TS2060 INTERFACE
PRODUCT SPECIFICATION

JANUARY 24, 1984

PRELIMINARY

TABLE OF CONTENTS

1.0 Scope

This product specification describes the TS2060 Interface Unit, Drives, and associated Software. The functional, physical, electrical, and environmental characteristics are specified. A description of the operation of the TS2068 system with this unit is included.

2.0 APPLICABLE DOCUMENTS

TS2068 Product Specification
TS2000 System Software Functional Specification
TS2000 System Software Architecture Specification
Timex Microdrive Operating System Functional Specification
Timex Microdrive Operating System Architecture Specification
TS2065 Microdrive Transport Specification
TS2070 Microdrive Cartridge Sspecification
TS2070 Microdrive Tape Format Specification
CP/M for Microdrive Specification
TS2060 Qualification Test Procedure
TS2060 Marketing Design Guide

3.0 Product Overview

The TS2060 Interface Unit provides the electronics, connectors, and firmware to adapt the TS2068 Computer to control:

(a) Up to 8 TS2065 Microdrive transports

(b) CP/M Module - a RAM/ROM plug-in to extend the unit to support the CP/M operating system on the TS2068.

(c) A printer - Centronics parallel interface.

(d) RS-232-C interface - for attachment of compatible non - Timex peripherals. (9 wire)

(e) Local Area Network - for interconnection of up to 64 TS2068 computers via the Sinclair 2 wire circuit.

(f) System Buss Expansion - a 64 pin connector on the rear of the unit with the system buss buffered to drive up to six additional loads.

Outputs will also be provided for:

(a) R G B Monitor - TTL level drive with composit and vertical sync.

(b) Audio - buffered low level output for external amplifier.

The design of the Interface Unit is being executed initially in LS-TTL to speed first production deliveries. As work progresses a parallel effort is planned to provide a cost reduced version in gate array techonology. The cabinetry and many of the circuits are being designed to allow inclusion of a controller for Floppy Disc drives. At this time it is not known if both Microdrives and Floppy Discs can be incorporated together or if one must replace the other.

3.1 Mass Storage/ Controller

The Microdrive Mass Storage subsystem consists of 1 to 8 Microdrive transports and the control circuitry and firmware included in the Interface Unit. Microdrive Transports are connected daisy- chain fashion to the control unit, receiving control, data, and power over a single flat cable.

Each Microdrive Transport accommodates a removable endless loop tape castridge capable of storing at least 85k bytes of program, data, or memory images organized as files. The

tape cartridge holds 200 inches of magnetic tape that moves at 30 inches per second when necessary to perform read/ write/ search functions. Data is recorded on the tape in two tracks in an FM format at approximately 3333 bpi acheiving a data rate of approximately 12.5k bytes per second. Sectoring is completly soft with a sector length of 512 formatted data bytes.

The controller unit includes circuitry to select an individual Microdrive transport, and to interface data and control signals between the TS2068 computer and the selected transport. Data seperation, track selection, serialization/deserialization, read/write control, and erase control functions are performed by the controller. Firmware in the form of a 16k byte ROM is included to permit control of the Microdrive(s) from the TS2068 keyboard using the appropriate 'keywords' already imprinted. Extensions to the Timex/ Sinclair are provided in the firmware to support a channel/ data stream mechanism. An automatic mechanism is implemented for selection/ deselection of the ROM.

3.2 CP/M Module

An optional module can be plugged into the interface unit to extend the operation of the system to acommodate the CP/M operating system. The CP/M module consists of a plug in card with 32k bytes of dynamic RAM and a 1K byte ROM installed. Incorporated into the ROM is the 'cold boot' loader program necessary for system startup in the CP/M mode. The RAM is switched into the system under software (I/O port) control to enable a 64k byte contiguous RAM space starting from address 0h. This architecture is necessary to support the CP/M operating system. A switch and logic is provided in the interface unit to allow this mode of operation upon power-up. The operating system program is loaded from microdrive tape and runs out of RAM. Thereafter the operating system functions usually performed by disk drives are performed on the microdrive tape.

3.3 Printer Interface

The printer interface is an industry standard Centronics Parallel type. Support is provided in the firmware for the Timex TS2080 dot matrix impact printer or other Centronics compatible printers. A 34 conductor connector is provided.

Access to the interface port is supported by either of two channels; The 'C' channel for listings or character oriented data and the 'G' channel for graphics data. The 'G' channel sends the full 8 bit data allowing control codes to be sent directly to the attached printer. The 'C' channel will not send control codes.

3.4 RS-232-C Interface

An abbreviated 9 wire (common industry practice) RS-232-C interface that operates at baud rates from 50 to 19,200 is provided. The standard DB-25 connector is located at the rear of the unit. The mode of operation is half-duplex wth one start bit, one stop bit, and without parity. Attachment of serial printers, modems and other compatible devices is therefore allowed.

