Electronic Design Lab II
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Receiver for Data over FM band

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ABSTRACT

In this report we have described the design of a receiver capable of receiving data over FM band. It accepts the data and displays it on a GLCD (liquid crystal display) module with the user being capable of performing scrolling functions with the press of keys on the receiver. One can receive both text and graphics and display it on the GLCD.
In section I we provide a basic introduction about the design and potential applications of the design. Section II and III cover the description of the design along with detailed circuit diagrams. In section IV the test procedure is elaborated followed by the final design test results in section V and references in section VI.

I.INTRODUCTION

The basic design includes a FM receiver (commercially available) for receiving and demodulating data on FM band. The FM receiver is followed by a waveform shaping circuit .The output of the waveform shaping circuit goes to a microcontroller based circuit which does the work of accepting ,storing and displaying data on the GLCD which is interfaced to the microcontroller. We have also used external memory interfaced with the microcontroller for storing data.

The waveform shaper circuit shapes the incoming waveform from the FM receiver and provides 0-5V signal to the microcontroller circuit. The complete receiver unit runs on four pencil sized batteries (1.5V each).We have used a commercially available FM transmitter (VEGAKIT) for transmitting the data supplied by a computer through an RS232 serial port.

Such an application can be of use in rural areas by providing daily news items and other important information to the user carrying the handheld device at a cost effective price. The data can be transmitted by a FM base station giving coverage area of several sq.kms. Another possible application we have looked at is transmitting data between two computers using a transmitter capable of receiving data through the serial port and transmitting it to the receiver which can communicate to the computer. We have arranged it to be displayed on a LCD in our project design.

II. DESIGN APPROACH

The project can be divided into the following sections

1. Hardware
2. Software
3. Design Development

1. Hardware

Includes the following

A) Transmitter
B) Receiver

A. Transmitter:
On the transmitter side the data comes from a computer via a DB-9(9 pin) serial connector with voltage level (plus 3-12 V) for logic LOW and (minus 3-12V) for logic HIGH.
This voltage level is scaled down to a 200mV p-p signal and fed to the FM transmitter (Commercially available VEGAKIT)

B. Receiver:
The signal is received and demodulated by a FM receiver (commercially available)
It works on a Philips TEA5591 IC. It gives an output of 200mV p-p signal.

This FM receiver is followed by a waveform shaper which is basically a LM339 IC for producing a 0-5V digital data output for the microcontroller part.
The microcontroller displays the data on the graphic liquid crystal display (GLCD). A detailed analysis is as follows.

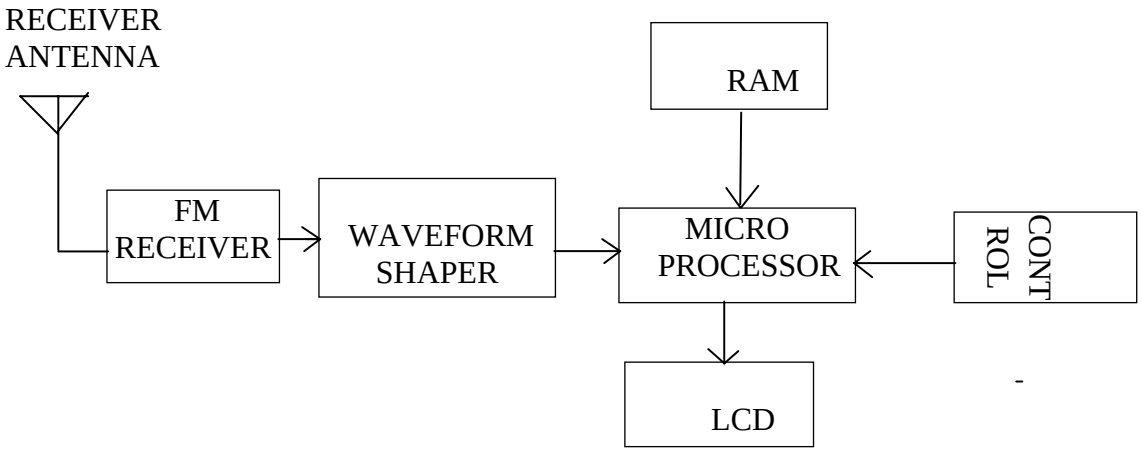


FIG.1 BLOCK DIAGRAM FOR THE RECEIVER

Waveform Shaper:
It consists of a quad comparator chip which runs on a 0-5 V single supply.
It has a slew rate of 13V/microsec and is capable of shaping data rates of up to 5Kbps with good quality.

