MR350MKII

Data Collection Terminal

Programming Reference Manual

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Introduction

This manual is a hand book for whom intend to develop an application program on MR350MKII and Host computer or MS-DOS based PC. It will introduce the I/O function calls, DOS Manager function calls, File Manager function calls and Host ESC commands. For your easy understanding, source code of the two sample programs are listed in appendix D and E.

All the programs mentioned in this manual are contained in a 3.5" MS-DOS format demo diskette. If you doesn't have the diskette, please contact your local unitech authorized dealer.

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1. System Kernel

This chapter is used to introduce the system kernel of MR350MKII. Where the system kernel is divided into six subsystems to service application programming interface, keyboard input, LCD display, communication I/O, Real Time Clock, Relay output/Digital input and Barcode wand/Magnetic stripe/Proximity reader.

1.1. Application Programming Interface

The MR350MKII kernel includes three basic modules: device driver, file manager and DOS manager. The programmer can design the application programs by calling those available functions just like that in the PC DOS environment.

The ROM based operating system of the terminal provides emulated MS/DOS function calls. The calling and parameter passing conventions are identical to that of MS/DOS. The detailed description of supported functions of the Terminal's subsystems, I/O interface, DOS manager and File manager is defined in later chapters.

The software to be run on MR350MKII may be programmed by using Microsoft C 5.1 and later version, and the IBM PC macro assembler version 1.0 and later version. Transaction data can be processed interactively with the computer or stored in a file.

NOTE in using Microsoft C:

When program execution area assigned less than 64K (see section 4.3) and a program with size more than 64K is invoked to run. A run time error message, "Not enough space for environment", will be shown. In this case add following statement in main:

```
/* mypgm.c */
_setenvp()
{
}
main()
{...
 ...
 ...
}
```

and link with: >LINK /NOE mypgm

1.2. *Keypad Subsystem*

The keypad subsystem scans the key matrix, converts the scan code to its associated key value, and stores the value in the input buffer of keyboard for program utilization. Note that the [SHIFT] key is not stored into the buffer, it is used to distinguish the alphabetic and numeric mode of associated key position and provide an alternative key code. The following table shows the key values of each key.

Table of Key Values

Key	Value	Key	Value	Key	Value	Key	Value
A	41H	O	4FH	[SP]	20H	F1/?	86H
B	42H	P	50H	0	30H	F2/?**?**	87H
C	43H	Q	51H	1	31H	F3/?	88H
D	44H	R	52H	2	32H	F4/?	89H
E	45H	S	53H	3	33H	F5/*	8AH
F	46H	T	54H	4	34H	F6/?	8BH
G	47H	U	55H	5	35H	F7/?	8CH
H	48H	V	56H	6	36H		
I	49H	W	57H	7	37H		
J	4AH	X	58H	8	38H		
K	4BH	Y	59H	9	39H		
L	4CH	Z	5AH	[E]	0DH		
M	4DH	+	2BH	[C]	08H		
N	4EH	-	2DH	.	2EH		

1.3. *Display Subsystem*

This subsystem provides the interface functions: Display character, Display string, Set cursor position, and Clear screen display. The display coordinates are organized as follows:

Min Row	Min Col	Max Row	Max Col
0	0	1	15

The origin (0,0) is always at the upper left hand corner.

1.4. Communication Subsystem

The MR350MKII terminal communication subsystem consists of

1) point-to-point connection mode and

2) multi-point connection mode for network processing.

1.4.1. Point to point mode

Either RS-232 or RS-485 port can be used in point-to-point mode when it is set as **serial port**. Each port can be configured, input data and output data by DOS call. Nevertheless to transfer files, a **Kermit** server can be invoked by selecting option “3) COM” in user command menu or typing ”C*OM*” in the **Ready** mode and a **Kermit** utility should also run on the Host side in order to make the data communication.

1.4.2. Multi-point mode

Either RS-232 or RS-485 port can be also used in multi-point mode by Multi-protocol (define by Unitech) when it is set as **Host port**. While RS-485 port is assigned to serve multi-point mode, up to 32 terminals can be accessed through one channel, On the other hand, while RS-232 is selected, the number of accessible terminals is limited by the number of available RS-232 ports on the host computer. There is also a multi-point communication protocol built in the MR350MKII for data communication of a multi-point networking.

1.5. Real time clock subsystem

This subsystem allows the program to set and read system date and time of the MR350MKII.

1.6. Relay output and Digital input subsystem

The MR350MKII supports two contact relay ports and four photocoupler input ports for digital signal input/output control, where pin #11/12 and pin #13/14 can also be assigned to RS-232 port and barcode scanner by setting of jumpers J1 to J6 (refer to MR350MKII Technical Reference Manual).

1.7. *Bar code / Magnetic stripe / Proximity / ICC*

The MR350MKII has two ports for connecting different reader **Internal reader** and **External reader**.

External reader port is dedicated for bar code reading by a bar code wand, CCD, or laser diode scanners, and the terminal supports reading of Code 39, Code 128, Codabar, Interleaved 2 of 5, UPC and EAN.

NOTE:

> *The CCD and laser diode scanner are only supported while connected through internal reader port. If the terminal block port #3 is set as scanner port, it can support **barcode wand**, **slot reade**r , magnetic stripe reader and **proximity reader**.*

The Internal reader, as badge reader port, is mainly designed for connecting a barcode slot reader, magnetic stripe reader, proximity reader(wiegand interface) or smart card (ICC) reader. The terminal supports the reading of single track 1, 2 or 3 magnetic card stripe.

1.8. *Download Program in Point-to-point mode*

Connect the Terminal in point-to-point mode through serial port interface, then follow the steps listed below to download a program to the Terminal:

Step 1. Connect a MR350MKII to a PC via RS232 interface with a proper cable.

Step 2. Press [F5/*] to invoke user command menu.

Step 3. Select option “3) COM” to enter the **Kermit** serve mode.

Step 4 Insert the UTILITY diskette into the PC.

Step 5. Run KERMIT in the PC.

Step 6. Use the send command from PC to MR350MKII to download the UTILITY program, 350TEST.EXE.

? **MS-Kermit>SEND <file name>**

Downloads an execution file from the PC disk to MR350MKII RAM area. (program)

? **MS-Kermit>GET <file name>**

Gets a collected data file from MR350MKII RAM area (data) to PC disk.

? **MS-Kermit>REMOTE DIR**

Displays all of the files which are stored in the MR350MKII

(Program as well as data file)

? **MS-Kermit>REMOTE DEL <file name>**

Deletes a program or data file in the MR350MKII.

Step 7. Press [SHIFT] in conjunction with [F5/*] on MR350MKII to exit from Kermit server mode to Ready mode.

Step 8. Select option "1) RUN" in user command menu and press [F7/?] key to step through the available downloaded executable object program, then press [E] to confirm for choosing 350TEST.EXE to run, or, type the filename (i.e. 350TEST) directly under system Ready prompt. This program allows you to scan barcode data and send data from the MR350MKII to the PC.

1.9. Download Program in Multi-point mode

A sample program, 485COM.EXE, in the UTILITY disk is for multi-point mode environment testing. Please note in multi-point mode each terminal should be assigned a unique address ID and consistent communication parameters with the PC.

NOTE: Following instructions use Host port to serve multi-point mode.

1) If Host port is RS232, directly connect to RS232 port between PC and MR350MKII

2) If Host port is RS485. Install an RS-485 interface card or an RS232/422 converter to the PC. And cabling the network trunk from RS485 interface to MR350MKII via RS485 port (note a twist-pair cable with 22 or 24 AWG should be used).

3) Set communication parameters including address ID on each MR350MKII properly. (The default values are, 9600 bps, non-parity, 8 data bits, 1 stop bit, address ID 'A')

4) Power up the PC and all terminals.

5) Run the test program, 485COM.EXE, on the PC.

   CRT screen shall appear the following message:

   Terminal type 1>350/360   2>700/870/860:

   Typing "1" for selecting MR350,

   COM(1-4)?:

   Typing "*1*" for selecting COM1, "*2*" for COM2.

6) Then, the screen will display:

```
V2.1 COM2  Address:  ESC=1  NAK=3  PARA=9600,1,8,NONE
0.Send     1.Poll      A.Stop     B.BarT     C.ComT     D.DIR        E.Del       F.ExeSize
f.Font     G.Memory    H.Reset    I.ExFile   J.Exist    K.Keypad     k.Kermit    L.Dnload
M.Time     N.Buzzer    O.Auto     P.Passwd   Q.UplMode  R.TrmID      T.TrmT      U.Upload
V.DEV_T    X.Exec      3.brk      5.ChgAdr   9.Loop     @.Modem      ?.320       ~.UPS off
F1.Addr    F2.Comm_P   F3.Retry   F4.Disp.   F5.Shell   F6.Pkt size : Select:
```

Item 0). Send a string of characters as message to MR350MKII.

1). Polling data from each terminals.

A). Warm start means putting all connected terminals to ready mode, previously running program is stopped.

B). Set enable/disable the barcode symbologies

C). Set communication control table.

D). Remote read the files existed on MR350MKII ram disk.

E). Remote delete a specified file which existed on ram disk.

F). Change RAM size of executable area (Not available on MR350MKII).

f). Change font size. (Not available on MR350MKII)

G). Get all connected terminals current total RAM size, execution area size, and free size.

H). Cold start means initializing the system parameters of all connected terminals to factory default values.

I). Get filename of current running program.

J). Check if specified file existed or not.

K). Set keypad Lock / Unlock / Partial lock. (Not available on MR350MKII)

k). Enter Kermit server mode (Not available on MR350MKII)

L). Download a program or data file to MR350MKII.

M). Set connected terminal’s date and time.

N). Set beeper's volume.

O). Set a executable object program to be started up automatically after power-up.

Q). Inquire Uploading status (Not available on MR350MKII)

R). Change terminal's ID.

T). Set terminal control table.

U). Upload a program or data file from MR350MKII.

V). Set device control table.

X). Remote run means that starting up an pre-downloaded executable object program on the terminal.

3). Set power saving (Not available on MR350MKII)

5). Set connected terminal address.

9). Loop back testing.

@). Dumping terminal and Modem control

?). MR320's setting (Not available on MR350MKII)

~). Disable UPS

F1). Set available terminal address to be communicated

F2). Set PC's communication parameter

F3). Set time period of Time-out/ NAK re-try / ACK

F4). Debug mode (display whole received and sent data)

F5). Go to DOS shell

F6). Set communication packet size (For debug only)

[ESC]. Exit 485COM.EXE and back to DOS prompt.

7) Select item F1) to key in the address of all connected terminals or some terminals to be tested; for example, if there are three terminals connected with address A, B, C, respectively, type "*ABC*".

8) Select item L) to download program 350TEST.EXE. This procedure will be repeated till all designated terminals have been downloaded.

9) Select item X) and input program name, 350TEST, to start up the program on all designated terminals in step 7.

10) Select item 1) to start getting data, PC screen will appear "**….**" indicating there is no data collected. If any of those terminals starting input data by scanning bar code label, PC screen will show as below:

    A (nn): XXXXXX

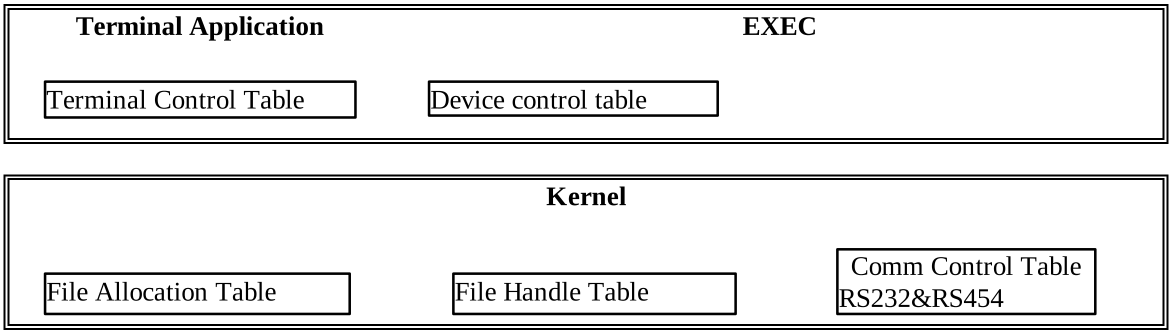
    The first character mean terminal address. Where XXXXXX is the data scanned from all connected barcode input devices or magnetic striper reader and **NN** is its data length.

10) Select item 0). to send message to terminals. Key in whether string according to PC screen instruction, and the string pattern will then be displayed on the terminal's LCD as **Application data:XXXXX** where XXXXX is the string you keyed in from PC keyboard.