Access to the RS-232-C port is supported by either of two channels; The 'T' channel is normally used for listings and other ASCII character oriented data. The 'B' channel is used to send full 8 bit codes for memory images or control codes.

3.5 Local Area Network

The local area network allows linking up to 64 Interface Unit equipped TS2068 computers in a daisy chain fashion with up to 100 meters of interconnect cables total. A network capable transferring programs, data, and messages at 87k baud is thereby formed. Transmission between individual computers is supported along with a broadcast mode .

Access to the network is supported in the firmware via the 'N' channel.

3.6 R G B Output

The R G B output provides positive TTL level signals to drive a compatible monitor. Red, Green, Blue, and sync signals are developed. Higher resolution (horizontal) than can be displayed on a television set is achieved. A 9 pin 'D' female style connector is used and a cable (not supplied) will be required to connect the monitor to the interface unit.

3.7 Audio Output

The audio output connector, a standard RCA phono jack provides a low level buffered signal to allow connection of an external amplifier and speaker for increased sound level. The internal speaker in the associated TS2068 is not muted.

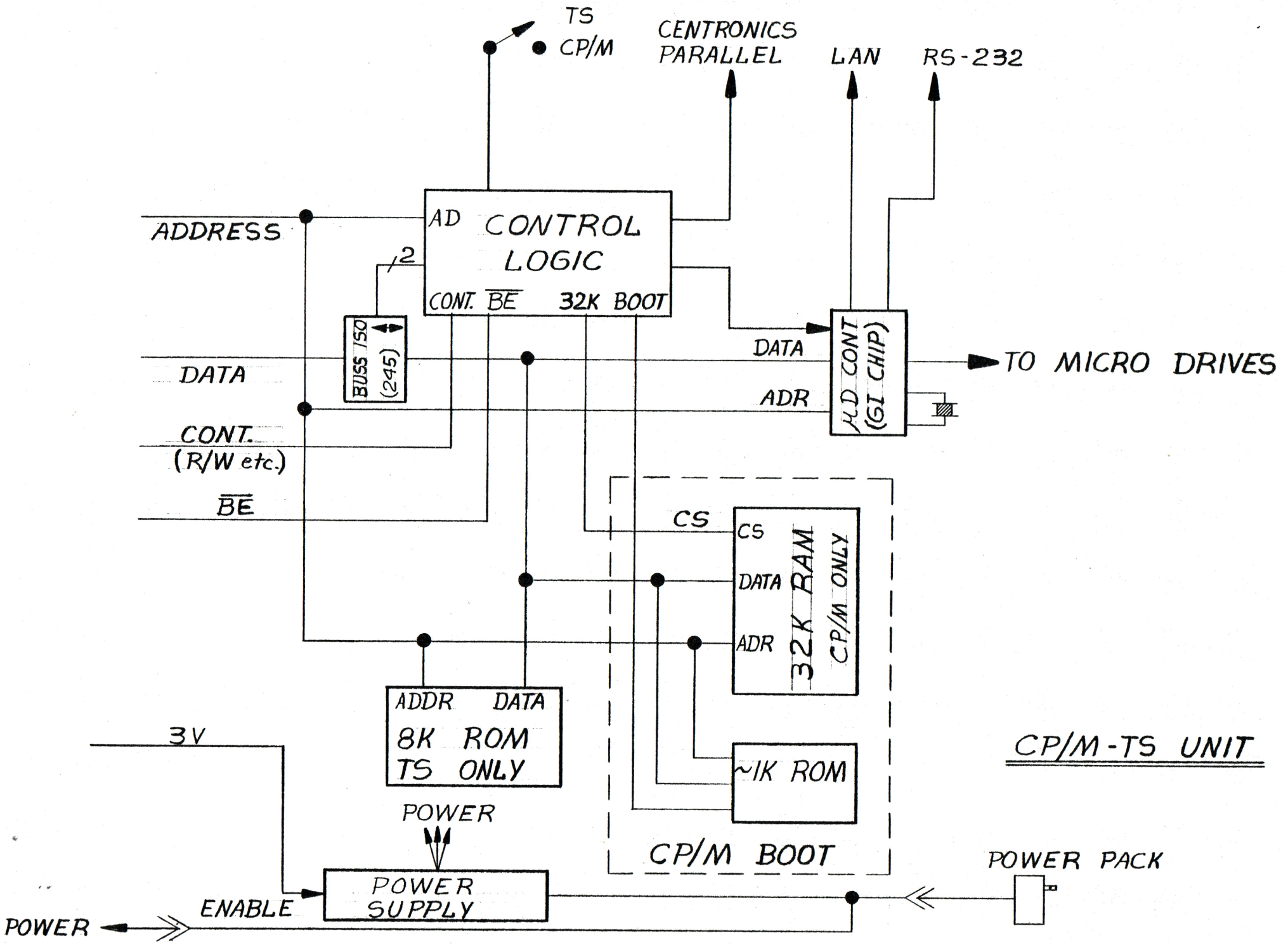
3.8 System Buss Expansion

The TS2068 expansion buss is buffered and brought out to a connector on the back of the Interface Unit. The connector is the same as and is in the same position as the expansion connector on the TS2068 console. Peripherals may be attached up to the limit of 6 LS-TTL loads in the same

fashion as to the TS2068. Control logic is provided to prevent buss contention with signal sources in the Interface Unit and in the TS2068. When not in use the expansion buss connector opening may be covered with the door supplied with the TS2068.

