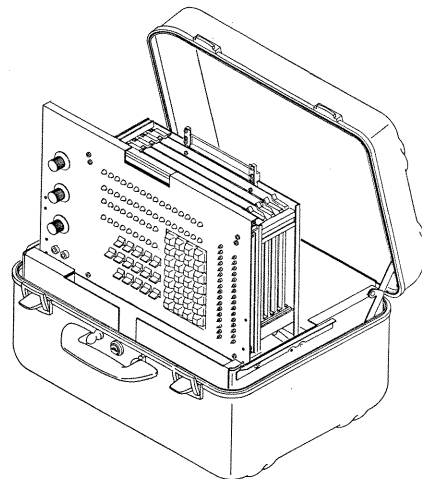


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**FIELD TEST UNIT**

**TB216**

**GENERAL DESCRIPTION  
OPERATION  
THEORY OF OPERATION  
MAINTENANCE  
DIAGRAMS  
WIRE LISTS  
PARTS DATA**



## REVISION RECORD

REVISION	DESCRIPTION
01 (11-21-78)	Preliminary manual released.
02 (02-12-79)	Preliminary manual revised with technical changes.
A (03-27-79)	Manual released with ECOs 55123 and 55224.
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REVISION LETTERS I, O, Q  
AND X ARE NOT USED.

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12701 Whitewater Drive  
Minnetonka, MN 55343  
or use Comment Sheet in the back  
of this manual.

# MANUAL TO EQUIPMENT LEVEL CORRELATION

---

This manual reflects the equipment configurations listed below.

EXPLANATION: Locate the equipment type and series code number, as shown on the equipment FCO log, in the list below. Immediately to the right of the series code number is an FCO number. If that number and all of the numbers underneath it match all of the numbers on the equipment FCO log, then this manual accurately reflects the equipment.

EQUIPMENT TYPE	SERIES CODE	WITH FCOs	COMMENTS
TB216	14	None	
	15	None	
	16	None	
	17	None	
	18	None	
	19	None	
	20	None	
	21	None	
	22	None	
	23	None	
	24	None	
	25	None	
	26	54327	
	27-37	None	
38			



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New features, as well as changes, deletions, and additions to information in this manual are indicated by bars in the margins or by a dot near the page number if the entire page is affected. A bar by the page number indicates pagination rather than content has changed.

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iii	J	2-5	C
Blank	-	2-6	C
v	L	2-7	C
vi	L	2-8	E
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## PREFACE

---

### INTRODUCTION

This manual is prepared for customer engineering and provides general description, operation theory of operation, maintenance, diagrams wire lists and parts data for the Seagate TB216 Field Test Unit (FTU).

It is assumed that customer engineering is familiar with the computer system, drive controller, and the drive logic, as well as system programming techniques for executing I/O operations, including sequencing I/O commands and routing signal between the drive and controller.

This manual is divided into seven sections as follows:

- Section 1 - General Description. Contains the physical description and functional specifications for the FTU.
- Section 2 - Operation - Provides installation information, a description of the front panel controls, indicators, and test points, procedures for operating the FTU in all modes, and descriptions of codes used with the FTU.
- Section 3 - Theory of Operation. Explains the functioning of the tester as a microprocessor-based tester.
- Section 4 - Maintenance. Contains procedures and required tools to maintain the FTU and information for handling electrostatic sensitive devices.
- Section 5 - Diagrams. Contains logic diagrams, both internal and I/O cabling diagrams, and a schematic diagram of the power supply.
- Section 6 - Wire Lists. Contains a double-ended listing of all wiring on the logic backpanel.
- Section 7 - Parts Data. Contains an exploded view of the FTU and a spare parts list.



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## IMPORTANT SAFETY INFORMATION AND PRECAUTIONS

---

Proper safety and repair is important to the safe, reliable operation of this unit. Service should be done by qualified personnel only. This maintenance manual describes procedures recommended by the manufacturer as effective methods of servicing the unit. Some of these procedures require the use of specially designed tools. For proper maintenance and safety, these specially designed tools should be used as recommended.

The procedures in this maintenance manual and labels on the unit contain warnings and cautions which must be carefully read and observed in order to minimize or eliminate the risk of personal injury. The warnings point out conditions or practices that are potentially hazardous to maintenance personnel. The cautions point out practices which, if disregarded, could damage the unit and make it unsafe for use.

For the safety of maintenance and operating personnel, the following precautions must be observed:

- Perform all maintenance in accordance with the procedures given in this manual.
- Read and observe all cautions and warnings provided in the procedures and labeled on the unit.
- Use the special tools called out in the maintenance procedures.
- Observe sound safety practices when performing maintenance.
- Use caution when troubleshooting a unit that has voltages present. Remove power from unit before servicing or replacing components.
- Wear safety glasses when servicing units.
- Wear safety shoes when removing or replacing heavy components.

It is also important to understand that these warnings and cautions are not exhaustive. The manufacturer could not possibly know, evaluate and advise maintenance personnel of all conceivable ways in which maintenance might be performed or the possible risk of each maintenance technique. Consequently, the manufacturer has not completed any such broad evaluation. Thus, any persons who use any non-approved maintenance procedure or tool must first satisfy themselves that neither their safety nor the unit performance will be jeopardized by the maintenance techniques they select.



## ABBREVIATIONS

ABV	Above	ENG2	Enable Gate 2
ADD	Address	ENLAT	Enable Latches
ADDR	Address	ENPIA	Enable Peripheral Interface Adapter
AM	Address Mark		
AMCTR	Address Mark Counter	ENRCV	Enable Receivers
AMFND	Address Mark Found	ENT	Entry
AMGT	Address Mark Gate	ENTRN	Enable Transmitters
A008X	Address 008X (X = Don't Care)	EOCOY	End of Conversion
		EOT	End of Test
BAVAL	Bus Available	ERR	Error
BCD	Binary Coded Decimal	FCO	Field Change Order
BIB	Bus In Bit	FIG	Figure
BIT	Binary	FLT	Fault
BLW	Below	FLTIO	Fault I/O
BOB	Bus Out Bit	FMD	Fixed Module Drive
BYTCK	Byte Clock	FTU	Field Test Unit
CKT	Circuit	FWD	Forward
CLK	Clock	G15US	5 usec G1 Gate
CLR	Clear	G25US	5 usec G2 Gate
CMD	Cartridge Module Drive	GND	Ground
CONFIG	Configuration	HEX	Hexadecimal
CONT	Continous	I/O	Input/Output
CRCTR	Character Counter	IRQ	Interrupt Request
CR-CRTREN	Character Counter Enable	LED	Light Emitting Diode
		MAN	Manual
CR REF	Cross Reference	MB	Megabyte
CTR	Counter	MEMSL	Memory Select
CYL	Cylinder	MFM	Modified Frquency Modulation
D/A	Digital To Analog		
DEC	Decimal	MMD	Mini-Module Drive
DISP	Display	MPU	Microprocessor Unit
ECL	Emitter - Coupled Logic	MUX	Multiplexed
		MUXIO	Multiplex I/O
ECO	Engineering Change Order	NC	No Connection
		NMI	Non-Maskable Interrupt
ENBL	Enable	NRZ	Non-Return-to-Zero
ENCK2	Enable Clock 2	PATT	Pattern
ENCL2	Enable Clock 2	PN	Part Number
ENG1-AM	Enable Gate 1 Address Mark	PROM	Programmable Read Only Memory

## ABBREVIATIONS (Contd)

---

PROT	Protect	SK	Seek
PWR	Power	SKEND	Seek End
PWRSQ	Power Sequence	SMD	Storage Module Drive
R/W	Read/Write	SRVCK	Servo Clock
R/-W	Read Not Write	STD	Standard
RAM	Random Access Memory	SW	Switch
RAN	Random	TB	Terminal Board
RCVR	Receiver	TLA	Top Level Assembly
RD	Read	TP	Test Point
RDCLK	Read Clock	TTL	Transistor-Transistor Logic
RDDAT	Read Data	W/	With
RDGT	Read Gate	W/O	Without
RDY	Ready	WRCLK	Write Clock
REV	Reverse	WRT	Write
RFI	Radio Frequency Interference	WRTDA	Write Data
ROM	Read Only Memory	WRTGT	Write Gate
RTZ	Return to Zero	WT	Write
S/C	Series Code	WTCK2	Write Clock 2
SECTR	Sector	VMA	Valid Memory Address
SEL DRV	Select Drive	XMTR	Transmitter
SELD	Selected	100 US CLOCK	100 usec Clock
SH	Sheet		

**SECTION 1**

**GENERAL DESCRIPTION**

---

## INTRODUCTION

The Seagate TB216 Field Test Unit (FTU) is a portable self contained (microprocessor 6800 based) unit housed in a suitcase-type carrying case (see figure 1-1). The FTU contains a front panel assembly, power supply, logic chassis assembly, power cable, I/O cables, and the head alignment adapter for CMD and SMD. The front panel assembly contains a hexadecimal keyboard, various switches, indicators, and test points. The FTU simulates off line input/output control functions of a disk storage controller and is used in maintaining the storage Module Drive (SMD), Mini-Modules Drive (MMD), Cartridge Module Drive (CMD), 1 X Fixed Module Drive (FMD) Lark Drive (LMD), Fixed Storage Drive (FSD), Removable Storage Drive (RSD), Expanded Module Drive (XMD), and Eight-Inch Module Drive (EMD).

## SPECIFICATIONS

Specifications for the FTU are provided in table 1-1.

## FUNCTIONAL DESCRIPTION

The FTU provides seven access modes, six read/write modes, and three modes for determining head selection.

### ACCESS MODE

In access modes (seeks), the moveable heads in the drive are positioned over a particular cylinder on the disk pack.

#### Direct Seek

The drive under test performs a single seek to the cylinder number selected by the operator.

#### Direct Continuous

The drive performs seeks between cylinder zero and the cylinder number selected by the operator.

### **Sequential Forward**

Starting at cylinder zero, the drive performs sequentially increasing seeks at cylinder intervals selected by the operator. After seeking the last track, it will return to cylinder zero and repeat the operation.

### **Sequential Reverse**

Starting at the maximum cylinder, the drive performs sequentially decreasing seeks at cylinder intervals selected by the operator. After seeking cylinder zero, it returns to the maximum cylinder and repeats the operation.

### **Sequential Forward/Reverse**

Starting at cylinder zero, the drive performs sequentially increasing seeks up to the maximum cylinder followed by sequentially decreasing seeks down to cylinder zero. The seeks are in increments selected by the operator.

### **Random Seek**

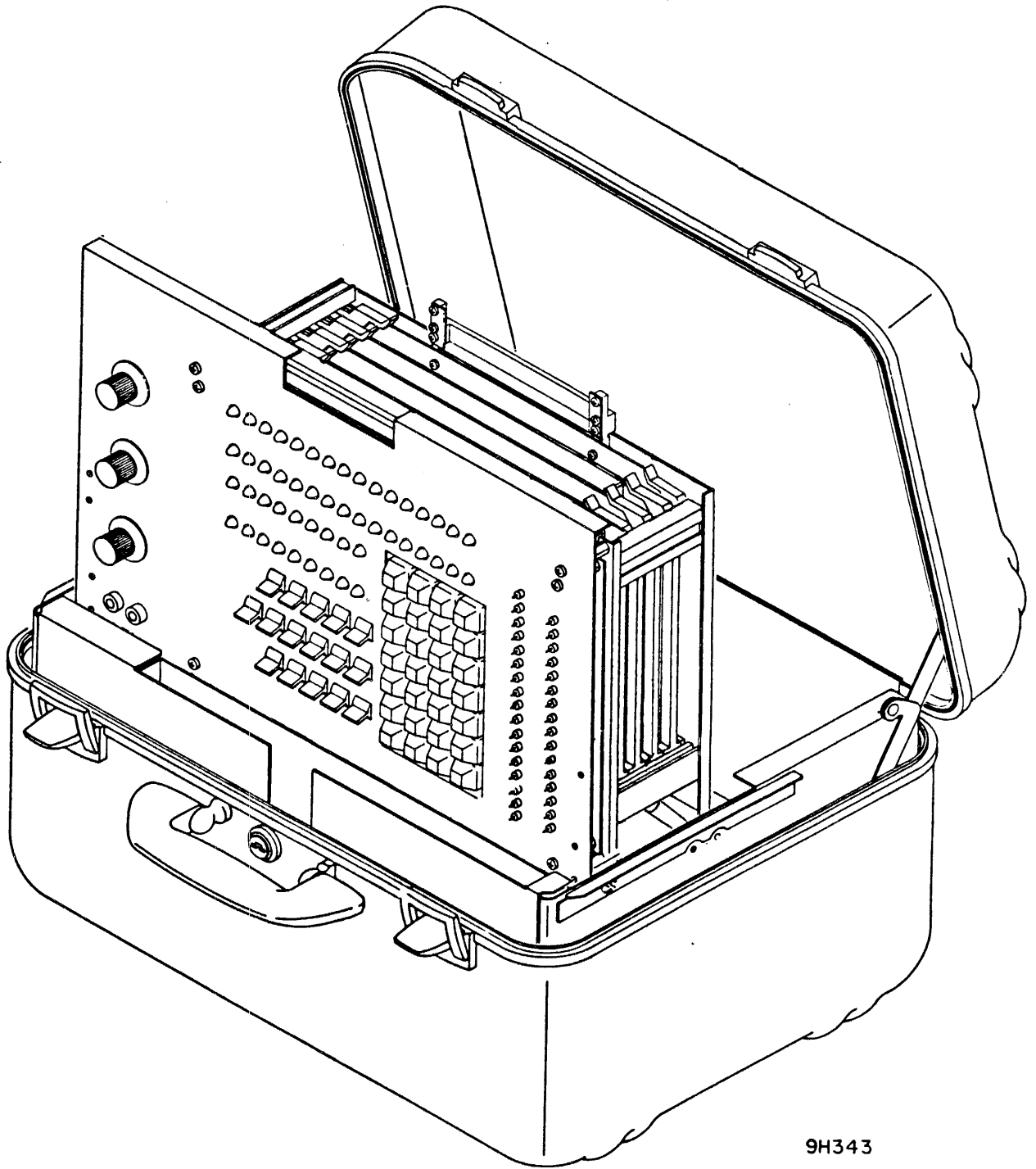
The drive seeks cylinder addresses generated randomly by the microprocessor.

### **X - N Seek**

The drive seeks from each cylinder to every higher numbered cylinder and back, thus performing all possible seeks.

### **READ/WRITE MODES**

The FTU generates serial NRZ or MFM write data at a rate determined by the servo clock signal transmitted from the unit under test. When a repeated access mode is selected, a read/write operation is completed at the selected cylinder. Then a seek is initiated to the next cylinder address (as determined by the access mode) and the read/write operation repeated. This seek - read/write sequencing continues until the end of test or until the STOP key is pressed. For direct seeks, the read/write operation continues at the selected cylinder (depending upon the head select mode) until the STOP key is pressed.



9H343

Figure 1-1. TB216 Field Test Unit (FTU)



TABLE 1-1. TB216 SPECIFICATIONS

Characteristic	Condition	Specification
Size	L x W x H	457 x 330 x 223 mm (18.0 x 13.0 x 8.75 in)
Weight		15.9 kg (35 lbs)
Temperature	Operating	15°C to 32°C (59°F to 90°F)
	Gradient (rise per hour)	6.7°C (12°F) per hour
	Non-Operating	-40.4°C to 70°C (-40°F to 158°F)
Relative Humidity (no condensation)	Operating	20% to 80%
	Non-Operating	5% to 95%
Altitude	Operating	-305 to 2000 m (-1000 to 6500 ft)
	Non-Operating	-305 to 4572 m (-1000 to 15 000 ft)
Input Power*	60 Hz, single	100 (+7, -10) V ac at 2.2 A, max.
		120 (+7, -16) V ac at 1.8 A, max. **
		200 (+20, -20) V ac at 1.1 A, max.
		240 (+17, -27) V ac at 0.9 A, max.
	50 Hz, single	100 (+7, -10) V ac at 2.2 A, max.
Table Continued on Next Page		

TABLE 1-1. TB216 SPECIFICATIONS (Contd)

Characteristic	Condition	Specification
		<p>120 (+8, -18) V ac at 1.8 A, max.</p> <p>200 (+20, -20) V ac at 1.1 A, max.</p> <p>220 (+15, -22) V ac at 1.0 A, max</p> <p>240 (+17, -24) V ac at 0.9 A, max</p>
<p>*Conversion is made on terminal board in power supply.  **Unit shipped with CSA listing at this rating any other combination not tested or listed by CSA.</p>		

The mode of head selection chosen determines the number of tracks read or written during each read/write operation. For manual head selection, the FTU reads or writes only the track under the head selected. For sequential head selection, the FTU sequences the heads to read or write each track in the cylinder. When the highest-numbered head has been exercised, the drive seeks to another cylinder (except in direct seek) and repeats the read/write operation at the new cylinder, starting with head zero. For random head selection, the FTU randomly selects one head per cylinder for its read/write operation.

The same options are available for record selection. In the manual record mode, one manually selected record is written or read for each selected track. In sequential record mode, the same operation takes place once per track on randomly chosen record.

#### Write Format

The FTU writes each selected track with the appropriate track address and a repetitive 16-bit data pattern that has been entered on the FTU keyboard. The FTU also provides a means for indicating a defective track when using the write format mode.

## **Write/Read Format**

The FTU commands the drive to alternate between writing the appropriate track address and repetitive data pattern and reading them back on each selected track.

### **Write**

After the track address has been read and verified, the FTU writes each selected track with a repetitive 16-bit data pattern that has been entered on the FTU keyboard. On drives that transmit MFM read data to the FTU, the address is not read.

### **Read**

The FTU commands the drive to read data from each selected track after the track address has been read and verified. On drives that transmit MFM read data to the FTU, the address is not read.

### **Write/Read**

The FTU commands the drive to alternate between writing a repetitive data pattern and then reading it on each selected track.

### **Access Only**

The FTU does not command a read or write operation after each track is accessed.

**SECTION 2**

**OPERATION**

---

## INTRODUCTION

This section is divided into two parts. The first provides general descriptive background information pertinent to the FTU and its interface with the drive. The second contains procedures for operating the FTU when servicing the drive. Refer to the individual drive manual for information concerning the drive during these operations:

## GENERAL OPERATING INFORMATION

### GENERAL

The general operating information consists of a variety of topics the operator should be familiar with prior to using the FTU. Topics included are:

- Operating voltage selection
- Description of I/O cables - their configuration, identification, and hook-up.
- Functions of FTU front panel controls and indicators.
- FTU front panel, test points, and jacks.
- Data entry switch loading parameters.

### OPERATING VOLTAGE SELECTION

The FTU operating voltage (input power) is set, at the factory, to 120 V ac, 60 Hz. Additional input power capabilities of 100, 200, 220, 240, V ac, 50/60 Hz and 120 V ac, 50 Hz require internal modification as follows:

1. Open FTU, raise front panel, and secure into place.
2. Remove transformer terminal block cover exposing terminal strip (see figure 2-1).

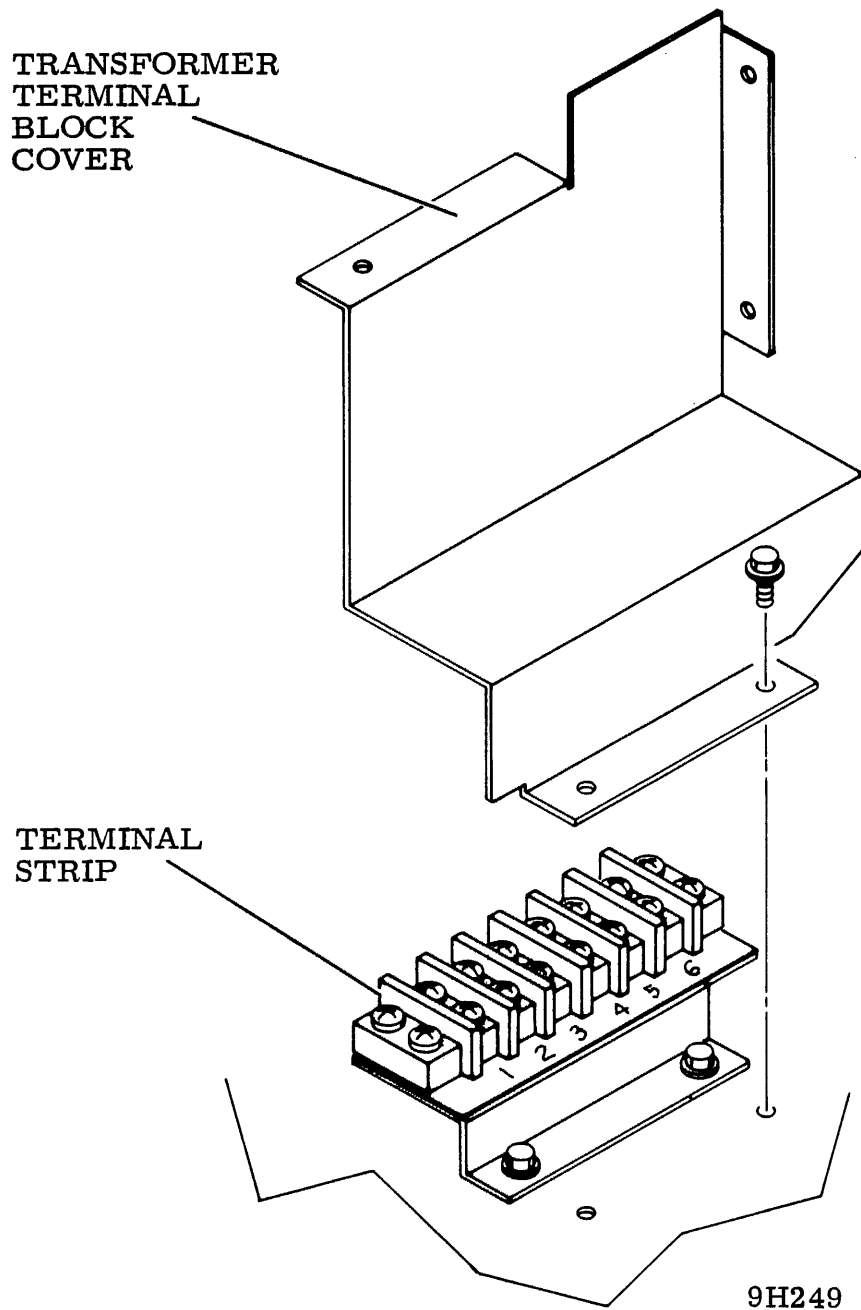


Figure 2-1. Accessing Terminal Strip

3. Modify FTU for input power of 100 V ac, 50/60 Hz by proceeding as follows:
  - a. Reposition wires on terminal board TB1 for 100 V ac (see figure 2-2).
  - b. Reinstall terminal block cover and lower front panel assembly.
  - c. Remove UL and CSA certification labels.
  - d. Mark up the power conversion label and affix next to the equipment configuration label.
4. Modify FTU for 120 V, 50 HZ input power by removing UL and CSA rating labels. Also, mark up the power conversion label and affix next to the equipment configuration label.
5. Modify FTU for 200, 220 and 240 V, 50/60 HZ input power by proceeding as follows:
  - a. Obtain appropriate cord plug.
  - b. Remove molded plug by cutting cord close to plug and stripping back wires.
  - c. Connect replacement plug as follows:
    - Black wire (phase 1) to brass colored terminal.
    - White wire (phase 2) to silver colored terminal.
    - Green wire (chassis ground) to ground terminal.
  - d. Reposition wires on terminal board TB1 for desired input power (see figure 2-2).
  - e. Remove bracket mounting holding power receptacle.

- f. Disconnect green/yellow ground wire, white wire, and black wire from power receptacle. Remove power receptacle from bracket.
  - g. Obtain dual rating power receptacle PN 24556501 from supplementary supply items and install this receptacle in bracket.
  - h. Connect replacement receptacle as follows:
    - Black wire (phase 1) to terminal X.
    - White wire (phase 2) to terminal Y.
    - Green/yellow wire (chassis ground) to middle terminal W.
  - j. Re-install bracket mounting in the tester.
  - k. Remove old power connector on power cord assembly 83271600.
  - l. Obtain dual rating power connector PN 24514300 from supplementary supply items and install connector as follows:
    - Black wire (phase 1) to pin X.
    - White wire (phase 2) to pin Y.
    - Green wire (chassis ground) to pin W.
  - m. Remove UL and CSA certification labels.
  - n. Re-install terminal block cover and lower front panel assembly.
  - o. Mark up the power conversion label and affix next to the equipment configuration label.
6. Check FTU operating voltage and adjust if necessary per Power Supply Adjustments procedure in the maintenance section of this manual.



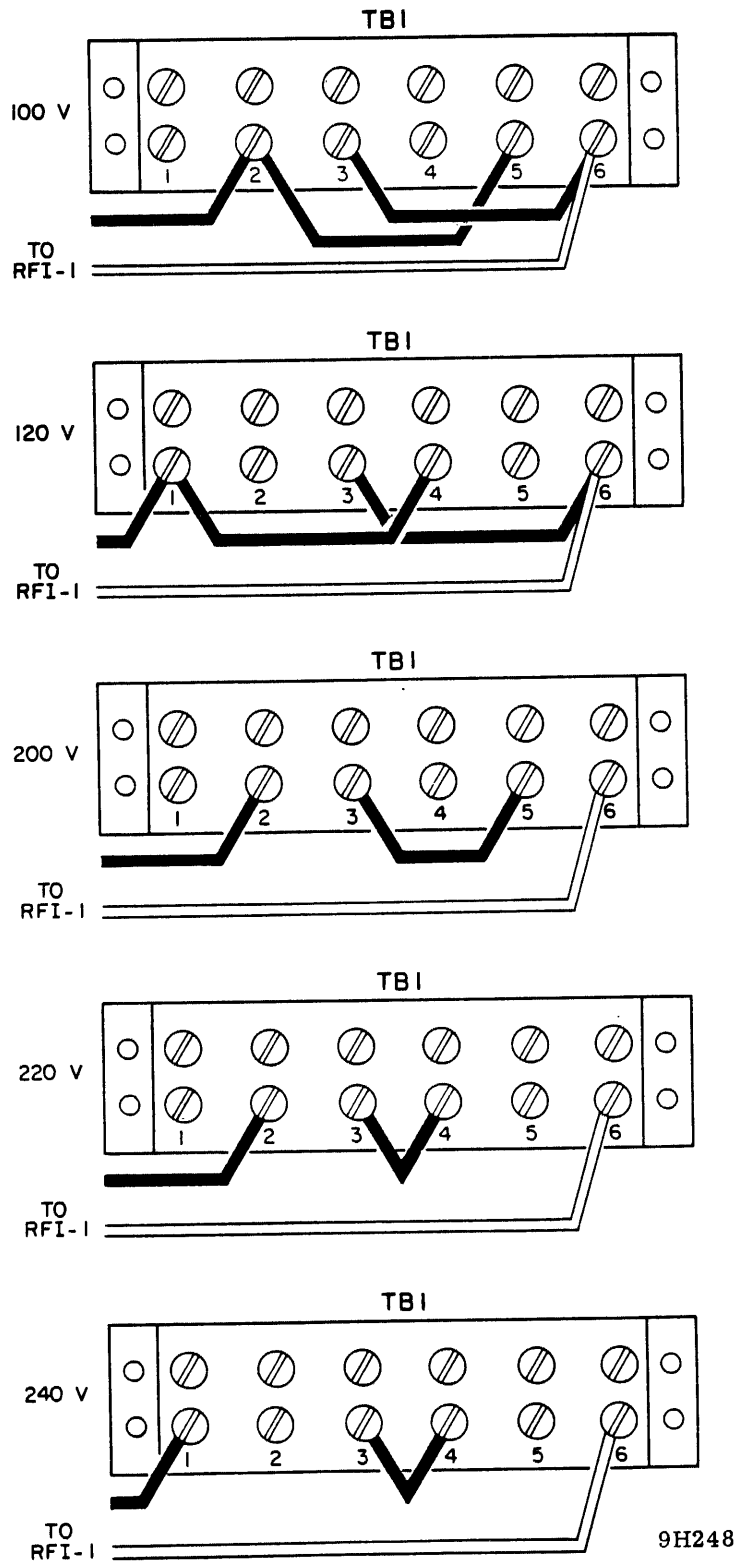


Figure 2-2. Terminal Strip Connections

## I/O CABLES

The cable configuration, that interfaces the FTU with the drive, varies with the type of drive being serviced. Cable information in this section includes: a listing of the different cable configurations (see table 2-1), identification of the individual cables and adapters within the configurations (see figure 2-3), and illustrations showing how the individual cables and adapters are interconnected (see figure 2-4). For signal information on the cables and adapters, refer to the Diagram section of this manual. For information on installing cables and terminators, into the drive, refer to the applicable drive manual.

TABLE 2-1. I/O CABLE CONFIGURATIONS

Drive	CABLE USED
75-Pin Mux	26 Pin I/O Cable Assembly B5 50 Pin I/O Cable Assembly-A2 10 Pin I/O Cable Assembly-A4 75 Pin Adapter Cable Assembly-A10 34 Pin Adapter Cable Assembly-B7
75 Pin Std	50 Pin I/O Cable Assembly-A2 10 Pin I/O Cable Assembly-A4 75 Pin Adapter Cable Assembly-A6 34 Pin Adapter Cable Assembly-B3 26 Pin I/O Cable Assembly B5
50 Pin I/O Cable	50 Pin I/O Cable Assembly-A2 26 Pin I/O Cable Assembly-B5
60 Pin I/O Cable Std and Mux	50 Pin I/O Cable Assembly-A2 10 Pin I/O Cable Assembly-A4 60 Pin Adapter Cable Assembly-A8 26 Pin I/O Cable Assembly-B5

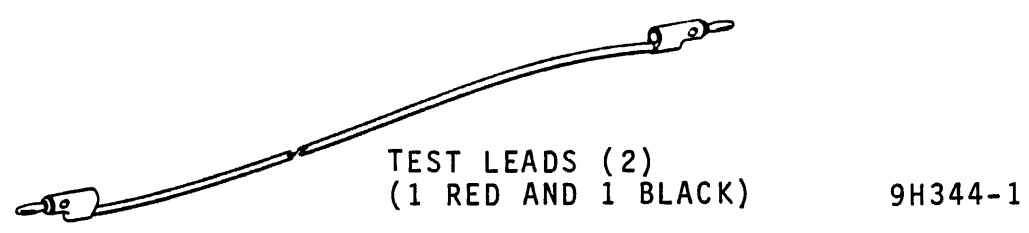
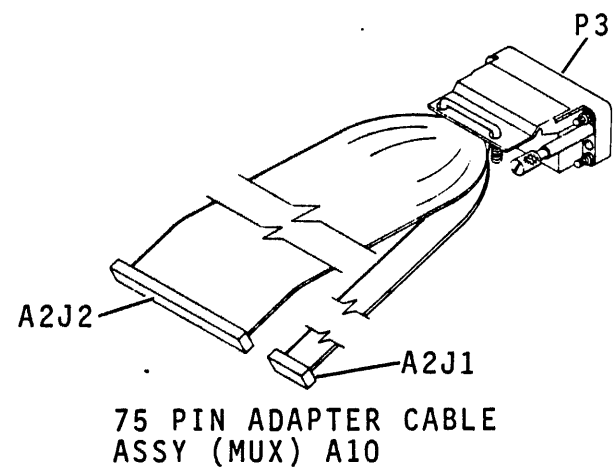
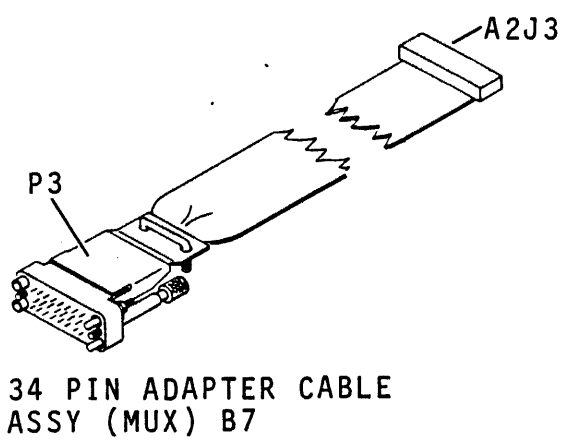
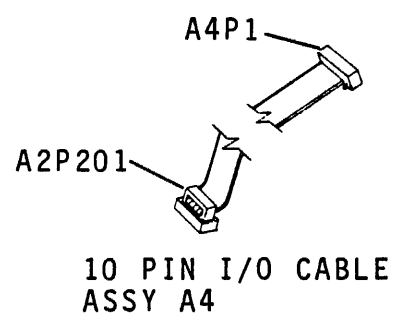
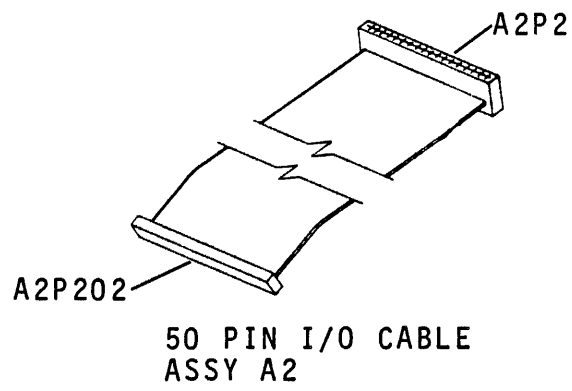
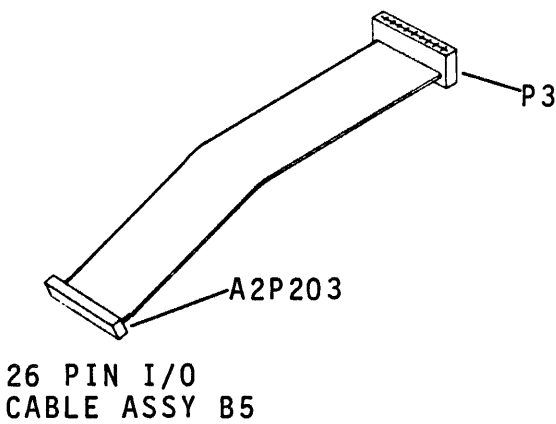
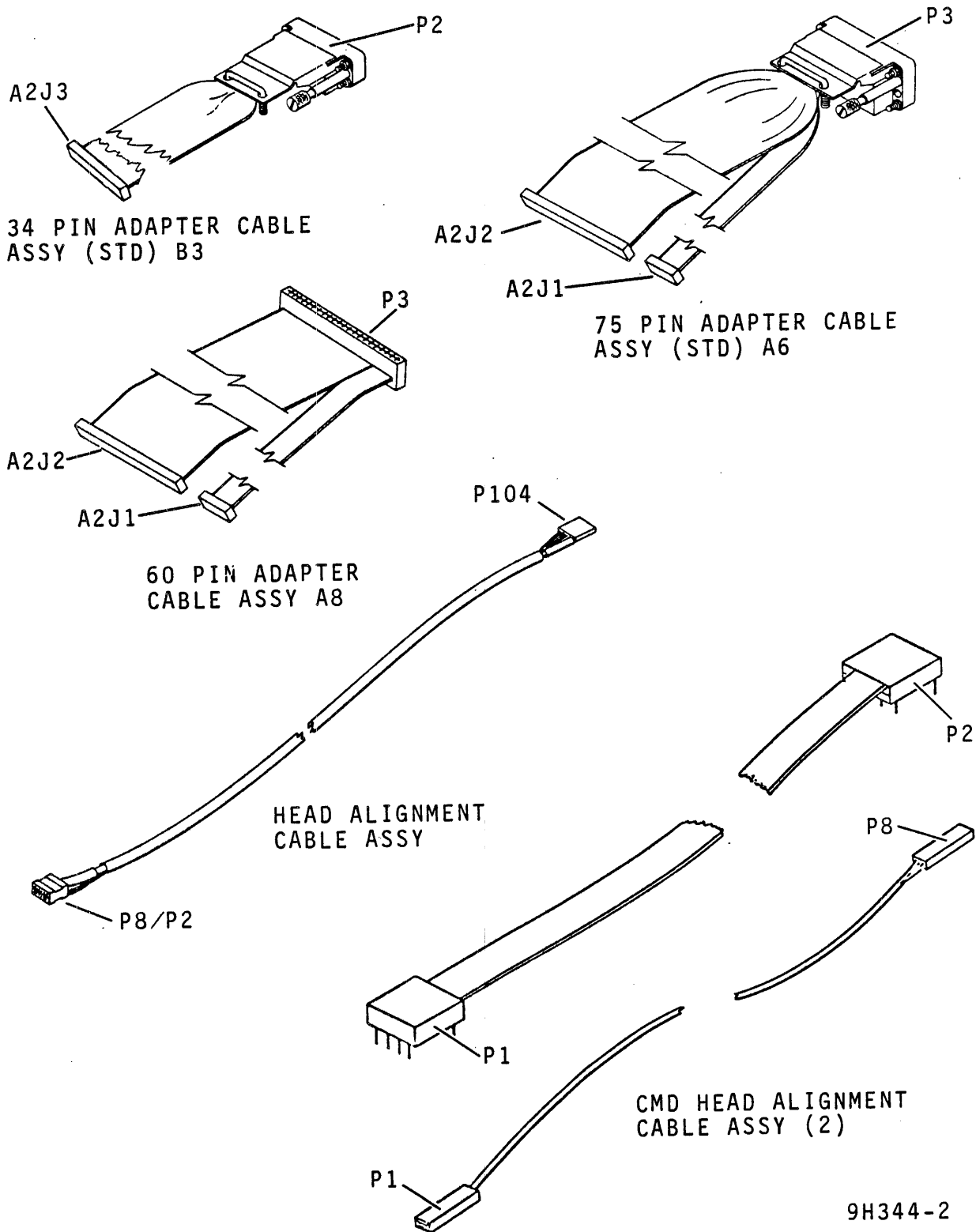
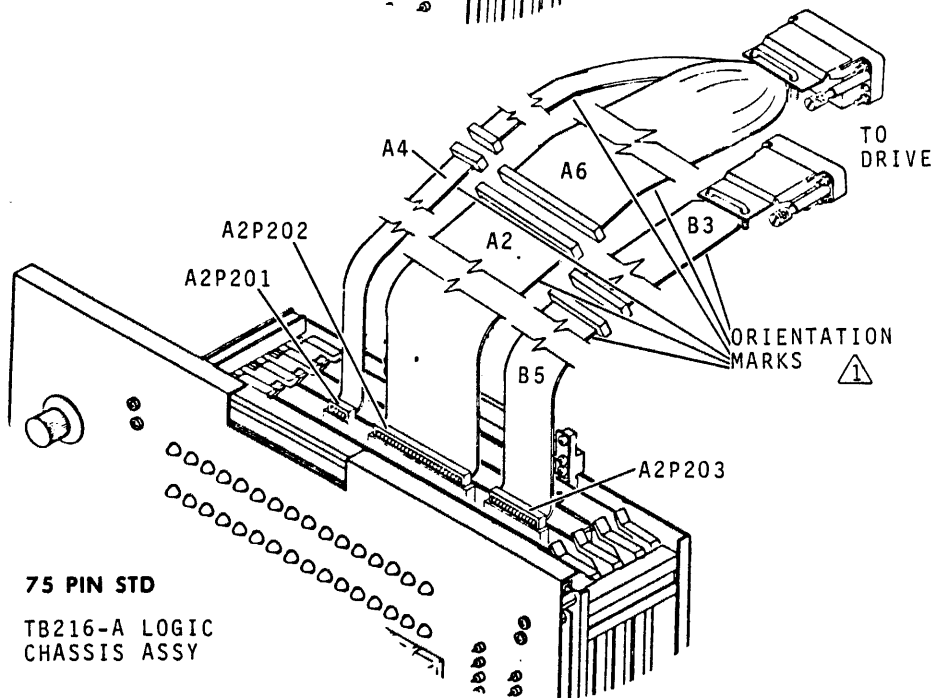
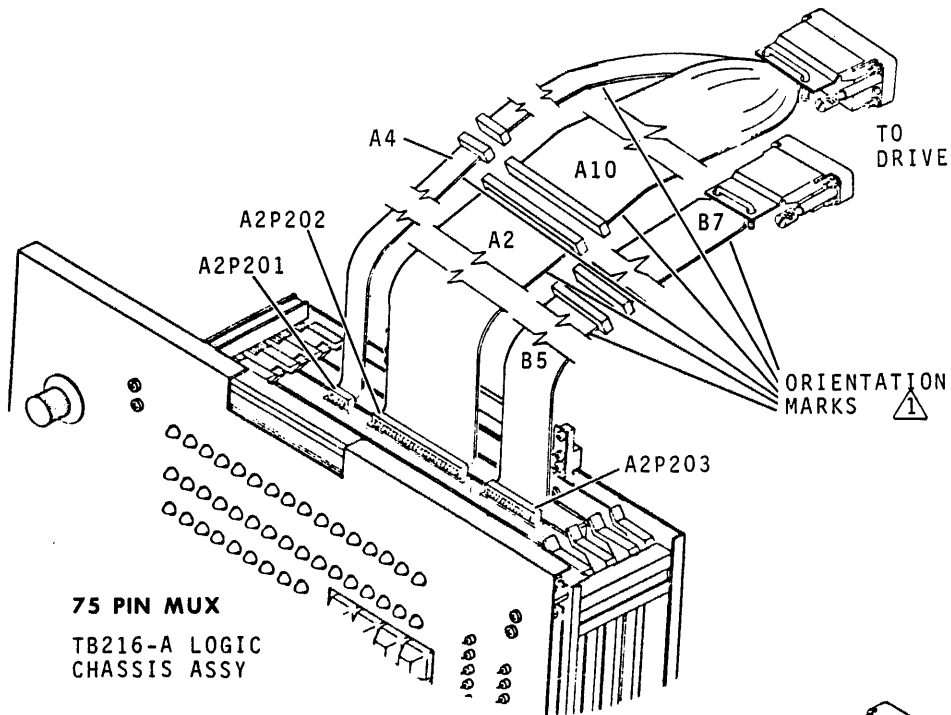


Figure 2-3. Cable Identification (Sheet 1)



9H344-2

Figure 2-3. Cable Identification (Sheet 2)



NOTE:

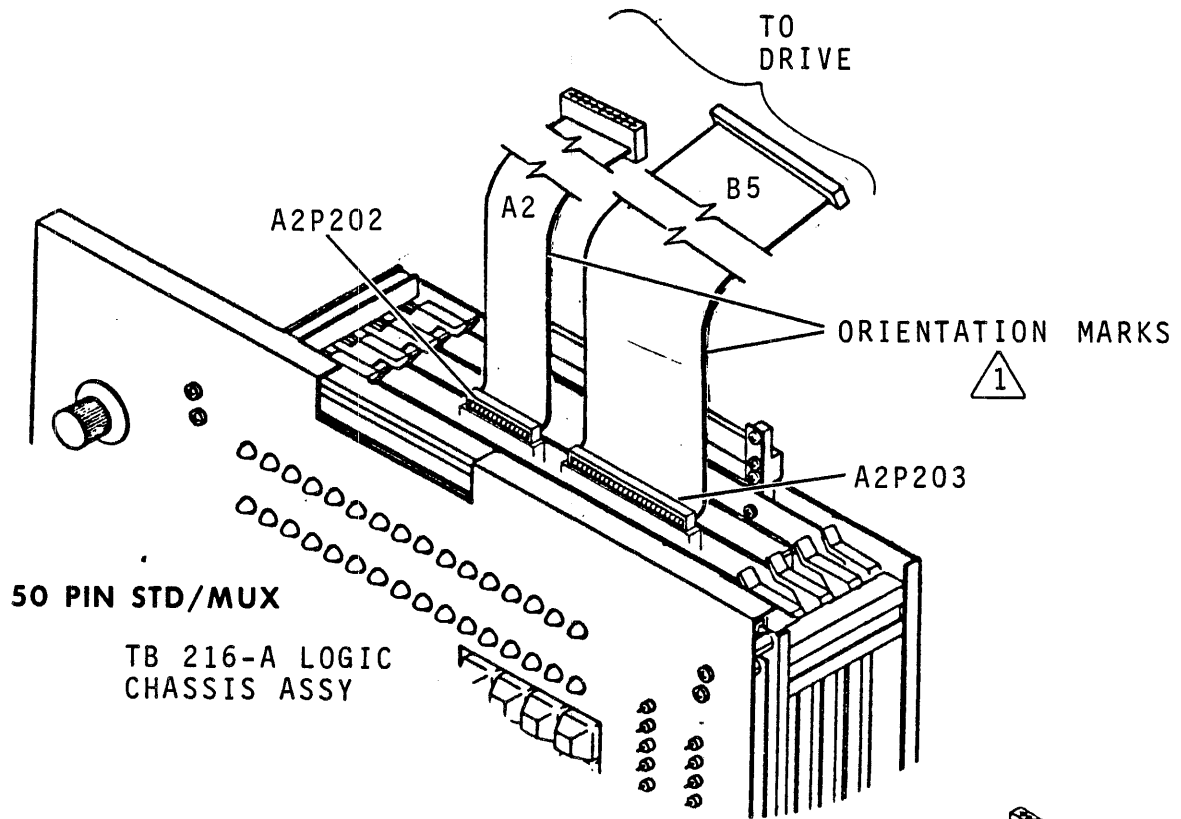


RED ORIENTATION MARKINGS DENOTES PIN 1, WHEN INSTALLING CABLES INTO DRIVE.

RED ORIENTATION MARKINGS ARE TO THE RIGHT, WHEN FACING FTU AND INSTALLING CABLES.

9H345-1A

Figure 2-4. I/O Cable Hook-Up (Sheet 1)



NOTES:

1 SEE NOTE ON SHEET 1.

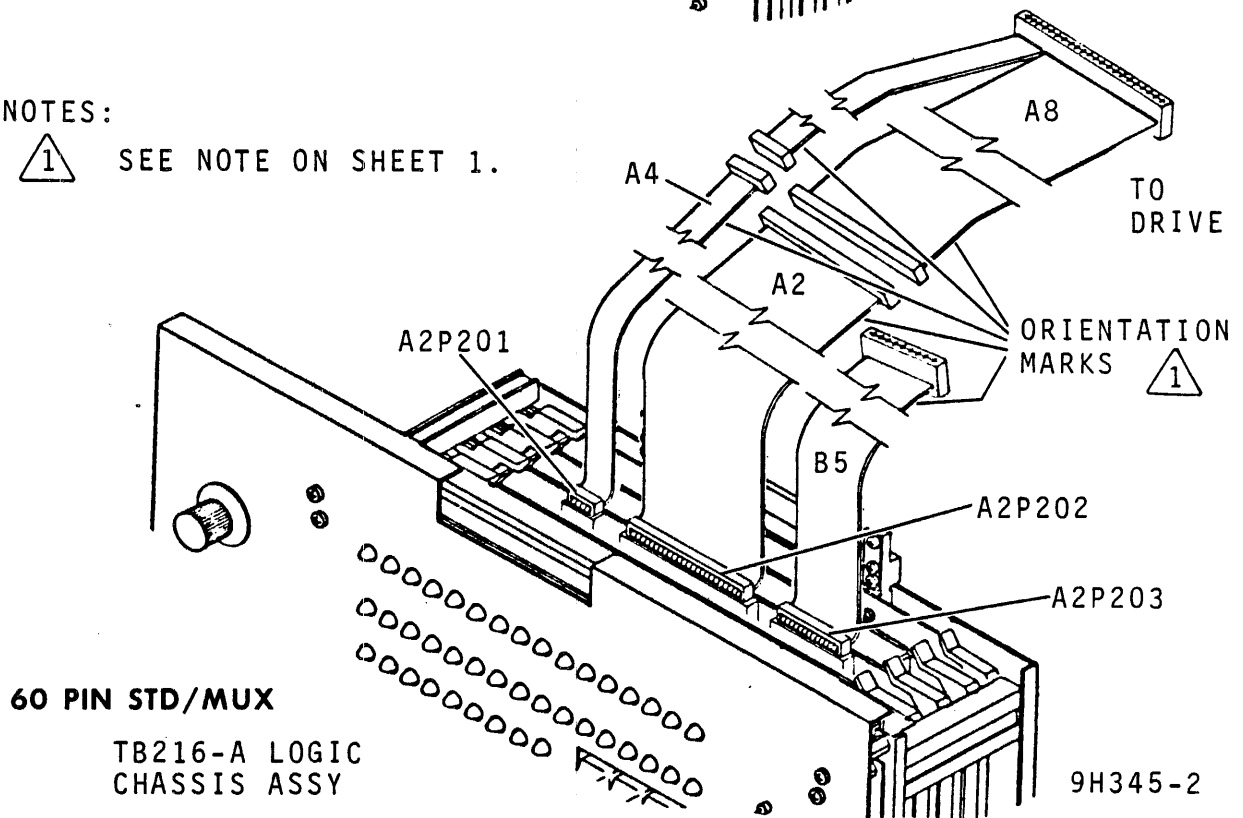


Figure 2-4. I/O Cable Hook-Up (Sheet 2)



## CONTROLS AND INDICATORS

Table 2-2 contains functional descriptions of the controls and indicators located on the front panel of the FTU. The purpose of each switch is given in general terms. Following that is a list of switch positions in the left-hand column; the drive and/or FTU operation corresponding to this switch setting is described in the right-hand column. Keyboard keys are listed on the left with a result of pressing them given to the right. Finally, the LED indicators are listed along with a description of the condition lighting them.

The only control not located on the front panel is the circuit breaker; this is mounted on the power supply module and is used to turn the FTU on and off.

TABLE 2-2. CONTROLS AND INDICATORS

Control/Indicator	Function
DATA ENTRY switch	This is a rotary switch that is set to different positions to allow specific kinds of information to be entered into the FTU memory through the keyboard. This information can be entered in either hexadecimal, decimal, or binary code unless only one of these codes is specified. Also, each switch position allows display (on the top row of 16 LEDs) of data previously entered in that segment of the FTU memory. A description of each switch position follows.
DEVICE TYPE	A four-character code is loaded into the FTU memory. This code programs the FTU to exercise a specific type of drive.
Table Continued on Next Page	



TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
UNIT NUMBER	The logical address of the drive being tested, determined automatically by the FTU, is displayed on row 1 LEDs. May be reset, to any unit number.
DESTINATION	The track destination for a direct seek is loaded into the FTU memory in the direct seek and direct continuous modes. The entry is made in decimal form.
HEAD	With the HEAD toggle switch in the MAN position, a specific moveable head address is selected. The entry is made in decimal form. High order byte displays bus-in for manual multiplex tag.
RECORD	A specific record address is loaded, provided that the RECORD toggle switch is in the MAN position. The entry is made in decimal form.
FIXED HEADS	The number of fixed heads is loaded (in decimal), and the microprocessor is setup for fixed head access.
DATA PATTERN	A sixteen-bit data pattern is entered (in hexadecimal) into the FTU memory. In write operations, this data pattern is repeated throughout the data field.

Table Continued on Next Page

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
<p>STATUS BYTES</p>	<p>Up to sixteen different status words are displayed on row 1 LEDs. The four least significant bits of row 2 LEDs indicate the code of the status word which has been entered on the keyboard and is being displayed. 512 memory locations may be displayed by pressing CLR ENT key and entering an address. It also allows entry of error bypass bit in status, byte F. Refer to table 2-11.</p>
<p>SEEK INCREMENT</p>	<p>In sequential access modes, the FTU is programmed to command seeks to every nth cylinder after the number "n" has been entered (in decimal) on the keyboard. For example, if three is entered, the drive will seek every third cylinder. With no entry, the seek increment is one, and no cylinders are skipped in the sequence.</p>
<p>MPU ADDRESS</p>	<p>A valid MPU address can be entered via the keyboard and displayed on row 2 LEDs. When the LOAD key is pressed, the address is transferred to row 1 LEDs and the data at this address is then displayed in the right 8 bits in row 2 LEDs. This operation is for use only by an operator who is extremely knowledgeable in the microprocessor machine language.</p>
<p>Table Continued on Next Page</p>	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
<p>MPU DATA</p> <p>B</p> <p>C</p> <p>D</p> <p>E</p>	<p>For a given MPU address, new data can be entered on the keyboard and loaded by pressing the LOAD key. Row 2 LEDs display the new data in the left eight bits and the contents of the next address in the right eight bits. The address on row 1 LEDs is incremented by one. This operation is for use only by an operator who is extremely knowledgeable in the microprocessor machine language.</p> <p>Used to enter valid write protect code (code 5754) prior to commanding drive to write on C.E. Cylinder (innermost, highest number) cylinder only. If code is not entered the WT PROT LED will flash.</p> <p>Ordinarily, the number of sectors used by the drive is automatically calculated by the FTU. In this position, the FTU can be programmed to operate on a different sector count.</p> <p>A maximum data length, other than that calculated by the FTU, is loaded into the FTU memory.</p> <p>Used to enable writing on any cylinder other than track 256 (FTU prevents writing on track 256). With switch at position E, enter, via keyboard, a hexadecimal non-zero number (1-F) into lower byte (row 1 LEDs 0-7) while preserving the number of logical records displayed in hexadecimal, in upper byte (row 1 LEDs 8-F). Note that pressing SEL DRV key destroys any information entered with DATA ENTRY switch at position E.</p>
<p>Table Continued on Next Page</p>	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

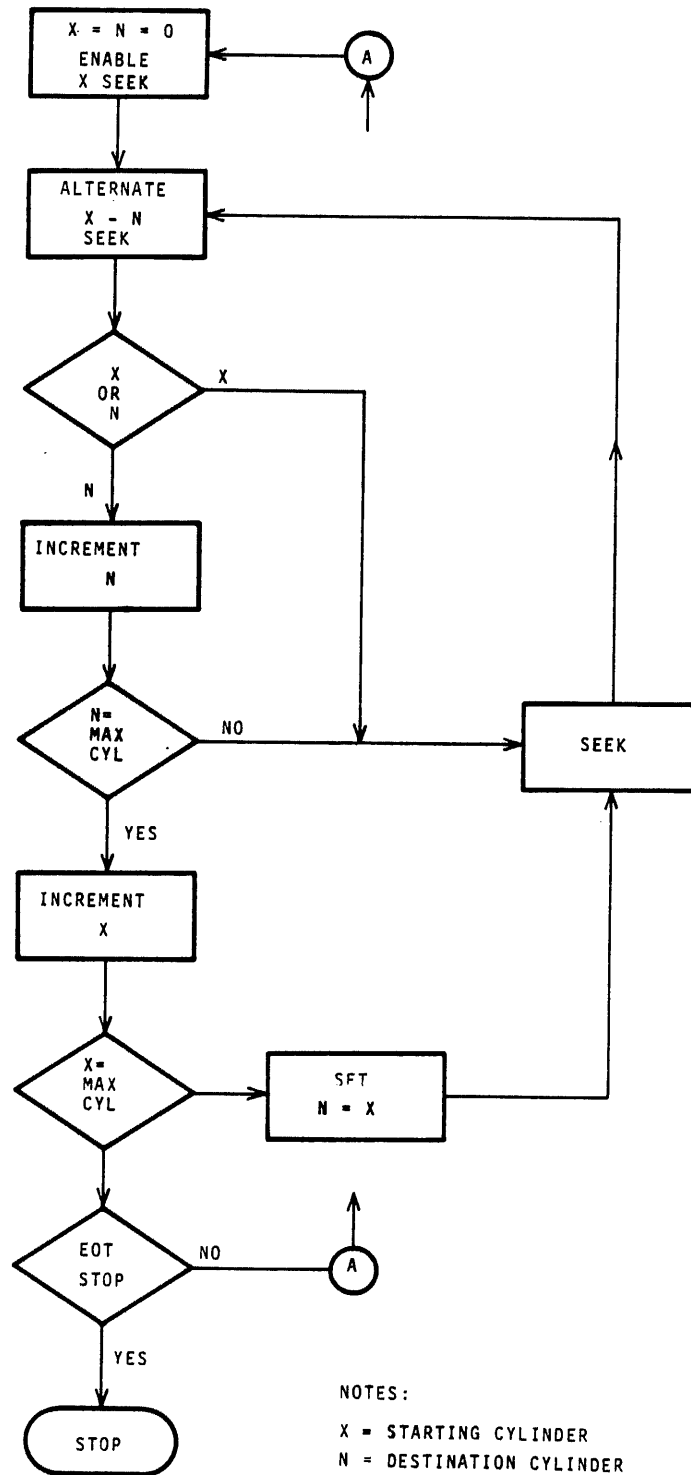
Control/Indicator	Function
<p>F</p> <p>RD/WRT SELECT switch</p> <p>WRT FORMAT</p> <p>WRT/RD FORMAT</p> <p>WRITE</p> <p>READ</p> <p>WRT/RD</p>	<p>Displays maximum cylinder number in hexadecimal, which can be altered.</p> <p>This is a rotary switch which determines the operation performed by the drive after each track has been accessed. A description of each switch position follows.</p> <p>The address and data pattern is written on the selected track.</p> <p>The drive alternates between writing the address and data pattern and then reading them back on a selected track.</p> <p>The data pattern is written on a selected track after the address has been read and verified. On drives that transmit MFM read data to the FTU, the address is not read. Positioning RD/WRT SELECT switch to a write position will not allow write operation if:</p> <ol style="list-style-type: none"> <li>1. WRITE PROT/OFF switch is set to OFF.</li> <li>2. The FTU write protect is overridden by rotating DATA ENTRY switch to B position and code 5754 is entered manually.</li> </ol> <p>The data pattern is read from a selected track after the address has been read and verified. On drives that transmit MFM read data to the FTU, the address is not read.</p> <p>Alternately, the data pattern is written and then read on a selected track.</p>
<p>Table Continued on Next Page</p>	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
ALIGNMENT	In head alignment procedures, the offset of a selected head is displayed in coded form on row 2 LEDs. Refer to table 2-12.
ACCESS ONLY	After accessing a cylinder, the FTU does not command any write or read operations.
7	After accessing each cylinder, the drive performs a Return-to-Zero seek.
8	After setting HEAD and RECORD toggle switches to RAN, the drive randomly performs either a write or a read operation on each selected track.
9	Checks write clock as if it were MFM data.
A-F	Unused
ACCESS SELECT switch	This is a rotary switch that enables selection of a number of accessing modes for the drive. These modes vary from a direct seek to a particular cylinder to a more complicated pattern of seeking between different cylinders. A description of each switch position follows.
MANUAL TAGS	The tag and bus data displayed on row 2 LEDs will be put on the I/O lines when the GO key is pushed.
Table Continued on Next Page	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
DIRECT SEEK	When the GO key is pressed, the drive seeks to the particular cylinder stored in the destination register.
DIRECT CONT	The drive continuously seeks between an origin cylinder address and a destination cylinder address until the STOP key is pressed. The operator must first load the origin address, switch to DIRECT SEEK, and then press the GO key. Afterward, the operator must switch to DIRECT CONT and load the destination address. The seek operation is initiated when the GO key is pressed and continues until the STOP key is pressed. With the EOT STOP switch in the up position, 10 000 seeks will be performed.
SEQ FORWARD	The drive seeks to cylinder zero and then sequences up to the maximum cylinder. If the EOT STOP toggle switch is in the up position, the test will end. Otherwise, the drive will return to cylinder zero and continue to sequence up until the STOP key is pressed.
Table Continued on Next Page	



L12E1

Figure 2-6. X -- N Test

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
SEQ REVERSE	The drive seeks to the maximum cylinder and then sequences down to cylinder zero. If EOT STOP toggle switch is in the up position, the test will end. If EOT STOP switch is not set, the drive will return to the maximum cylinder and continue to sequence down until the STOP key is pressed.
SEQ FWD/REV	Starting at cylinder zero, the drive seeks sequentially upward to the maximum cylinder and then seeks sequentially downward to cylinder zero. With the EOT STOP switch in the UP position, the test ends after one complete sequence. Otherwise, it continues until the STOP key is pressed.
RANDOM SEEK	The drive seeks to cylinder addresses randomly generated by the microprocessor until the STOP key is pressed or after 10 000 seeks with the EOT STOP switch up.
X -- N SEEK	The drive seeks from each cylinder to every higher-numbered cylinder and back, thereby performing all possible seeks. This seeking continues until all possible combinations of seeks have been completed with the EOT STOP switch up or until the STOP key is pressed, refer to Figure 2-6.
FIXED VOLUME	Pressing the SEL DRV key sets the FTU to access CMD fixed volume only. Pressing the GO key sets up the FTU to access both fixed volume and removable disk pack.
Table Continued on Next Page	



TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
LAMP TEST	<p>Pushing the GO key causes all LEDs except the +5 or -5 LEDs to flash on and off. A +5 or -5 LED not lighted indicates that power is not being applied to the FTU, and failure of the FTU power supply, or the failure of one or both of the LEDs.</p>
SELF TEST	<p>The processor performs a limited self-test routine on the FTU. During the test, the RD and WT LEDs alternately flash. Failure of the self-test is indicated by the RD and DATA ERR LEDs flashing alternately. If the test is satisfactory, it ends with the RD, 2<sup>9</sup> and 2<sup>11</sup> LEDs on steadily. Then all switch positions can be checked out; changing any switch position results in a change in the LED display. Normally self-test is performed with the HEAD, RECORD, -/+, and LATE/EARLY switches in the center position, DATA ENTRY switch set to DEVICE TYPE position, RD/WRT SELECT switch set to WRT FORMAT position, the PROCESSOR switches in the START and RUN positions, and all other toggle switches in the down position with the exception of SEQ PWR which is not tested.</p>
B	<p>The microprocessor program jumps to the MPU address entered on row 2 LEDs when the Go key is pressed.</p>
C	<p>Average access time for the drive can be measured for certain access modes by pressing the GO key. The RD/WRT SELECT switch must be in the ACCESS ONLY position. Calculation of this is done automatically after 10 000 seeks in DIRECT SEEK, DIRECT CONT, and RANDOM</p>
<p>Table Continued on Next Page</p>	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
<p>C (Contd)</p> <p>D-F</p>	<p>SEEK: calculation is done at the end of test for sequential seeks. Each group of four LEDs in row 1 represents a binary coded decimal digit, the least significant one being 0.1 ms and the most significant being 100 ms with a maximum display value of 999.9 ms. Time is displayed in status Byte A.</p> <p>Unused.</p>
<p>Toggle Switches</p> <p>HEAD switch</p> <p>MAN</p> <p>SEQ</p> <p>RAN</p>	<p>The toggle switches on the FTU and their respective switch positions are described below.</p> <p>This is a three-position switch that is used for moveable head sequencing.</p> <p>A particular head can be selected using the number loaded with the DATA ENTRY switch in the HEAD position.</p> <p>At each access track, record addresses are selected sequentially.</p> <p>At each accessed track, a record is randomly selected for the desired operation.</p>
<p>RECORD Switch</p> <p>MAN</p>	<p>This three-position switch allows different patterns of record addressing.</p> <p>A particular record can be selected using the number loaded with the DATA ENTRY switch in the RECORD position.</p>
<p>Table Continued on Next Page</p>	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
<p>SEQ</p> <p>RAN</p>	<p>At each accessed track, record addresses are selected sequentially.</p> <p>At each accessed track, one record is randomly selected for the desired operation.</p>
<p>PROCESSOR switches</p> <p>START/RESET RUN/HALT STEP</p>	<p>These three toggle switches are associated with the microprocessor.</p> <p>They are primarily intended for use during maintenance of the FTU and are of no concern to the operator of the FTU. In normal operation, the switches are respectively in the START and RUN positions (STEP is spring-loaded).</p>
<p>SINGLE/CONT switch</p> <p>SINGLE</p> <p>CONT</p>	<p>This toggle switch allows the choice of single or continuous accessing of tracks.</p> <p>An access is performed only once by the drive.</p> <p>An access is performed 10 000 times with the EOT STOP switch up until the STOP key is pressed.</p>
<p>-/+ switch</p> <p>-</p>	<p>This is a three-position toggle switch that directs the drive to offset the carriage for better data recovery.</p> <p>An offset is ordered away from the spindle.</p>
<p>Table Continued on Next Page</p>	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
center position  +	No offset is called for (normal position).  An offset is ordered toward the spindle.
LATE/EARLY switch  LATE  center position  EARLY	This is a three-position toggle switch that allows the shifting of read data strobes away from nominal timing to check error recovery.  The drive read strobes are shifted to a later time with respect to data.  The drive strobes at nominal timing (normal position).  The drive read strobes are shifted to an earlier time with respect to data.
WRITE FLAG/OFF switch	In the up position, the FTU will command the drive to write a flag on a bad track provided that:  a. RD/WRT SELECT switch is set to WRT FORMAT or WRT/RD FORMAT.  b. ACCESS SELECT switch is set to DIRECT SEEK.  c. HEAD switch is set to MAN.  In the up position, while performing a WRITE or READ operation, the FTU will stop if a flag bit is found.
WRITE PROT/OFF switch	In the up position, this switch protects the drive from being commanded to write by the FTU.
Table Continued on Next Page	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
<p>AM/SECTOR switch</p> <p>AM</p> <p>SECTOR</p>	<p>This toggle switch allows the choice of address mark or sector mode of operation.</p> <p>This drive writes or reads an address mark.</p> <p>The writing and reading of data is referenced to the sector count.</p>
<p>EOT STOP/OFF switch</p>	<p>With this switch in the up position, in sequential seeks, the test will stop after one complete sequence. Placed in the up position during self-test, this switch causes the error display to be bypassed which facilitates troubleshooting the FTU with an oscilloscope.</p>
<p>DATA ERROR OVERRIDE/OFF switch</p>	<p>With this switch in the up position, the FTU will not stop an access sequence when a data error is discovered. In self-test a data error in the MPU is bypassed; with the switch up, the MPU continually loops when there is a data error.</p>
<p>ADDR ERROR OVERRIDE/OFF switch</p>	<p>With this switch in the up position, the FTU will not stop an access sequence when an address error is discovered. In self-test, if there is a data error, that address will be skipped, the address counter will be incremented and the program will continue.</p>
<p>Table Continued on Next Page</p>	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
SHIFT PATT/DATA PATT switch	<p>In the DATA PATT position, the same data pattern is repeated throughout the entire accessing sequence. In the SHIFT PATT position, each time the drive seeks a new track, the data pattern is shifted one bit to left, and the sixteenth bit becomes the first bit. This function is used when performing a write/read operation.</p>
SEQ PWR switch	<p>In the SEQ PWR position, the FTU commands the drive to power up, provided that</p> <ul style="list-style-type: none"> <li>a. The drive is in the REMOTE mode.</li> <li>b. Primary power is available at the drive.</li> <li>c. The drive START switch is ON (indicator lighted).</li> </ul>
Keyboard Panel	<p>The result of pressing each keyboard key is given in the following description:</p>
Data Keys O-F	<p>New data can be entered with these keys. Entered data is displayed on row 1 LEDs.</p>
HEX key	<p>Pressing this key results in the conversion of the BCD number in the lower display to hexadecimal form.</p>
<p>Table Continued on Next Page</p>	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
DISP key	The hexadecimal data, in row 1 LED, is transferred into row 2 LED. The hexadecimal/decimal data, in row 2 LED, is transferred, in hexadecimal, into row 1 LED.
CLR ENT key	This key is used to clear the entry displayed in row 2 LEDs when an incorrect entry has been made.
LOAD key	Pressing the LOAD key transfers the data entry in the second row of 16 LEDs to row 1 LEDs and loads it into memory via the DATA ENTRY switch while clearing the second row.
DEC key	The hexadecimal number in the lower display is converted to decimal.
BIT key	When pressed prior to a data entry, the data will be entered bit-by-bit in binary form.
SEL DRV key	Pressing this key initiates a drive selection sequence. Note that pressing SEL DRV Key destroys any information that may have been entered with DATA ENTRY switch at position E.
CLR FLT key	Pressing this key initiates a fault clearing sequence.
RTZ key	Pressing this key initiates the drive by commanding a return-to-zero seek.
Table Continued on Next Page	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
CLR key	This key clears the display and all status, and resets the FTU.
GO key	Pressing this key initiates the selected FTU operation.
STOP key	When this key is pressed, the FTU is stopped at the end of the operation in progress.
<p>LED Display</p> <p>Row 1 LEDs</p> <p>Row 2 LEDs</p> <p>I/O RDY LED</p>	<p>A description of the condition, causing each of the LEDs to be lighted, is given below.</p> <p>These LEDs indicate in binary form data that has been loaded into the FTU memory. Possibilities include:</p> <ul style="list-style-type: none"> <li>a. A keyboard data entry that has been loaded with the LOAD key.</li> <li>b. A previous entry indicated by the DATA SELECT rotary switch.</li> <li>c. A status word.</li> <li>d. Self test information.</li> </ul> <p>These LEDs indicate data that has been entered on the keyboard before the LOAD key has been pressed. It also displays the code of the status word, when a status word is being displayed, head alignment offset, and the address of a failed component during self test.</p> <p>This LED indicates that a device type code has been loaded and that the transmitters and receivers have been enabled.</p>
<p>Table Continued on Next Page</p>	



TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
UNIT RUN LED	The drive is in the process of performing a commanded operation.
ON CYL LED	The FTU is receiving an On Cylinder signal from the drive. The On Cylinder LED flashes when an On Cylinder condition is disrupted.
RDY LED	The FTU is receiving a Unit Ready signal from the drive.
WT PROT LED	The FTU is receiving a Write Protect signal from the drive.
SELD LED	The FTU is receiving a Unit Selected signal from the drive.
SEEK ERROR LED	The FTU is receiving a Seek Error signal from the drive.
FLT LED	The FTU is receiving a Fault signal from the drive.
BUSY LED	The FTU is receiving a Busy signal from the drive. The BUSY LED will also flash while the FTU is waiting for a Ready signal during a select drive command.
FLAG LED	This LED lights when a flag is read. If the WRITE FLAG switch is OFF the FLAG LED goes off when the next head is selected. If the WRITE FLAG switch is ON, the FLAG LED stays on and the test stops, until the CLR key is pressed.
DATA ERR LED	This LED lights when the FTU has detected a discrepancy between the data pattern written by the drive and the data pattern read by the drive. If the DATA ERROR OVERRIDE switch is on, the DATA ERR LED goes off when the next head is selected. If the DATA ERROR OVERRIDE switch is off, this LED stays lighted and the test halts. A time out during
Table Continued on Next Page	

TABLE 2-2. CONTROLS AND INDICATORS (Contd)

Control/Indicator	Function
DATA ERR LED (Contd)	a read or write in the data field is indicated when DATA ERROR indicator is ON and row 3 LEDs continually flash.
ADDR ERR LED	This LED lights when the address information received from the drive differs from the requested address. If the ADDR ERROR OVERRIDE switch is on, the ADDR ERROR LED goes off when the next head is selected. If the ADDR ERROR OVERRIDE switch is off, this LED stays lighted and the test halts. A time out in the address field is indicated when ADDR ERR indicator is ON and row 3 LEDs continually flash.
RD LED	The FTU is commanding a read operation.
WT LED	The FTU is commanding a write operation.
CLK LED	The Read Clock signal is coming from the drive.
+5 LED	The power supply in the FTU has a +5 volt output.
-5 LED	The power supply in the FTU has a -5 volt output.
RUN LED	The microprocessor in the FTU is running.

