WIRELESS WIND ENERGY DATA TRANSMISSION SYSTEM

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ABSTRACT

Wireless communications represent a rapidly emerging area of growth and importance for providing ubiquitous access to the network for all type of community. Nowadays, all community increasingly wants network access for general purpose at classrooms, meeting rooms, auditoriums, and even the hallways of campus buildings. Wireless communications can both support the institution mission and provide cost-effective solutions. Wireless is being adopted for many new applications: to connect computers, to allow remote monitoring and data transceiver or acquisition, to provide access control and security, and to provide a solution for environments where wires may not be the best solution. Wireless technology will become our new life in the future.

ABSTRAK

Teknologi komunikasi tanpa wayar adalah teknologi yang semakin berkembang dengan pesat dan penting dalam memberikan kemudahan melayari internet tanpa kabel kepada semua lapisan masyarakat. Hari ini, masyarakat semakin memerlukan kemudahan teknologi ini untuk tujuan harian seperti di kelas, bilik kuliah, dewan, bilik mesyuarat, hinggakan di kawasan kolej. Teknologi komunikasi tanpa wayar ini memberikan kelebihan dan sokongan dalam mencapai misi sesuatu institusi dan memberikan pilihan yang berkesan dari segi kos penyelengaraan. Pada zaman ini hampir semua aplikasi baru mula menggunakan teknologi ini seperti: menghubungkan antara komputer, mengawasi alat secara jauh, menghantar dan menerima data, kemudahan mengawal dan keselamatan, dan memberikan pilihan terbaik untuk sesuatu situasi dimana mengunakan wayar bukanlah pilihan yang terbaik. Teknologi in akan menjadi sebahagian daripada hidup kita pada suatu hari nanti.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

V	-	Voltage
GND	-	Ground
Ω	-	Ohm
F	-	Farad
Hz	-	Hertz
m	-	Meter
A	-	Ampere
°	-	Degree
s	-	Second
dB	-	Decibel
ns	-	Nanosecond
°C	-	Celsius
kb	-	Kilobyte

LIST OF ABBREVIATIONS

I/O	-	Input or Output
ADC	-	Analog-to-digital converter
OSC	-	Oscillator
LOS	-	Lost of sight
RF	-	Radio Frequency
DC	-	Direct Current
PWM	-	Pulse Width Modulation
GPS	-	Global Positioning System
CTS	-	Clear To Send
RTS	-	Request To Send
IC	-	Integrated Circuit

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Wireless operations permits services, such as long range communications, that are impossible or impractical to implement with the use of wires. The term is commonly used in the telecommunications industry to refer to telecommunications systems (e.g., radio transmitters and receivers, remote controls, computer networks, network terminals, etc.) which use some form of energy (e.g. radio frequency (RF), infrared light, laser light, visible light, acoustic energy, etc.) to transfer information without the use of wires. Information is transferred in this manner over both short and long distances. Wireless networking is used to meet many needs. Perhaps the most common use is to connect laptop users who travel from location to location. A wireless transmission method is a logical choice to network a LAN segment that must frequently change locations. The following situations justify the use of wireless technology:

- To span a distance beyond the capabilities of typical cabling,
- To avoid obstacles such as physical structures
- To link portable or temporary workstations,
- To overcome situations where normal cabling is difficult or financially impractical, or
- To remotely connect mobile users or networks.

This technology without a doubt will become a mankind life for the future

1.2 Objective of Project

The main objective of this project is to be able to transfer data from hardware using wireless system and create a data logger to display the current speed and direction of the wind on computer.

1.3 Scope of Project

In order to achieve the objective of the project, several scopes have been outlined. The scope of this project are; understanding microcontroller PIC16F877 feature and working flow, using wireless technology as a transceiver medium between hardware and software, create a data logger to display a measurement on computer.

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1.4 Summary of Project

Implementation and works of the project are summarized into Figure 1.0 and Figure 1.1. Gantt charts as shown in Figure 1.2 and Figure 1.3 show the detail of the works of the project that has been implemented in the first and second semester.

