IBM Maintenance Library

3410-3411 Magnetic Tape Subsystem Theory-Diagrams

SY32-5028-1

Preface

This manual describes the operation of the IBM 3410/3411 Magnetic Tape Subsystem. It contains four sections covering the Tape Unit, the Tape Control, the microprocessor operation when the host system is a System/3, and microprocessor operation when the host system is a System/360/370.

This manual assumes the reader is host system trained. Previous tape subsystem training is helpful but not a prerequisite for using this manual.

Machine specifications are subject to change at any time and without prior notice by IBM. This manual does not necessarily reflect these changes or represent any specific machine. For information at the engineering change level of a specific machine, refer to the logic diagrams, microprogram listing, and the *3410/3411 Integrated Maintenance Manual* shipped with each machine.

Second Edition (April 1973)

This is a major revision of, and obsoletes, SY32-5028-0. Two new sections, "Microprogram System/370 Model 125" and "Microprogram Seven-Track," have been added. Other changes or additions to the text and illustrations are indicated by a vertical line.

Specifications contained herein are subject to change from time to time and will be reported in revisions to this manual or in FE supplements.

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This manual was prepared by the IBM General Products Division, Half-Inch Tape Writing, Dept. 26T, P.O. Box 1900, Boulder, Colorado 80302. A form is provided at the back of this publication for the reader's comments. If the form has been removed, comments may be sent to the above address.

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This Technical Newsletter provides pages to be inserted and/or replaced in the subject publication. These pages are:

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A change to the text or figure title is indicated by a vertical line to the left of the change.

Summary of Amendments

Added material describes the System/3 Model 8 and Model 12 Magnetic Tape Attachment.

Note: *Please file this cover letter at the back of the manual to provide a record of changes.*

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Abbreviations

ABI	attachment bus in
ABO	attachment bus out
ac	alternating current
ALU	arithmetic logical unit
atthmnt	attachment
bkwd	backward
BOB	beginning of block
BOT	beginning of tape
bpi	bits per inch
BPI	bytes per inch
BSB	backspace block
BSF	backspace file
CMO	command out
CPU	central processing unit
CRC	cyclic redundancy check
CS	cycle steal
CU	control unit
DBO	data bus out
dc	direct current
DOS	disk operating system
DSE	data security erase
EPO	emergency power off
EOT	end of tape
ERG	erase gap command
ERP	error recovery procedure
FE	field engineer
FF	flip flop
fnd	found
FSB	forward space block
FSF	forward space file
fwd	forward
IBG	interblock gap
IC	instruction counter
I/O	input/output
INTRO	introduction
LP	load point
LRC	longitudinal redundancy check
LSR	local storage register
LWR	loop write to read
MP	microprocessor
MTE	multi-track error
ms	millisecond
NRZI	non-return to zero inverted
ns	nanosecond
OS	operating system
PE	Phase Encoded
PET	phase error track
REW	Rewind
RIC	read in counter
ROC	read out counter
ROS	read only storage
RUN	rewind unload
R/W	read/write
SKB	skew buffer
SVI	service in
SVO	service out
TB	terminal board
TC	tape control
TI	tape indicate
TIE	track in error
trk	track
TU	tape unit
UC	unit check
usec	microsecond
vac	volts alternating current
VRC	vertical redundancy check
WTM	write tape mark

Introduction To Magnetic Tape Subsystems

A magnetic tape subsystem consists of a tape control and one or more tape units. Each tape unit can record (write) information on tape, or sense (read) information from tape.

The tape control communicates with each of the tape units and with a data processing system. In operation, the tape control receives an instruction from the system, prepares a specific tape unit to execute the instruction, and passes information which is read from tape, or is to be written on tape, between the tape unit and the system.

Magnetic Tape

Magnetic tape is widely used as an input/output medium because it rapidly stores large amounts of information in compact, easily handled form. Since tape can be reread repeatedly without destroying the recorded data, the information stored on magnetic tape can be retained as a permanent record. Since old data is erased automatically as new information is written on tape, magnetic tape can also be used as a temporary storage medium.

Construction

Magnetic tape consists of a flexible plastic strip coated with a thin layer of ferromagnetic material. The coating is a mixture of ferromagnetic particles and a binder solution. The binder is used only to hold the ferromagnetic particles to the plastic strip. The particles are narrow and are oriented lengthwise on tape. They are held in position by the binder and do not move when the polarity of tape is changed.

The oxide particles on tape are magnetized by applying an external magnetic source to the tape. The direction of the magnetic flux from the source determines the polarity in which the oxide particles are magnetized. An area of tape with all particles magnetized in one direction is considered polarized in that direction.

Each section of magnetic tape polarized in one direction simulates a single bar magnet, with a south pole at one end and a north pole at the other. When a tape is polarized continuously in one direction, the entire tape forms a single bar magnet. If half the tape is polarized in one direction (north pole at the left) and half polarized in the other direction (north pole at the right), the tape has the form of two bar magnets, with the south pole for each in the center. If the direction of polarization changes often along the length of tape, the tape has the form of a series of shorter bar magnets.

To write on tape, the direction of polarization of tape is changed by altering the direction of externally applied magnetic flux. When reading from tape, the change in polarization is detected.

Writing

The oxide on tape is polarized by passing the tape through magnetic flux generated by a write head. The direction of current flowing through the coil of the write head determines the direction of the flux through which the tape passes. When current flow through a write coil changes direction, the direction in which tape is magnetized also changes. The points on tape where polarity changes represent the recorded data.

Reading

Reading from magnetic tape uses the principle that a voltage is induced in a coil whenever there is a change in the direction or number of flux lines crossing the turns of the coil. Reading is performed by moving recorded tape across a read head.

As tape is moved across the read head, a point on tape is reached where the polarization of the oxide changes. At this point, the flux crossing the turns of the read head coil changes from maximum in one direction, to maximum in the other direction. This change in flux direction induces a pulse in the read coil. The direction of current in the coil is determined by the direction of polarity change on tape.

Bit

A bit is the smallest unit of information stored on magnetic tape. In the binary system, a bit represents one of two states: on and off, or active and inactive. The logical 1 and 0 are terms used to represent the binary on and off states; the 1 indicates on, the 0 indicates off.

A bit is stored on magnetic tape by changing the direction of polarization of the tape oxide. In the NRZI system of recording, only the one bits are stored on tape; a change in polarity at a given time represents a 1 bit, and no change in polarity at a given time represents a 0 bit. In the phase encoded system of recording, both 1 and 0 bits are stored on tape. The direction of polarity change determines whether the bit is a 1 or 0.

Erasing

Tape is erased by magnetizing it continuously in one direction. When polarity of tape does not change for a period of time, no bits are recorded; it is erased. Although old information is destroyed automatically as new information is written, physical differences among the read/write heads on different tape units may cause interchangeability problems when tape is written on one tape unit and then rewritten on another unit. An erase head applies a strong magnetic field to erase the entire width of tape during a write operation, to reduce interchangeability problems, and to reduce the possibility of leaving extraneous bits between data blocks on tape.

The erase head is located just below the read/write head in the tape path. When tape is moving forward in write status, it passes over the erase head before it crosses the write head, and flux lines pass through the tape and saturate the oxide to magnetic zero before new bits of information are written.

Tracks

Bits of information are written on tape in parallel rows called tracks. One read coil and one write coil are provided for each track. Although the read and write coils for all tracks are located in the same physical unit (read/write head), the coils for each track are independent of all other tracks. There are nine (seven) tracks across the tape, allowing nine (seven) bits of information to be written or read simultaneously.

Byte

The bits present in all nine (seven) tracks at any one time comprise a byte of information. One byte consists of eight data bits and one parity bit which were recorded on tape at the same time. The eight data bits of a byte may represent a letter, number, symbol, or special character. The ninth, or parity (P) bit is used for error checking.

The P position of a byte can contain a 1 or 0, depending on the number of 1's in the rest of the byte. For parity checking, the tape control uses odd parity; thus, the total number of 1's in a byte, including the P bit, should be odd. If the data portion of a byte contains an odd number of 1's, the P bit should contain a 0. If the data portion of a byte contains an even number of 1's, the P position should contain a 1, to make the total odd. If a byte with an even number of 1's is detected, an error is indicated.

Recording Area

Magnetic tape is available in a variety of lengths. On any reel of tape, all but a small length at each end may be used for recording. The recording area of tape is physically identified at each end by reflective markers adhered to the back of tape.

The markers are sensed by a system of lamps and photocells which signal the tape unit when the beginning or end of the recording area is reached. The markers are small strips of transparent plastic with a thin film of aluminum on one side. Pressure sensitive adhesive covers the aluminum film. The markers are applied to the base (uncoated) side of tape. New reels of magnetic tape have the markers in position. The load point marker is mounted on the plastic surface of tape about 15 feet from the physical beginning of tape. The marker is placed parallel to and about 1/32 inch from the front edge of tape. Sensing this marker identifies load point, where reading or writing should begin.

The end-of-tape marker is mounted on the plastic surface of tape about 25 feet from the physical end of tape. The marker is placed parallel to and about 1/32 inch from the rear edge of tape. Sensing this marker signals that the physical end of tape is near, and that writing should stop after the block being written.

Vacuum Columns

Two vacuum columns provide buffer storage areas for tape. A loop of tape is retained in each of these columns. As tape movement causes tape to be withdrawn from a column, the tape is replenished by the corresponding tape reel. As tape is placed in a column by tape movement, a tape reel withdraws the excess. This buffering action allows the tape reels to operate independently.

Besides acting as buffer storage areas for tape, vacuum columns use atmospheric pressure to exert gentle, uniform tension on tape while it is passing over the read/write head. This tension keeps tape in contact with the read and write heads and prevents buckling or stretching while starting or stopping tape.

Vacuum columns are rectangular in cross-section; their tops are open to receive a loop of tape, while a manifold at the bottom is connected to a vacuum pump. A loop of tape hangs in each column. The vacuum pump maintains vacuum below each tape loop, and atmospheric pressure presses tape downward and against the sides of the column. It is the tension caused by downward atmospheric pressure that holds tape in contact with the read and write head surfaces.

When tape is moving, the position of the tape loop in each vacuum column is sensed by sensing units attached to the columns. These sensing units control the starting and stopping of the tape reels as needed to maintain a constant supply of tape in each vacuum column.

Tape Guiding

To maintain interchangeability of tape reels, the alignment of the tape path must be closely controlled among different tape units. Tape guides establish the tape path through the tape transport. One edge of tape is the reference edge, and all tape units use this edge for guiding. On a 3410/3411 tape unit, this is the front edge, which is held in continual contact with a fixed reference flange on each of the tape guides in the transport. Since tape width varies slightly, the lower flange of a tape guide is spring loaded. The spring action exerts a light, though constant, pressure on the lower edge of tape. This pressure causes the reference edge of tape to remain in constant contact with the reference flange regardless of tape width.

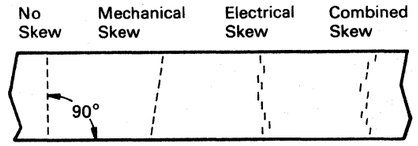
Skew

Skew is the misalignment of bits within a byte, and can occur during the reading or writing process.

Ideally, all bits of a byte should be perfectly aligned during a write operation and should be detected (read) at the same instant as the byte passes over the read head during a subsequent read operation. Unfortunately, this ideal condition is difficult to achieve because of write and read head manufacturing tolerances, small differences in head assembly mounting between tape units, and slight variations in circuit delay between tracks. These factors are further aggravated if tape swerves slightly as it passes over the heads during either the write operation or any subsequent read operation.

In the misalignment of bits within a byte, skew means a slanting or staggering of bits relative to the edge of tape. If skew is excessive, bits of adjacent bytes might mix and cause read errors.

Skew is either mechanical or electrical. Mechanical skew is usually caused by misalignment of the read/write head on the tape unit. Electrical skew is caused by head manufacturing tolerances or track-to-track circuit differences.



The example shows exaggerated write skew. It is write skew because the bytes are actually written on tape with the bits misaligned. However, bits written on tape in perfect alignment can be skewed during the read operation. Read heads and/or read circuits can cause the bits to be misaligned electrically; that is, some bits delayed longer than others.

Mechanical skew is corrected by physical alignment of the read/write head assembly. Electrical skew cannot be corrected since it is "built in" the heads and circuits. Two means of compensation for electrical skew are provided; one is used for each of the recording modes. Special buffer registers, capable of compensating for large amounts of skew, are used in Phase Encoded mode. In NRZI mode, adjustable single-shots allow all tracks to be electrically aligned.

Master Skew Tape

A master skew tape is a field tool for adjusting skew. It is manufactured to extremely rigid specifications since it is a standard used to obtain optimum tape unit performance. Master skew tapes have a density of 800 flux changes per inch and are written with one solid bit across the width of tape at each flux change. These tapes are written at the factory on a special tape unit designed to produce tape with a minimum of skew.

The master skew tape is used to adjust mechanical skew, then electrical skew while reading in both a forward and backward direction. With read electrical skew aligned in this manner, a normal tape is written and electrical skew is adjusted while writing. Read skew must be adjusted prior to measuring write skew since the read circuits are used in adjusting write skew.

Common Terminology

Feedthrough: A form of noise appearing on the read signal (during a write operation) whenever a write circuit switches polarity. Feedthrough is caused by some of the flux lines generated by the write head crossing the read head coils. If not eliminated through shielding or cancellation, feedthrough can cause errors in a write operation although the written data is correct.

Crosstalk: The unwanted transfer of energy from one track to another during a read or write operation. Crosstalk is caused by coupling of the read signal between tracks. Components in the read/write head, and cables throughout the subsystem are shielded to hold crosstalk to a minimum.

Read Signal: The voltage induced in a read coil as a polarity change on tape passes. This voltage is amplified and shaped by read circuits, and passed to the tape control as information read from tape.

Write Signal: The signal applied to the write coil to cause a polarity change to be written on tape as it passes.

File Protect: A method of preventing the inadvertent destruction of data on magnetic tape. Removal of a write-enable ring found in the back of the tape reel protects that reel from accidental rewrite. A tape reel with the write-enable ring removed is file protected. A write-enable ring must be inserted in any reel before writing on that reel can take place.

Tape Cleaner: A device in the tape path of most tape units to remove loose particles of dust or oxide as the tape passes. If not removed, these particles can cause head-to-tape separation at the read/write head, resulting in a greatly reduced read signal amplitude and errors.

The tape cleaner is positioned so that tape moving forward passes the cleaner before reaching the surface of the read/write head.

Error Recovery Procedure (ERP): A routine in the system program which is entered whenever a read or write error occurs. An ERP contains a sequence of instructions designed to recover from an error condition without major interruption of the customer's job.

There are separate ERP routines for each type of error, and each involves a predetermined number of retries of the failing operation. If recovery is successful (the operation is performed without error on one of the retries), the error is classified as temporary, and the customer job continues. If recovery is unsuccessful, the error is classified as permanent.

Write Skip: A procedure commonly used in write error ERP's. The tape unit is instructed to backspace over the block on which the write error occurred. An Erase Record Gap (ERG) instruction then causes 3.75 inches of tape to be erased. The block is again written. The write skip is intended to skip over a defective area of tape should it be the cause of the write error.

File Reel: The tape reel which is mounted and dismounted on the tape unit. The tape is normally resident on this reel and leaves only when a forward operation is in progress on the tape unit.

Machine Reel: The tape reel which remains on the tape unit at all times. This reel receives tape transferred from the file reel during a forward operation.

Loaded/Unloaded: Separate states of the transport portion of the tape unit. When a tape unit is loaded, tape is in the vacuum columns and the tape reels are under automatic control of the tape unit. When a tape unit is unloaded, tape is out of the columns and the reels must be manually operated.

Rewind: The process of returning tape to the file reel following a forward operation. A rewind can be initiated manually, using a pushbutton on the tape unit, or under program control. Since data is not recorded nor read, rewind normally occurs at a tape speed much higher than normal.

Data Format

A A block is a group of data bytes separated from other groups of bytes. The amount of data in one block (the number of bytes) is variable, and is determined by the system before the data is sent to the tape control.

B The block sent to the tape unit for recording in phase encoded mode has a burst of bytes added to each end by the tape control. The added bursts are necessary for the tape control to synchronize the read detection circuits when reading tape in either direction (forward/backward). The block recorded by the tape unit contains: 40 bytes of all zeros (including parity bit), 1 byte of all ones (including parity bit), the data bytes received from the system, 1 byte of all ones, and 40 bytes of all zeros. When transferring data from the tape unit to the channel, the tape control discards the added bursts.

A tape that contains phase encoded data is identified by a recorded burst at the load point marker. This is the phase encoding identification burst, and consists of 1600 flux changes per inch recorded in the P track, while all other tracks are erased. The burst begins before, and extends beyond the load point marker.

C No beginning or ending burst is used when recording data in NRZI mode. The NRZI block recorded on tape has two check characters added at the end. These check characters are discarded by the tape control during a read operation.

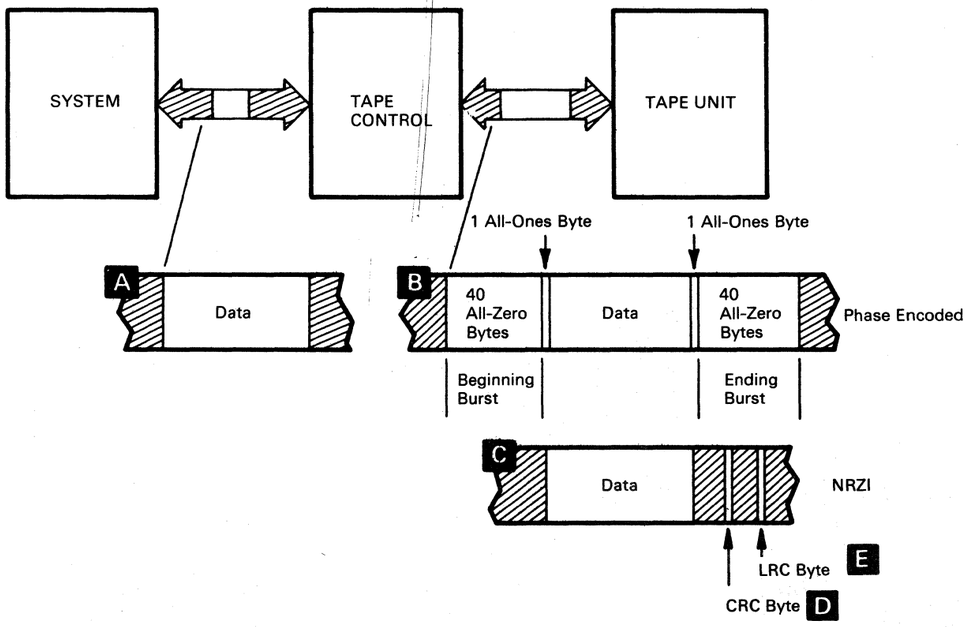
A tape that contains NRZI data is identified by the absense of a phase encoding identification burst. Instead, the first 6 inches of an NRZI tape are erased, beginning before, and ending after the load point marker. This erased area at the beginning of tape is the load point delay, and causes actual recorded data to begin away from the load point marker, where tape damage is most likely to occur.

Check Characters

In NRZI mode, the two check characters written at the end of each block are the Cyclic Redundancy Check (CRC) character, and the Longitudinal Redundancy Check (LRC) character.

D The CRC character is developed in the tape control during each NRZI write operation and represents an accumulation of all bits in the block. The CRC character is written on tape four byte spaces after the last data byte, and is used for single-track read error correction.

E The second, or LRC, check character is an odd/even parity count of all the bits in each track of a block. The total number of 1's in any track of a block is made an even number by placing a 1 or 0 in the LRC position for that track. The LRC character is written four byte spaces after the CRC character, or a total of eight byte spaces from the last data byte.



Inter-Block Gap (IBG)

A gap, or blank area of erased tape, is used to separate individual blocks on tape. The nominal length of the IBG is 0.6 inches. The IBG length of 0.6 inches is standard for all 9-track tape units and is sufficient to allow tape to come to a stop after the end of a block is sensed, and upon restart, to reach full speed before the beginning of the next block is sensed.

Two delays, generated by the tape unit when writing, create the IBG and determine its length. These delays govern:

- The time between writing the last byte of a data block, and actually stopping tape.
- The time between starting tape motion and writing the first byte of the next block.

When the tape unit is in write status, moving tape over the write head without writing data causes that tape to be erased. Together, the two delays cause 0.6 inches of tape to be erased between data blocks.

There are occasions when a customer job may require backspacing over a data block on tape, and writing a new block in its place. If, after the backspace, tape is not positioned at exactly the same point as before writing the original record, the new IBG length will be different. A tape unit which, in this type of operation, would shorten the IBG is said to have "backward creep." If the IBG is lengthened, the tape unit has "forward creep." Since backward creep, and the resulting short IBG may cause errors on subsequent read operations, a tape subsystem is designed so that stopping tape moving backward is quicker than stopping tape moving forward, causing forward creep.

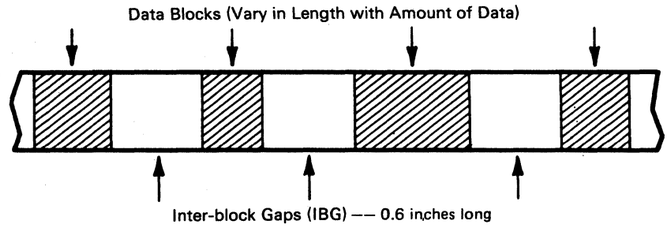
File

A file is a group of related blocks recorded on tape. Several files may be written on a tape, and to allow the system to recognize the end of one file and the start of another, a special block, or tape mark, is written at the end of each file.

Tape Mark Configuration

In phase encoded mode, the tape mark is a burst containing zeros in tracks P, 0, 2, 5, 6, and 7 with tracks 1, 3, and 4 erased.

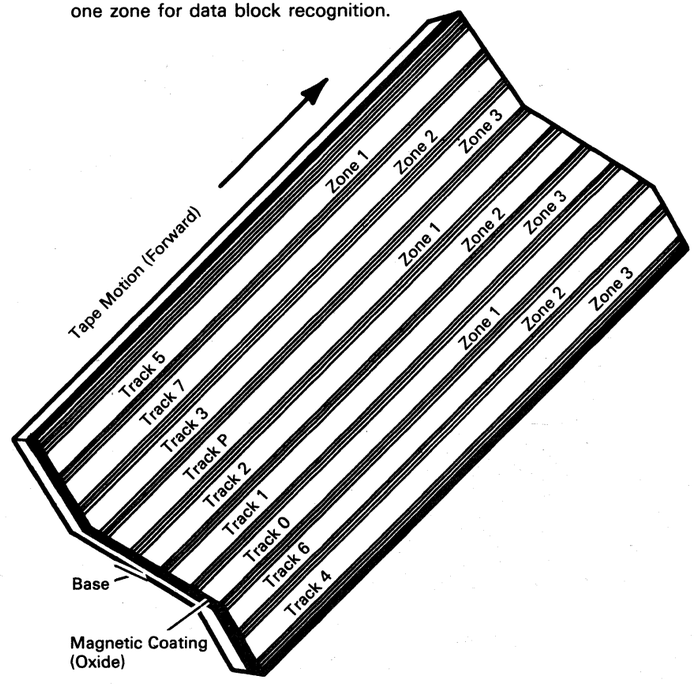
In NRZI mode, the tape mark is two bytes, eight byte spaces apart, each containing ones in tracks 3, 6, and 7 with zeros in all other tracks.



Track Arrangement

A byte consists of eight data bits and a parity bit. The bits are identified as P, 0, 1, 2, 3, 4, 5, 6, 7 and each is recorded in a separate track on tape. The tracks are arranged such that those most likely to contain one bits in NRZI mode are located in the middle of tape, and the least used tracks are on the outside edges where most tape defects occur.

The nine tracks are divided into zones, or groups, of three tracks each. The tracks of a zone are non-adjacent (separated by two tracks from other zones). In phase encoded mode, the tape control uses the zone configuration to distinguish between the start of a data block, and noise which may be sensed between blocks. A read signal must be sensed in all tracks of at least one zone for data block recognition.



Data Recording

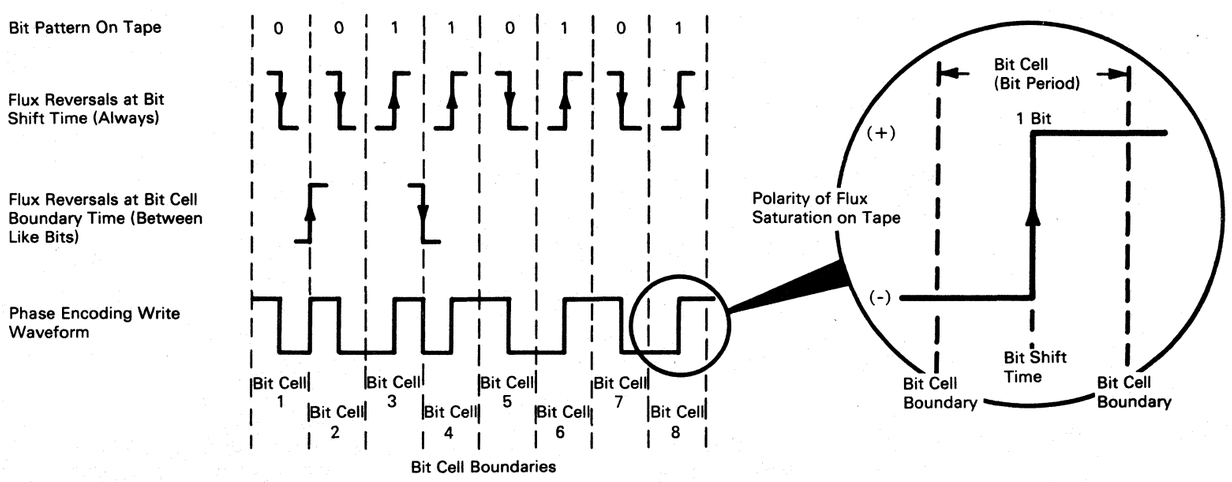
Phase Encoding And NRZI Recording Methods

The phase encoded method of recording on tape uses the direction of flux change to distinguish between binary ones and zeros. The NRZI method uses a flux change in either direction to represent a one and no flux change to represent a zero.

Phase Encoded Write

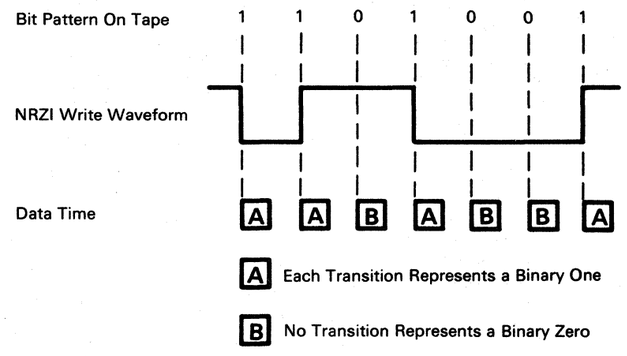
The time required to write a single binary bit is called a bit cell. The write clock in the tape control determines the timing of a bit cell and controls the generation of flux reversals (reversals of magnetic polarity) on tape. During the write process, a flux reversal is created in the middle of each bit cell (bit shift time). If this reversal is plus-to-minus (negative), the bit is a zero; if minus-to-plus (positive), a one.

When two consecutive one bits are written, both requiring a positive reversal at bit shift time, an extra, negative reversal must be written between the one bits. Also, when two consecutive zero bits are written (negative reversals), an extra positive reversal must be written between the zero bits. These extra flux reversals occur at bit cell boundary time and are not regarded as data.



NRZI Write

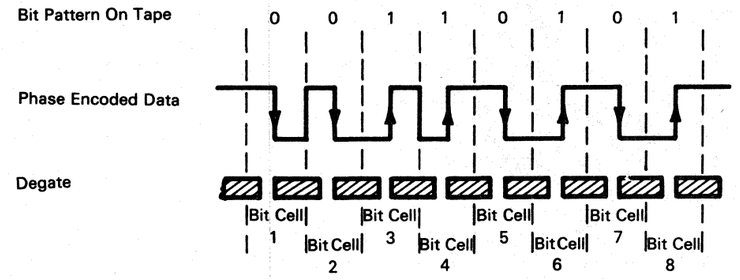
In NRZI recording, a flux reversal in either direction represents a binary one bit. If the bit to be written is a one, a flux reversal is created at data time, determined by a write clock in the tape control. If a zero is to be written, no flux reversal is created at data time.



Phase Encoded Read

In phase encoded mode, each bit cell contains a flux reversal at bit shift time. If this reversal is positive, the bit is a one. If the reversal is negative, the bit is a zero.

At the boundary between bit cells containing like bits (consecutive ones, consecutive zeros), an extra reversal occurs. To prevent recognition of these extra reversals as data, the read detection circuits are degated for approximately 70% of the period between bit shift times. This degating begins with the sensing of a flux reversal and ends as a function of a predetermined time-out.



NRZI Read

In NRZI mode, all flux reversals sensed from tape are one bits; therefore, no discrimination between positive and negative reversals is required. If a reversal in either direction is sensed, the bit is a one. If no reversal occurs, the bit is a zero.

Tape Problems

One of the major factors affecting the quality of an operating system is the quality of the magnetic tape. During use, it is stretched, flexed, and rubbed, causing its oxide to crack, or to be eroded. Eroded particles of oxide, fingerprints, and dust contaminate its surface, multiplying erosion and breaking contact between the tape and the read/write station. Improper handling by the operator can also damage tape.

There are some tapes that cause degradation of performance of the tape transport. These tapes are called inhibitor tapes. Such tapes will: (1) glaze or coat the capstan, (2) stick to the read/write head or cause other tapes to stick, (3) generate particles and debris that cause read, write, or motion control failures.

In order to trace the history of the tape, adequate records must be maintained. The primary objective of good housekeeping is the ability to quickly find the device or tape associated with a tape error.

Write Errors

The most common causes for write errors are tape lift, tape velocity, oxide voids, or a combination of all. Usually, tape lift is caused by physical distortion; that is, curvature, wavy or rippled edge, or cupped tape. There are many tape parameters which may cause these problems. Unfortunately, most are impossible to measure in the field. However, some common parameters which may be at fault are thickness, drag, and stiffness. These, and other tape characteristics, can cause a difference in performance between brands of tape.

Tape velocity or motion problems due to actual tape media are relatively rare.

Read Errors

Some of the parameters causing tape write errors can also cause tape read errors. One major difference is that the tape, during a write operation, may have experienced a stress or distortion that is aggravated when the tape is placed in storage. When this occurs, the CE can expect to see blocks on tape which have a high skew content, usually caused by tracking or packing/unpacking of bytes.

Permanent read or write errors cannot be ignored. Every effort and resource must be used to resolve this type of problem.

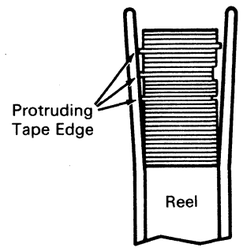
Damaged Tape

The cause of damaged tape is one of the most difficult problems to analyze. However, there are some causes which are common by the nature of their form and location in the reel. Two pieces of information are needed to properly resolve a tape damage problem: the reel for examination, and the tape units on which the reel was processed.

Usually, the damaged tape is discovered in a read operation, as a permanent read error. The reading tape unit is generally not at fault; however, if the tape is machine-damaged, chances are good that the tape unit which last processed the reel is at fault.

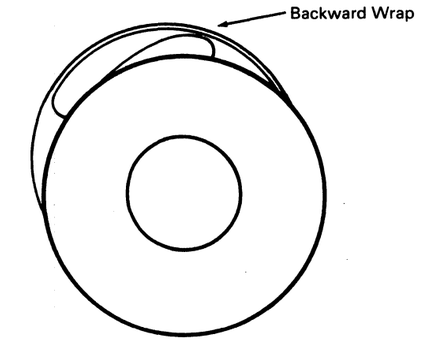
Edge Creases: Short creases (2 to 6 inches) at any point in the reel can be the result of uneven winding or rough handling. An uneven wind can be caused by the tape, reel, or the tape unit. Tapes with a high degree of curvature tend to wind unevenly. A lack of constant rewind tension by the machine will also contribute. The width of the reel flange spacing is a controlling factor. With the best conditions of tape unit and tape, the tape will still tend to wind unevenly if the width of the flange is not correct.

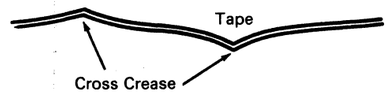
Tape wound with only a few protruding edges on a reel can be creased by squeezing the flange. This is usually done when mounting or removing the tape reel.

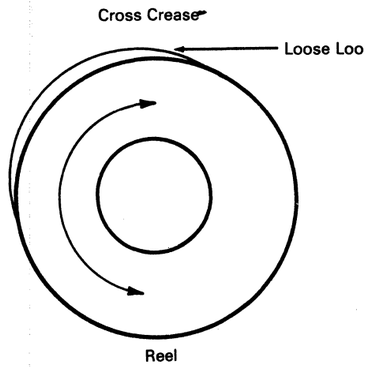


Uneven Wraps of Tape

Cross Crease: The cross crease usually comes in pairs; one crease toward the coating, and one away from the coating, a foot or less apart. This type of crease is created by a backward wrap and can be due to tape becoming slack at some point during rewind, or to a severely warped tape reel affecting tape during a motion reversal.

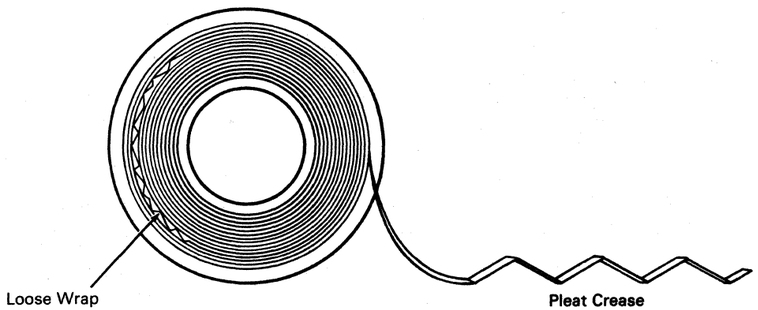




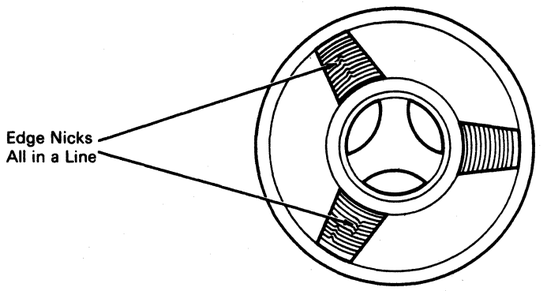


Indentations: Any foreign or tape particle causes an indentation in the coating surface when tape is wound tight on the reel. When tape is wound extremely tight, the end-of-tape marker often embosses the tape surface.

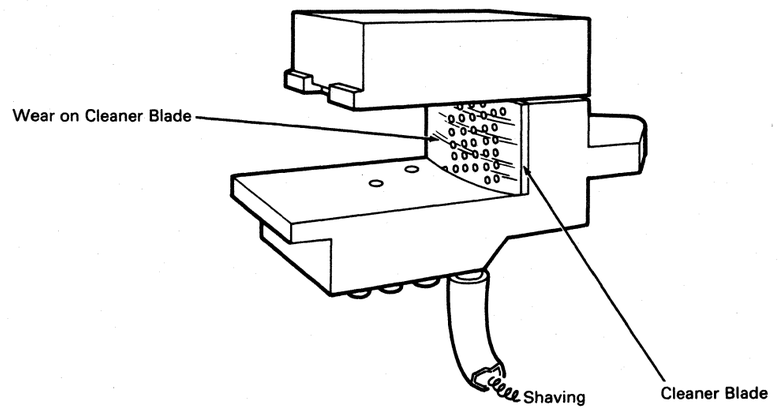
Pleat Creases: The pleat crease begins when one or more loose wraps are placed in the tape reel during a rewind. During subsequent processing of the reel, the outer mass of tape shifts on the loose wrap, causing it to pleat.



Edge Nicks: In most cases, edge nicks are operator inflicted. The open-flanged reel with uneven wraps is very subject to edge damage. Fingernails, or stacking tapes out of their containers are the most prevalent causes.



Edge Shavings: Many times, a small edge nick becomes caught on the cleaner blade and causes the edge of tape to be shaved. A worn, rough cleaner blade can also cause the tape edge to be shaved. This condition can continue for several hundred feet, causing the tape to track incorrectly on subsequent passes.



Environmental Problems

Temperature

Temperatures within the specified operating range have little effect on performance of magnetic tape. However, extremely high temperature during storage, along with heavy winding tension, can cause oxide voiding.

Humidity

Relative humidity up to 80% has little effect on tape performance. Low humidity has two pertinent effects:

1. The tape backing becomes stiff and the coating less flexible. Thus, wear particles build up faster.

2. Static charges build up faster at low humidity. Applications which shoe-shine over small sections of tape are very sensitive in low humidity. A combination of static charge and the smoothness of tape causes clinging in the tape transport. This results in poor tape start and stop times, and if the condition is severe, read or write failures.

Contamination

Prolonged or unnecessary exposure of tape to dust and dirt can contaminate the tape surface and result in signal loss and errors. The following basic rules will help reduce the risk of tape contamination:

1. Maintain recommended temperature and humidity conditions in areas where tape is used or stored.

2. Thoroughly clean the entire floor area daily using a damp mop. Avoid sweeping, dry mopping, or dusting in areas where tape is used or stored.

3. Floor waxing should be kept at a minimum. When necessary, the floor should be machine buffed to remove excess wax, damp mopped with cold water to harden the surface, then machine buffed again when dry. Steel wool, or other metal abrasives should never be used for buffing.

4. Periodically inspect and clean tape units to remove particles accumulated during normal use.

Tape Handling

There are only two places that can be considered proper for a tape reel; in use on the tape unit, or in its container. Adequate procedures should be established to protect magnetic tape from contamination which will undoubtedly result in decreased tape unit performance. Some common rules are:

1. Never leave tape reels or containers exposed. In addition to the possibility of tape damage, dust in the air can accumulate on the tape or in the container, and eventually contaminate the tape.

2. Erasing a tape reel identification label is a primary source of contamination. Select a label with an adhesive backing that does not leave a residue and that can be applied and removed easily.

3. Never allow a loose end of tape to trail on the floor, even though the end of tape does not contain data. Dirt picked up can be deposited in the transport areas of the tape unit and be passed on to other sections of the tape.

4. Smoking should not be permitted in areas where tape is in use. Ashes are a source of contamination. Live ashes can produce permanent tape damage if they contact the tape surface.

5. Mount reels carefully. When a reel is improperly seated on the tape unit reel hub, the tape edge receives undue wear and becomes burred. This burred edge winds to a larger diameter than the undamaged tape. Eventually, the center of the tape collapses, and the burred edge of tape is permanently stretched.

   Avoid physical contact with the tape through the reel openings or excessive pressure on the reel flanges. Such pressure will compress the tape and damage its edges.

6. Use extreme care when removing the write enable ring. Never remove the ring while tape is loaded on the tape unit.

Tape Storage

To prevent tape contamination and damage during storage, follow these procedures:

1. Before a tape is stored, secure the loose end of tape with a tape end retainer to prevent the tape from unwinding in the container.

2. Always store tape in an upright position. Never store tapes flat or in stacks; accidental damage or reel warpage may result.

3. Store tapes in a cabinet or shelf elevated from the floor and away from sources of paper and card dust. This minimizes the transfer of dust from the outside of the container to the reel during loading and unloading operations.

Tape Subsystem Description

General Description

The 3410/3411 Magnetic Tape Subsystem consists of a tape control and as many as six tape units. A tape unit is an electromechanical device that transports magnetic tape across a read/write head, and either records (writes) data on the tape or senses (reads) data previously recorded on the tape. The tape control is an electronic device that controls the operation of several tape units. The tape control selects a specific tape unit, initiates the proper status conditions for an operation, provides timing signals and delays, and controls the transfer of data between the tape unit and host system.

To write on tape, the tape control sends tape-motion control commands, write control commands, and data to the tape unit. The tape unit then transports the tape across the read/write head and writes the received data on tape. To read from tape, the tape control sends tape-motion control commands and read control commands to the tape unit. The tape unit then transports the tape across the read/write head, reads the data from the tape, and sends it to the tape control. The tape unit also rewinds and unloads tape upon command from the tape control.

Up to six tape units may be included in an IBM 3410/3411 tape subsystem. The tape control and power supplies for the subsystem are located in one of the tape units. This unit is the 3411 and functions as a tape unit and tape control. The remaining units in the subsystem are 3410's and function only as tape units under complete control of the 3411. The tape unit portion of a 3411 is identical to the 3410 in function and appearance.

There are three models of the IBM 3410/3411 subsystem. The differences between models are 1) the speed at which tape is moved across the read/write head, which determines data rate, and 2) the maximum number of tape units which may be included in the subsystem.

Tape units of a Model 1 subsystem move tape at 12.5 inches per second (ips) resulting in a maximum data rate of 20,000 bytes per second. A maximum of four tape units may be included in the subsystem.

Tape units of a Model 2 subsystem move tape at 25 ips resulting in a maximum data rate of 40,000 bytes per second. A maximum of six tape units may be included in the subsystem. *

Tape units of a Model 3 subsystem move tape at 50 ips resulting in a maximum data rate of 80,000 bytes per second. A maximum of six tape units may be included in the subsystem. *

* No more than four tape units, of any model, may be attached to System/3 because of input/output device addressing limitations.

Recording Method

The IBM 3410/3411 writes and reads nine tracks of phase encoded information at 1600 bytes per inch (BPI). With the Dual Density feature, the subsystem will also write and read nine tracks of NRZI information at 800 BPI. With the seven-track feature, the subsystem will write and read NRZI at 200, 556, and 800 BPI.

Interfaces

The tape control must communicate with both the channel of the host system and with individual tape units of the subsystem. A means for this communication is provided by two interfaces; a subsystem interface and a tape control to tape unit interface.

The subsystem interface allows information to be passed in both directions between the system and tape control. All commands, tape unit selection, and read and write data are passed over this interface.

The tape control to tape unit interface connects the selected tape unit to the tape control. This interface carries the signals required to execute any tape unit operation, as well as data to or from the selected tape unit.

Radial Connection

Each tape unit attached to a tape control is connected with an individual interface cable. This is known as radial connection and allows a tape unit to be disconnected from the tape control without affecting other tape units of the subsystem.

The address of a given tape unit is determined by the socket location, in the tape control, into which its cable is plugged. When the tape control communicates with a tape unit, switching circuits route the interface signals only to the selected tape unit. These circuits are the tape unit switch, and are in the tape control.

Subsystem Control

The system instructs the 3410/3411 subsystem to perform specific tasks. The tape control receives, decodes, and executes the instructions. To execute an instruction, the tape control issues, to the selected tape unit, the commands required to perform the desired operation. Commands from the tape control direct the tape unit to:

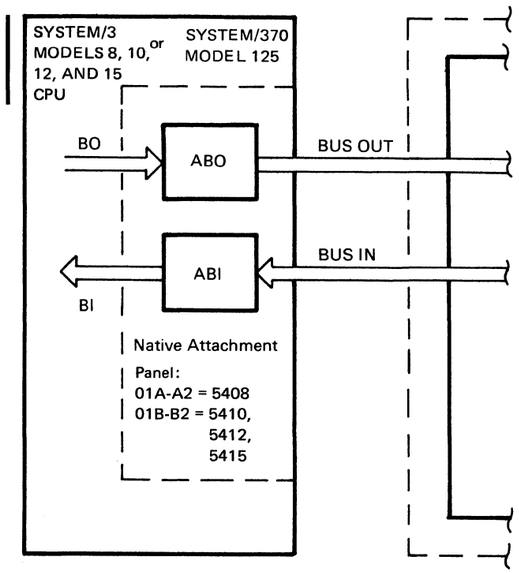
- Read tape
- Write tape
- Space forward or backward over sections of previously written tape
- Erase a section of tape
- Write special tape mark characters identifying the end of an information section on tape
- Write a special identification burst at the beginning of tape indicating that the tape is written in phase encoded mode
- Rewind tape to the beginning of tape
- Rewind tape to the beginning of tape and unload the tape unit

Metering

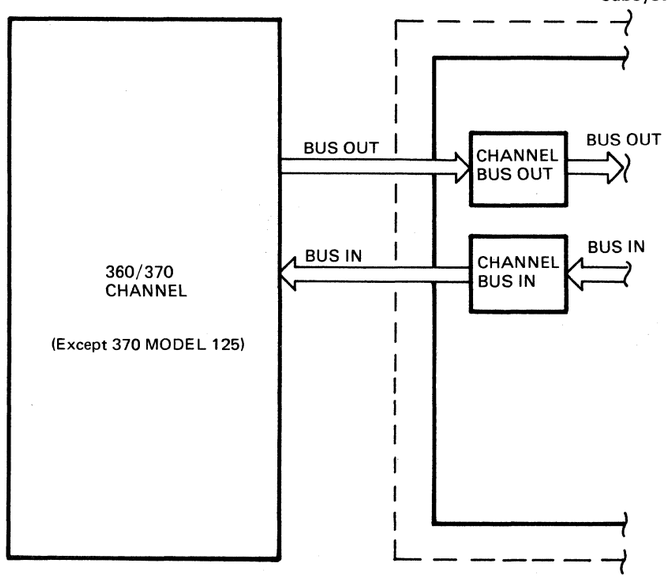
A time meter is present on the 3411 and on each 3410 tape unit. The meters record the time that each individual device is in use. The meters are disabled by a switch (ENABLE/DISABLE) on the 3411, but when metering is disabled, the subsystem is automatically placed in an off-line status and no subsystem operations may be performed under system control.

Power Supplies

All power supplies for the subsystem are contained in the 3411. The required dc voltages are provided to the individual tape units through interconnecting cables from the 3411 to each 3410.



OR



System Attachment

The 3410/3411 subsystem is attached to the host system in one of two ways, depending on the system.

On a System/3 Model 8, 10, 12, or 15, or System/370 Model 125, the subsystem is connected to a native attachment. The native attachment occupies logic panel 01BB2 of the System/3 CPU (5410, 5412, and 5415), 01AA2 of the System/3 CPU (5408) and 01AB1 of the System/370 CPU (3125). The attachment contains the circuitry required to adapt the system input/output controls to the 3410/3411 subsystem.

Communication from the System/3 to the subsystem, including instructions, control signals, and write data, enter the native attachment on DATA BUS OUT (DBO) and are sent to the subsystem on ATTACHMENT BUS OUT (ABO). Information entering the system from the subsystem, including subsystem and tape unit status, error indications, and read data, enter the native attachment on ATTACHMENT BUS IN (ABI) and are sent to the System/3 on DATA BUS IN (DBI). For Model 125 information, refer to the *System/370 Model 125 Magnetic Tape Adapter Maintenance Library Manual,* SY33-1064.

For use on a System 360 or 370 (except Model 125), the subsystem is connected directly to the input/output channel of the system. Communication from the channel to the subsystem uses CHANNEL BUS OUT and from the subsystem to the channel, CHANNEL BUS IN.

Tape Control

The tape control, under direction of the attached system, controls tape unit operation (writing, reading, motion control, etc.). It passes write data to the tape unit and read data to the attached system, testing data parity and correcting when possible. A microprocessor directs the various functions of the tape control. A microprogram is permanently stored in Read Only Storage (ROS) within the tape control. It consists of instructions arranged in groups, or routines. Each routine causes the tape control to perform a specific task. The instructions of a routine are executed, one at a time, until the task is completed.

Communication from the tape control to the tape unit is on TAPE UNIT BUS OUT and from the tape unit to the tape control on TAPE UNIT BUS IN. Since several tape units are connected to a tape control, a tape unit switch in the tape control must be conditioned to activate only the signal lines to and from the tape unit specified by the system.

The TAPE UNIT BUS IN lines bring read data from the tape unit to the tape control. In phase encoded mode, data signals are present on these lines for both "ones" and "zeros." The phase encoded detection circuits determine which is present. The "ones" are then loaded into the skew buffers which assemble the bits from each track into bytes. In NRZI mode, data signals are present on TAPE UNIT BUS IN only for ones; therefore, no detection is necessary before loading the read data into the skew buffers. When a byte is assembled in the skew buffers, it is sent through the microprocessor to the system.

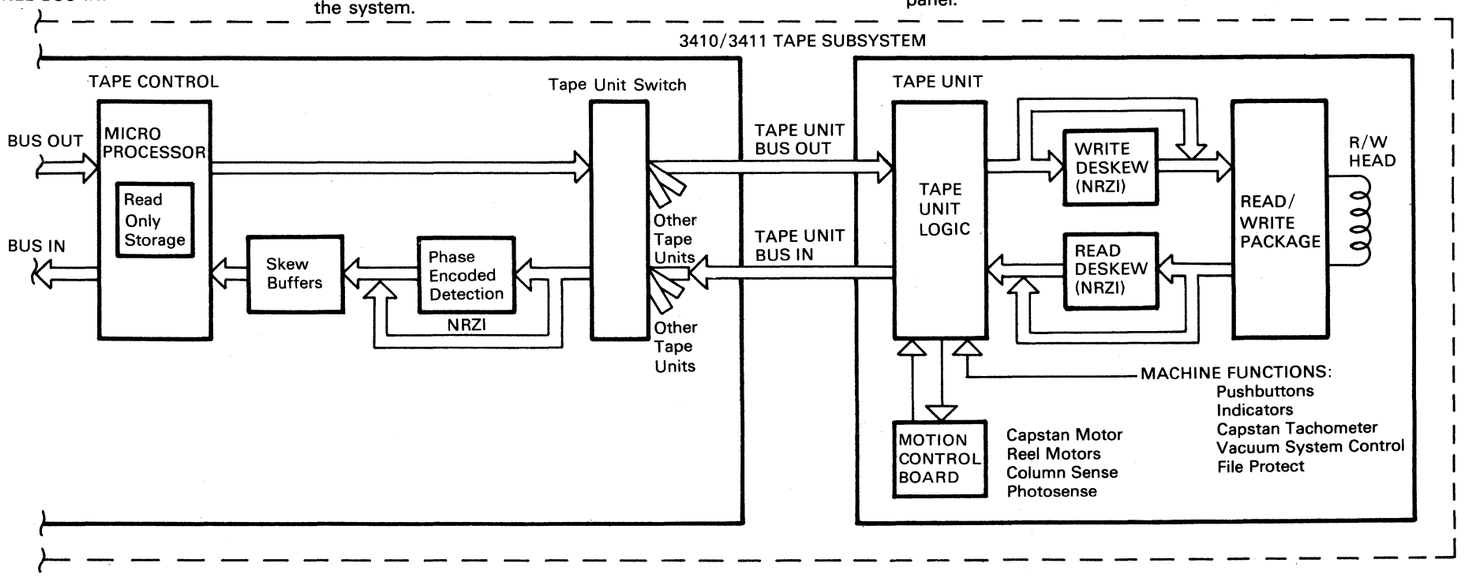
Tape Unit

The tape unit receives commands from the tape control and conditions the various areas of the tape unit to respond appropriately for the desired operation.

The read/write package is attached to the read/write head and contains (1) the driving circuits which supply current to the write coils when writing, and (2) the circuits for sensing and amplifying data stored magnetically on tape when reading. The tape unit logic conditions the read/write package for either a read or write operation and for the desired recording mode (phase encoded or NRZI). In NRZI mode, data entering or leaving the read/write package is electronically aligned by deskew circuits to compensate for differences between tracks.

A motion control board contains driving circuits for the reel and capstan motors. The motion control board receives timing pulses and control signals from the tape unit logic and regulates the speed and direction of the motors. Also on the motion control board are circuits for detecting the beginning and end of tape (photosense) and for sensing the position of tape in the vacuum columns (column sense).

The tape unit logic receives signals from manual controls on the operator's panel and causes the proper tape unit response. The tape unit logic also turns on and off the vacuum system and the indicators on the operator's panel.



Commands

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Revised 10/27/75 by TNL SN26-0323

Purpose of Commands

The subsystem is under control of an attached system which can be a System/3, System/360, or System/370. The system and subsystem are connected through an attachment which converts interface signals so the two can communicate.

A Start I/O instruction from the system initiates a tape operation. The system also sends a command which designates the operation the subsystem is to execute. If the subsystem is attached to System/3, the command is part of the Start I/O "Q" byte. An explanation of the individual commands follows.

Read Forward

A read forward command causes the selected tape unit to move tape forward and read one block of data. The tape unit sends the data to the tape control which interprets the data as ones and zeros. The tape control checks the parity of each data byte as it is received and puts it in a buffer. Single track errors detected by the parity check are corrected. Tape control sends the buffered bytes to the system, through the attachment. When the tape unit reaches the end of the data block, the tape control stops sending data to the system and stops the tape unit.

Read Backward

A read backward command causes the selected tape unit to move tape backward and read one block of data. Read Backward is identical to Read Forward with one exception. When reading a NRZI tape backward, the first two bytes read are check characters and are not sent to the system.

Write

The selected tape unit moves tape forward and writes one block of data. The write data comes from the system, through the attachment. The parity of each byte is checked in the attachment, and again in the tape control. If a parity error occurs, it cannot be corrected during a write, so a Data Check error is set. The tape control sends data bytes to the tape unit, timed to coincide with proper write time. The tape unit writes each byte as it is received.

The tape unit reads back each byte after it is written and sends it to tape control where parity is checked. Tape control sets an error if bad parity is found.

The write operation ends when the system sends no more data and the subsystem finishes the read back check.

Request Track In Error (System/360 and 370 Only)

This command transfers the Track-In-Error (TIE) byte from the system to the subsystem. The tape control uses the data to correct the next data block to be read. This command is effective only during nine-track NRZI operations and when correcting single-track errors.

Control Commands

Control commands do not transfer data between the system and subsystem. On System/3, a Control command is part of the Start I/O "R" byte.

Rewind

The selected tape unit winds tape onto the file reel until the beginning-of-tape (load point) marker is sensed. The tape unit then positions the tape at load point and stops. Any subsequent command which causes forward tape motion or no tape motion can be issued from beginning of tape.

Rewind-Unload

The selected tape unit winds tape onto the file reel until the load-point marker is sensed, then unloads tape. Only the sense command can be successfully completed from the unloaded state. Before the tape unit can execute another command, the operator must load tape and make the tape unit ready.

Erase Gap

The selected tape unit erases tape for approximately 3.6 inches. When the selected tape unit is in phase-encoding (PE) mode and is positioned at load point, a PE identification burst is written before the erased portion of tape.

Write Tape Mark

The selected tape unit writes a block of special "non-data" bytes called a tape mark, preceded by a three-inch interblock gap. When the tape unit is in PE and positioned at load point, a PE identification burst is written before the interblock gap and tape mark. No data is transferred to the subsystem from the system. The tape mark format is predetermined and the tape control generates the bytes to be written.

The tape unit reads back the tape mark and sends it to tape control for checking. If an error is found, tape control initiates a retry. After 15 unsuccessful retries, the subsystem erases approximately 45 inches of tape and sets EQUIPMENT CHECK and TAPE MARK CHECK in sense bytes.

Space Block (Forward/Backward)

The selected tape unit moves tape in the direction specified, past one block of data. No data is transferred.

Space File (Forward/Backward)

The selected tape unit moves tape in the direction specified until a tape mark or load point is detected. No data is transferred and interblock gaps are ignored.

Data Security Erase

The selected tape unit erases tape from its present position to the end-of-tape marker.

Mode 1 Set (Seven-Track Feature)

This command establishes the operating conditions in tape control for subsequent seven-track operations. Mode 1 set determines the density, turns the data converter and translator on or off, and sets subsystem operations to odd or even parity. The subsystem retains the mode set until reset or until another mode set command is received.

Mode 2 Set (Dual Density Feature)

The subsystem, if the dual density feature is installed, is capable of writing and reading in PE or nine track NRZI. The Mode 2 set commands are used in nine-track operation to select either 1600 bits per inch (PE), or 800 bits per inch (NRZI).

Diagnostic Commands

On System/3 the diagnostic commands are part of the Start I/O "R" byte.

Diagnostic Write

When the system issues this command, special patterns and records can be written. Data from the system is written as sent, except when two or more successive ones are written. Two or more ones cause the track they are written in to be erased.

Loop Write to Read

This command connects the write and read circuits together within the tape unit. Write data from the system is sent back through the read circuits and checked. Tape does not move and data is not written on tape.

Skew Check

The tape unit reads two bytes from a Master Skew Tape and sends them to tape control. Tape control measures the time between two tracks of the two bytes and places the result in a sense byte.

Crosstalk Check

The tape unit reads data previously written in all tracks but one. Tape control checks the blank track for data. Any data in the blank track indicates excessive crosstalk.

Diagnostic Measure

The tape control starts the tape unit moving and measures the time between tachometer pulses. The time between tachometer pulses indicates the speed at which the tape unit is moving tape. This data is sent to the system to be analyzed by the diagnostic program.

IBG Timing Test

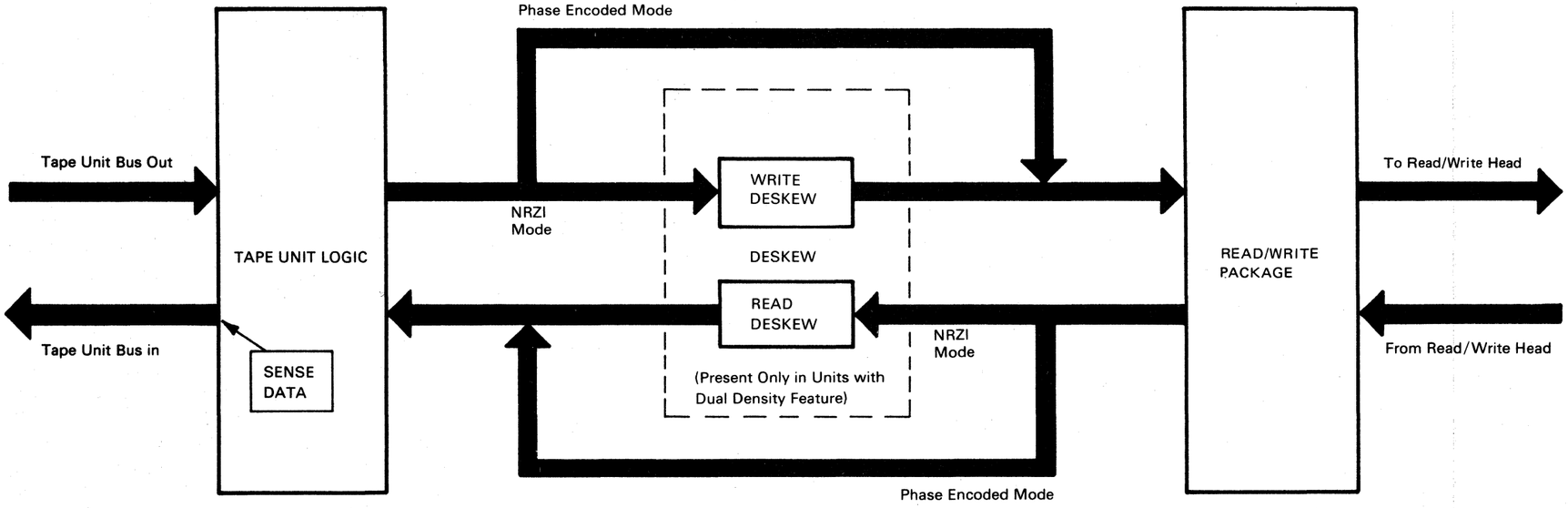
The tape control starts the tape unit moving and measures the time between the detection of "interblock gap" and the next "beginning of block." This time represents the length of the interblock gap, and is placed in a sense byte.

Load Byte

The tape control requests two bytes of data from the system. The data is for use by a subsequent diagnostic measure command.

Tape Unit

Data Flow (Simplified)

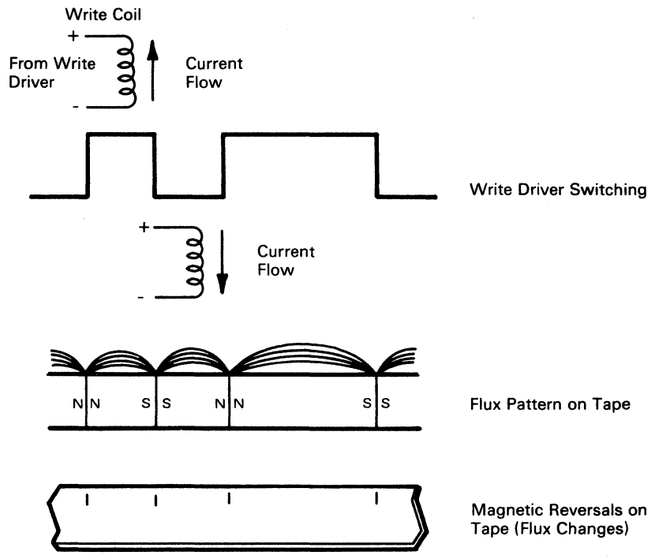


Read/Write

Write Operation

In a write operation, a byte of information is sent from the tape control to the tape unit logic over nine parallel interface lines (bus out). The tape unit logic sends the byte to the read/write package where it is used to switch the state of a write driver for each track. The state of the write driver determines the polarity of the magnetic field written on tape.

Current is passed through the write coils of each track whenever the tape unit is in write status. The direction of current flow in a given write coil is determined by the state of the write driver for that track. Switching of the write driver causes a reversal of current flow in the coil and a corresponding reversal of its magnetic field (flux change). This reversal writes the byte on tape.

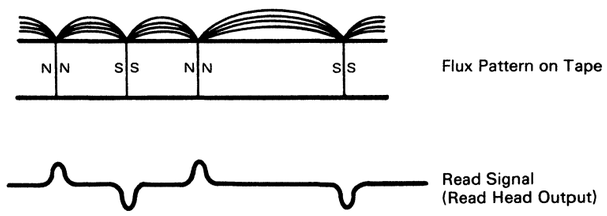


Read Operation

Bits, or magnetic reversals on tape, are sensed by the read coils as the tape is drawn across the read/write head and are sent to the read/write package as low-amplitude pulses.

The read/write package amplifies and generates a digital signal which is then gated to the tape unit logic by an amplitude sensing circuit. Signals below a voltage threshold selected by the tape control are rejected as noise and are not sent to the tape unit logic.

The tape unit logic receives read signals from all nine tracks and sends the byte of data to the tape control over nine parallel interface lines (bus in).



Feedthrough Compensation

During a write operation, magnetic lines of force are generated at the write gap to magnetize bits on tape. Because the write and read heads are so close, some of the lines of force reach the read head and induce noise in the read head windings. If amplified, this noise could cause write error indications during the read back check. To prevent amplification of this type of noise to a level sufficient for read circuit detection, a feedthrough compensation signal is applied to the read circuits.

A portion of the signal applied to the write coils is inverted and fed as an out-of-phase voltage to the read circuits to cancel feedthrough. The amplitude of the feedthrough compensation signal is set at the factory and is matched to the feedthrough characteristics of individual read/write heads and circuits.

Read Back Checking

During any write operation, the read circuits are enabled to allow read back checking. When writing, tape first crosses the write gap where bits are written. A few milliseconds later, the freshly-written bits are sensed at the read gap and sent through the normal read data path to the tape control. In the tape control, each byte is checked for validity and then discarded.

Deskew

When writing or reading in NRZI mode, the write pulses going to the read/write package, or the read pulses coming from the read/write package, are passed through the deskew circuits. These circuits electronically compensate for physical misalignment of tracks across the read/write head, and for variation between tracks in electrical characteristics.

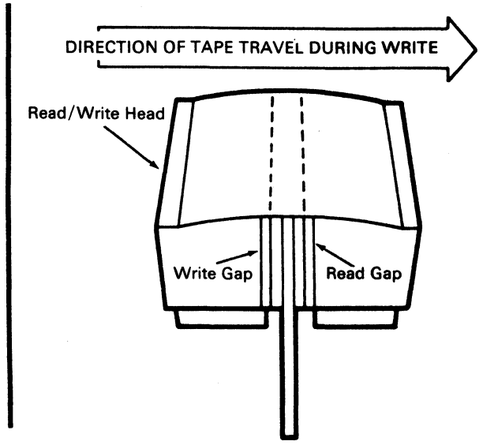
Read Deskew

Because of track-to-track differences, all bits of a byte are not sensed in the read/write package at the same instant. Read deskew is accomplished by delaying the early tracks with adjustable single-shots so that the read signals in all tracks arrive simultaneously at the tape unit logic.

Since tape does not follow exactly the same path in both directions over the read/write head, separate sets of deskew single-shots are used during forward and backward read operations.

Write Deskew

The switching of individual write drivers must be timed by the write deskew circuits so that all bits of a byte are written in a straight line across tape. Write deskew is accomplished by delaying the write pulses which switch the individual write drivers in the read/write package. A deskew single-shot for each track is adjusted such that all bits of a byte are written in a straight line across tape rather than simultaneously.



Auto-Degaussing

An auto-degaussing circuit demagnetizes the read/write head each time the tape unit is switched from write to read status and tape motion is stopped. During a write operation, current through the write coils partially magnetizes the read/write head. If this magnetism was not removed before a subsequent read operation, it would partially erase the information on tape and distort the read signal waveform.

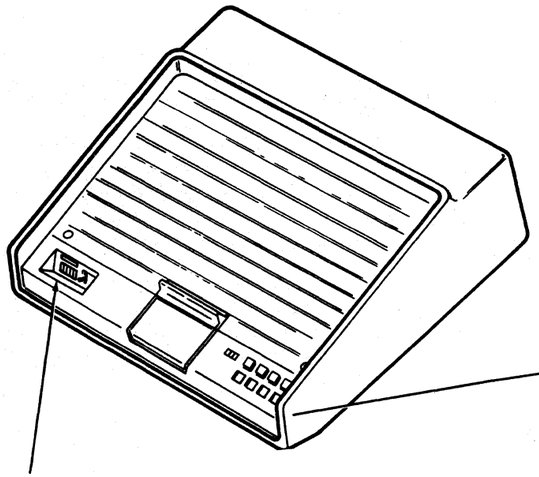
At the end of every write operation, when tape unit status changes to read, a degauss burst is applied to the write circuit for each track. The degauss burst is a series of write pulses which decrease from a maximum amplitude to zero. This produces ever-diminishing current reversals through each write coil which neutralize, or degauss, the magnetism of the read/write head. The degauss circuit is located on the motion control board.

Sense

The tape unit logic stores, as sense data, information relative to the state of the tape unit, including unusual conditions resulting from the last operation.

Sense data is transferred from the tape unit to the tape control when requested by the tape control. When the tape unit receives a request for sense data, it sends a byte of the stored sense information to the tape control on the bus in lines.

Operator's Panel



Usage Meter

A time meter on the 3411 records the time that the tape control is in use. The meter runs whenever the subsystem is enabled (online) with the ENABLE/DISABLE switch, and the system **METER OUT** line is active.

A time meter on each 3410 records only the time that the tape unit is in use. The meter runs whenever the subsystem is enabled, tape is away from load point, and the system meter out line is active.

READY

This lamp indicates that the tape unit is capable of executing commands from the tape control.

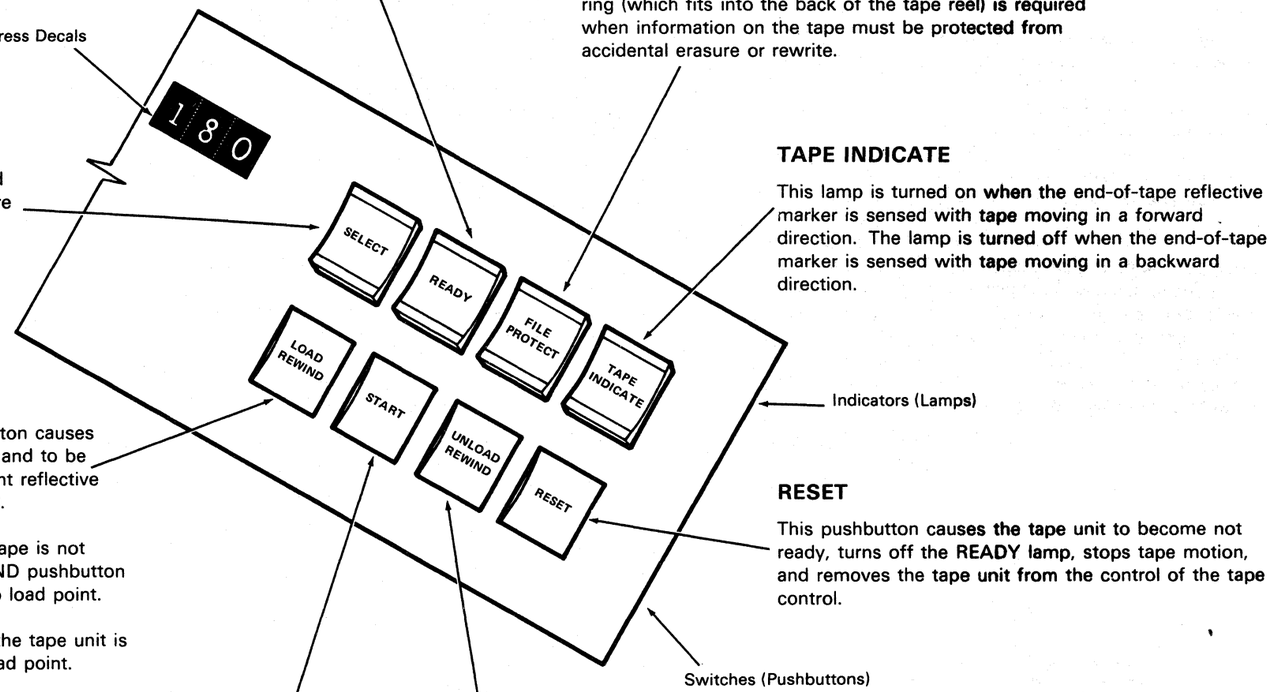
To turn on the READY lamp, the tape unit must be loaded, the START key must be pressed, and tape must not be in motion, as in a load or rewind operation. Pressing the START key while tape is in motion causes the READY lamp to turn on after the operation is complete and tape motion stops.

FILE PROTECT

This lamp indicates that the tape unit is not capable of executing a write or erase command from the tape control.

The FILE PROTECT lamp is turned on when the tape unit is not ready or when a file-protected tape reel is mounted. A file-protected reel is one from which the write-enable ring has been removed. Removal of this ring (which fits into the back of the tape reel) is required when information on the tape must be protected from accidental erasure or rewrite.

Tape Unit Address Decals



Indicators (Lamps)

Switches (Pushbuttons)

SELECT

This lamp is turned on when the tape unit is addressed by the tape control. The tape unit must be ready before it can execute commands from the tape control.

TAPE INDICATE

This lamp is turned on when the end-of-tape reflective marker is sensed with tape moving in a forward direction. The lamp is turned off when the end-of-tape marker is sensed with tape moving in a backward direction.

LOAD REWIND

If the tape unit is not loaded, this pushbutton causes the tape to load into the vacuum columns and to be moved forward to load point (the load point reflective marker is sensed at the photosense block).

If the tape unit is loaded, not ready, and tape is not positioned at load point, the LOAD REWIND pushbutton causes tape to move backward (rewind) to load point.

Pressing LOAD REWIND has no effect if the tape unit is ready or if tape is already positioned at load point.

RESET

This pushbutton causes the tape unit to become not ready, turns off the READY lamp, stops tape motion, and removes the tape unit from the control of the tape control.

START

If the tape unit is loaded, this pushbutton places the tape unit under control of the tape control, turns on the READY lamp, and disables all other pushbuttons except RESET.

The START pushbutton has no effect if the tape unit is ready or not loaded.

UNLOAD REWIND

This pushbutton causes the tape unit to rewind tape to load point and then unload. If the tape is at load point when you press UNLOAD REWIND, the tape unit unloads immediately. The UNLOAD REWIND pushbutton is disabled when the tape unit is ready.

Tape Transport

Reel Drive

- Each tape reel is driven by a separate dc motor.
- The motors are servo controlled by the position of the tape loop in the vacuum column.
- When tape is moved by the capstan, the reel motors rotate the reels to feed and take up tape; but they allow enough slack to maintain a sensing loop in each vacuum column.

Tape Drive Capstan

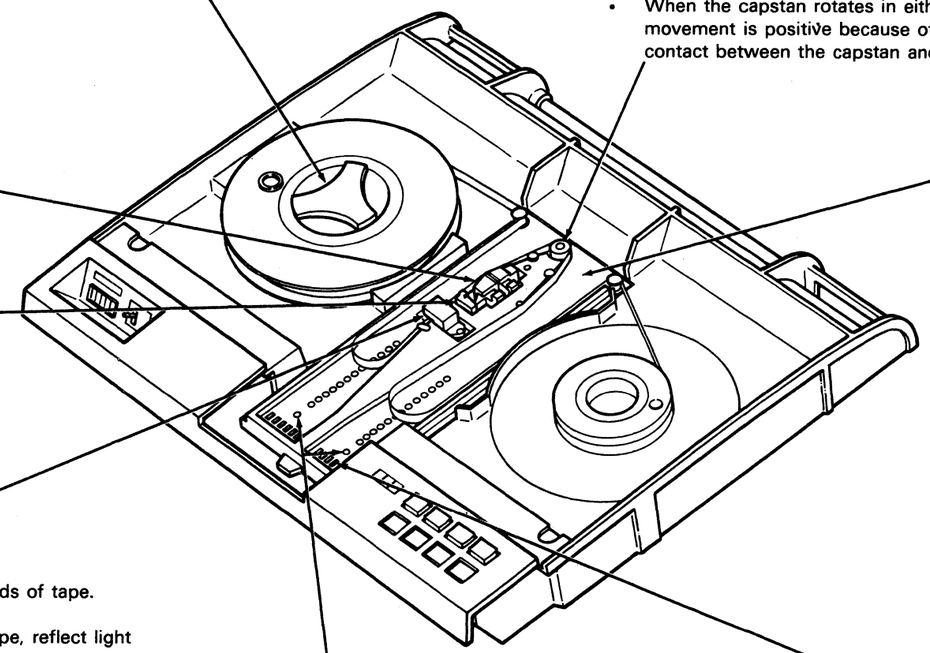
- A single tape drive capstan is used to move tape forward and backward.
- The capstan is driven by a reversible dc motor.
- In a loaded condition the tape, which wraps approximately 170 degrees around the capstan, is held firmly against the capstan surface by the pull of vacuum on the tape loops in the vacuum columns.
- When the capstan rotates in either direction, tape movement is positive because of the large area of contact between the capstan and the tape surface.

Read/Write Head

- A single two-gap head is used.
- Nine separate write coils write data on nine tracks.
- Nine separate read coils read data from nine tracks.

Erase Head

- A single-gap head erases old information from tape before new information is written.
- Erasure is accomplished by passing dc current through the erase head coil.
- The erase head is always active during a write operation, and never active during a read operation.



Vacuum Columns

- Two vacuum columns are used as tape loop buffer areas.
- A vacuum is developed at the bottom of each column. This vacuum is used to:
  1. Attract tape into the vacuum columns during a load operation.
  2. Provide a gentle, uniform tension on tape in a loaded condition.
  3. Operate a tape loop position sensor located behind each vacuum column and activated through a series of small ports in the column surface.
- Tape loop buffering allows the capstan to turn intermittently without the tape reels having to turn simultaneously.

Photosense Block

- The photosense block detects the ends of tape.
- Reflective markers, at each end of tape, reflect light from a lamp to a photocell.
- The load point marker (15 feet from the beginning of tape) reflects light to the load point photocell.
- The end-of-tape marker (25 feet from the end of tape) reflects light to the tape indicate photocell.
- A tape cleaner blade within the photosense block removes particles of dust and loose oxide from the tape surface.

Vacuum Column Switches

- Vacuum switches are connected to each column to indicate the presence of tape in the column.

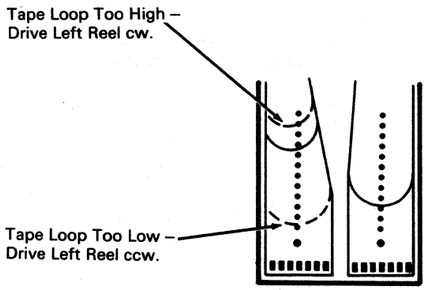
Vacuum Ports

- Each vacuum column has a vacuum port through which air is exhausted from the column by a vacuum pump.
- The vacuum pump runs whenever the tape unit is loaded (tape is in the columns) or is in the process of loading.

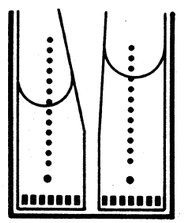
Reel Motor Control/Capacitive Sense

Tape Loop Positioning

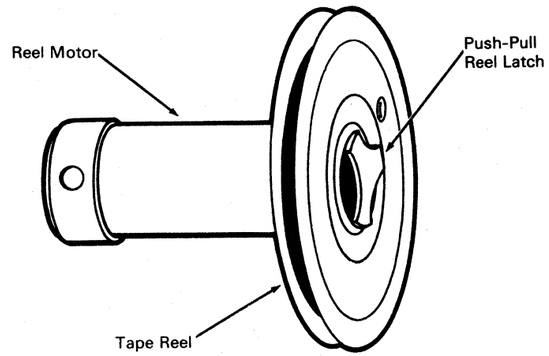
The position of the tape loop in the vacuum column is sensed through a series of small holes in the rear wall of the column. For each direction of tape movement, there is an optimum, or null, position for the tape loops within the column. When a loop drops below, or rises above this position, the corresponding reel drive circuit is activated. The power applied to the motor is in proportion to the distance of the tape loop from its null position.



Null Position of Tape Loops in Forward Status



Null Position of Tape Loops in Backward Status



Reel Motor

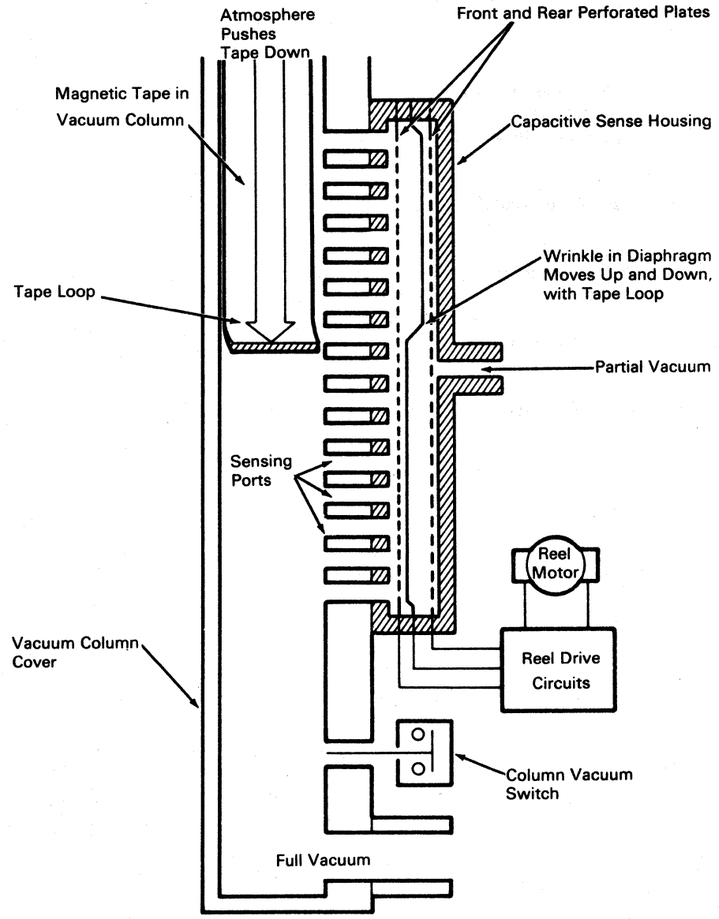
Separate reversible dc motors drive each tape reel. When tape is moved by the capstan, the reel motors rotate the reels to feed and take up tape; but they allow enough slack to maintain a sensing loop in each vacuum column.

Reel drive circuits control the speed and direction of the reel motors. These circuits respond to the position of the tape loop in the vacuum column and drive the reel motor either clockwise or counterclockwise to properly locate the tape loop.

Capacitive Sense

A capacitive sense unit, attached to the back of each vacuum column, senses the position of the tape loop in the column and supplies this information to the reel drive circuits.

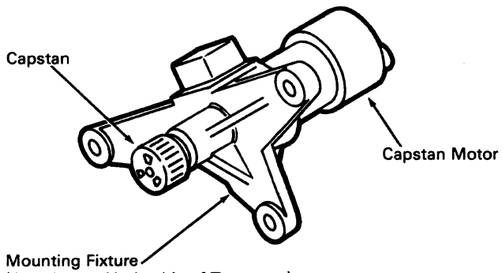
Atmospheric pressure above and vacuum below the tape loop are sensed through the small holes (sensing ports) in the rear wall of the column. The sensing ports allow vacuum to act upon a long, flexible diaphragm which is part of a capacitor whose capacitance varies as the diaphragm is shifted. For any position of the tape loop, this capacitance modulates an oscillator signal applied to the center plate. The modulated signal forms the input to the reel drive circuits, where a change in capacitance, caused by tape loop movement, is detected.



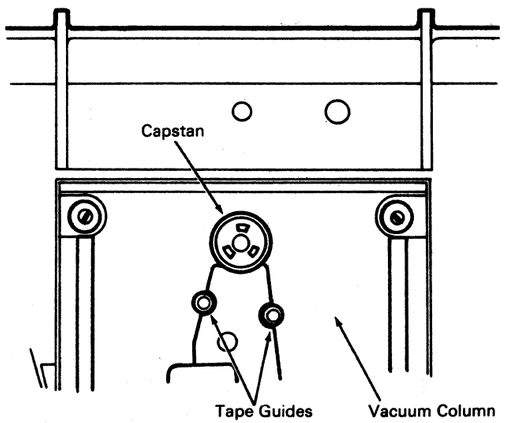
Capstan

A single tape drive capstan moves tape forward and backward. The capstan is driven by a reversible dc motor designed with high torque and low inertia characteristics for quick starts and stops.

The capstan is coated with a thin layer of rubber. Grooves are cut in the rubber coating for maximum traction on the tape surface.



In a loaded condition, the tape is held firmly against the capstan surface by the pull of vacuum on the tape loops in the vacuum columns. This tension is equal on both sides of the capstan and is constant regardless of tape loop fluctuations. This results in minimum load to the capstan motor when initially accelerating in either direction.

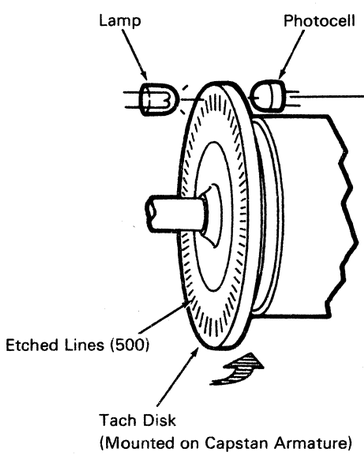


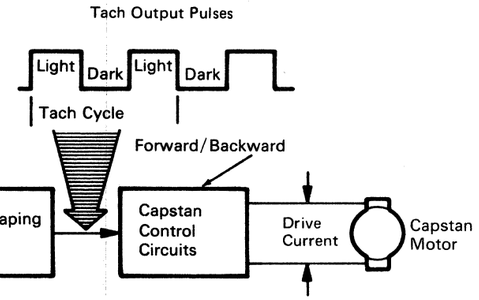
Capstan Control

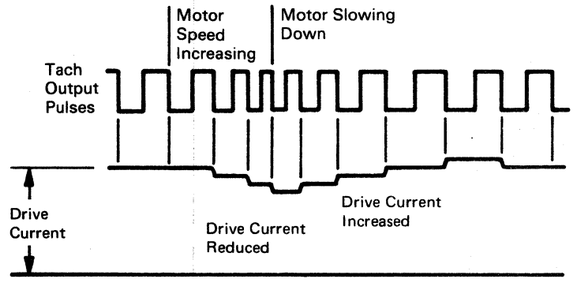
The capstan rotates when the tape control instructs the tape unit to move tape. The direction the capstan is to turn (forward/backward) also comes from the tape control. A capstan speed feedback system governs the speed at which tape is moved. A tachometer (tach) disk is attached to the capstan motor armature. As the disk turns, a beam of light from a lamp to a photocell is interrupted by a mask of darkened lines in the disk. Since these lines are equally spaced around the disk, the photocell output represents capstan speed. During tape movement, the frequency of tachometer output pulses is measured and used by the capstan control circuits to regulate capstan speed.

The capstan control circuits supply drive current to the capstan motor. The control circuits vary the current level to maintain correct capstan speed. To provide the proper current to the motor, the control circuits measure the duration of each tach cycle. If a tach cycle is long (motor running slow), the drive current is increased during the next tach cycle, causing the motor to speed up. If the tach cycle is short (motor running fast), the drive current is reduced to cause the motor to slow down. This process is repeated each tach cycle during capstan operation, with the drive current being shifted when required to maintain accurate capstan speed.

During rewind, the control circuits apply a dc current to the motor to cause continuous high speed rotation. At the beginning and end of a rewind, this current is applied and removed slowly. This allows the reel motors time to respond to the changing rate of tape movement.







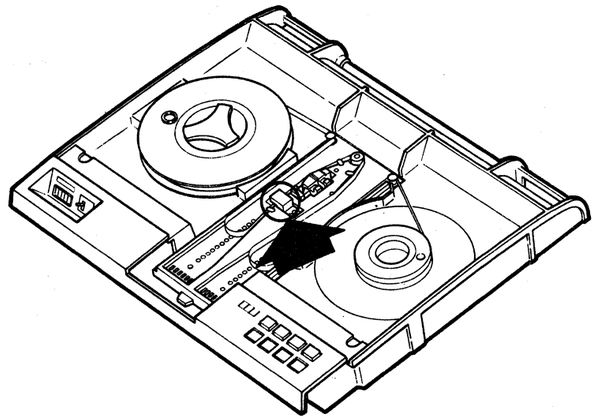
Photosensing/Tape Cleaner

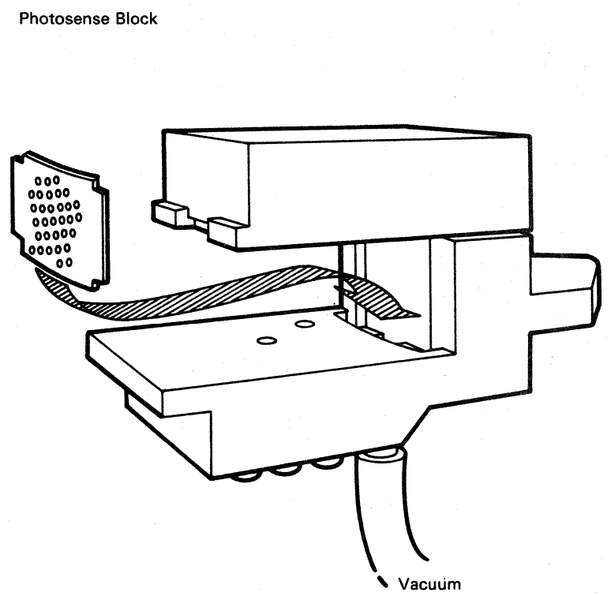
Photosense Block

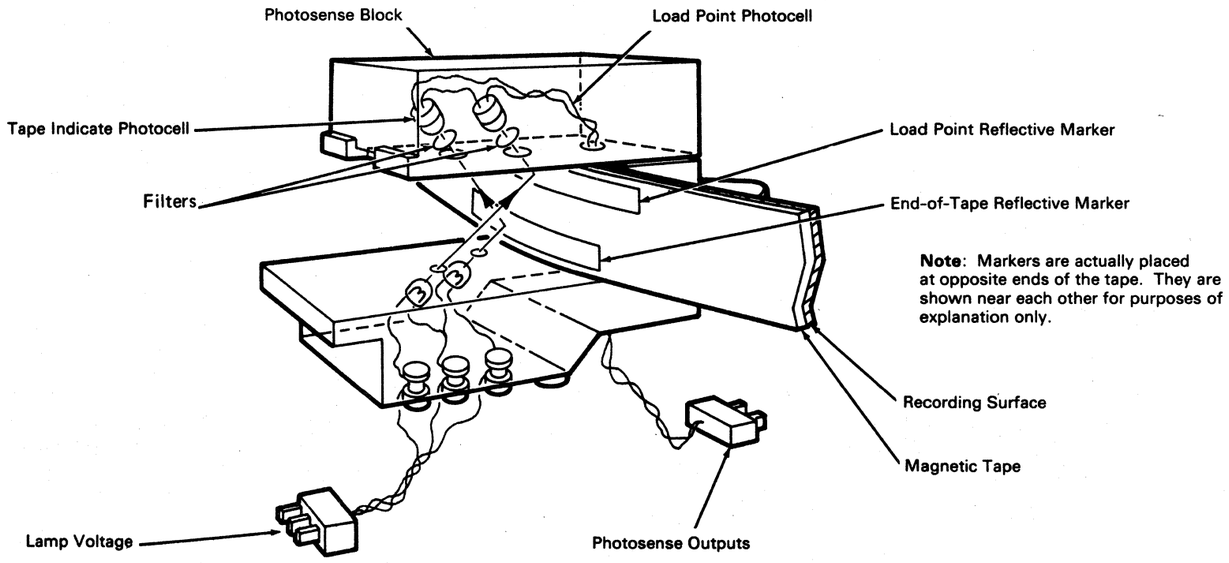
The photosense block senses the ends of tape. It is located in the left vacuum column below the read/write head.

The load point is indicated by a reflective marker (attached to the tape with adhesive) adjacent to the front edge of tape, 15 feet from the beginning of tape. When this marker passes through the photosense block, light from a lamp directed at the front edge of tape is reflected to the load point photocell. An output from the load point photocell indicates that the beginning of tape has been reached.

The end of tape is indicated by a reflective marker adjacent to the back edge of tape, 25 feet from the end of tape. When this marker passes through the photosense block, light from a lamp directed at the back edge of tape is reflected to the tape indicate photocell. An output from the tape indicate photocell indicates that the end of tape has been reached.







Note: Markers are actually placed at opposite ends of the tape. They are shown near each other for purposes of explanation only.

Tape Cleaner Blade

The blade is perforated with small holes. As tape moves across the surface of the blade, the edges of these holes scrape loose oxide and other particles from the tape recording surface.

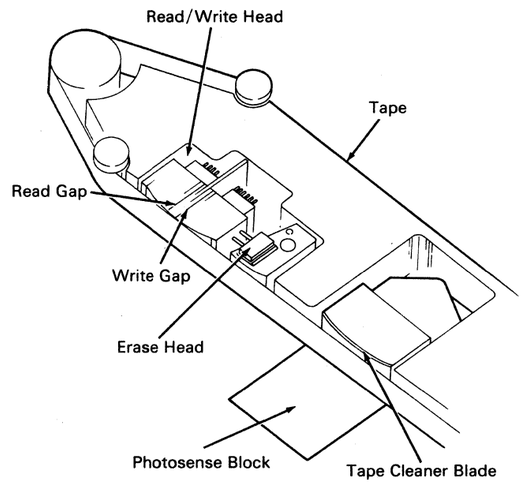
Vacuum is present behind the cleaner blade to attract the tape to the blade surface and to carry off whatever debris is removed by the blade.

Erase Head/File Protect

Erase Head

The erase head is located between the photosense block and the read/write head. During write or erase operations, dc current is passed through the windings of the erase head to erase the entire width of tape.

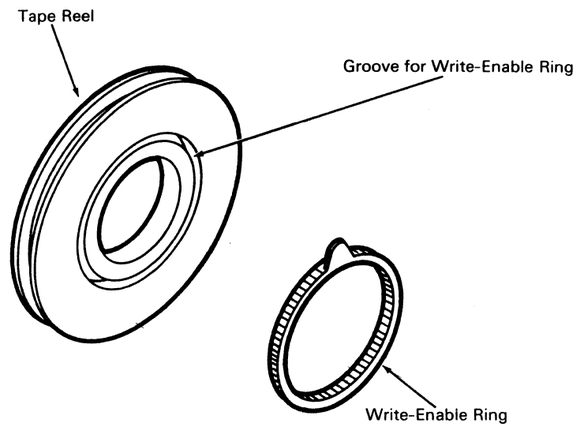
Tape passes the erase head before passing over the write gap. In a write operation, the erase head generates a magnetic field which saturates the tape to magnetic zero as it passes. New information is then written at the write gap.

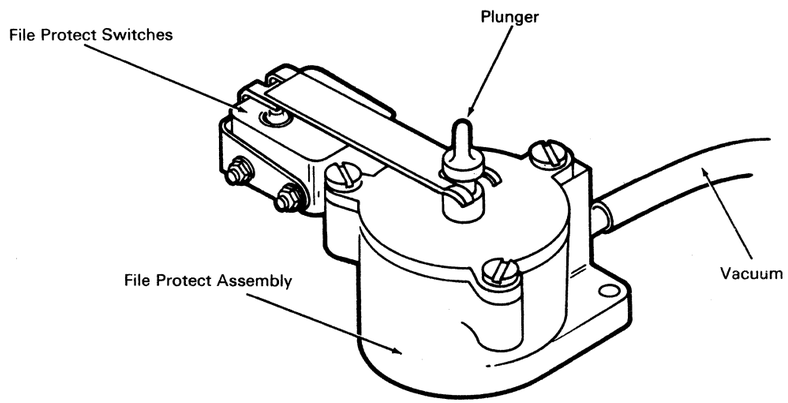


File Protect Assembly

The back of all tape reels has a groove that accepts a write-enable ring. Mounting a reel with this ring installed partially displaces the file protect plunger. Partial transfer of the plunger causes vacuum to further displace and hold the plunger. As the plunger is pushed by the write-enable ring into the file protect assembly, two file protect switches are closed. Closing these switches allows the erase head and write circuits to be activated when write status is enabled. When vacuum is up, the plunger is pulled away from the write-enable ring.

When no reel is mounted, or when a reel is mounted without a write-enable ring, the file protect plunger remains extended and writing cannot take place.





Read/Write Package

The read/write package consists of a read/write head, a read/write circuit board, and an erase head.

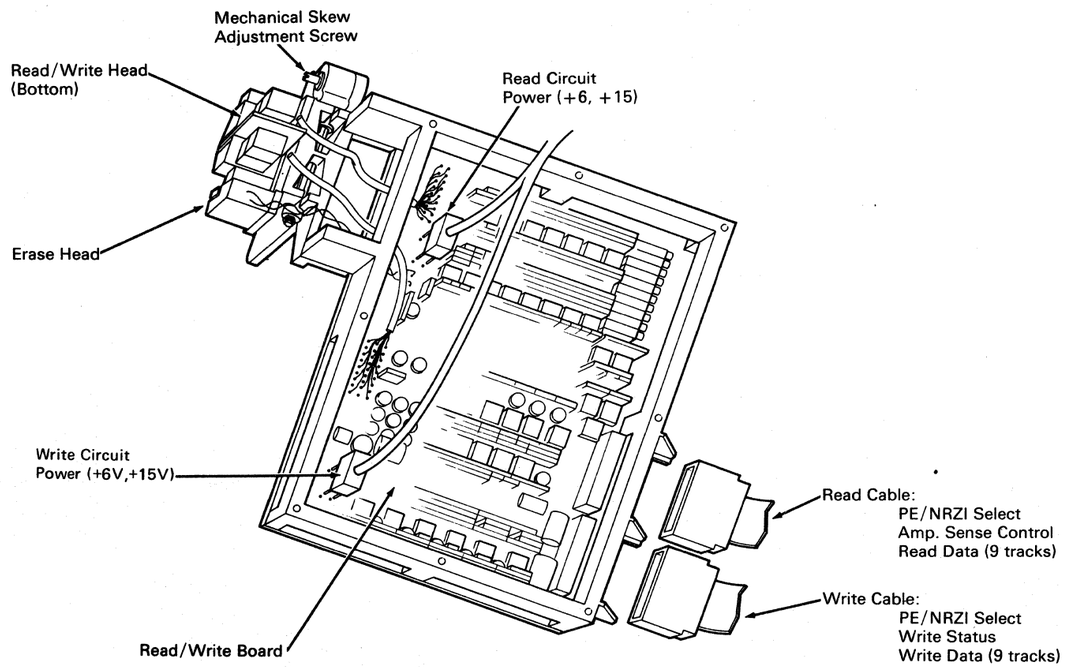
Read/Write Head

The read/write head contains a write section and a read section. The write section is composed of nine individual write heads which record nine parallel tracks of information. Write current is supplied to the write heads by circuits on the read/write board.

The read section has nine individual read heads which sense information recorded on tape. The read heads provide low-amplitude signals to read circuits on the read/write board, which amplify the signal to a useable level.

Read/Write Board

The read/write board contains the read/write circuits. The read circuits are separate from the write circuits and each functions independently of the other. Each track in the read/write head has one set of read, and one set of write circuits.



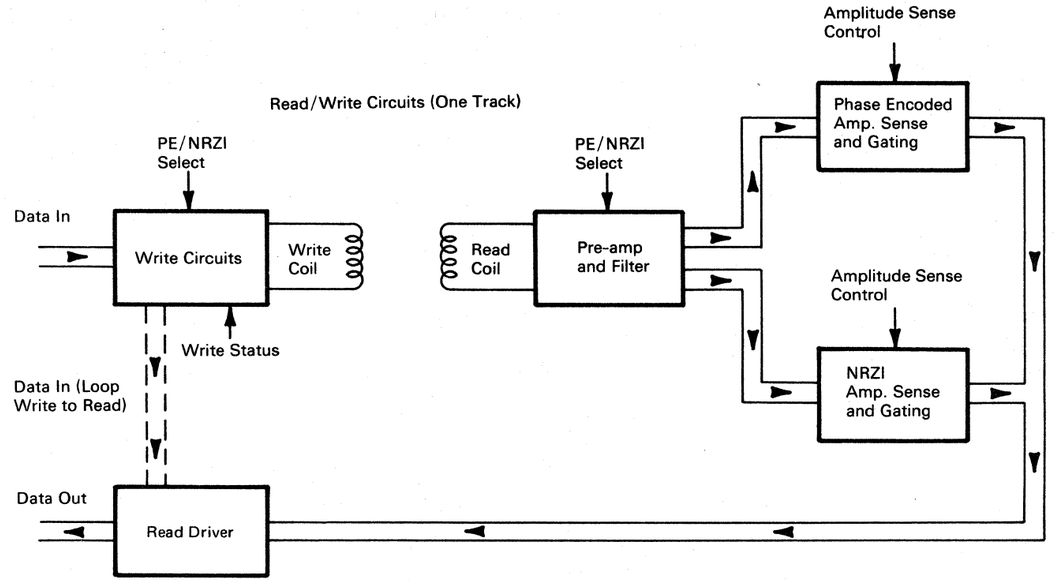
The circuits for each track are adjusted at the factory to match the characteristics of the individual read or write heads. For this reason, the read/write head and read/write board are considered one unit, and must be removed or replaced as a unit.

Erase Head

The erase head is mounted on the support bracket for the read/write head. In a write operation, tape passes the erase head, and is erased, just before passing the write head, where new information is recorded.

Read/Write Head Alignment

The read/write head must be physically aligned so that all bytes are written in a straight line, perpendicular to the edge of tape. The mechanical skew adjustment screw shifts the position of the read/write head to achieve this alignment.



Read/Write Circuits

Write

Write data enters the write circuits in digital form. The write circuits, when conditioned by the write status line, convert the input data into a waveshape suitable for driving the write coils.

Recording in NRZI mode uses higher write current than recording in Phase Encoded mode. The current to the write coils is determined in the write circuits by the status of the PE/NRZI Select line.

Read

The read circuits receive input signals from the read head coils in the form of low amplitude sinusoidal pulses. The pre-amp and filter circuit removes unwanted noise and amplifies the read signal. The signal is passed to an amplitude sense and gating stage where the amplitude of the read signal is sensed. Only signals of a predetermined amplitude are gated beyond this stage. The gated signal is again amplified, converted to square wave form, and passed to the read drivers. These drivers send data over the read cable to the tape unit logic board for PE and to the deskew board for NRZI.

The read signal produced in reading NRZI data is of a higher amplitude and at a different frequency than that produced reading Phase Encoded data. For this reason, separate amplitude sense and gating circuits are used for the two modes. The read signal is routed to the proper circuit by the PE/NRZI Select line at the pre-amp and filter circuit.

Amplitude Sense Control

The amplitude threshold used to gate the read signal is controlled by the tape control. Amplitude sense control signals enter the read circuits over the read cable, and are used to set the threshold to one of several levels.

During a write operation, the threshold is always at a higher level than during a read operation. This causes the readback check (reading freshly written data during a write operation for validity checking) to be more stringent, resulting in confidence that the written data may be read at a later date.

Loop Write-to-Read (LWR)

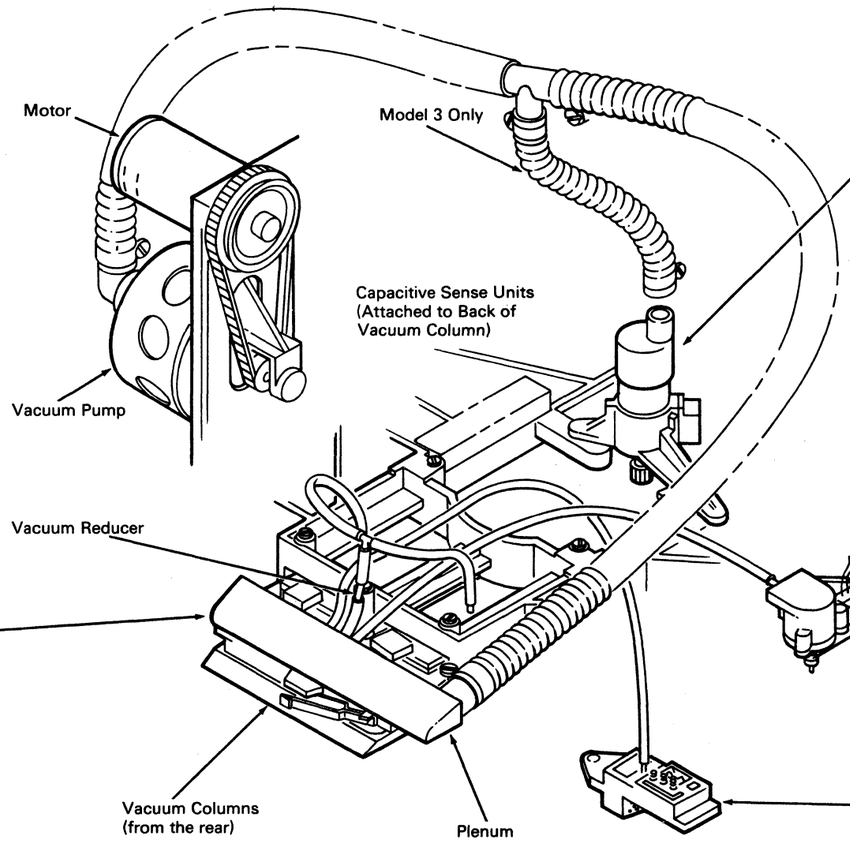
To assist in isolating read or write failures in the field, the LWR function is provided. LWR is under diagnostic program control and causes write data to be looped through the read drivers and returned to the system through the normal read process. A LWR operation simulates a normal write (with readback check) without actually recording information on tape by bypassing the bulk of the read/write circuits.

Vacuum System

Vacuum Pump And Motor

The vacuum pump consists of a centrifugal blower which is belt-driven by a motor. Air is drawn into the center of the blower and exhausted.

The vacuum pump supplies vacuum whenever the drive motor is running. The motor operates on 208 volts ac (single phase) and is energized whenever the tape unit is loaded or is in the process of loading. The motor is turned off at the beginning of the unload operation.



Vacuum Columns And Capacitive Sense

Vacuum is supplied to the vacuum columns and capacitive sense units through a plenum located at the bottom rear of the vacuum columns. During operation, when rapid tape motion occurs in the vacuum column, the plenum reduces fluctuation of the vacuum level within the columns.

A vacuum reducer is installed between the plenum and capacitive sense assemblies so that only partial vacuum is supplied to these units.

Capstan Motor

On the 3410/3411 Model 3, vacuum is supplied to the capstan motor to prevent the accumulation of dust or brush-wear particles around the tachometer assembly.

File Protect Mechanism

When a tape reel with a write-enable ring installed is placed on the left reel hub, a plunger on the file protect mechanism is depressed by the ring. Depression of the plunger closes a vacuum chamber within the assembly and when the drive is loaded, the plunger is further retracted and held by vacuum.

Tape Cleaner Assembly

Vacuum is supplied to the tape cleaner assembly to attract the tape to the cleaner blade surface and to exhaust debris as it is removed from tape.

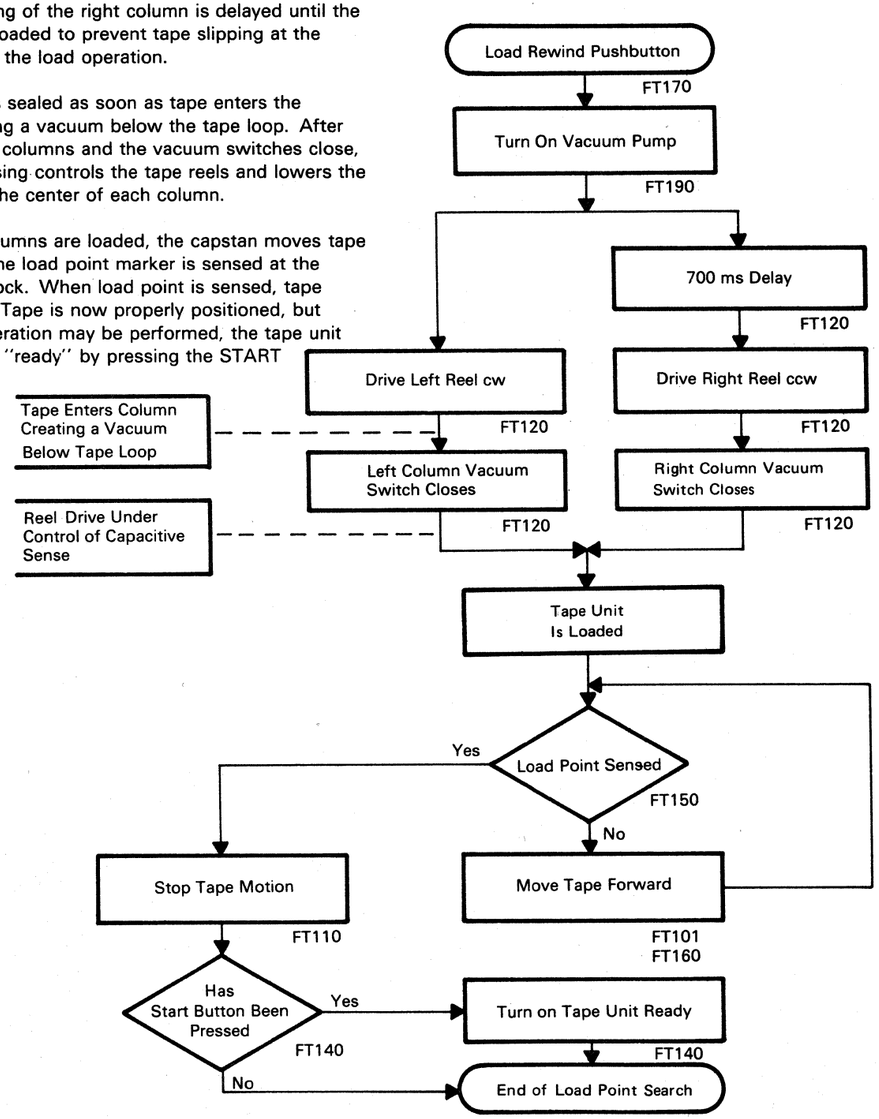
Load/Unload Operation

Load Operation

After you thread tape over the top of the vacuum columns, press the LOAD REWIND pushbutton and the vacuum pump starts. The left reel lowers tape into the left column, then the right reel lowers tape into the right column. Loading of the right column is delayed until the left column is loaded to prevent tape slipping at the capstan during the load operation.

Each column is sealed as soon as tape enters the column, creating a vacuum below the tape loop. After tape is in both columns and the vacuum switches close, capacitive sensing controls the tape reels and lowers the tape loops to the center of each column.

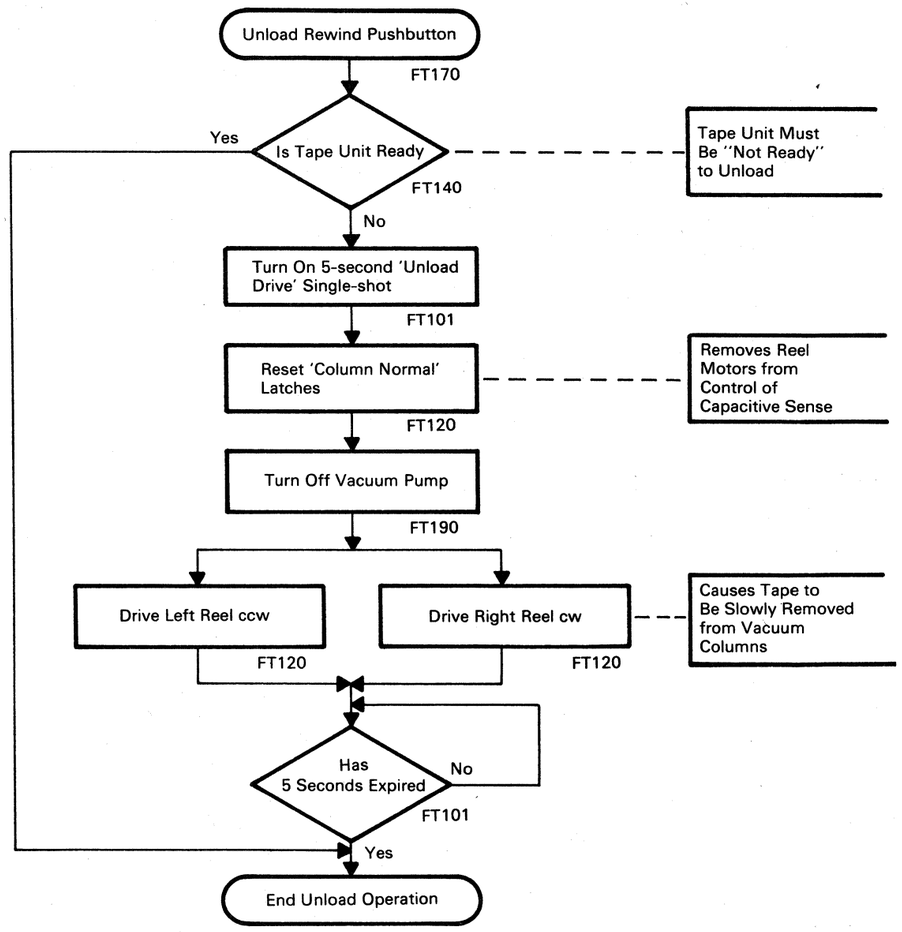
When both columns are loaded, the capstan moves tape forward until the load point marker is sensed at the photosense block. When load point is sensed, tape motion stops. Tape is now properly positioned, but before any operation may be performed, the tape unit must be made "ready" by pressing the START pushbutton.



Unload Operation

Press the RESET pushbutton to make the tape unit "not ready." Then press the UNLOAD/REWIND pushbutton, firing the 5-second Unload Drive single-shot. During the time-out of this single-shot, the Column A Normal and Column B Normal latches are reset, which disconnects the reel drive circuits from capacitive sense control. The vacuum pump turns off and the reels rotate slowly to remove tape from the vacuum columns.

After five seconds, the Unload Drive single-shot times out, drive voltage to the reel motors drops, and the unload operation is complete.



Rewind/Rewind Unload

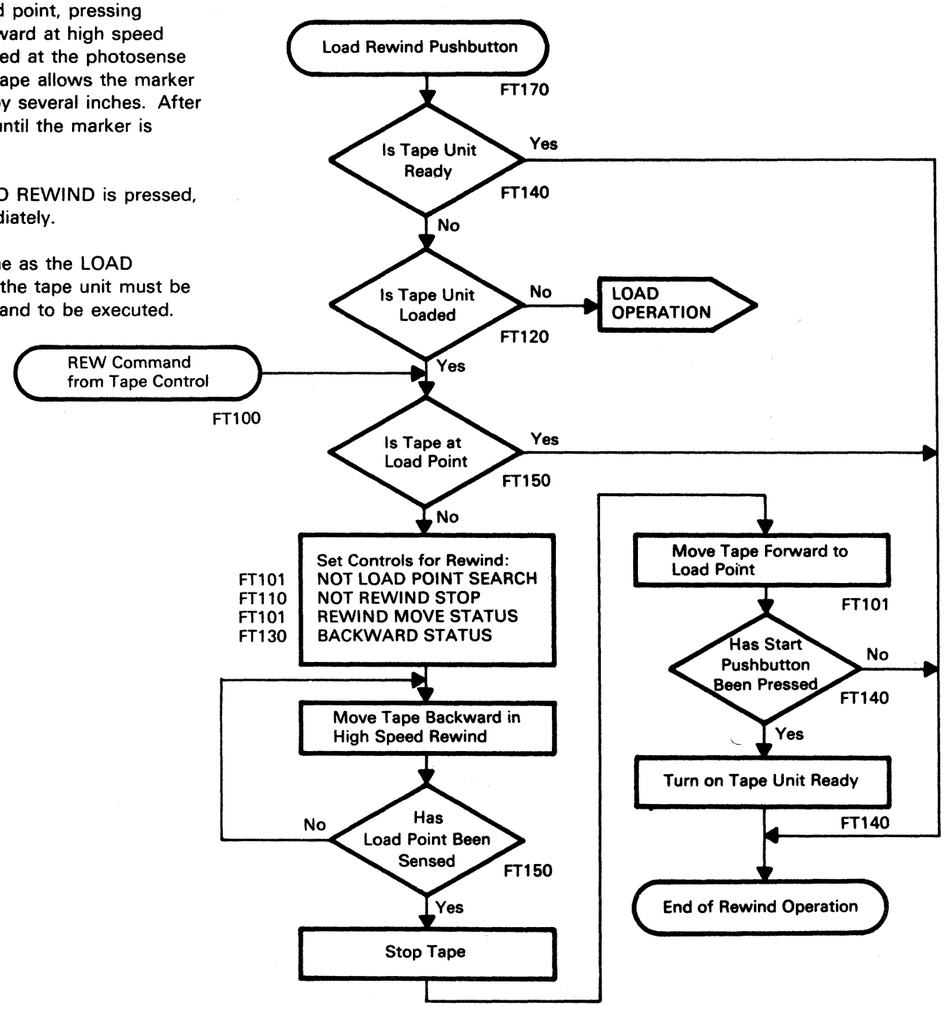
Rewind Operation

The LOAD REWIND pushbutton, or a Rewind (REW) command from the tape control, initiates a rewind operation. The LOAD REWIND pushbutton is active only when the tape unit is "not ready."

If the tape unit is not loaded when LOAD REWIND is pressed, a normal load operation will result, ending with tape properly positioned at load point. If the tape unit is loaded and tape is away from load point, pressing LOAD REWIND moves tape backward at high speed until the load point marker is sensed at the photosense block. The time required to stop tape allows the marker to overrun the photosense block by several inches. After stopping, tape is moved forward until the marker is again sensed.

If tape is at load point when LOAD REWIND is pressed, the operation will terminate immediately.

The REW command does the same as the LOAD REWIND pushbutton, except that the tape unit must be loaded and "ready" for the command to be executed.



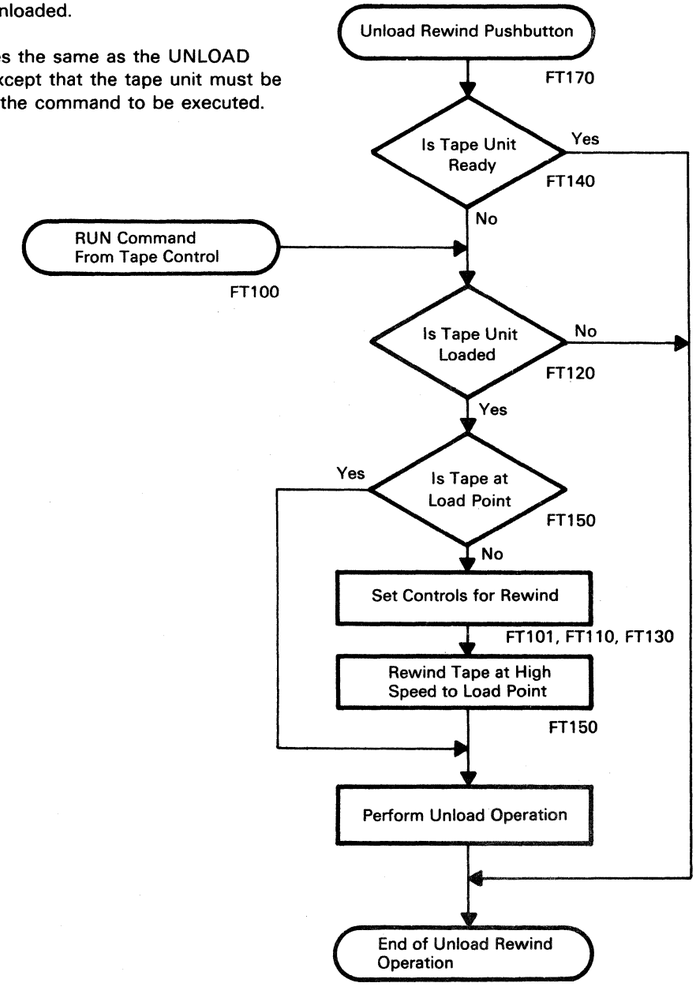
Rewind Unload Operation

The UNLOAD REWIND pushbutton, or a Rewind Unload (RUN) command from the tape control, initiates a rewind unload operation. The UNLOAD REWIND pushbutton is active only when the tape unit is "not ready."

If tape is at load point when UNLOAD REWIND is pressed, a normal unload operation results.

If away from load point, tape rewinds at high speed to load point and is then unloaded.

The RUN command does the same as the UNLOAD REWIND pushbutton, except that the tape unit must be loaded and "ready" for the command to be executed.



Tape Unit Sense

Tape unit status is sampled periodically by the tape control. Each tape unit provides this information in three sense bytes. These are tape unit sense bytes 0,1, and 2, which are requested one at a time by the tape control. Each byte is sent from the tape unit on the TAPE UNIT BUS IN lines.

The tape control places the tape unit sense information into the subsystem sense data format, to be sent to the host system following a Sense instruction.

Included with normal status information in the tape unit sense data, are indicators of any abnormal condition which is internally detected in the tape unit.

CROSS-REFERENCE OF TAPE UNIT SENSE BYTES AND CORRESPONDING SUBSYSTEM SENSE BYTES

Tape Unit Sense Byte	Subsystem Sense Byte System/3	Subsystem Sense Byte System/360/370
0	2	*
1	4	6
2	6	7

* Because of programming requirements of System/360/370, information contained in Tape Unit Sense Byte 0 is spread over several subsystem sense bytes.

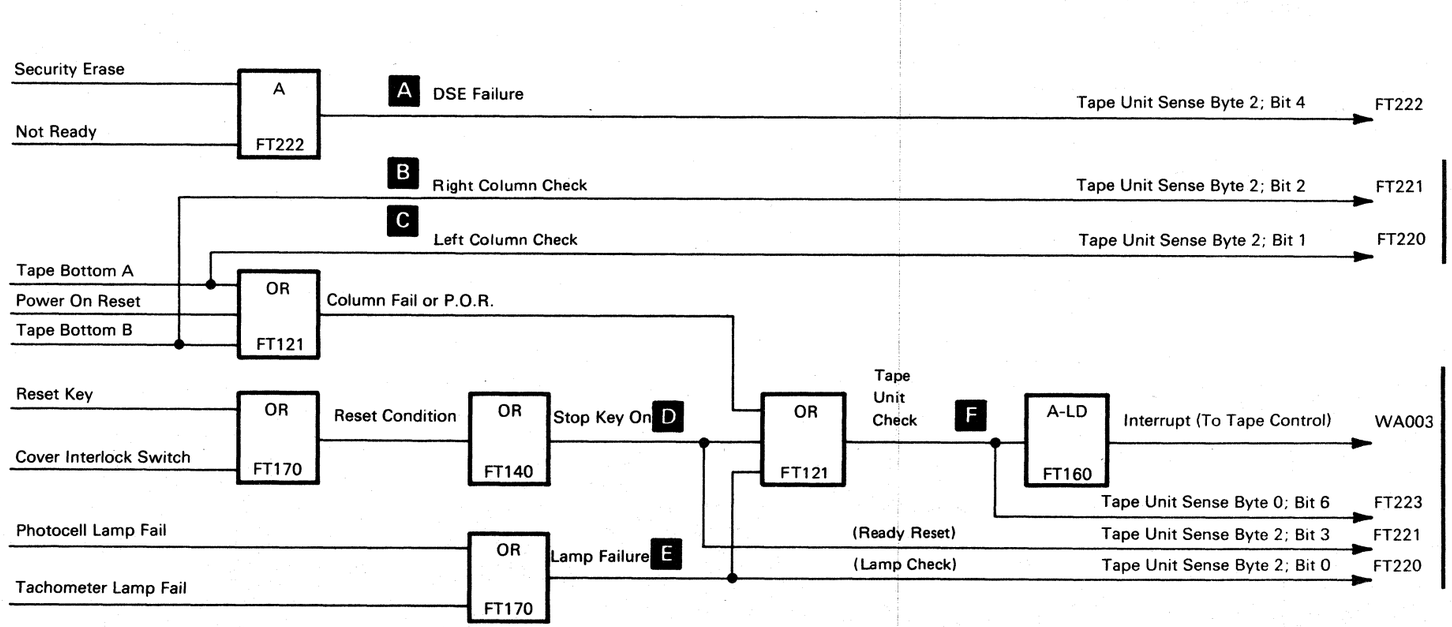
CROSS-REFERENCE OF TAPE UNIT SENSE BYTE 0 AND CORRESPONDING SUBSYSTEM SENSE DATA (360/370)

Tape Unit Sense Byte 0	Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
Corresponding Location in Subsystem Sense/Data (System/360/370)	Byte 3 Bit 6	Byte 1 Bit 6 *	Byte 4 Bit 2	Byte 1 Bit 4	Byte 1 Bit 5	Byte 1 Bits 1 and 2	Byte 4 Bit 6	Byte 1 Bits 1 and 2

* Inverted from NOT FILE PROTECTED in tape unit sense data to FILE PROTECTED in 360/370 subsystem sense data.

TAPE UNIT ABNORMAL CONDITIONS

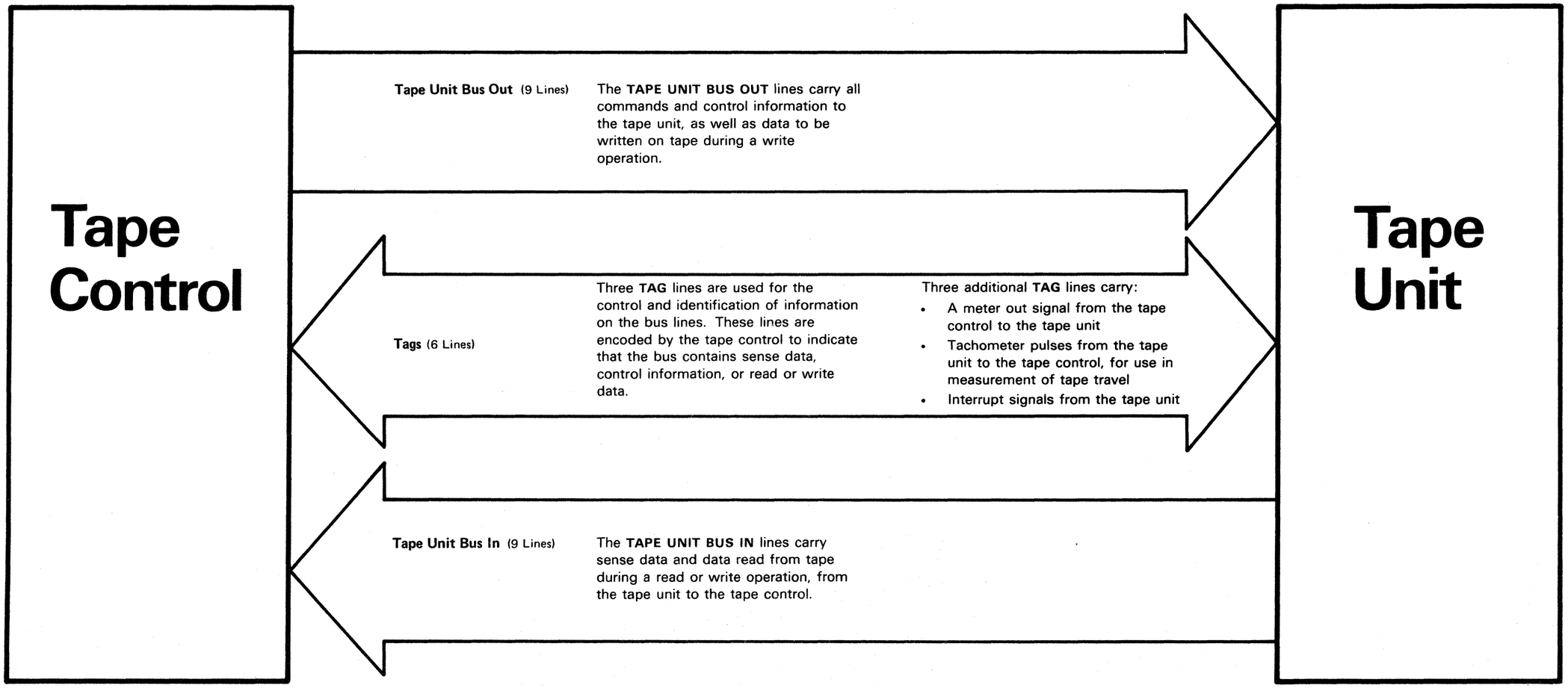
	Symptom	Location in Tape Unit Sense Data	Cause
A	DSE Failure	Sense Byte 2, Bit 4	The selected tape unit is not ready while attempting a Data Security Erase operation.
B	Right Column Check	Sense Byte 2, Bit 2	Loss of vacuum in the right vacuum column (column B) has been sensed. The tape loop has bottomed in the right column, allowing the column vacuum switch to open.
C	Left Column Check	Sense Byte 2, Bit 1	Loss of vacuum in the left vacuum column (column A) has been sensed. The tape loop has bottomed in the left column, allowing the column vacuum switch to open.
D	Stop Key On	Sense Byte 2, Bit 3	Either the Reset key has been pressed, or the cover interlock switch has opened.
E	Lamp Check	Sense Byte 2, Bit 0	The filament of the EOT, the BOT, or the tachometer lamp is open.
F	Tape Unit Check	Sense Byte 0, Bit 6	Set when: 1. Tape has bottomed in either vacuum column. 2. A load failure occurs. 3. Power on reset is received. 4. The Reset key is pressed. 5. The cover interlock switch is opened. 6. A photosensing lamp is open.



Tape Control/Tape Unit Interface

The tape control/tape unit interface is the communication link between the tape control and the various tape units attached. Twenty-four signal lines are provided for this communication. Nine **TAPE UNIT BUS OUT** lines carry information from tape control to tape unit. Nine **TAPE UNIT BUS IN** lines carry information from tape unit to tape control. Both sets of bus lines include a parity line to allow validity checking of the information transmitted over the interface.

The interface is multiplexed, meaning that a set of bus lines is used to carry several types of information. Three **TAG** lines are encoded by the tape control to identify the type of information on the bus lines. Three other tag lines carry specific information such as clock and tachometer signals.



Tape Control

Introduction

The tape control operates under control of the microprogram. A command from the system initiates a tape operation, and the microprogram controls the sequence of events until the operation is completed.

The tape control functional units discussed in this section are directly controlled by the microprogram, except the clock and ROS.

Clock

The clock provides basic timing for the tape control and synchronizes the hardware circuits with the microprogram. It consists of eight stages of PH circuits, driven by a free-running, 20.48 MHz oscillator. The basic pulse duration of the oscillator is 25 nanoseconds. The eight stages of the clock feed AND-OR combinations to generate the necessary pulses for either a 150 nanosecond (short) or 200 nanosecond (long) instruction cycle. A cycle is the amount of time needed to execute one microprogram instruction.

Instruction Counter (IC)

The IC contains an address which selects the proper instruction (ROS word) to control operation during one cycle. The address is updated each instruction cycle. Normally, the look-ahead circuit increments the address by one each cycle, but three microprogram instructions can replace a part or all of the address with a new value. This gives the microprogram control over IC, and its own sequence of operation.

Read Only Storage (ROS)

The ROS unit contains the permanently stored microprogram which controls tape control operation. The storage locations (ROS words) in ROS are 16 bits long. Any one of the locations can be selected and the contents put in the ROS Register where they remain for one instruction cycle. The ROS Register distributes the ROS word to the control and data flow circuits. At the end of the cycle a new ROS word replaces the current one, to execute the next instruction in the sequence.

Local Storage Registers (LSR)

During each cycle, if directed by the microprogram, data can be written into or read out of LSR. During logical operations, Field 1 of the ROS word and a Hi/Lo Select latch are used to address one of 32 storage locations. During Store and Transfer operations, bit 3 and Field 1 address one of 32 locations.

The D Bus is the LSR input bus. It may contain output data from the ALU, read data from the tape unit, or input data from the ABO. When directed by the instruction, the data on the D Bus is stored in the LSR location addressed by Field 1 of the ROS word.

The B Bus is the LSR output bus. When the ROS word requires data from an LSR, the contents of the location addressed by Field 1 of the ROS word are placed on the B Bus. From the B Bus, the data is gated to the system, to the tape unit, into the A Register, or is used as an input to ALU. The ROS word selects the destination.

Arithmetic Logic Unit (ALU)

The purpose of ALU is to arithmetically combine the A Bus and the B Bus inputs by using one of the logical instructions: ADD, AND, ORI, or XO. The ROS word selects the operation and addresses an LSR. The LSR is transferred to the B Bus. The A Bus contains the constant in Field 2 of the ROS word, ORed with data contained in the A Register. Any data contained in the A Register was transferred in during a previous instruction.

The output of ALU goes to the D Register and is stored in an LSR if instructed by the ROS word.

Transfer Decode

The tape control moves data or changes the status of certain hardware by a Transfer instruction. The Transfer-Decode circuits receive Field 2 of the Transfer instruction to determine which of 24 transfer operations to execute.

Branch Test

The tape control tests one of 31 different conditions (hardware status) when it encounters a Branch on Condition instruction.

The Branch-Test circuits decode bits 3-7 of the instruction to determine which of the 31 conditions to test for.

Skew Buffers (SKB)

The Skew Buffers receive the data from tape and pass it on to the D Register to be stored in LSR by the microprogram.

Examples of Operations (See Tape Control Data Flow Diagram)

All the functional units work together, under control of the microprogram to execute an operation. Some microprogram instructions cause operations within the tape control while others cause the transfer of data or control information to the system or tape unit.

Add

An example of an operation within the tape control is an ADD instruction. Bits 0-3 contain the Op code, bits 4-7 contain the address of the LSR, and bits 8-15 contain the constant to be added.

1. The LSR addressed in bits 4-7 is transferred to the B Bus.
2. The constant (ROS 8-15) is ORed with the contents of the A Register and placed on the A Bus (the A Register contains zeros unless it was loaded by a XFR instruction since the last logical operation).
3. The ALU arithmetically adds the A Bus and B Bus.
4. The sum is transferred to the D Register where it remains until the next logical, Transfer to LSR, or store operation.
5. If the instruction is not a modified ADD (bit 3 is off) the sum of the inputs is written into the LSR addressed by ROS word 4-7. If the ADD is modified (bit 3 is on), the sum is not written in LSR, but remains in the D Register and on the D Bus.

Transfer (XFR)

An example of an instruction which transfers data from subsystem to system is a XFR to Attachment Bus In (ABI). The ROS word contains a XFR op code in bits 0-2, the LSR address in bits 3-7, and the transfer code which designates the ABI in bits 8-15.

1. The LSR addressed by bits 3-7 is read onto the B Bus.
2. The B Bus is gated to the ABI.

Data on the ABI is transferred through the attachment to the system.

There is one XFR instruction, but 24 different transfer codes that can be used in bits 8-15. See the microprogram listing for a complete list of the transfer codes.

Read Data Flow

The system sends a read command. The tape control checks the status of the selected tape unit and starts it moving tape if status is good. If the tape unit is starting from load point, the tape control determines the format of the tape (PE or NRZI). PE format is indicated by a burst of P bits 4.5 inches long; NRZI by a 3 inch erased gap. The tape control sets the tape unit to the proper mode to read the tape.

The tape control checks for the first **DATA READY** indication. On a PE tape this comes after the forty all-zero bytes. On a NRZI tape the first **DATA READY** comes when the first byte is read. The microprogram transfers the byte from the Skew Buffer through the D Register to an LSR. As data ready occurs for each data byte read, the parity of the byte is checked on the D Bus before it is stored in an LSR.

Normal **SERVICE IN, SERVICE OUT** sequences accompany the transfer of each byte to the system. A XFR to ABI and a **SERVICE IN** send the byte to the attachment. A **SERVICE OUT** indicates the system accepted the byte.

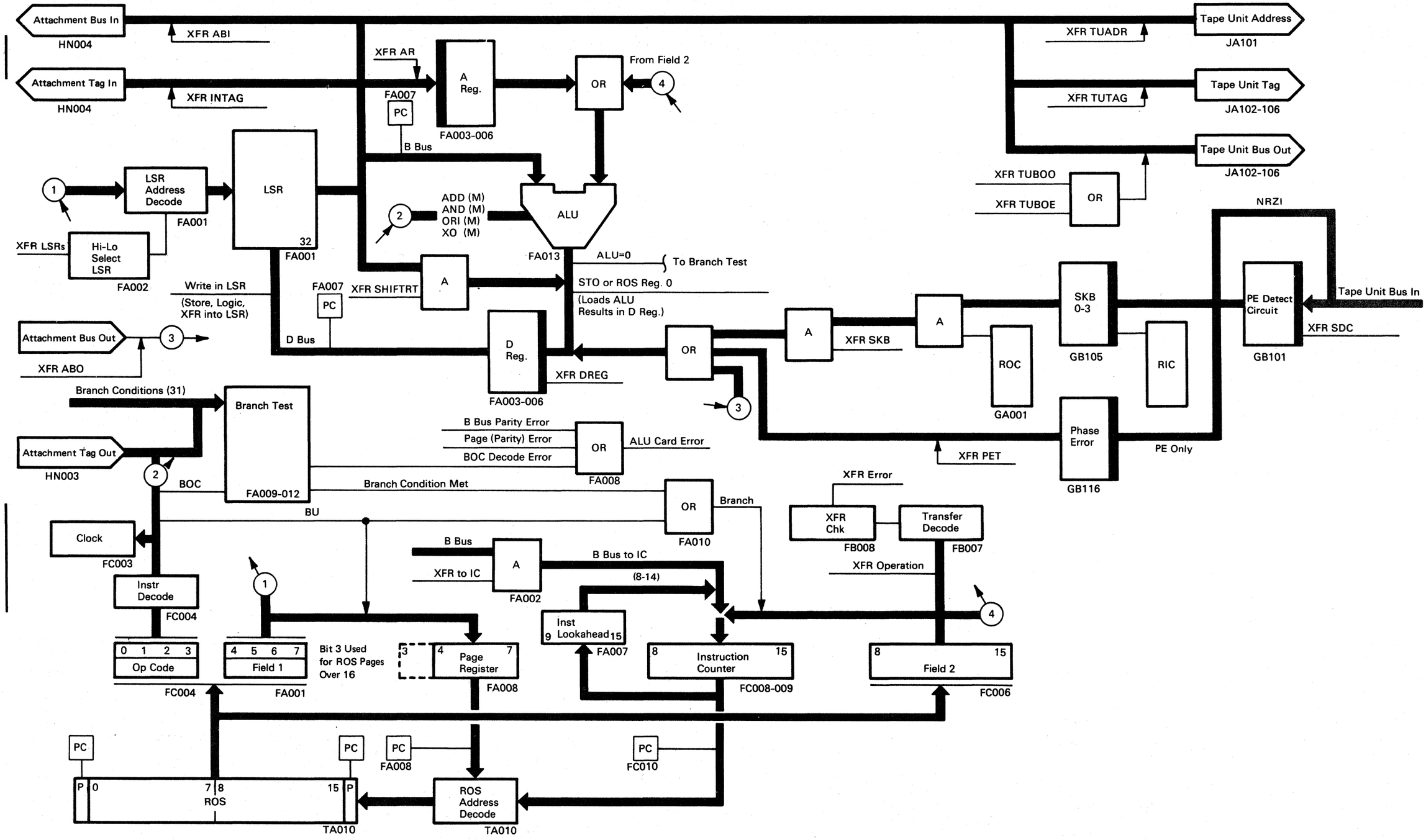
End of Data

In PE mode the tape control decodes **END OF DATA** when the tape unit reads an all-ones byte followed by two all-zero bytes.

