

**TSYST  
PC/104 System I/O Board****16th May 1995**

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## 1 INTRODUCTION

The TSYST provides a range of commonly used system support facilities for PC/104 processors. It provides floppy disk and IDE disk support, two serial ports and a printer port. It is optimised for PC compatible processors.

The key features of the TSYST are listed below:

- **PC compatible floppy disk controller for one or two floppy disk drives, to 1.44M bytes capacity.**
- **PC compatible IDE disk drive port.**
- **Two PC compatible RS-232 serial ports with options to convert to RS-485 operation.**
- **Centronics printer port (can be used as general purpose I/O).**
- **Single +5V power supply. Very low power operation possible.**
- **Complies with PC/104 specification Revision 2.2**

## **2 FLOPPY DISK CONTROLLER**

The floppy disk controller is implemented as part of the FDC37C652 multi-function peripheral chip. It is completely PC compatible.

Two drives are supported. These would normally be 3½" drives with capacities of 720K or 1.4Mbyte. The older 5¼" drives can also be supported, at both 360K and 1.2Mbyte capacities

The connector pin assignments on the J4 connector is such that a single floppy is connected with a straight through 34 way ribbon cable (no twists in the cable are required). The floppy drive itself should be set to be drive 0 (there will be a switch or jumper on the drive to select drive 0 or 1). This is different from standard PC practise, where the first floppy disk drive is attached to the PC through a cable with a twist in it, and with the drive switch set to drive 1.

If a second floppy drive is fitted then a twist is required in the 34 way cable between the first and second floppy drives. Pins 13 through to 17 inclusive should be rotated by 180 degrees before being crimped in the second 34 way female IDC connector. Additionally, the second drive should be set to be drive 1 (there will be a switch or jumper on the disk drive to set the drive to unit 0 or unit 1).

The floppy drive electronics occupies I/O addresses 3F0H - 3F7H, interrupt request level IRQ6 and DMA channel 2. This is exactly the same as any other PC compatible floppy disk controller. Interface to the PC compatible processor is through the 64 way PC bus connector J1.

The floppy disk circuitry can be disabled if the floppy is not required, or if the floppy circuitry is implemented elsewhere. See Appendix C for configuration details.

## **3 IDE DISK CONTROLLER**

The IDE disk controller is implemented as part of the FDC37C652 multi-function peripheral chip. It is completely PC compatible.

Two drives are supported. These would normally be 3½" drives, which use a 40 way connector on 0.1" pitch. Alternatively, 2½" drives can also be used. These drives use 2mm pitch connectors with 44 pins, so an adapter cable is required if the smaller drives are to be used. DSP Design can provide a suitable adapter cable. See Appendix F for ordering information.

The connector pin assignments on the J5 connector is such that a single IDE drive is connected with a straight through 40 way ribbon cable. The drive is likely to have configuration jumpers, which should be set in accordance with the manufacturer's instructions. The drive will require a power supply - probably both +5V and +12V, which will have to be connected in addition to the 40 way cable.

If a second IDE drive is fitted then a second socket will need to be fitted to the cable. Unlike the floppy drive no twist is required in the cable. Jumpers on both drives will have to be configured appropriately: one drive will have to be configured as a master and the other as a slave.

The IDE drive electronics occupies I/O addresses 1F0H - 1F7H, 3F6H and 3F7H. It uses interrupt request level IRQ14. No DMA channel is required. This is exactly the same as any other PC compatible. Interface to the PC compatible processor is through the 64 way PC bus connector J1 and the 40 way PC bus connector J2. Note that IDE drives are connected to the bus as 16-bit peripherals, and will not work with processors which are limited to the 8-bit PC bus.

The IDE disk circuitry can be disabled if the IDE drives are not required, or if the IDE circuitry is implemented elsewhere. See Appendix C for configuration details.

