MICRO-SYSTEM TROUBLSHOOTER
ADVANCED TRAINING

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Micro-System Troubleshooter Training
Evaluation Form

Location:

Instructor:

Please indicate below the area which best describes your job function.

Manager							
Engineer							
Sr. Technician							
Technician (0-4 years)							
	R&D	Mfg. Test	Mfg. Repair	Depot Service	Field Service	Design	Calib.

Please circle the answer below which reflects your opinlon of the training session.

Was the content or value to you?

Excellent			Good			Falr			Poor
10	9	8	7	6	5	4	3	2	1

Will the presented ideas be useful for your application?

Excellent			Good			Fair			Poor
10	9	8	7	6	5	4	3	2	1

How effective were the course materials?

Excellent			Good			Fair			Poor
10	9	8	7	6	5	4	3	2	1

What was the overall effectiveness of the instructor presentation?

Excellent			Good			Fair			Poor
10	9	8	7	6	5	4	3	2	1

Please circle the appropriate answer to the questions below:

Was the overall level:	**Too advanced**	**About right**	**Too basic**
Was the pace (tempo):	**Too fast**	**About right**	**Too slow**
Was time 8llOWed for questions:	**Too much**	**About right**	**Too little**
Was the response to questions:	**Too involved**	**About right**	**inadequates**

Comments:

ADVANCED MICRO-SYSTEM
TROUBLESHOOTER TRAINING

Laboratory Workbook

The objective of this course is to familiarize the student with the methods or applying the Micro-System Troubleshooter to microprocessor-based systems using practical examples.

During this class you will be using a 9010A with an 8080 pod on an 8080-based UUT (Unit Under Test). The UUT is a designers board made by Nippon Electric Corporation. Using this setup and this lab you will develop a number of programs that will be of use to you on your own systems.

This course is comprised of three (3) major sections. Section I is a review 01 the basic operations of the 9010A. At the completion of this section everyone in the class will be using the same terminology and have the same understanding about the basic operations of the 9010A. In Section II you will develop a number of utility programs that will simplify the application of the 9010A to your systems at work. Section III will teach a suggested method of deciding how the Micro-System Troubleshooter should be applied to troubleshooting problems. Two circuits on the UUT will be used as actual examples on which this method will be used.

This binder and all material inside is now the property of the student. In addition, all programs developed in class will be recorded on a tape which is also yours to keep.

SECTION I - REVIEW BASIC OPERATIONS

Inputting "KNOWN GOOD" information

What are the four methods of inputting "KNOWN GOOD" information into the 9010A memory ?

1. _____ 3. _____

2. _____ 4. _____ (optional)

The following is provided to you as "KNOWN GOOD" information about the 8080A based UUT now attached to the 9010A.

RAM is MEMORY MAPPED from address 8C00 to 8FFF.

ROM is MEMORY MAPPED from address 0 TO 7FF.

I/O is I/O MAPPED from address F8 to FA
with ONLY bits 3 & 5 read-writable.

Now use one of the four methods listed above to enter the "KNOWN GOOD" information into the 9010A memory.

Built-in Tests

1. Place a number in the boxes below that represents in which order each of the following tests are performed when the AUTO test is run.

[ ] Bus Test

[ ] RAM Short Test

[ ] RAM Long Test

[ ] ROM Test

[ ] I/O Test

2. On the lines provided above, place a brief description of what checks are performed for each of the built-in tests.

3. Perform an AUTO TEST on the UUT. Record the results of the test below.

Troubleshooting Functions

The TROUBLESHOOTING functions are probably the most used functions of the Micro-System Troubleshooter. The next questions will review these operations.

1. At the completion of each troubleshooting command the word "OK" will be added to the display. What does the "OK" mean ?

_____

2. What SETUP selections are associated with the "OK" in question 1 ?

_____

3. What troubleshooter functions are associated with STS/CTL ?

_____

Probe Operation

The probe is one of the most useful tools the troubleshooter has to offer. This section will review the probe operation.

1. List the four functions of the probe available to the operator and check the appropriate box for the Valid Sync modes that will affect each probe function ?