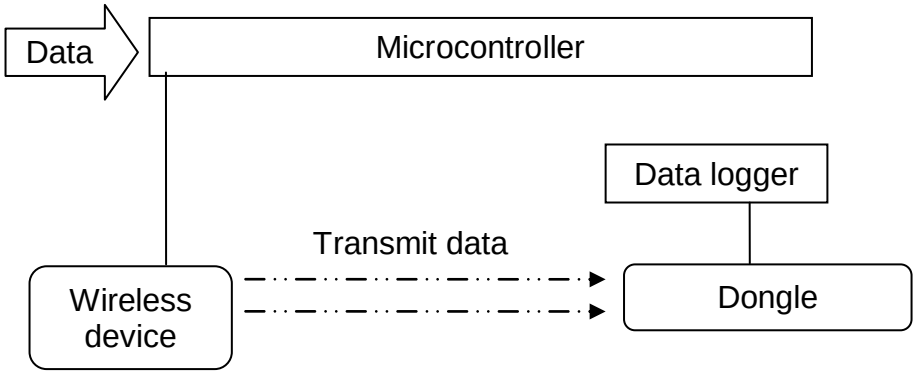


Figure 1.0 Block Diagram

Description:

The project is divided into two parts; the circuit and the software. For the circuit part, a wireless transceiver device will be connected with microcontroller to make wireless data transmission happened. Microcontroller can be programmed to control all the processes required in it. For the software part, a data logger will be creating to records data of wind speed and direction from hardware through wireless system on computer.

