Embedded Systems Design (0630414)

Lecture 13

Serial Interfacing

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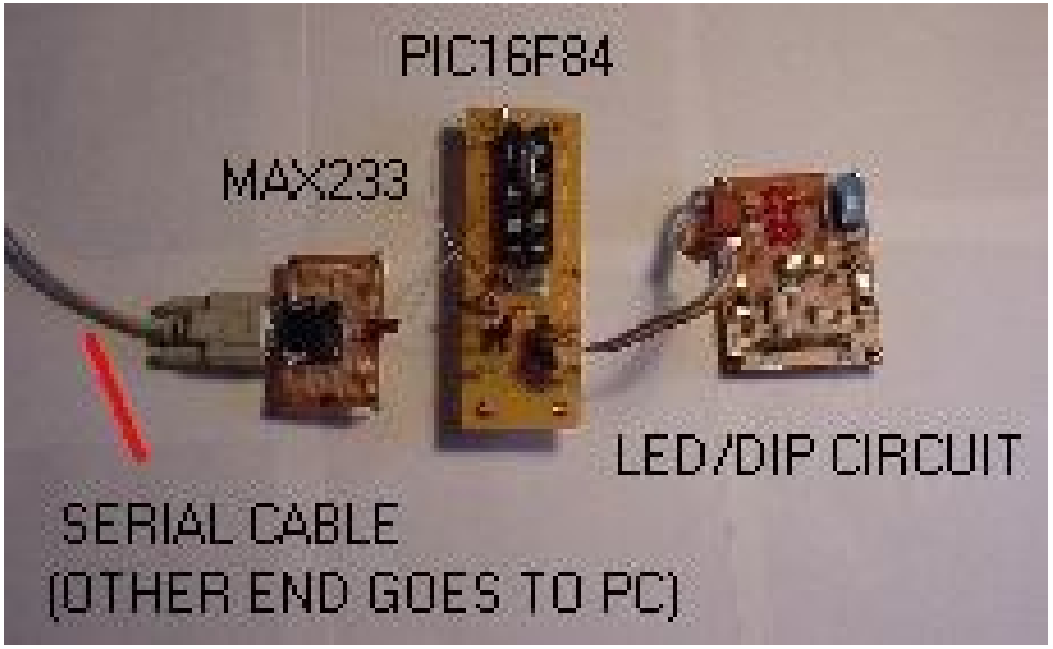
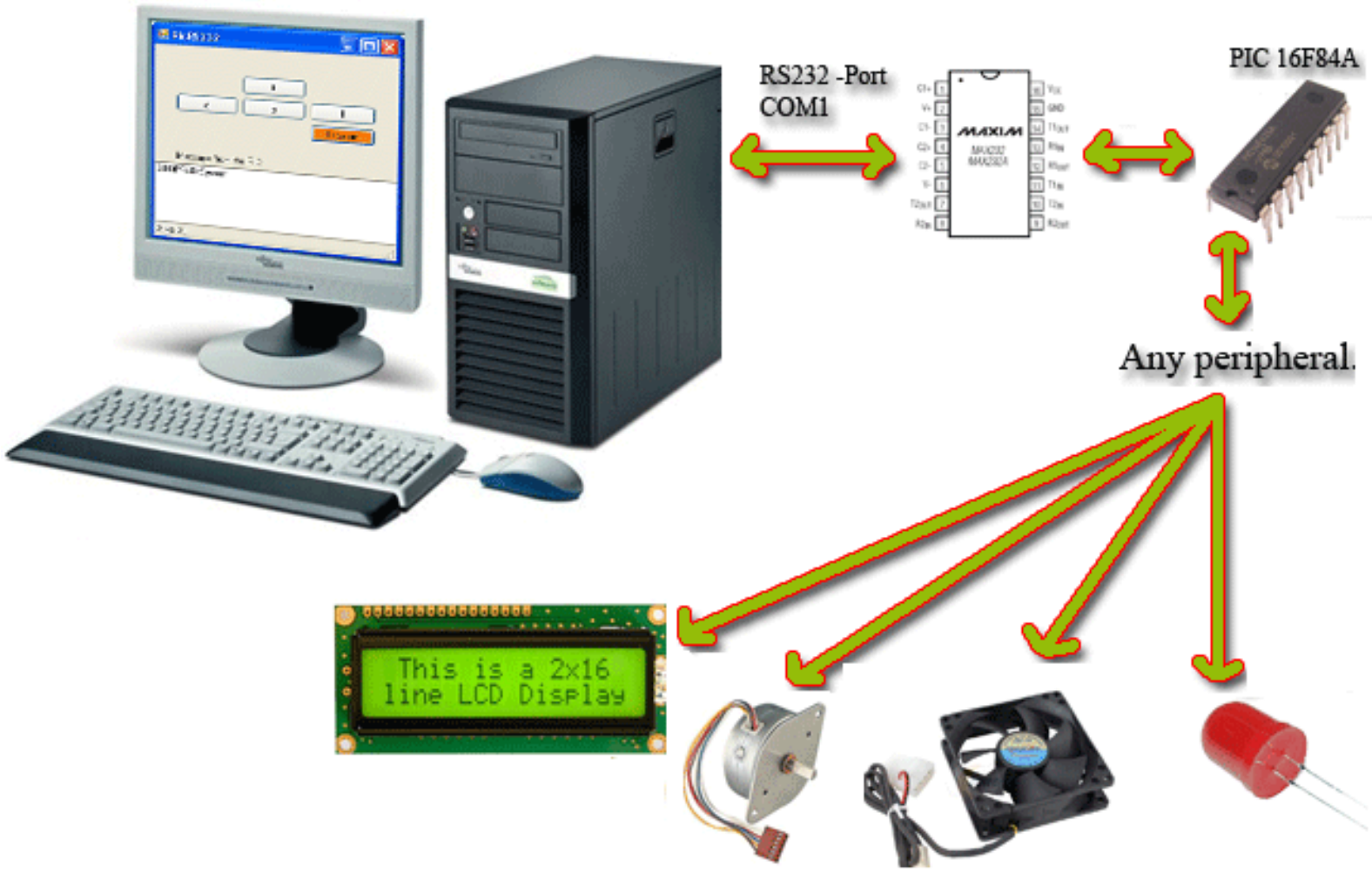
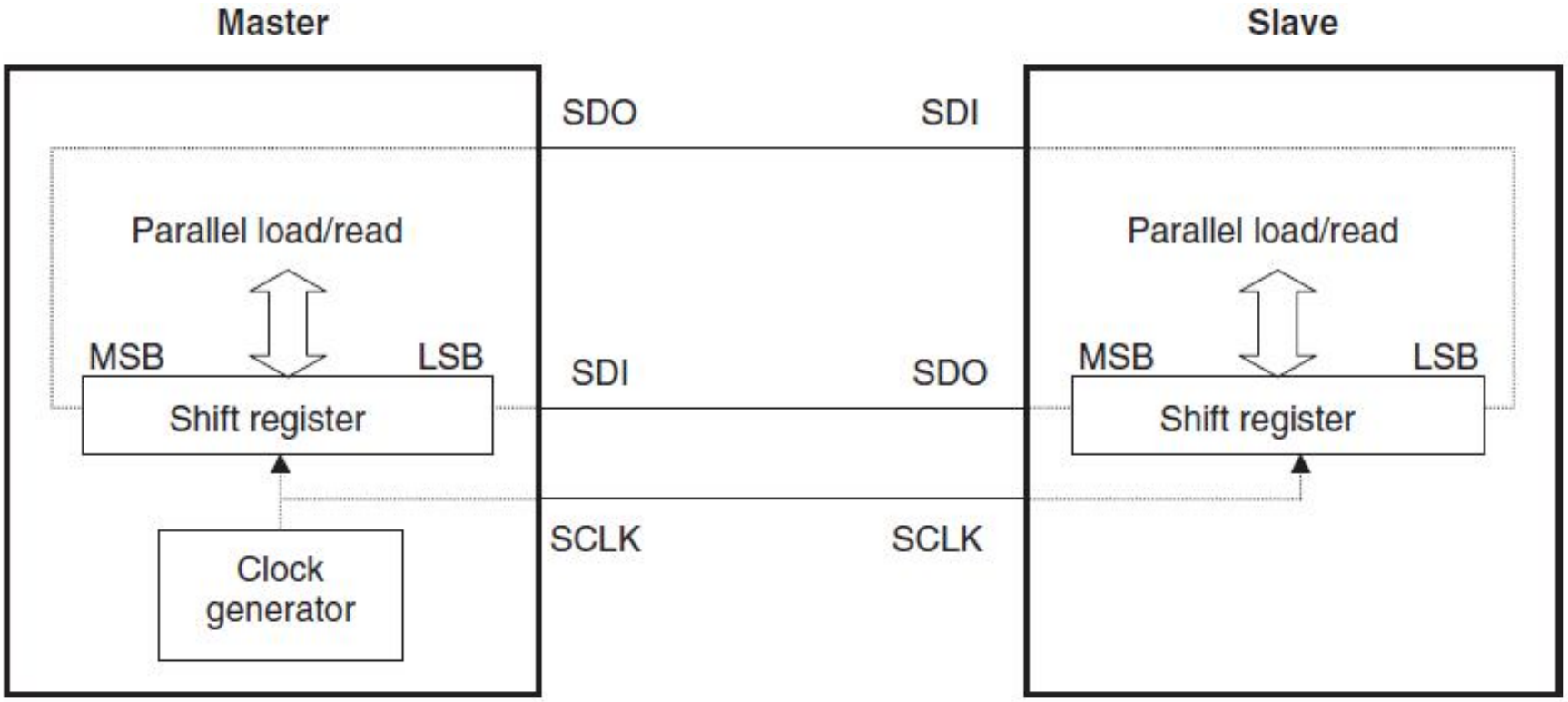
- **Serial Communication:**
- The PIC16F84 has no serial port, but with some hardware & software, PIC-to-PC serial communication can be established.
- Typically the PC's serial port has a DB9 male connector. The photo shows a MAX233 chip, serial cable, PIC and LED/DIP circuits.
- The PIC can send or receive 8-bit values at prescribed intervals (baud rate).