4.0 Hardware Description

The following hardware description should be used in conjunction with the appropriate drawings and specifications listed in section 2.0.

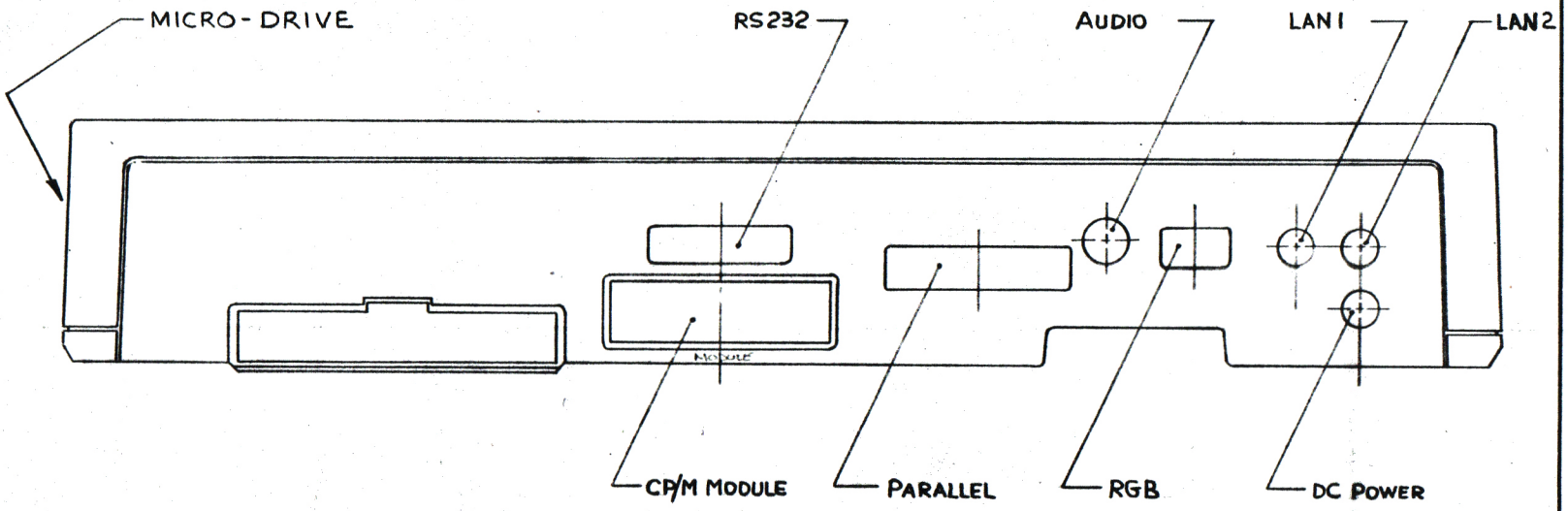

TS
CP/M
CENTRONICS
PARALLEL
LAN
RS-232
AD
CONTROL
LOGIC
/2
CONT. BE
32K BOOT
ADDRESS
DATA
CONT.
(R/W etc.)
BE
BUSS ISO
(245)
DATA
ADR
μD CONT
(GI CHIP)
TO MICRO DRIVES
CS
CS
DATA
ADR
32K RAM
CP/M ONLY
ADDR
DATA
8K ROM
TS ONLY
~1K ROM
CP/M BOOT
3V
POWER
POWER
SUPPLY
ENABLE
POWER
POWER PACK
CP/M-TS UNIT

4.1 Figures

4.1.1 Block Diagram

T B S

DWG. NO.



CHANGES			
ISSUE NO.	ERD/ECO	DATE	DESCRIPTION

TIMEX
CORPORATION
WATERBURY, CT 06720

NAME

DWG. NO.

