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STUDY ON THE MEASUREMENT,ANALYSIS AND FORECASTING OF THE ELECTROMAGNETIC FIELD ENVIRONMENT.

(PHASE I)

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Final Report: "STUDY ON THE MEASUREMENT,ANALYSIS AND FORECASTING OF THE ELECTROMAGNETIC FIELD ENVIRONMENT (PART I)"

1. Introductory Statement

This report is a summary of work done for the Department of Communications,under DSS Contract OSU 82-00175,under the direction of T.J.F. Pavlasek at McGill University. The renumerated staff engaged in this work consisted of Mr. P. Ilott, Research Associate on a part-time basis and Mr. Vladamir Glavac, computer hardware consultant on a part-time basis.This report covers the period April 1,1982 to March 31,1983.

-----Statement of Objectives----

The original objectives of this two part study were and are the following.

THE INVESTIGATION OF -

1. the temporal behavior of the electromagnetic environment.
2. the micro-structure of a typical section of urban area (e.g. a university campus).
3. the vertical profile of the field in the vicinity of high rise buildings.
4. the penetration of electromagnetic fields into buildings.
5. the electromagnetic environment in frequency ranges not emphasized in previous studies for prediction purposes.

These studies were to be carried out keeping in mind the conditions particular to high density metropolitan areas and existing techniques for measuring and analyzing the urban E.M. environment for prediction purposes .

The first year of the study was intended to define the feasibility and the methodology of achieving the above objectives. Preliminary measurements and analyses were to be carried out to demonstrate the feasibility and to establish a detailed plan of activities for the second year,which would entail exploitation of those areas described above which seemed to have the greatest significance (for example- detailed measurements relating to number three above.)

2. REVIEW OF THE PROBLEM

1. Introduction

In recent years concern has been growing over the large rate of growth of the strengths of the electromagnetic fields which mankind intentionally and unintentionally generates in the environment.Pessimistic predictions indicate that the fields due intentional radiators alone could, before the turn of the century (see reference (1)), be in the range of values tentatively designated as biologically hazardous.Fields due to unintentional radiators are to some of even greater concern due to their random and uncontrollable properties.

Though, in the future, biological dangers may or may not prove to be a problem, the ambient fields in and around human centers of development currently, and will continue in the future, to pose threats to the technological devices upon which we as a species are becoming more and more dependent.It is unfortunate that the silicon devices, now the very basis of our current technological revolution, not only are sources of rather objectionable radiated fields, but are also extremely sensitive to damage resulting from medium to strong external impinging electromagnetic radiation.(see reference (2))

At the present stage these problems produce not only annoyances,but also non-trivial effects on critical control systems and in systems on which human safety and health may depend.Many of these can be dealt with by appropriate protective procedures, both for the radiators and the devices to be protected. However, as our society continues to incorporate ever more sophisticated equipment into everyday life we must develop the techniques of measurement and of prediction of field levels to ensure that we are able to deal with the problems of controlling and regulating the EM spectrum and its use, or overuse, by man.

2. IMPORTANCE OF MONITORING

Though constant monitoring of the commercial and non-commercial radiators in our environment is in general the responsibility of certain governmental agencies and regulatory bodies, the task of constant anu detailed examination of the micro-stucture of the EM fields within which most of us live is one which is very costly and time consuming for such institutions, given the techniques currently in use. These techniques usually involve rather expensive mobile facilities.(see reference (5)) While these large systems and installations are indispensable for general monitoring of the EM envirnonment they have their limitations when it comes to gathering information about the fields in and around actual facilities where such information is vital.

The solution to this problem would seem to be some kind of statistical modelling of the environment and a way to make predictions based on this modelling.In fact, short of constant monitoring at the myriad of crucial locations present ,even in a city of modest size, there is no alternative.However to develop a model which could be considered reliable one must have the ability to gather enormous amounts of data in and around a typical urban area.The large mobile facilities already mentioned would play a key role in this data gathering.But the problem still remains of how to take measurements within structures to which such large equipment would not have access.Even small vehicles are not appropriate for measurements inside buildings at different floor levels.

To develop the statistical models to be used in the future we must first be able to measure the fields inside and around buildings of interest, in an efficient manner.This data will serve, among other things, to enable the cross-correlation of outside field values (which are readily obtainable), to those within typical edifices. With such cross-correlation data available, statistical parameters may be adjusted to give the best possible fits to the curves which should indicate the onset of questionable conditions.

3. MINI-MONITORING STATIONS.

The solution to the measurement and monitoring problem as perceived, is to develop small,lightweight,inexpensive and reliable field measuring facilities which can be transported within the average installation to gather the large amounts of data needed for valid statistical analysis. To this end we have undertaken the work which is the subject of this report.

We will discuss in more detail the decisions that were taken and describe the working model that has been constructed. We will discuss the advantages and the limitations of our system and how they can contribute to the problem at hand. We will further discuss our plan of measurement to be carried out over the next year in and around the campus of McGill. Cross-correlation techniques will be developed for working with both the data taken indoors and that supplied by the D.O.C.'s mobile field measuring facilities.

Firstly we will discuss some results of some preliminary work, performed in late spring 1982, to give us an idea of the types of field strengths we would be dealing with,to enable us to plan the sort of system which would be most useful.We will see that some of the numbers we found were both surprising and disconcerting.

3. Preliminary Results

To get a rough idea of the upper and lower bounds of the field strengths that could be expected when measuring inside a building on the McGill campus, a preliminary project at the undergraduate level was carried out using three undergraduates in the electrical engineering program at McGill, from January to May 1982. It was hoped that the results would provide enough data to enable the definition of both places and frequencies of interest.

The general guidelines of the project were as follows;

1. measurements at frequencies producing strong fields in various areas of the McConnell Engineering Building.
2. to get approximate horizontal and vertical profiles at typical locations in the building.

The measurements taken were very crude. They were done using a single adjustable dipole antenna. The output of the antenna was fed into a spectrum analyzer via a 50 ohm coaxial line and since the dipole is balanced and the line is unbalanced, a balun has to be constructed. It consisted of a resistance network coupled to a 1:1 ferrite balun-transformer. The resistance network was necessary to achieve the required impedance match between 75 and 50 ohms. The use of the ferrite core device was necessary in order to have a device of sufficient bandwidth, eliminating the need to readjust the balun for each frequency of interest. (see reference (3))

The frequency range investigated was from 100 MHz to 380 MHz. Upon scanning through this range it was found that one frequency in particular, 106 MHz (105.7-CFGL), consistently had amplitudes above all others. Most of the preliminary measurments were therefore limited to this frequency.

An approximate determination of the variation of field with respect to height was found by measuring the field strength at a similar location on each of the seven floors of the McConnell Engineering building. Thus a rough vertical profile through the building was obtained.The results are summarized in figure 3.1. As can be seen, the field varies from less than .002 V/M in the basement, to more than .153 on the third floor.The same type of measurement was repeated for a frequency of 204 MHz.The results are shown in figure 3.2.These values are of course not definitive.The measurements were not done in a statistical manner, there being only one sample for each point.As a rough check on the structure seen,the measurements were repeated two days later and the plots showed the same trends. (These results are not shown here.)

A study was also done on a typical horizontal area within the building, along one of the main corridors. The antenna was maintained at 1.93 meters above the floor. A plot of the results is given in figure 3.3. Here the maximum field level is at

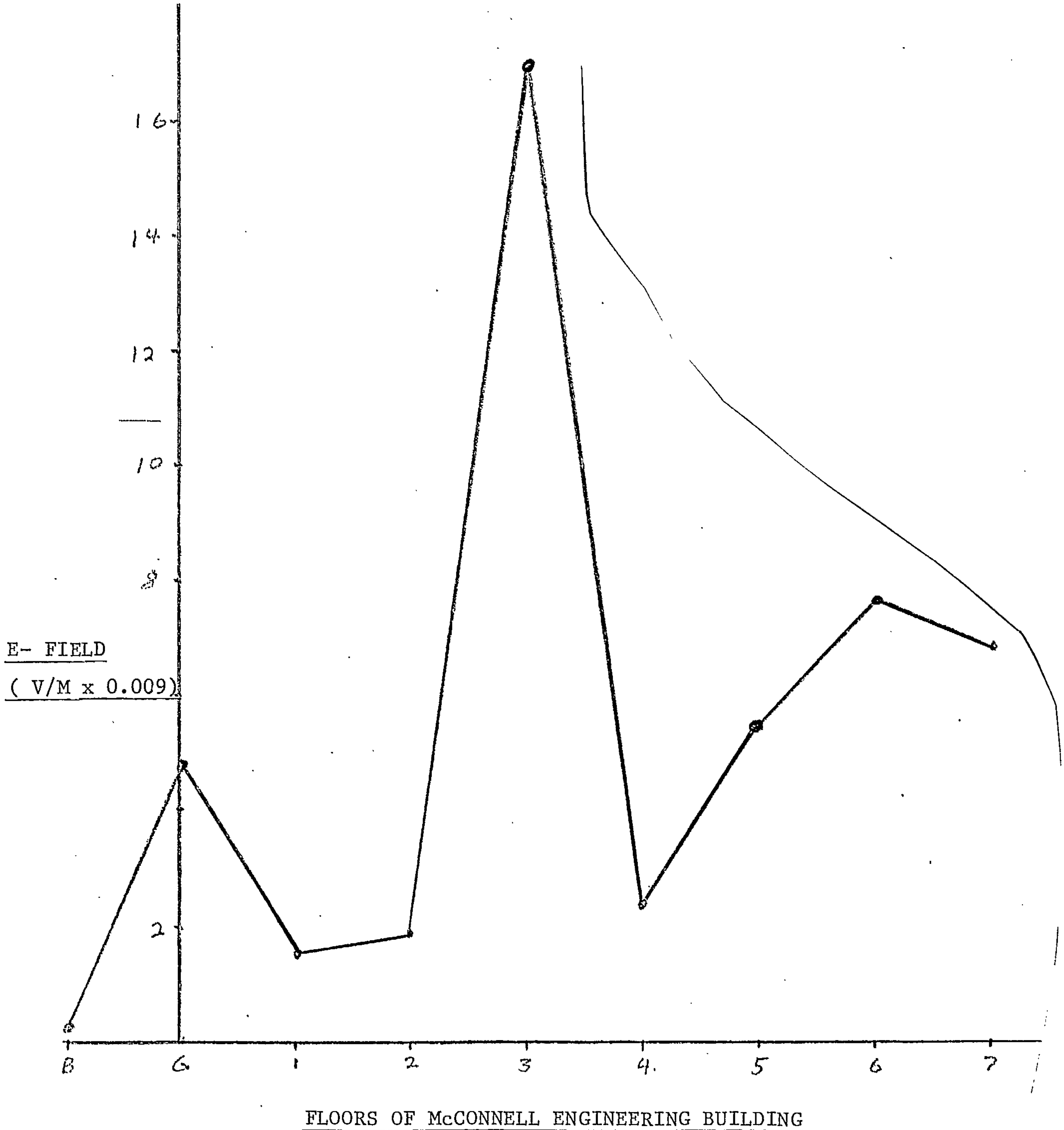
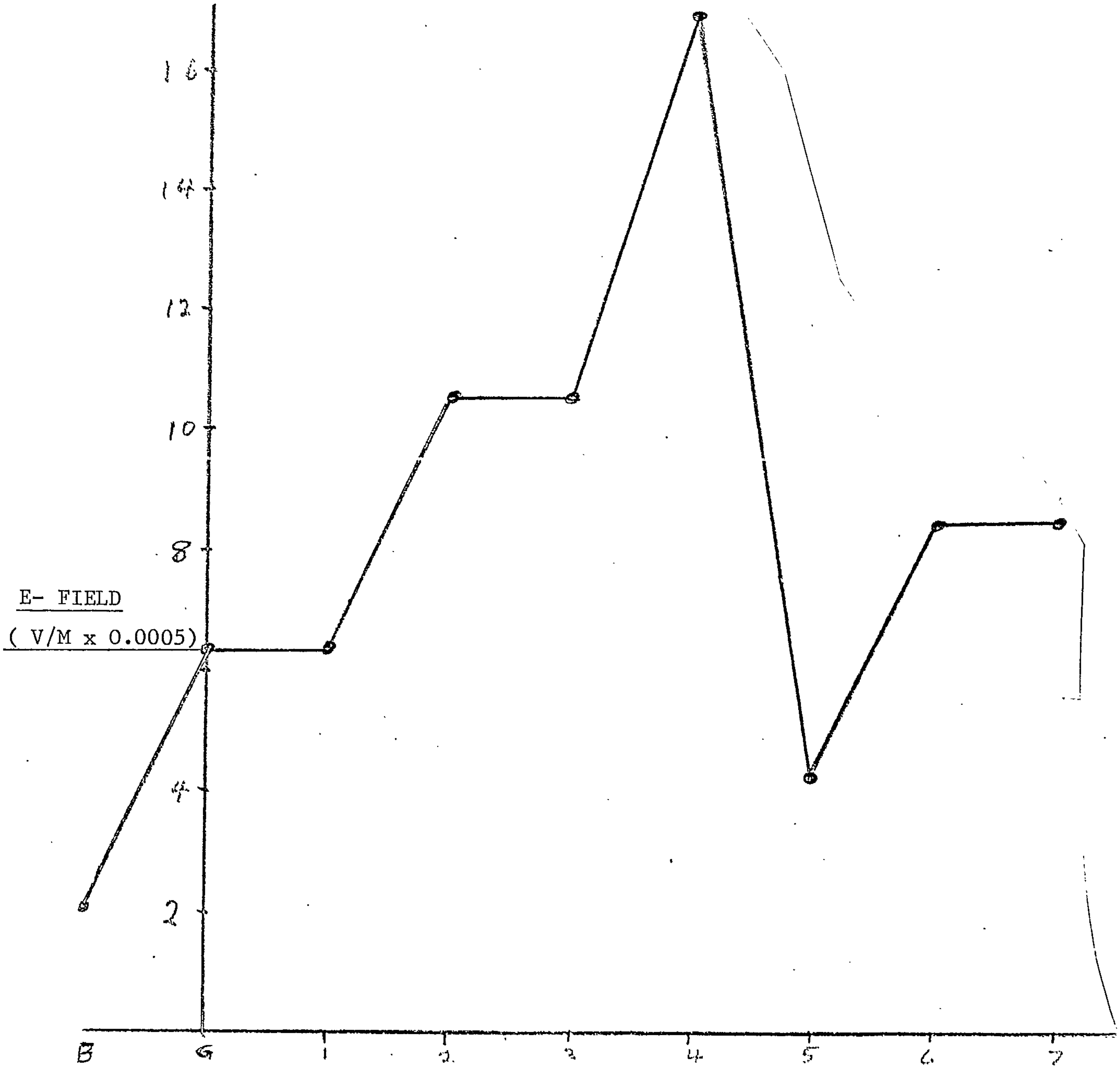


FIGURE 3.1

E - FIELD Vs. FLOORS OF McCONNELL BUILDING

FREQUENCY MEASURED AT -- 106 MHz



FLOORS OF McCONNELL ENGINEERING BUILDING

FIGURE 3.2 E- FIELD Vs. FLOORS OF McCONNELL BUILDING

FREQUENCY MEASURED AT -- 204 MHz

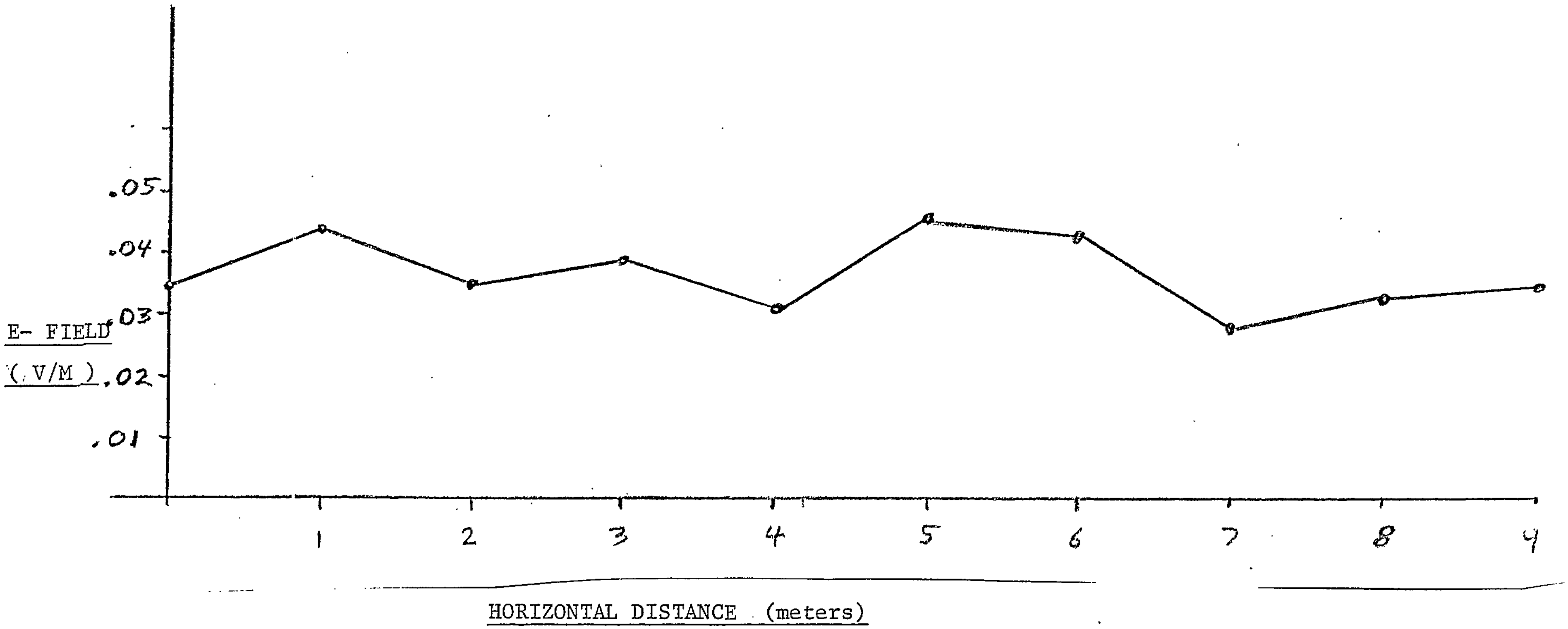


FIGURE 3.3

E- FIELD Versus HORIZONTAL DISTANCE (in meters)

of TYPICAL BUILDING CORRIDOR.

FREQUENCY OF MEASUREMENT - 106 MHz

about .046 V/M.

Some tests were made to investigate the change in values between indoors and outdoors. For a typical building entrance it was found that the field level changed from an inside value of about 0.02 to an outside value of about 0.044 V/M (at 106 MHz).

