

## SOFTWARE FOR ON-LINE MONITORING OF E10-B TELEPHONE EXCHANGE

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### ABSTRACT

The proposed software aims at enhancing the monitoring of the E10-B telephone exchange. It combines functions normally performed by two dedicated hardware devices and facilitates access to detailed maintenance information contained in manuals. The equipment required to run the software is a standard IBM-compatible XT (or higher) computer. Field trials of the software demonstrate its successful operation. In addition, a demo version has been compiled to illustrate the program features on any standard IBM compatible PC.

### INTRODUCTION

One of the basic functions performed by a telecommunication administration is to ensure the smooth and fault-free operation of its telephone network. The switching centers (or exchanges) constitute the heart of the telephone network and monitoring their operation, therefore, is of a paramount importance.

During the operation of a typical exchange, two types of maintenance information are usually reported, and these are sent in the form of alarm messages and fault messages. **Alarm messages** relate to conditions conducive to the proper operation of the exchange, such as:

- power supply status
- air conditioner status
- fire hazards
- burglar (or intruder) hazards

Meanwhile, **fault messages** relate to the actual functions performed by the exchange and any auxiliary operations related to it. These include:

- connection unit status
- switching unit status
- control unit status

as well as the integrity of the software and hardware modules that are involved in the operation of the above units.

In the present paper, we describe a newly developed software which greatly enhances the functioning of maintenance staff supervising telephone networks which employ the well-known French exchange, type E10-B. This exchange is used in Qatar and is extensively used worldwide because of its outstanding features. A summary of these features is listed below (GRINSEC, 1983):

### **System**

Time-division switching  
Pulse code modulation (PCM) to CCITT<sup>1</sup> and CEPT<sup>2</sup> standards  
Stored program control (SPC)

### **Capacity**

255 switchable PCM links  
Traffic handling capacity of 2400 to 2600 erlangs  
30,000 lines as a subscriber exchange

## MOTIVATION FOR THE PROPOSED SOFTWARE

The current arrangement for monitoring the E10-B exchange in many countries typically uses two dedicated hardware devices for monitoring maintenance information. These are:

- The Visual Console (abbreviated CV), which displays the **alarm** and **fault** messages transmitted by the minicomputer MITRA 225 employed in the Operation and Maintenance Center (OMC).
- The General Visual Display console (abbreviated PGV), which provides a mimic board representation of the E10-B exchange units and its associated satellites. This board incorporates 240 three-color lamp positions and provides **alarm** indications at each unit by lighting up the proper color and sounding a warning.

In addition to these devices, the maintenance staff would normally consult a set of Dictionary Manuals which contain explanations concerning the source unit of the alarm or fault, the probable causes for such an event, and the recommended course of action to adopt.

It was believed that the time and effort of the maintenance staff could be more efficiently utilized by developing a software package that can run on an

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<sup>1</sup> CCITT stands for *Comite Consultatif International Telephonique et Telegraphique*

<sup>2</sup> CEPT stands for *Conference European des Postes et Telecommunications*

IBM-compatible PC, so as to perform the functions currently realized by the CV and the PGV, and at the same time, allow the staff to access the Dictionary Manuals' information rapidly. Moreover, it was sought to make the software as user friendly as possible. This would be achieved by incorporating features such as menu selection and the ability to select individual units of the exchange by using cursor movement. Furthermore, it was conceived that by involving a graduating student in some aspects of the software development, he becomes better equipped to contribute directly to the Qatari society upon his graduation.

Figure 1 shows a graphical representation of the typical configuration used for monitoring the E10-B exchange, as well as the proposed configuration for using the IBM-compatible PC to perform the aforementioned functions.

