IBM®

Customer Engineering
Reference Manual

733

Magnetic Drum Storage

733 MAGNETIC DRUM STORAGE
CE REFERENCE MANUAL

ADDENDUM SHEET

SYMBOLS USED IN THE DIAGNOSTIC CHARTS THAT START ON PAGE 30-15

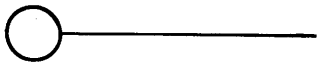
Diagnostic charts are read as a time sequence chart; that is, the action starts at the left, then moves from left to right. The time scale is shown at the top and bottom of each chart.

A few special symbols are used on these charts. They are explained below:

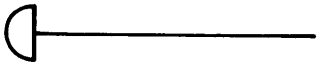
Inputs to "AND" or "OR" symbols. Connections between control or execution lines.

Indicates an execution or control line. Length of line shows period of time line is present.

Line is tapped off to help generate another line.



AND circuit. More than one input brings up line.

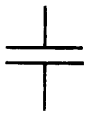


OR circuit. Any one of several inputs brings up line.

Line is brought up. If a thyratron, inverter, cathode follower, or trigger is turned on; its abbreviation appears above the X.

Indicates definite time of turn off.

Test point used for checking presence of pulse or line.



Capacitor turn on or off. Shows where a spike is needed to initiate action. Also shows change in pulse value.

System diagram location. Shows where detail of the circuit may be found.

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NOTICE

The purpose of this manual is to aid the Customer Engineer in the maintenance of the 733 Magnetic Drum. Therefore, in this manual you will find testing schedules, preventive maintenance procedures, adjustment specifications, troubleshooting charts, and any other information which will be useful to the man who services this machine.

Each different unit, item, and test of this machine has been assigned a "Reference Manual Code Number." This code number is located in the tens and units position of each section number. For example:

	Waveforms & Levels	Removals & Repl.	Adjustments & Timings
19 Read/Write Heads	733.15.19	733.21.19	733.22.19

CODE NUMBER

This manual applies to the 733 Magnetic Drum whether it is used in a 704 or a 709 CPU installation. In most cases, drum operation is identical in both installations. However, where any differences occur they are noted in the manual.

The following index chart can be used to find the location of the appropriate maintenance information.

INDEX CHART

AREA	REF MAN CODE NO	ITEM	CLEAN & INSPECT	WAVE-FORM & LEVELS	REMOVALS & REPLACEMENTS	ADJ & TIMINGS
GENERAL INSPECTION	0	General Cleaning	733.14.00			
	1	General Heat Problems	733.14.01			
	2	Appear/Air Filters	733.14.02		733.21.02	
	3	Motors & Blowers	733.14.03			
	4	Signal Shoe & Recept.	733.14.04			
	5	Thermal Interlocks	733.14.05			733.22.05
	6	Test/Control Panels	733.14.06			
	7	Relays	733.14.07			
	8	Reliability	733.14.08			
POWER SUPPLY	9	Service Voltage Terms.	733.14.09			
	10	Resistor & Filter Panel	733.14.10			
	11	Fuses	733.14.11			
	12	Biasing	733.14.12			
DRIVE ASSEMBLY	13	Motors - Drive Belts	733.14.13			733.22.13
	14	Static Brush	733.14.14			
	15	Excessive Vibration	733.14.15			
	16	Drum Housing	733.14.16		733.21.16	
	17	Bearings	733.14.17		733.21.17	
	18	Drum Speed	733.14.18			733.22.18
READ/WRITE CIRCUITS	19	Read/Write Heads		733.15.19	733.21.19	733.22.19
	20	Read Tgr. Input		733.15.20		
	21	WD Output		733.15.21		
TIMING TRACK	22	Timing Track Head		733.15.22	733.21.22	733.22.22
	23	Erasing				733.22.23
	24	Writing New Timing Track				733.22.24
MISCELLANEOUS	25	Covers			733.21.25	
WAVEFORMS	26	Special Pulse Specs.		733.15.26		
	27	Pulse Checking		733.15.27		
	28	Misc. Waveforms		733.15.28		

CONTENTS

733.10.00 PREVENTIVE MAINTENANCE

A customer engineer is called upon to perform two types of maintenance - corrective and preventive. Corrective maintenance is the finding and correcting of trouble after it has occurred. Preventive maintenance is work which is performed on a regularly scheduled basis to correct potential trouble, minimize service calls, and maintain maximum machine availability to the customer.

The importance of regularly scheduled preventive maintenance is twofold. First, it is important to the customer because the work is done on the machine during off-peak load periods. Second, it is important to the customer engineer because it enables him to schedule his activities and use his time to the greatest advantage.

By applying preventive maintenance techniques, more machine time is made available to the customer. Overscheduling of preventive maintenance is as undesirable as underscheduling. The objective is to increase machine availability to the customer by reducing total maintenance time.

For the first three months of operation, preventive maintenance should be performed as recommended in section 733.12.00 (P.M. Procedure). By this time the customer engineers of each installation should have filled in the frequency of inspection on the P.M. Guide and Record (Section 733.11.00). Also by this time they should have developed their own preventive maintenance schedule.

SERIAL	SUFFIX	DATE INSTALLED

MAGNETIC DRUM UNIT

CODE NO. FOR 733 REF. MANUAL	FREQUENCY OF INSPECTION IN MONTHS			YR. / MO.												
DC BIAS TEST	12	+ 150	+ 163													
	12		+ 143													
	12	+ 220	+ 234													
	12		+ 198													
	12	− 250	− 254													
	12		− 230													
	12	− 100	− 108													
	12		− 96													
	12	− 30	− 33													
	12		− 27													
GENERAL INSPECTION	0	GEN. CLEANING														
	2	AIR FILTERS														
	3	MOTORS BLOWERS														
	7	RELAYS														
	8	RELIABILITY														
	12	BIASING														
DRIVE ASSEMBLY	13	MTR. −DR. BELTS														
	14	STATIC BRUSH														
	17	BEARINGS														
	18	DRUM SPEED														
RD WR CKTS	19	RD WR HEAD														
TIMING TRACK	22	TIMING TRACK HD														
PULSE CHK	27	PULSE CHECKING														

733.12.00 PREVENTIVE MAINTENANCE PROCEDURE

Ref. Man. Code No.	Item	Freq.	Time	Action
2	Air Filters	2 mos.	.5 hr.	Remove and check all air filters, replacing those that are dirty.
12	Bias Tests	1 mo.	.4 hr.	Using a random number RD/WR test (4D10 or 9D01) vary each DC supply, with one minute of error-free operation at each limit, as follows:

Nominal Voltage	Test Voltage
+150	+163 + 1
	+143 + 1
+220	+198 + 1
	+234 + 1
-250	-230 + 1
	-259 + 1
-100	- 96 + 1
	-108 + 1
- 30	- 27 + .5
	- 33 + .5

13 16	Drive Assembly	3 mos.	.3 hrs.	Using a soft cloth and approved solvent, remove all traces of dirt from the drive motor, belt guard, drum housing, and the entire portion of the frame enclosing the drum assemblies and their associated drives.
27	Visual Check of Pulses	3 mos.	1.5 hrs.	Use list of pulses on the following sheet as guide. These pulses should be checked during customer operation.

733.13.00 LUBRICATION

The 733 Drum requires only an occasional light oiling of the gate and cover hinges. No other lubrication is necessary.

733.14.00 CLEAN/INSPECT

General Cleaning and Inspection

All traces of dirt must be removed from the drive motor, belt guard, drum housing, and the entire portion of the frame enclosing the drum assemblies and drives. **Clean every three months, using a vacuum cleaner and/or soft cloth with approved solvent.**

733.14.01 General Heat Problems

Below are the general rules to follow when checking the operating temperature of blower motors, drive motors, bearings, resistors, and similar components.

Blower Motors, Drive Motors

These have an allowable range of 20°C (78°F) temperature rise above surrounding room temperature. They may be checked by mounting an accurate thermometer nearby.

Bearings

Drive motor bearings should operate up to about 130°F. Blower motor bearings should operate at a somewhat lower temperature, because air flowing over the bearings has a cooling effect. Bearing temperature may be measured by mounting a thermometer in putty on the outside of the bearing surface.

Resistors, Inductors, and Capacitors

The best way to determine operating limits on components is to measure the voltage drop across, and the current through the component. Then by means of Ohm's Law, check against its rated wattage. Remember that feeling a surface to check temperature is ineffective, unreliable, and dangerous.

All panels are protected by thermal interlocks which are discussed in 733.14.05.

733.14.02 Appearance/Air Filters

Clean windows and satin-finish trim. Check the covers for loose brackets and needed adjustments. Check door hinges. Clean covers when necessary with IBM cover cleaner.

Air Filters

Check all four filters for dirt. Use new filters, do not try to clean the old ones. Check nearby pluggable units for dirt.

733.14.03 Motors and Blowers

Check for excessive vibration or noise from blowers. Check for binding motor armature. Check for proper direction of rotation. A simple way to do this is to hold an IBM card against the intake duct at the bottom of the drum frame. If rotation is correct, the card will be snapped against the duct. Listen for noisy bearings. The temperature of motors and their bearings may be checked by methods outlined in 733.14.01.

733.14.04 Signal Shoe and Cable Receptacles

Check for loose terminals, contact corrosion, and bent or broken contacts. To clean contacts, use a cleaning solvent. Never burnish, as this will destroy the coating.

The drum is connected into the system with the following cables:

AC Power 320205
DC Power 320206
Signal 319489

Refer to 709 system diagram 0X.03.01 for a drawing of the drum SP connector receptacle.

733.14.05 Thermal Interlocks

A thermal switch consists of two bimetal elements which provide the motion to transfer a spring loaded contact under a temperature change beyond fixed limits. When temperature exceeds its rated limit, the normally closed contact in the power interlock circuit drops power from the system while the normally open contact turns on the thermal light in the main frame.

Check thermal light for proper operation. Check contact alignment and clean the points for a good "make" surface. Test to be sure power is knocked down when contact points are operated. Check connections to see that they are not loose, grounded, or shorted.

The thermals should be set to operate at 131-5°F. A thermal not operating in its proper temperature range can be corrected by turning its adjusting screw.

733.14.06 Test/Control Panels

Check drum amplifier and timing track amplifier selection switches (Figure 14-1) for loose handles and loose connections. Check timing write switch (Figure 14-2) for loose handle and loose connections. See the Service Aids section (733.46.00) for further information on these panels.

733.14.07 Relays

Duo Relays

There are only two duo relays used in drum circuitry. One (Relay 57) is energized when the "Load Drum" button is pressed. The other is the Reset relay located in the Power Terminal Panel of the 733 Drum Frame. Periodically burnish or wire brush dirty points, check the air gap, rise, and contact pile tightness. Lubricate armature pivot points.

Wire Contact Relays

The drum makes use of wire contact relays mainly in the write circuits. Check them only if they appear to be operating poorly. When necessary, clean the wire contacts and check for free operation. Check spring tension. Check the screws which hold the phenolic in which the wire contact ends are secured. If these screws are not tight, proper tension on the wires will be lost.

Relay Numbers

There are twenty-four 12 position wire-contact relays used in the drum for write circuit switching. Wire contact relay point numbering and coil combinations are shown in Figure 14-3.

The system of numbering each of the twenty-four relays in panel 3 of the drum, is shown in Figure 14-4.

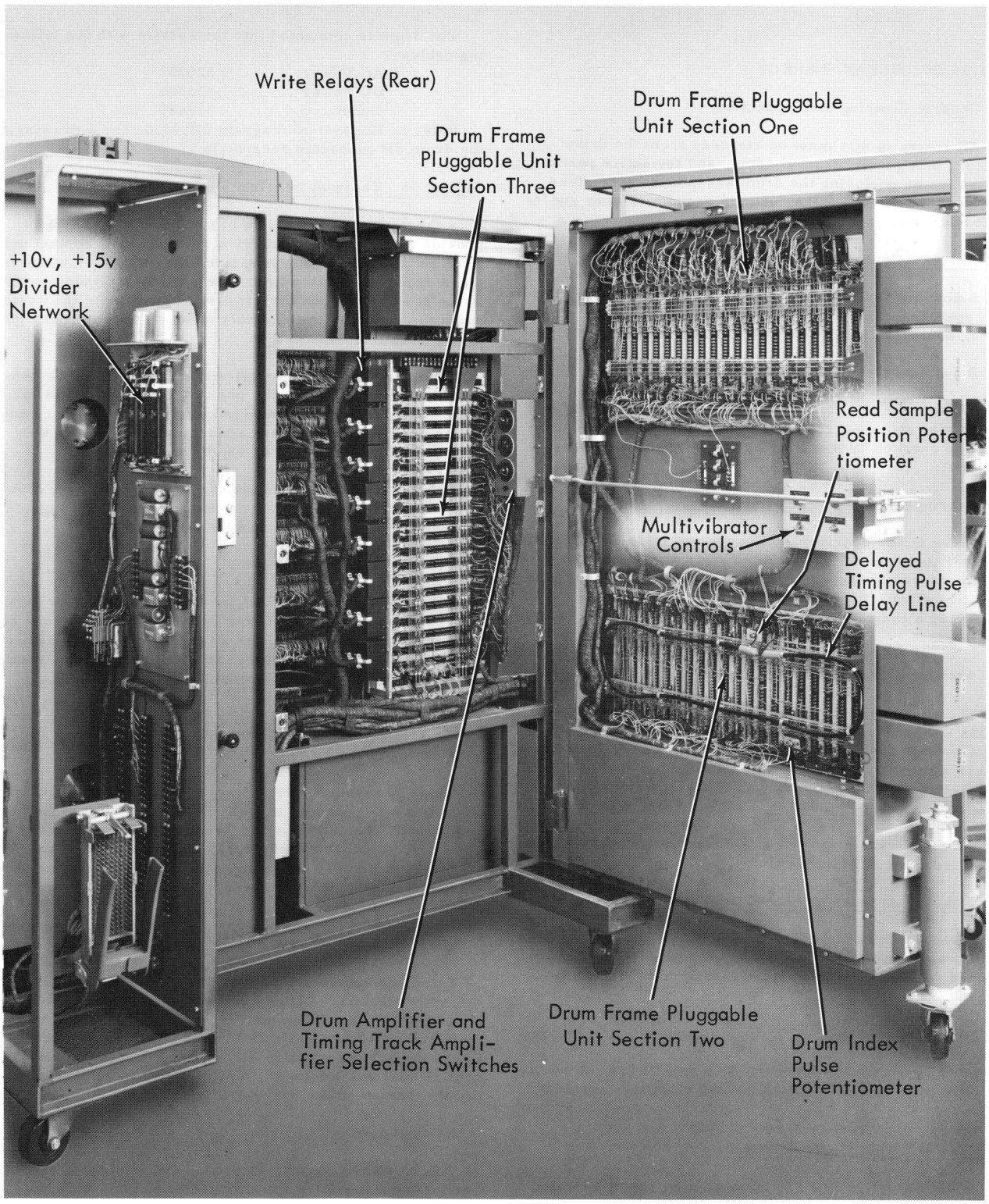


Figure 14-1. Drum Frame, Rear View, Door Opened

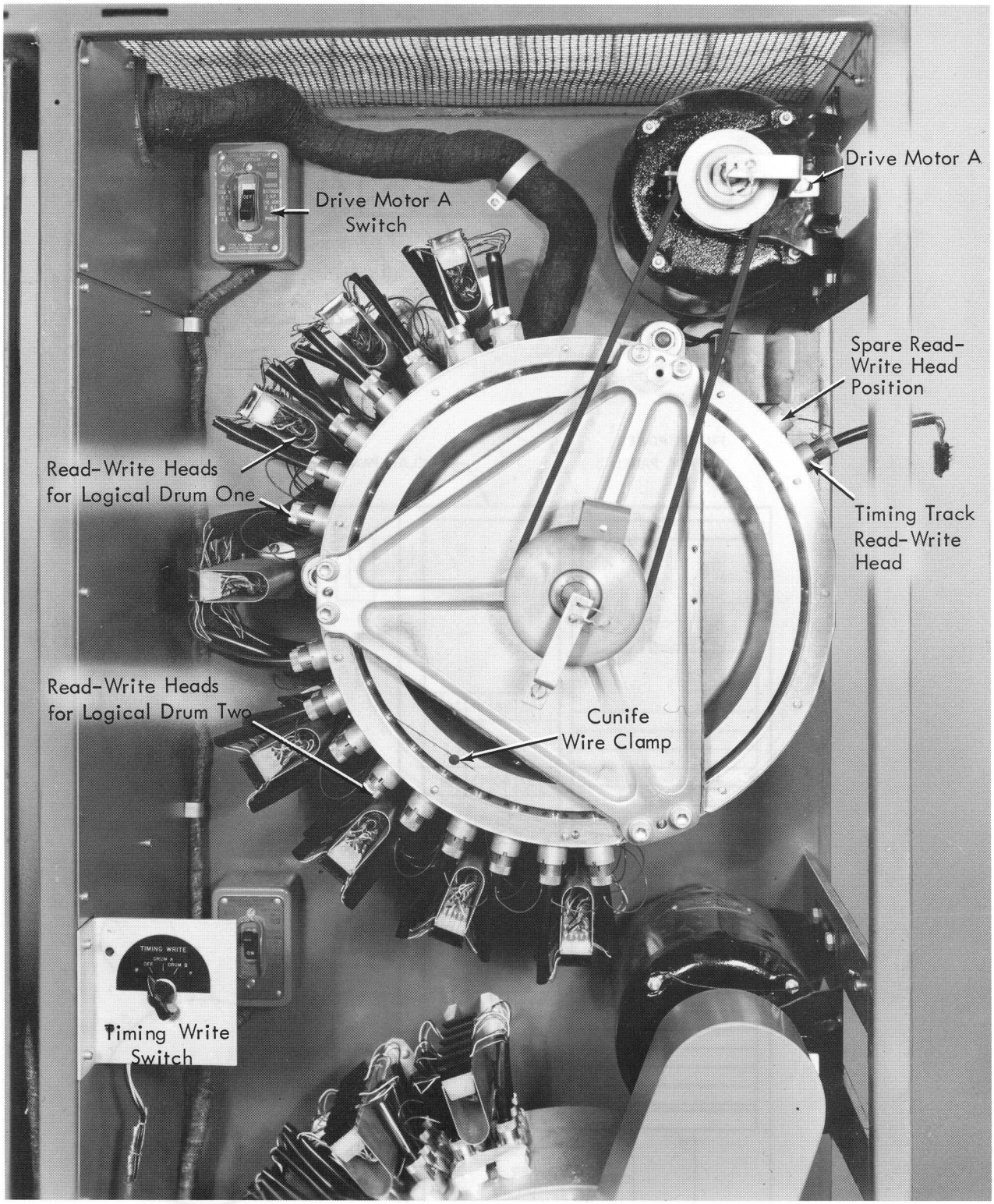


Figure 14-2. Physical Drum A

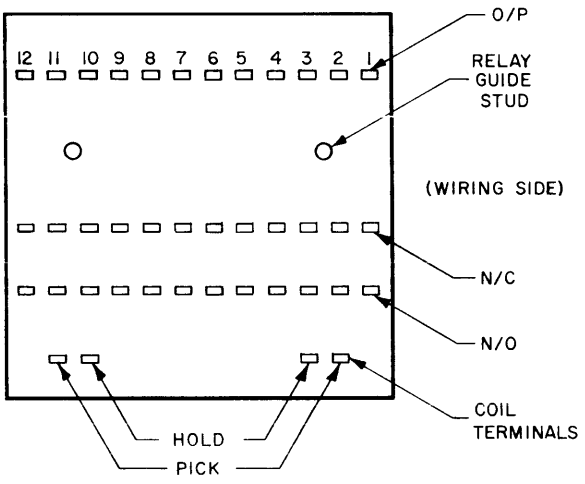


Figure 14-3. 21- Position Wire Contact Relay

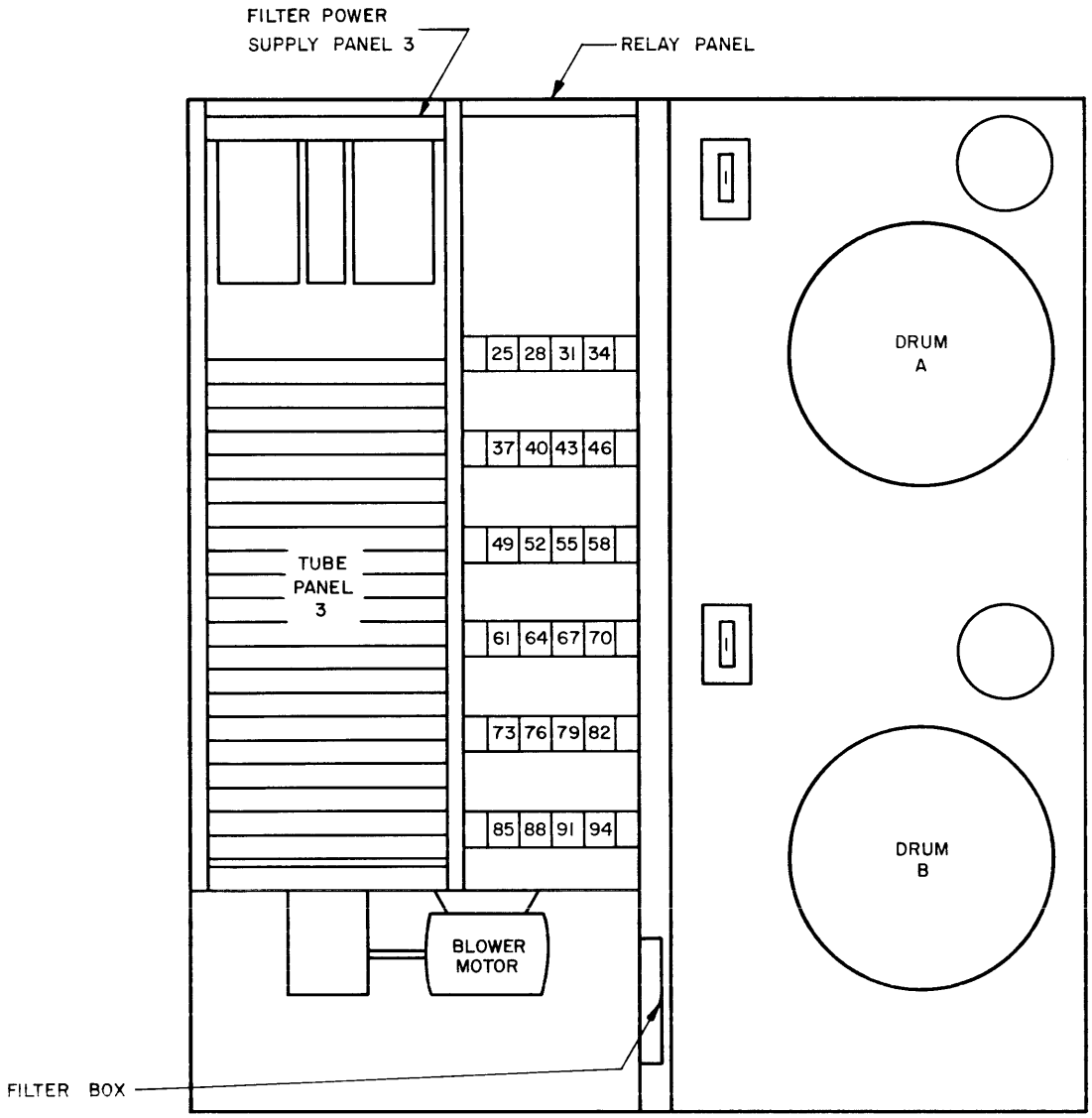


Figure 14-4. Drum Panel 3 Relay Numbering

The relay point used for each I/O position is shown in CPU System Diagram 7.03 Sheet 2 of 3. Note that both the "Write 1" and "Write 0" relay points for the same logical drum are picked up simultaneously. Thus when one drum is selected to be written upon, all six relays in a vertical line on the relay panel will be energized at once. (Figure 14-4).