Probe Function	Valid Sync Modes: Free Run(F)	SyncId (0-E)	No Affect
I. _____	☐	☐	☐
II. _____	☐	☐	☐
III. _____	☐	☐	☐
IV. _____	☐	☐	☐

2. What are the valid sync modes, for the probe, when using the Micro-System Troubleshooter with an 8080 POD ?

_____

3. What sync modes are available from the O'Scope SYNC output, when using the Micro-System Troubleshooter with an 8080 POD ?

_____

4. When the SYNC mode is FREE RUN, at what speed does the PROBE operate ? _____

Registers

Registers are used extensively in the programming mode for storing and transfering data. The following questions will review the information on registers. It is not so important that you be able to remember all the details aoout the registers but that you know where to find the information.

1. How many registers are available for data storage in the Troubleshooter ? _____

2. How are the registers identified ? _____

3. What are DEDICATED registers and how are they identified ?

_____

4. What are NON-DEDICATED registers and how are they identified ?

_____

5. What are GLOBAL registers and how are they identified ?

_____

6. What are LOCAL registers and how are they identified ?

_____

7. Where was the above information found the quickest ?

_____

Arithmetic Functions

This next section will review the operation of the arithmetic functions or' the Troubleshooter.

1. What troubleshooter function(s) allows you to count within a program ? _____

2. The SHIFT LEFT and SHIFT RIGHT functions will cause the binary digits in a value to be shifted one place to the LEFT or RIGHT each time you press the appropriate key. If you took 8FFF and shifted it once to the RIGHT what would the result be in hex ?

_____

3. If you took the answer to question 9 and shifted it LEFT one time what would the result be ? _____

4. What would the result be if you took 8FF8 and ANDed it with FOOF ? _____

5. What would the result be if you took 8FF8 and ORed it with FOOF ?

_____

6. What is the COMPLIMENT of 8FF8 ? _____

Basic Programing

In this next section you will review the PROGRAMMING operations of the Troubleshooter.

1. What are the proper key strokes for creating a program ?

2. What is the REAL limiting factor on program storage capability and what is its maximum value ?

3. Once inside a program, in the PRCGRAMMING mode, what method(s) are available to move form one step to another ?

4. What Troubleshooter function(s) are used for UNCONDITIONAL JUMPING ?

5. What Troubleshooter function(s) are used for CONDITIONAL JUMPING ?

6. What Troubleshooter function can you use in a program to print messages on a printer ?

7. What Troubleshooter function can you use to write messages to the display ?

8. When entering a display message in the programming mode, what key(s) will delete only one character ?

Built-in Tests in a Program

As you may know, all the Built-in tests can be used inside a program. In the next part of the lab you will construct a very simple program that will perform an AUTO TEST and then display DONE and beep the beeper.

KEY	DISPLAY
PROGM	PROGRAM _
1	PROGRAM 1-
ENTER	PROGRAM 1 CREATED
AUTO TEST	AUTO TEST
DISPL	DPY--
D	DPY-D-
>	DPY-DO-
IF	DPY-DON-
E	DPY-DONE-
VIEW ROM	DPY-DONE _
ENTER	DPY-DONE
PROGM	PROG 1 CLOSED - 10182 BYTES LEFT

Now execute program 1

SECTION II - UTILITY PROGRAMS

Since the introduction of the Micro-System Troubleshooter a number of generic type programs, hereafter referred to as UTILITY programs, have been developed by customers.

These programs are generic in the sense that they are usable with any of the pods with very little, if any, modifications. Once generated and loaded on tape they can be used on any UUT.

The Probe and the Program - B0163

The PROBE is a very useful device that not only can be used to stimulate but also to monitor any node on a UUT. When the probe is used to monitor a node, there are three basic steps that must be performed to gather probe data at that node.

1. What are the three basic steps when gathering probe information ?

   1. _____
   2. _____
   3. _____

2. How is the probe data transferred into a program ?

   _____

3. With the above information, make a program that:

   A. Gets the probe data.

   B. Seperates the three pieces of probe information into three seperate registers.

   C. And can be used as a subroutine whenever probe information is desired.

PROGRAM NOTES

4. To test the program developed in question 3 make another program that will:

   A. Stimulate the UUT with a RAMP function.

   B. Separate the probe information using the program in question 3.

   C. And display the three pieces of probe data.

PROGRAM NOTES

Identifying Address and Data lines

There are times when nothing is known about a UUT: no schematic, no program listing, nothing *more* than the UUT itself. True, the LEARN feature can find the BUS connected devices, but how does that relate to each IC on the UUT. i.e. what UP signal goes to the pins on the device.