Microprocessor circuit:
It consists of an AT89C52 microcontroller using a 12MHZ crystal. It is interfaced to a RAM, a control input and the GLCD. It takes in data serially coming from the waveform shaper and stores in into the RAM for use later .This data is retrieved from the RAM and displayed on the GLCD (repeatedly in absence of fresh transmissions) .The control signal is given through a simple push-button switch for scrolling functions (page up, page down, line up, line down).
RAM used has a capacity of 32KB (for storing text and graphics)

GLCD:
GLCD used is a 48 x 84 pixels Nokia 3310 capable of both graphic and text display. It It consists of an inbuilt Philips controller PCD8544.
It has following pin functions.

Pin no	Connection	
1	Vcc	(supply)
2	SCLK	(clock)
3	SDIN	(data input)
4	D/C	(command/data)
5	CS	(chip select)
6	Gnd	(ground)
7	Vout	
8	RESET	

Data Description:
The data is organized as follows.
The microcontroller code is capable of making the decision between character and graphic data and displaying them accordingly

An article represents a block of information same as a newspaper article. Each article has a start and stop sequence (1 Byte) which identifies start and end. Similarly each line has a start and stop sequence (1 Byte).Finally each character has a start and stop bit and is sent as an ASCII string. The data is stored in a RAM; the articles are stored in separate compartments in the RAM so page up/down accesses different compartments (i.e.) different articles.

The graphic data consists of 504 bytes per image display. Each byte is transferred to the GLCD from the buffer and is displayed. The data is displayed in a horizontal scan with the 1^{st} 8 bits display 1^{st} 8 rows of the 1^{st} column and this is repeated for every column till the 84^{th} iteration, after which we move into the next eight rows and repeat the same procedure.

2. Software

The software organization can also be divided into transmitter and receiver sections. Following are the important points enumerating basic software design.

Data format:

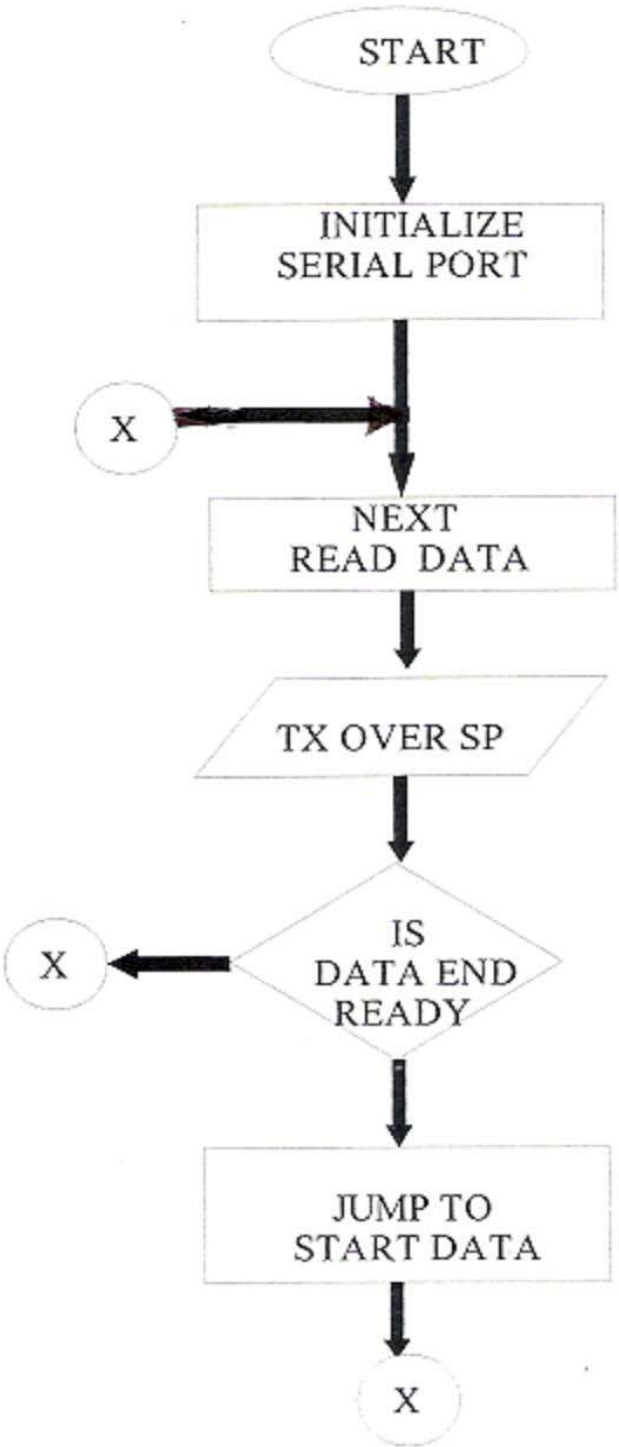
The data is organized into articles/pages. There are a fixed number of articles. Each article has a start and stop sequence. Each article has a maximum size. Each line of the article has a fixed size and each line has a start and stop sequence. The articles are repeatedly transmitted.

