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CUSTOMER ENGINEERING DIVISION

(Preliminary Hardware Manual)

2246R Remote Standalone Workstation

(WLI Part Number 177-22VS-57)

August 1, 1979

III.D.3

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(Preliminary Hardware Manual)

2246R Remote Standalone Workstation

(WLI Part Number 177-22VS-57)

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Error notices and/or suggestions for improvements of this
preliminary release text may be sent to the following address:

Wang Laboratories, Inc.

Customer Engineering Division (Dept 113)

Technical Writing Group (Mail Stop 4212)

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Lowell, MA 01851

ADDENDUM #1

The following changes are provided as update information to all users of
the Model 2246R Remote Standalone Workstation (Preliminary) manual, dated 1
August 1979:

1.   The omitted part number for the 2716-type Diagnostics 2K PROM called
       out in para. 8.3(1) (page 8-1) is WLI #378-4136. Record this catalog num-
       ber in that blank space and as an add-on (per ECN #12389) to the system
       BOM.

2.   The 22V06-Series IOP-update inputs referenced in para. 4.2.A.2.b and
       duplicated in Appendix B have been produced as CSNL #128 (bringing the
       210-7426 TC IOP Motherboard to E-REV level 4) and CSNL #129 (bringing the
       associated 210-7427 TC IOP Daughterboard to E-REV level 1). Both CSNL's
       must be incorporated in order to obtain full communications between the VS
       CPU and the 2246R Remote Workstation. In addition, note that PROM's L49
       and L50 on the 210-7426 TC IOP Motherboard must be updated (per ECN
       #12330) to 378-4049-R1 and 378-4050-R1, respectively (refer to para.
       4.2.A.2.a).

3.   The eight 2716-type PROM's in locations L88 through L95 on the
       210-7478 TC/Memory board (DLP) are identified on the 7478 schematic (sheet
       6) in Section 13 only by their "unloaded" catalog number, #376-9021. The
       operational identifications of these PROM's, which contain the DLP Operat-
       ing System firmware, are as follows (per ECN #12382):

       PROM-Loading Order on 210-7478 TC/Memory Board (Component Side)

L	L95	L94	L93	L92	L91	L90	L89	L88	R
E									I
F									G
T	378-	378-	378-	378-	378-	378-	378-	378-	H
	4135	4128	4129	4130	4131	4132	4133	4134	T

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SECTION 1

INTRODUCTION

1.1 SCOPE

    This document describes the installation, checkout, maintenance, and theo-
ry of operation for the Model 2246R Remote Stand-Alone Workstation, hereafter
called either the 2246R Remote Workstation or simply the Remote Workstation.

1.2 RELATED PUBLICATIONS

    Table 1-1 lists available WLI-published documents pertaining to telecom-
munications equipment associated with the VS system. The WLI part number or
other ordering-identification information are included within parentheses,
following the title.

    Table 1-2 lists Bell-System Reference documents pertaining to both general
and specific Bell-manufactured equipment. Inquiries related to these Bell-
published technical references should be communicated in writing to:

        American Telephone and Telegraph Company
        Information Distribution Center (Room C190)
        ATTN: Technical References
        P.O. Box #3513
        New Brunswick, New Jersey 08903

1.3 PHYSICAL DESCRIPTION

    The 2246R Remote Workstation consists of a CRT screen and a typewriter-
like keyboard with associated electronics circuits, together with a built-in
telecommunications controller enabling it to function as a remote

Table 1-1. Wang-Published Technical Publications on Telecommunications

ITEM	WLI STOCK NO.	FULL PUBLICATION TITLE
1.	WLI #700-3830	2227B Buffered Asynchronous Telecommunications Data Sheet
2.	WLI #700-4086	Telecommunications Support Utilities User Manual.
3.	WLI #700-4086-1	Telecommunications Support Utilities User Manual Addendum.
4.	WLI #700-4114	2227B Buffered Asynchronous Telecommuications User Manual.
5.	WLI #700-4143	2228B Bisynchronous Telecommunications Data Sheet.
6.	WLI #700-4412	Telecommunications Marketing Guide.
7.	WLI #700-4703	Telecommunications Sales Guide.
8.	WLI #700-4704	Teletype Emulator Data Sheet.
9.	WLI #700-4705	Burroughs Emulator Data Sheet.
10.	WLI #700-4706	2741 Emulator Data Sheet.
11.	WLI #700-4707	HASP Multileaving Data Sheet.
12.	WLI #700-4708	3741 Software Utilities Data Sheet.
13.	WLI #700-4709	2780/3780 Software Utilities DAta Sheet.
14.	WLI #700-4718	Asynchronous I Manual (Marketing Publication).
15.		Product Service Telecommunications Guide (CE Publication, Service Bulletin #77).
16.		Telecommunications Self-Teaching Manual (CE Publication, #03-0078)

Table 1-2. Bell-System Technical Reference Publications

ITEM	IDENTIFICATION NO.	FULL-NOMENCLATURE TITLE
1.	Bell Pub. #40000	Technical Reference Catalog.
2.	Bell Pub. #40001	Technical Reference Ring Binder.
3.	Bell Pub. #41001	Complete Set of Data Communications Technical References.
4.	Bell Pub. #41004	Data Communications Using Voiceband Private-Line Channels.
5.	Bell Pub. #41005	Data Communications Using the Switched Telecommunications Network.

Table 1-2. Bell-System Technical Reference Publications (Continued)

ITEM	IDENTIFICATION NO.	FULL-NOMENCLATURE TITLE
6.	Bell Pub. #41008	Transmission Parameters Affecting Voiceband Data Transmission (Description of Parameters).
7.	Bell Pub. #41009	Transmission Parameters Affecting Voiceband Data Transmission (Measuring Techniques).
8.	Bell Pub. #41021	Digital Data System (Channel Interface Specification).
9.	Bell Pub. #41101	Data Set 103A Interface Specification.
10	Bell Pub. #41102	Data Set 103A3, Data Set 103E, Data Set 103G, Data Set 103H Interface Specification.
11.	Bell Pub. #41103	Data Set 103F Interface Specification.
12.	Bell Pub. #41105	113-Type Data Station Interface Specification.
13.	Bell Pub. #41201	Data Sets 201A and 201B
14.	Bell Pub. #41202	Data Sets 202C and 202D Interface Specification.
15.	Bell Pub. #41209	Data Set 208A Interface Specification.
16.	Bell Pub. #41210	Data Set 201C Interface Specification.
17.	Bell Pub. #41211	Data Set 208B Interface Specification.
18.	Bell Pub. #41212	Data Sets 202S and 202T Interface Specifications.
19.	Bell Pub. #41213	Data Set 209A Interface Specification.
20.	Bell Pub. #41214	Data Set 212A Interface Specification.
21.	Bell Pub. #41450	Digital Data System Data Service Unit Interface Specifications.
22.	Bell Pub. #41601	Data Auxiliary Set 801A (Automatic Calling Unit) Interface Specification.
23.	Bell Pub. #41602	Data Auxiliary Set 801C (Automatic Calling Unit) Interface Specification.
24.	Bell Pub. #41603	801C-L1/2 Data Auxiliary Set Interface Specification.
25.	Bell Pub. #41802	Data Couplers CBS and CBT for Automatic Terminals.

standalone workstation for single-site applications. The controller elec-
tronics also support a parallel printer, which can be directly connected to
the back of the Remote Workstation. The Remote Workstation is packaged in a
standard Wang workstation cabinet (see Figures 1-1 and 1-2), that may be lo-
cated for operator convenience in a variety of user applications.

Figure 1-3 shows a rear view of the interior assemblies, showing mounting
locations for two large PC-board logic assemblies behind the CRT tube and for
a power-supply regulators board, containing dc-voltage adjustment potentio-
meters, which is mounted on the side. A fourth card, concerned with CRT con-
trol and adjustments of the display presentation, is mounted horizontally be-
neath the CRT tube (see Figure 1-4). In addition, the unit also includes a
horizontal motherboard assembly in its base, into which the two large logic
cards are inserted, but that motherboard does not include logic devices or
discrete components. The following subparagraphs identify the major assem-
blies of the Remote Workstation.

1.3.1 CRT ASSEMBLY

The workstation CRT and associated electronics are standard Wang assem-
blies, displaying 24 lines of 80 selectable characters, formatted into dis-
crete fields for programmable assignment of specific attributes (numeric,
alphanumeric, protected, modifiable, etc.). The screen can display the entire
ASCII character set, including both uppercase and lowercase, plus certain
special editing characters, in program-selectable high or low intensities,
with an optional blinking function.

1.3.2 KEYBOARD

The standard keyboard is divided into four zones, each containing a group
of keys dedicated to certain types of operation. The largest such zone is the
typewriter-like character entry zone, which is used to enter alphabetic, nu-
meric, punctuation, and other ASCII symbols into the data block controlling
the display presentation. Immediately to the right of that character-entry
zone is a block of cursor-move/character-edit keys, which facilitate editing
of the data contents. Still further to the right is a third zone, comprising
a compact numeric keypad that provides a convenient means of entering numeric
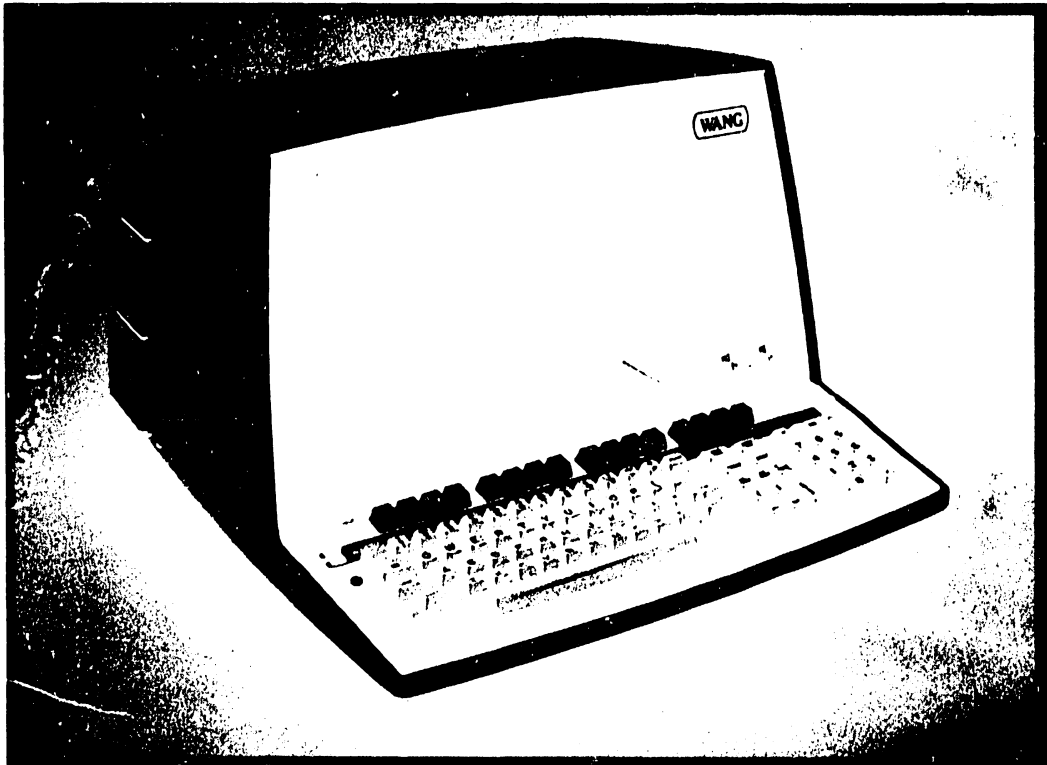
Figure 1-1.   2246R Remote Workstation, Front View
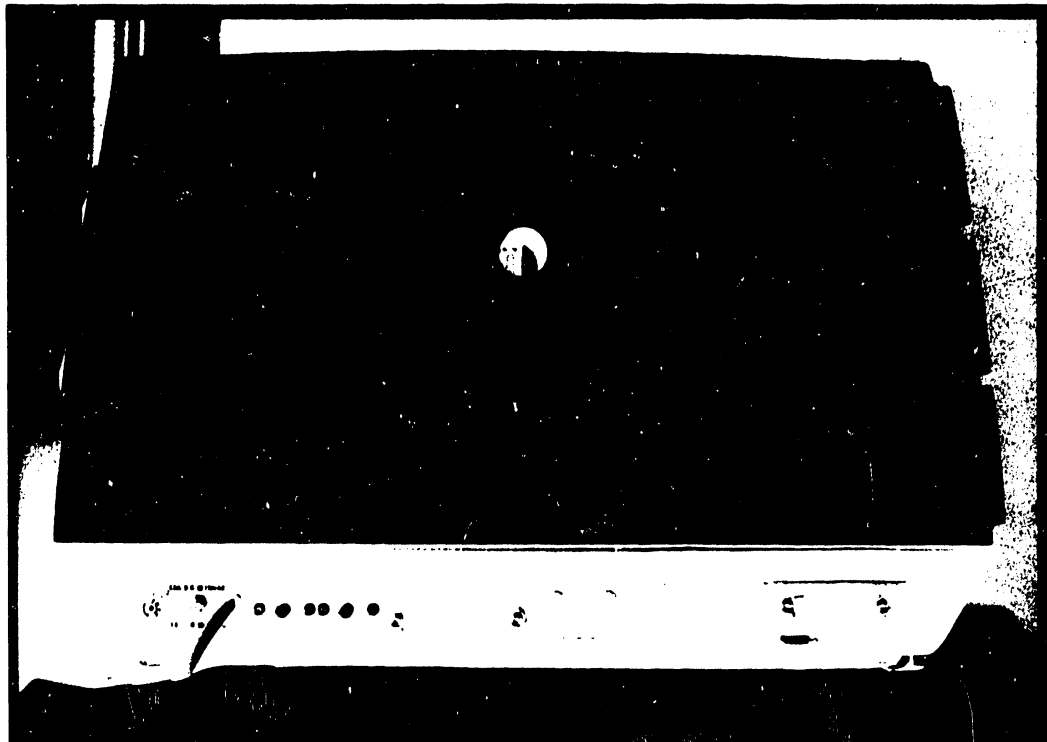
Figure 1-2.   2246R Remote Workstation, Rear View
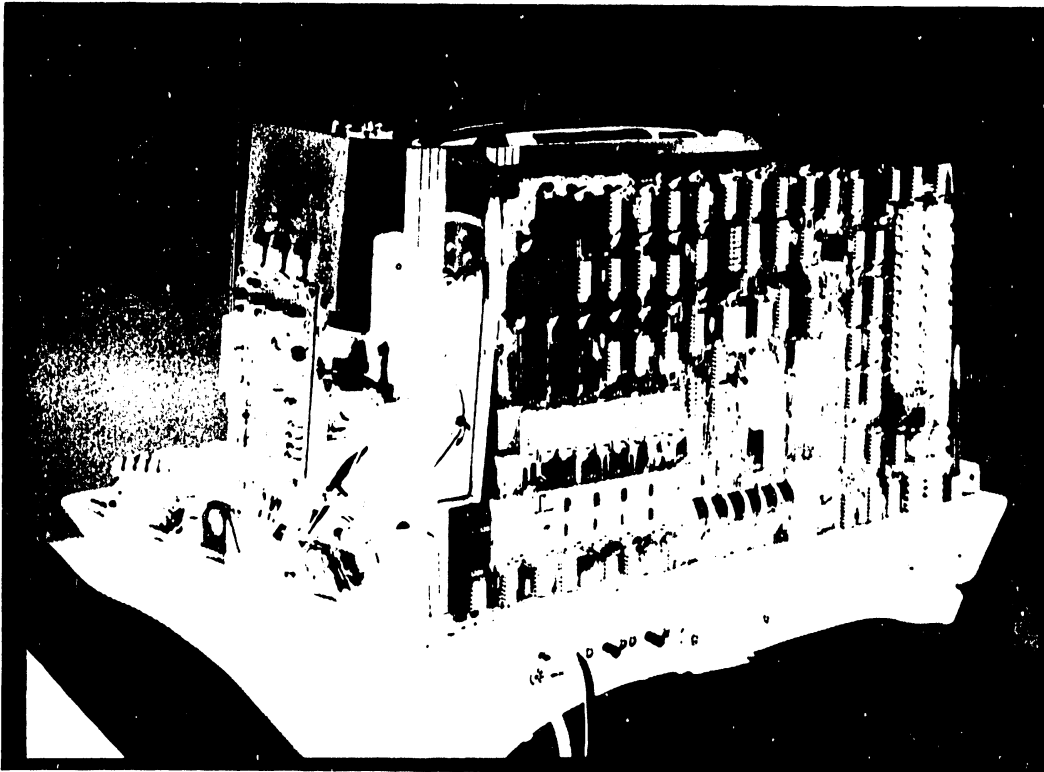
Figure 1-3. Interior Assemblies of the 2246R Remote Workstation (Rear View)

210-7456
CRT MONITOR
ELECTRONICS
BOARD
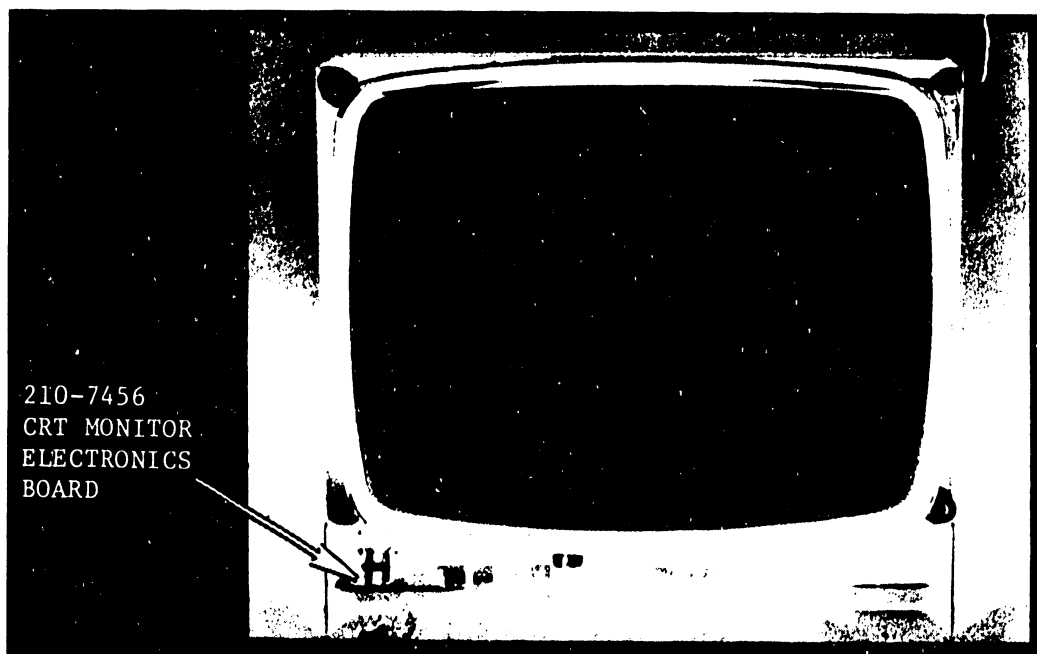
Figure 1-4. Location of 210-7456 CRT Monitor Electronics Board

data. Finally, a row of sixteen special program-function keys runs across the top of the keyboard; these can be used independently or in combination with the SHIFT key to enter 32 system-defined functions affecting program branching for manipulation of the edited data.

1.3.3 210-7478 REMOTE TELECOMMUNICATIONS WORKSTATION CONTROLLER

The 210-7478 Remote Telecommunications Workstation Controller assembly (see Figure 1-5), hereafter referenced either as the TC/Memory board or as the Telecommunications Data Link Processor (DLP), contains the input/output control circuits through which the VS host computer and the remaining workstation/printer electronics communicate with each other. This logic board contains a row of normal-operation PROM's (L88 through L95, not loaded at the time the Figure 1-5 photograph was taken), which contain the DLP Operating Systems firmware. For testing purposes, the Customer Engineer can temporarily replace one of these Operating System PROM's (L94, as shown in Figure 1-5, on E-REV 0 boards, L95 on E-REV 1 boards) with a special Diagnostics Test 2K PROM that contains firmware subroutines for checking out the operational integrity of key Remote Workstation function circuits. This test-program firmware operates in combination with test-module selections on an 8-pole switchbank mounted in location L44 on the card. Two optional LED-readouts can be mounted on either side of that switchbank (i.e., in L43 & L45). When so-mounted on the rear-facing TC/Memory card, these readouts can be viewed through a hole in the back of the workstation cover following removal of a pull-out plug (see Figure 1-3). During the performance of the Diagnostics Test program, these LED readouts present a 2-digit error code providing identification of firmware-detected test failures. (Additional Diagnostics Test information also is presented on the CRT screen; refer to Section 8 of this document for details.) During normal operation, the L44 switchbank establishes a specific device address identifying the Remote Workstation for device-polling and selection applications. The TC/Memory board also contains a 5-pole switchbank in location L22, which provides additional device-type identification, not currently used by the DL firmware.
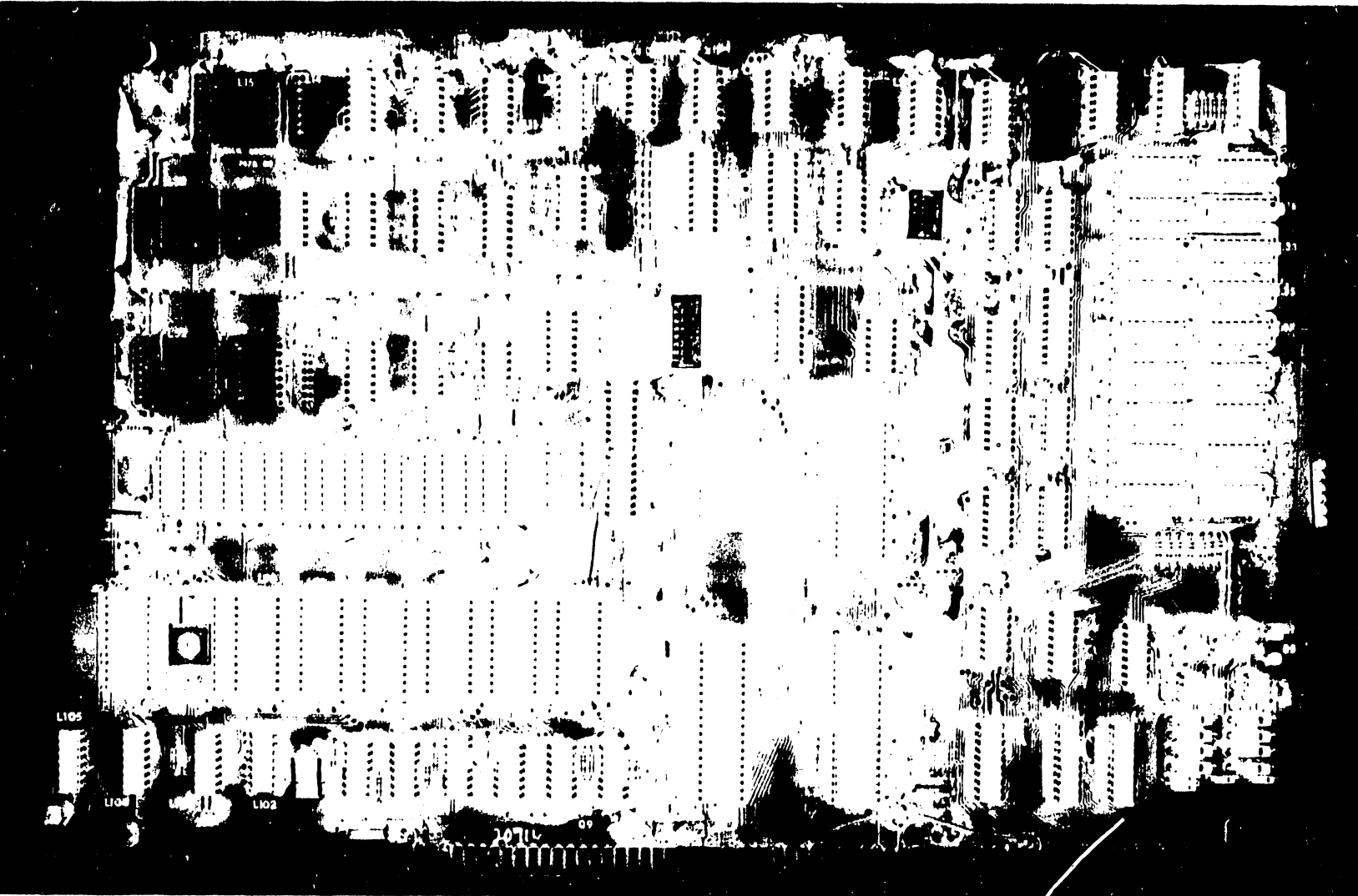
Figure 1-5. 210-7478 TC/Memory Board (DLP)

1.3.4 210-7479 ENHANCED WORKSTATION CPU

The 210-7479 Enhanced Workstation CPU assembly (see Figure 1-6), elsewhere referred to either as the Workstation Processor (WP) or the CRT/CPU board, contains a microprocessor, an 8K CRT RAM storage area, and CRT-control logic, including row/column character generator, dual-intensity gating, character blanking and blinking functions, etc. The WP card also contains keyboard-input circuitry, together with interface circuitry for an optional parallel printer that can be connected to the Remote Workstation. Finally, the board also contains interface circuitry for communication with the 210-7478 TC/Memory board, including a data-link circuit that can use the upper 32K of the TC/Memory board's RAM storage area for direct-memory addressing (DMA) applications with large-scale data transfers between the CRT RAM data and the VS host computer.

The WP board is located directly ahead of the 210-7478 TC/Memory board. It contains a program-readable 8-pole switchbank in the middle of the bottom row, but the current Operating System firmware does not make use of the switch output signals. The board also contains a top-mounted video cable that connects to associated CRT electronics.

1.3.5 210-7156 POWER SUPPLY REGULATORS

The 210-7156 Power Supply Regulators board (see Figure 1-7) is mounted on the right side of the CRT chassis (refer to Figure 1-3). This board contains regulation circuits providing current-foldback protection (in conjunction with resistors mounted on the power suply heatsink). Overload/short-circuit conditions cause the voltage outputs to drop to zero instantaneously, thereby preventing the power supply components from overheating to the point of damage. The board contains potentiometers for field adjustment of the respective dc-voltage outputs produced by each regulator circuit.

1.3.6 210-7456 CRT MONITOR ELECTRONICS

The 210-7456 CRT Monitor Electronics board (see Figure 1-8), mounted beneath the CRT tube, contains various CRT presentation control circuits, affecting size, linearity, and focus of the display. Numerous adjustments on
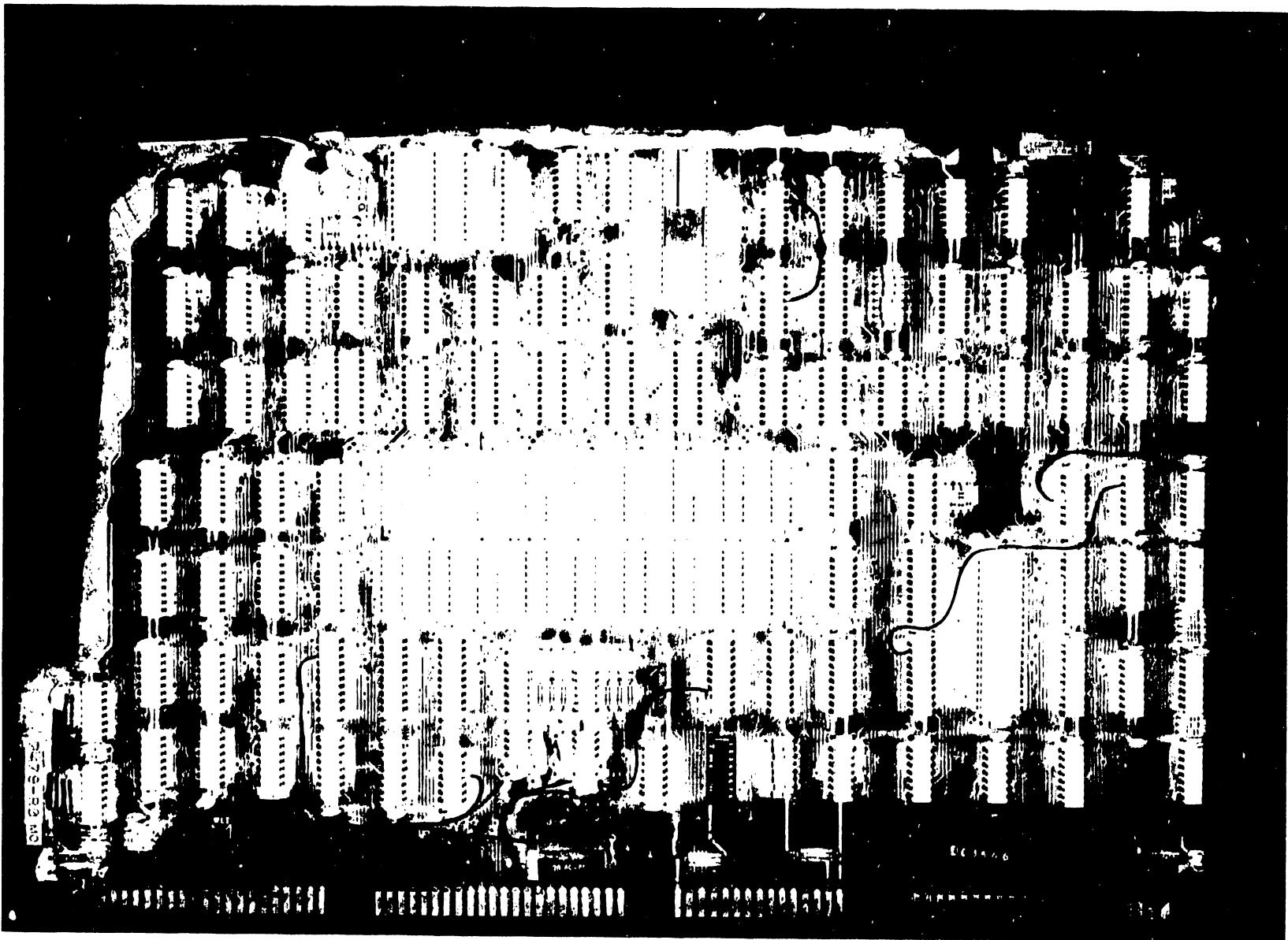
Figure 1-6. 210-7479 Enhanced Workstation Processor Board (WP)
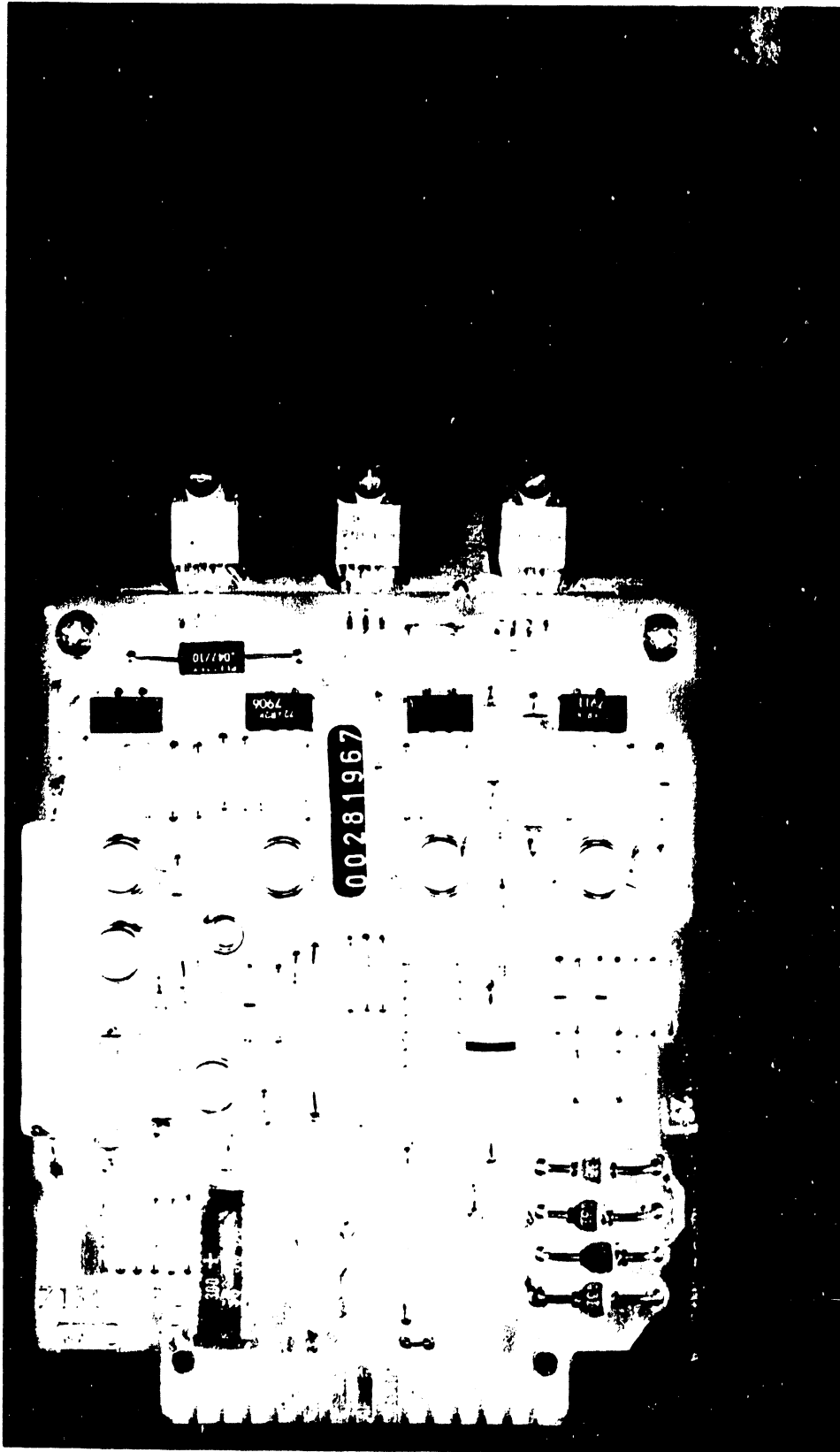
Figure 1-7. 210-7156 Power Supply Regulators Board

Figure 1-8.   210-7456 CRT Monitor Electronics Board

this board let the Customer Engineer set up the display circuits for optimum
presentation, offsetting component variability and/or performance degradation.

