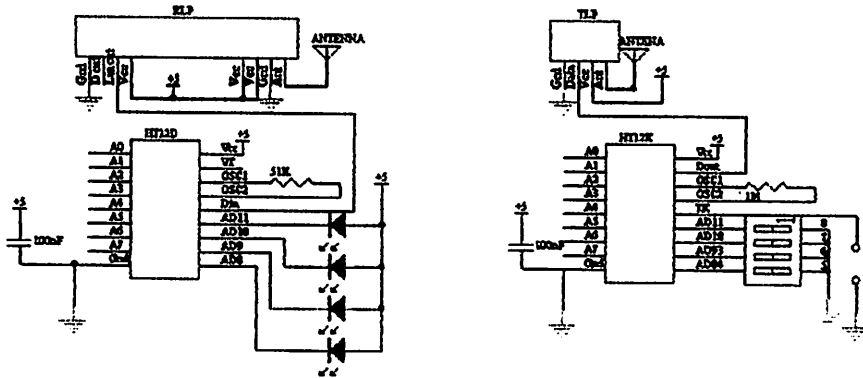
4.6.2. Pealatan Yang Dibutuhkan.

1. Rangkaian TLP dan Rangkaian RLP

4.6.3. Prosedur Pengujian Kondisi *Wireless* TLP/RLP 434A

1. Menyusun rangkaian seperti gambar 4-8
1. Memasang catu daya rangkaian sebesar 5 volt.
2. Menggeser *dip-switch* kemudian menekan tombol.sambil berjalan menjauhi salah satu rangkaian.

4. Mengamati nyala lampu dan mengukur jarak jangkauan



Gambar 4-7
Rangkaian Pengujian Kondisi TLP/RLP434

4.5.4. Hasil Pengujian Kondisi *Wireless* TLP/RLP 434A

Hasil pengujian dapat dilihat pada table berikut :

Tabel 4-2
Hasil pengujian TLP dan RLP 434

| No <i>Dip-Switch</i> | Dihubungkan ke | Nyala LED |
|----------------------|----------------|-----------|
| 1 | <i>Ground</i> | Menyala |
| 2 | - | Mati |
| 3 | <i>Ground</i> | Menyala |
| 4 | <i>Ground</i> | Menyala |

Keterangan:

- Menyala = LED menyala sesuai dengan pergeseran dip-switch kearah *ground*
- Mati = LED tidak menyala sesuai dengan pergeseran dip-switch bukan *ground*

Dari hasil pengujian diatas dapat disimpulkan bahwa modul TLP dan RLP dapat bekerja sebagaimana mestinya.

4.7. Pengujian Sinyal Keluaran TLP/RLP 434

4.7.1. Tujuan Pengujian Sinyal Keluaran TLP/RLP 434

Untuk mengetahui bentuk gelombang keluaran dari RLP.

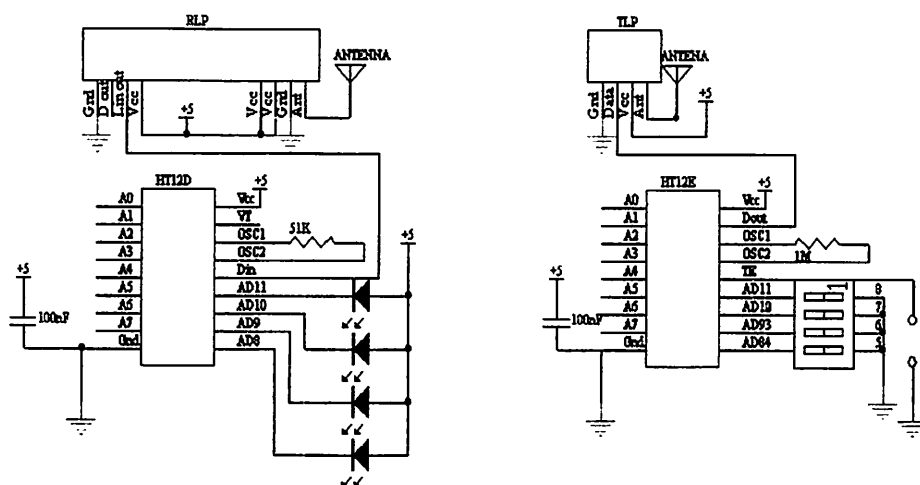
4.7.2. Pealatan Yang Dibutuhkan.

4. Rangkaian TLP dan Rangkaian RLP

5. *Osiloscop*

4.7.3. Prosedur Pengujian Sinyal Keluaran TLP/RLP 434

1. Menyusun rangkaian seperti gambar 4-9
2. Memasang catu daya rangkaian sebesar 5 volt.
3. Menggeser dua buah *dip-switch* ke ground.
4. Menghubungkan input *osiloscop* pada pin 3 RLP dan input ground pada osiloscon dihubungkan ke ground rangkaian RLP.
5. Mengamati nyala lampu dan mengamati gelombang pada osiloscop.

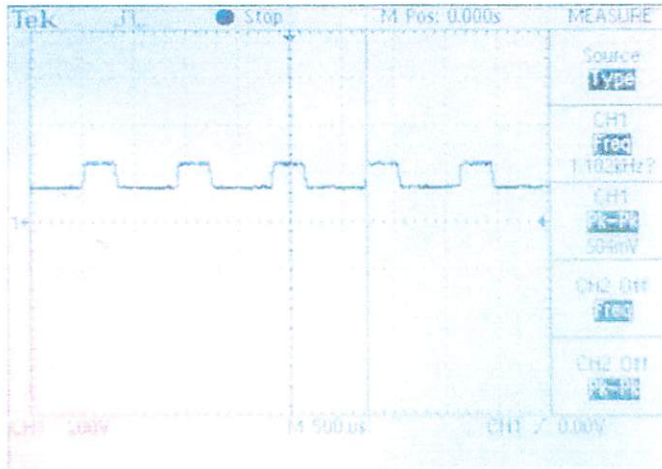


Gambar 4-9
Rangkaian Pengujian Sinyal Keluaran TLP/RLP 434

4.6.4. Hasil Pengujian Sinyal Keluaran TLP/RLP 434

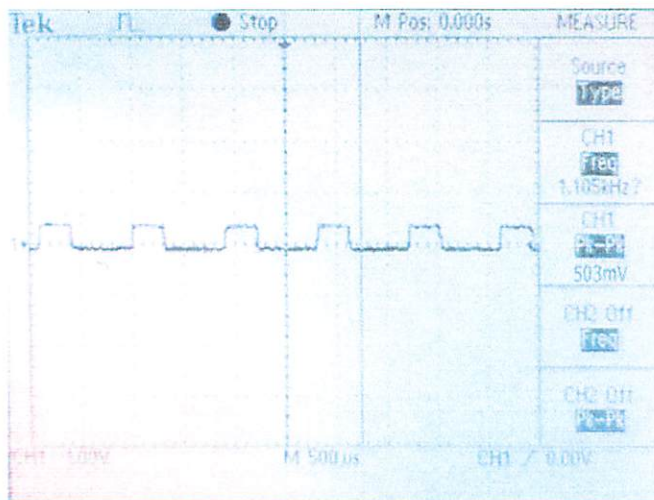
1. Hasil pengujian keluaran RLP 434 (Input osiloscope dihubungkan ke pin 3 RLP dan input ground osiloscope dihubungkan ke ground.

Hasilnya adalah sebagai berikut :



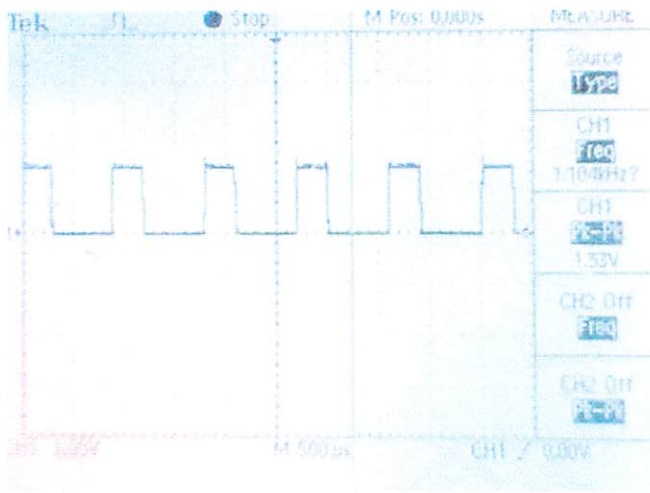
Gambar 4-9
Gelombang keluaran dari RLP 434A

2. Hasil pengujian keluaran RLP 434 setelah melewati rangkaian RC



Gambar 4-10
Gelombang keluaran dari RLP 434A
setelah melewati rangkaian RC

3. Hasil pengujian keluaran RLP 434 setelah melewati penguatan IC LM358



T/div = 500μs

V/div = 1V

Gambar 4-11
Gelombang keluaran dari RLP 434A
setelah melewati penguatan IC LM358

4.7. Pengujian Frekuensi Pembawa dari TLP/RLP 434A

4.7.1. Tujuan Pengujian Frekuensi Pembawa dari TLP/RLP 434A

Untuk mengetahui frekuensi pembawa yang sebenarnya dari TLP/RLP 434A

4.7.2. Pealatan Yang Dibutuhkan.

1. Rangkaian TLP
2. Frekuensi counter

4.7.3. Prosedur Pengujian Frekuensi Pembawa dari TLP/RLP 434A

1. Menghubungkan pin 2 pada TLP 434A ke +5V agar TLP 434A mengirimkan logika 1 (*high*) secara terus-menerus.
2. Menghubungkan input frekuensi counter pada antenna TLP 434 dan menghubungkan *ground* pada frekuensi counter pada *ground* rangkaian TLP 434A

3. Memasang catu daya rangkaian sebesar 5 volt.
4. Mengamati besar frekuensi pada frekuensi counter.

4.7.4. Hasil Pengujian Frekuensi Pembawa dari TLP/RLP 434A

Hasil pengujian dapat dilihat pada gambar berikut :



Gambar 4-12
Gelombang keluaran dari RLP 434A

Dari hasil pengujian ternyata frekuensi pembawanya adalah 433,9354 Hz.

4.8. Pengujian Alat Keseluruhan

4.8.1. Tujuan Pengujian Alat Keseluruhan

Untuk mengetahui apakah keseluruhan alat yang telah dirangkai bekerja dengan baik dan mengukur jarak maksimal yang mampu dilakukan alat untuk mengirimkan dan menerima data.

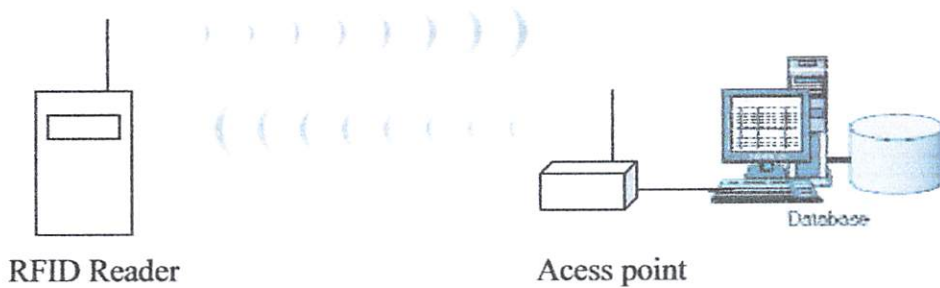
4.8.2. Peralatan Yang Dibutuhkan.

1. Alat keseluruhan.

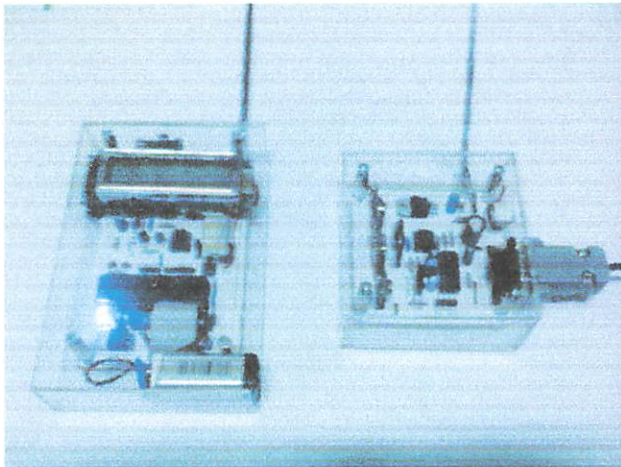
4.8.3. Prosedur Pengujian Alat Keseluruhan

1. Menyusun rangkaian seperti gambar 4 - 13
2. Memasang catu daya rangkaian sebesar 5 volt.
3. Membuka program Delphi yang telah dibuat.

4. Mendekatkan *Tag RFID* ke *RFID Reader* dan melihat data dari *tag* yang terlihat pada program Delphi kemudian melihat tulisan yang muncul pada LCD
5. Mengecek data yang dikirim oleh *tag* RFID dan data yang dikirim oleh komputer apakah sudah sesuai dengan yang ditampilkan oleh LCD.
6. melakukan langkah ke 4 secara berulang – ulang dengan jarak penerimaan yang berbeda.



Gambar 4-13
Skema Pengujian Keseluruhan



Gambar 4-14
Gambar Pengujian Keseluruhan

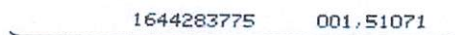
4.9.4. Hasil Pengujian Alat Keseluruhan

1. Hasil pengujian dengan mendekatkan *Tag* RFID



Gambar 4-14
Gambar Pengujian Tampilan Kode *Tag* RFID

Pada kolom diatas terdapat kode |046201C77FDF| yang merupakan kode asli dari *tag* RFID, kemudian kode 1644283775 merupakan kode dari *tag* RFID yang telah dikonversi menjadi bilangan *decimal*. Kebenaran dari kode *decimal* tersebut dapat dilihat pada gambar *tag* di bawah ini



Gambar 4-15
Gambar *Tag* RFID

Pada gambar di atas terlihat bahwa kode dari *tag* tersebut belum terdaftar sehingga pada LCD akan muncul kata 'Belum Terdaftar'. Hasilnya dapat dilihat pada gambar di bawah ini.



Gambar 4-16
Tampilan 'Belum Terdaftar' pada LCD

Oleh karena kode dari *tag* tersebut belum terdaftar maka perlu dilakukan pendaftaran dengan cara meng-*click* tombol 'DAFTAR' sehingga akan muncul form Pendaftaran Pendatang Baru.

| PENDAFTARAN PENDATANG BARU | |
|----------------------------|-----------------------------|
| Tag ID | 1644263775 |
| NIK | 22.0202.300595.0003 |
| Nama | I Made Hendry Jayamiharja |
| Jns Kelamin | pria |
| Tpt Lahir | Perayangan |
| Tgl Lahir | 5/30/1985 |
| Alamat | Jl P Sumba 16, Negara, Bali |
| Agama | Hindu |
| Kewarganegaraan | Indonesia |

Gambar 4-17
Gambar Pengujian Pendaftaran Pendatang Baru

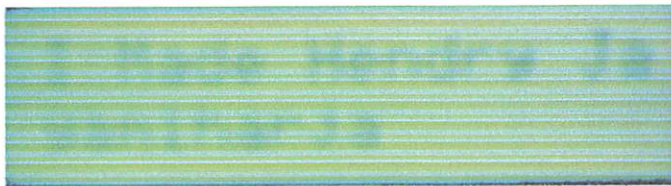
Sementara untuk melakukan pendaftaran pada petugas administrasi diperkirakan memerlukan waktu sekitar 2 menit per orang.

2. Setelah melakukan pendaftaran maka langkah selanjutnya yaitu dengan mendekatkan *tag* RFID yang telah didaftarkan. Gambar berikut merupakan hasil pembacaan *tag* RFID yang telah didaftarkan :



Gambar 4-19
Gambar Pengujian Hasil Pendaftaran Pendatang Baru

Kemudian pada layar LCD akan tampil tulisan seperti gambar berikut :



Gambar 4-20
Tampilan nama pada LCD

3. Setelah sukses dengan pengujian diatas maka selanjutnya melakukan pengujian yang sama dengan cara nomor 2 diatas namun dengan jarak penerimaan yang tidak sama. Hasil dari pengujian ini dapat dilihat pada table berikut :

Tabel 4-4
Hasil pengujian jarak jangkauan alat keseluruhan

| Jarak (m) | Penerimaan data pada LCD |
|-----------|--------------------------|
| 1-10 | Sukses |
| 11-20 | Sukses |
| 21-30 | Sukses |
| 31-35 | Sukses |
| 31-35 | Sukses |
| 36-45 | Sukses |
| 46-60 | Gagal |
| 60-65 | Gagal |
| 65-70 | Gagal |
| 70-100 | Gagal |

Keterangan :

Sukses : data yang dikirim oleh RFID *reader* diterima oleh komputer dengan sempurna sesuai tag RFID dan data yang dikirim oleh komputer yang berupa nama ditampilkan dengan sempurna di layar LCD.

Gagal : data yang dikirim oleh RFID *reader* diterima oleh komputer tidak sempurna dan data yang dikirim oleh komputer yang berupa nama tidak ditampilkan dengan sempurna di layar LCD.

BAB V

PENUTUP

5.1. Kesimpulan

Berdasarkan hasil perancangan dan pembuatan alat ini maka dapat diperoleh beberapa kesimpulan sebagai berikut :

1. *Wireless* yang digunakan adalah TLP/RLP 434A dan memiliki pemodulasian secara ASK dan bekerja pada frekuensi 433.93 MHz.
2. Keluaran dari RLP 434A pada pin 3 adalah 0,5 volt. Jadi perlu penguatan 3 kali untuk mengaktifkan transistor C945 agar tegangan yang masuk ke mikrokontroler atau max 232 adalah 5 volt.
3. Komunikasi serial antara rangkaian penerima dan pengirim dengan PC menggunakan baudrate 9600 bps sehingga data yang diterima sesuai dengan data yang dikirim.
4. Jarak maksimum antara rangkaian pengirim dengan penerima tanpa halangan adalah sekitar 45 meter. Dan jarak pembacaan tag FRID hanya sampai 5 cm.
5. Untuk pendatang yang sudah pernah masuk ke Bali memerlukan waktu sekitar 1 detik untuk identifikasi dan bagi pendatang yang baru pertama datang ke pulau Bali diperlukan waktu sekitar 2 menit untuk melakukan pendaftaran pada bagian administrasi.

5.2. Saran

Alat ini masih mempunyai banyak kekurangan yang sekiranya perlu diadakan penambahan-penambahan baik secara *software* maupun *hardware*. Jika alat ini ingin dikembangkan lebih lanjut, maka penulis sarankan untuk menambahkan spesifikasi, seperti menambahkan fasilitas *client* baik secara *software* maupun *hardware*, menggunakan antenna yang lebih berkualitas agar jarak pengiriman dan penerimaan lebih jauh, menggunakan LCD yang lebih dari 16x2 karakter dan masih banyak lagi pengembangan pengembangan.

DAFTAR PUSTAKA

1. Data sheet Microcontroller AT89S51. Atmel Corp.
2. Panduan Praktis Antarmuka & Pemrograman mC AT89s51, Gramedia
3. Rachmad Setiawan, Mikrokontroler MCS51.
4. Sudjadi (2005). Teory & Aplikasi Mikrokontroller: Aplikasi pd mikrokontroler AT89c51, Yogyakarta : Graha Ilmu.
5. Teddy Marcus, Agus Prijono dan Josef Widiadhi, Delphi Developer dan SQL Server 2000, Penerbit CV.Invformatika, Bandung, 2002.
6. www.adilam.com.
7. www.atmel.com.
8. www.digiware.com.
9. www.electroniclab.com.
10. www.laipac.com.
11. www.maxim-ic.com.
12. www.righttag.com.

LAMPIRAN



FORMULIR BIMBINGAN SKRIPSI

Nama : I Made Hendry Jayamiharja
NIM : 0317122
Masa Bimbingan : 22 Mei 2007 s/d 22 November 2007
Judul Skripsi : Aplikasi Rfid Sebagai Pengecek Id Bagi Warga Pendatang Ke Pulau Bali Menggunakan Wireless System

| No | Tanggal | Uraian | Paraf Pembimbing |
|----|----------|-----------------------------------------------|------------------|
| 1 | 30/05 07 | Revisi batasan masalah & latar belakang Bab I | |
| 2 | 25/06 07 | Bab II. Semua Gambar diberi sumber. | |
| 3 | 22/06 07 | Keterangan tabel ditulis di atas Bab II | |
| 4 | 2/07 07 | Blok diagram direvisi Bab III | |
| 5 | 24/07 07 | Tambahkan komposisi alaphi yg perlu. Bab III | |
| 6 | 13/08 07 | Bab IV. Tambahkan pengujian badra | |
| 7 | 20/08 07 | Revisi Kesimpulan. Bab V | |
| 8 | 22/08 07 | Acc COMPLETE | |
| 9 | | | |
| 10 | | | |

Malang,
Dosen Pembimbing I

Joseph Dedy Irawan ST,MT
NIP.132315178



FORMULIR BIMBINGAN SKRIPSI

Nama : I Made Hendry Jayamiharja
NIM : 0317122
Masa Bimbingan : 22 Mei 2007 s/d 22 November 2007
Judul Skripsi : Aplikasi Rfid Sebagai Pengecek Id Bagi Warga Pendatang Ke Pulau Bali Menggunakan Wireless System

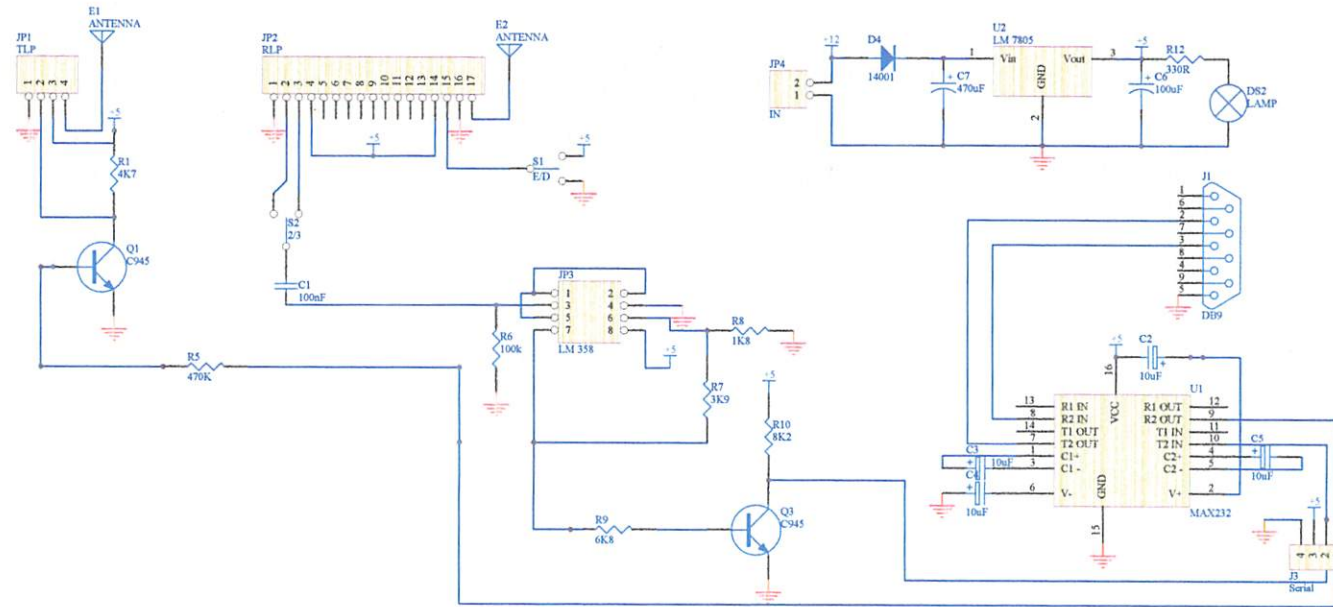
| No | Tanggal | Uraian | Paraf Pembimbing |
|----|-------------|------------------------------------------------------------------|------------------|
| 1 | 22/6 07. | Proposal skripsi | |
| 2 | 24/6 07. | Revisi Bab I & Bab II | |
| 3 | 17/07 17 | Revisi Bab III * Gbr. Rangkaian. di susunikan. | |
| 4 | 20/07 17 | Revisi Bab IV di lanjutkan Bab V Bab VI Bab VII Bab VIII | |
| 5 | 31/07 17 | Revisi Bab VIII + data lengkap. Pengisian | |
| 6 | 1/07 18 | Revisi Bab VIII Revisi | |
| 7 | 18/07 18 | Revisi Bab VIII / Laporan Skripsi + bab I s.d. V + lampiran ! | |
| 8 | 30/07 18 | Revisi Bab VIII skripsi + bab I & Abstract | |
| 9 | | | |
| 10 | | | |

Malang,

Dosen Pembimbing II

I Komang Somawirata, ST, MT
NIP.1030100361

access point



| Title | | |
|-------|-----------------------------------------------------------------------------|----------|
| Size | Number | Revision |
| B | | |
| Date: | 24-Aug-2007 | Sheet of |
| File: | D:\DATA (D:) \DATA \Document Hendry\18\Kspantil\18\ansi access lampiran.DDB | |

;write more character to lcd

org 0h

LCD_RS bit P2.7

LCD_CS bit P2.6

call initserial

call init_LCD

call delay

call delay

call delay

call init_LCD

;

start: call init_lcd

call init_lcd

call init_lcd

call GetChar

mov r1,#80h+00h

acall write_inst

add a,#00h

mov r1,a

acall write_data

call GetChar

mov r1,#80h+01h

acall write_inst

add a,#00h

mov r1,a

acall write_data

call GetChar

mov r1,#80h+02h

acall write_inst

add a,#00h

mov r1,a

acall write_data

call GetChar

mov r1,#80h+03h

acall write_inst

add a,#00h

mov r1,a

acall write_data

call GetChar

mov r1,#80h+04h

```
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+05h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+06h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+07h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+08h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+09h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+0Ah
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+0Bh
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+0Ch
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+0Dh
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+0Eh
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+0Fh
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+040h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+041h
acall write_inst
```

```
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+042h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+043h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+044h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+045h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+046h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+047h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```



```
call GetChar
mov r1,#80h+048h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+049h
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+04Ah
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+04Bh
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+04Ch
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+04Dh
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+04Eh
acall write_inst
add a,#00h
```

```
mov r1,a
acall write_data
```

```
call GetChar
mov r1,#80h+04Fh
acall write_inst
add a,#00h
mov r1,a
acall write_data
```

```
;
initserial:
mov scon,#52h;initialize serial mode 1
mov tmod,#20h;timer1 mode 2
mov th1,#0FDh;Reload value for baud rate 9600
mov TCON,#40
setb tr1
ret
```

```
GetChar:
jb P3.0,detect
call init_lcd
detect: call init_lcd2
      clr RI
      jnb ri,$
      mov A, SBUF
      mov r1,A
      mov r2,A
      cjne r2,#02Fh,pil1;2F = tanda / untuk menulis Belum Terdaftar
      ljmp mulai
pil1:  cjne r2,#02Dh,pil2 ;2D = tanda '-' untuk menghapus lcd
      ljmp start
pil2:  cjne r2,#0AFh,pil3; AF = tanda / untuk menulis Belum Terdaftar
      ljmp mulai
pil3:  cjne r2,#0BDh,pil4;BD = tanda '_' untuk menghapus lcd
      ljmp start
pil4:  cjne r2,#02Eh,pil5
      mov r2,#041h
pil5:  call init_lcd2
      call init_lcd2
      call init_lcd2
ret
```

```
Init_lcd2:
mov r1,#00111000b ;Function set,
                ;Data 8 bit,2 line font 5x7
acall write_inst ;
```

```

mov r1,#00001100b ;Display on,
      ;cursor off,cursor blink off
acall write_inst
mov r1,#00000110b ;Entry mode, Set increment
acall write_inst
ret

```

```

;
Init_lcd:

```

```

mov r1,#00000001b ;Display clear
acall write_inst ;
mov r1,#00111000b ;Function set,
      ;Data 8 bit,2 line font 5x7
acall write_inst ;
mov r1,#00001100b ;Display on,
      ;cursor off,cursor blink off
acall write_inst
mov r1,#00000110b ;Entry mode, Set increment
acall write_inst
ret

```

```

;
Write_inst:

```

```

clr P2.7 ; RS = P2.7 = 0, write mode instruction
mov P0,R1 ; D7 s/d D0 = P0 = R1
setb P2.6 ; EN = 1 = P2.6
call delay; call delay time
clr P2.6 ; EN = 0 = P2.6
ret

```

```

;
Write_data:

```

```

setb P2.7 ; RS = P2.7 = 1, write mode data
mov P0,R1 ; D7 s/d D0 = P0 = R1
setb P2.6 ; EN = 1 = P2.6
call delay; call delay time
clr p2.6 ; EN = 0 = P2.6
ret

```

```

;
delay: mov R0,#5

```

```

delay1:mov R7,#0fh
      djnz R7,$
      djnz R0,delay1
      ret

```

```

delay0: mov R0,#0

```

```

delay10:mov R7,#0fh
      djnz R7,$
      djnz R0,delay10
      ret

```

```
mulai: call init_lcd
mov dptr,#tulis_atas
mov r3,#16
mov a,#80h
call write_inst2
tulis: clr a
movc a,@a+dptr
inc dptr
call write_data2
djnz r3,tulis
jmp detect
```

```
=====
; Inisialisasi LCD
=====
```

```
=====
; Routine untuk menulis instruksi ke LCD
=====
```

```
write_inst2:
clr LCD_RS
setb LCD_CS
mov P0,A ;instruksi ke LCD
clr LCD_CS ;module
setb LCD_CS
call delay0
ret
```

```
=====
; Routine untuk menulis data ke LCD
=====
```

```
write_data2:
setb LCD_RS
setb LCD_CS
mov P0,A ;data ke LCD
clr LCD_CS ;module
setb LCD_CS
call delay0
ret
```

```
=====
; Routine penghasil delay
=====
```

```
tulis_atas:
db 'Belum Terdaftar '
end
```

```
;
```

// PROGRAM PADA DELPHI //

//MAINFORM

unit TUnit;

interface

uses

Windows, Messages, SysUtils, Classes, Graphics, Controls, Forms, Dialogs,
ExtCtrls, sScrollBar, ExtDlgs, sEdit, Menus,
sButton, StdCtrls, sSkinProvider, sSkinManager, sCheckBox, Buttons,
sBitBtn, sComboBox, sLabel, ImgList, sAlphaListBox, sGauge, sPanel,
ComCtrls, CheckLst, Mask, Grids, DBGrids, SUIDBCtrls, DB, ADODB,
VaClasses, VaComm, Math, SUIStatusBar, SUIButton;

type

TMainForm = class(TForm)
 sSkinManager1: TsSkinManager;
 sPanel4: TsPanel;
 ComboBox1: TsComboBox;
 OpenPictureDialog1: TOpenPictureDialog;
 sSkinProvider1: TsSkinProvider;
 sCheckBox1: TsCheckBox;
 sButton9: TsBitBtn;
 ImageList1: TImageList;
 sPanel1: TsPanel;
 sPanel2: TsPanel;
 sPanel3: TsPanel;
 sPanel5: TsPanel;
 sScrollBar1: TsScrollBar;
 sLabel1: TsLabel;
 sLabel2: TsLabel;
 sScrollBar2: TsScrollBar;
 sPanel6: TsPanel;
 sLabel3: TsLabel;
 sLabel4: TsLabel;
 sPanel7: TsPanel;
 sPanel8: TsPanel;
 sPanel9: TsPanel;
 sCheckBox4: TsCheckBox;
 sCheckBox5: TsCheckBox;
 sCheckBox6: TsCheckBox;
 sCheckBox7: TsCheckBox;
 sPanel10: TsPanel;
 sPanel11: TsPanel;
 sPanel12: TsPanel;
 sCheckBox8: TsCheckBox;
 sLabel5: TsLabel;
 sEdit2: TsEdit;

sPanel13: TsPanel;
sPanel14: TsPanel;
sLabel6: TsLabel;
sCheckBox9: TsCheckBox;
sEdit3: TsEdit;
sPanel15: TsPanel;
sPanel17: TsPanel;
sPanel16: TsPanel;
ADOConnection1: TADOConnection;
ADOQuery1: TADOQuery;
ADOCommand1: TADOCommand;
DataSource1: TDataSource;
suiDBGrid1: TsuiDBGrid;
ADOQuery2: TADOQuery;
DataSource2: TDataSource;
suiDBGrid2: TsuiDBGrid;
sPanel19: TsPanel;
sPanel20: TsPanel;
sBitBtn6: TsBitBtn;
sBitBtn7: TsBitBtn;
VaComm1: TVaComm;
Timer1: TTimer;
sBitBtn2: TsBitBtn;
sBitBtn3: TsBitBtn;
sBitBtn4: TsBitBtn;
sPanel21: TsPanel;
sBitBtn5: TsBitBtn;
sPanel18: TsPanel;
sLabel11: TsLabel;
sLabel12: TsLabel;
sLabel13: TsLabel;
sLabel14: TsLabel;
sLabel15: TsLabel;
sLabel16: TsLabel;
sLabel17: TsLabel;
sLabel18: TsLabel;
sLabel19: TsLabel;
sLabelID: TsLabel;
sLabelNIK: TsLabel;
sLabelNama: TsLabel;
sLabelJns: TsLabel;
sLabelTpt: TsLabel;
sLabelTgl: TsLabel;
sLabelAlmt: TsLabel;
sLabelAgama: TsLabel;
sLabelWarganegara: TsLabel;
sLabel20: TsLabel;
sLabel22: TsLabel;

```

sLabel23: TsLabel;
sLabel24: TsLabel;
sLabel25: TsLabel;
sPanel22: TsPanel;
sLabel7: TsLabel;
sLabel9: TsLabel;
sLabel10: TsLabel;
sLabel8: TsLabel;
sLabel21: TsLabel;
sBitBtn8: TsBitBtn;
sEdit1: TsEdit;
Button1: TButton;
sLabel26: TsLabel;
sEdit4: TsEdit;
sEdit5: TsEdit;
sBitBtn1: TsBitBtn;
sBitBtn9: TsBitBtn;
sBitBtn10: TsBitBtn;
sBitBtn11: TsBitBtn;
Button2: TButton;
procedure ComboBox1Change(Sender: TObject);
procedure sButton9Click(Sender: TObject);
procedure FormShow(Sender: TObject);
procedure OpenPictureDialog1SelectionChange(Sender: TObject);
procedure sSkinManager1AfterChange(Sender: TObject);
procedure sCheckBox1Click(Sender: TObject);
procedure sScrollBar2KeyUp(Sender: TObject; var Key: Word;
  Shift: TShiftState);
procedure sScrollBar2MouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
procedure sScrollBar1KeyUp(Sender: TObject; var Key: Word;
  Shift: TShiftState);
procedure sScrollBar1MouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
procedure sScrollBar1Change(Sender: TObject);
procedure sScrollBar2Change(Sender: TObject);
procedure sButton5Click(Sender: TObject);
procedure sCheckBox4Click(Sender: TObject);
procedure sCheckBox5Click(Sender: TObject);
procedure sCheckBox6Click(Sender: TObject);
procedure sCheckBox7Click(Sender: TObject);
procedure sCheckBox8Click(Sender: TObject);
procedure sEdit2Change(Sender: TObject);
procedure tampil;
procedure cari;
procedure tampilKosong;
procedure delay( lama : longint);
procedure Timer1Timer(Sender: TObject);

```

```

procedure SetActivePage(PageIndex : integer);
procedure sEdit3Change(Sender: TObject);
procedure FormCreate(Sender: TObject);
procedure insert_into_T_Kedatangan;
procedure VaComm1RxChar(Sender: TObject; Count: Integer);
procedure sBitBtn6Click(Sender: TObject);
procedure sBitBtn7Click(Sender: TObject);
procedure sBitBtn4Click(Sender: TObject);
procedure sBitBtn3Click(Sender: TObject);
procedure suiDBGrid1 CellClick(Column: TColumn);
procedure sBitBtn5Click(Sender: TObject);
procedure sBitBtn2Click(Sender: TObject);
procedure sBitBtn8Click(Sender: TObject);
procedure Button1Click(Sender: TObject);
procedure sBitBtn1Click(Sender: TObject);
procedure sBitBtn9Click(Sender: TObject);
procedure sBitBtn11Click(Sender: TObject);
procedure sBitBtn10Click(Sender: TObject);
procedure Button2Click(Sender: TObject);

```

```

private
{ Private declarations }
public
{ Public declarations }
FRIDTagCode      : String;

```

end;

```

var
MainForm: TMainForm;
Loading : boolean;
NewBGName : string;

```

implementation

```

uses
sSkinProps, FileCtrl, sStyleSimply, sConst, sMaskData, sVclUtils, Unitdaftar,
Unitedit, UnitPencarianID, UnitPkedatangan;

```

```

var
CurPanel : TsPanel = nil;

```

```

{$R *.DFM}

```

```

procedure TMainForm.Timer1Timer(Sender: TObject);
begin

```



```
sLabel23.Caption:=DateTimeToStr(now);
```

```
{Jam}
```

```
sLabel25.Caption := FormatDateTime('HH:NN:SS', Time);
```

```
{Greetings}
```

```
If Time < StrToTime('11:00') Then
```

```
  sLabel24.Caption := 'Selamat Pagi ';
```

```
If (Time >= StrToTime('11:00')) And (Time < StrToTime('16:00')) Then
```

```
  sLabel24.Caption := 'Selamat Siang ';
```

```
If (Time >= StrToTime('16:00')) And (Time < StrToTime('19:00')) Then
```

```
  sLabel24.Caption := 'Selamat Sore ';
```

```
If Time >= StrToTime('19:00') Then
```

```
  sLabel24.Caption := 'Selamat Malam ';
```

```
end;
```

```
function HexToDec(Str: string): Integer;
```

```
var
```

```
  i, M: Integer;
```

```
begin
```

```
  Result:=0;
```

```
  M:=1;
```

```
  Str:=AnsiUpperCase(Str);
```

```
  for i:=Length(Str) downto 1 do
```

```
  begin
```

```
    case Str[i] of
```

```
      '1'..'9': Result:=Result+(Ord(Str[i])-Ord('0'))*M;
```

```
      'A'..'F': Result:=Result+(Ord(Str[i])-Ord('A')+10)*M;
```

```
    end;
```

```
    M:=M shl 4;
```

```
  end;
```

```
end;
```

```
procedure TMainForm.Delay(lama:longint);
```

```
var ref: longint;
```

```
begin
```

```
  ref:= gettickcount;
```

```
  repeat
```

```
    Application.ProcessMessages;
```

```
  until ((GetTickCount-ref)>=lama);
```

```
end;
```

```
procedure TMainForm.tampil;
```

```
begin
```

```

sLabelID.Caption:= ADOQuery1.fieldbyname('Tag_ID').asString;
sLabelNIK.Caption:= ADOQuery1.fieldbyname('nik').asString;
sLabelNama.Caption:= ADOQuery1.fieldbyname('nama').asString;
sLabelJns.Caption:= ADOQuery1.fieldbyname('Jns_kelamin').asString;
sLabelTpt.Caption:= ADOQuery1.fieldbyname('Tpt_lahir').asString;
sLabelTgl.Caption:= ADOQuery1.fieldbyname('Tgl_lahir').asString;
sLabelAlmt.Caption:= ADOQuery1.fieldbyname('Alamat').asString;
sLabelAgama.Caption:= ADOQuery1.fieldbyname('Agama').asString;
sLabelwarganegara.Caption:=
ADOQuery1.fieldbyname('Kewarganegaraan').asString;
sLabel26.Caption:= ADOQuery1.fieldbyname('nama').asString;
end;

```

```

procedure TMainForm.tampilKosong;
begin
sLabelID.Caption:= "";
sLabelNIK.Caption:= "";
sLabelNama.Caption:= ' ';
sLabelJns.Caption:= "";
sLabelTpt.Caption:= "";
sLabelTgl.Caption:= "";
sLabelAlmt.Caption:= "";
sLabelAgama.Caption:= "";
sLabelwarganegara.Caption:= "";
end;

```

```

procedure TMainForm.ComboBox1Change(Sender: TObject);
var
sl : TStringList;
s : string;
i : integer;
begin
if Loading then Exit;
if ComboBox1.ItemIndex = 0 then begin
if SelectDirectory(s, [], 0) then begin
sSkinManager1.SkinDirectory := s;
sl := TStringList.Create;
sSkinManager1.SkinName := sSkinManager1.GetSkinNames(sl);
ComboBox1.Items.Clear;
ComboBox1.Items.Add("Skins directory...");
for i := 0 to sl.Count - 1 do begin
ComboBox1.Items.Add(sl[i]);
end;
FreeAndNil(sl);
end;
end;
else begin

```

```
sSkinManager1.SkinName := ComboBox1.Text;
end;
end;
```

```
procedure TMainForm.sButton9Click(Sender: TObject);
begin
  if OpenPictureDialog1.Execute then begin
    NewBGName := OpenPictureDialog1.FileName;
    // SkinSections and PropNames are defined in sSkinProps.pas unit
    ChangeImageInSkin(NormalForm, PatternFile, OpenPictureDialog1.FileName,
sSkinManager1);
    ChangeImageInSkin(NormalForm, HotPatternFile,
OpenPictureDialog1.FileName, sSkinManager1);
    // Update of all controls
    sSkinManager1.UpdateSkin;
  end;
end;
```

```
procedure TMainForm.FormShow(Sender: TObject);
var
  sl : TStringList;
  i : integer;
begin
  sl := TStringList.Create;
  sSkinManager1.GetSkinNames(sl);
  ComboBox1.Clear;
  ComboBox1.Items.Add('Skins directory...');
  for i := 0 to sl.Count - 1 do begin
    ComboBox1.Items.Add(sl[i]);
  end;
  // If no available skins...
  if ComboBox1.Items.Count < 1 then begin
    ComboBox1.Items.Add('No skins available');
    ComboBox1.ItemIndex := 0;
  end
  else begin
    // Sets ComboBox to current skin name value without skin changing
    Loading := True;
    ComboBox1.ItemIndex := sl.IndexOf(sSkinManager1.SkinName) + 1;
    Loading := False;
  end;
  FreeAndNil(sl);
end;
```

```
procedure TMainForm.OpenPictureDialog1SelectionChange(Sender: TObject);
begin
  if (pos('.BMP', UpperCase(OpenPictureDialog1.FileName)) > 0) or
    (pos('.JPG', UpperCase(OpenPictureDialog1.FileName)) > 0) or
```

```

        (pos('.BMP', UpperCase(OpenPictureDialog1.FileName)) > 0) then begin
// SkinSections and PropNames are defined in sSkinProps.pas unit
NewBGName := OpenPictureDialog1.FileName;
ChangeImageInSkin(s_Form, s_Pattern, OpenPictureDialog1.FileName,
sSkinManager1);
ChangeImageInSkin(s_Form, s_HotPattern, OpenPictureDialog1.FileName,
sSkinManager1);
// Update of all controls
sSkinManager1.UpdateSkin;
end;
end;

```

```

procedure TMainForm.insert_into_T_Kedatangan;
begin
With ADOCommand1 do
begin
CommandText := 'insert into T_Kedatangan '+
'(Tag_id, NIK, Nama, '+
'tgl_Kedatangan) '+
'VALUES (:tag_ID, :NIK, :Nama, :Tgl) ';
Parameters.ParamByName('tag_ID').Value:= Form2.sEdit2 .Text;
Parameters.ParamByName('NIK').Value:= Form2.sEdit3.Text;
Parameters.ParamByName('Nama').Value :=Form2.sEdit4.Text;
Parameters.ParamByName('Tgl').Value := MainForm.sLabel23.Caption;
CommandType := cmdText;
Execute;
end;
end;

```

```

procedure TMainForm.VaComm1RxChar(Sender: TObject; Count: Integer);
var
I:integer;
Str: String;
terima : string;
begin
delay(20);
sEdit1.Clear;
Form2.sEdit2.Clear;
str:= VaComm1.ReadText;
for I := 1 to length(str) do
case str[I] of
#02:; //data awal RFID
#03: //Data akhir RFID
begin
sEdit5.Clear;
sEdit5.Text:=Str;
FRIDTagCode := Str;
Terima:=(Copy(FRIDTagCode,4,8));

```