The TSYST has four holes drilled in the PCB, which align with the mounting holes on some 2½" IDE disk drives. It may be possible to mount an IDE drive directly on the TSYST PCB. In this case the user must provide suitable stand-off pillars, and ensure that insulation washers are provided so that the pillars or the body of the IDE drive do not short against tracks on the PCB.

## 4 CENTRONICS PRINTER PORT

The FDC37C652 also implements a PC/AT compatible printer port.

The printer is normally configured as LPT1: at I/O addresses 378H - 37AH. It can be set to alternative addresses, or disabled, so as to accommodate more than one parallel port in a system. The alternative addresses are 278H - 27AH and 3BCH - 3BEH. See Appendix C for configuration information.

The parallel port optionally generates an interrupt on IRQ7. The interrupt can be enabled or disabled under software control - the default following reset is for it to be disabled.

The printer port has one 8-bit output-only data port (signals PDO-7), four open drain outputs with weak pull-up resistors (STROBE-, INIT, AUTOFD- and SLCTIN-), and five inputs (ACK-, BUSY, PE, SLCT and ERROR-). Although they are intended to be used to drive a parallel printer, the signals can be used as general purpose I/O pins, accessible through registers at addresses 378H - 37AH (or corresponding alternative addresses).

The data port can only operate as an output.

Appendix E includes extracts from the FDC37C652 data sheet to help programming the serial and parallel ports.

## 5 SERIAL PORTS

Two serial ports are also implemented in the FDC37C652 peripheral chip. They are equivalent to the NS16450 UART, as used in IBM/AT computers. The serial port is fully compatible with the 16450 registers, and can be programmed to standard baud rates between 50 baud and 115.2k baud.

The serial ports are usually configured as COM1: (I/O addresses 3F8H - 3FFH) and COM2: (2F8H - 2FFH) although the addresses can be changed, or the ports disabled, with jumpers. See Appendix C for configuration information.

The serial ports may optionally operate under interrupt control. The first serial port can drive interrupt IRQ4 (IRQ4 is usually associated with COM1: or COM3:). The second serial port can drive interrupt IRQ3 (IRQ3 is usually associated with COM2: or COM4:). Note that in a PC environment interrupts cannot be shared, so only one serial port should drive each interrupt line at a time.

The serial port can be configured with an RS-232 or an RS-485 interface. The default is an RS-232 interface. All eight RS-232 signals are present (three outputs and five inputs). The RS-232 port transceiver is a MAX211E device, which generates its own RS-232 voltage levels from a single +5V supply. The MAX211E includes components to provide a level of protection against damage from electrostatic discharge.

RS-485 is an enhanced RS-422 interface standard. It uses a balanced twisted pair wiring system, and gives much higher speed, longer cable distance and better noise immunity than RS-232. RS-485 also supports multi-drop operation, where several nodes can reside on one twisted pair, with one node transmitting and the others receiving.

If RS-485 operation is required the following must be done. First the RS-232 transceiver chip should be disabled with a jumper. Secondly, an RS-485 transceiver chip (MAX485 or equivalent) must be installed in the 8-pin DIL socket provided. Each serial port can be configured for RS-485 operation by default.

The RS-485 port operates as a half-duplex node. That is, only a single twisted pair is provided, with both transmission and reception occurring through the same pair. The direction of the transceiver is controlled by software.

The RTS signal from the UART is used to enable the RS-485 transmitter. When asserted (by writing a 1 to bit 1 of the Modem Control Register) the transmitter will be enabled and will drive the twisted pair. The receiver will then be disabled. Following reset the RTS signal is negated, so that the RS-485 transceiver is set to receive.

A suitable protocol needs to be agreed by all nodes on a single twisted pair to ensure that a maximum of one computer transmits at any one time.

All but the shortest lengths of twisted pair cable should be treated as transmission lines. Transmission lines must be terminated at each end in an impedance matching the characteristic impedance of the cable, typically 110 ohms for twisted pair. This is provided as an option on the TSYST. To minimise power dissipation the termination resistor is implemented in series with a 100nF capacitor, ensuring that the resulting network provides correct termination at AC frequencies, but does not draw any DC current.