1.4 FUNCTIONAL DESCRIPTION

The addition of the 2246R Remote Workstation to the VS product line pro-
vides a telecommunications capability by which devices that are physically re-
mote from the VS system (with no real distance limitation) can access the VS
system. The 2246R Remote Workstation has been implemented in such a manner
that this device appears to the remainder of the VS system as if it were a lo-
cal device.

The terminal housing contains the CRT and keyboard, together with the con-
trol unit (and, optionally, a parallel printer interface to which a parallel
printer may be attached). Remote workstations communicate directly over a
telephone line to the 22V06 IOP in the VS system via modems. The stand-alone
nature of this unit eliminates the need to install an entire cluster control-
ler at each remote location at which only one terminal and possibly a printer
is required. Remote workstations may be used either in a point-to-point
(dial-up or leased line) or in a multipoint (leased-line) environment (see
Figure 1-9). In a point-to-point environment, each line will accommodate only
a single remote stand-alone workstation, whereas a multipoint environment al-
lows multiple remote workstations to share a single communications line.

A maximum of 32 workstations can be supported on a single VS system. Of
these 32 workstations, one must be designated as the system console (Worksta-
tion #0) and must be locally attached to the VS system, while the other 31 may
be any combination of local or remote workstations. Certain configuration re-
strictions exist, however, which can affect the actual number of devices sup-
ported. Each 22V06 IOP assembly supports a maximum of three communications
lines (each of which may connect to multiple Standalones/Clusters). There-
fore, the number of lines which may be allocated to Remote Workstations is de-
pendent upon the following three factors:

```
                                                  !--------------!
                                     !--------!    !    2246R      !
                                     ! MODEM  !......!   REMOTE    !
                                     ! (DCE)  !    ! STANDALONE    !
                                     !---*----!    ! WORKSTATION   !
                                         *         !------.------!
                                         *                .
                                         *                .
                                         *                .
!-----------!--------!    !--------!     *         !----.-----!
! VS CPU    ! 22V06  !.......! MODEM !****************!  PARALLEL !
! MAINFRAME ! IOP    !    ! (DCE)  !     *         !  PRINTER  !
!-----------!--------!    !--------!     *         !----------!
                                         *
                                         * (LEASED
                                         *   LINE)
                                         *
                                         *
                                         *         !--------------!
                                     !---*---!    !    2246R      !
                                     ! MODEM  !......!   REMOTE    !
                                     ! (DCE)  !    ! STANDALONE    !
                                     !--------!    ! WORKSTATION   !
                                                   !--------------!
```

Figure 1-9. Representative Multipoint Interface To VS Computer System

(1) Which model of 22V06 is ordered. The 22V06-1 IOP supports one com-
     munications line, the 22V06-2 IOP supports two communications lines
     and the 22V06-3 IOP supports three communications lines.

(2) The number of 22V06 IOP's that are ordered (as limited by the number
     of slots available in the system).

(3) The number of telecommunications protocols desired on the single VS
     system. Each emulation package (2780, 3270, etc) requires one or
     more separate lines.

To VS application programs, Remote Workstations look like local worksta-
tions. Remote Workstations thus can perform identical functions to those per-
formed by local workstations (but at a slower speed, because of the delays
associated with communications lines).

SECTION 2

SITE PREPAR-ATION

SECTION 2

SITE PREPARATION

2.1 GENERAL

     When a Wang Telecommunications System is delivered, it is not sufficient
merely to find floor space for the system components and to insert their power
plugs into an AC-power outlet. Some preparation is necessary to select a
suitable location for the system and to determine if the AC-power lines to be
used by the system are adequate, as well as to ensure that an appropriate mo-
dem and other associated hardware (e.g., data access arrangement equipment and
automatic calling unit) is installed simultaneously with or prior to the 2246R
Remote Workstation (and associated parallel printer, if applicable). The fol-
lowing paragraphs describe the ideal environment in which a Telecommunications
System should operate and the preparations necessary to meet the basic site
criteria. Selection and installation of the modem equipment must be separate-
ly arranged betweeen the customer and his local Telephone Company (or a pri-
vate vendor of the customer's choice). Acceptable modem units and customer
selection options are defined in Section 4, Installation & Initial Setup.

2.2 SELECTING A LOCATION

     The environment in which a Telecommunications System operates can greatly
affect its performance. An ideal location would be one in which:

     (1) Temperature and humidity are controlled.

     (2) Airborne dirt and contaminants are reduced to a minimum.

     (3) AC-power outlets are adequate, regulated, and noise free.

     (4) Sufficient room is available for future expansion.

Since such locations are difficult to find, the system often must be in-stalled in a less than desirable environment. In addition, the selected loca-tion should be one that is easily accessible to operating personnel. At the same time, however, it should be sufficiently removed from the main flow of traffic to prevent interference with the smooth operation of the Remote Work-station.

2.3 ENVIRONMENTAL CONSIDERATIONS

Once a location is selected, installation/user personnel should give some consideration to four environmental parameters: temperature, humidity, clean-liness, and the electrical environment.

2.3.1 TEMPERATURE CONSIDERATIONS

Temperature is the most important factor to consider, because it can vary greatly from day to day. The recommended operating temperature range is from $+65^{\circ}F$ to $+75^{\circ}F$, but the allowable range is from $+50^{\circ}F$ to $+90^{\circ}F$. Low outside temperatures are usually not a problem, because most locations never fall below the minimum temperature limit, even with air conditioning. If the system is used where temperatures go higher than the maximum high-temperature limit, however, component failure rates will drastically increase, resulting in costly downtime for the user.

If an air conditioning unit is already installed or if one is to be in-stalled, it is imperative that a separate power line be used. If a separate power line is not used, Telecommunications System errors can occur as a result of voltage-spike glitches when the air conditioner is in use.

2.3.2 HUMIDITY CONSIDERATIONS

Air conditioning is good for maintaining the proper temperature, but it also removes moisture and dust from the air, thereby lowering the humidity. If the system is installed in a carpeted room, this lower humidity operates in combination with the static generating capability of carpets and synthetic clothing to impart a static electrical charge to operating personnel. If the static-charged operator subsequently comes in contact with components of the

Telecommunications System, the resultant static discharge not only is uncomfortable but also can cause Telecommunications System malfunctions.

The recommended humidity range is from 40% to 60%, relative, but 20% to 80%, relative, is allowable (and the lower limit can be 10% or lower in heated buildings during very cold weather). Low humidity not only increases the certainty of static build-up, however, but also can cause oxide shed in data storage material. Humidifiers and dehumidifiers should be installed to increase or decrease the humidity as required.

If carpeting is to be installed, it should be a nonstatic variety. If carpeting already exists and is not a nonstatic variety, either that carpet must be treated with a non-static spray, or an electrically conductive mat must be installed to prevent a static charge build-up.

Carpets treated with non-static spray should be thoroughly cleaned before the first treatment, and they should be retreated at least once every three months, thereafter. If an electrically conductive mat is used, it should be installed under the system operating area and must be properly connected to an earth ground.

2.3.3 CLEANLINESS CONSIDERATIONS

Because most Wang equipment does not contain filters, dirt can accumulate rapidly on circuit boards and components. Dirt and grease form a film that prevents proper heat dissipation from components and can also create a leakage path for signals. Dirt also causes excessive mechanical wear in tape and disc drives and causes scratches in the oxide coating of storage material and on read/write heads.

To prevent unnecessary failures that might b e caused by dirt, all air conditioning, heating, and ventilating units should have air filters installed   These filters should be cleaned or replaced regularly. In areas where filters do not remove airborne dirt sufficiently, an electrostatic filter should be installed.

2.3.4 ELECTRICAL ENVIRONMENT CONSIDERATIONS

For most Wang Telecommunications Systems, a 20-ampere, 115-volt (60 hertz, single-phase) dedicated power line is adequate. System requirements dicate that this line must be regulated to within $\pm10\%$ and must be noise free. Wherever feasible, the system should have its own dedicated AC-power line. Wang systems also operate on 50-hertz power.

If the line is not regulated within the specified $\pm10\%$ limits, a constant voltage transformer should be installed. If the line is noisy, however, a detailed analysis of the problem must be performed to insure a correct solution.

Since computers and peripheral equipments are extremely susceptible to Electromagnetic Interference (EMI), the source of the EMI condition must be determined before a solution is proposed. EMI can enter the Telecommunications System by conduction along wiring and cabling or by direct radiation. If EMI sources (including office machines, air conditioning units, electric motors, machinery, and arc welders) are in close proximity to the Telecommunications System, EMI can enter by direct radiation. In such cases, the noise-generating device should be relocated, repaired, or filtered to prevent it from interfering with the Telecommunications System. If the source of the noise cannot be found, an EMI filter with a cut-off frequency near 10 kHz should be installed on the System's AC-power line. In all cases, be sure that the AC-power line has been properly installed in steel conduit and that the conduit is properly connected to junction boxes. Also, insure that other devices (including fluorescent lighting) are not connected to the dedicated AC-power line. In extreme cases, as when arc welders are used in the vicinity, it may also be necessary to shield the peripheral cables.

SECTION
3
UNPACKING &
INCOMING
INSPECTION

SECTION 3

UNPACKING & INCOMING INSPECTION

3.1 UNPACKING

The remote workstation device is packaged in a cardboard container with INSTAPACK for protection. To prevent internal damage to the cathode-ray tube, the printed-circuit boards are removed and taped across the front of the CRT screen The unpacking and accessing of each remote workstation unit is simplified by the use of the cardboard containers.

NOTE

Do not destroy the packing containers; the
INSTAPAK forms are ideal for any return ship-
ment to Wang Laboratories that might be re-
quired because of damage or malfunction.

3.2 INCOMING INSPECTION

1. Unpack and inspect each unit for possible shipping damage. Exercise extreme caution when unpacking each of the devices. Special attention should be given to the video display units. If any physical damage is discovered, report the damage to the shipping carrier immediately. In addition, the Home Office (traffic manager) should be notified of any discrepancies at the same time.

CAUTION

Exercise caution when removing the main
workstation cover to not damage either the
fan power cable or the CRT-screen
contrast/brightness control cable, both of
which are attached to that cover.

2. Remove the electrical circuit boards that are wrapped and taped on the front of the Remote Workstation CRT display screen.

3. Remove the keyboard cover by removing three #10-32 x 3/4" phillips fastening screws below program-function keys (see Figure 3-1) and then lifting keyboard cover away.

4   Remove the main cover by removing two #10-32 x 1" phillips fastening screws (one on each side of the base; see Figure 3-1), and then carefully lifting the workstation cover up and tilting it to the left for access to and disconnection of both fan cable and CRT brightness/control cable.
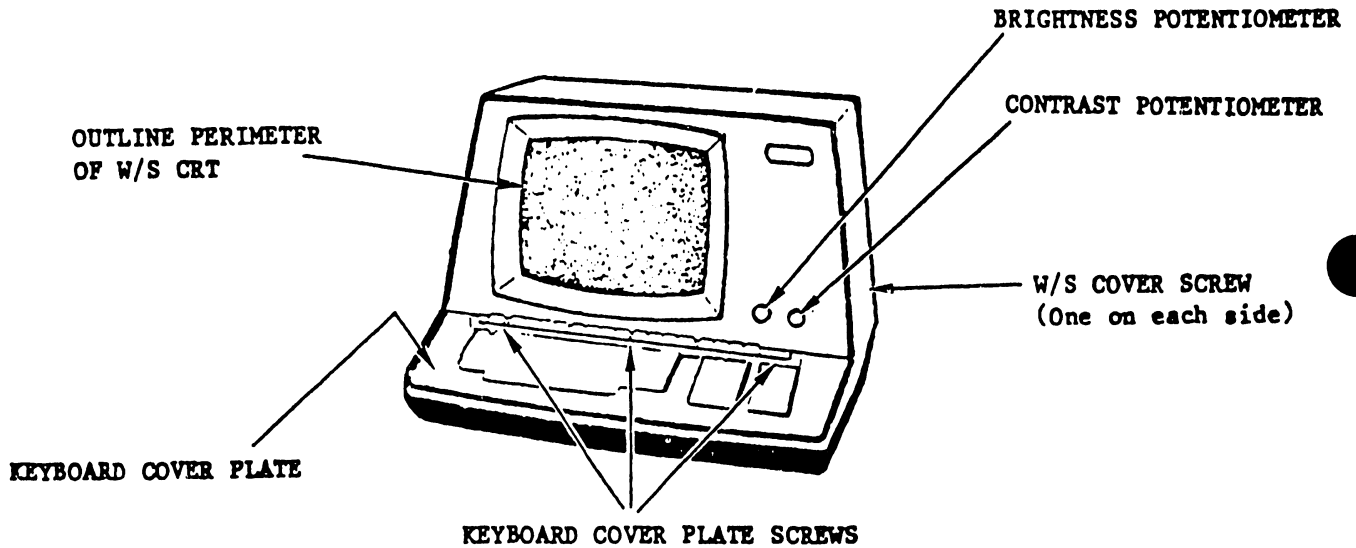
Figure 3-1. Removal of Covers From 2246R Remote Workstation

5. After removing the covers, unwrap and install the logic boards that were removed from the front of the screen. Plug the 210-7479 Workstation CPU board into the "CRT/CPU" location on the motherboard. Plug the 210-7478 TC/Memory board into the "MEM/DL" location on the motherboard.

NOTE

Do not replace the two covers until all
remote workstation installation checks are
successfully performed, as described in
Section 4, Installation & Initial Setup.

SECTION
4
INSTALLATION &
INITIAL SETUP

SECTION 4

INSTALLATION & INITIAL SETUP

4.1 GENERAL

   To simplify Telecommunications System installation, observe the following
procedure:

NOTE

The modems used both at the local location
(connected to the 22V06 IOP assembly in the
VS CPU Mainframe) and at the remote location
(connected to the 2246R Remote Workstation)
both must be compatible units of the same or
equivalent type.

1.   Check with Customer/Marketing representatives to ensure that the cus-
     tomer has ordered a correct modem and applicable options either from
     a local telephone company or from a private vendor. (For incorpora-
     tion of different options into specific modems, refer to requirements
     for that modem in Table 4-2, following.)

2.   After the customer has ordered the correct modem, plan to install the
     Telecommunications System on the same day that the modem is being in-
     stalled. The modem installer thus should be present at the time you
     check out the system, so that he can help you identify any modem or
     telephone line problems if they occur.

3.   Obtain the correct sign-on procedure and telephone number from the
     customer. Verify these by calling the data processing manager in
     charge at the applicable VS system location.

4.2 SYSTEM REQUIREMENTS

The minimum system requirements to equip the VS computer system with a 2246R Remote Workstation having Binary Synchronous Communications (BSC, commonly called "bisync") capabilities are as follows:

A. FOR REMOTE MODEM CONNECTION:

   1. VS software Operating System, release 4.03 (or later), installed.

   2. One or more 22V06-1/-2/-3 Telecommunications Input/Output Processor (TC IOP) assembly (WLI 177-22VS-61/-62/-63, as applicable), installed and connected to an applicable system-end modem, with the following updates in place:

      a. The 210-7426 TC IOP Motherboard must be updated with new firmware, as follows:

         (1) PROM release 378-4049R1 in logic-chip location L49.

         (2) PROM release 378-4050R1 in logic-chip location L50.

      b. The 210-7426 TC IOP Motherboard must be E-REV level 4 or higher -- i.e., CSNL #128 (22V06 IOP's #2) installed).

   3. A 2246R Remote Workstation (WLI #187-2246-R).

   4. A 12-foot, RS-232-C (25-pin) compatible, telecommunication cable (WLI #220-0113).

   5. A remote-end modem (and any applicable ACU or DAA equipment, depending on customer's needs), matched to the VS system modem attached to the 22V06 IOP.

B. FOR DIRECT/LOCAL CONNECTION:

   1. All of the above items except the remote-end modem.

2.   An additional 12-foot, RS-232-C (25-pin) compatible, telecommunica-
     tions cable (WLI #220-0113).

3.   A Model 2228N Null Modem (WLI #177-2228N)

4.3 MODEM REQUIREMENTS

                              NOTE

          Ordering a modem for a Wang customer is not
          the responsibility of a Wang Salesman, and
          the installation of a modem and/or its vari-
          ous option selections is not the responsibil-
          ity of a Wang Customer Engineer.

The controller conforms to the nationally recognized EIA RS-232-C standard
and to the internationally recognized CCITT V.24 standard for voltage levels
and pin connections (refer to Product Service Teleprocessing Guide, page 76).
The signal polarity and the voltage of driven and detected signals are as fol-
lows:

Logic Level	Applied Voltage	Detected Voltage
"0" (ON, or "Spacing")	+8V	+3V to +25V
"1" (OFF, or "Marking")	-8V	-3V to -25V

     Table 4-1 lists RS-232-C 25-pin connector pin assignments, giving both EIA
and CCITT designations for the circuit associated with each pin. That table
also includes standard signal descriptions and sources for each designated
signal. The modem (or data set) used with the system may be either rented
from the telephone company or purchased from any one of several modem ven-
dors. The modems used at both ends of a communications line must be compati-
ble. If a BELL 201C type modem is used at one end, for example, another BELL
201C or equivalent must be used at the other end (not a 201A, 208B, 202C, or
202S). Table 4-2 lists the nominal Bell modems and their associated option
choices, and Table 4-3 lists the nominal Automatic Calling Units (ACU's) asso-
ciated with those modems (In both cases, equivalent units may be used).

     In either case, employees of the local telephone company must connect the
modem to the telephone network through a Data Access Arrangement (DAA) unit
installed by the telephone company. The DAA unit consists of a telephone

handset and a modem interface rented from the telephone company. Table 4-4
lists the nominal types and their respective options. Since a modem or DAA
unit usually is permanently wired to a wall, both should be installed as close
as possible to the associated Remote Workstation.

Table 4-1. RS-232-C Connector Pin Assignments

PIN	EIA	CCITT	SIGNAL DESCRIPTION	SOURCE
1*	AA	101	Protective Ground	2246R
2*	BA	103	Transmitted Data	Modem
3*	BB	104	Received Data	2246R
4*	CA	105	Request to Send	Modem
5*	CB	106	Clear to Send	Modem
6*	CC	107	Data set Ready	
7*	AB	102	Signal Ground	Modem
8*	CF	109	Received Line Signal Detector	Modem
9				
10				
11*	SCA	120	Secondary Request to Send	2246R
12*	SCF	122	Secondary Rec'd Line Sig. Det.	Modem
13	SCB	121	Secondary Clear to Send	Modem
14	SBA	118	Secondary Transmitted Data	2246R
15*	DB	114	Trans. Signal Element Timing	Modem
16	SBB	119	Secondary Received Data	Modem
17*	DD	115	Receive Signal Element Timing	Modem
18		124	Select Frequency Groups	2246R
19*	SCA	120	Secondary Request to Send	2246R
20*	CD	108.2	Data Terminal Ready	2246R
21	CG	110	Signal Quality Detector	Modem
22	CE	125	Ring Indicator	Modem
23	CH/CI	111/112	Data Signalling Rate Selector	2246R/Modem
24	DA	113	Trans. Signal Element Timing	2246R
25			Unassigned	

---

*Asterisked signals are used by the 2246R Workstation.

4.4 INSTALLATION

     The following subparagraphs give installation procedures for each of two
configurations: the full remote modem application (para. 4.4.1) and a direct/
local application (para. 4.4.2).

4.4.1 INSTALLATION FOR REMOTE MODEM CONNECTION

1. Connect one end of the supplied RS-232-C TC cable (WLI #220-0113) to
    the Remote Workstation's RS-232-C 25-pin connector (located in lower
    right-hand corner on rear base panel).

2   Connect the other end of that same RS-232-C cable to the modem con-
    nector labeled "CUSTOMER EQUIPMENT" (refer to Figure 4-1, lower
    right-hand corner).

3. If a parallel printer is to be included at the given site, plug the
    free end of its interconnection cable into 36-pin connector in center
    of base panel on rear of Remote Workstation (see Figure 4-1, upper
    right-hand corner).

4. Connect the modem and remote workstation power cords to appropriate
    power-service outlets, and then set their power switches ON.

4.4.2 INSTALLATION FOR DIRECT/LOCAL CONNECTION

                              NOTE

          The 2228N Null Modem must be connected as in-
          dicated in the following steps (see Figure
          4-2). This device has definite polarity and
          will not operate if cabling is incorrect.
          (For internal circuit details of the 2228N
          Null Modem, refer to the 2228N schematic in
          Section 12.)

```
!------------!                                  RS-232-C      !-------------!
! VS  CPU    !              !--------!          CABLE         !   2246R     !
! MAINFRAME  !              ! MODEM  !........................!  REMOTE     !
!-!--------!-!              ! (DCE)  !                         ! STANDALONE  !
  ! 22V06  !               !----*--!                          ! WORKSTATION !
  !  IOP   !                    *                              !------.------!
  !---.---!                     *                                   .
      .                         *                                   .(PRINTER
      . RS-232-C                *                                   .  CABLE)
      . CABLE                   *                                   .
      .                         *                              !----.-----!
  !---.---!   (LEASED LINE)     *                              ! PARALLEL !
  ! MODEM !********************* *                              ! PRINTER  !
  ! (DCE) !                     *                              !----------!
  !-------!                     *
                                *
                                *
                                *
                                *                RS-232-C      !-------------!
                                *                 CABLE         !   2246R     !
                            !----*--!                          !  REMOTE     !
                            ! MODEM !........................!  REMOTE     !
                            ! (DCE) !                         ! STANDALONE  !
                            !-------!                          ! WORKSTATION !
                                                              !-------------!
```

Figure 4-1. Representative Remote (Multipoint) Interface To VS System

```
!------------!              !--------!          RS-232-C      !-------------!
! VS  CPU    !              ! 2228B  !          CABLE         !   2246R     !
! MAINFRAME  !              ! NULL   !........................!  REMOTE     !
!-!--------!-!              ! MODEM  !                         ! STANDALONE  !
  ! 22V06  !               !----.--!                          ! WORKSTATION !
  !  IOP   !                    .                              !------.------!
  !-.---.-!                     .                                   .
    `.   .    RS-232-C          .                                   .(PRINTER
    .   .     CABLE             .                                   .  CABLE)
    .   ..................       .                                   .
    .                           .                              !----.-----!
    .                           .                              ! PARALLEL !
    . RS-232-C                  .                              ! PRINTER  !
    . CABLE                     .                              !----------!
    .                           .
    .                           .
    .                    !-------!           RS-232-C      !-------------!
    .                    ! 2228N !            CABLE         !   2246R     !
    ..............!      NULL !............................!  REMOTE     !
                     ! MODEM !                              ! STANDALONE  !
                     !-------!                              ! WORKSTATION !
                                                           !-------------!
```

Figure 4-2. Representative Local (NULL-Modem) Interface To VS System

1. Connect one end of the supplied RS-232-C TC cable (WLI #220-0113) to
    the "Modem" connector on the 22V06 IOP assembly, and then connect the
    other end of that same cable to the connector on the end of the 2228N
    Null Modem assembly that bears the "2228N" label.

2. Connect one end of the second supplied TC cable to the other side of
    the 2228N Null Modem assembly, and then connect the other end of that
    same cable to the Remote Workstation's RS-232-C 25-pin connector (lo-
    cated in lower right-hand corner on rear base panel)

3. If a parallel printer is to be included at the given site, plug the
    free end of its interconnection cable into 36-pin connector in center
    of base panel on rear of Remote Workstation (see Figure 4-2, upper
    right-hand corner).

4. Connect the remote workstation power cord to an appropriate power-
    service outlet, and then set its power switch on.

3. Perform on-line remote workstation diagnostic tests if available (re-
    fer to Section 8).

Table 4-2. Modem Customer Options

A. Customer Options for Bell 201A Modem

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. EIA Interface	A1	
	2. Contact Interface		
B	3. With Alternate Voice	B3	This option is required for operation with the dial-up network (allows for voice communications)
	4. Without Alternate Voice		
C	5. New Sync Used	C6	
	6. New Sync Not Used		
D	7. Half-Duplex (2-wire)	D7	This option is required for operation with the dial-up network
	8. Full-Duplex (4-wire)		
E	9. 4-wire Continous Carrier		If D7 was choosen, no E decision is made. E9 is the normal option for point to point, 4-wire connections. For the E9 option, indicate a CLEAR-TO-SEND delay of either 0 ms or 7 ms.
	10. 4-wire Carrier Controlled		

Table 4-2. Modem Customer Options (Continued)

B. Customer Options for Bell 201C Modem (Private Line)

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. Transmitter Timing Internal	A1	
	2. Customer-Selected Timing Options		
B	3. New Sync _Not_ Used	B3	
	4. New Sync Used		
C	5. Switched Carrier Operation	C6	This option is needed for 4-wire point-to-point connections. For this C6 option, select one of the following suboptions for CLEAR-TO-SEND delay: (C6a) 1. 4-wire, 7 ms 2. 4-wire, 0 ms
	6. Continuous Carrier Operation		For the C5 option, select one of the following suboptions for CLEAR-TO-SEND delay: (C5a) 1. 4-wire, 7 ms 2. 2-wire, 150 ms
D	7. Continuous RECEIVER BIT CLOCK - IN	D8	
	8. Continuous RECEIVER BIT CLOCK - OUT		
E	9. EIA Interface Pin 18 Initiates Local Analog Loopback	E9	
	10. EIA Interface Pin 18 Provides RECEIVE SYMBOL CLOCK		
F	11. Factory-Furnished EIA Interface and Ground Options	F12	With F12, select the suboptions listed below: F12a1 (DATA-SET-READY _on_ during local analog loopback)
	12. Customer-Selected EIA Interface and Ground Options		F12b1 (Frame ground connected to signal ground)

Table 4-2. Modem Customer Options (Continued)

C. Customer Options for Bell 201C Modem (Switched Telephone Network)

DECISION		OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1.	Transmitter Timing Internal	A1	
	2.	Transmitter Timing External		
B	3.	Automatic Answer Not Provided	B4	
	4.	Automatic Answer Controlled by Data Terminal Ready (DTR)		
C	5.	Ring Indicator on EIA Interface Pin 22	C5	
	6.	Ring Indicator Contact Closure on EIA Interface Pins 22 and 23		
D	7.	Continuous RECEIVER BIT CLOCK - IN	D8	
	8.	Continuous RECEIVER BIT CLOCK - OUT		
E	9.	EIA Interface Pin 18 Initiates Local Analog Loopback	E9	
	10.	EIA Interface Pin 18 Provides RECEIVE SYMBOL CLOCK		
F	11.	Signal and Frame Gound Connected	F11	
	12.	Signal and Frame Ground Not Connected		

Table 4-2. Modem Customer Options (Continued)

D. Customer Options for Bell 208A Modem

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. Transmitter Timing Internal	A1	
	2. Transmitter Timing External		
B	3. Continuous Carrier	B3	Normal option for point-to-point connection. Use B4 if multipoint.
	4. Switched Carrier		
C	5. Switched REQUEST-TO-SEND	C6	If B4 is selected (multi point), C5 must also be selected for proper opera tion.
	6. Continuous REQUEST-TO-SEND		
D	7. One-Second Holdover Is Used	D7	The D7 option is preferred if B3 was selected; other-wise, use option D8.
	8. One-Second Holdover Not Used		
E	9. New Sync Is Used	E10	
	10. New Sync Not Used		
F	11. DATA SET READY (CC) Lead On in Analog Loopback Test Mode	F11	
	12. DATA SET READY (CC) Lead Off in Analog Loopback Test Mode		

Table 4-2. Modem Customer Options (Continued)

E. Customer Options for Bell 208B Modem

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. Transmitter Timing Internal	A1	
	2. Transmitter Timing External		
B	3. Without 801 Automatic Calling Unit	B3	Select B4 if auto-calling is required (requires interface adapter).
	4. With 801 Automatic Calling Unit		
C	5. DATA SET READY (CC) Off When AL Pressed	C6	
	6. DATA SET READY (CC) ON When AL Pressed		
D	7. Without Automatic Answer	D8	
	8. With Automatic Answer (Permanent)		
E	9. Desk Mounting	E9	Option E10 requires mounting brackets.
	10. Rack or Cabinet Mounting		

Table 4-2. Modem Customer Options (Continued)