Transmitter:

The data is stored in the computer and is send to the transmitter using the serial port of the computer.

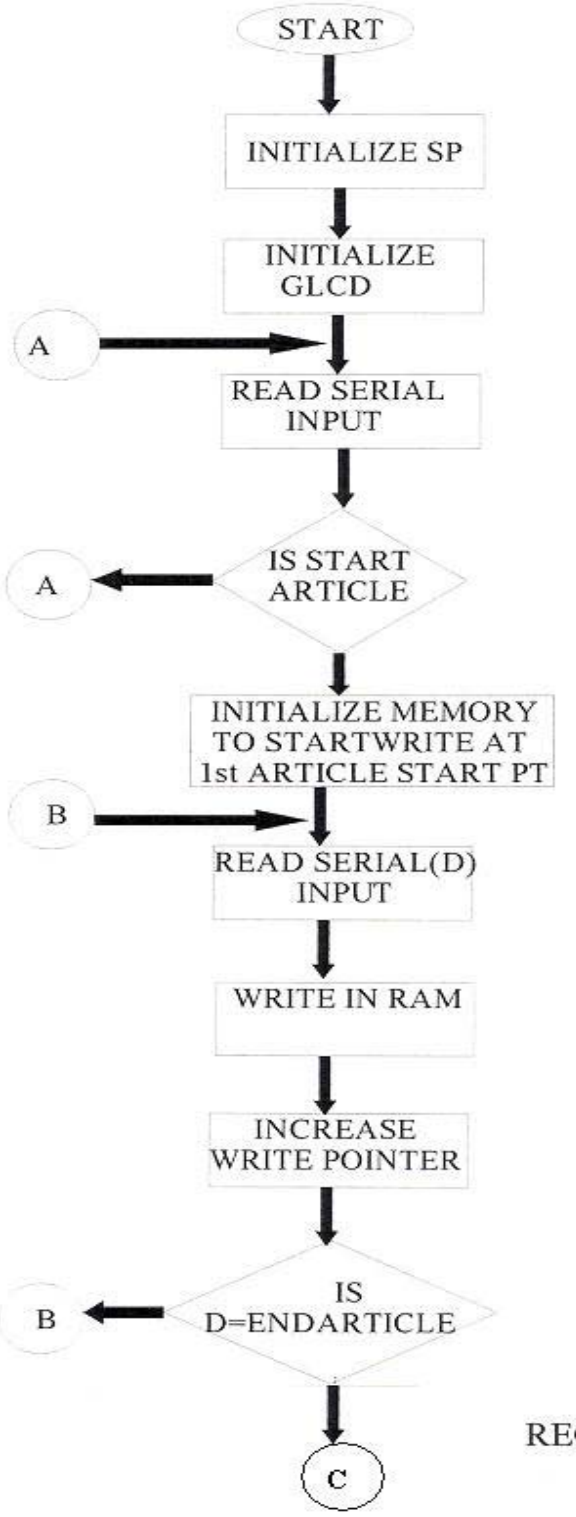
Receiver:

At the receiver the data is received at the serial port of a microcontroller. The microcontroller stores a specific number of articles, depending on the memory connected to it. The microcontroller then displays the first article on the GLCD.
The receiver has four keys line-up, line-down, article-up, article-down. Also there is a fifth key which resets the receiver to receive data again. The data once received is not lost updated till the reset button is pressed again.