733.14.08 Reliability

Establish reliability daily by running diagnostic program 4D10 on a 704 system or 9D01 on a 709 system.

733.14.09 Service Voltage Terminals

Service voltage connections for the drum can be found on CPU system diagram 9.32. Make sure all terminals are clean and tight.

733.14.10 Resistor/Filter Panel

Four bleeder resistors and two -250 reset resistors are located on the drum power supply panel (Figure 14-1). Check that all connections and solder joints are good. For proper methods of checking operating temperature see 733.14.01.

Filterol networks, mounted below the bleeder resistors, are used to filter the power supply voltages coming from the Power Distribution Frame. Their purpose is to prevent ripples on the supply voltage from affecting the operation of pre-amps and amplifiers located in panel 3. Check that these connections are clean and tight. A voltage drop on the order of 3% of nominal rating is normal across these filters. Thus, the -100v line might drop 3 volts across the filter network, making the voltage at panel 3 actually -97v.

733.14.11 Fuses

A list of the fuse locations used for the drum can be found on system diagram 9.32. Check fuse clips for weak tension.

733.14.12 Biasing

Voltage bias limits for the drum are as follows:

Nominal	+220	+150	-30	-100	-250
Lower	198	143	-27	-96	-230
Upper	234	163	-33	-108	-259

While running the 4D10 or 9D01 diagnostic test, vary the DC voltages to the limits given above. You should obtain at least one minute of error-free operation at each limit. Run this bias test at one month intervals.

In most cases, bias limits for the drum differ quite a bit from those of main frame. Therefore, it is not possible to bias the system with a round robin diagnostic if drum is on the line.

Bias Failures

The fact that the drum has trouble at one voltage limit rather than another helps you to determine which circuit is failing. For instance, the -100 volt supply in drum is quite sensitive. The cathodes of inverters (I_Q) used in the drum write circuits are tied to this supply. If the drum begins to operate incorrectly as -100 volts is varied towards -96 volts, you can generally assume trouble in the I_Q or write circuits.

Voltage supplies which are varied when the drum is biased are discussed below. **Don't forget to return each voltage to normal before biasing the next.**

220v. Used principally in AND, -OR, and SS circuits. Also found in special drum circuits SS_A, A_D, TPA, and WD.

When trouble occurs at this bias limit, scope the 25 usec. SS on systems page 7.01.01. If its timing falls much below 24 micro-seconds, the circuits will not operate properly. If the fault is not in this area, then the other circuits will have to be checked. The type of error that is occurring will determine which circuit you will check. For instance, if you have read errors, check the A_D circuits; with write errors, check the WD circuits.

150v. This voltage is used extensively throughout the machine. Some of the circuits which use it are:

CF	A	TPS
PCF	A_D	IPG
I	SS	SR
T	SS_D	PKR_E
T_D	D	

Failure at this voltage limit is usually due to a bad CF, PCF, or T, but this does not really narrow down the search. Troubleshooting time might be shortened if the failure can be repeated at another bias limit.

15v. Used in diode clamps and as plate supply for I_Q. This voltage is seldom biased. However, if, when it is varied, write errors appear on the drum, the I_Q circuits should be checked.

-30v. Used in diode clamps, SC, SG, CG, DL, A, SS, and T circuits.

Read errors that occur when this voltage is biased can generally be traced to bad triggers, especially in the read register. The -30v supply is used as a tie point for the -12v divider to which the trigger grids are clamped. This portion of the circuit is very sensitive and, therefore, is a good indicator of how well the trigger is working.

Other trouble, such as write errors, might also be due to bad triggers elsewhere in the system. It helps, especially when biasing this voltage, if the trouble can be isolated in either the main frame or the drum frame.

-100v. The drum is particularly sensitive to biasing this voltage. This is due not only to the I_Q circuits, as explained previously, but also to other critical drum circuits. These special drum circuits are the SR and ST circuits, used in picking which drum is to be used. Therefore, if really bad errors appear on this voltage bias, check to see if you are reading or writing on the proper drum.

The -100v supply is also used in the following component circuits.

CF	SG	TPA
PCF	CG	TPS
SS	I_{SY}	IPG
D	I_{CL}	
SC	A_D	

If trouble appears on drum when the -100v supply is moved towards -108v suspect these circuits and not the I_Q's, SR's, or ST's.

-250v. This voltage is used throughout the machine. It is found on almost all voltage dividers, on OR and-AND circuits and on some tube cathodes. Determine if trouble is in reading or writing, and try to isolate whether it is happening in main frame or drum frame. Special drum circuits such as I_Q's, SR's, and ST's are particularly susceptible to trouble at this voltage bias limit. A combination of this voltage bias and -100v bias should enable you to find if these circuits are faulty.

733.14.13 Motors - Drive Belts

The 733 Drum is driven by a one horsepower, induction start, synchronous run, 3600 rpm motor. Driving force is applied to the drum through a belt and pulley arrangement. Check for binding motor shafts. Check the pulley setscrews for tightness. Check the belts for wear and cracking.

A certain amount of squeal and knocking occurs when the motor is first started, due to slipping between the drive pulley and the belt. As the drum comes up to speed, this noise should disappear. If the noise continues, the belt is too loose or the bearing is bad.

733.14.14 Static Brush

Static brushes are connected to the front end of the drive motor and the drum assembly. Each brush is used to make contact between the end of the moving shaft and ground. The brushes insure that no stray magnetic fields are developed which will affect reading and writing on the drum. If the brushes are not operating correctly, a magnetic bias might be placed on the drum and result in intermittent loss of bits when reading or writing.

Therefore, all wire connections to the brushes must be checked; these and the bearing surfaces which they contact must be periodically cleaned to remove glazed spots and dirt.

733.14.15 Excessive Vibration

The alignment of the drum drive motors, drive belts, and pulleys should be such that there is no visually detectable vibration of the drive motors. Alignment may be checked by laying a straight edge along the side of the drum assembly pulley and seeing how well it contacts the drive motor pulley. If alignment is correct, the straightedge will be flat across the surface of both pulleys. Loosening the four bolts which hold the drive motor to the frame will enable you to bring the pulleys into alignment.

733.14.16 Drum Housing

Make sure the three bolts which hold the housing to the frame are tight. Use erase hole covers to cover erase holes whenever they are not in use. This will reduce the amount of dirt that accumulates in the head area.

733.14.17 Bearings

The 733 uses the following type of bearings: rear, single ball; front, double thrust ball. The read/write heads of the drum are likely to be ruined if bearings are bad. There is also danger of destroying the cunife wire covering on the drum surface. To prevent these things from happening, take the machine out of service at the first sign of bearing troubles.

Bad bearings are easy to identify by the characteristic noise they make. Check the drum bearings at least once every three months. Four ways of doing this follow:

1. Stop the drum by turning off the drum drive motor switch and then disconnect the green ground wire on the timing track head from the surface of the drum. Connect an ohmmeter between the green wire and the drum housing. The meter should not indicate. Now squeeze the belt between the pulleys. If you obtain a reading on the meter, there is excessive play in the bearings and they will have to be replaced.

2. While the drum is running, a metal rod such as a center punch or drift pin, may be used as a stethoscope to listen for noise in the bearings. Hold one end against the drum housing while you listen at the other end. The success of this method depends on doing this often enough while the bearing is good so as to recognize that a change has occurred when the bearing starts to fail.

3. Shut the drum motor off and measure the time it takes to coast to a stop. If the time becomes shorter and shorter over a period of months, the bearing is deteriorating. If stopping time is shortened as much as 5 minutes, a bad bearing is indicated.

4. Finally, when a bearing goes bad, there is a distinct rise in temperature which you should be able to feel with your hand. However, the bearing may be too far gone by the time this temperature rise becomes apparent.

733.14.18 Drum Speed

Correct drum speed is 2429 rpm or 24.7 milliseconds per revolution. A variation of ± 10% is allowable. Thus, its speed can vary from 2186 rpm to 2672 rpm. CAUTION: Avoid a speed of 2400 rpm. This speed is a harmonic of 60 cycles. If the drum rotates at a harmonic of 60 cycles, it becomes impossible to erase without leaving considerable bias on the drum.

The best way to check drum speed is by use of the drum diagnostic test (4D05 when the drum is used with a 704 CPU, or 9D01 with a 709 CPU). This information appears in the appropriate diagnostic program book, together with instructions on how to use the test. Actual drum speed appears in the accumulator in binary coded decimal.

See Corrective Maintenance, Section 733.22.18, for how to adjust drum speed.

733.15.00 WAVEFORMS AND LEVELS

733.15.19 Read/Write Head

Outputs of all read amplifiers for all read/write heads must have a minimum peak to peak amplitude of 80 volts. Pictures of the main amplifier output under different conditions are shown in Figures 15-1 and 15-2.

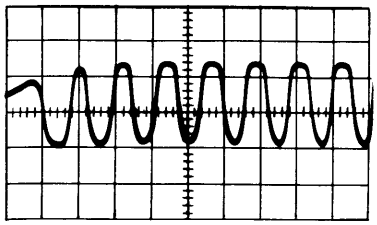


Figure 15-1
Read all ones - A_D output at test switch, 7.03
Sweep tgr - index pulse
10 usec/cm 50 volts/cm
Conditions: RDS drum 1 after having written all ones.

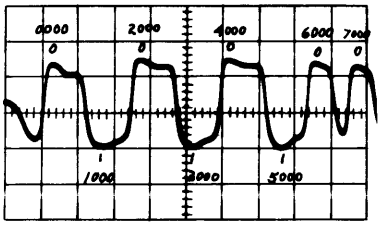


Figure 15-2
Read zeros and ones - A_D output at test switch 7.03
Sweep tgr - index pulse
10 usec/cm 50 volts/cm
Conditions: RDS drum 1 after having written ones at 1000, 3000 and 5000 with zeros at all other drum addresses.

733.15.20 Read Trigger Input

Output from the read main amplifier is sent through an AND circuit together with the Drum Read Sample pulse. This AND circuit output is used to flip on the read register trigger. Consequently, it is important that the Drum Read Sample pulse is in the correct position to properly gate the main amplifier output. A potentiometer mounted on drum panel 2 (A-13) is used to vary the position of this pulse.

To check for correct position, use a dual trace oscilloscope with one probe on the Drum Read Sample pulse (DF2-E01-1) and the other probe on the main amplifier test switch output. Use the Ext. Trigger, with the Drum Read Sample pulse as a sync. Write zeroes all over the drum, then continually read and display both traces on the scope. The Drum Read Sample should come up once every eighth main amplifier pulse. Adjust the position of the Read Sample pulse by turning the potentiometer till the pulse comes up just as the main amplifier output is at maximum (Figure 15-3). This pulse position should now be correct for all tracks. Check by turning the test switch through all positions and observing the scope traces. If any major variation in position is seen, check for bad PA or A_D tubes or for loose pluggable unit pin connections in that particular track.

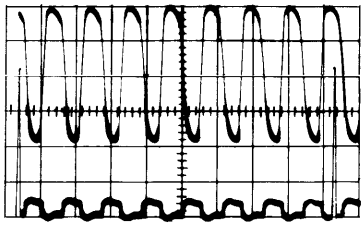


Figure 15-3
Read sample pulse superimposed below the A_D output. The voltage scale is 20 v/cm for A_D, and 10 v/cm for Read Sample. The time scale is 10 usec/cm for both pulses.

733.15.21 WD Output

Each Write Driver circuit output is fed to either the "Write 1" or "Write 0" coil of its track head. This output pulse is shown in Figure 15-4a. The same pulse will appear inverted across the other end of the center tapped coil due to transformer action. For instance, if you write a one bit on track S, the waveform of Figure 15-4a will be found on DF1-C01-7 and its reflection, completely reversed, will appear on DF1-D01-5, as shown in Figure 15-4b. (Refer to systems diagram 7.03).

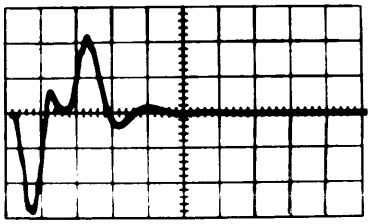


Figure 15-4a
Write a One
20 v/cm 1 usec/cm

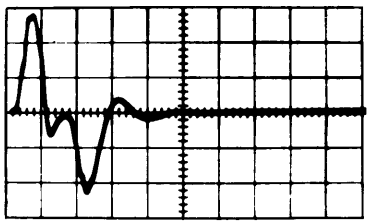


Figure 15-4b
Write a One, Reversed
20 v/cm 1 usec/cm

733.15.22 Timing Track Head

The main amplifier output of a good timing track should have an appearance similar to that shown in Figure 15-5. It must have an amplitude of at least 80 volts, peak to peak. The gap in the timing track should be from 150 to 350 microseconds (Figure 15-6).

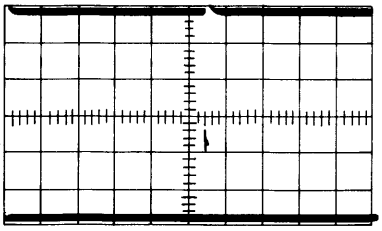


Figure 15-5
Timing Track
20 v/cm

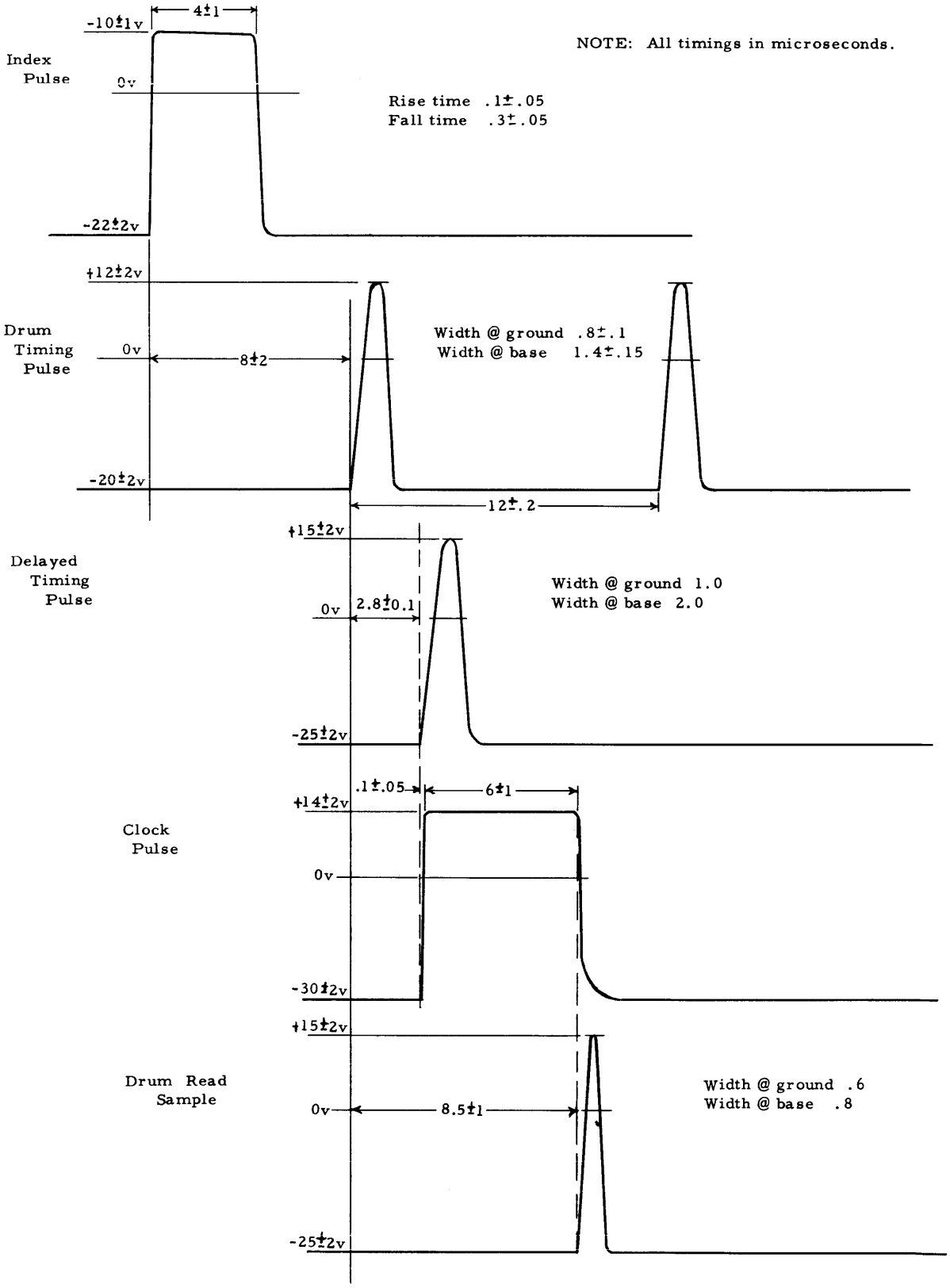


Figure 15-7. Pulse Specifications

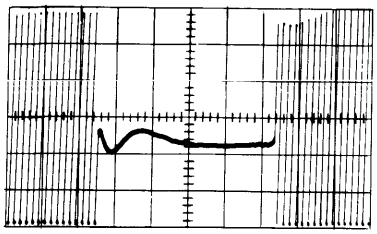


Figure 15-6
Timing Track Gap
20 v/cm 50 usec/cm

A new timing track must be written if:

1. Noise level at the timing amplifier exceeds 4 volts, peak to peak.
2. Output from the timing track is weak.
3. Noise appears in the timing track gap.

Sometimes errors due to picking up or dropping false bits may best be corrected by erasing the entire drum and writing a new timing track. Before you do this, make sure the trouble is not in the read/write heads or their associated circuits.

733.15.26 Special Pulse Specifications

Refer to Figure 15-7 for engineering specifications applying to special drum pulses.

733.15.27 Pulse Checking

The following pulse waveform photographs are listed in the order in which the pulses are found in the PM Guide Chart. They are to be checked every three months. These waveforms are intended only as guides, since it is likely that pulses will differ in minor respects with each machine.