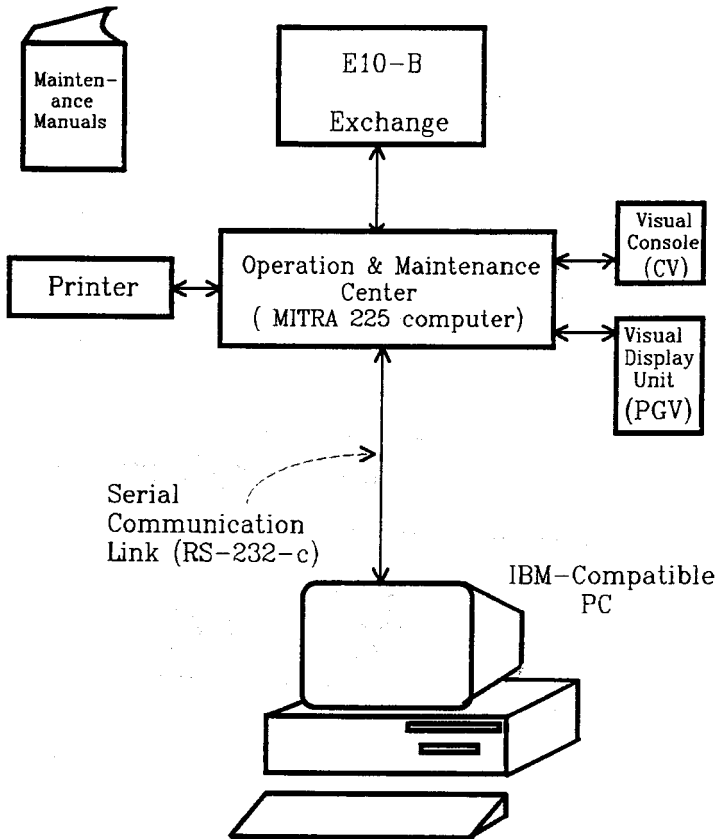


Fig. 1: Graphical representation of the typical and proposed arrangement for monitoring the E10-B exchange.

MAINTENANCE INFORMATION FORMAT

The MITRA 225 computer in the OMC of the exchange transmits alarm and fault messages to the CV over a standard RS-232-C cable. The message format and the meaning of each field within the message, are shown in Fig. 2 for an alarm message (Notes, 28.2) and in Fig. 3 for a fault message (Notes, 28.1).

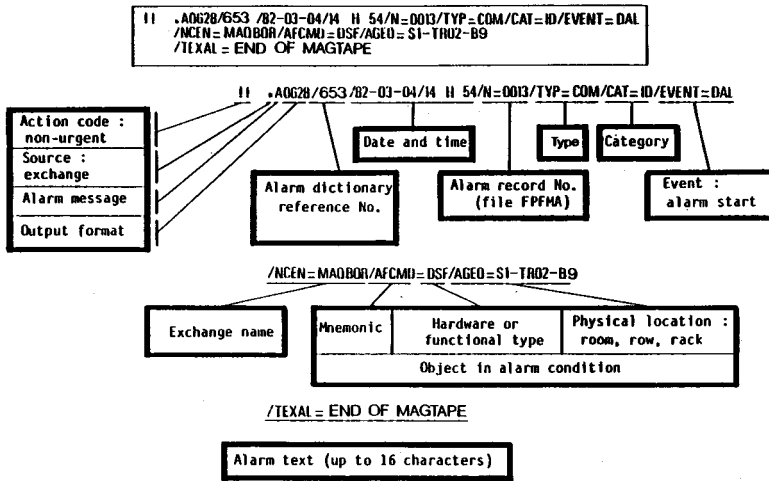


Fig. 2: Format of the alarm message sent by the MITRA 225 computer to the CV device.

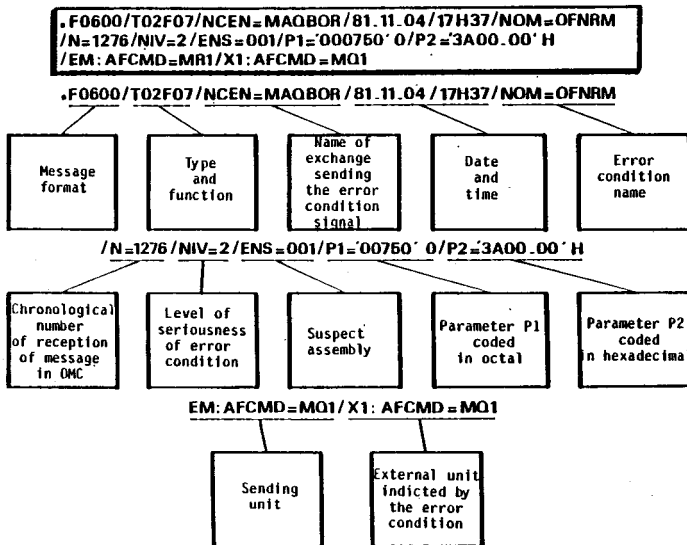


Fig. 3: Format of the fault message sent by the MITRA 225 computer to the CV device.

## DESIRED FEATURES OF THE NEW SOFTWARE

The software program for monitoring the E10-B exchange has been designed so as to accomplish the following tasks:

- Task 1:** To present the alarm and fault messages sent by the MITRA 225 computer on the monitor of the IBM-compatible PC.
- Task 2:** To display alarm and fault information of the various units in the E10-B exchange, the OMC, and their environments, in a graphical form, on the monitor of the IBM-compatible PC.
- Task 3:** To provide a listing on the PC monitor of all alarm messages and all fault messages, associated with any exchange unit, at any desired time.
- Task 4:** To provide all possible information that is pertinent to existing alarms and faults, through simple manipulations of the PC keyboard, and displaying such information on the PC monitor.