In NRZI mode the Inter-Block Gap (IBG) signals the end of the data block.

When no more data is to be read the tape control stops the tape unit and sends status to the system.

Tape Control Data Flow



Error Checking

The internal operations of the tape control are monitored by error checking circuits (hardware) and the microprogram. When an error is detected, by hardware or microprogram, a bit is set in the Hardware Error Byte. Tape Control places the error byte on the ATTACHMENT BUS IN. The system must then execute a Sense instruction to fetch the error byte. The byte is then analyzed for diagnostic and error recovery purposes. The error byte remains on the interface until reset by the system.

Bit 7 of the Hardware Error Byte is used to distinguish between hardware detected and microprogram detected errors. If bit 7 is a zero, the error was hardware detected. If bit 7 is a one, the error was microprogram detected.

Hardware Detected Errors

When a hardware detected error occurs, all tape control operations stop and the appropriate bit is set in the Hardware Error Byte. The errors are listed in the accompanying table. Manual intervention is required to restart after an error is detected.

ERROR SUMMARY
HARDWARE-DETECTED

Error	Cause	Result
Instruction	Incorrect update of Instruction Counter by a BOC, BU, or XFR to IC instruction.	Tape Control stops all operations. Manual intervention required to restart.
Transfer Error	Incorrect decode of a Transfer (XFR) instruction code.	
ALU Card Error	1. Incorrect update of Page Register by a BU instruction. 2. More than one Branch Condition decoded on a BOC instruction. 3. B-Bus parity error.	
ROS Parity	ROS Word has bad parity.	

Microprogram Detected Errors

The microprogram continually checks for errors. Any errors detected by the microdiagnostics and during the selection sequence will stop the microprogram. A reset from the system is required to restart.

An error detected during a data operation is stored until the end of the operation and presented as sense information.

Note: Because there is no maintenance panel on the subsystem the only indication as to what the error is will come from running the diagnostic programs.

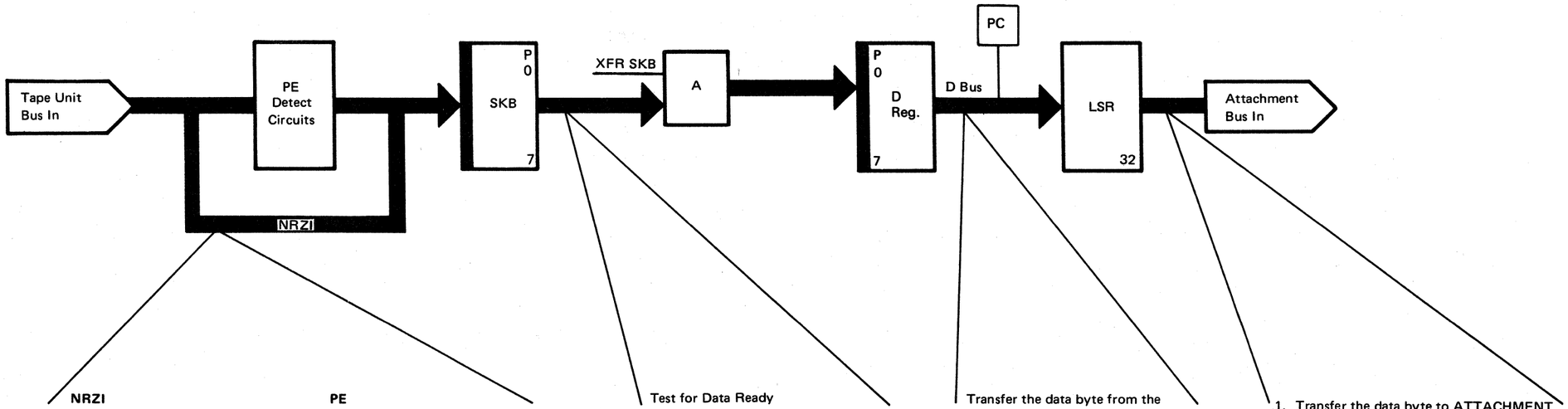
ERROR SUMMARY
MICROPROGRAM-DETECTED

Error	Cause	Result
ALU FRU Error	Internal micro-diagnostics detected an ALU failure. An AND, ORI, ADD, or XO instruction could not be executed correctly.	Microprogram hangs waiting for a Check Reset from System.
Instruction Counter Error	Internal micro-diagnostics could not update the Instruction Counter with an XFR to IC instruction.	
ABO Parity Error	Bad parity detected on Bus Out when Address Out or Command Out tags were active.	
Attachment Control Tag Error	A Control Tag (Address Out, Command Out, or Service Out) remained active after being reset by the microprogram.	
Instruction Tag Error	After the Subsystem was selected, no instruction tag (LIO, SIO, or SNS) was found active, or two tags were found active, by the microprogram.	
VRC Error*	The microprogram has detected (on the D Bus) bad parity in a data byte read from tape.	Tape operation does not stop. Errors are presented at the end of the operation.
Bus Out Check*†	Microprogram has detected (on the D Bus) bad parity in a data byte from CPU.	

* These errors do not set any bits in the Hardware Error byte.

† This error is a Channel Data Check on System/370 Model 125.

Read Data Flow (Simplified)

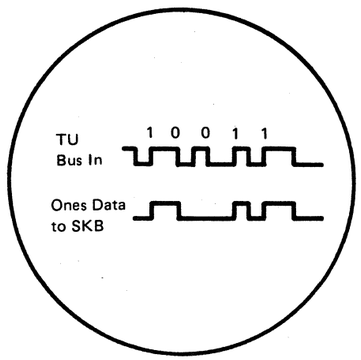


NRZI

Tape unit data is loaded in the SKB as received. Read detection is not necessary. Each flux change causes a one to be loaded into the SKB.

PE

Tape unit data is sent to the read detection and a pulse (ones data) is produced for each one bit detected. The data is gated to the Skew Buffer (SKB) by a Read In Clock (RIC). The RIC is stepped by a pulse generated in the detection circuits.



Test for Data Ready

a. If data is not ready, wait until it is.

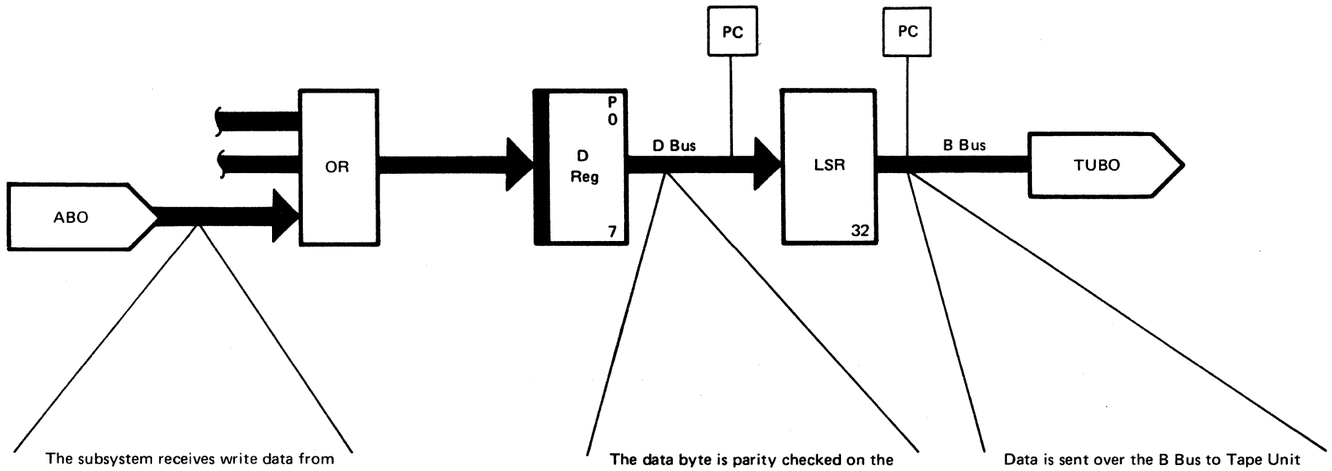
b. When data is ready, transfer it to LSR via the D Register.

Transfer the data byte from the D Register to the LSR.

Parity of the data is checked at this point.

1. Transfer the data byte to ATTACHMENT BUS IN (ABI). Activate SERVICE IN to the Attachment.
2. The Attachment responds with SERVICE OUT to accept the data byte.
3. If the Attachment does not respond, Overrun is set and the subsystem goes idle.

Write Data Flow (Simplified)



The subsystem receives write data from the attachment.

The subsystem resets SERVICE IN to acknowledge receipt of the data byte.

The data byte is parity checked on the D Bus.

a. If parity is good, the data byte is stored and the next byte requested.

b. If parity is bad, the byte is stored and the tape control sets Bus Out Check. The write operation continues.

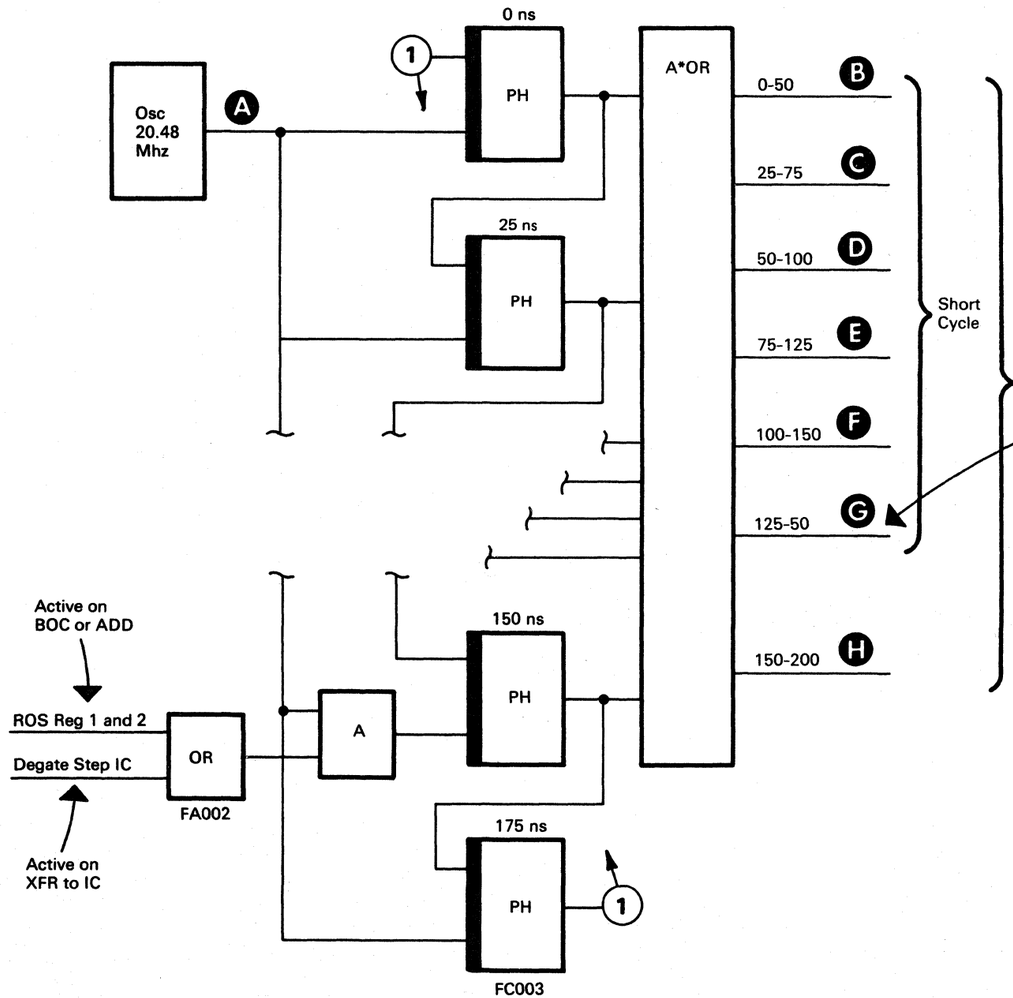
Data is sent over the B Bus to Tape Unit Bus Out.

The data is read back to verify that it has been written correctly.

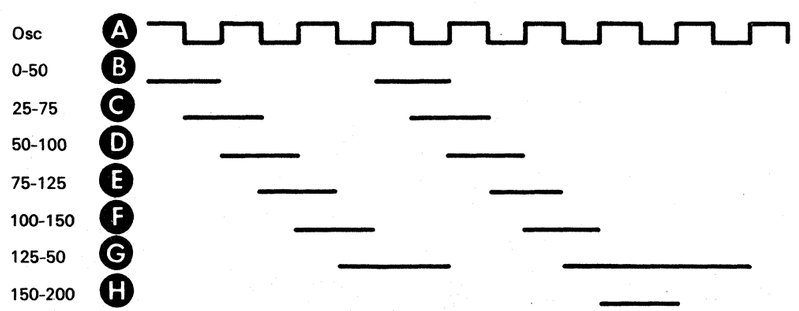
If written incorrectly, VRC error is set, but writing continues.

Eight-Stage Shift Clock

- The clock supplies timing pulses which control the operations of the tape control.
- The clock is capable of two cycle lengths (150 ns and 200 ns). All operations except BOC, ADD, and XFR to IC use a short cycle.



The 125-50 clock pulse degates the transfer of the ROS Register to the Transfer Decode circuits, and the transfer out of LSR until 50 nanoseconds after the beginning of the clock cycle. The duration of the 125-50 clock pulse is 75 nanoseconds during a short cycle and 125 nanoseconds during a long cycle.



Instruction Counter (IC)

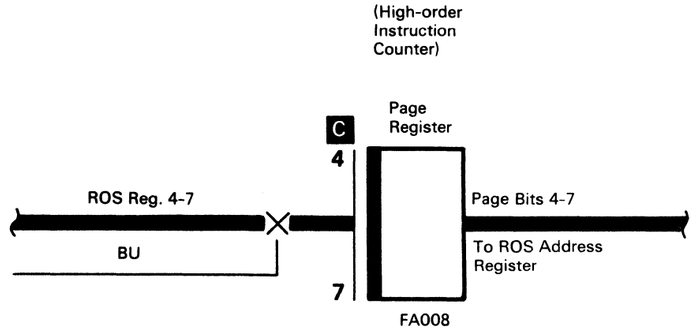
A The Instruction Counter (IC) contains the ROS address of the next program step to be executed.

If no branch or transfer (XFR to IC) instruction is decoded, IC is stepped by one (1) at the beginning of each instruction cycle.

If a branch or XFR to IC instruction is decoded, IC is reset (2) and then reloaded (3) later in the cycle.

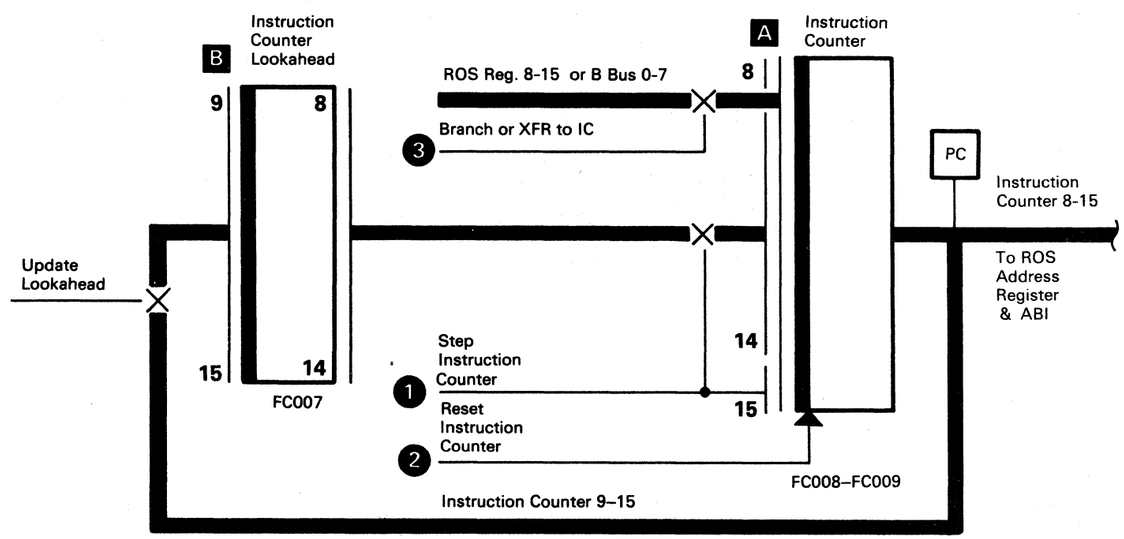
B A faster update of IC is possible by having look-ahead increment IC 9-15 during the instruction cycle. When IC is stepped, positions 8-14 are set; position 15 is complemented.

C The Page Register contains the high-order bits of the Instruction Counter. A page is a block of 256 addresses within the microprogram. The only way to change pages is by an unconditional branch instruction.



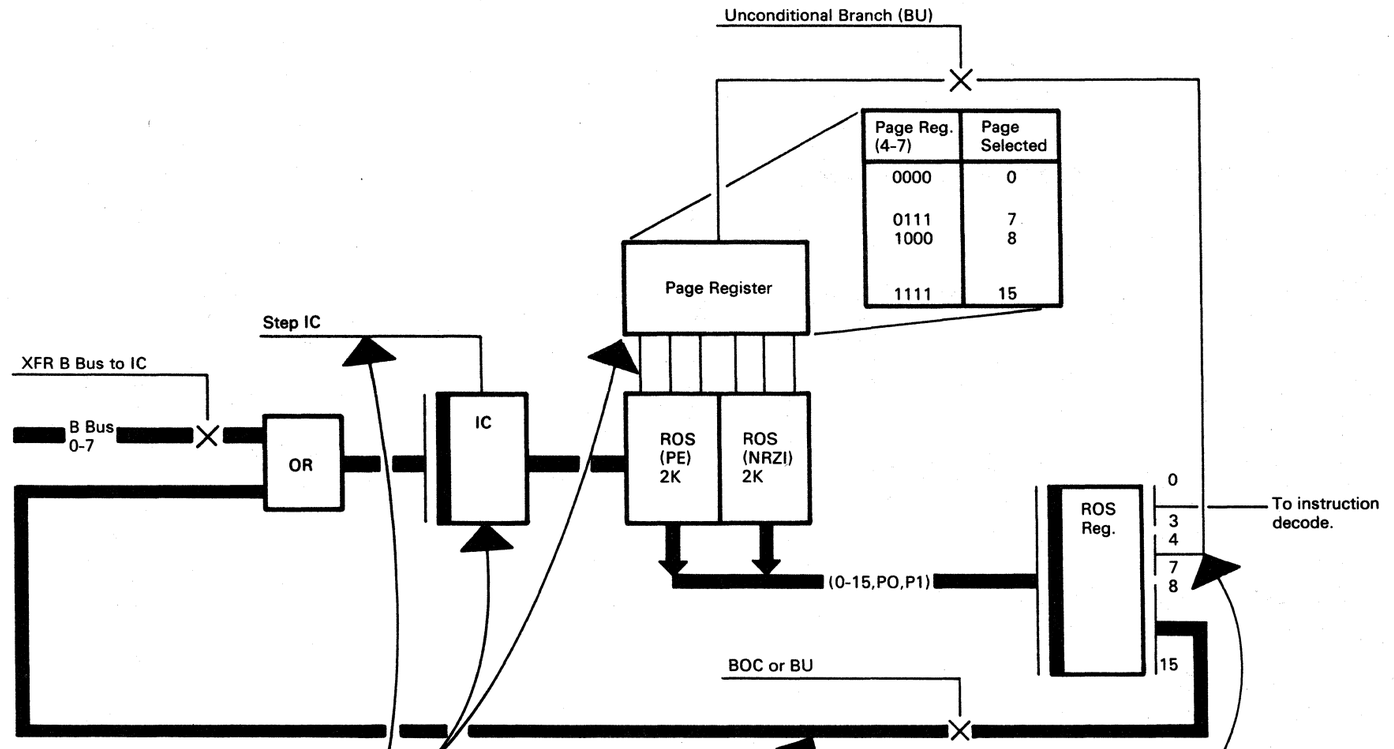
Instruction Counter Value	Instruction Counter Look-Ahead	Results in Instruction Counter
9 through 15	Step 8 through 14 Complement 15	8 through 15
1 1 1 1 1 1 1		1 0 0 0 0 0 0 0
0 1 1 1 1 1 1	Step 9 through 14 Complement 15	X 1 0 0 0 0 0 0
0 0 0 0 0 0 1	Step 14 Complement 15	X X X X X X 1 0
0 0 0 0 0 0 0		X X X X X X X 1

X = Bits that remain unchanged.



Read Only Storage (ROS)

- Read Only Storage (ROS) contains the microprogram which controls subsystem operation.
- The capacity of ROS can be up to 8K (8,192) 16-bit words. Capacity depends on system attachment and installed features.



1. The ROS word is addressed by the Instruction Counter (IC) which contains the low-order address, and a Page Register which contains the high-order address.
2. During Logical operations the IC is stepped by one for each instruction executed.
3. During BU, BOC (when condition is met), and XFR to IC instructions, the contents of IC are replaced by ROS Reg 8-15 (BU & BOC) or the B Bus (XFR).
4. The contents of the Page Register are replaced by ROS Register 4-7 only during a BU instruction.

Local Storage Registers (LSR)

- Thirty-two 1 byte registers (eight bits plus parity).
- Provides storage for control information and data.
- See microprogram listing for allocations.
- Low LSRs Registers 0-15.
- High LSRs Registers 16-31.
- Instructions affected by pre-set high/low selection: ORI, XO, AND, and ADD.
- Instructions not affected: STO, XFR, BOC, and BU.

A Transfer LSRs with bit 3 on sets a PH (FB002) to select high LSRs, while bit 3 off selects low LSRs. The affected instructions use the selected LSRs until another Transfer LSRs changes the selection. Unaffected instructions use bit 3 of their Operations Code to select high or low LSRs.

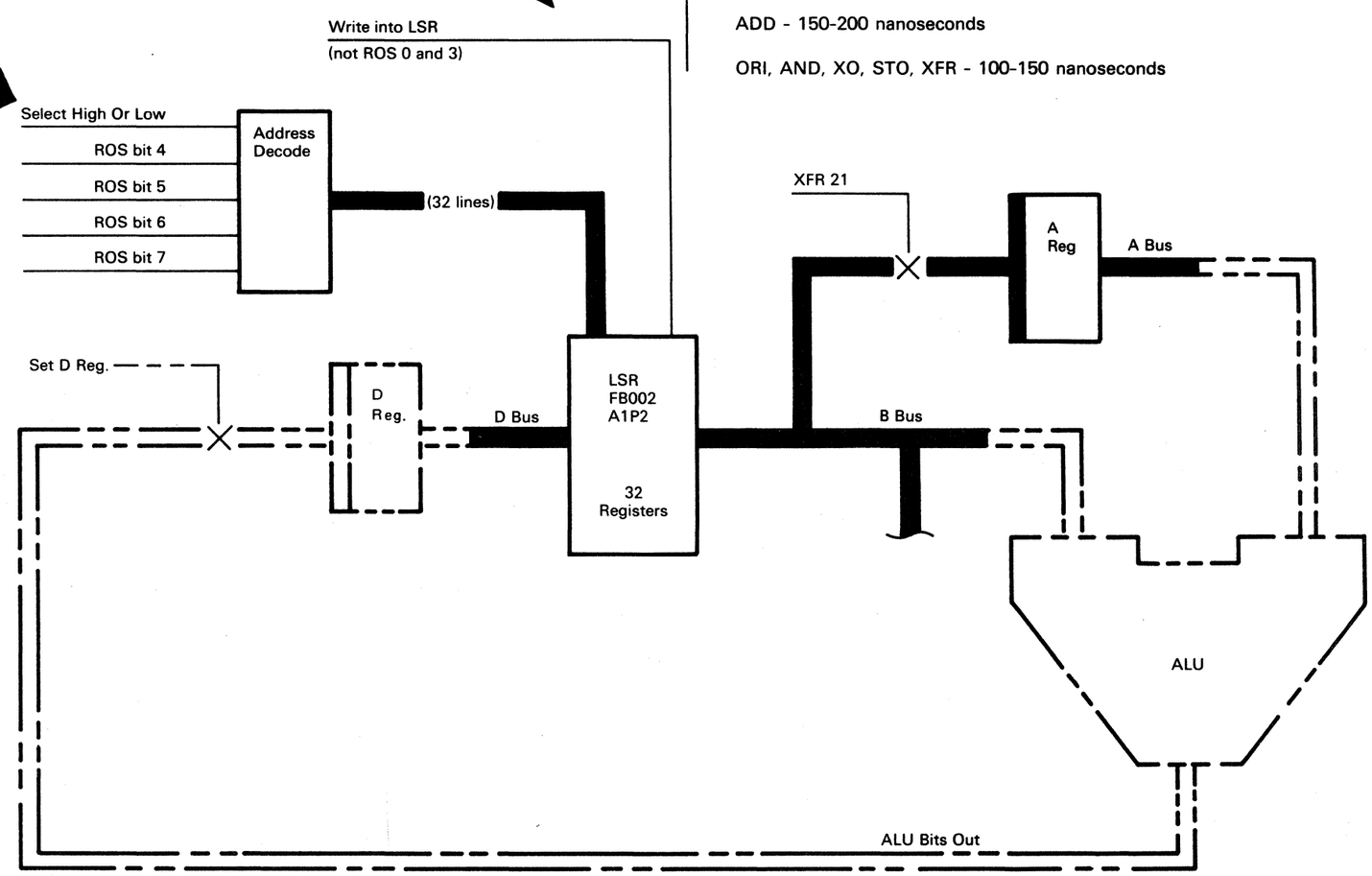
The logical operations (ORI, AND, XO, ADD) have bit zero on as part of the operations code. If the operation is of the **M** type (Modified — See ALU), bit 3 is also on, preventing Write into LSR.

Store and Transfer also write into LSR and have no bit 3 option to prevent this.

Write into LSR timing:

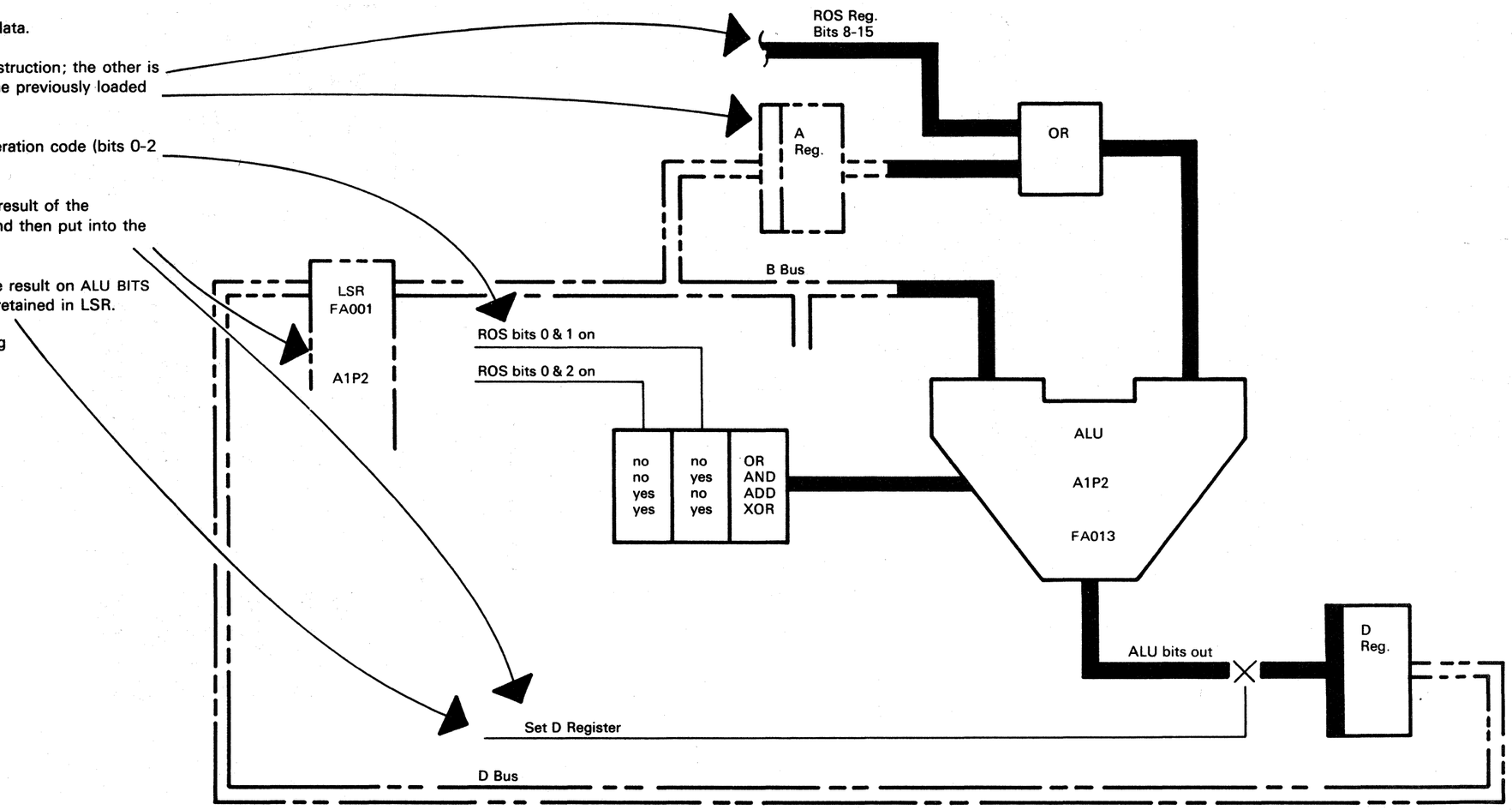
ADD - 150-200 nanoseconds

ORI, AND, XO, STO, XFR - 100-150 nanoseconds

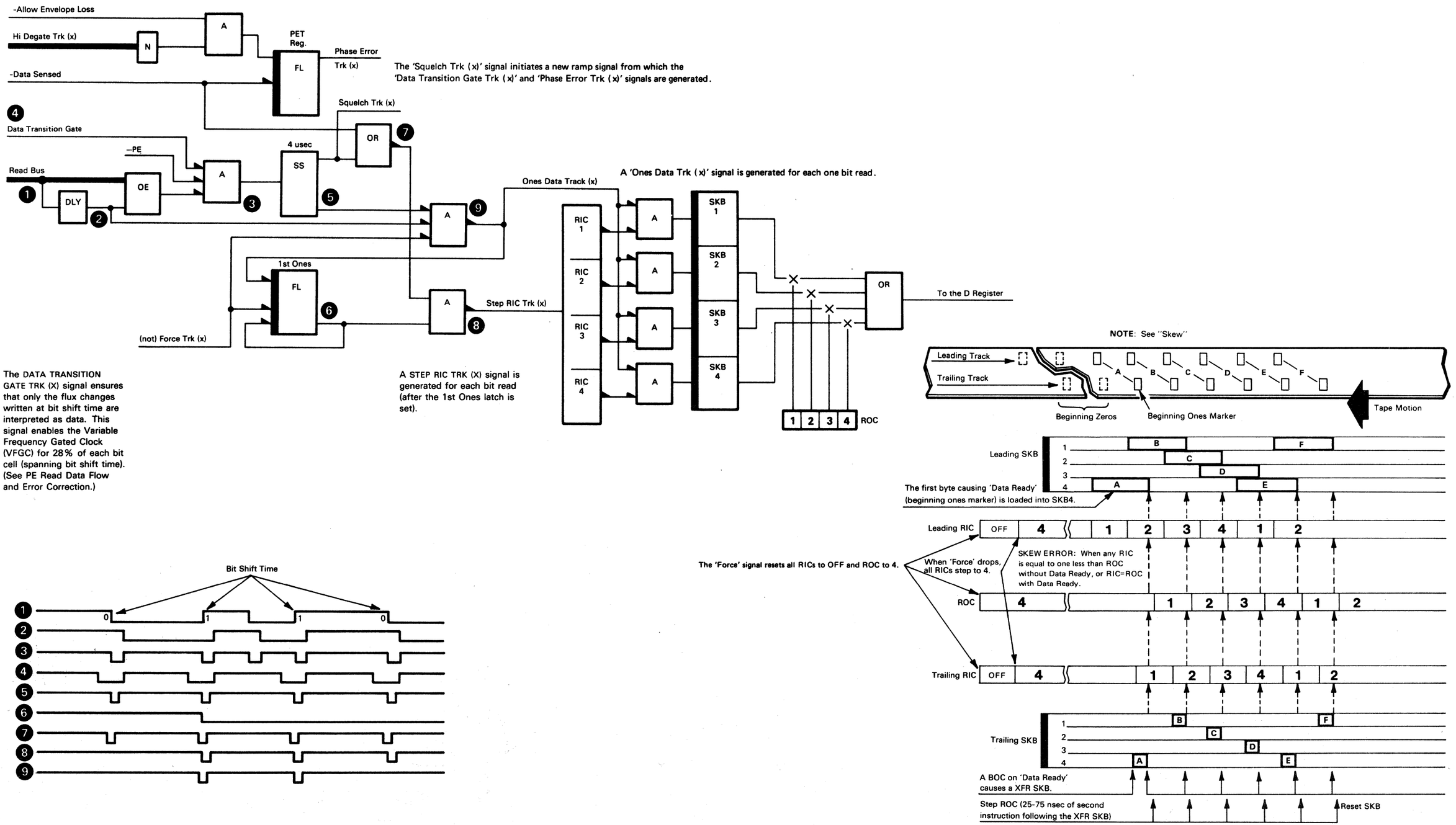


Arithmetic Logic Unit (ALU)

- ALU executes the logical operations called for by the microprogram.
- ALU can OR, Exclusive OR, AND, or ADD two bytes of data.
- One of the bytes is located in an LSR selected by the instruction; the other is a constant contained in Field 2 of the instruction, or in the previously loaded A Register.
- The ALU executes the operation under control of the operation code (bits 0-2 of the instruction).
- With bit 3 of the instruction off (normal instruction), the result of the operation, on ALU BITS OUT, is set into the D Register and then put into the selected LSR.
- With bit 3 of the instruction on (modified instruction), the result on ALU BITS OUT is set into the D Register, but original contents are retained in LSR.
- The microprogram tests the result on ALU BITS OUT using a BOC instruction.



PE Read Detection and Skew Buffers



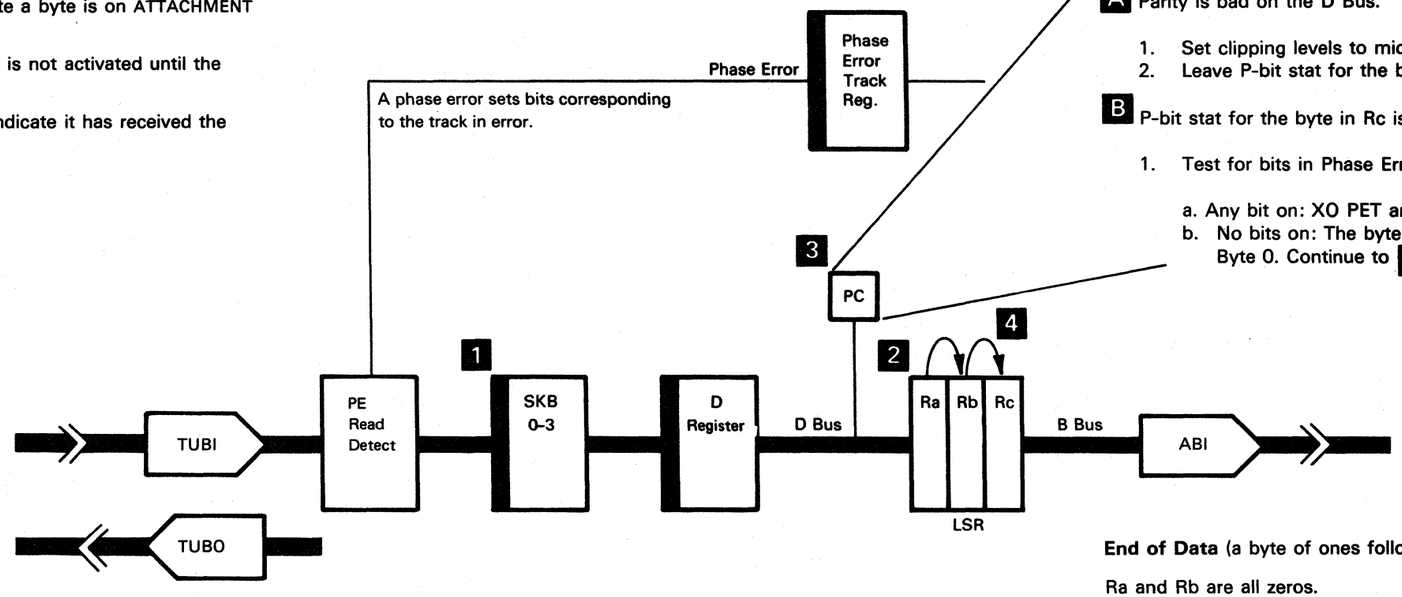
The DATA TRANSITION GATE TRK (X) signal ensures that only the flux changes written at bit shift time are interpreted as data. This signal enables the Variable Frequency Gated Clock (VFGC) for 28% of each bit cell (spanning bit shift time). (See PE Read Data Flow and Error Correction.)

A STEP RIC TRK (X) signal is generated for each bit read (after the 1st Ones latch is set).

PE Read Data Flow and Error Correction

This figure assumes a read operation away from load point.

- The tape control receives data from the tape unit on TAPE UNIT BUS IN (TUBI).
- The microprogram tests parity of each byte and corrects those with phase errors.
- The microprogram buffers three data bytes in LSR to provide effective in-flight error correction, and a means by which to detect End of Data.
- The microprogram activates SERVICE IN to indicate a byte is on ATTACHMENT BUS IN (ABI).
- To prevent transferring the preamble, SERVICE IN is not activated until the first three data bytes are stored in the LSR.
- The attachment responds with SERVICE OUT to indicate it has received the byte.



In-Flight Error Correction

A Parity is bad on the D Bus.

1. Set clipping levels to mid-range.
2. Leave P-bit stat for the bad byte (Ra) zero. Continue to **4**

B P-bit stat for the byte in Rc is zero.

1. Test for bits in Phase Error Track (PET) Register.

   a. Any bit on: XO PET and Rc to correct the byte. Continue to **5**
   b. No bits on: The byte cannot be corrected. Set VRC error in Sense Byte 0. Continue to **5**

1 Test for data ready (data in SKB).

2 Transfer Rb to Rc, Ra to Rb, and SKB to Ra.

3 Test parity of the byte transferred to Ra (on the D BUS). Good parity (odd) — set P-bit stat to a 1. P-bit stats are LSR bits used for storing the parity status (odd or even) of each data byte until the byte is shifted into Rc, where correction is possible. P-bit stats are set to one to indicate odd parity and to zero to indicate even parity.

Bad parity (even) — see In-Flight Error Correction **A**

4 Test P-bit stat to see if the byte in Rc needs correction **B**
P-bit stat for Rc 0: see In-Flight Error Correction
P-bit stat for Rc 1 (byte in Rc is correct): continue to **5**

5 Test bytes in Ra and Rb for all zeros.
Ra and Rb all zeros: see End of Data.
Ra and Rb not all zeros: continue to **6**

6 Transfer Rc to ABI.

7 Subtract one from byte count. Continue to **1**

End of Data (a byte of ones followed by two bytes of zeros)

Ra and Rb are all zeros.

Test Rc for all ones.

A. Rc is all ones (end-of-data sensed).

1. Test for wrong length record.
2. Test PET for:

   a. No phase error or in only one track. This is a normal end. A phase error in only one track indicates in-flight error correction was successful.
   b. Phase error in not all but more than one track. Byte is uncorrectable; set Envelope Check and Multi-Track Error in Sense Byte 5.
   c. Phase error in all tracks. Byte is uncorrectable; set Envelope Check and Multi-Track Error in Sense Byte 5.

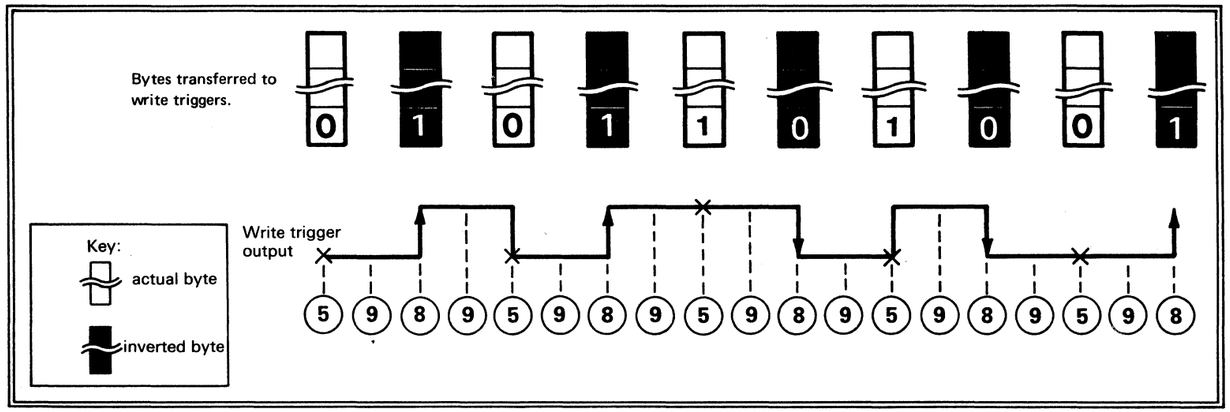
B. Rc is not all ones. Continue to **6**

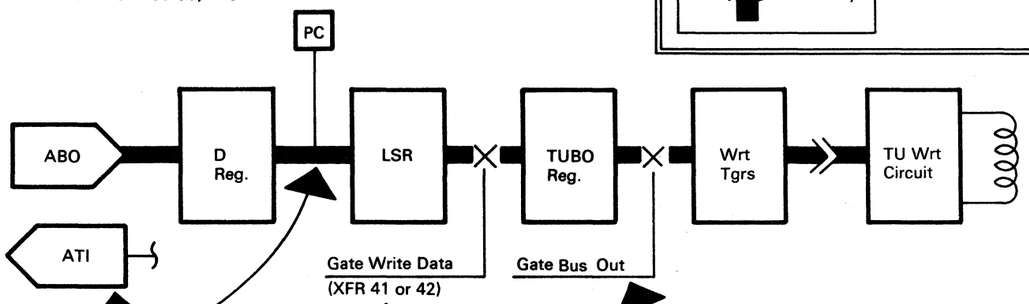
Write Data Flow and Read-Back Check

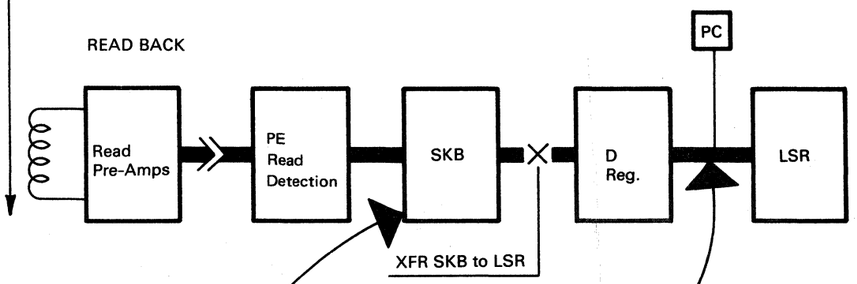
This figure assumes a write operation already in progress.

- The tape control requests write data by activating SERVICE IN to the attachment.
- The attachment activates SERVICE OUT to indicate a byte is on ABO.
- The microprogram sends the data byte to the tape unit to be written.
- The tape unit reads back the written data and the microprogram checks for parity errors.

The microprogram tests for SERVICE OUT, gets the data byte from ABO, stores it in LSR and resets SERVICE IN. If SERVICE OUT is not active when tested, the microprogram sets an overrun error.







The Microprogram

1. Tests parity of the data byte.
2. Subtracts one from the byte count in LSR.
3. Activates SERVICE IN if the byte count is not zero.
4. Loads the write data into the TUBO register (sets up for flux reversal at Bit Cell Boundary).

Hardware

(5) Generates GATE BUS OUT from GATE WRITE DATA and write oscillator. Flux reversals are written on tape at Bit Cell Boundary time when data is transferred to the write triggers. (These flux reversals are not data.)

6. Waits for XFR WRITE DATA clock.
7. Loads inverted write data into the TUBO register. (Sets up to write the data byte.)

(8) Generates GATE BUS OUT which writes the data byte on tape (Flux reversals at Bit Shift time— See Phase Encoded Write).

The Microprogram

(9) Tests for data ready (data in SKB).

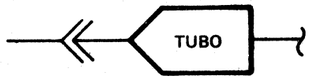
10. Transfers data (when ready) to LSR.
11. Tests data parity. (If parity is bad, set VRC.)

Sense Data Flow

System/3

- For each sense command the Tape Control sends two of the eight available sense bytes to Attachment Bus Out (ABO). The odd-numbered byte is sent first, then the even byte.
- Each sense command is accompanied by a Q byte from the attachment.
- Tape Unit sense bytes 0, 1, and 2, stored in the tape unit, are used as subsystem sense bytes 2, 4, and 6.
- If sense bytes 6 and 7 are sent to ABI, the Tape Control updates the tape unit status.
- The sense bytes are not parity checked, but proper parity is assigned before the bytes are sent to the attachment.

(The tape unit does not have to be ready.)



System/3

1 The Tape Control selects the tape unit, using the address bits in the Q byte.

2 The Tape Control decodes the N field of the Q byte to determine which two sense bytes are requested.

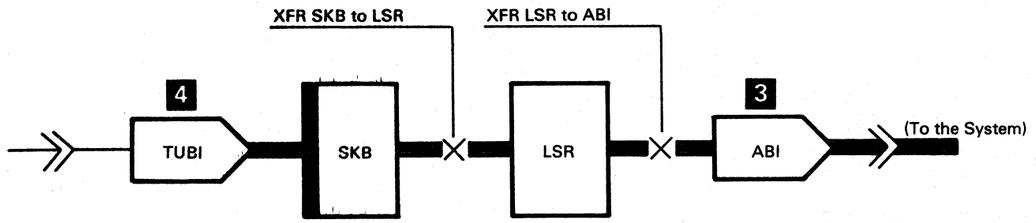
3 The odd-numbered sense byte is sent to ABI first (from LSR).

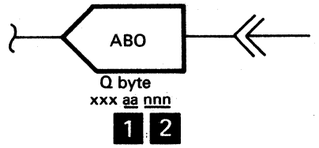
4 If the requested pair of bytes includes 2, 4, or 6, the Tape Control requests it from the tape unit (Subsystem sense bytes 2, 4, and 6 are kept in the tape unit).

3 The Tape Control sends the even-numbered sense byte to ABI when the Attachment accepts the odd-numbered byte (indicated by Attachment activating **SERVICE OUT**).

System/360/370

- For each sense command the Tape Control sends nine sense bytes to the System.
- Tape Unit sense bytes 0, 1, and 2 are used to assemble the subsystem sense bytes sent to the System.
- The sense bytes are not parity checked, but proper parity is assigned before the bytes are sent to the System.





System/360/370

The Tape Control selects the tape unit.

3 The Tape Control sends status to the System.

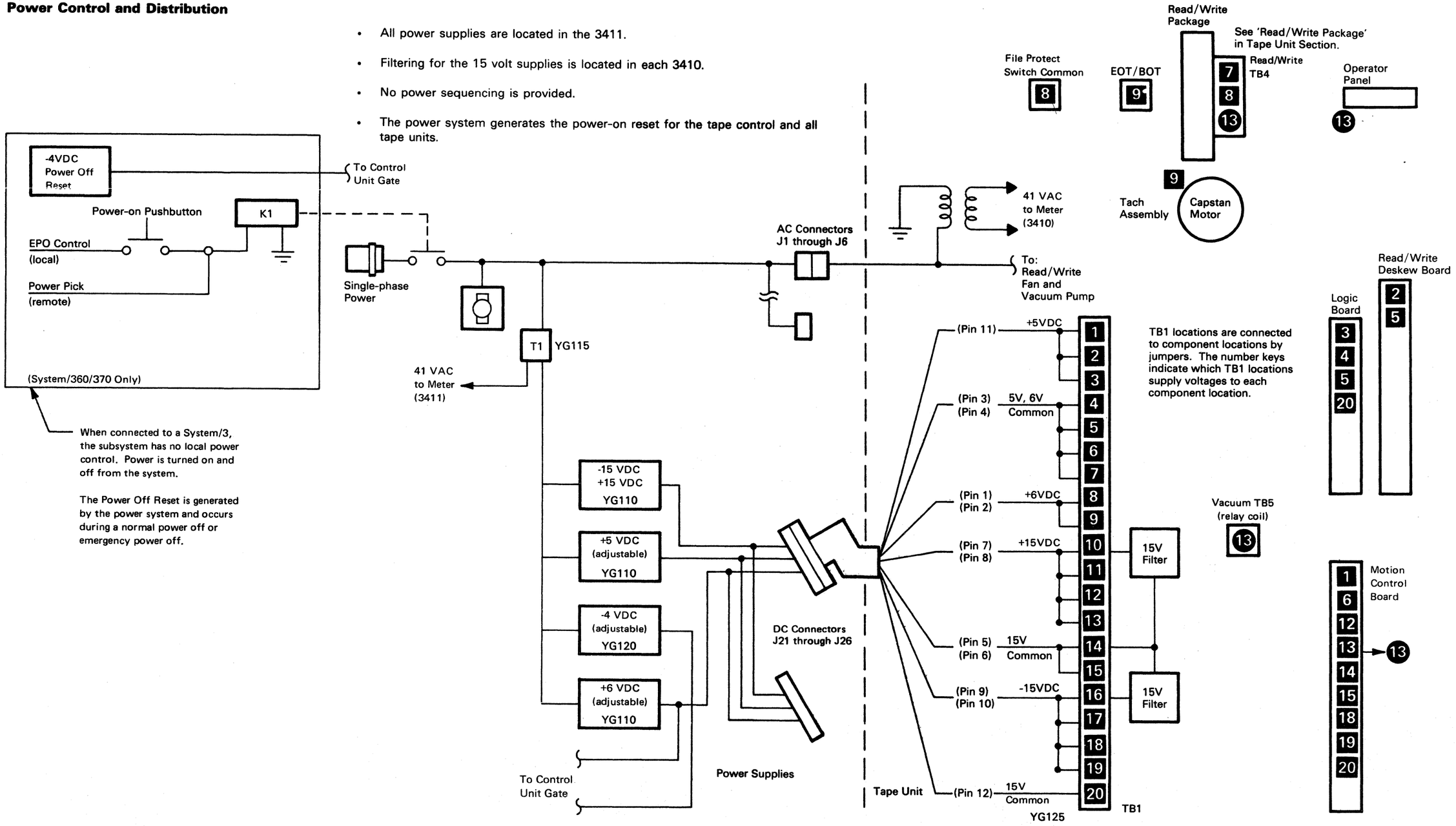
4 The Tape Control gets tape unit sense bytes 0, 1, and 2 from the tape unit.

The Tape Control assembles nine sense bytes, using tape unit sense bytes 0, 1, and 2, and information stored in the LSRs.

3 The Tape Control sends sense bytes 0 through 8, one at a time, to the System.

Power Control and Distribution

- All power supplies are located in the 3411.
- Filtering for the 15 volt supplies is located in each 3410.
- No power sequencing is provided.
- The power system generates the power-on reset for the tape control and all tape units.



Microinstructions

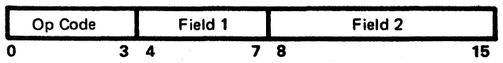
Microprogram

A microprogram controls operation of the tape control, and controls the tape unit over the tape unit interface. The microprogram is permanently stored in Read Only Storage (ROS). It consists of instructions arranged in groups or routines, each routine instructs the tape control to do a specific task. Instructions are executed, one at a time, until the task is completed.

The following instructions are used in the microprogram.

Basic instruction format is:

(ROS WORD)



Op Code: The instruction to be executed.

Field 1 and Field 2: Contain data necessary for execution of the Op Codes. See the specific instruction in the following figures.

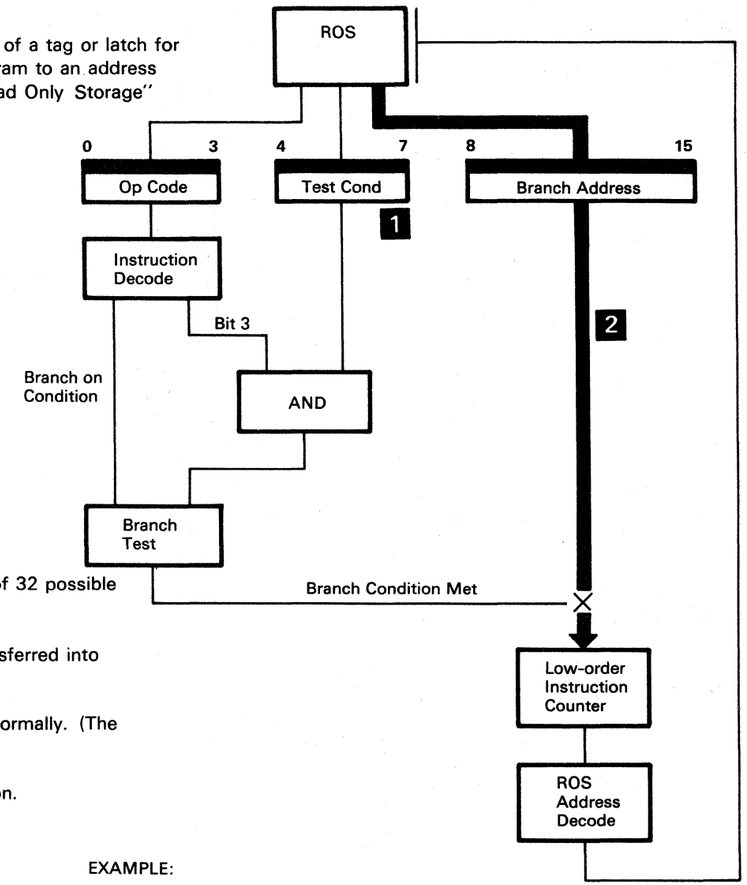
Instruction	Op Code (hex)	Field 1 Contains	Field 2 Contains
Branch On Condition (BOC)	2	Test Condition**	LSR Address
Branch Unconditional (BU)	6 or 7*	High ROS Address	Low ROS Address
Logical			
ADD	A	LSR Address	Constant
ADDM	B	LSR Address	Constant
AND	C	LSR Address	Constant
ANDM	D	LSR Address	Constant
ORI	8	LSR Address	Constant
ORM	9	LSR Address	Constant
XO	E	LSR Address	Constant
XOM	F	LSR Address	Constant
Store (STO)	0	LSR Address	Constant
Transfer (XFR)	4	LSR Address	Location**

* Use Op Code 7 to access the ROS Test Card.

** See Appendix B for Test Conditions or Transfer Codes.

Branch On Condition (BOC)

A Branch on Condition instruction tests a condition (the state of a tag or latch for example) and if the condition is met, branches the microprogram to an address within a page. (A page is a block of 256 addresses. See "Read Only Storage" and "Instruction Counter.")



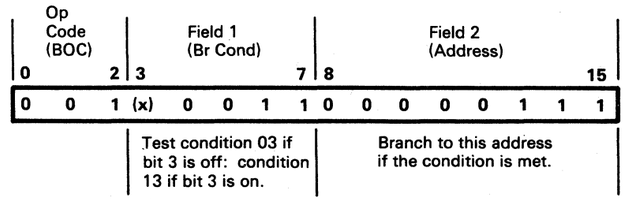
1 ROS bits 3-7 contain the branch condition code to be tested (one of 32 possible conditions).

2 If the branch condition is met, the address in ROS bits 8-15 is transferred into the low-order Instruction Counter (IC).

If the condition is not met, no transfer is made and IC is stepped normally. (The next sequential instruction is executed.)

The Page Register (high-order IC) is not altered by a BOC instruction.

EXAMPLE:



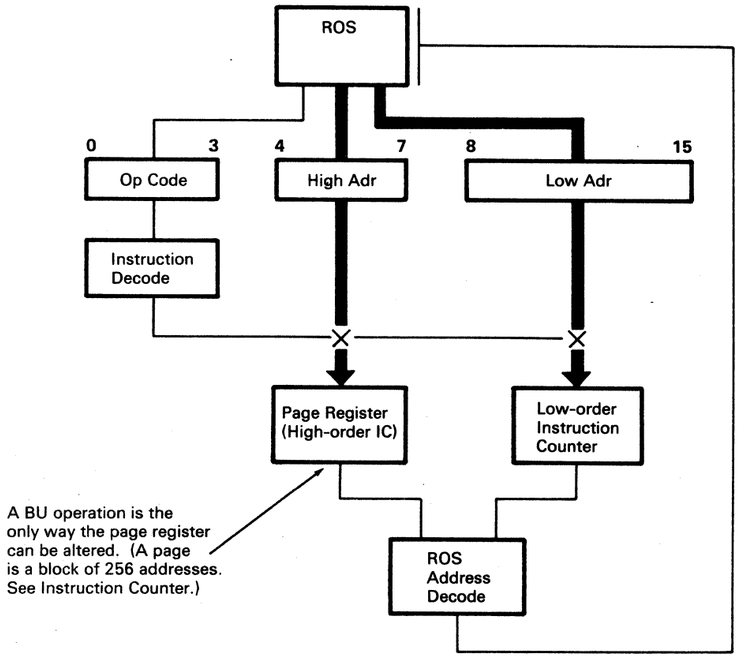
In a microprogram listing this appears as:

```
2307        BOC DBUS,ADDR          Branch on D Bus parity
                    or, if bit 3 is on:
3307        BOC DREG3,ADDR         Branch if D Reg 3 on
```

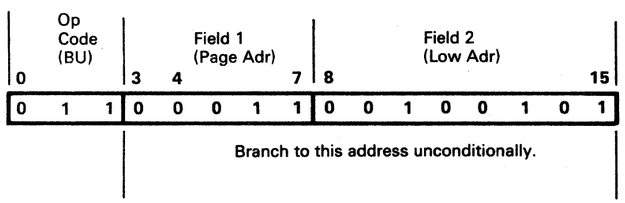
Branch Unconditional (BU)

A Branch Unconditional instruction branches the microprogram each time it is executed.

ROS bits 4-7 are transferred into the Page Register (high-order Instruction Counter), and ROS Bits 8-15 are transferred into the low-order Instruction Counter (IC).



EXAMPLE:



In a microprogram listing this appears as:

```
6325    BU ADDRESS    Branch to ADDRESS (325)
7325    BU ADDRESS    (ROS Test Card)
```

Logical Instructions (AND, ORI, XO, ADD)

The ALU uses the A Bus (ROS 8-15 ORed with the A Reg) and the B Bus (addressed LSR) as operands to execute a logical instruction. The result is placed on the D Bus.

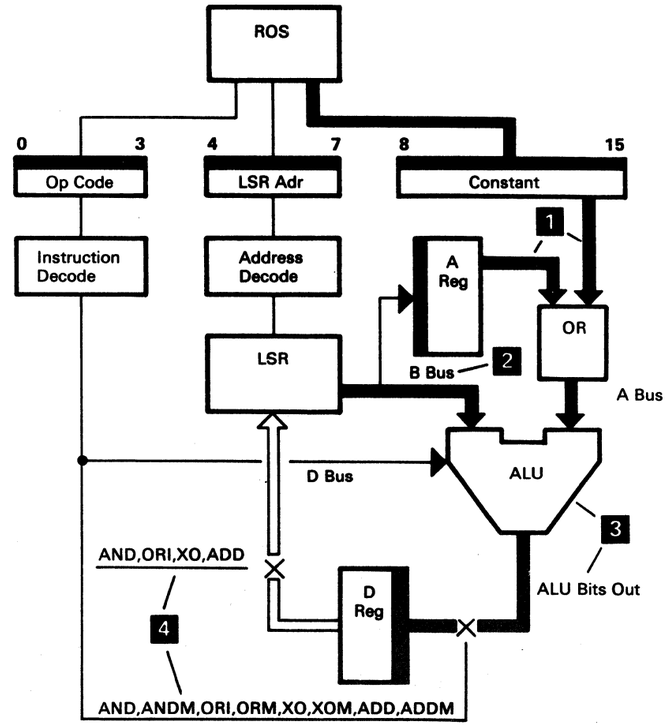
1. ROS 8-15 is ORed with the A Register to provide the A Bus operand. If ROS 8-15 is to be modified, the A Register is loaded with a constant by a previous instruction.

2. The LSR addressed by ROS 4-7 provides the B Bus operand. Selection of high or low LSR depends on the last use of Transfer Code 05 (See "Local Storage Registers.")

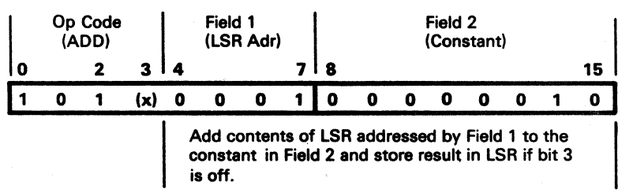
3. ALU executes the logical operation as directed by the instruction decode of ROS 0-3. The result appears on **ALU BITS OUT** and is loaded into the D Register.

4. Normal logical operation (ADD, AND, ORI, XO):
   The result is stored in the LSR addressed by ROS 4-7 and remains in the D Register until the next logical instruction or store.

   Modified logical operation (ADDM, ANDM, ORM, XOM):
   The result is not stored in LSR, but is held in the D Register until the next logical instruction or store. See "Arithmetic Logic Unit (ALU)."



EXAMPLE:

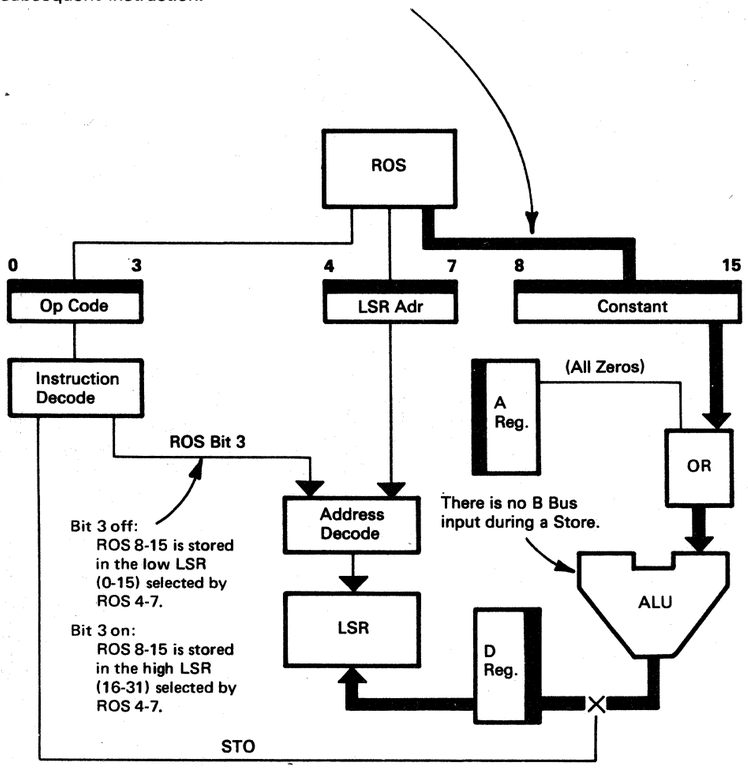


In a microprogram listing this appears as:

```
A102    ADD     R1,X'02'          Add 2 to LSR1
                or, if bit 3 is on:
B102    ADDM    R1,X'02'          Add 2 to LSR1
```

Store (STO)

The constant in ROS 8-15 is stored in the LSR selected by ROS 4-7 (modified by ROS bit 3). The constant also remains in the D Register until replaced during a subsequent instruction.



EXAMPLE:

Op Code (STO) 0–2	Field 1 (LSR Adr) 3–7	Field 2 (Constant) 8–15
0 0 0	(x) 0 1 1 0	1 1 1 0 0 1 1 1
	Select LSR6 if bit 3 is off; LSR22 if bit 3 is on.	Store this constant into the addressed LSR (6 or 22).

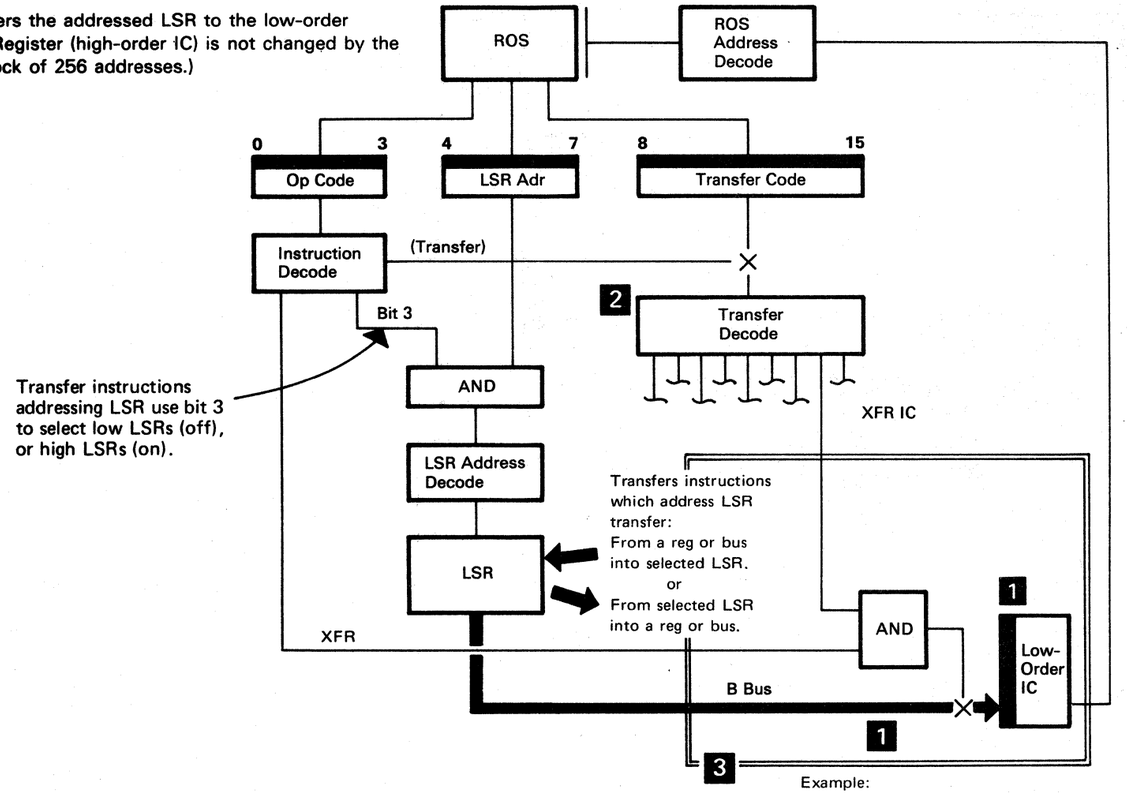
In a microprogram listing this appears as:

06E7	STO	R6,X'E7'	Store 'E7' in R6
		or, if bit 3 is on:	
16E7	STO	R22,X'E7'	Store 'E7' in R22

Transfer (XFR)

1. A Transfer instruction causes:
   - A. A data transfer from one internal location to another, or:
   - B. A pulse to set or reset a specific latch.
2. ROS 8-15, when decoded, selects the specific transfer operation.
3. The example shown (XFR IC) transfers the addressed LSR to the low-order Instruction Counter (IC). The Page Register (high-order IC) is not changed by the transfer instruction. (A page is a block of 256 addresses.)

Note: If Bit 8 is on, data is transferred into the LSR; if Bit 8 is off, data is transferred from the LSR.



Example:
Data is transferred from an LSR to IC.

Op Code (XFR) 0–2	Field 1 (LSR Adr) 3–7	Field 2 (XFR Code) 8–15
0 1 0	(x) 0 0 1 1	0 0 1 0 0 0 1 0
	Transfer LSR3 (or LSR19) to the Instruction Counter.	

In a microprogram listing this appears as:

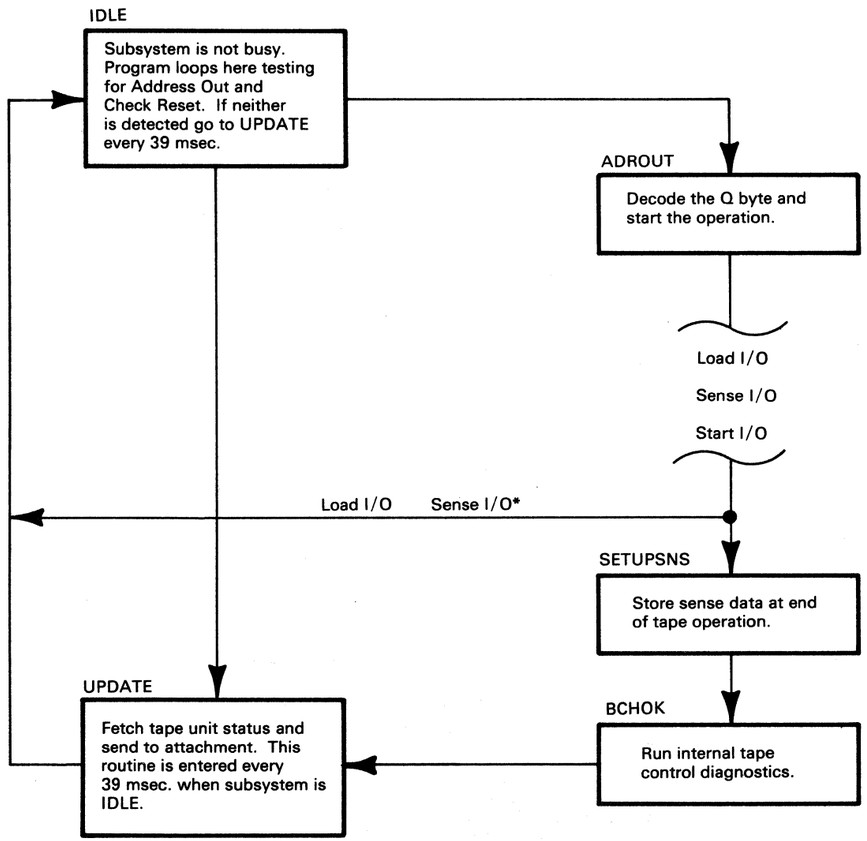
4322	XFR	R3,IC	Transfer LSR3 to IC
		or, if bit 3 is on:	
5322	XFR	R19,IC	Transfer LSR19 to IC

Microprocessor

This section contains the microprocessor operational flowcharts. All tape control operations are executed by a microprogram stored in ROS. The flowcharts illustrate the sequence of routines that perform these operations. Program labels are on the flowcharts as reference pointers to the microprogram listing. For the particular details of a routine use the label and the cross-reference list in the back of the program listing.

System/3 Microprogram Overview

The microprogram always executes certain routines in a particular order. The diagram illustrates the sequence.



*Go to UPDATE if sense bytes 6 and 7 are sent to the system.

Sequence Of Operations

Load I/O (LIO)---Loads the byte count into the selected LSRs.

The microprogram loops in the IDLE routine and exits to ADROUT to determine the type of operation. From ADROUT, exit to LOAD to store the byte count. If no errors are found, the program exits to IDLE at the completion of the LOAD routine.

Start I/O (SIO)---Contains the Read, Write, and Control commands.

The microprogram loops in IDLE and exits to ADROUT to determine the type of operation. From ADROUT the program exits to START to execute the command.

At the completion of the operation, exit to SETUPSNS to store sense data and then to BCHOK to run internal diagnostics. If no errors are found, exit to UPDATE to get status of tape units to send to the attachment. From UPDATE, go to IDLE to await the next command.

Sense I/O (SNS)---Gathers the subsystem sense information.

The microprogram loops in IDLE and exits to ADROUT to determine the type of operation. From ADROUT, the program exits to SENSE to get the sense bytes.

At the completion of the sense operation, exit IDLE and await the next command. If the sense command was for bytes 6 and 7, exit to UPDATE to get the tape unit status to send to the attachment. Exit to IDLE to await the next command.

Idle/Adrout Routines (System/3)

Objectives

- Test for Address Out from CPU

HANG1 — A hardware error has occurred. All tape operations are stopped. The subsystem must wait for a Check Reset from CPU before restarting.

CKRST — Check Reset is active. Reset all tape control sense bytes and start internal diagnostics.

IDLE1 — Address out is not active. Loop until Address Out is active or a carry occurs.

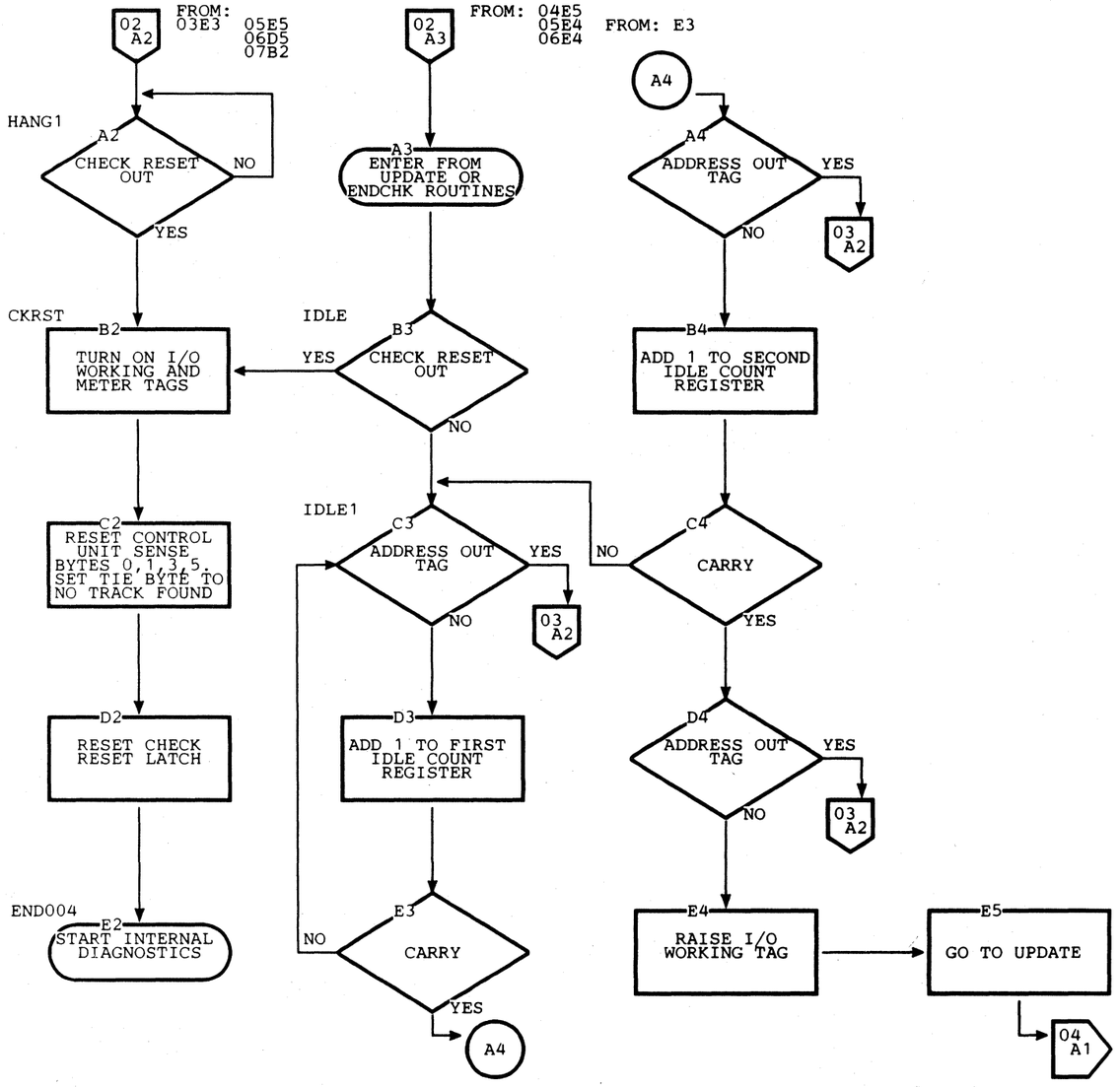
When a carry occurs, 39 ms have elapsed. Exit to UPDATE to fetch tape unit status.

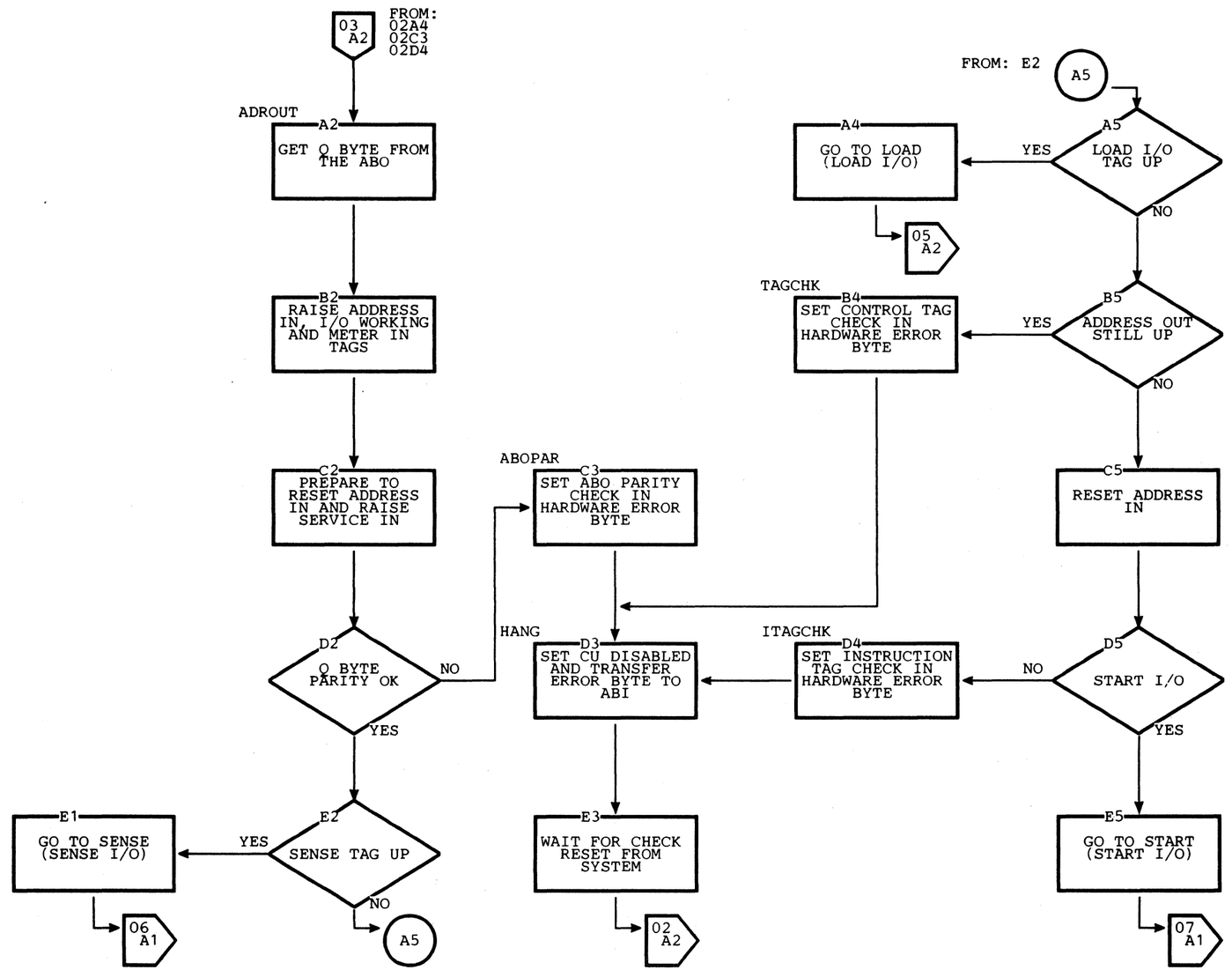
ADROUT — Reads in the Q Byte. Checks Q byte parity and for the I/O instruction tag.

ABOPAR — Q byte parity is bad. The ABO Parity Check bit is set in the Hardware Error Byte.

TAGCHK — Address Out was not reset. The Control Tag Check bit is set in the Hardware Error Byte.

ITAGCHK — No I/O instruction tag was active. The Instruction Tag Check bit is set in the Hardware error byte.




03 A2
FROM: 02A4 02C3 02D4
ADROUT
A2
GET O BYTE FROM THE ABO
B2
RAISE ADDRESS IN, I/O WORKING AND METER IN TAGS
C2
PREPARE TO RESET ADDRESS IN AND RAISE SERVICE IN
D2
O BYTE PARITY OK
NO
YES
ABOPAR
C3
SET ABO PARITY CHECK IN HARDWARE ERROR BYTE
HANG
D3
SET CU DISABLED AND TRANSFER ERROR BYTE TO ABI
E1
GO TO SENSE (SENSE I/O)
YES
E2
SENSE TAG UP
NO
A5
06 A1
E3
WAIT FOR CHECK RESET FROM SYSTEM
02 A2
ITAGCHK
D4
SET INSTRUCTION TAG CHECK IN HARDWARE ERROR BYTE
FROM: E2
A5
A4
GO TO LOAD (LOAD I/O)
YES
A5
LOAD I/O TAG UP
NO
05 A2
TAGCHK
B4
SET CONTROL TAG CHECK IN HARDWARE ERROR BYTE
YES
B5
ADDRESS OUT STILL UP
NO
C5
RESET ADDRESS IN
D5
START I/O
NO
YES
E5
GO TO START (START I/O)
07 A1

Update (System/3)

Objectives

- To get the status of each tape unit and transfer it to the Device Status Register in the attachment.

UPDATE1 — Get tape unit sense byte 0 (initial status) from the first tape unit.

ADDAGN1 — Wait for tape unit response. When the sense byte is received, save bits 5 and 7. Check the Not busy and Start bits.

UPDATE2 — The tape unit is not busy. Store bits 5 and 7 in an LSR and select the next tape unit.

CKMANREW — The tape unit is busy and the Start bit is on. If the Reset bit of sense byte 2 is set, the tape unit is manually rewinding, and the Meter In tag can be reset.

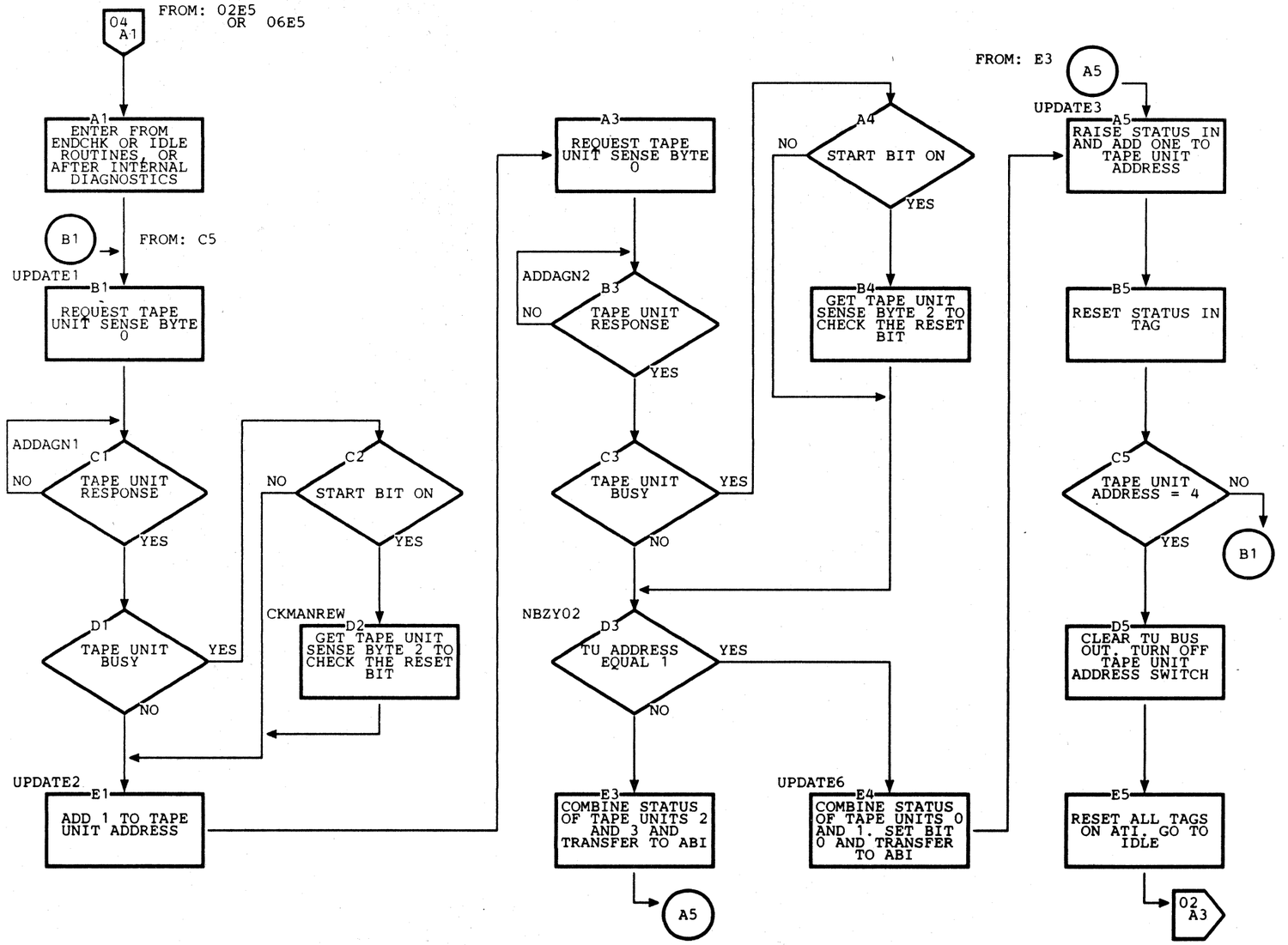
ADDAGN2 — Same as ADDAGN1.

NBZY02 — Check the tape unit address to determine which pair of tape units have been updated.

UPDATE6 — Tape units 0 and 1 have been updated. Bit 0 of the status byte is set to indicate the status is from tape units 0 and 1.

UPDATE3 — The status byte is transferred to the attachment. Update the status of tape units 2 and 3.

If the status of all tape units have been updated, reset the interface tags and return to IDLE.

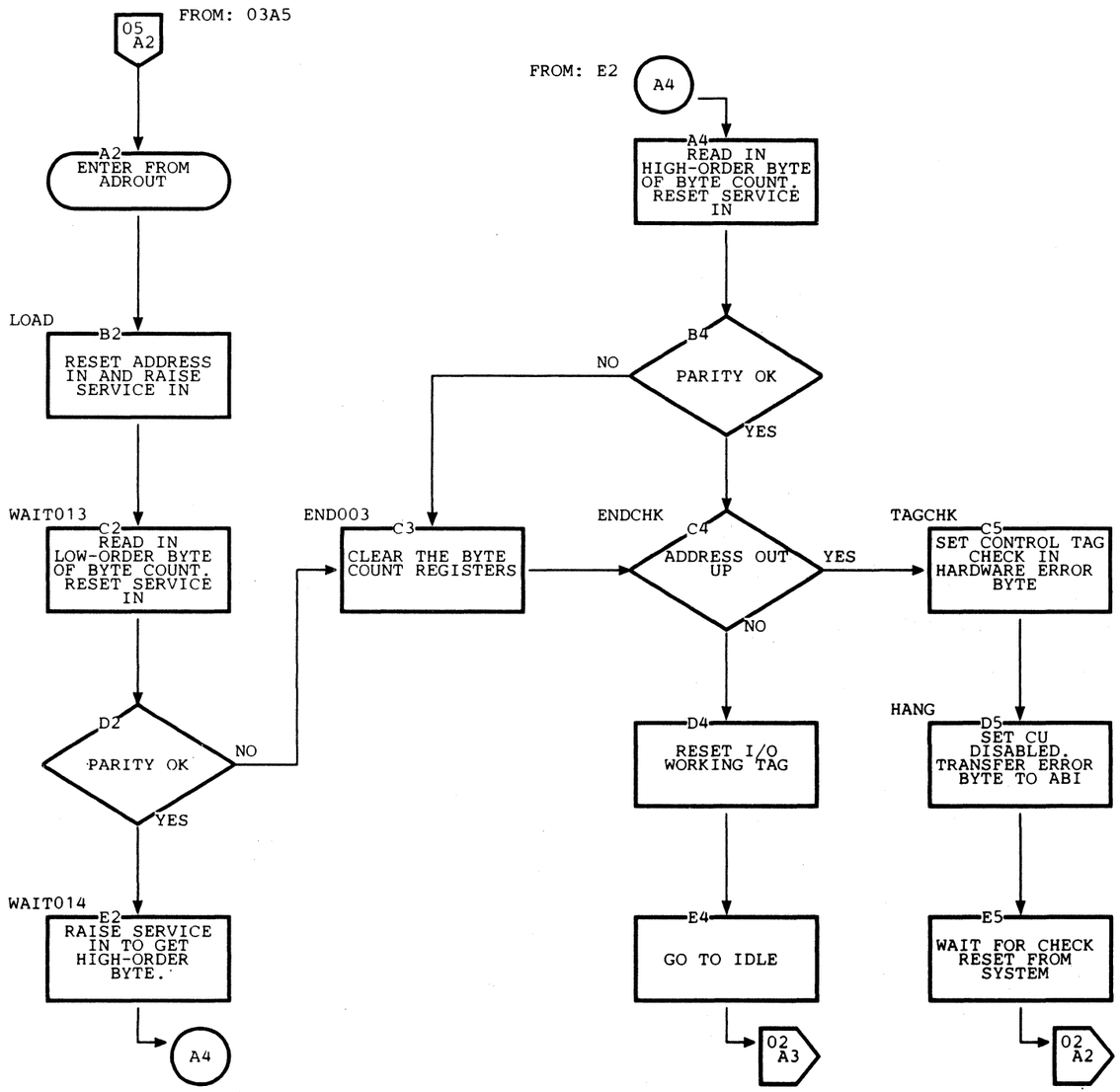


Load I/O (System/3)

Objectives

- Load a byte count into the designated LSRs.

WAIT013	Read in the first byte and check parity as it is received.
END003	Parity is bad. Clear the byte count registers and go to ENDCHK and then to IDLE to await the next command.
WAIT014	Read in the second byte and check parity. If bad, go to END003.
ENDCHK	Test for Address Out still active. If Address Out is inactive, reset I/O Working and go to IDLE to await the next command.
TAGCHK	Address Out is still active. Set the Control Tag Check bit in the Hardware Error byte. The subsystem then waits for Check Reset from CPU.



Sense I/O (System/3)

Objectives

- To fetch the two sense bytes requested by CPU.

SENSE — The Q Byte is decoded for the tape unit address and requested sense bytes.

The tape control responds with the odd-numbered sense byte first followed by the even-numbered one.

REQUEST — Get the tape unit sense byte. Tape unit sense bytes 0, 1, and 2 become subsystem sense bytes 2, 4, and 6 when transferred to CPU.

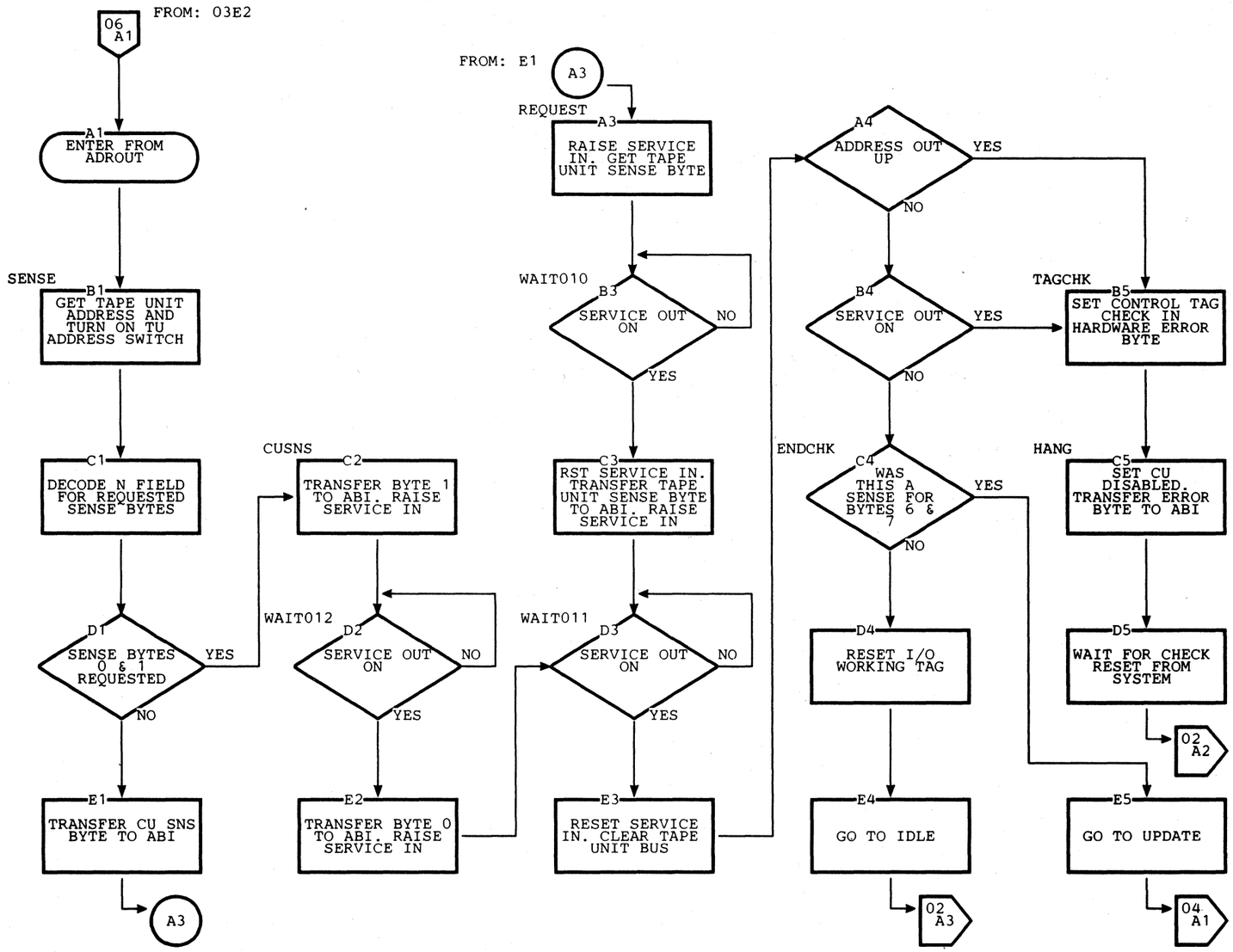
TAGCHK — Address Out or Service Out is still active. Set the Control Tag Check bit in the Hardware Error Byte. The subsystem then waits for Check Reset from CPU.

ENDCHK — Test for Address Out and determine which sense bytes were sent. If bytes 6 and 7 were sent, the tape unit status is updated. If bytes 6 and 7 were not sent, the subsystem goes to IDLE to await the next command.

Q BYTE

Sub-Sys			TU Adr		N-Field		
P	0	1	1	x	x	n	n	n
0		2	3		4	5		7

Tape Unit	x x	Sense Bytes	n n n
0	0 0	0 & 1	0 0 0
1	0 1	2 & 3	0 0 1
2	1 0	4 & 5	0 1 0
3	1 1	6 & 7	0 1 1



Start I/O (System/3)

Objectives

- To initiate a tape operation
- The command is decoded and the selected tape unit reset.

Q BYTE

Sub-Sys			TU Adr		N-Field		
P	0	1	1	x x	n	n	n
0		2	3	4	5		7

Tape Unit	x x	n n n	Command
0	0 0	0 0 0	Control
1	0 1	0 0 0	Read Forward
2	1 0	0 1 0	Write
3	1 1	0 1 1	Read Backward
		1 0 0	Diagnostic Write
		1 0 1	Diagnostic Read

START — Read in the R byte and check parity.

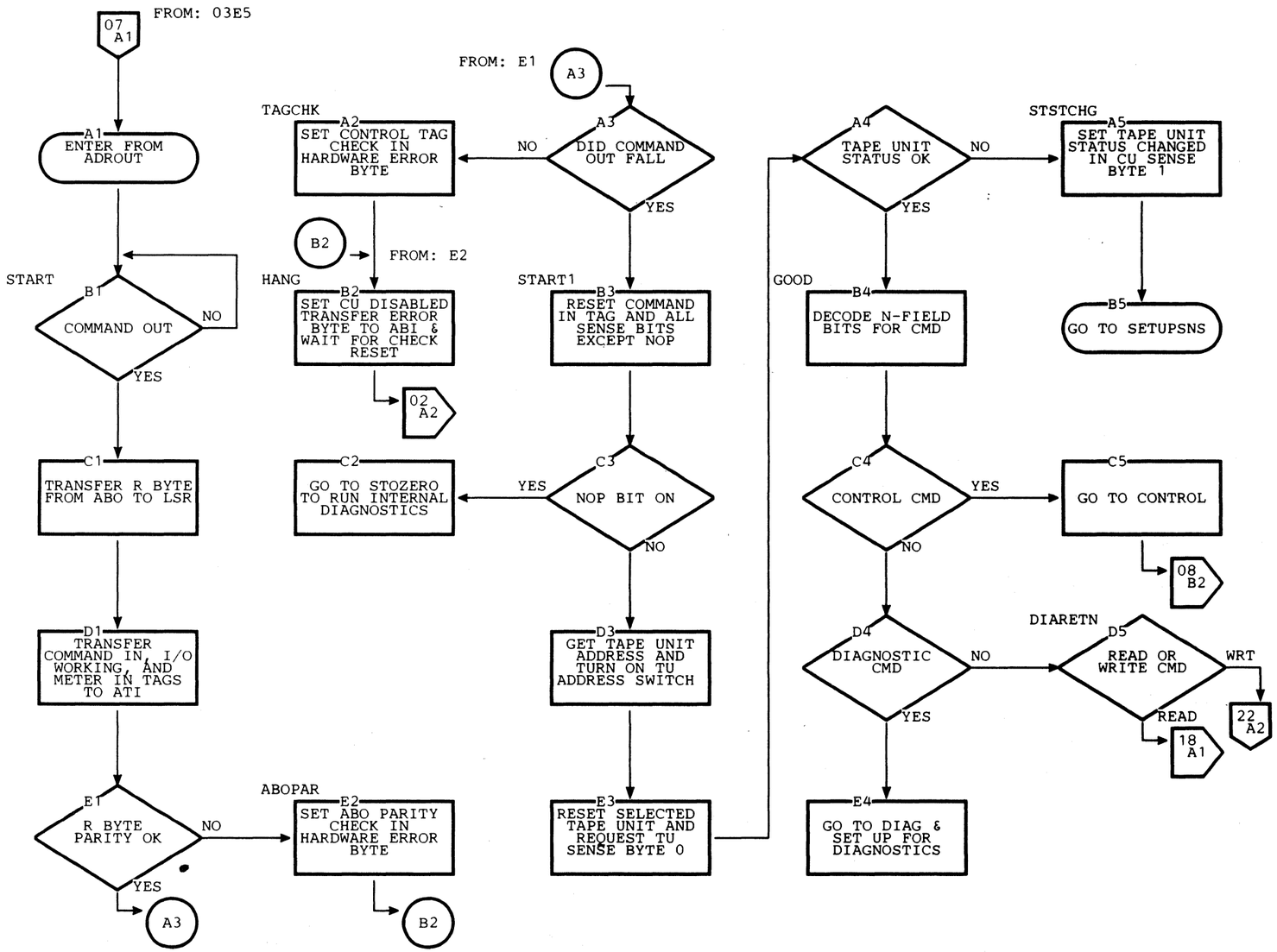
ABOPAR — R Byte parity is bad. Set the ABO Parity Check bit in the Hardware Error byte.

START1 — Reset all sense bits except NOP. If NOP is on, the operation is terminated. Go to STOZERO to do internal diagnostics and then to UPDATE before returning to IDLE.

If NOP is not set, reset the selected tape unit and get the status.

GOOD — The tape unit status is good. Decode the Q Byte N-field for the command.

STSTCHG — The tape unit is busy or unit check is on. Store the sense data, run internal diagnostics, update the tape unit status, and return to IDLE.



Control Commands (System/3)

Objectives

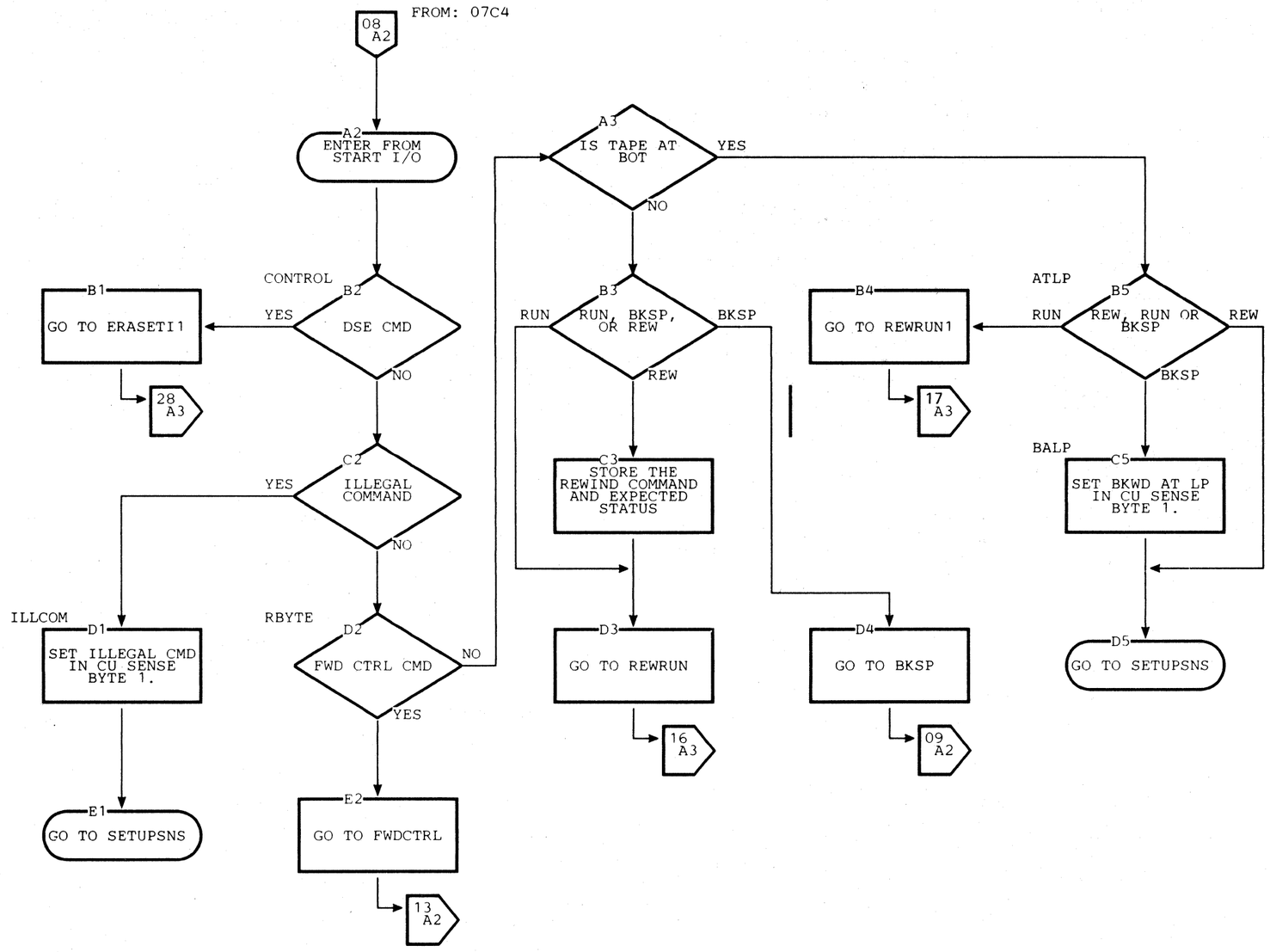
- Decode the R Byte for the particular control-type command.

RBYTE — Determine if the command is a forward or backward motion type command. If backward, check for tape at BOT.

ATLP — Tape is at BOT. Determine which backward operation is being attemped at BOT. If a Rewind Unload command, the operation will be completed when the tape unit is unloaded.

If a Rewind Command, the operation is complete. Store the sense data, run internal diagnostics, update tape unit status, and return to IDLE.

BALP — Tape is at BOT and the command is a Backspace. Set Backward at Load Point. Store the sense data, run internal diagnostics, update the tape unit status, and return to IDLE.

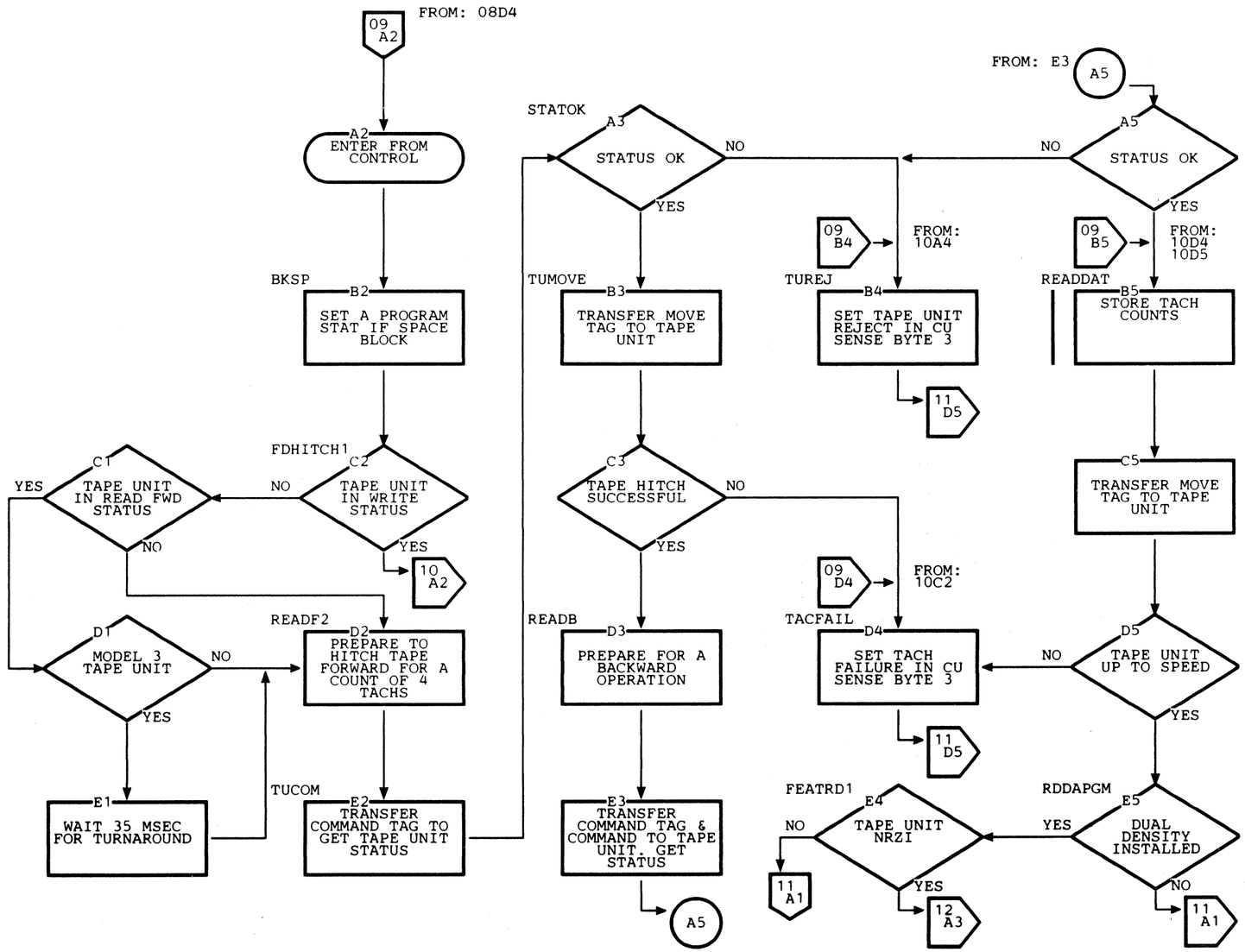


Backspace Block/File (System/3)

Objectives

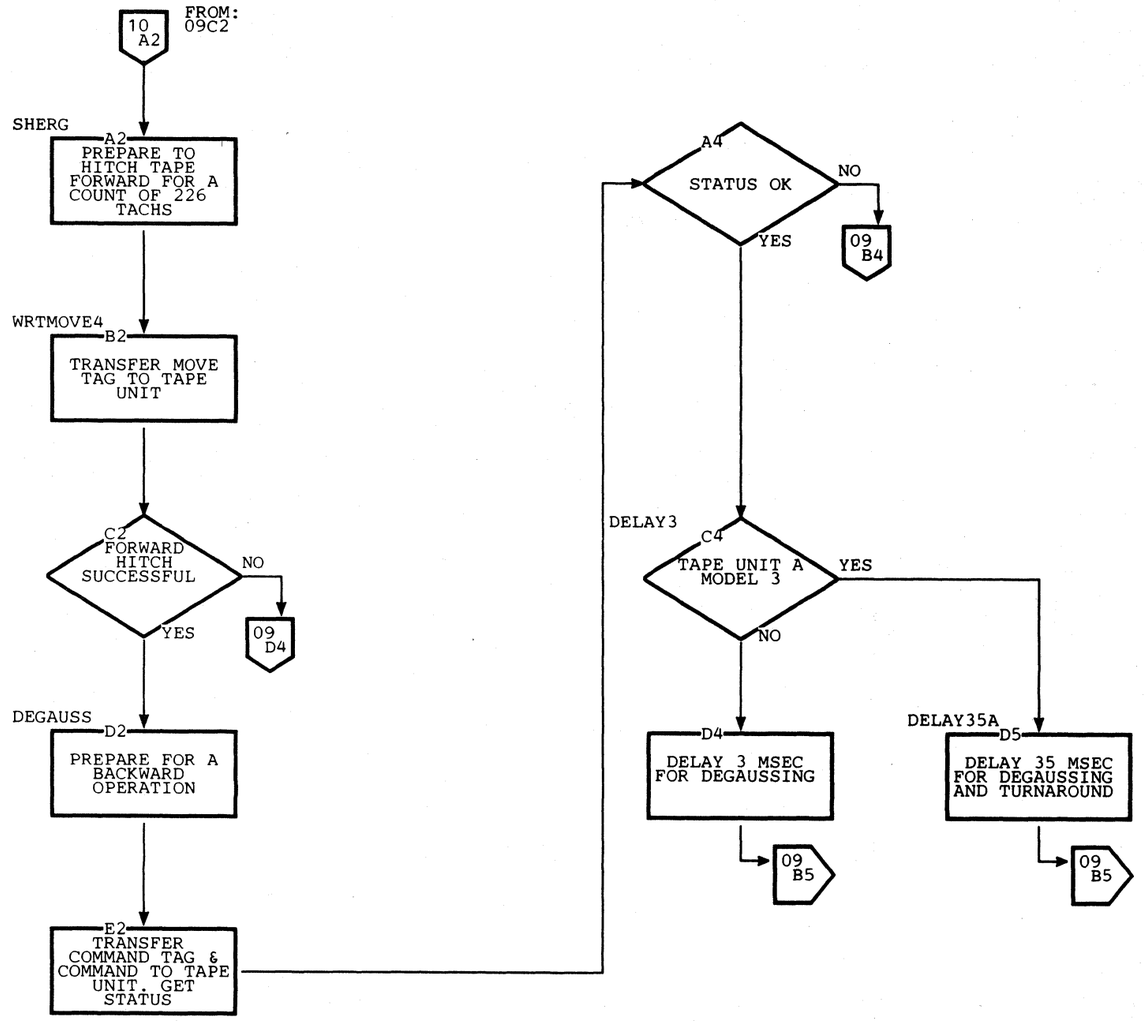
- To move tape backward over a block or file of data. No data is transferred to CPU.
- The Backspace Block and File commands are decoded by the CONTROL routine.

FDHITCH1	Determine if the tape is in read or write status.
READ	The tape unit is in read status. Set up to hitch the tape forward for a count of 4 tach pulses.
TUCOM	Get the tape unit command staus. If the status is not good, reject the tape unit and terminate the operation.
READDAT	Tape has been hitched forward. Compare old and new tape unit status. Set up up tach counts.



Backspace Block/File (System/3)

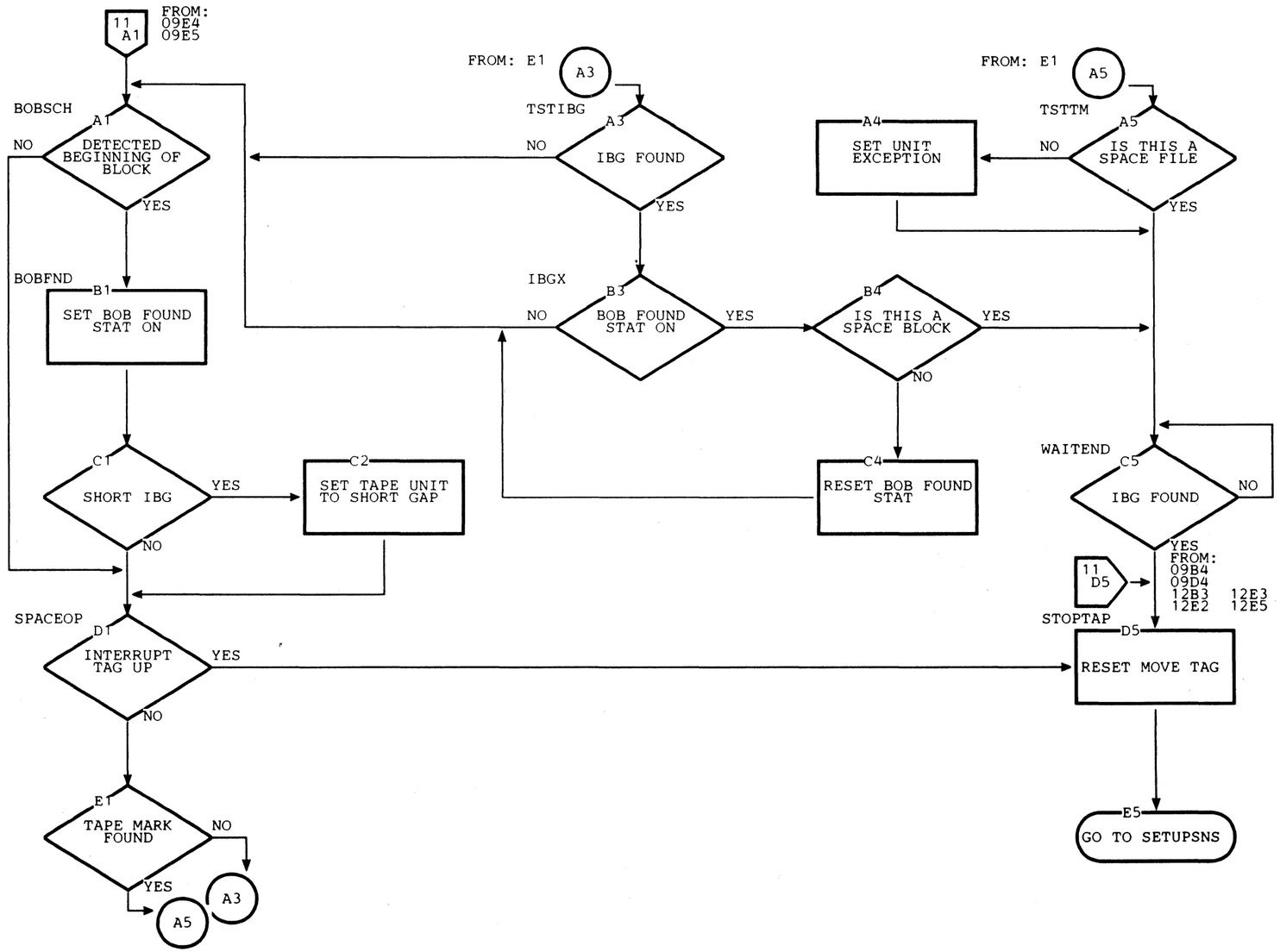
SHERG	The tape unit is in write status. Set up to hitch tape forward for a count of 226 tach pulses before changing to read status.
DEGAUSS	Set up for a backward operation. Degauss the write head before moving tape backward.



Backspace Block/File (System/3)

BOBSCH — Tape control is in PE mode. Start looking for the beginning of data block.

STOPTAP — The IBG or tape mark has been found or an error has occurred. Stop the tape and set up sense data. After running internal diagnostics, update the tape unit status and go to IDLE.

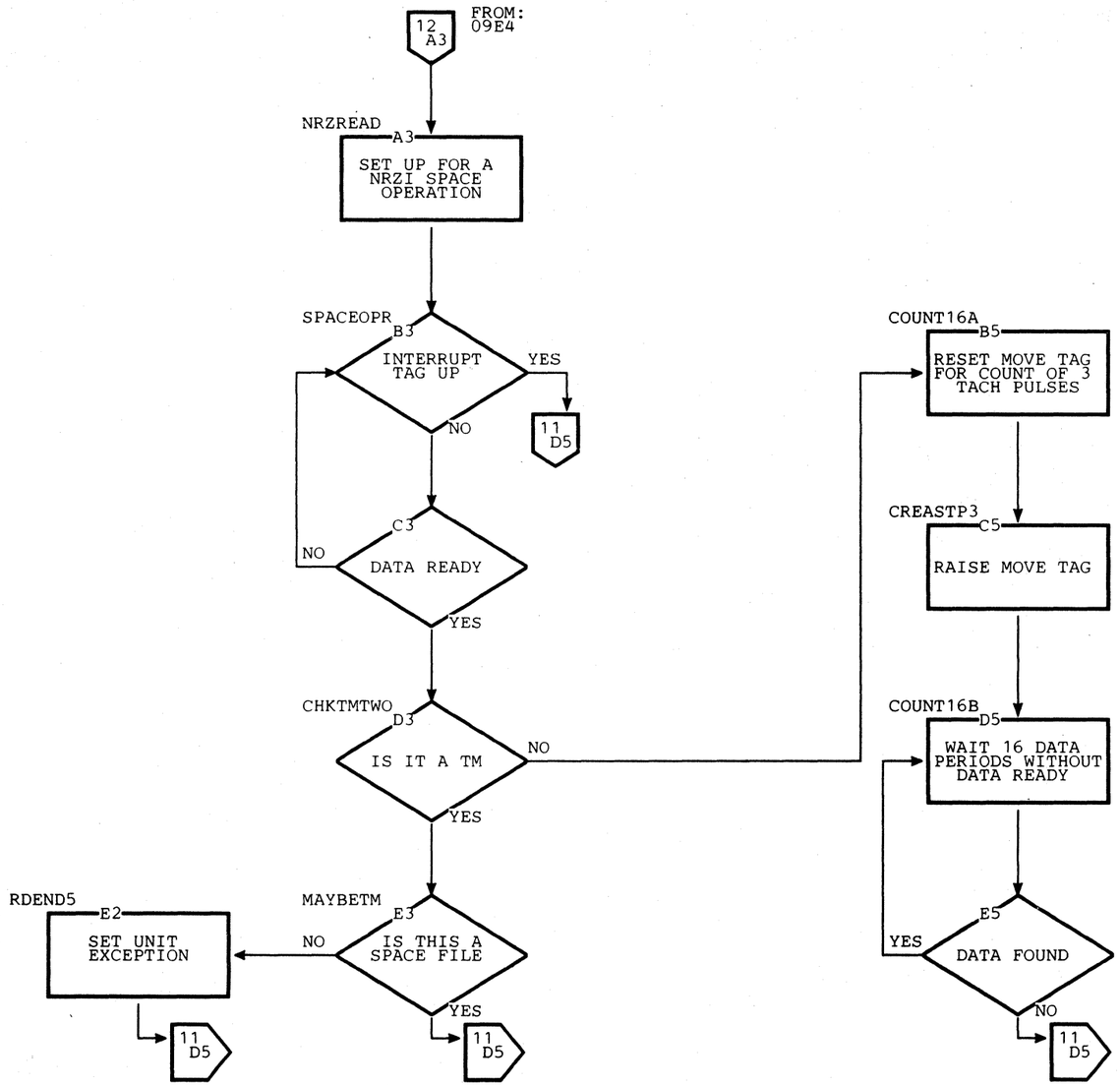


Backspace Block/File (System/3)

NRZREAD — Set up data time counts for a NRZI space operation.

SPACEOPR — Look for data. If found, check it for tape mark configuration.

COUNT16A — The data is not a tape mark. The Move Tag is reset for a count of 3 to signal the tape unit to prepare to stop. The Move Tag is then reactivated to search for data. If no data is found after 16 data periods, the tape unit stops. If data is found, continue looping until no data is found for 16 data periods.

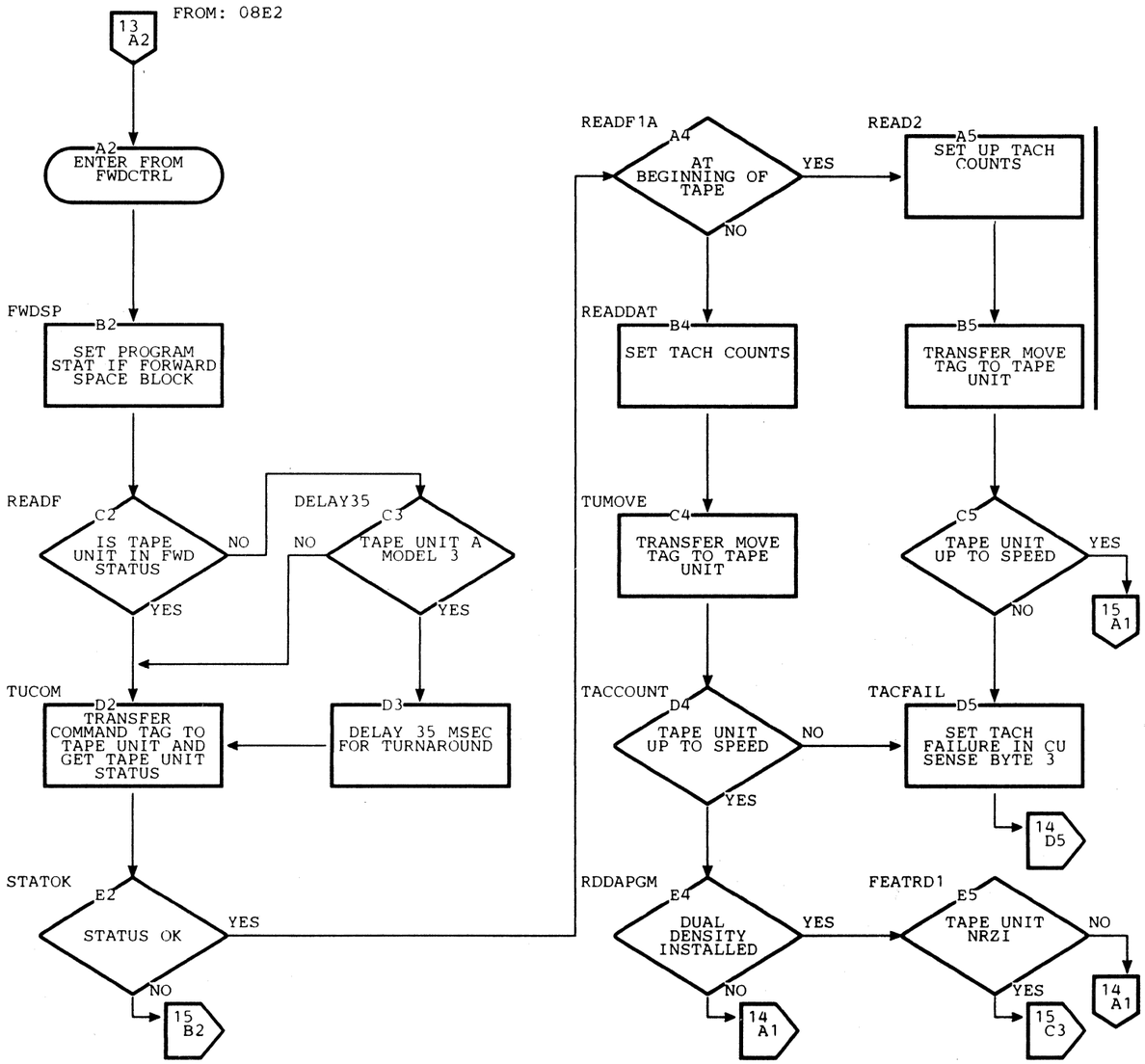


Forward Space Block/File (System/3)

Objectives

- To move tape forward over a block or file of data. No data is transferred to CPU.
- The Forward Space Block and File commands are decoded by the CONTROL routine.

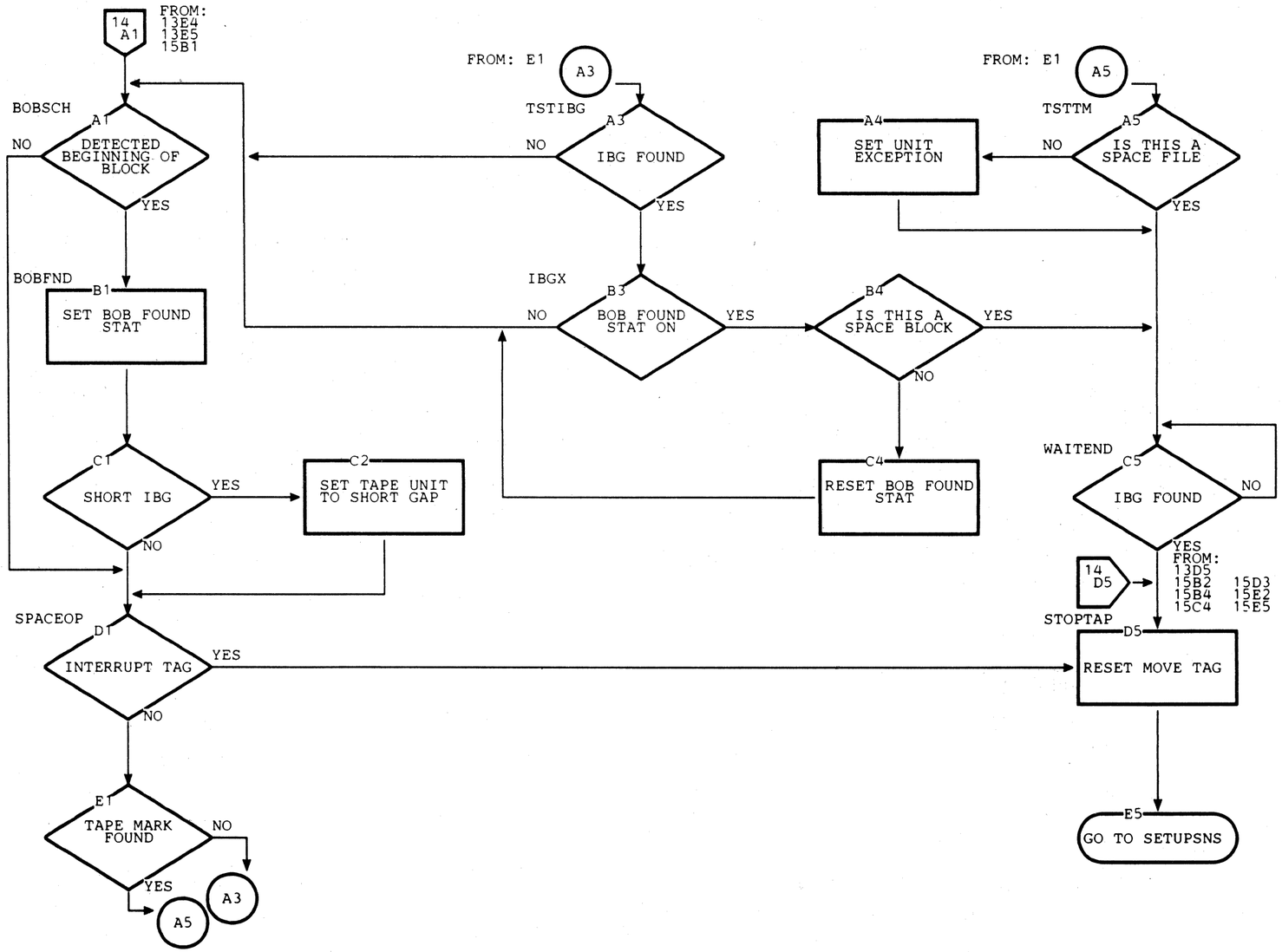
READF	Determine if the tape unit is in backward or forward status. If backward, initiate turnaround.
TUCOM	Get tape unit command status. If status is not good, reject the tape unit and terminate the operation.
READF1A	Tape unit status is good. Check for tape at BOT.
READDAT	Tape is not at BOT. Compare old and new tape unit status and set tach counts.
READ2	Same as READDAT except tape is at BOT.
TACCOUNT	Check for tach pulses to verify tape unit is running.



Forward Space Block/File (System/3)

BOBSCH — Tape control is in PE mode. Start looking for beginning of data block.

STOPTAP — The IBG or tape mark has been occurred. Stop the tape and set up sense data. After running internal diagnostics, update the tape unit status and go to IDLE.



Forward Space Block/File (System/3)

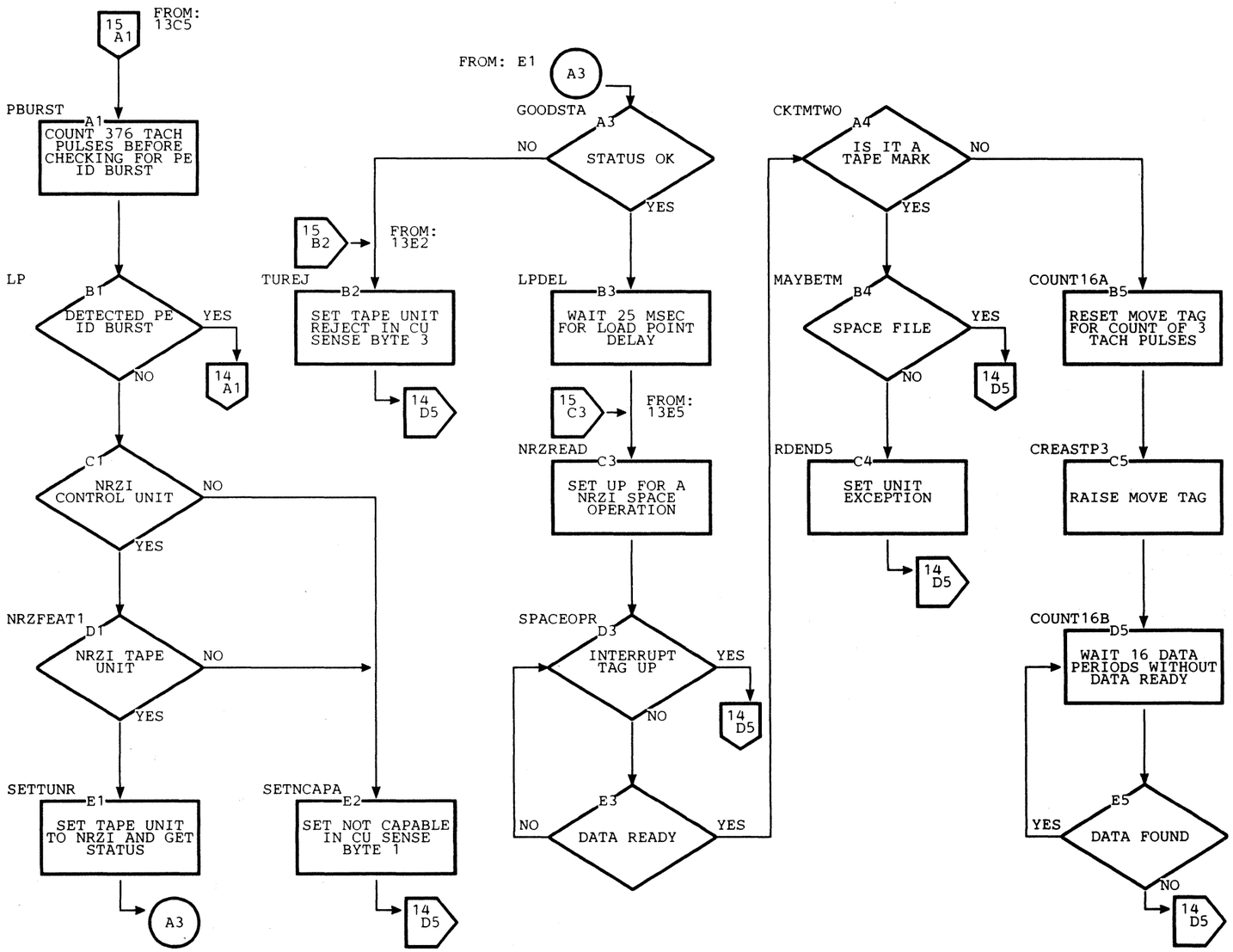
PBURST Tape is at BOT. Start looking for PE ID Burst. If none is found, the tape is recorded in NRZI. Check that the subsystem is capable of reading NRZI.

SETTUNR The tape control is capable of reading NRZI. Set the tape unit to NRZI and get the status.

NRZREAD Set up the data timing counts for a NRZI space operation.

SPACEOPR Look for data. If found, check for tape mark configuration.

COUNT16A The data is not a tape mark. The Move Tag is reset for a count of 3 to signal the tape unit to prepare to stop. The Move Tag is then reactivated to search for data. If no data is found after 16 data periods, the tape unit stops. If data is found, continue looping until no data is found for 16 data periods.

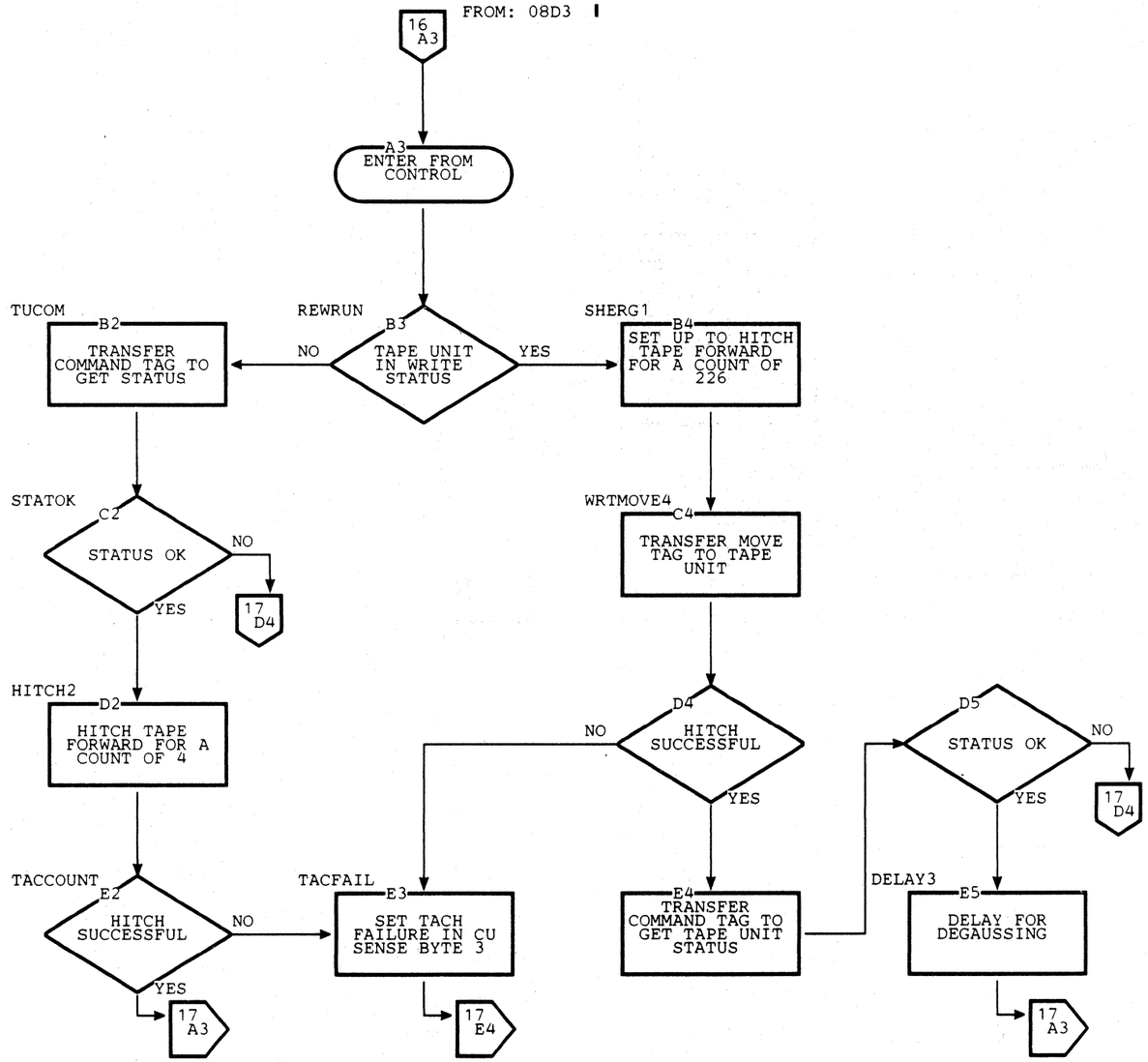


Rewind/Rewind Unload (System/3)

Objectives

- To move tape backwards at high speed to the beginning of tape (BOT) and if a Rewind Unload command, unload the tape unit. Tape is not pulled out of columns during the high speed rewind.