SHEET OF

MATERIAL
SPEC
SIZE & TOL
TEMPER
PHY SPEC

DO NOT SCALE DRAWING

DRW. CHK. APVD.
REF. DATE
FINISH SCALE
USED ON

THIRD ANGLE PROJECTION
FIRST ANGLE PROJECTION

DIMENSIONS WITHOUT BOX ARE IN MILLIMETERS WITH TOLERANCES IN MICRONS
DIMENSIONS WITHIN BOX ARE IN INCHES

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:
LINEAR ± .075 [.003] ANGULAR ± 1/2°

4.1.2 Connector Locations

T B S

4.2 Unit Specifications

4.2.1 Mechanical

SIZE: L= 15.7" W= 6.2" H= 2.6"
WEIGHT: 3 lbs. (approximately)
COLOR: Top; Silver Bottom; Gray. Per Industrial Design Specification

4.2.2 Absolute Maximum Ratings

STORAGE TEMPERATURE: -40 to +65 C.
OPERATING TEMPERATURE: 0 to +50 C.
RELATIVE HUMIDITY: 15% to 90% (Non-Condensing)
POWER DISSIPATION: 10 W. MAX.
POWER SUPPLY INPUT VOLTAGE: 25 VDC.
SIGNAL INPUTS:
TTL LEVEL: +5.5/ -0.5 Volts
RS-232-C: +/- 25 V. Per EIA
LAN: 25 VAC max.
OTHERS: See Qualification Test Procedure.

4.3 Interfaces

4.3.1 Microdrive Interface

The Microdrive Interface consists of a PCB edge connector on the right side of the Interface Unit of 8 dual sided positions. The connections are numbered 1A to 8A on the component (top) side and 1B to 8B on the solder side. Connection 1 is to the front (TS2068) end of the connector. The connections are assigned as :

Nr.	NAME	FUNCTION
1A	RAW1	Track 1 raw digital data, bidirectional
2A	WRPRT	Write protect sense from selected drive
3A	- -	Key slot
4A	10V	10 VDC power for drive
5A	R/W	Read-Write control to drive
6A	GND	Ground
7A	GND	Ground
8A	GND	Ground
1B	RAW2	Track 2 raw digital data, bidirectional
2B	CCLK	Select bit shift clock
3B	- -	Key slot
4B	CBIT	Select control bit
5B	ERASE	Erase head current sink
6B	GND	GROUND
7B	GND	GROUND
8B	GND	GROUND

The Microdrive connection supports up to 8 drives. The first drive is connected to the Interface Unit with a short flat cable. Additional drives are connected to the first drive via connectors to be supplied with each drive. Electrically all of the signals are in parallel except for the 'CBIT' line. The 'CBIT' acts as the serial input to a shift register formed by the individual drives. To select a particular drive, the 'CCLK' line is used to shift a one bit to a drive with the 'CBIT' line forming a daisy chain connection thru each drive.

The Microdrive control and data lines are all LS-TTL levels except for:

10V	Power supply to the drives, 10VDC nominal, 8.0V. min.,11.0V. max., 0.45A. peak, 0.25A max average
ERASE	Current sink from the erase winding of the selected drive. 20mA. nominal, 30mA. max, 10.8V. max.

4.3.2 Printer Interface

The printer interface is an 8 bit parallel 'Centronics' type capable of driving industry standard printers with this interface. Connection is made to the interface via an edge connector of 36 signals in two rows. A cable with an Amphenol type 57-30360 connector on the printer end and an header type connector on the computer end is required. The interface is capable of driving up to a two meter cable. Signal levels are standard LS-TTL levels.

Connections are assigned as:

Nr.	NAME	FUNCTION
1	STROBE*	Output data strobe pulse, active low Pulse width is greater than .55 us.
2	DATA1	True data output, parallel with DATA2 thru DATA8.
3	DATA2	
4	DATA3	
5	DATA4	
6	DATA5	
7	DATA6	
8	DATA7	
9	DATA8	
10	ACK*	Active low input indicating that printer has received data and can accept next data byte. Minimum width to be 4 us.

11	BUSY	Active high input indicates that printer cannot receive data.
12	NC	Not used
13	SLCT	Active high input indicating the printer is selected, ie; on-line.
14	NC	Not used.
15	KEY	Connector Key Location
16	GND	Signal Return Ground
17	F-GND	Frame Ground. Chassis connection, not for signal return
18	NC	Not used.
19 to 30		Signal return ground.
31	INIT*	Power on reset, active low output.
32	ERROR*	Active low input indicating printer error or failure.
33	KEY	Connector Key Location.
34 to 36		Not used.

NOTES:
1. All signal levels are LS-TTL with rise and fall times less than 0.2 us.
2. Frame ground is for protective, shielding, and RFI purposes and must not be used as signal return. This ground is not connected to the power line ground in the computer.
3. Signal names with a * as the last charcter are active low.

4.3.3 RS-232-C Interface

The RS-232-C interface provided is a subset of the E.I.A. specified standard interface. Signal levels accepted as inputs are standard levels as per the E.I.A.. Output levels are +/- 9V nominal and the inputs will accept TTL up to E.I.A levels. Software selected baud rates supported range from 50 to 19,200. Connection for the interface is via a standard DB-25 style connector. Depending on baud rate, up to 50 feet of cable can be drivin

The RS-232-C interface subset supported and pin assignments are as follows:

Nr.	CIRCUIT	DESCRIPTION
1	AA	Protective Ground.