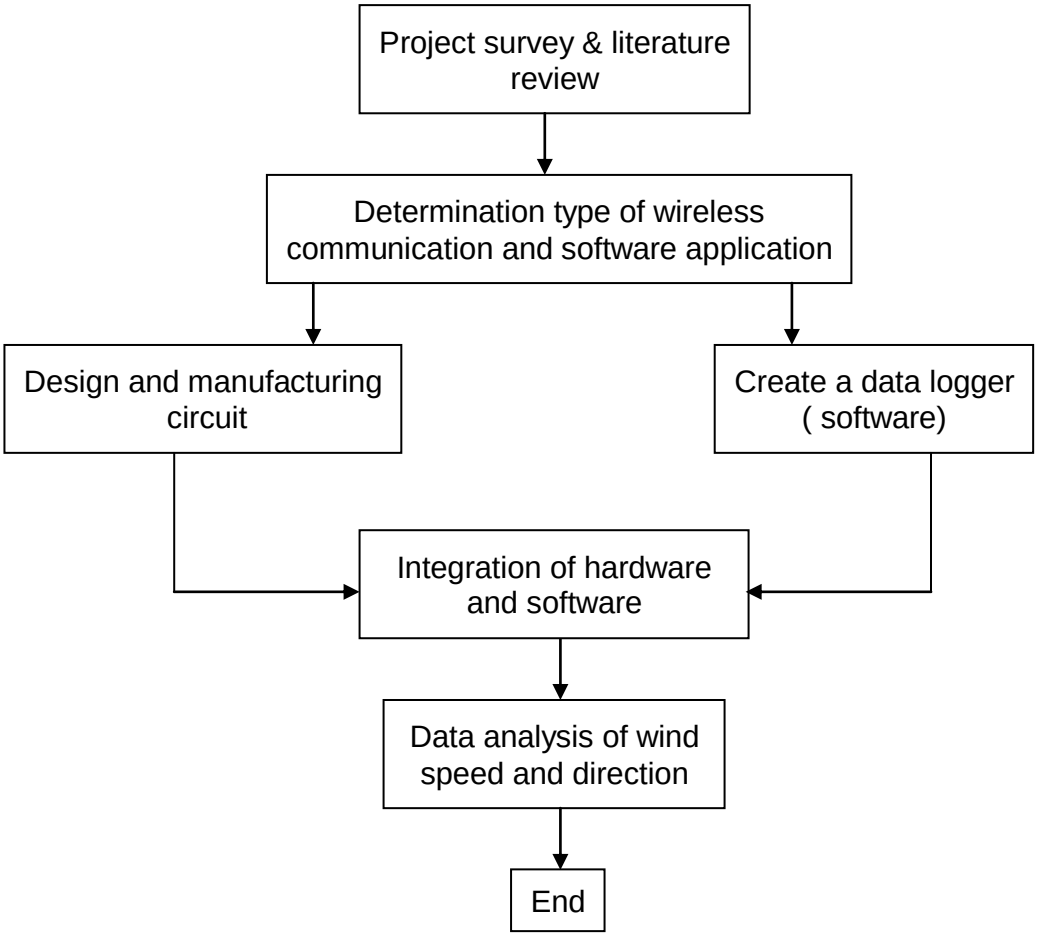


Figure 1.1 Flow Developments

Description:

Literature review and research on theories related to the project begins after the title of the project was decided. These involve theories such as type wireless technology, microcontroller and a few others. By obtaining most of the information from the internet and a few reference book, the Zigbee wireless device was chosen to be developed in this project because of it suitable function and features for this project.

ACTIVITY	SEM 1					
	JAN08	FEB08	MAR08	APR08	MAY08	JUN08
Project Approval						
Project Survey						
Project Discussion						
Component Analysis						
Preliminary Design						

Figure 1.2 Gantt chart of the project schedule for PSM 1

CONSTRUCTION	SEM 2					
	DEC08	JAN09	FEB09	MAC09	APR09	MAY09
Detail Design						
Manufacturing Circuit						
Configure Software						
Project Testing, Presentation						
Draft & Thesis						

Figure 1.3 Gantt chart of the project schedule for PSM 2

CHAPTER 2

THEORY AND LITERATURE REVIEW

2.1 Introduction

This chapter includes the study of wireless technology, Bluetooth and microcontroller. It's about the feature, application and adaptation. It also touches slightly on other relevant hardware used in this project.

2.2 Wireless Communications

Wireless communications refers to technologies where information signals are transferred is the transfer of information over a distance without the use of electrical conductors or "wires". The distances involved may be short (a few meters as in television remote control) or very long (thousands or even millions of kilometers for radio communications). When the context is clear the term is often simply shortened to "wireless". Wireless communications is generally considered to be a branch of telecommunications. There are numerous applications for all the different wireless technologies. General applications of wireless technologies are divided into the voice and messaging, hand-held and other Internet-enabled devices, and data networking. Although a traditional classification, this way of categorizing wireless technologies also includes their differences in cost models, bandwidth, coverage areas, etc.

2.2.1 ZigBee

ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless personal area networks (WPANs), such as wireless headphones connecting with cell phones via short-range radio. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. ZigBee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking.

Figure 2.0 ZigBee XBee physical look

Table 2.0 Pin Assignment for Zigbee

Pin #	Name	Direction	Description
1	VCC	-	Power supply
2	DOUT	Output	UART Data Out
3	DIN / **CONFIG**	Input	UART Data In
4	DIO12	either	Digital I/O 12
5	**RESET**	Input	Module Reset (reset pulse must be at least 200 ns)
6	PWM0 / RSSI / DIO10	either	PWM Output 0 / RX Signal Strength Indicator / Digital IO
7	DIO11	either	Digital I/O 11
8	[reserved]	-	Do not connect
9	DTR / SLEEP_RQ/ DIO8	either	Pin Sleep Control Line or Digital IO 8
10	GND	-	Ground
11	DIO4	either	Digital I/O 4
12	**CTS** / DIO7	either	Clear-to-Send Flow Control or Digital I/O 7. CTS, if enabled, is an output.
13	ON / **SLEEP**	Output	Module Status Indicator or Digital I/O 9
14	VREF	Input	Voltage reference for A/D inputs
15	Associate / AD5/DI05	either	Associated Indicator, Digital I/O 5
16	RTS/AD6/DI06	either	Request-to-Send Flow Control, Digital I/O 6. RTS, if enabled, is an input
17	AD3/DI03	either	Analog Input 3 or Digital I/O 3
18	AD2/DI02	either	Analog Input 2 or Digital I/O 2
19	AD1/DI01	either	Analog Input 1 or Digital I/O 1
20	AD0/DI00/ Commissioning Button	either	Analog Input 0, Digital IO 0, or Commissioning Button