F. Customer Options for Bell 209A Modem

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. Transmitter Timing Internal	A1	
	2. Transmitter Timing External		
B	3. DATA SET READY Interface Lead On in Analog Loopback Mode	B3	
	4. DATA SET READY Interface Lead Off in Analog Loopback Mode		
C	5. Transmit Timing Slaved to Receive Timing	C6	Normal option for point to point connection.
	6. Transmit Timing Is Not Slaved to Receive Timing		
D	7. Elastic In	D8	Normal option for point to point connection.
	8. Elastic Out		
E	9. Continous Carrier (Decision F Is Required)	E9	Normal option for 4-wire point to point connection
	10. Switched Carrier (Decision F Is Not Required)		
F	11. Switched REQUEST-TO-SEND	F12	If E10 is selected, F11 becomes automatically selected.
	12. Continuous REQUEST-TO-SEND		

Table 4-2. Modem Customer Options (Continued)

G. Customer Options for Bell 212A Modem

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. Factory-Supplied Disconnect Options	A1	
	2. Customer-Selected Disconnect Options		
B	3. Automatic Answer (<u>Yes</u>)	B3	
	4. <u>No</u> Automatic Answer		
C	5. Factory-Supplied EIA Interface and Ground Options	C5	
	6. Customer-Selected EIA Interface and Ground Options		
D	7. Factory-Supplied Dual Mode	D8	Select D8 and the below-listed sub-options for dual-mode 1200-bps synchronous or 300-bps asynchronous operation:
	8. Customer-Selected Modes Of Operation		
			D8a2 (1200-bps synchronous operation)
			D8c1 (transmitted timing internal)
			D8d2 (dual-speed mode)
			D8e1 (receiver responds to digital loop IN)
			D8f2 (interface speed indicator OUT)
E	9. Make-Busy/Analog Loop (CN) Circuit Enabled (<u>In</u>)	E10	
	10. Make-Busy/Analog Loop (CN) Circuit Disabled (<u>Out</u>)		

Table 4-3. Automatic Calling Unit (ACU) Customer Options

A. Customer Options for Bell 801A ACU (Rotary Dialer)

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. EIA Voltage Interface	A1	
	2. Contact Interface		
B	3. Call Terminated Via ACU After Data Set Status (DSS) On	B4	
	4. Call Terminated Via Data Set After Data Set Status (DSS) On		
C	5. Abandon-Call-and-Retry (ACR) Timer Is Stopped After DSS On	C5	
	6. Abandon-Call-and-Retry (ACR) timer Is Not Stopped After DSS On		
D	7. End-of-Number Signal From Customer Terminal	D8	If D7 option is used, no E decision is needed.
	8. No End-of-Number Signal From Customer Terminal		
E	9. ACU Answer-Tone Detection	E9	
	10. Data Set Answer-Tone Detection		

Table 4-3. Automatic Calling Unit (ACU) Customer Options (Continued)

B. Customer Options for Bell 801C ACU (Touch Tone Dialer)

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. 2-wire	A1	Normal option for switched telephone network.
	2. 4-wire		
B	3. Call Terminated Through ACU	B4	
	4. Call Terminated Via Data Set After Data Set Status (DSS) On		
C	5. Abandon-Call-and-Retry (ACR) Timer Stopped After Data Set Status On	C5	
	6. Abandon-Call-and-Retry (ACR) Timer Is Not Stopped After DSS On		
D	7. End-of-Number Signal From Customer Terminal	D8	If D7 option is used, no E decision is 9.
	8. No End-of-Number Signal From Customer Terminal		
E	9. ACU Answer-Tone Detection	E9	
	10. Data Set Answer-Tone Detection Without End-Of-Number (EON)		
F	11. Loop Start	F12	
	12. Ground Start		

Table 4-4. Data Access Arrangement (DAA) Customer Options

A. Customer Options for Bell 1000A (CDT) DAA: NONE

B. Customer Options for Bell 1001A and Bell 1001F (CBS) DAA's

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. With Customer-Provided Power	A2	Option A1 is provided
	2. With Telephone CompanyProvided Power		
B	3. EIA - RS-232-B Interface	B4	Option B4 is provided only with 1001F.
	4. EIA - RS-232-C Interface		
C	5. With Associated Telephone Set	C5	Option C5 is used with switched telephone network. If C6 is used, no further decisions are required.
	6. Without Associated Telephone Set		
D	7. Coupler Controls Line	D8	Option D8 is for manual operation, and option D7 is for automatic operation
	8. Telephone Set Controls Line		
E	9. Ringer Connected On Telephone Set Side of Exclusion Key	E10	With option E9, no audible ring is heard. With option E10, an audible ring is heard until the modem answers the call.
	10. Ringer Connected on Line Side of Exclusion Key		

Table 4-4. Data Access Arrangement (DAA) Customer Options (Continued)

C. Customer Options for Bell 1000B and Bell 1001D (CBT) DAA's

DECISION	OPTION	OPTION REQUIREMENT WITH 2246R	COMMENTS
A	1. With Telephone	A1	Option A1 is used with switched telephone network. If A2 is used, no further decisions are required.
	2. Without Telephone		
B	3. DAA Controls Line	B4	Option B4 is for manual operation and option B3 is for automatic operation
	4. Telephone Set Controls Line		
C	5. Ringer Connected On Telephone Set Side Of Exclusion Key -- Only DAA Rings	C6	
	6. Ringer Connected On Line Side of Exclusion Key -- Both DAA (Ring Indicator) and Telephone Ring		
D	7. Ringer Connected On Telephone Set Side of Exclusion Key -- If Exclusion Key Is Down, Only Telephone Rings; If Exclusion Key Is Up, Only DAA Rings (Ring Indicator)	D8	
	8. Ringer Connected On Line Side of Exclusion Key -- If Exclusion Key Is Down, Only Telephone Rings; If Exclusion Key Is Up, Both DAA (Ring Indicator) and Telephone Set Ring		

SECTION 5

WORK-STATION PROTOCOL

SECTION 5

WORKSTATION PROTOCOL

5.1 GENERAL

This section defines the VS system's remote-device protocol, as implemented within the initial test-site release of the 2246R Remote Workstation and the microcode support for its companion 22V06-series IOP controller. The communications architecture is layered into a link protocol and a device protocol. This layering allows independent enhancement of each layer, as applicable.

The link protocol is multipoint transparent mode bisync, using EBCDICcoded transmission-control characters. The link protocol supports all standard transmission speeds up to 9600 bits/second.

Device protocol messages are blocked for transmission, using data-link escape (DLE), end-of-intermediate transmission block (ITB) separation and conversational-reply formats. The system polls sites, rather than individual devices.

The initial test-site release of the remote device support software contains a single round-robbin polling loop. Nonresponding sites are polled during each cycle of the loop.

All data messsages are transmitted without compression.

The device protocol is similar to the control protocol of locally-attached devices. Input/output command word (IOCW), device microcode, and device data messages are transmitted from the VS computer to the remote device. Device data and input/output status word (IOSW) messages are transmitted from the remote devices to the VS computer.

In the following discussion, the 22V06 IOP assembly is referred to as the
"host controller" and the 2246R Remote Workstation controller is referred to
simply as the "remote controller." The discussion uses slightly-modified
Backus-Naur Format (BNF) telecommunications-protocol notation, as defined in
Table 5-1.

<div align="center">NOTE</div>

> For the reader's convenience, Table 5-1 and
> the much-referenced format-description tables
> which follow it are placed at the end of this
> section. One predominant modification of the
> standard BNF notation system is that the
> angle-bracket symbols normally used to set
> off software entities are not available in
> the character set used by the equipment pro-
> ducing this book; consequently, this discus-
> sion substitutes asterisks for those brackets
> (see TAble 5-1).

5.2 LINK PROTOCOL

The link protocol employs data-link sequences defined in Tables 5-2 and
5-3. The sequences follow multipoint bisync conventions, with the host play-
ing the primary role and the remote playing the secondary role.

The data link is the medium that interconnects a group of remote devices
with the host controller. Figure 5-1 shows a representative data link setup,
including the line, line drop connections, modems, and a modem sharing unit.
The effect of a modem sharing unit is to make several remote devices connected
to a single modem appear as if they were individually dropped. Each of the
remote devices in the illustrated configuration would be addressed as a unique
site. If the data link configuration included a dial-up line with more than
one remote connected through a modem sharing unit to a single modem, each such
remote also would be addressed as a unique site.

5.2.1 POLLING

Whenever the host controller has no data to transmit and is not engaged in
transmission or reception of a message, it transmits a *poll sequence* to a
remote site on one of its polling lists, inviting the remote controller to
send data.

```
                    !--------!     !--------!     !--------!     !--------!
            !-------! REMOTE !     ! REMOTE !     ! REMOTE !     ! REMOTE !
            !       !  #2    !     !  #3    !     !  #4    !     !  #5    !
            !       !---!----!     !---!----!     !---!----!     !---!----!
     !----!-----!      !                !            !             !
     ! PARALLEL !      !                !-----!     !-----!         !
     ! PRINTER  !      !                     !     !     !          !
     !----------!      !---------------!     !     !     !---------------!
                                       !     !     !     !
                                       !     !     !     !
                                    !--!----!----!----!--!
     !------!     !--------!        !      MODEM        !
     ! HOST !     ! REMOTE !--------!      SHARING      !
     !      !     !  #1    !        !      UNIT         !
     !--!---!     !---!----!        !----------!--------!
        !             !                        !
        !             !      !----!-----!      !
     !-------!     !-------!  ! PARALLEL !   !-------!
     ! MODEM !     ! MODEM !  ! PRINTER  !   ! MODEM !
     !---!---!     !---!---!  !----------!   !---!---!
         !             !                         !
         !             !                         !          TO OTHER
     !-------------!-------------------------------!----------------DEVICES
           LINE DROP                     LINE DROP          (IF ANY)
```

Figure 5-1.   Typical Data-Link Configuration.

Upon receiving a *poll sequence* containing its site address, as defined by the five low-order bits of the device-options switches on the applicable remote controller board (L44 on the 210-7478 TC/Memory board), the corresponding remote controller responds in one of two ways:

1.   An *EOT sequence* if that controller currently has no data to send, or

2.   A *text block* if that controller curently has one or more device protocol messages queued for transmission.

5.2.2   SELECTION

Whenever the host controller has data to transmit to a remote device (and is not currently engaged in transmission or reception of a message), it transmits a *select sequence* to the remote site, requesting permission to send data.

Upon receiving a *select sequence* containing its site address, the remote controller responds in one of two ways:

1. A *NAK sequence* if that controller currently does not have sufficient buffer space for the largest allowable data block, or

2. An *ACKO sequence* if that controller currently has sufficient buffer space for the largest allowable data block.

5.2.3 FLOW CONTROL

Receive flow control is accomplished in the conventional manner, using a *WACK sequence*. Whenever a receiver (in the host controller or or any remote controller) correctly receives a *text block* but does not possess sufficient buffer space to receive another one, that receiver waits for a 2-second delay period and then transmits a *WACK sequence* requesting an affirmative acknowledgement.

TTD transmit flow control is not used. When a transmitter (in the host controller or any remote controller) receives an affirmative acknowledgement and does not contain any further data block(s) to transmit, that transmitter terminates the transmission with an end-of-transmission *EOT sequence*.

5.2.4 MESSAGE BLOCKING

One or more device protocol messages are blocked together within a *text block*. The transmission block uses transparent mode transmission with DLE insertion and with DLE ITB separation of messages for data transparency. Each block is a transmission message and ends with the DLE end-of-text (ETX) character. The DLE end-of-transmission-block (ETB) character is not used.

5.2.5 CONVERSATIONAL REPLY

Conversational replies (a *text block* transmitted in reply to another *text block*) may be used by either the host controller or any remote controller, provided that two consecutive conversational replies do not occur.

5.2.6 REVERSE INTERRUPT

The bisync reverse-interrupt feature (RVI) is not used.

5.2.7 TIMEOUTS

Standard 3-second timeouts are used for detection of no-reply conditions.
Standard 2-second timeouts are used for detection of flow slowdown or trans-
mission of a *WACK sequence*.

5.2.8 ERROR RECOVERY

Text blocks contain 16-bit cyclic redundancy check characters (using the
polynomial, $x^{**}16 + x^{**}15 + x^{**}2 + 1$), which are used by the receiver to de-
tect errors. If a CRC error is detected, the receiver transmits a *NAK se-
quence*, requesting retransmission of the same message block.

5.3 DEVICE PROTOCOL

The device protocol employs the messages defined in Tables 5-4 and 5-5,
using the notation defined in Table 5-1. This protocol uses the same standard
VS device-control procedures used for the support of locally attached devices.

The VS Operating System and/or the given system's application program,
which generally are referred to indiscriminately in the following discussion
as the "host program" without separate distinction, participate in three lev-
els of communications interchanges:

1. With the 22V06 TC IOP (referred to in the following discussion as the
    "host controller").

2. With (through that host controller and the intervening modem lines)
    the 2246R Remote Workstation's 210-7478 TC/Memory board (referred to
    in the following discussion as the "remote controller").

3. With (through that remote controller) the 2246R Remote Workstation's
    210-7479 Workstation CPU board and associated CRT-control circuits
    (collectively referred to in the following discussion as the "remote
    device").the he host controller and any remote controller.

5.3.1 HOST-PROGRAM/HOST-CONTROLLER INTERCHANGES

5.3.1.1 Loading Host Controller Microcode

The VS Operating System (i.e., the host program) is responsible for load-
ing the host controller's data-link processor's microcode. The data-link pro-
cessor's microcode is loaded piecemeal, each separate piece being handled by a
respective CONTROL-I/O *LOAD-22V06 command*. The data area pointed to by the
command contains a memory image of the specific microcode piece to be loaded
into the host controller's data-link processor's memory at the "current ad-
dress" (maintained as a state variable by the bus-processor portion of the
host controller). Initially, the current-address value is zero. Whenever a
LOAD-22V06 command is executed, the current-address value becomes incremen-
ted by the length (byte count) of the applicable data area. When all micro-
code pieces have been loaded, the data-link processor is started by a
CONTROL-I/O *START-22V06 command*.

5.3.1.2 Loading Polling List

The host program also is responsible for loading a polling list into the
host controller. Each polling list entry is loaded by an individual CONTROL
I/O *VS LOAD-POLL-LIST command*. The data area pointed to by the command con-
tains a 4-byte poll list entry for a specific device. The host controller up-
dates its polling list table and then issues a VS IOSW to the host program,
terminating the command.

Subsequent host program commands to the device are issued to the same VS
device address as was the *VS LOAD-POLL-LIST command* for that device.

5.3.2 HOST-PROGRAM/REMOTE-CONTROLLER INTERCHANGES

5.3.2.1 Loading Remote Device Microcode

    Device microcode is down-loaded into Remote Workstations by the VS host
program in a manner that is similar to that in which local 928-type serially-
attached devices are loaded. The host program first loads a device memory
image in piecemeal fashion by a *VS LOAD-DEVICE command* sequence. The Remote
Workstation device then is started up by a *VS START-DEVICE command* to oper-
ate on the down-loaded program.

5.3.2.1.1 LOAD-DEVICE Command

    The host program loads a piece of microcode into a Remote Workstation by
means of a CONTROL-I/O *VS LOAD-DEVICE command*. The data area pointed to by
that command contains a memory image of the desired device microcode piece.
Figure 5-2 diagrams typical data-link communications activity for the *LOAD-
DEVICE command* sequence.

REMOTE CONTROLLER ACTIVITY   HOST CONTROLLER ACTIVITY

                                   <------- *select sequence*
          ACKO sequence ------->
                                          LOAD-DEVICE command and
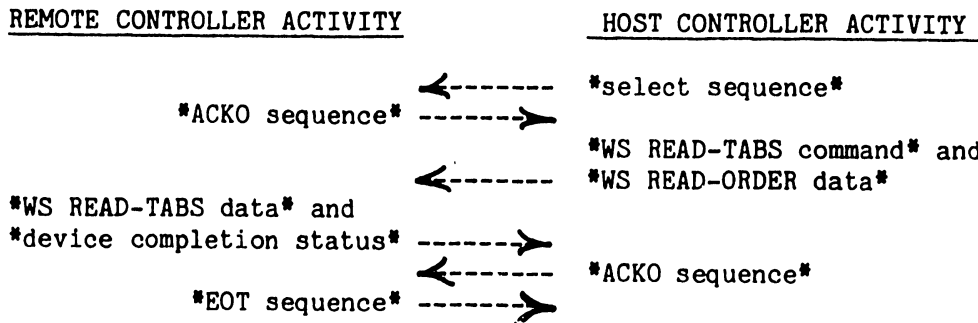   <------- *device microcode data*
      load complete status ------->
                                   <------- *ACKO sequence*
            EOT sequence ------->
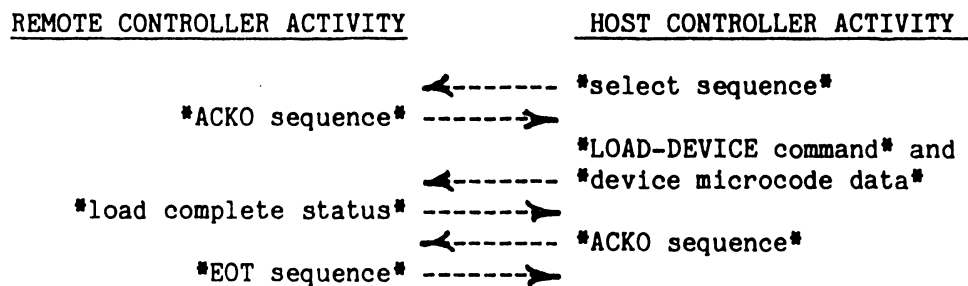
    Figure 5-2. Data Link Handshaking for *LOAD-DEVICE Command* Sequence

    The host controller first establishes communication with the applicable
remote device and then creates and queues for transmission both a *LOAD-DEVICE
command* message and a *device microcode data* message. (For format details
of these output messages, refer to Table 5-4.)

The host link protocol mechanism transmits the messages, normally blocked
together, to the remote site, where they are processed by the remote control-
ler. The remote controller loads the microcode piece into the remote device's
memory at the "current" address, an initially-zero state variable that is
maintained by the remote controller and becomes incremented by the data length
of each stored message. If no device errors are detected during this loading
process, the remote controller creates a *load complete status* message and
queues it for transmission. If any device error is detected, however, the de-
vice controller creates and queues a *load error status* message. (For format
details of these input messages, refer to Table 5-5.)

The remote controller's link protocol mechanism normally transmits the
message to the host controller as a bicync conversational reply. The host
controller extracts a VS IOSW from that message and then passes the IOSW data
to the host program, thereby completing the *LOAD-DEVICE command*.

5.3.2.1.2 START-DEVICE Command

After all applicable microcode pieces have been loaded, the host control-
ler starts the remote device by transmitting a CONTROL-I/O *VS START-DEVICE
command*. Figure 5-3 diagrams typical data link handshaking activity for the
START-DEVICE command sequence.

<pre>
    REMOTE CONTROLLER ACTIVITY   HOST CONTROLLER ACTIVITY

                              <-------- *select sequence*
        ACKO sequence ------->
                              <------- *START-DEVICE command*
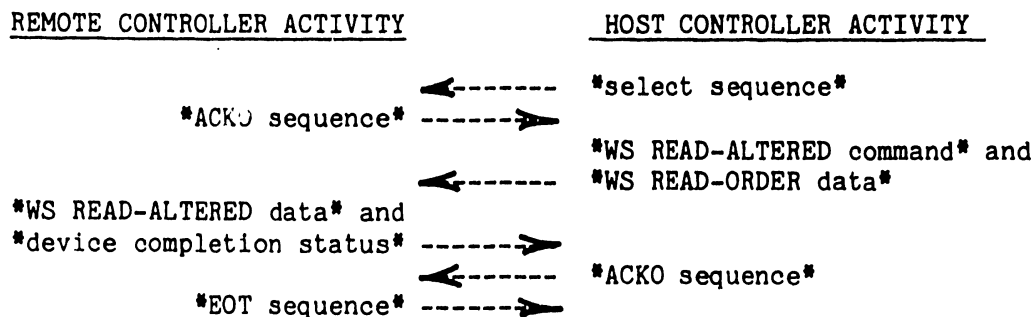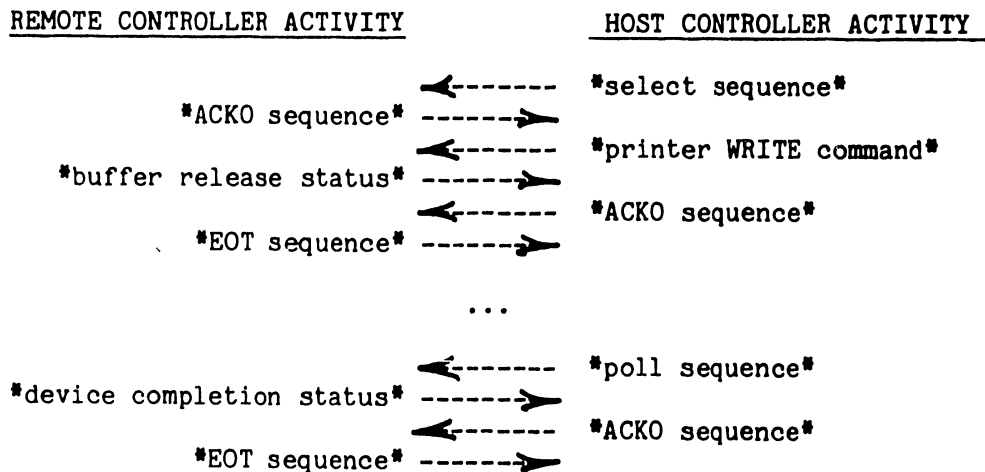 *load complete status* ------->
                              <------- *ACKO sequence*
        EOT sequence ------->
</pre>
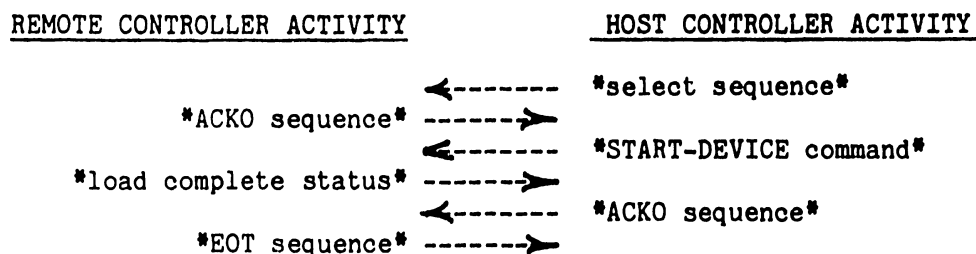
        Figure 5-3. Data Link Handshaking for *START-DEVICE Command* Sequence

The host controller first establishes communication with the selected Remote
Workstation and then creates a *START-DEVICE command* (refer to Table 5-4 for
format details) and queues it for transmission to the remote site by the host
link protocol mechanism. When the remote controller processes the received

command, the current-address value becomes reset to zero and the remote device
becomes started up. If no device errors are detected during this processing
sequence, the remote controller creates a *load complete status* message and
then queues that message for transmission. If any device error is detected,
however, the device controller creates and queues a *load error status* mes-
sage. (For format details of these input messages, refer to Table 5-5.)

The remote controller's link protocol mechanism normally transmits the
message to the host controller as a bisync conversational reply. The host
controller extracts a VS IOSW from the message and then passes the IOSW data
to the host program, thereby completing the command.

5.3.3 HOST-PROGRAM/REMOTE-DEVICE INTERCHANGES

5.3.3.1 Host-Initiated Commands to Remote Workstations

5.3.3.1.1 Workstation WRITE Command

The host program writes a portion of a screen image to a remote device by
a START-I/O *VS WS WRITE command*. The data area pointed to by the command
contains a 4-byte "order area" that is followed by the screen image piece.
Figure 5-4 diagrams typical data-link handshaking activity for the *WS WRITE
command* sequence.

         REMOTE CONTROLLER ACTIVITY   HOST CONTROLLER ACTIVITY

                                  ◄--------   *select sequence*
              ACKO sequence -------►
                                              WS WRITE command and
                                  ◄--------   *WS WRITE data*
        device completion status -------►
                                  ◄--------   *ACKO sequence*
                EOT sequence -------►
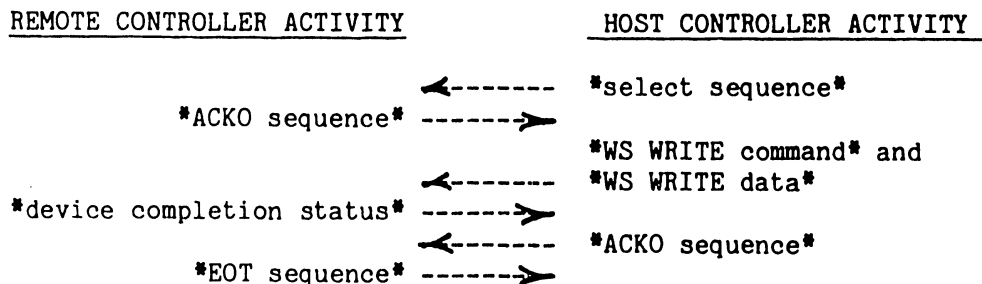
        Figure 5-4. Data Link Handshaking for *WS WRITE Command* Sequence

The host controller first establishes communications with the selected re-
mote device and then creates both a *WS WRITE command* message and a *WS

WRITE data* message. (For format details of these output messages, refer to Table 5-4.) The host program then queues these messages for transmission by the host controller's link-protocol mechanismm. That mechanism then transmits the messages, normally blocked together, with the *WS WRITE date* message compressed and transmitted as *contiguous compressed data*.

When the applicable remote controller receives these messages at the remote site, it passes them to the remote device. That device then generates and queues a status reply for transmission, packaging that reply either as a *device completion status* message or as a *completion double status* message. (For format details of these input messages, refer to Table 5-5.)

The remote controller's link-protocol mechanism normally transmits the messages to the host controller as a bisync conversational reply. When this reply is received, the host controller extracts a VS IOSW from the message and then passes the IOSW data to the host program, thereby completing the command.

5.3.3.1.2 Workstation WRITE-TABS Command

A "tab list" defining the location of horizontal-tab characters is written to a Remote Workstation by means of a START-I/O *VS WS WRITE-TABS command*. The data area pointed to by the command contains a 4-byte "order area" that is followed by the tab list data. Figure 5-5 diagrams typical data-link handshaking activity for the *WS WRITE-TABS command* sequence.

```
    REMOTE CONTROLLER ACTIVITY                HOST CONTROLLER ACTIVITY

                                  ◄-------  *select sequence*
             *ACKO sequence*  ------->

                                            *WS WRITE-TABS command* and
                                  ◄-------  *WS WRITE-TABS data*
    *device completion status*  ------->

                                  ◄-------  *ACKO sequence*
             *EOT sequence*  ------->
```
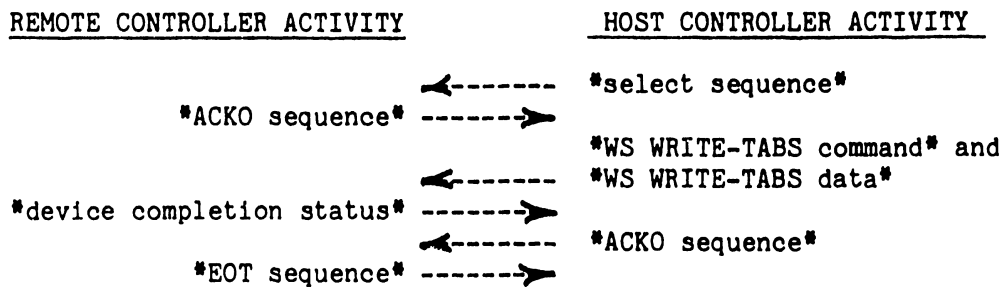
Figure 5-5. Data Link Handshaking for *WS WRITE-TABS Command* Sequence

The host controller first establishes communication with the selected re-
mote device. The host controller then creates and queues for transmission
both a *WS WRITE-TABS command* message and a *WS WRITE-TABS data* message,
compressed for transmission in *contiguous compressed data* format. (For for-
mat details, refer to TAble 5-4.)

When the host controller's link-protocol mechanism transmits these mes-
sages, they are passed by the applicable remote controller at the remote site
to the addressed remote device. That remote device then generates and queues
for transmission a status reply, which is packaged either in a *device comple-
tion status* messsage or in a *completion double status* message. (For format
details of these input messages, refer to Table 5-5.)

The remote controller's link-protocol mechanism then transmits the mes-
sage, normally passed as a bisync conversational reply to the host control-
ler. Upon receipt of that message, the host controller extracts a VS IOSW
from the message data and then passes the IOSW data to the host program,
thereby completing the command.

5.3.3.1.3 Workstation WRITE-SELECTED Command

The host program writes a selected field from a portion of a screen image
to a Remote Workstation by means of a START-I/O *VS WS WRITE-SELECTED com-
mand*. The data area pointed to by that command contains a 4-byte "order
area" that is followed by the screen image piece. Figure 5-6 diagrams typical
data-link handshaking activity for the *WS WRITE-SELECTED command* sequence.

After establishing communications with the selected remote device, the
host controller creates and queues for transmission both a *WS WRITE-SELECTED
command* message and a *WS WRITE-SELECTED data* message, which is compressed
(to exclude fields having a selected-field bit that is not set) for transmis-
sion in *disjoint compresed data* format. (For format details of these output
messages, refer to Table 5-4.) The host controller's link-protocol mechanism
normally blocks the two messages together for transmission to the remote site.

REMOTE CONTROLLER ACTIVITY   HOST CONTROLLER ACTIVITY

                                <------- *select sequence*
            ACKO sequence ------->
                                        WS WRITE-SELECTED command and
                                <------- *WS WRITE-SELECTED data*
   device completion status ------->
                                <------- *ACKO sequence*
            EOT sequence ------->
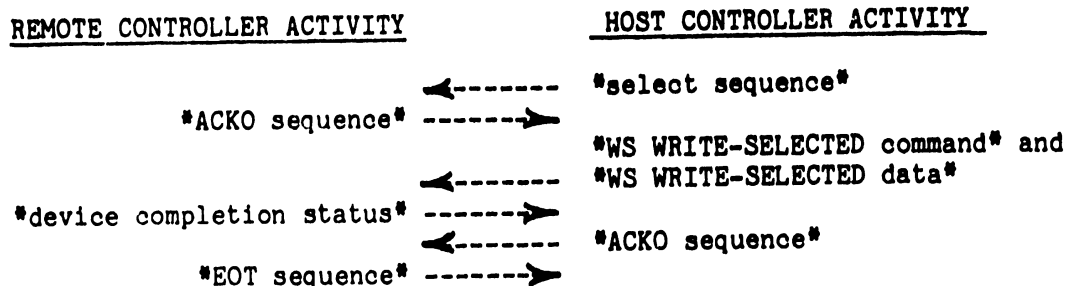
Figure 5-6. Data Link Handshaking for *WS WRITE-SELECTED Command* Sequence

Upon receipt of these messages, the applicable remote controller passes them to the addressed remote device. That remote device then generates and queues for transmission a status reply, which is packaged either in a *device completion status* message or in a *completion double status* message. (Fcr format details of these input messages, refer to Table 5-5.)

The remote controller's link-protocol mechanisms normally transmits the status message to the host controller as a bisync conversational reply. The host controller then extracts a VS IOSW from the message and passes that IOSW data to the host program, thereby completing the command.

5.3.3.1.4 Workstation READ Command

The host controller reads a specific portion of a Remote Workstation's screen image by means of a START-I/O *VS WS READ command*. The data area pointed to by that command contains a 4-byte "order area" that is followed by the screen image buffer. Figure 5-7 diagrams typical data-link handshaking activity for the *WS WRITE-SELECTED command* sequence.