## BUILDING BLOCKS OF THE DEVELOPED SOFTWARE

The software program developed to implement these tasks has the structure shown in Fig. 4. Basically, the PC receives the information that would otherwise go from the MITRA 225 to a printer or a CV, (through an RS-232-C cable). The received information is then processed by a subprogram called Message.Handler, which consists of two parts. The function of the first part is to extract one message (either alarm or fault) from the incoming information, and hence is called Message Reader. This part also feeds the received information into a screen that can be displayed on the monitor by pressing a suitable key. Such a screen is called the "CV screen" since it does the job of the classical CV display. In this manner, Task 1 can be realized.

The second part of the Message.Handler subprogram is called the Message Analyzer. Its function is to analyze the extracted message, depending on whether it is an alarm or a fault. For an alarm message, a flashing 'A' would appear on a graphical representation of the exchange, the OMC, and their environments. This graphical representation appears on one of the screens of the PC monitor, which is called the "Opening Screen". The flashing "A" would appear at the location of the unit in which an alarm has occurred. In this way the job of the classical PGV is realized. Moreover, a flashing "F" would appear at the location of the unit in which a fault has occurred. As a result, Task 2 is also implemented.

The analysis performed by the Message Analyzer is also used to update the alarm status and the fault status of each unit in the system. To do so, each unit (there are

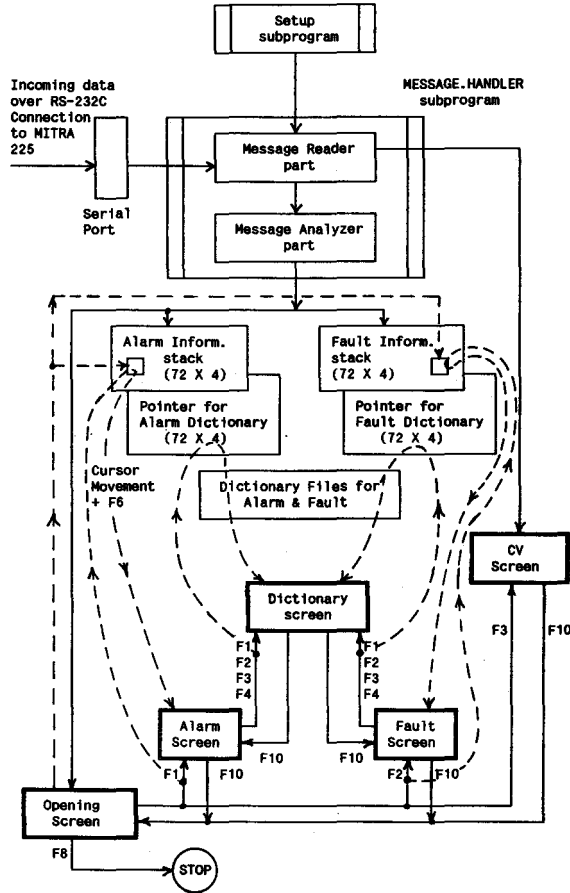


Fig. 4: General structure of the software program for on-line monitoring of the E10-B exchange.

72 units in total) is allocated up to 4 storage cells to record current alarms, and another 4 alarm cells to record current faults. Thus, there is a stack for alarm information whose size is (72 units x 4 messages), and another stack for fault information of a similar size. Fig. 5 shows a pictorial representation of the 72 units that appear on the "Opening Screen", as well as the alarm information stack and the fault information stack.

For each of the 72 units in the system, it is possible to display either the messages stored in the alarm information stack, or the messages stored in the fault information stack. To do so, one has first to select the desired unit by using the arrow keys (to move a cursor within a block of units) and the F6 function key (to

move between different blocks of units). The next step is to press either F1 (if alarm information is desired), or F2 (if fault information is desired). In the first case, the monitor displays a screen containing the alarm messages (called "Alarm Screen"), and in the second case another screen is displayed showing the fault messages (called "Fault Screen"). In this way, Task 3 is implemented.

Finally, in order to implement Task 4, the dictionary information for alarms and faults is stored in individual files. These files are given codes, called dictionary numbers. Now, whenever a particular alarm or fault occurs in a unit, its dictionary number is automatically stored in a storage cell. The storage cells for the alarms are called "Pointers for Alarm Dictionary", and those for faults are called "Pointers for Fault Dictionary". These pointers are shown in Fig. 5.

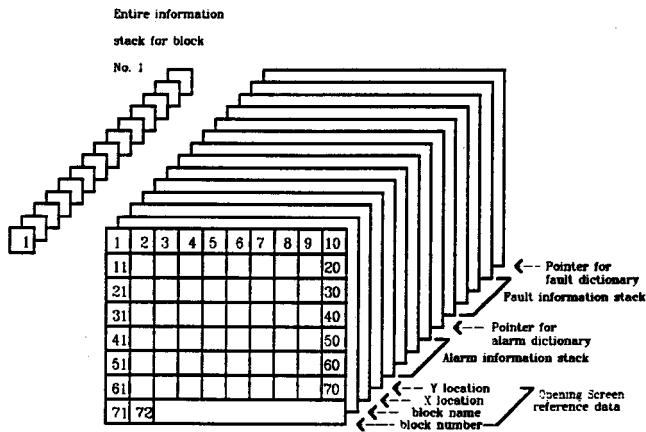


Fig. 5: Pictorial representation of the arrays used for identifying different units of the E10-B exchange on the Opening Screen, and for storing the relevant maintenance information.