The most interesting result,however,came from a series of readings taken in some of the undergraduate computer labs.In one such room it was found that the field, (at 106 MHz),varied between a low of .007 and a high of .44 V/M. This maximum value is itself quite high and something to be concerned with. It turns out that this lab is in almost direct line of sight with the transmitting source of the frenquency in question. The shocking thing about this is the fact that just outside the window of this room the field rises to as high as 2 V/M. This is a value which could conceivably cause considerable damage to many microchip based instruments and devices.

The results of the preliminary measurements summarized above demonstrate the need for further investigation into the microstructure of the EM environment,particularly in regions where there are large numbers of commercial radiators.These results also show that the situation is more serious,in some cases, than might have been expected.The value quoted above of 2 V/M is in itself serious enough, however, this value is for one frequency only and the effect of many such signals from many transmitters is something that is hard to investigate both experimentally and theoretically.

For the time being the best that can be done is to document the structure and relative behavior of the fields on a scale small enough to enable the taking of a sufficient amount of meaningful data, but large enough to give some indications of general trends.We hope the current project will contribute to this work.

4. Methodology

We have already established the form of the problem at hand. Futhermore we have decided that a knowledge of the microstructure of the EM fields in and around a typical building in an urban area would provide the possibility of cross-correlation with those measurements of the outside micro and macrostructure of the EM environment determined by the major mobile systems in common use at the moment.

We would like to be able to study the fields within most areas in a typical building.This implies the need of a portable measuring system. Futher,we might wish to make some more unusual measurements,such as finding the vertical field strength profile on the outside of a building,or to make a continuous and precise measurement of the field on passing from inside to outside the enclosure.We would want to be able to do so at any floor of the building.

Our portable system should be versatile as well as easily portable and manoeuverable.There is one further problem.The amount of data needed to make such measurements statistically valid is very large. The old pencil and lab journal methods of data gathering is far too slow and costly in terms of manpower and time. Thus a system for gathering and storing large amounts of data for later retrieval and analysis is needed.Such a system should provide virtually unlimited storage space,as a typical day's work in the field could easily provide numbers of data points well in excess of

100,000.This of course depends on the grid size .

Using the working model that has been constructed over the last few months, and which will be described in the next section, we envisage the following series of experiments.

i) The detailed mapping of the field structure on particular floors of interest in the McConnell building.

ii) The measurement of the vertical profiles on the outside of the same building.

iii) The temporal behavior of the fields at certain key frequencies of the spectrum.(for example over a 24 hr period)

iv) Similar but less detailed measurements in other buildings of concern on campus, such as the Montreal Neurological Institute of the Royal Victoria Hospital.

Obviously unless a rather substantial commitment of funds for certain specialized pieces of equipment were made, it would not be possible to perform the above mentioned measurements over the entire commercial frequency range,or even parts of it.Fortunately we are most concerned with making measurements at frequencies at which large amplitude fields exist. Thus, the use of very expensive scanning receivers is unnecessary.In fact we need only simple receivers to be able to measure one frequency at a time.Only high level signals are of interest, thus receiver sensitivity is of secondary concern.

5. Working Model

In this section we describe the working model of a portable field measuring system which has been constructed.Section one is a general overview of the system including the computer controller. Section two gives an in-depth description of the data gathering and control computer and the software which has been written for it. Section three gives a description of the methods used to make the actual measurements.

5.1 Overview

The need for an efficient data gathering system has been discussed previously.Recent well known developments have simplified considerably the problem of portable data management and control systems.After a search through the currently availiable technology it was decided that the most versatile device, at a reasonable cost, was the 'OSBORNE 01' microcomputer,on which this report was written. The following is a list of the standard features.

i) Includes an interface for the IEEE-488 standard bus (GPIB)

ii) Two double density mini-floppy disk drives; providing more than 350k bytes storage at a time.

iii) Full 64k real memory (2**16) .Plus a certain amount of ROM storage used to backup the operating system with such things as the video control,and of course the BOOT system.

iv) RS232 serial port.

v) Portability and Operation With a Battery Pack

The OSBORNE forms the heart of the system.At the time of purchase, the dealer was offering,probably as an incentive, a database management software package.Since such a package was not needed, (this is a business oriented package), we managed to obtain a MICROSOFT fortran 80 compiler in its place for the same price.Thus for just over $3000 we had an almost complete "blackbox" data gathering and control system.We will discuss in more detail the major aspects of this system later.

With the above 'micro' we can control an experiment,gather and process data in the field and of course store it on disk for future analysis.An important point is that the amount of data taken at a time ,in the field, is limited only by the number of disks one takes along. One disk dedicated to data can hold upwards of 185k bytes of ASCII coded data. To take actual data values we further purchased two instruments manufactured by KEITHLEY. The first is a digital multimeter, the second a digital mutiplexer. Both devices have internal 6800 microprocessor control units.They also have as a standard feature the IEEE-488 GPIB interface bus.Thus they can be controlled by and the data read from them using the OSBORNE.In this way experiments can be automated. The software written to do this will be discussed at length later.

The fields are measured using an antenna and receiver (with the AGC cut off) whose IF amplifier output represents the field strength level. The IF output will be read using a radio-frequency probe,(also manufactured by KEITHLEY),connected to the DMM.The probe produces a DC potential directly proportional to the RF RMS value.The proportionality constant is one.That is one obtains 1 volt dc for 1 volt rms rf input.The probe gives an almost flat response from 100 KHz to 250 MHz.The intermediate frequency of consumer type receivers falls well within this range. Thus the probe can be used to make measurements over most of the commercial frequency bands using inexpensive home type receivers (appropriately modified). By calibrating a given measured voltage against a known input signal (using for example an rf signal generator), one can measure the carrier signals of all the strongest stations in an urban area. The output of the DMM can be transmitted over the IEEE bus line and stored directly on disk.(It can also be processed before storage).The DMM can be programmed in many different ways (mostly over the bus), which allows many different sampling rates and filtering to be used.

To facilitate the use of the system, a movable laboratory 'bench' on wheels has been constructed.The 'bread board' model was constructed using an old packing crate with enough space inside for the three digital instruments plus room left over.The cost was minimal. The unit and its contents can be pushed about inside corridors and rooms of buildings to take measurements.In the future it is intended to install an odometer type device to be used in doing field versus distance type measurements. Futhermore, on the top of this 'box' we can mount a pulley system which allows the lowering of antennas and small receivers over the sides of buildings.The distances are measured using a ten turn potentiometer. By incorporating the digital multiplexor into the circuit we can sample both the field values from the receivers and the calibrated distance values from the pot. This gives a vertical profile up the sides of buildings.On the same mechanical support which the pulley rests, an antenna may be mounted to allow the measuring of the field profile on passing from inside to outside by using any convenient windows.

As is well known, the radiated EM noise from modern digital equipment is quite large.To ensure that the fields generated by the digital devices do not interfere with the measurements, the inside of the 'box' has been converted into a Faraday cage. At first,for simplicity, a single layer of screening was used.The AM type frequencies are effectively screened out,however it was found that certain strong FM signals leak through with significant amplitude.Since the radiated noise of the equipment is significant well into and past the FM we are currently in the process of including a second screen into the box.The cage will conform to standard practice by having the two screens connected and grounded at a single point (this eliminates the possibility of ground loops).Figure 5.1 gives a block diagram of the measuring system. The experience gained with this crude equipment will be used to design and construct more permanent and 'elegant' equipment for operational use.Figure 5-1 gives a block diagram of the measurment system.

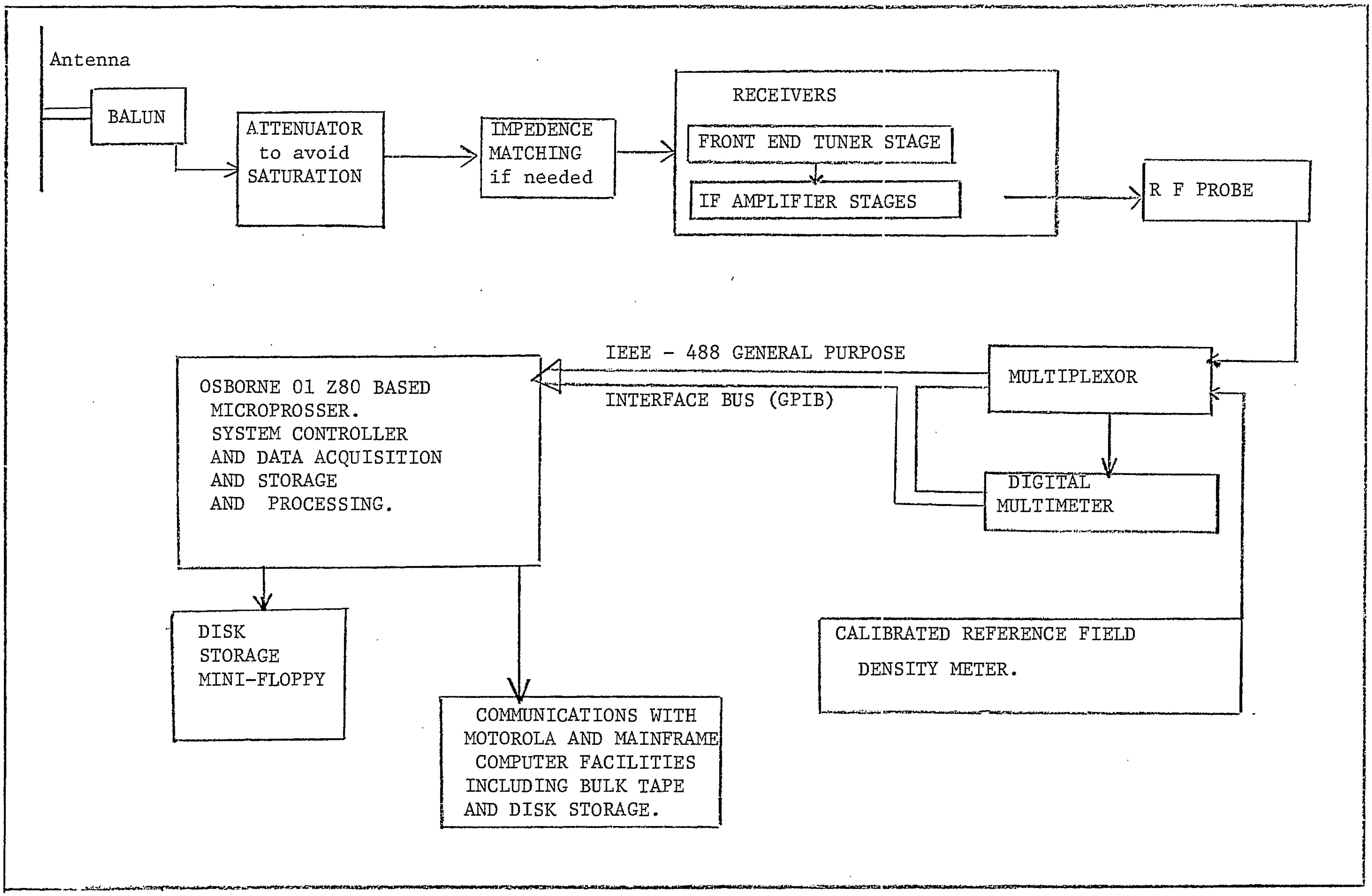


FIGURE 5.1 BLOCK DIAGRAM OF MEASURING SYSTEM

5.2 The Computer and Developed Software

The OSBORNE 01 is a Z-80 based microprossor system.The operating system is the very popular CP/M ,similar to the CROMENCO CDOS.The entire system is packaged in a more or less weather proof case, about the size of a typewriter case. It was decided to purchase the double density version of the system.This choice was made to avoid having to continually change disks. An external video adapter and monitor was also purchased for occasions when the system would be worked on for extended periods, while the small screen that is part of the standard package is useful in the field. One option not purchased was the battery pack.This pack will power the computer for up to an hour on one charge.The cost is several hundred dollars.It was decided that the cost was not worth it.The KEITHLEY devices have no such option thus it would be necessary to run a power line in any case.

As has been stated a fortran compiler was obtained for the OSBORNE.This compiler emulates virtually all of the 1966 ANSI fortran standard.(Only the complex number variable is not implemented).The particular version obtained was of course the one compatible with CP/M.The package also includes a relocatable macro assembler which can generate Z80 or 8080 code.(Actually the 8080 machine code is a subset of the Z80 machine code,however the source code differs somewhat.The assembler can handle both types.) Thus it becomes a simple matter to interface routines necessarily written in assembler to fortran subroutines.

In order to accommodate as wide a range of users as possible, the designers of the OSBORNE used many unorthodox circuits to implement all the features.For example ,the GPIB bus interface is implemented using a Motorola PIA interface instead of one of the standard industry GPIB chips.This was done to allow the GPIB interface to double as a parallel printer type interface.The GPIB system would thus be difficult to emulate quickly as the programmer would have to simulate the GPIB by controlling the PIA chip. Fortunately, the designers have supplied a certain amount of software included as part of the operating system routines.These subroutines are called by jumping to certain specified locations.The entire IEEE-488 standard is implemented using these routines (except for some limitations in generating service interrupts).

Along with the assembler control routines a series of fortran subroutines ,which call the assembler control routines,has been written.Thus an experimenter unfamiliar with assembler programming can write experiments by simply calling standard formatted fortran subroutines.Using these basic IEEE routines an experiment development package has been written.The package is tree structured with the main menu at the top node.From this node one can branch to one of any number of other nodes.The first node gives a menu which allows direct manipulation of the assembler routines which control the IEEE-488 bus.Tests on external devices may be run through this facility.The second node of the tree gives a menu similar to that of the first node,but differs in that this node controls the fortran subroutines which call the assembler routines. This node is most useful for testing experiments written in fortran. When an experiment is written it can be tested one step at a time manually to verify that the logical flow is correct.It should be noted that if an experiment works by hand it will not necessarily work on its own.This is due to the fact that exterior devices respond only in a finite time,which may not be fast enough for a given series of fortran statements. In such a case timeout and device error flags may be set by the assembler software routines.The experimenter will find it necessary to introduce time delays in the experimental logical flow,to allow enough time for devices to respond to commands.A "time killing" fortran subroutine has been written for this.It is called TIMKIL.It requires an input integer parameter.The routine generates a time delay of approximately .1 seconds per unit input integer parameter.For example if the parameter is 10,the delay will be 1 second.

The third node is a routine which allows the transfer of files to and from the OSBORNE disks to the Motorola system disks located in the antenna laboratory at McGill. (This software is still under development.)

Any number of other nodes may be added,(up to the limit of memory).Two "experiments" have been written and tested and added as nodes.

The first "experiment" takes readings at any given interval greater than or equal to one second.This allows a temporal study of the fields over long time periods.A second "experiment" was written which allows the study of the field on a horizontal grid of small or large scale.Once data has been taken it can be processed and transferred to the Motorola to be plotted graphically using the digital plotter in the laboratory.Thus an experiment may be run and the results diplayed in easily interpretable form with a minimum of effort.These two experiments were written to test the development package and also to do some preliminary measurements.As this work progresses many different experiments will be developed,each tailored to the specific situation.The development software makes creating a new experiment reasonably simple.The routines are very user friendly,with many interactive checks.Figure 5.2 gives a block diagram description for the development package and the appendix gives the most current versions of the listings.

Another modification which has been made in the laboratory, in part for this project, will provide an important capability for data analysis. V. Glavac has construted the hardware for and written the software for a standard IEEE-488 interface for the Motorola.This will allow the OSBORNE system to be able to transfer files to and from the Motorola and therefore also the mainframe computer at McGill. The Motorola can also be used to control some measurements in the laboratory.Reference 6 gives a complete description of the hardware and software for this interface,and provides a good introduction to the GPIB standard.

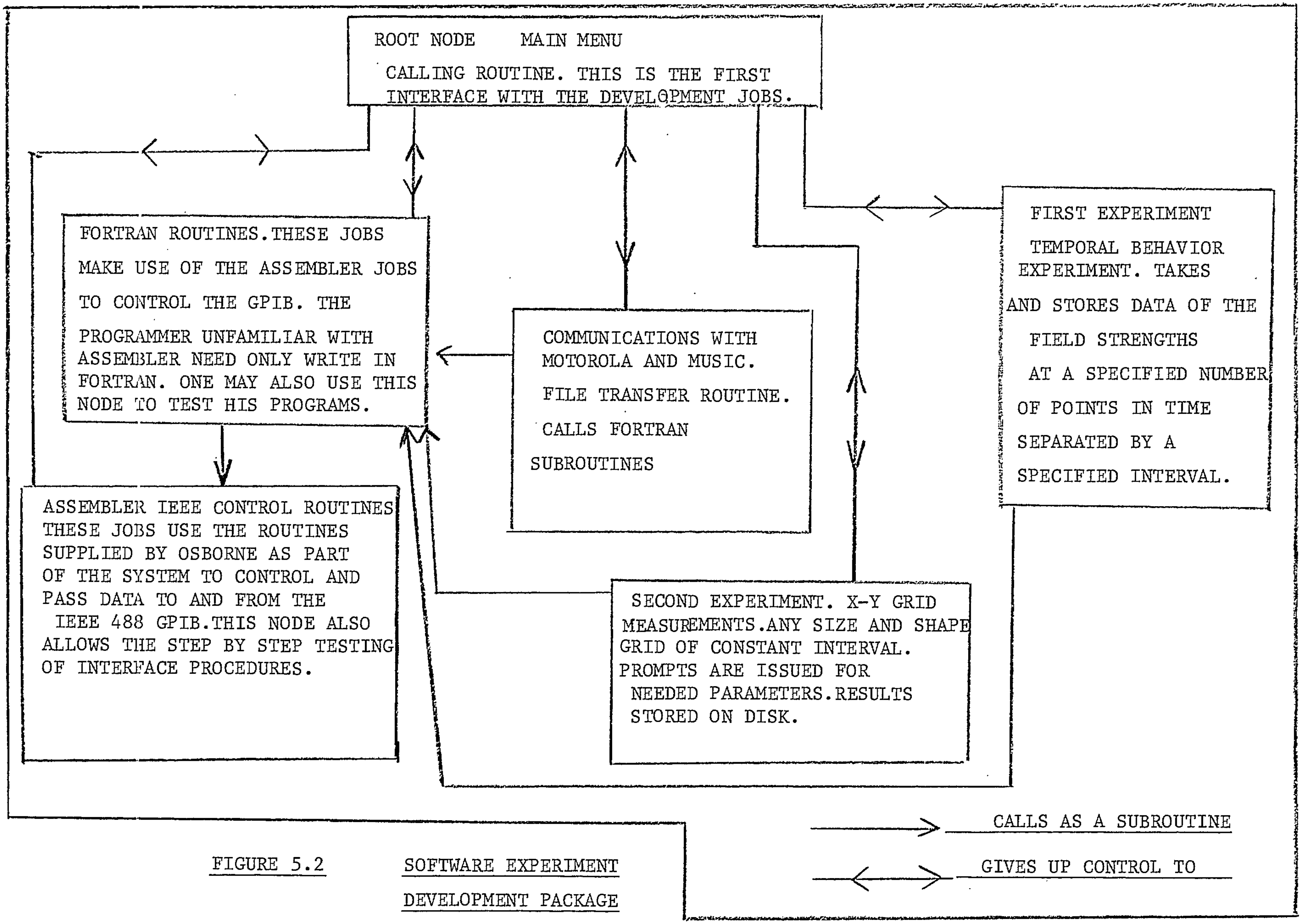


FIGURE 5.2 SOFTWARE EXPERIMENT DEVELOPMENT PACKAGE BLOCK DIAGRAM

5.3 Measuring The Fields

As has been said, an rf probe is used to measure the rms value of the field as detected by simple inexpensive receivers. Normally we would not expect the output from any stage of a simple receiver to accurately reflect the true potential across the terminals of the connected antenna.This is due to the various automatic gain control feedback networks which keep the audio levels in receivers at reasonably constant volumes and protect various amplification stages from saturation.To use simple receivers we must eliminate this feedback.Once done another problem occurs.When strong signals are measured,it is possible that one or more stages will saturate.To aid in the measurements we must introduce an attenuator between the antenna and the front end of the receiver.