The host controller first selects the applicable remote device and then creates and queues for transmission both a *WS READ command* message and a *WS READ-ORDER data* message. (For format details of these output messages, refer to Table 5-4.) The host controller's link-protocol mechanism then transmits these messages, normally blocked together, to the remote site. Upon receipt, the applicable remote controller passes the messages to the addressed remote device. That remote device then generates and queues a data reply for

REMOTE CONTROLLER ACTIVITY   HOST CONTROLLER ACTIVITY

```
                              <-------  *select sequence*
           *ACKO sequence*  ------->

                                        *WS READ command* and
                              <-------  *WS READ-ORDER data*
  *WS READ data* and
  *device completion status*  ------->
                              <-------  *ACKO sequence*
               *EOT sequence*  ------->
```
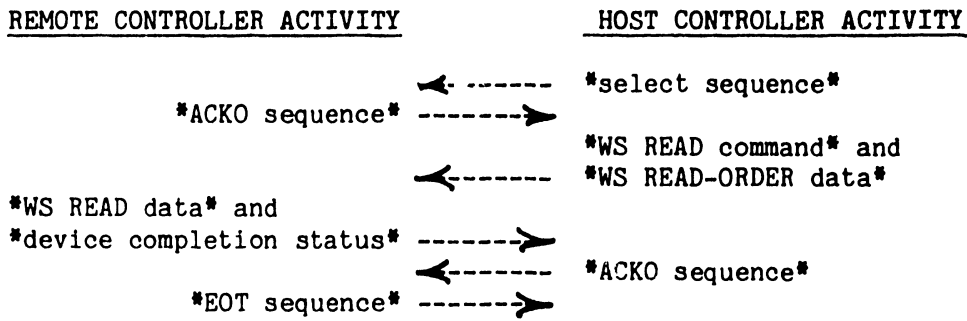
Figure 5-7. Data Link Handshaking for *WS READ Command* Sequence

transmission, packaging it as a *WS READ data* message (compressed for trans-
mission in *contiguous compressed data* format). In addition, the device con-
troller also generates and queues for transmission a status reply, which is
packaged either in a *device completion status* message or in a *completion
double status* message. (For format details of these input messages, refer to
Table 5-5.)

    The remote controller's link-protocol mechanism normally transmits these
messages to the host controller as a bisync conversational reply. Upon re-
ceipt of these messages, the host controller extracts a VS IOSW from the sup-
plied data and passes the IOSW data to the host program, thereby completing
the command sequence.

5.3.3.1.5 Workstation READ-DIAGNOSTIC Command

    The host controller reads diagnostic data from a Remote Workstation by
means of a START-I/O *VS WS READ-DIAGNOSTIC command*. The data area pointed
to by that command contains a 4-byte "order area" that is followed by the
diagnostic data buffer. Figure 5-8 diagrams typical data-link handshaking
activity for the *WS READ-DIAGNOSTIC command* sequence.

    The host controller first establishes communications with the selected re-
mote device and then creates and queues for transmission both a *WS READ-
DIAGNOSTIC command* message and a *WS READ-ORDER data* message, compressed for
transmission in *contiguous compressed data* format. (For format

REMOTE CONTROLLER ACTIVITY   HOST CONTROLLER ACTIVITY

                                   <------   *select sequence*
            ACKO sequence ------>

                                             WS READ-DIAG command and
                                   <------   *WS READ-ORDER data*
 WS READ-DIAG data and
 device completion status   ------>
                                   <------   *ACKO sequence*
             EOT sequence   ------>
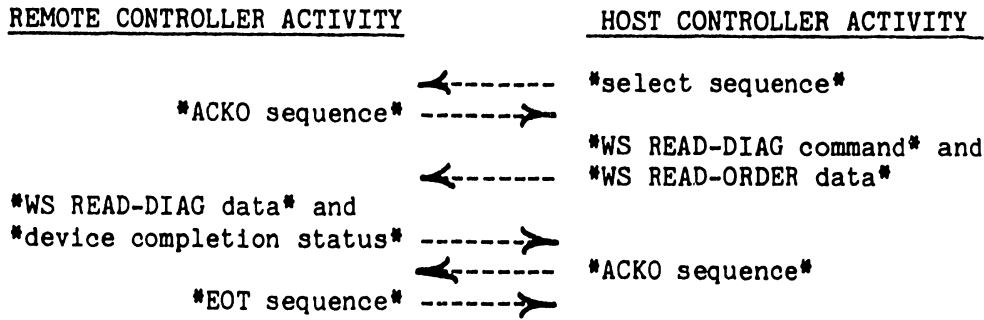
Figure 5-8. Data Link Handshaking for *WS READ-DIAGNOSTIC Command* Sequence

details of these output messages, refer to Table 5-4.) The host controller's
link-protocol mechanism subsequently transmits these messages to the selected
remote site, normally blocking them together.

Upon receipt of these messages, the remote controller generates and queues
for transmission both a data reply and a status reply. The data reply is
packaged as a *WS READ-DIAGNOSTIC data* message. The status reply is packaged
either as a *device completion status* message or as a *completion double sta-
tus* message. (For format details of these input messages, refer to Table
5-5.)

The remote controller's link-protocol mechanism subsequently transmits
these messages to the host controller, normally blocking them together within
a bisync conversational reply. The host controller then extracts a VS IOSW
from the message data and passes the IOSW data to the host program, thereby
completing the command.

5.3.3.1.6 Workstation READ-TABS Command

The host controller reads a "tab list" (defining the location of horizon-
tal-tab characters) from a Remote Workstation by means of a START-I/O *VS WS
READ-TABS command*. The data area pointed to by the command contains a 4-byte
"order area" that is followed by the tab list buffer. Figure 5-9 diagrams
typical data-link handshaking activity for the *WS READ-TABS command* sequence.

REMOTE CONTROLLER ACTIVITY   HOST CONTROLLER ACTIVITY

                                   <------- *select sequence*
            ACKO sequence ------->

                                          WS READ-TABS command and
                                   <------- *WS READ-ORDER data*
WS READ-TABS data and
device completion status ------->
                                   <------- *ACKO sequence*
            EOT sequence ------->

Figure 5-9. Data Link Handshaking for *WS READ-TABS Command* Sequence

The host controller first establishes communications with the selected re-
mote device. The host controller then creates and queues for transmission
both a *WS READ-TABS command* message and a *WS READ-ORDER data* message, com-
pressed for transmission in *contiguous compressed data* format. (For format
details, refer to Table 5-4.)

When the host controller's link-protocol mechanism transmits these mes-
sages, normally blocked together, the applicable remote controller at the re-
mote site passes them to the addressed remote device. That remote device then
generates and queues for transmission both a data reply and a status reply.
The data reply is packaged as a *WS READ-TABS data* message. The status reply
is packaged either in a *device completion status* messsage or in a *comple-
tion double status* message. (For format details of these input messages, re-
fer to Table 5-5.)

The remote controller's link-protocol mechanism then transmits the mes-
sages to the host controller, normally blocking them together within a bisync
conversational reply. Upon receipt of the messages, the host controller ex-
tracts a VS IOSW from the message data and then passes the IOSW data to the
host program, thereby completing the command.

5.3.3.1.7 Workstation READ-Altered Command

     The host controller reads modified fields within a portion of the screen
image data from a Remote Workstation by means of a START-I/O *VS WS READ-TABS
command*. The data area pointed to by that command contains a 4-byte "order
area" that is followed by the screen image buffer. Figure 5-10 diagrams typi-
cal data-link handshaking activity for the *WS READ-ALTERED command* sequence.

     The host controller first establishes communications with the selected re-
mote device. The host controller then creates and queues for transmission
both a *WS READ-ALTERED command* message and a *WS READ-ORDER data* message.
The latter data message is compressed (to exclude fields having a modified
field bit that is not set) for transmission in *contiguous compressed data*
format. (For format details, refer to Table 5-4.)

REMOTE CONTROLLER ACTIVITY   HOST CONTROLLER ACTIVITY

                                    ◄------- *select sequence*
              ACKO sequence ------►

                                           WS READ-ALTERED command and
                                    ◄------- *WS READ-ORDER data*
WS READ-ALTERED data and
device completion status ------►
                                    ◄------- *ACKO sequence*
              EOT sequence ------►

     Figure 5-10. Data Link Handshaking for *WS READ-ALTERED Command* Sequence

     When the host controller's link-protocol mechanism transmits these mes-
sages, normally blocked together, the applicable remote controller at the re-
mote site passes them to the addressed remote device. That remote device then
generates and queues for transmission both a data reply and a status reply.
The data reply is packaged as a *WS READ-ALTERED data* message. The status
reply is packaged either in a *device completion status* messsage or in a
completion double status message. (For format details of these input mes-
sages, refer to Table 5-5.)

The remote controller's link-protocol mechanism then transmits the mes-
sages to the host controller, normally blocking them together within a bisync
conversational reply. Upon receipt of the messages, the host controller ex-
tracts a VS IOSW from the message data and then passes the IOSW data to the
host program, thereby completing the command.

5.3.4 HOST-INITIATED COMMANDS TO REMOTE PRINTERS

The host program writes a block of print-image records to a parallel prin-
ter attached to a Remote Workstation by means of a START-I/O *VS PRINTER WRITE
command*. The data area pointed to by that command contain a block of com-
pressed print-image records. Figure 5-11 diagrams typical data-link hand-
shaking activity for the *printer WRITE command* sequence.

```
        REMOTE CONTROLLER ACTIVITY              HOST CONTROLLER ACTIVITY

                                    <-------  *select sequence*
                   *ACKO sequence*  ------->
                                    <-------  *printer WRITE command*
           *buffer release status*  ------->
                                    <-------  *ACKO sequence*
                    *EOT sequence*  ------->

                                      . . .

                                    <-------  *poll sequence*
        *device completion status*  ------->
                                    <-------  *ACKO sequence*
                    *EOT sequence*  ------->
```

Figure 5-11. Data Link Handshaking for *Printer WRITE Command* Sequence

The host controller begins the interchange sequence by establishing com-
munication with the remote device to which the selected parallel printer is
connected. The host controller then creates and queues for transmission both
a *printer WRITE command* message and a *printer WRITE data* message. Unlike
the previously discussed workstation-data messages, the *printer WRITE data*
message is transmitted in *uncompressed data* format; the telecommunications
facility need not compress the data in this instance, because the host program

compresses the data before passing it to the host controller. (For format de-
tails, refer to Table 5-4.)

When the host controller's link-protocol mechanism transmits these mes-
sages, normally blocked together, the applicable remote controller at the re-
mote site passes them to the addressed remote device. That device then gener-
ates and queues for transmission a buffer-release status signal, which is
packaged as a *buffer release status* message. The remote link-protocol mech-
anism then transmits that message to the host controller, normally within a
bisync conversational reply. Upon receipt of that message, the host control-
ler extracts a VS IOSW from the message data and then passes the IOSW data to
the host program, thereby signaling the host program that it may release the
data buffer that was pointed to by the *printer WRITE command*. After all
print-image records have been printed, the remote device generates a new sta-
tus reply, which is packaged and queued for transmission either as a *device
completion status* message or as a *completion double status* message. (For
format details, refer to Table 5-5.)

The remote controller's link-protocol mechanism normally transmits this
status reply message in response to a host-initiated *poll sequence*. Upon
receipt of this message, the host controller extracts a VS IOSW from the mes-
sage and then passes that IOSW data to the host program, thereby completing
the command sequence.

5.3.5 REQUEST FOR ATTENTION BY A REMOTE DEVICE

Any remote device having no outstanding command may issue an *unsolicited
IOSW* message to initiate servicing by the host program   In normal Remote
Workstation operation, for example, this event occurs whenever the operator
activates either of the ENTER or HELP keys or any PF key. The remote control-
ler for that device then creates an *unsolicited status* message and queues
that message for transmission. Figure 5-12 diagrams typical data-link hand-
shaking activity for the *unsolicited IOSW* communications sequence.

The remote controller's link-protocol mechanism normally transmits the
message to the host controller as a reply to a host-initiated *poll se-
quence*. Upon receiving the *unsolicited IOSW* message, the host controller

REMOTE CONTROLLER ACTIVITY   HOST CONTROLLER ACTIVITY

                          <------- *poll sequence*
    unsolicited IOSW ------->
                          <------- *ACKO sequence*
        EOT sequence ------->
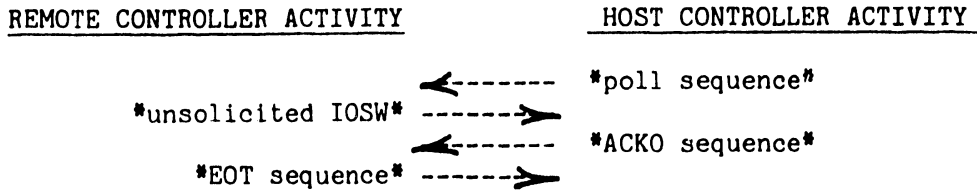
Figure 5-12. Data Link Handshaking for *Unsolicited IOSW* Sequence

extracts the VS IOSW data from that message and then passes the IOSW data to
the host program, thereby signalling to the host program that the associated
Remote Workstation desires attention. If the host program issues any higher
priority command before the *unsolicited IOSW* message reaches the host con-
troller, the host controller holds the received message until that command has
been completed and then passes the IOSW data to the host program.

5.3.6 COMMAND ABORTION BY HOST PROGRAM

   The host program may abort an outstanding command by issuing a HALT-I/O
command. Upon receipt of that command, the host controller creates a *HALTIO*
message and queues that message for transmission. The remote link-protocol
mechanism subsequently transmits the message to the applicable remote device.
In the event that the remote device has issued a command-termination IOSW by
the time that the *HALTIO* message reaches the remote controller, the remote
controller ignores the *HALTIO* message. Otherwise, the *HALTIO* message is
passed to the remote device in normal sequence.

   After a *HALTIO* message has been passed to the remote device, that remote
device normally will respond by issuing a new IOSW message, which is queued
for transmission as a *device completion status* message. When the remote
controller's link-protocol mechanism transmits the message, the host control-
ler extracts the VS IOSW data from the message and then passes that IOSW data
to the host program, thereby completing the command.

Table 5-1. Modified BNF Notation for Defining Data Formats

NOTE

Wang documentation defines the formats of messages and data
areas using a modified version of Backus-Naur Format (BNF) no-
tation, as summarized below. The entire set of possibilities
for the format of a mesage or for data structure in general is
defined through a set of expressions called "productions," as
separately delineated in the following tables. These produc-
tions describe stepwise decomposition of the data structure in-
to "terminal elements." A terminal element may be any of a
mnemonic representation of a character, a graphic representa-
tion of a character string, a binary represensentation of a bit
string, or a hexadecimal representation of a nibble string.
The convention as to the order of transmission/reception is as
follows:

character string	--	leftmost character first
bit string	--	rightmost bit first
nibble string	--	leftmost byte-within-string, right-most nibble-within-byte first
character/nibble	--	low-order bit first

NOTATION	SIGNIFICANCE
::=	Denotes "consists of" and is the verb of a production.
	Separates alternative adjacent items within the predicate of a production.
< > or * *	Encloses the name of a decomposable item. Indivisible items (usually a byte, a nibble, or a bit) have a mnemonic or single-word name.
X' '	Encloses a string of hexadecimal digits.
b' '	Encloses a string of binary digits.
x	Indicates an arbitrary nibble or bit within a hexadecimal or bit string.
" "	Encloses a character string.
[ ]	Encloses an expression that defines a repetition count of the preceding item.
..	Separates the smallest and largest values of a range.
( )	Encloses a sequence of alternative items or a repeated item.

Table 5-2. Data-Link Sequences Transmitted by Remote Site

```
<data link sequence>        ::=  <EOT sequence> | <ENQ sequence> | <NAK sequence> | <ACK0 sequence> |
                                 <ACK1 sequence> | <WACK sequence> | <text block>

<EOT sequence>              ::=  SYN(4) EOT X'FF'
<ENQ sequence>              ::=  SYN(4) ENQ X'FF'
<NAK sequence>              ::=  SYN(4) NAK X'FF'
<ACK0 sequence>             ::=  SYN(4) DLE X'70' X'FF'
<ACK1 sequence>             ::=  SYN(4) DLE X'61' X'FF'
<WACK sequence>             ::=  SYN(4) DLE X'6B' X'FF'
<text block>                ::=  SYN(4) DLE STX (<device message> DLE ITB 16-bit-block-check
                                 SYN(2) DLE STX)(0+) <device message> DLE ETX 16-bit-block-check X'FF'

SYN                         ::=  X'32'
DLE                         ::=  X'10'
NAK                         ::=  X'3D'
EOT                         ::=  X'37'
ENQ                         ::=  X'2D'
STX                         ::=  X'02'
ITB                         ::=  X'1F'
ETX                         ::=  X'03'
```

Table 5-3.   Data-Link Sequences Transmitted by Host Controller

```
<data link sequence>          ::=  <EOT sequence> | <ENQ sequence> | <poll sequence> | <select sequence> |
                                   <NAK sequence> | <ACK0 sequence> | <ACK1 sequence> | <WACK sequence> |
                                   <text block>

<EOT sequence>                ::=  SYN(4) EOT X'FF'
<ENQ sequence>                ::=  SYN(4) ENQ X'FF'
<poll sequence>               ::=  SYN(4) <site address> X'FF' X'xx' ENQ X'FF'
<select sequence>             ::=  SYN(4) <site address> <port address> <device address> ENQ X'FF'
<NAK sequence>                ::=  SYN(4) NAK X'FF'
<ACK0 sequence>               ::=  SYN(4) DLE X'70' X'FF'
<ACK1 sequence>               ::=  SYN(4) DLE X'61' X'FF'
<WACK sequence>               ::=  SYN(4) DLE X'6B' X'FF'
<text block>                  ::=  SYN(4) DLE STX (<device message> DLE ITB 16-bit-block-check
                                   SYN(2) DLE STX)[0+] <device message> DLE ETX 16-bit-block-check X'FF'

<site address>                ::=  X'C0' .. X'DF'
<port address>                ::=  X'C0'
<device address>              ::=  <workstation address> | <attached printer address>

<workstation address>         ::=  X'C0'
<attached printer address>    ::=  X'C1'

SYN                           ::=  X'32'
DLE                           ::=  X'10'
NAK                           ::=  X'3D'
EOT                           ::=  X'37'
ENQ                           ::=  X'2D'
STX                           ::=  X'02'
ITB                           ::=  X'1E'
ETX                           ::=  X'03'
```

Table 5-4. Message Formats for Output Messages Passed to Remote Device by Host Controller

```
<device message>                    ::=  <haltio> | <LOAD-DEVICE command> | <START-DEVICE command> | <printer WRITE command>
                                         | <ws WRITE command> | <ws WRITE-DIAGNOSTIC command> | <ws WRITE-TABS command> |
                                         <ws WRITE-SELECTED command> | <ws READ command> | <ws READ-DIAGNOSTIC command> |
                                         <ws READ-TABS command> | <ws READ-ALTERED command> | <device microcode data> |
                                         <printer WRITE data> | <ws READ-ORDER data> | <ws WRITE data> |
                                         <ws WRITE-DIAGNOSTIC data> | <ws WRITE-TABS data> | <ws WRITE-SELECTED data>


<haltio>                            ::=  <address header> X'00'
<LOAD-DEVICE command>               ::=  <address header> X'01' <LOAD-DEVICE iocw>
<START-DEVICE command>              ::=  <address header> X'01' <START-DEVICE iocw>
<printer WRITE command>             ::=  <address header> X'02' <printer WRITE iocw>
<ws WRITE command>                  ::=  <address header> X'02' <ws WRITE iocw>
<ws WRITE-DIAGNOSTIC command>       ::=  <address header> X'02' <ws WRITE-DIAGNOSTIC iocw>
<ws WRITE-TABS command>             ::=  <address header> X'02' <ws WRITE-TABS iocw>
<ws WRITE-SELECTED command>         ::=  <address header> X'02' <ws WRITE-SELECTED iocw>
<ws READ command>                   ::=  <address header> X'02' <ws READ iocw>
<ws READ-DIAGNOSTIC command>        ::=  <address header> X'02' <ws READ-DIAGNOSTIC iocw>
<ws READ-TABS command>              ::=  <address header> X'02' <ws READ-TABS iocw>
<ws READ-ALTERED command>           ::=  <address header> X'02' <ws READ-ALTERED iocw>
<device microcode data>             ::=  <address header> X'03' device-microcode-piece
<printer WRITE data>                ::=  <address header> X'03' block-of-print-records
<ws READ-ORDER data>                ::=  <address header> X'03' ws-order
<ws WRITE data>                     ::=  <address header> X'04' contiguous-compressed-ws-order-&-screen-image-piece
<ws WRITE-DIAGNOSTIC data>          ::=  <address header> X'04' contiguous-compressed-ws-order-&-diagnostic-data
<ws WRITE-TABS data>                ::=  <address header> X'04' contiguous-compressed-ws-order-&-tab-column-list
<ws WRITE-SELECTED data>            ::=  <address header> X'05' disjoint-compressed-ws-order-&-screen-image-piece


<LOAD-DEVICE iocw>                  ::=  (X'A0' | X'A2) X'00'[0..8]
<START-DEVICE iocw>                 ::=  X'E0' X'00'[0..8]
<printer WRITE iocw>                ::=  (X'80' | X'82') X'00'[3] <data length> X'xx'[0..2]
<ws WRITE iocw>                     ::=  (X'80' | X'82') X'00'[3] <data length> X'xx'[0..2]
<ws WRITE-DIAGNOSTIC iocw>          ::=  (X'88' | X'8A') X'00'[3] <data length> X'xx'[0..2]
<ws WRITE-TABS iocw>                ::=  (X'84' | X'86') X'00'[3] <data length> X'xx'[0..2]
<ws WRITE-SELECTED iocw>            ::=  (X'90' | X'92') X'00'[3] <data length> X'xx'[0..2]
<ws READ iocw>                      ::=  (X'40' | X'42') X'00'[3] <buffer length> X'xx'[0..2]
<ws READ-DIAGNOSTIC iocw>           ::=  (X'48' | X'4A') X'00'[3] <buffer length> X'xx'[0..2]
<ws READ-TABS iocw>                 ::=  (X'44' | X'46') X'00'[3] <buffer length> X'xx'[0..2]
<ws READ-ALTERED iocw>              ::=  (X'50' | X'52') X'00'[3] <buffer length> X'xx'[0..2]


<address header>                    ::=  <site address> <port address> <device address>


<site address>                      ::=  X'C0' .. X'DF'
<port address>                      ::=  X'C0'
<device address>                    ::=  <workstation address> | <2246r printer address>

<workstation address>               ::=  X'C0'
<2246r printer address>             ::=  X'C1'
```

Table 5-5. Message Formats for Input Messages Passed to Host Controller by Remote Device

```
<device message>              ::=  <device completion status> | <load complete status> | <load error status> |
                                   <device unsolicited iosw> | <power-on status> | <device error status> |
                                   <completion double status> | <buffer release status> | <ws READ data> |
                                   <ws READ-DIAGNOSTIC data> | <ws READ-TABS data> | <ws READ-ALTERED data>

<device completion status>    ::=  <address header> X'06' device-completion-iosw
<load complete status>        ::=  <address header> X'06' <load complete iosw>
<load error status>           ::=  <address header> X'06' <load error iosw>
<device unsolicited status>   ::=  <address header> X'07' device-unsolicited-iosw
<power-on status>             ::=  <address header> X'07' <power-on iosw>
<device error status>         ::=  <address header> X'07' <device error iosw>
<completion double status>    ::=  <address header> X'08' device-completion-iosw
<buffer release status>       ::=  <address header> X'09' device-buffer-release-iosw
<ws READ data>                ::=  <address header> X'0B' contiguous-compressed-screen-image-buffer
<ws READ-DIAGNOSTIC data>     ::=  <address header> X'0B' contiguous-compressed-diagnostic-data
<ws READ-TABS data>           ::=  <address header> X'0B' contiguous-compressed-tab-list
<ws READ-ALTERED data>        ::=  <address header> X'0C' disjoint-compressed-ws-screen-image-piece

<load complete iosw>          ::=  X'4000' X'00'[6]
<load error iosw>             ::=  X'2019' X'00'[6]
<power-on iosw>               ::=  X'10<device type>9' X'00'[6]
<device error iosw>           ::=  X'1018' X'00'[6]

<device type>                 ::=  X'4-bits-from-device-type-switches'


<address header>              ::=  <site address> <port address> <device address>

<site address>                ::=  b'110<low-order-5-bits-from-option-switches>'
<port address>                ::=  X'C0'
<device address>              ::=  <workstation address> | <2246r printer address>

<workstation address>         ::=  X'C0'
<2246r printer address>       ::=  X'C1'
```

Table 5-6. Message Formats for Compressed Data Messages


```
<contiguous compressed data> ::=   <c-compressed string>(1+)

<c-compressed string>        ::=   <n-byte string> | <byte repeated n times>
<n-byte string>              ::=   b'0<n-1>' data-byte(n)
<byte repeated n times>      ::=   b'1<n-1>' data-byte


<disjoint compressed data>   ::=   <d-compressed string>(1+)

<d-compressed string>        ::=   <n-byte string> | <byte repeated n times> | <skip n bytes>
<n-byte string>              ::=   b'01<n-1>' data-byte(n)
<byte repeated n times>      ::=   b'00<n-1>' data-byte
<skip n bytes>               ::=   b'1<n-1>' data-byte
```

Table 5-7. VS Remote Device I/O Commands and Data Formats

```
<I/O command>                        ::=   <CONTROL-I/O command> | <START-I/O command> | HALT-IO-command

<CONTROL-I/O command>                ::=   <LOAD-22v06 command> | <START-22v06 command> | <VS LOAD-POLL-LIST command> |
                                           <VS LOAD-DEVICE command> | <VS START-DEVICE command>

<START-I/O command>                  ::=   <VS WS WRITE command> | <VS WS WRITE-DIAGNOSTIC command> |
                                           <VS WS WRITE-TABS command> | <VS WS WRITE-SELECTED command> |
                                           <VS WS READ command> | <VS WS READ-DIAGNOSTIC command> |
                                           <VS WS READ-TABS command> | <VS WS READ-ALTERED command> |
                                           <VS PRINTER WRITE command>

<LOAD-22v06 command>                 ::=   (X'90' | X'92) <data area address> <data area length> X'xx'[0..2]
<START-22v06 command>                ::=   X'D0' X'xx'[0..8]
<VS LOAD-POLL-LIST command>          ::=   (X'A9' | X'AB) <data area address> <data area length> X'xx'[0..2]
<VS LOAD-DEVICE command>             ::=   (X'A0' | X'A2) <data area address> <data area length> X'xx'[0..2]
<VS START-DEVICE command>            ::=   X'E0' X'xx'[0..8]

<VS WS WRITE command>                ::=   (X'60' | X'82) <data area address> <data area length> X'xx'[0..2]
<VS WS WRITE-DIAGNOSTIC command>     ::=   (X'88' | X'8A) <data area address> <data area length> X'xx'[0..2]
<VS WS WRITE-TABS command>           ::=   (X'84' | X'86) <data area address> <data area length> X'xx'[0..2]
<VS WS WRITE-SELECTED command>       ::=   (X'90' | X'92) <data area address> <data area length> X'xx'[0..2]
<VS WS READ command>                 ::=   (X'40' | X'42) <data area address> <data area length> X'xx'[0..2]
<VS WS READ-DIAGNOSTIC command>      ::=   (X'48' | X'4A) <data area address> <data area length> X'xx'[0..2]
<VS WS READ-TABS command>            ::=   (X'44' | X'46) <data area address> <data area length> X'xx'[0..2]
<VS WS READ-ALTERED command>         ::=   (X'50' | X'52) <data area address> <data area length> X'xx'[0..2]
<VS PRINTER WRITE command>           ::=   (X'80' | X'82) <data area address><data area length> X'xx'[0..2]

<data area address>                  ::=   3-byte-VS-memory-address
<data area length>                   ::=   2-byte-length

<command data area>                  ::=   <LOAD-22v06 data> | <VS LOAD-POLL-LIST data> | <VS LOAD-DEVICE data> |
                                           <VS WS WRITE data> | <VS WS WRITE-DIAGNOSTIC data> | <VS WS WRITE-TABS data> |
                                           <VS WS WRITE-SELECTED data> | <VS WS READ data> | <VS WS READ-DIAGNOSTIC data>
                                           | <VS WS READ-TABS data> | <VS WS READ-ALTERED data> | <VS PRINTER WRITE data>

<LOAD-22v06 data>                    ::=   22v06-microcode-piece
<LOAD-POLL-LIST data>                ::=   <site address> <port address> <device address> <device type>
<LOAD-DEVICE data>                   ::=   device-microcode-piece
<VS WS WRITE data>                   ::=   4-byte-ws-order  screen-image-piece
<VS WS WRITE-DIAGNOSTIC data>        ::=   4-byte-ws-order  diagnostic-data
<VS WS WRITE-TABS data>              ::=   4-byte-ws-order  tab-column-list
<VS WS WRITE-SELECTED data>          ::=   4-byte-ws-order  screen-image-piece
<VS WS READ data>                    ::=   4-byte-ws-order  screen-image-buffer>
<VS WS READ-DIAGNOSTIC data>         ::=   4-byte-ws-order  diagnostic-data-buffer>
<VS WS READ-TABS data>               ::=   4-byte-ws-order  tab-column-list-buffer>
<VS WS READ-ALTERED data>            ::=   4-byte-ws-order  screen-image-piece-buffer>
<VS PRINTER WRITE data>              ::=   block-of-print-records
```

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SECTION 6

OPERATOR INFORMATION

6.1 GENERAL

To initialize the 2246R Remote Workstation, proceed as follows at the VS
system's Command Console (Workstation #0).

NOTE

The illustrations of CRT-screen presenta-
tions referenced in the following procedure steps
are reduced copies of VS system printouts ob-
tained by pressing program-function key PF15 on
the Command Console after performing the applica-
ble step. These diagrams thus include time/day
information and specific port assignments (deter-
mined by the port-selection switches on the 22V06
TC IOP assembly in the VS CPU mainframe) that may
differ from equivalent values that will appear on
the CRT screen when you perform this same proce-
dure. In addition, these printouts include a
screen-edge border that does not appear as part
of the actual CRT presenation, and character-
entry locations that are displayed as bright
character-size squares on the screen are symbo-
lized in these printouts by the use of asterisks.

a.   IPL the VS system to establish normal operating conditions, producing
     the system-setup presentation shown in Figure 6-1 on the Vs system's
     Command Console.

b.   At the Command Console, press program-function key PF7 to obtain a
     CRT presentation of the DEVICE STATUS control menu shown in Figure
     6-2.

c.   Press program-function key PF9 to obtain the REMOTE DEVICES control
     presentation shown i: Figure 6-3.

```
                        *** WANG VS OPERATOR'S CONSOLE ***
                  9:00 AM      WEDNESDAY      JULY 25, 1979






   (1) RETURN to User Mode

   (2) Display and Control PRINT QUEUE Entries     (7)   Control DEVICE STATUS
   (3) Control PRINTER(S)                          (8)   Print I/O Error LOG
   (4) Display and Control JOB QUEUE Entries       (9)   Control SYSTEM STATUS

   (5) Control IBM Processing Tasks
   (6) Control INTERACTIVE Processing Tasks


          PRESS (HELP) AT ANY TIME TO RETURN TO THE OPERATOR CONSOLE MENU
```

Figure 6-1. System-Setup Presentation on Command Console Following IPL

```
                        *** CONTROL DEVICE STATUS ***
                  9:01 AM      WEDNESDAY      JULY 25, 1979










                     (4) Display DEVICE STATUS

                     (6) MOUNT/DISMOUNT Device
                     (7) ATTACH/DETACH Device

                     (9) Control REMOTE DEVICES


          Press (HELP) at Any Time to Return to the Main Operator Menu
```

Figure 6-2. DEVICE STATUS Control Menu

d.   Using the cursor positioning keys and/or the TAB key, as applica-
     ble, move the cursor to the appropriate device-assignement line and
     enter zero-digit identifications (i.e., press the 0 key while the
     cursor is at entry block) in the CLUSTER, PORT, and DEVICE-ON-PORT
     columns of the REMOTE DEVICES control presentation, as shown in
     Figure 6-4. (This assignment value may be changed by future multi-
     station applications.)