In addition to the termination resistor, resistors applying a bias voltage to the cable are recommended so that the cable is held in a known (inactive) state while no data is being transmitted.

The TSYST optionally provides both of these RS-485 termination functions. The termination components are connected to the twisted pair cable by jumpers on the board. See Appendix C for configuration information.

## APPENDIX A: SPECIFICATION

Product:	TSYST
Description:	PC/104 System I/O Board
PC/104 interface:	I/O mapped, 8-bit data bus. I/O addresses of serial ports and printer ports can be configured. Floppy Disk and IDE disk controllers use fixed I/O addresses.
Interrupts:	Serial Ports use IRQ3, IRQ4 (if enabled). Printer Port uses IRQ7 (if enabled). Floppy Disk controller uses IRQ6 (if enabled). IDE drive uses IRQ14.
DMA:	Floppy Disk Controller uses DRQ3 and DACK3*
Connectors:	PC/104 J1 (64-pin) and J2 (40-pin) stack-through connectors. 50-way right angle pin header (serial and printer ports, J3). 50-way right angle pin header (Opto-22 interface). 34-way right angle pin-header (floppy disk drive, J4). 40-way right angle pin header (IDE drive, J5).
Serial Ports:	Two PC compatible RS-232 ports. Optionally configurable for RS-485 operation (with optional termination networks).
Printer Port:	PC compatible Centronics port.
Floppy Disk Controller:	PC compatible. Drives one or two floppies, 3½ or 5¼.
IDE Disk Controller:	PC compatible. Drives one or two IDE drives.
Dimensions:	90mm x 96mm (PCB) (3.55" x 3.775")
Weight:	70g approx.
Temperature:	0 - 70 degrees C. (Ask about industrial temperature range version).
Humidity:	10% - 90% non-condensing.
Power Supplies:	+5V / 22mA typical (all digital I/O set to inputs, no floppy or IDE access)

## **APPENDIX B: PIN ASSIGNMENTS**

There are five connectors on the TSYST. Connectors J1 and J2 are defined by the PC/104 specification, and are in effect the PC/AT bus signals. Connectors J3, J4 and J5 are defined by DSP Design, and carry the I/O signals to and from the on-board peripherals. This Appendix gives the pin assignments of these connectors.

### **B.1 PC Bus Connector (J1)**

The PC bus connector is, for the most part, what it sounds - the signals found on PC bus expansion cards.

The PC bus connector is labeled J1 - it is the 64-way connector on the TSYST. It is defined by the PC/104 specification. The connector has two parts - male and female - so that the TSYST can be stacked in a PC/104 board stack. The PC bus connector is used as the main set of signals between the TSYST and additional I/O boards, as well as being part of the mechanical system which secures the TSYST processor to other PC/104 boards.

PC bus cards have 62 pins - rows a and b, and pins 1 to 31. The PC/104 boards have most of these signals present on the connector marked J1, as well as two extra pins. The two extra pins (32a and 32b) are two additional GND pins (the OV power supply signal).

Table B1 lists the pin assignments of the PC bus connector, J1:

Pin	Signal	Pin	Signal
1a	/IOCHCHK *	1b	0V (Gnd)
2a	SD7	2b	RESETDRV
3a	SD6	3b	+5V (VCC)
4a	SD5	4b	IRQ2/9 *
5a	SD4	5b	-5V *
6a	SD3	6b	DRQ2
7a	SD2	7b	-12V*
8a	SD1	8b	/ENDXFR *
9a	SD0	9b	+12V *
10a	IOCHRDY	10b	(KEY)
11a	AEN	11b	/SMEMW *
12a	SA19 *	12b	/SMEMR *
13a	SA18 *	13b	/IOW
14a	SA17 *	14b	/IOR
15a	SA16 *	15b	/DACK3 *
16a	SA15 *	16b	DRQ3 *
17a	SA14 *	17b	/DACK1 *
18a	SA13 *	18b	DRQ1 *
19a	SA12 *	19b	/REFRESH *
20a	SA11 *	20b	CLK *
21a	SA10 *	21b	IRQ7
22a	SA9	22b	IRQ6
23a	SA8	23b	IRQ5 *
24a	SA7	24b	IRQ4
25a	SA6	25b	IRQ3
26a	SA5	26b	/DACK2
27a	SA4	27b	TC
28a	SA3	28b	BALE
29a	SA2	29b	+5V (VCC)
30a	SA1	30b	OSC *
31a	SA0	31b	0V (Gnd)
32a	0V (Gnd)	32b	0V (Gnd)