One last important problem must be discussed.Using the above systems we can make relative field strength measurements.To have a good idea of the actual values being measured we must have the use of at least one instrument which will give us 'true' values of the field which can be used as an "calibrating" reference. To this end we have borrowed from the D.O.C. two field strength meters. One is an older analogue meter, a "Roahde and Schwarz-type HUZ". This one has the advantages of being extremely portable with its own extendable dipole antenna. It covers the frequency range extending past television channel 12.This includes all the range we are interested in except channel 17 ,a local UHF station (Radio

Quebec),which puts out an extremely strong signal in the Montreal area. This meter would be very useful in the field where portability is essential. A second meter on loan is a more recent model, a "Singer Stoddart NM-37/57 EMI/Field Intensity Meter" which is more sophisticated and features digital outputs which can be read using the A/D convertors in the Motorola system in our lab.This device will serve as a system calibrator.As well it can be used in place of the smaller meter where portability is not essential.

In our tests we are currently using a simple dipole antenna. The antenna is connected using a standard 75 ohm coaxial line. Since the line is unbalanced and the antenna is balanced we must insert the 1:1 balun between the antenna and the line. For broadband performance without the need for continual readjustment we use a ferrite core balun. (See reference (3) .) We are currently examining the use of different antennas depending on the measurments to be made. We will definitely have need of different antennas for certain frequency ranges, as for example the lower frequencies, such as the AM band. Certain broadband antennas are also being considered. Cost is of course important in any choices made. It is probable that one or more antennas will be constructed in the workshop here at McGill.

Using more than one antenna in conjunction with an equal number of small receivers and rf probes would allow the measurement of both the vertical and horizontal field components.For measurements done on television channels we measure only the audio carrier and use the video to audio carrier power ratio to get the video carrier.(see reference (2)). We will ,in this work, be partially implementing two of the recommendations given in reference (2).

6. Data Correlation

One of the major reasons for doing this work is to provide data which can be cross-correlated with that taken outdoors with the mobile facilities of the D.O.C. in collaboration with Dr. J. Lebel.

The facilities available at McGill for reading data stored on magnetic tape have been utilized to read those sent to us by Dr. Lebel. The translation software is now in place and at the time of this writing we are waiting the arrival of the data for measurements made on campus by the mobile facilities. These measurments were made on March 3,1983, the earlier scheduled dates having become infeasible due to weather conditions.

To make all the measurements meaningful we must have information on the radiation patterns of the various commercial transmitters in the Montreal area.We have been supplied with digitized versions of the AM radiation patterns.We are currently engaged in using the digital plotter to reproduce these patterns on a 1:50000 scale.They will be transferred to transparencies which will be placed as overlays on local area maps of the same scale. Along with those of the other radiators in the area (which we hope to obtain in the near future),we will know what the power distribution should be in a given direction for a given radiator,and thus we will be in a better position to understand and make meaningful correlation ,since random measurement and analysis with no idea of the sources will not give us any statistical understanding of the fields within a city. All data taken must be carefully correlated with the topological environment where it is measured. This will form a major portion of further work.

7. Design Of Experiments

We now outline the plan of action for the next stage of this project.With most of the hardware already developed we are ready to acquire the bulk of the necessary data. As a preliminary study we will want to carry out an in depth measurement of the strongest signals on campus.These measurements would be best performed such as to give horizontal profiles within the McConnell building.We would like also to have the vertical profiles mentioned earlier. It would be extremely useful as well to repeat some of these measurements in other critical buildings on campus.This along with the radiation patterns and the outdoor data from the mobile facilities will provide information to analyse the behavior of the fields.Plots of the profiles could point out areas of interest within the buildings. At the same time this first part will be a learning experience, giving us the practice and time to refine the measurement techniques.This first step is expected to last till the end of the summer,1983.After that we will carry out more extensive measurements.In the first part of the measurement program we will concentrate on the FM band and on up to four television channels.In the second part we will expand to other bands for the very strongest signals only.Given the equipment at hand, it is not clear whether in depth studies will be made on channel 17 during this project. Measurements will be done to gather information about any interesting phenomena that become evident during the first part,and concerning any areas of interest to the D.O.C..This part will last through till the end of the calendar year.After this the data which has been taken will be fully analysed and a statistical evaluation performed. Subject to interpretation the data will be used to attempt construction of prediction models.This work will take the project to the end of the fiscal and contract year.

8. Data Analysis

The underlying problem of this entire project is to be able to predict the magnitude of the field strengths which are probable within buildings of interest, given a number of known radiators and their radiation patterns. As an example, consider the problems of installing a high tech laboratory dealing with VLSI circuitry, near a commercial transmitting station.The question which would have to be considered is, what are the typical field levels that can be expected in various places within the building, and are those levels potentially harmful to equipment ?

The data analysis must be carried out with this type of problem in mind.Using the data from the mobile facilities we will produce amplitude contour maps of the McGill campus and its immediate environs. On these maps we will superimpose,so to speak, the contours of the known radiation patterns.Thus we will have an indication of the structure of the field outdoors. The data gathered with the small measuring system, which gives profiles from outside to inside will provide the transition information , the change from the typical values outdoors to the typical values indoors.These particular measurements will be very important as they will provide an idea of the change in the magnitude of the fields.It will be interesting to compare this transition information for at least two different structures,for example a stone building and a more modern one in which a larger amount of metallic conducting materials was used in construction.

Finally the indoor data will provide much information about the behavior of fields with respect to the structure itself.One interesting aspect of the edifices here at McGill is that there are several buildings,constructed at very different points in time, using very different materials, which are now interconnected.This will allow continuous profiles to be measured on passing from one building to another.Presumably there could be situations which result in large changes in the fields between buildings and the measurements could provide better information on what to expect within typical structures.

It is hoped that a meaningful model will be constructed which will allow the prediction of levels in specified areas.This formulation will require close collaboration with Dr. Lebel. Certain statistical models have been formulated by Dr. Lebel with respect to this problem and the data gathered and correlated here at McGill will be incorporated in these models to help in the verification procedure. Even with the limits we have imposed on the measurement goals ,the amount of data needed to give statistically valid information is staggering.It is of necessity that we have taken the time and effort to develop the data acquisition system.

Reference (2) describes in detail the assumptions which lead to the construction of prediction models.To quote the reference,'The approach followed is based on the premise that field strengths predicted by a free space model and modified by empirical constants, can be adjusted by means of variability statistics to yield corrected field strength probability distributions.' Such modelling techniques will be applied to the data measurments taken indoors.It is concluded in reference (2) that the EM environment can be adequately described for EMI/C applications,using such techniques.Hopefully we can extend these models to the smaller scale of buildings.The problem indoors is that the topology has a great many more discontinuities. We might find it necessary to utilize more empirical parameters in order to model adequately the environmental effects.

By convolving the predicted field strength probabibility distribution with the variability distribution given by the differences between the measured and the predicted values at certain locations, a parameter model for probability distributions can be constructed.(reference (2)).It has been found that a minimum of 700 data points is sufficient for characterization of a city. It is difficult to get an idea of the number of points needed to characterize a building. Some preliminary testing of the models must be done to see how well it predicts strengths indoors. Modifications might be necessary to the model to take into account the differences between the indoor and outdoor environments.

One of the greatest areas of uncertainty, as is usually the case in statistical analysis, is the uncertainty in the true distribution functions.However reference (2) has found that the analysis on the data for AM and FM bands can give EM probability predictions for a city with a confidence interval of 95 %.

9. Concluding Remarks

The feasibility of making detailed measurements of the micro-structure of the EM envirnoment has been demonstrated. Futhermore, it has been found that due to recent developments in the electronics industry rather inexpensive data acquisition systems can be designed and a preliminary working model has been constructed.If the number of frequencies which are to be monitored at any one time are limited to a few discrete channels, it is not necessary to have expensive scanning receivers,but rather very inexpensive ones are sufficient.

In effect the working model which has been constructed is a very inexpensive (less than $10,000 in material and equipment costs),portable,miniature version of the D.O.C. mobile field measuring truck. The two systems should not in fairness be compared as they are used for very different purposes.The large truck is capable of scanning and measuring an enormous range of frequencies,which the small system could not hope to do.However the small system will complement the large system by measuring signals of interest in places the large system cannot go.

We are confident that the systems developed will prove invaluable ,in the future, in aiding workers in the field of EM interference.This project is an ongoing concern here at McGill, and the work will not stop with the end of this contract. It is hoped that we will continue to collaborate with the D.O.C. in the future, as the underlying problems of concern will only continue .

10. Appendix

Appendix (A) gives a listing of the software written for the OSBORNE computer. The listings include both the assembler routines and the fortran subroutines and main program.Because of time limitations the documentation for them is quite limited.Since many of the routines are also under constant revision final commentaries are impractical.The routines have yet to be put into the most efficient form as much testing is ongoing.

APPENDIX (A)