                              NOTE

            If you are connected to a 2246R Remote Work-
            station through a 2228N Null Modem assembly, you
            can now activate that workstation by skipping
            steps e and f, following, and proceding directly
            to step g., below. If you are connected through
            an operational telecommunications modem, however,
            continue with this procedure.

e.   Dial the telephone number associated with the telecommunications
     modem at the remote site, and establish contact with appropriate
     operator personnel in that area. Explain that you are initializing
     the 2246R Remote Workstation at that site, and direct the person at
     that site to perform the following steps in sequence:

     (1) Ensure that the power-breaker toggle switch on the left end of
          the 2246R Remote Workstation's rear base panel is set up,
          applying power to workstation circuits.

     (2) Depress the DATA pushbutton switch on the far-end
          telecommunications modem (at which point you will lose contact).

     (3) Confirm that the Remote Workstation becomes initialized (after
          you perform step f, following), as indicated by presentation of
          the normal LOGIN presentation on its CRT screen.

f.   After you hear a clear dial tone, indicating that the far-end
     operator has depressed the DATA pushbutton switch on his
     telecommunications modem, depress the DATA pushbutton switch on the
     VS system modem connected to the 22V06 TC IOP. Confirm that the
     indicator in this DATA pushbutton switch becomes and remains lit,
     indicating establishment of telecommunications service.

Figure 6-3. REMOTE DEVICES Control Presentation

Figure 6-4. Entry of "Zero" Assignments for Remote Workstation's
CLUSTER, PORT, and DEVICE-ON-PORT Control Identifications

g. Press program-function key PF8 on the Command Console to pass the
    zero-digit assignment entries to the VS Operating System. The
    Operating System then should respond by blanking out the entered
    assignments and presenting a DEVICE RESERVED identification in the
    STATUS column of the REMOTE DEVICES control presentation, as shown in
    Figure 6-5.

Following a short delay, the 2246R Remote Workstation at the remote site
should become activated, producing a normal LOGIN solicitation on its screen.
From that point on, display and entry performance of that 2246R Remote
Workstation should be identical to display and entry performance of any
"local" workstation connected to the VS system.

In the event, now or later, that data communications with the Remote
Workstation becomes lost (as, for example, by loss or shutdown of power at the
remote site), an "ASSISTANCE REQUIRED FOR WORKSTAT" message will appear across
the top of the Command Console's REMOTE DEVICES control presentation, together
with the applicable device-assignment number and the time at which
communications were lost, as shown in Figure 6-6.

```
                    ***  CONTROL REMOTE DEVICES  ***
               9:06 AM        WEDNESDAY        JULY 25, 1979


     DEVICE    LINE      TYPE   CLUSTER    PORT   DEVICE-ON-PORT      STATUS
     32                  2246R                                        DEVICE RESERVED
     33                  2246R
     34                  2246R
     64                  2246R
     65                  2246R
     66                  2246R




     Position Cursor to Indicate Device and Press Pfkey to Perform Action:

                                   (8) ACTIVATE
                                   (9) DEACTIVATE
```

Figure 6-5.   REMOTE DEVICES Control Presentation Following Completion
of CLUSTER, PORT, and DEVICE-ON-PORT Assignments


```
                    ***  CONTROL REMOTE DEVICES  ***
               10:12 AM        WEDNESDAY        JULY 25, 1979

     ASSISTANCE REQUIRED FOR WORKSTAT  32  .............................  10:12


     DEVICE    LINE      TYPE   CLUSTER    PORT   DEVICE-ON-PORT      STATUS
     32                  2246R                                        DEVICE RESERVED
     33                  2246R
     34                  2246R
     64                  2246R
     65                  2246R
     66                  2246R




     Position Cursor to Indicate Device and Press Pfkey to Perform Action:

                                   (8) ACTIVATE
                                   (9) DEACTIVATE
```

Figure 6-6.   Production of "ASSISTANCE REQUIRED" Message on Command Console's
REMOTE DEVICES Control Presentation In Event of Telecommunications Failure

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SECTION 7

THEORY OF OPERATION

7.1 GENERAL

Logic/control circuits on the 210-7456 CRT Monitor Electronics board and
the 210-7156 Power Supply Regulators board are standard subassemblies of the
standard workstation monitor design, common to all Wang workstations, and are
not discussed here. The unique 2246R Remote Workstation logic is composed of
two major sections, each contained on a separate PC-board:

      a.   The Telecommunication Data Link Processor (DLP)

      b.   The Workstation Processor (WP)

7.2 TELECOMMUNICATIONS DATA LINK PROCESSOR (210-7478 TC/MEMORY BOARD)

The hardware design of the telecommunications data link processor (DLP)
logic exploits the functional capabilities of the Z80 CPU chip, together with
its companion CTC, SIO, and DMA microelectronic devices, while providing suf-
ficient memory and a modem interface capable of supporting both bisync and
bit-oriented protocols. The DLP circuitry is contained on the 210-7478
TC/Memory board (see Figure 7-1), as detailed in the following subparagraphs.

7.2.1 Z80 CPU

The Z80 CPU chip is the hub around which the DLP is built. It requires a
single +5V power source and a single clock frequency, which in this case is
17.1 MHz. The chip uses a 16-bit address bus and an 8-bit data bus for bi-
directional data flow. A reset line initializes the chip and six major status
output lines. These lines are M1, MREQ, IORQ, RD, WR, and RFSH, which collec-
tively inform the associated circuitry what function the CPU is about to per-
form. The M1 signal is active during the first cycle (the fetch cycle) of

Figure 7-1. 210-7478 TC/Memory Board (DLP), Block Diagram (Sheet 1 of 2)
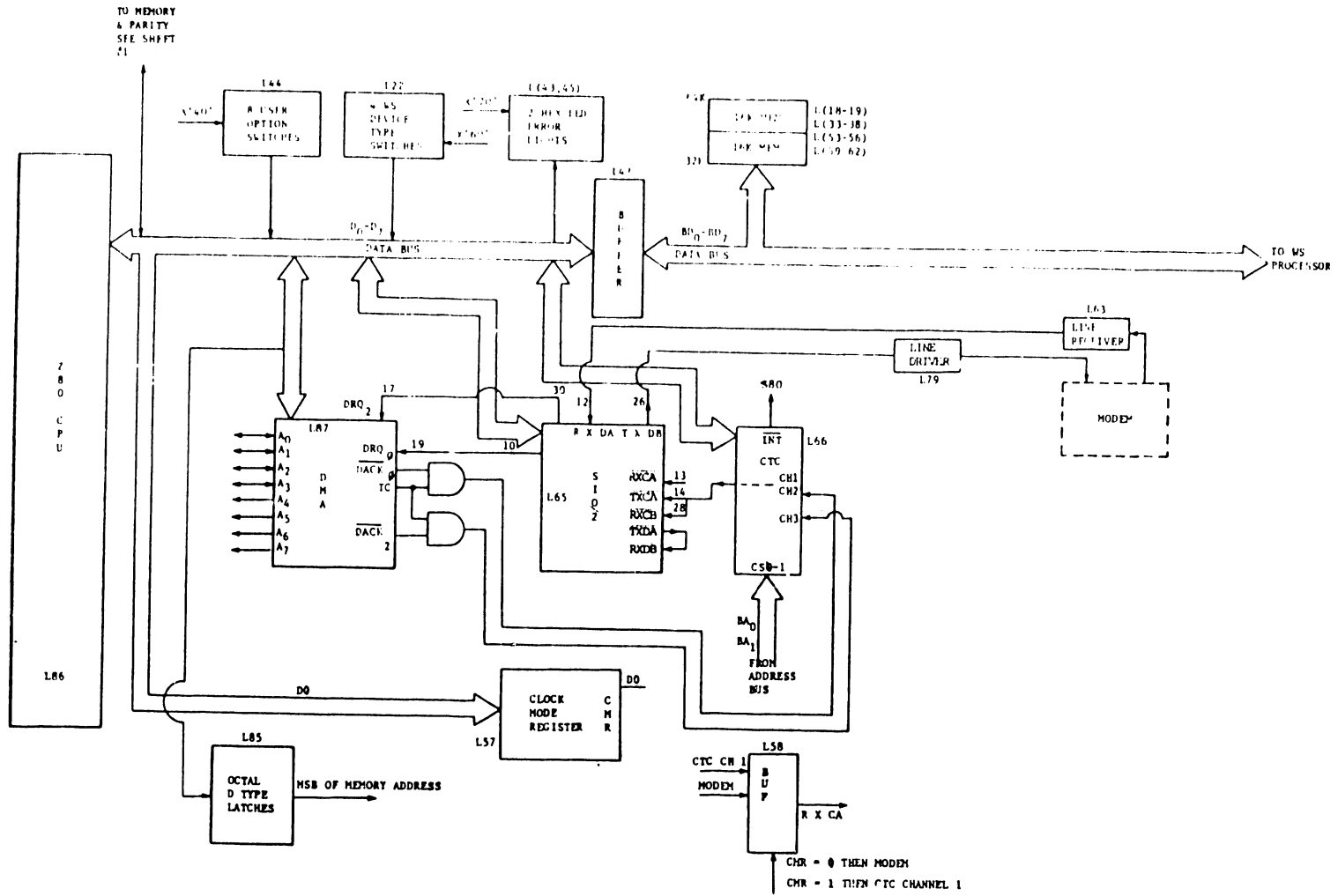
Figure 7-2.   210-7478 TC/Memory Board (DLP), Block Diagram (Sheet 2 of 2)

each instruction cycle and also during a special interrupt-acknowledge cycle that is discussed in further detail later in this discussion. The MREQ (Memory REQuest) signal is active when memory is being accessed to fetch either an instruction or data. The IORQ (Input/Output ReQuest) signal goes active to indicate an input or output to a peripheral device or during the same previously mentioned interrupt acknowledge cycle. The RD (ReaD) signal indicates that the CPU will input data while performing a memory access or I/O instruction, while the WR (WRite) signal indicates that the CPU will output data. During an M1 (Memory period #1) fetch cycle, the CPU will output an address for memory refresh; the RFSH (ReFreSH) signal confirms the active presence of that address.

In addition, the Z80 CPU receives a BUSRQ (BUS-ReQuest) input, which requests the CPU to switch its address, data, and status bus lines into the high impedance state so that an outside device may use these buses. An associated BUSAK (BUS-AKnowledge) output goes active when the CPU has complied with this request. Another WAIT input requests the CPU to extend the current memory access or I/O cycle as long as it is active. Finally, the Z80 CPU uses two interrupt inputs, INT (INTerrupt) and NMI (Non-Maskable Interrupt). The non-maskable NMI input signals the DLP when a parity error occurs. The maskable INT signal serves as the interrupt input for all other interrupt-causing devices in the system and is under software control.

Z80 vectored interrupts are generated for the following functions, listed by interrupt priority:

SIO Channel A receiver
SIO Channel A transmitter (used only by loopback diagnostic)
SIO Channel A status (not used by bisync support)
SIO Channel B receiver (used only by loopback diagnostic)
SIO Channel B transmitter
SIO Channel B status (not used by bisync support)
CTC Channel 0 software timer
CTC Channel 1 (interrupt not used)
CTC Channel 2 (interrupt vector source for DMA channel 0)
CTC Channel 3 (interrupt vector source for DMA channel 1)

Because of the load imposed upon them, the address lines must be buffered. L83 provides buffering for the lower eight bits, and L84 provides buffering for the upper eight. The outputs from these buffers go to the high-impedance (HI-Z) state in response to an active BUSAK signal from the CPU, allowing some other circuit to use the address bus. The buffered address lines go to the Workstation Processor and select the upper 32K bytes of RAM, which is addressed as 0-32K by the workstation memory.

Address lines A_{11} through A_{13} also go direct from the CPU to decoder L103, which selects any 2K portion out of a 16K-byte PROM made up by L88 through L95. L68 and L67 use address bits A_0 through A_{13} to select any location from 16K RAM through 32K RAM (L69 through L76). L77 is used as bit 9 for the L7 RAM parity 9-bit odd/even generator checker. In addition, L46 decodes A_4 through A_6 to generate the I/O port addresses.

7.2.2 INPUT/OUTPUT ARCHITECTURE

The DLP I/O architecture is constant from one controller to another, except for variations of the machine interface and the optional presence or absence of an auto-dial interface and/or a DMA chip.

All I/O hardware is addressed by the DLP through input-output ports. The I/O port addresses are summarized in Table 7-1. Memory-mapped I/O is not possible because of the need for the VS single remote workstation DLP to address 64K of data memory. Address bit A_{15} (L10) is used by the DLP microprocessor to address the upper 32K byte of its memory.

The clock required by the CPU is generated by a crystal-controlled circuit, producing a 17.1-MHz output frequency.

Like the address lines, the data lines are buffered (by L42). These data lines also go directly from the CPU to the Counter/Timer chip, the Serial I/O chip, and the DMA chip (each of which is separately discussed in the following paragraphs).

Table 7-1. Z80 CPU I/O-Port Addresses

PORT	OUTPUT PORT DESTINATION	INPUT PORT SOURCE	NOTE
X'00'	SIO Channel A Data Register	SIO Channel A Data Register	
X'01'	SIO Channel B Data Register	SIO Channel B Data Register	
X'02'	SIO Channel A Command Register	SIO Channel A Status Register	
X'03'	SIO Channel B Command Register	SIO Channel B Status Register	
X'10'	DMA Channel 0 Address Register	DMA Channel 0 Address Register	(1)
X'11'	DMA Channel 0 Count Register	DMA Channel 0 Count Register	(1)
X'14'	DMA Channel 2 Address Register	DMA Channel 2 Address Register	(1)
X'15'	DMA Channel 2 Count Register	DMA Channel 2 Count Register	(1)
X'16'	DMA Channel 3 Address Register	DMA Channel 3 Address Register	(1)
X'17'	DMA Channel 3 Count Register	DMA Channel 3 Count Register	(1)
X'18'	DMA Mode Register	DMA Status Register	(1)
X'20'	CTC Channel 0 Control Register	CTC Channel 0 Status Register	
X'21'	CTC Channel 1 Control Register	CTC Channel 1 Status Register	
X'22'	CTC Channel 2 Control Register	CTC Channel 2 Status Register	
X'23'	CTC Channel 3 Control Register	CTC Channel 3 Status Register	
X'30'	ACU Control Signal Register	ACU Status Signals	(2)
X'40'	Internal Clock Enable Register	User Option Switches	
X'50'	Signal Bus Processor		(3)
X'60'	Signal Workstation Restart	Workstation Status Register	(4)
X'70'	Error Light Register		(5)

NOTES
  (1) Applies only to data-link processors having an Intel 8257 DMA chip.
  (2) Applies only to data-link processors having an RS-366 ACU interface.
  (3) Applies only to data-link processors attached to a new bus processor.
  (4) Applies only to single remote workstation processor.
  (5) Optional (for output of diagnostic information).

7.2.3 COUNTER/TIMER CIRCUIT (CTC)

     The Counter/Timer circuit is contained in a single chip (L66). This chip
actually contains four identical circuits, which can be used independently as
either timers or event counters. This system uses CTC Channel 0 as a software
timer, with no external connections. CTC Channel 1 is used as a synchronous
transmission clock, connected both to the Serial I/O and to the modem inter-
face. CTC Channel 2 is used by DMA Channel 0, and CTC Channel 3 is used by
DMA Channel 2, both being used to generate interrupts.

7.2.4 SERIAL INPUT/OUTPUT (SIO)

     The SIO chip contains two transmit channels and two receive channels. The
SIO Transmit Channel A output is connected to its Receive Channel B for

internal loopback diagnostic use. SIO Transmit Channel B and Receive Channel
A are connected to the RS-232 modem interface. SIO Receive Channel A is con-
nected to DMA Channel 0, and SIO Transmit Channel B is connected to DMA Chan-
nel 2.

CTC Channel 1 provides the synchronous clocking for the diagnostic loop-
back channels. In addition, this clock signal output can be switched into Re-
ceive Channel A under program control in order to guarantee clock pulses for
performance of the cyclic redundance check (CRC) in HDLC mode. The same out-
put also goes to modem interface pin 11 (the otherwise unused SECONDARY
REQUEST TO SEND signal) for null modem use.

Table 7-2 shows how signals are distributed between the SIO channels and
the modem interface.

Table 7-2.   SIO and Modem Interface Signal Distribution

DESTINATION SIGNAL	SOURCE SIGNAL	
SIO Channel A CARRIER DETECT	Modem pin 8	Carrier Detect
SIO Channel A RECEIVE CLOCK	(Determined by Clock Mode Register)	
SIO Channel A RECEIVE DATA	Modem pin 3	Receive Data
DATA TERMINAL READY - (Modem pin 20)	SIO Channel B	Data Term. Rdy
REQUEST TO SEND - (Modem pin 4)	SIO Channel B	Request to Send
SIO Channel B CLEAR TO SEND	Modem pin 5	Clear to Send
SIO Channel B TRANSMIT CLOCK	Modem pin 15	Transmit Clock
TRANSMIT DATA - (Modem pin 2)	SIO Channel B	Transmit Data
SIO Channel A CLEAR TO SEND	SIO Channel A	Request to Send
SIO Channel A TRANSMIT CLOCK	CTC Channel 1	clock output
SIO Channel B CARRIER DETECT	Modem pin 6	Data Set Ready
SIO Channel B RECEIVE DATA	SIO Channel A	Transmit Data
SIO Channel B RECEIVE CLOCK	CTC Channel 1	clock output
SECONDARY REQUEST TO SEND - (Modem pin 11)	CTC Channel 1	clock output

7.2.5 CLOCK MODE REGISTER (CMR)

The Clock Mode Register (CMR) contains only one bit, bit 0, which controls
the source signal for the SIO Channel A RECEIVE CLOCK signal, as follows:

CMR bit 0 = Logic 0	CMR bit 0 = Logic 1
RECEIVE CLOCK (from modem pin 17)	CTC Channel 1 clock output

7.2.6 DIRECT-MEMORY ADDRESSING (DMA)

The Direct-Memory Addressing (DMA) circuit is a single logic chip (L87)
that provides for the direct flow of information between memory and the SIO
ports without involving the CPU.

The 8257 chip (L87) provides four separate DMA channels, labeled CH-0
through CH-3. Each channel includes two 16-bit registers: (1) a DMA address
register and (2) a terminal-count register. Both registers must be initial-
ized before a channel is enabled. The DMA address register must be loaded
with the address of the first memory location to be accessed. The terminal-
count register must be loaded with a two-part code that identifies both the
number of DMA cycles that the associated channel is to process and the type of
DMA operation that is involved.

The two most significant bits of the terminal-count register specify the
type of DMA operation for the associated channel. These two bits are not mod-
ified during a DMA cycle, but they can be changed between DMA blocks. In gen-
eral, however, a value of n-1 (where $\underline{n}$ = the number of desired DMA cycles)
must be loaded into the 14 low-order bits of the terminal-count register.
This 14-bit value specifies the number of DMA cycles, minus one, before the
Terminal Count (TC) output is activated. A terminal count of 0, for example,
would cause the TC output to be active in the first DMA cycle for that channel.

Each channel also accepts a DMA Request input (DRQn) and provides a DMA
Acknowledge output (DACKn), as discussed in the following subparagraphs.

7.2.6.1 DMA Request Lines DRQ 0 Through DRQ 3

These four individual asynchronous-channel DMA request inputs are used by
the peripherals to obtain a DMA cycle. If the system is currently not in the
rotating priority mode, DRQ 0 has the highest priority, and DRQ 3 has the low-
est. A request can be generated by raising the associated request line and
holding it high until DMA Acknowledge conditions occur. For multiple DMA cy-
cles (Burst Mode), the request line is held high until the DMA Acknowledge
signal for the last cycle arrives.

7.2.6.2 DMA Acknowledge Lines DACK 0 Through DACK 3

An active low logic level on any of these DMA Acknowledge output lines informs the peripheral device connected to that channel that it has been selected for a DMA cycle.

7.2.7 DATA BUS BUFFER

This three-state, bidirectional, eight bit buffer (L42) interfaces the 8257 DMA chip to the system data bus:

7.2.7.1 Data Bus Lines D_0 Through D_7

These are bidirectional three-state lines. When the 8257 DMA circuit is being programmed by the CPU, eight bits of data are received on this data bus for a DMA address register, a terminal-count register, or the Mode Set register. When the CPU reads a DMA address register, a terminal count register, or the Workstation Status register, conversely, the data outputs from the applicable circuit is sent to the CPU over this same data bus. During DMA cycles (when the 8257 chip is the bus master), the 8257 chip outputs the eight most significant bits of the memory address (from one of the DMA address registers) to a 74LS373 latch (L85) via the data bus. These address bits are transferred at the beginning of the DMA cycle; the bus then becomes released to handle the memory data transfer during the balance of the DMA cycle.

7.2.8 ADDRESS BUS BUFFER

The address bus buffer (L83 and L84) uses tri-state logic to release the system address bus for use by other circuits when the CPU's BUSAK signal is active. The buffer also protects the heavily used address lines, which serve a variety of functions, from being loaded down.

7.2.8.1 Address Lines A_0 Through A_3

These four least-significant address lines are bidirectional. In the "slave" mode, they are inputs that select one of the registers to be read or

programmed. In the "master" mode, they are outputs that constitute the four
least-significant bits of the 16-bit memory address generated by the 8257.

7.2.8.2 Address Lines A_4 Through A_7

These four address lines are three-state outputs, constituting bits 4
through 7 of the 16-bit memory address generated by the 8257 chip during all
DMA cycles.

7.2.9 MEMORY ORGANIZATION

The memory organization of the DLP varies slightly, according to the con-
troller device within which it resides. In all cases, however, the memory
provides for a minimum of 16K-byte storage and a maximum of 32K-byte storage,
making use either of 16K-bit RAM chips or 2K-byte PROM chips. Parity checking
on RAM is supported. Figure 7-2 delineates the DLP memory organization.
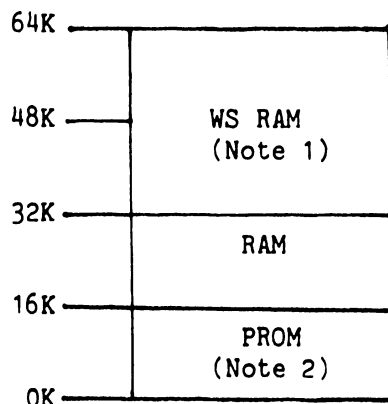
```
64K ┌──────────────┐    NOTES:
    │              │
    │   WS RAM     │    (1)  Workstation memory, which is ad
48K │   (Note 1)   │    dressed as OK through 32K by the work
    │              │    station microprocessor, is addressed as
    │              │    32K through 64K by the DLP.
32K ├──────────────┤
    │     RAM      │    (2)  Telecommunications microcode must
    │              │    be PROM resident.  Only the amount of
16K ├──────────────┤    PROM used, which may be less than 16K,
    │   PROM       │    need be loaded.
    │   (Note 2)   │
 OK └──────────────┘
```

Figure 7-2. DLP Memory Organization for the VS Single Remote Workstation

The RAMs are MOS 16Kx1-bit, dynamic memory circuits, having a chip access
time of 150 nanoseconds and a read/modify-write cycle time of 320 nanoseconds.

7.2.9.1 Multiplexed Memory Addressing

Each MOS memory chip is physically arranged as a two-dimensional array of
cells. Certain address inputs are used for row selection and the remaining
address inputs are used for column selection. Row selection is required

before the sense amplifiers can begin their slow detection process. Column
selection is not required until the outputs of the sense amplifiers become
valid, however, because its function is to gate data from the selected sense
amplifier to the data output circuitry. Since the column selection informa-
tion is not used internally until well after the row selection information is
required, only the row addresses need to be available to the chip at the start
of a cycle. The column address thus can be determined later with no penalty
of access time. The multiplexed memory address technique takes advantage of
this delayed need for a column address; rather than using 13 address lines to
select one of 16,384 memory cells, the memory first uses seven address lines
to select one of 128 rows and then subsequently uses those same seven lines to
select one of 128 columns in that selected row.

7.2.9.2 Multiplex Timing Considerations

Although address multiplexing provides some very substantial system bene-
fits, it complicates system timing. The multiplexing technique requires that
both row and column addresses get into the chip within a short time, using the
same address pins. This requirement establishes a rather tight timing window
during which the individual events must occur. The sequence of events re-
quired to address any given memory-chip location is as follows:

(1) Establish a 7-bit row address to specify one of 128 rows of storage
     cells in the chip.

(2) Bring the $\overline{RAS}$ (Row Address Strobe) signal low to start the row selec-
     tion process by the chip's sense amplifiers.

(3) Maintain that same row address valid for some minimum hold time to
     allows the chip's sense amplifiers to complete the detection process.

(4) Establish a 7-bit column address (on the same address lines) to spec-
     ify one of 128 columns in the selected row of memory storage cells.

(5) Bring the $\overline{CAS}$ (Column Address Strobe) signal low to confirm the sta-
     bilized column address.

(6) Hold that same column address valid for some minimum hold time to al-
     low the chip's sense amplifiers to complete the column-address detec-
     tion process (and to allow the associated read/write operation for
     the resultant location).

To achieve the specified access time from $\overline{RAS}$, $\overline{CAS}$ must be brought low
within some specified maximum delay after $\overline{RAS}$ goes low.

To summarize, the functions of $\overline{RAS}$ are to initiate a cycle, to strobe or
latch the row address, to enable the selected row of memory cells, to sense
and restore the data in that row of memory cells, and to maintain the sensed
data from the entire row of addressed memory cells in their respective sense
amplifiers. The sense amplifiers maintain this data as long as $\overline{RAS}$ remains
active. At the end of a cycle, when $\overline{RAS}$ is taken high, the selected row is
immediately turned off, isolating the correct data in the cells. After the
row is off, the half-digit lines are prepared for a new cycle.

$\overline{CAS}$, on the other hand, controls column selection circuitry and the trans-
fer of data from the selected sense amplifier to the output circuitry. After
$\overline{RAS}$ strobes the row address information from the multiplexed address input
pins, $\overline{CAS}$ strobes the column address from the same pins. When $\overline{CAS}$ goes active
(low), the column address is strobed or latched into the circuit. This ad-
dress is then decoded to select the proper column. Data from the selected
sense amplifier is then transferred to the output buffer, completing the
read-access operation.

The 2716 PROM is a fully-static 16,348-bit (2048 X 8), erasable programmable read-only memory. There are eight such chips (L88 through L95) in the circuit. Each has an access time of 450 ns.

7.2.10 USER OPTION SWITCHES

Software-defined User Option Switches are provided on a single chip (L44 on the 210-7478 TC/Memory board). These switches are used to set the site address of a multipoint secondary station and to set any other available user options. The switch settings are read into the Z80 accumulator as shown in Figure 7-3.

7.2.11 VS SINGLE REMOTE WORKSTATION CONTROLLER

The data-link processor in the single remote workstation controller has four aspects with respect to its interface to the workstation processor:

1.   The DLP has the ability to read and write the first 32K of the workstation memory as if it were the second 32K of its own memory.
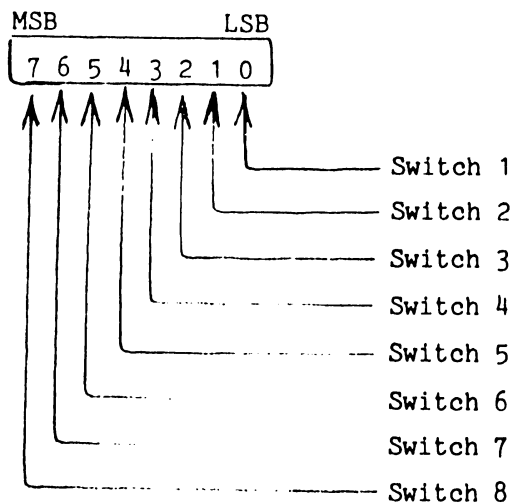
Figure 7-3. Read Sequence of L44 User Option Switches On TC/Memory Board

2.   The DLP can restart the workstation by writing an output to port X'60', thereby causing the workstation processor to begin execution at its address 0.

3. The DLP can read a Workstation Status Register, located on the
    210-7478 TC/Memory board (L22), which is connected both to a set
    of four switches that define the workstation type and to a latch
    that indicates whether a memory parity error has occurred in the
    workstation. Figure 7-4 shows the Workstation Status Register
    output format.

```
MSB             LSB
 7 6 5 4 3 2 1 0
 | | | | |   |   |____> Not Running
 | | | | |   |_____> Workstation memory parity error
 | | | | |_____> Workstation device-type switch 1
 | | | |_____> Workstation device-type switch 2
 | | |_____> Workstation device-type switch 3
 | |_____> Workstation device-type switch 4
```
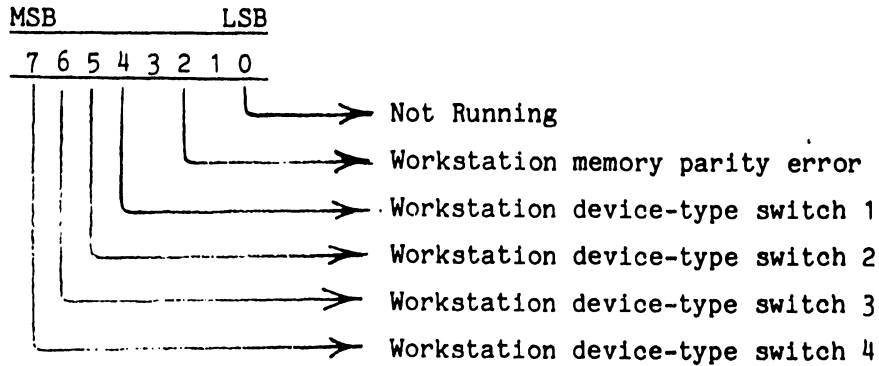
        Figure 7-4. Workstation Status Register Readout Format

4. The workstation modem which supports reverse video and box graphics
    has certain hardware which must be initialized by the workstation
    processor. For reason of compatibility with other workstation mod-
    els, this hardware is not visible to the workstation-resident appli-
    cation software. Instead, it is initialized by a routine that is
    loaded into the workstation by the data-link processor and executed
    by the workstation processor at power-up time.

7.3 WORKSTATION PROCESSOR (210-7479 ENHANCED WORSTATION CPU)

                        TO BE SUPPLIED

SECTION
8
DIAG-
NOSTICS
TESTING

SECTION 8

DIAGNOSTICS TESTING

8.1 GENERAL

     The purpose of the 2246R Diagnostics Test is to verify the basic opera-
tional integrity of the following logic boards of the 2246R Remote Workstation
and to make their respective status known to the operator:

     1.   210-7478 TC/Memory Board ("MEM/DL" PC-board).

     2.   210-7479 Enhanced Workstation CPU ("CRT/CPU" PC-board).