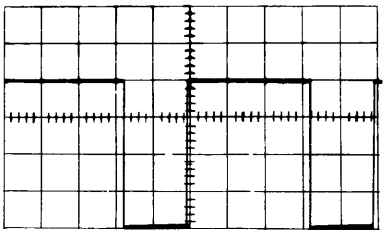


Figure 15-8

14 Msec. Delay

10 v/cm
10 Msec/cm

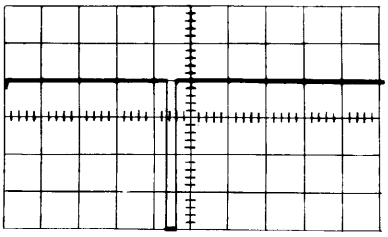


Figure 15-9

500 usec. Delay

10v/cm
2 Msec/cm

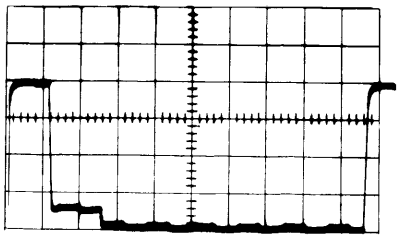


Figure 15-10

Read Gate

10 v/cm
10 usec/cm

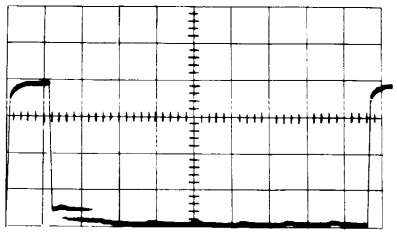


Figure 15-11

Write Gate

10 v/cm
10 usec/cm

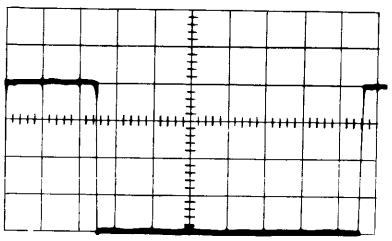


Figure 15-12

25 usec. SS

10 v/cm
10 usec/cm

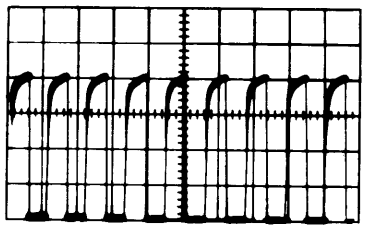


Figure 15-13

Drum Counter 1

10 v/cm
20 usec/cm

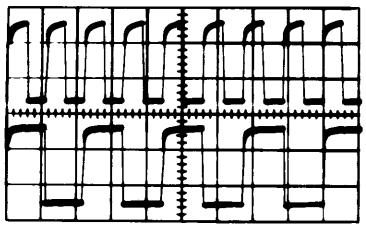


Figure 15- 14

Drum Counter 1
&
Drum Counter 2

20 v/cm
20 usec/cm

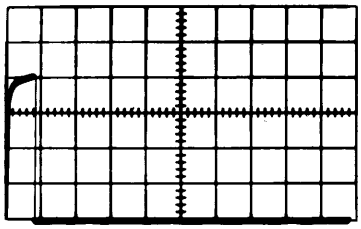


Figure 15-15

True End Carry

10 v/cm
10 usec/cm

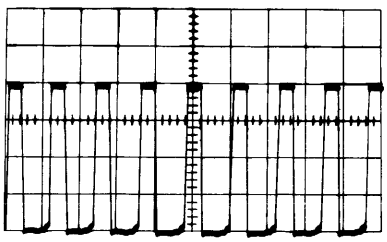


Figure 15-16

Drum Adder Gate

10 v/cm
10 usec/cm

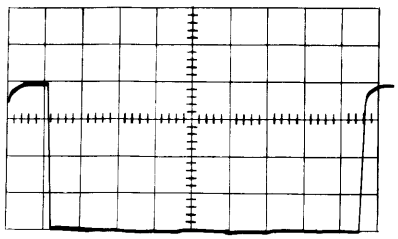


Figure 15-17

Interlace Ctr. Carry

10 v/cm
10 usec/cm

The following pictures show drum pulses not listed on the PM Guide Chart. These will prove useful when tracing drum circuits.

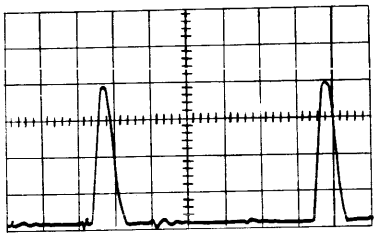


Figure 15-18

Timing Pulse
(sync on Index)

10 v/cm
2 usec/cm

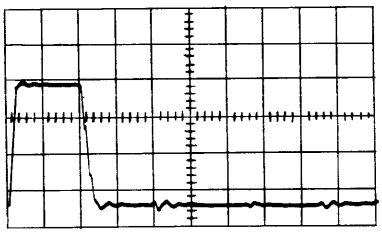


Figure 15-19

Index Pulse

10 v/cm
2 usec/cm

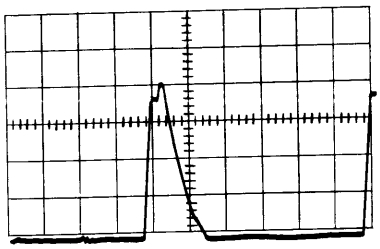


Figure 15-20

Delayed Timing
Pulse
(sync on Index)

10 v/cm
2 usec/cm

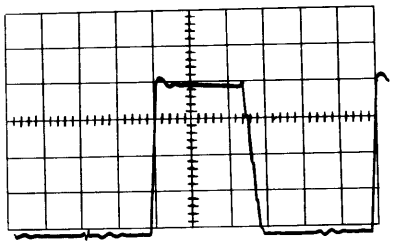


Figure 15-21

Clock Pulse
(sync on Index)

10 v/cm
2 usec/cm

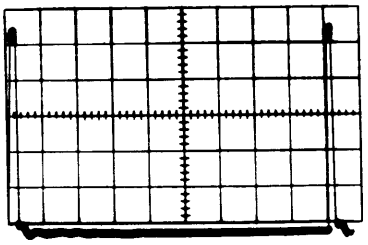


Figure 15-22

Write Pulse

10 v/cm
10 usec/cm

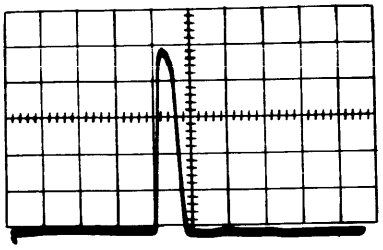


Figure 15-23

Read Sample

10 v/cm
1 usec/cm

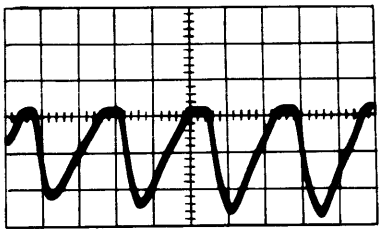


Figure 15-24
Raw Timing Pulse - DF3 A19-4, 7.03
Sweep Trigger - Index Pulse
50 v/cm 5 usec/cm

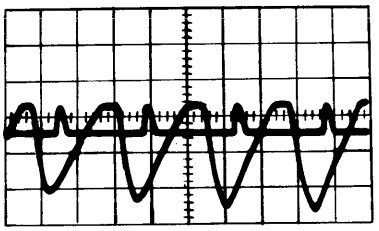


Figure 15-25
Shaped Timing Pulse - DF2 D14-5, 7.03
Raw Timing Pulse - DF3 A19-4, 7.03
Sweep Trigger - Index Pulse
50 v/cm 5 usec/cm

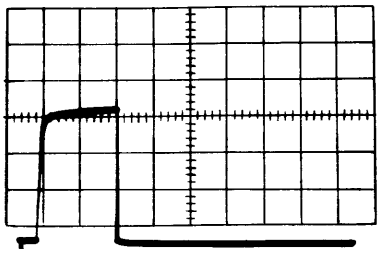


Figure 15-26
Stretched Index Pulse - MF3 P09-1, 7.02.02
Sweep Trigger - Index Pulse
10 v/cm 5 usec/cm

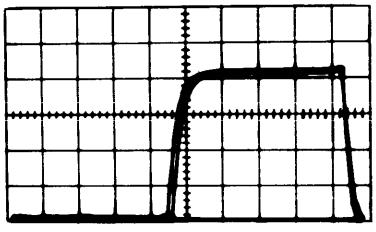


Figure 15-27
Interrogate 9 Carry - MF3 P05-3, 7.02.01
Sweep Trigger - Clock Pulse
10 v/cm 1 usec/cm

CONTENTS

733.20.00 CORRECTIVE MAINTENANCE

733.21.00 REMOVALS AND REPLACEMENTS

733.21.02 Air Filters

There are two pairs of air filters in the Drum. One is located under Panel 3 and the other under Panel 1 and 2. Filters are removed in the following manner:

1. Remove outside grill. This exposes the filter.
2. Remove side or bottom retainer plates.
3. Slide out vertical filter.
4. Lift out filter lying beneath blower.

To replace filters reverse above procedure. Use new filters, do not clean and use old ones again.

733.21.16 Drum Housing

To remove the entire drum housing, including the physical drum and all read/write heads, proceed as follows:

1. Disconnect all head plugs.
2. Use masking tape (or equivalent) to tape rows of head leads together. This will keep them out of the way of protruding cable troughs.
3. Remove static brush holder.
4. Take drive belt off the drum pulley.
5. Remove bolts and lock washers holding drum housing to three retaining lugs set in the rear wall.
6. Wheel over a cushioned seat.
7. Find the strongest man in the group and have him grasp the drum housing, (weight-60lbs), pull it straight out, and place it on the seat with the pulley facing up.

To replace the housing, reverse the above procedure. Don't forget to tape the head leads, otherwise they may catch and break on the cable troughs.

733.21.17 Bearings

When it becomes necessary to replace bearings, remove the entire drum housing assembly and replace with a new one. This will do away with the necessity of finding and replacing read/write heads which have been scored due to the bearing failure.

733.21.19 Read/Write Head Assembly

The complete head assembly is shown in Figure 21-1. There are six wires connected to each read/write head. Five of them enter a plastic block containing the pin terminations. The sixth, a green wire with a spade on the end, is a ground connection for the mu metal read/write core. Each of the wires is a different color. See the following table for relationship.

Pin #	Wire Color	Internal Connection
1	red	Write coil (zero)
2	white	Write coil (one)
3	blue	Read coil
4	black	Center tap for Write coil
5	yellow	Read coil

Removing Drum Heads

To remove a drum head, proceed as follows:

1. Disconnect the drum head leads by pulling out the plug.
2. Loosen the screw which holds the green ground wire and remove the wire from the drum assembly.
3. Use the drum head wrench to loosen the locking nut.
4. Unscrew the head until it can be pulled free of its mounting hole.

Replacing Drum Heads

To replace a drum head, proceed as follows:

1. Stop the drum.
2. Rotate the outer drum head screw until it just covers the topmost third of the threads on the inner screw.
3. Place the head assembly in position over its mounting hole. Make certain that the key on the drum head case is in line with the keyway in the mounting hole.
4. Slide the head assembly into the hole as far as it will go. Give the outer screw a few clockwise turns to secure the head.
5. Connect an ohmmeter between the head ground wire (Green) and the drum frame.
6. Rotate the outer screw clockwise until the ohmmeter needle flickers, indicating contact between the head and the surface of the drum.
7. If the outer screw tightens up before the head contacts the drum, remove the head assembly and back off the outer screw a few turns. Repeat steps 3-6, and step 7 if necessary.
8. If the case is not firmly positioned at the time the head contacts the drum, remove the head assembly and advance the outer screw a few turns. Repeat steps 3-6, and step 8 if necessary.
9. Rotate the drum slowly, and carefully adjust the outer screw so that the ohmmeter needle flickers at only the highest spot on the drum surface. From this point, back off the outer screw 1/4 turn to obtain a gap of approximately 2 mils.
10. Connect the drum head leads and start the drum.
11. Write and then continuously read this drum.
12. Observe the main amplifier output for a new head.
13. If it is below 80 volts, peak to peak, the drum head is too far from the drum surface. Rotate the outer screw 1/8 turn clockwise and repeat steps 11 and 12. Remember that every 1/8 turn off the outer screw moves the head approximately 1 mil and that the minimum specified drum head to drum surface spacing is 1 mil.

733.21.22 Timing Track Head

When removing or replacing the timing track head, follow exactly the same procedure as when changing the read/write heads. Refer to section 733.21.19.

733.21.25 Covers

The cover on the gate hinge side must be removed before the drum gate can be swung open. A key is required to unlock this cover before it can be taken off. The key which fits the front covers will also fit this side cover.

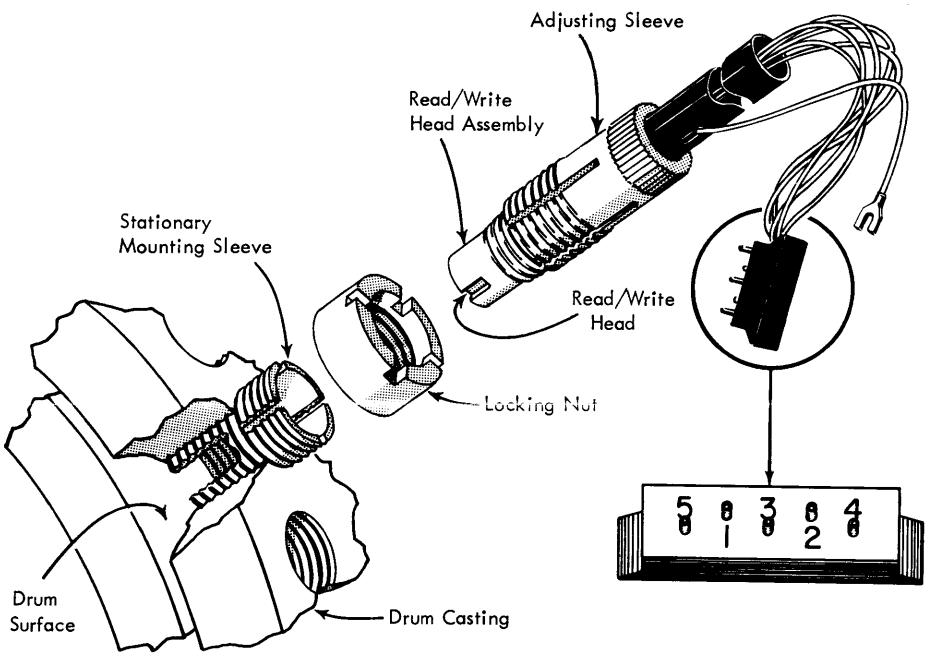


Figure 21-1. Read/Write Head Assembly

733.22.00 ADJUSTMENTS AND TIMINGS

733.22.05 Thermal Interlocks

Mount an accurate thermometer directly above the thermal interlock to check for proper operating range. The thermal should operate at 131 ± 5° F. If it goes off before this temperature range is reached, turn the adjusting screw clockwise. If it doesn't work until you go beyond this temperature range, turn the screw counter clockwise.

733.22.13 Motors - Drive Belts

Sometimes drive belts will slap against their guards. This can usually be corrected by loosening the belt guard screws and moving the guard slightly. In extreme cases the entire motor may be shifted by loosening the four base screws and moving the motor up; but, if this is done, pulley alignment and drum speed will have to be rechecked. The belt should be left as loose as possible without hitting its guard so that plenty of slippage can occur when the motor is first started.

733.22.18 Drum Speed

The only method of varying drum speed is by changing the effective diameter of the adjustable pulley attached to the drive motor. This pulley can be turned in or out on its shaft to increase or decrease its diameter and consequently the speed at which the drum rotates. Set screws are used to lock the pulley into final position.

Changing drum speed will affect the length of the timing track gap. Therefore, after adjusting the speed of the drum, check the timing track gap to be sure it is within specifications.

733.22.19 Read/Write Head Adjustment

A great deal of time can be wasted by trying to adjust drum heads when actually a new tube is needed in the PCF_A and/or WD circuits. Check these circuits by interchanging pluggable units before attempting any head adjustment.

If the drum head is already seated so that only minor adjustment is necessary, the following procedure may be used:

1. Key in a program which alternately writes and reads on the drum. A good program for this purpose is the one suggested on Sheet 4 of the Troubleshooting Charts.

2. Place a light behind the physical drum assembly so that the space between the head and the drum surface is illuminated.

3. Scope the track output; loosen the locking nut; and turn the head screw in towards the drum surface. Visually check to be sure that the drum head does not rub against the drum surface.

4. Observe the output wave form. It should have a constant amplitude, over 80 volts, peak to peak, at all points (see Figure 15-5).

5. When the output is satisfactory, tighten the lock nut securely. Check to be sure this did not change the waveform.

733.22.22 Timing Track Head Adjustment

Spacing between the timing track head and drum surface should be checked before writing a new timing track. Check by means of the ohmmeter method, explained in section 733.21.19 (Replacing Drum Heads).

The head should be turned in as close as possible without actually touching the drum surface. After writing the timing track, place the drum in read status and scope the timing track output. Sometimes a narrowing in the wave envelope may appear due to overloading the PA's (Figure 22-1a). This can be corrected by backing out the head slightly until the envelope assumes a normal condition (Figure 22-1b).

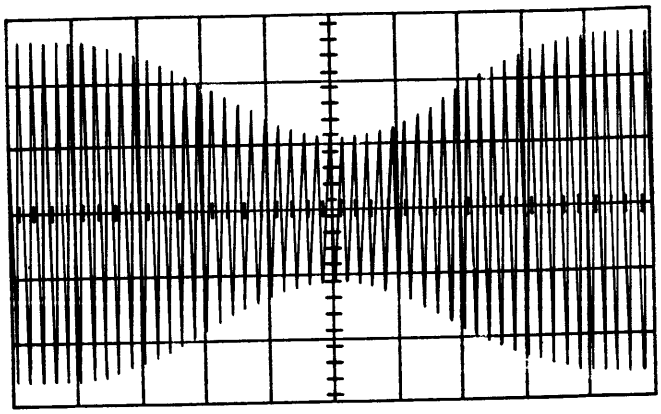


Figure 22-1a

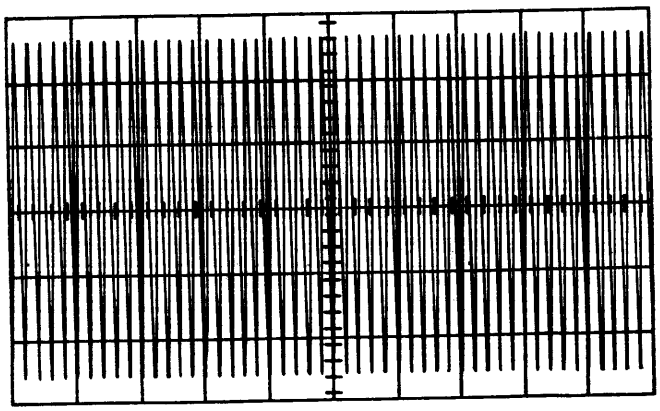


Figure 22-1b

733.22.23 Erasing

Before a timing track is written, the entire physical drum must be erased. This is done as follows:

1. Remove the cover from the erase holes and turn on the eraser.

2. Place the scribed line on the eraser in a vertical direction and insert its snout in the erase hole as far as it will go.

3. Slowly rotate the eraser till the scribed line is in a horizontal position.

4. Slowly and steadily withdraw the snout. This should take about 8 to 10 seconds.

5. Repeat procedure for each erase hole. The alignment of erase holes to drum surface can be seen in Systems diagram 7.03.01.

Checking Quality of Erasing

To check the quality of erasing, the drum main amplifier output must be inspected. To do this, the drum must be in read status. Either of the following methods may be used to achieve this result:

Method 1: Select the erased drum by entering a RDS drum instruction on the operator's panel keys. Place the CPU in manual and press the Enter Instruction key. Check at drum Panel 3 to see that the proper Read Drum neon is lit which indicates the correct drum is selected.

Method 2: With this method, drum may be off the line and CPU time need not be used while drum is being erased. Pull out the shoe connector, then place the drum in in read status by using a wire jumper to apply +10 volts from any convenient point to the input of the appropriate SR (see Systems diagram 7.08).

To read drum 1 put +10v. on DF3-H20-1
To read drum 2 put +10v. on DF3-G20-3
To read drum 3 put +10v. on DF3-F20-2
To read drum 4 put +10v. on DF3-F20-1

Check that the correct drum is selected by observing the neon as in Method 1 above.

After the correct drum has been selected, proceed as follows to check the quality of erasing:

1. Scope outputs of all erased tracks.

2. Erase again those tracks on which noise output exceeds 4 volts, peak to peak. With careful erasing, you can achieve a noise level as low as 1/2 volt, peak to peak.

3. Check all tracks on both logical drums if the entire physical drum has been erased.

At times large noise spikes may appear on an erased track and be impossible to get rid of. This could be caused by a noisy pre-amp tube. Check each of the four pre amps connected to this track.

733.22.24 Writing a New Timing Track

To write a new timing track, proceed as follows:

1. Turn multivibrator on-off switch to the on position.

2. Allow multivibrator to warm up for eight to ten minutes.

3. Connect a scope to any main frame clock pulse. Adjust the sweep time calibration of the scope so that the leading edges of two successive clock pulses are ten divisions apart on the face of the scope.

4. Maintaining the same calibration, connect the scope to the drum multivibrator pulses and adjust the multivibrator frequency so that the leading edges of two successive pulses are ten divisions apart.

5. Turn on the drum timing write switch on main frame 3.

6. Turn the drum rotor selection switch, on the front of drum, to select the proper drum.

7. Momentarily depress the write-timing-track push button at the drum frame.

8. Turn the drum rotor selection switch to the off postion.

9. Connect a scope to the output of the timing pulse amplifier and measure the length of the gap in the timing track. The gap should be between 150 and 350 usecs. (See Figure 15-6.)

10. If the timing gap does not fall within this limit, adjust the multivibrator period slightly. Specifications allow 12 plus or minus 0.2 usecs. between leading edges of two successive timing pulses. If the multivibrator period is changed by 0.2 usec., an overall change on the timing track of over 400 usec. results (2048 x 0.2 = 409.6).

11. If the timing track gap is still not correct, check the drum speed and adjust the speed if necessary. (See section 733.22.18.)

12. After a satisfactory timing track has been written, turn off:

    a. Drum rotor switch on front of drum.

    b. Drum timing track write switch on main frame 3.

    c. Drum multivibrator.

CONTENTS

Service techniques are intended to be used as guides in the servicing of the machine. After gaining experience on the equipment, most men will develop their own techniques to supplement these guides.

733.31.00 SIMPLIFIED MACHINE LOGIC

In the following discussion of drum write and read circuits, refer to Figure 31-1.

733.31.01 Writing

1. There is only one set of 36 WD's (Write Drivers). The particular logical drum they write upon is determined by the write relays.

2. There is a total of 24 relays in the drum frame. Six of these must be energized simultaneously to write on one logical drum.