OSBORNE EXPERIMENT DEVELOPMENT SOFTWARE

written by PETER ILOTT

i) ASSEMBLER IEEE-488 (GPIB)
CONTROL ROUTINES. (TEST VERSIONS-NON-OPTIMIZED)

```
;***************************************************************
;  -------------------------------------------------------
;        THIS IS AN 8080 ASSEMBLER JOB TO COMMUNICATE WITH
;        PERIFERALS CONNECTED TO THE IEEE 488 BUS.
;         ++++++++++++++++++++++++++++++++++++++
;
;        THE CHARACTER STRINGS ARE PROMPTED FOR.
;        THE APPROPRIATE IEEE ADDRESS IS ALSO ASKED FOR.
;
;     This software is complete but not in its final form.
;     It has yet to be optimized for efficiency.The current
;     structure is  such as to allow the subroutines to be
;     called from both the assembler menu as well as the fortran
;     menu.This is leads to inefficiencies in program
;     as the routines must constantly check to see which type
;     of main routine is calling them.Eventually the assembler
;     menu will be removed as it will be redundant once
;     I have complete confidance in the fortran-assembler
;     interfacing.The routines will then run as much as 1/4 th faster.
;  +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
;***************************************************************
        DSEG
        GLOBAL  ADRSET,DEVCLR,DETALK,NOTALK,DELIST,UNLIST
        GLOBAL  LOKOUT,UNLOK,INTCLR,STROUT,STRGIN,STANBY
        GLOBAL  TAKCON,RENABL,GOLOCL,GRPTRG,SRQONE,STACON
        GLOBAL  SRQCON,SERPOL,BEGIN,INBYTE,EXTSET
BDOUTCH EQU    2H
BDINCH  EQU    1H
BDOUTST EQU    9H
BCONSTAT EQU   0BH
BDOS    EQU    5H
ENDTXT  EQU    03H
CR      EQU    0DH
LF      EQU    0AH
BELL    EQU    07H
BACKSPACE EQU  08H
SPACE   EQU    20H
COLDST  EQU    0H
ZERO:   DB     0H
EXTERN: DS     1H
MESSG1: DB     'THIS IS AN INTERACTIVE JOB TO TRANSMIT DATA AND'
        DW     0D0AH
        DB     'CHARACTER STRINGS TO AND FROM IEEE DEVICES.'
MESSG2: DW     0D0AH
        DB     '--- MENU-- ½CHOOSE A TOPIC*(ENTER NUMBER)*'
        DW     0D0AH
        DB     ' ! SET IEEE DEVICE ADDRESS ...........= 0    * T *'
        DW     0D0AH
        DB     ' ! DEVICE CLEAR ......................= 1    * H *'
        DW     0D0AH
        DB     ' ! DEVICE TALK (ADRESSED).............= 2    * I *'
        DW     0D0AH
        DB     ' ! UNTALK (UNIVERSAL).................= 3    * S *'
        DW     0D0AH
        DB     ' ! DEVICE LISTEN (ADRESSED)...........= 4'
```

```
         DW      ODOAH
         DB      ' ! UNLISTEN (UNIVERSAL)...............= 5    * I *'
         DW      ODOAH
         DB      ' ! LOCAL LOCK OUT (PLUS SET REN TRUE).= 6    * S *'
         DW      ODOAH
         DB      ' ! REMOVE L L OUT (OR SET REN FALSE)..= 7'
         DW      ODOAH
         DB      ' ! INTERFACE CLEAR COMMAND............= 8    * A *'
         DW      ODOAH
         DB      ' ! OUTPUT CHARACTER STRING ...........= 9    * S *'
         DW      ODOAH
         DB      ' ! INPUT CHARACTER STRING ............= 10   * S *'
         DW      ODOAH
         DB      ' ! GO TO STANDBY .....................= 11   * E *'
         DW      ODOAH
         DB      ' ! TAKE CONTROL ......................= 12   * M *'
         DW      ODOAH
         DB      ' ! REN SET TRUE (PLUS ADRESSED SET)...= 13   * B *'
         DW      ODOAH
         DB      ' ! GO TO LOCAL (ADRESSED) (REN LEFT T)= 14   * L *'
         DW      ODOAH
         DB      ' ! GROUP EXECUTE TRIGGER (ADRESSED) ..= 15   * E *'
         DW      ODOAH
         DB      ' ! SRQ CHECK ROUTINE (ONE SHOT).......= 16   * R *'
         DW      ODOAH
         DB      ' ! SRQ CHECK ROUTINE (CONTINUOUS).....= 17'
         DW      ODOAH
         DB      ' ! SERIAL POLLING.....................= 18   * M *'
         DW      ODOAH
         DB      ' ! DISPLAY MENU ......................= 19   * E *'
         DW      ODOAH
         DB      ' ! EXIT TO CP/M ......................= 20   * N *'
         DW      ODOAH
         DB      ' ! RETURN TO MAIN FORIEEE MENU.........=50   * U *'
         DW      ODOAH
         DB      ' ! ENTER FUNCTION     -½ '
         DB      BELL,ENDTXT
MESSG3:  DW      ODOAH
         DW      ODOAH
         DB      '?? INPUT ERROR.TWO DIGIT # S.V.P..0 TO 20.????'
         DW      ODOAH
         DW      ODOAH
         DB      ' ! ENTER FUNCTION     -½ '
         DB      BELL,ENDTXT
COUNT:   DS      1H
TOPIC:   DS      2H
         DB      ENDTXT
BEGIN:   CALL    MENU
         MVI     A,1H
         STA     EXTERN
INPUT:   CALL    INCHAR
         SUI     30H
         JM      CHRERR
         CPI     OAH
         JP      CHRERR
```

```
         STA    TOPIC
         MVI    A,1H
         STA    COUNT
         CALL   INCHAR
         CPI    0DH
         JZ     PROSES
         SUI    30H
         JM     CHRERR
         CPI    0AH
         JP     CHRERR
         STA    TOPIC+1
         MVI    A,2H
         STA    COUNT
         CALL   INCHAR
         CPI    0DH
         JZ     PROSES
CHRERR:  LXI    H,MESSG3
         CALL   OUTSTR
         JMP    INPUT
;HERE BEGINS THE PROSESS OF PERFORMING THE REQUESTED
;FUNCTION.
;
PROSES:  CALL   CONVERT_NUMBER
         LDA    NUMBER
         CPI    0H
         JNZ    SKIP1
         LXI    D,0000H
         CALL   ADRSET1
         JMP    REVIEW_IT
SKIP1:   CPI    1H
         JNZ    SKIP2
         CALL   DEVCLR
         JMP    REVIEW_IT
SKIP2:   CPI    2H
         JNZ    SKIP3
         CALL   DETALK
         JMP    REVIEW_IT
SKIP3:   CPI    3H
         JNZ    SKIP4
         CALL   NOTALK
         JMP    REVIEW_IT
SKIP4:   CPI    4H
         JNZ    SKIP5
         CALL   DELIST
         JMP    REVIEW_IT
SKIP5:   CPI    5H
         JNZ    SKIP6
         CALL   UNLIST
         JMP    REVIEW_IT
SKIP6:   CPI    6H
         JNZ    SKIP7
         CALL   LOKOUT
         JMP    REVIEW_IT
SKIP7:   CPI    7H
         JNZ    SKIP8
```

```
        CALL  UNLOK
        JMP   REVIEW_IT
SKIP8:  CPI   8H
        JNZ   SKIP9
        CALL  INTCLR
        JMP   REVIEW_IT
SKIP9:  CPI   9H
        JNZ   SKIP10
        CALL  STROUT
        JMP   REVIEW_IT
SKIP10: CPI   0AH
        JNZ   SKIP11
        CALL  STRGIN
        JMP   REVIEW_IT
SKIP11: CPI   0BH
        JNZ   SKIP12
        CALL  STANBY
        JMP   REVIEW_IT
SKIP12: CPI   0CH
        JNZ   SKIP13
        CALL  TAKCON
        JMP   REVIEW_IT
SKIP13: CPI   0DH
        JNZ   SKIP14
        CALL  RENABL
        JMP   REVIEW_IT
SKIP14: CPI   0EH
        JNZ   SKIP15
        CALL  GOLOCL
        JMP   REVIEW_IT
SKIP15: CPI   0FH
        JNZ   SKIP16
        CALL  GRPTRG
        JMP   REVIEW_IT
SKIP16: CPI   10H
        JNZ   SKIP17
        CALL  SRQONE
        JMP   REVIEW_IT
SKIP17: CPI   11H
        JNZ   SKIP18
        CALL  SRQCON
        JMP   REVIEW_IT
SKIP18: CPI   12H
        JNZ   SKIP19
        CALL  SERPOL
        JMP   REVIEW_IT
SKIP19: CPI   13H
        JNZ   SKIP20
        CALL  MENU
        JMP   INPUT
SKIP20: CPI   32H
        JNZ   SKIP21
        LDA   ZERO
        STA   EXTERN
        RET
```

```
SKIP21: CPI   14H
        JZ    COLDST
REVIEW_IT: CALL  PARMEN
        JMP   INPUT
;..................................................
;
; THE CHARACTER INPUT ROUTINE.INPUT BYTE PARITY
;IS CLEARED.INPUT IS STORED IN ACCUMULATOR.
;
INCHAR: CALL  INPUTCH
        ANI   7FH
        RET
;_______________________
;THIS IS THE CALL TO THE BDOS CHARACTER INPUT
;JOB.AS WITH OUTCHAR THE C REGISTER IS SET TO
;THE APPROPRIATE FUNCTION VALUE.(1 FOR CONSOLE READ)
;
INPUTCH: MVI   C,BDINCH
        JMP   BDOS
;..........................................................
;THIS IS A CONSOLE STATUS CHECK TO BE CALLED BY
;FORTRAN ROUTINES.
STACON:     SHLD  PARAMETER1_STORE
            CALL  CONSOLE_STATUS
            LHLD  PARAMETER1_STORE
            MOV   M,A
            RET
;..........................................................
;THIS CHECKS THE STATUS OF THE CONSOLE TO BE
;USED IN INTERRUPT TYPE ROUTINES.STATUS IS
;RETURNED IN ACCUMULATOR.A=FFH MEANS READY.
;A=00H MEANS NOT READY.
;
CONSOLE_STAT     EQU  0E106H
CONSOLE_STATUS:  JMP  CONSOLE_STAT
;
; !!!!!IMPORTANT!!!!!!!!!
;THIS ROUTINE USED A DIRECT CALL TO BIOS JOB.THE
;BDOS ROUTINE DOESN'T SEEM TO WORK BUT I LEAVE
;IT HERE COMMENTED OUT FOR POSSIBLE FUTURE USE.
;CONSOLE_STATUS: MVI  C,BCONSTAT
;              JMP  BDOS
;..........................................................
;THE STRING OUTPUT ROUTINE USEING BDOS CHARACTER OUTPUT.
;
OUTSTR: MOV   E,M
        MOV   A,E
        CPI   ENDTXT
        RZ
        SHLD  MESSADD
        CALL  OUTCHAR
        LHLD  MESSADD
        INX   H
        JMP   OUTSTR
MESSADD: DS    2H
```

```
;________________________
;THIS IS THE STEP WHICH CALLS BDOS TO OUTPUT A
;CHARACTER TO THE CONSOLE.NOTICE THAT IT DOES
;NOT CONTAIN A RETURN.THIS IS SO SINCE THE RETURN
;FROM THE BDOS WILL ACCESS THE STACK FOR THE RETURN
;ADDRESS WHICH WILL BE THAT FOLLOWING THE CALL
;FOR OUTCHAR.NOTICE THAT BDOUTCH IS THE BDOS FUNCTION
;CALL FOR CHARACTER OUTPUT.
;
OUTCHAR: MVI   C,BDOUTCH
         JMP   BDOS
;..................................................
;THIS ROUTINE OUTPUTS TO THE SCREEN A BYTE STORED
;IN SAVE_BYTE TO THE SCREEN IN BINARY FORM.
SAVE_BYTE:     DS       1H
EIGHT_COUNT:   DS       1H
BYTE_TO_BINARY: MVI     A,8H
               STA      EIGHT_COUNT
BYTE_LOOP:     LDA      SAVE_BYTE
               RLC
               JC       PRINT_ONE
PRINT_ZERO:    MVI      E,30H
               JMP      OUT_IT
PRINT_ONE:     MVI      E,31H
OUT_IT:        STA      SAVE_BYTE
               CALL     OUTCHAR
               LDA      EIGHT_COUNT
               DCR      A
               STA      EIGHT_COUNT
               RZ
               JMP      BYTE_LOOP
;.....................................................
;
; THIS IS A ROUTINE WHICH TRANSFORMS A TWO DIGIT
; NUMBER,STORED AS TWO ASCII CHARACTERS INTO A
; INTEGER BINARY NUMBER.THE NUMBER IS ASSUMED TO BE
; STORED IN TOPIC AND TOPIC+1.COUNT=1 MEANS ONLY
; ONE DIGIT USED.(ONLY TOPIC USED.).COUNT=2 MEANS
; TWO DIGITS USED.(BOTH BYTES USED.).THE RESULT
; IS STORED IN NUMBER,A ONE BYTE INTEGER.
;
NUMBER: DS     1H
CONVERT_NUMBER:   MVI  A,0H
                  STA  NUMBER
                  LDA  COUNT
                  DCR  A
                  JZ   SECOND_BYTE
FIRST_BYTE:       LDA  TOPIC
                  CPI  0H
                  JZ   SKIP
                  MOV  B,A
                  MVI  A,0H
ADD_AGAIN:        ADI  0AH
                  DCR  B
                  JNZ  ADD_AGAIN
```

```
                  STA  NUMBER
SKIP:             LDA  TOPIC+1
                  JMP  HERE_THEN
SECOND_BYTE:      LDA  TOPIC
HERE_THEN:        MOV  B,A
                  LDA  NUMBER
                  ADD  B
                  STA  NUMBER
                  RET
;................................................
;THIS JOB PRINTS THE ENTIRE MENU.
MENU:    LXI   H,MESSG1
         CALL  OUTSTR
         RET
;................................................
;THIS IS THE PARTIAL MENU PRINT ROUTINE.
;
PARTIAL_MENU:     DW   ODOAH
                  DW   ODOAH
                  DW   ODOAH
                  DB   'DISPLAY MENU = 19'
                  DW   ODOAH
                  DB   'EXIT TO CP/M = 20'
                  DW   ODOAH
                  DB   'ENTER CHOICE.FUNCTION -½ '
                  DB   BELL,ENDTXT
PARMEN:           LXI  H,PARTIAL_MENU
                  CALL OUTSTR
                  RET
;.......................................................
;THIS IS CALLED BY EXTERNAL FORTRAN ROUTINES
;TO TAKE CARE OF CERTAIN HOUSEKEEPING FLAGS!!
EXTSET:     LDA   ZERO
            STA   EXTERN
            STA   ERROR_FLAG
            STA   DONT_DO
            RET
;.......................................................
;THIS IS A LIST OF EQUATES FOR IEEE BIOS JUMP ROUTINES.
OUT_INTER_MESS    EQU  0E14BH
GOTO_STANDBY      EQU  0E145H
TAK_CONTROL       EQU  0E148H
CONTROL_OUT       EQU  0E13FH
OUT_DEV_MESS      EQU  0E14EH
IN_DEV_MESS       EQU  0E151H
STATUS_IN         EQU  0E142H
IN_PAR_POL_MESS   EQU  0E154H
;................................................
;THIS IS STORAGE AREA FOR PARAMETER ADRESSESS USED
;TO KEEP TRACK OF PARAMETERS PASSED BY FORTRAN
;CALL PROGRAMS.
PARAMETER1_STORE:     DS   2H
PARAMETER2_STORE:     DS   2H
PARAMETER3_STORE:     DS   2H
PARAMETER4_STORE:     DS   2H
```

```
PARAMETER5_STORE:       DS    2H
PARAMETER6_STORE:       DS    2H
PARAMETER7_STORE:       DS    2H
;..................................................
;THIS IS THE TIME OUT ERROR JOB.
ERROR_FLAG:         DS    1H
TIME_ERROR:         DW    ODOAH
                    DW    ODOAH
                    DB    'THERE HAS BEEN A TIME OUT ERROR.COMMAND CANCELLED!!!'
                    DW    ODOAH
                    DB    BELL,ENDTXT
TIME_OUT_ERROR:     LDA   EXTERN
                    CPI   OH
                    JNZ   NOT_SET_IT
                    LHLD  PARAMETER1_STORE
                    MVI   M,OFFH
                    LHLD  PARAMETER2_STORE
                    MVI   M,OOH
                    JMP   TES_TON
NOT_SET_IT:         LXI   H,TIME_ERROR
                    CALL  OUTSTR
TES_TON:            MVI   A,OFFH
                    STA   ERROR_FLAG
                    RET
;..................................................
;THIS IS THE NO DEVICE MESSAGE JOB.
NO_SUCH_THING:      DW    ODOAH
                    DW    ODOAH
                    DB    'THERE IS NO SUCH DEVICE ON THE BUS.COMMAND CANCELLED!!!'
                    DW    ODOAH
                    DB    BELL,ENDTXT
NO_DEVICE:          LDA   EXTERN
                    CPI   OH
                    JNZ   NOT_SET_IT1
                    LHLD  PARAMETER2_STORE
                    MVI   M,OFFH
                    LHLD  PARAMETER1_STORE
                    MVI   M,OOH
                    JMP   TES1_TON
NOT_SET_IT1:        LXI   H,NO_SUCH_THING
                    CALL  OUTSTR
TES1_TON:           MVI   A,OFFH
                    STA   ERROR_FLAG
                    RET
;.....................................................
;
;THIS IS A GENERAL ERROR CONDITION MESSAGE JOB.
ERR_MESS:           DW    ODOAH
                    DW    ODOAH
                    DB    'THERE IS AN ERROR CONDITION.COMMAND CANCELLED!!!'
                    DW    ODOAH
                    DB    BELL,ENDTXT
ER_OR:              LDA   EXTERN
                    CPI   OH
                    JNZ   NOT_SET_IT2
```

```
                  LHLD PARAMETER2_STORE
                  MVI  M,0FFH
                  LHLD PARAMETER1_STORE
                  MVI  M,00H
                  JMP  TES3_TON
NOT_SET_IT2:      LXI  H,ERR_MESS
                  CALL OUTSTR
TES3_TON:         MVI  A,0FFH
                  STA  ERROR_FLAG
                  RET
;..................................................
; THIS IS THE DEVICE ADRESS SET ROUTINE.THE ROUTINE
; USES CONVERT_NUMBER.THE RESULT IS STORED IN
; THE BYTE LABELED CURRENT_DEVICE.
;
CURRENT_DEVICE:   DS   1H
ADRES_MESSAGE:    DW   0D0AH
                  DW   0D0AH
                  DB   'INPUT A TWO DIGIT NUMBER FROM 0 TO 30.NUMBER='
                  DB   BELL,ENDTXT
ERROR_MESS:       DW   0D0AH
                  DW   0D0AH
                  DB   'INPUT ERROR.INTEGER 0 TO 30'
                  DB   BELL,ENDTXT
ADRSET1:          LXI  H,ADRES_MESSAGE
                  CALL OUTSTR
IN_ADRESS:        CALL INCHAR
                  SUI  30H
                  JM   IN_ERROR
                  CPI  0AH
                  JP   IN_ERROR
                  STA  TOPIC
                  MVI  A,1H
                  STA  COUNT
                  CALL INCHAR
                  CPI  0DH
                  JZ   CONTINUE_IT
                  SUI  30H
                  JM   IN_ERROR
                  CPI  0AH
                  JP   IN_ERROR
                  STA  TOPIC+1
                  MVI  A,2H
                  STA  COUNT
                  CALL INCHAR
                  CPI  0DH
                  JZ   CONTINUE_IT
IN_ERROR:         LXI  H,ERROR_MESS
                  CALL OUTSTR
                  JMP  ADRSET1
CONTINUE_IT:      CALL CONVERT_NUMBER
                  LDA  NUMBER
                  STA  CURRENT_DEVICE
                  RET
;..............................................
```

```
;THIS IS A VERSION OF THE ADRESS SET ROUTINE
;TO BE USED BY A CALLING FORTRAN ROUTINE
;WHICH SUPPLIES THE ADRESS IN THE REGISTER
;HL..
ADRSET: MOV   A,M
        STA   CURRENT_DEVICE
        RET
;..................................................
;THIS IS THE INTERFACE CLEAR COMMAND.
INTCLR: MVI  C,00000001B
        CALL CONTROL_OUT
        RET
;..................................................
;
;THIS IS THE CALL TO THE STATUS CHECK ROUTINE.
;IT ONLY CHECKS THE SRQ LINE.ACCUMULATOR IS
;EQUAL TO 00000001 FOR TRUE,AND EQUAL TO
; 00000000 FOR FALSE.
STATUS_TRUE:    DW      ODOAH
                DW      ODOAH
                DB      '  !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!'
                DW      ODOAH
                DB      '!!! THERE IS A SERVICE REQUEST ON LINE !!!'
                DW      ODOAH
                DB      '  !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!'
                DW      ODOAH
                DW      ODOAH
                DB      BELL,ENDTXT
STATUS_FALSE:   DW      ODOAH
                DW      ODOAH
                DB      'THERE IS NO SERVICE REQUEST!!'
                DW      ODOAH
                DW      ODOAH
                DB      BELL,ENDTXT
SRQONE:         SHLD    PARAMETER1_STORE
                CALL    STATUS_IN
                ORA     A
                JZ      NO_SRQ
                LDA     EXTERN
                CPI     OH
                JNZ     NOT_DO
                LHLD    PARAMETER1_STORE
                MVI     M,OFFH
                RET
NOT_DO:         LXI     H,STATUS_TRUE
                CALL    OUTSTR
                RET
NO_SRQ:         LDA     EXTERN
                CPI     OH
                JNZ     NOT_DO1
                LHLD    PARAMETER1_STORE
                MVI     M,OOH
                RET
NOT_DO1:        LXI     H,STATUS_FALSE
                CALL    OUTSTR
```

```
                RET
;.................................................
;THIS IS A PSEUDO INTERRUPT ROUTINE WHICH RUNS UNTIL
;IT FINDS A SRQ TRUE.IT ALSO CHECKS THE KEYBOARD FOR
;A CARRIAGE RETURN WHICH INDICATES AN INTERRUPT.
;
SRQ_MESS1:      DW ODOAH
                DW ODOAH
                DB 'SRQ CHECKING IN PROGRESS.TO INTERRUPT HIT RETURN!'
                DW ODOAH
                DW ODOAH
                DB '½½ '
                DB BELL,ENDTXT
SRQ_MESS2:      DW ODOAH
                DW ODOAH
                DB 'SRQ CHECK HAS BEEN INTERRUPTED.CONTINUE = Y. ½ '
                DB BELL,ENDTXT
SRQ_MESS3:      DW ODOAH
                DW ODOAH