8.2 EQUIPMENT REQUIREMENTS

     RS-232 Loopback Connector (see Figure 8-1)

8.3 OPERATING PROCEDURE

     1.   For "E-REV 0" 210-7478 TC/Memory boards, install a Diagnostics 2K
          PROM (2716, WLI # 378-4130) in location L94 in place of the normal-
          operation PROM used in that location. For "E-REV 1" boards, install
          that Diagnostic 2K PROM in location L95.

     2.   Insert two optional Hex LED's (WLI #340-0015) in locations L43 and
          L45 on that same TC/Memory board.

     3.   Select the desired test mode.

          The PROM-loaded Diagnostics Test is activated by means of switch set-
          tings at location L44 on the 210-7478 TC/Memory board, between the
          two diagnostics readout LED's. The test has two different test modes:

```
!--------------------------------------------------------------!
!                                                              !
!                                                              !
!       !------------------------------------------------------------!
!       !                                                    !       !
!       !                                                    !       !
!       !                                        !01!        !       !
!       !                                  !14!                !     !
!       !    !-----TRANSMIT DATA------!02!                     !     !
!       !    !                        !15!---TRANSMIT CLOCK---!      !
!       !    !------RECEIVE DATA------!03!                            !
!       !                            !16                       !     !
!       !    !----REQUEST TO SEND-----!04!                     !     !
!       !    !                        !17!---RECEIVE CLOCK----!
!       !    !------CLEAR TO SEND------!05!                           !
!       !                            !18!                             !
!       !    !-----DATA SET READY------!06!                           !
!       !    !                        !19!                             !
!       !    !                        !07!                             !
!       !    !                        !20!---DATA TERMINAL READY----!
!       !----!-----CARRIER------------!08!
!       !                            !21!
!                                    !09!
!                                    !22!
!                                    !10!                    JUMPER LOCATIONS
!                                    !23!                    Pin   to   Pin
!--INT. CLK/SEC. REQUEST TO SEND---!11!                       2          3
!                                    !24!                      4          5
!--SEC. RECEIVE LINE TO DETECTOR---!12!                        6          8
!                                    !25!                      8         20
!                                !13!                         11         12
                                                              12         15
                                                              15         17
```

Figure 8-1. Loopback Test Connector Wiring
(For Standard RS-232-C 25-Pin Male Connector, WLI #350-1030)

a. Continue-On-Error Mode   -   Recycles full range of tests in
                                    continuous sequence.

b. Selected Test Module Mode -   Repeats a selected Diagnostics Test
                                    Module continuously.

8.3.1 CONTINUE-ON-ERROR MODE TESTING:

1. Set switch S_8 in the L44 switchbank on the 210-7478 TC/Memory board
    to the ON position. The PROM-loaded firmware program automatically
    tests the following function circuits in a continually repeating loop
    mode:

    a. Memory.

    b. Workstation CPU, Workstation CPU Memory Parity, and Video Timer-
        Controller (VTAC).

    c. Clock-Timer Circuit (CTC) (Internal Loopback Mode).

    d. Serial Input/Output (SIO) Circuit (Internal Loopback Mode).

    e. Direct Memory Addressing (DMA) Function (Needs loopback connec-
        tor).

8.3.2 SELECTED-TEST-MODULE MODE TESTING

1. Set the Remote Workstation's power breaker to OFF.

2. In the L44 switchbank on the 210-7478 TC/Memory board, set both
    switch S_8 and the particular switch associated with the desired
    test module (refer to Table 8-1) to the ON position. (Only these two
    switches should be ON at any one time; if more than two switches are
    ON -- e.g., $S_8 + S_1 + S_2$ -- the software will function on a
    continuous loop over the entire program, thereby duplicating the Con-
    tinue-On-Error mode.)

3. Test modules are executed in sequence until the test module associa-
    ted with the currently active switch selection is reached. The pro-
    gram then loops continuously on that particular test module.

Table 8-1. Selectable 2246R Diagnostics Test Modules

DIAGNOSTICS PROGRAM TEST MODULE	ASSOCIATED SWITCH (PLUS SW. 8)
MEMORY Test	1

WORKSTATION CPU/
    WORKSTATION CPU MEMORY PARITY/
    VTAC Test
	2

CTC Test (Internal Loopback Mode)	3
SIO Test (Internal Loopback Mode)	4
DMA Test (Needs Loopback Connector)	5

If switches S_8 and S_4 are ON, for example, the Diagnostics Test
program runs the first three test modules once and then loops contin-
uously on the SIO test module, without performing the DMA test module.

8.4 ERROR CODES

A 2-bit error code value is displayed both by the optional hex-readout
LED's on the 210-7478 TC/Memory board (visible through a cutout in the middle
of the back surface of the 2246R Remote Workstation cover) and as part of a
special CRT-screen presentation produced during performance of the Diagnostics
Test. Table 8-2 lists and defines the error-code values.

When Remote Workstation power is turned on with the Diagnostics Test
PROM's in place, the workstation's CRT screen automatically produces the spe-
cial IPL test presentation shown in Figure 8-2. The greater part of this
presentation consists of a quality-check readout of the first 24 letters of
the English alphabet, each row containing 80 occurrences of its respective
letter, except that the top row replaces part of the A-character string with
Diagnostics Test results, including the following information:

1. ERROR CODE=nn (where nn identifies any one of 21 error conditions, as
    listed in Table 8-2).

Table 8-2. Diagnostics Test ERROR CODE Readouts

ERROR CODE	CAUSE/SOURCE OF ASSOCIATED ERROR
01	DLK memory parity failed - (test module 1).
02	Nonmaskable parity error did not occur - memory test (test module 1). (No interrupt occurs.)
03	Bad data found in 48K RAM memory - (test module 1).
04	R/W control memory error in Workstation CPU (PCB 7479) - (test module 2).
05	R/W CRT memory error in Workstation CPU - (test module 2).
06	Slave status register did not indicate Workstation CPU IPL module - (test module 2).
07	Slave status register did not indicate slave run mode - (test module 2).
08	Slave CPU not operational - (test module 2).
09	CTC did not generate an interrupt - (test module 3).
10	CTC did not generate correct number of interrupts - (test module 3).
11	VTAC column port bad - (test module 2).
12	VTAC line port bad - (test module 2).
13	Channel A SIO transmitter status (CTS not high) - (test module 4).
14	Channel B - SIO receiver status bad - (test module 4).
15	SIO data bad - (test module 4).
16	SIO transmitter status bad - (test module 4).
17	SIO receiver status Channel B bad, RCVX bit data not high - (test module 4).
18	DMA terminal count bit bad - (test module 5).
19	DMA data receiver bad - (test module 5).
20	SIO transmitter status bad (hunt mode on) - either SIO test (test module 4) or DMA test (test module 5)
21	Slave CPU memory parity error - (test module 2).
FF	No error conditions detected during full test sequence.

```
IPL TEST - ERROR CODE=nn PART-n COUNT nnnnnnnn ERR-CNT = nnnn AAAAAAAAAAAAAAAAAA
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG
HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
JJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJJ
KKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKK
LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL
MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
00000000000000000000000000000000000000000000000000000000000000000000000000000000
PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
QQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQ
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
UUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUU
VVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVV
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Figure 8-2. Diagnostics Test Presentation on 2246R Remote Workstation Screen

2. PART-n (where n identifies the inprocess test module, as listed in
    Table 8-1, reading zero if the "Continue-on-Error" mode is in pro-
    cess).

3. COUNT nnnnnnnn (where nnnnnnnn identifies the number of times the
    given Diagnostic Test module has been performed in the current test
    sequence).

4. ERR-CNT=nnnn (where nnnn identifies the number of Diagnostic Test
    failures detected during the continuing sequence).

Error-code readouts usually are displayed both on the workstation CRT
screen, as shown in Figure 8-2, and by the optional hex-readout LED's on the
210-7478 TC/Memory board. When switches S_8 and S_1 both are ON at the same
time, however, error codes are displayed on the hex-readout LED's (when appli-
cable), but a NO DISPLAY message is produced on the CRT screen.

If no errors are found, the hex-readout LED presentation should change
from 00 to FF without stopping at any intermediate values.

SECTION
9
PREVENTIVE
MAINTENANCE

SECTION 9

PREVENTIVE MAINTENANCE

9.1 GENERAL

Perform the following preventive maintenance procedure at two-week
intervals (or more frequently if equipment is installed in an unusually dirty
environment):

1. Check fan blower for proper operation. Confirm that fan motor is
    operating, that air is being drawn into left-side cabinet vents, and
    that air is being exhausted from right-side cabinet vent.

2. Dust keyboard and inspect the keyboard area for any foreign material
    that might have dropped between the keys, removing such material if
    found.

3. Clean face of CRT and external surfaces of cabinet with a soft cloth
    and a mild detergent, used sparingly.

4. Check workstation for proper operation of all keys and display/entry
    functions.

SECTION
10
ADJUST-
MENTS

SECTION 10

ADJUSTMENTS

10.1 GENERAL

This section contains basic adjustments and operating paramter information, including DC-voltage adjustments, video display paramter adjustments, a reference table for IC pin voltages, and logic-board selector switch settings.

10.2 DC VOLTAGE ADJUSTMENTS

Adjustment pots for regulated power supply outputs are located on the 210-7156-1 Power Supply Regulator board. To check out and/or adjust DC voltages in the 2246R Remote Workstation, proceed as follows:

a. Turn off 2246R Remote Workstation power.

b. If voltage check is to be followed by adjustment of video display paramters, as per paragraph 10.3, use a greasepencil or any nonindelible marker to outline the perimeter of the CRT viewing-area aperture in the workstation cover directly on the CRT screen (refer to Figure 10-3).

c. Remove workstation main cover (refer to paragraph 3.2).

d. Turn workstation power back on.

e. Using a VTVM, check the following voltages:

+5.0V (+0.1V)   At pin B of connector 2 on 210-7478 TC/Memory board
                 (see Figure 10-1). If measurement does not fall within
                 range from +4.9V through +5.1V, adjust potentiometer R5
                 on 210-7156 Power Supply Regulators board (refer to
                 Figure 10-2) to bring measurement within +5.0V + 0.1V
                 limits.

-5.0V (+0.1V)   At pin A of connector 3 on 210-7478 TC/Memory board
                 (see Figure 10-1). If measurement does not fall within
                 range from -4.9V through -5.1V, adjust potentiometer
                 R35 on 210-7156 Power Supply Regulators board (refer to
                 Figure 10-2) to bring measurement within -5.0V + 0.1V
                 limits.

+12.0V (+0.1V)   At pin S of connector 2 on 210-7478 TC/Memory board
                 (see Figure 10-1). If measurement does not fall within
                 range from +11.9V through +12.1V, adjust potentiometer
                 R16 on 210-7156 Power Supply Regulators board (refer to
                 Figure 10-2) to bring measurement within +12.0V + 0.1V
                 limits.

-12.0V (+0.1V)   At pin Z of connector 3 on 210-7478 TC/Memory board
                 (see Figure 10-1). If measurement does not fall within
                 range from -11.9V through -12.1V, adjust potentiometer
                 R24 on 210-7156 Power Supply Regulators board (refer to
                 Figure 10-2) to bring measurement within -12.0V + 0.1V
                 limits.

+0V (+0.1V)   At pin A of connector 2 on 210-7478 TC/Memory board
                 (see Figure 10-1). If measurement does not fall within
                 range from -0.1V through +0.1V, troubleshoot power
                 supply system. (There is no adjustment for the +0.0V +
                 0.1V voltage-return line.)

+18.0V (+0.1V)   At common D1/D3 cathode connection on 210-7156 Power
                 Supply Regulators board (refer to Figure 10-2). If
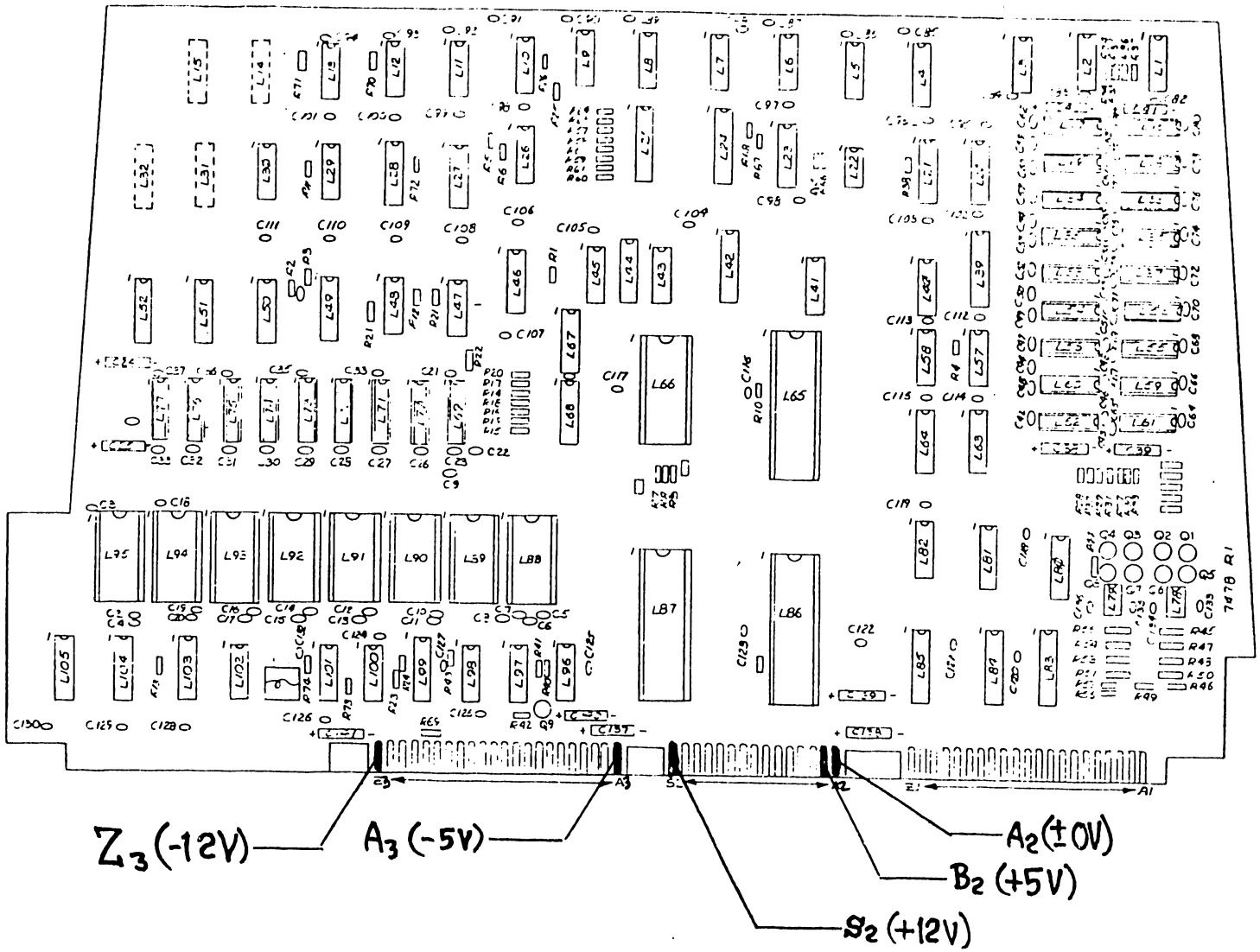
Figure 10-1   Test Points on 210-7478 TC/Memory board
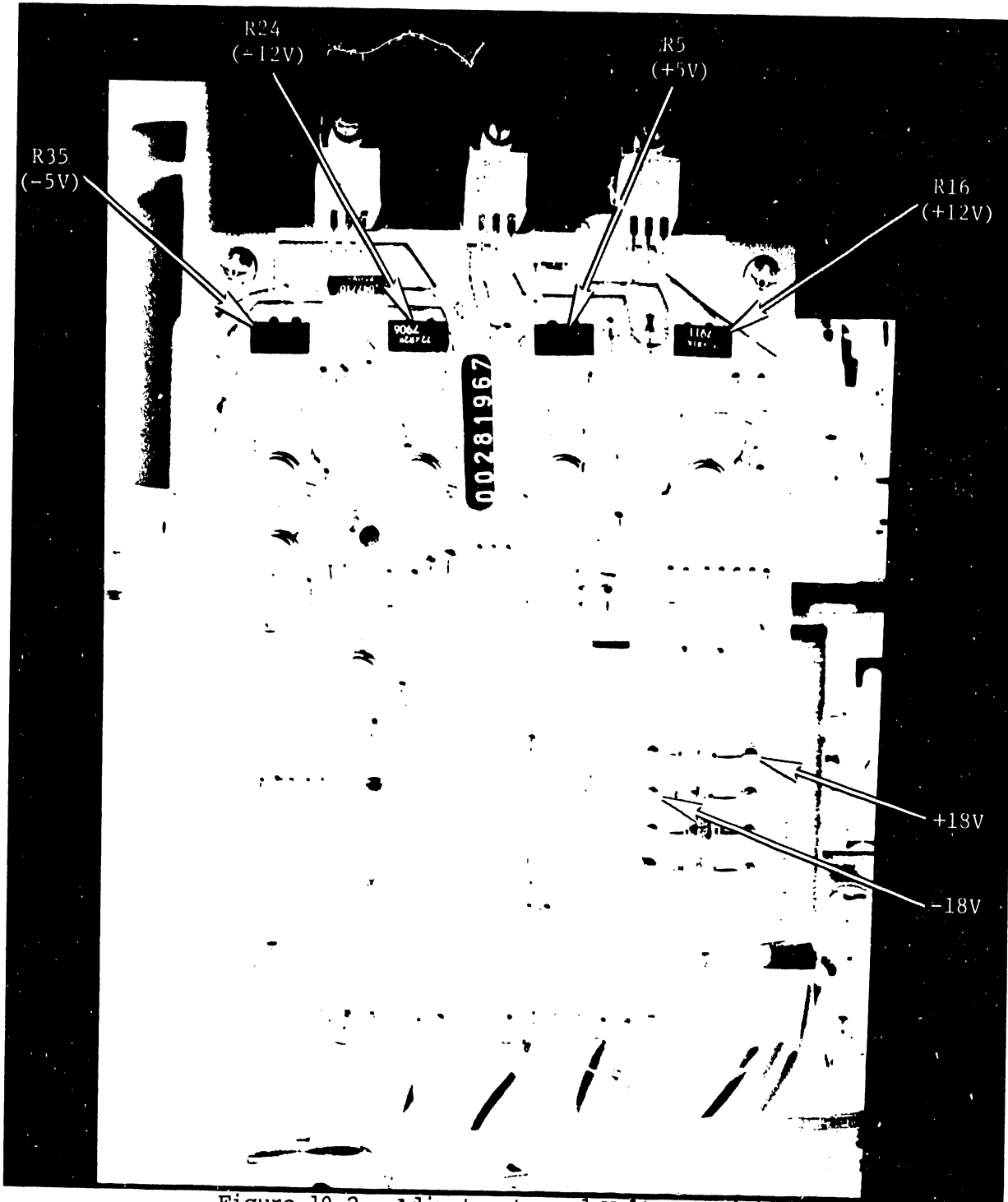
Figure 10-2. Adjustments and Voltage Points on
210-7156 Power Supply Regulators Board

measurement does not fall within range from +17.9V

through +18.1V, troubleshoot power supply system.

(There is no adjustment for the +18.0V $\pm$ 0.1V voltage.)

-18.0V ($\pm$0.1V)   At common D2/D4 anode connection on 210-7156 Power

Supply Regulators board (refer to Figure 10-2). If

measurement does not fall within range from -17.9V

through -18.1V, troubleshoot power supply system.

(There is no adjustment for the -18.0V $\pm$ 0.1V voltage.)

10.3   VIDEO DISPLAY ADJUSTMENTS

To check out and/or adjust video diaplsy parameters, confirm that all DC
voltages are within specification, as per paragraph 10.2 and then check each
adjustment setting described in the following subparagraphs.

10.3.1   BRIGHTNESS AND CONTRAST ADJUSTMENTS

Perform the turn-on procedure of Section 6 of this document to initialize
the 2246R Remote Workstation and obtain a video raster on the CRT screen,
together with the VS LOGIN presentation. Monitoring that presentation, adjust
the front-panel BRIGHTNESS and CONTRAST controls as applicable to obtains a
desirable operator-viewing intensity (refer to Figure 10-3).
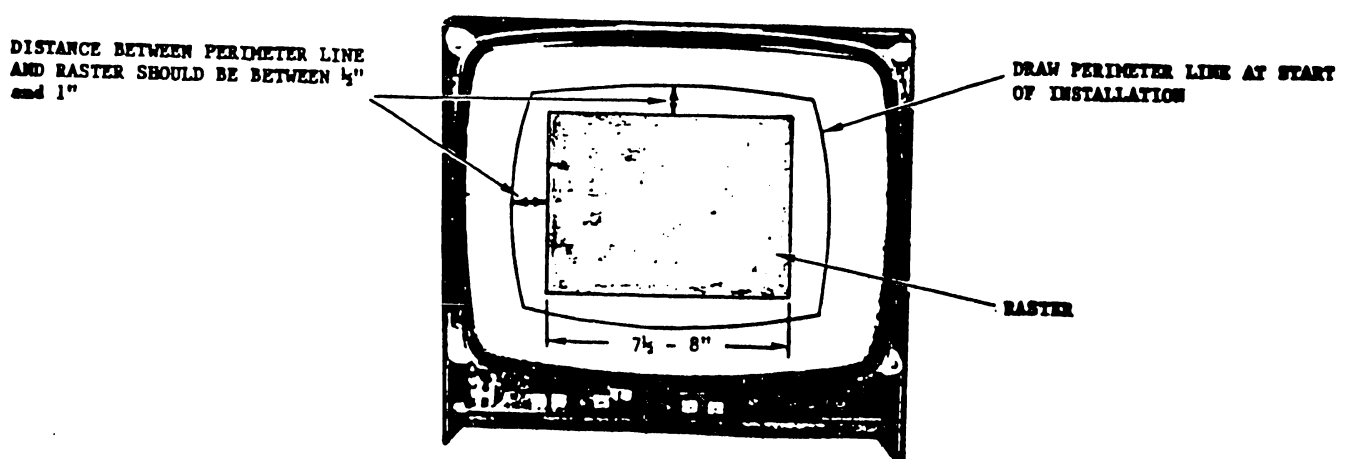
Figure 10-3. Relationships Between Display Raster Position
         and CRT Screen Viewing-Area Aperture

10.3.2   VERTICAL LINEARITY ADJUSTMENT

Confirm that the LOGIN (or other menu, as desired) presentation shows rows of equal-height characters. If the rows are uneven, adjust vertical-linearity potentiometer R18 on the 210-7456 CRT Monitor Electronics board (refer to Figure 10-4) to bring vertical linearity within adjustment.

10.3.3   VERTICAL SIZE ADJUSTMENT

Confirm that the distance between the top edge of the CRT raster and the test-setup perimeter line drawn on the CRT screen (as drawn prior to removal of main cover assembly, per paragraph 10.2.b) measures within range from 1/2" through 1" (refer to Figure 10-3). If the given presentation does not fall within this range, adjust vertical-size potentiometer R24 on the 210-7456 CRT Monitor Electronics board for compliance with 3/4" $\pm$ 1/4" specification limits.

10.3.4   HORIZONTAL WIDTH ADJUSTMENT

Confirm that the horizontal width of the CRT raster measures within the range from 7-1/2" through 8", with a space of 3/4" $\pm$ 1/4" between each end of that horizontal distance and the test-setup perimeter line drawn on the CRT screen (refer to Figure 10-3). If the given presentation does not fall within theses ranges, adjust width coil Z2 on the 210-7456 CRT Monitor Electronics board for compliance with these 7-3/4" $\pm$ 1/4" width and 3/4" $\pm$ 1/4" spacing specification limits.

10.3.5   HORIZONTAL PHASING CHECK

Confirm that the letters displayed in the existing menu presentation are horizontally aligned within the CRT displays raster. If not, adjust horizontal phase potentiometer R35 on the 210-7156 CRT Monitor Electronics board to center the character set horizontally.

10.3.6   FOCUS

Adjust focus potentiometer R28 on the 210-7156 CRT Monitor Electronics board for operator's preference of best overall focus.
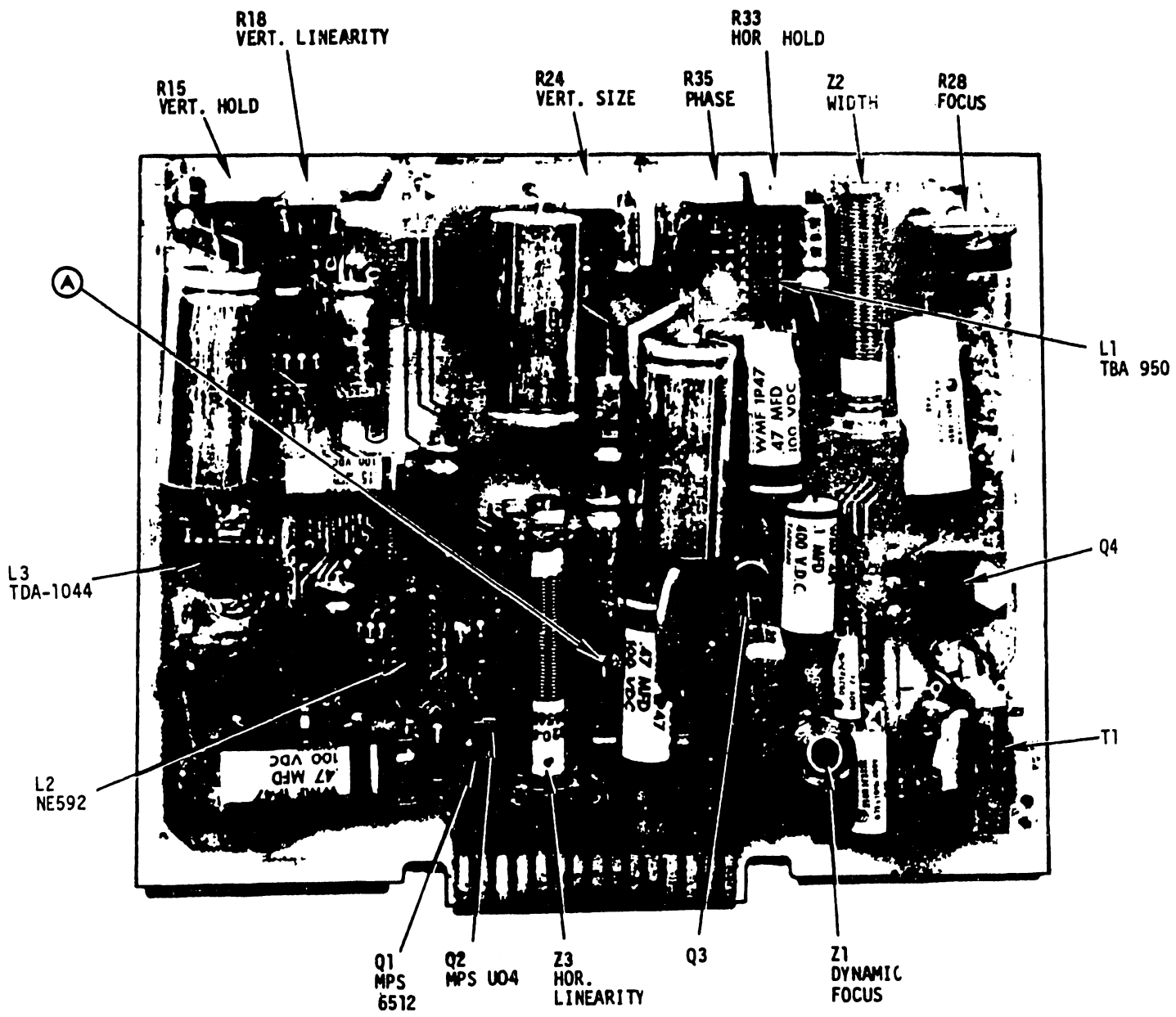
Figure 10-4. Adjustments on 210-7456 CRT Monitor Electronics Board

Following completion of the preceding adjustments, turn off workstation power, clean the CRT display screen with a very mild detergent and a soft cloth to remove the greasepencil/ink markings, and then reinstall the main cover on the workstation unit.

10.4 IC VOLTAGE TEST POINTS

Table 10-1 delineates input-voltage pins for all IC's used in the telecommunications system circuits.

Table 10-1. Power-Supply Voltage Pins for Telecommunications System IC's

ASSOCIATED IC PINS \ POWER SUPPLY OUTPUTS	-12V	-5V	±0V	+5V	+12V
LS04, S04, LS08, LS32, LS74, 125, LS280	---	---	7	14	---
LS75, LS138, LS139, LS157, LS194, LS368, LS367	---	---	8	16	---
LSS240, LS244, LS245, LS373	---	---	10	20	---
Z80 CPU	---	---	29	11	---
Z80 CTC	---	---	5	24	---
Z80 SIO	---	---	31	9	---
8257 DMA	---	---	20	31	---
2716 EPROM	---	21	12	24	19
4116 RAM	---	1	16	9	8
75150	5	---	4	---	8
75154	---	---	8	15	---

10.5 SELECTOR SWITCH SETTINGS

Each of the two large logic cards mounted behind the CRT subassembly on the 2246R Remote Workstation contains digital-logic switch circuits. The foremost 210-7479 Workstation CPU board, mounted in the motherboard CRT/CPU slot, contains a single switchbank, containing a set of eight switches. These switches perform no software-supported function at the present time, but their data outputs can be read by the Workstation CPU logic and may at some future time have meanings assigned to them. Until further notice, all eight switches should be left in their factory-set OFF position.

The rearmost 210-7478 TC/Memory board, mounted in the motherboard MEM/DL slot, has two switchbanks. One switchbank set, mounted in location L22, contains five switches, labeled S1 through S5. Switch S5 currently is not used. Switches S1 through S4 are designed to provide a device-type identification code, with switch S1 being the least-significant bit and switch S4 being the most-significant bit. For the single-site configuration currently being supported, all five switches should be left in their factory-set OFF position. While the device-type code provided by these switches becomes part of a power-turnon message, the current DLP firmware does not send power-turnon messages to the host computer. (An equivalent effect is obtained, however, because the 22V06 TC IOP logic recognizes the establishment of communications with the Remote Workstation and subsequently notifies the VS CPU that the particular DLP controller -- and associated device(s) -- has become powered.)

The other switchbank set on the TC/Memory board is an 8-pole switchbank in location L44. In normal operation, switches S1 through S5 of this switchbank provide the remote address selection used by the VS CPU to identify the given Remote Workstation, with switch S1 representing the least-significant bit and switch S5 representing the most-significant bit, and switches S6 through S8 are not used. During performance of the Diagnostics Test program, these same switches identify which test modules are to be performed (for further details, refer to Section 8). For the single-site configuration currently being supported, all eight switches should be left in their factory-set OFF position during normal operation -- and should be returned to the OFF positions following any Diagnostics Test exercises.

SECTION 11 TROUBLE-SHOOTING

SECTION 11

TROUBLESHOOTING

11.1 GENERAL

This section provides information useful for isolating failure conditions
associated with the Telecommunications System. The information includes a
description of the ITS 1 EIA Interface Test Set and a discussion of general
telecommunications troubleshooting, together with a detailed troubleshooting
checklist and a full description of RS-232-C interface/control signals. The
section also includes detailed self-test procedures for the Bell 201C and 208B
Data Sets (the most common data sets to be found in the field).

11.2 ITS 1 EIA INTERFACE TEST SET

The ITS 1 EIA Interface Test Set is a self-contained pocket-sized test set
that can be used for checkout of Data Communication Equipment (DCE), or modem,
and Data Terminal Equipment (DTE) -- i.e., a 2246R Remote Workstation. As il-
lustrated in Figure 11-1, the ITS 1 test set can be connected (1) to the DCE
to simulate a DTE, (2) to the DTE to simulate a modem, or (3) between the DCE
(modem) and the DTE (workstation) to monitor their operating communications
lines. The ITS 1 test set thus permits the user to test and/or monitor the
EIA RS-232 signals and hence to isolate and identify sources of trouble. Ta-
ble 11-1 delineates the basic specifications of the test set.

The ITS 1 test set contains nine indicators that continuously monitor the
level of nine RS-232-C interface signals: TRANSMITTED DATA, RECEIVED DATA,
REQUEST TO SEND, CLEAR TO SEND, DATA SET READY, RECEIVED CARRIER DETECT, DATA
TERMINAL READY, SIGNAL QUALITY DETECT, and RING INDICATOR. Two other indica-
tors monitor the TRANSMIT CLOCK and RECEIVE CLOCK signals; unlike the nine
levels indicators, however, these two indicators do not respond when only a DC

```
!---------!              !---------!
!   (DTE) !              !         !
! TERMINAL !--//----//--! ITS 1  !
!  OR CPU !              !         !
!---------!              !---------!