11) You may also select H) and A) to test the Cold-start and Warm-start functions. Or press ***[ESC]*** key to end this program.

2. Data Structure

MR350MKII system control data structures are outlined in the following diagram. The system kernel uses the File Allocation Table (FAT), File Handle Table (FHT), Communication Control Table, Device Control Table and Key Alias Table. The following sections will describe each one of these control tables. The description includes a "typedef" part and the "default" values of the table.



Terminal Application **EXEC**

Terminal Control Table

Device control table

Kernel

File Allocation Table

File Handle Table

Comm Control Table
RS232&RS454

2.1. Device Control Table

The device control table contains MR350MKII peripheral configuration information including the barcode scanner port, the badge reader port, LCD display, keyboard and buzzer output. The barcode scanner is controlled by a separate data structure and barcode control table, to be discussed later.

2.2. Type Definition

```
typedef struct {        BYTE  scanner;
                        BYTE  badge;
                        BYTE  lcd_backlight;
                        BYTE  buzzer;
                        BYTE  keylock;
                        BYTE  buzzer_volume;
                } DEV_CONFIG;
```

scanner:	'N'	= enable scanner port
	'**F**'	= disable scanner port (default)
badge	'**B**'	= enable badge port for barcode slot reader (default)

'M' = enable badge port for magnetic card reader
'D' = disable badge port

lcd_backlight: 'N' = set LCD backlight ON
'**F**' = set LCD backlight OFF (default)

buzzer: '**N**' = set buzzer ON (default)
'F' = set buzzer OFF

keylock: '**N**' = set keyboard Unlock (default)
'K' = set keyboard Locked
'P' = set keyboard Partial Locked

buzzer_volume: '**0**' = Low volume (default)
'5' = Middle volume
'9' = High volume

2.3. *Barcode Control Table*

The MR350MKII supports decoding software to automatically discriminate bar code symbologies: Code 39, Code 39 Full ASCII, EAN-8, EAN-13, UPC-A, UPC-E, Code 128, Codabar and Interleaved 2 of 5.

2.3.1. Type Definition

```
typedef struct {        BYTE  code39;
                        BYTE  i2of5;
                        BYTE  codabar;
                        BYTE  ean_upc;
                        BYTE  code128;
        } BARCODE_CONFIG;
```

code39: '**N**' = Enable barcode decoding of Code 39(default)
'F' = Disable barcode decoding of Code 39

i2of5: '**N**' = Enable barcode decoding of Interleaved 2 of 5 (default)
'F' = Disable barcode decoding of Interleaved 2 of 5

codabar: '**N**' = Enable barcode decoding of codabar(default)
'F' = Disable barcode decoding of Codabar

ean_upc: '**N**' = Enable barcode decoding of UPC/EAN (default)
'F' = Disable barcode decoding of UPC/EAN

code128: '**N**' = Enable barcode decoding of Code 128 (default)

'F'	= Disable barcode decoding of Code 128

2.4. *Communication Control Table of Host port*

The communication control table is applicable to configure the host port of the MR350MKII.

The communication control table specifies all communication parameters between the host system and the MR350MKII. When a hard reset command is issued via keypad input or host command sequence the default communication parameters are restored. The host system may then configure most MR350MKII parameters by issuing host command sequences. The host command sequences will be introduced in this manual.

2.4.1. Type Definition

```
typedef struct {        BYTE   baud_rate;
                        BYTE   stop_bit;
                        BYTE   data_bit;
                        BYTE   parity;
                        BYTE   protocol;
                        BYTE   address;
                        WORD   timeout;
               } COM_CONFIG;
```

The MR350MKII terminal communicates with the host via the host port. The communication baud rate may be programmed from 110 to 38.4K baud (bits per second).

baud_rate:	'0'	= 110 bits per second
	'1'	= 150
	'2'	= 300
	'3'	= 600
	'4'	= 1200
	'5'	= 2400
	'6'	= 4800
	'**7**'	= 9600 (default)
	'8'	= 19200
	'9'	= 38400
stop_bit:	'**1**'	= one stop bit (default)
	'2'	= two stop bits
data_bit:	'7'	= 7 data bits
	'**8**'	= 8 data bits (default)
parity:	'**N**'	= None parity (default)

'O' = Odd parity
'E' = Even parity

protocol: '**M**' = Multipoint (default)
'F' = None protocol

address: '**A**' = terminal address ID for Multipoint mode (default)

Each MR350MKII has to be assigned a unique communication address when it is used in a Multipoint environment. The address is used by a host or concentrator to perform polling functions. Characters 'A'-'Y' and '0'-'6' are used for assigning an address ID of each terminal.

timeout: '**02**' = polling timeout two cycle periods (default).
'02'-'FF' in hex format.

The value of this setting is specified for the communication timeout. If the MR350MKII does not receive a response from the host system within the number of timeout cycle periods, the MR350MKII regards the communication as unsuccessful and the transmission is then aborted. If the timeout value is set to zero, no timeout check is performed by the MR350MKII.

2.5. Terminal Control Table (available for host port only)

The terminal control table is meaningful only if the MR350MKII operation switch is set to "terminal mode". All other operational modes ignore the terminal control table.

2.5.1. Type Definition

The terminal control table is defined by the following typedef TERM_CONFIG. There is only one instance of the TERM_CONFIG data structure:

```
typedef struct {   char terminal_id[8];      /* terminal id */
                    BYTE          online;
                    BYTE          echo;
                    BYTE          autolf;      /* auto LF */
                    BYTE          mode;
                    BYTE          linepage; /* line or page block */
                    BYTE          lineterm;  /* line terminator */
```

```
        BYTE        pageterm;/* page terminator */
            } TERM_CONFIG;
```

Each MR350MKII "terminal" is identified by an ASCII string. There can be up to seven characters of a terminal identification. The identification entry in the TERM_CONFIG table has one more character space to allow ASCII_Z (hex 0) termination, as in C language convention.

online: '**R**' = set to Remote and transmit data to the host port (default)
'L' = set to Local and not transmit

echo: '**N**' = Collected data displayed
'F' = Collected data not displayed

Above two variables, TERM_online and TERM_echo, are used to control transmission and display of the collected data, respectively. If TERM_online is set to **Remote** the MR350MKII will transmit data to the host, otherwise it will not transmit. If TERM_echo is set to **Echo** collected data will be displayed on the MR350MKII LCD, otherwise data will not be displayed.

autolf: 'N' = set not to append a LF after a CR

'**F**' = set to append a LF (default)

This variable instructs the MR350MKII to append a LF character whenever a CR is collected from an input scanning device.

mode: 'C' = set to Character mode

'**B**' = set to Block mode (default)

This parameter specifies either character mode or block mode free-format operation. The aforementioned form caching operation is only applicable when the MR350MKII is set in block mode.

linepage: '**L**' = set line block mode (default)
'P' = set page block mode
'B' = set both line and page block modes

The **linepage** parameter is useful only if **mode** has been specified as 'B'.

lineterm: designates the termination character of line block mode (default = null)

pageterm: designates the termination character of page block mode (default = null)

3. I/O Function Calls

The operating system of the MR350MKII supports BIOS/DOS Function to control LCD display, Keyboard input, Proximity/Barcode/Magnetic stripe input, Buzzer, Security alarm, Photo-coupler input, Relay output, and serial port input/output of RS232 and RS485. The whole C sample program are gathered into library file "350LIB.C" on Utility Diskette.

3.1. LCD Display INT 10H

00 Clear screen

Entry Parameters:	AH = 0	
Returned Values:	None	

```
void TL_clrscr()
{
  regs.h.ah= 0;
  int86(0x10,&regs,&regs);
}
```

01 Set cursor type

Entry Parameters:	AH = 1	
	AL = 1	;set Block cursor
	0	;set Underscore cursor
	3	;set cursor off
Returned Values:	None	

```
void TL_cursor_type(int status)
{
  regs.h.ah = 1;
  regs.h.al = (unsigned char)status;
  int86(0x10,&regs,&regs);
}
```

02 Set cursor position

Entry Parameters:	AH = 2	
	DH = 0 ~ 1	;row
	DL = 0 ~ 15	;column
Returned Values:	None	

```
void TL_gotoxy(int x,int y)
{
  regs.h.ah = 2;
  regs.h.dh = (unsigned char)y;
  regs.h.dl = (unsigned char)x;
  int86(0x10,&regs,&regs);
}
```

03 Get cursor position

Entry Parameters:	AH = 3	
Returned Values:	DH = 0 ~ 1	;row
	DL = 0 ~ 15	;column

```
void TL_getxy(int *x,int *y)
{
  regs.h.ah = 3;
  int86(0x10,&regs,&regs);
  *y = regs.h.dh;
  *x = regs.h.dl;
}
```

04 Scroll screen

Entry Parameters:	AH = 4	
	AL = 0	;disable
	= 1	;enable

```
void TL_scroll(int status)
{
  regs.h.ah = 4;
  regs.h.al = (unsigned char)status;
  int86(0x10,&regs,&regs);
}
```

1A Enable/disable LCD Backlight <u>INT 21H</u>

Entry Parameters:	AH = 0x1A	
	BH = 0	
	AL = 0	;disable
	1	;enable
Returned Values:	None	

```
void TL_backlight(int status)
{
  regs.h.ah = 0x1A;
  regs.h.al = (unsigned char)status;
  regs.h.bh = 0;
  int86(0x21,&regs,&regs);
}
```

3.2. Communication Environment Setup

Before placing MR350MKII into the communication environment, you have to decide:

1) Whether the RS-422/485 port or RS-232 port assigned as host port and another one as serial port.

2) Set communication protocol for host port. Please note, the protocol for serial port is always none.

3) If you have installed a internal modem interface. You have to set COM1 as modem instead of RS485.

The factory defaults for the communication environment are:

Host port: as RS-422/485, multi-point protocol.

Serial port: RS-232, none protocol.

Once you have assigned the protocol to the host port, the MR350MKII's system kernel will automatically packing or unpacking the sending or receiving data according to the selected protocol. On the other hand, since the serial port has no protocol, you must use INT 34H (RS232) or INT 33H (RS-422/485) to read or write data character by character.

✍✍ ***NOTE:***

*If you want to control the host port I/O service, you must designate "**NONE**" protocol for the host port and then using INT 34H or INT 33H to control I/O for RS232 or RS422/485. The proper function call depends on which port is assigned as host port(see the next two sections).*

1C Select COM1 or COM2 as the host port

Entry Parameters:	AH = 1C	
	BH = 0	
	AL = 1	; Select COM1 as host
	2	; Select COM2 as host
Returned Value:	None	

✍✍ ***NOTE:***

While one of the COM port is designated as host, the other one is set as serial port automatically by system.

```
void TC_select_host(int status)
{
  regs.h.ah = 0x1C;
  regs.h.al = (unsigned char)status;
  regs.h.bh = 0;
  int86(0x21,&regs,&regs);
}
```

1C Set host port protocol

Entry Parameters:	AH = 1C	
	BH = 1	
	AL = 2	; Multi-point (default)
	3	; None protocol
Returned Valued:	None	

```
void TC_protocol(int status)
{
  regs.h.ah = 0x1C;
  regs.h.al = (unsigned char)status;
  regs.h.bh = 1;
  int86(0x21,&regs,&regs);
}
```

1C Set serial port flow control

The system provides three handshaking mode for serial port: XON/XOFF, CTR/RTS and none. The system default flow control for serial port is ? ONE”. The CTS/RTS is only available while the RS-232 is designated to serial port.

Entry Parameters:	AH = 1C	
	BH = 2	
	AL = 0	; None
	1	; XON/XOFF
	2	; CTS/RTS
Returned Value:	None	

✍✍ ***NOTE:***

If you want to control the hand shaking flow of serial port, you must set the flow control as “NONE”.

```
void TC_flow_ctrl(int status)
{
  regs.h.ah = 0x1C;
  regs.h.al = (unsigned char)status;
  regs.h.bh = 2;
  int86(0x21,&regs,&regs);
}
```

19 Set COM1 port as RS485 or modem

This function call is used to set COM1 port as RS485 serial port or modem when you have the internal modem interface installed. Before you can start to use modem for communication, you must set COM1 port as modem.

Entry Parameters:	AH = 19	
	AL = 0	; set as RS485
	1	; set as modem
Returned Value:	None	

```
void TC_modem_port(int status)
{
regs.h.ah= 0x19;
regs.h.al= status;
int86(0x21,&regs,&regs);
}
```

3.3. Host Port for Multi-point Protocol I/O (INT21H)

1C Setup multi-point address

Entry Parameters:	AH = 0x1C	
	BH = 06	
	AL = 'A'..'Y','0'..'6'	
Returned Values:	None	

```
void TC_set_address(char status)
{
   regs.h.ah= 0x1C;
   regs.h.al= status;
   regs.h.bh= 6;
   int86(0x21,&regs,&regs);
}
```

1C Set polling timeout duration

Entry Parameters:	AH = 0x1C	
	BH = 09	
	AL = 0-255	;timeout period with base timeout cycle 80ms
Returned Values:	None	;timeout period is 160ms when set AL=2; AL=0 for no timeout

```
void TC_time_out(int status)
```

```
{
   regs.h.ah= 0x1C;
   regs.h.al= status;
   regs.h.bh= 9;
   int86(0x21,&regs,&regs);
}
```

5F Read host port

Entry Parameters:	AH = 0x5F	
Returned Values:	DS:DX = buffer pointer	
	AL = 0	;output succeed
	1	;no data

```
int TC_str_I(unsigned char *str,int wait)
{
  do {
    regs.h.ah=0x5F;
    segregs.ds = FP_SEG(str);
     regs.x.dx = FP_OFF(str);
     int86x(0x21,&regs,&regs,&segregs);
  } while (wait && regs.h.al);
  return(regs.h.al);
}
```

60 Output data

Entry parameters:	AH = 0x60	
	DS:DX = buffer pointer	
Returned Values:	AL = 0	;output succeed
	1	;buffer busy now

```
 int TC_str_O(unsigned char *str,int wait)
{
  do {
    regs.h.ah=0x60;
    segregs.ds = FP_SEG(str);
     regs.x.dx = FP_OFF(str);
     int86x(0x21,&regs,&regs,&segregs);
  } while (wait && regs.h.al);
  return(regs.h.al);
}
```

61 Check if Busy-port

Entry Parameters:	AH = 0x61

Returned Values:	AL = 0	;port is available
	1	;port is busy

```
int TC_ready(int wait)
{
  int i;
  do {
    regs.h.ah=0x61;
     int86(0x21,&regs,&regs);
  } while (wait && regs.h.al);
  return(regs.h.al);
}
```

3.4. Serial I/O for RS-232 and RS-485

The system allow to the RS-232 and RS-485 to serve serial input/output (character mode I/O) no matter the port is assigned as host or serial port. However, if the port is assigned as host, must select “NONE” as its active protocol.

The INT 34H is dedicated for RS-232 and INT33H is dedicated for RS-485 and the both function calls are functional for host and serial port.

RS-232 port serial I/O using INT 34H

01 Input data

Entry Parameters: AH = 1

Returned Values:
1) if a character received
   AH = 0
   AL = Data character
2) if no character received
   AH = 1
   AL = undefined

```
unsigned char TC_232_char_I()
{

  regs.h.ah = 1;
  int86(0x34,&regs,&regs);
  if (regs.h.ah == 0)
    return(regs.h.al);
  return(255);
}
```

02 Output data

Entry Parameters: AH = 2
AL = Data character
Returned Values: None

```
void TC_232_char_O(unsigned char ch)
{
  regs.h.ah = 2;
  regs.h.al = ch;
  int86(0x34,&regs,&regs);
}
```

03 Enable RS-232 port

Entry Parameters: AH = 3
Returned Values: None

```
void TC_232_enable()
{
  regs.h.ah = 3;
  int86(0x34,&regs,&regs);
}
```

04 Disable RS-232 port

Entry Parameters: AH = 4
Returned Values: None

```
void TC_232_disable()
{
  regs.h.ah = 4;
  int86(0x34,&regs,&regs);
}
```

00 Set Communication parameters

Entry Parameters:	AH = 0	BIT #	
		76543210	
	AL = bit 0	xxxxxxx0	7 data bits
		xxxxxxx1	8 data bits
	bit 1	xxxxxx0x	1 stop bit
		xxxxxx1x	2 stop bits
	bit 2-3	xxxx00xx	NONE parity
		xxxx01xx	ODD parity
		xxxx11xx	EVEN parity
	bit 4-7	0000xxxx	110 baud rate

0001xxxx	150 baud rate
0010xxxx	300 baud rate
0011xxxx	600 baud rate
0100xxxx	1200 baud rate
0101xxxx	2400 baud rate
0110xxxx	4800 baud rate
0111xxxx	9600 baud rate
1000xxxx	19200 baud rate
1001xxxx	38400 baud rate

Return Values: None

```
void TC_232_parameter(long baud,int parity,int stop,int data)
{
  unsigned char cc=0;
  unsigned int i_baud;

  i_baud = (int)(baud / 10L);
  switch (i_baud)
  {
    case   11 : cc=0x00; break;
    case   15 : cc=0x10; break;
    case   30 : cc=0x20; break;
    case   60 : cc=0x30; break;
    case  120 : cc=0x40; break;
    case  240 : cc=0x50; break;
    case  480 : cc=0x60; break;
    case 1920 : cc=0x80; break;
    case 3840 : cc=0x90; break;
    default: cc=0x70;  break;
  }
  switch (parity)
  {
    case 0 : break;
    case 1 : cc=cc|0x04; break;
    case 2 : cc=cc|0x0c; break;
    case 3 : cc=cc|0x08; break;
  }
  switch (stop)
  {
    case 1 : break;
    case 2 : cc=cc|0x02; break;
  }
  switch (data)
  {
    case 7 : break;
    case 8 : cc=cc|0x01; break;
  }
  regs.h.ah = 0;
  regs.h.al = cc;
  int86(0x34,&regs,&regs);
}
```

05 Set RTS signal of RS-232 port

Entry Parameters:	AH =	5	
	AL =	2	
	DH =	0	;set RTS to LOW
		1	;set RTS to HIGH (default)
Returned Values:	None		

```
void TC_232_RTS(int rts)
{
  regs.h.ah = 5;
  regs.h.al = 2;
  regs.h.dh = (unsigned char)rts;
  int86(0x34,&regs,&regs);
}
```

06 Read CTS signal of RS-232 port

Entry Parameters:	AH =	6	
	AL =	2	
Returned Values:	DH =	0	;when CTS is LOW
		1	;when CTS is HIGH

```
int TC_232_CTS()
{
  regs.h.ah = 6;
  regs.h.al = 2;
  int86(0x34,&regs,&regs);
  return((int)regs.h.dh);
}
```

NOTE:

1) *If the RS-232 port is controlled by use of INT 34H, and the port acts as the host port. You must set the protocol as ? ONE”.*

RS-485 port serial I/O using INT 33H

01 Input data

Entry Parameters:	AH = 1
Returned Values:	1) if a character received

AH = 0
AL = Data character
2) if no character received
AH = 1
AL = undefined

```
unsigned char TC_485_char_I()
{
  regs.h.ah = 1;
  int86(0x33,&regs,&regs);
  if (regs.h.ah == 0)
    return(regs.h.al);
  return(255);
}
```

02 Output data

Entry Parameters: AH = 2
AL = Data character
Returned Values: None

```
void TC_485_char_O(unsigned char ch)
{
  regs.h.ah = 2;
  regs.h.al = ch;
  int86(0x33,&regs,&regs);
}
```

03 Enable RS-485 port for serial I/O

Entry Parameters: AH = 3
Returned Values: None

```
void TC_485_enable()
{
  regs.h.ah = 3;
  int86(0x33,&regs,&regs);
}
```

04 Disable RS-485 port for serial I/O

Entry Parameters: AH = 4
Returned Values: None

```
void TC_485_disable()
{
    regs.h.ah = 4;
    int86(0x33,&regs,&regs);
}
```

00 Set Communication parameters

Entry Parameters:	AH = 0	BIT # 76543210	
	AL = bit 0	xxxxxxx0	7 data bits
		xxxxxxx1	8 data bits
	bit 1	xxxxxx0x	1 stop bit
		xxxxxx1x	2 stop bits
	bit 2-3	xxxx00xx	NONE parity
		xxxx01xx	ODD parity
		xxxx11xx	EVEN parity
	bit 4-7	0000xxxx	110 baud rate
		0001xxxx	150 baud rate
		0010xxxx	300 baud rate
		0011xxxx	600 baud rate
		0100xxxx	1200 baud rate
		0101xxxx	2400 baud rate
		0110xxxx	4800 baud rate
		0111xxxx	9600 baud rate
		1000xxxx	19200 baud rate
		1001xxxx	38400 baud rate
Return Values:	None		

```
void TC_485_parameter(long baud,int parity,int stop,int data)
{
    unsigned char cc=0;
    unsigned int i_baud;

    i_baud = (int)(baud / 10L);
     switch (i_baud)
    {
      case   11 : cc=0x00;  break;
      case   15 : cc=0x10;  break;
      case   30 : cc=0x20;  break;
      case   60 : cc=0x30;  break;
      case  120 : cc=0x40;  break;
      case  240 : cc=0x50;  break;
      case  480 : cc=0x60;  break;
      case 1920 : cc=0x80;  break;
      case 3840 : cc=0x90;  break;
```

```
        default: cc=0x70;   break;
      }
      switch (parity)
      {
        case 0 :  break;
        case 1 : cc=cc|0x04;  break;
        case 2 : cc=cc|0x0c;  break;
        case 3 : cc=cc|0x08;  break;
      }
      switch (stop)
      {
        case 1 :  break;
        case 2 : cc=cc|0x02;  break;
      }
      switch (data)
      {
        case 7 :  break;
        case 8 : cc=cc|0x01;  break;
      }
      TD_int_dos1(0x1C,cc,1,0);
      regs.h.ah = 0;
      regs.h.al = cc;
      int86(0x33,&regs,&regs);
}
```

05 Open RS-485 multi-bus to send out data

The RS-485 is a multi-bus architecture that means more than one RS-485 I/O port can access the trunk line. Thus, if the RS-485 intends to do serial data input/output, it must occupy the bus first to prevent from other linked terminals to send or receive data. The bus will be released while the data transmission is done and then release the bus to be used by other terminals for data transmission.

Entry Parameters: AH = 5
Returned Values: None

```
void TC_485_open()
{
  regs.h.ah = 5;
  int86(0x33,&regs,&regs);
}
```

06 Close RS-485 multi-bus (release RS-485 bus)

Entry Parameters: AH = 6
Returned Values: None

```
void TC_485_close()
{
  regs.h.ah = 6;
  int86(0x33,&regs,&regs);
}
```

NOTE:

1) *While the RS-485 post is used for serial input/output (character I/O) communication. The application must enable RS-485 first to set communication characteristic and make the system ready for serial I/O and then open its RS-485 to occupy the bus prior to reading or writing data. The application should close the RS-485 port when the data pack transmission completed and release the bus to be used by other terminals. And the application should disable the RS-485 port while all data packs are send or received.*

Ex. *Enable RS-485 port for character based communication*

?

Open RS-485 to occupy the bus

?

Repeat { read/write data to RS-485 port } until completed

?

Close RS-485 to release the bus

?

Disable RS-485 port for character based communication

2) *When the RS-422/485 is controlled by use of INT 33H and the port is assigned as host. The protocol must set as "NONE".*

3) *If the RS-422/485 port acts as serial port, and the flow of hand shaking will be controlled by user program instead of XON/XOFF. You must set the flow control as "NONE".*

3.5. *Relay Output / Digit Input / Buzzer / LED Indicator*

Set LED indicator ON/OFF <u>INT 09H</u>

Entry Parameters:	AH = 2
	Bit# 76543210
	AL= 0000xxxx, where:
	x: 1, Set LED on
	0, Set LED off
	Bit0: LED1
	Bit1: LED2
	Bit2: LED3
	Bit3: LED4
Returned Value:	None

Ex. AL = 00000011 means to turn on LED1 and LED2.

```
void TD_LED(int led1,int led2,int led3,int led4)
{
    regs.h.ah = 2;
    regs.h.al = 0;
   if (led1 > 0) regs.h.al = regs.h.al |1;
   if (led2 > 0) regs.h.al = regs.h.al |2;
   if  (led3 > 0) regs.h.al = regs.h.al |4;
   if (led4 > 0) regs.h.al = regs.h.al |8;
   int86(0x09,&regs,&regs);
}
```

Read Photo Coupler Level state <u>INT 08H</u>

Entry Parameters:	AH = 1	;Read input from port 1
	2	;Read input from port 2
	3	;Read input from port 3
	4	;Read input from port 4
	AL = 0	;Read level state
	1	;Read edge switching state
Returned Values:	by level	
	AL = 0	(LOW)
	1	(HIGH)
Returned Values:	by edge switching state	
	AL = 0	(No switching edge)
	1	(Switching edge occurred)

```
int TD_photocouple(int port,int type)
{
    regs.h.ah = (unsigned char)port;
    regs.h.al = (unsigned char)type;
   int86(0x08,&regs,&regs);
    return((int)regs.h.al);
}
```