**TEST POINTS AND JACKS**

Thirty-three test points and two head alignment jacks are located on the front panel of the FTU. Many of these test points serve a dual purpose; the signal found on them depends on whether a standard interface or multiplexed interface is being used. In this case, the signal designation for standard and multiplexed interfaces are printed to the left and right of the test point respectively. One label is valid for both interfaces when it appears alone to the left of the test point.

Table 2-3 lists the test point labels as they appear on the FTU front panel. Definitions of the signals present are given for both types of interfaces.

Two banana jacks for head alignment are located in the lower left corner of the front panel. The black and red leads from the head alignment card plug into the jacks marked - and + respectively.

TABLE 2-3. TEST POINTS

STD Label	MUX Label	STD Definition	Mux Definition
AM FOUND	BIB <sub>0</sub>	Address Mark Found from the drive	Bus In Bit 0 from the drive
NOT USED	BIB <sub>1</sub>	Not Used	Bus In Bit 1 from the drive
ON CYL	BIB <sub>2</sub>	On Cylinder from the drive	Bus In Bit 2 from the drive
READY	BIB <sub>3</sub>	Ready signal from the drive	Bus In Bit 3 from the drive
NOT USED	BIB <sub>4</sub>	Not Used	Bus In Bit 4 from the drive
NOT USED	BIB <sub>5</sub>	Not Used	Bus In Bit 5 from the drive
SK ERR	BIB <sub>6</sub>	Seek Error from the drive	Bus In Bit 6 from the drive
FAULT	BIB <sub>7</sub>	Fault signal from the drive	Bus In Bit 7 from the drive
RD GATE	RD GATE	Read Gate from the drive	Read Gate to the drive
RD CLK	RD CLK	Read Clock from the drive	Read Clock from the drive

Table Continued on Next Page

TABLE 2-3. TEST POINTS (Contd)

STD Label	MUX Label	STD Definition	Mux Definition
RD DATA	RD DATA	Read Data from the drive	Read Data from the drive
WRT GATE	WRT GATE	Write Gate to the drive	Write Gate to the drive
WRT CLK	WRT CLK	Write Clock to the drive	Write Clock to the drive
WRT DATA	WRT DATA	Write Data to the drive	Write Data to the drive
AM GATE	AM GATE	Address Mark Gate	Address Mark Gate
READ ERR	READ ERR	A read error is detected in the FTU	A read error is detected in the FTU
GND	GND	Ground Test Point	Ground Test Point
TAG 1	TAG 2 <sup>0</sup>	Tag 1 to the drive	Tag 2 <sup>0</sup> to the drive
TAG 2	TAG 2 <sup>1</sup>	Tag 2 to the drive	Tag 2 <sup>1</sup> to the drive
TAG 3	TAG 2 <sup>2</sup>	Tag 3 to the drive	Tag 2 <sup>2</sup> to the drive
BOB <sub>0</sub>	BOB <sub>7</sub>	Bus Out Bit 2 <sup>0</sup> to the drive	Bus Out Bit 2 <sup>7</sup> to the drive
BOB <sub>1</sub>	BOB <sub>6</sub>	Bus Out Bit 1 <sup>2</sup> to the drive	Bus Out Bit 2 <sup>4</sup> to the drive
BOB <sub>2</sub>	BOB <sub>5</sub>	Bus Out Bit 2 <sup>2</sup> to the drive	Bus Out Bit 2 <sup>5</sup> to the drive

Table Continued on Next Page

TABLE 2-3. TEST POINTS (Contd)

STD Label	MUX Label	STD Definition	Mux Definition
BOB <sub>3</sub>	BOB <sub>4</sub>	Bus Out Bit 2 <sup>3</sup> to the drive	Bus Out Bit 2 <sup>4</sup> to the drive
BOB <sub>4</sub>	BOB <sub>3</sub>	Bus Out Bit 2 <sup>4</sup> to the drive	Bus Out Bit 2 <sup>3</sup> to the drive
BOB <sub>5</sub>	BOB <sub>2</sub>	Bus Out Bit 2 <sup>5</sup> to the drive	Bus Out Bit 2 <sup>2</sup> to the drive
BOB <sub>6</sub>	BOB <sub>1</sub>	Bus Out Bit 2 <sup>6</sup> to the drive	Bus Out Bit 2 <sup>1</sup> to the drive
BOB <sub>7</sub>	BOB <sub>0</sub>	Bus Out Bit 2 <sup>7</sup> to the drive	Bus Out Bit 2 <sup>0</sup> to the drive
BOB <sub>8</sub>	NOT USED	Bus Out Bit 2 <sup>8</sup> to the drive	
BOB <sub>9</sub>	NOT USED	Bus Out Bit 2 <sup>9</sup> to the drive	
BOB <sub>10</sub>	NOT USED	Bus Out Bit 2 <sup>10</sup> to the drive	
INDEX	INDEX	Index signal from the drive	Index signal from the drive
SECTOR	SECTOR	Sector signal from the drive	Sector signal from the drive

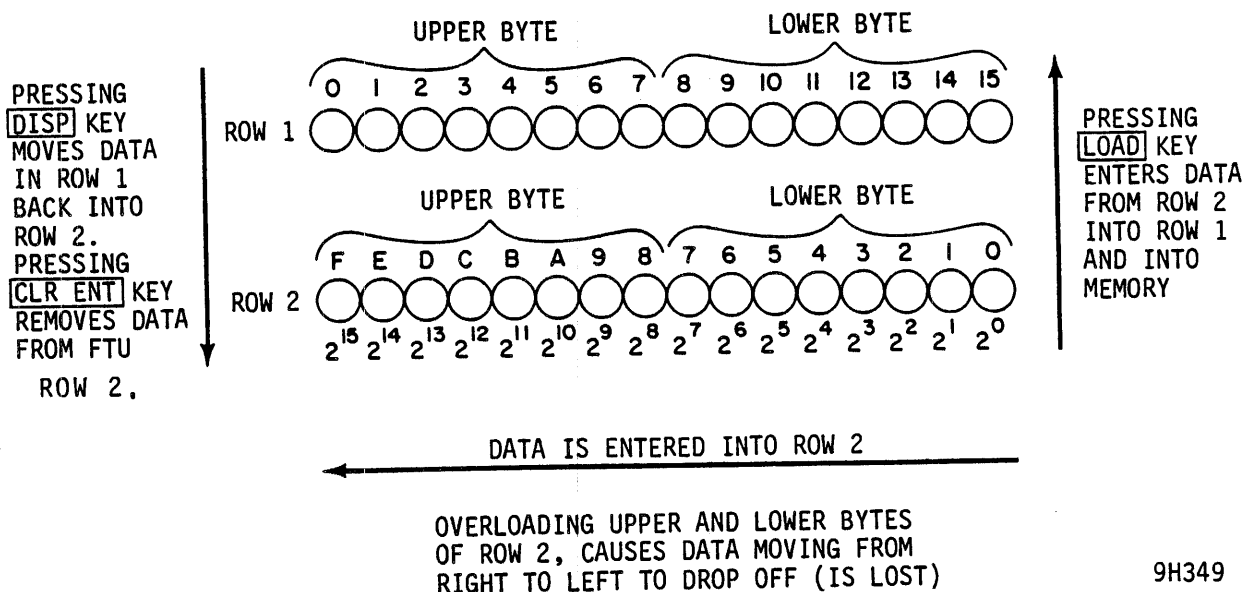
LOADING DATA

Data is entered into upper byte (8-F LEDs) and lower byte (0-7 LEDs) of row 2 via the FTU key board switches 0-F (see figure 2-7). After ensuring data, in row 2, is correct pressing LOAD key:

- Transfers row 2 data into row 1.
- Enters row 2 data into memory.

The following are 3 methods of entering data after rotating DATA ENTRY switch to desired position.

- Normal entry - Each time any (0-F) key is pressed, its hexadecimal value is entered into lower 4 LEDs (0-4) of row 2. Data presently in LEDs 0-4 shifts 4 LEDs to the left. Any data shifted left beyond F is lost (drops off).



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Figure 2-7. Loading Data into FTU

- Bit entry - Pressing BIT key, prior to entering data, causes the corresponding LEDs to toggle. Pressing LOAD key clears bit mode.
- Display - Data can be exchanged between row 1 and row 2 by pressing DISP key (action will not effect memory).

Pressing DEC key converts row 2 hexadecimal data to (BCD) data. Pressing HEX key converts row 2 decimal data (to hexadecimal data). Pressing CLR ENT key clears row 2 LEDs.

## OPERATING PROCEDURES

### GENERAL

The operating procedures provide instructions for operating the FTU when controlling the drive. Prior to performing these operations, the operator should be familiar with all the information contained in General Operating Information. Refer to the individual drive manual for procedures concerning operation of the drive.

### POWER UP INITIALIZATION

1. Remove drive, to be serviced, from the system and connect FTU to drive using applicable cable configuration listed in table 2-1.
2. Set circuit breaker CB1, on power supply assembly, to ON and ensure that LEDs -5 and +5, in row 4, are lighted.
3. Position PROCESSOR switches; on FTU front panel, as follows:
  - a. Set START/RESET switch to RESET position.
  - b. Set RUN/HALT switch to HALT position
4. Position switches on FTU front panel as follows:

<u>SWITCH</u>	<u>POSITION</u>
SINGLE/CONT	CONT
-/+(Carrage offset)	Center (OFF)
LATE/EARLY	Center (normal)
WRITE FLAG	OFF
WRITE PROT	ON
AM/SECTOR	as desired
EOT STOP	OFF
DATA ERROR OVERRIDE	OFF
ADDR ERROR OVERRIDE	OFF
SHIFT PATT/DATA PATT	DATA PATT
R/W SELECT	ACCESS ONLY
ACCESS SELECT	DIRECT SEEK

5. Position PROCESSOR switches as follows:
  - a. Set START/RESET toggle switch to start.
  - b. Set RUN/HALT switch to RUN and ensure that ON CYL, RDY, WT PROT, SELD, SEEK ERR, FLT, BUSY, and RUN LEDs are lighted.
6. If drive is operating in remote power sequence mode, ensure that FTU SEQ PWR/OFF switch is set to SEQ PWR to allow drive to complete power up first seek operation.
7. Perform Selecting Drive Procedures.
8. Install scratch pack on drive. For fixed media drives, perform read/write tests on C.E. (innermost, highest number) cylinder only.
9. Initiate drive heads load sequence per individual drive manual.

## SELECTING DRIVE

### NOTE

Erratic and unreliable drive operation is possible if drive type code is not correct.

Determine device type code, for drive being serviced, by referring to table 2-4 and/or figure 2-8.

When selecting drive, the FTU sequences through 16 (0-15) possible logic signals from drive. The logic number is displayed in row 1 LED, when DATA ENTRY switch is rotated to UNIT NUMBER position. If drive is not selected, following several retries, the FTU times out and the SEL LED flashes.

1. Perform the following substeps for all drive types.
  - a. Rotate DATA ENTRY switch to DEVICE TYPE position.
  - b. Enter device type code. Ensure that code is entered correctly by observing its display, in hexadecimal on row 2 of LEDs. If code is not correct, press CLR ENT key, clearing row 2, and reenter code.



TABLE 2-4. DEVICE TYPE CODES

DRIVE FAMILY	DEVICE CAPACITY	INTER-FACE	DEVICE TYPE INDEX-SECTOR/B (NRZ DATA) *B	DEVICE TYPE INDEX-SECTOR/A (NRZ DATA) *A	DEVICE TYPE INDEX-SECTOR/B (MFM DATA) **B	DEVICE TYPE INDEX-SECTOR/A (MFM DATA) **A
S M D	9760-40	Mux 60/75 Std	1A05 0A05	1205 0205	3A05 2A05	3205 2205
	9762-80	Mux 60/75 Std	1905 0905	1105 0105	3905 2905	3105 2105
	9764-150	Mux 60/75 Std	1A19 0A19	1219 0219	3A19 2A19	3219 2219
	9766-300	Mux 60/75 Std	1919 0919	1119 0119	3919 2919	3119 2119
M M D	973X-12	Mux 60/75 Std	1802 0802	1002 0002	3802 2802	3002 2002
	973X-24	Mux 60/75 Std	1804 0804	1004 0004	3804 2804	3004 2004
	973X-80	Mux 60/75 Std	1905 0905	1105 0105	3905 2905	3105 2105
	973X-160	Mux 60/75 Std	1910 0910	1110 0110	3910 2910	3110 2110
	973X-2.5	Mux 60/75 Std	1D04 0D04	1504 0504	2D04 2D04	3504 2504
Table Continued on Next Page						

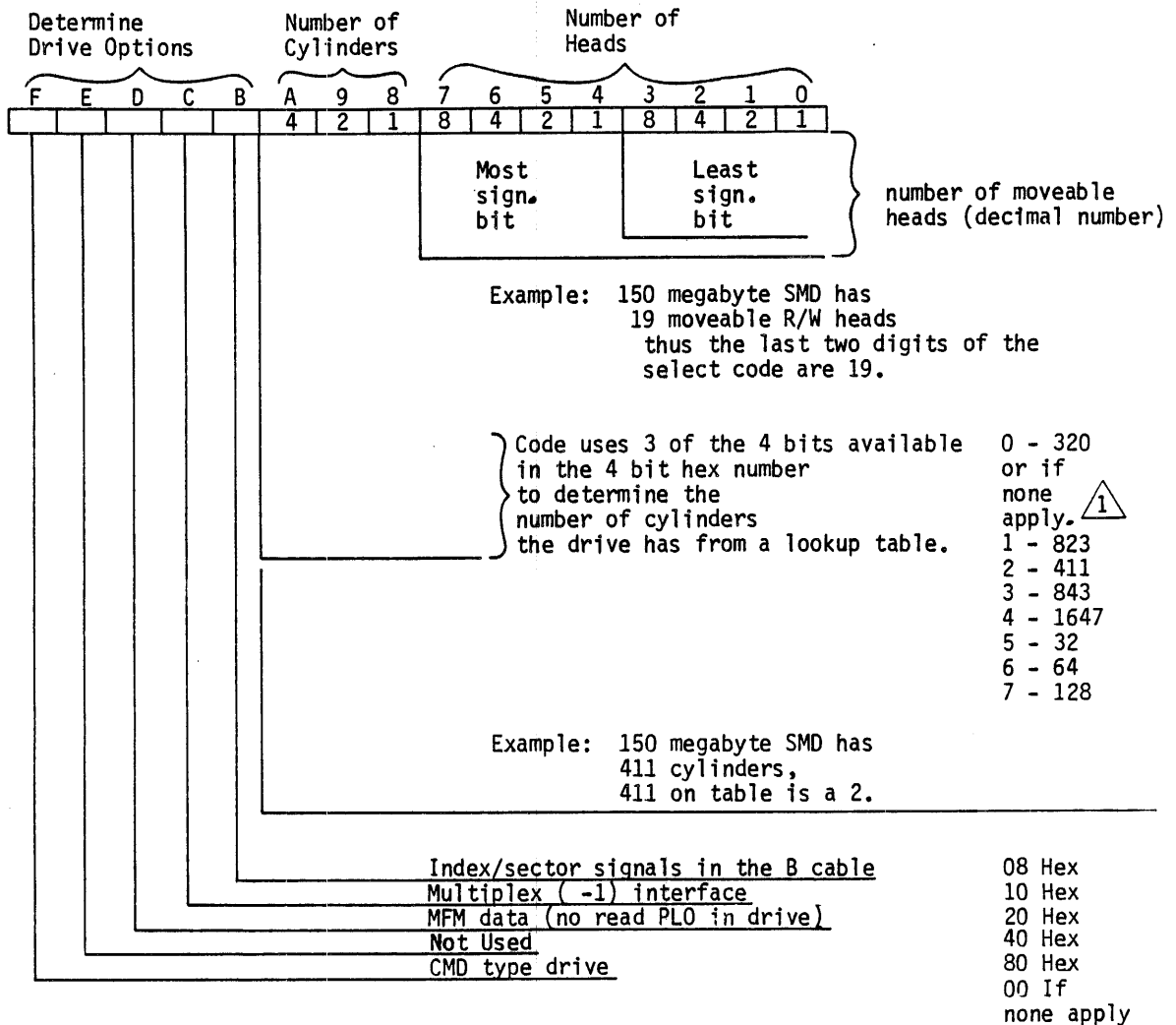
TABLE 2-4. DEVICE TYPE CODES (Contd)

DRIVE FAMILY	DEVICE CAPACITY	INTER-FACE	DEVICE TYPE INDEX-SECTOR/B (NRZ DATA)*B	DEVICE TYPE INDEX-SECTOR/A (NRZ DATA)*A	DEVICE TYPE INDEX-SECTOR/B (MFM DATA)**B	DEVICE TYPE INDEX-SECTOR/A (MFM DATA)**A
M M D	973X-5.0	Mux 60/75 Std	1E04 0E04	1604 0604	3E04 2E04	3604 2604
	973X-10	Mux 60/75 Std	1F04 0F04	1704 0704	3F04 2F04	3704 2704
C M D	9448	Mux 60/75 Std	99XX 89XX	91XX 81XX	B9XX A9XX	B1XX A1XX
F M D	9775	Mux 60/75 Std	1B40 0B40	1340 0340	3B40 2B40	3340 2340
L M D ***	9455/ 9457	Mux 60/75 Std	1904 0904	1104 0104	3904 2904	3104 2104
F S D	9715-160	Mux 60 Std	1910 0910	1110 0110	----- -----	----- -----
	9715-340 ****	60 Std	0924	0124	-----	-----
	9715-515 ****	60 Std	4924	4124	-----	-----
Table Continued on Next Page						

TABLE 2-4. DEVICE TYPE CODES (Contd)

DRIVE FAMILY	DEVICE CAPACITY	INTER-FACE	DEVICE TYPE INDEX-SECTOR/B (NRZ DATA)*B	DEVICE TYPE INDEX-SECTOR/A (NRZ DATA)*A	DEVICE TYPE INDEX-SECTOR/B (MFM DATA)**B	DEVICE TYPE INDEX-SECTOR/A (MFM DATA)**A
R S D	9710-80	Mux 60 Std	1905 0905	1105 0105	----	----
X M D	9771-825 *****	60 Std	4816	4016	----	----
E M D	9720-368 *****	60 Std	4810	4010	----	----

\* Units with Read PLO for MFM to NRZ conversion  
 \*\* Units without Read PLO for MFM to NRZ conversion  
 \*\*\* Maximum cylinder number must be modified (DATA ENTRY position F) to 00CD hex (9455) or 026E hex (9457).  
 \*\*\*\* Maximum cylinder number must be modified (DATA ENTRY position F) to 02C6 hex or 710 decimal.  
 \*\*\*\*\* Maximum cylinder number must be modified (DATA ENTRY position F) to 03FF hex or 1023 decimal.  
 The TB216 15 MHz tester was not designed to function on MFM data type drives. To operate a MFM data type drive, install a BJJX or CJJX (removed when tester was converted to 15 MHz capabilities) in location A2A/B03.



The first 5 bits determines I/O and drive options and are entered with the cylinder code as two Hex numbers.

Example: 150 megabyte SMD with standard 60 pin I/O with no read PLO, and index/sector signals in the B cable is a 28 (Hex) code.

28 Hex Thus the device type code is 2A19.  
 + 2 Hex  
 2A Hex

Note:

<sup>1</sup> If none apply, after selecting drive, rotate DATA ENTRY switch to F position and manually enter, via keyboard, the number of cylinders.

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Figure 2-8. Device Type Code Determination

- c. Press LOAD key, transferring code from row 2 into row 1 and into memory. Ensure that code has transferred correctly by observing its display on row 1 of LEDs. If code is not correct, press DISP key, returning code from row 1 back into row 2. Press CLR ENT key, clearing code from row 2, and reenter code.
  - d. Ensure that LED I/O RDY, in row 3, is lighted. Status of remaining LEDs, in row 3, can be disregarded for this step of the procedure.
  - e. Turn WT PROT switch on and press SEL DRV key. Interpret results as follows:
    - If SEL LED, lights and drive logical address appears in row 1 of LEDs, selection is successful, proceed directly to step 2.
    - If SEL LED is flashing and/or incorrect logical address appears in row 1 LEDs, selection is unsuccessful, proceed to step 5.
2. If selecting only fixed volumes, or both fixed and removable volumes on CMD drives, the operator must execute the following additional substeps, otherwise proceed directly to step 3.

#### NOTE

When going between fixed and removeable volumes, any information that may have been entered with the DATA ENTRY switch at position E is destroyed when the SEL DRV Key is pressed.

- a. When selecting fixed volumes only proceed as follows:
  - Rotate ACCESS SELECT switch to FIXED VOLUME position.
  - Rotate DATA ENTRY switch to STATUS BYTES position.
  - Select status byte 2 by pressing key 2.

#### NOTE

When changing from removable volume to fixed volume, pressing SEL DRV after performing function E will destroy contents of E.

- Press SEL DRV key and interpret results as follows:
  - (1) If SELD LED lights and drive logical address appears in row 1 of LEDs, selection is successful, proceed directly to step 2b.
  - (2) If SELD LED is flashing and/or incorrect logical address appears in row 1 of LEDs, selection is unsuccessful, proceed directly to step 5.
- Proceed as follows if unable to select drive:
  - (1) Verify that correct device type code is entered.
  - (2) Troubleshoot select problem on drive. If drive is selected during troubleshooting, perform status bypass procedures prior to pressing SEL DRV key.
- b. When selecting both fixed and removable volumes, proceed as follows:
  - Rotate ACCESS SELECT switch to FIXED VOLUME position.
  - Rotate DATA ENTRY switch to STATUS BYTES position.
  - Select status byte 2 by pressing key 2.
  - Press GO key and interpret results as follows:
    - (1) If SEL LED, lights and drive logical address appears in row 1 of LEDs, selection is successful, proceed to step 3.
    - (2) If SEL LED is flashing and/or incorrect logical address appears in row 1 of LEDs, selection is unsuccessful, proceed to step 5.
- 3. If selecting LMD drives enter maximum cylinder address by performing the following procedures otherwise go directly to step 4.
  - a. Rotate DATA ENTRY switch to F position.

- b. Enter via keyboard, the LMD hexadecimal maximum cylinder number 00CD (9455) or 026E (9457).
  4. If selecting FSD-340 drives, the FTU must be configured with the CJHX or higher level card, and the operator must enter the maximum cylinder number.
    - a. All test units at series code 29 and above are properly configured with the CJHX or later card. FTUs at series code 28 with ECO DH10034 are also properly configured. All units below series code 28 must have SPO 68816-2 installed.
    - b. To enter the maximum cylinder address, the operator must rotate the DATA ENTRY switch to the F position, and then enter 02C6 hex (710 decimal) via the keyboard.
  5. If selecting FSD-515, EMD, or XMD drives, the FTU must be configured with the CJHX or later card, the DJJX or later card, and the EJGX or later card. The operator must enter the appropriate maximum cylinder number.
    - a. All test units must have SPO 68872-1 installed to allow use on the FSD-515, EMD, and XMD product lines. This SPO provides a DJJX or later card and a EJGX or later card. Units below series code 29, without ECO DH10034 logged as installed, require SPO 68816-2 to provide the CJHX or later card. FTU units below series code 29 with ECO DH10034 logged as installed, and all units above series code 29, have the CJHX or later card.
    - b. To enter the maximum cylinder address, the operator must rotate the DATA ENTRY switch to the F position, and then enter 02C6 hex (710 decimal) for FSD-515 or 03FF hex (1023 decimal) for XMD and EMD.
  6. Proceed as follows if unable to select drive:
    - a. Verify that correct device type code is entered.
    - b. Troubleshoot select problem on drive. If desired to select drive during troubleshooting, perform Status Bypass procedures prior to pressing SEL DRV key.
  7. Go to step 8 of Power Up Initialization procedure.

## SECTOR COUNT CHECK

The FTU automatically counts and displays the number of sector pulses generated by the drive per revolution of the disk. This sector pulse count is used to calculate the length and number of data records to be written on each track.

Note that while the FTU is capable of handling a maximum of 128 sectors, the following procedure will vary according to the number of sectors the particular drive is set to generate. Some sector counts, generated by the drive, will produce an extra sector pulse at the end of the track that will result in a short sector (the last sector of the track will be shorter than the rest). Sector counts not listed in Table 2-4.1 will result in a short sector at the end of track. Whenever the FTU counts and displays a sector count not listed in Table 2-4.1, the FTU must be programmed to ignore the short sector to eliminate the possibility of writing over index and into the protected area.

1. Refer to the applicable drive specifications or sector switch settings and determine the correct number of sector pulses for the drive (not the number observed, as on an oscilloscope).
2. Refer to Table 2-4.1, and determine whether the sector count will result in a short sector and verify the sector count as follows:
  - a. Rotate DATA ENTRY switch to C position.
  - b. Press DISP key, on keyboard, displaying the sector count in hexadecimal.
  - c. Press DEC key, converting the sector count to decimal. If the sector count is the same number as determined in step 1, proceed with desired operation. If the sector count is one number larger than the number determined in step 1, program the FTU to ignore the short sector by proceeding to step 3. If the sector count is not the same as the number determined in step 1 or one number larger, troubleshoot the problem, prior to performing any write operation.
3. Program the FTU to ignore the short sector at the end of track as follows:
  - a. Press CLEAR ENT key, canceling display.
  - b. Enter the correct sector count, determined in step 1, in decimal.



- c. Press HEX key, converting number entered to hexadecimal.
- d. Press LOAD key, entering correct sector count number into memory.
- e. Repeat step 2 to verify that the FTU is counting and displaying the correct sector count for that particular drive.

TABLE 2-4.1 SECTOR COUNTS WITHOUT A SHORT SECTOR

1	14	32	70
4	15	35	80
5	16	40	84
6	20	42	96
7	21	48	105
8	24	56	112
10	28	60	120
12	30	64	128

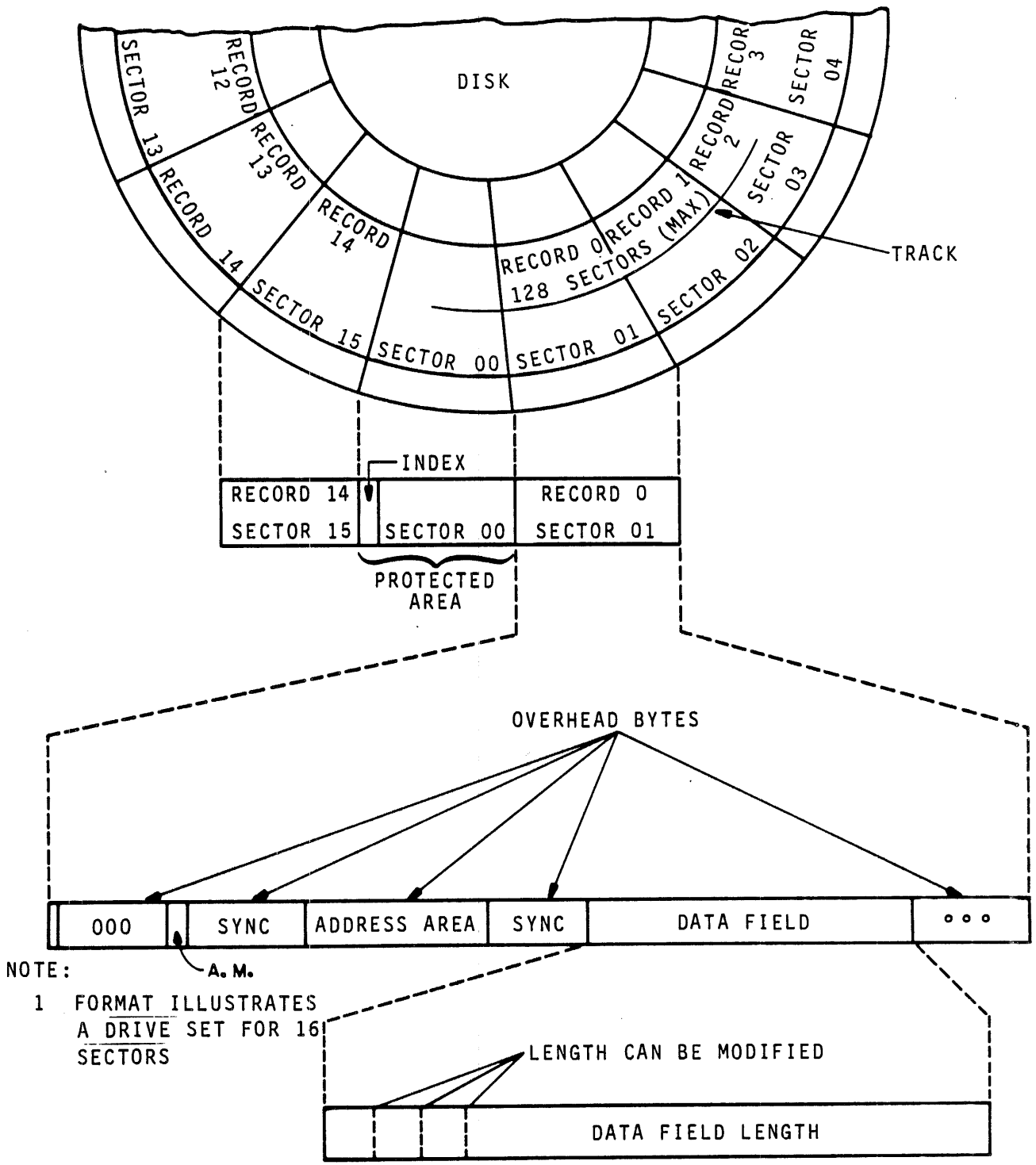
#### DATA FIELD LENGTH

The data field length, based on the number of sectors per drive (see figure 2-8) is automatically updated when the sector length of the drive is updated. The data field length is displayed in row 1 LEDs when DATA ENTRY switch is set to D position (see table 2-6).

TABLE 2-5. DATA FIELD LENGTH

Switch Setting	ROW 1 LED Indicators ( $2^{15} - 2^8$ )	ROW 2 LED Indicators ( $2^7 - 2^0$ )
DATA ENTRY switch set to D position	Number of words less 1.	Number of 4 bit bytes per word less 1.

For special test purposes, the data field length can be modified as follows:



NOTE:  
 1 FORMAT ILLUSTRATES  
 A DRIVE SET FOR 16  
 SECTORS

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Figure 2-9. Read/Write Data Format Diagram

## CAUTION

Use extreme care not to enter a number larger than the number calculated in step 1, when modifying the data field length. Entering too large a number could cause drive to write into protected area (see figure 2-8).

1. Calculate maximum allowable data field length as follows:

Data Field Length = Bytes per Record minus Overhead Bytes where:

$$\text{Bytes per Record} = \frac{\text{Bytes per track} - \text{Bytes in Protected sectors}}{\text{Number of Records}}$$

Overhead Bytes = 111 (for all applications (see figure 2-8))

$$\text{Bytes in Protected Sector(s)} = \frac{\text{Bytes per Track} \times \text{Number of Protected Sectors}}{\text{Number of sectors}}$$

(see figure 2-7)

2. Rotate DATA ENTRY switch to D position and observe row 1 LEDs.
3. Manually enter (in hexadecimal) desired data field length, not to exceed the number calculated in step 1.

## NUMBER OF DATA RECORDS

The FTU displays the total number of data records available for use on each track. The number of records correspond to the total number of sectors per track minus the sectors contained in the protected area immediately following index (see figure 2-8). The FTU prevents writing in the protected area thus any sectors located in the protected area are unavailable for storage of data.

The number of sectors in the protect area , varies with the total number of sectors per revolution generated by the drive, while the size of the protected area remains constant. Changing the total number of sectors, per revolution, causes the size of the sectors (bytes per sector) to change. The relationship between the number of sectors, protected area, and sector location available for writing the first data record is illustrated in table 2-6.

TABLE 2-6. SECTOR AND DATA RECORD RELATIONSHIP

Number of Sectors	Number Protected	Sector Location of 1st Data Record
1-16	1 (0)	1
17-32	2 (0,1)	2
33-48	3 (0-2)	3
49-64	4 (0-3)	4
65-80	5 (0-4)	5
71-96	6 (0-5)	6
87-112	7 (0-6)	7
103-128	8 (0-7)	8

EXAMPLE: 64 sector drive (sector 0-63).

Sector 0,1,2, and 3 are protected.

Sectors 4 through 63 are available for data records numbered 0 through 59.

Record 0 corresponds to sector 4.

Record 59 corresponds to sector 63.

NOTE

Perform step 1 to display number of data records. Perform step 2 to change number of data records.

1. Display the number of data records as follows:
  - a. Rotate DATA ENTRY switch to position E.
  - b. Observe number of data records displayed in upper byte of row 1 LEDs.
2. Change the number of data records as follows:

**CAUTION**

When changing the number of data records, do not enter a number larger than the number of sectors generated by the drive minus the sectors in the protected area (see Sector Check procedure). Entering a number of data records larger than the number of sectors could cause drive to write into protected area (see figure 2-8).

- a. Rotate DATA ENTRY switch to E position.
- b. Using Bit entry per Data Loading procedures; enter new number of data records.
- c. Observe upper byte if row 1 LEDs to ensure that the number is correct.

## MANUAL TAGS

Manual tags allow a specific command (combination of tag and bus bits) to be put on I/O lines to drive being serviced when GO key is pressed. Determine proper tag and bus bits of desired command by referring to applicable drive manual.

1. Rotate ACCESS SELECT switch to MANUAL TAG position.
2. Set SINGLE/CONT switch to desired position. If single tag is desired, set switch to SINGLE position. If multiple tags are desired, set switch to CONT position.
3. Press BIT key.
4. Enter applicable information from drive manual and table 2-8 to make desired tag and bus bits true. Observe bit selection displayed on row 2 LEDs.

### NOTE

If transient tag is desired, proceed to step 7. If permanent tag is desired:

- Perform steps 6 and 7 for drive with multiplex interface
  - Perform steps 5 and 7 for drives with standard interface.
5. Ensure that SINGLE/CONT switch is set to SINGLE position. Press BIT key, on keyboard, and observe bit selection on row 2 LEDs.
  6. Ensure that SINGLE/CONT switch is set to SINGLE position. Proceed to STATUS BYPASS procedure and perform CONT. UPDATE MUX STATUS bypass prior to pressing BIT key on keyboard. Observe bit selection on row 2 LEDs.
  7. Press GO key, sending the I/O command out on interface.

TABLE 2-7. MANUAL TAGS

FTU KEY/LED	STD I/O Bit	MUX I/O Bit	Data Entry Switch Positioned To Head				
			Mux	Bus	In	Bit	0
F	--	--					0
E	Tag 3	Tag <sup>2</sup>					1
D	Tag 2	Tag <sup>1</sup>					2
C	Tag 1	Tag <sup>0</sup>					3
B	--	--					4
A	--	--					5
9	Bit 9	--					6
8	Bit 8	--					7
7	Bit 7	Bus Out Bit 0	-	-	-		
6	Bit 6	Bus Out Bit 1	-	-	-		
5	Bit 5	Bus Out Bit 2	-	-	-		
4	Bit 4	Bus Out Bit 3	-	-	-		
3	Bit 3	Bus Out Bit 4	-	-	-		
2	Bit 2	Bus Out Bit 5	-	-	-		
1	Bit 1	Bus Out Bit 6	-	-	-		
0	Bit 0	Bus Out Bit 7	-	-	-		

## STATUS BYPASS

The FTU will normally not send commands to drive if error conditions are present. For special test purposes; it is possible to over ride this condition and continue exercising the drive by positioning FTU front panel switches as follows:

1. Rotate DATA ENTRY switch to STATUS BYTES position.
2. Press F key.
3. Press CLR ENT key.
4. Press BIT key.
5. Enter appropriate bypass bit(s) from table 2-8. Row 2 LEDs will display the bypass bit(s) of error condition in row 3 directly below it.
6. Press LOAD key.
7. Press F key.

TABLE 2-8. STATUS BYPASS BIT TABLE

Bit Display	Bypass Bit	Bypass Status
2 <sup>13</sup>	D	On Cylinder
2 <sup>12</sup>	C	Tag Gate In (RDY)
2 <sup>10</sup>	A	Selected
2 <sup>9</sup>	9	Seek Error
2 <sup>8</sup>	8	Fault
2 <sup>15</sup>	F	Time Out
2 <sup>14</sup>	E	Continuous Updated MUX Status

The FTU is now programmed to continue exercising the drive despite error condition.

## RTZ COMMAND

Command drive to perform RTZ (return to zero) seek by positioning FTU front panel switches as follows:

1. Press RTZ key.
2. Ensure that ON CYL, RDY, and SELD LEDs are lighted.

## DIRECT SEEK/ACCESS ONLY

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection Procedure.
3. Rotate RD/WRT SELECT switch to ACCESS ONLY position.
4. Rotate ACCESS SELECT switch to DIRECT SEEK position.
5. Rotate DATA ENTRY switch to DESTINATION position.
6. Enter a cylinder address number (in decimal) and press LOAD key.
7. Press GO key.
8. Press STOP key.
9. Press CLR key. FTU is now ready to be programmed for next test.
10. Observe row 1 LEDs, to ensure that cylinder address is being sequenced, after positioning switches as follows:
  - a. Rotate DATA ENTRY switch to STATUS BYTES position.
  - b. Press 1 key.

## DIRECT CONT/ACCESS ONLY

Perform steps 1 through 7 to perform a seek between 0 and one selected address. Perform steps 1 through 11 to perform a seek between two selected addresses.

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection Procedure.



3. Rotate RD/WRT SELECT switch to ACCESS ONLY position.
4. Rotate ACCESS SELECT switch to DIRECT SEEK position.
5. Rotate DATA ENTRY switch to DESTINATION position.
6. Enter a cylinder address number (in decimal) and press LOAD key.
7. Press GO key.
8. Press STOP key.
9. Rotate ACCESS SELECT switch to DIRECT CONT position.
10. Enter second cylinder address (in decimal) and press LOAD key.
11. Press GO key.

NOTE

Observe each cylinder address by performing step 12. Otherwise proceed to step 13.

12. Each cylinder address will be displayed, on row 1 LEDs; each time GO key is pressed after positioning switches as follows:
  - a. Set SINGLE/CONT toggle switch to SINGLE position.
  - b. Rotate DATA/ENTRY switch to STATUS BYTES position.
  - c. Press 1 key.
  - d. Press GO key, and observe first selected address.
  - e. Press GO key, and observe second selected address.
13. Set SINGLE/CONT switch to desired position. In SINGLE, drive seeks between two tracks once and stops. In CONT, the number of seeks performed depends on setting of EOT STOP/OFF switch. Set EOT STOP/OFF switch as instructed in either a or b below.
  - a. Enable drive to seek continuously until STOP key is pressed by setting EOT STOP/OFF switch to OFF.
  - b. Enable drive to stop automatically after 10 000 seeks by setting EOT STOP/OFF switch to EOT STOP. Test can also be stopped manually, at anytime, by pressing STOP key.

14. Press GO key. Drive is now performing test. Proceed to step 15 when test is complete.
15. Press CLR and RTZ keys. The FTU is now ready to be programmed for next test.

#### SEQ FORWARD SEEK/ACCESS ONLY

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection Procedure.
3. Rotate ACCESS SELECT switch to SEQ FORWARD position. This test normally causes seeks in increments of one cylinder. If desired to increment by more than one cylinder, position switches as follows:
  - a. Rotate DATA ENTRY switch to SEEK INCREMENT position.
  - b. Enter (in hexadecimal) the desired increment number and observe that the number is displayed in row 1 LEDs.
4. Rotate RD/WRT SELECT switch to ACCESS ONLY position.
5. Set SINGLE/CONT switch to desired position. In SINGLE, drive performs one seek and stops. In CONT, the number of seeks performed depends on setting of EOT STOP/OFF switch. Set EOT STOP/OFF switch as instructed in either a or b below.
  - a. Enable drive to seek continuously until STOP key is pressed by setting EOT STOP/OFF switch to OFF.
  - b. Enable drive to stop automatically after performing all possible seeks once by setting EOT STOP/OFF switch to EOT STOP. Test can also be stopped manually, at anytime, by pressing STOP key.
6. Observe row 1 LEDs, to ensure that the cylinder address is being sequenced, after positioning switches as follows:
  - a. Rotate DATA/ENTRY switch to STATUS BYTES position.
  - b. Press 1 key.
  - c. Press GO key, instructing drive to perform test. when test is completed, proceed to step 7.
7. Press CLR and RTZ keys. The FTU is now ready to be programmed for next test.

## SEQ REVERSE SEEK/ACCESS ONLY

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection Procedure.
3. Rotate ACCESS SELECT switch to SEQ FORWARD position. This test normally causes seeks in increments of one cylinder. If desired to increment by more than one cylinder, position switches as follows:
  - a. Rotate DATA ENTRY switch to SEEK INCREMENT position.
  - b. Enter (in hexadecimal) the desired increment number and observe that the number is displayed in row 1 LEDs.
4. Rotate RD/WRT SELECT switch to ACCESS ONLY position.
5. Set SINGLE/CONT switch to desired position. In SINGLE, drive performs one seek and stops. In CONT, the number of seeks performed depends on setting of EOT STOP/OFF switch. Set EOT STOP/OFF switch as instructed in either a or b below.
  - a. Enable drive to seek continuously until STOP key is pressed by setting EOT STOP/OFF switch to OFF.
  - b. Enable drive to stop automatically after performing all possible seeks once by setting EOT STOP/OFF switch to EOT STOP. Test can also be stopped manually, at anytime, by pressing STOP key.
6. Observe row 1 LEDs, to ensure that the cylinder address is being sequenced, after positioning switches as follows:
  - a. Rotate DATA/ENTRY switch to STATUS BYTES position.
  - b. Press 1 key.
  - c. Press GO key two times, instructing drive to perform test. When test is completed, proceed to step 7.
7. Press CLR and RTZ keys. The FTU is now ready to be programmed for next test.

## SEQ FWD/REV - ACCESS ONLY

1. Perform Power Up Initialization procedure.
2. Perform Selection Drive Procedure.

3. Rotate ACCESS SELECT switch to SEQ FORWARD position. This test normally causes seeks in increments of one cylinder. If desired to increment by more than one cylinder, position switches as follows:
  - a. Rotate DATA ENTRY switch to SEEK INCREMENT position.
  - b. Enter (in hexadecimal) the desired increment number and observe that the number is displayed in row 1 LEDs.
4. Rotate RD/WRT SELECT switch to ACCESS ONLY position.
5. Set SINGLE/CONT switch to desired position. In SINGLE, drive performs one seek and stops. In CONT, the number of seeks performed depends on setting of EOT STOP/OFF switch. Set EOT STOP/OFF switch as instructed in either a or b below.
  - a. Enable drive to seek continuously until STOP key is pressed by setting EOT STOP/OFF switch to OFF.
  - b. Enable drive to stop automatically after performing all possible seeks once by setting EOT STOP/OFF switch to EOT STOP. Test can also be stopped manually, at anytime, by pressing STOP key.
6. Observe row 1 LEDs, to ensure that the cylinder address is being sequenced, after positioning switches as follows:
  - a. Rotate DATA/ENTRY switch to STATUS BYTES position.
  - b. Press 1 key.
  - c. Press GO key two times, instructing drive to perform test. When test is completed, proceed to step 7.
7. Press CLR and RTZ keys. The FTU is now ready to be programmed for next test.

#### RANDOM SEEK/ACCESS ONLY

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection Procedure.
3. Rotate ACCESS SELECT switch to RANDOM SEEK position.
4. Rotate RD/WRT SELECT switch to ACCESS ONLY position.

5. Observe row 1 LEDs, to ensure that the cylinder address is being sequenced, after positioning switches as follows:
  - a. Rotate DATA/ENTRY switch to STATUS BYTES position.
  - b. Press 1 key.

NOTE

Command each seek individually by performing step 6, otherwise proceed to step 7.

6. Command each seek individually, by positioning switches as follows:
  - a. Set SINGLE/CONT toggle switch to SINGLE position.
  - b. Press 1 key.
  - c. Press GO Key for each seek.
7. Set SINGLE/CONT switch to desired position. In SINGLE, drive performs one seek and stops. In CONT, the number of seeks performed depends on setting of EOT STOP/OFF switch. Set EOT STOP/OFF switch as instructed in either a or b below.
  - a. Enable drive to seek continuously until STOP key is pressed by setting EOT STOP/OFF switch to OFF.
  - b. Enable drive to stop automatically after performing all possible seeks once by setting EOT STOP/OFF switch to EOT STOP. Test can also be stopped manually, at anytime, by pressing STOP key.
8. Press GO key. Drive is now performing test. Proceed to step 9 when test is complete.
9. Press CLR and RTZ keys. The FTU is now ready to be programmed for next test.

**X - N SEEK/ACCESS ONLY**

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection Procedure.

3. Rotate ACCESS SELECT switch to X - N SEEK position. This test normally causes seeks in increments of one cylinder. If desired to increment by more than one cylinder, position the switches as follows:
  - a. Rotate DATA ENTRY switch to SEEK INCREMENT position.
  - b. Enter (in hexadecimal) desired increment number and observe that the number is displayed in row 1 LEDs.
  - c. Press LOAD key.
4. Rotate RD/WRT SELECT switch to ACCESS ONLY position.
5. Observe row 1 LEDs, to ensure that the cylinder address is being sequenced, after positioning switches as follows:
  - a. Rotate DATA/ENTRY switch to STATUS BYTES position.
  - b. Press 1 key.
6. Set SINGLE/CONT switch to desired position. In SINGLE, drive performs one seek and stops. In CONT, the number of seeks performed depends on setting of EOT STOP/OFF switch. Set EOT STOP/OFF switch as instructed in either a or b below.
  - a. Enable drive to seek continuously until STOP key is pressed by setting EOT STOP/OFF switch to OFF.
  - b. Enable drive to stop automatically after performing 10 000 seeks by setting EOT STOP/OFF switch to EOT STOP. Test can also be stopped manually, at anytime, by pressing STOP key.
7. Press GO key. Drive is now performing test. Proceed to step 8 when test is complete.
8. Press CLR and RTZ keys. The FTU is now ready to be programmed for next test.

## READ/WRITE OPERATIONS

The FTU is capable of performing five types of read/write operations. It can perform any one of these in conjunction with any one of the access operations. All read/write operations are covered in the following three procedures: (1) Write/Write Format, (2) Write/Read or Write/Read Format, and (3) Read.

#### NOTE

During sequential head operations, if I/O status goes bad, the test execution will stop but the head counter will cycle through to zero. To determine which head is failing, the test must be rerun with the head switch in RANDOM or MANUAL.

#### Write or Write Format Operation

The following procedure describes how to prepare the FTU to perform either a write or write format operation. During a write, the FTU commands the drive to write the data field portion of a record (see figure 2-8) with the operator determining the data pattern. During a write format, the entire data record including the address field is written, the operator supplies only the data field, the address is calculated and supplied automatically by the FTU.

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection procedure.
3. Perform Sector Count Check procedure.
4. Prepare for desired seek operation by performing a, b, or c below and then proceeding to step 5:
  - a. If X -N, random, or sequential (FWD, REV or FWD/REV) seek is desired, set ACCESS SELECT switch to that position.
  - b. If direct seek is desired, perform steps 3 through 6 of Direct Seek procedure.
  - c. If direct continuous seek is desired, perform steps 3 through 13 of Direct Continuous Seek procedure.
5. Set HEAD switch to desired position (see Head Selection procedure. If switch is set to MANUAL Position, perform a and b. Otherwise, proceed to step 6.

#### NOTE

Manual WRITE FORMAT may destroy data in the next record.

- a. Rotate DATA ENTRY switch to HEAD position.
- b. Enter desired head number (in decimal) and press LOAD key.

6. Rotate RD/WRT SELECT switch either WRT or WRT FORMAT position.

NOTE

If in WRT FORMAT position, RECORD toggle switch must be in SEQ position.

7. Set RECORD switch to desired position. If switch is set to MANUAL position, perform a and b. Otherwise, proceed to step 8.
  - a. Set DATA ENTRY switch to RECORD position.



- b. Enter desired head number (in decimal) and press LOAD key.
8. Set +/- switch to OFF (center position). Setting switch to + or - position causes drive to indicate fault condition.
9. Set EARLY/LATE switch to OFF (center position).
10. Set WRITE FLAG/ Off switch to desired position.
11. Set AM/SECTOR switch to desired position.
12. Set ERROR OVERRIDE switches (DATA/OFF, ADDR/OFF) to desired positions.
13. Set SHIFT PATT/DATA PATT switch to desired position.
14. Rotate DATA ENTRY switch to DATA PATTERN position and enter desired data pattern as follows:
  - a. Enter 16 bit data pattern (consisting of four hexadecimal characters).
  - b. Press LOAD key.

### CAUTION

Return WRITE PROT/OFF toggle switch to WRITE PROT position after desired write operation is completed. Failure to return switch to protect position could cause an accidental loss of customer data.

15. Set WRITE PROT/OFF switch to OFF.

### NOTE

Perform step 16 to write on C.E. (innermost, highest number) cylinder only. Perform steps 16 and 17 to write all tracks except 256, (track 256 is locked out when drive is controlled by FTU).

16. Allow writing only on CE (innermost highest number) cylinder by proceeding as follows:
  - a. Rotate DATA ENTRY switch to position B.
  - b. Enter 5754 via keyboard.
  - c. Press LOAD key.

17. Allow writing on all cylinders (except 256) by proceeding as follows:
  - a. Rotate DATA ENTRY switch to position E.
  - b. Press DISP key.
  - c. Press BIT key.
  - d. Press 1 key.
  - e. Press LOAD key.
18. Press GO key. FTU is now commanding drive to perform desired write operation.

#### **Write/Read or Write/Read Format Operation**

The following procedure describes how to prepare the FTU to command the drive to first write information and then to read the same information back. During a write/read format operation, the FTU writes then reads the entire record including the address field (see figure 2-7). During a write/read, the entire record is read but only the data field portion of a record is written. In both cases, the operator can control only what is written in the data field portion of the record, the address field is automatically calculated and supplied by the FTU.

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection procedure.
3. Perform Sector Count Check procedure.
4. Prepare for desired seek operation by performing a, b, or c below and then proceeding to step 5:
  - a. If X - N, random, or sequential (FWD, REV or FWD/REV) seek is desired, set ACCESS SELECT switch to that position.
  - b. If direct seek is desired, perform steps 3 through 6 of Direct Seek procedure.
  - c. If direct continuous seek is desired, perform steps 3 through 13 of Direct Continuous Seek procedure.

5. Set HEAD switch to desired position (see Head Selection procedure). If switch is set to MANUAL Position, perform a and b. Otherwise, proceed to step 6.
  - a. Rotate DATA ENTRY switch to HEAD position.
  - b. Enter desired head number (in decimal) and press LOAD key.
6. Rotate RE/WRT SELECT switch either WRT/RD or WRT/RD FORMAT position.
7. Set RECORD switch to desired position. If switch is set to MANUAL position, perform a and b. Otherwise, proceed to step 8.
  - a. Set DATA ENTRY switch to RECORD position.
  - b. Enter desired head number (in decimal) and press LOAD key.
8. Set +/- switch to OFF (center position) Setting switch to + or - position causes drive to indicate fault condition of this test.
9. Set EARLY/LATE switch to OFF (center position).
10. Set WRITE FLAG/ Off switch to desired position.
11. Set AM/SECTOR switch to desired position.
12. Set ERROR OVERRIDE switches (DATA/OFF, ADDR/OFF) to desired positions.
13. Set SHIFT PATT/DATA PATT switch to desired position.
14. Rotate DATA ENTRY switch to DATA PATTERN position and enter desired data pattern as follows:
  - a. Enter 16 bit data pattern (consisting of four hexadecimal characters).
  - b. Press LOAD key.

## CAUTION

Return WRITE PROT/OFF toggle switch to WRITE PROT position after desired write operation is completed. Failure to return switch to protect position could cause an accidental loss of customer data.

15. Set WRITE PROT/OFF switch to OFF.

### NOTE

Perform step 16 to write on C.E. (innermost, highest number) cylinder only. Perform steps 16 and 17 to write all tracks except 256, (track 256 is locked out when drive is controlled by FTU).

16. Allow writing only on CE (innermost highest number) cylinder by proceeding as follows:
  - a. Rotate DATA ENTRY switch to position B.
  - b. Enter 5754 via keyboard.
  - c. Press LOAD key.
17. Allow writing on all cylinders (except 256) by proceeding as follows:
  - a. Rotate DATA ENTRY switch to position E.
  - b. Press DISP key.
  - c. Press BIT key.
  - d. Press 1 key.
  - e. Press LOAD key.
18. Press GO key. FTU is now commanding drive to perform desired write operation.

## READ/WRITE OPERATION ON FIXED HEADS

Whenever an entry is made with DATA ENTRY switch set to fixed heads, information previously entered with DATA ENTRY switch in E position, will be destroyed, and WT PROT LED will flash. WRITE PROT switch may be switched ON, to stop the flashing, but if a write operation is desired, the WRITE PROT switch must be switched OFF again prior to performing a write operation.

When performing read/write operations on fixed heads the read/write functions and displays apply as for movable heads, with the following exceptions:

- Status byte 1, for standard interface drives, will display the logical cylinder address of the fixed head being accessed.
- Only the maximum logical cylinder is displayed for sequential fixed heads.
- Status byte 2 displays the physical head number.
- When performing an Access Select function, rotate ACCESS SELECT switch to DIRECT SEEK and load DESTINATION to zero (zero cylinder address).
- Other access functions may not work correctly.

When moving from fixed heads to movable heads operation, with DATA ENTRY switch in FIXED HEADS position, enter all zeros.

## CAUTION

Customers data will be destroyed when writing with fixed heads.

1. Rotate DATA ENTRY switch to FIXED HEADS position.
2. Enter the total number of heads being access (48 or 96).
3. Perform steps 15 through 17 of Read/Write operation.

## MFM READ/WRITE EXCEPTIONS TO READ/WRITE OPERATIONS

When performing MFM read/write operation, the following exceptions exist:

- RD/WRT select switch applies to WRT/FORMAT, WRT/RD FRMT, and READ functions only.
- SHIFT PAT.T switch is ignored because pattern is neither high or low frequency.
- Address is not written or read, therefore ADDRESS ERROR, FLAG, and A.M./SECTOR switches do not apply.
- MRM type drives do not have read PLO, therefore EARLY/LATE strobe switch, that controls the read PLO, is inoperative.

### Read Operations

The following procedure describes how to prepare the FTU for read operation. During a read operation, the FTU commands the drive to read any data record (or records) selected by the operator. It is important to note that this test will work only if the record (or records) to be read were written by the FTU.

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection procedure.
3. Perform Sector Count Check procedure.
4. Prepare for desired seek operation by performing a, b, or c below and then proceeding to step 5:
  - a. If X - N, random, or sequential (FWD, REV or FWD/REV) seek is desired, set ACCESS SELECT switch to that position and proceed to step 4.
  - b. If direct seek is desired, perform steps 3 through 6 of Direct Seek procedure.
  - c. If direct continuous seek is desired, perform steps 3 through 13 of Direct Continuous Seek procedure.
5. Set HEAD switch to desired position (see Head Selection procedure. If switch is set to MANUAL Position, perform a and b. Otherwise, proceed to step 6.
  - a. Rotate DATA ENTRY switch to HEAD position.
  - b. Enter desired head number (in decimal) and press LOAD key.

6. Rotate RD/WRT SELECT switch Read position.
7. Set RECORD switch to desired position. If switch is set to MANUAL position, perform a and b. Otherwise, proceed to step 8.
  - a. Set DATA ENTRY switch to RECORD position.
  - b. Enter desired head number (in decimal) and press LOAD key.
8. Set +/- switch to desired position.
9. Set EARLY/LATE switch to OFF (center position).
10. Set AM/SECTOR switch to desired position.
11. Set ERROR OVERRIDE switches (DATA/OFF, ADDR/OFF) to desired positions.
12. Rotate DATA ENTRY switch to DATA PATTERN position and enter desired data pattern as follows:
  - a. Enter 16 bit data pattern (consisting of four hexadecimal characters).
  - b. Press LOAD key.

### CAUTION

Return WRITE PROT/OFF toggle switch to WRITE PROT position after desired read operation is completed. Failure to return switch to protect position could cause an accidental loss of customer data.

13. Set WRITE PROT/OFF switch to OFF.

### NOTE

Perform step 14 to read on C. E. (innermost, highest number) cylinder only. Perform steps 14 and 15 to read all tracts except 256, (track 256 is locked out when drive is controlled by the FTU).

14. Allow reading only on C.E. (innermost, highest number) cylinder by proceeding as follows:

- a. Rotate DATA ENTRY switch to B position.
  - b. Enter 5754 via keyboard.
  - c. Press LOAD key.
15. Allow reading on all cylinders (except 256) by proceeding as follows:
- a. Rotate DATA ENTRY switch to E position.
  - b. Press DISP key.
  - c. Press BIT key.
  - d. Press 1 key.
  - e. Press LOAD key.
16. Press GO key. FTU is now commanding drive to perform desired read operation.

#### I/O LINE CHECK

FTU commands drive to seek cylinders that are numbered by powers of 2 only (1,2,4,8,16, etc.) to check I/O lines.

1. Perform Power Up Initialization procedure and select drive.
2. Rotate DATA ENTRY switch to SEEK INCREMENT position.
3. Enter number 8000 and press LOAD key.
4. Rotate RD/WRT SELECT switch to ACCESS ONLY position.
5. Rotate ACCESS SELECT switch to SEQ REVERSE position.
6. Press GO key.
7. Ensure that the cylinder address is being sequenced by observing row 1 LEDs, after positioning switches as follows:
  - a. Rotate DATA/ENTRY switch to STATUS BYTES position.
  - b. Press 1 key.



## **ACCESS TIME CHECK :**

The FTU automatically calculates the time that the drive requires to perform a seek operation. The operator can use either of two methods, EOT (End of test) stop or manual stop, to obtain this time. Using the EOT stop method, the FTU indicates the access when the drive takes to complete the entire test (10 000 seeks for random, direct continuous, or sequential and 1 cycle for X - N). Using the manual stop method the FTU indicates the access time for any number of seeks.

The FTU uses a crystal oscillator to generate the time base for the access time check. Due to tolerances and differences between crystals, the access time indicated by the FTU may vary slightly from the actual time. Therefore, when the FTU is first used and periodically thereafter (due to changes in crystal characteristics) the access time should be checked. This is done by checking it against a known time standard and noting the percentage of deviation.

The following procedures explain both methods of calculating access time and also describe a method for verifying that the FTU is calculating the time correctly.

For specific access time information refer to the test and adjustments procedures in the specific drive maintenance manual.

### **EOT Stop Access Time Check**

1. Set SINGLE/CONT switch to CONT and EOT STOP/OFF switch to EOT STOP.
2. Command desired seek operation.
3. Rotate DATA ENTRY switch to STATUS BYTES position, press A key, and read access time from ROW 1 LEDs.

### **Manual Stop Access Time Check**

1. Set SINGLE/CONT and EOT STOP/OFF switches to desired positions.
2. Command desired seek function.
3. Rotate ACCESS SELECT switch to C position .
4. Press GO key.
5. Rotate DATA ENTRY switch to STATUS BYTES position, press A key, and read access time from ROW 1 LEDs.

## FTU Access Time Verification

1. Connect oscilloscope to observe on-cylinder signal at drive. Note that the on-cylinder signal referred to here remains active all during the time the drive is on cylinder. Do not confuse it with the on cylinder pulses, which are active only for a short time after the drive reaches on cylinder.
2. Command drive to perform direct seek by performing steps 1 through 8 of Direct Seek/Access Only procedure. Observe and note how long the on-cylinder signal remains inactive (on-cylinder goes inactive when the seek begins and active again when the seek ends).
3. Rotate ACCESS SELECT switch to position C.
4. Rotate DATA ENTRY switch to STATUS BYTES position, press GO key, and read access time from ROW 1 LEDs.
5. Calculate percentage of deviation between values obtained in steps 2 and 4 by using the following formula.

$$\% \text{ of Deviation} = \frac{\text{Oscilloscope Value} - \text{FTU Value}}{\text{FTU Value}} \times 100$$

Example: Assume oscilloscope value (from step 2) is 100 ms and FTU value (from step 4) is 125 ms.

$$\% \text{ of Deviation} = \frac{100 - 125}{125} \times 100 = -20\%$$

6. Write value from step 5 on piece of tape and attach tape to upper right hand corner of FTU front panel. During subsequent access time checks, use percentage of deviation to calculate actual access time.

## FLAGGING A BAD TRACK

With the ERROR OVERRIDE switches down any read test in progress, the FTU will stop exercising the drive in the event of a data or address error. Before flagging the track on which the error occurred, first WRITE and then READ the track several times to ensure that the error was not a random one.

1. Program tester to command operations on bad track.
  - a. Place DATA ENTRY switch in STATUS BYTES position, press the 1 key and observe cylinder address of bad track in hexadecimal form on row 1 LEDs.

- b. Press DISP key to move cylinder address to row 2 LEDs.
  - c. Place DATA ENTRY switch in DESTINATION position.
  - d. Press DEC key to convert bottom display from hex to BCD.
  - e. Press LOAD key.
2. Program tester to command operations at bad head address.
    - a. Place DATA ENTRY switch in STATUS BYTES position, press the 2 key and observe head address of bad track in hexadecimal form on row 1 LEDs.
    - b. Press DISP key to move head address to row 2 LEDs.
    - c. Place DATA ENTRY switch in HEAD position.
    - d. Press DEC key to convert row 2 LEDs from hex to BCD.
    - e. Press LOAD key.
  3. Place HEAD toggle switch in MAN position.
  4. Set RECORD switch to SEQ position.
  5. Place ACCESS SELECT switch in DIRECT SEEK position.

NOTE

The logical record number is not the same as the sector number (see table 2-7).

6. Place RE/WRT SELECT switch in WRT/RD and SINGLE/CONT toggle switch in SINGLE position.
7. Press GO key and note whether ADDR ERR or DATA ERR LEDs light. Repeat this step several time. If either LED lights consistently, the track is bad. Flag bad track by performing steps 8, 9, and 10. Otherwise, skip to step 11.
8. Place WRITE FLAG toggle switch in up position.
9. Place RD/WRT SELECT switch in WRT FORMAT position.
10. Press GO key.

## NOTE

When any operation other than formatting is being done and WRITE FLAG toggle switch is in up position, the FTU will stop when a write flag is detected.

11. Place WRITE FLAG toggle switch in OFF position.
12. Press RTZ and CLR keys.
13. Return to WRT/RD procedure in progress prior to discovering bad track.

## RELEASING PROCESSOR FROM LOOP

The processor may get hung up in a loop if it is given an illegal command. Then the keyboard STOP, GO, CLR, and RTZ keys will have no effect on the condition of the UNIT RUN LED. In this situation, you have two options. One option is initializing the FTU again by reentering all the previously entered parameters. However, a more convenient option is the following:

1. Place PROCESSOR RUN/HALT switch in HALT position.
2. Press STOP key.
3. Place PROCESSOR RUN/HALT switch in RUN position.
4. Press GO key.

The FTU will continue in the test at the point where the malfunction occurred.

## HEAD ALIGNMENT

### General

This section is used with the head alignment procedure in the manual for the drive being tested. That manual provides the specific procedure and specifications for head alignment. The information here relates to operation of the FTU and interpretation of the displays of head offset on the FTU.

## FTU Preparation

Perform the following steps to prepare the FTU for head alignment.

1. Perform Power Up Initialization procedure.
2. Perform Drive Selection procedure.
3. Connect test leads (see figure 2-3) between + and - jacks on head alignment card, that is installed in the drive, and the + and - HEAD ALIGNMENT jacks on the FTU front panel. (observe polarity).
4. Connect Head Alignment Cable per alignment procedures in applicable drive manual.
5. Set X1/X.1 switch, on head alignment board to X1 position and leave switch in X1 position disregarding drive manual instructions.