Using just the Troubleshooter and the probe, you can find out a lot about your UUT. One thing you might find useful would be which pins on a device are tied to an address line and which are tied to data lines.

Your next problem is to design a program that, after the probe is placed on an unknown point:

A. Will tell if the probe is setting on an address or data line.

B. If it is, then identify which line.

C. If not, then display "CAN'T IDENTIFY".

To help in developing the program answer the following questions:

1. What STIMULUS from the Troubleshooter should you use to identify the address and data lines ? _____

2. What piece of probe data should be used to identify the address and data line when using the stimulus from question 1 ? _____

3. Using the utility program for the probe, what register will contain the probe data for question 2 ? _____

4. What value will you expect to find in register — (Ans. Q3) when the probe is on an address or data line ? _____

Use the space provided to write your program.

PROGRAM NOTES

Mapping Devices on vour UUT

Another useful thing to know about an unknown UUT is what conditions must be met to cause a device to be selected.

Design a program which after placing the probe on the chip select or chip enable pin, will:

A. Use the probe utility program.

B. Stimulate the UUT in such a way as to identify the conditions which cause the chip to be selected.

C. If found, display the condition.

D. If not found, display "CAN'T IDENTIFY".

Again, some basic decisions have to be made about the method this program will use. The following questions will help in these decisions.

1. What usually determines when a device is selected ?

   _____

2. What form will the STIMULUS take to identify the chip select ?

   _____

3. Which piece of probe data will help identify chip select ?

   _____

4. What SYNC MODE will be used for this program ? _____

5. Using the probe utility program, which register will be used to identify chip select (ans. Q3 ? _____

6. What value will you find in register — (Ans. Q4) when the probe senses a LOW ? _____

Using the space below design the chip select program.

PROGRAM NOTES

Display and Print Messages

When designing a Guided Fault Isolation (GFI) program you will probably use a lot of display, or printer messages, These messages are used to guide the operator through the circuitry of the UUT, telling him what needs to be done next. You will find that a lot of these messages are repetitive and time consuming for the programmer. In aadition these messages consume a lot of memory space, especially when they are repeated throughout a GFI program.

For example take the message:

PLACE PROBE ON PIN 5 OF U30

True, in order to save memory space such a message could be abbreviated to:

PROBE U30 PIN 5

Or simply

PROBE U30-5

You can however, save a lot more space by making a subroutine that contains the repetitive parts of the message and allows any variables to be changed by the calling program.

For your next problem, design a program that will:

A. Use a single register to recieve all the message variables from the calling program.

B. Seperate each variable from the register.

C. Display the variables in their proper place in the message.

D. Returns to the calling program.

First answer the following:

1. What are the variables in the message PROBE U30 PIN 5 ?

2. What are the maximum values allowed for each variable ?

3. For each variable, how many register bits will be required ?

PROGRAM NOTES

Probe Placement Detector

When using display messages in the Micro-System Troubleshooter to Guide an operator through the UUT, it will be necessary to wait for the operator to place the probe properly on the node. If the program did not stop, or wait, the program would fly right by the message and take a measurement before the operator could even pick the probe up off on the table.

One solution would be to follow each message with a STOP command. When the operator has the probe placed on the node, he will press the CONTinue key to go on. This is a perfectly viable solution to the problem, but there is a way of completely automating this whole procedure.

Your next problem is to design a program that:

A. When called will determine when the probe is placed on a node.

B. Will return to the calling program indicating that the probe is placed properly or is on an open circuit.

Some specific questions have to be answered before writing this program.