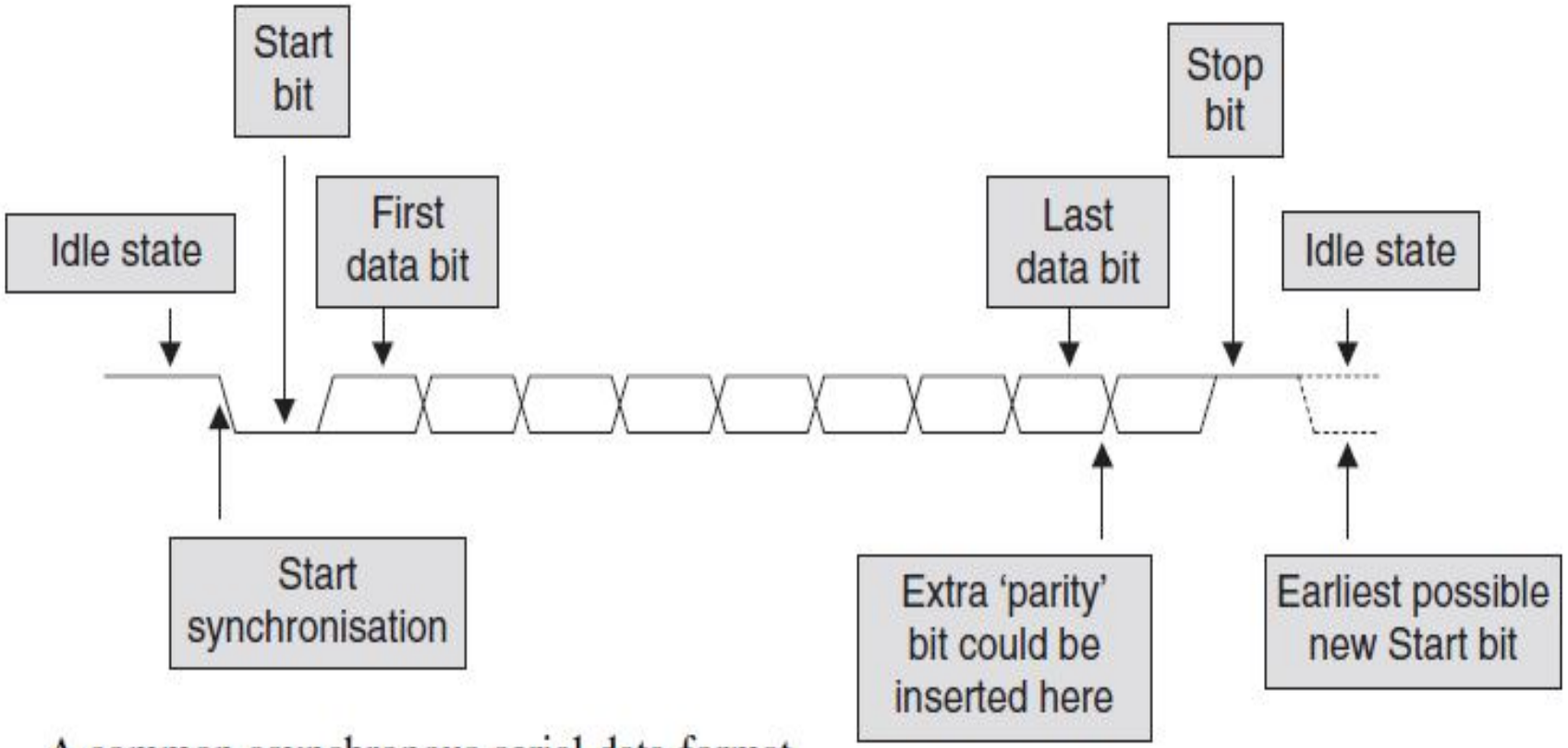

RS232 -Port
COM1
MAXIM
PIC 16F84A
Any peripheral.
This is a 2x16
line LCD Display

Synchronous Serial Data Transfer:



The synchronous serial link implemented in a microcontroller

Asynchronous Serial Data Transfer:



A common asynchronous serial data format

RS232 specifications:

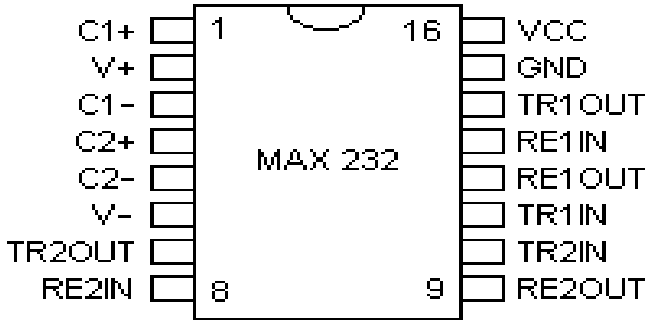
- Communication in the RS232 standard is an synchronous **serial** communication method.
- The word **serial** means that the information is sent one bit at a time.
- The word **asynchronous** tells us that the information is not sent in predefined time slots. Data transfer can start at any given time, and it is the task of the receiver to detect when a message starts and ends