Depending on whether one is displaying the Alarm Screen or the Fault Screen, it is always possible to display the dictionary file for the event (alarm or fault) of interest. To do so, one simply presses a function key (F1, F2, F3, or F4), which corresponds to the order in which events are displayed (1st event, 2nd event, 3rd event, and 4th event). In response, a new screen — called "Dictionary Screen" — appears on the PC monitor showing the contents of the dictionary file corresponding to the event of interest.

**Remarks:**

1. Function key F10 has been programmed to switch from the Dictionary Screen to the Alarm (Fault) Screen, or from the Alarm (Fault) Screen to the Opening Screen, or from the CV Screen to the Opening Screen.

2. Function key F8 has been programmed to exit from the software program to the DOS environment of the PC.
3. In order to setup the initial values of variables and constants in the program; to program the various function keys; to open the serial communication port; and to setup the various screens of the monitor, a number of subprograms are used. These "Setup" subprograms are supported by another set of subprograms that provide certain utilities such as timer function, and initializing the contents of alarm and fault stacks.

In the Appendix that follows, we describe the setup subprograms, the Message.Handler subprogram, and the other supporting subprograms in some detail.

### ILLUSTRATIONS ON THE USE OF THE DEVELOPED SOFTWARE

In order to validate the operation of the developed software, a field trial has been carried out on one of the E10-B exchanges. A standard IBM-compatible AT computer was used as the platform, and it was connected to the MITRA 225 minicomputer in the OMC via an RS-232-C cable. The developed software package was run under the MS-DOS operating system. The results of this field trial are shown in Figs. 6-13.

Figure 6 shows the control room in which the trial was carried out. Also shown in the figure is the conventional monitoring arrangement which consists of the CV equipment (in front of the operator), the PGV equipment (in the background) and the Dictionary Manuals typically consulted by the operator (shelved below the CV).



Fig. 6: View of the control room in which a field trial was carried out using the developed software.



Figure 7 depicts the standard IBM-compatible AT computer being connected to the MITRA 225 of the OMC. The Opening Screen that displays a graphical representation of the exchange, its satellites and its environment is shown in Fig. 8. The screen represents each unit in the exchange by a box, with its name coded using the standard abbreviations for that unit.

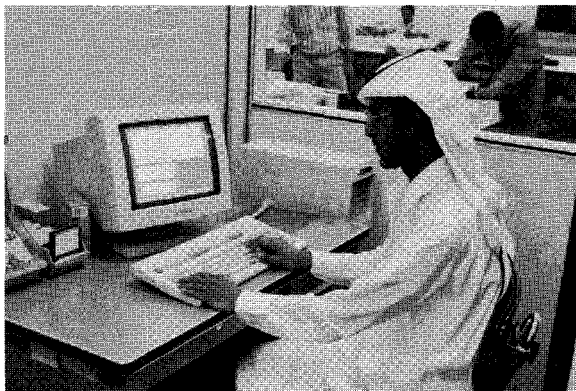


Fig. 7: View of the standard IBM-compatible AT computer which was connected to the MITRA 225 computer via an RS-232-C cable.

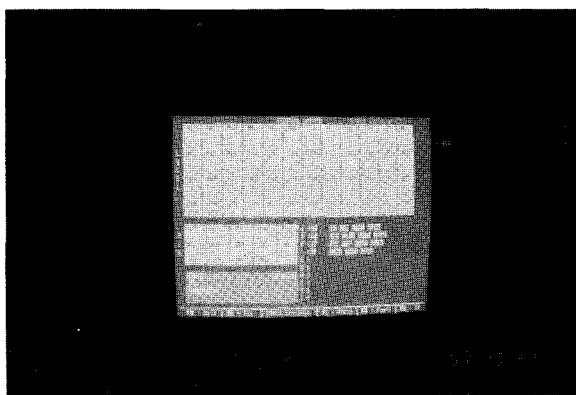


Fig. 8: View of the Opening Screen appearing on the monitor of the microcomputer during the field trial.

The maintenance information that would otherwise be displayed on the CV device is obtained by pressing the F3 key, in which case the same information would be shown on the monitor of the microcomputer (Fig. 9).