1. What function of the probe will be used to detect that it is placed on a node ? _____

2. Using the function choosen in question 1, what will indicate that the probe is sitting on a node ? _____

3. How will the program detect an open node (high impedance)?

_____

4. What will be the SYNC mode for this program ? _____

5. How will the program sense that the probe is firmly in place on a node ? _____

6. How will this program indicate to the calling program that the probe is on an active node, or on an open circuit?

_____

PROGRAM NOTES

SECTION III - ACTUAL CIRCUIT APPLICATIONS

Working With I/O Devices

When developing tests for devices like Peripheral Interface Adapters (PIA), Dual Asynchronous Receiver/Transmitter (DART), Universal Asycnronous Receiver/Transmitter (UART), Programmable Interrupt Controllers (PIG), Serial Input/Output (SIO), etc. there are some basic steps that you should always follow.

1. Understand the internal operations of the device and what each input and output signal does.

2. Determine how the device is used for the UUT application.

3. Identify how the device is accessed by the microprocessor on the UUT.

4. Identify how to stimulate the device and how to evaluate the results.

Once you have completed the four steps above and manipulated the device using the immediate mode functions, its a very easy process to put the procedure into a program that guides an operator through the test.

Using the Troubleshooter with different I/O devices requires a little ingenuity on the part of the operator, but in most cases the Troubleshooter can be of significant help in troubleshooting these devices. The remainder of this LAB deals with applying the four step technique above to actual circuits on the UUT Once you understand the technique, you can easily apply it to other I/O devices that you may run into.

In review, remember that the built-in I/O test *oniy* works on those devices that have read/writable bits, like RAM. The I/O test is also bit selective for those addresses in which not all bits are used.

It is obvious that there are many types of I/O devices that do not fall into this category. No attempt has been made to make a test that covers all types of I/O devices. Such a task would be monstrous to say the least. This is where the programming capability of the Troubleshooter comes in.

You can customize the basic functions of the Micro-System Troubleshooter into a programmed sequence that tests all portions of a particular I/O device.

Example #l

For this example you will devise some tests for the programmable I/O that passes keyboard data on the UUT. Looking at the schematic you will see that this I/O device, U30, is an 8255.

Step 1 - understand the internal operations of the device and what each input and output signal does.

The first step in the technique is to learn the operations of the I/O device and how it performs its function. The number one source for this inf'ormation is usually the data book on the device. Sometimes there are differences between chips of the same type but of different manufacture. Be sure to get the data book that is published by the same company that manufactures the device itself.

In the reference data section of this manual you will find data book information on the 8255. Read this material and answer the questions bel ow.

1. How many ports are available through the 8255 ? _____

2. What are the different modes of operation for the 8255 ?

3. How are the various modes set on the 8255 ?

4. What does bit 7 in the control word do ? _____

5. What function does pin 35 serve ? _____

6. What lines are used to transfer data between the microprocessor and the PIA? _____

7. Which pin(s) and what logic level does it take to select the PIA?

8. Which pin(s) and what logic level(s) will select the port(s) of the 8255 ? _____

9. Are there any other signal conditions that must be met in order to operate this device ? _____ If so, what are they ?

Step 2 - Determine how the device is used for the UUT application.

To test U30 properly, you must create the same configuration that is used during normal UUT operations. This next section will help you identify how the 8255 is configured for the keyboard application on the UUT.

Using the reference data section on the 8255 and the UUT schematic, answer the following questions:

1. What ports are used for the keyboard application ? _____

2. Looking at the circuit design. what gives you the clue that a port is used as input? _____

3. Which direction are these ports configured?

_____

4. What gives the best clue as to what mode is used on the 8255 ?

_____

5. What mode is U30 programmed for in the UUT application ? _____

Step 3 - Identify how the device is accessed by the microprocessor on the UUT.

Using the information gleaned from the data book, as well as other information and tools at your disposal, you can determine what it takes to access the device.

You know from reading the data book information what it takes to select this device (see 4.7 of step 1). In 95% of the cases the address is what determines when this device is selected.

1. What address must the microprocessor put on the address bus to select this chip ? _____

In addition to selecting the device itself the microprocessor must also select which of the ports it is communicating with (see 4.8 of step 1).

2. What microprocessor line(s) are tied to the port select Pin(s) ?

_____

3. What microprocessor signals are needed to satisfy the requirements of Step #1 question 9? _____

_____

Step 4 - Identify how to stimulate the device and how to evaluate the results.