3. Both the "Write 1" and Write 0" relay points are connected at the same time to each drum head on the chosen drum.

4. Head connections can be interchanged.

This design simplifies troubleshooting. If write errors appear on the same track on different drums, check the write driver circuits. If they appear on different tracks on different drums, check relay points and write head. Write circuit pluggable units (0424) may be interchanged to see if the error follows the unit. These units are in Panel 1 of the drum drame.

733.31.02 Reading

1. Each track on each drum has its own PA (Pre-Amplifier). There are 144 tracks making a total of 144 PA's.

2. The same track on all four drums share the same A_D (drum main amplifier). Thus there is a PA for the S track on Drum 1, another for the same track on Drum 2, another for Drum 3, and another for Drum 4. All four of these PA's feed into one A_D. The particular PA conducting at any one time depends on which drum was selected for reading.

3. One set of 36 Read Register Triggers is used to store information till CPU is ready to accept it.

4. Head connections may be interchanged.

If read errors appear on the same track on all drums, check the read register triggers, then the main amplifiers. If read errors appear on different tracks on different drums check the PA's and then the read heads. The Read Register pluggable units (0338) are in Panel 2 while the PA and A_D pluggable units (0427) are in Panel 3. Interchanging Panel 2 units or Panel 3 units will isolate trouble readily.

733.31.03 Write Circuit Switching

Figure 31-2 is a simplified diagram of the operation of the drum write circuit. Refer to this figure while reading the following explanation. Since the write circuits are all identical, this circuit which is drawn for one track will be correct for all the others.

Tube WD1 and its associated components are used for writing a binary one; tube WD2 is used for writing a binary zero. Relay contacts connect the write-one circuit and write-zero circuit to the drum head of the appropriate logical drum. When not writing, the write relays are de-energized and write coil halves are grounded through resistors R_R. This is done so that random voltages across the write coils due to stray pick-up are not developed.

Normally the grids of tubes WD1 and WD2 are held below cut-off. Condenser C is charged to the B+ voltage. To write a binary one, a positive pulse is applied to the grid of WD1, bringing it above cut-off and causing the tube to conduct. Condenser C then discharges through a path consisting of the write-one half of the write coil, now connected to the write circuit by the relay contacts, and the conducting tube WD1. Thus, the discharging condenser C supplies write current to magnetize the drum surface. For further details on this circuit see Electronic Operations, Section 7.00.00.

733.31.04 Read Circuit Switching

Read coils are not switched by relays as are write coils, but are connected to the grids of tubes. Figure 31-3 shows the circuits used for switching three representative tracks (S, 1, and 35) of the four logical drums. These triodes and associated components are called pre-amplifiers (PA). Four PA's, representing the same track on each of the four logical drums, share a common plate load resistor (R_L) and are connected to one main amplifier. Switching between logical drums is accomplished by selecting which of the four PA's is to feed a signal into the corresponding main amplifier.

Normally the SR circuit (shown at the top of Figure 31-3) conducts, placing -20 volts on the grids of the PA's. This insures that the PA's will not conduct.

If you want to read information from a drum, for example Drum 1, the SR switch labeled "Read Drum 1" becomes cut off and causes the grids of the Drum 1 preamps to go to ground potential. The PA's for Drum 1 are now free to amplify signals applied at their grids. For further details on these circuits see Electronic Operations, Section 7.00.00.

733.31.05 Selection of I/O Devices

Figure 31-4 shows the 704 CPU circuits employed in the select instructions. Figure 31-5 shows the same circuits for the 709 CPU.

733.31.06 Drum Write Select

The WRS drum instruction does the following:

1. Sets I/O interlock.

2. Conditions drum write circuits on.

3. Selects correct timing track.

4. Energizes write relays for proper drum.

5. Delays operation of drum write circuits for 15 ms to allow time for the relay points to close. Cyclic makeup of WRS drum is I, ER, ...ER, end operation. The cycle timer stays in ER time until any previously selected I/O unit is disconnected. When the drum is used with a 709 CPU, this amounts to waiting until the DSU channels are not in use.

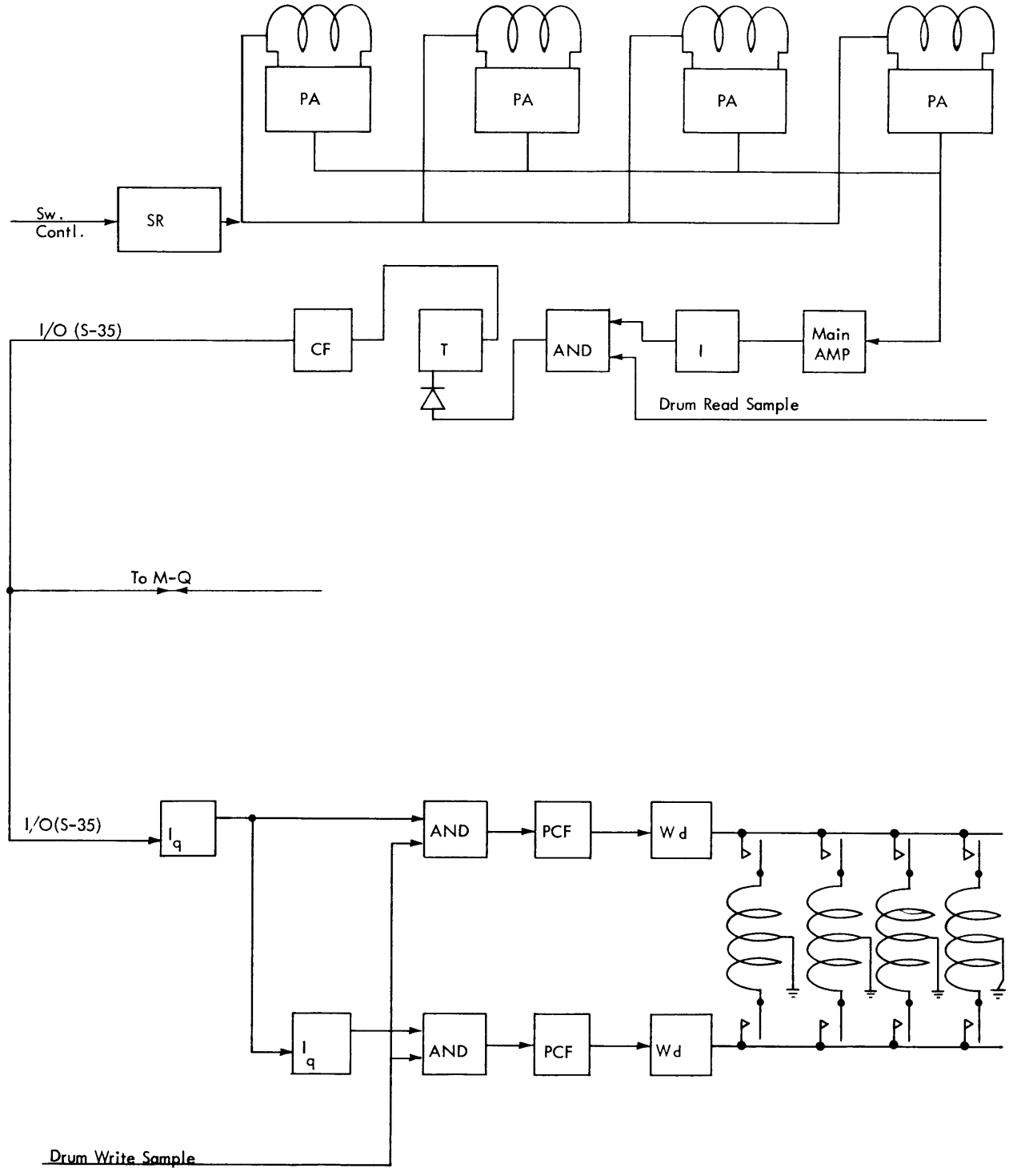


Figure 31-1. Drum Read and Write Circuits

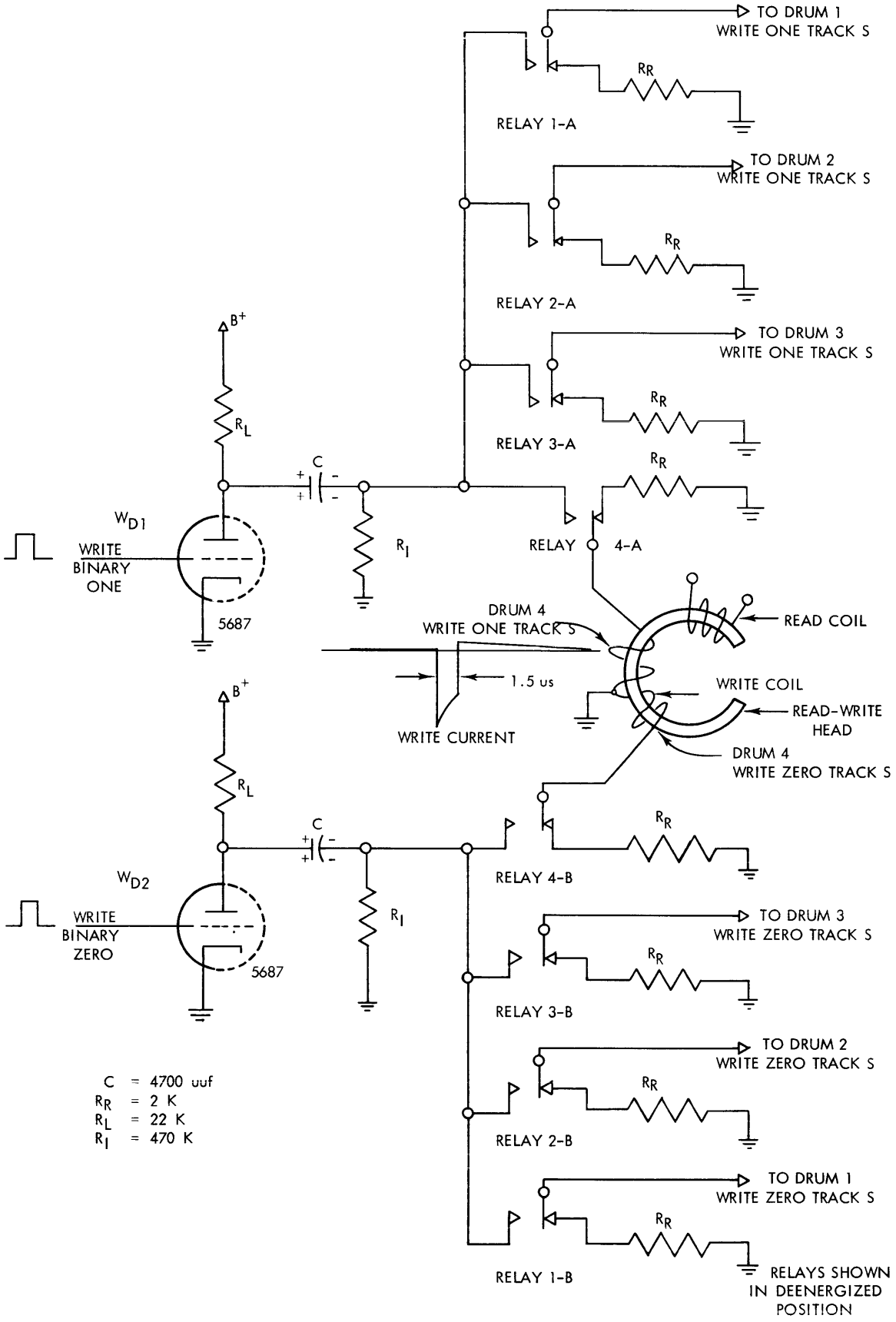


Figure 31-2. Basic Write Circuit

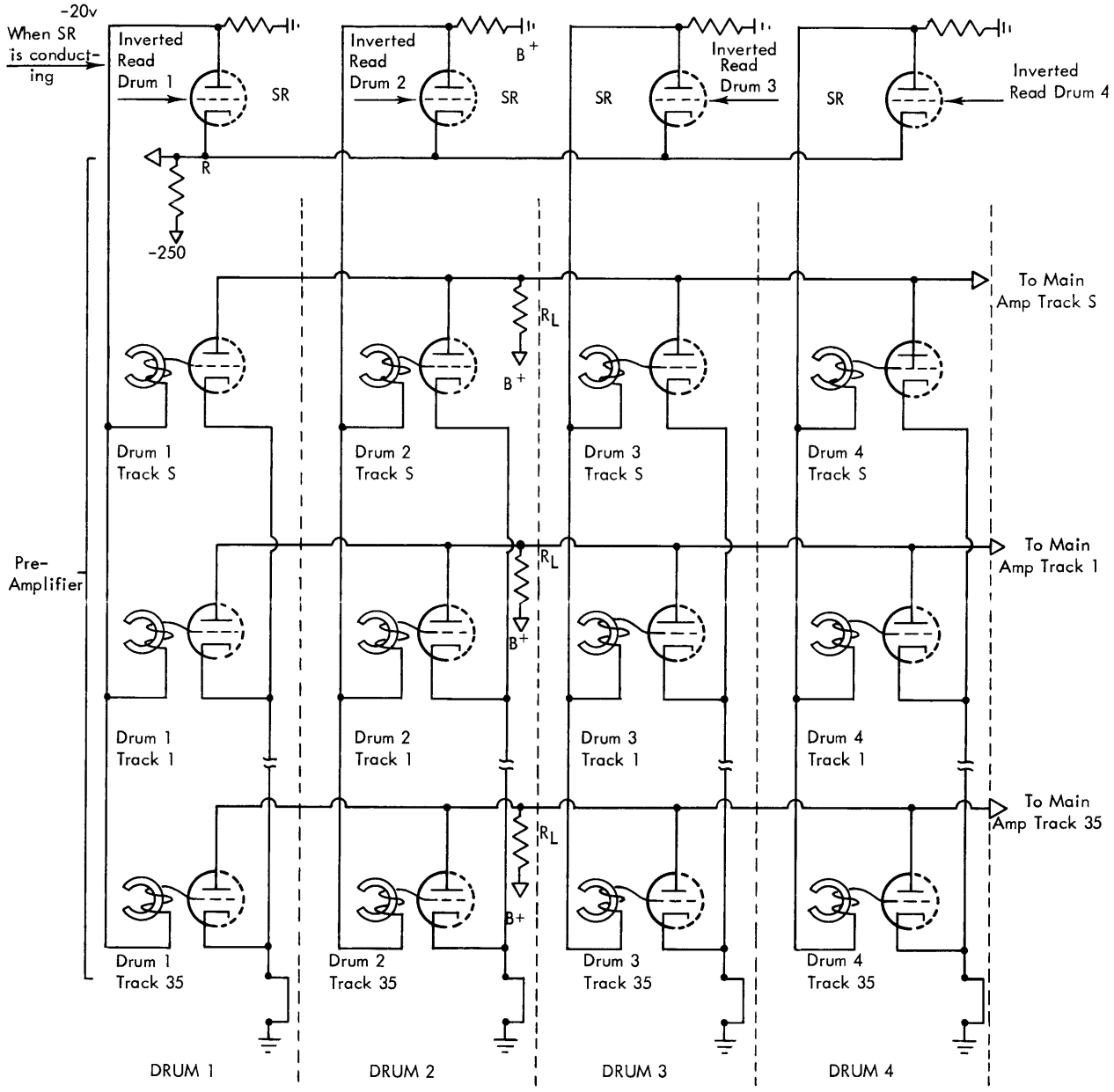


Figure 31-3. Basic Read Circuit Switching

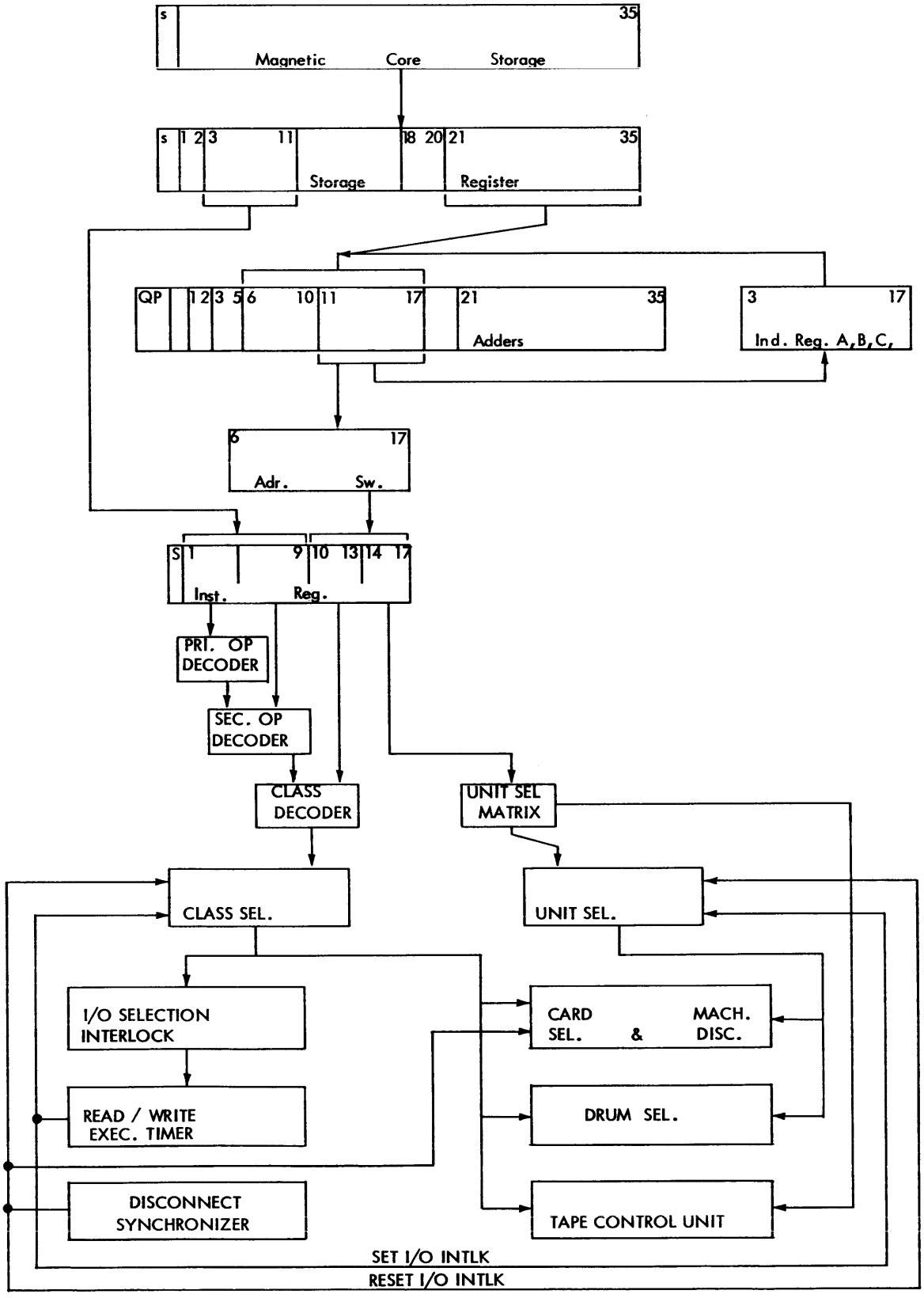


Figure 31-4. Selection of I/O Devices (704)

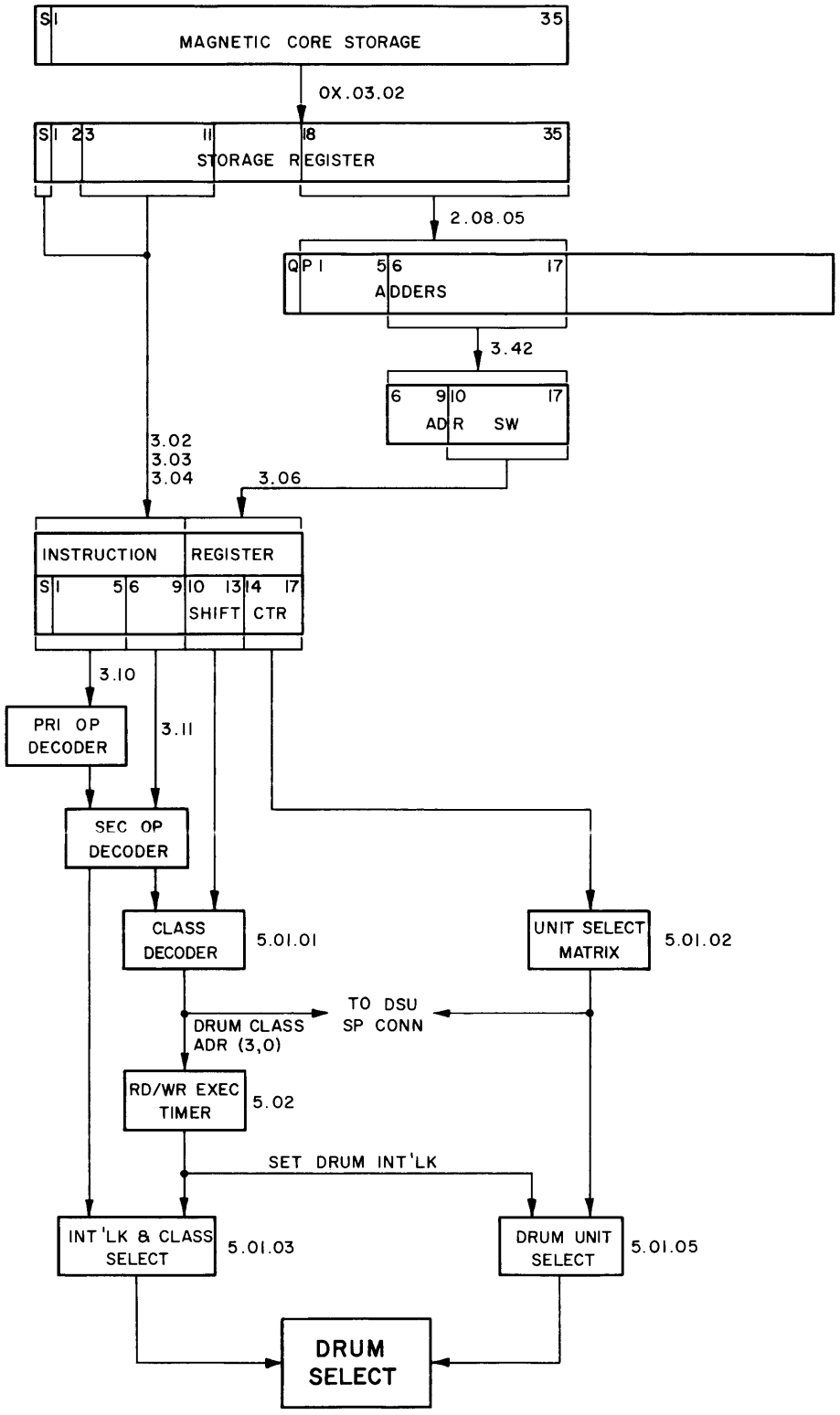


Figure 31-5. Selection of I/O Devices (709 CPU)

733.31.07 Drum Read Select

The RDS drum instruction is similar in many ways to the WRS drum instruction. RDS drum accomplishes the following:

1. I/O interlock is set.
2. Drum read circuits are conditioned on.
3. Correct timing track is selected.
4. Selected pre-amplifiers are allowed to conduct by setting grids at ground potential.
5. Use of read circuits is delayed for 15 ms after first RDS. On succeeding RDS instructions, a delay of only 500 usecs. is used.