RS232 bit streams

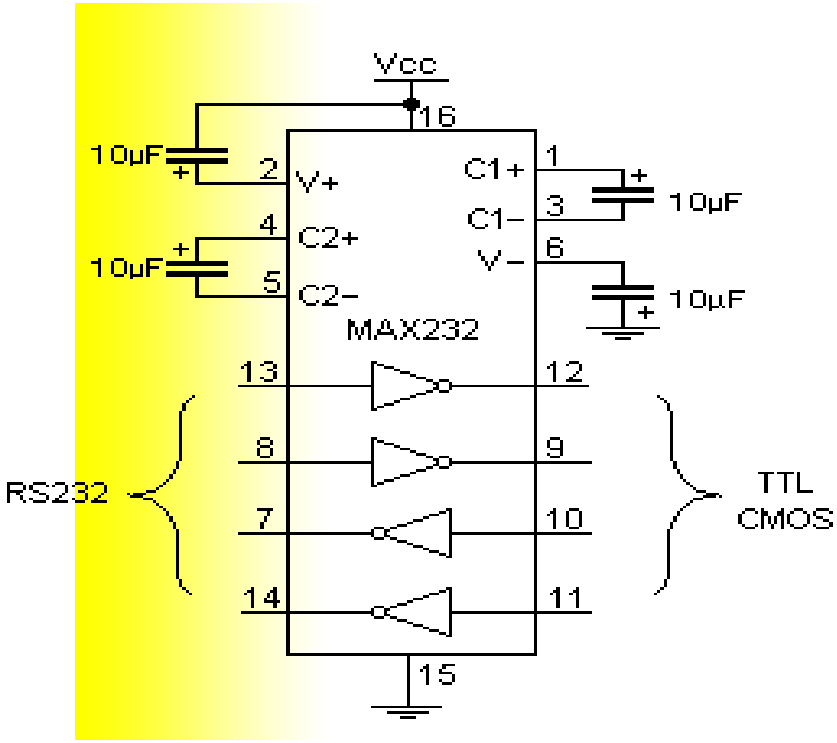
- The RS232 standard describes a communication method where information is sent bit by bit on a physical channel. The information must be broken up in data words. The length of a data word is variable. On PCs, a length between 5 and 8 bits can be selected. This length is the net information length of each word. For proper transfer, additional bits are added for synchronization and error checking purposes. It is important that the transmitter and receiver use the same number of bits. Otherwise, the data word may be misinterpreted, or not recognized at all.
- Data bits are sent with a predefined frequency, the baud rate. Both the transmitter and receiver must be programmed to use the same bit frequency. After the first bit is received, the receiver calculates at which moments the other data bits will be received. It will check the line voltage levels at those moments.
- With RS232, the line voltage level can have two states. The on state is also known as mark, the off state as space. No other line states are possible. When the line is idle, it is kept in the mark state.

RS-232 Level Converters:

- Almost all digital devices require either TTL or CMOS logic levels. Therefore the first step to connecting a device to the RS-232 port is to transform the RS-232 levels back into 0 and 5 Volts,.
- The MAX-232 device includes a Charge Pump, which generates +10V and -10V from a single 5v supply. This IC also includes two receivers and two transmitters in the same package.



Pinouts for the MAX- 232, RS-232 Driver/Receiver.



RS232 Asynchronous communications

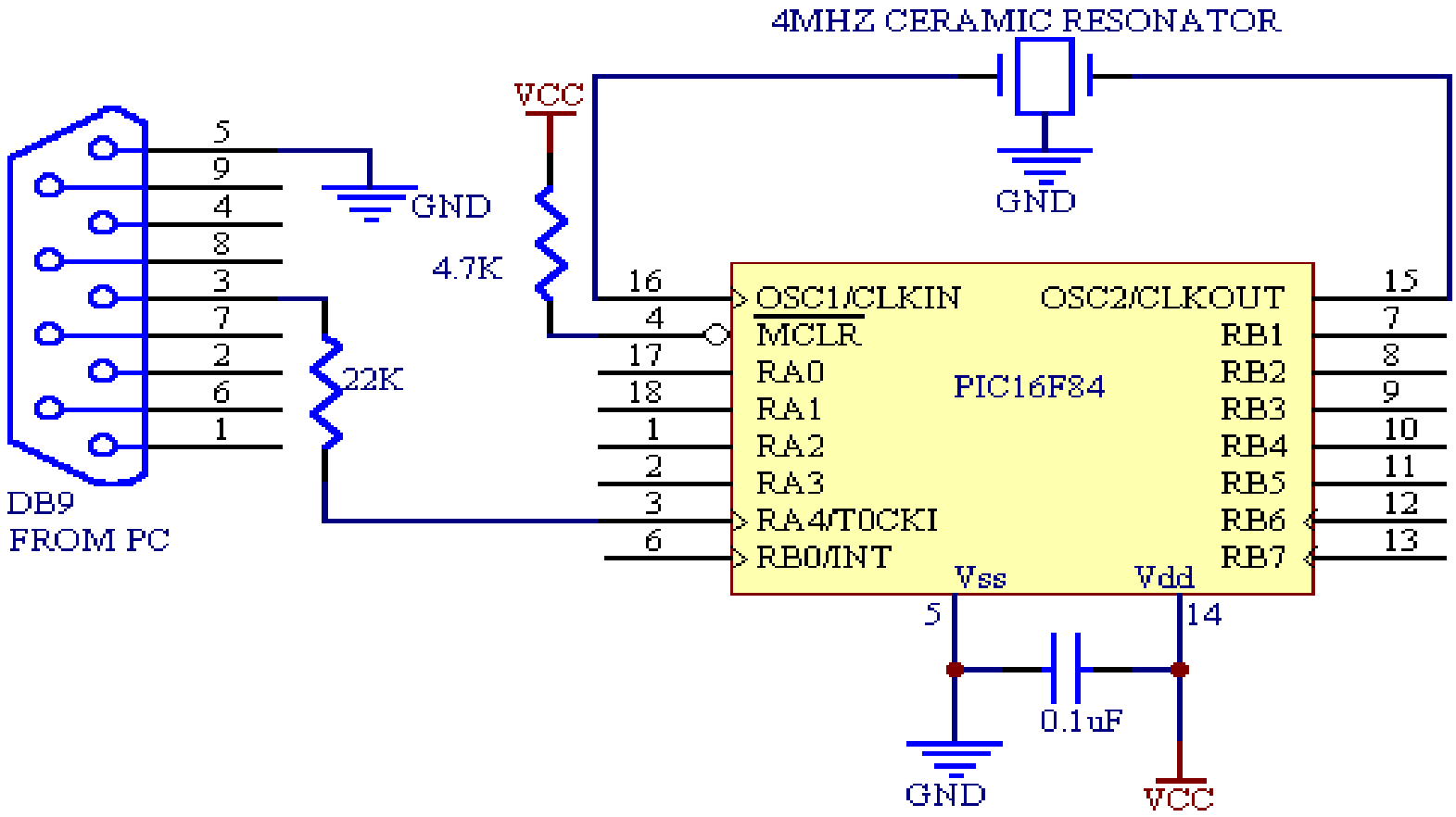
Advantages

- Popular interface with many examples
- Many compatible legacy devices
- Relatively long distance, 50 feet maximum for low baud rates although longer distances work in practice, with low baud rates and error correction
- Immune to noise due to +/-5 Volts or higher voltage levels for logic "0" and "1"
- Implemented in hardware or software
- Ease to implement, many examples