Data format contains the start/stop sequence

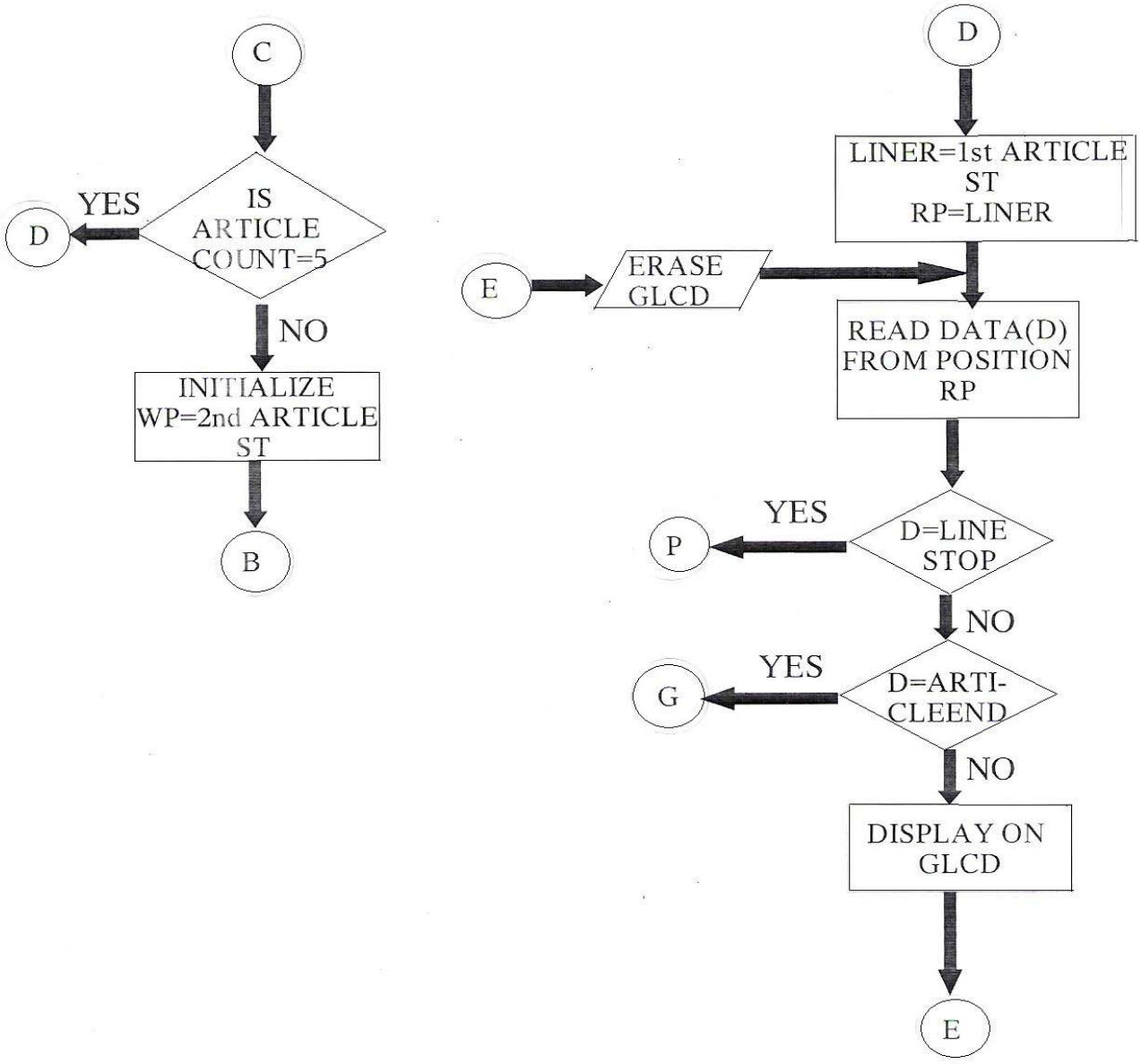
TRANSMITTER

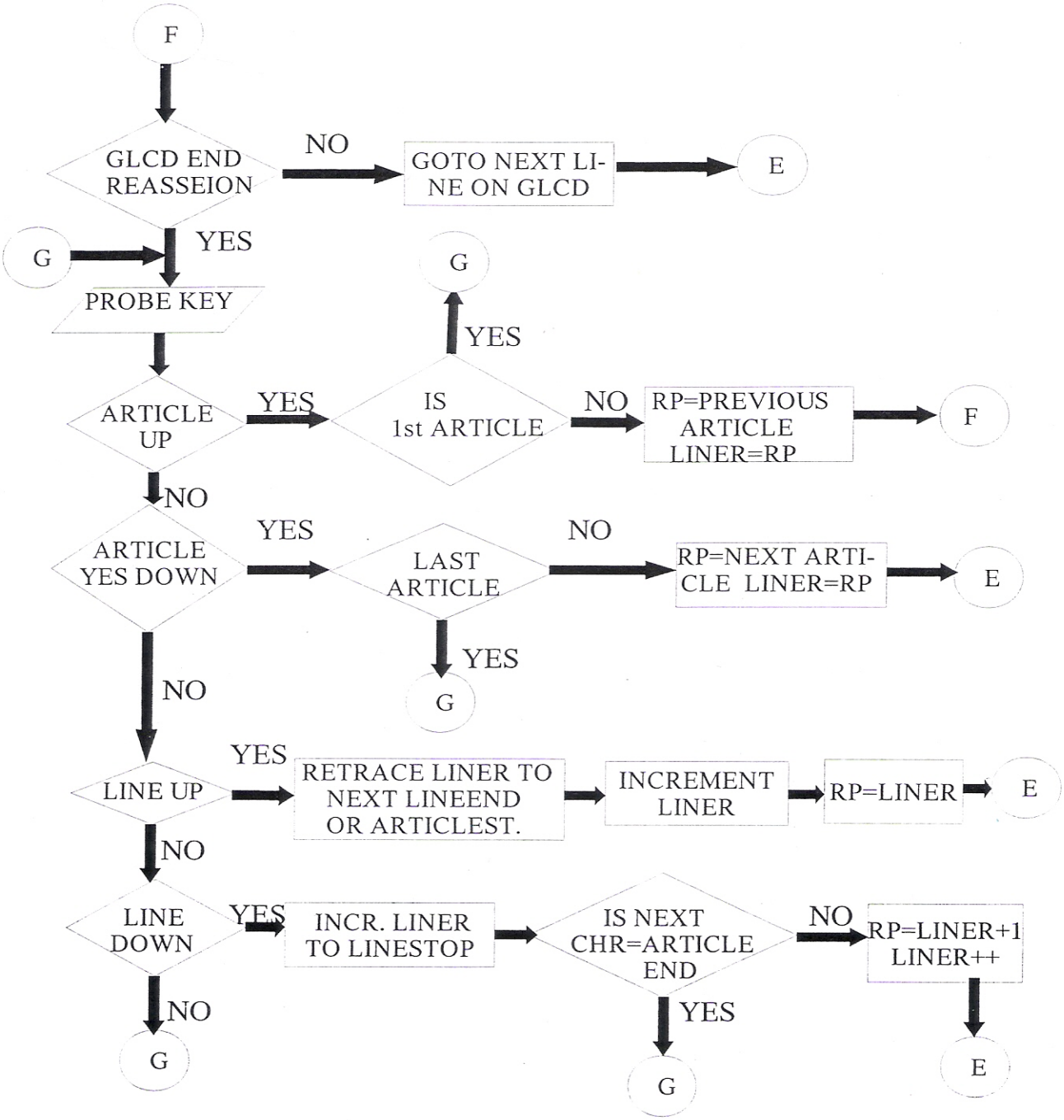


Each article is alloted to a fixed memory size and has a specific starting point

of the length of the previous article

RECEIVER


C
IS ARTICLE COUNT=5
YES
D
NO
INITIALIZE WP=2nd ARTICLE ST
B
D
LINER=1st ARTICLE ST
RP=LINER
E
ERASE GLCD
READ DATA(D) FROM POSITION RP
D=LINE STOP
YES
P
NO
D=ARTI-CLEEND
YES
G
NO
DISPLAY ON GLCD
E


