U.S. Department
of Transportation

FEDERAL RAILROAD
ADMINISTRATION

Northeast Corridor Speed Profile Simulator

Office of Research
and Development
Washington, DC 20590

Locomotive Performance in Terms of Real Speed Profiles

B.J. Stewart
J.P. Conner II
R. E. Scofield

ENSCO, Inc.
Transportation Technology Engineering Division
5400 Port Royal Road
Springfield, Virginia 22151

DOT/FRA/ORD-82/52

February 1983
Final Report

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United Stated Government assumes no liability for the contents or use thereof.

The contents of this report reflect the view of ENSCO, Inc. who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policy of the Department of Transportation. This report does not constitute a standard, specification, or regulation.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FRA/ORD-82-52		

4. Title and Subtitle	5. Report Date
NORTHEAST CORRIDOR PROFILE SIMULATOR	January 1983
	6. Performing Organization Code: 1444-207-020
7. Author(s): J. Conner, B. Stewart and B. Scofield	8. Performing Organization Report No.: DOT-FRA-83-04
9. Performing Organization Name and Address: ENSCO, INC. Transportation Technology Engineering Div 5400 Port Royal Road Springfield, VA 22151	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: DTFR53-80-C-00002
12. Sponsoring Agency Name and Address: Office of Freight and Passenger Systems Federal Railroad Administration Department of Transportation 400 Seventh St., S.W. Washington, DC 20590	13. Type of Report and Period Covered
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

A microprocessor device to display speed profile information to a locomotive engineer is described. This system was deployed at the Transportation Test Center to provide speed profile information to simulate Northeast Corridor operations.

17. Key Words	18. Distribution Statement
Northeast Corridor Speed Profile Information	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	96	

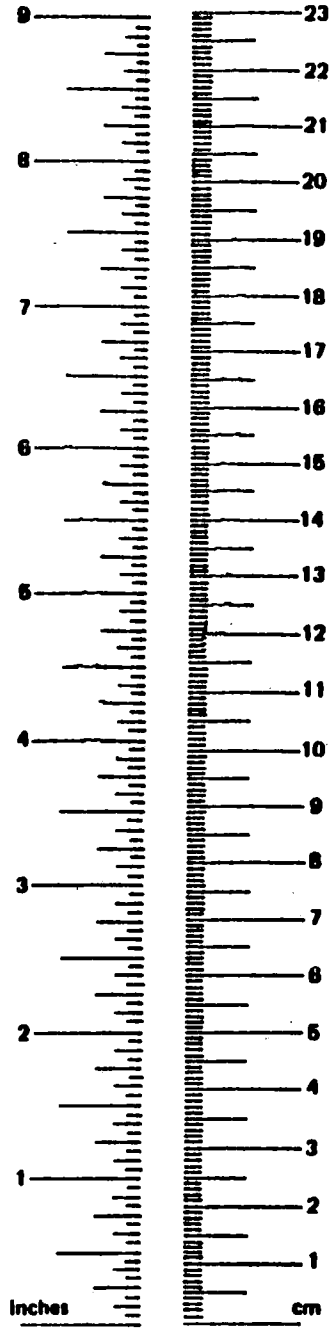
Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS Misc. Publ. 286, Units of Weight and Measures. Price $2.25 SD Catalog No. C13 10 286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	36	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

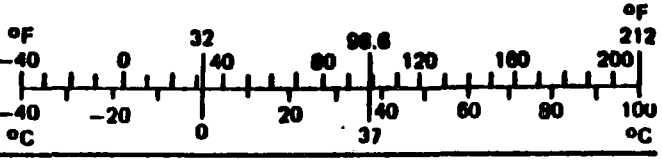


TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

1.0 INTRODUCTION

Ideally, passenger trains are operated in such a way that they arrive at and depart from specific railroad depots at prepublished times. These times, of course, are the times indicated by the operating railroad's time tables. From the passenger locomotive operator's point of view the time table generates a speed profile requirement for a passenger consist. This speed profile is one criteria for locomotive performance.

Evaluation of a locomotive as a candidate for passenger service includes its performance in terms of real speed profiles; however, it is not always considered prudent to introduce new equipment into revenue service before realistic evaluation of relevant performance has been made. Therefore, speed profile testing may be performed without conflict to revenue service by conducting tests at a suitable facility. For tests of this nature to be realistic, a method for reproducing the required speed profile must be implemented.

The NEC Speed Profile Simulator is a device that has been used to pass comprehensive instructions to a locomotive operator, automatically, for the purpose of producing specific speed profiles in the test environment.

2.0 NEC PROFILE SIMULATOR IN OVERVIEW

The NEC Profile Simulator is a microprocessor-controlled device. It consists of three major components: a display head, a Hoffman enclosure containing the simulator electronic hardware, and a power converter (Figure 1).

Speed profiles are incorporated into the system at the engineering level using a read only memory device. Subsequently, under the control of software resident in the microprocessor-associated memory, speed profiles

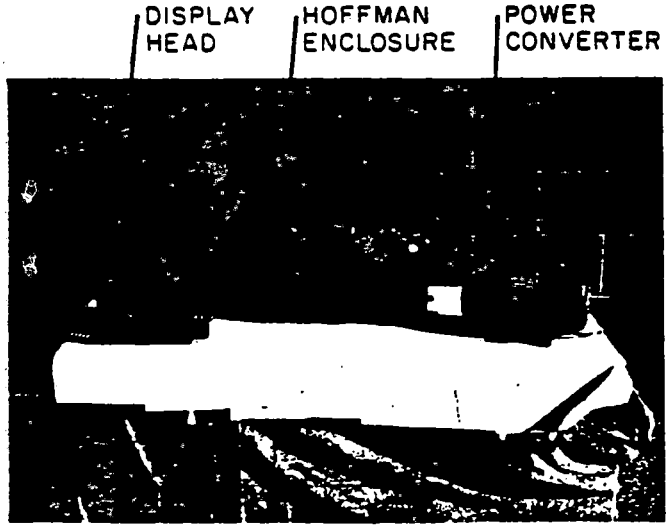


Figure 1. NEC Profile Simulator Components

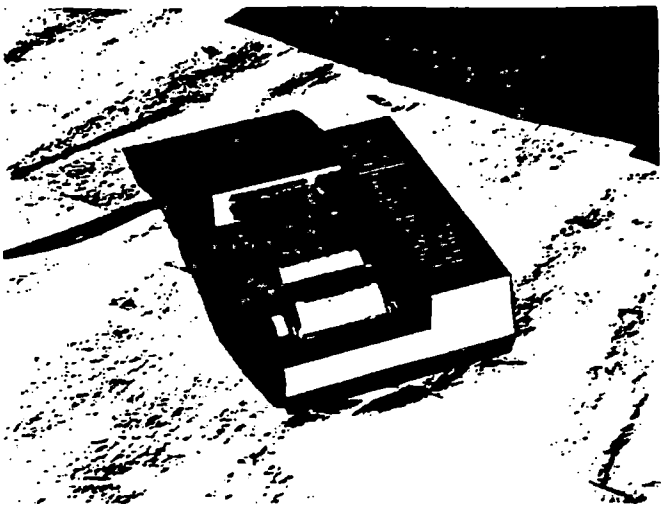


Figure 2. Text Printer

are displayed at the display head in response to a simple startup command.

Within the Hoffman enclosure is a reporting device in the form of a text printer (Figure 2). The text from this printer reports the degree to which the locomotive operator achieved the schedule represented by the speed profile (Table 1).

TABLE 1
SPEED PROFILE

Mile	Posted Speed	Time	Comments
00:00	15	00:00:00	
00:72	60	00:02:59	
03:02	70	00:05:31	
03:69	105	00:06:06	
06:11	100	00:07:39	
06:40	105	00:07:49	
08:23	45	00:08:52	
09:73	35	00:10:28	
10:77	60	00:11:26	
12:02	120	00:13:04	
14:26	65	00:14:25	
16:20	120	00:15:55	
22:67	105	00:19:31	
23:50	120	00:19:59	
24:97	90	00:20:31	
25:43	95	00:21:07	
26:08	100	00:21:32	
27:52	90	00:22:24	
28:19	95	00:22:50	
28:68	100	00:23:09	
29:19	120	00:23:27	
58:06	120	00:39:48	
75:30	90	00:49:41	
76:65	120	00:50:31	
81:32	70	00:53:00	
82:51	50	00:53:49	
83:32	110	00:54:44	
85:36	50	00:56:11	
86:13	40	00:56:47	
86:70	50	00:57:38	

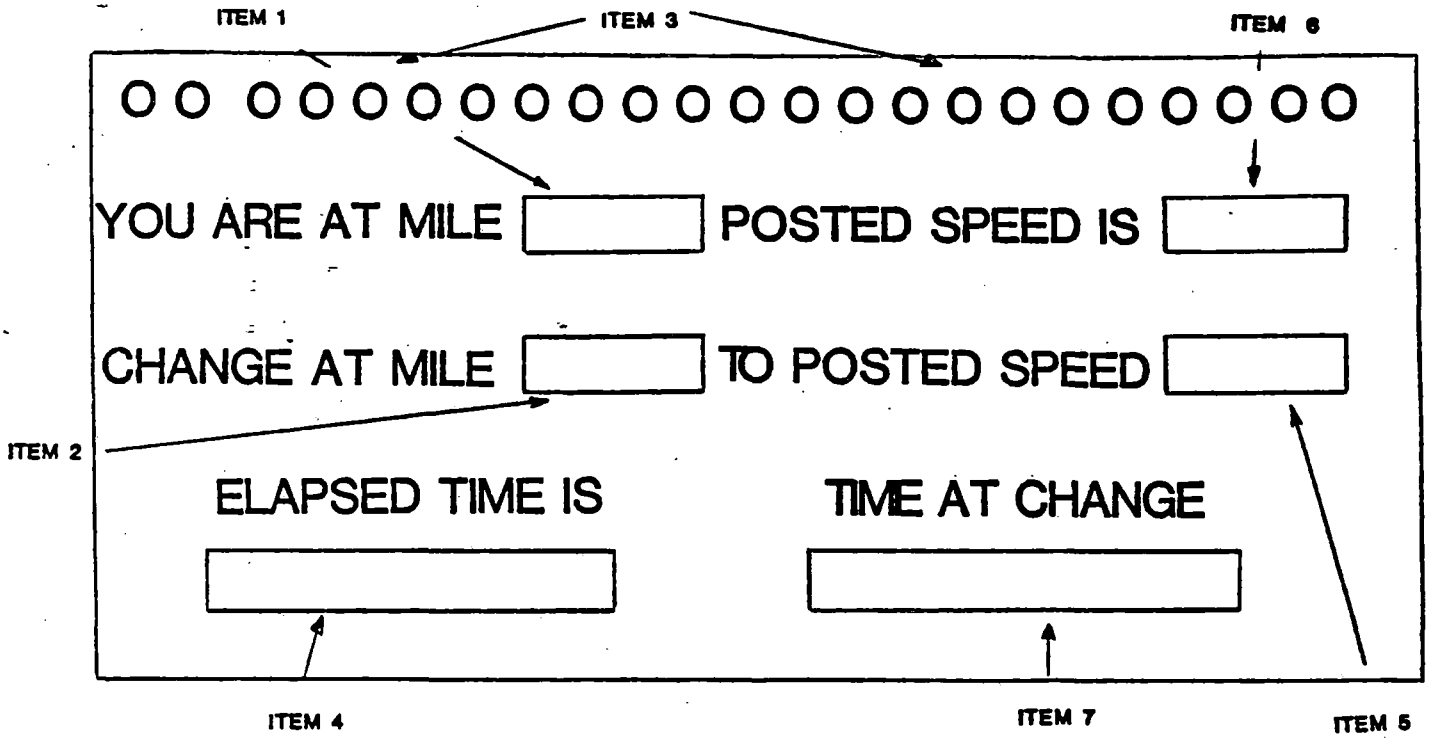


Figure 3. Display Head Front Panel

DISPLAY HEAD INTERPRETATION

The display head presents seven items of information (Figure 3). Item (1) is a milepost indicator. During revenue service the operator observes mileposts as the consist moves down the track, and due to a combination of location recognition and route experience, he is able to anticipate the next milepost occurrence accurately. The speed profile simulator provides for loss of this phenomena by displaying continuous milepost information to the nearest one-tenth of a mile. For example, Item (1) can clearly tell the operator "You are at mile 198.2."

Item (2) on the display represents the mile location at which the next speed change should occur. Therefore, the operator can prepare to adjust speed as the number displayed by Item (1) approaches the number displayed by Item (2). In reality a good locomotive operator can arrive at a particular point on the track at precisely the required speed provided the locomotive has sufficient performance, and if he knows where that point is.

The anticipator lights, Item (3), are provided to give the operator a feel for precision approach to a point. This anticipator function works as follows. At that point in time when the display "You are at mile ___" is three miles or less from the "Change at mile ____" display, the anticipator lights illuminate. As the change milepost (2) is approached, the anticipator lights extinguish one at a time from the left. At exactly the simulated milepost position, the last lamp on the right side extinguishes. The system produces excellent operator anticipation.

At the beginning of a simulation, with the train at rest, the profile simulator display head will display the starting milepost (1), and the milepost at which the first speed change shall occur (2).

Elapsed time (4) will indicate zero until the train starts to move and will then progress in real increments of time. The operator may read the first section speed from Item (6), "Posted speed is ____," and may then anticipate the first speed change from Item (5), "To posted speed ___."

As soon as the locomotive starts to move, the simulator goes into the profile simulation routine contained in read only memory. Elapsed time increments are displayed as the locomotive accelerates from the starting milepost to the posted speed (6). As the current milepost ("You are at mile ____") approaches the change milepost ("Change at mile ____") the anticipator lights illuminate. In response to the speed posted in the "To posted speed ___" display, The operator prepares to arrive at the change point at the correct speed. At that instant when display (1) and (2) are exactly the same, the "To posted speed ___" display is moved to the "Posted speed is ___" display. The next change speed milepost is entered into the "Change at mile ___" display. The next profile speed is entered into the "To posted speed ___" display. At the change point, the elapsed time that the event should have taken place is displayed in the "Time at

change" window (Item 7) and can now be compared to actual "elapsed time" to see how far ahead or behind schedule he is.

Given that both the locomotive operator's performance and the locomotive's response are such that the simulated profile can be achieved, then each "Time at change" will be those times shown in the profile listing (Table 1). The reporting device (a text printer), reports the "Time at change" on a paper tape and also reports deviation from the time schedule.

3.0 DEPLOYMENT OF THE NEC PROFILE SIMULATOR

Use of the NEC simulator involves the following steps:

- Preparation of the speed profile from a given time table and train route.
- Entering the data of the speed profile into the NEC simulator read only memory.
- Bench testing of the simulation using a software-controlled imitation of locomotive response using the NEC simulator computer.
- Selection of power conversion equipment that is compatible with the power reuqirements of the NEC simulator.
- NEC simulator installation on the test locomotive.
- Operation of NEC simulator during locomotive testing.
- Equipment recovery.

3.1 GENERATION OF THE SPEED PROFILE TABLE

Preparation of the speed profile is not a trivial task. It is understood that as a passenger consist approaches a slow ordered section, the consist speed shall be reduced to the maximum speed for that section before entering. By the same token, the consist shall remain at a limited speed until clearing a slow section. Therefore, locomotive accelerations, positive or negative, effect the total elapsed time accumulated to complete any section. Clearly accelerations shall also be accounted for from station stops.

3.2 DATA ENTRY OF SPEED PROFILE INTO THE NEC SIMULATOR PROM

Entering data into the NEC Speed Profile Simulator program read only memory (Prom, Rom or Eprom) is accmplished with software using equipment that is not a part of the NEC simulator.

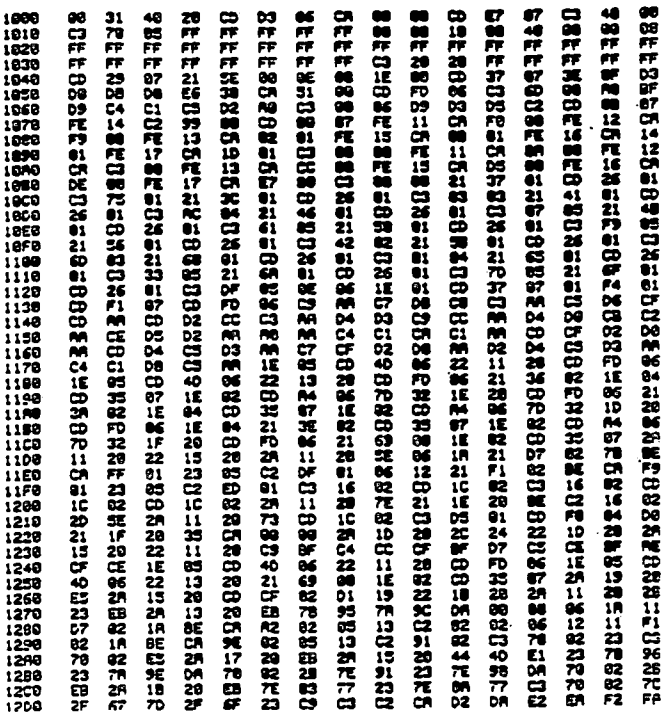


Figure 4. Machine Level Hexidecimal Code

Entering information into Prom is accomplished in two steps. Step 1 involves loading a program code into a computer software development system and then entering all mileposts, posted speeds, and time data that interact with the development system's dialog. Following data entry an operator-controlled data dump is initiated to type out the correct machine level "hexidecimal code" for the required profile in tabular form (Figure 4).

The speed profile is now represented by a series of numbers that the NEC Profile Simulator can understand. This complexity is necessary because these numbers are the only language the machine does understand. Hence, the reference earlier to machine level code which is normally referred to as machine language.

Step 2 of this process consists of entering the machine language from program Prom code into an Eprom using an Eprom burner. This step is relatively simple but time consuming. This step permanently enters a given speed profile into memory. The Prom is then installed into the NEC Profile Simulator. A simulation run is then performed prior to simulator installation using bench equipment.

4.0 ASSEMBLY AND CHECKOUT PROCEDURES

This section provides the instructions for field installation, operation and removal of the NEC Profile Simulator.

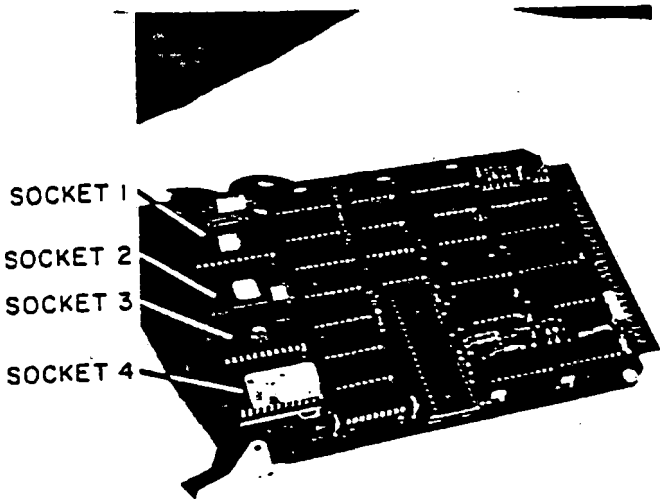


Figure 5. EPROM Board

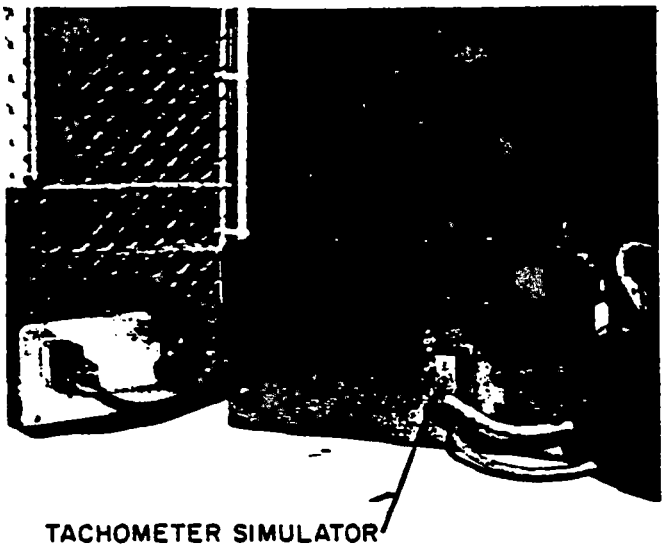


Figure 7. TACH: Simulator Connection

4.1 ASSEMBLY AND CHECKOUT FOR THE NEC SPEED PROFILE SIMUALATOR

Before installing the programmed Prom into the NEC Profile Simulator, disconnect the profile simulator power cord from the line supply. Plug the programmed Eprom into Socket 1, 2, 3 or 4 of the Prom board (Figure 5). Buttons 1, 2, 3 and 4, located on the top face of the computer within the Hoffman enclosure select the Proms in Sockets 1, 2, 3 or 4, respectively (Figure 6). These buttons should be named in correspondence with the names of the profiles they select. With the Eprom installed, the NEC Profile Simulator shall be checked out as follows.

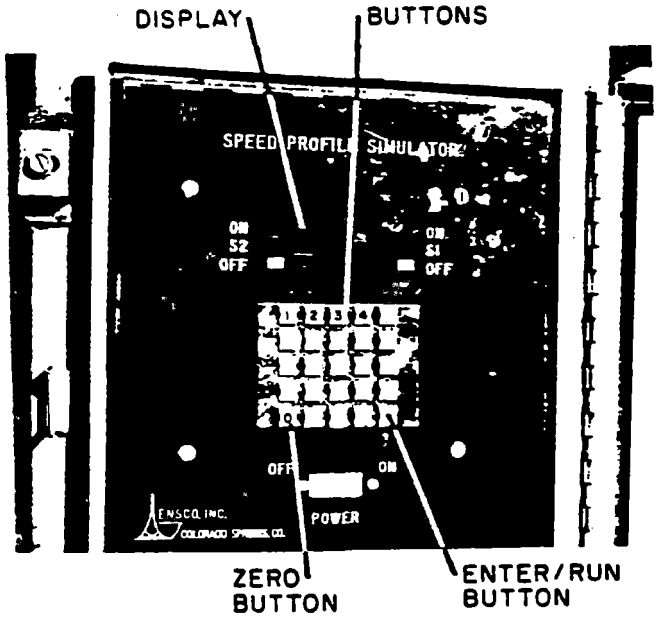


Figure 6. PROM Selection Buttons

A simulated tachometer pulse shall be connected to the tachometer input terminal (Figure 7). The NEC Profile Simulator shall be connected to 115V, 60 Hz power by plugging in the line cord (Figure 8). Turn on Switches S1 and S2 and the power switch (Figure 6).

As the main power switch is closed, the computer keyboard display (Figure 6) will print the question, "Which profile?". In response, press the appropriate profile call button once (Figure 6).

As soon as the profile is called the display (Figure 6) will print out "What is the starting time?". Press the zero button on the computer keyboard four times and verify that the display shows "0000". Press the Enter/Run button once (Figure 6). The display will read "Ready." Finally, press the Enter/Run button once more and the NEC Profile Simulator will start the simulation.

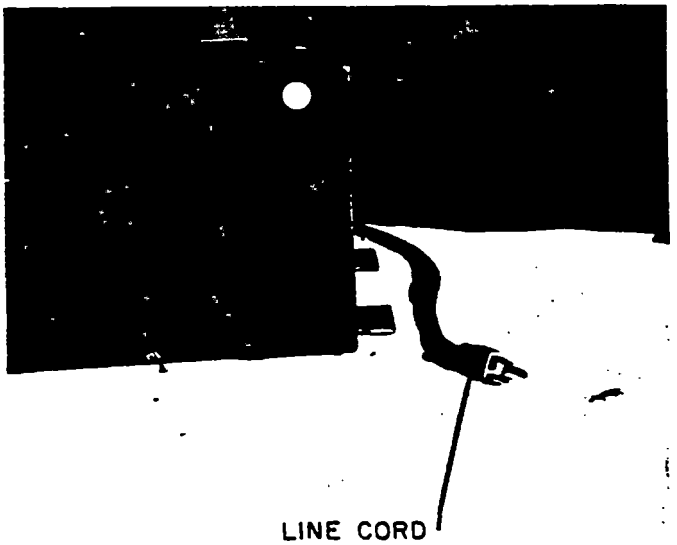


Figure 8. Line Cord

During this simulation of operation, it is recommended that the operator adjust the tachometer frequency to simulate the required profile speeds. Run the entire profile and verify that the display head reproduces the mileposts, speeds and times that were used as a source to program the profile Prom.

In the test environment not all simulations continue without interruption; therefore, the NEC Profile Simulator has been designed to start from any speed change point in the programmed profile.

To initiate the NEC Profile Simulator at an intermediate profile point, proceed exactly as described in the "Start from zero" procedures until the computer readout asks for "Starting Time?" At this point, refer to the speed profile table (Table 2); select the time associated with a chosen starting point and enter the first four time digits rounded up to the next minute. In this example the start point is selected as mile 22.67 at time 00:19:31. Enter time as 0020. Following the time entry, press the enter button once. As soon as the enter button is pressed, the computer display will return with "Select starting milepost." This example specified 22.67 miles, therefore press 2267, and press the enter button on the computer keyboard. In response the computer display will announce "ready." One more press on the enter button will start the profile from mile 22.67 and time 19:31 minutes.