At this point it's time to start considering how the Micro-System Troubleshooter is going to fit into the test procedure. Knowing that the 8255 is programmable, you will have to first initialize and configure it. Not wanting to reprogram the device you would best be advised to clear it.

1. What is the easiest way to clear any previous programming of the PIA and how can it be done on the UUT ?

Now perform the steps that you have outlined in questions 1.

With the device cleared, it is now time to start programming the PIA for test.

2. What PIA control word, in hex, will set the proper mode and port direction(s) for testing the UUT keyboard (See Step 2, Q3 & Q5) ?

It becomes obvious that with the 9010A plugged into the UUT's microprocessor socket it will have to configure the 8255.

3. What signal conditions have to be met on the 8255 before the control word will configure the PIA ?

4. What is the complete 9010A command that will satisfy the conditions of question 3 ?

Using the immediate mode of the 9010A, configure the PIA.

With the PIA properly configured you will want to try and sense the keyboard back through the 8080 pod. To test out our approach to the problem, let's say that we want to test Key 0.

5. Looking at the schematic, what steps have to be taken before we can see the expected data back through the pod ?

6. What 9010A command(s) will accomplish question 5 ?

7. What is the expected data word that will come back through the pod if none of the keys are pressed ?

8. What is the expected data word that will come back through the pod if the 0 key is pressed ?

9. What 9010A command(s) will accomplish questions 7 & 8 ?

Now that you have tested your approach using the 9010A in the immediate mode, design a program that will:

A. Instruct the operator to reset the PIA and have the 9010A sense when it has been done.

B. Configure the PIA for testing keys 0-7 on the keyboard.

C. Instruct the operator which key to press.

D. Test the keyboard to verify that the proper key was pressed. If correct, test the next key. If incorrect, report the error to the operator.

PROGRAM NOTES

Before claiming that the device is good, you would test the remaining two columns of keys . For the purpose of this class however, we will assume that you would be able to complete the program on your own.

The previous program would be a COMPLETE THROUGH TEST of the keyboard circuit. This is very nice but as in real world situations, things do fail from time to time. Considering failure to be realistic it is now necessary to decide what to do if the test fails.

The usual procedure is to "DIVIDE AND CONQUER". If you divide this problem in half you would probably do so at the keyboard itself. This means you have port C as output to the keyboard and port A as input from the keyboard. To decide which way to go first is really a toss up. For this example you will test the input side first.

When testing the PIA for input you can **use** the probe in its pulser mode, and by probing each port pin you can sense the changes back through the pod.

To demonstrate, perform a read at port A and then loop on it.

1. Before you can probe the port, however, what logic level should be selected on the probe to stimulate port A? _____

2. Is it necessary to synchronize the probe to provide the proper stimulus? _____

Now probe each input pin of port A and note the Troubleshooter display. In the table below list the data read as each input line of port A is pulsed by the probe.

PA0 _____

PA1 _____

PA2 _____

PA3 _____

PA4 _____

PA5 _____

PA6 _____

PA7 _____

Now that you have checked the 8255 for input, you need a check for port C, which is programmed for output. There a number of ways to check for output using the probe. Each of the three functions of the probe will test the port for output very nicely. However, for this next example, you will use the probes signature function on port C.

To test using signatures, you have to know what the signature is for a good data line. Assuming that the 8255 passes input data directly to the output the signatures should be the same.

MAKE SURE PULSER IS OFF

3. Using the RAMP function for a stimulus, what is the proper signatures for the following data lines:

INPUT		OUTPUT	
D_0	96EC	PC0	
D_1		PC1	
D_2		PC2	
D_3		PC3	
D_4		PC4	
D_5		PC5	
D_6		PC6	
D_7		PC7	

This same technique can be use for all output ports.

4. If you use the same stimulus should the signatures be different for each output port ? (For example is PA0 different than PBO or PC0) _____

Another way of checking the ports would be to use a jumper that feeds one port into another port. Make one port output the other input. Then have the Troubleshooter write data to the appropriate port and read the same data from the other.

If the lines from the PIA go to an edge connector or jack then a special jumper plug could be constructed for testing. In the case of our UUT we have the I/O lines go through a buffer and off of the board through a plug. The buffers, however, are not installed so we can not use a special plug.