Whenever the Opening Screen is displayed on the monitor, one can select any particular unit in the exchange (using the cursor keys and F6), and then zoom into

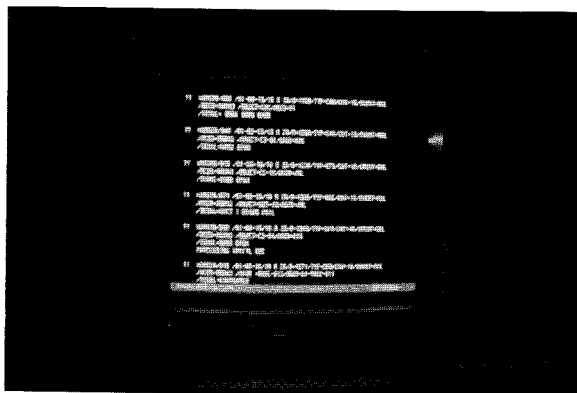


Fig. 9: View of the CV Screen appearing on the monitor of the microcomputer during the field trial.

that unit. Pressing key F1 from the Opening Screen would display the Alarm Screen for the selected unit, as shown in Fig. 10 for the case of the Subscriber Connection Unit (UR13). Moreover, the Dictionary Information relevant to the alarm message indexed by F1 in Fig. 10, can be obtained by pressing key F1 from the Alarm Screen, and this is shown in Fig. 11.

Likewise, pressing key F2 from the Opening Screen would display the Fault Screen for the selected unit, as is shown in Fig. 12 for the case of the Multiregister Unit (MR-1). Also, the Dictionary Information relevant to the fault message indexed by F1 in Fig. 12, can be obtained by pressing key F1 from the Fault Screen, and this is shown in Fig. 13.

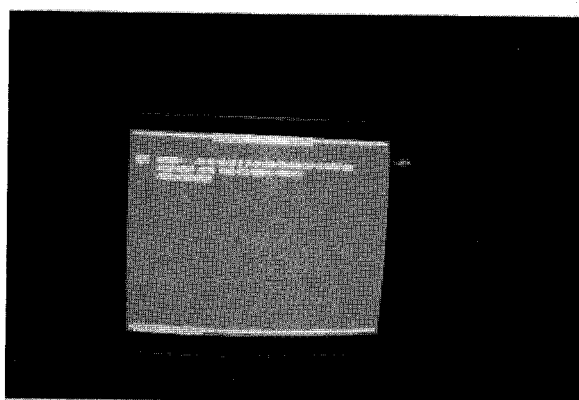
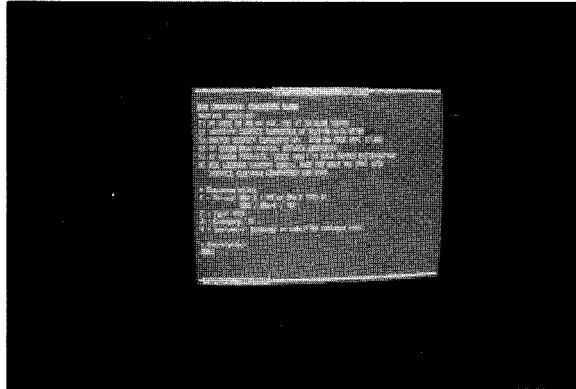
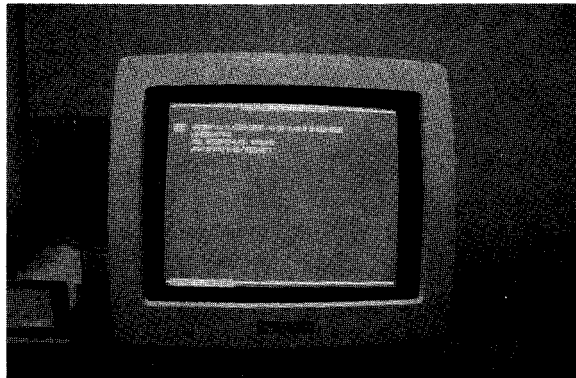


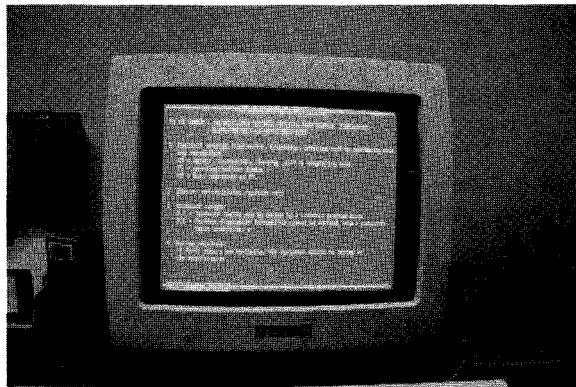
Fig. 10: View of the Alarm Screen appearing on the monitor of the microcomputer during the field trial.