Activate/Deactivate Relay ports **INT 09H**

Entry Parameters:	AH = 0	;select Relay #1
	1	;select Relay #2
	AL = 0	;deactivate selected Relay contact OPEN
	1	;activate selected Relay contact CLOSE
Returned Values:	None	

```
void TD_relay(int port,int status)
{
    regs.h.ah=(unsigned char)port;
    regs.h.al= (unsigned char)status;
   int86( 0x09 ,&regs,&regs);
    return(regs.h.al);
}
```

1A Buzzer On/Off **INT 21H**

Entry Parameters:	AH = 0x1A	
	BH = 1	
	AL = 0	;disable buzzer
	1	;enable buzzer
Returned Values:	None	

```
void TD_buzzer(int status)
{
    regs.h.ah=0x1A ;
    regs.h.al= (unsigned char)status;
    regs.h.bh=1;
   int86(0x21,&regs,&regs);
    return(regs.h.al);
}
```

1A Set buzzer volume <u>INT 21H</u>

Entry Parameters:	AH = 0x1A	
	BH = 3	
	AL = 0	;set LOW volume
	1	;set MEDIUM volume
	2	;set HIGH volume
Returned Values:	None	

```
void TD_beeper_vol(int status)
{
    regs.h.ah=0x1A ;
    regs.h.al= (unsigned char)status;
    regs.h.bh= 3;
   int86(0x21,&regs,&regs);
    return(regs.h.al);
}
```

1B Get Security state <u>INT 21H</u>

Entry Parameters:	AH = 0x1B	
	BH = 7	
Returned Values:	AL = 0	;close
	1	;open

```
int TD_security_status()
{
    regs.h.ah = 0x1B;
    regs.h.bh = 7;
   int86(0x21,&regs,&regs);
    return((int)regs.h.al);
}
```

1B Alarm On/Off <u>INT 21H</u>

Entry Parameters:	AH = 0x1B	
	BH = 8	
	AL = 0	;disable
	1	;enable
Returned Values:	None	

```
void TD_alarm(int status)
{
    regs.h.ah = 0x1B;
    regs.h.al = (unsigned char)status;
    regs.h.bh = 8;
   int86(0x21,&regs,&regs);
}
```

54 Buzzer volume control with user-defined frequency and time INT 21H

Entry Parameters: AH = 0x54
CX = 1-3000 ;frequency in Hz
DX = 1-1600 ;sound duration in mini-second
Returned Values: None

```
void TD_beep_user(int fz,int tm)
{
    regs.h.ah=0x54;
    regs.x.cx= fz;
    regs.x.dx= tm;
   int86(0x21,&regs,&regs);
}
```

Buzzer volume control with predefined frequency and time INT 35H

Entry Parameters: AX = 0-8 ;frequency assignment
BX = 0-8 ;time duration
Returned Values: None

		Frequency			Time duration
AX =	0	200 Hz	BX =	0	10 ms
	1	400		1	50
	2	600		2	100
	3	800		3	200
	4	1K		4	500
	5	2K		5	800
	6	2.5K		6	1 second
	7	3K		7	1.5 seconds
	8	5K		8	2 seconds

```
void TD_beep(int fz,int tm)
{
    regs.x.ax= fz;
    regs.x.bx= tm;
   int86(0x35,&regs,&regs);
}
```

3.6. Internal/ External reader Port: INT 21H

There are two readers can be connected to MR350 MKII --- **Internal Reader** and **External Reader**. **Internal reader** is a build-in reader, it is installed inside of MR350 MKII. **External reader** can be connected to either scanner port or terminal block. For internal reader, if it cannected with Magnetic stripe reader or Bar code slot reader, the system can automatically set up the Internal reader type by detecting the first time swiped card type. If the user use the default type, the Bar code slot reader. When he attempts to swipe the magnetic card through the slot reader, the terminal will detect it and change the slot reader type into Magnetic stripe reader automatically. However, this automatically discriminating reader type feature will not keep the first attempt data. The user must re-swipe again.

51 Enable/Disable External reader port

Entry Parameters:	AH = 0x51	
	AL = 1	;enable external port
	0	;disable external port
Returned Values:	None	

```
void TD_set_external(int status)
{
    regs.h.ah = 0x51;
    regs.h.al = (unsigned char) status;
   int86(0x21,&regs,&regs);
}
```

18 Set external slot reader (only available for Barcode and Magnetic reader)

Entry Parameters:	AH = 0x18	
	AL = 1	;define as Bar code slot reader
	0	;define as Magnetic stripe reader
Returned Values:	None	

```
void TD_set_external_type(int status)
{
    regs.h.ah = 0x18;
    regs.h.al = (unsigned char) status;
   int86(0x21,&regs,&regs);
}
```

50 Read data from external reader(only available for Barcode and Magnetic reader)

Entry Parameters:	AH = 0x50		
Returned Values:	DS:DX = buffer pointer		
	AX =	0	;data input
		1	;no data input
			Scanning direction
	CL =	0	;from right to left
		1	;from left to right

```
int TD_get_external(unsigned char *str,int wait,int
                    *direction)
{
    int i;
    do
    {
        segregs.ds = FP_SEG(str);
        regs.x.dx= FP_OFF(str);
        regs.h.ah=0x50;
       int86x(0x21,&regs,&regs,&segregs);
       *direction = regs.h.cl;
    } while (wait && regs.h.al);
    return(regs.h.al);
}
```

52 Read Internal port

Entry Parameters:	AH = 0x52			
Returned Values:	DS:DX = buffer pointer			
	AX =	0	; data input	
		1	; no data input	
			Scanning direction	
	CH = 0		; Barcode data	
		CL =	0	;from right to left
			1	;from left to right
		BL =	0x010	; Code 39
			0x02	; Interleaved 2 of 5
			0x03	: CODABAR
			0x05	: Code 128
			0x06	: EAN 128
			0x07	: Code 93
			0x11	: UPC-A
			0x12	: UPC-E

0x13 : EAN-13
0x14 : EAN-8
CH = 1 :Magnetic data
CL = 0 ;from right to left
2 ;from left to right
BL = 0x01 : Track 1
0x02 : Track 2/3
'K' : ARK501 keypad input
CH = 2 : Wiegand data
CL = 0 : formatted data
1 : unformatted data
BL = data length in bit

```
int TD_get_internal(unsigned char *str,int *direct_format,int
                    *dev_type,int *data_type,int wait)
{
    int i;
     do
    {
        i= TD_intdos_I(0x52,0,str);
        *direct_format = regs.h.cl;
        *dev_type = regs.h.ch;
        *data_type = regs.h.bl;

    } while (wait && i);
     return(i);
}
```

53 Enable/disable Internal reader

Entry Parameters: AH = 0x53
AL = 1 ;enable internal port
0 ;disable internal port
Returned Values: None

```
void TD_set_internal(int status)
{
    TD_int_dos1(0x53,(unsigned char)status,0,0);
}
```

1F Enable/Disable the Decoder of Wiegand Format (Proximity reader)

Entry Parameters: AH = 0x1F

	BH =	5	
	BL =	0	; for both 26- and 36-bit formats
		26	; for 26-bit only
		36	; for 36-bit only
		0xff	; for un-formatted data
	AL =	0	; Disable
		1	; Enable
Returned Values:	None		

```
void TD_set_wiegand_status(int status,int type)
{
  regs.h.ah= 0x1f;
  regs.h.al= (unsigned char)status;
  regs.h.bh= 5;
  if (type == -1) regs.h.bl= 0xff;
  else regs.h.bl= (unsigned char)type;
  int86(0x21,&regs,&regs);
}
```

1F Get Decoder status of Wiegand Format (Proximity reader)

Entry Parameters:	AH =	0x1F	
	BH =	6	
	BL =	0	; for both 26- and 36-bit formats
		27	; for 26-bit only
		37	; for 36-bit only
		0xff	; for un-formatted data
Returnne value	AL =	0	; Disable
		1	; Enable

```
int TD_get_wiegand_status(int type)
{
  regs.h.ah= 0x1f;
  regs.h.bh= 6;
  if (type == -1) regs.h.bl= 0xff;
  else regs.h.bl= (unsigned char)type;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

1A Assign barcode or magnetic stripe input of Internal reader

Entry Parameters:	AH = 0x1A
	BH = 6

	AL = 0	;assign barcode input
	1	;assign magnetic stripe input
Returned Values:	None	

```
void TD_set_internal_type(int status)
{
  regs.h.ah= 0x1A;
  regs.h.al= (unsigned char)status;
  regs.h.bh= 6;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

1F Enable the decoding of a barcode symbology

Entry Parameters:	AH =	0x1F	
	BH =	1	
	AL =	0	; Disable
		1	; Enable
	BL =	0	; All
		1	: Code 39
		2	: I 2 of 5
		3	: CODABAR
		4	: EAN/UPC
		5	: Code 128
Returned Values:	None		

```
void TD_set_decode_status(int status,int type)
{
  regs.h.ah = 0x1F;
  regs.h.al = (unsigned char)status;
  regs.h.bh = 1;
  regs.h.bl = (unsigned char)type;
  int86(0x21,&regs,&regs);
}
```

3.7. Miscellaneous: INT 21H

1A Check lithium battery level

Entry Parameters:	AH = 0x1A
	BH =09h

Returned Values:	AL = 1	; Lithium battery low
	0	; Normal

```
int TS_lithium_battery()
{
  regs.h.ah= 0x1A;
  regs.h.bh= 9;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

1B Get Address ID of the terminal

Entry Parameters:	AH = 0x1B
	BH = 6
Returned Values:	AL = Address ID

```
char TC_get_address()
{
  regs.h.ah = 0x1b;
  regs.h.bh = 6;
  int86(0x21,&regs,&regs);
  return((char)regs.h.al);
}
```

25 Set interrupt vector

Entry Parameters:	AH = 0x25
	AL = interrupt number
	DS:DX = address of interrupt routine
Returned Values:	none

```
void TS_set_interrupt_vector(int vect,unsigned int ds,unsigned int dx)
{
  regs.h.ah= 0x25;
  regs.h.al= (unsigned char)vect;
  segregs.ds=ds;
  regs.x.dx=dx;
  int86x(0x21,&regs,&regs,&segregs);
}
```

35 Get interrupt vector

Entry Parameters:	AH = 0x35
	AL = interrupt number
Returned Values:	ES:BX = address of interrupt routine

```
void TS_get_interrupt_vector(int vect,unsigned int *es,unsigned int *bx)
{
   regs.h.ah= 0x35;
   regs.h.al= (unsigned char)vect;
   int86x(0x21,&regs,&regs,&segregs);
   *es = segregs.es;
   *bx = regs.x.bx;
}
```

36 Get free disk cluster

Entry Parameters:	AH = 0x36
Returned Values:	AH = 1 (number of sector per cluster)
	BX = number of available clusters
	CX = 1024 (number of bytes per sector)

```
long TS_free_disk()
{
  regs.h.ah= 0x36;
  int86x(0x21,&regs,&regs,&segregs);
  return((long)regs.x.bx*(long)regs.x.cx);
}
```

1A Enable/disable system key-pressing commands: Warm start, Invoke user command menu, Invoke supervisor mode

Entry Parameters:	AH = 0x1A	
	BH = 05	
	AL = 0	; disable system keys
	1	; enable system keys
Returned Values:	None	

```
void TD_set_system_key(int status)
{
   regs.h.ah= 0x1A;
   regs.h.al= (unsigned char)status;
   regs.h.bh= 5;
   int86(0x21,&regs,&regs);
}
```

1E Change the Keyboard map

Entry Parameters:	AH = 0x1E
	BH = 1

DS:DX = keyboard map with 128 bytes corresponded to numeric and alphabetic ASCII code table; a NULL for defining unused key.
CX = 0x80 (table length for 128 bytes)

Returned Values: None