733.31.08 Drum Copy Instruction

Copy instruction may be given at any time after the drum is selected. If WRS or RDS drum is followed immediately by copy, a 36 bit word will be written on, or read from drum address 0000. After the first copy, succeeding copies must be programmed within three machine cycles (36 usecs.) or the drum disconnects. The drum only disconnects in one way; that is, through lack of copy.

Copy following Write Select Drum has a cyclic makeup of I, E, ER...ER, end operation.

The cyclic makeup of copy following Read Select Drum is I, ER...ER, E, end operation.

733.31.09 Locate Drum Address (LDA)

An LDA instruction is needed to start writing or reading on the drum at an address other than 0000. The address part of the LDA instruction is not the number of the drum pocket being located. It is actually the address of the memory location which contains the drum address required. Thus, if it is desired to write or read from drum address 3000, a program of the following type will be used:

1. WRS or RDS drum
2. LDA 4
3. CPY
4. HTR 3000

The cyclic makeup of LDA is I, E, ER...ER, end operation. In brief, LDA does the following:

1. Storage bus goes to storage register, then to MQ in E time.
2. MQ is shifted left one place, effectively multiplying the MQ by 2 and making sure it's an even number.
3. The doubled number in the MQ is then returned to the SR.
4. The SR is tested to see if it contains all zeros. This test occurs during the first ER cycle, called ER Step 1. All succeeding ER cycles are called ER Step 2.
5. The zero test is made by adding all ones to the SR in adders 6 through 16. If there is no adder 6 carry, LDA ends operation, for the address being located is 0000.
6. When the SR is not zero, there is an adder 6 carry, and normal comparison begins between the doubled SR address and the drum counter output in adders 6 through 16. The drum counter is reset by the index pulse and stepped down by following timing pulses.
7. As long as the number in the drum counter is larger than the number in the SR, a carry out of position 9 of the adders will occur.
8. The first "no 9 carry" following a "9 carry" indicates that the proper pocket is eight timing pulses away and approaching the read-write heads. At this point LDA ends operation.
9. Now the interlace counter begins to be stepped up by the drum timing pulses. Eight pockets later the interlace counter carries and reading or writing occurs at the proper address, assuming that copy follows LDA. If copy does not follow LDA, the drum will disconnect.

733.32.00 DIAGNOSTICS AND TROUBLESHOOTING CHARTS

733.32.01 Use of Diagnostics

Be sure to check main frame by running a comprehensive main frame diagnostic such as 4M01 or 9M01 before attempting to check the operation of drum or any other I/O device.

Only one diagnostic test is needed for checking the drum. In a 709 system it is 9D01 and in a 704 it is 4D10. A description, flow chart, and instruction listing will be found in the appropriate diagnostic manual. The drum diagnostic is arranged so that the simplest operations are tried first. If these are performed correctly, the machine goes on to more and more complex operations. The actual format used is as follows:

1. Load Drum is tested on the first pass.
2. The ability to write and read zeros and ones is tested.
3. The length of time available between copies is tested.
4. A short LDA test is run.
5. The drum is then put through a "worst pattern" test of writing, then reading zeros and ones.
6. Two addresses on drum, 3472 and 307, are LDA'ed, written at, read back, and checked for error.
7. A Locate Drum Address test is run. The choice of using either a long or short LDA test is left to the C.E.. If sense switch 5 is left up, a short LDA test is run, wherein every twentieth actual address is tested. Placing sense switch 5 down will allow a long LDA test to be run, which LDA's every address on the drum.
8. Physical drums are switched during an LDA test to be sure that each timing track correctly steps the drum counter.
9. A bit pattern giving the worst switching conditions is written, read back from the drum, and then compared.
10. A random number LDA test is run in which 100 random numbers are written on the drum, starting at a random address. The first, last, and zero address number (if any) are checked.
11. A write and read random number test is run. Four thousand random numbers are written on the drum three times. Then another 4000 random numbers are written on the drum, read back, and compared.
12. The drum is checked for the ability to operate with over a 500 usec delay between RDS and LDA.
13. Indexed and indirectly-addressed LDA is checked. This applies only to 9D01.
14. A drum speed test is provided in 9D01. This test will not be run normally. When you wish to check drum speed you must load 9D01 into storage, then connect a jumper wire from MF3 R06-1 to MF4 F02-3. Key in a transfer to 7022, then start. Drum speed can be read from the accumulator as explained in the diagnostic write up.

If sense switches 2 and 3 are up, a print-out of the error will occur. The following is the print-out of the results of an actual test.

MSE 1000	indicating sense light 1 is on
Comp Error	indicating comparison error
Rec 00001	indicating record no. (always 1 on drum)
Word 00307	indicating word no. 307 in record
Inds 0000 0000 0000	indicating no. in indicators
Keys 0000 0000 0000	indicating no. in op. panel keys
Test Loc 01024	indicating location in memory of start of test
Opn Rdr 01	indicating error occurred in reading drum 1
Error Loc 01037	indicating where exit was made from program
O Loc 002000000034	indicating contents of 0 storage
Sw 000001	indicating condition of sense sw. (6 down)
Word Generated	is the 36 bits generated
Word Read	is the 36 bits read back

Running the entire program should narrow any trouble down to a specific area, either Read or Write Select, Copy, or LDA. Quite often an LDA error printout will turn out to be a simple trouble in the read/write circuits. It is much easier to isolate an error of this type by interchanging pluggable units than to attempt to find it by checking LDA timing.

Once the trouble has been restricted to a definite area, modify the program so that the machine will run through a small loop which contains the failing instruction. The smaller the loop, the better. You'll have less pulses to look at on the scope. Sometimes it is a good idea to key in a simple program of your own, especially when you want to keep the loop as small as possible. Some small, useful programs can be found in this manual in section 733.48.00.

733.32.02 Troubleshooting Charts

These troubleshooting charts are used in tracking down and correcting machine failures which have been indicated by a diagnostic program. Start at the top of the chart and follow the arrows. In some of the boxes questions are given, which; when answered by "yes" or "no," will show which path to follow from that box. Continue in this way, moving from box to box and performing the operations indicated until the solution to the trouble is found.

733.32.03 Diagnostic Charts

Diagnostic charts are included at the end of this section following the troubleshooting charts. Diagnostic charts show by the use of symbols, the condition of the various signals, relays, and components required to perform an operation and their relationship to each other on a linear time base. The inclusion of test points on the chart means that a large part of trouble diagnosis can be completed without referring to the system diagrams.

Instruction timing and test points which appear on these charts pertain only to a drum in a 709 installation. However, differences in operation between the two installations are only minor, and the charts may be used, at least as review and reference material, by men who work with drums which are part of a 704 system.