**Fig. 11:** View of the alarm Dictionary Screen appearing on the monitor of the microcomputer during the field trial.



**Fig. 12:** View of the Fault Screen appearing on the monitor of the microcomputer during the field trial.



**Fig. 13:** View of the fault Dictionary Screen appearing on the monitor of the microcomputer during the field trial.

## CONCLUSIONS

Telecommunication administrations are becoming increasingly aware of the importance of fast and adequate monitoring of their network resources. Moreover, almost all new exchanges that have been recently installed are of the digital type, such as the French E10-B exchange. With these facts in mind, the objective of the present innovation has been to develop a new software package that can run on a standard microcomputer, for the purpose of monitoring the widely used E10-B exchange.

The developed software package was designed to carry out the functions presently performed by two dedicated devices called the CV and the PGV. In addition to concentrating the effort and time of the maintenance staff — since only the monitor of the microcomputer need to be attended — it also provides the maintenance staff with all the information that are relevant to the alarms or faults currently in progress.

Field trials of the new software package has demonstrated its successful operation. Additional features to the package are currently being developed in order to extend its range of application.

A working sample of the developed software has been produced on a 5¼" floppy diskette, which clearly illustrates its current capability.

## REFERENCES

1. GRINSEC, 1983, *Electronic Switching*, ELSEVIER Science Publishers, The Netherlands, Chapter VII-1.
2. Notes for Training Course in Electronic Switching, E10-B Maintenance Objective: 28.2.
3. Notes for Training Course in Electronic Switching, E10-B Maintenance Objective: 28.1.

## APPENDIX: SOFTWARE DESCRIPTION

### 1 — Setup Subprograms of the Developed Software

There are 9 subprograms used for setting up the software package. These are (see Fig. 14):

#### 1. **start:**

Its function is to print the name of the software on the screen.

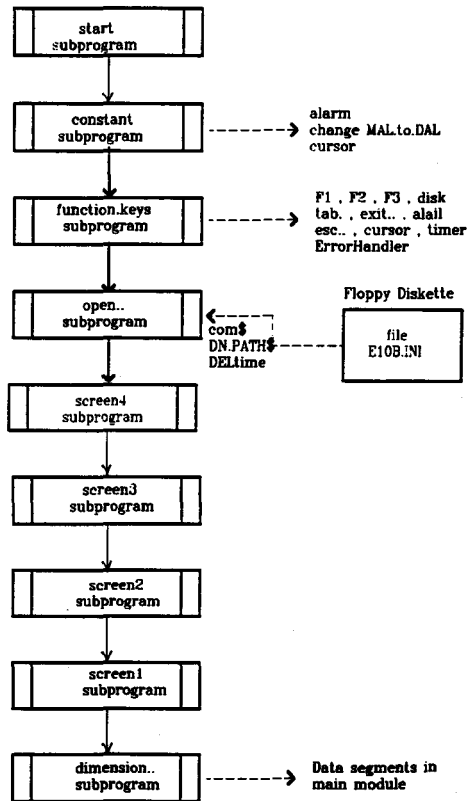


Fig. 14: Subprograms used for setting up the software program. (Shown on the right are other subprograms which interact with the setup subprograms).

2. **constant:**

Its function is to set up values of some variables used in other subprograms, namely: the alarm., change.MAL.to.DAL, and cursor subprograms.

3. **function keys:**

Its function is to determine the operation of the function keys in each step of the program. This subprogram is also called by the disk, exit., alail, esc., and timer subprograms.

4. **open:**

Its function is to open the serial communication port to receive maintenance information from the MITRA 225 computer. The parameters for the serial port are read from a file called E10B.INI which is stored on the floppy diskette.

This subprogram also gets the name of the subdirectory containing the various dictionary file from the same floppy diskette.

5. **screen 1:**

This is the subprogram that displays the Opening Screen (see Fig. 15). From this screen, one can move to the Alarm Screen (by pressing F1) or to the Fault Screen (by pressing F2), or to the CV Screen (by pressing F3). One can return to the Opening Screen from any of the three screens by pressing F10. The software is also designed to return to this screen from any other screen, if a certain time-out expires. Meanwhile, pressing F8 from the Opening Screen causes the software to be aborted and one exits to DOS.

Opening screen												E10-B Exchange/Doha3		
MR1	MR2	MR3	MR4	MR5	MR6	UTC	BT	DSF	TX1	TX2	MDE			
L O C A L	OC	MQ1	MQ2	CX1	CX2	CX3	CX4	CX5	CX6	TR1	TR2	MDE		
	BDA	URM 64	ETA 2	URM 16	URM 32	ETA 3	URM 80	TEA 1	UR3	UR4	UR5	MDE		
	URM 128	URMA 144	ETA 4	UR6	UR7	UR8	UR9	UR 10	UR 11	UR 12	UR 13	MDE		
R L U	KTN	KTS	KTG	KTR	KTU	EWID E10 DOOR OPEN								
	WBE	WBS	WBN	WBU	WBCA	NWID CONVERTER 2								
	USA	USM	JML	MOB		VW IW RW OW MW EW NW TW								
WBC		08 H 31												
ID		CONVERTER KTR												
F8 = Quit			F6 = Tab			DOHA3 Exchange			F1 = Fault		F2 = CV			

Fig. 15: Layout of the Opening Screen

6. **screen 2:**

This is the subprogram that displays either the Alarm Screen or the Fault Screen (see Figs. 16 and 17). All messages displayed in this screen are numbered sequentially as F1, F2, F3, and F4. By pressing a function key that corresponds to the message number, one switches to the Dictionary Screen. Return from either the Alarm or the Fault Screen to the Opening Screen is accomplished by pressing F10, or else if a time-out expires.