Another way of getting the ports tied back to back is through a 40 pin clothes pin adapter. You are provided one of these adapters already wired in the accessory kit next to your 9010A. Using the clothes pin adapter provided, slip the adapter over the 8255 with the TALL pins on the RIGHT. This ties ports A and B together.

5. What is the control word, in HEX, that programs port A for mode 0 output, port B for mode 0 input and port C as input ? _____

Configure the PIA using the control word in question 5 and then send data out port A and read it back through port B.

Up to this point you have been working with the 8255 in mode 0. This next section will demonstrate some techniques to use for mode 7.

6. What is the significant difference between Mode 0 and Mode 1 operation ? _____

7. What control word will make port A input and port B output in Mode 1 ? _____

8. Can port C be used while ports A and B are in mode 1 ? _____
If so how ? _____

9. What are the pin numbers and labels for the handshake lines for both the input and output ports? _____

10. How can you use the Troubleshooter to pass data in and out of these ports when handshaking is necessary ?

_____

Using the clothes pin adapter, test the 8255 in mode 1 by configuring the device as port A input and port B output. Write data to port B, pass the data to port A by using the answer from question 12 then read port A.

In the space provided list the necessary immediate node commands of the Troubleshooter that will test the 8255 in mode 1. Be ***sure*** to Reset the UUT before testing begins.

_____

_____

_____

_____

_____

_____

_____

_____

Example #2

This last example of working with I/O devices is a bit different than the first. There may be occasions when it would be desirable to test circuitry beyond the I/O device. When testing components off the bus, the difficulty lies with how to get the stimulus to the device. The trick is "how does the microprocessor get the information there?" The problem becomes twofold because you not only have to understand the I/O device that must be "written" through but also determine the best means of stimulating the device under test.

Now develop a test that will completely test the operation of U52B in the Tape Interface section of the UUT.

Step 1 - Understand the internal operations of the device and what each input and output signal does.

1. Looking at the Function Table provided in the Reference Section for the 74LS74, list the conditions that must be met to make the Q output high?

   D _____

   CR _____

   PRE _____

   CLR _____

2. Are any of these inputs set by the design of the UUT? _____ If so, which lines? _____

3. Is it possible to change the configuration of U52B through program control? _____

Step 2 - Determine how the device is used for the UUT application

1. What is the application of U52B?

_____

_____

Step 3 - Identify how the device is accessed by the microprocessor on the UUT.

With the information that we have obtained up to this point we can now make the determination as to how the microprocessor accesses U52B.

1. How does the microprocessor gain access to the flip-flop?

_____

2. Determine the configuration that U30 must be in to test U52B.

_____

3. What is the control word, in hex, that will configure U30 properly ? _____

Step 4 - Identify how to stimulate the device and how to evaluate the results.

1. What 9010A stimulus could be used to satisfy the D input requirements? _____

2. What 9010A stimulus could be used to satisfy the clock input?

_____

3. Once the stimulus has been determined for the clock, what format should that statement take to leave the clock LOW when the stimulus is complete? _____

4. What piece of probe data could be used to determine if U52B is operating properly? _____

5. What is the complete 9010A command that will configure U30 for this test ? _____

6. What address(s) will be needed to test U52B? _____

Now with all of the information gathered, design a program that will test U52B by:

A. Configure U30 properly.

B. Have the operator place the probe on the Q output using the following utility programs:

1. display
2. probe placement detector

C. Have the program stimulate U52B so that a predetermined count will be collected by the probe.

D. If the count is incorrect, have the 9010A display the results.

E. If the *count is correct,* then display OK.

PROGRAM NOTES

USING RUN UUT

Not all devices can be tested using the functions of the Micro-System Troubleshooter. If absolute timing in a test is necessary, a program written in microprocessor code can be written and downloaded into UUT RAM and then exercised with RUN UUT.