2	BA	Transmit Data.
3	BB	Received Data
5	CB	Clear To Send.
6	CC	+10V (Nominally data set ready)
7	AB	Signal Ground
20	CD	Data Terminal Ready

Notes:

1. Only those pin numbers assigned above are connected. Pin assignments are per E.I.A. standard RS-232-C.
2. Data transmission is bit serial per E.I.A.
3. One stop bit and no parity is sent. The data word is 8 bits long.
4. Protective ground is a frame connection only. It is provided for protective, shielding, and RFI purposes only and must not be used as signal return. This ground is not connected to the power line ground in the computer.

4.3.4 Local Area Network

The local area network is a two wire connection using TTL levels in a 340 Ohm terminated twisted pair of up to 100 meters total length. Two 3.5 mm. switching phone jacks connected in parallel are provided for connection. The switching mechanism is arranged to connect 680 Ohm terminating resistor across unused jacks thereby terminating the network with 340 Ohms. The one level on the network is achieved by active pull-up and the zero level by passive pull-down. Data is sensed with a protected Schmidt trigger input. Protection is sufficient to withstand 24 Volts AC.

The data rate (set by software in the TS2060 ROM) is approximately 87k baud. Collision detection with psuedo-random back-off is employed.

4.3.5 R G B Output

TTL level outputs are provided to drive a RGB input monitor. A sync seperator circuit in the interface generates composit sync and seperately vertical sync. Those monitors that require horizontal sync can use the composit sync for this function.

The RGB and sync outputs are positive going TTL level. The RGB outputs have sufficient bandwidth to accomodate the full 80 column output possible from the TS2068 and will drive a 2 meter cable. The RGB output does not support the BRIGHT mode of the TS2068. Connection to the RGB output is via a 9 pin 'D' female connector on the back of the interface.

Signals are assigned to the RGB connector as follows:

Nr.	NAME	DESCRIPTION
1	CSYNC	Composit Sync
2	R	Red Video
3	G	Green Video
4	B	Blue Video
5	GND	Ground - Signal Return
6	GND	Ground as #5
7	NC	Not Used
8	NC	Not Used
9	VSYNC	Vertical Sync

4.3.6 Audio Output

The audio produced by the TS2068 'BEEP' and 'SOUND' commands is buffered and routed to a standard RCA phono jack on the rear of the interface. The output level, 0.5V into 10k Ohm, is sufficient to drive the auxiliary input of most HI-FI equipment. Use of this output does not silence the speaker of the associated TS2068.

4.3.7 System Buss Expansion

The data, address, and control signals of the associated TS2068 are buffered to increase the drive level to enable the system to drive up to 6 standard LS-TTL loads. The buss expansion connector is a PC edge connection in the rear of the interface unit and is the same size and position as the buss connection on the TS2068.

Circuitry is provided for direction control of the data signals and to prevent external devices from interfering with the operation of either the Microdrive controller or the other interfaces in the unit. Maximun access time of memory devices attached to the expansion buss is reduced by (XX) ns due to the propogation delay of the data, address, and control buffers.

The signals brought out in the buss expansion connector are:

A SIDE			B SIDE		
Nr.	NAME	COMMENT	Nr.	NAME	COMMENT
A1	GND	GROUND	B1	GND	GROUND
2	EAR	P/T	2	SP/T 0	P/T
3	A7RB	BUFF	3	+15V	XX MA MAX
4	D7	XCV	4	+5V	XX MA MAX
5	NC	NOT USED	5	NC	NOT USED
6	KEY	KEY SLOT	6	KEY	KEY SLOT
7	D0	XCV	7	GND	GROUND
8	D1	XCV	8	GND	GROUND
9	D2	XCV	9	0*	CLK P/T
10	D6	XCV	10	A0	BUFF
11	D5	XCV	11	A1	BUFF
12	D3	XCV	12	A2	BUFF
13	D4	XCV	13	A3	BUFF
14	INT*	P/T	14	A15B	BUFF
15	NMI*	P/T	15	A14B	BUFF
16	HALT*	P/T	16	A13B	BUFF
17	MREQB*	BUFF	17	A12	BUFF
18	IORQB*	BUFF	18	A11	BUFF
19	RDB*	BUFF	19	A10	BUFF
20	WRB*	BUFF	20	A9	BUFF
21	BUSAK*	P/T	21	A8	BUFF
22	WAIT*	P/T	22	A7	BUFF
23	BUSRQ*	P/T	23	A6	BUFF
24	RESET*	BUFF	24	A5	BUFF
25	M1*	BUFF	25	A4	BUFF
26	RFSHB*	BUFF	26	NC	NOT USED
27	EXROM*	P/T	27	R	BUFF
28	ROSCS*	P/T	28	G	BUFF
29	BE*	P/T	29	B	BUFF
30	IOA5	P/T	30	NC	NOT USED
31	SOUND	BUFF	31	VIDEO	P/T
32	GND	GROUND	32	GND	GROUND

NOTES:

1. Signal names with * as the last character are active low.
2. Comment definitions;
   BUFF = buffered, if digital then 6 LS-TTL loads may be driven.
   P/T = Pass through, signal is not modified.
   XCV = Bi-directional buffering with controls for proper operation. Tri-state high impedance state for TS2068 internal or interface unit read operations.
3. See the TS2068 product specification for complete description of signals and timing information.