REWRUN	Determine if the tape unit is in read or write status.
TUCOM	Transfer the command tag to get the status byte. If status is not good, reject the tape unit and terminate the operation.
HITCH2	The tape unit is in read status. Set up to hitch the tape unit forward before turnaround. Send the Move Tag to the tape unit.
TACCOUNT	Check for and time the tach to verify tape forward hitch. If not correct, terminate the operation.
SHERG1	The tape unit is in write status. Move the tape forward before changing to read status.
DELAY3	The tape has been moved forward. Degauss the write head before moving tape backward.

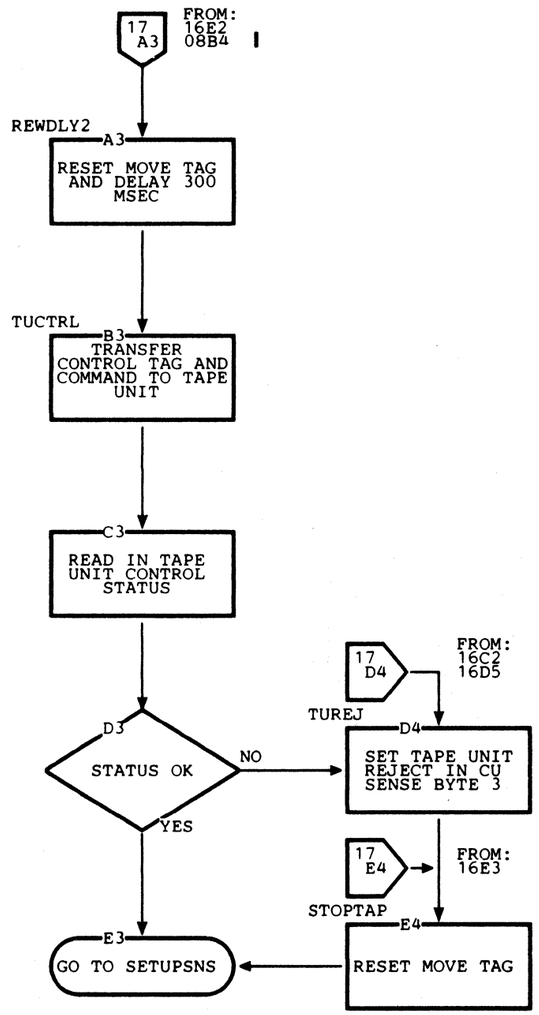


Rewind/Rewind Unload (System/3)

REWDLY2 — Delays 300 msec. to ensure that two or more tape units are not starting to rewind at the same time.

TUCTRL — Transfer the control tag and command to the tape unit. Get the status byte. If status is good, tape control will store the sense data, run internal diagnostics, update tape unit status, and go to IDLE while the tape unit completes the rewind operation.

STOPTAP — The tape unit status is not good or the tape unit tachometer failed. Reset the Move Tag and store the sense data. Run internal diagnostics, update tape unit status, and go to IDLE.



Read Operation (System/3)

Objectives

- To read data (PE or NRZI) in either direction.

DIARETN — Determine the type of read command.

READF — The command is a Read Forward. Determine if the tape unit is in forward or backward status. Execute a delay for turnaround if backward.

READBKWD — The command is a Read Backward. The tape must be hitched forward. If in write status, hitch forward for a count of 226. If in read status, hitch forward for a count of 4.

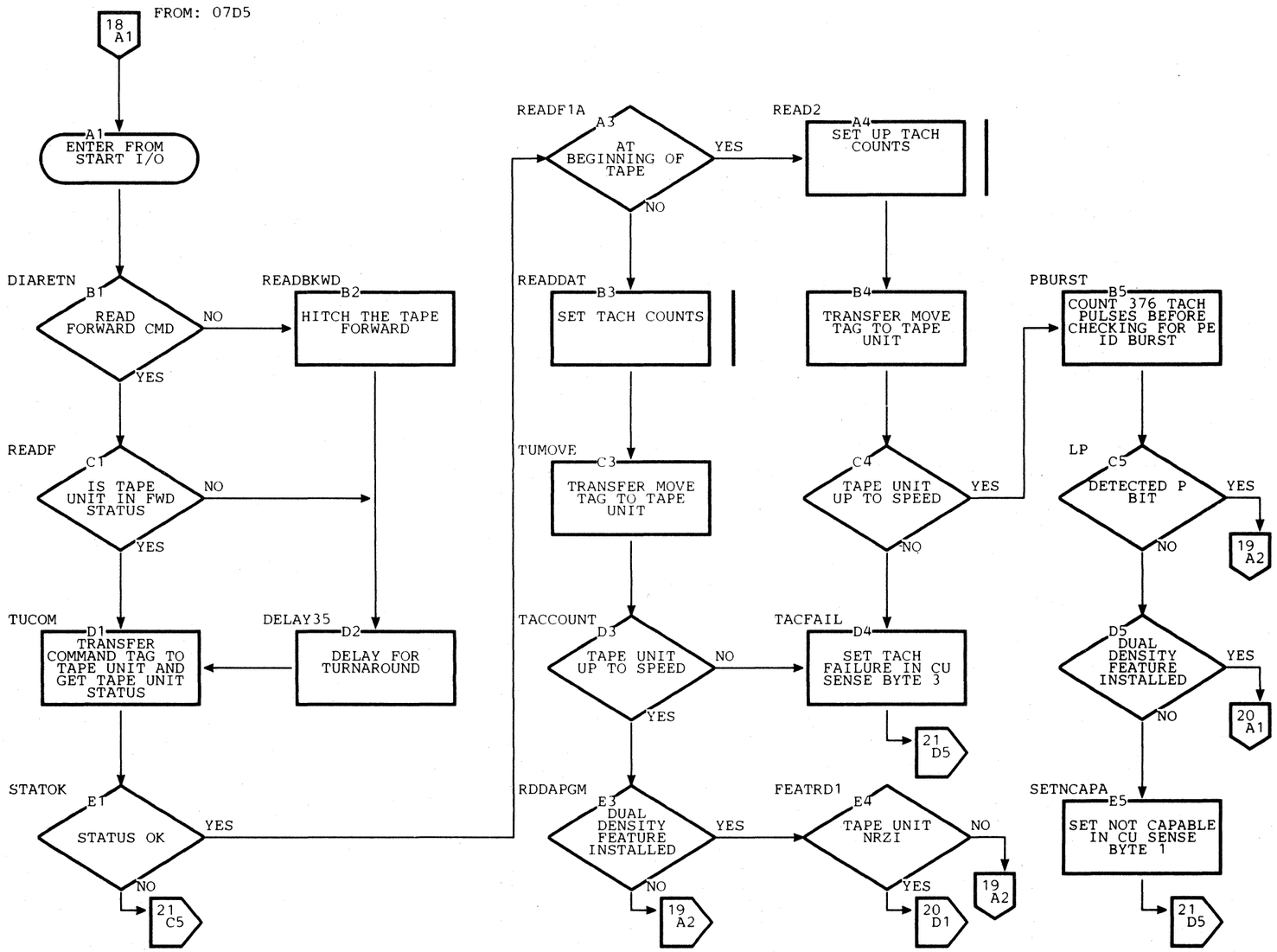
STATOK — Check the command status byte. If not good, reject the tape unit and terminate the operation.

READDAT — The tape is not at BOT. Compare old and new tape unit status and use the results to set up tach counts.

READ2 — Same as READDATA except the tape is at BOT.

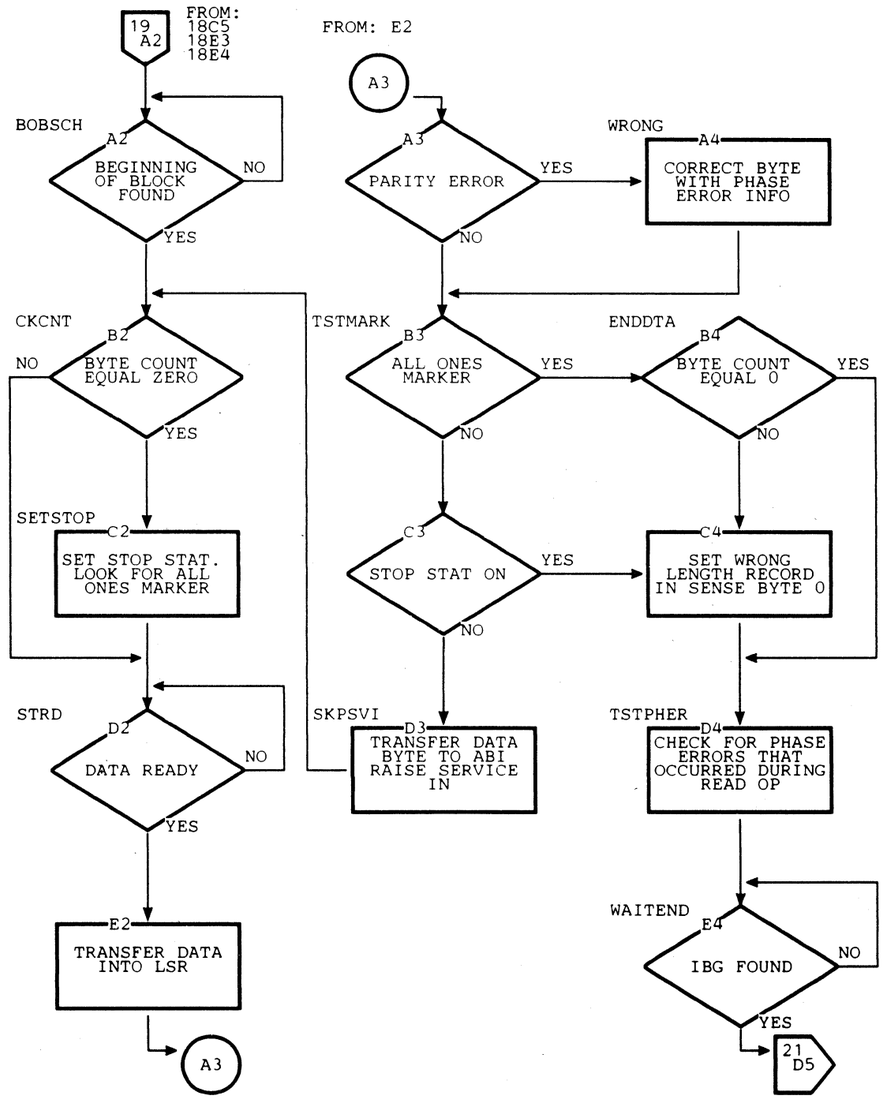
TACCOUNT — Verify that tape is moving. If not, reset the Move Tag to stop tape and terminate the operation.

PBURST — Tape is at BOT. Start looking for PE ID Burst. If no burst is found, the tape is recorded in NRZI. Determine if the tape control and tape unit are capable of reading NRZI.



Read Operation (System/3)

BOBSCH	The tape is recorded in PE. Start searching for the beginning of the data block.
STRD	Three data bytes are buffered in the LSR. If an error is detected as a phase error, the byte is corrected just before it is sent to ABI. Only single-track errors are corrected.
ENDDTA	The all-ones marker has been detected. Check that the byte count is zero and for any accumulated phase errors.
WAITEND	The postamble is being read. When the IBG is detected, reset Service In and stop tape.



Read Operation (System/3)

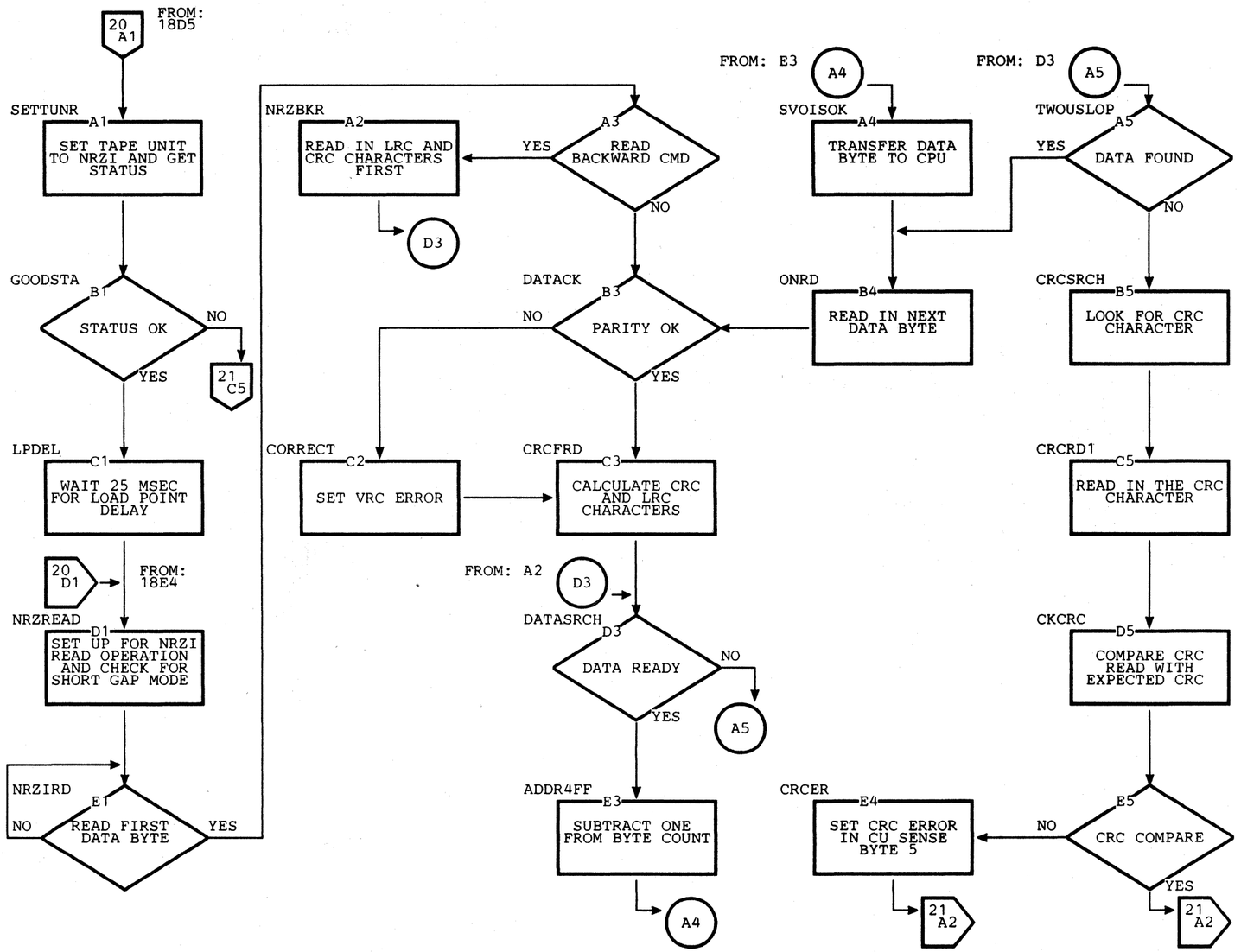
SETTUNR — The tape is at BOT and is a NRZI tape. Start looking for the first data byte.

NRZREAD — The tape is not at BOT and is a NRZI tape. Start looking for the first data byte.

NRZBKR — This is a Read Backward operation. The first bytes read are the LRC and CRC characters. Then start looking for the data bytes.

CRCFRD — A data byte has been read and parity checked. The LRC and CRC characters are calculated each time data is read.

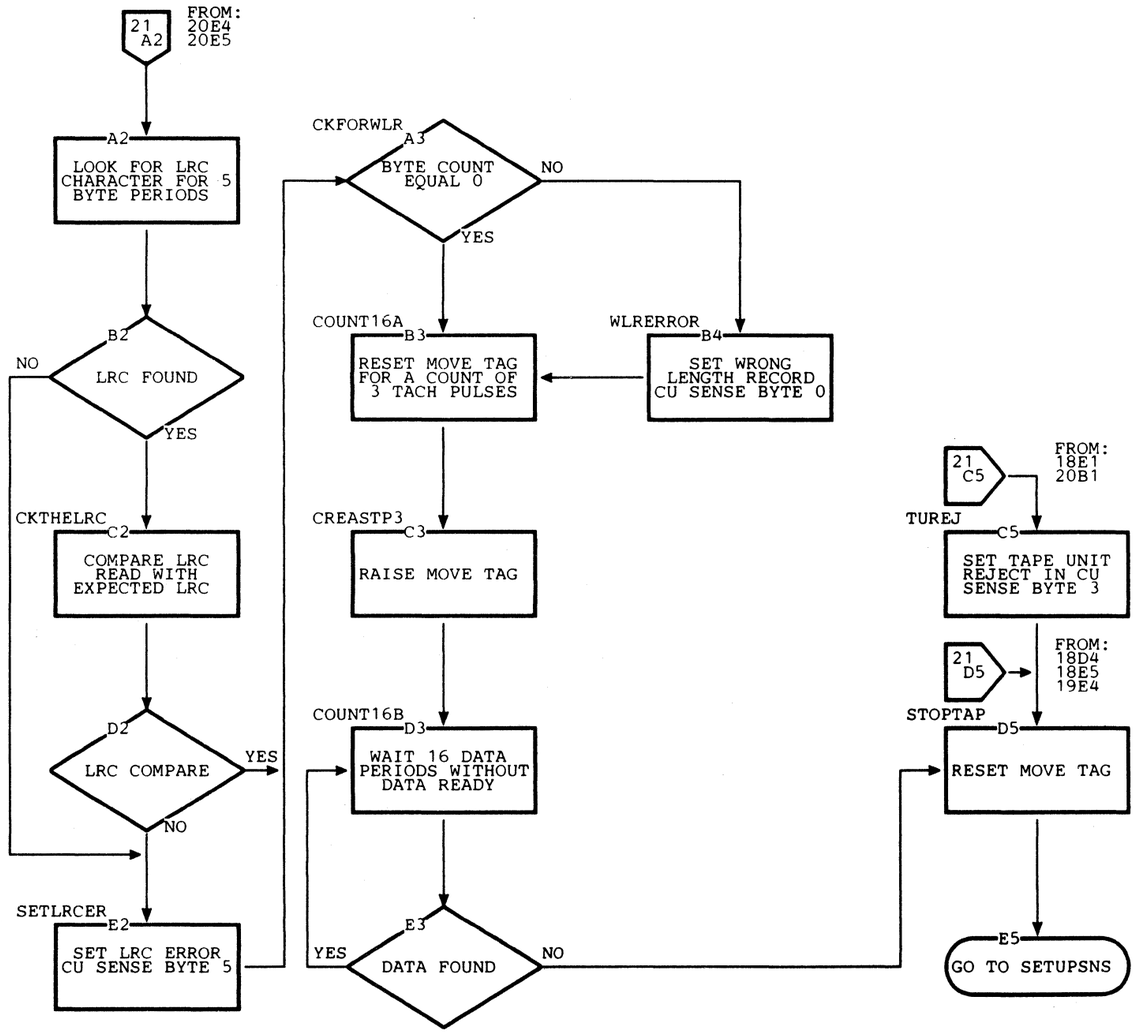
TWOUSLOP — Loop for 1 1/2 byte periods searching for data. If none is found, a byte may have been lost. Loop again for 1 more byte period. If still no data, search for the CRC and LRC characters. If reading backward, send the last byte read to CPU.



Read Operation (System/3)

COUNT16A — The data is not a tape mark. The Move Tag is reset for a count of 3 to signal the tape unit to prepare to stop. The Move Tag is then reactivated to search for data. If no data is found after 16 data periods, the tape unit stops. If data is found, continue looping until no data is found for 16 data periods.

STOPTAP — The operation is completed or an error has occurred. Reset Service In and the Move tag. Store the sense data, run the internal diagnostics, and update tape unit status before returning to IDLE.

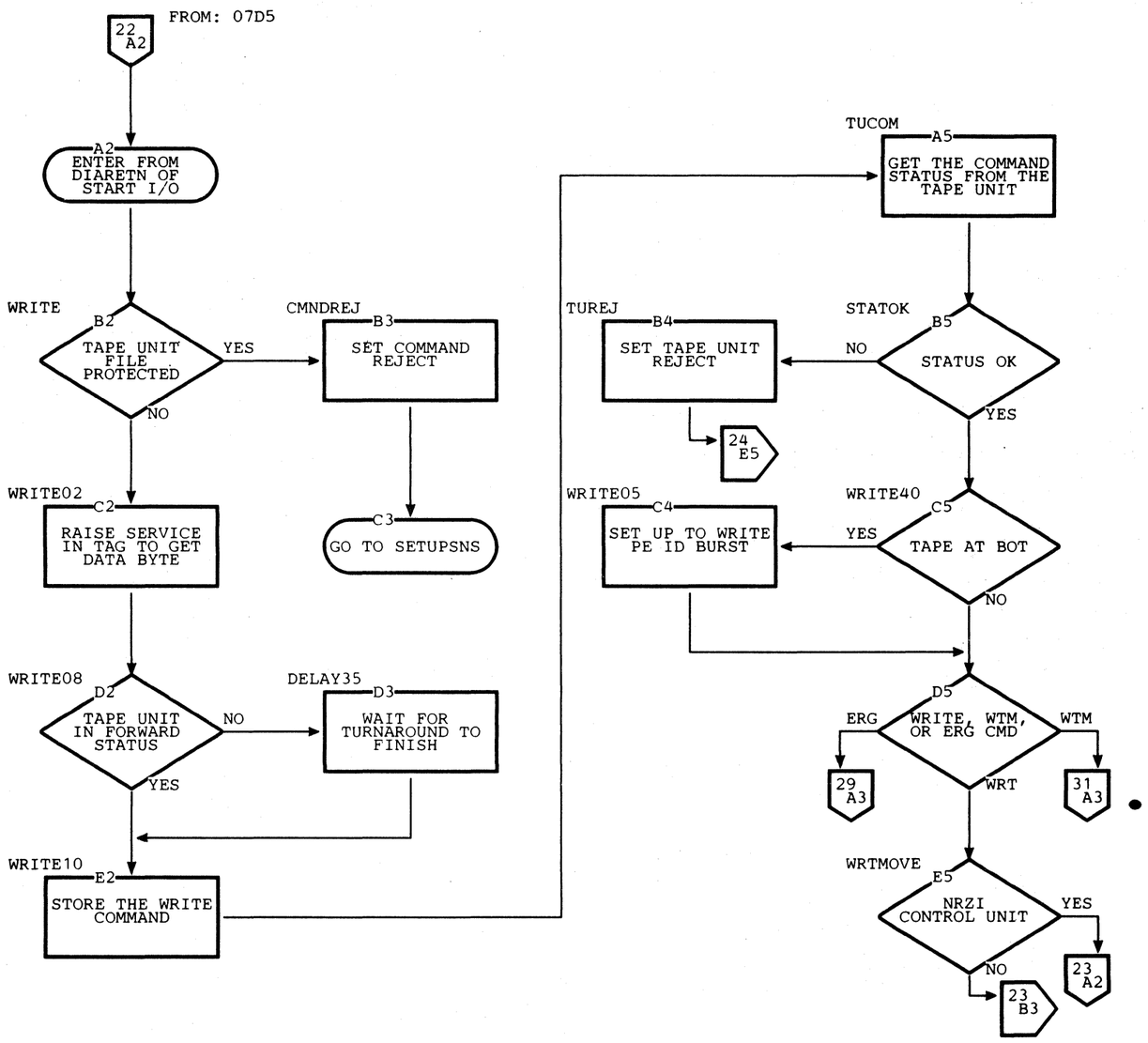


Write Operation (System/3)

Objectives

- To write data (PE or NRZI) on tape.

WRITE	Determine if tape unit is file protected. If it is, set Command Reject and terminate the operation.
WRITE08	Check the status of the tape unit. If in write status, store the write command. If in backward status, wait for turnaround sequence before storing write command. If in read forward status and not at BOT, hitch tape backward before storing write command.
TUCOM	The tape unit is not file protected. Get the command status and set the tape unit to write status. If command status is not good, reject the tape unit and terminate the operation.
WRITE40	Check that tape is at BOT. If it is, set up to write the PE ID Burst.
WRTMOVE	Determine if NRZI is installed in tape control . If not, go to TUMOVE.



Write Operation (System/3)

FEATWRT1 — Tape control has NRZI installed. Determine if tape is at BOT. If not at BOT, check that the tape unit unit is already set to NRZI mode. If at BOT, check that tape unit has Dual Density feature.

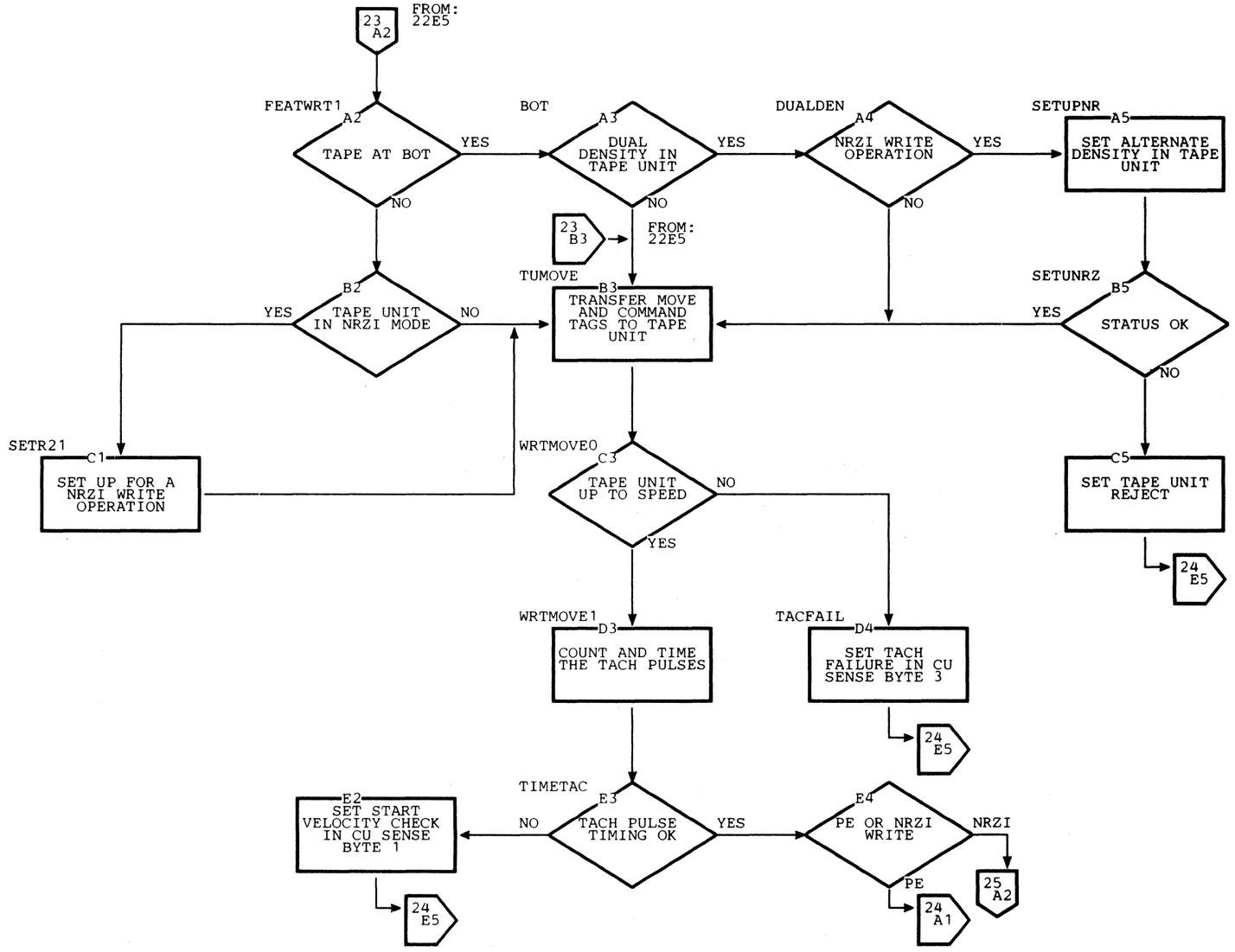
DUALDEN — Tape unit has dual density installed and is at BOT. Check Mode Set of the Tape control.

SETUPNR — A Mode Set command was executed. Set the tape unit to NRZI and check the status.

TUMOVE — The tape unit status is good and ready to write (PE or NRZI). Transfer Move Tag to get tape moving.

WRTMOVE0 — The tape unit is in write status and Move Tag transferred. When Gap Control is detected the the tape unit is up to speed.

WRTMOVE1 — Set up to count and time tach pulses to verify tape speed. If tach count is bad, set tachometer failure; if tach timing is bad, set Start Velocity Check. Terminate the operation if either condition occurs.



Write Operation (System/3)

PBWPGM The tape unit is at BOT and in PE Mode. Write the PE ID Burst before writing data on tape.

WRDAPGM The PE ID burst has been written or the tape is not at BOT. Write a preamble of 40 zeros and all ones marker.

WRTDATA The preamble is written. Get the data byte from CPU and check it for parity. If parity is bad, set bus out check.

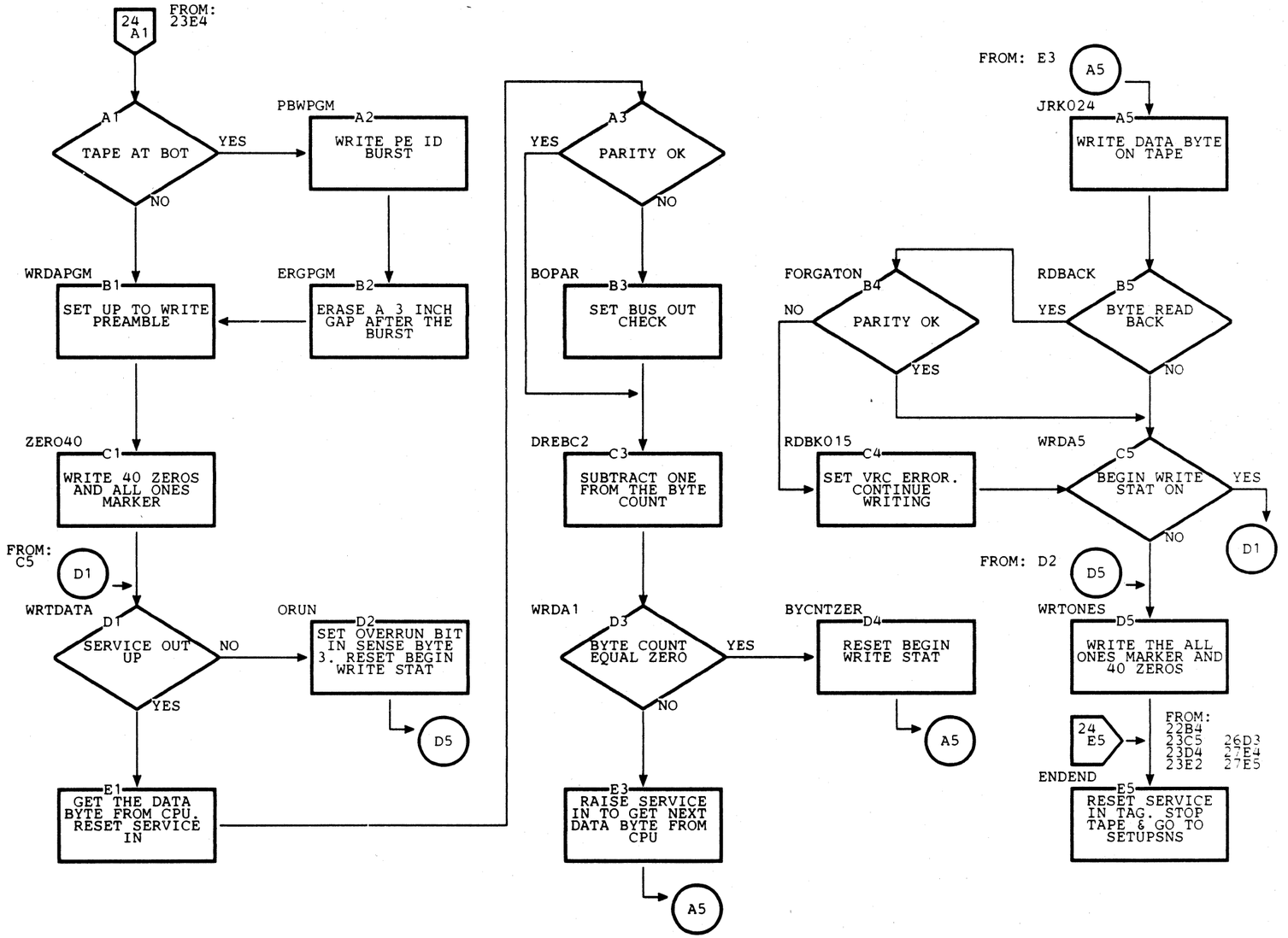
DREBC2 Decrement the byte count by one.

BYCNTZER Check the byte count. If the count is zero, reset the Begin Write stat to indicate the last byte has been received. If byte count is not zero, raise Service In to get next byte.

JRK024 Transfer byte to the tape unit and wait for read back. If a parity error is detected, set VRC Error.

WRTONES The byte count is zero and the last byte written. Write the postamble. Continue read back until the end of block is sensed.

ENDEND The operation is completed or an error detected. Reset the Service In and Move Tags. Store the sense data, update the tape unit status and return to IDLE.

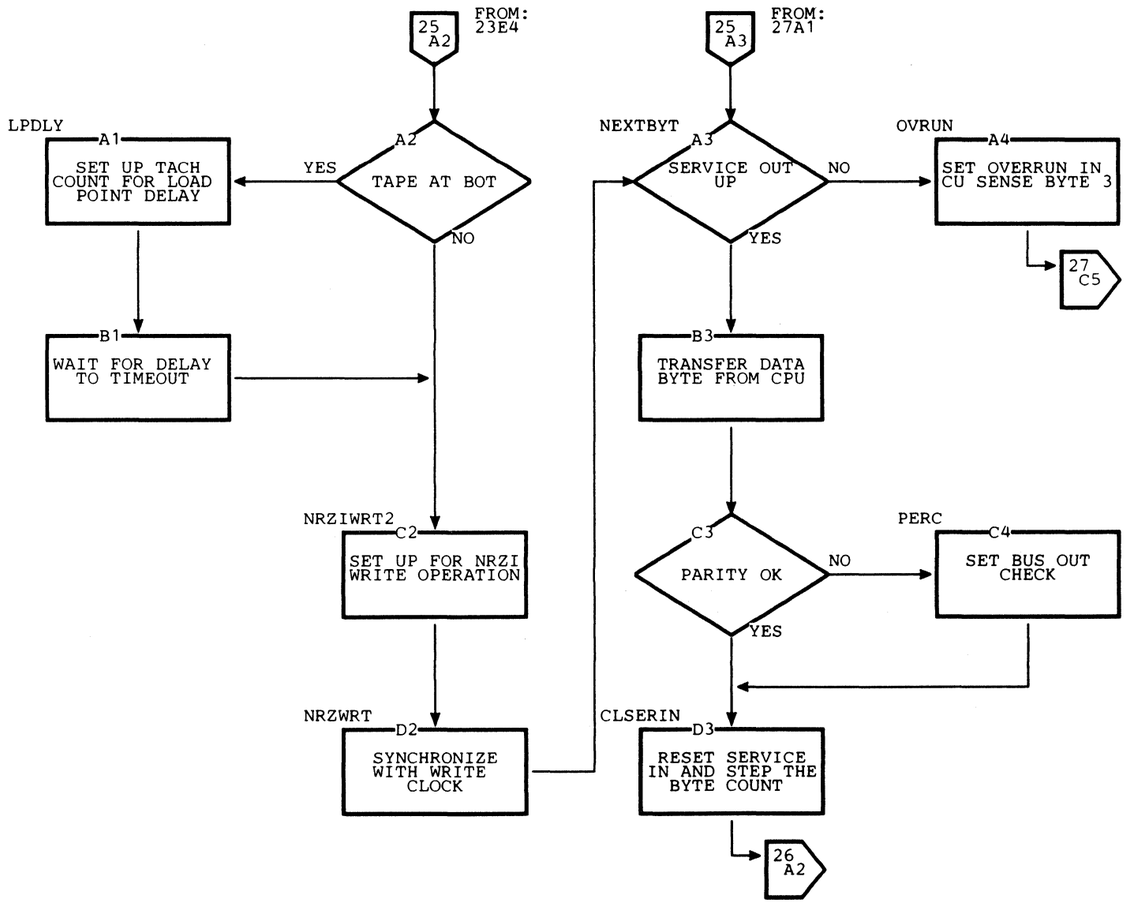


Write Operation (System/3)

LPDLY — This is a NRZI write operation and tape is at BOT. Set up for a load point delay.

NEXTBYT — Get the data byte from CPU. Check for correct parity. If bad, set Bus Out Check.

CLSERIN — Reset Service In and decrement byte count. Check if byte count equals zero.



Write Operation (System/3)

HANGUP3 — Determine if Service Out was reset after resetting Service In Tag.

TAGCHK — Service Out is still active. Set Control Tag Check in Hardware Error byte.

SETSERI — Service Out is inactive. Raise Service In to get next byte from CPU.

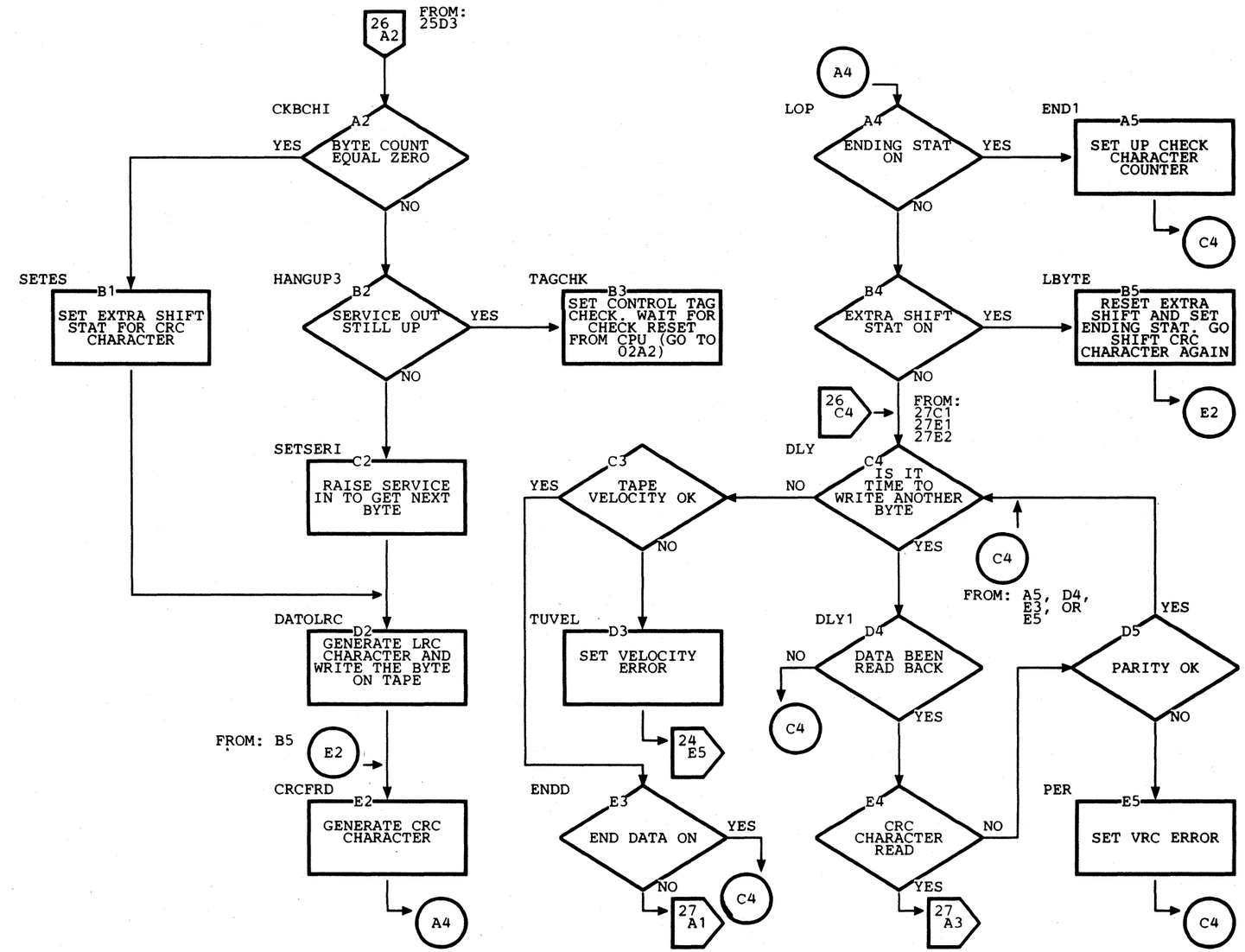
LOP — Check if Ending Stat bit is on. Ending Stat is set when the byte count equals zero and the last CRC calculation has been made.

END1 — The Ending Stat is on. Set up a counter to ensure correct spacing between check characters.

DLY — The LRC and CRC characters have been calculated. Wait until either a byte is read back or another byte is written.

Each time a byte is written and until it is read back a data counter is stepped. The count is maintained to ensure that tape is moving at the correct speed at the beginning of the operation. The first byte should be read back after writing 112 to 128 bytes. If no data is read back before writing 128 bytes, Tape Velocity Check is set. If data is read back before writing 112 bytes the No Noise stat is set which will set a VRC Error during read back.

When a byte is read back, parity is checked. If bad parity is detected, set VRC Error.



Write Operation (System/3)

ENCHAR The Ending Stat is set, step the Check Character Counter. The counter is stepped three times before writing each check character. (See END1.)

END5 Write the CRC character and set up to write the LRC character.

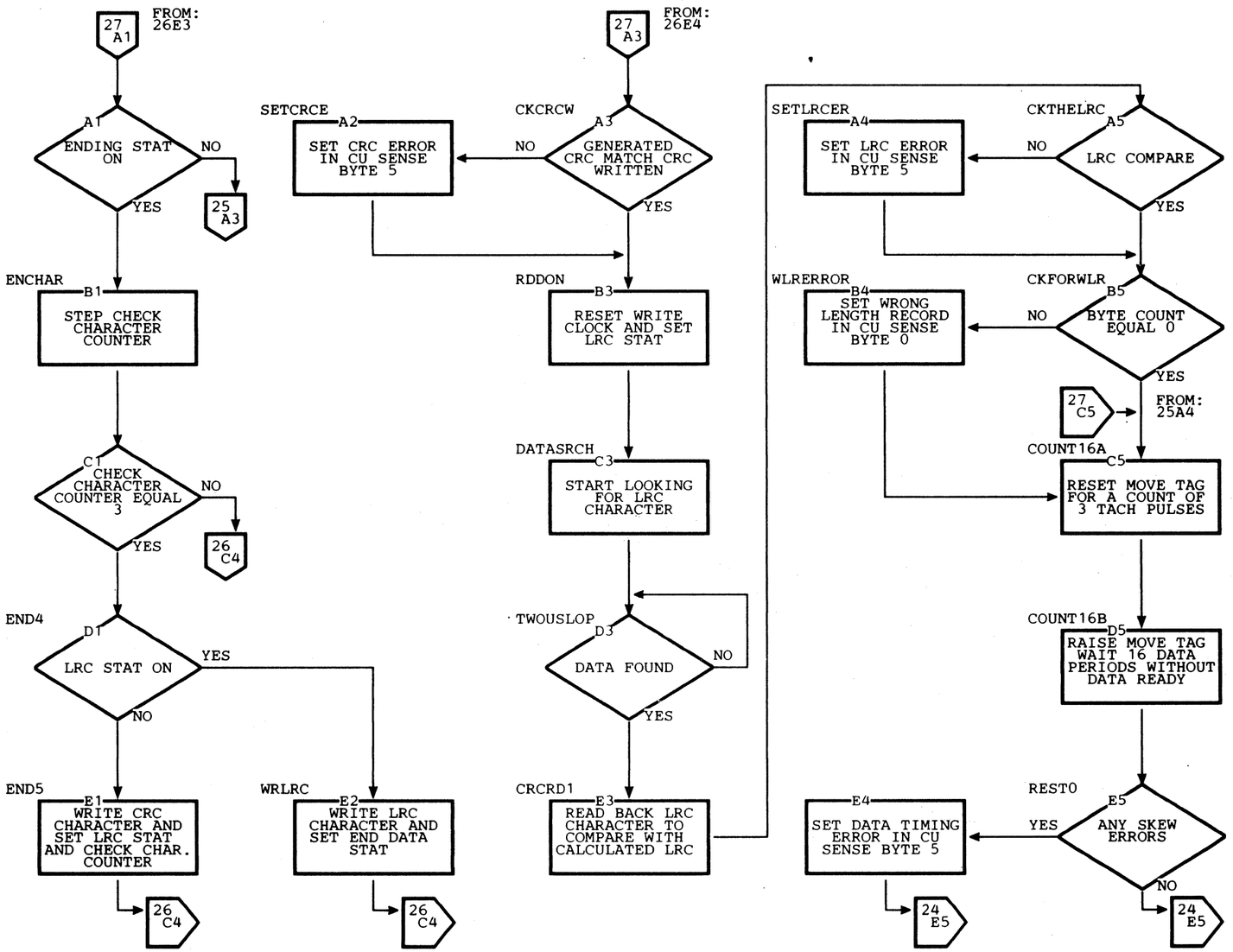
WRLRC Write the LRC character and set up to end the write operation.

CKCRCW The byte read back is the CRC character. Compare the CRC written with the CRC calculated.

TWOUSLOP Wait for the LRC character.

CRCRD1 The byte read back is the LRC character. Compare the calculated LRC with the LRC read back.

COUNT16A The data is not a tape mark. The Move Tag is reset for a count of 3 to signal the tape unit to prepare to stop. The Move Tag is then reactivated to search for data. If no data is found after 16 data periods, the tape unit stops. If data is found, continue looping until no data is found for 16 data periods.



Data Secutity Erase (DSE) (System/3)

Objectives

- To erase tape from its present position to the end of tape (EOT) marker. When the EOT marker is detected, the Tape Indicate lamp is turned on.

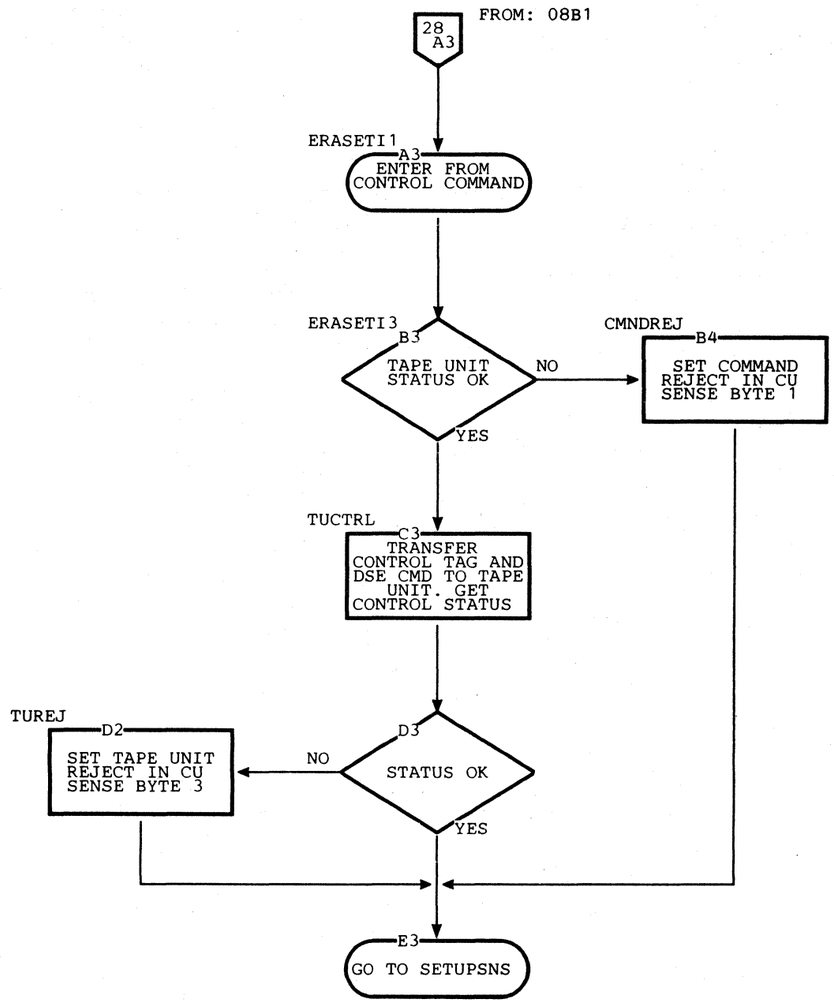
ERASETI1 — The Data Security Erase command was decoded during the CONTROL routine.

ERASETI3 — Get tape unit status. Tape unit must be in write status, not busy, and not file protected. If status is not correct, set Command Reject and terminate the operation. If already at EOT, go to SETUPSNS to finish the operation.

TUCTRL — Tape unit status is good. Transfer the Control Tag and command to the tape unit. Read in the status byte from the tape unit.

If tape unit status is good, store the sense data, run internal diagnostics and return to IDLE.

TUREJ — Tape unit status is bad, set tape unit reject and terminate the operation.



Erase Gap Command (System/3)

Objectives

To erase a 3 inch gap on tape.

WRITE40 — Check that tape is at BOT. If it is, set up to write PE ID Burst.

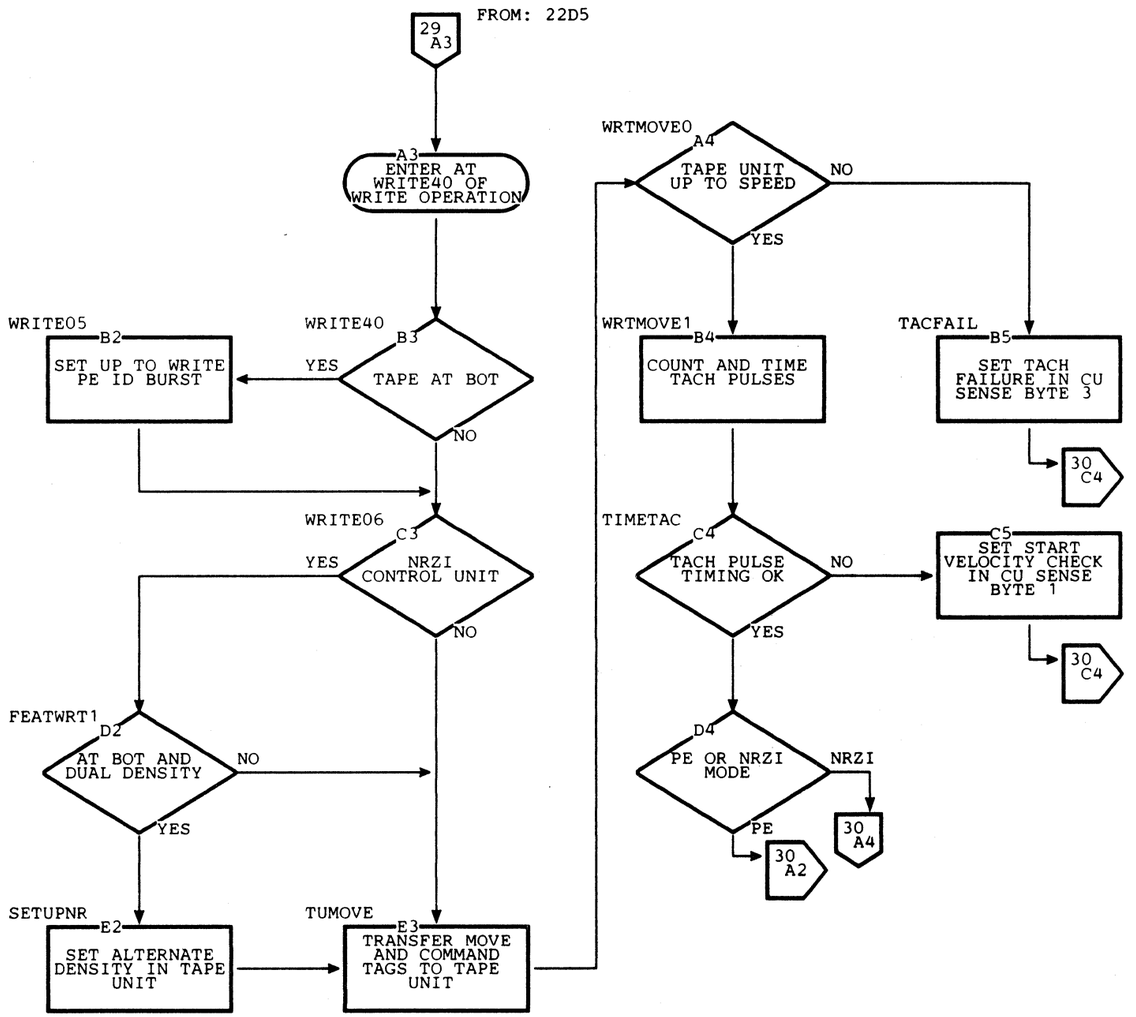
FEATWRT1 — Tape control has NRZI installed. Determine if tape is at BOT. If not at BOT, check that the tape unit is already set to NRZI mode.

SETUPNR — A Mode Set command was issued Set the tape unit to NRZI and check the status.

TUMOVE — The tape unit status is good and ready to erase tape. Transfer Move Tag to the tape unit.

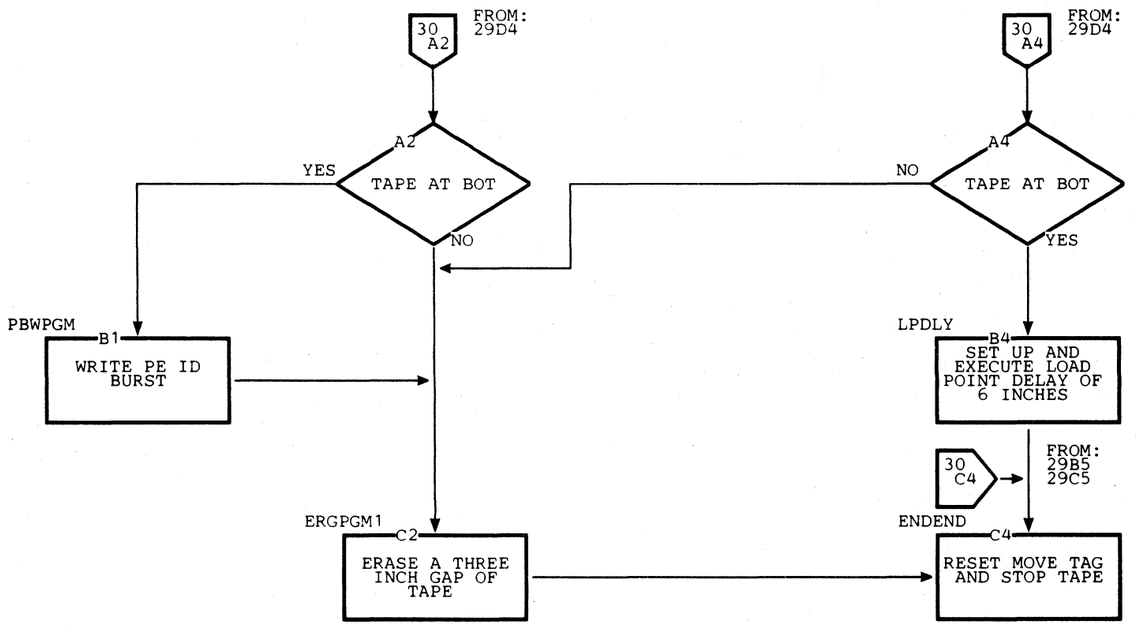
WRTMOVE0 — The tape unit is in write status and Move Tag transferred. When Gap Control is detected the the tape unit is up to speed.

WRTMOVE1 — Set up to count and time tach pulses to verify tape speed. If tach count is not good, set tachometer failure; if tach timing is bad, set Start Velocity Check. Terminate the operation if either error occurs.



Erase Gap Command (System/3)

PBWPGM	The tape unit is at BOT and in PE Mode. Write the PE ID Burst before erasing tape.
LPDLY	This is a NRZI operation and tape is at BOT. Set up for a load point delay.
ENDEND	The operation is completed or an error detected. Reset the Service In and Move tags. Store the sense data, update the tape unit status and return to IDLE.

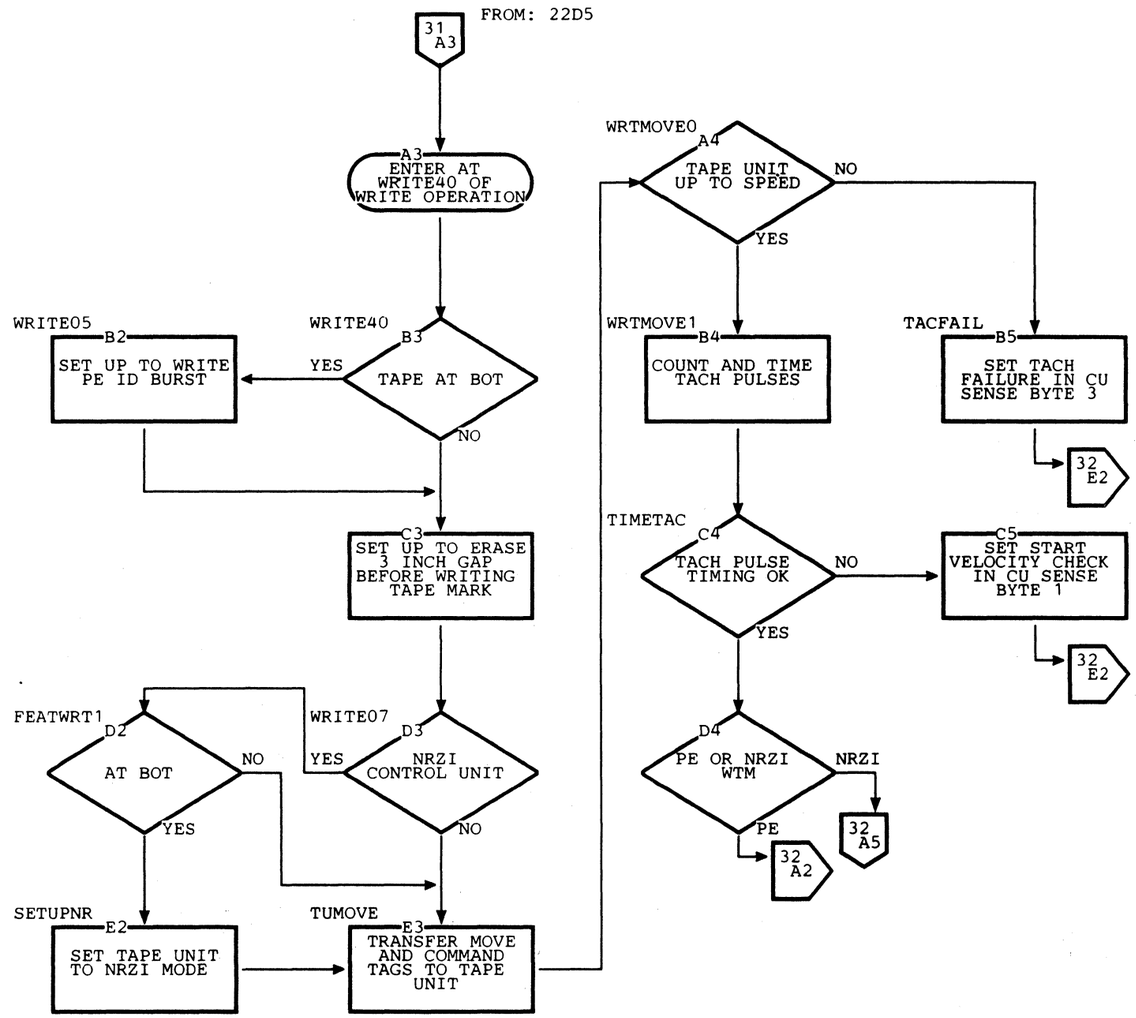


Write Tape Mark (WTM) (System/3)

Objectives

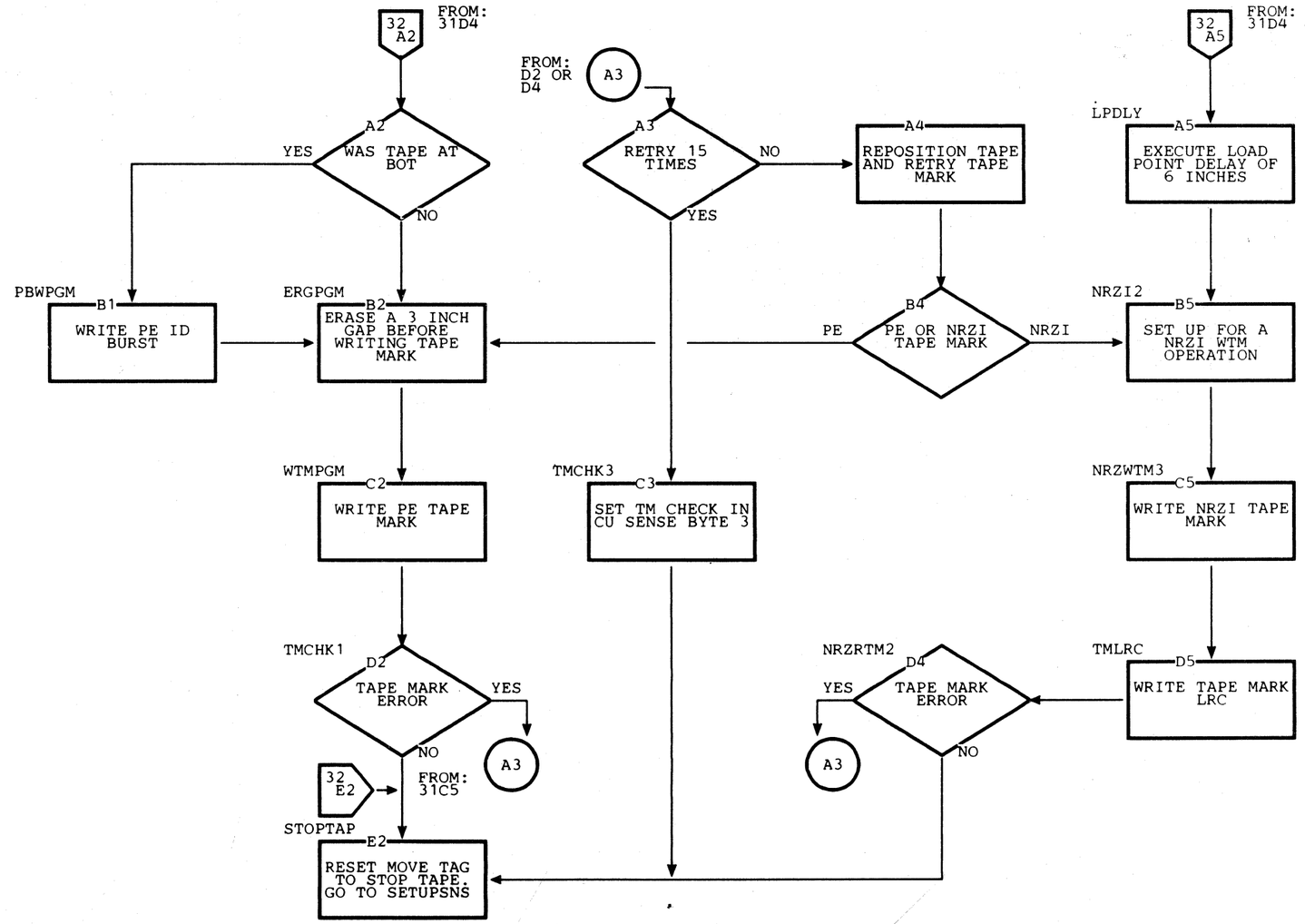
- To write a PE or NRZI tape mark.
- The subsystem generates the tape mark; no data is transferred between CPU and the subsystem.

WRITE40	Check that tape is at BOT. If it is set up to write PE ID Burst.
FEATWRT1	Tape control has NRZI installed. Determine if tape is at BOT. If not at BOT, check that the tape unit is already set to NRZI mode.
SETUPNR	A Mode Set command was issued. Set the tape unit to NRZI and check the status.
TUMOVE	The tape unit status is good and ready to write the tape mark. Transfer the Move tag to the tape unit.
WRTMOVE0	The tape unit is in write status and Move tag transferred. When Gap Control is detected the tape unit is up to speed.
WRTMOVE1	Set up to count and time tach pulses to verify tape speed. If tach count is bad, set tachometer failure; if tach timing is bad, set Start Velocity Check. Terminate the operation if either error occurs.



Write Tape Mark (WTM) (System/3)

PBWPGM	The tape unit is at BOT and in PE Mode. Write the PE ID Burst before writing the tape mark.
LPDLY	This is a NRZI operation and tape is at BOT. Set up for a load point delay.
TMCHK3	Tape control could not write a tape mark after 15 tries. Set Tape Mark Check and terminate the operation.
STOPTAP	The operation is completed or error detected. Reset the Move tag to stop tape. Store the sense data, update the tape unit status, and return to IDLE.

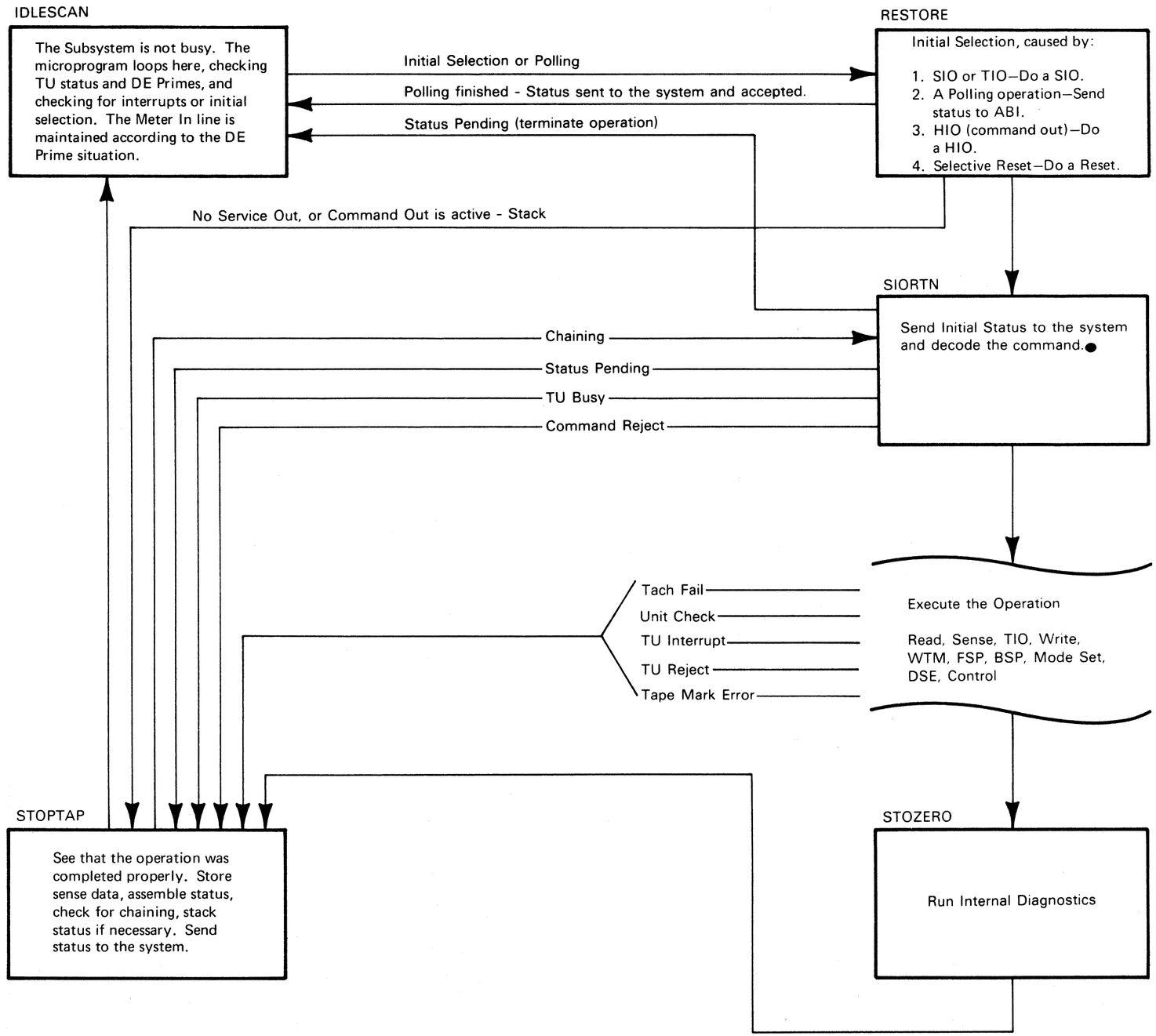


Microprogram Overview (System/360/370)

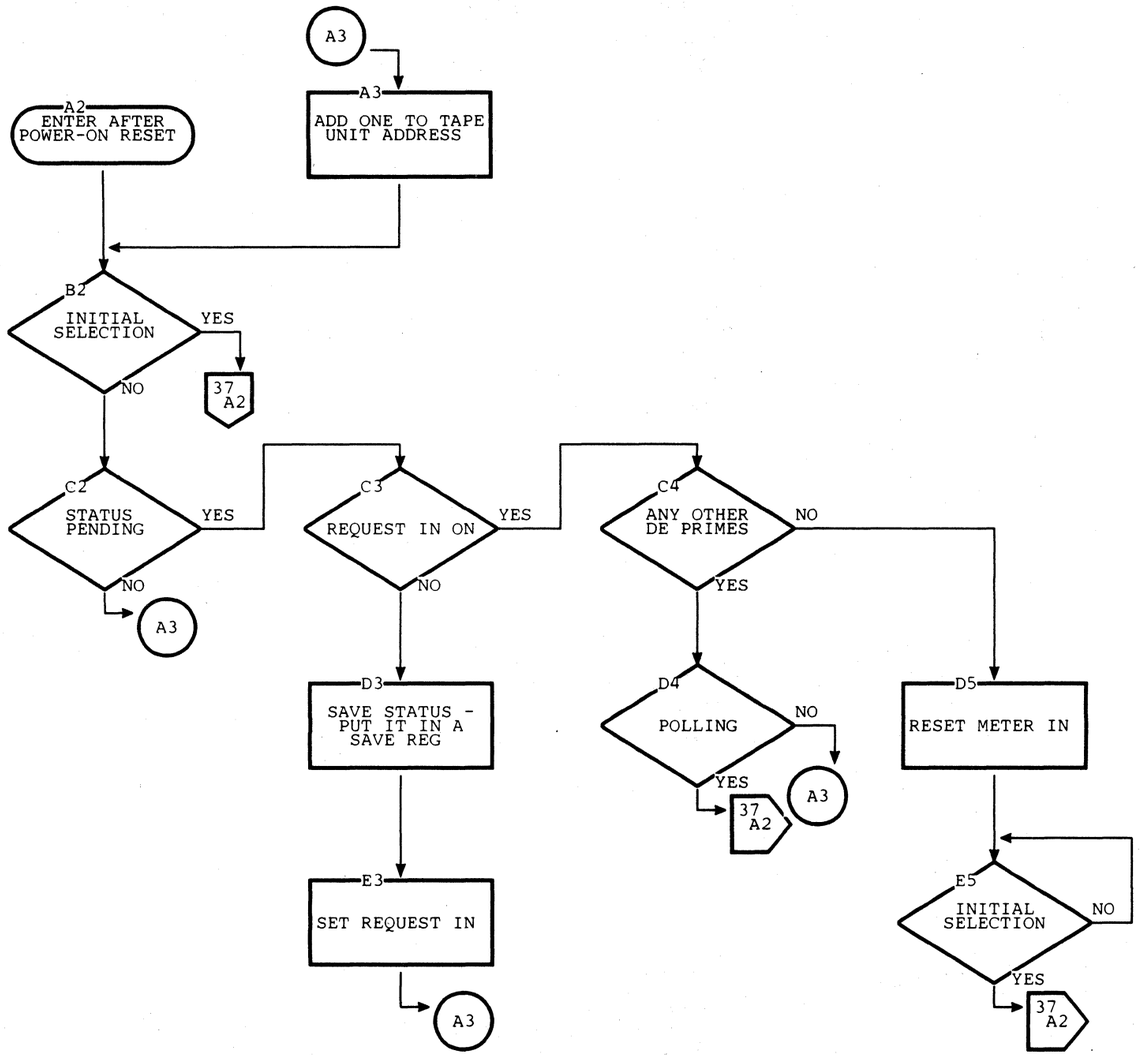
This section contains the tape control operational flowcharts used when the tape control is attached to a System/360 or System/370. All tape control operations are executed by a microprogram stored in ROS. The flowcharts illustrate the sequence of routines that perform the operations.

Program labels are included on the flowcharts as reference pointers to the microprogram listing. For the particular details of a routine, use the label and the cross-reference list in the back of the program listing.

Note: If the 3410/3411 is attached to System/370 Model 125, see flowcharts starting at MicroProcessor 67.



IDLESCAN Overview (System/360/370)

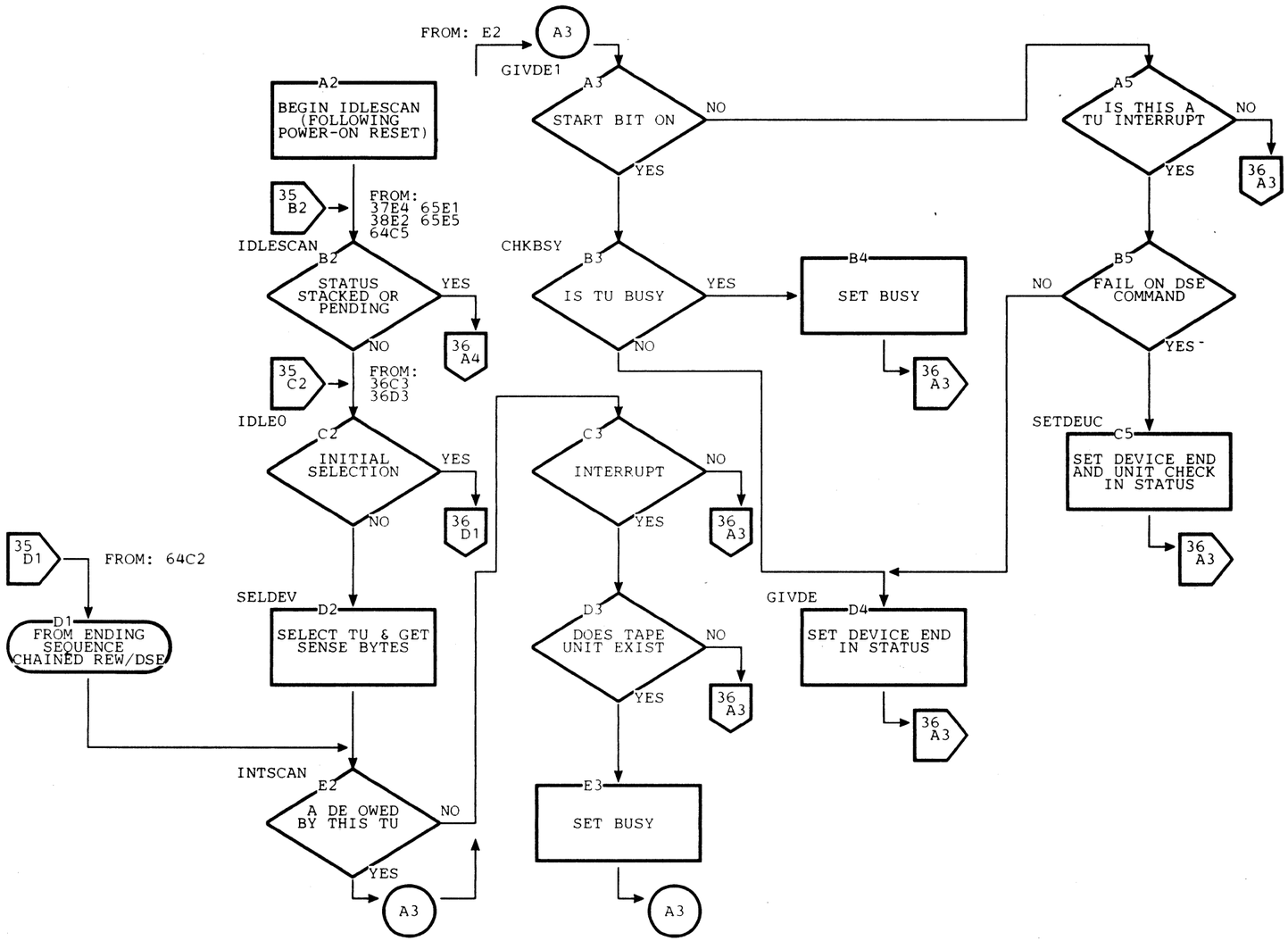


IDLESCAN (System/360/370)

Objectives

- Monitor Device End Primes for all tape units and keep the Meter In line in the proper state.
- Detect an Initial Selection or Polling sequence and branch to the proper microprogram location.
- Detect interrupts from tape units and set Device End and Unit Check in status when appropriate.

IDLE0	There is no status pending (no bits on in the pending status register). This is the return point (from 36C3 or 36D3) of the scanning loop.
SETDEUC	A DSE operation failed.
GIVEDE	A DSE or Rewind is properly completed.

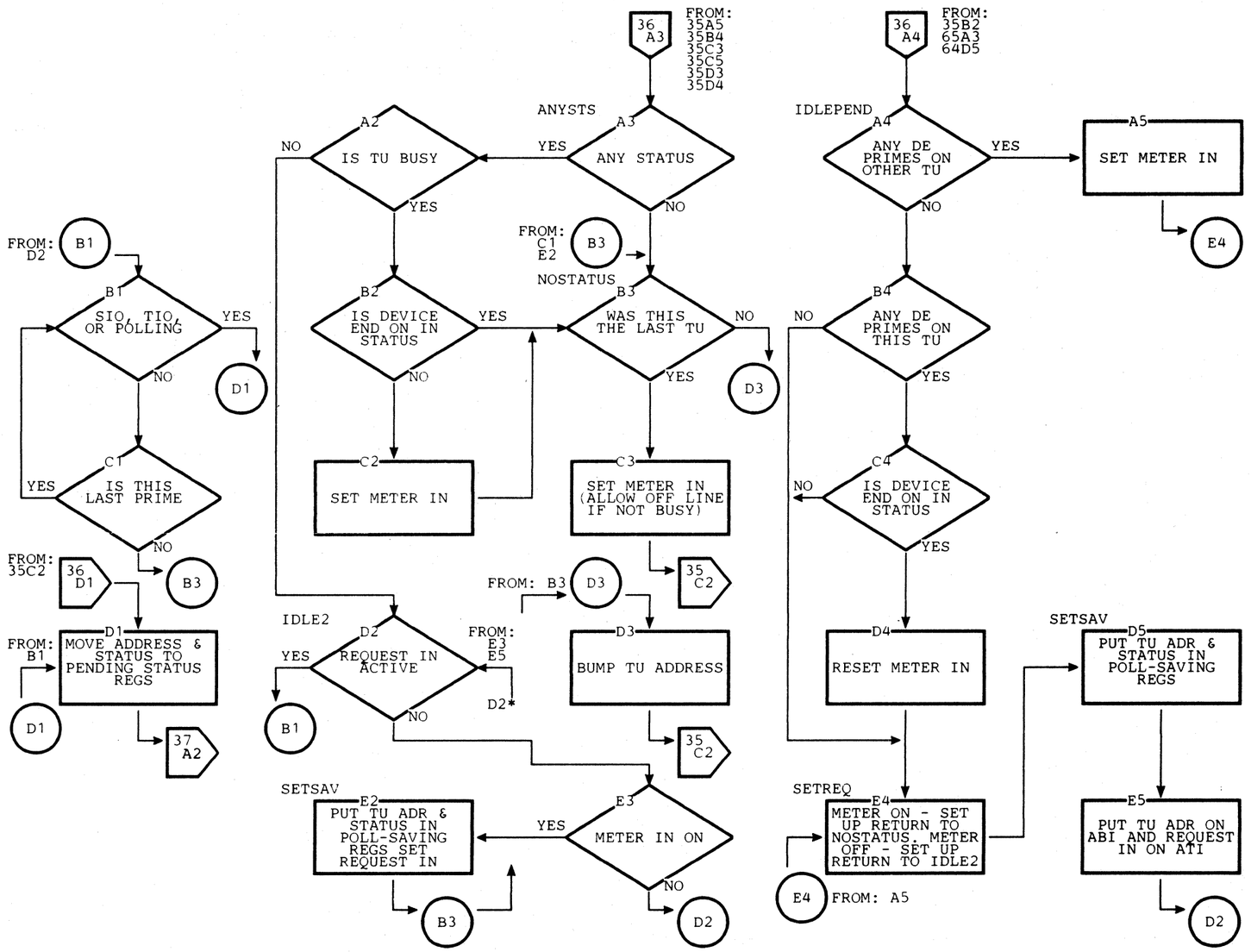


IDLESCAN (System/360/370)

NOSTATUS There is no status pending, Device-End interrupts, or Initial Selection. If this is not the last TU, step the address. Continue the scanning loop.

RESTORE Either Initial Selection or Polling has been detected, or status is pending.

SETSAV Status is pending. Send it to ABI if Request In is active.

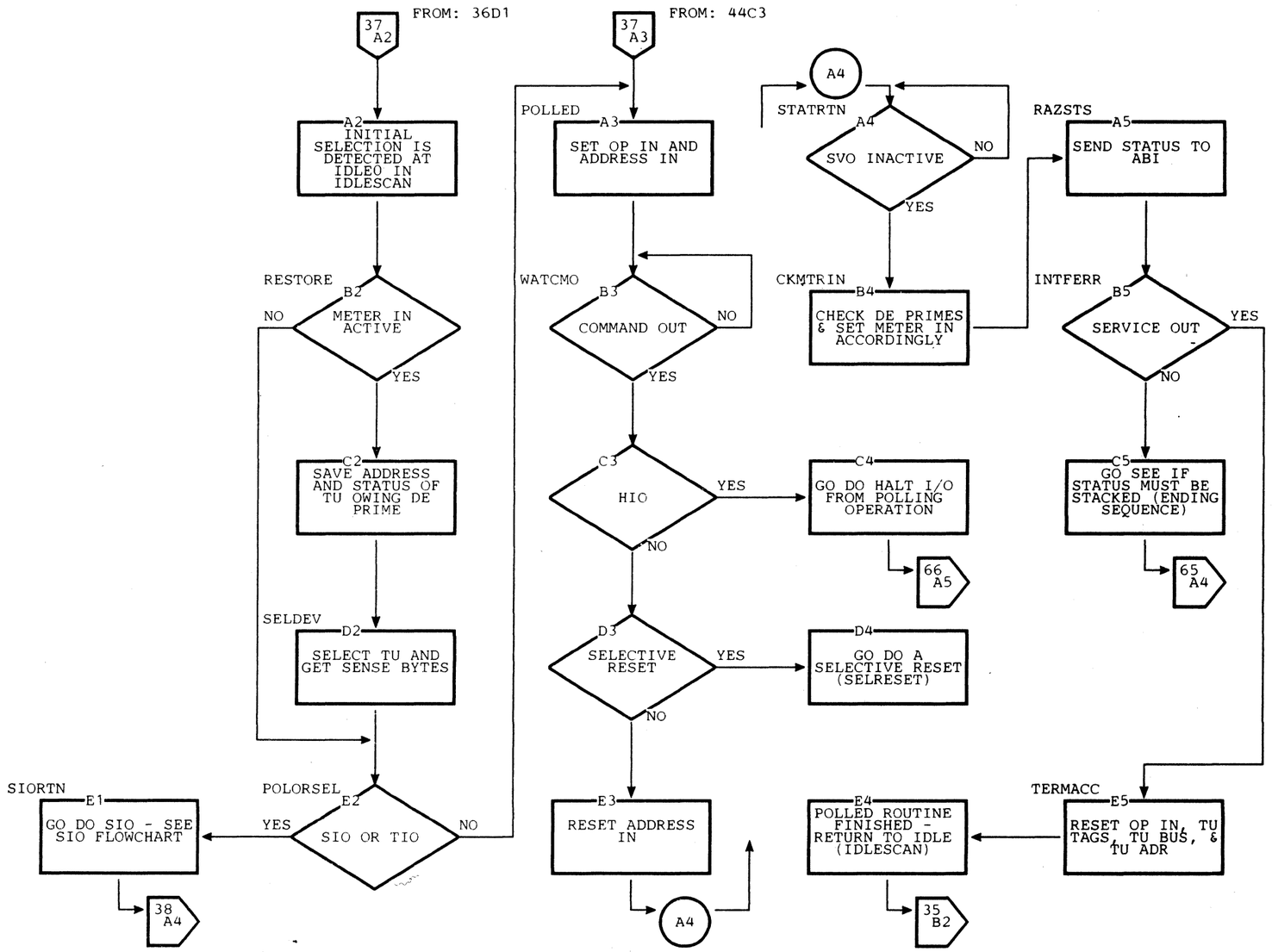


Initial Selection (System/360/370)

Objectives

- Save any stacked or pending status.
- Send status to ABI during a polling sequence.
- Branch to SIO, TIO, HIO, or Reset.

CKMTRIN Meter In is kept on as long as any DE Primes are outstanding.

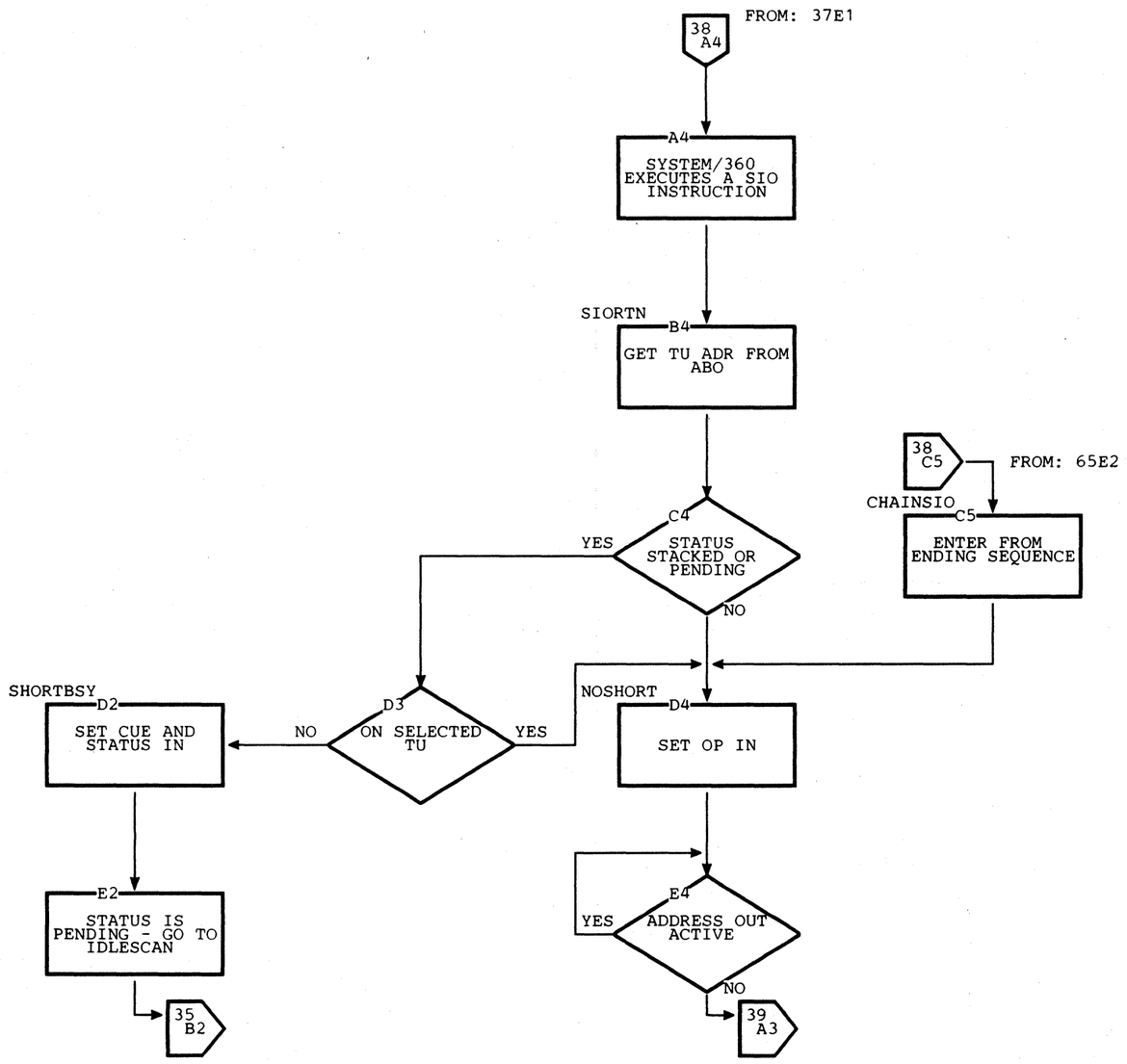


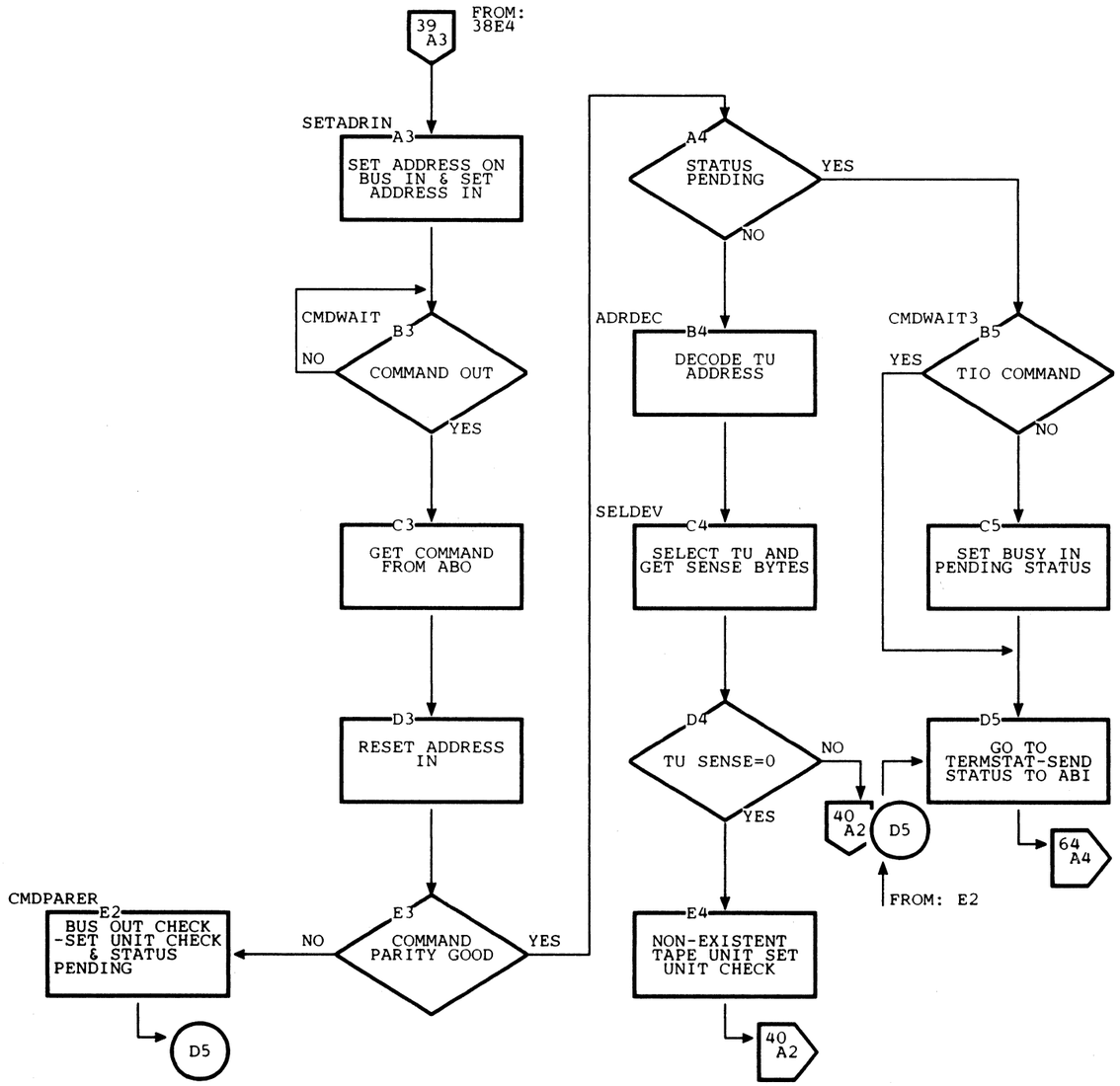
START I/O and TEST I/O (System/360/370)

Objectives

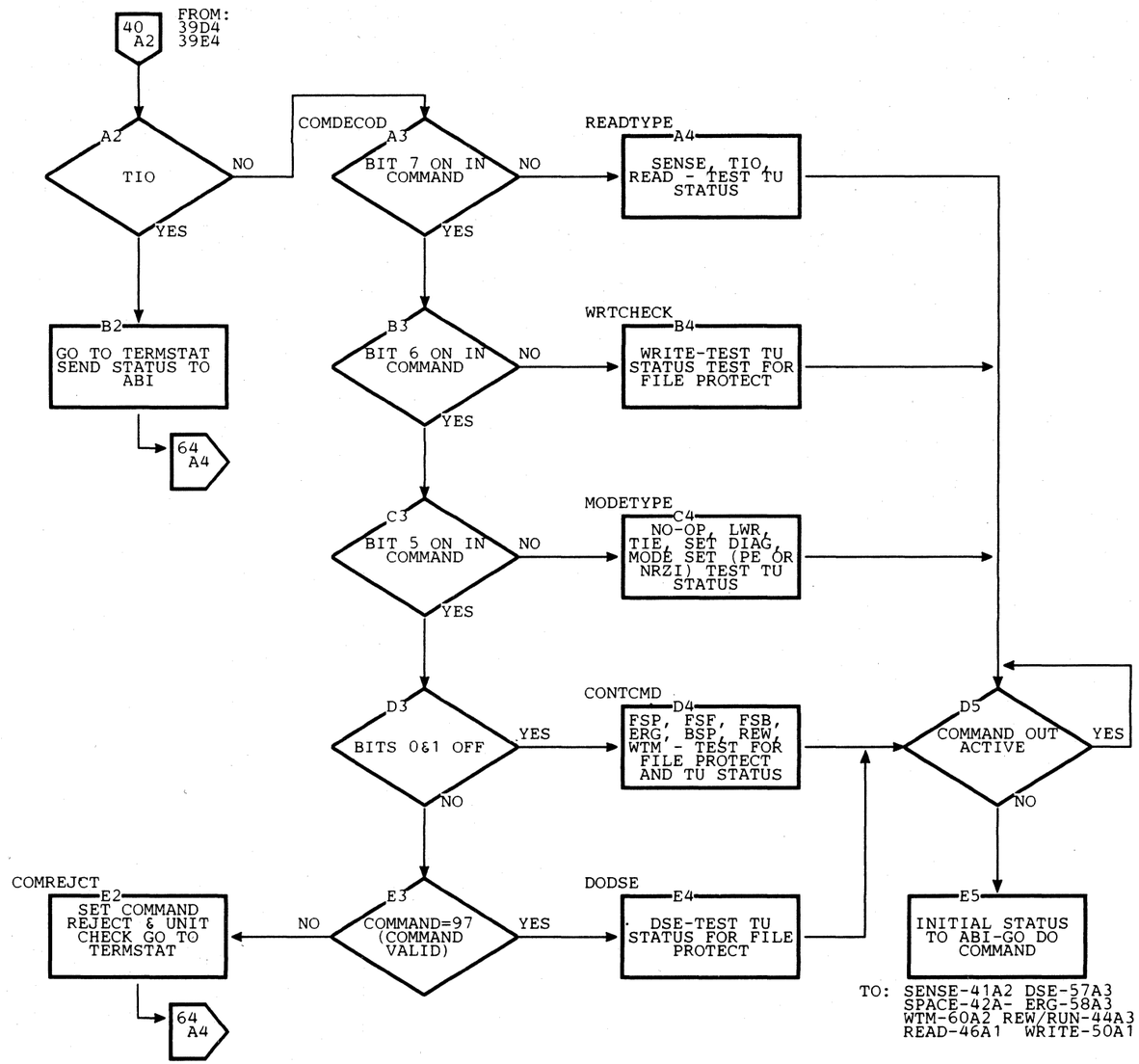
- Prevent the loss of pending status (SHORTBUSY).
- Get the command from ABO and check its parity.
- Decode the command and branch to the proper microprogram location.
- Reject any invalid commands.

SHORTBUSY	Status is stacked or pending for a tape unit other than the selected one. This status must be sent to ABI first.
SELDEV	Test the tape unit status and set Unit Check if required.
COMDECOD	Tape unit status is good. Decode the command and set up links to exit the status handling routine.




39
A3
FROM:
38E4
SETADRIN
A3
SET ADDRESS ON BUS IN & SET ADDRESS IN
CMDWAIT
B3
NO
COMMAND OUT
YES
C3
GET COMMAND FROM ABO
D3
RESET ADDRESS IN
E3
COMMAND PARITY GOOD
NO
YES
CMDPARER
E2
BUS OUT CHECK -SET UNIT CHECK & STATUS PENDING
D5
A4
STATUS PENDING
YES
NO
ADRDEC
B4
DECODE TU ADDRESS
SELDEV
C4
SELECT TU AND GET SENSE BYTES
D4
TU SENSE=0
NO
YES
E4
NON-EXISTENT TAPE UNIT SET UNIT CHECK
40
A2
CMDWAIT3
B5
YES
TIO COMMAND
NO
C5
SET BUSY IN PENDING STATUS
D5
GO TO TERMSTAT-SEND STATUS TO ABI
64
A4
40
A2
D5
FROM: E2

Start I/O and Test I/O (System/360/370)



Sense Operation (System/360/370)

Objectives

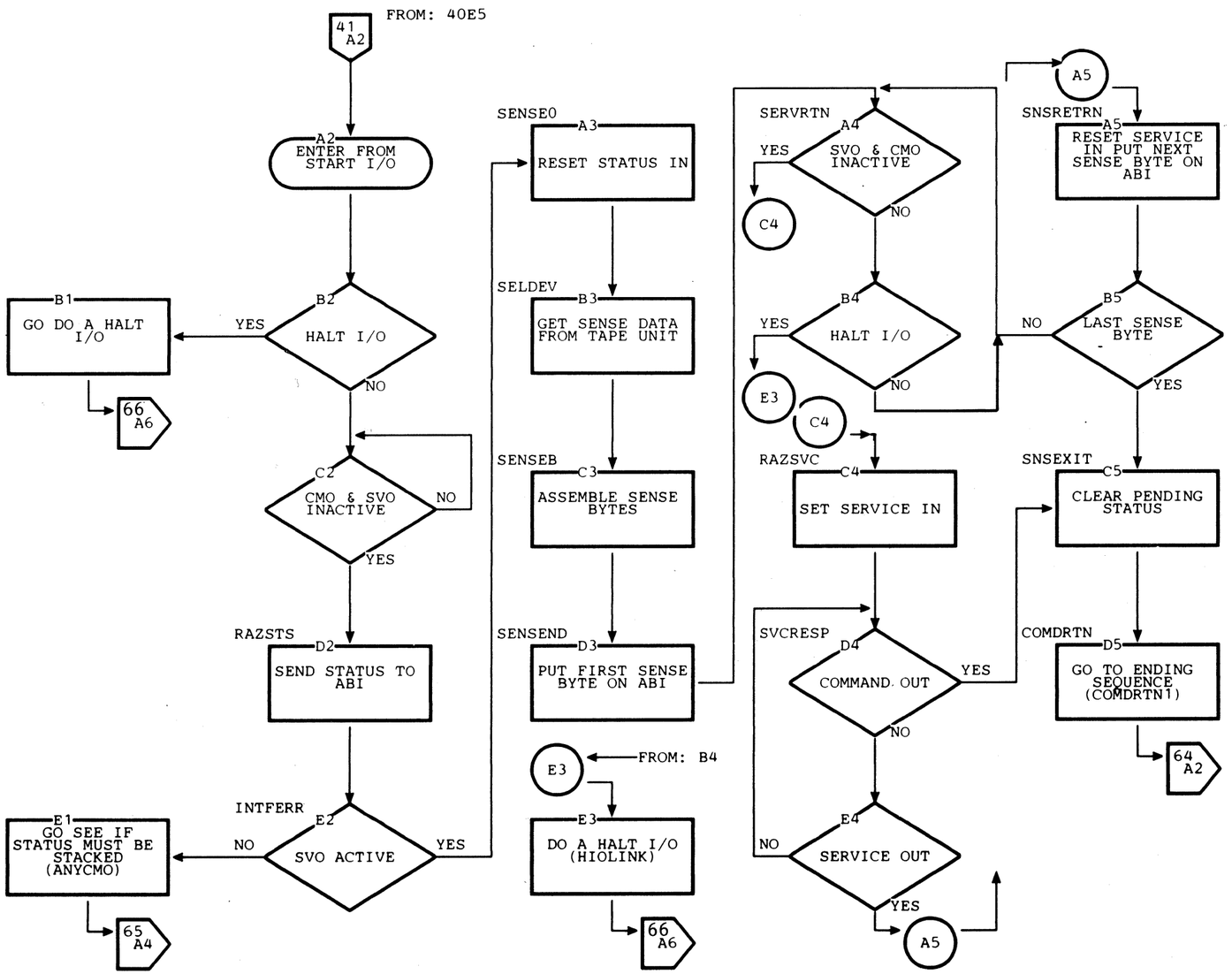
- Send Status and eight Sense Bytes to the System.

RAZSTS Initial Selection is completed, and Command Out and Service In are both inactive.

INTFERR If Service Out is active the system accepted the status. If not, the status may have to be stacked and the Sense operation terminated.

SENSEND The system accepted the status and the control unit assembled the sense bytes. The control unit puts the first Sense Byte on the ABI.

SNSRETRN The system accepted the previous sense byte. The control unit puts the next one on the ABI.



Space Operation (System/360/370)

Objectives

FWDSPBL The microprogram decoded a Forward-Space-Block command. Enter from CONTCMD (40E5).

FWDSPFL The microprogram decoded a Forward-Space-File command. Enter from CONTCMD (40E5).

BKSPBL The microprogram decoded a Backward-Space-Block command. Enter from CONTCMD (40E5).

BKSPFL The microprogram decoded a Backward-Space-File command. Enter from CONTCMD (40E5).

CKMOVIN The command is a Backward Space. A forward read command is sent to the tape unit to cause a forward hitch. If the tape unit is in backward status the microprogram delays while the tape unit changes to forward status.

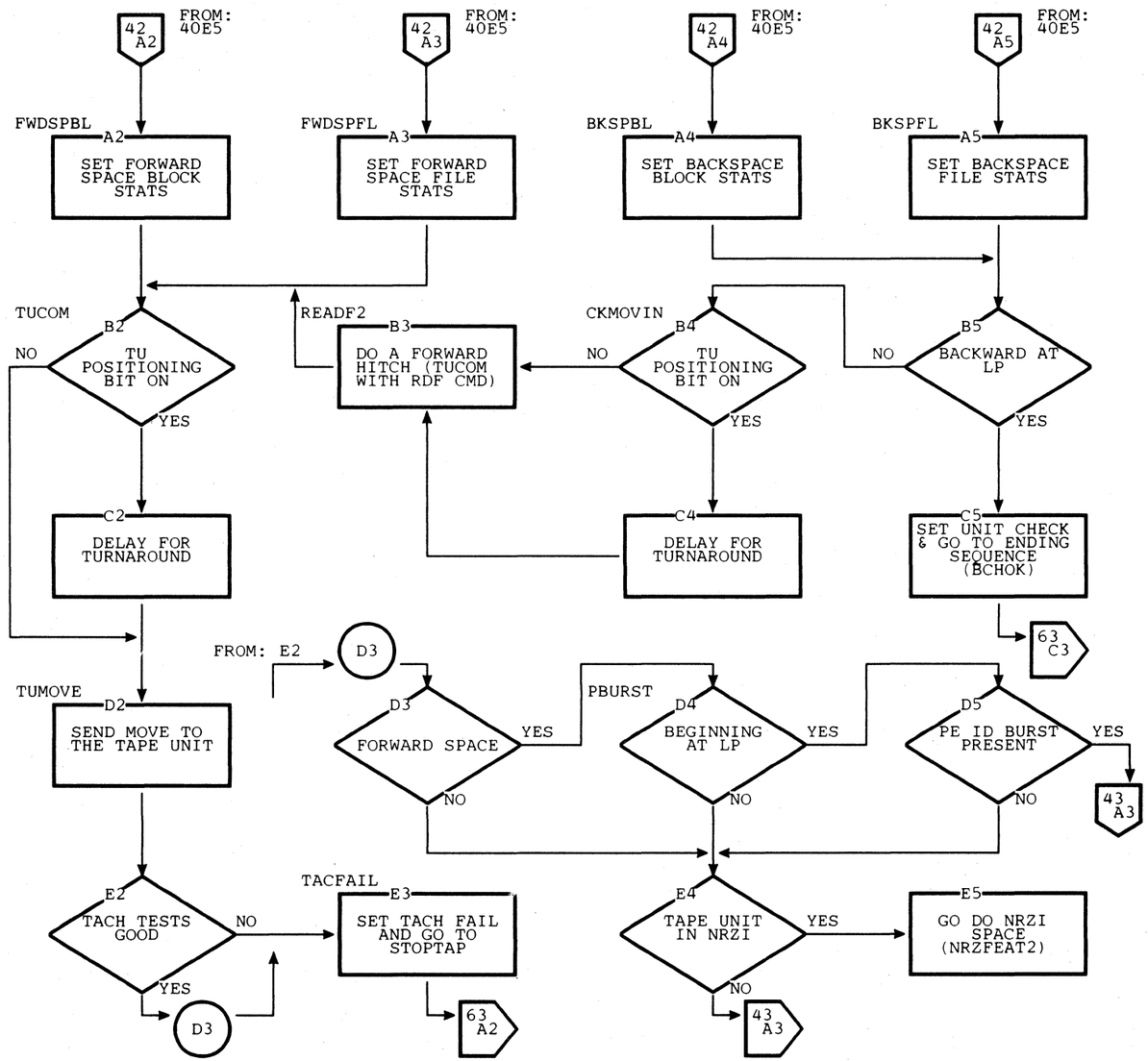
TUCOM Forward Space: The Forward Space command is sent to the tape unit. No forward hitch was executed. If the tape unit is in backward status, the microprogram delays while the tape unit changes to forward status.

Backward Space: The backward space command is sent to the tape unit following a forward hitch. A delay is needed while the tape unit changes to backward status.

TUMOVE The tape unit is in the proper directional status. Send 'Move' to the tape unit to start tape motion.

TACFAIL The tach pulses indicate the capstan is not moving at the correct speed.

PBURST The capstan is moving forward at the correct speed. If the tape started at load point, test for a PE identification burst.



Space Operation (System/360/370)

BOBSCH — Entry from 42D5: A PE Identification Burst is present (the tape unit is spacing a PE tape forward, starting at load point).

Entry from 42E4: The tape unit is spacing a tape forward which was not positioned at load point, or was not in NRZI mode.

(TSTIBG) — Entry from TSTIBG: An inter-block gap, tape unit interrupt, or tape mark has not been found. Continue to loop.

(IBGX) — Entry from IBGX: An inter-block gap has been detected but Beginning-of-Block has not. Continue looping until a block has been spaced over.

Entry from 43A4: An inter-block gap and a Beginning-of-Block have been detected, but this is a space file operation. Continue looping until a tape mark is detected.

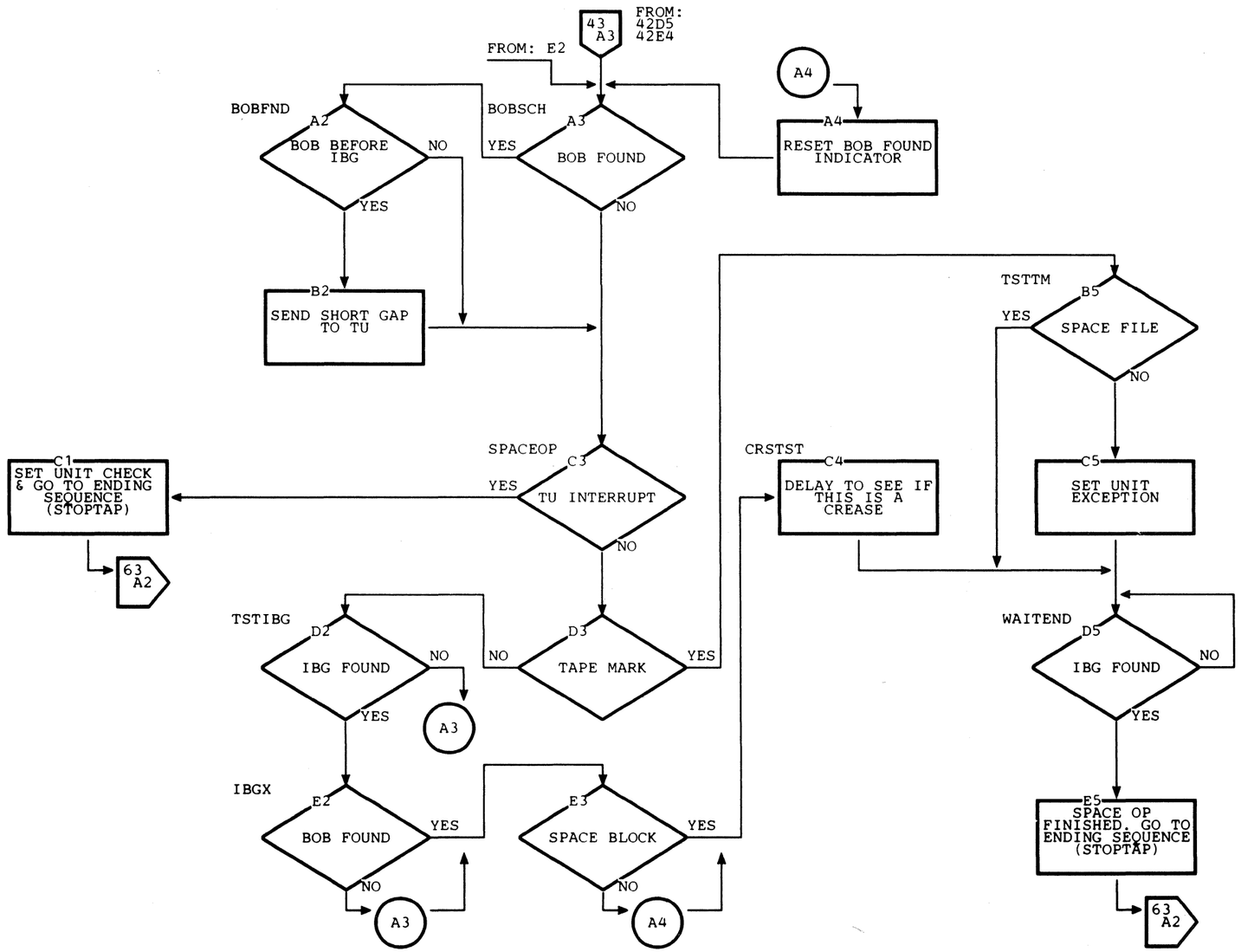
SPACEOP — If a Tape Unit Interrupt is detected, the tape unit has become 'not ready.'

TSTTM — A tape mark has been detected.

CRSTST — An inter-block gap has been detected during a space block operation. The delay allows the IBG indication time to become inactive if the indication was caused by a crease.

WAITEND — Space File: A tape mark has been detected. Wait for IBG before stopping tape.

Space Block: Wait until the IBG indication is valid (part of crease check) and stop the tape.



Rewind/Rewind Unload (System/360/370)

Objectives

- To move tape forward a short distance (forward hitch) and then backward at high speed to the beginning of tape (BOT).
- If in a Rewind Unload command, unload the tape unit when BOT is reached.
- Tape is not pulled out of the columns during the high speed rewind.

REWUNL — The command is a Rewind Unload. If tape is at BOT, no forward hitch is needed; go to RUN4 to unload.

SHERG — The tape unit is in write status. Prepare for degauss before rewinding.

WRTMOVE4 — Move tape 1.5 inches beyond the last block written before degaussing.

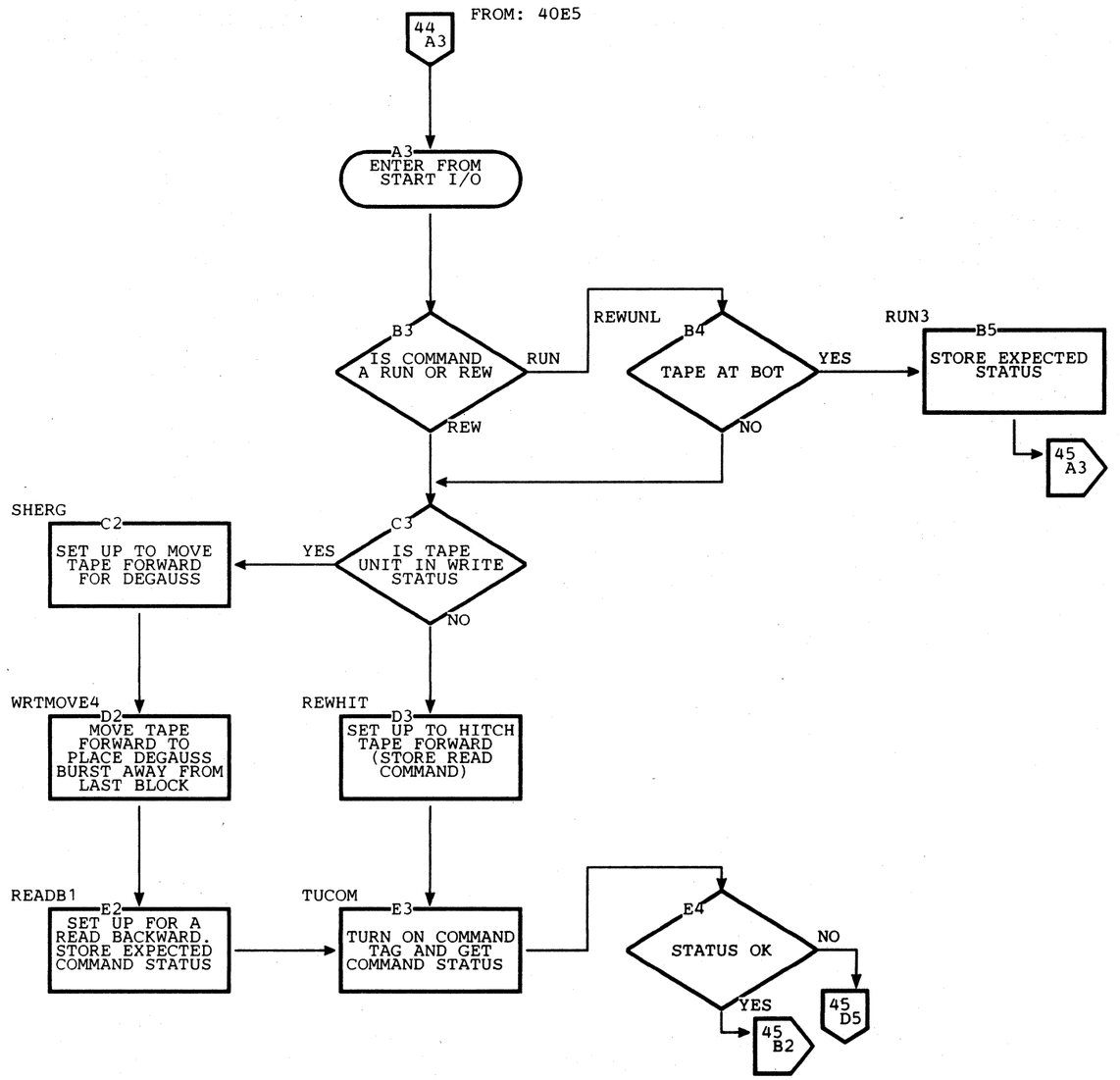
READB1 — Tape has been positioned beyond the last block written. Set up to move tape backward. Degauss will occur when tape unit status is switched from write to read status (TUCOM).

REWHIT — Tape unit is in read status. Set up for a forward hitch before rewinding.

TUCOM — Turn on Command Tag and get the command status. If status is bad, set Tape Unit Reject and terminate the operation.

DELAY3 — Wait 3 milliseconds for degauss to finish.

HITCH2 — Hitch tape forward.

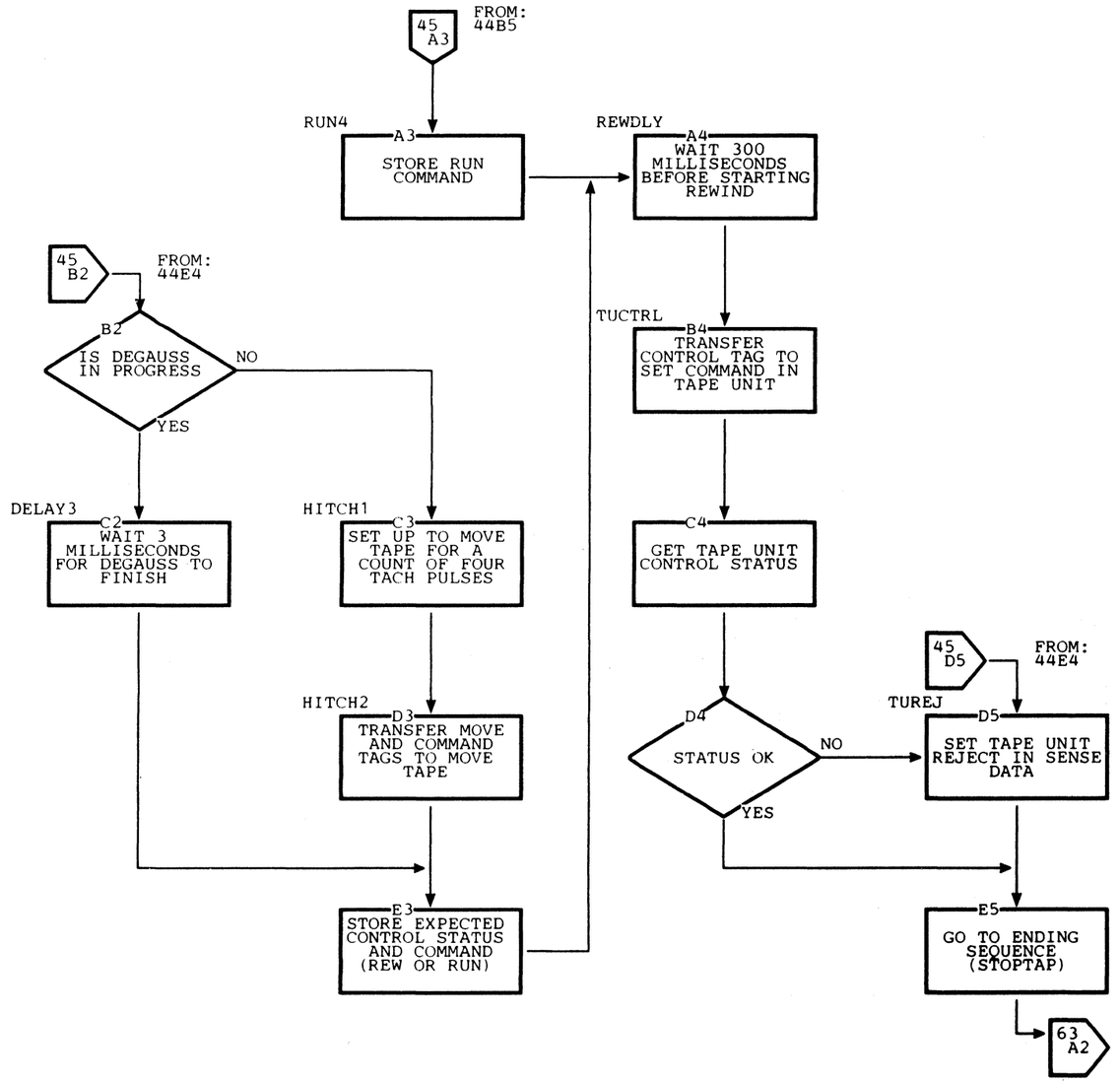


Rewind/Rewind Unload

REWDLY — Wait 300 milliseconds to ensure that multiple tape units do not start to rewind simultaneously.

TUCTRL — Transfer Command and Control Tags to start tape rewinding. Get the tape unit control status. If status is bad, set Tape Unit Reject and terminate the operation.

If status is good, run internal diagnostics and return to IDLESCAN. The tape control releases the tape unit. Independent circuits in the tape unit cause tape movement to continue until the operation is completed.



Read Operation (System/360/370)

Objectives

- To read data (PE or NRZI) in either direction.

CHKDIAG Determine the type of read command.

READF2 The command is a Read backward. The tape must be hitched forward. Send the Move tag to the tape unit with a Read-forward command.

TUCOM If the command is Read-backward, the forward hitch is completed. Send the Read-backward command to the tape unit. If the command is Read-forward send it to the tape unit.

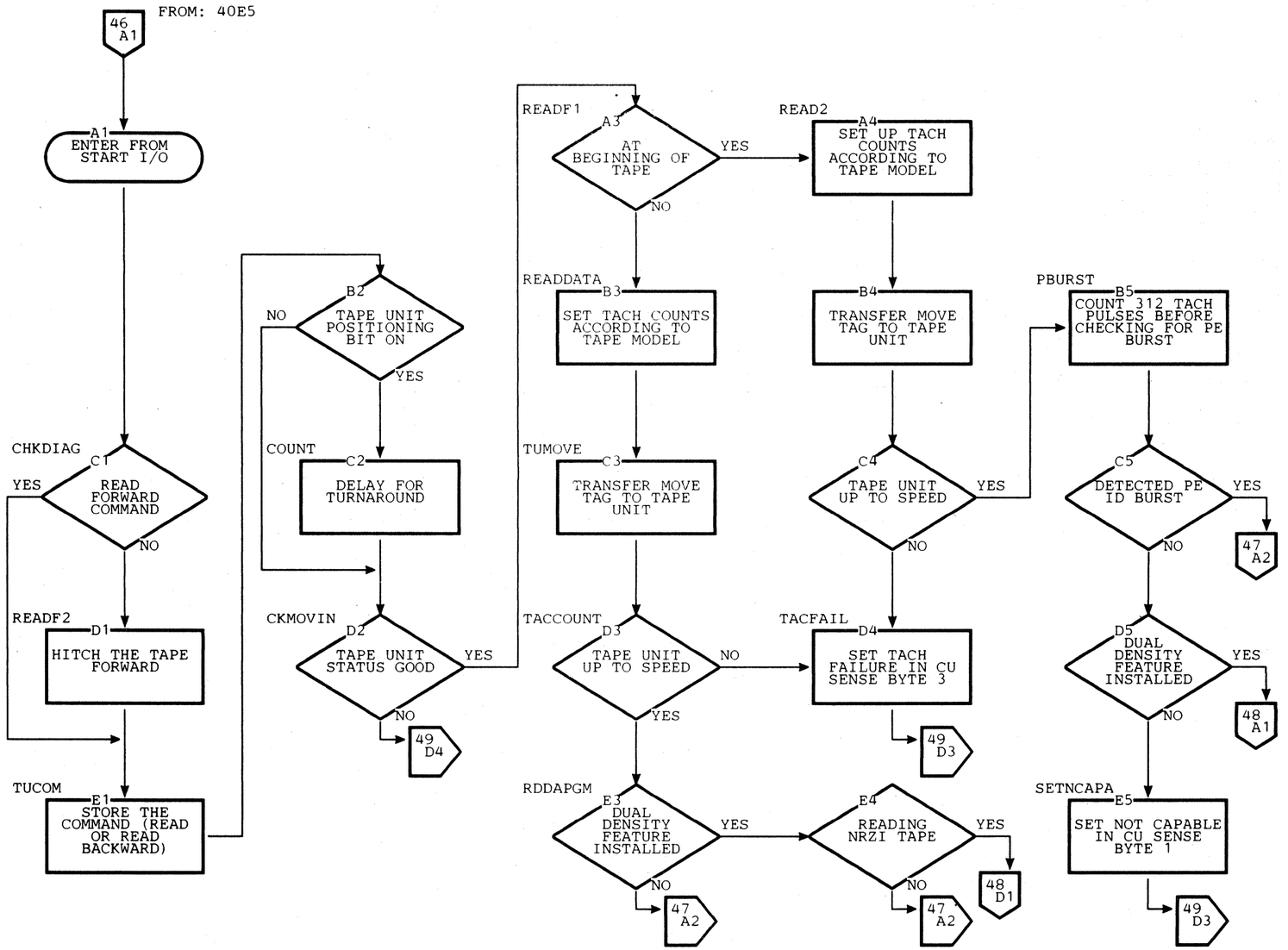
CKMOVIN Check the command status byte. If it is not good reject the tape unit and terminate the operation.

READDATA The tape is not at BOT. Compare old and new tape unit status and use the results to set up tach counts according to tape model.

READ2 Same as READDATA except the tape is at BOT.

TACCOUNT Verify that tape is moving and at correct speed. If not, reset the Move tag to stop tape and terminate the operation.

PBURST Tape is at BOT. Start looking for PE ID Burst. If no burst is found, the tape is recorded in NRZI. Determine if the tape control and tape unit are capable of reading NRZI.



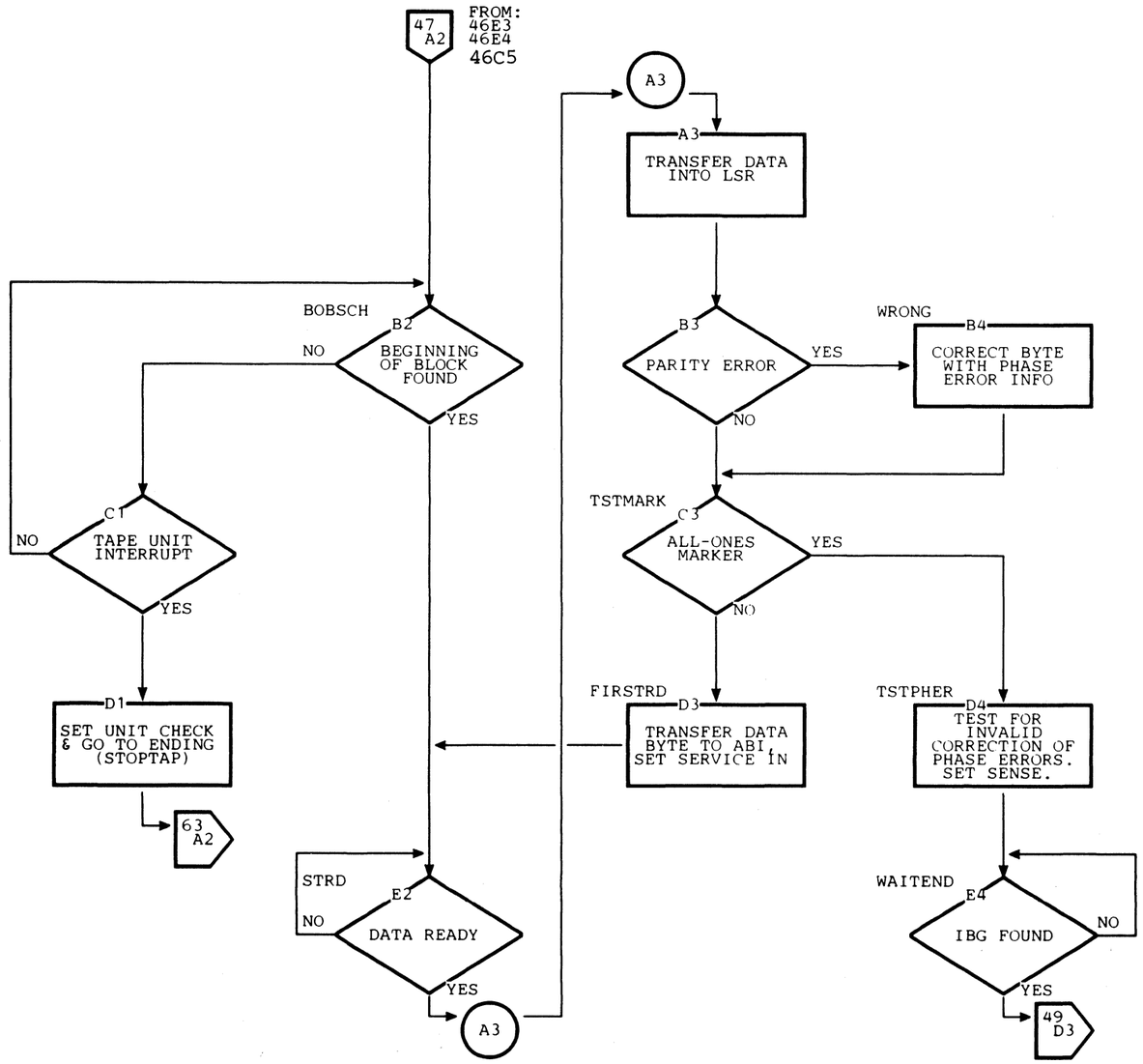
Read Operation (System/360/370)

BOBSCH — The tape is recorded in PE. Start searching for the beginning of the data block.

STRD — Three data bytes are buffered in the LSR. If an error is detected as a phase error, the byte is corrected just before it is sent to ABI. Only single-track errors are corrected.

TSTPHER — The all-ones marker has been detected. Check for any accumulated phase errors.

WAITEND — The postamble is being read. When the IBG is detected, reset Service In and stop tape.



Read Operation (System/360/370)

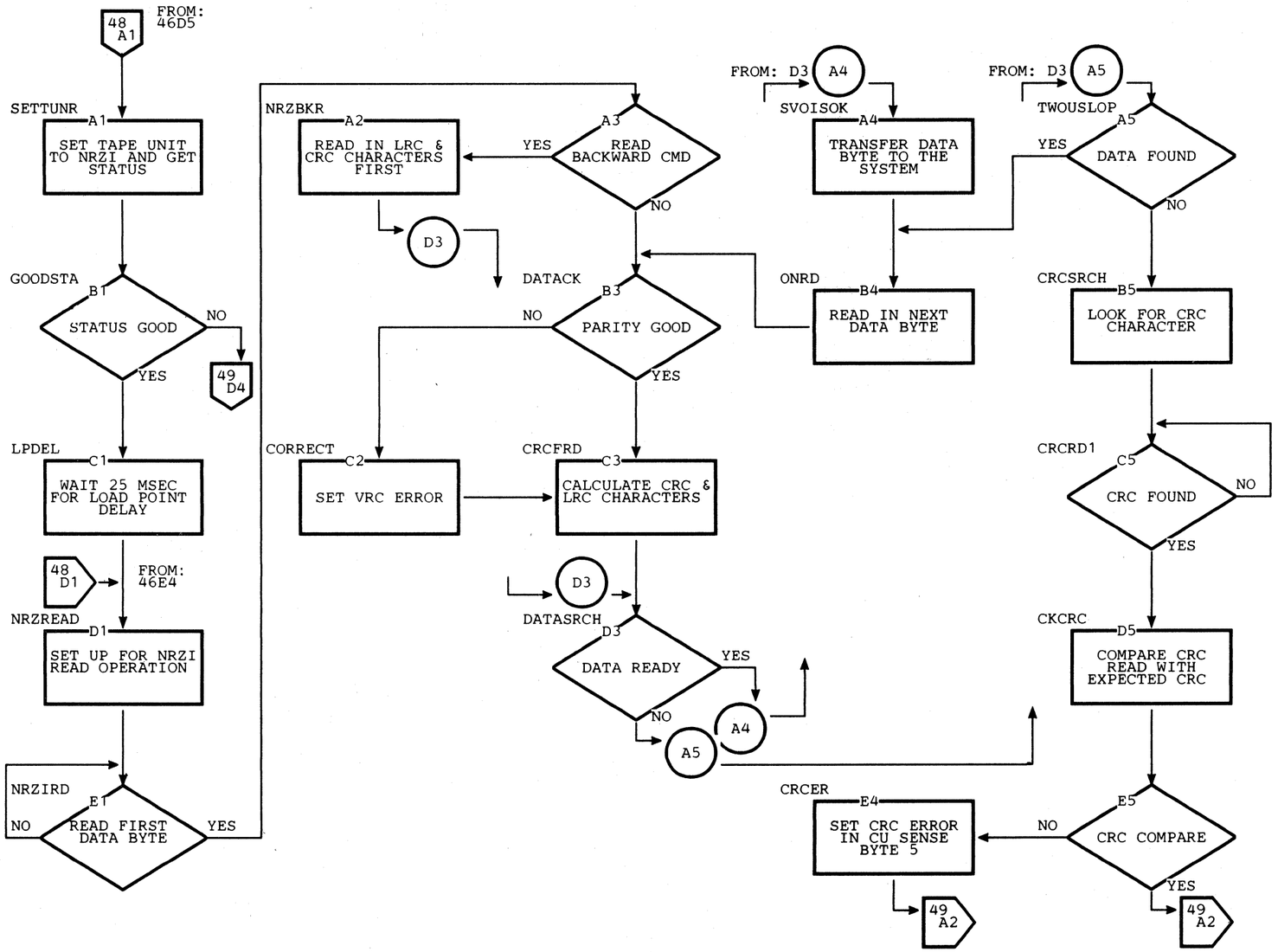
SETTUNR — The tape is at BOT and is a NRZI tape. Start looking for the first data byte.

NRZREAD — The tape is not at BOT and is a NRZI tape. Start looking for the first data byte.

NRZBKR — This is a NRZI Read-backward operation. The first bytes read are the LRC and CRC characters. Store the check characters for use at the end of the read operation. Then start looking for the data bytes.

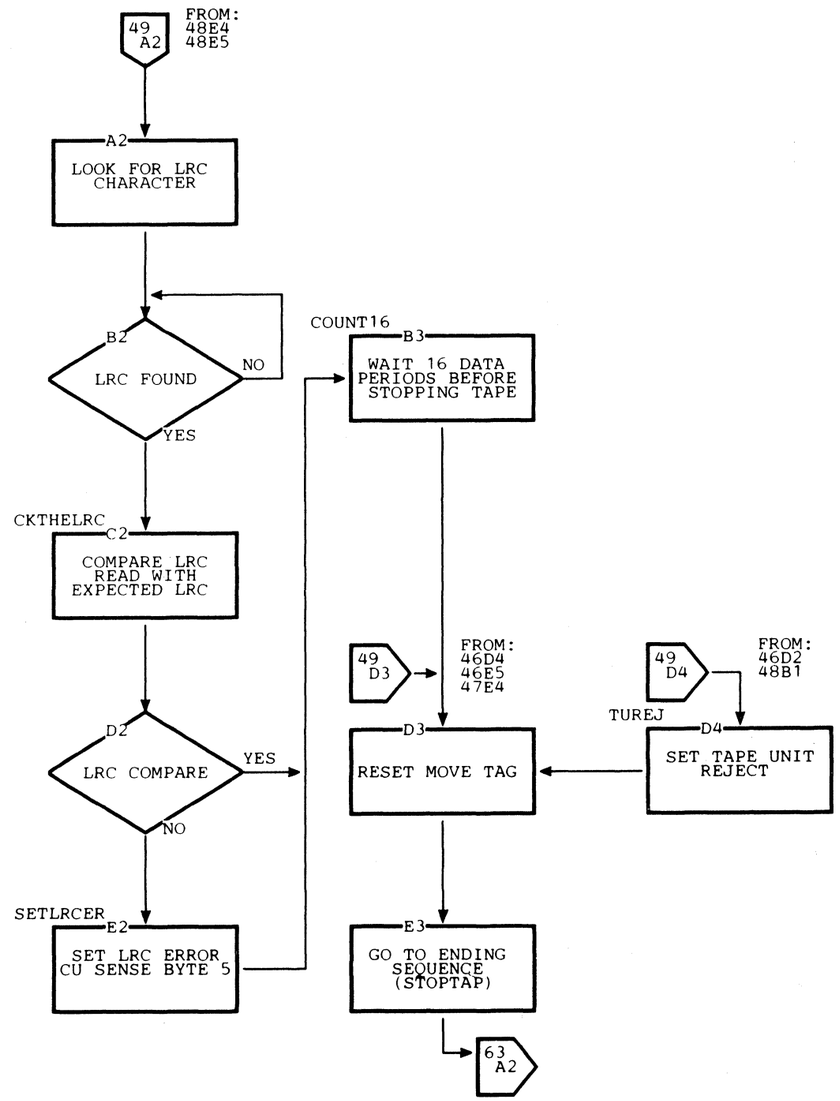
CRCFRD — A data byte has been read and parity checked. The LRC and CRC characters are calculated each time data is read.