                DB 'HIT RETURN TO ACKNOWLEDGE MESSAGE!!'
                DW ODOAH
                DB ENDTXT
OK_MESS:        DW ODOAH
                DB 'OK.SRQ MESSAGE ACKNOWLEDGED!!!'
                DW ODOAH
                DB ENDTXT
SRQCON:         SHLD PARAMETER1_STORE
SRQCON1:        LDA  EXTERN
                CPI  OH
                JZ   SRQ_START
                LXI  H,SRQ_MESS1
                CALL OUTSTR
SRQ_START:      CALL STATUS_IN
                ORA  A
                JNZ  ITS_TRUE
                CALL CONSOLE_STATUS
                CPI  OFFH
                JNZ  SRQ_START
                CALL INCHAR
                CPI  ODH
                JNZ  SRQ_START
                LXI  H,SRQ_MESS2
                CALL OUTSTR
                CALL INCHAR
                CPI  59H
                JZ   SRQCON1
                CPI  79H
                JZ   SRQCON1
                LDA  EXTERN
                CPI  OH
                JNZ  NOT_DO3
                LHLD PARAMETER1_STORE
                MVI  M,OOH
NOT_DO3:        RET
ITS_TRUE:       LDA  EXTERN
```

```
                CPI  00H
                JNZ  BELL_LOP
                LHLD PARAMETER1_STORE
                MVI  M,0FFH
                RET
BELL_LOP:       LXI  H,STATUS_TRUE
                CALL OUTSTR
                LXI  H,SRQ_MESS3
                CALL OUTSTR
BELL_LOOP:      MVI  A,BELL
                MOV  E,A
                CALL OUTCHAR
                LDA  LOOP_COUNT ;THIS IS A LOOP
BELL_LOOP1:     LXI  B,0001H    ;OF 64K TIMES
                LXI  H,0000H    ;LOOP_COUNT (ABOUT
LOOP_64K:       DAD  B          ;.5 SECS PER LOOP_COUNT=1H)
                JNC  LOOP_64K   ;
                DCR  A          ;
                JNZ  BELL_LOOP1 ;
                CALL CONSOLE_STATUS
                CPI  0FFH
                JNZ  BELL_LOOP
                CALL INCHAR
                CPI  0DH
                JNZ  BELL_LOOP
                LXI  H,OK_MESS
                CALL OUTSTR
                RET
LOOP_COUNT:     DB   3H
;...................................................
POLL_MESS1:     DW 0D0AH
                DW 0D0AH
                DB 'Input the adresses of the devices to be polled.'
                DW 0D0AH
                DB 'There are only three avaliable for now.A carriage'
                DW 0D0AH
                DB 'return without an input number stops the polling '
                DW 0D0AH
                DB 'of that device.'
                DW 0D0AH
                DB 'FIRST DEVICE ½½½½½½½½½½½'
                DW 0D0AH
                DB BELL,ENDTXT
SECOND_ONE:     DW 0D0AH
                DB 'SECOND DEVICE ½½½½½½½½½½'
                DW 0D0AH
                DB BELL,ENDTXT
THIRD_ONE:      DW 0D0AH
                DB 'THIRD DEVICE  ½½½½½½½½½½'
                DW 0D0AH
                DB BELL,ENDTXT
PROB_MESS:      DW 0D0AH
                DB 'NO DEVICE SPECIFIED.CANCEL COMMAND = Y..'
                DW 0D0AH
                DW 0D0AH
```

```
                DB '½½ '
                DB BELL,ENDTXT
STAT_BYTE_MESS:    DW    ODOAH
                   DB    'THE DEVICE STATUS BYTES READ AS FOLLOWS½½½'
                   DW    ODOAH
                   DB    '** FIRST DEVICE STATUS BYTE ** = '
                   DB    ENDTXT
NEXT_BYTE_MESS:    DW    ODOAH
                   DB    '** SECOND DEVICE STATUS BYTE * = '
                   DB    ENDTXT
LAST_BYTE_MESS:    DW    ODOAH
                   DB    '** THIRD DEVICE STATUS BYTE ** = '
                   DB    BELL,ENDTXT
FIRST_DEVICE:      DS 1H
SECOND_DEVICE:     DS 1H
THIRD_DEVICE:      DS 1H
NUMBER_DEVICES:    DS 1H
STORE_ADRESS:      DS 1H
TRANSFER_ADRESS:   DS 2H
SERPOL:         LDA  ZERO
                STA  NUMBER_DEVICES
                STA  FIRST_DEVICE
                STA  SECOND_DEVICE
                STA  THIRD_DEVICE
                STA  ERROR_FLAG
                LDA  EXTERN
                CPI  OOH
                JZ   LOAD_FOR
SERPOL1:        LXI  H,POLL_MESS1
                CALL OUTSTR
ADRESS_STORE:   LXI  H,ADRES_MESSAGE
                CALL OUTSTR
                CALL INCHAR
                CPI  ODH
                JZ   PROBLEM
                SUI  30H
                JM   INPUT_WRONG
                CPI  OAH
                JP   INPUT_WRONG
                STA  TOPIC
                MVI  A,1H
                STA  COUNT
                CALL INCHAR
                CPI  ODH
                JZ   STORE_IT_HERE
                SUI  30H
                JM   INPUT_WRONG
                CPI  OAH
                JP   INPUT_WRONG
                STA  TOPIC+1
                MVI  A,2H
                STA  COUNT
                CALL INCHAR
                CPI  ODH
                JZ   STORE_IT_HERE
```

```
INPUT_WRONG:   LXI  H,ERROR_MESS
               CALL OUTSTR
               JMP  ADRESS_STORE
STORE_IT_HERE: CALL CONVERT_NUMBER
               LDA  NUMBER_DEVICES
               CPI  OH
               JZ   FIRST_TIME
               CPI  1H
               JZ   SECOND_TIME
THIRD_TIME:    INR  A
               STA  NUMBER_DEVICES
               LDA  NUMBER
               STA  THIRD_DEVICE
               JMP  DO_IT
FIRST_TIME:    INR  A
               STA  NUMBER_DEVICES
               LDA  NUMBER
               STA  FIRST_DEVICE
               LXI  H,SECOND_ONE
               CALL OUTSTR
               JMP  ADRESS_STORE
SECOND_TIME:   INR  A
               STA  NUMBER_DEVICES
               LDA  NUMBER
               STA  SECOND_DEVICE
               LXI  H,THIRD_ONE
               CALL OUTSTR
               JMP  ADRESS_STORE
PROBLEM:       LDA  NUMBER_DEVICES
               CPI  OH
               JNZ  DO_IT
               LXI  H,PROB_MESS
               CALL OUTSTR
               CALL INCHAR
               CPI  59H
               RZ
               CPI  79H
               RZ
               JMP  SERPOL1
LOAD_FOR:      MVI  A,1H
               STA  DONT_DO
               SHLD PARAMETER1_STORE
               SHLD PARAMETER5_STORE
               XCHG
               SHLD PARAMETER2_STORE
               SHLD PARAMETER6_STORE
               MOV  H,B
               MOV  L,C
               MOV  A,M
               STA  TRANSFER_ADRESS
               INX  H
               MOV  A,M
               STA  TRANSFER_ADRESS+1
               INX  H
               SHLD PARAMETER3_STORE
```

```
                LHLD TRANSFER_ADRESS
                MOV  A,M
                STA  NUMBER_DEVICES
                LHLD PARAMETER3_STORE
                MOV  A,M
                STA  TRANSFER_ADRESS
                INX  H
                MOV  A,M
                STA  TRANSFER_ADRESS+1
                INX  H
                SHLD PARAMETER3_STORE
                LHLD TRANSFER_ADRESS
                MOV  A,M
                STA  FIRST_DEVICE
                LHLD PARAMETER3_STORE
                MOV  A,M
                STA  TRANSFER_ADRESS
                INX  H
                MOV  A,M
                STA  TRANSFER_ADRESS+1
                INX  H
                SHLD PARAMETER3_STORE
                LHLD TRANSFER_ADRESS
                MOV  A,M
                STA  SECOND_DEVICE
                LHLD PARAMETER3_STORE
                MOV  A,M
                STA  TRANSFER_ADRESS
                INX  H
                MOV  A,M
                STA  TRANSFER_ADRESS+1
                INX  H
                SHLD PARAMETER3_STORE
                LHLD TRANSFER_ADRESS
                MOV  A,M
                STA  THIRD_DEVICE
DO_IT:          LDA  ZERO
                STA  TRIES
IT111:          MVI  C,00011000B
                CALL OUT_INTER_MESS
                RRC
                JNC  IT12
                CALL NO_DEVICE
                RET
IT12:           ORA  A
                JZ   GO_TELL_IT
                LDA  TRIES
                CPI  0FFH
                JNZ  IT21
                CALL TIME_OUT_ERROR
                RET
IT21:           INR  A
                STA  TRIES
                JMP  IT111
GO_TELL_IT:     LDA  CURRENT_DEVICE
```

```
              STA   STORE_ADRESS
              LDA   FIRST_DEVICE
              STA   CURRENT_DEVICE
              LHLD  PARAMETER6_STORE
              XCHG
              LHLD  PARAMETER5_STORE
              CALL  DETALK
              LDA   ERROR_FLAG
              CPI   00H
              JZ    YEP1
              RET
YEP1:         LHLD  PARAMETER6_STORE
              XCHG
              LHLD  PARAMETER5_STORE
              CALL  INBYTE
              STA   FIRST_DEVICE
              LDA   ERROR_FLAG
              CPI   00H
              JZ    YEP11
              RET
YEP11:        LHLD  PARAMETER6_STORE
              XCHG
              LHLD  PARAMETER5_STORE
              CALL  NOTALK
              LDA   ERROR_FLAG
              CPI   00H
              JZ    YEP2
              RET
YEP2:         LDA   NUMBER_DEVICES
              CPI   1H
              JZ    PRINT_RESULT
              LDA   SECOND_DEVICE
              STA   CURRENT_DEVICE
              LHLD  PARAMETER6_STORE
              XCHG
              LHLD  PARAMETER5_STORE
              CALL  DETALK
              LDA   ERROR_FLAG
              CPI   00H
              JZ    YEP3
              RET
YEP3:         LHLD  PARAMETER6_STORE
              XCHG
              LHLD  PARAMETER5_STORE
              CALL  INBYTE
              STA   SECOND_DEVICE
              LDA   ERROR_FLAG
              CPI   00H
              JZ    YEP33
              RET
YEP33:        LHLD  PARAMETER6_STORE
              XCHG
              LHLD  PARAMETER5_STORE
              CALL  NOTALK
              LDA   ERROR_FLAG
```

```
              CPI   00H
              JZ    YEP4
              RET
YEP4:         LDA   NUMBER_DEVICES
              CPI   2H
              JZ    PRINT_RESULT
              LDA   THIRD_DEVICE
              STA   CURRENT_DEVICE
              LHLD  PARAMETER6_STORE
              XCHG
              LHLD  PARAMETER5_STORE
              CALL  DETALK
              LDA   ERROR_FLAG
              CPI   00H
              JZ    YEP5
              RET
YEP5:         LHLD  PARAMETER6_STORE
              XCHG
              LHLD  PARAMETER5_STORE
              CALL  INBYTE
              STA   THIRD_DEVICE
              LDA   ERROR_FLAG
              CPI   00H
              JZ    YEP55
              RET
YEP55:        LHLD  PARAMETER6_STORE
              XCHG
              LHLD  PARAMETER5_STORE
              CALL  NOTALK
              LDA   ERROR_FLAG
              CPI   00H
              JZ    PRINT_RESULT
              RET
PRINT_RESULT: LDA   ZERO
              STA   DONT_DO
              LDA   EXTERN
              CPI   0H
              JNZ   B19
              LXI   B,0000H
              LDA   ZERO
              STA   COUNT
              LDA   FIRST_DEVICE
              STA   STORAGE
B1:           LHLD  PARAMETER3_STORE
              MOV   A,M
              STA   TRANSFER_ADRESS
              INX   H
              MOV   A,M
              STA   TRANSFER_ADRESS+1
              INX   H
              SHLD  PARAMETER3_STORE
              LHLD  TRANSFER_ADRESS
              LDA   STORAGE
              RLC
              JNC   B2
```

```
                MVI   M,01H
                JMP   B3
B2:             MVI   M,00H
B3:             INX   H
                RLC
                JNC   B4
                MVI   M,01H
                JMP   B5
B4:             MVI   M,00H
B5:             INX   H
                RLC
                JNC   B6
                MVI   M,01H
                JMP   B7
B6:             MVI   M,00H
B7:             INX   H
                RLC
                JNC   B8
                MVI   M,01H
                JMP   B9
B8:             MVI   M,00H
B9:             INX   H
                RLC
                JNC   B10
                MVI   M,01H
                JMP   B11
B10:            MVI   M,00H
B11:            INX   H
                RLC
                JNC   B12
                MVI   M,01H
                JMP   B13
B12:            MVI   M,00H
B13:            INX   H
                RLC
                JNC   B14
                MVI   M,01H
                JMP   B15
B14:            MVI   M,00H
B15:            INX   H
                RLC
                JNC   B16
                MVI   M,01H
                JMP   B17
B16:            MVI   M,00H
B17:            INX   H
                LDA   COUNT
                INR   A
                STA   COUNT
                CPI   1H
                JNZ   B18
                LDA   NUMBER_DEVICES
                CPI   1H
                JZ    B19
                LDA   SECOND_DEVICE
```

```
                STA   STORAGE
                JMP   B1
B18:            LDA   NUMBER_DEVICES
                CPI   2H
                JZ    B19
                LDA   COUNT
                CPI   3H
                JZ    B19
                LDA   THIRD_DEVICE
                STA   STORAGE
                JMP   B1
B19:            LDA   STORE_ADRESS
                STA   CURRENT_DEVICE
                LDA   ZERO
                STA   TRIES
IT222:          MVI   C,00011001B
                CALL  OUT_INTER_MESS
                RRC
                JNC   IT121
                CALL  NO_DEVICE
                RET
IT121:          ORA   A
                JZ    SKIP_TO_IT
                LDA   TRIES
                CPI   0FFH
                JNZ   IT212
                CALL  TIME_OUT_ERROR
                RET
IT212:          INR   A
                STA   TRIES
                JMP   IT222
SKIP_TO_IT:     LDA   EXTERN
                CPI   0H
                JNZ   PIKS
                LHLD  PARAMETER5_STORE
                MVI   M,00H
                LHLD  PARAMETER6_STORE
                MVI   M,00H
                RET
PIKS:           LXI   H,STAT_BYTE_MESS
                CALL  OUTSTR
                LDA   FIRST_DEVICE
                STA   SAVE_BYTE
                CALL  BYTE_TO_BINARY
                LXI   H,NEXT_BYTE_MESS
                CALL  OUTSTR
                LDA   SECOND_DEVICE
                STA   SAVE_BYTE
                CALL  BYTE_TO_BINARY
                LXI   H,LAST_BYTE_MESS
                CALL  OUTSTR
                LDA   THIRD_DEVICE
                STA   SAVE_BYTE
                CALL  BYTE_TO_BINARY
                RET
```

```
;.....................................................
;THIS IS THE DEVICE TALK ROUTINE.THE ADRESS VALUE
; IS STORED IN REGISTER C AND THE BIOS ROUTINE
; IS CALLED.NOTE THAT THIS IS NOT FOR EXTENDED
; ADRESSING DEVIVE.
;
TRIES:          DS   1H
DETALK:         SHLD PARAMETER1_STORE
                XCHG
                SHLD PARAMETER2_STORE
                MVI  A,0H
                STA  TRIES
TALK_YOU:       LDA  CURRENT_DEVICE
                ADI  01000000B
                MOV  C,A
                MVI  A,0H
MAKE_TALK:      CALL OUT_INTER_MESS
                RRC
                JNC  SKIP_OVER3
                CALL NO_DEVICE
                RET
SKIP_OVER3:     ORA  A
                JZ   FIN1
                LDA  TRIES
                CPI  0FFH
                JNZ  SKIP_OVER4
                CALL TIME_OUT_ERROR
                RET
SKIP_OVER4:     INR  A
                STA  TRIES
                JMP  TALK_YOU
FIN1:           LDA  EXTERN
                CPI  0H
                JNZ  NOT_DO10
                LHLD PARAMETER1_STORE
                MVI  M,00H
                LHLD PARAMETER2_STORE
                MVI  M,00H
NOT_DO10:       RET
;.....................................................
;THIS IS THE UNTALK COMMAND.
NOTALK:         MVI  A,0H
                STA  TRIES
UNTALK:         SHLD PARAMETER1_STORE
                XCHG
                SHLD PARAMETER2_STORE
UNTALK1:        MVI  C,01011111B
                CALL OUT_INTER_MESS
                RRC
                JNC  SKIP_OVER5
                CALL NO_DEVICE
                RET
SKIP_OVER5:     ORA  A
                JZ   FIN2
                LDA  TRIES
```

```
                CPI   0FFH
                JNZ   SKIP_OVER6
                CALL  TIME_OUT_ERROR
                RET
SKIP_OVER6:     INR   A
                STA   TRIES
                JMP   UNTALK1
FIN2:           LDA   EXTERN
                CPI   0H
                JNZ   NOT_DO11
                LHLD  PARAMETER1_STORE
                MVI   M,00H
                LHLD  PARAMETER2_STORE
                MVI   M,00H
NOT_DO11:       RET
;..............................................
;THIS IS THE DEVICE LISTEN ROUTINE.
DELIST:         SHLD  PARAMETER1_STORE
                XCHG
                SHLD  PARAMETER2_STORE
                LDA   ZERO
                STA   TRIES
LISTEN_YOU:     LDA   CURRENT_DEVICE
                ADI   00100000B
                MOV   C,A
                MVI   A,0H
MAKE_LISTEN:    CALL  OUT_INTER_MESS
                RRC
                JNC   SKIP_OVER7
                CALL  NO_DEVICE
                RET
SKIP_OVER7:     ORA   A
                JZ    FIN3
                LDA   TRIES
                CPI   0FFH
                JNZ   SKIP_OVER8
                CALL  TIME_OUT_ERROR
                RET
SKIP_OVER8:     INR   A
                STA   TRIES
                JMP   LISTEN_YOU
FIN3:           LDA   EXTERN
                CPI   0H
                JNZ   NOT_DO12
                LHLD  PARAMETER1_STORE
                MVI   M,00H
                LHLD  PARAMETER2_STORE
                MVI   M,00H
NOT_DO12:       RET
;.....................................................
;THIS IS THE UNLISTEN ROUTINE.
UNLIST:         SHLD  PARAMETER1_STORE
                XCHG
                SHLD  PARAMETER2_STORE
                MVI   A,0H
```

```
                STA   TRIES
UNLISTEN:       MVI   C,00111111B
                CALL  OUT_INTER_MESS
                RRC
                JNC   SKIP_OVER9
                CALL  NO_DEVICE
                RET
SKIP_OVER9:     ORA   A
                JZ    FIN4
                LDA   TRIES
                CPI   OFFH
                JNZ   SKIP_OVER10
                CALL  TIME_OUT_ERROR
                RET
SKIP_OVER10:    INR   A
                STA   TRIES
                JMP   UNLISTEN
FIN4:           LDA   EXTERN
                CPI   OH
                JNZ   NOT_DO13
                LHLD  PARAMETER1_STORE
                MVI   M,OOH
                LHLD  PARAMETER2_STORE
                MVI   M,OOH
NOT_DO13:       RET
;..................................................
;THIS IS THE DEVICE CLEAR ROUTINE.THE CHOICE BETWEEN
;UNIVERSAL OR ADRESSED CLEAR IS PROMPTED.
QUESTION1:      DW    ODOAH
                DW    ODOAH
                DB    'DO YOU WANT DEVICE ADRESSED OR UNVERSAL.'
                DW    ODOAH
                DW    ODOAH
                DB    'UNIVERSAL=U; ADRESSED=A; CANCEL COMMAND=?'
                DW    ODOAH