!---------!              !---------!
!         !              !  (DCE)  !
! ITS 1   !--//----//--! MODEM   !
!         !              !         !
!---------!              !---------!


!---------!          !-------!          !---------!
!   (DTE) !          !       !          !  (DCE)  !
! TERMINAL !--//----//--! ITS 1 !--//----//--! MODEM   !
!  OR CPU !          !       !          !         !
!---------!          !-------!          !---------!
```
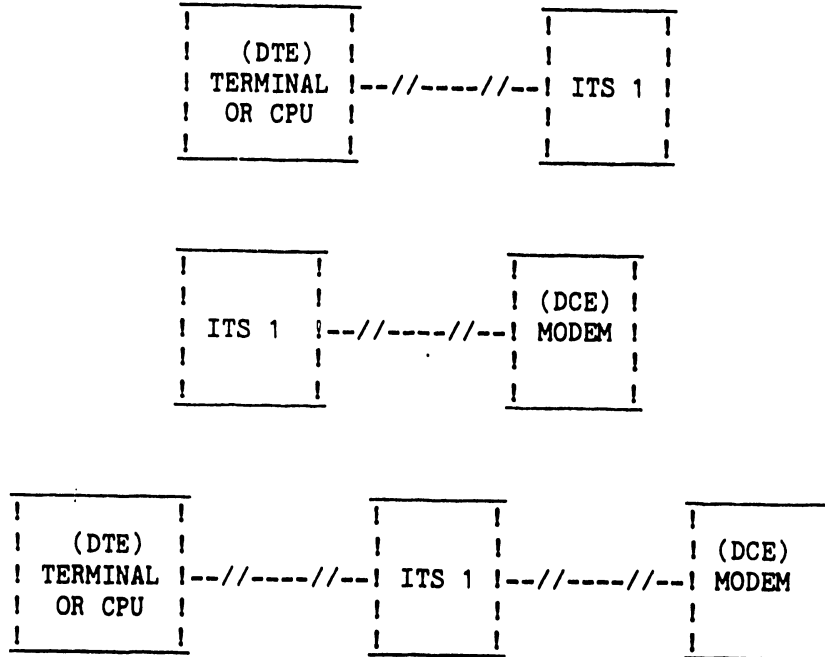
Figure 11-1.   Typical ITS 1 Test Setup Applications

Table 11-1.   Basic Specifications of the ITS 1 EIA Interface Test Set

Level Indicators   Activity Indicators ....TRANSMIT CLOCK
                                                              RECEIVE CLOCK
TRANSMITTED DATA
RECEIVED DATA   Indicator Thresholds..........±3 volts
REQUEST-TO-SEND
CLEAR-TO-SEND   Indicator Input Impedance.....30,000 ohms
DATA SET READY
RECEIVED CARRIER   Power.........................Two 1.5V AA Batteries
   DETECT
DATA TERMINAL READY   Dimensions....................5.5"l x 3.6"w x 1.6"h
SIGNAL QUALITY DETECT
RING INDICATOR   Weight........................12 oz.
POSITIVE TEST
NEGATIVE TEST

level is present but instead turn on only when an active clock signal is pres-
ent. Finally, two additional, uncommitted indicators are available for moni-
toring either positive or negative levels on any of the interface lines.

The ITS 1 test set contains 24 on/off toggle switches, which allow any of
the interface signals except line 1 (FRAME GROUND) to be interrupted. These
switches are physically located in the center of the front panel, functionally
dividing the test set into two halves. The upper half contains a cable and
connector for connecting the test set to the DCE (modem). The indicators that
monitor signals originating from the modem are also located on the upper half
of the front panel.

The lower half of the test set's front panel contains a connector to which
the DTE (terminal or CPU) can be connected, together with indicators that mon-
itor signals originating from the DTE. All indicators are labeled with both
the standard EIA designation and the commonly used abbreviations. The lower
half of the panel also contains positive and negative test indicators. Final-
ly, the test set's front panel also contains two sets of 25 jumperconnection
pins, one set located above the center bank of switches, and the other set lo-
cated below those switches. These pins permit monitoring of any of the inter-
face lines with either or both of the positive and negative test indicators,
using jumpers supplied or using a probe with an external meter or oscillo-
scope. Both sets of pins are arranged in the same configuration and order as
the pins in a standard EIA RS-232 female connector.

The ITS 1 test set is housed in a sturdy plastic case with aluminum extru-
sions and a hinge. A positive latch is provided on the cover to keep the test
set securely closed when not in use. The test set is self-contained and is
powered by two penlite batteries, which provide over 100 hours of continuous
operation.

11.3 GENERAL TELECOMMUNICATIONS SYSTEM TROUBLESHOOTING HINTS

Troubleshooting the telecommunications system is a complex task involving
many factors and components, including telephone lines, modems, and host com-
puters, any of of which can cause a problem. But problems are not always due
to hardware failures. For example, more than 70% of the problems encountered

during telecommunications system installations are caused by insufficient in-
formation for sign-on procedure, wrong modem options, or inadequate knowledge
of operating procedures.

11.3.1 TROUBLESHOOTING CHECKLIST

    As a first-attack approach for any problem, proceed as follows:

    a. Check the entire remote workstation by running all available diagnos-
        tics tests and checking all voltages.

    b. Check the telecommunications processor for correct addressing.

    c. Visually inspect the cards for any broken components, shorted etches,
        etc. Make sure the cards are seated properly in connectors.

    d. Run the off-line Diagnostic Test if available (refer to Section 8).
        Most of the hardware functions are checked by the Diagnostic Test.

    e. Check the telecommunications interconnection cable for any bad con-
        tacts. Do a continuity check on the cable from one end to the other
        end, making sure all the required signal wires are connected on both
        ends of the cable.

    f. Call the Telephone Data Service Center and have the modem checked.
        If possible, be present when the modem service representative arrives
        and show him the problem.

    g. Make sure the customer's host computer can support the Wang telecom-
        munications system. If the host computer can support only single re-
        cord blocks, for example, a change is required in the 2246R Remote
        Workstation controller's firmware to accomodate that host computer.

    h. Contact host computer data processing personnel to discuss sign-on
        procedures and/or the given problem. Almost all sign-on problems can
        be resolved this way. (If you know anyone else using the same host
        computer or a similar system, find out how he is using it.)

i. Most important of all, try to get help from your Area Office, the
    program analyst, or the Home Office, as applicable.

11.3.2 CHECKOUT OF MODEM CONTROL SIGNALS

If the modem is suspected of causing trouble, set the modem in the "Data"
mode and then use an oscilloscope to check the RS-232-C control signals, as
detailed in the following steps. To obtain access to these interface signals,
either mount the 210-7478 TC/Memory board on a card extender or install the
previously discussed ITS 1 EIA Interface Test Set. Signal pin numbers given
in these steps refer to the standard 25-pin Cannon connector.

NOTE

Pins 1 and 7 are chassis ground and reference
ground, respectively. Before examining any
true interface signals, check for any noise
on the ground circuit.

a. Pin 2 -- TRANSMITTED DATA (to data set).

    Data signals on this line are generated by the data terminal equip-
    ment (DTE) -- i.e., the 2246R Remote Workstation. Check to confirm
    whether the terminal is transmitting data when in the transmit mode.
    The data terminal will not transmit data unless the CLEAR-TO-SEND
    signal is on (+3V to +25V on pin 5) while both the DATA TERMINAL
    READY signal is on (+3V to +25V on pin 20) and the DATA SET TERMINAL
    READY signal is on (+3V to +25V on pin 6).

b. Pin 3 -- RECEIVED DATA (from data set).

    Data signals on this line are generated by the receiving data set in
    response to data signals from a remote data set. This line is always
    held in the mark state (-3V to -25V) when the RECEIVED LINE SIGNAL
    DETECTOR signal is off (-3V to -25V at pin 8).

c.   Pin 4 -- REQUEST-TO-SEND (to data set).

The data terminal activates an on signal (+3V to +25V) on this line
whenever that terminal intends to transmit data. After turning this
signal on, the data terminal must wait for the CLEAR-TO-SEND signal
to go on (+3V to +25V on pin 5) before starting data transmission.

d.   Pin 5 -- CLEAR-TO-SEND (from data set).

This signal is generated by the data set to indicate whether or not
the data set is ready to transmit data. This circuit is turned on
(+3V to +25V) in response to an active REQUEST-TO-SEND signal (+3V to
+25V on pin 4), with this response being delayed approximately 50 ms
to 200 ms (depending on type of modem and customer options selected).

e.   Pin 6 -- DATA SET READY (from data set).

An on condition (+3V to +25V) on this line indicates that the data
set is in its "Data" mode and is capable of receiving and transmit-
ting data. The DATA TERMINAL READY signal must be on (+3V to +25V on
pin 20) during Data-mode operation. An off condition (-3V to -25V)
on this pin indicates that the data set is in one of its "Talk" or
"Test" or "On-Hook" modes.

f.   Pin 8 -- RECEIVED LINE SIGNAL DETECTOR (carrier) (from data set).

An on condition (+3V to +25V) on this line indicates the presence of
a data carrier signal above the receiver threshold for a period of at
least 47±3 ms. This signal is on during "Receive" mode operation and
will turn off (-3V to -25V) to disable the receiver when the data
terminal is in its "Transmit" mode or whenever the REQUEST-TO-SEND
signal is turned on (+3V to +25V on pin 4).

g.   Pin 15 -- TRANSMITTER SIGNAL ELEMENT TIMING (<u>from</u> data set).

The data set presents square-wave signals on this line at 2000 Hz
(for 2000 baud modem), or 2400 Hz (for 2400 baud modem), or 4800 Hz
(for 4800 baud modem) to provide the DTE (i.e., the Remote Worksta-
tion) with signal-element timing information for the transmitted data
circuit. A timing signal will be present on this line at all times
while data set power is on.

h.   Pin 17 -- RECEIVER SIGNAL ELEMENT TIMING (<u>from</u> data set).

The data set presents square-wave signals on this line at 2000 Hz
(2000 baud modem), or 2400 Hz (2400 baud modem), or 4800 Hz (4800
baud modem) to provide the DTE with receiver signal-element timing
information. The transition from <u>on</u> to <u>off</u> normally indicates the
center of each signal element on the received-data circuit. For 201A
and 201C data sets, a timing signal will be present on this circuit
while the carrier (RECEIVED LINE SIGNAL DETECTOR) is <u>on</u> (+3V to +25V
on pin 8).

i.   Pin 20 -- DATA TERMINAL READY (<u>to</u> data set).

The data terminal must present an <u>on</u> condition (+3V to +25V) on this
line at all times to go into the "Data" mode. An <u>off</u> signal (-3V to
-25V) on this line will not allow data set to go into the "Data"
mode. If an <u>off</u> condition (-3V to -25V) appears on this line during
data transmission or reception, the data set will drop the communi-
cation line, terminating the inprocess data exchange.

11.4 <u>MODEM SELF-TESTS</u>

Several manufacturers, including Bell Telephone, build a loopback test or
other self-test capabilities into their modems. Before calling the local
Telephone Company or other manufacturer personnel about any problem(s), use
these self-test features to check modem operation. The following paragraphs
give self-test instructions for the Bell 201C and 208B data sets. For other
data set models, refer to test procedures given in the modem operating manual.

11.4.1 DATA SET 201C SELF-TESTS

11.4.1.1 201C Data Set Switch Buttons

The front panel of the 201C data set contains five switch buttons. The functions of these switch buttons are as follows:

1.   RO (Receive Only) - Depression of this switch button conditions the data set such that it acts locally as a receiver (used for testing, only).

2.   AL (Analog Loopback) - Depression of this switch button connects the output of the local transmitter to the input of the local receiver.

3.   ST (Self Test) - Depression of this switch button causes the data set transmitter to turn on and transmit a fixed pattern.

4.   RT (Remote Test) - Depression of this switch button conditions the data set such that it can be tested remotely from a Telephone Company Data Test Center (DTC).

5.   DL (Digital Loopback) - Depression of this switch button enables digital loopback testing on a 4-wire data set.

11.4.1.2 201C Data Set Status Indicators

The data set's front panel contains eight status indicators. Each indicator lights a portion of the front panel to show the name of the control line being monitored. The indicators and their functions are as follows:

1.   ON indicator - Lights when the power cord is plugged into an appropriate ac-power source, providing from 105 volts through 130 volts.

2.   TR (Terminal Ready) - Monitors the status of the DATA TERMINAL READY signal on the customer interface. When this indicator is lit, the DATA TERMINAL READY line is in the on condition, telling the data set that the terminal is ready for data communication.

3. MR (Modem Ready) - Monitors the status of the DATA SET READY signal on the customer interface. When this indicator is lit, the DATA SET READY line is in the on condition and the DCE (i.e., modem) is ready for data communication.

4. RS (Request-To-Send) - Monitors the status of the REQUEST-TO-SEND signal on the customer interface or from the internal circuits which check the data set. When this indicator is lit, the REQUEST-TO-SEND line is in the on condition, telling the data set to become conditioned to transmit data. In normal operation, when the CO indicator is on, the RS indicator will be off regardless of the status of the RS signal at the customer interface.

5. CS (Clear-to-Send) - Monitors the status of the CLEAR-TO-SEND signal on the customer interface during both normal and test modes of operation. When this indicator is lit, the CLEAR-TO-SEND line is in the on condition and the data set is ready to transmit data.

6. CO (Carrier On) - Monitors the status of the CARRIER ON signal on the customer interface during both normal and test modes of operation. This indicator lights while a signal is being received by the data set.

7. MC (Modem Check) - Indicates the absence or presence of the RECEIVER SIGNAL ELEMENT TIMING signal (pin 17) at the customer interface. In normal operation, this indicator lights while the CO indicator is off. The indicator goes off when the CO indicator and the RECEIVED LINE SIGNAL DETECTOR (carrier) signal (pin 8) are on. When using the self-test feature, this MC indicator lights whenever CO is off. When CO is on during self-test, however, this MC indicator flashes on whenever an error occurs on the RECEIVED DATA line.

8. TM (Test Mode) - Lights when the data set is placed in the test mode by use of the AL, ST, RT or DL test switches.

11.4.2 DATAPHONE TESTING WITH THE 201C DATA SET

    Perform an analog loopback self-test, as described in the following sub-
paragraph, with a 201C data set at each end of the loop. If either data set
fails, replace it with one known to be operating correctly.

    If both data sets pass the analog loopback self-test, perform the
end-to-end self-test (2-wire sets), as described below.

11.4.2.1 201C Data Set Analog Loopback Self-Test (2-Wire or 4-Wire Data Sets)

                            NOTE

                If the specified results are not obtained in
                any test condition, the data set has failed
                the Analog Loopback Self-Test.

1. Depress the AL and ST switch buttons.

    Requirement: All indicators except the MC indicator must become lit
    during a 30-second interval. If the MC indicator blinks (or remains
    on) or if any of the other indicators go out, the data set is defec-
    tive and should be replaced.

2. Depress the RO switch button.

    Requirement: The RS and CS indicators must go out, and the MC indi-
    cator must light. If the data set is optioned for switched carrier
    operation (options XA, XD, or XE), the CO indicator also must go out.

3. Return the data set to normal operation by depressing the RO, ST, and
    AL switch buttons.

    Requirement: The switch buttons must return to the off position and
    the TM indicator must go out.

11.4.2.2 <u>201C Data Set End-to-End Self-Test (2-Wire Data Set)</u>

NOTE

If the specified results are not obtained in
any test condition, the data set has failed
the End-to-End Self-Test.

1. Depress ST switch button at both ends.

    <u>Requirement</u>: The TM indicator must light.

2. Depress RO switch button at the receive end.

3. Establish a line connection.

    <u>Requirement</u>: At the transmit end, all indicators except the CO indi-
    cator must become lit. At the receive end, all indicators except the
    RS, CS, and MC indicators must become lit. If the MC indicator
    blinks an average of more than twice per minute or remains steadily
    <u>on</u>, the source of trouble is either the data set or the associated
    telephone facilities.

4. Repeat the test in the opposite direction by releasing the RO switch
    button at one end of the loop and depressing the RO switch button at
    the other end, and confirm that the same results are obtained with
    respect to the new transmit/receive orientation.

5. Return to the "Pretest" mode by releasing the ST switch buttons at
    both ends of the loop and releasing the RO switch button at the re-
    ceive end.

    <u>Requirement</u>: The TM indicator must go <u>off</u>.

11.4.3 DATA SET 208B SELF-TESTS

11.4.3.1 208B Data Set Switch Buttons

The front panel of the 208B data set contains six switch buttons. All of these except one, the LP button, are push-to-operate/push-to-release type. The functions of these switch buttons are as follows:

1. LP (Lamp Test) - Depression of this switch button lights all lamps except the ON lamp (which is normally lit while power is applied to the data set). This switch button is used to determine whether all status lamps are functional; its use does not affect other data set operations.

2. AL (Analog Loopback) - Depression of this switch button connects the output of the local transmitter to the input of the local receiver. This action prevents the data set from entering the Data mode from the Talk mode or upon automatic answer. While the Talk mode is not inhibited and calls can be made with the telephone set, any attempt to transfer to the Data mode will result in the line becoming disconnected if the AL button is depressed.

3. ST (Self Test) - Depression of this switch button causes the data set transmitter to turn on and then transmit a fixed pattern. The receiver is conditioned to look for this pattern and to then generate a signal causing the ER lamp to flash if an error is detected.

4. RO (Receive Only) - Depression of this switch button conditions the data set as a local receiver. When depressed, the switch button internally conditions the REQUEST-TO-SEND signal to off, regardless of the state of the REQUEST-TO-SEND signal from the terminal equipment or from other test buttons.

5. RT (Remote Test) - Depression of this switch button conditions the data set such that it can be tested remotely from a Telephone Company Data Test Center (DTC).

6. 50 Button - Depression of this switch button establishes a 50-milli-
    second delay interval for the REQUEST-TO-SEND/CLEAR-TO-SEND sequence
    (while the button is held depressed). When the button is released,
    the REQUEST-TO-SEND/CLEAR-TO-SEND interval is 150 milliseconds. The
    50-millisecond REQUEST-TO-SEND/CLEAR-TO-SEND interval (button de-
    pressed) can be used in most cases. The 150-ms REQUEST-TO-SEND/
    CLEAR-TO-SEND interval (button released) is provided to ensure ter-
    minal compatibility with various systems and for applications in
    which the channel delay exceeds the length of the transmitted sig-
    nal. (NOTE: If the terminal equipment exhibits frequent time-outs,
    the 150-millisecond REQUEST-TO-SEND/ CLEAR-TO SEND interval might
    correct the condition.)

11.4.3.2 208B Data Set Status Indicators

    The data set's front panel contains seven status indicators. Each indi-
cator lights a portion of the front panel to show the name of the control line
being monitored. The indicators and their functions are as follows:

1. ON indicator - Lights when the power cord is plugged into an appro-
    priate ac-power source, providing from 105 volts through 130 volts.

2. TR (Terminal Ready) - Monitors the status of the DATA TERMINAL READY
    signal on the customer interface. When this indicator is lit, the
    DATA TERMINAL READY line is in the on condition, telling the data set
    that the terminal (i.e., the Remote Workstation) is ready for data
    communication.

3. MR (Modem Ready) - Monitors the status of the DATA SET READY signal
    on the customer interface. When this indicator is lit, the DATA SET
    READY line is in the on condition and the DCE (i.e., modem) is ready
    for data communication.

4. RS (Request-To-Send) - Monitors the status of the REQUEST-TO-SEND
    signal on the customer interface or from the internal circuits which
    check the data set. When this indicator is lit, the REQUEST-TO-SEND

line is in the on condition, telling the data set to become condi-
tioned to transmit data. In normal operation, when the CO indicator
is on, the RS indicator will be off regardless of the status of the
RS signal at the customer interface.

5.   CS (Clear-to-Send) - Monitors the status of the CLEAR-TO-SEND signal
     on the customer interface during both normal and test modes of opera-
     tion. When this indicator is lit, the CLEAR-TO-SEND line is in the
     on condition and the data set is ready to transmit data.

6.   CO (Carrier On) - Monitors the status of the CARRIER ON signal on the
     customer interface during both normal and test modes of operation.
     This indicator lights while a signal is being received by the data
     set.

7.   ER (Equalizer Retrain) - Monitors the status of the Automatic Retrain
     mode. If the CO indicator is lit, a blinking conditon of this ER in-
     dicator shows that invalid data has been received and that the auto-
     matic equalizer is now retraining. A continuous blinking condition
     of this ER indicator while the CO indicator is lit signifies marginal
     performance. When the data set is in the ST mode, the ER indicator
     blinks when an error is detected in received data. For normal opera-
     tion, the CO and ER indicators light alternately: the ER indicator
     should be lit when the CO indicator is off, and the ER indicator
     should be off when the CO indicator is lit. A steadily on ER indi-
     cator thus signifies an abnormal condition only when the CO indicator