### NOTE

Select heads as described in steps 6 and 7 only when directed to do so in applicable drive manual Head Alignment procedure.

6. Select first head to be aligned by setting switches as follows:
  - a. Rotate RD/WRT SELECT switch to ALIGNMENT position.
  - b. Rotate DATA ENTRY switch to HEAD position.
  - c. Set HEAD toggle switch to MAN position.
  - d. Enter the head number of the head being aligned.
  - e. Press LOAD key.
  - f. Select type of offset display (Bit: GO) (HEX: GO) or (DEC: GO) and proceed with head alignment as directed in drive manual.
7. Select next head to be aligned by positioning switches as follows:
  - a. Press STOP and CLR keys.
  - b. Perform steps d, e, and f above.

## Offset Displays

Three different LED displays of head offset voltage are possible. All three displays in table 2-10, use row 2 LED's. These LEDs are labelled O-F just as on the FTU front panel. For all three display modes, if LED F is lit then the read out is negative.

For example to obtain the head offset in HEX, push HEX key and then the GO key. This will set up a display pattern such that

LEDS 0-3 indicates the offset value (mV) multiplied by  $16^0$ .

LEDS 4-7 indicates the offset value (mV) multiplied by  $16^1$ .

LEDS 8-A indicates the offset value (mV) multiplied by  $16^2$ .

LEDS B-E not used.

LEDS F indicates minus sign.

Thus, if the following LEDs are lit:

●	0	0	0	0	●	0	0	●	0	0	●	0	●	0	●
F	C	B		8	7		4	3		0					

The offset read is  $-125_{16}$  mV = -293 mV

(or, from table 2-4, HEX mode,

LED		(mV)
8	=	+ 256
+5	=	+ 32
+2	=	+ 4
+0	=	<u>+ 1</u>
		293 mV

and LED F indicates that this result is negative)

Similarly, to obtain an offset readout in BCD, push the DEC key and then the GO key.

The display pattern for this mode is:

LEDS 0-3 indicates the offset value (mV) multiplied by  $10^0$ .

LEDS 4-7 indicates the offset value (mV) multiplied by  $10^1$ .

LEDS 8-B indicates the offset value (mV) multiplied by  $10^2$ .

LEDS C is the offset value (in mV) multiplied by  $10^3$ .

LEDS D-E not used.

LEDS F indicates minus sign.

Thus, if the following LEDs are lit:

0	0	0	0	0	●	0	0	0	0	●	●	0	0	0	●
F	C	B	8	7	4	3	0								

The offset read is  $+469_{10}$  mV = +469 mV

(or, from table 2-4, DEC mode,

LED		(mV)
A	=	+ 400
+6	=	+ 40
+5	=	+ 20
+3	=	+ 8
+0	=	<u>+ 1</u>
		469 mV

Pushing the BIT key and then the GO key sets up a third type of display. Each of the nine LEDs on the right side of the display (0 through 8) represents an increment of 10 mV. Each of the next five LEDs (9 through D) represents an increment of 100 mV. If the offset is 600 mV or more, LED E is lighted. For example, if LEDs F, A, and 5 are lit, the head offset is -260 mV.

TABLE 2-9. HEAD ALIGNMENT DISPLAYS

LED Designation	Representation (In. mV)		
	HEX Mode	DEC Mode	BIT Mode
0	1	1	10
1	2	2	20
2	4	4	30
3	8	8	40
4	16	10	50
5	32	20	60
6	64	40	70
7	128	80	80
8	256	100	90
9	512	200	100
A	1024	400	200
B	Not Used	800	300
C	Not Used	1000	400
D	Not Used	Not Used	500
E	Not Used	Not Used	600 And Above
F	- Sign	- Sign	- Sign

**STATUS BYTES**

**General**

Sixteen status bytes are available to the operator of the FTU. They are numbered from hexadecimal 0 to hexadecimal F. To call up a particular status byte, place the DATA ENTRY switch in



STATUS BYTES position and press the corresponding key on the keyboard. The number of the chosen status byte appears on the righthand 4 LEDs on row 2. The status byte appears on row 1 LEDs. For each of the 16 status bytes, table 2-10 gives the value assigned to each LED.

#### Tag-Bus I/O (0)

This status byte displays tag and bus signals as they are sent from the FTU to the drive.

#### Cylinder (1)

This status byte displays the cylinder on which the drive is operating. The binary value assigned to each LED is given in table 2-10.

#### Head (2)

This status byte displays the head with which the drive is reading or writing in hexadecimal. For example, for head 17, LEDs 4 and 0 are lighted.

#### Record (3)

This status byte displays the record on which the drive is performing a read/write operation. The display pattern is identical to the Head display. This is readily visible only in manual or random record (see description of RECORD toggle switch in table 2-2).

#### Sector (4)

When the drive has been selected, this status byte indicates the total number of sectors being used by the drive. During read/write operations, the sector on which the drive is reading or writing is indicated. This is readily visible only in manual or random record.

#### Pattern (5)

This status byte displays the 16-bit data pattern that has been entered in FTU memory and is repeated in the data field written by the drive.

### **Address Error Counter (6)**

This status byte displays a count of the number of address errors occurring during an extended read operation. Unless the ADDR ERROR OVERRIDE toggle switch is in the up position, the drive will stop reading when an address error occurs.

### **Data Error Counter (7)**

This status byte displays a count of the number of records that contain data errors. Unless the DATA ERROR OVERRIDE toggle switch is in the up position, the drive will stop reading when a data error occurs.

### **Flag/Pass Counters (8)**

Display bits 0 through 7 indicate how many passes the drive has made through the disk pack in an extended seek operation. Display bits 8 through F indicate the number of flagged tracks detected in a read operation.

### **Seek Counter (9)**

This status byte displays a count of number of seeks performed in a multiple seek operation.

### **Average Access Time (A)**

This status byte displays the average access time for a series of seeks. The display is binary-coded decimal where each group of four LEDs represents a decimal digit. The least significant digit is in tenths of milliseconds.

### **Access Time Counter (B and C)**

These two displays indicate the total access time required for a series of seeks. This is a binary representation where the lower order 16 bits compose the C status byte, and the higher order 16 bits compose the B status byte. The readout is in tenths of milliseconds.

### **Cylinder Destination 1 (D)**

When the drive is performing a continuous seek between two cylinders, this status byte indicates the address of the first cylinder.

### **Cylinder Destination 2 (E)**

When the drive is performing a continuous seek between two cylinders, this status byte indicates the address of the second cylinder.

### **MUX Status (F)**

This display indicates the fault status signals sent back from a drive that has a multiplexed interface. The status condition indicated by each LED is given in table 2-10. LEDs 2 and 6 are not used.

TABLE 2-10. STATUS BYTES

Status Byte Number/Name						
0 Tag-Bus I/O			1 Cylinder	2 Head	3 Record	
	F	R/W First Enabled	Fixed Volume Access	Enabled (CMD) Not Used	Not Used	
D	E	T 4	16384	/	/	
I	D	A 2	8192			
S	C	G 1	4096			
P	B	Hold Tag	2048			
L	A	1024	1024			
A	9	512	512			
Y	8	256	256			
	7	B 128	128			
	6	U 64	64			
B	5	S 32	32			
I	4	16	16			
T	3	I 8	8			
S	2	O 4	4			
	1	2	2			
	0	1	1			
Table Continued on Next Page						

TABLE 2-11. STATUS BYTES (Contd)

		Status Byte Number/Name			
		4	5	6	7
		Sector	Pattern	Addr Error Ctr	Data Error Ctr
DISPLA Y B I T S	F	Not Used	32768	Not Used	32768
	E		16384		16384
	D		8192		8192
	C		4096		4096
	B		2048		2048
	A		1024		1024
	9		512		512
	8		Not Used		256
	7	128	128	128	128
	6	64	64	64	64
	5	32	32	32	32
	4	16	16	16	16
	3	8	8	8	8
	2	4	4	4	4
	1	2	2	2	2
	0	1	1	1	1
Table Continued on Next Page					

TABLE 2-11. STATUS BYTES (Contd)

Status Byte Number/Name					
		8	9	A	B
		Flag/Pass Counters	Seek Counter	Average Access Time	Access Time Cts (0.1MS)
D	F	F 128	32768	800 MS	2 147 483 648
I	E	L 64	16384	400 MS	1 073 741 824
S	D	A 32	8192	200 MS	536 870 912
P	C	G 16	4096	100 MS	268 435 456
L	B	8	2048	80 MS	134 217 728
A	A	C 4	1024	40 MS	67 108 864
Y	9	T 2	512	20 MS	33 554 432
	8	R 1	256	10 MS	16 777 216
B	7	P 128	128	8 MS	8 388 608
I	6	A 64	64	4 MS	4 194 304
T	5	S 32	32	2 MS	2 097 152
S	4	S 16	16	1 MS	1 048 576
	3	C 8	8	0.8 MS	524 288
	2	T 4	4	0.4 MS	262 144
	1	R 2	2	0.2 MS	131 072
	0	1	1	0.1 MS	65 536

Table Continued on Next Page

TABLE 2-11. STATUS BYTES (Contd)

STATUS BYTE NUMBER/NAME					
		C	D	E	F
		Access Time Ctr (0.1MS)	Cylinder Destination	Cylinder Destination	Mux Status
D	F	32768	32768	32768	No Head Sel
I	E	16384	16384	16384	Wrt Fault
S	D	8192	8192	8192	W+R Off Cyl
P	C	4096	4096	4096	W/R Fault
L	B	2048	2048	2048	Voltage Fault
A	A	1024	1024	1024	HD SEL Fault
Y	9	512	512	512	Seek Error
	8	256	256	256	WRT Protect
	7	128	128	128	
B	6	64	64	64	
I	5	32	32	32	On Cyl
T	4	16	16	16	Unit Rdy
S	3	8	8	8	
	2	4	4	4	
	1	2	2	2	Offset Active
	0	1	1	1	Chk Diag.





## **SECTION 3**

### **THEORY OF OPERATION**

---

## INTRODUCTION

The TB216 is a microprocessor-controlled tester containing a 6800 series microprocessor and related support chips. The microprocessor operates under control of firmware loaded into FTU memory during manufacture.

The main elements in the FTU are a power supply, four cards in the logic chassis, and three circuit boards on the front panel. The microprocessor system is located on the logic cards. The front panel circuit boards contain switches and indicators that are used by the operator to control and monitor FTU and drive operation.

Figure 3-1 is a block diagram of the FTU showing the circuit cards and their principal logic elements. This figure also shows the data bus, address bus, and various control lines connecting these elements. The logic elements appearing in the figure are described in table 3-1. The following text describes the purpose of each circuit card and its relationship to the system.

### MICROPROCESSOR CARD

The microprocessor card performs the processing and memory functions of the FTU. The microprocessor chip on this card makes computations and controls data transfer to and from the other system elements as directed by the microprogram. The microprocessor is responsive to changes in the front panel switch settings (operator instructions) and signal appearing on the drive I/O. The microprocessor sends commands to the I/O control, read/write control, and control panel interface. These determine what is communicated on the interface to the disk drive and what is displayed on the front panel.

### I/O CONTROL CARD

The I/O control card contains circuitry to interface the FTU with the drive. Commands from the microprocessor prepare the I/O

control for communications between the FTU and the drive. Responding to the device type code entered by the operator into FTU memory, ensures that the proper interface is used in routing these communications on the I/O lines.

Signals transmitted to the drive include commands and write data. The I/O control follows microprocessor instructions to generate the command signals. It also routes write data (format and data pattern) from the read/write control card to the drive I/O lines.

Signals received from the drive include status information and read data. The I/O control indicates the drive status to the microprocessor and routes read data to the read/write control card.

### **READ/WRITE CONTROL CARD**

The read/write control card processes read/write data by preparing it to be written and interpreting it as it is read. During a write operation, it enters into its memory formatting data followed by repetitions of the data pattern entered by the operator on the FTU keyboard. This data is sent to the drive via the I/O control card when the heads are at the proper point over the disk pack. The FTU determines the proper point by using the Index and Sector signals it receives from the drive.

During the read operation, the data read by the drive is routed by the I/O control card to the read/write control card for comparison with the data stored in its memory. This comparison indicates data and address errors that occurred in the write/read operation.

An additional function of this card is conversion of the analog head alignment offset into digital form for LED display of head offset.

### **CONTROL PANEL INTERFACE CARD**

The control panel interface card has two basic functions. First, it translates control panel switch settings into instructions for the microprocessor. Second, it responds to specific signal combinations on the microprocessor system busses by lighting appropriate LEDs on the front panel.

### **LED DISPLAY BOARD**

The LED display board provides a number of indications to the operator. These include keyboard entries, FTU status bytes,

self test status, and head alignment offset. For more information about these, refer to the controls and indicators table in the operation section.

### **CONTROL PANEL BOARD**

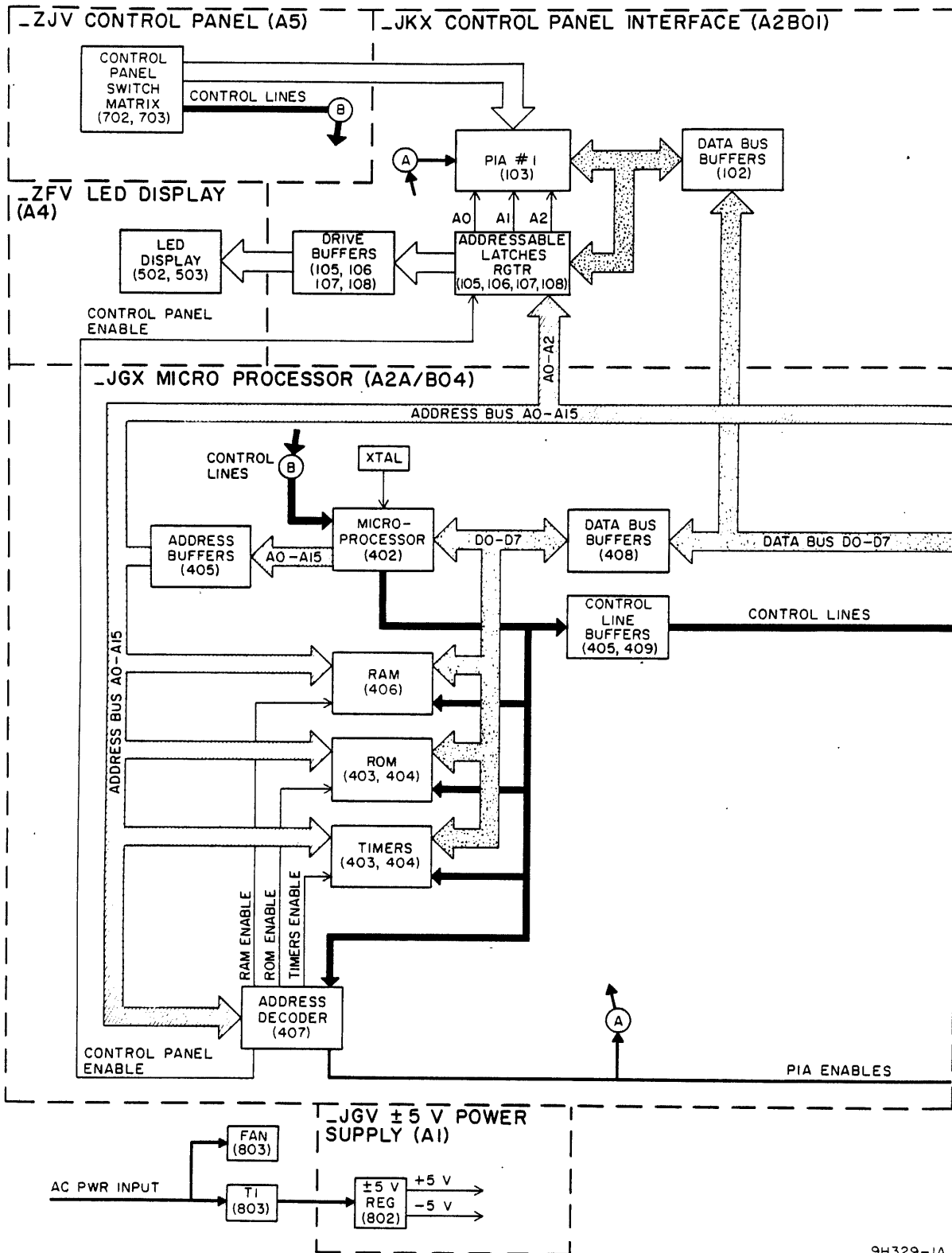
The control panel board contains the switches used to control operation of the FTU. For more information about these, refer to the controls and indicators table in the operation section.

### **TEST POINT BOARD**

The test point board allows the operator to connect an oscilloscope to various drive I/O lines. The test point terminals are defined in the operation section under Test Points and Jacks.

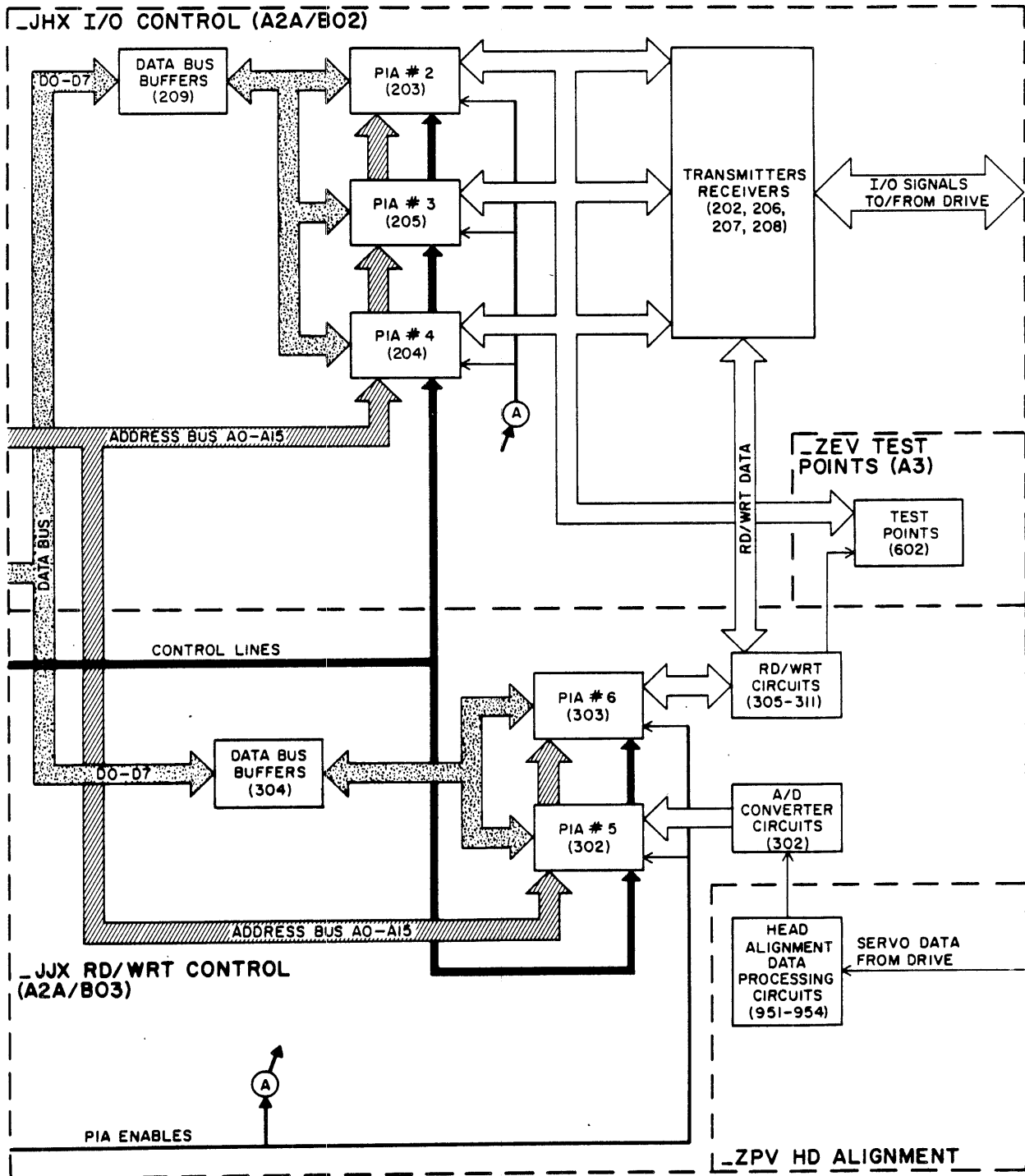
### **POWER SUPPLY**

The power supply, located in the FTU case, produces the regulated voltages ( $\pm 5$  V dc) used by the FTU circuitry. By changing connections and jumpers on the primary of the power transformer (T1), the operator can use the FTU with a variety of line voltages (refer to Operating Voltage Selection in the operation section).



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Figure 3-1. Functional Block Diagram (Sheet 1 of 2)



NOTES:

1. NUMBERS IN PARENTHESIS ARE REF NUMBERS OF DIAGRAMS WHERE LOGIC IS FOUND.

9H329-2

Figure 3-1. Functional Block Diagram (Sheet 2 of 2)

TABLE 3-1. FTU CIRCUIT ELEMENTS

Circuit Element	Function
Microprocessor	A single chip containing arithmetic and logic elements that control operation of the FTU. The processor operates under control of firmware stored in the read only memory (ROM).
RAM	Random access memory for temporary storage of data used during microprocessor operation.
ROM	Programmable read only memory chip containing firmware that directs the activities of the microprocessor chip. This chip is programmed during manufacture.
Timers	Control and measure timing during seek and read/write operations.
Data and Address Buffers	Extend the fan-out capability of the microprocessor chip.
PIAs	Peripheral interface adapters allowing the microprocessor chip to interface with external circuitry such as control panel switches of drive I/O.
Address Decoder	Enables particular devices (RAM, ROM, timers, PIAs) depending on the address present on the address bus.
Addressable Latches Register	Recognizes microprocessor command to light a particular front panel LED and then energizes the LED driver for that LED.

**SECTION 4**

**MAINTENANCE**



---

## INTRODUCTION

This section contains procedures to check and adjust power supply voltages, information for handling electrostatic sensitive devices, tests to maintain the FTU, and a list of required maintenance tools in table 4-1.

## POWER SUPPLY VOLTAGE CHECK AND ADJUSTMENTS

The FTU power supply voltages must be checked per table 4-2 and adjusted if necessary when any of the following problems are evident:

- FTU operation becomes unreliable (processor will not initialize).
- FTU operating voltage (input power) has been modified.
- Power supply board assembly -ZJV has been replaced.

Adjust power supply as follows:

1. Raise FTU front panel assembly and secure into place.
2. Install 30 pack extender into spare logic slot (location A2A01).
3. Ensure that all logic cards are installed into logic chassis assembly.
4. Apply power to FTU:

## CAUTION

To prevent possible damage to equipment, always use a nonmetallic screwdriver when making any voltage adjustments.

TABLE 4-1. MAINTENANCE TOOLS

Description	Part Number	Description	Part Number
Chip Extender (Chipclip)	12212196	Wire Wrap Bit, 30 Gage	12218402
Extender Board, 30 Pack	75845700	Wire Wrap Gun, Electric	12259111
Extender Board, 60 Pack	75845300	Wire Wrap Re- moval Tool CDC 12259183	
Oscilloscope, Dual Trace	Tektronix 454 or equivalent Sleeve, 30 Gage	Wire Wrap	12218403
Volt/ohmmeter, Digital	Fluke 8000A or equivalent		

5. Using digital meter, measure power supply voltages per table 4-2.
6. Adjust any out of tolerance voltages through access holes marked -5 and +5 VOLTAGE ADJ, in power supply board assembly cover.

TABLE 4-2. VOLTAGE ADJUSTMENTS

<u>VOLTAGE</u>	<u>EXTENDER PIN NO.</u>	<u>ADJUSTMENT CONDITIONS</u>
+5 V	44A/B	+5.0 ± 0.05 V
-5 V	02A/B	-5.0 ± 0.05 V
GND	06A/B	

### PROCESSOR TEST

1. Set Circuit Breaker CBl, on power supply, to ON position and ensure that +5 V and -5 V LEDs are lighted.
2. Set PROCESSOR switches as follows:

<u>SWITCH</u>	<u>POSITION</u>
PROCESSOR START/RESET	START
PROCESSOR RUN/HALT	RUN

3. Ensure that +5, -5, RUN, BUSY, FLT, SEEK, ERR, SELD, WT PROT, RDY, and ON CYL LEDs are lighted. If any of these LEDs are not lighted, a probable microprocessor malfunction is indicated.

### Lamp Test

1. Rotate ACCESS SELECT switch to LAMP TEST position.
2. Press GO key.

3. Ensure that LEDs, on FTU front panel, flash and continue to flash until STOP key is pressed. Failure of LEDs to light indicates a probable failure of:

- LEDs
- Decoder LED drivers
- Data bus buffer
- PIA 1

### SELF TEST :

This test includes both a component check and switch test. The component check must be completed satisfactorily prior to performing the switch test to ensure the reliability of switch test results.

1. Rotate ACCESS SELECT switch to SELF TEST position.
2. Set ERROR OVERRIDE switch DATA/OFF and ADDR/OFF to OFF position.
3. Rotate DATA ENTRY switch to DEVICE TYPE position.
4. Rotate RD/WRT SELECT switch to WRITE FORMAT position.
5. Set the following switches:

<u>SWITCH DESCRIPTION</u>	<u>POSITION</u>
HEAD	SEQ
RECORD	SEQ
SINGLE/CONT	CONT
-/+ OFFSET	CENTER (OFF)
EARLY/LATE	CENTER (OFF)
WRT FLAG	OFF
WRT PROT	OFF
AM/SECTOR	SECTOR
EOT STOP	OFF
SHIFT PATT	DATA PATT
SEQ PWR	DON'T CARE

6. Press GO key, initiating component check.

7. Interpret component check results as follows:
  - a. If LEDs RUN, +5, -5, RD, and 2<sup>9</sup> and 2<sup>11</sup> in row 2 LEDs are all lighted, FTU is operating properly, proceed to step 11 and perform switch test.
  - b. If any LEDs, in step a, do not light the FTU has detected an error and is displaying the address of the error causing component in row 2 LEDs (see table 4-3).

NOTE

Perform a repeat test or stop on error for troubleshooting purposes by performing steps 8 through 10.

8. Set EOT STOP/OFF and ERROR OVERRIDES switches to desired operation in a or b.
  - a. Repeat test once and stop on error by setting EOT STOP/OFF and ERROR OVERRIDE switches to OFF position.
  - b. Repeat test continuously and stop on error only, by positioning switches as follows:
    - o Set ERROR OVERRIDES switch to OFF position.
    - o Set EOT STOP/OFF switch to EOT STOP position.
9. Set PROCESSOR START/RESET switch to RESET and then back to START position.
10. Press GO key. FTU is now repeating test.
11. Prepare FTU for switch test as follows:
  - a. Set all switches to initial positions shown in Table 4-4.
  - b. Observe that all LEDs are off in row 1 and 2 and that LEDs RD, +5, -5 and RUN are on.

TABLE 4-3. ERROR ADDRESS

Address Of Error*	Location Of Error				
	Card		Circuit		
	Type	Location	Type**	Location	Function
0000-007F	_JGX	A2A/B04	585	3841	MPU
0088-8B	_JKX	A2A/B01	586	0741	PIA#1
008C-8F	_JHX	A2A/B02	586	4442	PIA#2
0090-93	_JHX	A2A/B02	586	5242	PIA#3
0094-97	_JHX	A2A/B02	586	5842	PIA#4
0098-9B	_JJX	A2A/B03	586	0429	PIA#5
009C-9F	_JJX	A2A/B03	586	1329	PIA#6
00A0-A7	_JGX	A2A/B04	587	0446	TIMER#1
00A8-AF	_JGX	A2A/B04	587	1246	TIMER#1
00B0-B7	_JGX	A2A/B04	587	1946	TIMER#3
00B8-BF	_JGX	A2A/B04	587	2746	TIMER#4
1000-13FF	_JGX	A2A/B04	2114L-2	0409	RAM (Bits 0-3)
			2114L-2	2609	RAM (Bits 4-7)
3000-37FF	_JGX	A2A/B04	5905	2731	ROM
3800-3FFF	_JGX	A2A/B04	5904	0431	ROM

\* Displayed in row 2 LEDs. Data written is in Row 1, High Order; Data Read or Check Sum, is in Row 1, Low Order.

\*\* This refers to element number as shown on the logic diagrams.


TABLE 4-4. SWITCH TEST INITIAL SETUP

Switch	Initial Position
DATA ENTRY RE/WRT SELECT ACCESS SELECT HEAD/MAN, SEQ, RAN RECORD/MAN, SEQ, RAN PROCESSOR, START/RESET PROCESSOR, RUN/HALT PROCESSOR, STEP SINGLE/CONT -/+ (offset) LATE/EARLY (strobe) WRITE FLAG/OFF WRITE PROT/OFF AM/SECTOR EOT STOP/OFF ERROR OVERRIDES, DATA/OFF ERROR OVERRIDES, ADDR/OFF SHIFT PATT/DATA PATT SEQ PWR/OFF	DEVICE TYPE WRITE FORMAT MANUAL TAGS SEQ SEQ START RUN down CONT center center OFF OFF SECTOR OFF OFF OFF DATA PATT OFF


12. Perform switch test as follows:

- a. Set switch to be tested to desired test position.
- b. Refer to figure 4-1 and ensure proper LEDs are lighted.
- c. Return switch to its initial position (see table 4-4).
- d. Repeat a through c for each switch tested.
- e. Failure of switches indicates a probable failure of:
  - Switches
  - Data bus buffer
  - PIA 1



		LED DISPLAY 														
ROW 1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROW 2	2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>
S W I T C H E S	DATA ENTRY															
	DEVICE TYPE	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	UNIT NUMBER	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
	DESTINATION	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
	HEAD	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-
	RECORD	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	FIXED HEADS	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-
	DATA PATTERN	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
	STATUS BYTES	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-
	SEEK INCREMENT	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MPU ADDRESS	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-
	MPU DATA	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
	B	2	-	2	2	-	-	-	-	-	-	-	-	-	-	-
	C	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	2	2	-	2	-	-	-	-	-	-	-	-	-	-	-
	E	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
F	2	2	2	2	-	-	-	-	-	-	-	-	-	-	-	
RD/WRT SELECT																
WRT FORMAT	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WRT/RD FORMAT	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	
WRITE	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	
READ	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-	
WRT/RD	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	
ALIGNMENT	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-	
ACCESS ONLY	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	

NOTES:


 X = INDICATES INITIAL POSITION OF SWITCH. RETURN EACH SWITCH TO ITS INITIAL POSITION BEFORE TESTING NEXT SWITCH


1 = INDICATES LIGHTED ROW 1 LED

2 = INDICATES LIGHTED ROW 2 LED

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Figure 4-1. Switch Test Display (Sheet 1 of 5)

LED DISPLAY 																
ROW 1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROW 2	2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>
	7	-	-	-	-	-	-	-	-	2	2	2	-	-	-	-
	8	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
	9	-	-	-	-	-	-	-	2	-	-	2	-	-	-	-
	A	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-
	B	-	-	-	-	-	-	-	2	-	2	2	-	-	-	-
	C	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-
	D	-	-	-	-	-	-	-	2	2	-	2	-	-	-	-
	E	-	-	-	-	-	-	-	2	2	2	-	-	-	-	-
	F	-	-	-	-	-	-	-	2	2	2	2	-	-	-	-
	ACCESS SELECT															
S	MANUAL TAGS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
W	DIRECT SEEK	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
I	DIRECT CONT	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
T	SEQ FORWARD	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-
C	SEQ REVERSE	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
H	SEQ FWD/REV	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-
E	RANDOM SEEK	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
S	X - N SEEK	-	-	-	-	-	2	2	2	-	-	-	-	-	-	-
	FIXED VOLUME	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
	LAMP TEST	-	-	-	-	2	-	-	2	-	-	-	-	-	-	-
	SELF TEST	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-
	B	-	-	-	-	2	-	2	2	-	-	-	-	-	-	-
	C	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-
	D	-	-	-	-	2	2	-	2	-	-	-	-	-	-	-
	E	-	-	-	-	2	2	2	-	-	-	-	-	-	-	-
	F	-	-	-	-	2	2	2	2	-	-	-	-	-	-	-


NOTES:  
 See Sheet 1

9H350-2A

Figure 4-1. Switch Test Display (Sheet 2 of 5)


		LED DISPLAY 															
ROW 1		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROW 2		2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>
S W I T C H E S	HEAD																
	MAN	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
	SEQ	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	RAN	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
	RECORD																
	MAN	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
	SEQ	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	RAN	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	SINGLE/CONT																
	SINGLE	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
	CONT	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	- / +																
	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	CENTER POSITION	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	+	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
LATE/EARLY																	
LATE	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CENTER POSITION	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
EARLY	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	


NOTES:

 See Sheet 1

9H350-3

Figure 4-1. Switch Test Display (Sheet 3 of 5)

LED DISPLAY 																		
ROW 1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
ROW 2	2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>		
S W I T C H E S	WRITE FLAG/OFF																	
	WRITE FLAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1		
	OFF	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	WRITE PROT/OFF																	
	WRITE PROT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	
	OFF	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	AM/SECTOR																	
	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
	SECTOR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	EOT STOP/OFF																	
	EOT STOP	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	
	OFF	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	DATA/OFF																	
	DATA ERROR	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	
OFF	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
ADDR/OFF																		
ADDR ERROR	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-		
OFF	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
SHIFT PATT/ DATA PATT																		
SHIFT PATT	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-		
DATA PATT	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
SEQ PWR/OFF																		
SEQ PWR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
OFF	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

NOTES:  
 See Sheet 1

9H350-4

Figure 4-1. Switch Test Display (Sheet 4 of 5)

LED DISPLAY <sup>1</sup>																	
ROW 1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
ROW 2	2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>	
	KEYBOARD	INDICATES VALUE (IN BCD) OF KEY PRESSED. IN 2 <sup>0</sup> -2 <sup>3</sup> ROW 2 LEDS.															
	0-9	}															
	A-F	}															
S	HEX	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	
W	DISP	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	
I	CLR ENT	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	
T	LOAD	-	-	-	-	-	-	-	-	-	-	2	-	-	2	2	
C	DEC	-	-	-	-	-	-	-	-	-	-	2	-	2	-	-	
H	BIT	-	-	-	-	-	-	-	-	-	-	2	-	2	-	2	
E	SEL DRV	-	-	-	-	-	-	-	-	-	-	2	-	2	2	-	
S	CLR FLT	-	-	-	-	-	-	-	-	-	-	2	-	2	2	2	
	RTZ	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-	
	CLR	-	-	-	-	-	-	-	-	-	-	2	2	-	-	2	
	GO	-	-	-	-	-	-	-	-	-	-	2	2	-	2	-	
	STOP	-	-	-	-	-	-	-	-	-	-	2	2	-	2	2	

NOTES:  
<sup>1</sup> See Sheet 1

9H350-5

Figure 4-1. Switch Test Display (Sheet 5 of 5)

## ELECTROSTATIC DISCHARGE PROTECTION

### NOTE

The following material is needed to perform these procedures:

Conductive Static Shielding Bags*	95038604 (8 x 10)
	95038606 (12 x 16)

\*Vendor: Minnesota Mining & Mfg Co.

## HANDLING ELECTROSTATICALLY SENSITIVE ASSEMBLIES

All drive electronic assemblies are sensitive to static electricity, due to the electrostatically sensitive devices used within the drive circuitry. Although some of these devices such as metal-oxide semiconductors (MOS) on logic cards are extremely sensitive, all semiconductors as well as some resistors and capacitors may be damaged or degraded by exposure to static electricity.

Electrostatic damage to electronic devices may be caused by a direct discharge of a charged conductor, or by exposure to the static fields which surround charged objects. To avoid damage to drive electronic assemblies, service personnel must observe the following precautions when servicing the drive:

- Ground yourself to the drive - whenever the drive electronics are or will be exposed, connect yourself to ground with a wrist strap . Make the connection to any metal assembly or to the dc grounding block at the rear of the drive. As a general rule, remember that you, the drive, and the circuit cards must all be at ground potential to avoid potentially damaging static discharges.
- Keep cards in conductive bags - when circuit cards are not installed in the drive, keep them in conductive static shielding bags. These bags provide absolute protection from static discharge and from static fields surrounding charged objects. Remember that these bags are conductive and should not be placed where they might cause an electrical short circuit.
- Remove cards from bags only when you are grounded - all cards received from the factory are in static shielding bags, and should not be removed unless you are grounded.

## HANDLING ELECTROSTATICALLY SENSITIVE LOGIC CARDS

Metal oxide semiconductor (MOS) integrated circuits are used on several logic cards in the unit. The logic cards are identified by orange colored injectors/ejectors. MOS integrated circuits are extremely sensitive and therefore require special handling to avoid damage caused by static electricity. Observe the following precautions when handling or working with logic cards using MOS integrated circuits:

- Turn off power before removing and installing the logic card.
- Ensure that anything or anyone coming in contact with the card is electrically connected to ground, including tools, the body, clothing, containers, etc.
- Touch the logic chassis to bleed off any accumulated static charge before removing or installing the card.
- Handle the card only by a non-circuit portion. Do not touch pins and circuit connection points.
- Never use an ohmmeter on cards having microprocessor assemblies.
- Always remove the microprocessor cards before using an ohmmeter on the drive.
- Place the card in a conductive shielded bag immediately following its removal from the unit. The card and the bag must be in contact with logic chassis ground before and during the time that the card is inserted or removed from the bag. The bag should have a warning label indicating that it contains an electrostatic-sensitive device. The logic card must remain in the bag or at a properly prepared work station whenever it is not installed in the logic chassis.





**SECTION 5**

**DIAGRAMS**

---

## INTRODUCTION

This section contains diagrams describing all electrical circuitry and wiring found in the FTU. It also contains information concerning the interpretation of the electrical circuit and wiring diagrams. This results in the diagrams set actually containing three different types of diagrams; (1) key to logic, (2) card logic diagrams, and (3) cabling diagrams.

The diagrams set begins with the key to logic diagrams. These sheets contain information concerning the interpretation on the actual circuit diagrams. The key to logic is divided into the following sections: assembly locator, cable and backpanel locations, intersheet referencing, card coordinates, logic levels, abbreviations, and integrated circuit descriptions.

The card logic diagrams follow the key to logic and constitute the major portion of the diagram set. The organization of these diagrams is discussed later in this section.

The cabling diagrams show each cable. Signal names are given for each wire as well as the connector pin number where the wires terminate. In following a signal from one card to another, it is not necessary to trace it through the relevant cabling diagram. The cabling diagrams are presented for completeness and to facilitate troubleshooting.

In cases where one of several card types may appear in a particular location in the FTU, there may be similar sets of diagrams covering the different card types. In this case, each set of diagrams contains a note on its cover sheet that specifies which card type is described by it. To determine what card types appear in a particular tester, find out the tester's series code by examining the equipment identification plate. Then refer to the spare parts list at the end of the parts data section; this list correlates the card types to the tester series code.

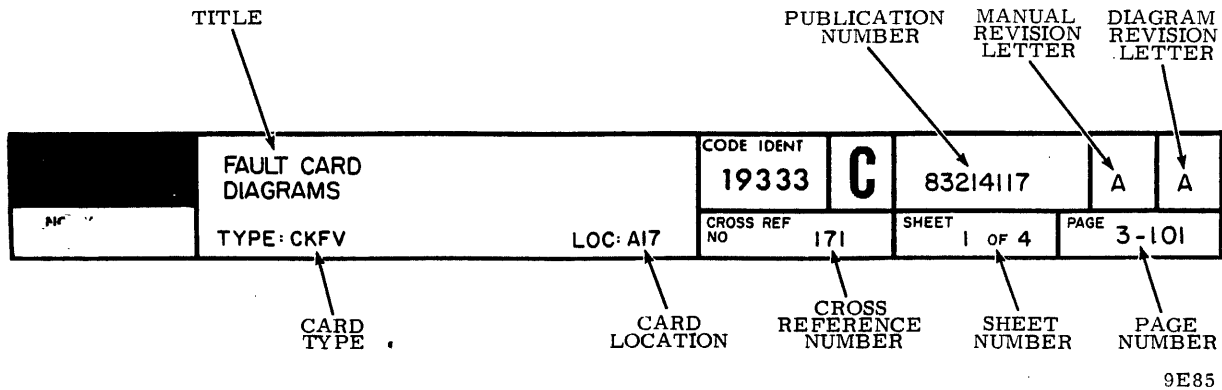


Figure 5-1. Diagram Title Block

Each sheet in the diagrams has a title block containing the information shown on figure 5-1. This information is explained as follows:

- Title - Descriptive of the information contained on that sheet.
- Publication Number - Indicates the publication number of this manual. This number is in lieu of the number usually found at the bottom of each page.
- Manual Revision Letter - Indicates the revision level of the page.
- Diagram Revision Letter - Indicates revision level of this diagram and changes due to engineering change order etc.
- Card Type - Indicates the type of card containing the circuitry shown on this diagram. This is included only on the first sheet of each card type but not at all on diagrams showing key to logic or cabling information.
- Card Location - Indicates the location of the card within the FTU.

- Cross Reference Number - Each sheet (except those in key to logic) has a unique 3 digit cross reference number.
- Sheet Number - Pertains to the number of sheets required to show this circuitry and should match the last digit of the cross reference number.
- Page Number - Indicates the page number of this sheet within the manual. This number is in lieu of the number usually found at the bottom of each sheet.

Table 5-1 lists the contents of the diagrams set and includes the cross reference number, location and title of each sheet in the set. However, each title and cross reference number is listed only once. This is important to note where several sheets have the same title and cross reference number but contain different information because they apply to different units.

TABLE 5-1. CONTENTS OF DIAGRAMS

Cross Reference Number	Module Location	Title
001	A2A01	Key to Diagrams - Assembly Locator Key to Diagrams - Cable and Backpanel Locator Key to Diagrams - Intersheet Referencing Key to Diagrams - Miscellaneous Prewired Spare Card Slot Microprocessor Signals Diagrams
002	A2A01	Prewired Spare Slot Microprocessor Signals
101	A2B01	Control Panel Interface Diagrams
Table Continued on Next Page		

TABLE 5-1. CONTENTS OF DIAGRAMS (Contd)

Cross Reference Number	Module Location	Title
102	A2B01	Bidirectional Data Bits 0-7
103	A2B01	Row and Column Switch Decode
104	A2B01	Interrupt and Processor Run/Halt/Reset
105	A2B01	Decoder and LED Drivers, Part 1
106	A2B01	Decoder and LED Drivers, Part 2
107	A2B01	Decoder and LED Drivers, Part 3
108	A2B01	Decoder and LED Drivers, Part 4
201	A2A/B02	I/O Control Diagrams
202	A2A/B02	Input Receivers
203	A2A/B02	PIA Data and Bus Control
204	A2A/B02	PIA Data and Receiver Enable
205	A2A/B02	PIA Data and Transmitter Enable
206	A2A/B02	Output Transmitters
207	A2A/B02	Bus Out Multiplexer and Transmitters, Part 1
208	A2A/B02	Bus Out Multiplexer and Transmitters, Part 2
209	A2A/B02	Bidirectional Data Bits
301	A2A/B03	Read/Write Control Diagram
302	A2A/B03	Head Alignment
Table Continued on Next Page		

TABLE 5-1. CONTENTS OF DIAGRAMS (Contd)

Cross Reference Number	Module Location	Title
303	A2A/B03	Read/Write Enable Control
304	A2A/B03	Bidirectional Data Bits 0-7
305	A2A/B03	MFM and Write/Read Enable
306	A2A/B03	Address Mark and Data Error
307	A2A/B03	Read/Write Data Control
308	A2A/B03	Write Address/Data RAM
309	A2A/B03	Address/Data Error Compare
310	A2A/B03	Read/Write Data Control Counter
311	A2A/B03	Read/Write Address Control Counter
401	A2A/B04	Microprocessor
402	A2A/B04	Microprocessor and Reset
403	A2A/B04	Read Only Memory
404	A2A/B04	Clock and Address Mark Counter
405	A2A/B04	Buffered Addresses 0-15
406	A2A/B04	Read/Write Random Access Memory
407	A2A/B04	ROM and RAM Decode Select
408	A2A/B04	Bidirectional Read/Write Data Bits 0-7.
409	A2A/B04	Phase Two Clock
501	A4	LED Display Diagrams
Table Continued on Next Page		

TABLE 5-1. CONTENTS OF DIAGRAMS (Contd)

Cross Reference Number	Module Location	Title
502	A4	LED Display, Part 1
503	A4	LED Display, Part 2
601	A3	Test Point Board Diagrams
602	A3	Test Point Board
701	A5	Control Panel Board Diagrams
702	A5	Control Panel Board
703	A5	Control Panel Board
801	A1	+5 / -5 Volt Power Supply Diagrams
802	A1	+5 / -5 Volt Power Supply
803		Input Power Configuration TB216 Microprocessor
901		FTU Internal Cabling Diagrams
902		LED Display Cables
903		Test Point Cables
904		Control Panel Cable
910		I/O Cabling Diagrams
911		I/O "A" A2/A4
912		I/O "A" 75 Pin Adapter Cable (A6 STD) (A10 MUX)
913		60 Pin Adapter Cable A8 (STD and MUX)

Table Continued on Next Page

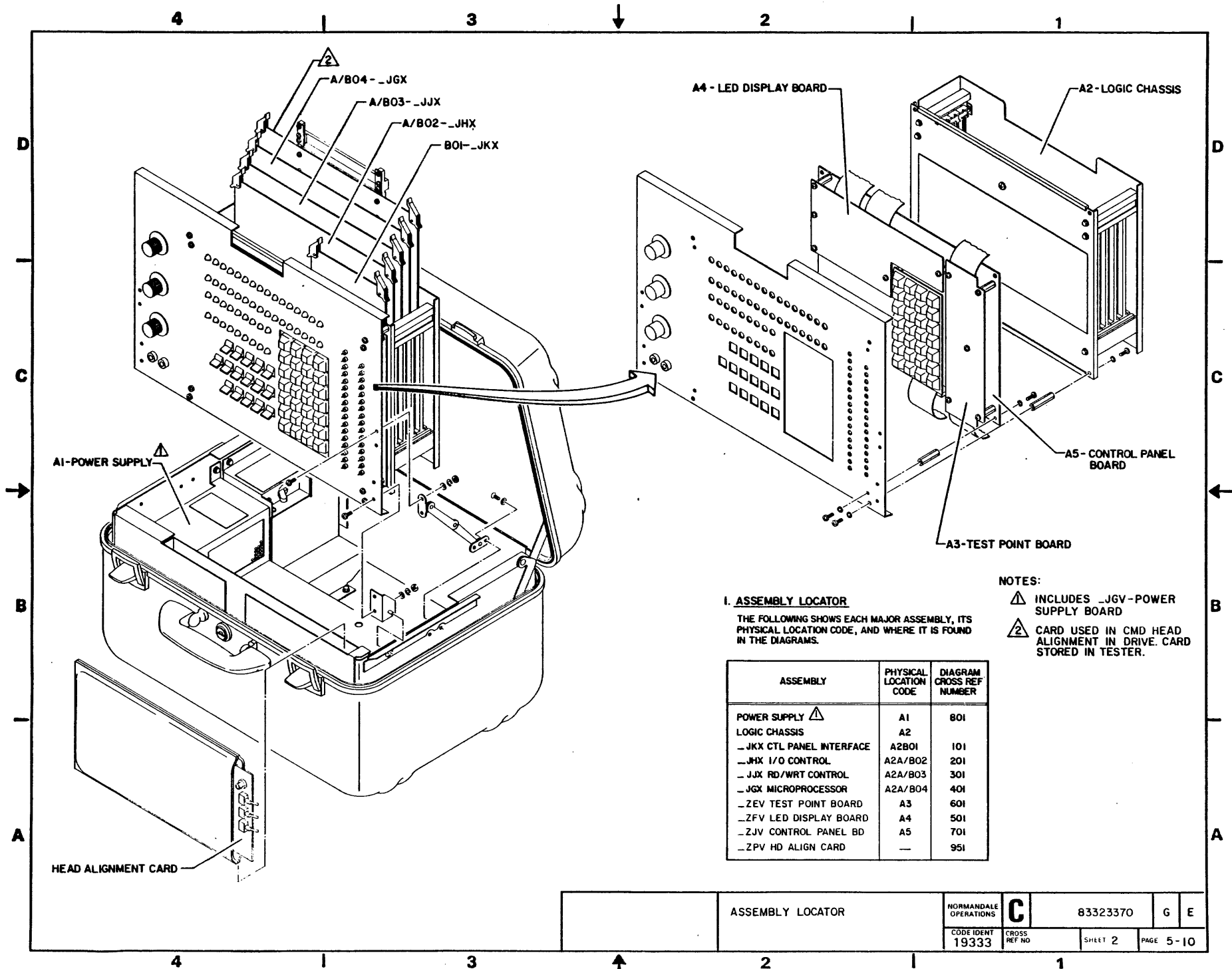
TABLE 5-1. CONTENTS OF DIAGRAMS (Contd)

Cross Reference Number	Module Location	Title
914		75 Pin Adapter B7 (MUX) / I/O Cable B5 (STD and MUX)
915		75 Pin Adapter B3 (STD) / Head Alignment Cable
951		Head Alignment Diagrams
952		DIBIT Amplifier, Part 1
953		DIBIT Amplifier, Part 2
954		DIBIT Amplifier, Part 3









**I. ASSEMBLY LOCATOR**

THE FOLLOWING SHOWS EACH MAJOR ASSEMBLY, ITS PHYSICAL LOCATION CODE, AND WHERE IT IS FOUND IN THE DIAGRAMS.

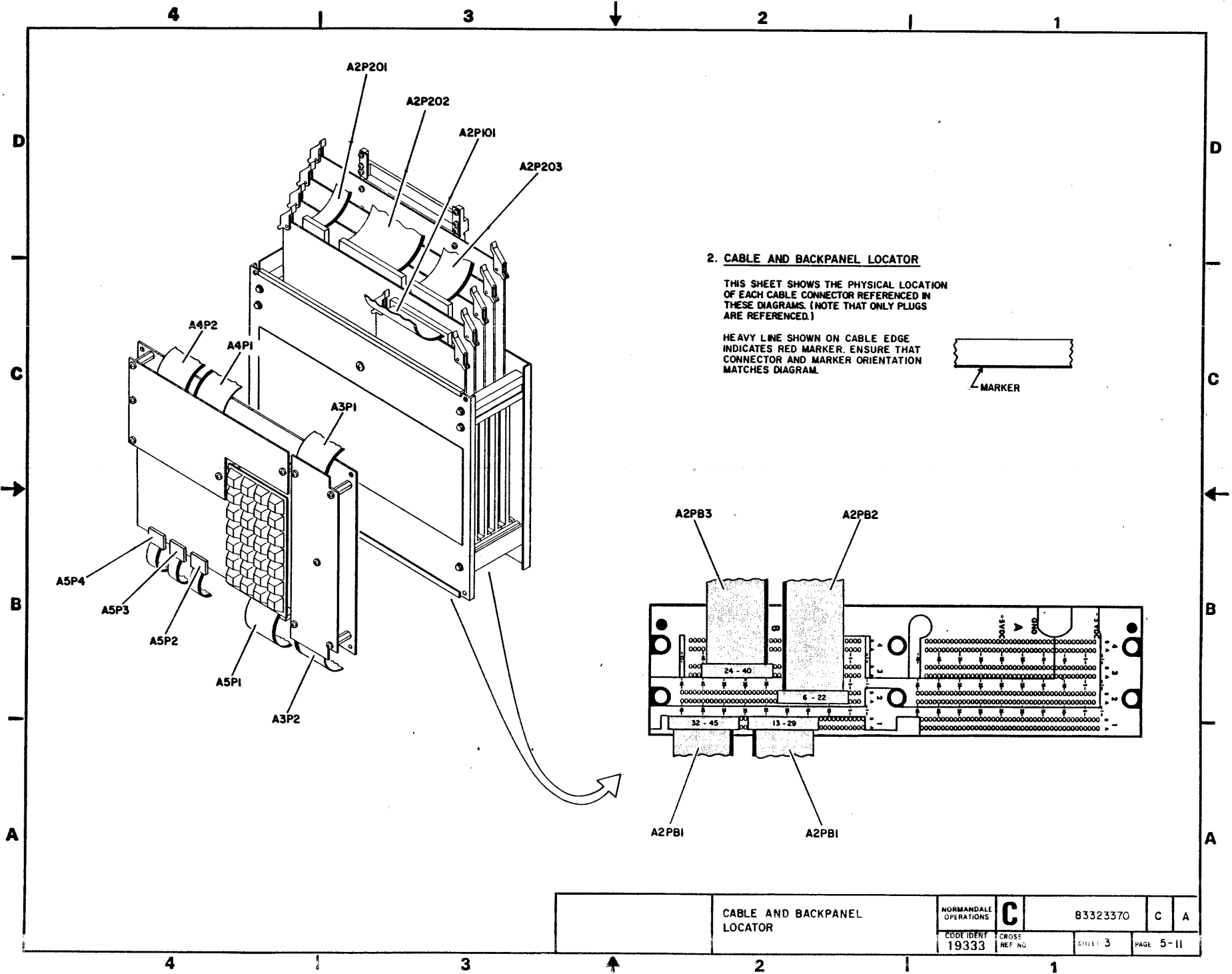
ASSEMBLY	PHYSICAL LOCATION CODE	DIAGRAM CROSS REF NUMBER
POWER SUPPLY	A1	801
LOGIC CHASSIS	A2	
-JXX CTL PANEL INTERFACE	A2B01	101
-JHX I/O CONTROL	A2A/B02	201
-JXX RD/WRT CONTROL	A2A/B03	301
-JGX MICROPROCESSOR	A2A/B04	401
-ZEV TEST POINT BOARD	A3	601
-ZFV LED DISPLAY BOARD	A4	501
-ZJV CONTROL PANEL BD	A5	701
-ZPV HD ALIGN CARD	—	951

**NOTES:**

- INCLUDES -JGV-POWER SUPPLY BOARD
- CARD USED IN CMD HEAD ALIGNMENT IN DRIVE. CARD STORED IN TESTER.

ASSEMBLY LOCATOR

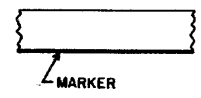
NORMANDALE OPERATIONS	<b>C</b>	83323370	G	E
CODE IDENT 19333	CROSS REF NO	SHEET 2	PAGE 5-10	



**2. CABLE AND BACKPANEL LOCATOR**

THIS SHEET SHOWS THE PHYSICAL LOCATION OF EACH CABLE CONNECTOR REFERENCED IN THESE DIAGRAMS. (NOTE THAT ONLY PLUGS ARE REFERENCED.)

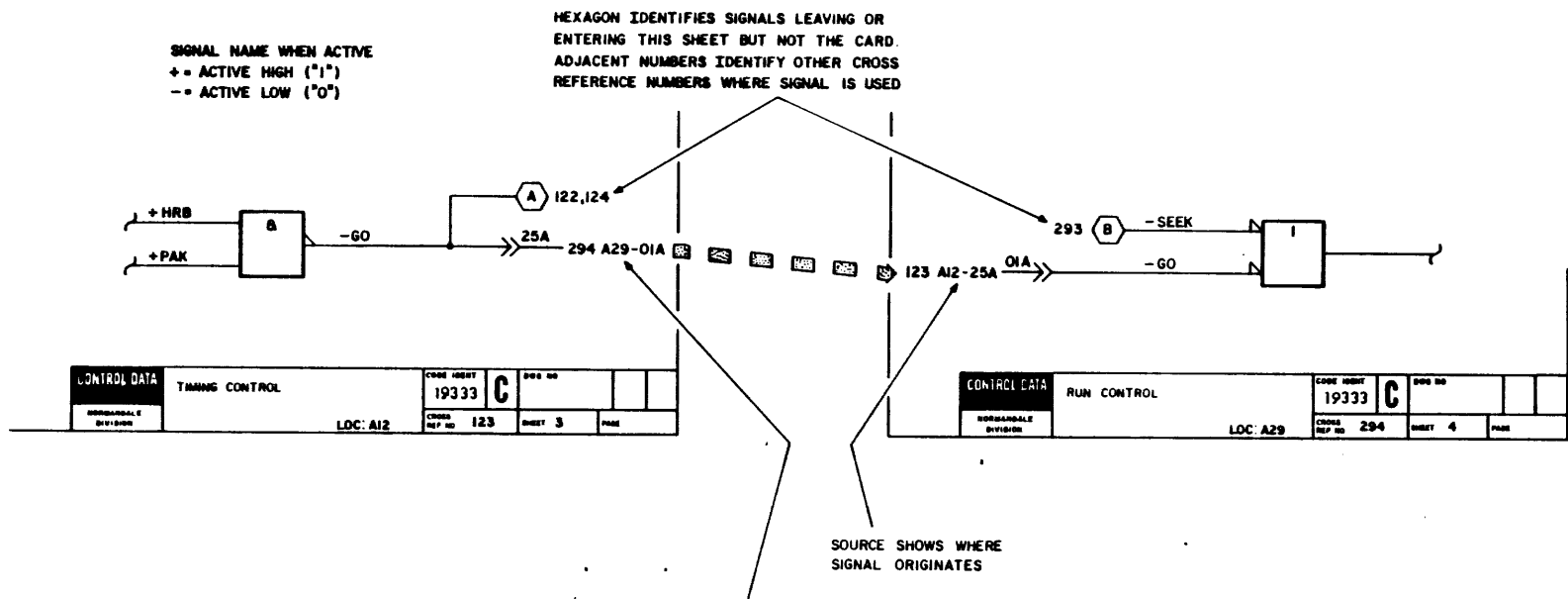
HEAVY LINE SHOWN ON CABLE EDGE INDICATES RED MARKER. ENSURE THAT CONNECTOR AND MARKER ORIENTATION MATCHES DIAGRAM.



		CABLE AND BACKPANEL LOCATOR		NORMANDEALE OPERATIONS	<b>C</b>	83323370	C	A
CODE IDENT	CROSS REF NO	SHEET	PAGE					
19333		3	5-11					

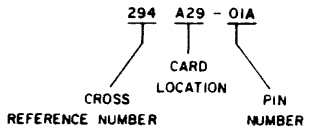
### 3. INTERSHEET REFERENCING

THE FOLLOWING EXPLAINS THE BASIC METHOD OF INTER-SHEET REFERENCING.



SOURCE SHOWS WHERE SIGNAL ORIGINATES

DESTINATIONS SHOW ALL LOCATIONS WHERE OUTPUT SIGNALS GO WITHOUT REGARD TO ACTUAL BACKPANEL WIRE ROUTING, IN THE EXAMPLE SHOWN IT IS AS FOLLOWS:



4 | 3 | 2 | 1

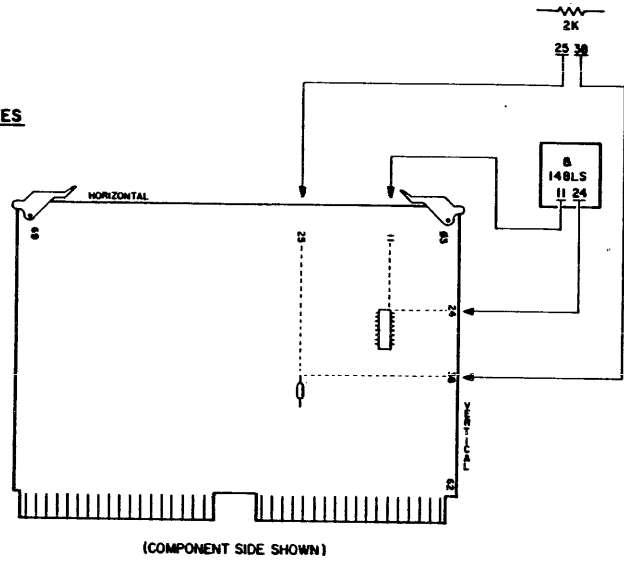
D

C

B

A

**4. CARD COORDINATES**



EACH COMPONENT ON THE A2 LOGIC CARDS IS IDENTIFIED ON THE LOGIC DIAGRAM BY A FOUR-DIGIT COORDINATE LOCATOR. THE FIRST TWO DIGITS LOCATE IT HORIZONTALLY, AND THE LAST TWO DIGITS LOCATE IT VERTICALLY. EACH CARD HAS THE COORDINATE NUMBERS PRINTED ALONG ITS EDGES. AS VIEWED FROM THE COMPONENT SIDE, THE COORDINATES FOR AN INTEGRATED CIRCUIT ARE GIVEN FOR THE LOCATION OF THE UPPER RIGHT-HAND PIN (ACROSS FROM PIN 1). THE COORDINATES FOR A DISCRETE COMPONENT ARE GIVEN FOR THE POINT WHERE THE UPPER LEAD IS ATTACHED.

**5. LOGIC LEVELS**

- TTL "1" = +3.6 (±1.6) V
- "0" = +0.4 (±0.4) V
- ECL "1" = 0.79 (±0.18) V
- "0" = 1.95 (±0.43) V
- CMOS "1" = 2.4 V MIN
- "0" = 0.4 V MAX

**6. ABBREVIATIONS**

ALL ABBREVIATIONS ARE DEFINED IN A LIST PROVIDED IN THE FRONT MATTER OF THIS MANUAL.

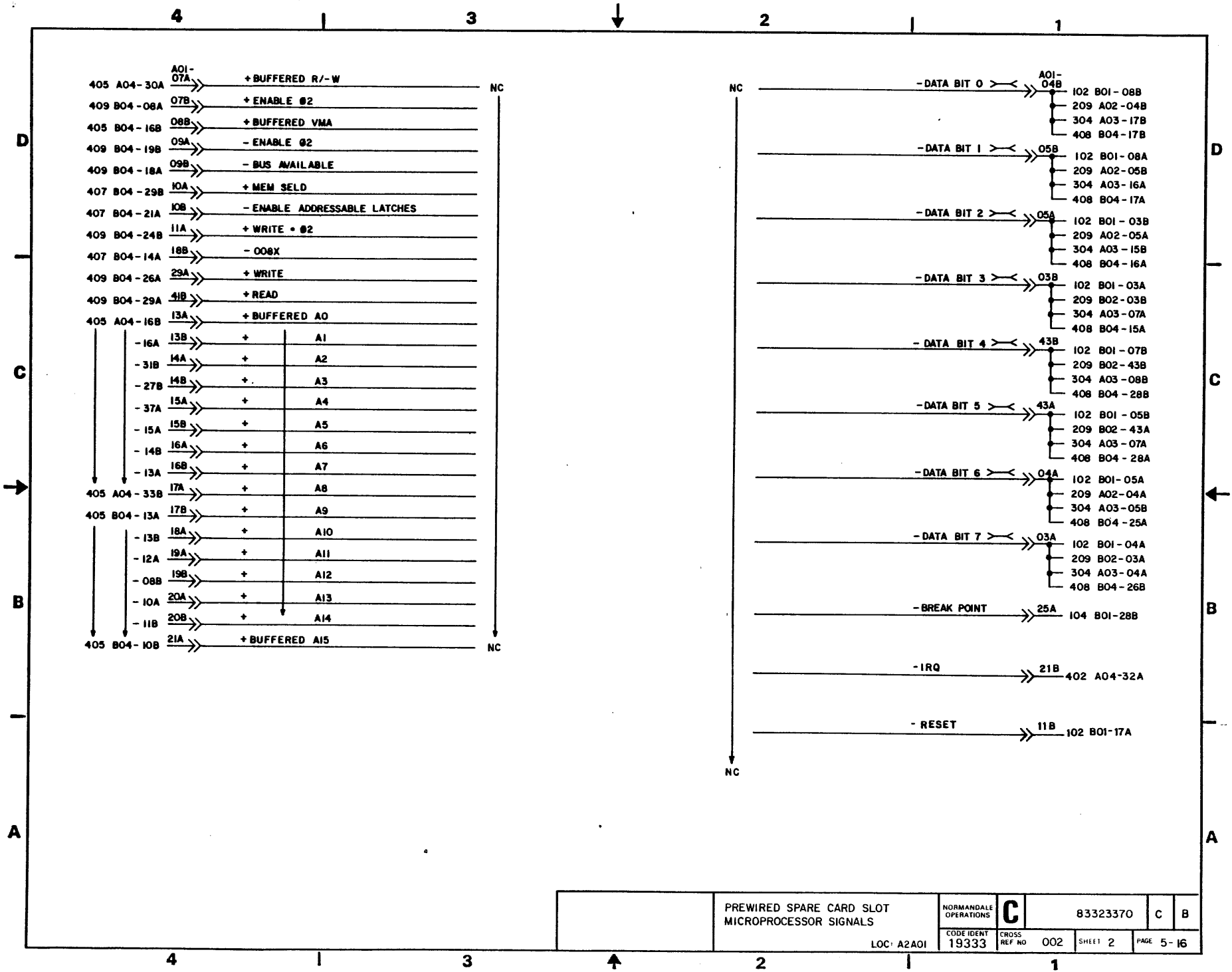
**7. INTEGRATED CIRCUIT DESCRIPTIONS**

ALL INTEGRATED CIRCUITS ARE DESCRIBED IN THE NORMANDEALE CIRCUITS MANUAL.