                DB    BELL,ENDTXT
DEVCLR:         LDA   EXTERN
                CPI   OOH
                JNZ   LABEL1
                SHLD  PARAMETER1_STORE
                XCHG
                SHLD  PARAMETER2_STORE
                MOV   H,B
                MOV   L,C
                MOV   A,M
                CPI   OOH
                JNZ   UNIVERSAL
                JMP   ADRESSED
LABEL1:         LDA   ZERO
                STA   TRIES
                LXI   H,QUESTION1
                CALL  OUTSTR
                CALL  INCHAR
                CPI   41H
                JZ    ADRESSED
```

```
                CPI  61H
                JZ   ADRESSED
                CPI  55H
                JZ   UNIVERSAL
                CPI  75H
                JZ   UNIVERSAL
                RET
ADRESSED:       LHLD PARAMETER2_STORE
                XCHG
                LHLD PARAMETER1_STORE
                CALL DELIST
DE_CLEAR:       MVI  C,00000100B
                CALL OUT_INTER_MESS
                RRC
                JNC  SKIP_OVER11
                CALL NO_DEVICE
                RET
SKIP_OVER11:    ORA  A
                JNZ  AGAINN
                CALL STANBY
                LDA  EXTERN
                CPI  OH
                JNZ  NOT_DO14
                LHLD PARAMETER1_STORE
                MVI  M,OOH
                LHLD PARAMETER2_STORE
                MVI  M,OOH
NOT_DO14:       RET
AGAINN:         LDA  TRIES
                CPI  OFFH
                JNZ  SKIP_OVER12
                CALL TIME_OUT_ERROR
                RET
SKIP_OVER12:    INR  A
                STA  TRIES
                JMP  DE_CLEAR
;.........
;
UNIVERSAL:      MVI  C,00010100B
CLEARIT:        CALL OUT_INTER_MESS
                RRC
                JNC  SKIP_OVER13
                CALL NO_DEVICE
                RET
SKIP_OVER13:    ORA  A
                JNZ  SKIP_OVER14
                CALL STANBY
                LDA  EXTERN
                CPI  OH
                JNZ  NOT_DO15
                LHLD PARAMETER1_STORE
                MVI  M,OOH
                LHLD PARAMETER2_STORE
                MVI  M,OOH
NOT_DO15:       RET
```

```
SKIP_OVER14:        LDA  TRIES
                    CPI  OFFH
                    JNZ  SKIP_OVER15
                    CALL TIME_OUT_ERROR
                    RET
SKIP_OVER15:        INR  A
                    STA  TRIES
                    JMP  CLEARIT
;.....................................................
;THIS IS THE GO TO STANDBY COMMAND.
STANBY:             CALL GOTO_STANDBY
                    RET
;....................................................
;THIS IS THE TAKE CONTROL COMMAND
TAKE_MESS:          DW   ODOAH
                    DW   ODOAH
                    DB   'TAKE CONTROL ASYNCHRONOUSLY, Y/N??'
                    DW   ODOAH
                    DB   BELL,ENDTXT
TAKCON:             SHLD PARAMETER1_STORE
                    XCHG
                    SHLD PARAMETER2_STORE
                    MOV  H,B
                    MOV  L,C
                    LDA  ZERO
                    STA  TRIES
                    STA  ERROR_FLAG
                    LDA  EXTERN
                    CPI  OOH
                    JNZ  DO_IT_SLOW
                    MOV  A,M
                    CPI  OOH
                    JZ   TAKE_CNTROL_SYN
                    JMP  TAKE_CNTROL_ASY
DO_IT_SLOW:         LXI  H,TAKE_MESS
                    CALL OUTSTR
                    CALL INCHAR
                    CPI  59H
                    JZ   TAKE_CNTROL_ASY
                    CPI  79H
                    JZ   TAKE_CNTROL_ASY
TAKE_CNTROL_SYN:    MVI  C,OH
                    CALL TAK_CONTROL
                    RRC
                    JC   LP1
                    ORA  A
                    JZ   SKIP_OVER16
                    CALL ER_OR
SKIP_OVER16:        LDA  EXTERN
                    CPI  OH
                    JNZ  NOT_DO16
                    LDA  ERROR_FLAG
                    CPI  OOH
                    JNZ  NOT_DO16
                    LHLD PARAMETER1_STORE
```

```
                    MVI  M,00H
                    LHLD PARAMETER2_STORE
                    MVI  M,00H
NOT_DO16:           RET
LP1:                LDA  TRIES
                    CPI  OFFH
                    JNZ  SKIP_OVER17
                    CALL TIME_OUT_ERROR
                    RET
SKIP_OVER17:        INR  A
                    STA  TRIES
                    JMP  TAKE_CNTROL_SYN
TAKE_CNTROL_ASY:    MVI  C,1H
                    CALL TAK_CONTROL
                    RRC
                    JC   LP2
                    ORA  A
                    JZ   SKIP_OVER18
                    CALL ER_OR
SKIP_OVER18:        LDA  EXTERN
                    CPI  OH
                    JNZ  NOT_DO17
                    LDA  ERROR_FLAG
                    CPI  00H
                    JNZ  NOT_DO17
                    LHLD PARAMETER1_STORE
                    MVI  M,00H
                    LHLD PARAMETER2_STORE
                    MVI  M,00H
NOT_DO17:           RET
LP2:                LDA  TRIES
                    CPI  OFFH
                    JNZ  SKIP_OVER19
                    CALL TIME_OUT_ERROR
                    RET
SKIP_OVER19:        INR  A
                    STA  TRIES
                    JMP  TAKE_CNTROL_ASY
;..................................................
;THIS IS THE LOCAL_LOCK_OUT CALL.
LOKOUT:             LDA  ZERO
                    STA  TRIES
                    STA  ERROR_FLAG
                    CALL RENABL
LOOP:               MVI  C,00010001B
                    CALL OUT_INTER_MESS
                    RRC
                    JNC  SKIP_OVER20
                    CALL NO_DEVICE
                    RET
SKIP_OVER20:        ORA  A
                    JNZ  LOOP1
                    LHLD PARAMETER2_STORE
                    XCHG
                    LHLD PARAMETER1_STORE
```

```
                CALL DELIST
                LDA  ERROR_FLAG
                CPI  OH
                JZ   SKIP_ON25
                RET
SKIP_ON25:      LHLD PARAMETER2_STORE
                XCHG
                LHLD PARAMETER1_STORE
                CALL UNLIST
                LDA  ERROR_FLAG
                CPI  OH
                JZ   SKIP_ON26
                RET
SKIP_ON26:      LDA  EXTERN
                CPI  OH
                JNZ  NOT_DO18
                LHLD PARAMETER1_STORE
                MVI  M,OOH
                LHLD PARAMETER2_STORE
                MVI  M,OOH
NOT_DO18:       RET
LOOP1:          LDA  TRIES
                CPI  OFFH
                JNZ  SKIP_OVER21
                CALL TIME_OUT_ERROR
                RET
SKIP_OVER21:    INR  A
                STA  TRIES
                JMP  LOOP
;.....................................................
;THIS IS THE REMOVE LOCAL LOCK OUT CALL.(NOTE
;THAT IT IS A UNIVERSAL COMMAND.)
;
UNLOK:          MVI  C,00000100B
                CALL CONTROL_OUT
                RET
;.....................................................
;THIS IS THE OUTPUT STRING CALL.THE STRING IS STORED
;IN OUT_STRING.THE MAXIMUM SIZE IS 127 CHARACTERS.
OUT_STRING:     DS   80H
STRING_POINT:   DS   2H
STRING_MESS:    DW   ODOAH
                DW   ODOAH
                DB   '½½ ENTER STRING (MAX 127 CHARACTERS).'
                DW   ODOAH
                DW   ODOAH
                DB   ' -½½'
                DB   BELL,ENDTXT
STROUT:         LDA  EXTERN
                CPI  OH
                JNZ  STR1
                SHLD PARAMETER1_STORE
                XCHG
                SHLD PARAMETER2_STORE
                MOV  H,B
```

```
                 MOV  L,C
                 MOV  A,M
                 STA  TRANSFER_ADRESS
                 INX  H
                 MOV  A,M
                 STA  TRANSFER_ADRESS+1
                 INX  H
                 SHLD PARAMETER3_STORE
                 LHLD TRANSFER_ADRESS
                 MOV  A,M
                 STA  NUMBER
                 MOV  B,A
                 LXI  H,OUT_STRING
                 SHLD STRING_POINT
                 LHLD PARAMETER3_STORE
                 MOV  A,M
                 STA  TRANSFER_ADRESS
                 INX  H
                 MOV  A,M
                 STA  TRANSFER_ADRESS+1
                 INX  H
                 SHLD PARAMETER4_STORE
                 LHLD TRANSFER_ADRESS
                 SHLD PARAMETER3_STORE
ST1:             LHLD PARAMETER3_STORE
                 MOV  A,M
                 INX  H
                 SHLD PARAMETER3_STORE
                 LHLD STRING_POINT
                 MOV  M,A
                 INX  H
                 SHLD STRING_POINT
                 DCR  B
                 JNZ  ST1
                 DCX  H
                 SHLD STRING_POINT
                 JMP  PROCEDE
STR1:            LXI  H,OUT_STRING
                 DCX  H
                 SHLD STRING_POINT
                 LXI  H,STRING_MESS
                 CALL OUTSTR
                 LDA  ZERO
                 STA  TRIES
                 MVI  A,80H
                 STA  COUNT
LOOPY:           LDA  COUNT
                 DCR  A
                 JZ   PROCEDE
                 STA  COUNT
                 CALL INCHAR
                 CPI  0DH
                 JZ   PROCEDE
                 LHLD STRING_POINT
                 INX  H
```

```
                MOV  M,A
                SHLD STRING_POINT
                JMP  LOOPY
PROCEDE:        LHLD STRING_POINT
                INX  H
                MVI  M,ENDTXT
                LXI  H,OUT_STRING
                DCX  H
                SHLD STRING_POINT
LOOP5:          LHLD STRING_POINT
                INX  H
                SHLD STRING_POINT
                MOV  A,M
                CPI  ENDTXT
                JNZ  LOOP6
                LDA  EXTERN
                CPI  OH
                JNZ  NOT_DO19
                LHLD PARAMETER1_STORE
                MVI  M,00H
                LHLD PARAMETER2_STORE
                MVI  M,00H
                XCHG
                LHLD PARAMETER1_STORE
NOT_DO19:       CALL DELIST
                RET
LOOP6:          MOV  C,A
                INX  H
                MOV  A,M
                CPI  ENDTXT
                JNZ  LOOP10
                MVI  B,00000001B
                JMP  LOOP12
LOOP10:         MVI  B,00000000B
LOOP12:         CALL OUT_DEV_MESS
                RRC
                JNC  SKIP_OVER23
                CALL NO_DEVICE
                RET
SKIP_OVER23:    ORA  A
                JZ   LOOP5
                LDA  TRIES
                CPI  OFFH
                JNZ  SKIP_OVER24
                CALL TIME_OUT_ERROR
                RET
SKIP_OVER24:    INR  A
                STA  TRIES
                JMP  LOOP12
;.....................................................
;THIS INPUTS ONE BYTE FROM THE BUS.IF EOI IS TRUE
;THEN EOI_SET =1.OTHERWISE EOI_SET =0.BYTE STORED
;IN ACCUMULATOR..
;
EOI_SET:     DS 1H
```

```
TEMPORARY:     DS 1H
DONT_DO:       DS 1H
INBYTE:        LDA  DONT_DO
               CPI  0H
               JNZ  DONT_1
               SHLD PARAMETER1_STORE
               XCHG
               SHLD PARAMETER2_STORE
               MOV  H,B
               MOV  L,C
               SHLD PARAMETER3_STORE
DONT_1:        LDA  ZERO
               STA  TRIES
               STA  EOI_SET
TRY_ENCORE:    CALL IN_DEV_MESS
               STA  TEMPORARY
               MOV  A,L
               RLC
               JNC  SKIP_OVER25
               LDA  TRIES
               CPI  0FFH
               JNZ  DONT_22
               CALL TIME_OUT_ERROR
               LDA  EXTERN
               CPI  00H
               JNZ  GO_BACK_YOU
               LDA  DONT_DO
               CPI  0H
               JNZ  GO_BACK_YOU
               LHLD PARAMETER3_STORE
               MVI  M,00H
GO_BACK_YOU:   RET
DONT_22:       INR  A
               STA  TRIES
               JMP  TRY_ENCORE
SKIP_OVER25:   ANI  2H
               JZ   NOT_EOI
               MVI  A,0FFH
               STA  EOI_SET
               CALL STANBY
               MVI  C,1H
               CALL TAK_CONTROL
NOT_EOI:       LDA  EXTERN
               CPI  0H
               JNZ  NOT_DO20
               LDA  DONT_DO
               CPI  0H
               JNZ  NOT_DO20
               LHLD PARAMETER1_STORE
               MVI  M,00H
               LDA  EOI_SET
               LHLD PARAMETER2_STORE
               MOV  M,A
               LDA  TEMPORARY
               CPI  0DH
```

```
                JNZ  YES_SIR
                MVI  A,20H
YES_SIR:        LHLD PARAMETER3_STORE
                MOV  M,A
NOT_DO20:       LDA  TEMPORARY
                RET
;.....................................................
;THIS IS THE INPUT STRING CALL.THE STRING IS STORED
;IN IN_STRING.THE MAXIMUM SIZE IS 127 CHARACTERS.
IN_STRING:         DS   80H
POINT_STRING:      DS   2H
MESS_STRING:       DW   0D0AH
                   DW   0D0AH
                   DB   'THE STRING RECIEVED IS AS FOLLOWS½½'
                   DW   0D0AH
                   DW   0D0AH
                   DB   ENDTXT
STRGIN:            SHLD PARAMETER1_STORE
                   XCHG
                   SHLD PARAMETER2_STORE
                   MOV  H,B
                   MOV  L,C
                   SHLD PARAMETER3_STORE
                   LXI  H,IN_STRING
                   MVI  M,ENDTXT
                   DCX  H
                   SHLD POINT_STRING
                   LDA  ZERO
                   STA  TRIES
                   MVI  A,80H
                   STA  COUNT
LOPY:              LDA  COUNT
                   DCR  A
                   JNZ  SKIPIT
                   STA  COUNT
                   LHLD POINT_STRING
                   INX  H
                   MVI  M,ENDTXT
                   JMP  PRINT_STRING
SKIPIT:            STA  COUNT
READ_IT_AGAIN:     CALL IN_DEV_MESS
                   MOV  B,A
                   MOV  A,L
                   RLC
                   JC   LOOPIT
                   LHLD POINT_STRING
                   INX  H
                   MOV  M,B
                   ANI  2H
                   JZ   AVANCER
                   INX  H
                   MVI  M,ENDTXT
                   CALL STANBY
                   MVI  C,1H
                   CALL TAK_CONTROL
```

```
                JMP   PRINT_STRING
AVANCER:        SHLD  POINT_STRING
                JMP   LOPY
PRINT_STRING:   LXI   H,MESS_STRING
                CALL  OUTSTR
                LXI   H,IN_STRING
                CALL  OUTSTR
                LDA   EXTERN
                CPI   0H
                JZ    TRANSFER_DATA
                RET
LOOPIT:         LDA   TRIES
                CPI   0FFH
                JNZ   SKIP_OVER26
                CALL  TIME_OUT_ERROR
                RET
SKIP_OVER26:    INR   A
                STA   TRIES
                JMP   READ_IT_AGAIN
TRANSFER_DATA:  LDA   ZERO
                MOV   B,A
                LHLD  PARAMETER1_STORE
                MVI   M,00H
TRANSFER2:      LXI   H,IN_STRING
                SHLD  TOPIC
                LHLD  PARAMETER3_STORE
                XCHG
TRANSFER3:      LHLD  TOPIC
                MOV   A,M
                INX   H
                SHLD  TOPIC
                CPI   03H
                JZ    LAST_SHIFT
                CPI   0DH
                JZ    SEND_A_BLANK
                CPI   0AH
                JNZ   SEND_IT_THERE
SEND_A_BLANK:   INR   B
                XCHG
                MVI   M,20H
                INX   H
                XCHG
                JMP   TRANSFER3
SEND_IT_THERE:  INR   B
                XCHG
                MOV   M,A
                INX   H
                XCHG
                JMP   TRANSFER3
LAST_SHIFT:     LHLD  PARAMETER2_STORE
                MOV   M,B
                INX   H
                MVI   M,00H
                RET
;.....................................................
```

```
;THIS IS THE REMOTE ENABLE CALL.
;
STORAGE:        DS   1H
RENABL:         LDA  ZERO
                STA  ERROR_FLAG
                SHLD PARAMETER1_STORE
                XCHG
                SHLD PARAMETER2_STORE
                MVI  C,00000110B
                CALL CONTROL_OUT
                LHLD PARAMETER2_STORE
                XCHG
                LHLD PARAMETER1_STORE
                CALL DELIST
                LDA  ERROR_FLAG
                CPI  OH
                JZ   SKIP_ON2
                RET
SKIP_ON2:       LHLD PARAMETER2_STORE
                XCHG
                LHLD PARAMETER1_STORE
                CALL UNLIST
                LDA  EXTERN
                CPI  OH
                JNZ  RETOURNE
                LHLD PARAMETER2_STORE
                MVI  M,00H
                LHLD PARAMETER1_STORE
                MVI  M,00H
RETOURNE:       RET
;...................................................
;THIS IS THE GO_TO_LOCAL CALL.
GOLOCL:         SHLD PARAMETER1_STORE
                XCHG
                SHLD PARAMETER2_STORE
GOLOCL1:        MVI  C,00000001B
                CALL OUT_INTER_MESS
                RRC
                JNC  SKIP_OVER27
                CALL NO_DEVICE
                RET
SKIP_OVER27:    ORA  A
                JNZ  NEXTT
                LDA  EXTERN
                CPI  OH
                JNZ  NOT_DO21
                LHLD PARAMETER1_STORE
                MVI  M,00H
                LHLD PARAMETER2_STORE
                MVI  M,00H
NOT_DO21:       RET
NEXTT:          LDA  TRIES
                CPI  OFFH
                JNZ  SKIP_OVER28
                CALL TIME_OUT_ERROR
```

```
                    RET
SKIP_OVER28:        INR  A
                    STA  TRIES
                    JMP  GOLOCL1
;..................................................
GRPTRG:             LDA  ZERO
                    STA  TRIES
                    SHLD PARAMETER1_STORE
                    XCHG
                    SHLD PARAMETER2_STORE
                    MVI  C,00001000B
FURTHER:            CALL OUT_INTER_MESS
                    RRC
                    JNC  SKIP_OVER30
                    CALL NO_DEVICE
                    RET
SKIP_OVER30:        ORA  A
                    JNZ  PROCHAIN
                    CALL STANBY
                    LDA  EXTERN
                    CPI  0H
                    JNZ  NOT_D022
                    LHLD PARAMETER1_STORE
                    MVI  M,00H
                    LHLD PARAMETER2_STORE
                    MVI  M,00H
NOT_D022:           RET
PROCHAIN:           LDA  TRIES
                    CPI  0FFH
                    JNZ  SKIP_OVER31
                    CALL TIME_OUT_ERROR
                    RET
SKIP_OVER31:        INR  A
                    STA  TRIES
                    JMP  FURTHER
;..................................................
;..................................................
          END
;*****************************************************************
```