```
void TD_key_map(unsigned char *str)
{
  regs.h.ah=0x1E;
  regs.h.bh=1;
  regs.x.cx=0x80;
  segregs.ds = FP_SEG(str);
  regs.x.dx = FP_OFF(str);
  int86x(0x21,&regs,&regs,&segregs);
}
```

ASCII code corresponded to scan code in Numeric mode

Numeric keyboard layout				
F1 ? ?	**F5** *****	1	2	3
F2 ? ?	**F6** ?	4	5	6
F3 ? ?	**F7** ?	7	8	9
F4 ? ?	SHIFT	[C]	0	[E]

ASCII code [Scan code]				
86 [23]	**8A** [1B]	**31** [13]	**32** [0B]	**33** [03]
87 [22]	**8B** [1A]	**34** [12]	**35** [0A]	**36** [02]
88 [21]	**8C** [19]	**37** [11]	**38** [09]	**39** [01]
89 [20]	**1F** [18]	**08** [10]	**30** [08]	**0D** [00]

Figure 3-1 ASCII code vs. scan code cross reference table (numeric mode)

ASCII code corresponded to scan code in Alphabetic mode

Alphabetic mode keyboard layout				
F1 ? ?	**F5** *	QZ.	ABC	DEF
F2 ? ?	**F6** ?	GHI	JKL	MNO
F3 ? ?	**F7** ?	PRS	TUV	WXY
F4 ? ?	SHIFT	[C]	-SP+	[E]

ASCII code, ASCII code, ASCII code [Scan code, Scan code, Scan code]				
86 [23]	**8A** [1B]	**51,5A,2E** [24,25,26]	**41,42,43** [27,28,29]	**44,45,46** [2A,2B,2C]
87 [22]	**8B** [1A]	**47,48,49** [2D,2E,2F]	**4A,4B,4C** [30,31,32]	**4D,4E,4F** [33,34,35]
88 [21]	**8C** [19]	**50,52,53** [36,37,38]	**54,55,56** [39,3A,3B]	**57,58,59** [3C,3D,3E]
89 [20]	**1F** [18]	**08** [10]	**2D,20,2B** [1D,1E,1F]	**0D** [00]

Figure 3-2 ASCII code vs. scan code cross reference table (alphabetic-mode)

3.8. DOS Manager

The following MS/DOS function calls are emulated by MR350MKII. The calling convention is identical to that of MS/DOS, i.e. INT 21H with function code in registered AH. The parameter passing mechanism is also identical to the MS/DOS convention. Unsupported DOS calls are returned with a completion status code immediately. Please refer to MS/DOS Technical Reference Manual for further details.

Standard Input/Output

01 Read stdin (wait if no key) and write it to stdout

No check on control keys (ESC)
Entry Parameters: AH = 01
Returned Values: AL = 8-bit data

```
unsigned char TS_stdin()
{
  regs.h.ah= 1;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

02 Write stdout

Entry Parameters: AH = 02

DL = 8-bit data
Returned Values: None

```
void TS_stdout(unsigned char ch)
{
  regs.h.ah= 2;
  regs.h.dl= ch;
  int86(0x21,&regs,&regs);
  return;
}
```

03 Read stdaux (COM2 RS-232 port)

No check on control keys (ESC)
Entry Parameters: AH = 03
Returned Values: AL = 8-bit data

```
unsigned char TS_stdaux_in()
{
  regs.h.ah= 3;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

04 Write stdaux (COM2 RS-232 port)

Entry Parameters: AH = 04
DL = 8-bit data
Returned Values: None

```
void TS_stdaux_out(unsigned char ch)
{
  regs.h.ah= 4;
  regs.h.dl= ch;
  int86(0x21,&regs,&regs);
  return;
}
```

06 Read / Write stdin or return 0 if none is ready

```
Entry Parameters:   AH = 06
                    DL =   0~0xFE ; Write this character to stdout
                           FF     ; Read stdin
Returned Values:    For Write stdin : none
                    For Read stdin
                           if char ready,   Zero = clear
                                  AL = 8-bit data
```

if char not ready, Zero = set

```
unsigned char TS_stdin_out(unsigned char ch)
{
  regs.h.ah= 6;
  regs.h.dl= ch;
  int86(0x21,&regs,&regs);
  if (ch == 0xFF)
  {
    if ((regs.x.cflag & 0x40) == 0) return(regs.h.al);
    else return(0);
  }
  return(0);
}
```

07 Read stdin (wait if no key)

No check on control keys (ESC)
Entry Parameters: AH = 07
Returned Values: AL = 8-bit data

```
unsigned char TS_stdin_noecho()
{
  regs.h.ah= 7;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

08 Read stdin (wait if no key)

No check on control keys (ESC)
Entry Parameters: AH = 08
Returned Values: AL = 8-bit data

```
unsigned char TS_stdin_wait()
{
  regs.h.ah= 8;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

09 Write character string to stdout

Entry Parameters: AH = 09
DS:DX = segment:offset of string
Returned Values: None

```
void TS_stdout_string(unsigned char *str)
{
  segregs.ds = FP_SEG(str);
  regs.x.dx = FP_OFF(str);
  regs.h.ah= 9;
  int86x(0x21,&regs,&regs,&segregs);
  return;
}
```

0A Keyboard buffer input

Entry Parameters:	AH = 0A
	DS:DX = pointer to input buffer area
Returned Values:	Buffer filled with last character by a CR

```
void TS_stdin_string(unsigned char *str)
{
  segregs.ds = FP_SEG(str);
  regs.x.dx = FP_OFF(str);
  regs.h.ah= 0x0a;
  int86x(0x21,&regs,&regs,&segregs);
  return;
}
```

0B Keyhit check

Entry Parameters:	AH = 0B
Returned Values:	AL = 00 if char not ready
	AL = FF if char ready

```
unsigned char TS_kbhit()
{
  regs.h.ah= 0x0b;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

Date/Time

The four function calls below are used to set/retrieve the system time and data by directly accessing the real-time-clock chip.

2A Get System date

Entry Parameters:	AH = 2A
Returned Values:	AL = Week

	CX = year (1980..2099)
	DH = month (1..12)
	DL = day (1..31)

```
void TS_get_date(int *year,int *month,int *day,int *week)
{
  TD_int_dos1(0x2a,0,0,0);
  *year = regs.x.cx;
  *month = regs.h.dh;
  *day = regs.h.dl;
  *week = regs.h.al;
}
```

2B Set System date

Entry Parameters:	AH = 2B
	CX = year (1980..2099)
	DH = month (1..12)
	DL = day (1..31)
Returned Values:	AL = 0

```
int TS_set_date(int year,int month,int day)
{
  regs.h.ah = 0x2b;
  regs.x.cx = year;
  regs.h.dh = month;
  regs.h.dl = day;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

2C Get System clock

Entry Parameters:	AH = 2C
Returned Values:	CH = hour (0..23)
	CL = min (0..59)
	DH = sec (0..59)
	DL = 0

```
void TS_get_time(int *hour,int *minute,int *second,int *hund_sec)
{
  TD_int_dos1(0x2c,0,0,0);
  *hour = regs.h.ch;
  *minute = regs.h.cl;
  *second = regs.h.dh;
  *hund_sec = regs.h.dl;
}
```

2D Set System clock

Entry Parameters:	AH = 2D
	CH = hour (0..23)
	CL = min (0..59)
	DH = sec (0..59)
Returned Values:	AL = 0

```
int TS_set_time(int hour,int minute,int second,int hund_sec)
{
  regs.h.ch = hour;
  regs.h.cl = minute;
  regs.h.dh = second;
  regs.h.dl = hund_sec;
  regs.h.ah = 0x2d;
  int86(0x21,&regs,&regs);
  return(regs.h.al);
}
```

3.9. File Manager

When the file is downloaded or uploaded, the working file can not be opened by the application command. As the same result, when the file is opened by application, the host computer can not download or upload with the same file. This limitation is used to protect the file pointer from re-writing and corrupt the file system.

3C Create or truncate file

When a file is created, the file manager searches the file table for a file name matched. If it is found, the corresponding file handle is returned, and the file pointer is reset to the beginning of the file. The actual file size is reset to zero. If the file does not exist in the file table, a file entry is allocated, and memory is assigned.

Entry Parameters:	AH = 3C
	DS:DX = segment:offset of ASCIIZ file name
Returned Values:	if successful : Carry = clear, AX = handle
	if fail : Carry = set, AX = 3

```
int TS_create_file(char *fn)
{
  segregs.ds = FP_SEG(fn);
  regs.x.dx = FP_OFF(fn);
  regs.h.ah=0x3C;
  int86x(0x21,&regs,&regs,&segregs);
  if ((regs.x.cflag & 0x01) == 1) return(-1);
  else return(regs.x.ax);
}
```

3D Open file

The file must exist in the file table. This function returns the file handle.

Entry Parameters:	AH =	3D	
	AL =	0	; Read only
		1	; Write only
		2	; Both Read and Write
	DS:DX = segment:offset of ASCIIZ file name		
Returned Values:	if successful : Carry = clear, AX = handle		
	if fail : Carry = set, AX = 2		

When a file is opened, the file manager searches the file table for a file name match. If a match is found, the corresponding file handle is returned. The current pointer is reset to the beginning of the file, i.e. the current offset field is set to zero.

```
int TS_open_file(char *fn,int mode)
{
  regs.h.al=(unsigned char)mode;
  segregs.ds = FP_SEG(fn);
  regs.x.dx = FP_OFF(fn);
  regs.h.ah=0x3D;
  int86x(0x21,&regs,&regs,&segregs);
  if ((regs.x.cflag & 0x01) == 1) return(-1);
  else return(regs.x.ax);
}
```

3E Close file

Entry Parameters:	AH = 3E	
	BX = file handle	
Returned Values:	Carry = clear	; OK
	= set	; Failed

```
void TS_close_file(int hdl)
{
  regs.h.ah= 0x3e;
  regs.x.bx= hdl;
  int86(0x21,&regs,&regs);
}
```

3F Read file

Copy (CX) bytes from current address to DS:DX.
Advance the current address (CX) number of bytes.

Entry Parameters: AH = 3F
BX = file handle
CX = number of bytes to read
DS:DX = segment:offset of buffer area
Returned Values: if successful: Carry = clear,
AX = number of bytes read, 0 if EOF
if fail: Carry = set, AX = 6

```
int TS_read_file(int hdl,int cnt,char *str)
{
  segregs.ds = FP_SEG(str);
  regs.x.dx = FP_OFF(str);
  regs.h.ah=0x3f;
  regs.x.cx=cnt;
  regs.x.bx=hdl;
  int86x(0x21,&regs,&regs,&segregs);
  if ((regs.x.cflag & 0x01) == 0) return(regs.x.ax);
  else return(-1);
}
```

40 Write file

Copy (CX) bytes from DS:DX to file (BX). Update BX current address and ending address. If CX is assigned with 0 (zero), the system will truncate the file from the current file pointer position. This function can be used by MSC function call chsize().

Entry Parameters: AH = 40
BX = file handle
CX = number of bytes to write or 0
DS:DX = segment:offset of buffer area
Returned Values: if successful: Carry = clear,
AX = number of bytes read, 0 if full
if fail: Carry = set, AX = 6

```
int TS_write_file(int hdl,int cnt,char *str)
{
  segregs.ds = FP_SEG(str);
  regs.x.dx = FP_OFF(str);
  regs.h.ah=0x40;
  regs.x.bx=hdl;
  regs.x.cx=cnt;
  int86x(0x21,&regs,&regs,&segregs);
  if ((regs.x.cflag & 0x01) == 0) return(regs.x.ax);
  else return(-1);
}
```

41 Delete file

Entry Parameters: AH = 41
DS:DX = segment:offset of ASCIIZ file name
Returned Values: if successful : Carry = clear,
if fail : Carry = set, AX = 2

```
int TS_delete_file(char *fn)
{
  segregs.ds = FP_SEG(fn);
  regs.x.dx = FP_OFF(fn);
  regs.h.ah=0x41;
  int86x(0x21,&regs,&regs,&segregs);
  if ((regs.x.cflag & 0x01) == 0) return(1);
  else return(-1);
}
```

42 Move file pointer

Entry Parameters: AH = 42
AL = 0 offset from beginning
1 offset from current
2 offset from end
BX = file handle
CX = most significant half of offset
DX = least significant half of offset
Returned Values: if successful: Carry = clear,

AX = least significant half of new current

DX = most significant half of new current

if fail: Carry = set, AX = 6

```
struct LONG_INT {
      long ll;
      };
struct LONG_INT1 {
      unsigned int ii1, ii2;
      };
union LONG_III {
      struct LONG_INT l;
      struct LONG_INT1 i;
      };
```

```
long TS_seek_file(int hdl,int type,long loc)
{
  union LONG_III aa;

  regs.h.ah=0x42;
  regs.h.al=(unsigned char)type;
  regs.x.bx=hdl;
  aa.l.ll = loc;
  regs.x.cx=aa.i.ii2;
  regs.x.dx=aa.i.ii1;
  int86(0x21,&regs,&regs);
  aa.i.ii2=regs.x.dx;
  aa.i.ii1=regs.x.ax;
  if ((regs.x.cflag & 0x01) == 0) return(aa.l.ll);
  else return(-1L);
}
```

43 Get file attribute

Entry Parameters: AH = 43
AL = 0
DS:DX = segment:offset of ASCIIZ file name
Returned Values: if file found: Carry = Clear, CX = 0
if file not found: Carry = set, AX = 2