TABLE 2
PROFILE TABLE

Mile	Posted Speed	Time	Comments
00.00	10	00:00:00	
00.50	35	00:03:04	
01.65	55	00:05:10	
02.60	80	00:06:15	
07.00	120	00:09:36	
08.08	80	00:10:20	
08.75	120	00:10:49	
Station Stop	-0-		
11.62	50	00:14:18	
11.82	120	00:14:56	
12.82	80	00:15:53	
13.52	120	00:16:24	
15.22	80	00:17:29	
19.52	120	00:20:43	
22.04	80	00:22:16	
24.12	120	00:23:51	
34.52	80	00:29:19	
35.42	120	00:30:00	
38.42	50	00:31:57	
38.92	30	00:32:35	
39.32	60	00:33:23	
40.17	30	00:34:24	
40.57	70	00:35:12	
42.22	30	00:36:55	
42.62	25	00:37:44	
43.62	25		
Station Stop	-0-		
43.72	15	00:41:52	
44.22	65	00:43:38	
46.02	45	00:45:37	
47.82	80	00:48:01	
49.02	120	00:49:05	

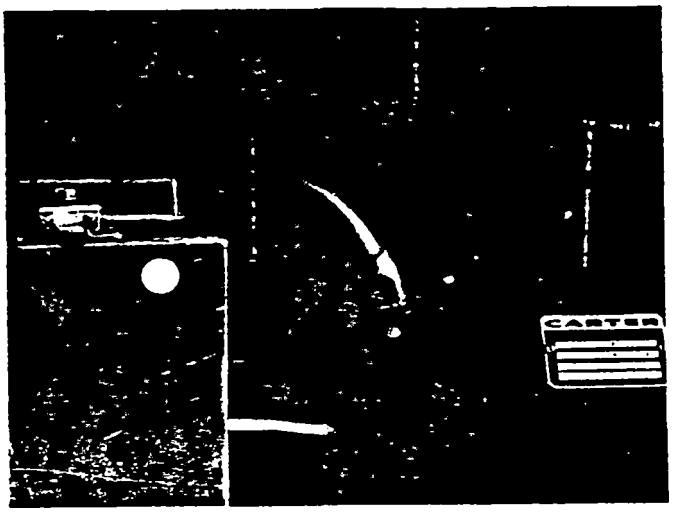


Figure 9. 110 Volt Line Cord to Power Converter

4.2 SELECTION OF POWER CONVERSION EQUIPMENT FOR THE NEC PROFILE SIMULATOR

The NEC Profile Simulator is designed to operate using 115V, 60 Hz power. If this type of power is available, the simulator may be directly connected to the power source using the power cord shown in Figure 8.

Where 115V, 60 Hz power is not directly available the correct power must be made available before the NEC Profile Simulator can be used. Most locomotives have an engine starting or support system battery. Normally the terminal voltage of these batteries is 72 volts DC. The NEC Profile Simulator is equipped with a Carter Rotary Converter that converts 72 volts DC to 115V, 60 Hz AC power. For 72-volt installations, the input terminal of the 72-volt converter may be connected to the 72-volt locomotive battery and the NEC Profile Simulator plugged into the Carter Rotary Converter's 115V, 60 Hz socket (Figures 9 and 10). It

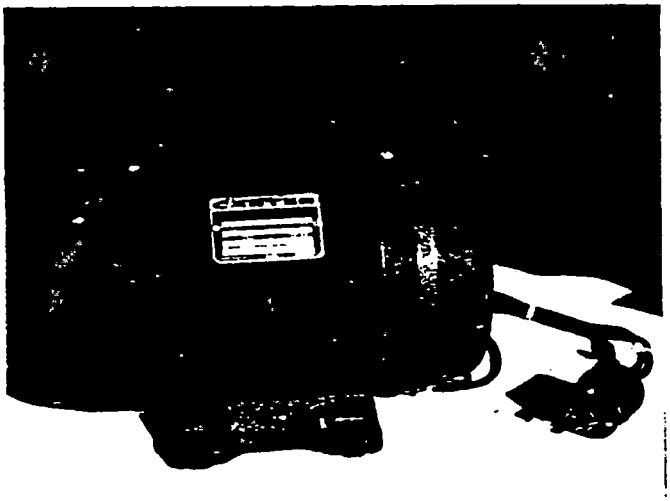


Figure 10. Power Converter Power Cord

is recommended that an isolation switch be used between the locomotive batteries and the Carter Rotary Converter so that the 72-volt DC supply can be switched off easily.

Switch-on procedures are as follows. All switches should be in the off position; turn isolation switch to the on position; wait for the Carter Rotary Converter to spin up to full speed; switch on the NEC Profile Simulator power switch and proceed as outlined in paragraph 3.2 above.

In those circumstances where neither locomotive 72-volt DC power or 115V, 60 Hz power is available, the NEC Profile Simulator may be supplied with power from a regular 12-volt automobile battery. However, the rotary converter must be replaced by a similar device rated for 12-volt DC to 115-volt AC, 60 Hz conversion at 400 watts.

4.3 NEC SIMULATOR INSTALLATION ON THE TEST LOCOMOTIVE

Installation of the NEC Profile Simulator on a locomotive involves the following procedure. Determine the characteristics of the locomotive's DC power source. (115 AC at 60 Hz is not generally available.) Select a rotary converter that is suitable for conversion of the available locomotive DC power.

Select a mounting site for the rotary converter close to the locomotive's battery power source. Select a location in the operator's cab for the Hoffman enclosure. This location shall be within 20 feet of the location of the display head.

Proceed with the installation by mounting the rotary converter securely and then connecting the positive side to the locomotive battery via an electrical isolation switch. Switch on the isolation switch and measure the voltage and frequency at the output side of the rotary converter. These parameters shall be 110-120V, 58-62 Hz. Switch off the rotary converter isolation switch.

Place the Hoffman enclosure at the selected position and secure it in place. The enclosure has four mounting lugs for securing points. Orient the Hoffman enclosure so that the connector plugs and sockets are situated in a position where they will not be accidently kicked or stepped on.

Mount the display head on top of the locomotive operator's console. The display head has a powerful magnetic base that will secure the display head to a ferromagnetic (iron or steel, not aluminum) surface. The magnetic mounting fixture is designed to permit each locomotive engineer to position the display head for his particular viewing.

Connect the interconnecting cable from the Hoffman enclosure to the display head and then connect the NEC Profile Simulator power cord to the rotary converter (Figure 11). Tape or secure all cables to eliminate the possiblity of being tripped over.

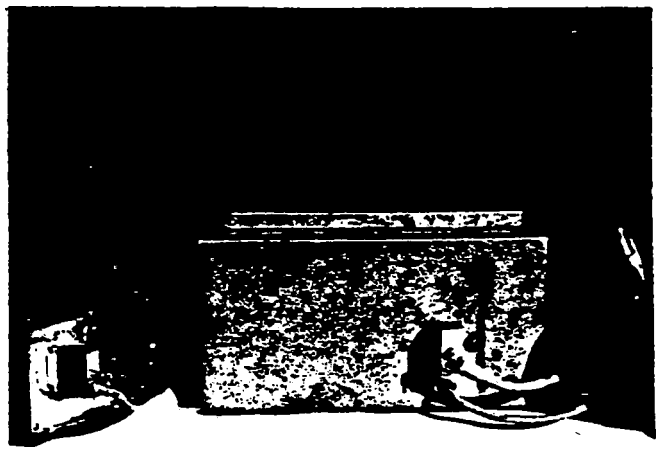


Figure 11. NEC Profile Simulator Cables

Obtain the documentation that describes the locomotive's tachometer circuitry. The information needed is as follows:

- Tachometer pulse shape and amplitude
- Number of tachometer pulses per mile
- Location of an accessible electrical interception point to the tachometer pulses

The program resident in the NEC Profile Simulator contains conversion constants that adjust the effect of locomotive tachometer pulses within the simulator to produce an accurate speed standard against which the profile is generated.

In the ideal situation this conversion constant is correctly programmed into the Prom as part of the profile program. Normally the precise locomotive tachometer characteristics are not known during the Prom burning process; therefore, an easy method for changing this constant has been built into the NEC Profile Simulator.

The tachometer conversion may be displayed at the processor panel by the following method. Switch on the main power switches on the keyboard; elect the desired profile (Figure 6) by pressing the coinciding profile button and then enter the time. As soon as the time has been entered the display will read "Ready." At this point, press the button marked "Tach" (Figure 12). The display will respond with "0045". The current scale factor ____ enter new. This statement is interpreted as "The current tachometer scale factor is 0045." Now enter the new tachometer scale factor.

To enter the new scale factor use the four digit form. For example, if the new factor is 51, press 0051, then press the enter button "Ent Run" button shown in Figure 12. The new scale factor is in the correct memory location. At this point a word of

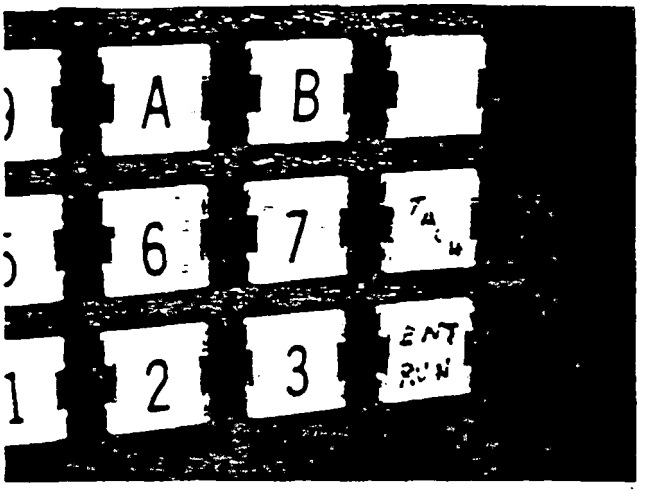


Figure 12. Keyboard Buttons

caution: the new scale factor is in Ram, not Prom, this is not in hexidecimal form. If the simulator is switched off and then on again the Prom will load the original factor of 45 back into Ram and the new scale factor will be lost. Of course, the new factor can be re-entered but it may also be forgotten. Therefore, at the first opportunity, program the correct scale factor into the Prom using the profile generation process.

The tachometer scale factor is the number of tachometer pulses that occur when the locomotive moves one thousandth of a mile (5.28 feet).

To calculate the tachometer constant, measure the locomotive's wheel circumference. Determine the number of tachometer pulses per wheel revolution. Divide the tachometer pulses per wheel revolution by the locomotive wheel circumference to produce tach pulses per foot. Multiply this number of 5.28 to produce the scale factor.

It is sometimes necessary to adjust the tachometer tach constant to produce agreement between the displayed distance run by the locomotive and the actual distance run. This is done by changing the factor in small increments.

At this point the NEC Profile Simulator is ready to operate although it is recommended that a dynamic checkout be conducted as follows. To check the NEC Profile Simulator for correct operation the locomotive shall be at rest but ready to go. Instruct the locomotive operator in the use of the speed profile head. Start the locomotive and the profile simulator using the procedure described for the laboratory checkout. Allow the locomotive operator the time needed to assimilate the methods of operation. During this period check that the actual distance run by the locomotive is in agreement with the distance displayed by the display head. In those cases where discrepancies exist, alter the tachometer calibration coefficients in small increments in the NEC Profile Simulator to zero in on the correct distance calibration.

4.4 OPERATION OF NEC PROFILE SIMULATOR DURING A TEST

Locomotive tests associated with speed profile simulation are normally conducted over thousands of miles and hundreds of hours of operation. Because of this situation, the NEC Profile Simulator is designed for use by test locomotive crews or field test personnel in order to avoid the costs of engineer-attended operation.

Following checkout of the NEC Profile Simulator, as described in the preceeding sections, it is required that the correct profile be selected at the profile simulator keyboard before a test run may proceed. A new roll of printer paper should be placed in the text printer before each run. This task is easily performed as described in the text printer manual.

Experience has shown that the pertinent points concerning a profile event will appear on the text printer paper tape record. Additional documentation describing relevant test events may be recorded in a text record or log.

Table 2 shows that station stops may be included in the speed profile. These stops are displayed by a posted speed of 0000 on the NEC Profile Simulator display head. It may not be advisable for the locomotive operator to stop the consist at precisely the point indicated by the simulator (phase break, road crossing, etc.). Therefore, the text printer will print out the distance overrun in units of 1/100 of a mile, up to ten miles. When the locomotive stops with 0000 in the posted speed window, the NEC Profile Simulator will start a time-delay of one minute. At the end of this one minute time-delay, a beeper tone is sounded by the simulator and the next speed will appear in the "posted speed is" display.

The end of the simulated profile is indicated at the display head (Figure 3) by indicating "station stop" followed by speed information that is zero.

4.5 RECOVERY OF THE NEC PROFILE SIMULATOR

Before removing the NEC Profile Simulator from a locomotive, first ensure that the battery supply isolation switch is open, then disconnect the Carter Rotary Converter leads from the locomotive battery.

Disconnect all simulator cables, including the tachometer connection to the locomotive. Release the mounting fasteners on the rotary converter and the Hoffman enclosure and then remove the entire simulator system from the locomotive.

Reassemble the NEC Profile Simulator in the checkout configuration and assess the system condition. Repair as necessary.

5.0 TECHNICAL DESCRIPTION

5.1 SOFTWARE

The NEC Profile Simulator is a microprocessor-controlled device. Microprocessor control is achieved by the implementation of a series of software programs. These programs have been written in full comment form to allow a trained programmer to decipher the logic flow.

Appendix B contains the program listings of the following routines:

- NEC00C Description of Program NEC
- NEC10C Restart and Interrupt Vectors Addr 0000-0040
- NEC20C Initialization Program Addr 0100-0
- NEC30C Command Program
- NEC40C Profile Run Program
- NEC51C Current Status Display Driver
- NEC52C Display Subroutine
- NEC53C Upgrade Current Status Display
- NEC54C Update Next Status Display
- NEC55C Printer Driver
- NEC56C Computer Time Difference
- NEC57C Convert BCD to ASCII
- NEC58C Convert time and place in Print Buffer
- NEC91C Elapsed Time Interrupt Routine
- NEC92C Interrupt Routine for Odometer

5.2 HARDWARE

Appendix C contains a complete set of drawings that describe the electronic apparatus of the NEC Profile Simulator. Where possible this hardware is off-the-shelf equipment, supplemented by custom-designed and fabricated devices as required to accomplish the intended function.

Drawing 1116-480-05 (Appendix C) is a block diagram of the entire system and shows that the Z80 Central Processing Unit (CPU) interacts with Ram, Eprom, the keyboard, input/output (I/O) interface via a STD-BUS.

The speed and distance unit, the elapsed time module, and program communications interface are controlled directly by the CPU using the STD-BUS.

The microprocessor is a Zilog Z80, 8-bit machine fabricated into a system by the ProLog Corporation. Figure 13 shows the ProLog Corporation components installed in the system card cage. Board 1 is the keyboard display card (Schematic 7303D104973, Assembly 7303D104974).

Board 2 is the processor card which also contains both Ram and Eprom (Schematic 7803 processor card Z80 CPU D103218; and Assembly 7803 processor card Z80 CPU D103219).

Board 3 is a special I/O board and is described by drawings 1116-483-480-02 through 04. Supplemental to the special I/O drawings is the locator drawing that shows the physical positions of each integrated circuit on the special I/O board. Connectors are designated as DS301 (1), DS302 (2), DS303 (3), and DS304 (4).

All of the electronics within the display head appear on drawing 1116-483-480-01. Note that only one set of displays are shown on this drawing as both display sets are wired identically.

There are only three external extrance points in the system. Drawing 1116-483-480-02 shows that the locomotive tachometer signal enters on terminal D304. This signal shall be Transistor-Transistor Logic (TTL)-compatible.

Drawing 1116-483-480-03 shows a 60 Hz clock function generated by the circuit element U306. This element of the circuit is described by the Quest Electronics pamphlet in Appendix 3. Finally, system power enters the card rack mother board.

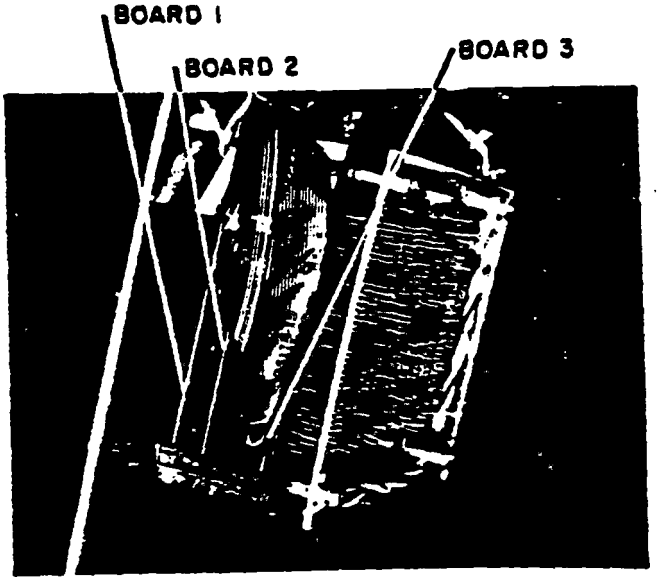


Figure 13. ProLog Microprocessor Components

APPENDIX A

TEXT PRINTER MANUAL INFORMATION

TEXT PRINTER MANUAL INFORMATION

The Text Printer utilized in the Northeast Corridor Speed Profile Simulator is a Quick Printer II, catalog number 26-1155, manufacturerd by Radio Shack, a Division of the Tandy Corporation.

Listed in the Text Printer Manual contents are:

Controls and Functions
Paper Loading Instructions
Connection
Power-Up Messages
Using the PRINT Mode Switch
Output to the Quick Printer II
Special Features
Details of Operation
Assembly Language Output
Using with a Serial Output Device
If You Have Problems
Care and Maintenance
Specifications
Schematic Diagram