APPENDIX (A)

ii) FORTRAN IEEE CONTROL AND EXPERIMENT ROUTINES (NON-OPTIMIZED)

written by PETER ILOTT

```
      PROGRAM  FOR488
C.............................................................
C THIS IS THE MAIN MENU ROUTINE..
C
      INTEGER      K
C
1     WRITE(1,2)
2     FORMAT(1X,/1X,'** THIS IS THE MAIN IEEE488 MENU **'/
     1/1X,'CHOOSE A TOPIC FROM THE MENU.(ENTER NUMBER)'/
     1/1X,'@ GO TO THE ASSEMBLER JOBS DIRECTLY.........=1  * *'
     1/1X,'@ GO TO THE FORTRAN TEST MENU...............=2  * *'
     1/1X,'@ GO TO TIME EXPERIMENT.....................=3  * *'
     1/1X,'@ GO TO THE "X-Y" EXPERIMENT................=4  * *'
     1/1X,'@ TRANSFER FILES TO AND FROM MOTOROLA.......=5  * *'
     1/1X,'@ RETURN TO CP/M............................=6  * *'
     1//1X,'@  ENTER CHOICE½½½½½ ')
C
3     READ(1,4)  K
4     FORMAT(I2)
C
      GO TO (10,20,30,40,50,60),K
      GO TO 1
C
10    CALL   ALL488
      GO TO  1
C
20    CALL   MENUW1
      GO TO  1
C
30    CALL   TIMEEX
      GO TO  1
C
40    CALL   XYEXP
      GO TO  1
C
50    CALL   TO6800
      GO TO  1
C
60    STOP
      END
C.............................................................
C THIS IS A GROUP OF FORTRAN SUBROUTINES USED TO
C ACCESS THE IEEE488 8080 ASSEMBLER ROUTINES.
C IT CALLS THESE ROUTINES AND DOES THE APPROPRIATE
C PARAMETER PASSING TO SIMPLIFY THE CALLING OF THE
C ASSEMBLER JOBS.IN EFFECT ONE NEEDS TO INCLUDE IN
C THE MAIN PROGRAM ONLY CALLS TO THESE JOBS IN THE
C STANDARD FORTRAN MANNER,AND THESE DO THE REST.
C.............................................................
C.............................................................
      SUBROUTINE   MENUW1
C
      INTEGER      J,I,K,L,M,N,CURDEV,NUMDEV,DEV1,DEV2,DEV3,NUMCHA
C
      REAL         R,S,T,U,V,W,X,Y,Z
```

```
C
      LOGICAL      TIMERR,DEVERR,DECIDE,SRQYES,BYTE1(8)
     1,BYTE2(8),BYTE3(8),EOI,BUSBYT,BUSSTR(127)
C
1     WRITE(1,2)
2     FORMAT(1X,/1X,'CHOOSE A TOPIC FROM THE MENU.(ENTER NUMBER)'
     1/1X,':SET CURRENT DEVICE ADRESS.................=1  * T *'
     1/1X,':DEVICE CLEAR .............................=2  * H *'
     1/1X,':DEVICE TALK (ADRESSED)....................=3  * I *'
     1/1X,':UNTALK      (UNIVERSAL)...................=4  * S *'
     1/1X,':DEVICE LISTEN (ADRESSED)..................=5'
     1/1X,':UNLISTEN    (UNIVERSAL)...................=6  * I *'
     1/1X,':LOCAL LOCK OUT (PLUS SET REN TRUE)........=7  * S *'
     1/1X,':REMOVE LOCAL L O (SET REN FALSE UNIVERSAL)=8'
     1/1X,':INTERFACE CLEAR...........................=9  * T *'
     1/1X,':OUTPUT CHARACTER STRING...................=10 * H *'
     1/1X,':INPUT CHARACTER STRING....................=11 * E *'
     1/1X,':INPUT ONE BYTE FROM BUS...................=12'
     1/1X,':GO TO STANDBY.............................=13 * T *'
     1/1X,':TAKE CONTROL..............................=14 * E *'
     1/1X,':REMOTE ENABLE SET TRUE (PLUS ADRESSED SET)=15 * S *'
     1/1X,':GO TO LOCAL(ADRESSED) (REN LEFT TRUE).....=16 * T *'
     1/1X,':GROUP EXECUTE TRIGGER (ADRESSED)..........=17'
     1/1X,':SRQ CHECK (ONE SHOT)......................=18 * M *'
     1/1X,':SRQ CHECK (CONTINUOUS)....................=19 * E *'
     1/1X,':SERIAL POLLING............................=20 * N *'
     1/1X,':PRINT VARIOUS PARAMETERS..................=21 * U *'
     1/1X,':RETURN TO MAIN MENU ROUTINE...............=22'
     1/1X,'***ENTER FUNCTION ½½ ')
C
      READ(1,3)  K
3     FORMAT(I2)
4     CALL   SETEXT(TIMERR,DEVERR)
C
      GO TO (10,20,30,40,50,60,70,80,90,100,110,120
     1,130,140,150,160,170,180,190,200,210,220),K
      GO TO 1
10    WRITE(1,11)
11    FORMAT(/1X,'ENTER AN INTEGER NUMBER BETWEEN 0 AND 30!½½ ')
      READ(1,3) J
      IF(J.GT.30.OR.J.LT.0)GO TO 10
      CURDEV=J
      CALL   DEVADR(CURDEV)
      GO TO  900
20    WRITE(1,21)
21    FORMAT(/1X,'ADRESSED OR UNIVERSAL CLEAR.UNIVERSAL=T (TRUE)½ ')
      READ(1,22) DECIDE
22    FORMAT(L1)
      CALL CLRDEV(TIMERR,DEVERR,DECIDE)
      IF(TIMERR.OR.DEVERR)GO TO 300
      GO TO  900
30    CALL   TALK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 300
      GO TO  900
```

```
40    CALL   OFFTOK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 300
      GO TO  900
50    CALL   LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 300
      GO TO  900
60    CALL   OFFLIS(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 300
      GO TO  900
70    CALL   LOCLOK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 300
      GO TO  900
80    CALL   UNLOCK
      GO TO  900
90    CALL   CLRINT
      GO TO  900
100   WRITE(1,101)
101   FORMAT(/1X,'ENTER NUMBER OF CHARACTERS IN THE STRING.½½ ')
      READ(1,104) K
104   FORMAT(I3)
      WRITE(1,102)
102   FORMAT(/1X,'INPUT THE STRING (EQUAL TO THE NUMBER INPUT)'/1X,'½')
      READ(1,103) (BUSSTR(I),I=1,K)
103   FORMAT(127A1)
      NUMCHA=K
      CALL   LINOUT(TIMERR,DEVERR,NUMCHA,BUSSTR)
      IF(TIMERR.OR.DEVERR) GO TO  300
      GO TO  900
110   CALL   INSTRG(TIMERR,NUMCHA,BUSSTR)
      IF(TIMERR) GO TO  300
      WRITE(1,111) NUMCHA,(BUSSTR(I),I=1,NUMCHA)
111   FORMAT(/1X,'THE NUMBER OF CHARACTERS RECIEVED ARE ½ ',I3
     1/1X,'THE STRING RECIEVED IS ½½½ '/1X,
     1127A1/1X)
      GO TO  900
120   CALL   BYTEIN(TIMERR,EOI,BUSBYT)
      IF(TIMERR)GO TO 300
      WRITE(1,121) BUSBYT,EOI
121   FORMAT(/1X,'THE BYTE RECIEVED IS ½½ ',A1
     1/1X,'THE EOI STATUS IS AS FOLLOWS½½ ',L1)
      GO TO  900
130   CALL   STANBI
      GO TO  900
140   WRITE(1,145)
145   FORMAT(/1X,'TAKE CONTROL SYNCRONOUSLY,OR ASYNCRONOUSLY?'
     1/1X,'ASYNCRONOUSLY=T (TRUE)½½ ')
      READ(1,22) DECIDE
      CALL   TACCON(TIMERR,DEVERR,DECIDE)
      IF(TIMERR.OR.DEVERR)GO TO 300
      GO TO  900
150   CALL REMENA(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 300
      GO TO  900
160   CALL   GO2LOC(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 300
```

```
      GO TO  900
170   CALL   GREXTR(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 300
      GO TO  900
180   CALL   SRQ1(SRQYES)
      IF(.NOT.SRQYES)GO TO 183
181   WRITE(1,182)
182   FORMAT(/1X,'THERE IS A STATUS REQUEST ON LINE!!')
      GO TO  900
183   WRITE(1,184)
184   FORMAT(/1X,'THERE IS NO STATUS REQUEST ON LINE!!')
      GO TO  900
190   CALL   SRQ2(SRQYES)
      IF(.NOT.SRQYES)GO TO 183
      GO TO  181
200   WRITE(1,201)
201   FORMAT(/1X,'ENTER NUMBER OF DEVICES TO BE POLLED.½ ')
      READ(1,3) NUMDEV
202   WRITE(1,203)
203   FORMAT(/1X,'ENTER DEVICE ADRESS½½ ')
      READ(1,3) DEV1
      IF(NUMDEV.EQ.1)GO TO 204
      WRITE(1,203)
      READ(1,3) DEV2
      IF(NUMDEV.EQ.2)GO TO 204
      IF(NUMDEV.NE.3)GO TO 200
      WRITE(1,203)
      READ(1,3) DEV3
204   CALL   POLSER(TIMERR,DEVERR,NUMDEV,DEV1,DEV2,DEV3
     1,BYTE1,BYTE2,BYTE3)
      IF(TIMERR.OR.DEVERR)GO TO 300
      WRITE(1,205) BYTE1(1),BYTE1(2),BYTE1(3),BYTE1(4)
     1,BYTE1(5),BYTE1(6),BYTE1(7),BYTE1(8),BYTE2(1)
     1,BYTE2(2),BYTE2(3),BYTE2(4),BYTE2(5),BYTE2(6)
     1,BYTE2(7),BYTE2(8),BYTE3(1),BYTE3(2),BYTE3(3)
     1,BYTE3(4),BYTE3(5),BYTE3(6),BYTE3(7),BYTE3(8)
205   FORMAT(/1X,'FIRST DEVICE BYTE= ',8L1
     1/1X,'SECOND DEVICE BYTE= ',8L1
     1/1X,'THIRD DEVICE BYTE= ',8L1)
      GO TO  900
210   WRITE(1,215) CURDEV,TIMERR,DEVERR
215   FORMAT(/1X,'HERE ARE THE CURRENT VALUES OF'
     1/1X,'VARIOUS CONTROL PARAMETERS.'
     1/1X,'THE CURRENT DEVICE ADRESS IS ½½ ',I2
     1/1X,'THE TIME_OUT_ERROR STATUS IS ½½ ',L1
     1/1X,'THE DEVICE_ERROR STATUS IS   ½½ ',L1)
      GO TO 900
220   RETURN
300   WRITE(1,305) CURDEV,TIMERR,DEVERR
305   FORMAT(/1X,'THERE IS AN ERROR IN DEVICE CONTROL.'
     1/1X,'THE COMMAND GIVEN HAS BEEN PREMATURELY CANCELLED!'
     1/1X,'THE CURRENT DEVICE IS NUMBER ',I2
     1/1X,'THE CONDITIONS ARE THE FOLLOWING½½'
     1/1X,'TIME_OUT_ERROR= ',L1,' DEVICE_ERROR= ',L1)
      GO TO  900
```

```
900   WRITE(1,905)
905   FORMAT(/1X,'PRINT THE MENU....HIT RETURN½ '
     1/1X,'RETURN TO MAIN MENU........=22'
     1/1X,'ENTER CHOICE ½½½ ')
      READ(1,3) K
      IF(K.EQ.22) GO TO 220
      IF(K.GT.0.OR.K.LT.22)GO TO 4
      GO TO 1
      END
C.................................................
      SUBROUTINE   SETEXT(TIMERR,DEVERR)
C
      LOGICAL    TIMERR,DEVERR
      TIMERR=.FALSE.
      DEVERR=.FALSE.
C
      CALL       EXTSET
      RETURN
      END
C.................................................
      SUBROUTINE   CONSTA(INTRPT)
C
      LOGICAL  INTRPT
      CALL     STACON(INTRPT)
      RETURN
      END
C.................................................
      SUBROUTINE   LINOUT(TIMERR,DEVERR,NUMCHA,BUSSTR)
C
      INTEGER   NUMCHA
      LOGICAL   TIMERR,DEVERR,BUSSTR(NUMCHA)
      TIMERR=.FALSE.
      DEVERR=.FALSE.
C
      CALL      STROUT(TIMERR,DEVERR,NUMCHA,BUSSTR)
      RETURN
      END
C.................................................
      SUBROUTINE   INSTRG(TIMERR,NUMCHA,BUSSTR)
C
      INTEGER      NUMCHA
      LOGICAL      BUSSTR(127),TIMERR
      TIMERR=.FALSE.
      NUMCHA=0
C
      CALL   STRGIN(TIMERR,NUMCHA,BUSSTR)
      RETURN
      END
C.................................................
      SUBROUTINE   BYTEIN(TIMERR,EOI,BUSBYT)
C
      LOGICAL      TIMERR,EOI,BUSBYT
      TIMERR=.FALSE.
      EOI=.FALSE.
      BUSBYT=.FALSE.
```

```
C
      CALL  INBYTE(TIMERR,EOI,BUSBYT)
      RETURN
      END
C.........................................
      SUBROUTINE   POLSER(TIMERR,DEVERR,NUMDEV,DEV1
     1,DEV2,DEV3,BYTE1,BYTE2,BYTE3)
C
      INTEGER      NUMDEV,DEV1,DEV2,DEV3,I
      LOGICAL      TIMERR,DEVERR,BYTE1(8),BYTE2(8),BYTE3(8)
C
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      DO  2000 I=1,8
        BYTE1(I)=.FALSE.
        BYTE2(I)=.FALSE.
        BYTE3(I)=.FALSE.
2000  CONTINUE
C
      CALL         SERPOL(TIMERR,DEVERR,NUMDEV,DEV1,DEV2,DEV3
     1,BYTE1,BYTE2,BYTE3)
      RETURN
      END
C.........................................
      SUBROUTINE   SRQ2(SRQYES)
C
      SRQYES=.FALSE.
      CALL   SRQCON(SRQYES)
      RETURN
      END
C.........................................
      SUBROUTINE   SRQ1(SRQYES)
C
      SRQYES=.FALSE.
      CALL   SRQONE(SRQYES)
      RETURN
      END
C.........................................
      SUBROUTINE   GREXTR(TIMERR,DEVERR)
C
      LOGICAL      TIMERR,DEVERR
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL   GRPTRG(TIMERR,DEVERR)
      RETURN
      END
C.........................................
      SUBROUTINE   GO2LOC(TIMERR,DEVERR)
C
      LOGICAL      TIMERR,DEVERR
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL   GOLOCL(TIMERR,DEVERR)
      RETURN
      END
```

```
C...........................................
      SUBROUTINE   REMENA(TIMERR,DEVERR)
C
      LOGICAL      TIMERR,DEVERR
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL   RENABL(TIMERR,DEVERR)
      RETURN
      END

C...........................................
      SUBROUTINE   TACCON(TIMERR,DEVERR,DECIDE)
C
      LOGICAL      TIMERR,DEVERR,DECIDE
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL   TAKCON(TIMERR,DEVERR,DECIDE)
      RETURN
      END
C...........................................
      SUBROUTINE   STANBI
C
      CALL   STANBY
      RETURN
      END
C...........................................
      SUBROUTINE   CLRINT
C
      CALL   INTCLR
      RETURN
      END
C...........................................
      SUBROUTINE LOCLOK(TIMERR,DEVERR)
C
      LOGICAL      TIMERR,DEVERR
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL   LOKOUT(TIMERR,DEVERR)
      RETURN
      END
C...........................................
      SUBROUTINE   UNLOCK
C
      CALL   UNLOK
      RETURN
      END
C...........................................
      SUBROUTINE   LISDEV(TIMERR,DEVERR)
C
      LOGICAL      TIMERR,DEVERR
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL   DELIST(TIMERR,DEVERR)
      RETURN
      END
```

```
C.................................................
      SUBROUTINE   OFFLIS(TIMERR,DEVERR)
C
      LOGICAL      TIMERR,DEVERR
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL   UNLIST(TIMERR,DEVERR)
      RETURN
      END
C.................................................
      SUBROUTINE   CLRDEV(TIMERR,DEVERR,DECIDE)
C
      LOGICAL      TIMERR,DEVERR,DECIDE
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL    DEVCLR(TIMERR,DEVERR,DECIDE)
      RETURN
      END
C..................................................
      SUBROUTINE   ALL488
C
      CALL  BEGIN
      RETURN
      END
C..................................................
      SUBROUTINE   OFFTOK(TIMERR,DEVERR)
C
      LOGICAL      TIMERR,DEVERR
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL  NOTALK(TIMERR,DEVERR)
      RETURN
      END
C..................................................
      SUBROUTINE   DEVADR(CURDEV)
C
      INTEGER      CURDEV
      CALL  ADRSET(CURDEV)
      RETURN
      END
C..................................................
      SUBROUTINE   TALK(TIMERR,DEVERR)
      LOGICAL      TIMERR,DEVERR
      TIMERR=.FALSE.
      DEVERR=.FALSE.
      CALL  DETALK(TIMERR,DEVERR)
      RETURN
C..........................
      END
```

```
C..........................................................
C THESE ARE THE EXPERIMENT ROUTINES.
C THEY ARE TO BE LINK LOADED WITH FORIEEE.
C.........................................................
C
      SUBROUTINE   TIMEEX
C
      INTEGER DDMADR,SCANAD,I,J,K,L,M,N,NUMCHA,CURDEV,NUMRED
     1,NUMSEC,DEV1,DEV2,DEV3,NUMDEV,NUMDMM,NUMSCA
C
      LOGICAL BUSSTR(127),TIMERR,DEVERR,GOBACK,INTRPT,DECIDE,
     1EOI,BUSBYT,FREQUN(9),SRQYES,SECINT(9),LINEFD,
     1SCAMES(24),DMMMES(27),BUSDMM(127)
C
1     WRITE(1,2)
2     FORMAT(1X,/1X,'*** THIS IS THE TIME EXPERIMENT ROUTINE ***'
     1//1X,'YOU WILL BE PROMTED APPROPRIATELY.'
     1/1X,'SET THE PROPER TIME (AND DATE) ON THE SCANNER USING'
     1/1X,'THE TEST MENU JOB.IF NOT DONE ALREADY'
     1/1X,'ENTER * T * TO RETURN TO MAIN MENU.'
     1/1X,'DO YOU WANT TO RETURN?  (T OR F)½½ ')
      READ(1,3) GOBACK
3     FORMAT(L1)
      IF(GOBACK)GO TO 1000
C
      LINEFD=10
      DEV1=0
      DEV2=0
      DEV3=0
      NUMDEV=1
4     WRITE(1,5)
5     FORMAT(1X,/1X,'ENTER ADRESS OF THE DIGITAL MULTIMETER½ ')
6     READ(1,7) DDMADR
7     FORMAT(I2)
8     WRITE(1,9)
9     FORMAT(1X,/1X,'ENTER ADRESS OF THE DIGITAL SCANNER½½ ')
      READ(1,7) SCANAD
10    WRITE(1,11)
11    FORMAT(1X,/1X,'ENTER THE FREQUENCY.(FORMAT NNN.NNXHZ)'