REVISION STATUS OF SHEETS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	A	A	A	A	A	A	A												
B	A	B	B	A	A	A	A												

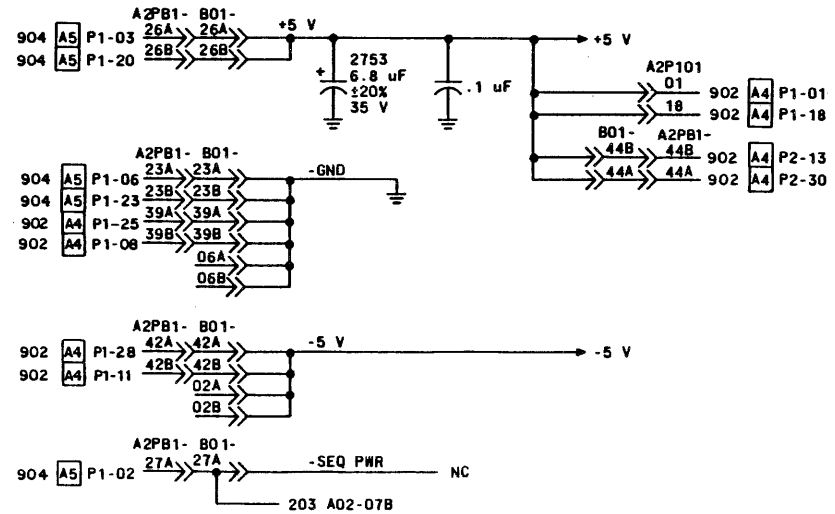
FILTER CAPACITORS

.1 uF	
+5 V	
0610	1743
0622	2210
1133	2221
1610	2233
1622	2355
1633	2710
1655	2733

UNUSED LOGIC ELEMENTS

ELEMENT	LOCATION	OUTPUT PIN(S)
140LS	1953	11
140LS	0331	3, 8, 11
141	2453	6
141	2920	6, 8
200	2931	6, 12
200	1909	6, 8

REVISIONS					
REV.	ECO.	DESCRIPTION	DRFT.	DATE	CHK'D
A	PE23000	RELEASE			
B	PE54236	ADD TWO SIGNALS	CB	5-21-80	



DRAWN	G RAB:MC	1/31/79
CHECKED		
ENGINEER	<i>[Signature]</i>	1/31/79
APPROVED		

CONTROL PANEL INTERFACE DIAGRAMS

TYPE: AJKX

LOC: A2B01

NORMANDEALE OPERATIONS

C

83323370

E B

CODE IDENT 19333

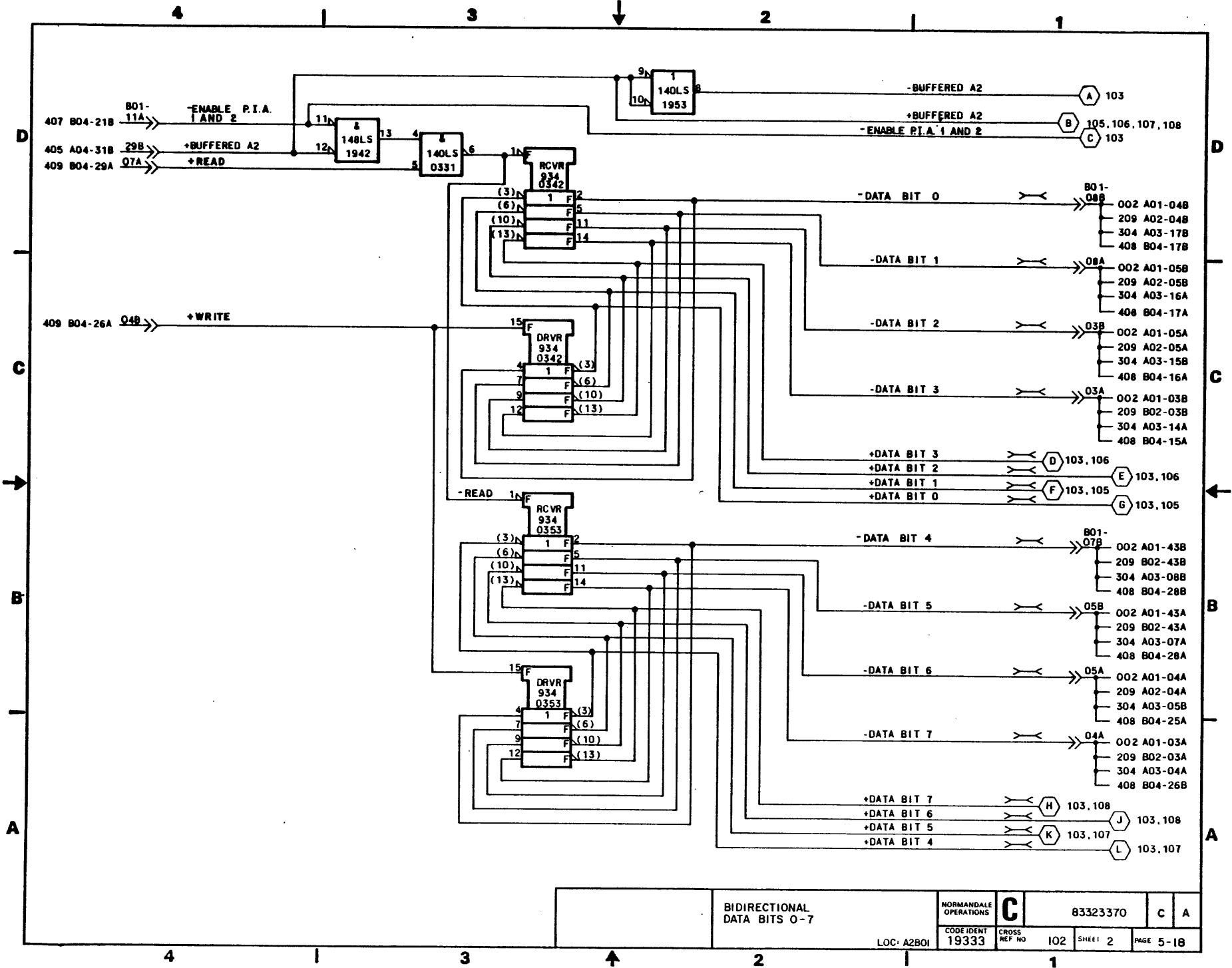
CROSS REF. NO.

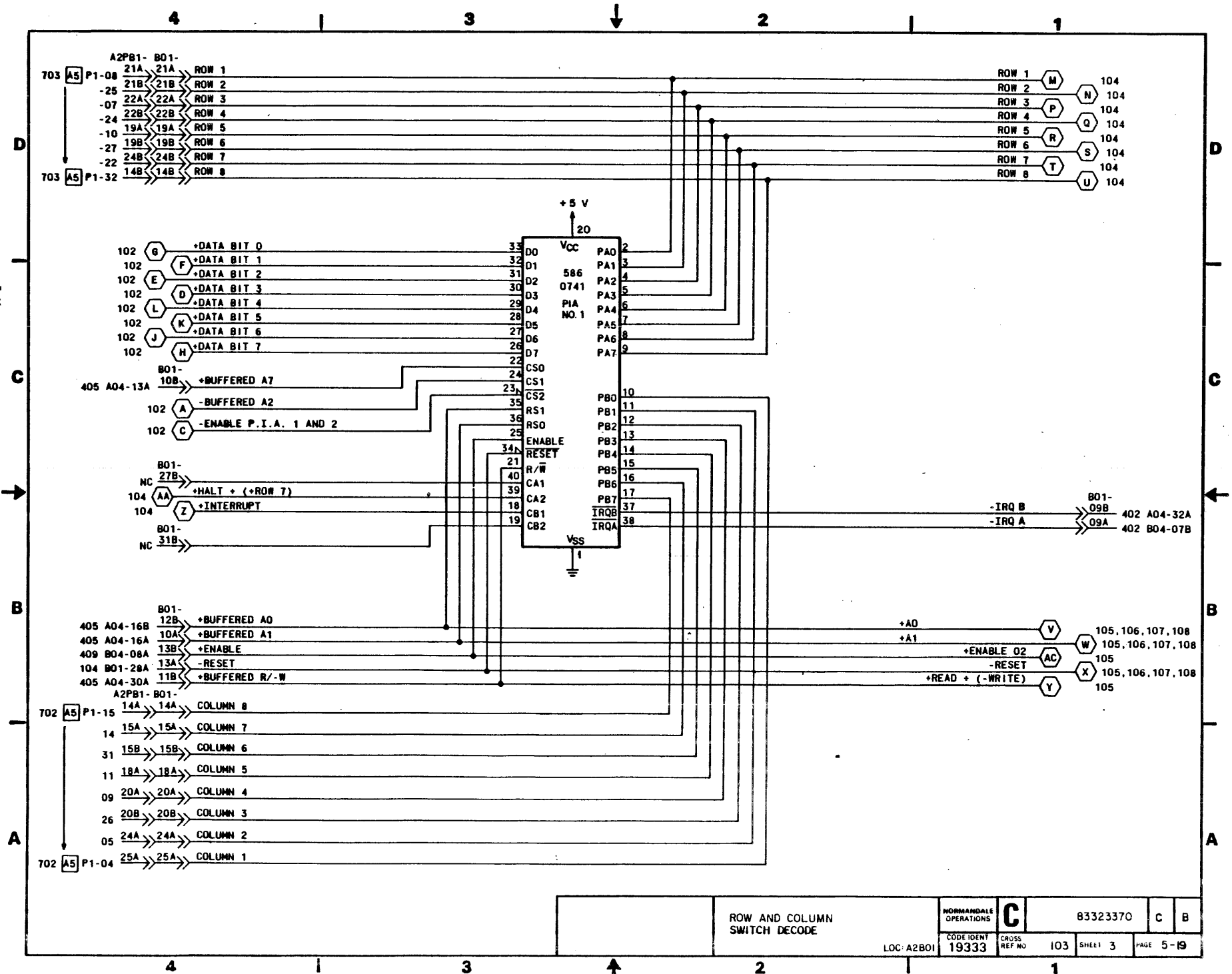
101

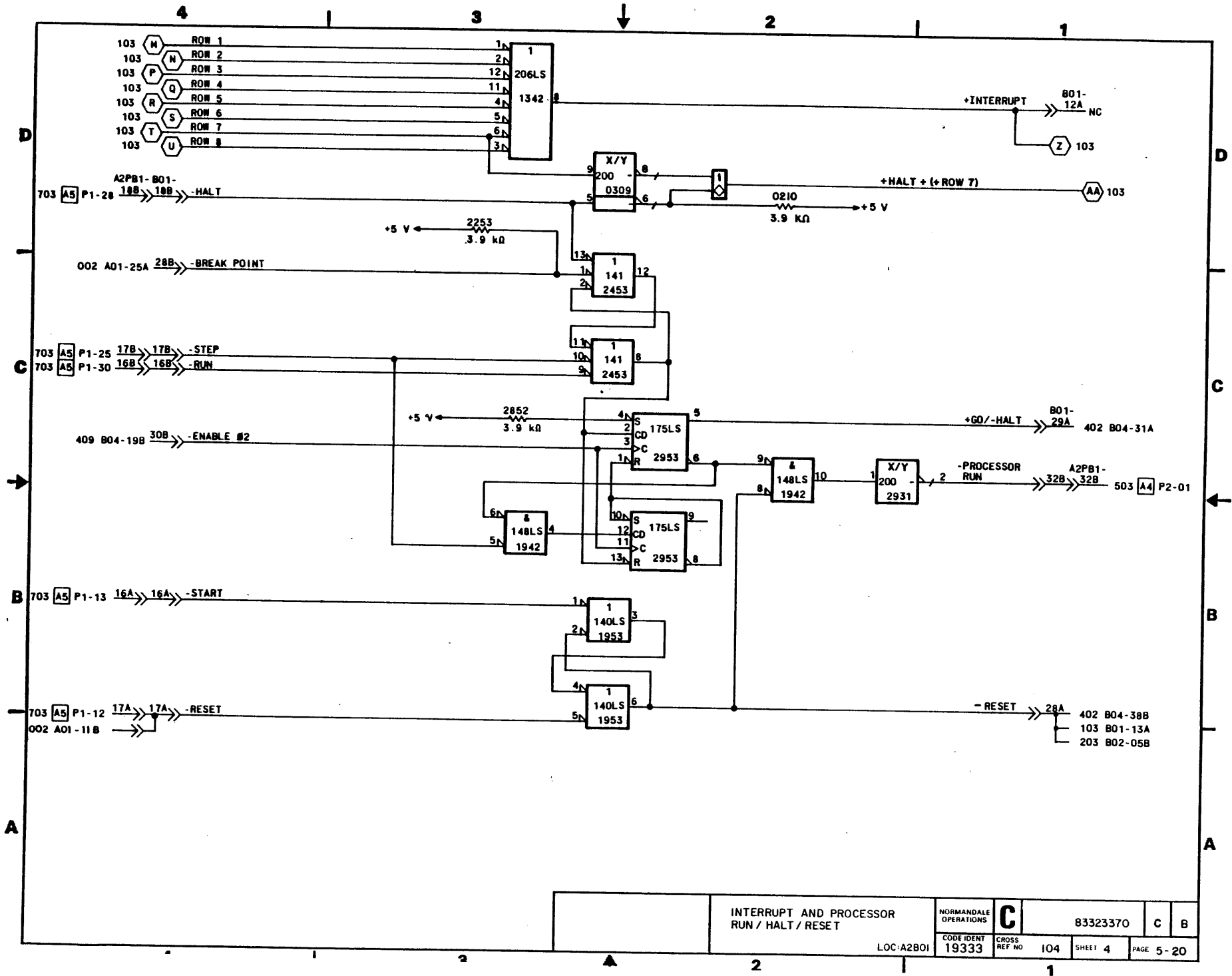
SHEET 1 OF 8

PAGE 5-17

REF: 7012102







INTERRUPT AND PROCESSOR  
RUN / HALT / RESET

NORMANDALE  
OPERATIONS

**C**

83323370

C

B

CODE IDENT  
19333

CROSS  
REF NO

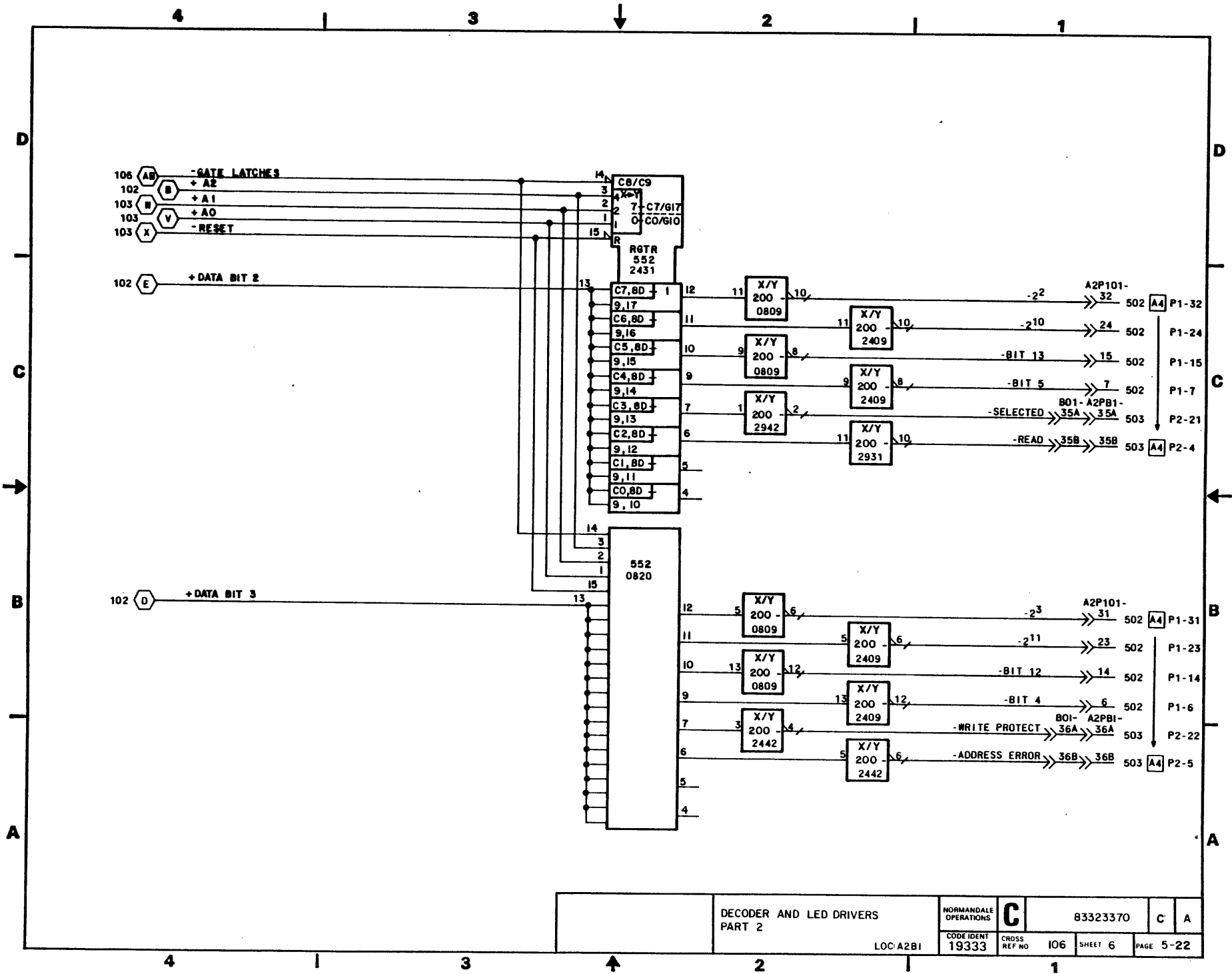
104

SHEET 4

PAGE 5-20

LOC:A2B01





DECODER AND LED DRIVERS  
PART 2

NORMANDALE  
OPERATIONS

**C**

83323370

C A

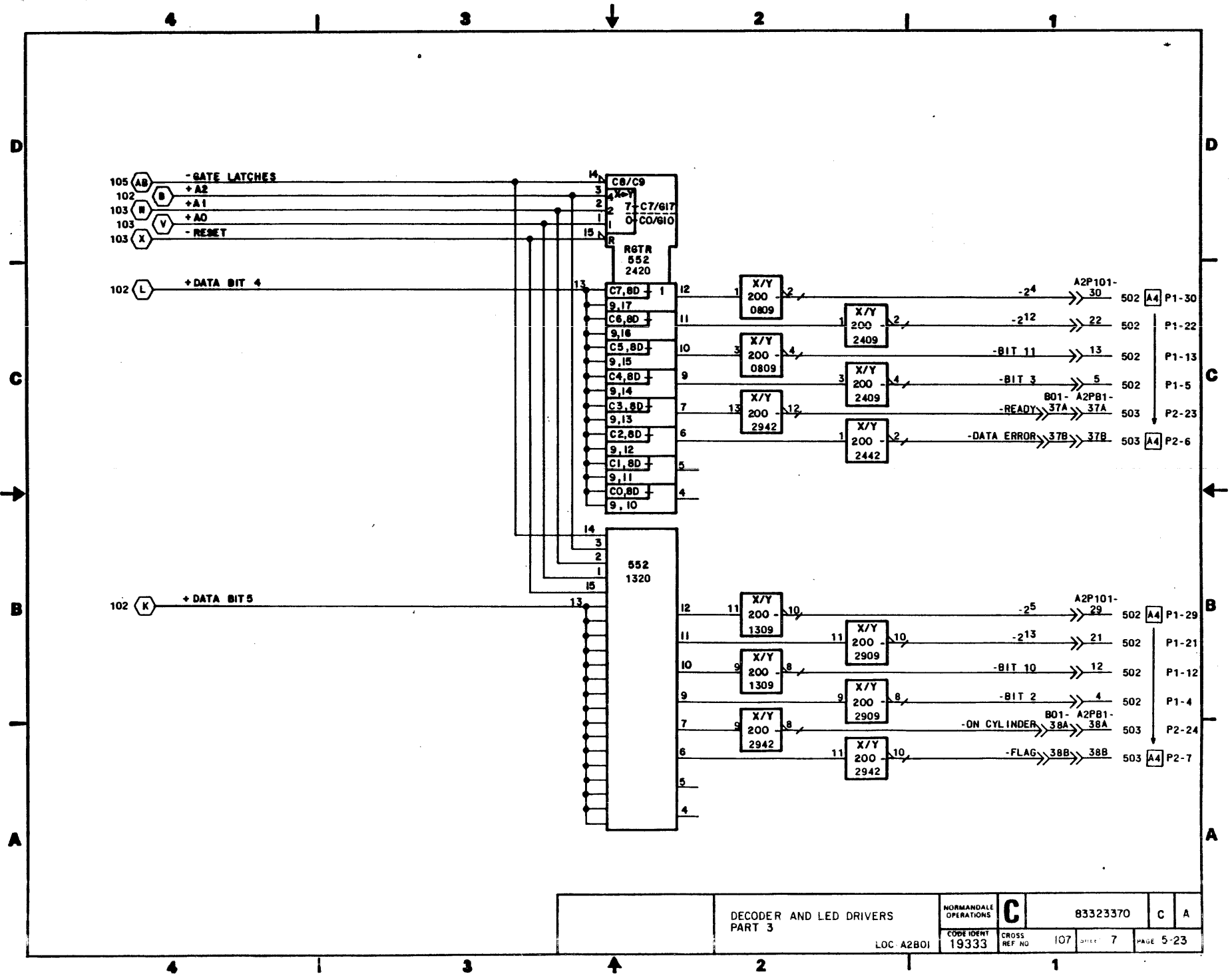
CODE IDENT  
19333

CROSS  
REF NO 106

SHEET 6

PAGE 5-22

LOC: A2B1



DECODER AND LED DRIVERS  
PART 3

NORMANDEALE  
OPERATIONS

C

83323370

C A

CODE IDENT  
19333

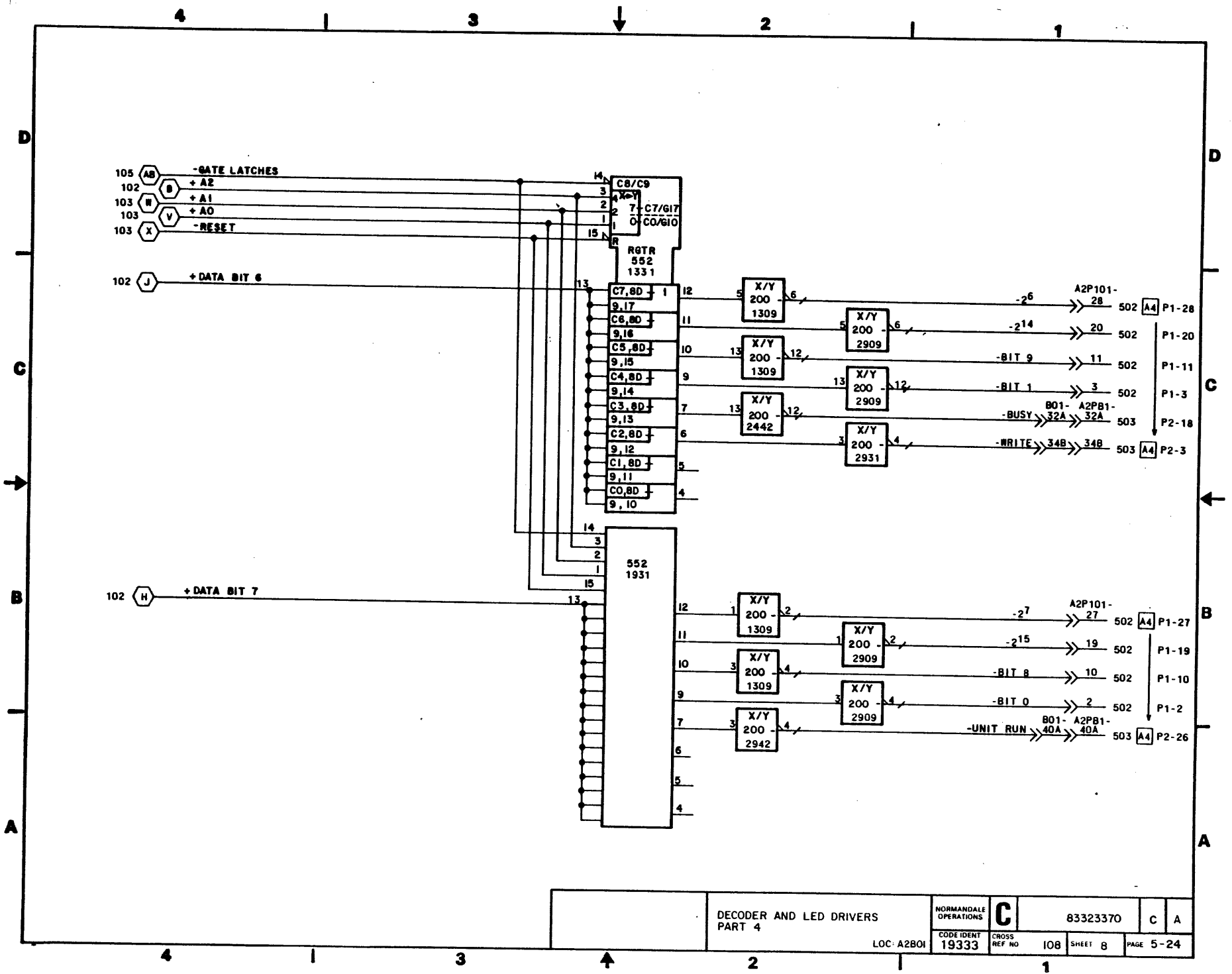
CROSS  
REF NO 107

DATE 7

PAGE 5-23

LOC. A2B01





DECODER AND LED DRIVERS  
PART 4

NORMANDE  
OPERATIONS

**C**

83323370

C A

LOC: A2B01

CODE IDENT  
19333

CROSS  
REF NO

108

SHEET 8

PAGE 5-24

REVISION STATUS OF SHEETS																			
I	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	A	A	A	A	A	A	A	A											
B	B	A	B	A	B	A	A	A											
C	B	A	B	C	B	A	A	A											
D																			

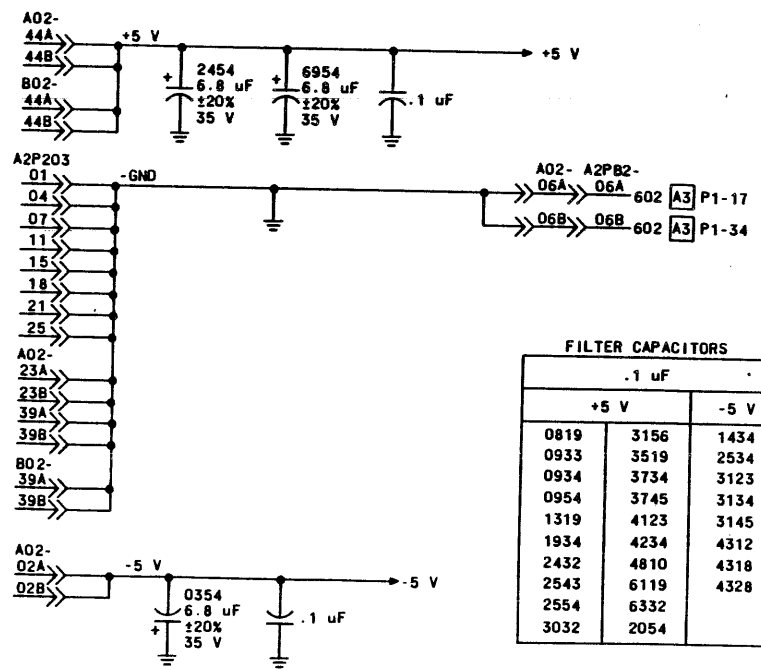
UNUSED RESISTOR PACKS

LOCATION	PIN(S)
0831	3, 6, 7, 8
3020	2, 7, 8
4220	6, 7, 8
4720	3, 6, 8
5920	3, 4, 6, 7
6020	2, 7, 8

UNUSED LOGIC ELEMENTS

ELEMENT	LOCATION	OUTPUT PINS
146LS	6031	2, 10
146	1042	6, 8, 10, 12
189LS	0442	9, 12

REVISIONS					
REV	ECO	DESCRIPTION	DRFT.	DATE	CHK'D
A	PE23000	RELEASE			
B	PE54237	CHANGE DUAL CHANNEL BUSY	CB	5-2-80	
C	PE54248A	CHANGE CARD TEST POINT	CB	5-21-80	
D		ADD HISTORY TO PAGE	DLF	11-9-82	

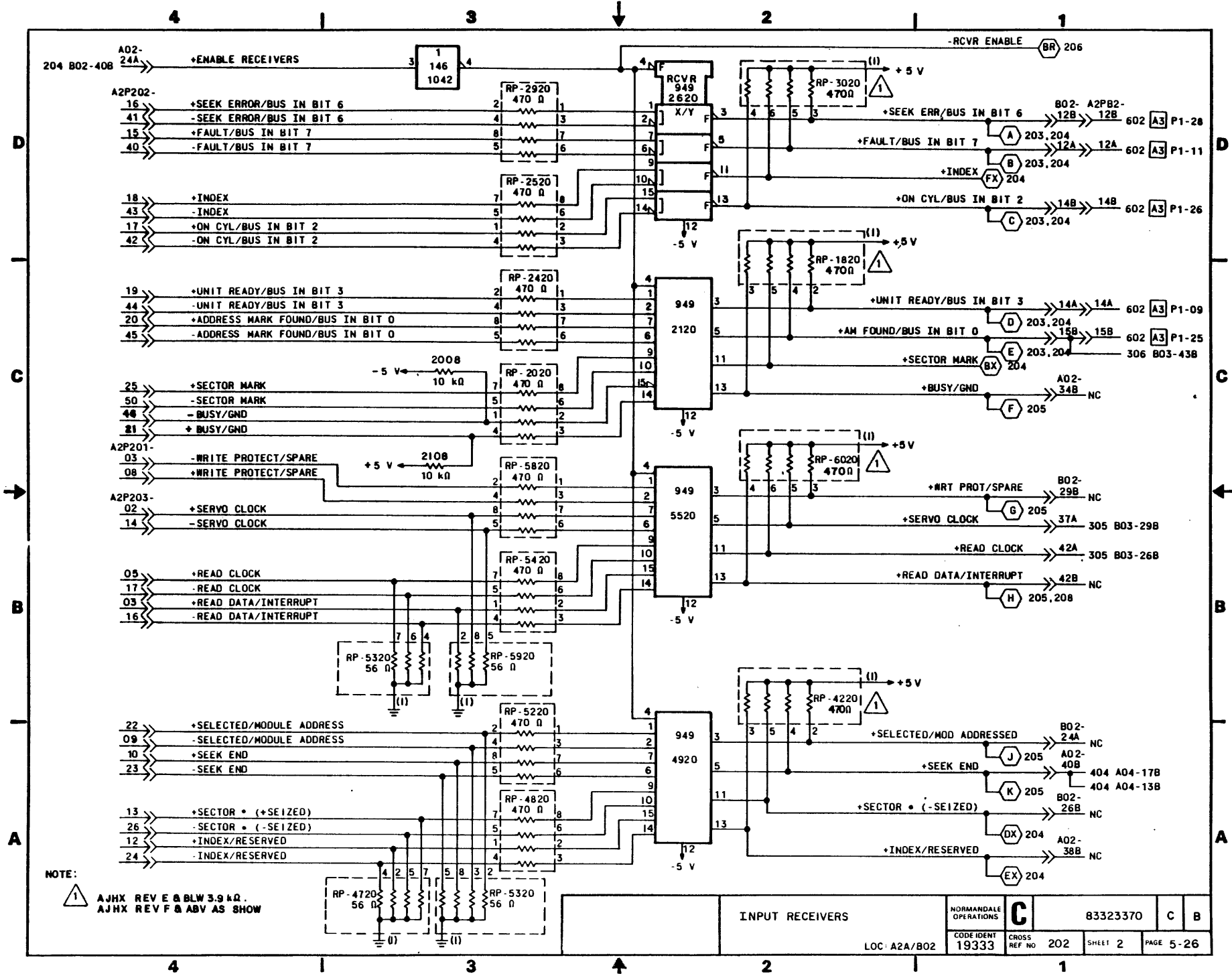


NOTE:  
 1 PINS 9 & 12 OF 189LS AT 0442 ARE UNUSED ONLY ON AJHX REV E & BLW

S/C 28 & BLW, W/O 10034

DRAWN G. RABINER 8-77	I/O CONTROL DIAGRAMS	NORMANDEALE OPERATIONS	C	83323370	G	D
CHECKED		CODE IDENT				
ENGINEER 1/14/77		19333				
APPROVED		LOC: A2A/B02				
TYPE: AJHX		MOSS REF NO: 201	SHEET 1 of 9		PAGE 5-25	

1 REF 75121202



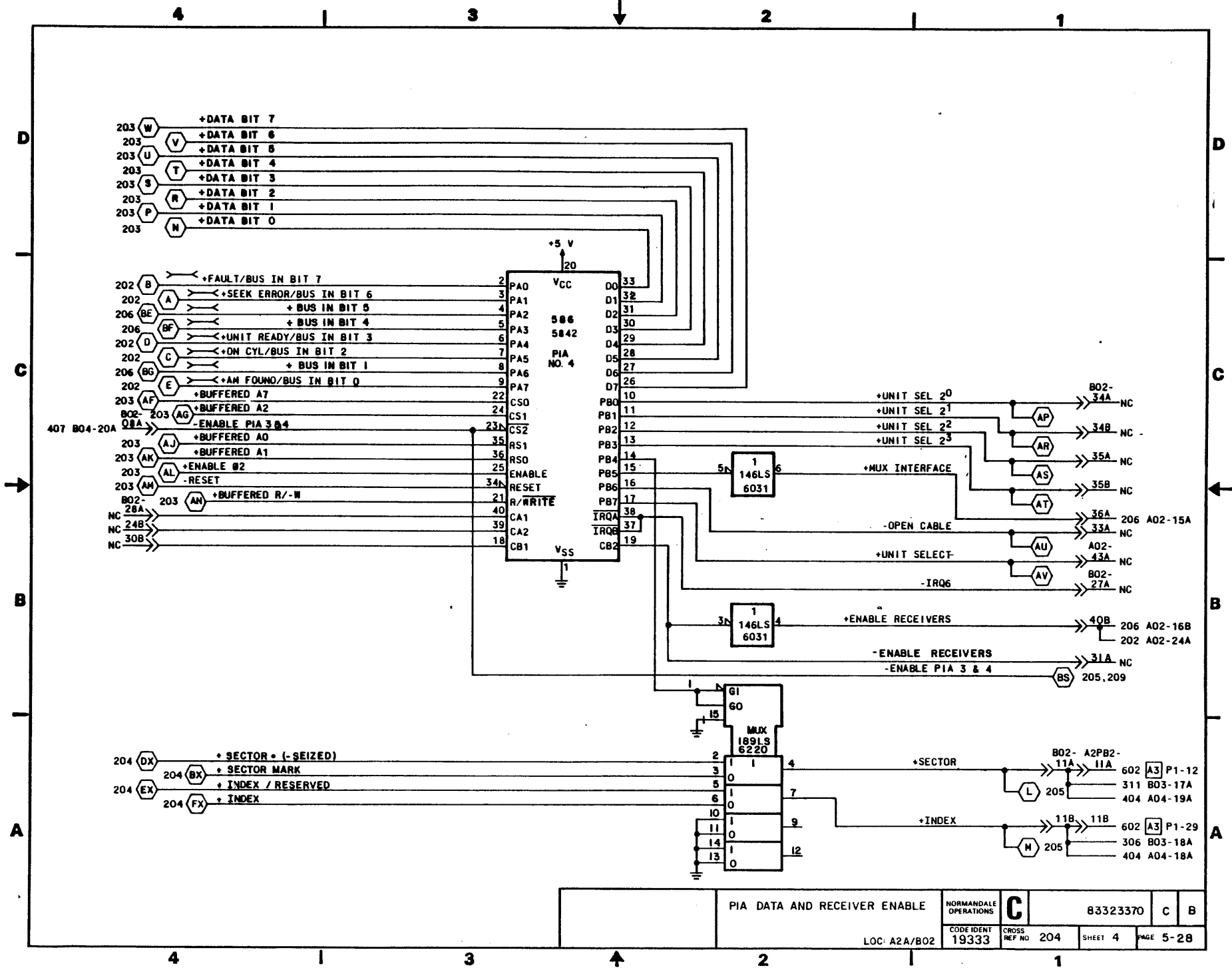
NOTE:  
 1 AJHX REV E & BLW 3.9 kΩ.  
 AJHX REV F & ABV AS SHOW

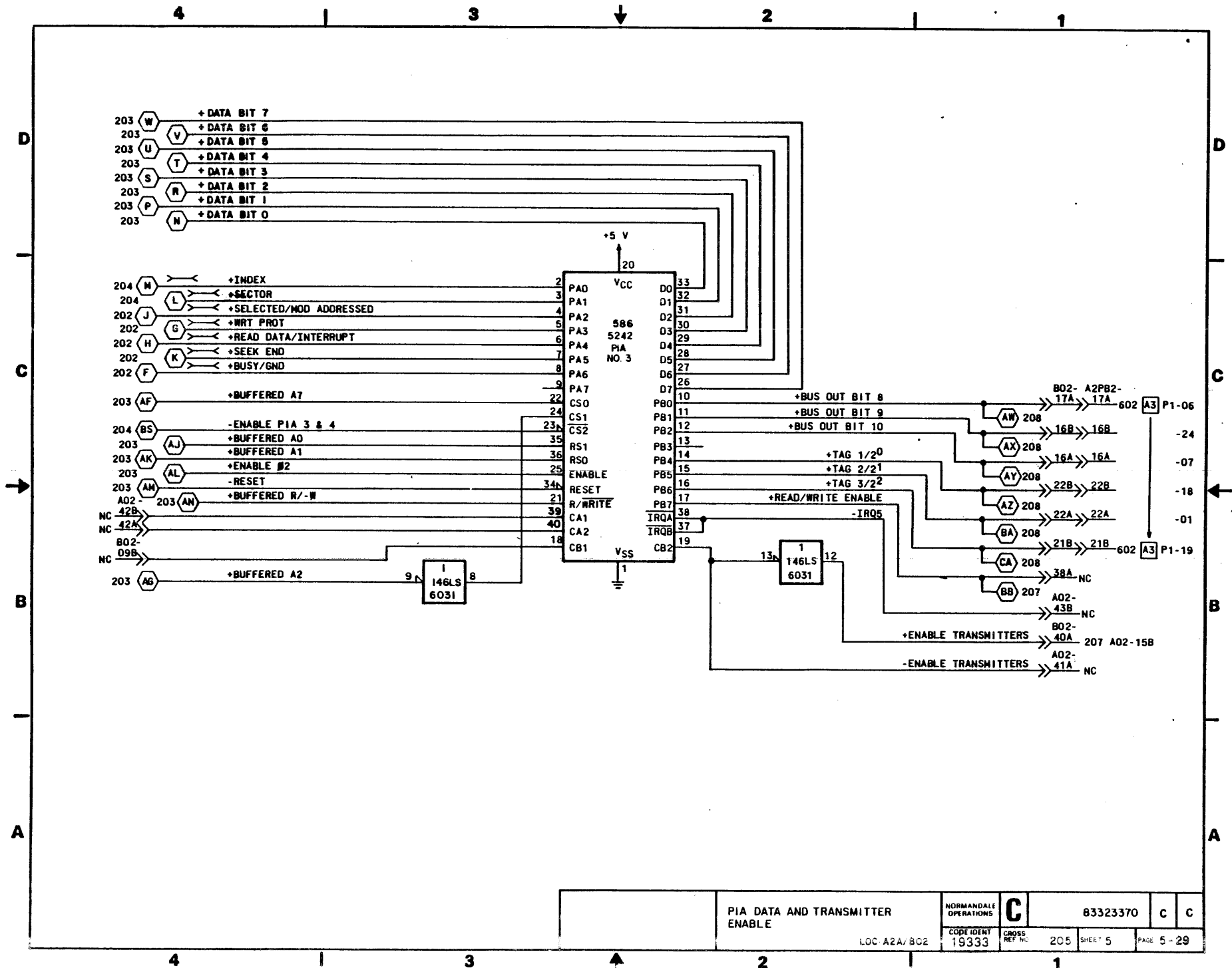
INPUT RECEIVERS

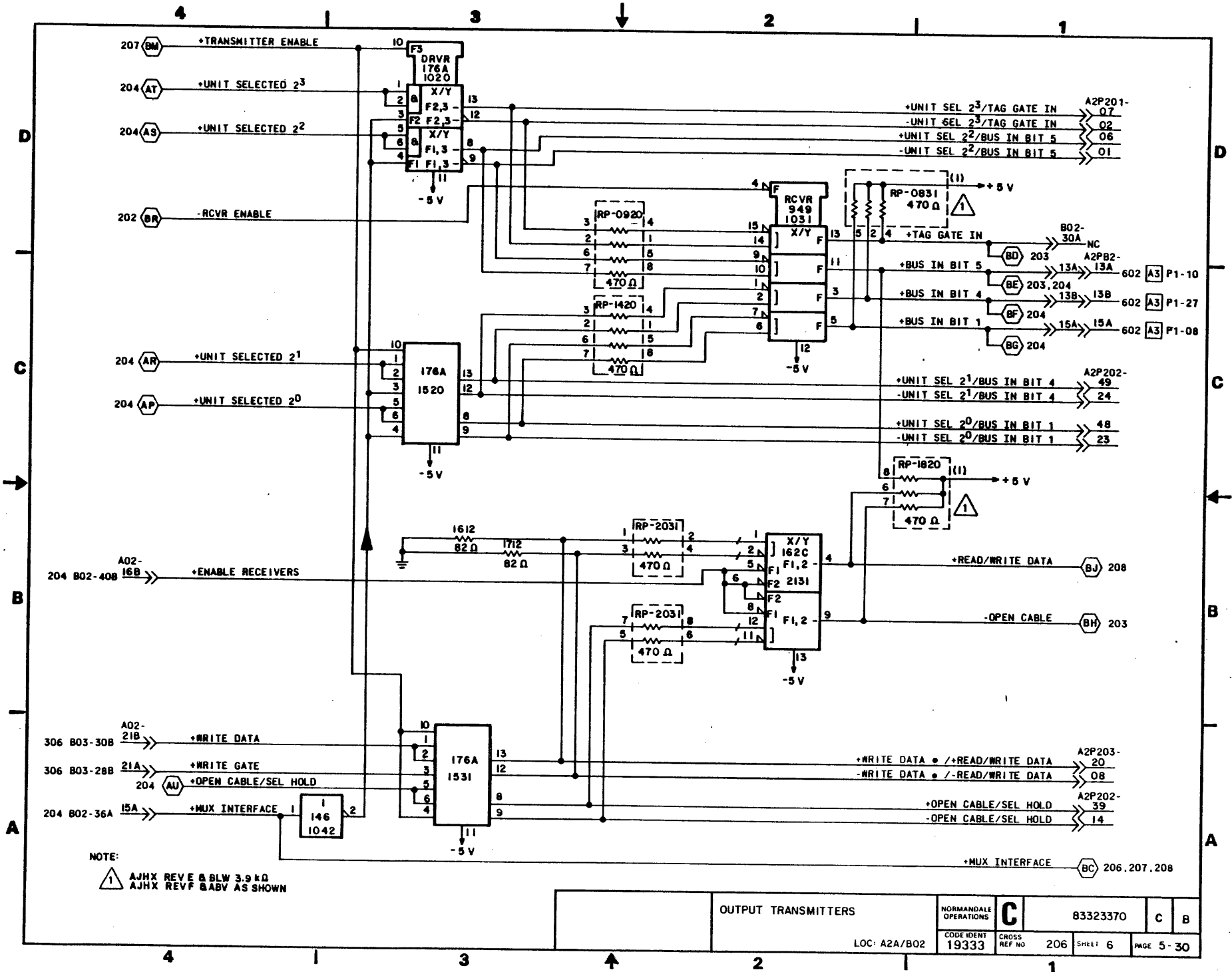
NORMANDALE OPERATIONS	C	83323370	C	B

LOC: A2A/B02









NOTE:  
 1 AJHX REV E & BLW 3.9 KΩ  
 AJHX REV F & BABV AS SHOWN

OUTPUT TRANSMITTERS

NORMANDALE OPERATIONS

C

83323370

C

B

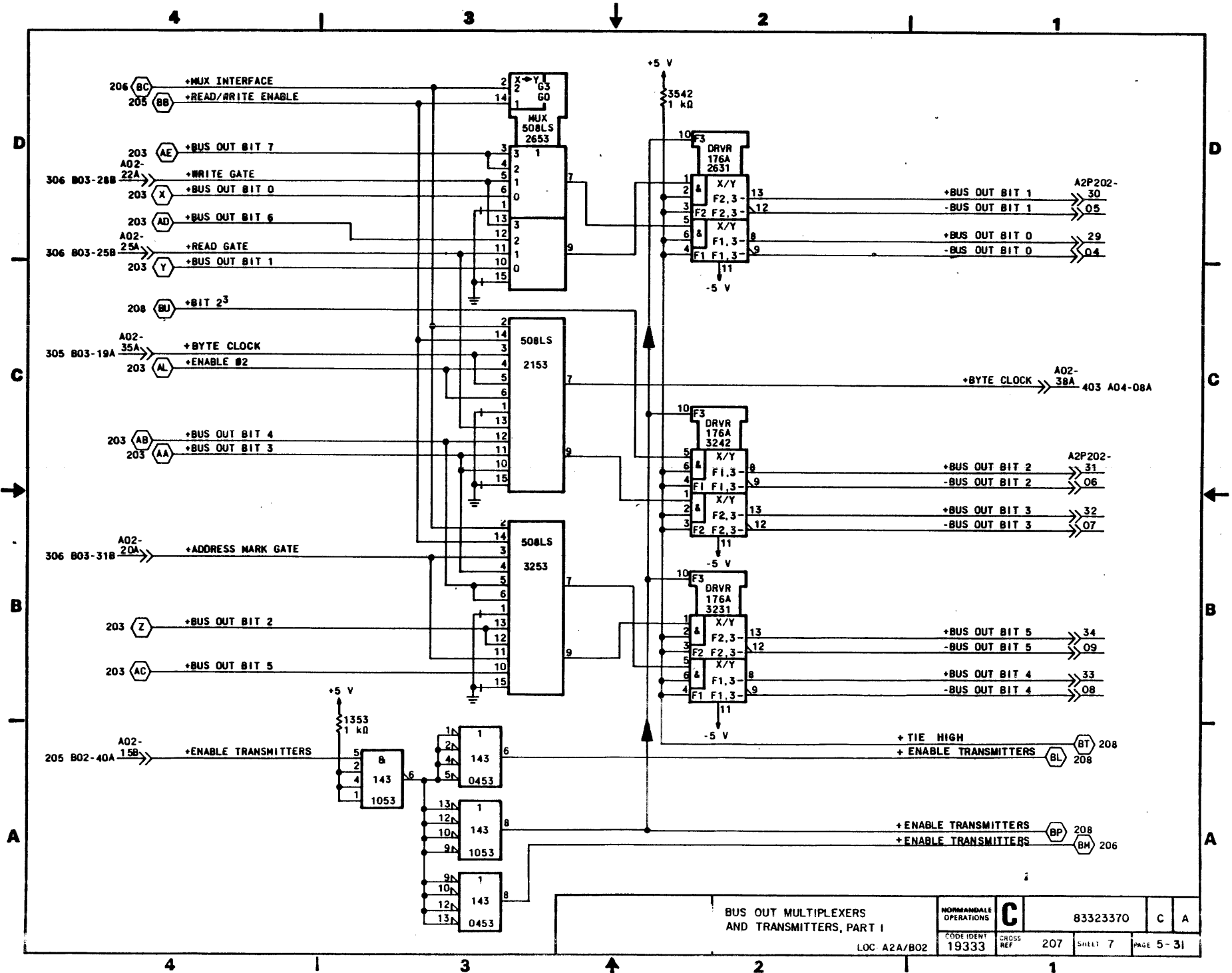
CODE IDENT 19333

CROSS REF NO 206

SHEET 6

PAGE 5-30

LOC: A2A/B02

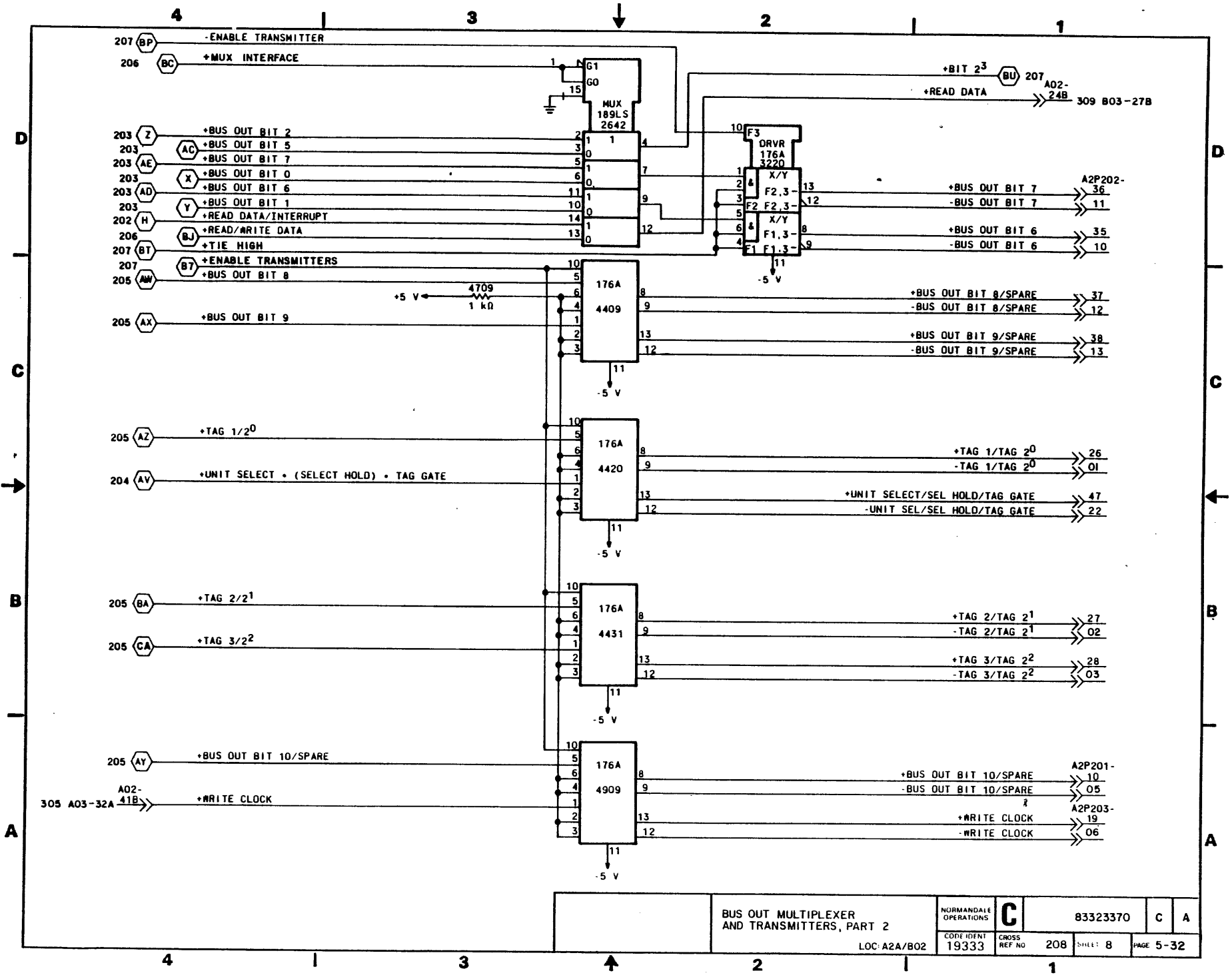


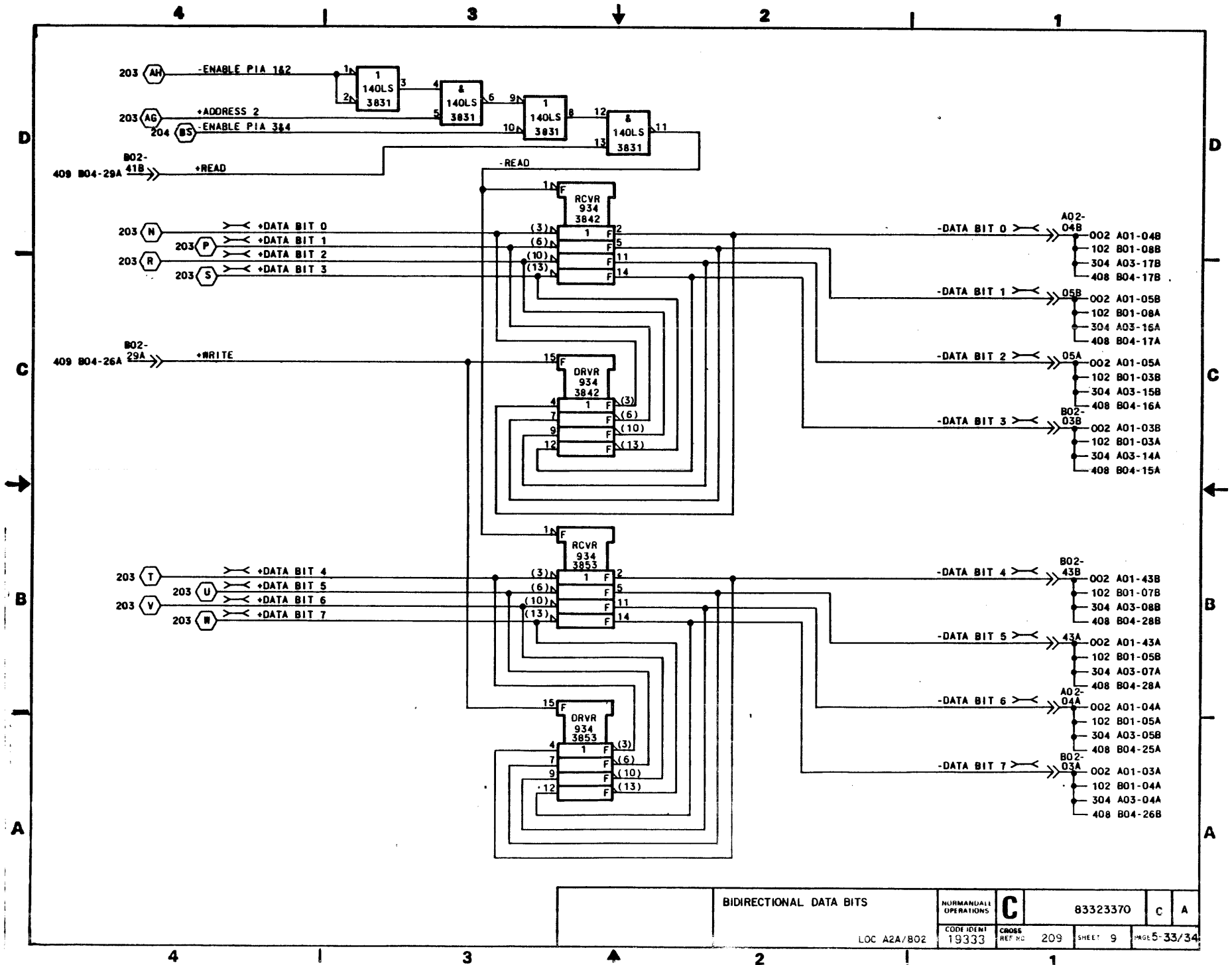
BUS OUT MULTIPLEXERS  
AND TRANSMITTERS, PART I

NORMANDALE OPERATIONS	<b>C</b>	83323370	C	A
CODE IDENT 19333	CROSS REF 207	SHEET 7	PAGE 5-31	

LOC. A2A/B02







BIDIRECTIONAL DATA BITS

NORMANUAL OPERATIONS

C

83323370

C

A

LOC A2A/B02

CODE IDENT 19333

CROSS REF NO 209

SHEET 9

PAGE 5-33/34

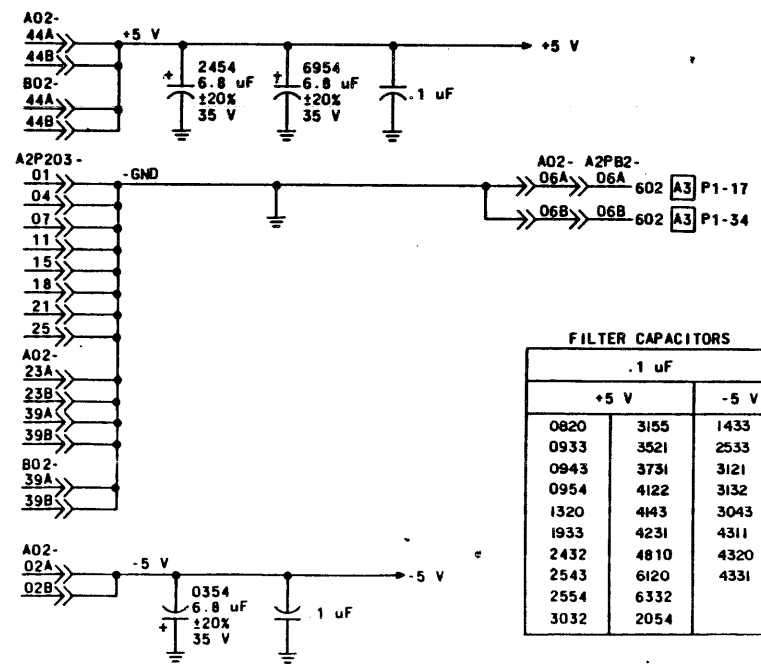


4 3 2 1

REVISIONS					
REV	ECO	DESCRIPTION	DRFT	DATE	CHK'D
A	PE23000	RELEASE	BL	2-2-77	TK
B	PE34237	INC DSGN CHNG-B	TH	6-28-79	TK
C	PE34249	CHG CARD TEST POINT	JS	7-23-79	TK
D	DH0008	CHG RES ON AJHX	DT	8-22-80	
E	DH0008A	CHG RESISTOR ON AJHX	DW	8-25-80	
F	DH0034	CHG AJHX TO CJHX	SCHLES	12-22-82	
G		NO CHANGE	JG	11-27-84	
H	DJ10126	CJHX TO EJHX	JG	11-27-84	

UNUSED RESISTOR PACKS	
LOCATION	PIN(S)
0831	3, 6, 7, 8
3020	2, 7, 8
4220	6, 7, 8
4720	3, 6, 8
5920	3, 4, 6, 7
6020	2, 7, 8

UNUSED LOGIC ELEMENTS		
ELEMENT	LOCATION	OUTPUT PINS
146LS	6031	2
146	1042	6, 8, 10, 12



S/C 28 & ABOVE, W/10034

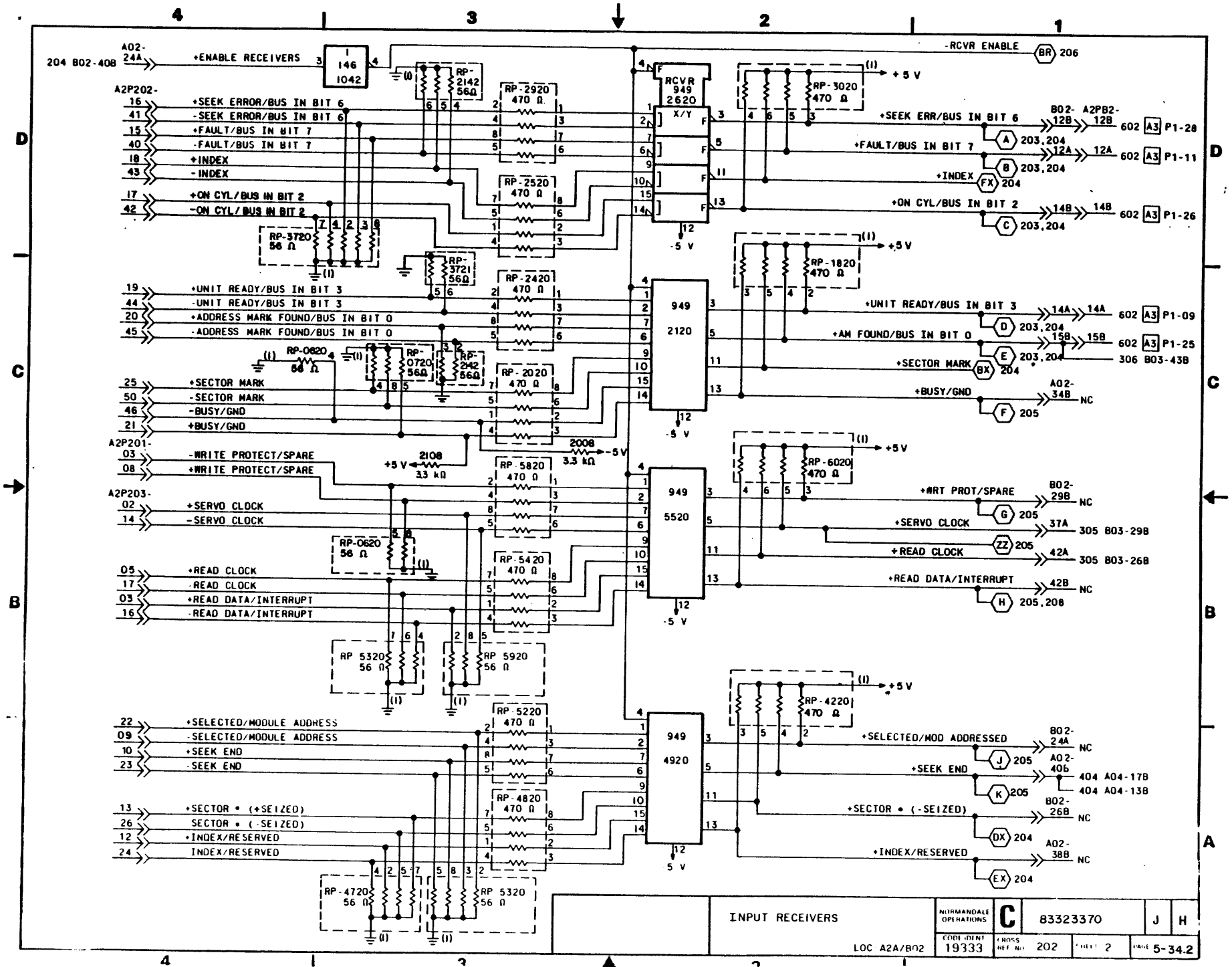
DRAWN	G. R. RIVERA	8/77
CHECKED		
ENGINEER	R. L. RIVERA	11/87
APPROVED		

I/O CONTROL  
DIAGRAMS  
TYPE: E.JHX

LOC: A2A/B02

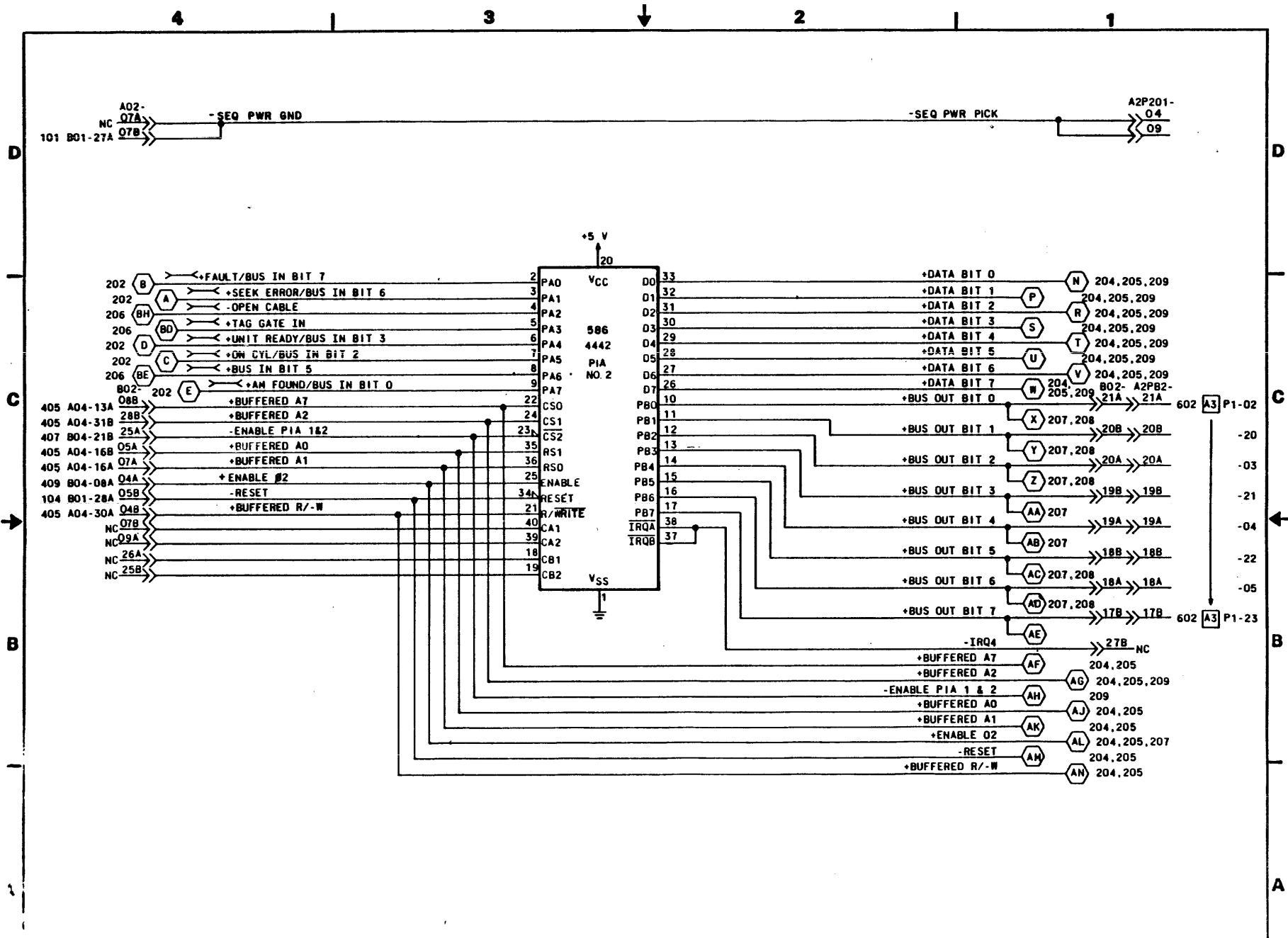
NUMERICAL OPERATIONS	C	83323370	J	H
CODE IDENT	19333	CROSS REF NO	201	SHEET 1 OF 9
REF	75121202	DATE	5-34-81	