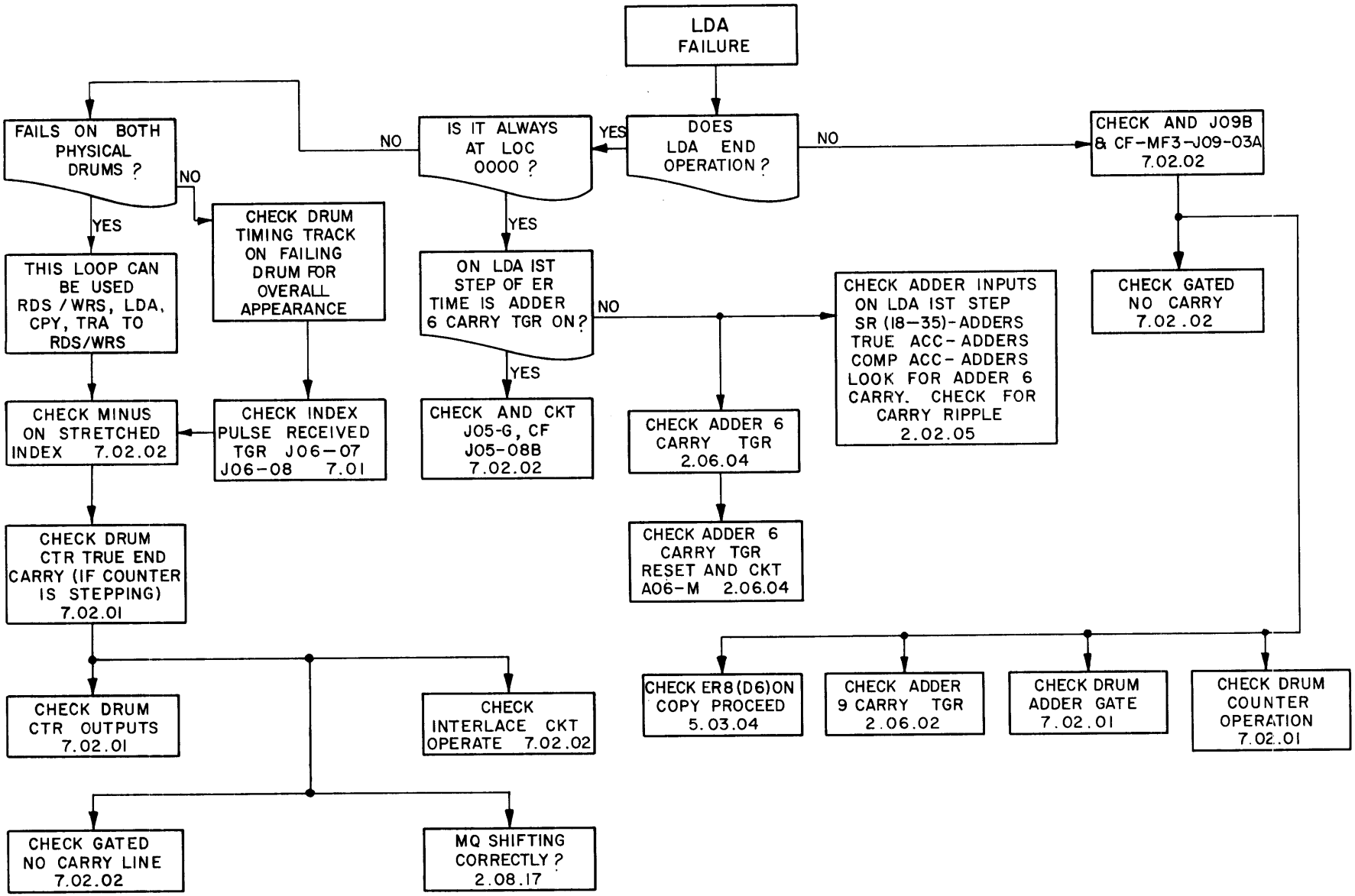


Figure 32-1. Locate Drum Address

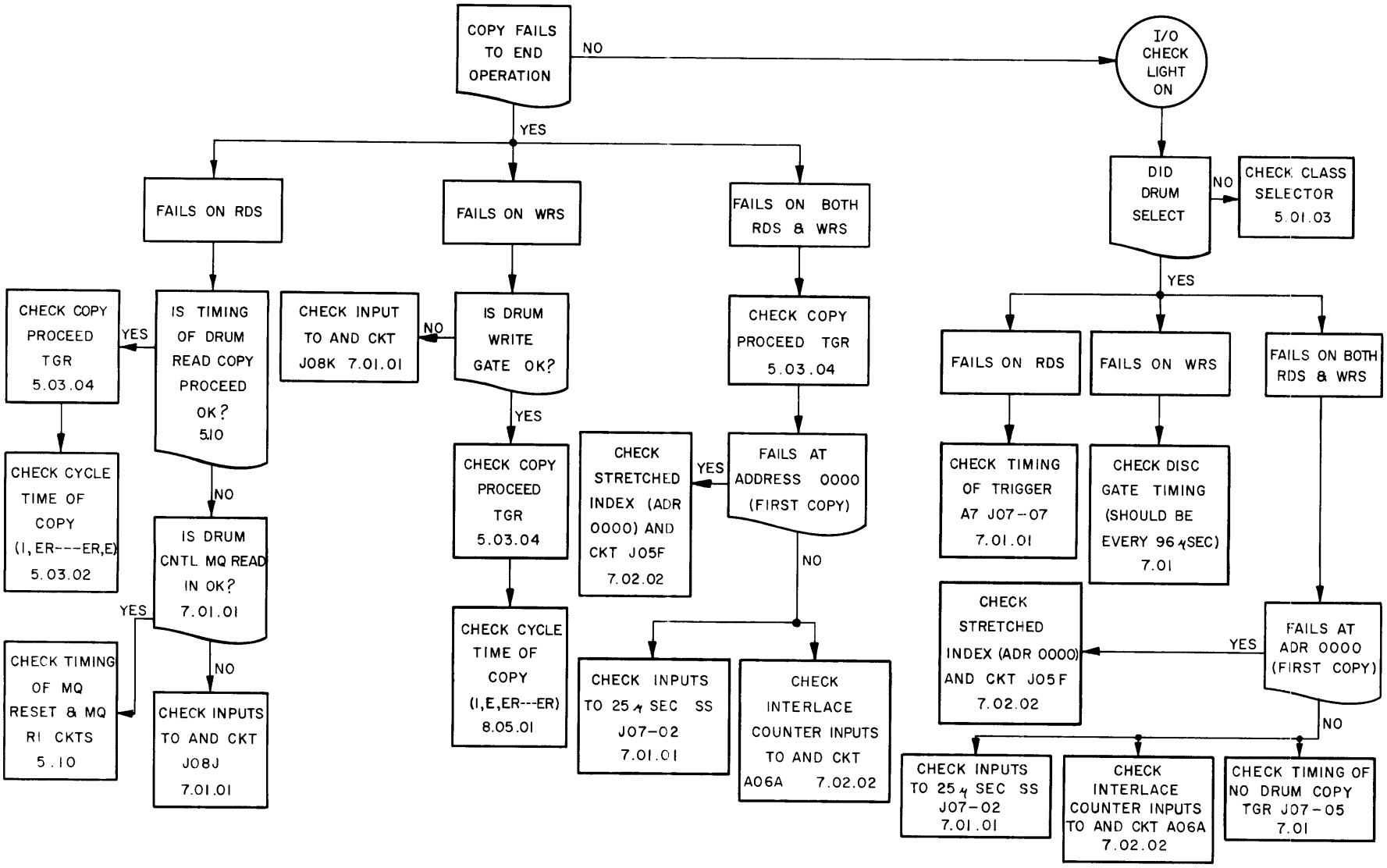


Figure 32-2. Copy

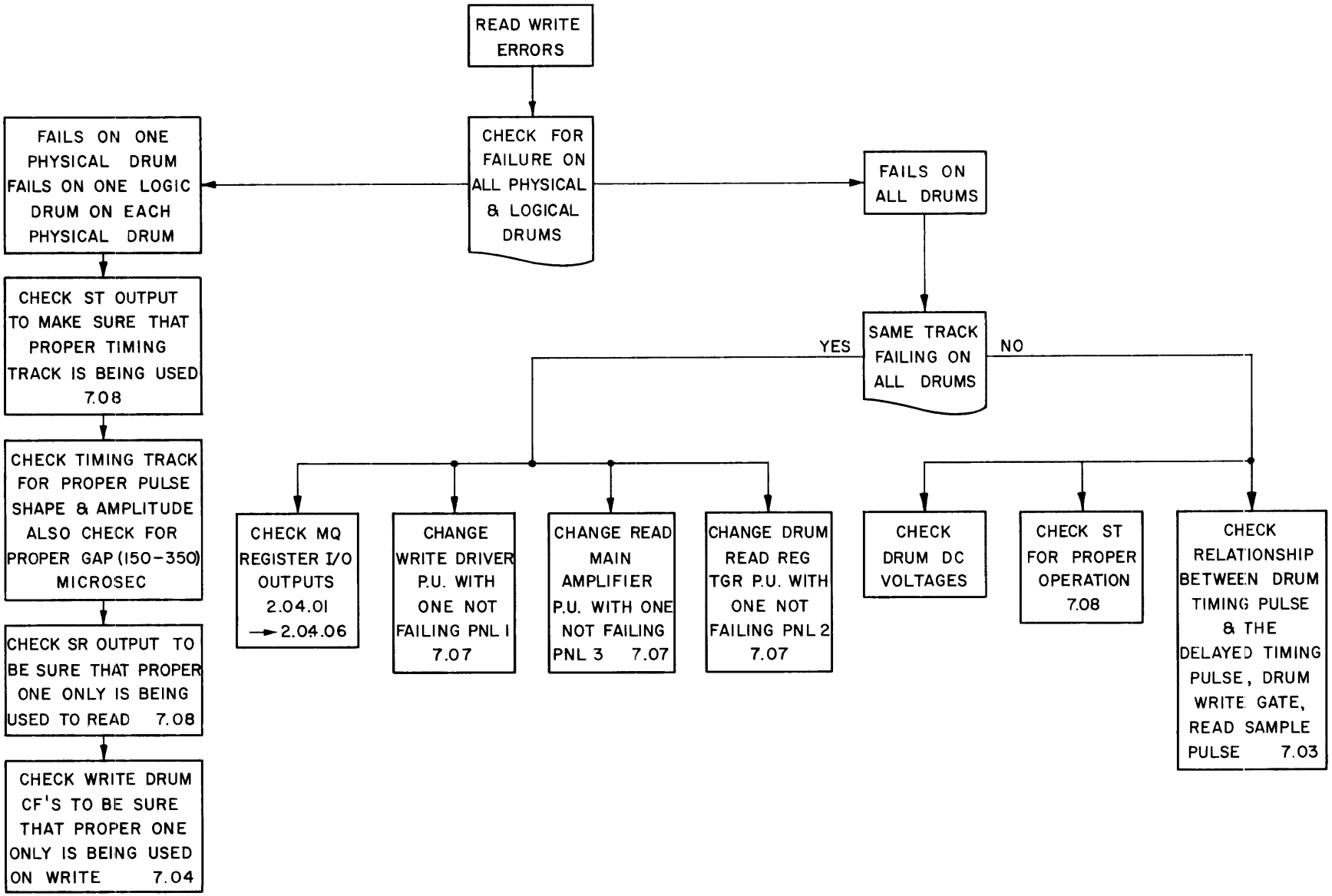


Figure 32-3. Read/Write Errors

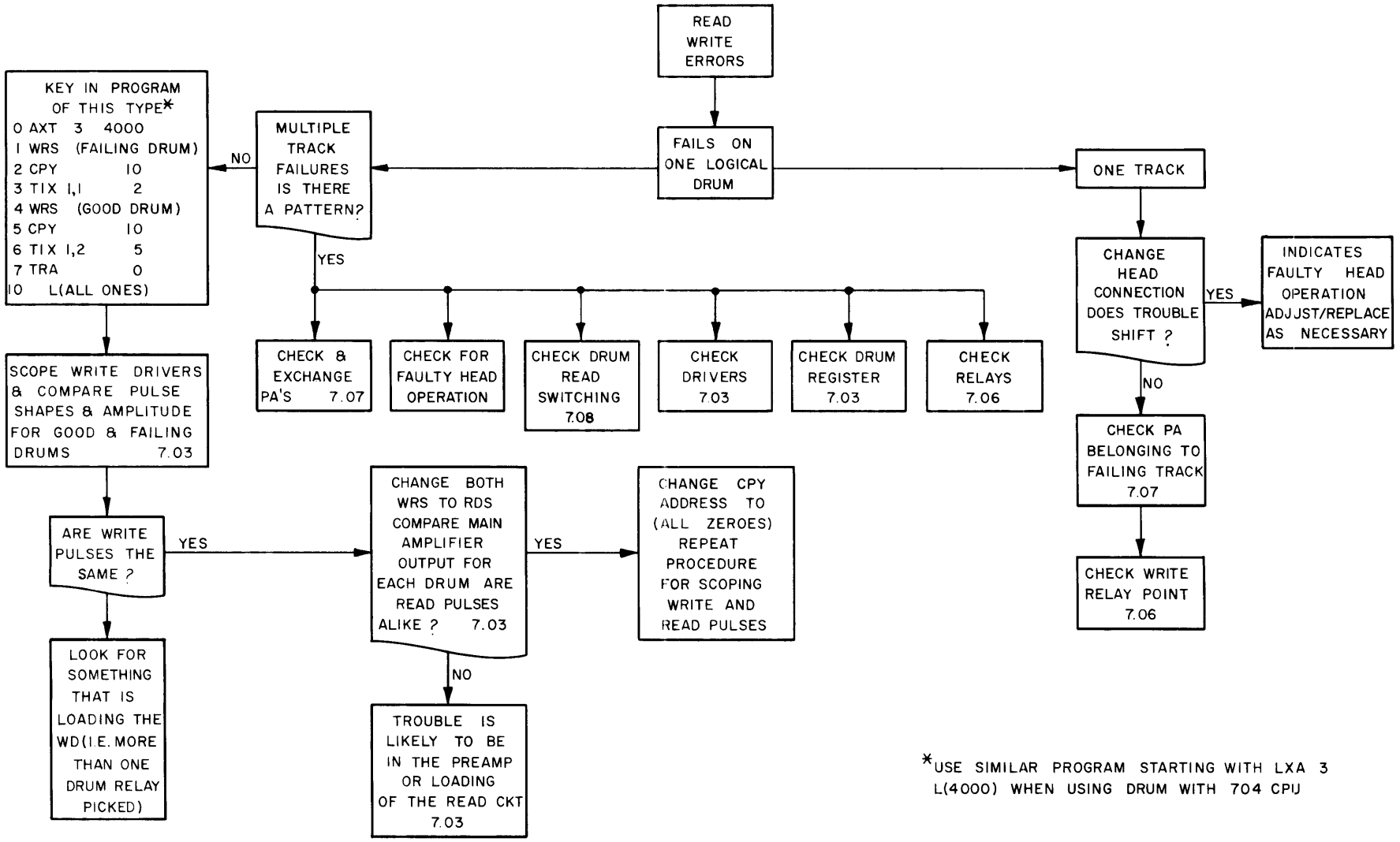


Figure 32-4. Read/Write Errors Using Keyed-in Program

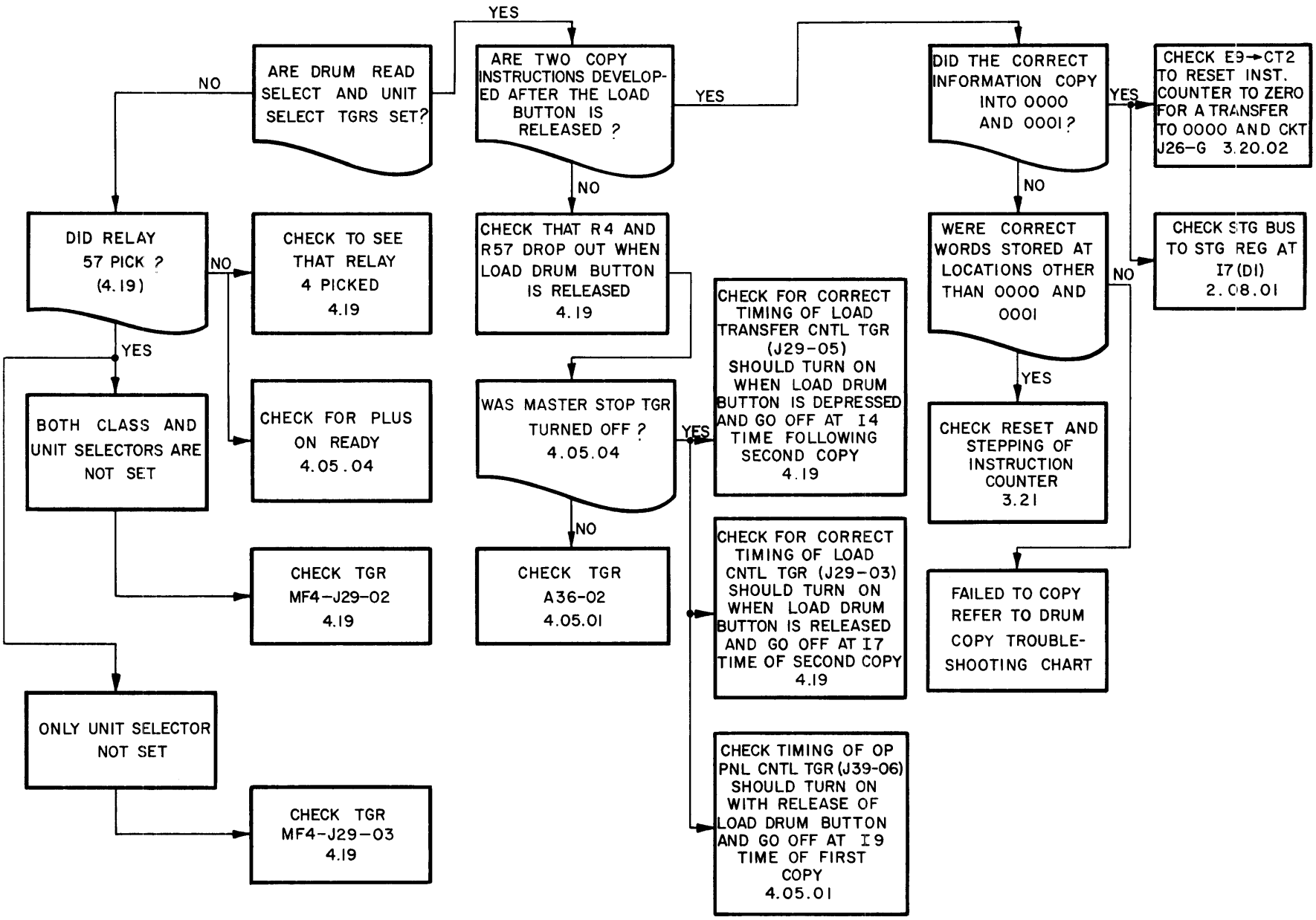


Figure 32-5. Load Drum Trouble (Used with 709 CPU)