APPENDIX B

PROGRAM LISTINGS

```
1000   00 31 40 20 CD D3 06 CA 00 08 CD E7 07 C3 40 00
1010   C3 70 05 FF FF FF FF FF 00 08 10 08 40 08 00 08
1020   FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
1030   FF FF FF FF FF FF FF FF C3 20 20 FF FF FF FF FF
1040   CD 29 07 21 5E 00 0E 08 1E 00 CD 37 07 3E 0F D3
1050   D0 DB D0 E6 30 CA 51 00 CD FD 06 C3 6D 00 A0 BF
1060   D9 C4 C1 C5 D2 A0 C3 00 06 D9 D3 D5 C2 CD 8B 07
1070   FE 14 C2 99 00 CD 80 07 FE 11 CA F0 00 FE 12 CA
1080   F9 00 FE 13 CA 02 01 FE 15 CA 0B 01 FE 16 CA 14
1090   01 FE 17 CA 1D 01 C3 00 00 FE 11 CA BA 00 FE 12
10A0   CA C3 00 FE 13 CA CC 00 FE 15 CA D5 00 FE 16 CA
10B0   DE 00 FE 17 CA E7 00 C3 00 00 21 37 01 CD 26 01
10C0   C3 75 01 21 3C 01 CD 26 01 C3 03 03 21 41 01 CD
10D0   26 01 C3 AC 04 21 46 01 CD 26 01 C3 07 05 21 4B
10E0   01 CD 26 01 C3 61 05 21 50 01 CD 26 01 C3 F9 05
10F0   21 56 01 CD 26 01 C3 42 02 21 5B 01 CD 26 01 C3
1100   6D 03 21 60 01 CD 26 01 C3 B1 04 21 65 01 CD 26
1110   01 C3 33 05 21 6A 01 CD 26 01 C3 7D 05 21 6F 01
1120   CD 26 01 C3 DF 05 0E 06 1E 01 CD 37 07 01 F4 01
1130   CD F1 07 CD FD 06 C9 AA C7 D0 C8 C3 AA C5 D6 CF
1140   CD AA CD D2 CC C3 AA D4 D3 C9 CC AA D4 D0 CB C2
1150   AA CE D5 D2 AA A0 AA C4 C1 CA C1 AA CD CF D2 D0
1160   AA CD D4 C5 D3 AA C7 CF D2 D0 AA D2 D4 C5 D3 AA
1170   C4 C1 D8 C5 AA 1E 05 CD 4D 06 22 11 20 CD FD 06
1180   1E 05 CD 4D 06 22 13 20 CD FD 06 21 36 02 1E 04
1190   CD 35 07 1E 02 CD A4 06 7D 32 1E 20 CD FD 06 21
11A0   3A 02 1E 04 CD 35 07 1E 02 CD A4 06 7D 32 1D 20
11B0   CD FD 06 1E 04 21 3E 02 CD 35 07 1E 02 CD A4 06
11C0   7D 32 1F 20 CD FD 06 21 69 00 1E 02 CD 35 07 2A
11D0   11 20 22 15 20 2A 11 20 5E 06 1A 21 D7 02 7B BE
11E0   CA FF 01 23 05 C2 DF 01 06 12 21 F1 02 BE CA F9
11F0   01 23 05 C2 ED 01 C3 16 02 CD 1C 02 C3 16 02 CD
1200   1C 02 CD 1C 02 2A 11 20 7E 21 1E 20 BE C2 16 02
1210   2D 5E 2A 11 20 73 CD 1C 02 C3 D5 01 CD F0 04 D0
1220   21 1F 20 35 CA 00 00 2A 1D 20 2C 24 22 1D 20 2A
1230   15 20 22 11 20 C9 BF C4 CC CF BF D7 C5 CE BF AE
1240   CF CE 1E 05 CD 4D 06 22 11 20 CD FD 06 1E 05 CD
1250   4D 06 22 13 20 21 69 00 1E 02 CD 35 07 2A 19 20
1260   E5 2A 15 20 CD CF 02 D1 19 22 1B 20 2A 11 20 2B
1270   23 EB 2A 13 20 EB 7B 95 7A 9C DA 00 00 06 1A 11
1280   D7 02 1A BE CA A2 02 05 13 C2 82 02 06 12 11 F1
1290   02 1A BE CA 9E 02 05 13 C2 91 02 C3 70 02 23 C3
12A0   70 02 E5 2A 17 20 EB 2A 15 20 44 4D E1 23 7B 96
12B0   23 7A 9E DA 70 02 2B 7E 91 23 7E 98 DA 70 02 2B
12C0   EB 2A 1B 20 EB 7E 83 77 23 7E 8A 77 C3 70 02 7C
12D0   2F 67 7D 2F 6F 23 C9 C3 C2 CA D2 DA E2 EA F2 FA
12E0   CD C4 CC D4 DC E4 EC F4 FC 22 2A 01 11 21 31 32
12F0   3A 3E 06 0E 16 1E 26 2E 36 C6 CE D6 DE E6 EE F6
1300   FE D3 DB 1E 05 CD 4D 06 22 15 20 CD FD 06 1E 05
1310   CD 4D 06 22 17 20 CD FD 06 1E 05 CD 4D 06 22 19
1320   20 21 69 00 1E 02 CD 35 07 2A 15 20 EB 2A 17 20
1330   7D 93 4F 7C 9A 47 2A 19 20 7D 93 7C 9A D2 50 03
1340   CD 64 03 CA 00 00 1A 77 3E 00 12 13 23 C3 40 03
1350   03 EB 03 EB CD 64 03 CA 00 00 1A 77 3E 00 12 1B
1360   2B C3 54 03 03 3E FF B9 C0 3E FF B8 C9 CD CB 06
1370   00 CA ED 03 AF D3 51 1E 05 CD 4D 06 22 11 20 CD
1380   FD 06 1E 05 CD 4D 06 22 13 20 CD FD 06 1E 05 CD
1390   4D 06 22 15 20 3E 20 D3 51 DB 51 FE 2C C2 99 03
13A0   2A 13 20 EB 2A 11 20 CD 09 04 DB 51 FE 6C CA AA
13B0   03 21 05 04 1E 02 CD 35 07 CD 80 07 FE 15 CA DC
13C0   03 FE 14 C2 B9 03 CD 80 07 FE 15 C2 C6 03 1E 02
13D0   21 66 01 CD 35 07 CD 40 04 C3 E7 03 1E 02 21 47
13E0   01 CD 35 07 CD 71 04 AF D3 51 D3 50 C7 0E 08 1E
13F0   00 21 FD 03 CD 37 07 CD E0 07 C3 00 00 A1 D2 CD
```

```
1400  C7 D0 A0 CF CE BF CC AF D0 0E 02 3E 60 D3 51 7C
1410  D3 50 CD 2B 04 7D 0F 0F 0F 0F D3 50 CD 2B 04 7D
1420  D3 50 CD 2B 04 EB 0D C2 0F 04 C9 DB 51 1F DA 2B
1430  04 3E E0 D3 51 DB 51 1F D2 35 04 3E 60 D3 51 C9
1440  2A 13 20 EB 2A 11 20 E5 2A 15 20 DB 51 1F DA 48
1450  04 7E D3 50 3E E0 D3 51 DB 51 1F D2 58 04 3E 60
1460  D3 51 E3 CD A6 04 CA 6F 04 23 E3 23 C3 48 04 E1
1470  C9 2A 13 20 EB 2A 11 20 E5 2A 15 20 3E 20 D3 51
1480  DB 51 1F DA 80 04 3E A0 D3 51 DB 51 1F D2 8A 04
1490  DB 52 77 3E 20 D3 51 E3 CD A6 04 CA A4 04 23 E3
14A0  23 C3 80 04 E1 C9 7B BD C0 7A BC C9 3E 00 C3 B3
14B0  04 3E FF F5 1E 05 CD 4D 06 22 11 20 CD FD 06 1E
14C0  05 CD 4D 06 22 13 20 1E 02 21 69 00 CD 35 07 2A
14D0  11 20 F1 F5 77 BE C4 E2 04 CD F0 04 D2 C7 04 C3
14E0  00 00 1E 02 CD AD 06 CD 80 07 FE 10 C2 E7 04 C9
14F0  2A 11 20 3A 14 20 BC C2 02 05 3A 13 20 BD C2 02
1500  05 37 23 22 11 20 C9 1E 05 CD 4D 06 CD FD 06 1E
1510  04 CD AD 06 1E 00 CD 4C 07 CD 80 07 FE 10 CA 0F
1520  05 FE 14 C2 19 05 CD 80 07 FE 10 C2 26 05 2B 2B
1530  C3 0F 05 1E 05 CD 4D 06 CD 15 07 1E 04 CD AD 06
1540  E5 1E 01 CD A4 06 7D E1 77 BE C4 51 05 23 C3 38
1550  05 1E 02 16 C5 CD 65 07 CD 80 07 FE 10 C2 58 05
1560  C9 1E 05 CD 4D 06 7E 32 08 20 3E D7 77 C3 00 00
1570  CD 00 06 E3 2B F5 3A 08 20 77 F1 E3 C9 2A 0F 20
1580  E5 21 3D 06 1E 04 CD 35 07 1E 03 CD 4D 06 E5 CD
1590  15 07 21 41 06 1E 04 CD 35 07 1E 03 CD 4D 06 E5
15A0  CD 15 07 21 45 06 1E 04 CD 35 07 1E 03 CD 4D 06
15B0  E5 CD 15 07 21 49 06 1E 04 CD 35 07 1E 03 CD 4D
15C0  06 E5 CD FD 06 21 50 01 0E 06 1E 01 CD 37 07 CD
15D0  80 07 FE 17 C2 CF 05 CD FD 06 F1 C1 D1 E1 C9 1E
15E0  05 CD 4D 06 22 0F 20 21 50 01 0E 06 1E 01 CD 37
15F0  07 CD 80 07 FE 17 C2 F1 05 2A 0F 20 CD FD 06 E9
1600  F5 C5 D5 E5 22 00 20 EB 22 02 20 C5 E1 22 04 20
1610  F5 E1 22 06 20 21 3D 06 E5 21 00 20 06 04 1E 00
1620  CD 42 07 E3 CD 35 07 E3 CD 80 07 FE 10 C2 28 06
1630  05 C2 1E 06 CD FD 06 E1 E1 D1 C1 F1 C9 A0 BD CC
1640  C8 A0 BD C5 C4 A0 BD C3 C2 A0 BD C6 C1 01 05 05
1650  21 0B 20 CD 80 07 FE 10 D2 6F 06 0D CA 6B 06 77
1660  57 D5 CD 60 07 D1 1D 23 C3 53 06 0C C3 53 06 CA
1670  88 06 FE 13 C2 53 06 B8 CA 53 06 1C 2B 0C 16 A0
1680  D5 CD 65 07 D1 C3 53 06 79 FE 01 C2 53 06 21 0B
1690  20 7E 07 07 07 07 23 B6 57 23 7E 07 07 07 07 23
16A0  B6 5F EB C9 01 03 03 21 0D 20 C3 53 06 55 CD 60
16B0  07 1C 7D 0F 0F 0F 0F 57 CD 60 07 1C 54 CD 60 07
16C0  1C 7C 0F 0F 0F 0F 57 CD 60 07 C9 DB 51 FE FF C8
16D0  E6 08 C9 DB D0 FE FF C8 FE C0 C9 FF 1E 08 56 1D
16E0  D5 F5 CD 65 07 F1 D1 23 C2 DE 06 CD E7 07 7E FE
16F0  FF C8 7D D6 07 6F 7C DE 00 67 C3 DC 06 16 A0 1E
1700  F8 CD 65 07 1C C2 01 07 C9 16 A0 1E FC CD 65 07
1710  1C C2 0D 07 C9 16 A0 1E 04 1D F5 CD 65 07 F1 C2
1720  19 07 C9 11 00 0F C3 2C 07 11 00 00 CD 65 07 1E
1730  04 CD 65 07 C9 0E 04 56 CD 65 07 1C 23 0D C2 37
1740  07 C9 0E 02 CD 4C 07 0D C2 44 07 C9 56 CD 60 07
1750  1C 7E 0F 0F 0F 0F 57 CD 60 07 1C 23 C9 FF FF FF
1760  7A CD D0 07 57 7A D3 D0 7B E6 F7 D3 D1 7B F6 08
1770  D3 D1 7B E6 F7 D3 D1 C9 FF FF FF FF FF FF FF FF
1780  3E 0F D3 D0 DB D0 E6 3F C2 84 07 D5 C5 16 88 7A
1790  07 57 E6 0F D3 D0 DB D0 E6 3F EA 8F 07 5F CD EE
17A0  07 DB D0 E6 3F AB C2 8F 07 01 00 00 7A 1F DA B5
17B0  07 04 C3 AD 07 7B 1F 0C DA BE 07 C3 B6 07 0D 78
17C0  CA C9 07 C6 04 0D C2 C3 07 C1 D1 C9 FF FF FF FF
17D0  E6 0F FE 0A DA DA 07 C6 B7 C9 F6 B0 C9 FF FF FF
17E0  01 E8 03 C3 F1 07 FF 01 C8 00 C3 F1 07 FF 01 14
17F0  00 0B C5 0E AF 0D C2 F5 07 C1 78 B1 C2 F1 07 C9
```

```
0800  F3 31 00 30 C3 80 08 00 00 00 00 00 00 00 00 00
0810  F3 08 AF 3A 15 21 3C 27 32 15 21 FE 60 20 1C AF
0820  32 15 21 3A 16 21 3C 27 32 16 21 FE 60 20 0C AF
0830  32 16 21 3A 17 21 3C 27 32 17 21 08 FB ED 4D 00
0840  F3 08 AF 3A 10 21 3C 27 32 10 21 FE 00 20 1C AF
0850  32 10 21 3A 11 21 3C 27 32 11 21 FE 00 20 0C AF
0860  32 11 21 3A 12 21 3C 27 32 12 21 08 FB ED 4D 00
0870  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0880  3E 0D D3 FC D3 FD C6 10 FE 0D 20 F6 AF D3 FE D3
0890  FC 21 00 21 3E 53 BE 20 06 23 BE 20 02 18 20 3E
08A0  00 21 00 21 77 11 01 21 01 00 10 ED B0 3E 53 21
08B0  00 21 77 00 00 3E 47 32 02 21 3E 00 32 03 21 ED
08C0  5E 3E 18 D3 F0 3E 20 D3 F4 3E 47 D3 F0 3E 00 D3
08D0  F0 3E 47 D3 F1 3E 3C D3 F1 3E 47 D3 F2 3A 02 21
08E0  D3 F2 3E 47 D3 F3 3A 03 21 D3 F3 3E E9 D3 F9 3E
08F0  11 D3 F9 CD A0 0E CD 00 0D CD 00 0D CD 00 0D CD
0900  00 0D 21 00 0F 11 00 22 01 00 01 ED B0 00 00 00
0910  CD 90 0E 00 21 00 0E CD DC 06 CD 80 07 FD 21 00
0920  10 FE 14 28 18 FD 21 00 14 FE 15 28 10 FD 21 00
0930  18 FE 16 28 08 FD 21 00 1C FE 17 20 D3 CD F5 09
0940  CD DC 06 1E 03 CD 4D 06 22 05 21 AF BC 20 0B BD
0950  20 08 22 07 21 22 13 21 18 48 21 37 0E CD DC 06
0960  1E 03 CD 4D 06 22 07 21 11 08 00 7C FD BE 02 20
0970  0A 7D FD BE 01 30 04 28 0B 18 04 FD 19 18 EC 11
0980  F8 FF FD 19 FD 7E 00 DD 77 00 FD 7E 01 DD 77 01
0990  FD 7E 02 DD 77 02 FD 7E 03 DD 77 03 FD 7E 04 DD
09A0  77 04 AF DD 77 05 3A 05 21 DD 77 06 3A 06 21 DD
09B0  77 07 21 51 0E 0E 08 1E 00 CD 37 07 CD 80 07 FE
09C0  10 CA 00 0A FE 11 20 F4 21 02 21 1E 00 CD 42 07
09D0  CD 09 07 CD E0 07 21 59 0E CD DC 06 1E 03 CD 4D
09E0  06 22 02 21 3E 47 D3 F2 7D D3 F2 3E 47 D3 F3 7C
09F0  D3 F3 18 BE 00 FD 22 00 25 21 15 0E C9 FF FF FF
0A00  FB 3E C1 D3 F2 18 5F 3E C1 D3 F1 CD 20 0D CD 60
0A10  0D 3A 09 21 FE 00 28 0D 3D 32 09 21 2A 0A 21 CD
0A20  00 0D 22 0A 21 DD 7E 02 FD BE 02 38 43 DD 7E 01
0A30  FD BE 01 38 3B DD 7E 00 FD BE 00 38 33 AF D3 FE
0A40  CD 70 0B FD 7E 03 DD 77 03 FD 7E 04 DD 77 04 11
0A50  08 00 FD 19 CD 98 0A ED 4B 13 21 3E 00 B8 20 10
0A60  B9 20 0D CD C0 0A CD A0 0A DD BE 00 28 FB 18 97
0A70  FD 7E 02 DD 96 02 27 FE 00 20 17 FD 7E 01 DD 96
0A80  01 27 FE 38 38 04 28 04 18 08 CB 27 CB 27 F6 03
0A90  D3 FE C3 0B 0A 00 FF FF FD 22 00 25 C3 20 0D 00
0AA0  CD 20 0D DD 7E 00 C9 FF FF FF FF FF FF FF FF FF
0AB0  2A 14 21 22 0C 21 2A 16 21 22 0E 21 21 0D 21 C9
0AC0  DD 46 00 DD 7E 05 DD BE 05 28 FB DD 7E 00 B8 20
0AD0  EF 3E 41 D3 F2 21 40 21 DD 7E 05 77 23 DD 7E 06
0AE0  77 23 DD 7E 07 77 CD B0 0A 11 40 21 CD 80 0C CD
0AF0  60 0D 3A 0E 21 FE 00 20 0F 3A 0D 21 FE 45 CC 69
0B00  0B FE 47 CC 69 0B 18 DE 3A 0D 21 FE 14 CC 69 0B
0B10  FE 15 20 D2 DD 7E 00 FD 96 00 27 32 0B 21 DD 7E
0B20  01 FD 9E 01 27 32 0C 21 21 0B 21 CD 60 0C 78 32
0B30  C8 22 79 32 C7 22 23 CD 60 0C 78 32 C6 22 79 32
0B40  C4 22 21 B0 22 CD 00 0D CD 00 0D CD 00 0D FD 7E
0B50  00 DD 77 00 FD 7E 01 DD 77 01 FD 7E 02 DD 77 02
0B60  3E C1 D3 F2 AF 32 09 21 C9 F5 3E F0 D3 FC F1 C9
0B70  DD E5 E1 11 20 21 01 08 00 ED B0 FD E5 E1 01 08
0B80  00 ED B0 21 20 21 CD 60 0C 79 32 30 22 23 CD 60
0B90  0C 78 32 2F 22 79 32 2D 22 23 CD 60 0C 3E 30 B9
0BA0  20 07 0E 20 B8 20 02 06 20 ED 43 2B 22 23 CD 60
0BB0  0C ED 43 52 22 23 CD 60 0C 3E 30 B8 20 0E 06 20
```

```
0BC0  3A 52 22 FE 30 20 05 3E 20 32 52 22 78 32 51 22
0BD0  23 11 86 22 CD 40 0C 23 23 23 CD 60 0C ED 43 5F
0BE0  22 23 CD 60 0C 78 FE 30 20 0E 06 20 3A 5F 22 FE
0BF0  30 20 05 3E 20 32 5F 22 78 32 5E 22 23 11 A9 22
0C00  CD 40 0C 21 25 21 11 2D 21 CD 80 0C F5 38 05 11
0C10  20 22 18 03 11 0F 22 21 0D 21 CD 40 0C F1 38 05
0C20  21 11 22 18 03 21 00 22 CD 00 0D 3E 0E 32 09 21
0C30  21 22 22 22 0A 21 C9 00 00 00 00 00 00 00 00 00
0C40  CD 60 0C 78 12 1B 79 12 1B 1B 23 CD 60 0C 78 12
0C50  1B 79 12 1B 1B 23 CD 60 0C 78 12 1B 79 12 23 C9
0C60  7E 4F E6 0F F6 30 47 79 0F 0F 0F 0F E6 0F F6 30
0C70  4F C9 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0C80  0E 00 E5 D5 23 13 23 13 1A BE 38 14 20 0E 2B 1B
0C90  1A BE 38 0C 20 06 2B 1B 1A BE 38 04 D1 E1 18 04
0CA0  0E FF E1 D1 1A 96 27 23 13 F5 30 22 F1 C6 60 27
0CB0  F5 1A D6 01 27 30 05 D6 40 27 37 00 12 30 0F 13
0CC0  1A D6 01 27 30 06 47 AF 90 27 00 00 12 1B 1A 96
0CD0  27 23 13 F5 30 12 F1 C6 60 27 F5 1A D6 01 27 30
0CE0  06 47 AF 90 27 00 00 12 1A 96 27 32 0F 21 00 00
0CF0  79 B7 28 01 37 C1 78 32 0E 21 C1 78 32 0D 21 C9
0D00  4E 23 CD 12 0D FE 0D 20 F7 0E 20 10 FE 0D 20 FB
0D10  C9 00 DB F9 E6 81 FE 81 20 F8 79 D3 F8 C9 00 00
0D20  FD 7E 01 0E 21 CD A0 0D FD 7E 02 0E 43 CD A0 0D
0D30  FD 7E 03 0E 65 CD A0 0D FD 7E 04 0E 07 CD A0 0D
0D40  FD 7E 05 0E 98 CD A0 0D FD 7E 06 0E BA CD A0 0D
0D50  FD 7E 07 0E DC CD A0 0D C9 00 00 00 00 00 00 00
0D60  DD 7E 01 0E 21 CD D0 0D DD 7E 02 0E 43 CD D0 0D
0D70  DD 7E 03 0E 65 CD D0 0D DD 7E 04 0E 07 CD D0 0D
0D80  DD 7E 05 0E 98 CD D0 0D DD 7E 06 0E BA CD D0 0D
0D90  DD 7E 07 0E DC CD D0 0D C9 00 00 00 00 00 00 00
0DA0  F5 3E F0 A1 28 12 47 F1 F5 CB 3F CB 3F CB 3F CB
0DB0  3F B0 D3 FD E6 0F D3 FD 3E 0F A1 CB 27 CB 27 CB
0DC0  27 CB 27 47 F1 E6 0F B0 D3 FD E6 0F D3 FD C9 00
0DD0  F5 3E F0 A1 28 12 47 F1 F5 CB 3F CB 3F CB 3F CB
0DE0  3F B0 D3 FC E6 0F D3 FC 3E 0F A1 CB 27 CB 27 CB
0DF0  27 CB 27 47 F1 E6 0F B0 D3 FC E6 0F D3 FC C9 00
0E00  A0 A0 D2 D5 CE A0 D7 C8 C9 C3 C8 A0 D0 D2 CF C6
0E10  C9 CC C5 BF FF A0 A0 C5 CE D4 C5 D2 A0 D3 D4 C1
0E20  D2 D4 C9 CE C7 A0 C5 CC C1 D0 D3 C5 C4 A0 D4 C9
0E30  CD C5 A0 A0 A0 A0 FF A0 A0 C5 CE D4 C5 D2 A0 D3
0E40  D4 C1 D2 D4 C9 CE C7 A0 CD C9 CC C5 A0 A0 A0 A0
0E50  FF AA D9 C4 C1 C5 D2 AA AA A0 C9 D3 A0 D4 C8 C5
0E60  A0 C3 D5 D2 D2 C5 CE D2 A0 D4 C1 C3 C8 A0 C6 C1
0E70  C3 D4 CF D2 A0 A0 A0 C5 CE D4 D2 A0 CE C5 D7 AD
0E80  A0 A0 A0 A0 FF FF FF FF FF FF FF FF FF FF FF FF
0E90  FD 2A 00 25 DD 21 10 21 3A 01 25 B7 C8 C3 00 0A
0EA0  3A 01 21 FE 53 CA 10 09 3E 53 32 01 21 21 D0 0E
0EB0  C9 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0EC0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0ED0  20 20 20 20 20 45 4E 53 43 4F 20 20 49 4E 43 2E
0EE0  0D 0D 20 53 50 45 45 44 20 50 52 4F 46 49 4C 45
0EF0  20 53 49 4D 55 4C 41 54 4F 52 0D 0D 0D FF FF FF
```

```
                                                 --  --  -
0F00   0F 42 45 48 49 4E 44 20 30 30 3A 30 30 3A 30 30
0F10   0D 0F 41 48 45 41 44 20 20 31 31 3A 31 31 3A 31
0F20   31 0D 0D 41 54 20 4D 49 4C 45 20 32 32 32 2E 32
0F30   32 0D 0D 50 4F 53 54 45 44 20 53 50 45 45 44 20
0F40   43 48 41 4E 47 45 44 0D 20 20 20 46 52 4F 4D 20
0F50   20 33 33 33 0D 20 20 54 4F 20 20 20 20 20 34 34
0F60   34 0D 0D 54 52 49 50 20 45 4C 41 50 53 45 44 20
0F70   54 49 4D 45 20 57 41 53 0D 20 20 20 20 20 20 36
0F80   36 3A 36 36 3A 36 36 0D 49 54 20 53 48 4F 55 4C
0F90   44 20 48 41 56 45 20 42 45 45 4E 0D 00 20 20 20
0FA0   20 20 37 37 3A 37 37 3A 37 37 0D 0D 0D 0D 0D 0D
0FB0   0F 4D 49 53 53 45 44 20 53 54 41 54 49 4F 4E 0D
0FC0   0F 42 59 20 30 2E 30 30 30 20 4D 49 4C 45 53 0D
0FD0   0D 0D 0D 0D 0D FF FF FF FF FF FF FF FF FF FF FF
0FE0   FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0FF0   FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

```
1000  00 00 00 15 00 00 00 00 70 03 00 30 00 36 01 00
1010  10 05 00 60 00 55 01 00 20 30 00 80 00 31 04 00
1020  50 36 00 00 01 03 05 00 80 89 00 55 00 27 08 00
1030  99 98 00 20 00 31 09 00 99 99 00 00 00 49 09 00
1040  00 00 01 40 00 04 11 00 30 02 01 60 00 46 11 00
1050  40 05 01 90 00 08 12 00 70 19 01 20 01 12 13 00
1060  90 52 01 70 00 11 15 00 10 61 01 20 01 53 15 00
1070  00 41 02 10 01 19 20 00 90 48 02 90 00 46 20 00
1080  90 59 02 95 00 30 21 00 30 76 02 75 00 34 22 00
1090  00 81 02 90 00 57 22 00 00 87 02 10 01 23 23 00
10A0  10 91 02 20 01 39 23 00 70 76 05 45 00 19 38 00
10B0  30 80 05 00 00 00 39 00 30 80 05 45 00 15 40 00
10C0  10 83 05 95 00 58 40 00 60 85 05 05 01 15 41 00
10D0  10 05 06 20 01 37 42 00 40 10 07 00 01 02 48 00
10E0  20 18 07 20 01 30 48 00 00 51 07 90 00 18 50 00
10F0  60 63 07 10 01 08 51 00 10 84 07 20 01 20 52 00
1100  90 01 08 15 01 17 53 00 00 19 08 60 00 19 54 00
1110  90 23 08 55 00 49 54 00 90 30 08 85 00 35 55 00
1120  20 45 08 70 00 44 56 00 20 83 08 45 00 01 00 01
1130  10 86 08 35 00 25 00 01 30 94 08 60 00 50 01 01
1140  30 01 09 40 00 39 02 01 70 05 09 00 00 29 03 01
1150  70 05 09 40 00 44 04 01 60 11 09 50 00 56 05 01
1160  20 25 09 80 00 35 07 01 70 26 09 20 01 44 07 01
1170  20 48 09 70 00 19 09 01 60 68 09 90 00 04 11 01
1180  60 74 09 20 01 32 11 01 20 88 09 10 01 24 12 01
1190  40 12 10 00 01 45 13 01 50 35 10 15 01 08 15 01
11A0  00 46 10 20 01 44 15 01 80 73 10 10 01 10 17 01
11B0  70 22 11 90 00 51 19 01 20 33 11 95 00 33 20 01
11C0  30 55 11 45 00 05 22 01 40 58 11 40 00 30 22 01
11D0  50 62 11 00 00 14 23 01 50 62 11 35 00 29 24 01
11E0  50 65 11 45 00 16 25 01 70 70 11 05 01 59 25 01
11F0  50 99 11 20 01 00 28 01 40 19 12 05 01 05 29 01
1200  10 26 12 20 01 28 29 01 60 58 13 15 01 14 36 01
1210  80 66 13 20 01 39 36 01 90 77 13 10 01 14 37 01
1220  70 89 13 90 00 54 37 01 40 99 13 20 01 33 38 01
1230  20 23 14 05 01 55 39 01 10 30 14 15 01 18 40 01
1240  60 34 14 20 01 34 40 01 00 57 14 95 00 47 41 01
1250  30 63 14 10 01 11 42 01 10 71 14 20 01 39 42 01
1260  60 94 14 90 00 56 43 01 20 05 15 20 01 38 44 01
1270  40 35 15 10 01 22 46 01 30 45 15 20 01 54 46 01
1280  10 10 16 05 01 12 50 01 30 12 16 20 01 19 50 01
1290  20 68 16 00 01 14 53 01 80 75 16 20 01 42 53 01
12A0  10 47 17 10 01 24 57 01 60 73 17 20 01 51 58 01
12B0  20 91 17 15 01 46 59 01 50 08 18 75 00 46 00 02
12C0  70 09 18 60 00 53 00 02 80 15 18 65 00 30 01 02
12D0  30 28 18 50 00 40 02 02 20 42 18 30 00 24 04 02
12E0  00 47 18 00 00 29 05 02 00 47 18 30 00 44 06 02
12F0  00 65 18 40 00 34 10 02 90 71 18 45 00 38 11 02
1300  70 76 18 80 00 16 12 02 50 93 18 00 01 40 13 02
1310  80 11 19 10 01 51 14 02 10 23 19 95 00 30 15 02
1320  70 27 19 10 01 47 15 02 40 42 19 05 01 39 16 02
1330  70 49 19 00 01 04 17 02 30 53 19 90 00 17 17 02
1340  90 59 19 20 01 44 17 02 50 41 21 10 01 11 27 02
1350  80 55 21 05 01 58 27 02 70 60 21 10 01 14 28 02
1360  80 74 21 00 01 01 29 02 20 81 21 20 01 24 29 02
1370  80 22 22 00 01 36 31 02 70 37 22 45 00 42 32 02
1380  20 43 22 30 00 27 33 02 20 44 22 15 00 42 33 02
1390  90 48 22 00 00 39 35 02 00 00 00 00 00 00 00 00
13A0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
13B0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

```
13C0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
13D0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
13E0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
13F0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
1400  00 00 00 15 00 00 00 00 70 03 00 30 00 36 01 00
1410  10 05 00 60 00 55 01 00 20 30 00 65 00 31 04 00
1420  00 31 00 80 00 36 04 00 50 36 00 00 01 03 05 00
1430  80 89 00 55 00 27 08 00 30 97 00 50 00 17 09 00
1440  10 99 00 40 00 30 09 00 10 02 01 60 00 57 09 00
1450  20 05 01 90 00 19 10 00 50 19 01 20 01 23 11 00
1460  70 52 01 70 00 22 13 00 90 60 01 20 01 04 14 00
1470  80 40 02 10 01 30 18 00 70 48 02 90 00 58 18 00
1480  70 59 02 95 00 42 19 00 10 76 02 75 00 46 20 00
1490  80 80 02 90 00 08 21 00 80 86 02 10 01 34 21 00
14A0  90 90 02 20 01 50 21 00 10 79 05 95 00 25 36 00
14B0  30 85 05 05 01 49 36 00 80 04 06 20 01 58 37 00
14C0  10 10 07 00 01 21 43 00 90 17 07 20 01 49 43 00
14D0  70 50 07 90 00 37 45 00 10 63 07 10 01 27 46 00
14E0  80 83 07 20 01 40 47 00 60 01 08 15 01 36 48 00
14F0  70 18 08 60 00 39 49 00 60 23 08 55 00 08 50 00
1500  60 30 08 85 00 54 50 00 90 44 08 70 00 03 52 00
1510  90 82 08 45 00 21 55 00 80 85 08 35 00 45 55 00
1520  00 94 08 60 00 09 57 00 00 01 09 40 00 58 57 00
1530  40 05 09 00 00 48 59 00 40 05 09 40 00 03 00 01
1540  30 11 09 50 00 15 01 01 90 24 09 80 00 54 02 01
1550  40 26 09 20 01 03 03 01 90 47 09 70 00 38 04 01
1560  00 71 09 90 00 36 06 01 30 74 09 20 01 51 06 01
1570  90 87 09 10 01 43 07 01 20 35 10 15 01 27 10 01
1580  70 45 10 20 01 03 11 01 50 73 10 10 01 29 12 01
1590  40 22 11 90 00 10 15 01 90 32 11 95 00 52 15 01
15A0  00 55 11 45 00 24 17 01 10 58 11 40 00 49 17 01
15B0  00 63 11 35 00 33 18 01 00 66 11 45 00 20 19 01
15C0  20 71 11 05 01 03 20 01 00 00 12 20 01 04 22 01
15D0  90 19 12 05 01 09 23 01 60 26 12 20 01 32 23 01
15E0  10 59 13 15 01 18 30 01 30 67 13 20 01 43 30 01
15F0  20 90 13 90 00 58 31 01 90 99 13 20 01 37 32 01
1600  70 23 14 05 01 59 33 01 60 30 14 15 01 22 34 01
1610  10 35 14 20 01 38 34 01 50 57 14 95 00 51 35 01
1620  80 63 14 10 01 15 36 01 60 71 14 20 01 43 36 01
1630  10 95 14 90 00 00 38 01 70 05 15 20 01 42 38 01
1640  90 35 15 10 01 26 40 01 80 45 15 20 01 58 40 01
1650  60 10 16 05 01 16 44 01 80 12 16 20 01 23 44 01
1660  70 68 16 00 01 18 47 01 30 76 16 20 01 46 47 01
1670  60 47 17 10 01 28 51 01 10 74 17 20 01 55 52 01
1680  70 91 17 15 01 50 53 70 00 09 18 75 00 50 54 01
1690  20 10 18 60 00 57 54 01 30 16 18 65 00 34 55 01
16A0  80 28 18 50 00 44 56 01 70 42 18 30 00 28 58 01
16B0  50 47 18 00 00 33 59 01 50 47 18 30 00 48 00 02
16C0  50 65 18 40 00 38 04 02 40 72 18 45 00 42 05 02
16D0  20 77 18 80 00 20 06 02 00 94 18 00 01 44 07 02
16E0  30 12 19 10 01 55 08 02 60 23 19 95 00 34 09 02
16F0  20 28 19 10 01 51 09 02 90 42 19 05 01 43 10 02
1700  20 50 19 00 01 08 11 02 80 53 19 90 00 21 11 02
1710  40 60 19 20 01 48 11 02 00 42 21 10 01 15 21 02
1720  30 56 21 05 01 02 22 02 20 61 21 10 01 18 22 02
1730  30 75 21 00 01 05 23 02 70 81 21 20 01 28 23 02
1740  30 23 22 00 01 40 25 02 20 38 22 45 00 46 26 02
1750  70 43 22 30 00 31 27 02 70 44 22 15 00 46 27 02
1760  40 49 22 00 00 43 29 02 00 00 00 00 00 00 00 00
```

```
1770  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
1780  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
1790  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
17A0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
17B0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
17C0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
17D0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
17E0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
17F0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF

0800  00 00 00 10 00 00 00 00 00 05 00 35 00 05 03 00
0810  80 17 00 90 00 24 05 00 70 13 01 50 00 46 11 00
0820  20 16 01 00 00 18 12 00 20 16 01 50 00 33 13 00
0830  20 18 01 95 00 10 04 00 70 60 01 05 01 10 17 00
0840  60 40 02 20 01 46 21 00 90 44 03 90 00 05 27 00
0850  90 53 03 10 01 41 27 00 60 84 03 55 00 37 29 00
0860  10 00 04 50 00 18 31 00 70 03 04 70 00 44 31 00
0870  30 22 04 65 00 22 33 00 00 27 04 55 00 49 33 00
0880  20 36 04 20 00 57 34 00 20 37 04 00 00 11 35 00
0890  20 37 04 20 00 26 36 00 40 42 04 55 00 06 38 00
08A0  80 69 04 50 00 13 41 00 10 74 04 85 00 44 41 00
08B0  70 85 04 95 00 41 42 00 10 90 04 20 01 59 42 00
08C0  90 45 05 90 00 02 46 00 30 75 05 95 00 00 48 00
08D0  80 85 05 20 01 40 48 00 00 85 06 10 01 54 53 00
08E0  90 93 06 20 01 23 54 00 60 46 07 80 00 08 57 00
08F0  10 64 07 75 00 27 58 00 20 72 07 85 00 06 59 00
0900  00 11 08 80 00 51 01 01 50 35 06 70 00 42 03 01
0910  00 40 08 80 00 05 04 01 10 68 08 75 00 13 06 01
0920  00 06 09 85 00 14 09 01 20 23 09 55 00 31 10 01
0930  50 31 09 65 00 26 11 01 00 50 09 60 00 09 13 01
0940  60 63 09 55 00 31 14 01 30 70 09 70 00 14 15 01
0950  90 91 09 60 00 08 17 01 20 98 09 75 00 45 17 01
0960  70 01 10 80 00 02 18 01 40 23 10 60 00 44 19 01
0970  70 42 10 50 00 40 21 01 80 51 10 40 00 47 22 01
0980  60 58 10 30 00 49 23 01 20 60 10 00 00 16 24 01
0990  20 60 10 30 00 31 25 01 20 64 10 45 00 32 26 01
09A0  70 84 10 60 00 19 29 01 30 20 11 75 00 54 32 01
09B0  20 33 11 80 00 58 33 01 20 50 11 75 00 15 35 01
09C0  90 60 11 60 00 07 36 01 60 69 11 75 00 59 36 01
09D0  70 94 11 90 00 02 39 01 40 15 12 75 00 28 40 01
09E0  80 23 12 50 00 10 41 01 60 28 12 85 00 45 41 01
09F0  30 50 12 80 00 24 43 01 10 67 12 70 00 40 44 01
0A00  90 70 12 75 00 00 45 01 00 94 12 85 00 51 46 01
0A10  90 23 13 80 00 59 48 01 00 41 13 70 00 16 50 01
0A20  50 47 13 80 00 49 50 01 40 61 13 00 01 53 51 01
0A30  30 78 13 15 01 58 52 01 10 06 14 90 00 30 54 01
0A40  40 14 14 70 00 05 55 01 40 19 14 75 00 31 55 01
0A50  00 35 14 90 00 46 56 01 00 66 14 80 00 53 58 01
0A60  90 71 14 50 00 24 59 01 50 80 14 60 00 26 00 02
0A70  60 53 15 45 00 47 07 02 30 67 15 00 00 49 09 02
0A80  30 67 15 50 00 04 11 02 50 70 15 70 00 49 11 02
0A90  40 90 15 60 00 35 13 02 20 95 15 80 00 04 14 02
0AA0  90 52 16 70 28 18 02 80 80 59 16 75 00 03 19 02
0AB0  80 24 17 45 00 19 24 02 50 37 17 30 00 02 26 02
0AC0  10 44 17 70 00 21 27 02 00 65 17 75 00 20 29 02
0AD0  90 92 17 70 00 34 31 02 50 98 17 80 00 03 32 02
0AE0  30 72 18 75 00 36 37 02 40 75 18 45 00 55 37 02
0AF0  90 79 18 75 00 31 38 02 10 45 19 60 00 51 43 02
```

```
0E00  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0E10  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0E20  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0E30  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0E40  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0E50  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0E60  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0E70  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0E80  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0E90  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0EA0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0EB0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0EC0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0ED0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0EE0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0EF0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F00  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F10  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F20  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F30  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F40  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F50  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F60  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F70  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F80  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0F90  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0FA0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0FB0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0FC0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0FD0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0FE0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