```

sEdit4.Text:=terima;
sEdit1.Text:=IntToStr(HexToDec(terima));
Form2.sEdit2.Text:=sEdit1.Text;
cari;
end;
else // bukan #10 atau #13
Button1.Click; // agar parogram tidak dijalankan

end;
end;

procedure TMainForm.cari;
var
A:integer;
begin
if ADOQuery1.Locate('Tag_ID',sEdit1.Text,[loPartialKey]) then // untuk
mencari berdasarkan Tag
begin
tampil;
sBitBtn2.Click;
With ADOCommand1 do
begin
CommandText := 'insert into T_Kedatangan '+
'(Tag_id, NIK, Nama, '+
'tgl_Kedatangan) '+
'VALUES (:tag_ID,:NIK,:Nama,:Tgl) ';
Parameters.ParamByName('tag_ID').Value:= sLabelID.Caption;
Parameters.ParamByName('NIK').Value:= sLabelNIK.Caption;
Parameters.ParamByName('Nama').Value :=sLabelNama.Caption;
Parameters.ParamByName('Tgl').Value := sLabel23.Caption;
CommandType := cmdText;
Execute;
end;

Form3.tampilEdit;
ADOQuery2.Last;

end
else
tampilKosong;

ADOQuery2.Last;
A:= StrToIntDef (sLabelID.Caption,0);
if A=0 then
begin
VaComm1.WriteText('/'); // menulis 'belum Terdaftar pada LCD
sLabel26.Caption:='Belum Terdaftar' ;

```

```

//if MessageDlg('Data Tidak Ditemukan,
//DARTAR?',mtInformation,[mbYES,mbNO],0)=mryes
//then
ADOQuery2.Last;
end;

```

```

sLabel9.Caption:=IntToStr(ADOQuery1.RecordCount);
ADOQuery2.Close;
ADOQuery2.Open;
sLabel10.Caption:=IntToStr(ADOQuery2.RecordCount);
ADOQuery2.Last;
end;

```

```

procedure TMainForm.sSkinManager1AfterChange(Sender: TObject);
var
  i : integer;
begin
  i := sSkinManager1.GetSkinIndex(NormalForm);
  if sSkinManager1.IsValidSkinIndex(i) then sButton9.Enabled :=
sSkinManager1.gd[i].ImagePercent > 0;
end;

```

```

procedure TMainForm.sCheckBox1Click(Sender: TObject);
begin
  sSkinManager1.Active := sCheckBox1.Checked;
  ComboBox1.Enabled := sSkinManager1.Active;
end;

```

```

procedure TMainForm.sScrollBar2KeyUp(Sender: TObject; var Key: Word;
Shift: TShiftState);
begin
  sSkinManager1.HueOffset := sScrollBar2.Position
end;

```

```

procedure TMainForm.sScrollBar2MouseUp(Sender: TObject; Button:
TMouseButton; Shift: TShiftState; X, Y: Integer);
begin
  sSkinManager1.HueOffset := sScrollBar2.Position
end;

```

```

procedure TMainForm.sScrollBar1KeyUp(Sender: TObject; var Key: Word;
Shift: TShiftState);
begin
  sSkinManager1.Saturation := sScrollBar1.Position;
end;

```

```

procedure TMainForm.sScrollBar1MouseUp(Sender: TObject; Button:
TMouseButton; Shift: TShiftState; X, Y: Integer);
begin
  sSkinManager1.Saturation := sScrollBar1.Position;
end;

procedure TMainForm.sScrollBar1Change(Sender: TObject);
begin
  sLabel3.Caption := IntToStr(sScrollBar1.Position)
end;

procedure TMainForm.sScrollBar2Change(Sender: TObject);
begin
  sLabel4.Caption := IntToStr(sScrollBar2.Position)
end;

procedure TMainForm.sButton5Click(Sender: TObject);
begin
  SetActivePage(TControl(Sender).Tag)
end;

procedure TMainForm.sCheckBox4Click(Sender: TObject);
begin
  if sCheckBox4.Checked
  then sSkinManager1.AnimEffects.Buttons.Events :=
sSkinManager1.AnimEffects.Buttons.Events + [beMouseEnter]
  else sSkinManager1.AnimEffects.Buttons.Events :=
sSkinManager1.AnimEffects.Buttons.Events - [beMouseEnter]
end;

procedure TMainForm.sCheckBox5Click(Sender: TObject);
begin
  if sCheckBox5.Checked
  then sSkinManager1.AnimEffects.Buttons.Events :=
sSkinManager1.AnimEffects.Buttons.Events + [beMouseLeave]
  else sSkinManager1.AnimEffects.Buttons.Events :=
sSkinManager1.AnimEffects.Buttons.Events - [beMouseLeave]
end;

procedure TMainForm.sCheckBox6Click(Sender: TObject);
begin
  if sCheckBox6.Checked
  then sSkinManager1.AnimEffects.Buttons.Events :=
sSkinManager1.AnimEffects.Buttons.Events + [beMouseDown]
  else sSkinManager1.AnimEffects.Buttons.Events :=
sSkinManager1.AnimEffects.Buttons.Events - [beMouseDown]
end;

```

```

procedure TMainForm.sCheckBox7Click(Sender: TObject);
begin
  if sCheckBox4.Checked
  then sSkinManager1.AnimEffects.Buttons.Events :=
sSkinManager1.AnimEffects.Buttons.Events + [beMouseUp]
  else sSkinManager1.AnimEffects.Buttons.Events :=
sSkinManager1.AnimEffects.Buttons.Events - [beMouseUp]
end;

procedure TMainForm.sCheckBox8Click(Sender: TObject);
begin
  sSkinManager1.AnimEffects.SkinChanging.Active := sCheckBox8.Checked
end;

procedure TMainForm.sEdit2Change(Sender: TObject);
begin
  try
    sSkinManager1.AnimEffects.SkinChanging.Time := StrToInt(sEdit2.Text)
  except
    end;
end;

procedure TMainForm.SetActivePage(PageIndex: integer);
begin
  if sCheckBox9.Checked and sSkinManager1.Active then
    PrepareForAnimation(Self);

  sBitBtn11.Down := PageIndex = sBitBtn11.Tag;
  sBitBtn10.Down := PageIndex = sBitBtn10.Tag;
  sBitBtn9.Down := PageIndex = sBitBtn9.Tag;
  sBitBtn1.Down := PageIndex = sBitBtn1.Tag;

  case PageIndex of
    0 : CurPanel := sPanel3;
    1 : CurPanel := sPanel1;
    2 : CurPanel := sPanel15;
    3 : CurPanel := sPanel17;
  end;
  CurPanel.BringToFront;

  if sCheckBox9.Checked and sSkinManager1.Active then begin
    AnimShowControl(Self, StrToInt(sEdit3.Text));
    // RedrawWindow(Self.Handle, nil, 0, RDW_ERASE or
RDW_INTERNALPAINT or RDW_INVALIDATE or RDW_UPDATENOW or
RDW_ALLCHILDREN);
  end;
end;

```



```
procedure TMainForm.sEdit3Change(Sender: TObject);
begin
  try
    StrToInt(sEdit3.Text)
  except
    sEdit3.Text := '200'
  end;
end;
```

```
procedure TMainForm.FormCreate(Sender: TObject);
begin
  ChangeImageInSkin(NormalForm, PatternFile, OpenPictureDialog1.FileName,
sSkinManager1);
  ChangeImageInSkin(NormalForm, HotPatternFile,
OpenPictureDialog1.FileName, sSkinManager1);
  sSkinManager1.UpdateSkin;

  sBitBtn11.Click;
  tampilKosong;
  CurPanel := sPanel17;
  sLabel23.Caption:=DateTimeToStr(now);
  VaComm1.Open;
  ADOQuery1.Close;
  ADOQuery1.Open;
  ADOQuery2.Close;
  ADOQuery2.Open;
  sLabel9.Caption:=IntToStr(ADOQuery1.RecordCount);
  sLabel10.Caption:=IntToStr(ADOQuery2.RecordCount);
  ADOQuery2.Last;
end;
```

```
procedure TMainForm.sBitBtn6Click(Sender: TObject);
begin
```

```
  form2.sEdit3.clear;
  Form2.sEdit4.Clear;
  Form2.sEdit5.Clear;
  Form2.sEdit6.Clear;
  Form2.sEdit8.Clear;
  Form2.sEdit9.Clear;
  Form2.sEdit10.Clear;
  Form2.Show;
end;
```

```
procedure TMainForm.sBitBtn7Click(Sender: TObject);
begin
```

```

Form3.Show;
end;

procedure TMainForm.sBitBtn4Click(Sender: TObject);
begin
Form4.Show;
end;

procedure TMainForm.sBitBtn3Click(Sender: TObject);
begin
Form1.Show;
end;

procedure TMainForm.suiDBGrid1CellClick(Column: TColumn);
begin
tampil;
Form3.tampilEdit;
end;

procedure TMainForm.sBitBtn5Click(Sender: TObject);
begin
if MessageDlg('Apakah data dari ' +
ADOQuery1.fieldbyname('nama').asString + ' Mau Dihapus?',
mtconfirmation,[mbYes,mbNo],0) = mryes
then
With ADOCommand1 do
begin
CommandText := 'Delete from T_Biodata '+
'where tag_ID = :tag ';
Parameters.ParamByName('tag').Value:= sLabelID.Caption;

CommandType := cmdText;
Execute;
end;
tampilKosong;
ADOQuery1.Close;
ADOQuery1.Open;
sLabel9.Caption:=IntToStr(ADOQuery1.RecordCount);
sLabel10.Caption:=IntToStr(ADOQuery2.RecordCount);
end;

procedure TMainForm.sBitBtn2Click(Sender: TObject);
var
x:integer;
begin
VaComm1.WriteText('-');// menghapus lcd
for x:=0 to length(sLabelNama.Caption) do

```

```

begin
VaComm1.WriteText(sLabelnama.Caption[x]);
//VaComm1.WriteText('.');
delay(1);
end
end;

```

```

procedure TMainForm.sBitBtn8Click(Sender: TObject);
begin
ADOQuery1.Close;
ADOQuery1.Open;
end;

```

```

procedure TMainForm.Button1Click(Sender: TObject);
begin
sEdit1.Text:=IntToStr(HexToDec(sEdit4.Text));
Form2.sEdit2.Text:=sEdit1.Text;
end;

```

```

procedure TMainForm.sBitBtn1Click(Sender: TObject);
begin
SetActivePage(TControl(Sender).Tag)
end;

```

```

procedure TMainForm.sBitBtn9Click(Sender: TObject);
begin
SetActivePage(TControl(Sender).Tag)
end;

```

```

procedure TMainForm.sBitBtn11Click(Sender: TObject);
begin
SetActivePage(TControl(Sender).Tag)
end;

```

```

procedure TMainForm.sBitBtn10Click(Sender: TObject);
begin
SetActivePage(TControl(Sender).Tag)
end;

```

```

procedure TMainForm.Button2Click(Sender: TObject);
begin
With ADOCommand1 do
begin
CommandText := 'insert into T_Kedatangan '+
'(Tag_id, NIK, Nama, '+
'tgl_Kedatangan) '+
'VALUES (:tag_ID,:NIK,:Nama,:Tgl) ';

```

```

Parameters.ParamByName('tag_ID').Value:= sLabelID.Caption;
Parameters.ParamByName('NIK').Value:= sLabelNIK.Caption;
Parameters.ParamByName('Nama').Value :=sLabelNama.Caption;
Parameters.ParamByName('Tgl').Value := sLabel23.Caption;
CommandType := cmdText;
Execute;
end;
Form4.ADOQuery1.Close;
Form4.ADOQuery1.Open;
Form4.ADOQuery1.Last;
end;

end.

```

```
//FORM1
```

```
unit UnitPencarianID;
```

```
interface
```

```
uses
```

```
Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
Dialogs, Grids, DBGrids, SUIDBCtrls, StdCtrls, sButton, sEdit, ExtCtrls,
sPanel, sSkinProvider, DB, sLabel, ADODB;
```

```
type
```

```
TForm1 = class(TForm)
sSkinProvider1: TsSkinProvider;
sPanel18: TsPanel;
sPanel1: TsPanel;
sEdit1: TsEdit;
sEdit2: TsEdit;
sEdit3: TsEdit;
sButton1: TsButton;
sButton2: TsButton;
sButton3: TsButton;
DataSource1: TDataSource;
sLabel1: TsLabel;
sLabel2: TsLabel;
sLabel3: TsLabel;
sLabel4: TsLabel;
sLabel5: TsLabel;
sLabel6: TsLabel;
sLabel7: TsLabel;
sLabel8: TsLabel;
sLabel9: TsLabel;
sLabel10: TsLabel;
sLabel11: TsLabel;

```

```

sLabel12: TsLabel;
sLabel13: TsLabel;
sLabelID: TsLabel;
sLabelNIK: TsLabel;
sLabelNama: TsLabel;
sLabelJns: TsLabel;
sLabelTpt: TsLabel;
sLabelTgl: TsLabel;
sLabelAlmt: TsLabel;
sLabelAgama: TsLabel;
sLabelWarganegara: TsLabel;
ADOQuery1: TADOQuery;
suiDBGrid1: TsuiDBGrid;
procedure tampil;
procedure sButton1Click(Sender: TObject);
procedure sButton2Click(Sender: TObject);
procedure sButton3Click(Sender: TObject);
procedure suiDBGrid1CellClick(Column: TColumn);
procedure FormCreate(Sender: TObject);
private
  { Private declarations }
public
  { Public declarations }
end;

```

```

var
  Form1: TForm1;

```

```

implementation

```

```

uses TUnit;
{$R *.dfm}

```

```

procedure TForm1.tampil;
begin

```

```

Form1.sLabelID.Caption:= ADOQuery1.fieldbyname('Tag_ID').asString;
Form1.sLabelNIK.Caption:= ADOQuery1.fieldbyname('nik').asString;
Form1.sLabelNama.Caption:= ADOQuery1.fieldbyname('nama').asString;
Form1.sLabelJns.Caption:= ADOQuery1.fieldbyname('Jns_kelamin').asString;
Form1.sLabelTpt.Caption:= ADOQuery1.fieldbyname('Tpt_lahir').asString;
Form1.sLabelTgl.Caption:= ADOQuery1.fieldbyname('Tgl_lahir').asString;
Form1.sLabelAlmt.Caption:= ADOQuery1.fieldbyname('Alamat').asString;
Form1.sLabelAgama.Caption:= ADOQuery1.fieldbyname('Agama').asString;
Form1.sLabelwarganegara.Caption:=
ADOQuery1.fieldbyname('Kewarganegaraan').asString;
end;

```

```

procedure TForm1.sButton1Click(Sender: TObject);

```

```

begin
With ADOQuery1 do
begin
Close;
SQL.Clear;
sql.Add( 'select * from T_Biodata '+
        'where Tag_ID like :Tag_ID ');

Parameters.ParamByName('Tag_ID').Value:= sEdit1.Text;
Open;
end;
tampil;
end;

```

```

procedure TForm1.sButton2Click(Sender: TObject);
begin
With ADOQuery1 do
begin
Close;
SQL.Clear;
sql.Add( 'select * from T_Biodata '+
        'where NIK like :NIK ');

Parameters.ParamByName('NIK').Value:= sEdit2.Text;
Open;
end;
tampil;
end;

```

```

procedure TForm1.sButton3Click(Sender: TObject);
begin
With ADOQuery1 do
begin
Close;
SQL.Clear;
sql.Add( 'select * from T_Biodata '+
        'where Nama like :Nama ');

Parameters.ParamByName('Nama').Value:= '%'+ sEdit3.Text +'%';
Open;
end;
tampil;
end;

```

```

procedure TForm1.suiDBGrid1CellClick(Column: TColumn);
begin

```

```

ampil;
end;

procedure TForm1.FormCreate(Sender: TObject);
begin

end;

end.

```

//FORM2

```
unit Unitdaftar;
```

```
interface
```

```
uses
```

```
Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
Dialogs, sSkinManager, sSkinProvider, StdCtrls, ComCtrls, ExtCtrls,
sPanel, Buttons, sBitBtn, ImgList, ADOdb, DB, sEdit, sLabel;
```

```
type
```

```

TForm2 = class(TForm)
  sSkinProvider1: TsSkinProvider;
  ImageList1: TImageList;
  sBitBtn6: TsBitBtn;
  DateTimePicker1: TDateTimePicker;
  sLabel1: TsLabel;
  sLabel2: TsLabel;
  sLabel3: TsLabel;
  sLabel4: TsLabel;
  sLabel5: TsLabel;
  sLabel6: TsLabel;
  sLabel7: TsLabel;
  sLabel8: TsLabel;
  sLabel9: TsLabel;
  sEdit2: TsEdit;
  sEdit3: TsEdit;
  sEdit4: TsEdit;
  sEdit5: TsEdit;
  sEdit6: TsEdit;
  sEdit8: TsEdit;
  sEdit9: TsEdit;
  sEdit10: TsEdit;
  sLabel10: TsLabel;
  Label1: TLabel;
  procedure sBitBtn6Click(Sender: TObject);
  procedure DateTimePicker1Change(Sender: TObject);

```

```

    procedure FormCreate(Sender: TObject);
    private
    { Private declarations }
    public
    { Public declarations }
    end;

var
    Form2: TForm2;

implementation
uses tUnit;

{$R *.dfm}

procedure TForm2.sBitBtn6Click(Sender: TObject);
begin
With MainForm.ADOCommand1 do
    begin
        CommandText := 'insert into T_Biodata '+
            '(Tag_id, NIK, Nama, Jns_kelamin, Tpt_lahir, '+
            'tgl_lahir, Alamat, Agama, Kewarganegaraan) '+
            'VALUES
(:tag_ID,:NIK,:Nama,:Jns,:Tpt,:Tgl,:Alamat,:Agama,:Kewarganegaraan) ';
        Parameters.ParamByName('tag_ID').Value:= sEdit2.Text;
        Parameters.ParamByName('NIK').Value:= sEdit3.Text;
        Parameters.ParamByName('Nama').Value := sEdit4.Text;
        Parameters.ParamByName('Jns').Value := sEdit5.Text;
        Parameters.ParamByName('Tpt').Value := sEdit6.Text;
        Parameters.ParamByName('Tgl').Value:= Label1.Caption;
        Parameters.ParamByName('Alamat').Value:= sEdit8.Text;
        Parameters.ParamByName('Agama').Value := sEdit9.Text;
        Parameters.ParamByName('Kewarganegaraan').Value := sEdit10.Text;
        CommandType:=cmdText;
        Execute;
    end;
    MainForm.insert_into_T_Kedatangan;
    MainForm.ADOQuery1.Close;
    MainForm.ADOQuery1.Open;

    MainForm.sLabel9.Caption:=IntToStr(MainForm.ADOQuery1.RecordCount);
    MainForm.ADOQuery2.Close;
    MainForm.ADOQuery2.Open;
    MainForm.sLabel10.Caption:=IntToStr(MainForm.ADOQuery2.RecordCount);
    Form2.Close;

end;

```



```

procedure TForm2.DateTimePicker1Change(Sender: TObject);
begin
  Label1.Caption:=datetostr(datetimepicker1.date);
end;

procedure TForm2.FormCreate(Sender: TObject);
begin

end;

end.
//FORM3
unit UnitEdit;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, StdCtrls, ADODB, DB, ComCtrls, sSkinProvider, Buttons, sBitBtn,
  ImgList, sEdit, sLabel;

type
  TForm3 = class(TForm)
    sSkinProvider1: TsSkinProvider;
    DateTimePicker1: TDateTimePicker;
    ImageList1: TImageList;
    sBitBtn6: TsBitBtn;
    sLabel1: TsLabel;
    sLabel2: TsLabel;
    sLabel3: TsLabel;
    sLabel4: TsLabel;
    sLabel5: TsLabel;
    sLabel6: TsLabel;
    sLabel7: TsLabel;
    sLabel8: TsLabel;
    sLabel9: TsLabel;
    sEdit2: TsEdit;
    sEdit3: TsEdit;
    sEdit4: TsEdit;
    sEdit5: TsEdit;
    sEdit6: TsEdit;
    sEdit8: TsEdit;
    sEdit10: TsEdit;
    sLabel10: TsLabel;
    sEdit9: TsEdit;
    Label1: TLabel;
    procedure tampilEdit;

```

```

    procedure sBitBtn6Click(Sender: TObject);
    procedure FormCreate(Sender: TObject);
    procedure DateTimePicker1Change(Sender: TObject);
private
    { Private declarations }
public
    { Public declarations }
end;

var
    Form3: TForm3;

implementation
uses TUnit;

{$R *.dfm}

procedure TForm3.tampilEdit;
begin

sedit2.Text:= MainForm.ADOQuery1.fieldbyname('Tag_ID').asString;
sEdit3.Text:= MainForm.ADOQuery1.fieldbyname('nik').asString;
sEdit4.Text:= MainForm.ADOQuery1.fieldbyname('nama').asString;
sEdit5.Text:= MainForm.ADOQuery1.fieldbyname('Jns_kelamin').asString;
sEdit6.Text:= MainForm.ADOQuery1.fieldbyname('Tpt_lahir').asString;
DateTimePicker1.Date:=
MainForm.ADOQuery1.fieldbyname('Tgl_lahir').AsDateTime;
sEdit8.Text:= MainForm.ADOQuery1.fieldbyname('Alamat').asString;
sEdit9.Text:= MainForm.ADOQuery1.fieldbyname('Agama').asString;
sEdit10.Text:=
MainForm.ADOQuery1.fieldbyname('Kewarganegaraan').asString;
end;

procedure TForm3.sBitBtn6Click(Sender: TObject);
begin
MainForm.ADOQuery1.Edit;
MainForm.ADOQuery1.FieldByName('Tag_Id').Value:=sEdit2.Text;
MainForm.ADOQuery1.FieldByName('NIK').Value:=sEdit3.Text;
MainForm.ADOQuery1.FieldByName('Nama').Value:=sEdit4.Text;
MainForm.ADOQuery1.FieldByName('Jns_kelamin').Value:=sEdit5.Text;
MainForm.ADOQuery1.FieldByName('Tpt_lahir').Value:=sEdit6.Text;
MainForm.ADOQuery1.FieldByName('Tgl_lahir').Value:=Label1.Caption;
MainForm.ADOQuery1.FieldByName('Alamat').Value:=sEdit8.Text;
MainForm.ADOQuery1.FieldByName('Agama').Value:=sEdit9.Text;
MainForm.ADOQuery1.FieldByName('Kewarganegaraan').Value:=sEdit10.Text;

```

```

MainForm.ADOQuery1.Post;
Form3.Close;
end;
procedure TForm3.FormCreate(Sender: TObject);
begin
sEdit2.Text:= MainForm.sEdit1.Text;
end;

procedure TForm3.DateTimePicker1Change(Sender: TObject);
begin
Label1.Caption:=datetostr(datetimepicker1.date);
end;

end.

```

```
//FORM4
```

```
unit UnitPkedatangan;
```

```
interface
```

```
uses
```

```
Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
Dialogs, DB, StdCtrls, sButton, sEdit, Grids, DBGrids, SUIDBCtrls,
ExtCtrls, sPanel, sSkinProvider, ComCtrls, sLabel, ADODB;
```

```
type
```

```

TForm4 = class(TForm)
sSkinProvider1: TsSkinProvider;
sPanel18: TsPanel;
suiDBGrid1: TsuiDBGrid;
sPanel1: TsPanel;
sEdit1: TsEdit;
sEdit2: TsEdit;
sEdit3: TsEdit;
sButton1: TsButton;
sButton2: TsButton;
sButton3: TsButton;
DataSource1: TDataSource;
sButton4: TsButton;
DateTimePicker1: TDateTimePicker;
sLabel1: TsLabel;
sLabel2: TsLabel;
sLabel3: TsLabel;
sLabel4: TsLabel;
sLabelID: TsLabel;
sLabelNIK: TsLabel;
sLabelNama: TsLabel;

```

```

sLabeltglK: TsLabel;
sLabel10: TsLabel;
sLabel11: TsLabel;
sLabel12: TsLabel;
sLabel13: TsLabel;
sLabel14: TsLabel;
ADOQuery1: TADOQuery;
Label1: TLabel;
procedure tampil;
procedure sButton1Click(Sender: TObject);
procedure sButton2Click(Sender: TObject);
procedure sButton3Click(Sender: TObject);
procedure sButton4Click(Sender: TObject);
procedure suiDBGrid1 CellClick(Column: TColumn);
procedure DateTimePicker1 Change(Sender: TObject);
procedure FormCreate(Sender: TObject);
private
  { Private declarations }
public
  { Public declarations }
end;

var
  Form4: TForm4;

implementation
uses Tunit, UnitPencarianID;

{$R *.dfm}

procedure tform4.tampil;
begin
Form4.sLabelID.Caption:= ADOQuery1.fieldbyname('Tag_ID').asString;
Form4.sLabelNIK.Caption:= ADOQuery1.fieldbyname('nik').asString;
Form4.sLabelNama.Caption:= ADOQuery1.fieldbyname('nama').asString;
Form4.sLabeltglK.Caption:=
ADOQuery1.fieldbyname('Tgl_Kedatangan').asString;

end;

procedure TForm4.sButton1Click(Sender: TObject);
begin
With ADOQuery1 do
begin
Close;
SQL.Clear;
sql.Add('select * from T_Kedatangan '+
'where Tag_ID like :Tag_ID ' +

```

```

        'order by tgl_kedatangan');
Parameters.ParamByName('Tag_ID').Value:= sEdit1.Text;
Open;
end;
tampil;
end;

procedure TForm4.sButton2Click(Sender: TObject);
begin

With ADOQuery1 do
begin
Close;
SQL.Clear;
sql.Add( 'select * from T_Kedatangan '+
        'where nik like :nik ' +
        'order by tgl_kedatangan');
Parameters.ParamByName('nik').Value:= sEdit2.Text;
Open;
end;
tampil;
end;

procedure TForm4.sButton3Click(Sender: TObject);
begin

With ADOQuery1 do
begin
Close;
SQL.Clear;
sql.Add( 'select * from T_Kedatangan '+
        'where nama like :nama ' +
        'order by tgl_kedatangan');
Parameters.ParamByName('nama').Value:= '%' + sEdit3.Text + '%';
Open;
end;
tampil;
end;

procedure TForm4.sButton4Click(Sender: TObject);
begin
With ADOQuery1 do
begin
Close;
SQL.Clear;
sql.Add( 'select * from T_Kedatangan '+
        'where tgl_Kedatangan like :tgl_Kedatangan '+
        'order by nama');

```

```
Parameters.ParamByName('tgl_Kedatangan').Value:= '%'+ Label1.Caption +%';  
Open;  
end;  
tampil;  
end;
```

```
procedure TForm4.suiDBGrid1CellClick(Column: TColumn);  
begin  
tampil;  
end;
```

```
procedure TForm4.DateTimePicker1Change(Sender: TObject);  
begin  
Label1.Caption:=datetostr(datetimestr(datetimepicker1.date));  
end;
```

```
procedure TForm4.FormCreate(Sender: TObject);  
begin  
DateTimePicker1.DateTime:=now  
end;
```

