CAMAC Link Operations Manual

NOTE: Changes since the last edition of this document are indicated by a bar in the right margin.

1. Introduction.

The CAMAC links of the CICADA computer system are an integral part of TFTR Operations. This document describes the standards for installation, troubleshooting, documentation, and maintenance of these CAMAC Serial Highway links.

2. Reference Documents.

2.1 U-Port Adapter and LAM Grader, CICADA Handbook Volume I, TFTR-10B3-H313

2.2 Fiber Optic Transceiver Module, CICADA Handbook Volume I, TFTR-10B3-H352

2.3 CD.COCAD Computer CAMAC Interface Diagnostic Design, CICADA Handbook Volume IV, TFTR-S8433

2.4 Serial Highway Interface System (CAMAC), IEEE Standard 595-1976

2.5 TFTR Communications Links Family Tree, Drawing #C-AC4200, Sheet 1.

3. Link Components.

There are only three standard types of CAMAC modules in CICADA's CAMAC links: The H313 U-Port, the H352 Fiber Optic, and the Kinetics 3952 L-2 Crate Controller modules. The purpose and limitations of each of these components is described in the following sections. All components operate at 5MHZ, the maximum frequency permitted by the CAMAC standard.

3.1 H313 U-Port Module.

The first module in any link is the Master H313 U-Port module (see Reference 2.1). A U-Port is either a Master or a Slave, depending on the position of a DIP switch. The Master U-Port accepts CAMAC clock and data from a CAMAC interface in the Computer room. The data enters the master U-Port via the pigtail D connector. The U-Port then encodes the data into a Bi-Phase format. After it is encoded, the data is sent through a switchable 10-Tap, 100 ns delay line. After the delay line, the data is transformer-coupled to a front-panel LEMO connector.

The clock from the CAMAC interface also enters the master U-Port via the pigtail D connector. The clock can be inverted by a DIP switch. In either case, the clock is transformer-coupled to a front-panel LEMO connector.

The clock and Bi-Phase data are then sent out on the CAMAC highway. These 5-volt differential signals will be received by either an H352 Fiber Optic Transceiver or a slave U-Port.

The purpose of the data delay and the clock inversion is to modify the data-clock phase relationship for the CAMAC highway downstream of the U-Port.

Ultimately, a slave U-Port will receive the Bi-Phase signals. A slave U-Port receives clock and bi-phase data at its front-panel LEMO connectors. The signals are routed through Bypass Relay contacts. If the U-Port is in Bypass, the relay will simply turn the signals around so that the LEMO outputs have the same (physical) signal as the LEMO inputs. An electrical "T" of the LEMO inputs is sent into the U-Port for monitoring purposes. This permits the U-Port to send CAMAC commands to its associated L-2 crate controllers, although the crate controllers cannot send any reply downstream.

If a U-Port is online, then the input signals are routed through the relay contacts and transformer coupled to the U-Port proper.

The Bi-Phase data is then routed through a switchable 10-Tap, 100 ns delay line. The clock can be inverted, or not, via a switch.

After the input delay line, the Bi-Phase data is converted to CAMAC NRZ data by being clocked through a D-Type flip-flop. It is then sent to the L-2 crate controller via the pigtail D connector.

The purpose of the switchable data delay and the switchable clock inversion is optimally to set the data-clock phase relationship so that the U-Port will clock the correct data from the CAMAC highway into the L-2.

After the L-2 has processed the data, it transmits CAMAC NRZ data and clock to the U-Port via the pigtail D connector. The data and clock are then encoded and delayed (clock inverted) and retransmitted out the LEMO front panel connectors of the U-Port.

In addition to CAMAC data and clock, the L-2 generates a permissive signal called BYPASS CONTROL. The Bypass Control is actually a relay contact in the L-2 module controlled by the internal bypass feature of the L-2. If the "Bypass" LED of an L-2 is lit, this contact is closed. When the contact is closed, a Ground is transmitted which causes the transistor in the U-Port to de-energize the signal relays. This forces the U-Port into Bypass. If the Bypass Control signal is open, the U-Port will be online (unless the front-panel switch is in the Bypass position).

Also, if the CAMAC +6 volt supply is low, the Bypass relays will de-energize and the U-Port will be in Bypass.

The CAMAC-related switches on the U-Port are:

(1) 10-position Data In delay (10 ns/position)
(2) Clock In Inversion Switch
(3) Online/Bypass Front-Panel Switch
(4) Master/Slave U-Port Switch
(5) 10-position Data Out delay (10 ns/position)
(6) Clock Out Inversion Switch

"Tuning the links" is the process of setting the switches on the U-Port module so that:

(1) The data decoded for the L-2 is optimally set. This is performed by delaying the input Data In and setting the Clock In inversion.

(2) The data leaving the U-Port LEMO connectors has the same Data-to-Clock phase relation as the input signals. This is performed by delaying the output Data delay and setting the Clock Out inversion.

Detailed "tuning" information will be presented in Section 7.

3.1.1. Electrical Signal Levels.

The signal levels at the LEMO input connectors should nominally be 5 volts balanced differential; i.e., the voltage differential between LEMO pins 2 and 3 should be 5 volts . Secondly, the voltage at pin 2 or 3 should be 2.5 volts with respect to ground.

Normally, the signals are not 5 volts, but are usually above 4 volts. The rise and fall times of the pulse transitions are dependent on the type and length of cable which is driving the input. Relatively slow rise/fall times contribute to edge jitter and duty cycle distortion.

The input impedance of the module inputs are about 150 ohms. The inputs are transformer coupled.

The pigtail D connector inputs are also 5 volts differential signals.

The pigtail Bypass Control input should either be OPEN or a short to ground. This signal is sourced at the L-2.

The LEMO outputs are 5 volts balanced differential (signals into 100 ohms). Again, the signal levels and rise/fall times are dependent upon the type and length of cable being driven. The outputs are transformer-coupled.

The electrical outputs to the L-2 are also 5-volt balanced differential signals.

3.1.2 Power Supply Requirements.

The H313 U-Port requires +6 CAMAC supply voltage.

3.1.3 Link Bypass Adapter Module.

This module is actually a very slightly modified H313 U-Port Adapter with a special front panel. The modifications consist of jumpering out the "Bypass" switch, changing the pigtail male "D" connector to a panel mount female "D" connector, interchanging the data and clock input lines with the data and clock output lines in this "D" connector and then reversing the "D" connector clock output wires.

The purpose of this module is to provide a means to bypass an entire section (branch) of a CAMAC link. To do this, it is installed in conjunction with a standard H313 module. The Bypass Adapter module transmits and receives the data and clock signals of the branch through its front panel LEMO's. The H313 module's pigtail is connected to the front panel "D" connector of the Bypass Adapter module and the data and clock signals of the main body of the link are transmitted and

received through the H313's front panel LEMO's. Both modules are set as Master U-Ports.

Once these modules are properly tuned (see Section 4.5), placing the H313's "Bypass" switch in the bypass position will cause the main body of the link to loop through the H313's bypass relays. This effectively will bypass the branch connected to the Link Bypass Adapter module.

3.2 L-2 Serial Crate Controller.

The second component of the CAMAC links is the L-2 crate controller module. This module accepts differential CAMAC Data and Clock at D-Type connectors.

As far as the CAMAC link is concerned, there is only one operational state of the L-2. That is the Online state. In this state, the L-2 receives and transmits CAMAC data according to the IEEE protocol.

It is important that all L-2 controllers on a CAMAC Link be in the Online state to ensure that cable attenuations and possible mistuned U-Ports do not cause random data transmission errors (No Syncs).

A CAMAC command is required to "wake up" a crate to the Online state. This can be done with the "LINK BOX", the Console page CU09, or from CD.2070 at the subsystem terminal.

The L-2 crate controller accepts CAMAC Clock and Data at its D-Input connector. The L-2 then shifts the Data into a shift-register on the rising edge of the Clock line.

If the data/clock phasing in the U-Port is wrong by a large percentage, the data clocked into the L-2 will be completely inverted. This will cause severe loss of SYNC. If the data/clock phasing is wrong by a small percentage, the data

into the L-2 will be partially correct, and subject to intermittent parity and loss of SYNC states.

The CAMAC link modules that CICADA uses slightly distort the duty cycle and edge timing of the Data and Clock signals. To compensate for these dynamic distortions, the Data delay capabilities of the U-Port are used optimally to set the data/clock phasing to decode the data for the L-2.

Once the Data is clocked into an L-2, the L-2 is in control of the data manipulation. The L-2 will, after some variable delay, send CAMAC Clock and Data out at its D-Output connector. These signals then go through the U-port and propagate downstream.

Inside the L-2, a parallel-to-serial shift register sends data to its D-Output connector. The clock used to shift out the data is a delayed (delay by Buffered RC inside L-2) version of the input clock. The data/clock relationship on L-2 output data is always the same. This is because of the L-2 internal timing. However, while the phase is consistent, the data is either correct or corrupted, depending upon the L-2 input integrity.

3.2.1 Electrical Signal Levels.

The L-2 crate controller inputs accept balanced differential 5-volt signals.

The L-2 Data and Clock output signals are 5-volt balanced differential levels (into 100 ohms). The Bypass Control signal is a relay contact which is CLOSED to ground when the L-2 is in Bypass (as shown by its front panel LED) or without power and OPEN when it not in Bypass.

An auxiliary connector on the L-2 front panel provides TTL versions of the received and transmitted Clock and Data signals.

3.2.2 Supply Voltages.

The L-2 crate controllers need +6 and +24 volt CAMAC supplies.

3.2.3 L-2 Cabling.

In the event that a U-Port hosts more than one L-2, the Bypass Control signals from each L-2 are logically ANDed. That is, if any of the L-2's go into Bypass, it will cause the U-Port to enter the Bypass state. This can only be accomplished through proper cabling between L-2's. Specifically, the Bypass Control line of all the crate controllers should be connected in parallel.

The current installation techniques call for a single series cable arrangement to connect all of the L-2's associated with a U-Port. This cable will carry:

(a) DATA/CLOCK IN
(b) DATA/CLOCK OUT
(c) BYPASS CONTROL

A turn-around connector is used on the L-2 at the "end" crate (furthest from the U-port).

3.2.4 L-2 Versions, Old and New.

Currently, there are two types of L-2's in service, an "old" type which can be distinguished by the use of all red LED's and a 19 pin miniature "D" type auxiliary connector on its front panel and a "new" type which uses a mix of red and yellow LED's and a 14 pin ribbon type auxiliary connector on its front panel. Functionally, these L-2's are the same, however, they exhibit different data throughput delays. This results in the host U-Port's output becoming mistuned if these two types of L-2's are interchanged. Therefore, should it be necessary to replace an L-2, it should be replaced with the same type. If this is not possible, the U-Port must be retuned per section

4.1. This criteria also applies to L-2's D-Ported to other L-2's.

3.3 H352 Fiber Optic Module.

The H352 Fiber Optic module (see Reference 2.3) is used when electrical isolation or long transmission distances are required. The module transmits and receives electrical and optical Bi-Phase CAMAC Data and Clock signals. It has provisions for battery backup so that a CAMAC link can remain operational if the CAMAC power supply is disabled. The batteries will supply power for about 1 hour.

The module is driven by a U-Port Module or another H352 Module, and drives a U-Port module,or another H352 Module. The electrical inputs and outputs are similar to the U-Port.

Transformer coupling is used for the Data and Clock signals.

3.3.1 Power Supply Requirements.

The modules use CAMAC +6 and +24 volt supplies. Older versions of the module require -6 volts (and -24 volts if battery backup is used).

The fiber optic module is especially susceptible to power supply ripple fluctuations. The CAMAC supplies should be checked for noise if an intermittent link problem suddenly appears.

3.3.2 H352C Fiber Optic Module.

This is the newest version of the Fiber Optic Module. Electrically, it is compatible with H352 installations, however, it utilizes different optical components and is not optically compatible with an H352. Therefore, H352C's must be installed in pairs, one at each end of an optical link.

Additionally, it provides selectable throughput delays on its receiver circuitry. These delays consist of a switchable 10-Tap, 100ns delay line on the output of each receiver. Their purpose is to permit the output phasing of the clock and data signals being transmitted through the optic link to be adjusted to equal the input phasing thereby permitting a consistent clock/data phase relationship through an entire CAMAC link. The advantage this provides is that any section of crates in the link can then be jumpered out or bypassed without necessitating the retuning of the link.

4 Installation Procedures.

There are two approaches which may be taken to add a new crate to a link:

(1) To use a U-Port,
(2) To D-Port the crate to an existing crate on the link.

The link configuration and installation details will be made by the link engineer.

4.1 To U-Port a crate the following steps should be taken:

(1) Install a U-Port (H313) in the crate in slot 23. If it is not possible to reach the U-Port DIP switches with the U-Port in the crate, it should be temporarily installed on an extender card. An extender cable will also be necessary for the pigtail to reach the L-2.

(2) Connect the Data and Clock input cables to the U-Port. Then connect the Data and Clock output cables to the U-Port with Link LEMO Boxes in series with them. Connect the pigtail to the L-2 and power up the crate. Using the Link Box place the L-2 "online" ("wake it up"). The U-Port switch should be in the online position (down) and the red "online" LED of the U-Port should now be lit. Set the four switches of SW1 to the up position except for "2" (Master/Slave) which should be down.

(3) Connect the scope probes to TP1 and TP2 on the U-Port. By moving the delay switch SW2 (uppermost on the U-Port) the rising and falling edge of the long high data signal should be centered in the high pulses of the clock. If this is not possible, switch "1" of SW1 should be pushed down. This inverts the clock signal and centering should now be possible.

(4) Connect the scope probes to pin 2 (lower right) of the data and clock Link LEMO Box side connectors. Place the U-Port in bypass and note the phase relationship between the data and clock waveforms. The accepted practice is to observe the time in nanoseconds between positive transition of the clock with respect to the positive transition of the long data high. Place the U-Port back online and adjust the delay switch SW3 (lowermost on the U-Port) until the phase relationship between the data and clock matches the relationship observed with the U-Port in bypass. If this is not possible, switch "3" of SW1 should be pushed down. This inverts the output clock signal and matching should now be possible. Because this "tuning" is a very critical step, flip back and forth between online and bypass several times to verify that the phasing is adjusted to the optimum setting.

(5) This completes the "tuning" of the U-Port. If it is on an extender, remove the extender and install the U-Port in the crate. Remove the Link LEMO Boxes from the circuit, "wake up" the L-2 and switch the U-Port online. Tie wrap up the cabling to permit removal of the L-2 should it ever be necessary.

4.2 To Add a New Crate by D-Porting It To An Existing Crate.

(1) First, connect the Link LEMO Boxes in series with the data and clock output lines of the existing U-Port. With this U-Port and its L-2 online, the phase relationship between the data and clock should be carefully noted (write it down) per the criteria described in Section 4.1.(4). The purpose of this procedure is that this relationship must remain exactly the same when the "tuning" has been finished.

Remove the turnaround from the existing crate's L-2 and using a D-Port cable, connect the "output" D connector of the new crate's L-2 to the "Input" D connector of the existing crate's L-2. "Wake up" the new crate with the Link Box and

install a turnaround on the "Input" D connector of the new crate's L-2.

(2) Connect the scope probes to TP1 and TP2 of the U-Port and check that the data and clock relationship meet the criteria described in Section 4.1.(3). If not, follow the steps outlined in 4.1.(3) to satisfy this criteria.

Connect the scope probes to pin 2 (lower right) of the data and clock Link LEMO Box side connectors. Adjust the delay switch SW3 (lowermost on the U-Port) until the phase relationship between the data and clock matches the relationship noted at the beginning of the installation. If this is not possible, the position of switch "3" of SW1 should be changed. This inverts the output clock signal and matching should now be possible. It is very important that this match be as close as possible to the original data/clock relationship.

(3) This completes the "tuning" of this installation. Remove the Link LEMO Boxes from the circuit and tie wrap up the cabling as necessary.

4.3 Labeling Requirements.

All LEMO terminated cables plugged into the front panel of a U-Port and all optic cables should be labeled per the following format:

LINK ID
SIGNAL TYPE + DIRECTION
SIGNAL SOURCE OR DESTINATION

EXAMPLE:

DIAG 2
DATA FROM
CTCB-EE-536

D-Port cables should be labeled only if they leave the rack in which the crate is located. If this is the case, the crate number of the other end of the cable should replace the signal type and direction on the label.

EXAMPLE:

DIAG 2
TO/FROM CRATE 12
CTCB-EE-525

4.4 Replacing an Existing U-Port.

When replacing an existing U-Port, it is important that the data and clock relationship outbound from the existing U-Port be maintained. Therefore, the measurement should be made as described in the beginning of Section 4.2.(1) before removing the existing U-Port. This measurement should be made with the existing U-Port and L-2 online.

To replace the existing U-Port, replace it with a new U-Port and "tune" it per the procedures outlined in Section 4.2.(2).

If the existing U-Port is bad and the measurements of Section 8.1 are not possible, the new U-Port should be installed with its DIP switches set in the same positions as the U-Port it is replacing.

4.5 Tuning a Link Bypass Adapter/H313 U-Port Set.

The only criteria that must be met before a branch of a link can be established with this module set is that the data/clock phase relationship returning from the branch is the same as is being sent. If optic links are involved, it may be necessary to utilize the H352C Optic modules to establish this criteria.

Once it is established, the Link Bypass Adapter/H313 U-Port module set should be installed as described in Section 3.1.3 and tuned per the following procedure:

(1) Tune the test points TP1 and TP2 of the H313 as described in Section 4.1.(3).

(2) Tune the Data/Clock output phase relationship of the Link Bypass Adapter module (measured at the front panel output LEMO's) until it is the same as the phase relationship being input to the H313 input LEMO's.

(3) Tune the test points TP1 and TP2 of the Link Bypass Adapter module as described in Section 4.1.(3).

(4) Tune the Data/Clock output phase relationship of the H313 as described in Section 4.1.(4).

Use of this module set will be determined by the link engineer who will oversee their installation.

4.6 Tuning of the H352C Optic Links.

The purpose of this tuning is to provide the same data/clock phase relationship at the output of the optic link as was input. The following steps should be taken:

(1) Measure the data/clock phase relationship at the input LEMO connectors to the optic link by placing the Link LEMO Boxes in series with the input.

(2) Set the data and clock delay switches at the receiving optic module until the phase relationship measured at the output LEMO connectors is the same as measured in step 1.

(3) Repeat steps (1) and (2) for the return signal path.

4.7 Scope Settings.

It is important when "tuning" U-Ports that the scope settings are proper. If they are not, there is a risk of "tuning" the U-Port 180° out of phase. This situation can be monitored using the Link Box to observe "Wait" bytes (right four LED's lit) at the crate. If you tune 180° out of phase, the "Wait" byte will become inverted (right six LED's lit). When finished, you should check the "Wait" bytes at the next crate in the link for this situation. Should the next crate have inverted "Wait" bytes, you should return to the U-Port you have just tuned and change the position of switch "3" of SW1.

The following is a list of critical scope settings.

(1) Display both channels using "CHOP" not "ALT".

(2) Trigger on "INT" from the data signal channel.

(3) "TRIGGER MODE" set to "AUTO".

(4) "INVERT" switch should be out (disengaged).

(5) .1 microsec/DIV is most convenient (when using "X10" go to 1 microsec/DIV).

(6) Both scope probes should be grounded to crate.

5. Documentation Standards.

5.1 Overview.

It is important to document link changes and problems. Weekly meetings may be held to supplement information flow, but the records in the CAMAC Log Book (CLB) should provide all necessary information.

The CAMAC Log Book contains all the information to troubleshoot a CAMAC link. It has a section for each subsystem. For each CAMAC link, there is a:

(a) Link status display
(b) Link MAP displays
(c) Crate/rack cross-reference

There is a section for log entries by link personnel. Schematics for the various link modules are also provided.

The following sections will explain each documentation format that will be used by link personnel.

5.2 Console Page CU09

This COS page is the crate initialization page. It contains a block for each CAMAC link. Hitting that block and subsequently the link ID with the cursor will show the link (online/offline crate status, errors) for that subsystem.

Underneath each subsystem block is a number which represents the expected number of online crates for that link.

For each online subsystem (except CONSOLE links), there is a hardcopy of this page in the CAMAC Log Book.

This page is useful in determining if any crates or U-Ports are in Bypass (e.g., if an intermittent NO SYNC suddenly appears at the INTERFACE).

Whenever a crate is removed or added to the link, the number underneath the subsystem block should be updated on the CAMAC Log Book hardcopy for that subsystem. Also, the affected crate(s) should be noted on the horizontal link display.

CU09 will be updated following any changes The revision information will come from the marked-up CLB pages.

5.3 Console Link (MAP) Displays.

The Consoles have a directory (CCCK) of displays which show the physical configuration of the CAMAC links. That is, the order in which racks, crates, electrical, and optical connections appear is noted on these pages. Each subsystem has several pages. A hardcopy of each of these pages is kept in the CLB.

These pages are very useful when troubleshooting a link problem because they are a MAP of the link.

Whenever a crate, rack, electrical, or optical connection is inserted or deleted in a link, that (hardcopy) display should be appropriately marked up in the CLB.

The CCCK directory will be updated following any changes. The revision information will come from the marked-up CLB pages.

5.4 Rack/Crate Cross-Reference.

This listing contains several important items. Primarily, it provides a cross-reference between crate # and rack #. Also, the digraph for the TFTR system and the cognizant CICADA engineer are shown for each rack/crate. Finally,

the listing shows whether a crate should be online, and whether the crate is physically in the CAMAC link. An Online crate has an asterisk in the "Online" column, a crate physically on the link, but offline is designated by an asterisk in the "Bypassed" column.

This information can be used in conjunction with the COS CU09 display to determine which crate is in a WRONG-STATE.

Whenever a link change is made, or a crate or rack assignment is made, the listing in the CLB should be marked up.

The listing will periodically be revised. The revision information will come from the marked-up listing in the CLB.

5.5 CICADA Operator's Log Book.

The CICADA Operator's Log Book contains a record of all changes made to the CICADA computer system. This includes the CAMAC links and therefore an entry should be made whenever a change to the link hardware is performed.

This Log entry is especially important when an Online system fails during scheduled up-time. The log entry should be brief and accurate in explaining the cause of the failure. Speculation as to the cause of a failure, or proposed solutions, is not recommended here. Remember, this is the "official" log book and is normally reviewed by CICADA management.

5.6 CAMAC Log Book (CLB) Entries.

The first few pages of the CAMAC Log Book contain pages for any entries pertaining to the CAMAC links. The most recent entries appear first. Typical entries will provide more technical accounts of online system failures and troubleshooting methods. Suggestions for improvement of link operations can be made here. This section can be very

informal and speculative in nature. It is a good place to pass ideas between personnel.

5.7 Link Wake Up File.

These files reside on each subsystem computer and contain a listing of all online crates in link order for the use of that subsystem's CD.2070 program. Whenever a link change is made, the appropriate file should be updated.

5.8 Summary.

The following documentation should be updated when adding or removing any crate:

(a) Page CU09
(b) Link MAP
(c) Crate/Rack Cross-Reference
(d) CICADA Operator Log
(e) CLB Log (optional)
(f) Link Wake Up file used by CD.2070.

When an online system failure has been repaired.

(a) CICADA Operator Log
(b) CLB Log (recommended)

6. Troubleshooting Procedures.

These procedures assume that the reader has a knowledge of the software and hardware tools that are available.

6.1 Common Failure Modes.

While each failure can have a unique cause, experience has shown that common failure modes do exist for the CAMAC links.

(A) Hard Failures (complete loss of signal)

(1) CAMAC power supply turned off

(2) L-2 crate controller bad

(B) Intermittent Failures

(1) Non-Optics

(a) Data-clock phasing into L-2

(b) Bad CAMAC power supply causing low voltage and/or excessive ripple

(2) Optics

(a) Very loose or (on H352's only) a very tight optic connector

(b) Ripple on CAMAC power buses

6.2 Troubleshooting Flowchart.

The following flowchart depicts the procedures to follow when troubleshooting a link. Once the cause of failure has been

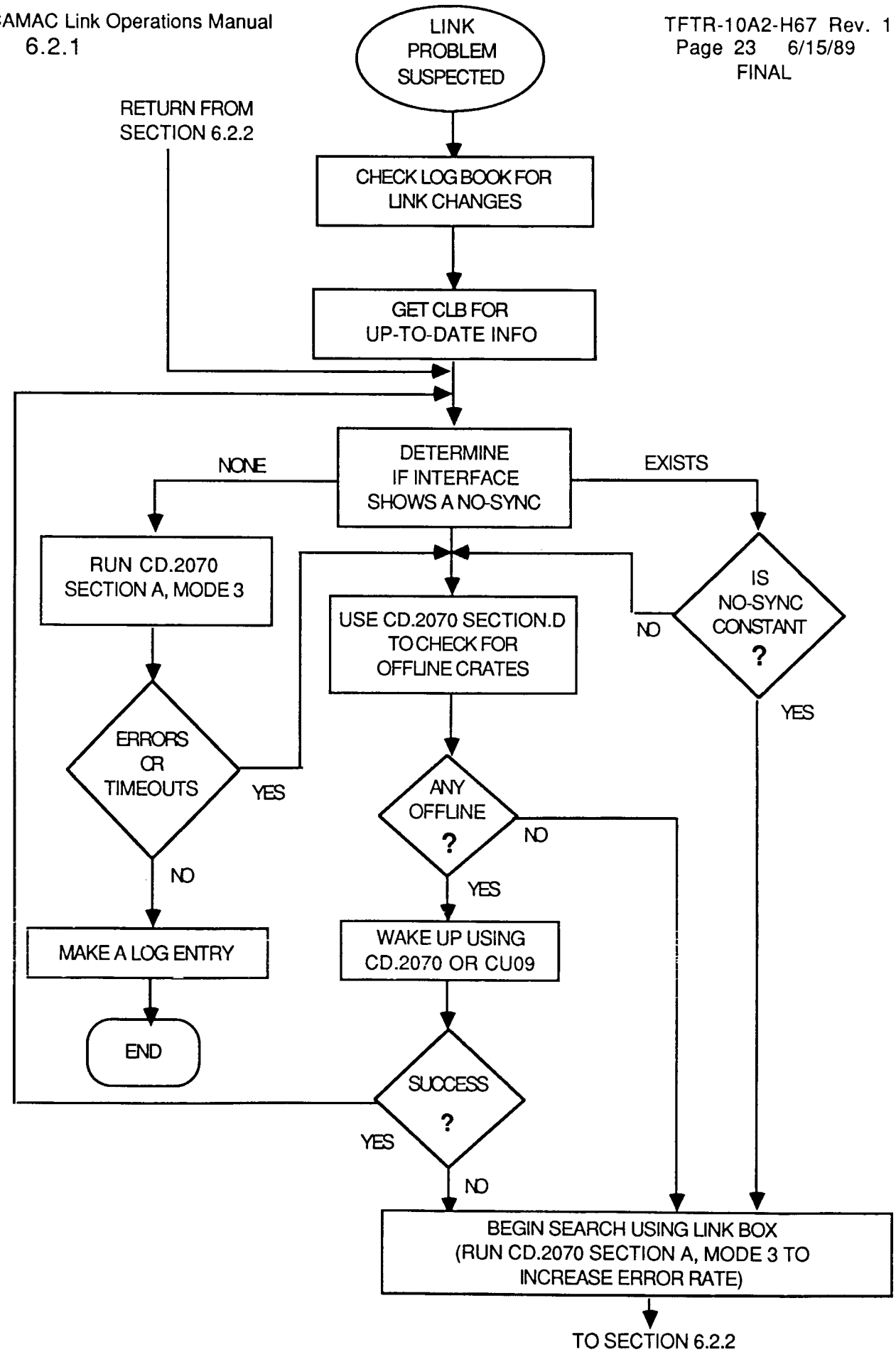
determined, it is assumed that the technical personnel know the corrective action. This is done in order not to clutter up the troubleshooting concepts with unnecessary details.

Also:

(1) Keys to most areas where the links go are in the LINK Key Box. Other areas can be entered if SECURITY is called at x2536.

(2) During TFTR Operations, Controlled or Hot Access may be required for some locations. Operations technicians will assist you when entry to such areas are required.

Begin the troubleshooting using the flowchart on the next page.


LINK PROBLEM SUSPECTED
RETURN FROM SECTION 6.2.2
CHECK LOG BOOK FOR LINK CHANGES
GET CLB FOR UP-TO-DATE INFO
DETERMINE IF INTERFACE SHOWS A NO-SYNC
NONE
EXISTS
RUN CD.2070 SECTION A, MODE 3
USE CD.2070 SECTION.D TO CHECK FOR OFFLINE CRATES
IS NO-SYNC CONSTANT ?
NO
YES
ERRORS OR TIMEOUTS
YES
NO
ANY OFFLINE ?
NO
YES
MAKE A LOG ENTRY
WAKE UP USING CD.2070 OR CU09
END
SUCCESS ?
YES
NO
BEGIN SEARCH USING LINK BOX (RUN CD.2070 SECTION A, MODE 3 TO INCREASE ERROR RATE)
TO SECTION 6.2.2

6.2.2 Search for Cause of Failure.

Note: Once repaired, return to 6.2.1.

Once an L-2 is found with SYNC errors, check that:

(a) The L-2 is Online

(b) The U-Port is Online

If these check out, then proceed backwards along the link until the L-2 in which the errors first appear is found.

At this L-2, check:

(a) The L-2 is Online

(b) The U-Port is Online

(c) All CAMAC supply voltages are OK

Next check:

(d) Data-Clock phasing at U-Port test points.

(e) Loaded and Unloaded Clock and Data signal levels into the U-Port at each leg.

(f) Look for loose/intermittent connections

If Optics are immediately Upstream:

(g) Inspect optic connectors at module front-panel. These should not be very tight(in the case of H352's), nor very loose.

(h) Inspect the rear viking connector to make sure the connection is secure.

(i) Verify that there is not excessive ripple on the CAMAC power busses.

(j) Check the receiver outputs loaded and unloaded. The signals at both LEMO legs need to be checked.

(k) Verify that light (red) is being emitted from the Optic cable connected to the receiver. This light should appear whether data is being transmitted or not (carrier).

6.3 Precautions.

Some of the CAMAC links are very sensitive to timing changes of the slightest magnitude. Because of this, "shot-gun" solutions to problems based on "hunches" is discouraged. That is, every action taken during troubleshooting should have a reasonable cause.

Things which should be avoided unless all other alternatives are ruled out:

(a) Swapping U-Ports.

If a U-Port is swapped, be sure to write down the biphase data-clock phase being sent downstream from the existing U-Port first.

(b) Re-Tuning existing U-Port.

If re-tuning is attempted, write down all switch positions prior to altering them.

(c) Changing optic modules.

If an optic module is switched, note the tightness of the optic connectors before removing them.

(d) Loosening optic connectors.

If this is done, be sure that link passes CD.2070 link tests in Mode 3. Be sure to note the action in the CAMAC Log Book.

7. Troubleshooting Tools.

This section will present an overview of the software and hardware tools a link troubleshooter has to assist in finding and correcting a link problem.

The intent here is to identify the functions that each tool performs in regard to troubleshooting a link. It is not an instruction manual for these tools nor an exhaustive presentation of their full capabilities.

7.1 Software Tools.

7.1.1 CD.2070

CD.2070 is a program that is run from a Subsystem terminal in the Computer Room. CD.2070 permits one to:

(a) Perform a CAMAC link test (Section A).

This tests the link by writing to and reading from a Register module in crate 62.

(b) Wake-up all crates, put crates on and offline and determine which are online (Section C).

(c) Find crates that are on or offline that should not be (Section D).

(d) Get a history of crate online/offline changes (Section E).

7.1.2 COS Page CU09.

This COS page shows the Online/Offline crate summary for each CAMAC link (except CONSOLE links). Crates can be "awakened" from this page.

7.2 Hardware Tools.

7.2.1 Link Box.

The famed link Box is the ultimate troubleshooting aid in existence at PPPL. Too bad there are only two in the (known) Universe. With the link Box one can:

(a) Wake up a crate from Bypass.

(b) Observe the occurrence of link parity and SYNC disruptions.

(c) Observe the data being transmitted into or out of an L-2 crate controller.

7.2.2 Oscilloscope.

The oscilloscope is used to inspect:

(a) Data-clock phase

(b) Power supply ripple

(c) Signal levels

7.2.3 Link LEMO Box.

A link LEMO box is a three-way "T" network. This permits the monitoring of the "inline" link signals.

Also, there are 100 ohm LEMO termination connectors that can locally load a line driver.

7.2.4 D-Cable Tester.

This box tests the D-Port cables used between L-2 crate controllers. It can also check the turnaround connectors and the "Y" configuration cables used to connect the CAMAC interface to the Master U-Port.

7.2.5 LEMO Test Boxes.

These test boxes are used together to test a LEMO terminated cable. One is used at each end of the cable to be tested and if all of the LED's in both boxes light, the cable and connectors are good.

7.2.6 Pulse-Width Module (PWM).

The Pulse-Width Module is a single-width CAMAC module used for CAMAC link maintenance and trouble shooting. The module performs three functions using the 5 MHz clock and data signals:

(1) Dynamic Pulse-Width Measurement
(2) Dynamic Clock/Data Phase Measurement
(3) Dynamic centering of clock within data 'mark'

The module accepts CAMAC clock and data signals from two sources: They are the CAMAC highway (5 V differential) via LEMO connectors and from the H313 U-Port Test Points (TTL) via a special cable.

The switches are used to select the desired function and the signal source for the PWM.
Several arrays of LED's depict the measured parameters and the presently-invoked function. The LED's are time-extended to capture infrequently occurring parameters. The parameters taken from the LEMO inputs are from LEMO pin #2 with LEMO pin #3 as the reference (pin 2 is the lower right).

7.3 Other Tools.

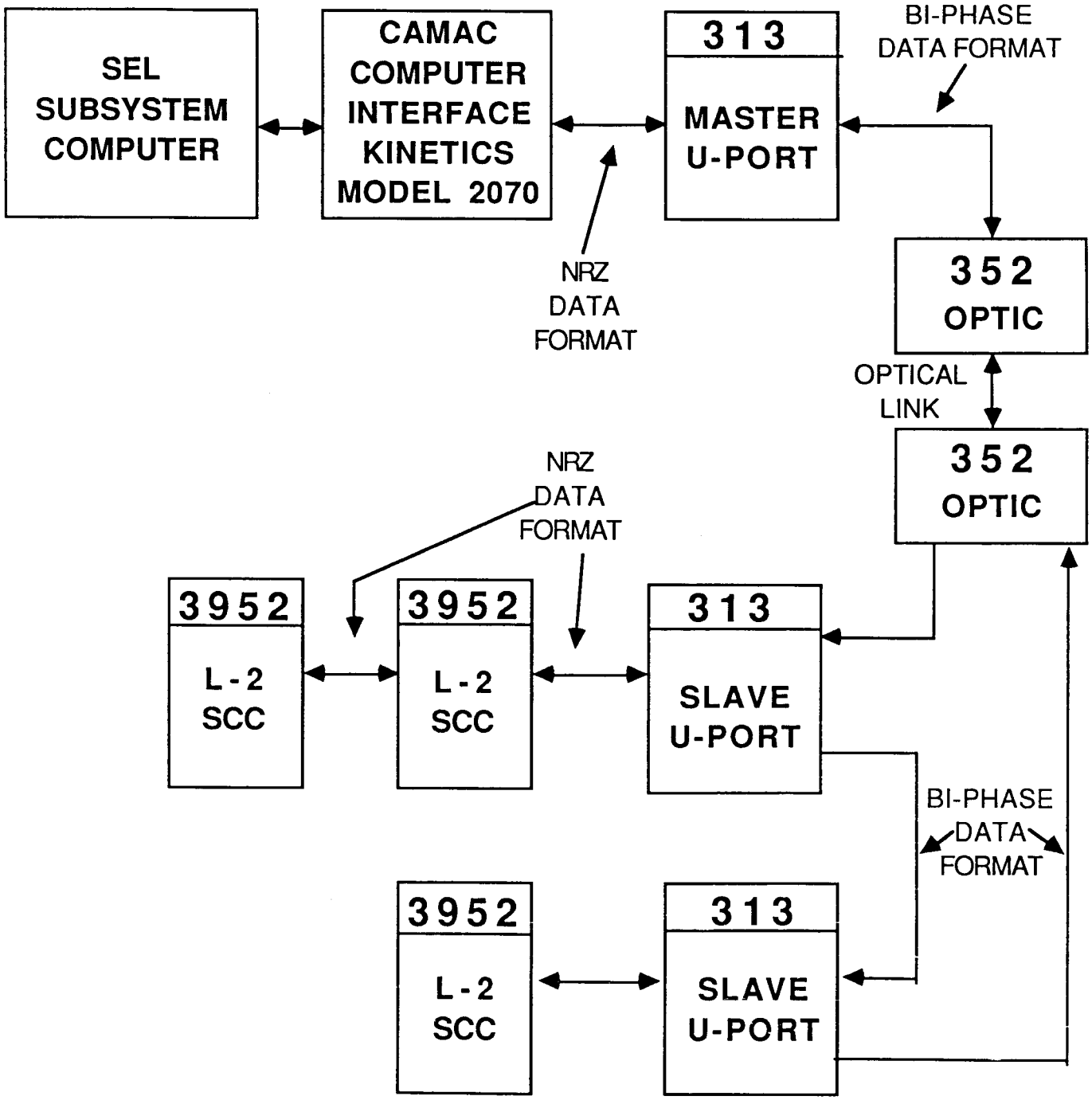
The other tools are the different documentation devices; that is,the CICADA Operators Log Book, or the CAMAC Log Book may have recent entries that indicate the probable location of the failure.

Also, the CAMAC Log Book offers the link MAPs and other up-to-date CAMAC link information.

8. Figures.

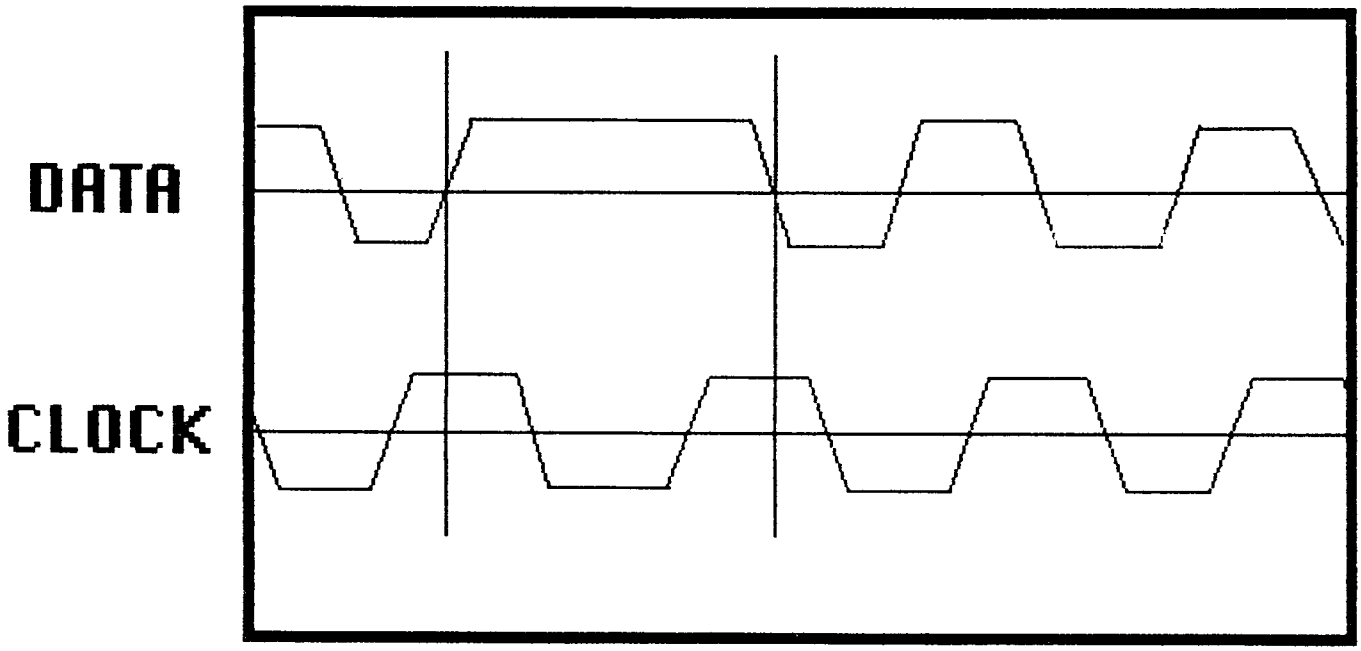
Figure 8.1. illustrates a portion of a properly "Tuned" CAMAC WAIT byte.

Figure 8.2. illustrates a typical CAMAC Serial Highway using the 313, 352, and 3952 CAMAC modules.



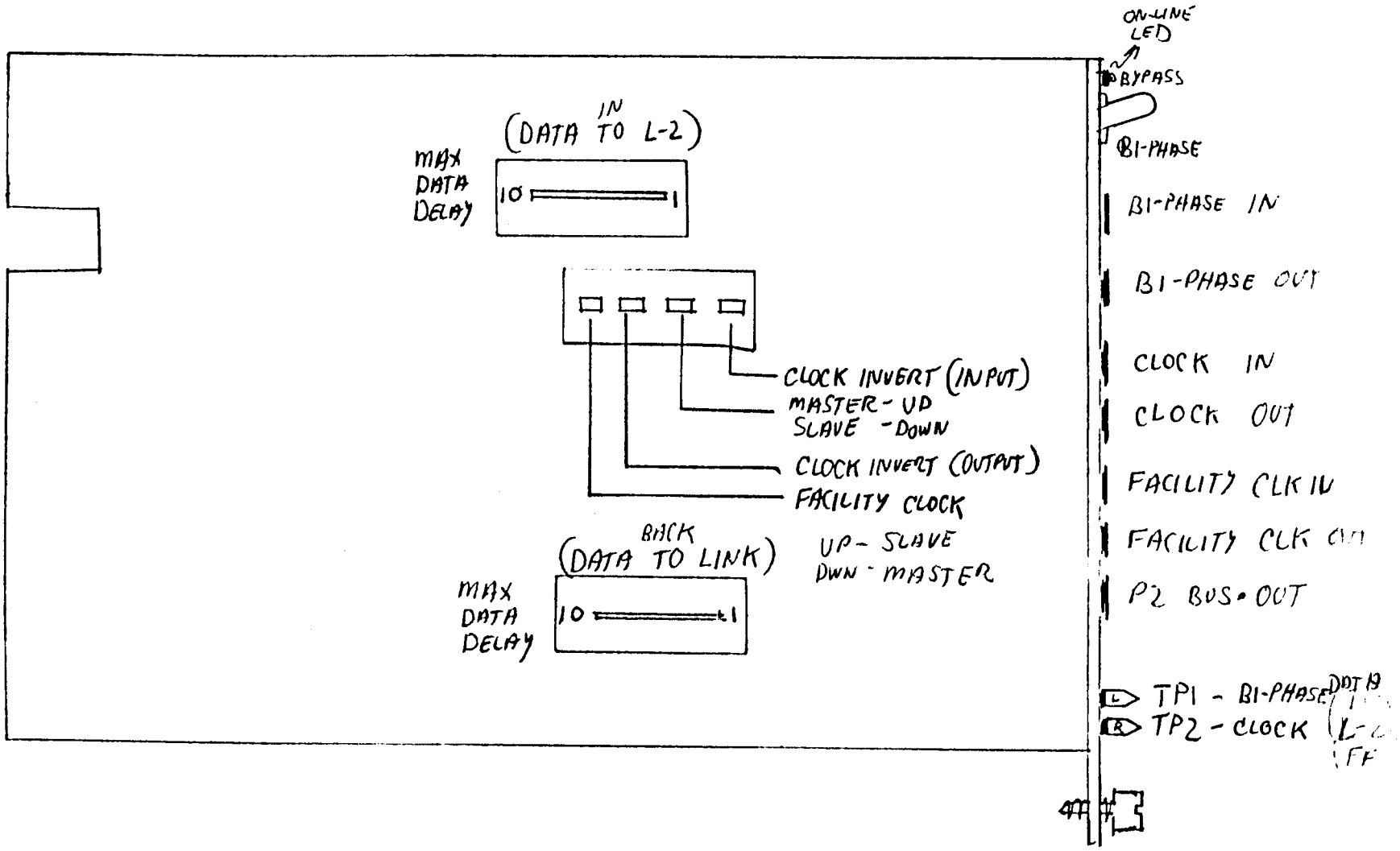
TYPICAL CAMAC LINK CONFIGURATION

FIGURE 8.1

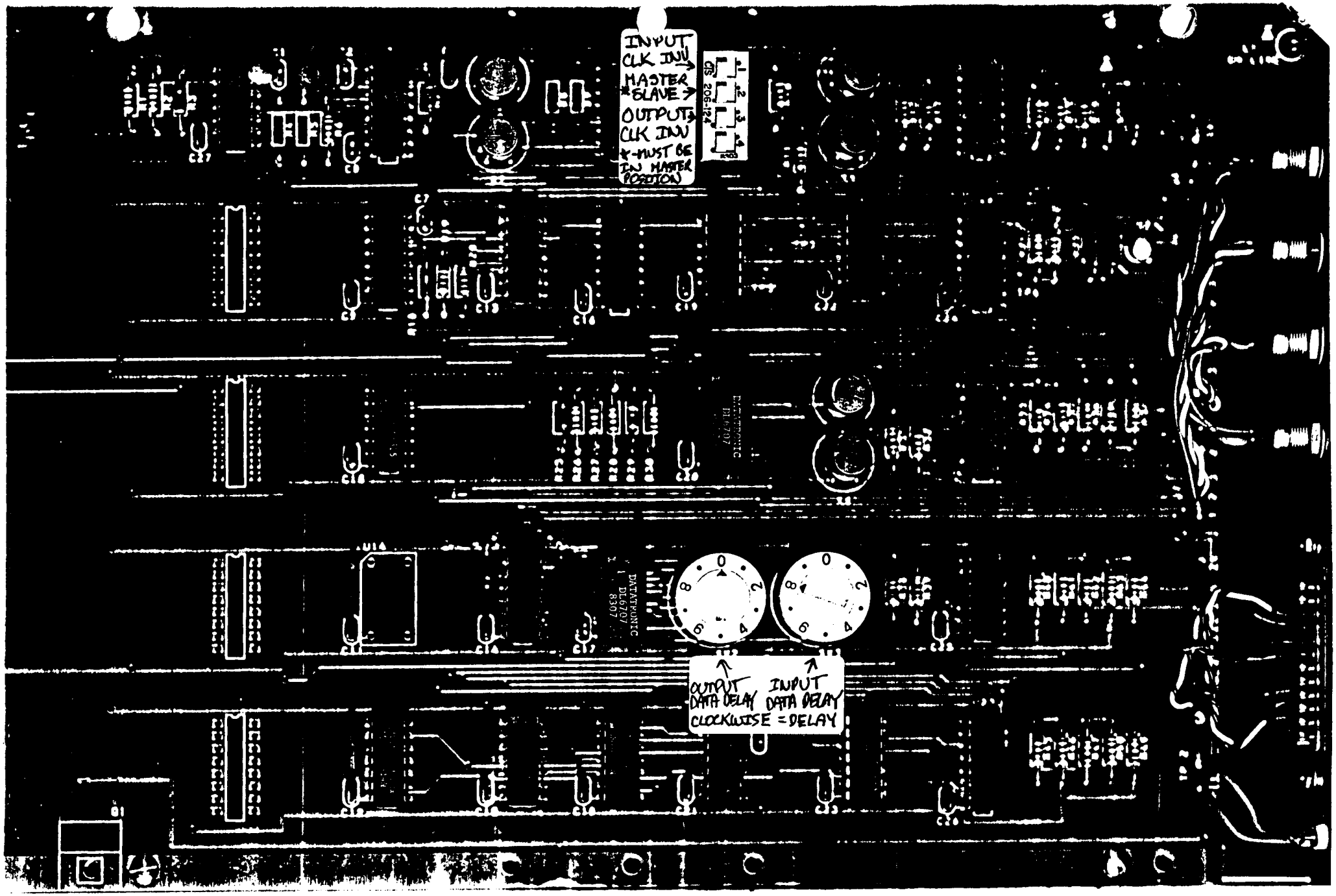


"TUNED WAIT BYTE "

FIGURE 8.2



H313 U-PORT SKETCH


INPUT CLK INV →
MASTER SLAVE →
OUTPUT CLK INV →
* - MUST BE IN MASTER POSITION
OUTPUT DATA DELAY
INPUT DATA DELAY
CLOCKWISE = DELAY