```
0B00  10 49 19 45 00 16 44 02 00 54 19 30 00 57 44 02
0B10  80 59 19 00 00 14 46 02 80 59 19 30 00 29 47 02
0B20  00 63 19 60 00 23 48 02 50 66 19 75 00 51 48 02
0B30  50 87 19 70 00 33 50 02 60 28 20 40 00 09 54 02
0B40  30 34 20 65 00 00 55 02 70 52 20 70 00 46 56 02
0B50  40 68 20 75 00 07 58 02 10 74 20 80 00 35 58 02
0B60  30 15 21 30 00 51 01 03 90 25 21 20 00 59 03 03
0B70  10 31 21 70 00 32 05 03 10 39 21 95 00 32 06 03
0B80  80 58 21 55 00 00 08 03 00 62 21 50 00 21 08 03
0B90  80 65 21 65 00 49 08 03 00 80 21 60 00 09 10 03
0BA0  20 86 21 70 00 46 10 03 10 03 22 55 00 15 12 03
0BB0  60 07 22 60 00 44 12 03 00 14 22 65 00 23 13 03
0BC0  50 16 22 70 00 37 13 03 50 29 22 45 00 46 14 03
0BD0  60 32 22 50 00 11 15 03 20 47 22 55 00 56 16 03
0BE0  50 62 22 50 00 36 18 03 60 67 22 45 00 13 19 03
0BF0  80 74 22 50 00 11 20 03 50 77 22 45 00 31 20 03
0C00  30 92 22 50 00 29 22 03 30 14 23 15 00 15 25 03
0C10  30 17 23 00 00 30 26 03 00 00 00 00 00 00 00 00
0C20  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0C30  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0C40  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0C50  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0C60  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0C70  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0C80  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0C90  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0CA0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0CB0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0CC0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0CD0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0CE0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0CF0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D00  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D10  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D20  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D30  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D40  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D50  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D60  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D70  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D80  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0D90  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0DA0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0DB0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0DC0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0DD0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0DE0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0DF0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

```
00100 ; PROGRAM NEC00C
00110 ;
00120 ;     PROGRAM NEC IS THE CONTROL PROGRAM FOR THE ENSCO
00130 ; INC. N.E.C. PROFILE SIMULATOR.  THE SIMULATOR PROVIIDES
00140 ; SPEED CHANGE INFORMATION TO A LOCOMOTIVE ENGINEER
00150 ; ALLOWING HIM TO SIMULATE A TRAIN MOVE ALONG A TRACK
00160 ; OTHER THAN THE ONE HE IS ACTUALLY ON.
00170 ;
00180 ;     THE SIMULATOR REQUIRES ONLY A TACHOMETER SIGNAL
00190 ; FROM ONE OF THE LOCOMOTIVE WHEELS.  TACH COUNTS PER
00200 ; WHEEL REVOLUTION AND WHEEL SIZE ARE PROVIDED IN THE
00210 ; PROGRAM AND MAY BE CHANGED FROM THE CONTROL PANEL IF
00220 ; REQUIRED.
00230 ;
00240 ;     THE SIMULATOR PROVIDES THE FOLLOWING OUTPUTS:
00250 ;       1. THE CURRENT POSTED SPEED, CURRENT TRIP
00260 ;          MILEAGE, AND TRIP ELAPSED TIME.
00270 ;       2. THE NEXT POSTED SPEED, THE MILEAGE AT WHICH
00280 ;          THAT SPEED BECOMES THE POSTED SPEED, AND
00290 ;          THE TIMETABLE TIME OF THE SPEED CHANGE.
00300 ;       3. DURING SIMULATED STATION STOPS AN AUDIO
00310 ;          BUZZER WILL SOUND TWICE AT 30 SECONDS
00320 ;          BEFORE THE END OF THE STOP PEROID AND ONCE
00330 ;          AT THE END OF THE STOP PEROID.
00340 ;       4. A PRINTED RECORD OF THE TRIP PROFILE AS RUN
00350 ;          INCLUDING THE ELAPSED TIME AT EACH SPEED
00360 ;          CHANGE, THE AVERAGE SPEED DURING THE LAST
00370 ;          SPEED BLOCK, AND OTHER INFORMATION.
00380 ;       5. A DISPLAY OF THE DISTANCE TO THE NEXT SPEED
00390 ;          CHANGE.
00400 ;
00410 ;    THE PROFILES ARE STORED IN AN EPROM AND CAN BE
00420 ; STARTED AT ANY POINT AS REQUIRED.
00430 ;
00440 ;
00450 ;     SUBPROGRAMS MAKING UP PROGRAM NEC ARE:
00460 ;       NEC00C DESCRIPTION OF PROGRAM NEC
00470 ;       NEC10C--RESTART AND INTERRUPT VECTORS
00480 ;               ADDR 0000-0040
00490 ;       NEC20C--INITIALIZATION PROGRAM
00500 ;               ADDR 0100-0
00510 ;       NEC30C--COMMAND PROGRAM
00520 ;       NEC40C--PROFILE RUN PROGRAM
00530 ;       NEC50C THRU NEC89C---MISC. SUBROUTINES
00540 ;       NEC51C--CURRENT STATUS DISPLAY DRIVER
00550 ;       NEC53C--UPDATE CURRENT STATUS DISPLAY
00560 ;       NEC54C--UPDATE NEXT STATUS DISPLAY
00570 ;       NEC55C--PRINTER DRIVER
00580 ;       NEC56C--COMPUTE TIME DIFFERENCE
00590 ;       NEC57C--CONVERT BCD TO ASCII
00600 ;       NEC58C--CONVERT TIME AND PLACE IN PRINT BUFFER
00610 ;       NEC52C--NEXT STATUS DISPLAY DRIVER
00620 ;       NEC90C THRU NEC99C---INTERRUPT ROUTINES
00630 ;       NEC91C--ELAPSED TIME INTERRUPT ROUTINE
00640 ;
00650 ; EXTERNAL VECTORS AND CONSTANTS
```

```
                00660 CR        EQU     0DH             ;CARRIAGE RETURN
                00670 ;
                00680 ; MEMORY MAP
2000            00690           ORG     2000H
2000 5353       00700           DEFW    5353H           ;SYSTEM RUNNING CONSTANT
2002 0000       00710 TACHCT    DEFW    0000H           ;TACHOMETER CONSTANT
2004 00         00720 PROFIL    DEFB    00H             ;PROFILE IDENTIFIER
2005 0000       00730 STIME     DEFW    0000H           ;STARTING ELAPSED TIME
2007 0000       00740 SMILE     DEFW    0000H           ;STARTING MILES
2009 00         00750 LINCNT    DEFB    00H             ;OUTPUT LINE COUNTER
200A 0000       00760 LINPNT    DEFW    0000H           ;OUTPUT LINE POINTER
0001            00770           DEFS    1H              ;NOT USED
200D 00         00780 DTIMES    DEFB    00H             ;TIME DIFFERENCE (SEC)
200E 00         00790 DTIMEM    DEFB    00H             ;TIME DIFFERENCE (MIN)
200F 00         00800 DTIMEH    DEFB    00H             ;TIME DIFFERENCE (HR)
2010 00         00810 CODO01    DEFB    00H             ;CURRENT ODOMETER 0.001 MILE
S
2011 00         00820 CODOL     DEFB    00H             ;CURRENT ODOMETER 0.1 MILES
2012 00         00830 CODOH     DEFB    00H             ;CURRENT ODOMETER 10 MILES
2013 0000       00840 CSPD      DEFW    0000H           ;CURRENT POSTED SPEED
2015 00         00850 CSEC      DEFB    00H             ;ELAPSED TIME (SEC)
2016 00         00860 CMIN      DEFB    00H             ;       (MIN)
2017 00         00870 CHR       DEFB    00H             ;       (HRS)
0008            00880           DEFS    8H              ;NOT USED
0003            00890 CBODO     DEFS    3H              ;CHANGE BUFFER CURRENT ODO
0002            00900 CBSPD     DEFS    2H              ;       CURRENT SPEED
0003            00910 CBTIME    DEFS    3H              ;       CURRENT TIME
0003            00920 NBODO     DEFS    3H              ;       NEXT ODO
0002            00930 NBSPD     DEFS    2H              ;       NEXT SPEED
0003            00940 NBTIME    DEFS    3H              ;       NEXT TIME
2100            00950           ORG     2100H
2100 0F         00960 PBHND     DEFB    0FH             ;PRINT BUFFER (LARGE LETTERS
)
2101 42         00970           DEFM    'BEHIND '       ;LINE1
     45 48 49 4E 44 20
2108 0000       00980           DEFW    00H             ;HRS
210A 3A         00990           DEFM    ':'
210B 0000       01000           DEFW    0000H           ;MIN
210D 3A         01010           DEFM    ':'
210E 00         01020           DEFB    00H
210F 00         01030 PBTIME    DEFB    00H             ;SEC
2110 0D         01040           DEFB    CR
2111 0F         01050 PAHEAD    DEFB    0FH             ;LARGE LETTERS
2112 41         01060           DEFM    'AHEAD
     48 45 41 44 20 20
2119 0000       01070           DEFW    0000H           ;HRS
211B 3A         01080           DEFM    ':'
211C 0000       01090           DEFW    0000H           ;MIN
211E 3A         01100           DEFM    ':'
211F 00         01110           DEFB    00H
2120 00         01120 PATIME    DEFB    00H             ;SEC
2121 0D         01130           DEFB    CR
2122 0D         01140 LINE2     DEFB    CR
2123 41         01150 LINE3     DEFM    'AT MILE '
```

```
     54 20 4D 49 4C 45 20
0003           01160           DEFS    3H              ;MILES
212E 2E        01170           DEFM    '.'
212F 00        01180           DEFB    00H             ;TENTHS
2130 00        01190 PMILE     DEFB    00H             ;HUNDREDTHS
2131 0D        01200           DEFB    CR
2132 0D        01210 LINE4     DEFB    CR
2133 50        01220 LINE5     DEFM    'POSTED SPEED CHANGED'
     4F 53 54 45 44 20 53 50
     45 45 44 20 43 48 41 4E
     47 45 44
2147 0D        01230           DEFB    CR
2148 20        01240 LINE6     DEFM    '   FROM  '
     20 20 46 52 4F 4D 20 20
2151 0000      01250           DEFW    0000H           ;HUNDREDS AND TENS
2153 00        01260 PCSPD     DEFB    00H             ;CURRENT SPEED
2154 0D        01270           DEFB    CR
2155 20        01280 LINE7     DEFM    '   TO    '
     20 20 54 4F 20 20 20 20
215E 0000      01290           DEFW    0000H
2160 00        01300 PNSPD     DEFB    00H             ;NEXT SPEED
2161 0D        01310           DEFB    CR
2162 0D        01320 LINE8     DEFB    CR
2163 54        01330 LINE9     DEFM    'TRIP ELAPSED TIME WAS'
     52 49 50 20 45 4C 41 50
     53 45 44 20 54 49 4D 45
     20 57 41 53
2178 0D        01340           DEFB    CR
2179 20        01350 LINE10    DEFM    '
     20 20 20 20 20
217F 0000      01360           DEFW    0000H           ;HRS
2181 3A        01370           DEFM    ':'
2182 0000      01380           DEFW    0000H           ;MIN
2184 3A        01390           DEFM    ':'
2185 00        01400           DEFB    00H
2186 00        01410 PCTIME    DEFB    00H             ;SEC
2187 0D        01420           DEFB    CR
2188 49        01430 LINE11    DEFM    'IT SHOULD HAVE BEEN'
     54 20 53 48 4F 55 4C 44
     20 48 41 56 45 20 42 45
     45 4E
219B 0D        01440           DEFB    CR
219C 20        01450 LINE12    DEFM    '       '
     20 20 20 20 20
21A2 0000      01460           DEFW    0000H           ;HRS
21A4 3A        01470           DEFM    ':'
21A5 0000      01480           DEFW    0000H           ;MIN
21A7 3A        01490           DEFM    ':'
21A8 00        01500           DEFB    00H
```

```
21A9 00         01510 PNTIME  DEFB    00H             ;SEC
21AA 0D         01520         DEFB    CR
21AB 0D         01530 LINE13  DEFB    CR
21AC 0D         01540 LINE14  DEFB    CR
21AD 0D         01550 LINE15  DEFB    CR
                01560 ;
                01570 ;
0000            01580         END
00000 TOTAL ERRORS
```

```
                00100 ;
                00110 ; PROGRAM  NEC10C
                00120 ;
                00130 ; VERSION 1.0   12/11/79    CONNER
                00140 ;
                00150 ; RESTART AND INTERRUPT VECTORS
                00160 ;
                00170 ;     THIS PROGRAM PROVIDES RESTART AND INTERRUPT VECTOR
                00180 ; ADDRESSES FOR THE NEC PROFILE SIMULATOR.  ALL UNUSED
                00190 ; RESTARTS ARE VECTORED TO LOCATION 0000H.
                00200 ;
                00210 ;
                00220 ; EXTERNAL VECTORS
                00230 ;
0880            00240 NEC20C  EQU     0880H           ;START OF INITIALIZATION
0810            00250 NEC91C  EQU     0810H           ;START OF ELAPSED TIME
                00260                                 ;INTERRUPT SERVICE ROUTINE
0840            00270 NEC92C  EQU     0840H           ;START OF ODOMETER
                00280                                 ;INTERRUPT SERVICE ROUTINE
                00290 ;
0800            00300         ORG     0800H
0800 F3         00310 NEC10C  DI                      ;DISABLE INTERRUPTS ON RESTA
RT
0801 310030     00320         LD      SP,3000H        ;SET STACK AT TOP OF MEM
0804 C38008     00330         JP      NEC20C          ;GO TO INITIALIZATION PGM
                00340 ;
                00350 ;
                00360 ;  THE FOLLOWING MUST BE INSERTED IN TO THE MP-3 PROM
                00370 ;
0018            00380         ORG     0018H
0018 0008       00390 RST18   DEFW    NEC10C          ;CTC1 CH0 VECTOR TO 0800H
001A 1008       00400         DEFW    NEC91C          ;CTC1 CH1 VECTOR TO NEC91C
001C 4008       00410         DEFW    NEC92C          ;CTC1 CH2 VECTOR TO NEC91C
001E 0008       00420         DEFW    NEC10C          ;CTC1 CH3 VECTOR TO 0800H
                00430 ;
                00440 ;
0800            00450         END     NEC10C
00000 TOTAL ERRORS
```

CBODO	2020	CBSPD	2023	CBTIME	2025	CHR	2017	CMIN	2016
CODO01	2010	CODOH	2012	CODOL	2011	CR	000D	CSEC	2015
CSPD	2013	DTIMEH	200F	DTIMEM	200E	DTIMES	200D	LINCNT	2009
LINE10	2179	LINE11	2188	LINE12	219C	LINE13	21AB	LINE14	21AC
LINE15	21AD	LINE2	2122	LINE3	2123	LINE4	2132	LINE5	2133
LINE6	2148	LINE7	2155	LINE8	2162	LINE9	2163	LINPNT	200A
NBODO	2028	NBSPD	202B	NBTIME	202D	PAHEAD	2111	PATIME	2120
PBHND	2100	PBTIME	210F	PCSPD	2153	PCTIME	2186	PMILE	2130
PNSPD	2160	PNTIME	21A9	PROFIL	2004	SMILE	2007	STIME	2005
TACHCT	2002								

```
NEC10C  0800     NEC20C  0880     NEC91C  0810     NEC92C  0840     RST18   0018
```

```
                00100 ;
                00110 ;  PROGRAM  NEC20C
                00120 ;
                00130 ;  VERSION 1.0    12/7/79    CONNER
                00140 ;
                00150 ;
                00160 ; INITIALIZATION PROGRAM
                00170 ;
                00180 ;     THIS PROGRAM TURNS OFF ALL DISPLAYS, CHEKS POWER
                00190 ; ON RESTART (FIRST TWO MEMORY LOCATIONS DO NOT CONTAIN
                00200 ; 53H), INITILIZES THE CTC'S AND USART, AND THEN OUTPUTS
                00210 ; A LIST OF COMMANDS ON THE PRINTER AS A TEST.
                00220 ;
                00230 ;
                00240 ;  CONSTANTS AND EXTERNAL VECTORS
0900            00250 NEC30C  EQU     0900H           ;START OF CMD PROGRAM
0D00            00260 NEC55C  EQU     0D00H           ;START OF LINE PRINTER
0D0A            00270 NEC55A  EQU     0D0AH           ;START OF CHARACTER PRINT
00FC            00280 CDSPLY  EQU     0FCH            ;PORT ADDR CURRENT STATUS
00FD            00290 NDSPLY  EQU     0FDH            ;PORT ADDR NEXT STATUS
00FE            00300 MDSPLY  EQU     0FEH            ;PORT ADDR MILES TO GO
0018            00310 CTC1V   EQU     18H             ;CTC#1 INTERRUPT VECTOR
00F0            00320 CTC10   EQU     0F0H            ;PORT ADDR CTC1 CH0
0047            00330 CTC10C  EQU     47H             ;CTC#1 CH 0 CONTROL WORD
                00340                                 ;INT DISAVLED, CNTR MODE
                00350                                 ;NEG EDGE, TC NEXT, START
0000            00360 CTC10T  EQU     00H             ;TC=256  USART F=610 HZ
00F1            00370 CTC11   EQU     0F1H            ;PORT ADDR CTC1 CH1
0047            00380 CTC11C  EQU     47H             ;CH 1 CONTRLO WORD
                00390                                 ;SAME AS CH 0
003C            00400 CTC11T  EQU     3CH             ;TC=60 FOR 1 SEC
00F2            00410 CTC12   EQU     0F2H            ;PORT ADDR CTC1 CH2
0047            00420 CTC12C  EQU     47H             ;CH 2 CONTROL WORD
                00430                                 ;SAME AS CH 0
00F3            00440 CTC13   EQU     0F3H            ;PORT ADDT CTC1 CH3
0047            00450 CTC13C  EQU     47H             ;CH 3 CONTROL WORD
                00460                                 ;SAME AS CH 0
0020            00470 CTC2V   EQU     20H             ;CTC#2 INTERRUPT VECTOR
00F4            00480 CTC20   EQU     00F4H           ;PORT ADDR CTC2 CH0
00F5            00490 CTC21   EQU     00F5H           ;PORT ADDR CTC2 CH1
00F6            00500 CTC22   EQU     00F6H           ;PORT ADDR CTC2 CH2
00F7            00510 CTC23   EQU     00F7H           ;PORT ADDR CTC2 CH3
2102            00520 TACH    EQU     2102H           ;ADDR OF TACH CONSTANTS
0010            00530 TC1     EQU     10H             ;TACH CONSTANT 1
0001            00540 TC2     EQU     01H             ;TACH CONSTANT 2
00F8            00550 USARTD  EQU     00F8H           ;PORT ADDR USART DATA
00F9            00560 USARTC  EQU     00F9H           ;PORT ADDR USART CTRL
00E9            00570 USARTM  EQU     0E9H            ;USART MODE CONTROL WORD
                00580                                 ;D7=1,D6=1 --2 STOP BITS
                00590                                 ;D5=1,D4=0 --EVEN PARITY
                00600                                 ;            DISABLED
                00610                                 ;D3=1,D2=0 --7 DATA BITS
                00620                                 ;D1=0,D0=1 --X1 CLOCK
0011            00630 USRTER  EQU     11H             ;RESET ERRORS (BIT D4)
                00640                                 ;ENABLE TRANSMIT (BIT D0)
000D            00650 DSPLOF  EQU     0DH             ;DISPLAY BLANKING CHAR
```

```
0F00            00660 PTRDTA  EQU     0F00H           ;ADDRESS OF PRINTER OUTPUT
2200            00670 PBEHND  EQU     2200H           ;ADDRESS OF PRINT BUFFER
000D            00680 CR      EQU     0DH             ;CARRIAGE RETURN CHARACTER
                00690 ;
                00700 ;
                00710 ;
0880            00720         ORG     0880H
0880 3E0D       00730 NEC20C  LD      A,DSPLOF        ;BLANK ALL DISPLAYS
0882 D3FC       00750 NXTOFF  OUT     (CDSPLY),A
0884 D3FD       00760         OUT     (NDSPLY),A
0886 C610       00770         ADD     A,10H           ;ADDR OF NEXT DISPLAY
0888 FE0D       00780         CP      0DH             ; FINISHED?
088A 20F6       00790         JR      NZ,NXTOFF
088C AF         00800         XOR     A               ;CLEAR MILES-TO-GO DISPLAY
088D D3FE       00810         OUT     (MDSPLY),A
088F D3FC       00815         OUT     (CDSPLY),A      ;TURN OFF BEEPER
                00820 ;
                00830 ;
                00840 ; ROUTINE TO CHECK FOR COMPLETE RESTART
                00850 ;
0891 210021     00860 CHKRAM  LD      HL,2100H        ;START OF RAM
0894 3E53       00870         LD      A,53H           ;TEST VALUE NOT IN MEMORY
                00880                                 ;IF POWER JUST TURNED ON
0896 BE         00890         CP      (HL)            ;IS IT IN FIRST LOC?
0897 2006       00900         JR      NZ,ZMEM         ;NO, THEN ZERO AND SET UP
0899 23         00910         INC     HL              ;CHECK NEXT LOC
089A BE         00920         CP      (HL)
089B 2002       00930         JR      NZ,ZMEM
089D 1820       00940         JR      SETCTC          ;MEM OK, SET UP CTC'S
                00950 ;
                00960 ;
                00970 ; THIS ROUTINE ZEROS ALL MEMORY, IT IS USED ONLY AT
                00980 ; POWER ON.
                00990 ;
089F 3E00       01000 ZMEM    LD      A,00H
08A1 210021     01010         LD      HL,2100H        ;HL POINTER TO SOURCE
08A4 77         01020         LD      (HL),A          ;CLEAR FIRST LOC
08A5 110120     01030         LD      DE,2001H        ;DE POINTER TO DEST.
08A8 010010     01040         LD      BC,1000H        ;BC NUMBER OF BYTES
08AB EDB0       01050         LDIR                    ;BLOCK CLEAR
08AD 3E53       01060         LD      A,53H           ;TEST BYTE
08AF 210021     01070         LD      HL,2100H        ;START OF RAM
08B2 77         01080         LD      (HL),A
08B3 23         01090         INC     HL
08B4 77         01100         LD      (HL),A
                01110 ;
                01120 ; PUT WHEEL SIZE AND PPR INFO HERE
08B5 3E10       01130         LD      A,TC1           ;SET TACH CONSTANTS
08B7 320221     01140         LD      (TACH),A
08BA 3E01       01150         LD      A,TC2
08BC 320321     01160         LD      (TACH+1),A
                01170 ;
                01180 ;
08BF ED5E       01190 SETCTC  IM      2               ;SET INTERRUPT MODE
08C1 3E18       01200         LD      A,CTC1V         ;LOAD INTERRUPT VECTORS
08C3 D3F0       01210         OUT     (CTC10),A
```

```
08C5 3E20      01220          LD      A,CTC2V
08C7 D3F4      01230          OUT     (CTC20),A
08C9 3E47      01240          LD      A,CTC10C        ;LOAD CH CTRL WORDS & TC'S
08CB D3F0      01250          OUT     (CTC10),A
08CD 3E00      01260          LD      A,CTC10T
08CF D3F0      01270          OUT     (CTC10),A
08D1 3E47      01280          LD      A,CTC11C
08D3 D3F1      01290          OUT     (CTC11),A
08D5 3E3C      01300          LD      A,CTC11T
08D7 D3F1      01310          OUT     (CTC11),A
08D9 3E47      01320          LD      A,CTC12C
08DB D3F2      01330          OUT     (CTC12),A
08DD 3A0221    01340          LD      A,(TACH)
08E0 D3F2      01350          OUT     (CTC12),A
08E2 3E47      01360          LD      A,CTC13C
08E4 D3F3      01370          OUT     (CTC13),A
08E6 3A0321    01380          LD      A,(TACH+1)
08E9 D3F3      01390          OUT     (CTC13),A
               01400 ;
               01410 ;
08EB 3EE9      01420 SETURT   LD      A,USARTM        ;SET USART MODE
08ED D3F9      01430          OUT     (USARTC),A
08EF 3E11      01440          LD      A,USRTER        ;RESET ERRORS AND ENABLE
08F1 D3F9      01450          OUT     (USARTC),A
08F3 21D00E    01460 SAYHI    LD      HL,HELLO        ;SET POINTER TO MESSAGE
08F6 CD000D    01470          CALL    NEC55C          ;PRINT ONE LINE
08F9 CD000D    01480          CALL    NEC55C
08FC CD000D    01490          CALL    NEC55C
08FF CD000D    01500          CALL    NEC55C
0902 21000F    01510          LD      HL,PTRDTA       ;MOVE PRINTER OUTPUT
0905 110022    01520          LD      DE,PBEHND       ;TO PRINT BUFFER
0908 010001    01530          LD      BC,0100H        ;NUMBER OF BYTES
090B EDB0      01540          LDIR
               01550 ;
               01560 ;
090D C30009    01570          JP      NEC30C          ;GO TO COMMAND ROUTINE
               01580 ;
0ED0           01590          ORG     0ED0H           ;WAKEUP MESSAGE
0ED0 20        01600 HELLO    DEFM    '     ENSCO  INC.'
     20 20 20 20 45 4E 53 43
     4F 20 20 49 4E 43 2E
0EE0 0D        01610          DEFB    CR
0EE1 0D        01620          DEFB    CR
0EE2 20        01630          DEFM    ' SPEED PROFILE SIMULATOR'
     53 50 45 45 44 20 50 52
     4F 46 49 4C 45 20 53 49
     4D 55 4C 41 54 4F 52
0EFA 0D        01640          DEFB    CR
               01650 ;
               01660 ;
0000           01670          END
00000 TOTAL ERRORS
```