4.4 CP/M Module

The requirements of the CP/M Operating system dictate

inclusion of additional RAM and ROM. To support this the CP/M Module includes 32k bytes of dynamic RAM and a 1k byte ROM. The ROM is enabled upon power-up when in the CP/M mode. The ROM contains code forming the 'cold boot' loader. Excecution of this code enables the system to load additional code from the number 1 microdrive transport into high memory. Control is then passed to the additional code so loaded and this code disables the ROM by writing a bit to an I/O port (see section 4.6 for I/O port map). Upon disabling the ROM in the CP/M mode the software then enables the 32k of additional RAM in the address range 0h to 7FFFh. Whenever the system requires access to the display file memory or the 'HOME' ROM, the additional RAM is disabled by the software by means of a bit in an I/O port.

The CP/M Module proper includes only the 'COLD BOOT ROM' , the 32k byte dynamic RAM and a data buffer. The control logic for RAM refresh and for enable/ disable functions are part of the interface unit electronics. A switch mounted on the front of the case is wired through the module to control entry into CP/M mode upon power-up. The switch is ignored after power-up or if no CP/M module is installed.

The CP/M module is a user installed option. It is supplied as a PCB with a handle and is plugged into the rear of the interface unit after removal of a 'battery door' style acess cover.

4.5 Power Supply

Power for the Interface Unit and for the Microdrive Transports is derived from the associated TS2068's power pack. The power pack output is plugged into a power jack on the rear of the unit. A short cable mounted to the interface unit is then plugged into the power jack on the TS2068.

Inside the interface unit, the 17.5V output of the power pack is regulated down to 10V to provide power for the Microdrive Transports and positive supply for the RS-232-C outputs. A switching supply provides 5V for logic, sync seperator and memory power. A simple inverter circuit generates -10V for the negative supply to the RS-232-C outputs.

The 5V output of the associated TS2068 is sensed and used to control the internal supplies in the interface unit. This allows the power switch on the TS2068 to control the interface unit.

The rating of the supplies are:

VOLTAGE	TOLERANCE	CURRENT
+5	+/-0.25V	TBD
+10	+1/-1.5V	0.455 A. peak, 0.225A. average
-10	+/-2.5V	0.025 A

4.6 I/O Port Map

The following port map lists only those ports assigned to the TS2060 Interface unit. For other port information see the TS2068 I/O Port Map, Drawing XXX-XXXXX.

PORT ADDRESS	BIT NUMBER	DESCRIPTION
		Microdrive Data Port
E4	0-7	Data port from/to Microdrive, track selection is automatic.
		Microdrive Control/Status
E5	0	Write Protect (Read), Drive select Data (Write)
	1	Sync1(Read), Drive Select Clock (Write)
	2	Data Gap (Read), Read/Write (Write)
	3	DTR RS-232 (Read), Erase (Write)
	4	Busy (Read), CTS (Write)
	5-7	IC Test Points, Write as 0's
		RS-232-C Port
E6	0	NET (Read), RX Data & NET Out (Write)
	1-6	Not Used
	7	TX Data (Read), Not Used (Write)
		Select and Parallel Status
E7	0	BROM Select (Read/Write)
	1	MRAM Select (Read/Write)
	2	MROM Select (Read/Write)
	3	CP/M / TDOS* MODE (Read Only)
	4	ERROR*, Parallel Port (Read)
	5	SELECT, Parallel Port (Read)
	6	BUSY, Parallel Port (Read)
	7	ACK*, Parallel Port (Read)
		Parallel Port Data
EF	0-7	Data Out to Parallel Port

4.7 Memory Map

T B S

5.0 Software Description

5.1 Timex Sinclair BASIC Support

The ROM in the Interface Unit contains code extending the BASIC native to the TS2068. New commands are added for control and use of the microdrives, the LAN, the RS-232-C interface, and the parallel printer interface.

A Data Stream structure is established with up to 16 streams. Four streams are initially linked to the channels for the TS2040 printer, the Screen (lines 0-21, the input area screen, and the keyboard. The remaining 12 can be assigned by the extended BASIC to future peripherals or may duplicate existing assignments.

For a complete description, see the Timex Microdrive Operating System Functional Specification.

5.2 CP/M Support

The version of the CP/M operating system to be implemented for the TS2068 treats the microdrive essentially as a one track disc drive. The operations normally associated with disc drives are supported.

For a complete description, see the CP/M for Microdrives Functional Specification.