Table B1: TSYST PC Bus Connector (J1) Pin assignments

\* These signals are not used on TSYST

## B.2 AT BUS EXTENSION CONNECTOR (J2)

The J2 connector is defined by the PC/104 specification. It carries the signals required for 16-bit bus cycles, as used on AT expansion boards.

The connector has two parts - male and female - so that the TSYST can be stacked in a PC/104 board stack. The AT bus connector is used to provide 16-bit data transfers (used for the IDE drive on the TSYST), as well as being part of the mechanical system which secures the TSYST processor to other PC/104 boards.

The pin assignments of J2 follow:

Pin	Signal	Pin	Signal
0c	0V (Gnd)	0d	0V (Gnd)
1c	/SBHE *	1d	/MEMCS16 *
2c	LA23 *	2d	/IOCS16
3c	LA22 *	3d	IRQ10 *
4c	LA21 *	4d	IRQ11 *
5c	LA20 *	5d	IRQ12 *
6c	LA19 *	6d	IRQ15 *
7c	LA18 *	7d	IRQ14
8c	LA17 *	8d	/DACK0 *
9c	/MEMR *	9d	DRQ0 *
10c	/MEMW *	10d	/DACK5 *
11c	SD8	11d	DRQ5 *
12c	SD9	12d	/DACK6 *
13c	SD10	13d	DRQ6 *
14c	SD11	14d	/DACK7 *
15c	SD12	15d	DRQ7 *
16c	SD13	16d	+5V (VCC)
17c	SD14	17d	/MASTER *
18c	SD15	18d	0V (Gnd)
19c	(KEY)	19d	0V (Gnd)

Table B2: TSYSTAT BUS Connector (J2) Pin Assignments

\* These signals are not used on the TSYST

## B.3 50-way I/O Connector (J3)

J3 carries signals to and from the serial ports and the printer port. The I/O connector, designated J3, is a 50-way connector situated along one of the edges of the TSYST, perpendicular to J1 and J2. The pin assignments for the 50-way J3 connector are given in Table B3. Pin 1 is marked on the PCB artwork.

Often the signals on J3 will be connected to standard PC connectors, and are arranged in a sequence to make connection to these connectors straightforward. Table B3 also lists the pin assignments for these standard connectors.

Used By		J3				Used By	
Device	Pin	Signal	Pin	Pin	Signal	Pin	Device
COM1	1	DCD0	1	2	DSR0	6	COM1
	2	RxD0	3	4	RTS0	7	
	3	TxD0	5	6	CTS0	8	
	4	DTR0	7	8	RI0	9	
	5	GND	9	10	N/C		
PRN	1	/STB	11	12	/AFD	14	PRN
	2	PD0	13	14	/ERROR	15	
	3	PD1	15	16	/INIT	16	
	4	PD2	17	18	/SLIN	17	
	5	PD3	19	20	GND	18	
	6	PD4	21	22	GND	19	
	7	PD5	23	24	GND	20	
	8	PD6	25	26	GND	21	
	9	PD7	27	28	GND	22	
	10	/ACK	29	30	GND	23	
	11	BUSY	31	32	GND	24	
	12	PE	33	34	GND	25	
	13	SLCT	35	36	N/C		
COM2	1	DCD1	37	38	DSR1	6	COM2
	2	RxD1	39	40	RTS1	7	
	3	TxD1	41	42	CTS1	8	
	4	DTR1	43	44	RI1	9	
	5	GND	45	46	N/C		
		N/C	47	48	N/C		
		N/C	49	50	N/C		

Table B3: TSYST I/O Connector (J3) Pin Assignments

**B.4 Floppy Disk Drive Connector (J4)**

J4 carries signals to the floppy disk drives. The floppy connector, designated J4, is a 34-way connector situated along one of the edges of the TSYST, opposite the J1 and J2 connectors.