CDSPLY	00FC	CHKRAM	0891	CR	000D	CTC10	00F0	CTC10C	0047
CTC10T	0000	CTC11	00F1	CTC11C	0047	CTC11T	003C	CTC12	00F2
CTC12C	0047	CTC13	00F3	CTC13C	0047	CTC1V	0018	CTC20	00F4
CTC21	00F5	CTC22	00F6	CTC23	00F7	CTC2V	0020	DSPLOF	000D
HELLO	0ED0	MDSPLY	00FE	NDSPLY	00FD	NEC20C	0880	NEC30C	0900
NEC55A	0D0A	NEC55C	0D00	NXTOFF	0882	PBEHND	2200	PTRDTA	0F00
SAYHI	08F3	SETCTC	08BF	SETURT	08EB	TACH	2102	TC1	0010
TC2	0001	USARTC	00F9	USARTD	00F8	USARTM	00E9	USRTER	0011
ZMEM	089F								

```
                00100 ;
                00110 ; PROGRAM  NEC40C
                00120 ;
                00130 ;   VERSION 1.0   12/11/79   CONNER
                00140 ;
                00150 ;        THIS PROGRAM CONTINUALLY UPDATES THE DISPLAYS
                00160 ; WITH CURRENT INFORMATION, CHECKS DISTANCE FOR SPEED
                00170 ; CHANGE , AND OUTPUTS DATA TO THE PRINTER IF THERE
                00180 ; IS DATA IN THE BUFFER.
                00190 ;
                00200 ;
                00210 ;        REG IX IS THE CURRENT STATUS POINTER
                00220 ;        REG IY IS THE NEXT STATUS POINTER
                00230 ;
                00240 ; EXTERNAL VECTORS AND CONSTANTS
0870            00250 NEC41C   EQU     0870H           ;PRINT SPEED CHANGE INFO
0AC0            00260 NEC42C   EQU     0AC0H           ;STATION STOP
0D60            00270 NEC53C   EQU     0D60H           ;CURRENT DISPLAY UPDATE
0D20            00280 NEC54C   EQU     0D20H           ;NEXT DISPLAY UPDATE
0D00            00290 NEC55C   EQU     0D00H           ;LINE OUTPUT DRIVER
00F1            00300 CTC11    EQU     0F1H            ;ADDRESS OF CTC1 CH1
00C1            00310 CTC11C   EQU     0C1H            ;CTC1 CH1 CTRL WORD
                00320                                  ;ENABLES INTERRUPTS
00F2            00330 CTC12    EQU     0F2H            ;ADDRESS OF CTC1 CH2
00C1            00340 CTC12C   EQU     0C1H            ;CTC1 CH1 CTRL WORD
2110            00350 CURRNT   EQU     2110H           ;ADDRESS OF CURRENT STATUS
2113            00360 CSPD     EQU     2113H           ;CURRENT POSTED SPEED
1000            00370 NEXT     EQU     1000H           ;ADDRESS OF NEXT STATUS LIST
00FE            00380 MDSPLY   EQU     0FEH            ;PORT ADDR MILES TO GO
2109            00390 LINCNT   EQU     2109H           ;ADDRESS OF LINE COUNTER
210A            00400 LINPTR   EQU     210AH           ;ADDRESS OF LINE POINTER
0000            00410 ZERO     EQU     00H
                00420 ;
                00430 ;
0A00            00440          ORG     0A00H
0A00 FB         00450 NEC40C   EI                     ;ACCEPT INTERRUPTS
0A01 3EC1       00460          LD      A,CTC12C        ;START TACH
0A03 D3F2       00470          OUT     (CTC12),A
0A05 185F       00480          JR      WTACH           ;WAIT FOR TRAIN TO START
0A07 3EC1       00490 LOOPB    LD      A,CTC11C        ;START ELAPSED TIME CLOCK
0A09 D3F1       00500          OUT     (CTC11),A
0A0B CD200D     00510          CALL    NEC54C          ;UPDATE NEXT STATUS
0A0E CD600D     00520 LOOPA    CALL    NEC53C          ;UPDATE CURRENT STATUS
0A11 3A0921     00530          LD      A,(LINCNT)      ;ANY DATA TO OUTPUT?
0A14 FE00       00540          CP      ZERO
0A16 280D       00550          JR      Z,CONT          ;NO, CONTINUE
0A18 3D         00560          DEC     A               ;YES, OUTPUT A LINE
0A19 320921     00570          LD      (LINCNT),A      ;SAVE LINE COUNT
0A1C 2A0A21     00580          LD      HL,(LINPTR)     ;GET LINE POINTER
0A1F CD000D     00590          CALL    NEC55C          ;OUTPUT THE LINE
0A22 220A21     00600          LD      (LINPTR),HL     ;SAVE LINE POINTER
0A25 DD7E02     00610 CONT     LD      A,(IX+2)        ;CHECK DISTANCE CODO>=NODO
0A28 FDBE02     00620          CP      (IY+2)
0A2B 3843       00630          JR      C,NOCHNG        ;CODO<NODO
0A2D DD7E01     00640          LD      A,(IX+1)
0A30 FDBE01     00650          CP      (IY+1)
```

```
0A33 383B       00660           JR      C,NOCHNG        ;CODO<NODO
0A35 DD7E00     00670           LD      A,(IX)
0A38 FDBE00     00680           CP      (IY)
0A3B 3833       00690           JR      C,NOCHNG        ;CODO<NODO
0A3D AF         00700           XOR     A               ;CLEAR MILES TOGO DISPLAY
0A3E D3FE       00710           OUT     (MDSPLY),A
0A40 CD700B     00720           CALL    NEC41C          ;TIME FOR CHANGE
0A43 FD7E03     00730           LD      A,(IY+3)        ;GET SPEED
0A46 DD7703     00740           LD      (IX+3),A        ;MOVE TO CURRENT
0A49 FD7E04     00750           LD      A,(IY+4)
0A4C DD7704     00760           LD      (IX+4),A
0A4F 110800     00770           LD      DE,0008H        ;MOVE TO NEW STATUS
0A52 FD19       00780           ADD     IY,DE
0A54 CD200D     00790           CALL    NEC54C          ;DISPLAY NEW NEXT STATUS
0A57 ED4B1321   00800           LD      BC,(CSPD)       ;GET CURRENT SPEED
0A5B 3E00       00810           LD      A,ZERO
0A5D B8         00820           CP      B               ;10S=0
0A5E 2010       00830           JR      NZ,NOCHNG       ;NO, SPEED > 0
0A60 B9         00840           CP      C               ;10S & MPH=0?
0A61 200D       00850           JR      NZ,NOCHNG       ;NO, SPEED>0
0A63 CDC00A     00860           CALL    NEC42C          ;YES, SPEED=0 DO STATION STO
P
0A66 DD7E00     00870 WTACH     LD      A,(IX)          ;GET CURRENT ODO
0A69 DDBE00     00880 WMOVE     CP      (IX)            ;WAIT FOR TRAIN TO MOVE
0A6C 28FB       00890           JR      Z,WMOVE
0A6E 1897       00900           JR      LOOPB           ;CONTINUE PROFILE
0A70 FD7E01     00910 NOCHNG    LD      A,(IY+1)        ;GET NEXT CHANGE MILE
0A73 DD9601     00920           SUB     (IX+1)          ;SUBTRACT CURRENT MILE
0A76 27         00930           DAA                     ;ADJUST FOR BCD
0A77 FE40       00940           CP      40H             ;MORE THAN 4 MILES?
0A79 3804       00950           JR      C,LESS4         ;NO
0A7B 2802       00960           JR      Z,LESS4         ;NO
0A7D 188F       00970           JR      LOOPA           ;YES
0A7F 3C         00980 LESS4     INC     A               ;ADD A TENTH
0A80 27         00990           DAA
0A81 CB27       01000           SLA     A               ;X4
0A83 CB27       01010           SLA     A
0A85 F603       01020           OR      03H             ;SET LSBS TO 1
0A87 D3FE       01030           OUT     (MDSPLY),A      ;DISPLAY MILESTO GO
0A89 C30E0A     01040           JP      LOOPA
                01050 ;
                01060 ;
0000            01070           END
00000 TOTAL ERRORS
```

		CSPD	2113	CTC11	00F1	CTC11C	00C1	CTC12	00F2
CTC12C	00C1	CURRNT	2110	LESS4	0A7F	LINCNT	2109	LINPTR	210A
LOOPA	0A0E	LOOPB	0A07	MDSPLY	00FE	NEC40C	0A00	NEC41C	0B70
NEC42C	0AC0	NEC53C	0D60	NEC54C	0D20	NEC55C	0D00	NEXT	1000
NOCHNG	0A70	WMOVE	0A69	WTACH	0A66	ZERO	0000		

```
                        00100 ;
                        00110 ;   PROGRAM  NEC30C
                        00120 ;
                        00130 ;     . VERSION 1.0     01/12/80        CONNER
                        00140 ;
                        00150 ;
                        00160 ;       THIS PROGRAM DISPLAYS MESSAGES ON THE 7303
                        00170 ;   KEYBOARD/DISPLAY AND REQUESTS OPERATOR INPUTS
                        00180 ;   TO SET UP THE POINTERS TO BE USED FOR A PROFILE.
                        00190 ;
                        00200 ;
                        00210 ;       EXTERNAL VECTORS AND CONSTANTS
                        00220 ;
0A00                    00230 NEC40C  EQU     0A00H           ;START OF PROFILE RUN PGM
0709                    00231 BLANKL  EQU     0709H           ;BLANK LEFT DISPLAY
2113                    00232 CSPD    EQU     2113H           ;ADDR OF CURRENT POSTED SPED
00F2                    00233 CTC12   EQU     0F2H            ;PORT ADDR OF CTC1 CH2
0047                    00234 CTC12C  EQU     47H             ;CTC1 CH2 CONTROL WORD
00F3                    00235 CTC13   EQU     0F3H            ;PORT ADDR OF CTC1 CH3
0047                    00236 CTC13C  EQU     47H             ;CTC1 CH3 CONTROL WORD
0742                    00237 DISDTA  EQU     0742H           ;DISPLAY DATA SUBROUTINE
0737                    00238 DSPLN   EQU     0737H           ;DISPLAY N CHARACTERS
064D                    00239 ENTRAD  EQU     064DH           ;ENTER ADDR SUBROUTINE
06DC                    00240 MESSAG  EQU     06DCH           ;7303 MESSAGE OUTPUT
0780                    00241 RDONCE  EQU     0780H           ;READ ONCE SUBROUTINE
2107                    00242 SMILE   EQU     2107H           ;START MILE LOC
2105                    00243 STIME   EQU     2105H           ;START TIME LOC
2102                    00244 TACH    EQU     2102H           ;TACH LOC
07E0                    00245 ONESEC  EQU     07E0H           ;ONE SEC WAIT ROUTINE
                        00250 ;
                        00260 ;
                        00270 ;
                        00280 ;
                        00290 ;
                        00300 ;
0910                    00310         ORG     0910H
0910 DD211021           00320 NEC30C  LD      IX,2110H        ;CURRENT STATUS POINTER
0914 21000E             00330         LD      HL,MSG1         ;POINT TO FIRST MSG
0917 CDDC06             00340         CALL    MESSAG          ;DISPLAY IT
091A CD8007             00350         CALL    RDONCE          ;READ A PROFILE KEY
091D FD210010           00360         LD      IY,1000H        ;POINTER TO P1 DATA
0921 FE14               00370         CP      14H             ;WAS P1 PRESSED?
0923 2818               00380         JR      Z,GTIME         ;YES, GET TIME
0925 FD210014           00390         LD      IY,1400H        ;NO, P2 DATA POINTER
0929 FE15               00400         CP      15H             ;WAS P2 PRESSED?
092B 2810               00410         JR      Z,GTIME         ;YES, GET TIME
092D FD210018           00420         LD      IY,1800H        ;NO, P3 DATA POINTER
0931 FE16               00430         CP      16H             ;WAS P3 PRESSED?
0933 2808               00440         JR      Z,GTIME         ;YES,GET TIME
0935 FD21001C           00450         LD      IY,1C00H        ;NO, P4 DATA POINTER
0939 FE17               00460         CP      17H             ;WAS P4 PRESSED?
093B 20D3               00470         JR      NZ,NEC30C       ;WAS NOT A PROFILE KEY
093D 21150E             00480 GTIME   LD      HL,MSG2         ;FOUND PROFILE GET TIME
0940 CDDC06             00490         CALL    MESSAG          ;DISPLAY TIME MESSAGE
0943 1E03               00500         LD      E,03H           ;DISPLAY POINTER
0945 CD4D06             00510         CALL    ENTRAD          ;READ TIME (HHMM)
```

```
0948 220521    00520          LD      (STIME),HL      ;SAVE STARTING TIME
094B AF        00530          XOR     A               ;A=0
094C BC        00540          CP      H               ;HRS=0?
094D 200B      00550          JR      NZ,GMILE        ;HRS>0 NEED TO GET MILES
094F BD        00560          CP      L               ;MIN=0?
0950 2008      00570          JR      NZ,GMILE        ;MIN>0 NEED TO GET MILES
0952 220721    00580          LD      (SMILE),HL      ;ZERO TIME, ZERO MILES
0955 221321    00590          LD      (CSPD),HL       ;ZERO SPEED
0958 1848      00600          JR      STTIME          ;GET READY TO RUN
095A 21370E    00610 GMILE    LD      HL,MSG3         ;GET START DIST MSG
095D CDDC06    00620          CALL    MESSAG
0960 1E03      00630          LD      E,03H
0962 CD4D06    00640          CALL    ENTRAD          ;READ IN MILES (HTMT)
               00650                                  ;(HTMT)=HUND,TENS,MILES,TENT
HS
0965 220721    00660          LD      (SMILE),HL      ;STORE START MILES
0968 110800    00670          LD      DE,08H          ;LENGTH OF EACH ITEM IN PROF
ILE LIST
096B 7C        00680 FIND     LD      A,H             ;FIND CLOSEST ITEM IN LIST
096C FDBE02    00690          CP      (IY+2)          ;HUND AND TENS THE SAME?
096F 200A      00700          JR      NZ,NEXT         ;NO
0971 7D        00710          LD      A,L             ;YES
0972 FDBE03    00720          CP      (IY+3)          ;MILES AND TENTHS THE SAME
0975 3804      00730          JR      C,NEXT          ;STILL LESS
0977 280B      00740          JR      Z,GOOD          ;EQUAL, OK
0979 1804      00750          JR      TOMUCH          ;GREATER
097B FD19      00760 NEXT     ADD     IY,DE           ;GET NEXT ITEM
097D 18EC      00770          JR      FIND            ;TRY AGAIN
097F 11F8FF    00780 TOMUCH   LD      DE,0FFF8H       ;BACK UP 1 ITEM
0982 FD19      00790          ADD     IY,DE
0984 FD7E00    00800 GOOD     LD      A,(IY)          ;MOVE DATA FROM LIST
0987 DD7700    00810          LD      (IX),A
098A FD7E01    00820          LD      A,(IY+1)
098D DD7701    00830          LD      (IX+1),A
0990 FD7E02    00840          LD      A,(IY+2)
0993 DD7702    00850          LD      (IX+2),A
0996 FD7E03    00860          LD      A,(IY+3)        ;SPEED
0999 DD7703    00870          LD      (IX+3),A
099C FD7E04    00880          LD      A,(IY+4)
099F DD7704    00890          LD      (IX+4),A
09A2 AF        00900 STTIME   XOR     A               ;SEC=0
09A3 DD7705    00910          LD      (IX+5),A
09A6 3A0521    00920          LD      A,(STIME)       ;MOVE MIN
09A9 DD7706    00930          LD      (IX+6),A
09AC 3A0621    00940          LD      A,(STIME+1)     ;MOVE HR
09AF DD7707    00950          LD      (IX+7),A
09B2 21510E    00960 RDY      LD      HL,MSG4         ;READY MESSAGE
09B5 0E08      00970          LD      C,8             ;8CHAR MESSAGE
09B7 1E00      00975          LD      E,00            ;RIGHT MOST DISPLAY
09B9 CD3707    00980          CALL    DSPLN           ;DISPLAY MESSAGE
09BC CD8007    00990 WAIT     CALL    RDONCE          ;READ KEYS
09BF FE10      01000          CP      10H             ;WAS RUN PRESSED?
09C1 CA000A    01010          JP      Z,NEC40C        ;YES, START RUN
09C4 FE11      01020          CP      11H             ;NEED TO CHANGE TACH?
09C6 20F4      01030          JR      NZ,WAIT         ;NO, IGNORE ALL OTHER KEYS
09C8 210221    01040          LD      HL,TACH         ;DISPLAY CURRENT TACH
09CB 1E00      01050          LD      E,00
09CD CD4207    01060          CALL    DISDTA
```

```
09D0 CD0907    01070          CALL    BLANKL
09D3 CDE007    01080          CALL    ONESEC
09D6 21590E    01090          LD      HL,MSG5          ;DISPLAY TACH MESSAGE
09D9 CDDC06    01100          CALL    MESSAG
09DC 1E03      01110          LD      E,03H            ;GET NEW TACH DATA
09DE CD4D06    01120          CALL    ENTRAD
09E1 220221    01130          LD      (TACH),HL        ;SAVE NEW TACH
09E4 3E47      01140          LD      A,CTC12C         ;SET UP CTC
09E6 D3F2      01150          OUT     (CTC12),A
09E8 7D        01160          LD      A,L              ;TACH CONSTANT
09E9 D3F2      01170          OUT     (CTC12),A
09EB 3E47      01180          LD      A,CTC13C
09ED D3F3      01190          OUT     (CTC13),A
09EF 7C        01200          LD      A,H
09F0 D3F3      01210          OUT     (CTC13),A
09F2 18BE      01220          JR      RDY              ;WAIT FOR RUN
               01230 ;
0E00           01240          ORG     0E00H            ;START OF KBD MESSAGES
0E00 20        01250 MSG1     DEFM    '  RUN WHICH PROFILE?'
     20 52 55 4E 20 57 48 49
     43 48 20 50 52 4F 46 49
     4C 45 3F
0E14 FF        01260          DEFB    0FFH
0E15 20        01270 MSG2     DEFM    '  ENTER STARTING ELAPSED TIME    '
     20 45 4E 54 45 52 20 53
     54 41 52 54 49 4E 47 20
     45 4C 41 50 53 45 44 20
     54 49 4D 45 20 20 20 20
0E36 FF        01280          DEFB    0FFH
0E37 20        01290 MSG3     DEFM    '  ENTER STARTING MILE    '
     20 45 4E 54 45 52 20 53
     54 41 52 54 49 4E 47 20
     4D 49 4C 45 20 20 20 20
0E50 FF        01300          DEFB    0FFH
0E51 2A        01310 MSG4     DEFM    '**READY*'
     2A 52 45 41 44 59 2A
0E59 20        01320 MSG5     DEFM    ' IS THE CURRENT TACH FACTOR '
     49 53 20 54 48 45 20 43
     55 52 52 45 4E 54 20 54
     41 43 48 20 46 41 43 54
     4F 52 20
0E75 20        01330          DEFM    ' ENTER NEW-    '
     45 4E 54 45 52 20 4E 45
     57 2D 20 20 20 20
0E84 FF        01340          DEFB    0FFH
               01350 ;
               01360 ;
0000           01370          END
00000 TOTAL ERRORS
```

BLANKL	0709	CSPD	2113	CTC12	00E2	CTC12C	0047	CTC13	00E3
CTC13C	0047	DISDTA	0742	DSPLN	0737	ENTRAD	064D	FIND	096B
GMILE	095A	GOOD	0984	GTIME	093D	MESSAG	06DC	MSG1	0E00
MSG2	0E15	MSG3	0E37	MSG4	0E51	MSG5	0E59	NEC30C	0910
NEC40C	0A00	NEXT	097B	ONESEC	07E0	RDONCE	0780	RDY	09B2
SMILE	2107	STIME	2105	STTIME	09A2	TACH	2102	TOMUCH	097F
WAIT	09BC								

```
                00050 ; PROGRAM  NEC51C
                00060 ;
                00100 ; DISPLAY SUBROUTINE
                00110 ;
                00120 ; CURRENT STATUS DISPLAY VERSION
                00130 ;
                00140 ; THIS SUBROUTINE WILL OUTPUT DATA IN A-REG TO
                00150 ; DISPLAYS IN C-REG.  TWO DISPLAYS ARE ADDRESSED
                00160 ; UNLESS THE HIGH NIBBLE OF C-REG IS ZERO.
                00170 ; DISPLAY 0 IIS ALWAYS TURNED OFF BY THIS
                00180 ; SUBROUTINE.
                00190 ;
                00200 ;       REGISTERS WHEN CALLED
                00210 ;               A= BCD DATA
                00220 ;               C= BCE ADDRS OF DISPLAYS
                00230 ;
                00240 ;       REGISTERS ON RETURN
                00250 ;               A= CHANGED
                00260 ;               B= CHANGED
                00270 ;               C= CHANGED
                00280 ;
00FC            00290 DSPLY   EQU     0FCH            ;PORT ADDR OF DISPLAYS
                00300 ;
0DD0            00310         ORG     0DD0H
0DD0 F5         00320 NEC51C  PUSH    AF              ; SAVE DATA
0DD1 3EF0       00330         LD      A,0F0H
0DD3 A1         00340         AND     C               ; CHECK FOR ONE ADDR
0DD4 2812       00350         JR      Z,ONLY1
0DD6 47         00360         LD      B,A             ; ADDR OF HIGH DISPLAY
0DD7 F1         00370         POP     AF
0DD8 F5         00380         PUSH    AF
0DD9 CB3F       00390         SRL     A               ;MOVE HIGH DATA TO LOW
0DDB CB3F       00400         SRL     A
0DDD CB3F       00410         SRL     A
0DDF CB3F       00420         SRL     A
0DE1 B0         00430         OR      B               ; COMBINE ADDR & DATA
0DE2 D3FC       00440         OUT     (DSPLY),A
0DE4 E60F       00450         AND     0FH             ;CLEAR DISPLAY LATCH
0DE6 D3FC       00460         OUT     (DSPLY),A
0DE8 3E0F       00470 ONLY1    LD     A,0FH
0DEA A1         00480         AND     C               ;CLEAR HIGH BITS
0DEB CB27       00490         SLA     A               ;MOVE LOW BITS HIGH
0DED CB27       00500         SLA     A
0DEF CB27       00510         SLA     A
0DF1 CB27       00520         SLA     A
0DF3 47         00530         LD      B,A             ;SAVE ADDR
0DF4 F1         00540         POP     AF              ;GET DATA
0DF5 E60F       00550         AND     0FH             ;MASK OUT HIGH BITS
0DF7 B0         00560         OR      B               ;COMBINE DATA & ADDR
0DF8 D3FC       00570         OUT     (DSPLY),A
0DFA E60F       00580         AND     0FH             ;CLEAR DISPLAY LATCH
0DFC D3FC       00590         OUT     (DSPLY),A
0DFE C9         00600         RET
                00610 ;
                00620 ;
                00630 ;
0000            00640         END
00000 TOTAL ERRORS
```