5.3 Machine Language Support

The ROM in the interface unit contains code to support microdrive functions. Operations supported include Read Data, Write Data, Format Tape, Find Sector, and erase a block.

5.4 Error Handling

Like all magnetic storage systems a certain error rate is inevitable. Errors divide into two classes, detectable and undetectable.

5.4.1 Detectable Error Handling

A checksum error detection algorythm is incorporated into the interface unit ROM code. Upon detection of a error, up to 5 retries are automatically initiated. A Verify command is also available to detect otherwise undetectable write errors. Soft (correctable) errors can thus be corrected. Hard errors will require using

a backup copy on another microdrive cartridge.

5.4.2 Undetectable Errors

Undetectable errors can occur due to certain error combinations that defeat the error detection algorythm. No automatic system operation can help in this case so backup copies should be used.

6.0 Regulatory Requirements

The Interface unit is designed to require a minimum of regulatory agency approvals. No high voltages or currents are present, and high temperatures and user handled chemicals are avoided.

6.1 UL Requirements

Underwriters Laboratories listing is not required for this product.

6.2 CSA Requirements

Canadian Standards Association listing is not required for this product.

6.3 FCC Requirements

The Interface Unit must comply with the Federal Communications Commission requirements for a Computer Peripheral Device pursuant to Subpart J of Part 15 of the FCC rules (Class B). The Interface Unit must be tested in the configuration shown in figure 6.3.1.

The TS2068, classified as a Television Interface device, must meet the FCC Emission requirements (Subpart J, Part 15, Class B) with the appropriate number of Microdrive units attached. Measurements are to be made in accordsance with FCC measurement procedure MP-4 ("FCC Methods Of Measurement of Radio Noise Emissions From Computing Devices").