```
int TS_check_file_exit(char *str)
{
  regs.h.ah=0x43;
  regs.h.al=0;
  segregs.ds = FP_SEG(str);
  regs.x.dx = FP_OFF(str);
  int86x(0x21,&regs,&regs,&segregs);
  if ((regs.x.cflag & 0x01) == 0) return(1);
  else return(0);
}
```

56 Rename a file

Entry Parameters: AH = 56
DS:DX = pointer to ASCII filename to be renamed
ES:DI = pointer to new ASCII filename
Returned Values: AH = 0 and clear Carry flag ;if success
1 and set Carry flag ;if not success

```
int TS_rename_file(char *inf,char far *outf)
{
    segregs.ds = FP_SEG(inf);
    regs.x.dx = FP_OFF(inf);
    segregs.es = FP_SEG(outf);
    regs.x.di = FP_OFF(outf);
    regs.h.ah=0x56;
    int86x(0x21,&regs,&regs,&segregs);
    if ((regs.x.cflag & 0x01) == 0) return(regs.x.ax);
    else return(-1);
}
```

Memory Access

48 Allocate specified number of paragraphs memory

Entry Parameters:	AH = 48
	BX = number of segment
Returned Values:	AX = seg addr of block allocated Error code, if carry flag set
	BX = largest available block (on failure)

49 Free allocated memory

Entry Parameters:	AH = 49
	ES = seg of block to free
Returned Values:	AX = error code, if carry flag is set
	BX = largest available block (on failure)

4A Modify allocated block

Entry Parameters:	ES = seg of the block to modify
	BX = The new number of segs wanted
Returned Values:	AX = error code, if carry flag is set
	BX = largest available block (on failure), if carry flag is set

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4. Host ESC Commands

There are three classes of host communication activities:

(1) Host Sends Control/Configuration Commands to the MR350MKII

Almost all MR350MKII configurations and operations may be controlled by the host system via control commands. Configuration commands are used to set up system tables such as the communication control table. Control commands are used to abort MR350MKII operations, reset the MR350MKII, instruct the MR350MKII to execute an application program, or other functions related to operations.

Configuration commands are normally issued by the host system during the initialization process. Control commands, however, may be issued at any time during normal operation or during a recovery action.

(2) Host Requests Data from the MR350MKII

Two kinds of data are usually requested by the host system: MR350MKII system data and application data. Application data is the information which is generated from application program, system data is the information which is pertinent only to MR350MKII executives, e.g. file names, system parameters, etc. The MR350MKII transmits data depending on the protocol used.

(3) File Transfers Between the Host and the MR350MKII

Executable program file and data files are downloaded to the MR350MKII from the host or uploaded to the host from the MR350MKII. File transfers may use a special file transfer protocol to move data in a point-to-point or multi-point connection.

In the following sections we will first discuss the host communication commands and briefly describe their functions. Then we will examine detailed protocol of each function.

4.1. General Control Commands

1. Hard Reset (ESC H)

A hard reset command clears all the MR350MKII RAM memory content. It performs tests on all major hardware devices. Programs or data that have previously accumulated in the MR350MKII or previously been downloaded by the host will be purged from the memory. Default system parameters are restored from the Flash ROM.The hard reset command will not purge the program files that stored on Flash ROM

The hard reset command does not have any parameter or value. The equivalent keypad invoking sequence is entering the supervisor mode and selecting an initialization command.

2. Abort (ESC A)

Abort is the "soft reset" command. The MR350MKII terminates its execution and returns to ready mode. Programs and data that have been stored in the MR350MKII RAM space are preserved. The system parameters remain unchanged. The abort command does not have any parameter or value. The equivalent keypad invoking sequence is pressing the [SHIFT] and [F5/*] keys at the same time.

3. Execute (ESC X filename)

The host system may instruct the MR350MKII to execute a program which is resided in the RAM or Flash ROM of MR350MKII. The host issues this command with the executable program name as its parameter. The MR350MKII acknowledges with an ACK response if the program exists and starts execution.

The Execute command has one parameter, the file name. The Execute command can also be invoked via the MR350MKII workstation menu.

Execute Flash ROM program (ESC X/ROM filename)

The host system may instruct the MR350MKII to execute a program which is resided in the Flash ROM of MR350MKII.

4. Directory (ESC D)

The directory command instructs the MR350MKII to return a list of available files in the RAM of the MR350MKII. The directory command can also be invoked via the MR350MKII workstation menu. When invoked from the keypad the directory is listed on the LCD display.

Directory Flash ROM (ESC D/ROM)

The directory command instructs the MR350MKII to return a list of available programs in the Flash ROM of the MR350MKII.

5. Erase (ESC E filename)

The erase command deletes a file from the MR350MKII RAM. An ACK response will be given if the file existed and was deleted, otherwise an NAK response is generated by the MR350MKII. The erase command has one parameter, the file name. The erase command can also be invoked via the MR350MKII workstation menu.

6. **Autoboot (ESC O program name)**

This command defines an autoboot program name in the MR350MKII. The autoboot program will be executed automatically each time the power is turned OFF and ON.

7. **Password (ESC P password)**

To create or edit a supervisor password.

8. **Get RAM size (ESC G)**

Get the MR350MKII total RAM size, program execution memory, and free memory which available for RAM disc.

Get Flash ROM size (ESC G/ROM)

Get the MR350MKII total Flash ROM size and free memory which available for RAM disc.

9. **Get filename of current executing program (ESC I filename)**

While the <ESC I> command is received by MR350MKII, the system will response the current executing program name or no program is running.

10. **Check file existed and files size(ESC J filename)**

Check if the file is existed on MR350MKII or not. If file is exist, it will return its size

11. **Set keyboard locking (ESC K state)**

Set the MR350MKII? keyboard locking state. There are three states allowed to be assigned: UNLOCK, LOCK, or PARTIAL LOCK.

12. **Change terminal address ID (ESC 5 ID)**

Assign a new terminal address ID to the terminal. Once the terminal address ID is changed, it will take effect immediately without having to reset the terminal.

13. **Disable UPS battery (ESC F)**

In general, UPS battery can supply power to MR350MKII when disconnect power adapter or power failure. User can use this command to disable UPS battery after power failure.

14. **Loopback test (ESC 9)**

The loopback test is used for testing the line communication. The testing program run on host sends this command with test data to terminal and terminal echoes back the data to be verified by the program.

15. Buzzer Volume (ESC N)

This command can remote changing MR350MKII's buzzer sound.

16. Supervisor password (ESC P)

This command can remote changing MR350MKII's buzzer sound.

17. Get terminal ID (ESC R)

This commcand can get terminal ID. The default terminal ID is "MR350"

18. Get terminal ID and version no (ESC v)

This commcand can get terminal ID and version no. The default terminal ID is "MR350 V4.xx".

4.2. Configuration Commands

Configuration commands from the host always follow the standard host command sequence: ESC, cmd, table. The cmd field actually specifies the object to be configured. The table field contains the data organized in a pre-defined format.

1. Terminal Configuration (ESC T)

The terminal configuration command has the following format:

ESC T termtable

This command takes the data structure "termtable" from the host and writes it to the MR350MKII internal terminal control table. The structure within "termtable" must conform to the TERM_CONFIG typedef (see section 2.5 on page 2-17) specified in the previous section.

The new terminal control table takes effect immediately after the ESC T command has been successfully received.

2. Communication Configuration (ESC C)

The communication configuration command has the following format:

ESC C comtable

This command takes the data structure "comtable" from the host and writes it to one of the two MR350MKII internal communication control tables. The structure within "comtable" must conform to the COM_CONFIG typedef (see section 2.4 on page 2-16) specified in the previous section.

The new communication control table takes effect immediately after the ESC C command has been successfully received. The MR350MKII will reinitialize the corresponding communication port with its new parameters. For example, if ESC C instructs the RS-232 port to change the baud rate from 9600 to 1200 the MR350MKII will switch to 1200 right after the ESC C command has been received. The next host communication will use 1200 baud.

3. Device Configuration (ESC V)

The device configuration command has the following format:

ESC V devtable

This command takes the data structure "devtable" from the host and writes it to the MR350MKII internal device control table. The structure of "devtable" must conform to the DEV_CONFIG typedef (see section 0 on page 2-14) specified in the previous section.

The new device control table takes effect immediately after the ESC V command has been successfully received.

4. Barcode symbology Configuration (ESC B)

The barcode symbology configuration command has the following format:

ESC V bartable

This command takes the data structure "bartable" from the host and writes it to the MR350MKII internal barcode symbology control table. The structure of "bartable" must conform to the BAR_CONFIG typedef (see section 0 on page 2-13) specified in the previous section.

The new device control table takes effect immediately after the ESC V command has been successfully received.

5. Date/Time Configuration (ESC M)

The date/time configuration command has the following format:

ESC M datetime

This command allows the host system to initialize the MR350MKII real time clock function. The parameter datetime is an ASCII character string with the following interpretations: yyyymmddhhmmss.

The first four characters represent the year. The next two characters represent the month, where January is 01. The fields after the month field represent the day of the month, hour (24 hour format), minute, and second, respectively.

For example, command ESC M 199009262345 will initialize the MR350MKII clock to September 26, 1990. The time is 11:45 PM. The MR350MKII reconfigures the real time clock chip as soon as the ESC M command has been successfully received.

4.3. *File Transfer Commands*

1. Download (ESC L filename)

The download command is used to transfer a binary executable program or data file from the host system to the MR350MKII. When the MR350MKII receives the download command it sends an ACK response back to the host and immediately puts itself into a file receiving state. The file receiving state is determined by a preassigned host protocol Kermit. The host system may start transmission of the file as soon as the ACK response has arrived.

The download command has one parameter, the file name. Download can also be invoked via the MR350MKII workstation menu.

The upload command performs the opposite function of the download command. It is normally used to transfer a data file from the MR350MKII to the host system. This is the typical means of retrieving collected data in workstation mode.

2. Upload (ESC U filename)

When the MR350MKII receives an upload command it puts itself in file transmission state and starts sending the designated data file. The file transfer protocol is determined by a preassigned host protocol Kermit. The host system waits for the arrival of the data file after it sends out the upload command.

The upload command has one parameter, the file name. The upload command can also be invoked via the MR350MKII workstation menu.

4.4. *Multipoint Protocol*

In Multipoint operation the MR350MKII uses an asynchronous serial multi-drop protocol for communication with the host computer. Note that to make this protocol operable an RS-232 to RS-485 converter is needed between the host and the MR350MKII. The terminal protocol consists of commands and responses of the following format:

Symbol	Description
=>	Transmission from host to terminal
<=	Transmission from terminal to host

ADDR	Terminal address (A-Y,0-6) + 80H
CMD	Network command to terminal, 2 bytes, A-F,0-9
CS1	Checksum, first byte
CS2	Checksum, second byte

The checksum is calculated by adding each byte of the transmission, ADDR, and length of data block (excluding STX and ETX). CS1 is high nibble (4 bits) +40H and CS2 is low nibble +40H.

Example: Command to load the file named A.EXE

STX ESC L A . E X E CS1 CS2 ADDR

Data block = ESC L A . E X E (excluding STX)
Length of data block = 7
CS = ESC + L + A + . + E + X + E + ADDR + 7
CS1 = high nibble of CS + 40H
CS2 = low nibble of CS + 40H

The ASCII data characters and their values are as follows:

STX	0x02
ETX	0x03
ACK	0x06
NAK	0x15
DC1	0x11
ESC	0x1B
EOT	0x04

The maximum frame size including protocol control characters is 128 bytes. Transparent transmission of protocol control characters STX and ETX is achieved by preceding them with a '\' (backslash) character. Transparent transmission of the '\' character is achieved by sending two '\' characters consecutively.

Rule of data convention during data transmission:

1) One-byte data converted to two-byte data

\	convert to	\\
00 hex -- 1F hex	convert to	\ 80 hex -- \ 9F hex
A0 hex -- FF hex (excluding DC hex)	convert to	\ 20 hex -- \ 7F hex

2) one-byte data transmitted as original data without converting

other codes	unchanged

Host Transmissions

Transmission	Format
Poll	STX, ADDR
Host Data	STX, CMD, data, CS1, CS2, ADDR
Acknowledgment	ACK
Negative ACK	NAK

Terminal Transmissions

Transmission	Format
Terminal Data	STX, data, CS1, CS2, ETX
Acknowledgment	ACK
Negative ACK	NAK

4.4.1. Protocol Operation

The terminal protocol operates as a multi-point stop and wait protocol. A station sends only one frame and then stops and waits for a response.

The following scenarios typify link transmissions (**Poll**):

* Terminal has no data for the host:

=> STX ADDR
<= EOT - if no data is ready for transmission

* Terminal has data for the host:

=> STX ADDR
<= STX <data> CS1 CS2 ETX - if data is ready

=> ACK	- if data is received correctly, or
NAK	- if an error has occurred

* The host sends a command to and receives a response from the terminal in one poll cycle; it then acknowledges receipt of the terminal command response:

=>	STX, CMD, parms, ... CS1, CS2, ADDR
<=	ACK - if data is received correctly and no response is required, or NAK - if an error occurred or if there is response data to be sent.
<=	Command response and data:
=>	ACK - if a command response was sent from the terminal and received correctly by the host, or NAK - if an error occurred in the command response

4.4.2. Commands

The following commands are supported for download, diagnostic, and application data transfers. Each command and its parameters will be framed as shown before being transmitted; responses have the same format without the ADDR fields.

STX, CMD, parms, ... CS1, CS2, ADDR

ESC 0 - Application data

=>	STX ESC 0 <data> CS1 CS2 ADDR
<=	ACK or NAK

Since the MR350MKII has only one frame to hold the single incoming application data, and the frame will not become available until the holding data is retrieved by terminal? application program. Therefore, it is important to check the terminal echo back status whether ACK or NAK to sure the terminal has received the data.

ESC 5 - Set multipoint address

```
=>      STX ESC '5' <addr> CS1 CS2 ADDR
                where <addr> = 'A'~'Y','0'~'6'
<=      STX ESC '5' <Retcode> CS1 CS2 ETX
                where <Retcode>=     0x00    if set OK
        0x01    error
=>      ACK or NAK
```

ESC 9 - Send diagnostic test data

```
=>      STX ESC '9' <data> CS1 CS2 ADDR
<=      STX ESC '9' <data> CS1 CS2 ETX
=>      ACK or NAK
```

ESC A - Soft Reset, Restart, or Abort

This command stops any MR350MKII program execution as if control-exit has been pressed on the keypad.