     1/1X,'WHERE N=NUMBER,X=M OR K.FILL THE FIELD! ½½½ ')
      READ(1,12) (FREQUN(I),I=1,9)
12    FORMAT(9A1)
      WRITE(1,14)
14    FORMAT(1X/1X,'ENTER NUMBER OF READINGS.(LESS THAN 5000)½ ')
      READ(1,16) NUMRED
16    FORMAT(I4)
      WRITE(1,18)
18    FORMAT(1X,/1X,'ENTER INTERVAL BETWEEN READINGS.(SECONDS)'
     1/1X,'FORMAT NNN, GREATER THAN OR EQUAL TO 001 SECOND ½½ ')
      READ(1,20) (SCAMES(I),I=2,4)
20    FORMAT(5A1)
      SCAMES(1)='W'
      SCAMES(5)='.'
      SCAMES(6)='0'
      SCAMES(7)='0'
```

```
      SCAMES(8)='O'
      SCAMES(9)='X'
      SCAMES(10)='M'
      SCAMES(11)='8'
      SCAMES(12)='X'
      SCAMES(13)='P'
      SCAMES(14)='1'
      SCAMES(15)='X'
      SCAMES(16)='D'
      SCAMES(17)='O'
      SCAMES(18)='X'
      SCAMES(19)='T'
      SCAMES(20)='4'
      SCAMES(21)='X'
      SCAMES(22)='G'
      SCAMES(23)='6'
      SCAMES(24)='X'
      NUMSCA=24
C
      WRITE(1,13)
13    FORMAT(1X,/1X,'ENTER THE DESIRED "SNX" COMMAND,N=0 TO 9.N=½½ ')
      READ(1,24) GOBACK
C
      NUMDMM=27
      DMMES(1)='T'
      DMMES(2)='4'
      DMMES(3)='X'
      DMMES(4)='F'
      DMMES(5)='O'
      DMMES(6)='X'
      DMMES(7)='R'
      DMMES(8)='4'
      DMMES(9)='X'
      DMMES(10)='S'
      DMMES(11)=GOBACK
      DMMES(12)='X'
      DMMES(13)='G'
      DMMES(14)='O'
      DMMES(15)='X'
      DMMES(16)='M'
      DMMES(17)='O'
      DMMES(18)='X'
      DMMES(19)='B'
      DMMES(20)='O'
      DMMES(21)='X'
      DMMES(22)='W'
      DMMES(23)='O'
      DMMES(24)='X'
      DMMES(25)='T'
      DMMES(26)='3'
      DMMES(27)='X'
C
      WRITE(1,15)
15    FORMAT(1X,/1X,'DO YOU WANT PREFIXES ON THE DATA? YES=T ½½ ')
C
```

```
      READ(1,3)GOBACK
      IF(GOBACK)GO TO 17
C
      SCAMES(23)='7'
      DMMMES(11)='1'
C
17    WRITE(1,21)
21    FORMAT(1X,/1X,'DO YOU WANT TO RE-INPUT? T OR F½½ ')
C
      READ(1,3) GOBACK
      IF(GOBACK)GO TO 4
C
      WRITE(1,22)
22    FORMAT(1X,/1X,'DO YOU WANT CANCEL THIS JOB? T OR F½½ ')
C
      READ(1,3) GOBACK
      IF(GOBACK)GO TO 1000
C
      WRITE(1,23)
23    FORMAT(1X,/1X,'PUT DATA DISK IN DRIVE B! THEN HIT RETURN')
C
      READ(1,24) GOBACK
24    FORMAT(A1)
C
      WRITE(1,25)
25    FORMAT(1X,/1X,'THE FILE NAME WILL BE TIMEEXP.DAT !')
C
      DECIDE=.TRUE.
C
      CALL    SETEXT(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2000
C
      CALL    CLRDEV(TIMERR,DEVERR,DECIDE)
      IF(TIMERR.OR.DEVERR)GO TO 2000
C
      DECIDE=.FALSE.
C
      CALL    DEVADR(DDMADR)
C
      CALL    REMENA(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2000
C
      CALL    LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2000
C
      CALL    LINOUT(TIMERR,DEVERR,NUMDMM,DMMMES)
      IF(TIMERR.OR.DEVERR)GO TO 2000
C
      CALL    TALK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2000
C
27    CALL    OFFTOK(TIMERR,DEVERR)
      IF(.NOT.TIMERR)GO TO 28
C
      CALL    SETEXT(TIMERR,DEVERR)
```

```
      GO TO 27
C
28    CALL    DEVADR(SCANAD)
C
      CALL    SETEXT(TIMERR,DEVERR)
C
      CALL    LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2000
C
      CALL    OPEN (8,'TIMEEXP DAT',2)
C
      WRITE(8,29) (SCAMES(I),I=2,4),LINEFD,NUMRED,
     1(FREQUN(I),I=1,9),LINEFD
29    FORMAT(1X,'THIS IS THE TIME EXPERIMENT.'
     1,' THE INTERVAL TIME IS=',4A1
     1/1X,'THE NUMBER OF READINGS IS =',I4
     1,' THE FREQUENCY IS =',9A1,A1)
C
      WRITE(1,30)
30    FORMAT(1X,/1X,'HIT RETURN WHEN READY TO START!!!')
      READ(1,24) GOBACK
C
      CALL    LINOUT(TIMERR,DEVERR,NUMSCA,SCAMES)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    OFFLIS(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    DEVADR(DDMADR)
C
      CALL    LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    GREXTR(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    OFFLIS(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    DEVADR(SCANAD)
C
40    CALL    SRQ2(SRQYES)
C
      CALL    TALK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    INSTRG(TIMERR,NUMCHA,BUSSTR)
      IF(TIMERR)GO TO 2025
C
      CALL    LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    CLRDEV(TIMERR,DEVERR,DECIDE)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
```

```
      CALL    LINOUT(TIMERR,DEVERR,NUMSCA,SCAMES)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    OFFLIS(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    SETEXT(TIMERR,DEVERR)
C
C______________________________________
      CALL    DEVADR(DDMADR)
C
42    CALL    TALK(TIMERR,DEVERR)
      IF(.NOT.TIMERR)GO TO 43
C
      CALL    SETEXT(TIMERR,DEVERR)
      GO TO 42
C
43    IF(DEVERR)GO TO 2025
C
44    CALL    INSTRG(TIMERR,NUMDMM,BUSDMM)
      IF(.NOT.TIMERR)GO TO 45
C
      CALL    SETEXT(TIMERR,DEVERR)
      GO TO 44
C
45    CALL    LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    GREXTR(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C
      CALL    OFFLIS(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 2025
C...............................................
C
      CALL    DEVADR(SCANAD)
C
      WRITE(8,50) (BUSSTR(I),I=1,NUMCHA),
     1(BUSDMM(J),J=1,NUMDMM),LINEFD
50    FORMAT(127A1)
C
      NUMRED=NUMRED-1
      IF(NUMRED.EQ.0)GO TO 60
      GO TO  40
C
60    WRITE(8,65) LINEFD
65    FORMAT(1X,'**END OF FILE**END OF FILE**',A1)
C
66    ENDFILE 8
      WRITE(1,70)
70    FORMAT(1X,/1X,'EXPERIMENT OVER!!!!!')
C
      RETURN
2000  WRITE(1,2050)
2010  RETURN
```

```
2025  ENDFILE 8
C
      WRITE(1,2050)
2050  FORMAT(1X,/1X,'THERE IS AN ERROR.RETURNING TO MAIN MENU')
C
1000  RETURN
      END
C.......................................................
C
      SUBROUTINE   XYEXP
C
      INTEGER DDMADR,SCANAD,I,J,K,L,X,Y,
C
     1NUMCHA,CURDEV,NUMRED
     1,TIMINT,XGRID,YGRID,NUMDEV,NUMDM2,
     1NUMDMM,NUMDM1,XMAX,YMAX,NUMCHL,NUMCHH
C
      LOGICAL BUSSTR(30),TIMERR,DEVERR,
C
     1GOBACK,INTRPT,DECIDE,NUM,
     1BUSBYT,FREQUN(9),SRQYES,SECINT(9),LINEFD,
     1AVERAG(20),LOW(20),HIGH(20),DMMES(3),
     1SCAMES(12),DMMMES(25),DMMES0(3),
     1DMMES1(3),UNITS(10)
C
1     WRITE(1,2)
2     FORMAT(1X,/1X,'*** THIS IS THE  X-Y  EXPERIMENT ROUTINE ***'
     1//1X,'YOU WILL BE PROMTED APPROPRIATELY.'
     1/1X,'SET THE PROPER TIME (AND DATE) ON THE SCANNER USING'
     1/1X,'THE TEST MENU JOB.IF NOT DONE ALREADY'
     1/1X,'ENTER * T * TO RETURN TO MAIN MENU.'
     1/1X,'DO YOU WANT TO RETURN?  (T OR F)½½ ')
      READ(1,3) GOBACK
3     FORMAT(L1)
      IF(GOBACK)GO TO 1000
C
      LINEFD=10
C
      X=0
      Y=0
      L=0
C
4     WRITE(1,5)
5     FORMAT(1X,/1X,'ENTER ADRESS OF THE DIGITAL MULTIMETER½ ')
C
6     READ(1,7) DDMADR
7     FORMAT(I2)
C
8     WRITE(1,9)
9     FORMAT(1X,/1X,'ENTER ADRESS OF THE DIGITAL SCANNER½½ ')
C
      READ(1,7) SCANAD
C
10    WRITE(1,11)
11    FORMAT(1X,/1X,'ENTER THE FREQUENCY.(FORMAT NNN.NNXHZ)'
```

```
     1/1X,'WHERE N=NUMBER,X=M OR K.FILL THE FIELD! ½½½ ')
C
      READ(1,12) (FREQUN(I),I=1,9)
12    FORMAT(9A1)
C
      WRITE(1,14)
14    FORMAT(/1X,'ENTER X INTERVAL (GRID SPACING)(4 DIGITS MAX)½ ')
C
      READ(1,16) XGRID
16    FORMAT(I5)
C
      WRITE(1,18)
18    FORMAT(/1X,'ENTER Y INTERVAL (GRID SPACING)(4 DIGITS MAX)½ ')
C
      READ(1,16) YGRID
C
      WRITE(1,19)
19    FORMAT(/1X,'ENTER THE UNITS OF THE GRID (CM,M) ½')
C
      READ(1,20) (UNITS(I),I=1,10)
20    FORMAT(10A1)
C
      WRITE(1,22)
22    FORMAT(1X,/1X,'ENTER THE NUMBER OF READINGS BETWEEN'
     1/1X,'TAKING AND STORING THE TIME.( ¼ 4 DIGITS)½ ')
C
      READ(1,16) TIMINT
C
      SCAMES(1)='G'
      SCAMES(2)='6'
      SCAMES(3)='X'
      SCAMES(4)='D'
      SCAMES(5)='2'
      SCAMES(6)='X'
      SCAMES(7)='T'
      SCAMES(8)='4'
      SCAMES(9)='X'
      SCAMES(10)='M'
      SCAMES(11)='0'
      SCAMES(12)='X'
      NUMSCA=12
C
      WRITE(1,24)
24    FORMAT(1X,/1X,'THE PROGRAM 7 WILL BE RUN WITH R=0.100 DATA VALUES'
     1/1X,1X,'WILL BE TAKEN AND THE AVERAGE STORED ALONG WITH'
     1/1X,1X,'THE LOWEST AND THE HIGHEST VALUES TAKEN.')
C
      NUMDMM=25
      DMMMES(1)='T'
      DMMMES(2)='2'
      DMMMES(3)='X'
      DMMMES(4)='F'
      DMMMES(5)='0'
      DMMMES(6)='X'
      DMMMES(7)='R'
```

```
      DMMMES(8)='4'
      DMMMES(9)='X'
      DMMMES(10)='M'
      DMMMES(11)='4'
      DMMMES(12)='X'
      DMMMES(13)='G'
      DMMMES(14)='0'
      DMMMES(15)='X'
      DMMMES(16)='S'
      DMMMES(17)='0'
      DMMMES(18)='X'
      DMMMES(19)='W'
      DMMMES(20)='0'
      DMMMES(21)='X'
      DMMMES(22)='Q'
      DMMMES(23)='0'
      DMMMES(24)='1'
      DMMMES(25)='X'
C
      DMMES(1)='U'
      DMMES(2)='2'
      DMMES(3)='X'
C
      DMMES0(1)='U'
      DMMES0(2)='3'
      DMMES0(3)='X'
C
      DMMES1(1)='U'
      DMMES1(2)='4'
      DMMES1(3)='X'
C
      NUMDM1=3
C
      WRITE(1,23)
23    FORMAT(1X,/1X,'ENTER S AND R COMMANDS FOR DMM.'
     1/1X,'FORMAT "SNXRNX".(USUALLY SOXR4X )½ ')
C
      READ(1,25) (DMMMES(I),I=16,18),(DMMMES(J),J=7,9)
25    FORMAT(6A1)
C
      WRITE(1,26)
26    FORMAT(1X,/1X,'DO YOU WANT PREFIXES ON THE DATA? YES=T ½½ ')
C
      READ(1,3)GOBACK
      IF(GOBACK)GO TO 28
C
      SCAMES(2)='7'
      DMMMES(14)='1'
C
28    WRITE(1,30)
30    FORMAT(/1X,'ENTER XMAX ½½ ')
C
      READ(1,16) XMAX
C
      WRITE(1,32)
```

```
32    FORMAT(/1X,'ENTER YMAX ½½ ')
C
      READ(1,16) YMAX
C
      WRITE(1,36)
36    FORMAT(/1X,'WE START AT X=0,Y=0,AND INCREMENT X FIRST!')
C
      WRITE(1,38)
38    FORMAT(1X,/1X,'DO YOU WANT CANCEL THIS JOB? T OR F½½ ')
C
      READ(1,3) GOBACK
      IF(GOBACK)GO TO 1000
C
      WRITE(1,40)
40    FORMAT(1X,/1X,'PUT DATA DISK IN DRIVE B! THEN HIT RETURN')
C
      READ(1,42) GOBACK
42    FORMAT(A1)
C
      WRITE(1,44)
44    FORMAT(1X,/1X,'THE FILE NAME WILL BE XYEXPER.DAT !')
C
      DECIDE=.TRUE.
C
      CALL    SETEXT(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 500
C
      CALL    CLRDEV(TIMERR,DEVERR,DECIDE)
      IF(TIMERR.OR.DEVERR)GO TO 500
C
      CALL    DEVADR(DDMADR)
C
      CALL    REMENA(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 500
C
      K=0
      L=0
C
      CALL    OPEN (8,'XYEXPER DAT',2)
C
      WRITE(8,46) XMAX,(UNITS(I),I=1,10),YMAX,(UNITS(J),J=1,10),LINEFD,
     1XGRID,YGRID,(FREQUN(I),I=1,9),LINEFD,LINEFD
46    FORMAT(1X,'THIS IS THE X-Y EXPERIMENT.'
     1,' XMAX=',I5,10A1,'.'
     1,' YMAX=',I5,10A1,'.',A1
     1/1X,'  X INTERVAL=',I5,'.  Y INTERVAL=',I5,
     1'. THE FREQUENCY IS =',9A1,A1
     1/1X,'    AVERAGE          LOWEST            HIGHEST   ',A1)
C
      WRITE(1,48)
48    FORMAT(1X,/1X,'HIT RETURN WHEN READY TO START!!!')
      READ(1,42) GOBACK
C
50    WRITE(1,51) X,Y
51    FORMAT(1X/,1X,'HIT ENTER TO TAKE MESUREMENT!!'
```

```
     1/1X,'TO CANCEL THIS MESURMENT ENTER "C"!'
     1/1X,'TO END EXPERIMENT ENTER "E"!'
     1/1X,'THE CURRENT X AND Y VALUES ARE ½',I5,I5
     1/1X,'WHAT DO YOU WANT? ½½ ')
C
      READ(1,42) GOBACK
      IF(GOBACK.EQ.67.OR.GOBACK.EQ.99)GO TO 71
      IF(GOBACK.EQ.69.OR.GOBACK.EQ.101)GO TO 77
C
      CALL    TIMKIL(100)
C
      CALL    DEVADR(DDMADR)
C
      CALL    LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    LINOUT(TIMERR,DEVERR,NUMDMM,DMMMES)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    TIMKIL(10)
C
      CALL    GREXTR(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    SRQ2(SRQYES)
C
      CALL    LINOUT(TIMERR,DEVERR,NUMDM1,DMMES)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    TALK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    TIMKIL(140)
C
54    CALL    INSTRG(TIMERR,NUMCHA,AVERAG)
      IF(.NOT.TIMERR)GO TO 56
C
      CALL    SETEXT(TIMERR,DEVERR)
      GO TO 54
C
56    CALL    LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    LINOUT(TIMERR,DEVERR,NUMDM1,DMMESO)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    TALK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    TIMKIL(140)
C
60    CALL    INSTRG(TIMERR,NUMCHL,LOW)
      IF(.NOT.TIMERR)GO TO 62
C
      CALL    SETEXT(TIMERR,DEVERR)
```

```
      GO TO 60
C
62    CALL    LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    LINOUT(TIMERR,DEVERR,NUMDM1,DMMES1)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    TALK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    TIMKIL(140)
C
66    CALL    INSTRG(TIMERR,NUMCHH,HIGH)
      IF(.NOT.TIMERR)GO TO 68
C
      CALL    SETEXT(TIMERR,DEVERR)
      GO TO 66
C
68    CALL    OFFTOK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    CLRDEV(TIMERR,DEVERR,DECIDE)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      WRITE(8,70) (AVERAG(I),I=1,NUMCHA),
     1(LOW(J),J=1,NUMCHL),
     1(HIGH(K),K=1,NUMCHH),LINEFD
70    FORMAT(127A1)
C
      GO TO 75
C
71    WRITE(8,73) LINEFD
73    FORMAT(' -------THIS READING CANCELLED------- ',A1)
75    GOBACK=.FALSE.
      X=X+XGRID
      IF(X.LE.XMAX)GO TO 72
      Y=Y+YGRID
      X=0
      IF(Y.GT.YMAX)GOBACK=.TRUE.
C
72    L=L+1
      IF(L.EQ.TIMINT)GO TO 74
C
      IF(.NOT.GOBACK)GO TO 50
C
74    L=0
      CALL    DEVADR(SCANAD)
C
      CALL    LISDEV(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    LINOUT(TIMERR,DEVERR,NUMSCA,SCAMES)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
```

```
      CALL    TIMKIL(10)
C
      CALL    TALK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      CALL    INSTRG(TIMERR,NUM,BUSSTR)
      IF(TIMERR)GO TO 450
C
      WRITE(8,76) (BUSSTR(I),I=1,NUM),LINEFD
76    FORMAT(1X,'THE TIME IS ',40A1)
C
      CALL    OFFTOK(TIMERR,DEVERR)
      IF(TIMERR.OR.DEVERR)GO TO 450
C
      IF(.NOT.GOBACK)GO TO 50
C
77    WRITE(8,78) LINEFD
78    FORMAT(1X/,1X,'**END OF FILE**END OF FILE**',A1)
C
      ENDFILE 8
      GO TO 1000
C
450   ENDFILE 8
C
500   WRITE(1,505)
505   FORMAT(/1X,'THERE HAS BEEN AN ERROR CONDITION! CANCELLED!')
C
1000  RETURN
      END
C.........................................................
C
      SUBROUTINE   TO6800
C
      WRITE(1,1)
1     FORMAT(1X,/1X,'*** MOTOROLA COMMUNICATIONS ROUTINE ***'
     1//1X,'THE MENU FOLLOWS½½½½½½ ')
C
      RETURN
      END
C..........................................................
C THIS ROUTINE KILLS TIME (APPROXIMATELY N*.1 SECS)
      SUBROUTINE   TIMKIL(N)
      INTEGER N,I,J
C
      DO  2  J=1,N
C
        DO  1 I=1,4334
1       CONTINUE
C
2     CONTINUE
C
      RETURN
C..........................................................
      END
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11. References

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