F
GLCD END REASSEION
NO
GOTO NEXT LI-NE ON GLCD
E
G
YES
PROBE KEY
G
YES
ARTICLE UP
YES
IS 1st ARTICLE
NO
RP=PREVIOUS ARTICLE LINER=RP
F
NO
ARTICLE YES DOWN
YES
LAST ARTICLE
NO
RP=NEXT ARTI-CLE LINER=RP
E
YES
G
NO
LINE UP
YES
RETRACE LINER TO NEXT LINEEND OR ARTICLEST.
INCREMENT LINER
RP=LINER
E
NO
LINE DOWN
YES
INCR. LINER TO LINESTOP
IS NEXT CHR=ARTICLE END
NO
RP=LINER+1 LINER++
NO
G
YES
G
E

3. Design Development

We directly fed data as the input to the transmitter. We also tested various modulation schemes like QPSK, Manchester encoding and FSK at the baseband.
On the receiver side we implemented scrolling up/down functions on 16 x 2 Oriole character LCD and tested both by-wire and RF-link transmission. This was followed by same procedure for the graphic LCD.
We also tested various waveform shaping circuits and finally settled on LM339 because of its low power consumption and minimal circuitry.
We also measured the robustness of the RF-link by measuring the BER (bit error rate) on a DSO (details later).We ran the whole receiver assembly on four pencil cell batteries of 1.5 volts each.

III.FINAL CIRCUIT

Following is the final circuit design along with a list of components used.

