TS-1325 User's Manual

Technologic
SYSTEMS

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All modifications from previous versions are listed in the appendix.

Limited Warranty

Technologic Systems warrants this product to be free of defects in material and workmanship for a period of one year from date of purchase. During this warranty period Technologic Systems will repair or replace the defective unit in accordance with the following instructions:

- Contact Technologic Systems and obtain a Return Material Authorization (RMA) number and a copy of the RMA form.

- Fill out the RMA form completely and include it and dated proof of purchase with the defective unit being returned. Clearly print the RMA number on the outside of the package.

This limited warranty does not cover damages resulting from lighting or other power surges, misuse, abuse, abnormal conditions of operation, or attempts to alter or modify the function of the product.

This warranty is limited to the repair or replacement of the defective unit. In no event shall Technologic Systems be liable or responsible for any loss or damages, including but not limited to any lost profits, incidental or consequential damages, loss of business, or anticipatory profits arising from the use or inability to use this product.

Repairs made after the expiration of the warranty period are subject to a flat rate repair charge and the cost of return shipping. Please contact Technologic Systems to arrange for any repair service.

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1   Introduction

The model TS-1325 is a compact, full-featured PC compatible Single Board Computer based on the 386EX processor. If you are coming up from the 8-bit microcontroller world, you will find that this product provides much more performance and much quicker development since you can now use standard PC development tools such as Turbo C or Quick Basic. If you have done work in the PC world in the past, you will find you can now build applications for a very small target that does not require a keyboard, video, floppy disks, or hard drives.

You can typically write and test code on a host PC using standard development tools for the PC platform, then simply copy it to and run it on the TS-1325 without major modification. If additional peripherals are required, the PC/104 expansion bus allows for many standard functions available off-the-shelf. It is also very simple to create a custom PC/104 daughter board for those special features that differentiate your product. Technologic Systems can provide technical support as well as a free quotation for any custom hardware, software, or BIOS modifications you may require.

This manual is fairly short. This is because for the most part, the TS-1325 is a standard 80386 based PC compatible computer, and there are hundreds of books about writing software for the PC platform. The purpose of this manual is documenting where the TS-1325 differs from a standard PC.

2   PC Compatibility

PC compatibility requires much more than just a 386 processor. It requires PC compatible memory and I/O maps as well as a PC compatible BIOS. The General Software EMBEDDED BIOS offers a high degree of compatibility with past and present BIOS standards allowing it to run off-the shelf operating systems and application software.

The EMBEDDED BIOS has been tested with all major versions of DOS, including MS-DOS, DR-DOS, and Embedded DOS 6-XL; all major versions of OS/2, including MS-OS/2 and IBM OS/2; MS-Windows 3.1, Windows-95, Windows NT, and NetWare 386.

The EMBEDDED BIOS has been rigorously tested with programs such as MSD, Check-It, Manifest, and Q/A Plus ensuring its compatibility with established desktop application standards.

3   Power & Environment

The model TS-1325**B** has a 3mm power jack and an on-board 5V regulator. It is designed for applications where an inexpensive 9Volt DC wall-mount power supply can be used for power and PC/104 expansion boards are generally not installed. A plastic enclosure and 9VDC supply are available for the model TS-1325B allowing for a very compact inexpensive PC solution.

When power is first supplied to the TS-1325, the board mounted LED is immediately turned on under hardware control. Once the processor begins execution, the LED is turned off (under software control). If the LED does not turn on at all, the most likely problem is the power supply. If it was not purchased from Technologic Systems, check that the +V and GND connections are not reversed.

The standard TS-1325 is rated for an ambient temperature range of 0º to 70º C. An extended temperature range version is available. Contact Technologic Systems for details.

4   Memory

4.1   DRAM

The TS-1325 has a total of 2 Megabytes of DRAM providing 640 Kbytes of base memory, 1 Megabyte of extended memory, and 128 Kbytes of shadow RAM for the BIOS and DOS-ROM. This is identical to a standard PC memory map. The Flash SSD is the exception -- see below for details.