     is also lit.

11.4.4 DATAPHONE TESTING WITH THE 208B TEST SET

    In cases of suspected trouble, check out the data terminal equipment
(i.e., the Remote Workstation), and then perform the Lamp Chec.., the Analog
Loopback Test, and then the End-to-End Self-Test before calling the Telephone
Company to report trouble. Report the trouble to the Telephone Company only
if these checks indicate trouble in equipment provided by the Telephone Com-
pany.

In addition to the following tests, Telephone Company DTC personnel may request further assistance in trouble isolation by use of built-in features.

11.4.4.1 208B Data Set Lamp Test

Depress the LP nonlocking switch button. All the indicators on the data set should light. (Since it does not affect normal data set operation, the LP switch button can be depressed at any time.)

11.4.4.2 208B Data Set Analog Loopback Self-Test

To analyze the data set without using external equipment, proceed as follows:

NOTE

If the specified results are not obtained in any test condition, the data set has failed the Analog Loopback Self-Test.

1. Check that the data set is idle and that power is applied.

2. Depress the AL and ST switch buttons.

    Requirement: The ON, RS, CS, and CO indicators must remain or become lit, and the ER and MR indicators must remain or become off (disregard the status of the TR indicator).

3. Observe the ER indicator for 30 seconds.

    Requirement: The ER indicator must not light or blink within this 30-second period.

4. Depress the AL and ST switch buttons.

    Requirement: The data set must return to its normal operating condition.

NOTE

The data set's power supply is equipped with
an over-voltage protection circuit, which
crowbars the output voltage whenever an ex-
cessive-voltage condition occurs. Such an e-
vent automatically causes the data set to
fail the Analog Loopback Self-Test. To reset
the power supply, unplug the data set's power
cord and then replug it into the ac-power
outlet. If the data set still fails the Ana-
log Loopback Self Test, notify the Telephone
Company Repair Service for correction of the
problem.

11.4.4.3 208B Data Set End-to-End Self Test

To test both far-end and near-end data sets, together with the telephone
channel between the two sets, proceed as follows:

NOTE

If specified results are not obtained for any
test condition, the system has failed the
End-to-End Self-Test procedure.

1. Place a call to the far-end data set and arrange to perform the
    End-to-End Self Test. Discuss the duration of the test (at least
    five minutes) and when to return to the Talk mode. Request the
    far-end operator to check the following indicator conditions after
    the far-end data set has been transferred to the Data mode: ON, RS,
    CS, and ER indicators must be on; MR and CO indicators must be off
    (the status of the TR indicator can be disregard).

2. Request the far-end operator to depress both the ST switch button on
    the data set and the DATA switch button on the telephone set, thereby
    transferring the far-end data set is now transferred to the data mode.

3. Depress the ST and RO switch buttons on your data set, and then de-
    press the DATA button on the telephone set, thereby transferring your
    data set to the Data mode and enabling it to received data.

Requirement: The ON and CO indicators on at your data set should
light or remain lit, and its RS, CS, MR, and ER indicators should go
or remain off (disregard status of the TR indicator).

4. Observe the ER indicator for a 5-minute period.

    Requirement: The ER indicator should remain off and should not blink
    more than an average of three times in any 1-minute period.

5. After the prearranged time interval has passed, return to the Talk
    mode and discuss the results of the test with personnel at the
    far-end data set to confirm whether appropriate conditions were ob-
    served at the far-end data set.

6. Inform the far-end operator that you now intend to repeat the test in
    the opposite direction by releasing the RO switch button on your data
    set and depressing the DATA switch button on the associated telephone
    set, while the far-end operator must depress the RO button on that
    data set and depress the DATA switch button on its associated tele-
    phone set. Before initiating this reversal, request the far-end
    operator to confirm the following indicator results after both data
    sets have been transferred to the Data mode: ON and CO indicators
    must light or remain lit; RS, CS, MR, and ER indicators remain or go
    off (status of the TR indicator can be disregard).

7. Release the RO switch button on the data set and depress the DATA
    switch button on the telephone set.

    Requirement: The ON, RS, CS, and ER indicators on your data set must
    remain or become lit, and the MR and CO indicators must remain or go
    off (disregard status of the TR indicator).

8. Observe the ER indicator for a 5-minute period.

    Requirement: The ER indicator should remain off and should not blink
    more than an average of three times in any 1-minute period.

9. After the prearranged time interval has passed, return to the Talk
    mode and discuss the results of the test with personnel at the
    far-end data set to confirm whether appropriate conditions were ob-
    served at the far-end data set.

10. Return the data sets to normal operation as follows:

    a. Release the ST switch button at your data set, returning the data
        set to normal operation.

    b. Request the far-end personnel to release the ST and RO switch
        buttons, returning the far-end data set to normal operation.

                              NOTE

        If tests fail, repeat the test with a new
        connection before reporting trouble.

SECTION 12
REPAIR/ REPLACEMENT PROCEDURES

SECTION 12

REPAIR/REPLACEMENT PROCEDURES

12.1 GENERAL

TO BE SUPPLIED

SECTION
13
DRAWINGS

SECTION 13

DRAWINGS

13.1 GENERAL

This section contains reduced reproductions of Engineering drawings
providing circuit details and signal timing for the 2246R Remote Workstation
electronics. The drawings are arranged in numerical sequence, as follows:

210-7156 Power Supply Regulator Board, Schematic Diagram.

210-7456/7456-1 CRT Monitor Board, Schematic Diagram (Including External
Connections to CRT and Power Transformer).

210-7463 Bi-Sync Null Modem Board, Schematic Diagram.

210-7478 TC/Memory Board, Schematic Diagram (6 Sheets).

210-7479 Enhanced Workstation CPU Board, Schematic Diagram (5 Sheets).
      (Not Available At Time of This Preliminary Publication Release)

P.S. REGULATOR WITH FOLD BAC

WANG LABORATORIES INC.

210-7156 D 7156

This schematic is a full-page technical drawing and is reproduced as an image reference.

WANG — WANG LABORATORIES, INC. — PRELIMINARY — ELECTRONICS FOR 9" AND 12" MONITOR — DRAWING NO. 7456 — SIZE D — REV 5

DO NOT SCALE

B 7463

COMPONENT	WL PART NO	TYPE
CONN. 1, 2	350-1031	DB-25S CH CONN
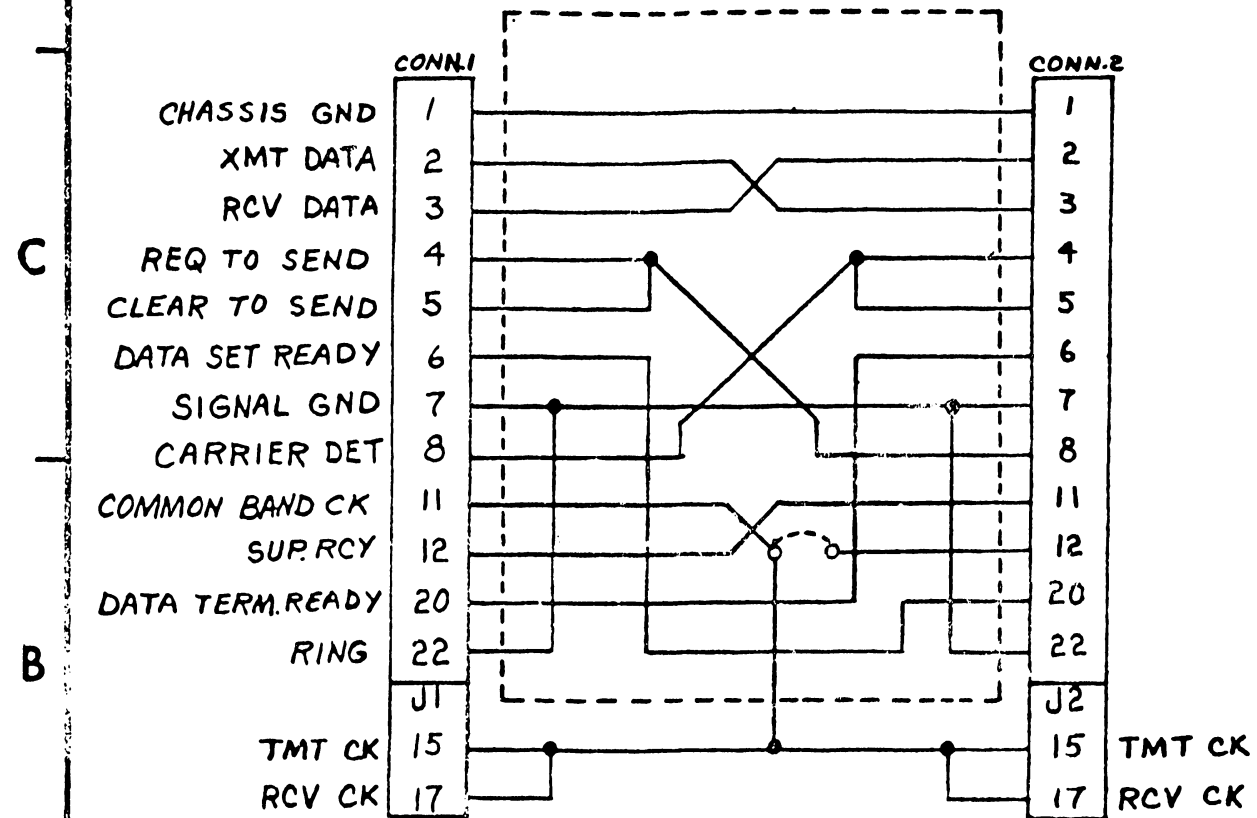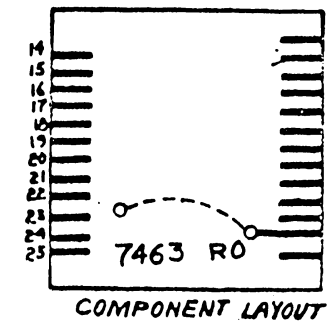
CONN.1

			CONN.1		CONN.2		
CHASSIS GND	1				1		
XMT DATA	2				2		
RCV DATA	3				3		
REQ TO SEND	4				4		
CLEAR TO SEND	5				5		
DATA SET READY	6				6		
SIGNAL GND	7				7		
CARRIER DET	8				8		
COMMON BAND CK	11				11		
SUP. RCY	12				12		
DATA TERM. READY	20				20		
RING	22				22		
	J1				J2		
TMT CK	15				15	TMT CK
RCV CK	17				17	RCV CK

PRELIMINARY

JUL 19 1978

7463 R0

COMPONENT LAYOUT

E-REV
0
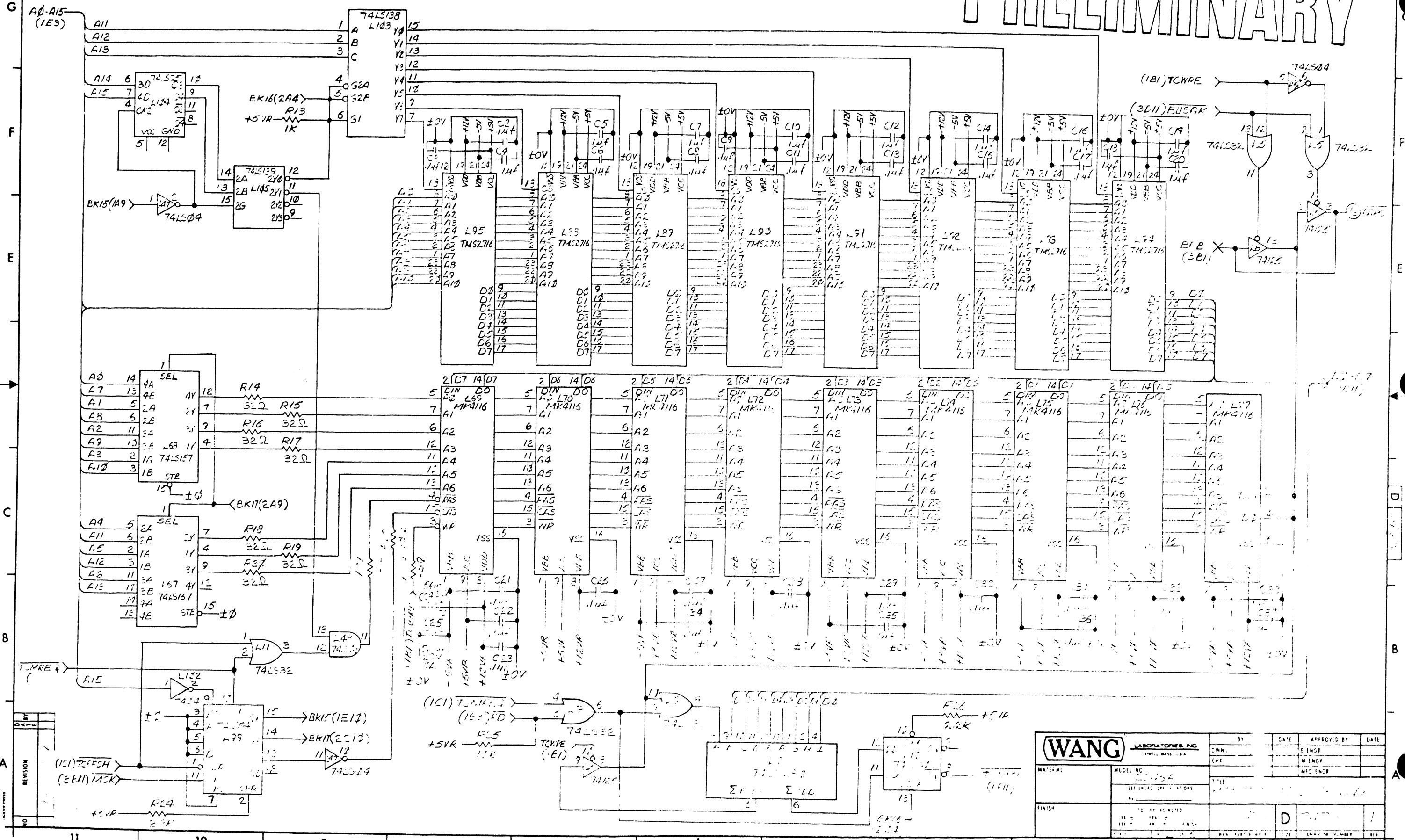
WANG LABORATORIES, INC. LOWELL, MASS. U.S.A.

	BY	DATE	APPROVED BY	DATE
DWN	GK	4-7-78	E. ENGR K. OSBORN	5-2-78
CHK	JJ	5-2-78	M ENGR	
E. C. CONTROL			MFG ENGR	

MATERIAL

MODEL NO. 928

SEE ENGRG SPECIFICATIONS No _____

FINISH

TOL. EX. AS NOTED
.XX ± .010 FRAC. ± 1/64
.XXX ± .005 ANG. ± 1°30' FINISH ∨

TITLE BI-SYNC NULL MODEM BOARD

210-7463	B	7463	0
WANG PART NUMBER	SIZE	DRAWING NUMBER	REV

SCALE | SHT / OF /

PRELIMINARY

PRELIMINARY

PRELIMINARY

WANG LABORATORIES, INC.
LOWELL, MASS. U.S.A.

MODEL NO

TITLE

D 7475

IC LOCATION	TYPE	W.L. NO.
L1,8,12,48	74LS08	376-0153
L2-13,40,47,82 98,101	74LS04	376-0180
L3,6,29,58	74125	376-0224
L4,105	74LS139	376-0225
L5,9,11,26,41	74LS32	376-0211
L7	74LS280	376-0276
L10,30,57,97,98	74LS74	376-0215
L14,15,31,32	SPARES	
L16-19,L33-38 L53-56,59-62 L69-77	MK4116	377-0345
L20-104	74LS75	376-0312
L21,28,99	74LS194	376-0221
L22	SW325/15?	
L23	74LS365	376-0193
L24,83,84	74LS244	376-0233
L25	74LS81?	376-0297
L27	74LS367	376-0198
L39,42	74LS245	376-0355
L43,45	TILL 311	
L44	SW 325/18?	
L46,103	74LS138	376-0233
L49	9602	376-0164
L50-52		
L63,64	74154	376-0256
L65	7801?	376-0211
L66	2800?	376-0215
L67,69,80,81	74LS157	376-0176
L78,79	7515?	376-0176
L85	74LS37?	376-0270
L86	280-0??	377-0341
L87	NEC6??	
L88-95	0776	376-0267
L100	7415??	376-0237
L102	7404	376-0271

LOCATION	TYPE	SPARES
L1 L15	74LS08	6 1
L13 L40 L47 L96 L101	74LS04	4 2 2 2 2
L100	74LS00	3

MNEMONIC	COORDINATE
BA	4A9
BA1-BA15	1E1
EB	1C11
B?G	3C11
B??	1G11
B?KE?	3C11
B?EC?	3D11
B?REQ	3A6
CA	4A9
CB	1C11
CC	1C11
CD	4A9
CK	4C1
CF	1C11
CB	1C11
CEA	3A11
DB3-DB7	DE7
DD	1B11
?B	3E11
M??	?A11
M?F?	4D11
M?A??	
NR	4D11
PARE	3E1
PR?MCS	
PR?MSW	
PWRST	1F11
RESTART	1G1
SCA	4A9
WRE	3D11

COMPONENT	TYPE	W.L. NO.
R1,3,25	12K,1/4W,1%	330-4010
R2,4,9,13, 24,26,38,39, 43,44,69,72	2.2K,1/4W,1%	330-3022
R5,6,7,8, 11,12	4.7K,1/4W,1%	330-3047
R13,40	1K,1/4W,1%	330-3010
R14,23,27,37	3?Ω,1/4W,1%	330-1033
R41,73,74	3?Ω,1/3W,1%	330-3023
R42	1?Ω,1/4W,1%	330-1010
R73,71	1?K,1/4W,1%	330-4010
R45-56	18?Ω,1/4W,1%	330-2012
R57-68	47KΩ SIP	
C1	.001f	300-2010
C2-C81	.1µf CER.	300-1930
C82-C131	.05µf CER	300-1900
C132	68?,300,5%	300-5003
C133-C136	30?,5%,15%	300-5023
C137	47µf,20VTA.	300-4061
C138-C141	15µf,20VTA	300-4052

CONN.3 — +5V, ±0V, PARE, ±0V, ... PWRST, PROMCS, RESTART, BLA, -12V ... WRE, ±0V, CK, ±0V, -12V

CONN.2 — ±12V, ±5V, LB, MCK, EMREQ, CD, DD, MPE, PROMSW, DB3, DB2, DBD, DEI, +12V, DB4, DB5, DB6, DB7

CONN.1 — ... PARE, NR

SIGNAL-TERMINAL DESIGNATIONS VIEW FROM BOTTOM (WIRING SIDE OF CONNECTOR)

Power circuit:
-12V, C137 47µf 20V TA., C82-C130 0.5µf
+5VR, C138, C140
±0V, C139, 15µf 20V TA.
-5VR, 15µf 20V TA., C141
-12V, 15µf 20V TA.

PRELIMINARY

SECTION 14

BILL OF MATER-IALS

SECTION 14

BILL OF MATERIALS (ASSEMBLY LEVEL)

14.1 GENERAL

This section contains the assembly-level Bill of Materials for the 2246R
Remote Workstation, delineating the official WLI part numbers, description,
and kitting information for each assembly-level item.

MB0080-A   M U L T I - L E V E L   B I L L   O F   M A T E R I A L   AS OF   RUN DATE 04/24/79   PAGE   1

ASSEMBLY PART NUMBER   177-22VS-57- -   LEGEND
ASSEMBLY DESCRIPTION   2246R REMOTE STAND ABOVE WS   1: P=PHANTOM 2 ITEM MASTER DELY CODE 3: *=TAGGED OUT OF KIT/PROD STR)

POSITION IN STRUCTURE	LEGEND 1 2 3	COMPONENT PART NUMBER	DESCRIPTION	E C N	QUANTITY PER ASSY	U/M	L/T
1	IN	167-2246-R - -	2246R WK/ST REMOTE 60HZ 2246R		1.0000	EACH	00010
2	IN	210-7478-A - -	PCA 2246R REMOTE TC WS CONTROLLER		1.0000	EACH	00010
3	IN	209-7478- - -	PCA 2246R REMOTE TC WS CONTROLLERNC		1.0000	EACH	00010
2	IN	210-7479-A - -	PCA 2200VS ENHANCED WS CPU		1.0000	EACH	00010
3	IN	209-7479- - -	PCA 2200VS ENHANCED WS CPU NC		1.0000	EACH	00010
2	IN	220-0219- - -	TC MODEM CABLE 22V-06 25FIC6482-402	E11965	1.0000	EACH	00010
2	IN	220-1143- - -	WIRE & LUG ASSY TYPE P065 D6482-12		1.0000	EACH	00010
2	IN	271-1126- - -	6300 KEYBOARD & BEARING PLATE ASSY		1.0000	EACH	00010
3	IN	210-7229- - -	PCA 928/2236/46P WS KEYBD	EC7259	1.0000	EACH	00010
2	P IN	279-0388- - -	2246R COMMON MECH ASSY 60H	E11965	1.0000	EACH	
3	IN	210-7156- - -	PCA 928 PS REG FOR MOTOROLA MONITOR		1.0000	EACH	00010
3	IN	220-1143- - -	WIRE & LUG ASSY TYPE P065 D6482-12		1.0000	EACH	00010
3	IN	270-0373- - -	12" MONITOR II & PWR SUP ASM II		1.0000	EACH	00010
4	IN	270-0371- - -	POWER SUPPLY 11,12" MONITOR(PRELIM)		1.0000	EACH	00010
5	P FS *	210-7455- - -	PCA 9/12 MONITOR WANG MON PS REG		1.0000	EACH	
6	IN	220-1107- - -	12" CRT POWER SUPLY CABLE B6482-141		1.0000	EACH	00010
4	IN *	270-0372- - -	12" MONITOR ASM II (LESS PWR SUP)		1.0000	EACH	00010
5	IN *	210-7456- - -	PCA 12" MONITOR ELEC	EC8373	1.0000	EACH	00010
5	IN	220-0160- - -	BRIGHTNESS POT CABLE ASSY C6482-140		1.0000	EACH	00010
5	P IN	270-3068- - -	12" CRT HARNESS ASSY D6482-139		1.0000	EACH	
5	P IN	270-3092- - -	YOKE ASSY (12" MONITOR) B6482-246		1.0000	EACH	
5	P IN	270-3104- - -	12"FLYBACK XFORMER HARN C6482-327	EC9723	1.0000	EACH	
3	P IN	270-0597- - -	2246R WK/ST CHASSIS ASSY		1.0000	EACH	
4	IN	210-7542-1 - -	PCA 2246R MOTHER BOARD	E12044	1.0000	EACH	00010
5	IN	220-3014- - -	24 COND 14"FLAT CABLE C-6482-79		1.0000	EACH	00010
4	IN	220-1143- - -	WIRE & LUG ASSY TYPE P065 D6482-12		1.0000	EACH	00010
4	IN	220-1180- - -	WIRE & LUG ASSY TYPE P077 D6482-12		1.0000	EACH	00010
4	IN	270-0346-1 - -	WS POWER SUPPLY ASSY		1.0000	EACH	00010
5	IN	220-1042- - -	P022 WIRE & LUG ASSY(2LCRT)D6482-12		1.0000	EACH	00010
5	IN	220-1074- - -	CABLE PS/MB(F CHASSIS)B6482-91		1.0000	EACH	00010
5	IN	220-1077- - -	P043 WIRE & LUG ASSY(F CHAS)B648296		1.0000	EACH	00010
5	IN	220-1094- - -	P048 WIRE & LUG ASSY B		1.0000	EACH	00010
3	IN	272-0004- - -	928W2 BEZEL ASSY(ALUM TAPE) 6841-31		1.0000	EACH	00010
3	IN	279-1015- - -	928WZ BASE ASSY(ALUM TAPE) 6841-30		1.0000	EACH	00010
3	IN	279-4117- - -	2246R WK/ST COVER		1.0000	EACH	00010

ASSY   1.0000   EACH 00010

END OF REPORT MB0080-A

APPENDIX A

APPENDIX A

IBM EBCDIC-DP CODE SET

HIGH ORDER HEX DIGIT

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	DLE			SP	&	-						{	}	\	0
1	SOH	DC1			RSP		/		a	j	~		A	J		1
2	STX	DC2		SYN					b	k	s		B	K	S	2
3	ETX	DC3							c	l	t		C	L	T	3
4									d	m	u		D	M	U	4
5	HT	NL	LF						e	n	v		E	N	V	5
6			ETB						f	o	w		F	O	W	6
7			ESC	EOT					g	p	x		G	P	X	7
8									h	q	y		H	Q	Y	8
9		EM							i	r	z		I	R	Z	9
A					¢	!			:								
B	VT				.	$	,	#								
C	FF				<	*	%	@								
D	CR	IGS	ENQ	NAK	(	)	-	'								
E		IRS			+	;	>	=								
F		ITB	BEL			¬	?	"								PAD

BSC DATA LINK CHARACTERS

BEL	Bell
CR	Carriage Return
DLE	Data Link Escape
ENQ	Enquiry
EOT	End of Transmission
ESC	Escape
ETB	End of Text Block
ETX	End of Text
HT	Horizontal Tab
ITB	Intermediate Text Block
NAK	Negative Acknowledgement
NUL	Null
PAD	Trailing Pad Character
SOH	Start of Header
STX	Start of Text
SYN	Synchronous Idle

IBM 2780 CONTROL CHARACTERS

EM	End of Media
SP	Space

IBM 3780 CONTROL CHARACTERS

DC1	Device Select Printer
DC2	Device Select Punch
DC3	Device Select Punch
FF	Form Feed
IGS	Interchange Group Separator
IRS	Interchange Record Separator
LF	Line Feed
NL	New Line
SP	Space
VT	Vertical Tab

BSC DATA LINK CONTROL SEQUENCES

ACK 0	Positive Acknowledgment 0 (DLE X'70')
ACK 1	Positive Acknowledgment 1 (DLE /)
DLE EOT	Disconnect Sequence for a Switched Line
RVI	Reverse Interrupt (DLE @)
TTD	Temporary Text Delay (STX ENQ)
WACK	Wait-Before-Transmit Positive Acknowledgment (DLE ,)

APPENDIX
B

APPENDIX B

CUSTOMER ENGINEERING INPUTS FOR CSNL #128 (22V06 IOP's #2)

GENERAL

    The following text is a copy of unedited engineering inputs currently
being processed to produce CSNL #128 (22V06 IOP's #2), referenced in this
document as a prerequisite for successful operation of the 2246R Remote
Workstation. This material is provided here to assist you in updating the
22V06 IOP to the required condition in the event of a need to install a 2246R
Remote Workstation prior to release of the final CSNL document.

Category + Sequence # :   22V06 TC IOP   #

☐1   ECN # 10330   PCB # 210-7426

A.   Reason for change

        To correct decoupling and undershoot on MAR counters

B   Correction / Solution

        increase filtering on +5V and Clk lines

C.   Prerequisite

        NONE

D.   Time Required

        30 minutes

E.   Parts Required

        Five   .05uf 20% 12V ceramic capacitors   WLI # 300-1900
        one   .01uf 20% 25V ceramic capacitor   WLI # 300-1903
        one   200pf 10% 500V ceramic capacitor   WLI # 300-1220
        one   10 ohm 1/4w 5% resistor   WLI # 330-1011-4B

F.   Procedure

        ON component side of board

        1. Add a .05uf capacitor WLI # 300-1900 between pins 8 and 16 of L113.
        2. Add a .05uf capacitor WLI # 300-1900 between pins 8 and 16 of
           IC's L144 thru L147
        3. Add a 10 ohm resistor WLI# 330-1011-4B between L94 pin 6 and
           the feed thru located directly below IC L95
        4. Add a 200pf cap. WLI# 300-1220 between pins 2 and 8 of L144

5. Add a .01 uf cap WLI# 300-1903 between pins 4 and 6 of L 13

6. For boards of artwork revision level R0 or R1, add a jumper wire between L42 pin 7 and I0v.

7. Increment E-REV level to 1

8. update schematics to reflect this change

Category & Sequence # :   22V06   TC ICP   #

☑2   ECN # 10521   PCB # 210-7426

A. Reason for Change

    To correct memory errors

B   Correction / Solution

    1. To drive Main Memory write data lines during a   Main Memory read
        operation
    2. Prevent erroneous write operations into the motherboard TC Processor when
        performing IPL and DMA write operations on either of the daughterboard's
        TC Processors .

C. Prerequisites

    E - Rev 1

D. Time Required

    30 minutes

E. Parts Required

    24 gauge wire   WLI # 600 - 9012

F.   Procedure

    ON NON - Component side of board perform the following :
    1. Cut etch on L96 pin 6. Make etch cut at the base of pin 6.
    2. Cut etch on L61 pin 6. Make etch cut at the base of pin 6.
    3. Cut etch between L23 pin 3 and L3 pin 3. NOTE: This step
        requires two etch cuts and they must be made in the locations given in Figure 1.
    •.

    ON the Component side of board perform the following :

4. Add a wire between L156 p.n 1 and L114 p.n 12. This jumper is installed just to the left of L96. See figure 2.

5. Add a wire between L155 p.n 15 and L16 p.n 6.

6. Add a wire between L23 p.n 7 and L18 p.n 6.

7. Increment E-Rev to 2.
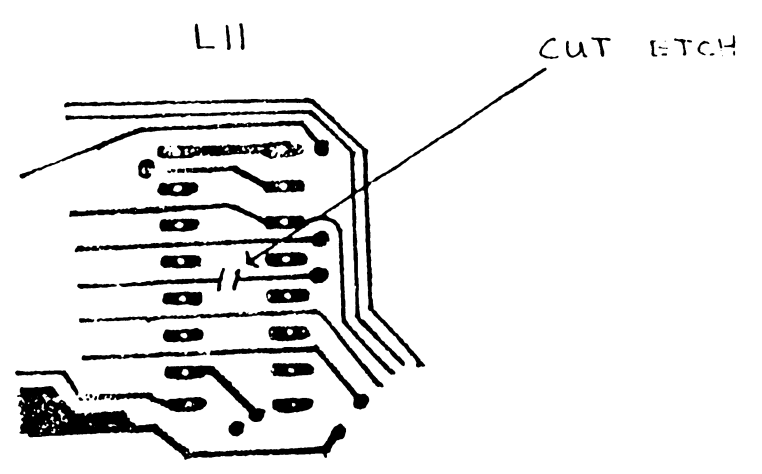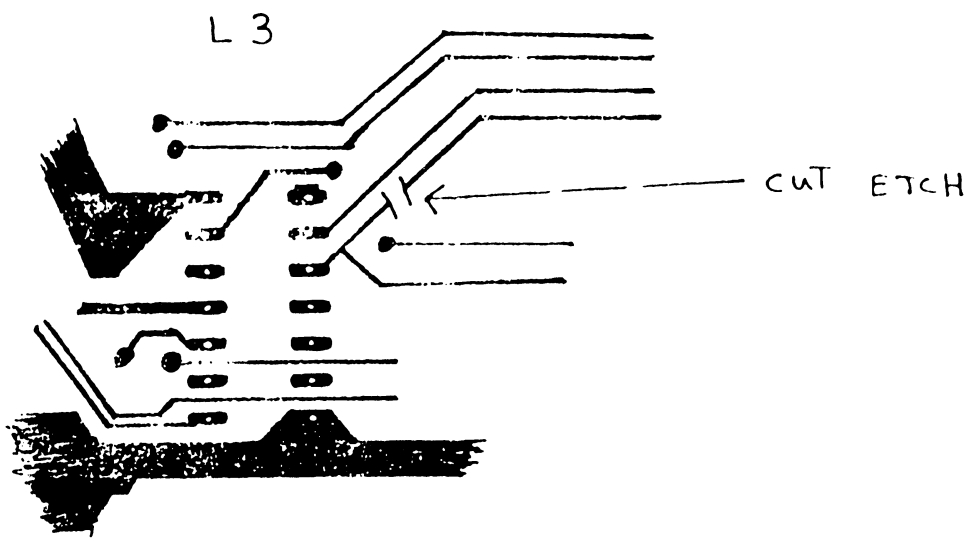
8. update Schematics to reflect this change.

L 3

CUT ETCH

L 11

CUT ETCH

Figure 1

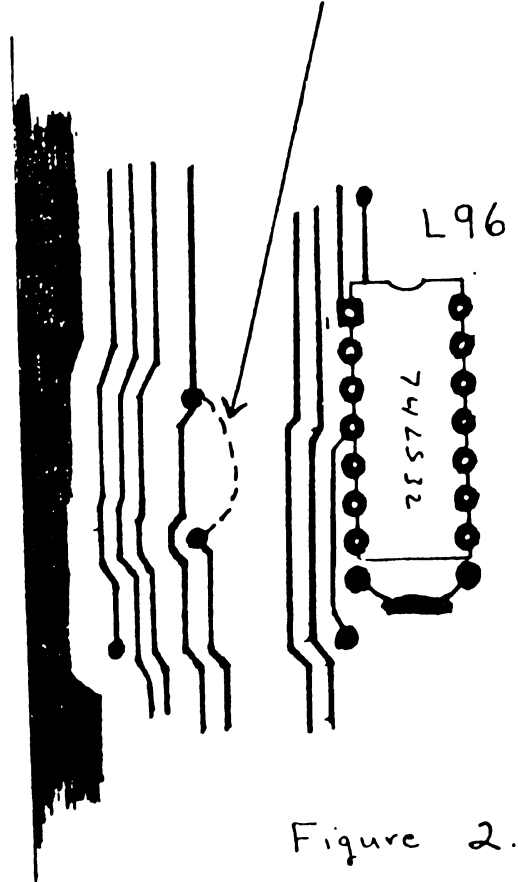Add Jumper

L96

74S32

Figure 2.

B-E

Category & Sequence #: 22V06 TC IOP   #

[3]   ECN # 10997   PCB # 210.7426

A. Reason for Change

   To prevent RAS and CAS signals from turning on simultaneously during
   subsequent memory DMA operations.

B. Correction / Solution

   Change the value of resistor R47

C. Prerequisites

   PCB AT E-REV 2

D. Time Required

   15 minutes

E. Parts Required

   one   1 Kohm 1/4 w resistor   WLI # 330 - 3010 - 4B

F. Procedure

   1. On the component side of the board, remove the 10K resistor R47 located
   to the left of L56.
   2. Replace R47 with a 1 Kohm resistor   WLI # 330 - 3010 - 4B
   3. Increment the E-REV to 3.
   4. update the schematics and BOM to reflect this change.

Category & Sequence # :   22V06   TC IOP   #

4   ECN # 12190 .and # 12275   PCB # 210-7426

A. Reason for Change

The VS to peripheral processor DMA sequence terminates early due to noise glitches on the output of the transfer length counter.

This can cause problems such as not being able to transfer a complete line of data or and give an "unable to load microcode" failure.

B. Correction / Solution

Buffer the output of the transfer length counter

C. Prerequisites

PCB AT REV 3

D. Time Required

30 minutes

E. Parts Required

ONE 2.2K 1/4 w resistor   WLI # 330-3022-4B
Approximately 4 feet of 24 gauge wire WLI # 600-9012

F. Procedure

ON Component Side of board perform the following :

1. Remove the 270 pf capacitor C5 which is connected to IC L165 pin 15. The capacitor is located just above IC L163.
2. Cut etch at the base of L165 pin 15. See Figure 1.
3. Add a wire from L165 pin 15 to L24 pin 12.

4. Add a wire from L24 pin 9 to feed thru located above L165. See Figure 1. This feed thru was previously connected to L165 pin 15 and was cut in step 2.

5. Add a wire from L67 pin 12 to L24 pin 11.

6. Add a 2.2K resistor from L24 pin 13 to the +5V etch connected to pin 14.

7. Add a wire from L24 pin 13 to L24 pin 10.

8. upgrade E-REV to 4.

9. Change schematics to reflect this change. See Figure 2.

Add-
wire from L24 pin 9

L165

CUT ETCH

74LS161

1

Figure 1

B-12

Y

L 1L5
LS161
CLR   LD   9
RW   Q3Q2Q1QA
16   11 14 13 14

2.2K   +5V

10   13
P,   CLR
12 D   Q 9
+M₁ 11 >
L 24

C5 22pf
-CV

+END DMA
(4B1)

OMIT CAP.

CUT ETCH

Add GATE

Add WIRE

+M₁

12
44 L 67
LS158

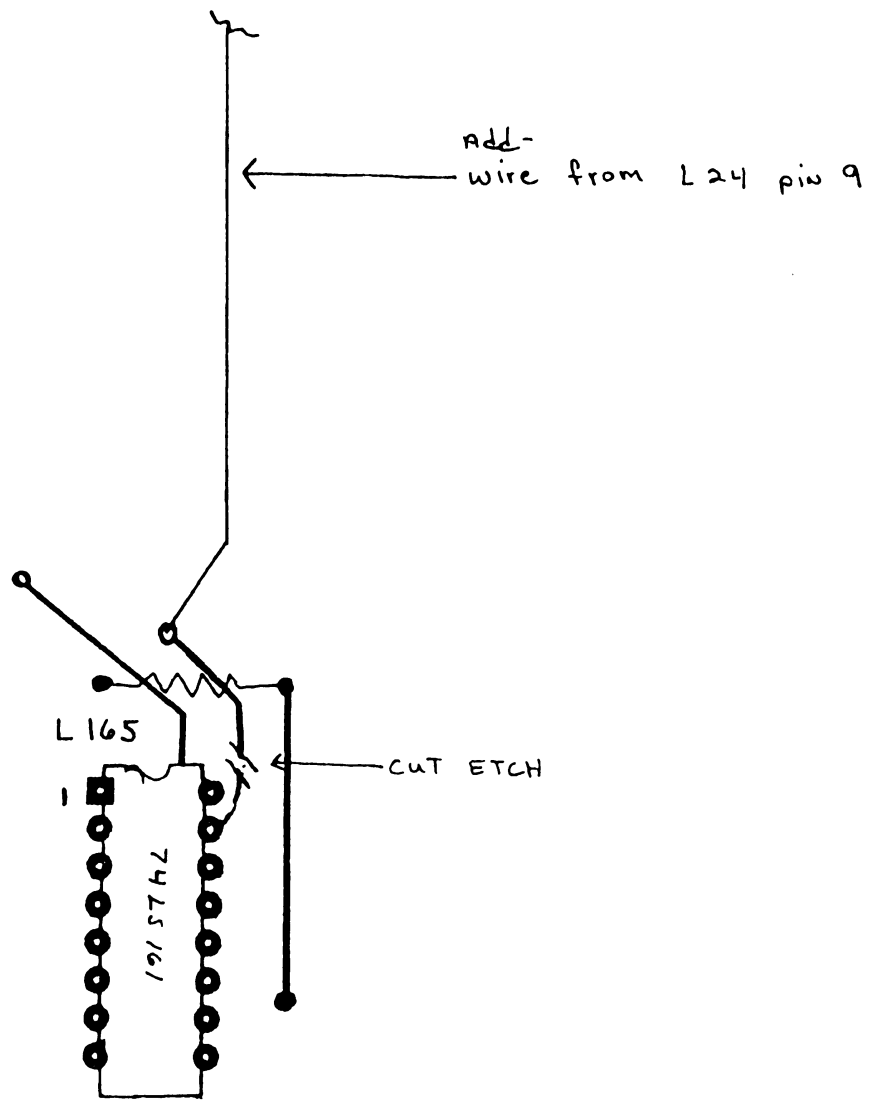Figure 2

Category & Sequence #: 22V06   TC IOP   ⊗ #

☐ 1   ECN # 10998   PCB # 210-7427 and 2 -1

A.   Reason for change

     To prevent RAS and CAS signals from turning on simultaneously during
     subsequent memory DMA operation.

B.   Correction / Solution

     Change the values of resistors R1 and R17

C.   Prerequisites

     NONE

D.   Time Required

     15 minutes

E.   Parts Required

     FOR A 210-7427 PCB   -   ONE   1K ohm 1/4 resistor WLI # 330-3010-4B
     FOR A 210-7427-1 PCB -   two   1K ohm 1/4 resistors WLI # 330-3010-4B

     ~~For a board~~ NOTE: The 210-7427 is a 22V06-2
                            The 210-7427-1 is a 22V06-3

F.   Procedure

     FOR PCB 210-7427 perform steps 1-4 only

     1. ON component side of board, remove the 10K resistor R1 located just below L73.
     2. Replace R1 with a 1Kohm resistor WLI # 330-3010-4B.
     3. Increment E-REV TO 1.
     4. Change schematics and BOM To reflect this change.

the following steps apply only to PCB 210-7427-1

5. Perform steps 1 and 2
6. On the component side of board, remove the 10K resistor R17 connected to L63 pins 9 and 12.
7. Replace R17 with a 1 K ohm resistor WLI # 330-3010-4B.
8. Increment the E-Rev to 1.
9. Change schematics and BOM to reflect this change.

END