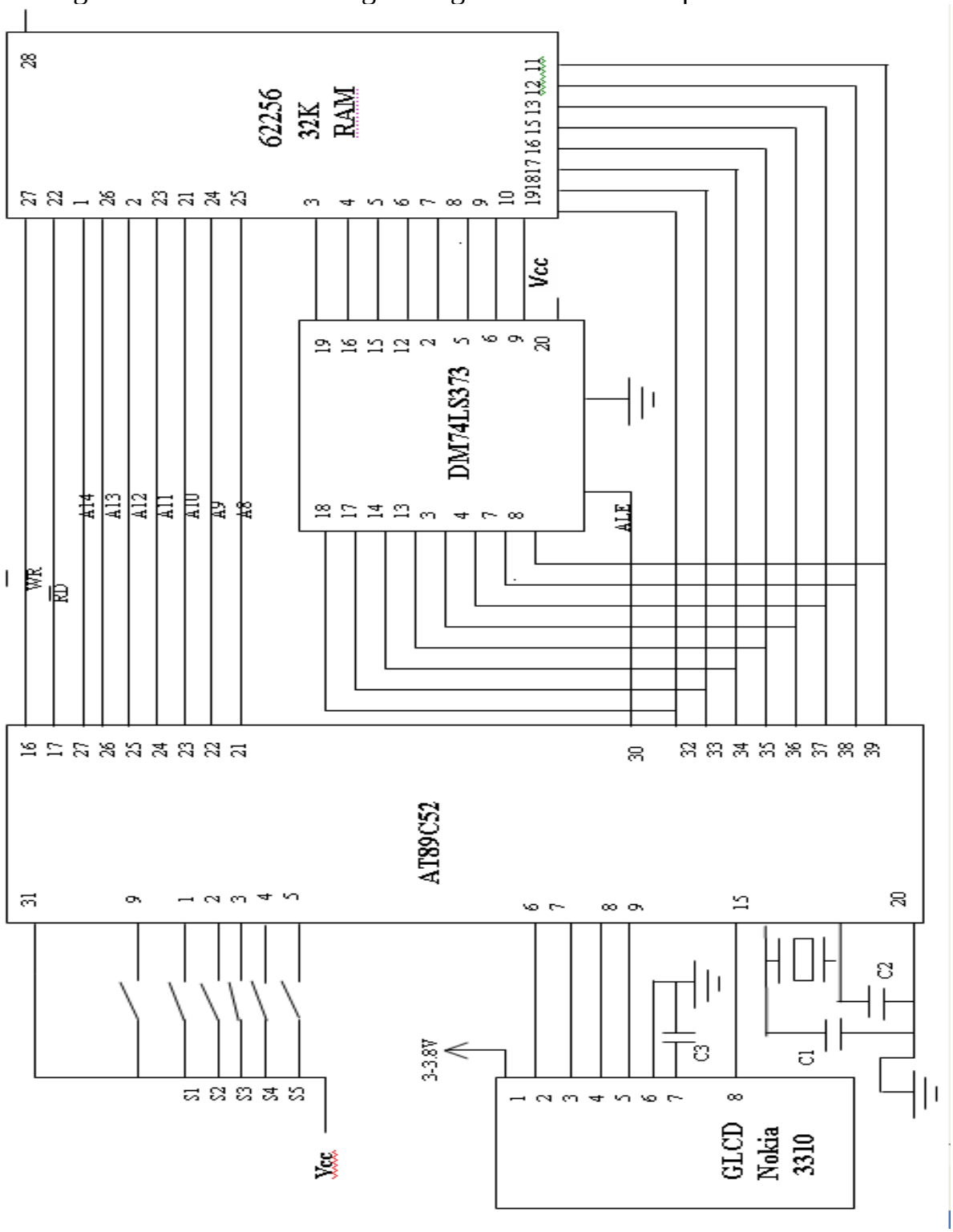


FIG.2 WIRING DIAGRAM OF
MICROCONTROLLER-RAM-GLCD INTERFACING

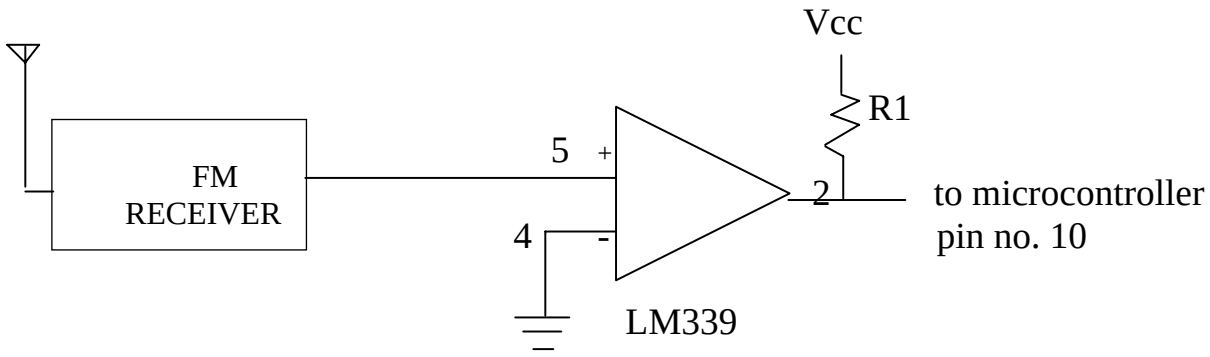


FIG.3 FM RECEIVER AND WAVEFORM SHAPER

List of Components

Name	***Description***	***Quantity***
Resistors:		
R1	3K Ω	1
Capacitors		
C1,C2	47pF	2
C3	47μF	1
Chips		
AT89C52	microprocessor	1
LM339	Quad comparator	1
DM74LS373	Latch IC	1
62256	32KB RAM	1
Miscellaneous		
Quartz Crystal	12MHZ	1
GLCD Module	Nokia 3310	1
Switches	Push-Button	5

IV. TEST PROCEDURE

The test procedure consists of checking the expected outputs at various points in the circuit for easy debugging and checking the circuit working. The details are as follows.

1. Ouptut of the FM receiver is tapped at point A.
Signal output: 200mV p-p digital signal with variable dc.

2. Output of the LM339 (input to microcontroller) is tapped at pin no 2 of the IC.
Signal output: 0-5V digital signal

3. Pin no 6 of microprocessor gives out digital data to the GLCD.
Signal output: 0-3.5V digital signal

4. The control pins give 5V or 0V as signal to the microcontroller at pin no.

V. TEST RESULTS

The test results include the performance metrics of the working circuit and also give some information about circuit robustness and battery longevity.

Bit error rate: The bit error rate was found to be <0.001.No error was found in 1000 bit samples of the data even after repeated sampling.

Current consumption:
The receiver when receiving data and displaying on the GLCD consumes 100mA
When no data is being received and the stored data is repeatedly displayed, it consumes 100mA.

VI.REFERENCES

1. Datasheet of LM339
www.datasheetarchive.com

2. Connection diagrams of AT89C52, 62256RAM, 27256EEPROM, DM74LS373
The 8051 Microcontroller, Architecture, Programming and Application. Kenneth J.Ayala Penram Publications

3. General References
Microelectronic Circuit (fourth edition).Sedra & Smith.