TWOUSLOP — Loop for two microseconds searching for data. If none is found, a byte may have been lost. Loop again for two microseconds. If still no data, search for the CRC and LRC characters. If reading backward, send the last byte read to ABI.



Read Operation (System/360/370)

STOPTAP — The operation is completed or an error has occurred. Reset Service In and the Move tag. Store the sense data, run the internal diagnostics, and update tape unit status before returning to Idle.



Write Operation (System/360/370)

Objectives

- To write data (PE or NRZI) on tape.

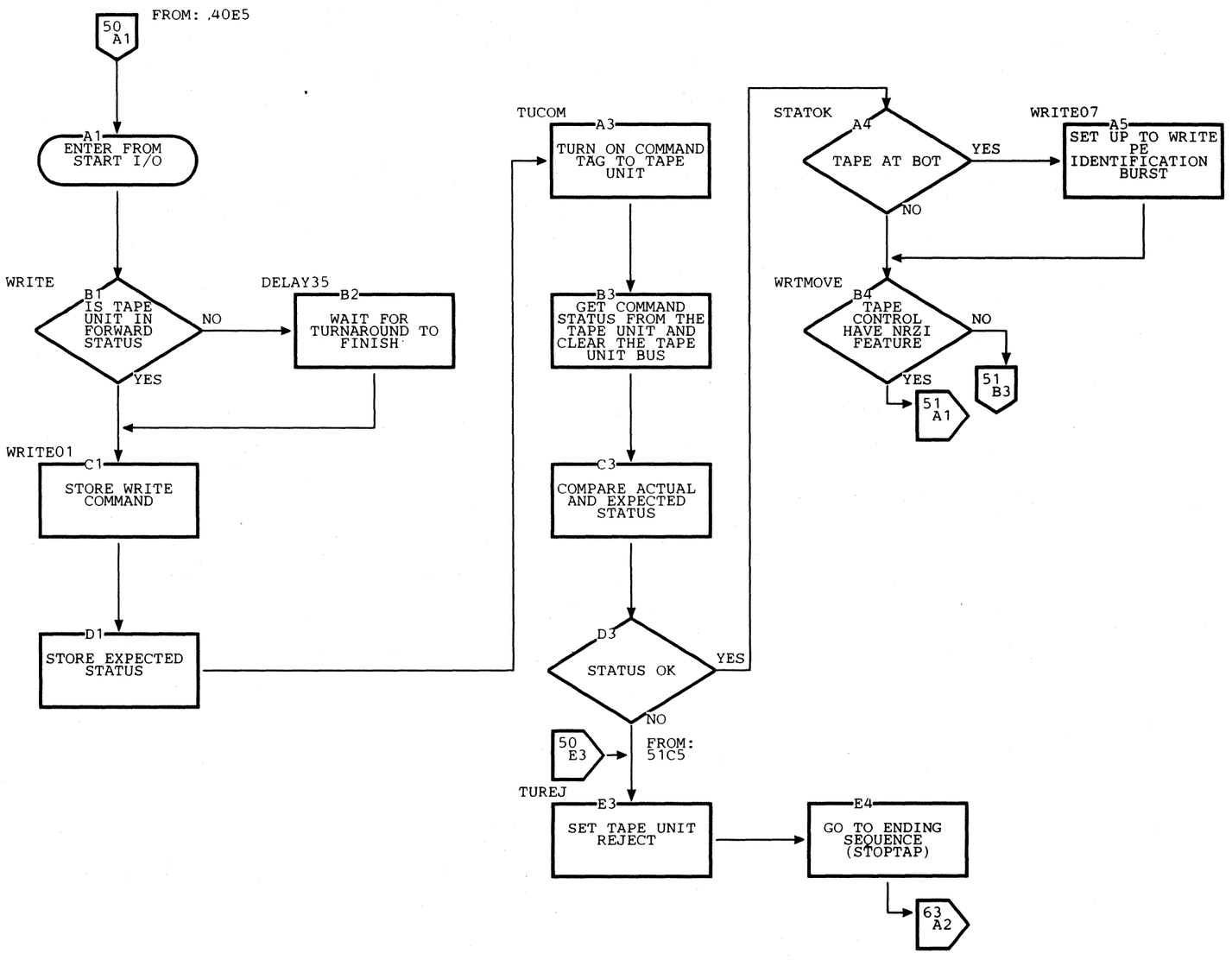
WRITE — Check the status of the tape unit. If in forward status, store the write command.

If in backward status, wait for turnaround sequence before storing write command.

TUCOM — Get the command status and set the tape unit to write status. If command status is not good, reject the tape unit and terminate the operation.

STATOK — Check if tape is at BOT. If it is, set up to write PE ID Burst.

WRTMOVE — Determine if NRZI is installed in tape control. If not, go to TUMOVE.



Write Operation (System/360/370)

FEATWRT — Tape control has NRZI installed. Determine if tape is at BOT. If not at BOT, check if this is a NRZI operation. If it is, set up controls for a NRZI write. If not, go to TUMOVE.

DUALDEN — Tape unit has dual density feature and is at BOT. Check that a Mode Set command has been issued.

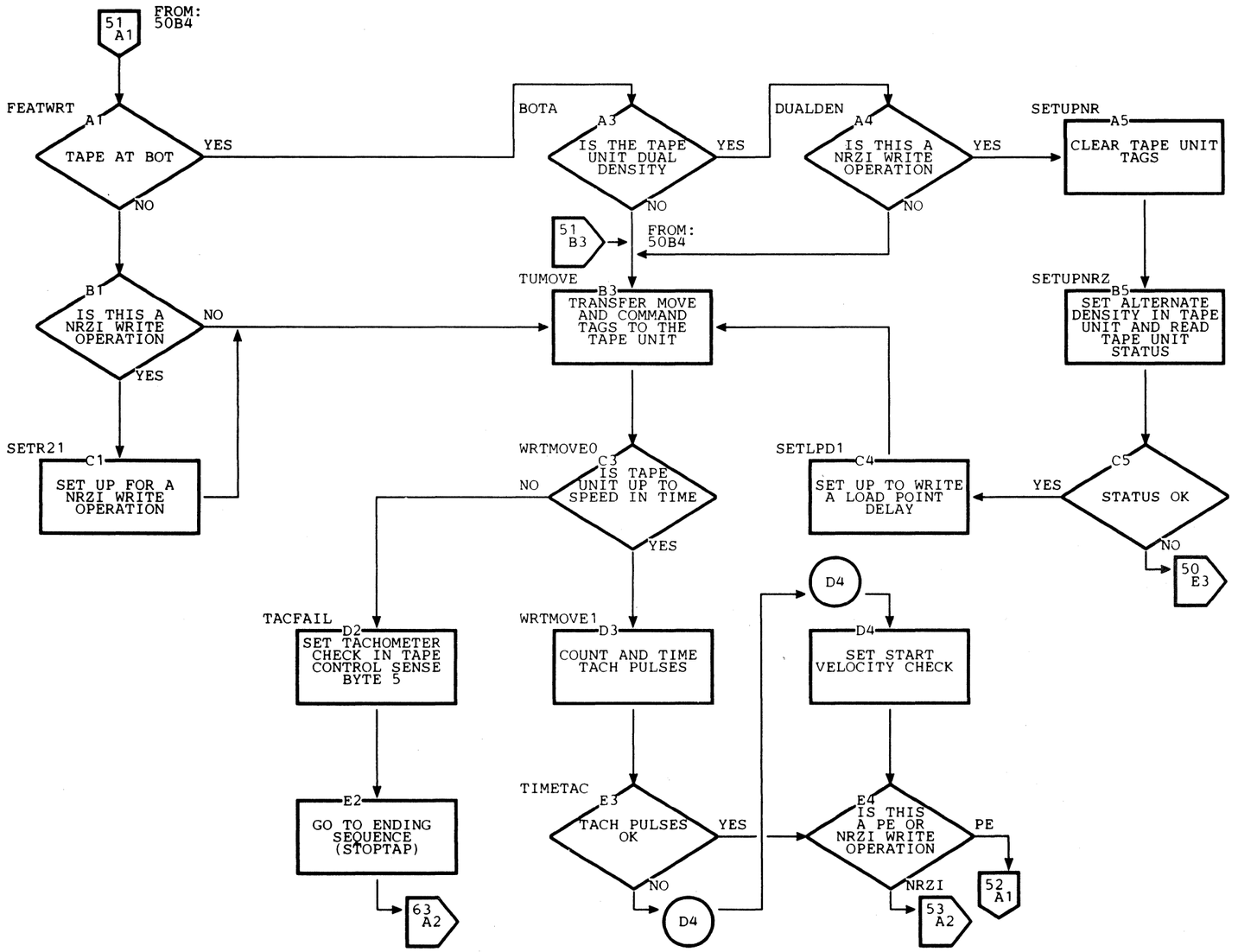
SETUPNR — A Mode Set command was issued. Set the tape unit to NRZI and check the status.

SETLPD1 — Set controls to cause a load point delay before the first data block is written (NRZI only).

TUMOVE — The tape unit status is good and ready to write (PE or NRZI). Transfer Move Tag to get tape moving.

WRTMOVE0 — The tape unit is in write status and Move Tag transferred. When gap control is detected, the tape unit is up to speed. The tach pulses from the capstan motor are measured to determine when the capstan is up to speed. If the capstan does not reach full speed within a predetermined time, go to TACFAIL.

WRTMOVE1 — Set up to count and time tach pulses to verify tape speed. If tape speed is not good, set tachometer check and terminate the operation, or set Start Velocity Check and continue the operation.



Write Operation (System/360/370)

PBWPGM The tape unit is at BOT and in PE Mode. Write the PE ID Burst before writing data on tape.

WRDAPGM The PE ID Burst has been written or the tape is not at BOT. Write a preamble of 40 zeros and an all ones marker.

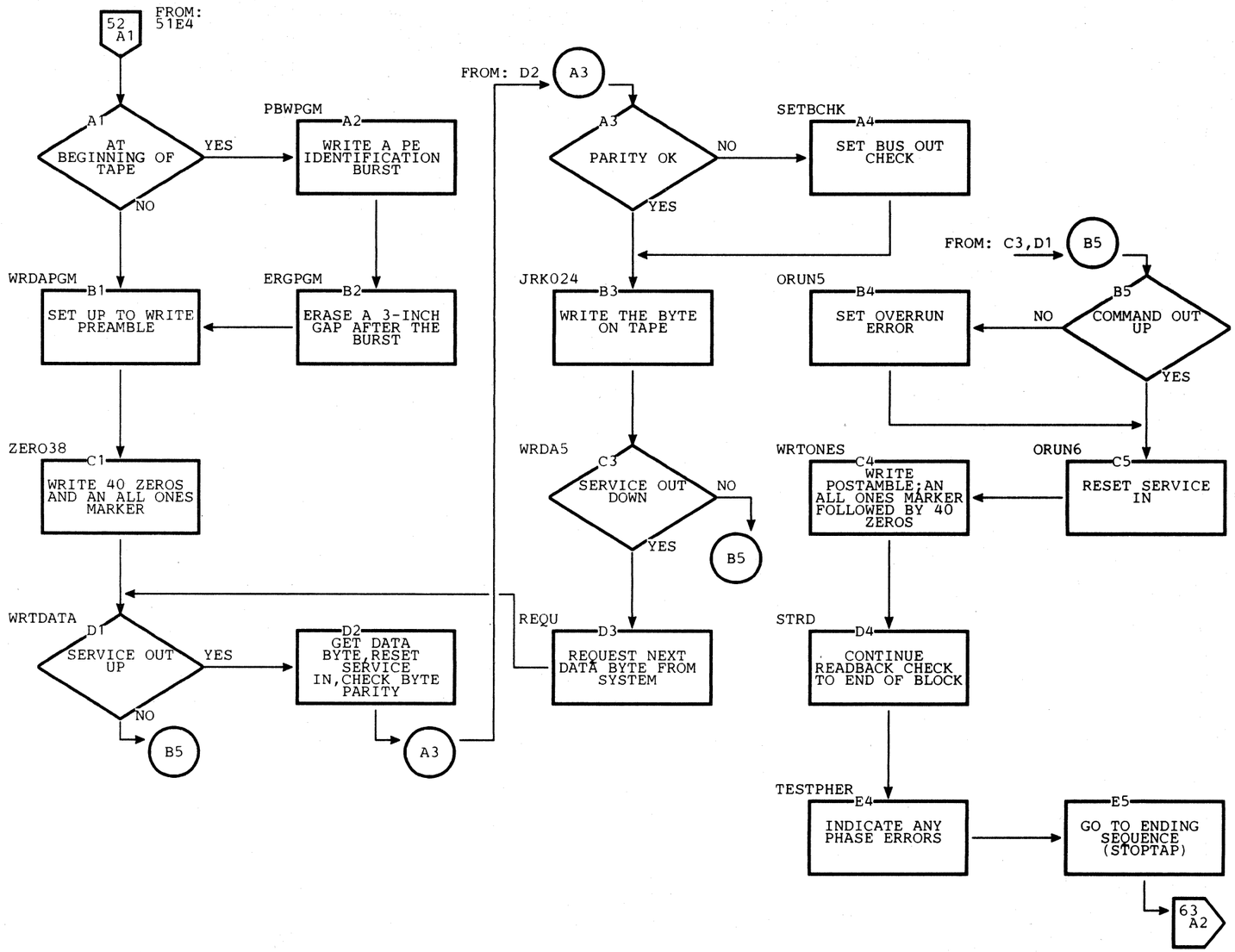
WRTDATA The preamble is written. Service Out up indicates a data byte is ready to be written. Get the data byte from the channel and check it for parity. If parity is bad, set Bus Out Check.

WRDA5 Make sure Service Out is down before requesting another data byte. If Service Out is up, go to ORUN.

JRK024 Write the byte on tape and perform a parity check on any byte which has been read back. If parity is bad, set VRC error.

REQU Raise Service In to get another byte from the channel.

WRTONES The last data byte has been written. Write the postamble and continue readback check until the end of the block is sensed.



Write Operation (System/360/370)

LPDLY2 — This is a NRZI write operation and tape is at BOT. Set up for a load point delay.

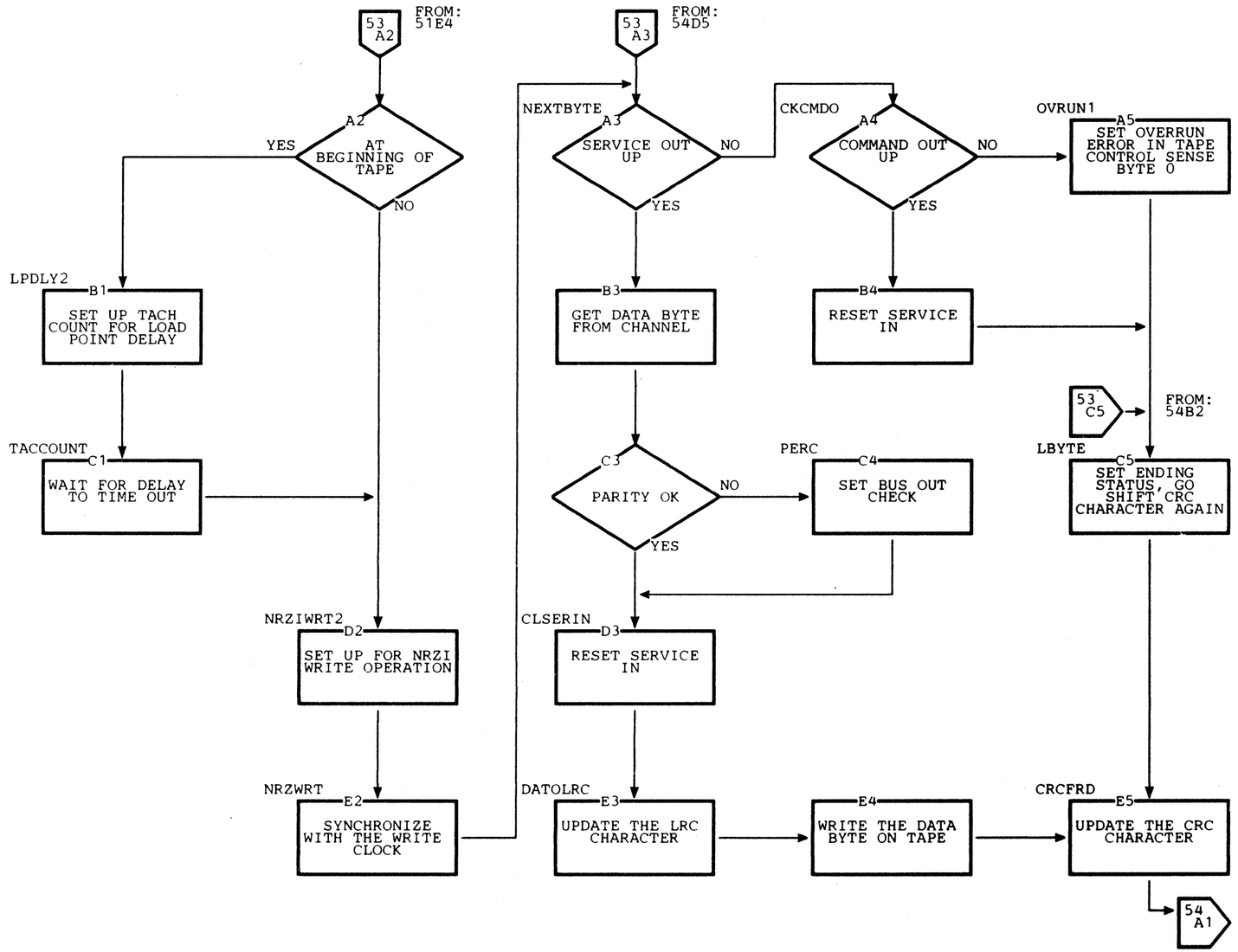
NEXTBYT — Check the condition of Service Out. If down, and Command Out is also down, go to LBYTE to finish up. If Command Out is up, set Overrun Error and go to LBYTE.

If Service Out is up, get the next data byte from the channel.

Check for correct parity. If bad, set Bus Out Check.

CLSERIN — Reset Service In.

DATOLRC — Update the LRC and CRC characters. Write the data byte on tape.



Write Operation (System/360/370)

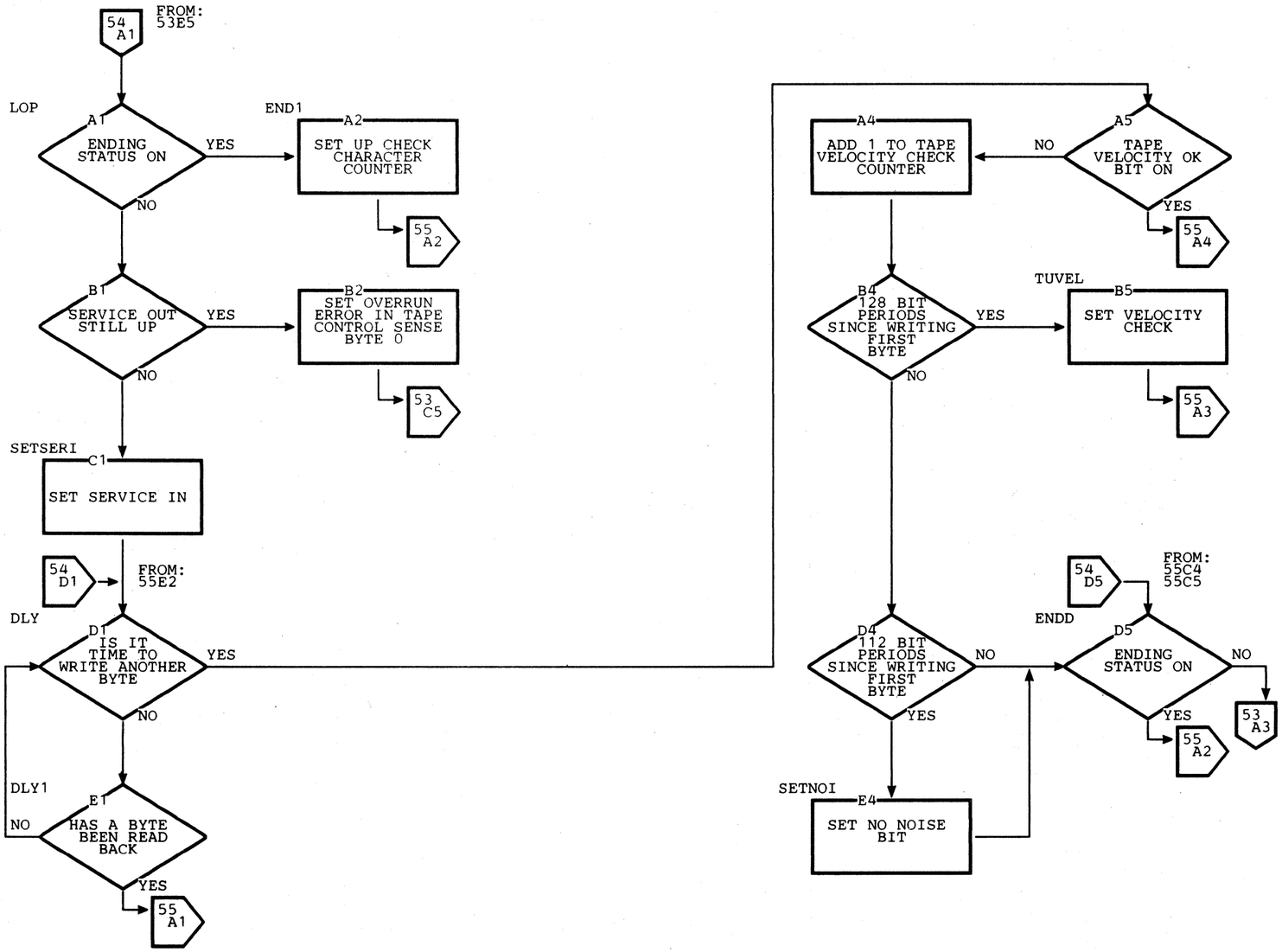
LOP — Check if Ending Status bit is on. Ending Status is set when the last data byte has been written (LBYTE).

END1 — Ending Status is on. Set up a counter to ensure correct spacing between check characters.

DLY — Wait until either a byte is read back or another byte is to be written.

Each time a byte is written until the first byte is read back, a counter is stepped. The counter is maintained to ensure that tape is moving at the proper speed in the early stages of the write operation. The first byte should be read back after writing 112-128 byte. If no data has been read back (tape velocity OK bit not on) before 128 bytes have been written, Tape Velocity Check is set. If a byte arrives before 112 bytes have been written, the No Noise Bit is not turned on, causing VRC error to be set during readback check of the byte.

When a byte is read back, parity is checked. If parity is bad, or if the No Noise bit is not set, VRC error is set.

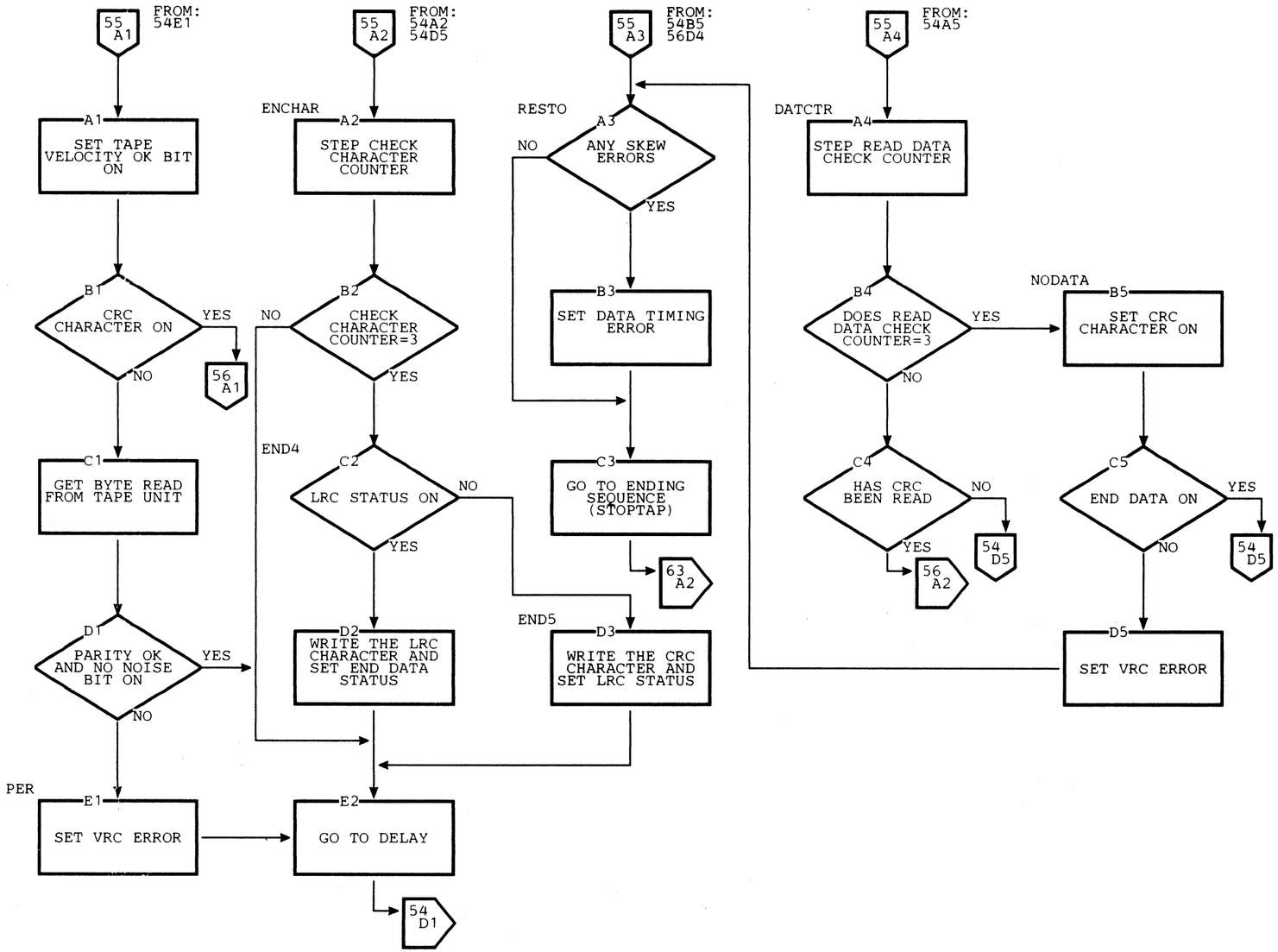


Write Operation (System/360/370)

ENCHAR — Ending Status is set; step the check character counter. The counter is stepped three times before writing each check character. (See END1.)

END4 — If LRC Status is off, write the CRC character and turn on LRC status.

If LRC Status is on, write the LRC character and set End Data Status. Return to DLY.



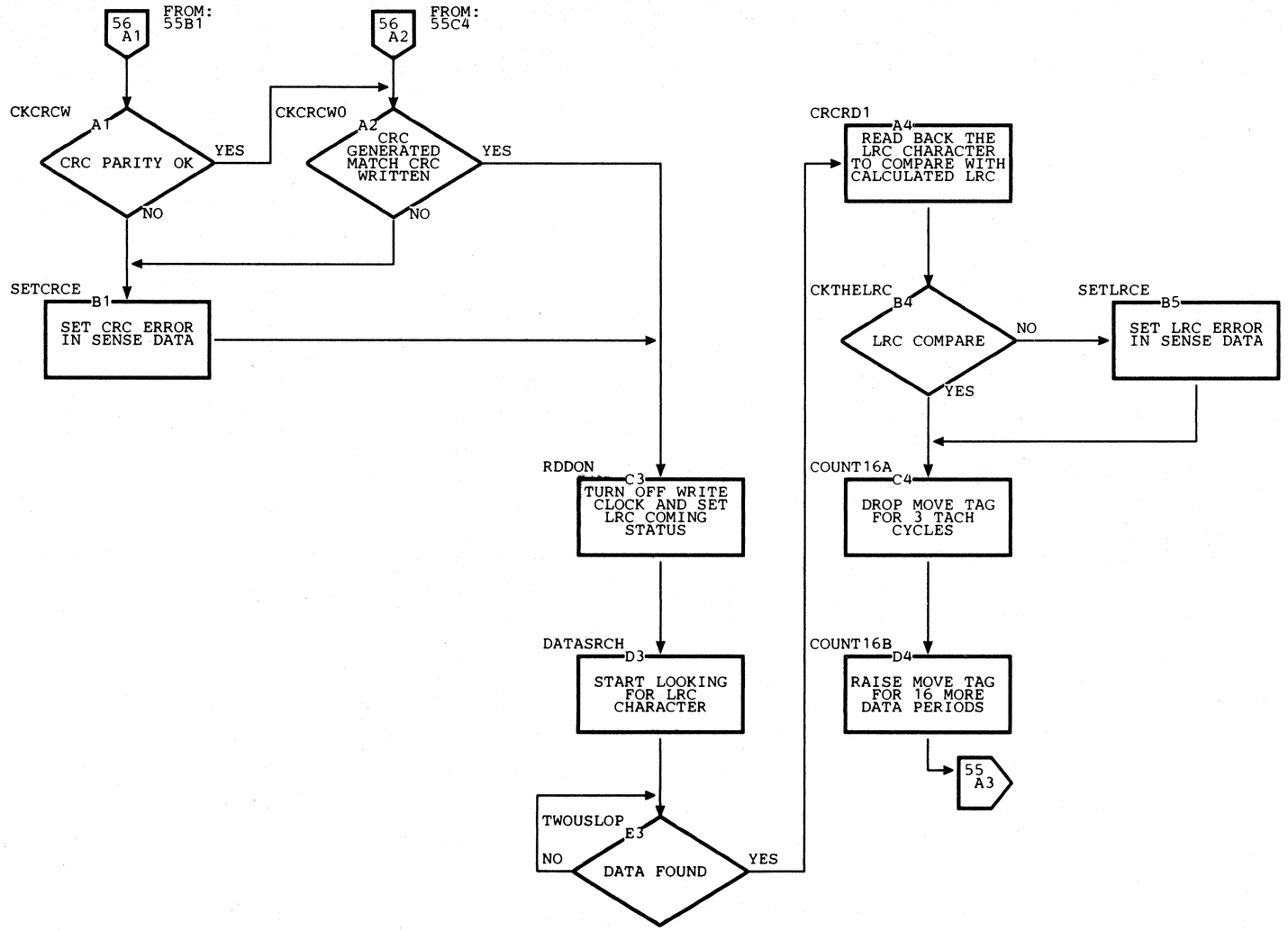
Write Operation (System/360/370)

CKCRCW — The byte read back is the CRC character. Compare the CRC written with the CRC calculated.

TWOUSLOP — Wait for the LRC character.

CRCRD1 — The byte read back is the LRC character. Compare the calculated LRC with the LRC read back.

COUNT16A — Loop for 16 data periods before stopping tape. If no more data is read back check for any skew errors and go to STOPTAP to terminate the operation.



Data Security Erase (DSE)

Objectives

- To erase tape from its present position to the end of tape (EOT) marker.

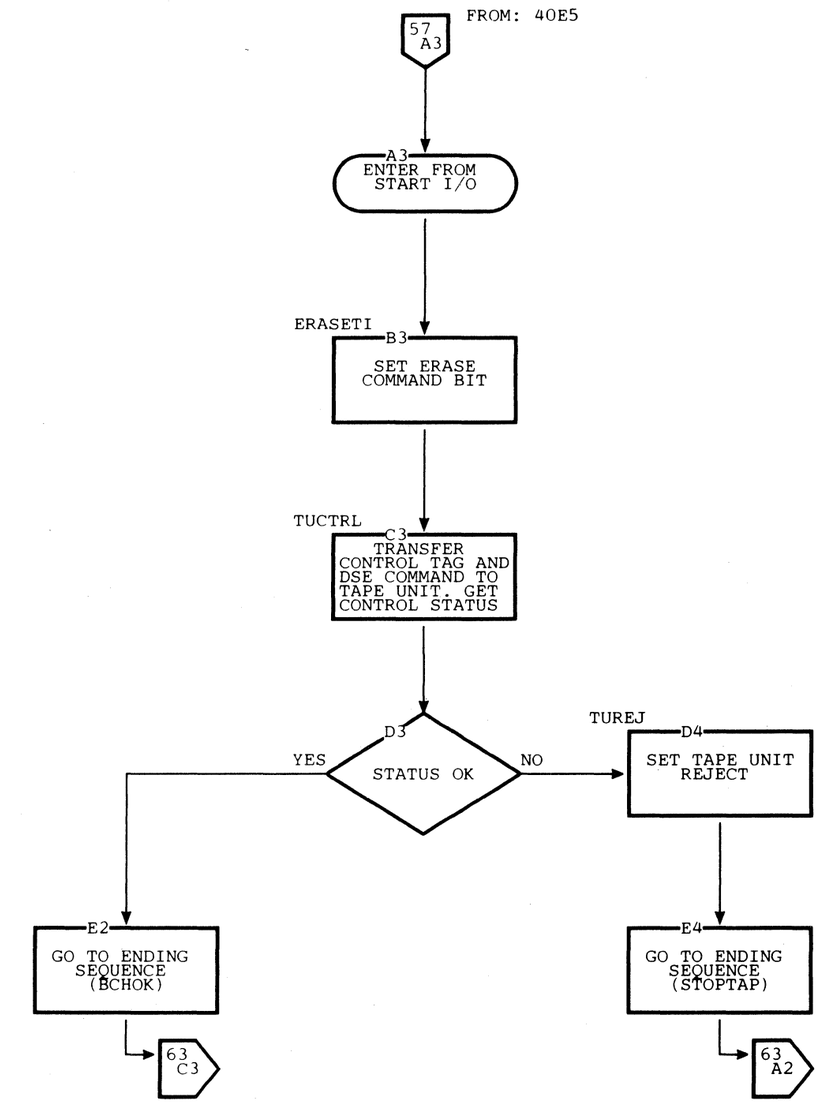
ERASETI — The Data Security Erase command was decoded during the CONTROL routine. To enter the DSE routine, tape unit status must indicate write status, not at EOT, and not file protected.

TUCTRL — Tape unit status is good. Transfer the Control tag and Command to the tape unit. Read in the status byte from the tape unit.

If tape unit status is good, store the sense data, run internal diagnostics, and return to IDLE.

The tape control releases the tape unit. Independent circuits in the tape unit cause tape movement to continue until EOT is sensed.

TUREJ — Tape unit status is bad. Set tape unit reject and terminate the operation.



Erase Gap Command (System/360/370)

Objectives

- To erase a 3 inch gap on tape.

STATOK — Check that tape is at BOT. If it is set up to write PE ID Burst.

FEATWRT — Tape control has NRZI installed. Determine if tape is at BOT, if the tape unit has NRZI feature, and if this is a NRZI operation. If so, go to SETUPNR to prepare for a load point delay.

SETUPNR — Set the tape unit to NRZI mode, and check status. If status is bad, set Tape Unit Reject and terminate the operation.

TUMOVE — The tape unit status is good and ready to erase tape. Transfer Move Tag to get tape moving.

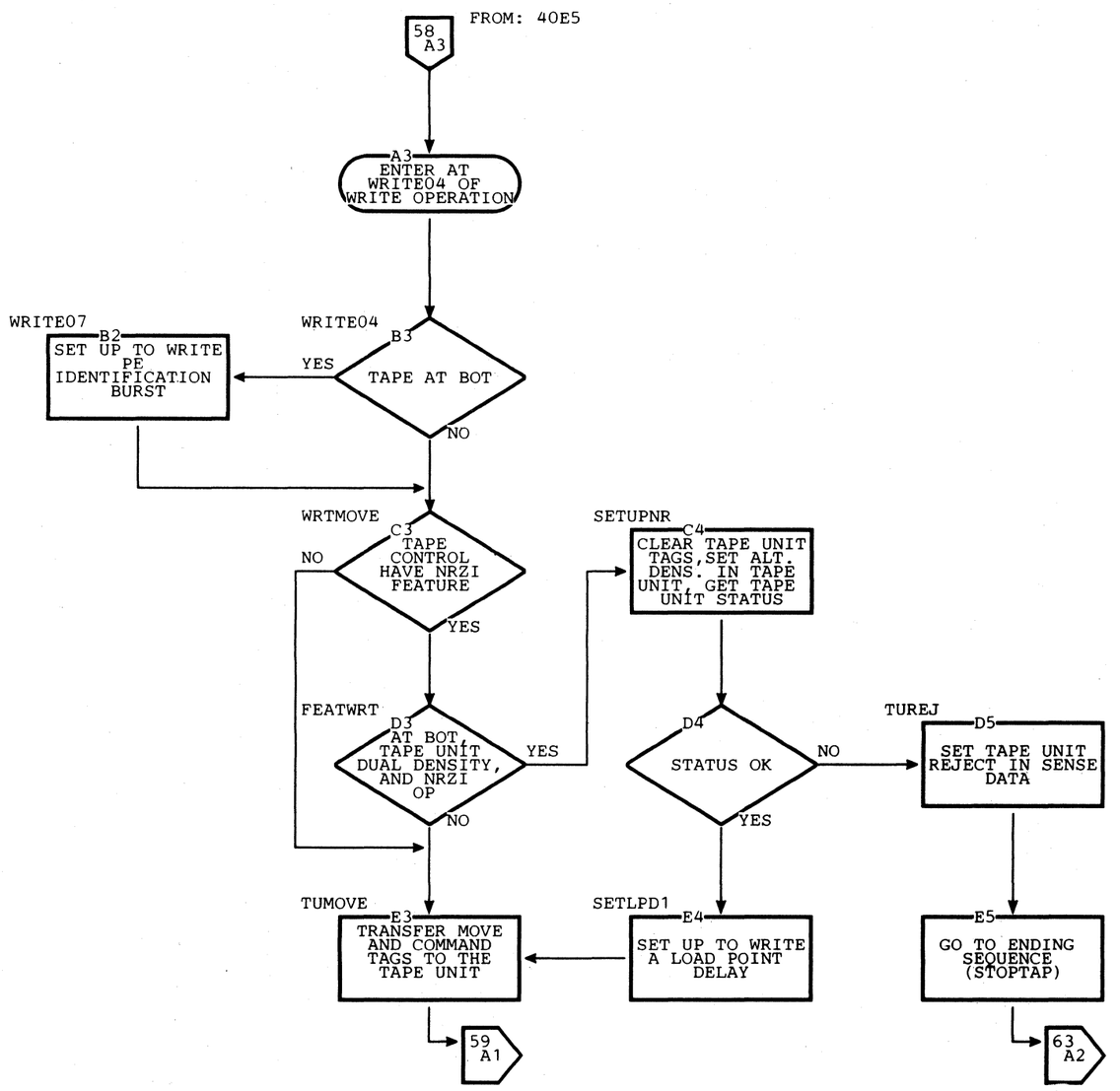
WRTMOVE0 — The tape unit is in write status and Move Tag transferred. When gap control is detected the the tape unit is up to speed.

WRTMOVE1 — Set up to count and time tach pulses to verify tape speed. If tape speed is not good, set Tachometer Check and terminate the operation, or set Start Velocity Check and continue the operation.

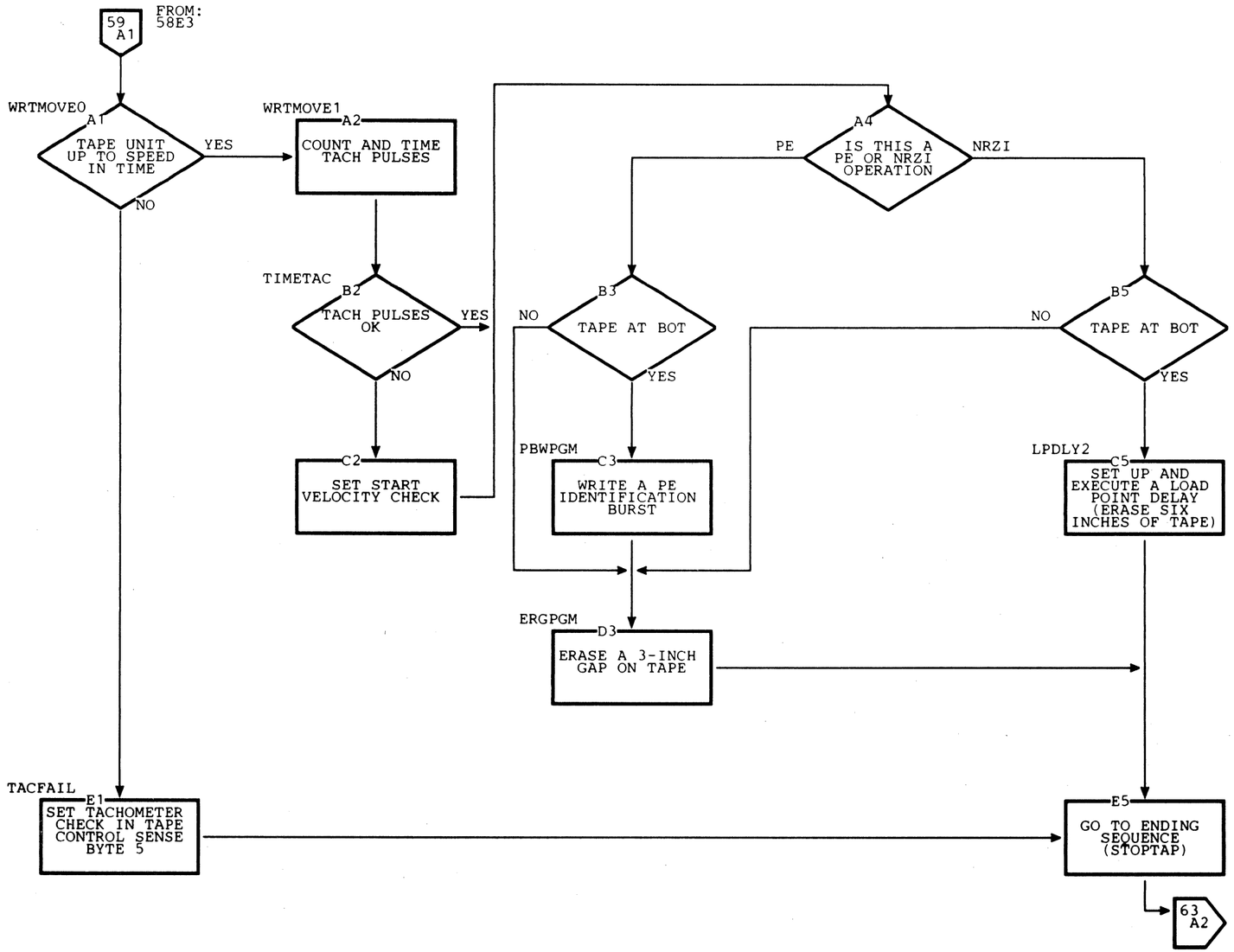
PBWPGM — The tape unit is at BOT and in PE Mode. Write the PE ID Burst before erasing tape.

ERGPGM — Erase 3 inches of tape and go to ending sequence.

LPDLY2 — This is a NRZI operation and tape is at BOT. Perform a load point delay and go to ending sequence.



Erase Gap Command (System/360/370)



Write Tape Mark (System/360/370)

Objectives

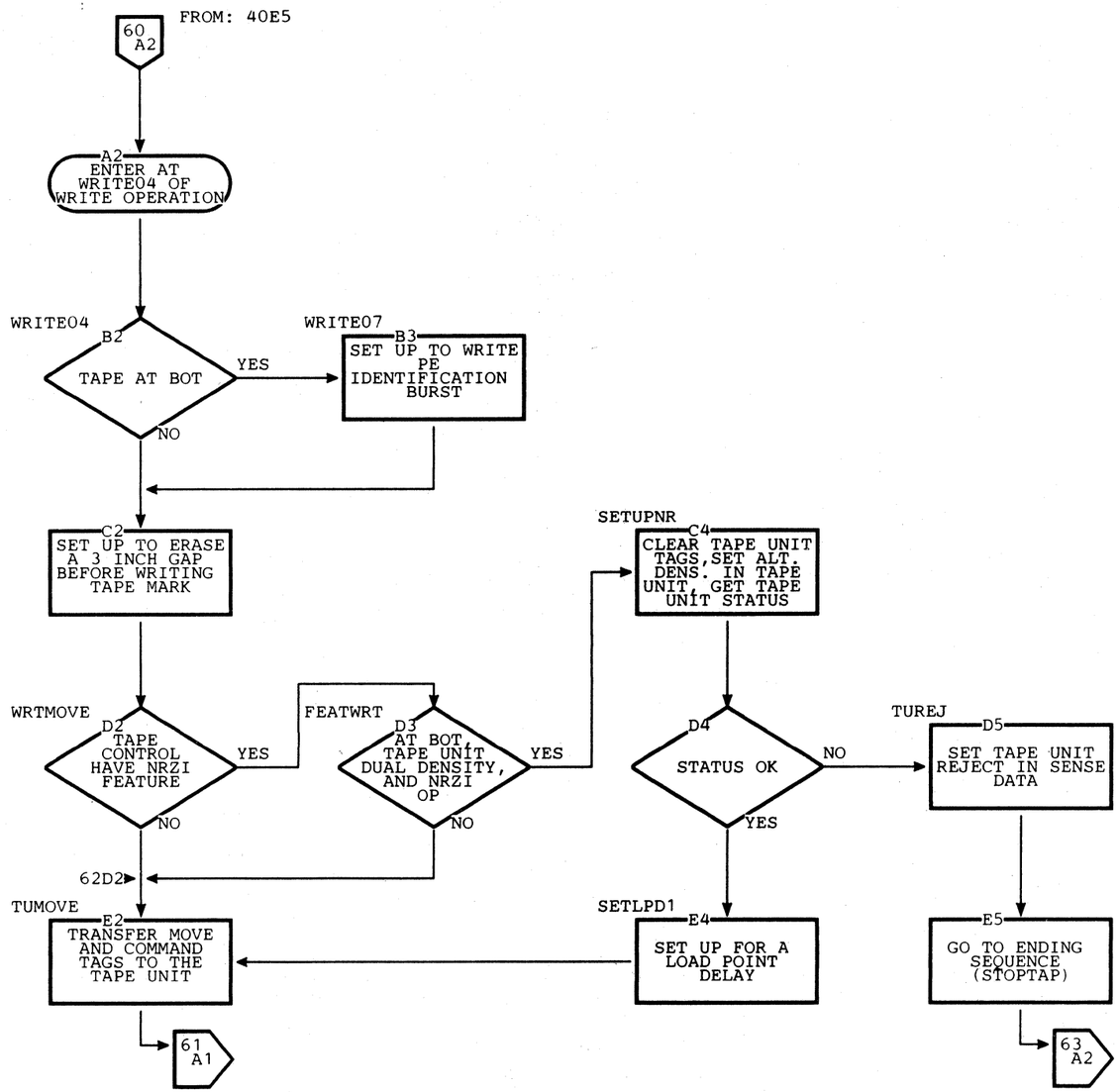
- To write a PE or NRZI tape mark.
- The subsystem generates the tape mark; no data is transferred between CPU and the subsystem.

STATOK Check that tape is at BOT. If it is set up to write PE ID Burst.

FEATWRT Tape control has NRZI installed. Determine if tape is at BOT, if tape unit has NRZI feature, and if this is a NRZI operation. If so, go to SETUPNR to prepare for a NRZI operation beginning with a load point delay.

SETUPNR Set the tape unit to NRZI mode, and check status. If status is bad, set tape unit reject and terminate the operation.

TUMOVE The tape unit status is good and ready to write the tape mark. Transfer the Move Tag to get tape moving.



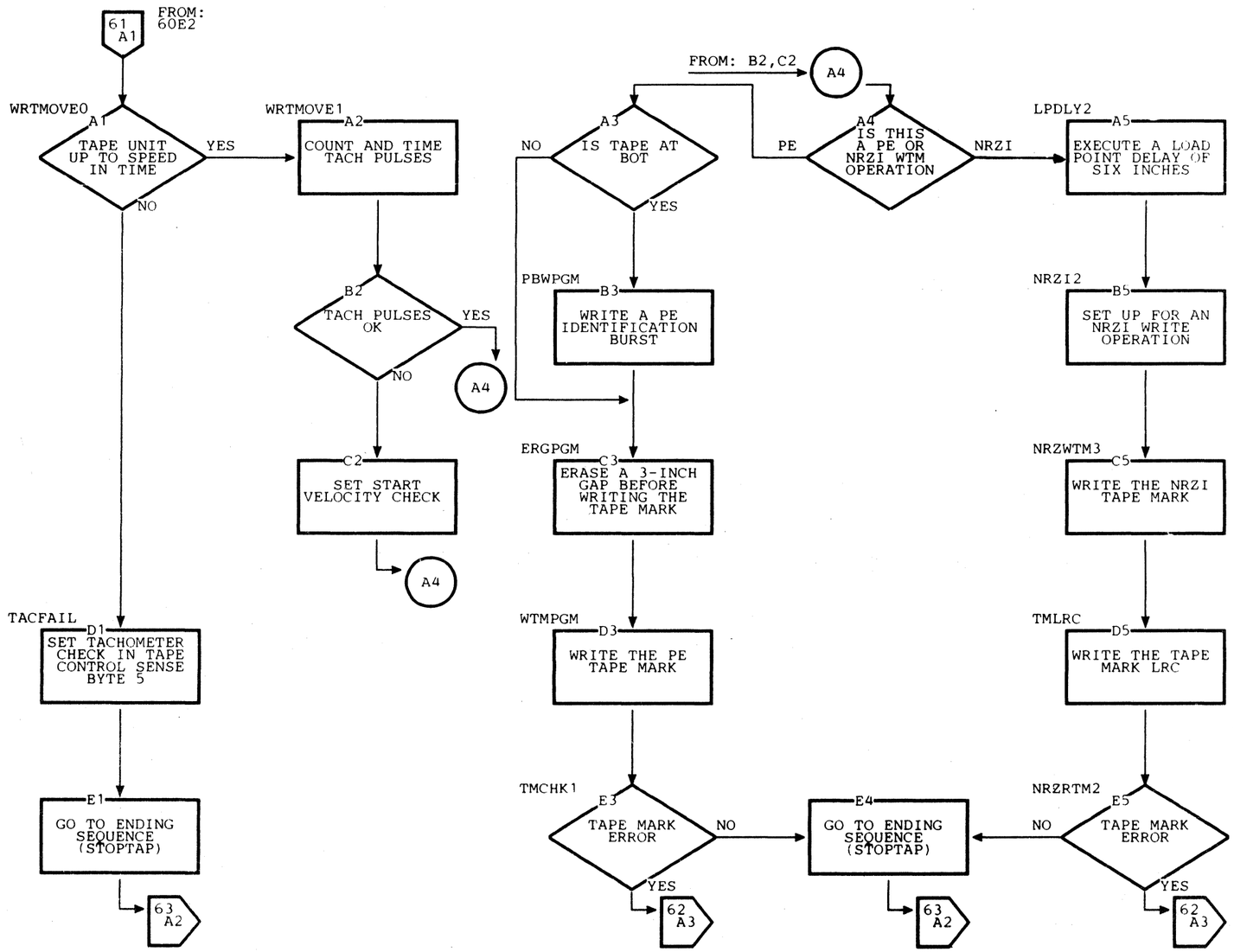
Write Tape Mark (System/360/370)

WRTMOVE0 The tape unit is in write status and Move tag transferred. When gap control is detected the tape unit is up to speed. Go to TACFAIL if full speed is not reached in a predetermined time.

WRTMOVE1 Set up to count and time tach pulses to verify tape speed. If tape speed is not good, set Tachometer Check and terminate the operation, or set Start Velocity Check and continue the operation.

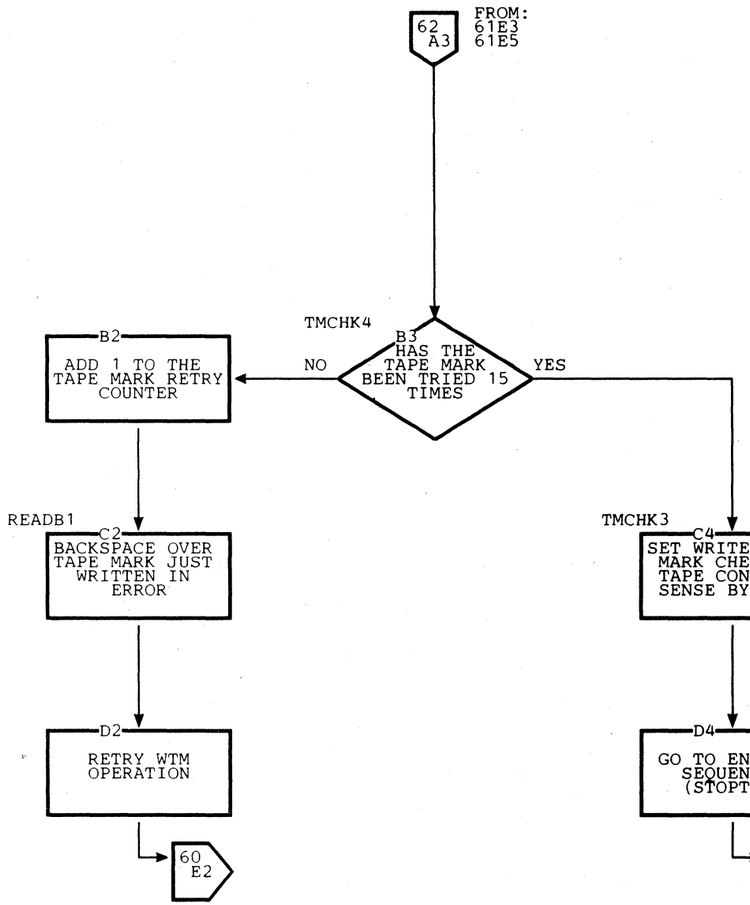
PBWPGM The tape unit is at BOT and in PE Mode. Write the PE ID Burst before writing the tape mark.

LPDLY2 This is a NRZI operation and tape is at BOT. Perform a load point delay.



Write Tape Mark (System/360/370)

TMCHK3	Tape Control could not write a tape mark after 15 tries. Set Tape Mark Check and terminate the operation.



Ending Sequence (System/360/370)

Objectives

- Stop tape when the next IBG is found.
- Generate ending status and send it to ABI.
- Reset all busses and tags.
- Return to the proper location in the microprogram. (IDLESCAN, IDLEPEND, INTSCAN, CHAINSIO)

STOPTAP — The operation is completed or an error has occurred. Reset Service In and the Move tag. Store the sense data, run internal diagnostics, and update the tape unit status before returning to IDLESCAN.

SETREJ — The tape unit went not ready or the start bit is not on.

ENVEL — No tach pulse was detected in 5 msec. Tach is not running.

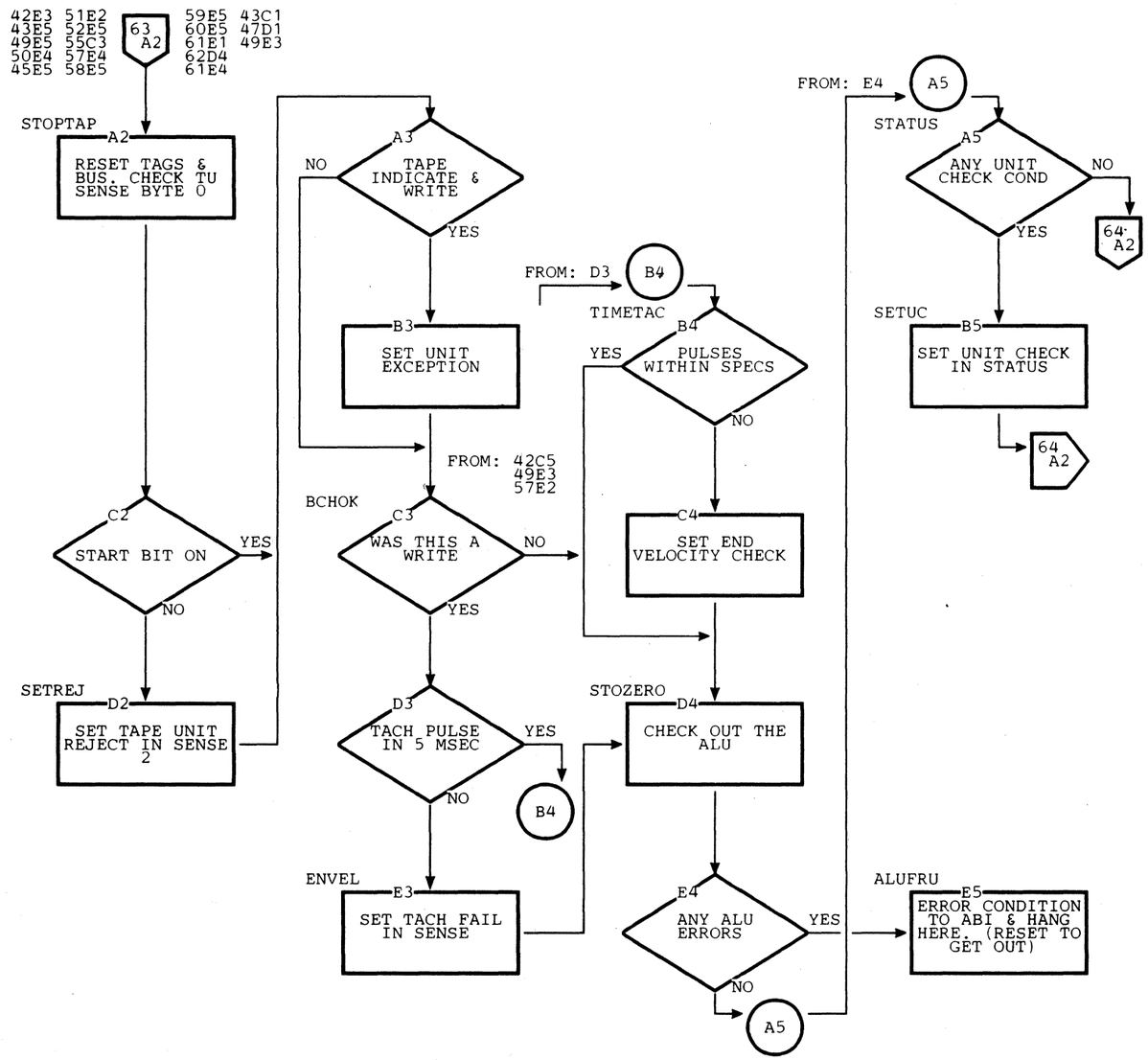
BKLP — A backward command issued at Load Point.

TIMETAC — Set End Velocity Check if tach pulses are too close together or too far apart.

STOZERO — Tape unit sense byte 0 has been checked and errors set. The tach has been checked and errors set. Now check out the ALU.

SETUC — The subsystem has a Unit Check in its sense bytes.

ALUFRU — An ALU operation failed during internal diagnostics.

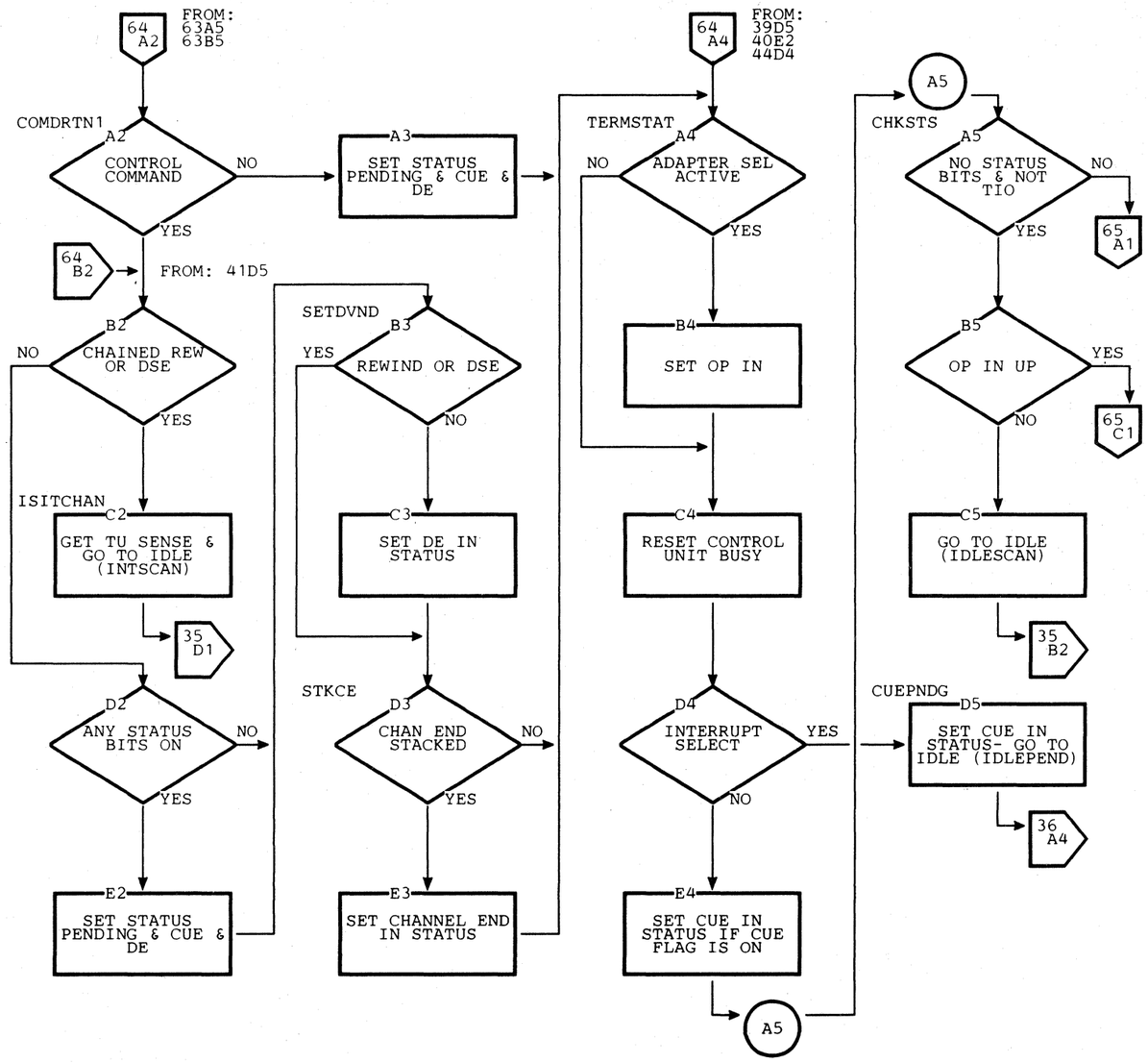


Ending Sequence (System/360/370)

ISITCHAN Don't send ending status; wait for the chained operation to continue.

SETDVND Set DE unless command is a Rewind or DSE. DE is not set on a Rewind or DSE until the tape unit is finished.

TERMSTAT Adapter Select active indicates the system is attempting an Initial Selection.



Ending Sequence (System/360/370)

STATRTN There are bits on in pending status, or this is a TIO. The subsystem presents status to the system during the Ending Sequence.

CLEANUP 1. (64B5) There are no bits on in pending status, and this is not a TIO. Reset tags and bus at end of an operation or a Halt I/O.

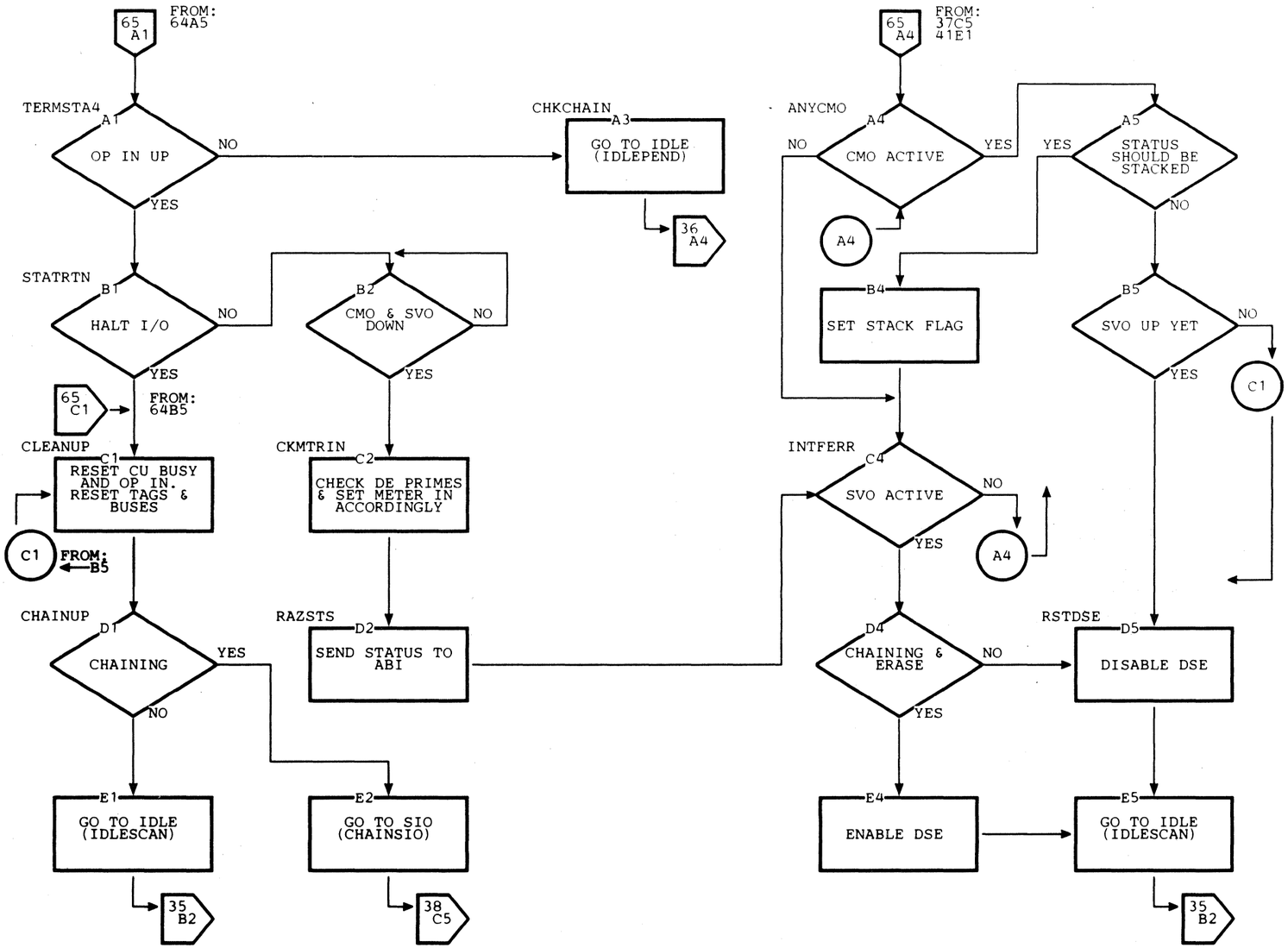
2. (65B1) There are bits on in pending status, and a HIO has been issued.

CHKCHAIN There are status bits on in pending status, or this is a TIO. The system is not attempting an Initial Selection.

CKMTRIN The meter must run as long as a Rewind or DSE is in progress.

INTFERR Status is sent to ABI. Check whether it is accepted or must be stacked.

RSTDSE A DSE is not legal unless it is chained to an ERG Command.

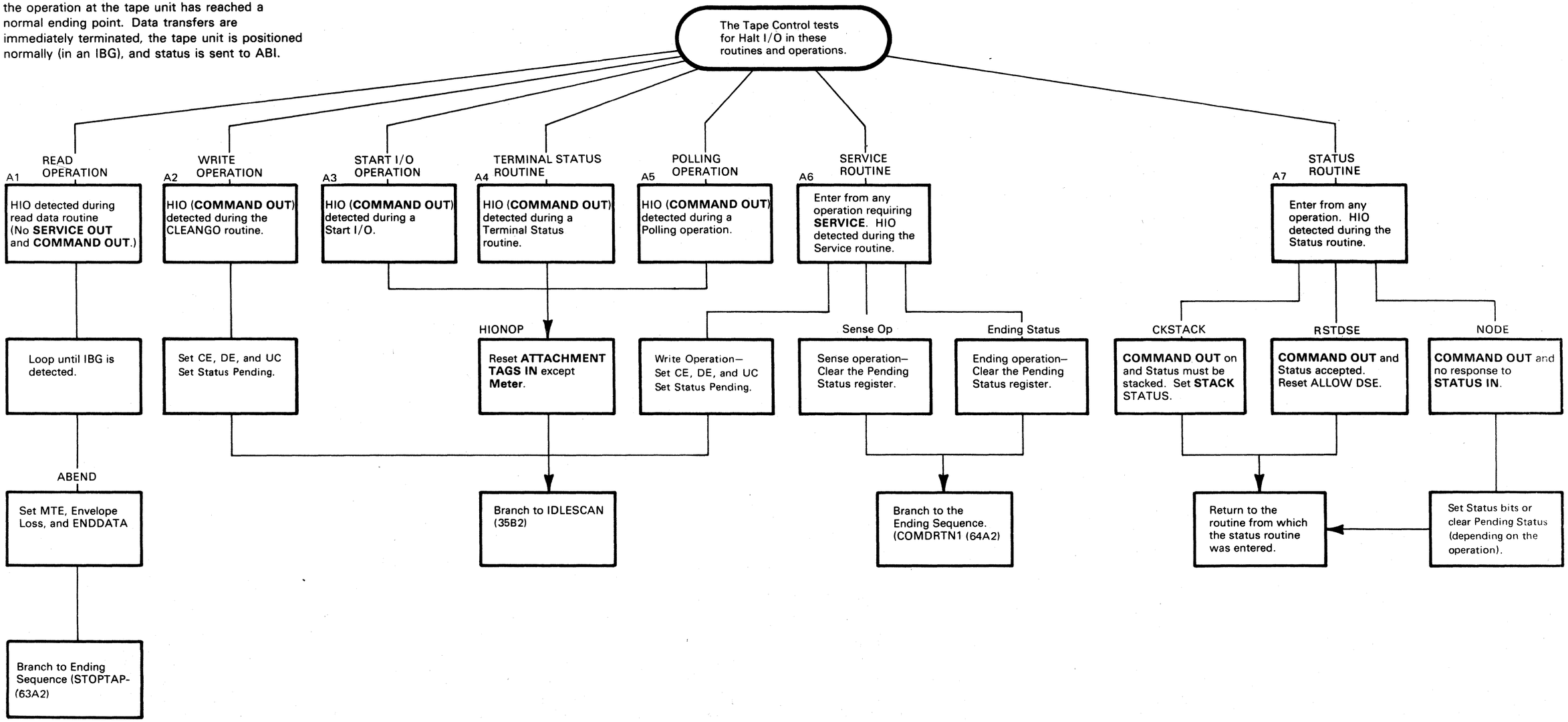


Halt I/O Operation (System/360/370)

The tape control tests for a command out signal at selected times during the execution of an operation. If command out is active at any of these times, the tape control interrogates it for a Halt I/O.

A Halt I/O is issued in order to terminate an operation before all data is transferred, or before the operation at the tape unit has reached a normal ending point. Data transfers are immediately terminated, the tape unit is positioned normally (in an IBG), and status is sent to ABI.

This chart shows the results of detecting a Halt I/O in the different operations and routines. The routines shown here can be entered from, and executed as a part of, any of the operations shown.



Microprogram Flowcharts (System/370 Model 125)

This section contains the tape control operational flowcharts used when the tape control is attached to a System/370 Model 125. All tape control operations are executed by a microprogram stored in ROS. The flowcharts illustrate the sequence of routines that perform the operations.

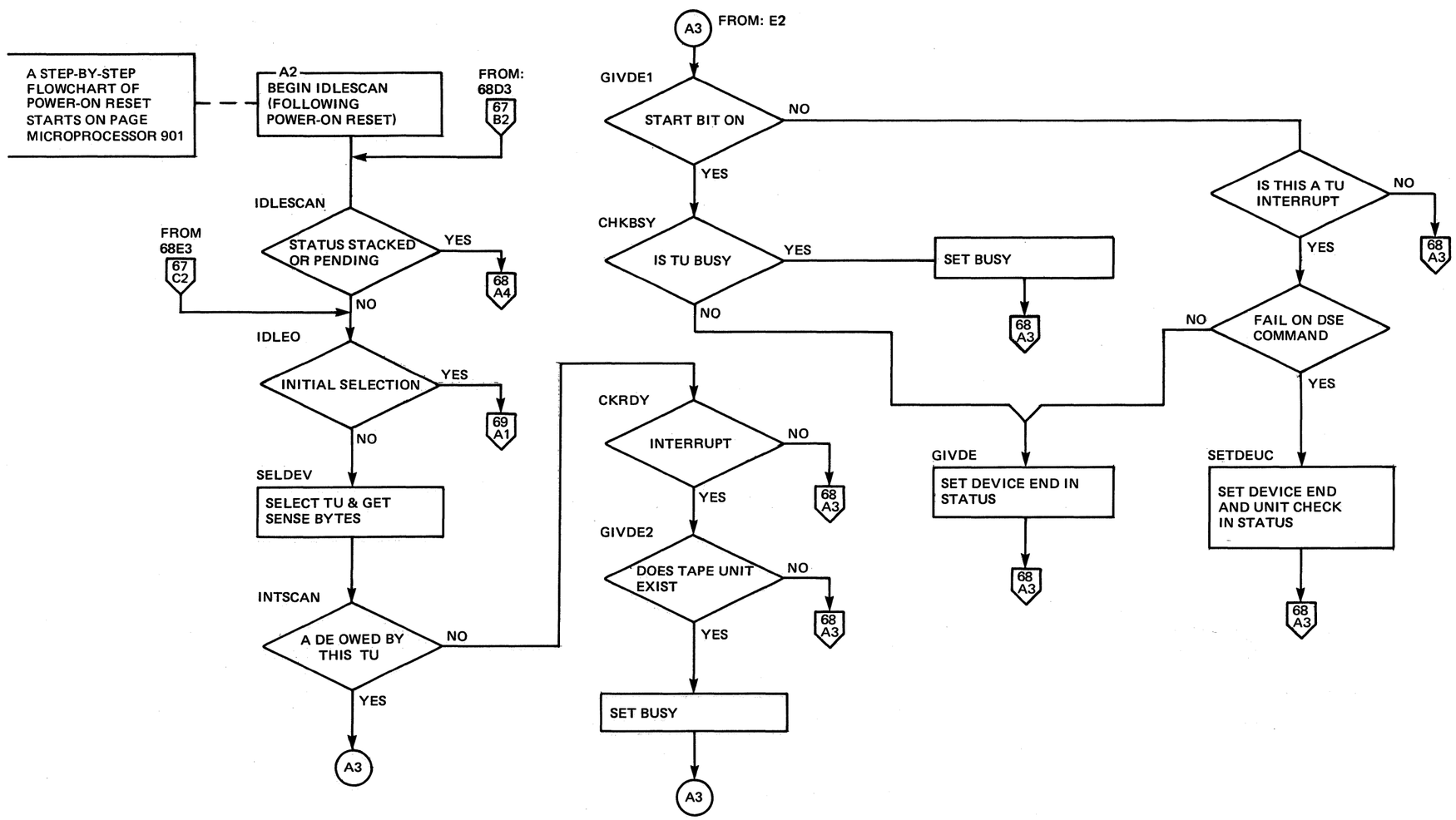
Program labels are included on the flowcharts as reference pointers to the microprogram listing. For the particular details of a routine, use the label and the cross-reference list in the back of the program listing.

IDLESCAN (System/370 Model 125)

Objectives

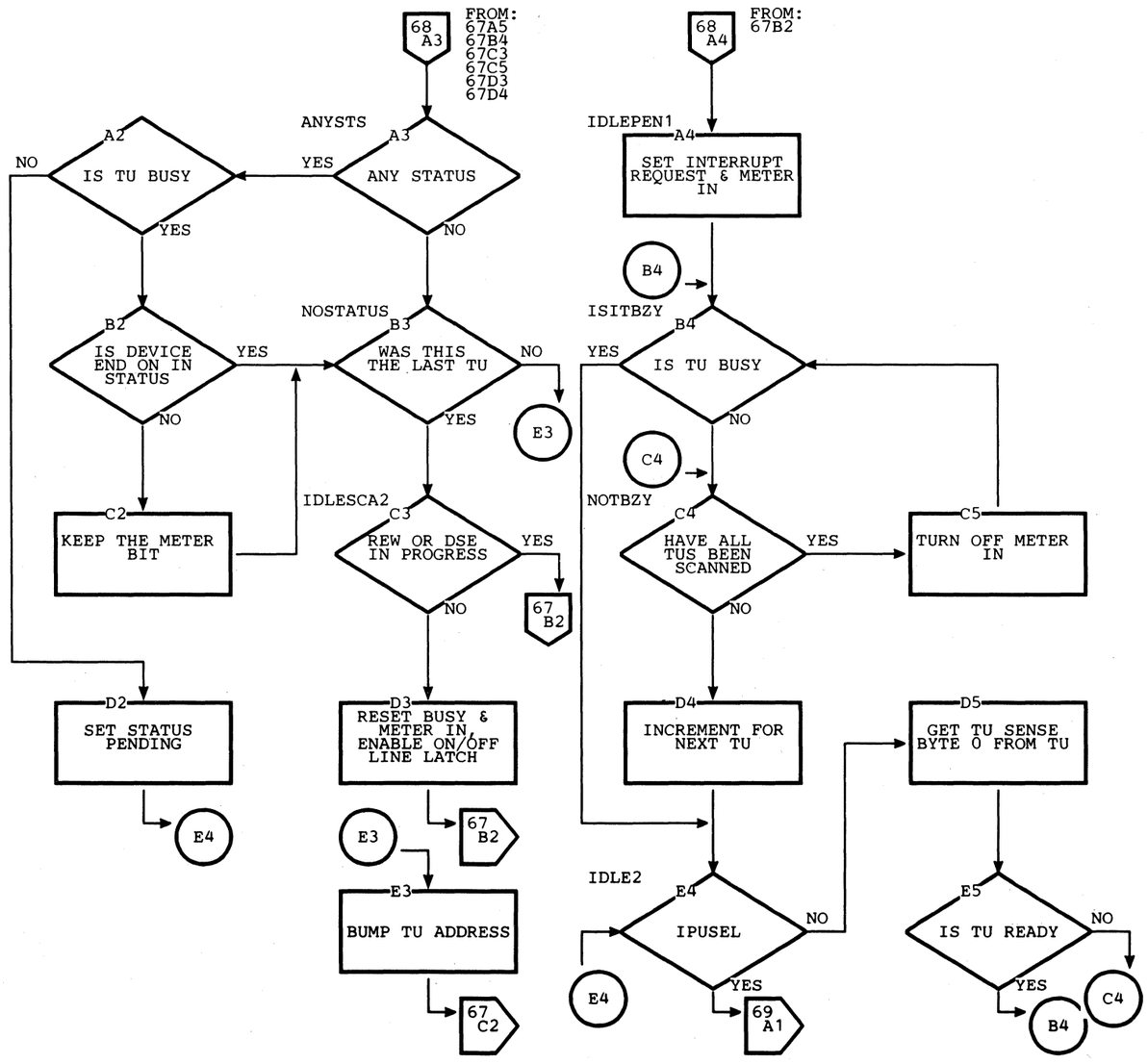
- Monitor Device End Primes for all tape units and set the METER IN line accordingly.
- Detect an Initial Selection or Polling sequence and branch to the proper microprogram location.
- Detect interrupts from tape units and set Device End and Unit Check in unit status byte when appropriate.

IDLEO	There is no stacked or pending status (no bits on in the Pending Status register). This is the return point for the scanning loop.
SETDEUC	A DSE operation failed.
GIVEDE	A DSE or Rewind is properly completed.



IDLESCAN (System/370 Model 125)

NOSTATUS Initial Selection is not active; and there are no status pending or device-end interrupt indicators active. If this is not the last TU, step the address. Continue the scanning loop.



Initial Selection (System/370 Model 125)

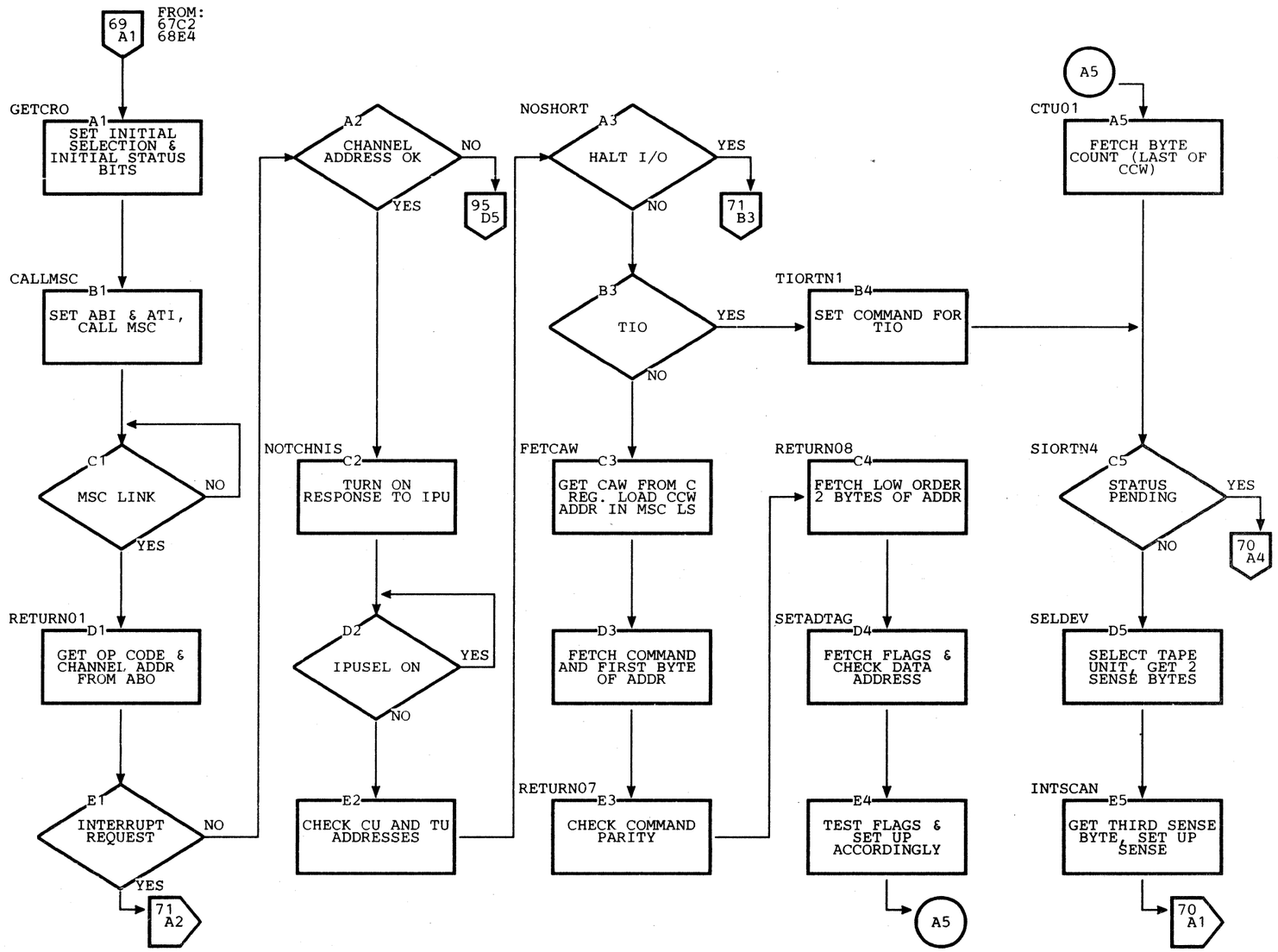
Objectives

- Control the Meter In line.
- Save any stacked or pending status.
- Send status to ABI during a polling sequence.
- Prevent the loss of pending status.
- Get the command from ABI and check its parity.
- Decode the command and branch to the proper microprogram location.
- Reject any invalid commands.

GETCRO IPUSEL has been detected indicating an Initial Selection sequence is being prepared.

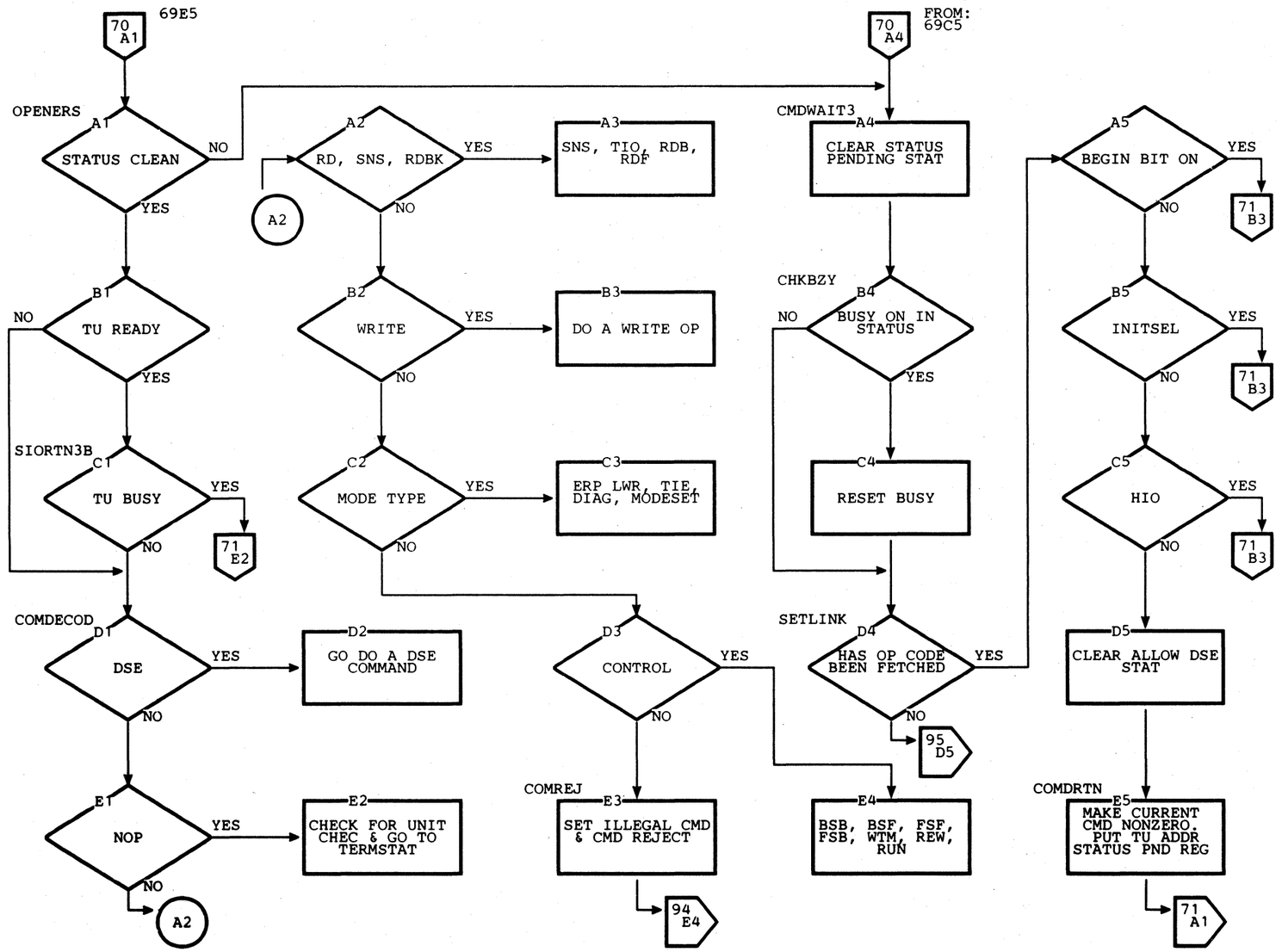
FETCAW This is not an Interrupt, HIO, or TIO. Get the CAW and CCW for this operation.

SELDEV Selection is successful so far, so select the tape unit and get sense information.



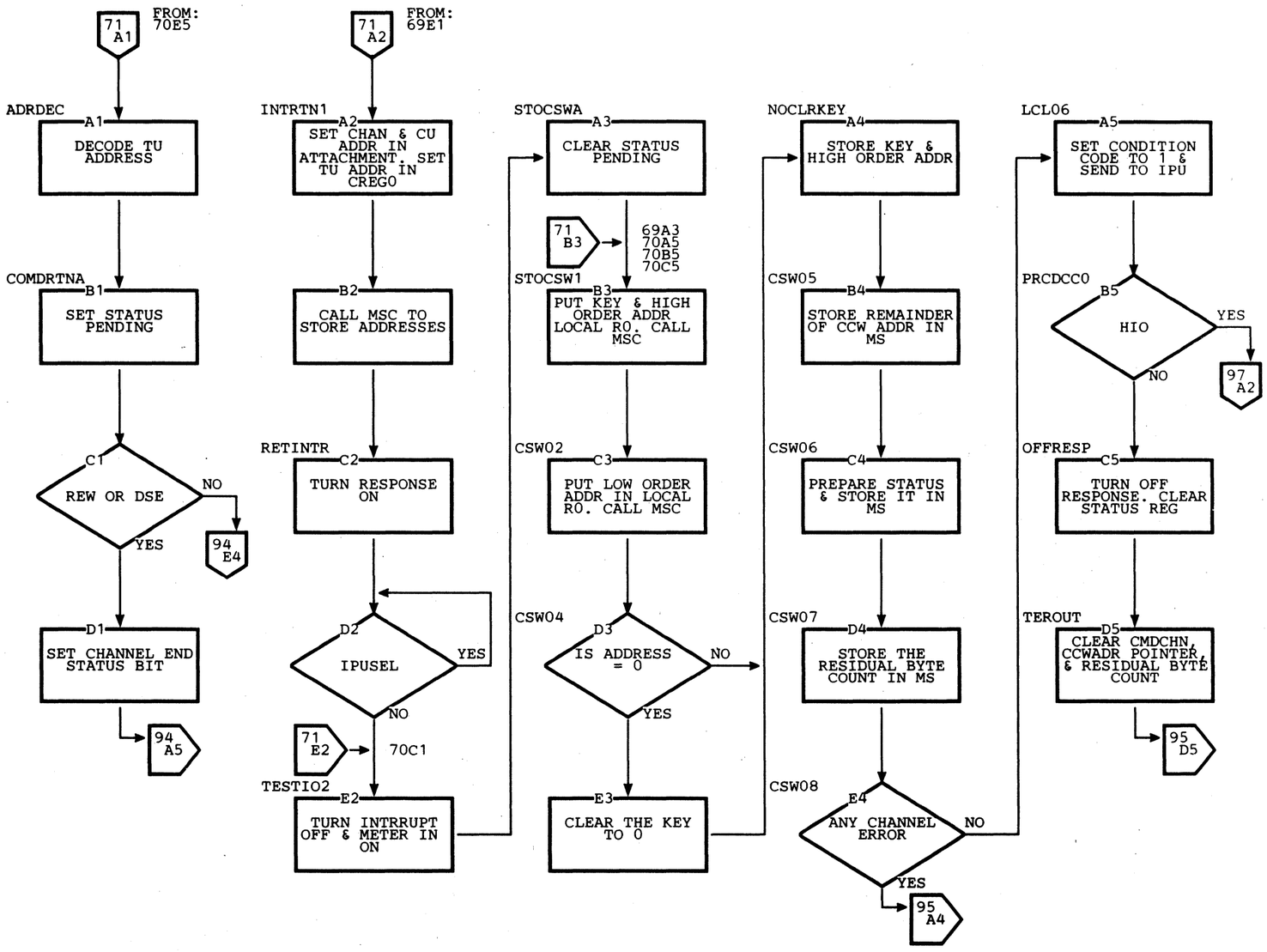
Initial Selection (System/370 Model 125)

COMDECOD	Selection is successful and tape unit status is clean, so decode the command.
CMDWAIT3	Send Pending Status to ABI.



Initial Selection (System/370 Model 125)

ADRDEC	Prepare to send status to ABI.
INTRTN1	This is an interrupt routine. Store the CAW.
TEROUT	The CSW has been stored, so return to the IDLESCAN loop.



Sense Operation (System/370 Model 125)

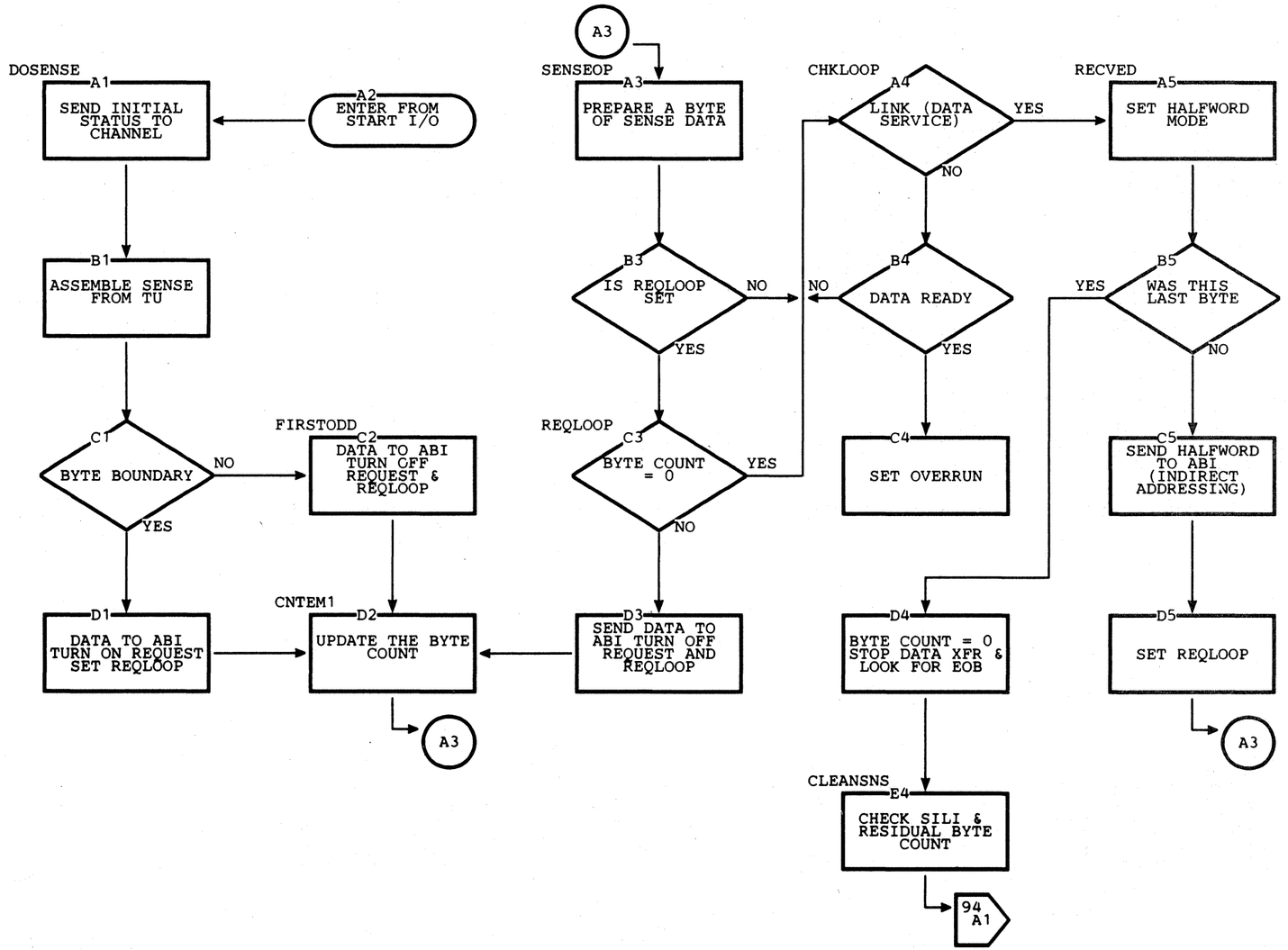
Objectives

- Send Unit Status Byte and the number of Sense Bytes indicated in the CCW to the System.

DOSENSE — Initial Selection is completed, so send status to ABI.

SENSEOP — The system accepted the previous sense byte. The tape control prepares the next one.

CLEANSNS — All the requested sense bytes have been sent to ABI, so terminate the operation.



Space Operation (System/370 Model 125)

Objectives

FWDSPBL The microprogram decoded a Forward Space Block command.

CLNBGN The microprogram decoded a Forward Space File command.

BKSPBL The microprogram decoded a Backspace Block command.

BKSPFL The microprogram decoded a Backspace File command.

CKMOVIN The command is a Backspace. A forward read command is sent to the tape unit to cause a forward hitch. If the tape unit is in backward status, the microprogram delays while the tape unit changes to forward status.

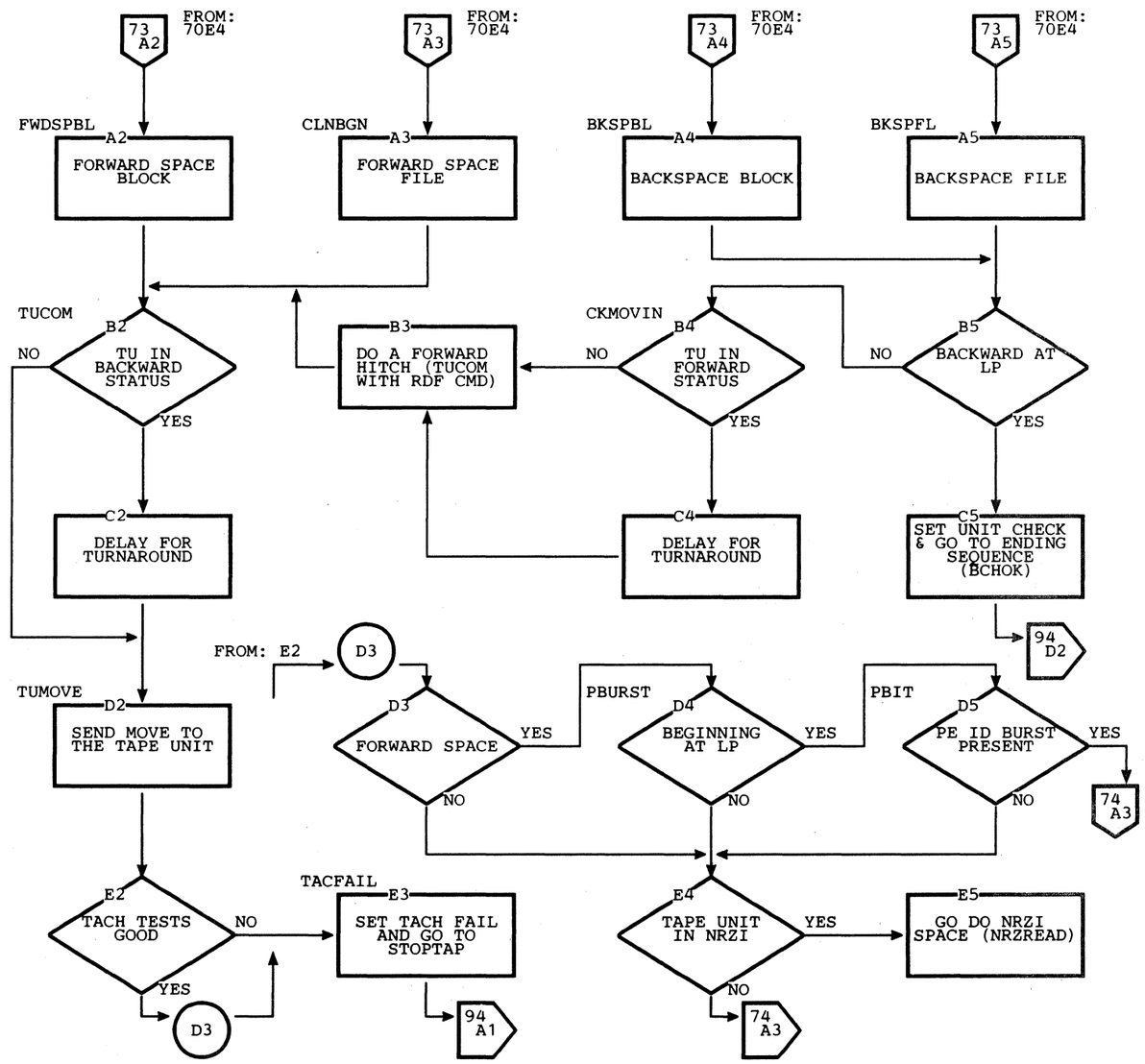
TUCOM Forward Space: The Forward space command is sent to the tape unit. No forward hitch was executed. If the tape unit is in backward status, the microprogram delays while the tape unit changes to forward status.

Backspace: The backspace command is sent to the tape unit following a forward hitch. A delay is needed while the tape unit changes to backward status.

TUMOVE The tape unit is in the proper directional status. Send the Move tag to the tape unit to start tape motion.

TACFAIL The tach pulses indicate the capstan is not moving at the correct speed.

PBURST The capstan is moving forward at the correct speed. If the tape started at load point, test for a PE Identification Burst.



Space Operation (System/370 Model 125)

BOBSCH — Entry from 73D5: A PE Identification Burst is present (the tape unit is spacing a PE tape forward, starting at load point).

Entry from 73E4: The tape unit is spacing a tape forward which was not positioned at load point, or was not in NRZI mode.

Entry from TSTIBG: An interblock gap, tape unit interrupt, or tape mark nas not been found, so continue to loop.

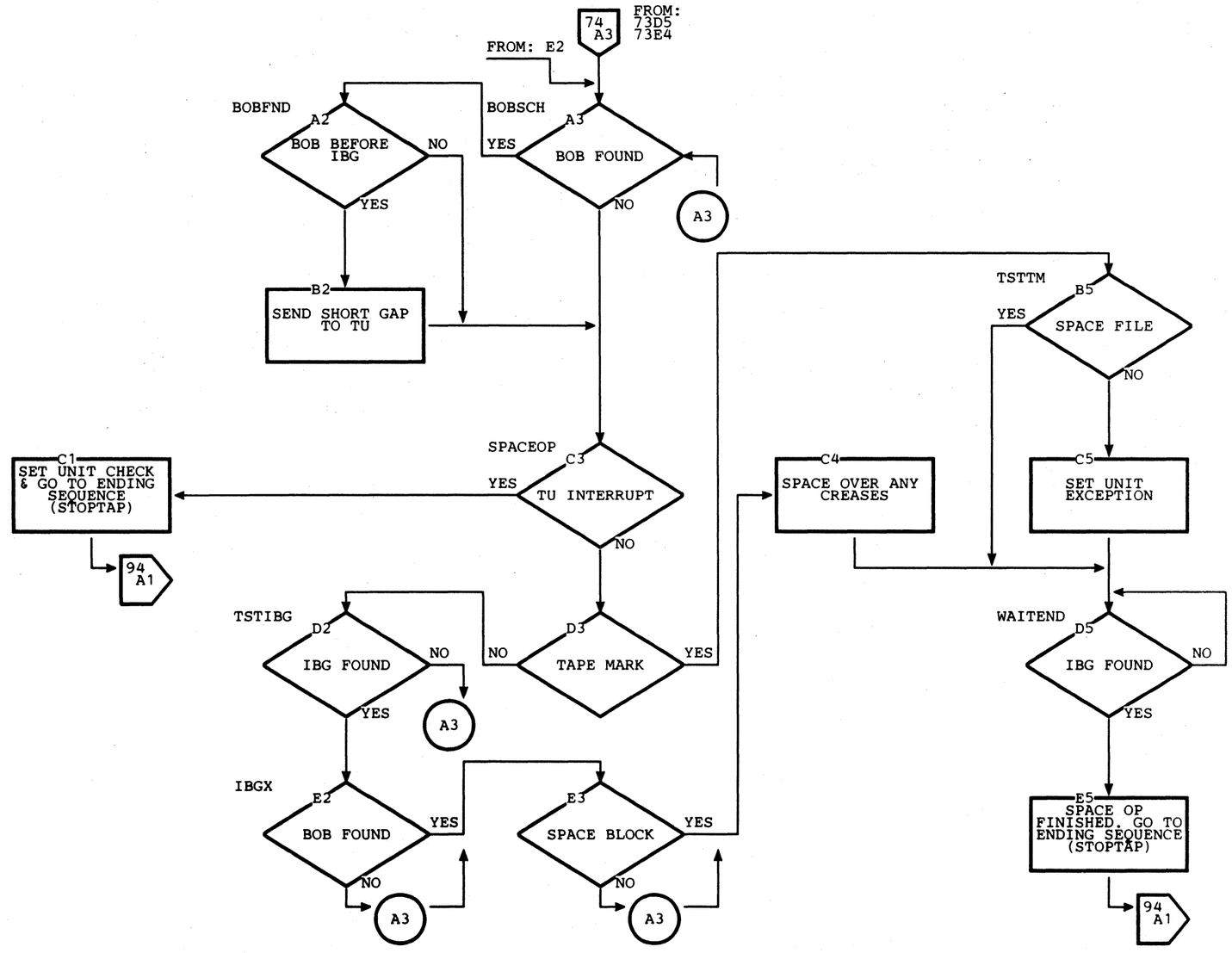
Entry from IBGX: An interblock gap has been detected, but beginning of block has not. Continue looping until a block has been spaced over.

SPACEOP — If a Tape Unit Interrupt is detected, the tape unit has become Not Ready.

TSTTM — A tape mark has been detected.

WAITEND — Space File: A tape mark has been detected. Wait for IBG before stopping tape.

Space Block: Wait until the IBG indication is valid (part of crease check) and stop the tape.

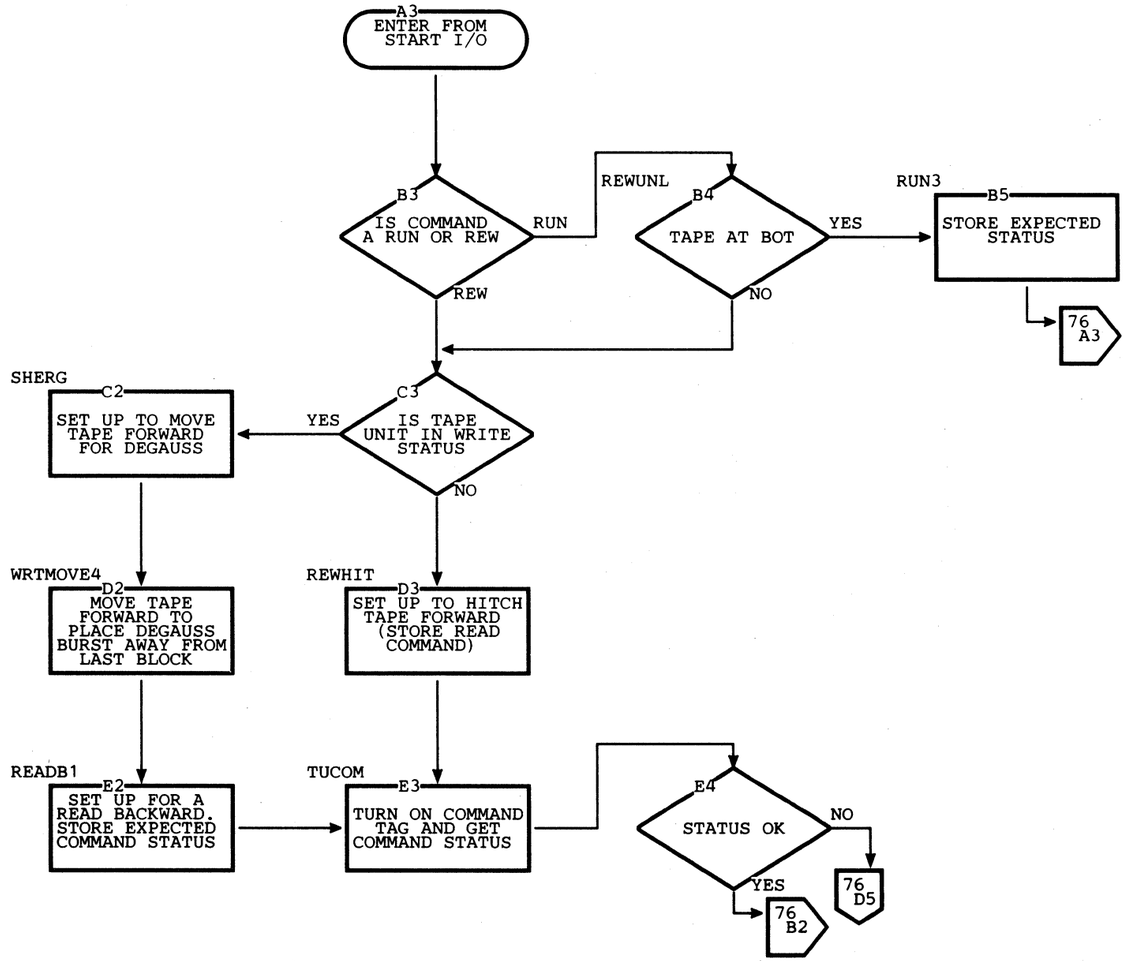


Rewind/Rewind Unload (System/370 Model 125)

Objectives

- To move tape forward a short distance (forward hitch) and then backward at high speed to the beginning of tape (BOT).
- If a Rewind Unload command, unload the tape unit when BOT is reached.
- Tape is not pulled out of the columns during the high speed rewind.

REWUNL	The command is a Rewind Unload. If tape is at BOT, no forward hitch is needed. Store the expected status and unload the tape.
SHERG	The tape unit is in write status. Prepare to degauss before rewinding.
WRTMOVE4	Move tape 1.5 inches beyond the last block written before degaussing.
READB1	Tape has been positioned beyond the last block written. Set up to move tape backward. Degauss occurs when tape unit status is switched from write to read status (TUCOM).
REWHIT	Tape unit is in read status. Set up for a forward hitch before rewinding.
TUCOM	Turn on Command Tag and get the command status. If status is bad, set Tape Unit Reject and terminate the operation.



Rewind/Rewind Unload
(System/370 Model 125)

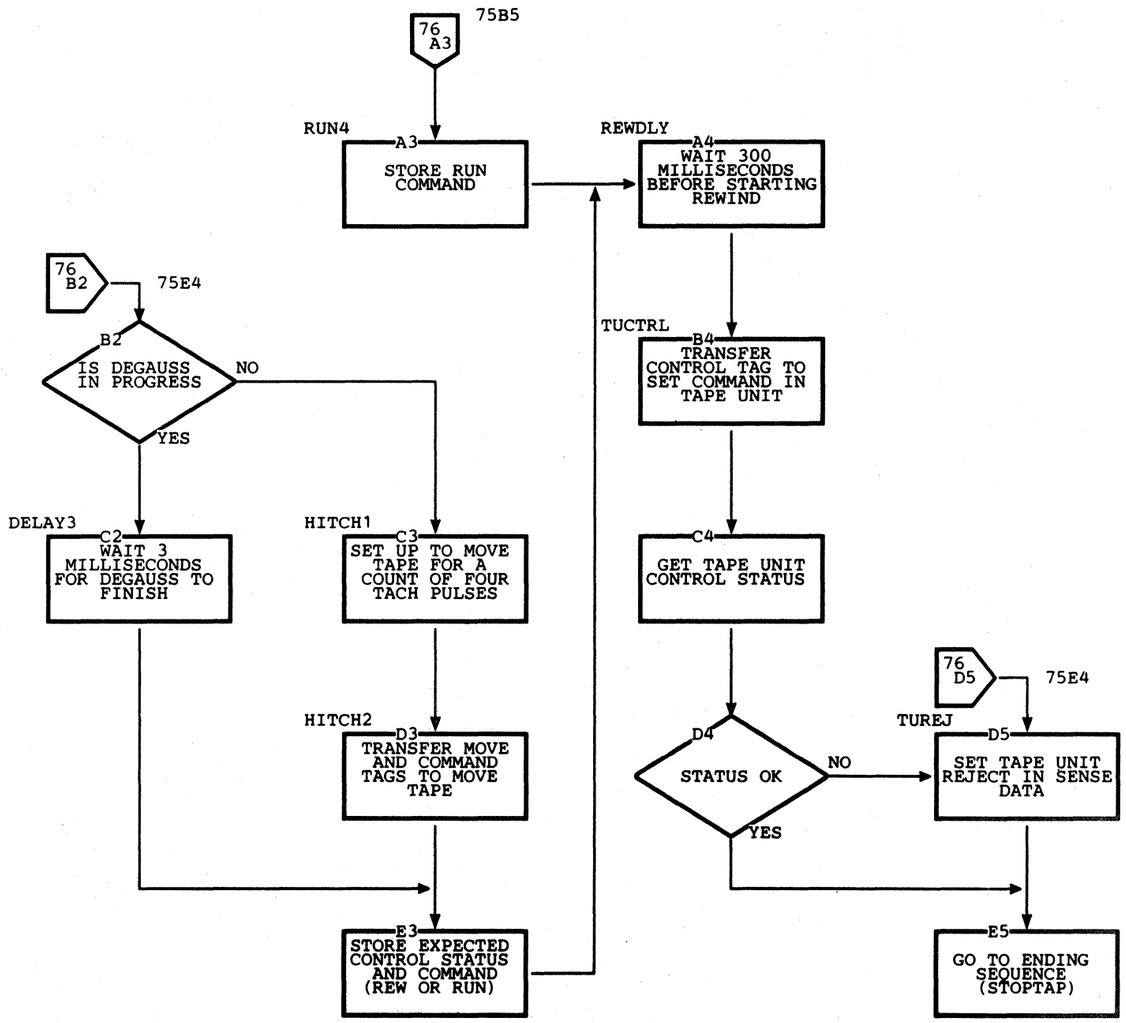
DELAY3 Wait 3 milliseconds for degauss to finish.

HITCH2 Hitch tape forward.

REWDLY Wait 300 milliseconds to ensure that multiple tape units do not start to rewind simultaneously.

TUCTRL Transfer Command and Control Tags to start tape rewinding. Get the tape unit control status. If status is bad, set Tape Unit Reject and terminate the operation.

If status is good, tape control releases the tape unit and runs internal diagnostics before returning to IDLESCAN. The tape unit continues to move tape until the rewind is completed.



Read Operation (System/370 Model 125)

Objectives

- To read data (PE or NRZI) in either direction.

77C1 Determine the type of read command (forward/backward).

77D1 The command is a Read Backward, so the tape must be hitched forward. Send the Move tag to the tape unit with a Read Forward command.

TUCOM If the command is Read Backward, the forward hitch is completed. Send the Read Backward command to the tape unit. If the command is Read Forward send it to the tape unit.

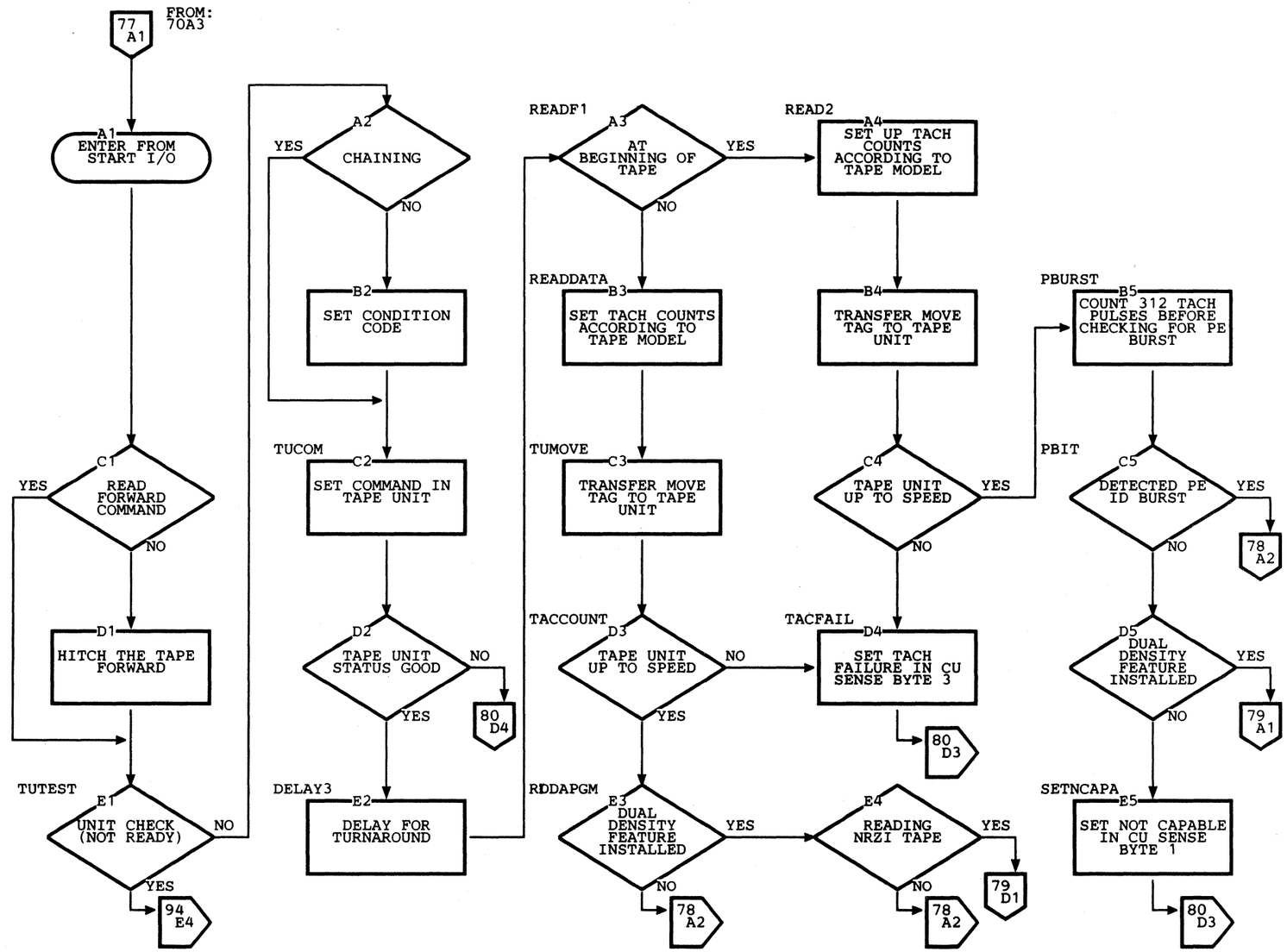
77D2 Check the Command Status Byte, and if it is not good reject the tape unit and terminate the operation.

READDATA The tape is not at BOT. Compare old and new tape unit status and use the results to set up tach counts according to tape model.

READ2 Same as READDATA except the tape is at BOT.

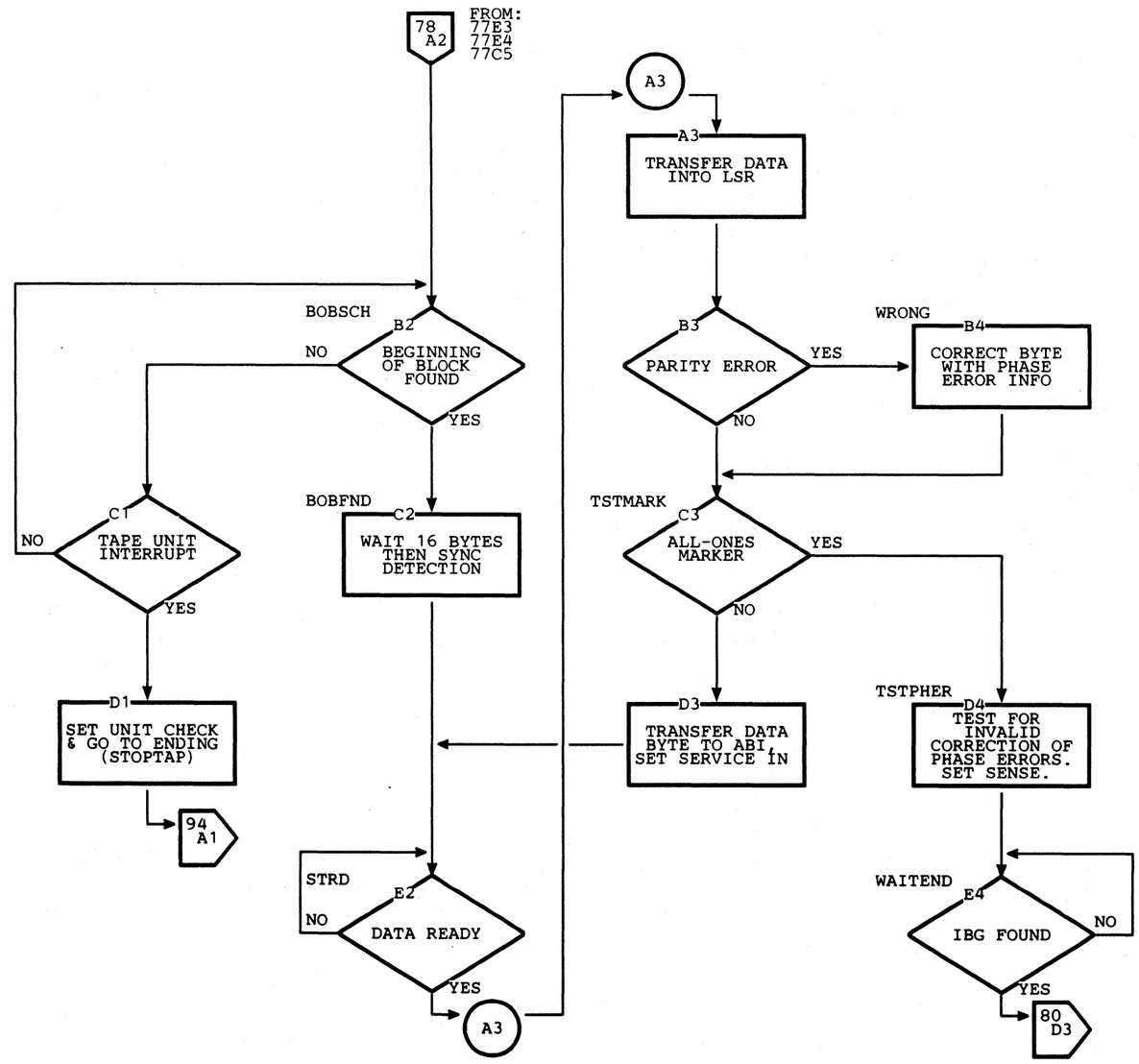
TACCOUNT Verify that tape is moving and at correct speed. If not, reset the Move tag to stop tape and terminate the operation.

PBURST Tape is at BOT, causing the microprogram to look for PE ID Burst. If no burst is found, the tape is recorded in NRZI. Determine if the tape control and tape unit are capable of reading NRZI.



Read Operation (System/370 Model 125)

BOBSCH	The tape is recorded in PE, causing the microprogram to search for the beginning of the data block.
STRD	Three data bytes are buffered in the LSR. If a phase error is detected, the byte is corrected just before it is sent to ABI. Only single-track errors are corrected.
TSTPHER	The all-ones marker has been detected, causing the microprogram to check for any accumulated phase errors.
WAITEND	The postamble is being read. When the IBG is detected, stop tape.



Read Operation (System/370 Model 125)

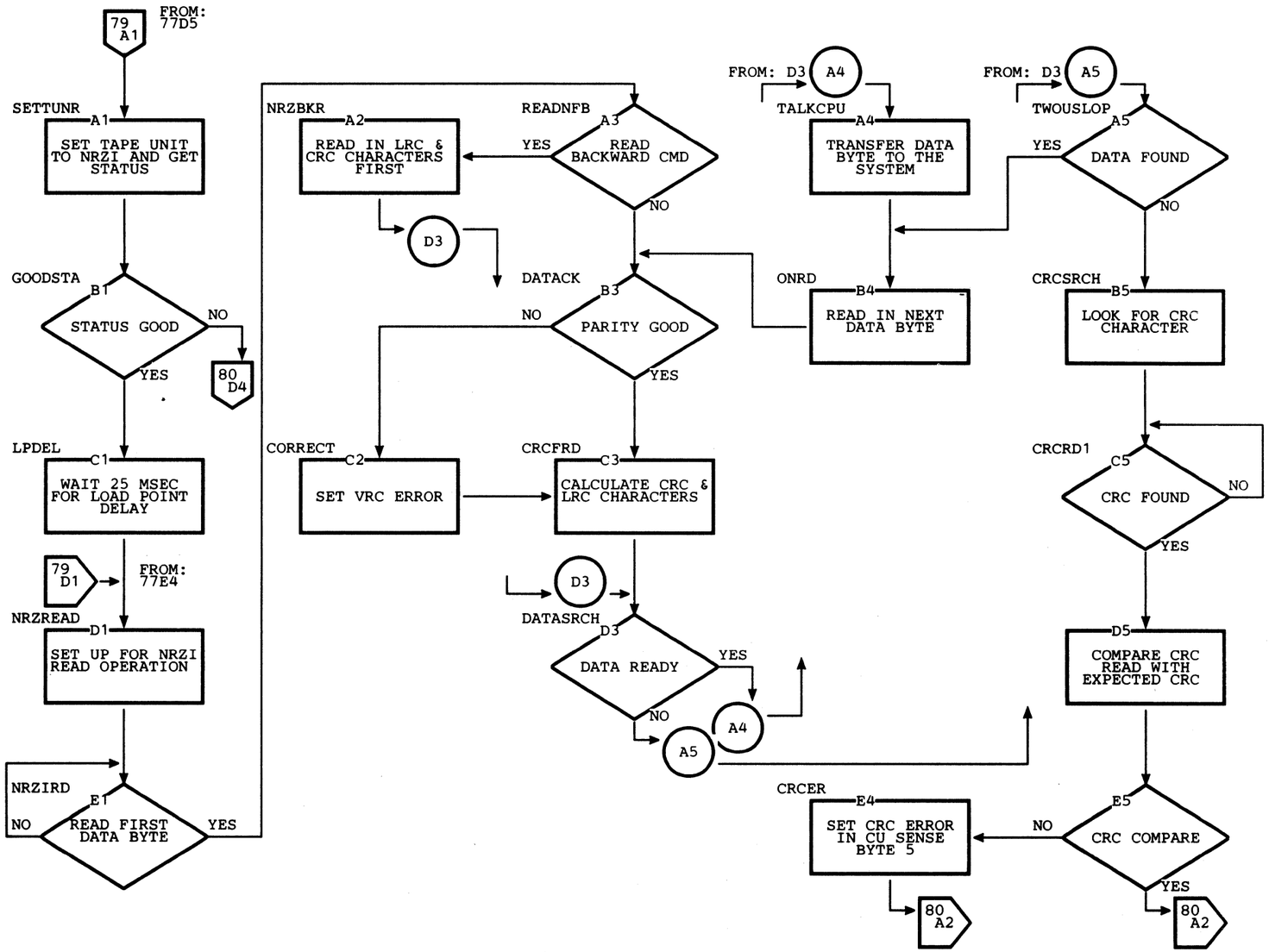
SETTUNR The tape is at BOT and is a NRZI tape. Start looking for the first data byte.

NRZREAD The tape is not at BOT and is a NRZI tape. Start looking for the first data byte.

NRZBKR This is a NRZI Read Backward operation, so the first bytes read are the LRC and CRC characters. Store the check characters for use at the end of the read operation, then start looking for the data bytes.

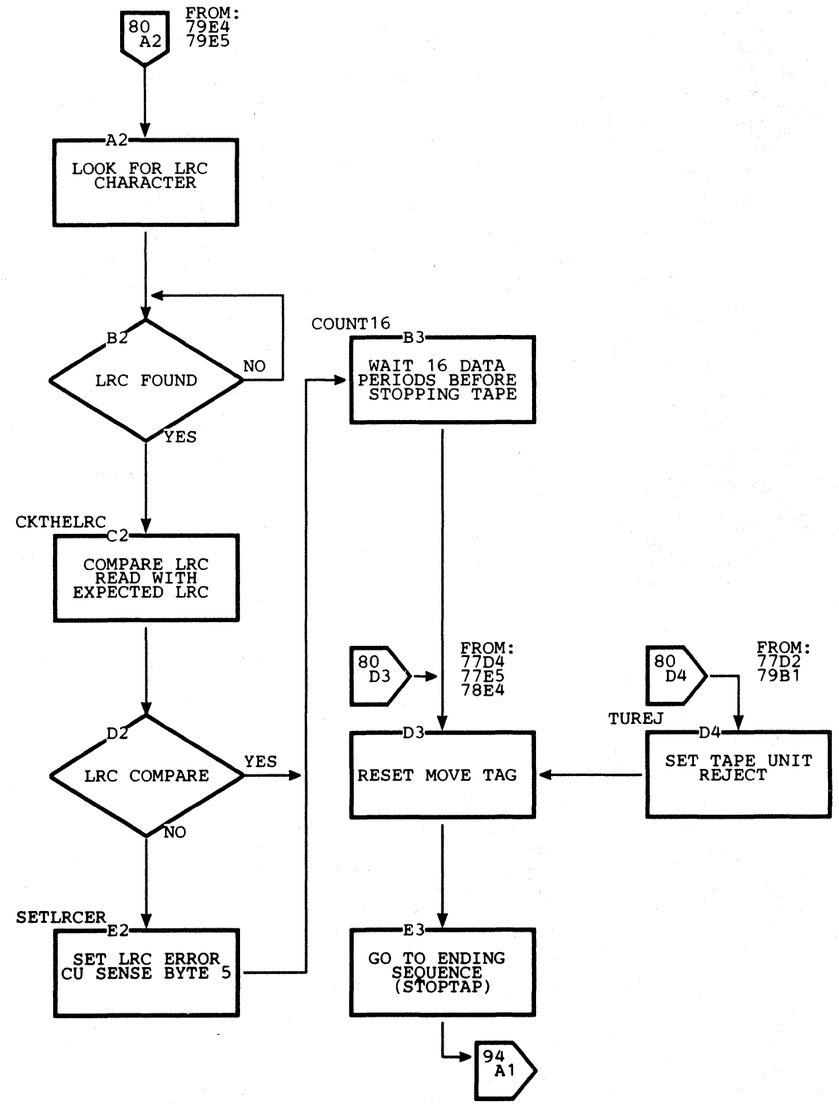
CRCFRD A data byte has been read and parity checked. The LRC and CRC characters are calculated each time data is read.

TWOUSLOP Loop for two microseconds searching for data. If none is found, a byte may have been lost. Loop again for two microseconds, and if data is still not found, search for the CRC and LRC characters. If reading backward, send the last byte read to ABI.



Read Operation (System/370 Model 125)

80D3 The operation is completed or an error has occurred. Reset the Move tag.



Write Operation (System/370 Model 125)

Objectives

- To write data (PE or NRZI) on tape.

WRT1 Check the status of the tape unit. If in forward status, store the write command.

If in backward status, wait for turnaround sequence before storing write command.

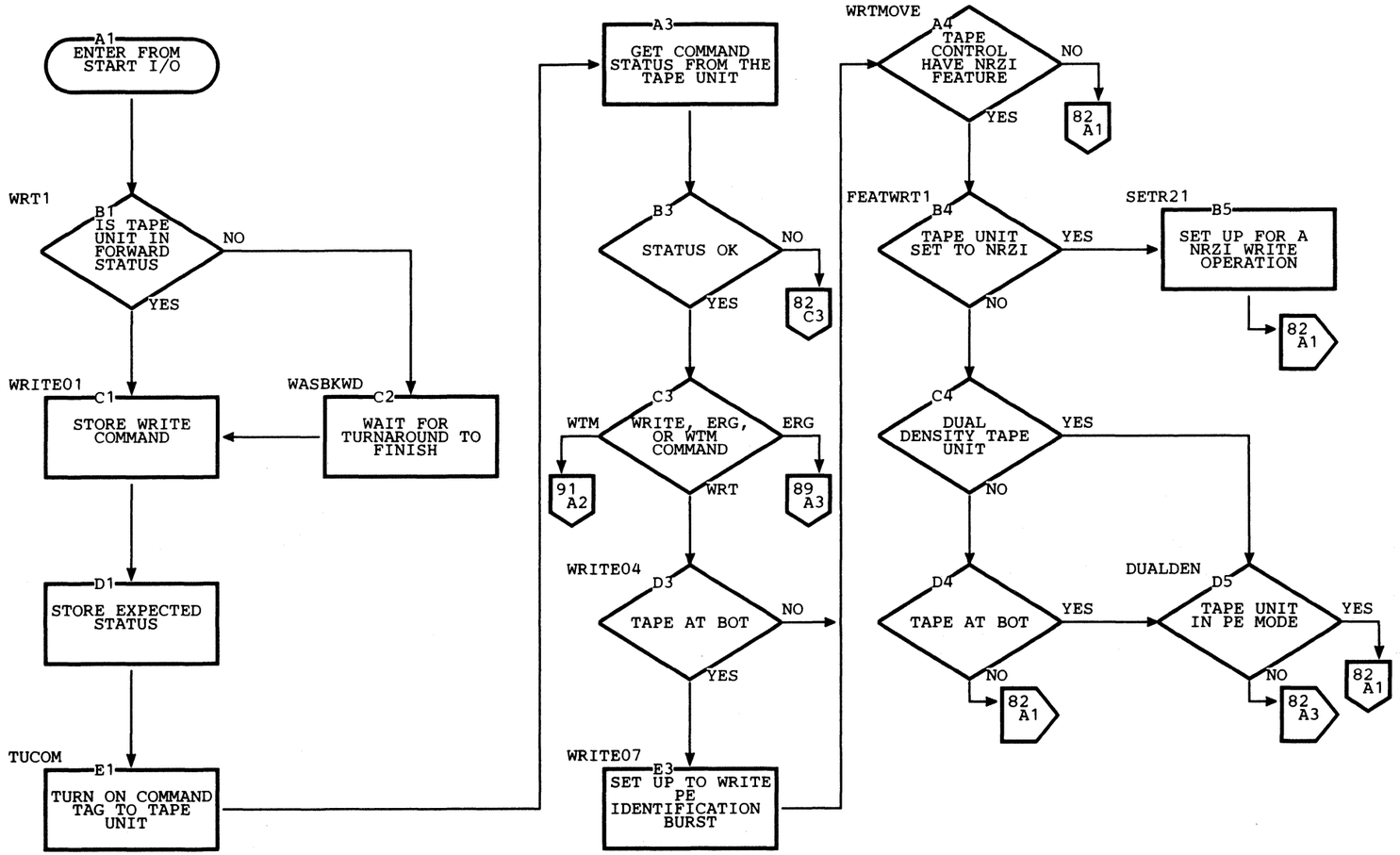
TUCOM Get the command status and set the tape unit to write status. If command status is not good, reject the tape unit and terminate the operation.

If status is good, check that tape is at BOT. If it is, set up to write PE ID Burst.

WRTMOVE Determine if NRZI is installed in tape control. If not, go to TUMOVE.

FEATWRT1 Tape control has NRZI installed. Check if the tape unit is set to NRZI. If it is, set up controls for a NRZI write. If not, check if tape unit has dual density feature and is at BOT. If not at BOT, go to TUMOVE.

DUALDEN Tape unit has dual density feature and is at BOT. Check that a Mode Set command has been issued.



Write Operation (System/370 Model 125)

SETUNRZ — A Mode Set command was issued. Set the tape unit to NRZI and check the status.

SETLPD1 — Set controls to cause a load point delay before the first data block is written (NRZI only).