Disadvantages

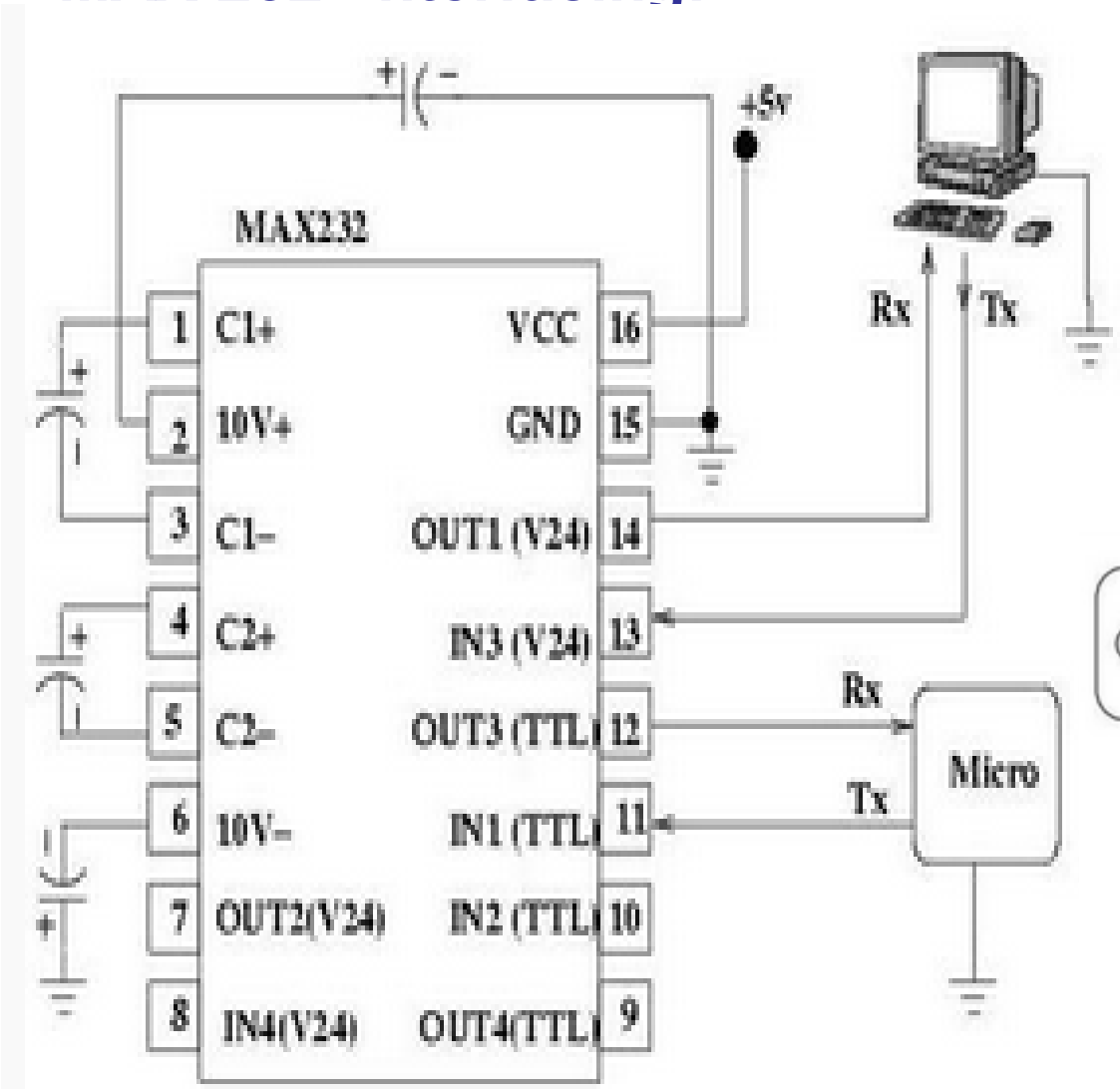
- More suitable for system to system communications, not so much for chip to chip or chip to sensor
- Low speed for long distance, 115200 baud can be achieved with small microcontrollers using short distances
- Requires transceiver chips which add to system cost (TTL/CMOS level RS232 can be used without transceiver chips).
- Single master/single slave

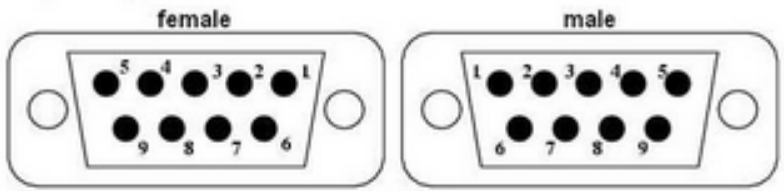
PC to Microcontroller Interfacing:



- The ability to directly interface the PIC microcontroller to the PC serial port eliminates the need for expensive RS-232 conversion ICs (such as the MAX-232). In this case a single 22K resistor is all that's required to complete the PC interface.

MAX 232 Interfacing:

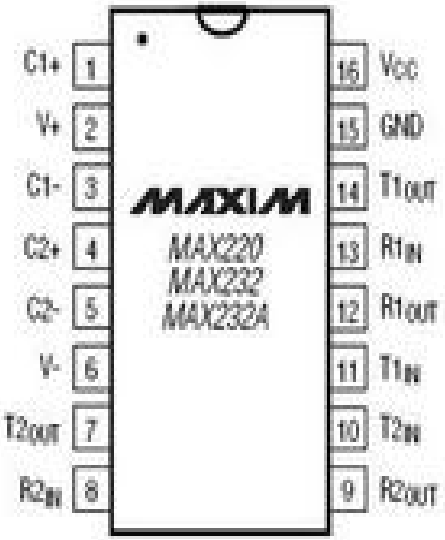




Pin number	Signal
1	DCD (Data Carrier Detect)
2	RX
3	TX
4	DTR (Data Terminal Ready)
5	GND
6	DSR (Data Sheet Ready)
7	RTS (Request To Send)
8	CTS (Clear To Send)
9	RI (Ring Indicator)

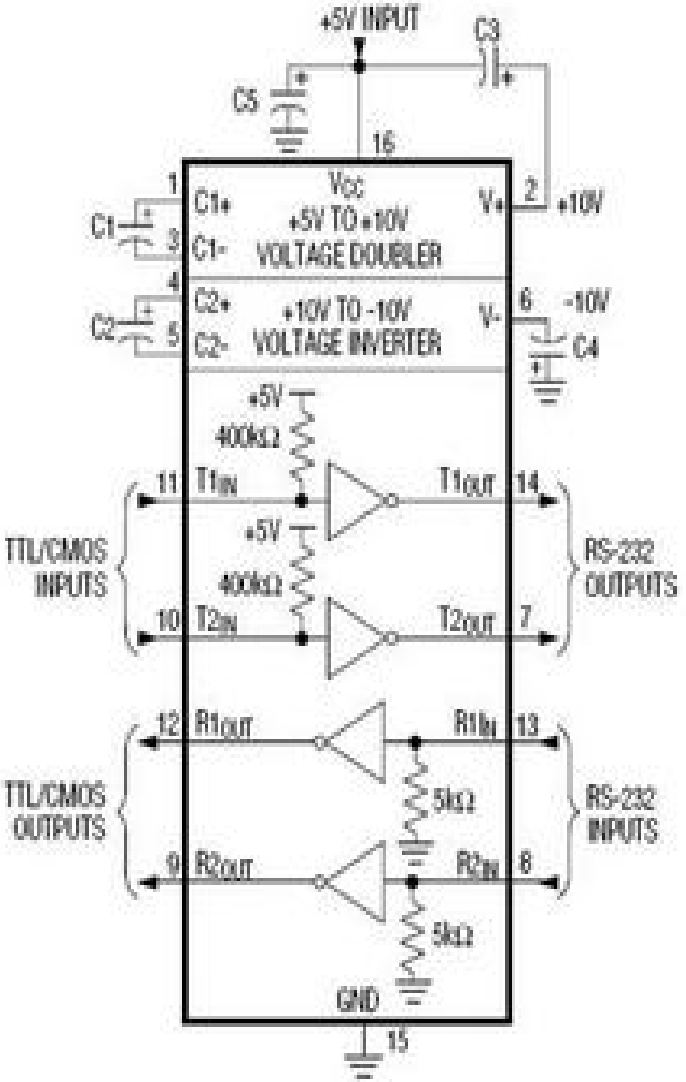
How to convert RS-232 signals (+10V to -10V) into TTL signals (+5V to -5V) and vice versa

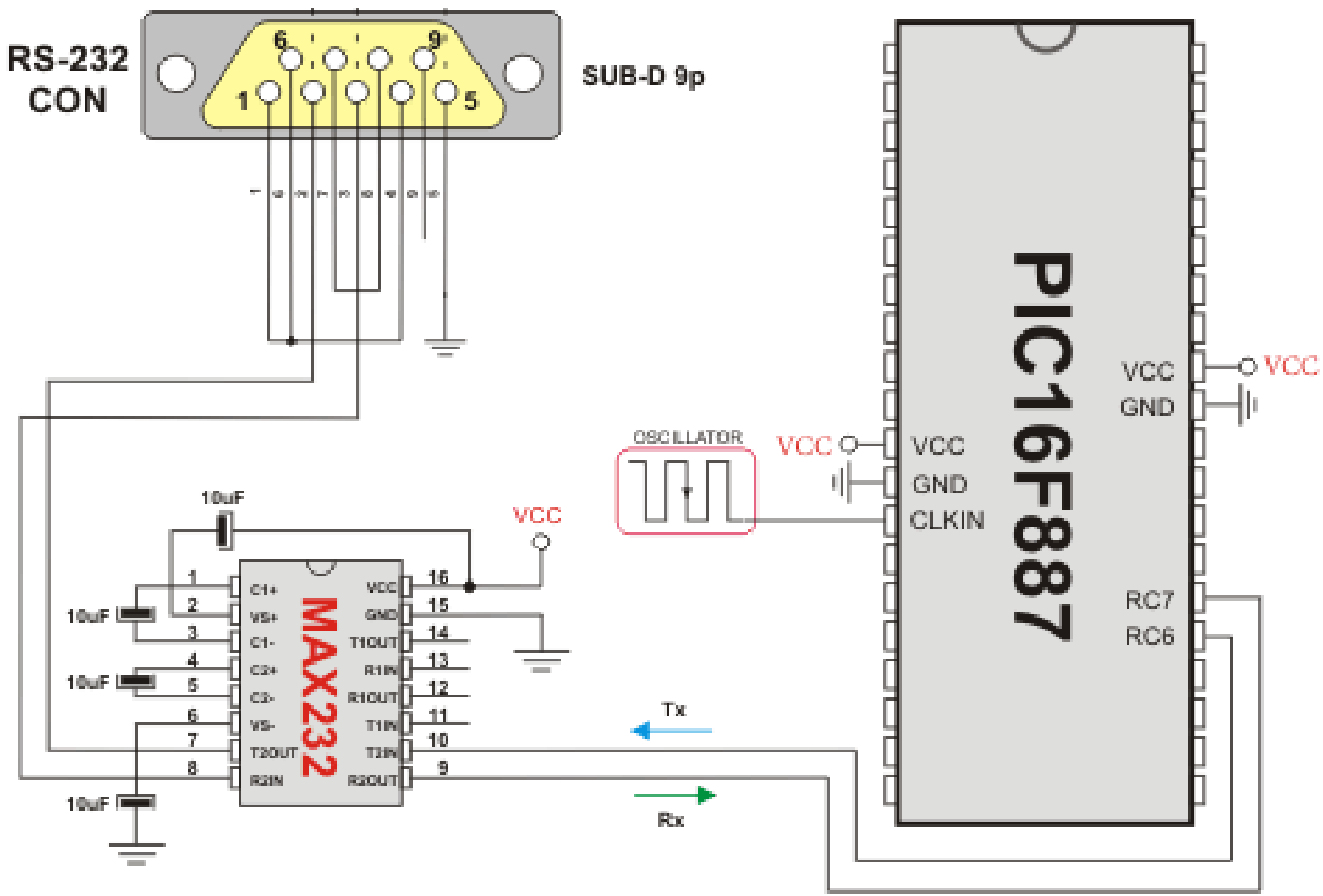
TOP VIEW

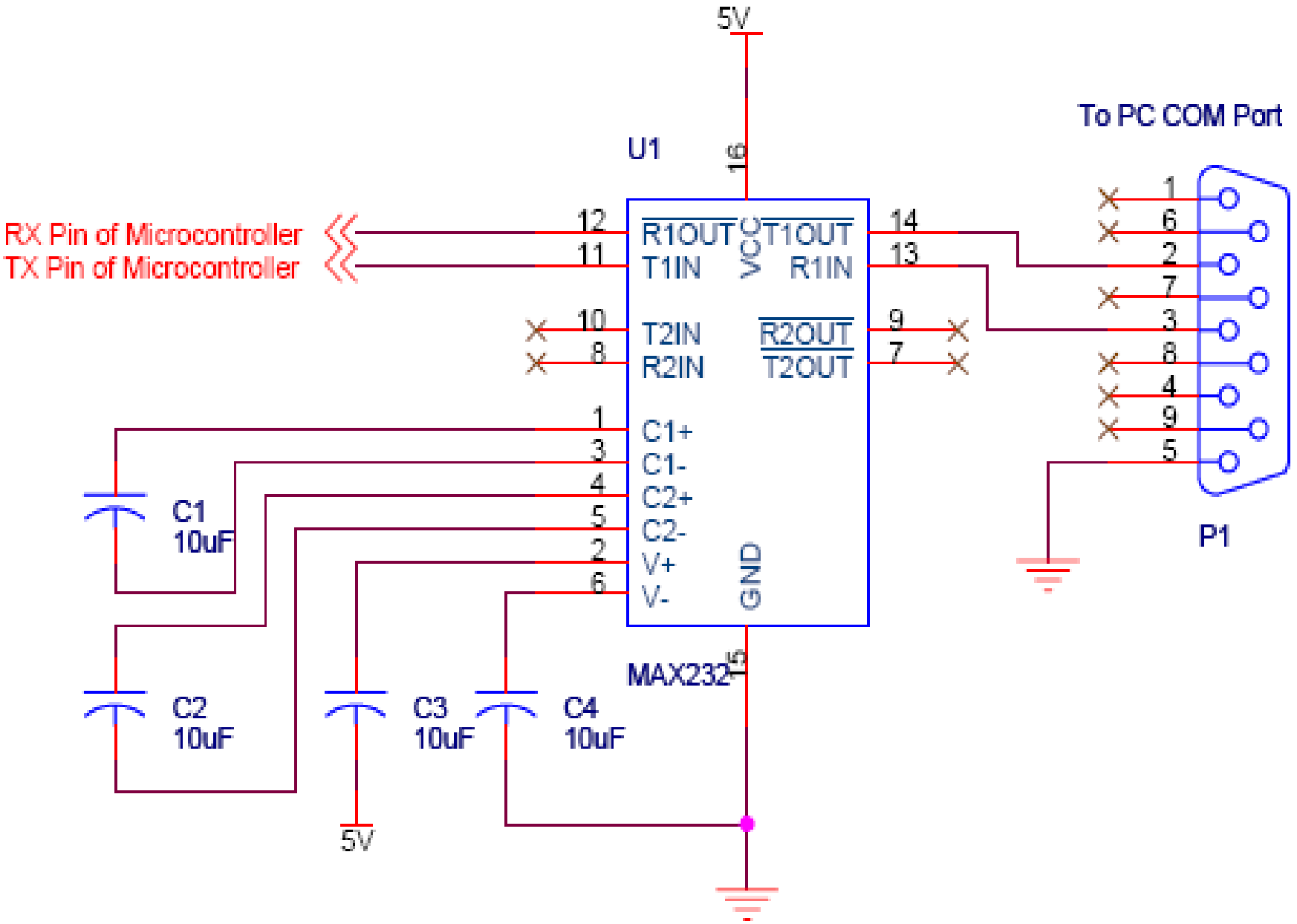


DIP/SO

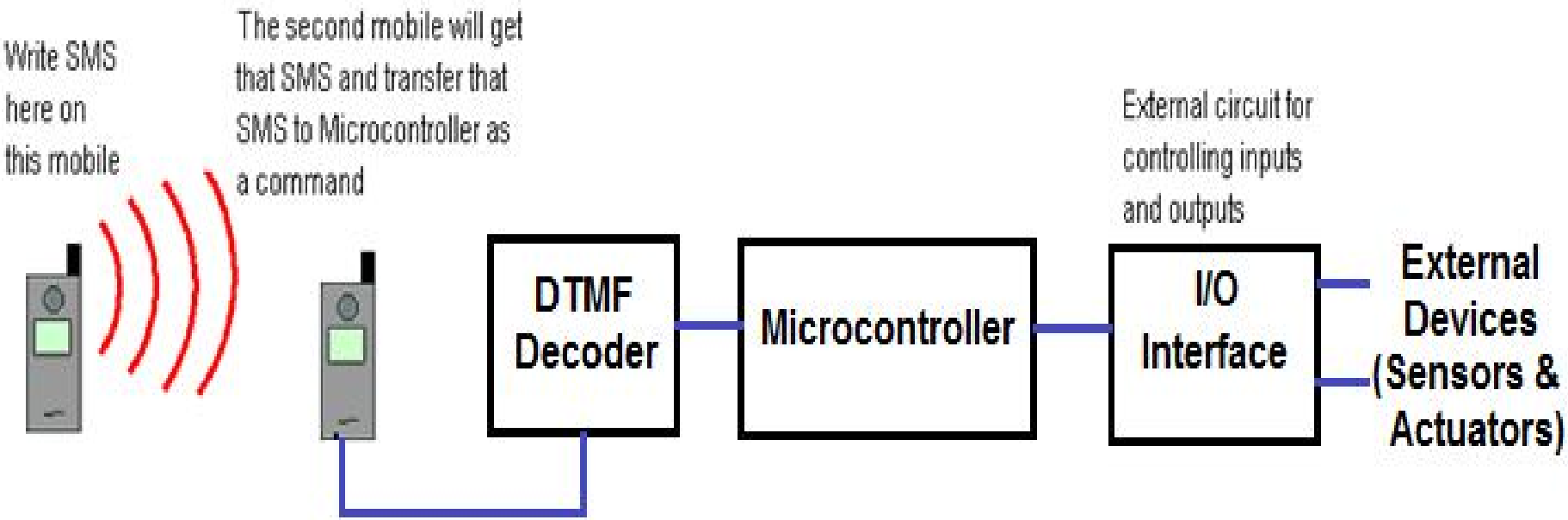
CAPACITANCE (µF)					
DEVICE	C1	C2	C3	C4	C5
MAX220	4.7	4.7	10	10	4.7
MAX232	1.0	1.0	1.0	1.0	1.0
MAX232A	0.1	0.1	0.1	0.1	0.1