2.2.2 Bluetooth

Bluetooth is a wireless protocol utilizing short-range communications technology facilitating data transmission over short distances from fixed and/or mobile devices, creating wireless personal area networks (PANs). The intent behind the development of Bluetooth was the creation of a single digital wireless protocol, capable of connecting multiple devices and overcoming issues arising from synchronization of these devices. Bluetooth provides a way to connect and exchange

information and its technology specification for small form factor, low-cost, short-range wireless links between devices such as mobile phones, telephones, laptops, personal computers, printers, GPS receivers, digital cameras, and video game consoles over a secure, globally unlicensed industrial.

2.2.3 Comparing ZigBee, Bletooth, Wi –Fi

Table 2.1 Compared between Zigbee, Bluetooth and Wi - Fi

Standard	ZigBee® 802.15.4	Wi-Fi™ 802.11b	Bluetooth™ 802.15.1
Transmission Range (meters)	1 – 100*	1 - 100	1 – 10
Battery Life (days)	100 – 1,000	0.5 – 5.0	1 - 7
Network Size (# of nodes)	> 64,000	32	7
Application	Monitoring & Control	Web, Email, Video	Cable Replacement
Stack Size (KB)	4 – 32	1,000	250
Throughput kb/s)	20 – 250	11,000	720

*****XBeePRO yields 2 – 3x the range of standard Zigbee Modules (up to 1200 meter)

2.3 Microcontroller

Microcontrollers must contain at least two primary components – random access memory (RAM), and an instruction set. RAM is a type of internal logic unit that stores information temporarily. RAM contents disappear when the power is turned off. While RAM is used to hold any kind of data, some RAM is specialized, referred to as registers. The instruction set is a list of all commands and their corresponding functions. During operation, the microcontroller will step through a program (the firmware). Each valid instruction set and the matching internal hardware are the features that differentiate one microcontroller from another [5].

Most microcontrollers also contain read-only memory (ROM), programmable read-only memory (PROM), or erasable programmable read-only memory (EPROM). Al1 of these memories are permanent: they retain what is programmed into them even during loss of power. They are used to store the firmware that tells the microcontroller how to operate. Often these memories do not reside in the microcontroller; instead, they are contained in external ICs, and the instructions are fetched as the microcontroller runs. This enables quick and low-cost updates to the firmware by replacing the ROM.

The number of I/O pins per controllers varies greatly, plus each I/O pin can be programmed as an input or output (or even switch during the running of a program). The load (current draw) that each pin can drive is usually low. If the output is expected to be a heavy load, then it is essential to use a driver chip or transistor buffer.

Most microcontrollers contain circuitry to generate the system clock. This square wave is the heartbeat of the microcontroller and all operations are synchronized to it. Obviously, it controls the speed at which the microcontroller functions. All that is needed to complete the clock circuit would be the crystal or RC components. We can, therefore precisely select the operating speed critical to many applications.

To summarize, a microcontroller contains (in one chip) two or more of the following elements in order of importance:

i. Instruction set
ii. RAM
iii. ROM, PROM or EPROM
iv. I/O ports
v. Clock generator
vi. Reset function
vii. Watchdog timer
viii. Serial port
ix. Interrupts
x. Timers
xi. Analog-to-digital converters
xii. Digital-to-analog converters

2.3.1 PIC16F877A

PIC 16F877A is a microcontroller developed by Microchip Technology. It is developed using RISC technology and only consists of 35 instructions set. It can run on variable speed up to 20MHz. Beside that, the PIC draws low poser consumption and provides a high speed Flash/EEPROM technology. The operating voltage range is wide, as low as 2.0V up to 5.5V.