Listed below is an example of an assembled 8080A/8085A microprocessor program for the TK-80 board.

```
8CO0    21 40 8C   LXI H,8C4OH      8C1B    77         MOV M,A
8CO3    36 50      MVI M,50         8C1C    01 FF OF   LXI B,OFFFH
8CO5    31 00 8D   LXI SP,8DOOH     8C1F    0B         DCX B
8CO8    3E 01      MVI A,01         8C20    79         MOV A,C
8COA    21 F8 8F   LXI H,8FF8H      8C21    BO         ORA B
8COD    77         MOV M,A          8C22    C2 1F 8C   JNZ 8ClFH
8C0E    2c         INCR L           8C25    F1         POP PSW
8COF    C2 OD 8C   JNZ 8CODH        8C26    07         RLC
8C12    F5         PUSH PSW         8C27    C3 OA 8C   JMP 8COA
8C13    21 40 8C   LXI H,8C4OH      8C2A    3E 01      MVI A,01H
8C16    7E         MOV A,M          8C2C    D3 FA      OUT FAH
8C17    3D         DCR A            8C2E    76         HLT
8C18    CA 2A 8C   JZ 8C2AH
```

Using the above information a 9010A program can be written that will load this program into the UUT's RAM space starting at 8CO0.

```
WRITE @ 8CO0 = 21
WRITE @ REGF INC = 40
WRITE @ REGF INC = 8C
WRITE @ REGF INC = 36
WRITE @ REGF INC = 50
WRITE @ REGF INC = 31
WRITE @ REGF INC = 0
WRITE @ REGF INC = 8D
WRITE @ REGF INC = 3E
WRITE @ REGF INC = 1
WRITE @ REGF INC = 21
WRITE @ REGF INC = F8
WRITE @ REGF INC = 8F
WRITE @ REGF INC = 77
WRITE @ REGF INC = 2C
WRITE @ REGF INC = C2
WRITE @ REGF INC = D
WRITE @ REGF INC = 8C
WRITE @ REGF INC = F5
WRITE @ REGF INC = 21
WRITE @ REGF INC = 40
WRITE @ REGF INC = 8C
WRITE @ REGF INC = 7E
WRITE @ REGF INC = 3D
WRITE @ REGF INC = CA
WRITE @ REGF INC = 2A
WRITE @ REGF INC = 8C
WRITE @ REGF INC = 77
WRITE @ REGF INC = 1
WRITE @ REGF INC = FF
WRITE @ REGF INC = F
WRITE @ REGF INC = B
WRITE @ REGF INC = 79
WRITE @ REGF INC = BO
WRITE @ REGF INC = C2
WRITE @ REGF INC = 1F
WRITE @ REGF INC = 8C
WRITE @ REGF INC = Fl
WRITE @ REGF INC = 7
WRITE @ REGF INC = C3
WRITE @ REGF INC = A
WRITE @ REGF INC = 8C
WRITE @ REGF INC = 3E
WRITE @ REGF INC = 1
WRITE @ REGF INC = D3
WRITE @ REGF INC = FA
WRITE @ REGF INC = 76
```