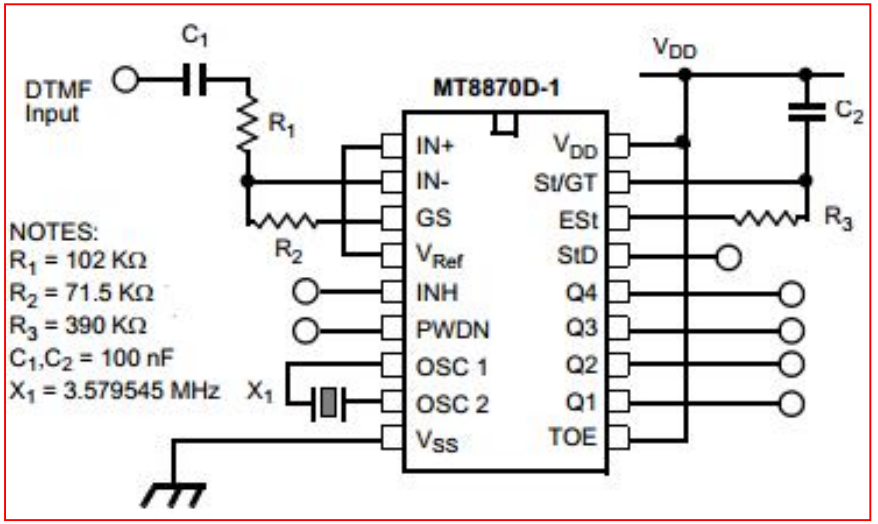

RS-232
CON
6
9
1
5
SUB-D 9p
PIC16F887
VCC
GND
VCC
VCC
GND
CLKIN
OSCILLATOR
VCC
RC7
RC6
10uF
VCC
MAX232
C1+
VS+
C1-
C2+
C2-
VS-
T2OUT
R2IN
VCC
GND
T1OUT
R1IN
R1OUT
T1IN
T2IN
R2OUT
10uF
10uF
10uF
Tx
Rx


5V
U1
16
To PC COM Port
RX Pin of Microcontroller
TX Pin of Microcontroller
12
11
R1OUT
T1IN
VCC
T1OUT
R1IN
14
13
10
8
T2IN
R2IN
R2OUT
T2OUT
9
7
1
3
4
5
2
6
C1+
C1-
C2+
C2-
V+
V-
GND
15
MAX232
C1
10uF
C2
10uF
C3
10uF
C4
10uF
5V
P1
1
6
2
7
3
8
4
9
5

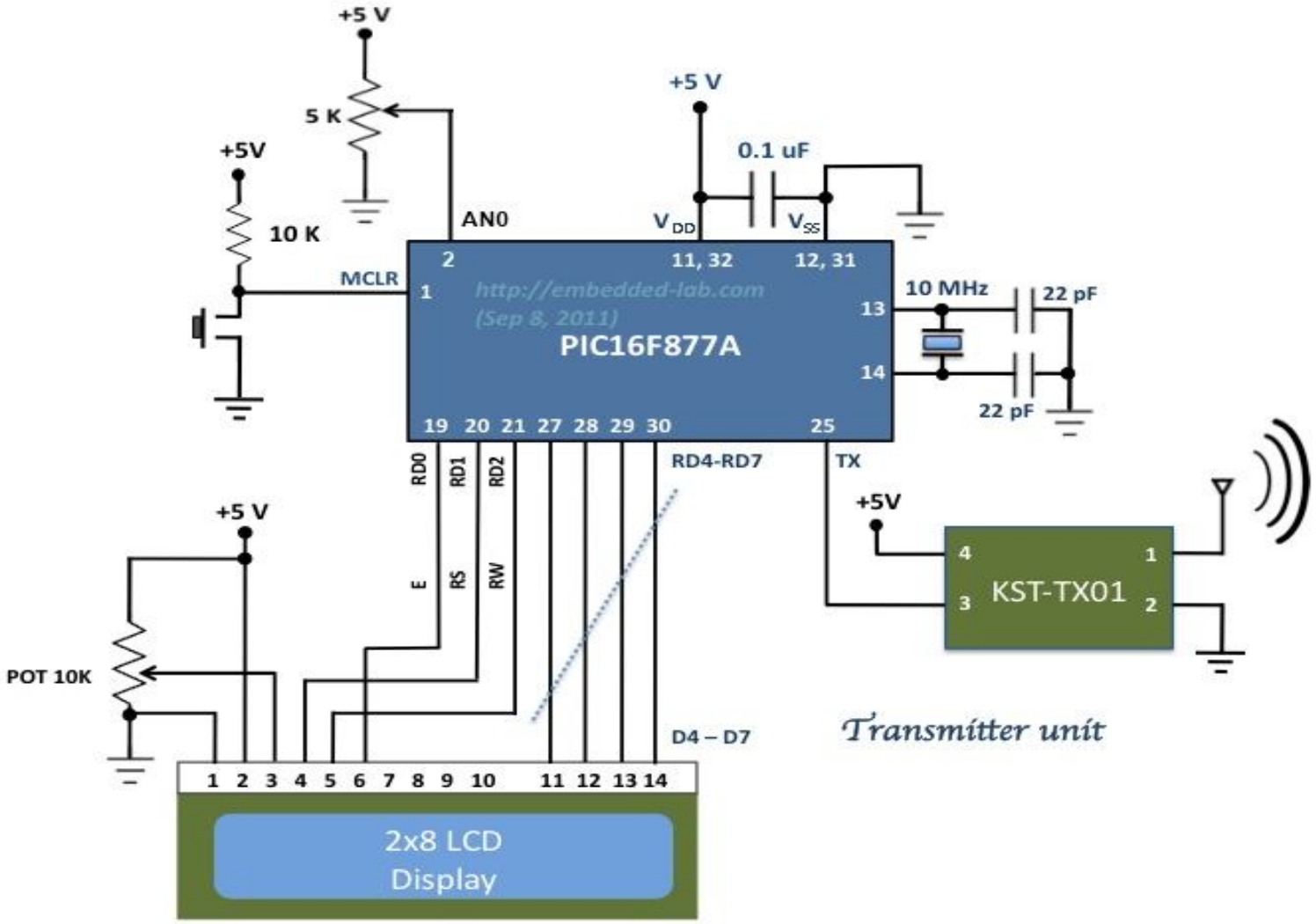
Mobile-Based Remote Monitoring and Control