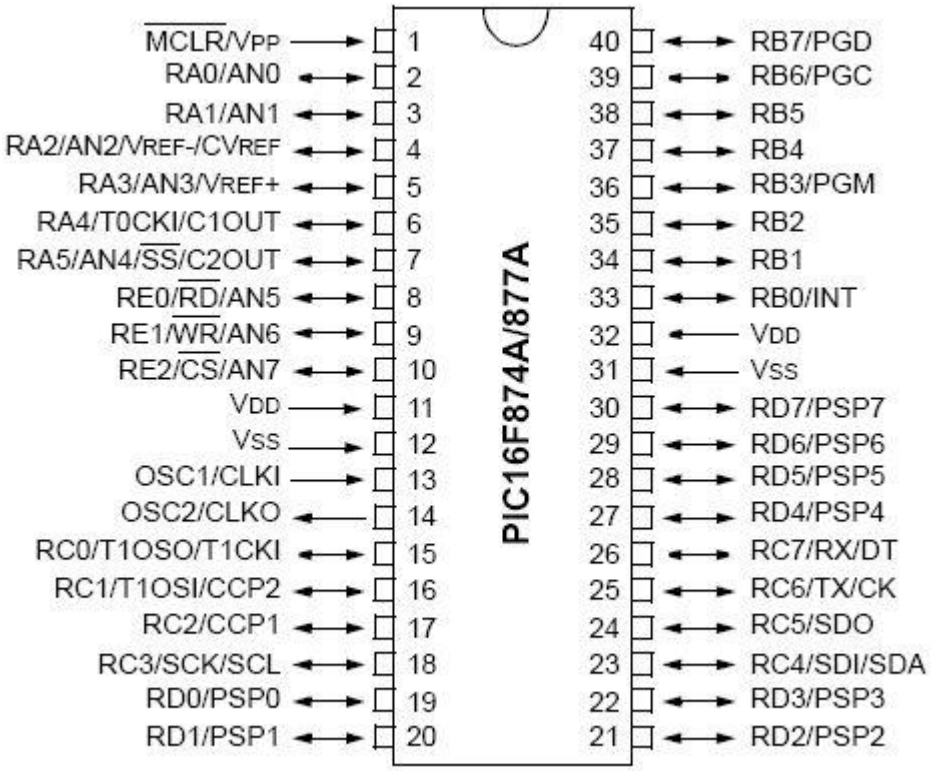


Figure 2.1 Physical look and diagram for PIC 16F877A

Features in PIC 16F877A;

1) Timer0: 8-bit timer/counter with 8-bit prescaler.
2) Timer1: 16-bit timer/counter with prescaler can be incremented during Sleep via external crystal/clock.
3) Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler.
4) Two Capture, Compare, PWM modules;
   - Capture is 16-bit, maximum resolution is 12.5 ns.
   - Compare is 16-bit, maximum resolution is 200 ns.
   - PWM maximum resolution is 10-bit.
5) Synchronous Serial Port (SSP) with SPI™ (Master mode) and I2C™ (Master/Slave).
6) Universal Synchronous Asynchronous Receiver.
7) Transmitter (USART/SCI) with 9-bit address detection.
8) Parallel Slave Port (PSP) – 8 bits wide with external RD, WR and CS controls (40/44-pin only).
9) Brown-out detection circuitry for Brown-out Reset (BOR).

For analog features, the PIC 16F877A have 10 bits, 8 channels analog-to-digital converter. With total of 5 I/O ports, the PIC16F877A is the most suitable device for controlling a lot of controlling circuits.

The summary of PIC 16F877A features and specification is shown in table below;

Table 2.2 PIC 16F877A features

Key Features	**PIC 16F877A**
Operating Frequency	DC – 20MHz
Reset (and delays)	POR, BOR (PWRT, OST)
Flash Program Memory(14-bit words)	8K
Data Memory (bytes)	368
EEPROM Data Memory (bytes)	256
Interrupts	15
I/O Ports	Ports A, B, C, D, E
Timers	3
Capture/Compare/PWM modules	2
Serial Communications	MSSP, USART
Parallel Communications	PSP
10-bit Analog-to-Digital Module	8 input Channels
Analog Comparators	2
Instruction Set	35 instructions
Packages	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN

2.3.1.1 Universal Synchronous Asynchronous Receiver (USART)

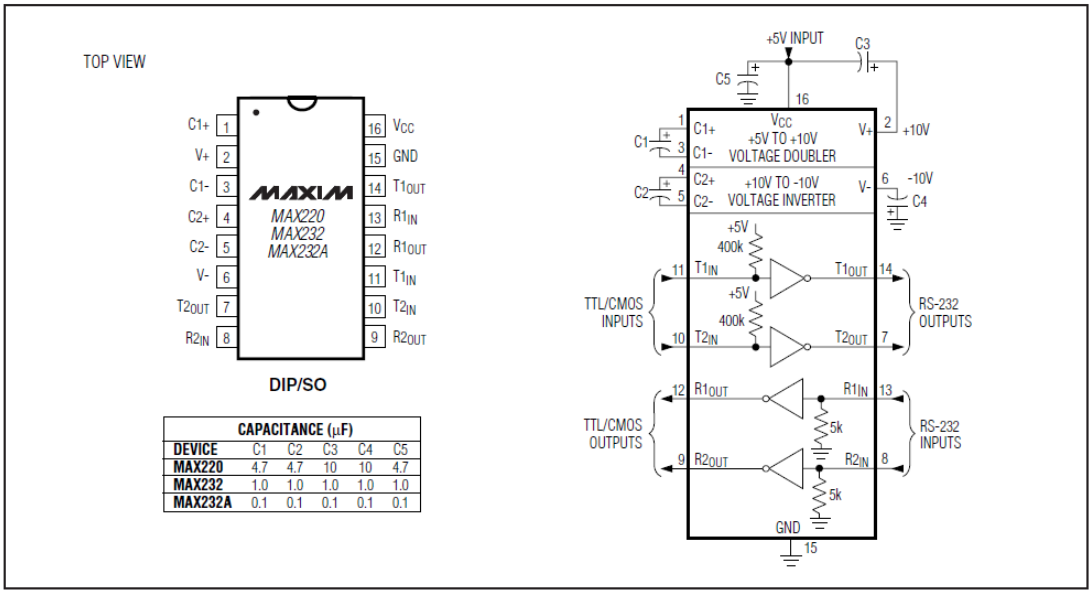
UART provides the ability to transmit data for one device to the other without a complex set of wiring. Once the connections are made data can be sent and received with the use of transmitting packets of data. Information such as start-stop bits, data bits, and timing information can be conveyed from one end device to the other. The Universal Asynchronous Receiver/Transmitter (UART) controller is the key component of the serial communications subsystem of a computer. The UART takes bytes of data and transmits the individual bits in a sequential fashion. At the destination, a second UART re-assembles the bits into complete bytes. Serial transmission of digital information (bits) through a single wire or other medium is much more cost effective than parallel transmission through multiple wires.

A UART is used to convert the transmitted information between its sequential and parallel form at each end of the link. Each UART contains a shift register which is the fundamental method of conversion between serial and parallel forms. The UART usually does not directly generate or receive the external signals used between different items of equipment. Typically, separate interface devices are used to convert the logic level signals of the UART to and from the external signaling levels. External signals may be of many different forms. Examples of standards for voltage signaling are RS-232, RS-422 and RS-485 from the EIA. Historically, the presence or absence of current (in current loops) was used in telegraph circuits. Some signaling schemes do not use electrical wires. Examples of such are optical fiber, IrDA (infrared), and (wireless) Bluetooth in its Serial Port Profile (SPP).

Some signaling schemes use modulation of a carrier signal (with or without wires). Communication may be "full duplex" (both send and receive at the same time) or "half duplex" (devices take turns transmitting and receiving).As of 2008, UARTs is commonly used with RS-232 for embedded systems communications. It is useful to communicate between microcontrollers and also with PCs.

2.4 MAX 232

MAX232 is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V. The later MAX232A is backwards compatible with the original MAX232 but may operate at higher baud rates and can use smaller external capacitors – 0.1 µF in place of the 1.0 µF capacitors used with the original device.



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

Figure 2.2 MAX232 Pin Configurations & Typical Operating Circuit