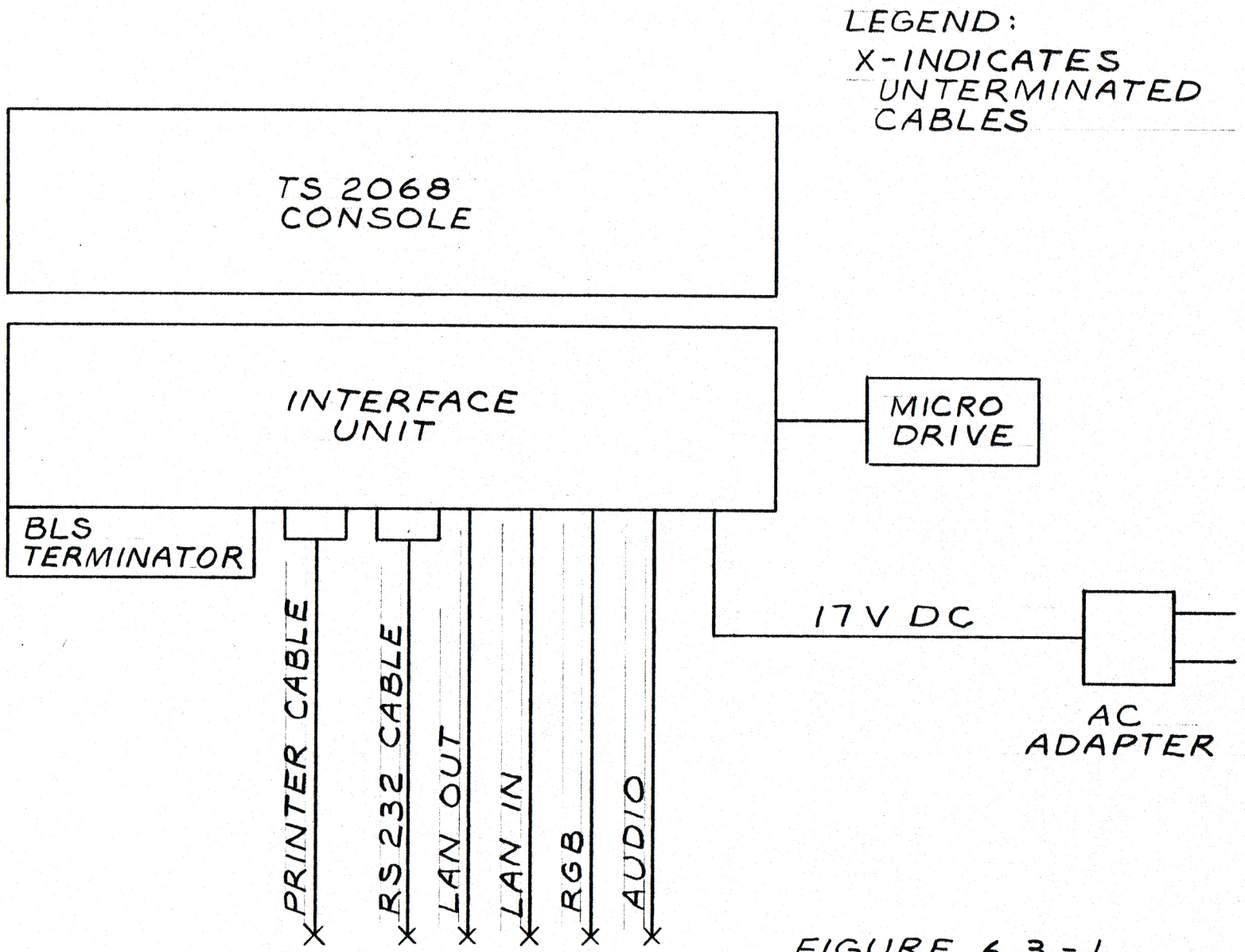


FIGURE 6.3-1
FCC COMPLIANCE TESTING
MINIMUM CONFIGURATION

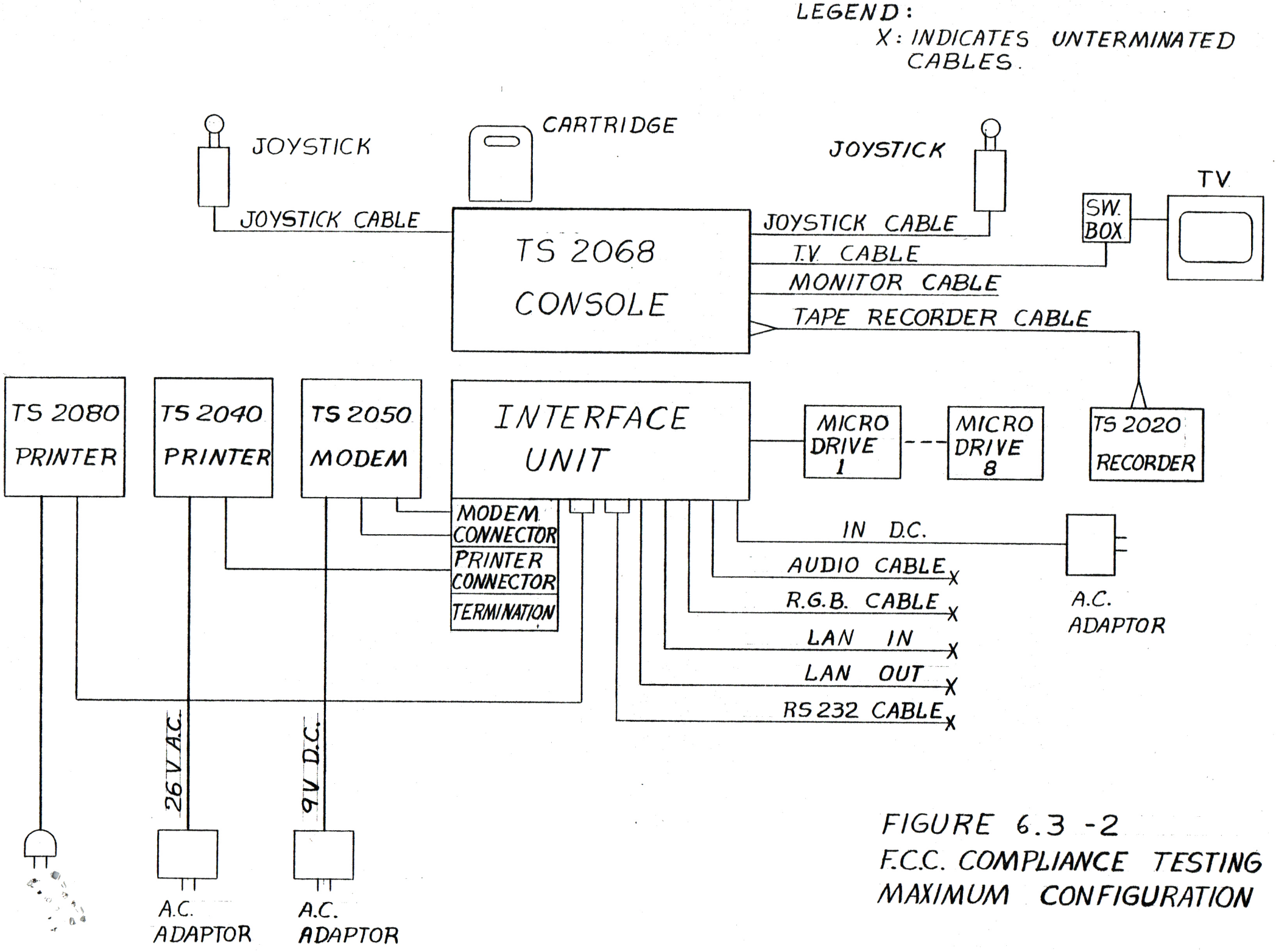


FIGURE 6.3 -2
F.C.C. COMPLIANCE TESTING
MAXIMUM CONFIGURATION