The pin assignments of the 34-way J3 connector are given in Table B4. Pin 1 is marked on the PCB artwork.

J4			
Signal	Pin	Pin	Signal
N/C	1	2	/HDS
GND	3	4	N/C
	5	6	N/C
	7	8	/INDEX
	9	10	/DRV0
	11	12	/DRV1
	13	14	/MO1
	15	16	/MO0
	17	18	/DIRC
	19	20	/STEP
	21	22	/WD
	23	24	/WE
	25	26	/TK00
	27	28	/WPT
	29	30	/RDATA
	31	32	/HS
	33	34	/DSKCHG

Table B4: TSYST Floppy Connector (J4)  
Pin Assignments

## B.5 IDE Disk Drive Connector (J5)

J5 carries signals to the IDE disk drives. The IDE connector, designated J5, is a 40-way connector situated along one of the edges of the TSYST, perpendicular to J1 and J2.

The pin assignments of the 40-way J5 connector are given in Table B5. Pin 1 is marked on the PCB artwork.

J4			
Signal	Pin	Pin	Signal
RESET-	1	2	GND
ID7	3	4	ID8
ID6	5	6	ID9
ID5	7	8	ID10
ID4	9	10	ID11
ID3	11	12	ID12
ID2	13	14	ID13
ID1	15	16	ID14
ID0	17	18	ID15
GND	19	20	N/C
N/C	21	22	GND
/IOW	23	24	GND
/IOR	25	26	GND
IOCHRDY	27	28	ALE
N/C	29	30	GND
IRQ14	31	32	/IOCS16
A1	33	34	N/C
A0	35	36	A2
/CS0	37	38	/CS1
N/C	39	40	GND

Table B5: TSYST IDE Connector (J4) Pin Assignments

## APPENDIX C: TSYST CONFIGURATION

There are 12 jumper areas on the TSYST, plus sockets for two optional chips. This Appendix describes how to configure the TSYST. The default jumper settings (when the TSYST is shipped) are indicated by an asterisk (\*).

### JUMPER AREA E1 AND E2 - PARALLEL PORT ADDRESS

These jumpers are set to configure the parallel port address, as follows:

	Disabled:	Set E1 2-3	Set E2 2-3
	3BCH - 3BEH:	Set E1 2-3	Set E2 1-2
	378H - 37AH:	Set E1 1-2	Set E2 2-3
*	278H - 27AH:	Set E1 1-2	Set E2 1-2

### JUMPER E3 - IDE PORT ENABLE/DISABLE

This jumper is used to enable or disable the IDE disk controller.

	Disabled:	Set E3 2-3
*	Enabled:	Set E3 1-2

### JUMPER E4 - FLOPPY DISK ENABLE/DISABLE

This jumper is used to enable or disable the floppy disk controller.

	Disabled:	Set E4 2-3
*	Enabled:	Set E4 1-2

### JUMPER E5 - FIRST SERIAL PORT RS-485 TERMINATION NETWORK

This jumper area is used to connect the RS-485 termination networks to the first serial port.

	Terminated:	Set E5 A1 -A2 and B1 -B2
*	Not Terminated:	Omit jumpers.

### JUMPER E6 - FIRST SERIAL PORT RS-232 ENABLE/DISABLE

This jumper is used to enable or disable the RS-232 transceiver chip on the first serial port.