7. **screen 3:**

This is the subprogram that displays the CV Screen (see Fig. 18). Return from the CV Screen to the Opening Screen is accomplished by pressing F10, or if a time-out expires.

```
-----| Alarm message |-----  
  
F1 *A0628/643 /91-05-23/88 H 31/N=1374/TYP=CON/CAT=ID/EVENT=DAL  
/NCEN=DOHA3 /AFUR =URAL-013/AGE0=S1-TR02-B11  
/TEXAL=CONVERTER  
  
-----| Press F10 to Exit |-----
```

Fig. 16: Layout of the Alarm Screen

```
-----| Fault message |-----  
  
F1 *F0607/T07F00/NCEN=DOHA3/90-08-15/13 H 30/NAW=OFSLD  
/N=3642/NIU=3  
/EM: AFCND=TR-X1: AFUR =BDA  
/UR=001/UT=0-21/EQT=0000/P1='067072' 0/P2='0000-21'H  
  
F2 *F0607/T07F00/NCEN=DOHA3/90-08-15/13 H 30/NAW=OFSLD  
/N=3642/NIU=3  
/EM: AFCND=TR-1/X1: AFUR =BDA  
/UR=001/UT=0-21/EQT=0000/P1='067072' 0/P2='0000-21'H  
  
-----| Press F10 to Exit |-----
```

Fig. 17: Layout of the Fault Screen

```
* *F0607/T07F00/NCEN=DOHA3/90-08-15/13 H 30/NAW=OFSLD  
/N=3642/NIU=3  
/EM: AFCND=TR-2/X1: AFUR =BDA  
/UR=001/UT=0-21/EQT=0000/P1='067072' 0/P2='0000-21'H  
  
!! *A0628/768 /91-05-23/88 H 31/N=0004/TYP=ENE/CAT=ID/EVENT=DAL  
/NCEN=DOHA3 /AFUR =OBJCT=REC/AGE0=S1  
/TEXAL=MDF DOOR OPEN  
  
* *F0607/T06F00/NCEN=DOHA3/90-08-15/13 H 30/NAW=OFSLD  
/N=3642/NIU=3  
Press F10 to Exit CV screen
```

Fig. 18: Layout of the CV Screen

8. **screen 4:**

This is the subprogram that displays the Dictionary Screen (see Fig. 19). Return from the Dictionary Screen to either the Alarm or Fault Screen is accomplished by pressing F10. Meanwhile, if a certain time-out expires, this screen would automatically switch to the Opening Screen.

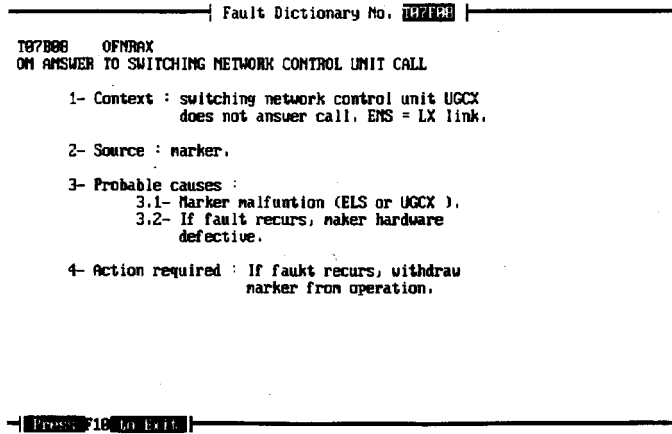


Fig. 19: Layout of the Dictionary Screen

9. **dimension:**

Its function is to dimension the arrays used for storing the alarm information (i.e. the Alarm Information Stack), and the fault information (i.e. the Fault Information Stack). It also dimensions the Pointer for Alarm Dictionary as well as the Pointer for Fault Dictionary. (See Fig. 5).

2. **Message.Handler Subprogram of the Developed Software**

This is one of the key subprograms in the software package. As mentioned above, it consists of two parts; the Message Reader and the Message Analyzer. In what follows, we briefly describe the operation of these two parts.

**The Message Reader**

It performs the following functions:

1. Sequentially extracting a complete message (alarm or fault), from the incoming data through the serial port.
2. Transferring the received message, to the CV screen of the PC.