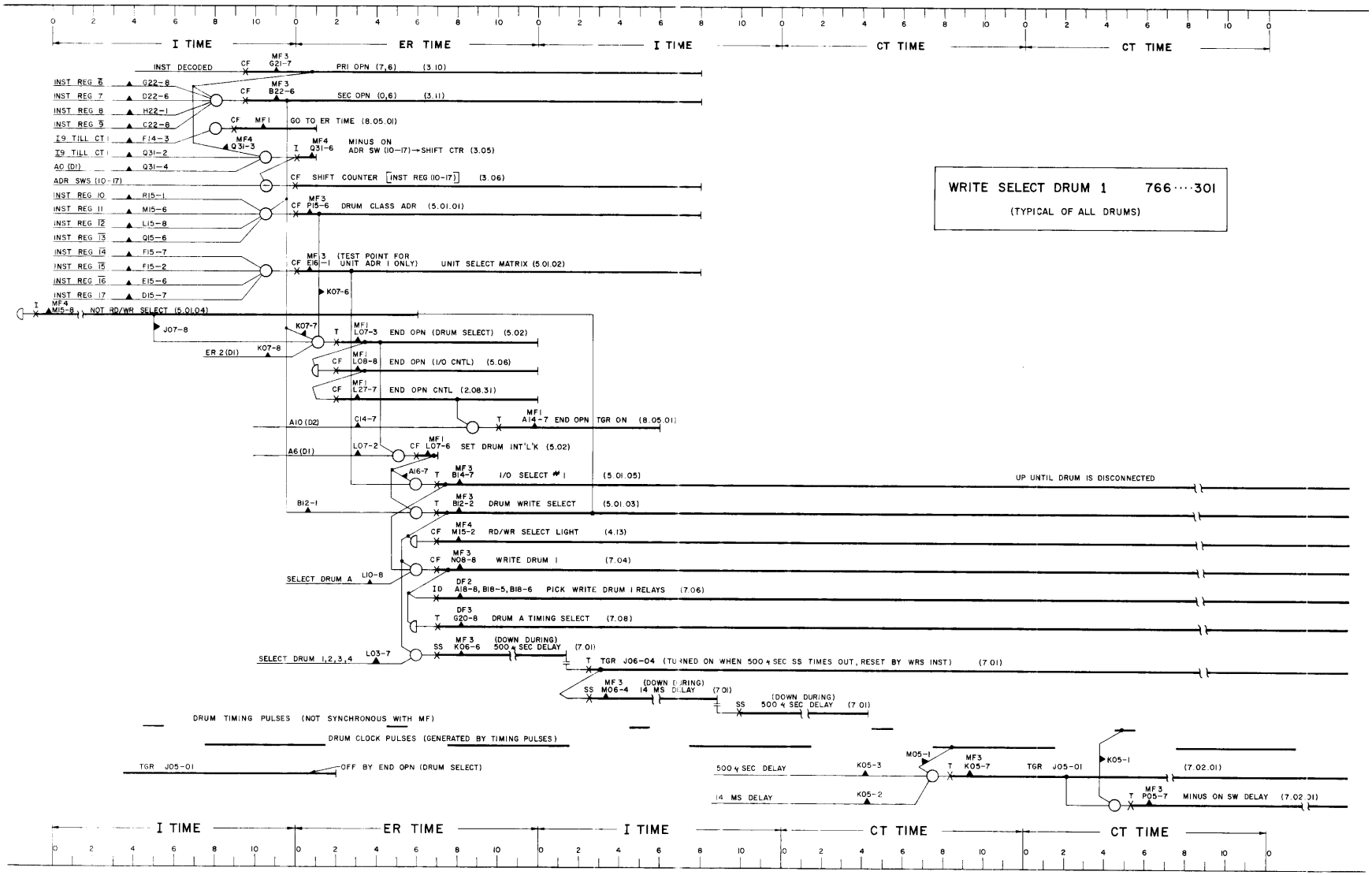


Figure 32-6. WRS, Drum 1

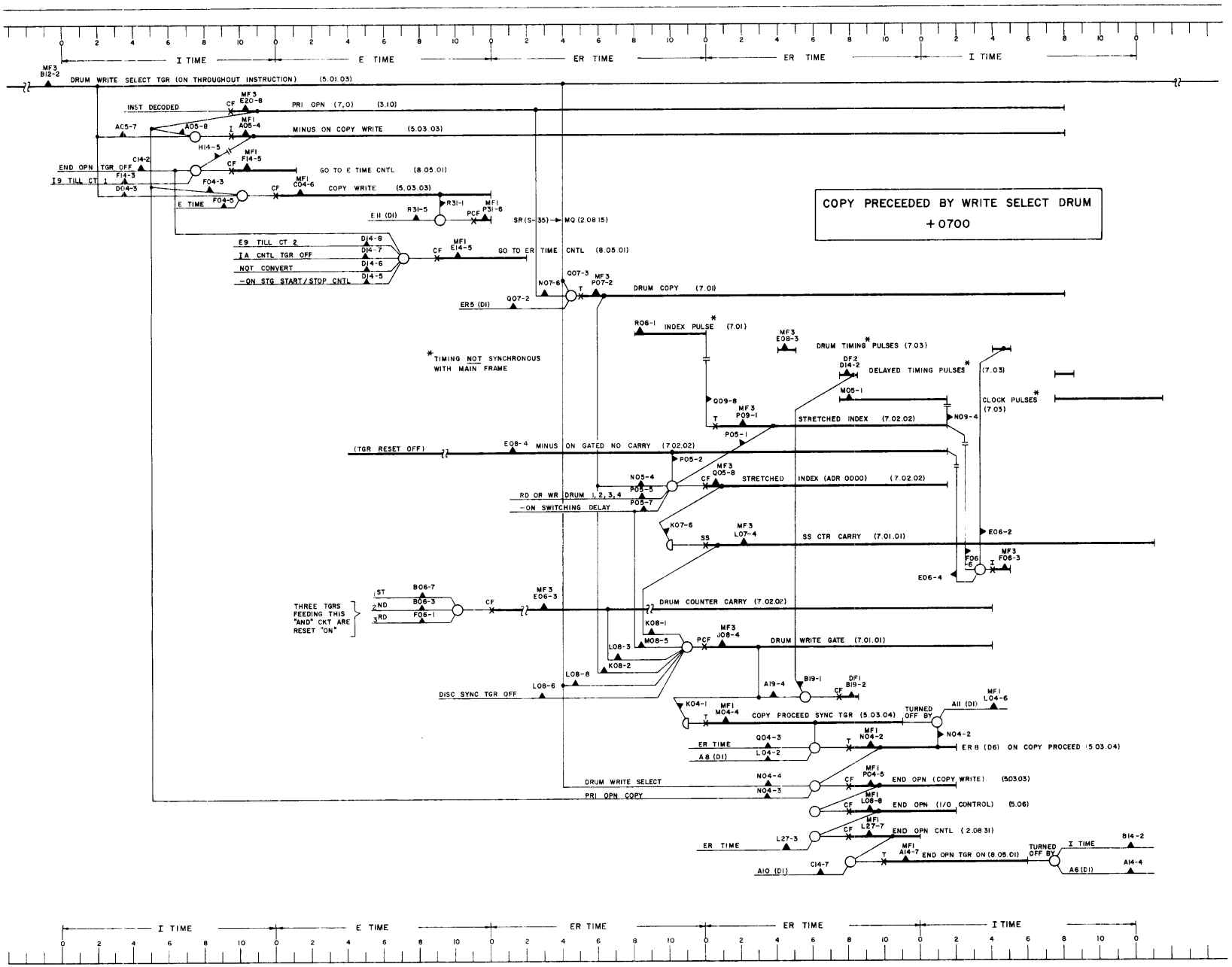


Figure 32-7. Copy preceded by WRS

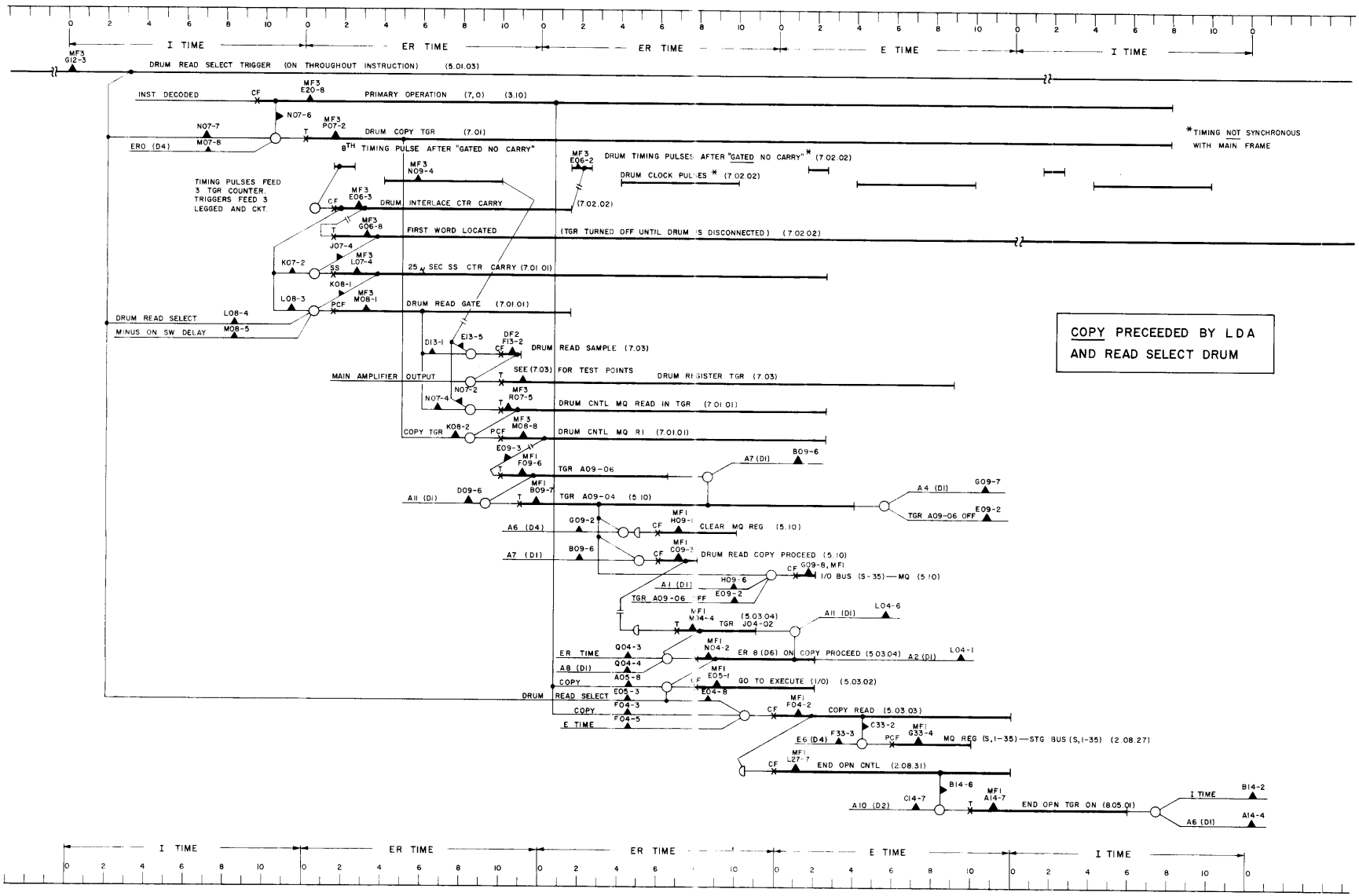


Figure 32-8. Copy Preceded by LDA and RDS

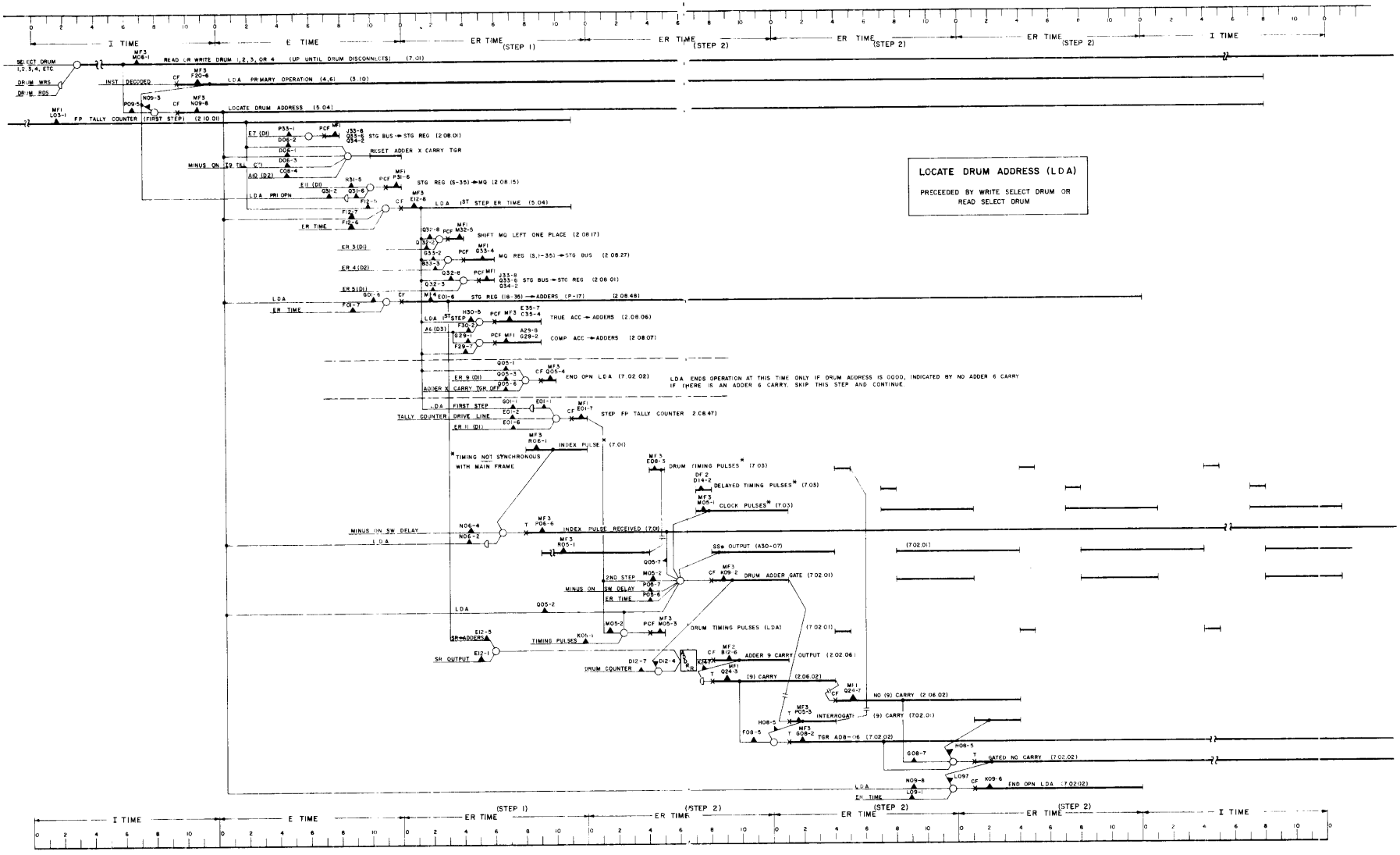


Figure 32-9. LDA Preceded by WRS or RDS

CONTENTS

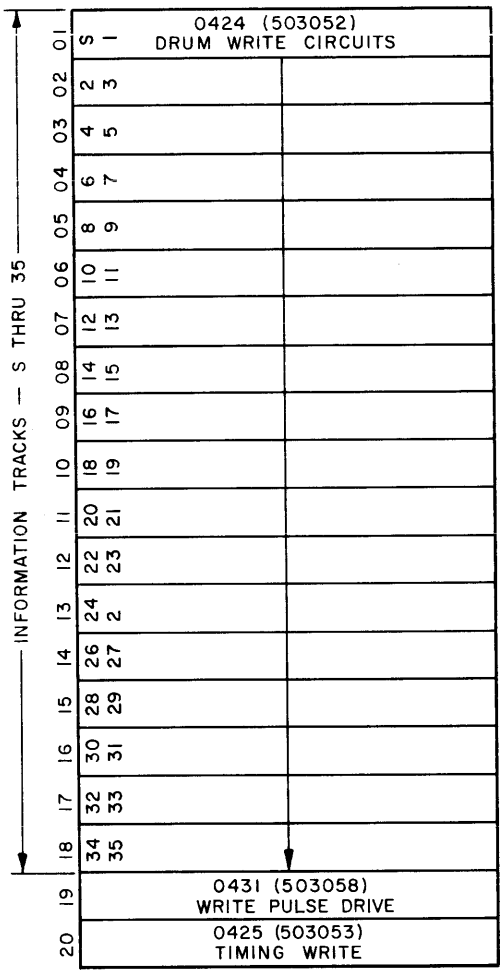


Figure 41-1. Panel 1

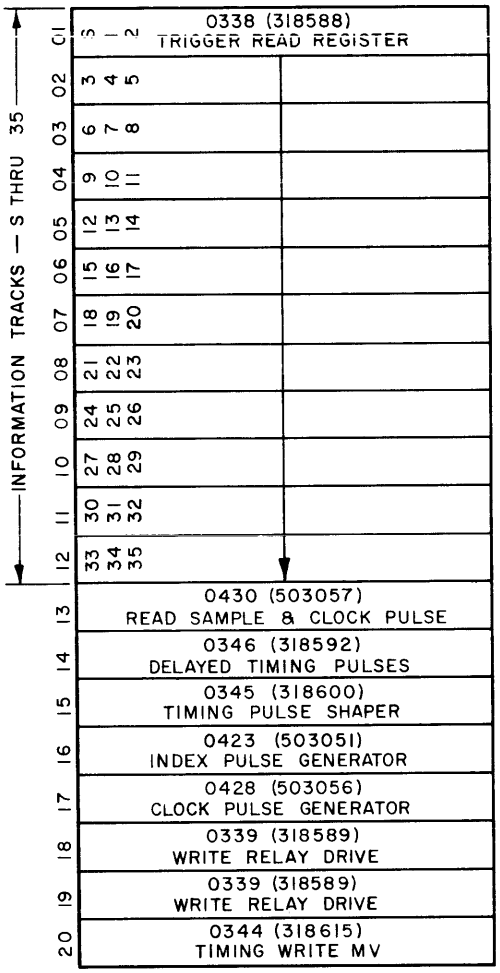
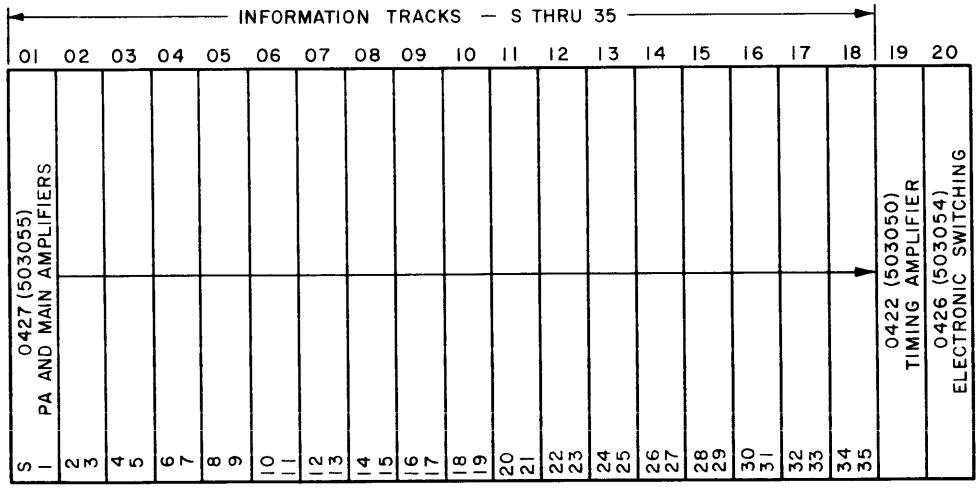
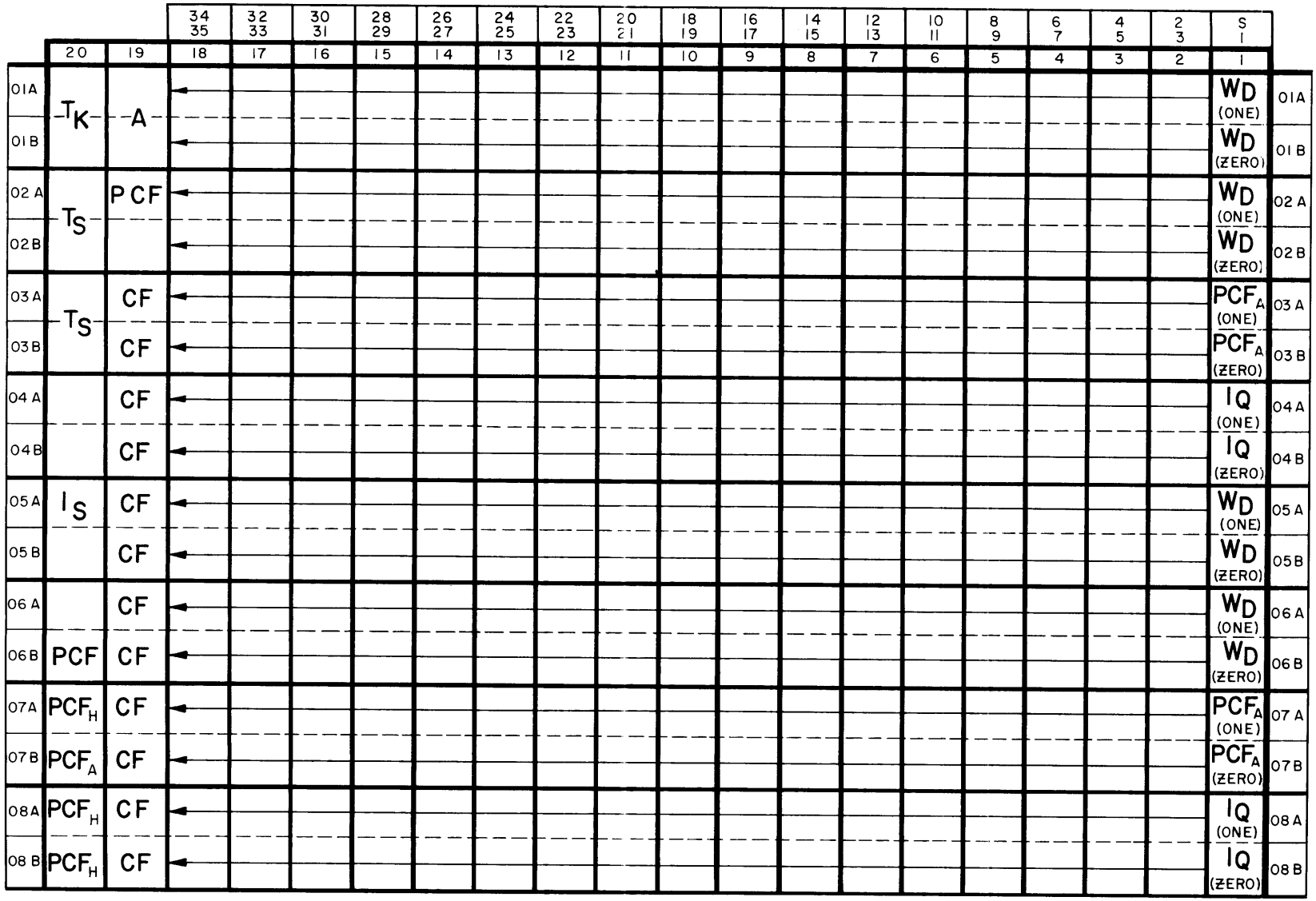


Figure 41-2. Panel 2



PLUGGABLE UNIT LOCATION CHART VIEWED FROM PLUGGABLE UNIT SIDE OF PANEL

Figure 41-3. Panel 3



NOTES:
VIEWED FROM TUBE SIDE
W_D USES TUBE 5687
I_Q USES TUBE 5965

Figure 42-1. Tube Location Chart, Panel 1

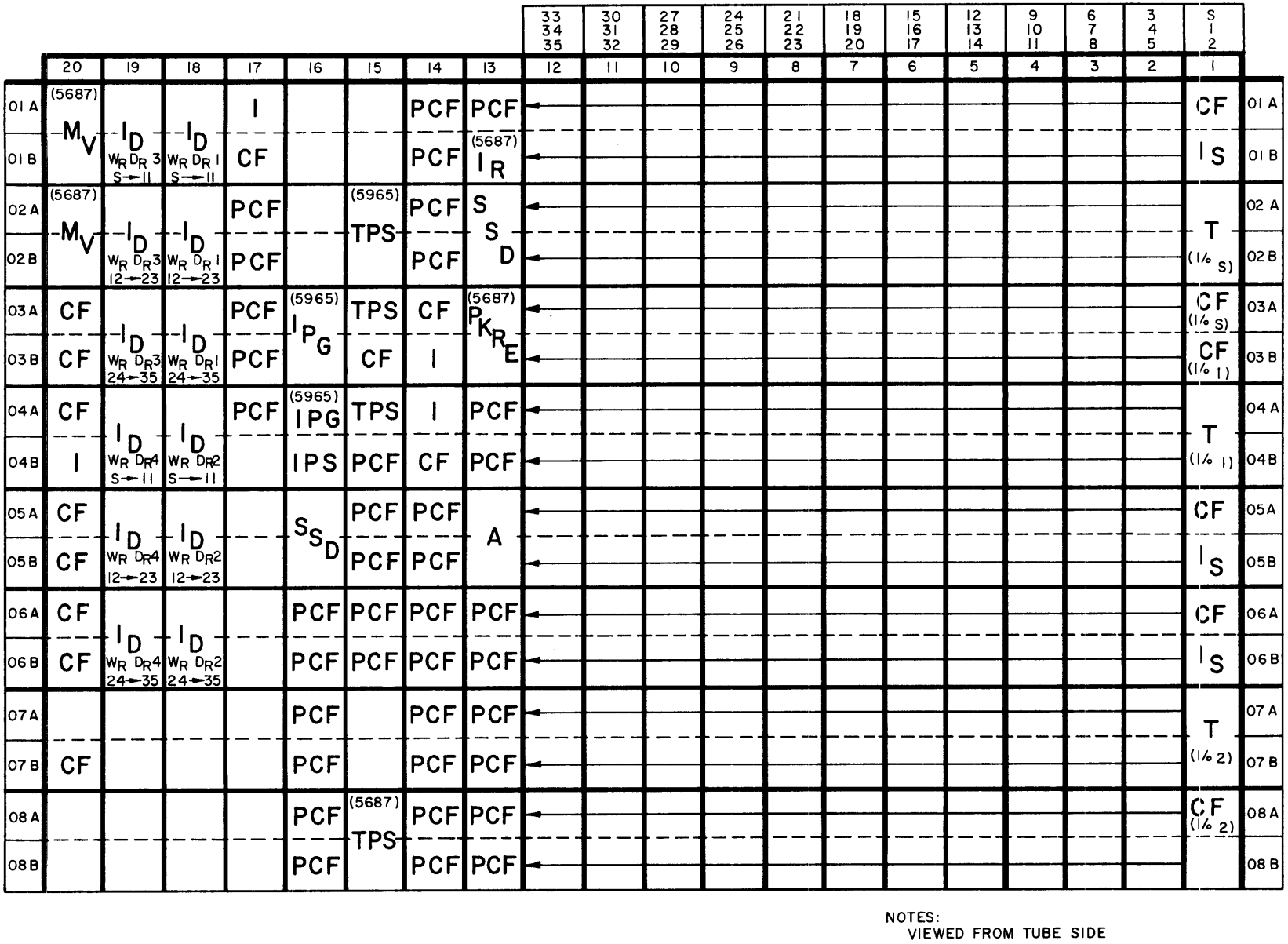


Figure 42-2. Tube Location Chart, Panel 2

	01 A	01 B	02 A	02 B	03 A	03 B	04 A	04 B	05 A	05 B	06 A	06 B	07 A	07 B	08 A	08 B	
1	5687 A_D S	5687 A_D I	5965 A_D S	5965 A_D I	5965 A_D S	5965 A_D I	5965 A_D S	5965 A_D I	PA D_{R4} S	PA D_{R4} I	PA D_{R3} S	PA D_{R3} I	PA D_{R2} S	PA D_{R2} I	PA D_{R1} S	PA D_{R1} I	1
2	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2
3	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	3
4	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	4
5	8	9	8	9	8	9	8	9	8	9	8	9	8	9	8	9	5
6	10	11	10	11	10	11	10	11	10	11	10	11	10	11	10	11	6
7	12	13	12	13	12	13	12	13	12	13	12	13	12	13	12	13	7
8	14	15	14	15	14	15	14	15	14	15	14	15	14	15	14	15	8
9	16	17	16	17	16	17	16	17	16	17	16	17	16	17	16	17	9
10	18	19	18	19	18	19	18	19	18	19	18	19	18	19	18	19	10
11	20	21	20	21	20	21	20	21	20	21	20	21	20	21	20	21	11
12	22	23	22	23	22	23	22	23	22	23	22	23	22	23	22	23	12
13	24	25	24	25	24	25	24	25	24	25	24	25	24	25	24	25	13
14	26	27	26	27	26	27	26	27	26	27	26	27	26	27	26	27	14
15	28	29	28	29	28	29	28	29	28	29	28	29	28	29	28	29	15
16	30	31	30	31	30	31	30	31	30	31	30	31	30	31	30	31	16
17	32	33	32	33	32	33	32	33	32	33	32	33	32	33	32	33	17
18	34	35	34	35	34	35	34	35	34	35	34	35	34	35	34	35	18
19	TP_A (5687)		TP_A (5965)		TP_A (5965)		TP_A (5965)		TP_A (6072)		TP_A (6072)		PA_T		PA_T		19
20	(5687) SR (DR4)		(5965) SR (DR3)	(5965) SR (DR4)	(5687) SR (DR3)		(5687) SR (DR2)		(5965) SR (DR1)	(5965) SR (DR2)	(5687) SR (DR1)		T_S		ST (DR A)	ST (DR B)	20

NOTES:

VIEWED FROM THE TUBE SIDE

MAIN AMPLIFIERS (A_D) ARE COMPOSED OF FOUR 1/2 TUBES
01A, 02A, 03A, 04A FOR EVEN TRACKS
01B, 02B, 03B, 04B FOR ODD TRACKS

PA USES 6072 TUBE
PA_T USES 6072 TUBE
ST USES 5687 TUBE

Figure 42-3. Tube Location Chart, Panel 3

733.43.00 TEST POINTS (PULSES: CPU-DRUM)

In the signal cable which connects the drum to the CPU are 36 I/O lines and a number of control lines. Table 43-A lists the I/O line test points and table 43-B lists the control line test points.

TABLE 43-A I/O LINE TEST POINTS

I/O Line	CPU	Drum	Systems Page
S	MF2-N03-4	DF1-G01-7	2.04.01
1	N04-4	G01-3	2.04.02
2	N05-4	G02-7	2.04.03
3	N06-4	G02-3	2.04.03
4	N07-4	G03-7	2.04.03
5	N08-4	G03-3	2.04.03
6	N09-4	G04-7	2.04.04
7	N10-4	G04-3	2.04.04
8	N11-4	G05-7	2.04.04
9	N12-4	G05-3	2.04.05
10	N13-4	G06-7	2.04.05
11	N14-4	G06-3	2.04.05
12	N15-4	G07-7	2.04.05
13	N16-4	G07-3	2.04.05
14	N17-4	G08-7	2.04.05
15	N18-4	G08-3	2.04.05
16	N19-4	G09-7	2.04.05
17	N20-4	G09-3	2.04.05
18	N21-4	G10-7	2.04.05
19	N22-4	G10-3	2.04.05
20	N23-4	G11-7	2.04.05
21	N24-4	G11-3	2.04.05
22	N25-4	G12-7	2.04.05
23	N26-4	G12-3	2.04.05
24	N27-4	G13-7	2.04.05
25	N28-4	G13-3	2.04.05
26	N29-4	G14-7	2.04.05
27	N30-4	G14-3	2.04.05
28	N31-4	G15-7	2.04.05
29	N32-4	G15-3	2.04.05
30	N33-4	G16-7	2.04.05
31	N34-4	G16-3	2.04.05
32	N35-4	G17-7	2.04.05
33	N36-4	G17-3	2.04.05
34	N37-4	G18-7	2.04.05
35	N38-4	G18-3	2.04.06

TABLE 43-B CONTROL LINE TEST POINTS

Control Lines	CPU	Drum	Systems Page
Clock Pulse	MF3-M05-1	DF2-B17-7	7.03
Index Pulse	MF3-R06-1	DF2-G16-8	7.03
Inverted MV Pulses	MF3-D08-4	DF2-B20-3	7.02.01
Read Dr 1	MF3-N08-4	DF3-H20-1	7.04
Read Dr 2	MF3-P08-2	DF3-G20-3	7.04
Read Dr 3	MF3-Q08-3	DF3-F20-2	7.04
Read Dr 4	MF3-Q08-4	DF3-F20-1	7.04
Read Gate	MF3-M08-1	DF2-D13-1	7.01.01
Reset Drum Register	MF3-M09-2	DF2-D01-4	7.01.01
Timing Pulse	MF3-E08-3	DF2-F15-1	7.03
Write Dr 1	MF3-N08-8	DF2-C18-1	7.04
Write Dr 2	MF3-P08-6	DF2-F18-1	7.04
Write Dr 3	MF3-Q08-7	DF2-C19-1	7.04
Write Dr 4	MF3-R08-5	DF2-F19-1	7.04
Write Gate	MF3-J08-4	DF1-A19-4	7.01.01
- 40v Drum Reset	MFRG-MC MF4-39A*	Reset Relay (B side)	4.10
-40v Return	MFBP-111	Reset Relay (A side)	4.10

*When drum is used with 704 CPU.

733.44.00 JONES PLUG NUMBERING

The drum head read coils are connected to the pre-amplifiers through Jones Plugs. See Figure 44-1 for pin numbering and the physical arrangement of the Jones receptacles. Note that the K column of receptacles connects to physical drum A (logical drums 1 and 2) and the J column connects to physical drum B (logical drums 3 and 4).

The vertical center row of terminals (pins 2, 5, 8, ... 26) in each receptacle is grounded. The vertical row on the right (pins 1, 4, 7, ... 25) connect to the Read Drum Switching lines from the SR. The vertical row on the left (pins 3, 6, 9, ... 27) connect to the read coils. With this arrangement each horizontal line of pins in each Jones receptacle connects to one specific read-write head. (For example: Pins 3, 2, 1 refer to drum 1, track S; and pins 4, 5, 6 refer to drum 1, track 1.) In systems diagram 7.03 a list of Jones Plug numbers for each track on each drum is included.

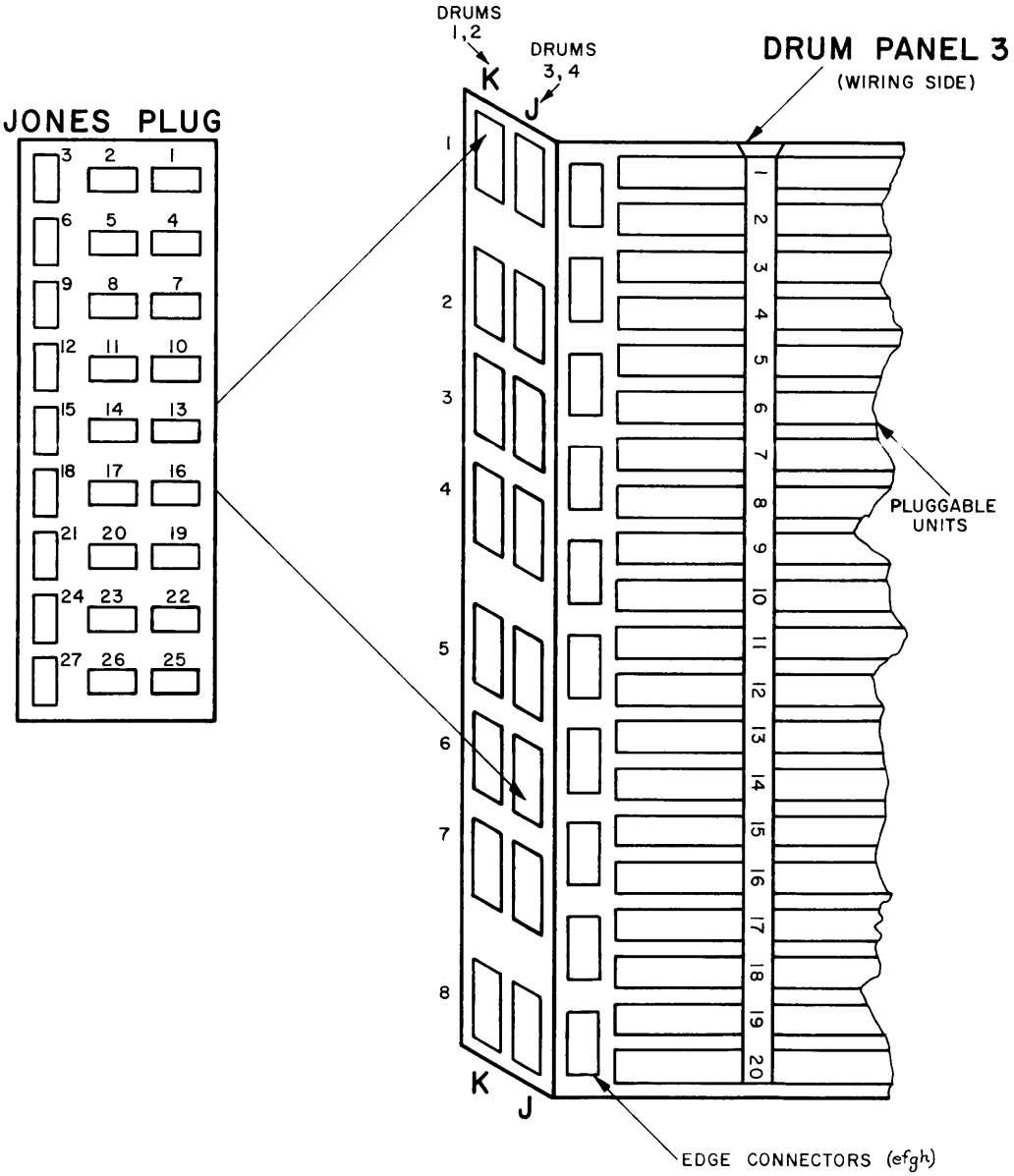


Figure 44-1. Jones Plug Numbering

733.45.00 TRIGGER NEON LOCATION

Most trigger circuits in the machine have neon bulbs associated with them. If the bulb is not mounted on the operator's panel, it is placed on the wiring side of the pluggable unit panels. The neons on the pluggable unit panels are color coded. This code indicates the location of the trigger in the pluggable unit behind which the bulb is located. The coding is a colored stripe at the tip of the bulb. The stripe on the tip is the RMA color for the number location of the trigger in the pluggable unit. As an example, assume that the color on the tip of a given neon is orange. A three (3), denoted by the orange, would indicate that the trigger operating the neon is the third tube from the top of the pluggable unit behind which the neon is located. The top of a pluggable unit is identified as the end to which the locking shaft is closest.