As shipped, the 1 Megabyte of extended memory is used as a RAM disk by the *vdisk.sys* device driver. The RAM disk is accessible as drive C:. The size of the disk can be reduced to provide extended memory for an application (or simply removed entirely) by editing the CONFIG.SYS file in the root directory of drive A:. Please see the *BIOS/DOS User's Manual* for further information on vdisk.sys.

4.2   Flash

There is a total of 512 Kbytes or optionally 1 Mbyte of Flash memory on the TS-1325. The top 128 Kbytes of Flash are reserved for the BIOS and DOS-ROM. During POST, they are copied from Flash into DRAM at addresses E0000h through FFFFFh for improved performance. The remainder of the Flash memory (either 384 Kbytes or 896 Kbytes) is used by a SSD (solid state disk) appearing as drive A. The SSD is fully supported by the BIOS as an INT 13h drive.

The physical Flash memory is accessed by the BIOS through a 32 Kbyte memory mapped window at addresses D8000h through DFFFFh. If you are installing a PC/104 daughter card that uses memory mapped I/O, it must not conflict with this address range.

The Flash memory is guaranteed capable of a minimum of 100,000 write/erase cycles. This means that if you completely erase and rewrite the SSD drive 10 times a day you have over 27 years before any problems would occur. Reading the SSD produces no wear at all.

5   Serial Ports

The two PC compatible asynchronous serial ports provide a means to communicate with external serial devices such as printers, modems, etc. Each is independently configured as a standard PC COM port which is compatible with the National Semiconductor's NS16C450. COM1 appears in the I/O space at 3F8h and uses IRQ4. COM2 is located at 2F8h and uses IRQ3.

The COM ports use a master clock of 1.8519 MHz as compared to a standard clock of 1.8432 MHz. This results in an error for all baud rates of .0047 (less than ½%). The error is insignificant and this clock value allows standard baud rate selections (for example, a divisor of 12 yields 9600 baud).

By changing an internal configuration register in the 386EX, the serial clock can be switched to 12.5 MHz (the processor clock divided by 2). This feature allows baud rates higher than 115 Kbaud (up to 781 Kbaud), as well as low error, non-standard lower baud rates (such as 24 Kbaud). See Appendix D for further information.

The COM ports may also be configured to use a DMA channel, which is useful when very high baud rates are being used. When enabled, a DMA request is issued any time a serial port's receive buffer is full or its transmit buffer is empty. This will allow higher speed operation with much lower CPU overhead. See the Intel 386EX User's Manual for further details.

5.1   Serial Port Configuration Registers

Because both serial ports are 100% PC compatible, software written for the PC that accesses serial ports directly or through standard BIOS calls will work without modification on the TS-1325. The details of the COM port internal registers are available in most PC documentation books or the data sheet for the National Semiconductor NS16C450 may be consulted.

5.2   Serial Port Hardware

The COM1 port has only 4 lines buffered, the two data lines and a handshake in each direction. This is quite sufficient to interface with the vast majority of serial devices. These lines are routed to a 10 pin header near the push switch labeled COM1. A serial adapter cable can be plugged into the header to convert this into a standard DB9 male connector. The pin out for the 10 pin header and DB9 male connector are listed below. The RTS signal is used to drive the RS-485 logic (see below) and is not connected to the 10 pin header. The RTS pin on the header is always asserted high (via a 330 Ù resistor to 5V).

When the TS-1325 is enclosed in the optional plastic case, the COM1 header is inaccessible. For this situation, COM1 can be rerouted to the on-board DB25**F** connector after disabling the parallel port. To do so, first remove the socketed 74HCT374 adjacent to the DB25F connector, then install all five jumpers on the COM1 redirection header (H3). The DB25F pinout for COM1 is listed below.