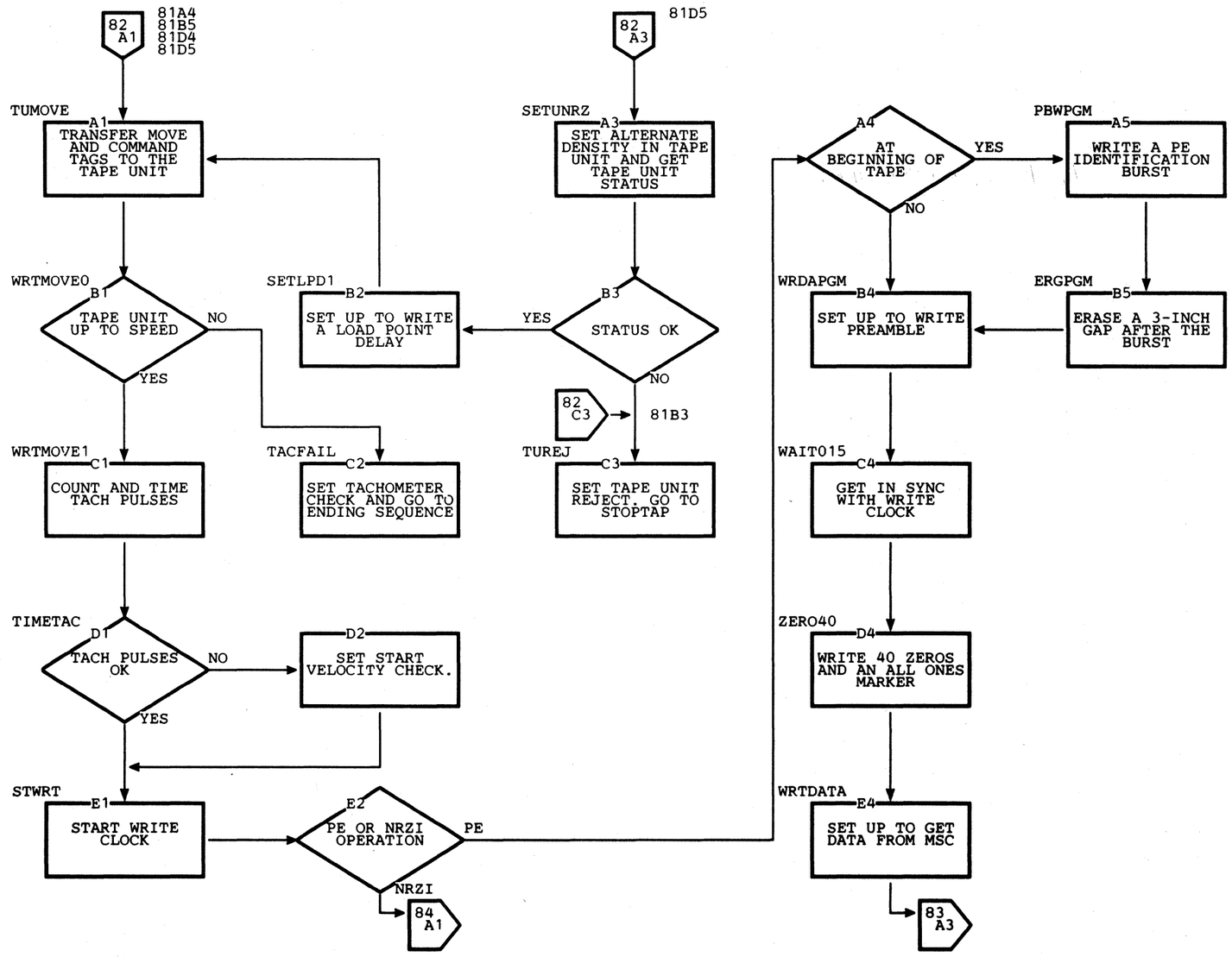
TUMOVE — The tape unit status is good and tape unit is ready to write (PE or NRZI). Transfer Move tag to get tape moving.

WRTMOVE0 — The tape unit is in write status and Move tag transferred. When Gap Control is detected, the tape unit is up to speed. The tach pulses from the capstan motor are measured to determine when the capstan is up to speed. If the capstan does not reach full speed within a predetermined time, go to TACFAIL.

WRTMOVE1 — Set up to count and time tach pulses to verify tape speed. If no tach pulses are counted, set tachometer check and terminate the operation. If tach timing is bad, set Start Velocity Check and continue the operation.

PBWPGM — The tape unit is at BOT and in PE Mode. Write the PE ID Burst before writing data on tape.

WRDAPGM — The PE ID Burst has been written or the tape is not at BOT. Write a preamble of 40 zeros and an all-ones marker.



Write Operation (System/370 Model 125)

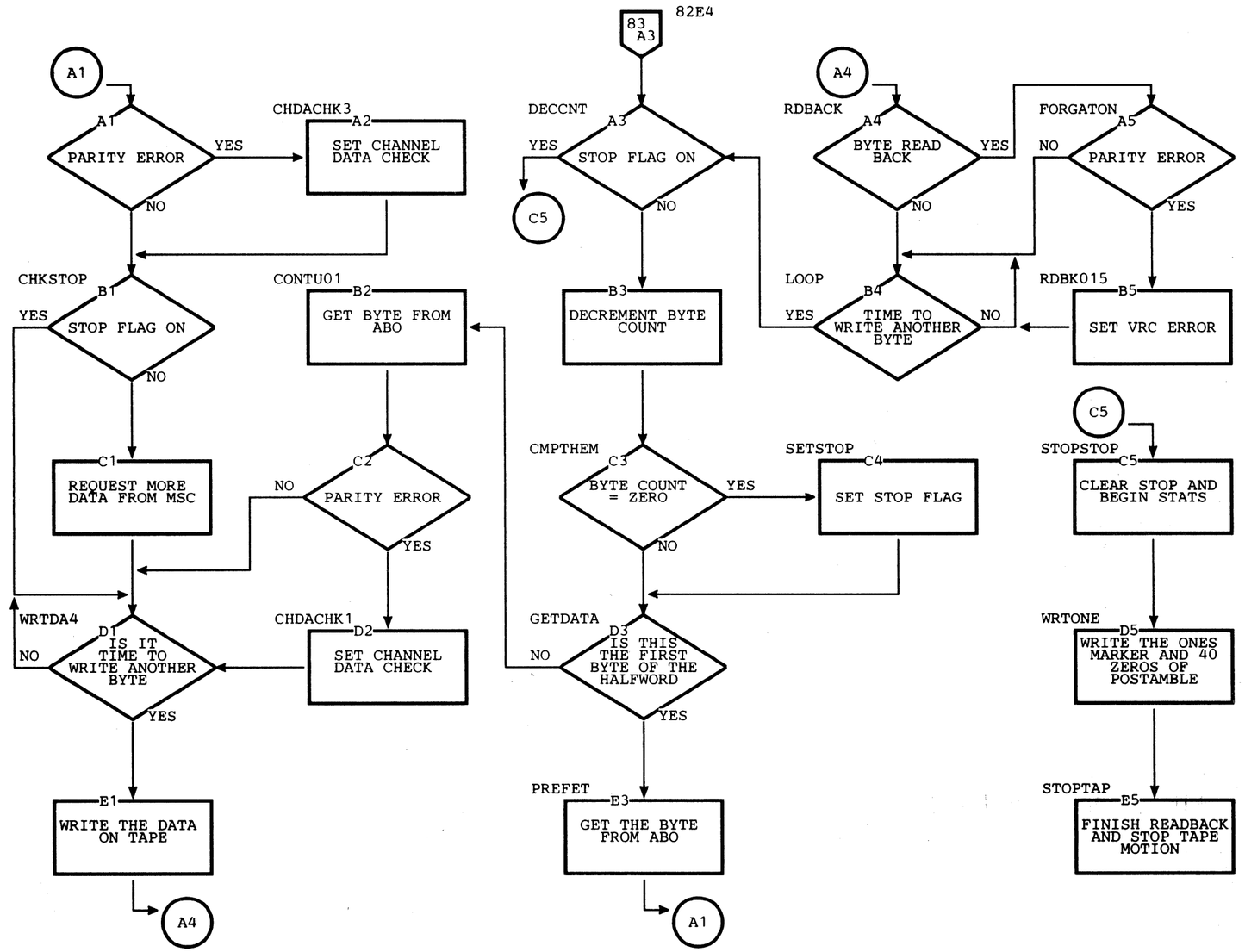
DECCNT Check for the Stop flag. If on, go finish up. If off, decrement the byte count and get the data from the tape adapter.

GETDATA The tape adapter gets the data from MSC one halfword at a time and sends it to the tape control a byte at a time. Get the byte from the ABO and check for parity. If parity is bad, set Channel Data Check.

WRTDA4 Write the byte on tape and perform a parity check on any byte which has been read back. If parity is bad, set VRC error.

CHKSTOP Check again for any stop conditions. If any stop conditions are on, go finish up the operation. If no stop conditions are on, request more data from MSC.

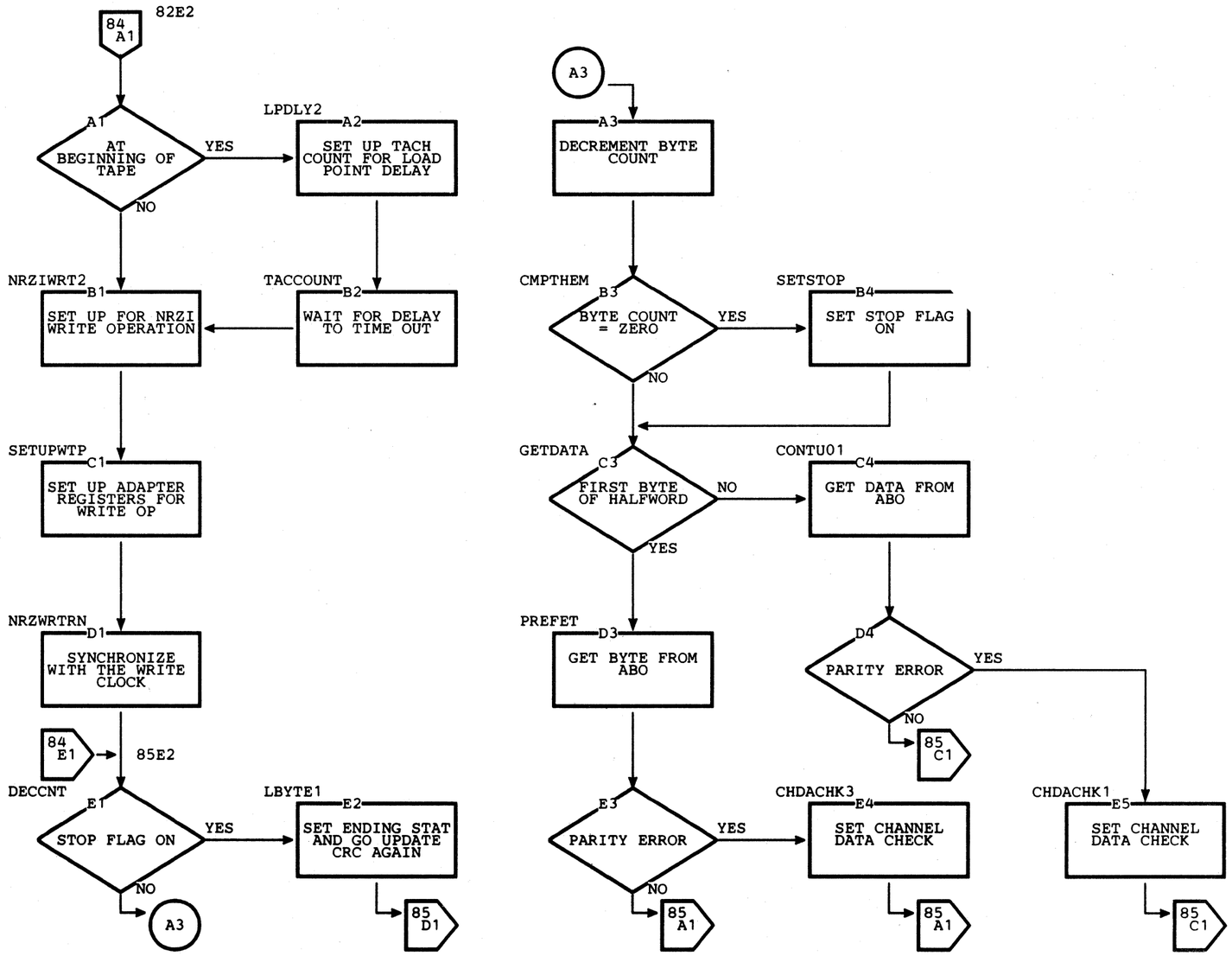
WRTONE The last data byte has been written. Write the postamble and continue readback check until the end of the block is sensed.



Write Operation (System/370 Model 125)

LPDLY2 This is a NRZI write operation and tape is at BOT. Set up for a load point delay.

DATOLRC Update the LRC and CRC characters. Write the data byte on tape.



Write Operation (System/370 Model 125)

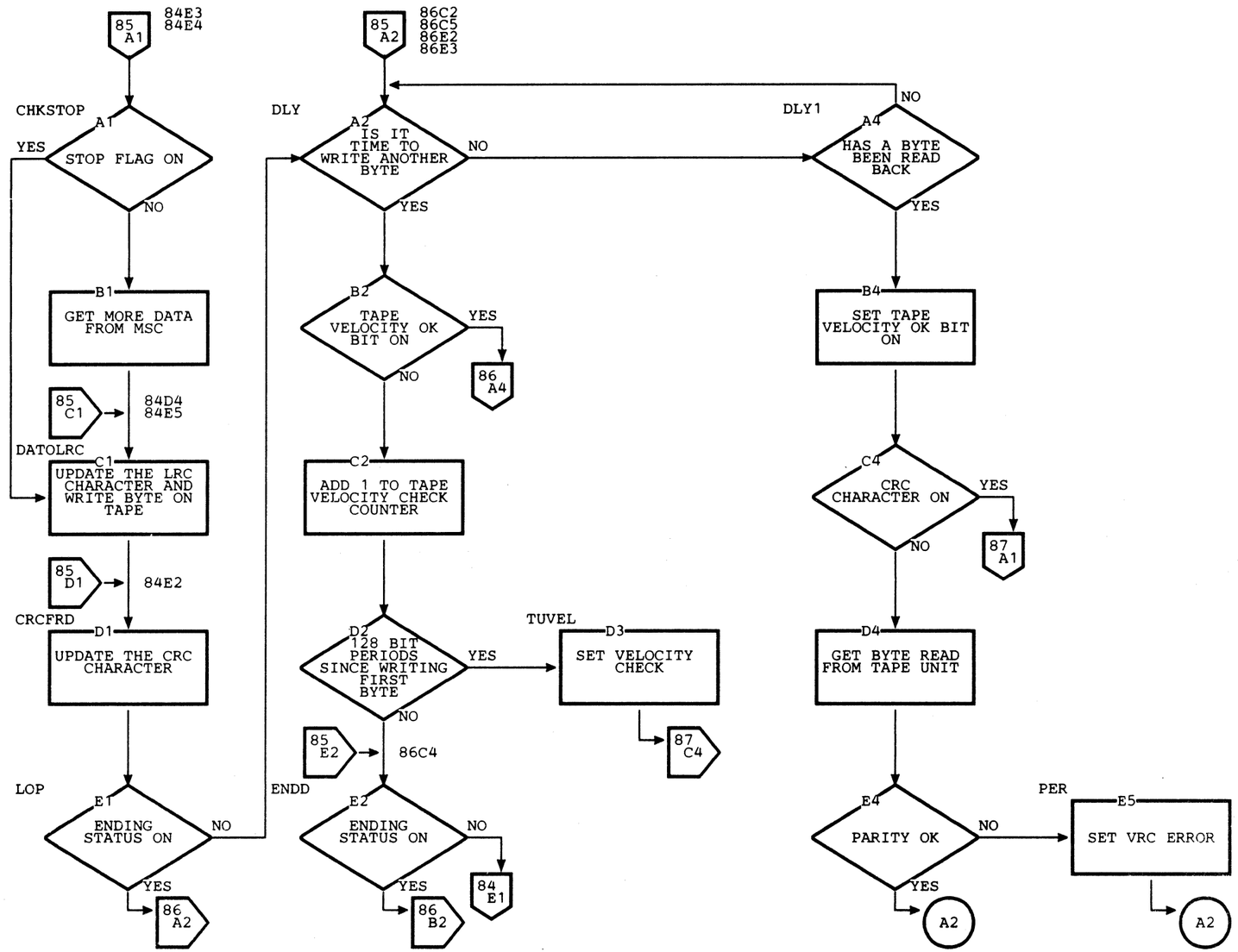
LOP — Check if Ending Status bit is on. Ending Status is set when the last data byte has been written (LBYTE1).

DLY — Wait until either a byte is read back or another byte is to be written.

A counter is used to ensure that tape is moving at the correct speed in the early stages of the write operation. The counter is stepped each time a byte is written.

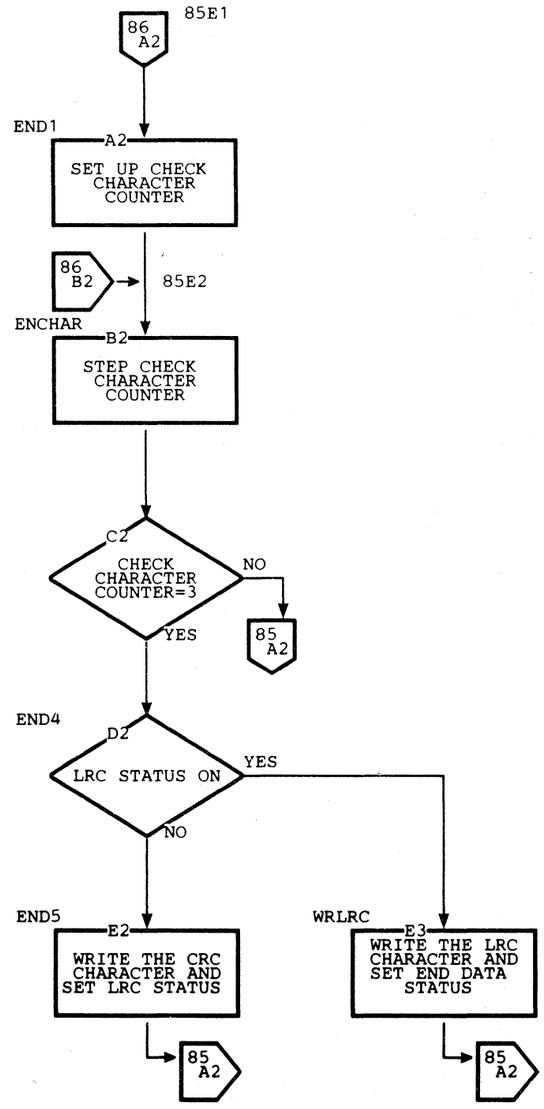
If no data has been read back (Tape Velocity OK bit not on) before 128 bytes have been written, Tape Velocity Check is set.

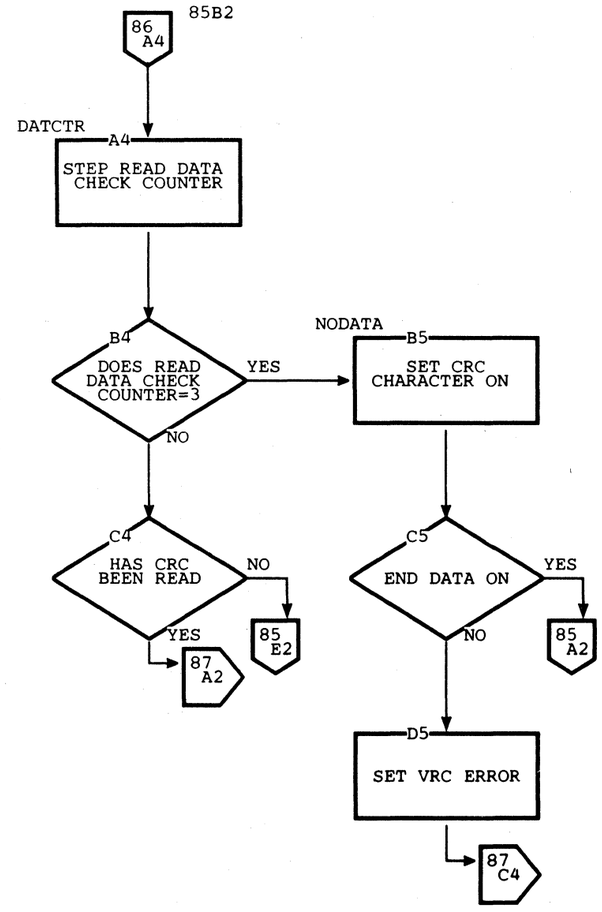
When a byte is read back, parity is checked. If parity is bad, VRC Error is set.



Write Operation (System/370 Model 125)

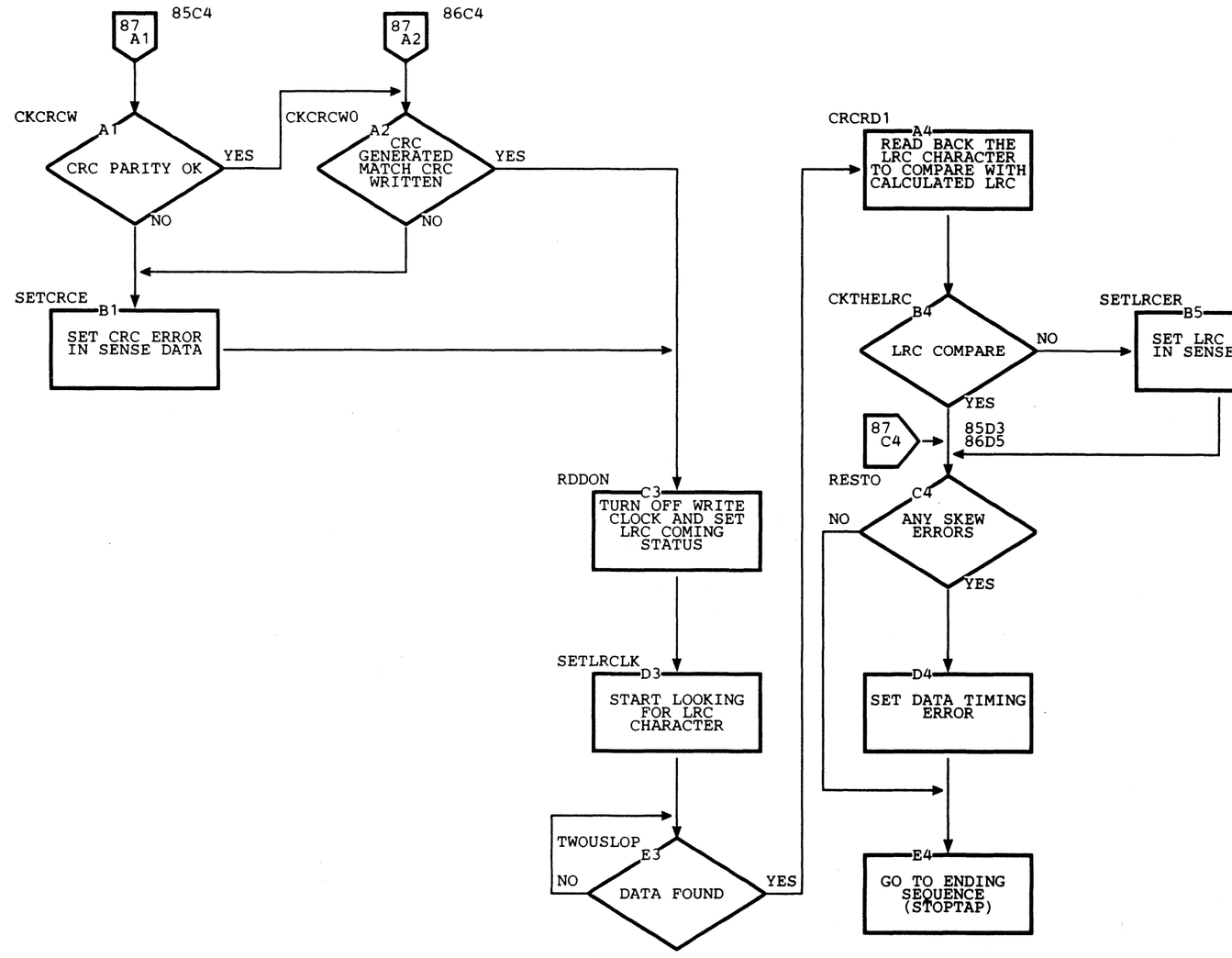
END1	Ending Status is on. Set up a counter to ensure correct spacing between check characters.
ENCHAR	Ending Status is set; step the check character counter. The counter is stepped three times before writing each check character.
END4	If LRC Status is off, write the CRC character and turn on LRC status. If LRC Status is on, write the LRC character and set End Data Status. Return to DLY.





Write Operation (System/370 Model 125)

CKCRCW	The byte read back is the CRC character. Compare the CRC written with the CRC calculated.
TWOUSLOP	Wait for the LRC character.
CRCRD1	The byte read back is the LRC character. Compare the calculated LRC with the LRC read back.
RESTO	Check for any skew errors and go to STOPTAP of ending sequence to finish the operation.



Data Security Erase (DSE) (System/370 Model 125)

Objectives

- To erase tape from its present position to the end of tape (EOT) marker.

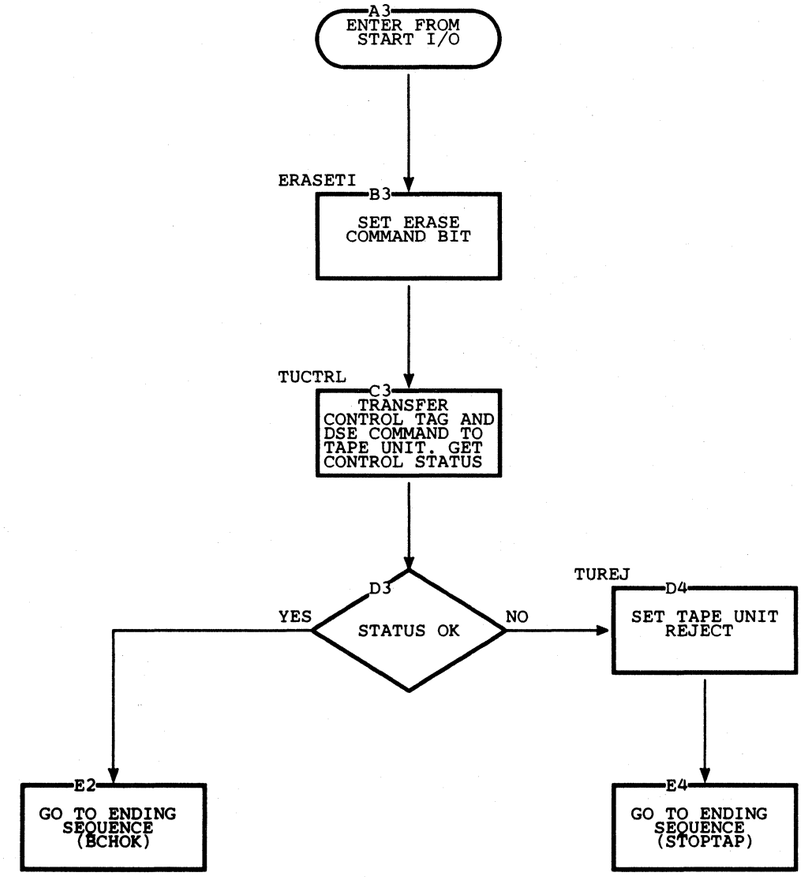
ERASETI — The Data Security Erase command was decoded by the COMDECOD routine. To enter the DSE routine, tape unit status must indicate Write Status, Not at EOT, and Not File Protected.

TUCTRL — Tape unit status is good. Transfer the Control tag and Command to the tape unit. Read in the status byte from the tape unit.

If tape unit status is good, store the sense data, run internal diagnostics, and return to IDLESCAN.

The tape control releases the tape unit. Tape motion continues until EOT is sensed.

TUREJ — Tape unit status is bad. Set Tape Unit Reject and terminate the operation.



Erase Gap Command (System/370 Model 125)

Objectives

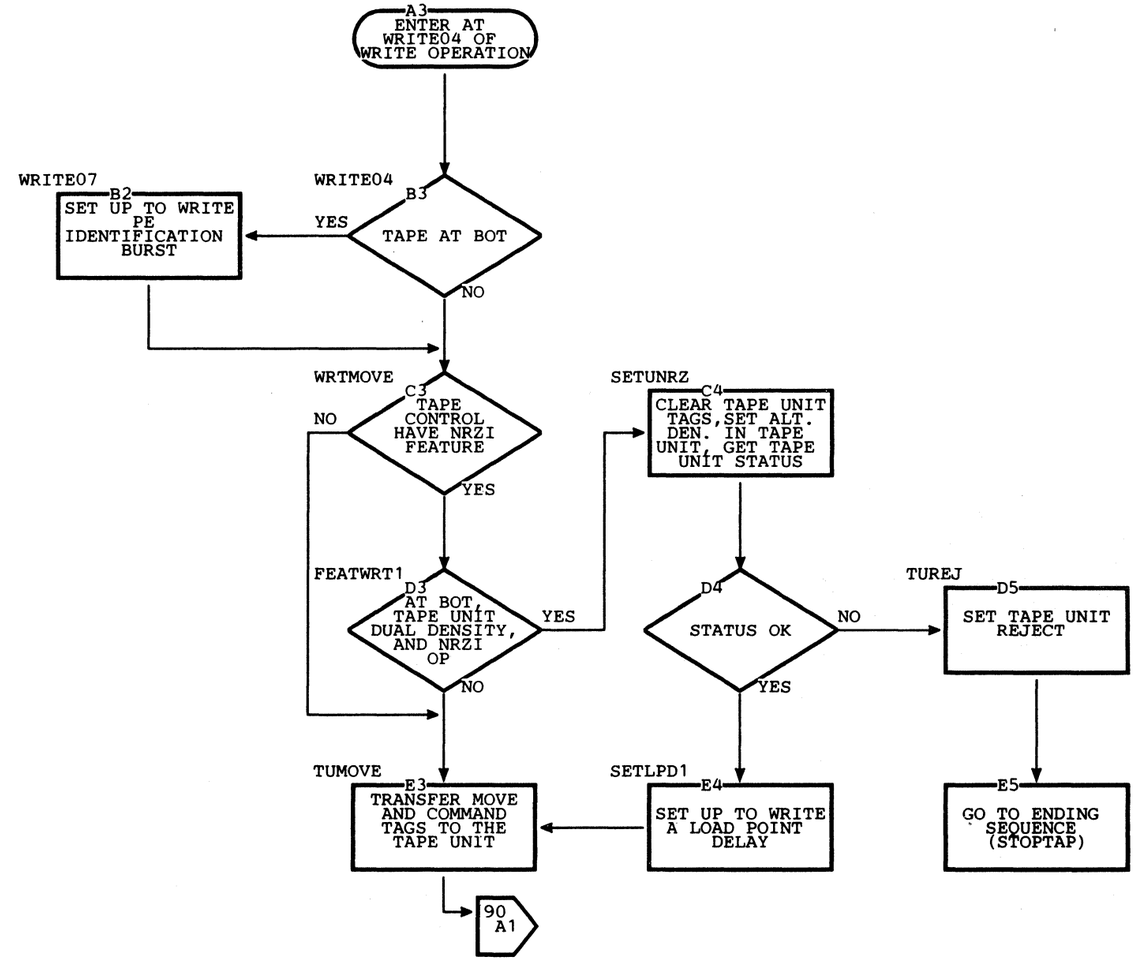
- To erase a 3-inch section of tape.

WRITE04 Check that tape is at BOT. If it is, set up to write PE ID Burst before erasing tape.

FEATWRT1 Tape control has NRZI installed. Determine if tape is at BOT, if the tape unit has NRZI feature, and if this is a NRZI operation. If all conditions are met, go to SETUNRZ to prepare for a load point delay.

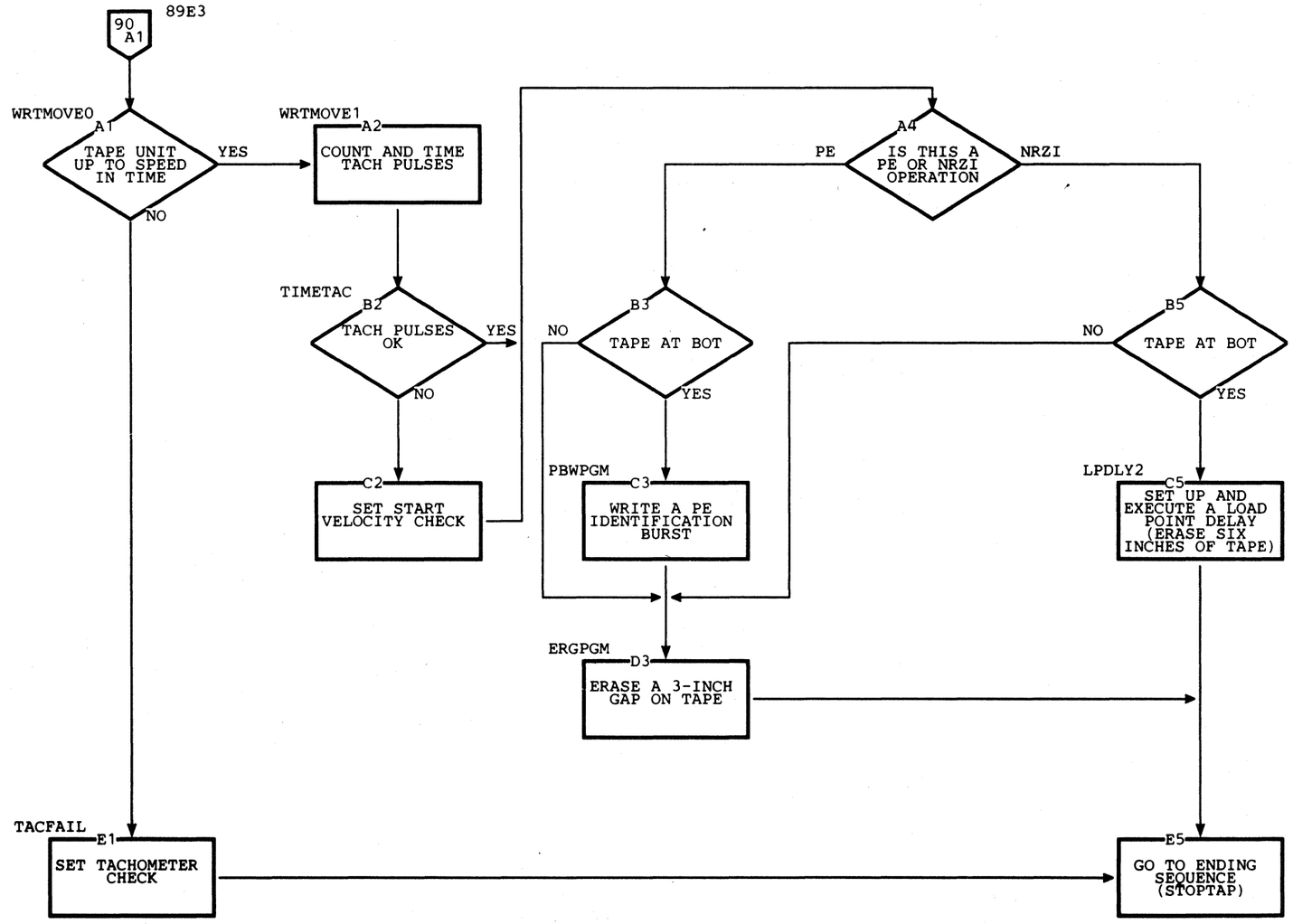
SETUNRZ Set the tape unit to NRZI mode, and check status. If status is bad, set Tape Unit Reject and terminate the operation.

TUMOVE The tape unit status is good and tape unit is ready to erase tape. Transfer the Move tag to get tape moving.



Erase Gap Command (System/370 Model 125)

WRTMOVE0	The tape unit is in write status and Move tag transferred. When Gap Control is detected, the tape unit is up to speed.
WRTMOVE1	Set up to count and time tach pulses to verify tape speed. If no tach pulses are counted, set Tachometer Check and terminate the operation. If tach timing is not good, set Start Velocity Check and continue the operation.
PBWPGM	The tape unit is at BOT and in PE Mode. Write the PE ID Burst before erasing tape.
ERGPGM	Erase 3 inches of tape and go to ending sequence.
LPDLY2	This is a NRZI operation and tape is at BOT. Perform a load point delay to erase tape, then go to ending sequence.



Write Tape Mark (System/370 Model 125)

Objectives

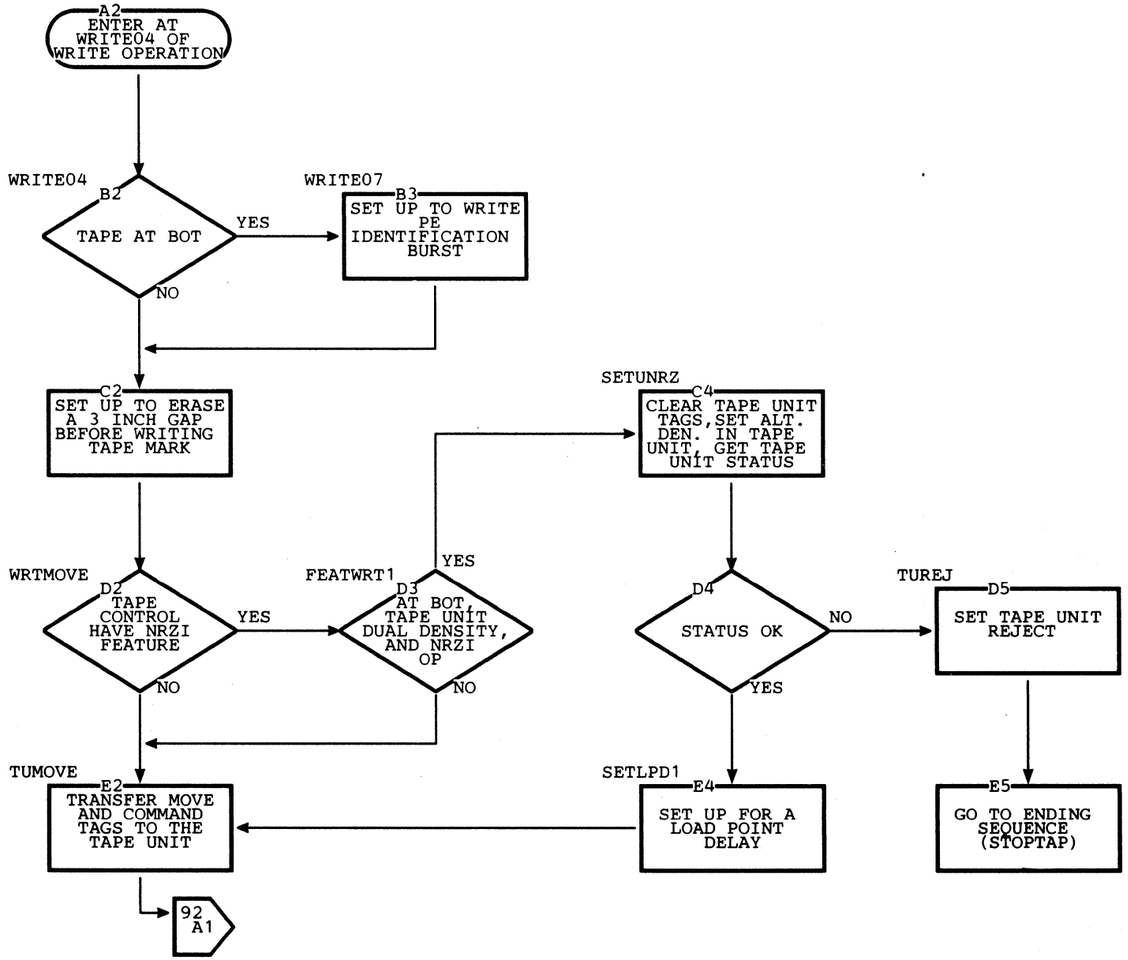
- To write a PE or NRZI tape mark.
- The subsystem generates the tape mark; no data is transferred between the system and the subsystem.

WRITE07 Check that tape is at BOT. If it is, set up to write PE ID Burst.

FEATWRT1 Tape control has NRZI installed. Determine if tape is at BOT, if tape unit has NRZI feature, and if this is a NRZI operation. If so, go to SETUNRZ to prepare for a NRZI operation beginning with a load point delay.

SETUNRZ Set the tape unit to NRZI mode, and check status. If status is bad, set Tape Unit Reject and terminate the operation.

TUMOVE The tape unit status is good and tape unit is ready to write the tape mark. Transfer the Move tag to get tape moving.



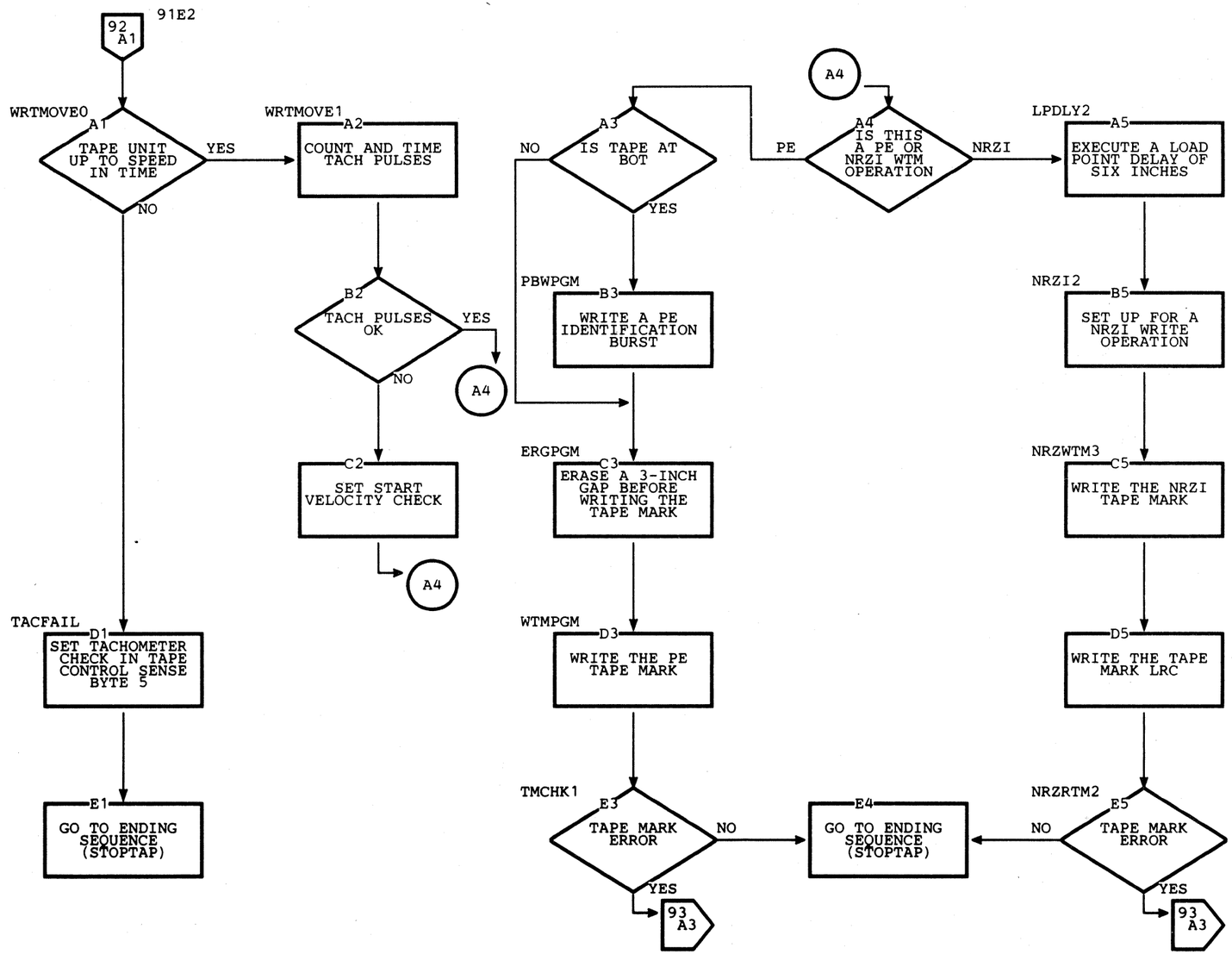
Write Tape Mark (System/370 Model 125)

WRTMOVE0 The tape unit is in write status and Move tag transferred. When gap control is detected the tape unit is up to speed. Go to TACFAIL if full speed is not reached in a predetermined time.

WRTMOVE1 Set up to count and time tach pulses to verify tape speed. If no tach pulses are counted, set Tachometer Check and terminate the operation. If tach timing is not good, set Start Velocity Check and continue the operation.

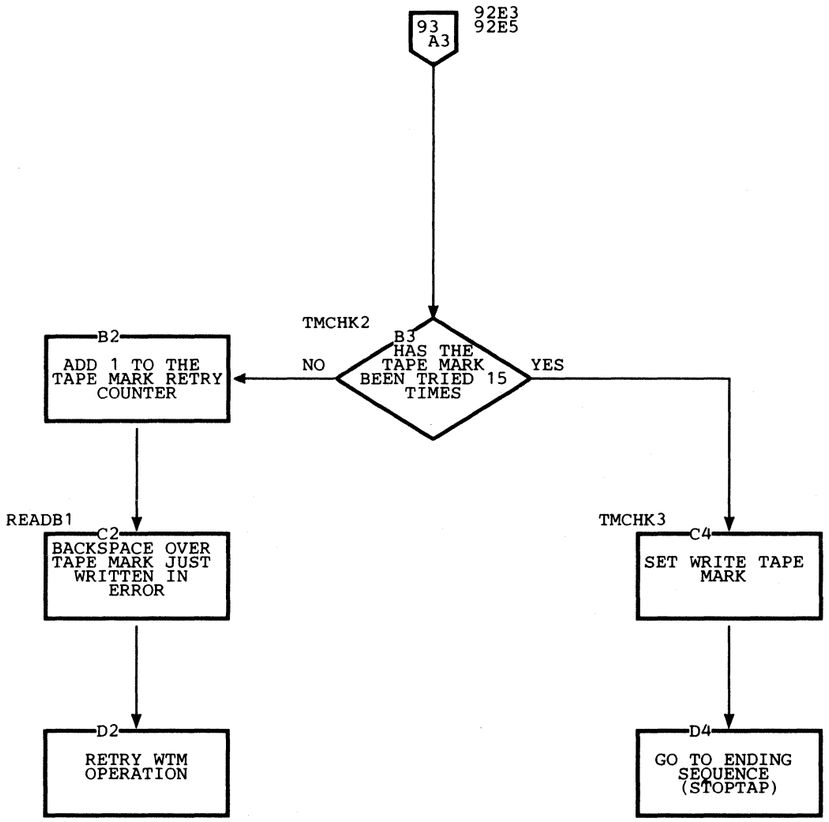
PBWPGM The tape unit is at BOT and in PE Mode. Write the PE ID Burst before writing the tape mark.

LPDLY2 This is a NRZI operation and tape is at BOT. Perform a load point delay.



Write Tape Mark (System/370 Model 125)

TMCHK3 Tape Control could not write a tape mark after 15 tries. Set Tape Mark Check and terminate the operation.



Ending Sequence (System/370 Model 125)

Objectives

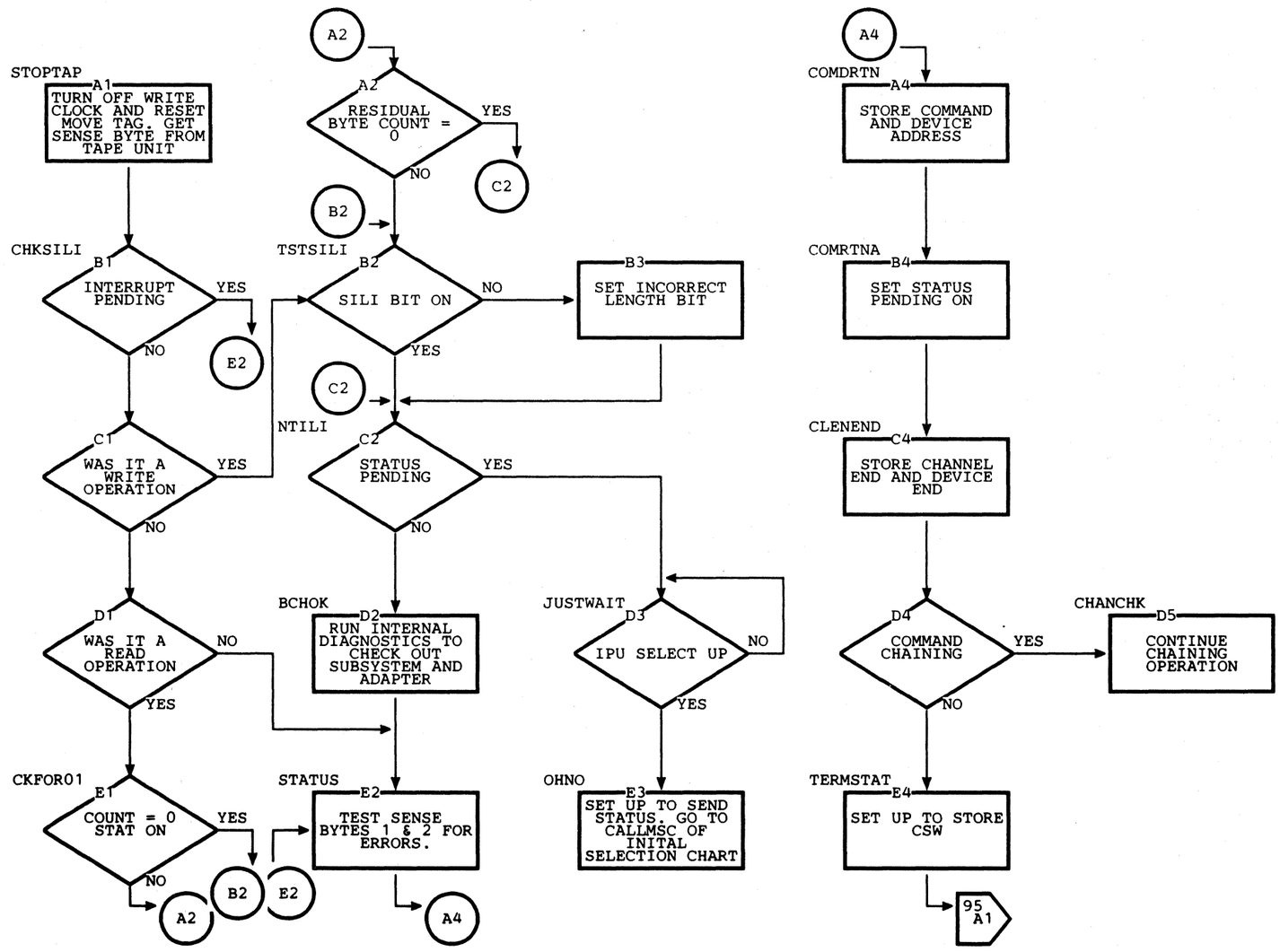
- Stop tape when the next IBG is found.
- Generate ending status and send it to ABI.
- Reset all busses and tags.

STOPTAP The operation is completed or an error has occurred. Reset the Move tag and check the sense data.

CHKSILI Check the byte count and the SILI bit. If the SILI bit is not on and the byte count is not zero, set Incorrect Length in the CSW.

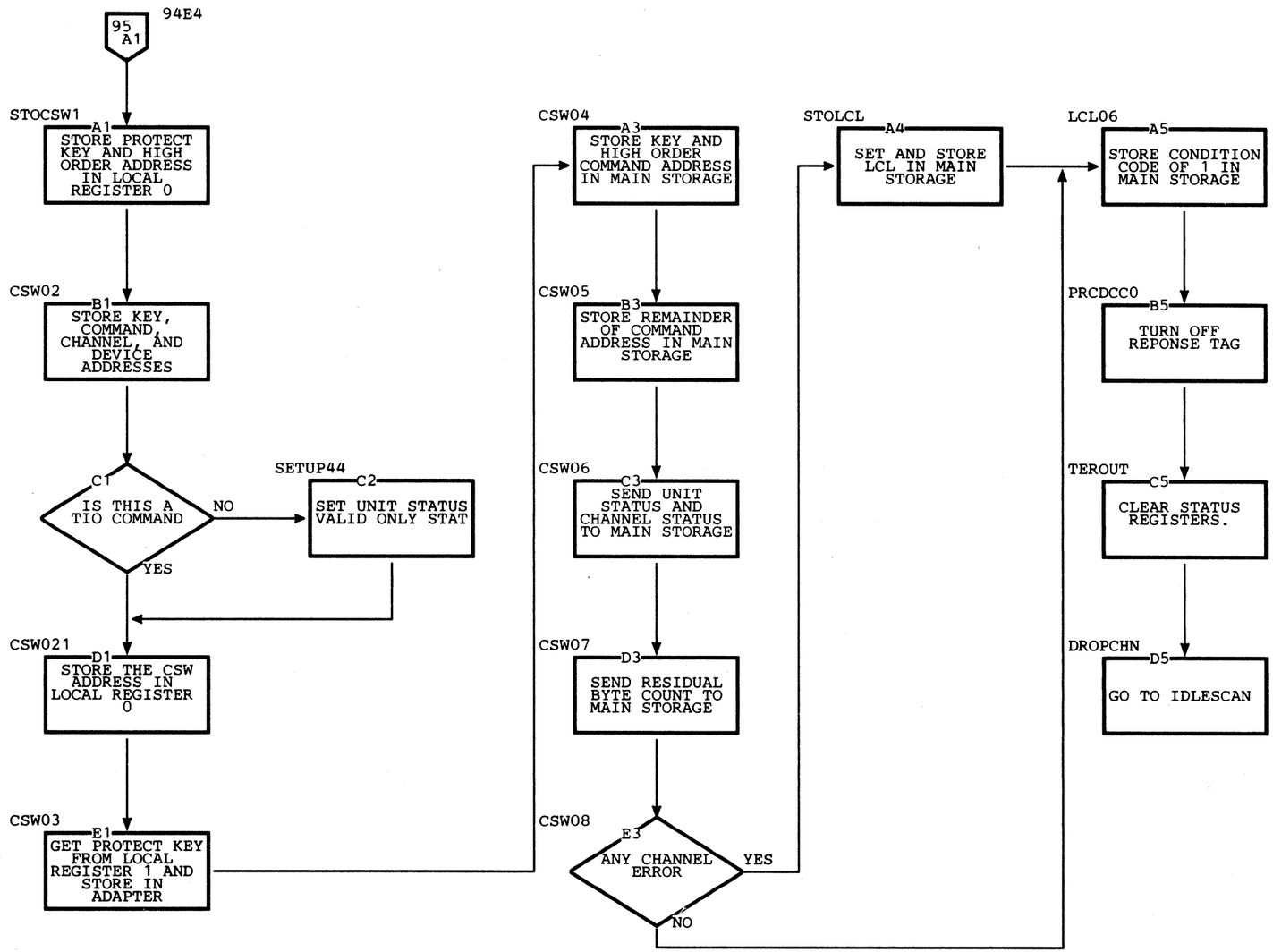
STATUS Check for any errors. If any sense bit in sense bytes 1 or 2 is on, set Unit Check.

TERMSTAT Set up to store CSW. If a Test I/O is being executed, store only the unit and channel status in the CSW.



Ending Sequence (System/370 Model 125)

LCL06 Store the condition code in MSC Common Register 1.



Halt I/O and Halt Device (System/370 Model 125)

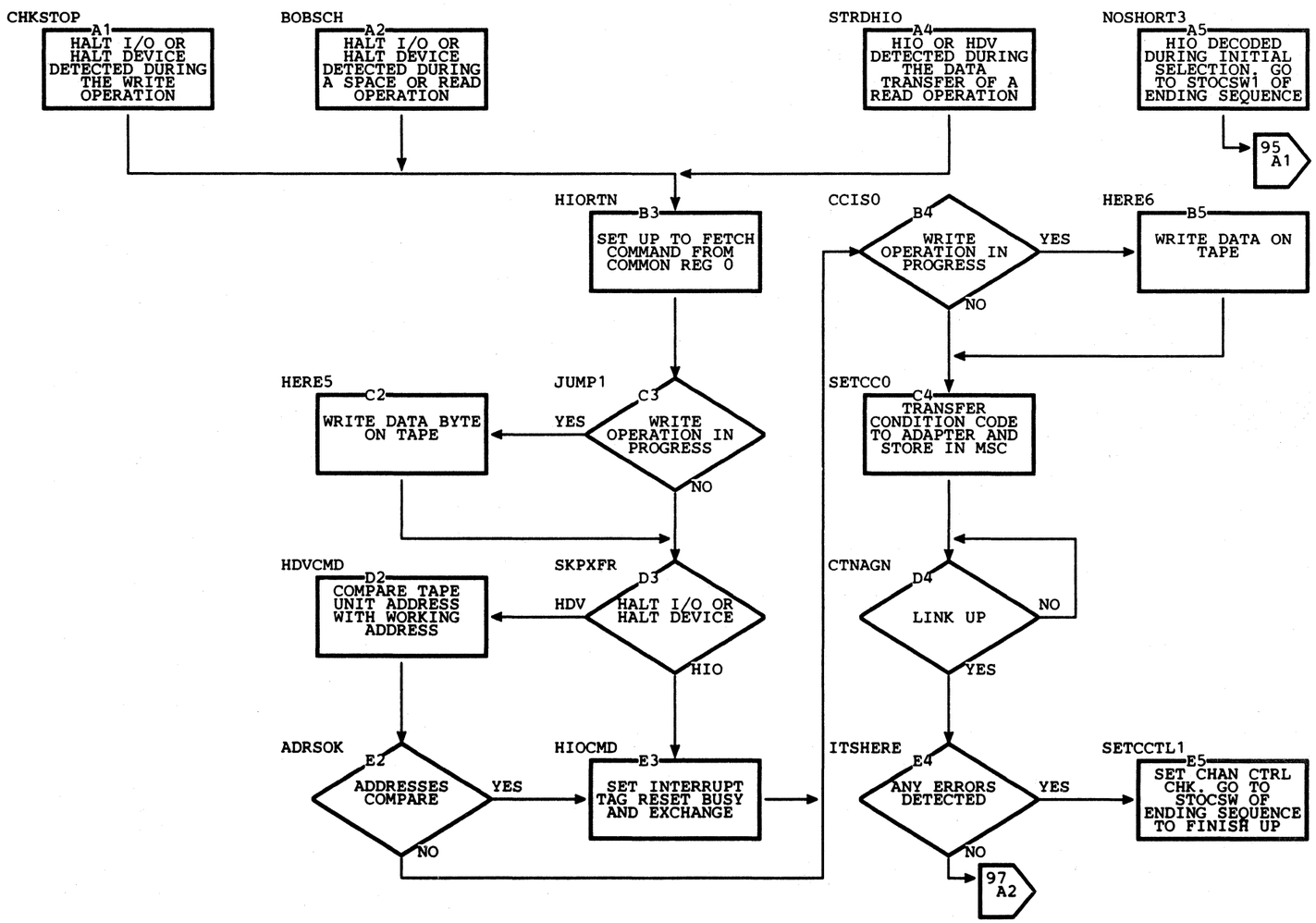
Objectives

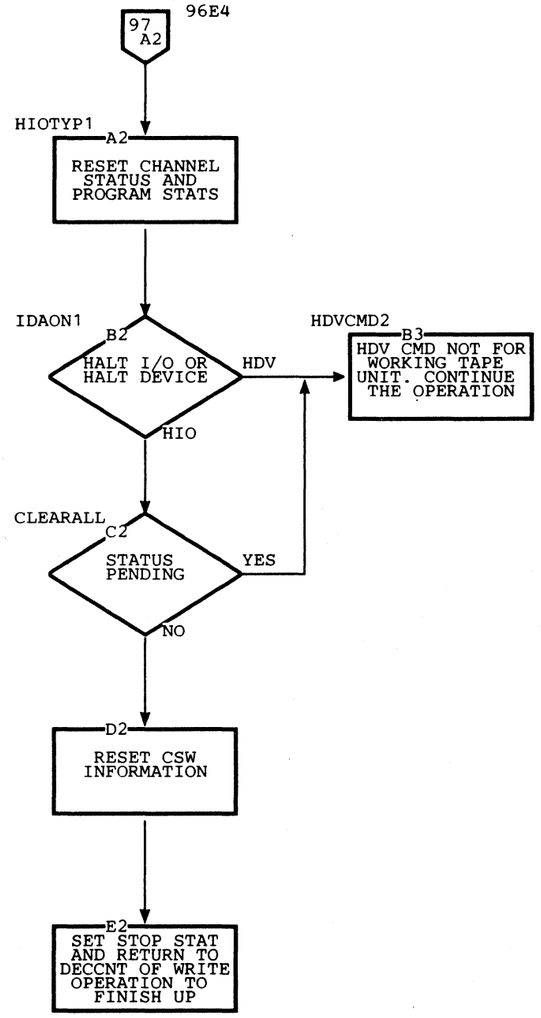
- The subsystem checks for Halt I/O (HIO) and Halt Device (HDV) at selected times during the execution of an operation.
- A HIO or HDV is issued to terminate an operation before all data is transferred, or before the operation has reached a normal ending at the tape unit. Data transfers are terminated, tape is positioned in the IBG, and status is sent to the system.

  HIORTN — A HIO or HDV command has been placed in the Common Register by the IPU. Go get the command.

  HDVCMD — The command is a Halt Device. Compare device address of the command with the address of the tape unit being worked. If the addresses compare, go to HIOCMD to finish up the operation. If the addresses do not compare, continue the operation in progress but halt the tape unit addressed.

  HIOCMD — The Halt I/O or Halt Device command has addressed the working tape unit. Set up to store the condition code and terminate the operation.




97
A2
96E4
HIOTYP1
A2
RESET CHANNEL STATUS AND PROGRAM STATS
IDAON1
B2
HALT I/O OR HALT DEVICE
HDV
HDVCMD2
B3
HDV CMD NOT FOR WORKING TAPE UNIT. CONTINUE THE OPERATION
HIO
CLEARALL
C2
STATUS PENDING
YES
NO
D2
RESET CSW INFORMATION
E2
SET STOP STAT AND RETURN TO DECCNT OF WRITE OPERATION TO FINISH UP

Seven-Track Microprogram Flowcharts (System/3 and System/360/370)

This section contains flowcharts representing the read and write operations when the subsystem is capable of seven-track operation. The Translate and Data Convert modes are included. In the 3411, data conversion and translation are carried out by the microprogram rather than by hard-wired circuitry.

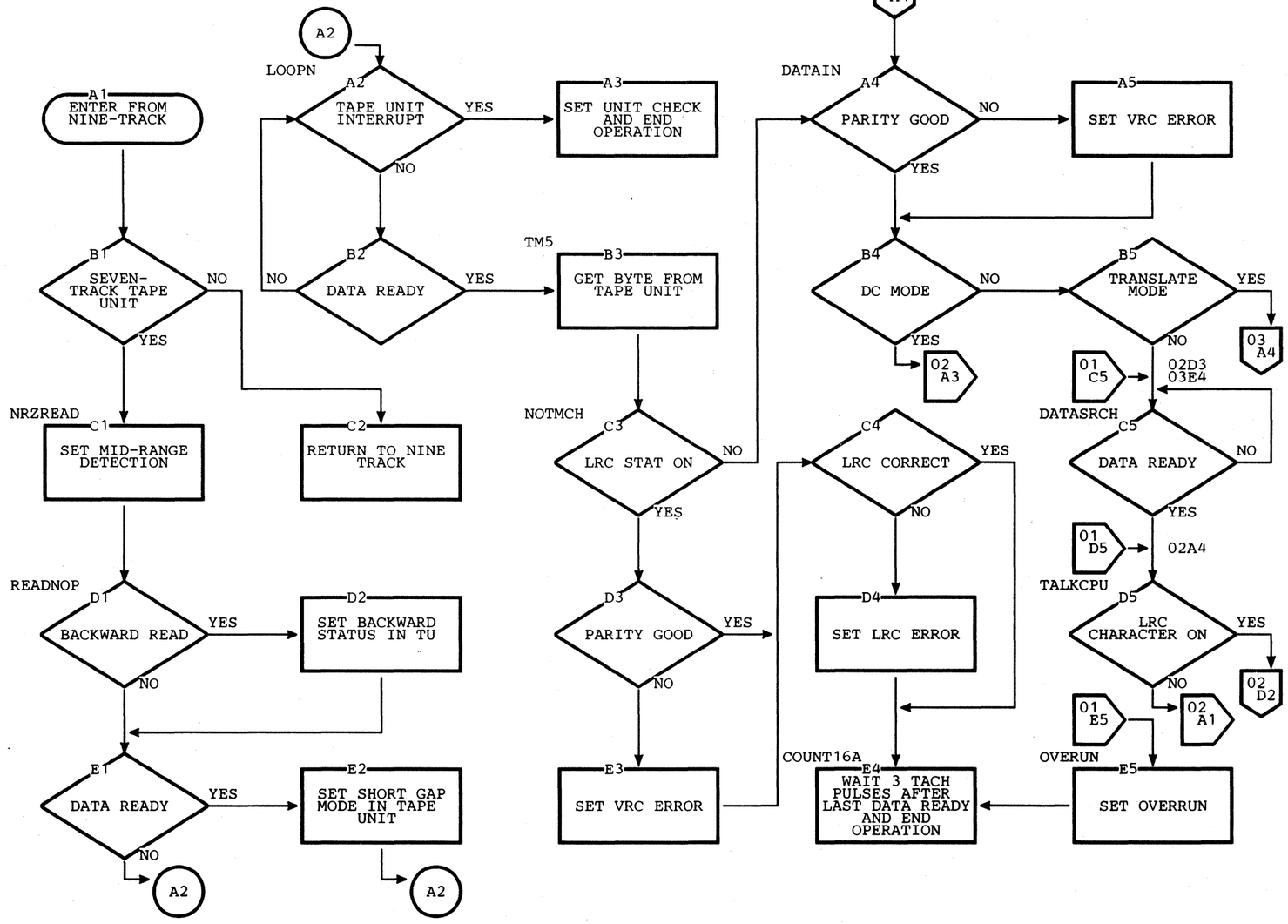
Program labels are included on the flowcharts as reference pointers to the microprogram listing. For details of a routine, use the labels and the cross-reference list in the back of the program listing which is at the same EC level as your tape control microprogram.

Seven-Track Read Operation (System/3 and System/360/370)

NRZREAD Both the tape control and the tape unit are capable of seven-track operation. Prepare to read tape in seven-track mode.

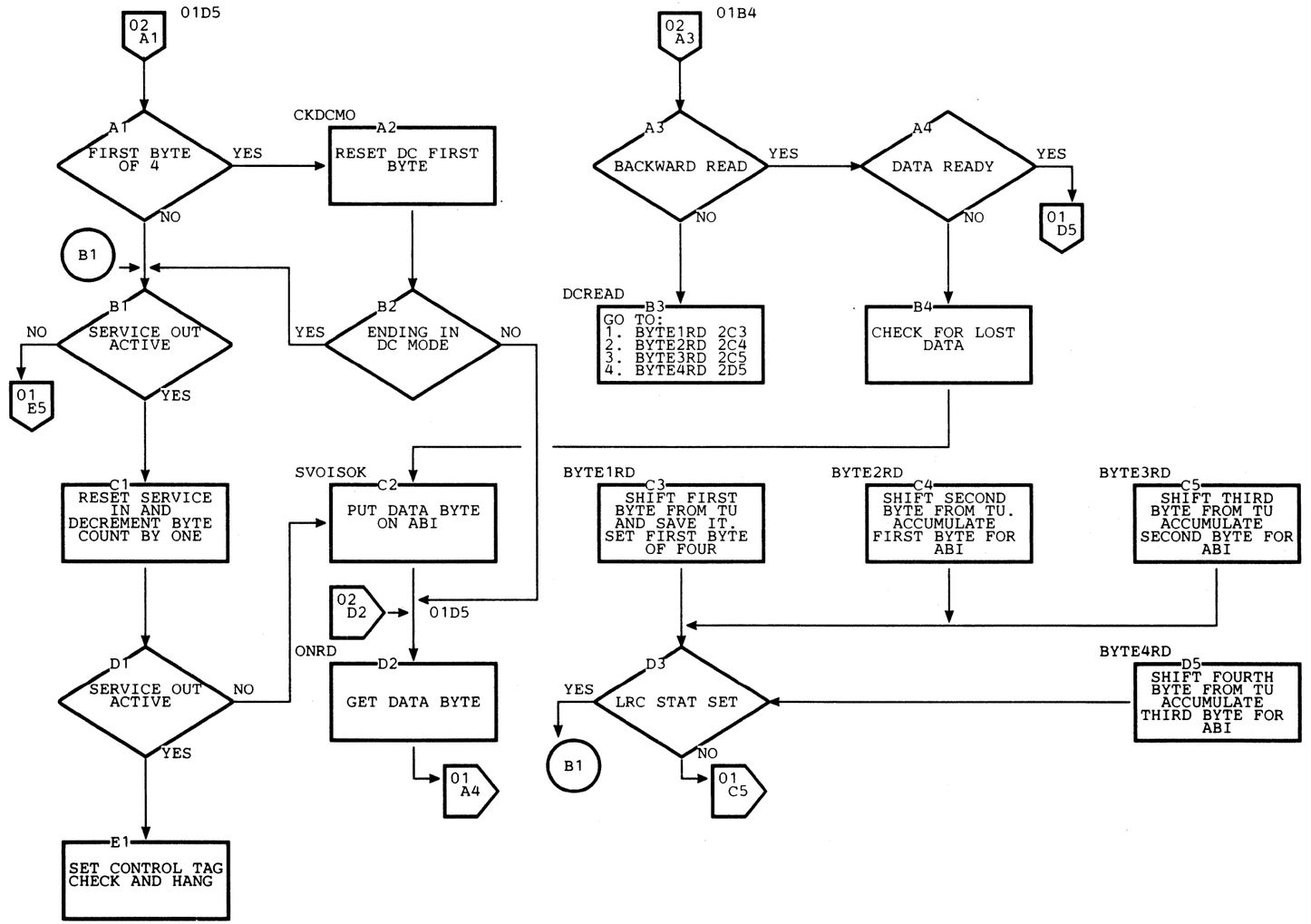
DATAIN A byte of data has been received from the tape unit. The tape control now checks parity and whether Translate or Data Convert mode is set.

DATASRCH Neither Translate nor Data Convert mode is set.



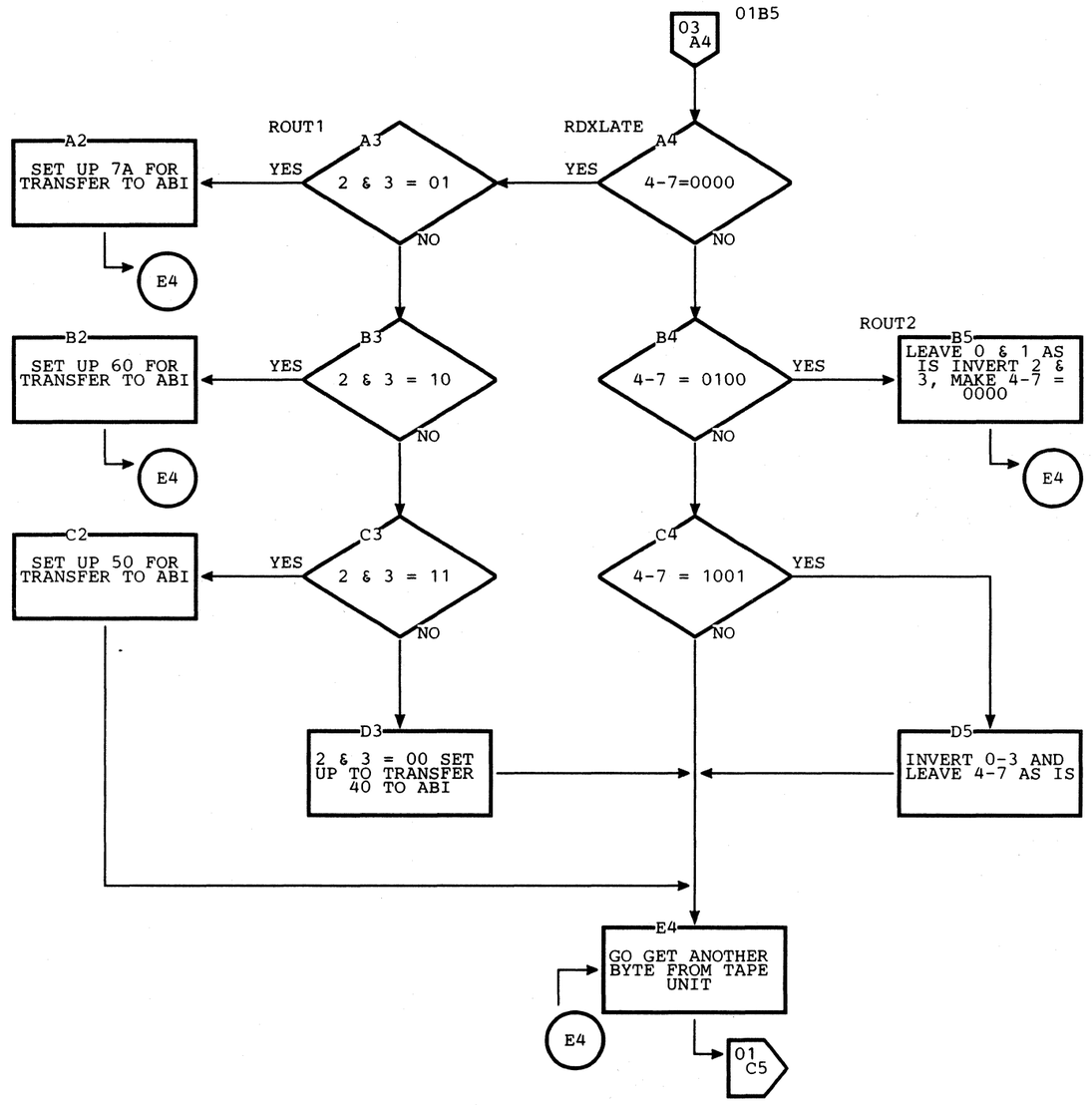
Seven-Track Read Operation (System/3 and System/360/370)

DCREAD	Data Convert mode is set and the command is Read Forward.
BYTE1RD	The first byte of a group of four is being read.
BYTE2RD	The second byte of a group of four is being read.
BYTE3RD	The third byte of a group of four is being read.
BYTE4RD	The fourth byte of a group of four is being read.



Seven-Track Read Operation (System/3 and System/360/370)

RDXLATE This is a Read operation with Translate ON.

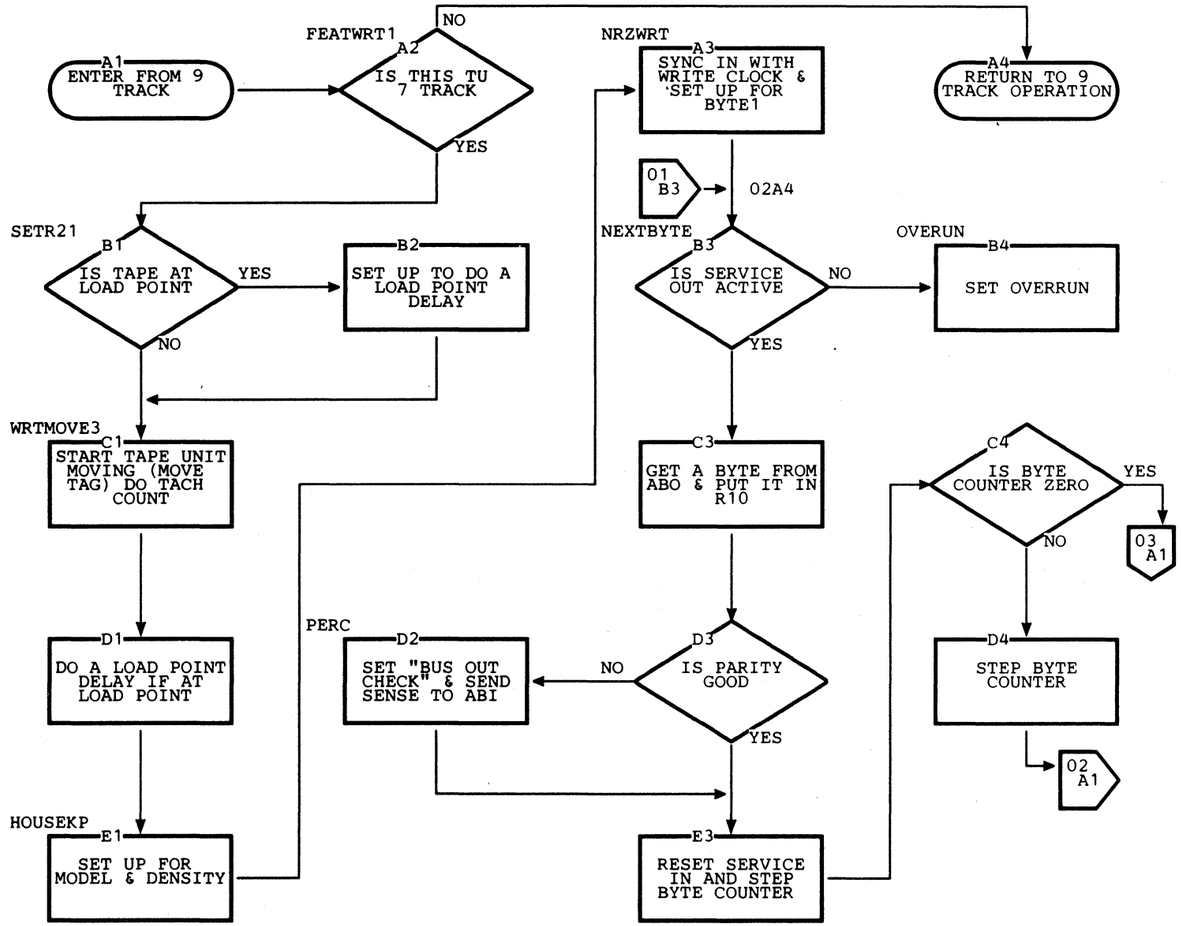


Seven-Track Write Operation
(System/3 and System/360/370)

SETR21 The tape control and tape unit are both capable of seven-track operation. This is a Write operation, so do a load point delay if tape unit is at load point.

NEXTBYTE SERVICE OUT should be active by now. If not, the system is not sending data fast enough.

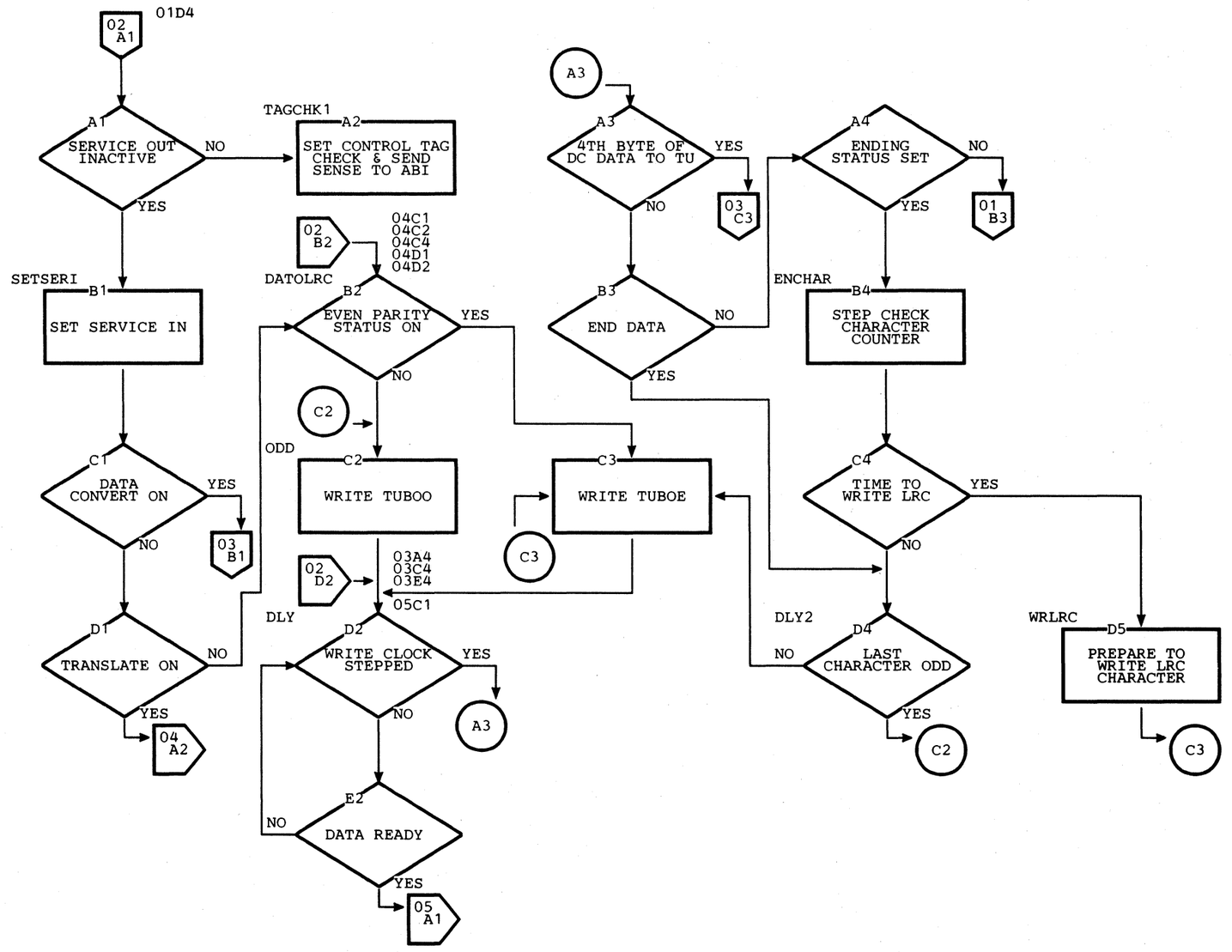
E3,C4,D4 When attached to a System/360, the tape control does not use byte count. The end of the data block is signaled by COMMAND OUT.



Seven-Track Write Operation (System/3 and System/360/370)

SETSERI — A byte of data has been received from ABO. The tape control sets SERVICE IN to indicate it is ready for another byte.

DLY — The tape control waits here until the byte of data is written on tape, or a DATA READY signals that the read head is passing over a previously written part of the data block.



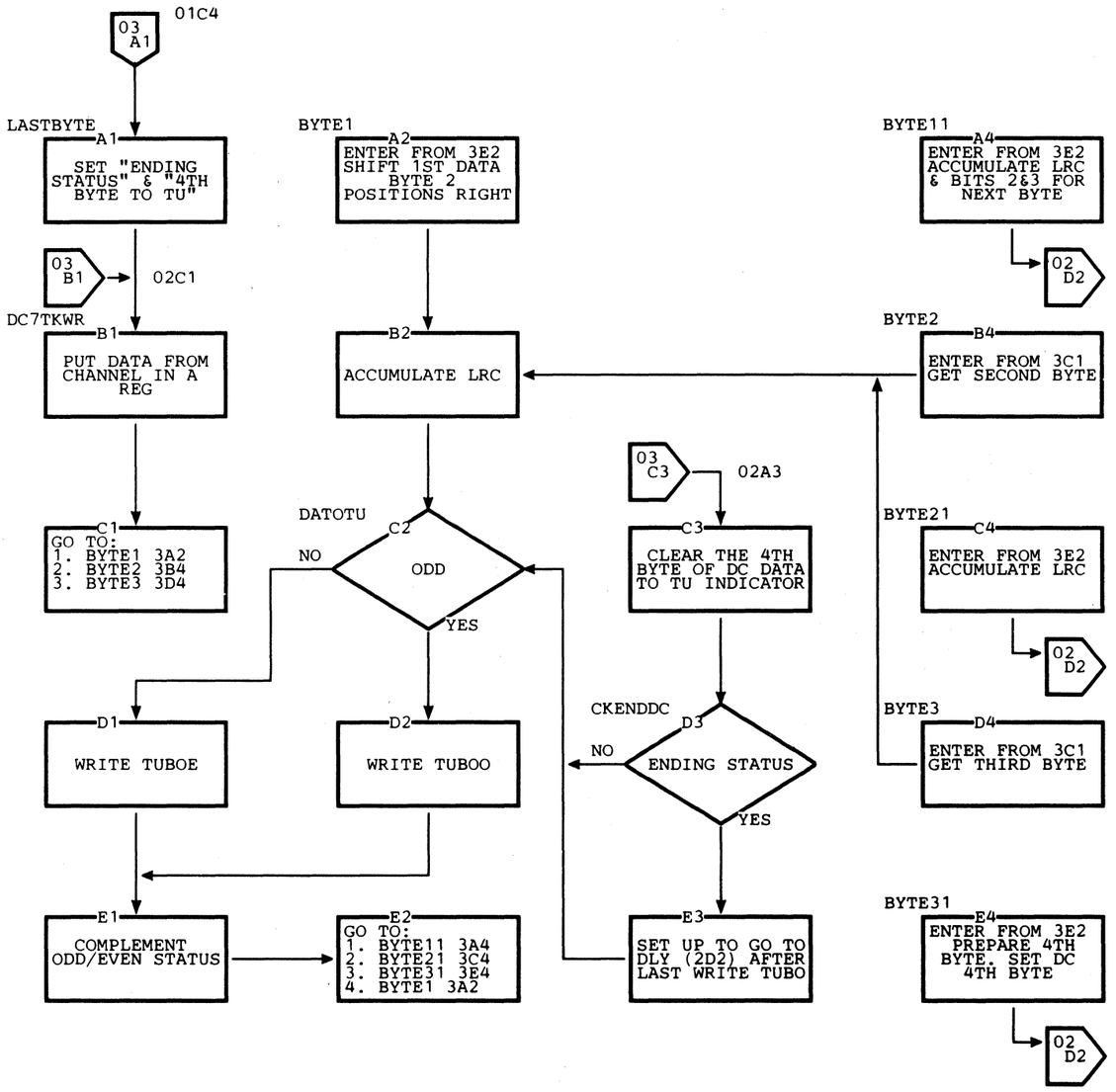
Seven-Track Write Operation (System/3 and System/360/370)

DC7TKWR The tape control is in Data Convert mode. Data bytes from the system must be shifted and accumulated to form bytes in Data Convert format.

C1 The first time through here, go to BYTE1, the second time go to BYTE2, and the third time go to BYTE3.

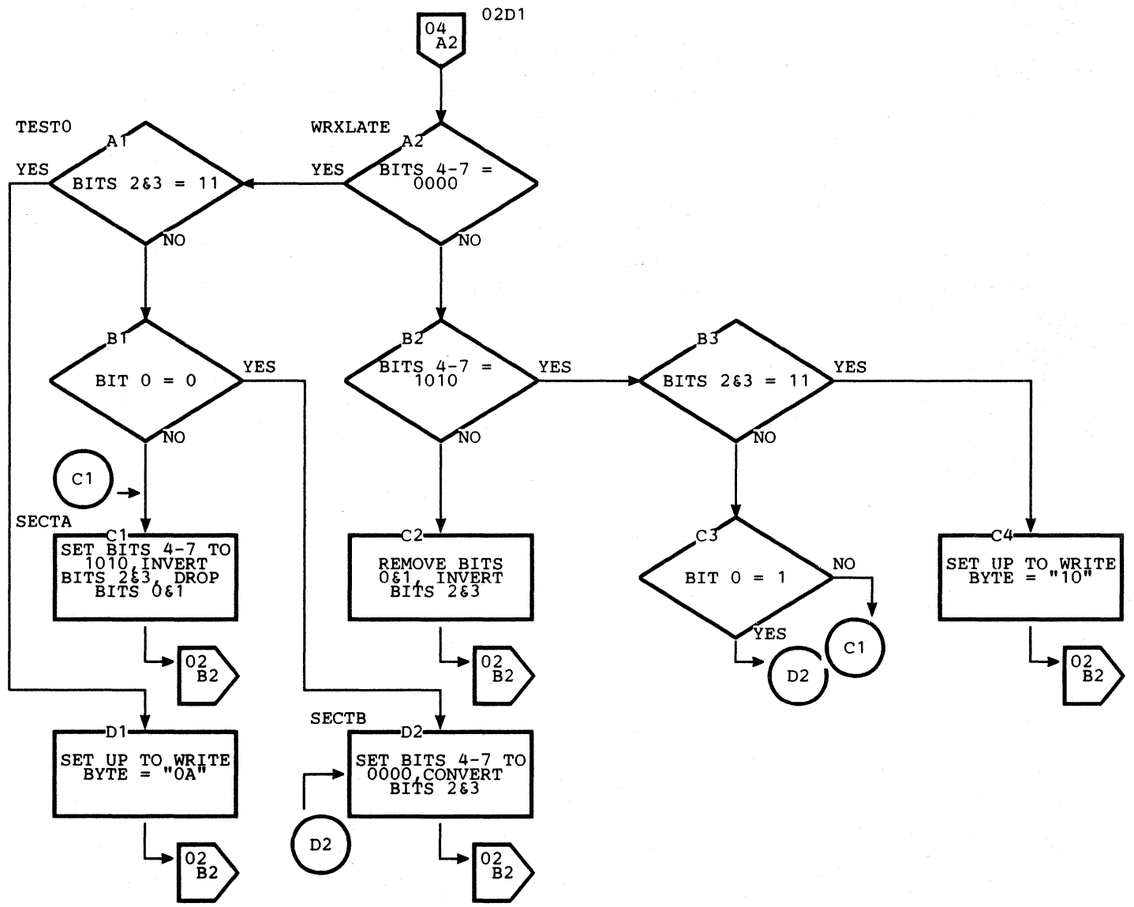
E2 The first time through here, go to BYTE11, the second time go to BYTE21, the third time go to BYTE31, and the fourth time go to BYTE1 to start the next series of four bytes.

CKENDDC A series of four bytes has been written, so check if it is time to end the Write operation.



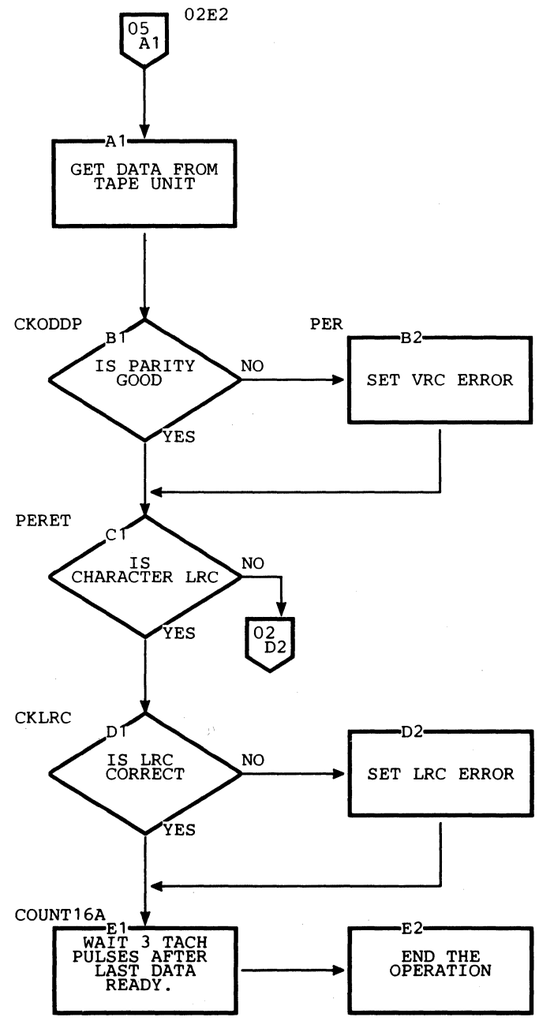
Seven-Track Write Operation (System/3 and System/360/370)

WRXLATE The tape control is in Translate mode. Data bytes from the system must be translated before they are written on tape.

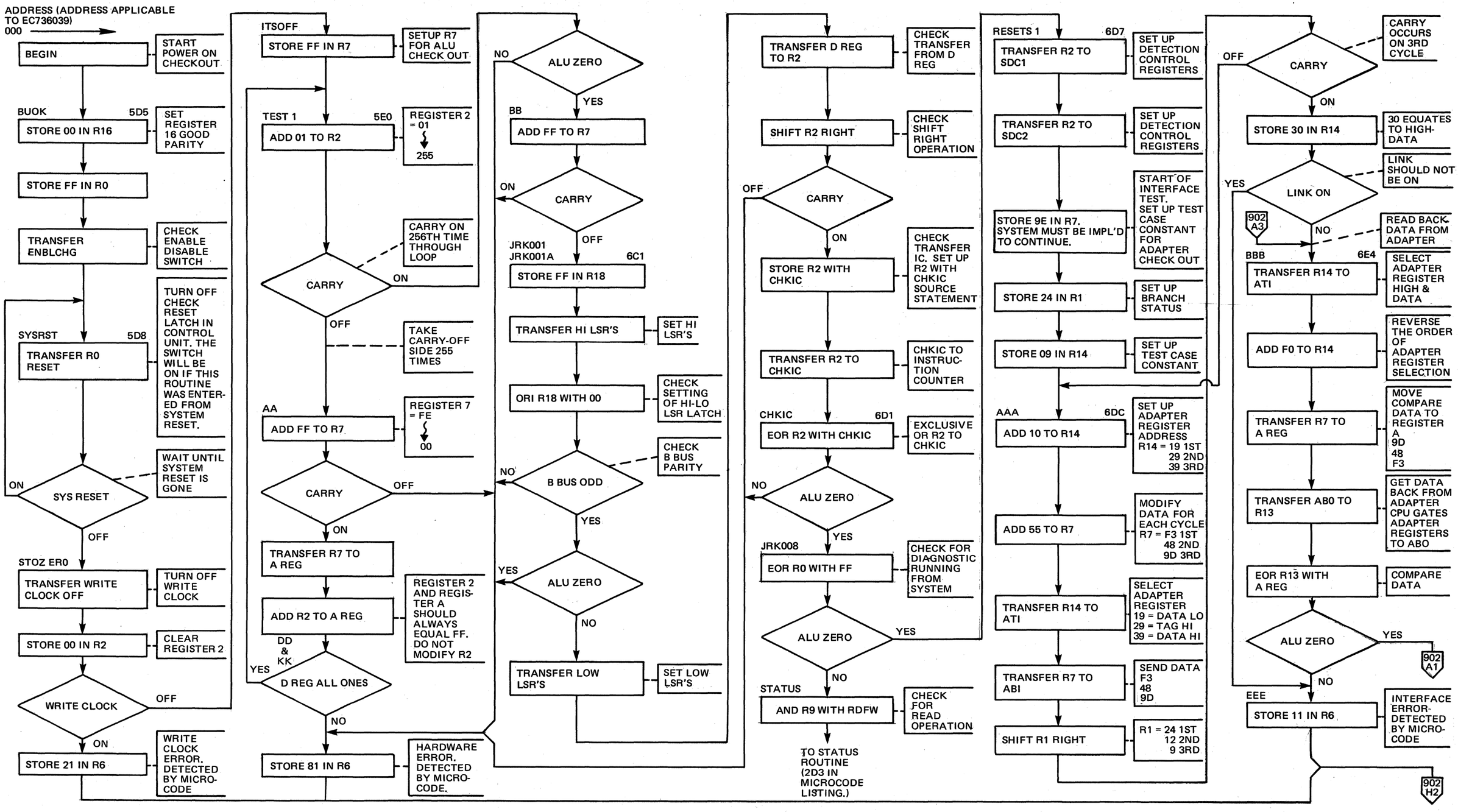


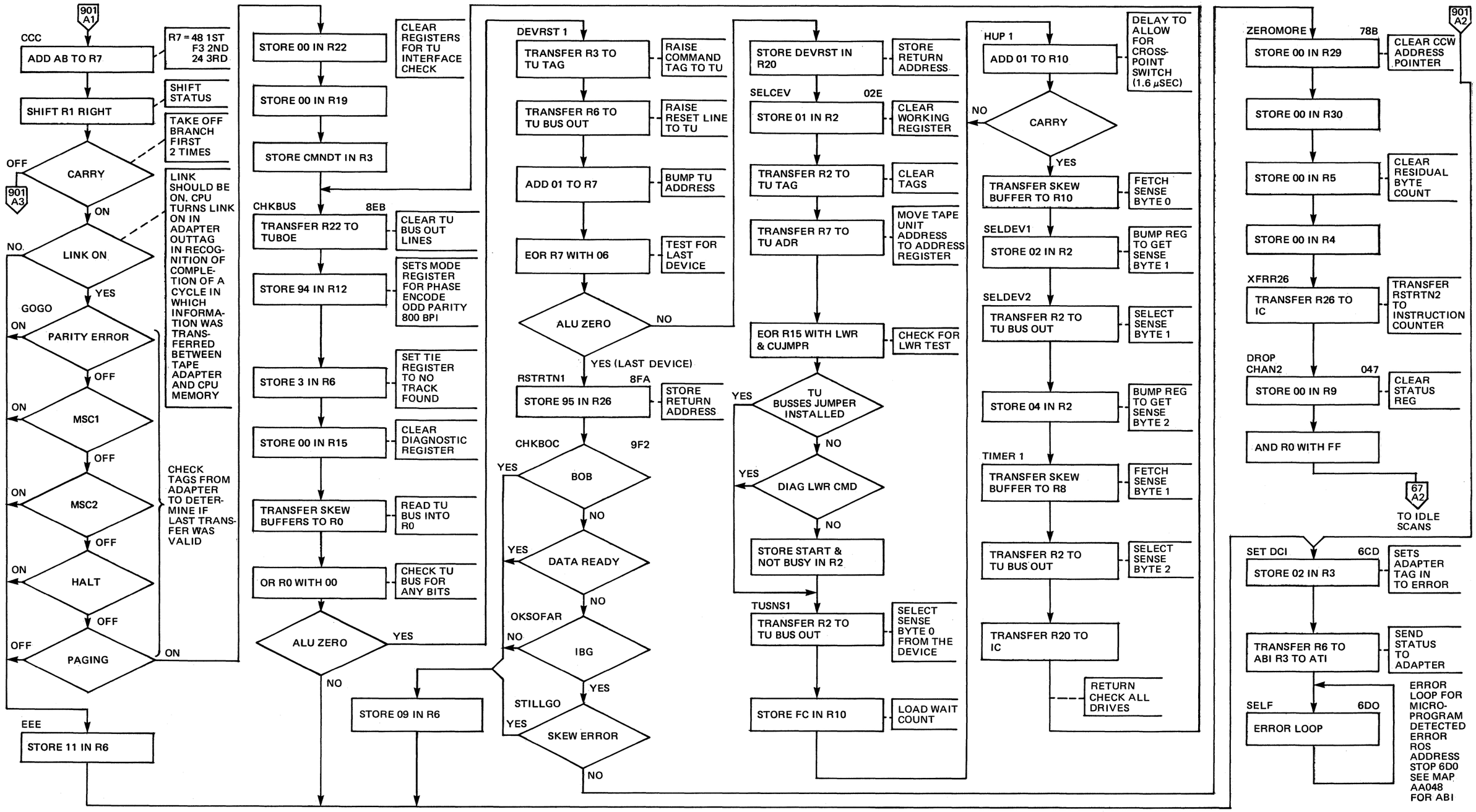
Seven-Track Write Operation (System/3 and System/360/370)

CKODDP — The tape unit is reading back the block being written. The tape control checks the parity of each byte and terminates the Write operation when the LRC character is read.



Power-On Reset (System 115/125)




901 A1
CCC
ADD AB TO R7
R7 = 48 1ST F3 2ND 24 3RD
SHIFT R1 RIGHT
SHIFT STATUS
TAKE OFF BRANCH FIRST 2 TIMES
OFF
CARRY
901 A3
ON
LINK SHOULD BE ON. CPU TURNS LINK ON IN ADAPTER OUTTAG IN RECOGNITION OF COMPLETION OF A CYCLE IN WHICH INFORMATION WAS TRANSFERRED BETWEEN TAPE ADAPTER AND CPU MEMORY
NO.
LINK ON
YES
GOGO
ON
PARITY ERROR
OFF
ON
MSC1
OFF
CHECK TAGS FROM ADAPTER TO DETERMINE IF LAST TRANSFER WAS VALID
ON
MSC2
OFF
ON
HALT
OFF
OFF
PAGING
ON
EEE
STORE 11 IN R6
STORE 00 IN R22
CLEAR REGISTERS FOR TU INTERFACE CHECK
STORE 00 IN R19
STORE CMNDT IN R3
CHKBUS
8EB
TRANSFER R22 TO TUBOE
CLEAR TU BUS OUT LINES
STORE 94 IN R12
SETS MODE REGISTER FOR PHASE ENCODE ODD PARITY 800 BPI
SET TIE REGISTER TO NO TRACK FOUND
STORE 3 IN R6
CLEAR DIAGNOSTIC REGISTER
STORE 00 IN R15
READ TU BUS INTO R0
TRANSFER SKEW BUFFERS TO R0
CHECK TU BUS FOR ANY BITS
OR R0 WITH 00
ALU ZERO
YES
NO
STORE 09 IN R6
DEVRST 1
TRANSFER R3 TO TU TAG
RAISE COMMAND TAG TO TU
TRANSFER R6 TO TU BUS OUT
RAISE RESET LINE TO TU
ADD 01 TO R7
BUMP TU ADDRESS
EOR R7 WITH 06
TEST FOR LAST DEVICE
ALU ZERO
NO
YES (LAST DEVICE)
RSTRTN1
8FA
STORE 95 IN R26
STORE RETURN ADDRESS
CHKBOC
9F2
YES
BOB
NO
YES
DATA READY
NO
OKSOFAR
NO
IBG
YES
STILLGO
YES
SKEW ERROR
NO
STORE DEVRST IN R20
STORE RETURN ADDRESS
SELCEV
02E
STORE 01 IN R2
CLEAR WORKING REGISTER
TRANSFER R2 TO TU TAG
CLEAR TAGS
TRANSFER R7 TO TU ADR
MOVE TAPE UNIT ADDRESS TO ADDRESS REGISTER
EOR R15 WITH LWR & CUJMPR
CHECK FOR LWR TEST
YES
TU BUSSES JUMPER INSTALLED
NO
YES
DIAG LWR CMD
NO
STORE START & NOT BUSY IN R2
TUSNS1
TRANSFER R2 TO TU BUS OUT
SELECT SENSE BYTE 0 FROM THE DEVICE
STORE FC IN R10
LOAD WAIT COUNT
HUP 1
ADD 01 TO R10
DELAY TO ALLOW FOR CROSS-POINT SWITCH (1.6 μSEC)
NO
CARRY
YES
TRANSFER SKEW BUFFER TO R10
FETCH SENSE BYTE 0
SELDEV1
STORE 02 IN R2
BUMP REG TO GET SENSE BYTE 1
SELDEV2
TRANSFER R2 TO TU BUS OUT
SELECT SENSE BYTE 1
STORE 04 IN R2
BUMP REG TO GET SENSE BYTE 2
TIMER 1
TRANSFER SKEW BUFFER TO R8
FETCH SENSE BYTE 1
TRANSFER R2 TO TU BUS OUT
SELECT SENSE BYTE 2
TRANSFER R20 TO IC
RETURN CHECK ALL DRIVES
901 A2
ZEROMORE
78B
STORE 00 IN R29
CLEAR CCW ADDRESS POINTER
STORE 00 IN R30
STORE 00 IN R5
CLEAR RESIDUAL BYTE COUNT
STORE 00 IN R4
XFRR26
TRANSFER R26 TO IC
TRANSFER RSTRTN2 TO INSTRUCTION COUNTER
DROP CHAN2
047
STORE 00 IN R9
CLEAR STATUS REG
AND R0 WITH FF
67 A2
TO IDLE SCANS
SET DCI
6CD
STORE 02 IN R3
SETS ADAPTER TAG IN TO ERROR
TRANSFER R6 TO ABI R3 TO ATI
SEND STATUS TO ADAPTER
SELF
6DO
ERROR LOOP
ERROR LOOP FOR MICRO-PROGRAM DETECTED ERROR ROS ADDRESS STOP 6D0 SEE MAP AA048 FOR ABI

Appendix A: System Attachments

System/3 Model 10 Attachment

Note: For System/3 Models 8, 12, and 15, see pages A47 through A92.

The magnetic tape attachment is located in the CPU, on channel bank 2, board location B-2 of the feature gate.

The purpose of the attachment is to adapt the subsystem interface to the CPU channel interface. The attachment interprets the signals between the system and subsystem. The attachment also handles data during read, write, and sense operations, and holds tape unit status until it is needed by the CPU.

Data Flow (System/3 Model 10 Attachment Data Flow Diagram)

System/3 Model 10 to Attachment

Instructions Causing Data Flow

There are four I/O instructions which cause data flow between the system and subsystem, through the attachment.

Sense I/O: A Sense instruction causes two bytes of sense information to be sent to the system. Bits 5-7 of the "Q" byte select the sense bytes.

Load I/O (LIO): A Load I/O instruction places two bytes of information in the Magnetic Tape Data Address Register (MTDAR) in CPU, or the Byte Count Register in the subsystem. Only that information going to the Byte Count Register passes through the attachment. Bits 5-7 of the "Q" byte select the destination of the information.

Test I/O (TIO): A Test I/O instruction tests the busy or not ready/unit check status of the tape unit. The attachment holds the tape unit status in the Device Status Register, and the subsystem is not addressed. Bits 5-7 of the "Q" byte select the status condition to be tested.

Start I/O (SIO): A Start I/O instruction initiates a read, write, or motion control operation in the subsystem. Bits 5-7 of the "Q" byte select the type of operation. When the "Q" byte contains a control or diagnostic command, the "R" byte selects which command the subsystem is to execute.

Inputs to Attachment from System

Instruction Tag Out: There are four instruction tag lines to indicate the presence of an instruction in the CPU Operations Register.

SIO Instr indicates a Start I/O instruction.

LIO Instr indicates a Load I/O instruction.

TIO Instr indicates a Test I/O instruction.

SNS Instr indicates a Sense I/O instruction.

Cycle Tag Lines: There are four cycle tag lines which indicate which cycle the CPU is executing during an I/O instruction: IQ Cycle, IR Cycle, EB 1 Cycle, and EB Not 1 Cycle.

Attachment Tags Out: The attachment converts System/3 interface signals and puts them on Attachment Tags Out Bus for use by tape control.

Bus Out: The Bus Out (DBO P, 0-7) transmits data from CPU to the attachment. The data is identified by the Instruction Tag and Cycle Tag lines. Device Address Decode receives the address field of the "Q" byte from DBO to determine which tape unit to select. Attachment Bus Out transfers data from DBO to the tape control.

Data on DBO:

DBO contains a "Q" byte when an Instruction tag and the IQ Cycle tag are up.

DBO contains an "R" byte when SIO Instr and IR Cycle tags are up.

DBO contains the contents of the Main Store location addressed by LIO when LIO Instr and EB Cycle are up.

DBO contains the contents of the Main Store location addressed by LIO, minus 1, when LIO Instr and EB Not 1 Cycle are up.

(In each case the information is available at Clock 6 time.)

I/O Cycle

Read or Write data is transmitted between CPU and the subsystem during I/O cycles. When the attachment requires an I/O cycle, it activates cycle steal request to CPU. When an I/O cycle is granted to an attachment, DBO contains information at Clock 5 of the I/O cycle during a write operation.

Attachment to System/3 Model 10

Sense I/O and Start I/O cause data flow from the subsystem to the system, through the attachment. The sense bytes and data read by the tape unit are transmitted through the Data Bus In to the Bus In (DBI P, 0-7).

Interrupt Requests: When the Interrupt Poll line is up, all interrupt requests are placed on the DBI.

Clock 0-8: CPU clock pulses provided for attachment timing.

Sample DBO (SDBO): A clock pulse which samples the data on DBO.

Early Phase C (EPHASEC): A clock pulse providing a delayed sampling of DBO.

Set ABO Register: A clock pulse generated by the fall of EPHASEC.

Attachment Tags In: The attachment converts the tape control Tags In signals for use by the CPU. The CPU uses these signals to keep track of the tape control working status.

Control In: Control In lines control the data flow of the CPU during an I/O cycle. They are: Store Data, Block SDR, Binary Subtract, and Inhibit LSR Load.

Status In: Status In lines indicate to CPU the status of the tape unit. They are I/O Condition A, and I/O Condition B and are used in combination. These lines are generated from the Device Status Register which keeps track of the tape unit status (ready or busy) and DBO parity check circuits. Any error condition detected by the attachment or the tape control sets the I/O Conditions.

Select Bus In: Select Bus In consists of five lines -- LSR Select 3, 4, 5, 6, and 7. The attachment uses 5 and 7 to select the MTDAR.

Error Checking

The attachment checks the data it receives from CPU and the data it receives from and sends to the subsystem. In addition, the attachment monitors the operation of its interface with the subsystem.

Bad parity detected in data received from the CPU will terminate the operation and turn on the PROCESSOR CHECK and CHAN DBO indicators on the system console. Errors in data transferred to and from the subsystem and in the interface operation activate I/O Check to CPU and set Adapter Check and Unit Check in the attachment. The I/O Check to CPU turns on the I/O Check indicator on the System CE Panel. The Adapter Check/Unit Check will activate I/O Condition A to CPU when a Test I/O is executed.

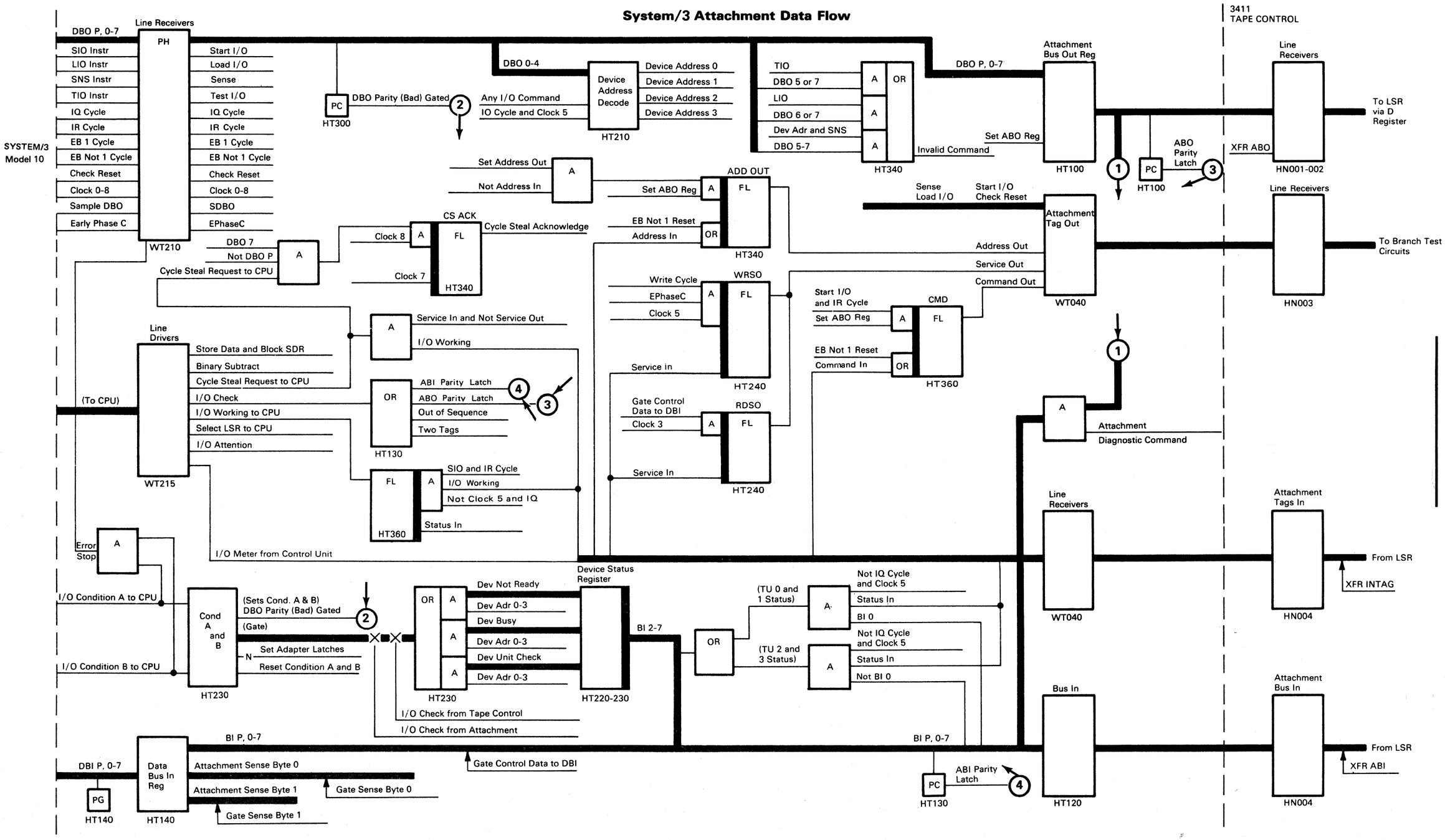
Two other error conditions that can occur set Adapter Check/Unit Check only. The first is an I/O Check from the subsystem. This I/O Check occurs if the microprogram (in the tape control) detects a bit set in subsystem sense byte 0. The second condition is if the subsystem becomes disabled by a hardware error or by the subsystem being taken offline.

The following table defines the errors in more detail.

ERROR SUMMARY

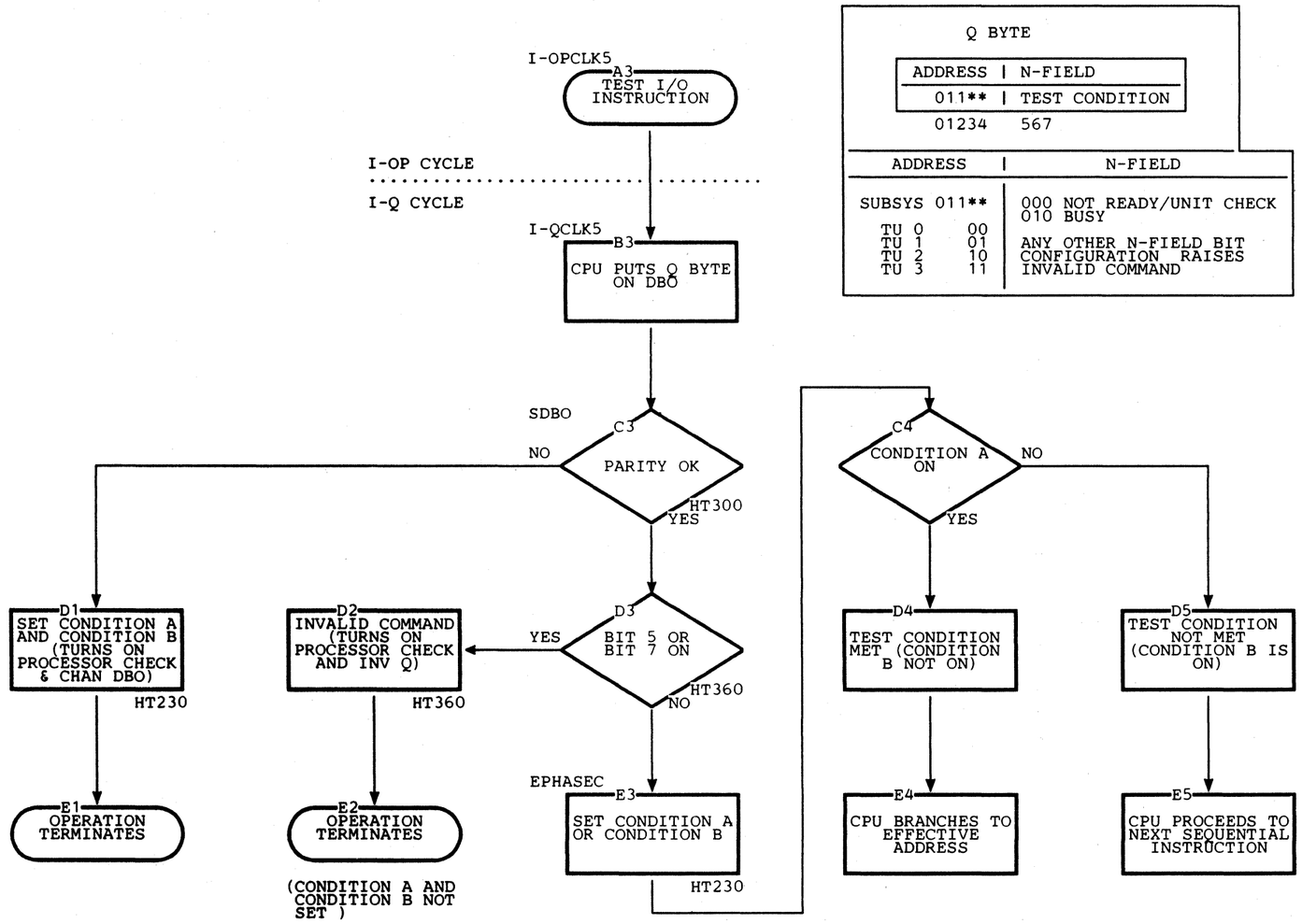
Error Indication	Cause	Comment
PROCESSOR CHECK and CHAN DBO on.	Bad parity detected in byte received from CPU.	Operation terminated. Manual intervention required to restart.
PROCESSOR CHECK and INV Q on.	Invalid command received from CPU.	
I/O CHECK	1. Data byte received from tape subsystem had bad parity on the ABI. 2. Detected bad parity in the data byte being sent to the subsystem on the ABO. 3. Two 'in tags,' status, service, command, or address were active simultaneously. 4. The subsystem did not respond with the correct 'in tag.'	Also sets 'Adapter Check' and 'Unit Check' in the attachment. The System will execute a sense instruction to determine the error condition.
Adapter Check/ Unit Check	1. Subsystem is disabled.	1. The ENABLE/DISABLE switch may be in the DISABLE position or a hardware error has occurred. Check the switch. The System will execute a sense instruction to get the hardware error byte.
	2. I/O Check from the subsystem.	2. The microprogram has detected a bit set in Subsystem Sense Byte 0. The System will execute a sense instruction to determine the error.

System/3 Attachment Data Flow



Test I/O

Test I/O checks for the Busy or Not Ready/Unit Check status of the addressed tape unit. The test conditions are contained in the N-Field of the Q Byte. If the condition is met the CPU program branches to the address specified by the Test I/O instruction. If the condition is not met, the CPU program proceeds to the next instruction.



Load I/O

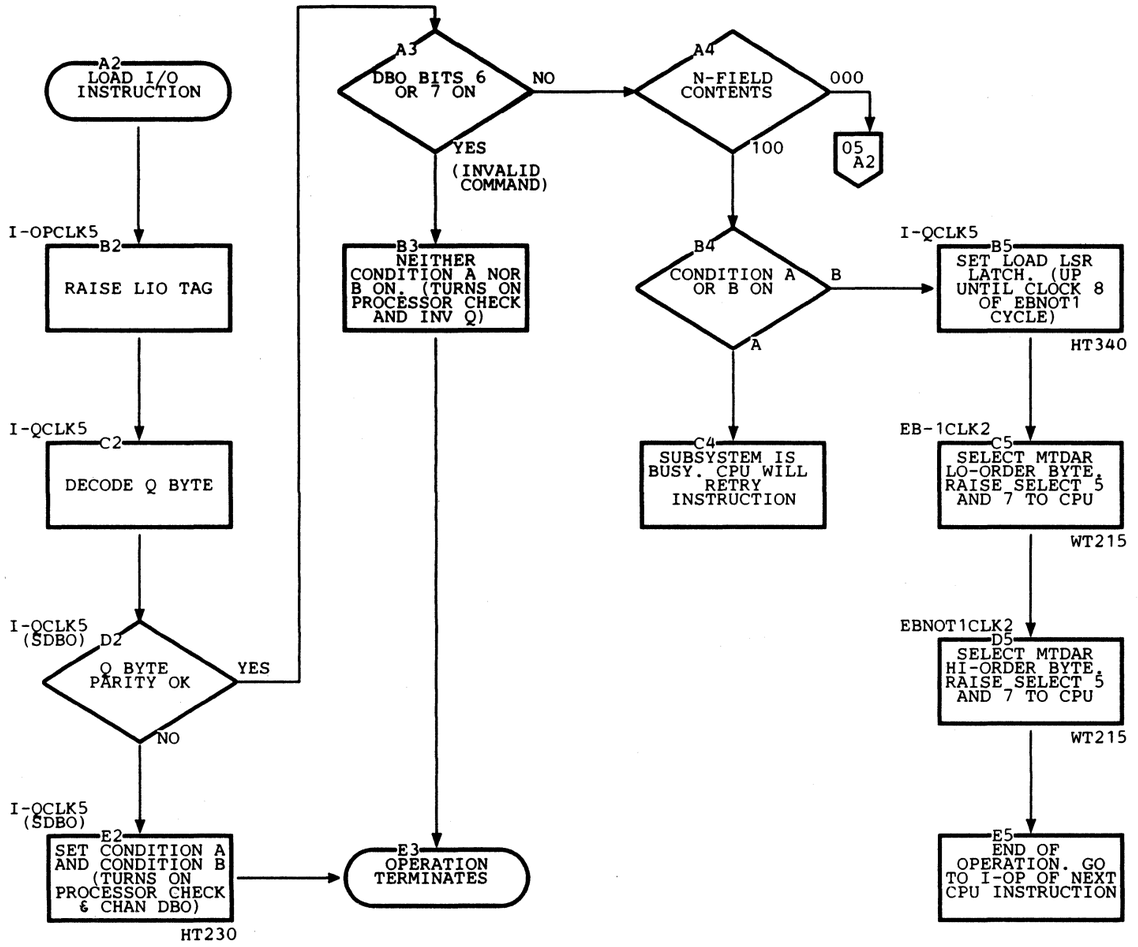
The Load I/O (LIO) instruction stores two bytes of data in the Magnetic Tape Data Address Register (MTDAR) or in the tape control LSR. The bytes stored in the MTDAR contain the main storage address where data is to be stored or fetched. The bytes stored in the tape control LSR contain the byte count for a subsequent data operation.

Q BYTE

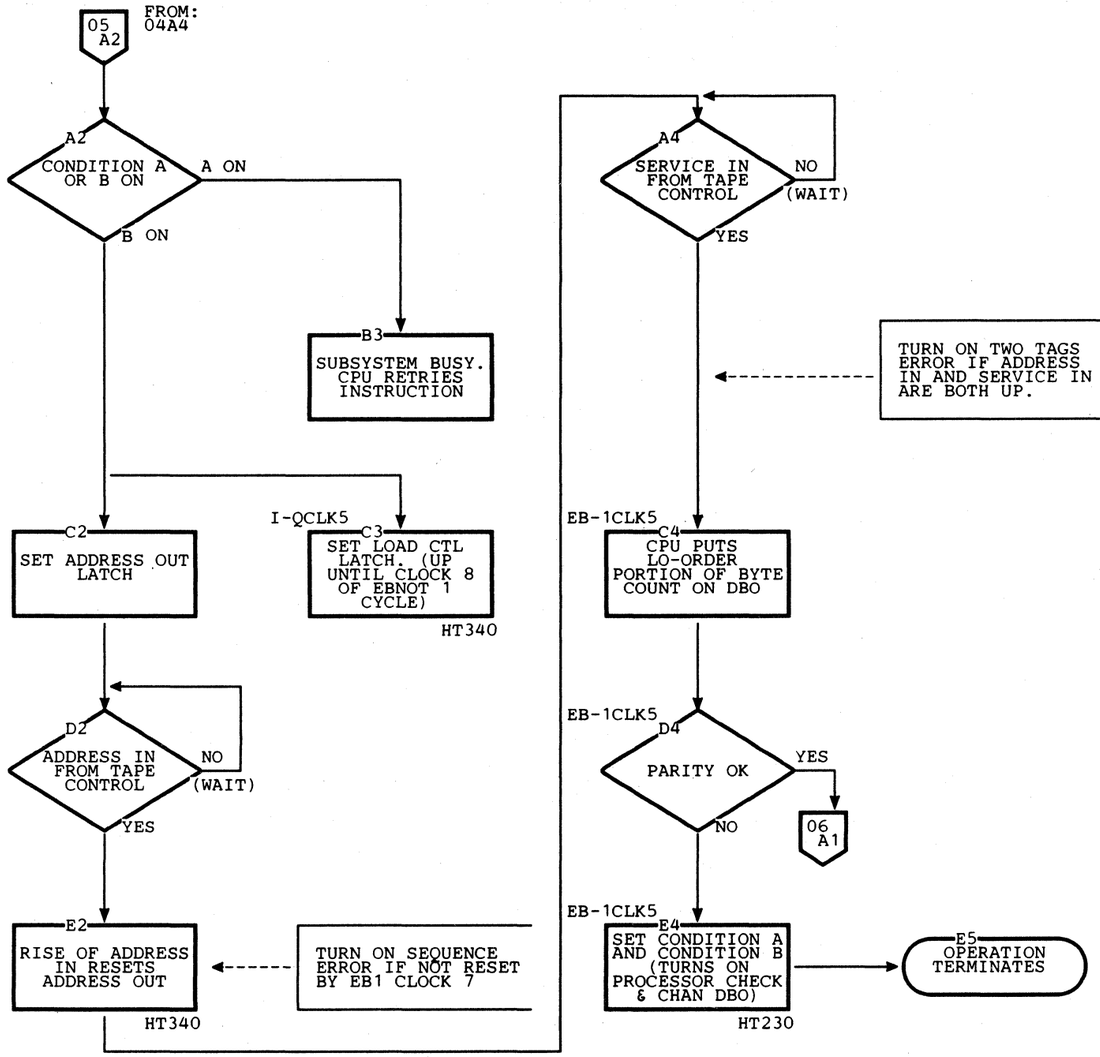
ADDRESS	N FIELD
011**	REGISTER

01234 567

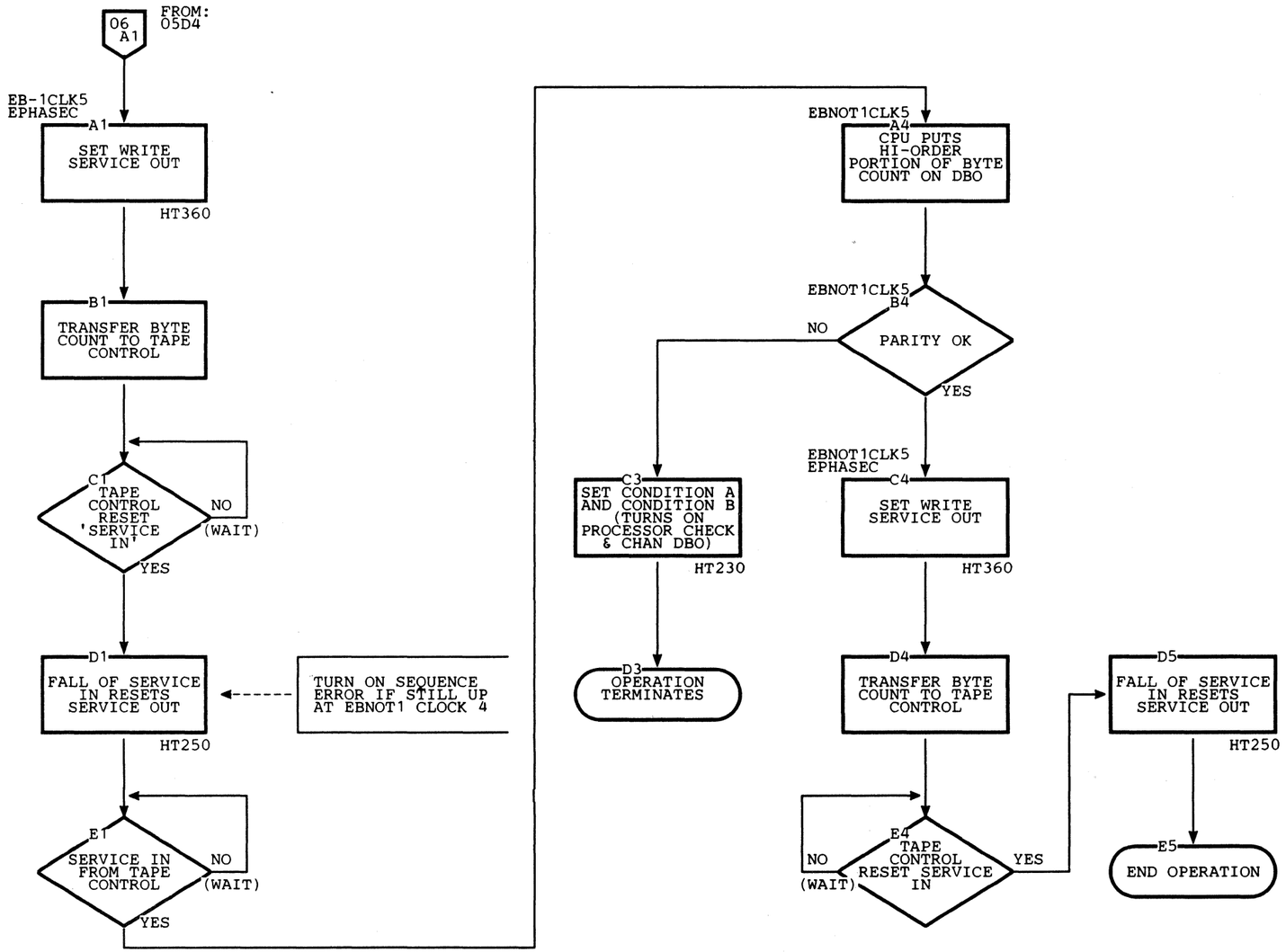
ADDRESS	N FIELD
SUBSYS 011**	000 LOAD BYTE COUNT IN TAPE CONTROL
TU 0 00 TU 1 01 TU 2 10 TU 3 11	100 LOAD MAGNETIC TAPE DATA ADDRESS REGISTER IN CPU
	ANY OTHER COMBINATION RAISES INVALID COMMAND



Load I/O


05
A2
FROM:
04A4
A2
CONDITION A OR B ON
A ON
B ON
B3
SUBSYSTEM BUSY. CPU RETRIES INSTRUCTION
C2
SET ADDRESS OUT LATCH
I-QCLK5
C3
SET LOAD CTL LATCH. (UP UNTIL CLOCK 8 OF EBNOT 1 CYCLE)
HT340
D2
ADDRESS IN FROM TAPE CONTROL
NO
(WAIT)
YES
E2
RISE OF ADDRESS IN RESETS ADDRESS OUT
HT340
TURN ON SEQUENCE ERROR IF NOT RESET BY EB1 CLOCK 7
A4
SERVICE IN FROM TAPE CONTROL
NO
(WAIT)
YES
TURN ON TWO TAGS ERROR IF ADDRESS IN AND SERVICE IN ARE BOTH UP.
EB-1CLK5
C4
CPU PUTS LO-ORDER PORTION OF BYTE COUNT ON DBO
EB-1CLK5
D4
PARITY OK
YES
NO
06
A1
EB-1CLK5
E4
SET CONDITION A AND CONDITION B (TURNS ON PROCESSOR CHECK & CHAN DBO)
HT230
E5
OPERATION TERMINATES

Load I/O


06 A1
FROM: 05D4
EB-1CLK5 EPHASEC
A1
SET WRITE SERVICE OUT
HT360
B1
TRANSFER BYTE COUNT TO TAPE CONTROL
C1
TAPE CONTROL RESET 'SERVICE IN'
NO
(WAIT)
YES
D1
FALL OF SERVICE IN RESETS SERVICE OUT
HT250
TURN ON SEQUENCE ERROR IF STILL UP AT EBNOT1 CLOCK 4
E1
SERVICE IN FROM TAPE CONTROL
NO
(WAIT)
YES
EBNOT1CLK5
A4
CPU PUTS HI-ORDER PORTION OF BYTE COUNT ON DBO
EBNOT1CLK5
B4
NO
PARITY OK
YES
C3
SET CONDITION A AND CONDITION B (TURNS ON PROCESSOR CHECK & CHAN DBO)
HT230
D3
OPERATION TERMINATES
EBNOT1CLK5 EPHASEC
C4
SET WRITE SERVICE OUT
HT360
D4
TRANSFER BYTE COUNT TO TAPE CONTROL
E4
TAPE CONTROL RESET SERVICE IN
NO
(WAIT)
YES
D5
FALL OF SERVICE IN RESETS SERVICE OUT
HT250
E5
END OPERATION

Start I/O (SIO)

Start I/O initiates a tape operation. During the I-Q Cycle, the Q Byte is decoded for the tape unit address and command. If the command is the Control or Diagnostic type, an R Byte is received during the I-R Cycle. The R Byte contains the specific Control or Diagnostic command. For a Read or Write command the R Byte is not used. However the I-R Cycle is still executed.

Q BYTE

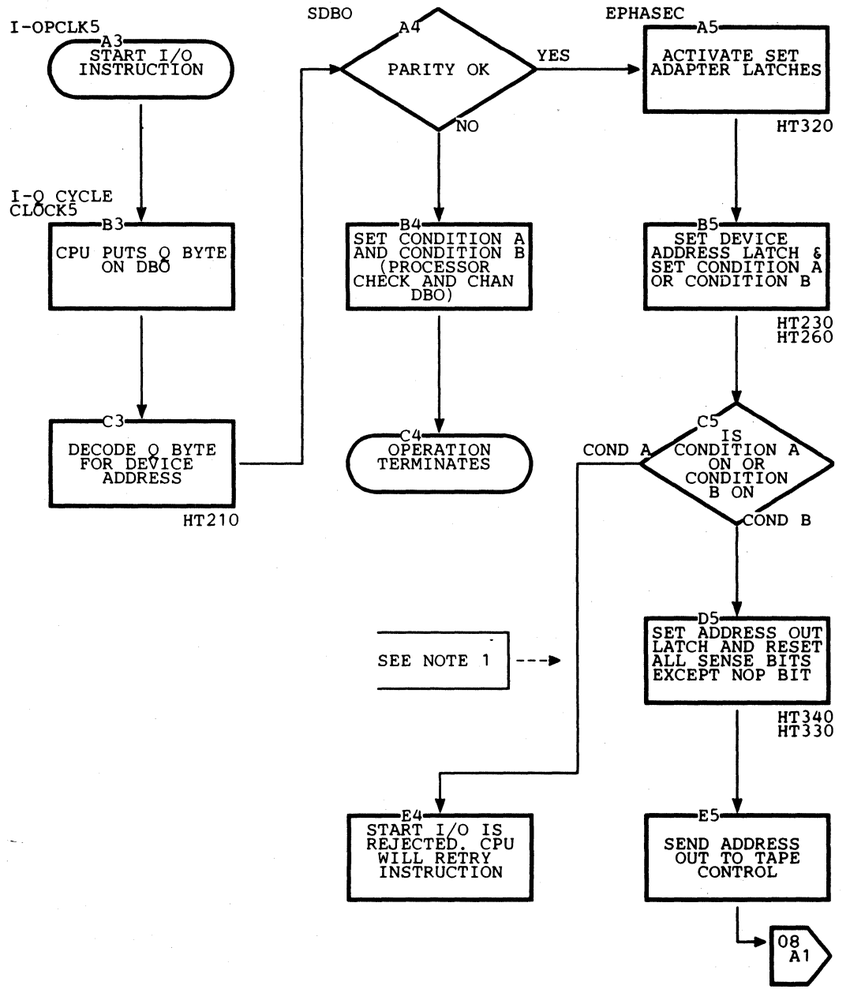
ADDRESS	N-FIELD
011**	COMMAND
01234	567

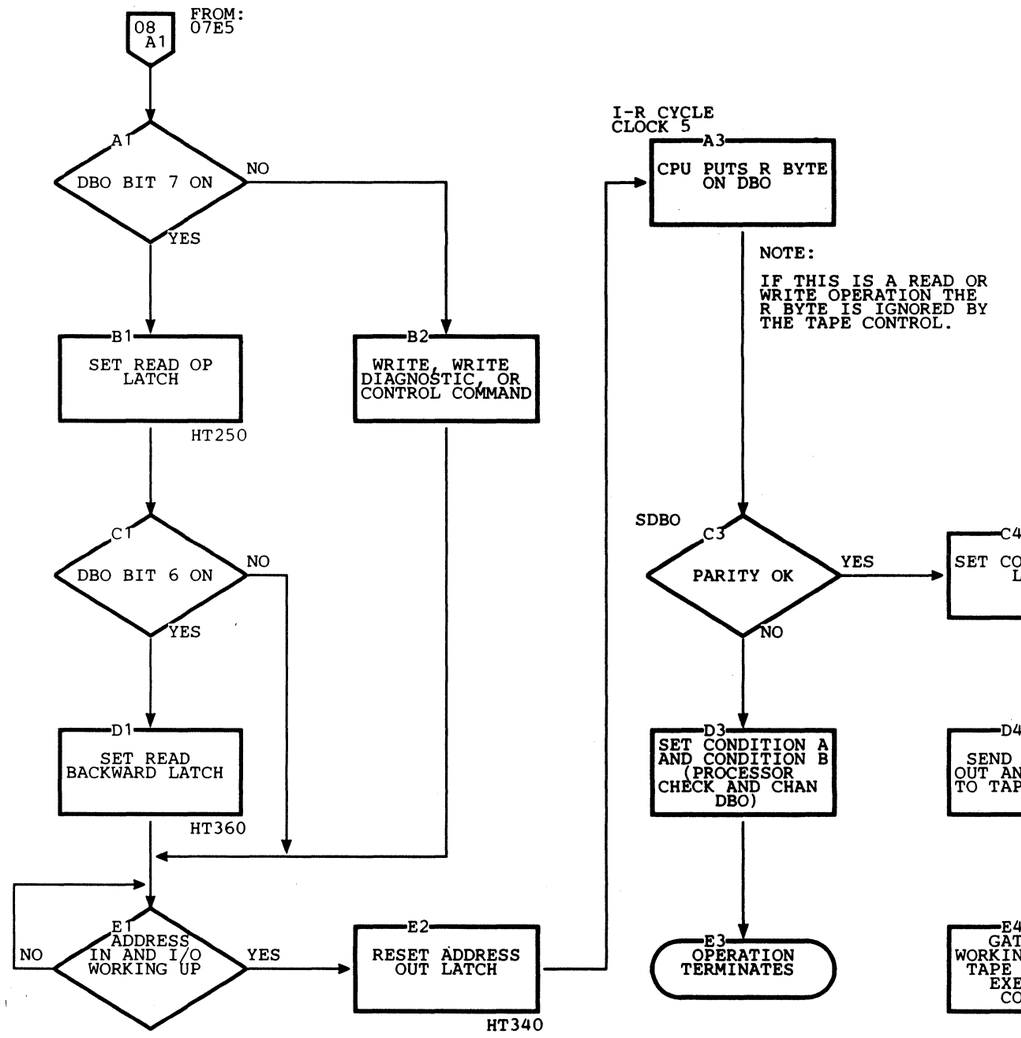
ADDRESS		N-FIELD	
SUBSYS 011**		COMMAND	
TU 0	00	000	CONTROL
TU 1	01	001	READ FORWARD
TU 2	10	010	WRITE
TU 3	11	011	READ BACKWARD
		100	WRITE DIAGNOSTIC (SUBSYSTEM)
		101	READ DIAGNOSTIC (SUBSYTEM)
		110	WRITE DIAGNOSTIC (ATTHMNT)
		111	READ DIAGNOSTIC (ATTHMNT)

NOTE 1

CONDITION A IS ON WHEN:

(1) I/O WORKING IS ACTIVE, OR
(2) DEVICE HAS GONE NOT READY, OR
(3) THE DEVICE IS BUSY.