Neon location in 709 CPU are pictured on systems pages OX.04.01, OX.04.03, and OX.04.04.

733.45.01 704-709 CPU Trigger Neons

Table 45-A shows the location in both 704 and 709 CPU of the neons especially associated with drum control lines.

733.45.02 Drum Frame Trigger Neon

Trigger neon locations in the 733 Drum are pictured in Figure 45-1.

TABLE 45-A CPU TRIGGER NEON LOCATION

Trigger Name	Physical Location	Systems Page	Remarks
14 MS Delay	MF3 J06-04	.7.01	
15 MS Delay	MF3 J05-01	.7.02.01	
Adder 6 Carry Trigger	MF4 A06-03	.2.06.04	
Adder 9 Carry Trigger	MF1 J24-06	.2.06.02	
Delayed RD Gate	MF3 J07-07	.7.01.01	
Drum Copy	MF3 J07-05	.7.01	
Drum Counter 1	MF3 A07-01	.7.02.01	
Drum Counter 2	MF3 A07-03	.7.02.01	
Drum Counter 3	MF3 A07-04	.7.02.01	
Drum Counter 4	MF3 A07-06	.7.02.01	
Drum Counter 5	MF3 A07-07	.7.02.01	
Drum Counter 6	MF3 A09-01	.7.02.01	
Drum Counter 7	MF3 A09-03	.7.02.01	
Drum Counter 8	MF3 A09-04	.7.02.01	
Drum Counter 9	MF3 A08-06	.7.02.01	
Drum Counter 10	MF3 A09-07	.7.02.01	
Drum Counter 11	MF3 A08-03	.7.02.01	
Drum Read Select	MF3 A12-03	.5.01.03	.704 Only
Drum Read Select	MF3 A12-08	.5.01.03	.709 Only
Drum Write Select	MF3 J13-06	.5.01.03	.704 Only
Drum Write Select	MF3 A12-01	.5.01.03	.709 Only
First Word Located	MF3 A06-07	.7.02.02	
Index Pulse Received	MF3 J06-07	.7.01	
Index Received Reset	MF3 J06-08	.7.01	
Interlace Counter 1st Stage	MF3 A06-01	.7.02.02	
Interlace Counter 2nd Stage	MF3 A06-03	.7.02.02	
Interlace Counter 3rd Stage	MF3 A06-04	.7.02.02	
Interlock Reset Timing	MF3 A11-04	.5.09.02	
Interrogate 9 Carry	MF3 J05-05	.7.02.01	
I/O Select #1	MF3 A14-03	.5.01.05	
I/O Select #2	MF3 A14-01	.5.01.05	
I/O Select #3	MF3 A14-06	.5.01.05	
I/O Select #4	MF3 A14-08	.5.01.05	
I/O Select #5	MF3 A10-03	.5.01.05	.Double Drum
I/O Select #6	MF3 A10-01	.5.01.05	.Double Drum
I/O Select #7	MF3 A10-06	.5.01.05	.Double Drum
I/O Select #8	MF3 A10-08	.5.01.05	.Double Drum
Load Control Trigger	MF4 A19-03	.4.19	.704 Only
Load Control Trigger	MF4 J29-03	.4.19	.709 Only
Load Trans. Control	MF4 J29-05	.4.19	.709 Only
Minus on Gated No Carry	MF3 A08-01	.7.02.02	
Minus on SW Delay	MF3 J05-03	.7.02.01	
MQ Loaded by Copy	MF1 A04-02	.5.03.03	.704 Only
MQ R1 Control Trigger	MF1 A09-06	.5.10	
MQ R1 Gate Trigger	MF1 A09-04	.5.10	
RD/WR Execution Timer	MF1 J07-02	.5.02	
Stretched Index	MF3 J09-07	.7.02.02	
T-02 Copy Proceed	MF1 J04-02	.5.03.04	
T-04 on Copy Proceed	MF1 J04-08	.5.03.04	
TK Turn on Load Control	MF4 A19-02	.4.19	.704 Only
TK Turn on Load Control	MF4 J29-02	.4.19	.709 Only
True End Carry	MF3 A08-05	.7.02.01	
Write Disconnect Gate	MF3 J10-02	.7.01	

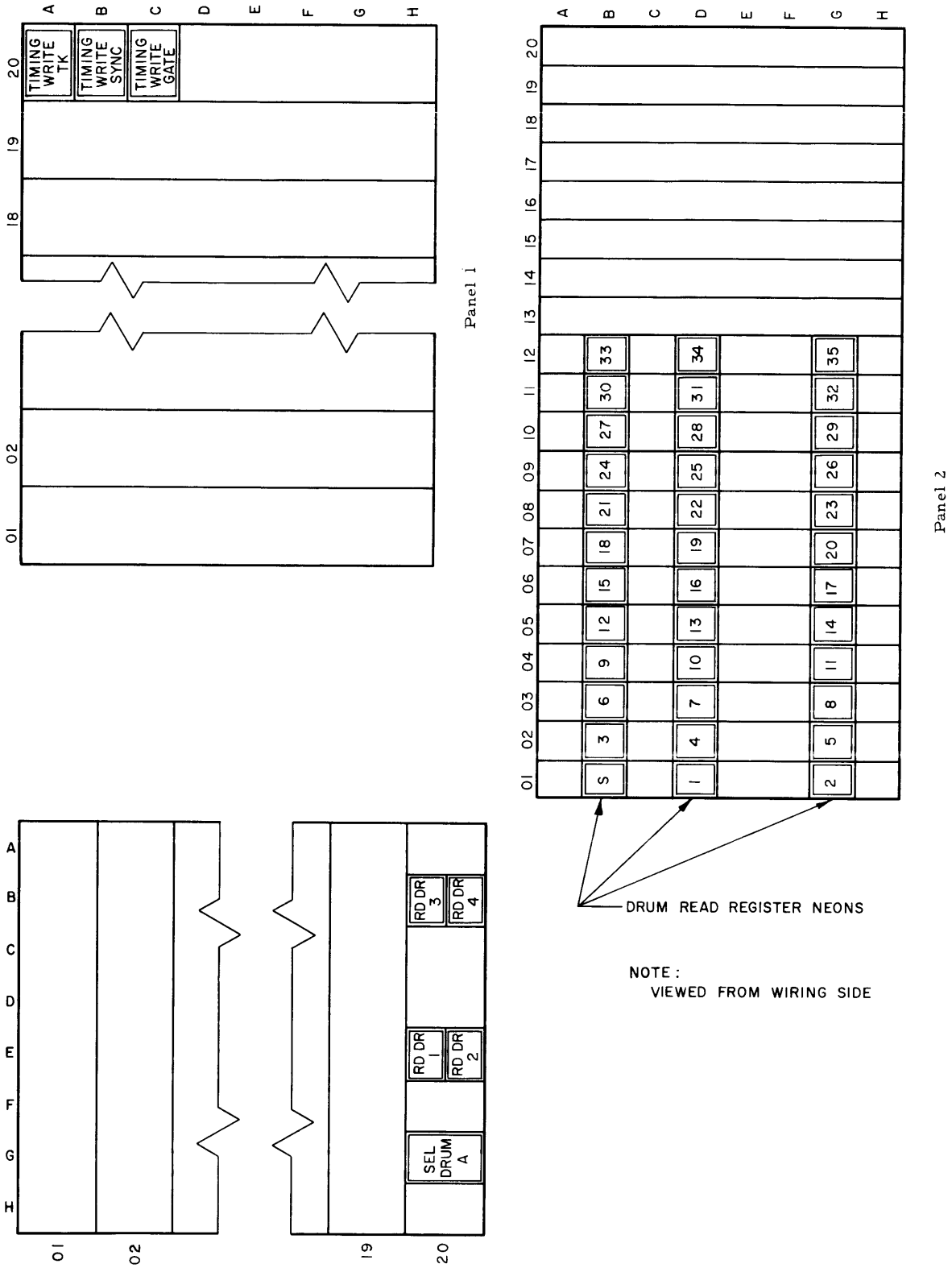


Figure 45-1. Drum Frame Neon Locations

733.46.00 TEST/CONTROL PANELS

The drum amplifier and timing track amplifier selection switches (Figure 14-1) are made up of three rotary switches and a scope receptacle mounted on the hinge side of drum panel 3. To use these switches you must read select one specific drum. A scope probe is then hung on the scope receptacle. Then by turning the switches to the appropriate number, the output of any correspondingly numbered main amplifier is connected to the scope probe. The highest numbered track to which the switches are turned will be connected to the output. For instance, if the top switch is on 10, the middle switch on 20, and the bottom switch on 30, then the main amplifier for track 30 will be connected to the scope receptacle.

When the bottom switch is turned to position T, the timing track output for either drum A or drum B will always be present on the output receptacle, whether or not the drum is in read status.

There are two other control panels on the drum, both used when writing a new timing track. A panel containing the timing track push button and the multivibrator controls (Figure 14-1) is mounted between panels 1 and 2. A switch, used to select upon which drum the timing track will be written, is mounted behind the glass window on the front of the drum frame. (Figure 14-2.)

733.47.00 LIST OF PARALLEL CF AND PCF IN DRUM

There are many places in the drum where groups of cathode followers are used to power important pulse lines. If one or two of these tubes become defective, the pulse may still appear but its level may have dropped. This could cause intermittent and troublesome errors.

Table 47-A has been compiled mainly so the Customer Engineer may visually inspect these tube groups to find tubes with open filaments.

TABLE 47-A PARALLEL CF AND PCF IN DRUM

Pulse	Powering Units	Drum Frame Location
Clock Pulse	5PCF	DF2 - A17 - 02, 03, 04A
Index Pulse	5PCF	DF2 - A16 - 06A, 07, 08
Inverted MV Pulses	5CF	DF2 - A20 - 05, 06, 07B
Read Sample	8PCF	DF2 - A14 - 05, 06, 07, 08
	6PCF	DF2 - A13 - 06, 07, 08
Timing Pulses	5PCF	DF2 - A15 - 04B, 05, 06
Timing Pulses (inverted)	4PCF	DF2 - A14 - 01, 02
Timing Write Pulse	$3PCF_H$	DF1 - A20 - 08, 07A
Write Pulse	12CF	DF1 - A19 - 03, 04, 05, 06, 07, 08

733.48.00 MISCELLANEOUS

733.48.01 Scope Procedure

The delayed sweep circuits of an oscilloscope can be used when you wish to examine a small portion of a long waveform. They are very handy when you have to closely investigate the output from any drum main amplifier and are particularly useful when you want to check the length of the timing track gap.

To understand the operation of the delaying sweep circuits used in the Tektronix Type 535 oscilloscope, the following points should be remembered:

1. The heart of this circuit is a delaying sweep generator which produces a sawtooth and is very similar to the main sweep generator.

2. The delaying sweep generator must be triggered externally.

3. There are two methods of using the sawtooth wave developed by the delaying sweep circuit. They are:

   a. The sawtooth drives the horizontal amplifier directly.

   b. The sawtooth provides a pulse to start the main sweep generator and allow it to control deflection. This pulse may be controlled so that it occurs at any time during the buildup of the delaying sweep sawtooth. A ten turn Delay Time Multiplier, calibrated in centimeters of delay, is used to effect this control.

Thus in one mode of operation the delaying sweep is triggered by an external signal and the main sweep receives its trigger signal later from the delaying sweep. At some time during the trace both sweeps are running, each producing its own unblanking signal and both unblanking signals helping to turn on the beam. The display on the face of the scope will have a brightened portion, showing that both the delayed sweep and main sweep are active at that point. The remainder of the display will be of normal intensity, showing that only the delayed sweep is active at that time.

The delayed sweep feature of the Type 535 may be used to good advantage when you have to check the length of the drum timing track gap, as mentioned before. Trigger the delayed sweep from the drum index pulse, using the lower TRIGGER OR EXT. SWEEP IN post. Then adjust the controls as follows:

1. Set VOLT/CM switch to 2 volts/cm.

2. Set toggle switch labeled SLOPE to +.

3. Set toggle switch labeled ATTEN to X1.

4. Set Horizontal Display control to DELAYING SWEEP.

5. Turn Main Sweep STABILITY and TRIGGERING LEVEL controls fully clockwise.

6. Set Delaying Sweep TIME/CM OR DELAY TIME control to 5 millisec.

7. Turn Delaying Sweep LENGTH control fully clockwise.

8. Set Main Sweep TIME/CM control to 10 usec.

9. Set Main Sweep MULTIPLIER to 5.

10. Set DELAY TIME MULTIPLIER to about 2 or 3 cms.

11. Adjust Delaying Sweep STABILITY and TRIGGERING LEVEL exactly as you would the Main Sweep's similar controls.

A trace should now be visible on the screen. Adjust the INTENSITY control to give a good contrast between the normal and the bright portions of the trace. The bright portion can be moved anywhere along the trace by turning the DELAY TIME MULTIPLIER control. Increasing the Main Sweep speed will narrow the bright portion, and turning the DELAY TIME MULTIPLIER clockwise will move the bright portion to the right.

If the Horizontal Display Switch is now turned to MAIN SWEEP DELAYED, the brightened portion will expand to fill the whole screen.

Thus if you are displaying a timing track output, move the brightened portion so that it is on the timing gap. Then turn the switch to MAIN SWEEP DELAYED. The length of the gap can now be read in centimeters and converted to microseconds by consulting the Main Sweep TIME/ CM and MULTIPLIER controls, which in this case have been set to 50 usec/cm. Note that you read the same TIME/CM and VOLTS/CM scale whether or not you use the Delayed Sweep, Main Sweep Delayed, or Main Sweep Normal mode of operation.

For further information on oscilloscope usage, consult Customer Engineering Manual of Instruction on Tektronix 531 and 535 Oscilloscopes (Form 22-6725-0 (1M-4/57-EP)).

733.48.02 Some Useful Short Programs

The following short programs can be used as an aid in troubleshooting the drum. They are designed to supplement the standard drum diagnostic, not to replace it. Always use the standard diagnostic first when trying to find trouble. Then, if it seems that you may be able to save time by doing so use a short program such as those given below. They are intended to be manually loaded into the machine by means of the op. panel keys.

Key-In Program

This program will allow you to manually load as many as 7000 instructions into sequential memory locations starting at zero, by merely entering the instruction on the op. panel keys and then pressing the start button. You will find that this program will save considerable time if you wish to manually load a program consisting of more than five or six steps.

To use the program, proceed as follows; 1) Manually load the following Key-In Program into the specified locations in memory:

LOC	OPN	DECR	TAG	ADDR
7000	LXA	0	1	7001
7001	HTP	0	0	7777
7002	ENK *			
7003	STQ	0	1	7777
7004	TIX	1	1	7001

* For use on the 704, the ENK instruction must be changed to NOP.

2) Manually enter a transfer to 7000 instruction into the machine; 3) Press the start button. The program will halt at 7001. When it does; 4) Place the instruction which you wish to store at zero on the op. panel keys. Then, 5) Press the start button. When using a 704 main frame you will have to first press the Enter MQ button, then press the start button. For either machine, your instruction will now be stored at zero and the program will again halt at 7001. Now, 6) Place the instruction which you wish to store at one on the op. panel keys. Continue as in step 5 and in a similar manner; i.e., placing the instructions on the op. panel keys and pressing the start button, you may load up to 7000 instructions into memory.

Simple Copy Loop

The smallest possible copy loop which will run continuously on the drum without disconnecting is:

LOC	OPN	DECR	TAG	ADDR
0	WRS or RDS			Drum Number (301, 302, etc.)
1	CPY			----------
2	TRA			1

Simple LDA Loop

The smallest LDA loop possible is:

LOC	OPN	DECR	TAG	ADDR
0	WRS or RDS			Drum Number (301, 302, etc.)
1	LDA			----------
2	CPY			----------
3	TRA			0

Write and Read Ones and Zeros and Compare

This program will write either ones or zeros on the drum selected and will then compare the information read with that written. In case of error the program will halt. Drum diagnostic 4D10 or 9D01 contains a very similar routine.

LOC	OPN	DECR	TAG	ADDR	REMARKS
0000	LXA		7	0016	
0001	WRS			0301	(or any other drum)
0002	CPY			0017	
0003	TIX	1	1	0002	
0004	RDS			0301	
0005	CPY		2	4100	
0006	TIX	1	2	0005	
0007	CLA		4	4100	
0010	LDQ			0017	
0011	CAS			0017	
0012	TRA			0014	
0013	TRA			0015	
0014	HPR				
0015	TIX	1	4	0007	
0016		000000	0	0400	
0017		111111	1	1111	Change to ALL ZEROS to write and read Zeros.

If the program halts due to an error in comparison; the information written will appear in the MQ, while that which was read back will appear in the accumulator.

Writing Addresses at Drum Addresses

The program given below is actually composed of four parts: 1) Memory locations are loaded with their corresponding addresses from 0000 to 3777; 2) At each drum address, the address itself is written; 3) The drum is read back and each address is LDA'ed and then copied into storage from location 0000 to 3777; 4) A comparison is made between the addresses read back and those originally written. In case of error, a halt at location 7023 will occur. Press the start button to continue comparing. When the entire drum has been read back and compared, the program halts at location 7030. Pressing the start button will then repeat the complete program from the beginning.

LOC	OPN	DECR	TAG	ADDR	REMARKS
7000	CLA			7031	Loads successive memory locations with corresponding addresses starting at 0000 up to 3777.
7001	LXA		7	7032	
7002	STO		1	4000	
7003	ADD			7033	
7004	TIX	1	1	7002	
7005	WRS			0301	Writes addresses on drum.
7006	CPY		2	4000	
7007	TIX	1	2	7006	
7010	RDS			0301	Read, LDA, and copy drum addresses back into storage from 0000 3777.
7011	LDA		4	4000	
7012	CPY		4	4000	
7013	TIX	1	4	7010	
7014	STZ			7034	Compare addresses read back with those originally written In case of error, halt at location 7023.
7015	LXA		1	7032	
7016	CLA		1	4000	
7017	LDQ			7034	
7020	CAS			7034	
7021	TRA			7023	
7022	TRA			7024	
7023	HPR				
7024	CLA			7034	
7025	ADD			7033	
7026	STO			7034	
7027	TIX	1	1	7016	
7030	HTR			7000	Normal halt at 7030.
7031		000000	0	00000	
7032		000000	0	04000	
7033		000000	0	00001	
7034		000000	0	00000	

When the program is first loaded into the machine, you must manually enter a transfer to 7000 instruction into the op. panel keys. This is only necessary once after the program is loaded.

733.48.03 Drum CEM Listing

CEM No.	Title
9	High Speed Erasure - 731
13	Procedure for Writing Timing and Index Tracks - 731
19	Service Techniques and Information - 731
31	Diagnostic Program and Service Techniques - 706, 726, 731
51	Dust Filtering - 731
493	Replacement of 12AY7 Tubes - DPM
526	Drum Read/Write Head Connector Removal - 732, 733, 734
681	Trigger Neon Labels - 704, 733, 737, 753
687	General Service Information - General
745	Adder 9 Carry Trigger - 704
754	Drum SS Index Pulse - 733

CONTENTS

BIBLIOGRAPHY

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704 Electronic Operations	
Volume 1	29-9183-2
Volume 2	29-9184-2
709 CE Manual of Instruction	
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Volume 2	29-9296-0
CE Manual of Instruction:	
Tektronix 531 and 535 Oscilloscopes	22-6725-0
IBM Technical Report:	
Diagnostic Charts, An Aid in Diagnosis of Machine Performance	TR 01.01.062.495

733.50.20 FIGURE LIST

Troubleshooting Charts

Diagnostic Charts

Pluggable Unit Location Chart

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