	Disabled:	Set E6 2-3
*	Enabled:	Set E6 1-2

## JUMPER AREA E7 AND E9 - SECOND SERIAL PORT ADDRESS

These jumpers are set to configure the address of the second serial port address, as follows:

Disabled:	Set E7 2-3	Set E9 2-3
COM4: 238H - 23FH:	Set E7 2-3	Set E9 1-2
COM1: 3F8H - 3FFH:	Set E7 1-2	Set E9 2-3
* COM2: 2F8H - 2FFH:	Set E7 1-2	Set E9 1-2

## JUMPER E8 - SECOND SERIAL PORT RS-232 ENABLE/DISABLE

This jumper is used to enable or disable the RS-232 transceiver chip on the first serial port.

Disabled:	Set E8 2-3
* Enabled:	Set E8 1-2

## JUMPER AREA E10 AND E12 - FIRST SERIAL PORT ADDRESS

These jumpers are set to configure the address of the second serial port address, as follows:

Disabled:	Set E10 1-2	Set E12 1-2
COM3: 338H - 33FH:	Set E10 1-2	Set E12 2-3
COM2: 2F8H - 2FFH:	Set E10 2-3	Set E12 1-2
* COM1: 3F8H - 3FFH:	Set E10 2-3	Set E12 2-3

## JUMPER E11 - SECOND SERIAL PORT RS-485 TERMINATION NETWORK

This jumper area is used to connect the RS-485 termination networks to the second serial port.

Terminated:	Set E11 A1 -A2 and B1 -B2
* Not Terminated:	Omit jumpers.

## FIRST SERIAL PORT RS-485 TRANSCEIVER

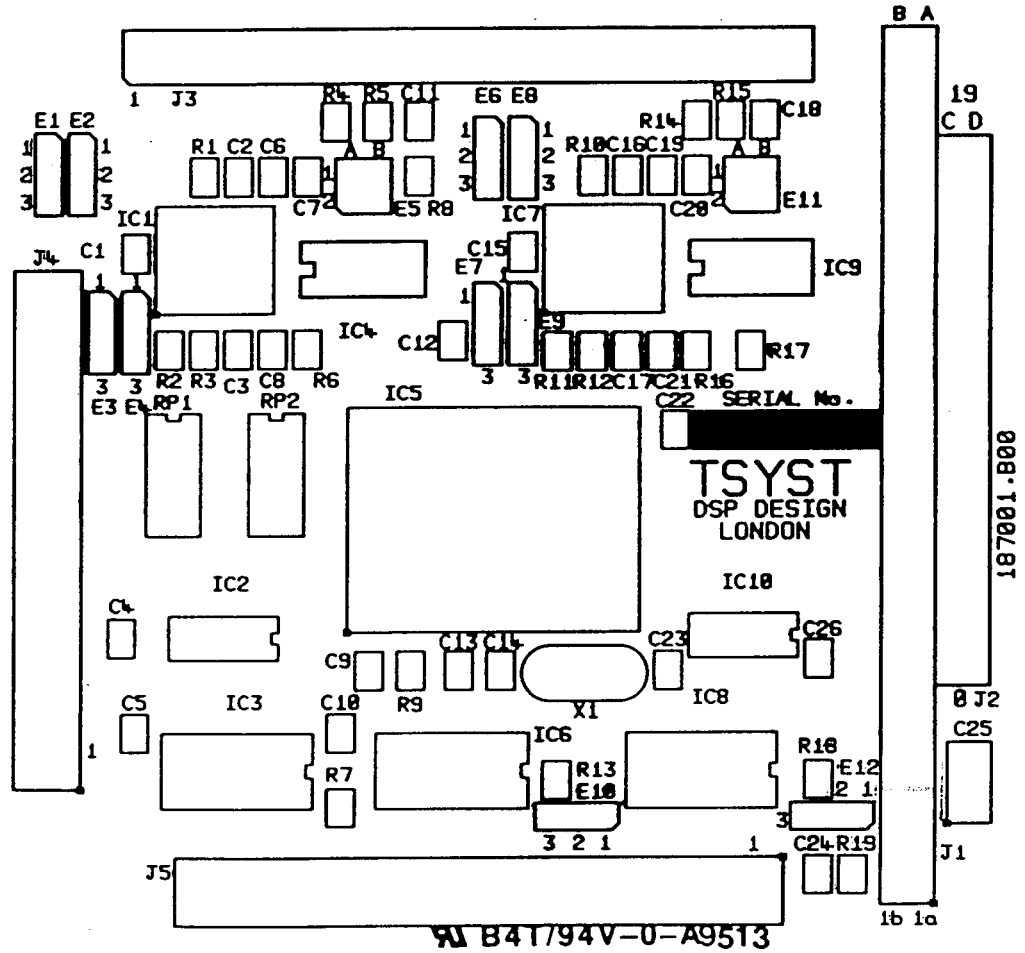
To convert the first serial port from RS-232 to RS-485, add an LTC485 or equivalent chip to the IC4 socket. The RS-232 transceiver must be disabled (at E8), and you may choose to add the termination components (at E5).