```
end.
```

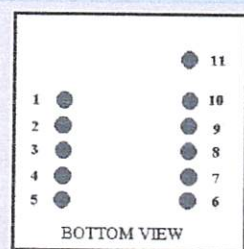
ID SERIES DATASHEET Mar 01, 2005

ID-2 / ID-12 / ID-20

The ID2, ID12 and ID20 are similar to the obsolete ID0, ID10 and ID15 MK(ii) series devices, but they have extra pins that allow Magnetic Emulation output to be included in the functionality. The ID-12 and ID-20 come with internal antennas, and have read ranges of 12+ cm and 16+ cm, respectively. With an external antenna, the ID-2 can deliver read ranges of up to 25 cm. All three readers support ASCII, Wiegand26 and Magnetic ABA Track2 data formats.



ID2 / ID12 / ID20 PIN-OUT



1. GND
2. RES (Reset Bar)
3. ANT (Antenna)
4. ANT (Antenna)
5. CP
6. Future
7. +/- (Format Selector)
8. D1 (Data Pin 1)
9. D0 (Data Pin 0)
10. LED (LED / Beeper)
11. +5V

Operational and Physical Characteristics

| Parameters | ID-2 | ID-12 | ID-20 |
|----------------------|-------------------------------|-------------------------------|-------------------------------|
| Read Range | N/A (no internal antenna) | 12+ cm | 16+ cm |
| Dimensions | 21 mm x 19 mm x 6 mm | 26 mm x 25 mm x 7 mm | 40 mm x 40 mm x 9 mm |
| Frequency | 125 kHz | 125 kHz | 125 kHz |
| Card Format | EM 4001 or compatible | EM 4001 or compatible | EM 4001 or compatible |
| Encoding | Manchester 64-bit, modulus 64 | Manchester 64-bit, modulus 64 | Manchester 64-bit, modulus 64 |
| Power Requirement | 5 VDC @ 13mA nominal | 5 VDC @ 30mA nominal | 5 VDC @ 65mA nominal |
| I/O Output Current | +/-200mA PK | - | - |
| Voltage Supply Range | +4.6V through +5.4V | +4.6V through +5.4V | +4.6V through +5.4V |

Pin Description & Output Data Formats

| Pin No. | Description | ASCII | Magnet Emulation | Wiegand26 |
|---------|------------------------------------------|---------------------|------------------|---------------|
| Pin 1 | Zero Volts and Tuning Capacitor Ground | GND 0V | GND 0V | GND 0V |
| Pin 2 | Strap to +5V | Reset Bar | Reset Bar | Reset Bar |
| Pin 3 | To External Antenna and Tuning Capacitor | Antenna | Antenna | Antenna |
| Pin 4 | To External Antenna | Antenna | Antenna | Antenna |
| Pin 5 | Card Present | No function | Card Present * | No function |
| Pin 6 | Future | Future | Future | Future |
| Pin 7 | Format Selector (+/-) | Strap to GND | Strap to Pin 10 | Strap to +5V |
| Pin 8 | Data 1 | CMOS | Clock * | One Output * |
| Pin 9 | Data 0 | TTL Data (inverted) | Data * | Zero Output * |
| Pin 10 | 3.1 kHz Logic | Beeper / LED | Beeper / LED | Beeper / LED |
| Pin 11 | DC Voltage Supply | +5V | +5V | +5V |

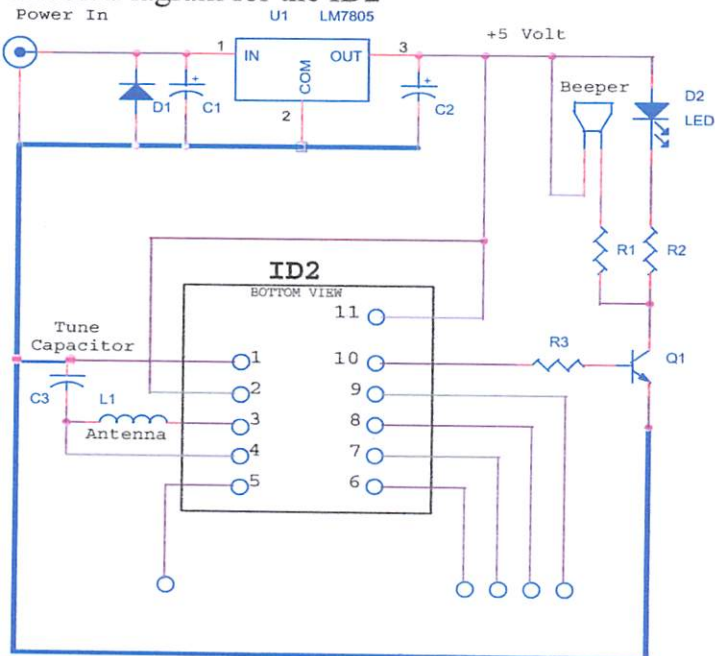
* Requires 4K7 Pull-up resistor to +5V

ID Innovations

Advanced Digital Reader Technology

---Better by Design

Circuit Diagram for the ID2



COMPONENT LIST

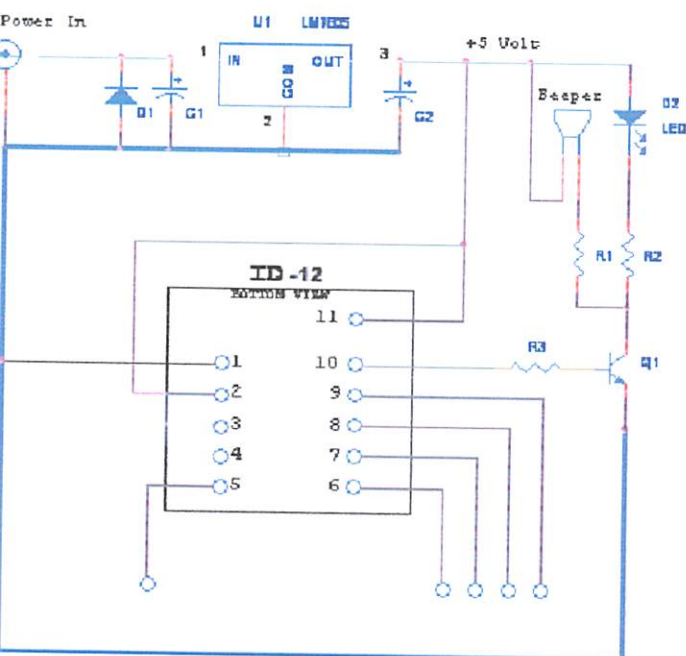
R1 = 100R
 R2 = 1K
 R3 = 1K
 C1 = 100uF 16V
 C2 = 100uF 10V
 C3 = 1nF COG 100V *
 Beeper = 2.7-3.5KHz 100R
 D1 = 1N4001
 D2 = GREEN LED
 U1 = LM7805
 Q1 = UTC8050 (NPN)
 L1 = 640uH

ID2 = ID Innovations ID2

* Please Note the ID2 has an internal tuning capacitor of 1.5nF and this makes the total tuning capacity = 2.5nF

The 3.1Khz Beeper Logic is centered for most Beepers in range 2.7-3.5Khz

Circuit Diagram for the ID-12/ID20



COMPONENT LIST

R1 = 100R
 R2 = 1K
 R3 = 1K
 C1 = 100uF 16V
 C2 = 100uF 10V
 Beeper = 2.7-3.5KHz 100R
 D1 = 1N4001
 D2 = GREEN LED
 U1 = LM7805
 Q1 = UTC8050 (NPN)
 ID2 = ID Innovations ID2

* Please Note the ID2 has an internal tuning capacitor of 1.5nF and this makes the total tuning capacity = 2.5nF

The 3.1Khz Beeper Logic is centered for most Beepers in range 2.7-3.5Khz

ID Innovations

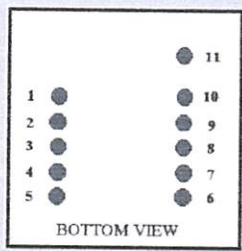
Advanced Digital Reader Technology

-Better by Design

ID-2RW, ID-12RW Brief Data

The ID2-RW, ID12-RW and ID15-RW are a new series of Read/Write modules for the Temec Q5 tag. It has full functionality including password. They contain built-in algorithms to assist customers programming the popular Sokymat Unique type tag. Password protection is allowed. Control is via a host computer using a simple terminal program such as hyper terminal or Qmodem.

ID2 / ID12 / ID20 PIN-OUT



- 1 GND
- 2 RES (Reset Bar)
- 3 ANT (Antenna)
- 4 ANT (Antenna)
- 5 Future
- 6 Program LED
- 7 ASCII in
- 8 Future
- 9 ASCII Out
- 10 Read (LED / Beeper)
- 11 +5V



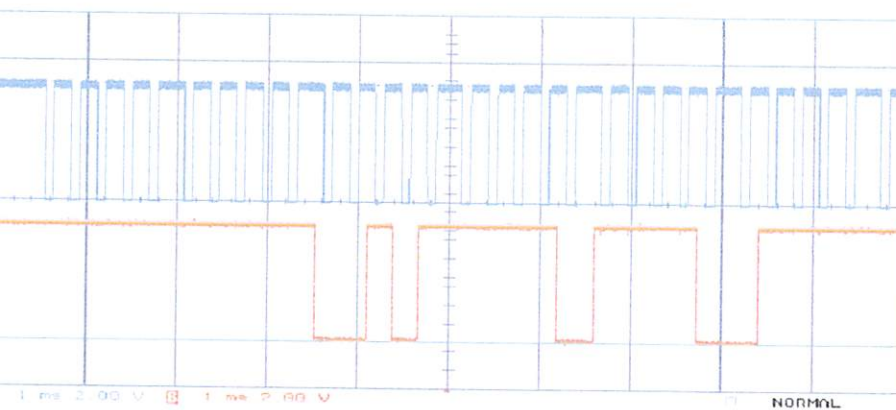
Operational and Physical Characteristics

| Parameters | ID-2RW | ID-12RW | ID-20RW |
|----------------------|------------------------------|------------------------|------------------------|
| Read Range | N/A (no internal antenna) | 12+ cm (Unique Format) | 15+ cm (Unique Format) |
| Dimensions | 21 mm x 19 mm x 6 mm | 26 mm x 25 mm x 7 mm | 40 mm x 40 mm x 9 mm |
| Frequency | 125 kHz | 125 kHz | 125 kHz |
| Card Format | Temec Q5555 | Temec Q5555 | Temec Q5555 |
| Read Encoding | Manchester modulus 64 | Manchester modulus 64 | Manchester modulus 64 |
| Power Requirement | 5 VDC @ 13mA nominal | 5 VDC @ 30mA nominal | 5 VDC @ 50mA nominal |
| I/O Output Current | +/-200mA PK | - | - |
| Voltage Supply Range | +4.6V through +5.4V | +4.6V through +5.4V | +4.6V through +5.4V |
| Coil Detail | L = 0.6mH - 1.5mH, Q = 15-30 | - | - |

Description

A host computer is required to send the commands to the module. A simple terminal program such as Qmodem or hyper-terminal can be used to send commands to the module. The blocks are individually programmable. If you have ever found that the Q5 can be a bit 'Twitchy' to program this programmer module is your solution. The command interface is simple to use and easily understood. The programmer also has two types of internal reader. One of these is provided to read Sokymat 'Unique' type tag configuration.

Magnetic Timing Diagram



DATA FORMATS

Output Data Structure – ASCII

| | | | | | |
|-----------|-----------------|---------------------|----|----|-----------|
| STX (02h) | DATA (10 ASCII) | CHECK SUM (2 ASCII) | CR | LF | ETX (03h) |
|-----------|-----------------|---------------------|----|----|-----------|

[The 1byte (2 ASCII characters) Check sum is the “Exclusive OR” of the 5 hex bytes (10 ASCII) Data characters.]

Output Data Structure – Wiegand26

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|---|---|---|---|---|---|---|---|----|----|----|----|----------------|----|----|----|----|----|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| P | E | E | E | E | E | E | E | E | E | E | E | E | O | O | O | O | O | O | O | O | O | O | O | O | P |
| Even parity (E) | | | | | | | | | | | | | Odd parity (O) | | | | | | | | | | | | |

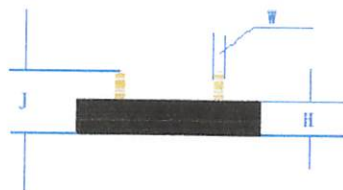
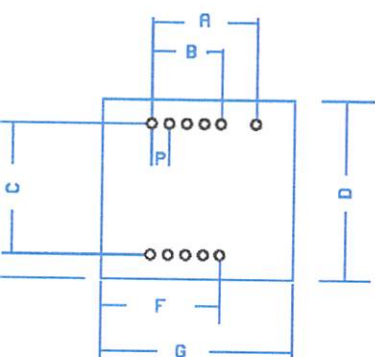
P = Parity start bit and stop bit

Output Data Magnetic ABA Track2

| | | | | | |
|------------------|----|------|----|-----|-----------------|
| 10 Leading Zeros | SS | Data | ES | LCR | 10 Ending Zeros |
|------------------|----|------|----|-----|-----------------|

[SS is the Start Character of 11010, ES is the end character of 11111, LRC is the Longitudinal Redundancy Check.]

Dimensions (Top View) (mm)



| | ID-2 | | | ID-12 | | | ID-20 | | |
|---|------|------|------|-------|------|------|-------|------|------|
| | Nom. | Min. | Max. | Nom. | Min. | Max. | Nom. | Min. | Max. |
| A | 12.0 | 11.6 | 12.4 | 12.0 | 11.6 | 12.4 | 12.0 | 11.6 | 12.4 |
| B | 8.0 | 7.6 | 8.4 | 8.0 | 7.6 | 8.4 | 8.0 | 7.6 | 8.4 |
| C | 15.0 | 14.6 | 15.4 | 15.0 | 14.6 | 15.4 | 15.0 | 14.6 | 15.4 |
| D | 20.5 | 20.0 | 21.5 | 25.3 | 24.9 | 25.9 | 40.3 | 40.0 | 41.0 |
| E | 18.5 | 18.0 | 19.2 | 20.3 | 19.8 | 20.9 | 27.8 | 27.5 | 28.5 |
| F | 14.0 | 13.0 | 14.8 | 16.3 | 15.8 | 16.9 | 22.2 | 21.9 | 23.1 |
| G | 22.0 | 21.6 | 22.4 | 26.4 | 26.1 | 27.1 | 38.5 | 38.2 | 39.2 |
| P | 2.0 | 1.8 | 2.2 | 2.0 | 1.8 | 2.2 | 2.0 | 1.8 | 2.2 |
| H | 5.92 | 5.85 | 6.6 | 6.0 | 5.8 | 6.6 | 6.8 | 6.7 | 7.0 |
| I | 9.85 | 9.0 | 10.5 | 9.9 | 9.40 | 10.5 | 9.85 | 9.4 | 10.6 |
| V | 0.66 | 0.62 | 0.67 | 0.66 | 0.62 | 0.67 | 0.66 | 0.62 | 0.67 |

Note – measurements do not include any burring of edges.

NOTICE - Innovated Devices reserve the right to change these specifications without prior notice.

Designing Coils for ID2

The recommended Inductance is 1.08mH to be used with an internal tuning capacitor of 1n5. In general the bigger the antenna the better, provided the reader is generating enough field strength to excite the tag. The ID-2 is relatively low power so a maximum coil size of 15x15cm is recommended if it is intended to read ISO cards. If the reader is intended to read glass tags the maximum coil size should be smaller, say 10x10cm.

There is a science to determine the exact size of an antenna but there are so many variables that in general it is best to get a general idea after which a degree of 'Try it and see' is unavoidable.

If the reader is located in a position where there is a lot of heavy interference then less range cannot be avoided. In this situation the coil should be made smaller to increase the field strength and coupling.

It is difficult to give actual examples of coils for hand winding because the closeness and tightness of the winding will significantly change the inductance. A professionally wound coil will have much more inductance than a similar hand wound coil.

For those who want a starting point into practical antenna winding it was found that 63 turns on a 120mm diameter former gave an inductance of 1.08mH. For those contemplating adding an additional tuning capacitor it was found that 50 turns on a 120mm diameter former gave 700uH. The wire diameter is not important.

Anybody who wishes to be more theoretical we recommend a trip to the Microchip Website where we found an application sheet for Loop Antennas. <http://ww1.microchip.com/downloads/en/AppNotes/00831b.pdf>

The Tuning Capacitor

It is recommended that the internal 1n5 capacitor is used for tuning, however a capacitor may be also be added externally. The combined capacitance should not exceed 2n7. Do not forget that the choice of tuning capacitor can also substantially affect the quality of your system. The Id12 is basically an ID2 with an internal antenna. The loss in an ID12 series antenna is required to be fairly high to limit the series current. A low Q will hide a lot of the shortcomings of the capacitor, but for quality and reliability and repeatability the following capacitors are recommend.

| | |
|---------------|--------------------------------------------------------------------|
| Polypropylene | Good Readily available. Ensure AC voltage at 125kHz is sufficient. |
| COG/NPO | Excellent. Best Choice |
| Silver Mica | Excellent but expensive |
| Polycarbonate | Good Readily available. Ensure AC voltage at 125kHz is sufficient. |

Voltage Working.

A capacitor capable of withstanding the RMS voltage at 125KHz MUST be chosen. The working voltage will depend on the coil design. I suggest the designer start with rugged 1n5 Polypropylene 630v capacitor to do his experiments and he come down to a suitable size/value. The capacitor manufacturer will supply information on their capacitors. Do not simply go by the DC voltage. This means little. A tolerance of 2% is preferable. A tolerance of 5% is acceptable.

Fine Tuning

We recommend using an oscilloscope for fine-tuning. Connect the oscilloscope to observe the 125KHz AC voltage across the coil. Get a sizeable piece of ferrite and bring it up to the antenna loop. If the voltage increases then you need more inductance (or more capacitance). If the voltage decreases as you bring the ferrite up to the antenna then the inductance is too great. If you have no ferrite then a piece of aluminum sheet may be used for testing in a slightly different way. Opposing currents will flow in the aluminum and it will act as a negative inductance. If the 125KH AC voltage increases as the aluminum sheet approaches the antenna then the inductance is too high. Note it may be possible that the voltage will first maximize then decrease. This simply means that you are near optimum tuning. If you are using ferrite then the coil is a little under value and if you are using an aluminum sheet then the coil is a over under value.

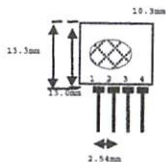
D Innovations

Advanced Digital Reader Technology

---Better by Design

TLP434A & RLP434A RF ASK Hybrid Modules for Radio Control (New Version)

TLP434A Ultra Small Transmitter

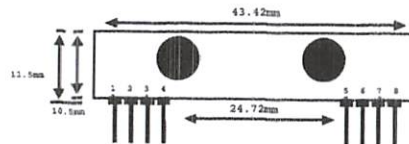


pin 1 : GND
pin 2 : Data In
pin 3 : Vcc
pin 4 : Antenna (RF output)

Frequency 315, 418 and 433.92 Mhz

Modulation : ASK
Operation Voltage : 2 - 12 VDC

RLP434A SAW Based Receiver



pin 1 : Gnd
pin 2 : Digital Data Output
pin 3 : RSSI
pin 4 : Vcc
pin 5 : Vcc
pin 6 : E/D (Enable = 1, Disable = 0)
pin 7 : Gnd
pin 8 : Antenna

Frequency 315, 418 and 433.92 Mhz

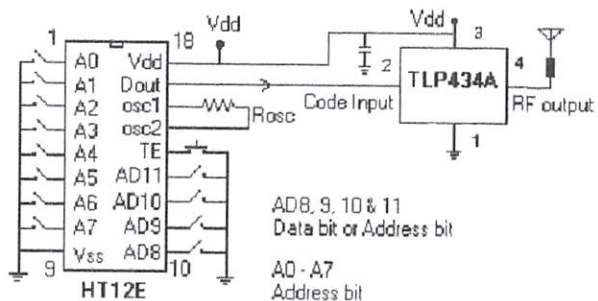
Modulation : ASK
Supply Voltage : 3.3 - 6.0 VDC
Output : Digital & Linear

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------|--------------------------|---------------------|---------|------|---------|------|
| Vcc | Operating supply voltage | | 2.0 | - | 12.0 | V |
| Icc 1 | Peak Current (2V) | | - | - | 1.64 | mA |
| Icc 2 | Peak Current (12V) | | - | - | 19.4 | mA |
| Vh | Input High Voltage | Idata= 100uA (High) | Vcc-0.5 | Vcc | Vcc+0.5 | V |
| VI | Input Low Voltage | Idata= 0 uA (Low) | - | - | 0.3 | V |
| FO | Absolute Frequency | 315Mhz module | 314.8 | 315 | 315.2 | MHz |
| PO | RF Output Power- 50ohm | Vcc = 9V-12V | - | 16 | - | dBm |
| | | Vcc = 5V-6V | - | 14 | - | dBm |
| DR | Data Rate | External Encoding | 512 | 4.8K | 200K | bps |

Notes : (Case Temperature = 25°C +/- 2°C , Test Load Impedance = 50 ohm)

Application Circuit :

Typical Key-chain Transmitter using HT12E-18DIP, a Binary 12 bit Encoder from Holtek Semiconductor Inc.



AD8, 9, 10 & 11
Data bit or Address bit
A0 - A7
Address bit

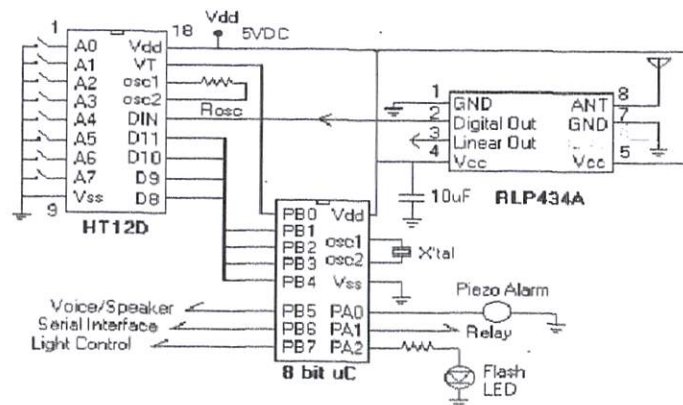
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------|--------------------------|--------------------------|---------|------|-----|------|
| Vcc | Operating supply voltage | | 3.3 | 5.0V | 6.0 | V |
| Itot | Operating Current | | - | 4.5 | - | mA |
| Vdata | Data Out | Idata = +200 uA (High) | Vcc-0.5 | - | Vcc | V |
| | | Idata = -10 uA (Low) | - | - | 0.3 | V |

Electrical Characteristics

| Characteristics | SYM | Min | Typ | Max | Unit |
|---------------------------|------|---------------------|------|-----|------|
| Operation Radio Frequency | FC | 315, 418 and 433.92 | | | MHz |
| Sensitivity | Pref | -110 | | | dBm |
| Channel Width | | | +500 | | Khz |
| Noise Equivalent BW | | | 4 | | Khz |
| Receiver Turn On Time | | | 5 | | ms |
| Operation Temperature | Top | -20 | - | 80 | C |
| Baseboard Data Rate | | | 4.8 | | KHz |

Application Circuit :

Typical RF Receiver using HT12D-18DIP, a Binary 12 bit Decoder with 8 bit uC HT48RXX from Holtek Semiconductor Inc.



Voice/Speaker
Serial Interface
Light Control

8 bit uC

Piezo Alarm
Relay
Flash LED

Features

Compatible with MCS-51® Products
4K Bytes of In-System Programmable (ISP) Flash Memory
Endurance: 1000 Write/Erase Cycles
1.8V to 5.5V Operating Range
Low Power Static Operation: 0 Hz to 33 MHz
Two-Level Program Memory Lock
128 x 8-bit Internal RAM
8 Programmable I/O Lines
Two 16-bit Timer/Counters
Five Interrupt Sources
Full Duplex UART Serial Channel
Low-power Idle and Power-down Modes
Rapid Recovery from Power-down Mode
Watchdog Timer
Two Data Pointers
Power-off Flag
Low Power Programming Time
In-System Programmable (Byte and Page Mode)

Description

AT89S51 is a low-power, high-performance CMOS 8-bit microcontroller with 4K of in-system programmable Flash memory. The device is manufactured using high-density nonvolatile memory technology and is compatible with the industry standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a single chip, the Atmel AT89S51 is a powerful microcontroller which provides a flexible and cost-effective solution to many embedded control applications.

AT89S51 provides the following standard features: 4K bytes of Flash, 128 bytes of internal RAM, 32 I/O lines, Watchdog timer, two data pointers, two 16-bit timer/counters, a five-level interrupt architecture, a full duplex serial port, on-chip oscillator, and support circuitry. In addition, the AT89S51 is designed with static logic for operation at zero frequency and supports two software selectable power saving modes. Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM content but freezes the oscillator, disabling all other chip functions until the next external reset or hardware reset.



8-bit Microcontroller with 4K Bytes In-System Programmable Flash

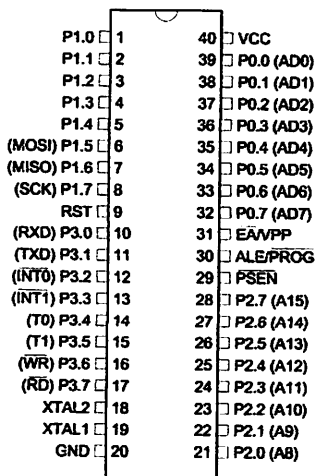
AT89S51



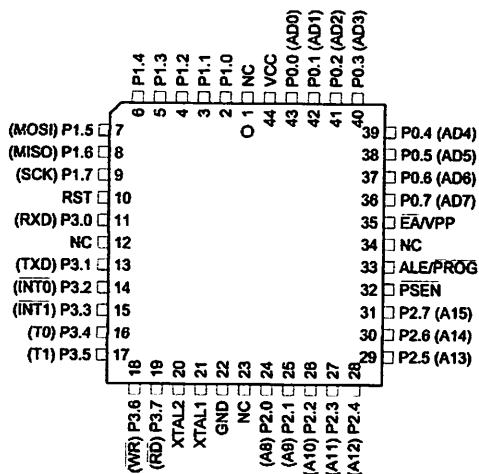


Configurations

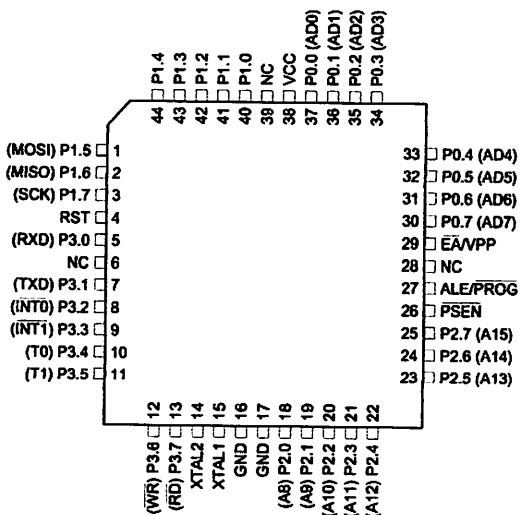
PDIP



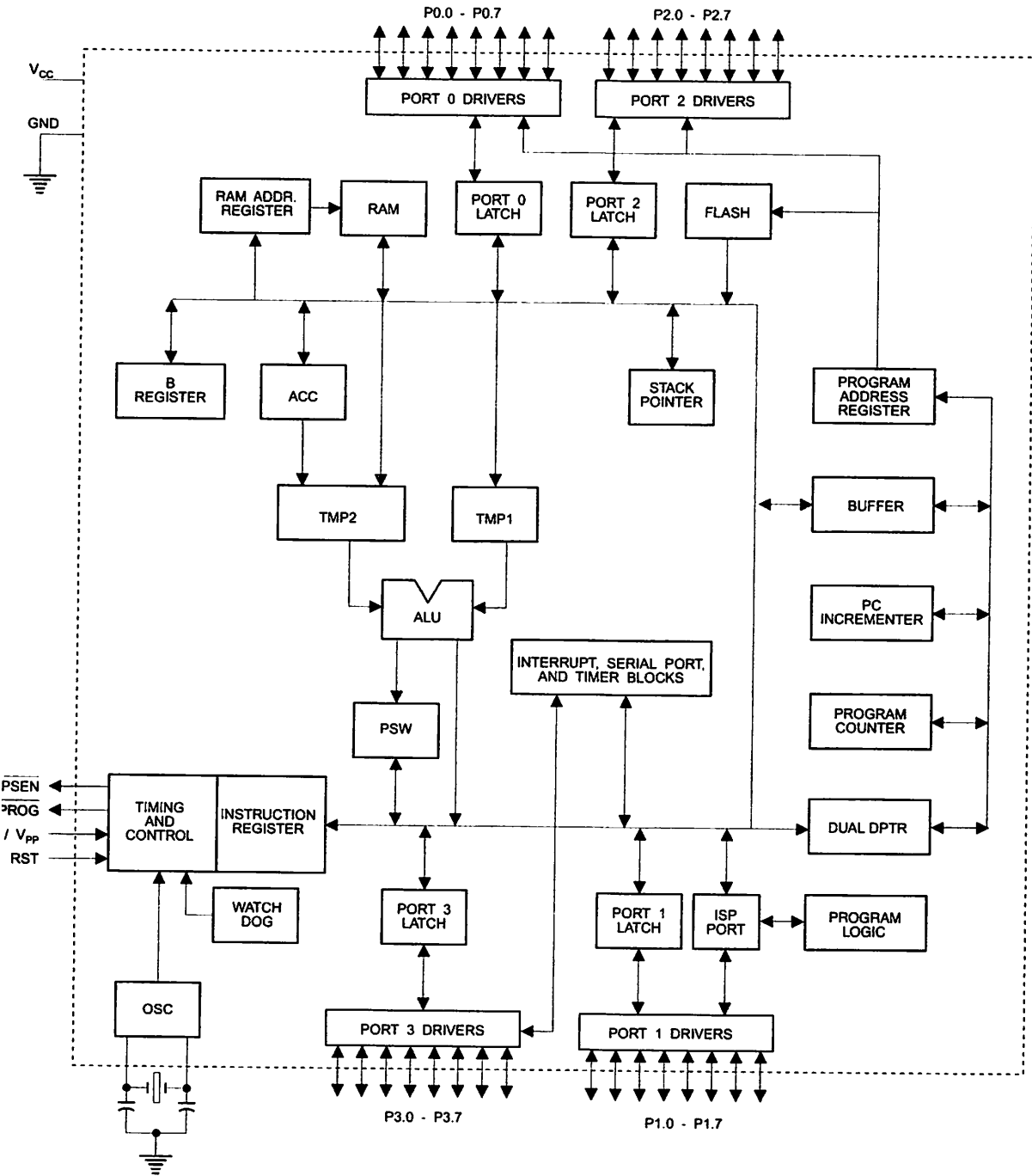
PLCC



TQFP



Block Diagram





Description

Supply voltage.

Ground.

Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high-impedance inputs.

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

Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. **External pull-ups are required during program verification.**

Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. 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 pull-ups 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 pull-ups.

Port 1 also receives the low-order address bytes during Flash programming and verification.

| Port Pin | Alternate Functions |
|----------|---------------------------------------|
| P1.5 | MOSI (used for In-System Programming) |
| P1.6 | MISO (used for In-System Programming) |
| P1.7 | SCK (used for In-System Programming) |

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

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

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

Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups 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 pull-ups.

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

Port 3 also serves the functions of various special features of the AT89S51, as shown in the following table.

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

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device. This pin drives High for 98 oscillator periods after the Watchdog times out. The DISRTO bit in SFR AUXR (address 8EH) can be used to disable this feature. In the default state of bit DISRTO, the RESET HIGH out feature is enabled.

PROG

Address Latch Enable (ALE) 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 (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.

Program Store Enable ($\overline{\text{PSEN}}$) is the read strobe to external program memory.

When the AT89S51 is executing code from external program memory, $\overline{\text{PSEN}}$ is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

PP

External Access Enable. $\overline{\text{EA}}$ must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset.

$\overline{\text{EA}}$ should be strapped to V_{CC} for internal program executions.

This pin also receives the 12-volt programming enable voltage (V_{PP}) during Flash programming.

1

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

2

Output from the inverting oscillator amplifier





Special Function Registers

A map of the on-chip memory area called the Special Function Register (SFR) space is shown in Table 1.

Note that not all of the addresses are occupied, and unoccupied addresses may not be implemented on the chip. Read accesses to these addresses will in general return random data, and write accesses will have an indeterminate effect.

Table 1. AT89S51 SFR Map and Reset Values

| | | | | | | | | |
|----|------------------|------------------|--------------------|------------------|------------------|--------------------|-----------------|------|
| 8H | | | | | | | | 0FFH |
| 0H | B 00000000 | | | | | | | 0F7H |
| 8H | | | | | | | | 0EFH |
| 0H | ACC 00000000 | | | | | | | 0E7H |
| 8H | | | | | | | | 0DFH |
| 0H | PSW 00000000 | | | | | | | 0D7H |
| 8H | | | | | | | | 0CFH |
| 0H | | | | | | | | 0C7H |
| 8H | IP XX000000 | | | | | | | 0BFH |
| 0H | P3 11111111 | | | | | | | 0B7H |
| 8H | IE 0X000000 | | | | | | | 0AFH |
| 0H | P2 11111111 | | AUXR1 XXXXXXXX0 | | | WDTRST XXXXXXXX | | 0A7H |
| 8H | SCON 00000000 | SBUF XXXXXXXX | | | | | | 9FH |
| 0H | P1 11111111 | | | | | | | 97H |
| 8H | TCON 00000000 | TMOD 00000000 | TL0 00000000 | TL1 00000000 | TH0 00000000 | TH1 00000000 | AUXR XXX0XX0 | 8FH |
| 0H | P0 11111111 | SP 00000111 | DP0L 00000000 | DP0H 00000000 | DP1L 00000000 | DP1H 00000000 | PCON 0XX0000 | 87H |

User 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.

Interrupt Registers: The individual interrupt enable bits are in the IE register. Two priorities can be set for each of the five interrupt sources in the IP register.

Table 2. AUXR: Auxiliary Register

| AUXR | | Address = 8EH | | | | | Reset Value = XXX00XX0B | |
|---------------------|---------------------------------|-------------------------------------------------------------------|---|--------|--------|---|-------------------------|--------|
| Not Bit Addressable | | | | | | | | |
| | - | - | - | WDIDLE | DISRTO | - | - | DISALE |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| - | Reserved for future expansion | | | | | | | |
| DISALE | Disable/Enable ALE | | | | | | | |
| | DISALE | | | | | | | |
| | Operating Mode | | | | | | | |
| | 0 | ALE is emitted at a constant rate of 1/6 the oscillator frequency | | | | | | |
| | 1 | ALE is active only during a MOVX or MOVC instruction | | | | | | |
| DISRTO | Disable/Enable Reset out | | | | | | | |
| | DISRTO | | | | | | | |
| | 0 | Reset pin is driven High after WDT times out | | | | | | |
| | 1 | Reset pin is input only | | | | | | |
| WDIDLE | Disable/Enable WDT in IDLE mode | | | | | | | |
| | WDIDLE | | | | | | | |
| | 0 | WDT continues to count in IDLE mode | | | | | | |
| | 1 | WDT halts counting in IDLE mode | | | | | | |

Dual Data Pointer Registers: To facilitate accessing both internal 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 AUXR1 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 rest under software control and is not affected by reset.

Table 3. AUXR1: Auxiliary Register 1

| | | | | | | | | |
|---------------------|-------------------------------|-----------------------------------|---|---|---|---|------------------------|-----|
| AUXR1 | | | | | | | | |
| Address = A2H | | | | | | | | |
| | | | | | | | Reset Value = XXXXXX0B | |
| Not Bit Addressable | | | | | | | | |
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | DPS |
| | - | - | - | - | - | - | - | 0 |
| - | Reserved for future expansion | | | | | | | |
| DPS | Data Pointer Register Select | | | | | | | |
| | DPS | | | | | | | |
| | 0 | Selects DPTR Registers DP0L, DP0H | | | | | | |
| | 1 | Selects DPTR Registers DP1L, DP1H | | | | | | |

Memory Organization

MCS-51 devices have a separate address space for Program and Data Memory. Up to 64K bytes each of external Program and Data Memory can be addressed.

Program Memory

If the \overline{EA} pin is connected to GND, all program fetches are directed to external memory.

On the AT89S51, if \overline{EA} is connected to V_{CC} , program fetches to addresses 0000H through FFFH are directed to internal memory and fetches to addresses 1000H through FFFFH are directed to external memory.

Memory

The AT89S51 implements 128 bytes of on-chip RAM. The 128 bytes are accessible via direct and indirect addressing modes. Stack operations are examples of indirect addressing, so the 128 bytes of data RAM are available as stack space.

Watchdog Timer (WDT) Enabled with Reset-out)

The WDT is intended as a recovery method in situations where the CPU may be subjected to software upsets. The WDT consists of a 14-bit counter and the Watchdog Timer Reset (WDTRST) SFR. The WDT is defaulted to disable from exiting reset. To enable the WDT, a user must write 01EH and 0E1H in sequence to the WDTRST register (SFR location 0A6H). When the WDT is enabled, it will increment every machine cycle while the oscillator is running. The WDT timeout period is dependent on the external clock frequency. There is no way to disable the WDT except through reset (either hardware reset or WDT overflow reset). When WDT overflows, it will drive an output RESET HIGH pulse at the RST pin.

Configuring the WDT

To enable the WDT, a user must write 01EH and 0E1H in sequence to the WDTRST register (SFR location 0A6H). When the WDT is enabled, the user needs to service it by writing 01EH and 0E1H to WDTRST to avoid a WDT overflow. The 14-bit counter overflows when it reaches 16383 (3FFFH), and this will reset the device. When the WDT is enabled, it will increment every machine cycle while the oscillator is running. This means the user must reset the WDT at least every 16383 machine cycles. To reset the WDT the user must write 01EH and 0E1H to WDTRST. WDTRST is a write-only register. The WDT counter cannot be read or written. When WDT overflows, it will generate an output RESET pulse at the RST pin. The RESET pulse duration is $98 \times TOSC$, where $TOSC = 1/FOSC$. To make the best use of the WDT, it

AT89S51

should be serviced in those sections of code that will periodically be executed within the time required to prevent a WDT reset.

WDT During Power-down and Idle

In Power-down mode the oscillator stops, which means the WDT also stops. While in Power-down mode, the user does not need to service the WDT. There are two methods of exiting Power-down mode: by a hardware reset or via a level-activated external interrupt, which is enabled prior to entering Power-down mode. When Power-down is exited with hardware reset, servicing the WDT should occur as it normally does whenever the AT89S51 is reset. Exiting Power-down with an interrupt is significantly different. The interrupt is held low long enough for the oscillator to stabilize. When the interrupt is brought high, the interrupt is serviced. To prevent the WDT from resetting the device while the interrupt pin is held low, the WDT is not started until the interrupt is pulled high. It is suggested that the WDT be reset during the interrupt service for the interrupt used to exit Power-down mode.

To ensure that the WDT does not overflow within a few states of exiting Power-down, it is best to reset the WDT just before entering Power-down mode.

Before going into the IDLE mode, the WDIDLE bit in SFR AUXR is used to determine whether the WDT continues to count if enabled. The WDT keeps counting during IDLE (WDIDLE bit = 0) as the default state. To prevent the WDT from resetting the AT89S51 while in IDLE mode, the user should always set up a timer that will periodically exit IDLE, service the WDT, and reenter IDLE mode.

With WDIDLE bit enabled, the WDT will stop to count in IDLE mode and resumes the count upon exit from IDLE.

UART

The UART in the AT89S51 operates the same way as the UART in the AT89C51. For further information on the UART operation, refer to the ATMEL Web site (<http://www.atmel.com>). From the home page, select 'Products', then '8051-Architecture Flash Microcontroller', then 'Product Overview'.

Timer 0 and 1

Timer 0 and Timer 1 in the AT89S51 operate the same way as Timer 0 and Timer 1 in the AT89C51. For further information on the timers' operation, refer to the ATMEL Web site (<http://www.atmel.com>). From the home page, select 'Products', then '8051-Architecture Flash Microcontroller', then 'Product Overview'.

Interrupts

The AT89S51 has a total of five interrupt vectors: two external interrupts ($\overline{INT0}$ and $\overline{INT1}$), two timer interrupts (Timers 0 and 1), and the serial port interrupt. These interrupts are all shown in Figure 1.

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

Note that Table 4 shows that bit position IE.6 is unimplemented. In the AT89S51, bit position IE.5 is also unimplemented. User software should not write 1s to these bit positions, since they may be used in future AT89 products.

The Timer 0 and Timer 1 flags, TF0 and TF1, are set at S5P2 of the cycle in which the timers overflow. The values are then polled by the circuitry in the next cycle.



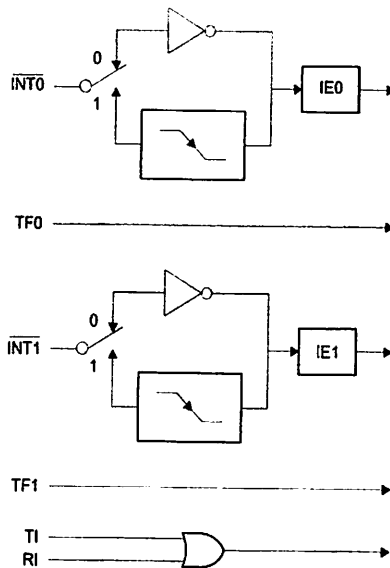
Table 4. Interrupt Enable (IE) Register

| (MSB) | | | | (LSB) | | | |
|----------------------------------------|---|---|----|-------|-----|-----|-----|
| EA | - | - | 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 |
| - | IE.5 | Reserved |
| ES | IE.4 | Serial Port 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 reserved bits, because they may be used in future AT89 products.

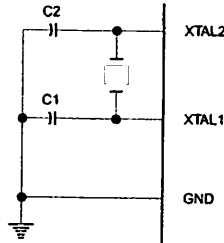
Figure 1. Interrupt Sources



Oscillator Characteristics

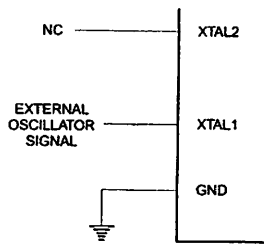
XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier that can be configured for use as an on-chip oscillator, as shown in Figure 2. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven, as shown in Figure 3. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed.

Figure 2. Oscillator Connections



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

Figure 3. External Clock Drive Configuration



Mode

In idle mode, the CPU puts itself to sleep while all the on-chip peripherals remain active. The mode is invoked by software. The content of the on-chip RAM and all the special function registers remain unchanged during this mode. The idle mode can be terminated by any enabled interrupt or by a hardware reset.

Note that when idle mode is terminated by a hardware reset, 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.

Power-down Mode

In the Power-down mode, the oscillator is stopped, and the instruction that invokes Power-down is the last instruction executed. The on-chip RAM and Special Function Registers retain their values until the Power-down mode is terminated. Exit from Power-down mode can be initiated either by a hardware reset or by activation of an enabled external interrupt into $\overline{INT0}$ or $\overline{INT1}$. Reset redefines the SFRs but does not change the on-chip RAM. The reset should not be activated before V_{CC} is restored to its normal operating level and must be held active long enough to allow the oscillator to restart and stabilize.





Table 5. Status of External Pins During Idle and Power-down Modes

| Mode | Program Memory | ALE | PSEN | PORT0 | PORT1 | PORT2 | PORT3 |
|------------|----------------|-----|------|-------|-------|---------|-------|
| Idle | Internal | 1 | 1 | Data | Data | Data | Data |
| Idle | External | 1 | 1 | Float | Data | Address | Data |
| Power-down | Internal | 0 | 0 | Data | Data | Data | Data |
| Power-down | External | 0 | 0 | Float | Data | Data | Data |

Program Memory Lock

The AT89S51 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.

Table 6. Lock Bit Protection Modes

| Program Lock Bits | | | | Protection Type |
|-------------------|-----|-----|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | LB1 | LB2 | LB3 | |
| 1 | U | U | U | No program lock features |
| 2 | P | U | U | MOV _C 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 is disabled |
| 3 | P | P | U | Same as mode 2, but verify is also disabled |
| 4 | P | P | P | Same as mode 3, but external execution is also disabled |

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.

Programming Flash – Parallel Mode

The AT89S51 is shipped with the on-chip Flash memory array ready to be programmed. The programming interface needs a high-voltage (12-volt) program enable signal and is compatible with conventional third-party Flash or EPROM programmers.

The AT89S51 code memory array is programmed byte-by-byte.

Programming Algorithm: Before programming the AT89S51, the address, data, and control signals should be set up according to the Flash programming mode table and Figures 13 and 14. To program the AT89S51, take the following steps:

1. Input the desired memory location on the address lines.
2. Input the appropriate data byte on the data lines.
3. Activate the correct combination of control signals.
4. Raise \overline{EA}/V_{PP} to 12V.
5. Pulse ALE/\overline{PROG} once to program a byte in the Flash array or the lock bits. The byte-write cycle is self-timed and typically takes no more than 50 μ s. Repeat steps 1 through 5, changing the address and data for the entire array or until the end of the object file is reached.

Data Polling: The AT89S51 features \overline{Data} Polling to indicate the end of a byte write cycle. During a write cycle, an attempted read of the last byte written will result in the complement of the written data on P0.7. Once the write cycle has been completed, true data is valid on all outputs, and the next cycle may begin. \overline{Data} Polling may begin any time after a write cycle has been initiated.

AT89S51

Ready/Busy: The progress of byte programming can also be monitored by the RDY/ $\overline{\text{BSY}}$ output signal. P3.0 is pulled low after ALE goes high during programming to indicate $\overline{\text{BUSY}}$. P3.0 is pulled high again when programming is done to indicate $\overline{\text{READY}}$.

Program Verify: If lock bits LB1 and LB2 have not been programmed, the programmed code data can be read back via the address and data lines for verification. The status of the individual lock bits can be verified directly by reading them back.

Reading the Signature Bytes: The signature bytes are read by the same procedure as a normal verification of locations 000H, 100H, and 200H, except that P3.6 and P3.7 must be pulled to a logic low. The values returned are as follows.

(000H) = 1EH indicates manufactured by Atmel
 (100H) = 51H indicates 89S51
 (200H) = 06H

Chip Erase: In the parallel programming mode, a chip erase operation is initiated by using the proper combination of control signals and by pulsing ALE/ $\overline{\text{PROG}}$ low for a duration of 200 ns - 500 ns.

In the serial programming mode, a chip erase operation is initiated by issuing the Chip Erase instruction. In this mode, chip erase is self-timed and takes about 500 ms.

During chip erase, a serial read from any address location will return 00H at the data output.

Programming Flash – Serial Mode

The Code memory array can be programmed using the serial ISP interface while RST is pulled to V_{CC} . The serial interface consists of pins SCK, MOSI (input) and MISO (output). After RST is set high, the Programming Enable instruction needs to be executed first before other operations can be executed. Before a reprogramming sequence can occur, a Chip Erase operation is required.

The Chip Erase operation turns the content of every memory location in the Code array into FFH.

Either an external system clock can be 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 1/16 of the crystal frequency. With a 33 MHz oscillator clock, the maximum SCK frequency is 2 MHz.

Serial Programming Algorithm

To program and verify the AT89S51 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 33 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 16.
3. The Code array is programmed one byte at a time in either the Byte or Page mode. The write cycle is self-timed and typically takes less than 0.5 ms at 5V.
4. Any memory location can be verified by using the Read instruction that 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 device 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.

Data Polling: The Data Polling feature is also available in the serial mode. In this mode, during a write cycle an attempted read of the last byte written will result in the complement of the MSB of the serial output byte on MISO.

The Instruction Set for Serial Programming follows a 4-byte protocol and is shown in Table 8 on page 18.

al
ramming
uction Set

ramming
rface –
lled Mode

Every code byte in the Flash array can be programmed by using the appropriate combination of control signals. The write operation cycle is self-timed and once initiated, will automatically time itself to completion.

All major programming vendors offer worldwide support for the Atmel microcontroller series. Please contact your local programming vendor for the appropriate software revision.

7. Flash Programming Modes

| | V _{CC} | RST | PSEN | ALE/ PROG | EA/ V _{PP} | P2.6 | P2.7 | P3.3 | P3.6 | P3.7 | P0.7-0 Data | P2.3-0 | P1.7-0 |
|------------|-----------------|-----|------|--------------|------------------------|------|------|------|------|------|------------------------|---------|--------|
| | | | | | | | | | | | | Address | |
| Code Data | 5V | H | L | (2) | 12V | L | H | H | H | H | D _{IN} | A11-8 | A7-0 |
| Code Data | 5V | H | L | H | H | L | L | L | H | H | D _{OUT} | A11-8 | A7-0 |
| Lock Bit 1 | 5V | H | L | (3) | 12V | H | H | H | H | H | X | X | X |
| Lock Bit 2 | 5V | H | L | (3) | 12V | H | H | H | L | L | X | X | X |
| Lock Bit 3 | 5V | H | L | (3) | 12V | H | L | H | H | L | X | X | X |
| Lock Bits | 5V | H | L | H | H | H | H | L | H | L | P0.2, P0.3, P0.4 | X | X |
| Erase | 5V | H | L | (1) | 12V | H | L | H | L | L | X | X | X |
| Atmel ID | 5V | H | L | H | H | L | L | L | L | L | 1EH | 0000 | 00H |
| Device ID | 5V | H | L | H | H | L | L | L | L | L | 51H | 0001 | 00H |
| Device ID | 5V | H | L | H | H | L | L | L | L | L | 08H | 0010 | 00H |

1. Each PROG pulse is 200 ns - 500 ns for Chip Erase.
2. Each PROG pulse is 200 ns - 500 ns for Write Code Data.
3. Each PROG pulse is 200 ns - 500 ns for Write Lock Bits.
4. RDY/BSY signal is output on P3.0 during programming.
5. X = don't care.

AT89S51

Figure 4. Programming the Flash Memory (Parallel Mode)

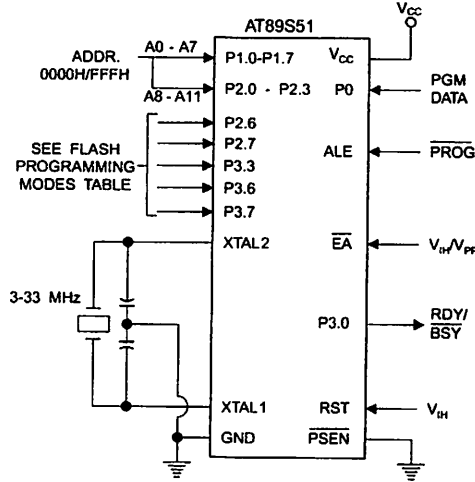
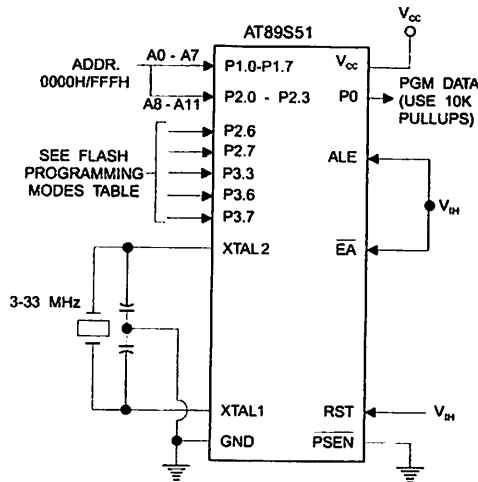


Figure 5. Verifying the Flash Memory (Parallel Mode)



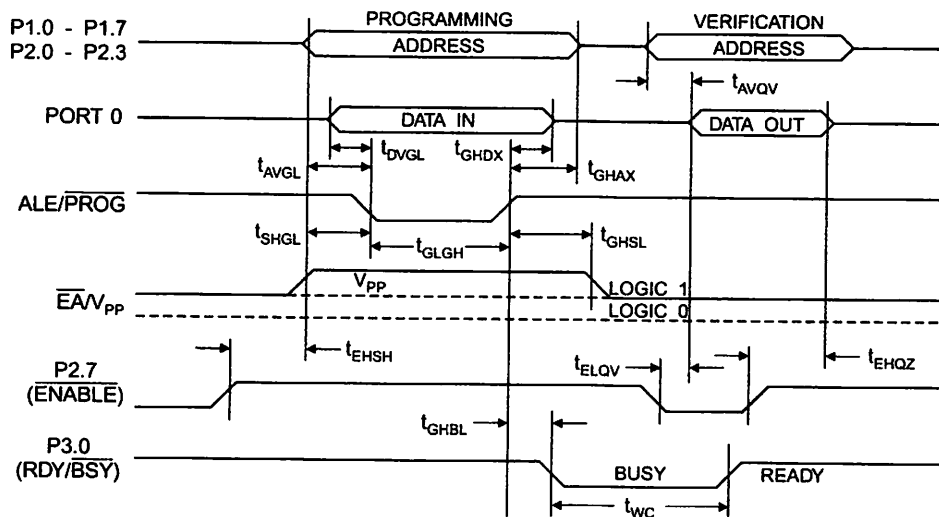


Flash Programming and Verification Characteristics (Parallel Mode)

20°C to 30°C, $V_{CC} = 4.5$ to $5.5V$

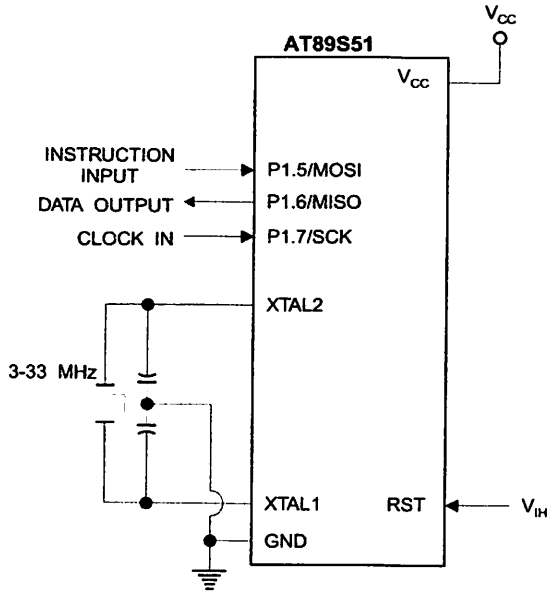
| Symbol | Parameter | Min | Max | Units |
|--------------------|-------------------------------------------------|--------------|--------------|-------|
| | Programming Supply Voltage | 11.5 | 12.5 | V |
| | Programming Supply Current | | 10 | mA |
| | V_{CC} Supply Current | | 30 | mA |
| f _{OCL} | Oscillator Frequency | 3 | 33 | MHz |
| t _{AS} | Address Setup to \overline{PROG} Low | $48t_{CLCL}$ | | |
| t _{AH} | Address Hold After \overline{PROG} | $48t_{CLCL}$ | | |
| t _{DS} | Data Setup to \overline{PROG} Low | $48t_{CLCL}$ | | |
| t _{DH} | Data Hold After \overline{PROG} | $48t_{CLCL}$ | | |
| t _{2.7} | P2.7 (\overline{ENABLE}) High to V_{PP} | $48t_{CLCL}$ | | |
| t _{VPPS} | V_{PP} Setup to \overline{PROG} Low | 10 | | μs |
| t _{VPPH} | V_{PP} Hold After \overline{PROG} | 10 | | μs |
| t _{PROG} | \overline{PROG} Width | 0.2 | 1 | μs |
| t _{ADV} | Address to Data Valid | | $48t_{CLCL}$ | |
| t _{ENL} | \overline{ENABLE} Low to Data Valid | | $48t_{CLCL}$ | |
| t _{DF} | Data Float After \overline{ENABLE} | 0 | $48t_{CLCL}$ | |
| t _{PROGH} | \overline{PROG} High to \overline{BUSY} Low | | 1.0 | μs |
| t _{WC} | Byte Write Cycle Time | | 50 | μs |

Figure 6. Flash Programming and Verification Waveforms – Parallel Mode



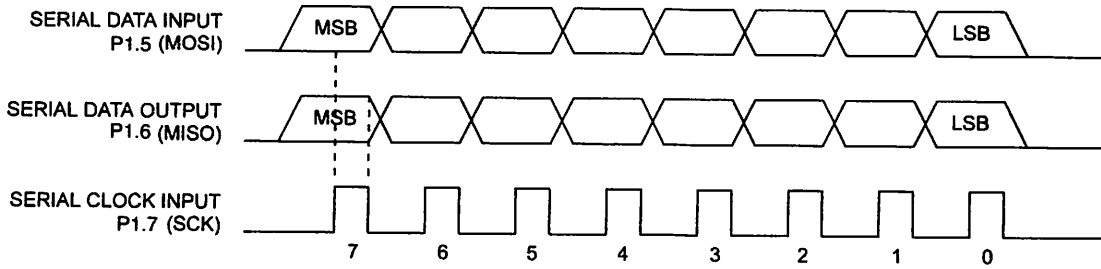
AT89S51

7. Flash Memory Serial Downloading



8. Programming and Verification Waveforms – Serial Mode

8.1. Serial Programming Waveforms





8. Serial Programming Instruction Set

| Instruction | Instruction Format | | | | Operation |
|-------------------------------------|--------------------|-----------------------------|-------------------------|------------------------------------|---------------------------------------------------------------------------------------|
| | Byte 1 | Byte 2 | Byte 3 | Byte 4 | |
| Programming Enable | 1010 1100 | 0101 0011 | xxxx xxxx | xxxx xxxx 0110 1001 (Output) | Enable Serial Programming while RST is high |
| Chip Erase | 1010 1100 | 100x xxxx | xxxx xxxx | xxxx xxxx | Chip Erase Flash memory array |
| Read Program Memory (Byte Mode) | 0010 0000 | xxxx A11 A10 A9 A8 A7 | A7 A6 A5 A4 A3 A2 A1 A0 | D7 D6 D5 D4 D3 D2 D1 D0 | Read data from Program memory in the byte mode |
| Write Program Memory (Byte Mode) | 0100 0000 | xxxx A11 A10 A9 A8 A7 | A7 A6 A5 A4 A3 A2 A1 A0 | D7 D6 D5 D4 D3 D2 D1 D0 | Write data to Program memory in the byte mode |
| Write Lock Bits ⁽²⁾ | 1010 1100 | 1110 00 B1 B2 | xxxx xxxx | xxxx xxxx | Write Lock bits. See Note (2). |
| Read Lock Bits | 0010 0100 | xxxx xxxx | xxxx xxxx | xx xx LB3 LB2 LB1 LB0 | Read back current status of the lock bits (a programmed lock bit reads back as a "1") |
| Read Signature Bytes ⁽¹⁾ | 0010 1000 | xxx A5 A4 A3 A2 A1 | A0 xxx xxxx | Signature Byte | Read Signature Byte |
| Read Program Memory (Page Mode) | 0011 0000 | xxxx A11 A10 A9 A8 A7 | Byte 0 | Byte 1... Byte 255 | Read data from Program memory in the Page Mode (256 bytes) |
| Write Program Memory (Page Mode) | 0101 0000 | xxxx A11 A10 A9 A8 A7 | Byte 0 | Byte 1... Byte 255 | Write data to Program memory in the Page Mode (256 bytes) |

1. The signature bytes are not readable in Lock Bit Modes 3 and 4.

2. B1 = 0, B2 = 0 → Mode 1, no lock protection
 B1 = 0, B2 = 1 → Mode 2, lock bit 1 activated
 B1 = 1, B2 = 0 → Mode 3, lock bit 2 activated
 B1 = 1, B2 = 1 → Mode 4, lock bit 3 activated

Each of the lock bits needs to be activated sequentially before Mode 4 can be executed.

After Reset signal is high, SCK should be low for at least 64 system clocks before it goes high to clock in the enable data bytes. No pulsing of Reset signal is necessary. SCK should be no faster than 1/16 of the system clock at XTAL1.

For Page Read/Write, the data always starts from byte 0 to 255. After the command byte and upper address byte are latched, each byte thereafter is treated as data until all 256 bytes are shifted in/out. Then the next instruction will be ready to be decoded.

Serial Programming Characteristics

Figure 9. Serial Programming Timing

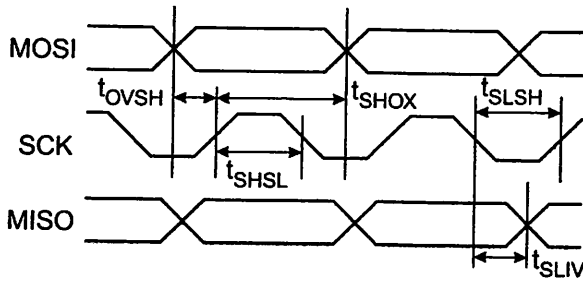


Table 9. Serial Programming Characteristics, $T_A = -40^\circ\text{C}$ to 85°C , $V_{CC} = 4.0 - 5.5\text{V}$ (Unless Otherwise Noted)

| Symbol | Parameter | Min | Typ | Max | Units |
|-------------|-----------------------------------|--------------|-----|---------------------|---------------|
| t_{CLCL} | Oscillator Frequency | 0 | | 33 | MHz |
| T_{CLCL} | Oscillator Period | 30 | | | ns |
| t_{HSL} | SCK Pulse Width High | $8 t_{CLCL}$ | | | ns |
| t_{LSH} | SCK Pulse Width Low | $8 t_{CLCL}$ | | | ns |
| t_{VSH} | MOSI Setup to SCK High | t_{CLCL} | | | ns |
| t_{HOX} | MOSI Hold after SCK High | $2 t_{CLCL}$ | | | ns |
| t_{SLIV} | SCK Low to MISO Valid | 10 | 16 | 32 | ns |
| t_{ERASE} | Chip Erase Instruction Cycle Time | | | 500 | ms |
| t_{WC} | Serial Byte Write Cycle Time | | | $64 t_{CLCL} + 400$ | μs |





Absolute Maximum Ratings*

| | |
|----------------------------------------------|-----------------|
| Operating Temperature..... | -55°C to +125°C |
| Storage Temperature..... | -65°C to +150°C |
| Voltage on Any Pin Respect to Ground..... | -1.0V to +7.0V |
| Maximum Operating Voltage..... | 6.6V |
| Maximum 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 $T_A = -40^\circ\text{C}$ to 85°C and $V_{CC} = 4.0\text{V}$ to 5.5V , unless otherwise noted.

| Model | 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 High Voltage | (Except XTAL1, RST) | $0.2 V_{CC} + 0.9$ | $V_{CC} + 0.5$ | V |
| | Input High Voltage | (XTAL1, RST) | $0.7 V_{CC}$ | $V_{CC} + 0.5$ | V |
| | Output Low Voltage ⁽¹⁾ (Ports 1,2,3) | $I_{OL} = 1.6 \text{ mA}$ | | 0.45 | V |
| | Output Low Voltage ⁽¹⁾ (Port 0, ALE, PSEN) | $I_{OL} = 3.2 \text{ mA}$ | | 0.45 | V |
| | Output High Voltage (Ports 1,2,3, ALE, PSEN) | $I_{OH} = -60 \mu\text{A}, V_{CC} = 5\text{V} \pm 10\%$ | 2.4 | | V |
| | | $I_{OH} = -25 \mu\text{A}$ | $0.75 V_{CC}$ | | V |
| | | $I_{OH} = -10 \mu\text{A}$ | $0.9 V_{CC}$ | | V |
| | Output High Voltage (Port 0 in External Bus Mode) | $I_{OH} = -800 \mu\text{A}, V_{CC} = 5\text{V} \pm 10\%$ | 2.4 | | V |
| | | $I_{OH} = -300 \mu\text{A}$ | $0.75 V_{CC}$ | | V |
| | | $I_{OH} = -80 \mu\text{A}$ | $0.9 V_{CC}$ | | V |
| | Logical 0 Input Current (Ports 1,2,3) | $V_{IN} = 0.45\text{V}$ | | -50 | μA |
| | Logical 1 to 0 Transition Current (Ports 1,2,3) | $V_{IN} = 2\text{V}, V_{CC} = 5\text{V} \pm 10\%$ | | -650 | μA |
| | Input Leakage Current (Port 0, \overline{EA}) | $0.45 < V_{IN} < V_{CC}$ | | ± 10 | μA |
| | Reset Pulldown Resistor | | 50 | 300 | $\text{k}\Omega$ |
| | Pin Capacitance | Test Freq. = 1 MHz, $T_A = 25^\circ\text{C}$ | | 10 | pF |
| | Power Supply Current | Active Mode, 12 MHz | | 25 | mA |
| | | Idle Mode, 12 MHz | | 6.5 | mA |
| | Power-down Mode ⁽²⁾ | $V_{CC} = 5.5\text{V}$ | | 50 | 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.

AT89S51

Characteristics

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

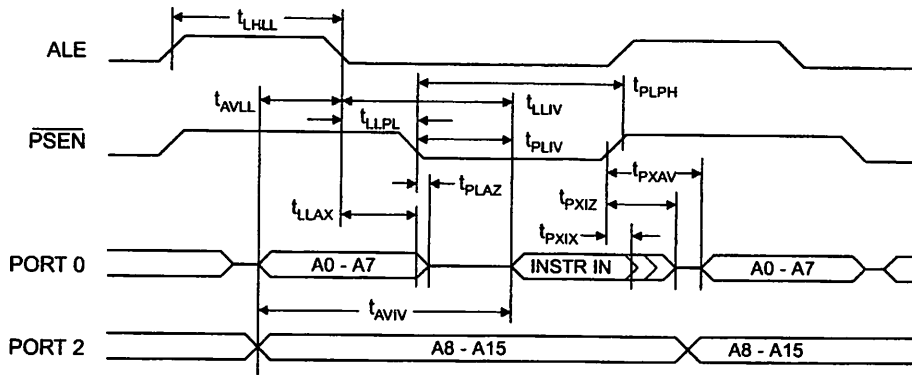
Internal Program and Data Memory Characteristics

| Symbol | Parameter | 12 MHz Oscillator | | Variable Oscillator | | Units |
|------------------|-------------------------------------------------------------------|-------------------|-----|------------------------|------------------------|-------|
| | | Min | Max | Min | Max | |
| f_{Osc} | Oscillator Frequency | | | 0 | 33 | MHz |
| | ALE Pulse Width | 127 | | $2t_{\text{CLCL}}-40$ | | ns |
| | Address Valid to ALE Low | 43 | | $t_{\text{CLCL}}-25$ | | ns |
| | Address Hold After ALE Low | 48 | | $t_{\text{CLCL}}-25$ | | ns |
| | ALE Low to Valid Instruction In | | 233 | | $4t_{\text{CLCL}}-65$ | ns |
| | ALE Low to $\overline{\text{PSEN}}$ Low | 43 | | $t_{\text{CLCL}}-25$ | | ns |
| | $\overline{\text{PSEN}}$ Pulse Width | 205 | | $3t_{\text{CLCL}}-45$ | | ns |
| | $\overline{\text{PSEN}}$ Low to Valid Instruction In | | 145 | | $3t_{\text{CLCL}}-60$ | ns |
| | Input Instruction Hold After $\overline{\text{PSEN}}$ | 0 | | 0 | | ns |
| | Input Instruction Float After $\overline{\text{PSEN}}$ | | 59 | | $t_{\text{CLCL}}-25$ | ns |
| | $\overline{\text{PSEN}}$ to Address Valid | 75 | | $t_{\text{CLCL}}-8$ | | ns |
| | Address to Valid Instruction In | | 312 | | $5t_{\text{CLCL}}-80$ | ns |
| | $\overline{\text{PSEN}}$ Low to Address Float | | 10 | | 10 | ns |
| | $\overline{\text{RD}}$ Pulse Width | 400 | | $6t_{\text{CLCL}}-100$ | | ns |
| | $\overline{\text{WR}}$ Pulse Width | 400 | | $6t_{\text{CLCL}}-100$ | | ns |
| | $\overline{\text{RD}}$ Low to Valid Data In | | 252 | | $5t_{\text{CLCL}}-90$ | ns |
| | Data Hold After $\overline{\text{RD}}$ | 0 | | 0 | | ns |
| | Data Float After $\overline{\text{RD}}$ | | 97 | | $2t_{\text{CLCL}}-28$ | ns |
| | ALE Low to Valid Data In | | 517 | | $8t_{\text{CLCL}}-150$ | ns |
| | Address to Valid Data In | | 585 | | $9t_{\text{CLCL}}-165$ | ns |
| | ALE Low to $\overline{\text{RD}}$ or $\overline{\text{WR}}$ Low | 200 | 300 | $3t_{\text{CLCL}}-50$ | $3t_{\text{CLCL}}+50$ | ns |
| | Address to $\overline{\text{RD}}$ or $\overline{\text{WR}}$ Low | 203 | | $4t_{\text{CLCL}}-75$ | | ns |
| | Data Valid to $\overline{\text{WR}}$ Transition | 23 | | $t_{\text{CLCL}}-30$ | | ns |
| | Data Valid to $\overline{\text{WR}}$ High | 433 | | $7t_{\text{CLCL}}-130$ | | ns |
| | Data Hold After $\overline{\text{WR}}$ | 33 | | $t_{\text{CLCL}}-25$ | | ns |
| | $\overline{\text{RD}}$ Low to Address Float | | 0 | | 0 | ns |
| | $\overline{\text{RD}}$ or $\overline{\text{WR}}$ High to ALE High | 43 | 123 | $t_{\text{CLCL}}-25$ | $t_{\text{CLCL}}+25$ | ns |

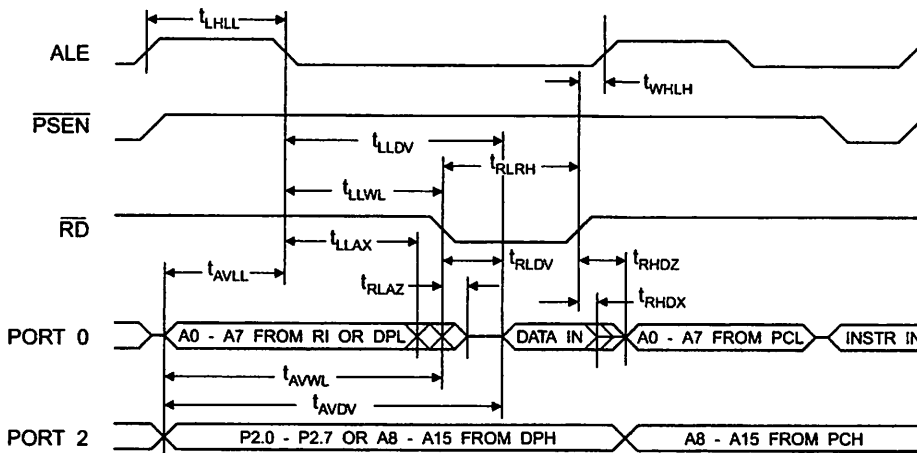




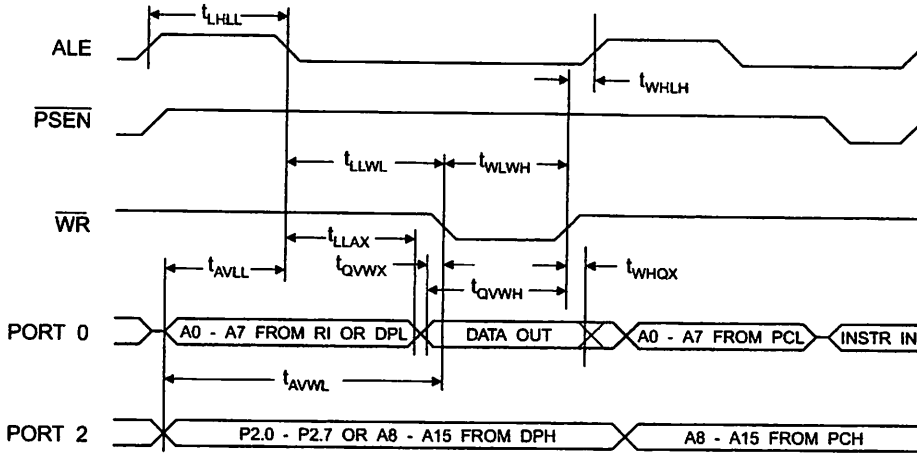
Internal Program Memory Read Cycle



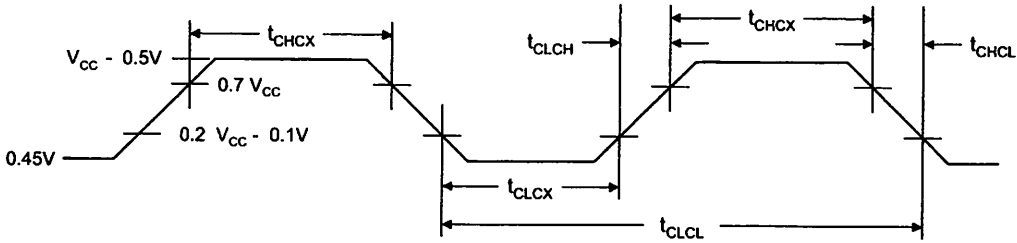
Internal Data Memory Read Cycle



Normal Data Memory Write Cycle



Normal Clock Drive Waveforms



Normal Clock Drive

| Parameter | Min | Max | Units |
|----------------------|-----|-----|-------|
| Oscillator Frequency | 0 | 33 | MHz |
| Clock Period | 30 | | ns |
| High Time | 12 | | ns |
| Low Time | 12 | | ns |
| Rise Time | | 5 | ns |
| Fall Time | | 5 | ns |



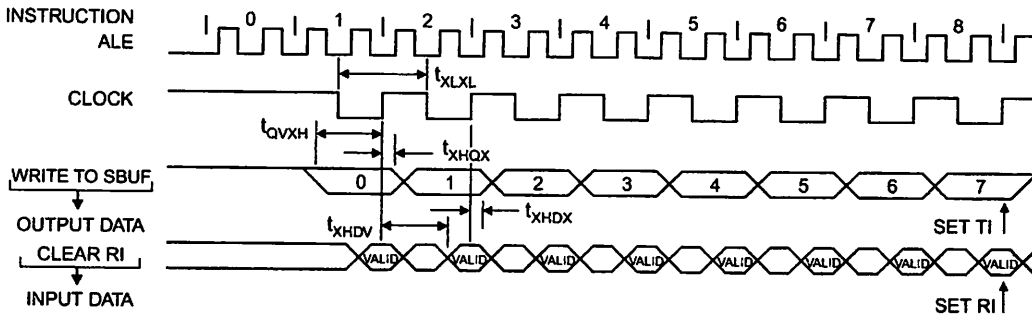


Serial Port Timing: Shift Register Mode Test Conditions

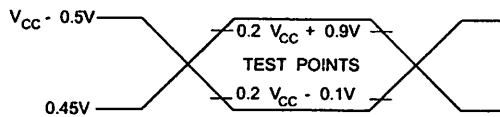
Values in this table are valid for $V_{CC} = 4.0V$ to $5.5V$ and Load Capacitance = 80 pF .

| Symbol | Parameter | 12 MHz Osc | | Variable Oscillator | | Units |
|-----------|------------------------------------------|------------|-----|---------------------|------------------|---------------|
| | | Min | Max | Min | Max | |
| t_{CLK} | Serial Port Clock Cycle Time | 1.0 | | $12t_{CLCL}$ | | μs |
| t_{OH} | Output Data Setup to Clock Rising Edge | 700 | | $10t_{CLCL}-133$ | | ns |
| t_{XH} | Output Data Hold After Clock Rising Edge | 50 | | $2t_{CLCL}-80$ | | ns |
| t_{IH} | Input Data Hold After Clock Rising Edge | 0 | | 0 | | ns |
| t_{IV} | Clock Rising Edge to Input Data Valid | | 700 | | $10t_{CLCL}-133$ | ns |

Shift Register Mode Timing Waveforms

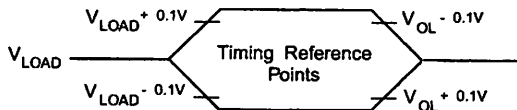


Testing Input/Output Waveforms⁽¹⁾



- 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.

Timing Waveforms⁽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.

Ordering Information

| Speed (MHz) | Power Supply | Ordering Code | Package | Operation Range |
|-------------|--------------|---------------|---------|---------------------------------|
| 24 | 4.0V to 5.5V | AT89S51-24AC | 44A | Commercial (0° C to 70° C) |
| | | AT89S51-24JC | 44J | |
| | | AT89S51-24PC | 40P6 | |
| | | AT89S51-24AI | 44A | Industrial (-40° C to 85° C) |
| | | AT89S51-24JI | 44J | |
| | | AT89S51-24PI | 40P6 | |
| 33 | 4.5V to 5.5V | AT89S51-33AC | 44A | Commercial (0° C to 70° C) |
| | | AT89S51-33JC | 44J | |
| | | AT89S51-33PC | 40P6 | |

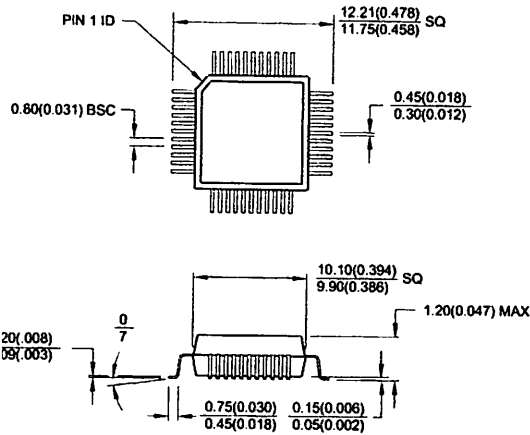
 = Preliminary Availability

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



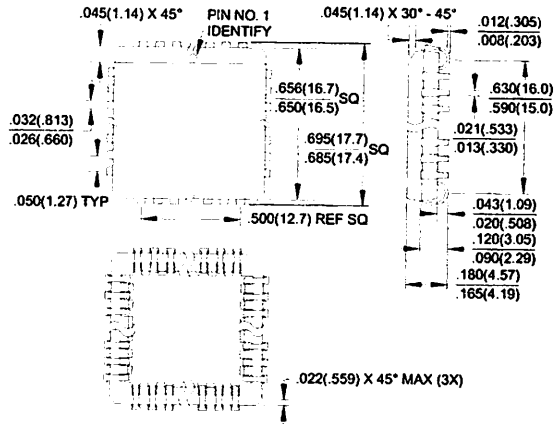
Packaging Information

44A, 44-lead, Thin (1.0 mm) Plastic Gull Wing Quad Flat Package (TQFP)
 Dimensions in Millimeters and (Inches)*

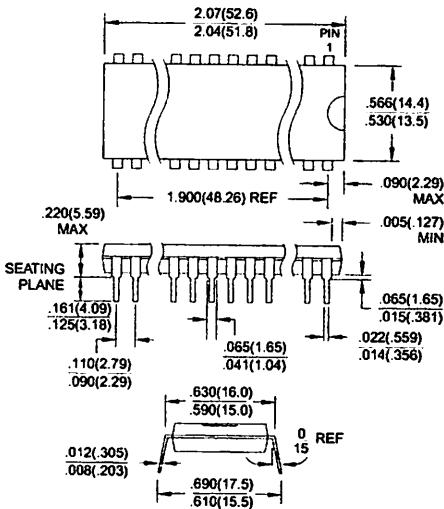


Controlling dimension: millimeters

44J, 44-lead, Plastic J-leaded Chip Carrier (PLCC)
 Dimensions in Inches and (Millimeters)



PDIP6, 40-pin, 0.600" Wide, Plastic Dual In-line Package (PDIP)
 Dimensions in Inches and (Millimeters)
 DEC STANDARD MS-011 AC





Atmel Headquarters

Corporate Headquarters
25 Orchard Parkway
Folsom, CA 95131
TEL (408) 441-0311
FAX (408) 487-2600

Atmel Sarl
Route des Arsenaux 41
Case Postale 80
CH-1705 Fribourg
Suisse
TEL (41) 26-426-5555
FAX (41) 26-426-5500

Atmel Asia, Ltd.
Room 1219
Fincham Golden Plaza
Mody Road Tsimshatsui
Kowloon
Hong Kong
TEL (852) 2721-9778
FAX (852) 2722-1369

Atmel Japan K.K.
1-1-1, Tonetsu Shinkawa Bldg.
4-8 Shinkawa
Chuo-ku, Tokyo 104-0033
Japan
TEL (81) 3-3523-3551
FAX (81) 3-3523-7581

Atmel Product Operations

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

Atmel Grenoble
Avenue de Rochepleine
BP 123
38521 Saint-Egreve Cedex, France
TEL (33) 4-7658-3000
FAX (33) 4-7658-3480

Atmel Heilbronn
Theresienstrasse 2
POB 3535
D-74025 Heilbronn, Germany
TEL (49) 71 31 67 25 94
FAX (49) 71 31 67 24 23

Atmel Nantes
La Chantreterie
BP 70602
44306 Nantes Cedex 3, France
TEL (33) 0 2 40 18 18 18
FAX (33) 0 2 40 18 19 60

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

Atmel Smart Card ICs
Scottish Enterprise Technology Park
East Kilbride, Scotland G75 0QR
TEL (44) 1355-357-000
FAX (44) 1355-242-743

e-mail
literature@atmel.com

Web Site
<http://www.atmel.com>

Atmel Corporation 2001.

Atmel Corporation makes no warranty for the use of its products, other than those expressly contained in the Company's standard warranty as detailed in Atmel's Terms and Conditions located on the Company's web site. The Company assumes no responsibility for any errors that may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein. No licenses to patents or other intellectual property of Atmel are granted by Atmel in connection with the sale of Atmel products, expressly or by implication. Atmel's products are not authorized for use as critical components in life support devices or systems.

Atmel is the registered trademark of Atmel.

Atmel is the registered trademark of Intel Corporation. Terms and product names in this document may be trademarks of others.



Printed on recycled paper.

2487A-10/01/xM

MAXIM

±15kV ESD-Protected, +5V RS-232 Transceivers

General Description

The MAX202E-MAX213E, MAX232E/MAX241E line drivers/receivers are designed for RS-232 and V.28 communications in harsh environments. Each transmitter output and receiver input is protected against ±15kV electrostatic discharge (ESD) shocks, without latching. The various combinations of features are outlined in the *Selection Guide*. The drivers and receivers for all ten devices meet all EIA/TIA-232E and CCITT V.28 specifications at data rates up to 120kbps, when loaded in accordance with the EIA/TIA-232E specification.

The MAX211E/MAX213E/MAX241E are available in 28-pin SO packages, as well as a 28-pin SSOP that uses 60% less board space. The MAX202E/MAX232E come in 16-pin narrow SO, wide SO, and DIP packages. The MAX203E comes in a 20-pin DIP/SO package, and needs no external charge-pump capacitors. The MAX205E comes in a 24-pin wide DIP package, and also eliminates external charge-pump capacitors. The MAX206E/MAX207E/MAX208E come in 24-pin SO, SSOP, and narrow DIP packages. The MAX232E/MAX241E operate with four 1µF capacitors, while the MAX202E/MAX206E/MAX207E/MAX208E/MAX211E/MAX213E operate with four 0.1µF capacitors, further reducing cost and board space.

Applications

Notebook, Subnotebook, and Palmtop Computers
Battery-Powered Equipment
Hand-Held Equipment

Ordering Information appears at end of data sheet.

| PART | No. of RS-232 DRIVERS | No. of RS-232 RECEIVERS | RECEIVERS ACTIVE IN SHUTDOWN | No. of EXTERNAL CAPACITORS | LOW-POWER SHUTDOWN | TTL THREE-STATE |
|---------|-----------------------|-------------------------|------------------------------|----------------------------|--------------------|-----------------|
| MAX202E | 2 | 2 | 0 | 4 (0.1µF) | No | No |
| MAX203E | 2 | 2 | 0 | None | No | No |
| MAX205E | 5 | 5 | 0 | None | Yes | Yes |
| MAX206E | 4 | 3 | 0 | 4 (0.1µF) | Yes | Yes |
| MAX207E | 5 | 3 | 0 | 4 (0.1µF) | No | No |
| MAX208E | 4 | 4 | 0 | 4 (0.1µF) | No | No |
| MAX211E | 4 | 5 | 0 | 4 (0.1µF) | Yes | Yes |
| MAX213E | 4 | 5 | 2 | 4 (0.1µF) | Yes | Yes |
| MAX232E | 2 | 2 | 0 | 4 (1µF) | No | No |
| MAX241E | 4 | 5 | 0 | 4 (1µF) | Yes | Yes |

LapLink is a registered trademark of Traveling Software, Inc.

MAXIM

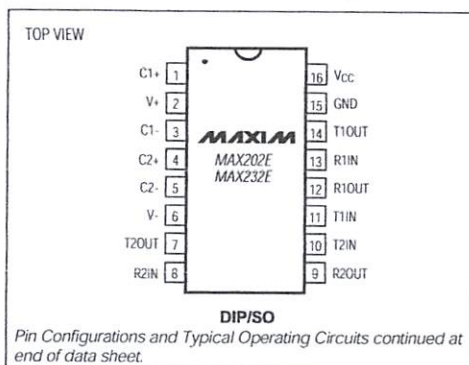
Maxim Integrated Products 1

For free samples & the latest literature: <http://www.maxim-ic.com>, or phone 1-800-998-8800

Features

- ◆ ESD Protection for RS-232 I/O Pins:
 - ±15kV—Human Body Model
 - ±8kV—IEC1000-4-2, Contact Discharge
 - ±15kV—IEC1000-4-2, Air-Gap Discharge
- ◆ Latchup Free (unlike bipolar equivalents)
- ◆ Guaranteed 120kbps Data Rate—LapLink™ Compatible
- ◆ Guaranteed 3V/µs Min Slew Rate
- ◆ Operate from a Single +5V Power Supply

Pin Configurations



MAX202E-MAX213E, MAX232E/MAX241E

±15kV ESD-Protected, +5V RS-232 Transceivers

ABSOLUTE MAXIMUM RATINGS

| | | | | |
|---------------------------------------------------------|----------------------------------------------------|-------------------------------------------------|--------------|-----------------|
| V _{CC} | -0.3V to +6V | 20-Pin SO (derate 10.00mW/°C above +70°C)..... | 800mW | |
| V ₊ | (V _{CC} - 0.3V) to +14V | 24-Pin Narrow Plastic DIP | | |
| V ₋ | -14V to +0.3V | (derate 13.33mW/°C above +70°C)..... | 1.07W | |
| Input Voltages | | | | |
| T _{IN} | -0.3V to (V ₊ + 0.3V) | 24-Pin Wide Plastic DIP | | |
| R _{IN} | ±30V | (derate 14.29mW/°C above +70°C)..... | 1.14W | |
| Output Voltages | | | | |
| T _{OUT} | (V ₋ - 0.3V) to (V ₊ + 0.3V) | 24-Pin SO (derate 11.76mW/°C above +70°C)..... | 941mW | |
| R _{OUT} | -0.3V to (V _{CC} + 0.3V) | 24-Pin SSOP (derate 8.00mW/°C above +70°C)..... | 640mW | |
| Short-Circuit Duration, T _{OUT} | | | | |
| Continuous Power Dissipation (T _A = +70°C) | | | | |
| 16-Pin Plastic DIP (derate 10.53mW/°C above +70°C)..... | 842mW | 28-Pin SO (derate 12.50mW/°C above +70°C)..... | 1W | |
| 16-Pin Narrow SO (derate 8.70mW/°C above +70°C)..... | 696mW | 28-Pin SSOP (derate 9.52mW/°C above +70°C)..... | 762mW | |
| 16-Pin Wide SO (derate 9.52mW/°C above +70°C)..... | 762mW | Operating Temperature Ranges | | |
| 20-Pin Plastic DIP (derate 11.11mW/°C above +70°C)..... | 889mW | MAX2_EC_..... | 0°C to +70°C | |
| | | | | |
| MAX2_EE_..... | | | | -40°C to +85°C |
| Storage Temperature Range..... | | | | -65°C to +165°C |
| Lead Temperature (soldering, 10sec)..... | | | | +300°C |

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

ELECTRICAL CHARACTERISTICS

(V_{CC} = +5V ±10% for MAX202E/206E/208E/211E/213E/232E/241E; V_{CC} = +5V ±5% for MAX203E/205E/207E; C1-C4 = 0.1µF for MAX202E/206E/207E/208E/211E/213E; C1-C4 = 1µF for MAX232E/241E; T_A = T_{MIN} to T_{MAX}; unless otherwise noted. Typical values are at T_A = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------|-----|-------|
| DC CHARACTERISTICS | | | | | | |
| V _{CC} Supply Current | I _{CC} | No load, T _A = +25°C | MAX202E/203E | 8 | 15 | mA |
| | | | MAX205E-208E | 11 | 20 | |
| | | | MAX211E/213E | 14 | 20 | |
| | | | MAX232E | 5 | 10 | |
| | | | MAX241E | 7 | 15 | |
| Shutdown Supply Current | | T _A = +25°C, Figure 1 | MAX205E/206E | 1 | 10 | µA |
| | | | MAX211E/241E | 1 | 10 | |
| | | | MAX213E | 15 | 50 | |
| LOGIC | | | | | | |
| Input Pull-Up Current | | T _{IN} = 0V (MAX205E-208E/211E/213E/241E) | 15 | 200 | | µA |
| Input Leakage Current | | T _{IN} = 0V to V _{CC} (MAX202E/203E/232E) | | ±10 | | µA |
| Input Threshold Low | V _{IL} | T _{IN} : EN, $\overline{\text{SHDN}}$ (MAX213E) or EN, SHDN (MAX205E-208E/211E/241E) | | | 0.8 | V |
| Input Threshold High | V _{IH} | T _{IN} | 2.0 | | | V |
| | | EN, $\overline{\text{SHDN}}$ (MAX213E) or EN, SHDN (MAX205E-208E/211E/241E) | 2.4 | | | |
| Output Voltage Low | V _{OL} | R _{OUT} ; I _{OUT} = 3.2mA (MAX202E/203E/232E) or I _{OUT} = 1.6mA (MAX205E/208E/211E/213E/241E) | | | 0.4 | V |
| Output Voltage High | V _{OH} | R _{OUT} ; I _{OUT} = -1.0mA | 3.5 | V _{CC} - 0.4 | | V |
| Output Leakage Current | | $\overline{\text{EN}}$ = V _{CC} , EN = 0V, 0V ≤ R _{OUT} ≤ V _{CC} . MAX205E-208E/211E/213E/241E outputs disabled | ±0.05 | ±10 | | µA |

±15kV ESD-Protected, +5V RS-232 Transceivers

MAX202E-MAX213E, MAX232E/MAX241E

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +5V ±10% for MAX202E/206E/208E/211E/213E/232E/241E; V_{CC} = +5V ±5% for MAX203E/205E/207E; C₁-C₄ = 0.1µF for MAX202E/206E/207E/208E/211E/213E; C₁-C₄ = 1µF for MAX232E/241E; T_A = T_{MIN} to T_{MAX}; unless otherwise noted. Typical values are at T_A = +25°C.)

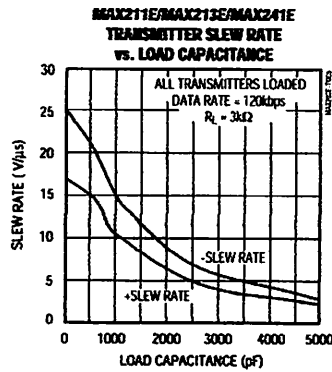
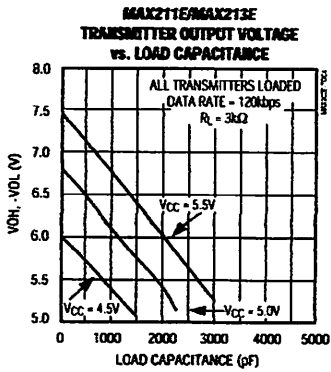
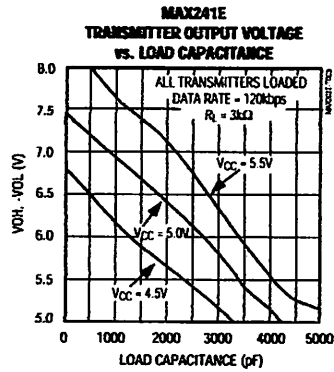
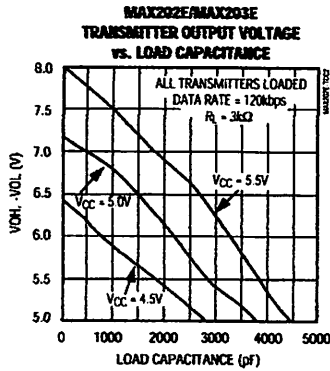
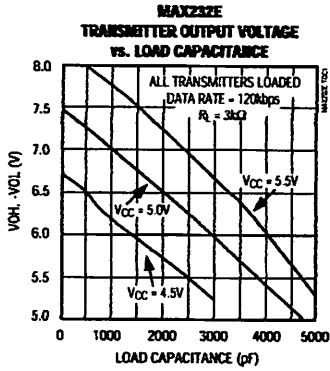
| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|--------------------------------------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|-----|-----|-------|---|
| EIA/TIA-232E RECEIVER INPUTS | | | | | | | |
| Input Voltage Range | | | -30 | | 30 | V | |
| Input Threshold Low | | T _A = +25°C, V _{CC} = 5V | All parts, normal operation | 0.8 | 1.2 | V | |
| | | | MAX213E, SHDN = 0V, EN = V _{CC} | 0.6 | 1.5 | | |
| Input Threshold High | | T _A = +25°C, V _{CC} = 5V | All parts, normal operation | | 1.7 | 2.4 | V |
| | | | MAX213E (R4, R5), SHDN = 0V, EN = V _{CC} | | 1.5 | 2.4 | |
| Input Hysteresis | | V _{CC} = 5V, no hysteresis in shutdown | 0.2 | 0.5 | 1.0 | V | |
| Input Resistance | | T _A = +25°C, V _{CC} = 5V | 3 | 5 | 7 | kΩ | |
| EIA/TIA-232E TRANSMITTER OUTPUTS | | | | | | | |
| Output Voltage Swing | | All drivers loaded with 3kΩ to ground (Note 1) | ±5 | ±9 | | V | |
| Output Resistance | | V _{CC} = V ₊ = V ₋ = 0V, V _{OUT} = ±2V | 300 | | | Ω | |
| Output Short-Circuit Current | | | | ±10 | ±60 | mA | |
| TIMING CHARACTERISTICS | | | | | | | |
| Maximum Data Rate | | R _L = 3kΩ to 7kΩ, C _L = 50pF to 1000pF, one transmitter switching | 120 | | | kbps | |
| Receiver Propagation Delay | t _{PLHR} , t _{PHLR} | C _L = 150pF | All parts, normal operation | 0.5 | 10 | µs | |
| | | | MAX213E (R4, R5), SHDN = 0V, EN = V _{CC} | 4 | 40 | | |
| Receiver Output Enable Time | | MAX205E/206E/211E/213E/241E normal operation, Figure 2 | | 600 | | ns | |
| Receiver Output Disable Time | | MAX205E/206E/211E/213E/241E normal operation, Figure 2 | | 200 | | ns | |
| Transmitter Propagation Delay | t _{PLHT} , t _{PHLT} | R _L = 3kΩ, C _L = 2500pF, all transmitters loaded | | 2 | | µs | |
| Transition-Region Slew Rate | | T _A = +25°C, V _{CC} = 5V, R _L = 3kΩ to 7kΩ, C _L = 50pF to 1000pF, measured from -3V to +3V or +3V to -3V, Figure 3 | 3 | 6 | 30 | V/µs | |
| ESD PERFORMANCE: TRANSMITTER OUTPUTS, RECEIVER INPUTS | | | | | | | |
| ESD-Protection Voltage | | Human Body Model | | ±15 | | kV | |
| | | IEC1000-4-2, Contact Discharge | | ±8 | | | |
| | | IEC1000-4-2, Air-Gap Discharge | | ±15 | | | |

Note 1: MAX211EE_ tested with V_{CC} = +5V ±5%.

±15kV ESD-Protected, +5V RS-232 Transceivers

Typical Operating Characteristics

(Typical Operating Circuits, $V_{CC} = +5V$, $T_A = +25^\circ C$, unless otherwise noted.)

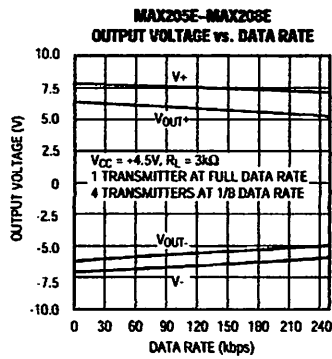
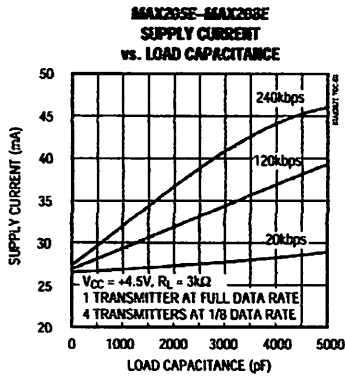
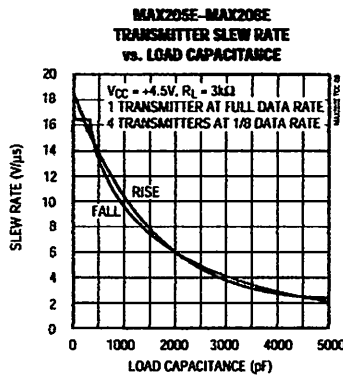
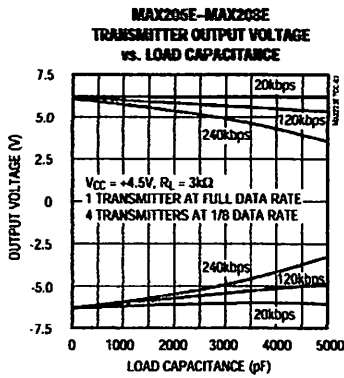
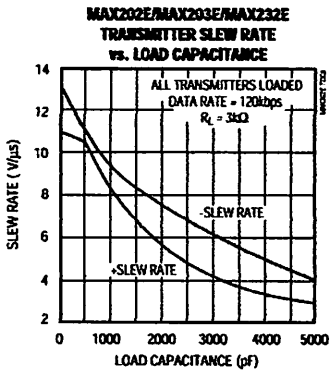


±15kV ESD-Protected, +5V RS-232 Transceivers

Typical Operating Characteristics (continued)

(Typical Operating Circuits, $V_{CC} = +5V$, $T_A = +25^\circ C$, unless otherwise noted.)

MAX202E-MAX213E, MAX232EMAX241E



±15kV ESD-Protected, +5V RS-232 Transceivers

Pin Descriptions

MAX202E/MAX232E

| PIN | | NAME | FUNCTION |
|--------|--------------|-----------------|--------------------------------------------------------|
| DIP/SO | LCC | | |
| 1, 3 | 2, 4 | C1+, C1- | Terminals for positive charge-pump capacitor |
| 2 | 3 | V+ | +2V _{CC} voltage generated by the charge pump |
| 4, 5 | 5, 7 | C2+, C2- | Terminals for negative charge-pump capacitor |
| 6 | 8 | V- | -2V _{CC} voltage generated by the charge pump |
| 7, 14 | 9, 18 | T_OUT | RS-232 Driver Outputs |
| 8, 13 | 10, 17 | R_IN | RS-232 Receiver Outputs |
| 9, 12 | 12, 15 | R_OUT | RS-232 Receiver Outputs |
| 10, 11 | 13, 14 | T_IN | RS-232 Driver Inputs |
| 15 | 19 | GND | Ground |
| 16 | 20 | V _{CC} | +4.5V to +5.5V Supply-Voltage Input |
| — | 1, 6, 11, 16 | N.C. | No Connect—not internally connected. |

MAX203E

| PIN | | NAME | FUNCTION |
|--------|--------|-----------------|--------------------------------------------------------------------------------|
| DIP | SO | | |
| 1, 2 | 1, 2 | T_IN | RS-232 Driver Inputs |
| 3, 20 | 3, 20 | R_OUT | RS-232 Receiver Outputs |
| 4, 19 | 4, 19 | R_IN | RS-232 Receiver Inputs |
| 5, 18 | 5, 18 | T_OUT | RS-232 Transmitter Outputs |
| 6, 9 | 6, 9 | GND | Ground |
| 7 | 7 | V _{CC} | +4.5V to +5.5V Supply-Voltage Input |
| 8 | 13 | C1+ | Make no connection to this pin. |
| 10, 16 | 11, 16 | C2- | Connect pins together. |
| 12, 17 | 10, 17 | V- | -2V _{CC} voltage generated by the charge pump. Connect pins together. |
| 13 | 14 | C1- | Make no connection to this pin. |
| 14 | 8 | V+ | +2V _{CC} voltage generated by the charge pump |
| 11, 15 | 12, 15 | C2+ | Connect pins together. |

MAX205E

| PIN | NAME | FUNCTION |
|-------------------|-----------------|--------------------------------------------------------------------|
| 1–4, 19 | T_OUT | RS-232 Driver Outputs |
| 5, 10, 13, 18, 24 | R_IN | RS-232 Receiver Inputs |
| 6, 9, 14, 17, 23 | R_OUT | TTL/CMOS Receiver Outputs. All receivers are inactive in shutdown. |
| 7, 8, 15, 16, 22 | T_IN | TTL/CMOS Driver Inputs. Internal pull-ups to V _{CC} . |
| 11 | GND | Ground |
| 12 | V _{CC} | +4.75V to +5.25V Supply Voltage |
| 20 | EN | Receiver Enable—active low |
| 21 | SHDN | Shutdown Control—active high |

±15kV ESD-Protected, +5V RS-232 Transceivers

Pin Descriptions (continued)

MAX202E-MAX213E, MAX232EMAX241E

MAX206E

| PIN | NAME | FUNCTION |
|--------------|-----------------|--------------------------------------------------------------------|
| 1, 2, 3, 24 | T_OUT | RS-232 Driver Outputs |
| 4, 16, 23 | R_IN | RS-232 Receiver Inputs |
| 5, 17, 22 | R_OUT | TTL/CMOS Receiver Outputs. All receivers are inactive in shutdown. |
| 6, 7, 18, 19 | T_IN | TTL/CMOS Driver Inputs. Internal pull-ups to V _{CC} . |
| 8 | GND | Ground |
| 9 | V _{CC} | +4.5V to +5.5V Supply Voltage |
| 10, 12 | C1+, C1- | Terminals for positive charge-pump capacitor |
| 11 | V+ | +2V _{CC} generated by the charge pump |
| 13, 14 | C2+, C2- | Terminals for negative charge-pump capacitor |
| 15 | V- | -2V _{CC} generated by the charge pump |
| 20 | EN | Receiver Enable—active low |
| 21 | SHDN | Shutdown Control—active high |

MAX207E

| PIN | NAME | FUNCTION |
|------------------|-----------------|--------------------------------------------------------------------|
| 1, 2, 3, 20, 24 | T_OUT | RS-232 Driver Outputs |
| 4, 16, 23 | R_IN | RS-232 Receiver Inputs |
| 5, 17, 22 | R_OUT | TTL/CMOS Receiver Outputs. All receivers are inactive in shutdown. |
| 6, 7, 18, 19, 21 | T_IN | TTL/CMOS Driver Inputs. Internal pull-ups to V _{CC} . |
| 8 | GND | Ground |
| 9 | V _{CC} | +4.75V to +5.25V Supply Voltage |
| 10, 12 | C1+, C1- | Terminals for positive charge-pump capacitor |
| 11 | V+ | +2V _{CC} generated by the charge pump |
| 13, 14 | C2+, C2- | Terminals for negative charge-pump capacitor |
| 15 | V- | -2V _{CC} generated by the charge pump |

MAX208E

| PIN | NAME | FUNCTION |
|---------------|-----------------|--------------------------------------------------------------------|
| 1, 2, 20, 24 | T_OUT | RS-232 Driver Outputs |
| 3, 7, 16, 23 | R_IN | RS-232 Receiver Inputs |
| 4, 6, 17, 22 | R_OUT | TTL/CMOS Receiver Outputs. All receivers are inactive in shutdown. |
| 5, 18, 19, 21 | T_IN | TTL/CMOS Driver Inputs. Internal pull-ups to V _{CC} . |
| 8 | GND | Ground |
| 9 | V _{CC} | +4.5V to +5.5V Supply Voltage |
| 10, 12 | C1+, C1- | Terminals for positive charge-pump capacitor |
| 11 | V+ | +2V _{CC} generated by the charge pump |
| 13, 14 | C2+, C2- | Terminals for negative charge-pump capacitor |
| 15 | V- | -2V _{CC} generated by the charge pump |

±15kV ESD-Protected, +5V RS-232 Transceivers

Pin Descriptions (continued)

MAX211E/MAX213E/MAX241E

| PIN | NAME | FUNCTION |
|------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1, 2, 3, 28 | T_OUT | RS-232 Driver Outputs |
| 4, 9, 18, 23, 27 | R_IN | RS-232 Receiver Inputs |
| 5, 8, 19, 22, 26 | R_OUT | TTL/CMOS Receiver Outputs. For the MAX213E, receivers R4 and R5 are active in shutdown mode when EN = 1. For the MAX211E and MAX241E, all receivers are inactive in shutdown. |
| 6, 7, 20, 21 | T_IN | TTL/CMOS Driver Inputs. Only the MAX211E, MAX213E, and MAX241E have internal pull-ups to V _{CC} . |
| 10 | GND | Ground |
| 11 | V _{CC} | +4.5V to +5.5V Supply Voltage |
| 12, 14 | C1+, C1- | Terminals for positive charge-pump capacitor |
| 13 | V+ | +2V _{CC} voltage generated by the charge pump |
| 15, 16 | C2+, C2- | Terminals for negative charge-pump capacitor |
| 17 | V- | -2V _{CC} voltage generated by the charge pump |
| 24 | $\overline{\text{EN}}$ | Receiver Enable—active low (MAX211E, MAX241E) |
| | EN | Receiver Enable—active high (MAX213E) |
| 25 | SHDN | Shutdown Control—active high (MAX211E, MAX241E) |
| | $\overline{\text{SHDN}}$ | Shutdown Control—active low (MAX213E) |

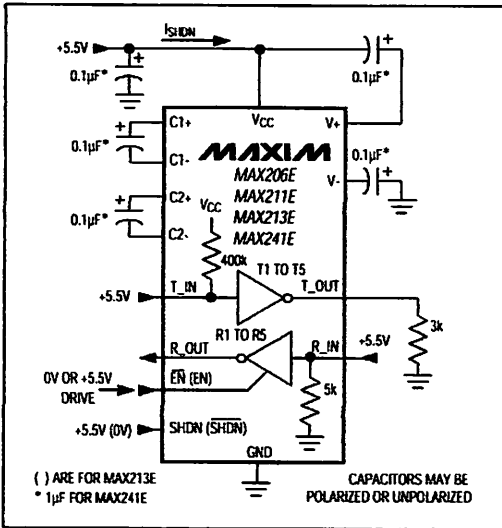


Figure 1. Shutdown-Current Test Circuit (MAX206E, MAX211E/MAX213E/MAX241E)

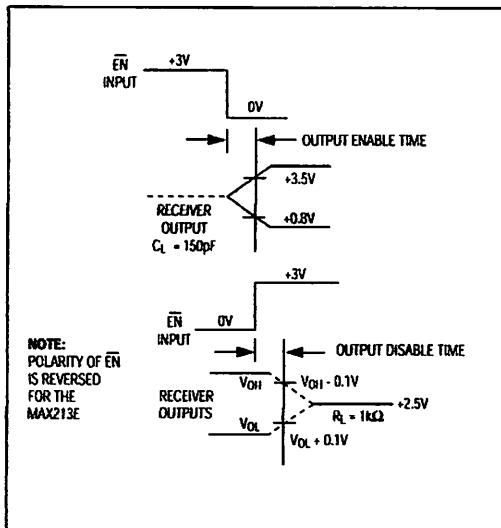


Figure 2. Receiver Output Enable and Disable Timing (MAX205E/MAX206E/MAX211E/MAX213E/MAX241E)

±15kV ESD-Protected, +5V RS-232 Transceivers

MAX202E-MAX213E, MAX232E/MAX241E

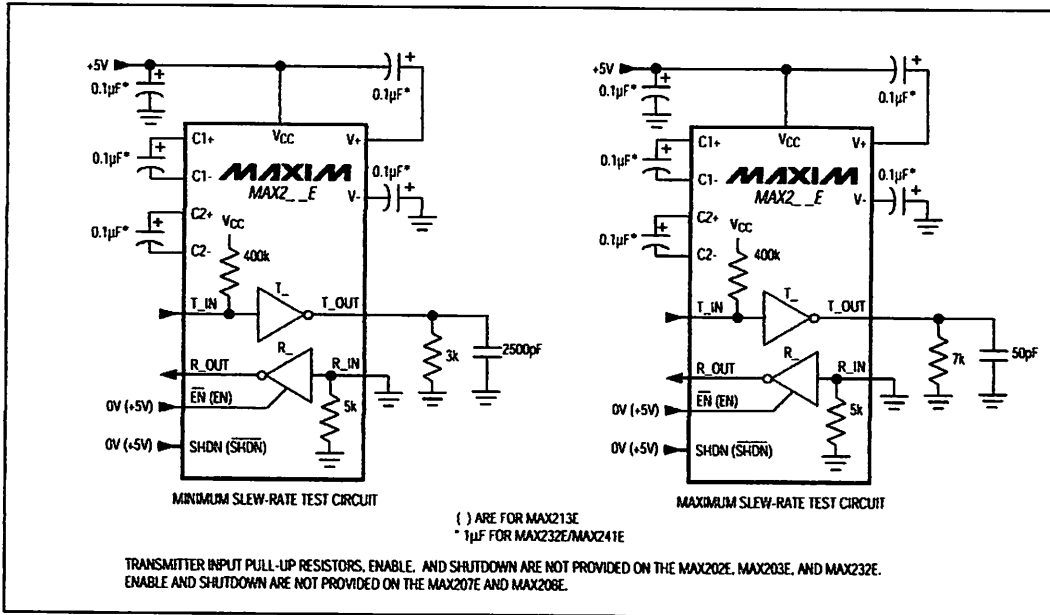


Figure 3. Transition Slew-Rate Circuit

Detailed Description

The MAX202E-MAX213E, MAX232E/MAX241E consist of three sections: charge-pump voltage converters, drivers (transmitters), and receivers. These E versions provide extra protection against ESD. They survive ±15kV discharges to the RS-232 inputs and outputs, tested using the Human Body Model. When tested according to IEC1000-4-2, they survive ±8kV contact-discharges and ±15kV air-gap discharges. The rugged E versions are intended for use in harsh environments or applications where the RS-232 connection is frequently changed (such as notebook computers). The standard (non-"E") MAX202, MAX203, MAX205-MAX208, MAX211, MAX213, MAX232, and MAX241 are recommended for applications where cost is critical.

+5V to ±10V Dual Charge-Pump Voltage Converter

The +5V to ±10V conversion is performed by dual charge-pump voltage converters (Figure 4). The first charge-pump converter uses capacitor C1 to double the +5V into +10V, storing the +10V on the output filter capacitor, C3. The second uses C2 to invert the +10V

into -10V, storing the -10V on the V- output filter capacitor, C4.

In shutdown mode, V+ is internally connected to VCC by a 1kΩ pull-down resistor, and V- is internally connected to ground by a 1kΩ pull-up resistor.

RS-232 Drivers

With VCC = 5V, the typical driver output voltage swing is ±8V when loaded with a nominal 5kΩ RS-232 receiver. The output swing is guaranteed to meet EIA/TIA-232E and V.28 specifications that call for ±5V minimum output levels under worst-case conditions. These include a 3kΩ load, minimum VCC, and maximum operating temperature. The open-circuit output voltage swings from (V+ - 0.6V) to V-.

Input thresholds are CMOS/TTL compatible. The unused drivers' inputs on the MAX205E-MAX208E, MAX211E, MAX213E, and MAX241E can be left unconnected because 400kΩ pull-up resistors to VCC are included on-chip. Since all drivers invert, the pull-up resistors force the unused drivers' outputs low. The MAX202E, MAX203E, and MAX232E do not have pull-up resistors on the transmitter inputs.

±15kV ESD-Protected, +5V RS-232 Transceivers

When in low-power shutdown mode, the MAX205E/MAX206E/MAX211E/MAX213E/MAX241E driver outputs are turned off and draw only leakage currents—even if they are back-driven with voltages between 0V and 12V. Below -0.5V in shutdown, the transmitter output is diode-clamped to ground with a 1kΩ series impedance.

RS-232 Receivers

The receivers convert the RS-232 signals to CMOS-logic output levels. The guaranteed 0.8V and 2.4V receiver input thresholds are significantly tighter than the ±3V thresholds required by the EIA/TIA-232E specification. This allows the receiver inputs to respond to TTL/CMOS-logic levels, as well as RS-232 levels.

The guaranteed 0.8V input low threshold ensures that receivers shorted to ground have a logic 1 output. The 5kΩ input resistance to ground ensures that a receiver with its input left open will also have a logic 1 output.

Receiver inputs have approximately 0.5V hysteresis. This provides clean output transitions, even with slow rise/fall-time signals with moderate amounts of noise and ringing.

In shutdown, the MAX213E's R4 and R5 receivers have no hysteresis.

Shutdown and Enable Control (MAX205E/MAX206E/MAX211E/ MAX213E/MAX241E)

In shutdown mode, the charge pumps are turned off, V+ is pulled down to VCC, V- is pulled to ground, and the transmitter outputs are disabled. This reduces supply current typically to 1μA (15μA for the MAX213E). The time required to exit shutdown is under 1ms, as shown in Figure 5.

Receivers

All MAX213E receivers, except R4 and R5, are put into a high-impedance state in shutdown mode (see Tables 1a and 1b). The MAX213E's R4 and R5 receivers still function in shutdown mode. These two awake-in-shutdown receivers can monitor external activity while maintaining minimal power consumption.

The enable control is used to put the receiver outputs into a high-impedance state, to allow wire-OR connection of two EIA/TIA-232E ports (or ports of different types) at the UART. It has no effect on the RS-232 drivers or the charge pumps.

Note: The enable control pin is active low for the MAX211E/MAX241E (EN), but is active high for the MAX213E (EN). The shutdown control pin is active high for the MAX205E/MAX206E/MAX211E/MAX241E (SHDN), but is active low for the MAX213E (SHDN).

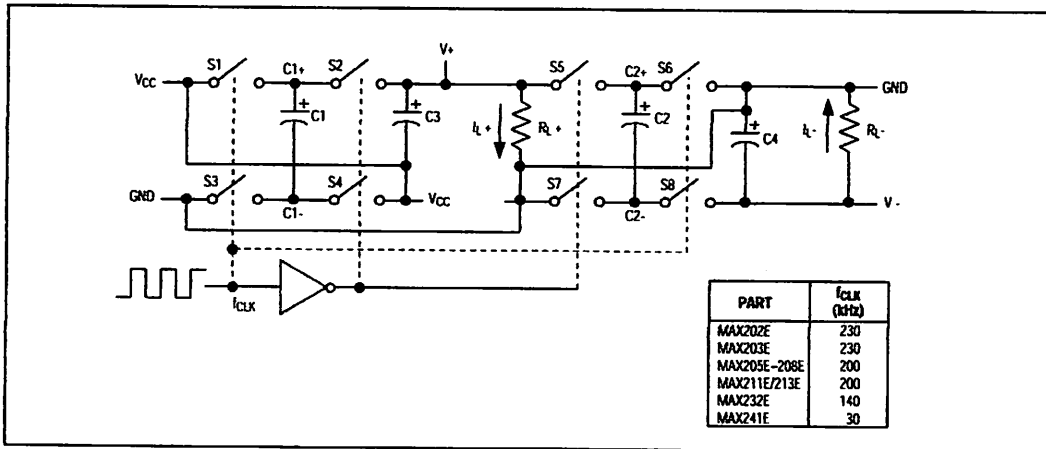


Figure 4. Charge-Pump Diagram

±15kV ESD-Protected, +5V RS-232 Transceivers

MAX202E-MAX213E, MAX232E/MAX241E

The MAX213E's receiver propagation delay is typically 0.5µs in normal operation. In shutdown mode, propagation delay increases to 4µs for both rising and falling transitions. The MAX213E's receiver inputs have approximately 0.5V hysteresis, except in shutdown, when receivers R4 and R5 have no hysteresis.

When entering shutdown with receivers active, R4 and R5 are not valid until 80µs after SHDN is driven low. When coming out of shutdown, all receiver outputs are invalid until the charge pumps reach nominal voltage levels (less than 2ms when using 0.1µF capacitors).

±15kV ESD Protection

As with all Maxim devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver outputs and receiver inputs have extra protection against static electricity. Maxim's engineers developed state-of-the-art structures to protect these pins against ESD of ±15kV without damage. The ESD structures withstand high ESD in all states: normal operation, shutdown, and powered down. After an ESD event, Maxim's E versions keep working without latchup, whereas competing RS-232 products can latch and must be powered down to remove latchup.

ESD protection can be tested in various ways; the transmitter outputs and receiver inputs of this product family are characterized for protection to the following limits:

- 1) ±15kV using the Human Body Model
- 2) ±8kV using the contact-discharge method specified in IEC1000-4-2
- 3) ±15kV using IEC1000-4-2's air-gap method.

ESD Test Conditions

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test set-up, test methodology, and test results.

Human Body Model

Figure 6a shows the Human Body Model, and Figure 6b shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5kΩ resistor.

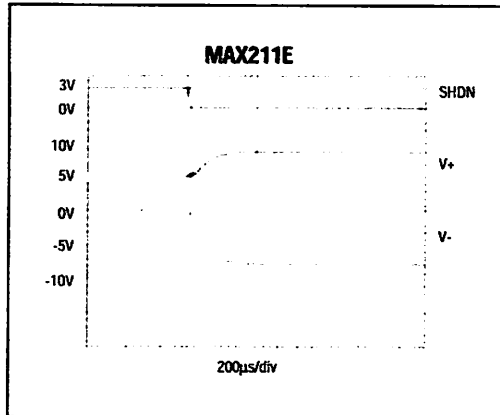


Figure 5. MAX211E V+ and V- when Exiting Shutdown (0.1µF capacitors)

Table 1a. MAX205E/MAX206E/MAX211E/MAX241E Control Pin Configurations

| SHDN | EN | OPERATION STATUS | Tx | Rx |
|------|----|------------------|------------|------------|
| 0 | 0 | Normal Operation | All Active | All Active |
| 0 | 1 | Normal Operation | All Active | All High-Z |
| 1 | X | Shutdown | All High-Z | All High-Z |

X = Don't Care

Table 1b. MAX213E Control Pin Configurations

| SHDN | EN | OPERATION STATUS | Tx 1-4 | Rx | |
|------|----|------------------|------------|--------|---------|
| | | | | 1-3 | 4, 5 |
| 0 | 0 | Shutdown | All High-Z | High-Z | High-Z |
| 0 | 1 | Shutdown | All High-Z | High-Z | Active* |
| 1 | 0 | Normal Operation | All Active | High-Z | High-Z |
| 1 | 1 | Normal Operation | All Active | Active | Active |

*Active = active with reduced performance

±15kV ESD-Protected, +5V RS-232 Transceivers

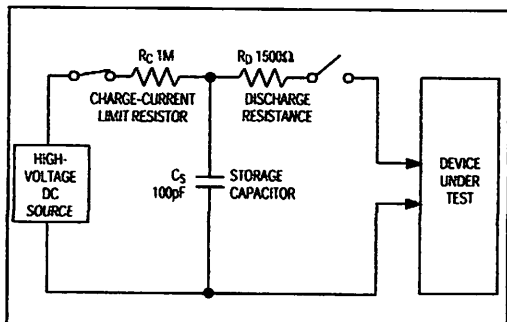


Figure 6a. Human Body ESD Test Model

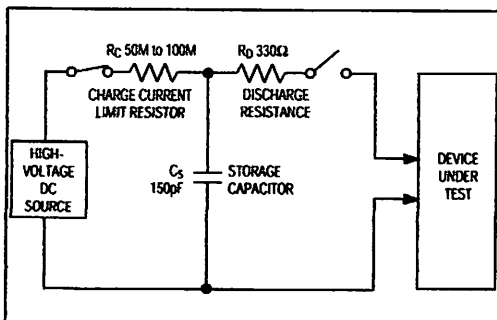


Figure 7a. IEC1000-4-2 ESD Test Model

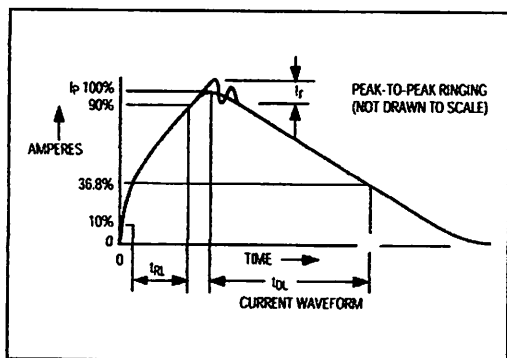


Figure 6b. Human Body Model Current Waveform

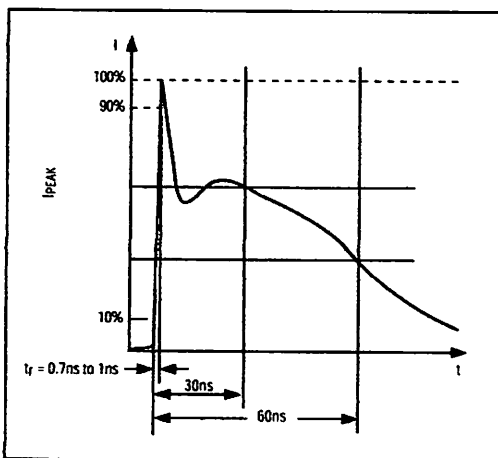


Figure 7b. IEC1000-4-2 ESD Generator Current Waveform

IEC1000-4-2

The IEC1000-4-2 standard covers ESD testing and performance of finished equipment; it does not specifically refer to integrated circuits. The MAX202E/MAX203E-MAX213E, MAX232E/MAX241E help you design equipment that meets level 4 (the highest level) of IEC1000-4-2, without the need for additional ESD-protection components.

The major difference between tests done using the Human Body Model and IEC1000-4-2 is higher peak current in IEC1000-4-2, because series resistance is lower in the IEC1000-4-2 model. Hence, the ESD withstand voltage measured to IEC1000-4-2 is generally lower than that measured using the Human Body Model. Figure 7b shows the current waveform for the 8kV IEC1000-4-2 level-four ESD contact-discharge test.

The air-gap test involves approaching the device with a charged probe. The contact-discharge method connects the probe to the device before the probe is energized.

Machine Model

The Machine Model for ESD tests all pins using a 200pF storage capacitor and zero discharge resistance. Its objective is to emulate the stress caused by contact that occurs with handling and assembly during manufacturing. Of course, all pins require this protection during manufacturing, not just RS-232 inputs and outputs. Therefore, after PC board assembly, the Machine Model is less relevant to I/O ports.

±15kV ESD-Protected, +5V RS-232 Transceivers

MAX202E-MAX213E, MAX232E/MAX241E

Applications Information

Capacitor Selection

The capacitor type used for C1–C4 is not critical for proper operation. The MAX202E, MAX206–MAX208E, MAX211E, and MAX213E require 0.1µF capacitors, and the MAX232E and MAX241E require 1µF capacitors, although in all cases capacitors up to 10µF can be used without harm. Ceramic, aluminum-electrolytic, or tantalum capacitors are suggested for the 1µF capacitors, and ceramic dielectrics are suggested for the 0.1µF capacitors. When using the minimum recommended capacitor values, make sure the capacitance value does not degrade excessively as the operating temperature varies. If in doubt, use capacitors with a larger (e.g., 2x) nominal value. The capacitors' effective series resistance (ESR), which usually rises at low temperatures, influences the amount of ripple on V+ and V-.

Use larger capacitors (up to 10µF) to reduce the output impedance at V+ and V-. This can be useful when "stealing" power from V+ or from V-. The MAX203E and MAX205E have internal charge-pump capacitors.

Bypass VCC to ground with at least 0.1µF. In applications sensitive to power-supply noise generated by the charge pumps, decouple VCC to ground with a

capacitor the same size as (or larger than) the charge-pump capacitors (C1–C4).

V+ and V- as Power Supplies

A small amount of power can be drawn from V+ and V-, although this will reduce both driver output swing and noise margins. Increasing the value of the charge-pump capacitors (up to 10µF) helps maintain performance when power is drawn from V+ or V-.

Driving Multiple Receivers

Each transmitter is designed to drive a single receiver. Transmitters can be paralleled to drive multiple receivers.

Driver Outputs when Exiting Shutdown

The driver outputs display no ringing or undesirable transients as they come out of shutdown.

High Data Rates

These transceivers maintain the RS-232 ±5.0V minimum driver output voltages at data rates of over 120kbps. For data rates above 120kbps, refer to the Transmitter Output Voltage vs. Load Capacitance graphs in the *Typical Operating Characteristics*. Communication at these high rates is easier if the capacitive loads on the transmitters are small; i.e., short cables are best.

Table 2. Summary of EIA/TIA-232E, V.28 Specifications

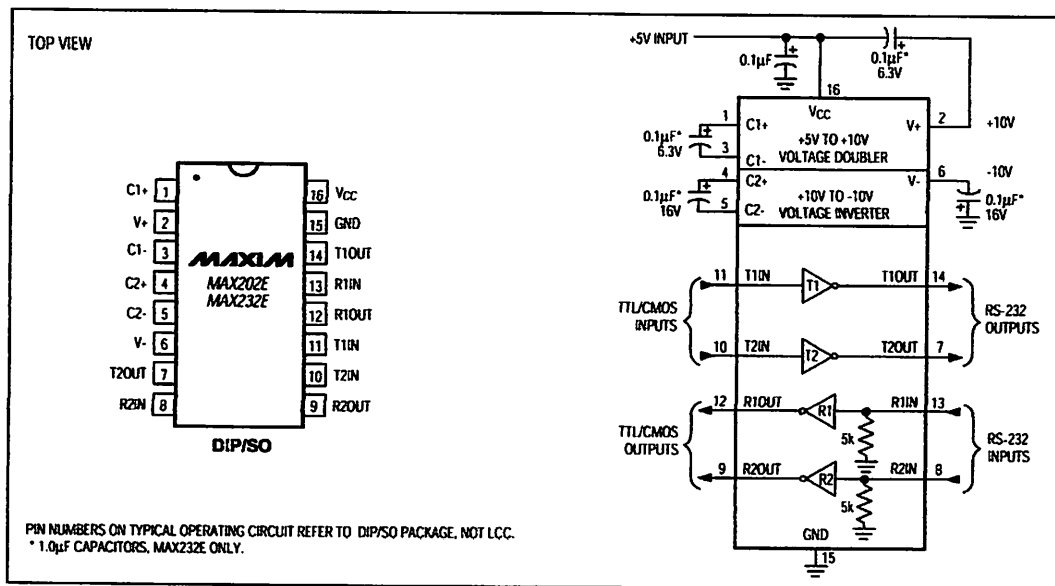
| PARAMETER | | CONDITIONS | EIA/TIA-232E, V.28 SPECIFICATIONS |
|------------------------------------------|---------|-----------------------------------------------------|-----------------------------------|
| Driver Output Voltage | 0 Level | 3kΩ to 7kΩ load | +5V to +15V |
| | 1 Level | 3kΩ to 7kΩ load | -5V to -15V |
| Driver Output Level, Max | | No load | ±25V |
| Data Rate | | 3kΩ ≤ R _L ≤ 7kΩ, C _L ≤ 2500pF | Up to 20kbps |
| Receiver Input Voltage | 0 Level | | +3V to +15V |
| | 1 Level | | -3V to -15V |
| Receiver Input Level | | | ±25V |
| Instantaneous Stew Rate, Max | | 3kΩ ≤ R _L ≤ 7kΩ, C _L ≤ 2500pF | 30V/µs |
| Driver Output Short-Circuit Current, Max | | | 100mA |
| Transition Rate on Driver Output | | V.28 | 1ms or 3% of the period |
| | | EIA/TIA-232E | 4% of the period |
| Driver Output Resistance | | -2V < V _{OUT} < +2V | 300Ω |

±15kV ESD-Protected, +5V RS-232 Transceivers

Table 3. DB9 Cable Connections
Commonly Used for EIA/TIAE-232E and V.24 Asynchronous Interfaces

| PIN | CONNECTION | |
|-----|----------------------------------------------------------------------|-----------------------------|
| 1 | Received Line Signal Detector (sometimes called Carrier Detect, DCD) | Handshake from DCE |
| 2 | Receive Data (RD) | Data from DCE |
| 3 | Transmit Data (TD) | Data from DTE |
| 4 | Data Terminal Ready | Handshake from DTE |
| 5 | Signal Ground | Reference point for signals |
| 6 | Data Set Ready (DSR) | Handshake from DCE |
| 7 | Request to Send (RTS) | Handshake from DTE |
| 8 | Clear to Send (CTS) | Handshake from DCE |
| 9 | Ring Indicator | Handshake from DCE |

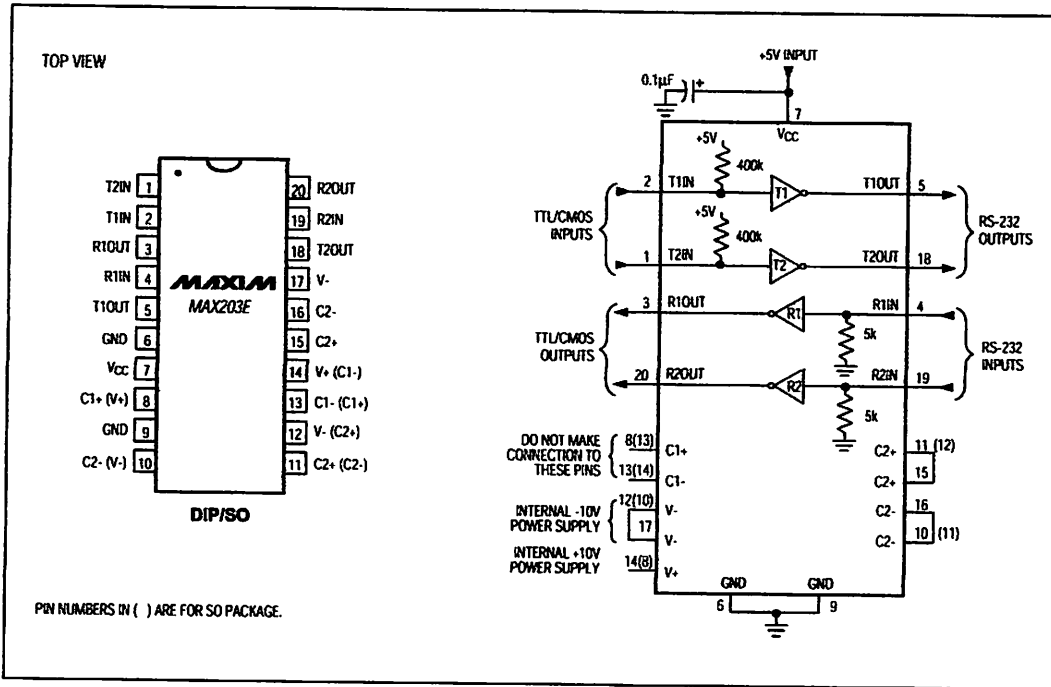
Pin Configurations and Typical Operating Circuits (continued)



±15kV ESD-Protected, +5V RS-232 Transceivers

Pin Configurations and Typical Operating Circuits (continued)

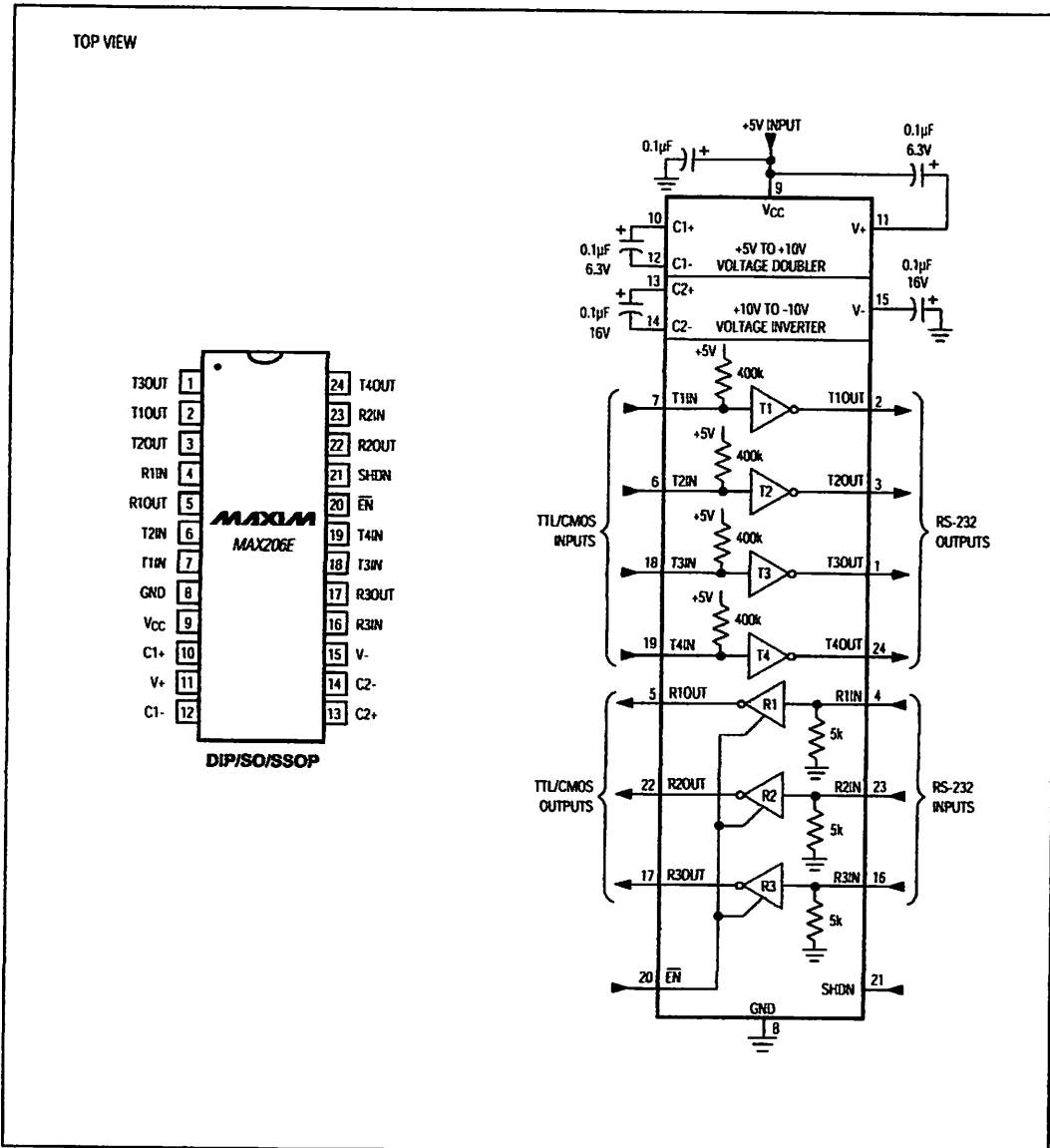
MAX202E-MAX213E, MAX232E/MAX241E



±15kV ESD-Protected, +5V RS-232 Transceivers

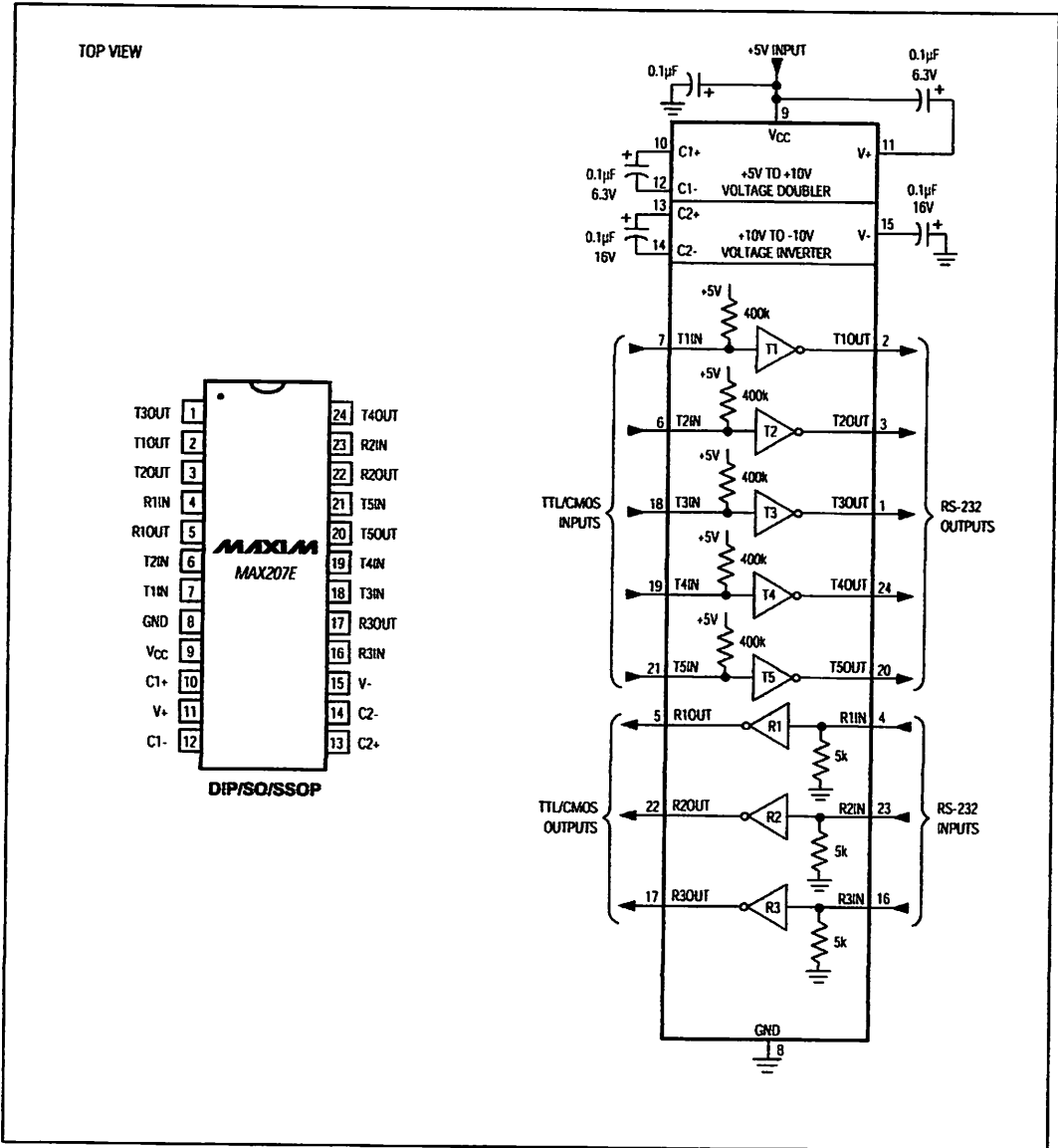
Pin Configurations and Typical Operating Circuits (continued)

MAX202E-MAX213E, MAX232E/MAX241E



±15kV ESD-Protected, +5V RS-232 Transceivers

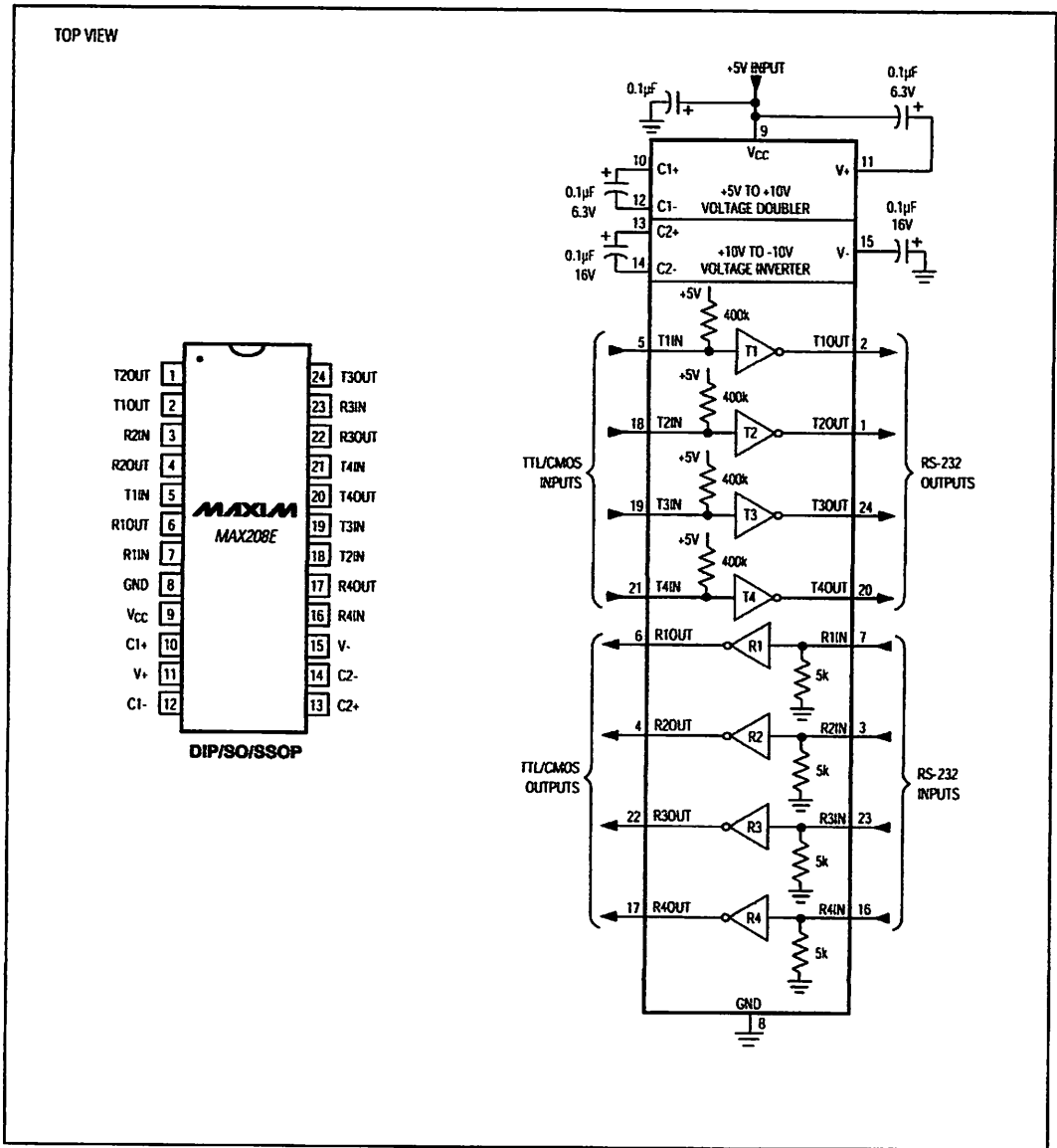
Pin Configurations and Typical Operating Circuits (continued)



±15kV ESD-Protected, +5V RS-232 Transceivers

Pin Configurations and Typical Operating Circuits (continued)

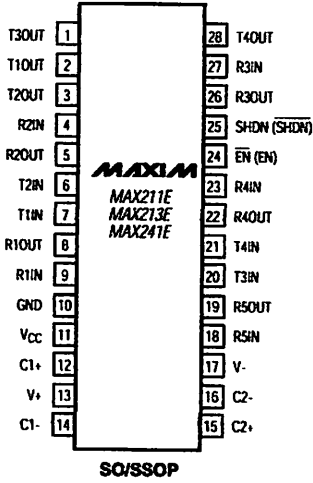
MAX202E-MAX213E, MAX232EMAX241E



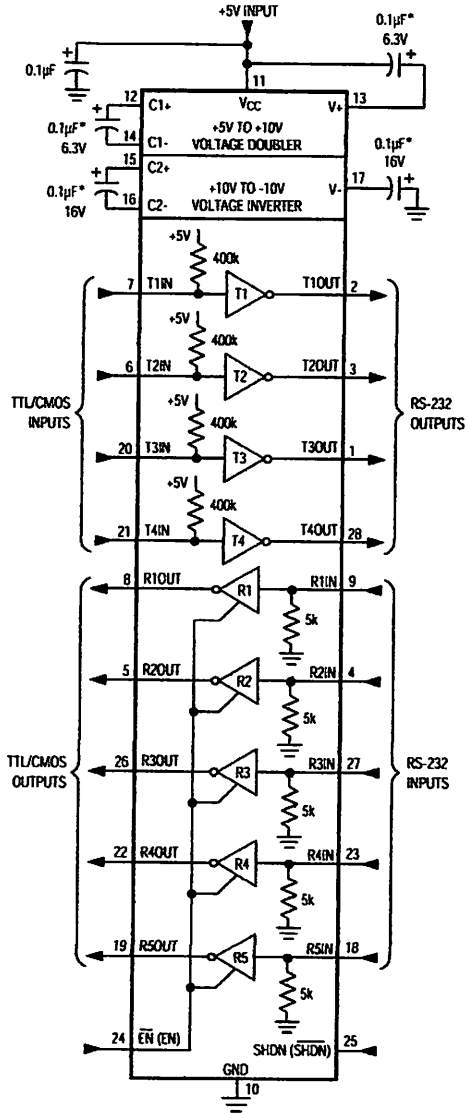
±15kV ESD-Protected, +5V RS-232 Transceivers

Pin Configurations and Typical Operating Circuits (continued)

TOP VIEW



() ARE FOR MAX213E ONLY
 * 1.0µF CAPACITORS, MAX241E ONLY



±15kV ESD-Protected, +5V RS-232 Transceivers

Ordering Information

| PART | TEMP. RANGE | PIN-PACKAGE |
|------------|----------------|-----------------------|
| MAX202ECPE | 0°C to +70°C | 16 Plastic DIP |
| MAX202ECSE | 0°C to +70°C | 16 Narrow SO |
| MAX202ECWE | 0°C to +70°C | 16 Wide SO |
| MAX202EC/D | 0°C to +70°C | Dice* |
| MAX202EEPE | -40°C to +85°C | 16 Plastic DIP |
| MAX202EESE | -40°C to +85°C | 16 Narrow SO |
| MAX202EEWE | -40°C to +85°C | 16 Wide SO |
| MAX203ECPP | 0°C to +70°C | 20 Plastic DIP |
| MAX203ECWP | 0°C to +70°C | 20 SO |
| MAX203EPP | -40°C to +85°C | 20 Plastic DIP |
| MAX203EWP | -40°C to +85°C | 20 SO |
| MAX205ECPG | 0°C to +70°C | 24 Wide Plastic DIP |
| MAX205EPPG | -40°C to +85°C | 24 Wide Plastic DIP |
| MAX206ECNG | 0°C to +70°C | 24 Narrow Plastic DIP |
| MAX206ECWG | 0°C to +70°C | 24 SO |
| MAX206ECAG | 0°C to +70°C | 24 SSOP |
| MAX206EENG | -40°C to +85°C | 24 Narrow Plastic DIP |
| MAX206EEWG | -40°C to +85°C | 24 SO |
| MAX206EEAG | -40°C to +85°C | 24 SSOP |
| MAX207ECNG | 0°C to +70°C | 24 Narrow Plastic DIP |
| MAX207ECWG | 0°C to +70°C | 24 SO |
| MAX207ECAG | 0°C to +70°C | 24 SSOP |
| MAX207EENG | -40°C to +85°C | 24 Narrow Plastic DIP |
| MAX207EEWG | -40°C to +85°C | 24 SO |
| MAX207EEAG | -40°C to +85°C | 24 SSOP |

| PART | TEMP. RANGE | PIN-PACKAGE |
|------------|----------------|-----------------------|
| MAX208ECNG | 0°C to +70°C | 24 Narrow Plastic DIP |
| MAX208ECWG | 0°C to +70°C | 24 SO |
| MAX208ECAG | 0°C to +70°C | 24 SSOP |
| MAX208EENG | -40°C to +85°C | 24 Narrow Plastic DIP |
| MAX208EEWG | -40°C to +85°C | 24 SO |
| MAX208EEAG | -40°C to +85°C | 24 SSOP |
| MAX211ECWI | 0°C to +70°C | 28 SO |
| MAX211ECAI | 0°C to +70°C | 28 SSOP |
| MAX211EEWI | -40°C to +85°C | 28 SO |
| MAX211EEAI | -40°C to +85°C | 28 SSOP |
| MAX213ECWI | 0°C to +70°C | 28 SO |
| MAX213ECAI | 0°C to +70°C | 28 SSOP |
| MAX213EEWI | -40°C to +85°C | 28 SO |
| MAX213EEAI | -40°C to +85°C | 28 SSOP |
| MAX232ECPE | 0°C to +70°C | 16 Plastic DIP |
| MAX232ECSE | 0°C to +70°C | 16 Narrow SO |
| MAX232ECWE | 0°C to +70°C | 16 Wide SO |
| MAX232EC/D | 0°C to +70°C | Dice* |
| MAX232EEPE | -40°C to +85°C | 16 Plastic DIP |
| MAX232EESE | -40°C to +85°C | 16 Narrow SO |
| MAX232EEWE | -40°C to +85°C | 16 Wide SO |
| MAX241ECWI | 0°C to +70°C | 28 SO |
| MAX241ECAI | 0°C to +70°C | 28 SSOP |
| MAX241EEWI | -40°C to +85°C | 28 SO |
| MAX241EEAI | -40°C to +85°C | 28 SSOP |

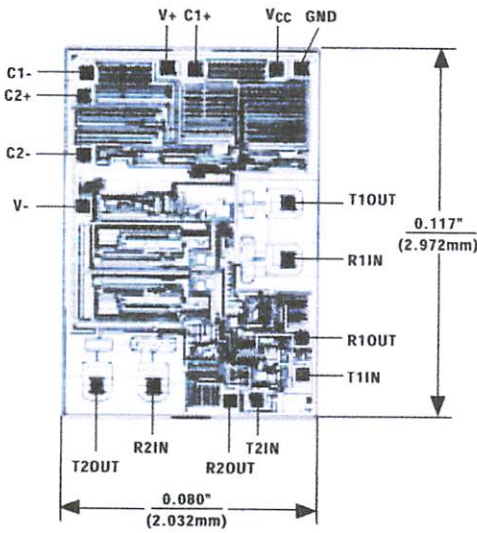
*Dice are specified at $T_A = +25^\circ\text{C}$.

MAX202E-MAX213E, MAX232E/MAX241E

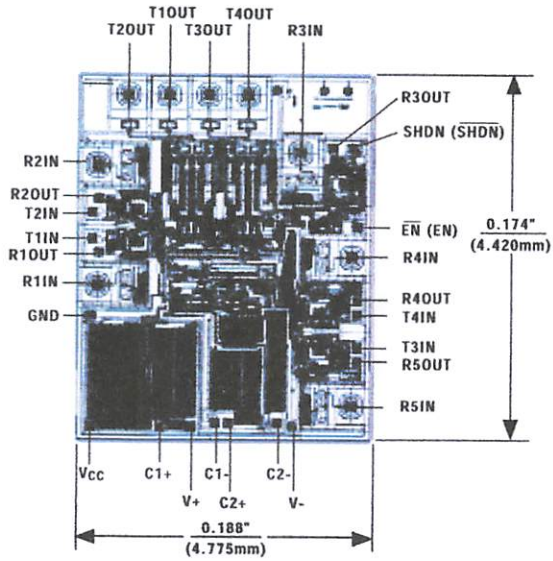
±15kV ESD-Protected, +5V RS-232 Transceivers

Chip Topographies

MAX202E/MAX232E



MAX211E/MAX213E/MAX241E



() ARE FOR MAX213E ONLY

TRANSISTOR COUNT: 123
SUBSTRATE CONNECTED TO GND

TRANSISTOR COUNT: 542
SUBSTRATE CONNECTED TO GND

Chip Information

MAX205E/MAX206E/MAX207E/MAX208E

TRANSISTOR COUNT: 328
SUBSTRATE CONNECTED TO GND

±15kV ESD-Protected, +5V RS-232 Transceivers

Package Information

MAX202E-MAX213E, MAX232E/MAX241E

**Plastic DIP
PLASTIC
DUAL-IN-LINE
PACKAGE
(0.300 in.)**

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | — | 0.200 | — | 5.08 |
| A1 | 0.015 | — | 0.38 | — |
| A2 | 0.125 | 0.175 | 3.18 | 4.45 |
| A3 | 0.055 | 0.080 | 1.40 | 2.03 |
| B | 0.018 | 0.022 | 0.41 | 0.56 |
| B1 | 0.045 | 0.065 | 1.14 | 1.65 |
| C | 0.008 | 0.012 | 0.20 | 0.30 |
| D1 | 0.005 | 0.080 | 0.13 | 2.03 |
| E | 0.300 | 0.325 | 7.62 | 8.26 |
| E1 | 0.240 | 0.310 | 6.10 | 7.87 |
| e | 0.100 | — | 2.54 | — |
| eA | 0.300 | — | 7.62 | — |
| eB | — | 0.400 | — | 10.16 |
| L | 0.115 | 0.150 | 2.92 | 3.81 |

| PKG. | DIM | PINS | INCHES | | MILLIMETERS | |
|------|-----|------|--------|-------|-------------|-------|
| | | | MIN | MAX | MIN | MAX |
| P | D | 8 | 0.348 | 0.390 | 8.84 | 9.91 |
| P | D | 14 | 0.735 | 0.765 | 18.67 | 19.43 |
| P | D | 16 | 0.745 | 0.765 | 18.92 | 19.43 |
| P | D | 18 | 0.885 | 0.915 | 22.48 | 23.24 |
| P | D | 20 | 1.015 | 1.045 | 25.78 | 26.54 |
| N | D | 24 | 1.14 | 1.265 | 28.96 | 32.13 |

21-0043A

**SSOP
SHRINK
SMALL-OUTLINE
PACKAGE**

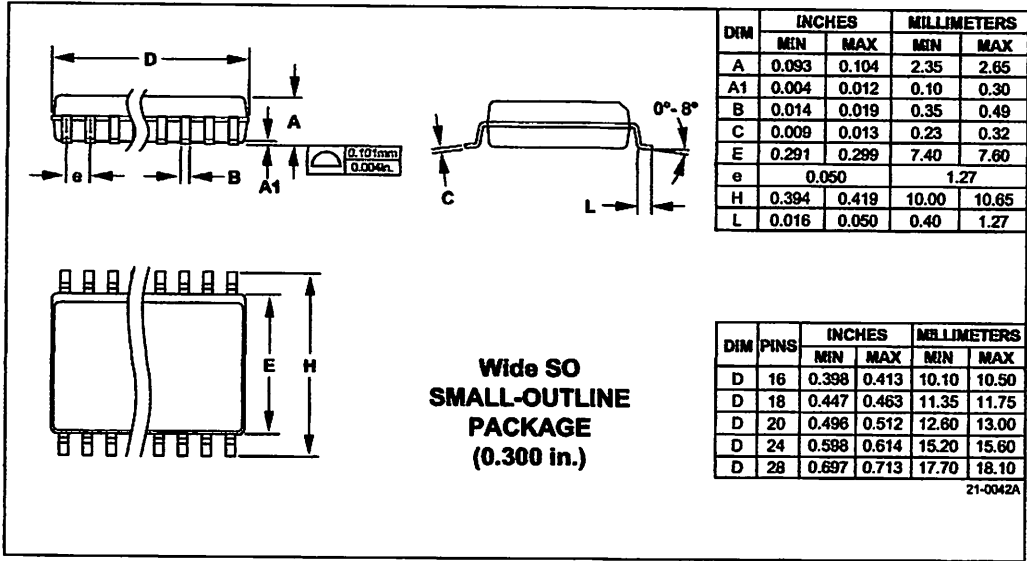
| DIM | INCHES | | MILLIMETERS | |
|-----|----------------|-------|-------------|------|
| | MIN | MAX | MIN | MAX |
| A | 0.068 | 0.078 | 1.73 | 1.99 |
| A1 | 0.002 | 0.008 | 0.05 | 0.21 |
| B | 0.010 | 0.015 | 0.25 | 0.38 |
| C | 0.004 | 0.008 | 0.09 | 0.20 |
| D | SEE VARIATIONS | | | |
| E | 0.205 | 0.209 | 5.20 | 5.38 |
| e | 0.0256 BSC | | 0.65 BSC | |
| H | 0.301 | 0.311 | 7.65 | 7.90 |
| L | 0.025 | 0.037 | 0.63 | 0.95 |
| α | 0° | 8° | 0° | 8° |

| DIM | PINS | INCHES | | MILLIMETERS | |
|-----|------|--------|-------|-------------|-------|
| | | MIN | MAX | MIN | MAX |
| D | 14 | 0.239 | 0.249 | 6.07 | 6.33 |
| D | 16 | 0.239 | 0.249 | 6.07 | 6.33 |
| D | 20 | 0.278 | 0.289 | 7.07 | 7.33 |
| D | 24 | 0.317 | 0.328 | 8.07 | 8.33 |
| D | 28 | 0.397 | 0.407 | 10.07 | 10.33 |

21-0056A

±15kV ESD-Protected, +5V RS-232 Transceivers

Package Information (continued)



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

24 Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94088 (408) 737-7600

© 1996 Maxim Integrated Products Printed USA MAXIM is a registered trademark of Maxim Integrated Products.

LM358, LM258, LM2904, LM2904V

Dual Low Power Operational Amplifiers

Utilizing the circuit designs perfected for recently introduced Quad Operational Amplifiers, these dual operational amplifiers feature 1) low power drain, 2) a common mode input voltage range extending to ground/ V_{EE} , 3) single supply or split supply operation and 4) pinouts compatible with the popular MC1558 dual operational amplifier. The LM158 series is equivalent to one-half of an LM124.

These amplifiers have several distinct advantages over standard operational amplifier types in single supply applications. They can operate at supply voltages as low as 3.0 V or as high as 32 V, with quiescent currents about one-fifth of those associated with the MC1741 (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

- Short Circuit Protected Outputs
- True Differential Input Stage
- Single Supply Operation: 3.0 V to 32 V
- Low Input Bias Currents
- Internally Compensated
- Common Mode Range Extends to Negative Supply
- Single and Split Supply Operation
- Similar Performance to the Popular MC1558
- ESD Clamps on the Inputs Increase Ruggedness of the Device without Affecting Operation

MAXIMUM RATINGS ($T_A = +25^\circ\text{C}$, unless otherwise noted.)

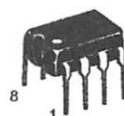
| Rating | Symbol | LM258 LM358 | LM2904 LM2904V | Unit |
|-------------------------------------------|------------------|----------------|-------------------|------------------|
| Power Supply Voltages | | | | Vdc |
| Single Supply | V_{CC} | 32 | 26 | |
| Split Supplies | V_{CC}, V_{EE} | ± 16 | ± 13 | |
| Input Differential Voltage Range (Note 1) | V_{IDR} | ± 32 | ± 26 | Vdc |
| Input Common Mode Voltage Range (Note 2) | V_{ICR} | -0.3 to 32 | -0.3 to 26 | Vdc |
| Output Short Circuit Duration | t_{SC} | Continuous | | |
| Junction Temperature | T_J | 150 | | $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | -55 to +125 | | $^\circ\text{C}$ |
| Operating Ambient Temperature Range | T_A | | | $^\circ\text{C}$ |
| LM258 | | -25 to +85 | - | |
| LM358 | | 0 to +70 | - | |
| LM2904 | | - | -40 to +105 | |
| LM2904V | | - | -40 to +125 | |

NOTES: 1. Split Power Supplies.

2. For Supply Voltages less than 32 V for the LM258/358 and 26 V for the LM2904, the absolute maximum input voltage is equal to the supply voltage.

DUAL DIFFERENTIAL INPUT OPERATIONAL AMPLIFIERS

SEMICONDUCTOR TECHNICAL DATA

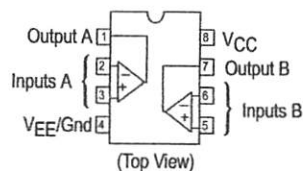


N SUFFIX
PLASTIC PACKAGE
CASE 626



D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO-8)

PIN CONNECTIONS



ORDERING INFORMATION

| Device | Operating Temperature Range | Package |
|----------|-------------------------------------------|-------------|
| LM2904D | $T_A = -40^\circ$ to $+105^\circ\text{C}$ | SO-8 |
| LM2904N | | Plastic DIP |
| LM2904VD | $T_A = -40^\circ$ to $+125^\circ\text{C}$ | SO-8 |
| LM2904VN | | Plastic DIP |
| LM258D | $T_A = -25^\circ$ to $+85^\circ\text{C}$ | SO-8 |
| LM258N | | Plastic DIP |
| LM358D | $T_A = 0^\circ$ to $+70^\circ\text{C}$ | SO-8 |
| LM358N | | Plastic DIP |

LM358, LM258, LM2904, LM2904V

ELECTRICAL CHARACTERISTICS ($V_{CC} = 5.0\text{ V}$, $V_{EE} = \text{Gnd}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

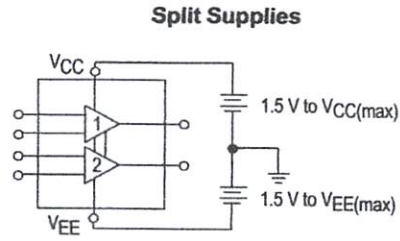
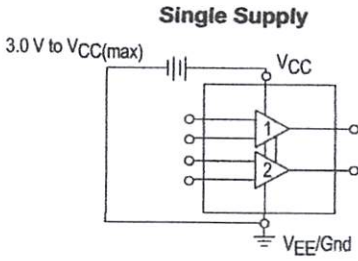
| Characteristic | Symbol | LM258 | | | LM358 | | | LM2904 | | | LM2904V | | | Unit |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------|------|----------|-------|------|----------|--------|------|----------|---------|------|----------|------------------------------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage $V_{CC} = 5.0\text{ V}$ to 30 V (26 V for LM2904, V), $V_{IC} = 0\text{ V}$ to $V_{CC} - 1.7\text{ V}$, $V_O = 1.4\text{ V}$, $R_S = 0\ \Omega$ $T_A = 25^\circ\text{C}$ $T_A = T_{\text{high}}$ (Note 1) $T_A = T_{\text{low}}$ (Note 1) | V_{IO} | - | 2.0 | 5.0 | - | 2.0 | 7.0 | - | 2.0 | 7.0 | - | - | - | mV |
| Average Temperature Coefficient of Input Offset Voltage $T_A = T_{\text{high}}$ to T_{low} (Note 1) | $\Delta V_{IO}/\Delta T$ | - | 7.0 | - | - | 7.0 | - | - | 7.0 | - | - | 7.0 | - | $\mu\text{V}/^\circ\text{C}$ |
| Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 1) | I_{IO} | - | 3.0 | 30 | - | 5.0 | 50 | - | 5.0 | 50 | - | 5.0 | 50 | nA |
| Input Bias Current $T_A = T_{\text{high}}$ to T_{low} (Note 1) | I_{IB} | - | -45 | -150 | - | -45 | -250 | - | -45 | -250 | - | -45 | -250 | nA |
| Average Temperature Coefficient of Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 1) | $\Delta I_{IO}/\Delta T$ | - | 10 | - | - | 10 | - | - | 10 | - | - | 10 | - | $\text{pA}/^\circ\text{C}$ |
| Input Common Mode Voltage Range (Note 2), $V_{CC} = 30\text{ V}$ (26 V for LM2904, V), $V_{CC} = 30\text{ V}$ (26 V for LM2904, V), $T_A = T_{\text{high}}$ to T_{low} | V_{ICR} | 0 | - | 28.3 | 0 | - | 28.3 | 0 | - | 24.3 | 0 | - | 24.3 | V |
| Differential Input Voltage Range | V_{IDR} | - | - | V_{CC} | - | - | V_{CC} | - | - | V_{CC} | - | - | V_{CC} | V |
| Large Signal Open Loop Voltage Gain $R_L = 2.0\text{ k}\Omega$, $V_{CC} = 15\text{ V}$, For Large V_O Swing, $T_A = T_{\text{high}}$ to T_{low} (Note 1) | A_{VOL} | 50 | 100 | - | 25 | 100 | - | 25 | 100 | - | 25 | 100 | - | V/mV |
| Channel Separation 1.0 kHz $\leq f \leq 20\text{ kHz}$, Input Referenced | CS | - | -120 | - | - | -120 | - | - | -120 | - | - | -120 | - | dB |
| Common Mode Rejection $R_S \leq 10\text{ k}\Omega$ | CMR | 70 | 85 | - | 65 | 70 | - | 50 | 70 | - | 50 | 70 | - | dB |
| Power Supply Rejection | PSR | 65 | 100 | - | 65 | 100 | - | 50 | 100 | - | 50 | 100 | - | dB |
| Output Voltage—High Limit ($T_A = T_{\text{high}}$ to T_{low}) (Note 1) $V_{CC} = 5.0\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $T_A = 25^\circ\text{C}$ $V_{CC} = 30\text{ V}$ (26 V for LM2904, V), $R_L = 2.0\text{ k}\Omega$ $V_{CC} = 30\text{ V}$ (26 V for LM2904, V), $R_L = 10\text{ k}\Omega$ | V_{OH} | 3.3 | 3.5 | - | 3.3 | 3.5 | - | 3.3 | 3.5 | - | 3.3 | 3.5 | - | V |
| Output Voltage—Low Limit $V_{CC} = 5.0\text{ V}$, $R_L = 10\text{ k}\Omega$, $T_A = T_{\text{high}}$ to T_{low} (Note 1) | V_{OL} | - | 5.0 | 20 | - | 5.0 | 20 | - | 5.0 | 20 | - | 5.0 | 20 | mV |
| Output Source Current $V_{ID} = +1.0\text{ V}$, $V_{CC} = 15\text{ V}$ | I_{O+} | 20 | 40 | - | 20 | 40 | - | 20 | 40 | - | 20 | 40 | - | mA |
| Output Sink Current $V_{ID} = -1.0\text{ V}$, $V_{CC} = 15\text{ V}$ $V_{ID} = -1.0\text{ V}$, $V_O = 200\text{ mV}$ | I_{O-} | 10 | 20 | - | 10 | 20 | - | 10 | 20 | - | 10 | 20 | - | mA |
| Output Short Circuit to Ground (Note 3) | I_{SC} | - | 40 | 60 | - | 40 | 60 | - | 40 | 60 | - | 40 | 60 | mA |
| Power Supply Current ($T_A = T_{\text{high}}$ to T_{low}) (Note 1) $V_{CC} = 30\text{ V}$ (26 V for LM2904, V), $V_O = 0\text{ V}$, $R_L = \infty$ $V_{CC} = 5\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ | I_{CC} | - | 1.5 | 3.0 | - | 1.5 | 3.0 | - | 1.5 | 3.0 | - | 1.5 | 3.0 | mA |

NOTES: 1. $T_{\text{low}} = -40^\circ\text{C}$ for LM2904
 $= -40^\circ\text{C}$ for LM2904V
 $= -25^\circ\text{C}$ for LM258
 $= 0^\circ\text{C}$ for LM358
 $T_{\text{high}} = +105^\circ\text{C}$ for LM2904
 $= +125^\circ\text{C}$ for LM2904V
 $= +85^\circ\text{C}$ for LM258
 $= +70^\circ\text{C}$ for LM358

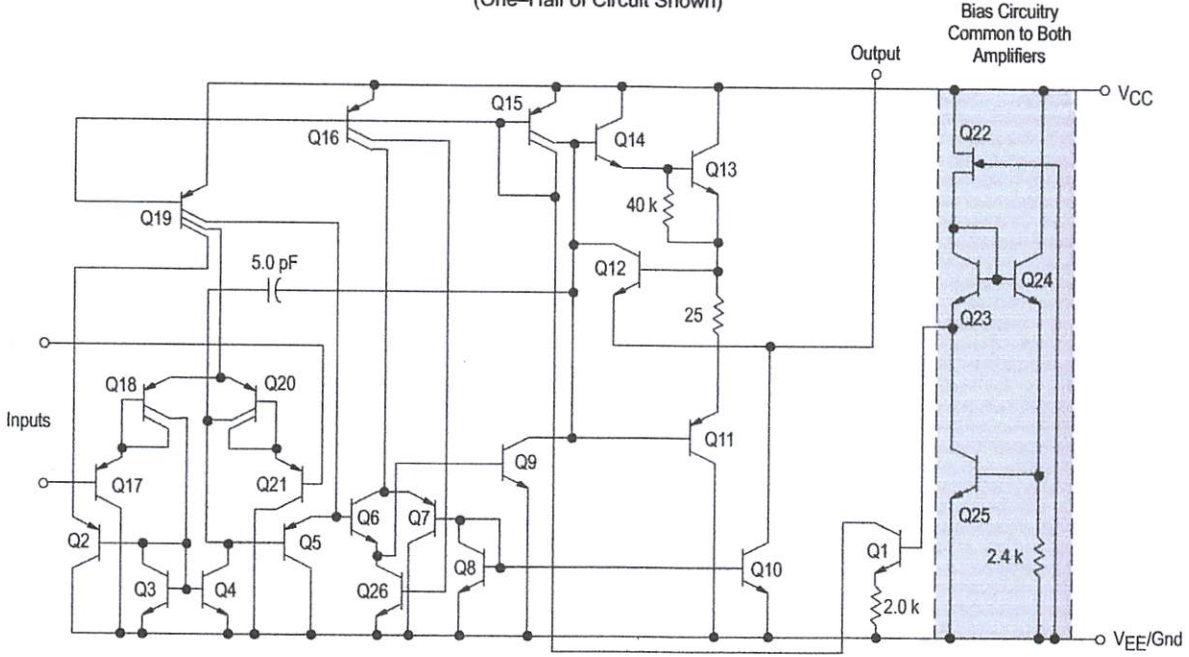
2. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is $V_{CC} - 1.7\text{ V}$.

3. Short circuits from the output to V_{CC} can cause excessive heating and eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

LM358, LM258, LM2904, LM2904V



Representative Schematic Diagram
(One-Half of Circuit Shown)

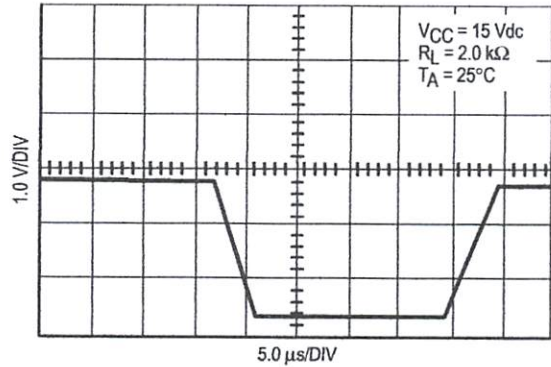


CIRCUIT DESCRIPTION

The LM258 series is made using two internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input devices Q20 and Q18 with input buffer transistors Q21 and Q17 and the differential to single ended converter Q3 and Q4. The first stage performs not only the first stage gain function but also performs the level shifting and transconductance reduction functions. By reducing the transconductance, a smaller compensation capacitor (only 5.0 pF) can be employed, thus saving chip area. The transconductance reduction is accomplished by splitting the collectors of Q20 and Q18. Another feature of this input stage is that the input common mode range can include the negative supply or ground, in single supply operation, without saturating either the input devices or the differential to single-ended converter. The second stage consists of a standard current source load amplifier stage.

Each amplifier is biased from an internal-voltage regulator which has a low temperature coefficient thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.

Large Signal Voltage Follower Response



LM358, LM258, LM2904, LM2904V

Figure 1. Input Voltage Range

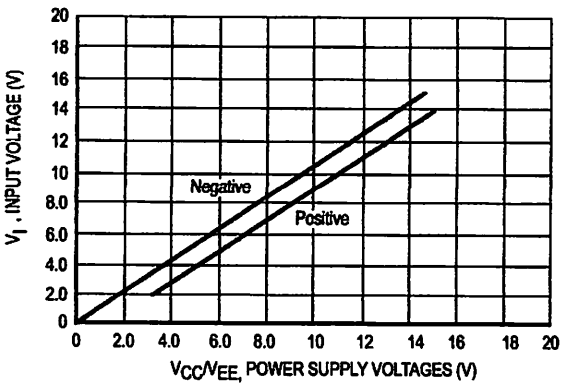


Figure 2. Large-Signal Open Loop Voltage Gain

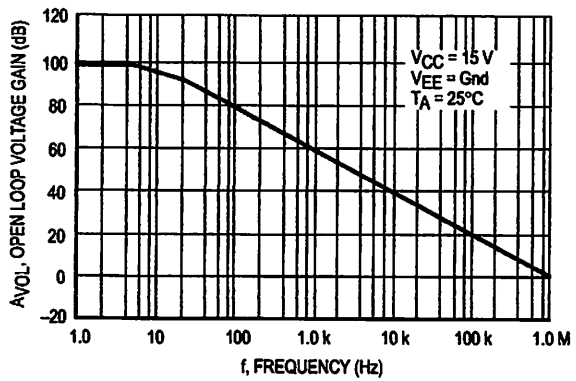


Figure 3. Large-Signal Frequency Response

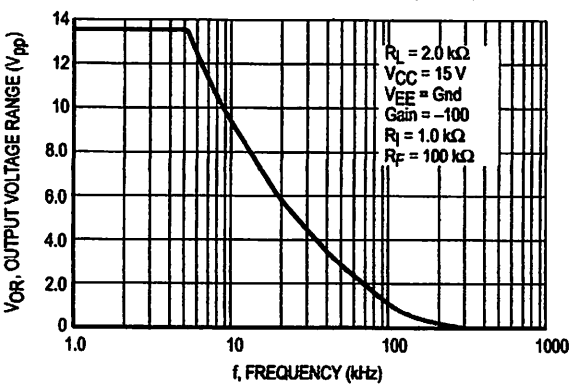


Figure 4. Small Signal Voltage Follower Pulse Response (Noninverting)

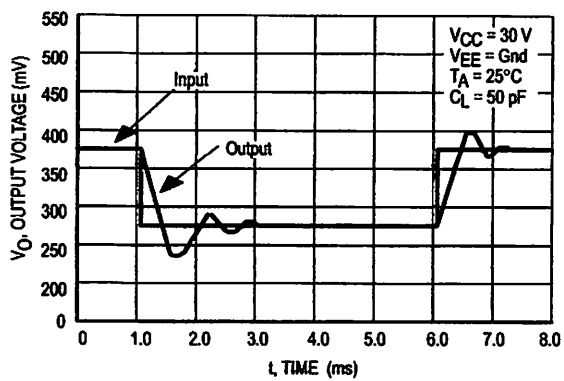


Figure 5. Power Supply Current versus Power Supply Voltage

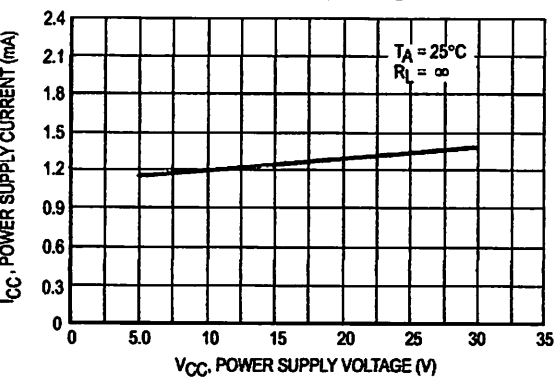
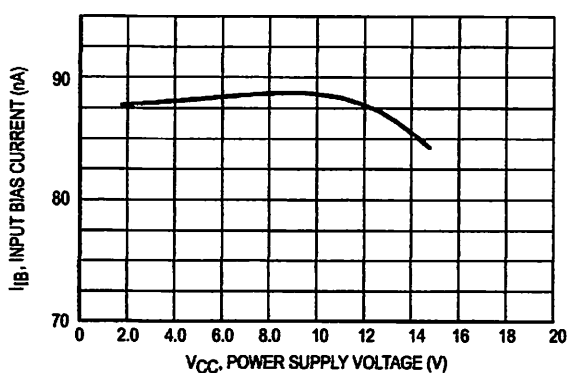
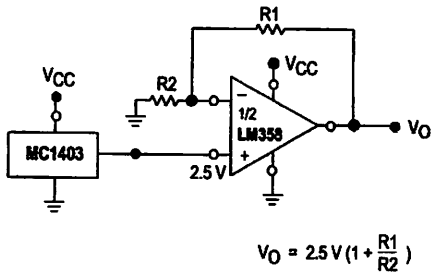


Figure 6. Input Bias Current versus Supply Voltage



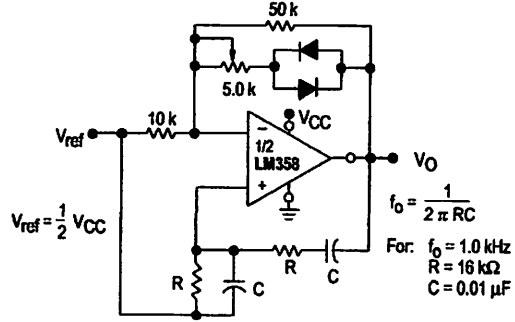
LM358, LM258, LM2904, LM2904V

Figure 7. Voltage Reference



$$V_O = 2.5V \left(1 + \frac{R_1}{R_2}\right)$$

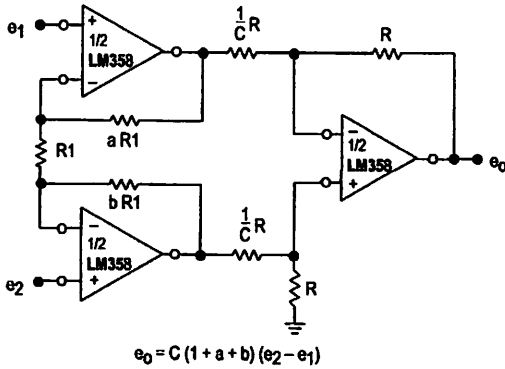
Figure 8. Wien Bridge Oscillator



$$f_o = \frac{1}{2\pi RC}$$

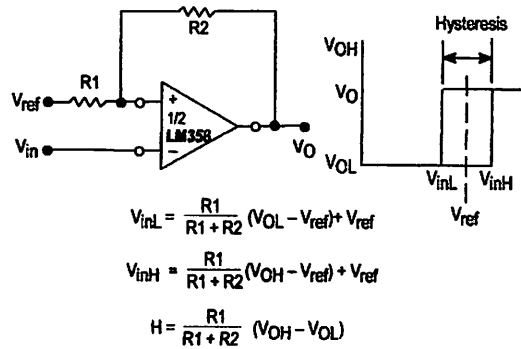
For: $f_o = 1.0 \text{ kHz}$
 $R = 16 \text{ k}\Omega$
 $C = 0.01 \mu\text{F}$

Figure 9. High Impedance Differential Amplifier



$$e_0 = C(1 + a + b)(e_2 - e_1)$$

Figure 10. Comparator with Hysteresis

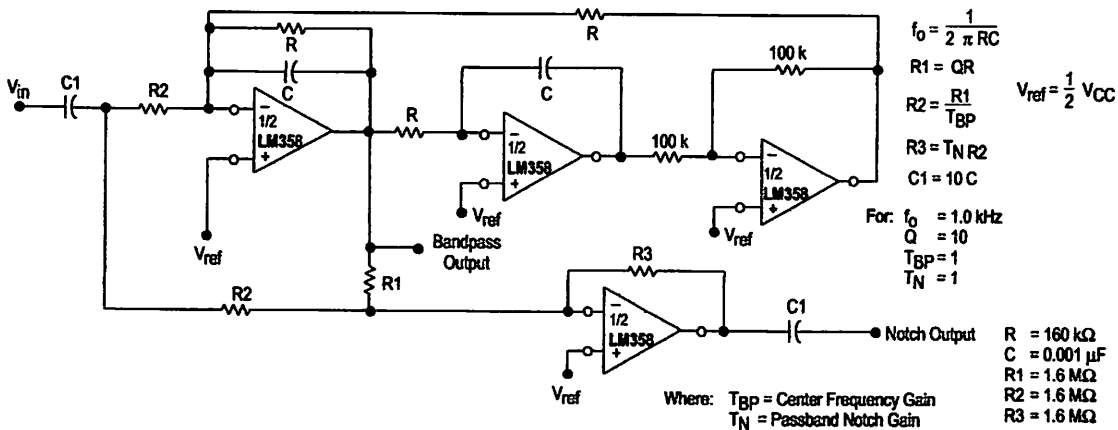


$$V_{inL} = \frac{R_1}{R_1 + R_2} (V_{OL} - V_{ref}) + V_{ref}$$

$$V_{inH} = \frac{R_1}{R_1 + R_2} (V_{OH} - V_{ref}) + V_{ref}$$

$$H = \frac{R_1}{R_1 + R_2} (V_{OH} - V_{OL})$$

Figure 11. BI-Quad Filter



$$f_o = \frac{1}{2\pi RC}$$

$$R_1 = QR$$

$$R_2 = \frac{R_1}{T_{BP}}$$

$$R_3 = T_N R_2$$

$$C_1 = 10C$$

$$V_{ref} = \frac{1}{2} V_{CC}$$

For: $f_o = 1.0 \text{ kHz}$

$$Q = 10$$

$$T_{BP} = 1$$

$$T_N = 1$$

$$V_{ref} = \frac{1}{2} V_{CC}$$

$$R = 160 \text{ k}\Omega$$

$$C = 0.001 \mu\text{F}$$

$$R_1 = 1.6 \text{ M}\Omega$$

$$R_2 = 1.6 \text{ M}\Omega$$

$$R_3 = 1.6 \text{ M}\Omega$$

Where: T_{BP} = Center Frequency Gain
 T_N = Passband Notch Gain

LM358, LM258, LM2904, LM2904V

Figure 12. Function Generator

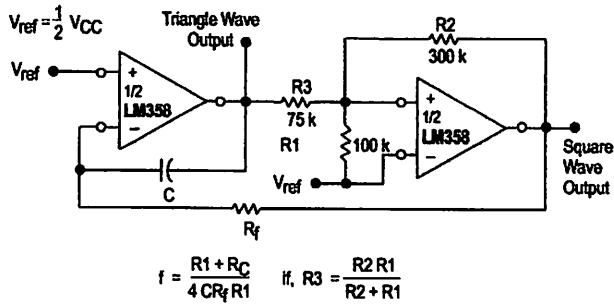
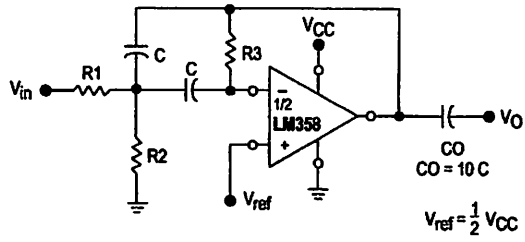


Figure 13. Multiple Feedback Bandpass Filter



Given: f_0 = center frequency
 $A(f_0)$ = gain at center frequency

Choose value f_0, C

Then: $R3 = \frac{Q}{\pi f_0 C}$

$R1 = \frac{R3}{2 A(f_0)}$


$R2 = \frac{R1 R3}{4Q^2 R1 - R3}$

For less than 10% error from operational amplifier. $\frac{Q_0 f_0}{BW} < 0.1$

Where f_0 and BW are expressed in Hz.

If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

LM358, LM258, LM2904, LM2904V

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

How to reach us:

USA/EUROPE/Locations Not Listed: Motorola Literature Distribution;
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447 or 602-303-5454

JAPAN: Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, 6F Seibu-Butsuryu-Center,
3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

MFAX: RMFAX0@email.sps.mot.com - TOUCHTONE 602-244-6609
INTERNET: <http://Design-NET.com>

ASIA/PACIFIC: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-28629298

 **MOTOROLA**

◇

LM358/D



NPN SILICON TRANSISTOR 2SC945

DESCRIPTION The 2SC945 is designed for use in driver stage of AF amplifier and low speed switching.

FEATURES

- High Voltage LV_{CEO} : 50 V MIN.
- Excellent h_{FE} Linearity
 h_{FE1} (0.1 mA)/ h_{FE2} (1.0 mA) : 0.92 TYP.

ABSOLUTE MAXIMUM RATINGS

Maximum Temperatures

Storage Temperature -55 to +125 °C

Junction Temperature +125 °C Maximum

Maximum Power Dissipation (Ta = 25 °C)

Total Power Dissipation 250 mW

Maximum Voltages and Currents (Ta = 25 °C)

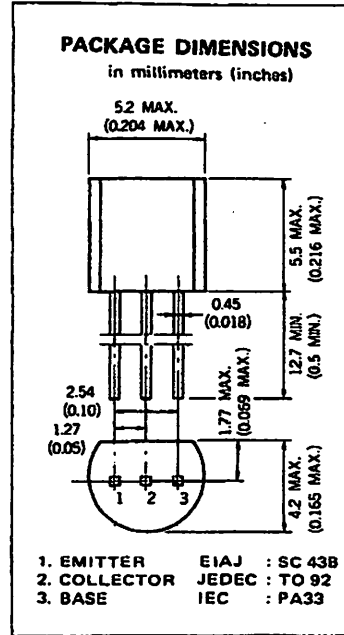
V_{CBO} Collector to Base Voltage 60 V

V_{CEO} Collector to Emitter Voltage 50 V

V_{EBO} Emitter to Base Voltage 5.0 V

I_C Collector Current 100 mA

I_B Base Current 20 mA



ELECTRICAL CHARACTERISTICS (Ta = 25 °C)

| SYMBOL | CHARACTERISTIC | MIN. | TYP. | MAX. | UNIT | TEST CONDITIONS |
|----------------------|-------------------------------|------|------|------|------|-----------------------------------------------------------------------------------|
| h_{FE1} | DC Current Gain | 50 | 185 | | | V _{CE} =6.0 V, I _C =0.1 mA |
| h_{FE2} | DC Current Gain | 80 | 200 | 600 | | V _{CE} =6.0 V, I _C =1.0 mA |
| NF | Noise Figure | | 0.8 | 15 | dB | V _{CE} =6.0 V, I _C =0.1 mA, R _G =2.0 kΩ, f=1.0 kHz |
| f _T | Gain Bandwidth Product | 150 | 250 | 450 | MHz | V _{CE} =6.0 V, I _E =-10 mA |
| C _{ob} | Collector to Base Capacitance | | 3.0 | 4.0 | pF | V _{CB} =6.0 V, I _E =0, f=1.0 MHz |
| I _{CBO} | Collector Cutoff Current | | | 100 | nA | V _{CB} =60 V, I _E =0 |
| I _{EBO} | Emitter Cutoff Current | | | 100 | nA | V _{EB} =5.0 V, I _C =0 |
| V _{BE} | Base to Emitter Voltage | 0.55 | 0.62 | 0.85 | V | V _{CE} =6.0 V, I _C =1.0 mA |
| V _{CE(sat)} | Collector Saturation Voltage | | 0.15 | 0.3 | V | I _C =100 mA, I _B =10 mA |
| V _{BE(sat)} | Base Saturation Voltage | | 0.88 | 1.0 | V | I _C =100 mA, I _B =10 mA |

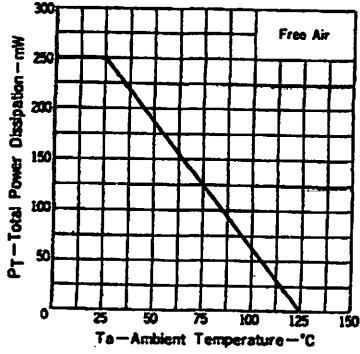
Classification of h_{FE2}

| Rank | R | Q | P | K |
|-------|----------|-----------|-----------|-----------|
| Range | 90 - 180 | 135 - 270 | 200 - 400 | 300 - 600 |

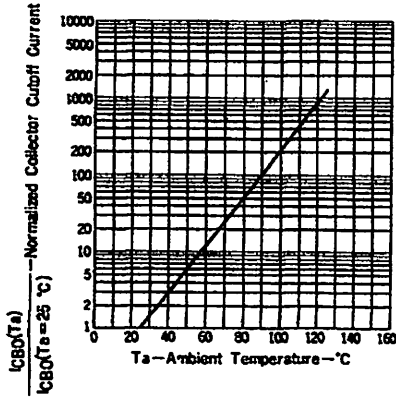
h_{FE2} Test Conditions : V_{CE} = 6.0 V, I_C = 1.0 mA

TYPICAL CHARACTERISTICS ($T_a = 25^\circ\text{C}$ unless otherwise noted)

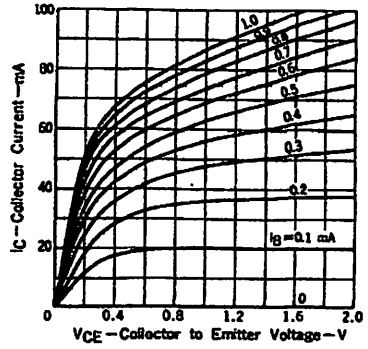
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



NORMALIZED COLLECTOR CUTOFF CURRENT vs. AMBIENT TEMPERATURE

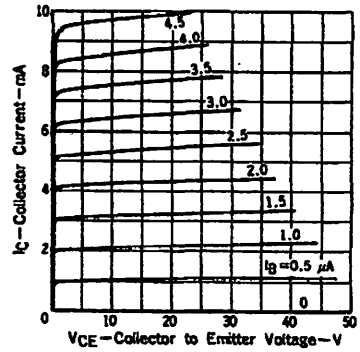


COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE

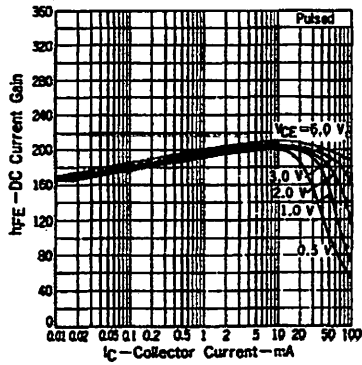


4-3

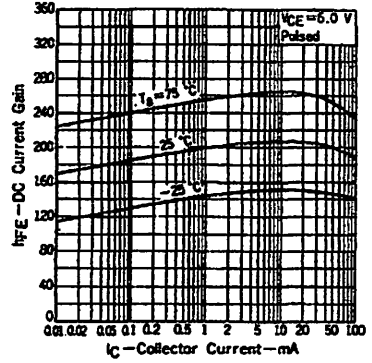
COLLECTOR CURRENT vs. COLLECTOR TO EMITTER VOLTAGE



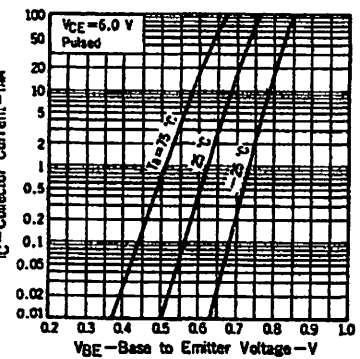
DC CURRENT GAIN vs. COLLECTOR CURRENT



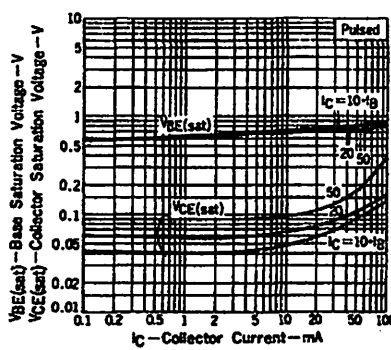
DC CURRENT GAIN vs. COLLECTOR CURRENT



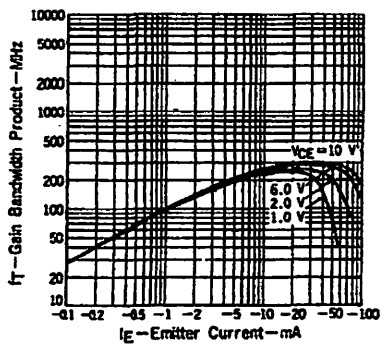
COLLECTOR CURRENT vs. BASE TO EMITTER VOLTAGE



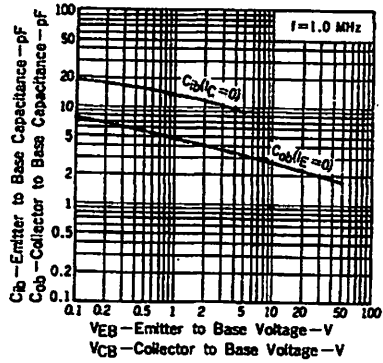
COLLECTOR AND BASE SATURATION VOLTAGE vs. COLLECTOR CURRENT



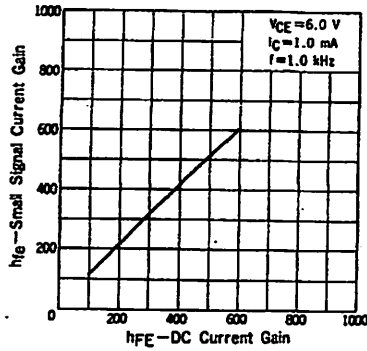
GAIN BANDWIDTH PRODUCT vs. EMITTER CURRENT



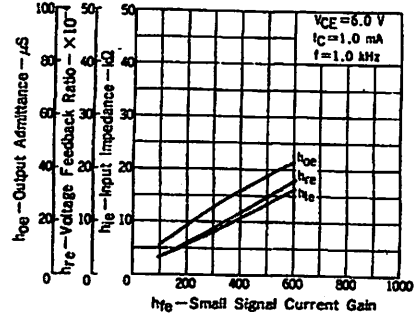
EMITTER TO BASE AND COLLECTOR TO BASE CAPACITANCE vs. REVERSE VOLTAGE



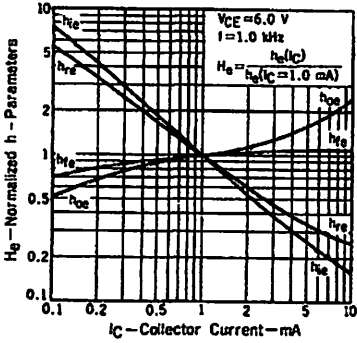
SMALL SIGNAL CURRENT GAIN vs. DC CURRENT GAIN



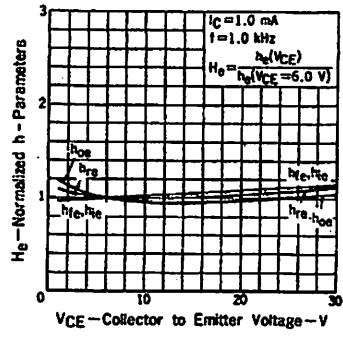
INPUT IMPEDANCE, VOLTAGE FEEDBACK RATIO AND OUTPUT ADMITTANCE vs. SMALL SIGNAL CURRENT GAIN



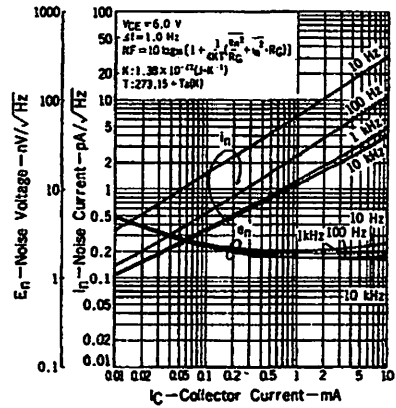
NORMALIZED h-PARAMETERS vs. COLLECTOR CURRENT



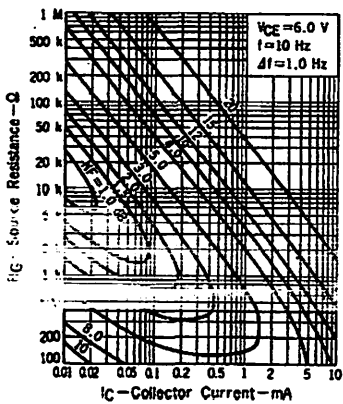
NORMALIZED h-PARAMETERS vs. COLLECTOR TO EMITTER VOLTAGE



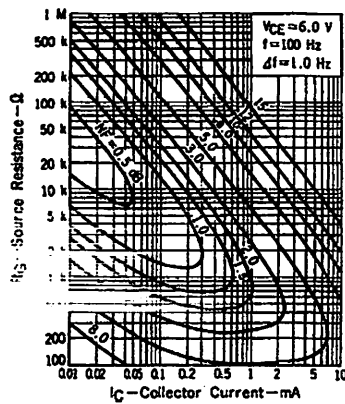
EN AND IN vs. COLLECTOR CURRENT



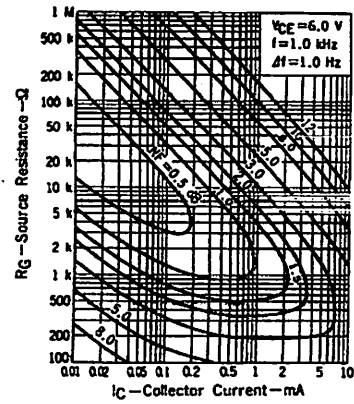
NOISE FIGURE MAP 1



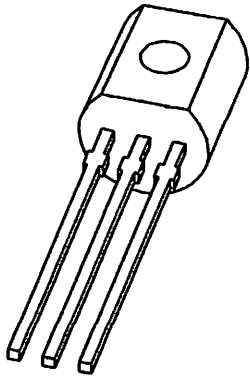
NOISE FIGURE MAP 2



NOISE FIGURE MAP 3



DATA SHEET



BC337; BC337A; BC338 NPN general purpose transistors

Product specification
Supersedes data of September 1994
File under Discrete Semiconductors, SC04

1997 Mar 10

NPN general purpose transistors

BC337; BC337A; BC338

FEATURES

- High current (max. 500 mA)
- Low voltage (max. 60 V).

APPLICATIONS

- General purpose switching and amplification, e.g. driver and output stages of audio amplifiers.

DESCRIPTION

NPN transistor in a TO-92; SOT54 plastic package. PNP complements: BC327, BC327A and BC328.

PINNING

| PIN | DESCRIPTION |
|-----|-------------|
| 1 | emitter |
| 2 | base |
| 3 | collector |

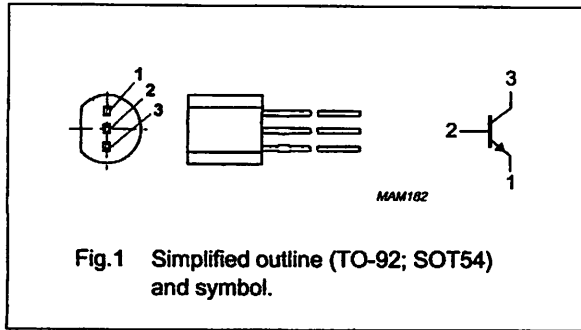


Fig.1 Simplified outline (TO-92; SOT54) and symbol.

QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|------------------|---------------------------|------------------------------------------------------------|------|------|------|
| V _{CBO} | collector-base voltage | open emitter | | | |
| | BC337 | | – | 50 | V |
| | BC337A | | – | 60 | V |
| | BC338 | | – | 30 | V |
| V _{CEO} | collector-emitter voltage | open base | | | |
| | BC337 | | – | 45 | V |
| | BC337A | | – | 60 | V |
| | BC338 | | – | 25 | V |
| I _{CM} | peak collector current | | – | 1 | A |
| P _{tot} | total power dissipation | T _{amb} ≤ 25 °C | – | 625 | mW |
| h _{FE} | DC current gain | I _C = 100 mA; V _{CE} = 1 V | | | |
| | BC337; BC338 | | 100 | 600 | |
| | BC337A | | 100 | 400 | |
| f _T | transition frequency | I _C = 10 mA; V _{CE} = 5 V; f = 100 MHz | 100 | – | MHz |

NPN general purpose transistors

BC337; BC337A; BC338

LIMITING VALUES

in accordance with the Absolute Maximum Rating System (IEC 134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|------------------|-------------------------------|----------------------------------|------|------|------|
| V _{CEO} | collector-base voltage | open emitter | | | |
| | BC337 | | – | 50 | V |
| | BC337A | | – | 60 | V |
| | BC338 | | – | 30 | V |
| V _{CEO} | collector-emitter voltage | open base | | | |
| | BC337 | | – | 45 | V |
| | BC337A | | – | 60 | V |
| | BC338 | | – | 25 | V |
| V _{EB0} | emitter-base voltage | open collector | – | 5 | V |
| I _C | collector current (DC) | | – | 500 | mA |
| I _{CM} | peak collector current | | – | 1 | A |
| I _{BM} | peak base current | | – | 200 | mA |
| P _{tot} | total power dissipation | T _{amb} ≤ 25 °C; note 1 | – | 625 | mW |
| T _{stg} | storage temperature | | –65 | +150 | °C |
| | junction temperature | | – | 150 | °C |
| T _{amb} | operating ambient temperature | | –65 | +150 | °C |

note

Transistor mounted on an FR4 printed-circuit board.

THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---------------------|---------------------------------------------|------------|-------|------|
| θ _{th j-a} | thermal resistance from junction to ambient | note 1 | 0.2 | K/mW |

note

Transistor mounted on an FR4 printed-circuit board.

NPN general purpose transistors

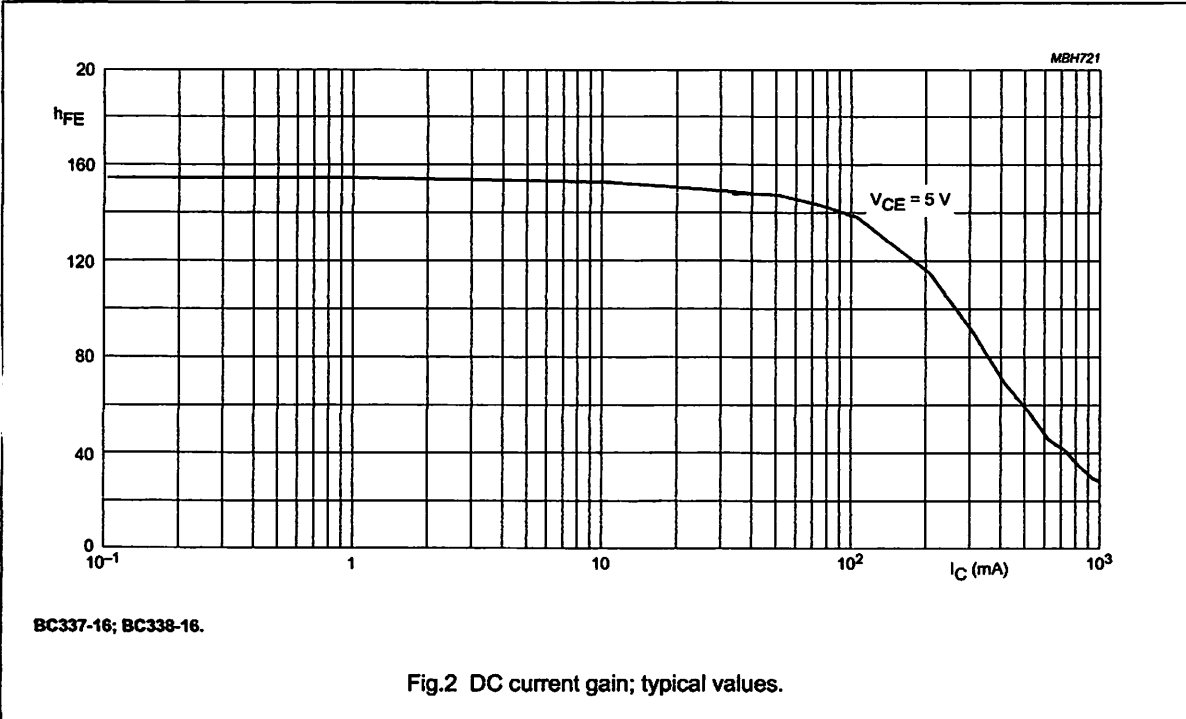
BC337; BC337A; BC338

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

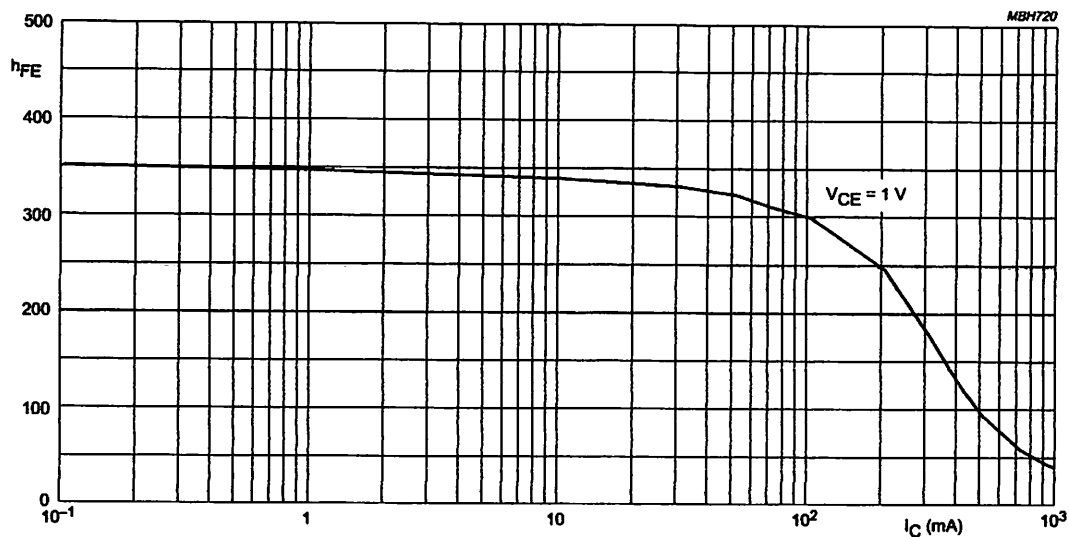
| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--------------------|-------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------|------|------|------|
| I _{CBO} | collector cut-off current | I _E = 0; V _{CB} = 20 V | - | - | 100 | nA |
| | | I _E = 0; V _{CB} = 20 V; T _j = 150 °C | - | - | 5 | µA |
| I _{EBO} | emitter cut-off current | I _C = 0; V _{EB} = 5 V | - | - | 100 | nA |
| h _{FE} | DC current gain BC337; BC338 BC337A BC337-16; BC338-16 BC337-25; BC338-25 BC337-40; BC338-40 | I _C = 100 mA; V _{CE} = 1 V; see Figs 2, 3 and 4 | 100 | - | 600 | |
| | | | 100 | - | 400 | |
| | | | 100 | - | 250 | |
| | | | 160 | - | 400 | |
| | | | 250 | - | 600 | |
| h _{FE} | DC current gain | I _C = 500 mA; V _{CE} = 1 V; see Figs 2, 3 and 4 | 40 | - | - | |
| V _{CEsat} | collector-emitter saturation voltage | I _C = 500 mA; I _B = 50 mA | - | - | 700 | mV |
| V _{BE} | base-emitter voltage | I _C = 500 mA; V _{CE} = 1 V; note 1 | - | - | 1.2 | V |
| C _c | collector capacitance | I _E = I _B = 0; V _{CB} = 10 V; f = 1 MHz | - | 5 | - | pF |
| f _T | transition frequency | I _C = 10 mA; V _{CE} = 5 V; f = 100 MHz | 100 | - | - | MHz |

- Note**
- V_{BE} decreases by about 2 mV/K with increasing temperature.



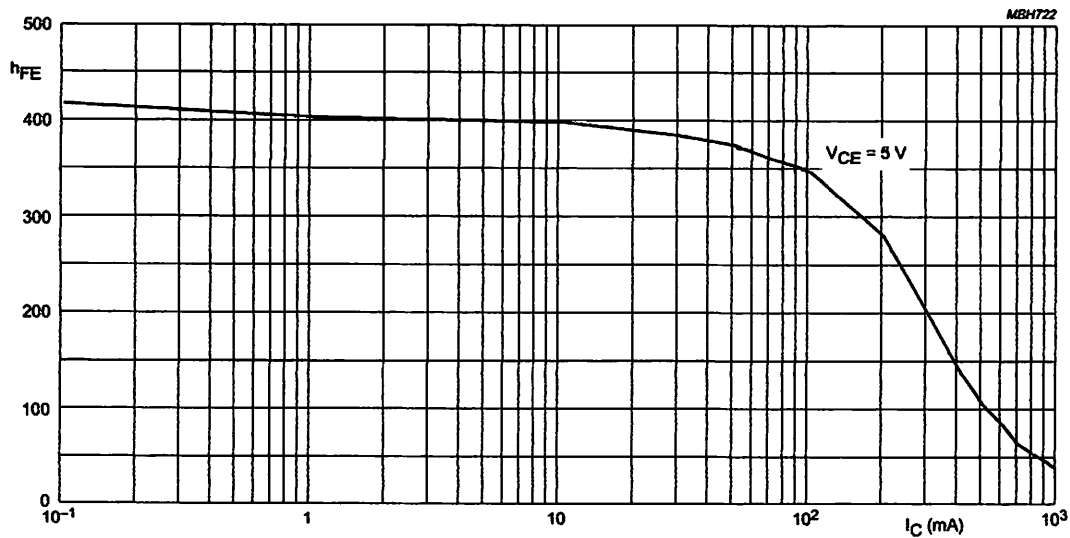
NPN general purpose transistors

BC337; BC337A; BC338



BC337-25; BC3378-25.

Fig.3 DC current gain; typical values.



BC337-40; BC338-40.

Fig.4 DC current gain; typical values.

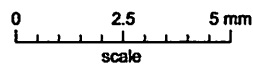
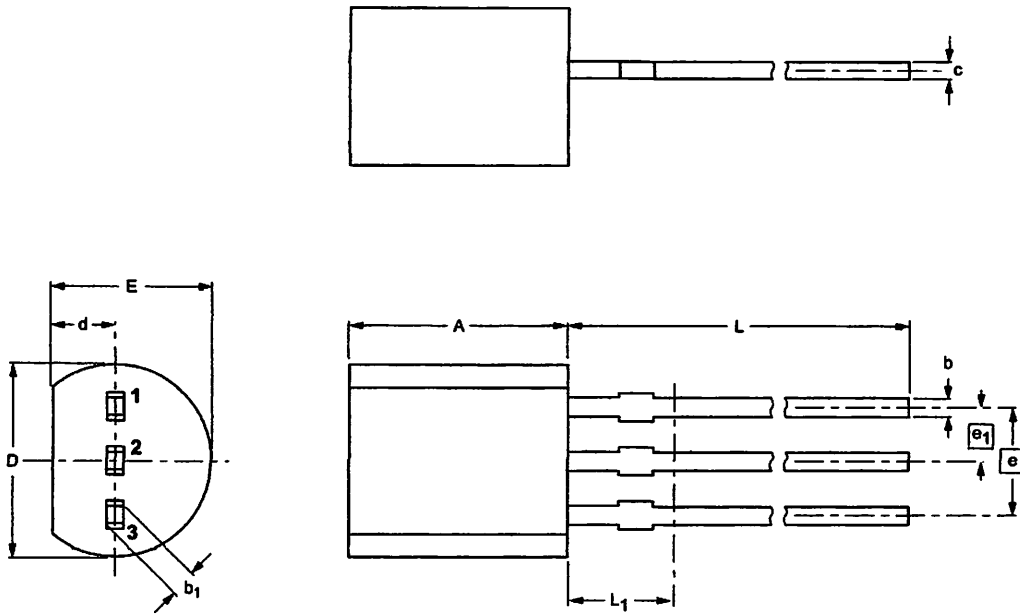
NPN general purpose transistors

BC337; BC337A; BC338

PACKAGE OUTLINE

Plastic single-ended leaded (through hole) package; 3 leads

SOT54



DIMENSIONS (mm are the original dimensions)

| UNIT | A | b | b ₁ | c | D | d | E | e | e ₁ | L | L ₁ (1) |
|------|------------|--------------|----------------|--------------|------------|------------|------------|------|----------------|--------------|--------------------|
| mm | 5.2 5.0 | 0.48 0.40 | 0.66 0.56 | 0.45 0.40 | 4.8 4.4 | 1.7 1.4 | 4.2 3.6 | 2.54 | 1.27 | 14.5 12.7 | 2.5 |

Note

1. Terminal dimensions within this zone are uncontrolled to allow for flow of plastic and terminal irregularities.

| OUTLINE VERSION | REFERENCES | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|-------|-------|---------------------|------------|
| | IEC | JEDEC | EIAJ | | |
| SOT54 | | TO-92 | SC-43 | | 97-02-28 |

NPN general purpose transistors**BC337; BC337A; BC338****DEFINITIONS**

| | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Data Sheet Status | |
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| Limiting values | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| Application information | |
| Where application information is given, it is advisory and does not form part of the specification. | |

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 34 Waterloo Road, NORTH RYDE, NSW 2113,
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213,
Tel. +43 1 60 101, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 689 211, Fax. +359 2 689 102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +852 2319 7888, Fax. +852 2319 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,
Tel. +45 32 88 2636, Fax. +45 31 57 1949

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615800, Fax. +358 9 61580/xxx

France: 4 Rue du Port-aux-Vins, BP317, 92156 SURESNES Cedex,
Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 23 53 60, Fax. +49 40 23 536 300

Greece: No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,
Tel. +30 1 4894 339/239, Fax. +30 1 4814 240

Hungary: see Austria

India: Philips INDIA Ltd, Shivsagar Estate, A Block, Dr. Annie Besant Rd.
Wortii, MUMBAI 400 018, Tel. +91 22 4938 541, Fax. +91 22 4938 722

Indonesia: see Singapore

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, TEL AVIV 61180,
Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108,
Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4890

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Saicedo Village, P.O. Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

Poland: Ul. Lukiska 10, PL 04-123 WARSZAWA,
Tel. +48 22 612 2831, Fax. +48 22 612 2327

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 1231,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,
Tel. +27 11 470 5911, Fax. +27 11 470 5494

South America: Rua do Rocio 220, 5th floor, Suite 51,
04552-903 São Paulo, SÃO PAULO - SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 829 1849

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 3 301 6312, Fax. +34 3 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 632 2000, Fax. +46 8 632 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2686, Fax. +41 1 481 7730

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2870, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,
Tel. +90 212 279 2770, Fax. +90 212 282 6707

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 625 344, Fax. +381 11 635 777

For all other countries apply to: Philips Semiconductors, Marketing & Sales Communications,
Building BE-p, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

Internet: <http://www.semiconductors.philips.com>

© Philips Electronics N.V. 1997

SCA53

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner.

The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Printed in The Netherlands

117047/00/02/pp8

Date of release: 1997 Mar 10

Document order number: 9397 750 01933

Let's make things better.

Philips
Semiconductors

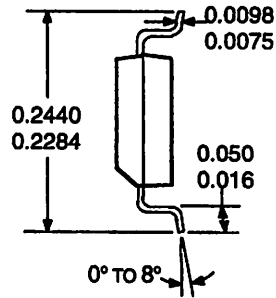
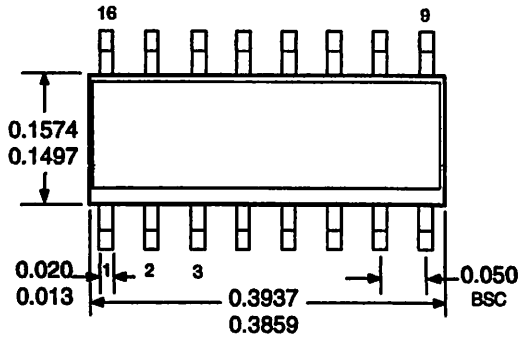


PHILIPS

**2003 THRU 2024
HIGH-VOLTAGE,
HIGH-CURRENT
DARLINGTON ARRAYS**

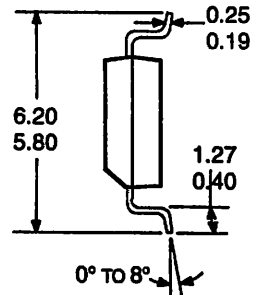
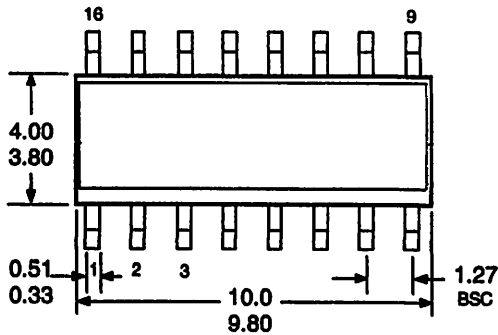
PACKAGE DESIGNATOR "L"

Dimensions in Inches
(for reference only)



Dwg. MA-007-16 In

Dimension in Millimeters
(controlling dimensions)



Dwg. MA-007-16A mm

- OTES: 1. Lead spacing tolerance is non-cumulative.
2. Exact body and lead configuration at vendor's option within limits shown.

**2003 THRU 2024
HIGH-VOLTAGE,
HIGH-CURRENT
ARLINGTON ARRAYS**

The products described here are manufactured under one or more U.S. patents or U.S. patents pending.

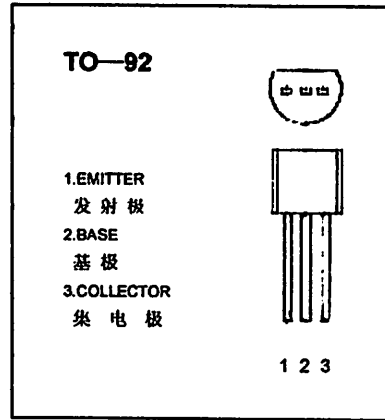
Allegro MicroSystems, Inc. reserves the right to make, from time to time, such departures from the detail specifications as may be required to permit improvements in the performance, reliability, or manufacturability of its products. Before placing an order, the user is cautioned to verify that the information being relied upon is current.

Allegro products are not authorized for use as critical components in life-support devices or systems without express written approval.

The information included herein is believed to be accurate and reliable. However, Allegro MicroSystems, Inc. assumes no responsibility for its use; nor for any infringement of patents or other rights of third parties which may result from its use.



115 Northeast Cutoff, Box 15036
Worcester, Massachusetts 01615-0036 (508) 853-5000



FEATURES

特 征

- Power dissipation (最大耗散功率)
 $P_{CM} : 0.625 \text{ W (Tamb=25}^\circ\text{C)}$
- Collector current (最大集电极电流)
 $I_{CM} : 0.5 \text{ A}$
- Collector-base voltage (集电极-基极击穿电压)
 $V_{(BR)CBO} : 45 \text{ V}$

ELECTRICAL CHARACTERISTICS (Tamb=25°C unless otherwise specified)

电 特 性 (环境温度 除非另有规定)

| Parameter 参 数 | Symbol 符 号 | Test conditions 测 试 条 件 | MIN 最 小 值 | TYP 典 型 值 | MAX 最 大 值 | UNIT 单 位 |
|------------------------------------------------------|---------------|---------------------------------------------------------------------|--------------|--------------|--------------|---------------|
| Collector-base breakdown voltage 集电极--基极击穿电压 | $V_{(BR)CBO}$ | $I_C = 100 \mu\text{A}, I_E = 0$ | 45 | | | V |
| Collector-emitter breakdown voltage 集电极--发射极击穿电压 | $V_{(BR)CEO}$ | $I_C = 0.1 \text{ mA}, I_B = 0$ | 25 | | | V |
| Emitter-base breakdown voltage 发射极--基极击穿电压 | $V_{(BR)EBO}$ | $I_E = 100 \mu\text{A}, I_C = 0$ | 5 | | | V |
| Collector cut-off current 集电极--基极截止电流 | I_{CBO} | $V_{CB} = 40 \text{ V}, I_E = 0$ | | | 0.1 | μA |
| Collector cut-off current 集电极--发射极截止电流 | I_{CEO} | $V_{CE} = 20 \text{ V}, I_B = 0$ | | | 0.1 | μA |
| Emitter cut-off current 发射极--基极截止电流 | I_{EBO} | $V_{EB} = 5 \text{ V}, I_C = 0$ | | | 0.1 | μA |
| DC current gain(note) 直 流 电 流 增 益 | $H_{FE(1)}$ | $V_{CE} = 1 \text{ V}, I_C = 50 \text{ mA}$ | 64 | | 300 | |
| | $H_{FE(2)}$ | $V_{CE} = 1 \text{ V}, I_C = 500 \text{ mA}$ | 40 | | | |
| Collector-emitter saturation voltage 集电极--发射极饱和压降 | $V_{CE(sat)}$ | $I_C = 500 \text{ mA}, I_B = 50 \text{ mA}$ | | | 0.6 | V |
| Base-emitter saturation voltage 基极-发射极饱和压降 | $V_{BE(sat)}$ | $I_C = 500 \text{ mA}, I_B = 50 \text{ mA}$ | | | 1.2 | V |
| Base-emitter voltage 基极--发射极正向电压 | V_{BE} | $I_E = 100 \text{ mA}$ | | | 1.4 | V |
| Transition frequency 特 征 频 率 | f_T | $V_{CE} = 6 \text{ V}, I_C = 20 \text{ mA}$ $f = 30 \text{ MHz}$ | 150 | | | MHz |

CLASSIFICATION OF $H_{FE(1)}$ (分类)

| Rank 档 次 | D | E | F | G | H | I |
|--------------|-------|--------|--------|---------|---------|---------|
| Range 范 围 | 64-91 | 78-112 | 96-135 | 112-166 | 144-220 | 190-300 |

Reliability Test Item And Condition

The reliability of products shall be satisfied with items listed below.

Confidence level : 90%

LTPD : 10%

| NO. | Item | Test Conditions | Test Hours/ Cycles | Sample Sizes | Failure Judgement Criteria | Ac/Re |
|-----|------------------------------------|------------------------------------------------------------------------------------------|-----------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1 | Solder Heat | TEMP. : 260°C ± 5°C | 10secs | 22pcs | $I_R \geq U \times 2$ $E_e \leq L \times 0.8$ $V_F \geq U \times 1.2$ U : Upper Specification Limit L : Lower Specification Limit | 0/1 |
| 2 | Temperature Cycle | H : +85°C 30mins \updownarrow 5mins \updownarrow L : -55°C 30mins | 50Cycles | 22pcs | | 0/1 |
| 3 | Thermal Shock | H : +100°C 5mins \updownarrow 10secs \updownarrow L : -10°C 5mins | 50Cycles | 22pcs | | 0/1 |
| 4 | High Temperature Storage | TEMP. : +100°C | 1000hrs | 22pcs | | 0/1 |
| 5 | Low Temperature Storage | TEMP. : -55°C | 1000hrs | 22pcs | | 0/1 |
| 6 | DC Operating Life | $I_F = 20\text{mA}$ | 1000hrs | 22pcs | | 0/1 |
| 7 | High Temperature/ High Humidity | 85°C / 85% R.H | 1000hrs | 22pcs | | 0/1 |

EVERLIGHT ELECTRONICS CO., LTD.

 Office: No 25, Lane 76, Sec 3, Chung Yang Rd,
 Tucheng, Taipei 236, Taiwan, R.O.C

Tel: 886-2-2267-2000, 2267-9936

Fax: 886-2267-6244, 2267-6189, 2267-6306

<http://www.everlight.com>

Device No:DIR-033-017

Typical Electro-Optical Characteristics Curves

Fig.5 Relative Intensity vs. Forward Current

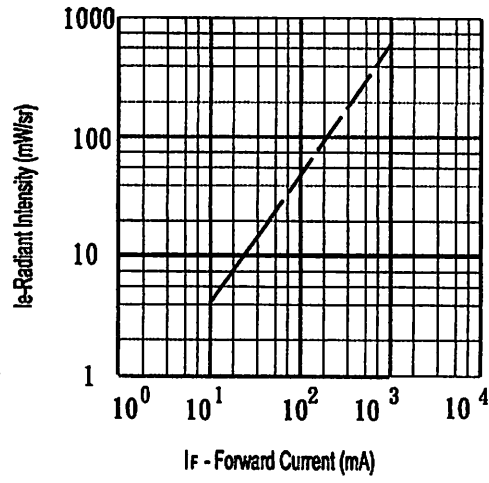


Fig.6 Relative Radiant Intensity vs. Angular Displacement

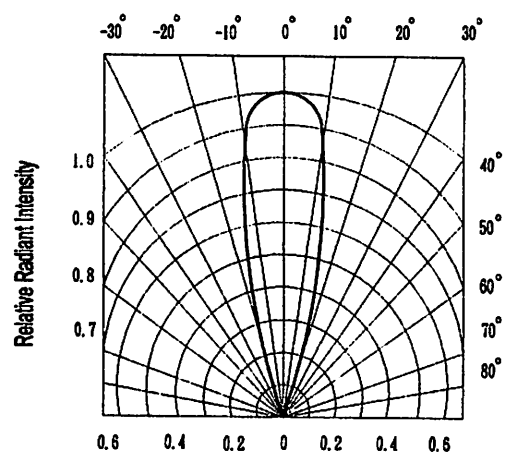


Fig.7 Relative Intensity vs. Ambient Temperature (° C)

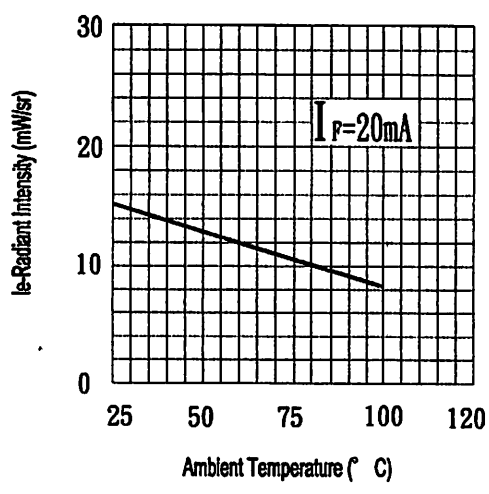
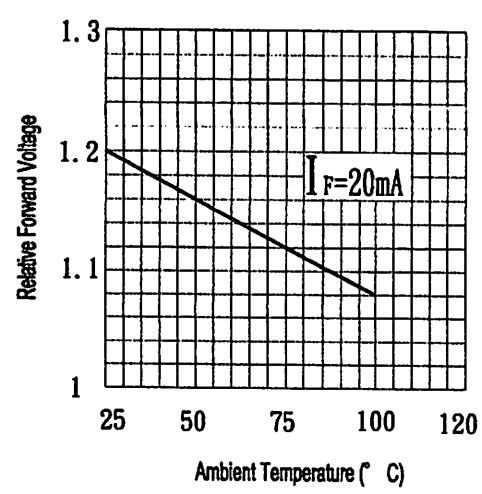


Fig.8 Forward Current vs. Ambient Temperature (° C)



Device No:DIR-033-017

Typical Electro-Optical Characteristics Curves

Fig.1 Forward Current vs. Ambient Temperature

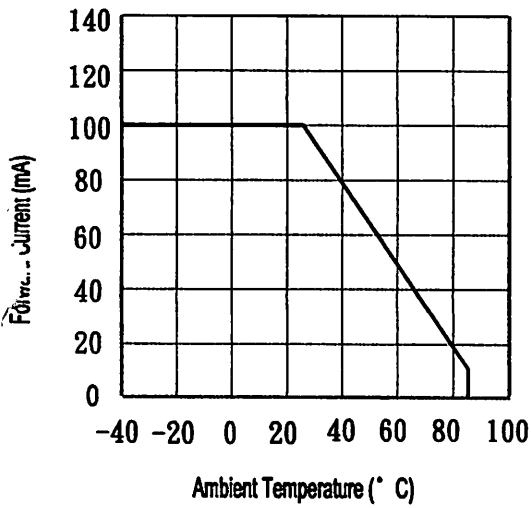


Fig.2 Spectral Distribution

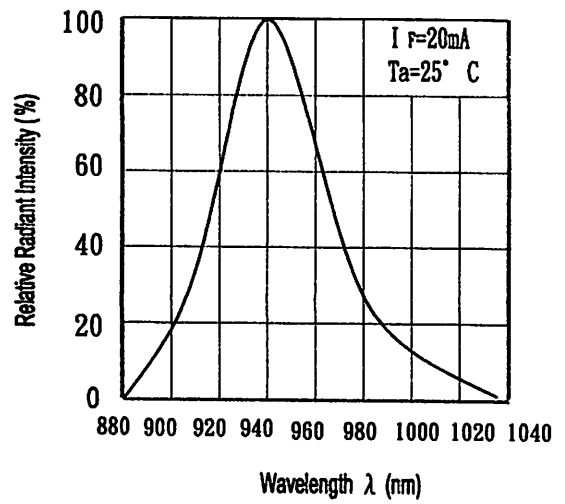


Fig.3 Peak Emission Wavelength vs. Ambient Temperature

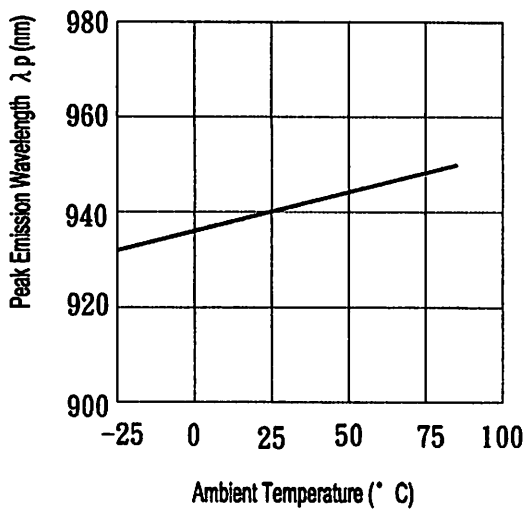
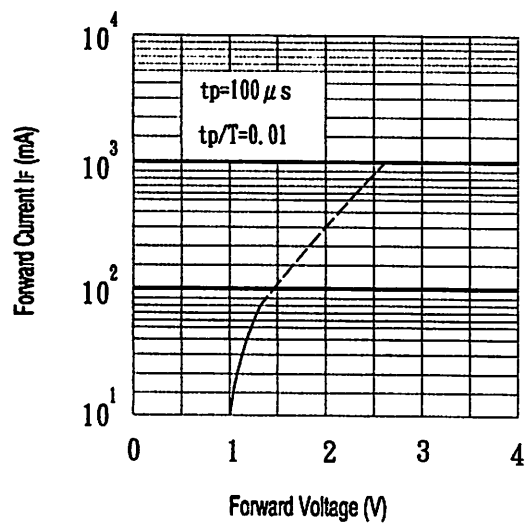


Fig.4 Forward Current vs. Forward Voltage



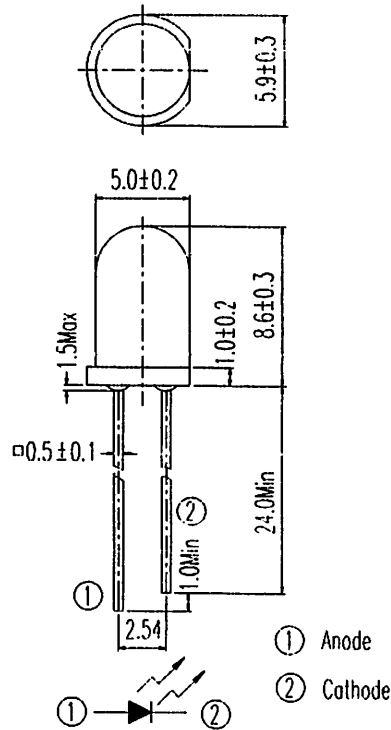
Device No:DIR-033-017

Electro-Optical Characteristics (Ta=25°C)

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Units |
|--------------------|----------------|-------------------------------------------------------------|------|------|------|-------|
| Radiant Intensity | E _e | I _F =20mA | 7.8 | 15 | -- | mW/sr |
| | | I _F =100mA Pulse Width ≤ 100 μs and Duty ≤ 1% | -- | 70 | -- | |
| | | I _F =1A Pulse Width ≤ 100 μs and Duty ≤ 1% | -- | 700 | -- | |
| Peak Wavelength | λ _p | I _F =20mA | -- | 940 | -- | nm |
| Spectral Bandwidth | Δλ | I _F =20mA | -- | 45 | -- | nm |
| Forward Voltage | V _F | I _F =20mA | -- | 1.2 | 1.5 | V |
| | | I _F =100mA Pulse Width ≤ 100 μs and Duty ≤ 1% | -- | 1.4 | 1.8 | |
| | | I _F =1A Pulse Width ≤ 100 μs and Duty ≤ 1% | -- | 2.6 | 4.0 | |
| Reverse Current | I _R | V _R =5V | -- | -- | 10 | μA |
| View Angle | 2θ 1/2 | I _F =20mA | -- | 30 | -- | deg |

Device No:DIR-033-017

Package Dimensions



- Notes:** 1.All dimensions are in millimeters
2.Tolerances unless dimensions $\pm 0.25\text{mm}$

Absolute Maximum Ratings (Ta=25°C)

| Parameter | Symbol | Rating | Units |
|-------------------------------------------------------------|-----------|-----------|-------|
| Continuous Forward Current | I_F | 100 | mA |
| Peak Forward Current | I_{FP} | 1.0 | A |
| Reverse Voltage | V_R | 5 | V |
| Operating Temperature | T_{opr} | -40 ~ +85 | °C |
| Storage Temperature | T_{str} | -40 ~ +85 | °C |
| Soldering Temperature | T_{sol} | 260 | °C |
| Power Dissipation at(or below) 25°C Free Air Temperature | P_d | 150 | mW |

- Notes:** *1: I_{FP} Conditions--Pulse Width $\leq 100 \mu s$ and Duty $\leq 1\%$.
*2:Soldering time ≤ 5 seconds.

Device No:DIR-033-017

Technical Data Sheet

5mm Infrared LED, T-1 3/4

IR333C/H2

Features

- High reliability
- 2.54mm lead spacing
- Low forward voltage
- Good spectral matching to Si photodetector
- High radiant intensity

Descriptions

EVERLIGHT's infrared emitting diode (IR333C/H2) is a high intensity diode, molded in a water clear plastic package.

The device is spectrally matched with phototransistor, photodiode and infrared receive module.

Applications

- Free air transmission system
- Optoelectronic switch
- Floppy disk drive
- Infrared applied system
- Smoke detector

Device Selection Guide

| LED Part No. | Chip | Lens Color |
|--------------|----------|-------------|
| | Material | |
| IR | GaAlAs | Water clear |

Device No:DIR-033-017

LIQUID CRYSTAL DISPLAY MODULE

M 1 6 3 2

USER MANUAL

Seiko Instruments Inc.

PREFACE

This manual describes technical informations on functions and instructions of M1632 from Seiko Instruments Inc. Please read this instruction manual carefully to understand all the module functions and make the best use of them. Description details may be changed without notice.

Revision Record

| <u>Edition</u> | <u>Revision</u> | <u>Date</u> |
|----------------|--------------------|-------------|
| 1 | Original | April 1985 |
| 2 | Completely revised | Jan. 1987 |

© Seiko Instruments Inc. 1987

Printed in Japan

1. GENERAL

1.1 General

The M1632 is a low-power-consumption dot-matrix liquid crystal display (LCD) module with a high-contrast wide-view TN LCD panel and a CMOS LCD drive controller built in. The controller has a built-in character generator ROM/RAM, and display data RAM. All the display functions are controlled by instructions and the module can easily be interfaced with an MPU. This makes the module applicable to a wide range of purposes including terminal display units for microcomputers and display units for measuring gages.

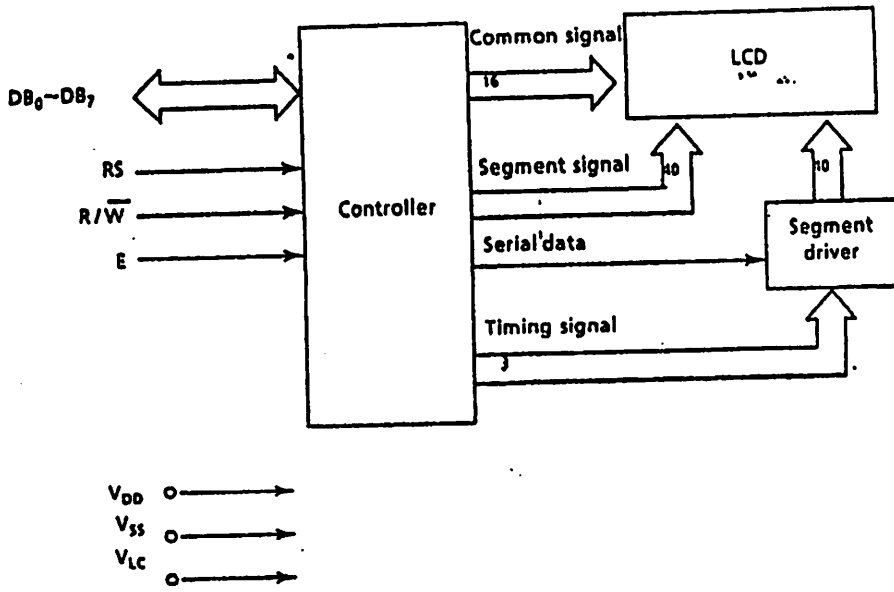
1.2 Features

- 16-character, two-line TN liquid crystal display of 5 x 7 dot matrix + cursor
- Duty ratio: 1/16
- Character generator ROM for 192 character types.
(character font: 5 x 7 dot matrix)
- Character generator RAM for eight character types (program write)
(character font: 5 x 7 dot matrix)
- 80 x 8 bit display data RAM (80 characters maximum)
- Interface with four-bit and eight-bit MPUs possible
- Display data RAM and character generator RAM readable from MPU
- Many instruction functions

Display Clear, Cursor Home, Display ON/OFF, Cursor ON/OFF, Display Character Blink, Cursor Shift, and Display Shift

- Built-in oscillator circuit
- +5 V single power supply
- Built-in automatic reset circuit at power-on
- CMOS process
- Operating temperature range: 0°C to 50°C

1.4 Block Diagram



5 Absolute Maximum Ratings

$V_{SS} = 0V$

| Item | Symbol | Standard | Unit | Remarks |
|-----------------------|-----------|-----------------------------------|------|-----------|
| Power supply voltage | V_{DD} | - 0.3 to + 7.0 | V | |
| | V_{LC} | $V_{DD} - 13.5$ to $V_{DD} + 0.3$ | V | |
| Input voltage | V_{in} | - 0.3 to $V_{DD} + 0.3$, | V | |
| Operating temperature | T_{opr} | 0 to + 50 | °C | |
| Storage temperature | T_{stg} | - 20 to + 60 | °C | At 50% RH |

6 Electrical Characteristics

$V_{DD} = 5V \pm 5\%$, $V_{SS} = 0V$, $T_A = 0^\circ C$ to $50^\circ C$

| Item | | Symbol | Conditions | Standard | | | Unit |
|-------------------------|------|-----------|------------------------------------|-------------|------|-------------|------|
| | | | | Min. | Typ. | Max. | |
| Input voltage | High | V_{IH1} | | 2.2 | - | V_{DD} | V |
| | Low | V_{IL1} | | 0 | - | 0.6 | V |
| Output voltage (TTL) | High | V_{OH1} | $-I_{OH} = 0.205$ mA | 2.4 | - | - | V |
| | Low | V_{OL1} | $I_{OL} = 1.2$ mA | - | - | 0.4 | V |
| Output voltage (CMOS) | High | V_{OH2} | $-I_{OH} = 0.04$ mA | $0.9V_{DD}$ | - | - | V |
| | Low | V_{OL2} | $I_{OL} = 0.04$ mA | - | - | $0.1V_{DD}$ | V |
| Power supply voltage | | V_{DD} | | 4.75 | 5.00 | 5.25 | V |
| | | $-V_{LC}$ | $V_{DD} = 5V$, $T_A = 25^\circ C$ | - | 0.25 | - | V |
| Current consumption | | I_{DD} | | - | 2.0 | 3.0 | mA |
| | | I_{LC} | $V_{LC} = 0.25V$ | - | - | 1.0 | mA |
| Clock oscillation freq. | | f_{osc} | Resistance oscillation | 190 | 270 | 350 | kHz |

1.7 Optical Characteristics

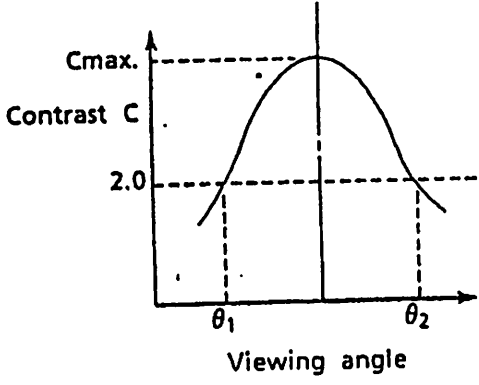
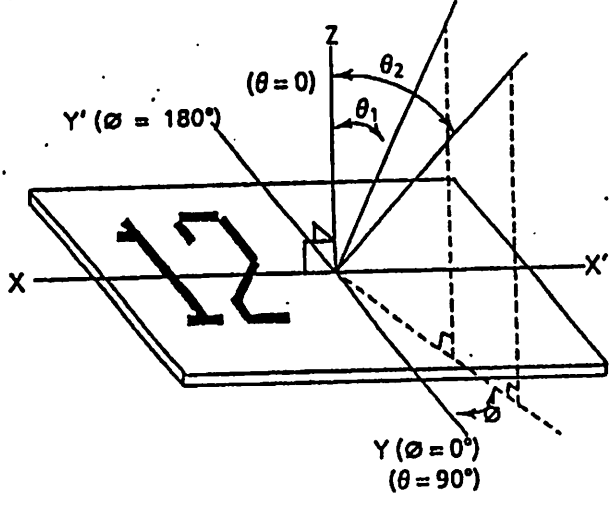
1.7.1 Optical characteristics

Maximum viewing angle: 6 o'clock ($\varnothing = 0^\circ$)
 $T_A = 25^\circ\text{C}$, $V_{opr} = 4.75\text{V}$

| Item | Symbol | Conditions | Min. | Typ. | Max. | Remarks |
|---------------|-----------------------|-----------------------------------------------|------|--------|--------|--------------------|
| Viewing angle | $\theta_2 - \theta_1$ | $C \geq 2.0$, $\varnothing = 0^\circ$ | 35 | - | - | See Notes 1 and 2. |
| Contrast | C | $\theta = 25^\circ$, $\varnothing = 0^\circ$ | 5 | 8 | - | See Note 3. |
| Rise time | t_{on} | $\theta = 25^\circ$, $\varnothing = 0^\circ$ | - | 60 ms | 70 ms | See Note 4. |
| Fall time | t_{off} | $\theta = 25^\circ$, $\varnothing = 0^\circ$ | - | 150 ms | 170 ms | See Note 4. |

Note 1: Definition of angles \varnothing and θ

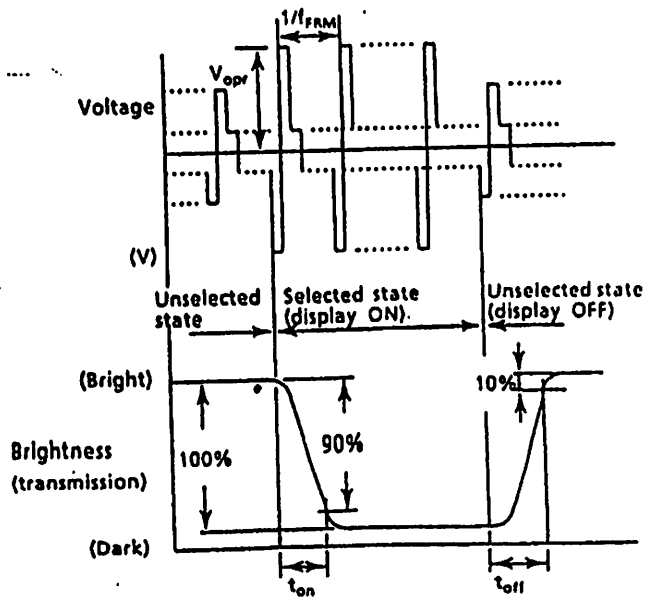
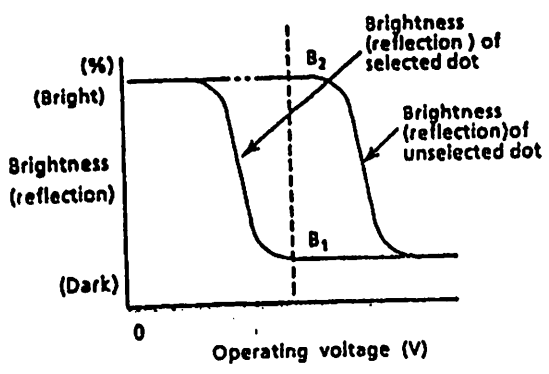
Note 2: Definition of viewing angles θ_1 and θ_2



Note 3: Definition of contrast C

Note 4: Definition of response time

$$C = \frac{\text{Brightness (reflection) of unselected dot (B2)}}{\text{Brightness (reflection) of selected dot (B1)}}$$



V_{opr} : Operating voltage (V)
 f_{FRM} : Frame frequency (Hz)
 t_{on} : Response time (rise)(ms)
 t_{off} : Response time (fall)(ms)

1.7.2 Recommended operating voltage

The viewing angle and screen contrast of the LCD panel can be varied by changing the liquid crystal operating voltage (V_{opr}), that is V_{LC} .

The optical characteristics is influenced by an ambient temperature. The recommended value of V_{opr} for an ambient temperatures are shown below.

| Temperature (°C) | 0 | 10 | 25 | 40 | 50 |
|-----------------------|------|------|------|------|------|
| Voltage V_{opr} (V) | 5.00 | 4.90 | 4.75 | 4.60 | 4.50 |

$$V_{opr} = V_{DD} - V_{LC}$$

OPERATING INSTRUCTIONS

2.1 Terminal Functions

Table 1 Terminal functions

| Signal name | No. of terminals | I/O | Destination | Function |
|------------------------------------|------------------|-------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DB ₀ to DB ₃ | 4 | I/O | MPU | Tristate bidirectional lower four data buses: Data is read from the module to the MPU or written to the module from the MPU through the buses. If the interface data is 4 bits, the signals are not used. |
| DB ₄ to DB ₇ | 4 | I/O | MPU | Tristate bidirectional upper four data buses: Data is read from the module to the MPU or written to the module from the MPU through the buses. DB ₇ is also used as a busy flag. |
| E | 1 | Input | MPU | Operation start signal: The signal activates data write or read. |
| R \overline{W} | 1 | Input | MPU | Read (R) and Write (W) selection signals 0: Write 1: Read |
| RS | 1 | Input | MPU | Register selection signals 0: Instruction register (Write) Busy flag and address counter (Read) 1: Data register (Write and Read) |
| V _{LC} | 1 | - | Power supply | Power supply terminal for driving liquid crystal display: The screen contrast can be varied by changing V _{LC} . |
| V _{DD} | 1 | - | Power supply | + 5 V |
| V _{SS} | 1 | - | Power supply | Ground terminal: 0 V |

2.2 Basic Operations

2.2.1 Registers

The controller has two kinds of eight-bit registers: the instruction register (IR) and the data register (DR). They are selected by the register select (RS) signal as shown in Table 2.

The IR stores instruction codes such as Display Clear and Cursor Shift, and the address information of display data RAM (DD RAM) and character generator RAM (CG RAM). They can be written from the MPU, but cannot be read to the MPU.

The DR temporarily stores data to be written into DD RAM or CG RAM, or read from DD RAM or CG RAM. When data is written into DD RAM or CG RAM from the MPU, the data in the DR is automatically written into DD RAM or CG RAM by internal operation. However, when data is read from DD RAM or CG RAM, the necessary data address is written into the IR. The specified data is read out to the DR and then the MPU reads it from the DR. After the read operation, the next address is set and DD RAM or CG RAM data at the address is read into the DR for the next read operation.

Table 2 Register selection

| RS | $\overline{R/W}$ | Operation |
|----|------------------|---------------------------------------------------------------------------------------------|
| 0 | 0 | IR selection, IR write. Internal operation : Display clear |
| 0 | 1 | Busy flag (DB ₇) and address counter (DB ₀ to DB ₆) read |
| 1 | 0 | DR selection, DR write. Internal operation : DR to DD RAM or CG RAM |
| 1 | 1 | DR selection, DR read. Internal operation : DD RAM or CG RAM to DR |

2.2.2 Busy flag (BF)

The flag indicates whether the module is ready to accept the next instruction. As shown in Table 2, the signal is output to DB₇ if RS = 0 and $\overline{R/W} = 1$. If the value is 1, the module is working internally and the instruction cannot be accepted. If the value is 0, the next instruction can be written. Therefore, the flag status needs to be checked before executing an instruction. If an instruction is executed without checking the flag status, wait for more than the execution time shown by 2.4 Instruction Outline.

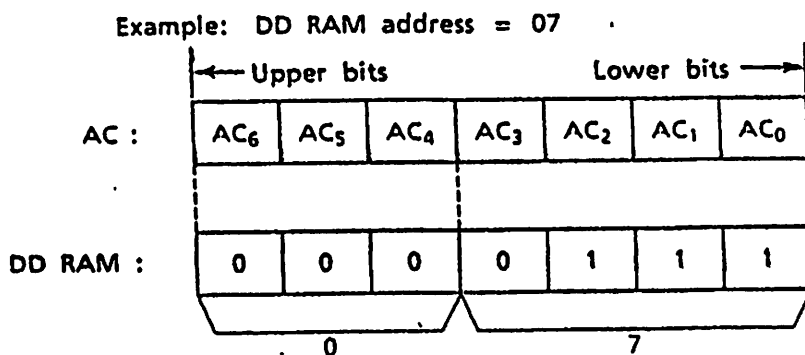
2.2.3 Address counter (AC)

The counter specifies an address when data is written into DD RAM or CG RAM and the data stored in DD RAM or CG RAM is read out. If an Address Set instruction (for DD RAM or CG RAM) is written in the IR, the address information is transferred from the IR to the AC. When display data is written into or read from DD RAM or CG RAM, the AC is automatically incremented or decremented by one according to the Entry Mode Set. The contents of the AC are output to DB₀ to DB₆ as shown in Table 2 if RS = 0 and $\overline{R/W} = 1$.

2.2.4 Display data RAM (DD RAM)

DD RAM has a capacity of up to 80 × 8 bits and stores display data of 80 eight-bit character codes. Some storage areas of DD RAM which are not used for display can be used as general data RAM.

A DD RAM address to be set in the AC is expressed in hexadecimal form as follows.



00H to 0FH of the DD RAM address is set in the line 1, and 40H to 4FH in the line 2.

Note : The addresses in the digit 16 of line 1 and the digit 1 of line 2 are not consecutive.

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

If the display is shifted, DD RAM address 00H to 27H are displayed in line 1 and 40H to 67H in line 2. The following figures are examples of display shifts.

***Left shift**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | Display digit |
|--------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----------------|
| Line 1 | 00 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | 10 | DD RAM address |
| Line 2 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F | 50 | |

***Right shift**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | Display digit |
|--------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----------------|
| Line 1 | 27 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | DD RAM address |
| Line 2 | 67 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | |

2.5 Character generator ROM (CG ROM)

Character generator ROM generates 192 types of 5 x 7 dot-matrix character patterns from eight-bit character codes.

Table 3 shows the correspondence between the CG ROM character codes and character patterns.

2.6 Character generator RAM (CG RAM)

CG RAM is used to create character patterns freely by programming. Eight types of character patterns can be written.

Table 4 shows the character patterns created from CG RAM addresses and data. To display a created character pattern, the character code in the left column of the table is written into DD RAM corresponding to the display position (digit). The areas not used for display are available as general data RAM.

Table 3 Correspondence between character codes and character patterns

| Upper bit 4 bit Lower 4 bit | 0 | 2 | 3 | 7 | 8 | 6 | 7 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|--------------------------------------|------------------|----|---|---|---|---|---|------|------|------|------|------|------|
| x x x 0000 | CG RAM (1) | | 0 | a | P | . | • | - | • | • | • | • | • |
| x x x 0001 | (2) | ! | 1 | A | Q | a | • | • | • | • | • | • | • |
| x x x 0010 | (3) | " | 2 | B | R | b | • | • | • | • | • | • | • |
| x x x 0011 | (4) | # | 3 | C | S | c | • | • | • | • | • | • | • |
| x x x 0100 | (5) | \$ | 4 | D | T | d | • | • | • | • | • | • | • |
| x x x 0101 | (6) | % | 5 | E | U | e | • | • | • | • | • | • | • |
| x x x 0110 | (7) | & | 6 | F | V | f | • | • | • | • | • | • | • |
| x x x 0111 | (8) | ' | 7 | G | W | g | • | • | • | • | • | • | • |
| x x x 1000 | (1) | (| 8 | H | X | h | • | • | • | • | • | • | • |
| x x x 1001 | (2) |) | 9 | I | Y | i | • | • | • | • | • | • | • |
| x x x 1010 | (3) | * | : | J | Z | j | • | • | • | • | • | • | • |
| x x x 1011 | (4) | + | ; | K | [| k | • | • | • | • | • | • | • |
| x x x 1100 | (5) | , | < | L |] | l | • | • | • | • | • | • | • |
| x x x 1101 | (6) | - | = | N | ^ | n | • | • | • | • | • | • | • |
| x x x 1110 | (7) | . | > | O | _ | o | • | • | • | • | • | • | • |
| x x x 1111 | (8) | / | ? | 0 | ~ | 0 | • | • | • | • | • | • | • |

Table 4 Relationships between CG RAM addresses and character codes (DD RAM) and character patterns (CG RAM data)

| Character code (DD RAM data) | | CG RAM address | | | | | | Character pattern (CG RAM data) | | | | | | | | |
|------------------------------|---|----------------|---|---|-------------|---|---|---------------------------------|---|---|---|-------------|---|---|---|----------------------------------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| ← Upper bit Lower bit → | | ← Upper bit | | | Lower bit → | | | ← Upper bit | | | | Lower bit → | | | | |
| 0 0 0 0 * 0 0 0 | | 0 0 0 | | | 0 | 0 | 0 | * * * | | | | 0 | 0 | 0 | 0 | Example of character pattern (R) |
| | | | | | 0 | 0 | 1 | ↑ | | | | 0 | 0 | 0 | 1 | |
| | | | | | 0 | 1 | 0 | | | | | 0 | 0 | 0 | 0 | |
| | | | | | 0 | 1 | 1 | | | | | 0 | 0 | 0 | 0 | |
| | | 0 0 0 | | | 1 | 0 | 0 | | | | | 0 | 0 | 0 | 0 | |
| | | | | | 1 | 0 | 1 | | | | | 0 | 0 | 0 | 1 | |
| | | | | | 1 | 1 | 0 | | | | | 0 | 0 | 0 | 0 | |
| | | | | | 1 | 1 | 1 | * * * | | | | 0 | 0 | 0 | 0 | |
| 0 0 0 0 * 0 0 1 | | 0 0 1 | | | 0 | 0 | 0 | * * * | | | | 0 | 0 | 0 | 0 | Example of character pattern (Y) |
| | | | | | 0 | 0 | 1 | ↑ | | | | 0 | 0 | 0 | 1 | |
| | | | | | 0 | 1 | 0 | | | | | 0 | 0 | 0 | 0 | |
| | | | | | 0 | 1 | 1 | | | | | 0 | 0 | 0 | 0 | |
| | | 0 0 1 | | | 1 | 0 | 0 | | | | | 0 | 0 | 0 | 0 | |
| | | | | | 1 | 0 | 1 | | | | | 0 | 0 | 0 | 1 | |
| | | | | | 1 | 1 | 0 | | | | | 0 | 0 | 0 | 0 | |
| | | | | | 1 | 1 | 1 | * * * | | | | 0 | 0 | 0 | 0 | |
| 0 0 0 0 * 1 1 1 | | 1 1 1 | | | 0 | 0 | 0 | * * * | | | | | | | | |
| | | | | | 0 | 0 | 1 | ↑ | | | | | | | | |
| | | | | | 1 | 0 | 0 | | | | | | | | | |
| | | | | | 1 | 0 | 1 | | | | | | | | | |
| | | | | | 1 | 1 | 0 | | | | | | | | | |
| | | | | | 1 | 1 | 1 | * * * | | | | | | | | |

- Notes:
- In CG RAM data, 1 corresponds to Selection and 0 to Non-selection on the display.
 - Character code bits 0 to 2 and CG RAM address bits 3 to 5 correspond with each other (three bits, eight types).
 - CG RAM address bits 0 to 2 specify a line position for a character pattern. Line 8 of a character pattern is the cursor position where the logical sum of the cursor and CG RAM data is displayed. Set the data of line 8 to 0 to display the cursor. If the data is changed to 1, one bit lights, regardless of the cursor.

The character pattern column positions correspond to CG RAM data bits 0 to 4 and bit 4 comes to the left end. CG RAM data bits 5 to 7 are not displayed but can be used as general data RAM.

When reading a character pattern from CG RAM, set to 0 all of character code bits 4 to 7. Bits 0 to 2 determine which pattern will be read out. Since bit 3 is not valid, 00H and 08H select the same character.

3 Timing Characteristics

2.3.1 Write timing characteristics

$V_{DD} = 5.0V \pm 5\%$, $V_{SS} = 0V$, $T_A = 0^\circ C$ to $50^\circ C$

| Item | Symbol | Standard | | Unit | |
|---------------------------|-----------------------------------|-----------|------|------|----|
| | | Min. | Max. | | |
| Enable cycle time | t_{cycE} | 1000 | - | ns | |
| Enable pulse width | High level | PW_{EH} | 450 | - | ns |
| Enable rise and fall time | t_{Er}, t_{Ef} | - | 25 | ns | |
| Setup time | $RS, \overline{RW} \rightarrow E$ | t_{AS} | 140 | - | ns |
| Address hold time | t_{AH} | 10 | - | ns | |
| Data setup time | t_{DSW} | 195 | - | ns | |
| Data hold time | t_H | 10 | - | ns | |

Write operation

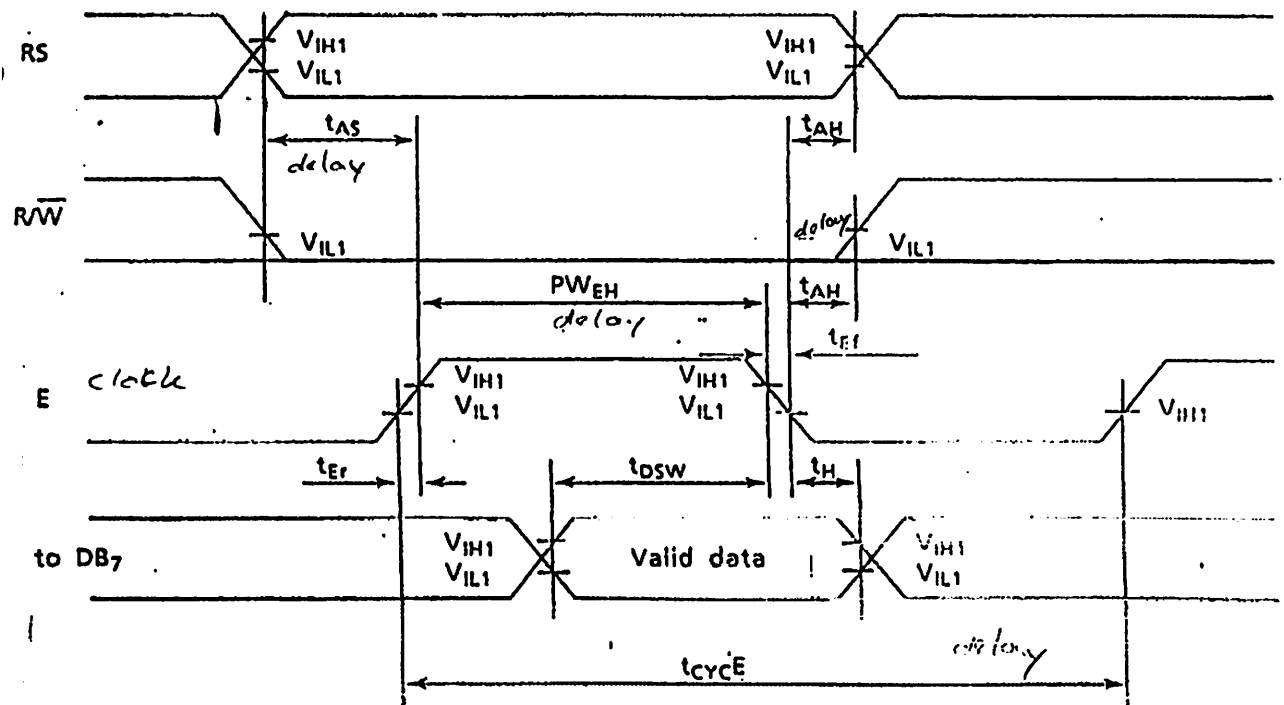


Figure 3 Data write from MPU to module

1.3.2 Read timing characteristics

$V_{DD} = 5.0V \pm 5\%$, $V_{SS} = 0V$; $T_A = 0^\circ\text{C} \text{ to } 50^\circ\text{C}$

| Item | Symbol | Standard | | Unit | |
|---------------------------|------------------------------------|-----------|------|------|----|
| | | Min. | Max. | | |
| Enable cycle time | t_{cycE} | 1000 | - | ns | |
| Enable pulse width | High level | PW_{EH} | 450 | - | ns |
| Enable rise and fall time | t_{Er}, t_{Ef} | - | 25 | ns | |
| Setup time | $RS, \overline{R/W} \rightarrow E$ | t_{AS} | 140 | - | ns |
| Address hold time | t_{AH} | 10 | - | ns | |
| Data delay time | t_{DDR} | - | 320 | ns | |
| Data hold time | t_{H} | 20 | - | ns | |

Read operation

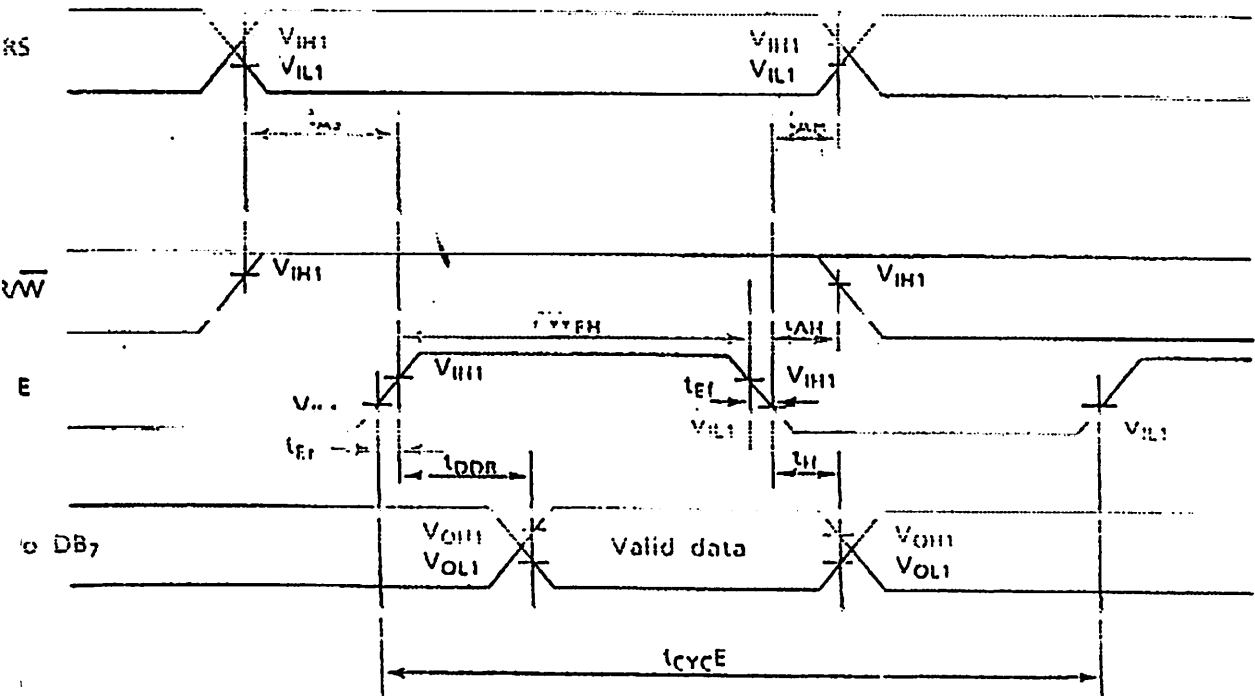


Figure 4 Data read from module to MPU

Instruction Outline

Table 5 List of instructions

| Instruction | Code | | | | | | | | | | | Function | Execution time |
|---------------------------------|------|----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------------------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|----------------|
| | RS | NW | DB ₇ | DB ₆ | DB ₅ | DB ₄ | DB ₃ | DB ₂ | DB ₁ | DB ₀ | | | |
| Display clear ✓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Clears all display and returns cursor to home position (address 0) | 1.64 ms |
| Cursor Home ✓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | • | Returns cursor to home position. Shifted display returns to home position and DD RAM contents do not change. | 1.64 ms |
| Entry Mode Set ✓ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | S | Sets direction of cursor movement and whether display will be shifted when data is written or read | 40 μs |
| Display ON / OFF control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | B | C | D | Turns ON/OFF total display (D) and cursor (C), and makes cursor position column start blinking (B) | 40 μs |
| Cursor/Display Shift | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | • | • | • | Moves cursor and shifts display without changing DD RAM contents | 40 μs |
| Function Set ✓ | 0 | 0 | 0 | 0 | 1 | R/L | 1 | • | • | • | • | Sets interface data length (DL) | 40 μs |
| CG RAM Address Set | 0 | 0 | 0 | 1 | Acc | | | | | | Sets CG RAM address to start transmitting or receiving CG RAM data | 40 μs | |
| DD RAM Address Set | 0 | 0 | 1 | Add | | | | | | Sets DD RAM address to start transmitting or receiving DD RAM data | 40 μs | | |
| BF/Address Read | 0 | 1 | 0 | AC | | | | | | Reads BF indicating module in internal operation and AC contents (used for both CG RAM and DD RAM) | 0 μs | | |
| Data Write to CG RAM or DD RAM | 1 | 0 | Write Data | | | | | | Writes data into DD RAM or CG RAM | 40 μs | | | |
| Data Read from CG RAM or DD RAM | 1 | 1 | Read Data | | | | | | Reads data from DD RAM or CG RAM | 40 μs | | | |

Invalid bit
 : CG RAM address
 : DD RAM address

I/D = 1 : Increment
 I/D = 0 : Decrement

C = 1 : Cursor ON
 C = 0 : Cursor OFF

R/L = 1 : Right shift
 R/L = 0 : Left shift

S = 1 : Display shift
 S = 0 : No display shift

B = 1 : Blink ON
 B = 0 : Blink OFF

DL = 1 : 8 bits
 DL = 0 : 4 bits

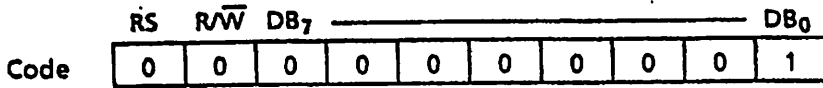
D = 1 : Display ON
 D = 0 : Display OFF

S/C = 1 : Display shift
 S/C = 0 : Cursor movement

BF = 1 : Internal operation in progress
 BF = 0 : Instruction can be accepted

Instruction Details

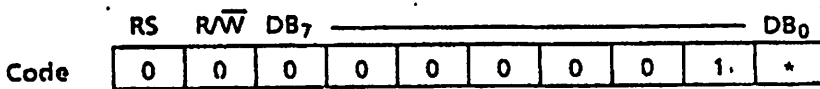
Display Clear



Display Clear clears all display and returns cursor to home position (address 0). Space code 20 (hexadecimal) is written into all the addresses of DD RAM, and DD RAM address 0 is set to the AC. If shifted, the display returns to the original position. After execution of the Display Clear instruction, the entry mode is incremented.

Note : When executing the Display Clear instruction, follow the restrictions listed in Table 6.

Cursor Home



* : Invalid bit

Cursor Home returns cursor to home position (address 0). DD RAM address 0 is set to the AC. The cursor returns to the home position. If shifted, the display returns to the original position. The DD RAM contents do not change. If the cursor or blinking is ON, it returns to the left side.

Note : When executing the Cursor Home instruction, follow the restrictions listed in Table 6.

Table 6 Restrictions on execution of Display Clear and Cursor Home instructions

| Conditions of use | Restrictions |
|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| When executing the Display Clear or Cursor Home instruction when the display is shifted (after execution of Display Shift instruction) | The Cursor Home instruction should be executed again immediately after the Display Clear or Cursor Home instruction is executed. Do not leave an interval of a multiple of $\frac{1}{\text{oscillation frequency}}$ second after the first execution. Example : 1/1000000 sec for 1000 kHz *osc: Oscillation frequency |
| When 23H, 27H, 63H, or 67H is used as a DD RAM address to execute Cursor Home instruction | When executing the Cursor Home instruction, the data of the four DD RAM addresses given at the left should be saved in advance. It is necessary to prevent the contents of the DD RAM addresses from being destroyed (overwritten). |

3) Entry Mode Set

| | RS | R/W | DB ₇ | | | | | I/D | S | DB ₀ |
|------|----|-----|-----------------------|---|---|---|---|-----|-----|-----------------|
| Code | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | S |

Entry Mode Set sets the direction of cursor movement and whether display will be shifted.

I/D : The DD RAM address is incremented or decremented by one when a character code is written into or read from DD RAM. This is also true for writing into or reading from CG RAM.

When I/D = 1, the address is incremented by one and the cursor or blink moves to the right.

When I/D = 0, the address is decremented by one and the cursor or blink moves to the left.

S : If S = 1, the entire display is shifted either to the right or left for writing into DD RAM. The cursor position does not change, only the display moves. There is no display shift for reading from DD RAM.

When S = 1 and I/D = 1, the display shifts to the left.

When S = 1 and I/D = 0, the display shifts to the right.

If S = 0, the display does not shift.

4) Display ON/OFF Control

| | RS | R/W | DB ₇ | | | | | D | C | B | DB ₀ |
|------|----|-----|-----------------------|---|---|---|---|---|---|---|-----------------|
| Code | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B | |

Display ON/OFF Control turns the total display and the cursor ON and OFF, and makes the cursor position start blinking. Display ON/OFF control is done in the column indicated by the specified DD RAM address by the AC.

When D = 1, the display is turned ON.

When D = 0, the display is turned OFF.

If D = 0 is used, display data remains in DD RAM. (The cursor does not blink.)

DATA SHEET

NEC

PHOTO DIODE
NDL5471R Series

1 000 to 1 600 nm OPTICAL FIBER COMMUNICATIONS
φ120 μm InGaAs PIN PHOTO DIODE RECEPTACLE MODULE

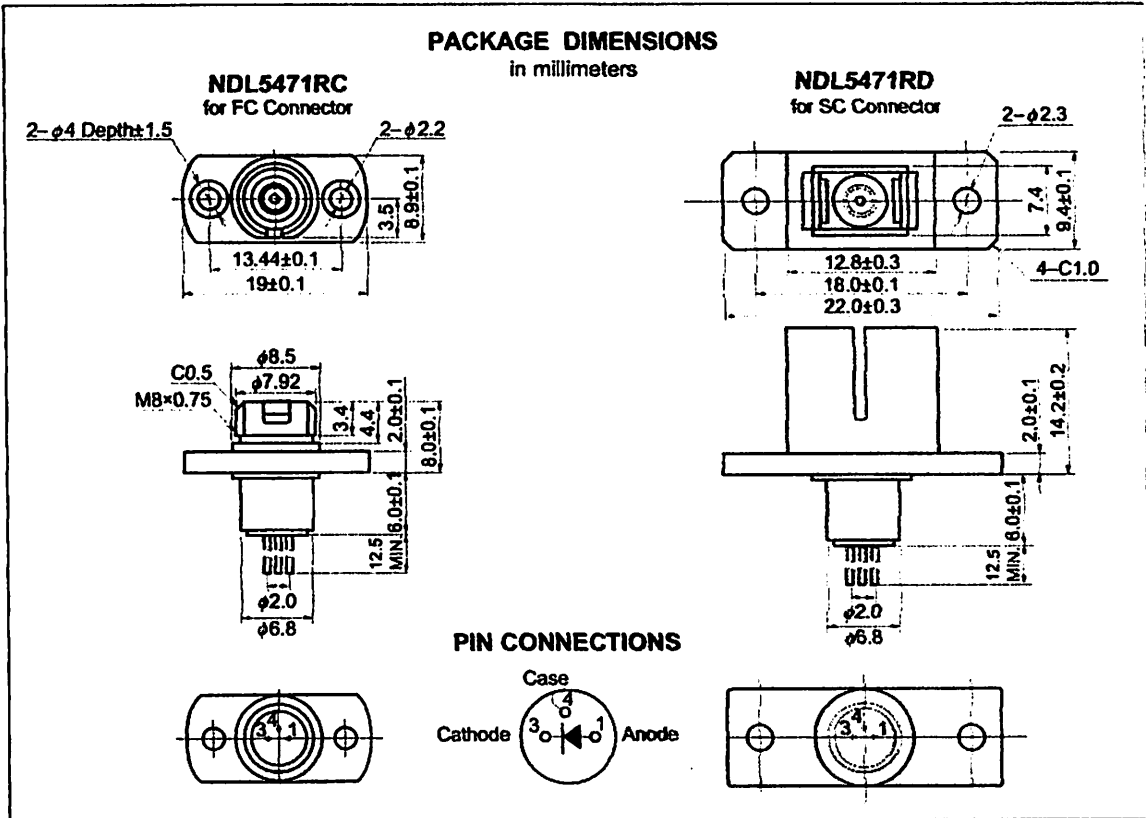
DESCRIPTION

The NDL5471R Series is an InGaAs PIN photo diode receptacle module especially designed for a detector of long wavelength optical fiber communications systems. It covers the wavelength range between 1 000 and 1 600 nm with high efficiency.

FEATURES

- Small dark current $I_D = 0.1 \text{ nA}$
- High quantum efficiency $\eta = 86 \% @ \lambda = 1\,300 \text{ nm}$
 $\eta = 80 \% @ \lambda = 1\,550 \text{ nm}$
- Cut-off frequency $f_c = 1.5 \text{ GHz MIN.}$
- Detecting area size $\phi 120 \text{ }\mu\text{m}$
- Low operating voltage

PACKAGE DIMENSIONS
in millimeters



The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version. Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

ORDERING INFORMATION

| Part Number | Device Type |
|-------------|---------------------------|
| NDL5471RC | FC type receptacle module |
| NDL5471RD | SC type receptacle module |

ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C, unless otherwise specified)

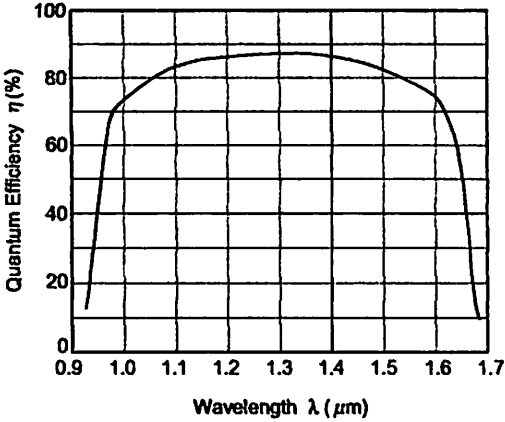
| Parameter | Symbol | Ratings | Unit |
|----------------------------|------------------|------------|------|
| Reverse Voltage | V _R | 20 | V |
| Forward Current | I _F | 10 | mA |
| Reverse Current | I _R | 0.5 | mA |
| Optical Input Power | P _{in} | 8 | mW |
| Operating Case Temperature | T _C | -40 to +85 | °C |
| Storage Temperature | T _{stg} | -40 to +85 | °C |

ELECTRO-OPTICAL CHARACTERISTICS (T_C = 25 °C)

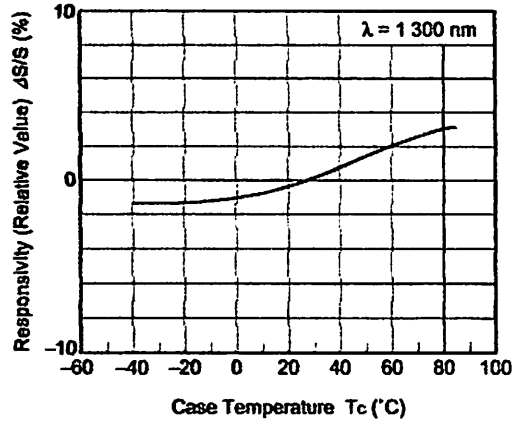
| Parameter | Symbol | Conditions | MIN. | TYP. | MAX. | Unit |
|----------------------|----------------|---------------------------------------------------|------|------|------|------|
| Dark Current | I _D | V _R = 5 V | | 0.1 | 1.0 | nA |
| Terminal Capacitance | C _t | V _R = 5 V, f = 1.0 MHz | | 1.1 | 1.5 | pF |
| Quantum Efficiency | η | λ = 1 300 nm, V _R = 5 V | 75 | 86 | | % |
| | | λ = 1 550 nm, V _R = 5 V | | 80 | | |
| Responsivity | S | λ = 1 300 nm, V _R = 5 V | 0.78 | 0.89 | | A/W |
| | | λ = 1 550 nm, V _R = 5 V | | 1.0 | | |
| Cut-off Frequency | f _c | V _R = 5 V, R _L = 50 Ω, -3dB | 1.5 | | | GHz |

TYPICAL CHARACTERISTICS ($T_c = 25^\circ\text{C}$, unless otherwise specified)

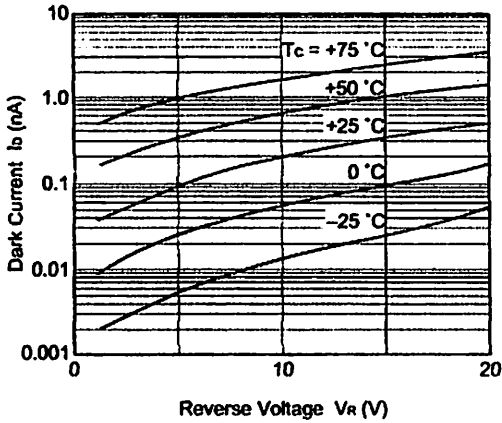
WAVELENGTH DEPENDENCE OF QUANTUM EFFICIENCY



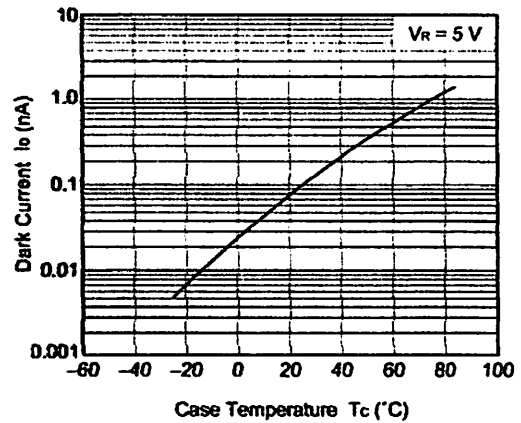
TEMPERATURE DEPENDENCE OF RESPONSIVITY



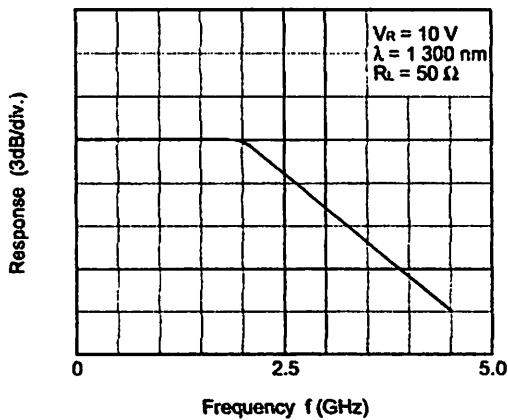
REVERSE VOLTAGE DEPENDENCE OF DARK CURRENT



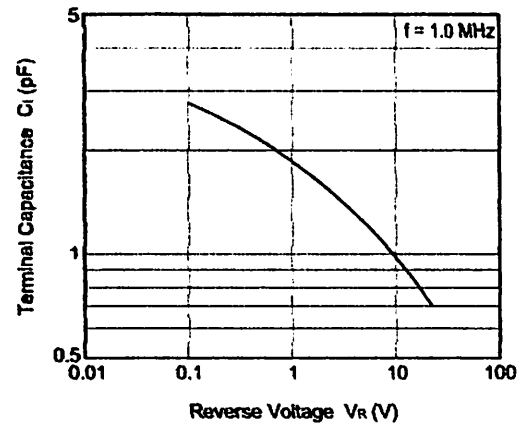
TEMPERATURE DEPENDENCE OF DARK CURRENT



FREQUENCY RESPONSE



REVERSE VOLTAGE DEPENDENCE OF TERMINAL CAPACITANCE



Remark The graphs indicate nominal characteristics.

★ InGaAs PIN-PD

| Part number | Absolute maximum ratings | | | Typical characteristics (Tc = 25°C) | | | | | | | | Package |
|----------------|--------------------------|------------------------|-------------------------|-------------------------------------|---------------------|------|---------------------|------|-----------|------|---------------------------------|-----------------------|
| | P _n (mW) | T _c (°C) | T _{op} (°C) | Detecting area size (μm) | I _b (nA) | | C _t (pF) | | S (A/W) | | f _c (GHz) MIN. | |
| | | | | | VR (V) | TYP. | VR (V) | TYP. | λ (nm) | TYP. | | |
| NDL5421P/P1/P2 | 8 | -40 to +85 | -40 to +85 | φ 50 | 5 | 0.1 | 5 | 0.7 | 1300 | 0.89 | 2.5 | Coaxial |
| | | | | | | | | | 1550 | 0.94 | | |
| NDL5422P | - | -40 to +70 | -40 to +85 | φ 50 | 5 | 0.1 | - | - | 1300 | 0.89 | 2.5 | Butterfly with AMP |
| | | | | | | | | | 1550 | 1.00 | | |
| NDL5461P/P1/P2 | 8 | -40 to +85 | -40 to +85 | φ 80 | 5 | 0.1 | 5 | 1.0 | 1300 | 0.89 | 2.5 | Coaxial |
| | | | | | | | | | 1550 | 0.94 | | |
| NDL5471RC/RD | 8 | -40 to +85 | -40 to +85 | φ 120 | 5 | 0.1 | 5 | 1.1 | 1300 | 0.89 | 1.5 | Receptacle |
| | | | | | | | | | 1550 | 1.00 | | |
| NDL5481P/P1/P2 | 8 | -40 to +85 | -40 to +85 | φ 80 | 10 | 0.1 | 10 | 0.7 | 1300 | 0.85 | 2.5 | Coaxial |

REFERENCE

| Document Name | Document No. |
|-------------------------------------------------------------|--------------|
| NEC semiconductor device reliability/quality control system | C11159E |
| Quality grades on NEC semiconductor devices | C11531E |
| Semiconductor device mounting technology manual | C10535E |
| Semiconductor selection guide | X10679E |