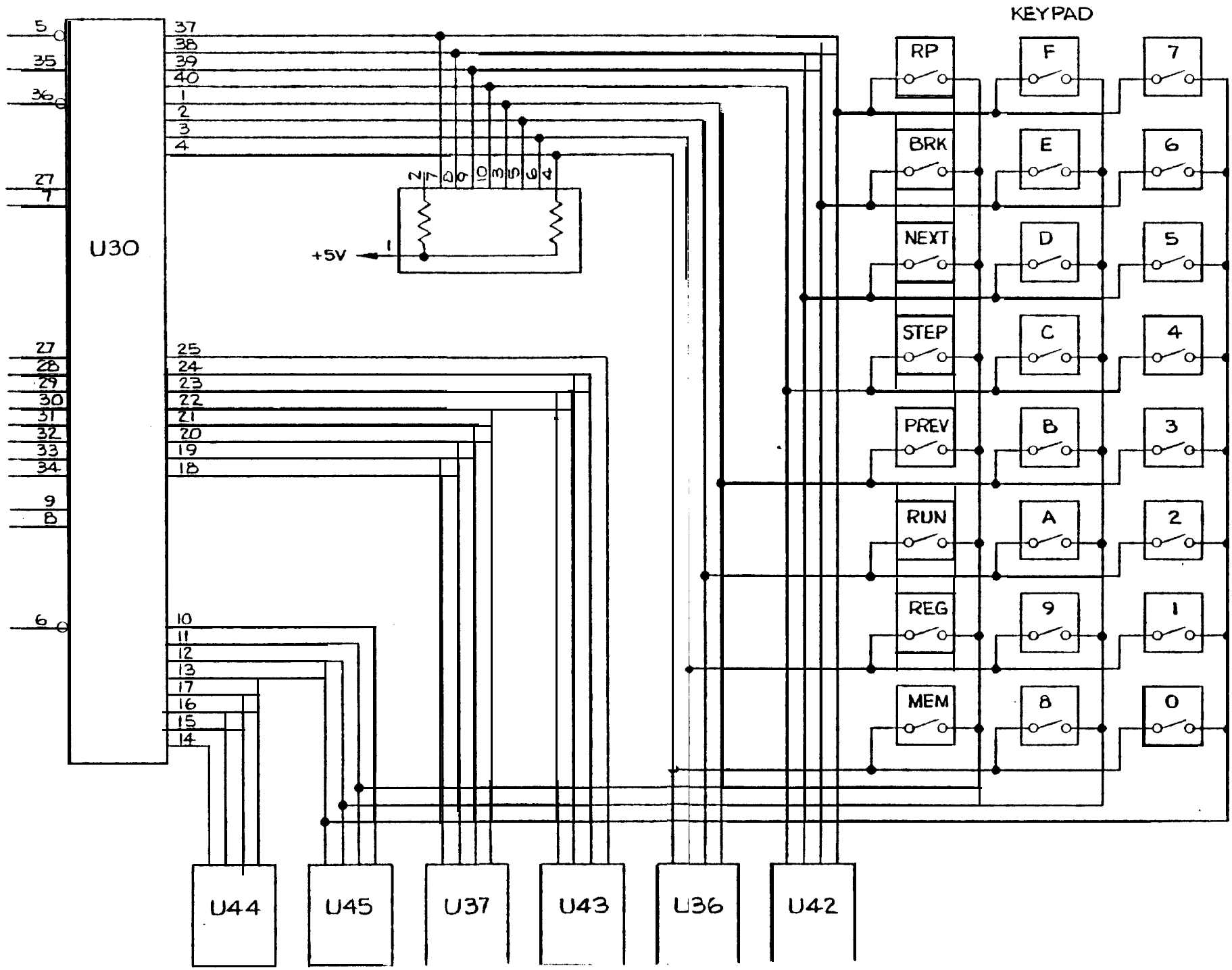
After this program is loaded into RAM, you start the program by pressing RUN UUT @ 8C00 and, in this case, the TK-80 LED segments will light in succession. This program was designed for illustration only and is of no practical value.

When you do run into a test that needs to be done at "real real" speed then you will need a way of determining when a microprocessor test program has finished. There are a number of ways to do this.

Once the 9010A is told to RUN UUT the POD cuts off communications with the Troubleshooter. As long as a program that is running in the Troubleshooter does not require action by the POD it will stay in RUN UUT. So, one method of terminating RUN UUT after a microprocessor has finished running, is to have the Troubleshooter go through a time delay program that runs just a little bit longer than the microprocessor program runs.

Another method is to find a part of the UUT circuit that is not used by the microprocessor test program, e.g. an unused chip select line or an output port line. You will design the microprocessor program to put a specific level, high or low, on this unused line when the program has finished running. The program listed above does this very thing. Of the last five instructions 3E, 1, D3 and FA cause the microprocessor to send a 1 out the port labeled FA. This raises bit 0 to a high when the program is done. By having the Probe synchronized to FREE RUN and continually monitoring bit 0 for a high it will cause the program to jump out when a high is sensed.

If a microprocessor test program has results that need to be tested for the proper values, then the test program will have to load the results of the test into another RAM location which, when the Troubleshooter determines that the RUN UUT program has finished, the Troubleshooter will read and make decisions based on that data.


KEYPAD
U30
+5V
RP
F
7
BRK
E
6
NEXT
D
5
STEP
C
4
PREV
B
3
RUN
A
2
REG
9
1
MEM
8
0
U44
U45
U37
U43
U36
U42