### The Message Analyzer

This part of the Message.Handler subprogram receives the complete message read by the Message Reader. It then analyzes it to perform the following functions:

1. routing each message (alarm or fault) to the proper software module for function processing.
2. updating the status of all units in the Opening Screen, with respect to alarm and fault conditions.
3. updating the contents of alarm information stack as well as fault information stack.

The overall flowchart for the Message Analyzer is shown in the Fig. 20. It is seen to contain two main subprograms: the alarm.. subprogram and the fault.. subprogram. Each subprogram carries out the two functions 2- and 3- mentioned earlier, for the proper message.

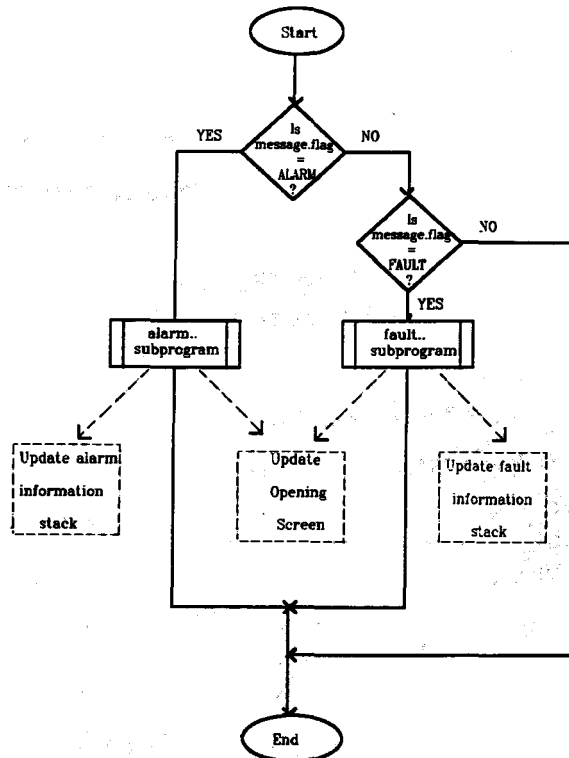


Fig. 20: Flowchart for the Message Analyzer part of the Message.Handler subprogram.

### 3. Other Supporting Subprograms for the Developed Software

In addition to the group of setup subprograms and the Message Handler subprogram described above, the software program uses another set of subprograms to realize the operation of the system as shown in Fig. 4. A brief description of each of these subprograms is given below:

1. **F1:**

This subprogram is used to program the function key F1 so as to;

- switch to the Alarm Screen, when the current visual screen is the Opening Screen
- switch to the Dictionary Screen and display the appropriate dictionary file (imported from the floppy diskette), when the current visual screen is either the Alarm or Fault Screen.

2. **F2:**

This subprogram is used to program the function key F2 so as to;

- switch to the Fault Screen, when the current visual screen is the Opening Screen
- switch to the Dictionary Screen and display the appropriate dictionary file, when the current visual screen is either the Alarm Screen or the Fault Screen.

3. **F3:**

This subprogram is used to program the function key F3 so as to;

- switch to the CV screen, when the current visual screen is the Opening Screen
- switch to the Dictionary Screen and display the appropriate dictionary file, when the current visual screen is either the Alarm Screen or the Fault Screen.

4. **F4:**

This subprogram is used to program the function key F4 so as to;

- switch to the Dictionary Screen and display the appropriate dictionary file, when the current visual screen is either the Alarm Screen or the Fault Screen.

5. **F8:**

This subprogram is used to program the function key F8 so as to stop the execution of the program and exit to the DOS.

6. **tab...:**

This subprogram is used to program the function key F6 so as to;

- move the cursor in the Opening Screen from one block to another (local ---> RLU ---> Environment ---> local).

7. **cursor:**

This subprogram is used to program the arrow keys (up, down, right, left) so as to move the cursor in the Opening Screen (within the same block) in the desired direction. The cursor subprogram also determines the X and Y location of the unit (see Fig. 5), depending on the current position of the cursor in the Opening Screen.

8. **FaultCleaner:**

This subprogram is used to clear the contents of the Fault Information Stack as well as to extinguish the flashing "F"s on the Opening Screen. The FaultCleaner is activated every 1 minute.

9. **ErrorHandler:**

This subprogram is used to trap any error that may occur during program execution, and to display an error message.

10. **timer:**

This subprogram performs 3 functions;

- to switch the current visual screen into the Opening Screen when 1 minute elapses
- to provide the timing required in the FaultCleaner subprogram
- to terminate the error message displayed by the ErrorHandler, after one minute has elapsed.

11. **A.F.screen.message:**

This subprogram is called by the F1 and F2 subprograms. Its functions include;

- loading the alarm message or fault message (depending on whether it has been called by F1 to F2), from the appropriate Information Stack into the Alarm Screen or Fault Screen
- indexing each displayed message with the proper code (F1, F2, F3, F4)