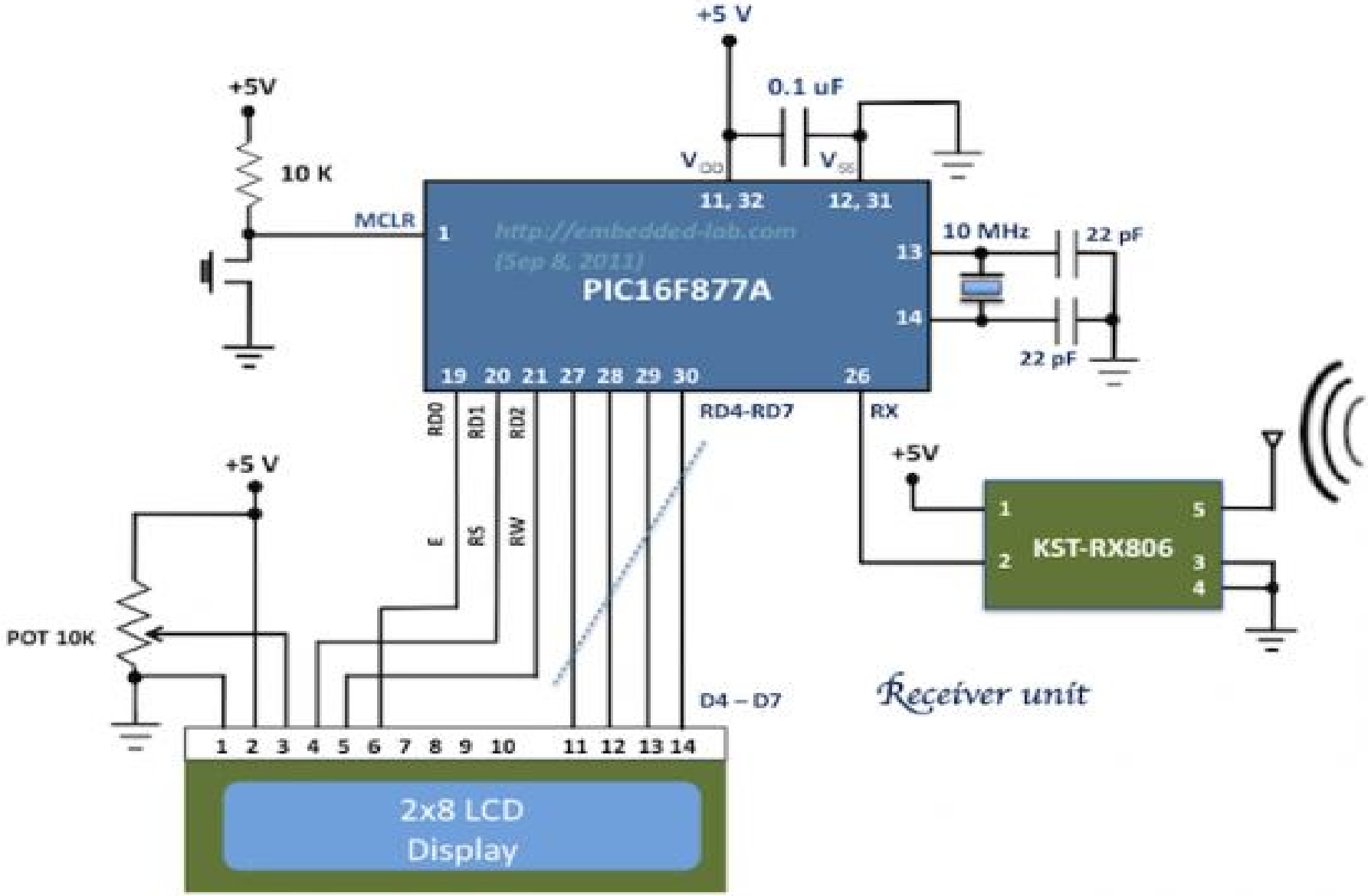


The MT8870D/MT8870D-1 is a complete DTMF receiver integrating both the bandsplit filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters; the decoder uses digital counting techniques to detect and decode all 16 DTMF tone-pairs into a 4-bit code.



Wireless data transmission between two PIC microcontrollers using low-cost RF modules

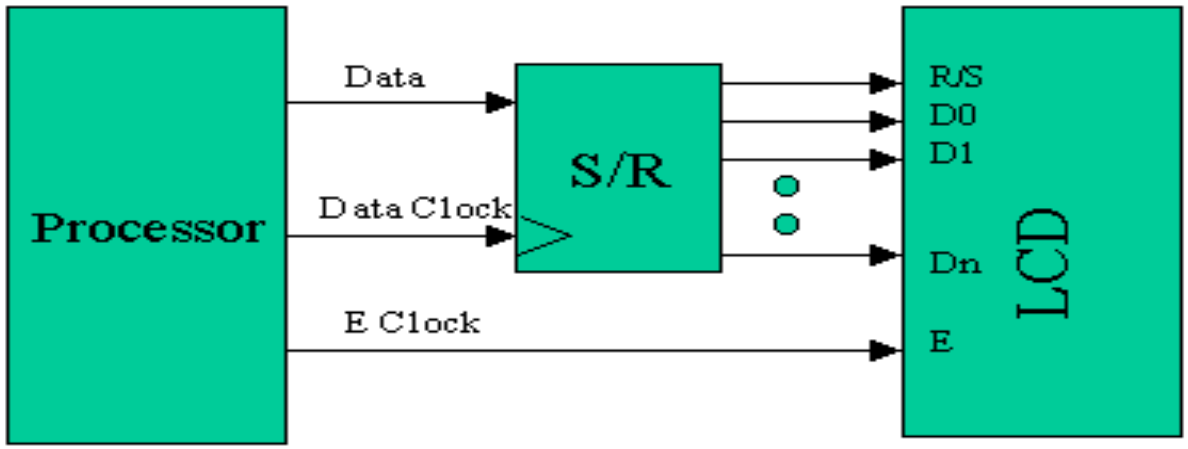




Ref: www.embedded-lab.com/blog/?p=3557

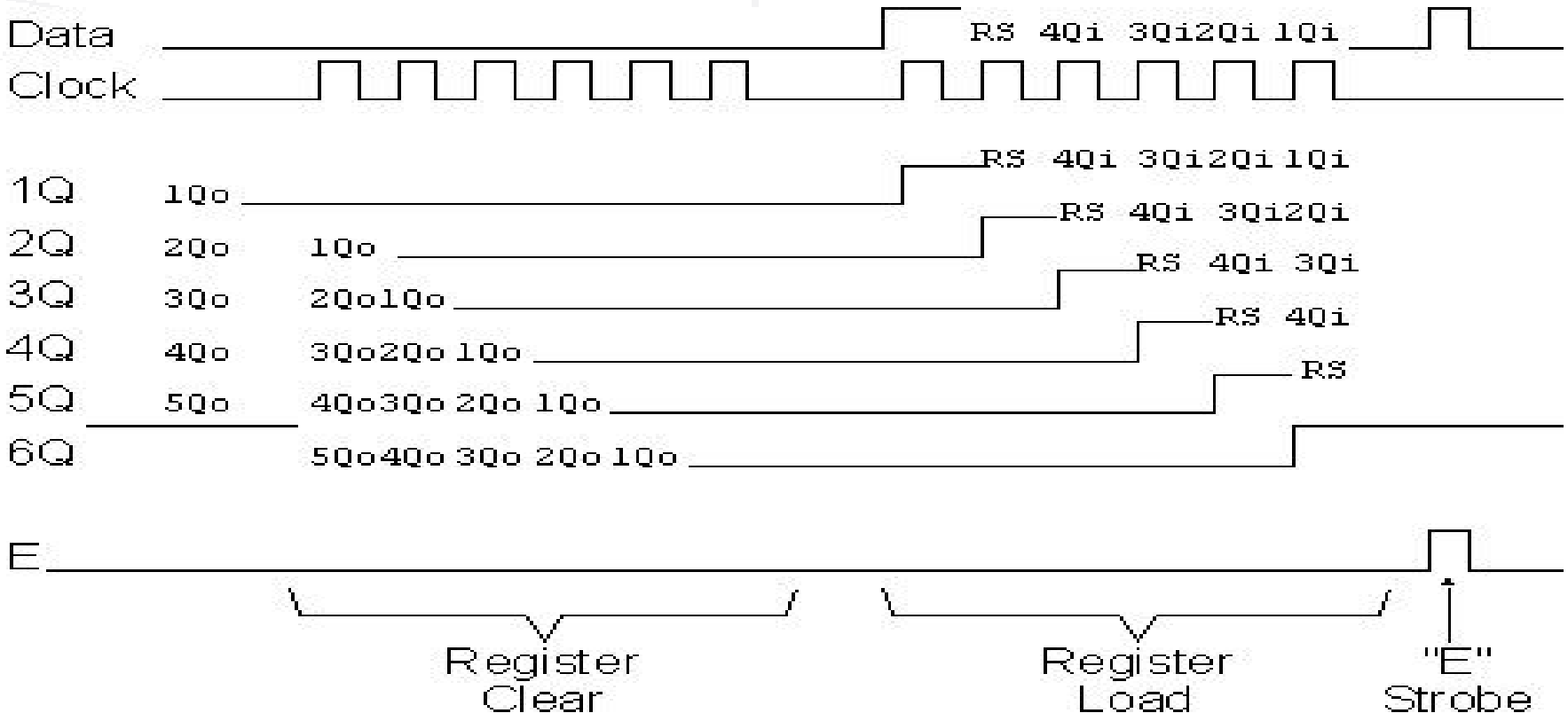
Serial interfacing LCD with PIC Microcontroller:

- Parallel interfacing LCD with microcontroller needs at least 6 I/O pins (4 bit mode) and maximum 11 I/O pins (8 bit mode).
- The I/O pin's can be cut down to 2 or 3 pin by serial interfacing using shift registers. There are a few **shift registers** that can be used such as **74HC164, 74HC595, CD4094** and other compatible 8 bit shift register.