4 3 2 1

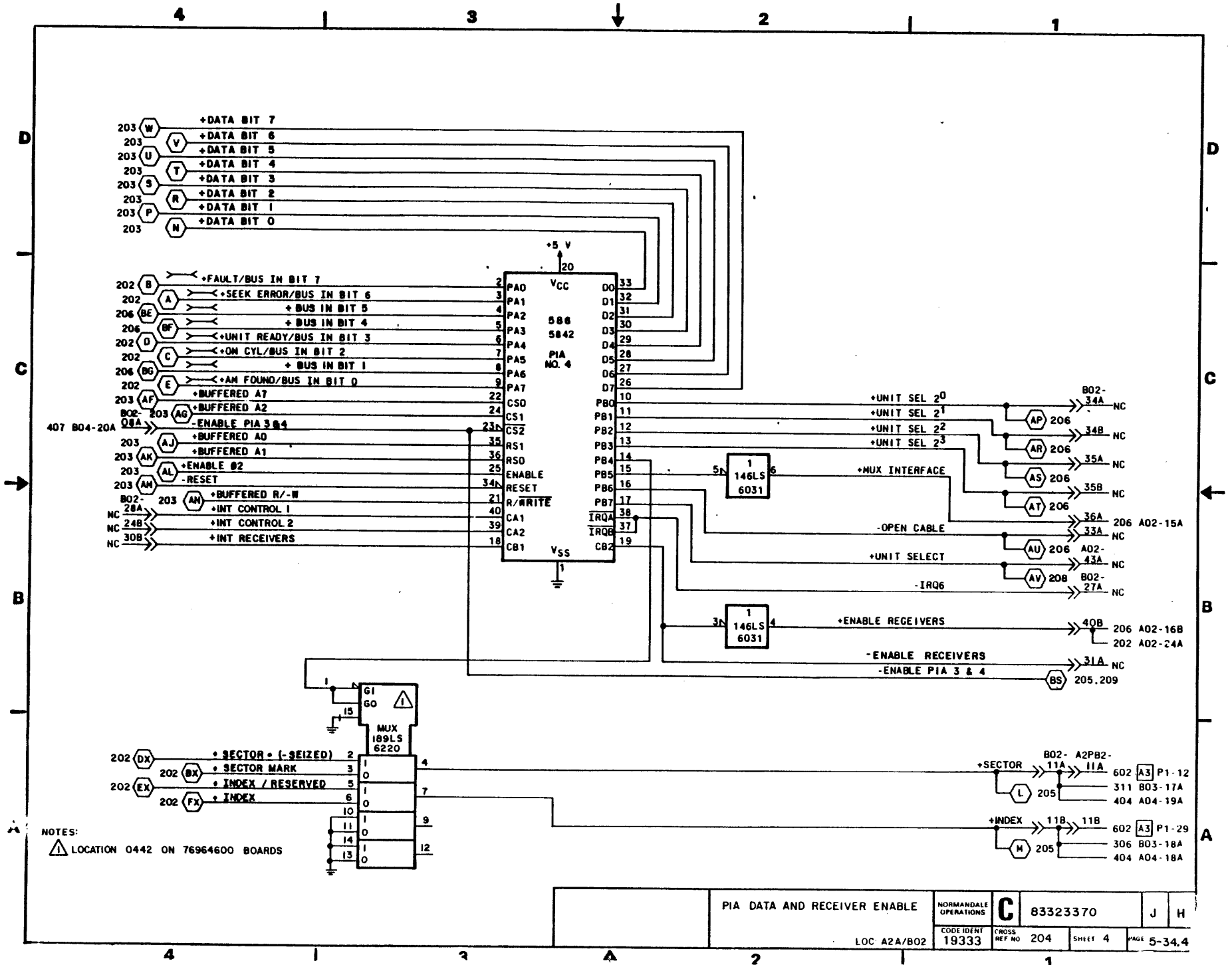


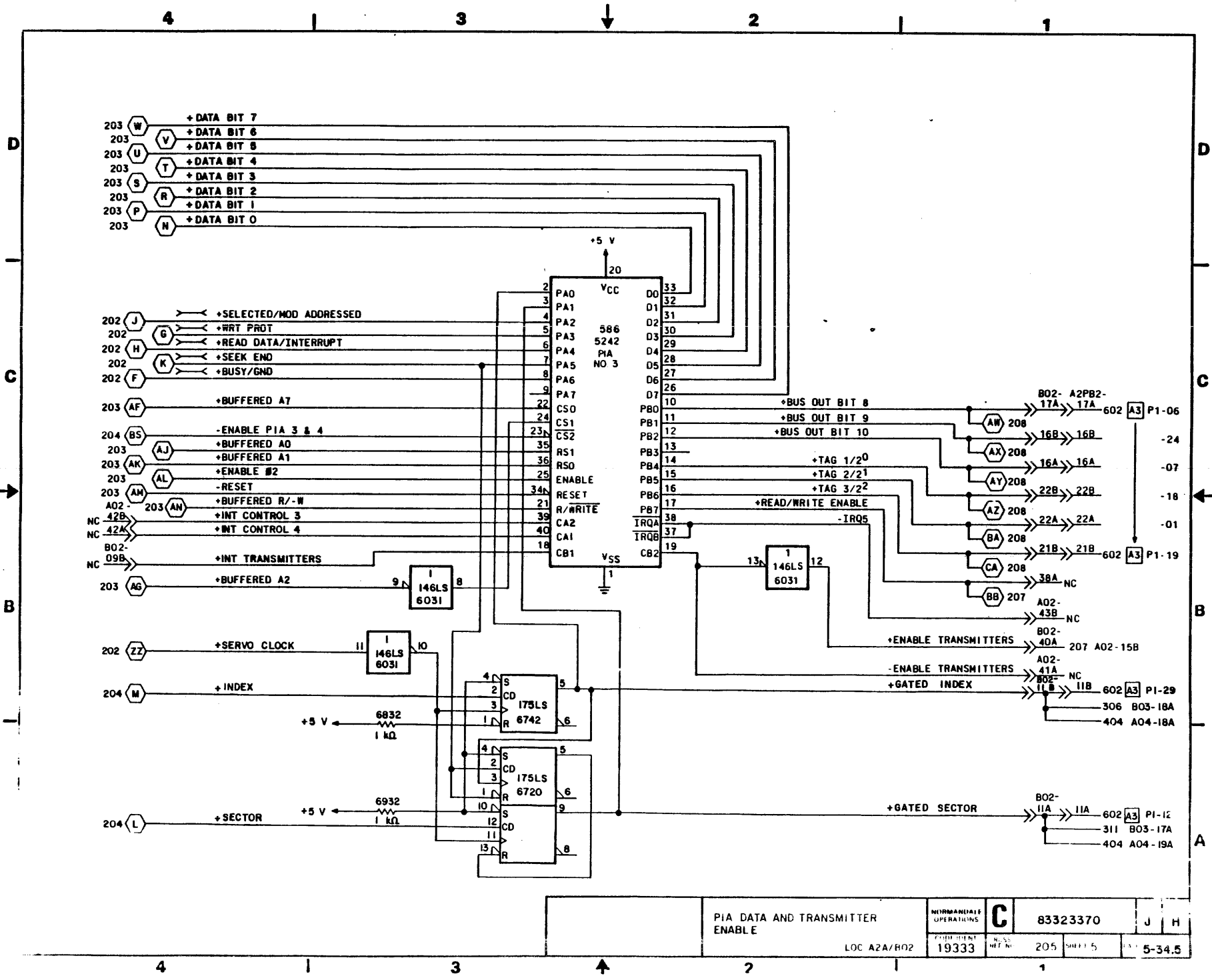
INPUT RECEIVERS

NORMANDE OPERATIONS	<b>C</b>	83323370	J	H



PIA DATA AND BUS CONTROL		NORMANDALE OPERATIONS	<b>C</b>	833 23370	G	A
LOC A2A/802	CODE IDENT 19333	CROSS REF NO 203	SHW 3	REV 5-34.3		

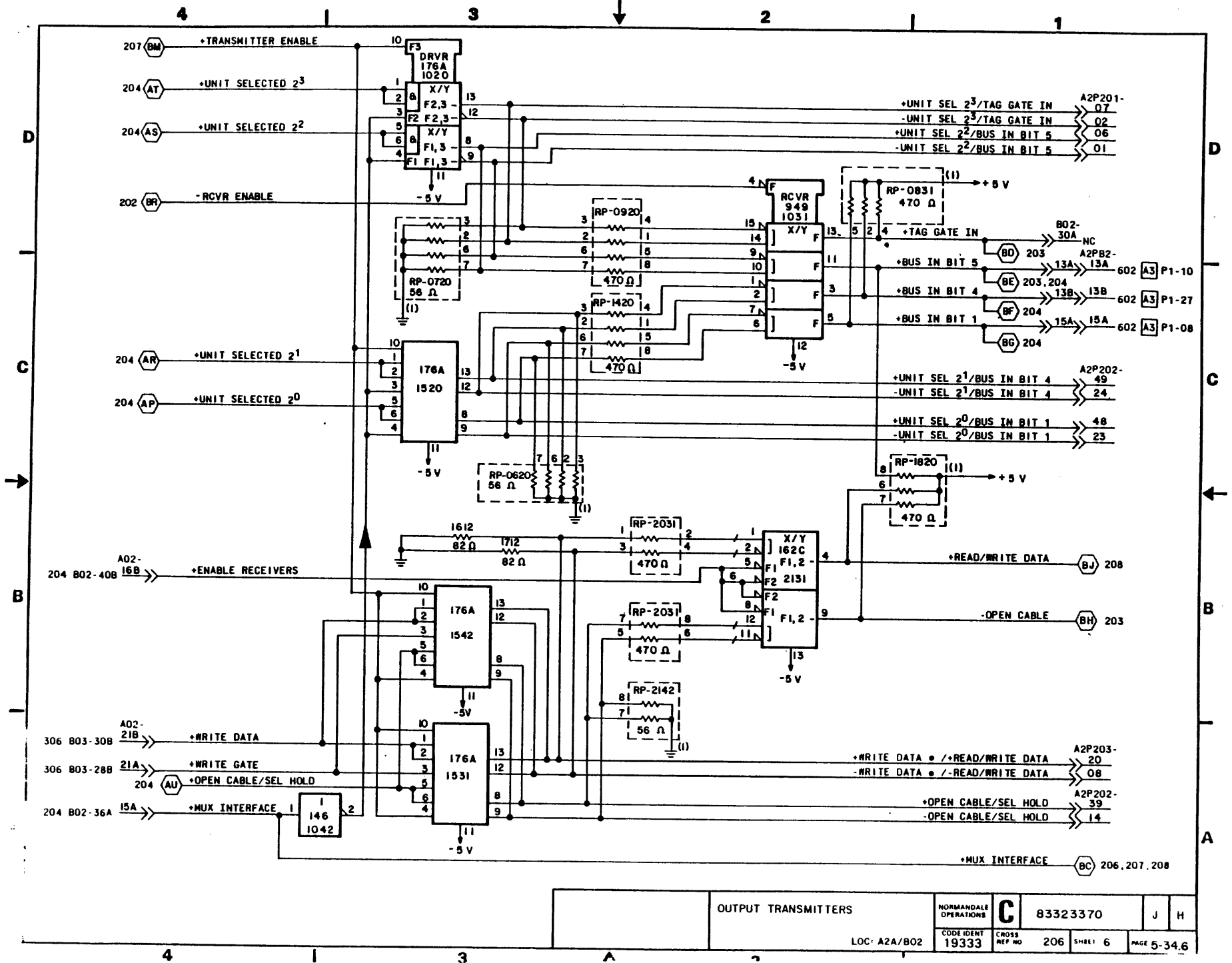




PIA DATA AND TRANSMITTER  
ENABLE  
LOC A2A/RO2

NORMANVILLE OPERATIONS	C	83323370		J	H
		19333	205	SHEET 5	5-34.5

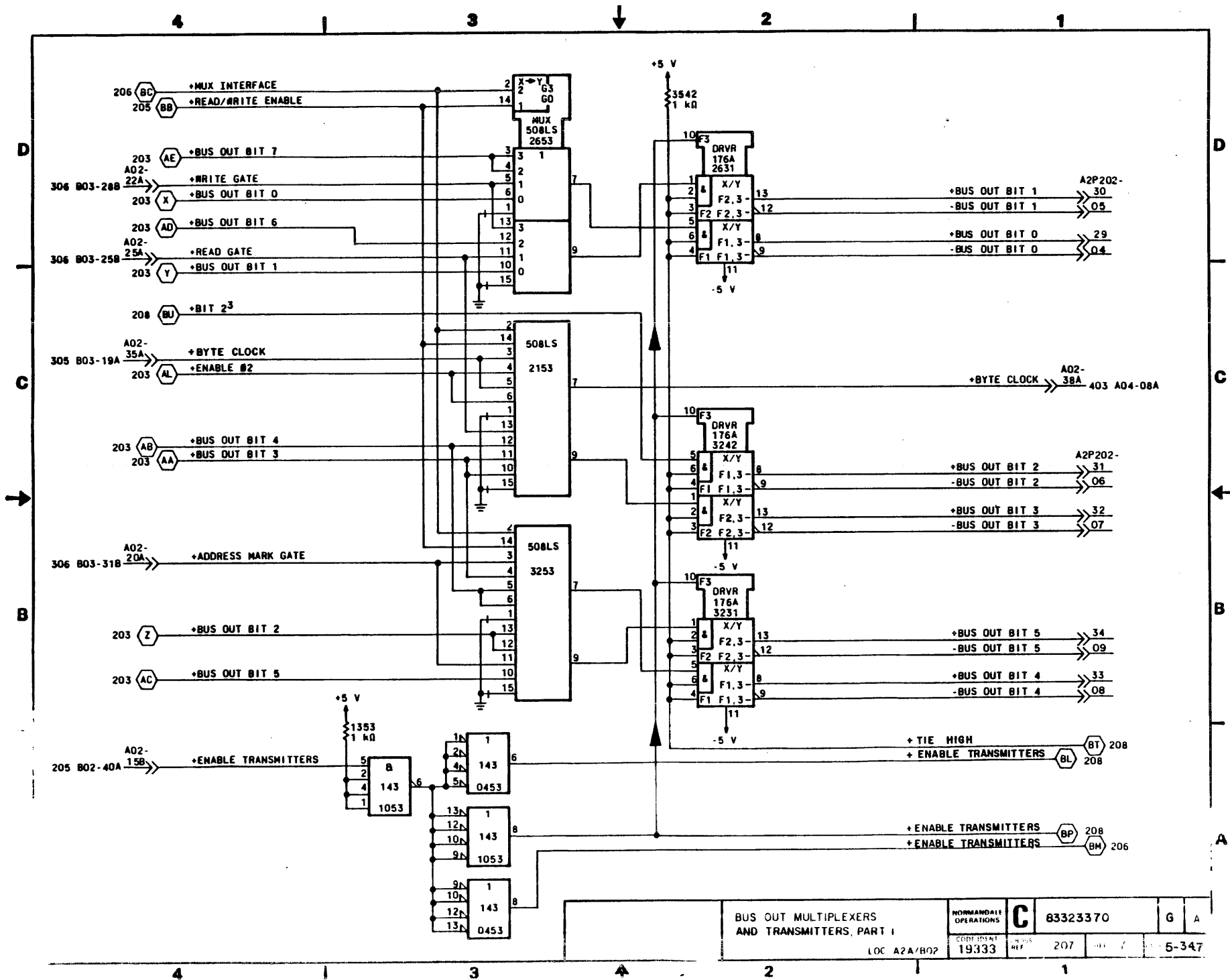




OUTPUT TRANSMITTERS

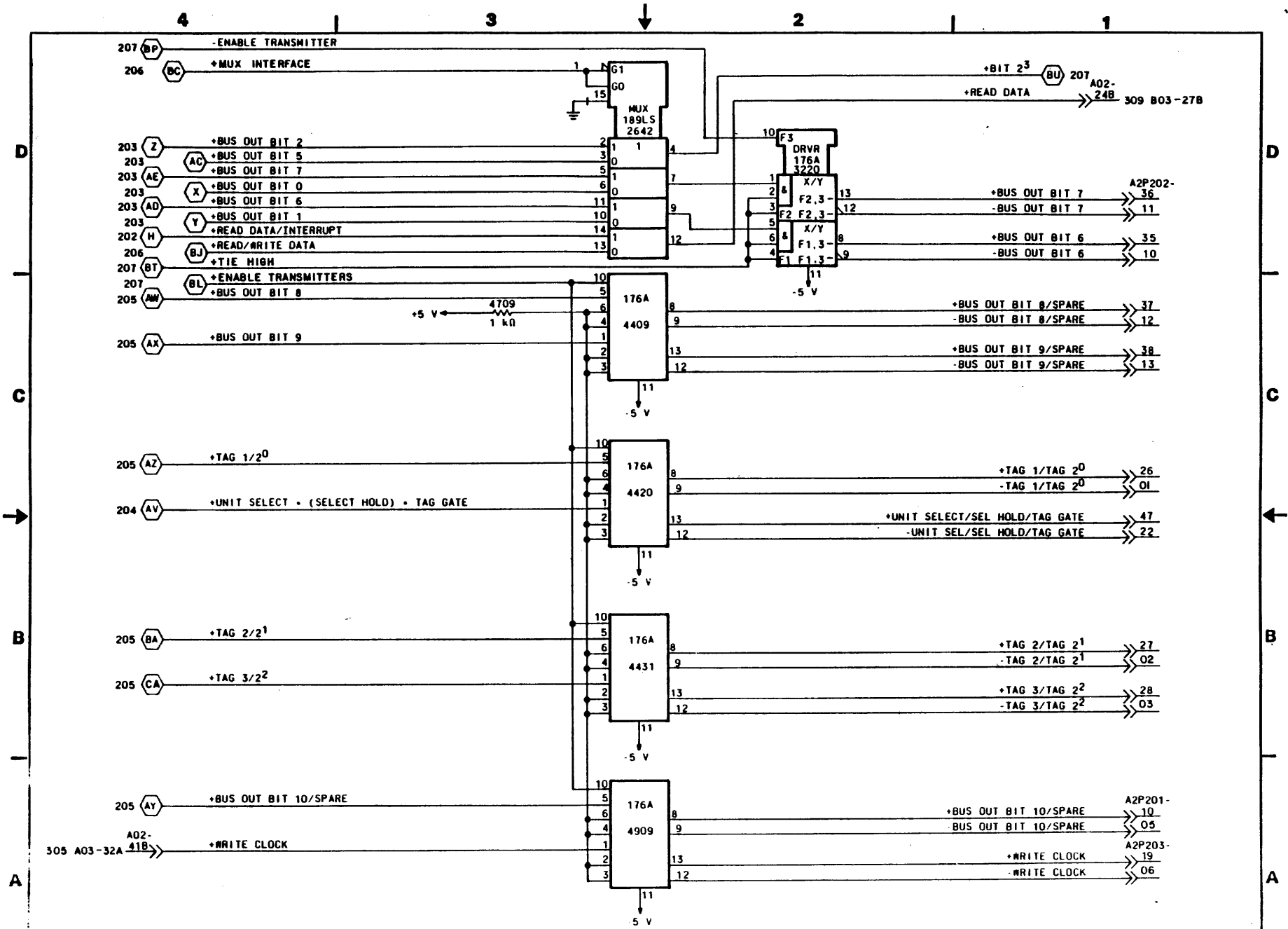
NORMANDALE OPERATIONS	<b>C</b>	83323370	J	H
CODE IDENT 19333				

LOC: A2A/B02



BUS OUT MULTIPLEXERS  
AND TRANSMITTERS, PART 1

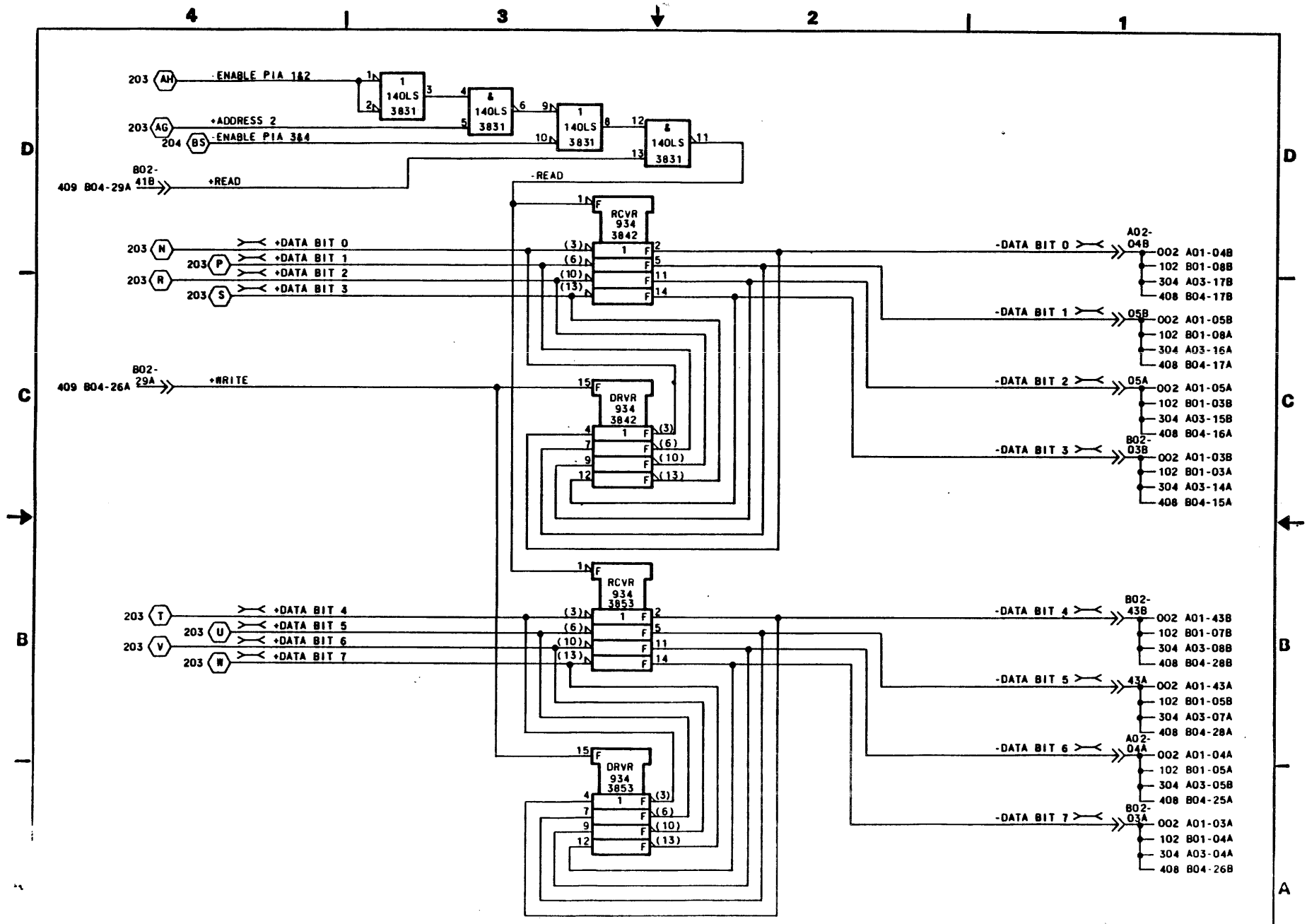
NONMANDATORY OPERATIONS	C	83323370	G	A



BUS OUT MULTIPLEXER  
AND TRANSMITTERS, PART 2

NORMANDALE OPERATION	<b>C</b>	83323370	J	H
DATE 19333	PAIRS REF No	208	8	PAGE 5-34.8

LOC A2A/B02



BIDIRECTIONAL DATA BITS

NORMANVILLE OPERATIONS	<b>C</b>	83323370	G	A
CODE POINT 19333	CROSS REF. NO. 209	SHEET 9	5-34.9	

LOC 42A:803

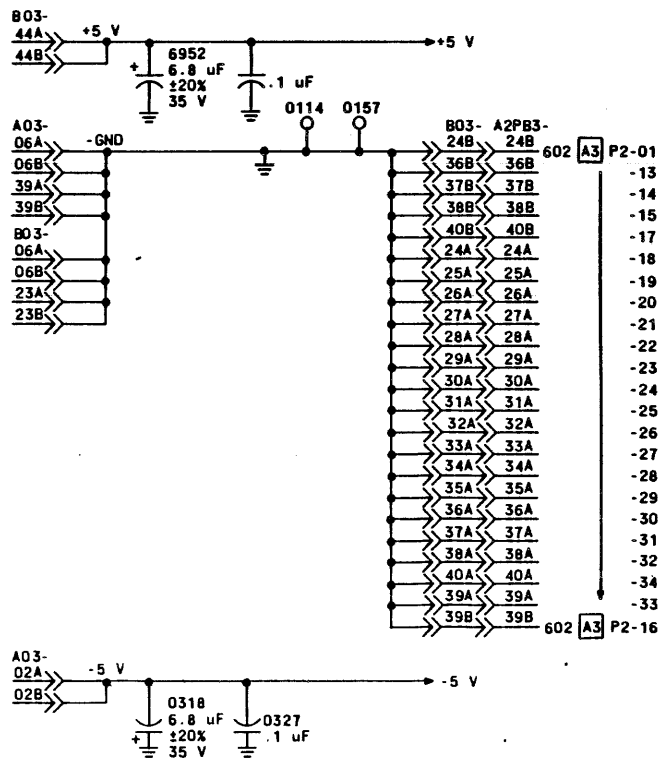
4 | 3 | 2 | 1

REVISION STATUS OF SHEETS																			
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A	A	A	A	A	A	A	A	A	A	A									
B	A	A	A	B	A	A	A	A	A	A									

UNUSED RESISTOR PACKS	
LOCATION	PIN(S)
3031	2, 3, 4
3042	2, 3, 6

UNUSED LOGIC ELEMENTS		
ELEMENT	LOCATION	OUTPUT PIN(S)
140LS	1553	6
140LS	4909	8, 11
208LS	2609	8
148LS	3209	1
148LS	5831	4
228S	2620	8
228S	6631	6
146LS	5842	6

REVISIONS					
REV	ECO.	DESCRIPTION	DRFT	DATE	CHK'D
A	PE23000	RELEASE			
B	PE54243	ADD INVERTERS	CB	5-2-80	



FILTER CAPACITORS	
.1 uF	
+5 V	
0310	4243
1408	4309
1419	4320
1810	4731
2042	5309
2453	5244
2509	5321
2523	5331
2533	6131
3153	6521
3144	6555
3519	6932
3734	

D  
C  
B  
A

D  
C  
B  
A

DRAWN	G. RABINE	1 2 79
CHECKED		
ENGINEER	<i>[Signature]</i>	1/1/79
APPROVED		

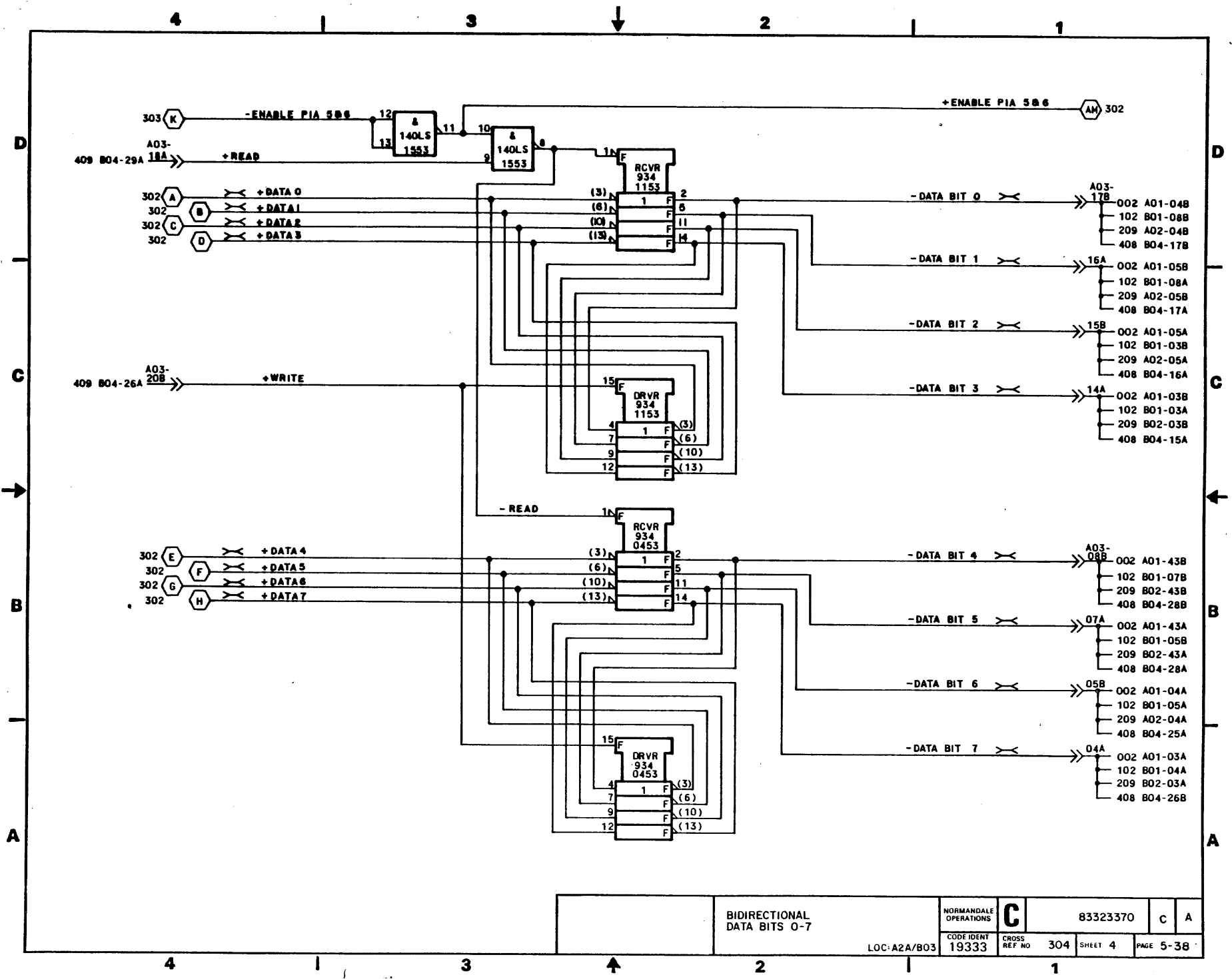
READ / WRITE CONTROL  
DIAGRAM  
TYPE: BJXX

NORMANDALE OPERATIONS	<b>C</b>	83323370	C	B
CODE IDENT	19333	CROSS REF. NO	301	SHEET 1 OF 11
LOC: A2A/B03				PAGE 5-35

4 | 3 | 2 | 1







BIDIRECTIONAL  
DATA BITS 0-7

NORMANDE  
OPERATIONS

C

83323370

C A

CODE IDENT  
19333

CROSS  
REF NO

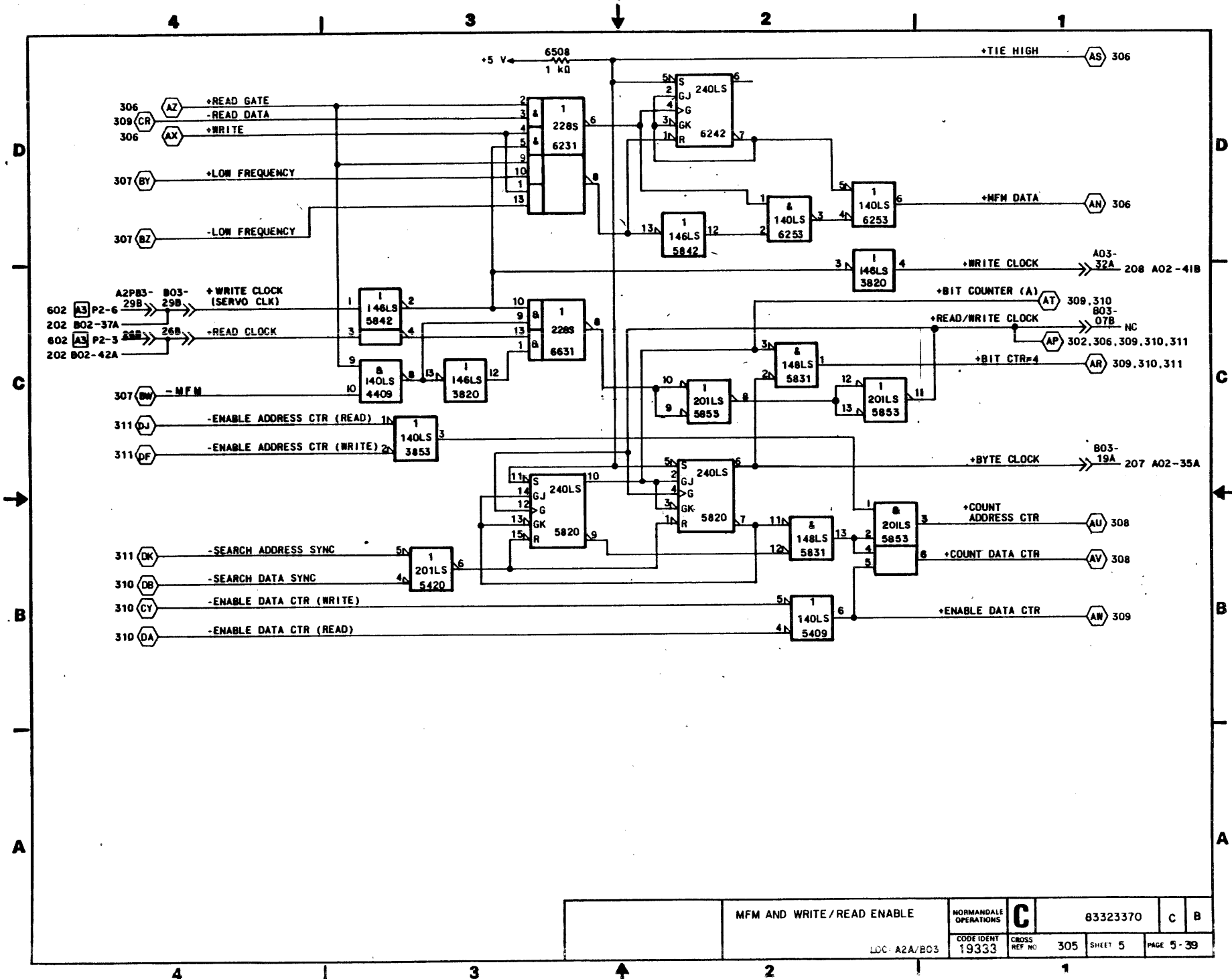
304

SHEET 4

PAGE 5-38

LOC: A2A/B03





MFM AND WRITE/READ ENABLE

NORMANDALE OPERATIONS

**C**

83323370

C B

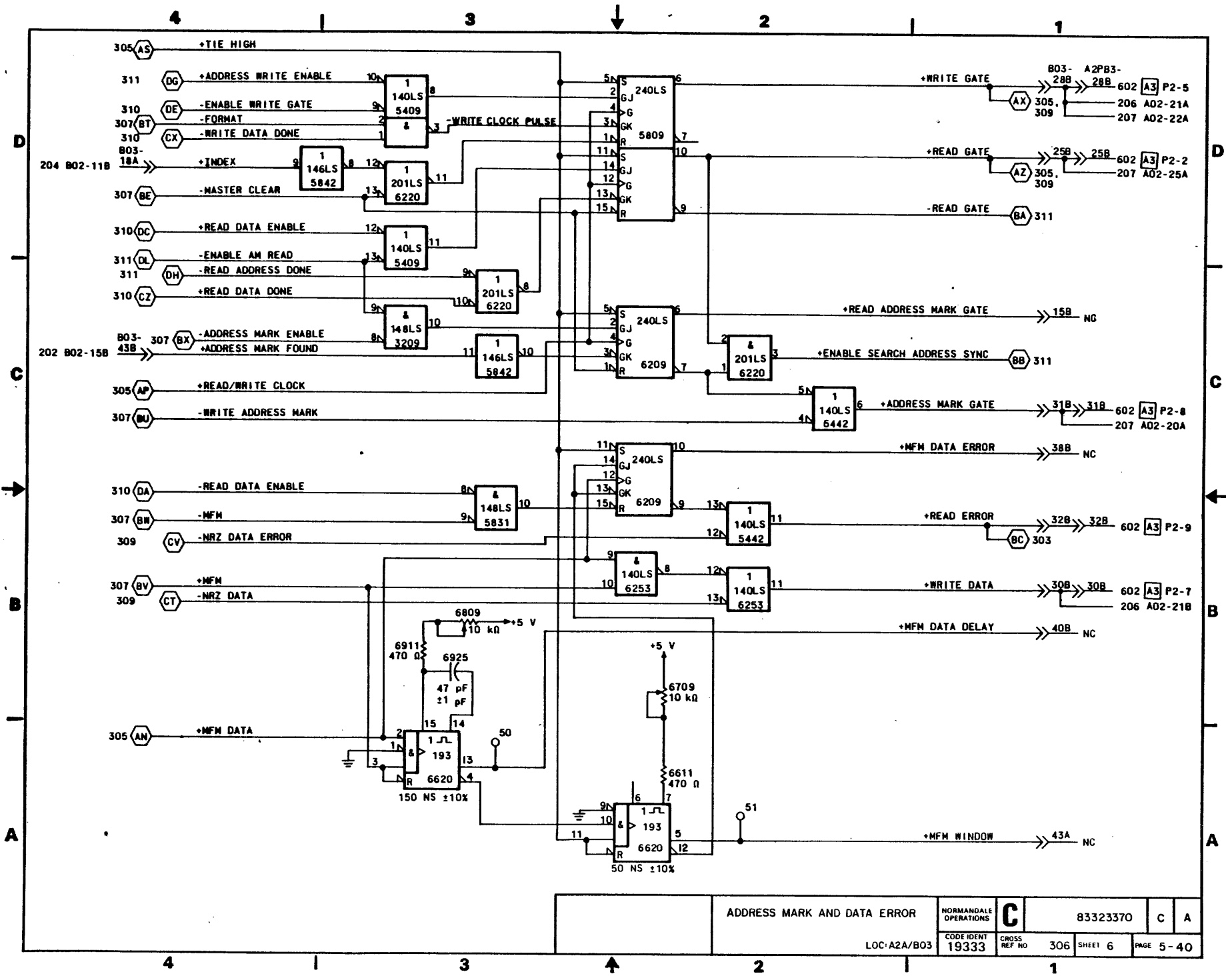
LDC: A2A/B03

CODE IDENT 19333

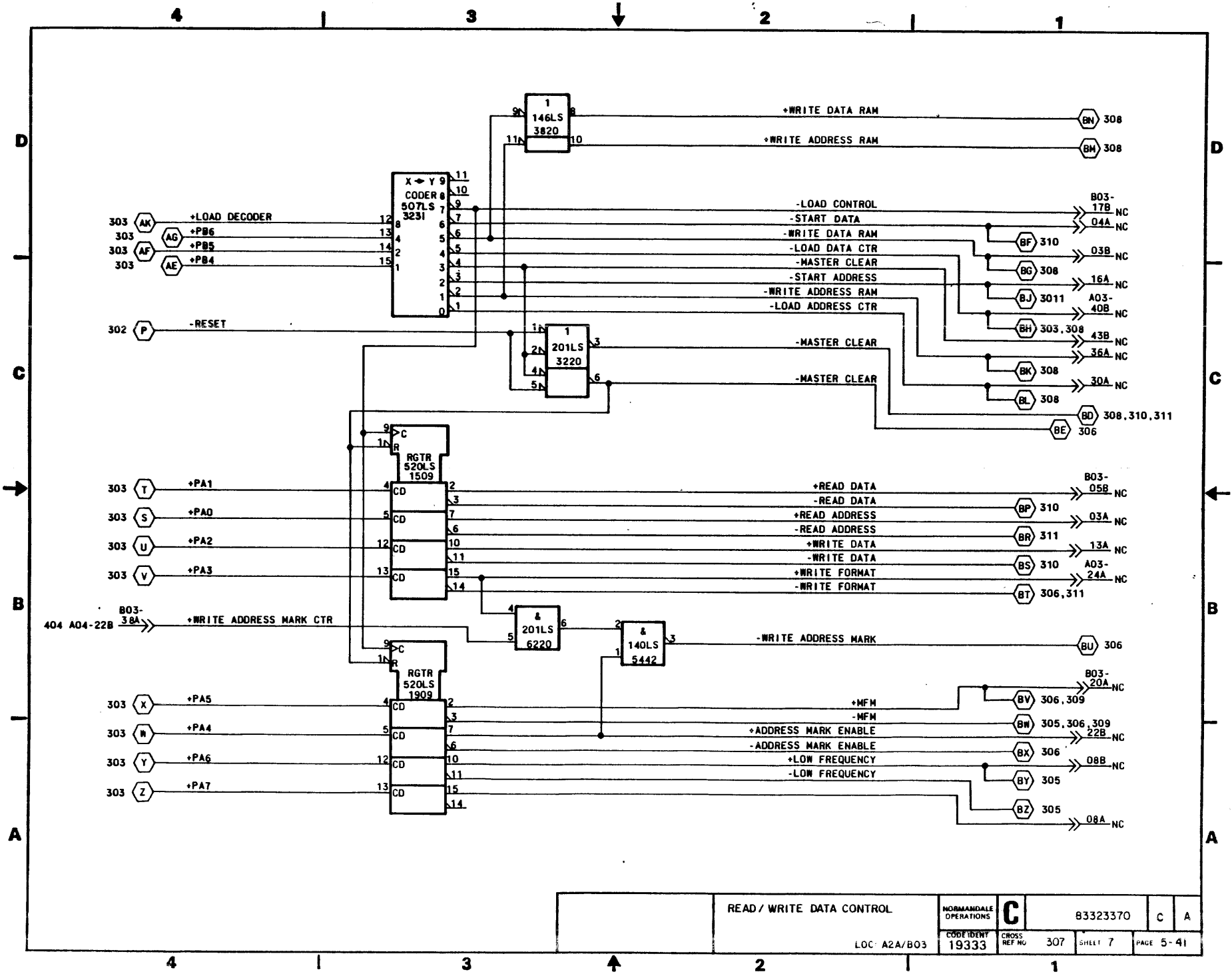
CROSS REF NO 305

SHEET 5

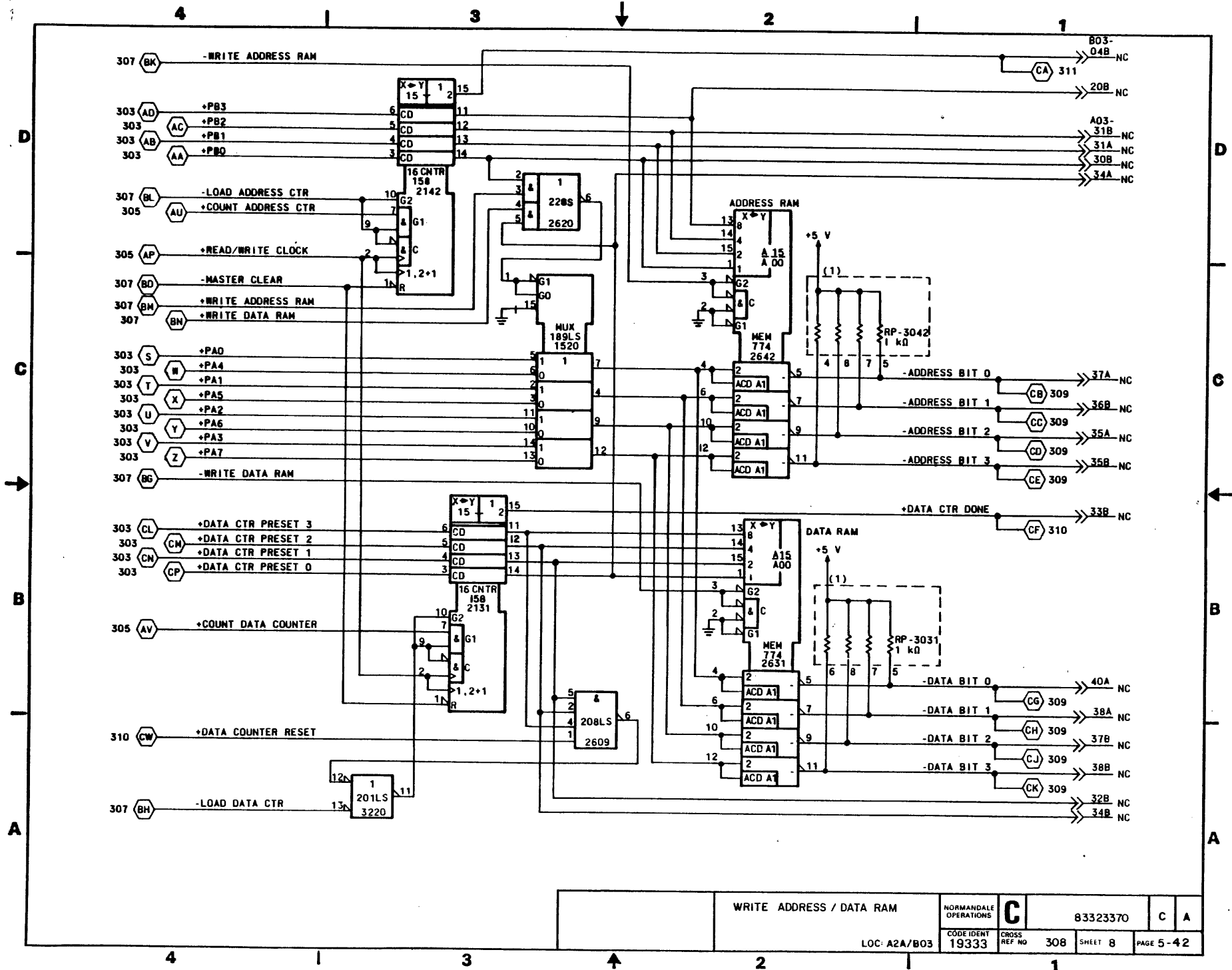
PAGE 5-39



ADDRESS MARK AND DATA ERROR		NORMANDALE OPERATIONS	<b>C</b>	83323370	C	A
LOC: A2A/B03	CODE IDENT 19333	CROSS REF NO	306	SHEET 6	PAGE 5-40	



READ / WRITE DATA CONTROL		NORMANDEALE OPERATIONS	<b>C</b>	83323370	C	A
LOC: A2A/B03	CODE IDENT: 19333	CROSS REF NO: 307	SHEET: 7	PAGE: 5-41		



WRITE ADDRESS / DATA RAM

NORMANVILLE OPERATIONS

**C**

83323370

C

A

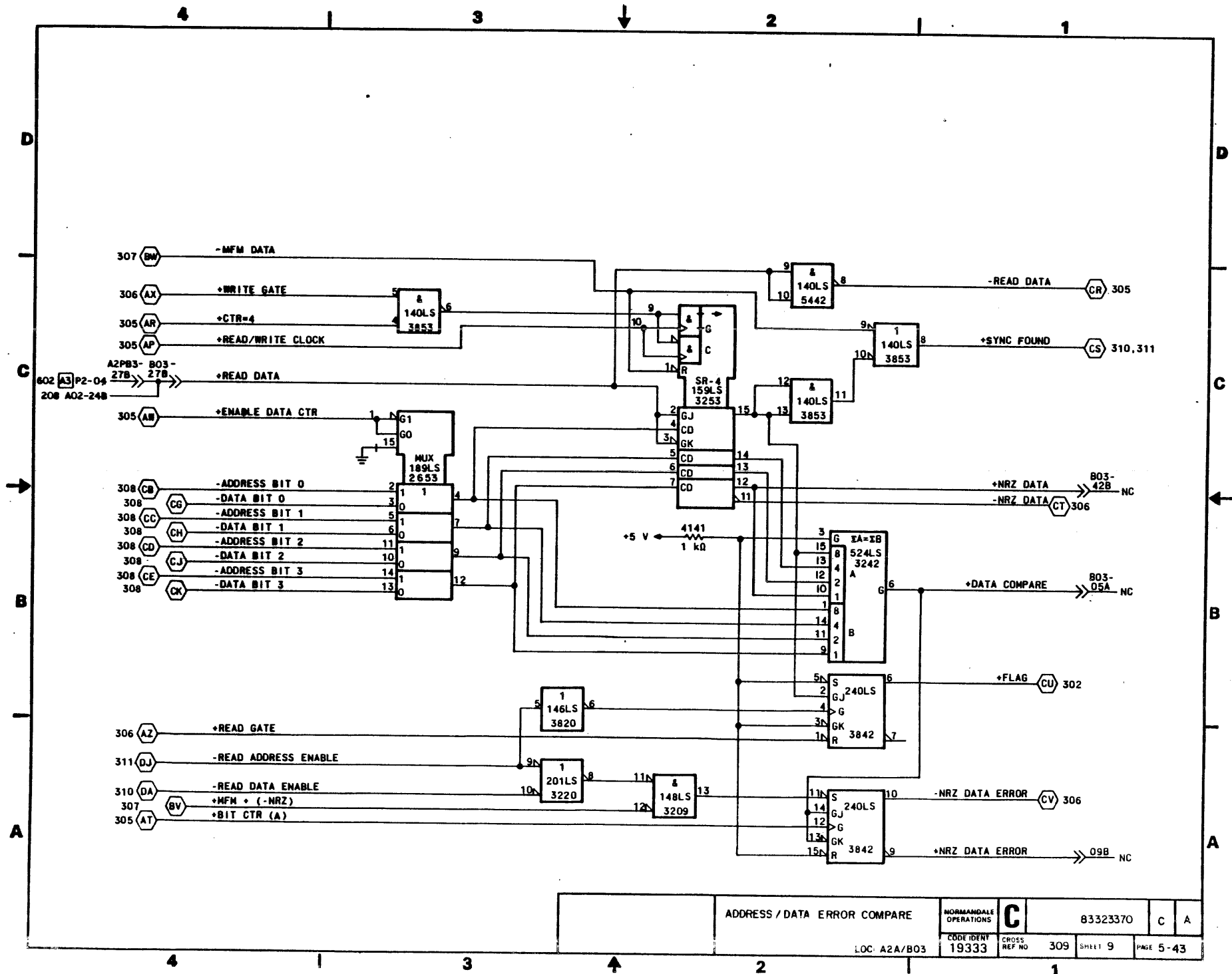
CODE IDENT 19333

CROSS REF NO 308

SHEET 8

PAGE 5-42

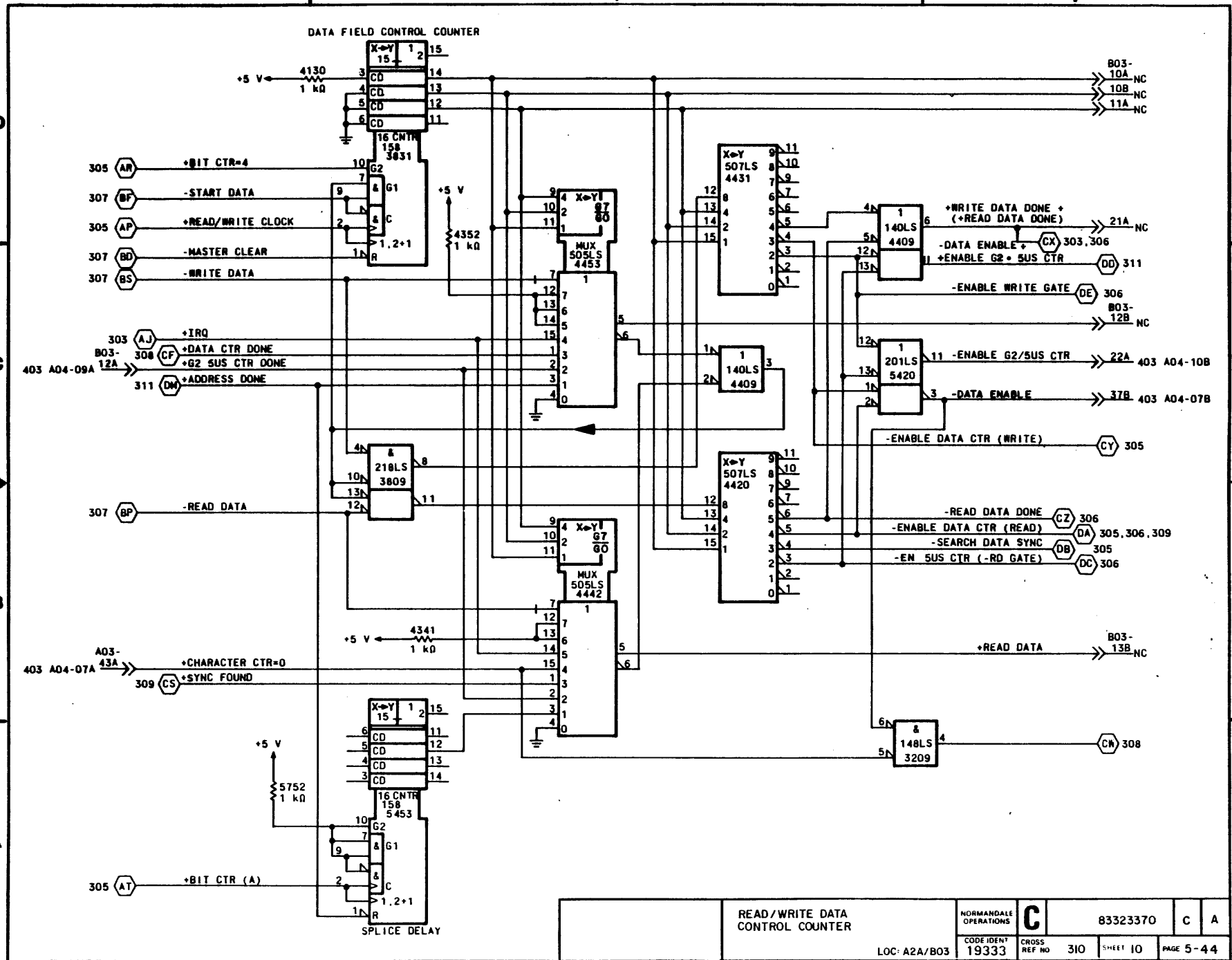
LOC: A2A/B03



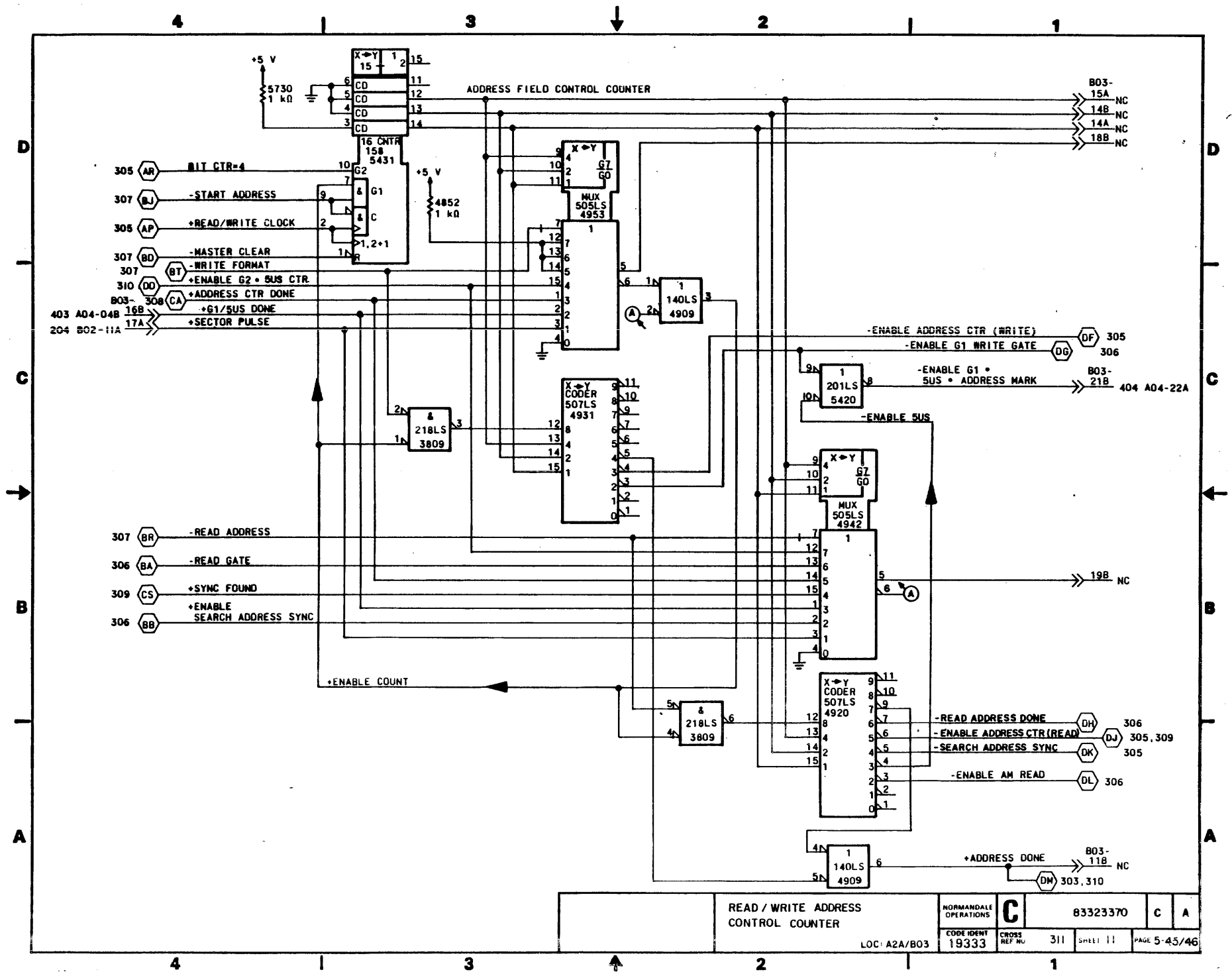
ADDRESS / DATA ERROR COMPARE

NORMANDEALE OPERATIONS	<b>C</b>	83323370		C	A
CODE IDENT 19333		CROSS REF NO 309	SHEET 9	PAGE 5-43	

LOC. A2A/B03



READ/WRITE DATA CONTROL COUNTER		NORMANDELE OPERATIONS	<b>C</b>	83323370	C	A
LOC: A2A/B03		CODE IDENT	CROSS REF NO	SHEET	PAGE	
		19333	310	10	5-44	





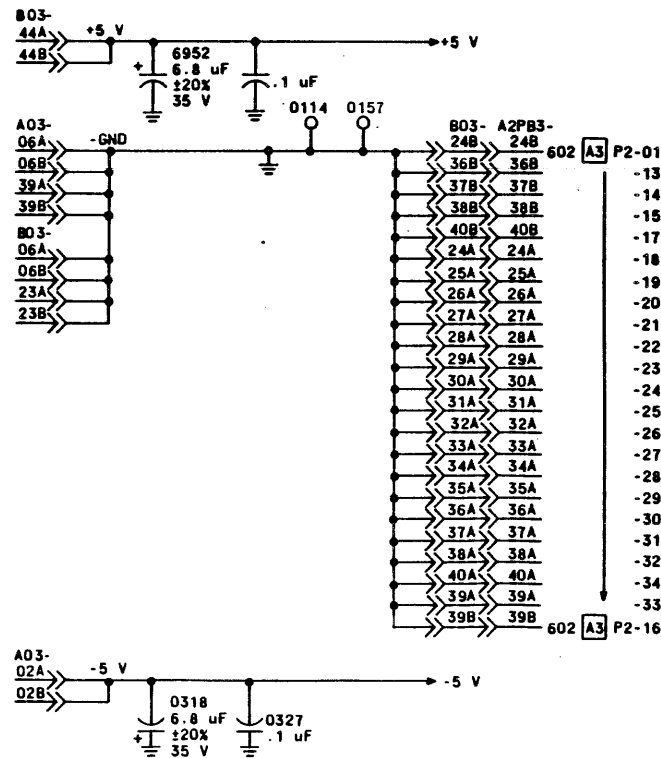


REVISION STATUS OF SHEETS																			
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A	A	A	A	A	A	A	A	A	A	A									
B																			
C	C		C	C	C		C	C	C										
D			D																

UNUSED RESISTOR PACKS	
LOCATION	PIN(S)
3031	2, 3, 4
3042	2, 3, 6

UNUSED LOGIC ELEMENTS		
ELEMENT	LOCATION	OUTPUT PIN(S)
140LS	1553	6
140LS	4909	8, 11
208LS	2609	8
148LS	3209	1
148LS	5831	4
140LS	5442	8
228S	2620	8
146LS	5842	6

REVISIONS					
REV	ECO	DESCRIPTION	DRFT.	DATE	CHK'D
A	PE23000	RELEASE			
B	PE54243	ADD INVERTERS	CB	8-2-80	
C	PE54256	ADD CLOCK TEST	TH	8-5-80	
D	DH10007	CHANGE IC	DLB	11-18-83	



FILTER CAPACITORS	
.1 uF	
+5 V	
0310	4243
1408	4309
1419	4320
1810	4731
2042	5309
2453	5244
2509	5321
2523	5331
2533	6131
3153	6521
3144	6555
3519	6932
3734	

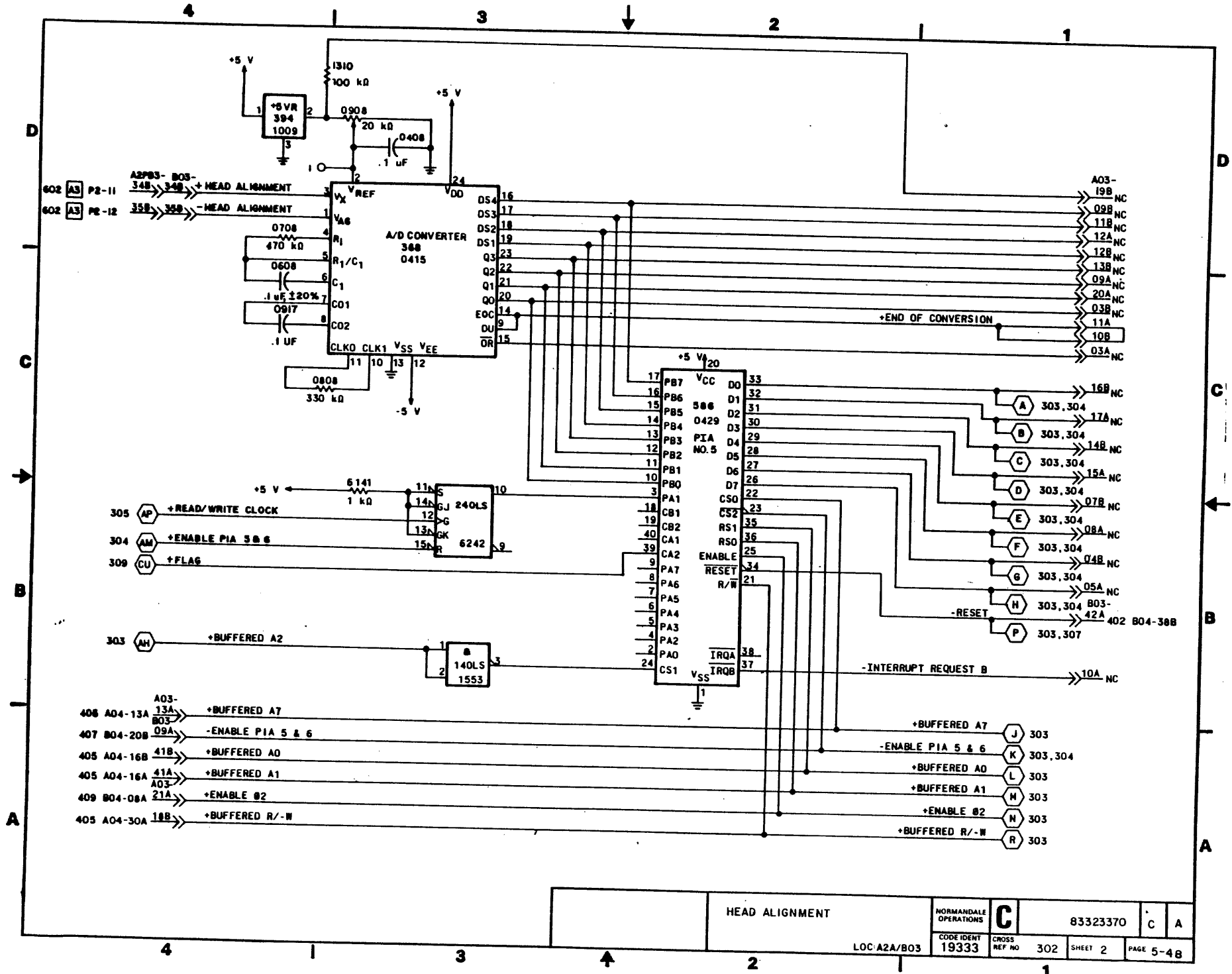
DRAWN	G. RABINE	1277
CHECKED		
ENGINEER	<i>[Signature]</i>	<i>[Signature]</i>
APPROVED		