DSPLY	00FC	NECS1C	0DD0	ONLY1	0DE8

```
                00050 ; PROGRAM  NEC51C
                00060 ;
                00100 ; DISPLAY SUBROUTINE
                00110 ;
                00120 ; CURRENT STATUS DISPLAY VERSION
                00130 ;
                00140 ; THIS SUBROUTINE WILL OUTPUT DATA IN A-REG TO
                00150 ; DISPLAYS IN C-REG.  TWO DISPLAYS ARE ADDRESSED
                00160 ; UNLESS THE HIGH NIBBLE OF C-REG IS ZERO.
                00170 ; DISPLAY 0 IIS ALWAYS TURNED OFF BY THIS
                00180 ; SUBROUTINE.
                00190 ;
                00200 ;        REGISTERS WHEN CALLED
                00210 ;                A= BCD DATA
                00220 ;                C= BCE ADDRS OF DISPLAYS
                00230 ;
                00240 ;        REGISTERS ON RETURN
                00250 ;                A= CHANGED
                00260 ;                B= CHANGED
                00270 ;                C= CHANGED
                00280 ;
00FC            00290 DSPLY   EQU     0FCH          ;PORT ADDR OF DISPLAYS
                00300 ;
0DD0            00310         ORG     0DD0H
0DD0 F5         00320 NEC51C  PUSH    AF            ; SAVE DATA
0DD1 3EF0       00330         LD      A,0F0H
0DD3 A1         00340         AND     C             ; CHECK FOR ONE ADDR
0DD4 2812       00350         JR      Z,ONLY1
0DD6 47         00360         LD      B,A           ; ADDR OF HIGH DISPLAY
0DD7 F1         00370         POP     AF
0DD8 F5         00380         PUSH    AF
0DD9 CB3F       00390         SRL     A             ;MOVE HIGH DATA TO LOW
0DDB CB3F       00400         SRL     A
0DDD CB3F       00410         SRL     A
0DDF CB3F       00420         SRL     A
0DE1 B0         00430         OR      B             ; COMBINE ADDR & DATA
0DE2 D3FC       00440         OUT     (DSPLY),A
0DE4 E60F       00450         AND     0FH           ;CLEAR DISPLAY LATCH
0DE6 D3FC       00460         OUT     (DSPLY),A
0DE8 3E0F       00470 ONLY1    LD     A,0FH
0DEA A1         00480         AND     C             ;CLEAR HIGH BITS
0DEB CB27       00490         SLA     A             ;MOVE LOW BITS HIGH
0DED CB27       00500         SLA     A
0DEF CB27       00510         SLA     A
0DF1 CB27       00520         SLA     A
0DF3 47         00530         LD      B,A           ;SAVE ADDR
0DF4 F1         00540         POP     AF            ;GET DATA
0DF5 E60F       00550         AND     0FH           ;MASK OUT HIGH BITS
0DF7 B0         00560         OR      B             ;COMBINE DATA & ADDR
0DF8 D3FC       00570         OUT     (DSPLY),A
0DFA E60F       00580         AND     0FH           ;CLEAR DISPLAY LATCH
0DFC D3FC       00590         OUT     (DSPLY),A
0DFE C9         00600         RET
                00610 ;
                00620 ;
                00630 ;
```

```
999
    DIR

A: MOVCPM   COM : PIP      COM : SUBMT   COM : XSUB     COM
A: ED       COM : ASM      COM : DDT     COM : LOAD     COM
A: STAT     CO : SYGEN   COM : DUMP     COM : PRINT    COM
A: LPRINT   COM : NULL     COM : DTEST   COM : MCONF    COM
A: KERNEL   SL5 : DEBUG   SL : ICOND    SL5 : COMMOD   SL5
A: COLD     SL5 : DISKDEF  LIB : INSTALL  COM : ASSEM    SL5
A: SL5      COM : ASSEM    COM : SBOOT3  HEX : BIOS132  HEX
A: CPM32    COM : SYSMAKE  COM : DEV     COM : DEBUG    COM
A: SL5      DOC : ROMSL5   COM
```

```
                00050 ; PROGRAM  NEC52C
                00060 ;
                00100 ; DISPLAY SUBROUTINE
                00110 ;
                00120 ; NEXT STATUS DISPLAY VERSION
                00130 ;
                00140 ; THIS SUBROUTINE WILL OUTPUT DATA IN A-REG TO
                00150 ; DISPLAYS IN C-REG.  TWO DISPLAYS ARE ADDRESSED
                00160 ; UNLESS THE HIGH NIBBLE OF C-REG IS ZERO.
                00170 ; DISPLAY 0 IIS ALWAYS TURNED OFF BY THIS
                00180 ; SUBROUTINE.
                00190 ;
                00200 ;       REGISTERS WHEN CALLED
                00210 ;               A= BCD DATA
                00220 ;               C= BCE ADDRS OF DISPLAYS
                00230 ;
                00240 ;       REGISTERS ON RETURN
                00250 ;               A= CHANGED
                00260 ;               B= CHANGED
                00270 ;               C= CHANGED
                00280 ;
00FD            00290 DSPLY   EQU     0FDH            ;PORT ADDR OF DISPLAYS
                00300 ;
0DA0            00310         ORG     0DA0H
0DA0 F5         00320 NEC52C  PUSH    AF              ; SAVE DATA
0DA1 3EF0       00330         LD      A,0F0H
0DA3 A1         00340         AND     C               ; CHECK FOR ONE ADDR
0DA4 2812       00350         JR      Z,ONLY1
0DA6 47         00360         LD      B,A             ; ADDR OF HIGH DISPLAY
0DA7 F1         00370         POP     AF
0DA8 F5         00380         PUSH    AF
0DA9 CB3F       00390         SRL     A               ;MOVE HIGH DATA TO LOW
0DAB CB3F       00400         SRL     A
0DAD CB3F       00410         SRL     A
0DAF CB3F       00420         SRL     A
0DB1 B0         00430         OR      B               ; COMBINE ADDR & DATA
0DB2 D3FD       00440         OUT     (DSPLY),A
0DB4 E60F       00450         AND     0FH             ;CLEAR DISPLAY LATCH
0DB6 D3FD       00460         OUT     (DSPLY),A
0DB8 3E0F       00470 ONLY1    LD     A,0FH
0DBA A1         00480         AND     C               ;CLEAR HIGH BITS
0DBB CB27       00490         SLA     A               ;MOVE LOW BITS HIGH
0DBD CB27       00500         SLA     A
0DBF CB27       00510         SLA     A
0DC1 CB27       00520         SLA     A
0DC3 47         00530         LD      B,A             ;SAVE ADDR
0DC4 F1         00540         POP     AF              ;GET DATA
0DC5 E60F       00550         AND     0FH             ;MASK OUT HIGH BITS
0DC7 B0         00560         OR      B               ;COMBINE DATA & ADDR
0DC8 D3FD       00570         OUT     (DSPLY),A
0DCA E60F       00580         AND     0FH             ;CLEAR DISPLAY LATCH
0DCC D3FD       00590         OUT     (DSPLY),A
0DCE C9         00600         RET
                00610 ;
                00620 ;
                00630 ;
0000            00640         END
00000 TOTAL ERRORS
```

```
DSPLY   -00FD _   NEC52C  0DA0      ONLY1   0DB8
```

```
                00050 ; PROGRAM  NEC52C
                00060 ;
                00100 ; DISPLAY SUBROUTINE
                00110 ;
                00120 ; NEXT STATUS DISPLAY VERSION
                00130 ;
                00140 ; THIS SUBROUTINE WILL OUTPUT DATA IN A-REG TO
                00150 ; DISPLAYS IN C-REG.  TWO DISPLAYS ARE ADDRESSED
                00160 ; UNLESS THE HIGH NIBBLE OF C-REG IS ZERO.
                00170 ; DISPLAY 0 IIS ALWAYS TURNED OFF BY THIS
                00180 ; SUBROUTINE.
                00190 ;
                00200 ;       REGISTERS WHEN CALLED
                00210 ;               A= BCD DATA
                00220 ;               C= BCE ADDRS OF DISPLAYS
                00230 ;
                00240 ;       REGISTERS ON RETURN
                00250 ;               A= CHANGED
                00260 ;               B= CHANGED
                00270 ;               C= CHANGED
                00280 ;
00FD            00290 DSPLY   EQU     0FDH            ;PORT ADDR OF DISPLAYS
                00300 ;
0DA0            00310         ORG     0DA0H
0DA0 F5         00320 NEC52C  PUSH    AF              ; SAVE DATA
0DA1 3EF0       00330         LD      A,0F0H
0DA3 A1         00340         AND     C               ; CHECK FOR ONE ADDR
0DA4 2812       00350         JR      Z,ONLY1
0DA6 47         00360         LD      B,A             ; ADDR OF HIGH DISPLAY
0DA7 F1         00370         POP     AF
0DA8 F5         00380         PUSH    AF
0DA9 CB3F       00390         SRL     A               ;MOVE HIGH DATA TO LOW
0DAB CB3F       00400         SRL     A
0DAD CB3F       00410         SRL     A
0DAF CB3F       00420         SRL     A
0DB1 B0         00430         OR      B               ; COMBINE ADDR & DATA
0DB2 D3FD       00440         OUT     (DSPLY),A
0DB4 E60F       00450         AND     0FH             ;CLEAR DISPLAY LATCH
0DB6 D3FD       00460         OUT     (DSPLY),A
0DB8 3E0F       00470 ONLY1    LD     A,0FH
0DBA A1         00480         AND     C               ;CLEAR HIGH BITS
0DBB CB27       00490         SLA     A               ;MOVE LOW BITS HIGH
0DBD CB27       00500         SLA     A
0DBF CB27       00510         SLA     A
0DC1 CB27       00520         SLA     A
0DC3 47         00530         LD      B,A             ;SAVE ADDR
0DC4 F1         00540         POP     AF              ;GET DATA
0DC5 E60F       00550         AND     0FH             ;MASK OUT HIGH BITS
0DC7 B0         00560         OR      B               ;COMBINE DATA & ADDR
0DC8 D3FD       00570         OUT     (DSPLY),A
0DCA E60F       00580         AND     0FH             ;CLEAR DISPLAY LATCH
0DCC D3FD       00590         OUT     (DSPLY),A
0DCE C9         00600         RET
                00610 ;
                00620 ;
                00630 ;
0000            00640         END
00000 TOTAL ERRORS
```

ODD0 ONLY1 0DE8

```
0000          00640          END
00000 TOTAL ERRORS
```

```
                00100 ;
                00110 ; PROGRAM  NEC53C
                00120 ;
                00130 ;  VERSION 1.0   12/11/79    CONNER
                00140 ;
                00150 ;       THIS ROUTINE UPDATES THE CURRENT STATUS DISPLAY.
                00160 ;
                00170 ;  EXTERNAL VECTORS AND CONSTANTS
0DD0            00180 NEC51C  EQU     0DD0H           ;CURRENT DISPLAY DRIVER
                00190 ;
                00200 ;
0D60            00210         ORG     0D60H
0D60 DD7E01     00220 NEC53C  LD      A,(IX+1)        ;GET CURRENT STATUS (ODOL)
0D63 0E21       00230         LD      C,21H           ;AND DISPLAY
0D65 CDD00D     00240         CALL    NEC51C
0D68 DD7E02     00250         LD      A,(IX+2)        ;ODOH
0D6B 0E43       00260         LD      C,43H
0D6D CDD00D     00270         CALL    NEC51C
0D70 DD7E03     00280         LD      A,(IX+3)        ;SPEED LO
0D73 0E65       00290         LD      C,65H
0D75 CDD00D     00300         CALL    NEC51C
0D78 DD7E04     00310         LD      A,(IX+4)        ;SPEED HI
0D7B 0E07       00320         LD      C,07H
0D7D CDD00D     00330         CALL    NEC51C
0D80 DD7E05     00340         LD      A,(IX+5)        ;SEC
0D83 0E98       00350         LD      C,98H
0D85 CDD00D     00360         CALL    NEC51C
0D88 DD7E06     00370         LD      A,(IX+6)        ;MIN
0D8B 0EBA       00380         LD      C,0BAH
0D8D CDD00D     00390         CALL    NEC51C
0D90 DD7E07     00400         LD      A,(IX+7)        ;HR
0D93 0EDC       00410         LD      C,0DCH
0D95 CDD00D     00420         CALL    NEC51C
0D98 C9         00430         RET
                00440 ;
0000            00450         END
00000 TOTAL ERRORS


NEC51C  0DD0      NEC53C  0D60
```

DSPLY	00FD	NEC52C	0DA0	ONLY1	0DB8

```
                00100 ;
                00110 ; PROGRAM  NEC54C
                00120 ;
                00130 ;  VERSION 1.0   12/11/79    CONNER
                00140 ;
                00150 ;       THIS ROUTINE UPDATES THE NEXT STATUS DISPLAY.
                00160 ;
                00170 ;  EXTERNAL VECTORS AND CONSTANTS
0DA0            00180 NEC52C  EQU     0DA0H           ;NEXT DISPLAY DRIVER
                00190 ;
                00200 ;
0D20            00210         ORG     0D20H
0D20 FD7E01     00220 NEC54C  LD      A,(IY+1)        ;GET NEXT STATUS (ODOL)
0D23 0E21       00230         LD      C,21H           ;AND DISPLAY
0D25 CDA00D     00240         CALL    NEC52C
0D28 FD7E02     00250         LD      A,(IY+2)        ;ODOH
0D2B 0E43       00260         LD      C,43H
0D2D CDA00D     00270         CALL    NEC52C
0D30 FD7E03     00280         LD      A,(IY+3)        ;SPEED LO
0D33 0E65       00290         LD      C,65H
0D35 CDA00D     00300         CALL    NEC52C
0D38 FD7E04     00310         LD      A,(IY+4)        ;SPEED HI
0D3B 0E07       00320         LD      C,07H
0D3D CDA00D     00330         CALL    NEC52C
0D40 FD7E05     00340         LD      A,(IY+5)        ;SEC
0D43 0E98       00350         LD      C,98H
0D45 CDA00D     00360         CALL    NEC52C
0D48 FD7E06     00370         LD      A,(IY+6)        ;MIN
0D4B 0EBA       00380         LD      C,0BAH
0D4D CDA00D     00390         CALL    NEC52C
0D50 FD7E07     00400         LD      A,(IY+7)        ;HR
0D53 0EDC       00410         LD      C,0DCH
0D55 CDA00D     00420         CALL    NEC52C
0D58 C9         00430         RET
                00440 ;
0000            00450         END
00000 TOTAL ERRORS


NEC52C  0DA0     NEC54C  0D20
```

```
                00100 ;
                00110 ;  PROGRAM  NEC55C
                00120 ;
                00130 ;       VERSION 1.0   12/14/79   CONNER
                00140 ;
                00150 ;       THIS PROGRAM WILL OUTPUT ONE LINE TO THE PRINTER.
                00160 ;  REG (HL) POINTS TO THE DATA TO BE PRINTED.  THE LAST
                00170 ;  CHARACTER TO BE PRINTED MUST BE A 'CR'.  ENTRY AT
                00180 ;  NEC55A WILL CAUSE THE BHARACTER IN REG C TO BE OUTPUT
                00190 ;  AND RETURNED IN REG A.
                00200 ;
                00210 ;  EXTERNAL VECTORS AND CONSTANTS
                00220 ;
00F8            00230 USARTD  EQU     0FBH            ;PORT ADDR USART DATA
00F9            00240 USARTC  EQU     0F9H            ;PORT ADDR USART CONTROL
0080            00250 DSR     EQU     80H             ;DSR STATUS BIT TRUE
0001            00260 TXRDY   EQU     01H             ;TXRDY STATUS BIT TRUE
0000            00270 NDSR    EQU     00H             ;DSR STATUS BIT FALSE
0000            00280 NTXRDY  EQU     00H             ;TXRDY STATUS BIT FALSE
000D            00290 CR      EQU     0DH             ;CARRIAGE RETURN CHAR.
                00300 ;
                00310 ;
0D00            00320         ORG     0D00H
                00330 ;
0D00 4E         00340 NEC55C  LD      C,(HL)          ;GET CHAR FROM STRING
0D01 23         00350         INC     HL              ;UP POINTER
0D02 CD120D     00360         CALL    NEC55A          ;OUTPUT CHARACTER
0D05 FE0D       00370         CP      CR              ;WAS IT A CARRIAGE RETURN
0D07 20F7       00380         JR      NZ,NEC55C       ;NO, DO ANOTHER
0D09 0E20       00390 WAIT    LD      C,20H           ;WAIT ABOUT 40 MSEC
0D0B 10FE       00400 HERE    DJNZ    HERE
0D0D 0D         00410         DEC     C
0D0E 20FB       00420         JR      NZ,HERE
0D10 C9         00440         RET                     ;YES, FINISHED
0D11 00         00445         NOP
                00450 ;
                00460 ;
0D12 DBF9       00470 NEC55A  IN      A,(USARTC)      ;GET USART STATUS
0D14 E681       00480         AND     DSR+TXRDY       ;CLEAR ERROR BITS
0D16 FE01       00490         CP      NDSR+TXRDY      ;CAN CHAR BE SENT?
0D18 20F8       00500         JR      NZ,NEC55A       ;NO, WAIT
0D1A 79         00510         LD      A,C             ;GET THE CHAR
0D1B D3F8       00520         OUT     (USARTD),A      ;OUTPUT IT
0D1D C9         00530         RET
                00540 ;
                00550 ;
0000            00560         END
00000 TOTAL ERRORS


CR      000D    DSR     0080    HERE    0D0B    NDSR    0000    NEC55A  0D12
NEC55C  0D00    NTXRDY  0000    TXRDY   0001    USARTC  00F9    USARTD  00F8
WAIT    0D09
```

```
                00100 ;
                00110 ;  PROGRAM  NEC56C
                00120 ;
                00130 ;   VERSION 1.0    12/15/79     CONNER
                00140 ;
                00150 ;       THIS PROGRAM COMPUTES THE TIME DIFFERENCE BETWEEN
                00160 ;   THE TIME POINTED TO BY REG (DE) AND THE TIME POINTED
                00170 ;   TO BY REG (HL).  RESULTS ARE RETURNED ON THE STACK IN
                00180 ;   THE FOLLOWING ORDER HR, MIN, SEC AND THE CARRY FLAG
                00190 ;   IS SET IF THE (DE) TIME IS GREATER THAN THE (HL) TIME.
                00200 ;
                00210 ;   EXTERNAL VECTORS AND CONSTANTS
                00220 ;
0060            00230 MINSEC  EQU     60H             ;HR-MIN-SEC CONVERSION
210F            00240 DTIME   EQU     210FH           ;LOC OF TIME DIFFERENCE
                00250 ;
                00260 ;
0C80            00270         ORG     0C80H
0C80 0E00       00280 NEC56C  LD      C,0             ;CLEAR C
0C82 E5         00290         PUSH    HL              ;SAVE POINTERS
0C83 D5         00300         PUSH    DE
0C84 23         00310         INC     HL              ;MOVE POINTERS TO HRS
0C85 13         00320         INC     DE
0C86 23         00330         INC     HL
0C87 13         00340         INC     DE
0C88 1A         00350         LD      A,(DE)          ;CHECK FOR LARGER TIME
0C89 BE         00360         CP      (HL)
0C8A 3814       00370         JR      C,SWAP          ;DHRS < HHRS
0C8C 200E       00380         JR      NZ,OK           ;DHRS > HHRS
0C8E 2B         00390         DEC     HL              ;CHECK MINS
0C8F 1B         00400         DEC     DE
0C90 1A         00410         LD      A,(DE)
0C91 BE         00420         CP      (HL)
0C92 380C       00430         JR      C,SWAP          ;DMIN < HMIN
0C94 2006       00440         JR      NZ,OK           ;DMIN > HMIN
0C96 2B         00450         DEC     HL              ;CHECK SECS
0C97 1B         00460         DEC     DE
0C98 1A         00470         LD      A,(DE)
0C99 BE         00480         CP      (HL)
0C9A 3804       00490         JR      C,SWAP          ;DSEC < HSEC
0C9C D1         00500 OK      POP     DE              ;DTIME >= HTIME
0C9D E1         00510         POP     HL
0C9E 1804       00520         JR      STIME           ;SUBTRACT TIMES
0CA0 0EFF       00530 SWAP    LD      C,0FFH          ;SET NEG FLAG
0CA2 E1         00540         POP     HL              ;SWAP REG
0CA3 D1         00550         POP     DE
0CA4 1A         00560 STIME   LD      A,(DE)          ;GET DSEC
0CA5 96         00570         SUB     (HL)            ;SUBTRACT HSEC
0CA6 27         00580         DAA                     ;ADJUST FOR BCD
0CA7 23         00590         INC     HL              ;UP POINTERS TO MIN
0CA8 13         00600         INC     DE
0CA9 F5         00610         PUSH    AF              ;SAVE SEC
0CAA 301F       00620         JR      NC,MIN          ;DSEC>HSEC
0CAC F1         00630         POP     AF              ;DSEC<HSEC
0CAD C660       00640         ADD     A,MINSEC        ;ADD 60 SEC
0CAF 27         00650         DAA                     ;ADJUST FOR BCD
```

```
0CB0 F5          00660          PUSH    AF              ;SAVE SEC
0CB1 1A          00670          LD      A,(DE)          ;GET DMIN
0CB2 D601        00680          SUB     1               ;SUBTRACT 1 MIN
0CB4 27          00690          DAA
0CB5 3004        00700          JR      NC,M1           ;DONT HAVE TO FIX HRS
0CB7 D640        00710          SUB     40H             ;FIX MIN FIRST
0CB9 27          00720          DAA
0CBA 37          00730          SCF                     ;CARRY MUST BE SET
0CBB 12          00740 M1       LD      (DE),A          ;SAVE DMIN
0CBC 300D        00750          JR      NC,MIN          ;DONT FIX HOURS
0CBE 13          00760          INC     DE              ;FIX HOURS
0CBF 1A          00770          LD      A,(DE)          ;GET DHRS
0CC0 D601        00780          SUB     1               ;SUBTRACT 1 HR
0CC2 27          00790          DAA
0CC3 3004        00800          JR      NC,H1           ;DHRS>0
0CC5 47          00810          LD      B,A             ;DHRS<0
0CC6 AF          00820          XOR     A               ;ZERO A
0CC7 90          00830          SUB     B               ;SUBTRACT HRS FROM 100
0CC8 27          00840          DAA
0CC9 12          00850 H1       LD      (DE),A          ;SAVE HRS
0CCA 1B          00860          DEC     DE              ;BACK TO MINS
0CCB 1A          00870 MIN      LD      A,(DE)          ;GET DMIN
0CCC 96          00880          SUB     (HL)            ;SUBTRACT HMIN
0CCD 27          00890          DAA
0CCE 23          00900          INC     HL              ;UP POINTERS TO HRS
0CCF 13          00910          INC     DE
0CD0 F5          00920          PUSH    AF              ;SAVE MIN
0CD1 3010        00930          JR      NC,HRS          ;DMIN>HMIN
0CD3 F1          00940          POP     AF              ;DMIN<HMIN
0CD4 C660        00950          ADD     A,MINSEC        ;ADD 60 MIN
0CD6 27          00960          DAA
0CD7 F5          00970          PUSH    AF              ;SAVE MIN
0CD8 1A          00980          LD      A,(DE)          ;GET DHRS
0CD9 D601        00990          SUB     1               ;SUBTRACT 1 HR
0CDB 27          01000          DAA
0CDC 3004        01010          JR      NC,HR           ;DHRS>0
0CDE 47          01020          LD      B,A             ;DHRS<0
0CDF AF          01030          XOR     A               ;ZERO A
0CE0 90          01040          SUB     B               ;SUB HRS FROM 100
0CE1 27          01050          DAA
0CE2 12          01060 HR       LD      (DE),A          ;SAVE HRS
0CE3 1A          01070 HRS      LD      A,(DE)          ;GET DHRS
0CE4 96          01080          SUB     (HL)            ;SUB    HHRS
0CE5 27          01090          DAA
0CE6 320F21      01100          LD      (DTIME),A       ;SAVE HRS
0CE9 3804        01110          JR      C,OUT2          ;DHR>BHRS
0CEB 79          01120          LD      A,C             ;DHRS<HHRS
0CEC B7          01130          OR      A               ;IS C FLAG SET
0CED 2801        01140          JR      Z,OUT1          ;DIFF IS POS
0CEF 37          01150 OUT2     SCF                     ;SET CARRY TO INDICATE
0CF0 C1          01160 OUT1     POP     BC              ;DIFF IS NEG
0CF1 78          01170          LD      A,B
0CF2 320E21      01180          LD      (DTIME-1),A     ;SAVE MIN
0CF5 C1          01190          POP     BC
0CF6 78          01200          LD      A,B
0CF7 320D21      01210          LD      (DTIME-2),A     ;SAVE SEC
```

```
0CSA C9          01220          RET
                 01230 ;
                 01240 ;
0000             01250          END
00000 TOTAL ERRORS
```