		10	5
		9	4
		8	3
		7	2
		6	1

Table 1 - COM1 Header Top View - Pin 1 is towards the push switch

Signal	Direction	COM1		COM2
		Header & DB9M	DB25F	DB25M
DCD	IN			8
RX data	IN	2	3	3
TX data	OUT	3	2	2
DTR	OUT	4	20	20
GND		5	7	7
DSR	IN	6	6	6
RTS	OUT	7*	4*	4
CTS	IN			5
RI	IN			22

Table 2 - Serial Port Pinouts

* Always True - Resistor pullup to 5V on ten pin header.

The COM2 port is a standard PC compatible serial port. All 8 lines are buffered with RS-232 compatible transceivers and are routed to the on-board DB25 male connector.

PLEASE NOTE: Not all serial adapter cables are alike! We are aware of at least two 'standard' pin outs for these cables. If you did not purchase your serial adapter cables from us, this may be an issue if the serial ports are not working correctly (or at all).

5.3   RS-485 support

An option is available to add half-duplex RS-485 support to COM1. RS-485 drivers allow multiple devices to communicate up to 4000 feet (1200 meters) via twisted pair cable for a low-cost networking solution. If you need full-duplex RS-485 (RS-422), it is available on other single board computers in our product line.

For RS-485 operation, a single twisted pair is used for transmitting and receiving. The COM1 RTS signal controls the RS-485 transmitter/receiver. When RTS is asserted true (bit 1 of the modem control register = 1), the RS-485 transmitter is enabled and the receiver disabled. When RTS is deasserted the transmitter is tri-stated (disabled) and the receiver is enabled. Since the transmitter and receiver are never both enabled, the data transmitted is not received on the COM1 UART. The transmitter and receiver share a single pair of signals that are available on the DB-25 male connector. See the table above for pinouts Note: the correct jumper must be installed on header H1.

DB25M Pin	RS-485 Function
7	Ground
14	TX/RX**-**
15	TX/RX**+**

Table 3 - RS-485 Pinouts

When the RS-485 option is installed, **J8** and **J10** of header H1 select which receiver is fed to the COM1 UART. Only one of these jumpers should be installed at a time!

If termination resistors are required, they must be added externally on the connector.

H1 Jumper	Receiver Source
J8	RS-485
J10	RS-232

Table 4 - COM1 Receiver Option

5.4   Adding Serial Ports

Additional serial ports may be added via the PC/104 expansion bus. Cards are available to add up to 4 additional serial ports per expansion board. Typically these would be configured as COM3 or COM4 or be assigned other non-standard I/O locations. Because DOS only directly supports 4 serial ports, any additional ports beyond 4 will require software drivers.

The PC/104 bus has IRQ3, 4,5,6,7 or 9 available for additional serial ports. If IRQ3 or IRQ4 are to be used on a PC/104 expansion card, then care must be taken since these IRQs are also used by COM2

and 1, respectively. For example, if IRQ4 is used for COM3 then either COM1 must be used in a non-interrupt fashion or only one COM port can have the interrupt enabled at a time. In any case only one COM should have the Interrupt Enable (Bit 3 of Modem Control Reg.) set at any one time if they share the same IRQ. This is a standard problem with the PC architecture. The solution is to simply use interrupts other than 3 or 4 for additional serial ports.

6 Parallel Port

The parallel port can be used to directly drive a parallel printer or it may be used as 17 general purpose digital I/O lines. This port is **not** a standard PC compatible parallel port. It is **not** located at standard LPT I/O locations and it is **not** capable of supporting enhanced parallel port modes such as EPP or ECP. It **is** capable of driving standard parallel printers in a unidirectional mode, which is usually quite sufficient for many applications. The port is configured to be LPT1 and the BIOS will support standard printer function calls. The following I/O locations are used to support this port:

I/O Address	Register	R/W	Description
074h	Data Register	Write only	8-bit data to be sent to printer
075h	Status Register 　Bit 7　- Busy (opposite polarity of 　　　　　standard PC port) 　Bit 6　- Acknowledge* 　Bit 5　- Paper Error* 　Bit 4　- Select 　Bit 3　- Error*　　　* = active low	Read only	5-bit printer status
F872h	Control Register	Read or Write	Strobe = bit 6

Table 5 - Parallel Port Register Definitions

The Status Register bits are of the normal PC polarity except for the busy bit which must be inverted for PC compatibility. Only the Strobe signal is supported in the Control Register and its bit position has been shifted from the normal bit 0 to bit 6. The other control register bits are not supported, but this minimal support does allow printing in a standard unidirectional manner. These non-compatibilities should not be an issue as long as BIOS calls are used to do all printing. If your program must communicate directly to the port then these differences should be taken into account.

Data Out	DB-25 pin	Data In	DB-25 pin
bit 0	2	bit 0	14
bit 1	3	bit 1	17
bit 2	4	bit 2	16
bit 3	5	bit 3	15
bit 4	6	bit 4	13
bit 5	7	bit 5	12
bit 6	8	bit 6	10
bit 7	9	bit 7	11
/Strobe (active low) pin 1			
DB25 pins 18 - 19, 21-25 are ground			

Table 6 - DB25-F Digital I/O Pinout

If the parallel port is to be used for 17-bits of digital I/O, then the port may considered as 2 octal registers. Location 074h is the 8-bit data out latch while location 075h is the 8-bit data input register. Both octal buffers are connected to the female DB-25 female connector with the following pin outs:

The 17th I/O line is an output connected to the DB25 pin 1 and equals the inverted value of bit 6 of I/O location F872h. The other 8 output lines and 8 input line are simply buffered with no inversion. The 8 digital input lines have TTL logic thresholds with a voltage lower than 0.8 V = logic 0 and a voltage above 2.0 V = logic 1. Two of the input lines (bit 7 and bit 5) have a 3.3K ohm resistor pull-up to 5V. The other 6 input lines have no bias (floating). The 9 output lines are CMOS levels (0V or 5V) and can source or sink 4 mA with less than a 0.4V loss. For higher sink or source currents a greater amount of voltage loss will result.

7   LED and Push Switch

The TS-1325 has a two color LED and momentary contact push switch available for user software. Example uses include diagnostics, status messages, and simple input.

BIOS interrupt functions are used to interface software with the LED, switch, and option jumpers. Please see Appendix C for further details and the utility disk for example code.

8   PC/104 Bus Expansion

The PC/104 is a compact implementation of the PC/AT ISA bus ideal for embedded applications. Designers benefit from using an already-developed standard, rather than creating their own. Further, the presence of a compact form-factor PC compatible standard has encouraged the development of a broad array of off-the-shelf products, allowing a very quick time to market for new products.

The electrical specification for the PC/104 expansion bus is identical to the PC ISA bus. The mechanical specification allows for the very compact implementation of the ISA bus tailor made for embedded systems. The full PC/104 specification is available from the IEEE Standards Office under # IEEE P996.1. Basically this bus allows multiple daughter boards in a 3.6 inch by 3.8 inch form factor to be added in a self-stacking bus. Since the electrical specs are identical (except for drive levels) to a standard PC ISA bus, standard peripherals such as COM ports, Ethernet, video, LCD drivers, and Flash drives may be easily added using standard drivers.

The TS-1325 implements a sub-set of the 8-bit version of the PC/104 bus. We have found this allows the support of the vast majority of PC/104 boards including all of the above mentioned examples.

Pin #	Signal Name
A2 thru A9	D7 thru D0
A10	IOCHRDY
A11	EN
A12 thru A31	A19 thru A0
A32	GND
B1	GND
B2	RESETDRV
B3	+5V
B4	IRQ9
B9	+12V
B11	SMEMW*
B12	SMEMR*
B13	IOW*
B14	IOR*
B20	SYSCLK (8.33 MHz)
B21	IRQ7
B22	IRQ6
B23	IRQ5
B24	IRQ4
B25	IRQ3
B28	BALE
B29	+5V
B31	GND
B32	GND

Table 7 - **Supported** PC/104 Signals

Pin #	Signal Name
A1	IOCHCHK*
B5	-5V
B6	DRQ2
B7	-12V
B8	ENDXFR*
B15	DACK3*
B16	DRQ3
B17	DACK1*
B18	DRQ1
B19	REFRESH*
B26	DACK2*
B27	TC
B30	OSC

Table 8 - **Unsupported** PC/104 Signals

9   Real Time Clock

The Dallas Semiconductor DS12887 is used for the PC compatible battery-backed real-time clock. It is a completely self-contained module that includes a Motorola 146818 compatible clock chip, the 32.768 kHz crystal, the lithium battery, and 114 bytes of battery-backed CMOS RAM. It is guaranteed to maintain clock operation for a minimum of 10 years in the absence of power. It is located at the standard PC I/O addresses of Hex 070 and 071. The top 32 bytes (index 60h through 7Fh) are not used by the BIOS and are available for user applications.

10 Watchdog Timer

The Intel 386EX processor has an on-board 32-bit watchdog timer available that may be used to cause an IRQ15 when it has not been fed within a prescribed amount of time. This can be used to add to software reliability by causing an interrupt if a application "hangs". For details see the Intel 386EX User Manual.

11 Video, Keyboard, and Console Redirection

The TS-1325 has no video controller or keyboard interface. This was done to keep the board size small and the cost low. For applications that require it, a PC/104 video board can be added to the system easily. This could be a VGA controller, LCD interface, or a custom board of your own design.

Without a video board in the system, the TS-1325 redirects all console activity to the COM2 serial port. Simply connect an ANSI terminal (or emulator) to COM2 with a null modem cable, using serial parameters of 9600 baud, 8 data bits, no parity, 1 stop bit. All text information that would normally be displayed on a video screen is now displayed in your terminal window, and any serial data sent to the TS-1325 is seen as standard keyboard input by programs.

Please note that the console redirection support is limited by the fact that there is no actual video or keyboard hardware on the TS-1325. Programs must use the standard BIOS routines for display and keyboard input, which are rerouted to the serial port. Any program that accesses the video or keyboard hardware directly will not work. Keyboard redirection is limited simply because most of the extended keys on the keyboard (function keys and Alt key in particular) are not sent by the terminal/emulator. For these reasons, the console redirection feature is meant more for system development, testing, and field repair, rather than as the primary user interface for a finished product.

If your application uses COM2, removing the jumper **J4** from pins 3-4 of header H1 easily disables console redirection.

 If a video board is installed on the PC/104 bus, the BIOS will automatically turn off the display redirection and use the video controller, but the keyboard redirection will continue. If the console redirection jumper is also removed, the keyboard redirection is disabled as well.

12 Loading and Executing Programs

Once you have written and debugged your software on a desktop PC, moving it to the TS-1325 and automatically executing it at power up could not be easier. The TS-1325 has a special feature called 'Manufacturing Mode' which makes the on board Flash SSD appear as just another drive on your desktop computer using a DOS device driver and a serial cable.

First, connect a null modem cable between COM2 on the TS-1325 and COM1 of your desktop computer. Next, the TS-1325 must be placed in Manufacturing Mode. To do so, insert a jumper on pins 1-2 of header H1 and power cycle the unit. Manufacturing Mode will automatically start once POST has been executed. At this point, the TS-1325 will simply sit and wait for serial packets to arrive from a host.

Now install the Manufacturing Mode driver on your desktop computer. To do so, simply copy the MFGDRV.SYS device driver from the utility disk to anywhere on your desktop machine's hard drive. Then insert the following line in your CONFIG.SYS file and reboot:

DEVICE=<PATH>\MFGDRV.SYS /UNIT=0 /BAUD=38K /PORT=COMX

Where <PATH> is the full path to the location where you copied the MFGDRV.SYS file, and X is the port on your host PC that the null modem cable is connected to (1 or 2).

The Flash SSD drive should now appear on the next free drive letter on your desktop computer (usually the D: or E: drive). Simply copy your program onto the drive, and that's it!

You can create directories, edit files, and even execute programs over the Manufacturing Mode link just the way you would with a regular disk drive, just a bit more slowly.

To make your program automatically execute at power up, just edit the AUTOEXEC.BAT file on the Flash SSD drive and replace the name of the sample program (LEDCYCLE.EXE) listed there.

When you are finished, turn off the TS-1325, remove the jumper, and turn it back on. Your program will now execute every time the TS-1325 is turned on.

While Manufacturing Mode is in operation, the board LED provides feedback. While idle, the LED will cycle on and off at approximately 1/2 Hertz. While data is being transferred, it will cycle much more rapidly (anywhere from 5 to 1000 Hertz)

NOTE: The Manufacturing Mode driver currently does **not** work correctly with Windows95. We are working with General Software to fix this problem, but for the time being you can work around the problem by booting your machine in MS-DOS mode, or by using a boot disk with the device driver on it.

13 Feedback

If you feel this manual is missing information, please let us know. We will do our best to address any shortcomings in documentation. Information on contacting us is listed in the front of the manual.

Appendix A - Board Diagram
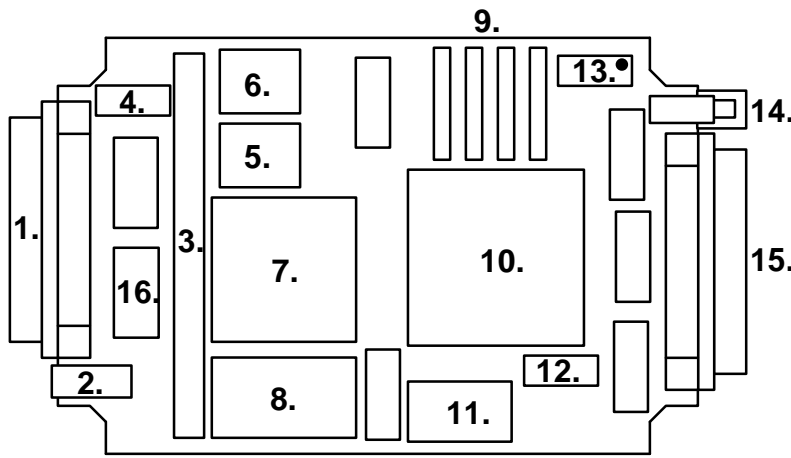
1. DB25F Parallel Printer Port
2. 3mm Power Jack
3. 8-bit PC/104 Connector
4. COM1 Redirection Header (**H3**)
5. Flash Chip 1
6. Flash Chip 2
7. Bus / Memory Interface
8. Dallas DS12887 Real Time Clock
9. DRAM - 2 Megabytes
10. Intel 386EX Processor
11. 50 MHz Crystal Oscillator
12. Option Header (**H1**)
13. COM1 Header (**H2**) -
    note: pin 1 is in the upper right corner
14. LED & Push Switch
15. DB25M COM2 Serial Port
16. Socketed 74HCT374

Appendix B - Jumpers

The following is a table of jumpers and their functions. These jumpers are located on header H1, which is adjacent to the crystal oscillator (the big silver rectangle).

Jumper	Function
J2	Manufacturing Mode
J4	Console Redirection
J6	Unused
J8	COM1 RS-485
J10	COM1 RS-232

Table 9 - Jumper Listing

Appendix C - BIOS Interrupt Functions

We have extended the standard BIOS interrupts with several functions that simplify interfacing with the TS-2325 hardware.

Many books are available with detailed information on using interrupts with just about any language. Example code is also available on the utility disk.