READ / WRITE CONTROL  
DIAGRAM  
TYPE: CJJX

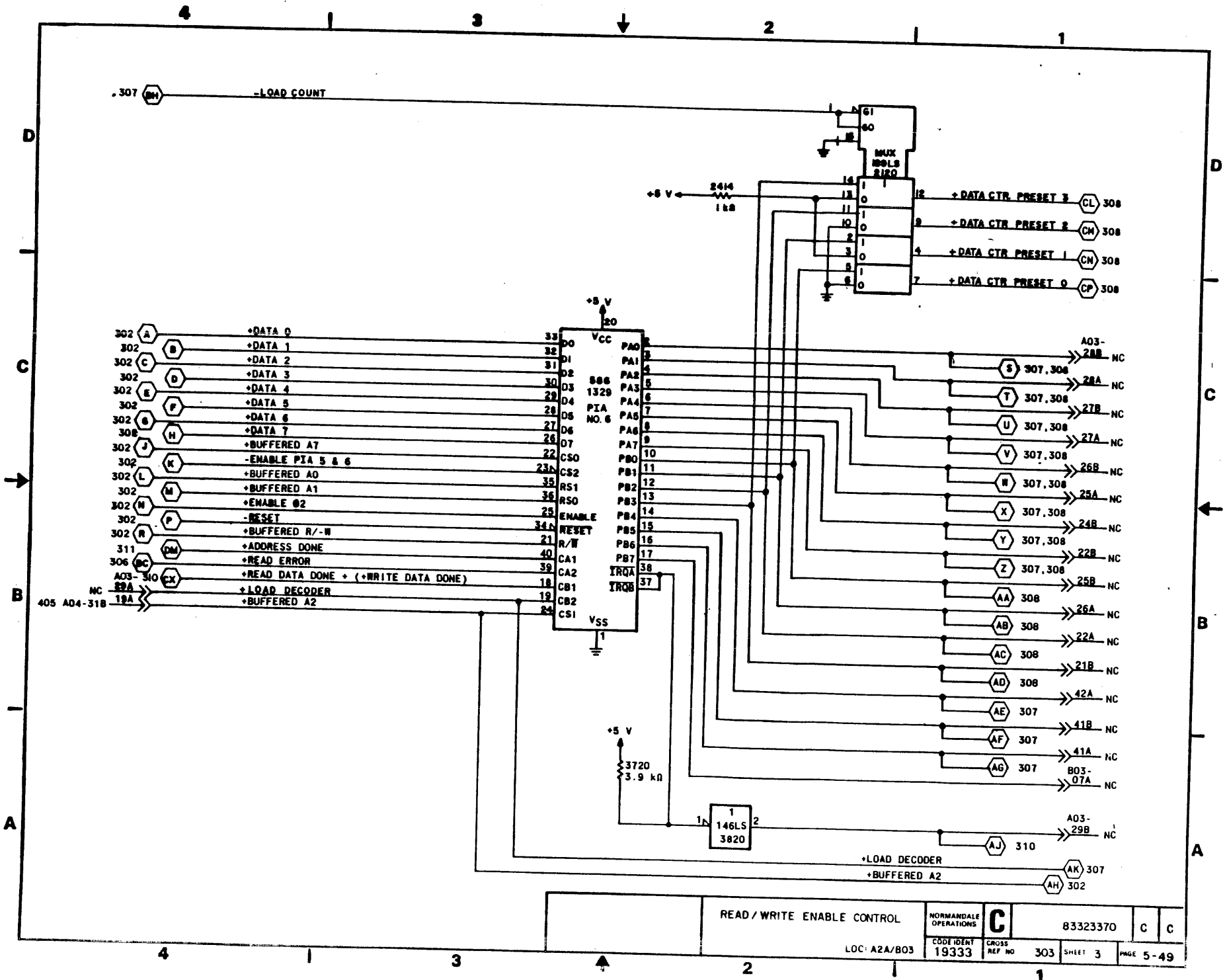
NORMANDALE  
OPERATIONS  
**C**

83323370 H D

CODE IDENT 19333 CROSS REF. NO. 301 SHEET 1 of 11 PAGE 5-47



HEAD ALIGNMENT		NORMANDALE OPERATIONS	83323370		C	A
LOC: A2A/B03		CODE IDENT	CROSS REF NO	SHEET 2	PAGE 5-4B	
		19333	302			



READ / WRITE ENABLE CONTROL

NORMANDEALE OPERATIONS

C

83323370

C

C

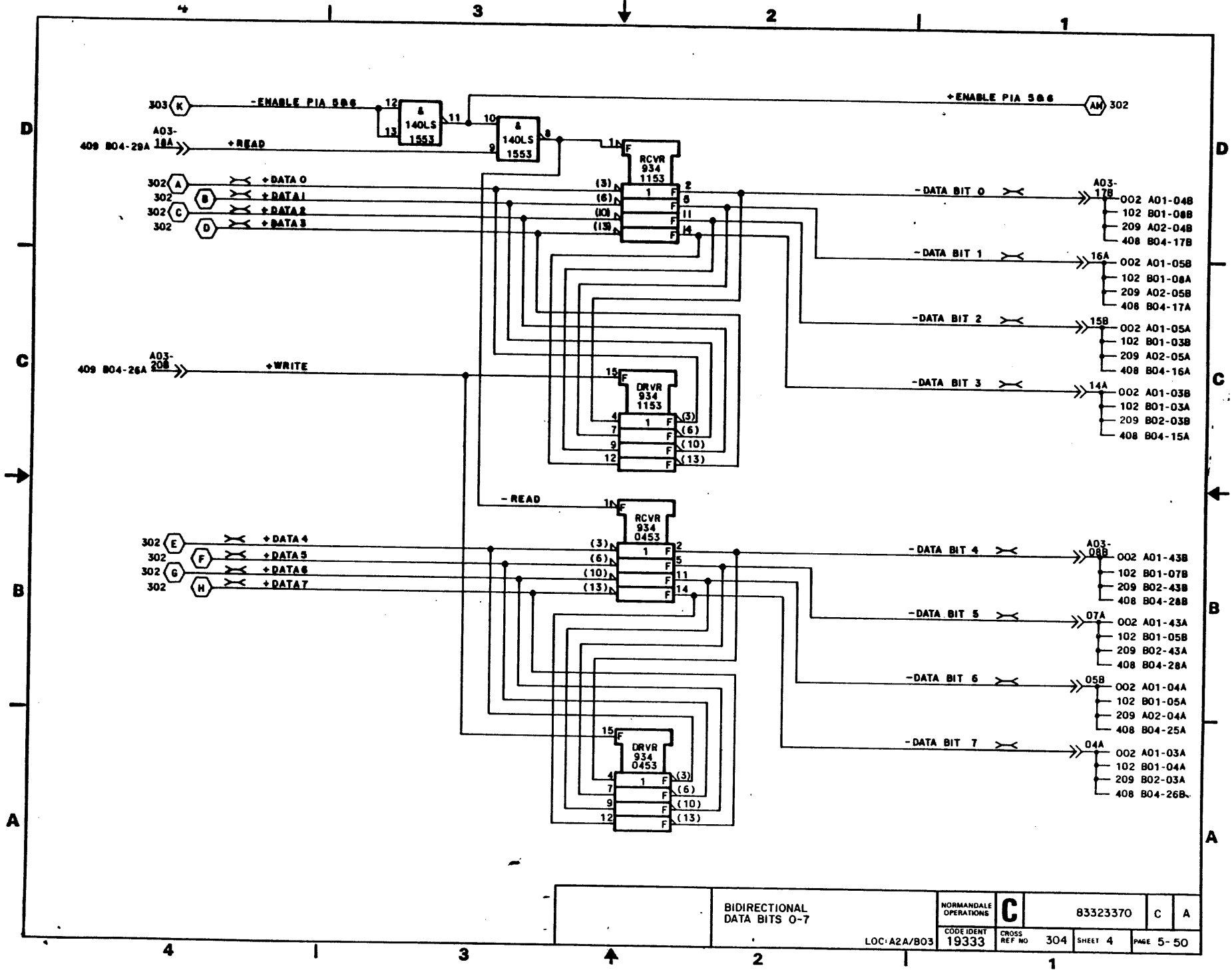
LOC: A2A/B03

CODE IDENT 19333

CROSS REF NO 303

SHEET 3

PAGE 5-49



BIDIRECTIONAL  
DATA BITS 0-7

NORMANDE  
OPERATIONS

C

83323370

C

A

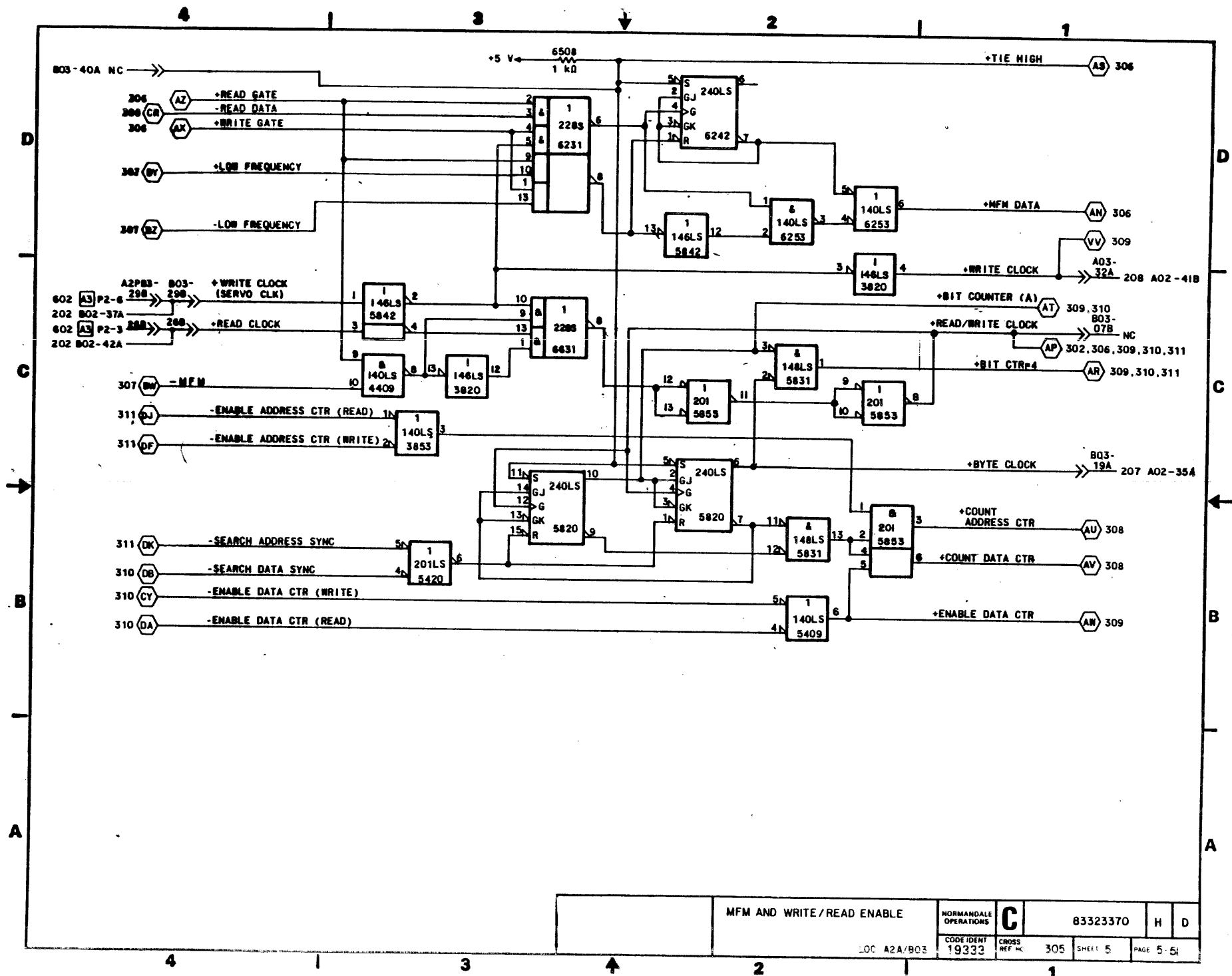
CODE IDENT  
19333

CROSS  
REF NO 304

SHEET 4

PAGE 5-50

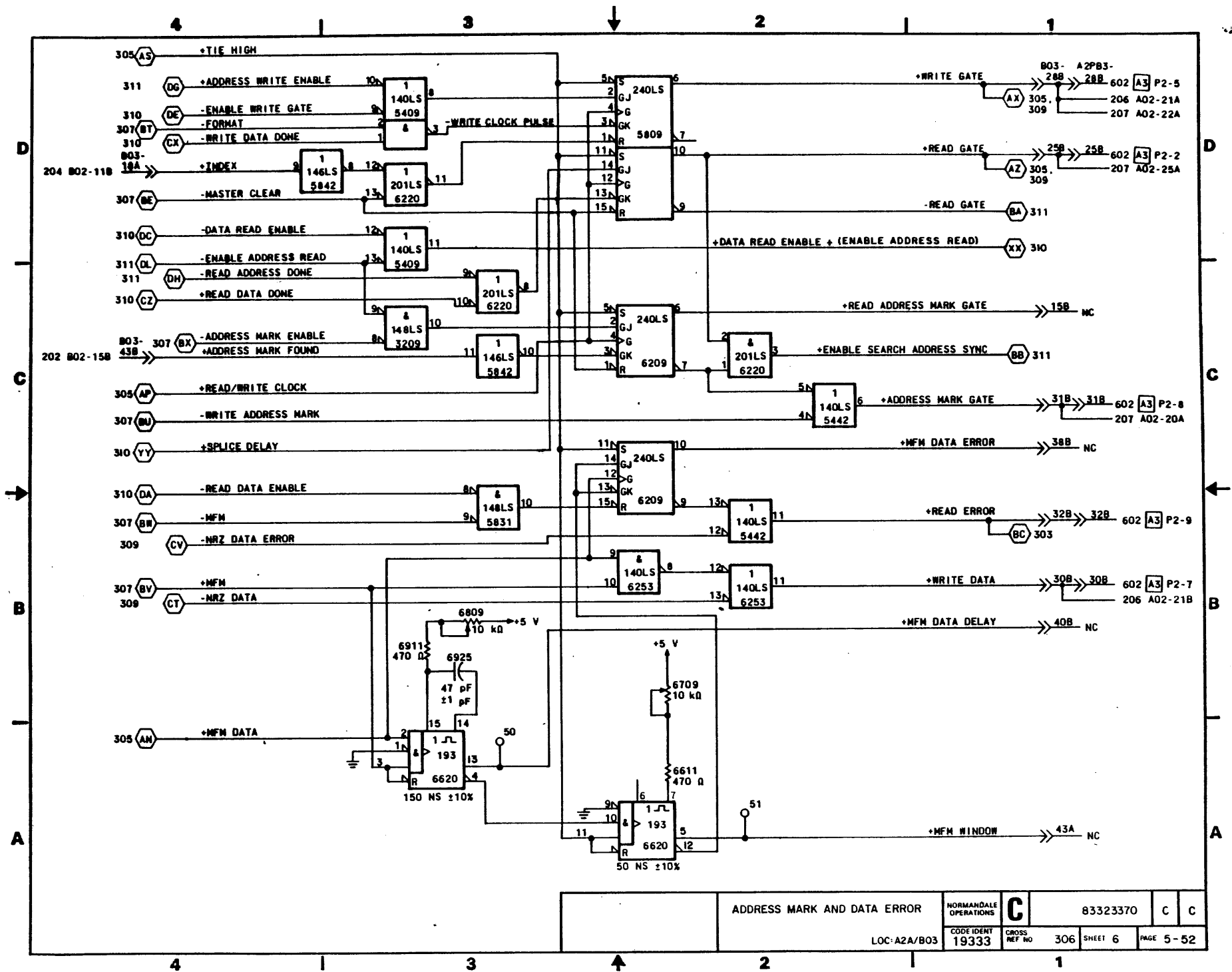
LOC: A2A/B03



MFM AND WRITE/READ ENABLE

NORMANDALE OPERATIONS	<b>C</b>	83323370	H	D
CODE IDENT 19333	CROSS REF NO 305	SHEET 5	PAGE 5-51	

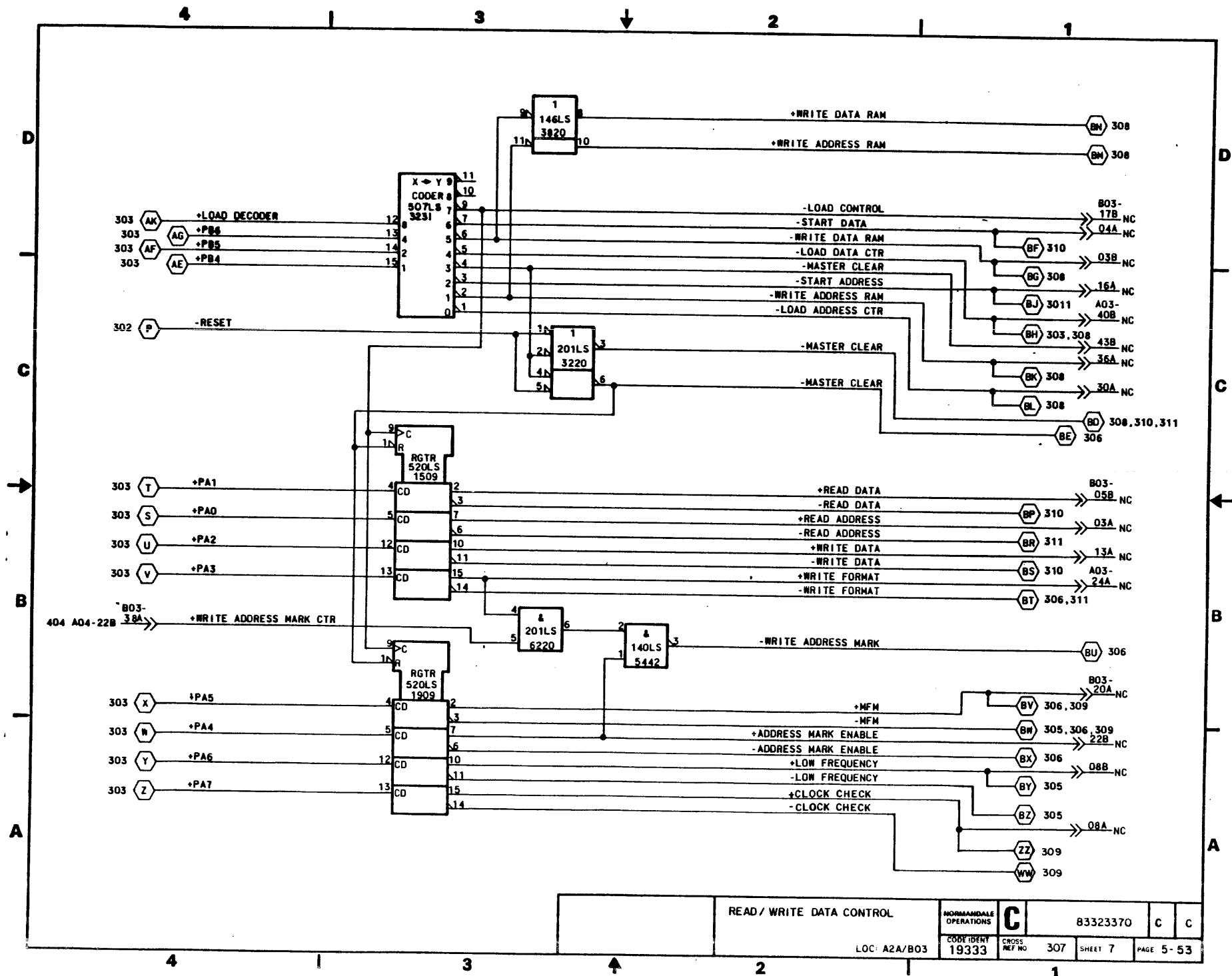
LOC A2A/B03



ADDRESS MARK AND DATA ERROR

NORMAN DALE OPERATIONS	<b>C</b>	83323370	C	C

LOC: A2A/B03



READ / WRITE DATA CONTROL

NORMANDALE  
OPERATIONS

C

83323370

C

C

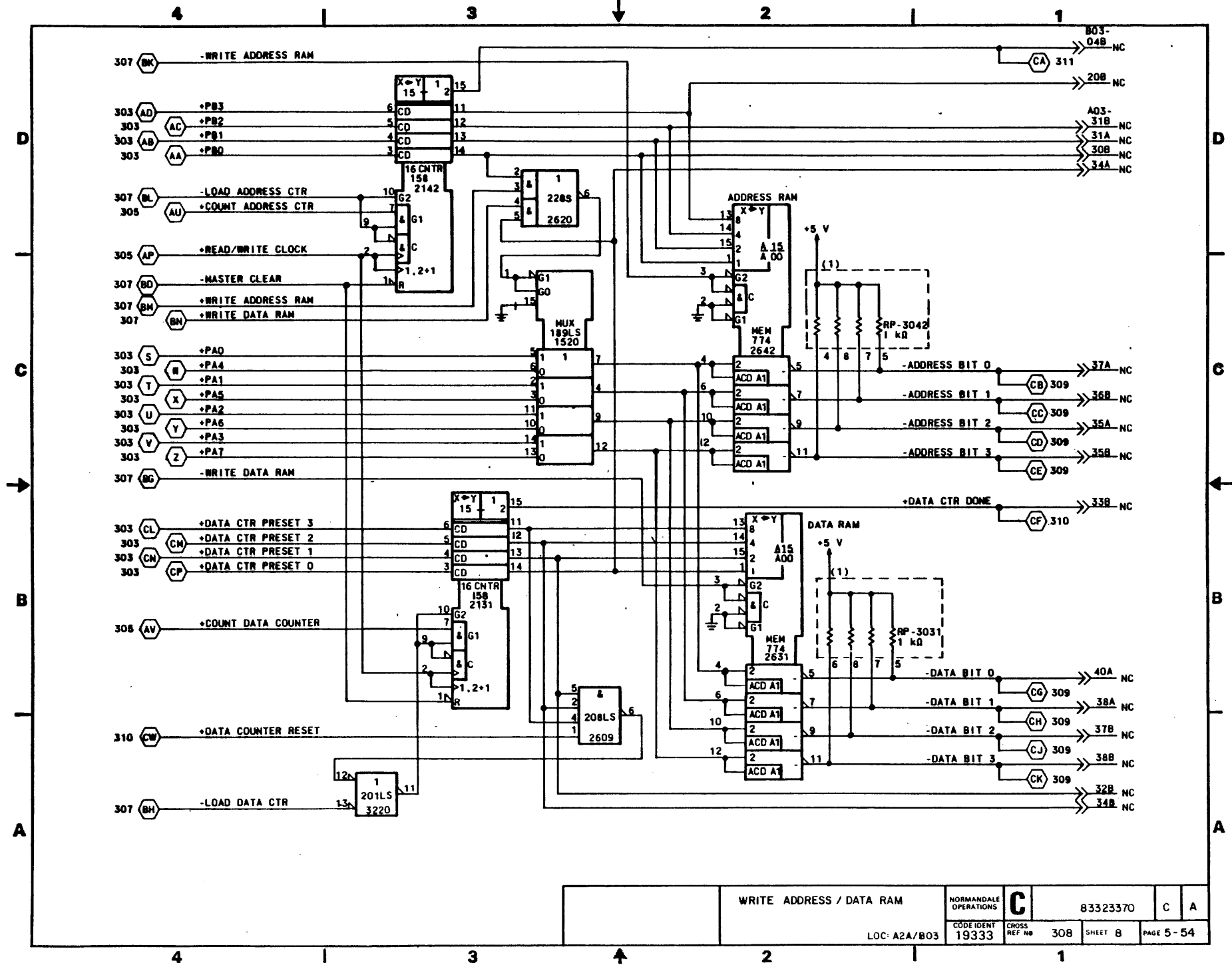
CODE IDENTY  
19333

CROSS  
REF NO 307

SHEET 7

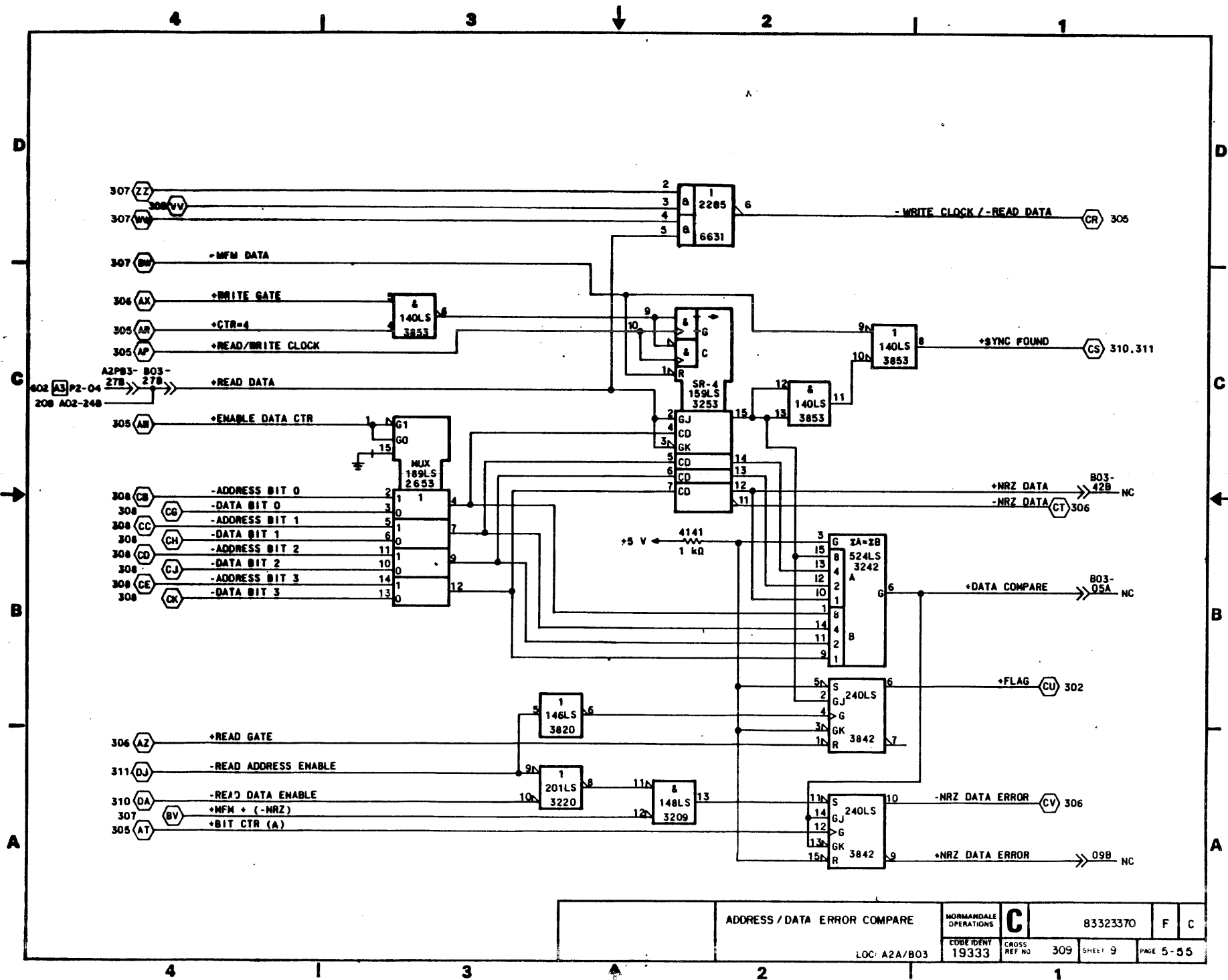
PAGE 5-53

LOC: A2A/B03



WRITE ADDRESS / DATA RAM		NORMANDALE OPERATIONS	<b>C</b>	83323370	C	A
LOC: A2A/B03	CODE IDENT 19333	CROSS REF. NO 308	SHEET 8	PAGE 5-54		





ADDRESS / DATA ERROR COMPARE

NORMANDALE OPERATIONS

C

83323370

F

C

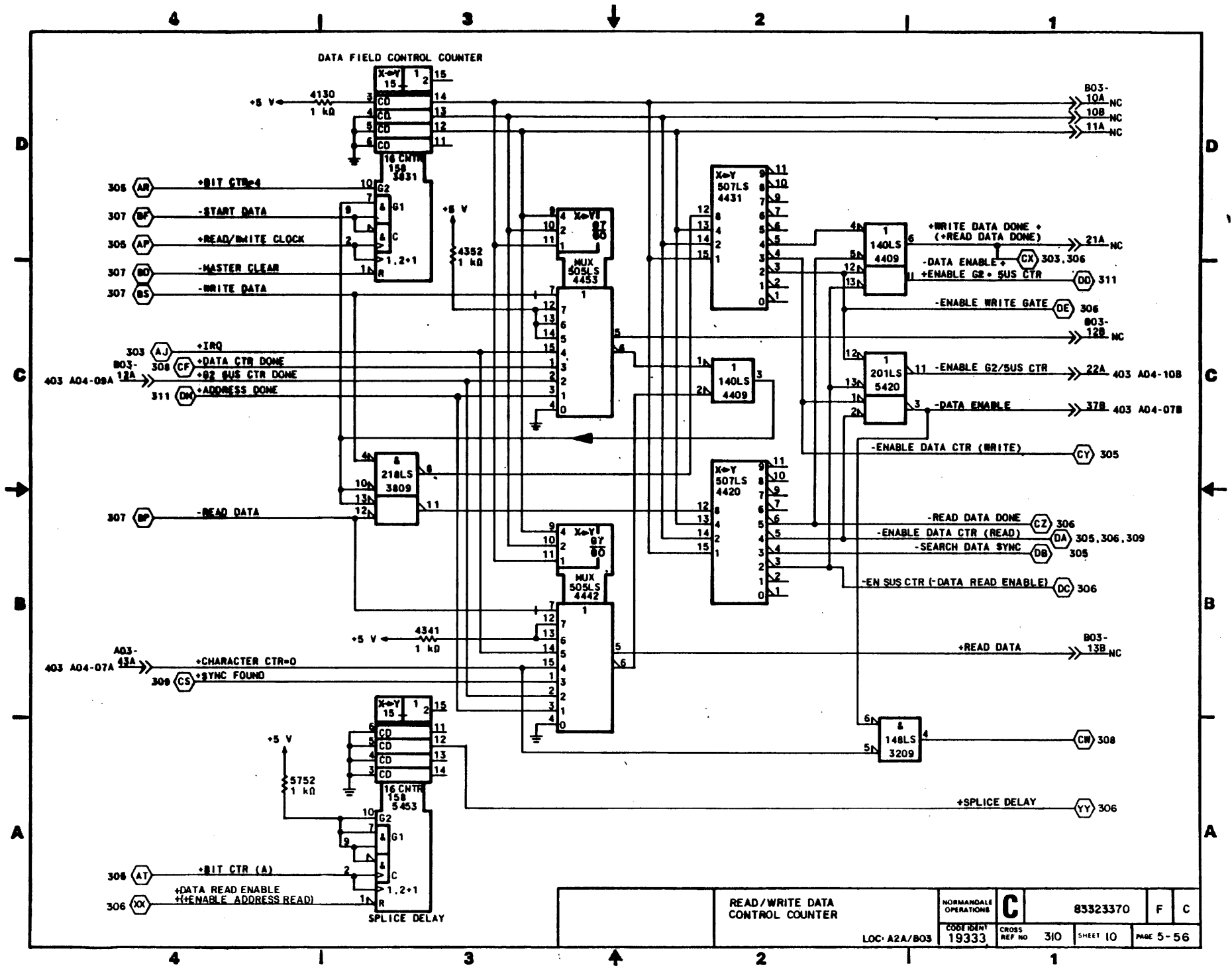
CDR IDENT 19333

CROSS REF NO 309

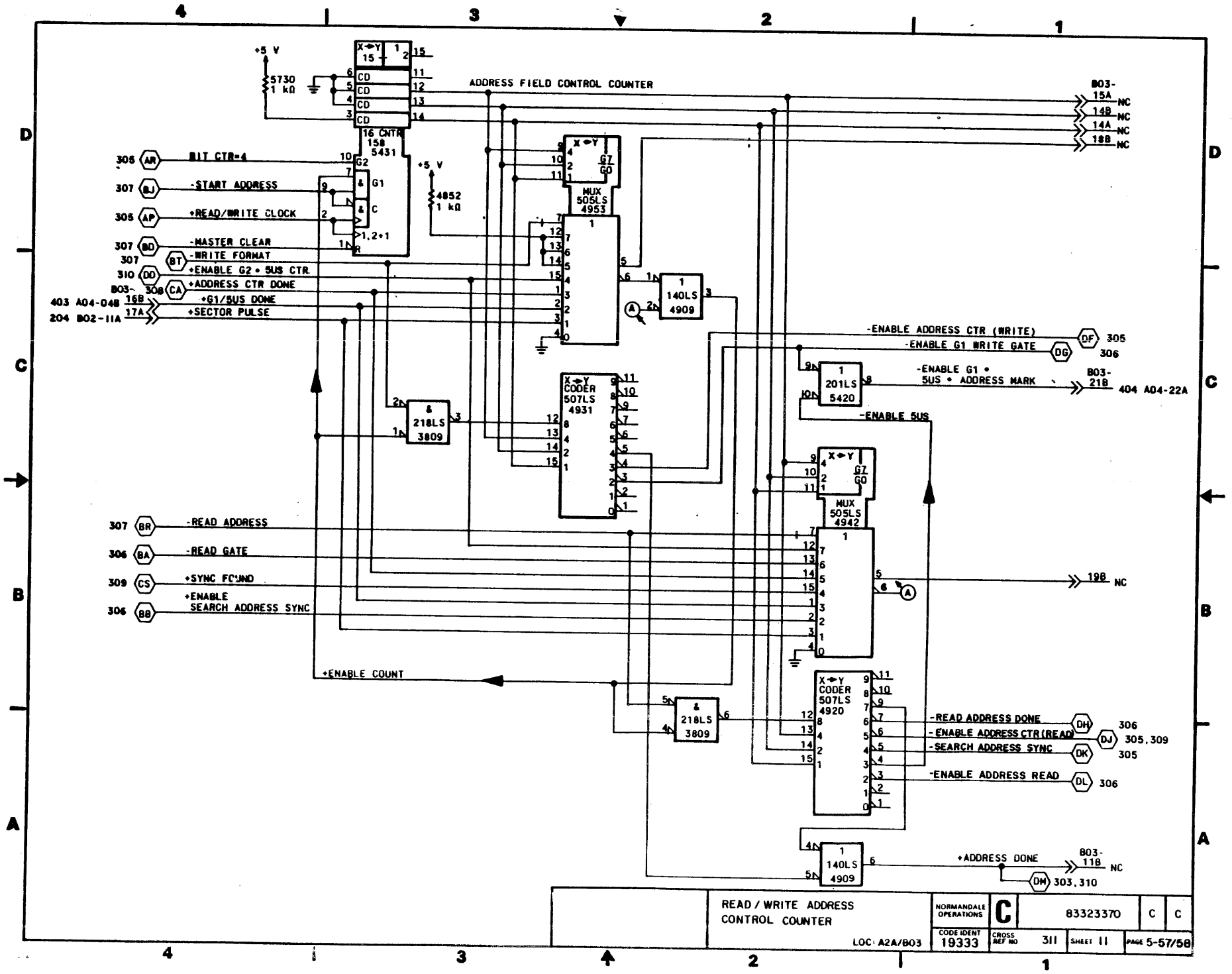
SHEET 9

PAGE 5-55

LOC: A2A/B03



READ/WRITE DATA CONTROL COUNTER		NORMANDEALE OPERATIONS	<b>C</b>	83523370	F	C
LOC: A2A/BO3	CROSS REF NO 19333	310	SHEET 10	PAGE 5-56		



READ / WRITE ADDRESS CONTROL COUNTER		NORMANDEALE OPERATIONS	<b>C</b>	83323370	C	C
LOC: A2A/B03		CODE IDENT	19333	CROSS REF NO	311	SHEET 11
				PAGE 5-57/58		



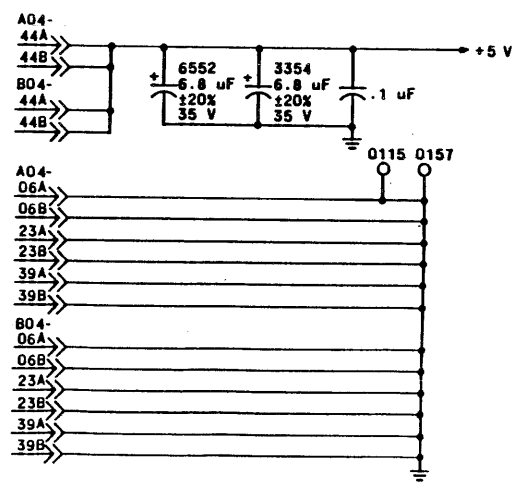
UNUSED LOGIC ELEMENTS		
ELEMENT	LOCATION	OUTPUT PINS
143	5520	6
148LS	5542	13



FILTER CAPACITORS

.1 uF	
+5 V	
0709	1924
1309	2724
1809	5931
2409	5332
2909	5443
3509	6443
4109	4844
5913	6949
5923	2554
0424	5354
1224	1055
	1755

REVISIONS					
REV	ECO	DESCRIPTION	DRAFT	DATE	CHK'D
A	PE23000	RELEASED			
B	PE84238	ADD TWO SIGNALS		8-18-81	
C	PE84308	CREATE NEW EPROMS		9-18-81	
D	PE84280	CHG EPROMS		9-18-81	
E	PE54327	CHG PROMS			
F	PE54384	CORRECT DIAGRAM	DLB	11-17-83	
G	PE68333	NO CHANGE	DLB	11-17-83	
H	DJ10087	CHG CAPACITOR LOG	DLB	11-17-83	
J	DJ10114	CHG CAPACITORS	JDR	12-28-84	
K	DJ10131	CREATE 15 MHZ FTU	SA	3-8-85	



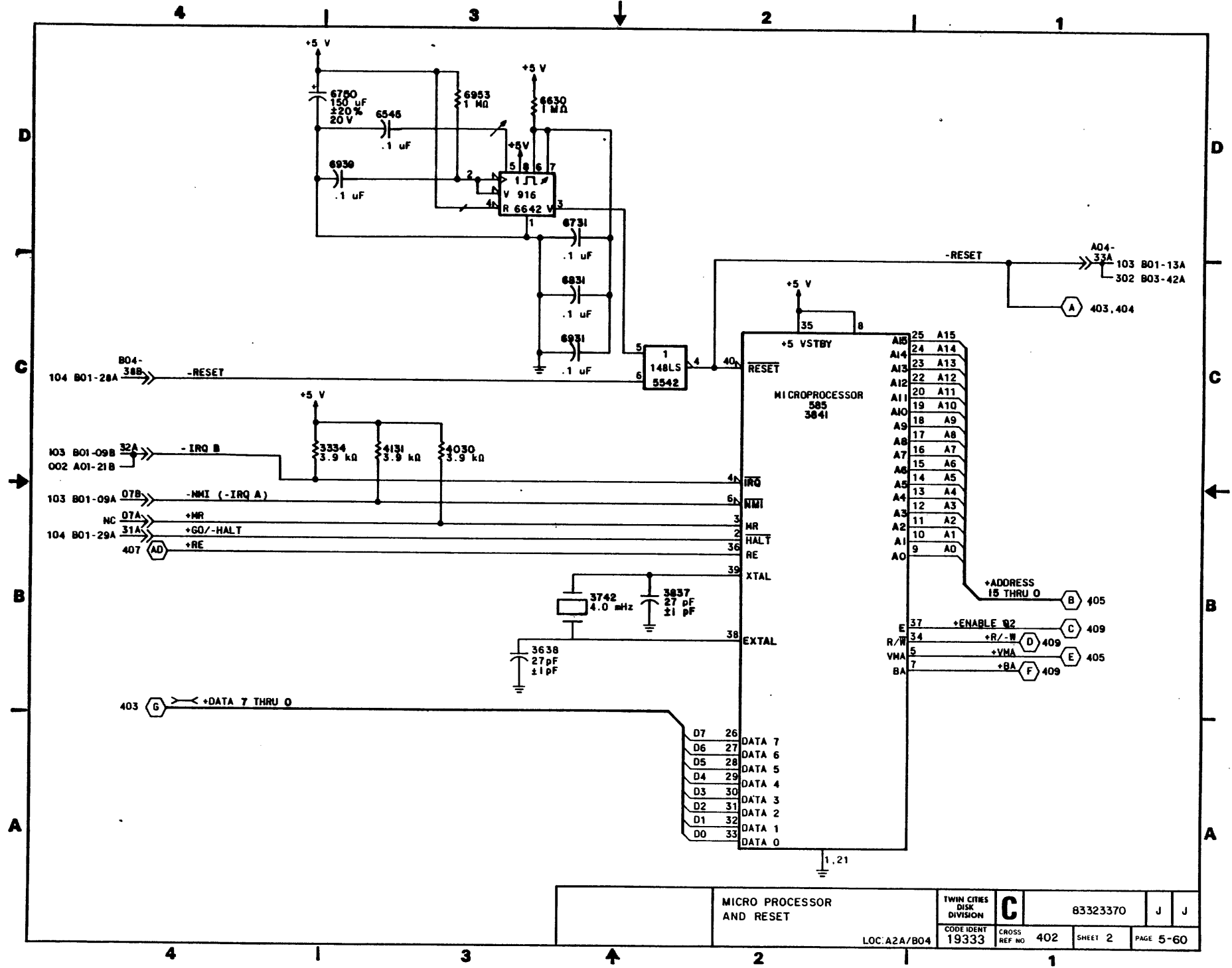
NOTE

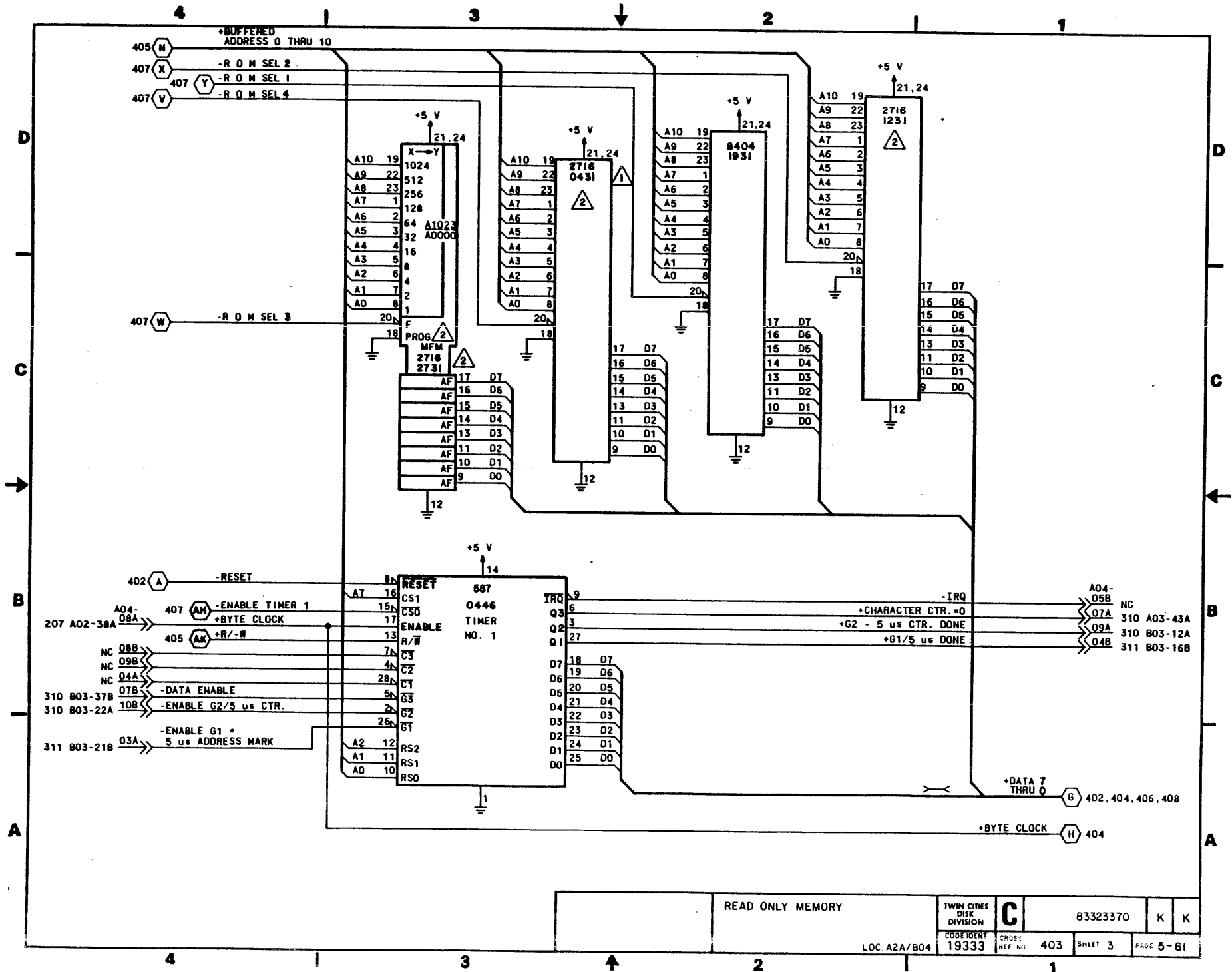
1 ON AJGX REV A-C OUTPUT PINS 10 & 13 OF 148LS AT 5542 ARE UNUSED. AJGX REV D & ABV ARE AS SHOWN.

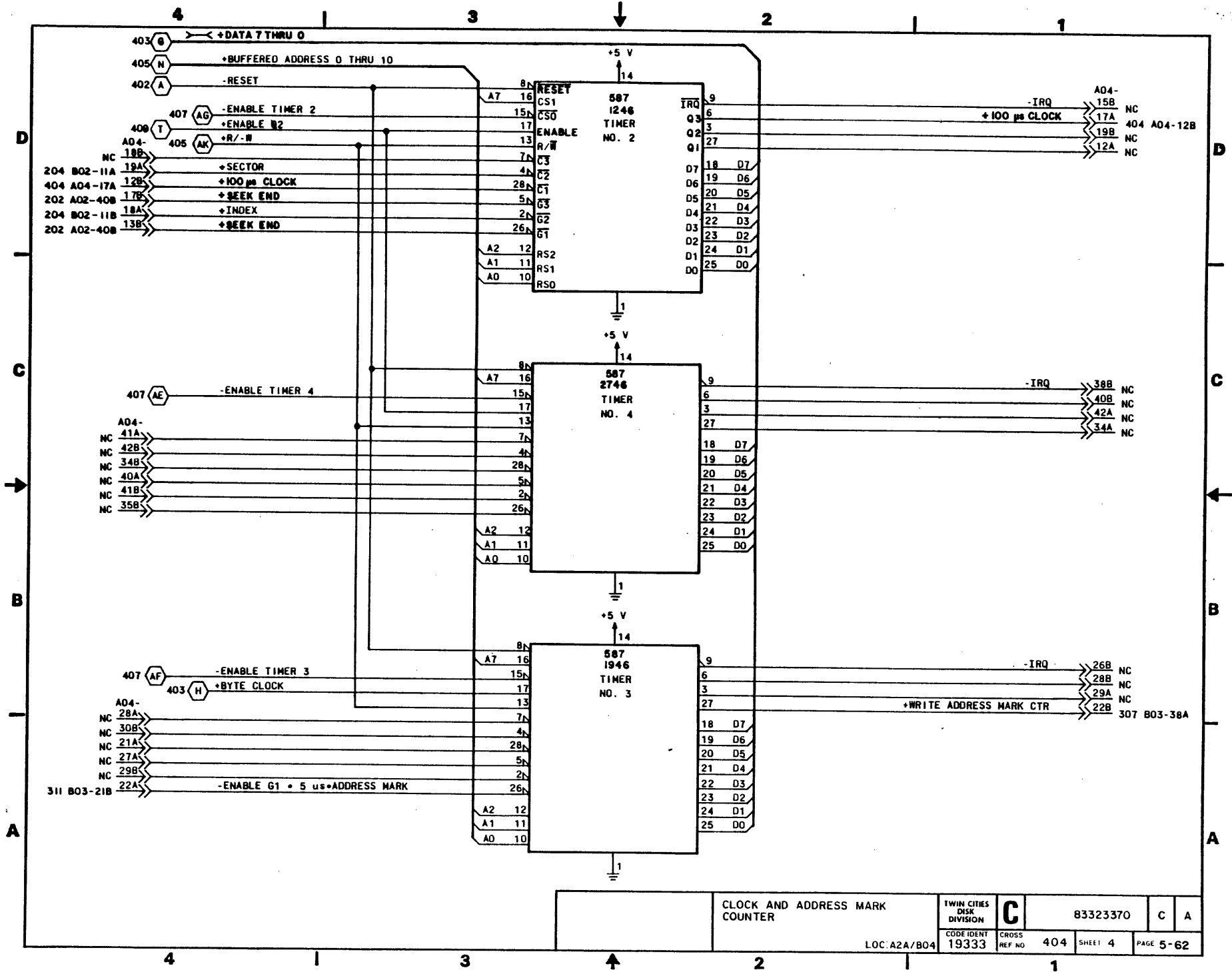
2 EPROM KIT PN 81068500  
 EPROM 4301 AT LOCATION 0431  
 EPROM 4302 AT LOCATION 1231  
 EPROM 4303 AT LOCATION 2731

DRAWN	<i>M. J. ...</i>	2-1-79
CHECKED		
ENGINEER	<i>R. V. ...</i>	1/1/79
APPROVED		

MICROPROCESSOR		TWIN CITIES DISK DIVISION	C	83323370	K	K
TYPE: CJGX/EJGX		LOC: A2A/B04				







CLOCK AND ADDRESS MARK COUNTER

TWIN CITIES DISK DIVISION

C

83323370

C

A

CODE IDENT 19333

CROSS REF NO

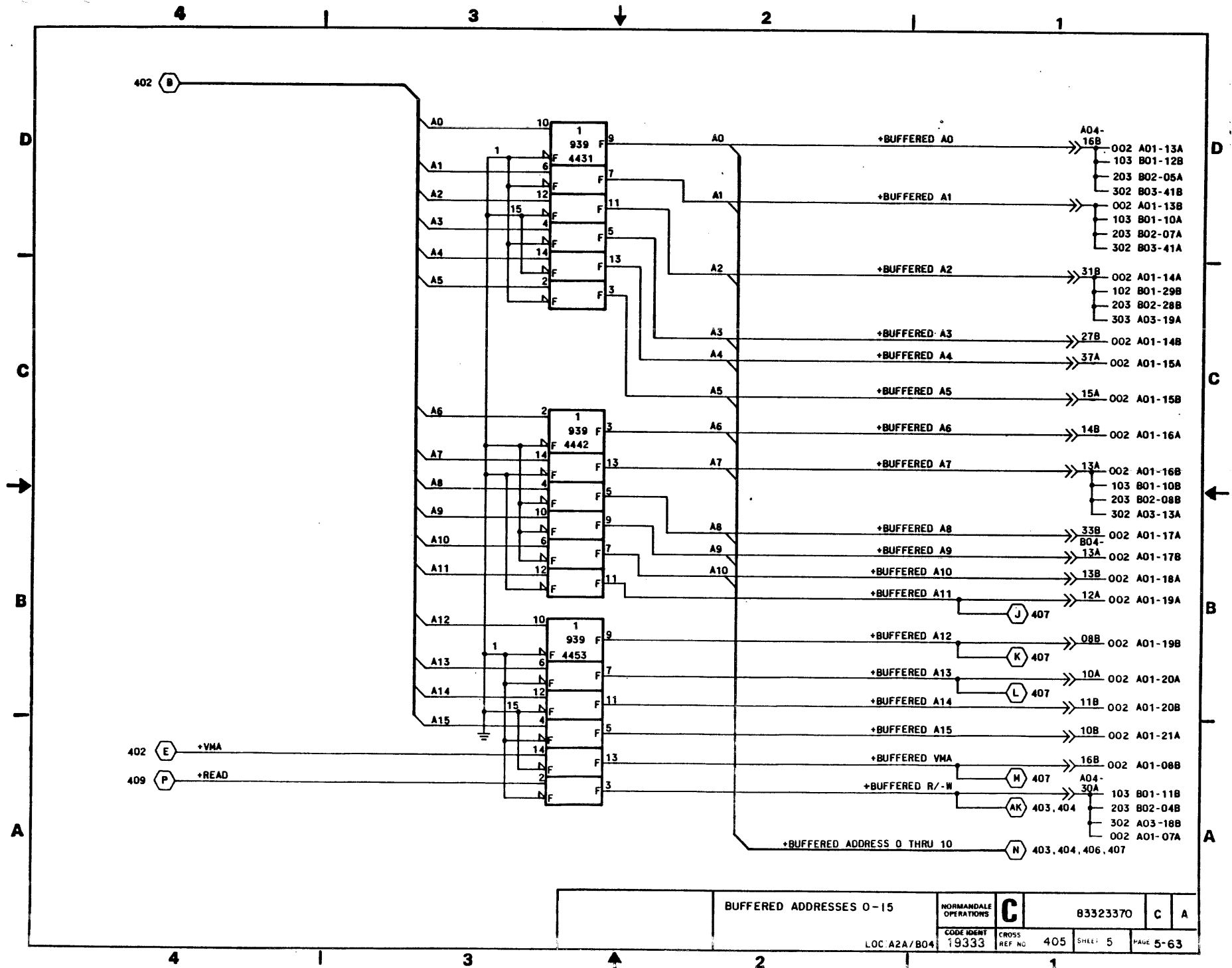
404

SHEET 4

PAGE 5-62

LOC. A2A/B04



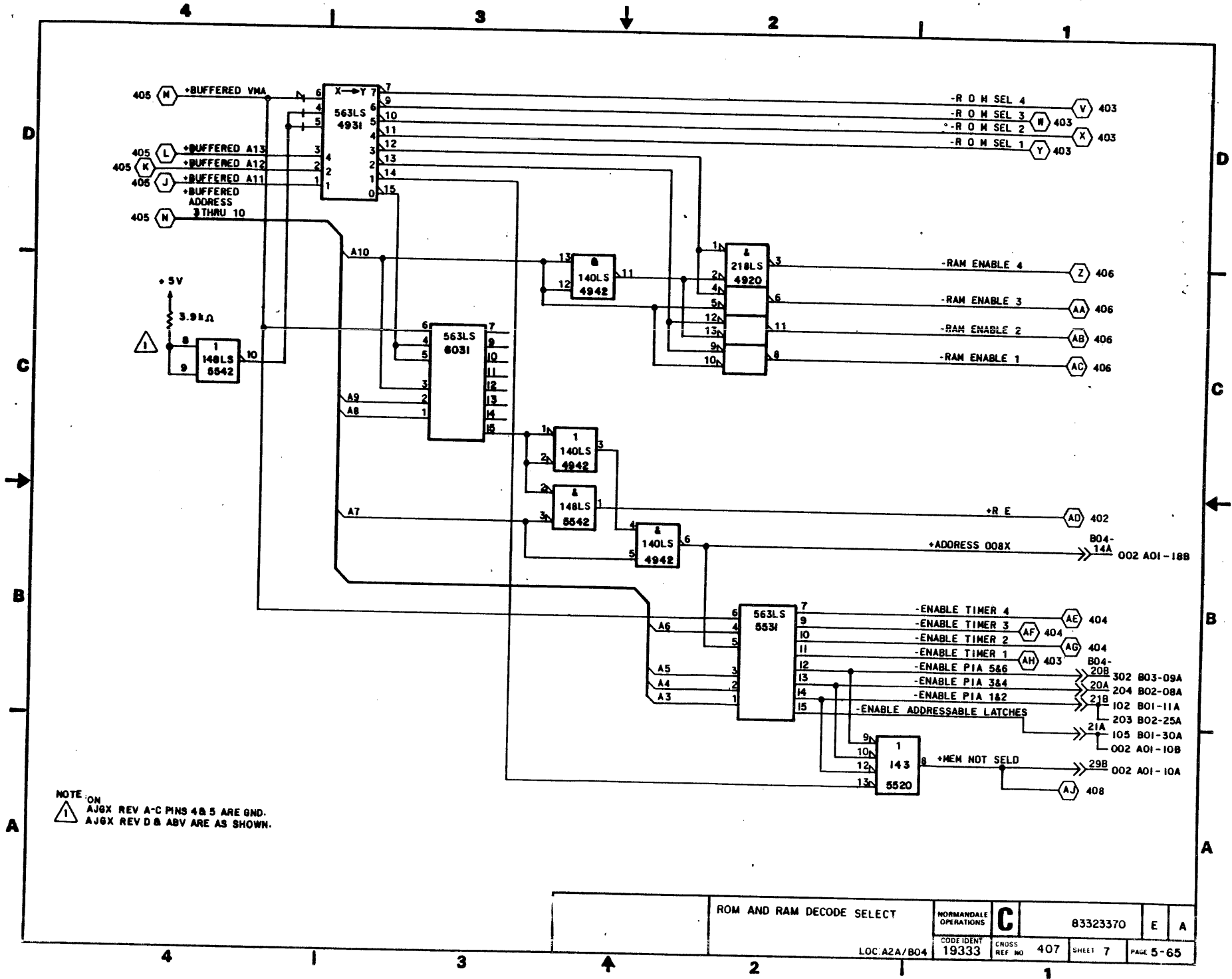


BUFFERED ADDRESSES 0-15

NORMANDEALE OPERATIONS	C	83323370	C	A

LOC. A2A/B04

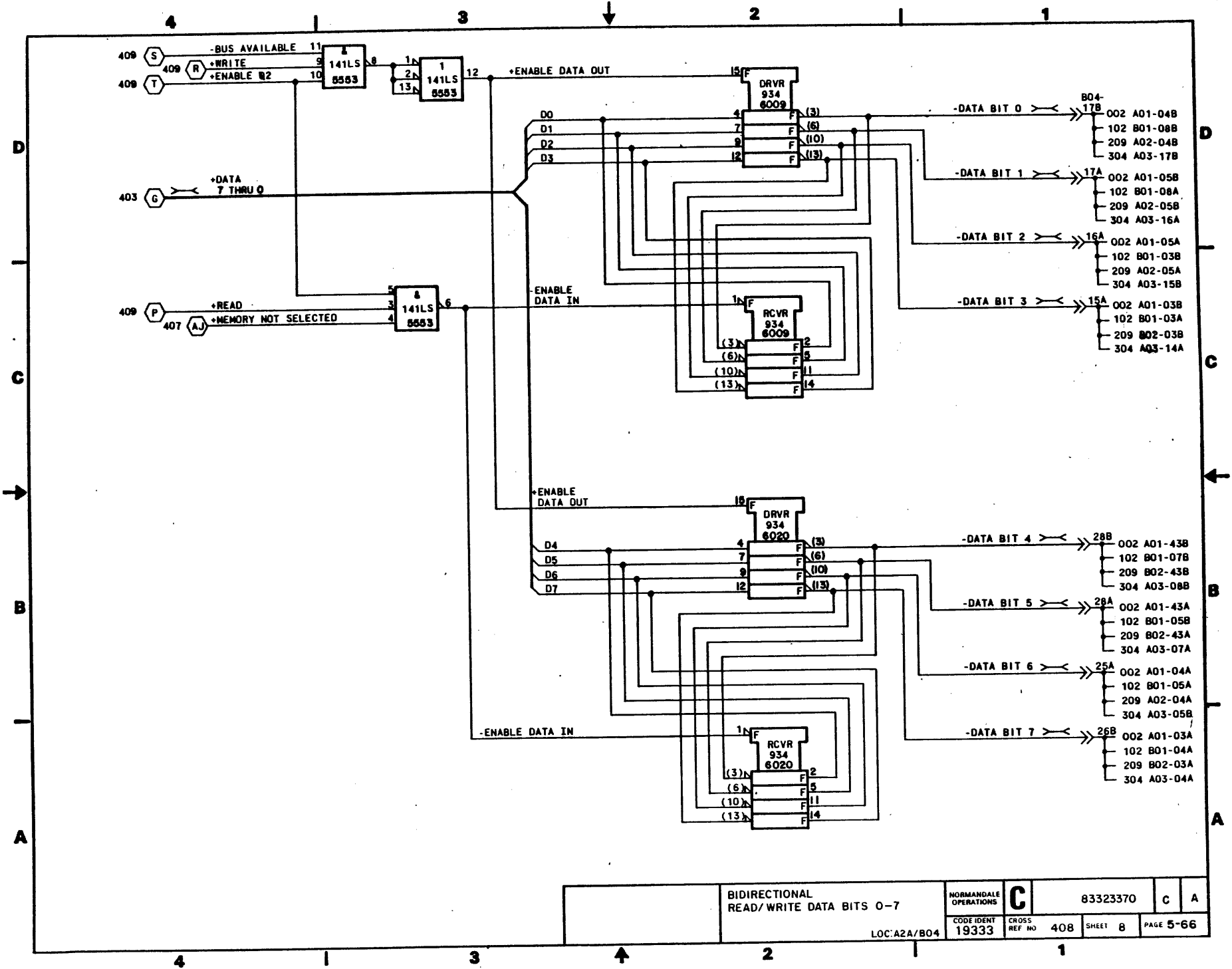


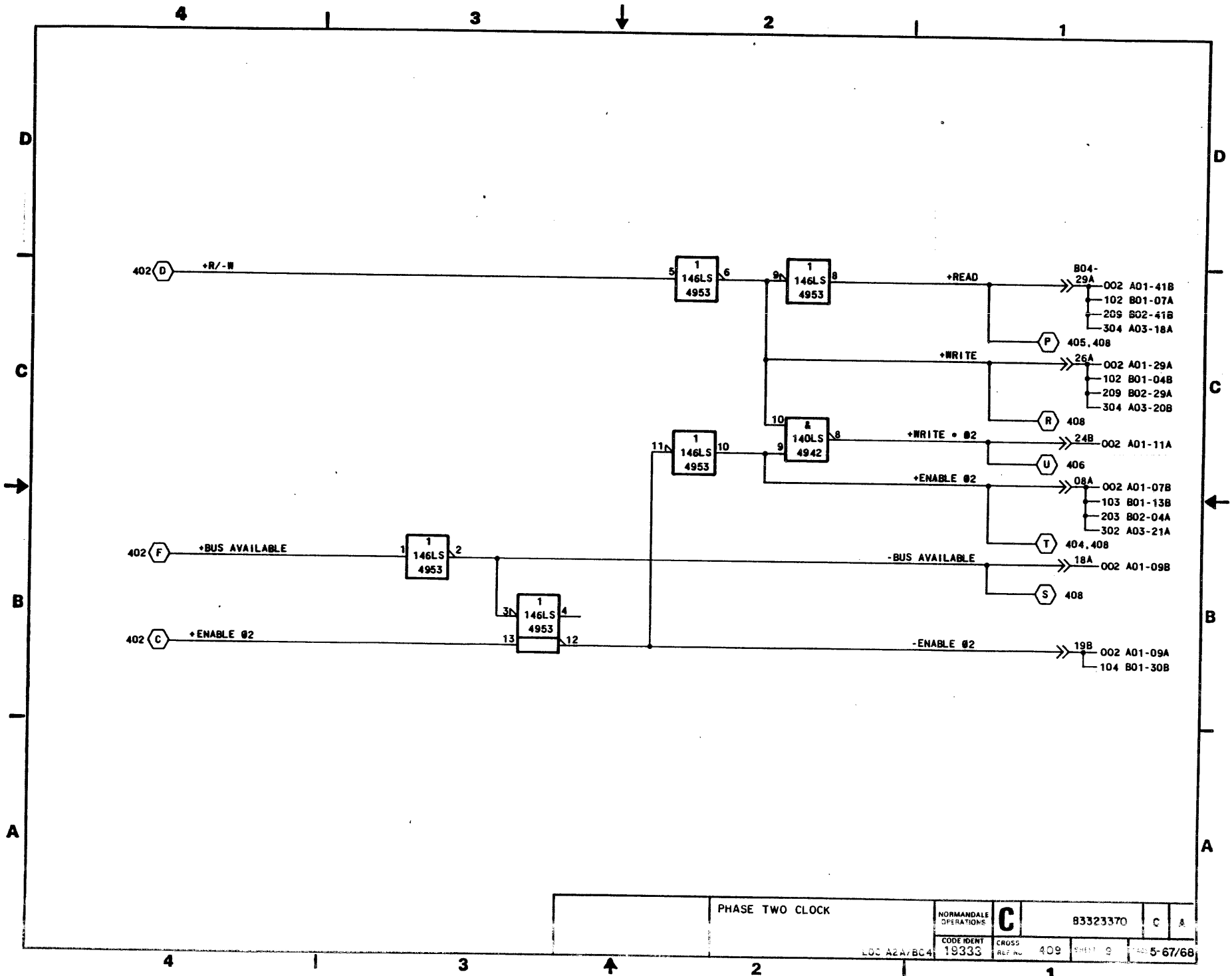


ROM AND RAM DECODE SELECT

NORMAN DALE OPERATIONS	<b>C</b>	83323370	E	A
CODE IDENT 19333		CROSS REF NO 407	SHEET 7	PAGE 5-65

LOC. A2A/B04

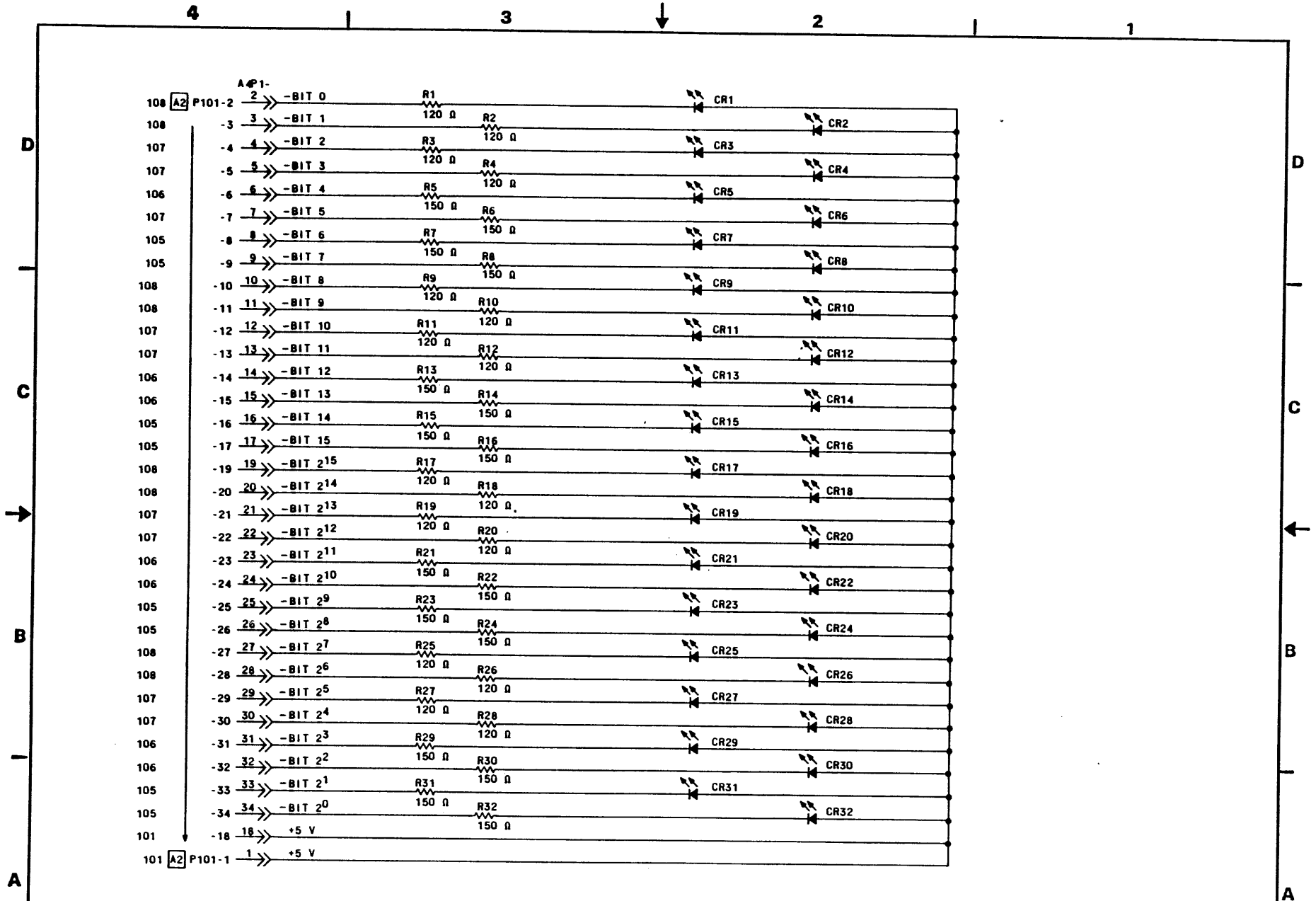




PHASE TWO CLOCK		NORMANDEALE OPERATIONS	<b>C</b>	83323370	C	A
LOC A2A/BC4	CODE IDENT 19333	CROSS REF. NO. 409	SHEET 9	5-67/68		