DTIME	210F	H1	0CC9	HR	0CE2	HRS	0CE3	M1	0CBB
MIN	0CCB	MINSEC	0060	NEC56C	0C80	OK	0C9C	OUT1	0CF0
OUT2	0CEF	STIME	0CA4	SWAP	0CA0				

```
                00100 ;
                00110 ;   PROGRAM  NEC57C
                00120 ;
                00130 ;   VERSION 1.0   12/17/79   CONNER
                00140 ;
                00150 ;       THIS PROGRAM CONVERTS THE BCD DATA IN THE LOCATION
                00160 ;   POINTED TO BY REG (HL) TO ASCII CHARACTERS.  THE LOW
                00170 ;  NIBBLE CHARACTER IS RETURNED IN REG B.  THE HIGH NIBBLE
                00180 ;  CHARACTER IS RETURNED IN REG C AND REG A IS CHANGED.
                00190 ;
                00200 ;   EXTERNAL VECTORS AND CONSTANTS
                00210 ;
0030            00220 ASCII   EQU     30H             ;CONVERSION BCD TO ASCII
                00230 ;
                00240 ;
0C60            00250         ORG     0C60H
0C60 7E         00260 NEC57C  LD      A,(HL)          ;GET BCD DATA
0C61 4F         00270         LD      C,A             ;SAVE DATA
0C62 E60F       00280         AND     0FH             ;CLEAR HIGH NIBBLE
0C64 F630       00290         OR      ASCII           ;MAKE ASCII
0C66 47         00300         LD      B,A             ;SAVE CHARACTER
0C67 79         00310         LD      A,C             ;GET DATA
0C68 0F         00320         RRCA                    ;MOVE HI TO LOW
0C69 0F         00330         RRCA
0C6A 0F         00340         RRCA
0C6B 0F         00350         RRCA
0C6C E60F       00360         AND     0FH             ;CLEAR HIGH
0C6E F630       00370         OR      ASCII           ;MAKE ASCII
0C70 4F         00380         LD      C,A             ;SAVE CHARACTER
0C71 C9         00390         RET
                00400 ;
                00410 ;
0000            00420         END
00000 TOTAL ERRORS


ASCII   0030     NEC57C  0C60
```

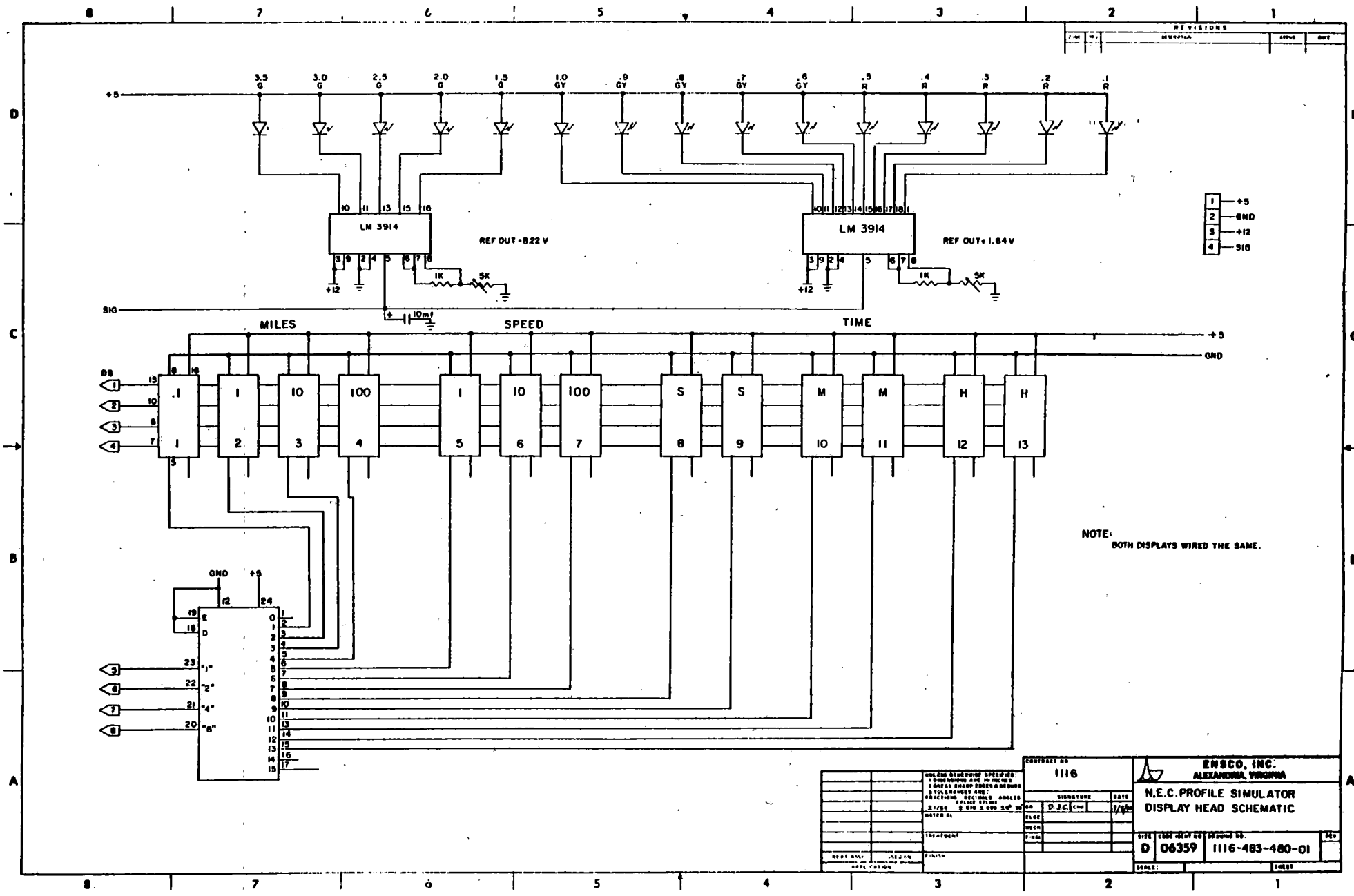
```
                00100 ;
                00110 ;  PROGRAM  NEC58C.
                00120 ;
                00130 ;       THIS PROGRAM WILL LOAD THE TIME POINTED TO BY
                00140 ;    REG (HL) INTO THE PRINT BUFFER AT THE LOCATION
                00150 ;    POINTED TO BY REG (DE).  REG (HL) POINTS TO THE
                00160 ;    LOCATION AFTER THE HOURS ON EXITING.
                00170 ;
                00180 ;
                00190 ;    EXTERNAL VECTORS AND CONSTANTS
                00200 ;
0C60            00210 NEC57C  EQU     0C60H           ;BCD TO ASCII CONVERSION
                00220 ;
                00230 ;
0C40            00240         ORG     0C40H
0C40 CD600C     00250 NEC58C  CALL    NEC57C          ;CONVERT SEC TO ASCII
0C43 78         00260         LD      A,B
0C44 12         00270         LD      (DE),A          ;STORE SEC
0C45 1B         00280         DEC     DE
0C46 79         00290         LD      A,C
0C47 12         00300         LD      (DE),A
0C48 1B         00310         DEC     DE              ;SKIP COLON
0C49 1B         00320         DEC     DE
0C4A 23         00330         INC     HL
0C4B CD600C     00340         CALL    NEC57C          ;CONVERT MIN TO ASCII
0C4E 78         00350         LD      A,B
0C4F 12         00360         LD      (DE),A          ;STORE MIN
0C50 1B         00370         DEC     DE
0C51 79         00380         LD      A,C
0C52 12         00390         LD      (DE),A
0C53 1B         00400         DEC     DE              ;SKIP COLON
0C54 1B         00410         DEC     DE
0C55 23         00420         INC     HL
0C56 CD600C     00430         CALL    NEC57C          ;CONVERT HRS
0C59 78         00440         LD      A,B
0C5A 12         00450         LD      (DE),A          ;STORE HRS
0C5B 1B         00460         DEC     DE
0C5C 79         00470         LD      A,C
0C5D 12         00480         LD      (DE),A
0C5E 23         00490         INC     HL              ;POINT TO NEXT DATA
0C5F C9         00500         RET
                00510 ;
                00520 ;
0000            00530         END
00000 TOTAL ERRORS


NEC57C  0C60     NEC58C  0C40
```

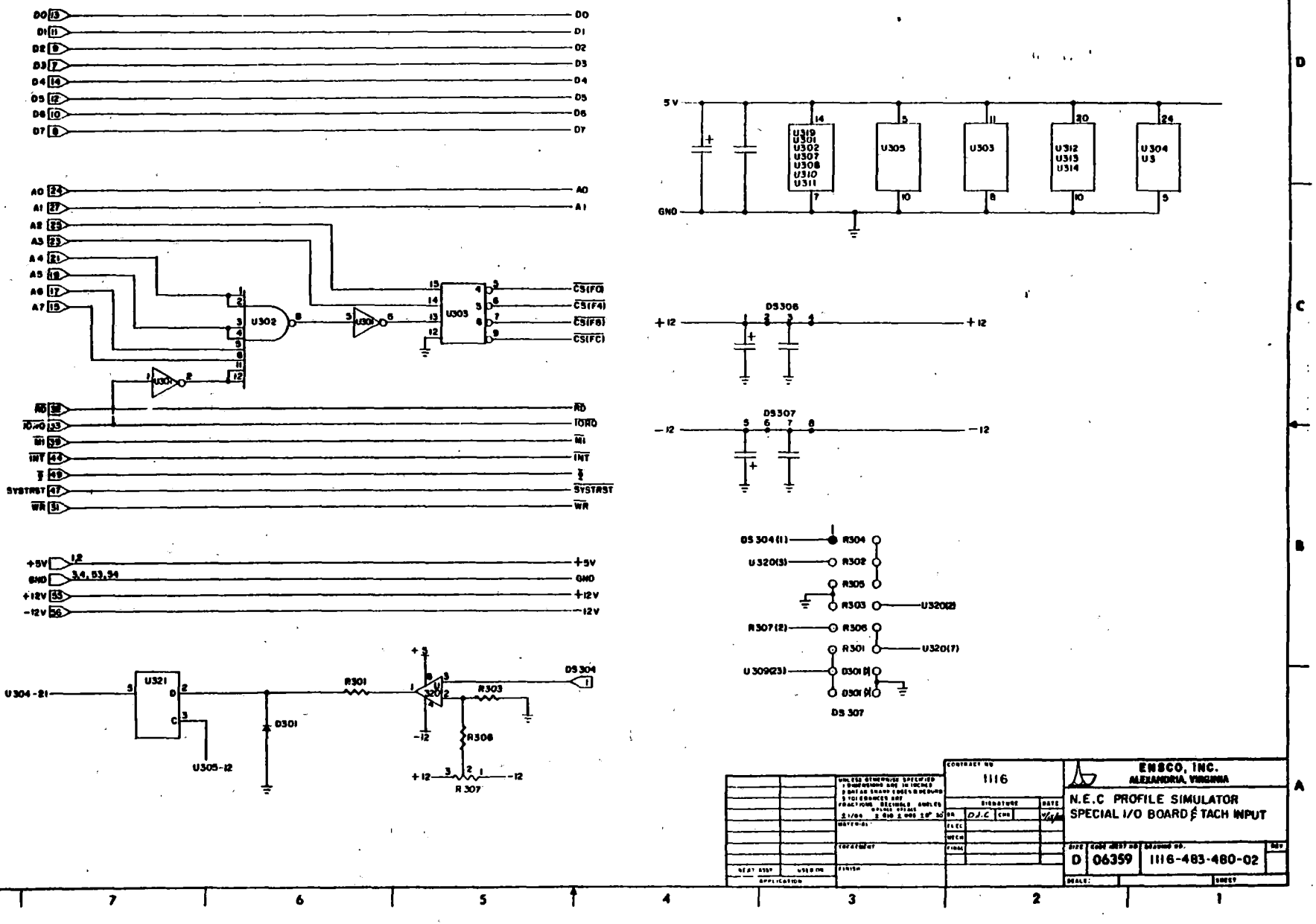
```
                00100 ;
                00110 ;PROGRAM NEC91C
                00120 ;
                00130 ; VERSION 1.0 12/11/79 CONNER
                00140 ;
                00150 ;INTERRUPT ROUTINE FOR ELAPSED TIME
                00160 ;
                00170 ;       THIS ROUTINE PROCESSES 1 SEC INTERRUPTS FOR THE
                00180 ;  ELAPSED TIME INDICATOR.  IT USES THE ALTERNATE REGISTER
                00190 ;  SET AND MODIFIES THE CONTENTS OF THE ELAPSED TIME
                00200 ;  COUNTER LOCATIONS.
                00210 ;
                00220 ;
                00230 ; EXTERNAL VECTORS AND ADDRESSES
                00240 ;
2115            00250 CSEC      EQU     2115H           ;CURRENT SEC COUNT ADDR
2116            00260 CMIN      EQU     2116H           ;CURRENT MIN COUNT ADDR
2117            00270 CHR       EQU     2117H           ;CURRENT HR COUNT ADDR
                00280 ;
                00290 ;
0810            00300           ORG     0810H
0810 F3         00310 NEC91C    DI                      ;DISABLE INTERRUPTS
0811 08         00320           EX      AF,AF'          ;SAVE REGISTER
0812 AF         00325           XOR     A               ;CLEAR FLAGS
0813 3A1521     00330           LD      A,(CSEC)        ;GER SEC COUNT
0816 3C         00340           INC     A               ;ADD 1 SEC
0817 27         00350           DAA                     ;ADJUST FOR BCD
0818 321521     00360           LD      (CSEC),A        ;SAVE SEC COUNT
081B FE60       00370           CP      60H             ;ONE MIN?
081D 201C       00380           JR      NZ,EXIT         ;NO, LEAVE
081F AF         00390           XOR     A               ;YES, CLEAR SEC'S
0820 321521     00400           LD      (CSEC),A
0823 3A1621     00410           LD      A,(CMIN)        ;GET MIN COUNT
0826 3C         00420           INC     A               ;ADD 1 MIN
0827 27         00430           DAA                     ;ADJUST FOR BCD
0828 321621     00440           LD      (CMIN),A        ;SAVE MIN COUNT
082B FE60       00450           CP      60H             ;ONE HR?
082D 200C       00460           JR      NZ,EXIT         ;NO, LEAVE
082F AF         00470           XOR     A               ;YES, CLEAR MIN COUNT
0830 321621     00480           LD      (CMIN),A
0833 3A1721     00490           LD      A,(CHR)         ;GET HR COUNT
0836 3C         00500           INC     A               ;ADD 1 HR
0837 27         00510           DAA                     ;ADJUST FOR BCD
0838 321721     00520           LD      (CHR),A         ;SAVE HR COUNT
083B 08         00530 EXIT      EX      AF,AF'          ;RETURN REGISTER
083C FB         00540           EI                      ;ENABLE INTERRUPTS
083D ED4D       00550           RETI                    ;RETURN
0000            00560           END
00000 TOTAL ERRORS


CHR     2117    CMIN    2116    CSEC    2115    EXIT    083B    NEC91C  0810
```

```
                00100 ;
                00110 ;PROGRAM NEC92C
                00120 ;
                00130 ; VERSION 1.0    01/12/80       CONNER
                00140 ;
                00150 ;INTERRUPT ROUTINE FOR ODOMETER
                00160 ;
                00170 ;       THIS ROUTINE PROCESSES .001 MILEC INTERRUPTS FOR THE

                00180 ;  ODOMETER INDICATOR.  IT USES THE ALTERNATE REGISTER
                00190 ;  SET AND MODIFIES THE CONTENTS OF THE ODOMETER
                00200 ;  COUNTER LOCATIONS.
                00210 ;
                00220 ;
                00230 ; EXTERNAL VECTORS AND ADDRESSES
                00240 ;
2110            00250 CODO1   EQU     2110H           ;CURRENT .001 MI COUNT ADDR
2111            00260 CODOL   EQU     2111H           ;CURRENT MILE COUNT ADDR
2112            00270 CODOH   EQU     2112H           ;CURRENT 10 MI COUNT ADDR
                00280 ;
                00290 ;
0840            00300         ORG     0840H
0840 F3         00310 NEC91C  DI                      ;DISABLE INTERRUPTS
0841 08         00320         EX      AF,AF'          ;SAVE REGISTER
0842 AF         00330         XOR     A               ;CLEAR FLAGS
0843 3A1021     00340         LD      A,(CODO1)       ;GET .001 MI COUNT
0846 3C         00350         INC     A               ;ADD 1 SEC
0847 27         00360         DAA                     ;ADJUST FOR BCD
0848 321021     00370         LD      (CODO1),A       ;SAVE .001 MI COUNT
084B 3012       00380         JR      NC,EXIT         ;LESS THAN .1 MILE
084D 3A1121     00390         LD      A,(CODOL)       ;GET MILES AND TENTHS COUNT
0850 3C         00400         INC     A               ;ADD .1 MILE
0851 27         00410         DAA                     ;ADJUST FOR BCD
0852 321121     00420         LD      (CODOL),A       ;SAVE MILE AND TENTH COUNT
0855 3008       00430         JR      NC,EXIT         ;LESS THAN 10 MILES
0857 3A1221     00440         LD      A,(CODOH)       ;GET HUND AND TENS COUNT
085A 3C         00450         INC     A               ;ADD 10 MILES
085B 27         00460         DAA                     ;ADJUST FOR BCD
085C 321221     00470         LD      (CODOH),A       ;SAVE HUND AND TENS COUNT
085F 08         00480 EXIT    EX      AF,AF'          ;RETURN REGISTER
0860 FB         00490         EI                      ;ENABLE INTERRUPTS
0861 ED4D       00500         RETI                    ;RETURN
0000            00510         END
00000 TOTAL ERRORS


CODO1   2110    CODOH   2112    CODOL   2111    EXIT    085F    NEC91C  0840
```

APPENDIX C

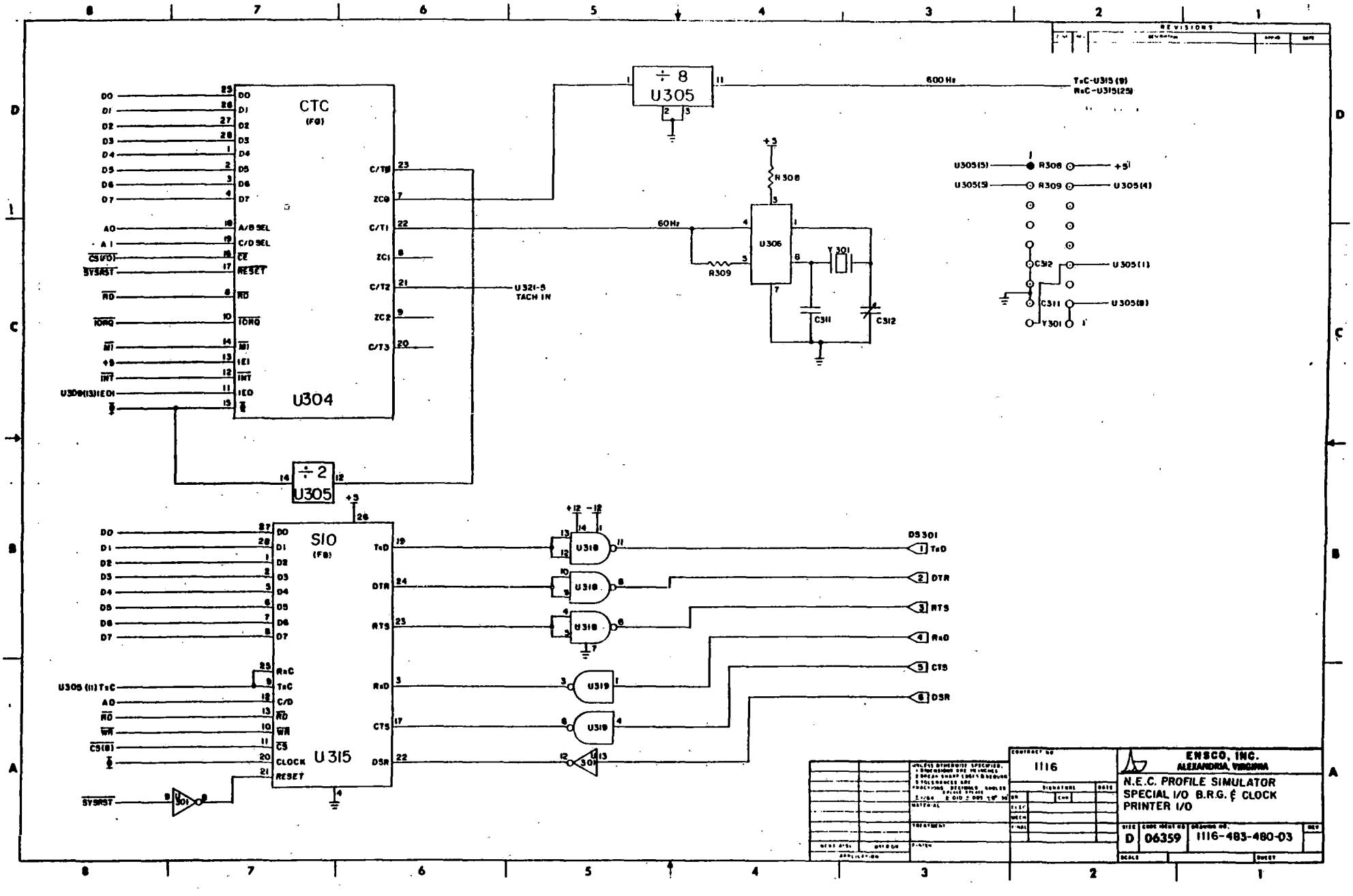
NEC PROFILE SIMULATOR
CIRCUIT DIAGRAMS

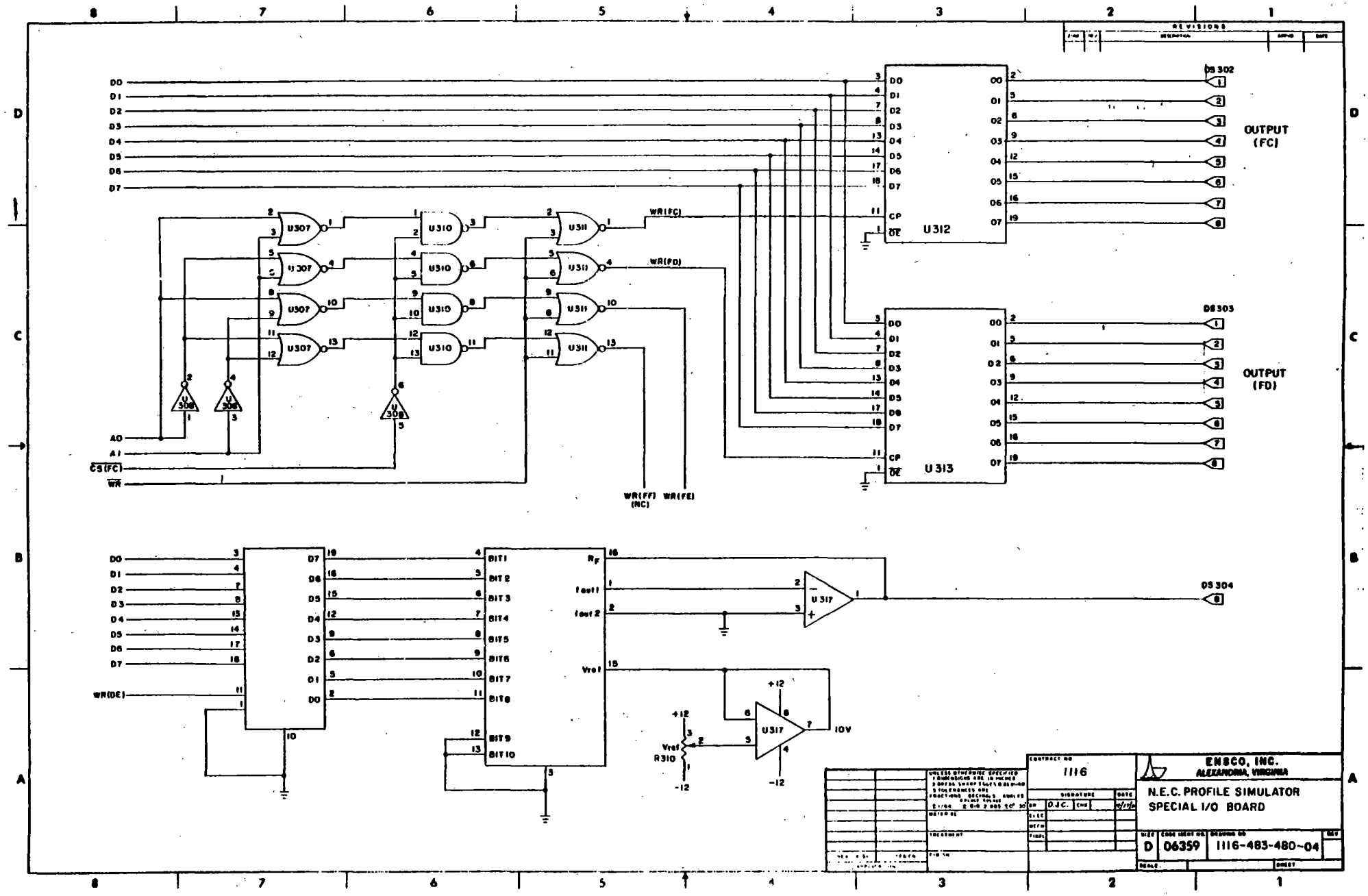

REVISIONS
3.5 G
3.0 G
2.5 G
2.0 G
1.5 G
1.0 GY
.9 GY
.8 GY
.7 GY
.6 GY
.5 R
.4 R
.3 R
.2 R
.1 R
+5
SIG
LM 3914
REF OUT +6.22 V
REF OUT+1.64 V
+12
1K
5K
10mf
MILES
SPEED
TIME
GND
.1
1
10
100
S
M
H
NOTE:
BOTH DISPLAYS WIRED THE SAME.
"1"
"2"
"4"
"8"
CONTRACT NO
1116
ENSCO, INC.
ALEXANDRIA, VIRGINIA
N.E.C. PROFILE SIMULATOR
DISPLAY HEAD SCHEMATIC
SIZE
D
CODE IDENT NO
06359
DRAWING NO.
1116-483-480-01
REV
SCALE:
SHEET