Int 15h / Function B000h - Technologic Systems BIOS information

This function is mostly for our own internal use, but may be useful for user programs as well. For example, your program could have debugging code that executes on your desktop machine, but does not when the program is executing on the TS-1325.

> **ENTRY:**
>
> > **AX = B000h**
>
> **EXIT:**
>
> > **CY = 0** (carry flag)
> > **AH = 0**
> > **AL = SP_VERSION**
> > > For standard versions of the BIOS, this is **0**. An 'SP number' is assigned when custom

modifications are made to the BIOS for a client, and it is returned in this register. Contact us for further information.

BH = BIOS Version, Major Number.
E.g. If the current BIOS version is 1.25, the register will contain **01h**.

BL = BIOS Version, Minor Number.
E.g. If the current BIOS version is 1.25, the register will contain **19h** (19h = 25 decimal).

CH = Base Flash Memory Size / 512kB
The TS-1325 is available with either 512kB or 1024kB of base Flash memory, which would be returned as **01h** or **02h**, respectively.

CL = 0Dh
This is the hardware model number (0Dh = 13 decimal).

DX = 'TS' (5452h)

Int 15h / Function B010h - LED Control

This function is used to turn the on board green and red LED on and off. You can also invert the LED, i.e. if the LED is off, it will be turned on, and if it is on it will be turned off.

ENTRY:

AX = B010h

BH =

00	- Red LED off, green LED off.	**81**	- Red LED inverted, green LED unchanged.
01	- Red LED on, green LED off.	**82**	- Red LED unchanged, green LED inverted.
02	- Red LED off, green LED on.	**83**	- Red LED inverted, green LED inverted.
03	- Red LED on, green LED on.		

EXIT:

CY = 0 (carry flag)
AH = 0

Int 15h / Function B020h - Jumper Pin Status

This function returns the status of the option jumpers in register BX according to the list below.

ENTRY:

AX = B020h

EXIT:

CY = 0 (carry flag)
AX = 0
BX = Jumper Pin Status. If Bit X = 1, the jumper is installed.

BX Bit	Jumper	Description
0	JP1	Manufacturing Mode
1	JP2	Console Redirection

Table 10 - Int15h/Function B020h register BX return values

Appendix D - Using A 12.5 MHz Baud Clock

Each serial port baud rate generator clock can be independently switched between either the standard 1.85 MHz clock or a 12.5 MHz clock (the internal processor clock divided by 2).

Changing the clock to 12.5 MHz allows baud rates higher than 115 Kbaud (up to 781 Kbaud), as well as low error, non-standard lower baud rates (such as 24 Kbaud).

The baud rate clock is controlled by I/O location 0F836h:

Bit 0 controls COM1.
Bit 1 controls COM2.

Setting a bit to 0 uses the standard 1.85 MHz clock, and setting a bit to 1 uses the 12.5 MHz processor clock. **NOTE:** You **must not** modify the other bits of this register. You **must** use a read-modify-write procedure to change these bits. The following example in assembly illustrates this:

```
MOV   DX, 0F836          ; load the I/O address
IN    AL, DX             ; read the configuration register
OR    AL, 00000001b      ; switch COM1 to the 12.5 MHz clock
OUT   DX, AL             ; write the register
```

Appendix E - Further References

Intel 386EX User's Guide
> http://www.intel.com/design/intarch/manuals/27248502.htm

National Semiconductor NS16C450 Data Sheet

Dallas Semiconductor DS12887 Data Sheet

Appendix F - Manual Revisions

03/17/98
- Added appendices C and D, added URL for Intel 386EX User's Guide.
- Added more information about the RAM disk in section 4.1.
- Rewrote section 5.2.
- Removed all references to RS-422 support, which is not available for the TS-1325.
- Removed all references to the A model, which has been replaced with the TS-2325.

01/19/98
- Added details about RS-422/485.
- Added board diagram (Appendix A)
- Minor formatting changes.

01/16/98
- Added more information on software (Section 12).

01/13/98
- New manual.