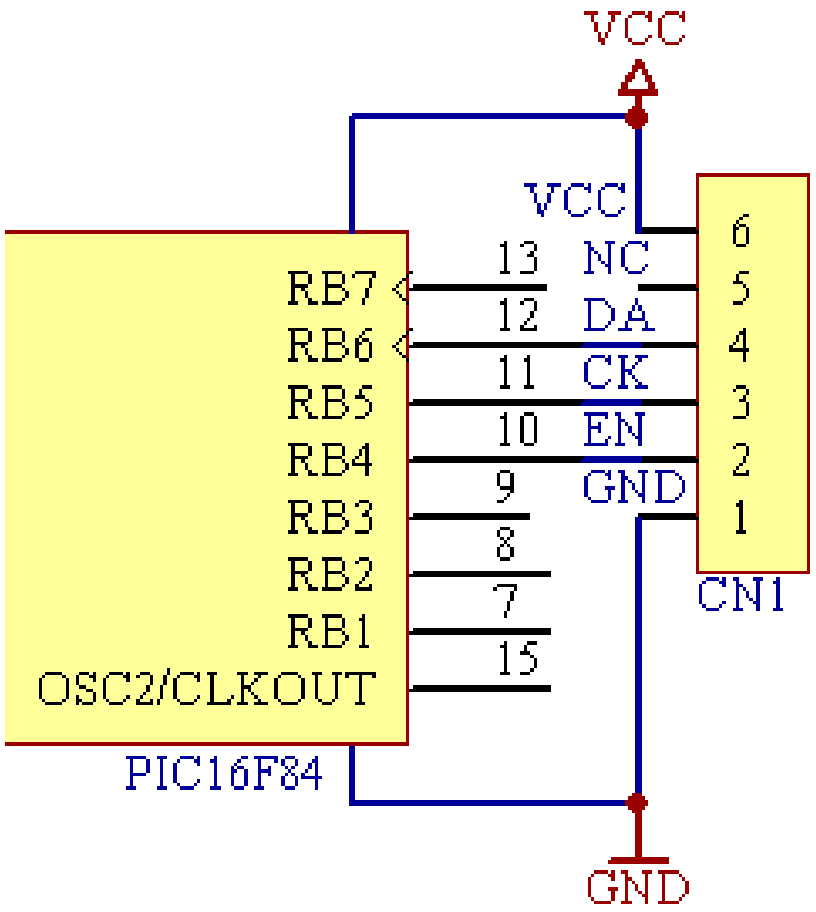


- In this case, different approaches have to be made. The most popular one is to use synchronous serial data (requiring a "clock" and "data") pin to load a serial-in/parallel-out shift register with the data bits and "R/S" pin information. The "E" Strobe Pin is driven directly by the microcontroller to latch in the data from the LCD.

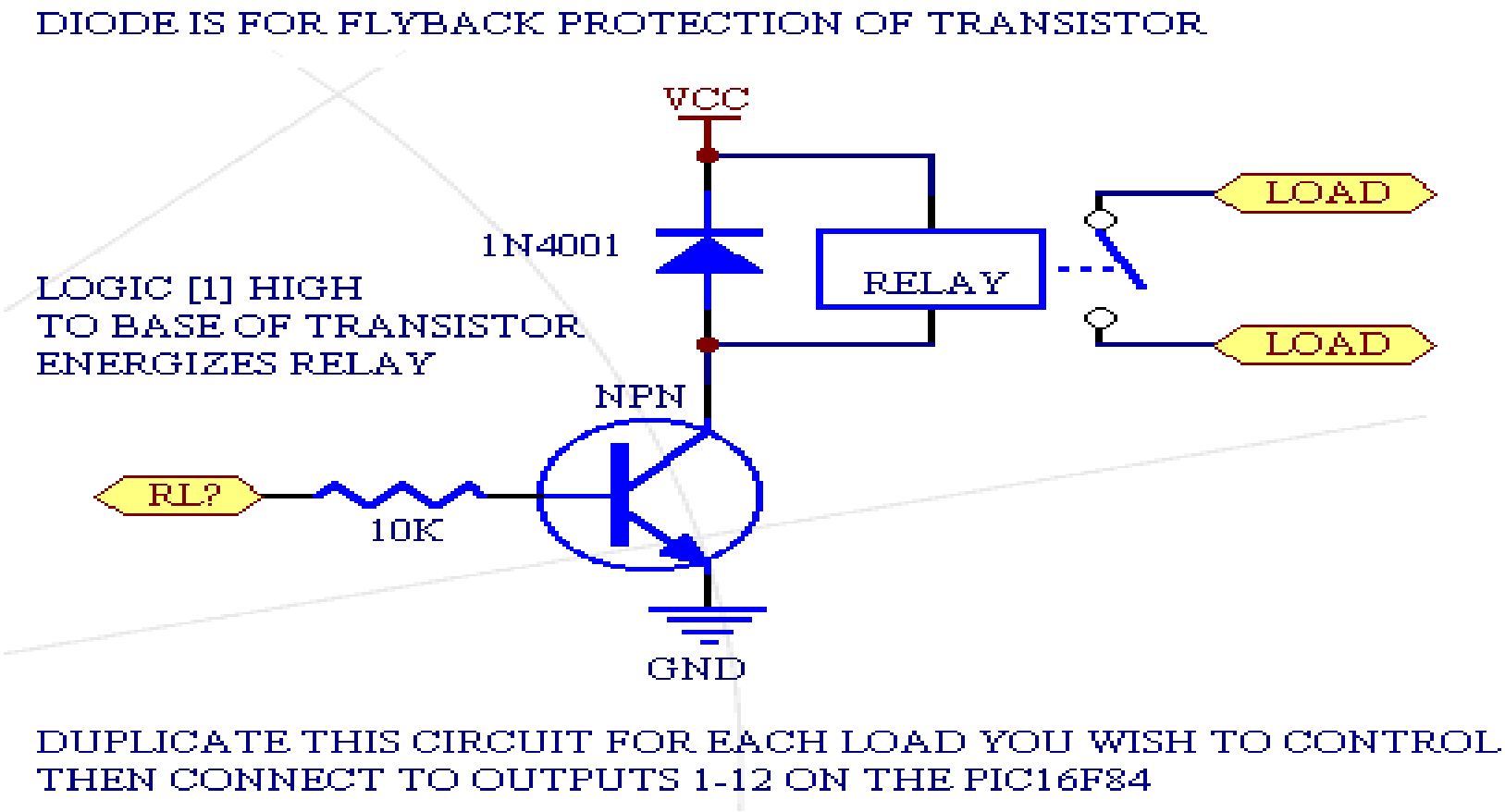
- To load the shift register, it first has to be cleared to ensure that the "E" will not be strobed to the LCD inadvertently. This is done by first shifting in six "0"s to make sure that while the correct data is being loaded into the shift register, no "high" voltage level is passed to the "E" pin of the LCD.
- Once this is done, the data can be shifted in. The diagram below shows how the shift register is initially cleared and then loaded with the data to be strobed (using "E") into the LCD:



LCD Serial Interfacing:



Relay Interfacing:



- The fly-back protection diode (1N4001) will save you from damaging your drive transistor when the magnetic field of the relay coil collapses after it's been de-energized.