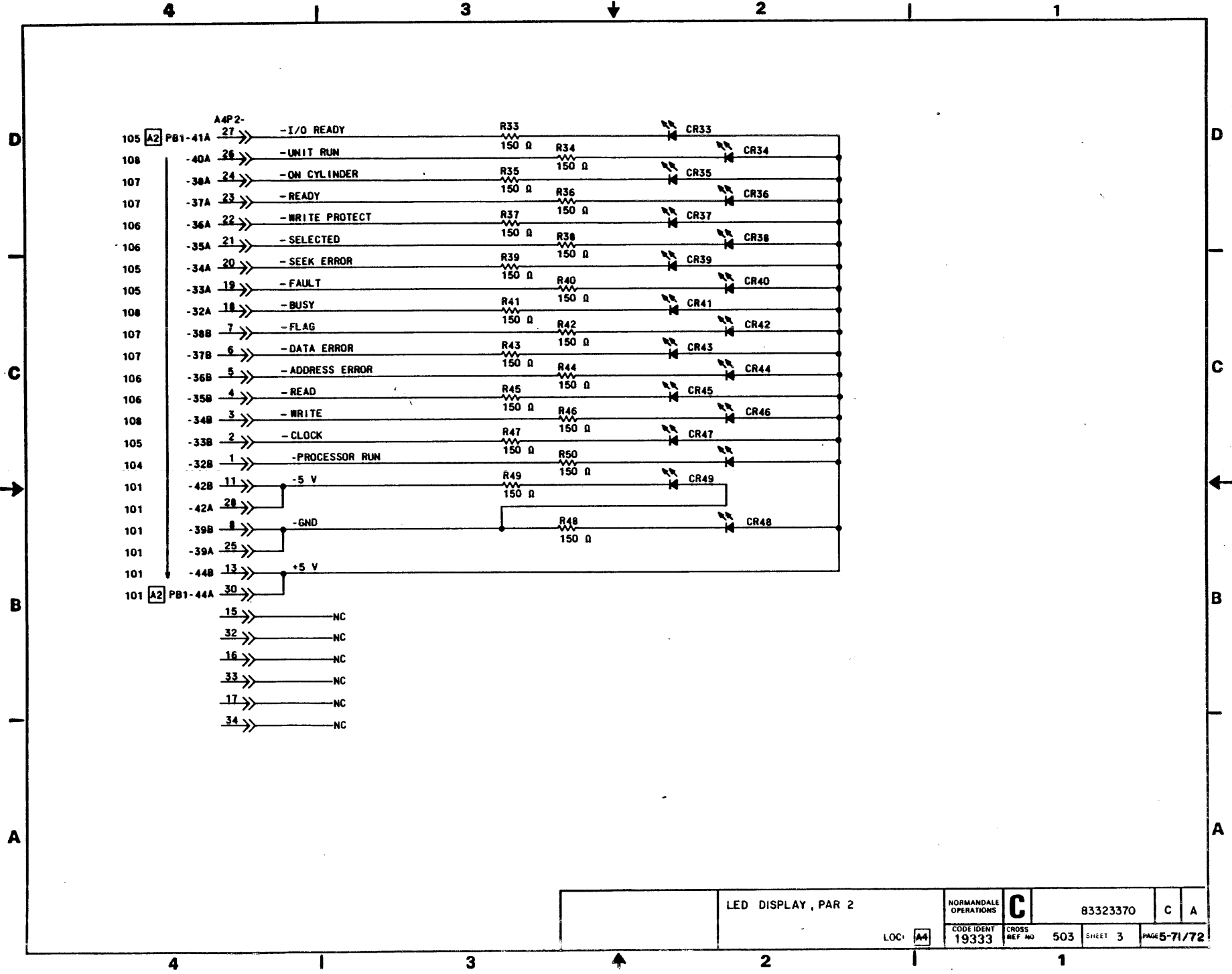


LED DISPLAY, PART 1

NORMANDALE OPERATIONS	<b>C</b>	83323370		C	A
		CODE IDENT 19333	CROSS REF NO 502	SHEET 2	PAGE 5-70

LOC: A4





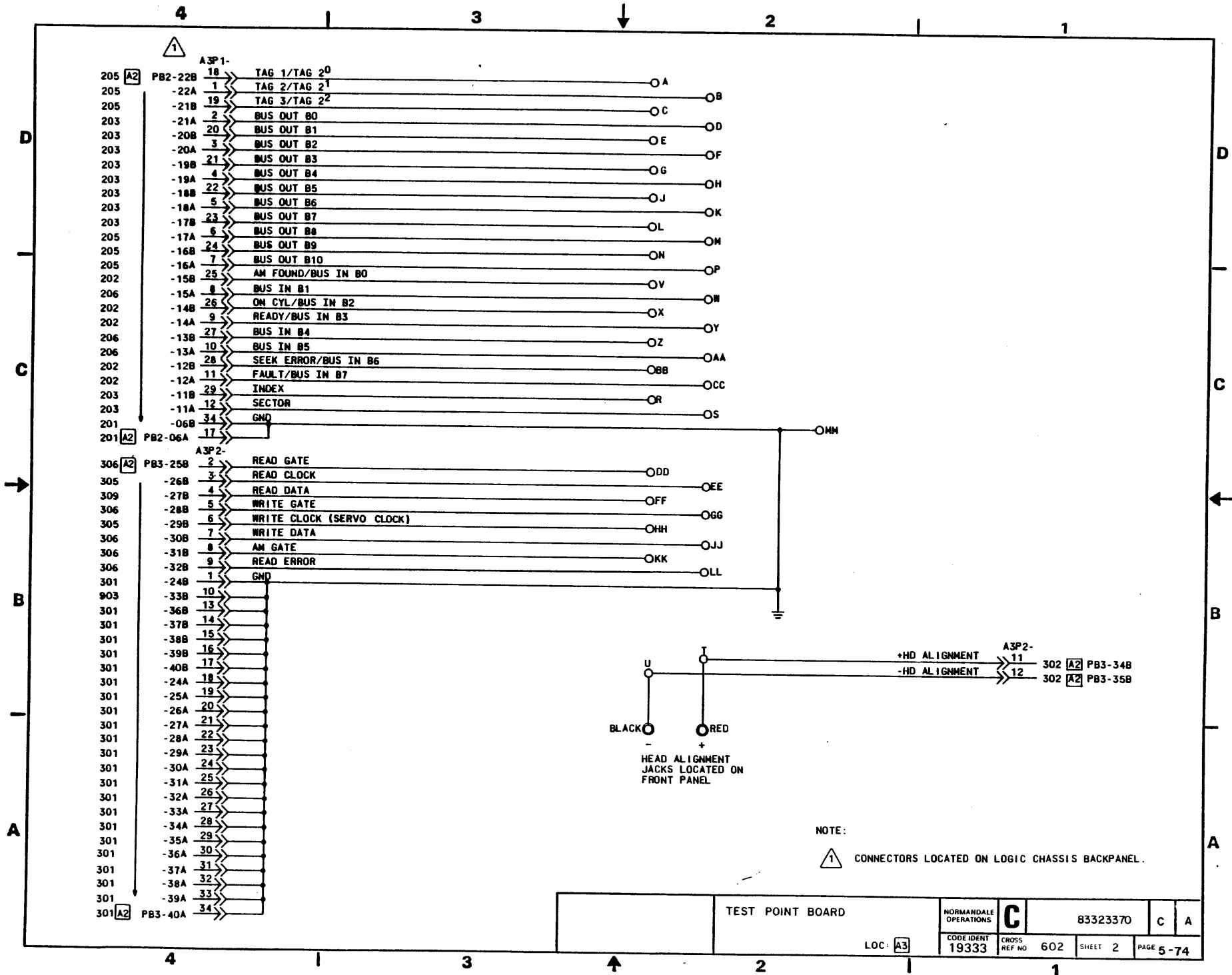
LED DISPLAY, PAR 2

NORMANDALE OPERATIONS	<b>C</b>	83323370	C	A
CODE IDENT 19333	CROSS REF NO 503	SHEET 3	PAGE 5-71/72	

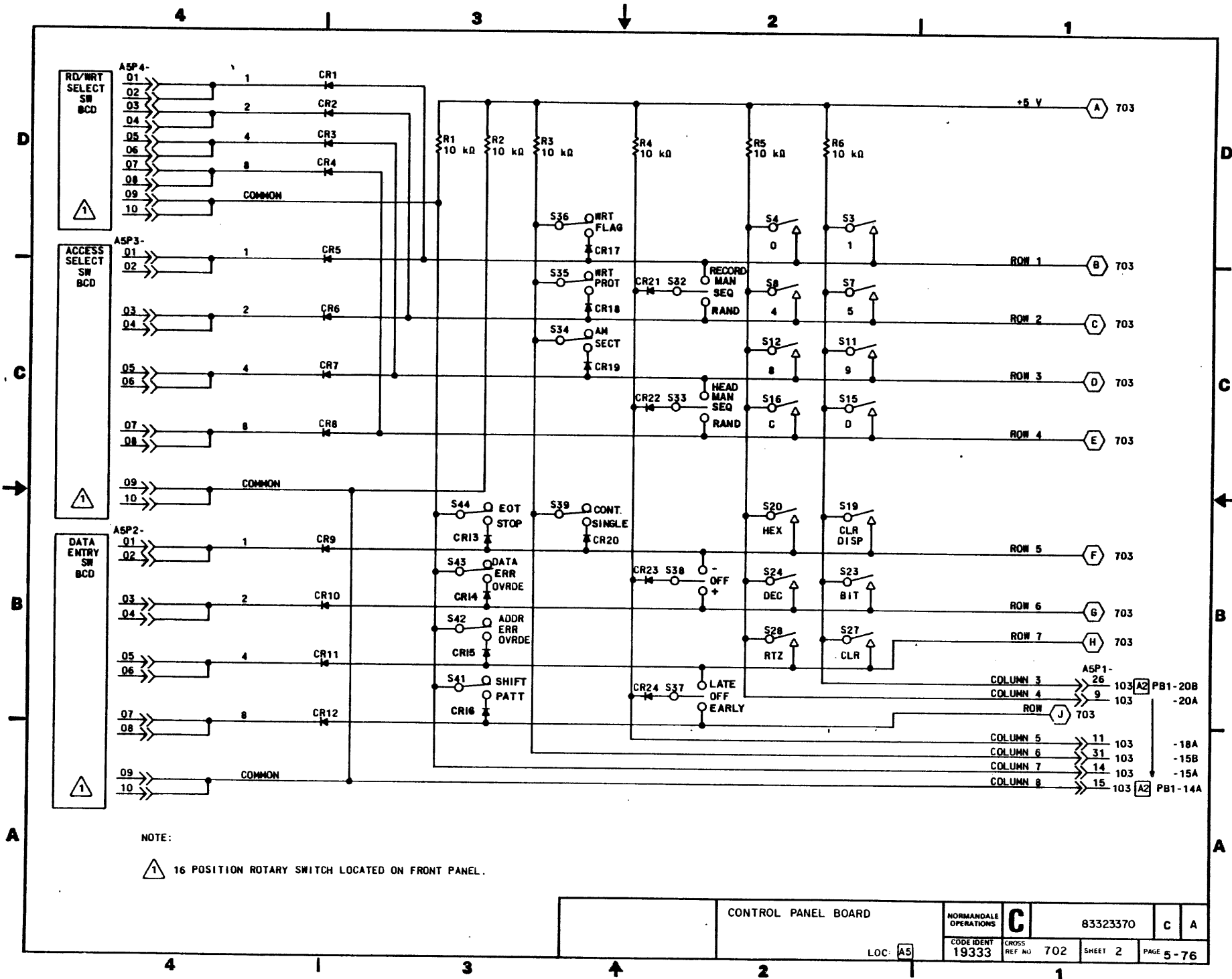
LOC: AA





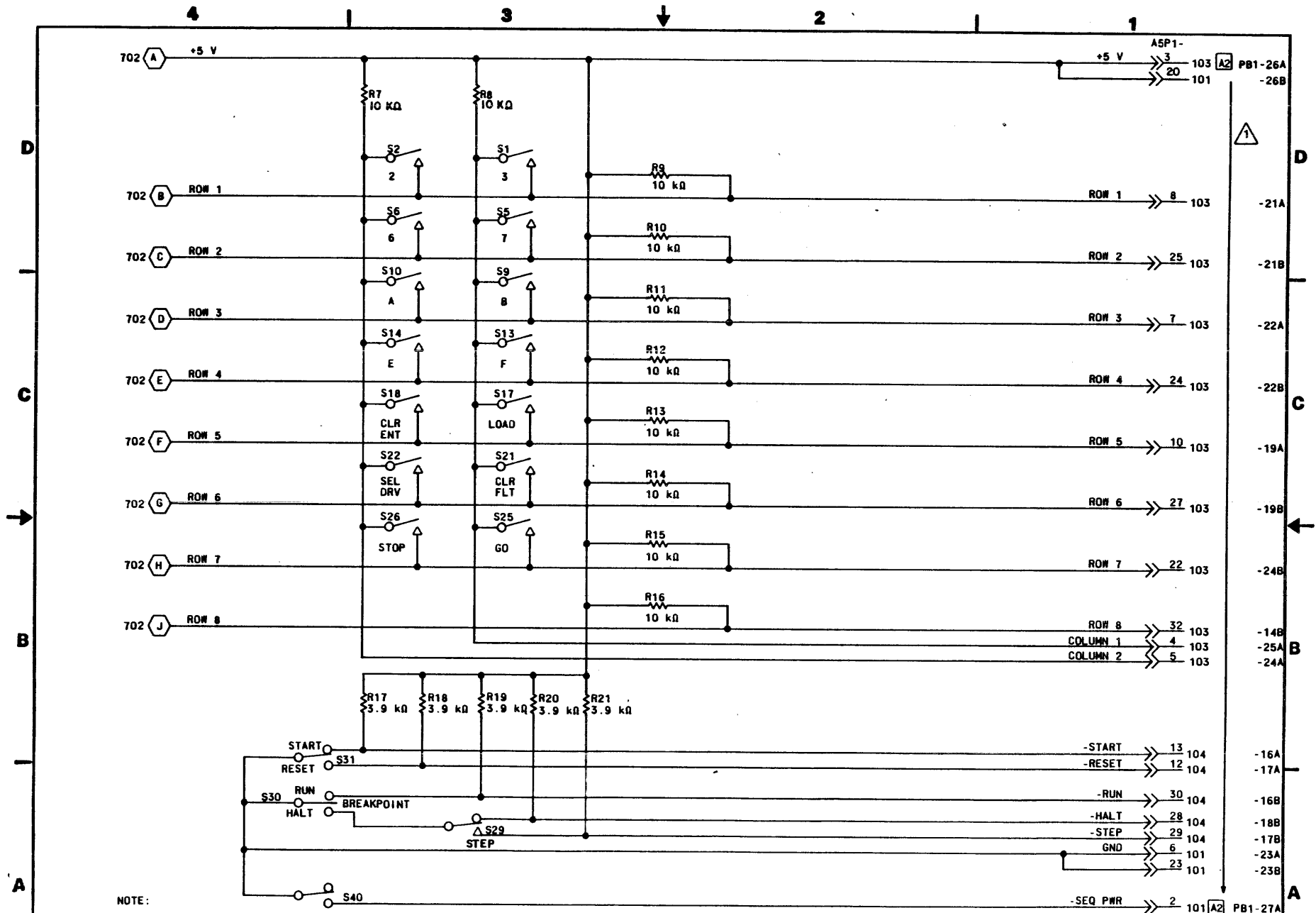






NOTE:  
 ⚠ 16 POSITION ROTARY SWITCH LOCATED ON FRONT PANEL.

CONTROL PANEL BOARD		NORMANDALE OPERATIONS	C	83323370	C	A
		CODE IDENT 19333				
		LOC: A5				



NOTE:

⚠ CONNECTOR LOCATED ON LOGIC CHASSIS BACKPANEL.

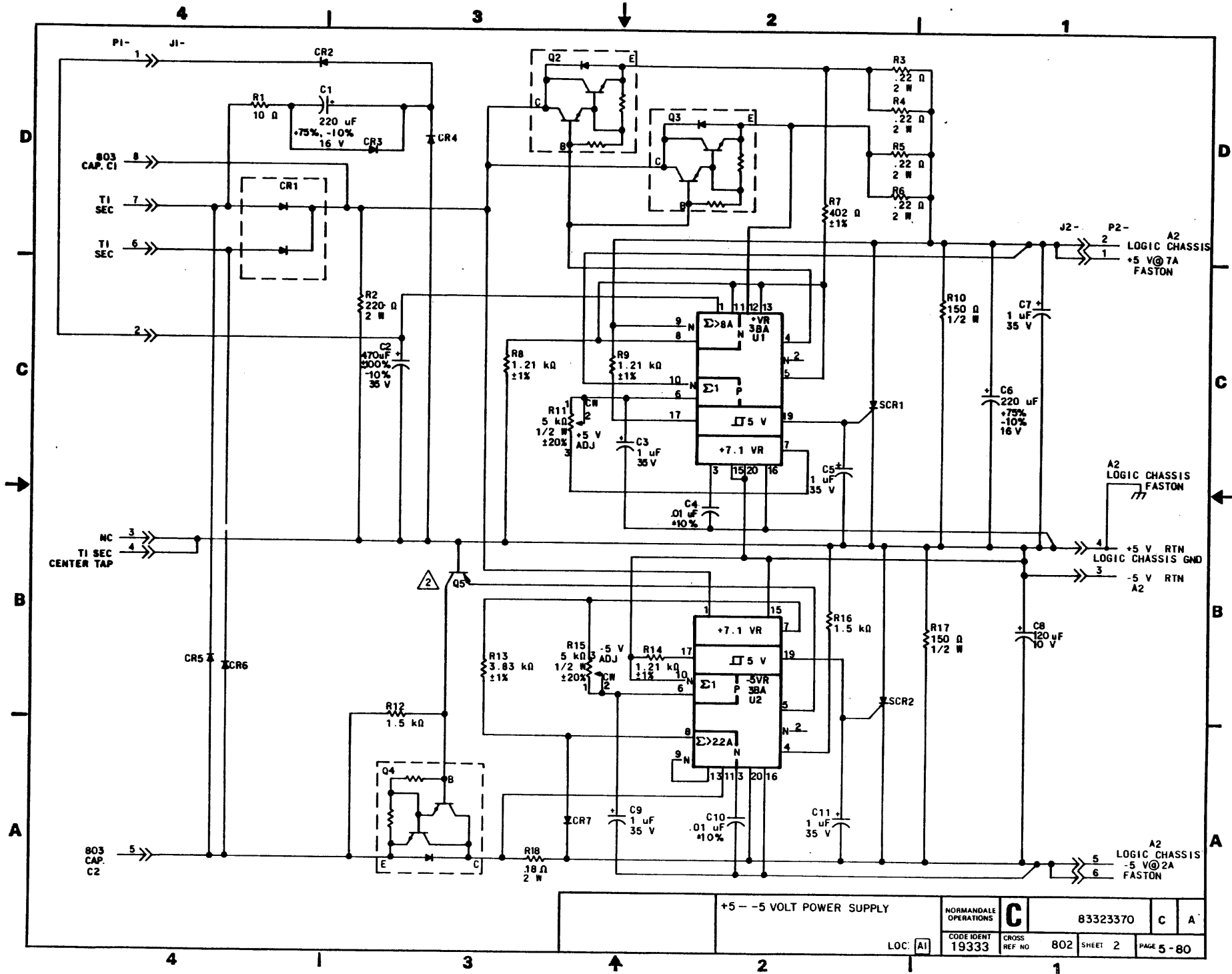
CONTROL PANEL BOARD

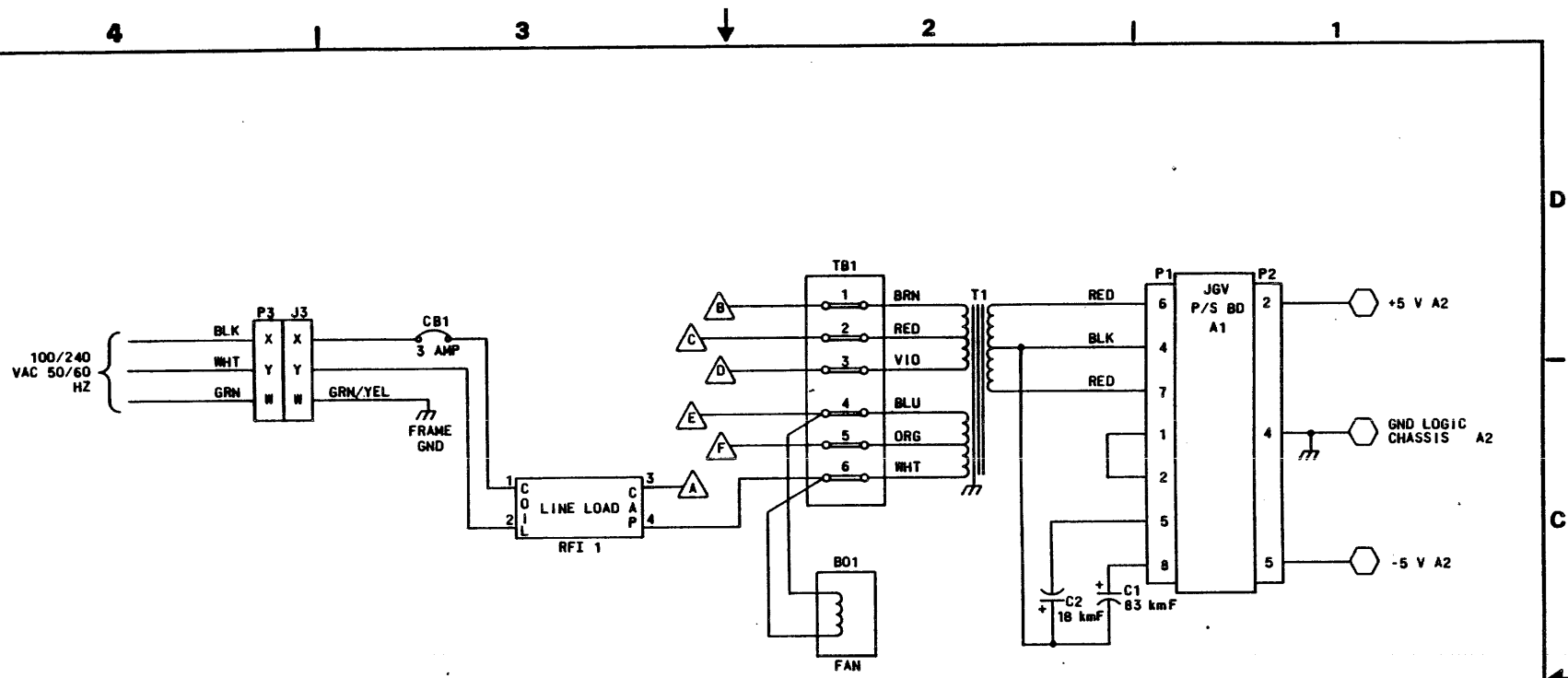
INORMANDALE OPERATIONS	<b>C</b>	83323370	C	A
CODE IDENT 19333	CROSS REF NO	703	SHEET	3
LOC	A5	PAU-5-77/78		











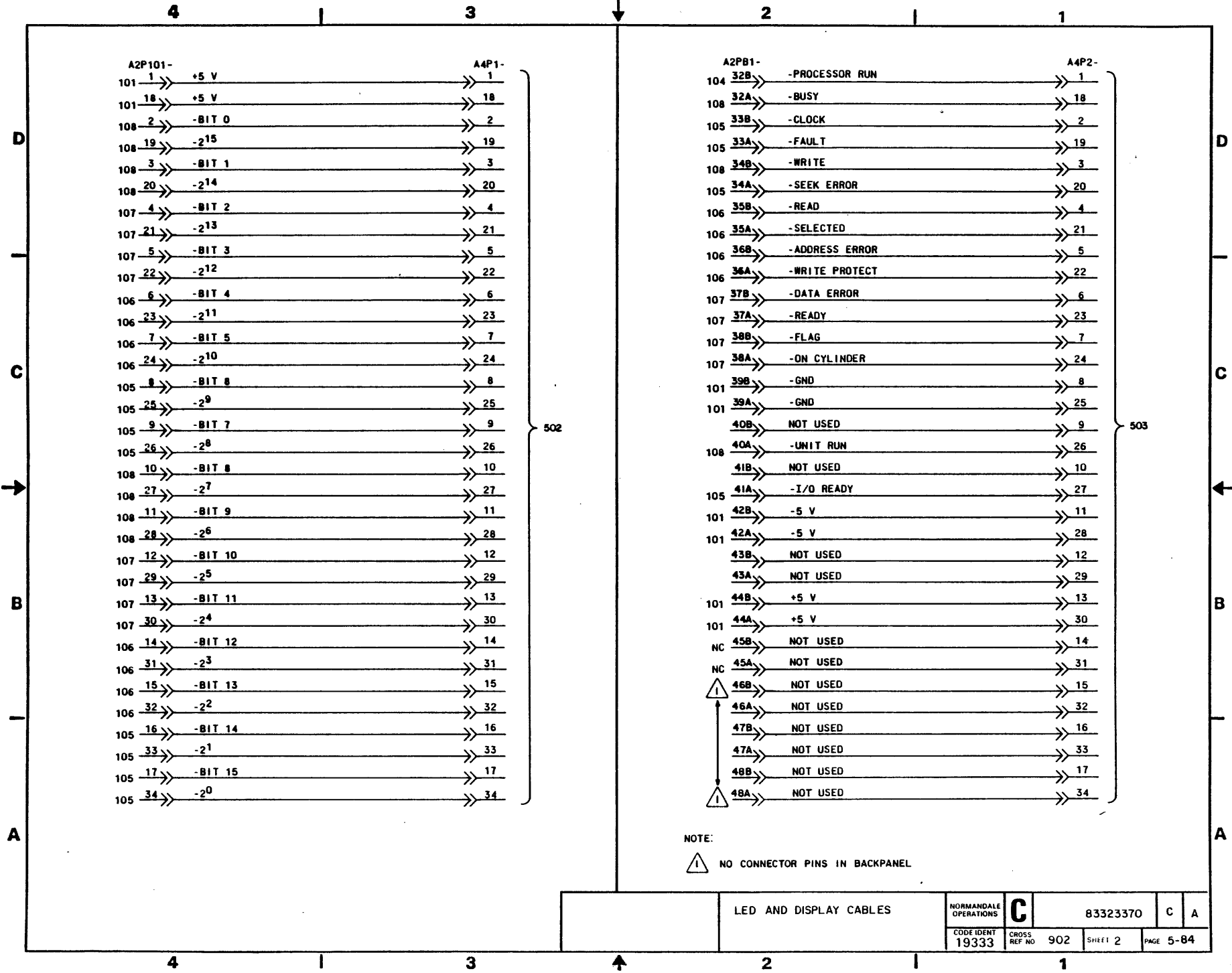
INPUT VOLTAGE	FREQ	JUMPER WIRE	TB1 TERMINAL CONNECTIONS
100	50/60	D-6	C TO F & A TO C
120	50/60	D-6	B TO E & A TO B
200	50/60	D-5	A TO C
220	50/60	D-4	A TO C
240	50/60	D-4	A TO B

- ⚠
- ⚠
- ⚠

NOTE:  
 ⚠ FIX UNUSED JUMPER TO TB1 TERMINALS FOR STORAGE.








A2P101-		A4P1-	
101	1 >> +5 V	>> 1	
101	18 >> +5 V	>> 18	
108	2 >> -BIT 0	>> 2	
108	19 >> -2 <sup>15</sup>	>> 19	
108	3 >> -BIT 1	>> 3	
108	20 >> -2 <sup>14</sup>	>> 20	
107	4 >> -BIT 2	>> 4	
107	21 >> -2 <sup>13</sup>	>> 21	
107	5 >> -BIT 3	>> 5	
107	22 >> -2 <sup>12</sup>	>> 22	
106	6 >> -BIT 4	>> 6	
106	23 >> -2 <sup>11</sup>	>> 23	
106	7 >> -BIT 5	>> 7	
106	24 >> -2 <sup>10</sup>	>> 24	
105	8 >> -BIT 8	>> 8	
105	25 >> -2 <sup>9</sup>	>> 25	
105	9 >> -BIT 7	>> 9	
105	26 >> -2 <sup>8</sup>	>> 26	
108	10 >> -BIT 8	>> 10	
108	27 >> -2 <sup>7</sup>	>> 27	
108	11 >> -BIT 9	>> 11	
108	28 >> -2 <sup>6</sup>	>> 28	
107	12 >> -BIT 10	>> 12	
107	29 >> -2 <sup>5</sup>	>> 29	
107	13 >> -BIT 11	>> 13	
107	30 >> -2 <sup>4</sup>	>> 30	
106	14 >> -BIT 12	>> 14	
106	31 >> -2 <sup>3</sup>	>> 31	
106	15 >> -BIT 13	>> 15	
106	32 >> -2 <sup>2</sup>	>> 32	
105	16 >> -BIT 14	>> 16	
105	33 >> -2 <sup>1</sup>	>> 33	
105	17 >> -BIT 15	>> 17	
105	34 >> -2 <sup>0</sup>	>> 34	

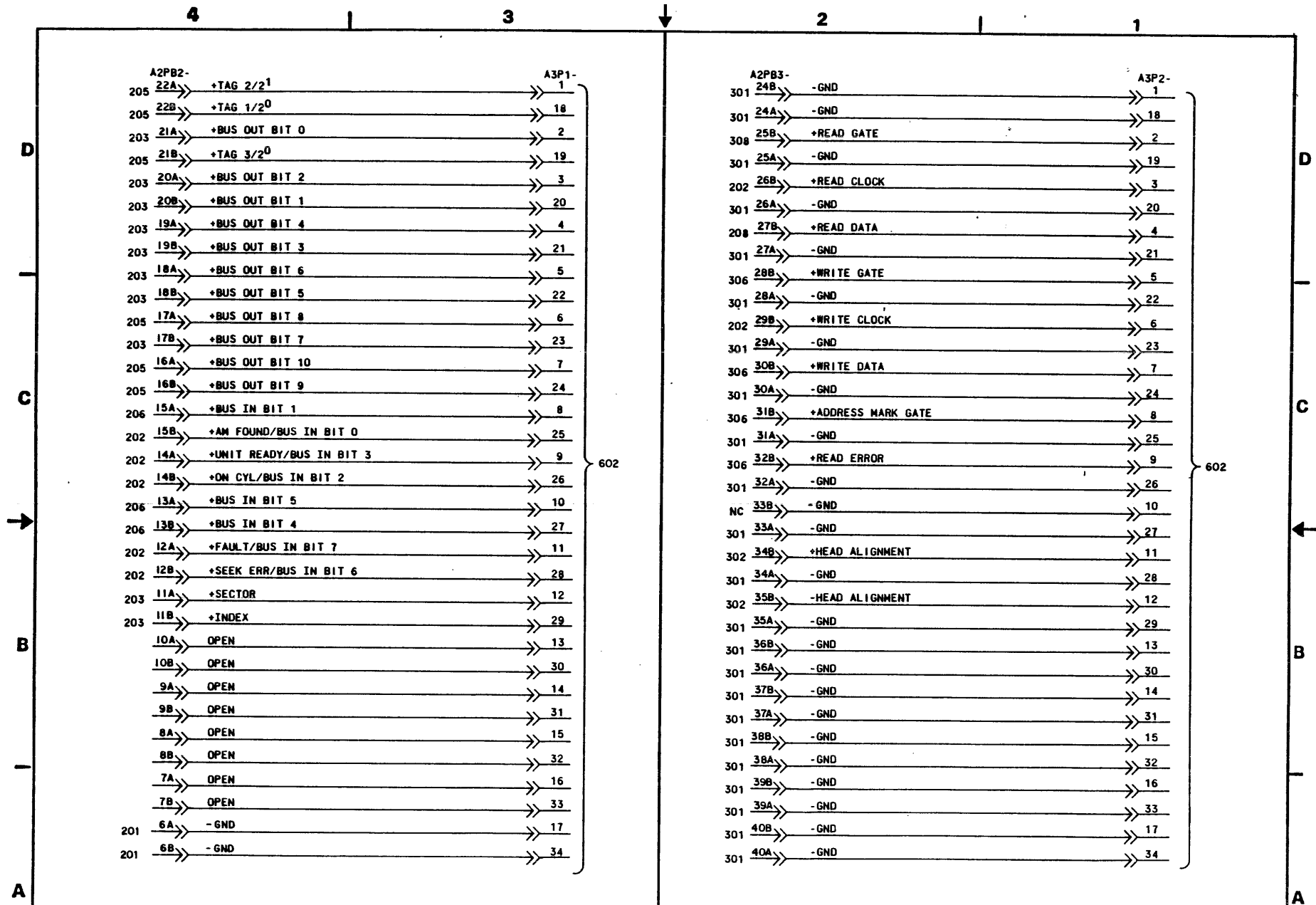
502

A2P81-		A4P2-	
104	32B >> -PROCESSOR RUN	>> 1	
108	32A >> -BUSY	>> 18	
105	33B >> -CLOCK	>> 2	
105	33A >> -FAULT	>> 19	
108	34B >> -WRITE	>> 3	
105	34A >> -SEEK ERROR	>> 20	
106	35B >> -READ	>> 4	
106	35A >> -SELECTED	>> 21	
106	36B >> -ADDRESS ERROR	>> 5	
106	36A >> -WRITE PROTECT	>> 22	
107	37B >> -DATA ERROR	>> 6	
107	37A >> -READY	>> 23	
107	38B >> -FLAG	>> 7	
107	38A >> -ON CYLINDER	>> 24	
101	39B >> -GND	>> 8	
101	39A >> -GND	>> 25	
	40B >> NOT USED	>> 9	
108	40A >> -UNIT RUN	>> 26	
	41B >> NOT USED	>> 10	
105	41A >> -I/O READY	>> 27	
101	42B >> -5 V	>> 11	
101	42A >> -5 V	>> 28	
	43B >> NOT USED	>> 12	
	43A >> NOT USED	>> 29	
101	44B >> +5 V	>> 13	
101	44A >> +5 V	>> 30	
NC	45B >> NOT USED	>> 14	
NC	45A >> NOT USED	>> 31	
	46B >> NOT USED	>> 15	
	46A >> NOT USED	>> 32	
	47B >> NOT USED	>> 16	
	47A >> NOT USED	>> 33	
	48B >> NOT USED	>> 17	
	48A >> NOT USED	>> 34	

503

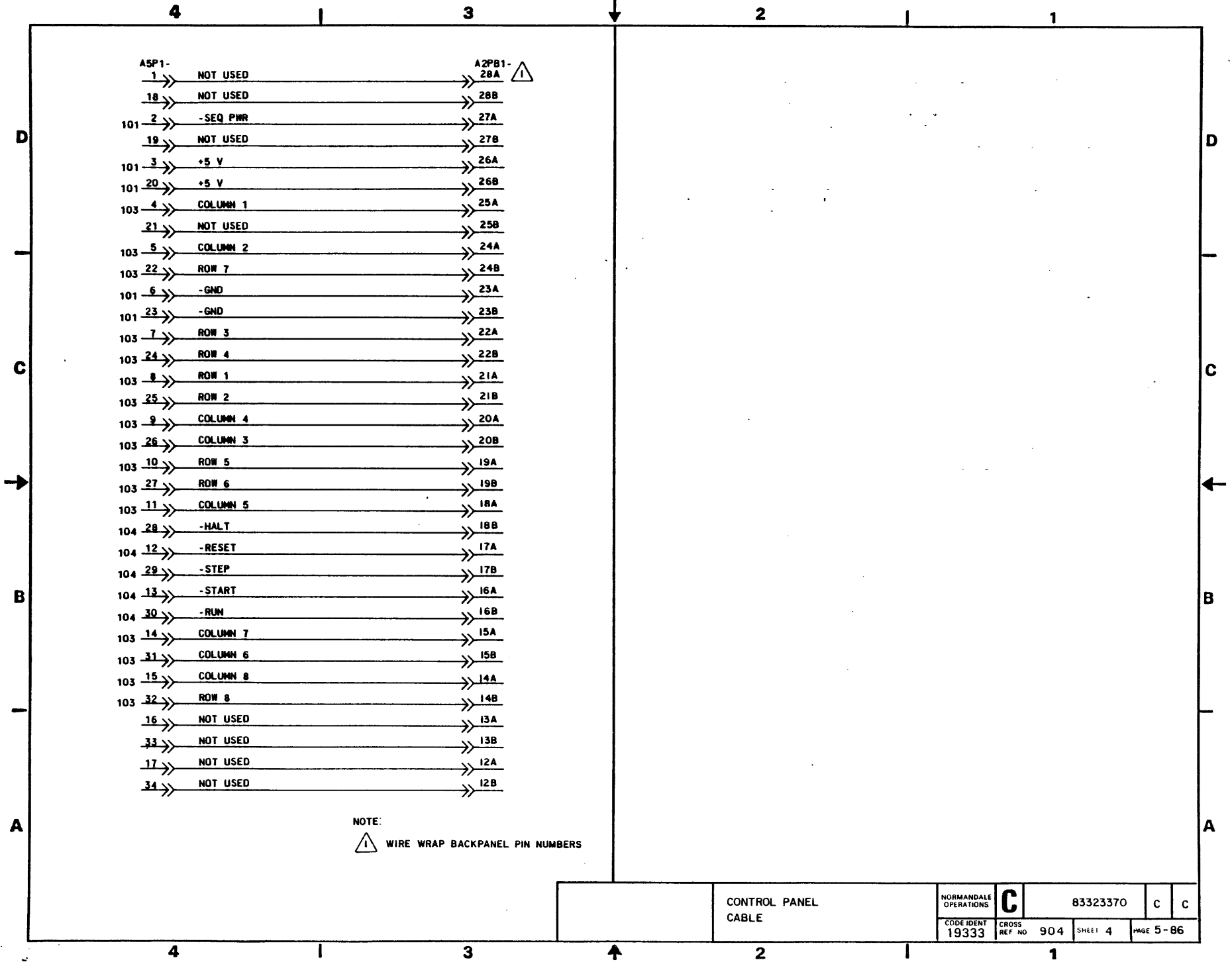
NOTE:  
 NO CONNECTOR PINS IN BACKPANEL


LED AND DISPLAY CABLES		NORMANDALE OPERATIONS	<b>C</b>	83323370	C	A
CODE IDENT	CROSS REF NO	902	SHEET 2	PAGE 5-84		
19333						



TEST POINT CABLES

NORMANDEALE OPERATIONS	<b>C</b>	83323370	C	A
CODE IDENT 19333	CROSS REF. No.	903	SHEET 3	PAGE 5-85



ASP1-	Connection	A2PB1-28A
1	NOT USED	28A 
18	NOT USED	28B
2	-SEQ PWR	27A
19	NOT USED	27B
3	+5 V	26A
20	+5 V	26B
4	COLUMN 1	25A
21	NOT USED	25B
5	COLUMN 2	24A
22	ROW 7	24B
6	-GND	23A
23	-GND	23B
7	ROW 3	22A
24	ROW 4	22B
8	ROW 1	21A
25	ROW 2	21B
9	COLUMN 4	20A
26	COLUMN 3	20B
10	ROW 5	19A
27	ROW 6	19B
11	COLUMN 5	18A
28	-HALT	18B
12	-RESET	17A
29	-STEP	17B
13	-START	16A
30	-RUN	16B
14	COLUMN 7	15A
31	COLUMN 6	15B
15	COLUMN 8	14A
32	ROW 8	14B
16	NOT USED	13A
33	NOT USED	13B
17	NOT USED	12A
34	NOT USED	12B

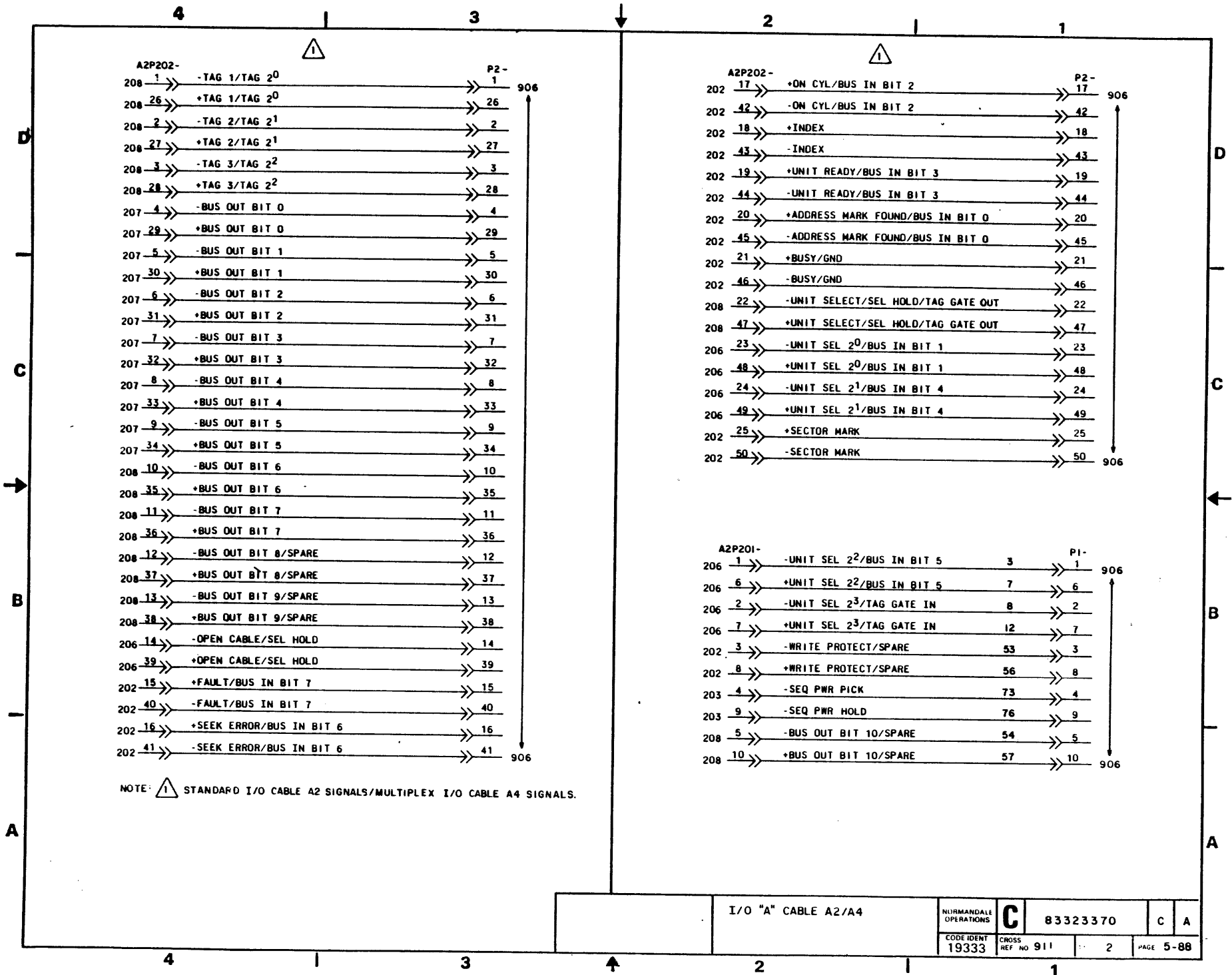
NOTE:  
 WIRE WRAP BACKPANEL PIN NUMBERS

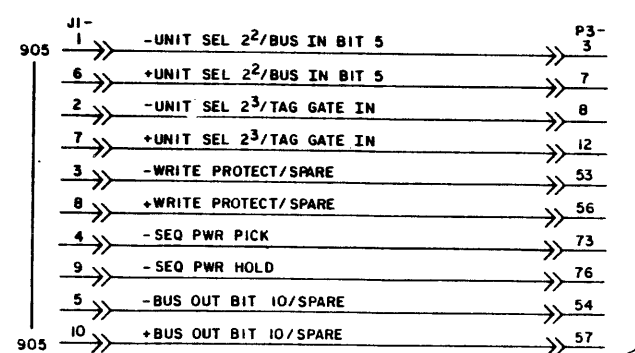
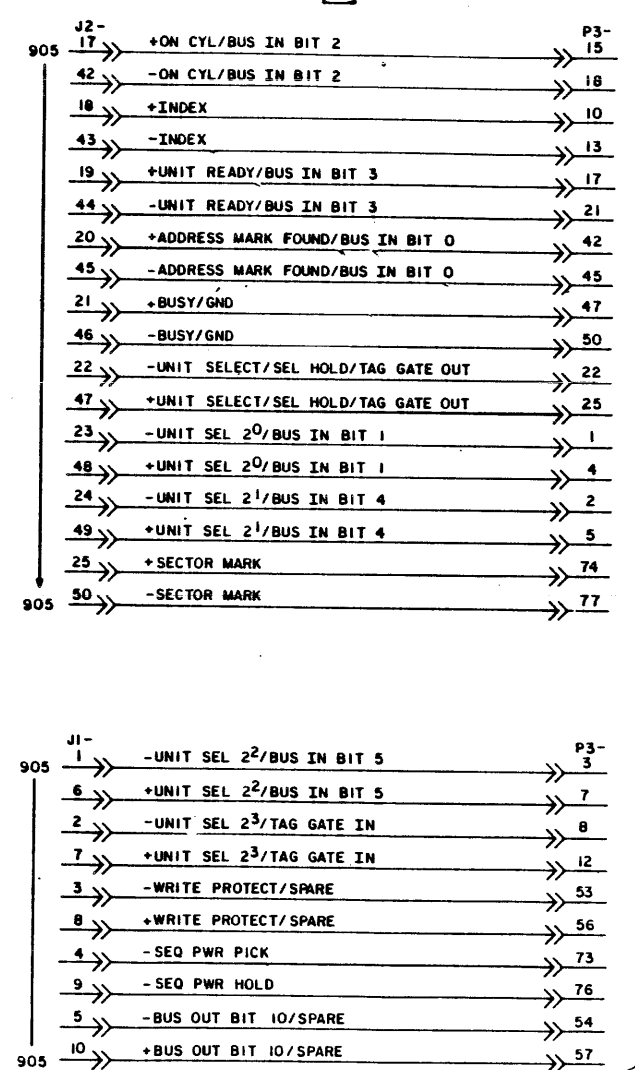
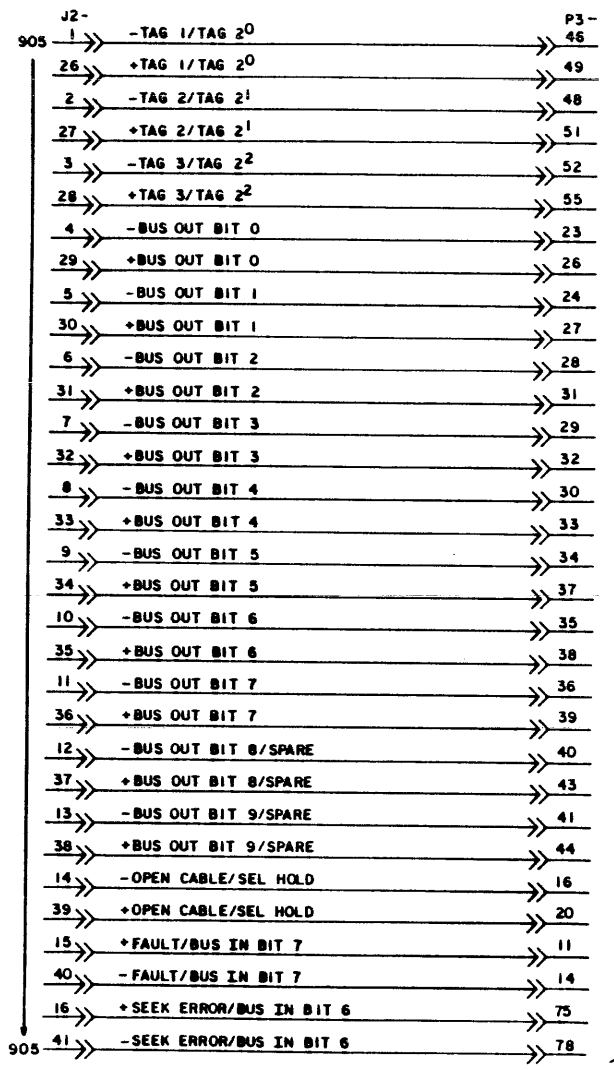
CONTROL PANEL  
 CABLE

NORMANDEALE OPERATIONS	<b>C</b>	83323370		C	C
		CODE IDENT 19333	CROSS REF NO 904	SHEET 4	PAGE 5-86



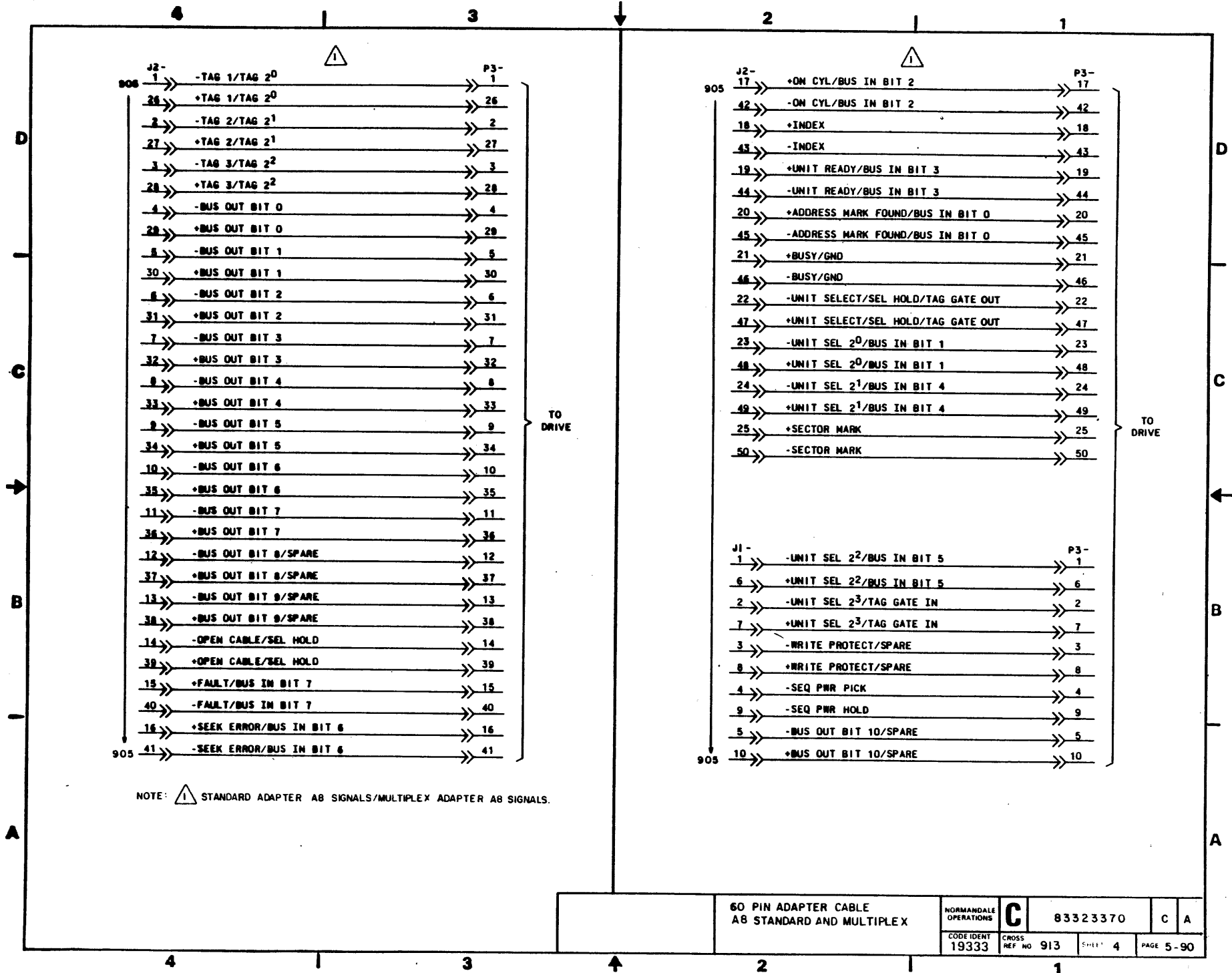






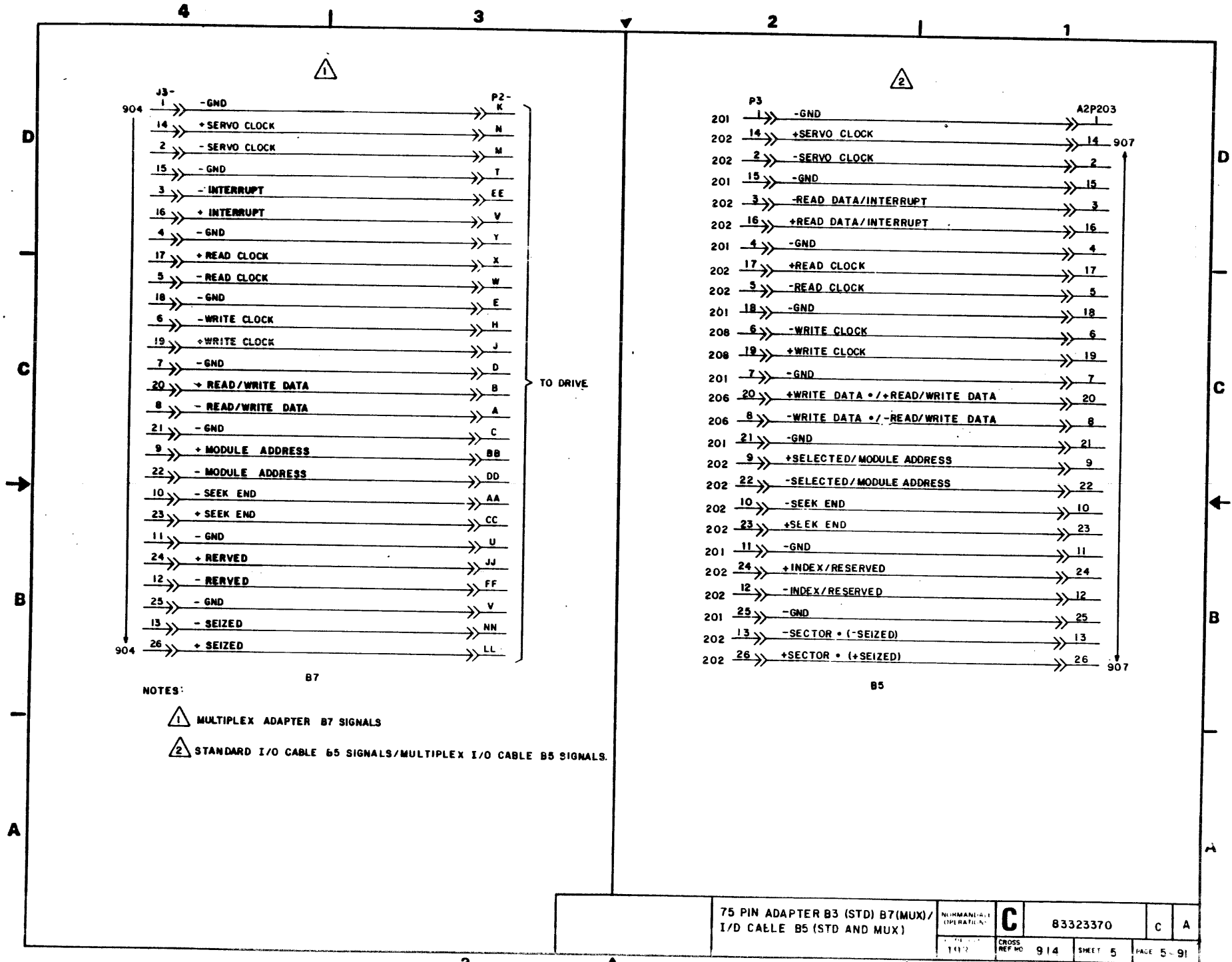
NOTE: STANDARD ADAPTER A6 SIGNALS/MULTIPLEX ADAPTER A10 SIGNALS.

I/O "A" 75 PIN ADAPTER CABLE (A6 STD) (A10 MUX)		NORMANDEALE OPERATIONS	<b>C</b>	83323370	C	A
CONF IDENT	19333	REV. NO.	912	PAGE	3	5-89



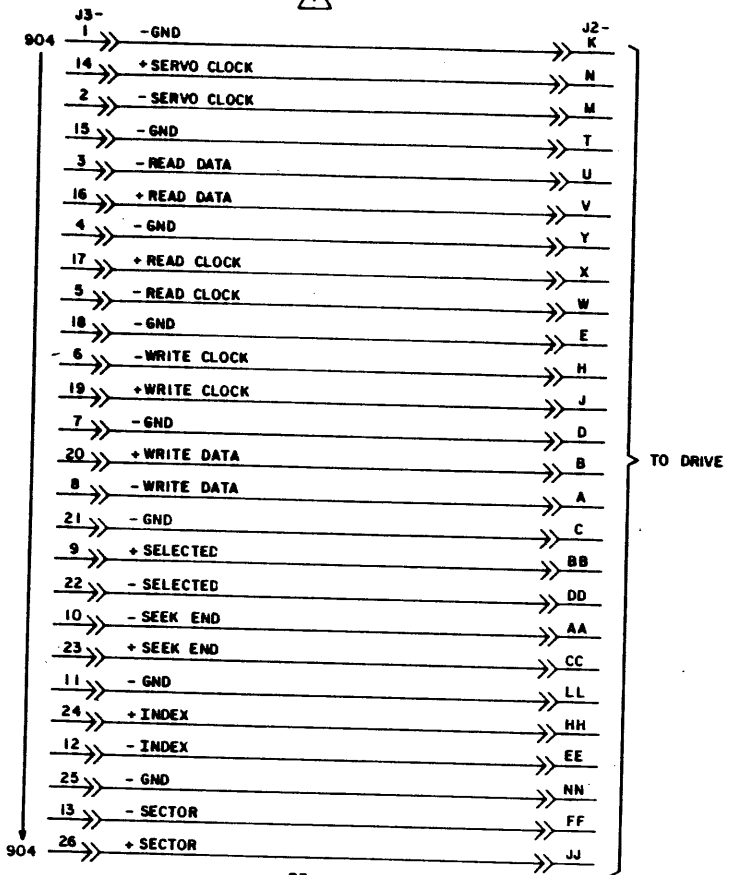
60 PIN ADAPTER CABLE  
AB STANDARD AND MULTIPLEX

NORMANDALE OPERATIONS	<b>C</b>	83323370	C	A
CODE IDENT 19333	CROSS REF NO 913	SHEET 4	PAGE 5-90	

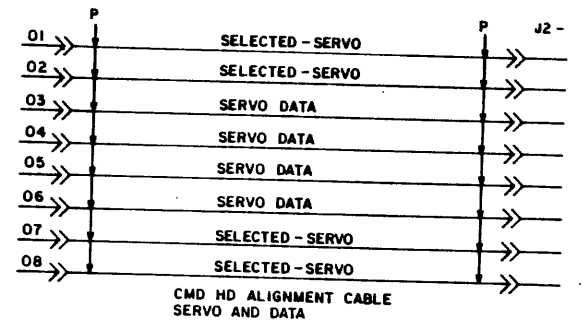
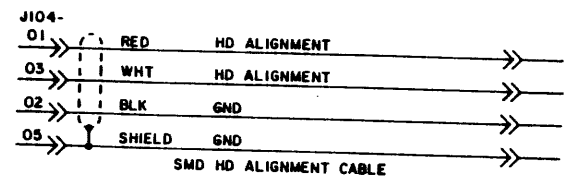
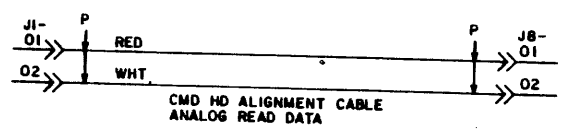


75 PIN ADAPTER B3 (STD) B7(MUX) / I/O CABLE B5 (STD AND MUX)

NONMANUAL OPERATION	<b>C</b>	83323370		C	A
		CROSS REF NO	914	SHEET 5	PAGE 5-91



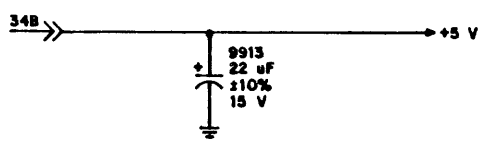
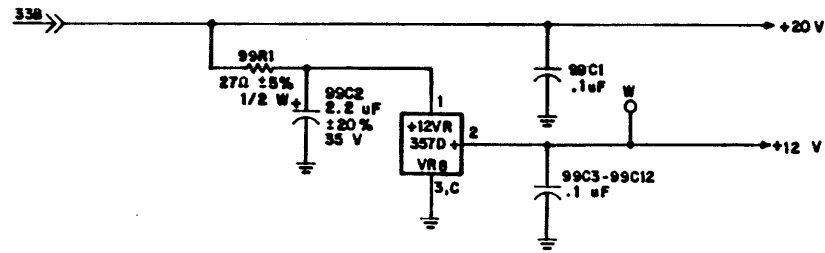
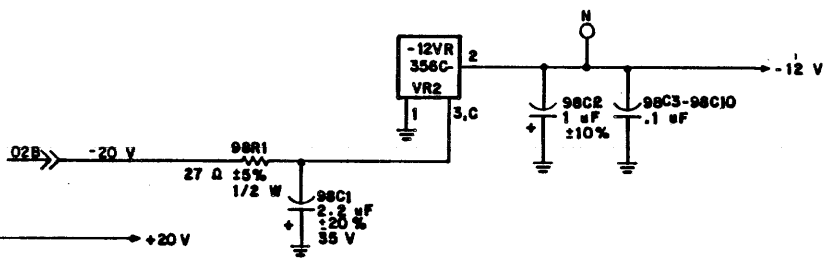
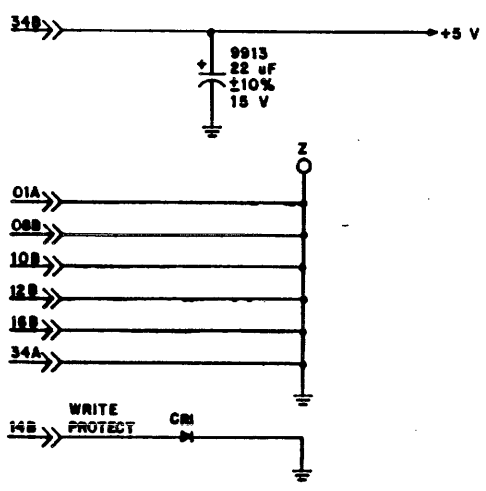
NOTE: STANDARD ADAPTER B3 SIGNALS.



75 PIN ADAPTER CABLE B3 (STD)/  
HEAD ALIGNMENT CABLES

NORTHAMPTON OPERATIONS	<b>C</b>	83323370		C	A
		EDITION 19333	REV. 915	SHEET 6	PAGE 5-92

REVISIONS					
REV.	ECO	DESCRIPTION	DRAFT	DATE	CHK'D
A	PE2300	RELEASED		3-8-78	
B	PE24133	CHG RES VALUES	DD D	5-24-78	RE
C	PE21000	ADD MOCC STICKER		4-18-80	
D	PE24323	CHG RELAYS-DELETE K4CR1 AND K4CR2		9-24-80	DBD
E	PE24133	CHG POT		12-18-80	DBD
F	PE20277	CHG POT		1-15-81	DD
G	DM1804	CHG TRN'S AND CAP		8-25-81	
H	DJ1019	ADD CONNECTOR		12-18-84	



UNUSED DIODE ARRAYS

LOCATION	PINS
CRP-B2	1, 2, 3, 4, 13, 14, 15, 16

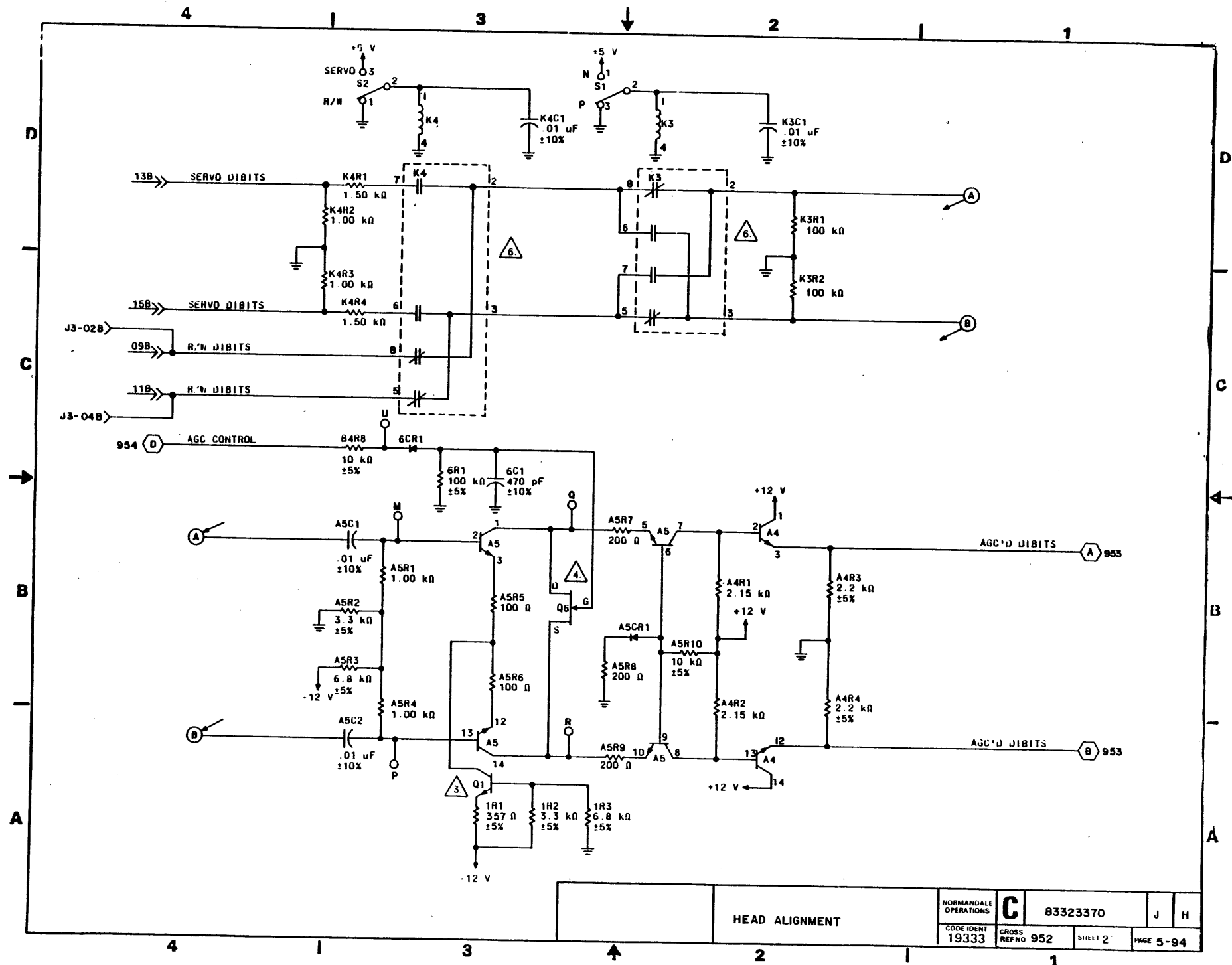
DRAWN	
CHECKED	
ENGINEER	
APPROVED	

HEAD ALIGNMENT  
TYPE: AZPV

TB 216 A

NORMANDEALE OPERATIONS	<b>C</b>	83323370	J	H
CODE IDENT 19333	CROSS REF NO 951	SHEET 1 of 4	PAGE 5-93	

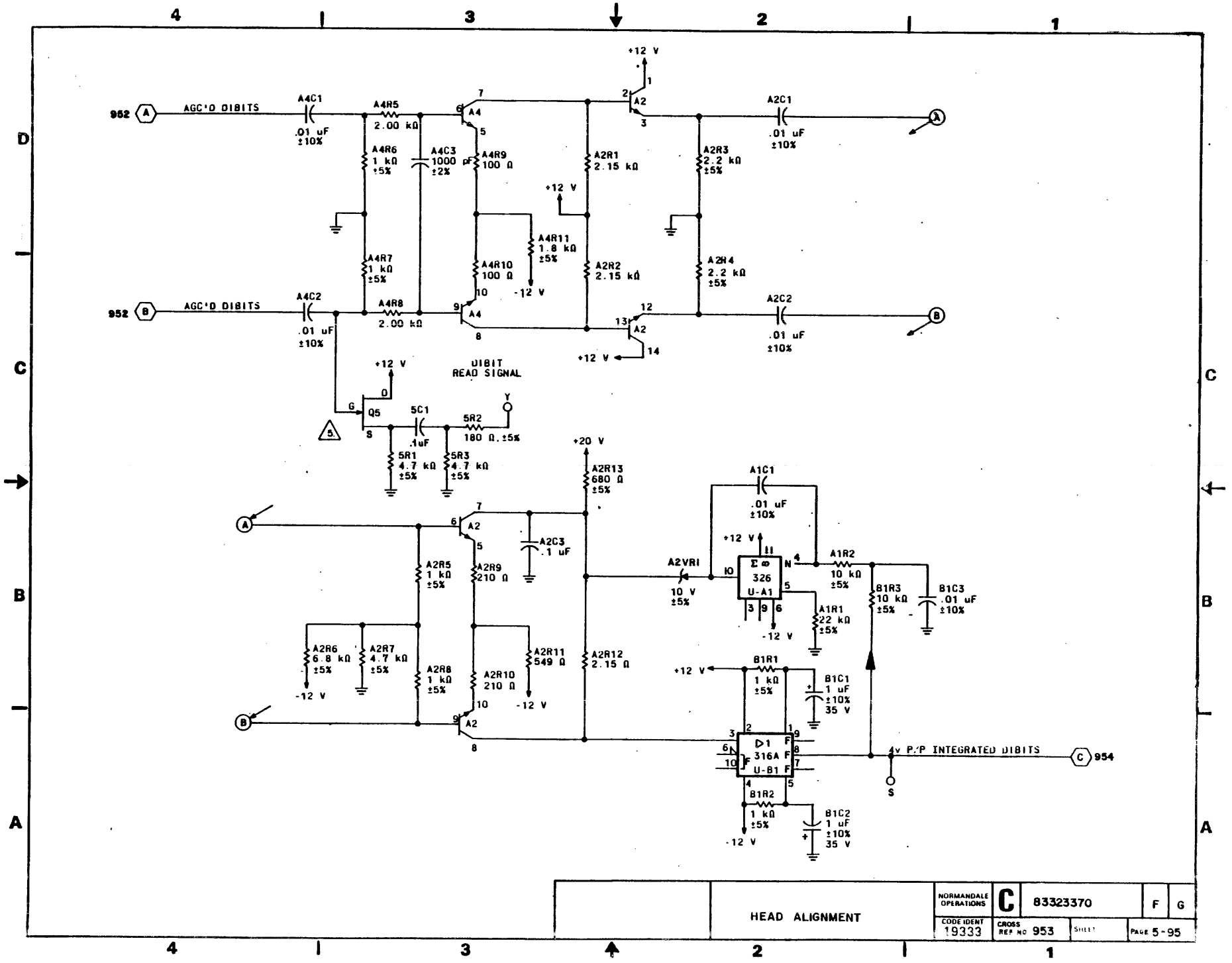
REF 54285400

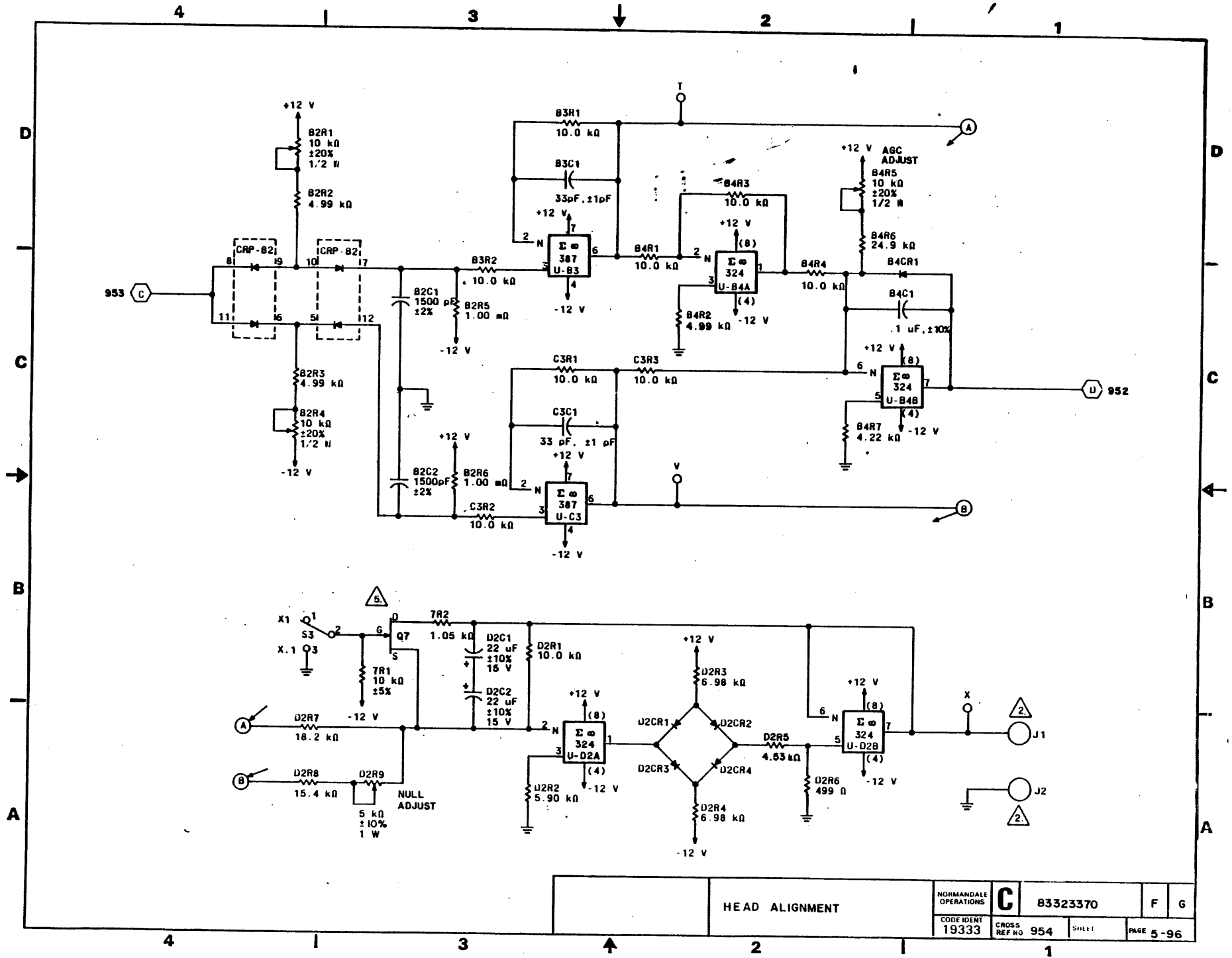


HEAD ALIGNMENT

NORMANDALE OPERATIONS	<b>C</b>	83323370	J	H
CODE IDENT 19333	CROSS REFNO 952	SHEET 2	PAGE 5-94	







HEAD ALIGNMENT

NORMANDEALE OPERATIONS	<b>C</b>	83323370	F	G
CODE IDENT 19333	CROSS REF NO	954	SHEET	PAGE 5-96

**SECTION 6**

**WIRE LIST**

---

## INTRODUCTION

This section contains wire lists for wiring the logic chassis backpanel of the TB216 Field Test Unit. It explains how to use the lists and identifies the columns shown on the lists. Only the wiring for the logic chassis backpanel is shown on the wire lists. All other wiring is shown on the cabling diagrams.