```
=>      STX ESC A CS1 CS2 ADDR
<=      ACK or NAK
```

ESC B - Enable/disable the decoding of barcode symbologies:

```
=>      STX ESC B <abcde> CS1 CS2 ADDR
```

where <abcde> is a five-character-positioned data to enable/disable the decoding of individual barcode symbology by the sequence of the first character for Code 39, the second for I2of5, then Codabar, EAN/UPC, and Code 128. Each positioned character with content of 'N' enables the decoding corresponded barcode symbology or 'F' disables the decoding.

```
<=      STX ESC B <Retcode> CS1 CS2 ETX
=>      ACK or NAK
```

ESC C - Write communication configuration table to MR350MKII

```
=>      STX ESC C <comtable> CS1 CS2 ADDR
<=      STX ESC C <Retcode> CS1 CS2 ETX
=>      ACK or NAK
```

ESC D - Read directory of RAM disk to host

=> STX ESC D CS1 CS2 ADDR
<= STX ESC D <directory data> CS1 CS2 ETX (or NAK)
=> ACK or NAK

ESC D/ROM - Read directory of Flash ROM to host

=> STX ESC D/ROM CS1 CS2 ADDR
<= STX ESC D/ROM <directory data> CS1 CS2 ETX (or NAK)
=> ACK or NAK

ESC E - Erase a file from the MR350MKII directory

=> STX ESC E <filename> CS1 CS2 ADDR
<= STX ESC E <RetCode> CS1 CS2 ETX
where <RetCode>:
00 if successfully erased
01 file does not exist
=> ACK or NAK

ESC F - Disable UPS battery to supply power

This command is used to stop UPS battery to continue to supply power to terminal. By using this command you can prevent exhausting UPS battery when the power source is switched off for some time.

=> STX ESC F CS1 CS2 ADDR
<= ACK or NAK

ESC G - Get MR350MKII's RAM size

=> STX ESC G CS1 CS2 ADDR
<= STX ESC G <xxx> <yyy> <zzz> CS1 CS2 ETX
where <xxx>= number of Kbytes of total memory
<yyy>= number of Kbytes of Exec memory
<zzz>= number of Kbytes of Free memory
=> ACK or NAK

ESC G/ROM - Get MR350MKII's Flash ROM size

```
=> STX ESC G/ROM CS1 CS2 ADDR
<= STX ESC G/ROM <xxx>  <zzz> CS1 CS2 ETX
        where <xxx>= number of Kbytes of total memory
                <zzz>= number of Kbytes of Free memory
=> ACK or NAK
```

ESC H - Hard Reset and initiate power on test

This command resets the MR350MKII terminal, and running applications are halted. Power-on test routines are run and, if completion is normal, the MR350MKII is ready for the next command.

```
=>      STX ESC H CS1 CS2 ADDR
<=      ACK or NAK
```

ESC I - Get filename of current executing program

```
=>      STX ESC I CS1 CS2 ADDR
<=      STX ESC I <filename> CS1 CS2 ETX
                if a program with filename is running in
                terminal
        STX ESC I <01> CS1 CS2 ETX
                if no program is running
=>      ACK or NAK
```

ESC J - Check if file existed or not

```
=> STX ESC J <filename> CS1 CS2 ADDR
<= STX ESC J <Retcode> CS1 CS2 ETX
        where Retcode = 00 means file exist
                      = 01 means file not exist
=> ACK or NAK
```

ESC K - Set keyboard locking

```
=> STX ESC K <state> CS1 CS2 ADDR
        where state = '0' set keyboard LOCK
                    = '1' set keyboard UNLOCK
                    = '2' set keyboard Partial LOCK
<= STX ESC K <Retcode> CS1 CS2 ETX
        where Retcode = 00 if successful
                      = 01 if not successful
=> ACK or NAK
```

ESC L - Transfer file to MR350MKII

```
=>      STX ESC L <filename> CS1 CS2 ADDR
<=      ACK or NAK
        .... loop on next two steps to transfer file until done
...     =>      STX ESC 'Y' <data> CS1 CS2 ADDR
        <=      ACK or NAK

=>      STX ESC Z CS1 CS2 ADDR (end of data sending)
<=      ACK or NAK
```

ESC M - Write date and time to MR350MKII

```
=>      STX ESC M <datetime> CS1 CS2 ADDR
                where <datetime>
                yyyymmddhhmmss in ASCII string
<=      STX ESC M <Retcode> CS1 CS2 ETX
=>      ACK or NAK
```

ESC N - Set Buzzer Volume

```
?  ?STX ESC ‘N’ <n> CS1 CS2 ADDR
                Where <n>  =  ‘0’ low volume
                              ‘5’ medium volume
                              ‘9’ high volume
?   ACK or NAK
```

ESC O - Set auto-execution program

```
=> STX ESC O <program name> CS1 CS2 ADDR
<= STX ESC O <Retcode> CS1 CS2 ETX
                where Retcode = 00 if successful
                              = 01 if not successful
=> ACK or NAK
```

ESC O/ROM - Set auto-execution program on ROM

=> STX ESC O <program name>/ROM CS1 CS2 ADDR
<= STX ESC O <Retcode>/ROM CS1 CS2 ETX
where Retcode = 00 if successful
= 01 if not successful
=> ACK or NAK

ESC P - Set supervisor password (maxi. 8 characters)

=> STX ESC P <password> CS1 CS2 ADDR
<= ACK or NAK

ESC R - Terminal ID

=> STX ESC R CS1 CS2 ADDR
<= STX ESC T <*terminal_id*> CS1 CS2 ETX
=> ACK or NAK

ESC T - Write terminal configuration table to MR350MKII

=> STX ESC T <termtable> CS1 CS2 ADDR
<= STX ESC T <Retcode> CS1 CS2 ETX
where Retcode= 00 means successful
= 01 means unauthorized command
=> ACK or NAK

ESC U - Transfer file from MR350MKII

=> STX ESC U <filename> CS1 CS2 ADDR
<= ACK or NAK or EOT (when file not found)
.... loop on next two steps to transfer file until done
=> STX ESC 'Y' CS1 CS2 ADDR
<= STX ESC 'Y' <data> CS1 CS2 ETX
<= ACK or NAK
<= STX ESC Z CS1 CS2 ETX (end of file transfer)
=> ACK or NAK

ESC V - Write device configuration table to MR350MKII

=> STX ESC V <devtable> CS1 CS2 ADDR
<= STX ESC V <Retcode> CS1 CS2 ETX

```
=>      ACK or NAK
```

ESC v - Get Terminal ID and version no

```
=>      STX ESC V <devtable> CS1 CS2 ADDR
<=      STX ESC V <terminal_id and ver> CS1 CS2 ETX
=>      ACK or NAK
```

ESC X - Start program execution

```
=>      STX ESC X <filename> CS1 CS2 ADDR
<=      STX ESC X <RetCode> CS1 CS2 ETX
                where <RetCode>:
                00      if successfully started
                01      file does not exist
=>      ACK or NAK
```

Where the <filename> should contain the name of file only but without file extension name “.EXE”.

For example: A executable program named ? RV30.EXE”

Command : STX ESC X ***DRV30*** *CS1 CS2 ADDR*

ESC X - Start program execution on ROM

```
=>      STX ESC X <filename>/ROM CS1 CS2 ADDR
<=      STX ESC X <RetCode>/ROM CS1 CS2 ETX
                where <RetCode>:
                00      if successfully started
                01      file does not exist
=>      ACK or NAK
```

Where the <filename> should contain the name of file only but without file extension name “.EXE”.

For example: A executable program named ? RV30.EXE”

Command : STX ESC X ***DRV30*** *CS1 CS2 ADDR*

4.5. ESC Commands Added for MV1100 Fingerprint Module .

ESC $D Get Template List

A list of all stored templates on the MV1100 is updated to the MR350 MKII reserved file $FP.LST. The items in $FP.LST have the format of $Txxxxxxxxxx.yyy, where xxxxxxxxx is the template ID and yyy is the template index.

```
==>   STX  ESC $D  CS1  CS2  ADDR
<==   STX  ESC $D RESULT  CS1 CS2  ETX
or
<==    NAK
RESULT          =         '0'       ;success
            =         '1'       ;fail
            =         '2'       ;busy
            =         '3'       ;timeout
```

NAK means command format error or checksum error.

For the host to get the MV1100 template list, it should issue ESC $D command first and then issue ESC U command to upload file $FP.LST if ESC $D command is successful.

ESC $E Erase Template

The command erases the specified template on MV1100.

```
        ==>   STX  ESC $E  xxxxxxxxxx.yyy  CS1  CS2  ADDR
        <==   STX  ESC $E  RESULT   CS1 CS2  ETX
        or
        <==   NAK
xxxxxxxxxx            ;template ID     ( '1'  --  '4294967294' )

yyy                   ;template index  ( '0' --  '255' )
RESULT        =       '0'     ;success
              =       '1'     ;fail
              =       '2'     ;busy
              =       '3'     ;timeout
```

NAK means command format error or checksum error.

ESC $F Enroll and Store Template on MR350 MKII

The command enrolls and stores the template with the specified ID to the MR350 MKII reserved file $FP.UPL .

```
        ==>   STX  ESC $F  xxxxxxxxxx  CS1  CS2  ADDR
        <==   STX  ESC $F  RESULT   < ,QUALITY, CONTENT >
        CS1 CS2  ETX
        or
        <==   NAK
xxxxxxxxxx            ;template ID       ( '1' --  '4294967294' )
RESULT        =       '0'     ;success
              =       '1'     ;fail
              =       '2'     ;busy
              =       '3'     ;timeout
```

If RESULT = '0', MR350MKII will response with QUALITY and CONTENT fields:

QUALITY is an integer that has a range of '000' – '100'

CONTENT is an integer that has a range of '000' – '100'

NAK means command format error or checksum error.

For the host to get the template, it should issue ESC $F command first and then issue ESC U command to upload file $FP.UPL if ESC $F command is successful.

ESC $G Enroll and Store Template on MV1100 ()

The command enrolls and stores the template with the specified ID on MV1100.

```
        ==>   STX  ESC $G  xxxxxxxxxx  CS1  CS2  ADDR
        <==   STX  ESC $G  RESULT   < ,QUALITY, CONTENT >
        CS1 CS2  ETX
        or
        <==    NAK
xxxxxxxxxx              ;template ID        ( '1' --  '4294967294' )
RESULT          =       '0'     ;success
                =       '1'     ;fail
                =       '2'     ;busy
                =       '3'     ;timeout
```

If RESULT = '0', MR350MKII will response with QUALITY and CONTENT fields:

QUALITY is an integer that has a range of '000' – '100'

CONTENT is an integer that has a range of '000' – '100'

NAK means command format error or checksum error.

ESC $H Verify Template

The command requests to verify the fingerprint against the template saved in the MR350 MKII reserved file $FP.DNL .

.