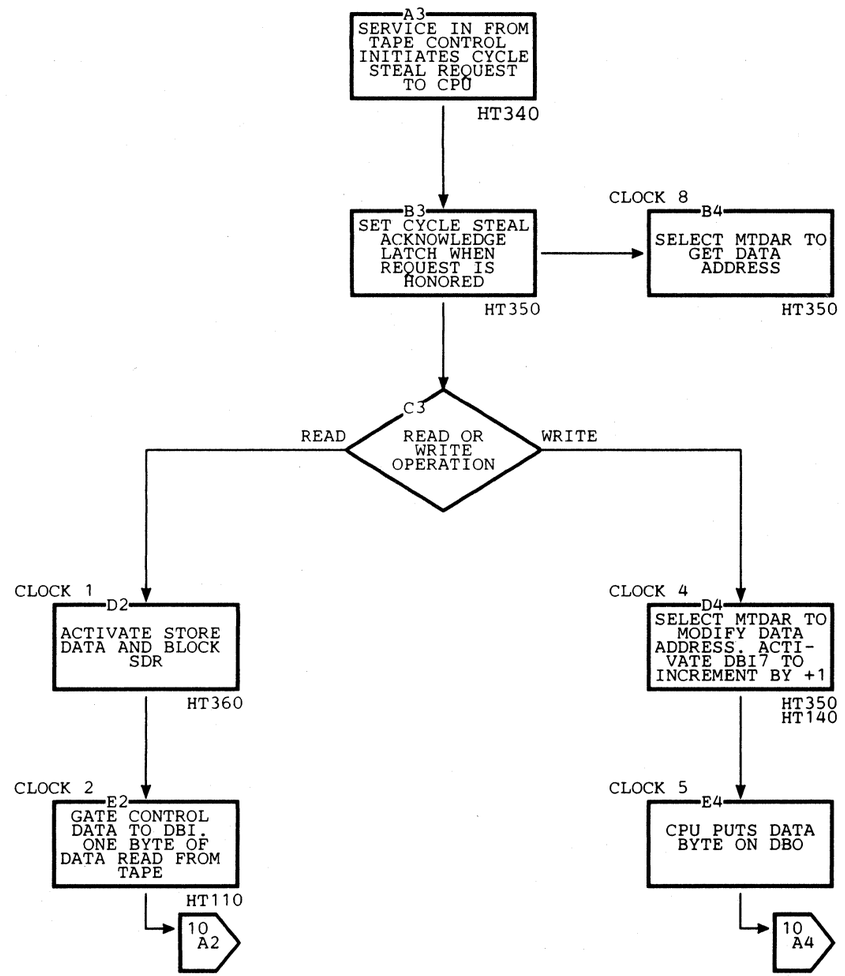


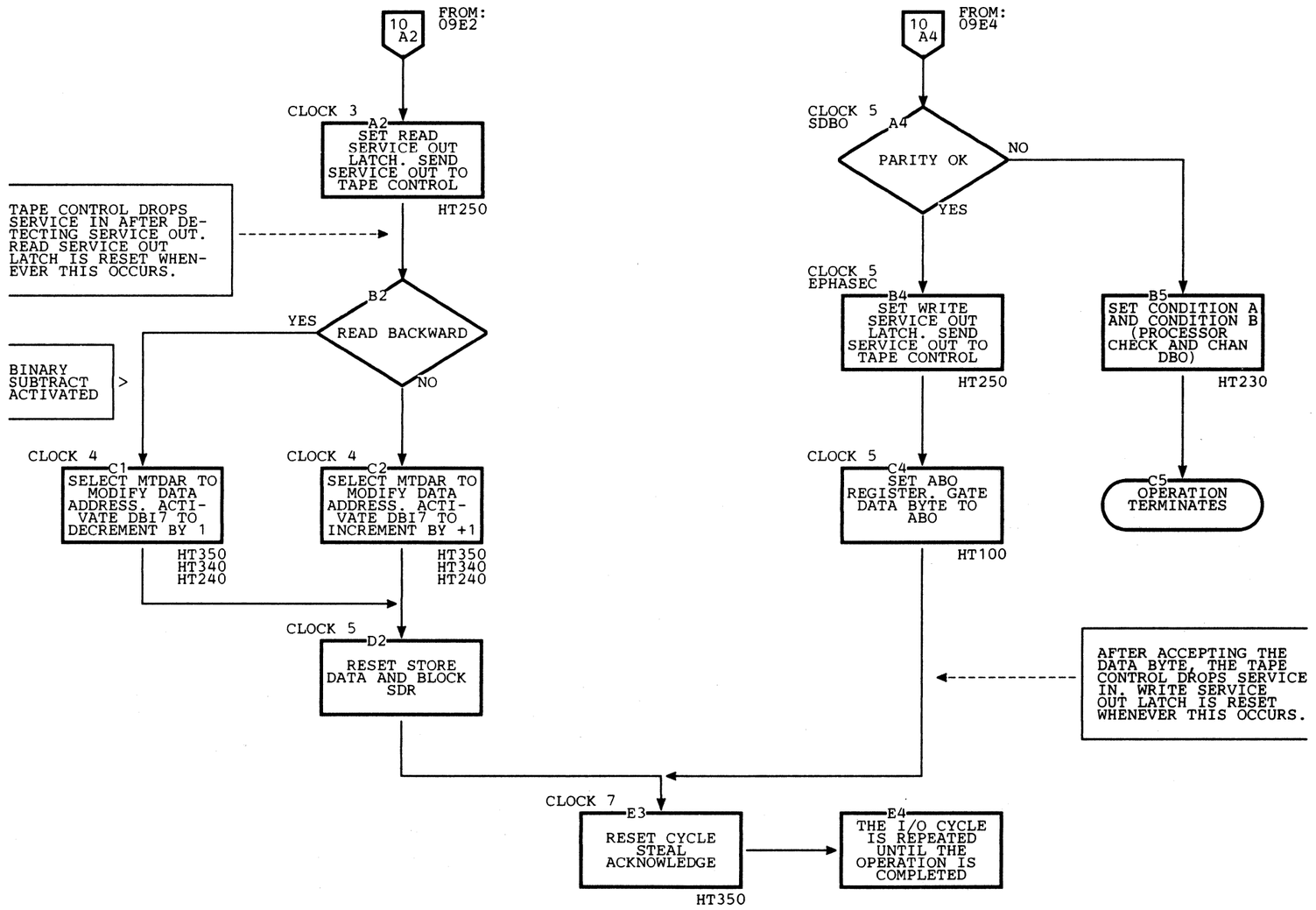
R BYTE

HEX CODE	CONTROL COMMAND
C3	MODE SET (9-TRACK PE)
CB	MODE SET (9-TRACK NRZI)
07	REWIND (REW)
0F	REWIND UNLOAD (RUN)
17	ERASE GAP (ERG)
1F	WRITE TAPE MARK (WTM)
27	BACKSPACE BLOCK (BSB)
2F	BACKSPACE FILE (BSF)
37	FORWARD SPACE BLOCK (FSB)
3F	FORWARD SPACE FILE (FSF)
97	DATA SECURITY ERASE (DSE)
	DIAGNOSTIC COMMAND
	WHEN N-FIELD IS 100
01	DIAGNOSTIC WRITE
03	LOOP WRITE TO READ
07	LOAD BYTE
08	WRITE SKEW CHECK
09	READ FWD SKEW CHECK
0D	READ BKWD SKEW CHECK
	WHEN N-FIELD IS 101
02	CROSSTALK CHECK
04	DIAGNOSTIC MEASURE (FWD)
06	IBG TIMING TEST
0C	DIAGNOSTIC MEASURE (BKWD)

I/O Cycles

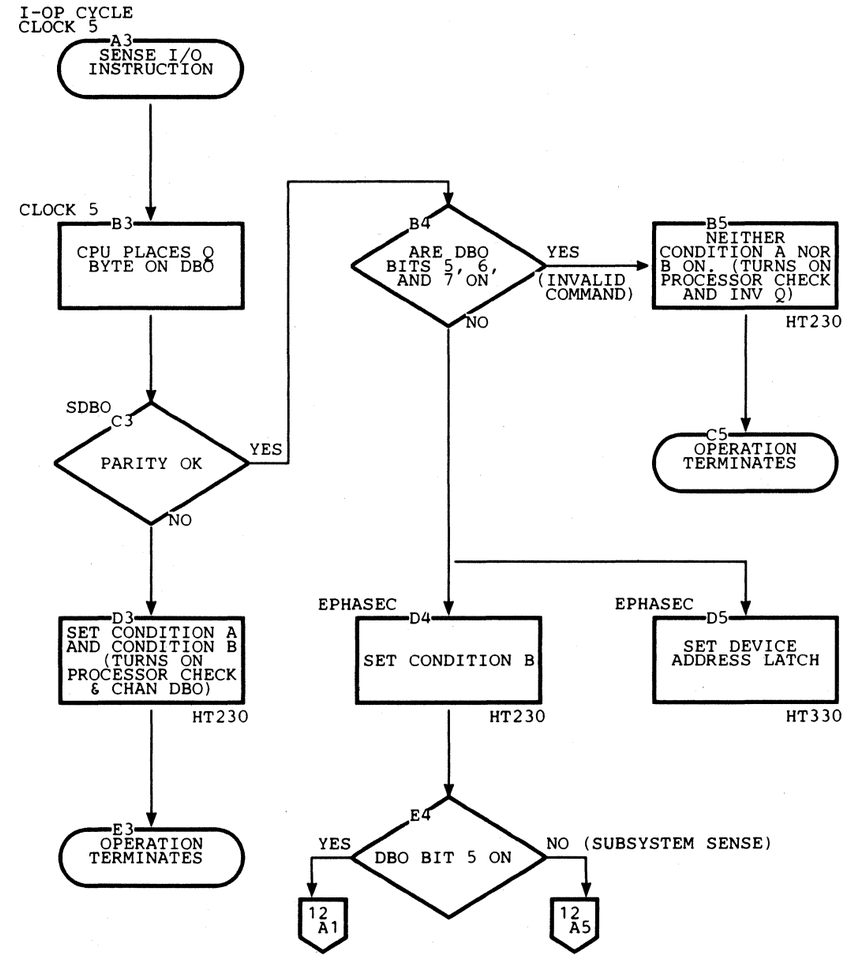
I/O Cycles are the result of the Start I/O instruction. The tape control requests the I/O Cycle by raising Service In to the attachment. The attachment then issues a Cycle Request 7 to CPU. After the CPU acknowledges the cycle steal request, the data transfer begins. One byte of data is transferred each I/O Cycle. When tape control is ready to receive or send the next byte, another Cycle Steal Request is made to CPU.




10 A2
FROM: 09E2
CLOCK 3
A2
SET READ SERVICE OUT LATCH. SEND SERVICE OUT TO TAPE CONTROL
HT250
TAPE CONTROL DROPS SERVICE IN AFTER DETECTING SERVICE OUT. READ SERVICE OUT LATCH IS RESET WHENEVER THIS OCCURS.
B2
READ BACKWARD
YES
NO
BINARY SUBTRACT ACTIVATED
CLOCK 4
C1
SELECT MTDAR TO MODIFY DATA ADDRESS. ACTIVATE DBI7 TO DECREMENT BY 1
HT350
HT340
HT240
CLOCK 4
C2
SELECT MTDAR TO MODIFY DATA ADDRESS. ACTIVATE DBI7 TO INCREMENT BY +1
HT350
HT340
HT240
CLOCK 5
D2
RESET STORE DATA AND BLOCK SDR
CLOCK 7
E3
RESET CYCLE STEAL ACKNOWLEDGE
HT350
E4
THE I/O CYCLE IS REPEATED UNTIL THE OPERATION IS COMPLETED
10 A4
FROM: 09E4
CLOCK 5 SDBO
A4
PARITY OK
NO
YES
CLOCK 5 EPHASEC
B4
SET WRITE SERVICE OUT LATCH. SEND SERVICE OUT TO TAPE CONTROL
HT250
B5
SET CONDITION A AND CONDITION B (PROCESSOR CHECK AND CHAN DBO)
HT230
C5
OPERATION TERMINATES
CLOCK 5
C4
SET ABO REGISTER. GATE DATA BYTE TO ABO
HT100
AFTER ACCEPTING THE DATA BYTE, THE TAPE CONTROL DROPS SERVICE IN. WRITE SERVICE OUT LATCH IS RESET WHENEVER THIS OCCURS.

Sense I/O

The Sense I/O (SNS) instruction requests sense data from the Attachment, the MTDAR, or the subsystem. During the I-Q Cycle, the Q Byte is decoded for the address and the unit being sensed. During the following EB-1 and EB-Not 1 Cycles, the requested sense data is sent to the CPU. If the subsystem is sensed, an I/O Cycle is taken but no data is transferred. The I/O Cycle is taken to provide time for the subsystem to assemble the requested sense data.



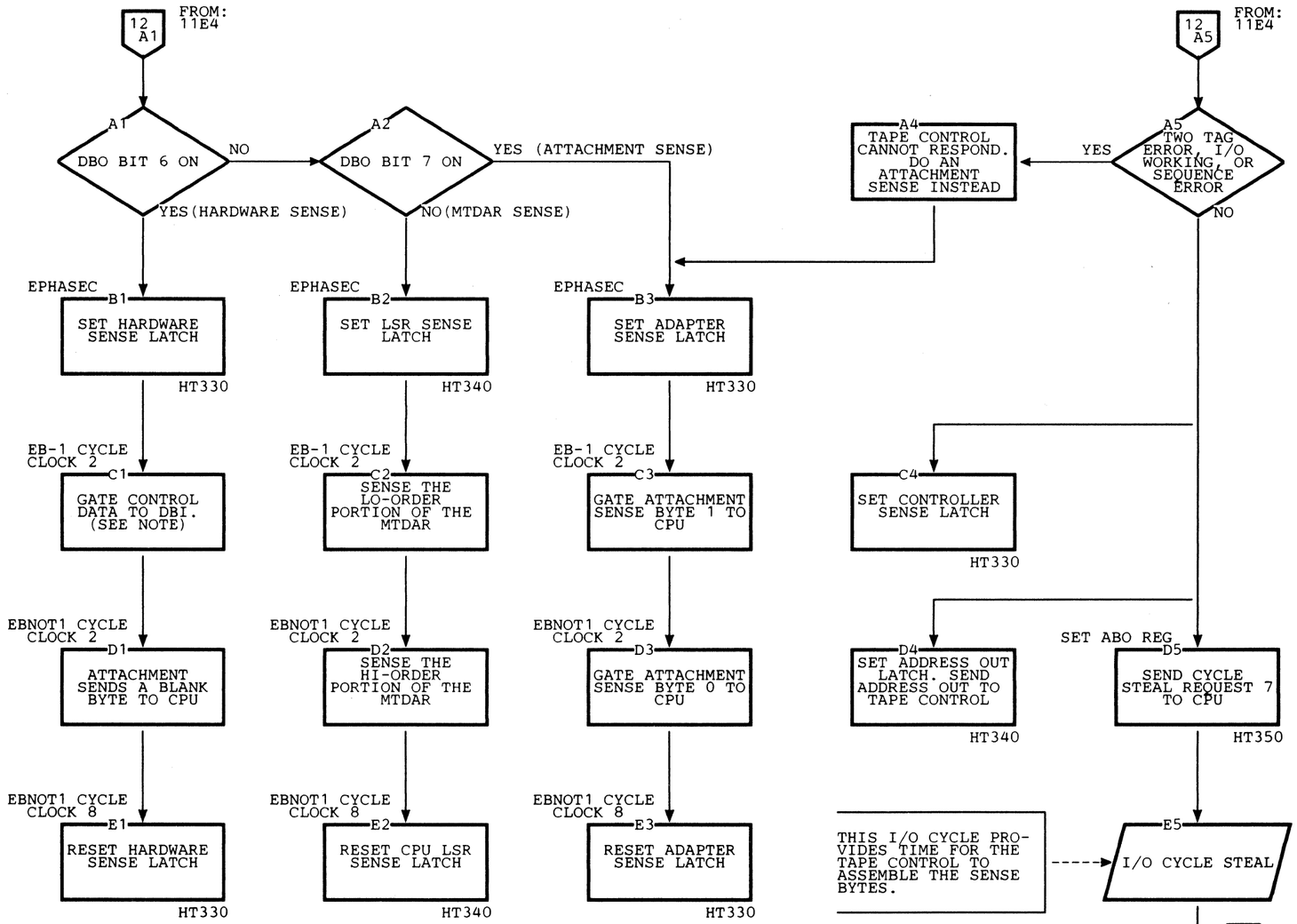
Q BYTE

ADDRESS	N FIELD
011**	UNIT
01234	567

ADDRESS	N FIELD
SUBSYS 011**	000 SUBSYSTEM 0/1 001 SUBSYSTEM 2/3 010 SUBSYSTEM 4/5 011 SUBSYSTEM 6/7 100 *MTDAR SENSE 101 ATTHMNT SENSE 110 HARDWARE SENSE 111 INVALID
TU 0 00	
TU 1 01	
TU 2 10	
TU 3 11	

*THE MTDAR (MAGNETIC TAPE DATA ADDRESS REGISTER) IS THE CPU LSR ASSIGNED TO THE SUBSYSTEM

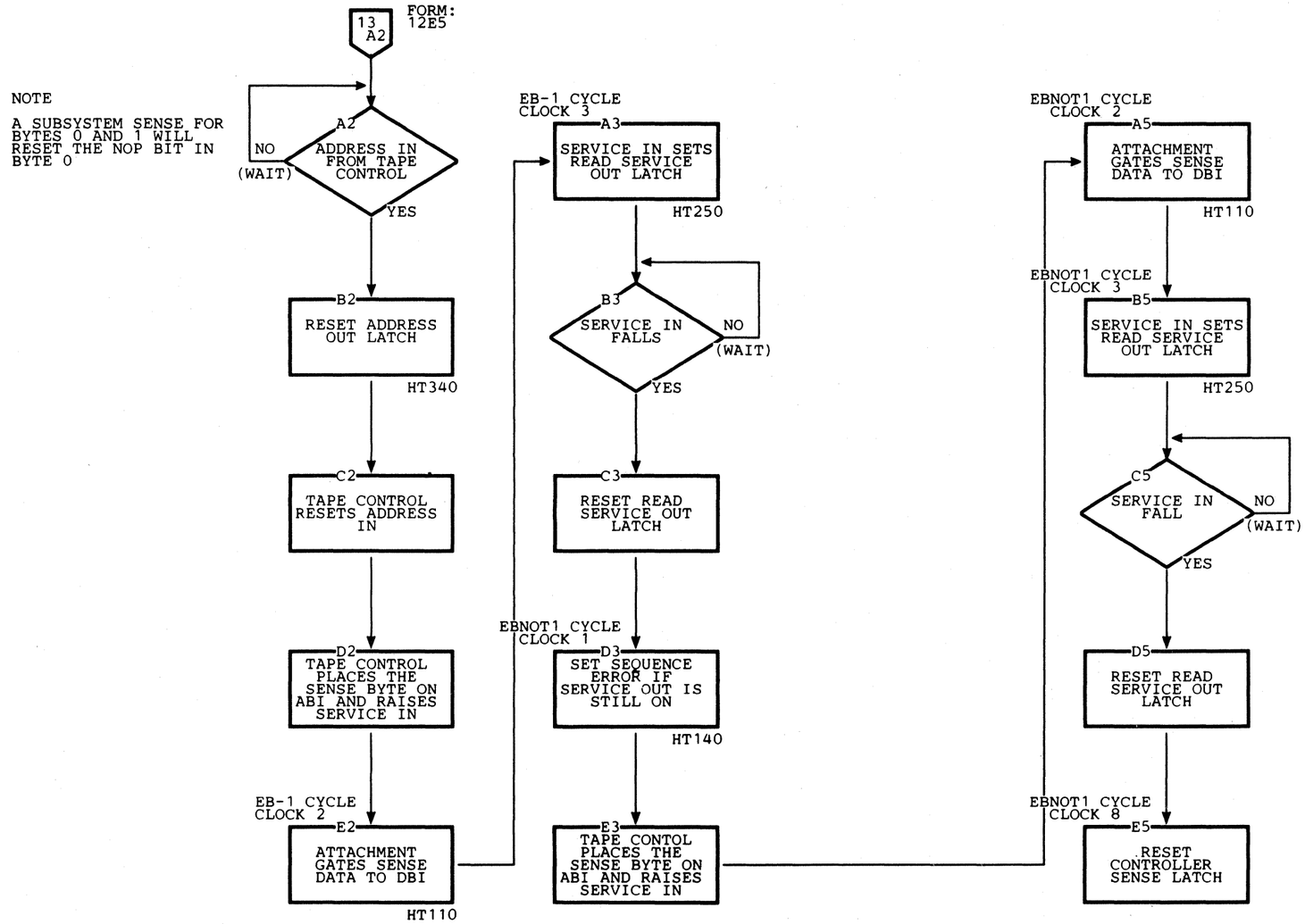
Sense I/O



NOTE:

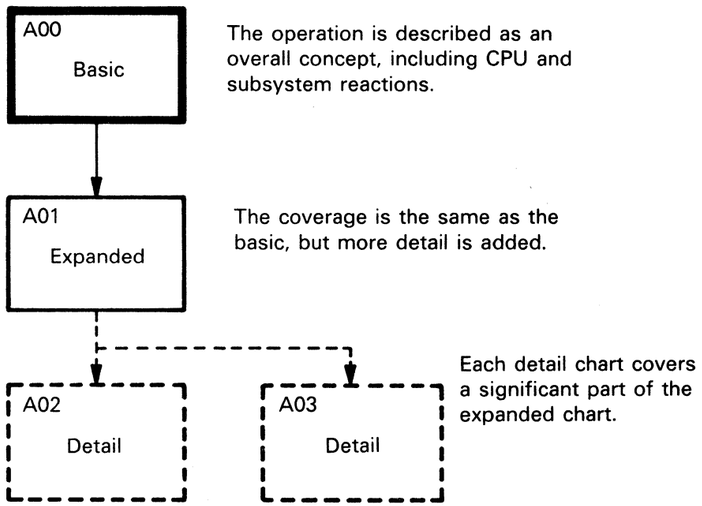
TAPE CONTROL FORCES EITHER THE HARDWARE DETECTED OR MICROPROGRAM DETECTED (NOT BOTH) HARDWARE ERROR BYTE ONTO THE ABI. IT IS GATED TO THE CPU AT THIS TIME.

Sense I/O


13
A2
FORM:
12E5
NOTE
A SUBSYSTEM SENSE FOR BYTES 0 AND 1 WILL RESET THE NOP BIT IN BYTE 0
A2
ADDRESS IN FROM TAPE CONTROL
NO
(WAIT)
YES
B2
RESET ADDRESS OUT LATCH
HT340
C2
TAPE CONTROL RESETS ADDRESS IN
D2
TAPE CONTROL PLACES THE SENSE BYTE ON ABI AND RAISES SERVICE IN
EB-1 CYCLE
CLOCK 2
E2
ATTACHMENT GATES SENSE DATA TO DBI
HT110
EB-1 CYCLE
CLOCK 3
A3
SERVICE IN SETS READ SERVICE OUT LATCH
HT250
B3
SERVICE IN FALLS
NO
(WAIT)
YES
C3
RESET READ SERVICE OUT LATCH
EBNOT1 CYCLE
CLOCK 1
D3
SET SEQUENCE ERROR IF SERVICE OUT IS STILL ON
HT140
E3
TAPE CONTOL PLACES THE SENSE BYTE ON ABI AND RAISES SERVICE IN
EBNOT1 CYCLE
CLOCK 2
A5
ATTACHMENT GATES SENSE DATA TO DBI
HT110
EBNOT1 CYCLE
CLOCK 3
B5
SERVICE IN SETS READ SERVICE OUT LATCH
HT250
C5
SERVICE IN FALL
NO
(WAIT)
YES
D5
RESET READ SERVICE OUT LATCH
EBNOT1 CYCLE
CLOCK 8
E5
RESET CONTROLLER SENSE LATCH

System/3 Attachment Diagrams

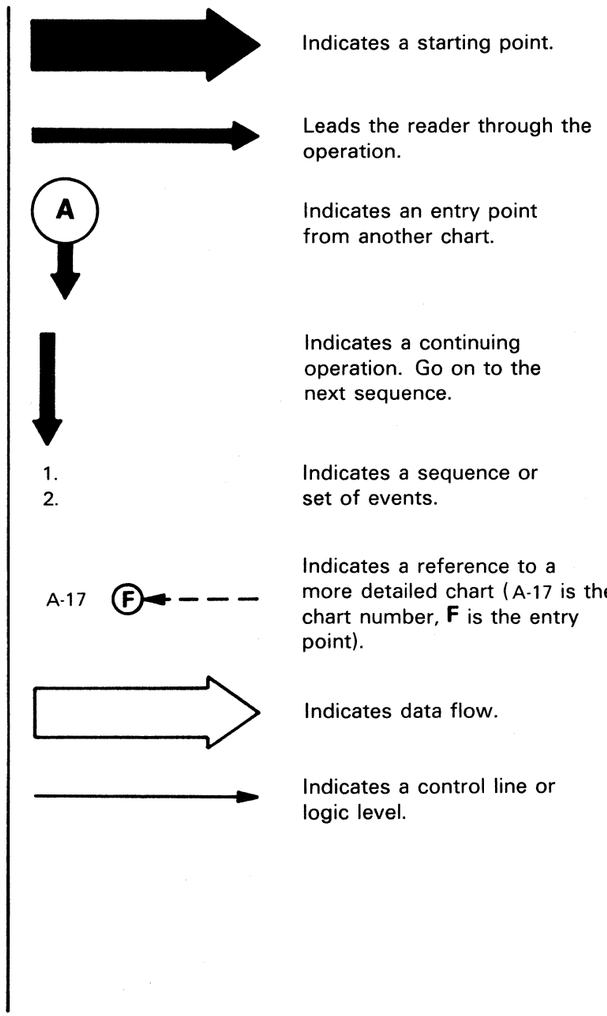
The following charts graphically describe the internal operations of the System/3 attachment for the 3410-3411 Tape Subsystem. Each operation is described at a basic level stressing the overall concept.
If necessary, the reader can proceed from the concept-level charts to charts having more detail. Refer to the table of contents, the scheme of which is shown below.



The operation is described as an overall concept, including CPU and subsystem reactions.

The coverage is the same as the basic, but more detail is added.

Each detail chart covers a significant part of the expanded chart.



Indicates a starting point.

Leads the reader through the operation.

Indicates an entry point from another chart.

Indicates a continuing operation. Go on to the next sequence.

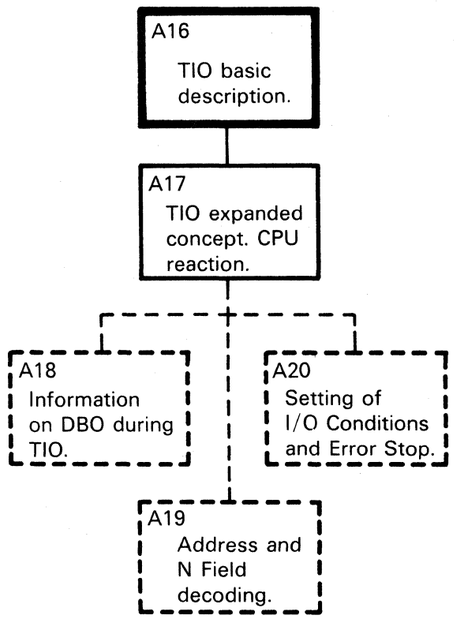
Indicates a sequence or set of events.

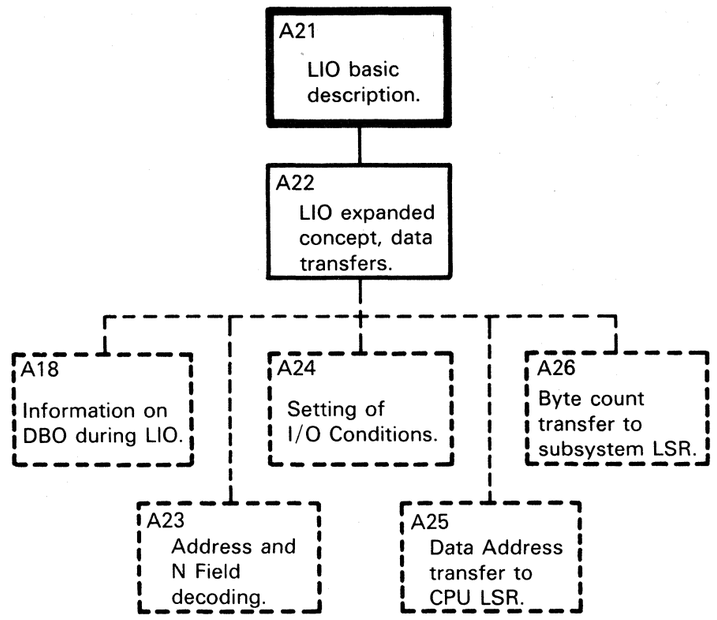
Indicates a reference to a more detailed chart (A-17 is the chart number, **F** is the entry point).

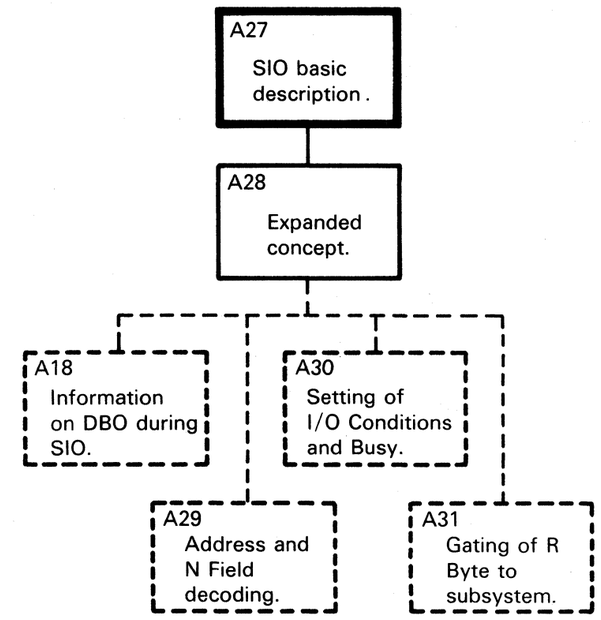
Indicates data flow.

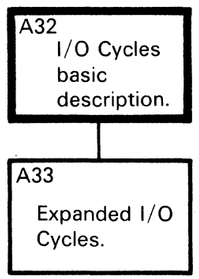
Indicates a control line or logic level.

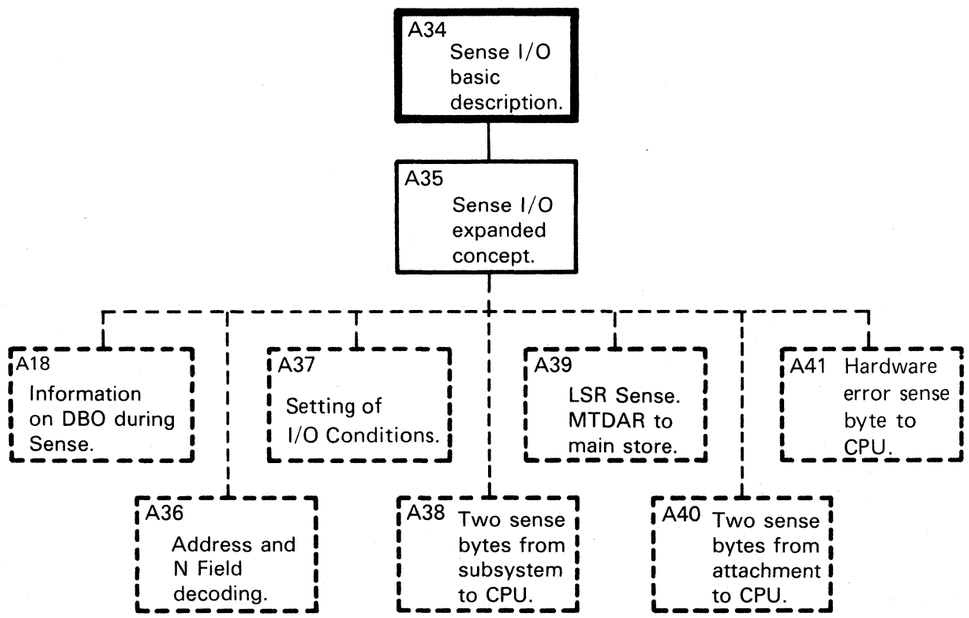
Table of Contents

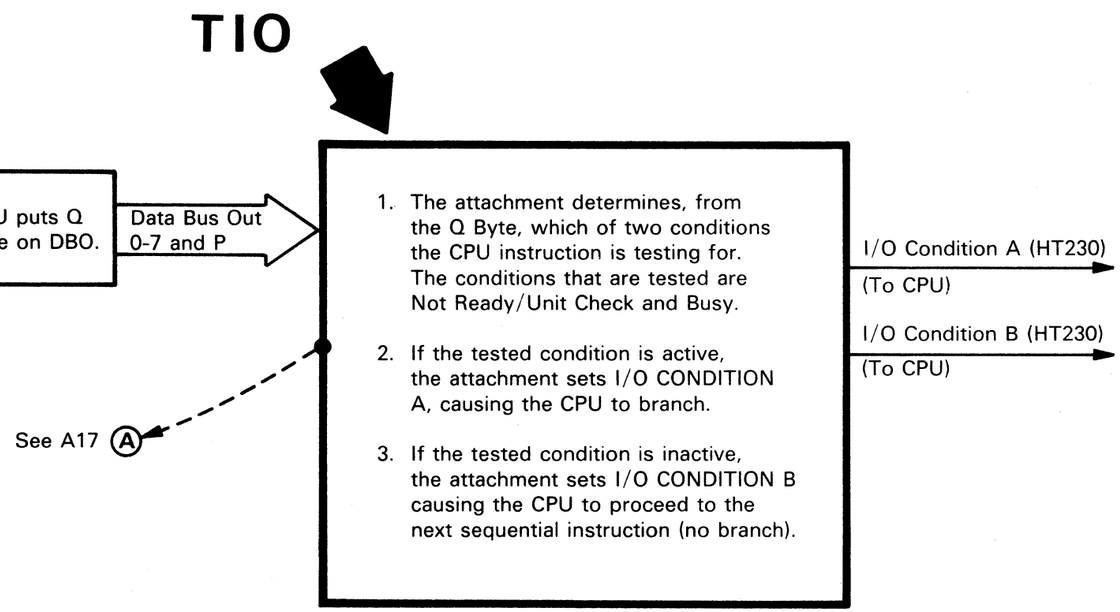


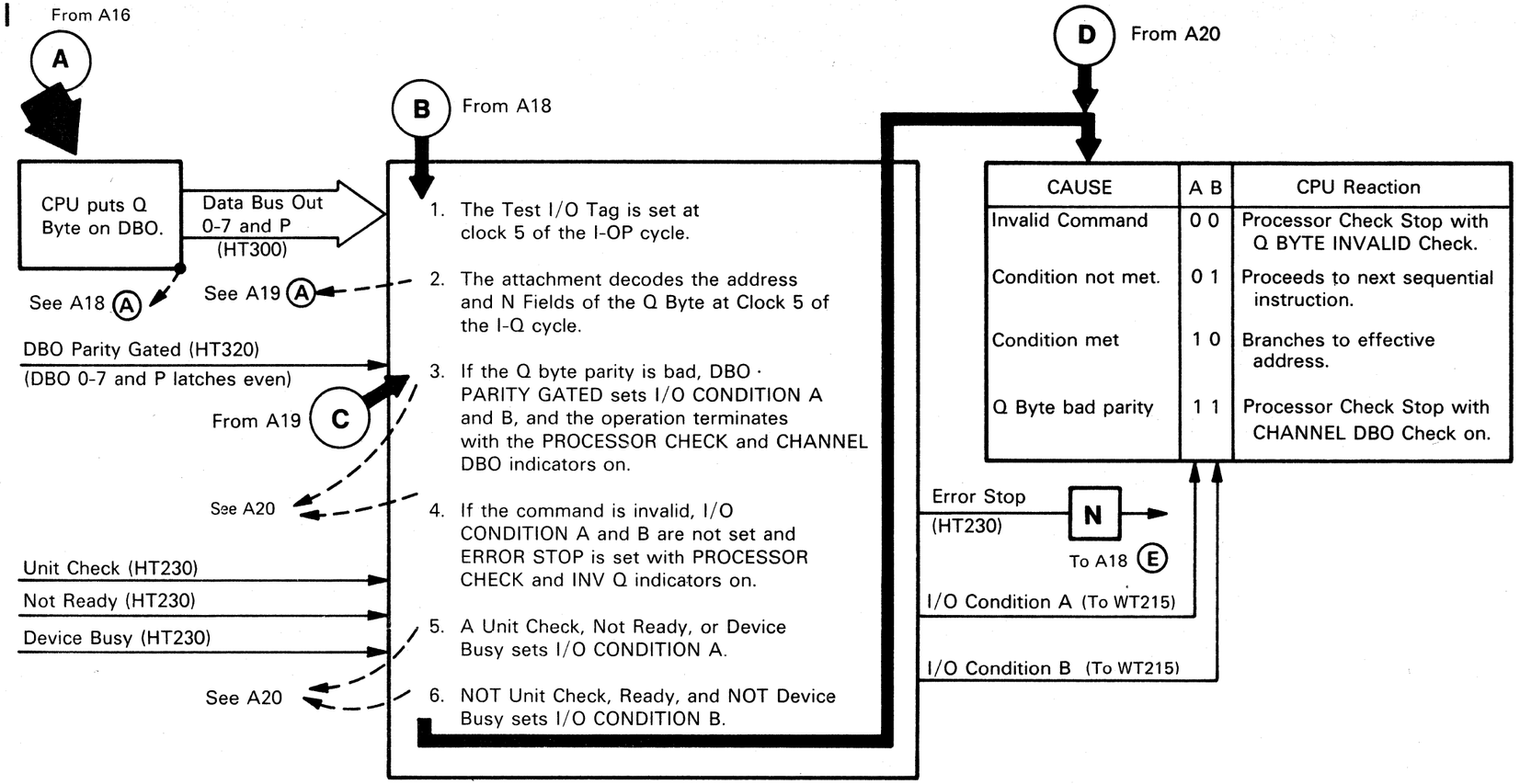








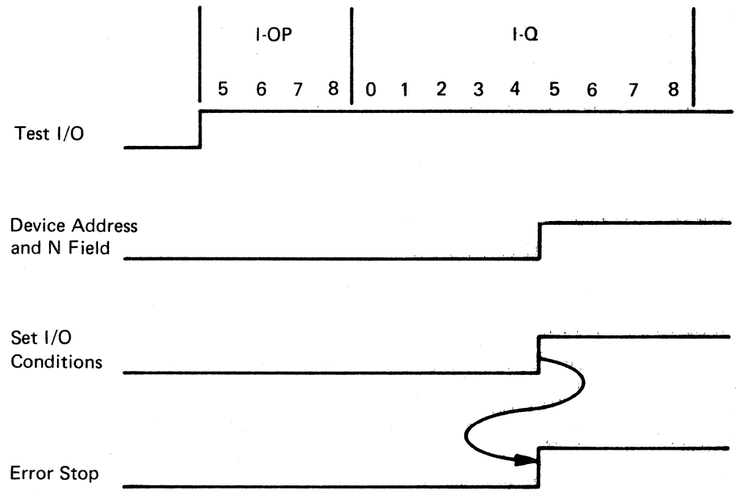

TIO
CPU puts Q byte on DBO.
Data Bus Out 0-7 and P
1. The attachment determines, from the Q Byte, which of two conditions the CPU instruction is testing for. The conditions that are tested are Not Ready/Unit Check and Busy.
2. If the tested condition is active, the attachment sets I/O CONDITION A, causing the CPU to branch.
3. If the tested condition is inactive, the attachment sets I/O CONDITION B causing the CPU to proceed to the next sequential instruction (no branch).
I/O Condition A (HT230)
(To CPU)
I/O Condition B (HT230)
(To CPU)
See A17 (A)

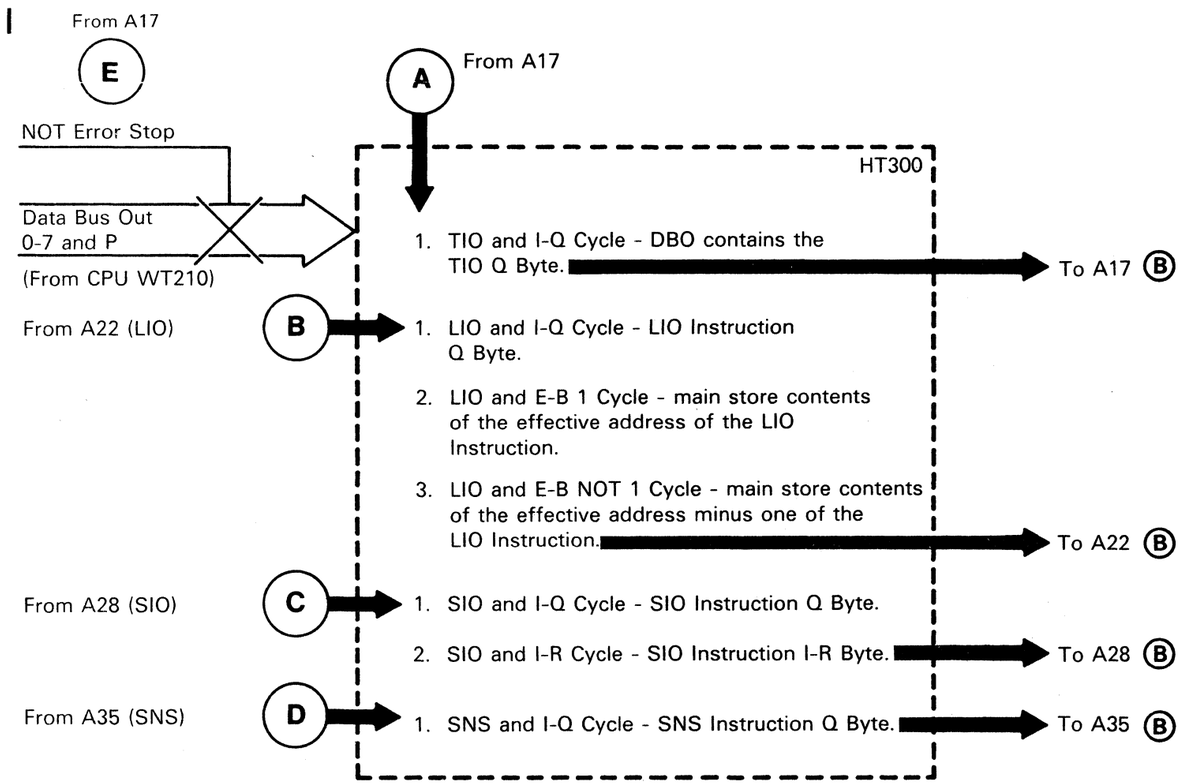


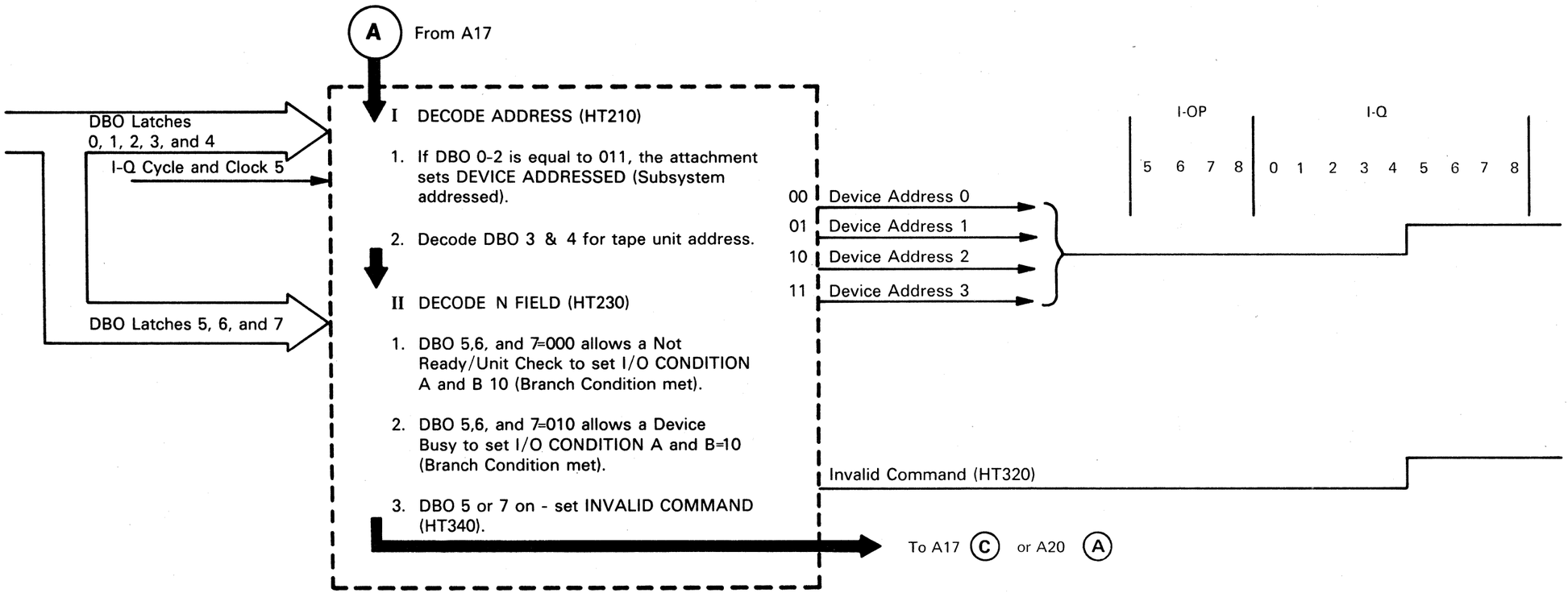
CAUSE	A B	CPU Reaction
Invalid Command	0 0	Processor Check Stop with Q BYTE INVALID Check.
Condition not met.	0 1	Proceeds to next sequential instruction.
Condition met	1 0	Branches to effective address.
Q Byte bad parity	1 1	Processor Check Stop with CHANNEL DBO Check on.

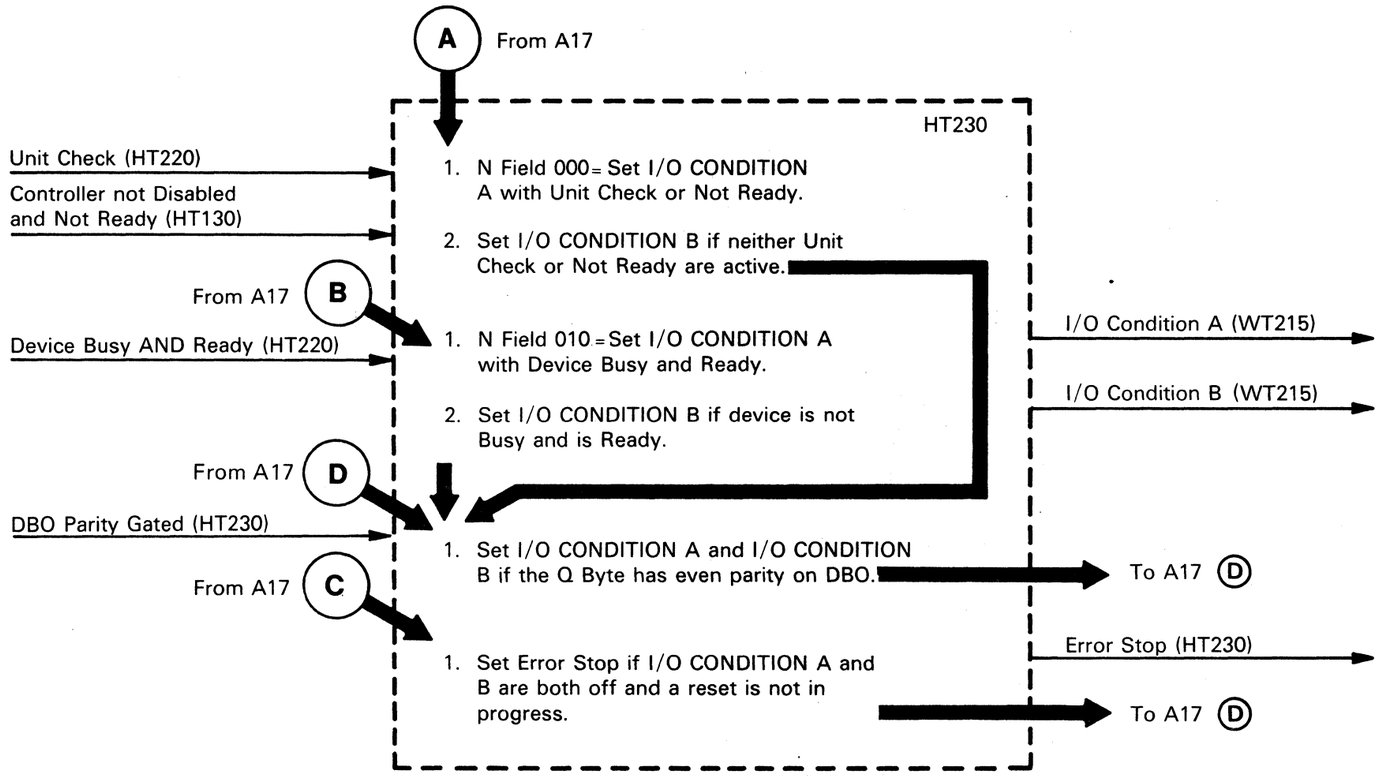
NOTES:

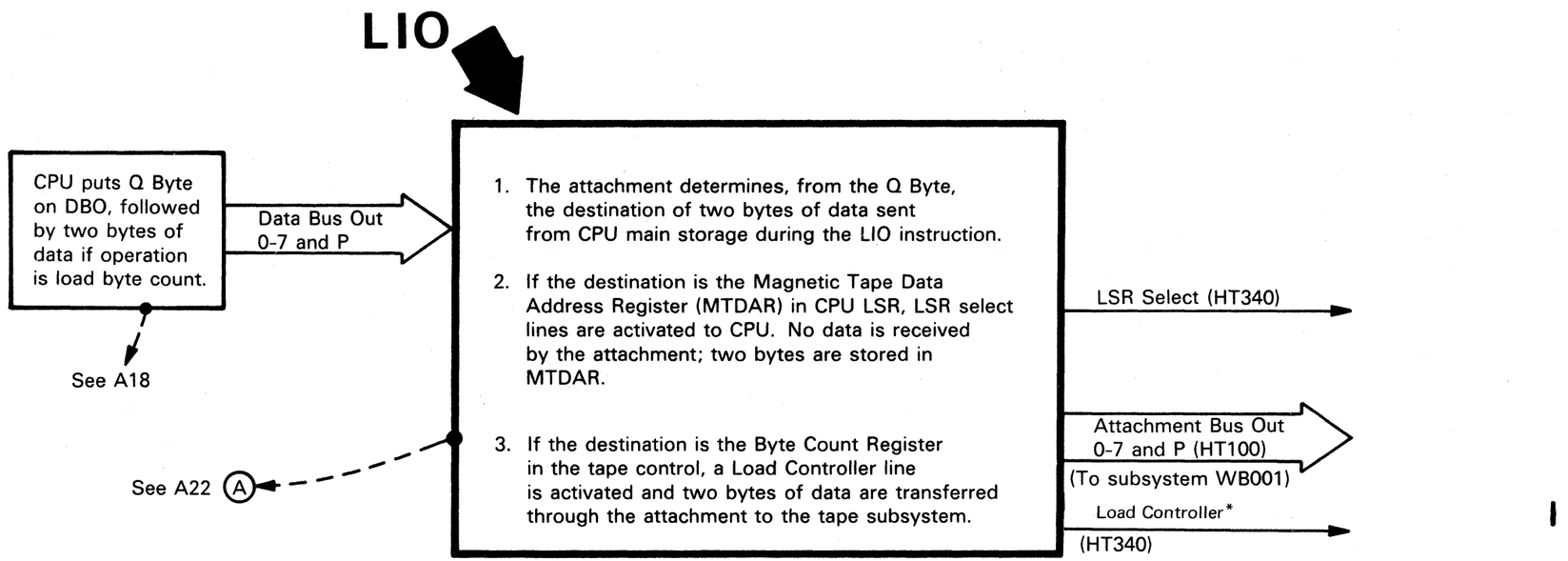
1. Unit Check is set by a Unit Check from a Tape Unit, a Not Ready, an I/O Check during I-Q Cycle at Clock 5, or an Adapter Check (HT230).




From A17
E
NOT Error Stop
Data Bus Out
0-7 and P
(From CPU WT210)
From A22 (LIO)
B
From A17
A
HT300
1. TIO and I-Q Cycle - DBO contains the TIO Q Byte.
To A17 B
1. LIO and I-Q Cycle - LIO Instruction Q Byte.
2. LIO and E-B 1 Cycle - main store contents of the effective address of the LIO Instruction.
3. LIO and E-B NOT 1 Cycle - main store contents of the effective address minus one of the LIO Instruction.
To A22 B
From A28 (SIO)
C
1. SIO and I-Q Cycle - SIO Instruction Q Byte.
2. SIO and I-R Cycle - SIO Instruction I-R Byte.
To A28 B
From A35 (SNS)
D
1. SNS and I-Q Cycle - SNS Instruction Q Byte.
To A35 B


A
From A17
DBO Latches
0, 1, 2, 3, and 4
I-Q Cycle and Clock 5
DBO Latches 5, 6, and 7
I DECODE ADDRESS (HT210)
1. If DBO 0-2 is equal to 011, the attachment sets DEVICE ADDRESSED (Subsystem addressed).
2. Decode DBO 3 & 4 for tape unit address.
II DECODE N FIELD (HT230)
1. DBO 5,6, and 7=000 allows a Not Ready/Unit Check to set I/O CONDITION A and B 10 (Branch Condition met).
2. DBO 5,6, and 7=010 allows a Device Busy to set I/O CONDITION A and B=10 (Branch Condition met).
3. DBO 5 or 7 on - set INVALID COMMAND (HT340).
00 Device Address 0
01 Device Address 1
10 Device Address 2
11 Device Address 3
I-OP
I-Q
5 6 7 8 0 1 2 3 4 5 6 7 8
Invalid Command (HT320)
To A17 C or A20 A


A
From A17
HT230
Unit Check (HT220)
Controller not Disabled and Not Ready (HT130)
1. N Field 000 = Set I/O CONDITION A with Unit Check or Not Ready.
2. Set I/O CONDITION B if neither Unit Check or Not Ready are active.
From A17
B
Device Busy AND Ready (HT220)
1. N Field 010 = Set I/O CONDITION A with Device Busy and Ready.
2. Set I/O CONDITION B if device is not Busy and is Ready.
I/O Condition A (WT215)
I/O Condition B (WT215)
From A17
D
DBO Parity Gated (HT230)
From A17
C
1. Set I/O CONDITION A and I/O CONDITION B if the Q Byte has even parity on DBO.
To A17 D
Error Stop (HT230)
1. Set Error Stop if I/O CONDITION A and B are both off and a reset is not in progress.
To A17 D



*The Load Controller line is used only by the attachment, it does not go to CPU.

From A21 (A)

1. CPU puts Q Byte on DBO at clock 5 I-Q Cycle

2. CPU puts first data byte on DBO at Clock 5 of EB 1 Cycle

3. CPU puts second data byte on DBO at Clock 5 of EB NOT 1 Cycle

Data Bus Out 0-7 and P

See A18 (B)

See A24 (A)

See A23 (A)

From A23 (C)

From A18 (B)

1. The load I/O tag is set at Clock 5 of the I-OP Cycle.
2. The attachment decodes the address and N fields of the Q Byte at Clock 5 of the I-Q cycle.
3. If the Q Byte parity is bad, DBO PARITY GATED sets I/O CONDITION A and B and the operation terminates with the PROCESSOR CHECK and CHANNEL DBO indicators on.
4. The N field is 000.
5. The N field is 100.
6. The CPU LSR (MTDAR) is to be accessed. LSR SELECT TO CPU is set.
7. During both EB 1 and EB NOT 1 cycles the data is stored in the CPU LSR. No data is received by the attachment. No DBO parity test is made.

See A25 (A)

From A23 (C)

CAUSE	A B	CPU REACTION
Invalid Command	0 0	I-Q - Processor Check Stop & Q Byte Invalid EB - Normal operation.
Subsystem not busy	0 1	Proceed to next instruction
Subsystem busy	1 0	Retry the LIO instruction
DBO Parity Error	1 1	Processor Check Stop and Channel DBO Check

See A26 (A)

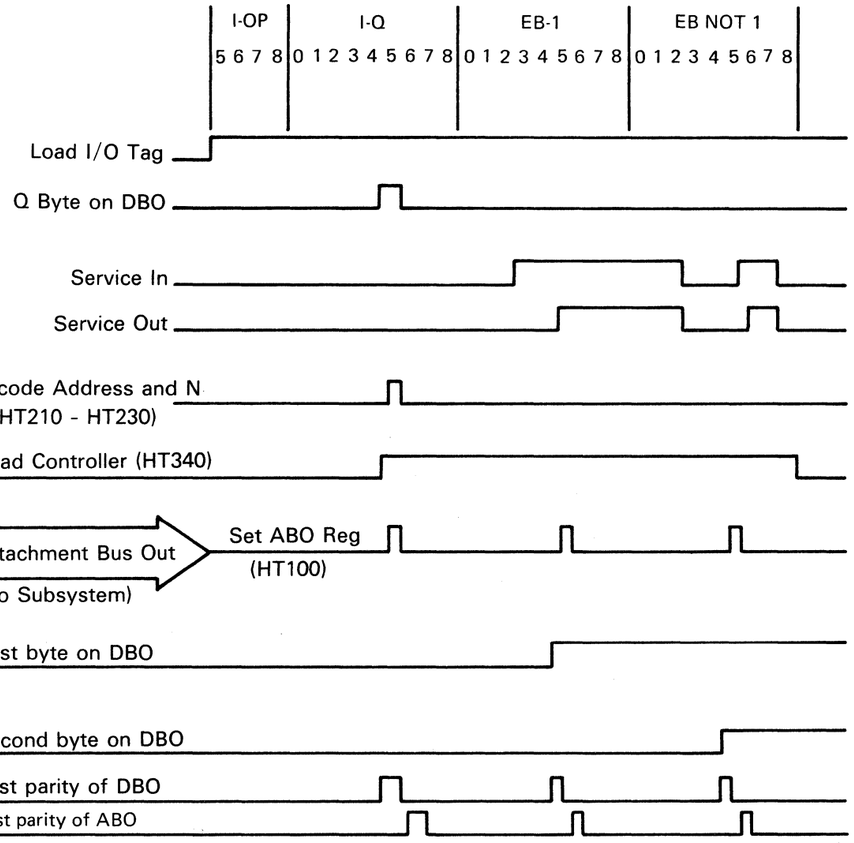
1. Byte count is to be transferred to the subsystem. If the subsystem is not busy, the attachment sets LOAD CONTROLLER.
2. If the subsystem is busy, the attachment sets CONDITION A. CPU retries the LIO instruction.

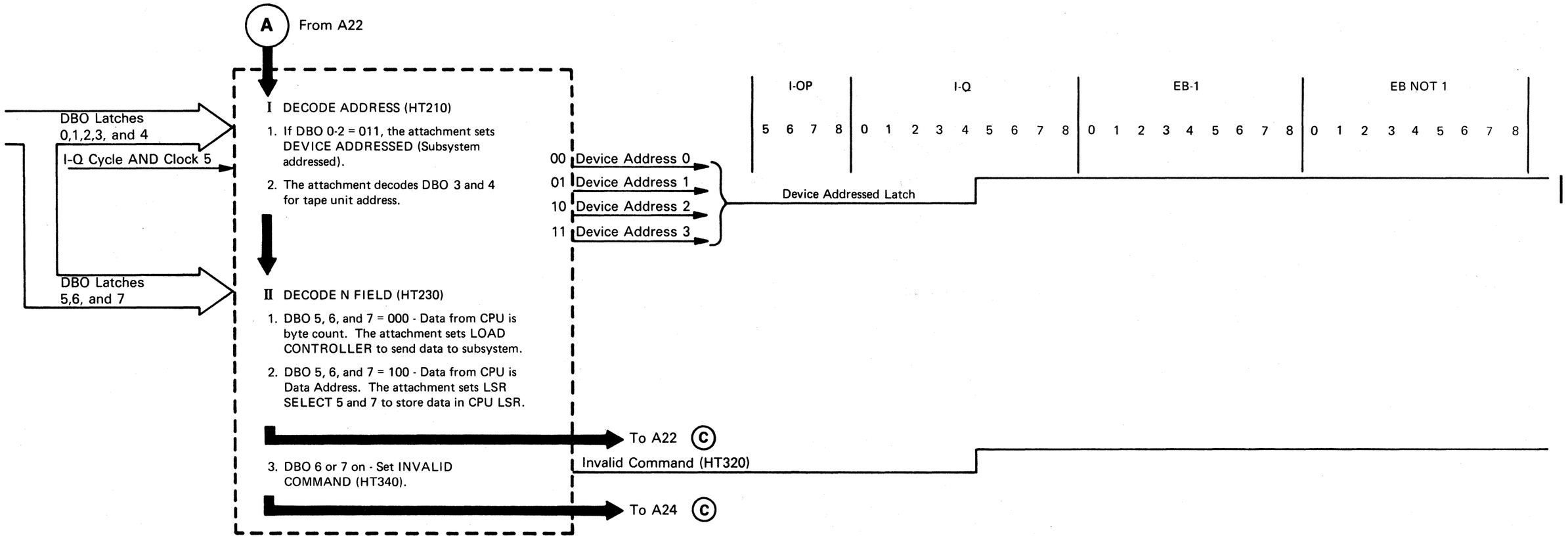
See A24 (B)

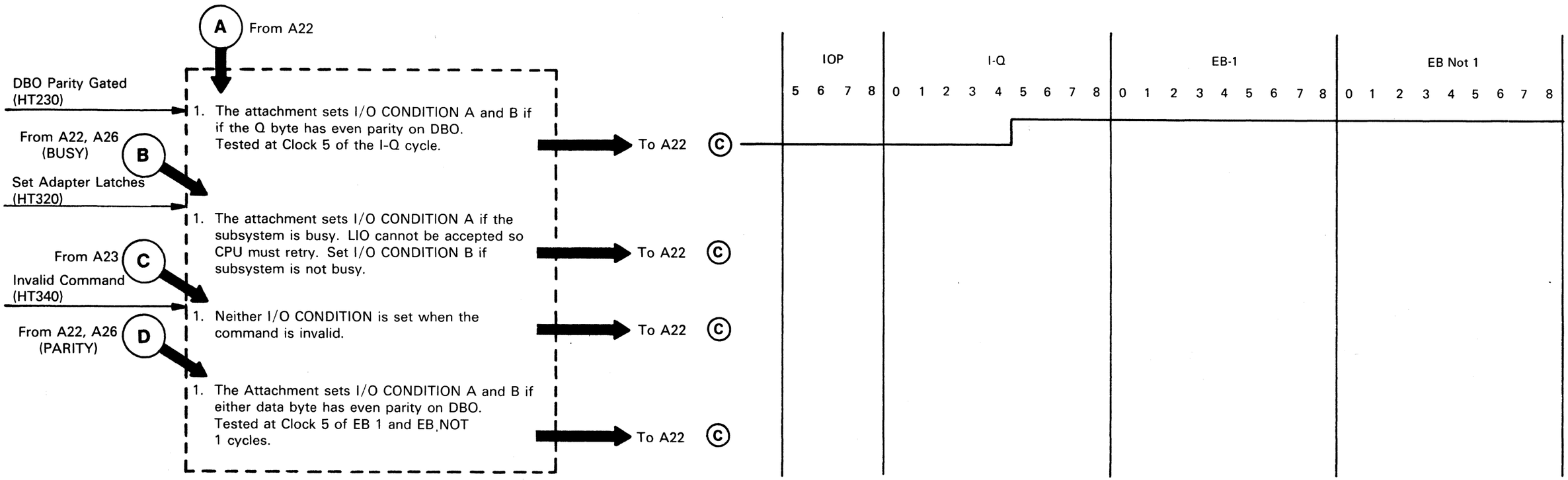
3. At Clock 5 of the EB 1 cycle, the first byte is placed on DBO and gated to the subsystem. DBO parity is tested.

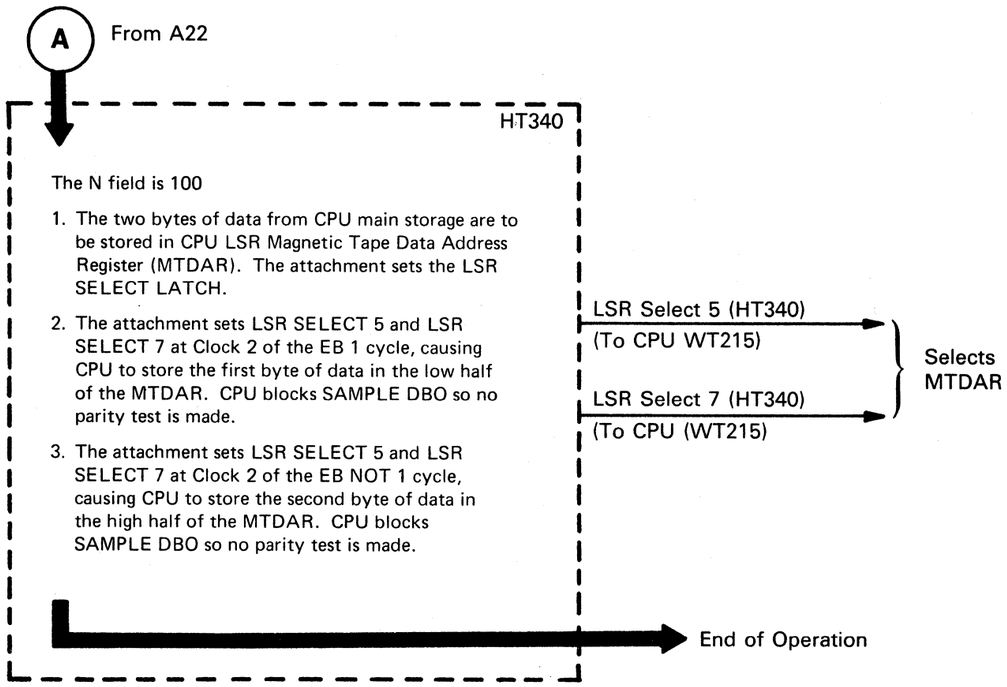
See A24 (D)

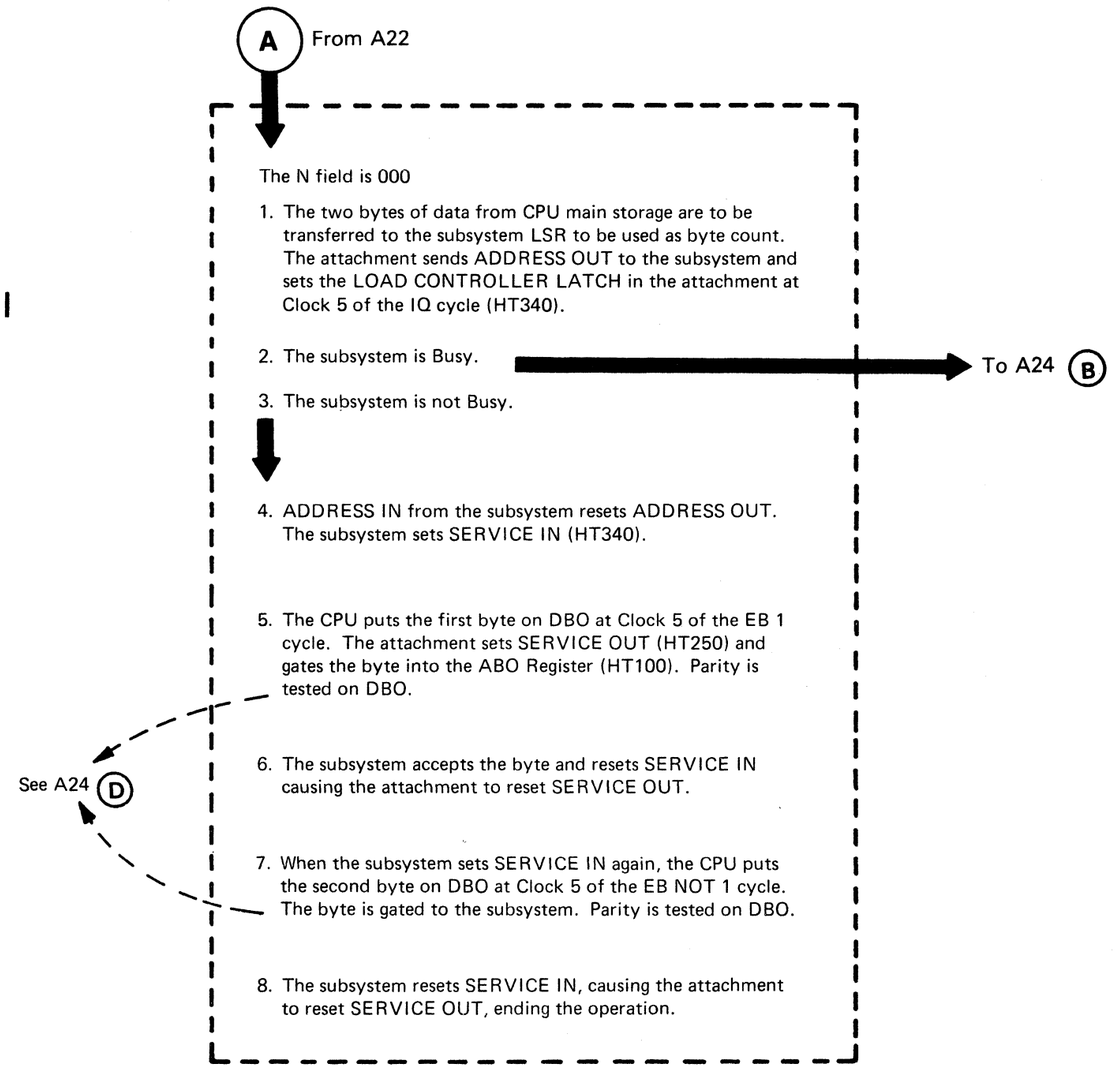
4. At Clock 5 of the EB NOT 1 cycle the second byte is placed on DBO and gated to the subsystem. DBO parity is tested.

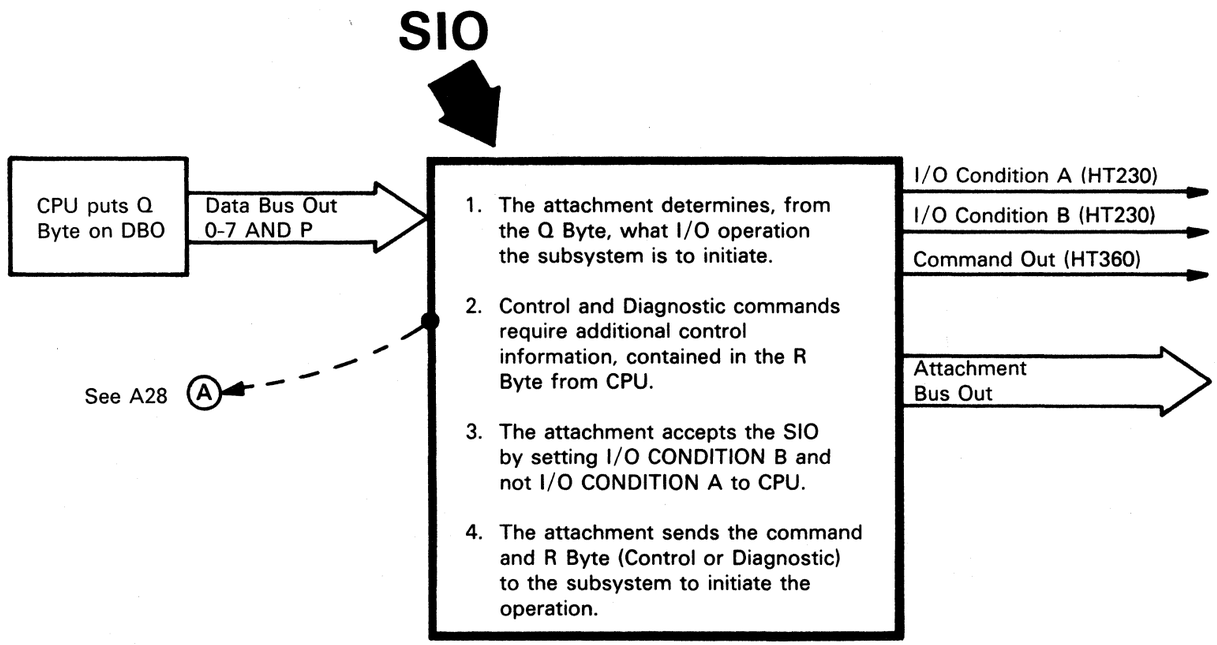


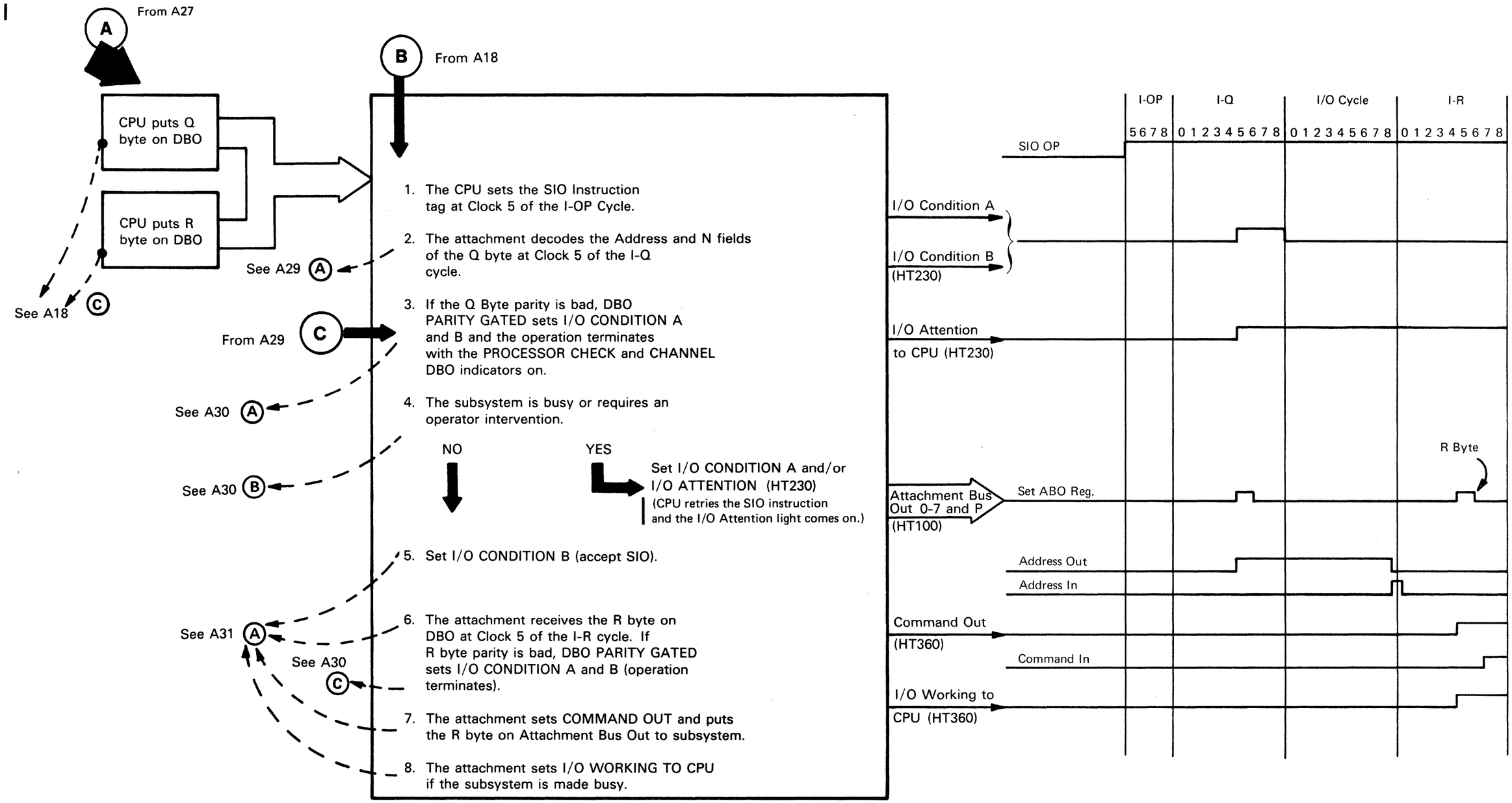

A
From A22
I DECODE ADDRESS (HT210)
1. If DBO 0-2 = 011, the attachment sets DEVICE ADDRESSED (Subsystem addressed).
2. The attachment decodes DBO 3 and 4 for tape unit address.
DBO Latches 0,1,2,3, and 4
I-Q Cycle AND Clock 5
00 Device Address 0
01 Device Address 1
10 Device Address 2
11 Device Address 3
Device Addressed Latch
I-OP
I-Q
EB-1
EB NOT 1
5 6 7 8
0 1 2 3 4 5 6 7 8
DBO Latches 5,6, and 7
II DECODE N FIELD (HT230)
1. DBO 5, 6, and 7 = 000 - Data from CPU is byte count. The attachment sets LOAD CONTROLLER to send data to subsystem.
2. DBO 5, 6, and 7 = 100 - Data from CPU is Data Address. The attachment sets LSR SELECT 5 and 7 to store data in CPU LSR.
To A22 C
Invalid Command (HT320)
3. DBO 6 or 7 on - Set INVALID COMMAND (HT340).
To A24 C

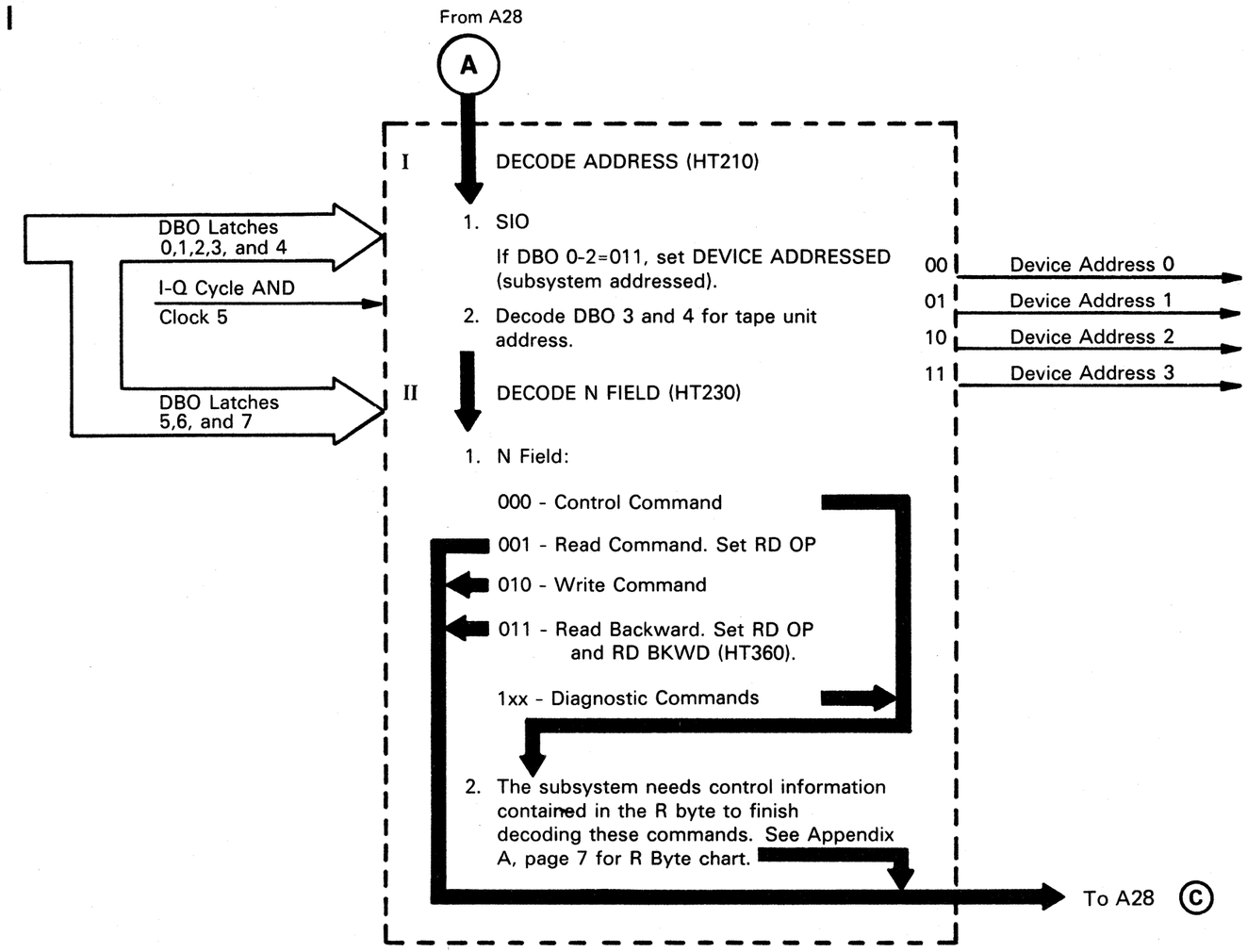

A
From A22
DBO Parity Gated
(HT230)
1. The attachment sets I/O CONDITION A and B if if the Q byte has even parity on DBO. Tested at Clock 5 of the I-Q cycle.
To A22
C
From A22, A26
(BUSY)
B
Set Adapter Latches
(HT320)
1. The attachment sets I/O CONDITION A if the subsystem is busy. LIO cannot be accepted so CPU must retry. Set I/O CONDITION B if subsystem is not busy.
To A22
C
From A23
C
Invalid Command
(HT340)
1. Neither I/O CONDITION is set when the command is invalid.
To A22
C
From A22, A26
(PARITY)
D
1. The Attachment sets I/O CONDITION A and B if either data byte has even parity on DBO. Tested at Clock 5 of EB 1 and EB NOT 1 cycles.
To A22
C
IOP
5 6 7 8
I-Q
0 1 2 3 4 5 6 7 8
EB-1
0 1 2 3 4 5 6 7 8
EB Not 1
0 1 2 3 4 5 6 7 8

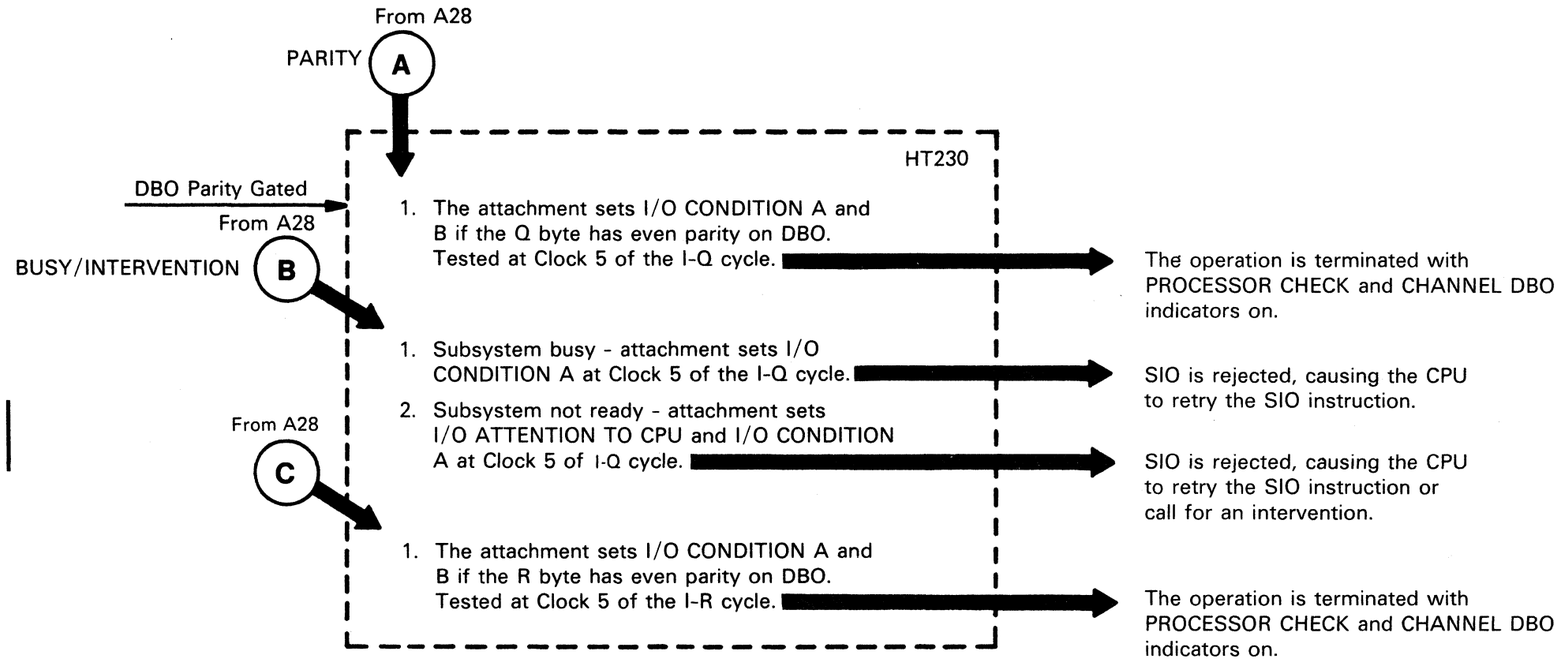

A
From A22
HT340
The N field is 100
1. The two bytes of data from CPU main storage are to be stored in CPU LSR Magnetic Tape Data Address Register (MTDAR). The attachment sets the LSR SELECT LATCH.
2. The attachment sets LSR SELECT 5 and LSR SELECT 7 at Clock 2 of the EB 1 cycle, causing CPU to store the first byte of data in the low half of the MTDAR. CPU blocks SAMPLE DBO so no parity test is made.
3. The attachment sets LSR SELECT 5 and LSR SELECT 7 at Clock 2 of the EB NOT 1 cycle, causing CPU to store the second byte of data in the high half of the MTDAR. CPU blocks SAMPLE DBO so no parity test is made.
LSR Select 5 (HT340)
(To CPU WT215)
LSR Select 7 (HT340)
(To CPU (WT215)
Selects MTDAR
End of Operation

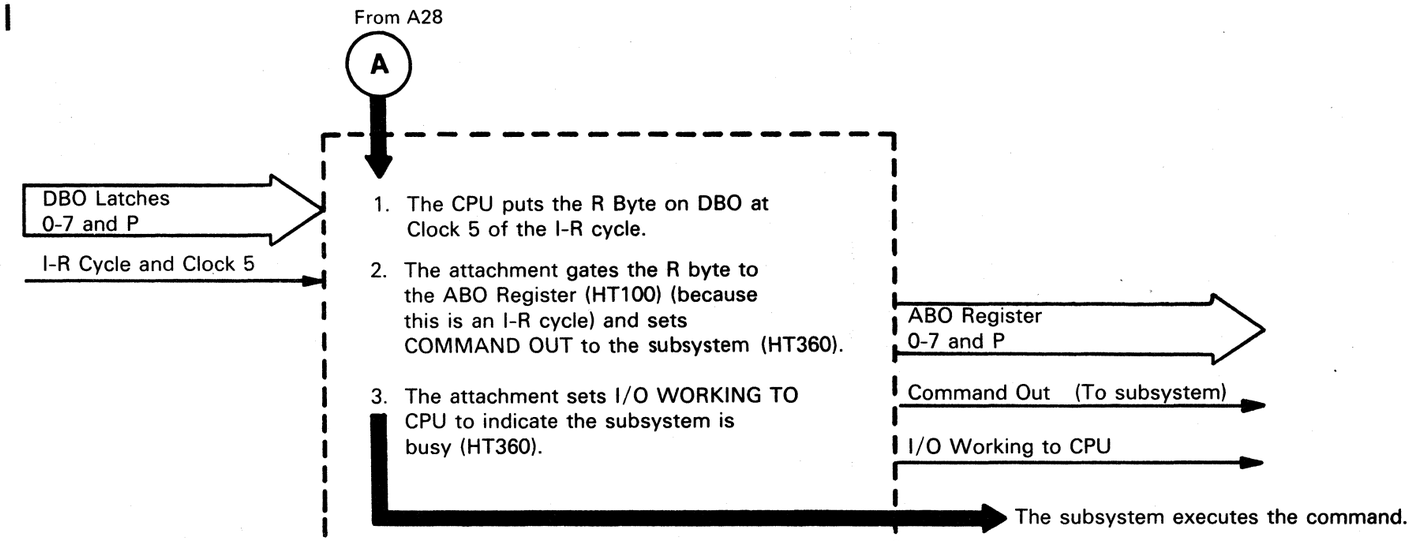

A
From A22
The N field is 000
1. The two bytes of data from CPU main storage are to be transferred to the subsystem LSR to be used as byte count. The attachment sends ADDRESS OUT to the subsystem and sets the LOAD CONTROLLER LATCH in the attachment at Clock 5 of the IQ cycle (HT340).
2. The subsystem is Busy.
To A24 B
3. The subsystem is not Busy.
4. ADDRESS IN from the subsystem resets ADDRESS OUT. The subsystem sets SERVICE IN (HT340).
5. The CPU puts the first byte on DBO at Clock 5 of the EB 1 cycle. The attachment sets SERVICE OUT (HT250) and gates the byte into the ABO Register (HT100). Parity is tested on DBO.
See A24 D
6. The subsystem accepts the byte and resets SERVICE IN causing the attachment to reset SERVICE OUT.
7. When the subsystem sets SERVICE IN again, the CPU puts the second byte on DBO at Clock 5 of the EB NOT 1 cycle. The byte is gated to the subsystem. Parity is tested on DBO.
8. The subsystem resets SERVICE IN, causing the attachment to reset SERVICE OUT, ending the operation.


SIO
CPU puts Q Byte on DBO
Data Bus Out 0-7 AND P
1. The attachment determines, from the Q Byte, what I/O operation the subsystem is to initiate.
2. Control and Diagnostic commands require additional control information, contained in the R Byte from CPU.
3. The attachment accepts the SIO by setting I/O CONDITION B and not I/O CONDITION A to CPU.
4. The attachment sends the command and R Byte (Control or Diagnostic) to the subsystem to initiate the operation.
I/O Condition A (HT230)
I/O Condition B (HT230)
Command Out (HT360)
Attachment Bus Out
See A28
A


From A27
A
B
From A18
CPU puts Q byte on DBO
CPU puts R byte on DBO
See A18
C
See A29
A
From A29
C
See A30
A
See A30
B
See A31
A
See A30
C
1. The CPU sets the SIO Instruction tag at Clock 5 of the I-OP Cycle.
2. The attachment decodes the Address and N fields of the Q byte at Clock 5 of the I-Q cycle.
3. If the Q Byte parity is bad, DBO PARITY GATED sets I/O CONDITION A and B and the operation terminates with the PROCESSOR CHECK and CHANNEL DBO indicators on.
4. The subsystem is busy or requires an operator intervention.
NO
YES
Set I/O CONDITION A and/or I/O ATTENTION (HT230)
(CPU retries the SIO instruction and the I/O Attention light comes on.)
5. Set I/O CONDITION B (accept SIO).
6. The attachment receives the R byte on DBO at Clock 5 of the I-R cycle. If R byte parity is bad, DBO PARITY GATED sets I/O CONDITION A and B (operation terminates).
7. The attachment sets COMMAND OUT and puts the R byte on Attachment Bus Out to subsystem.
8. The attachment sets I/O WORKING TO CPU if the subsystem is made busy.
I-OP
I-Q
I/O Cycle
I-R
5 6 7 8
0 1 2 3 4 5 6 7 8
0 1 2 3 4 5 6 7 8
0 1 2 3 4 5 6 7 8
SIO OP
I/O Condition A
I/O Condition B
(HT230)
I/O Attention
to CPU (HT230)
R Byte
Attachment Bus Out 0-7 and P
(HT100)
Set ABO Reg.
Address Out
Address In
Command Out
(HT360)
Command In
I/O Working to
CPU (HT360)

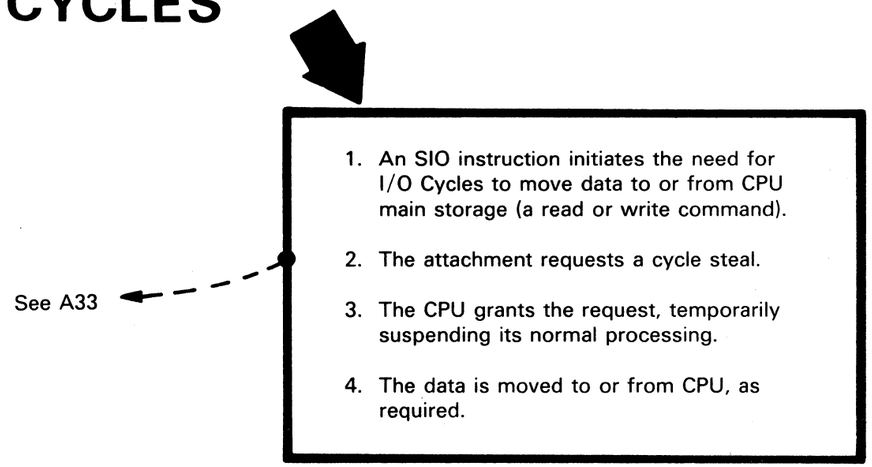

From A28
A
I
DECODE ADDRESS (HT210)
DBO Latches 0,1,2,3, and 4
I-Q Cycle AND Clock 5
1. SIO
If DBO 0-2=011, set DEVICE ADDRESSED (subsystem addressed).
2. Decode DBO 3 and 4 for tape unit address.
00 Device Address 0
01 Device Address 1
10 Device Address 2
11 Device Address 3
DBO Latches 5,6, and 7
II
DECODE N FIELD (HT230)
1. N Field:
000 - Control Command
001 - Read Command. Set RD OP
010 - Write Command
011 - Read Backward. Set RD OP and RD BKWD (HT360).
1xx - Diagnostic Commands
2. The subsystem needs control information contained in the R byte to finish decoding these commands. See Appendix A, page 7 for R Byte chart.
To A28
C

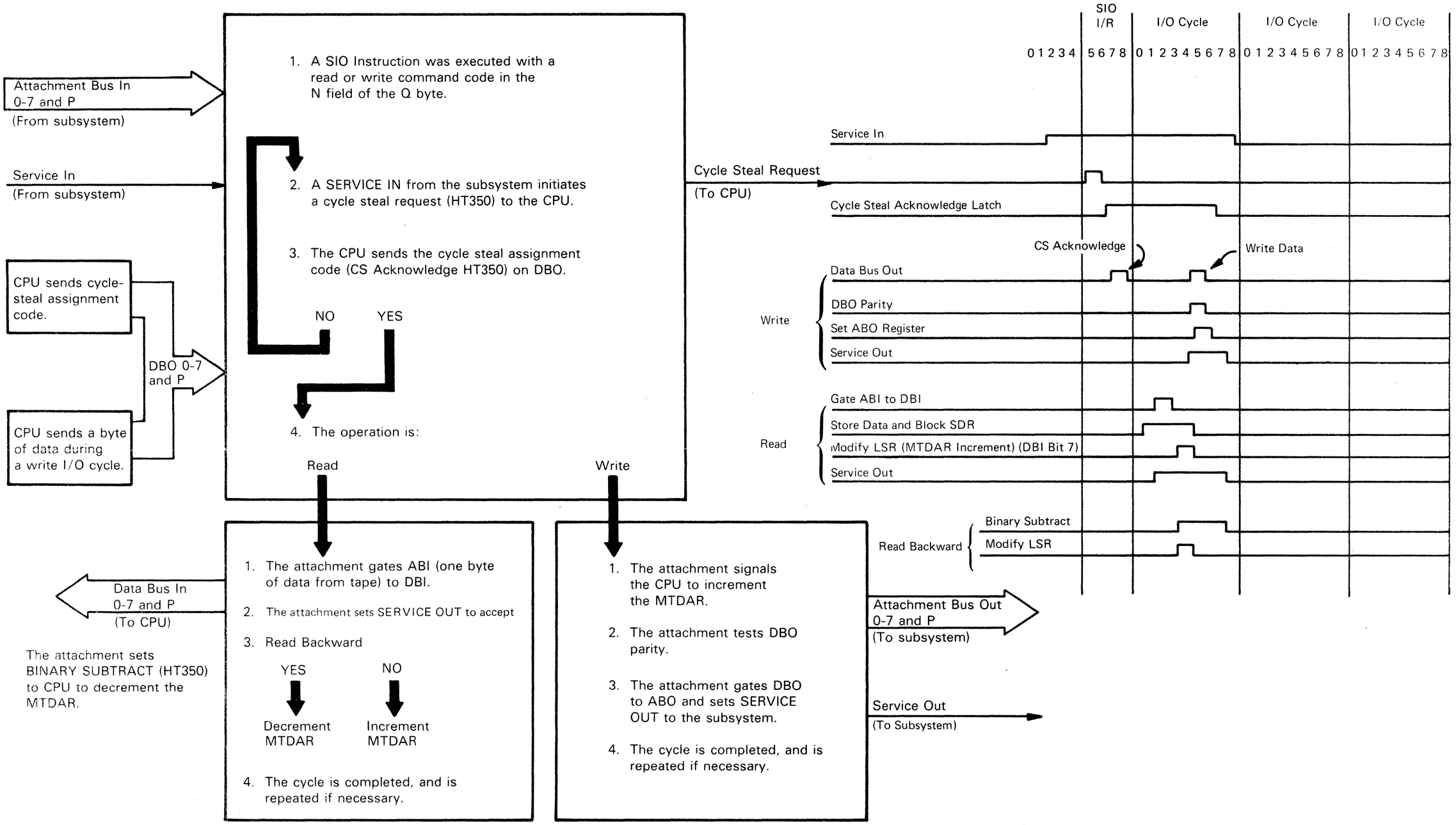

From A28
PARITY
A
HT230
DBO Parity Gated
From A28
BUSY/INTERVENTION
B
1. The attachment sets I/O CONDITION A and B if the Q byte has even parity on DBO. Tested at Clock 5 of the I-Q cycle.
The operation is terminated with PROCESSOR CHECK and CHANNEL DBO indicators on.
1. Subsystem busy - attachment sets I/O CONDITION A at Clock 5 of the I-Q cycle.
SIO is rejected, causing the CPU to retry the SIO instruction.
From A28
C
2. Subsystem not ready - attachment sets I/O ATTENTION TO CPU and I/O CONDITION A at Clock 5 of I-Q cycle.
SIO is rejected, causing the CPU to retry the SIO instruction or call for an intervention.
1. The attachment sets I/O CONDITION A and B if the R byte has even parity on DBO. Tested at Clock 5 of the I-R cycle.
The operation is terminated with PROCESSOR CHECK and CHANNEL DBO indicators on.



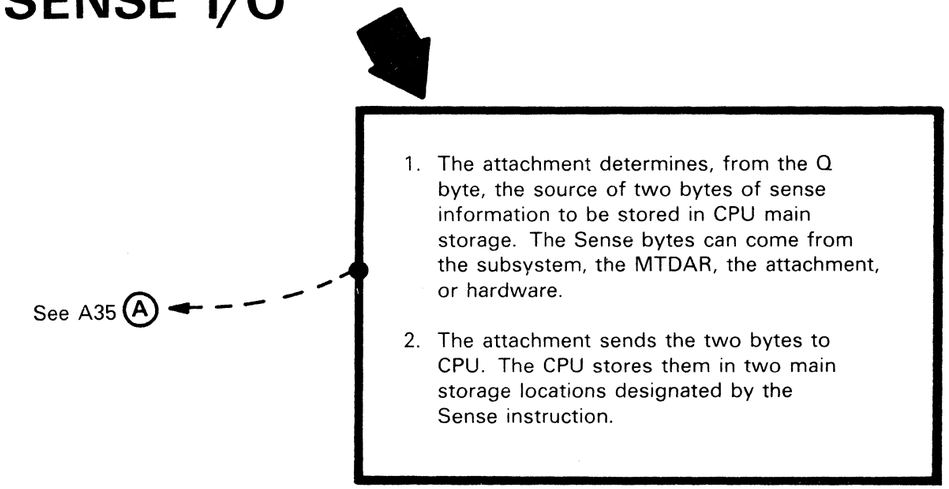
NOTES:
1. During a read or write operation the subsystem ignores the R byte.

I/O CYCLES


1. An SIO instruction initiates the need for I/O Cycles to move data to or from CPU main storage (a read or write command).
2. The attachment requests a cycle steal.
3. The CPU grants the request, temporarily suspending its normal processing.
4. The data is moved to or from CPU, as required.
See A33


Attachment Bus In 0-7 and P
(From subsystem)
Service In
(From subsystem)
CPU sends cycle-steal assignment code.
CPU sends a byte of data during a write I/O cycle.
DBO 0-7 and P
1. A SIO Instruction was executed with a read or write command code in the N field of the Q byte.
2. A SERVICE IN from the subsystem initiates a cycle steal request (HT350) to the CPU.
3. The CPU sends the cycle steal assignment code (CS Acknowledge HT350) on DBO.
NO
YES
4. The operation is:
Read
Write
1. The attachment gates ABI (one byte of data from tape) to DBI.
2. The attachment sets SERVICE OUT to accept
3. Read Backward
YES
NO
Decrement MTDAR
Increment MTDAR
4. The cycle is completed, and is repeated if necessary.
Data Bus In 0-7 and P
(To CPU)
The attachment sets BINARY SUBTRACT (HT350) to CPU to decrement the MTDAR.
1. The attachment signals the CPU to increment the MTDAR.
2. The attachment tests DBO parity.
3. The attachment gates DBO to ABO and sets SERVICE OUT to the subsystem.
4. The cycle is completed, and is repeated if necessary.
Cycle Steal Request
(To CPU)
SIO I/R
I/O Cycle
I/O Cycle
I/O Cycle
0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8
Service In
Cycle Steal Acknowledge Latch
CS Acknowledge
Write Data
Data Bus Out
Write
DBO Parity
Set ABO Register
Service Out
Gate ABI to DBI
Store Data and Block SDR
Read
Modify LSR (MTDAR Increment) (DBI Bit 7)
Service Out
Binary Subtract
Read Backward
Modify LSR
Attachment Bus Out 0-7 and P
(To subsystem)
Service Out
(To Subsystem)

SENSE I/O


1. The attachment determines, from the Q byte, the source of two bytes of sense information to be stored in CPU main storage. The Sense bytes can come from the subsystem, the MTDAR, the attachment, or hardware.
2. The attachment sends the two bytes to CPU. The CPU stores them in two main storage locations designated by the Sense instruction.
See A35 (A)

From A37

(A)

CPU puts Q Byte on DBO

DBO 0-7 and P

See A18 (D)

From A18

(B)

1. The Sense I/O tag is set at Clock 5 of the I-OP Cycle.

2. The attachment decodes address and N fields of the Q byte at Clock 5 of the I-Q cycle. The Q byte is gated to the subsystem on Attachment Bus Out.

See A36 (A)

3. If the Q byte parity is bad, DBO PARITY GATED sets I/O CONDITION A and B and the operation terminates with the PROCESSOR CHECK and CHANNEL DBO indicators on.

See A37

See A38 (A)

4. SUBSYSTEM SENSE

YES

5. An I/O cycle is taken to allow subsystem to assemble sense bytes. Send two bytes of subsystem sense data to CPU.

NO

See A39 (A)

6. MTDAR SENSE

YES

7. Send LSR Select to CPU.

NO

See A40 (A)

8. ATTACHMENT SENSE

YES

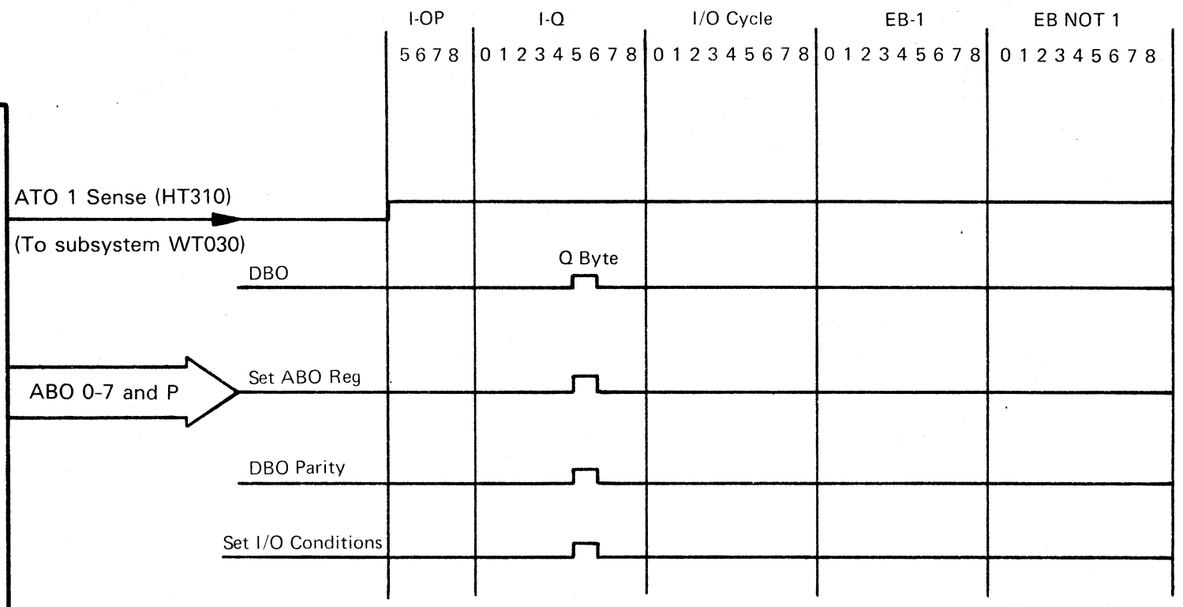
9. Attachment sends two bytes of attachment sense data to CPU.

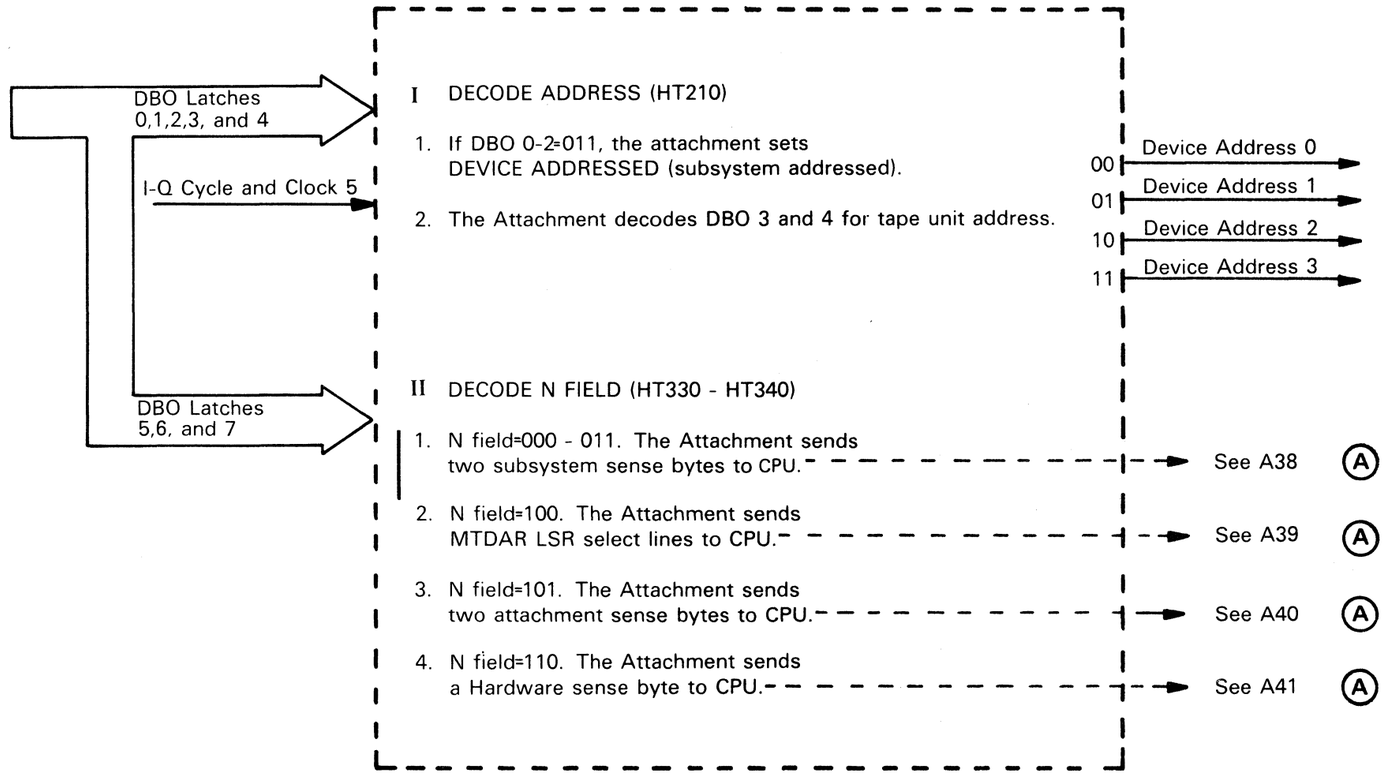
NO

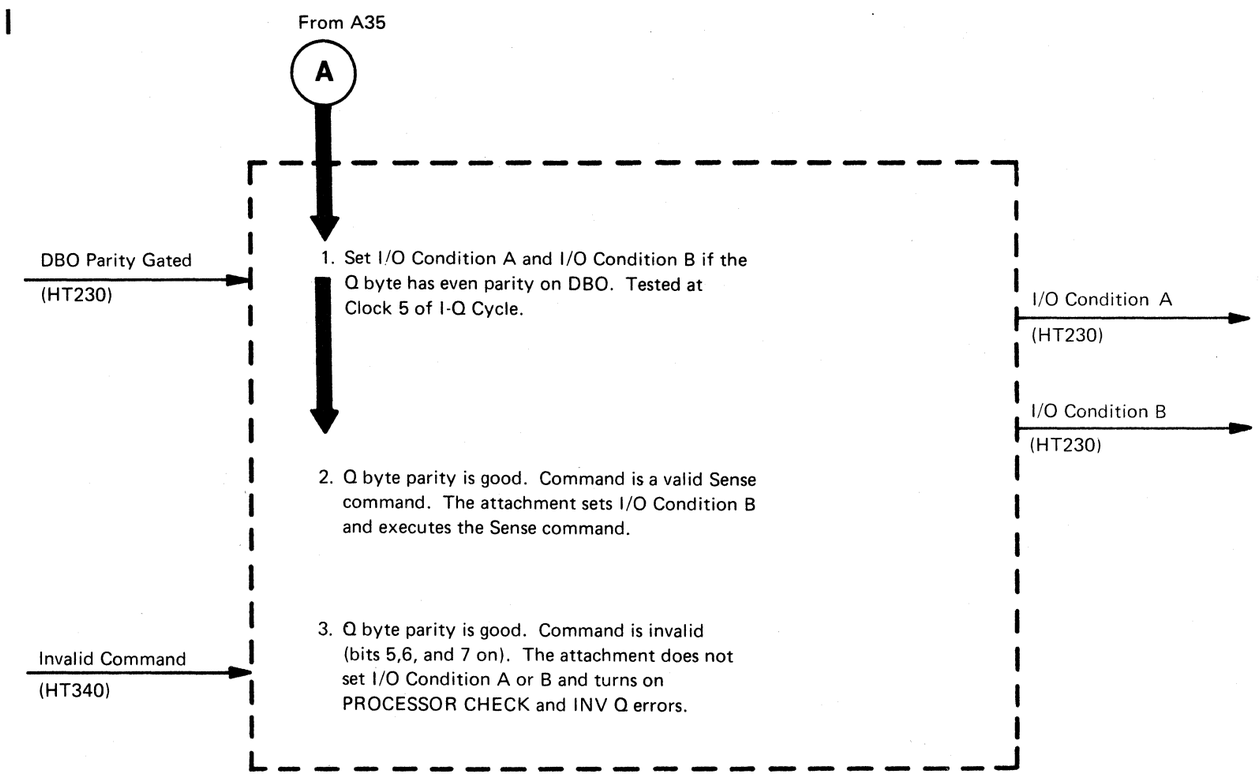
See A41 (A)

HARDWARE SENSE

10. Attachment sends one byte of sense data to CPU followed by one zero byte.




DBO Latches
0,1,2,3, and 4
I-Q Cycle and Clock 5
DBO Latches
5,6, and 7
I DECODE ADDRESS (HT210)
1. If DBO 0-2=011, the attachment sets DEVICE ADDRESSED (subsystem addressed).
2. The Attachment decodes DBO 3 and 4 for tape unit address.
00 Device Address 0
01 Device Address 1
10 Device Address 2
11 Device Address 3
II DECODE N FIELD (HT330 - HT340)
1. N field=000 - 011. The Attachment sends two subsystem sense bytes to CPU.
See A38
A
2. N field=100. The Attachment sends MTDAR LSR select lines to CPU.
See A39
A
3. N field=101. The Attachment sends two attachment sense bytes to CPU.
See A40
A
4. N field=110. The Attachment sends a Hardware sense byte to CPU.
See A41
A


From A35
A
DBO Parity Gated
(HT230)
1. Set I/O Condition A and I/O Condition B if the Q byte has even parity on DBO. Tested at Clock 5 of I-Q Cycle.
I/O Condition A
(HT230)
I/O Condition B
(HT230)
2. Q byte parity is good. Command is a valid Sense command. The attachment sets I/O Condition B and executes the Sense command.
3. Q byte parity is good. Command is invalid (bits 5,6, and 7 on). The attachment does not set I/O Condition A or B and turns on PROCESSOR CHECK and INV Q errors.
Invalid Command
(HT340)

From A35

A

1. The N field has bit 5 off indicating a subsystem sense. The attachment sets the CONTROLLER SENSE LATCH (HT330).

2. The attachment initiates a CYCLE STEAL REQUEST 7 (HT350) causing a dummy I/O cycle (channel is idle). The subsystem decodes the N field of the Q byte to determine which two sense bytes are requested (see Sense I/O, System/3 Flowchart) and assembles the bytes.

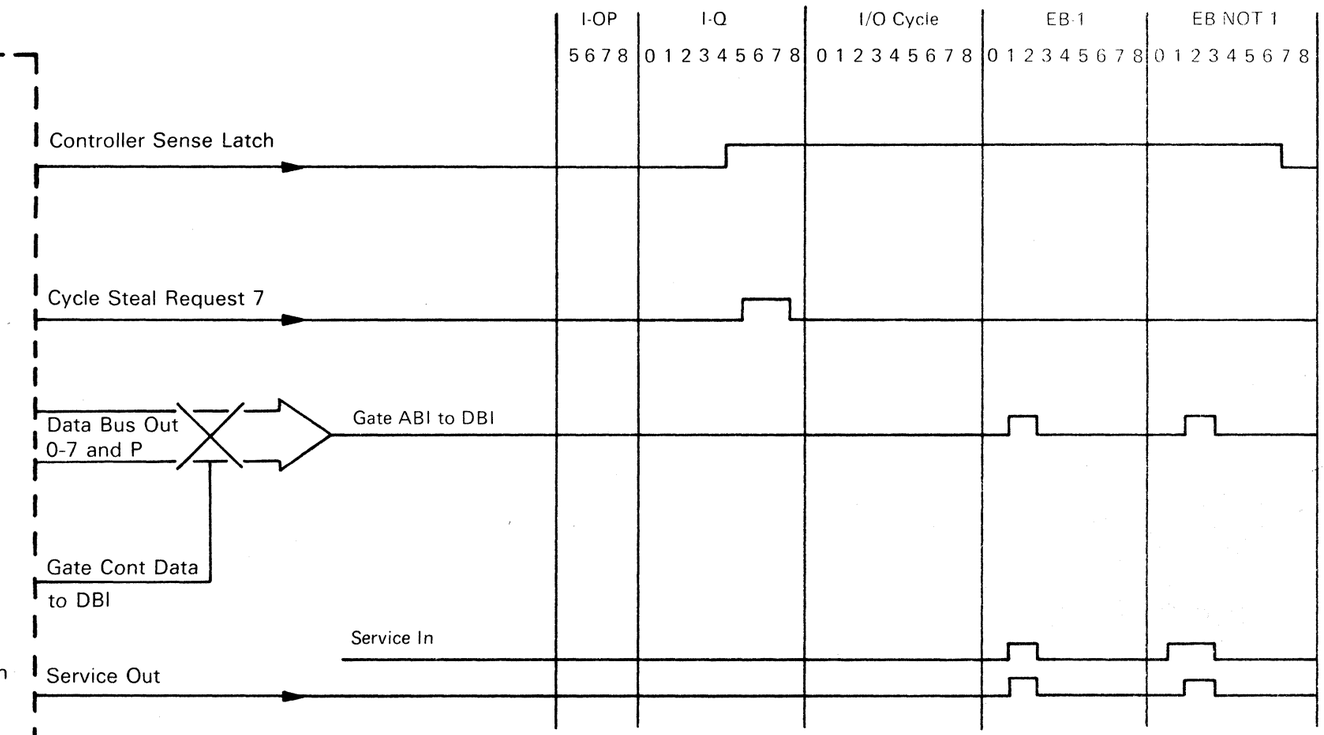
3. SERVICE IN (HT230—HT260) from the subsystem indicates the first byte is on ABI. The attachment gates ABI to DBI (GATE CONT DATA TO DBI - HT110) at Clock 2 of the EB 1 cycle.

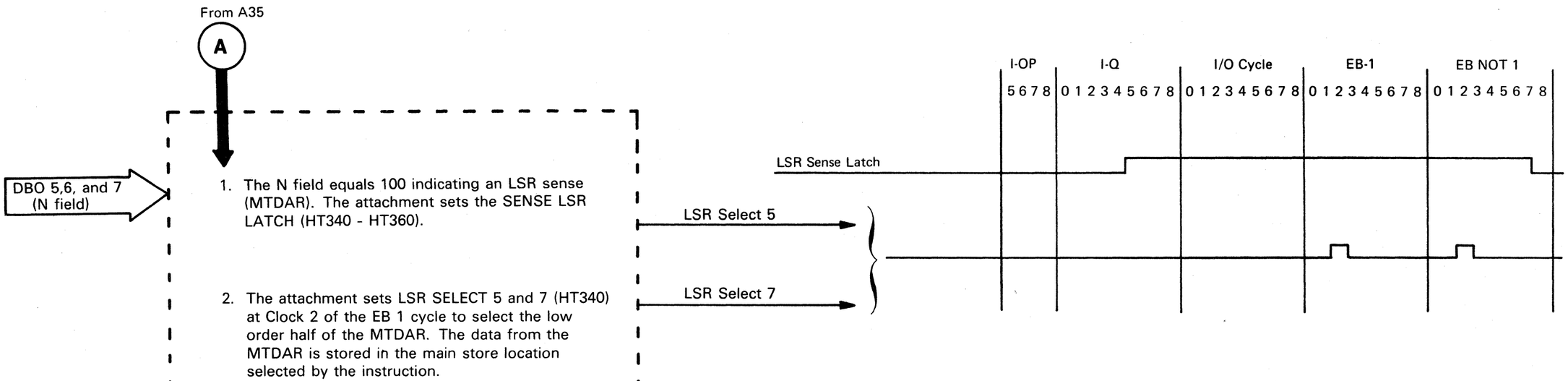
4. The attachment sets SERVICE OUT to the subsystem at Clock 3 of the EB 1 cycle, requesting the second sense byte.

5. SERVICE IN (HT230 - HT260) from the subsystem indicates the second byte is on ABI. The attachment gates ABI to DBI at Clock 2 of the EB NOT 1 cycle.

Attachment Bus In 0-7 and P

Service In




From A35
A
DBO 5,6, and 7
(N field)
1. The N field equals 100 indicating an LSR sense (MTDAR). The attachment sets the SENSE LSR LATCH (HT340 - HT360).
2. The attachment sets LSR SELECT 5 and 7 (HT340) at Clock 2 of the EB 1 cycle to select the low order half of the MTDAR. The data from the MTDAR is stored in the main store location selected by the instruction.
3. The attachment sets LSR SELECT 5 and 7 (HT340) at Clock 2 af the EB NOT 1 cycle to store the high order half of the MTDAR in main storage.
LSR Select 5
LSR Select 7
LSR Sense Latch
I-OP
I-Q
I/O Cycle
EB-1
EB NOT 1
5 6 7 8
0 1 2 3 4 5 6 7 8
0 1 2 3 4 5 6 7 8
0 1 2 3 4 5 6 7 8
0 1 2 3 4 5 6 7 8

From A35

A

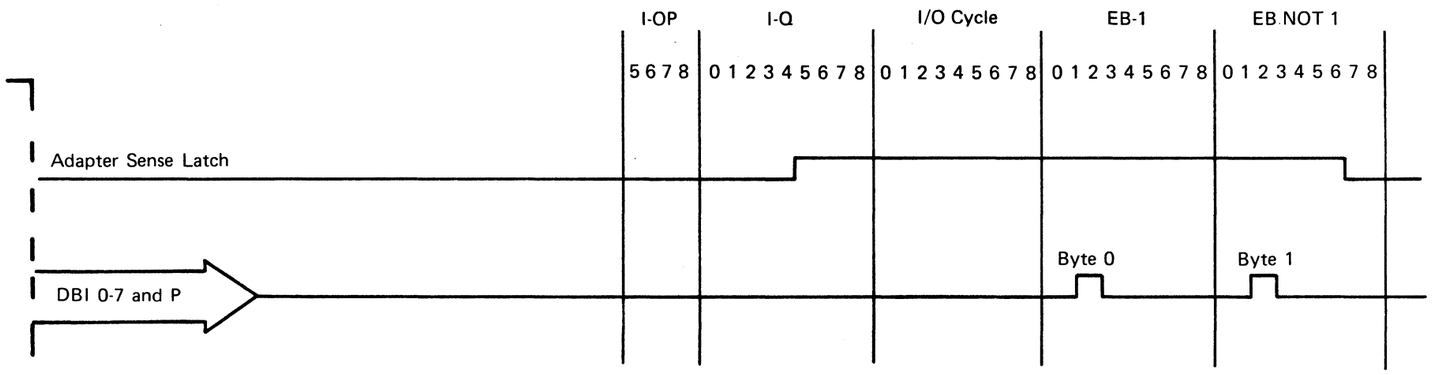
1. The N field equals 101 indicating an attachment sense. The attachment sets the ADAPTER SENSE LATCH (HT330) at Clock 5 of the I-Q cycle.

2. The attachment puts sense byte 0 on DBI at Clock 2 of the EB 1 cycle (GATE SENSE BYTE 0 - HT110).

3. The attachment puts sense byte 1 on DBI at Clock 2 af the EB NOT 1 cycle (GATE SENSE BYTE 1 - HT110).

ABI 0-7 and P

DBI 0-7 and P



NOTES:		
Sense Byte 0	Sense Byte 1	DBO Bits
	Address out of Sequence	0
ABI Parity	Service Out of Sequence	1
ABO Parity	Command out of Sequence	2
Controller Disabled	Address In Error	3
Two Tags Error	Service In Error	4
I/O Working Gated	Command In Error	5
Sequence Error	Status In Error	6
(Not used)	(Not used)	7

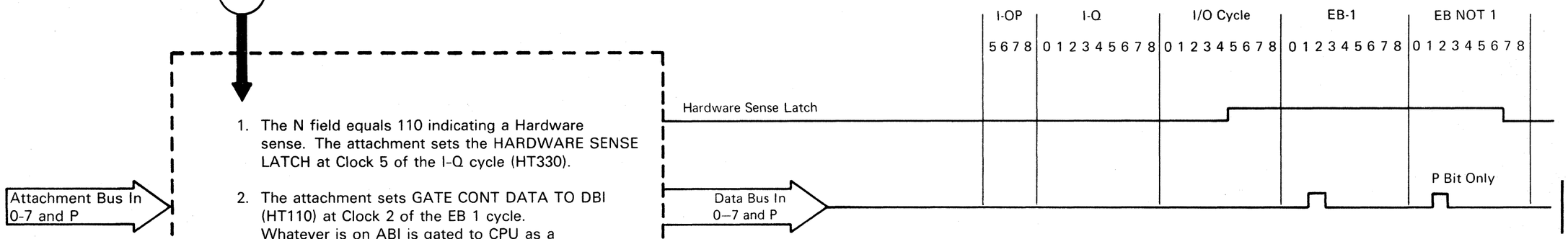
From A35

A

1. The N field equals 110 indicating a Hardware sense. The attachment sets the HARDWARE SENSE LATCH at Clock 5 of the I-Q cycle (HT330).

2. The attachment sets GATE CONT DATA TO DBI (HT110) at Clock 2 of the EB 1 cycle. Whatever is on ABI is gated to CPU as a sense byte (HT140).

3. GATE CONT DATA is inactive during the EB NOT 1 cycle causing a byte of zeros to be sent to CPU.



NOTE:

A Hardware Sense operation stores the state of the Attachment Bus In at the time of the error.

System/360/370 Attachment

The System/360/370 magnetic tape attachment for all models, except the 370-125, is located in the 3411. The purpose of the attachment is to adapt the subsystem interface to the CPU channel interface. The attachment interprets the signals between the system and subsystem. The attachment also handles data during read, write, and sense operations, and holds tape unit status until it is needed by the CPU.

Instructions Causing Data Flow

There are three I/O instructions which cause data flow between the system and subsystem, through the attachment.

Start I/O (SIO): A Start I/O Instruction initiates burst commands, non-motion control commands, or motion control commands in the subsystem. Burst commands transfer information across the channel/tape control interface. Channel end and device end are signaled when the burst operation is completed. Non-motion control commands do not move tape and do not transfer information across the channel/tape control interface. Channel end and device end are signaled when non-motion control commands are accepted. Motion control commands move tape but do not transfer information across the channel/tape control interface. Status varies for different motion control commands.

Test I/O (TIO): This instruction causes the tape control to send the selected tape unit's status byte to the channel for analysis. If the selected tape unit is available, the status byte is all zeros. If status is pending or stacked for a device other than the one being addressed, the subsystem responds with a control unit busy sequence. If no status is stacked, and if the addressed device is not ready, Unit Check is set in the unit status byte. If the addressed tape unit is rewinding, BUSY is set in the status byte.

Halt I/O (HIO): This instruction stops data transfer (interface disconnect). The tape control disconnects from the channel and completes the operation in progress. When the operation is completed, the tape control tries to reestablish connection with the channel to transfer ending status. If an interface disconnect becomes effective before initial selection is complete, no operation is performed. If addressed after a Halt I/O is issued and the tape control is completing an operation, the tape control appears busy. If a Halt I/O is executed before transfer of the first data byte during a write operation, the operation is canceled, and channel end, device end, unit check, and word count zero are set.

Inputs to Attachment from System

Bus Out: The bus out lines are used to transmit addresses, commands, control orders, and data to the control units. The outbound tag lines indicate the type of information transmitted over bus out.

Attachment Tags Out: The attachment converts the System 360/370 interface signals and puts them on Attachment Tags Out Bus for use by the tape control.

Operational Out: OPERATIONAL OUT is a line from the channel to all attached control units and is used for interlocking purposes. Except for SUPPRESS OUT, all lines from the channel are significant only when OPERATIONAL OUT is active.

Address Out: ADDRESS OUT is a tag line from the channel to all attached control units. It provides two functions:

1. I/O Device Selection: ADDRESS OUT signals all the control units to decode the I/O device address on BUS OUT.
2. Disconnect operation: If HOLD OUT is down and ADDRESS OUT rises, or ADDRESS OUT is active and HOLD OUT drops, the presently connected control unit must drop its OPERATIONAL IN, thus disconnecting from the interface. ADDRESS OUT remains active until OPERATIONAL IN drops.

Select Out/Hold Out and Select In: SELECT OUT, SELECT IN, and HOLD OUT control selection of the tape control. SELECT OUT and SELECT IN form a loop from the channel through each control unit to the cable terminator block (SELECT OUT), again through each control unit back to the channel (SELECT IN).

Command Out: COMMAND OUT is a tag line from the channel to all attached control units and is used to signal the selected I/O device in response to ADDRESS IN, STATUS IN or SERVICE IN. COMMAND OUT as a response to ADDRESS IN during the initial-selection sequence indicates to the selected I/O device that the channel has placed a command byte on BUS OUT. COMMAND OUT in response to STATUS IN means stack. COMMAND OUT in response to SERVICE IN always means stop. COMMAND OUT must stay up until the fall of the associated ADDRESS IN, STATUS IN, or SERVICE IN.

Service Out: SERVICE OUT is a tag line from the channel to all attached control units and signals the selected I/O device in recognition of a signal on SERVICE IN or STATUS IN.

Suppress Out: SUPPRESS OUT is a line from the channel to all attached control units and is used both alone and in conjunction with the out-tag lines to provide the following special functions: suppress data, suppress status, command chaining, and selective reset.

Clock Out: CLOCK OUT is a line from the channel to all attached control units and provides the CPU interlock control necessary for changing the enable/disable states of the units (signal must be down to permit changing states).

Metering Out: METERING OUT is a line from the channel to all attached control units and conditions all other meters in assignable units and I/O units.

Outputs from Attachment to System/360/370

The three I/O commands cause data flow from the subsystem, through the attachment to the system. The data read by the tape unit and the sense bytes are transmitted through the Data Bus In Register to the Bus In (DBI P,0-7).

Bus In: BUS IN is used to transmit addresses, status, sense information, and data to the channel. A control unit can place and maintain information on BUS IN only when its OPERATIONAL IN is active.

The type of information transmitted over BUS IN is indicated by the inbound tag lines.

Request In: REQUEST IN is a line from all attached I/O control units to the channel and indicates that the control unit is ready to present status information or data and is therefore requesting a selection sequence.

Operational In: OPERATIONAL IN is a line from all attached control units to the channel, and signals the channel that an I/O device has been selected. It must stay up for the duration of the selection. The selected I/O device is identified by the address byte transmitted over BUS IN.

Address In: ADDRESS IN is a tag line from all attached control units to the channel and signals the channel when the address of the currently selected I/O device has been placed on BUS IN. The channel responds to ADDRESS IN by COMMAND OUT.

Status In: STATUS IN is a tag line from all attached control units to the channel and signals the channel when the selected control unit has placed status information on BUS IN.

Service In: SERVICE IN is a tag line from all attached control units to the channel and signals to the channel when the selected I/O device wants to transmit or receive a byte of information.

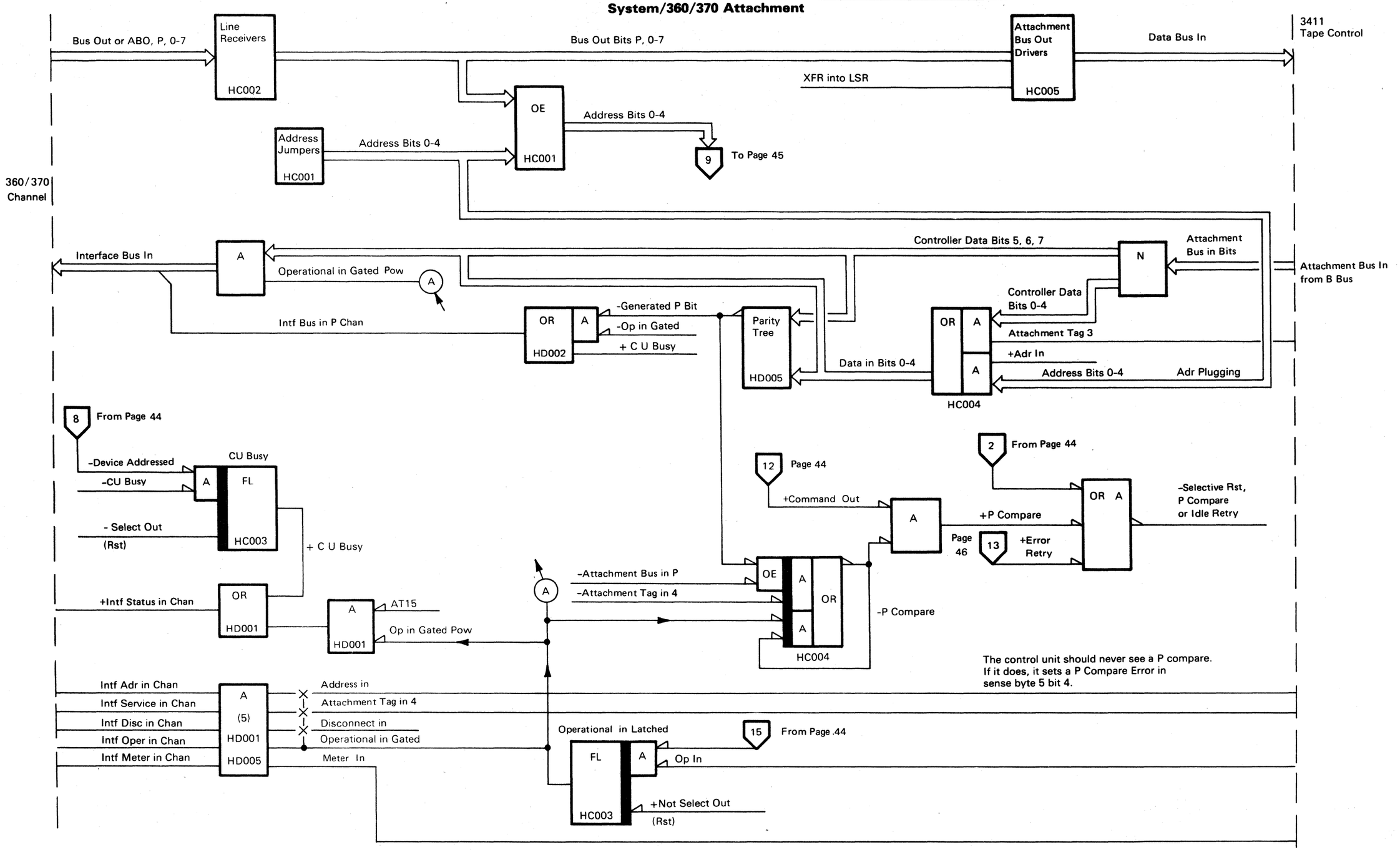
Metering In: METERING IN is a line from all attached control units and conditions the CPU meter for operation.

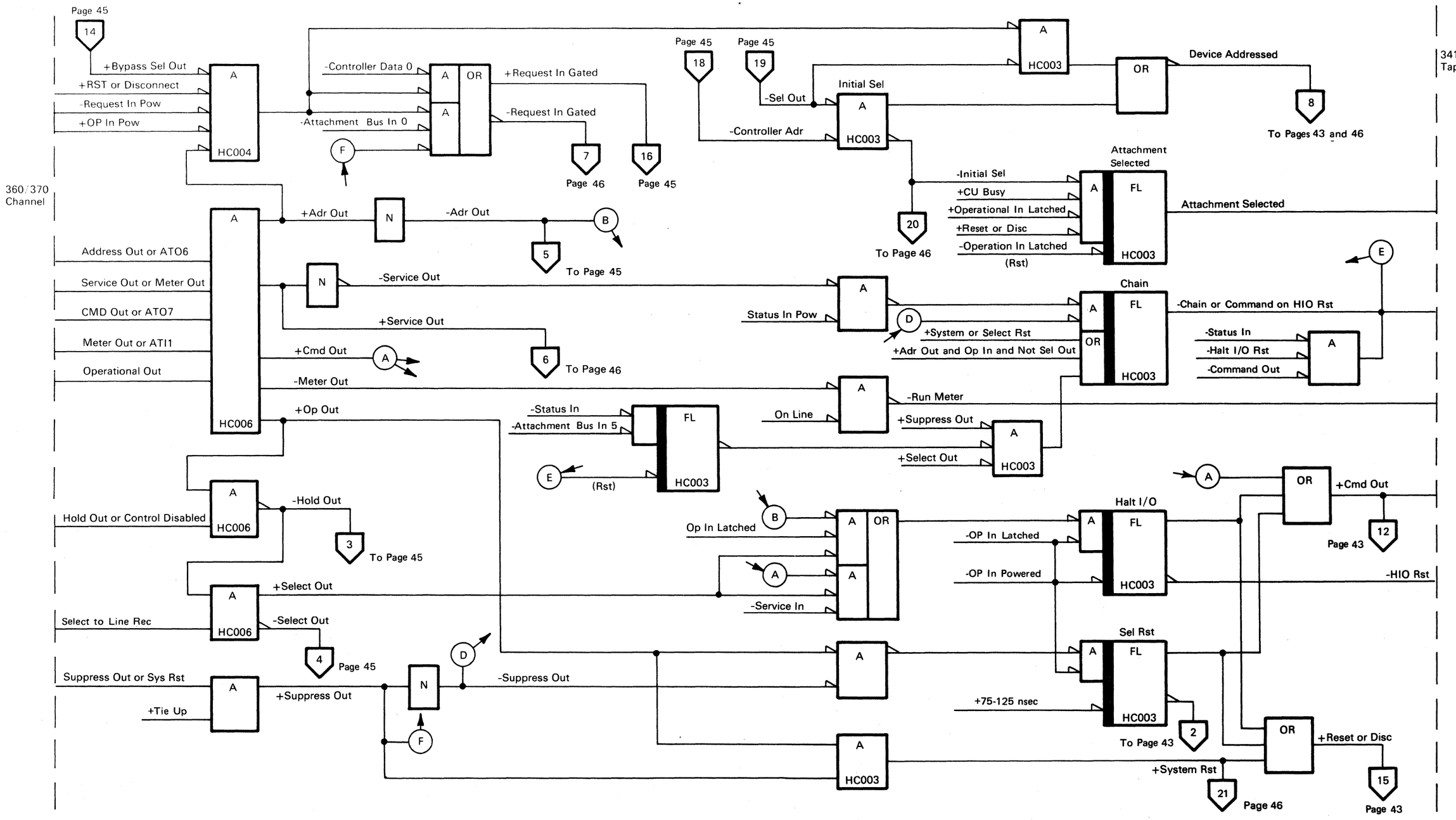
ATTACHMENT TAG IN (ATI) and ATTACHMENT TAG OUT (ATO) are 3411 line names which are converted to System/360/370 line names and functions by the 360/370 attachment.

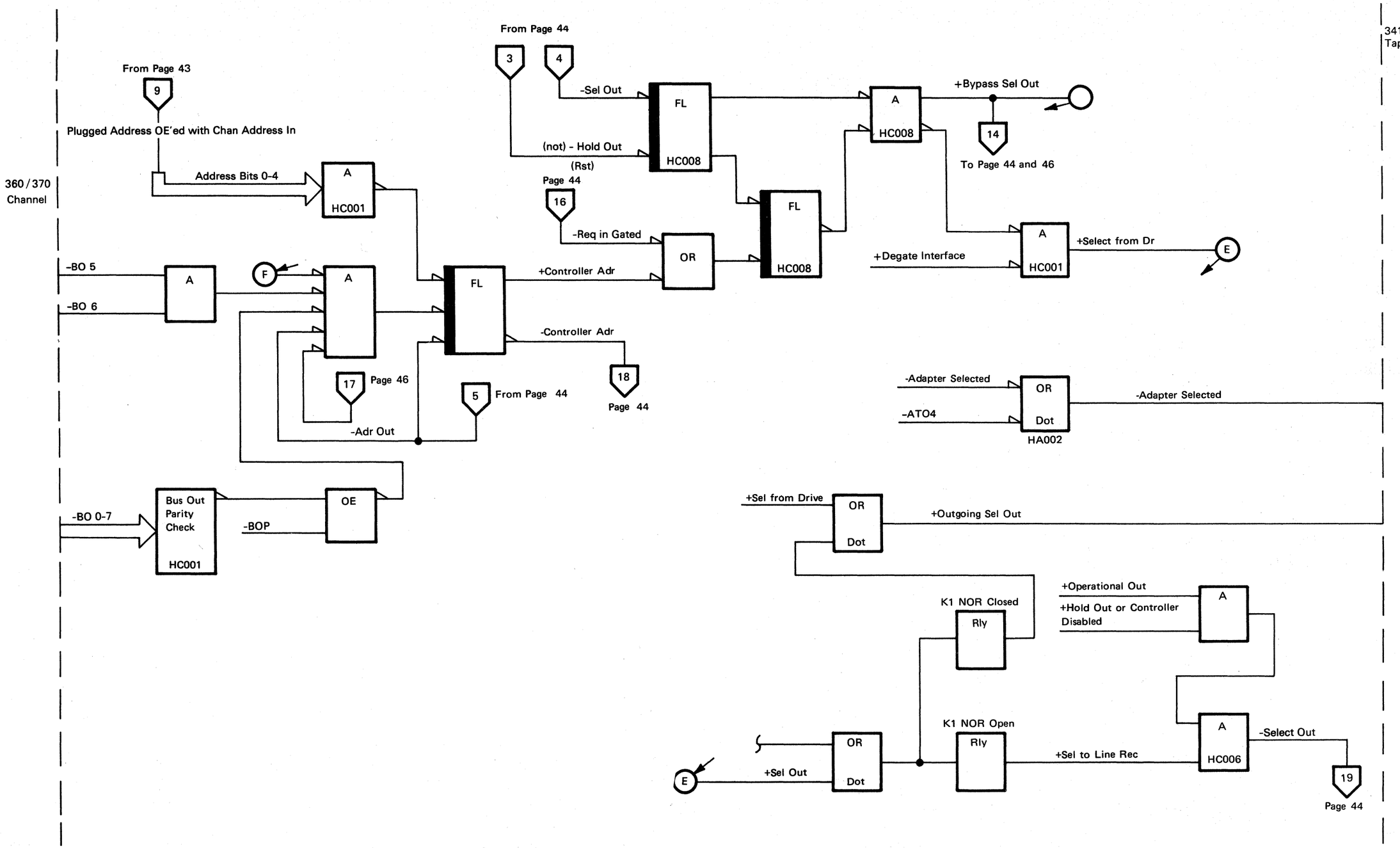
In Tags 3411	360/370 Chan
ATI0	Meter In
ATI1	Address In
ATI2	C U Busy
ATI3	Operational In
ATI4	Service In
ATI5	Status In
ATI6	Disconnect In
ATI7	Request In

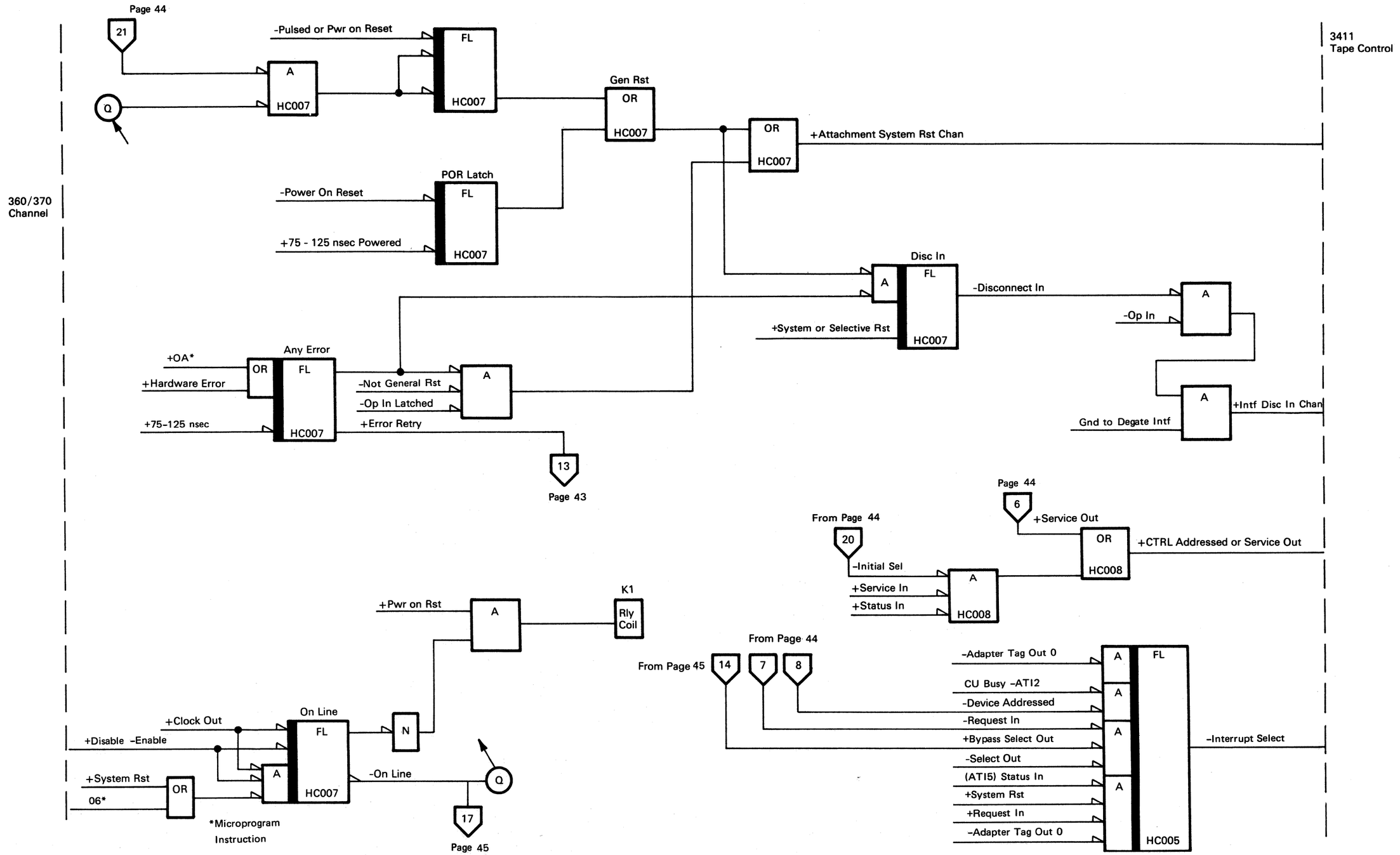
Out Tags 3411	360/370
ATO0	Interrupt Select
ATO1	Halt I/O Reset
ATO2	Suppress Out
ATO3	Chain or Command on HIO
ATO4	Adapter Selected
ATO5	Command Out
ATO6	Ctrl Addressed or Service Out
ATO7	Select Reset or P Compare

System/360/370 Attachment




3411
Tape Control
360/370
Channel
Page 45
14
+Bypass Sel Out
+RST or Disconnect
-Request In Pow
+OP In Pow
HC004
-Controller Data 0
-Attachment Bus In 0
+Request In Gated
-Request In Gated
F
7
Page 46
16
Page 45
Page 45
18
Page 45
19
-Sel Out
Initial Sel
-Controller Adr
HC003
OR
Device Addressed
8
To Pages 43 and 46
20
To Page 46
Attachment
Selected
-Initial Sel
+CU Busy
+Operational In Latched
+Reset or Disc
-Operation In Latched
(Rst)
FL
HC003
Attachment Selected
+Adr Out
N
-Adr Out
B
5
To Page 45
Address Out or ATO6
Service Out or Meter Out
CMD Out or ATO7
Meter Out or ATI1
Operational Out
HC006
-Service Out
+Service Out
+Cmd Out
A
6
To Page 46
-Meter Out
+Op Out
Status In Pow
D
+System or Select Rst
+Adr Out and Op In and Not Sel Out
Chain
-Chain or Command on HIO Rst
E
-Status In
-Halt I/O Rst
-Command Out
-Run Meter
On Line
+Suppress Out
+Select Out
-Status In
-Attachment Bus In 5
(Rst)
Hold Out or Control Disabled
-Hold Out
3
To Page 45
Op In Latched
-Service In
B
-OP In Latched
-OP In Powered
Halt I/O
-HIO Rst
Page 43
12
+Cmd Out
Select to Line Rec
+Select Out
-Select Out
4
Page 45
Suppress Out or Sys Rst
+Tie Up
+Suppress Out
-Suppress Out
Sel Rst
+75-125 nsec
To Page 43
2
+System Rst
21
Page 46
+Reset or Disc
15
Page 43


360/370 Channel
3411 Tape Control
From Page 43
9
Plugged Address OE'ed with Chan Address In
Address Bits 0-4
A HC001
From Page 44
3
4
-Sel Out
(not) - Hold Out
(Rst)
FL HC008
A HC008
+Bypass Sel Out
14
To Page 44 and 46
Page 44
16
-Req in Gated
OR
FL HC008
+Degate Interface
A HC001
+Select from Dr
E
-BO 5
-BO 6
A
F
A
FL
+Controller Adr
-Controller Adr
17
Page 46
-Adr Out
5
From Page 44
18
Page 44
-Adapter Selected
-ATO4
OR Dot HA002
-Adapter Selected
Bus Out Parity Check HC001
-BO 0-7
-BOP
OE
+Sel from Drive
OR Dot
+Outgoing Sel Out
K1 NOR Closed
Rly
+Operational Out
+Hold Out or Controller Disabled
A
K1 NOR Open
Rly
A HC006
-Select Out
E
+Sel Out
OR Dot
+Sel to Line Rec
19
Page 44


360/370
Channel
3411
Tape Control
Page 44
21
-Pulsed or Pwr on Reset
A
HC007
FL
HC007
Q
Gen Rst
OR
HC007
OR
HC007
+Attachment System Rst Chan
POR Latch
-Power On Reset
+75 - 125 nsec Powered
FL
HC007
Disc In
A
FL
HC007
-Disconnect In
+System or Selective Rst
A
-Op In
A
+Intf Disc In Chan
Gnd to Degate Intf
Any Error
+OA*
+Hardware Error
+75-125 nsec
OR
FL
HC007
-Not General Rst
-Op In Latched
+Error Retry
A
13
Page 43
Page 44
6
+Service Out
From Page 44
20
-Initial Sel
+Service In
+Status In
A
HC008
OR
HC008
+CTRL Addressed or Service Out
K1
+Pwr on Rst
A
Rly
Coil
From Page 44
From Page 45
14
7
8
-Adapter Tag Out 0
CU Busy -ATI2
-Device Addressed
-Request In
+Bypass Select Out
-Select Out
(ATI5) Status In
+System Rst
+Request In
-Adapter Tag Out 0
A
A
A
A
FL
HC005
-Interrupt Select
On Line
+Clock Out
+Disable -Enable
+System Rst
06*
OR
A
FL
HC007
N
-On Line
Q
17
Page 45
*Microprogram
Instruction

System/3 Models 8, 12, and 15 Attachment

Note: *See Appendix A1 through A41 for System/3 Model 10.*

All information located in Appendix pages A47 through A92, applies to System/3 Models 8, 12, and 15 unless noted otherwise. The magnetic tape attachment cards (four MST cards) are located in the CPU. The attachment card location for each model is as follows:

Model 8 — board location 01A-A2
Models 12 and 15 — channel bank 2, board location 01B-B2

The purpose of the attachment is to adapt the subsystem interface to the CPU channel interface. The attachment interprets the signals between the system and subsystem. The attachment also handles data during read, write, and sense operations, and holds tape unit status until it is needed by the CPU.

The magnetic tape attachment for the System/3 Model 10 requires three cards. The magnetic tape attachment for System/3 Models 8, 12, and 15 requires four cards. The fourth card contains the Op-End Interrupt circuitry. This circuitry is used primarily in the Model 15 because the CPU will accept the request for interrupt. The Op-End Interrupt circuitry also functions in the attachment for Models 8 and 12, but the respective CPUs will not accept the request for interrupt. However, it is possible to program all three models to test the Op-End Interrupt condition.

Data Flow (System/3 Models 8, 12, and 15 Attachment)

Instructions Causing Data Flow

There are four I/O instructions which cause data flow between the system and subsystem, through the attachment.

Sense I/O: A Sense instruction causes two bytes of sense information to be sent to the system. Bits 5-7 of the "Q" byte select the sense bytes.

Load I/O (LIO): A Load I/O instruction places two bytes of information in the Magnetic Tape Data Address Register (MTDAR) in CPU, or the Byte Count Register in the subsystem. Only that information going to the Byte Count Register passes through the attachment. Bits 5-7 of the "Q" byte select the desgination of the information.

The Load I/O instruction also enables, disables or resets interrupts. In the 5415 an additional LIO is used for Interrupt Control. On the 5408 and 5412 this interrupt handling capability is not normally used because the tape attachment cannot cause an interrupt in either CPU.

Test I/O (TIO): A Test I/O instruction tests the busy or not ready/unit check status of the tape unit. The attachment holds the tape unit status in the Device Status Register, and the subsystem is not addressed. Bits 5-7 of the "Q" byte select the status condition to be tested. An additional TIO can be used to test for Op-End Interrupt pending; however, it is not normally used for the 5408 and 5412. In the 5415 an additional TIO is used to test Interrupt Pending.

Start I/O (SIO): A Start I/O instruction initiates a read, write, or motion control operation in the subsystem. Bits 5-7 of the "Q" byte select the type of operation. When the "Q" byte contains a control or diagnostic command, the "R" byte selects which command the subsystem is to execute.

Inputs to Attachment from System

Instruction Tag Out: There are four instruction tag lines to indicate the presence of an instruction in the CPU Operations Register.

SIO Instr indicates a Start I/O instruction.

LIO Instr indicates a Load I/O instruction.

TIO Instr indicates a Test I/O instruction.

SNS Instr indicates a Sense I/O instruction.

Cycle Tag Lines: There are four cycle tag lines which indicate which cycle the CPU is executing during an I/O instruction: IQ Cycle, IR Cycle, EB 1 Cycle, and EB Not 1 Cycle.

Attachment Tags Out: The attachment converts System/3 interface signals and puts them on Attachment Tags Out Bus for use by tape control.

Bus Out: The Bus Out (DBO P, 0-7) transmits data from CPU to the attachment. The data is identified by the Instruction Tag and Cycle Tag lines. Device Address Decode receives the address field of the "Q" byte from DBO to determine which tape unit to select. Attachment Bus Out transfers data from DBO to the tape control.

Data on DBO:

DBO contains a "Q" byte when an Instruction tag and the IQ Cycle tag are up.

DBO contains an "R" byte when SIO Instr and IR Cycle tags are up.

DBO contains the contents of the Main Store location addressed by LIO when LIO Instr and EB Cycle are up.

DBO contains the contents of the Main Store location addressed by LIO, minus 1, when LIO Instr and EB Not 1 Cycle are up.

In each case the information is available at Clock 6 time.

Clock 0-8: CPU clock pulses provided for attachment timing.

Sample DBO (SDBO): A clock pulse which samples the data on DBO.

Early Phase C (EPHASEC): A clock pulse providing a delayed sampling of DBO.

I/O Cycle

Read or Write data is transmitted between CPU and the subsystem during I/O cycles. When the attachment requires an I/O cycle, it activates cycle steal request to CPU. When an I/O cycle is granted to an attachment, DBO contains information at Clock 5 of the I/O cycle during a write operation.

Outputs from Attachment to System/3 Models 8, 12, and 15

Sense I/O and Start I/O cause data flow from the subsystem to the system, through the attachment. The sense bytes and data read by the tape unit are transmitted through the Data Bus In Register (DBI P, 0-7).

Interrupt Requests: When the Interrupt Poll line is up, all interrupt requests are placed on the DBI.

Attachment Tags In: The attachment converts the tape control Tags In signals for use by the CPU. The CPU uses these signals to keep track of the tape control working status.

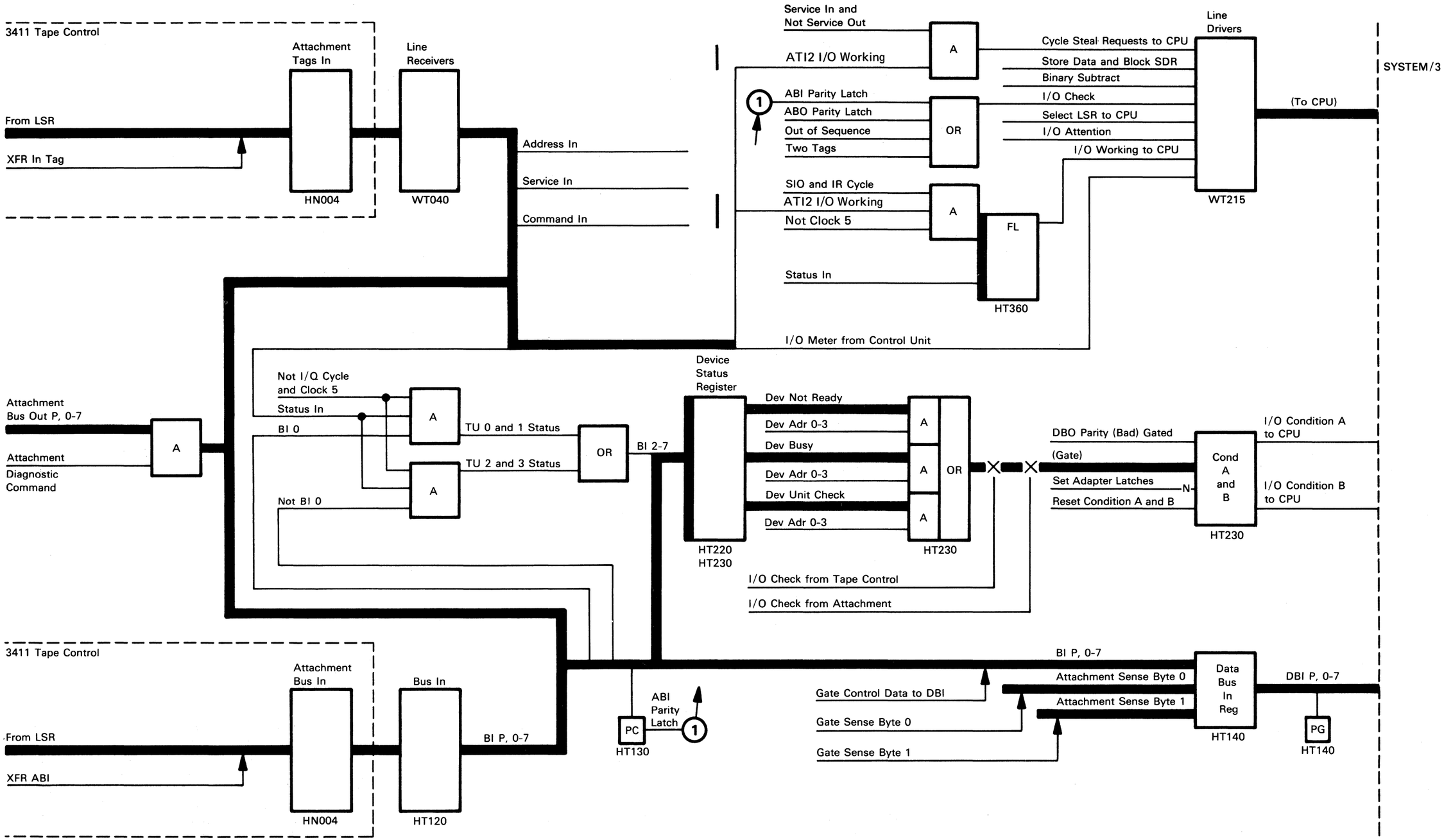
Control In: Control In lines control the data flow of the CPU during an I/O cycle. They are: Store Data, Block SDR, Binary Subtract, and Inhibit LSR Load.

Status In: Status In lines indicate to CPU the status of the tape unit. They are I/O Condition A, and I/O Condition B and are used in combination. These lines are generated from the Device Status Register which keeps track of the tape unit status (ready or busy) and DBO parity check circuits. Any error condition detected by the attachment or the tape control sets the I/O Conditions.

Select Bus In: Select Bus In consists of five lines -- LSR Select 3, 4, 5, 6, and 7. The attachment uses 5 and 7 to select the MTDAR.

Op-End Interrupts: For the model 15 the op-end interrupt is a means to tell the system when an operation is complete. It relieves the program from continually using TIOs to test a device busy status. When an operation is complete the attachment will send a request for interrupt to the CPU. In the tape attachment an interrupt is requested at the completion of every SIO except the diagnostic commands. The attachment request interrupts for five different reasons. A subsystem interrupt will occur for every SIO except the diagnostic SIOs. A tape unit interrupt will occur whenever a TU has completed a SIO rewind or Data Security Erase. The interrupt function only operates when it has been enabled by a LIO interrupt control. If interrupts are not enabled, then no interrupt requests occur at the completion of SIOs. For additional information on LIO, see page Appendix A53.

The Op-End Interrupt Circuitry also functions in the attachment for both Models 8 and 12. However, the CPUs will not accept the request for interrupt.



Appendix A50

Interrupt Control

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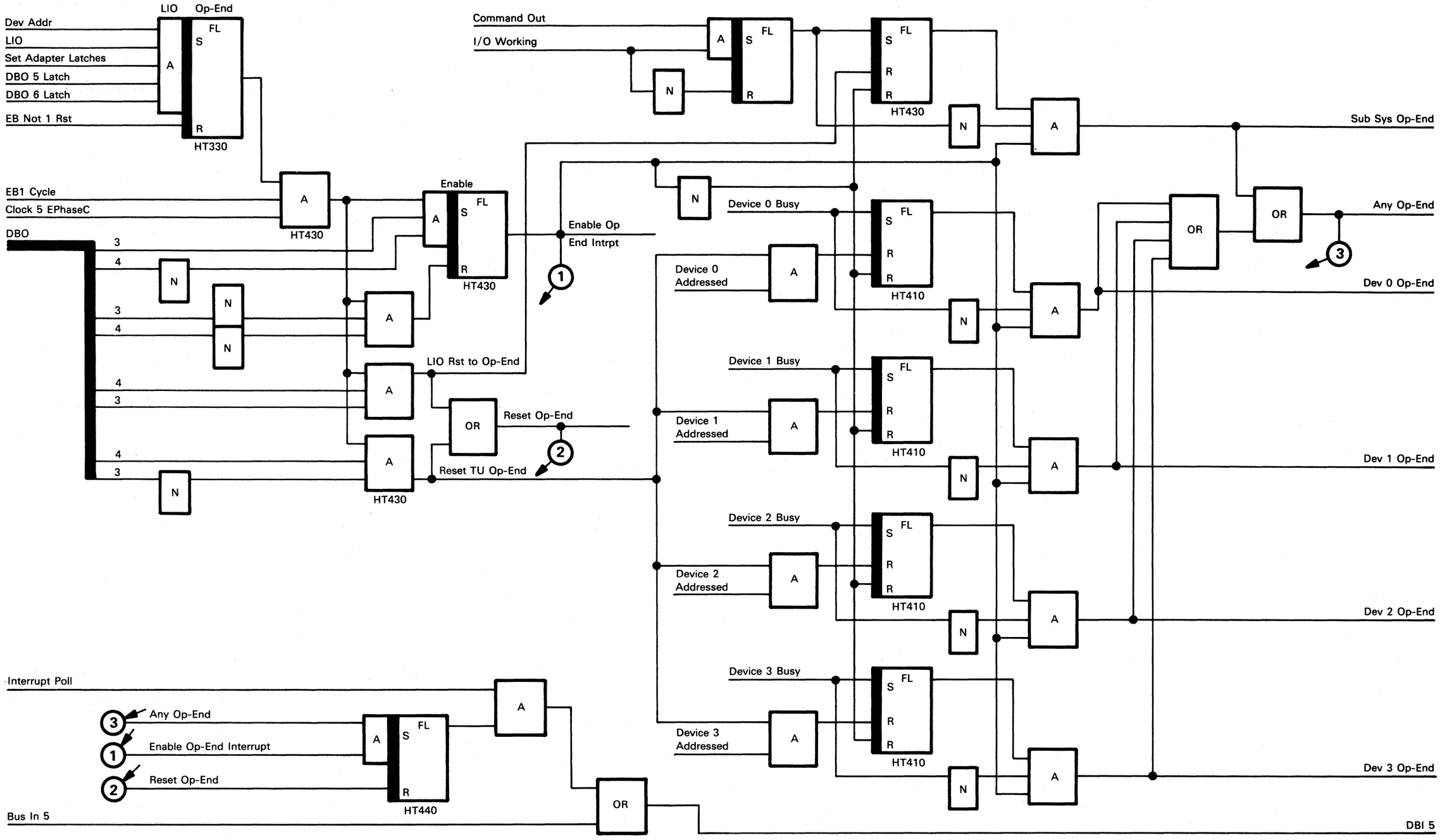
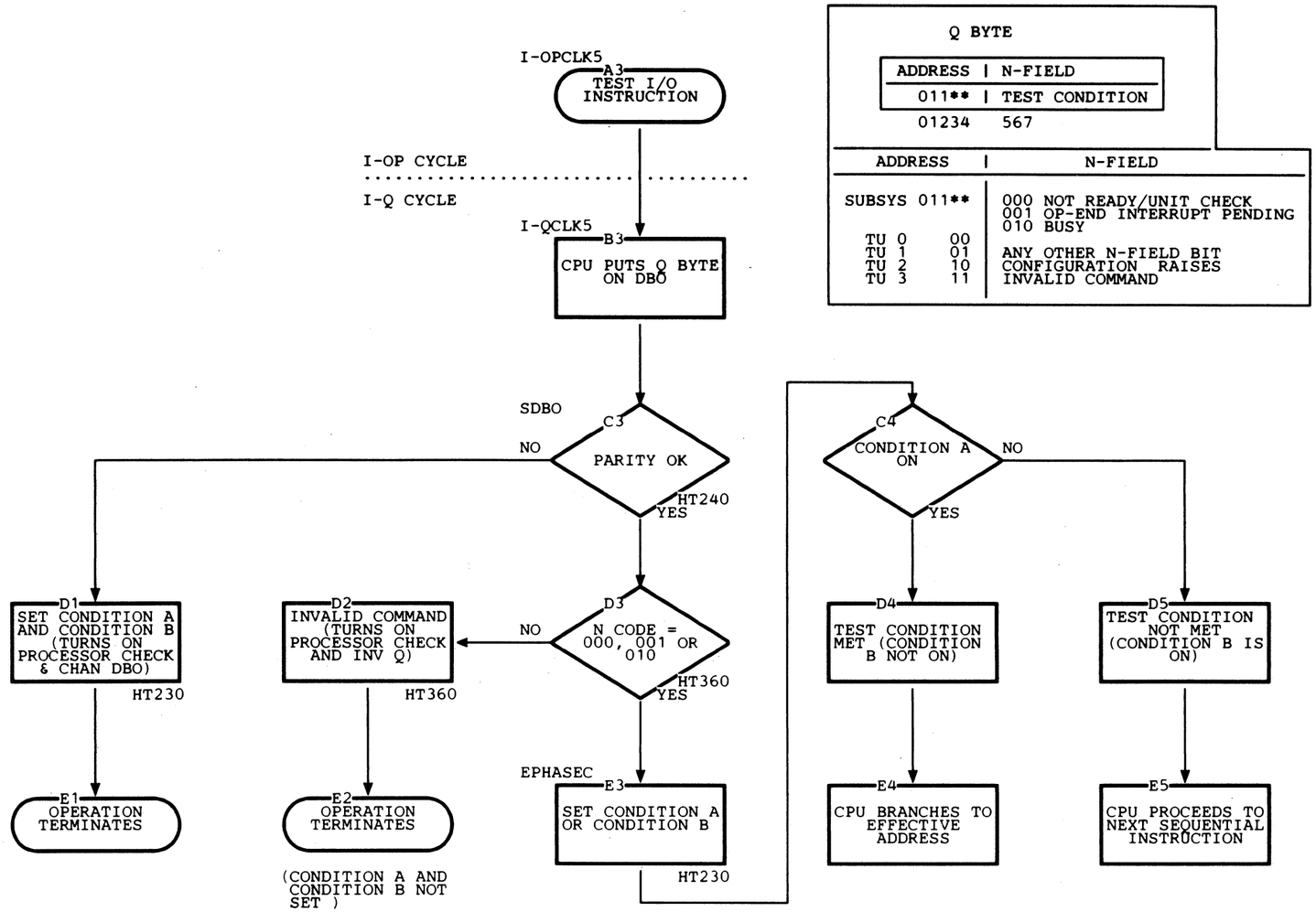


Test I/O

Test I/O checks for the Busy or Not Ready/Unit Check status of the addressed tape unit. The test conditions are contained in the N-Field of the Q Byte. If the condition is met the CPU program branches to the address specified by the Test I/O instruction. If the condition is not met, the CPU program proceeds to the next instruction. For the Model 15 an additional TIO is used for Interrupt Pending. It can also be used for Models 8 and 12, but normally is not.



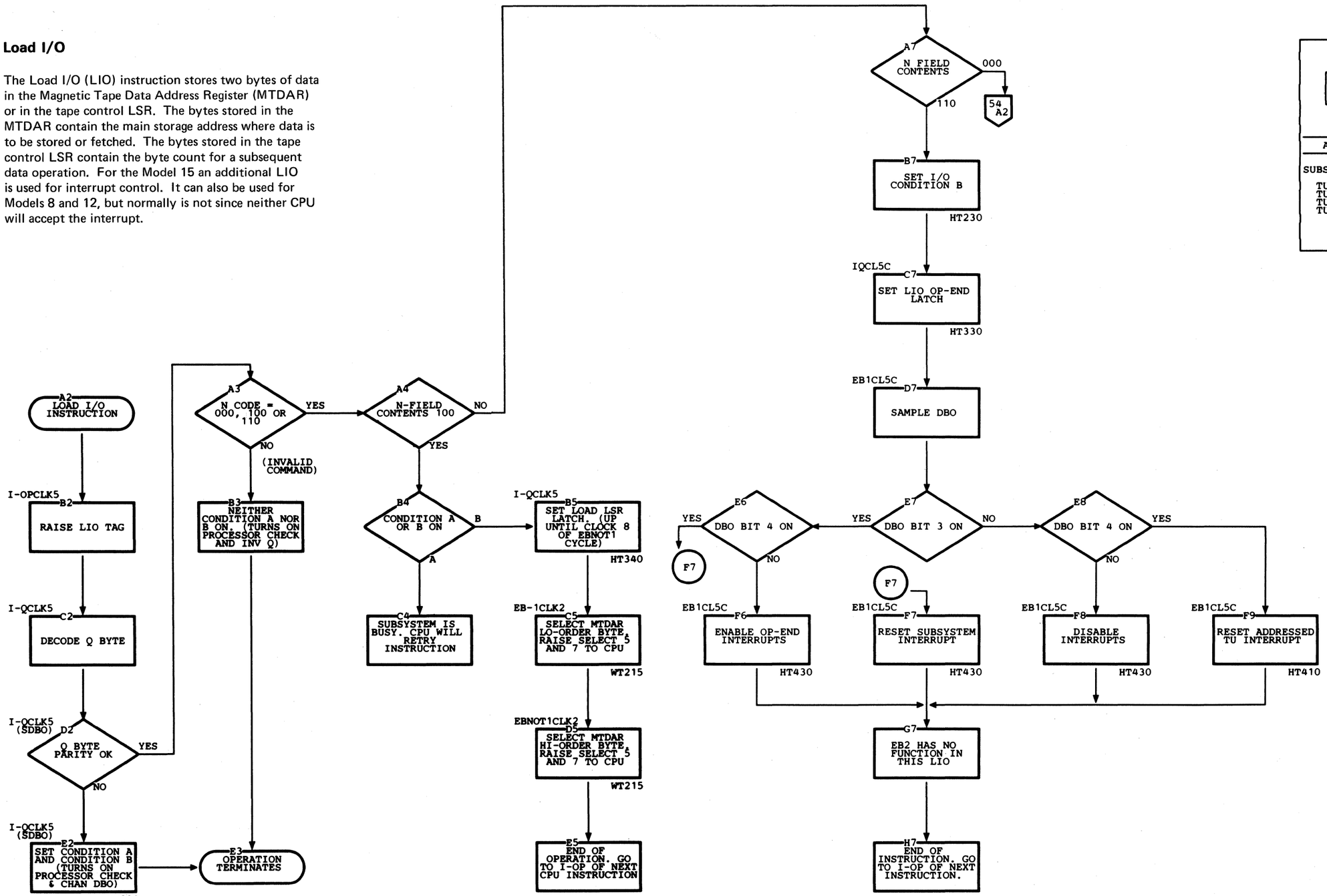
Load I/O

The Load I/O (LIO) instruction stores two bytes of data in the Magnetic Tape Data Address Register (MTDAR) or in the tape control LSR. The bytes stored in the MTDAR contain the main storage address where data is to be stored or fetched. The bytes stored in the tape control LSR contain the byte count for a subsequent data operation. For the Model 15 an additional LIO is used for interrupt control. It can also be used for Models 8 and 12, but normally is not since neither CPU will accept the interrupt.

Q BYTE

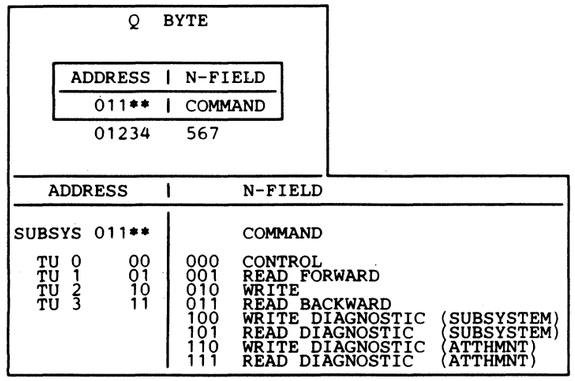
ADDRESS	N FIELD
011**	REGISTER
01234	567

ADDRESS		N FIELD
SUBSYS 011**		000 LOAD BYTE COUNT IN TAPE CONTROL
TU 0	00	
TU 1	01	100 LOAD MAGNETIC TAPE DATA ADDRESS REGISTER IN CPU
TU 2	10	
TU 3	11	110 INTERRUPT CONTROL ANY OTHER COMBINATION RAISES INVALID COMMAND



Start I/O (SIO)

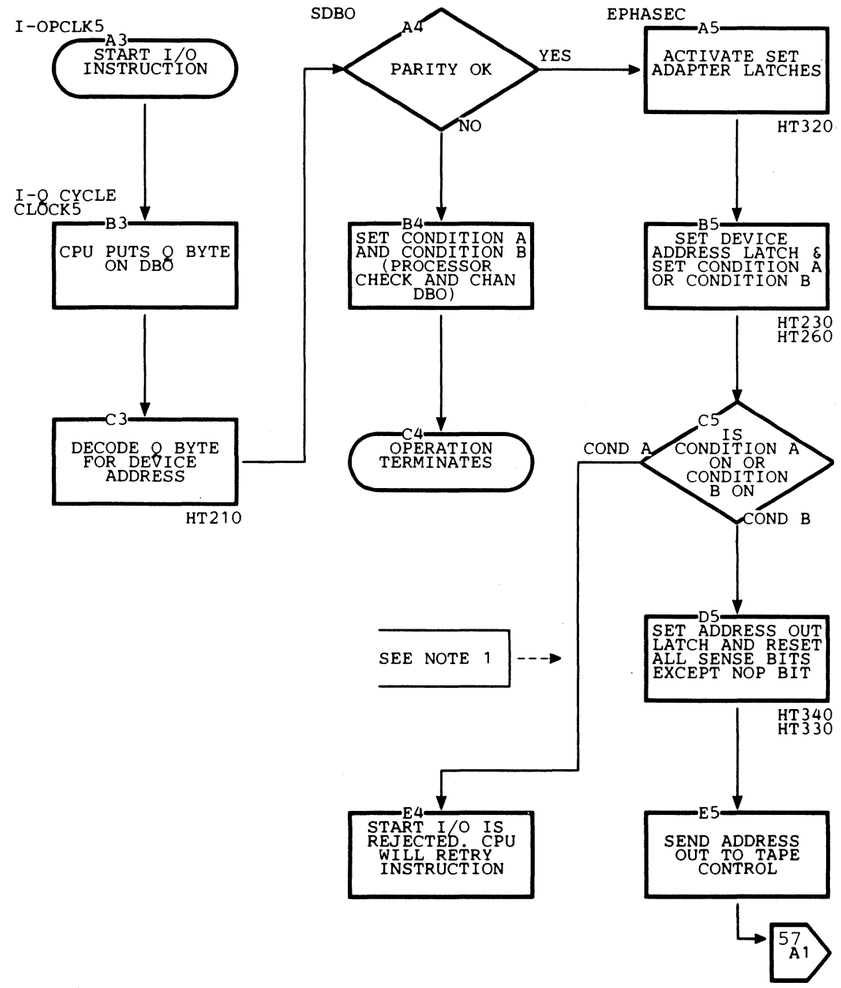
Start I/O initiates a tape operation. During the I-Q Cycle, the Q Byte is decoded for the tape unit address and command. If the command is the Control or Diagnostic type, an R Byte is received during the I-R Cycle. The R Byte contains the specific Control or Diagnostic command. For a Read or Write command the R Byte is not used. However the I-R Cycle is still executed.



NOTE 1

CONDITION A IS ON WHEN:

(1) I/O WORKING IS ACTIVE, OR
(2) DEVICE HAS GONE NOT READY, OR
(3) THE DEVICE IS BUSY.



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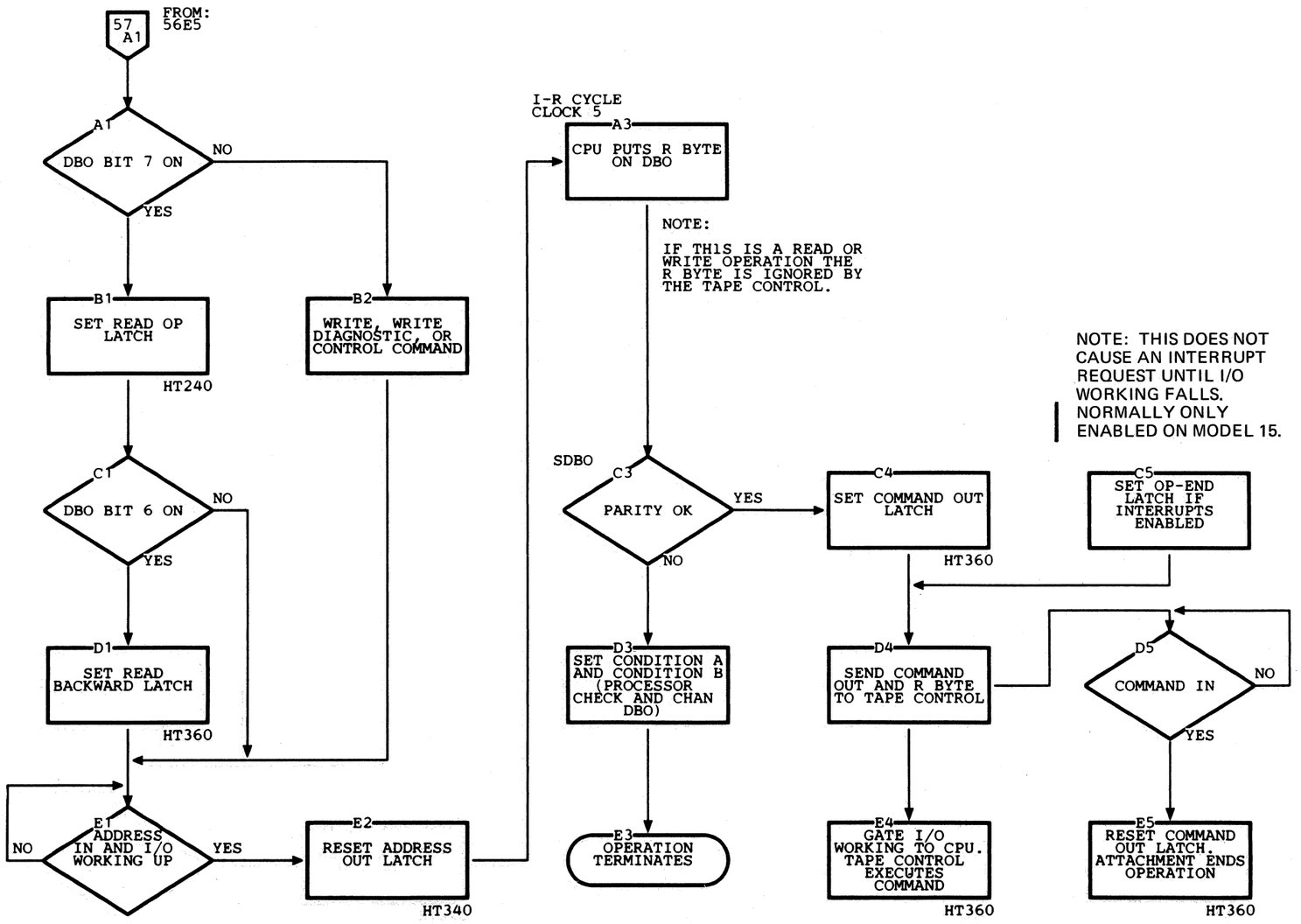
Revised 10/27/75 by TNL SN26-0323



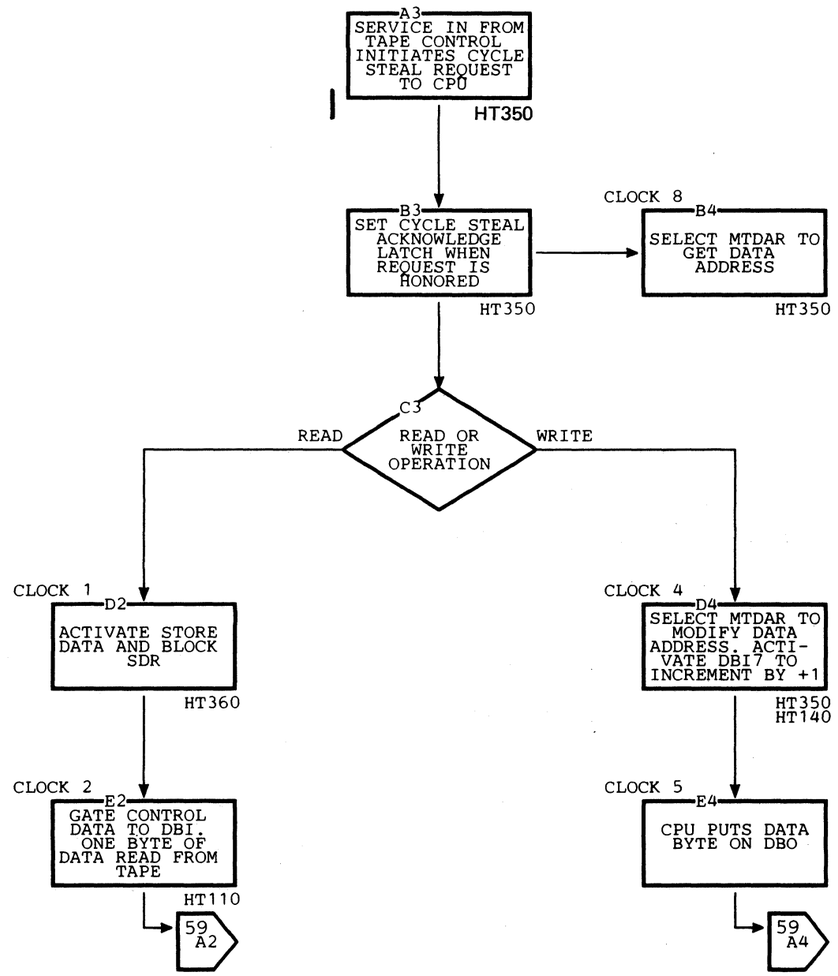
NOTE: THIS DOES NOT CAUSE AN INTERRUPT REQUEST UNTIL I/O WORKING FALLS. NORMALLY ONLY ENABLED ON MODEL 15.

R BYTE

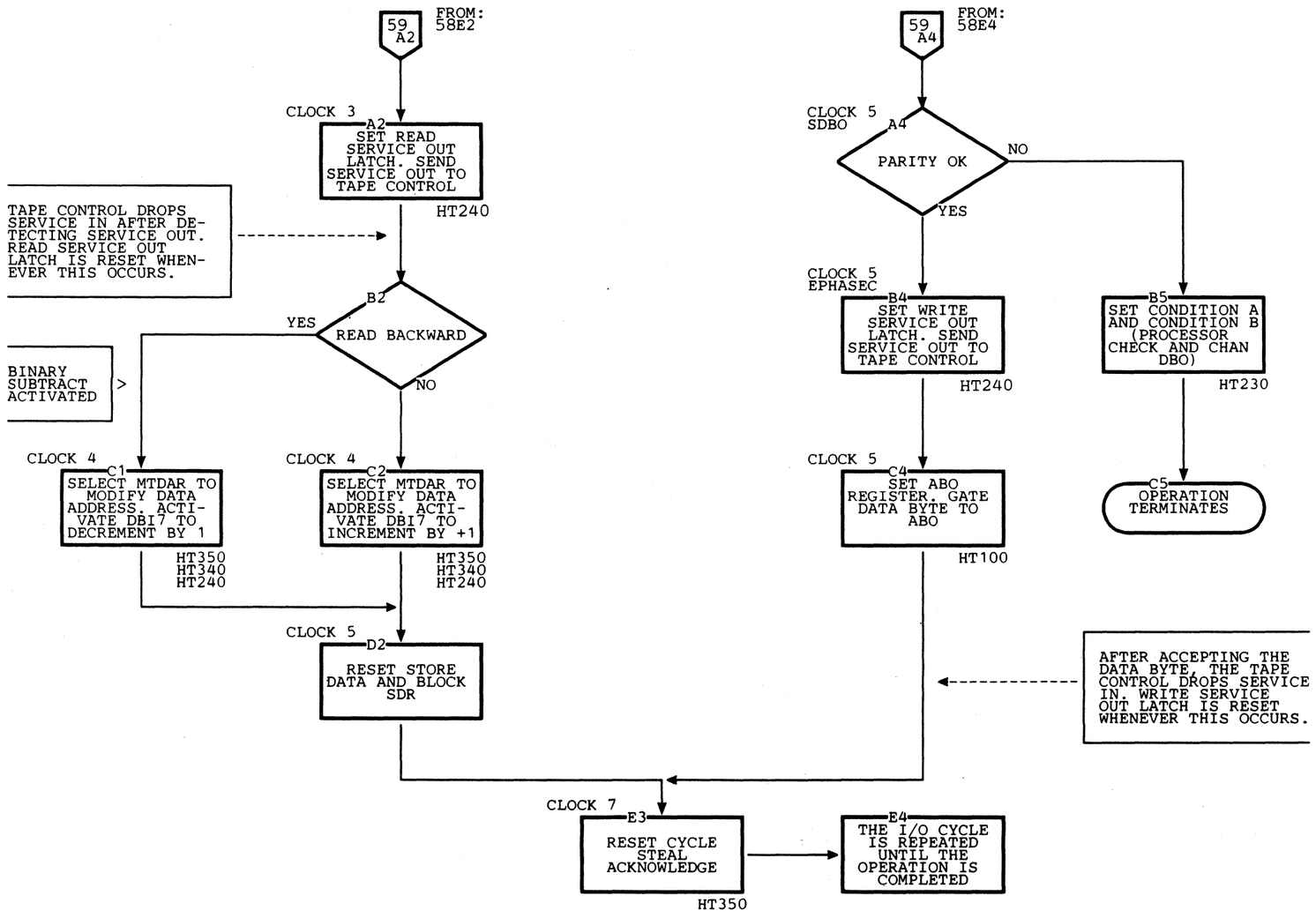
HEX CODE	CONTROL COMMAND
C3	MODE SET (9-TRACK PE)
CB	MODE SET (9-TRACK NRZI)
07	REWIND (REW)
0F	REWIND UNLOAD (RUN)
17	ERASE GAP (ERG)
1F	WRITE TAPE MARK (WTM)
27	BACKSPACE BLOCK (BSB)
2F	BACKSPACE FILE (BSF)
37	FORWARD SPACE BLOCK (FSB)
3F	FORWARD SPACE FILE (FSF)
97	DATA SECURITY ERASE (DSE)
	DIAGNOSTIC COMMAND
	WHEN N-FIELD IS 100
01	DIAGNOSTIC WRITE
03	LOOP WRITE TO READ
07	LOAD BYTE
08	WRITE SKEW CHECK
09	READ FWD SKEW CHECK
0D	READ BKWD SKEW CHECK
	WHEN N-FIELD IS 101
02	CROSSTALK CHECK
04	DIAGNOSTIC MEASURE (FWD)
06	IBG TIMING TEST
0C	DIAGNOSTIC MEASURE (BKWD)

I/O Cycles

I/O Cycles are the result of the Start I/O instruction. The tape control requests the I/O Cycle by raising Service In to the attachment. The attachment then issues a Cycle Steal Request 5 to the Model 15 CPU (Cycle Steal Request 7 for all other models). After the CPU acknowledges the cycle steal request, the data transfer begins. One byte of data is transferred each I/O Cycle. When tape control is ready to receive or send the next byte, another Cycle Steal Request is made to CPU.

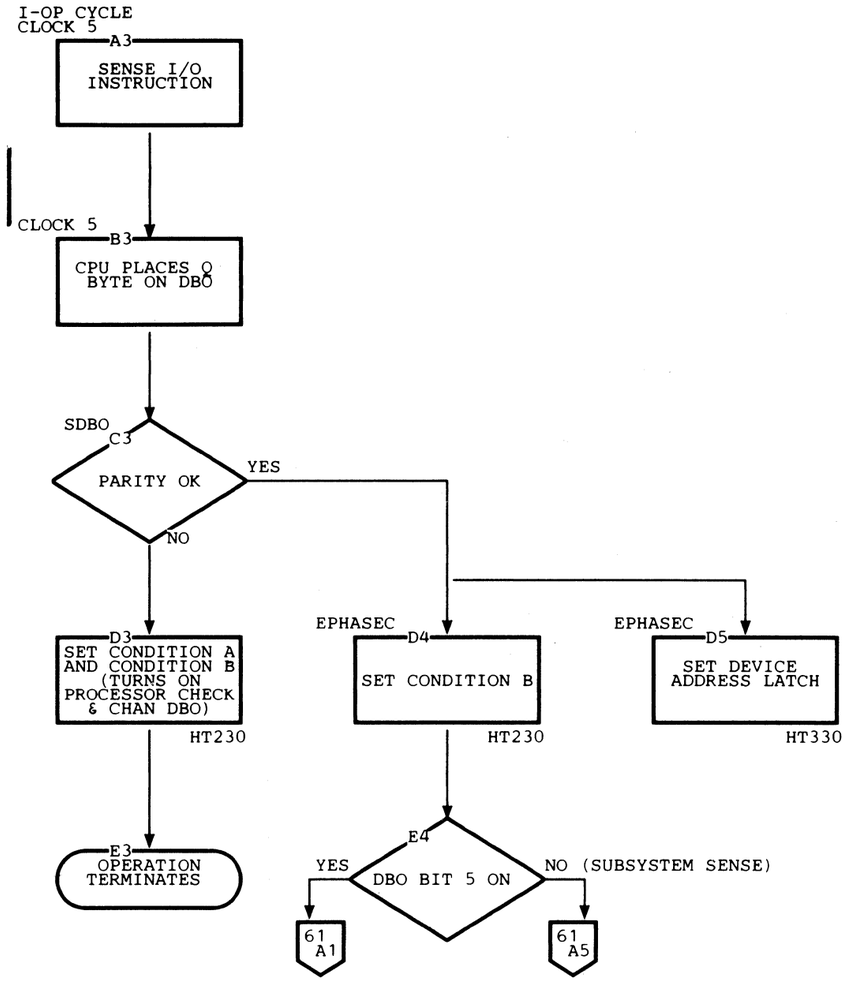


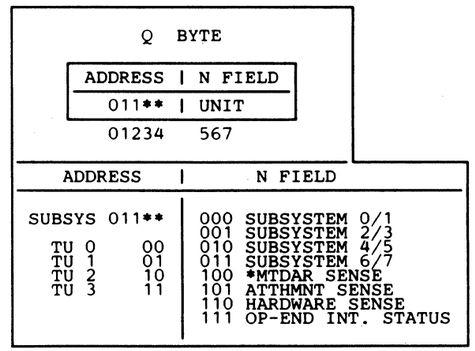
I/O Cycles


59 A2
FROM: 58E2
CLOCK 3
A2
SET READ SERVICE OUT LATCH. SEND SERVICE OUT TO TAPE CONTROL
HT240
TAPE CONTROL DROPS SERVICE IN AFTER DETECTING SERVICE OUT. READ SERVICE OUT LATCH IS RESET WHENEVER THIS OCCURS.
B2
READ BACKWARD
YES
NO
BINARY SUBTRACT ACTIVATED
CLOCK 4
C1
SELECT MTDAR TO MODIFY DATA ADDRESS. ACTIVATE DBI7 TO DECREMENT BY 1
HT350
HT340
HT240
CLOCK 4
C2
SELECT MTDAR TO MODIFY DATA ADDRESS. ACTIVATE DBI7 TO INCREMENT BY +1
HT350
HT340
HT240
CLOCK 5
D2
RESET STORE DATA AND BLOCK SDR
59 A4
FROM: 58E4
CLOCK 5 SDBO
A4
PARITY OK
NO
YES
CLOCK 5 EPHASEC
B4
SET WRITE SERVICE OUT LATCH. SEND SERVICE OUT TO TAPE CONTROL
HT240
B5
SET CONDITION A AND CONDITION B (PROCESSOR CHECK AND CHAN DBO)
HT230
CLOCK 5
C4
SET ABO REGISTER. GATE DATA BYTE TO ABO
HT100
C5
OPERATION TERMINATES
AFTER ACCEPTING THE DATA BYTE, THE TAPE CONTROL DROPS SERVICE IN. WRITE SERVICE OUT LATCH IS RESET WHENEVER THIS OCCURS.
CLOCK 7
E3
RESET CYCLE STEAL ACKNOWLEDGE
HT350
E4
THE I/O CYCLE IS REPEATED UNTIL THE OPERATION IS COMPLETED

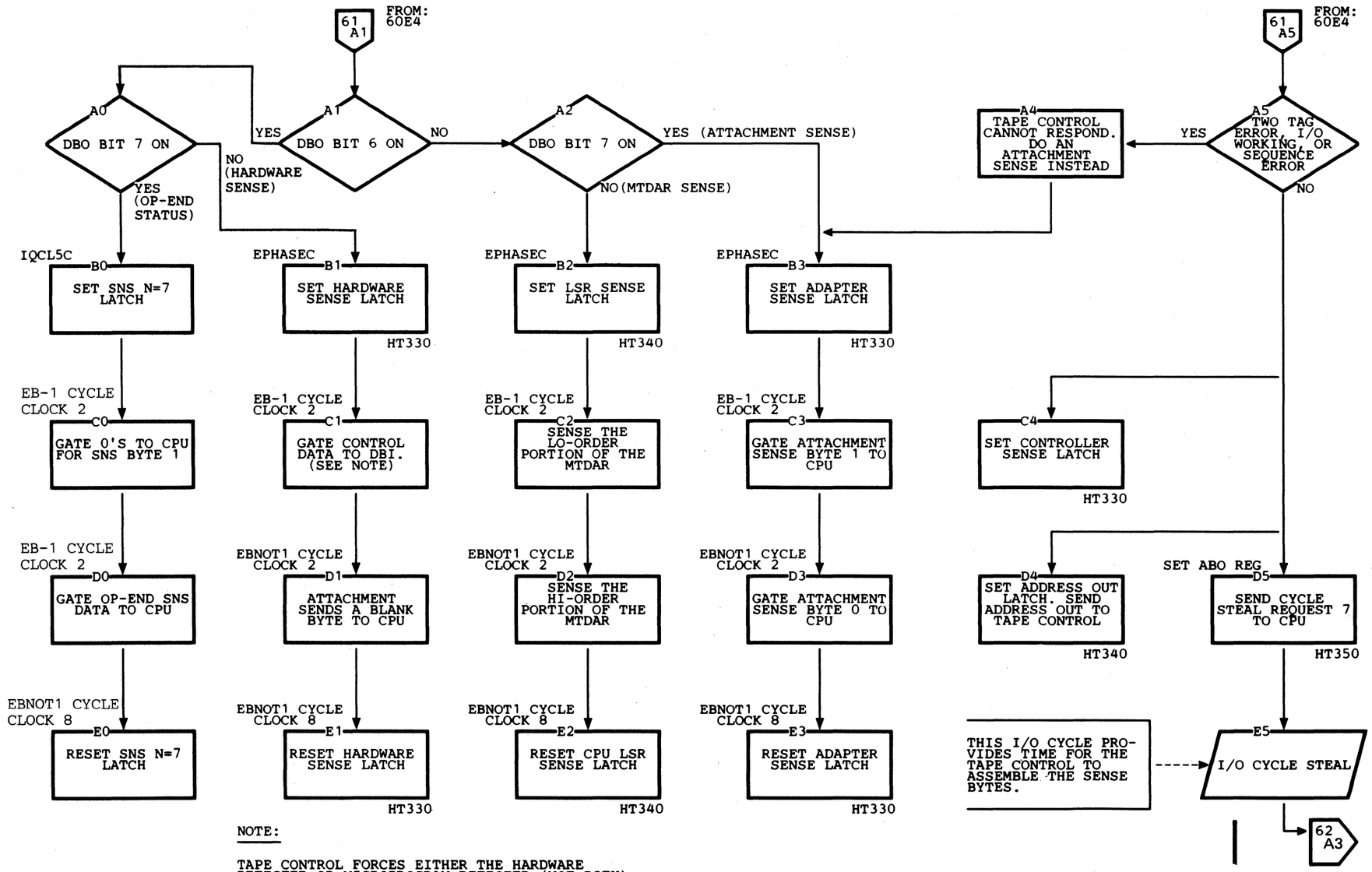
Sense I/O

The Sense I/O (SNS) instruction requests sense data from the Attachment, the MTDAR, or the subsystem. During the I-Q Cycle, the Q Byte is decoded for the address and the unit being sensed. During the following EB-1 and EB-Not 1 Cycles, the requested sense data is sent to the CPU. If the subsystem is sensed, an I/O Cycle is taken but no data is transferred. The I/O Cycle is taken to provide time for the subsystem to assemble the requested sense data.



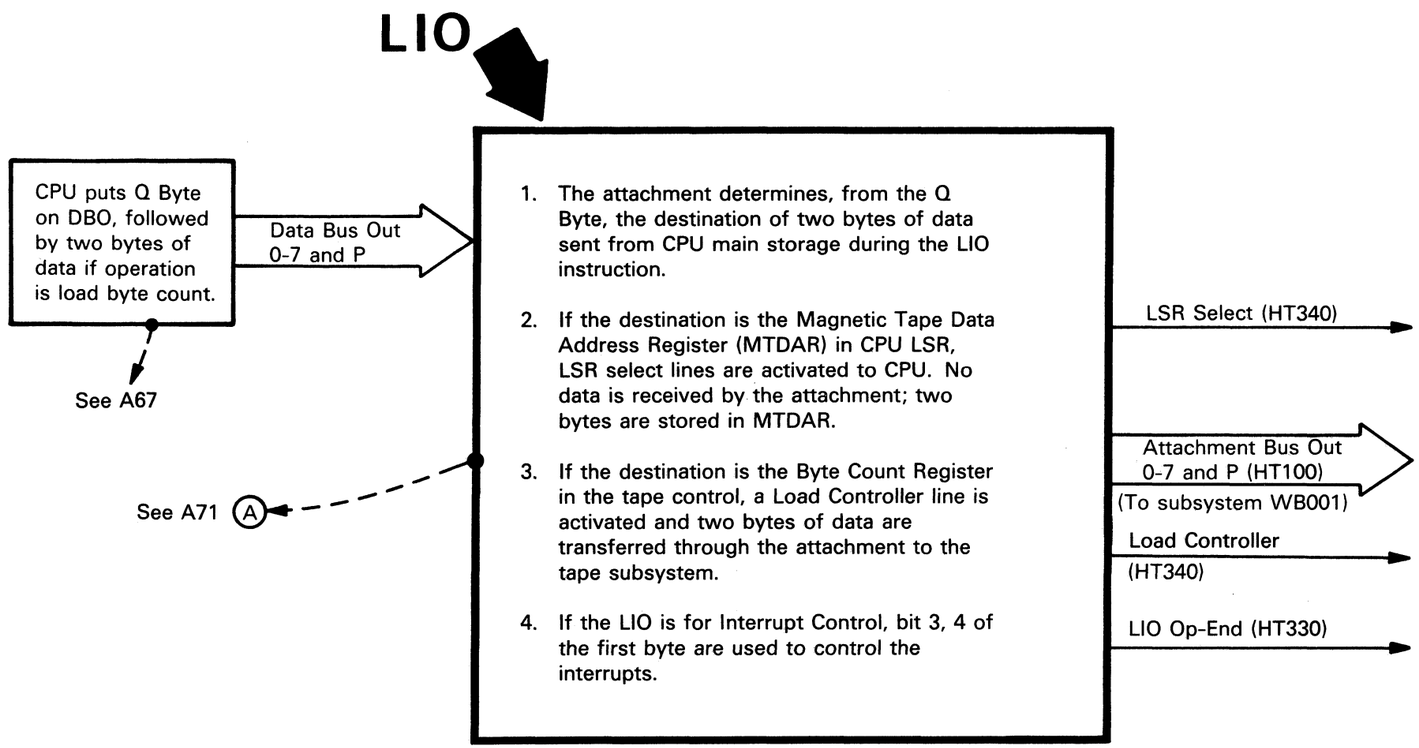


*THE MTDAR (MAGNETIC TAPE DATA ADDRESS REGISTER) IS THE CPU LSR ASSIGNED TO THE SUBSYSTEM



NOTE:

TAPE CONTROL FORCES EITHER THE HARDWARE DETECTED OR MICROPROGRAM DETECTED (NOT BOTH) HARDWARE ERROR BYTE ONTO THE ABI. IT IS GATED TO THE CPU AT THIS TIME.


LIO
CPU puts Q Byte on DBO, followed by two bytes of data if operation is load byte count.
Data Bus Out 0-7 and P
See A67
See A71 A
1. The attachment determines, from the Q Byte, the destination of two bytes of data sent from CPU main storage during the LIO instruction.
2. If the destination is the Magnetic Tape Data Address Register (MTDAR) in CPU LSR, LSR select lines are activated to CPU. No data is received by the attachment; two bytes are stored in MTDAR.
3. If the destination is the Byte Count Register in the tape control, a Load Controller line is activated and two bytes of data are transferred through the attachment to the tape subsystem.
4. If the LIO is for Interrupt Control, bit 3, 4 of the first byte are used to control the interrupts.
LSR Select (HT340)
Attachment Bus Out 0-7 and P (HT100)
(To subsystem WB001)
Load Controller
(HT340)
LIO Op-End (HT330)

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From A70 (A)

1. CPU puts Q Byte on DBO at clock 5 I-Q Cycle
2. CPU puts first data byte on DBO at Clock 5 of EB 1 Cycle
3. CPU puts second data byte on DBO at Clock 5 of EB NOT 1 Cycle

Data Bus Out 0-7 and P

See A72 (A)

From A67 (B)

From A72 (C)

1. The load I/O tag is set at Clock 5 of the I-OP Cycle.
2. The attachment decodes the address and N fields of the Q Byte at Clock 5 of the I-Q cycle.
3. If the Q Byte parity is bad, DBO PARITY GATED sets I/O CONDITION A and B and the operation terminates with the PROCESSOR CHECK and CHANNEL DBO indicators on.
4. The N field is 000.
5. The N field is 110.

   Interrupt control data is to be transferred to the attachment. The LIO for interrupt control is always accepted.

   At Clock 5 of EB1 the first byte is placed on DBO and gated to the attachment. DBO parity is tested.

   At Clock 5 of EB2 the second byte is placed on DBO but it is not used.
6. The N field is 100.
7. The CPU LSR (MTDAR) is to be accessed. LSR SELECT TO CPU is set.
8. During both EB 1 and EB NOT 1 cycles the data is stored in the CPU LSR. No data is received by the attachment. No DBO parity test is made.

See A67 (B)
See A73 (A)
See A74 (A)
See A75 (A)

CAUSE	A B	CPU REACTION
Invalid Command	0 0	I-Q - Processor Check Stop & Q Byte Invalid EB - Normal operation. Proceed to next instruction
Subsystem not busy	0 1	
Subsystem busy	1 0	Retry the LIO instruction
DBO Parity Error	1 1	Processor Check Stop and Channel DBO Check

See A76 (A)

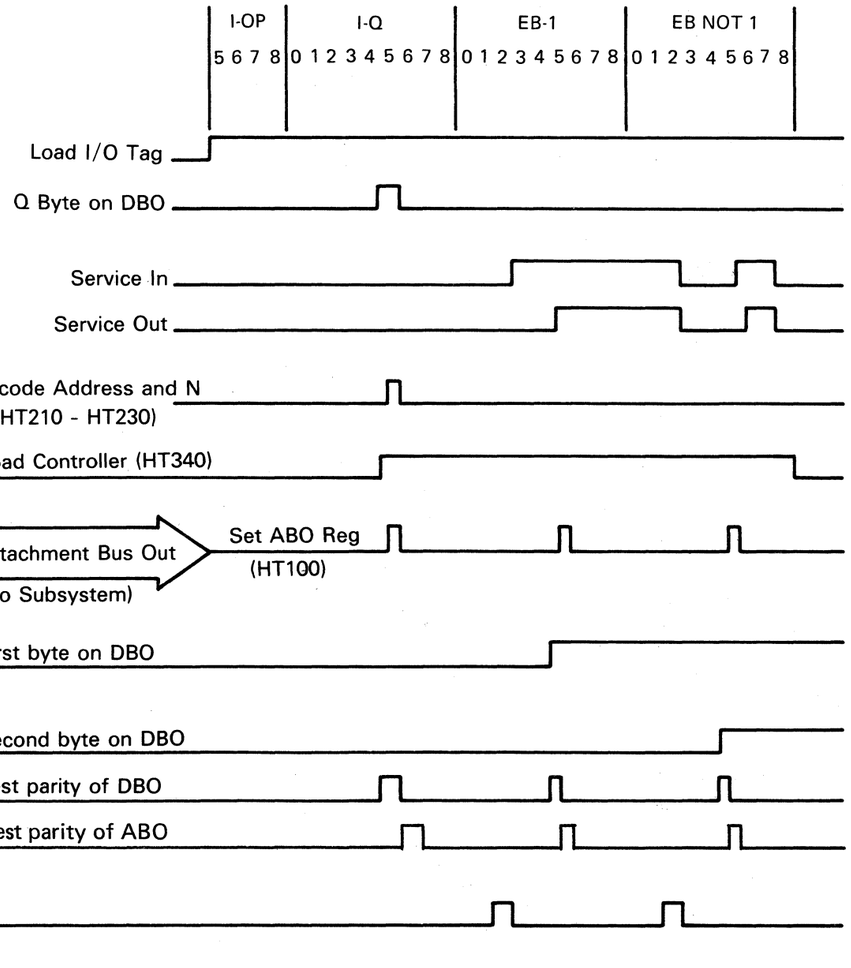
1. Byte count is to be transferred to the subsystem. If the subsystem is not busy, the attachment sets LOAD CONTROLLER.
2. If the subsystem is busy, the attachment sets CONDITION A. CPU retries the LIO instruction.

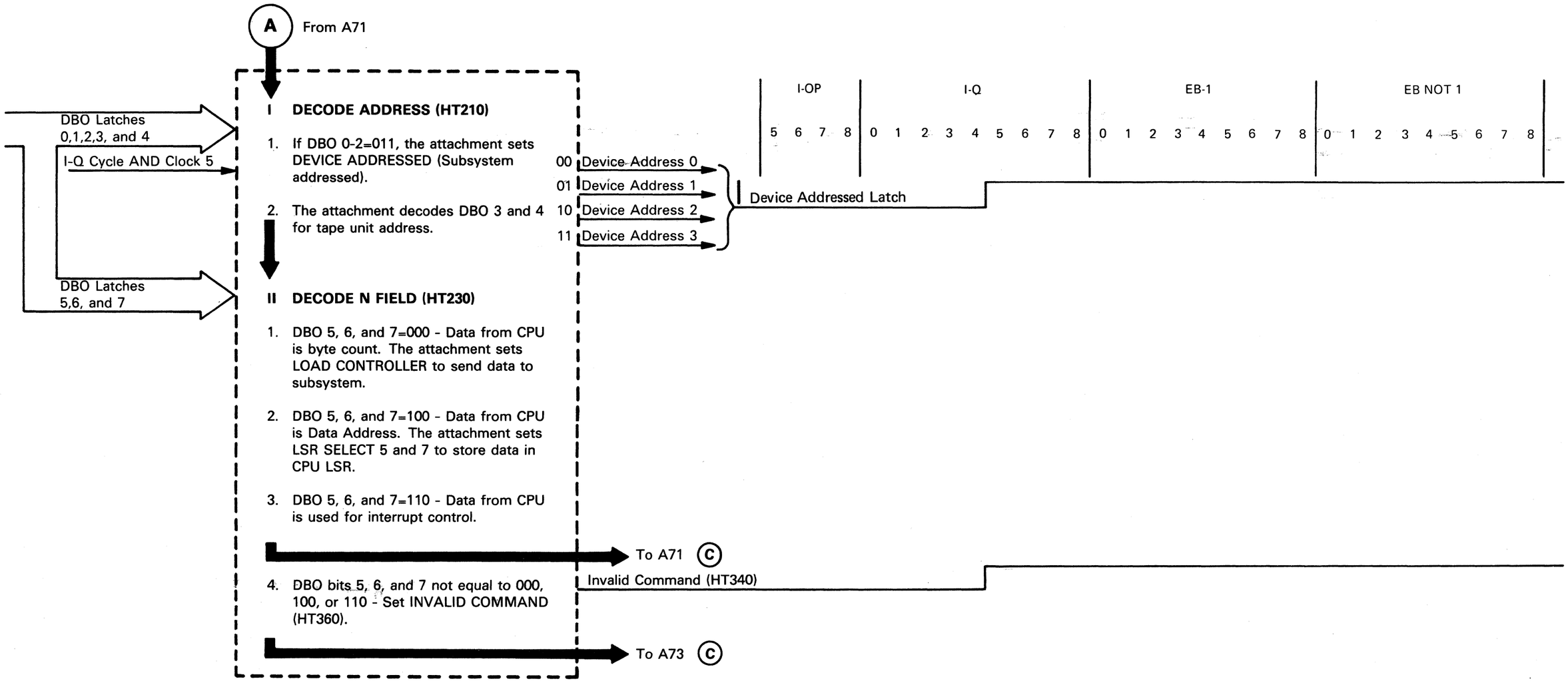
See A73 (B)

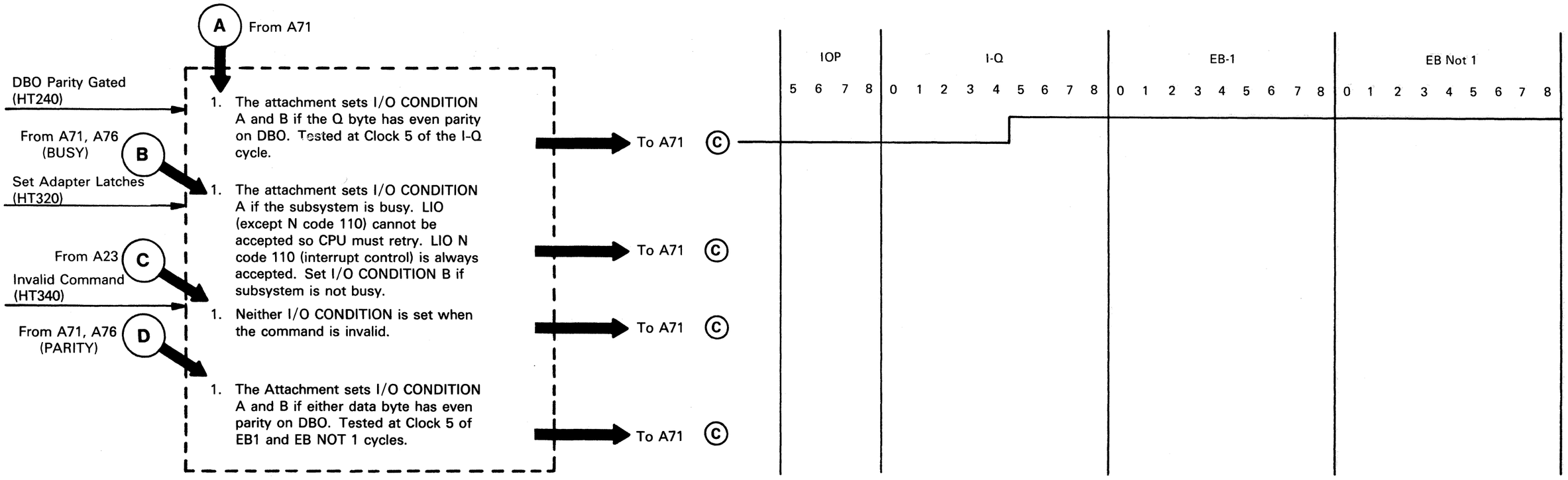
3. At Clock 5 of the EB 1 cycle, the first byte is placed on DBO and gated to the subsystem. DBO parity is tested.

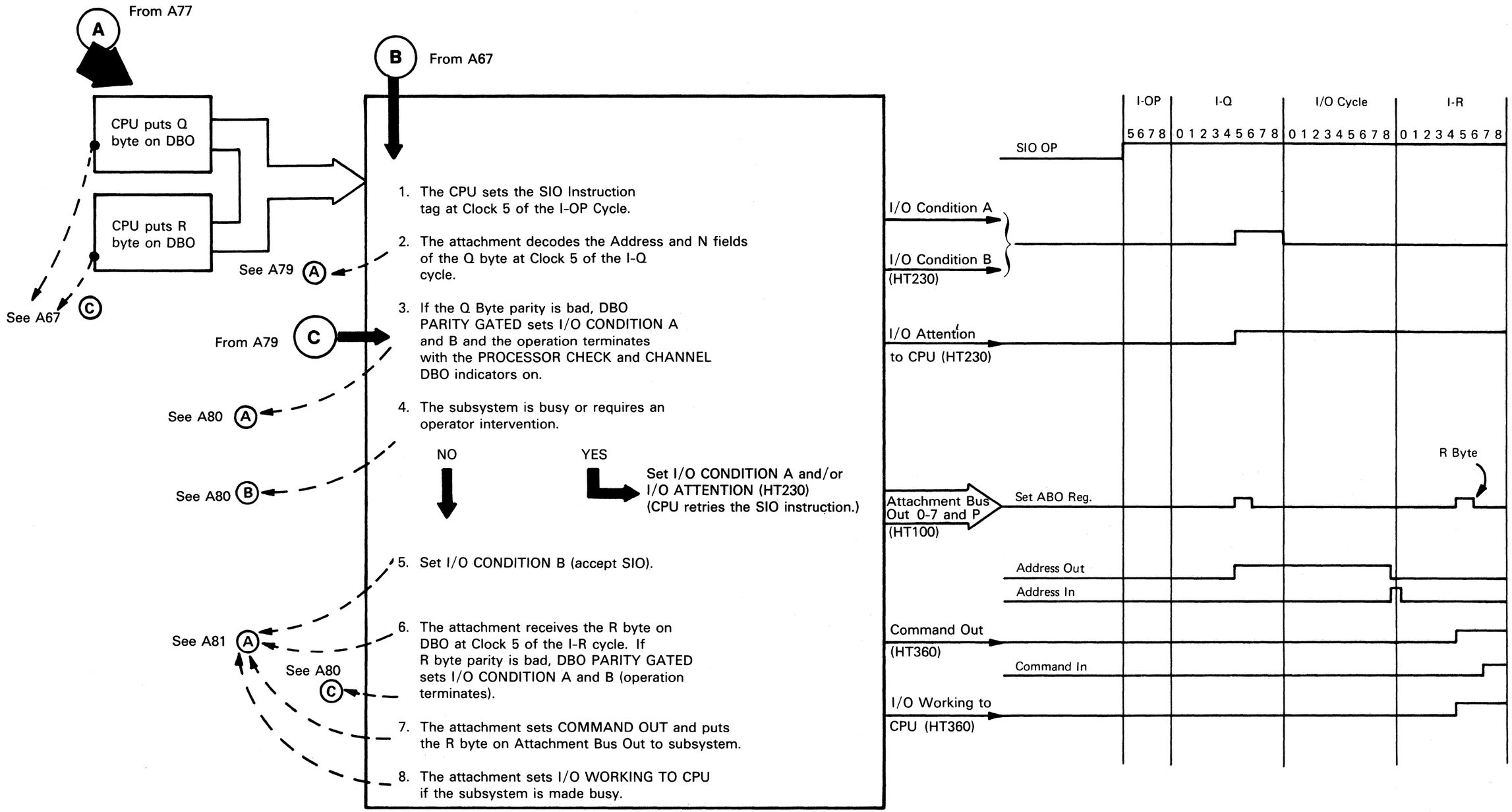
See A73 (D)

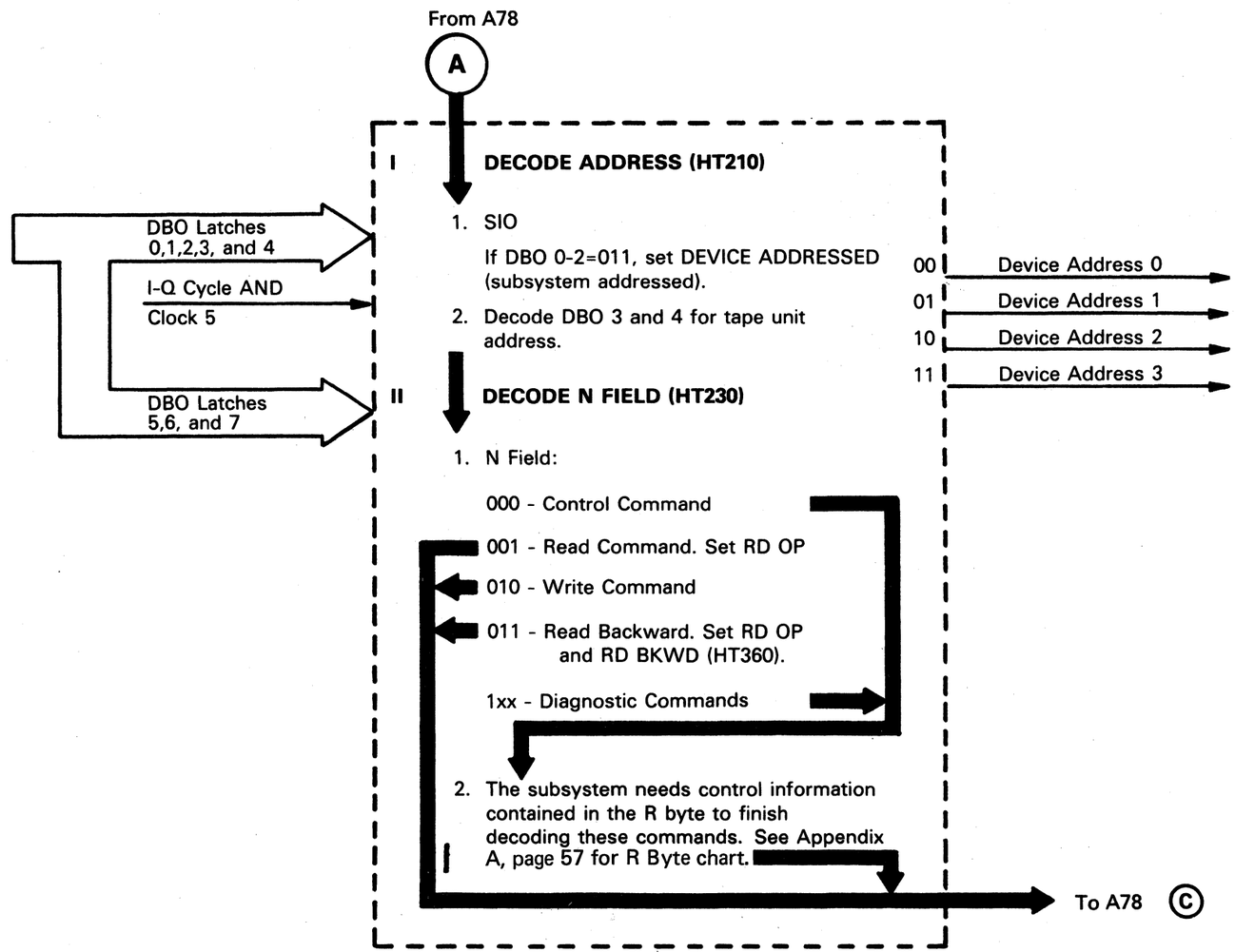
4. At Clock 5 of the EB NOT 1 cycle the second byte is placed on DBO and gated to the subsystem. DBO parity is tested.




A
From A71
DBO Latches 0,1,2,3, and 4
I-Q Cycle AND Clock 5
DBO Latches 5,6, and 7
I DECODE ADDRESS (HT210)
1. If DBO 0-2=011, the attachment sets DEVICE ADDRESSED (Subsystem addressed).
2. The attachment decodes DBO 3 and 4 for tape unit address.
II DECODE N FIELD (HT230)
1. DBO 5, 6, and 7=000 - Data from CPU is byte count. The attachment sets LOAD CONTROLLER to send data to subsystem.
2. DBO 5, 6, and 7=100 - Data from CPU is Data Address. The attachment sets LSR SELECT 5 and 7 to store data in CPU LSR.
3. DBO 5, 6, and 7=110 - Data from CPU is used for interrupt control.
4. DBO bits 5, 6, and 7 not equal to 000, 100, or 110 - Set INVALID COMMAND (HT360).
00 Device Address 0
01 Device Address 1
10 Device Address 2
11 Device Address 3
Device Addressed Latch
I-OP
5 6 7 8
I-Q
0 1 2 3 4 5 6 7 8
EB-1
0 1 2 3 4 5 6 7 8
EB NOT 1
0 1 2 3 4 5 6 7 8
To A71 C
Invalid Command (HT340)
To A73 C


A
From A71
DBO Parity Gated
(HT240)
1. The attachment sets I/O CONDITION A and B if the Q byte has even parity on DBO. Tested at Clock 5 of the I-Q cycle.
To A71
C
From A71, A76
(BUSY)
B
Set Adapter Latches
(HT320)
1. The attachment sets I/O CONDITION A if the subsystem is busy. LIO (except N code 110) cannot be accepted so CPU must retry. LIO N code 110 (interrupt control) is always accepted. Set I/O CONDITION B if subsystem is not busy.
To A71
C
From A23
C
Invalid Command
(HT340)
1. Neither I/O CONDITION is set when the command is invalid.
To A71
C
From A71, A76
(PARITY)
D
1. The Attachment sets I/O CONDITION A and B if either data byte has even parity on DBO. Tested at Clock 5 of EB1 and EB NOT 1 cycles.
To A71
C
IOP
5 6 7 8
I-Q
0 1 2 3 4 5 6 7 8
EB-1
0 1 2 3 4 5 6 7 8
EB Not 1
0 1 2 3 4 5 6 7 8


From A77
A
B
From A67
CPU puts Q byte on DBO
CPU puts R byte on DBO
See A79 A
See A67 C
From A79 C
See A80 A
See A80 B
See A81 A
See A80 C
1. The CPU sets the SIO Instruction tag at Clock 5 of the I-OP Cycle.
2. The attachment decodes the Address and N fields of the Q byte at Clock 5 of the I-Q cycle.
3. If the Q Byte parity is bad, DBO PARITY GATED sets I/O CONDITION A and B and the operation terminates with the PROCESSOR CHECK and CHANNEL DBO indicators on.
4. The subsystem is busy or requires an operator intervention.
NO
YES
Set I/O CONDITION A and/or I/O ATTENTION (HT230) (CPU retries the SIO instruction.)
5. Set I/O CONDITION B (accept SIO).
6. The attachment receives the R byte on DBO at Clock 5 of the I-R cycle. If R byte parity is bad, DBO PARITY GATED sets I/O CONDITION A and B (operation terminates).
7. The attachment sets COMMAND OUT and puts the R byte on Attachment Bus Out to subsystem.
8. The attachment sets I/O WORKING TO CPU if the subsystem is made busy.
I-OP
I-Q
I/O Cycle
I-R
5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8
SIO OP
I/O Condition A
I/O Condition B (HT230)
I/O Attention to CPU (HT230)
R Byte
Attachment Bus Out 0-7 and P (HT100)
Set ABO Reg.
Address Out
Address In
Command Out (HT360)
Command In
I/O Working to CPU (HT360)


From A78
A
I
DECODE ADDRESS (HT210)
DBO Latches 0,1,2,3, and 4
I-Q Cycle AND
Clock 5
1. SIO
If DBO 0-2=011, set DEVICE ADDRESSED (subsystem addressed).
2. Decode DBO 3 and 4 for tape unit address.
00 Device Address 0
01 Device Address 1
10 Device Address 2
11 Device Address 3
II
DECODE N FIELD (HT230)
DBO Latches 5,6, and 7
1. N Field:
000 - Control Command
001 - Read Command. Set RD OP
010 - Write Command
011 - Read Backward. Set RD OP and RD BKWD (HT360).
1xx - Diagnostic Commands
2. The subsystem needs control information contained in the R byte to finish decoding these commands. See Appendix A, page 57 for R Byte chart.
To A78 C

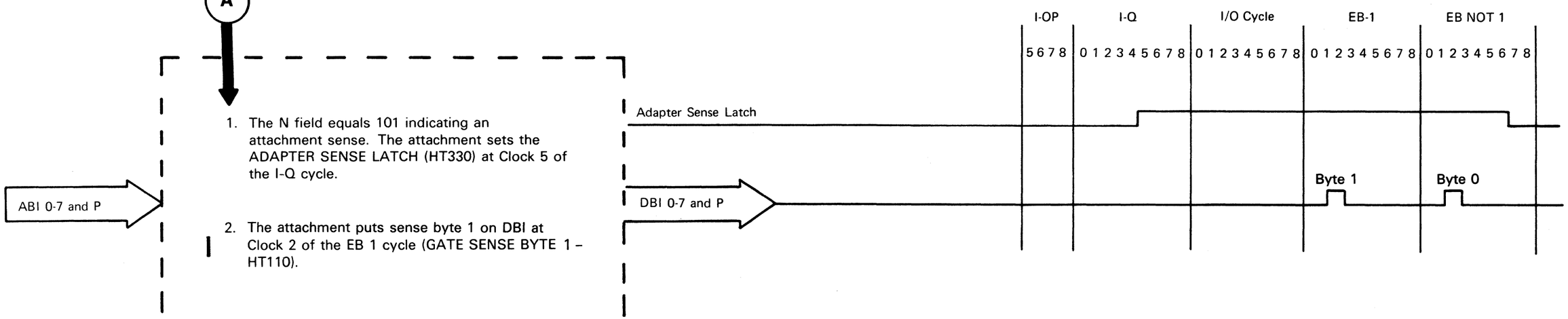
From A85

A

1. The N field equals 101 indicating an attachment sense. The attachment sets the ADAPTER SENSE LATCH (HT330) at Clock 5 of the I-Q cycle.

2. The attachment puts sense byte 1 on DBI at Clock 2 of the EB 1 cycle (GATE SENSE BYTE 1 – HT110).

3. The attachment puts sense byte 0 on DBI at Clock 2 of the EB NOT 1 cycle (GATE SENSE BYTE 0 – HT110).



NOTES:		
Sense Byte 0	Sense Byte 1	DBO Bits
	Address Out of Sequence	0
ABI Parity	Service Out of Sequence	1
ABO Parity	Command Out of Sequence	2
Controller Disabled	Address In Error	3
Two Tags Error	Service In Error	4
I/O Working Gated	Command In Error	5
Sequence Error	Status In Error	6
(Not used)	(Not used)	7

From A85

A

1. The N field equals 110 indicating a Hardware sense. The attachment sets the HARDWARE SENSE LATCH at Clock 5 of the I-Q cycle (HT330).

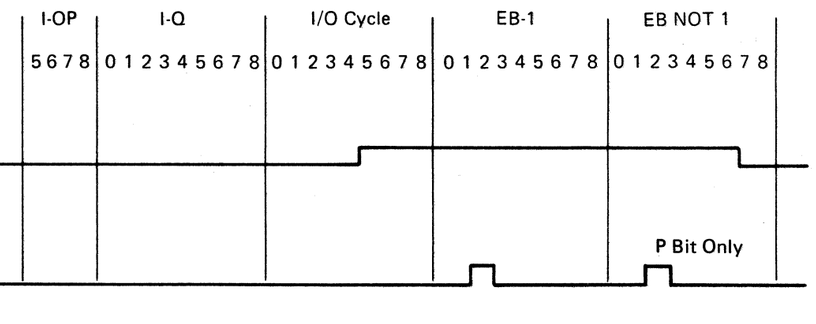
2. The attachment sets GATE CONT DATA TO DBI (HT110) at Clock 2 of the EB 1 cycle. Whatever is on ABI is gated to CPU as a sense byte (HT140).

3. GATE CONT DATA is inactive during the EB NOT 1 cycle causing a byte of zeros to be sent to CPU.

Attachment Bus In 0-7 and P

Data Bus In 0—7 and P

Hardware Sense Latch



NOTE:

A Hardware Sense operation stores the state of the Attachment Bus In at the time of the error.

From A85

(A)

1. The N field equals 111 indicating op-end status SNS. Attachment sets the SNS N=7 latch (AT330) at C5 of the I-Q cycle.

2. The attachment puts a byte of zeros on DBI at EB-1 C2.

3. The attachment puts interrupt status on DBI at EB-2 C2.

Sense Byte 0	Bit
TU 0 Interrupt	0
1	1
2	2
3	3
Subsystem Interrupt	4
Unused	5
Unused	6
Unused	7

Appendix B: Microprogram Sample Listing

```
LOC    OBJECT CODE  ADDR1 ADDR2  STMT   SOURCE STATEMENT                                    12/13/71  1
                                   103+* TRANSFER ADDRESSES                2
000005                             104+LSRS      EQU     X'05'  SELECT THE HIGH OR LOW LSR'S  3
000006                             105+TRNSF     EQU     X'06'  TRANSFER FUNCTION DEPENDS ON BIT 3  4
000009                             106+SPOUT1    EQU     X'09'  SPARE OUTBOUND REGISTER  5
00000A                             107+DETDERR   EQU     X'0A'  DISABLE CU--CODE DETECTED ERROR  6
000011                             108+WRTCLOCK  EQU     X'11'  ACTIVATE OR DE-ACTIVATE WRITE CLOCK  7
000012                             109+SDC3      EQU     X'12'  THIRD SKEW DETECTION AND CONTROL  8
000014                             110+SPOUT2    EQU     X'14'  SPARE OUTBOUND REGISTER  9
000018                             111+SDC2      EQU     X'18'  SECOND SKEW DETECTION AND CONTROL  10
000021                             112+AR        EQU     X'21'  ALU IPUT REGISTER  11
000022                             113+IC        EQU     X'22'  INSTRUCTION COUNTER  12
000024                             114+TUADR     EQU     X'24'  TAPE UNIT ADDRESS SELECTION  13
000028                             115+TUTAG     EQU     X'28'  TAPE UNIT OUT TAG REG  14
000041                             116+TUBOE     EQU     X'41'  TAPE UNIT BUS OUT WITH EVEN PARITY  15
000042                             117+TUBOO     EQU     X'42'  TAPE UNIT BUS OUT WITH ODD PARITY  16
000044                             118+RESET     EQU     X'44'  RESET THE CHECK/SYSTEM RESET LATCH  17
000048                             119+SDC1      EQU     X'48'  FIRST SKEW DETECTION AND CONTROL  18
000050                             120+INTAG     EQU     X'50'  IN TAGS TO ATTACHMENT  19
000060                             121+ABI       EQU     X'60'  DATA BUS INTO ATTACHMENT  20
000081                             122+DREG      EQU     X'81'  TRANSFER THE D REGISTER TO AN LSR  21
000082                             123+SPIN1     EQU     X'82'  SPARE INBOUND REGISTER  22
000084                             124+SHIFTRT   EQU     X'84'  SHIFT RIGHT ONE POSITION  23
000088                             125+PET       EQU     X'88'  PHASE ERRORS BY TRACK  24
000090                             126+SKB       EQU     X'90'  SKEW BUFFERS OUTPUT  25
0000A0                             127+ABO       EQU     X'A0'  DATA BUS OUT FROM ATTACHMENT  26
                                   129+*BRANCH ON CONDITION                28
000000                             130+*ALU0     EQU     X'00'  ALU OUTPUT IS EQUAL TO 0  29
000001                             131+*NC       EQU     X'01'  NOT ALU CARRY OUT  30
000002                             132+*BBUS     EQU     X'02'  B BUS PARITY ODD  31
000003                             133+*DBUS     EQU     X'03'  D BUS PARITY ERROR  32
000004                             134+*INTRPT   EQU     X'04'  INTERRUPT FROM THE TAPE UNIT  33
000005                             135+*SP1      EQU     X'05'  SPARE BRANCH ON CONDITION  34
000006                             136+*TACH     EQU     X'06'  TACH           35
000007                             137+*XFRWTDA  EQU     X'07'  TRANSFER THE WRITE DATA  36
000008                             138+*CRO      EQU     X'08'  CHECK RESET OUT  37
000009                             139+*SNS      EQU     X'09'  SENSE TAG      38
00000A                             140+*SIO      EQU     X'0A'  START I/O TAG  39
00000B                             141+*LIO      EQU     X'0B'  LOAD I/O TAG  40
00000C                             142+*PBE      EQU     X'0C'  P-BIT ENVELOPE  41
00000D                             143+*NDATRDY  EQU     X'0D'  SKEW BUFFERS EMPTY  42
00000E                             144+*BOB      EQU     X'0E'  BEGINNING OF BLOCK  43
00000F                             145+*IBG      EQU     X'0F'  END OF RECORD DETECTED  44
000010                             146+*DREG0    EQU     X'10'  D REGISTER BIT 0  45
000011                             147+*DREG1    EQU     X'11'  D REGISTER BIT 1  46
000012                             148+*DREG2    EQU     X'12'  D REGISTER BIT 2  47
000013                             149+*DREG3    EQU     X'13'  D REGISTER BIT 3  48
000014                             150+*DREG4    EQU     X'14'  D REGISTER BIT 4  49
000015                             151+*DREG5    EQU     X'15'  D REGISTER BIT 5  50
000016                             152+*DREG6    EQU     X'16'  D REGISTER BIT 6  51
000017                             153+*DREG7    EQU     X'17'  D REGISTER BIT 7  52
000018                             154+*NCO      EQU     X'18'  NOT COMMAND OUT TAG  53
000019                             155+*ADO      EQU     X'19'  ADDRESS OUT TAG  54
00001A                             156+*NSVO     EQU     X'1A'  NOT SERVICE OUT  55
00001B                             157+*INTSEL   EQU     X'1B'  INTERRUPT SELECT  56
00001C                             158+*NSKEW    EQU     X'1C'  NOT EXCESSIVE SKEW  57
00001D                             159+*TM       EQU     X'1D'  TAPE MARK      58
00001E                             160+*NCUFEAT  EQU     X'1E'  NO CONTROL UNIT FEATURE  59
00001F                             161+*JSTENBL  EQU     X'1F'  ENABLE HAS JUST BEEN SWITCHED ON  60
```

```
 LOC  OBJECT CODE    ADDR1 ADDR2  STMT   SOURCE STATEMENT                                  F01FEB69  12/13/71
                                   361 TAGCHK1  BU    TAGCHK                                          00001050
000002 6065                        364 IDLE     STO   R8,ZERO          CLEAR IDLE                    00001060
000003 0800                        367          STO   R9,ZERO            COUNTER                     00001070
000004 0900                        370          BOC   CRO,CKRST        BRANCH ON CHECK RESET         00001080
000005 28E6                        373 IDLE1    BOC   ADO,ADROUT       BRANCH ON ADDRESS OUT         00001090
000006 3951                        376          ADD   R8,X'01'         ADD ONE TO COUNT              00001100
000007 A801                        379          BOC   NC,IDLE1         BRANCH IF NO CARRY            00001110
000008 2106                        382          BOC   ADO,ADROUT       BRANCH ON ADDRESS OUT         00001120
000009 3951                        385          ADD   R9,X'01'         ADD ONE TO COUNT              00001130
00000A A901                        388          BOC   NC,IDLE1         BRANCH IF NO CARRY            00001140
00000B 2106

00000C 3951                        392          BOC   ADO,ADROUT       BRANCH ON ADDRESS OUT         00001160
00000D 4350                        395          XFR   R3,INTAG         TURN ON I/O WORKING           00001170
00000E 9000                        398          NOP1                                                 00001180
00000F 3951                        401          BOC   ADO,ADROUT       BRANCH ON ADDRESS OUT         00001190
000010 66EE                        404          BU    IDLE2                                          00001200
```

```
 LOC  OBJECT CODE    ADDR1 ADDR2  STMT   SOURCE STATEMENT                                  F01FEB69  12/13/71
                                  1158 ************************************                00004470
                                  1159 *                                  *                00004480
                                  1160 * SYSTEM 3 TAPE SYSTEM CHECK RESET *                00004490
                                  1161 *                                  *                00004500
                                  1162 ************************************                00004510
                                  1163 *                                  *                00004520
                                  1164 * WHEN A CHECK RESET IS ISSUED     *                00004530
                                  1165 * THE TAPE SYSTEM WILL RESET ALL   *                00004540
                                  1166 * SENSE BYTES.                     *                00004550
                                  1167 * THE STATUS OF EACH TAPE UNIT     *                00004560
                                  1168 * WILL THEN BE UPDATED.            *                00004570
                                  1169 *                                  *                00004580
                                  1170 ************************************                00004590

0000E6 5E50                       1173 CKRST    XFR   R30,INTAG         I/OWO METER ON                00004610
0000E7 0603                       1176 CKRST1   STO   R6,X'03'          SET TIE BYTE TO NO TRK FOUND  00004620
0000E8 0C00                       1179          STO   R12,X'00'         SET TO PE                     00004630
0000E9 0D01                       1182          STO   R13,X'01'         CLEAR SNS 0                   00004640
0000EA 0E00                       1185          STO   R14,X'00'         CLEAR SNS 5                   00004650
0000EB 0F00                       1188          STO   R15,ZERO          CLEAR DIAG REG                00004660
0000EC 1100                       1191          STO   R17,X'00'         CLEAR SNS 3                   00004670
0000ED 1200                       1194          STO   R18,X'00'         CLEAR SNS 1                   00004680
0000EE 5148                       1197          XFR   R17,SDC1                                        00004690
0000EF 5118                       1200          XFR   R17,SDC2                                        00004700
0000F0 5144                       1203          XFR   R17,RESET         RESET CHECK RESET LATCH       00004710
0000F1 1000                       1206          STO   R16,ZERO          GOOD PARITY TO R16            00004720
0000F2 1700                       1209          STO   R23,ZERO           & R23                        00004730
0000F3 63AD                       1212 END004   BU    STOZERO                                         00004740
```

```
LOC  OBJECT CODE    ADDR1 ADDR2  STMT   SOURCE STATEMENT                                  F01FEB69  12/13/71

                                 1766 ************************************                      00007090
                                 1767 *                                  *                      00007100
                                 1768 *    COUNT  TIME                   *                      00007110
                                 1769 *                                  *                      00007120
                                 1770 *        NORMAL EXIT IS VIA R22    *                      00007130
                                 1771 *        ERROR EXIT IS VIA R16     *                      00007140
                                 1772 *                                  *                      00007150
                                 1773 ************************************                      00007160

000196 5005                      1776 COUNT    XER   HI,LSRS                                    00007180
000197 A801                      1779 COUNT1   ADD   R27,X'01'          ADD ONE TO LO COUNT     00007190
000198 219D                      1782         BOC   NC,COUNT2                                  00007200
000199 AC01                      1785         ADD   R28,X'01'          ADD ONE TO HI COUNT     00007210
00019A 219E                      1788         BOC   NC,COUNT3                                  00007220
00019B 4005                      1791         XER   LO,LSRS                                    00007230
00019C 5022                      1794         XER   R16,IC             COUNT RAN OUT           00007240

00019D 209E                      1798 COUNT2   NOP2                                           00007260
00019E 209E                      1801         NOP2                                           00007270
00019E 4005                      1804 COUNT3   XER   LO,LSRS                                    00007280
0001A0 5622                      1807         XER   R22,IC             RETURN                  00007290
```

```
 LOC  OBJECT CODE    ADDR1 ADDR2  STMT   SOURCE STATEMENT                                  F01FEB69  12/13/71
                                  1810 ************************************                            00007310
                                  1811 *                                  *                            00007320
                                  1812 *   WRITE TACH COUNT CONTROL       *                            00007330
                                  1813 *                                  *                            00007340
                                  1814 ************************************                            00007350
0001A1 12EC                       1816 ENDVEL1  STO   R18,X'EC'           SET CNT 4 FOR TIME TACH      00007360
0001A2 09F0                       1819          STO   R9,X'F0'            SET CNT 16 FOR TIME TACH     00007370
0001A3 1814                       1822 ENDVEL2  STO   R27,X'14'           WAIT 5.0MSEC FOR FIRST TACH  00007380
0001A4 1CFA                       1825          STO   R28,X'FA'           WRITE OPS                    00007390
0001A5 16A6                       1828 TACCNT22 STO   R22,TACCOUNT                                     00007400

                                  1832 ************************************                            00007430
                                  1833 *                                  *                            00007440
                                  1834 *        TACH  COUNT  ROUTINE      *                            00007450
                                  1835 *                                  *                            00007460
                                  1836 *        NORMAL EXIT IS VIA R20    *                            00007470
                                  1837 *                                  *                            00007480
                                  1838 ************************************                            00007490

0001A6 5205                       1842 TACCOUNT XFR   HI,LSRS                                          00007520
0001A7 26AA                       1845          BOC   TACH,TACHUP         TACH UP                      00007530
0001A8 8810                       1848          ORI   R24,X'10'           SET STAT                     00007540
0001A9 33AC                       1851          BOC   DREG3,TACHDOWN                                   00007550

0001AA 9800                       1855 TACHUP   ORM   R24,X'00'           CHECK STAT                   00007570
0001AB 3382                       1858          BOC   DREG3,CNTTACH                                    00007580
0001AC 17FF                       1861 TACHDOWN STO   R23,X'FF'           SET UP NOP WAIT              00007590
0001AD A701                       1864 WAITO17  ADD   R23,X'01'                                        00007600
0001AE 21AD                       1867          BOC   NC,WAITO17          WAIT OVER                    00007610
0001AF 9000                       1870          NOP1                                                   00007620
0001B0 9000                       1873          NOP1                                                   00007630
0001B1 6197                       1876          BU    COUNT1              TO COUNT ROUTINE             00007640

0001B2 C8FF                       1880 CNTTACH  AND   R24,X'FF'           CLEAR STAT                   00007660
0001B3 A001                       1883          ADD   R25,X'01'           1 TO TACH COUNT              00007670
0001B4 21B8                       1886          BOC   NC,CLRCNTN          CARRY                        00007680
0001B5 AA01                       1889          ADD   R26,X'01'           1 TO HI TACH COUNT           00007690
0001B6 21BD                       1892          BOC   NC,CLRCNT           CARRY                        00007700
0001B7 4005                       1895          XFR   LO,LSRS                                          00007710
0001B8 9F00                       1898          ORM   R15,ZERO            IS THIS                      00007720
0001B9 34E7                       1901          BOC   DREG4,SKEWCMD1          A SKEW COMMAND          00007730
0001BA 5422                       1904          XFR   R20,IC              RETURN                       00007740

0001BB 20BC                       1908 CLRCNTN  NOP2                                                   00007760
0001BC 20BD                       1911          NOP2                                                   00007770
0001BD 1B00                       1914 CLRCNT   STO   R27,X'00'           CLEAR COUNT                  00007780
0001BE 1C00                       1917          STO   R28,X'00'           CLEAR COUNT                  00007790
0001BF 6197                       1920          BU    COUNT1              TO COUNT ROUTINE             00007800
```

```
000228 9800          2225 TIMETAC  ORM   R8,X'00'          TU SENSE BYTE 1                          00008990
000230 5005          2228          XFR   HI,LSRS                                                    00009000
000231 3746          2231          BOC   DREG7,WINPAR      WINTER PARK                              00009010
000232 3642          2234          BOC   DREG6,FIR3        FIR 3                                    00009020
000233 BB6D          2237          ADDM  R27,X'6D'         LO COUNT                                 00009030
000234 2137          2240          BOC   NC,RESET4         TO SMALL - LESS THAN 474.5 MICROSEC      00009040
000235 BB5C          2243          ADDM  R27,X'5C'         LO COUNT                                 00009050
000236 2154          2246 CHKLOW1  BOC   NC,ADD4           OK                                       00009060

000237 12EC          2250 RESET4   STO   R18,X'EC'         LO COUNT MORE THAN 527.8 MICROSEC        00009080
000238 4005          2253 ADD16    XFR   LO,LSRS                                                    00009090
000239 A901          2256          ADD   R9,X'01'          1 TO 16 COUNT                            00009100
00023A 214F          2259          BOC   NC,TIMEMORE       NO BRANCH IF 16 TACHS COUNTED            00009110
00023B EFE7          2262          XOM   R15,X'E7'         IS THIS A END VELOCITY CHECK             00009120
00023C 204A          2265          BOC   ALUO,ENDVELCK     BRANCH IF SO                             00009130
00023D 1210          2268          STO   R18,X'10'         SET START VELOCITY CHECK                 00009140
00023E EA10          2271          XOM   R10,X'10'         TAPE UNIT                                00009150
00023F 3341          2274          BOC   DREG3,STOPTAPO      AT LOAD POINT                          00009160
000240 BE02          2277          ORI   R14,X'02'         SET P-BURST CHECK                        00009170
000241 6A48          2280 STOPTAPO BU    STOPTAP                                                    00009180

000242 BBDB          2284 FIR3     ADDM  R27,X'DB'                                                  00009200
000243 2137          2287          BOC   NC,RESET4         GO COUNT                                 00009210
000244 BB06          2290          ADDM  R27,X'D6'         TOO SMALL                                00009220
000245 6236          2293          BU    CHKLOW1           LO COUNT                                 00009230

000246 BBB7          2297 WINPAR   ADDM  R27,X'B7'         LO COUNT                                 00009250
000247 2137          2300          BOC   NC,RESET4         TOO SMALL                                00009260
000248 BBAD          2303          ADDM  R27,X'AD'         LO COUNT                                 00009270
000249 6236          2306          BU    CHKLOW1                                                    00009280

00024A 0E00          2310 ENDVELCK STO   R15,ZERO          CLEAR THE DIAGNOSTIC REGISTER            00009300
00024B BD10          2313          ORI   R13,X'10'         SET DATA CHECK                           00009310
00024C 5005          2316          XFR   HI,LSRS           SET THE HIGH LSRS                        00009320
00024D 8140          2319          ORI   R17,X'40'         SET END VELOCITY CHECK                   00009330
00024E 63AA          2322 CTUDIAG1 BU    CTUDIAG           GET OUT                                  00009340

00024F 19FF          2326 TIMEMORE STO   R25,X'FF'         TACH COUNT                               00009360
000250 1AFF          2329          STO   R26,X'FF'         EQUAL 1                                  00009370
000251 1B00          2332          STO   R27,X'00'         CLEAR                                    00009380
000252 1C00          2335          STO   R28,X'00'         COUNT                                    00009390
```

```
  LOC  OBJECT CODE    ADDR1 ADDR2  STMT   SOURCE STATEMENT                                    F01FEB69  12/13/71
000253 6196                       2338 PBWRT6   BU    COUNT          TO COUNT ROUTINE                    00009400
000254 EC00                       2341 ADD4     XOM   R28,ZERO       HIGH COUNT                          0000941C
000255 2057                       2344          BOC   ALU0,ADD4A     OK                                  00009420
000256 6237                       2347          BU    RESET4         BAD                                 00009430
000257 A201                       2350 ADD4A    ADD   R18,X'01'      1 TO 4 COUNT                        00009440
000258 2138                       2353          BOC   NC,ADD16       4 COUNT NOT 4                       00009450
000259 0210                       2356          STO   R2,X'10'       STORE COMMAND TAG OFF               00009460
00025A 4005                       2359          XFR   LO,LSRS                                            00009470
00025B 5011                       2362          XFR   ON,WRTCLOCK    TURN ON THE WRITE CLOCK             00009480
00025C 0900                       2365          STO   R9,ZERO        CLEAR TO BYPASS END VEL ON WTM/ERG  00009490
00025D 5522                       2368          XFR   R21,IC         4 COUNT EQUALS 4 TACHS OK           00009500
```

```
0006FF 5005                       6359 IDLE2    XFR   HI,LSRS                                          00026770
0006F0 9700                       6362          ORM   R23,ZERO       I/O CHECK                           00026780
0006F1 4005                       6365          XFR   LO,LSRS          STAT                              00026790
0006F2 37F4                       6368          BOC   DREG7,IDLE3        ON                             00026800
0006F3 5006                       6371          XFR   ENBLCHG,TRNSF   ENABLE OFF LINE                   00026810
0006F4 6011                       6374 IDLE3    BU    UPDATE                                             00026820
```

CROSS-REFERENCE

SYMBOL	LEN	VALUE	DEFN	REFERENCES
AA	00001	0003B8	3489	3471
ADD16	00001	000238	2253	2353
ADD4	00001	000254	2341	2246
ADD4A	00001	000257	2350	2344
ADROUT	00001	000051	0638	0373 0382 0392 0401
BOT	00001	000815	6538	6525
CHKIC	00001	0003D3	3571	3559
CHKLOW1	00001	000236	2246	2293 2306
CKTUVEL	00001	000899	6979	
CKRST	00001	0000E6	1193	0730 2852
CKRST1	00001	0000E7	1176	1228
CLRCNT	00001	0001BD	1914	1892
CLRCNTN	00001	0001BB	1908	1886
CMNDREJ	00001	000139	1439	2548
CNTTACH	00001	0001B2	1880	1858
CONTROL	00001	000093	0874	0849 5083
COUNTHI	00001	000627	5731	5725
COUNT1	00001	000197	1779	1876 1920
COUNT2	00001	00019D	1798	1782
COUNT3	00001	00019F	1804	1788
CRCEVENP	00001	00090F	7339	7333 8948
CTUDIAG	00001	0003AA	3447	2012 2322
CTUDIAG1	00002	00024E	2322	3428
ENDEND	00001	0004A7	4451	1275 3821 4445 4771
ENDVELCK	00001	00024A	2310	2265
ENDVEL1	00001	0001A1	1816	1717 3443
ENDVEL2	00001	0001A3	1822	1711 2528 2725 3839
END004	00002	0000F3	1212	0730
FIRST	00001	000454	4144	4593 4602
FIR3	00001	000242	2284	2234
IDLE	00001	000003	0364	0572 1149
IDLE1	00001	000006	0373	0379 0388
IDLE2	00001	0006EF	6359	0404
IDLE3	00001	0006F4	6374	6368
PBWRT6	00002	000253	2338	2478
PET	00001	000088	0125	4244 4315 4334
REQUEST	00001	0000B3	0983	0963 0973
RESET4	00001	000237	2250	2240 2287 2300 2347
REWDLY1	00001	0004EA	4675	4678 4684 4690
STOPTAPO	00002	000241	2280	2274
TACCNT22	00001	0001A5	1828	1257 1506 4634 4658
TACCOUNT	00001	0001A6	1842	1263 1665 1828 2206 2649 2688 2694 5594
TACFAIL	00001	0001D7	1994	1699 1747 1967 5556 5559 8781
TACHDOWN	00001	0001AC	1861	1851
TACHUP	00001	0001AA	1855	1845
TIMEMORE	00001	00024F	2326	2259
TIMETAC	00001	00022F	2225	1991
TIMETACH	00002	0001D6	1991	1687 3440
WAITHERE	00001	00065C	5897	5897
WAIT011	00001	0000BA	1005	1005
WAIT017	00001	0001AD	1864	1867
WINPAR	00001	000246	2297	2231
WRDA4	00001	000349	3134	3125

Appendix C: Statistical Recording and Analysis

The maintenance strategy of the 3410/3411 Magnetic Tape Subsystem is dependent upon statistical information recorded by the host system. This statistical information is used at two separate times in the repair cycle. The information is first used by a program called Log Analysis which uses the statistics for data reduction and analysis. Later in the repair cycle, if the problem is not isolated, the Statistical Information is again used when you are told to print and interpret the statistics.

This section discusses the statistics which are recorded, Log Analysis and its role, and the utility programs used to print the statistics. This section assumes that you are host system trained, and summarizes information that exists in other publications. The recording and processing of statistical information is discussed in greater detail in both the OS and DOS libraries. See *OS Service Aids*, GC28-6719, Chapter 2: EREP0, and the *DOS System Control and Service Manual*, GC24-5056. Read the "Supervisor" section entitled "Recovery Management Support Recorder (RMSR)" and "System/370 DOS Volume Statistics" and the "Problem Determination" section entitled "The System/370 Environmental Recording, Exhibiting, and Printing" (EREP) program.

Additional operating information is contained in the *DOS Operating Guide*, GC24-5022 under the sections entitled "Problem Determination" and "Operator Reference Information: Commands and Statements." Message information is contained in the *DOS Messages Manual*, GC24-5074.

Statistical Information: What It Is and Why It Is Needed

The performance of the 3410/3411 Magnetic Tape Subsystem is affected by the condition of the magnetic tape. During use, tape is stretched, flexed, and rubbed, causing its oxide coating to crack or to be eroded. Particles of oxide, fingerprints, and dust contaminate its surface, multiplying erosion and breaking contact between the tape and the read/write head.

With statistical information, tape problems can often be separated from device problems. Also, the customer can determine when a reel of tape is causing an excessive number of errors and take the proper corrective action.

If the problems are attributed to a device, statistics can determine the cause of the problem. Temporary errors can be traced and a deteriorating subsystem performance detected. This allows corrective action to be taken before the customer experiences serious problems.

Statistical information is available in two forms: volume statistics and tape unit statistics. The statistics can be obtained in a detail or summary printout.

Following is an explanation of the detail and summary concepts.

Assume five tape volumes, A through E, were used a total of nine times in this order: A, B, C, D, A, D, C, A, E. The detail printout would contain nine entries—three for A, one for B, two for C, etc.—showing the activity (statistics) for each use. The summary printout would contain five entries, one for each volume. The printout would show the three runs with tape A summarized, the one run with tape B, the two runs with tape C summarized, etc. The same scheme is used for the detail and summary printouts of a tape unit's statistics.

Statistics: What Is Recorded

Volume statistics indicate the number, severity, and type of I/O errors that occurred while processing a particular volume (reel of tape), thus providing a tool to assist the customer in maintaining his library and to assist in determining whether a problem is tape or hardware.

System/360 and System/370, through OS and DOS, and System/3, through the Diagnostic Control Program (DCP), provide facilities to record volume and tape unit statistics.

The OS facility is Media Error Statistics (MES), and the DOS facility is Tape Error Statistics (TES). The following information is recorded whenever:

1. A volume is dismounted.
2. A permanent error occurs.
3. The counter overflows.

- The date the record was collected. (Serial number, CPU ID, and machine check extended logout for this CPU).
- The Channel Status Word (CSW).
- The address of the unit on which the volume was mounted and the channel to which the unit was attached.
- The device type code for this device.
- The length (in bytes) of the SDR area.
- The physical unit address.
- The number of I/O retries performed before a good read or good write operation occurred.
- The number of sense bytes used by this device.
- The volume serial number of standard labeled volumes (blank for nonstandard and unlabeled volumes).
- The block length of each record if the volume has fixed-length blocked records. When the type of record is undefined or of variable length, or if the program terminates abnormally (ABEND), a zero appears in the space allocated for block length. A zero also appears when physical IOCS is being used.
- The number of temporary read errors that occurred.
- The number of temporary write errors that occurred.
- The number of Start I/O instructions issued to the tape unit (does not include SIOs issued for or during error recovery).
- The number of permanent read errors that occurred.
- The number of permanent write errors that occurred.
- The number of noise blocks encountered (records less than 12 bytes on a read operation, or less than 18 bytes on a write operation).
- The bit density of the volume (800/1600 for 9-Track tape).
- The number of erase gaps (three inch lengths of erased tape) executed while in write error recovery.
- The number of cleaner actions (passing the record in error back and forth over the cleaner blade) taken while trying to correct read errors.
- The SDR counter area.
- The sense byte data.

How Statistical Information Is Used

Log Analysis (System/3)

The Log Analysis program consists of sections designed to analyze the accumulated system/subsystem error log and to determine the most probable failure. The message output will, whenever possible, identify the most probable field replacement unit (FRU) or, at most, the three most likely FRU's in the order of probability. In some cases a condition other than a failed FRU will be identified and a suggested corrective action given. If further analysis or a more detailed instruction is required the message output will identify a specific MAP entry point, or the loading and execution of another diagnostic program.

On System/3, Log Analysis is executed under control of the Diagnostic Control Program (DCP). The Log Analysis section, FORMAT, reads in the accumulated error log and puts it into a more usable form. The errors are cataloged and analyzed by section LOGANL in the following sequence:

PERMANENT ERRORS

1. Hardware Errors
2. Adapter Checks
3. Equipment Checks
4. Permanent write errors where Loop Write to Read failed
5. Permanent write errors where Loop Write to Read passed
6. Permanent read errors

TEMPORARY ERRORS

1. Temporary errors per volume
2. Temporary errors per unit

LOGANL begins by interrogating the hardware error table. If any hardware entries are found, the specific FRU is isolated and identified. In some cases the hardware error indication is due to a probable adapter (attachment) failure. In this case LOGANL will call the Adapter Fault Locator section. If no hardware errors are found, the Adapter Check table is interrogated. If any adapter check entries are found, the Adapter Fault Locator is executed. If no adapter check entries are found, the Equipment Check table is interrogated. If any Equipment Check entries are found, the most recent entries are analyzed first. Analysis will find and identify the most probable FRU failure or at most, the three most likely. In this manner, table analysis continues according to the established sequence.

If there are no permanent errors and Log Analysis cannot identify a probable FRU failure, suggest another diagnostic, or a MAP entry, section STEP is called. STEP (Statistical Tape Error Printout) will provide the error log with statistics arranged by volume and unit for your interpretation.

Processing Tape Statistical Data

In System/360 and System/370 the operating systems, OS and DOS, provide a program which processes the tape error statistics. In System/3, the program is a part of the diagnostic package and runs under the Diagnostic Control Program (DCP). The programs are IFCEREP0, EREP, and STEP in OS, DOS and System/3, respectively.

OS

In OS the read and write errors along with all environmental records are recorded by the error environment recording program OBR (see Page C-5), and by the recovery management programs SER0, SERI, MDR, CCH, and MCH, and by the Reliability Data Extractor program RDE on SYSI.LOGREC.

Use the utility program IFCEREP0 to retrieve the selected environmental records from the SYSI.LOGREC data set, and to edit and send them to an output device.

To print statistical information certain keywords must be used in the PARM field of the EXEC statement. A summary of the keywords needed to obtain a printout follows:

```
PARM =   TYPE=O,
         MES=Y
         VOLID=(VOLID1,...,VOLID4),
         DEV=3410,
         CUA=xxx,xxx
```

TYPE=O

Indicates the I/O Outboard records, to be processed.

MES=Y

Indicates that error statistics for tape volumes are to be summarized and printed. This parameter is only valid for the 3410 and 3420 tape units, and when Type=O is coded.

VOLID=xxxxxx,xxxxxx,

Indicates specific tape volumes for error statistics processing. A maximum of four volumes can be specified. If this parameter is omitted and MES=Y is coded, all volumes are processed.

DEV=3410

Indicates that selected record types — indicated in the TYPE parameter - for all 3410 tape units are processed. Only one tape unit designation can be specified.

CUA=xxx

Indicates the specific tape unit, by address, for which selected record types are to be processed. A maximum of two tape units can be specified.

There are other parameters which you should know about but may not use because the system defaults provide what is needed. The parameters are:

PRINT, which provides a detail printout, a summary printout, a detail and summary printout, or no printout at all.

PRINT=xx

PS	Provides detail and summary printouts
SU	Provides summary printout only
PT	Provides detail printout only
NO	Suppresses both detail and summary printouts

System default is PS which provides both the detail and summary printouts.

ZERO and ACC, which copy the statistical information in the system data set on a history tape and then clear the system data set. The information is copied on a history tape to prevent overlaying the old information when the data set is full. It is usually copied at the customer's option, for example once a day, or when a LOGREC FULL message is printed. When these parameters are not used, the statistical information is printed out. ZEROY causes 0 (hex) of the input data set (SYS1.LOGREC).

DATE, which prints statistics recorded within a specific time frame.

DATE=yy.ddd

where yy is the year (00-99) and
ddd is the day (001-366)

System default causes the printing of all statistics in the data set.

The following table shows examples of what you might request, followed by the PARM field to use. In all cases, a detail and summary printout result through default.

Example	Volume		Device	
	All	Specific	All	Specific
1			X	
2	X			
3		123456		
4				181

Example 1: PARM='TYPE=0,MES=Y,DEVICE=3410'

Example 2: PARM='TYPE=0,MES=Y'

Example 3: PARM='TYPE=0,MES=Y,VOLID=123456'

Example 4: PARM='TYPE=0,MES=Y,CUA=181'

A typical JCL statement using the PARM of Example 1 would be:

```
//JOBA JOB
// EXEC PGM=IFCEREP0,PARM='TYPE=O,MES=Y,DEVICE=3410'
//SERLOG DD DSNAME=SYS1.LOGREC,DISP=(OLD,KEEP)
//EREPPT DD SYSOUT=A
```

DOS

In DOS the read and write errors per volume and tape unit are monitored by the Tape Error Statistics portion of the Recovery Management Support Recorder (RMSR). The RMSR records all environmental data on the SYSREC file. The tape statistics can be edited and printed or summarized, or the tape error records may be selected or summarized from the complete file through EREP.

The options used to print the statistical information are shown below.

The EREP options are:

```
OPTION TES      ,NOTAPE
                ,PRINT
                ,SUM
                ,VOL

  SELECT        FORMAT=TES
                VOL=xxxxxx
                DEVICE=3410
```

TES

Indicates that tape error statistics are to be processed.

NOTAPE

Indicates that the statistical information is to be printed only; there is no transfer of data to the history data set.

PRINT

Indicates that the statistics are to be printed in detail form.

SUM

Indicates that the statistics are to be printed in summary form.

VOL

Indicates that the statistics are for all tape volumes that are to be processed. If this parameter is omitted the statistics for 2 tape units are processed. For the 3410 , to get a specific volume and a specific tape unit, use the SELECT option with the appropriate search parameters (see following discussions).

SELECT

Indicates the type of records that are to be processed. Several record types can be specified. Those listed below are the ones you must use.

VOLUME=xxxxxx

Indicates the specific tape volumes for error statistic processing. Only one volume can be specified.

DEVICE=3410

Indicates that the statistics for all 3410 tape units are to be processed.

CUA=xxx

Indicates that the statistics for a specific tape unit, by address, are to be processed. Only one device can be specified.

There are parameters, similar to those in OS, which allow the printing of statistics recorded in a specific time frame. When the parameters are not used, all the statistics in the system data set are printed.

This table shows examples of what you might request. Check marks indicate the type of statistics and printout format you may wish to obtain. Following the table are the statements required.

Example	Volume		Device		Printout	
	All	Specific	All	Specific	Detail	Summary
1			X		X	
2			X			X
3	X				X	X
4		X			X	X

Example 1:
```
// EXEC EREP
OPTION TES,NOTAPE,PRINT
```

Example 2:
```
// EXEC EREP
OPTION TES,NOTAPE,SUM
```

Example 3:
```
// EXEC EREP
OPTION TES,NOTAPE,PRINT,SUM,VOL
```

Example 4:
```
// EXEC EREP
OPTION TES,NOTAPE,PRINT,SUM,VOL
SELECT=VOLUME 123456
```

System/3

Magnetic Tape Error Summary Utility ($TVES)

This program provides a printed summary of magnetic tape error statistics by volume and by unit. When it is run periodically, it allows the customer to define and analyze deteriorating tape or subsystem performance.

The tape error statistics logged on the CE tracks on disk storage unit F1 are read into core storage. The statistics (counters) are sorted by tape volume serial number and tape unit. When all available core storage is filled, or when all the statistics have been read from F1, the system print routine, $$SYP1, prints the summary as follows.

Summary Magnetic Tape Error Statistics by Volume

Volume Serial	SIO Count	Temp Read	Temp Write	Write Skip
T1T1T1	00206	0000	0002	0002
T1	00256	0000	0002	0002
,,,,,	00040	0002	0001	0001
BB1	00007	0000	0001	0001

,,,,, Under volume serial stands for all unlabeled tapes and all 1st volumes (other than last) of a multivolume job with more than 2 volumes/unit

***** Under volume serial stands for all nonstandard labeled tapes

Summary Magnetic Tape Error Statistics by Tape Unit

Tape Unit	SIO Count	Temp Read	Temp Write	Write Skip	Diag Track
T1	00469	0000	0005	0005	0000
T2	00014	0000	0001	0001	0000
T4	00026	0002	0000	0000	0000

Tape Units which received no SIO commands are not included in the summary.

The program $TVES is a dedicated program and is loaded from the object library of the system or program disk pack.

```
// LOAD $TVES,xx   (xx=address of system
// RUN                or program unit.)
```

Printout Analysis

Sample printouts which are available through the utility programs are shown on the following pages.

```
SUMMARY OF I/C OUTBOARD ENVIRONMENT RECORDS FOR DEVICE 000202  DEVICE TYPE 3410     TU SERIAL  N/A
                                                                                    CPU MODEL  0155
                                                                                    CPU SERIAL 111111
                        DAY YEAR      DAY YEAR
OUTBOARD DATE RANGE - 001  70   TO  001  70

TOTAL NUMBER OF RECORDS   002

VOLUME LABELS ENCOUNTERED(MAXIMUM OF 10 ENTRIES)

VOL. LABEL  COMONE      002

CCW COMMAND CODES ENCOUNTERED(MAXIMUM OF 24 ENTRIES)
CMND    TOTAL
 03      002
SENSE BYTES SUMMARY

BYTE 0              BYTE 1              BYTE 2              BYTE 3              BYTE 4              BYTE 5
CMND REJ    000     NOISE       000     TRK ERR 0  000     VRC         000     TU POS CHK 000      NEW SUBSY  000
INTV REQ    000     TU STAT A   000     TRK ERR 1  000     MTE/LRCR    000     TU REJECT  000      NEW SUBSY  000
BUS O CHK   000     TU STAT B   000     TRK ERR 2  000     SKEW        002     ECT        000      WRT TM CHK 000
EQUIP CHK   000     RESERVED    000     TRK ERR 3  000     EDC/CRCR    000     RESERVED   000      PE ID BUR  000
DATA CHK    000     LOAD PT     000     TRK ERR 4  000     ENV CHECK   000     RESERVED   000      ERG CHECK  000
OVERRUN     000     WRT STA     000     TRK ERR 5  000     1600 BPI    002     D TRK ERR  002      TACH ERR   002
WRD CNT     000     FILE PROT   002     TRK ERR 6  000     BACKWARD    000     TU CHECK   000      FALSE END  002
RESERVED    002     NOT CAP     000     TRK ERR 7  000     RESERVED    000     ILL CMND   002      RPQ        000

BYTE 6              BYTE 7              BYTE 8
RESERVED    000     LAMP FAIL   000     RESERVED   000
SHORT GAP   000     LFT CL CHK  000     FEED THRU  000
DUAL DEN    000     RHT CL CHK  000     RESERVED   000
800 BPI     000     RES-DCOR    000     END V CHK  000
                    DSE         002     TAPE V CHK 002
                    RESERVED    000     ST VEL CHK 000
                    RESERVED    000     RESERVED   000
                    RESERVED    000     VEL RETRY  002

SDR AREA                                                                    DEVICE DEPENDENT COUNTERS
NOISE       0002    RESERVED    0000    END V CHK  0002    BACKWARD   0000  TEMP RDS   00004
VRC         0002    WRT TM CHK  0002    TAPE V CHK 0002    BUS O CHK  0000  TEMP WRTS   00006
MTE/LRCR    0002    ERG CHK     0002    ST V CHK   0002    TU POS CHK 0000  SIG COUNT  32767
EDC/CRCR    0002    TACH CHK    0002    RESERVED   0002                     ERASE GAPS 00006
ENV CHECK   0002    FALSE END   0002    VEL RETRY  0002                     CLEAN ACTS 49744
OVERRUN     0000    RESERVED    0002    RESERVED   0002                     NOISE RCD  00004
SKEW        0000    FEED THRU   0002    PE ID CHK  0002
RESERVED    0000


NO REQUESTED CPU RECORDED SINCE LAST EDIT

NO REQUESTED CCH RECORDED SINCE LAST EDIT

NO REQUESTED IPL RECORDED SINCE LAST EDIT

NO REQUESTED ECD RECORDED SINCE LAST EDIT

NO REQUESTED TP  RECORDED SINCE LAST EDIT
```

```
--- RECORD ENTRY SOURCE - OBR          TYPE -OUTBOARD      MODEL- 0155      SERIAL NO. 111111

   OS   REL.   21

 DEVICE      PRIMARY     SECONDARY   PROGRAM     VOLUME      MODE        DATE        TIME
 TYPE        CUA         CUA         IDENTITY    SERIAL      SET         DAY YR      HH MM SS.TH
 3410        000202      000352      NUTS        DUMONE      02          001 70      00 35 54 84

                CC    CA     FL    CT                                    K    CA     US CS  CT
FAILING CCW     03  003450   80 00 0289                          CSW     00 654320   0C 00 0069

UNIT STATUS       BYTE 0              BYTE 1              BYTE 2              BYTE 3              BYTE 4              BYTE 5
ATTENTION     0   CMND REJECT   0     NOISE         0     TRK ERR 0     0     VRC           0     TU POSN CHK   0     NEW SUBSY     0
STATUS MODIF  0   INTV REQUEST  0     TU STAT A     0     TRK ERR 1     0     MTE/LRCR      0     TU REJECT     0     NEW SUBSY     0
CONT UN END   0   BUS OUT CHK   0     TU STAT B     0     TRK ERR 2     0     SKEW          1     EOT           0     WRT TM CHK    0
BUSY          0   EQUIP CHK     0     RESERVED      0     TRK ERR 3     0     EDC/CRCR      0     RESERVED      0     PE ID BUR     0
CHANNEL END   1   DATA CHECK    0     LOAD POINT    0     TRK ERR 4     0     ENV CHECK     0     RESERVED      0     ERG CHECK     0
DEVICE END    1   OVERRUN       0     WRITE STA     0     TRK ERR 5     0     1600 BPI      1     DIAG TRK ERR  1     TACH CHK      1
UNIT CHECK    0   WRD COUNT     0     FL PROT       1     TRK ERR 6     0     BACKWARD      0     TU CHECK      0     FALSE END CHK 1
UNIT EXCEP    0   RESERVED      1     NOT CAPABLE   0     TRK ERR 7     0     RESERVED      0     ILLEGAL CMND  1     RPQ           0

BYTE 6            BYTE 7              BYTE 8
RESERVED      0   LAMP FAIL     0     RESERVED      0
SHORT GAP     0   LEFT COL CHK  0     FEED THRU     0
DUAL DEN      0   RHT COL CHK   0     RESERVED      0
800 BPI       0   RES-DCOR      0     END VEL CHK   0
                  DSE           1     TAPE VEL CHK  1
MODEL         3   RESERVED      0     ST VEL CHK    0
                  RESERVED      0     RESERVED      0
                  RESERVED      0     VEL RETRY     1

SDR AREA                                                                                    DEVICE DEPENDENT INFORMATION
NOISE       0001    RESERVED    0000    TAPE VEL CHK  0001                                  BLOCK LENGTH  00016
VRC         0001    WRT TM CHK  0001    ST VEL CHK    0001    PE ID CHK      1              TEMP RDS      0004
MTE/LRCR    0001    ERG CHECK   0001    RESERVED      0001                                   TEMP WRTS     0006
EDC/CRCR    0001    TACH CHK    0001    RESERVED      0001    TRK IN ERR  011111111        SIG COUNT     32767
ENV CHECK   0001    FALSE END CHK 0001  VEL RETRY     0001                                   ERASE GAPS    00006
OVERRUN     0000    RESERVED    0001    RESERVED      0001    BACKWARD       0000           CLEAN ACTS    00007
SKEW        0000    FEED THRU   0001    RESERVED      0000    BUS OUT CHK    0000
RESERVED    0000    RESERVED    0000    RESERVED      0000    TU PCSN CHK    0000

   HEX DUMP OF RECORD
   HEADER   3015C800    C00C0000    0C70001F    00355484        00111111    01550000

      0000  C5E4E3E2    40404040    03003450    80000289        00654321    0C000069    03000352    00008003
      0020  14000202    0CC80018    C4E4D4D6    D5C90010        00000000    04067FFF    02030402    00060007
      0040  CC010101    01010000    80FF1111    11011111        01000000    01020024    05060208    09
```

```
.D FF00. PROG 7130-01. SSWS

                                PERMANENT ERROR     DATE  02/10/72  1

Q              BYTE 0          BYTE 1          BYTE 2          BYTE 3          BYTE 4          BYTE 5
BYTE
01100010       NOISE      0    RESERVED   0    BACKWARD   0    TM CHECK   0    RESERVED   0    RESERVED   0
               WLR        0    CMND REJ   0    N FILE PT  1    ED VEL CK  0    SHT GAP    0    MTE/LRCR   0
               UNIT EXC   0    BCK LP PT  0    EOT        0    TU POS CK  0    DUAL DEN   0    DATA T ER  0
VOLUME         DATA CHK   1    ST VEL CK  0    BOT        0    REJECT TU  0    NRZI DEN   0    EDC/CRC    0
 M4272         DIA TK ER  0    ILL CMD    0    WRT STAT   1    WR FED CK  0    TU MODEL   0    ENV CK     1
               NO OP      0    TU STA CH  0    START KY   1    TP VEL CK  0    TU MODEL   0    FALS E MK  0
R              EQUIP CHK  0    WRD CNT 0  0    UNIT CHK   0    TACH FAIL  0    TU MODEL   0    PE ID CHK  0
BYTE           SENSE VAL  1    NOT CAP    0    NOT BUSY   1    OVERRUN    0    TU MODEL   1    VRC ERROR  1
00000000

BYTE 6          BYTE 7          BYTE 8          BYTE 9

LAMP FAIL  0    TRK ERR 0  0    RESERVED   0    ADD OUT    0
TP BOT LF  0    TRK ERR 1  0    ABI PAR    0    SER OUT    0
TP BOT RH  0    TRK ERR 2  0    ABO PAR    0    CMND OUT   0
RESET KEY  0    TRK ERR 3  0    CU O/L     0    ADD IN     0
DSE        0    TRK ERR 4  1    2 TAG ERR  0    SER IN     0
RESERVED   0    TRK ERR 5  0    CU BUSY    0    CMND IN    0
RESERVED   0    TRK ERR 6  0    SEQ ER     0    STAT IN    0
RESERVED   0    TRK ERR 7  0    SEN INVAL  0    RESERVED   0

                                PERMANENT ERROR     DATE  02/10/72  1

Q              BYTE 0          BYTE 1          BYTE 2          BYTE 3          BYTE 4          BYTE 5
BYTE
01110010       NOISE      0    RESERVED   0    BACKWARD   0    TM CHECK   0    RESERVED   0    RESERVED   0
               WLR        0    CMND REJ   0    N FILE PT  1    ED VEL CK  0    SHT GAP    0    MTE/LRCR   0
               UNIT EXC   0    BCK LP PT  0    EOT        0    TU POS CK  0    DUAL DEN   0    DATA T ER  0
VOLUME         DATA CHK   1    ST VEL CK  0    BOT        0    REJECT TU  0    NRZI DEN   0    EDC/CRC    0
 M4272         DIA TK ER  0    ILL CMD    0    WRT STAT   1    WR FED CK  0    TU MODEL   0    ENV CK     1
               NO OP      0    TU STA CH  0    START KY   1    TP VEL CK  0    TU MODEL   0    FALS E MK  0
R              EQUIP CHK  0    WRD CNT 0  0    UNIT CHK   0    TACH FAIL  0    TU MODEL   0    PE ID CHK  0
BYTE           SENSE VAL  1    NOT CAP    0    NOT BUSY   1    OVERRUN    0    TU MODEL   1    VRC ERROR  1
00000000

BYTE 6          BYTE 7          BYTE 8          BYTE 9

LAMP FAIL  0    TRK ERR 0  0    RESERVED   0    ADD OUT    0
TP BOT LF  0    TRK ERR 1  0    ABI PAR    0    SER OUT    0
TP BOT RH  0    TRK ERR 2  0    ABO PAR    0    CMND OUT   0
RESET KEY  0    TRK ERR 3  0    CU O/L     0    ADD IN     0
DSE        0    TRK ERR 4  1    2 TAG ERR  0    SER IN     0
RESERVED   0    TRK ERR 5  0    CU BUSY    0    CMND IN    0
RESERVED   0    TRK ERR 6  0    SEQ ER     0    STAT IN    0
RESERVED   0    TRK ERR 7  0    SEN INVAL  0    RESERVED   0

     ID FF00. PROG 7130-01. SSWS
     DCP-SECTION TERMINATED.
```

The example printout for System/3, in the area of summary and detail by tape unit and detail by volume, have one position reserved for tape unit address. To accomplish this the address portion of the Q byte is shifted left and the results follow:

Address Command

01100 010 = TU0 = C
01101 010 = TU1 = D
01110 010 = TU2 = E
01111 010 = TU3 = F

The Q bytes are shown in the upper left corner of the permanent error printout. The volume in error is right below the Q byte.

This example was run on a System/3 and the error indicates two permanent error logouts. After analyzing all available data the conclusion is that the error is probably track four on tape unit E.

The method for determining the error follows:

1 The permanent errors indicated both tape units C and E had failed, however the same volume (M4272) is shown in error on both tape units. A premature conclusion might be that volume M4272 is the source of the error. Further analysis will change this conclusion.

ID 0F00. PROG 7140-01. SSWS

SUMMARY TAPE ERROR STATISTICS BY VOLUME

VOLUME	SIO CNT	WRIT SKIP	TEMP WRIT	TEMP RDF	TEMP RDB	NOISE
D4920	00005DC4	00000000	00000000	00000000	00000006	00000000
D4909	00005DC4	00000000	00000000	00000000	00000005	00000000
D4463	00001B5A	00000000	00000000	00000000	00000001	00000000
D4876	00001B5A	00000000	00000000	00000000	00000002	00000001
D5020	00002EE2	00000000	00000000	00000000	00000001	00000000
D5019	00002EE2	00000000	00000000	00000000	00000001	00000000
D4899	00005DC4	00000000	00000000	00000000	00000005	00000000
D4372	000038A5	00000009	00000009	00000000	00000003	00000000
D5015	00002DE4	00000001	00000001	00000000	00000000	00000000
D5014	0000A854	00000001	00000001	00000000	00000008	00000000
D4373	0000E768	00000005	00000005	00000000	0000000D	00000000
D4610	00007478	00000000	00000000	00000000	00000005	00000000
J4890	00003684	00000000	00000000	00000000	00000003	00000000

DETAIL TAPE ERROR STATISTICS BY VOLUME

VOLUME	DATE	Q	SIO CNT	WRIT SKIP	TEMP WRIT	TEMP RDF	TEMP RDB	DEN-SITY	DEV TYP	BLOK LNTH	NOISE
D4920	021072	E	2EE2	00	00	00	04	1600	01	0800	00
	021072	E	2EE2	00	00	00	02	1600	01	0800	00
D4909	021072	E	2EE2	00	00	00	04	1600	01	0800	00
	021072	D	2EE2	00	00	00	01	1600	01	0800	00
D4463	021172	D	1B5A	00	00	00	01	1600	01	0800	00
D4876	021172	D	1B5A	00	00	00	02	1600	01	0800	01
D5020	021172	E	2EE2	00	00	00	01	1600	01	0800	00
D5019	021172	E	2EE2	00	00	00	01	1600	01	0800	00
D4899	021172	E	2EE2	00	00	00	02	1600	01	0800	00
	021172	E	2EE2	00	00	00	03	1600	01	0800	00
D4372	020872	E	38A5	09	09	00	03	1600	01	0800	00
D5015	020872	D	2DE4	01	01	00	00	1600	01	0800	00
D5014	020972	F	381C	01	01	00	00	1600	01	0800	00
	020972	E	381C	00	00	00	06	1600	01	0800	00
	020972	E	381C	00	00	00	02	1600	01	0800	00
D4373	020972	E	39A7	00	00	00	07	1600	01	0800	00
	020972	E	39EB	05	05	00	00	1600	01	0800	00
	020972	E	39EB	00	00	00	04	1600	01	0800	00
	020972	E	39EB	00	00	00	02	1600	01	0800	00
D4610	020972	E	3A3C	00	00	00	03	1600	01	0800	00
	020972	E	3A3C	00	00	00	02	1600	01	0800	00
J4890	021572	C	1B5A	00	00	00	02	1600	01	0800	00
	021572	C	1B5A	00	00	00	01	1600	01	0800	00

2 The summary of Tape Error Statistics by volume shows no errors on volume M4272.

3 The detail by volume shows no error records for volume M4272. Tape unit E shows more errors on other volumes.

SUMMARY TAPE ERROR STATISTICS BY TAPE UNIT

Q	SIO CNT	WRIT SKIP	TEMP WRIT	TEMP RDF	TEMP RDB	DIAG TRAK	TAPE VEL	TAPE MARK	NO RDBD	OVER RUN	SHRT GAPS	MULT TRAK	END DATA	ENVP CHEK	FLSE END	PEID BRST	VRC ERR	CRSS TALK
C	00003684	0000	0000	0000	0003	0000	0000	0000	0000	0000	0000	0000	0002	0000	0000	0000	0002	0000
D	0000937A	0001	0001	0000	0004	0000	0001	0000	0000	0000	0000	0000	0002	0001	0000	0001	0001	0000
E	00034CEB	000E	000E	0000	002E	0000	0000	0000	0000	0000	0000	0002	0002	003C	0000	0000	0038	0000
F	0000381C	0001	0001	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0001	0000	0000	0001	0000

4 The summary by tape unit analysis indicates that the predominate errors are on tape unit E. The SIO count is high compared to other tape units, therefore the error count would be higher and is inconclusive. Also note that tape unit C, one of the units with a permanent error recorded, shows practically no errors at all.

5

DETAIL TAPE ERROR STATISTICS BY TAPE UNIT

Q	DATE	SIO CNT	DEN-SITY	BLOK LNTH	NV UO L S	N O I S	WS RK TI P	TW ER MT P	TR ED MF P	TR ED MB P	DT IR AA GK	SV TE RL T	EV NE DL	TM AA PR EK	CT RA SL SK	NB OA RC DK	OR VU EN R	SG HA RP TS	MTE URR LAR TK	ED NA DT A	EC NH VE PK	FE LN SD E	PB ER IS DT	VE RR CR	TIE BYTE TRACK 01234567
C	021572	1B5A	1600	0800	01	00	00	00	00	01	00	00	00	00	00	00	00	00	0000	01	00	00	00	01	00010000
D	021172	1B5A	1600	0800	01	00	00	00	00	01	00	00	00	00	00	00	00	00	0000	01	00	00	00	00	00000000
D	021172	1B5A	1600	0800	01	01	00	00	00	02	00	00	00	00	00	00	00	00	0000	01	00	00	00	00	00000000
D	020872	2DE4	1600	0800	01	00	01	01	00	00	00	01	00	00	00	00	00	00	0000	00	00	00	01	00	00000000
D	021072	2EE2	1600	0800	01	00	00	00	00	01	00	00	00	00	00	00	00	00	0000	00	01	00	00	01	00000100
E	021072	2EE2	1600	0800	01	00	00	00	00	04	00	00	00	00	00	00	00	00	0000	00	04	00	00	04	00004000
E	021072	2EE2	1600	0800	01	00	00	00	00	04	00	00	00	00	00	00	00	00	0000	00	04	00	00	04	00003100
E	021172	2EE2	1600	0800	01	00	00	00	00	01	00	00	00	00	00	00	00	00	0000	00	01	00	00	01	00001000
E	021172	2EE2	1600	0800	01	00	00	00	00	01	00	00	00	00	00	00	00	00	0000	00	01	00	00	01	00001000
E	021172	2EE2	1600	0800	01	00	00	00	00	02	00	00	00	00	00	00	00	00	0000	00	02	00	00	02	00002000
E	021172	2EE2	1600	0800	01	00	00	00	00	03	00	00	00	00	00	00	00	00	0000	00	03	00	00	03	00003000
E	020872	38A5	1600	0800	01	00	09	09	00	03	00	00	00	00	00	00	00	00	0001	01	0C	00	00	0B	0000B000
E	020972	39A7	1600	0800	01	00	00	00	00	07	00	00	00	00	00	00	00	00	0000	00	07	00	00	07	00007000
E	020972	3A3C	1600	0800	01	00	00	00	00	03	00	00	00	00	00	00	00	00	0001	01	03	00	00	03	00002000
E	020972	3A3C	1600	0800	01	00	00	00	00	02	00	00	00	00	00	00	00	00	0000	00	02	00	00	02	00002000
E	020972	39EB	1600	0800	01	00	05	05	00	00	00	00	00	00	00	00	00	00	0000	00	05	00	00	05	00004100
E	020972	381C	1600	0800	01	00	00	00	00	06	00	00	00	00	00	00	00	00	0000	00	06	00	00	06	00006000
E	020972	381C	1600	0800	01	00	00	00	00	02	00	00	00	00	00	00	00	00	0000	00	02	00	00	02	00002000
E	020972	39EB	1600	0800	01	00	00	00	00	04	00	00	00	00	00	00	00	00	0000	00	04	00	00	04	00004000
E	020972	39EB	1600	0800	01	00	00	00	00	02	00	00	00	00	00	00	00	00	0000	00	02	00	00	02	00002000
E	021072	2EE2	1600	0800	01	00	00	00	00	02	00	00	00	00	00	00	00	00	0000	00	02	00	00	02	00002000
F	020972	381C	1600	0800	01	00	01	01	00	00	00	00	00	00	00	00	00	00	0000	00	01	00	00	01	00010000

5 The detail Tape Error Statistics by tape unit shows that there are only two failures on tape unit C and tape unit E has the highest count of failures. Analysis of tape unit E TIE byte shows track four consistently has more errors, concluding that track four, tape unit E is the error.

The permanent error on tape unit C with the same volume (M4272) is only a coincidence.

ID FF00. PROG 7140-04. SSWS
DCP-SECTION TERMINATED.

```
--- RECORD ENTRY SOURCE - CBR          TYPE -OUTBOARD      MODEL- 0145      SERIAL NO. 010528                RELEASE 21

 DEVICE      PRIMARY     SECONDARY   PROGRAM     VOLUME      MODE        DATE        TIME
 TYPE        CUA         CUA         IDENTITY    SERIAL      SET         DAY YR      HH MM SS.TH
 3410        0003A1      0003A1      CSCCS       EMU3A1      CB          103 72      19 52 49 49

          1  CC   DA     FL     CT                                K    CA     US CS  CT
FAILING CCW  01 040978  20 00 03EC                        CSW   00 0408C0  0E 00 01A4

UNIT STATUS      BYTE 0   3     BYTE 1   2     BYTE 2          BYTE 3          BYTE 4   5     BYTE 5
                                            4
ATTENTION     0  CMND REJECT  0  NOISE       1  TRK ERR 0  0  VRC          1  TU POSN CHK  0  NEW SUBSY    0
STATUS MODIF  0  INTV REQ     1  TU STAT A    0  TRK ERR 1  0  MTE/LRCR     1  TU REJECT    1  NEW SUBSY    1
CONT UN END   0  BUS OUT CHK  0  TU STAT B    1  TRK ERR 2  0  SKEW         0  ECT          0  WRT TM CHK   0
BUSY          0  EQUIP CHK    1  RESERVED     0  TRK ERR 3  0  EDC/CRCR     1  RESERVED     0  PE ID BUR    0
CHANNEL END   1  DATA CHECK   1  LOAD POINT   0  TRK ERR 4  0  ENV CHECK    1  RESERVED     0  ERG CHECK    0
DEVICE END    1  OVERRUN      0  WRITE STA    0  TRK ERR 5  0  1600 BPI     1  DIAG TRK ERR 0  TACH CHK     0
UNIT CHECK    1  WRD COUNT    0  FL PROT      1  TRK ERR 6  1  BACKWARD     0  TU CHECK     0  FALSE END CHK 0
UNIT EXCEP    0  RESERVED     0  NOT CAPABLE  0  TRK ERR 7  1  RESERVED     0  ILLEGAL CMND 0  RPQ          0

BYTE 6           BYTE 7           BYTE 8

RESERVED      0  LAMP FAIL     0  RESERVED     0
SHORT GAP     1  LEFT COL CHK  0  FEED THRU    0
DUAL DEN      0  RHT COL CHK   0  RESERVED     0
800 BPI       0  RDY/RST       0  END VEL CHK  0
                 DSE           0  TAPE VEL CHK 0
MODEL         3  RESERVED      0  ST VEL CHK   0
                 RESERVED      0  RESERVED     0
                 RESERVED      0  VEL RETRY    0

SDR AREA                                                                  DEVICE DEPENDENT INFORMATION

NOISE          0001   RESERVED        CCCC   TAPE VEL CHK   CCCC                          BLOCK LENGTH  00000
VRC            0011   WRT TM CHK      0000   ST VEL CHK     CCCC   PE ID CHK      0       TEMP RDS      0000
MTE/LRCR       0001   ERG CHECK       0000   RESERVED       0000                          TEMP WRTS     001C
EDC/CRCR       0001   TACH CHK        CCCC   RESERVED       CCCC   TRK IN ERR  010011011  SIC COUNT     09634
ENV CHECK      0011   FALSE END CHK   CCCC   VEL RETRY      CCCC                          ERASE GAPS    00010
OVERRUN        0000   RESERVED        0000   RESERVED       0000   BACKWARD       CCCC   CLEAN ACTS    00000
SKEW           0CC0   FEED THRU       CCCC   RESERVED       0000   BUS OUT CHK    CC00
RESERVED       0000   RESERVED        CCCC   RESERVED       CCCC   TU POSN CHK    0000

   HEX DUMP OF RECORD
   HEADER    30150800    CCCCCCCC    CC72103F    19524949        00C10528    014500C0

       0000  D6E2C4D6    E2404040    01040978    200003EC        000408C0    0E0C01A4    030003A1    34208003
       CC20  140C03A1    0CCC0009    C5D4E4F3    C1F10000        00000000    000A25A2    00000CCB    000ACCCC
       C040  01010801    010B0000    009BCCCC    CCCCCCCC        00CC0000    58A203DC    40404200    CC
```

This example is used to analyze a customer reported problem of occasionally dropping READY. The printout verifies that the customer information was accurate and also leads us to a conclusion regarding the problem.

The printout was analyzed as follows:

1 The failure occurred during a write operation.
Failing CCW Op Code 01

2 Taking a quick scan of the sense data to find a possible cause for the error it appears byte 1 bit 2 (TU Stat B) is significant as it indicates a loss of READY.

3 In byte zero, INTERVENTION REQUIRED is also on, which indicates that the operator had to do some manual operation, such as make the tape unit ready.

4 In byte 1, the FILE PROTECT bit is on which indicates that there is no ring in the tape reel, or the unit is not ready.

5 In byte 4, TAPE UNIT REJECT is on which indicates that READY dropped while tape was in motion.

The above indications show that the tape unit dropped READY while doing a write operation. All other error conditions are a result of dropping READY during the write operation.

Possible causes for dropping READY are sometimes shown in Byte 7, but in this case there are none. Since TAPE UNIT CHECK is not on and TAPE UNIT REJECT is on, a possibility is that someone hit the Reset key or the door interlock opened.

```
--- RECORD ENTRY SOURCE - OBR          TYPE -OUTBOARD      MODEL- 0145      SERIAL NO. 010528                RELEASE 21

 DEVICE      PRIMARY     SECONDARY   PROGRAM     VOLUME      MODE        DATE        TIME
 TYPE        CUA         CUA         IDENTITY    SERIAL      SET         DAY YR      HH MM SS.TH
 3410        000381      C00381      CSCOS       SYSIN       CB          123 72      15 57 34 77

          1  CC   DA     FL     CT                                K    CA     US CS  CT
FAILING CCW  02 037FC4  00 00 0064                        CSW   00 037550  OF 40 0064

UNIT STATUS      BYTE 0           BYTE 1           BYTE 2           BYTE 3           BYTE 4           BYTE 5

ATTENTION     0  CMND REJECT   0  NOISE         0  TRK ERR 0     0  VRC           0  TU POSN CHK   0  NEW SUBSY     0
STATUS MODIF  0  INTV REQUEST  0  TU STAT A      1  TRK ERR 1     0  MTE/LRCR      0  TU REJECT     0  NEW SUBSY     0
CONT UN END   0  BUS OUT CHK   1  TU STAT B      0  TRK ERR 2     0  SKEW          0  EOT           0  WRT TM CHK    0
BUSY          0  EQUIP CHK     0  RESERVED      0  TRK ERR 3     0  EDC/CRCR      0  RESERVED      0  PE-ID BUR     0
CHANNEL END   1  DATA CHECK    0  LOAD POINT    0  TRK ERR 4     0  ENV CHECK     0  RESERVED      0  ERG CHECK     0
DEVICE END    1  OVERRUN       0  WRITE STA     0  TRK ERR 5     0  1600 BPI      1  DIAG TRK ERR  0  TACH CHK      0
UNIT CHECK    1  WRD COUNT     0  FL PROT       0  TRK ERR 6     0  BACKWARD      0  TU CHECK      0  FALSE END CHK 0
UNIT EXCEP    0  RESERVED      0  NOT CAPABLE   0  TRK ERR 7     0  RESERVED      0  ILLEGAL CMND  0  RPQ           0

BYTE 6           BYTE 7           BYTE 8

RESERVED      0  LAMP FAIL     0  RESERVED      0
SHORT GAP     0  LEFT COL CHK  0  FEED THRU     0
DUAL DEN      0  RHT COL CHK   0  RESERVED      0
800 BPI       0  RES-DOOR      0  END VEL CHK   0
              DSE              0  TAPE VEL CHK  0
MODEL         1  RESERVED      0  ST VEL CHK    0
                 RESERVED      0  RESERVED      0
                 RESERVED      0  VEL RETRY     0

SDR AREA                                                                          DEVICE DEPENDENT INFORMATION

NOISE          0000    RESERVED       CCCC    TAPE VEL CHK   CC00                              BLOCK LENGTH  CC000
VRC            0000    WRT TM CHK     0000    ST VEL CHK     CC00   PE ID CHK      0           TEMP RCS      0000
MTE/LRCR       0C00    ERG CHECK      C000    RESERVED       0000                              TEMP WRTS     CCOC
EDC/CRCR       0000    TACH CHK       CCCC    RESERVED       C000   TRK IN ERR  100C00000      SIC COUNT     COCCS
ENV CHECK      0000    FALSE END CHK  C000    VEL RETRY      CCCC                              ERASE GAPS    00000
OVERRUN        0000    RESERVED       C000    RESERVED       C000   BACKWARD       CCCC        CLEAN ACTS    00CC0
SKEW           0000    FEED THRU      CCCC    RESERVED       0000   BUS OUT CHK    0001  2
RESERVED       0000    RESERVED       CCCC    RESERVED       CC00   TU PCSN CHK    0000

   HEX DUMP OF RECORD
   HEADER    30150800    CCCCCCC0    C072123F    15573477    00010528    014500C0

      0000  D6E2C4D6    E2404040    02037FC4    000C0064    0C037550    0F4CC064    03CC0381    34008003
      CC20  14CC0381    CCCC0018    E2E8E2C9    D5400000    00000000    00CC0009    CCCC0CCB    CCCCCCC0
      0040  01CCCCC0    CCCCCCCC    01CCCC01    CCCCCCC0    0CCC0010    20400004    00020000    C0
```

In this example, the customer reported a permanent I/O error. The OBR was logged because of UNIT CHECK in the status byte. A quick scan of the other sense bytes shows that only BUS OUT CHECK (byte 0 bit 2) is set.

1 The failing command code is 02, a Read command.

2 The BUS OUT CHECK is set on a data or command byte transfer to the tape control. Since this is a Read Command the BUS OUT CHECK could only have happened on a command byte transfer during initial selection.

The failure appears to be an ABO parity error during initial selection of the read operation. For a possible solution see the MAPS section of the MM.

Start at tape control entry 360/370, page AA020 and assume the system is not available to run diagnostics. Exit to AA021 (a customer reported problem, an OS/DOS error message, and the system is not available to run diagnostics). On AA021 see D message (BUS OUT CHECK). The codes are explained starting on page AA026. Code D shows possible causes of the error.

```
--- RECORD ENTRY SOURCE - OBR          TYPE -OUTBOARD      MODEL- 0145      SERIAL NO. 010528                RELEASE 21

 DEVICE      PRIMARY     SECONDARY   PROGRAM     VOLUME      MODE        DATE        TIME
 TYPE        CUA         CUA         IDENTITY    SERIAL      SET         DAY YR      HH MM SS.TH
 3410        000381      000381      OSDOS       SYSIN       CB          123 72      16 C5 09 74

          1  CC   DA     FL     CT                              K    CA     US CS  CT
FAILING CCW  02 037FC4   C0 C0 0064                    CSW     00 037550   0E 00 0000

UNIT STATUS      BYTE 0            BYTE 1            BYTE 2            BYTE 3            BYTE 4            BYTE 5

ATTENTION     0  CMND REJECT    0  NOISE          1  TRK ERR 0      0  VRC            1  TU POSN CHK    0  NEW SUBSY      0
STATUS MODIF  0  INTV REQUEST   0  TU STAT A      1  TRK ERR 1      0  MTE/LRCR       0  TU REJECT      0  NEW SUBSY      0
CONT UN END   0  BUS OUT CHK    0  TU STAT B      0  TRK ERR 2      0  SKEW           0  EOT            0  WRT TM CHK     0
BUSY          0  EQUIP CHK      0  RESERVED       0  TRK ERR 3      0  EDC/CRCR       0  RESERVED       0  PE ID BUR      0
CHANNEL END   1  DATA CHECK     1  LOAD POINT     0  TRK ERR 4      1  ENV CHECK      0  RESERVED       0  ERG CHECK      0
DEVICE END    1  OVERRUN        0  WRITE STA      0  TRK ERR 5      0  1600 BPI       1  DIAG TRK ERR   0  TACH CHK       0
UNIT CHECK    1  WRD COUNT      0  FL PROT        0  TRK ERR 6      0  BACKWARD       0  TU CHECK       0  FALSE END CHK  0
UNIT EXCEP    0  RESERVED       0  NOT CAPABLE    0  TRK ERR 7      0  RESERVED       0  ILLEGAL CMND   0  RPQ            0

BYTE 6           BYTE 7            BYTE 8

RESERVED      0  LAMP FAIL      0  RESERVED       0
SHORT GAP     0  LEFT COL CHK   0  FEED THRU      0
DUAL DEN      0  RHT COL CHK    0  RESERVED       0
800 BPI       0  RES-DOOR       0  END VEL CHK    0
                 DSE            0  TAPE VEL CHK   0
MODEL         1  RESERVED       0  ST VEL CHK     0
                 RESERVED       0  RESERVED       0
                 RESERVED       0  VEL RETRY      0

SDR AREA                                                                          DEVICE DEPENDENT INFORMATION

NOISE          0001    RESERVED        0000    TAPE VEL CHK   0000                BLOCK LENGTH   00CC0
VRC            0000    WRT TM CHK      0000    ST VEL CHK     CC00    PE ID CHK   0   TEMP RDS       0000
MTE/LRCR       0C00    ERG CHECK       0000    RESERVED       0000          3
EDC/CRCR       0000    TACH CHK        C000    RESERVED       0000    TRK IN ERR  000001000  SIO COUNT      C001C
ENV CHECK      0000    FALSE END CHK   0000    VEL RETRY      CC00                TEMP WRTS      000C
OVERRUN        0000    RESERVED        0000    RESERVED       0000    BACKWARD    CCC0    ERASE GAPS     00000
SKEW           0000    FEED THRU       C0C0    RESERVED       0000    BUS OUT CHK 0000    CLEAN ACTS     00018
RESERVED       0000    RESERVED        C0C0    RESERVED       CC00    TU PCSN CHK 0000

   HEX DUMP OF RECORD
   HEADER    30150800    CCC00000    C072123F    16050974    00010528    014500C0

       C000  D6E2C4D6    E2404040    02037FC4    CC0C0064    CCC37550    0ECCCCCC    03000381    34008003
       C020  14000381    CCC00018    E2E8E2C9    D5400000    00000000    0000000A    01000CC8    0CC00012
       C040  01010CC0    CCCCC0CC    01CC0001    C00C0CC0    0CCC0000    08C00884    00000000    00
```

In this example, the customer reported two permanent read errors on two different tape units using the same tape volume.

1. The failing command code is 02, a Read Command.
2. The OBRs show that there are two tape units involved, 000381 and 0003A0, and the tape volume is SYS IN.
3. The track-in-error in both OBRs is track 4.

```
--- RECORD ENTRY SOURCE - CBR          TYPE -OUTBOARD      MODEL- C145      SERIAL NO. 010528              RELEASE 21

 DEVICE      PRIMARY     SECONDARY   PROGRAM     VOLUME      MODE        DATE        TIME
 TYPE        CUA         CUA         IDENTITY    SERIAL      SET         DAY YR      HH MM SS.TH
 3410        0003A0      0003A0      OSDOS       SYSIN       CB          124 72      11 05 02 68

             1  CC   DA     FL     CT                                  K    CA     US CS  CT
FAILING CCW     02 037FC4  CC CC  0064                        CSW      00 037550  0E 00  C000

UNIT STATUS      BYTE 0            BYTE 1            BYTE 2            BYTE 3            BYTE 4            BYTE 5

ATTENTION    0   CMND REJECT   0   NOISE         1   TRK ERR 0     0   VRC           1   TU POSN CHK   0   NEW SUBSY     0
STATUS MODIF 0   INTV REQUEST  0   TU STAT A     1   TRK ERR 1     0   MTE/LRCR      0   TU REJECT     0   NEW SUBSY     0
CONT UN END  0   BUS OUT CHK   0   TU STAT B     0   TRK ERR 2     0   SKEW          0   ECT           0   WRT TM CHK    0
BUSY         0   EQUIP CHK     0   RESERVED      0   TRK ERR 3     0   EDC/CRCR      0   RESERVED      0   PE ID BUR     0
CHANNEL END  1   DATA CHECK    1   LOAD POINT    0   TRK ERR 4     1   ENV CHECK     0   RESERVED      0   ERG CHECK     0
DEVICE END   1   OVERRUN       0   WRITE STA     0   TRK ERR 5     0   1600 BPI      1   DIAG TRK ERR  0   TACH CHK      0
UNIT CHECK   1   WRD COUNT     0   FL PROT       0   TRK ERR 6     0   BACKWARD      0   TU CHECK      0   FALSE END CHK 0
UNIT EXCEP   0   RESERVED      0   NOT CAPABLE   0   TRK ERR 7     0   RESERVED      0   ILLEGAL CMND  0   RPQ           0

BYTE 6           BYTE 7            BYTE 8

RESERVED     0   LAMP FAIL     0   RESERVED      0
SHORT GAP    0   LEFT COL CHK  0   FEED THRU     0
DUAL DEN     0   RHT COL CHK   0   RESERVED      0
800 BPI      0   RES-DOOR      0   END VEL CHK   0
                 DSE           0   TAPE VEL CHK  0
MODEL        1   RESERVED      0   ST VEL CHK    0
                 RESERVED      0   RESERVED      0
                 RESERVED      0   VEL RETRY     0

SDR AREA                                                                    DEVICE DEPENDENT INFORMATION

NOISE          0001    RESERVED       0000   TAPE VEL CHK   0000
VRC            0000    WRT TM CHK     0000   ST VEL CHK     0000    PE ID CHK      0      BLOCK LENGTH  00000
MTE/LRCR       0000    ERG CHECK      0000   RESERVED       0000                          TEMP RDS      0000
EDC/CRCR       0000    TACH CHK       0000   RESERVED       0000  3 TRK IN ERR   000001000 TEMP WRTS     0000
ENV CHECK      0000    FALSE END CHK  0000   VEL RETRY      0000                          SIC COUNT     0001C
OVERRUN        0000    RESERVED       0000   RESERVED       0000    BACKWARD       0000   ERASE GAPS    00000
SKEW           0000    FEED THRU      0000   RESERVED       0000    BUS OUT CHK    0000   CLEAN ACTS    00018
RESERVED       0000    RESERVED       0000   RESERVED       0000    TU POSN CHK    0000

   HEX DUMP OF RECORD
   HEADER    30150800    00000000    0072123F    16050974        00010528    01450000

      0000   D6E2C4D6    E2404040    02037FC4    00000064        00037550    0E000000    03000381    34008003
      0020   14000381    00000018    E2E8E2C9    D5400000        00000000    00000000    01000008    00000012
      0040   01010000    00000000    01000001    00000000        00000000    08000884    00000000    00
```

4 DETAIL BY DEVICE

CUA	TU SERIAL	DATE DAY	YR	VOLUME SERIAL	TIME HH	MM	SS.TH	--TEMP-- RDS	WRTS	SIO COUNT	DEN-SITY	NRZI NOISE	R/W VRC	WR TG VRC	LRC MTE	CRC EDC	ECC ENV	SKEW ERR	ERLY BOR	VEL CHG	TIE
000381	N/A	133	72	PENLY	16	15	52 52	0000	0000	00005	1600	N/A	0000	N/A	0000	0000	0000	CCCO	N/A	N/A	000000000
000381	N/A	123	72	SYSIN	15	57	34 77	0000	0000	00C09	1600	N/A	0000	N/A	0000	0000	0000	0000	N/A	N/A	000000000
000381	N/A	123	72	SYSIN	16	05	09 74	0000	0000	00010	1600	N/A	0000	N/A	0000	0000	0000	0000	N/A	N/A	000001000
0003A0	N/A	124	72	SYSIN	11	05	02 68	0000	0000	00010	1600	N/A	0000	N/A	0000	0000	0000	0000	N/A	N/A	000001000

5 DETAIL BY VOLUME ID

VOLUME SERIAL	DATE DAY	YR	TIME HH	MM	SS	TH	CUA	TU SERIAL	RD/ WRT	--PERM-- RDS	WRTS	--TEMP-- RDS	WRTS	SIO CCUNT	BLOCK LENGTH	PROGRAM ID	----CPU---- ID	SERIAL	MOD NUMBER	DENSITY
SCRTH2	056	72	22	35	40	65	0003A0	N/A	R	CCCO	CCCO	C000	0000	C0023	00132		0050	000000	1	556
SCRTH2	122	72	17	40	19	44	0003A0	N/A	R	0000	0000	0000	0000	C0023	00132		0065	C0C000	1	556
SYSIN	123	72	15	57	34	77	000381	N/A	R	0000	0000	0000	0000	00009	00064	OSDOS	0145	010528	1	1600
SYSIN	123	72	16	05	09	74	000381	N/A	R	0001	0000	C000	C0C0	CC010	00000	CSDOS	0145	C10528	1	16C0
SYSIN	124	72	11	05	02	68	0003A0	N/A	R	0001	0000	0000	0000	00010	00000	OSDOS	0145	010528	1	1600
SYSIN	124	72	14	40	25	07	0003A0	N/A	R	0000	C000	0000	0000	00000	00001		0065	000000	1	556
SYSIN	124	72	14	41	08	78	0003A0	N/A	R	CCCO	CCCO	0000	0000	CC000	00001		0065	000000	1	556
SYSIN	124	72	15	32	15	37	0003A0	N/A	R	0000	C000	0000	00C0	CCCC0	00001		C065	CCCCC0	1	556
SYSIN	124	72	15	35	40	13	0003A0	N/A	R	0000	0000	0000	0000	CCCC0	00001		0065	C00C00	1	556
SYSIN	124	72	15	35	40	41	0003A0	N/A	R	C000	0000	0000	0000	00000	00001		0065	000000	1	556

4 The DETAIL BY DEVICE printout shows there were no temporary errors on either 000381 or 0003A0 when using tape volume SYS IN.

5 The DETAIL BY VOLUME printout shows volume SYS IN ran error free on tape unit 000381 at 15:57 on day 123. (Third record from the top.) At 16:05 of the same day (123) volume SYS IN had a permanent read error on tape unit 000381.

On day 124 volume SYS IN recorded the identical error on tape unit 0003A0.

The logical conclusion is that tape volume SYS IN has physical damage on track 4 (outside edge).

Retracing the history of SYS IN, note that it did run error free on tape unit 000381 but failed on the second pass. There is a possibility that tape unit 000381 is causing tape damage.

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From A35

A

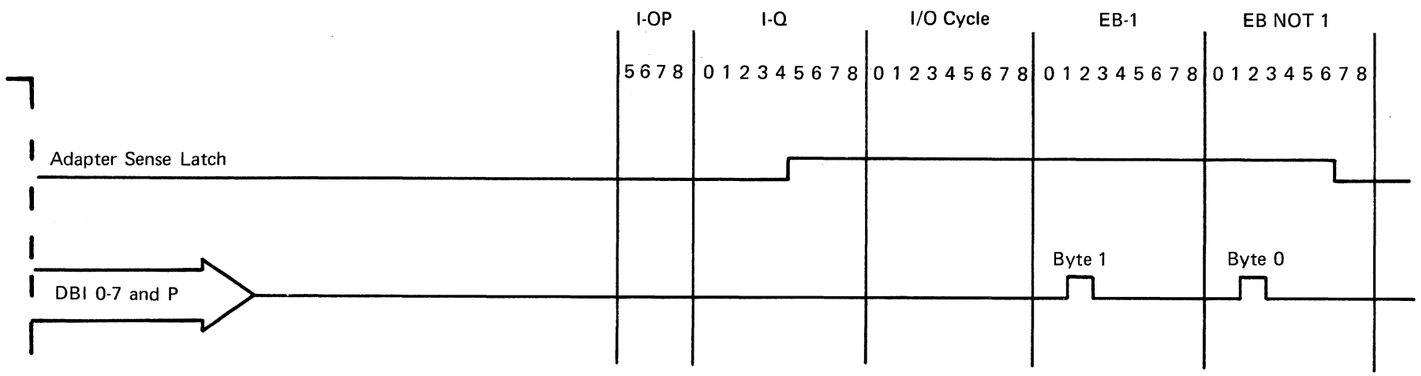
1. The N field equals 101 indicating an attachment sense. The attachment sets the ADAPTER SENSE LATCH (HT330) at Clock 5 of the I-Q cycle.

2. The attachment puts sense byte 1 on DBI at Clock 2 of the EB 1 cycle (GATE SENSE BYTE 1 - HT110).

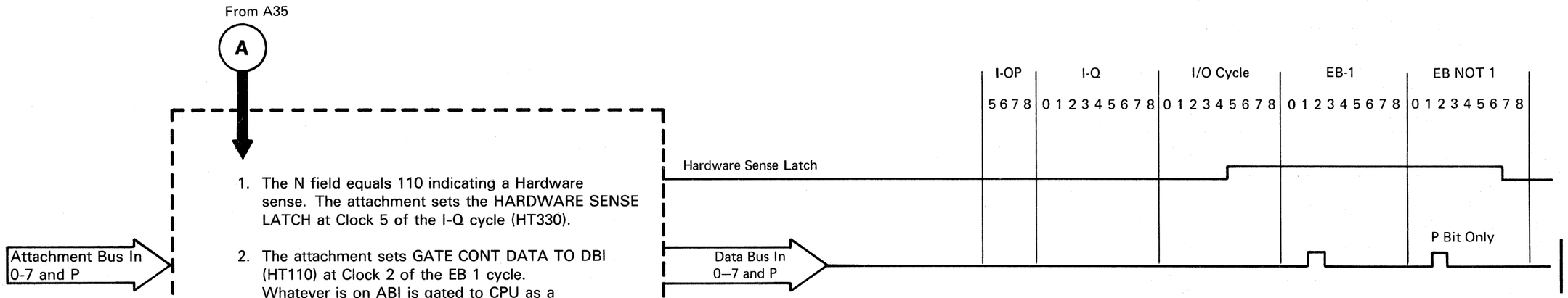
3. The attachment puts sense byte 0 on DBI at Clock 2 of the EB NOT 1 cycle (GATE SENSE BYTE 0 - HT110).

ABI 0-7 and P

DBI 0-7 and P



NOTES:		
Sense Byte 0	Sense Byte 1	DBO Bits
	Address Out of Sequence	0
ABI Parity	Service Out of Sequence	1
ABO Parity	Command Out of Sequence	2
Controller Disabled	Address In Error	3
Two Tags Error	Service In Error	4
I/O Working Gated	Command In Error	5
Sequence Error	Status In Error	6
(Not Used)	(Not Used)	7



NOTE:

A Hardware Sense operation stores the state of the Attachment Bus In at the time of the error.

Error Checking

The attachment checks the data it receives from CPU and the data it receives from and sends to the subsystem. In addition, the attachment monitors the operation of its interface with the subsystem.

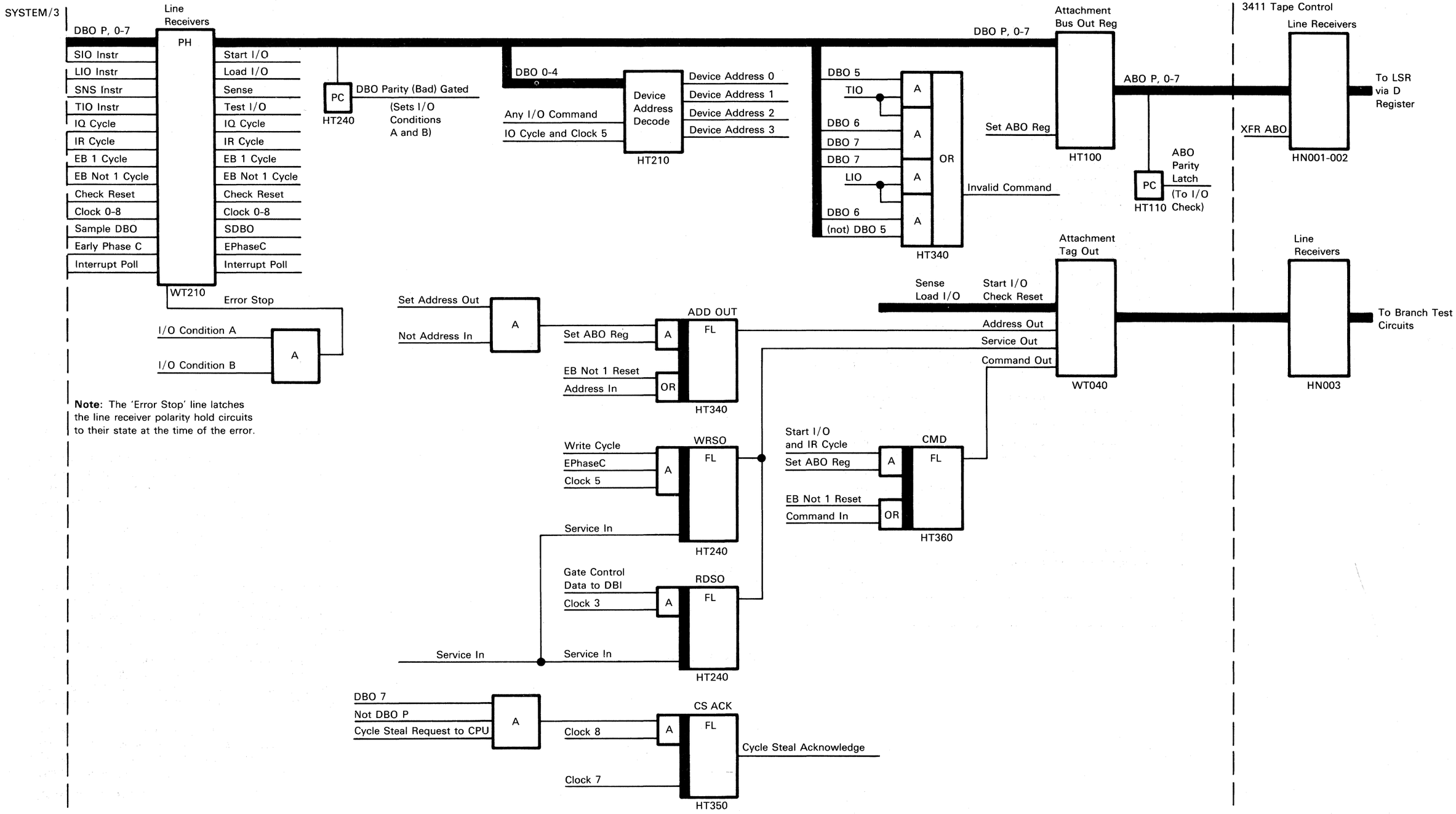
Bad parity detected in data received from the CPU will terminate the operation and turn on the PROCESSOR CHECK and CHAN DBO indicators on the system console. Errors in data transferred to and from the subsystem and in the interface operation activate I/O Check to CPU and set Adapter Check and Unit Check in the attachment. The I/O Check to CPU turns on the I/O Check indicator on the System CE Panel. The Adapter Check/Unit Check will activate I/O Condition A to CPU when a Test I/O is executed.

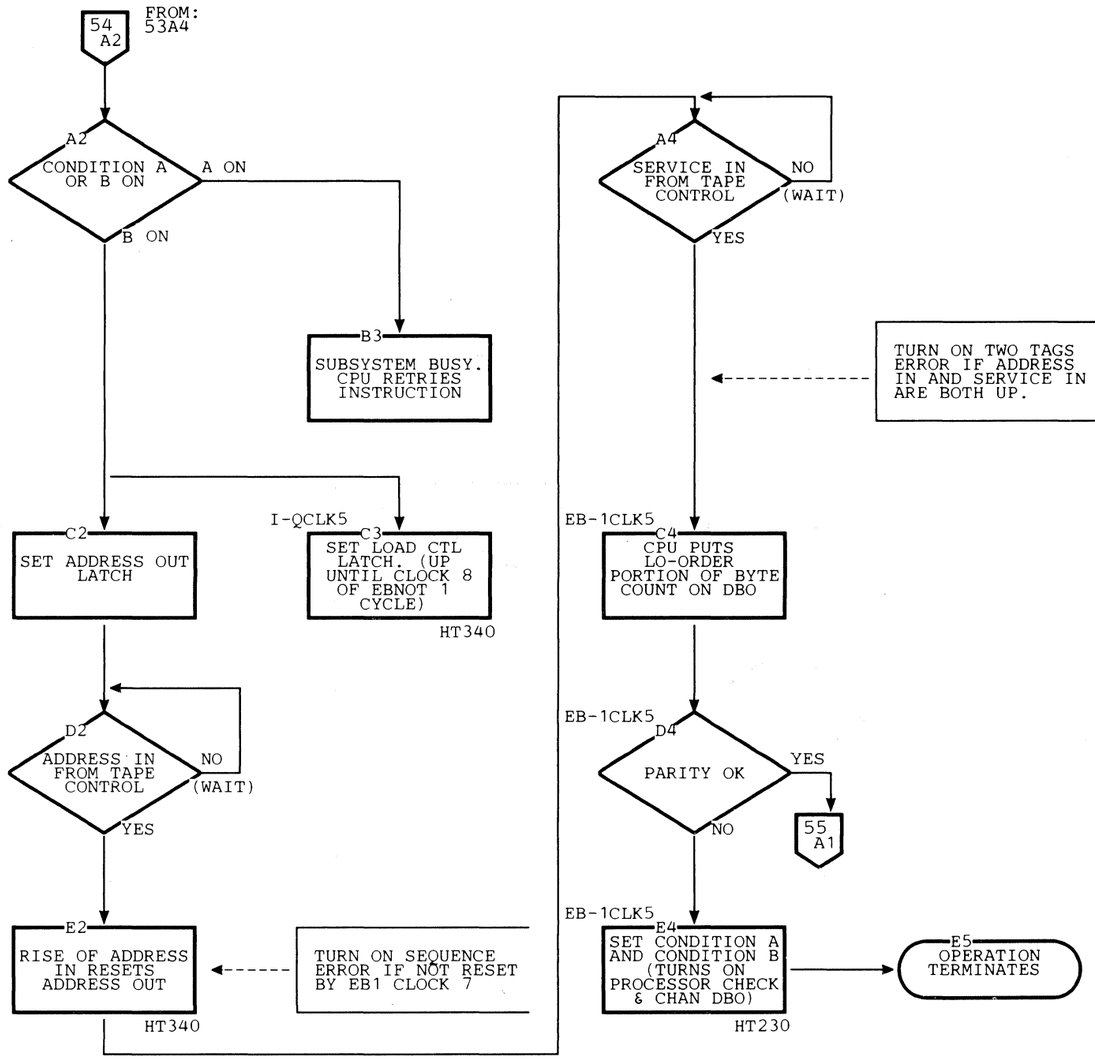
Two other error conditions that can occur set Adapter Check/Unit Check only. The first is an I/O Check from the subsystem. This I/O Check occurs if the microprogram (in the tape control) detects a bit set in subsystem sense byte 0. The second condition is if the subsystem becomes disabled by a hardware error or by the subsystem being taken offline.

The following table defines the errors in more detail.

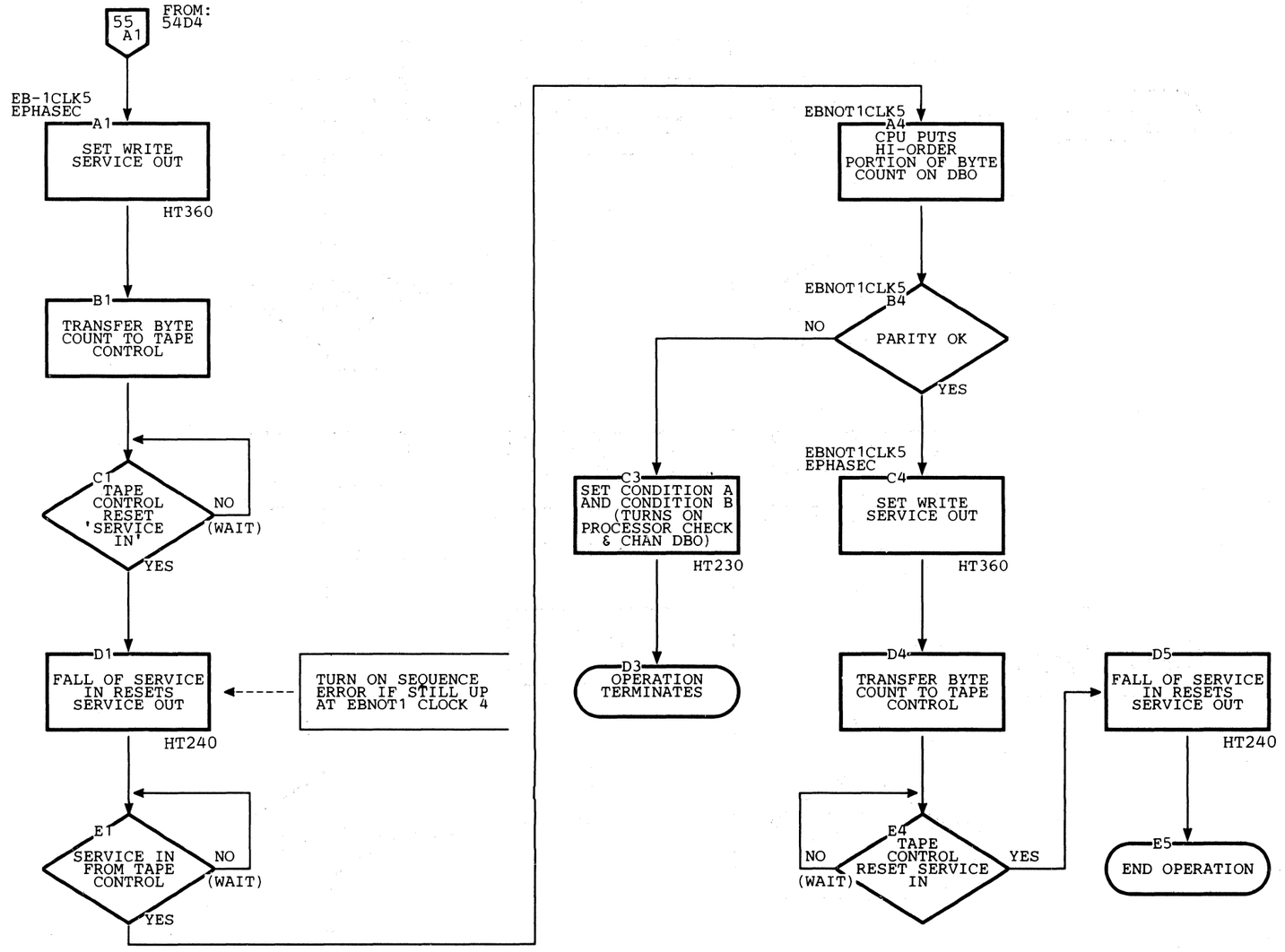
ERROR SUMMARY

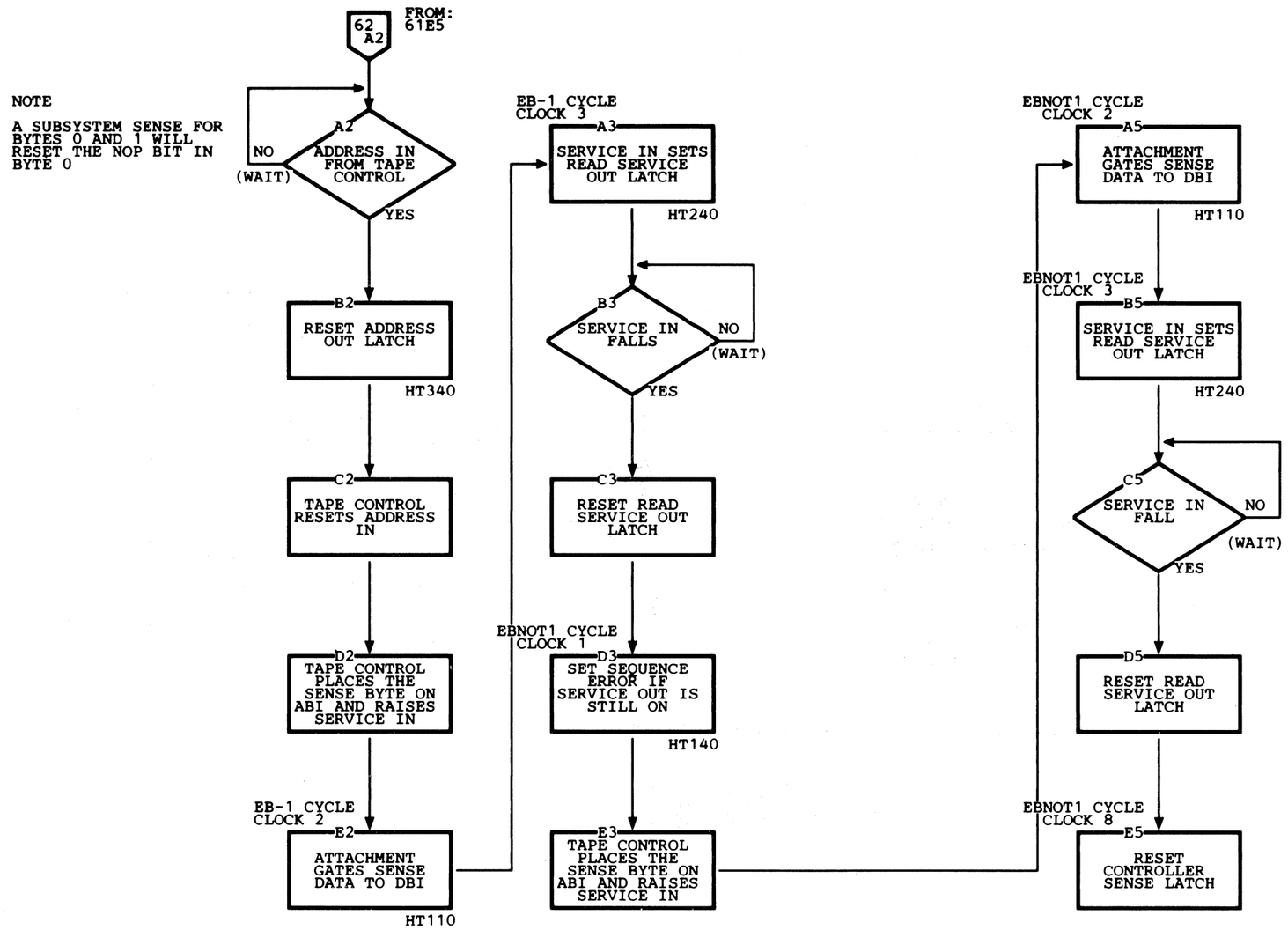
Error Indication	Cause	Comment
PROCESSOR CHECK and CHAN DBO on.	Bad parity detected in byte received from CPU.	Operation terminated. Manual intervention required to restart.
PROCESSOR CHECK and INV Q on.	Invalid command received from CPU.	
I/O CHECK	1. Data byte received from tape subsystem had bad parity on the ABI. 2. Detected bad parity in the data byte being sent to the subsystem on the ABO. 3. Two 'in tags,' status, service, command, or address were active simultaneously. 4. The subsystem did not respond with the correct 'in tag.'	Also sets 'Adapter Check' and 'Unit Check' in the attachment. The System will execute a sense instruction to determine the error condition.
Adapter Check/ Unit Check	1. Subsystem is disabled.	1. The ENABLE/DISABLE switch may be in the DISABLE position or a hardware error has occurred. Check the switch. The System will execute a sense instruction to get the hardware error byte.
	2. I/O Check from the subsystem.	2. The microprogram has detected a bit set in Subsystem Sense Byte 0. The System will execute a sense instruction to determine the error.


SYSTEM/3
Line Receivers
DBO P, 0-7
PH
SIO Instr
LIO Instr
SNS Instr
TIO Instr
IQ Cycle
IR Cycle
EB 1 Cycle
EB Not 1 Cycle
Check Reset
Clock 0-8
Sample DBO
Early Phase C
Interrupt Poll
Start I/O
Load I/O
Sense
Test I/O
IQ Cycle
IR Cycle
EB 1 Cycle
EB Not 1 Cycle
Check Reset
Clock 0-8
SDBO
EPhaseC
Interrupt Poll
WT210
Error Stop
I/O Condition A
I/O Condition B
A
Note: The 'Error Stop' line latches the line receiver polarity hold circuits to their state at the time of the error.
PC
HT240
DBO Parity (Bad) Gated
(Sets I/O Conditions A and B)
DBO 0-4
Any I/O Command
IO Cycle and Clock 5
Device Address Decode
HT210
Device Address 0
Device Address 1
Device Address 2
Device Address 3
DBO 5
TIO
DBO 6
DBO 7
DBO 7
LIO
DBO 6
(not) DBO 5
A
OR
HT340
Invalid Command
DBO P, 0-7
Attachment Bus Out Reg
Set ABO Reg
HT100
ABO P, 0-7
PC
HT110
ABO Parity Latch
(To I/O Check)
3411 Tape Control
Line Receivers
XFR ABO
HN001-002
To LSR via D Register
Set Address Out
Not Address In
Set ABO Reg
EB Not 1 Reset
Address In
ADD OUT
FL
HT340
Attachment Tag Out
Sense
Load I/O
Start I/O
Check Reset
Address Out
Service Out
Command Out
WT040
Line Receivers
HN003
To Branch Test Circuits
Start I/O and IR Cycle
Set ABO Reg
EB Not 1 Reset
Command In
CMD
HT360
Write Cycle
EPhaseC
Clock 5
WRSO
HT240
Service In
Gate Control Data to DBI
Clock 3
RDSO
HT240
Service In
Service In
DBO 7
Not DBO P
Cycle Steal Request to CPU
Clock 8
Clock 7
CS ACK
HT350
Cycle Steal Acknowledge


54
A2
FROM:
53A4
A2
CONDITION A OR B ON
A ON
B ON
B3
SUBSYSTEM BUSY. CPU RETRIES INSTRUCTION
C2
SET ADDRESS OUT LATCH
I-QCLK5
C3
SET LOAD CTL LATCH. (UP UNTIL CLOCK 8 OF EBNOT 1 CYCLE)
HT340
D2
ADDRESS IN FROM TAPE CONTROL
NO
(WAIT)
YES
E2
RISE OF ADDRESS IN RESETS ADDRESS OUT
HT340
TURN ON SEQUENCE ERROR IF NOT RESET BY EB1 CLOCK 7
A4
SERVICE IN FROM TAPE CONTROL
NO
(WAIT)
YES
TURN ON TWO TAGS ERROR IF ADDRESS IN AND SERVICE IN ARE BOTH UP.
EB-1CLK5
C4
CPU PUTS LO-ORDER PORTION OF BYTE COUNT ON DBO
EB-1CLK5
D4
PARITY OK
YES
NO
55
A1
EB-1CLK5
E4
SET CONDITION A AND CONDITION B (TURNS ON PROCESSOR CHECK & CHAN DBO)
HT230
E5
OPERATION TERMINATES

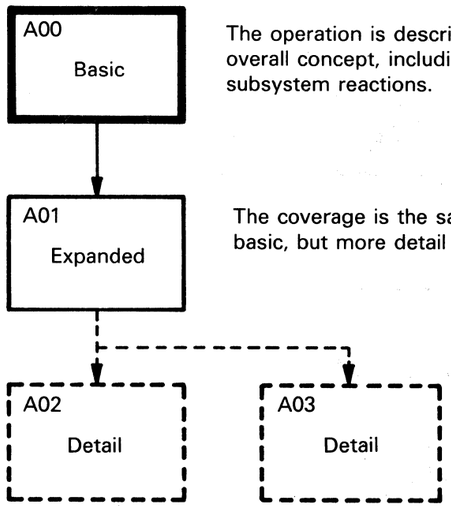
Load I/O


55
A1
FROM:
54D4
EB-1CLK5
EPHASEC
A1
SET WRITE
SERVICE OUT
HT360
B1
TRANSFER BYTE
COUNT TO TAPE
CONTROL
C1
TAPE
CONTROL
RESET
'SERVICE
IN'
NO
(WAIT)
YES
D1
FALL OF SERVICE
IN RESETS
SERVICE OUT
HT240
TURN ON SEQUENCE
ERROR IF STILL UP
AT EBNOT1 CLOCK 4
E1
SERVICE IN
FROM TAPE
CONTROL
NO
(WAIT)
YES
EBNOT1CLK5
A4
CPU PUTS
HI-ORDER
PORTION OF BYTE
COUNT ON DBO
EBNOT1CLK5
B4
NO
PARITY OK
YES
C3
SET CONDITION A
AND CONDITION B
(TURNS ON
PROCESSOR CHECK
& CHAN DBO)
HT230
D3
OPERATION
TERMINATES
EBNOT1CLK5
EPHASEC
C4
SET WRITE
SERVICE OUT
HT360
D4
TRANSFER BYTE
COUNT TO TAPE
CONTROL
E4
TAPE
CONTROL
RESET SERVICE
IN
NO
(WAIT)
YES
D5
FALL OF SERVICE
IN RESETS
SERVICE OUT
HT240
E5
END OPERATION


62
A2
FROM:
61E5
NOTE
A SUBSYSTEM SENSE FOR BYTES 0 AND 1 WILL RESET THE NOP BIT IN BYTE 0
A2
ADDRESS IN FROM TAPE CONTROL
NO
(WAIT)
YES
B2
RESET ADDRESS OUT LATCH
HT340
C2
TAPE CONTROL RESETS ADDRESS IN
D2
TAPE CONTROL PLACES THE SENSE BYTE ON ABI AND RAISES SERVICE IN
EB-1 CYCLE
CLOCK 2
E2
ATTACHMENT GATES SENSE DATA TO DBI
HT110
EB-1 CYCLE
CLOCK 3
A3
SERVICE IN SETS READ SERVICE OUT LATCH
HT240
B3
SERVICE IN FALLS
NO
(WAIT)
YES
C3
RESET READ SERVICE OUT LATCH
EBNOT1 CYCLE
CLOCK 1
D3
SET SEQUENCE ERROR IF SERVICE OUT IS STILL ON
HT140
E3
TAPE CONTROL PLACES THE SENSE BYTE ON ABI AND RAISES SERVICE IN
EBNOT1 CYCLE
CLOCK 2
A5
ATTACHMENT GATES SENSE DATA TO DBI
HT110
EBNOT1 CYCLE
CLOCK 3
B5
SERVICE IN SETS READ SERVICE OUT LATCH
HT240
C5
SERVICE IN FALL
NO
(WAIT)
YES
D5
RESET READ SERVICE OUT LATCH
EBNOT1 CYCLE
CLOCK 8
E5
RESET CONTROLLER SENSE LATCH

System/3 Attachment Diagrams

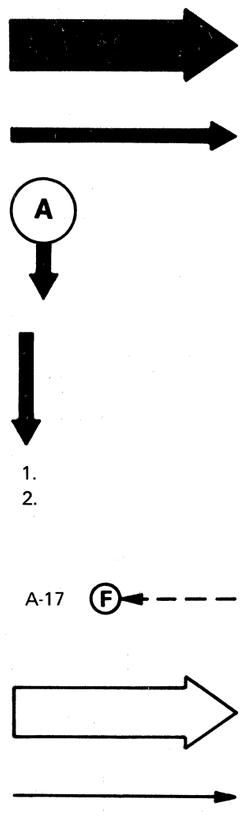
The following charts graphically describe the internal operations of the System/3 attachment for the 3410-3411 Tape Subsystem. Each operation is described at a basic level stressing the overall concept.
If necessary, the reader can proceed from the concept-level charts to charts having more detail. Refer to the table of contents, the scheme of which is shown below.



The operation is described as an overall concept, including CPU and subsystem reactions.

The coverage is the same as the basic, but more detail is added.

Each detail chart covers a significant part of the expanded chart.



Indicates a starting point.

Leads the reader through the operation.

Indicates an entry point from another chart.

Indicates a continuing operation. Go on to the next sequence.

Indicates a sequence or set of events.

Indicates a reference to a more detailed chart (A-17 is the chart number, **F** is the entry point).

Indicates data flow.

Indicates a control line or logic level.

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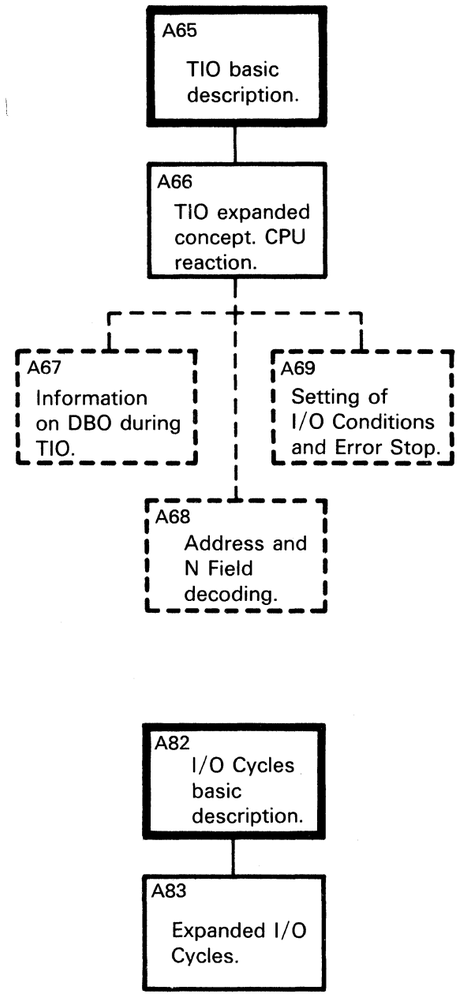
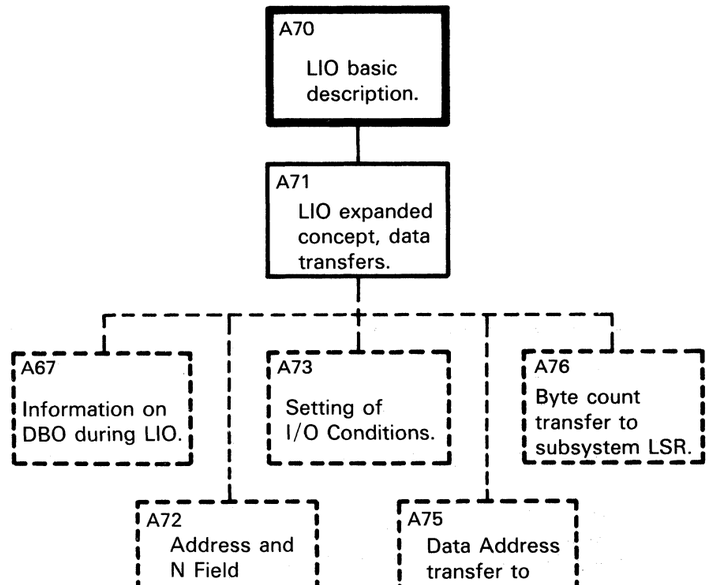
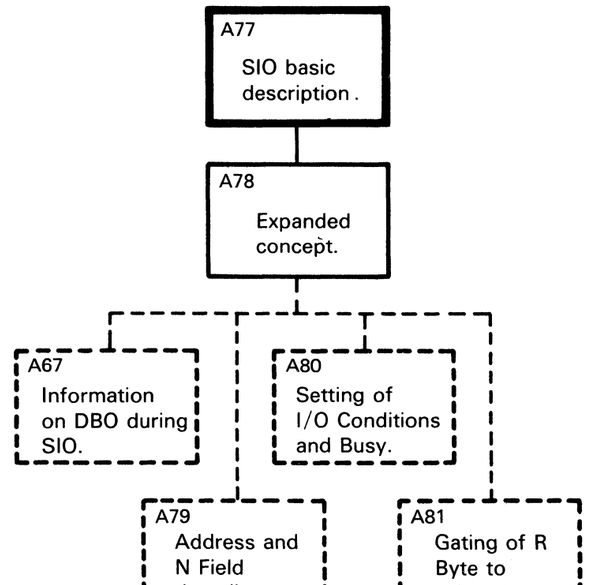
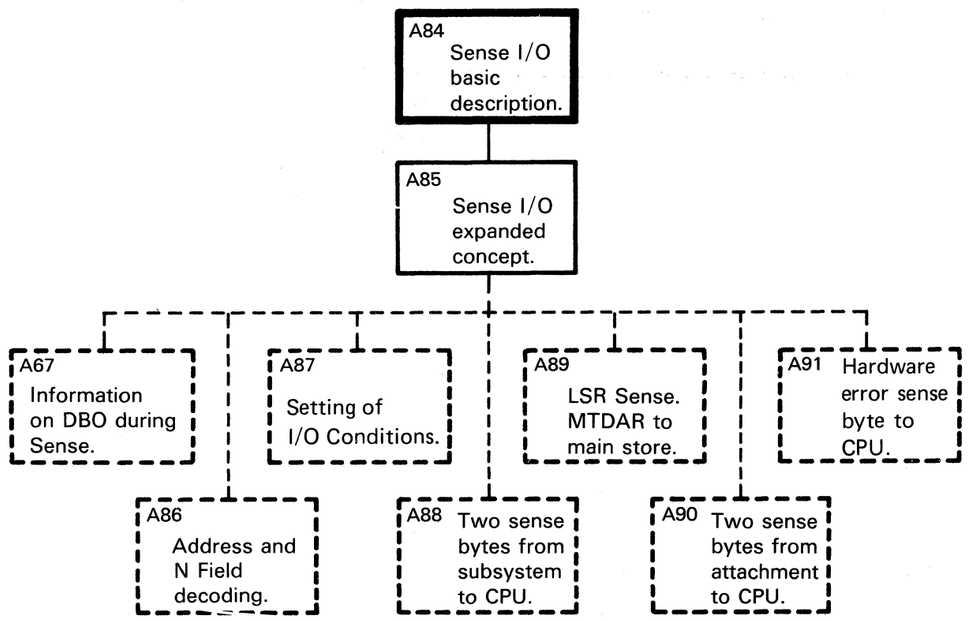
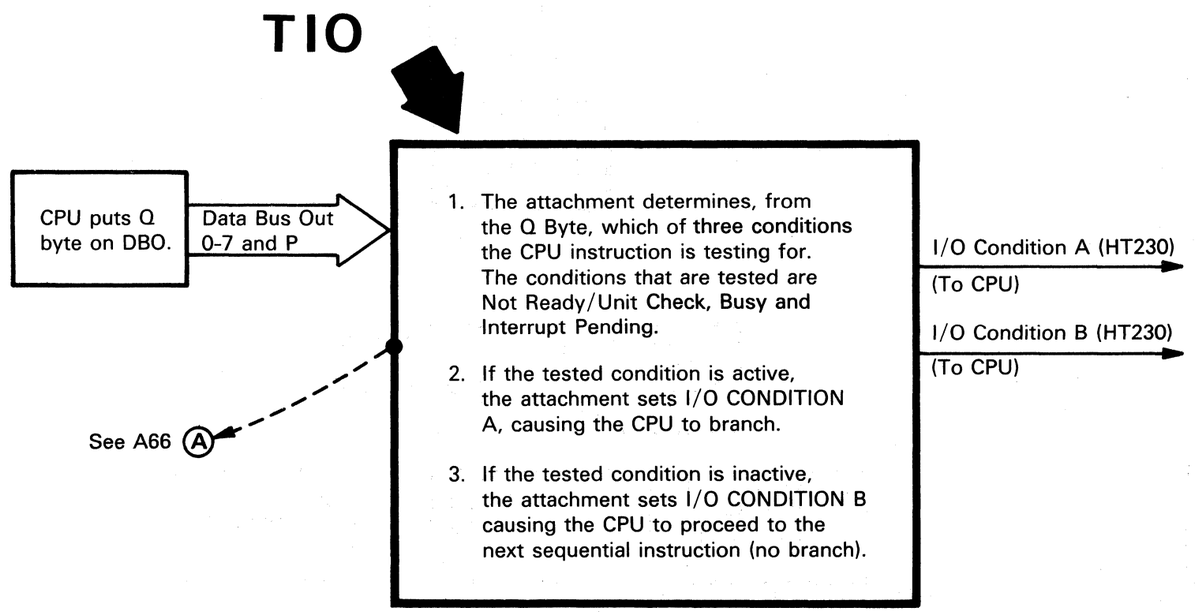
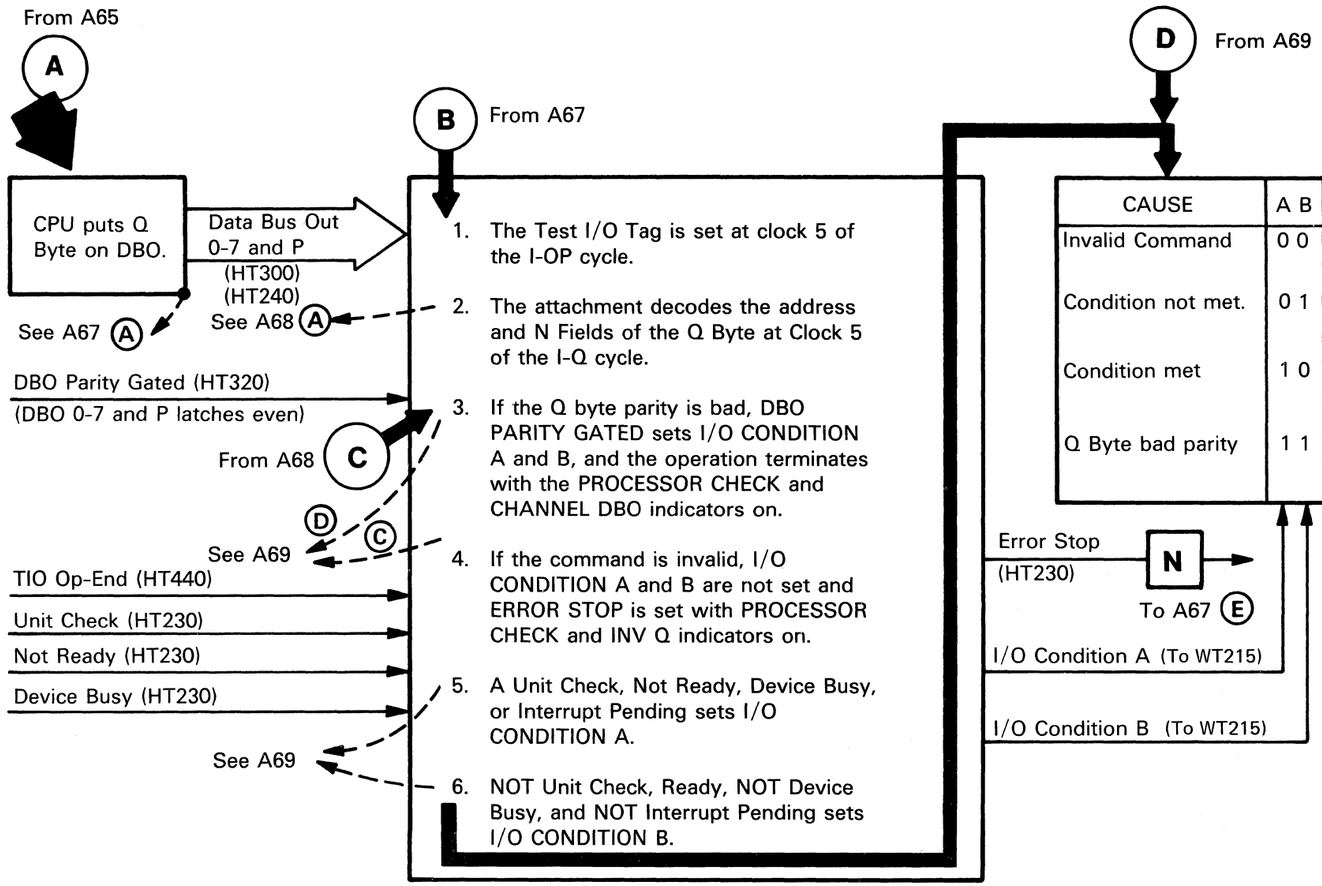








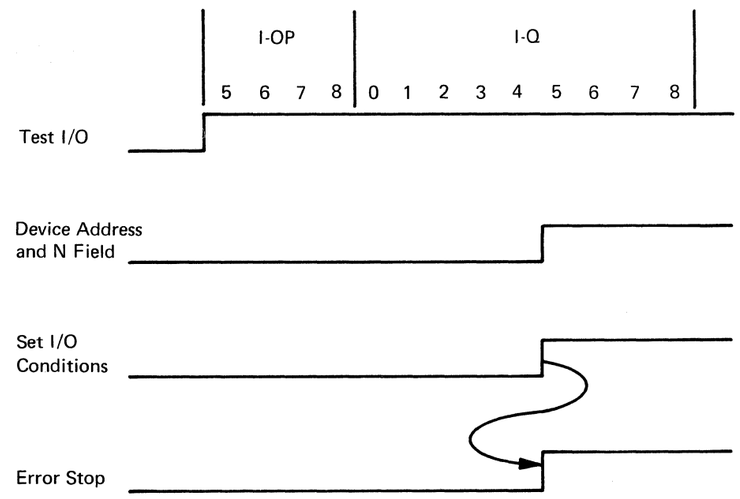

TIO
CPU puts Q byte on DBO.
Data Bus Out 0-7 and P
1. The attachment determines, from the Q Byte, which of three conditions the CPU instruction is testing for. The conditions that are tested are Not Ready/Unit Check, Busy and Interrupt Pending.
2. If the tested condition is active, the attachment sets I/O CONDITION A, causing the CPU to branch.
3. If the tested condition is inactive, the attachment sets I/O CONDITION B causing the CPU to proceed to the next sequential instruction (no branch).
I/O Condition A (HT230) (To CPU)
I/O Condition B (HT230) (To CPU)
See A66 (A)

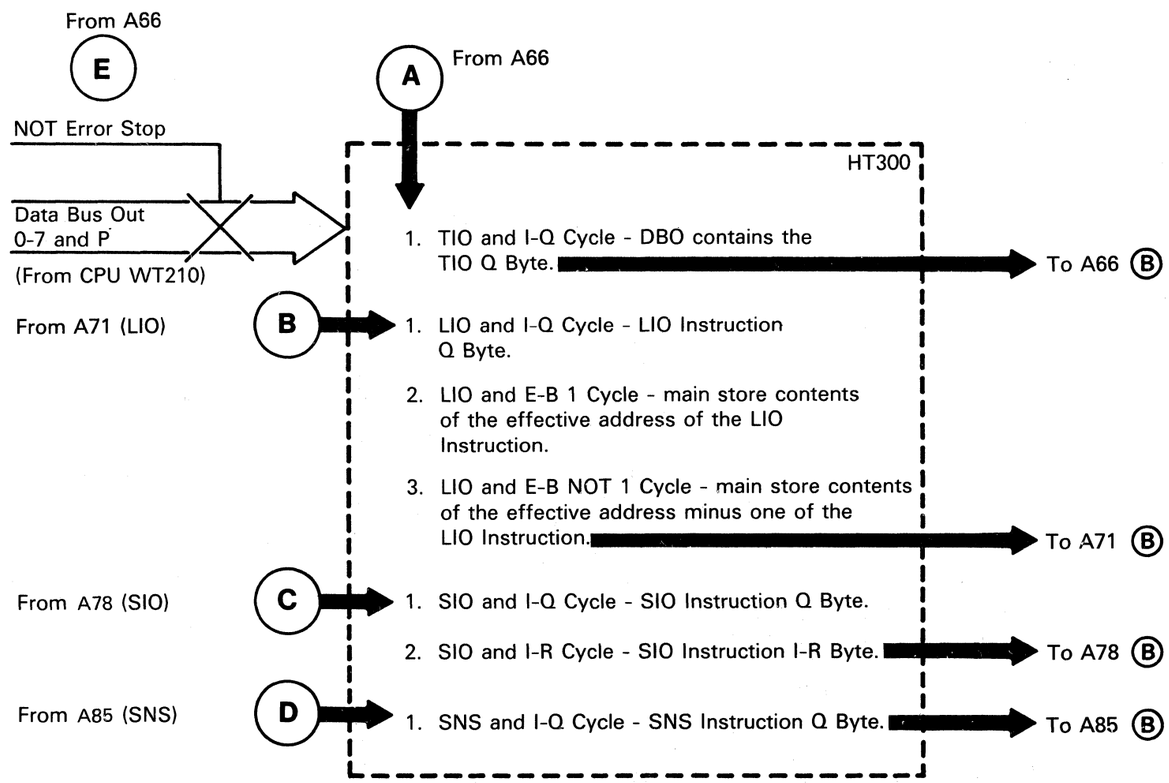


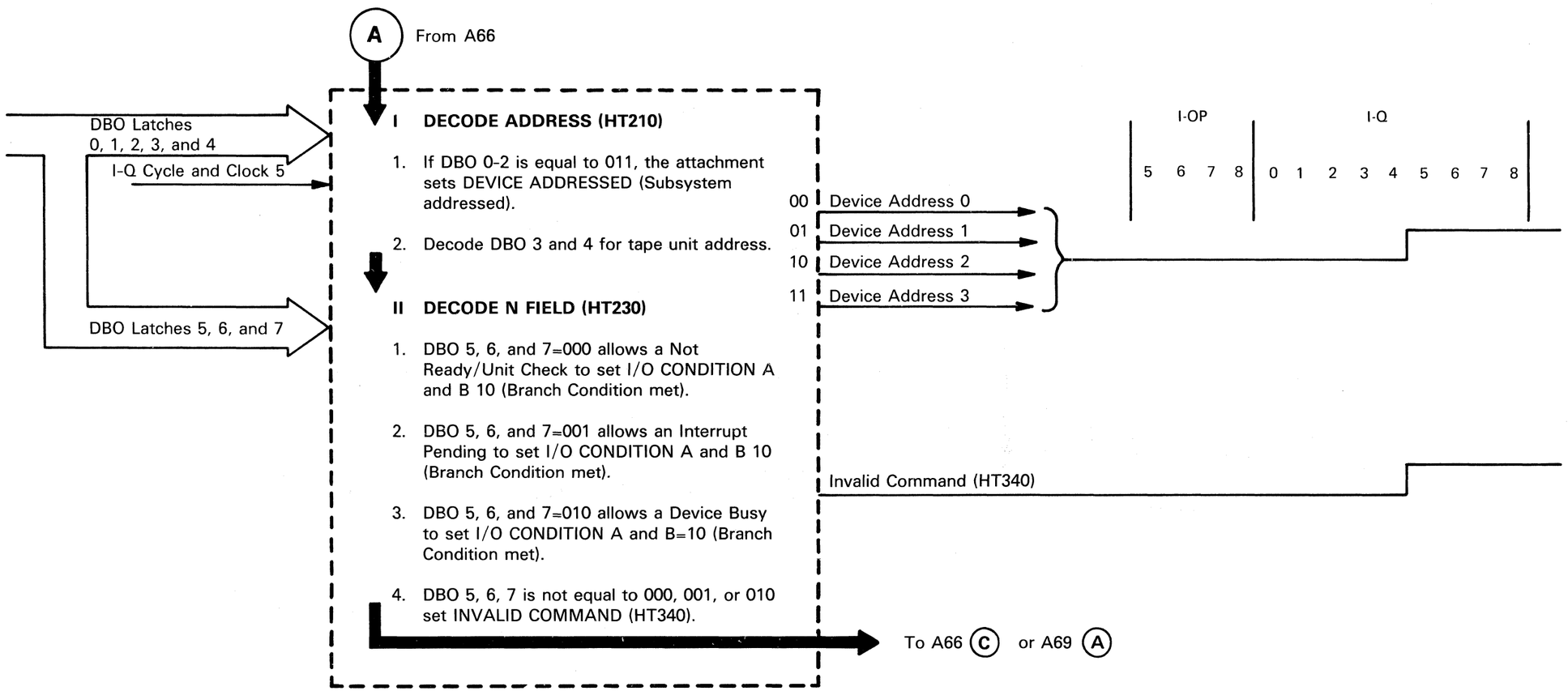
CAUSE	A B	CPU Reaction
Invalid Command	0 0	Processor Check Stop with Q BYTE INVALID Check.
Condition not met.	0 1	Proceeds to next sequential instruction.
Condition met	1 0	Branches to effective address.
Q Byte bad parity	1 1	Processor Check Stop with CHANNEL DBO Check on.

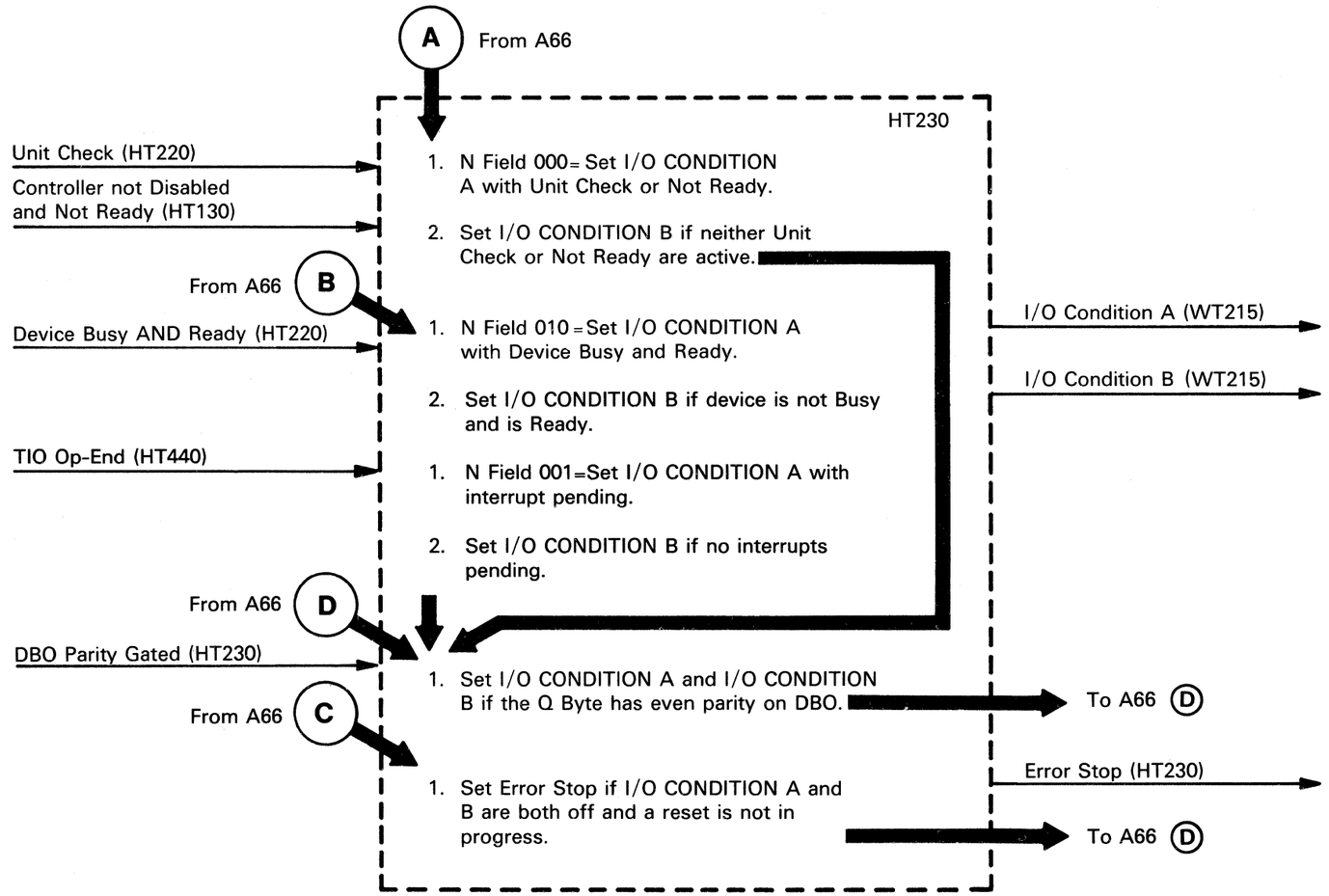
NOTES:

1. Unit Check is set by a Unit Check from a Tape Unit, a Not Ready, an I/O Check during I-Q Cycle at Clock 5, or an Adapter Check (HT230).
2. Interrupt Pending includes any Interrupt-- Subsystem or Tape Unit.




From A66
E
NOT Error Stop
Data Bus Out
0-7 and P
(From CPU WT210)
From A71 (LIO)
B
From A66
A
HT300
1. TIO and I-Q Cycle - DBO contains the TIO Q Byte.
To A66 B
1. LIO and I-Q Cycle - LIO Instruction Q Byte.
2. LIO and E-B 1 Cycle - main store contents of the effective address of the LIO Instruction.
3. LIO and E-B NOT 1 Cycle - main store contents of the effective address minus one of the LIO Instruction.
To A71 B
From A78 (SIO)
C
1. SIO and I-Q Cycle - SIO Instruction Q Byte.
2. SIO and I-R Cycle - SIO Instruction I-R Byte.
To A78 B
From A85 (SNS)
D
1. SNS and I-Q Cycle - SNS Instruction Q Byte.
To A85 B


A
From A66
DBO Latches
0, 1, 2, 3, and 4
I-Q Cycle and Clock 5
DBO Latches 5, 6, and 7
I DECODE ADDRESS (HT210)
1. If DBO 0-2 is equal to 011, the attachment sets DEVICE ADDRESSED (Subsystem addressed).
2. Decode DBO 3 and 4 for tape unit address.
II DECODE N FIELD (HT230)
1. DBO 5, 6, and 7=000 allows a Not Ready/Unit Check to set I/O CONDITION A and B 10 (Branch Condition met).
2. DBO 5, 6, and 7=001 allows an Interrupt Pending to set I/O CONDITION A and B 10 (Branch Condition met).
3. DBO 5, 6, and 7=010 allows a Device Busy to set I/O CONDITION A and B=10 (Branch Condition met).
4. DBO 5, 6, 7 is not equal to 000, 001, or 010 set INVALID COMMAND (HT340).
00 Device Address 0
01 Device Address 1
10 Device Address 2
11 Device Address 3
I-OP
I-Q
5 6 7 8 0 1 2 3 4 5 6 7 8
Invalid Command (HT340)
To A66 C or A69 A


A
From A66
HT230
Unit Check (HT220)
Controller not Disabled and Not Ready (HT130)
1. N Field 000= Set I/O CONDITION A with Unit Check or Not Ready.
2. Set I/O CONDITION B if neither Unit Check or Not Ready are active.
From A66
B
Device Busy AND Ready (HT220)
1. N Field 010 = Set I/O CONDITION A with Device Busy and Ready.
2. Set I/O CONDITION B if device is not Busy and is Ready.
I/O Condition A (WT215)
I/O Condition B (WT215)
TIO Op-End (HT440)
1. N Field 001=Set I/O CONDITION A with interrupt pending.
2. Set I/O CONDITION B if no interrupts pending.
From A66
D
DBO Parity Gated (HT230)
1. Set I/O CONDITION A and I/O CONDITION B if the Q Byte has even parity on DBO.
To A66 D
From A66
C
Error Stop (HT230)
1. Set Error Stop if I/O CONDITION A and B are both off and a reset is not in progress.
To A66 D

A From A71

The N field is 110

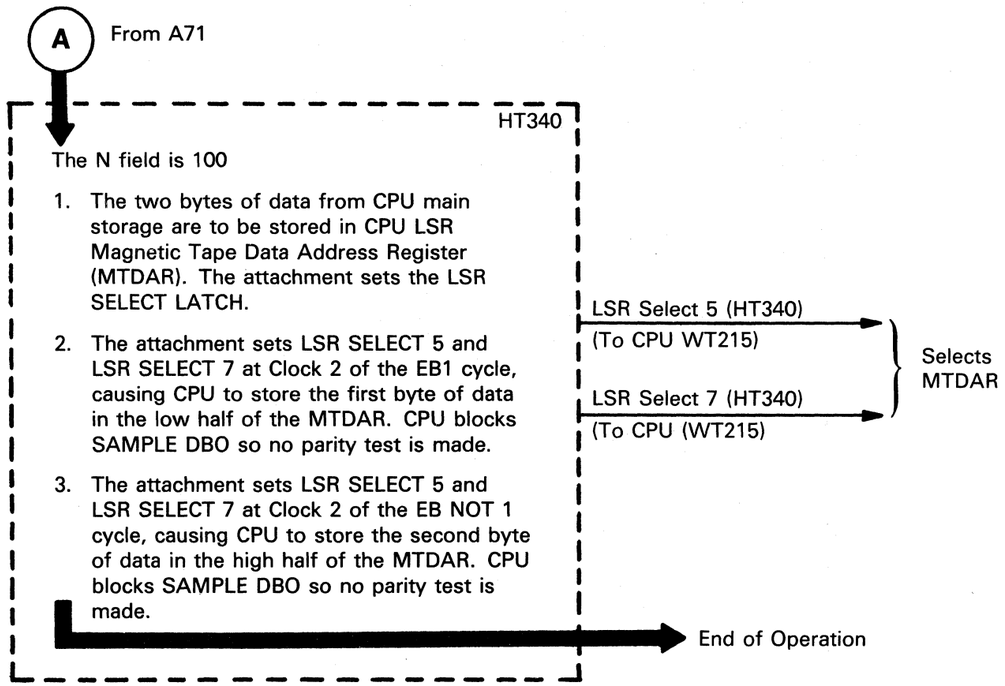
1. Two bytes of data are to be sent to the attachment. The first byte is used to control interrupts; the second byte is not used.

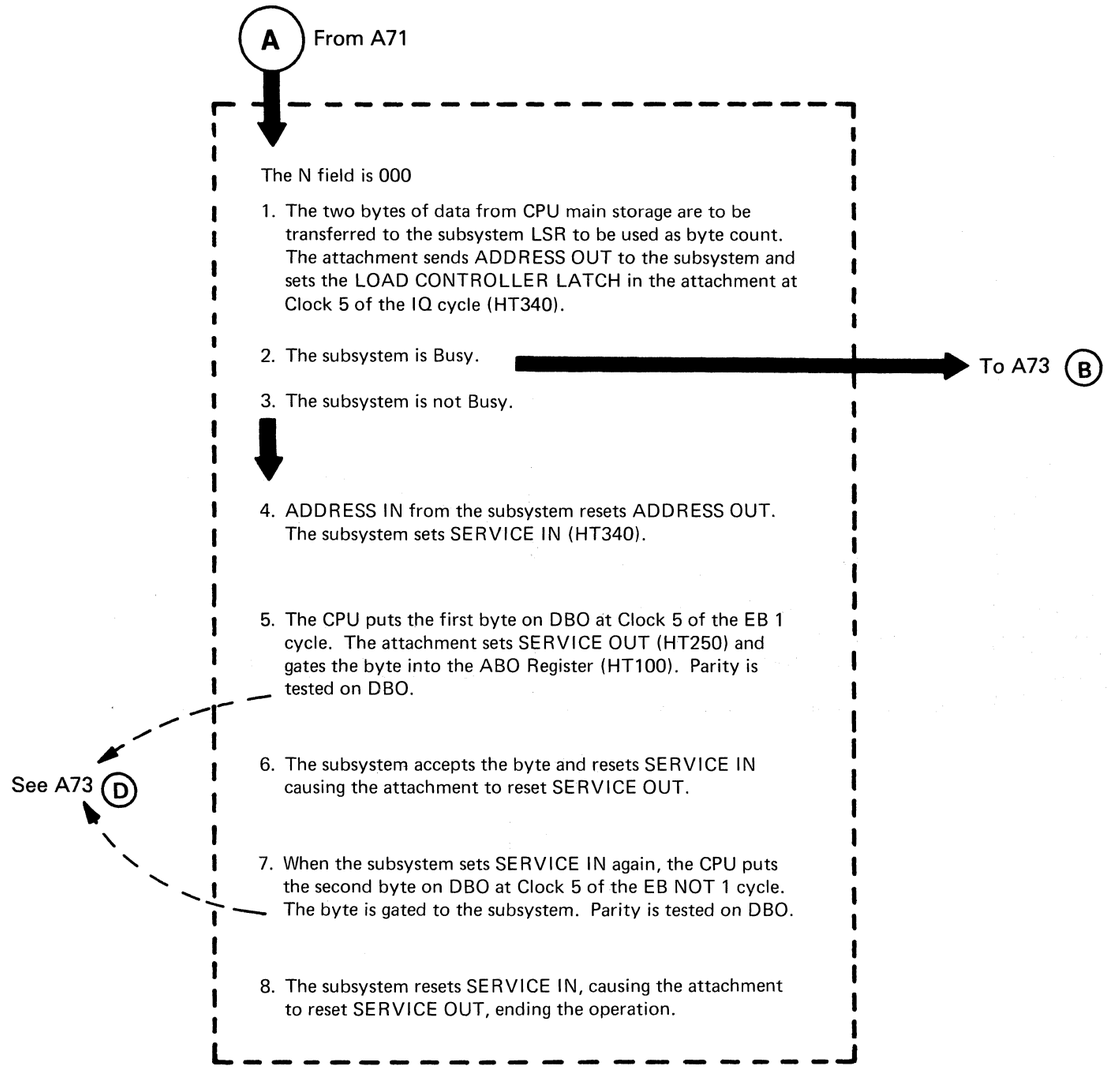
2. The LIO Op-End latch is set at C5 of the I-Q cycle.

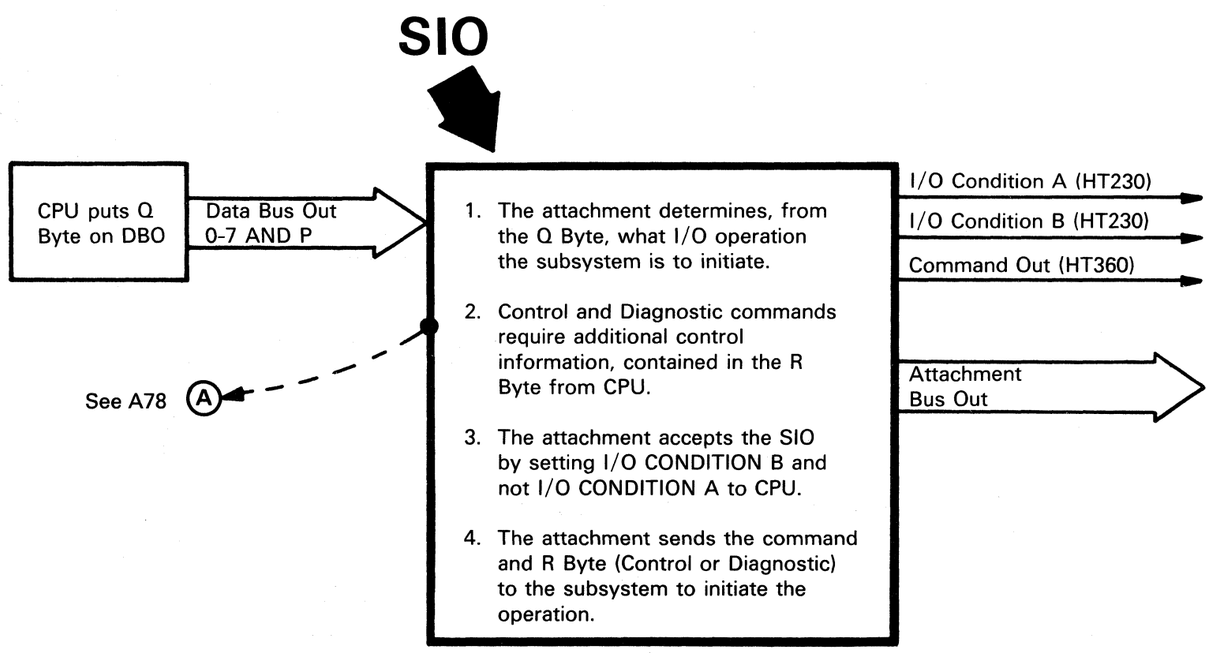
3. At C5 of the EB1 cycle DBO bits 3 and 4 are decoded to provide the following functions:

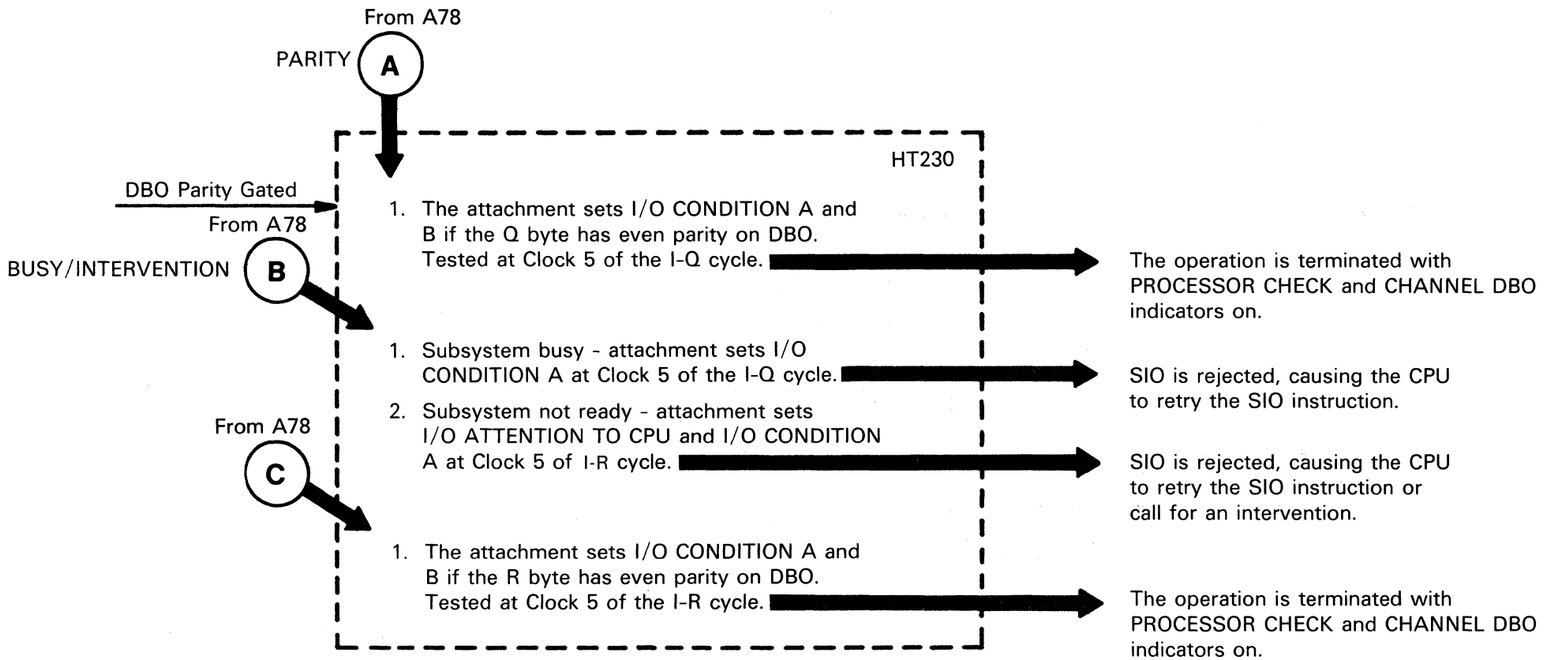
DBO Bits 3 4	
0 0	Disable interrupts by resetting the 'interrupt enable' latch,
1 0	Enable interrupts by setting the 'interrupt enable' latch,
0 1	Reset the addressed tape unit interrupt request. The tape unit address is bits 3 and 4 of the LIO Q code,
1 1	Reset the subsystem interrupt request.

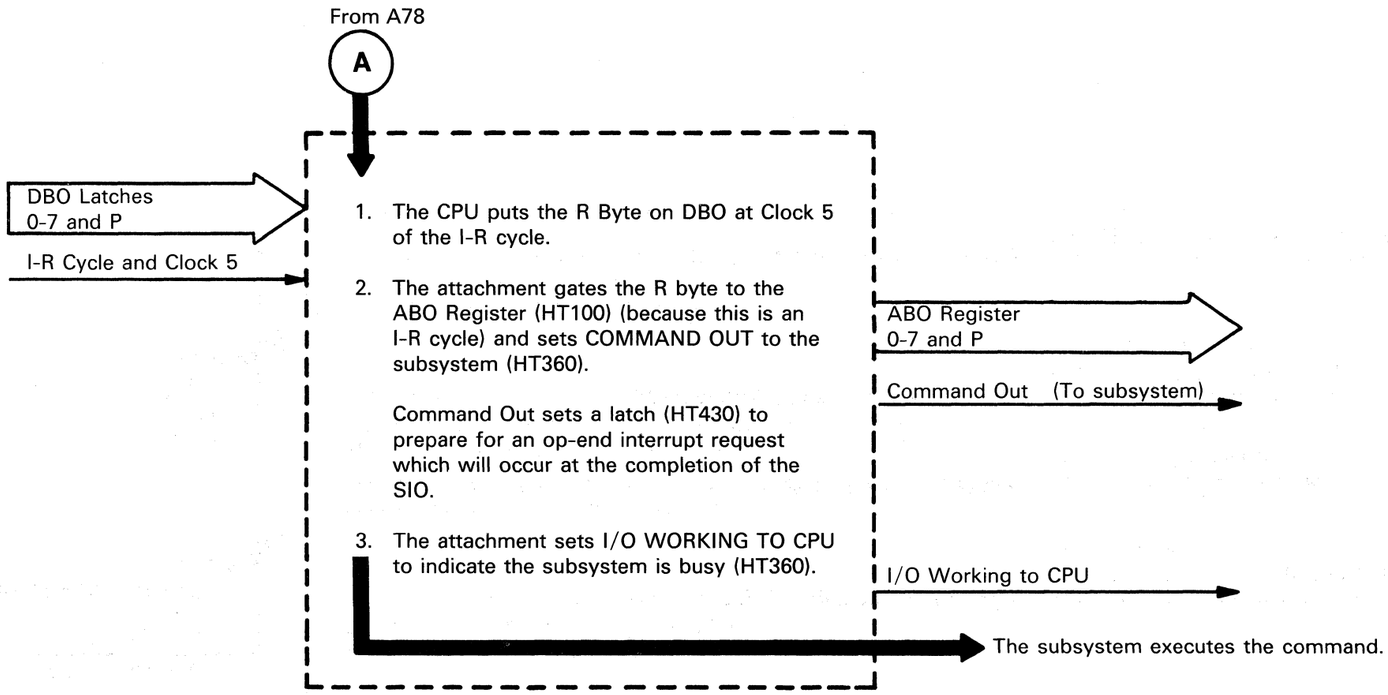
DBO parity is tested.


A
From A71
HT340
The N field is 100
1. The two bytes of data from CPU main storage are to be stored in CPU LSR Magnetic Tape Data Address Register (MTDAR). The attachment sets the LSR SELECT LATCH.
2. The attachment sets LSR SELECT 5 and LSR SELECT 7 at Clock 2 of the EB1 cycle, causing CPU to store the first byte of data in the low half of the MTDAR. CPU blocks SAMPLE DBO so no parity test is made.
3. The attachment sets LSR SELECT 5 and LSR SELECT 7 at Clock 2 of the EB NOT 1 cycle, causing CPU to store the second byte of data in the high half of the MTDAR. CPU blocks SAMPLE DBO so no parity test is made.
LSR Select 5 (HT340)
(To CPU WT215)
LSR Select 7 (HT340)
(To CPU (WT215)
Selects MTDAR
End of Operation


A
From A71
The N field is 000
1. The two bytes of data from CPU main storage are to be transferred to the subsystem LSR to be used as byte count. The attachment sends ADDRESS OUT to the subsystem and sets the LOAD CONTROLLER LATCH in the attachment at Clock 5 of the IQ cycle (HT340).
2. The subsystem is Busy.
To A73 B
3. The subsystem is not Busy.
4. ADDRESS IN from the subsystem resets ADDRESS OUT. The subsystem sets SERVICE IN (HT340).
5. The CPU puts the first byte on DBO at Clock 5 of the EB 1 cycle. The attachment sets SERVICE OUT (HT250) and gates the byte into the ABO Register (HT100). Parity is tested on DBO.
See A73 D
6. The subsystem accepts the byte and resets SERVICE IN causing the attachment to reset SERVICE OUT.
7. When the subsystem sets SERVICE IN again, the CPU puts the second byte on DBO at Clock 5 of the EB NOT 1 cycle. The byte is gated to the subsystem. Parity is tested on DBO.
8. The subsystem resets SERVICE IN, causing the attachment to reset SERVICE OUT, ending the operation.

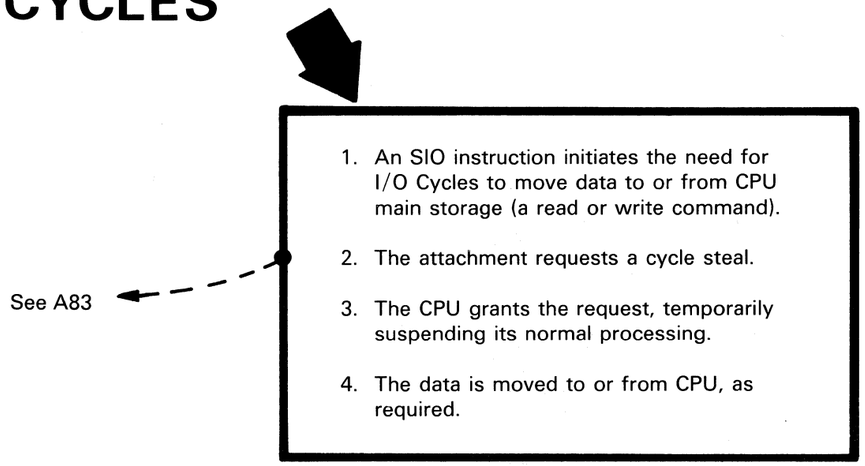

SIO
CPU puts Q Byte on DBO
Data Bus Out 0-7 AND P
1. The attachment determines, from the Q Byte, what I/O operation the subsystem is to initiate.
2. Control and Diagnostic commands require additional control information, contained in the R Byte from CPU.
3. The attachment accepts the SIO by setting I/O CONDITION B and not I/O CONDITION A to CPU.
4. The attachment sends the command and R Byte (Control or Diagnostic) to the subsystem to initiate the operation.
I/O Condition A (HT230)
I/O Condition B (HT230)
Command Out (HT360)
Attachment Bus Out
See A78
A

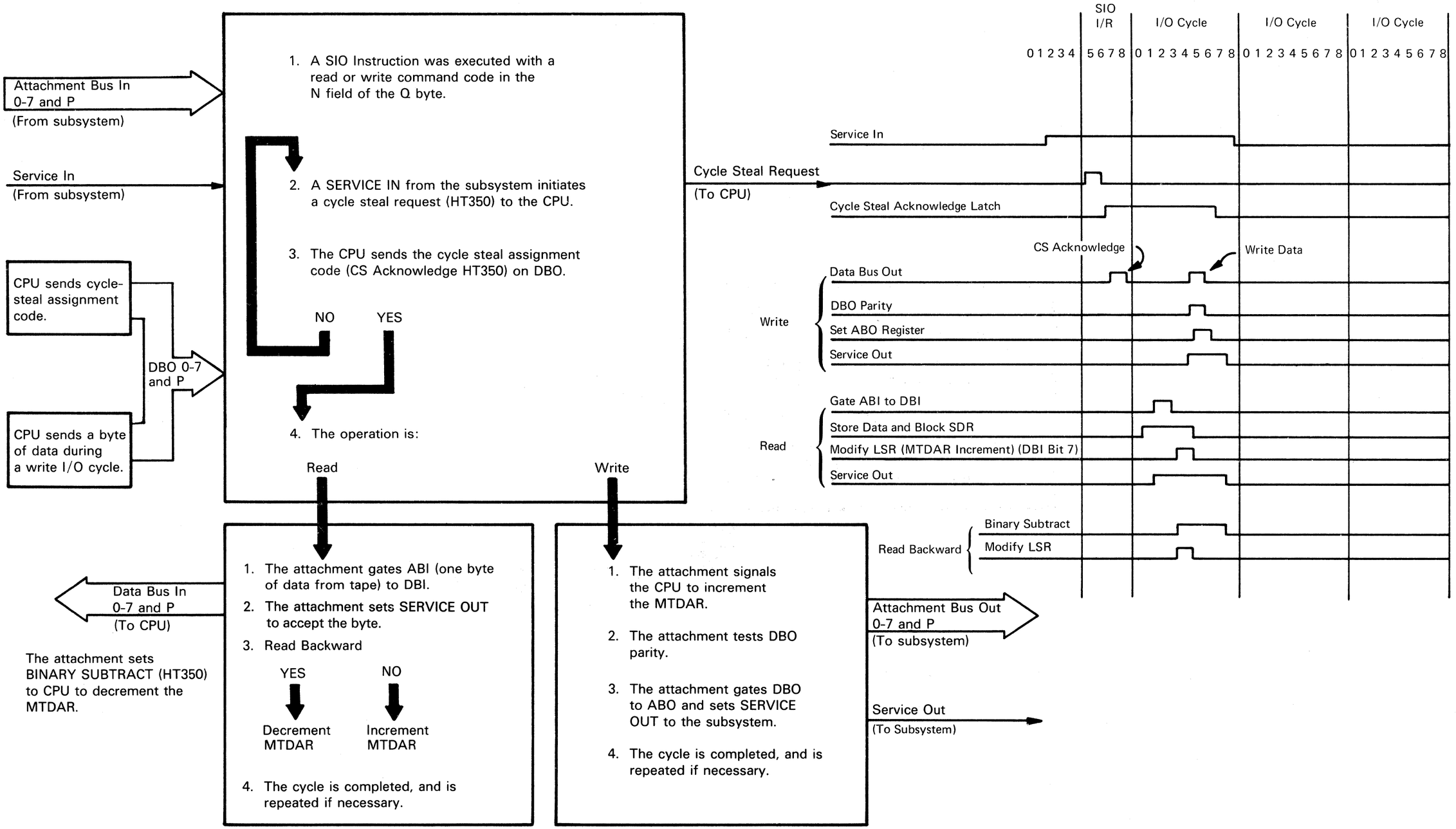

From A78
PARITY
A
HT230
DBO Parity Gated
From A78
BUSY/INTERVENTION
B
1. The attachment sets I/O CONDITION A and B if the Q byte has even parity on DBO. Tested at Clock 5 of the I-Q cycle.
The operation is terminated with PROCESSOR CHECK and CHANNEL DBO indicators on.
1. Subsystem busy - attachment sets I/O CONDITION A at Clock 5 of the I-Q cycle.
SIO is rejected, causing the CPU to retry the SIO instruction.
2. Subsystem not ready - attachment sets I/O ATTENTION TO CPU and I/O CONDITION A at Clock 5 of I-R cycle.
SIO is rejected, causing the CPU to retry the SIO instruction or call for an intervention.
From A78
C
1. The attachment sets I/O CONDITION A and B if the R byte has even parity on DBO. Tested at Clock 5 of the I-R cycle.
The operation is terminated with PROCESSOR CHECK and CHANNEL DBO indicators on.



NOTES:
1. During a read or write operation the subsystem ignores the R byte.

I/O CYCLES


1. An SIO instruction initiates the need for I/O Cycles to move data to or from CPU main storage (a read or write command).
2. The attachment requests a cycle steal.
3. The CPU grants the request, temporarily suspending its normal processing.
4. The data is moved to or from CPU, as required.
See A83


Attachment Bus In
0-7 and P
(From subsystem)
Service In
(From subsystem)
CPU sends cycle-steal assignment code.
CPU sends a byte of data during a write I/O cycle.
DBO 0-7 and P
1. A SIO Instruction was executed with a read or write command code in the N field of the Q byte.
2. A SERVICE IN from the subsystem initiates a cycle steal request (HT350) to the CPU.
3. The CPU sends the cycle steal assignment code (CS Acknowledge HT350) on DBO.
NO
YES
4. The operation is:
Read
Write
Cycle Steal Request
(To CPU)
SIO I/R
I/O Cycle
I/O Cycle
I/O Cycle
0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8
Service In
Cycle Steal Acknowledge Latch
CS Acknowledge
Write Data
Data Bus Out
Write
DBO Parity
Set ABO Register
Service Out
Gate ABI to DBI
Store Data and Block SDR
Read
Modify LSR (MTDAR Increment) (DBI Bit 7)
Service Out
Read Backward
Binary Subtract
Modify LSR
Data Bus In
0-7 and P
(To CPU)
The attachment sets BINARY SUBTRACT (HT350) to CPU to decrement the MTDAR.
1. The attachment gates ABI (one byte of data from tape) to DBI.
2. The attachment sets SERVICE OUT to accept the byte.
3. Read Backward
YES
NO
Decrement MTDAR
Increment MTDAR
4. The cycle is completed, and is repeated if necessary.
1. The attachment signals the CPU to increment the MTDAR.
2. The attachment tests DBO parity.
3. The attachment gates DBO to ABO and sets SERVICE OUT to the subsystem.
4. The cycle is completed, and is repeated if necessary.
Attachment Bus Out
0-7 and P
(To subsystem)
Service Out
(To Subsystem)

SENSE I/O

1. The attachment determines, from the Q byte, the source of two bytes of sense information to be stored in CPU main storage. The Sense bytes can come from the subsystem, the MTDAR, the attachment, or hardware.

2. The attachment sends the two bytes to CPU. The CPU stores them in two main storage locations designated by the Sense instruction.

See A85 (A)

From A87

A

CPU puts Q Byte on DBO

DBO 0-7 and P

See A67 (D)

From A67

B

1. The Sense I/O tag is set at Clock 5 of the I-OP Cycle.

2. The attachment decodes address and N fields of the Q byte at Clock 5 of the I-Q cycle. The Q byte is gated to the subsystem on Attachment Bus Out.

See A86 (A)

3. If the Q byte parity is bad, DBO PARITY GATED sets I/O CONDITION A and B and the operation terminates with the PROCESSOR CHECK and CHANNEL DBO indicators on.

See A87

4. SUBSYSTEM SENSE

See A88 (A)

YES

5. An I/O cycle is taken to allow subsystem to assemble sense bytes. Send two bytes of subsystem sense data to CPU.

NO

See A89 (A)

6. MTDAR SENSE

YES

7. Send LSR Select to CPU.

NO

See A90 (A)

8. ATTACHMENT SENSE

YES

9. Attachment sends two bytes of attachment sense data to CPU.

NO

See A91 (A)

10. HARDWARE SENSE

YES

11. Attachment sends one byte of sense data to CPU followed by one zero byte.

NO

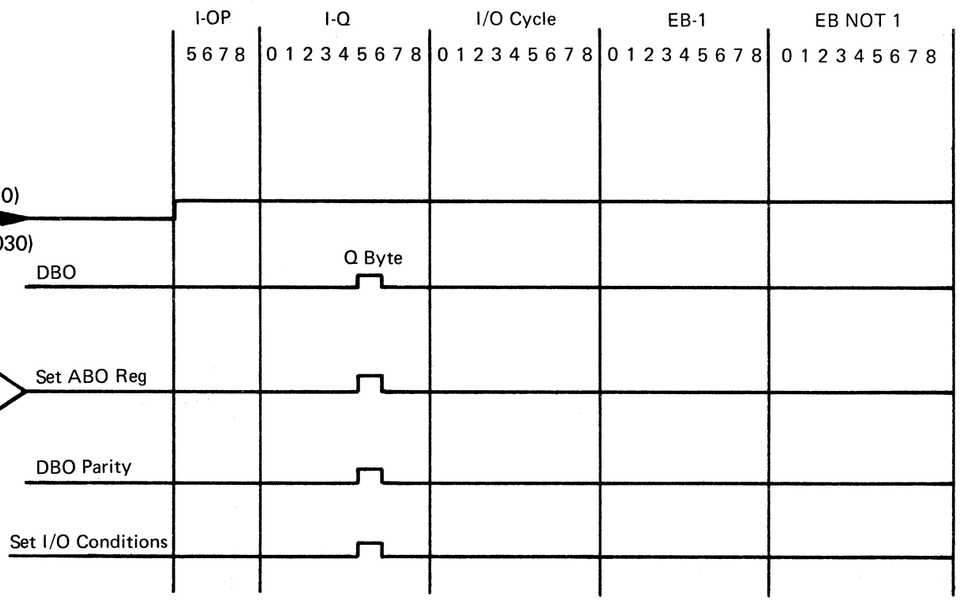
See A92 (A)

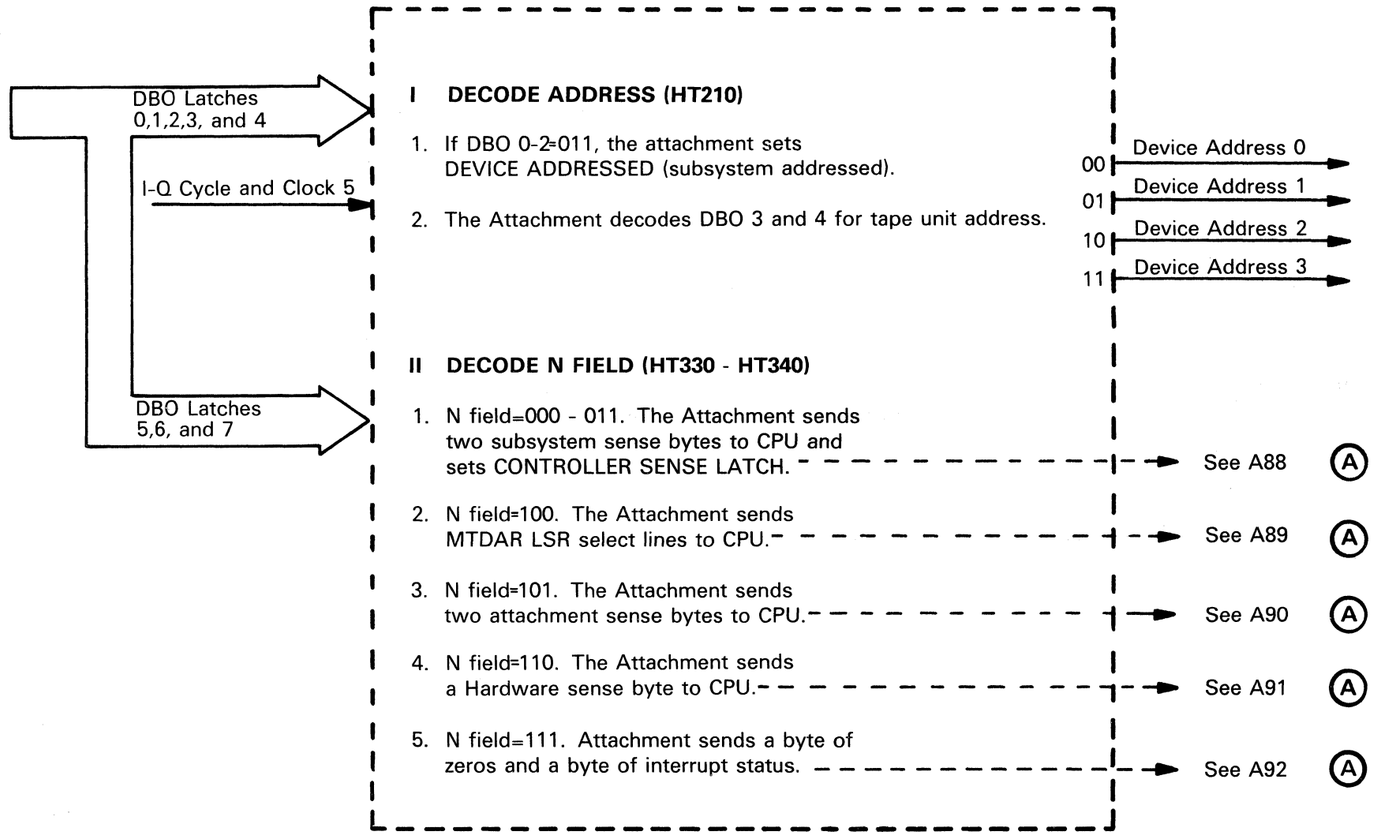
12. OP-END SENSE
Attachment sends one byte of op-end interrupt status to CPU preceded by one byte of zeros.

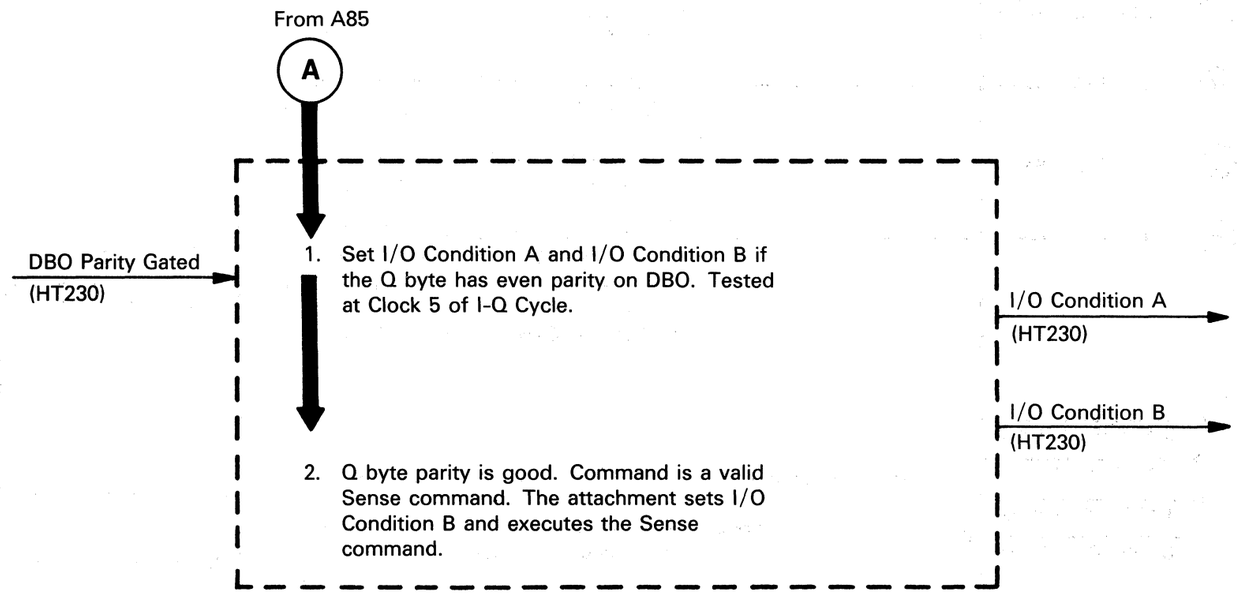
ATO 1 Sense (HT310)

(To subsystem WT030)

ABO 0-7 and P




DBO Latches
0,1,2,3, and 4
I-Q Cycle and Clock 5
DBO Latches
5,6, and 7
I DECODE ADDRESS (HT210)
1. If DBO 0-2=011, the attachment sets DEVICE ADDRESSED (subsystem addressed).
2. The Attachment decodes DBO 3 and 4 for tape unit address.
00 Device Address 0
01 Device Address 1
10 Device Address 2
11 Device Address 3
II DECODE N FIELD (HT330 - HT340)
1. N field=000 - 011. The Attachment sends two subsystem sense bytes to CPU and sets CONTROLLER SENSE LATCH.
See A88 A
2. N field=100. The Attachment sends MTDAR LSR select lines to CPU.
See A89 A
3. N field=101. The Attachment sends two attachment sense bytes to CPU.
See A90 A
4. N field=110. The Attachment sends a Hardware sense byte to CPU.
See A91 A
5. N field=111. Attachment sends a byte of zeros and a byte of interrupt status.
See A92 A


From A85
A
DBO Parity Gated
(HT230)
1. Set I/O Condition A and I/O Condition B if the Q byte has even parity on DBO. Tested at Clock 5 of I-Q Cycle.
2. Q byte parity is good. Command is a valid Sense command. The attachment sets I/O Condition B and executes the Sense command.
I/O Condition A
(HT230)
I/O Condition B
(HT230)

From A85

A

1. The N field has bit 5 off indicating a subsystem sense. The attachment sets the CONTROLLER SENSE LATCH (HT330).

2. The attachment initiates a CYCLE STEAL REQUEST 7 (HT350) causing a dummy I/O cycle (channel is idle). The subsystem decodes the N field of the Q byte to determine which two sense bytes are requested (see Sense I/O, System/3 Flowchart) and assembles the bytes.

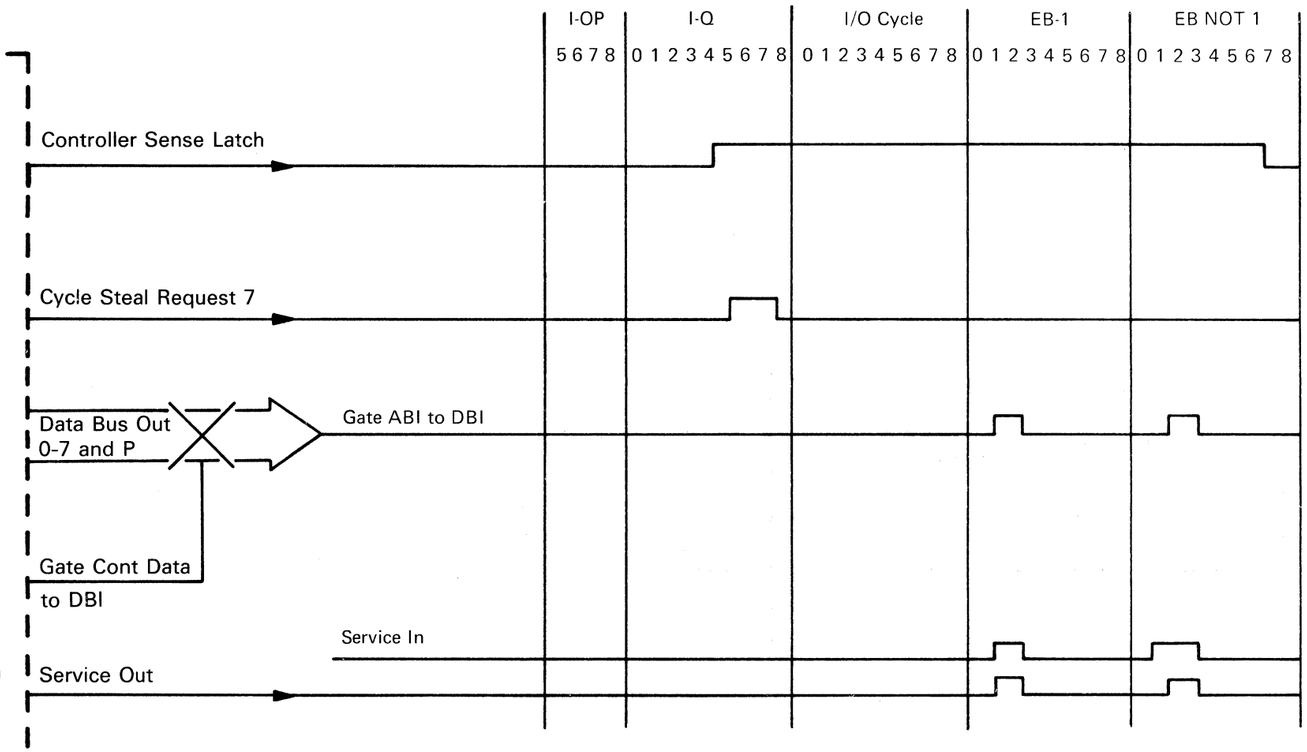
3. SERVICE IN (HT230—HT260) from the subsystem indicates the first byte is on ABI. The attachment gates ABI to DBI (GATE CONT DATA TO DBI - HT110) at Clock 2 of the EB 1 cycle.

4. The attachment sets SERVICE OUT to the subsystem at Clock 3 of the EB 1 cycle, requesting the second sense byte.

5. SERVICE IN (HT230 - HT260) from the subsystem indicates the second byte is on ABI. The attachment gates ABI to DBI at Clock 2 of the EB NOT 1 cycle.

Attachment Bus In 0-7 and P

Service In



From A85

A

DBO 5,6, and 7
(N field)

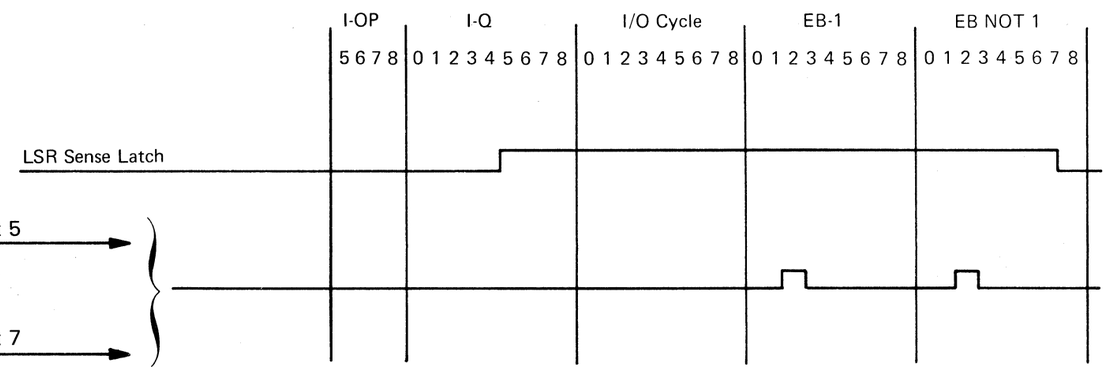
1. The N field equals 100 indicating an LSR sense (MTDAR). The attachment sets the SENSE LSR LATCH (HT340 - HT360).

2. The attachment sets LSR SELECT 5 and 7 (HT340) at Clock 2 of the EB 1 cycle to select the low order half of the MTDAR. The data from the MTDAR is stored in the main store location selected by the instruction.

3. The attachment sets LSR SELECT 5 and 7 (HT340) at Clock 2 of the EB NOT 1 cycle to store the high order half of the MTDAR in main storage.

LSR Select 5

LSR Select 7



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