## READING OF WIRE LIST

Wire lists show the signal name, origin, destination, and Z level of all wirewrap connections on the logic chassis backpanel. The wires are listed in the order of card location and pin number. The lowest numbered card location and pin number are listed first, and the highest numbered card number and pin location are listed last. The wire list is a double-ended list. This means that all wires are listed twice; each end is listed first as the origin and second as the destination. An explanation of all the columns used on the wire list follows.

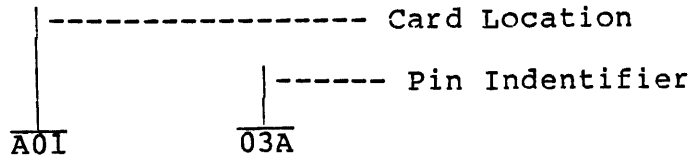
## SIGNAL NAME

The name of the signal carried by each wire appears in abbreviated form in the first column of the wire list. A complete signal name for each abbreviation is given in the list of abbreviations in the beginning of the manual.

## ORIGIN/DESTINATION

The origin column identifies the card location and pin number on which the wire begins. The destination column identifies the location of the opposite end of the wire. Both columns contain a six character number that specifies the points where the wire is connected. The first three characters represent that card location. The second three characters represent the pin number that appears in the Origin/Destination columns

follows:



### Z LEVEL NOTES

The Z level refers to the position of the wire on the pin. There are two Z levels on all pins (refer to figure 6-1). Z level 1 identifies the wirewrap connection closer to the surface of the wirewrap. Z level 2 identifies the wirewrap connection farthest from the surface of the wirewrap panel. All pins may contain two wires. However, if the pin contains only one wire, that wire will be connected on Z level 1. The same Z level is maintained at both ends of all wirewrap connections.

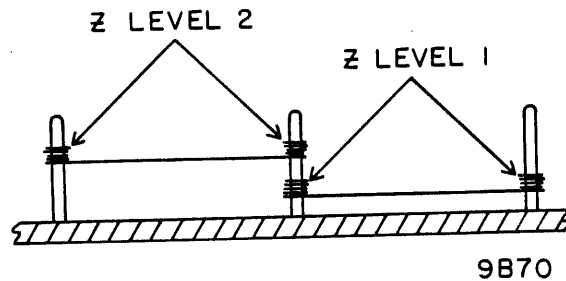


Figure 6-1. Z Levels

TITLE		WL		DOCUMENT NO.	SHEET NO.	REV.
LOGIC WIREWRAP				82361904	1	D
SIGNAL NAME OR NUMBER IDENTIFICATION	ORIGIN	DESTI- NATION	Z LEVEL	NOTES		
-DATA7		A0103A	B0203A 2			
-DATA7		A0103A	A0304A 1			
-DATA3		A0103B	B0203B 2			
-DATA3		A0103B	A0314A 1			
-DATA6		A0104A	A0204A 2			
-DATA6		A0104A	A0305B 1			
-DATA0		A0104B	A0204B ?			
-DATA0		A0104B	A0317B 1			
-DATA2		A0105A	A0205A 2			
-DATA2		A0105A	A0315B 1			
-DATA1		A0105B	A0205B 2			
-DATA1		A0105B	A0316A 1			
+R/-W		A0107A	B0204B ?			
+R/-W		A0107A	A0318B 1			
+ENCL2		A0107B	B0204A 2			
+ENCK2		A0107B	A0321A 1			
+BAVAL		A0108A	B0419A 1			
+VMA		A0108B	B0416B 1			
-ENCK2		A0109A	B0130B 2			
-BAVAL		A0109B	A0209B 1			
-MEMSL		A0110A	B0429B 1			
-ENLAT		A0110B	B0421A 1			
-WTCK2		A0111A	B0424B 1			
+RESET		A0111B	B0117A 1			
+ADD 0		A0113A	B0205A 1			
+ADD 0		A0113A	B0341B 2			
+ADD 1		A0113B	B0207A 1			
+ADD 1		A0113B	B0341A 2			
+ADD 2		A0114A	A0228B 2			
+ADD 2		A0114A	A0319A 1			
+ADD 3		A0114B	A0427B 1			
+ADD 4		A0115A	A0437A 1			
+ADD 5		A0115B	A0219B 2			
+ADD 6		A0116A	A0414B 1			
+ADD 7		A0116B	B0208B 2			
+ADD 7		A0116B	A0313A 1			
+ADD 8		A0117A	A0433B 1			
+ADD 9		A0117B	B0413A 1			
+ADD 10		A0118A	B0413B 1			
-A008X		A0118B	B0414A 1			
+ADD 11		A0119A	B0417A 1			
+ADD 12		A0119B	B0408B 1			
+ADD 13		A0120A	B0410A 1			
+ADD 14		A0120B	B0411B 1			
+ADD 15		A0121A	B0410B 1			
-IRQ		A0121B	B0109B 2			
-BKPNT		A0125A	B0128B 1			
+WRITE		A0129A	B0229A 1			
+READ		A0141B	B0241B ?			
+PEAD		A0141B	A0318A 1			
-DATA5		A0143A	B0243A 2			
-DATA5		A0143A	A0307A 1			
-DATA4		A0143B	B0243B 2			
-DATA4		A0143B	A0308B 1			
-DATA5		A0204A	B0425A 1			

TITLE		WL		DOCUMENT NO.	SHEET NO.	REV.
LOGIC WIREWRAP					2	B
SIGNAL NAME OR NUMBER IDENTIFICATION	ORIGIN	DESTI- NATION	Z LEVEL	NOTES		
-DATA6		A0204A	A0104A	2		
-DATA0		A0204B	B0417B	1		
-DATA0		A0204B	A0104B	2		
-DATA2		A0205A	B0416A	1		
-DATA7		A0205A	A0105A	2		
-DATA1		A0205B	B0417A	1		
-DATA1		A0205B	A0105B	2		
-PWR50		A0207B	B0127A	1		
-BAVAL		A0209B	B0418A	2		
-BAVAL		A0209B	A0109B	1		
+MUXIO		A0215A	B0236A	1		
+ENTPM		A0215B	B0240A	1		
+ENRCV		A0216B	A0224A	1		
+ADD 4		A0219A	A0437A	2		
+ADD 5		A0219B	A0415A	1		
+ADD 5		A0219B	A0115B	2		
+AMGT		A0220A	B0331B	1		
+WRTGT		A0221A	A0222A	1		
+WRTDA		A0221B	B0330B	1		
+WRTGT		A0222A	B0328B	2		
+WRTGT		A0222A	A0221A	1		
+ENRCV		A0224A	B0240B	2		
+ENRCV		A0224A	A0216B	1		
+R00AT		A0224B	B0327B	1		
+RDGT		A0225A	B0325B	1		
+FLTIO		A0225B	B0238B	1		
+BYTCK		A0235A	B0319A	1		
+BYTCK		A0235A	A0408A	1		
+SKEND		A0240B	A0417B	1		
+WPCLK		A0241B	A0332A	1		
-DATA7		A0304A	A0103A	1		
-DATA6		A0305B	A0104A	1		
-DATA5		A0307A	A0143A	1		
-DATA4		A0308B	A0143B	1		
+ENC0V		A0310B	A0311A	1		
+ENC0V		A0311A	A0310B	1		
+ADD 7		A0313A	A0115B	1		
-DATA3		A0314A	A0103B	1		
-DATA2		A0315B	A0105A	1		
-DATA1		A0315A	A0105B	1		
-DATA0		A0317B	A0104B	1		
+READ		A0319A	A0141B	1		
+R/-W		A0319B	A0107A	1		
+ADD 2		A0319A	A0114A	1		
+WRITE		A0320B	P0104B	2		
+ENCK2		A0321A	A0107B	1		
+WRCLK		A0332A	A0241B	1		
+CRCTR C3		A0343A	A0407A	1		
-ENG1-AM		A0403A	A0422A	2		
+G15US		A0404B	B0316B	1		
+CRCTR		A0407A	A0343A	1		
-CR-CTREN		A0407B	B0337B	1		

TITLE		WL		DOCUMENT NO.	SHEET NO.	REV.
LOGIC WIREWRAP					3	D
SIGNAL NAME OR NUMBER IDENTIFICATION	ORIGIN	DESTI- NATION	Z LEVEL	NOTES		
+BYTCK		A0408A	A0238A 1			
+G25US		A0409A	90312A 1			
-ENG2		A0410B	80322A 1			
100US	CLOCK	A0412B	A0417A 1			
+ADD	7	A0413A	80208B 1			
+ADD	7	A0413A	80110B 2			
+SKEND		A0413B	A0417B 2			
+ADD	6	A0414B	A0116A 1			
+ADD	5	A0415A	A0219B 1			
+ADD	1	A0416A	80207A 2			
+ADD	1	A0416A	80110A 1			
+ADD	0	A0416B	80205A 2			
+ADD	0	A0416B	80112B 1			
100US	CLOCK	A0417A	A0412B 1			
+SKEND		A0417B	A0240B 1			
+SKEND		A0417B	A0413B 2			
+INDEX		A0418A	80211B 2			
+SECTR		A0419A	80317A 1			
-ENGL-AM		A0422A	A0403A 2			
-ENGL-AM		A0422A	80321B 1			
+AMCTR		A0422B	80338A 1			
+ADD	3	A0427B	A0114B 1			
+R/-W		A0430A	80204B 1			
+R/-W		AC430A	80111B 2			
+ADD	2	A0431B	80228B 1			
+ADD	2	A0431B	80129B 2			
-IPQ		A0432A	80109B 1			
-RESET		A0433A	80113A 2			
-RESET		A0433A	80342A 1			
+ADD	9	A0433B	A0117A 1			
+ADD	4	A0437A	A0219A 2			
+ADD	4	A0437A	A0115A 1			
-DATA1		80103A	80415A 2			
-DATA2		80103B	80416A 2			
-DATA7		80104A	80426B 2			
+WRITE		80104B	80426A 1			
+WRITE		80104B	A0320B 2			
-DATA5		80105A	80425A 2			
-DATA5		80105B	80428A 2			
+READ		80107A	80429A 2			
-DATA4		80107B	80428B 2			
-DATA1		80108A	80417A 2			
-DATA0		80108B	80417B 2			
-NMI		80109A	80407B 1			
-IRQ		80109B	A0121B 2			
-IRC		80109B	A0432A 1			
+ADD	1	80110A	A0416A 1			
+ADD	7	80110B	A0413A 2			
-ENPLA1-2		80111A	80421B 1			
+R/-W		80111B	A0430A 2			
+ADD	0	80112B	A0416B 1			
-RESET		80113A	80205B 1			
-RESET		80113A	A0433A 2			



TITLE		WL		DOCUMENT NO.	SHEET NO.	REV.
LOGIC WIREWRAP					4	D
SIGNAL NAME OR NUMBER IDENTIFICATION	ORIGIN	DESTI- NATION	Z LEVEL	NOTES		
+ENCL2	02	801138	80408A	2		
-RESET		80117A	A0111B	1		
-PWR SO		80127A	A0207B	1		
+RESET		80128A	80438B	1		
-BKPNT		80128B	A0125A	1		
-HALT		80129A	80431A	1		
+ADD	2	80129B	A0431B	2		
-ENLAT		80130A	80421A	2		
-ENCK2		80130B	80419B	1		
-ENCK2		80130B	A0109A	2		
-DATA7		80203A	80426B	1		
-DATA7		80203A	A0103A	2		
-DATA7		80203B	80415A	1		
-DATA3		80203B	A0103B	2		
+ENCK2		80204A	80408A	1		
+ENCL2		80204A	A0107B	2		
+R/-W		80204B	A0430A	1		
+P/-W		80204B	A0107A	2		
+ADD	0	80205A	A0416B	2		
+ADD	0	80205A	A0113A	1		
-RESET		80205B	A0113A	1		
+ADD	1	80207A	A0416A	2		
+ADD	1	80207A	A0113B	1		
-ENPIA3-4		80208A	80420A	1		
+ADD	7	80208B	A0413A	1		
+ADD	7	80208B	A0116B	2		
+SECTR		80211A	80317A	2		
+INDEX		80211B	80318A	1		
+INDEX		80211B	A0418A	2		
+AMFND		80215B	80343B	1		
-ENPIA1-2		80225A	80421B	2		
+ADD	2	80229B	A0431B	1		
+ADD	2	80228B	A0114A	2		
+WRITE		80229A	80426A	2		
+WRITE		80229A	A0129A	1		
+MUXIO		80236A	A0215A	1		
+SPVCK		80237A	80329B	1		
+FLTIO		80238B	A0225B	1		
+ENTPN		80240A	A0215B	1		
+ENRCV		80240B	A0224A	2		
+READ		80241B	80429A	1		
+READ		80241B	A0141B	2		
+ROCLK		80242A	80325B	1		
-DATA5		80243A	80428A	1		
-DATA5		80243A	A0143A	2		
-DATA4		80243B	80428B	1		
-DATA4		80243B	A0143B	2		
-ENPIA5-6		80309A	80420B	1		
+G25US		80312A	A0409A	1		
+G15US		80315B	A0404B	1		
+SECTR		80317A	A0419A	1		
+SECTR		80317A	80211A	2		
+INDEX		80318A	80211B	1		
+BYTCK		80319A	A0235A	1		

TITLE		WL		DOCUMENT NO.	SHEET NO.	REV.
LOGIC WIREWRAP					5	B
SIGNAL NAME OR NUMBER IDENTIFICATION	ORIGIN	DESTI- NATION	Z LEVEL	NOTES		
-FNG1-AM	803218	A0422A	1			
-ENG 2	80322A	A04108	1			
+ROGT	803258	A0225A	1			
+RDCLK	803268	B0242A	1			
+RODAT	803278	A02248	1			
+WRTGT	803288	A0222A	2			
+SRVCK	803298	B0237A	1			
+WRTDA	803308	A02218	1			
+AMGT	803318	A0220A	1			
-CR-CTREN	803378	A04078	1			
+AMCTR	80338A	A04228	1			
+ADD 1	80341A	A01138	2			
+ADD 0	80341E	A0113A	2			
-RESET	80342A	A0433A	1			
+AMFND	803438	B02158	1			
-NMI	804078	B0109A	1			
+FNCK2	80408A	B0204A	1			
+ENCL2	80408A	901138	2			
+ADD 12	B0408B	A01198	1			
+ADD 13	80410A	A0120A	1			
+ADD 15	804108	A0121A	1			
+ADD 14	804118	A01208	1			
+ADD 11	80412A	A0119A	1			
+ADD 9	80413A	A01178	1			
+ADD 10	804139	A0118A	1			
-A008X	80414A	A01188	1			
-DATA3	80415A	B02038	1			
-DATA3	80415A	B0103A	2			
-DATA2	80416A	A0205A	1			
-DATA2	80416A	B01038	2			
+VMA 00	804168	A01088	1			
-DATA1	80417A	A02058	1			
-DATA1	80417A	B0108A	2			
-DATA0	804178	A02048	1			
-DATA0	804179	B01088	2			
-BAVAL	80418A	A02098	?			
+BAVAL	80419A	A0108A	1			
-FNCK2	804198	B01308	1			
-ENP1A3-4	80420A	B0208A	1			
-ENP1A5-6	804208	B0309A	1			
-ENLAT	80421A	A01108	1			
-ENLAT	80421A	B0130A	2			
-ENP1A1-2	804218	B0225A	2			
-ENP1A1-2	804218	90111A	1			
-WTCK2	804248	A0111A	1			
-DATA6	80425A	A0204A	1			
-DATA6	80425A	B0105A	2			
+WRITE	80426A	B0229A	2			
+WRITE	80426A	B01048	1			
-DATA7	804268	B0203A	1			
-DATA7	804268	B0104A	2			
-DATA5	80428A	B0243A	1			
-DATA5	80428A	B01058	2			
-DATA4	804288	B02438	1			
-DATA4	804288	B01078	2			
+READ	80429A	B02418	1			
+READ	80429A	B0107A	2			
-MEMSL	804298	A0110A	1			
-HALT	80431A	B0129A	1			
+RESET	804388	B0128A	1			



**SECTION 7**

**PARTS DATA**

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## INTRODUCTION

This section provides an Illustrated Parts Breakdown and a Spare Parts List for the TB216 Field Test Unit.

Information in this section is divided into two major categories as follows:

- Illustrated Parts Breakdown - This breakdown provides part number information for all field replaceable items.
- Spare Parts List - This is a list of recommended spare parts.

### NOTE

Parts listed in the illustrated parts breakdown, but not in the spare parts list, may be long lead time items subject to significant delays.

**SECTION 7A**

**ILLUSTRATED PARTS BREAKDOWN**

---

## GENERAL

The Illustrated Parts Breakdown provides the information needed to order field replaceable parts. This information is presented in assembly illustrations and parts lists.

The symbols used in this section are explained in the following paragraphs along with a definition of some of the abbreviations used. Refer to the front of this manual for a complete list of abbreviations

The illustrated parts breakdown is structured as follows. Each major assembly is shown in an exploded view and assigned a figure number. More than one illustration per figure number may be required for a complex assembly. In this case, the illustrations are titled figure X (sheet 1); figure X (sheet 2), etc. The parts shown on the illustrations are numbered. A parts list for each illustration. The numbers on the figure correspond to the index numbers on the associated part lists. In some cases, the parts list will have more than one page for the corresponding sheet of figure.

The Illustrated Parts Breakdown is divided into four columns:

Index Number Column - The numbers given in this column correspond to the numbers shown on the illustration. When more than one entry is given for a particular index number, the use of each part is defined in the Notes column. Items may be listed without index numbers, and are mentioned for reference only. These items do not appear on the illustration.

Part Number Column - This column provides the eight digit number by which a part may be ordered. There are several conditions when there will be an incomplete number or no number at all.





The symbol ## in the part number column indicates that the item is a recommended spare part, and that the part number is located in the Spare Parts List section. To find the part number refer to the instructions for using the Spare Parts List (section 7B).

The abbreviation CIC refers to Card Interchangeability Chart. The CIC in this manual is located in section 7C.

Description Column - This column gives the name and a brief description of each part and assembly. The relationship of parts and assemblies is shown within the column by means of indentation. When an item is indented more than the previous item, it is part of the previous item.

When the attaching hardware or associated parts for an item cannot be shown on the illustration, the note (ATTACHING PARTS) or (ASSOCIATED PARTS) appears in the Description column. All attaching/associated parts for the previously listed part or assembly are listed beneath this note and are separated from the rest of the parts list by the symbol ---\*---.

When necessary, items are identified as being right side or left side. Right and left are determined by facing the front of the FTU.

Notes Column - This column defines any multiple part number entries for a single index number. Multiple entries may be necessary to identify differences such as machine configuration (for example, the part issued on a series code XX unit with the Engineering Change Order (ECO) XXXX installed). Information that is unique to one particular equipment or application will also be noted in this column.

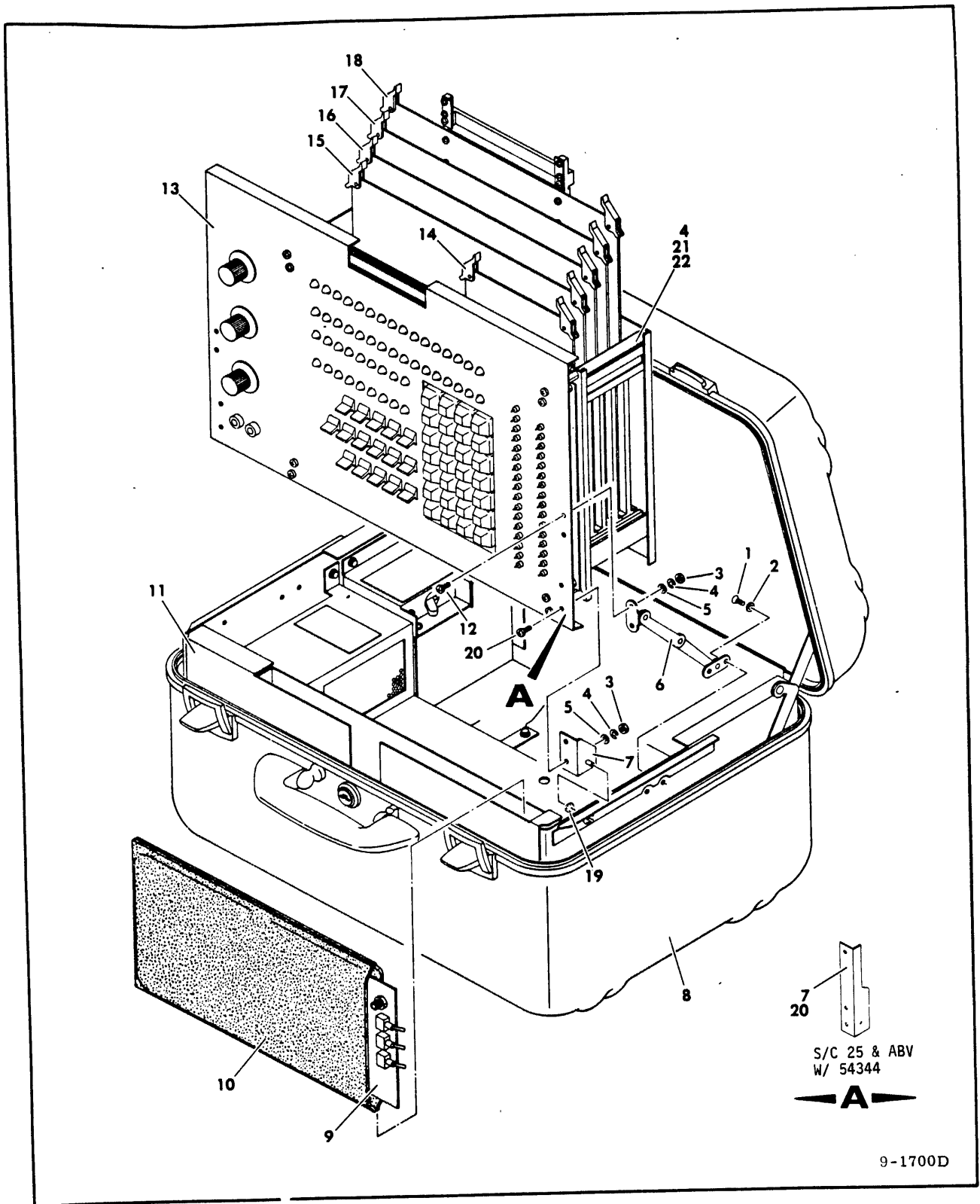


Figure 7-1. Final Assembly

INDEX NO	PART NO	PART DESCRIPTION	NOTE
7-1	82338800	FINAL ASSEMBLY	TB216-A
7-1	82338802	FINAL ASSEMBLY	TB216-B
7-1	82338803	FINAL ASSEMBLY	TB216-C
7-1	82338804	FINAL ASSEMBLY	TB216-D
1	10125712	SCREW, Flat Head, 6-32 x 1/4	
2	93201002	WASHER, Counter Sunk Lock	
3	10125105	NUT, 6-32	S/C 25 & Blw, W/O 54344
4	10126401	WASHER, Lock, 6	S/C 25 & Blw, W/O 54344
5	10125605	WASHER, Flat, 6	S/C 25 & Blw, W/O 54344
6	75020900	HINGE, Lid Support	Right Hinge
6	75020901	HINGE, Lid Support	Left Hinge
7	75129600	ARM, Hinge, Right Arm	S/C 25 & Blw, W/O 54344
7	75129601	ARM, Hinge, Left Arm	S/C 25 & Blw, W/O 54344
7	72874900	BRACKET, Hinge, Right Side	S/C 25 & Abv, W/ 54344
7	72874700	BRACKET, Hinge, Left Side	S/C 25 & Abv, W/ 54344
8	75144600	SUITCASE ASSEMBLY	
9	CIC	COMPONENT ASSEMBLY, ZPV	TB216-A/C
10	75147300	ENVELOPE, C. B., Foam	TB216-A/C
11		POWER SUPPLY ASSEMBLY (see Figure 7-5)	
12	10127112	SCREW, Phillips, 6-32 x 5/16	
13		FRONT PANEL ASSEMBLY (see Figure 7-2)	
14	CIC	COMPONENT ASSEMBLY, _JKX	
15	CIC	COMPONENT ASSEMBLY, _JHX	
16	CIC	COMPONENT ASSEMBLY, _JJX	
17	CIC	COMPONENT ASSEMBLY, _JGX	
18	75886001	ADAPTER, CMD, Head Alignment	TB216-A/C
19	10126103	WASHER, Lock, 6	
20	10127114	SCREW, Phillips, 6-32 x 1/2	S/C 25 & Blw, W/ 54344
20	10127123	SCREW, Phillips, 8-32 x 1/2	S/C 25 & Abv, W/ 54344



INDEX NO	PART NO	PART DESCRIPTION	NOTE
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7-1		FINAL ASSEMBLY	
21	10127112	SCREW, Phillips, 6-32 x 5/16	
22	93114326	STANDOFF, Tapped	

NOTE:

The following items are not shown.

75149401	SUPPLEMENTARY SUPPLY ITEMS	TB216-A
75149402	SUPPLEMENTARY SUPPLY ITEMS	TB216-B
75149403	SUPPLEMENTARY SUPPLY ITEMS	TB216-C
75149404	SUPPLEMENTARY SUPPLY ITEMS	TB216-D
75145500	I/O CABLE ASSEMBLY, 10 Pin (A4)	
75145501	I/O CABLE ASSEMBLY, 26 Pin (B5)	
75145502	I/O CABLE ASSEMBLY, 50 Pin (A2)	
75145801	ADAPTER CABLE ASSEMBLY, 34 Pin (B7)	MUX I/O - B Cable TB216-A/C
75145802	ADAPTER CABLE ASSEMBLY, 75 Pin (A6)	STD I/O - A Cable TB216-A/C
75145803	ADAPTER CABLE ASSEMBLY, 34 Pin (B3)	STD I/O - B Cable TB216-A/C
75145804	ADAPTER CABLE ASSEMBLY, 75 Pin (A10)	MUX I/O - A Cable TB216-A/C
75146000	ADAPTER CABLE ASSEMBLY, 60 Pin (A8)	STD OR MUX I/O - A Cable
83271600	LINE CABLE ASSEMBLY, 120 V	
77440300	HEAD ALIGNMENT CABLE ASSEMBLY	TB216-A/C
94389927	TEST LEAD, Red, Head Alignment,	TB216-A/C
94389907	TEST LEAD, Black, Head Alignment,	TB216-A/C
77612337	CABLE ASSEMBLY, CMD, Head Alignment	TB216-A/C
75882394	CABLE ASSEMBLY, CMD, Head Alignment	TB216-A/C
50151700	TERMINATOR ASSEMBLY, AMEN	TB216-B/D

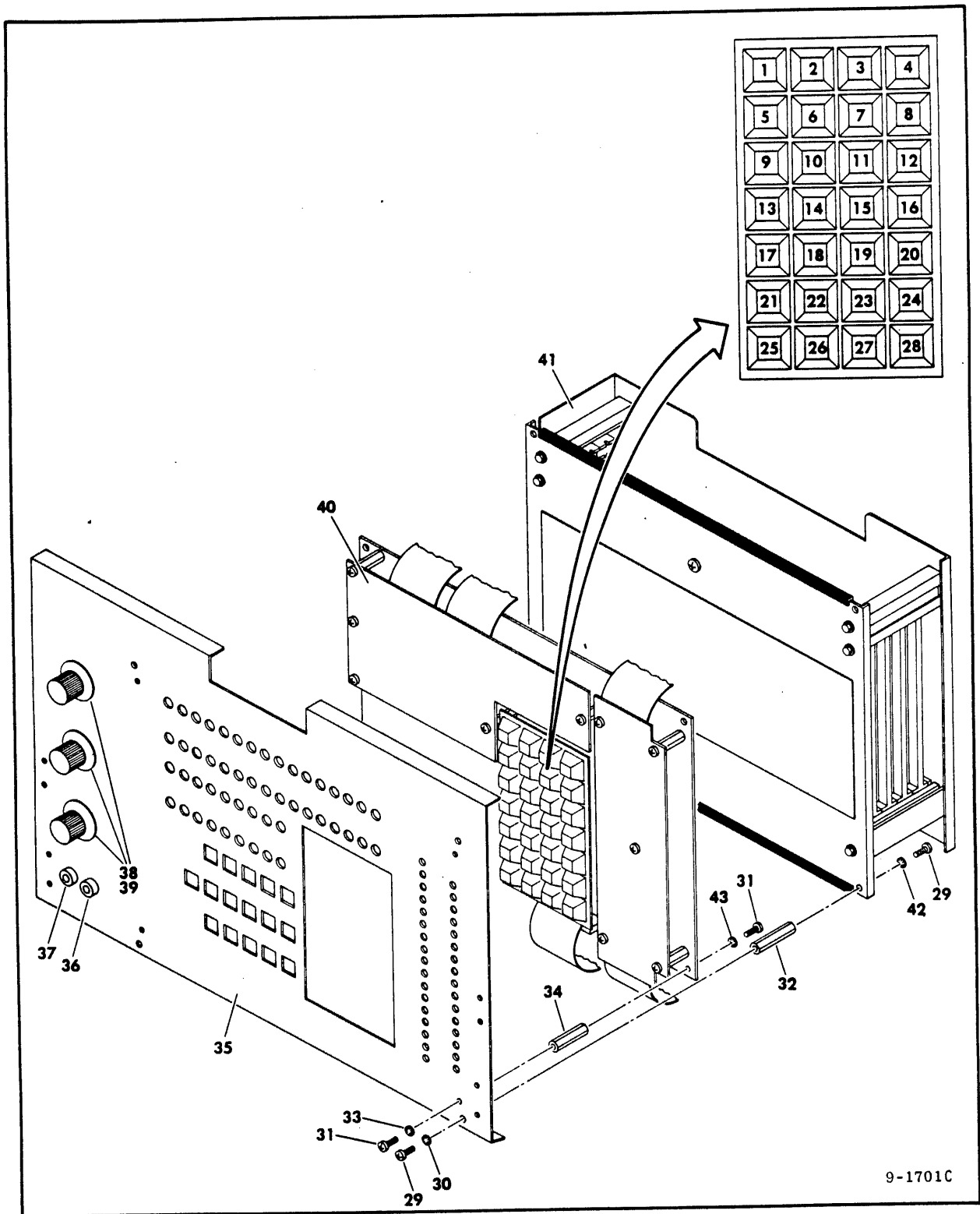


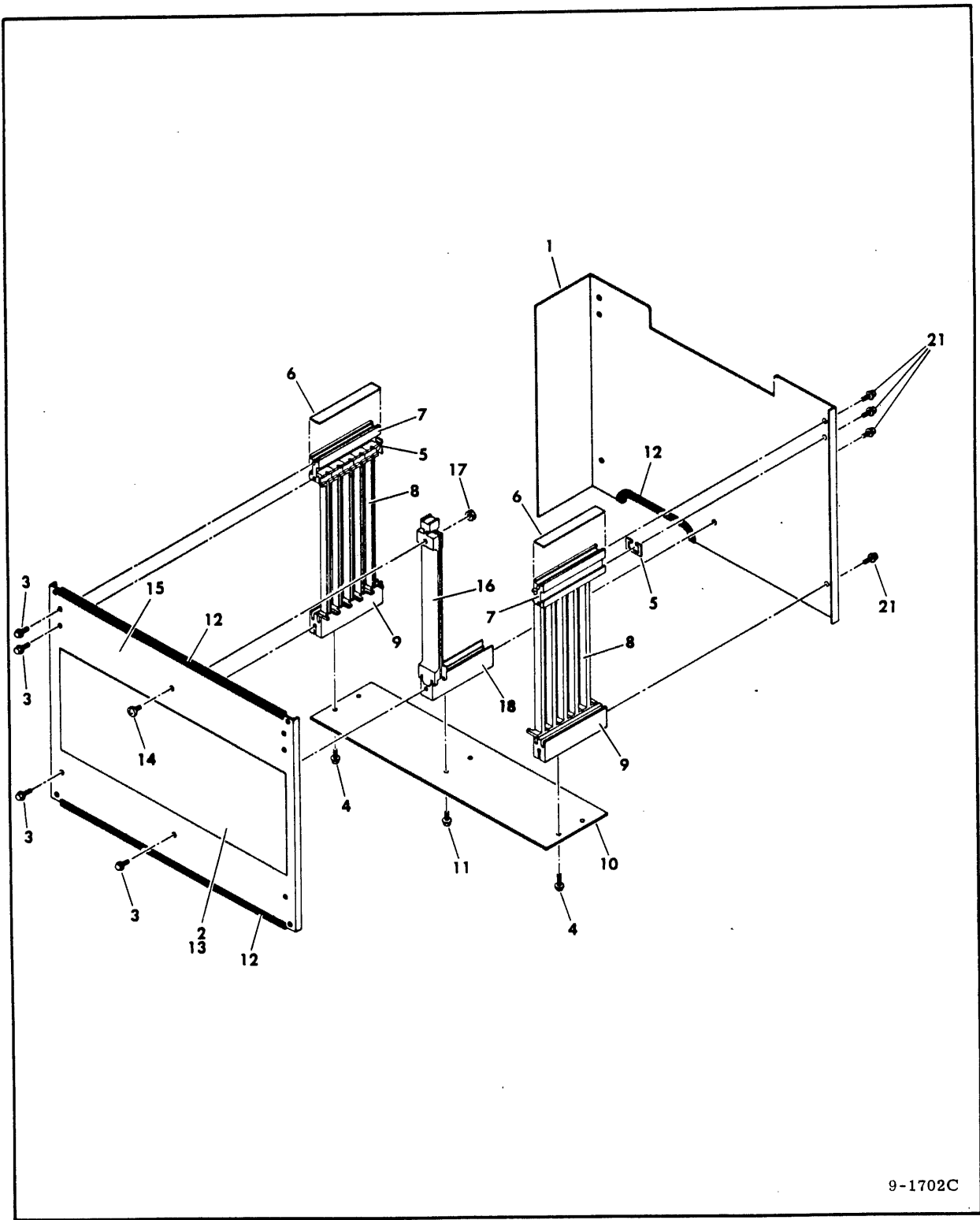
Figure 7-2. Front Panel Assembly

INDEX NO	PART NO	PART DESCRIPTION	NOTE
7-2	75144500	FRONT PANEL ASSEMBLY	S/C 25 & Blw, W/O 54344
7-2	75144501	FRONT PANEL ASSEMBLY	S/C 25 & Abv, W/ 54344
1	66301754	KEY CAP, "0"	
2	66301717	KEY CAP, "1"	
3	66301718	KEY CAP, "2"	
4	66301719	KEY CAP, "3"	
5	66301730	KEY CAP, "4"	
6	66301731	KEY CAP, "5"	
7	66301732	KEY CAP, "6"	
8	66301742	KEY CAP, "7"	
9	66301743	KEY CAP, "8"	
10	66301744	KEY CAP, "9"	
11	66301789	KEY CAP, "A"	
12	66301790	KEY CAP, "B"	
13	66301791	KEY CAP, "C"	
14	66301792	KEY CAP, "D"	
15	66301793	KEY CAP, "E"	
16	66301794	KEY CAP, "F"	
17	66301795	KEY CAP, "HEX"	
18	66301803	KEY CAP, "DISP"	
19	66301804	KEY CAP, "CLR ENT"	
20	66301800	KEY CAP, "LOAD"	
21	66301796	KEY CAP, "DEC"	
22	66301797	KEY CAP, "BIT"	
23	66301806	KEY CAP, "SEL DRV"	
24	66301805	KEY CAP, "CLR FLT"	
25	66301798	KEY CAP, "RTZ"	
26	66301799	KEY CAP, "CLR"	
27	66301802	KEY CAP, "GO"	
28	66301801	KEY CAP, "STOP"	
29	10127122	SCREW, Phillips, 8-32 x 3/8	
30	10126104	WASHER, Internal Tooth Lock, 8	
31	10127113	SCREW, Phillips, 6-32 x 3/8	
32	93114284	STANDOFF, Hex, 8-32 x 1.312	
33	10125103	WASHER, Internal Tooth, Lock, 6	





INDEX NO	PART NO	PART DESCRIPTION	NOTE
7-2		FRONT PANEL ASSEMBLY	
34	93114283	STANDOFF, Hex, 6-32 x 1.062	
35	75145000	PANEL, Tester Front	S/C 25 & Blw, W/ 54344
35	47391800	PANEL, Tester Front	S/C 25 & Abv, W/ 54344
36	95644000	JACK, Red Banana	
37	95644001	JACK, Black Banana	
38	##	CABLE AND SWITCH ASSEMBLY	
39	##	KNOB, Skirted	
40		CONTROL PANEL ASSEMBLY (See Figure 7-4)	
41		LOGIC CHASSIS ASSEMBLY (See Figure 7-3)	
42	10126402	WASHER, External Tooth Lock, 8	
43	10126401	WASHR, External Tooth Lock, 6	



9-1702C

Figure 7-3. Logic Chassis Assembly

INDEX NO	PART NO	PART DESCRIPTION	NOTE
7-3	75144100	LOGIC CHASSIS ASSEMBLY	
1	75148300	COVER, Lower Logic	
2	95001403	TAPE, Double Coated	
3	95655429	SCREW, Type B Flat Head, 8-18 x 3/8	
4	93592546	SCREW, Washer Head Hex 8-32 x 3/8	
5	82316700	SPACER	
6	82311801	LABEL, Marker	
7	82316602	BAR, Card Guard, Mounting	
8	82311701	GUIDE, Circuit Card	
9	82316502	SUPPORT, Card Guide	
10	75144300	WIREWRAPE PANEL ASSEMBLY	
11	93592238	SCREW, Washer Head, Hex 10-24 x 3/8	
12	94385500	GROMMET, Saftey Trim	
13	92318023	INSULATIOR, Fish Paper	
14	10127123	SCREW, Pan Head, 8-32 x 1/2	
15	75148400	COVER, Logic Upper	
16	82314500	GUIDE, Card Center	
17	10125106	NUT, Machine, Hex, 8-32 x 1/2	
18	82319802	BAR, Mounting Guide	
19	75148300	COVER, Lower, Logic	

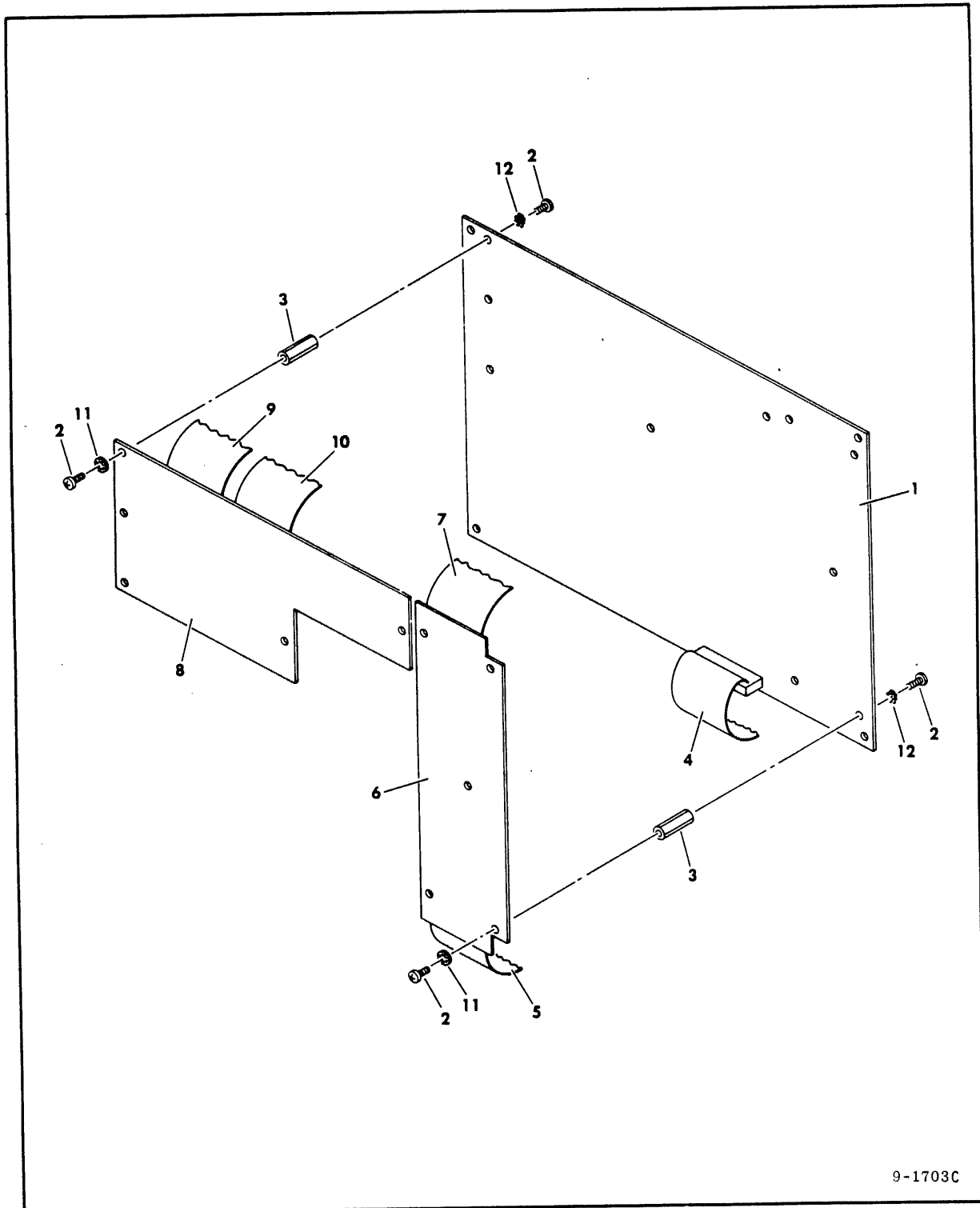
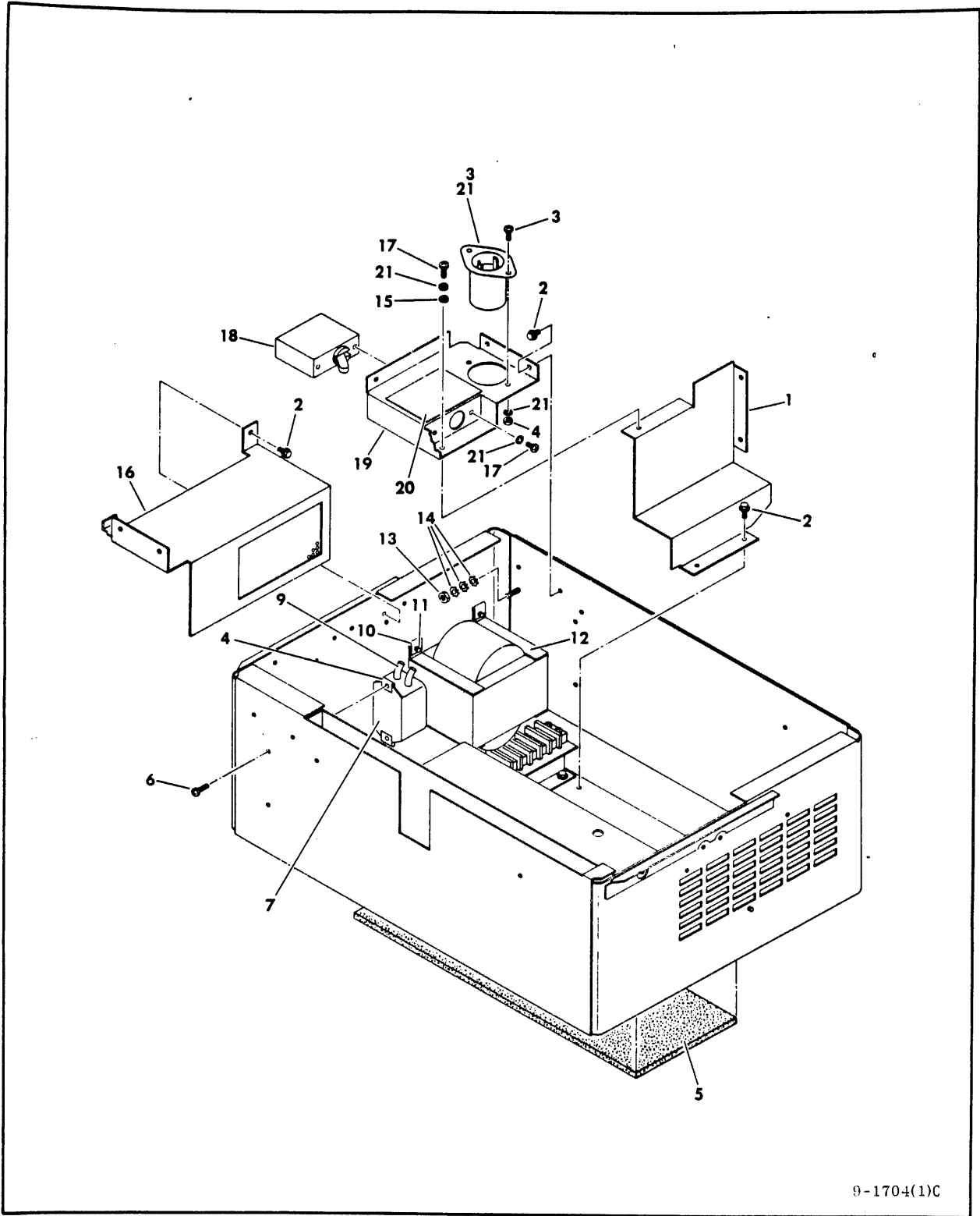


Figure 7-4. Control Panel Assembly

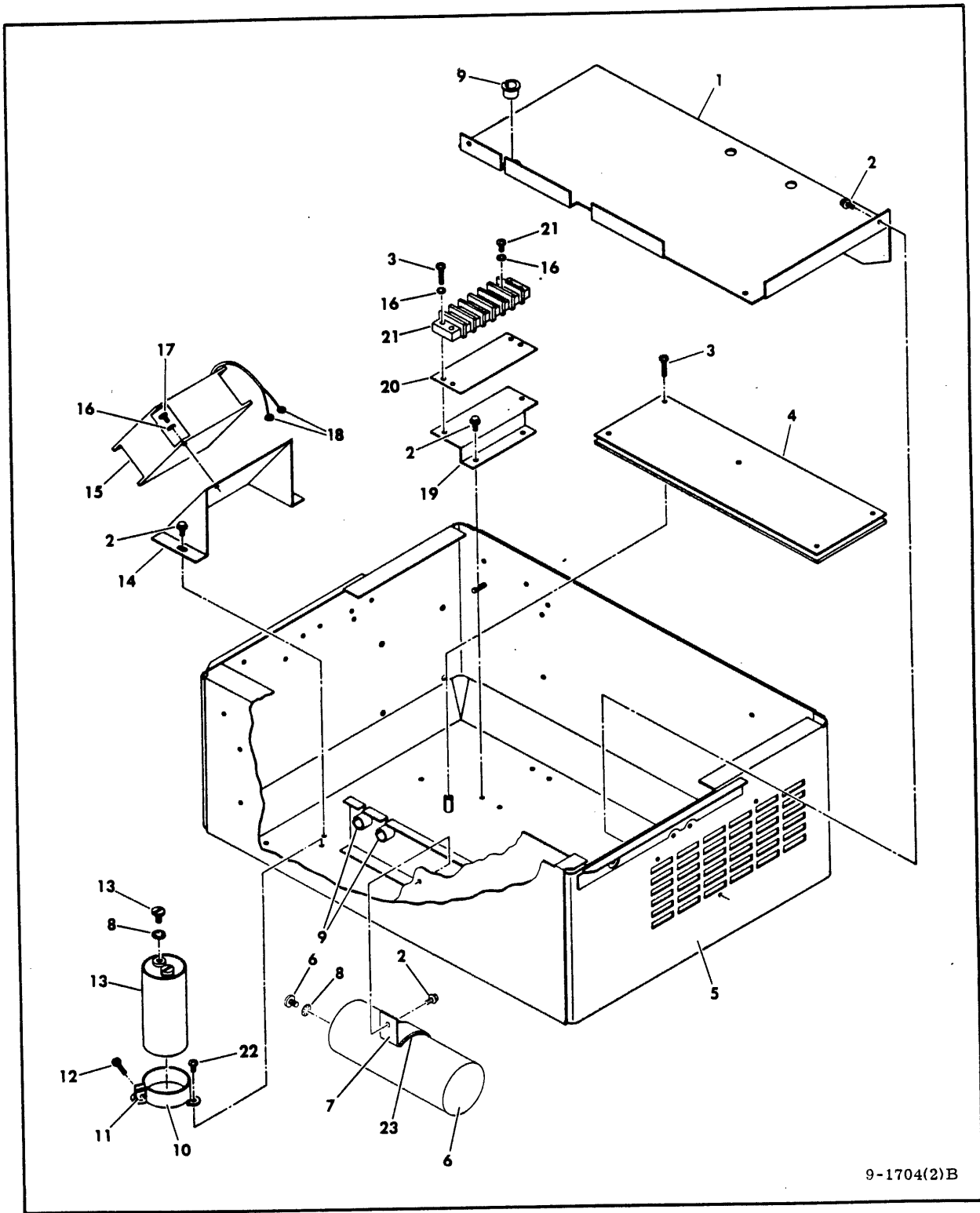
INDEX NO	PART NO	PART DESCRIPTION	NOTE
7-4	75144400	CONTROL PANEL ASSEMBLY	
1	54283300	COMPONENT ASSEMBLY, AZJV	
2	10127112	SCREW, Phillips, 6-32 x 5/16	
3	93114217	STANDOFF, Tapped Post	
4	75148603	CABLE, Control Panel	
5	75148602	CABLE, Test Point, Read/Write	
6	54281700	TEST POINT BOARD ASSEMBLY, AZEY	
7	75148600	CABLE, Test Point, I.O. Signal	
8	54282100	LED BOARD ASSEMBLY, AZFV	
9	75148601	CABLE, LED Display Board	
10	75148604	CABLE, JKX LED Display Board	
11	10126103	WASHER, Lock, 6	
12	10126401	WASHER, Lock, 6	



9-1704(1)C

Figure 7-5. Power Supply Assembly (Sheet 1 of 2)

INDEX NO	PART NO	PART DESCRIPTION	NOTE
7-5	701169XX	POWER SUPPLY ASSEMBLY (Sheet 1)	
1	75146400	COVER, Transformer Terminal Board	
2	93592158	SCREW, Self-Tapping Hex Head, 6-32 x 1/4	
3	24556501	CONNECTOR, 120 V	S/C 25 & Blw, W/O 54343B
3	10128000	CONNECTOR, 120 V	S/C 25 & Abv, W/ 54343B
4	10125105	NUT, Hex, 6-32	
5	75147203	FOAM, 1/4 Inch Thick	
6	10127113	SCREW, Pan Head, Machine, 6-32 x 3/8	
7	##	FILTER, R.F.	
8		NOT USED	
9	94168004	SLEEVING, Clear	
10	95634806	NUT, U Type Speed	
11	95655543	SCREW, Sheet Metal, 10-16 x 1/2	
12	70110000	TRANSFORMER ASSEMBLY	S/C 25 & Blw, W/O 54343B
12	70110002	TRANSFORMER ASSEMBLY	S/C 25 & Abv, W/ 54343B
13	10125107	NUT, Hex, 10-24	
14	10126402	WASHER, External Tooth Lock, 10	
15	10125605	WASHER, Plain, 6	
16	75146300	COVER, Fan Capacitor	
17	10127111	SCREW, 6-32 x 1/4	
18	##	CIRCUIT BREAKER	
19	75147100	BRACKET, Mounting Connector Circuit Brkr.	
20	92006913	PLATE, Warning	
21	10126103	WASHER, Internal Tooth Lock, 6	



9-1704(2)B

Figure 7-5. Power Supply Assembly (Sheet 2)



INDEX NO	PART NO	PART DESCRIPTION	NOTE
7-5		POWER SUPPLY ASSEMBLY (Sheet 2)	
1	75147000	COVER, Power Supply Board	
2	93592158	SCREW, Self-Tapping, Hex Head, 6-32 x 1/4	
3	10127115	SCREW, 6-32 x 5/8	
4	CIC	COMPONENT ASSEMBLY _JGV	
5	75145400	HOUSING, Tester	S/C 25 & Blw, W/O 54344
5	75145401	HOUSING, Tester	S/C 25 W/ 54344, W/O 54343B
5	75145402	HOUSING, Tester	S/C 25 & Abv, W/54343
6	95661326	CAPACITOR, 83 UF, 15 V	
7	00863717	CLAMP, Capacitor Mounting	
8	10126105	WASHER, Internal Tooth Lock, 10	
9	94305529	BUSHING, Snap-in	
10	92691003	CLAMP, Capacitor Mounting	
11	95634801	NUT, U Type Speed	
12	95655517	SCREW, Sheet Metal, 6-20 x 1/2	
13	95661324	CAPACITOR, 18 UF, 15 V	
14	75148500	BOX, Blower Mounting	
15	##	FAN, Axial, 50/60 Hz	
16	10126103	WASHER, Internal Tooth, Lock, 6	
17	10127112	SCREW, Pan Head Machine, 6-32 x 5/16	
18	93541010	TERMINAL, Ring Tongue 22-16, #4-6	
19	75147700	BRACKET, Block Terminal	
20	93106206	MARKER, Terminal Strip	
21	93041106	STRIP, Terminal	
22	17901508	SCREW, Thread Rolling, 6-32 x 1/4	

NOTE:

The following items are not shown.

75149600	AC/DC HARNESS ASSEMBLY	S/C 25 & Blw, W/O 54343B
75149601	AC/DC HARNESS ASSEMBLY	S/C 25 & Abv, W/ 54343B
94277400	TIE STRAP,, Cable	

**SECTION 7B**

**SPARE PARTS LIST**

## SPARE PARTS LIST

7B

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### GENERAL

The Spare Parts List serves as an aid in determining the interchangeability of assemblies and parts to be spared. An example of the columns used in the Spare Parts List is shown on the next page.

#### NOTE

The spare parts list establishes the support service level of the unit. Individual parts, assemblies, or components not on this list may be long lead time items subject to significant delays.

The Spare Parts List is divided into four columns:

Items Appear On - This column cross-references the part number in the spare parts list to the associated figure number, page number, and index number in the illustrated parts breakdown.

Description - This column gives the name and a brief description of the part or assembly. This column also tracks series code history information.

Part Number - The Part Number column gives the part number of the part when the unit was manufactured or as a result of the latest FCO. This part can be used as a replacement on the type and series code units indicated in the Description and Notes columns. However, always use the Replacement Part Number when ordering new parts or spares.

Replacement Part Number - Contains the interchangeable replacement part number. Use this number when ordering replacement parts or spares.

Notes - This column provides additional information such as Field Change Order (FCO), Special Purchase Order (SPO), serial number, and machine configuration.

EXAMPLE OF SPARE PARTS LIST

ENGINEERING RECOMMENDED SPARE PARTS LIST						
ITEMS APPEAR ON			DESCRIPTION	PART NUMBER	REPLACE- MENT PART NUMBER	NOTES
Fig.	Page	Index				
No.	No.	No.				
3-11	3-37	25	CONTROL PANEL ASSEMBLY Used S/C 14 and above Used S/C 14 and above	WWWWW YYYYY	XXXXX ZZZZZ	Single Channel Dual Channel

In the example above, the control panel assembly is referenced as index 25 on figure 3-11, which appears on page 3-37. The original part number for single-channel units was WWWWW; order part

number XXXXX if it must be replaced. WWWWW cannot be ordered from the factory but field spares can still be used on S/C 14 and above single-channel units.

ENGINEERING RECOMMENDED SPARE PARTS LIST

ITEMS APPEAR ON Fig.   Page   Index No.   No.   No.	DESCRIPTION	PART NUMBER	REPLACE- MENT PART NUMBER	NOTES
	CONTACT, Wirewrap Used S/C 14 & Above	82315001	82315001	
	ROM, 5904 Used S/C 26 & Above	50257904	50257904	Older units converted to this configuration by FCO 54327.
	ROM, 5905 Used S/C 26 & Above	50257905	50257905	Older units converted to this configuration by FCO 54327.
	LED, Green Used S/C 14 & Above	94372504	94372504	
	LED, Red Used S/C 14 & Above	94372501	94372501	
	MICROPROCESSOR, 6802 Used S/C 14 & Above	15163603	15163603	
	RAM, IC Used S/C 14 & Above	15163400	15163400	
	SWITCH, Keyboard Used S/C 14 & Above	94363700	94363700	

ENGINEERING RECOMMENDED SPARE PARTS LIST

ITEMS APPEAR ON Fig.   Page   Index No.   No.   No.	DESCRIPTION	PART NUMBER	REPLACE- MENT PART NUMBER	NOTES
	SWITCH, Momentary Used S/C 14 & Above	94263934	94263934	
	SWITCH, SPDT Used S/C 14 & Above	94263932	94263932	
	SWITCH, SPDT, Center Off Used S/C 14 & Above	94263933	94263933	
7-2 7-4 38	CABLE AND SWITCH ASSEMBLY Used S/C 14 & Above	75145600	75145600	
7-2 7-6 39	KNOB, Skirted Used S/C 14 & Above	93152007	93152007	
7-5 7-12 7	FILTER, R.F. Used S/C 14 & Above	94348403	94348403	
7-5 7-14 15	FAN, Axial, 50/60 Hz Used S/C 14 & Above	94390000	94390000	
7-5 7-12 18	CIRCUIT BREAKER Used S/C 14 & Above	95587003	95587003	

**SECTION 7C**

**CARD INTERCHANGEABILITY CHART**

# CARD INTERCHANGEABILITY CHART

7C

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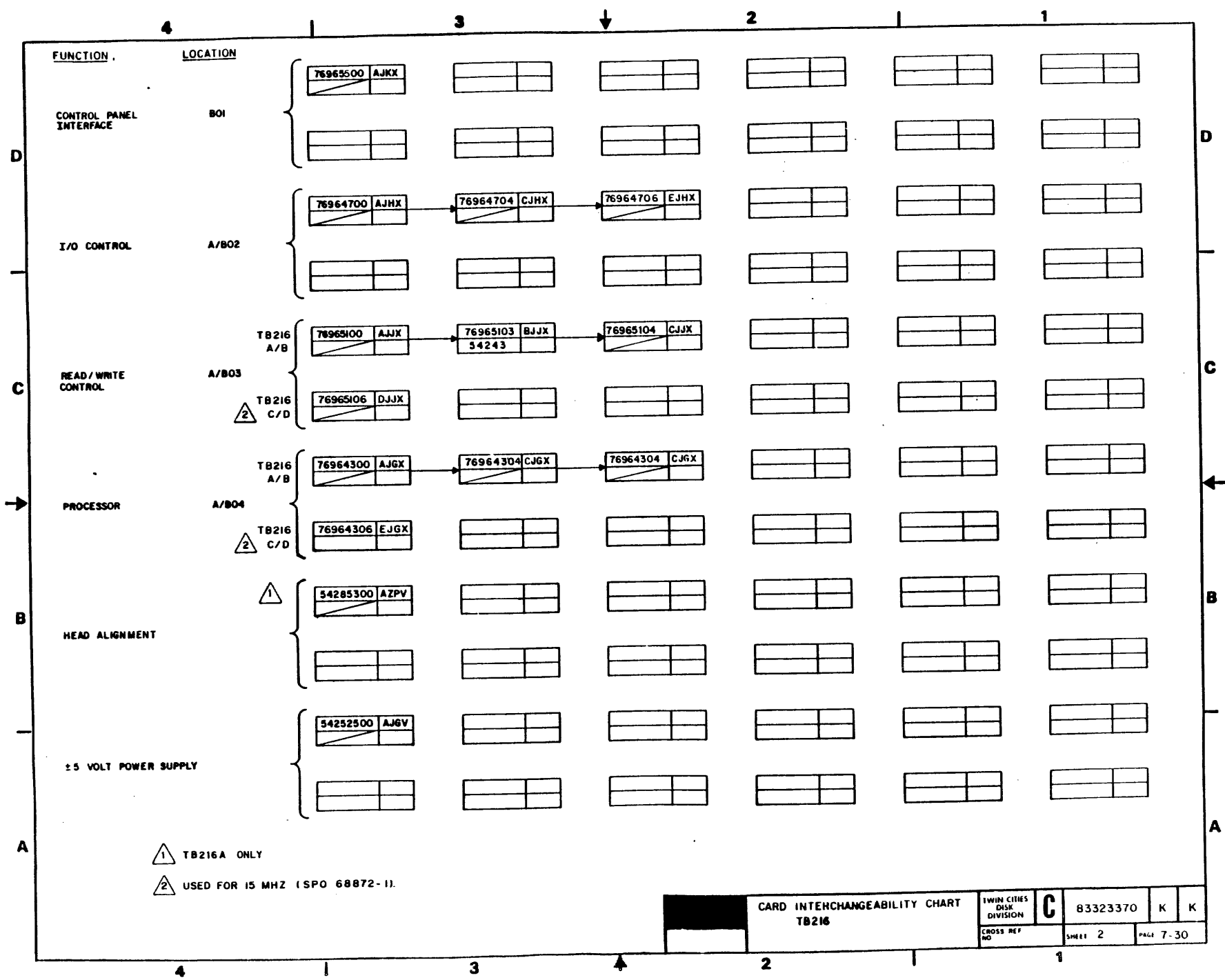
## GENERAL

The card interchangeability chart (CIC) provides the latest revision level of a card, its locations in the logic chassis, and its part number for ordering purposes.

Prior to attempting to use the charts, be sure to read and understand the rules for interpreting the CIC as given on page 7-29.







△ 1 TB216A ONLY  
 △ 2 USED FOR 15 MHZ (SPO 68872-1).

## COMMENT SHEET

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**Publication No:** \_\_\_\_\_

**Revision:** \_\_\_\_\_

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**Company:** \_\_\_\_\_

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**City:** \_\_\_\_\_ **State:** \_\_\_\_\_ **Zip Code:** \_\_\_\_\_

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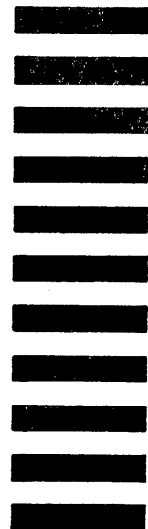
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