```
        ==>   STX  ESC $H  CS1  CS2  ADDR
        <==   STX  ESC $H  RESULT   < , INDEX , SCORE >  CS1
        CS2  ETX
        or
        <==    NAK
RESULT          =       '0'     ;success
                =       '1'     ;fail
                =       '2'     ;busy
                =       '3'     ;timeout
```

If RESULT = '0', MR350MKII will response with INDEX and SCORE fields:

INDEX is the index of the matched template that has an range of '000' – '255'

SCORE is an integer that has a range of '000' – '100'

NAK means command format error or checksum error.

For the host to verify against the template saved on its disk, it should issue ESC L command first to download the template to the MR350 MKII reserved file $FP.DNL and then issue ESC $H command to verify the fingerprint if ESC L command is successful.

ESC $I Verify ID ()

The command requests to verify the fingerprint against the template(s) with the specified ID stored on MV1100.

```
==>  STX  ESC $I  xxxxxxxxxx  CS1  CS2  ADDR
<==  STX  ESC $I  RESULT  < , INDEX , SCORE >  CS1 CS2
ETX
or
<==  NAK
xxxxxxxxxx                ;template ID
RESULT        =        '0'      ;success
              =        '1'      ;fail
              =        '2'      ;busy
              =        '3'      ;timeout
```

If RESULT = '0', MR350MKII will response with INDEX and SCORE fields:

INDEX is the index of the matched template that has an range of '000' – '255'

SCORE is an integer that has a range of '000' – '100'

NAK means command format error or checksum error.

ESC $L Download Template

The command downloads the template from the MR350 reserved file $FP.DNL to MV1100 and stores the template in MV1100 flash memory .

```
==>  STX  ESC $L  CS1  CS2  ADDR
<==  STX  ESC $L  RESULT   CS1 CS2  ETX
or
<==  NAK
RESULT        =        '0'      ;success
```

```
                =       ‘1’     ;fail
                =       ‘2’     ;busy
                =       ‘3’     ;timeout
```

NAK means command format error or checksum error.

For the host to download the template saved on its disk, it should issue ESC L command first to download the template to the MR350 MKII reserved file $FP.DNL and then issue ESC $L command to download it to MV1100 if ESC L command is successful.

ESC $S Set Globe Threshold ()

The command sets the globe verification value for MV1100 .

```
    ==>   STX  ESC $S  THRESH CS2  ADDR
    <==   STX  ESC $S  RESULT CS1 CS2  ETX
    or
    <==   NAK
THRESH          =       ‘1’     ,very high security
                =       ‘2’     ;high security
                =       ‘3’     ;medium security
                =       ‘4’     ;low security
                =       ‘5’     ;very low security
RESULT          =       ‘0’     ;success
                =       ‘1’     ;fail
                =       ‘2’     ;busy
                =       ‘3’     ;timeout
```

NAK means command format error or checksum error.

ESC $S Get Globe Threshold ()

The command sets the globe verification value for MV1100 .

```
    ==>   STX  ESC $S  CS2  ADDR
    <==   STX  ESC $S  RESULT  < ,THRESH >  CS1 CS2  ETX
    or
    <==   NAK
RESULT          =       ‘0’     ;success
                =       ‘1’     ;fail
                =       ‘2’     ;busy
                =       ‘3’     ;timeout
```

If RESULT = ‘0’, MR350MKII will response with THRESH field:

THRESH=	‘1’	,very high security	
	=	‘2’	;high security
	=	‘3’	;medium security
	=	‘4’	;low security
=	‘5’	;very low security	

NAK means command format error or checksum error.

ESC $U Upload Template ()

The command uploads the specified template from MV1100 flash memory to the MR350 reserved file $FP.UPL .

```
==>   STX  ESC $U xxxxxxxxxx.yyy  CS1  CS2  ADDR
<==   STX  ESC $U  RESULT   CS1 CS2  ETX
or
<==   NAK
```

xxxxxxxxxx ;template ID (‘1’ -- ‘4294967294’)

yyy ;template index (‘0‘ -- ‘255’)

RESULT	=	‘0’	;success
	=	‘1’	;fail
	=	‘2’	;busy
	=	‘3’	;timeout

NAK means command format error or checksum error.

For the host to upload the specified template on MV1100, it should issue ESC $U command first to upload the template to the MR350 MKII reserved file $FP.UPL and then issue ESC U command to upload file $FP.UPL if ESC $U command is successful.

ESC $V Get Version

The command gets the software version information from MV1100.

```
==>   STX  ESC $V  CS1 CS2  ADDR
<==   STX  ESC $V  RESULT < , Kx.xxx  Ay.yyyy >  CS1
CS2  ETX
or <==   NAK
```

RESULT	=	‘0’	;success
	=	‘1’	;fail
	=	‘2’	;busy
	=	‘3’	;timeout

If RESULT = ‘0’, MR350MKII will response with the version field:

Kx.xxxx Ay.yyyy where x.xxxx represents the version of the kernal and y.yyyy represents the version number of the algorithm.

NAK means command format error or checksum error.

5. How to to programming

There are two major parts for programming – 1. Programming MR350 MKII and 2. Programming communication program between MR350 MKII and Host computer. The following topic describe application and utility library that will help users to develop quickly and efficiently for their applications.

5.1. Programming MR350 MKII

MR350 MKII's OS is an open architecture and it provides a MS-DOS compatible platform, user can write a program run on MR350 MKII to fully control its input/output facilities or have a complicate accumulation, data validation or table look up features for your application program. So, users can use standard C, C++ or Assembly language development tools to develop their application. In Chapter 3, it describes detail DOS/BIOS call of MR350MKII, user can directly refer to this chapter to implement application program. If user dosen't familiar or skillful in programming language. Unitech also a program generator tool – Job Generator Pro (JobGen Pro). The MR350 MKII allows the user to write his application program by the following programming tools.

? ? JobGen Pro, a DOS base program generator that requiring the minimum programming skills. Please contact your local distributor or dealer for more detailed information.

? ? Microsoft C version 5.x, 6.x, 7.x or 8.x for MSDOS application

? ? Microsoft Visual C/C++ V1.52 or below for MSDOS application

? ? Borland C/C++ or Turbo C/C++ for MSDOS application

? ? Macro Assembler for MSDOS application

5.1.1. Programming by JobGen PRO

The JOB GENerator PROfessional (JobGenPRO) is an MS-DOS based software for developing applications for MR350MKII. With JobGenPRO, application developers may create an application program easily by defining the transactions, attributes of data fields and operation flow without writing program code. An executable program generated by JobGenPRO can be downloaded and run on the MR350 MKII then.

A JobGenPRO application consists of three files with same filename and different file extension:

.CFG Configuration of environment, communication and I/O interfaces of terminal.
.JB2 Definition of transactions, data fields and operation flow.
.EXE Execution program generated by JobGenPRO after linked a defined application.

The main features of JobGenPRO are listed below:

? Interactive user interface with pop-up windows.
? Define system configuration of the MR350 MKII.
? Define data fields and process flow.
? Download a JobgenPRO application to the MR350 MKII with lookup data files.
? Upload the collected data files from MR350 MKII to PC.
? Print specification of a JobgenPRO application for documentation.
? Application simulation on PC.

5.1.2. Programming by C/C++

The Unique advantage of MR350MKII is to give application programmer the power of the industry standard personal computer. Programmers develop MR350MKII applications by using standard C language and off-the-shelf Microsoft C / Borland C compiler on personal computers. The complied executable code is then download to MR350MKII through RS-232 / RS-485 link using Multipoint download.

Borland/Microsoft C/C++ compiler supports a superset of standard C programming language. MR350MKII provides the standard ANSI C functionality. As a result, some Microsoft extensions or DOS specific functions are not supported. For detail standard C function that are supported by MR350MKII firmware, please refer to **Appendix A**.

Unitech also provide a utility C (485LIB.C) library for user to develop their application program. The 350LIB.C incorporates a rich set of libraries to interface with all MR350MKII? input/output devices. All detailed calling convention and source code are listed behind each BIOS/DOS call in **Chapter 3**. For easily using this library, Unitech also provide sample program (350TEST.C) to help user to use it. So, user can directly modify this sample program. All of those files are stored on sub-directory "LIB" of DEMO disk.

5.2. Programming communication program

In Chapter 4, there are details description about Multi-Protocol between MR350MKII and Host computer. Users can follow this protocol to develop communication program or integrate them into their application program. But it seem that it is a little difficult for most user to implement communication program according specification of communication protocol. So, Unitech provide communication utility library to help user develop their application program without know detail communication protocol. In our demo disk, it includes DOS version and Windows version communication program, communication library and its sample program.

In DOS platform, we provide a C library (485LIB.C and SLIB.OBJ) for user to develop their DOS base communication program. We also provide a sample program 485COM.C for fully using 485LIB.C, so users can directly modify this program or porting it to your application program. All of those files are stored on sub-directory "DOSCOM" of DEMO disk

In Windows platform, we provide 16bits/32bits communication DLL for user to develop their Wondows communication program or intergate communication function into their application program. User can call this DLL from his Visual C/C++, Visual Basic or Delphi. All of those files are stored on sub-directory “DLL” of DEMO disk.

5.3. Contains of the Demo Disk

Below table show whole content of Demo disk

C function library for MR350 MKII programming

1)	350LIB.C/OBJ/H	C library source/object/header files MR350 MKII
2)	350TEST.C/EXE	Test program and source code for using C library

C library for programming DOS base Communication program

1)	485COM.EXE/C	Communication Utility
2)	485LIB.C/OBJ	C function library for 485COM.EXE
3)	SLIB.OBJ	Low level serial port I/O function written in Assembly

Windows DLL for programming Windows base Communication program

1)	16BIT\dll16	16bits DLL library for MS-Windows 3.1
	16BIT\multicom	16bits Communication Utility for MS-Windows 3.1
	16BIT\sample	VC++ (v1.5) Sample program for using 16bits DLL
2)	32BIT\dll32	32 bits DLL library for MS-Windows 95/NT
	32BIT\multi32	32bits Communication Utility for MS-Windows 95/NT
	32BIT\sample	VC++ (v5.0) Sample program for using 32bits DLL
3)	\Delphi	Delphi Sample program for using 32bits DLL
4)	\VB	Visual Basic Sample program for using 32bits DLL

JobGen Lite Demo. version

1)	\JGP_Lite\disk1	Disk1 of JobGen Lite
2)	\JGP_Lite\disk1	Disk2 of JobGen Lite

Appendix A. Standard C Libraries Routine for MR350MKII

1. **Buffer Manipulation**

   memccpy() memchr() memcmp() memicmp()
   memmove() memcpy() memset() movedata()

2. **Character Classification and Conversion**

   isalnum() isalpha() isascii() iscntrl()
   isdigit() isgraph() islower() isprint()
   ispunct() isspace() isupper() isxdigit()
   toascii() tolower() toupper()

3. **Data Conversion**

   atof() atoi() atol() ecvt()
   fcvt() gcvt() itoa() ltoa()
   strtod() strtol() strtoul() ultoa()

4. **File Handling**

   remove() unlink()

5. **Stream Routines**

   clearerr() fclose() fcloseall() fdopen()
   feof() ferror() fflush() fgetc()
   fgetchar() fgetpos() fgets() fileno()
   flushall() fopen() fprintf() fputc()
   fputchar() fputs() fread() freopen()
   fscanf() fseek() fsetpos() ftell()
   fwrite() getc() getchar() gets()
   getw() printf() putc() putchar()
   puts() putw() rewind() scanf()
   setbuf() setvbuf() sprintf() sscanf()
   ungetc() vfprintf() vprintf() vsprintf()

6. **Lower-level Routines**

   close() creat() eof() lseek()
   open() read() sopen() tell()
   write()

7. **Console and Port I/O**

   cgets() cprintf() cputs() cscanf()
   getch() getche() inp() inpw()
   kbhit() outp() outpw() putch()
   ungetch()

9. Memory Allocation

alloca() calloc() free() halloc()
hfree() malloc() msize() realloc()
sbrk() stackavail()

10. Porcess Control

exit()

11.Searching and Sorting

bsearch() l2ind() lsearch() qsort()

12.String Manipulation

strcat() strchr() strcmp() strcmpi()
strcpy() strcspn() strdup() strerror()
stricmp() strlen() strlwr() strncat()
strncmp() strncpy() strnicmp() strnset()
strpbrk() strrchr() strrev() strset()
strspn() strstr() strtok() strupr()

13.MS-DOS Interface

bdos() FP-OFF() FP-SEG() int86()
int86x() intdos() intdosx() segread()

14.Time

asctime() clock() ctime() difftime()
ftime() gmtime() localtime() mktime()
time() tzset()

15.Miscellaneous

abs() div() labs() ldiv()