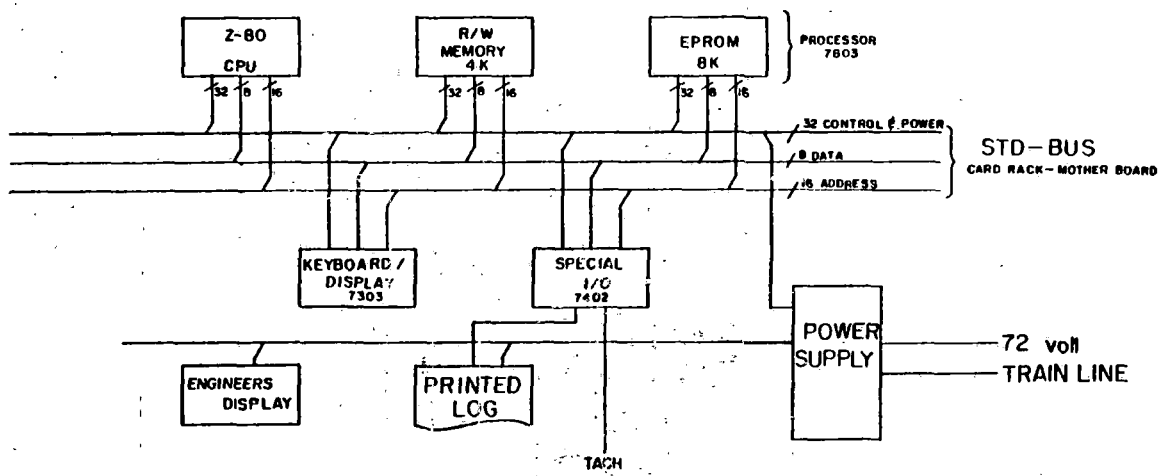


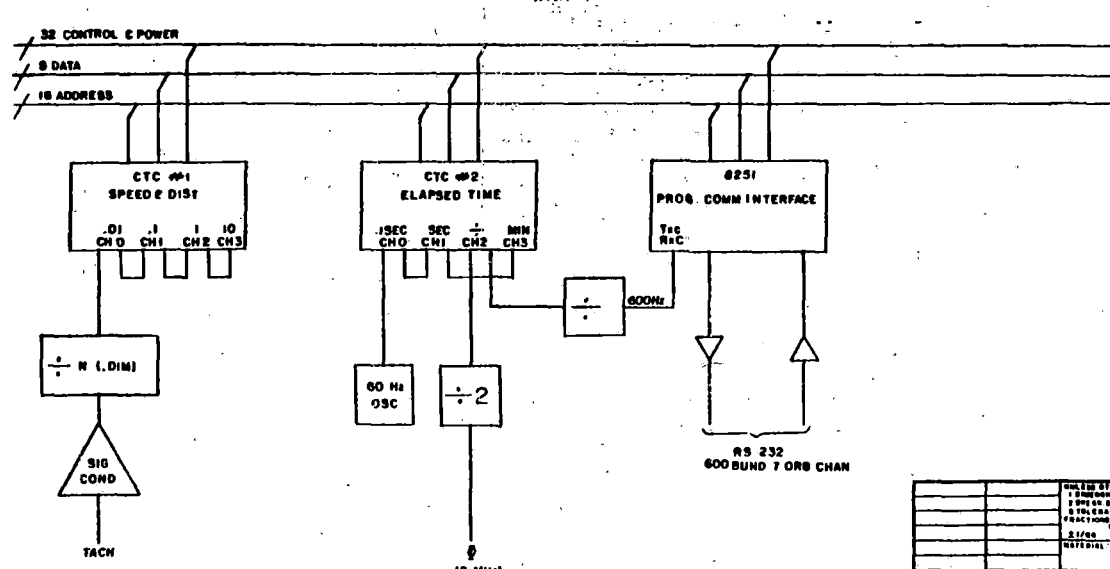
REVISIONS				
ITEM	REV	DESCRIPTION	APPVD	DATE

CONTRACT NO	1116	ENSCO, INC. ALEXANDRIA, VIRGINIA	
SIGNATURE	DATE	N.E.C PROFILE SIMULATOR SPECIAL I/O BOARD & TACH INPUT	
DJC		SIZE: D	CODE IDENT NO: 06359
		DRAWING NO: 1116-483-480-02	REV
		SCALE:	SHEET

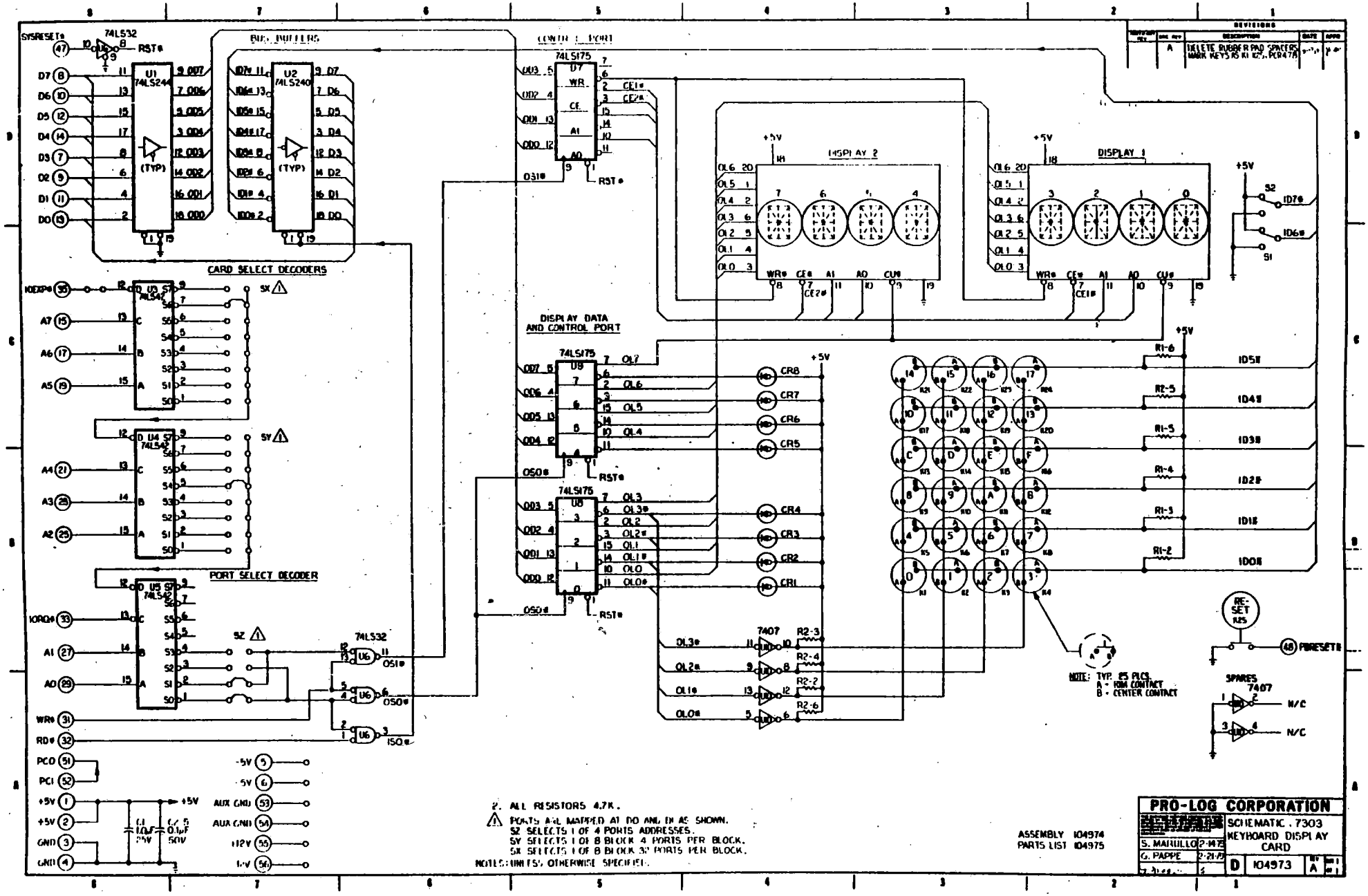

CTC
(F9)
U304
÷ 8
U305
÷ 2
U305
600 Hz
TxC-U315(9)
RxC-U315(25)
60Hz
R308
R309
U306
Y301
C311
C312
U305(5)
U305(9)
+5V
U305(4)
U305(11)
U305(8)
U321-5
TACH IN
SIO
(F8)
U315
U305(11) TxC
SYSRST
U318
U319
DS301
TxD
DTR
RTS
RxD
CTS
DSR
CONTRACT NO
1116
ENSCO, INC.
ALEXANDRIA, VIRGINIA
N.E.C. PROFILE SIMULATOR
SPECIAL I/O B.R.G. & CLOCK
PRINTER I/O
SIZE
D
CODE IDENT NO
06359
DRAWING NO
1116-483-480-03
SCALE
SHEET

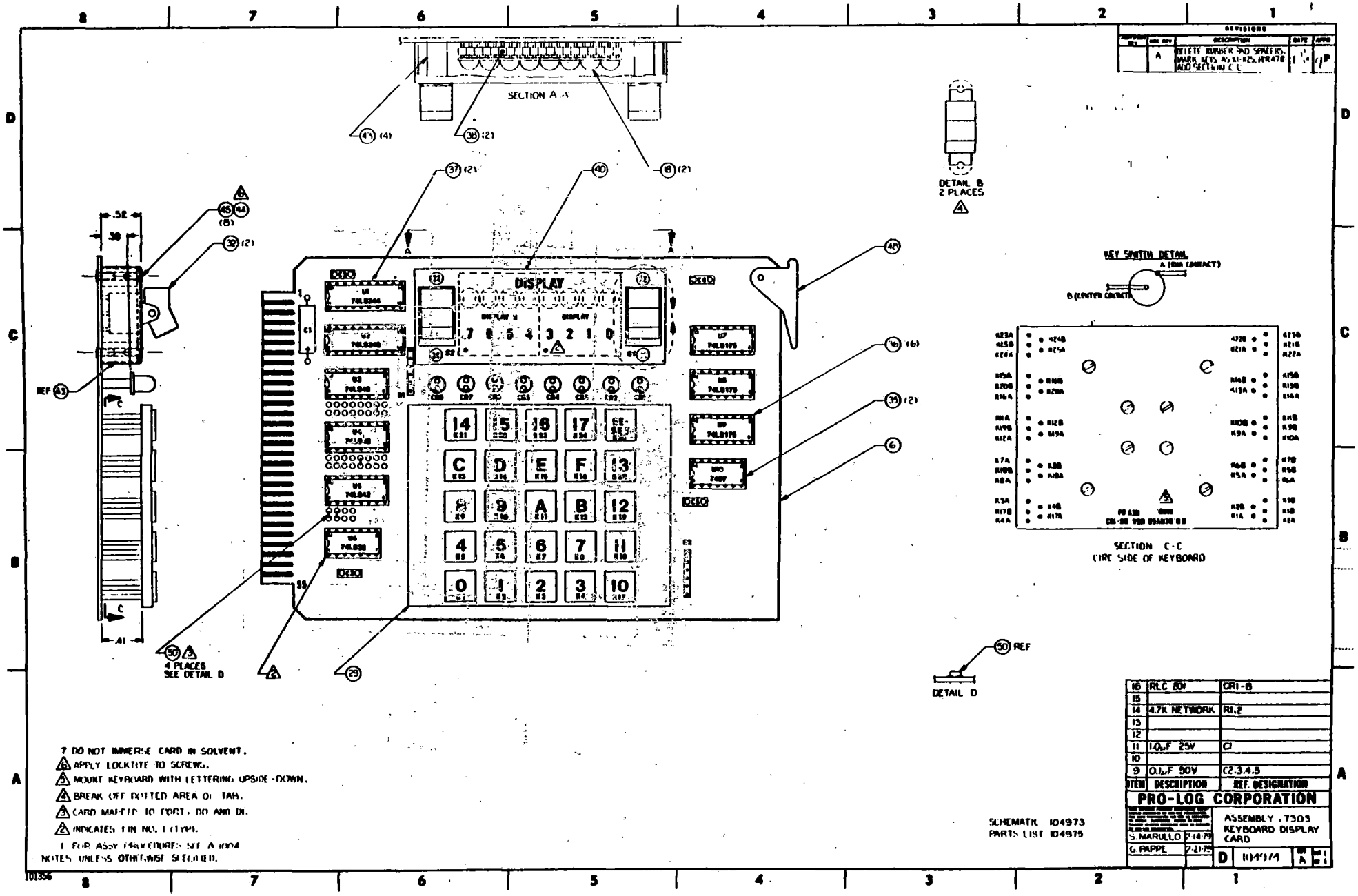

D0
D1
D2
D3
D4
D5
D6
D7
A0
A1
CS(FC)
WR
U307
U310
U311
U308
WR(FC)
WR(FD)
WR(FF) (NC)
WR(FE)
U312
U313
OUTPUT (FC)
OUTPUT (FD)
DS302
DS303
DS304
WR(DE)
BIT1
BIT2
BIT3
BIT4
BIT5
BIT6
BIT7
BIT8
BIT9
BIT10
Rf
Iout1
Iout2
Vref
U317
+12
-12
10V
R310
ENSCO, INC.
ALEXANDRIA, VIRGINIA
N.E.C. PROFILE SIMULATOR
SPECIAL I/O BOARD
1116
D
06359
1116-483-480-04





CONTRACT NO. 1116	ENSCO, INC. ALEXANDRIA, VIRGINIA		
	N.E.C. PROFILE SIMULATOR		
	SPECIAL INTERFACE BLOCK DIA.		
	SYSTEM BLOCK DIAGRAM		
	SIZE D	CODE IDENT NO. 06359	DRAWING NO. 1116-465-480-05


SYSRESET#
74LS32
RST#
BUS BUFFERS
U1 74LS244
U2 74LS240
(TYP)
CARD SELECT DECODERS
PORT SELECT DECODER
CONTR. PORT
74LS175
DISPLAY DATA AND CONTROL PORT
DISPLAY 2
DISPLAY 1
+5V
S2
S1
ID7#
ID6#
ID5#
ID4#
ID3#
ID2#
ID1#
ID0#
CR8
CR7
CR6
CR5
CR4
CR3
CR2
CR1
7407
R2-3
R2-4
R2-2
R2-6
RI-6
RI-5
RI-4
RI-3
RI-2
RESET
PRESET#
SPARES
N/C
NOTE: TYP. 85 PLCS.
A - 10M CONTACT
B - CENTER CONTACT
-5V
AUX GND
+12V
-12V
PCO
PCI
GND
2. ALL RESISTORS 4.7K.
PORTS ARE MAPPED AT DO AND UP AS SHOWN.
S2 SELECTS 1 OF 4 PORTS ADDRESSES.
SY SELECTS 1 OF 8 BLOCK 4 PORTS PER BLOCK.
SX SELECTS 1 OF 8 BLOCK 32 PORTS PER BLOCK.
NOTES: UNLESS OTHERWISE SPECIFIED.
ASSEMBLY 104974
PARTS LIST 104975
PRO-LOG CORPORATION
SCHEMATIC, 7303 KEYBOARD DISPLAY CARD
S. MARRILLO 2-14-79
G. PAPPE 2-21-79
D 104973 A
REVISIONS
A
DELETE RUBBER PAD SPACERS MARK KEYS AS REF. PER 478



REVISIONS			
REV	DESCRIPTION	DATE	APPD
A	DELETE RUBBER PAD SPACERS, MARK KEYS A5,B5,B25,AFR478 ADD SECTION C-C		

ITEM	DESCRIPTION	REF. DESIGNATION
16	RLC 80V	CR1-8
15		
14	4.7K NETWORK	R1-2
13		
12		
11	10μF 25V	C1
10		
9	0.1μF 50V	C2,3,4,5

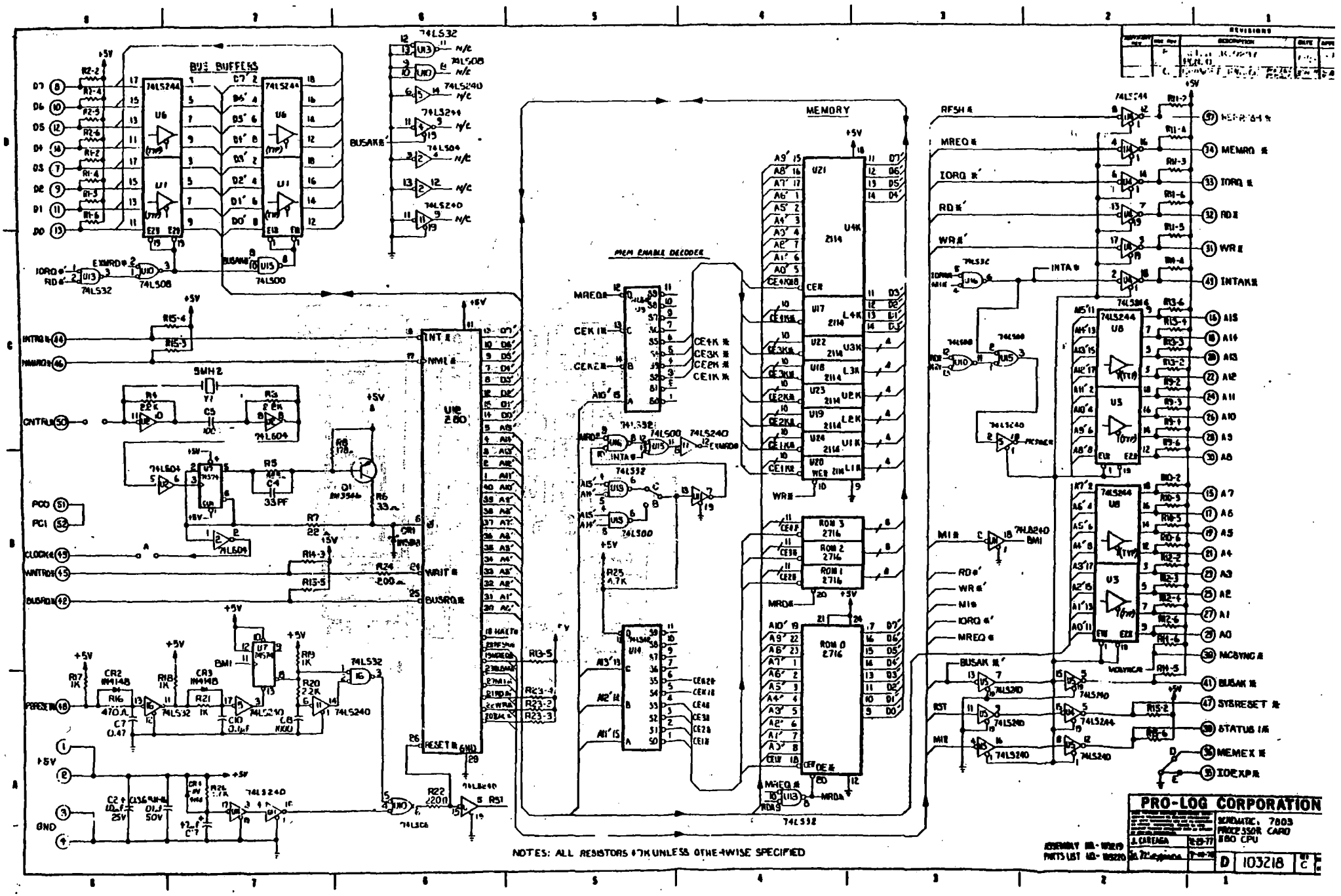
PRO-LOG CORPORATION

S. MARULLO	2-14-79	ASSEMBLY, 7303 KEYBOARD DISPLAY CARD
G. PAPPE	2-21-79	D 104974 A

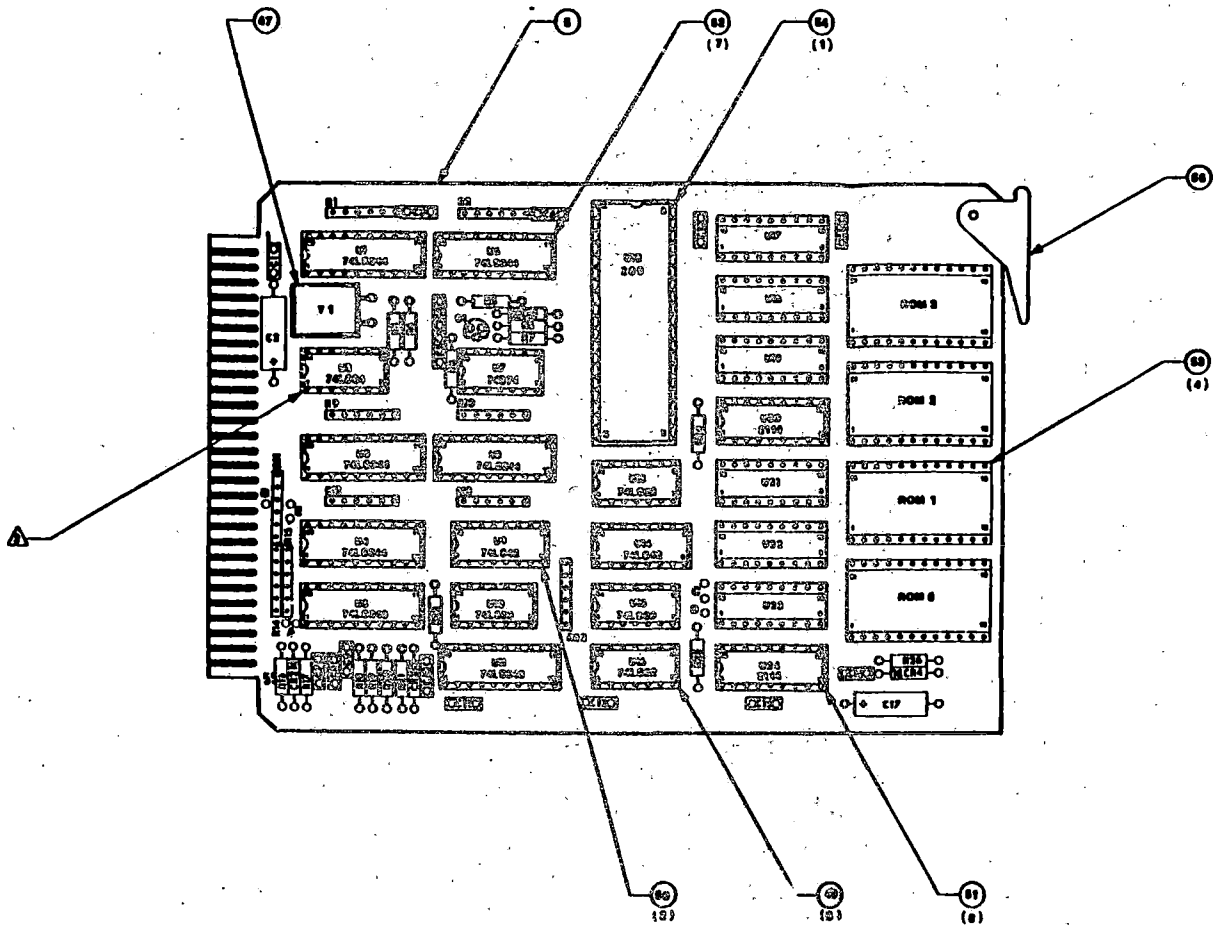
SCHEMATIC 104973
PARTS LIST 104975

7 DO NOT IMMERSE CARD IN SOLVENT.
6 APPLY LOCKTITE TO SCREWS.
5 MOUNT KEYBOARD WITH LETTERING UPSIDE-DOWN.
4 BREAK OFF DOTTED AREA OF TAB.
3 CARD MATED TO PORT. DD AND DE.
2 INDICATES PIN NO. 1 (TYP).
1 FOR ASSY PROCEDURES SEE A 1004
NOTES UNLESS OTHERWISE SPECIFIED.

101356


BUS BUFFERS
MEMORY
PROM ENABLE DECODER
NOTES: ALL RESISTORS 47K UNLESS OTHERWISE SPECIFIED
PRO-LOG CORPORATION
SCHEMATIC, 7803
PROCESSOR CARD
280 CPU
D
103218

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPD
	A	REF. PCR. 0197. PCN. 017	11-7-83	
	B	REF. PCR. 0297. PCN. 0164	6-11-84	
	C	DELETED NOTES 3 & 4 PCR 0297. PCN 0164	6-11-84	
	D	DELETED ITEM 13 AND ADDED ITEM 25. PCR 363. PCN 211	9-11-87	



ITEM	DESCRIPTION	REF. DESIGNATION
40	CRYSTAL	Y1
39	2N3550	Q1
38		
37	1N4148	CR1-3,9
36	1N5818	CR11
35	1K, 1/4W, 5%	R17,18,19,21
34	470Ω, 1/4W, 5%	R16
33	4.7K, NETWORK	RN1,2,3-15,17
32	47K, 1/4W, 5%	R20,24
31	2.2K, 1/4W, 5%	R23,25
30	680Ω, 1/4W, 1%	R5
29	200Ω, 1/4W, 5%	R22
28	240Ω, 1/4W, 5%	R24
27		
26	750Ω, 1/4W, 1%	R6
25		
24	33Ω, 1/4W, 5%	R4
23	33Ω, NWW, 5%	R7
22		
21	4.7μF, 25V	C17
20	1.0μF, 25V	C8
19	0.01μF, 50V	C7
18	.01μF, 50V	C1,2,4,5-16
17	1000pF, 50V	C12
16	330PF, 50V	C6

PRO-LOG CORPORATION

ASSEMBLY, 7809 PROCESSOR CARD Z80 CPU

C.A. CLARK 7-18-78

D 103219 D

SCHEMATIC NO 103218
PARTS LIST NO 103220

⚠ INDICATES PIN NO. 1 OF SOCKETS (TYP).
1 FOR ASSY PROCEDURES SEE A51004.
NOTES: UNLESS OTHERWISE SPECIFIED.

101356