## SECOND SERIAL PORT RS-485 TRANSCEIVER

To convert the second serial port from RS-232 to RS-485, add an LTC485 or equivalent chip to the IC9 socket. The RS-232 transceiver must be disabled (at E6), and you may choose to add the termination components (at E11).

**APPENDIX D: COMPONENT PLACEMENT DIAGRAM**

This Appendix includes a component placement diagram for the TSYST. This may assist in the location of jumpers, and connectors mentioned in this manual.



## APPENDIX F: ORDERING INFORMATION

The DSP Design part numbers for the TSYST and related products are given below. For further information regarding other products from DSP Design please contact your supplier.

### ORDER CODES

TSYST	PC/104 System I/O Board
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### ACCESSORIES

The following part numbers should be used to order various accessories for the TSYST:

TCDISK-130	2½" 130Mb IDE Disk Drive.
HDIDE214	3½" 214Mb IDE Disk Drive
IDE-3020	Cable assembly to link 2½" drive to the TSYST IDE drive connector J5.
TSYST-485KIT	RS-485 transceiver chip.

DSP Design manufacture a range of PC/104 processor boards, I/O boards and development systems. Contact your supplier for the latest details.

## **APPENDIX G: FAULT REPORTING**

DSP Design makes every effort to ship products and documentation which are completely free from faults, design errors and inconsistencies. Sometimes, however, problems do show up in the field. To help us put these right as quickly and efficiently as possible, we need as much information as possible from you, the user.

For this reason we have included here a "Product Fault Report" form. If you ever have cause to return a board for repair, or if you detect an error in the documentation, we would appreciate it if you could fill in the form on the next page, or a copy of it, and return the form to your supplier.

Prior to returning a faulty product, please check the following:

- 1 The board has been correctly configured for the intended application (see earlier appendix for board installation details).
2. The power supplies are providing correct voltage levels.
3. Cabling to the board is sound and connected correctly.
4. Other cards in the system are known to be correctly configured and functioning.
5. **PLEASE RETURN THE BOARD TO US IN EXACTLY THE SAME CONFIGURATION AS IT FAILED IN.**

*Your help with this will enable us to sort out your problem more quickly. Thank you.*

## PRODUCT FAULT REPORT

CUSTOMER INFORMATION

COMPANY NAME:

INDIVIDUAL CONTACT:

PHONE NO:

PRODUCT INFORMATION

PRODUCT/DOCUMENT:

SERIAL NO:

DATE OF RETURN:

---

SYMPTOMS OBSERVED /DOCUMENTATION ERRORS (as applicable):

---

IN WHAT CONFIGURATION IS THE BOARD USUALLY USED? (WHAT OTHER BOARDS, WHAT SOFTWARE ETC)?

---

FOR DSP DESIGN USE ONLY:

PRODUCT TEST REPORT:

DATE OF RECEIPT:

REPAIRED BY:

CHARGES TO BE INVOICED: E

DATE OF RETURN:

RETURNED BY: