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Using The Crakker^{TM} (Copyright 1992 - 2002)

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Crakker Communications for Windows^{TM} Software (Copyright 2002)

Logic Beach Incorporated,   La Mesa, California - All Rights Reserved

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Logic Beach Incorporated
8363-6F Center Drive
La Mesa, CA   91942
(619) 698-3300

www.crakker.com and **www.logicbeach.com**

Warranty Policy

Philosophy:

We at Logic Beach Incorporated continually strive to provide the best quality product available on the market today. We realize that equipment that does not perform properly for whatever reason can be costly, both financially as well as through inconvenience and mental anguish. For this reason we pride ourselves on producing a quality, easy to use product as well as providing cheerful, competent customer support through our Field Sales Representatives and our in-house factory staff.

We always welcome your input...on ALL subjects...staff performance, literature, pricing, customer support, product enhancements, and any other comments, complaints, or compliments that you feel would help make Logic Beach an even BETTER company!

Warranty:

Logic Beach Incorporated will repair or replace, free of charge, all parts of said products which are returned for inspection to its factory within one year from the date of shipment from Logic Beach. This is provided such an inspection discloses to the satisfaction of Logic Beach that the products are defective in material or workmanship. Equipment returned to Logic Beach for repair must be shipped freight prepaid.

Repairs necessitated by misuse, abuse, negligence, accident or alteration of the equipment are not covered by this warranty. No other warranties are expressed or implied, specifically those of merchantability or fitness for specific purpose. Logic Beach is not liable for indirect or consequential damages.

Before returning any equipment to Logic Beach, please contact us via phone to review the problem. If you should call, please have the following information available:

* Product Model
* Serial Number of the Unit
* Problem or Reason for Returning Goods
* Contact Name and Telephone Number

Non-warranty repairs require a Customer Purchase Order, against which repair charges may be invoiced.

The alteration or repair of this equipment except by Logic Beach personnel or Logic Beach authorized repair facilities will void the warranty. Logic Beach is not liable for incidental or consequential damage. If any questions arise concerning the warranty, contact Logic Beach before taking any action.

Call Logic Beach at 619-698-3300 when information, assistance or authorization are required.

Receiving Inspection / Reshipment

Delivery

Upon delivery, inspect all shipping containers for signs of damage. Note any shipping damage to the carrier before accepting the container.

We suggest retaining the original shipping container for use if it should become necessary to reship or return the product.

A visual inspection should be made when removing the instrument from the shipping container. A claim for any concealed damage should be placed with the carrier immediately. Retain all shipping materials for inspection.

Inspection

Before applying power, a thorough inspection of the unit is required. Visually examine the Crakker and Isolation Pods for:

* Cracks or abrasions
* Mechanical package damage
* Broken or damaged display buttons, etc. on Control Panels
* Damage to Pods or leads

Notify Logic Beach Customer Service Department immediately if any evidence of damage is noted. *Do Not Apply Power To A Unit That Has Visible Damage.*

Reshipment

If it becomes necessary to reship the Crakker, it should be packaged in the original container following these procedures:

1 Remove external leads and power supplies.
2 Place unit in original shipping containers with suitable packaging material for shipment or...
3 Pack according to good commercial practices using a **Minimum** of 4" of resilient padding around unit if original containers are not available.

Notes.....

1

INTRODUCTION

Manual Overview

This Users manual provides information relative to the use of the Crakker (TM) Logic and Timing Analyzer manufactured by Logic Beach Incorporated, La Mesa, CA. The manual is organized into a progression of sections to acquaint the user with the set-up, operation, and maintenance of the Crakker.

A section of this manual is dedicated to explaining each of the three main components that make up a Crakker System:

1   CK-2; Crakker System Base (the main instrument with display)

2   IP-2 Signal Isolation and Conditioning Pod

3   Crakker Communications for Windows Software (CCW)

It is *Highly Recommended* that the User's manual be read in its entirety before using the Crakker in a real application. The last section of the manual consists of the Appendices which give detailed specifications and information for advanced applications and general reference.

Crakker System; the 'Big Picture'

The Crakker Logic and Timing Analyzing System is a versatile test instrument used for troubleshooting and performance analysis of control systems. The Crakker was originally developed for use in troubleshooting Programmable Controller Systems (PLC's), relay logic controls and other ON/OFF type industrial control systems. Since its conception, its applications have expanded to a multitude of monitoring and troubleshooting applications beyond this original target.

The Crakker is used to monitor up to 16 different signals from a field control system. When a User specified combination or transition of these signals (called a *Trigger*) occurs, the Crakker traps into memory all of the transitions of these 16 inputs for a period of time *prior* to the Trigger as well as for a period of time *after* the Trigger. The Crakker may be benignly monitoring these signals for milliseconds or months waiting for the specific Trigger prior to trapping the data.

In a typical application, the Crakker could be left on site to monitor a number of On/Off signals (e.g. from a PLC I/O rack) waiting for a particular combination of signal states that meet a User specified Trigger condition. This Trigger condition typically would be an event that is indicative of an erroneous or fault condition (e.g. valve 1, valve 2, and pump P1 should never be on at the same time).

After a Trigger has occurred, the trapped data (recorded into memory within the Crakker) is then downloaded to a Personal Computer (PC) and displayed using the supplied Crakker Communications software (Figure 1.1). The data display graphically displays the relative and absolute timing of all 16 channels of data to time resolutions as fine as 165uS.

1. Introduction
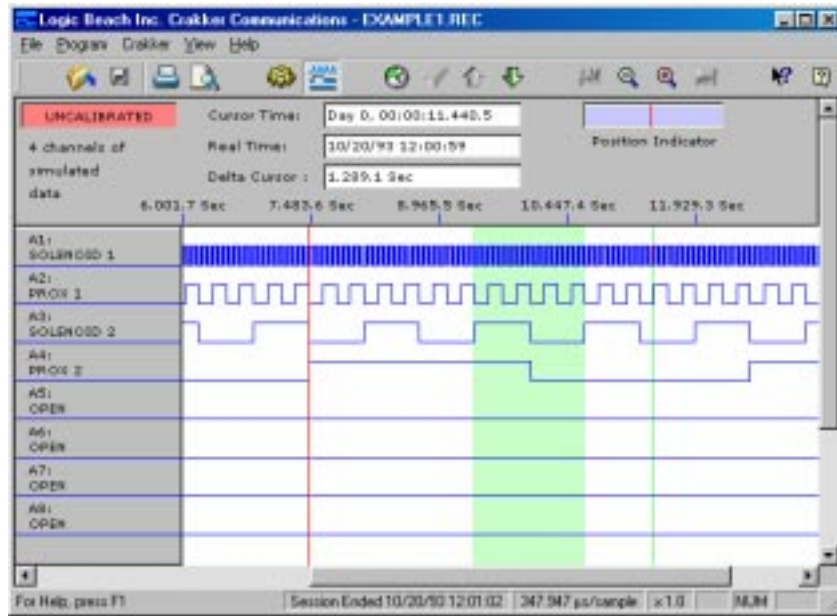
Figure 1.1 Resulting I/O Transition Timing Display from within CCW software

The Crakker System consists of the following components [Figure 1.2]:
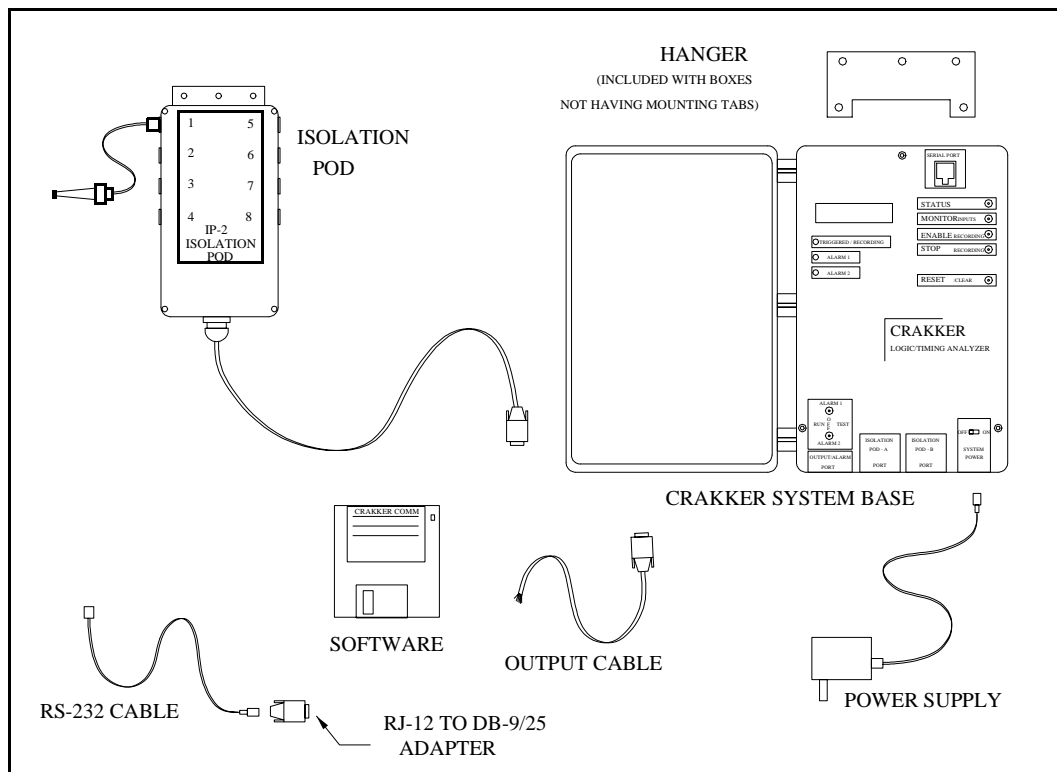
Figure 1.2 Crakker System Components

Isolation Pod (IP-2)

The IP-2, Isolation Pods provide the interface between the actual field control signals (up to 8 signals per Pod) and the Crakker System Base. Utilization of the POD allows for *direct* connection to various signal levels within the control system to be monitored through the supplied Insulation Displacement Quick Connect lead pairs.

Additionally, the Pod provides for high-voltage isolation between channels and the System Base.

A multi-conductor cable connects the isolated signals from the Pod to the System Base. Up to two Pods resulting in a total of 16 channels can be connected to the Crakker System Base.

Crakker System Base

The Crakker System Base contains additional signal conditioning circuitry, the microprocessor, memory, clock, and supporting circuitry.

Before deploying the Crakker in the field (factory floor, etc.) a *Run Program* is developed then uploaded into the Crakker's memory which defines its operation. This Run Program is developed by the User using the provided Crakker Communications software, then sent to the Crakker via a serial link.

Contained within this Run Program are a number of operational parameters including the Trigger and Alarm words as well as the User programmed Voltage Thresholds to be used by the Pod Channels for determination of High and Low states. In use, the Crakker is constantly reading the status of the inputs from the Pods, writing them to memory, and comparing them to the pre-programmed Trigger word. When a match occurs, the remaining memory is filled and the Crakker stops. The User can specify in the Run Program how the available data memory is utilized (e.g. 25% before Trigger, 75% after).

The collected data is then downloaded from Crakker memory to the PC via a serial link using the Crakker Communications software.

Crakker Communications for Windows Software

The Crakker Communications for Windows (CCW) program runs on a standard Personal Computer running Windows 98, 2000 or XP and allows the User to communicate with the Crakker via a serial link (RS-232), develop and upload Run Programs to the Crakker, and download and graphically analyze data trapped by the Crakker.

CCW is a very powerful, yet friendly software package with easy to follow organizational flow and menus...and understandable HELP screens with the press of a key.

Additional Components

In addition to the major components listed above, a Serial Cable, an RJ-12 to DB-25/9 adapter, a 120/240 to 12VDC power supply, and an Alarm Output Pigtail are included with the system.

Sequence of Steps to Utilize the Crakker

A typical data collection session utilizing the Crakker consists of the following sequence of steps. This sequence of steps should be referred to during the reading of the manual to assist in clarifying the use of the Crakker.

1 Using the CCW program, develop the Run Program for the Crakker including Trigger conditions, Memory allocation, Alarm Triggers, Pod Signal Logic Thresholds, etc.

2 Upload the Run Program to the Crakker via the serial link. The Crakker will then adopt the operational personality contained within the Run Program.

3 Connect the Pod signal leads to the nodes to be monitored.

4 Connect the Crakker and the Pod(s) together and press MONITOR to observe the current input state on all active channels.

5 Connect the Alarm outputs to the Crakker (optional)

6 Enable Recording within the Crakker and wait for the Trigger to occur.

7 After the TRIGGER has occurred, connect the Crakker to the PC (running CCW) and download the trapped data from the Crakker memory to the PC.

8 Display the data on the PC screen, analyze, print and/or output it to spreadsheet format.

Applications

Portable, enclosed, low power operation allows the Crakker to trap data in areas too punishing for other forms of instrumentation such as strip chart recorders, plotters, storage scopes etc. Additionally, the Crakker can be set up, connected directly to various control I/O nodes, and the data retrieved and analyzed...*all without interrupting the existing control process or reprogramming the PLC!*

Just a few uses for the Crakker...

- Trapping intermittent problems due to sticky switches, loose connections, over or under temperature, or faulty logic.

- Testing control loop speed for time critical applications.

- Characterizing response of control systems utilizing mechanical components.

- `First Out' analysis of control logic..."who-dunnit?"

- Quantifying cycling of equipment or multiple events over time.

- Testing new code involving high speed control logic.

- Detecting suspected low-voltage conditions on control I/O nodes, Power Supplies, etc.

Features

A summary of major features incorporated into every Crakker system follows. Each feature is addressed in further detail in later chapters.

- Extremely simple set-up and use

- Portable, self-contained, ready for stand-alone on-site use

- Eight or sixteen channel recording capability

- Direct connection (isolated) to signals ranging from TTL to 240 VAC

- 32 User Programmable Signal Logic Voltage Thresholds

- Input latching Loop Rates of 165uS (8 channels)

- Two programmable alarms (relay contact output)

- State, transition, time based, or `any change' Trigger conditions for Data Recording

- State and/or transition based Trigger conditions for Alarm output

- Provided Crakker Communication software with powerful zooming, timing measurement, and output capabilities.

- Independent battery back-up for memory retention

- Powered by low current, low voltage AC, DC or external battery pack

- Battery backed-up Real Time Clock with 24 Hr. Time and Date

1. Introduction

Notes...

2

CRAKKER SYSTEM BASE

System Base Overview

The Crakker System Base contains the controlling microprocessor, memory for storing collected data (and the Run Program), a Real Time Clock, interface circuitry to the Isolation Pod(s), and other supporting circuitry.

This Chapter details the User interface (Liquid Crystal Display, front panel switches and buttons), connection to the Isolation Pods and alarms, and deployment of the unit.

Mounting and Handling

The Crakker is housed in a general application plastic case that can be deployed in fairly dusty areas *protected from direct water spray*. Care should be taken to prevent heavy contamination of the connectors for the Pods and Alarms.

The Crakker can be semi-permanently mounted using the provided aluminum hanger [see Components in Chapter 1]. The two provided screws are used to fasten the hanger to the back of the Crakker case (two blind holes near the top). The Crakker/hanger assembly can then be fastened to any other surface using the holes in the hanger.

************************ *Caution* ************************
The Crakker is not designed for direct immersion. Mount upright for best protection.
****

Crakker System Power

Main Power

The Crakker can be powered from any number of low voltage (8-16VDC/10-16VAC) sources through the External Power Jack [Figure 2.1].

Replace

CK-XF:

The CK-XF [see Components in Chapter 1] plug-in power pack (provided with the Crakker) has been designed for use in providing external power to the Crakker and is equipped with a mating connector plug.

Alternate Power Sources

Alternatively, the Crakker can be powered from any clean voltage source that is capable of supplying 150 mA and is regulated within the voltage ranges of 8-16VDC/10-16VAC. The Crakker power supply is equipped with a full wave bridge hence polarity is not critical in the connection of DC supplies to the Crakker External Power Jack. Refer to Appendix E for a detailed pin-out of the External Power Connector. Additional mating connectors (with pigtail) are available from Logic Beach.

RPS-1:

For remote site applications, or applications where 120Vac is not readily available, the Crakker can be powered from the Logic Beach Inc. Portable Power Supply (model RPS-1). The RPS-1 will provide sufficient power to run the Crakker (in the *Recording Enabled* mode) for approximately 24 hours before recharging is required.

Memory and RTC Power

The data memory (SRAM) and the Real Time Clock integral to the System Base are powered by a 3 volt lithium cell when the Crakker main power switch is OFF. This insures that the time and date and data in memory is maintained during times when power is not connected to the Crakker.

Low-Voltage Indication

When the lithium cell voltage drops below approximately 2.6Vdc, a sensing circuit in the Crakker detects this and displays a *Low Voltage* indication on the Crakker display during *Status*, upon Power-Up, and after a *System Reset*.

Lithium Cell Replacement

If the above-mentioned Low Voltage message is seen, transfer any collected data in Crakker memory to a PC and replace the lithium cell (or risk the loss of data in memory). Refer to "Appendix F: Changing The Clock / Memory Backup Battery" on page 8-11 for details on changing the lithium cell.

Power Failure During Recording

In the event that a power failure should occur while the Crakker is in the *Record Enabled* mode, the Crakker will progress through a very high speed shut-down routine and save the data currently in memory.

When power is reapplied to the Crakker after a power failure has occurred, the LCD will display a message indicating when the power failure occurred and that data is present in memory. Data can be transferred to the PC and displayed as normal.

Crakker Front Panel and Connection Details

All of the System Base controls and the Liquid Crystal Display (LCD) are located on the System Base front panel and include the following [Figure 2.1]:
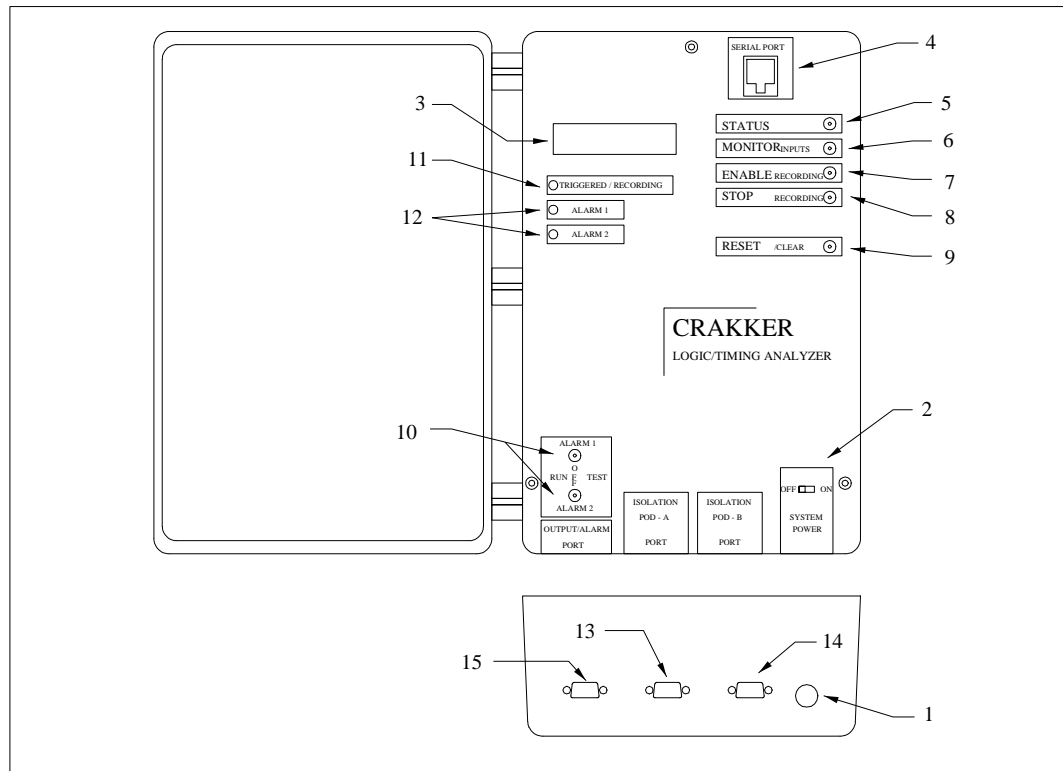
Figure 2.1 Crakker System Base Front Panel and Connections

System Power Switch (2)

Turns the power to the Crakker ON and OFF. Power must be turned OFF when replacing the Lithium Cell, EPROM, or any time the Crakker is removed from its case.

The system power does not affect data in memory or the Real Time Clock time/date as both have a lithium battery backup power source ("Appendix F: Changing The Clock / Memory Backup Battery" on page 8-11). This memory back-up battery will protect stored data for approximately one year at normal room temperatures.

Display (3)

An extended temperature range, 2-line by 16 character, liquid crystal display (LCD) is provided. Date, time, status and other informational set-up and operational messages are displayed on the LCD.

RS-232 Serial Communications Port (4)

A female 6/6 RJ-12 modular phone type jack is provided. A three wire RS-232 connection scheme is utilized with additional connections for future expansion. Refer to "Appendix H: RS-232 Cable, Adapter, And Port Specifications" on page 8-15 for a detailed pin-out.

2. Crakker System Base

This port is connected to the RS-232 serial port on the PC via the supplied serial cable and adapter [see Components in Chapter 1]. A standard four conductor telephone `base' type (not `headset') cable can be utilized for longer RS-232 distances. These cables are available from Logic Beach or at most stores that sell telephones and supplies.

At lower Baud Rates (e.g. 1200 Baud) in low electrical noise environments, RS-232 communication in excess of 100' has been successfully achieved.

Push Buttons

Status / Time (5)

Depressing this button will result in a sequence of displays on the LCD that indicate current *Status* of the Crakker. Displays will vary depending on whether or not collected data is retained in memory. The Status button will only respond when the Crakker is in the IDLE mode, i.e. Recording is NOT Enabled.

The *Status* display sequence with data in memory is:

DATA RECORDED <FINISHED> @ TIME ON DATE: indicating that collected data is currently retained in memory waiting for transfer to the PC or to be cleared. The Time and Date indicate when the recording session ended.

Crakker Time And Date: currently maintained within the Crakker Real Time Clock (RTC). If the Time and Date are incorrect, they can be set through the CLOCK SET feature in the Crakker Communications program (see Chapter 4). If the time and date become incorrect shortly after setting, this could indicate a discharged memory/RTC battery backup lithium cell (see"Lithium Cell Replacement" on page 2-2).

CURRENT Run Program LOADED: the name of the Run Program currently loaded into memory and the three line Program Description specified during the development of the Run Program is displayed.

If no Run Program is in memory, "NO Run Program LOADED" is displayed.

Press Status To Display Ch Names: this message is displayed for approximately three seconds. *While the message is displayed*, if the Status button is depressed again, the Crakker proceeds to display the first *Channel Description* entered by the User during the development of the Run Program.

Pressing the Status button repetitively steps the display through each of the Channel Descriptions. Step through all of the channels and the Crakker returns to the READY display mode.

Note This Channel Description feature can be extremely handy in the field when hooking up the Isolation Pod leads, serving as a sequential list of connections to be made.

If no data is in memory, the Status display also indicates that the Crakker is currently in the "SYSTEM IDLE" mode before it sequences to the current Crakker Time and Date and continues into the above sequence.

Monitor (6)

Pressing the *Monitor* button while the Crakker is IDLE (i.e. Recording is not Enabled) results in a continuously updating display of the input channels states. A `0' or a `1' will be displayed for all 16 channels (even if only one Pod is connected). A `1' indicates a voltage presence on that input in excess of the turn-on threshold (i.e. the input is ON).

A rapidly fluttering 0/1 display may indicate an AC input that requires a Debounce setting (See Debounce setting in Chapter 5).

The Monitor feature can be used during the connection of the Crakker and Pods to a system to insure that good electrical contact is made and that a channel is functioning as anticipated.

Press the *Stop Recording* button to exit from the Monitor display.

Enable Recording (7)

Pressing the *Enable* button initiates the continuous monitoring of the Input signals from the Pods and comparison to the Record and Alarm Triggers defined in the currently loaded Run Program.

After pressing the Enable button, the name of the currently loaded Run Program and its three line description are displayed. The LCD then changes to `RECORD ENABLED <WAITING>' while it continually loops testing for a Trigger condition match.

Note   If data is still in memory from a prior RECORDING session, RECORDING will not start. The following sequence will be displayed on the LCD:

<div align="center">

DATA IN MEMORY

TRANSFER AND CLEAR MEMORY

RECORDING NOT ENABLED

</div>

In order to Enable a Recording session, it is necessary to transfer the data in memory to the PC (if the data is to be saved), clear memory (see following for Clear Memory sequence), and then press the Enable Recording button.

Stop Recording (8)

If the Crakker is in the Monitor mode, the *Stop* button exits that mode and returns the Crakker to IDLE mode and the display to `READY'.

If the Crakker is in the RECORD ENABLED mode, pressing the Stop button immediately cancels the session and the display changes from `RECORD ENABLED <WAITING>' to `RECORD ENABLED <FINISHED>'.

Data recorded in memory between the ENABLE of RECORDING and the STOP of RECORDING will be retained in memory and must be transferred to the PC or CLEARED before another RECORD session can be ENABLED.

Reset / Clear Memory (9)

Used in conjunction with the Stop Recording button to perform system *Resets* and if desired, *Clear* data memory. This button must be pressed *simultaneously* with the Stop Recording button for response (to insure against accidental clearing of memory).

If data is present in memory from a prior recording session, when the two buttons are pressed simultaneously, the following message sequence will display:

<div align="center">

CRAKKER VX.X c 1992

RESET AGAIN TO CLEAR MEMORY

</div>

At this point, a Crakker system RESET has occurred without affecting data stored in memory. If no further action is taken, the display will return to

> DATA RECORDED <FINISHED>
> or
> DATA IN MEMORY SEND AND CLEAR

If erasure of stored data in Crakker memory is desired, the two buttons must be depressed a second time while the `RESET AGAIN TO CLEAR MEMORY' message is still displayed.  A message will then prompt the User `ARE YOU SURE? RESET IF YES'. If memory clear is desired, perform a third two button RESET.

This action will initiate a memory erasure sequence with a corresponding `CLEARED MEMORY' display.

> *************************** **Caution** ***********************
>
> IF DATA STORED IN MEMORY IS TO BE RETAINED, THE DATA MUST BE TRANSFERRED TO THE PC BEFORE CLEARING MEMORY.
>
> DATA CLEARED FROM MEMORY CANNOT BE RESTORED.
> ***

At the completion of the memory clearing process, the LCD displays READY. Total available memory can be verified with the Status/Time Button.

Note If a Power Failure occurs during a RECORDING session, appropriate messages will be displayed on the LCD indicating the occurrence of the failure and when it happened.

Alarm Control Switches (10)

Two *Alarm* relay (isolated N/O contact closure) outputs are provided on the Crakker. These Alarm outputs are energized if the Crakker input signals from the Pod(s) match the programmed Alarm Triggers contained in the Run Program currently running in the Crakker.

The ALARM 1 and ALARM 2, 3-position switches on the front panel of the Crakker are provided for manual override of the ALARM outputs. Description of operation in the three positions follow:

OFF: in the center position, the Alarm Output relays are disabled and can not be turned ON by the Crakker software.

TEST: when the switch is toggled to the right, the Alarm Relay is forced into an ON state and the relay contacts are closed. This is a `momentary' position and when the switch is released, it returns to the OFF position.

RUN: in the left position, the Alarm Relay is under the control of the Crakker microprocessor. The relays will be switched ON and OFF per the logic contained in the Run Program.

Wiring details for the ALARM outputs are contained in "Appendix D: Alarm Output Detail" on page 8-7.

Note: When the Crakker main power is switched ON, and the ALARM switches are in the RUN position, the output relays may cycle ON for a few hundred milliseconds. For this reason, when cycling the power, it is recommended that the Alarm switches be left in the OFF position.

Triggered / Recording Light (11)

When the Crakker is in the RECORD ENABLED mode and a Record Trigger condition is met, the Crakker turns on this light and continues recording data to fill its memory.

When memory is filled, the light turns OFF and the LCD displays DATA RECORDED <FINISHED>, indicating that a successful Recording session has been implemented.

Note If the TRIGGERED/RECORDING light is ON and the LCD displays RECORD ENABLED <WAITING> the Crakker is continuing to write Post-Trigger data to memory. If this Post-Trigger data is not needed, the front panel Stop button may be pressed and the session will be ended. Data can then be transferred to the PC for display.

Alarm Status Lights (12)

When the Alarm Output Relays are ON (contacts closed) the corresponding Alarm Status Lights will be lit.

Isolation Pod Connections (13 and 14)

One or two, 8 input Isolation Pods can be directly connected to the Crakker System Base via the *Isolation Pod Ports*[Figure 2.1] located on the bottom of the Crakker.

In connecting the Pod(s), visually inspect the both the male and female connectors before plugging them together to insure that no pins are bent or dirt is on the contacts. Tighten the retaining screws securely to insure good electrical connection.

***************************** CAUTION *********************
Connect ONLY Logic Beach Isolation Pod cables to the these ports. These ports are NOT for High Voltage nor Serial Communication.
****

Output / Alarm Port Connections (15)

A single Male DB-9 connector port is provided for connection between the two internal Alarm Relays and the outside world. Connection to these this port can be made using the provided mating connector pigtail or any mating DB-9F equipped cable.

A pin-out for the connector is provided in "Appendix D: Alarm Output Detail" on page 8-7.

************************* CAUTION *************************
Connect ONLY low voltage (i.e. 32 Vac/Vdc maximum) low current (500 mA maximum) loads to these Alarm Outputs. This port is *not for high voltage nor serial communications*
****

2. Crakker System Base

Notes....

3

ISOLATION PODS

Isolation Pod Overview

The Isolation Pods used in the Crakker System provide signal conditioning and high-voltage isolation between the Crakker System Base and the signal connection nodes. Additionally, the Pod provides high-voltage isolation between channels as well as initial signal conditioning.

One Pod can accept up to 8 signal inputs and two Pods can be used with one Crakker providing up to 16 channel capability. Each Pod is supplied with eight pairs of connection leads. The leads are equipped with Insulation Displacement Quick-Connect Clips that are capable of clipping onto leads up to 12 AWG. The clips have a sharpened spike integral to the J-hook that can be used to pierce through insulation, making a fast convenient connection to insulated wire.

Pods can accept up to 280 VAC or 400 VDC directly. The voltage thresholds utilized for the Signal HIGH or LOW decision are User programmed (via the CCW software) from a choice of 32 values. By setting the voltage thresholds properly for each channel, low voltage conditions as well as floating voltage effects of leaking currents in Triac type outputs are readily accommodated / detected. (i.e. in Triac switched outputs, a sizable voltage may exist on an unloaded output even though the output is `OFF'). The sensing circuitry for each channel has an input impedance for DC of 220Kohms and for 60hz AC of 120Kohms, resulting in a minimum loading on the control system under test.(see "Appendix C: Isolation Pod Circuit Design" on page 8-5 for details).

********************* **CAUTION** **************************

The isolation pods are designed for connection to high voltage, however care must be taken in the set-up and utilization of the pod and its leads.

In use, the clips will have a small exposed bare area (the J-hook at the end) that must be prevented from shorting to other points, leads, wires, as well as to humans.

Never remove the plastic cover from the pod as no user serviceable parts are inside and high voltage components will be exposed.
****

Mounting and Handling

The Pod is supplied with a metal hanger [Figure 3.1] that can be used for temporarily mounting the Pod near the connection points to be monitored.

The Pod enclosure is sealed from dirt and dust however the Pod *should not be used in wet areas* without further protection. The Pod cover should never be removed as high voltage nodes will be exposed and no User serviceable parts are contained within the enclosure.

The enclosure is made from plastic that can melt if exposed to high temperatures. Do not subject the Pod to extremely high heat (60C, 140F maximum operating ambient temperature). The electronic components within the Pod are designed for rugged normal use, however if the Pod enclosure is physically damaged in any way or if the unit experiences high impact (e.g. a hard drop onto a concrete floor), the unit should be returned for test and inspection by qualified Logic Beach staff.
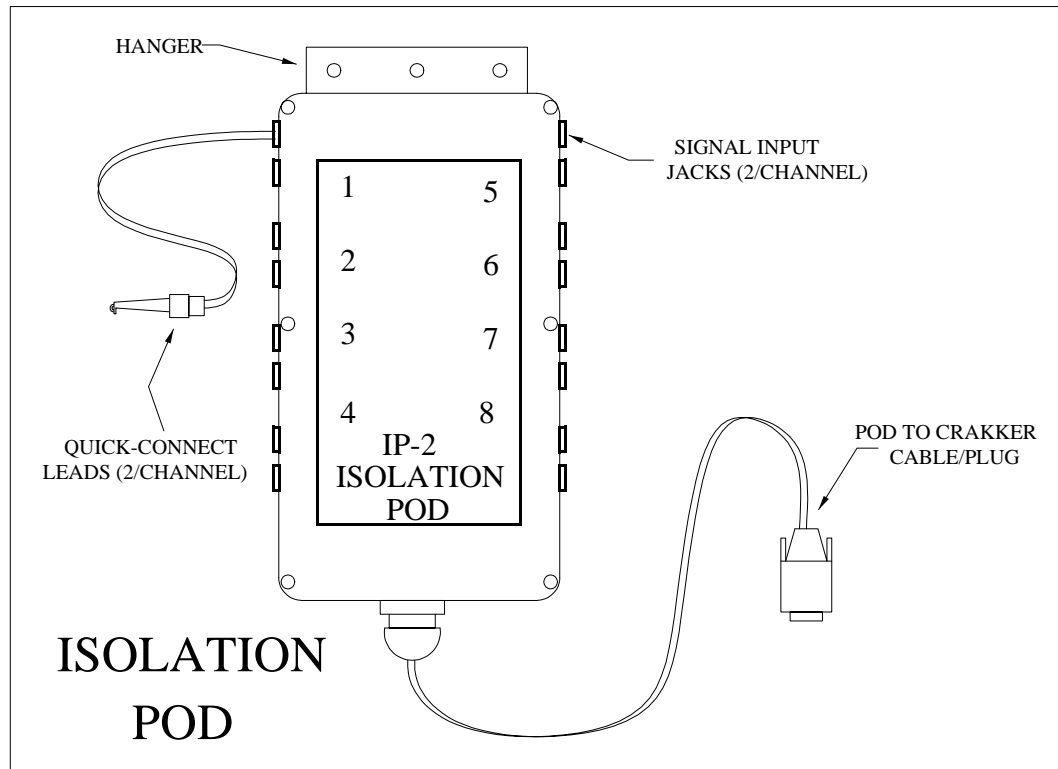
Figure 3.1 An Isolation Pod

Pod Switching Thresholds... Vth Setting

During a recording session, the Pod is constantly comparing the input signal (from a control system node) to an internal voltage threshold (Vth) which has been set by the User in the development of the Run Program (from within CCW). When the monitored input signal exceeds the Vth threshold, the Pod communicates a HIGH state to the Crakker System Base and when the input signal is lower, a LOW state is communicated.

Each Pod channel can be configured for a unique Vth, voltage threshold (one of 32 levels) by the User from within the CCW program. Refer to Figure 3.2 for approximate switching points (in volts) for each of the programmable Vth levels. Both OFF to ON and ON to OFF switching voltages are specified indicating the approximate switching hysteresis of the Pod. For example, with a Vth setting of `90', the Crakker will detect an ON state with increasing voltage when the signal rises to 90 Volts, the Crakker will then detect an OFF state when the voltage drops below 78 Volts. Details on the programming of this Vth threshold are covered in "Vth Voltage Threshold" on page 5-8.

Programmed Vth Level (Vdc)	Approximate OFF to On Voltage (Vdc)	Approximate ON to OFF Voltage (Vdc)
2.0	2.0	1.3
2.5	2.5	1.7
3.0	3.0	2.2
4.0	4.0	3.0
5.0	5.0	4.0
6.0	6.1	4.6
8.0	8.1	6.0
10.0	10.0	6.9
15	15	10
20	19	13
25	25	19
30	30	21
40	40	31
50	50	40
60	58	48
70	70	59
80	82	70
90	90	78
100	100	87
110	112	101
120	122	111
130	130	118
140	139	127
150	150	140
160	158	147
170	169	159
180	182	174
190	190	182
200	198	190
210	212	205

Figure 3.2 Isolation Pod Voltage Threshold Switching Values (approximate)

Prior to the programming of the Vth levels, it may be prudent to check the On/Off voltage levels of the nodes to be monitored during normal operation (using a voltmeter) to insure:

1 The voltage levels are within the maximum withstand range of the IP-2 Isolation Pod channels.

2 For future reference during the Vth programming process from within CCW.

Special Considerations - Triacs

In many control systems, AC signals are controlled with a `solid state switch' or Triac (or SCR for DC). These switches (unlike relays or mechanical switches) commonly have some leakage of current in their `OFF' state that can result in minimally loaded outputs `floating' up to 40 to 50 VAC. Evidence of this phenomenon is sometimes seen in where a pilot light on a controlled output may glow dimly...however the output it is connected to is theoretically `OFF'. The leakage current is sufficient to dimly illuminate the pilot light but insufficient to energize the main load.

To handle the interface to these type outputs, the Pod Vth thresholds can be set to a higher level, thereby requiring a `solid' ON driving voltage to be sensed as a logical ON by the Isolation Pod. By measuring the ON and OFF voltage levels during normal cycling of an electrical node a feel for the switching levels can be achieved. Alternatively, a value substantially higher than the halfway point may be used, for example setting the Vth to 80V for use on a 120VAC rms system. Proper Vth setting can be verified through use of the *Monitor* command on the Crakker System Base ("Monitor (6)" on page 2-4).

Connecting The Pod To Signal Nodes

Isolation

Each channel of the Pod is electrically isolated from the others and from the Crakker. Due to this isolation feature, each channel within a single Pod can be connected to a different voltage node on the system to be monitored. The Channel leads are NOT polarity sensitive.

A Bit Of Theory...

The Pod signal lead pair is connected to a voltage divider within the Pod internal circuitry (Figure 3.3). The output of this voltage divider is a scaled down voltage representative of the Input Signal Voltage. This scaled down voltage is then sent to signal conditioning and threshold comparison circuitry which then sends a digital (on/off) opto-isolated signal to the Crakker System Base.

On the input voltage divider, a capacitive filter resides for spike protection. Due to this capacitance, the effective input impedance of a channel is a function of the frequency of the input signal. In Appendix B, effective input impedance is listed as a function of the monitored signal frequency.

The input impedance of the Pod is effectively a measure of the loading that the Pod circuitry will add to the circuit under test. To operate, the Pod draws a minimal current from the control circuitry under test due to this input impedance. The higher the impedance, the better (for most applications) as high impedances draw less current. As can be seen in Appendix B, for DC signals, the input impedance is over 220K ohms and for 60 Hz AC, the effective impedance is over 130K ohms.

Another effect of the capacitive filtering on the inputs is manifest when the signal voltage impressed on the inputs turns off, the capacitors tend to delay turn-off of the signal to the Crakker System Base.

Note To optimize the speed response of the Crakker System, connections should be made in a manner that results in the Pod inputs being driven to a High or Low state as opposed to being allowed to `float' for the OFF condition. The delay in response will be a function of the Vth setting and the effective impedance of the node being monitored. Connection methods to minimize this delay are discussed in the following section.
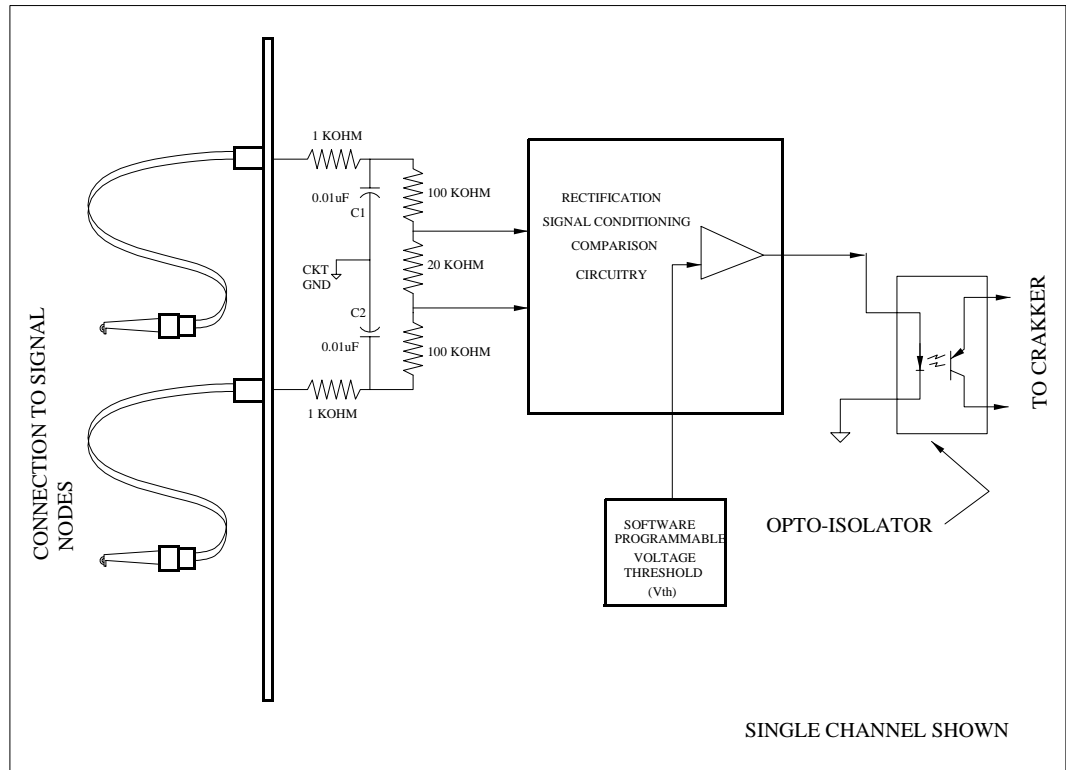
Figure 3.3 Equivalent Isolation Pod Input Circuitry

Connection Considerations

Before connecting Pod leads to any signal node, it is important to understand and assess any potential effects that the Pod current draw may have on the system to be monitored. Due to the relatively high impedance of the Pod channels (as explained above), for most applications, connection of the Pod will have no effect however, for low level signals, the potential effects should be assessed before connection of the Pod.

Additionally, by optimally determining the connection techniques to insure that signals are driven high and low, maximum speed of the Crakker System will result.

****************** **CAUTION** ******************************

If any question exists about the effect of connecting the pod leads to a critical control system, it is imperative that these questions be resolved before proceeding.

If this cautionary procedure is not followed, possible damage to equipment or life may result. Study each situation carefully before proceeding and feel free to contact Logic Beach Technical Support for assistance if desired.

****

Some examples of typical connection techniques are discussed in the following sections.

Triac or Relay PLC Output [Figure 3.4]:

The Pod leads are connected in parallel with the load. When the PLC output is energized, an additional 1 mA (apx at 120VAC output) of current flows through the Pod detection circuitry. In the case of Triac outputs, the small load presented by the Pod will actually help pull the output voltage closer to 0V when the output is `off' (see discussion on Triac leakage currents in "Special Considerations - Triacs" on page 3-4).

When the PLC output cycles OFF, the Pod inputs are effectively `shorted' through the low impedance of the load, insuring maintenance of the speed of the Pod input circuitry (see "A Bit Of Theory..." on page 3-4).
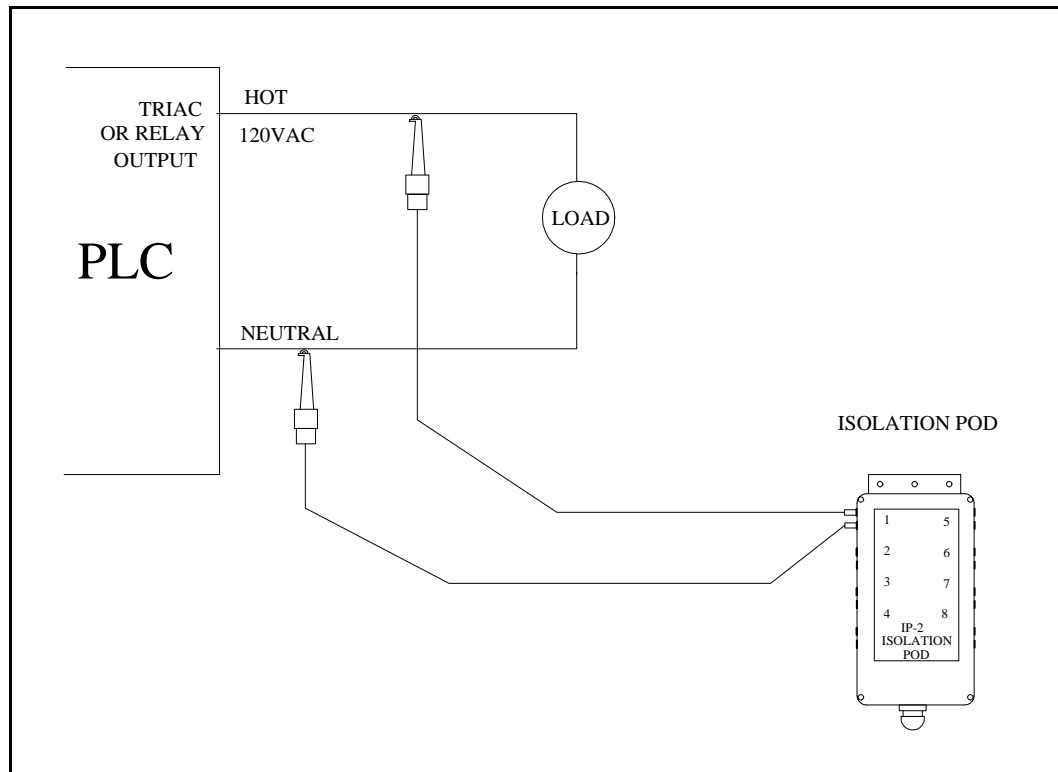

Figure 3.4 Pod Connection to Triac / Relay Outputs

Current Sinking Inputs

PLC controls commonly use current sinking digital inputs that turn ON when they are connected to the AC `HOT' line.  A typical connection with a proximity or limit switch is shown in Figure 3.5.  When the switch closes, a current path exists between the 120VAC `HOT' terminal and the PLC Input Terminal turning that input ON.

Figure 3.5 shows one method of connection of the Pod leads to this type of circuit. In an open switch condition, 0V exists across the Pod leads (logic 0). When the switch closes, 120Vac is supplied to the PLC Input Terminal (turning it ON) as well as being impressed across the Pod leads (logic 1).

For inputs operating from higher voltage supplies (e.g. 120VAC and above, as shown) this is the preferred method of connection as the small current that flows through the Pod circuitry will not have any effect on the PLC input circuitry as the two circuits are in parallel. The only concern with this connection configuration might be with respect to the turn off speed of the Pod input circuitry. When the Prox Switch is open, the Pod input circuitry is `shorted' through the circuitry contained within the PLC, however if the PLC utilizes some very high impedance input circuitry, the Pod circuit may have as high as 5 mS of delay before it turns off. This delay can be minimized by setting the Vth to a higher level (e.g. for a 120VAC supply, setting the Vth at 80V rather than at 20V will speed up the system response).
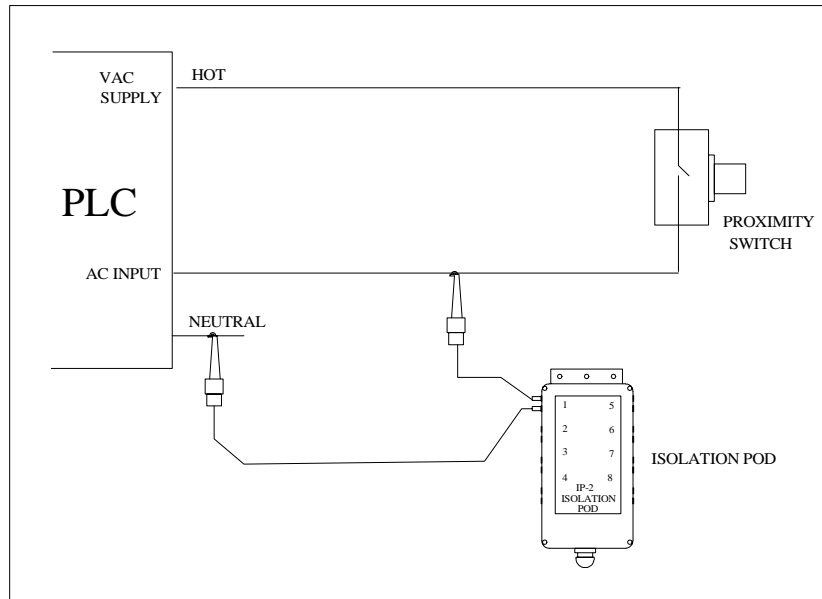
Figure 3.5 Pod Connection to a PLC Digital Input
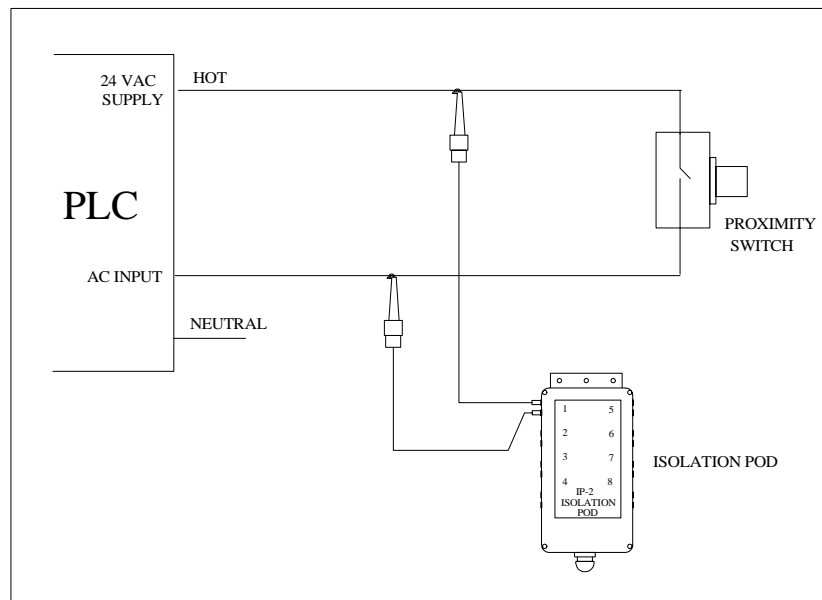
Figure 3.6 Pod Connection to a PLC Input (Alternate Method)

Figure 3.6 shows an alternative connection for monitoring a similar type digital input. With this type connection, when the Prox Switch is open, a logic HIGH will be recorded and when the switch is closed, a logic LOW will be recorded by the Crakker. The advantage of this connection is that the Pod inputs are driven high and low solidly, resulting in maximum speed. However, with this connection configuration, when the Prox Switch is open, a small current can still flow around the switch to the PLC Input Terminal via the Pod detection circuitry. For a control with very sensitive input circuitry within the Input Terminal, this current may be sufficient to effect a High condition on the PLC input when in fact, the Prox Switch is open.

With a 24VDC supply used (as shown), the current that will flow around the open Prox Switch (via the Pod Input circuitry) to the PLC Input will be less than 0.1 mA (24VDC/220,000 ohms =0.1mA) which in most cases is insufficient to switch an Input to a HIGH state...however reference should be made to the Specification / Operating manual for the Control under test before utilizing this connection method.

Note that the current that flows is in direct proportion to the supply voltage...for example, with a 5VDC supply, less than 23uA of current will flow (5VDC/220,000 ohms = 22.7uA).

Extremely High Voltage Signals:

In applications utilizing voltage levels beyond the range of the Pod, it may be necessary to connect the Pod leads across the load contactor actuation coil that is driven by the PLC (Figure 3.7). In this case, the voltage is within the Input Range of the Pod. The disadvantage of this technique is that the actual load side of the circuit is not being sensed in turn-on time critical applications (i.e. the actual electromechanical actuation delay of the high voltage load control contactor is not being measured by the Crakker).
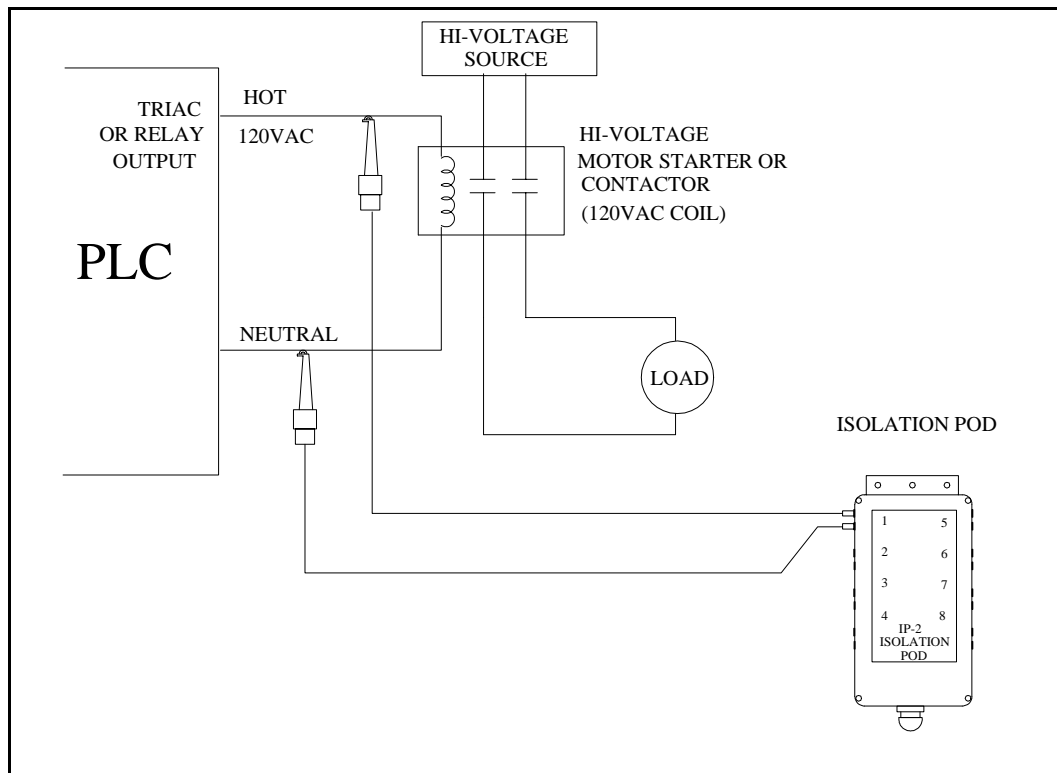
Figure 3.7 Hi-Voltage Node Connection Scheme

Contactor Actuation Time:

The Crakker employed in a circuit as shown in Figure 3.8 can be used to measure the actuation delay across a contactor. Here, two channels are used to measure the actuation signal and the load voltage.

Trapping Relay Logic `first Out' Conditions:

Many industrial control systems utilize master shutdown circuits configured with a series string of relay contacts. In the event that any of the relays open, a master control relay opens shutting down the process/system under control. Pod connections to determine which of the series relays opens first (`First Out' detection) are shown in Figure 9a. Additional technical information on First Out applications is contained in "Appendix M: Relay Logic `first-out' Detection With The Crakker" on page 8-29.
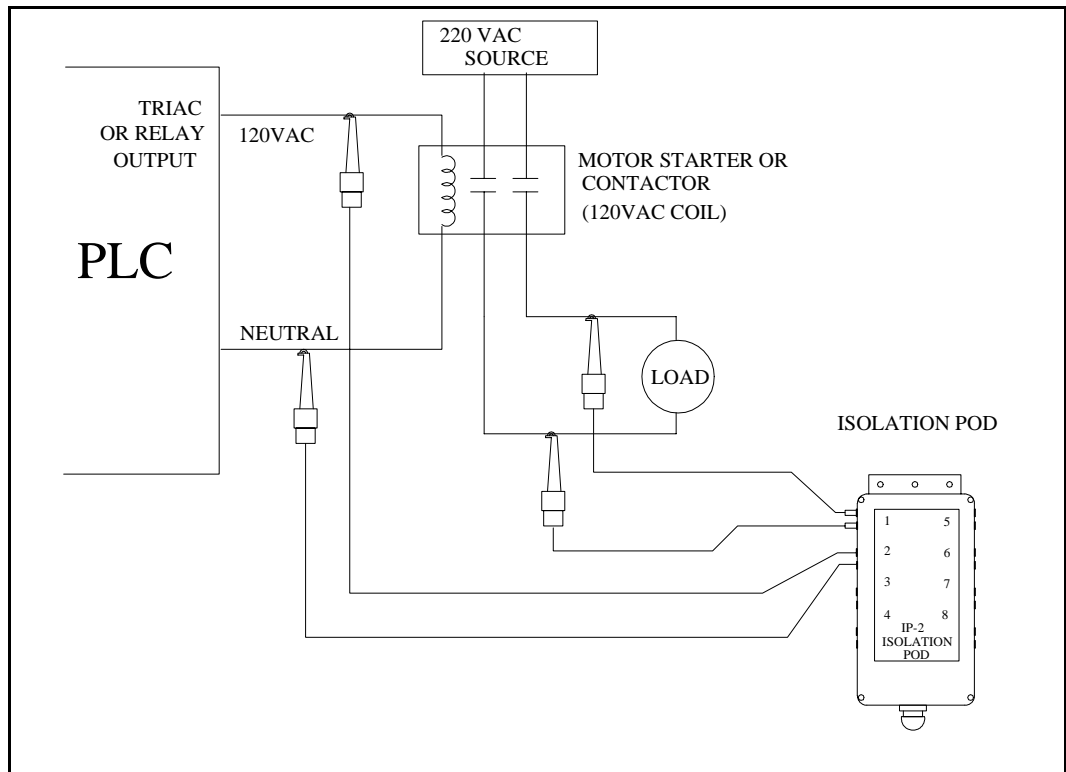
Figure 3.8 Testing Contactor Actuation Time
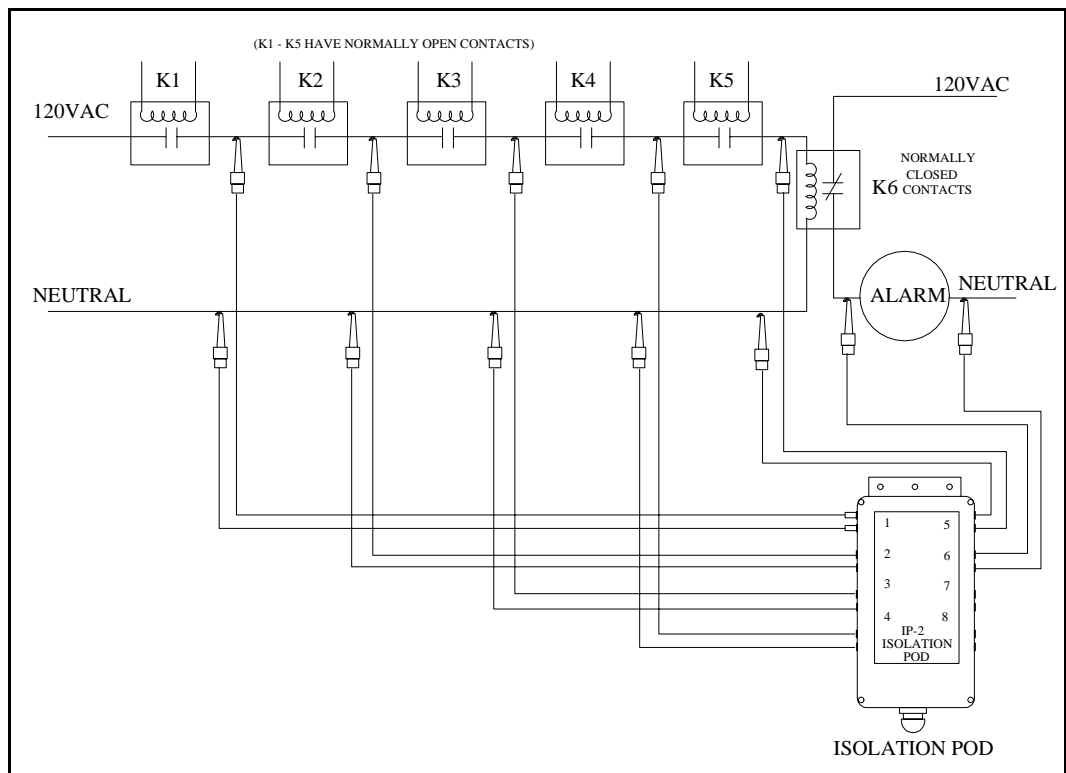
Figure 3.9 Relay Logic 'First Out' Detection

The concepts presented in the above examples can be extrapolated to many other logic and timing analysis applications. Feel free to contact our technical staff for assistance in any other unique applications.

Pod To Crakker Interconnection

Isolation Pods are connected to the Crakker System Base via the multi-conductor cable and its DB-15 type connector. If only using one Pod, connect to Port A on the Crakker to allow for the fastest scan rates.

Tighten the connector retaining screws securely to insure a good electrical connection.

4

CRAKKER COMMUNICATIONS FOR WINDOWS

Overview

The Crakker Communications for Windows (CCW) software is an integral component of the Crakker Logic / Timing Analyzer system. CCW performs four major functions during normal use of the Crakker:

- **Serial Communications:** Serial communication is fully implemented allowing the Crakker to communicate with the Personal Computer (PC) via a provided RS-232 serial cable. Communication is employed in programming the Crakker from the PC and in the transfer of collected data from the Crakker memory to the PC.

- **Crakker Programming:** The Crakker performs its Triggered data collection and Alarming functions per the instructions contained within a *Run Program*. This Run Program is developed on the PC (using the CCW program) then transferred to the Crakker's memory where it executes.

- **Display of Recorded Data:** Data collected by the Crakker in a Recording session is downloaded and saved to a file on the PC, then graphically displayed on the PC for inter-channel and absolute timing and state analysis.

- **File Export:** The collected data file can be converted into a Comma Delimited File format (*.csv) which in turn can be opened with Microsoft Excel and other spreadsheet applications.

Installation and an introduction to the Crakker Communications for Windows software is covered in this chapter. Following chapters detail using CCW for programming the Crakker and captured data display and data export.

PC Hardware / Software Requirements

CCW runs on WinTel compatible PC's running Microsoft Windows 98, 2000, XP and NT.

An RS-232 serial port is required for communication with the Crakker System Base and a CDROM drive for installation of CCW.

CCW Installation

CCW is provided on CDROM packaged with the Crakker System Base. To install CCW perform the following steps:

1 Close all currently running applications

2 Insert the provided CDROM into the drive

3 Upon drive tray closure, the installation program will automatically start. In the event that the installation does not automatically start, select the Run menu from the Start   (if this does not occur, use the Start menu to select Run then select the file Setup.exe on the CDROM drive)

> 4 Installation will automatically proceed and requests will be made for the desired installation directory. The default installation directory (recommended) is *C:\Windows\Program Files\Logic Beach\Crakker Comm for Windows.* Use the default path or specify an alternate desired drive, path and directory and continue.

Launching CCW

Upon successful installation of the CCW program, launch CCW with the conventional Windows *Start | Programs | CCW* sequence and CCW will launch with the following display:
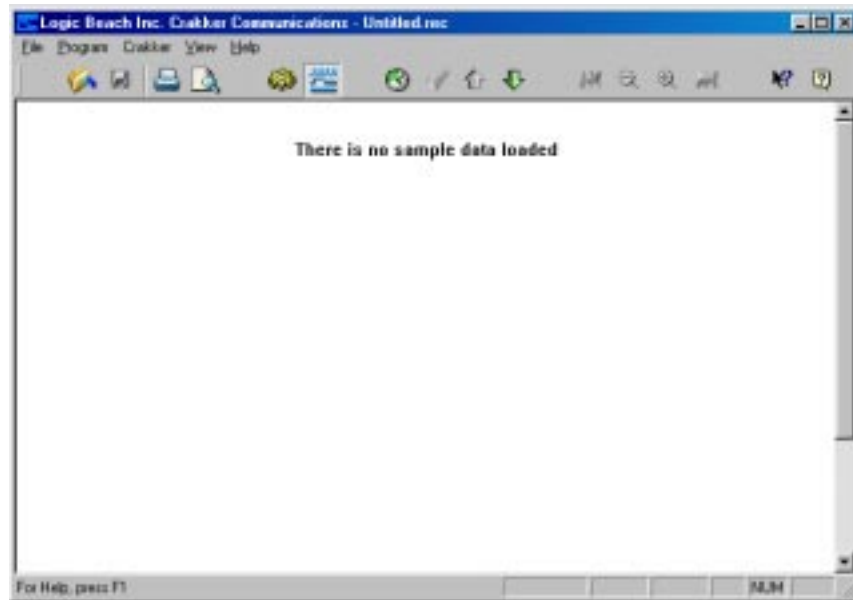
Figure 4.1 Crakker Communications for Windows Opening Screen

CCW Architecture Overview

CCW has two main windows, the *Program View* window and the *Data View* window. Details on developing Crakker *Run Programs* within the Program Window and data display from within the Data View window are in following chapters.

1 Program View: The Program View window is used during the development of a Run Program which is then transferred to the Crakker's memory where it executes… performing the conditional event data collection and alarming function.

2 Data View: The Data View window is for display of collected control system timing data after it has been downloaded from the Crakker's memory.

To switch between the two view windows, click on the appropriate buttons on the Button Bar or select from the *View* menu (Figure 4.2).

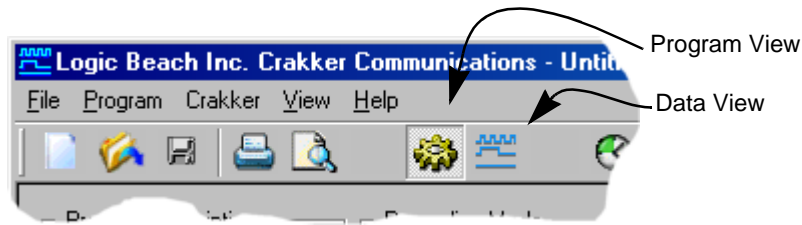**Figure 4.2** Data and Program View Selection Buttons

Serial Communications with the Crakker

Programming of the Crakker and collected data downloads from the Crakker are performed via an RS-232 serial connection linking the Crakker System Base and the PC.

Communication Overview

The Crakker communicates with the PC via an RS-232 serial communication link. Before communication can commence, the supplied RS-232 serial cable must be connected between the Crakker front panel Serial Port and one of the Personal Computer serial ports.

The supplied telephone style RS-232 cable and plug (RJ-12) mates directly with the Crakker front panel Serial Port. The other end of the cable should be plugged into the supplied adapter which converts the telephone style plug to the industry standard 25 pin DB-25 (or optionally 9 pin DB-9) male serial data connector supplied on IBM compatible PCs.

*************************** NOTE ***************************

Utilize only Logic Beach adapters that directly connect into the serial port on your PC. Although a multitude of gender and DB style adapters are manufactured by other companies, many are incompatible and will prevent successful communication (or could cause damage) between the Crakker and the PC. Please contact Logic Beach Technical Support for alternate cable adapter assistance.
****

Before communication, the Crakker must have power supplied (via the provided AC adapter or other low-voltage source) to the power jack, the System Power switch turned ON, and a `READY' or `DATA RECORDED' message displayed in the LCD. Similarly, the PC must be booted up, running the CCW program.

Serial Port Configuration

A serial port and baud rate must be selected after installation of CCW for use in communication with the Crakker. This selection is done within an Options dialog which is opened by selecting *File / Options* from the menu.

Select a Serial Port number then a baud rate. Typically, the baud rate setting should be left at 19.2K for fastest serial communications in all but extremely electrically noisy environments or long cable runs.
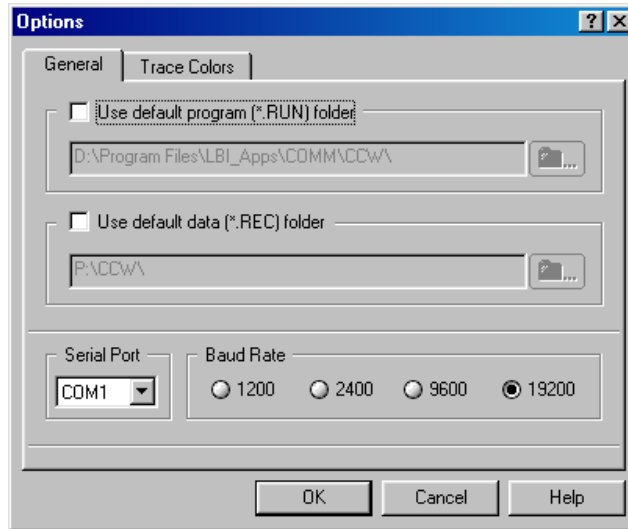
Figure 4.3 Options dialog for Default Path and Serial Comm setup

A quick test of the serial link can be performed via the *Query Status button* or menu choice *Crakker | Query Crakker Status.* This command queries the connected Crakker for a current system status and returns a dialog as shown in Figure 4.4.
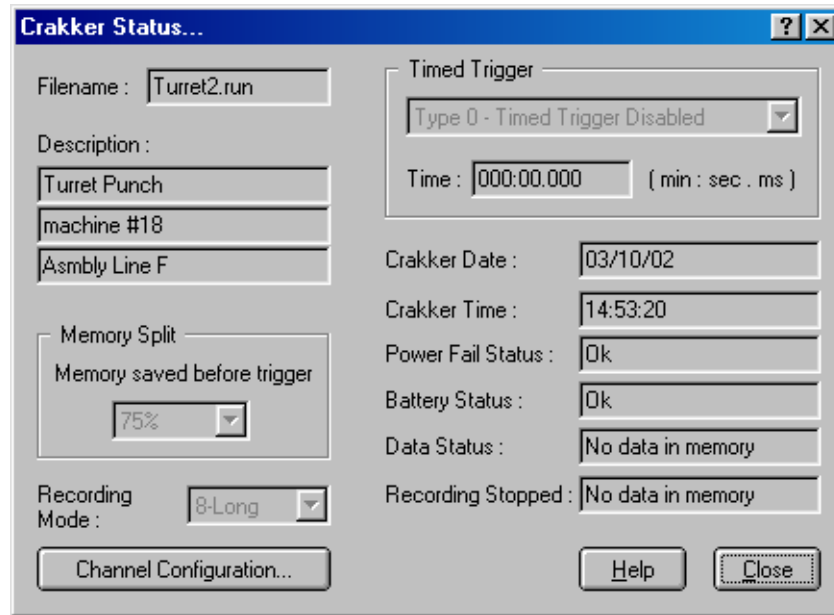
Figure 4.4 Query Crakker Status response dialog

At the start of any communication with the Crakker, a series of short commands are exchanged between the Crakker and the PC. If any problems exist in the serial link or configuration, a communication error message will be displayed on the PC. In the event that an error message is displayed, a quick check of the following points will remedy the problem in most cases.

Correct Port Specified?

Check that the correct PC port is being used. Change from within the Options dialog.

Crakker Powered Up?

Insure that the Crakker is powered up and is displaying a steady *Ready* or *Data Recorded* message in its display. Serial communications cannot operate while the Crakker is in the *Record Enabled* mode (if displaying Record Enabled, press the Crakker front panel *Stop* button).

Serial Cable Connections Correct?

Insure that the RS-232 cable is seated securely in the front panel Serial Port of the Crakker and plugged securely through the DB-9/25 adapter into the PC serial port.

Note: DB-9 to DB-25 (or the reverse) adapters manufactured by other than Logic Beach *may not work!*

Correct Cable?

If a cable other than the RS-232 cable supplied with the Crakker is used, insure that it is a four or six conductor cable with the modular plugs installed in the *same exact* configuration as the Logic Beach supplied cable. Refer to Appendix H or the supplied cable for verification.

Baud Rate Too Fast

If a substantially longer RS-232 cable is being used, the Baud Rate may need to be decreased. For general reference, 9600 Baud rates have been successfully used between a PC and the Crakker at up to 100 feet in relatively electrical noise free environments (although the RS-232 specs specify performance up to 50 feet). If problems persist, switch to a slower rate and repeat the test.

Serial Commands

Following is an explanation of the serial commands and responses commonly used during the deployment of a Crakker system.
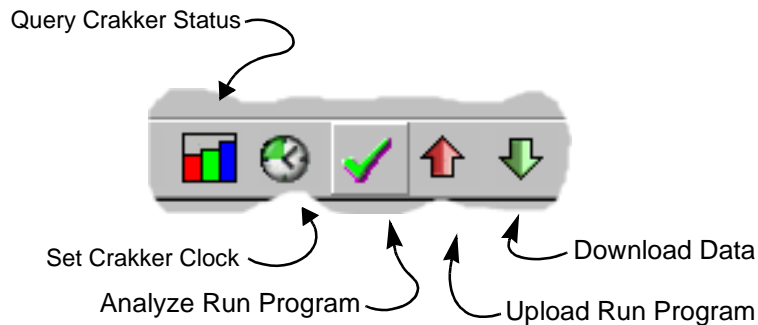

Figure 4.5 Serial Communications Buttons within CCW

Set Crakker Clock Time

The Crakker System Base includes a real-time clock that keeps track of the date and time. This internal clock is used for time-stamping of recorded data. To set the Crakker clock to match the PC clock click on the *Set Clock* button or use the menu selection *Crakker | Set Crakker Clock.*

Download Recorded Data

To download data from the Crakker memory click on the Download Data button or use the menu selection *Crakker |Download Data from Crakker.* A status dialog will open showing the progression of the serial download sequence. Upon completion, the data will be displayed within the *Data View* window.

NOTE: After download of data into the Data View window, if it is desired to save the data to disk, use the File Save button or the menu selections. Downloaded data *is not automatically saved to disk.*

Upload Run Program

After a Run Program has been developed (or loaded from file into CCW), it can be transferred to the Crakker memory where it executes. Clicking on the *Upload Run Program* button transfers the Run Program *currently open within CCW* into the Crakker memory. Note that the Upload Run Program button is only available (i.e. not grayed out) in the *Program View* window.

NOTE: To prevent inadvertent loss of recorded data within the Crakker, it is not possible to upload a new Run Program to the Crakker if the Crakker currently contains recorded data. An error dialog will display stating the Crakker memory must be cleared. Download the data (if desired) then clear the Crakker memory using the sequence of simultaneous Stop and Clear front panel button presses.

Analyze Run Program

From within the *Program View* window in CCW, clicking on the *Analyze Run Program* button results in a overview analysis of the expected performance of the Current Run Program open in CCW (i.e. not the Run Program in the Crakker memory). Details on the Analysis are covered in "Analysis of Run Program Performance" on page 5-16

Query Crakker Status

Selecting *Crakker | Query Crakker Status* from the menu results in two sequential dialogs that provide status information about the Crakker System Base and the Run Program currently loaded into the Crakker's memory. Pressing the Crakker front panel *Status* button will result in a local display of much of this same information.
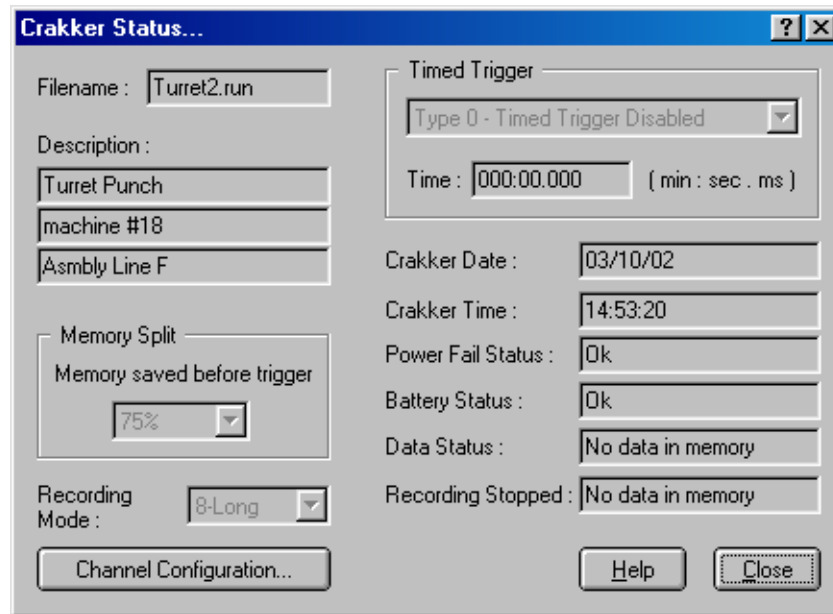

Figure 4.6 Query Crakker Status (first dialog)

Status information displayed in the first resulting dialog includes settings specified and contained within the Crakker Run Program. Run Program development is covered in detail in Chapter 5. Additional information about the Crakker System Base is displayed including:

Power Fail Status

In the event that the Crakker experiences a loss of power while in the *Record Enabled* mode, it performs a very fast orderly shut-down and preserves all data currently in memory. If this occurs, either a *Failed After Trigger* or a *Failed Before Trigger* message will be displayed indicating to the User the status at the time of power failure. Data can still be transferred from the Crakker to the PC and displayed in spite of the power failure.

Battery Status

If the lithium battery used to power the Crakker internal Real Time Clock and backup internal memory is low on energy, a *Low Battery* message will be displayed. If this message is seen, desired data in memory should be transferred from the Crakker to the PC and the lithium cell should be replaced (see "Appendix F: Changing The Clock / Memory Backup Battery" on page 8-11).

Data Status

An indication if data is currently maintained in memory or if it has been cleared since the last Recording session.

Recording Stopped

The time and date when the Crakker stopped writing data to memory during the last Recording session.

Selecting the *Channel Configuration* button from the Crakker Status dialog results in a second dialog display detailing the Record, Alarm, and Channel information for the Run Program currently loaded into the Crakker Memory.
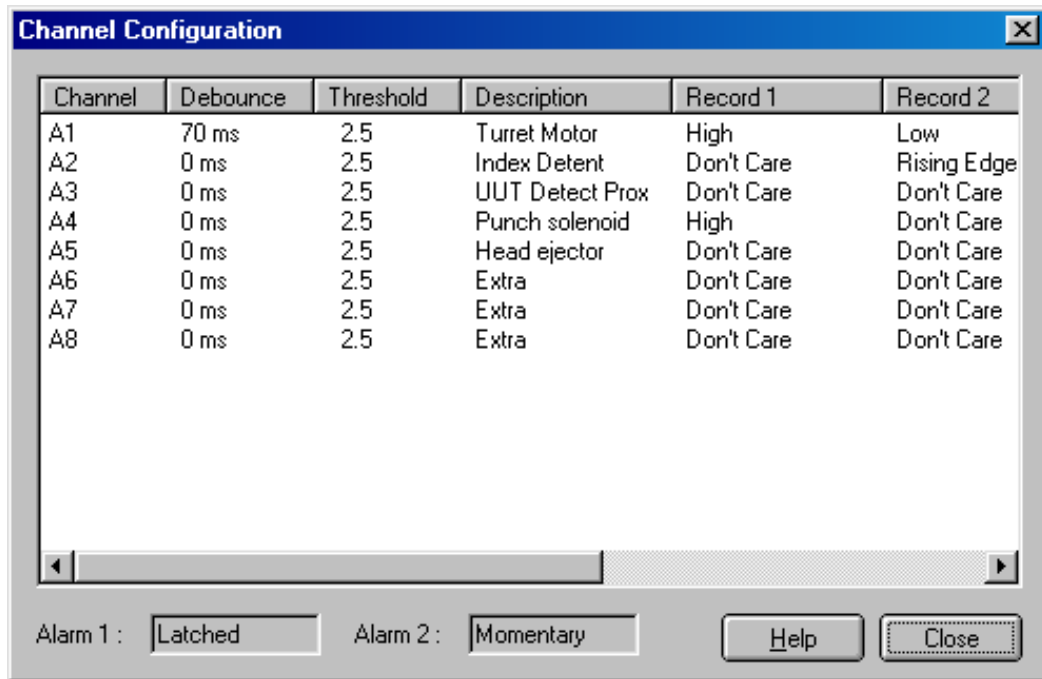

Figure 4.7 Crakker Query Status... currently loaded Run Program Configuration

CCW Default File Paths

Default paths to be used for the Run Program and downloaded data files can be specified in the Options dialog (Figure 4.3). Check to enable the default path(s) and browse or enter the desired folder location.

4. Crakker Communications for Windows

Notes.....

5

PROGRAMMING THE CRAKKER WITH CCW

Overview

The first step in implementing a Crakker Recording session is the development of a *Run Program.* A Run Program is a small file that is developed within CCW, then transferred to the Crakker memory. The Run Program contains configuration and operation information that the Crakker uses during its data Recording function (e.g. the *Trigger Word*, alarm conditions, etc.)

The file is called a *Run Program* because it contains information that the Crakker utilizes while it is RUNning during a Recording session. Run Programs developed in CCW are stored to disk with the file extension `.RUN' (e.g. FILENAME.RUN).

The following sections detail the User set-up of Run Program parameters from within CCW.

To display the Program View window, click on the Program View button on the Button Bar or select *View | Program View* from the menu.
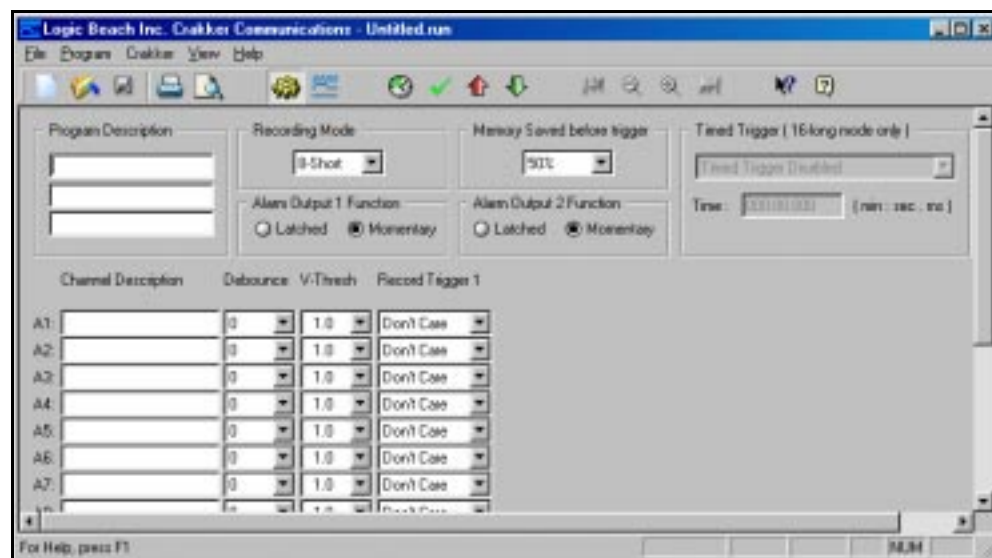

Figure 5.1 Program View Screen

Run Program Configuration

Within the Program View Screen, settings are entered to result in a desired Run Program.

The first step in development of a Run Program is mentally defining the condition(s) desired that will initiate the trapping of data into Crakker memory. These conditions will generally be indicative of a fault or erroneous condition within the control system to be monitored and will vary in complexity depending on the application. The conditions could range from something as simple as monitoring an 'Emergency Stop' button (or PLC input) from a production line to more complex triggering conditions explained below. Once this *Trigger* condition is defined, development of a Run Program can commence.

Opening and Saving Run Program Files

Every Run Program has a filename with the extension `.RUN'. Typically, many Run Programs may be developed and saved to disk and new Run Programs can be built by editing existing Run Programs and saving them with a new name. Use the conventional Windows *File | Open* menu to open an existing Run Program or *New* to start with a blank program.

After development of a Run Program, the program can be saved to disk view the *Save* button on the toolbar or the *File | Save As* or *Save* menu selections.

Run Program Development

In the development of the Run Program, various text fields and logical condition statements are completed. Upon completion, the program is saved and/or uploaded to the Crakker memory for execution. Following is a discussion of the various parameters to be specified by the User in development of a Run Program.

Program Description

Three lines of 16 characters each are provided for entry of a short description of the current Run Program under development. This description will be saved with the Run Program. During a *Status* display from the Crakker front panel, this description is displayed on the LCD immediately after the name of the Run Program currently in Crakker memory. This description can then serve as a reminder of the function of the associated Run Program.

Memory Saved Before Trigger

The Crakker allocates a certain block of its internal memory for storage of data. In the *Recording Enabled* mode, the Crakker is constantly writing, then over-writing data to this block of memory while it is waiting for the Record Trigger to occur. (A detailed explanation of the memory management scheme is provided in "Appendix K: Memory Utilization / Loop Rate Theory" on page 8-21.)

The *Memory Saved Before Trigger* percentage value determines how the total Crakker data memory is divided into Pre-Trigger and Post-Trigger data. When the Trigger occurs, the Crakker will continue to write `post-Trigger' data to memory until the specified percentage is met. Upon fill of memory, the Crakker then displays RECORD ENABLED <FINISHED> on its LCD and stops.

The percentages on the menu are approximate and specify the portion of the total data memory that is allocated to data storage of transitions PRIOR to the Trigger (i.e. pre-Trigger data). Typically, the events that occur just prior to a Trigger condition are of utmost interest in the troubleshooting sequence.

NOTE: If a Trigger occurs before the specified pre-Trigger memory percentage is filled, the Memory specification obviously will not be met...however, the amount of pre-Trigger data that was collected will be retained.

Recording Mode

The Crakker can operate in a number of different *Record Modes*. Different modes allow for varying operation and capability. Mode selection will vary depending on a number of setup parameters such as number of channels, types and quantity of Triggers, and timing.

Figure 5.2 Recording Modes

The Record Mode selection offers four different modes of operation (8-SHORT, 8-LONG, 16-SHORT, and 16-LONG) that include different combinations of these parameters. Different modes are offered so the User can optimize the performance of the Crakker for the particular application.

Generally speaking, in the selection of the Record Mode, the Loop Rate (the rate at which the inputs are latched into memory, checked for a Trigger match, then stored or discarded) is balanced against the other parameters such as number of channels, number of triggers, etc. For example, more active channels and/or enabled Triggers results in slower Loop Rates.

Note A detailed explanation of the Loop Rate can be found in "Appendix K: Memory Utilization / Loop Rate Theory" on page 8-21. Although it is not critical that the information explained in this Appendix be read, a basic understanding of the concepts involved will help in setup and application of the Crakker.

The Record Mode selection flow chart (Figure 5.3) can be used to select the desired Record Mode for most applications.

8 vs. 16 Mode

The `8-SHORT' and `8-LONG' modes are supplied for 8 channels of input (one Pod) and the `16-SHORT' and `16-LONG' modes are supplied for 16 channels (two Pods). (The `16-LONG' mode is also used for Timed Trigger applications with 8 channels...discussed later)

Short vs. Long Mode... A Cursory Explanation

In general, the `SHORT' mode has been designed for the fastest Loop Rate with a compromise on the total elapsed time window that can be stored to memory. Only one Record Trigger is allowed for the `SHORT' mode.

`LONG' mode runs at a slower Loop Rate, but allows for a considerably longer total elapsed time window to be stored to memory. In the `LONG' mode, up to three Record Triggers can be set and up to two Alarm Triggers can be set. The total quantity of Triggers used affects the resultant Loop Rate. The final Loop Rate can be checked using the *Analyze Run Program* command ("Analysis of Run Program Performance" on page 5-16)

Note: For simplicity in setup, Users may opt to always use the LONG mode for Crakker applications where timing resolution of less than 1mS is not required.

Short vs. Long Modes... More Considerations

When the Crakker is running in the RECORD ENABLED mode, the Crakker stores data to memory every time the Inputs have changed relative to the last time they were scanned. When this occurs, the new Input Status *and* the elapsed time (from the last change on the Inputs) are stored in memory.

In addition to storing when the Input Status has changed, the Crakker also stores data to memory (even though the Inputs have not changed) after a fixed period of time has elapsed. This is required to prevent the `elapsed time clock' (in software) from overflowing and the resultant loss of the time base for the measurements.

In the `SHORT' mode, a clock that has a `shorter' time span is used. Conversely, a `longer' time span clock is used in the `LONG' mode. Ultimately, this (generally) means that data memory will be consumed at a faster rate using the `SHORT' mode than in `LONG' mode configured sessions and the maximum window of time for which the Crakker can store data will be longer for the `LONG' mode.

Note: An exception to this occurs when monitoring inputs that are changing very quickly. In this case, data is stored due to changes on the inputs, not due to an overflow of the `elapsed time clock' and more data can actually be stored in memory in the `SHORT' mode since a `SHORT' sample requires less memory space to store than does a `LONG' sample.
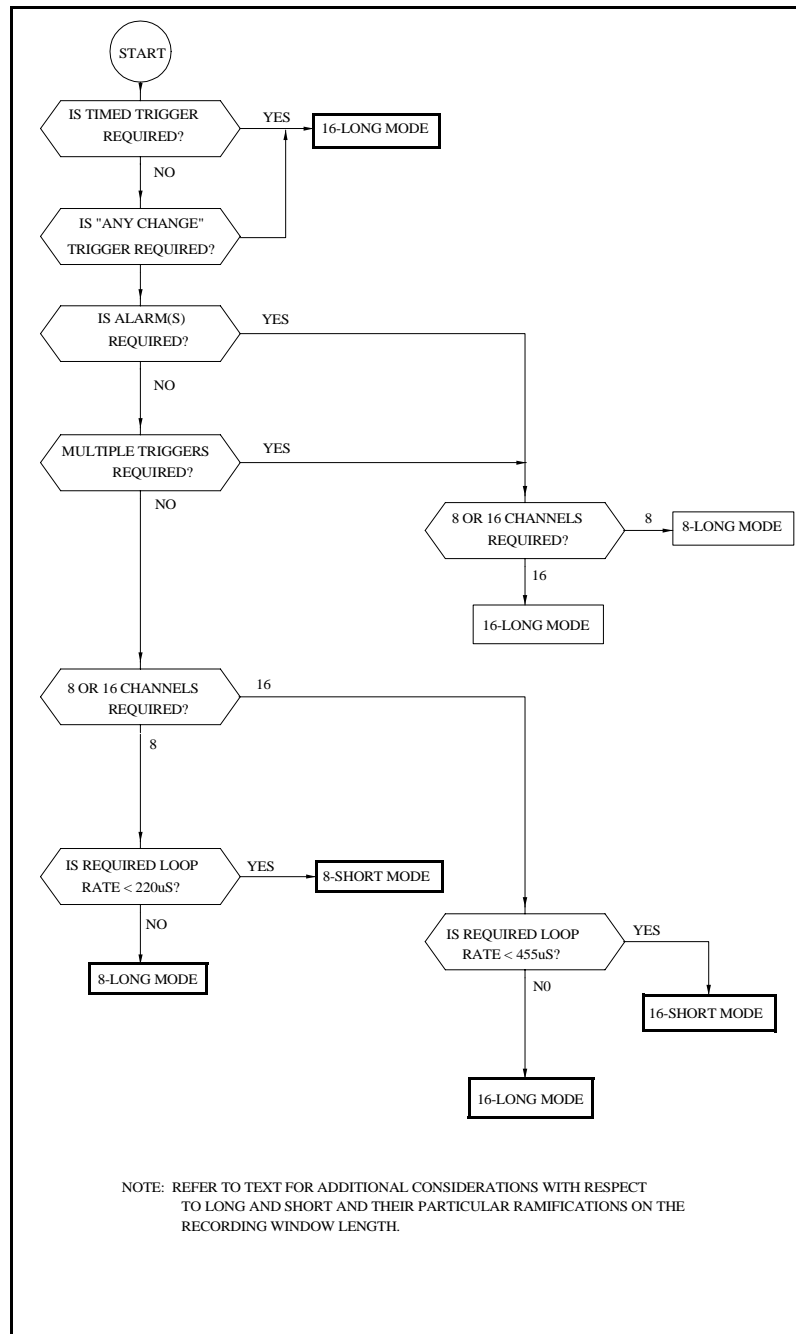
Figure 5.3 Record Mode Selection Flowchart

Channel Setup

The *Channel Setup* region (Figure 5.4) of the Program View screen is used to configure channel names, individual channel filtering (debounce), Record Triggers, Threshold Voltage (Vth) and Alarm Triggers (that control two output relays built into the Crakker system base) which are maintained in the Crakker Run Program.

The number of channels, Record Triggers, and Alarm Triggers available for configuration vary depending on the Record Mode selected.
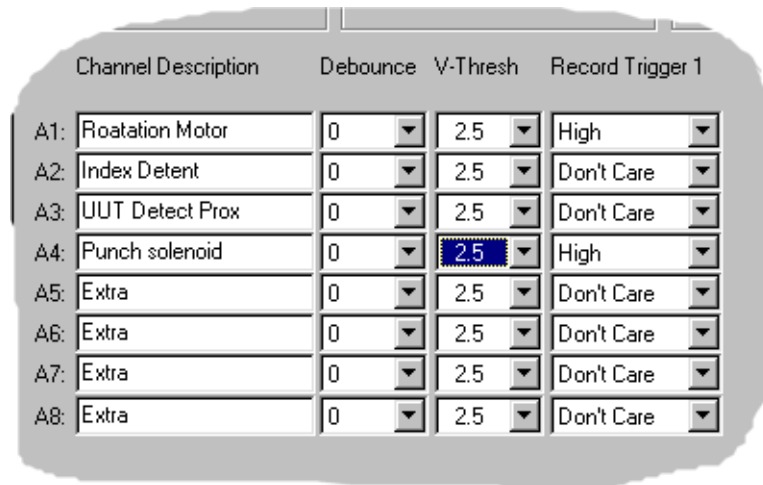
Figure 5.4 Channel Setup Screen for 8-Short Mode

Channel Number

At the left edge of the Channel Setup Screen, the available channels are listed. Depending on the Record Mode selected (8 or 16), Channels 1-8 for the `A' Pod and `B' Pod are listed.

Channel Description

Each Channel can be tagged with a short (16 characters maximum) descriptive name. In the field, the User can review each of the Channel Descriptions on the Crakker display during a STATUS display sequence. This can be of assistance when making the electrical connections from the Pod to the field control points.

Debounce

The text boxes immediately to the right of the Channel Descriptions allow for a setting of *Debounce* value for each channel. Four different levels of Debounce are available (0, 30, 50, and 70 mS). Use the pull-down menu to select the desired Debounce value for the channel.

The Debounce function enables different levels of filtering on each channels input to the Crakker. The levels correspond to an approximate Time Constant which can be used as a figure of merit for filtering and smoothing of input signals. Common applications and typical Debounce settings follow:

SWITCH CONTACT DEBOUNCE

When mechanical switches, contactors, and relays electrical contacts `close', they generally DO NOT switch together cleanly making immediate solid electrical contact. In actuality, they go through a short cycle of bouncing together, opening, bouncing together, opening, etc. until they finally come to rest in the closed position [Figure 5.5]. For a physically small switch, this cycle may consist of 5 to 10 bounces all occurring within 20 mS of time...larger relays with physically larger contacts and supporting arms impact harder and bounce longer.
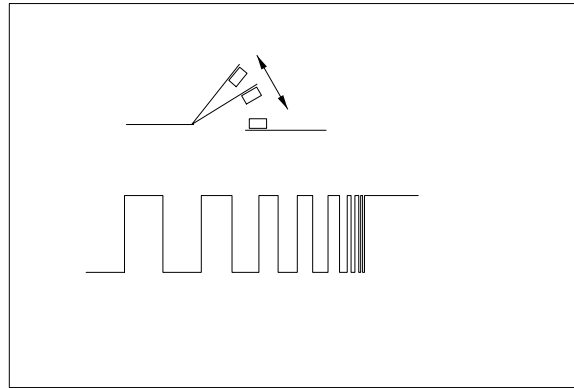
Figure 5.5 Contact Bounce

In switches utilized in DC (and to a certain extent in AC) circuits, this contact bounce will translate into a rapid sequence of on and off voltage levels being detected by the Pod circuitry. Figure 5.6 shows four channels of data collected from the same set of contacts on a large relay with various amounts of Debounce specified. The first channel has no Debounce and multiple transitions can be seen (zooming in on the data reveals six high/low cycles). If no Debounce is used (i.e. 0) The Crakker will trap these rapid voltage transitions into memory (and could possibly present a combination that fulfills a misleading TRIGGER condition). If these transitions are not desired during the playback of the collected timing/state data, the Debounce can be enabled to filter out these transitions.
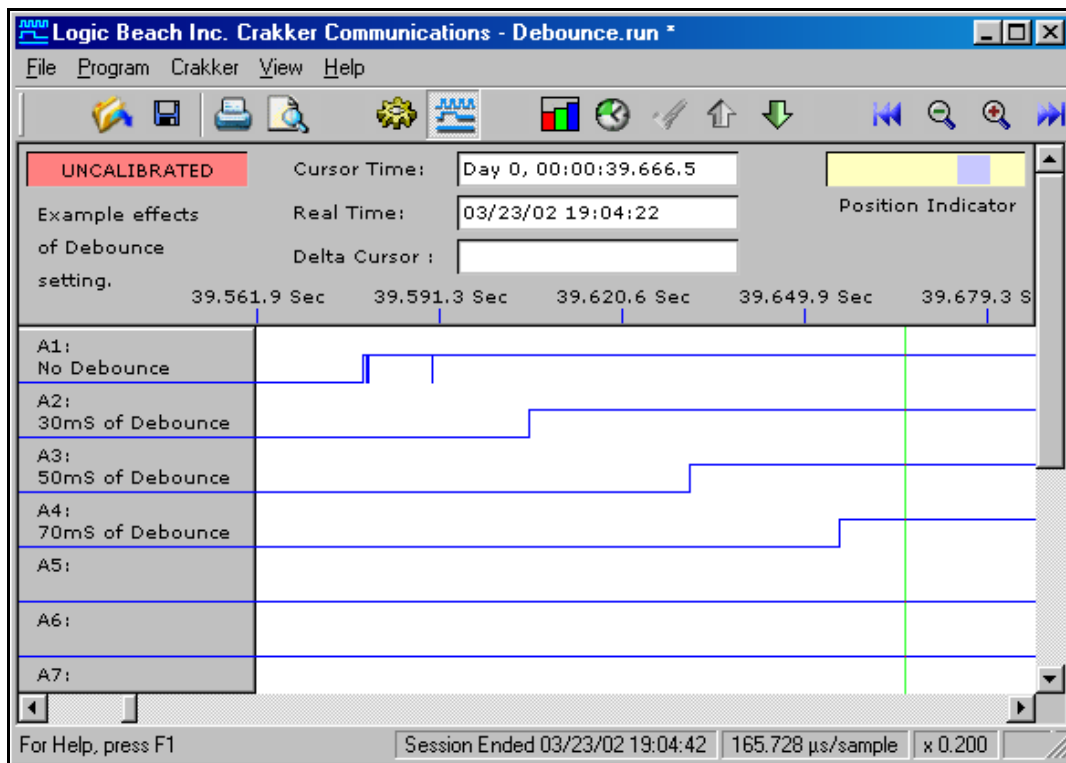

**Figure 5.6** Effects of Debounce Setting on Switch Closures

A value of 30mS can be used for small switches and a value of 50 or 75 for larger switches/contactors may be required. Experimentation through a series of short data recording sessions may be the best technique to use for selection of the optimum Debounce level.

5. Programming the Crakker with CCW

Note: Use of the Debounce function actually slows down ("skews") the effective detection rate of switch transitions by approximately the value selected. In critical high-speed troubleshooting applications, more insight into the system performance may be gained by leaving this Debounce value OFF (set to 0), with the trade-off that the data display may be considerably more visually complex due to the multiple transitions at each switching. Time skew can readily be seen between the different levels of Debounce in Figure 5.6.

MONITORING AC INPUTS

The actual voltage during one cycle on electrical nodes handling AC currents transitions from the peak AC voltage through zero to a reverse polarity peak voltage then back through zero to the peak voltage as seen Figure 5.7. If the Crakker is connected directly to an AC voltage node, it will record these cycles as a continuous string of ON/OFF transitions when in actuality, the node is in the `ON' state.
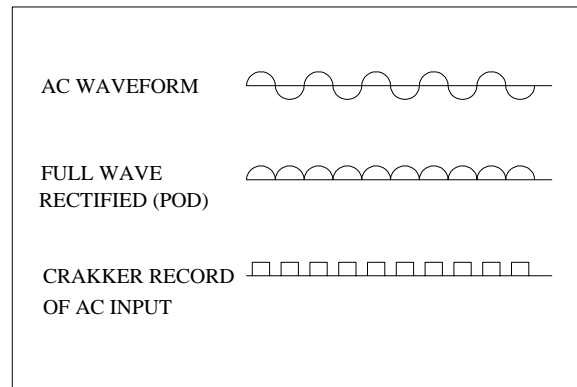
Figure 5.7 Pod Input Circuitry AC Rectification

Note: For the technically curious, Pod input circuitry effectively full-wave rectifies the incoming AC signals so the Crakker sees a signal that transitions from a positive voltage to zero and back to the positive voltage without crossing under the zero...at twice the normal frequency (Figure 5.7).

The Debounce function can assist in overcoming this misleading AC input problem by filtering the AC voltage into an ON and OFF state which corresponds to the presence or absence of AC at the monitored node. Figure 5.8 illustrates the monitoring of an AC node with two channels, one with and one without the Debounce enabled.

For typical 50/60 hz AC signals, a Debounce value of 30 mS will provide sufficient filtering assuming that the Vth level is set to approximately 1/2 to 3/4 of the AC rms ON state value.

Use of Debounce settings other than 0 will result in time skew (delay in time) of the transitions. This is illustrated Figure 5.8. Channel A1 has no Debounce enabled and accurately portrays the timing of the first positive voltage detected on the input. Channel A2 with 30mS of Debounce enabled filters out the 60Hz cycles into one continuous ON period, however note that its initial turn-on time is delayed by approximately 60mS.

Although the Debounce setting is 30mS, the combined effects of the duty-cycle of the AC waveform above the Vth threshold (see "Vth Voltage Threshold" on page 5-8) serves to impact the effective skew. In this example, a Vth of 10V was used for both channels and the actual node voltage being measured is 13Vac (rms). With the 10V threshold, in a half period (8.33mS) of the 60Hz cycle (16.666mS) the ON time was 5.6mS and the OFF time was 2.8mS. This imbalance serves to effect the Debounce time skew.
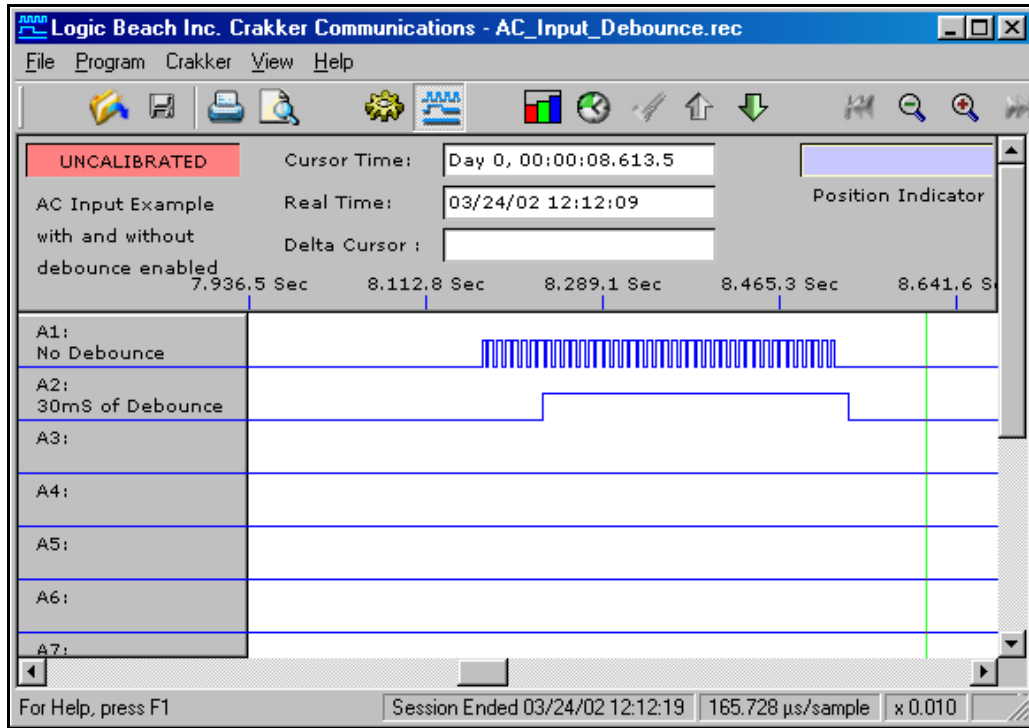
Figure 5.8 Measuring timing on AC signals with and without Debounce

HIGH-SPEED APPLICATIONS OF DEBOUNCE

In very fast dynamic applications requiring ultimate speed and response to incoming signal transitions, the Debounce should be set to 0mS. The corresponding data display will be considerably more complex and data memory will be filled at a faster rate (especially in the monitoring of AC nodes as data will be written to memory at the rate of 120 Records per second for channels monitoring 60Hz AC).

AC signals `ON' states will appear as a series of regular spaced pulses...`OFF' states will appear as steady low signals.

Vth Voltage Threshold

The column titled V-Thresh (Figure 5.4) specifies the approximate voltage thresholds that the Crakker system uses to determine a logical ON or OFF level for that channel. Use the drop-down list box to select the desired switching threshold for each channel.

Typically, the Vth setting should be set at approximately 1/2 to 3/4 of the voltage present at the control system node of interest. For example, on a node that swings between 0 and 5VDC, a setting at 3V should provide good performance. On an AC signal node that swings between 0 and 120VAC (rms), a setting of 80 or 90V should give good performance. When monitoring AC nodes, keep in mind that a Debounce setting may also be required (see prior section on *Debounce*).

Additional information on the Vth setting is provided in "Pod Switching Thresholds... Vth Setting" on page 3-2. For convenience, the Vth Threshold Table (Figure 5.9) is duplicated in both sections. Note that the voltage specifications are approximate and will vary slightly between units.

Programmed Vth Level (Vdc)	Approximate OFF to On Voltage (Vdc)	Approximate ON to OFF Voltage (Vdc)
2.0	2.0	1.3
2.5	2.5	1.7
3.0	3.0	2.2
4.0	4.0	3.0
5.0	5.0	4.0
6.0	6.1	4.6
8.0	8.1	6.0
10.0	10.0	6.9
15	15	10
20	19	13
25	25	19
30	30	21
40	40	31
50	50	40
60	58	48
70	70	59
80	82	70
90	90	78
100	100	87
110	112	101
120	122	111
130	130	118
140	139	127
150	150	140
160	158	147
170	169	159
180	182	174
190	190	182
200	198	190
210	212	205

Figure 5.9 Approximate Pod Voltage Thresholds (V-Thresh) Switch Points

Note: The Pod input channels will NOT be damaged by setting the Vth level incorrectly for the application.

Tip: The 32 levels of Vth thresholds are provided within the Crakker to facilitate further control system troubleshooting / analysis with the Crakker system. For example, droops in power supply voltages can be detected by utilizing multiple Pod channels configured with a sequence of Vth settings.

Record Triggers

While the Crakker is running in the RECORD ENABLED mode, it is constantly reading the input states (via the Pods) and comparing them to a *Trigger word(s)* contained in the Run Program. A Trigger is a combination of Input Channel activity defined by the User to initiate an Alarm
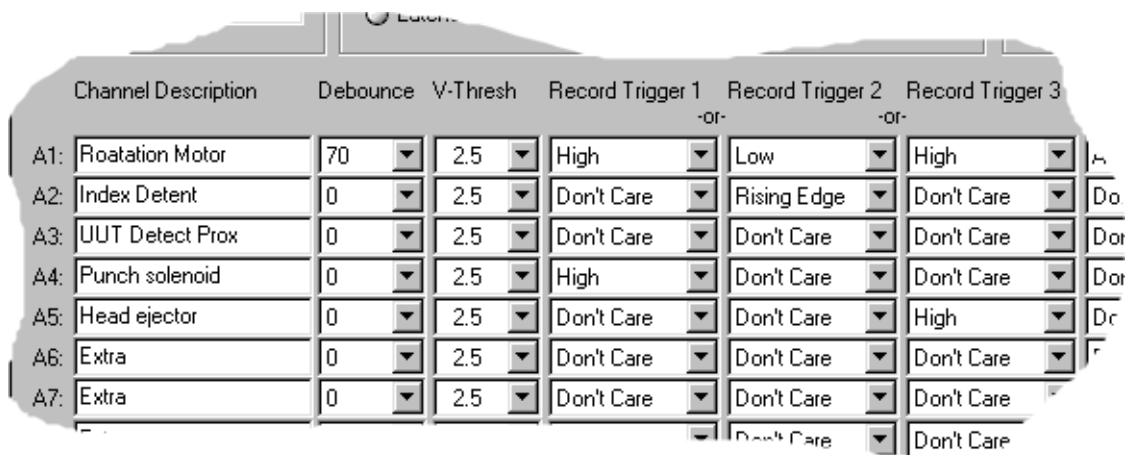
(discussed later) or Record function. When the condition of a Record Trigger are met, a marker is put into the file and timing and signal waveform data is stored surrounding the Trigger. Depending on the setting for the allocation of memory (see"Memory Saved Before Trigger") data before and/ or after the trigger condition will be saved.

The Trigger Configuration screen (Figure 5.10) allows the User to set the Trigger conditions for the initiation of Recording (Record Trigger). Depending on the Record Mode selected on the *Recording Mode* list box, different quantities, and types of Triggers will appear for editing on the Trigger Configuration screen. In the most powerful Record Mode... *16-Long*, 3 Record Triggers (16 channels), 2 Alarm Triggers (16 channels), and the Timed Trigger can be utilized. In contrast, in the fastest (but most limited) Record Mode... *8-Short*, only one Record Trigger is allowed (8 channel).

In Record Modes with multiple Record Triggers allowed (e.g. 8-Long and 16-Long), the Triggers for the Record function are logically OR'd together. For example, if a User sets up all three Record Triggers (8-LONG or 16-LONG mode) in a Run Program, loads the Run Program into the Crakker then Enables Recording, the Crakker will Trigger if Record Trigger 1 *OR* Trigger 2 *OR* Trigger 3 occurs.

In the 16-Long Record Mode, a Timed Trigger is also allowed as a fourth possible Record Trigger. If it is setup and enabled the Timed Trigger is logically OR'ed with the other utilized Record Triggers.

Figure 5.10 Record Trigger Configuration Section of Program View

Alarm Triggers

Quite similar to the Record Triggers, two *Alarm Triggers* (Figure 5.11) are also provided which control two output relays built into the Crakker. These Alarm Triggers are available only in the 8-Long and 16-Long Record Modes.

Each of the two Alarms has a single associated Trigger that will cause its Alarm to turn ON when the Trigger conditions are met. Unlike the Record Triggers, only one Trigger word is available for each alarm hence no logical ORing can be programmed. A special alarm mode, where the Alarm follows the Record Triggers is provided (*Any Record Trigger*). Similar Trigger conditions and editing techniques are used for the Alarm Triggers as are used in configuring the Record Triggers.

Figure 5.11 Alarm Trigger Configuration

Six types of Trigger Logic are supported by the Crakker:

1. DON'T CARE

If *Don't Care* is selected for a channels entry in a Trigger list box (Figure 5.13), the state and transitions associated with that channel are ignored by the Crakker during the Trigger determination process. All channels that are not to be involved in determining a Trigger condition should be set to *Don't Care.*

2. STATE TRIGGER LOGIC

Input Channel *States* refer to an input that is either *High* (On) or *Low* (Off) when scanned by the Crakker. An example of a *State* type Record Trigger is demonstrated in *Record Trigger 3* in Figure 5.10:

> *Trigger when Rotation Motor is ON (High) and the Head Ejector is ON (High)*

In the Trigger list box, State Triggers are listed as High or Low (Figure 5.13).

3. TRANSITIONAL / EDGE TRIGGER LOGIC

Input Channel *Transitions* refer to an input to the Crakker that changes from ON to OFF (High to Low) or OFF to ON (Low to High) relative to the last scan of that input. Transitions from OFF to ON are referred to as '*Rising Edge*' transitions and ON to OFF are referred to as `*Falling Edge*' transitions (Figure 5.12).

An example of a Transitional Trigger is shown in Figure 5.10 Trigger 2:

> *Trigger when the Rotation Motor is OFF (Low) and Index Detent actuates (transitions from Low to High)*

In the Trigger list box, Transitional / Edge Triggers are listed as *Rising Edge* or *Falling Edge* (Figure 5.13).

Note that in this example, by using a Transitional Trigger, the Index Detent may already be ON when the Crakker is ENABLED and the Crakker does not Trigger. Because a Transitional Trigger is used, the Crakker does not Trigger until the Index Detent turns ON (in this case, the Index Detent must turn OFF then turn back ON). In contrast, if a State Trigger

had been used for the Index Detent, the Crakker would have Triggered immediately upon ENABLING RECORDING as the Index Detent level was already steady state ON.
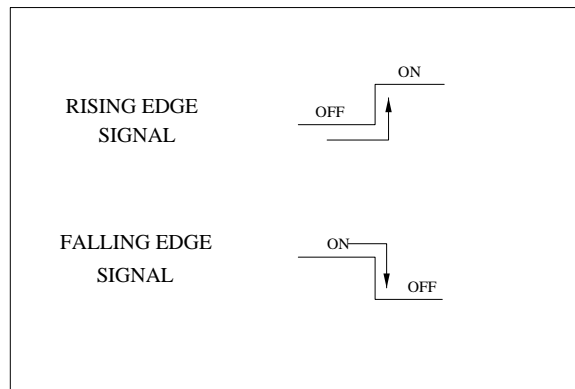

Figure 5.12 Transitional or Edge Triggers

4. TIMED TRIGGER LOGIC

A special *Timed Trigger* is provided that operates *only on Channels A1 and A2.* This Trigger can be set to initiate Recording if the Input to Channel A2 transitions too soon or too late after a previously defined transition of Input on Channel A1 (e.g. a Trigger could be set to initiate recording if a pump started `short cycling', turning ON and OFF faster than once every 60 seconds). The Timed Trigger is only available in the 16-Long Record Mode. Nine combinations of Timed Trigger are available. Details on the Timed Trigger configuration and use are covered in the following section, "Timed Trigger Details" on page 5-13.

5. TRIGGER ON ANY CHANGE

This Trigger can be set to initiate Recording as soon as any one of the inputs changes. The Record Mode must be set to 16-LONG and Timed Trigger cannot be used simultaneous with `Trigger on Any Change'.

In the Trigger list box specify *Any Change* (Figure 5.13).

6. ALARM FOLLOWS RECORD TRIGGER (APPLIES TO ALARM TRIGGERS ONLY)

Alarm Trigger can be set to follow the Record Triggers. If utilized, the Alarm output(s) will be set if any of the Record Triggers are met. This function can be used to sound an annunciator or light a warning light in the event that a Trigger condition has been met... drawing attention to the Crakker.

To utilize this trigger condition, select *Any Rec Trigger* for the alarm (Figure 5.14).

Combinations of *State, Transition and Timed* Trigger conditions can be implemented for more complex Triggering applications as follows:

Trigger when Pump 1 is ON and Valve 7 is OFF and when Pressure Switch 8 turns ON or if the Temperature regulation Switch turns ON more frequently than once per 100mS.
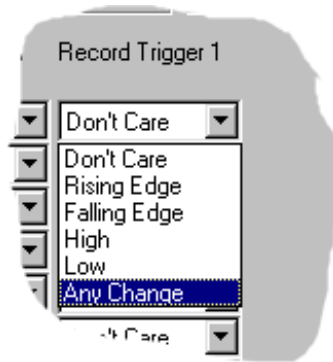
Figure 5.13 Record Trigger Options

Figure 5.14 Alarm Trigger Options

Trigger Relationships Reviewed

Record and Alarm Trigger conditions are logically *AND'ed* within a single trigger's vertical column. For example, in Figure 5.10, Channel A1 *and* Channel A4 have to be HIGH for the trigger condition to be met.

Triggers defined in columns are logically *OR'ed*. For example, in Figure 5.10, all three Record Triggers are used. So if conditions in Trigger 1 *OR* Trigger 2 *OR* Trigger 3 occur, data surrounding the trigger will be logged to memory.

Timed Trigger Details

The Timed Trigger can be configured as a fourth Record Trigger and logically OR'ed with up to three conventional logic type (Transitional or State) Triggers. The Timed Trigger is available only in the 16-Long Recording Mode. When the Timed Trigger is enabled, the Trigger rows associated with Channels A1 and A2 are highlighted.

The Timed Trigger *applies only to the signals received from Pod channel A1 and A2.* Specified activity of Channel A1 initiates the timing check for the following activity of the Channel A2 Input. If a fault condition is seen, the Timed Trigger becomes valid and Recording is enabled. If no fault condition is seen, scanning of inputs continues and Channel A1 input will be monitored for the specified activity to initiate the next timing check.

Two parameters must be specified for operation of the Timed Trigger, the *Type* and the *Timing*. The Type specifies the sequential pair of Channel A1 and A2 input transitions that must occur for the Timed Trigger to be valid. The Time specifies the allowable time in the logic sequence to make the Trigger valid.
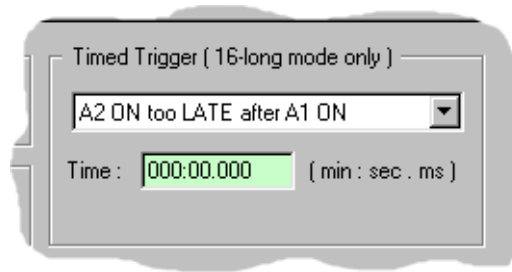
Figure 5.15 Timed Trigger Type and Timing Selection

TYPE SELECTION

Nine different types of Timed Trigger operation are available via a list box in the Timed Trigger section (). An understanding of Timed Triggers may be best developed by example. Following are further explanations of a few of the Timed Trigger functions. Additionally, timing diagrams are shown in Figure 5.16.

A2 ON too LATE after A1 ON

The trigger condition is met if the time between the ON transition of Channel A1's input and the ON transition of Channels A2's input exceeds the specified Trigger TIME.

This trigger could be used to trap actuation delays in the actuation of a part removal mechanism after a flawed part has been detected on a high-speed conveyor line.

Additionally, this function could be used to trap overly long periodic loop rates in a time critical PLC program. Too much delay between a PLC input asserting and a corresponding output asserting can be detected.

A2 OFF too EARLY after A1 ON

Trigger condition is met if the time between Channel A1's input transition from OFF to ON and the following Channel A2's transition from ON to OFF is shorter than the Time specification.

At the packaging end of a production line, a glue applicator is to apply glue to a moving product case for a stroke that lasts 800mS after detection of the presence of the case. This trigger could be used to trap short cycles of glue application.

Tip   Note that for some applications, both channel A1 and A2 can be connected to the same control node. In this way, a 'too short' or 'too long' pulse could be detected on a control line by using the A2 ON too Late after A1 ON (pulse too long) or the A2 OFF too Early after A1 ON (pulse too short) triggers.

TIME SELECTION

Within this list box, specify the time to be used in the Timed Trigger. Format is indicated in Minutes, Seconds and Milliseconds.
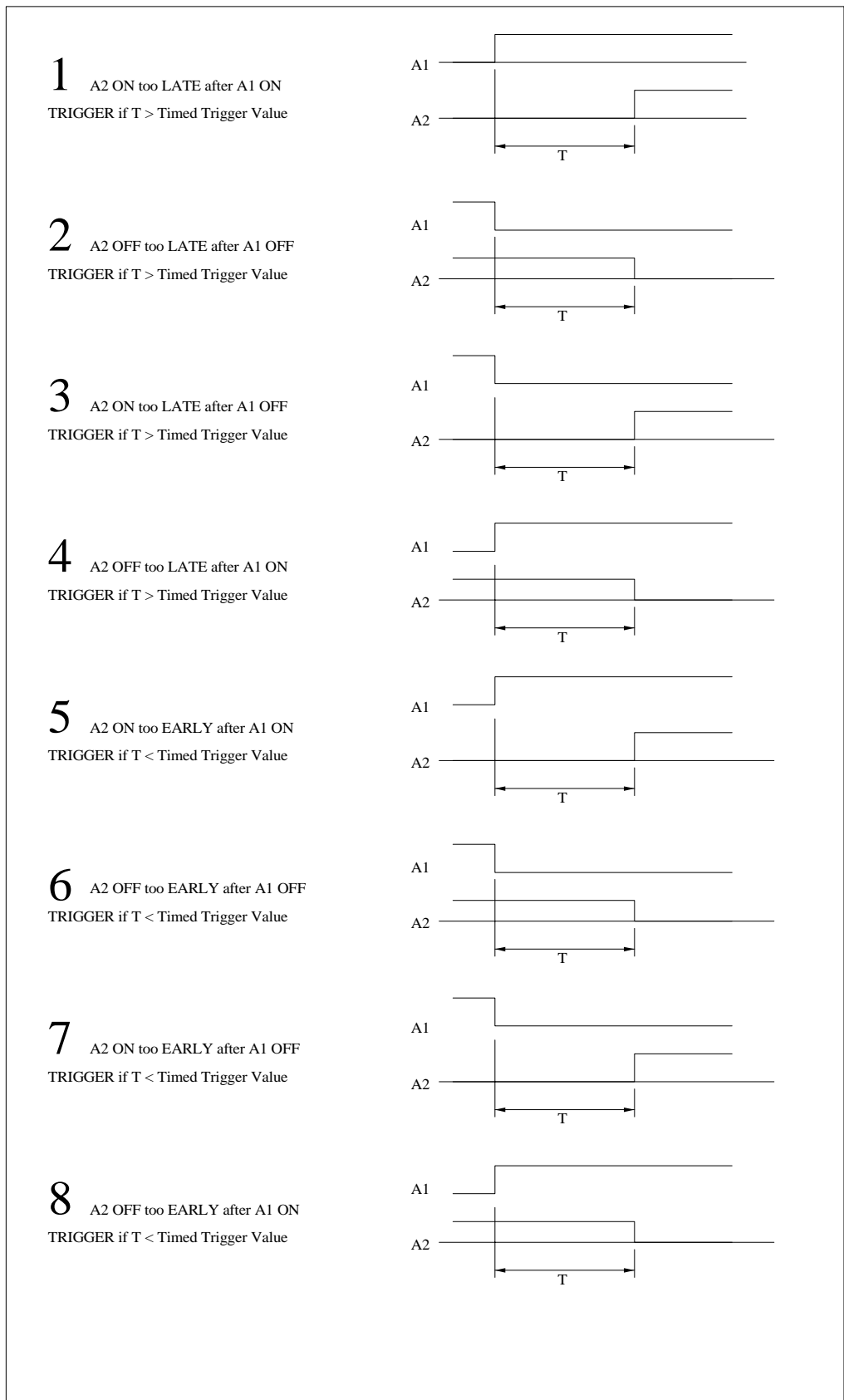
1 A2 ON too LATE after A1 ON

TRIGGER if T > Timed Trigger Value

A1

A2

T

2 A2 OFF too LATE after A1 OFF

TRIGGER if T > Timed Trigger Value

A1

A2

T

3 A2 ON too LATE after A1 OFF

TRIGGER if T > Timed Trigger Value

A1

A2

T

4 A2 OFF too LATE after A1 ON

TRIGGER if T > Timed Trigger Value

A1

A2

T

5 A2 ON too EARLY after A1 ON

TRIGGER if T < Timed Trigger Value

A1

A2

T

6 A2 OFF too EARLY after A1 OFF

TRIGGER if T < Timed Trigger Value

A1

A2

T

7 A2 ON too EARLY after A1 OFF

TRIGGER if T < Timed Trigger Value

A1

A2

T

8 A2 OFF too EARLY after A1 ON

TRIGGER if T < Timed Trigger Value

A1

A2

T

Figure 5.16 Timed Trigger Types

Alarm Output Operation

Two User programmable output functions are available for the logic associated with the actual Alarm output signal... which controls the output relays within the Crakker, *Latched* and *Momentary.*
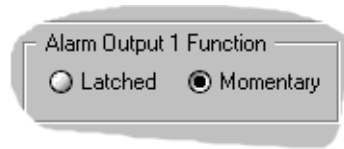
Figure 5.17 Alarm Output Operation

LATCHED

When Alarm Trigger conditions are met, the associated Alarm will turn ON. If the Alarm is configured in the LATCHED mode, the Alarm will stay ON indefinitely once it has been Triggered regardless of continued activity on the Channel Inputs. The Alarm can be disabled by implementing a *Reset* of the Crakker or by switching it OFF via the Crakker System Base front panel manual Alarm Control Switch ("Alarm Control Switches (10)" on page 2-6).

MOMENTARY

If the Alarm is configured in the *Momentary* mode, the alarm will turn ON when the Alarm Trigger conditions are met, then OFF as soon as the specified Trigger conditions are no longer met.

Note For the alarms to function in either mode, the Alarm Control switches on the front panel of the Crakker must be in the RUN position.

Analysis of Run Program Performance

After development of a Run Program, an inquiry into the expected performance of the program can be performed. The Analysis Report is provided to analyze and report to the User a summary of the expected performance from the Run Program currently under development. After reviewing the Analysis Report, the User may make changes in the Run Program to change or optimize the desired performance, then rerun the Analysis Report...noting the effects of the changes.

With the aid of the Analysis feature, the Run Program's performance within the Crakker can be evaluated and `fine-tuned' to the application prior to saving and loading into the Crakker's memory.

To perform an analysis of a Run Program, a Crakker must be connected via a serial link to the PC running CCW. For an analysis, CCW requires timing and memory information that is maintained within the memory of each Crakker System Base. This information is utilized in the performance calculations and may vary with different Crakker System Bases and memory configurations.

Although communication with the Crakker is required to utilize the Analysis Report function, the Analysis is performed on the Run Program *under development within CCW, NOT* on the Run Program currently loaded in the Crakker memory.

The following information is calculated from the current Run Program settings and displayed in the Analysis dialog (Figure 5.18):
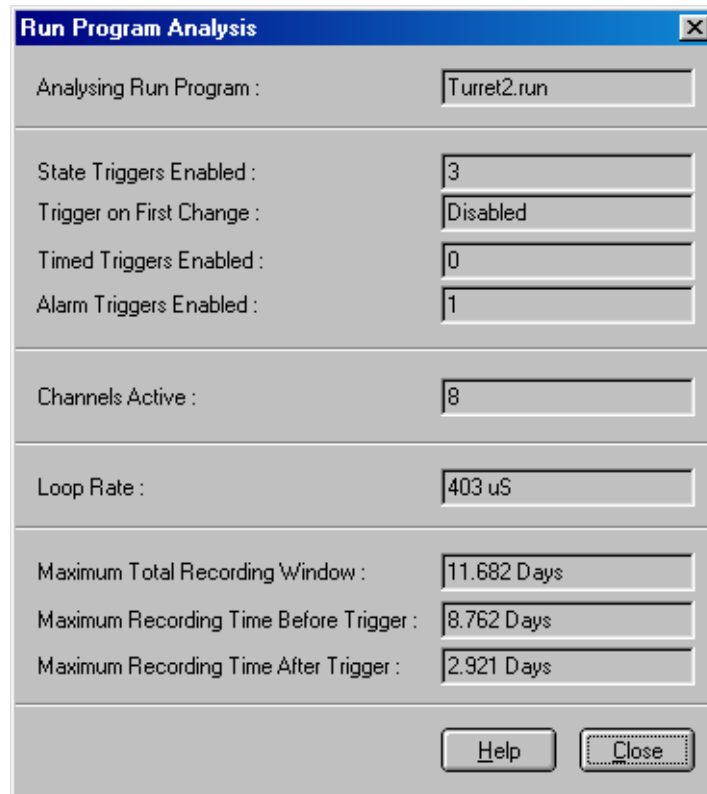
Figure 5.18 Analyze Run Program dialog

Enabled Triggers and Alarms

A listing of the types and quantity of triggers utilized in the Run Program being analyzed.

Active Channels

8 or 16

Loop Rate

With the current combination of Alarms, Triggers, Channels enabled, and Record Mode selected, the Active Inputs will be read once per Loop Rate. Changing any of the above mentioned variables will effect the Loop Rate. Refer to "Appendix K: Memory Utilization / Loop Rate Theory" on page 8-21 for a detailed explanation of the Loop Rate.

Maximum Recording Window

The MAXIMUM window of time that could be stored in data memory. In use, this window of time will be shorter due to the recording of Input Transitions, however, this value can be used as a relative figure of merit for comparison between different Run Program configurations.

Maximum Recording Time Before and After the Trigger

Indicates the effect of the selected *Memory Split* setting within the Record Program displayed on a time basis.

5. Programming the Crakker with CCW

Notes....

6

CAPTURED DATA DISPLAY AND OUTPUT

Overview

In the Data Display View, a file is loaded into CCW (either directly from the Crakker memory or opened from file using the File|Open Menu) and viewed (Figure 6.1). In the Data Window, logic comparisons between channels can be performed, absolute and relative timing measured, and fault conditions identified. A flexible zooming and panning function allows for detailed analysis of timing data. Channel's display order and colors can be changed.
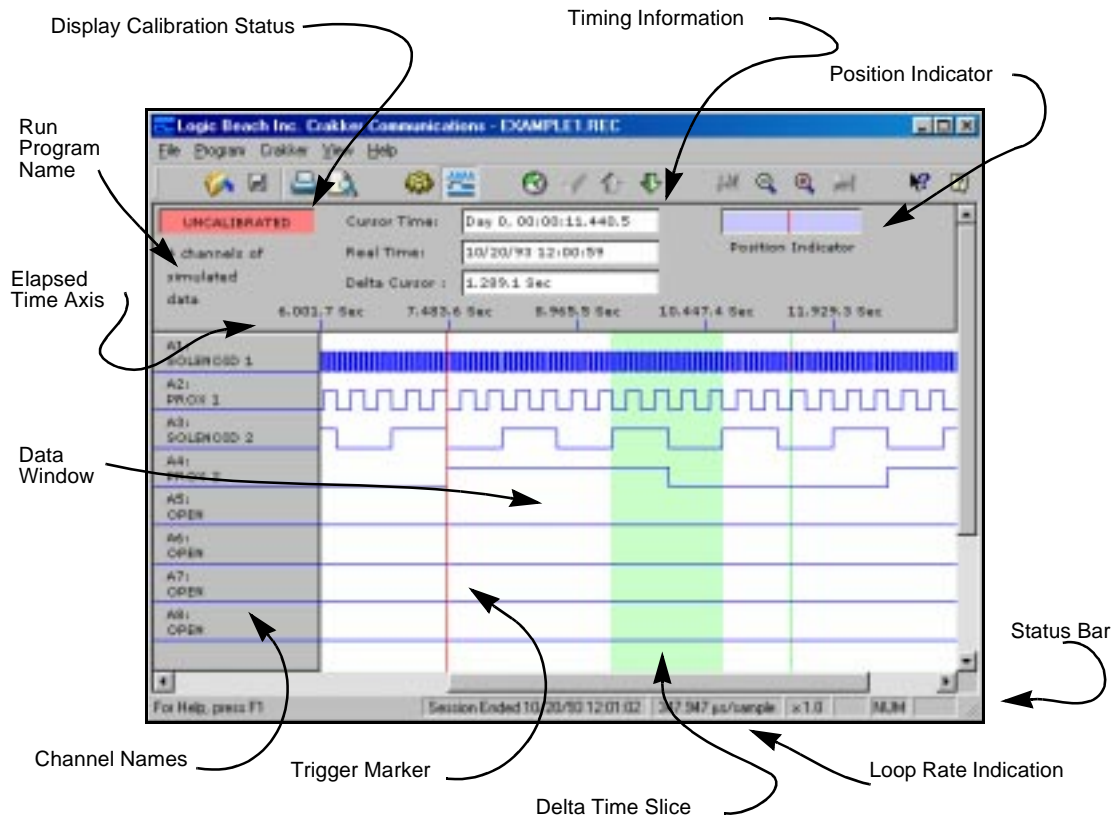
Figure 6.1 Display of Recorded Timing Data (Data View)

Display View Screen

Data Window

Timing displays representing each channel are displayed in the *Data Window* horizontally with a Hi or Lo state. The state represents the Channels voltage level at that point in time relative to the Voltage Threshold programmed into the Run Program.

Channel Numbers and Descriptions

Along the left edge of the Data Window (Figure 6.1) are Channel Numbers and their associated descriptions/names. The Channel numbers correspond to the Isolation Pod channels… the letter prefix indicates either Pod A or Pod B (if equipped with two Pods). Associated channel descriptions carry over from descriptions assigned during development of the Crakker Run Program. To view Channels B1 through B8, scroll the Data Window using the slider on the right edge of the Data Window.

Channel Display Order

The order of the channel display (top to bottom) by default is per the Channel's associated Pod Number (e.g. A1, A2, A3...). To facilitate inter-channel timing measurements, the top to bottom ordering of channels can be simply changed.

To move a channel to a different location in the top to bottom order, simply click on the Channel Number/Description box and drag the channel up or down to the desired location.

Channel Visibility

Right clicking on the Channel Number/Description box will display two menu choices. Select *Channel Visibility* and the Channel Visibility dialog (Figure 6.2) will display. Highlight channels, then select *Show* or *Hide* to toggle channel visibility within the Data View.

Alternatively, use the menu and select *View | Channel Visibility.*

Figure 6.2 Channel Visibility dialog

Channel Color

Right clicking on the Channel Number/Description box will display two menu choices. Select *Color Options* and the Channel Color dialog will display (Figure 6.3). Set the desired color for each channel with the color palette drop-down by each channel.

Figure 6.3 Channel Display Color dialog

Note that the global default colors used when opening a file can be set from within the *File | Options | Trace Colors* menu.

Elapsed Time Axis

Along the top edge of the Data Window is the *Elapsed Time Axis*. As the data is zoomed or panned (see following Navigation section), the time resolution tic marks on the time axis will change.

Trigger

If the Run Program loaded into the Crakker utilized the Trigger function, a vertical red *Trigger Marker* will display within the Data Window, passing vertically through all of the channels waveforms.

Tip At any time, keying <F4> or Menu selection *View | Scroll to Trigger* will jump the display to center up on the Trigger marker.

Data Display Navigation

The Crakker system is capable of logging millions of channel transitions… hence CCW is equipped with powerful data display capabilities. *Zoom* can be used to view timing details and the *Pan* commands allow easy navigation throughout a large file. The *Position Indicator* window aids in maintaining a 'big picture' overview of the currently displayed data.

Following are details on the use of these data display navigation features.
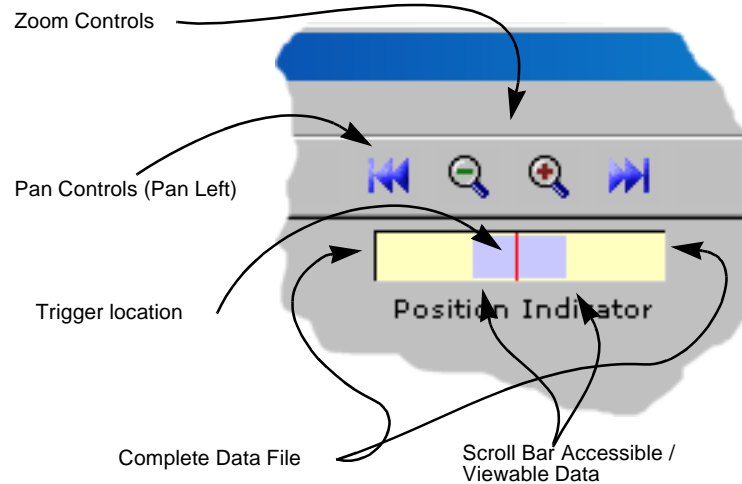
Figure 6.4 Position Indicator with Zoom and Pan Control Buttons

Zoom In / Zoom Out

Whenever the Data View is displaying valid sample data, the *Zoom In* command can be used to show more detail within the Data Window. Zooming in will result in less timing information being displayed but at a higher time detail. To Zoom In (or Out) use the Zoom buttons (magnifying glass icons) on the button bar or the equivalent menu commands (View | Zoom In).

Once you have zoomed in beyond a certain point, the Data Window cannot display all of the data (which might be hundreds of millions of individual samples). At this point, only a section of all sample data will be displayed within the active Data Window as indicated in the Position-Indicator bar at the top right of the screen (directly under the Zoom/Pan controls).

Menu selections (or Function Keys) can be used to jump quickly between the maximum zoom display level (View | Maximum Zoom) and minimum zoom display level (View | Minimum Zoom).

Position Indicator

Due to limits within the Windows environment, the full range of very large files can not be completely accessed start to finish via the slider on the bottom Scroll Bar. The Position Indicator represents the full data file…. The left edge being the start and the right edge being the end of the file. At low levels of timing resolution (i.e. zoomed out) the scroll bar at the bottom of the screen allows movement through the complete file. Zooming in to a finer timing detail will eventually result in a limitation in the Scroll Bar range to less than the full file. The Position Indicator shows this condition when it displays with a blue band indicating the data within the full file that can now be accessed by the Scroll Bar slider at the bottom of the screen.

A red vertical line in the Position Indicator indicates the location of the trigger within the file. Note that at any time, the view can be centered on the Trigger point by selecting View | Scroll to Trigger from the Menu Bar.

Pan Left / Pan Right

Panning control buttons move the scrollable range (the blue band) left and right through the data file… moving/stepping the region that is accessible with the Scroll Bar about within the full data file. Alternatively, use the <Page Up> and <Page Down> keys.

Data Display Timing:

Various timing information is available in the Data Display View. Across the top of the Data Window is a time axis for visual reference of elapsed time from the start of the file (time 0).

On-screen text boxes display:

Cursor Time

When the mouse pointer is moved over the Data Window, a green vertical cursor appears and moves with the pointer. The elapsed time from the start of the file is displayed with in the Cursor Time box. The time display format is Day, HH:MM:SS.ddd.d where H corresponds to Hours, M to minutes, S to seconds, and d to decimal seconds (milliseconds to microseconds).

Real Time

As the vertical cursor moves over timing data, the absolute real time is also displayed. Here, the date as well as the time in HH:MM:SS format is provided. Note that when zoomed in to a high level of time resolution, this Real Time display may not appear to update… this is because all of the displayed data is within a one second slice of time.

Delta Cursor Time

Time measurements of a waveform or between waveforms can easily be measured with the Delta Time feature. The Delta Cursor Time displays the length of time from the start to the end of a highlighted slice of the data. To highlight a section of the timing display, left click and drag the vertical cursor across the displayed timing data. Upon release of the mouse button, a green vertical band will display. The time encompassed by the band will be displayed in the Delta Cursor box.

To measure delta times at higher resolutions, the timing display can be zoomed (see section on Zoom controls following) to a desirable level and then the highlighting of the desired time slice can be done. As the cursor is dragged to the edge of the Data Window, the data will start scrolling… allowing access to timing data beyond the current view.

Tip: To scroll controllably through a timing sequence (that extends beyond a single monitor screen display width) while defining a Delta Time, mark the starting point of the desired Delta Time slice and while holding the mouse button down, use the left and right arrow keys and the PageUp and PageDown keys to move through the timing display. When the desired end point of the Delta measurement is found, release the mouse key and the green time slice band will display.

Display Timing Considerations

In the review of data, it is important to keep in mind the net time resolution that can be achieved using the Crakker system and its ultimate ramifications during the display of the collected data.

Time Resolution - Loop Rate

The ultimate absolute time resolution achieved by the Crakker during a Recording session is specified as the *Loop Rate*. The Loop Rate depends on the Record Mode, quantity, and type of Triggers employed in the Run Program.

The Loop Rate used during recording of the currently displayed data file is displayed in a pane on the Status Bar in the lower right corner of the screen (Figure 6.1).   The Loop Rate is further described and discussed in the Program View section of this manual. (Refer to "Appendix K: Memory Utilization / Loop Rate Theory" on page 8-21 for a detailed discussion of the Loop Rate.)

During operation of the Crakker, all of the active inputs to the Crakker are latched and read each period of time specified by the Loop Rate. Therefore, in the display of collected timing data, the smallest time resolution that can be meaningfully displayed is this Loop Rate value.

Calibrated / Uncalibrated

In the upper left corner of the Data View Window (Figure 6.1) is the *Calibration Indicator*. When making critical time measurements on displayed timing data using the Cursor or Delta Time functions, it is imperative that the data display be expanded to the Calibrated level for maximum timing measurement resolution and accuracy. This bar displays one of two states:

- *Calibrated* indicates that the currently displayed time base equals or exceeds the Loop Rate used during Recording of the data.
- *Uncalibrated* indicates the currently displayed time base is longer than the Loop Rate.

When making critical time measurements, the screen can be Zoomed In to the *Calibrated* level, marked, then Zoomed Out (to facilitate rapid movement of the Cursor), the Cursor moved, then Zoomed In again to the CALIBRATED level. Time resolution will be retained throughout the Zooming processes.

Viewing Associated Run Program

During the review of a recorded data, it can be advantageous to know the details and settings used in the Crakker Run Program during the data collection process. Quick access to this information is available via the *Crakker | View Run Parameters* menu selection. Upon selection, a dialog will open that includes the associated Run Program particulars and trigger conditions.

If desired, the displayed parameters can be exported to a new Run Program using the *Export* button at the bottom of the dialog. This will generate a new Run Program that can be loaded into the Crakker and used. The resulting Run Program will be identical to the original Run Program used in the original data collection phase.

Printing

From within CCW, timing data can be printed on the installed Windows printer. A number of printing methods can be used to meet the desired hardcopy annotation needs. Printing is performed from the conventional *File | Print* menu (or Print and Print Preview buttons on the Button Bar) and the follow-on Print dialog. Typically, it is desired to select *Landscape* mode for timing printouts.

Print Complete Data File

The full data file can be printed on consecutive sheets by selecting the *Print Range | All xxx Pages* radio button. The file will be printed at the currently displayed Zoom level.

Note: Be aware that large files printed at higher Zoom levels can result in 100's of printed sheets!

Print a Range of Pages

Prior to printing, display the data at the Zoom level desired on the printout. To print just a range of pages of the data file, select the *Print Range | Pages from...* radio button and specify the pages desired in the appropriate text boxes.
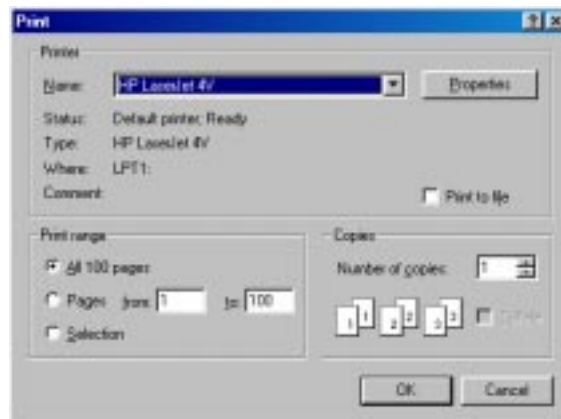
Figure 6.5 Windows Print dialog

Print a Selected Page

To print just a single page from within CCW, Zoom into the desired printout level, identify the time range on the Time Axis, then select *File | Print Preview* menu choice. From within the Print Preview
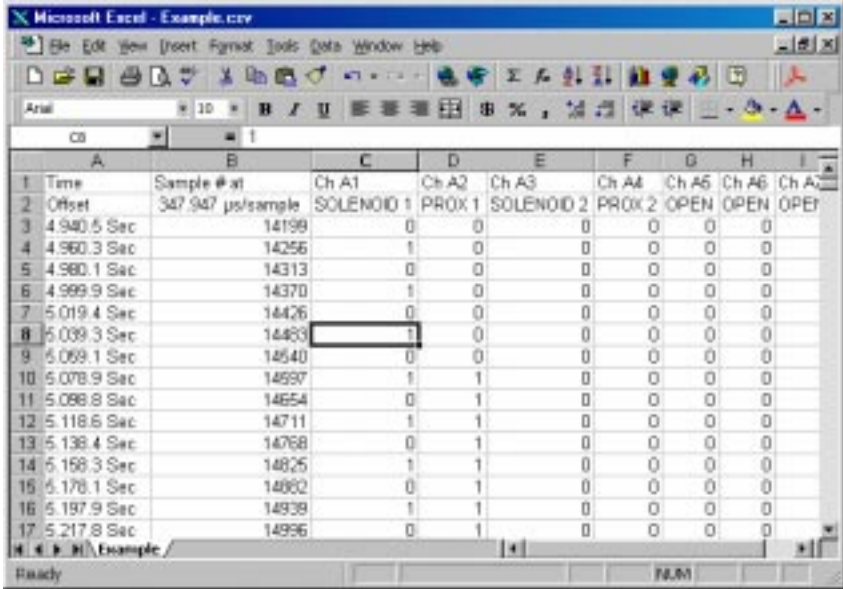
dialog, step ahead until the desired data page is displayed (observe the Time Axis to locate your position in the file as data may or may not be visible in the Print Preview dialog). When the desired data is displayed, click on the Printer button and that page will be sent to the printer.

Print a Selected Range of Data

A specific range of data that may span one or more pages can be printed by highlighting, then printing. Using the Delta Cursor, highlight the range of data to be printed. Then from the Printer dialog, select the *Print Range | Selection* radio button choice and hit *OK* to print. The highlighted selection area will be printed.

Exporting Data to a CSV File Format

Displayed data can be exported to a *.CSV (comma delimited file) format from using the menu *File | Export* selection. A dialog opens allowing the currently displayed file to be saved as a file with the *CSV* extension. CSV files can be opened within various other applications such as spreadsheets such as Excel (Figure 6.6).

Figure 6.6 Excel Display of a CSV Converted Data File

6. Captured Data Display and Output

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7

UTILIZING THE CRAKKER

Overview

The prior sections of this manual provided detailed information on the three components that make up a Crakker Logic/Timing Analyzer System, the Crakker System Base, the Isolation Pod(s), and CCW, the Crakker Communications Software. Building on that previously presented material, this section, describes a typical sequence of steps that would be performed in an application of the Crakker.

Assess The Problem

When a problem with a control system is detected, some deductive troubleshooting thought needs to be applied before the Crakker can be brought into action.

Minimize The Variables

In large, complex, control systems, it is imperative that some basic reduction of the `playing field' be performed prior to applying the Crakker. Attempt to identify and limit your studies to the variables, sensors, switches, outputs, etc. that could be related to the problem. For example, if a single PLC is controlling material feed conveyors, stamping equipment and material scrap removal, concentrate your studies on the aspect of the production line that is causing the problem.

However, *use caution* in limiting the scope of the troubleshooting quest. Keep an *open mind* as many problems can be the result of some fairly intricate inter-related stimuli. Non-judicious limiting of the troubleshooting effort may hide some key indications of the problem and unduly prolong the troubleshooting process.

Determine A Trigger Condition

The best way to trap problems in unattended or intermittent applications is by using the Crakker's powerful Triggering capabilities. When the Crakker sees the Trigger condition, it will trap the sequence of events surrounding the fault for review on the PC. Triggers can come from a number of sources:

System Signal

An ideal Crakker Trigger situation exists where a known combination of I/O occurs on the PLC just before, during, or after a fault condition. This combination can be programmed into the conventional Record and Alarm Triggers of the Crakker Run Program (e.g. maybe two outputs should never be ON at the same time).

System Alarm

The Control system may already have an alarm output that asserts upon a problem... for example, an emergency shutdown signal (E-Stop), overload warning horn, etc. that could be used by the Crakker to Trigger.

External Trigger

In some applications, an external Trigger sensor or device may need to be added to the Crakker system to detect a fault condition. When the external Trigger device sees a fault condition, it would then provide a Trigger signal to the Crakker Pod trapping data into memory. For example, a low-voltage moisture detection switch may be employed under a liquid filling line...if any containers are over-filled, the moisture detector would provide a Trigger signal to the Crakker, trapping data in Crakker memory.

Manual Trigger

In many operator attended cases, a fault condition may be very obvious to operators near a process or line. In this case, an instructed operator could press the *Stop* button on the Crakker to end the Recording Session and trap data in memory. In manual Trigger applications, it is important that the Crakker be stopped before valuable data in memory is overwritten. In the fastest mode (8-Short Mode) this occurs within approximately 14 minutes.

On rare occasion, it may be nearly impossible to identify an appropriate Trigger to use. In these cases, it may be necessary to resort to iterations of various Triggers to determine the problem. However, judicious selection of the Trigger for each attempt should gain valuable insight into the problem....or at least, eliminate some variables.

Develop The Run Program

After an appropriate Trigger condition has been identified, the *Run Program* to be used by the Crakker can be developed. Boot up the PC running the Crakker Communications (CCW) program and select the Program View mode to start developing a Run Program.

Throughout the development of the Crakker Run Program, the *Analysis* feature should be used to evaluate the expected performance of the Run Program. Remember that a Crakker must be connected via the serial port to use the Analysis function.

Filename / Description

Choose a logical Filename and three line Program Description that will assist future Users in determining the utility and application of the Run Program.

Memory Saved Before Trigger

Select the desired memory split by specifying the amount of total data memory to be used for storage of Pre-Trigger data.

Record Mode

The selection of the Record Mode can be made through utilization of the Record Mode Flowchart [Figure 5.3].

Trigger / Channel Configuration

After the Record Mode has been selected and the desired mode highlighted, the Timed Trigger, Record Trigger(s), and Alarm Triggers can be configured.

Timed Trigger

In configuring the Timed Trigger, the TYPE must be selected before the TIME can be set. Additionally, remember that the Timed Trigger function only functions on the A1 and A2 input channels. To use the Timed Trigger, the LONG-16 mode must be selected.

Debounce

Enable the Debounce appropriately if AC inputs are being monitored or if mechanical switch bounce is to be rejected. Remember that the Debounce filtering slows down the response time of the Crakker. In trapping inputs that are extremely fast, it may be desirable to disable (i.e. set to `0') the Debounce filtering.

Voltage Threshold, Vth

Select the Vth setting for each of the connected channels. For most applications, a Vth setting of approximately 1/2 to 3/4 of the ON voltage will suffice.

Channel Descriptions

The Channel Descriptions can be displayed on the Crakker LCD during field installation. Choosing logical, descriptive names for each channel can greatly simplify the field installation process.

Record And Alarm Triggers

Depending on the Record Mode selected, various quantities and types of Triggers are available. After configuring the desired Triggers, use the Run Program Analysis button or menu and perform performance analysis of the configuration. If speed is a concern, minimizing the use of channels, Triggers, and Alarms will optimize the Loop Rate ["Appendix K: Memory Utilization / Loop Rate Theory" on page 8-21].

Save / Exit

After development of the Run Program, save it to disk using the conventional Windows Save or Save As buttons or menu selections.

Uploading The Run Program

Connect the Crakker to the PC serial port with the provided RS-232 cable and adapter. From the CCW Program View window, open the desired Run Program from disk (if not already open within CCW) then select the *Upload Program to Crakker* button to transfer it to the Crakker's memory.

After sending the Run Program to the Crakker, use the *Crakker | Query Crakker Status* menu selection to verify proper time/date and Run Program configuration.

Isolation Pod Setup

Carry the Crakker and Isolation Pod(s) to the site of the control system to be analyzed. *Before Connecting Any Pod Leads To High Voltage*, connect the provided low voltage power supply to the Crakker System Base power jack.

Press the *Status* button on the Crakker System Base and the Status display sequence will commence. When the LCD displays *Press Status to Display Ch Names* press the Status button again. The LCD will then display and hold the first Isolation Pod channel name as entered into the Run Program. Pressing the Status button again steps the display through each of the channels. With this sequence, the Quick Connect Pod Leads can be connected to the various nodes on the control system under test.

*********************** **NOTE** ***************************

It is highly recommended that if at all possible, power be disconnected from the control system to be monitored before connecting any Pod test leads. *This is to minimize the risk of electrical shock or erratic / unexpected operation of the equipment under control.*
****

*********************** **Caution** ***************************

Extreme care should be exercised in connecting the Pod Quick Connect leads to any high-voltage nodes. The probe tips have exposed conductive surfaces when installed. Mishandling could result in *fatal electrical shock.*

Before making any connections to a control system, insure that the addition of the Pod circuitry will not interfere with the normal control function. Refer to Chapter 3 and Appendix L for additional circuit connection details. Do Not Hesitate To Call Logic Beach For Technical Support Assistance.
****

Connect the Pod low voltage output cable (multi-conductor cable extending from the bottom of the box) to the mating connector on the Crakker System Base. If only one Pod is used, connect its cable to Port A. Insure that the connector retaining screws are securely tightened.

Power up the control system under test and watch for any erratic operation indicating operational interference from the Pod circuitry. The Crakker *Monitor* button can be pressed to observe the cycling operation of the control system signal nodes.

Alarm Output Connection

If Alarms are utilized, pre-wire the Alarm pigtail assembly (refer to Appendix D) to the low-voltage alarm devices then plug the pigtail into the Alarm Output connector on the Crakker System Base. The Alarm functions can be tested by switching the Manual Alarm switches to the momentary *TEST* position. After testing, be sure to leave the Alarm Switches in the *RUN* position to allow the Crakker to control them per the loaded Run Program Alarm Trigger logic.

Enable Crakker Recording

After checking that the Crakker and Pod have been correctly installed and connected, press the *Enable* button and the Crakker will roll through a number of displays, then proceed to start reading the inputs, waiting for the pre-programmed Trigger condition(s). If the Crakker detects any errors, they will be displayed on the LCD at this time. For this reason, it is a good practice to watch the LCD after pressing Enable until the *WAITING* message is displayed, indicating a proper initiation of the Enabling of Recording.

Collected Data Download

The Crakker System Base should be checked regularly. A lit green light on the front panel indicates that the Record Trigger has been met and data is stored (or currently being stored) in memory. When the complete Crakker memory has been filled, the LCD will display *DATA RECORDED <FINISHED>*.

After Triggering (and fill of memory if Post-Trigger data is desired) the Crakker System Base can be powered OFF (memory will be retained) and disconnected from the Pods and Alarm devices (if desired). The Crakker System Base can then be transported to the PC location and powered up. The collected data should then be transferred from the Crakker to a *.REC file within the PC using the serial cable and the *Download Data from Crakker* menu or button in the Data View window.

Data Display and Analysis

From within the Data View window use the zoom, pan and other powerful commands to review the data... looking for the control system problem.

Tip Don't forget that a simple way to jump to the Trigger within a displayed data file is to use the *View | Scroll to Trigger* menu (or the F4 function key). This function works at any zoom level.

7. Utilizing The Crakker

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APPENDICES

Appendix A: Operational And Error Messages

During the use of the Crakker System Base and the associated Crakker Communications software, certain error conditions can result. In many of these cases, error messages will be displayed on the Crakker LCD or on the PC screen. Most of the errors are self-explanatory with obvious remedies that can be implemented by the User on site. The following is a summary of errors and where applicable, possible solutions. The listing is divided into two groups; Crakker Communications Errors and Crakker System Base Errors.

Crakker Communications for Windows Errors:

Serial Communication Problems

The Crakker and PC can't communicate via the connected serial link for Status, Uploads, Downloads, etc.

Bad Serial Cable or Adapter Connection:

Check all cabling and adapters.

NOTE: Utilize only Logic Beach adapters that directly connect into the serial port on your PC. Although a multitude of gender and DB style adapters are manufactured by other companies, many are incompatible and will prevent successful communication (or could cause damage) between the Crakker and the PC. Please contact Logic Beach Technical Support for alternate cable adapter assistance.

Baud Rate Too Fast:

In noisy environments or with very long cable runs (e.g. 10's of feet), it may be necessary to run at slower Baud Rates. Change the Baud Rate setting from within CCW, the Crakker will automatically adapt accordingly.

POWER LOSS DURING DATA TRANSMISSION:

Check that the Crakker power is ON. Insure that a message is displayed in the Crakker LCD (which indicates that power is on). Check all power connections.

Tip If communication problems persist after checking all of the above, reset the Crakker and the computer to clear possible communications errors and to initialize the communications port again.

Upload Failed;

Unable to Send Run Program to Crakker; Please clear Crakker memory before sending a new Run Program.

The Crakker memory must be cleared before a new RUN program can be loaded. Transfer any valuable collected data to the PC, then clear memory and Upload the Run Program again.

Crakker System Base Errors:

Various error messages can be displayed on the Crakker System Base LCD. Their descriptions and remedies follow:

Test Mode:

Indicates that one (or more) of the four Crakker internal self-test switches are ON. These switches are located inside the Crakker System base on the back of the top PCB (refer to Appendix G). These switches are used for production testing and they should all be left OFF during normal use of the Crakker.

Framing Error

Indicates improper timing during RS-232 communication. Will commonly be displayed when PC is powered down and the RS-232 cable is still connected to the Crakker as garbage can be transmitted in this uncontrolled state. Reset the Crakker to clear the display and if desired, retry communication. Slower baud rates may rectify the situation in certain conditions.

Overrun Error:

Crakker UART port is receiving characters faster than it is able to take them out of the port. May indicate a hardware problem. Retry communications at a slower Baud Rate. Contact factory technical support for further assistance.

Parity Error:

Data byte was received incomplete or with the wrong character length. Problem may be noise or hardware related problem. Reduce cable length and/or Baud Rate and retry. Contact factory technical support for further assistance.

Comm Error Or Xmit Error:

Retry communication. Contact factory technical support for further assistance.

Comm Timeout:

Indicates incomplete or corrupted Run Program file is being sent to Crakker. Check the Run Program and retry. Contact factory technical support for further assistance.

Data In Memory:

Displayed during a sequence of messages when *Enable Recording* is pressed and data is already in memory. Transfer recorded memory to PC, clear the Crakker memory and retry.

No Run Program Loaded:

Displayed during a sequence of messages when *Enable Recording* is pressed. A Run program must be developed from within CCW and transferred to the Crakker before Enable Recording is pressed.

Appendix B: Crakker Technical Specifications

System Base

Main Power Requirements:

Input Voltage Range - 9VDC nominal (8-16VDC / 10-16VAC)

Current -   Single Pod connected: 110mA @ 9VDC; Two Pods Connected: 180mA

Memory And Clock Backup Power:

Internal lithium cell P/N BR2325 (Panasonic or equivalent)

Lifetime of approximately 6 months to 1 year depending on ambient temperature and use.

Memory, Data Storage:

Refer to Appendix K for detailed information on memory capacity.

Input Acquisition Window:

In 8 channel Record Modes, the actual time required to latch the inputs is approximately 50nS. In 16 channel modes, approximately 100nS. No detectable skew exists between all `A' channels nor `B' channels. Approximately 5uS (maximum) skew exists between latching of `A' and `B' channels. Ultimately, these acquisition rates are negligible with respect to the Loop Rates (Refer to Appendix K).

Display:

Two line by 16 Character Liquid Crystal Display (LCD)

Operating Temperature Range:

-10 to 60C (14 to 140F)

Shipping Temperature:

-30 to 65C (-22 to 149F)

Relative Humidity, Operating And Storage:

90% non-condensing

Shock And Vibration:

The Crakker and Pods will withstand the shock and vibration conditions normally encountered during regular commercial shipping and handling.

Dimensions:

9.75"H x 8.5"W x 5.5"D

Weight:

4.5 LBS.

Isolation Pod:

Input Voltage Range:

280 Vac(rms) maximum
400 Vdc maximum

Inter-channel Isolation:

600 VAC

Input Impedance:

DC: 220,000 ohms
AC: @ 50 Hz130 Kohms
        @ 60 Hz120 Kohms
        @ 100 Hz93 Kohms
        @ 1000 Hz16.5 Kohms
        @ 4000 Hz5.8 Kohms

Dimensions:

9.5"H x 6.5"W x 4.5"D

Weight:

4.5 LBS. (including 8 pair of test leads)

Appendix C: Isolation Pod Circuit Design

The Isolation Pod provides high-voltage isolation between control system nodes and the Crakker System Base. Additionally, it provides signal rectification, filtering, and signal level threshold comparison to the User programmed Vth levels.

The detection circuitry has a DC input impedance of 220 Kohms. AC input impedance varies as a function of frequency (due to the capacitive filter elements shown). This input impedance loads (i.e. draws current from) the node being monitored. Ramifications of this current draw should be considered prior to making any connections to the control system under test. Refer to Chapter 3 for additional information about using the Isolation Pods.
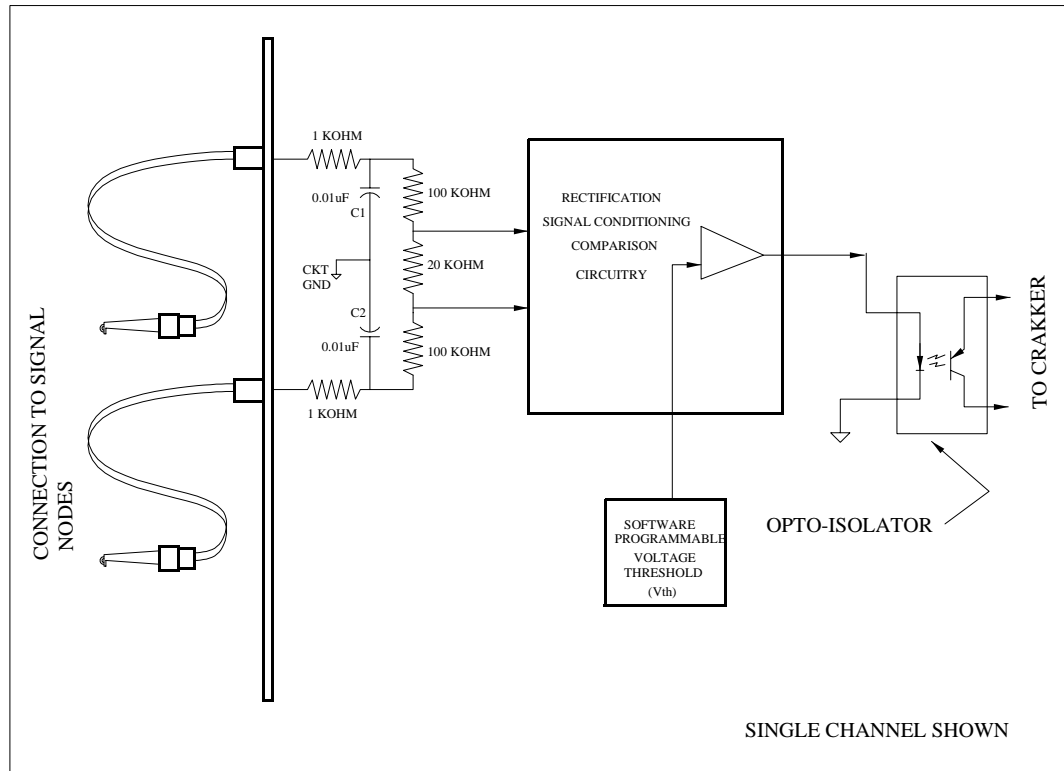
Figure 8.1 Equivalent Circuit for Pod Input Channel

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Appendix D: Alarm Output Detail

The left DB-9M connector on the bottom end of the Crakker System Base provides connection to the two internal Alarm relays as well as three other TTL (0-5VDC) signal outputs.

A mating plug (DB-9F) with a short cable is provided with the Crakker for use in connecting external devices to these various outputs. Due to variations in cable manufacturing standards, the correlation between connector pins and wire color is not standardized. If this cable is to be used for the interface between the external devices and the Output connector, it is necessary to first match the colored leads to their associated pins. The following figure identifies the numbering scheme for the connector on the Crakker and the mating connector on the provided cable. A quick continuity test will help to identify the color/pin number correlation. The supplied *Cable Pin-out* table (below) can be completed with the color for future reference.

BOTTOM END OF CRAKKER SYSTEM BASE

OUTPUT CABLE

CONN PIN	WIRE COLOR
1	
2	
3	
4	
5	
6	
7	
8	
9	
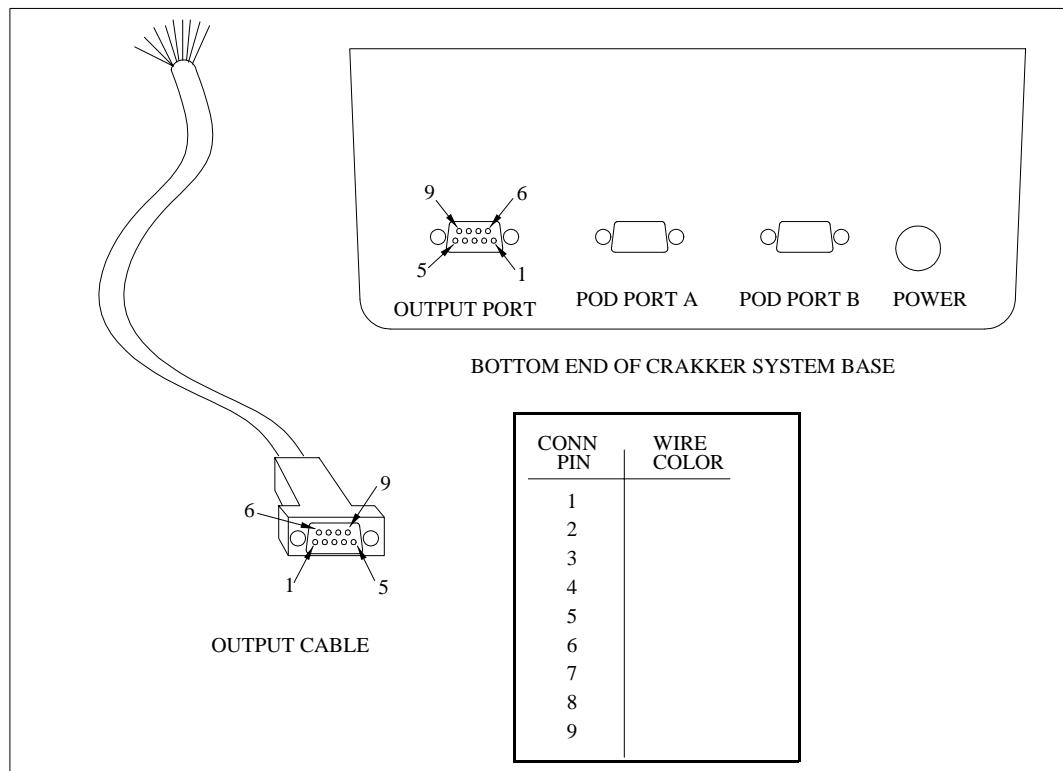
Figure 8.2 Crakker System Base Output Port

Output Port pin and function listing follows:

1 +5V from the Crakker main power bus. Current limited by internal series 4.3K resistor.

2 Recording Status. TTL level output current limited by internal 4.3K resistor. Logic follows the front panel Triggered/Recording indicator (HIGH = active).

3 RPS-1 Control 1. Same as pin 2 however the logic follows Alarm 1 (HIGH = Alarm ON). This output can be used to control one of the optional RPS-1 power supply outputs which in turn can actuate an audible alarm or other function (see RPS-1 in Appendix L).

4 RPS-1 Control 2. Same as pin 3 however the logic follows Alarm 2.

5 Upon Alarm 1 turning ON, Pin 5 is shorted to Pin 6 via an internal relay. The maximum voltage to be switched by these outputs is 30 VDC/VAC and the maximum current is 1A.

6 See Pin 5 above.

7 Upon Alarm 2 turning ON, Pin 7 is shorted to Pin 8 via an internal relay. The maximum voltage to be switched by these outputs is 30 VDC/VAC and the maximum current is 1A.

8 See Pin 7 above.

9 Connects to Crakker circuit ground. This is the ground reference for the TTL level outputs (pins 2,3 & 4).

Note Upon power up and/or system *Reset*, the Alarm Outputs can turn on briefly as the microprocessor gains control of the system. If a short Alarm state on the outputs is a problem, insure that the front panel *Alarm* switches are both in the center OFF position before performing a Reset or cycling the power on the Crakker.

Appendix E: Power Connection Details

Main power for the Crakker is supplied through the Power Connector located on the right side of the bottom end of the System Base enclosure. Only two of the three conductors in the connector are used. Note the mechanical alignment notch and mating boss on the plug and jack. An external power supply can be connected to pins 2 and 3 (pin 1 is unused). The Crakker will run from input voltages in the range of 8 to 24 VAC or VDC. Polarity is not critical as the Crakker is equipped with a full wave bridge input.

Additional mating connectors with 4 ft. leads are available from Logic Beach.

OUTPUT PORT   POD PORT A   POD PORT B   PIN 1

PIN 3

POWER INPUT PIN 2 AND 3
8-24 VDC/VAC
POLARITY IS NOT CRITICAL

PIN 2

POWER

BOTTOM END OF CRAKKER SYSTEM BASE

RED/WHITE (PIN 3)

RED/BLACK (PIN 2)

GREEN (PIN 1) NOT USED
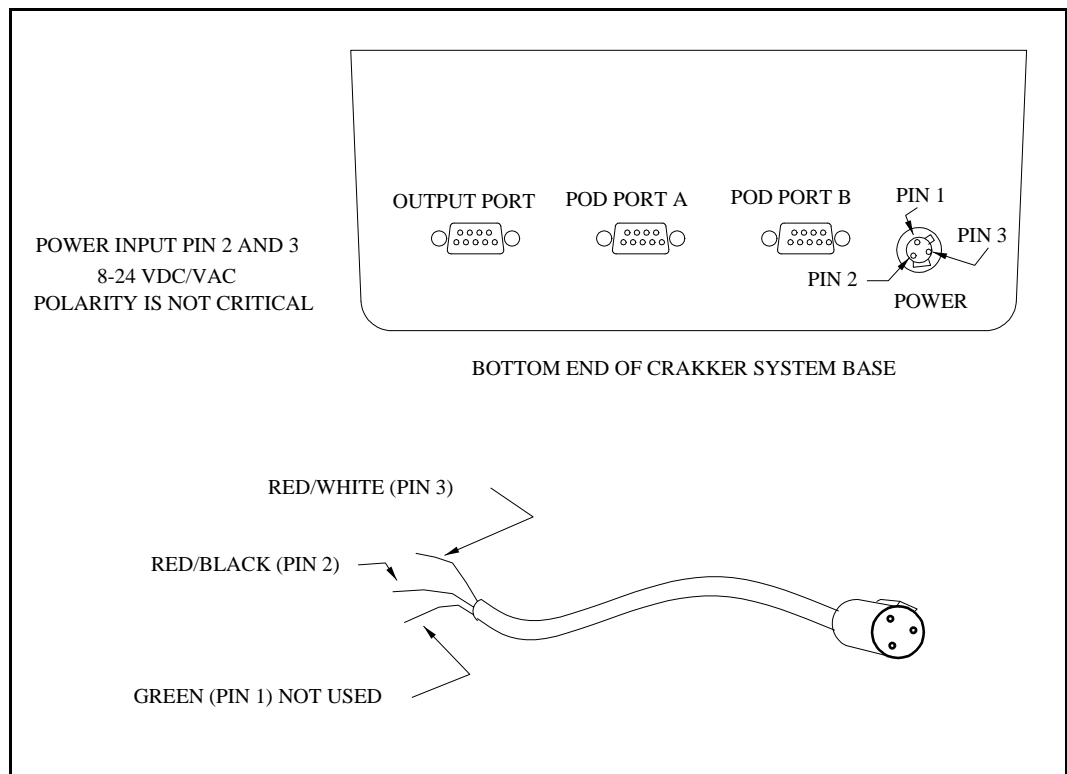
Figure 8.3 Crakker System Base Power Jack and Mating Connector

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Appendix F: Changing The Clock / Memory Backup Battery

Upon power-up of the Crakker, after a system Reset, or during a Status display, if the message *Low Voltage* is displayed the LCD, it indicates that the Clock/Memory backup lithium cell battery is nearing its end of charge. To prevent future loss of data from memory, the cell should be promptly replaced (Panasonic BR2325 or equivalent) as follows:
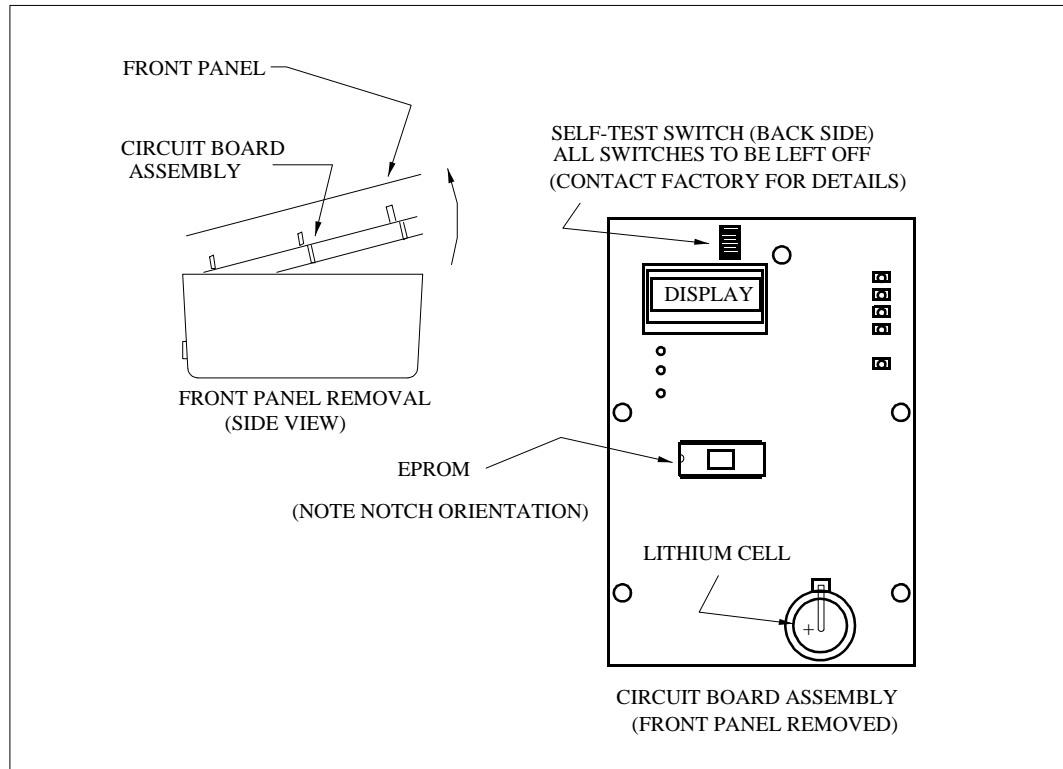
Figure 8.4 Replacing the Lithium Cell in the Crakker System Base

Note: Download any valuable data currently stored in Crakker memory before starting this procedure.

Caution: When the Crakker circuitry is exposed, it is susceptible to damage from static electricity discharges. Ideally, work on a grounded surface and discharge any residual charge on your body by touching an earth grounded surface (water pipe, grounded appliance, etc.) prior to working on the Crakker. If you walk away and return to finish the job, insure that you discharge your body charge prior to touching the Crakker.

Turn the Crakker Main Power switch OFF, remove the three Phillips head screws (identified with blue rings) and tilt the top of the front panel and circuit board assembly partially out of the box. Put a pencil or some other spacer between the top of the box (the end toward the display) and the top of the circuit board/front panel assembly. Remove the 7 remaining black screws from the front cover and the black front panel will separate from the two circuit board assembly below. Set the front panel aside and locate the lithium cell per the following diagram.

Gently pry the cell to be replaced out of its holder with a small blunt non-metallic tool being careful not to puncture the cell or damage any surrounding circuitry. Insulated tweezers may assist in pulling the cell out of the holder.

Slide a new cell (P/N Panasonic BR 2325 or equivalent) into the holder with the positive terminal UP. A properly installed cell will seat approximately flush with the holder.

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********************** **Caution** ******************************
Use Care In Handling Lithium Cells. Currently Manufactured
Cells Such As The Br2325 Are Very Stable And Safe Parts,
However, Do Not Tempt Fate! Do Not Puncture, Short, Or
Dispose Of In Fire As Explosions Could Occur.
****

Reattach the front panel to the circuit board assembly with the 7 small black screws, then reinstall the Crakker into its case, reconnect the power and turn on the System Power switch. After a reset, the display should no longer display the *Low Voltage Message*.

Perform a two button Reset and Clear of Memory to reinitialize the Crakker and proceed to normal use of the unit.

Appendix G: Changing The Crakker Eprom

Updates to improve performance and / or add features are sometimes performed on the Crakker by changing the EPROM to a later version EPROM. The EPROM contains the software code which controls the function of the Crakker. In the event that an update is initiated by Logic Beach Inc., the User will be sent a package containing the necessary components. At this time (and only at this time) will the customer be requested to follow the following procedure which outlines the steps required to exchange EPROMs.

```
******************** Caution ****************************
```

The Eprom Chip Is Especially Sensitive To Damage From Static Discharge When Out Of Its Socket. Discharge Body Static Before Working With The Crakker / Eprom By Touching A Grounded Surface Before Starting This Procedure.

```
*************************************************************
```
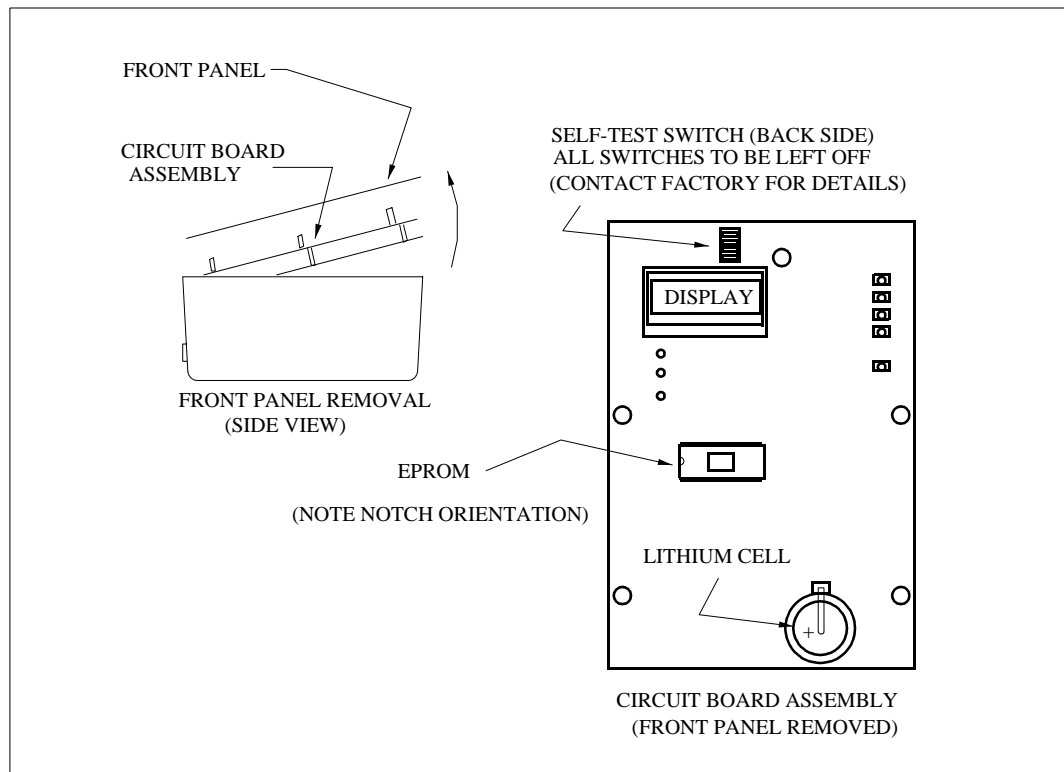

Figure 8.5 EPROM location within System Base

The EPROM exchange procedure follows:

Note: Transfer any valuable data currently stored in Crakker memory before starting this update procedure.

Disconnect the Crakker Power Supply and turn OFF the main system power switch, remove the three Phillips head screws (identified with blue rings) and tilt the top of the front panel and circuit board assembly partially out of the box. Put a pencil or some other spacer between the top of the box (the end toward the display) and the top of the circuit board/front panel assembly. Remove the 7

remaining black screws from the front cover and the black front panel will separate from the two circuit board assembly below. Set the front panel aside and locate the EPROM per Figure 8.5

Carefully, using a small flat screwdriver, pry the EPROM chip, out of its socket. Replace the removed EPROM with the new enclosed EPROM by carefully aligning the pins in the socket and slowly pressing it evenly into the socket.

Caution: Orient The Eprom With The Notched End To The Left

(i.e. toward the left edge of the Crakker when viewed from front)

After completely seating the EPROM in the socket, observe all of the pins to make sure that they have been properly seated and did not bend. Looking under the part from the end is a good inspection practice.

Reattach the front panel to the circuit board assembly with the 7 small black screws, then reinstall the Crakker into its case, reconnect the power and turn on the System Power switch. After a reset, the display should reflect the appropriate Firmware revision number. If the display does not come up, turn off power and re-inspect the EPROM to insure that all leads are properly seated.

Reset and Clear Memory within the unit (using the two button sequence) to reinstalled the Crakker and proceed to normal use of the unit.

Please do not hesitate to call Logic Beach Technical Staff with any questions.

Appendix H: RS-232 Cable, Adapter, And Port Specifications

Figure 8.6 documents the connections for the Crakker System Base serial port, serial cable and DB-9 and DB-25 adapters.

Note: Cables and adapters not provided with the Crakker may cause wiring errors and serial comm problems. Insure that the wiring of any non-Logic Beach provided cables or adapters conform to the following wiring connectivity.

PLUG CONTACTS SHOWN (BOTH ENDS)

6 CONDUCTOR PHONE CABLE

PIN 1 +5 VDC (CURRENT LIMITED)
    2 CRAKKER GROUND
    3 TRANSMIT (CRAKKER OUTPUT)
    4 RECEIVE (CRAKKER INPUT)
    5 DTR (NOT USED)
    6 DCD (NOT USED)

6 5 4 3 2 1

SERIAL PORT
(FRONT PANEL OF CRAKKER)

RJ-12 TO DB-25 ADAPTER

6	DSR
20	DTR
4	RTS
5	CTS
NC	
NC	
NC	
7	GND
3	RECV
2	XMIT

RJ-12 TO DB-9 ADAPTER

6	DSR
4	DTR
7	RTS
8	CTS
NC	
NC	
NC	
5	GND
2	RECV
3	XMIT
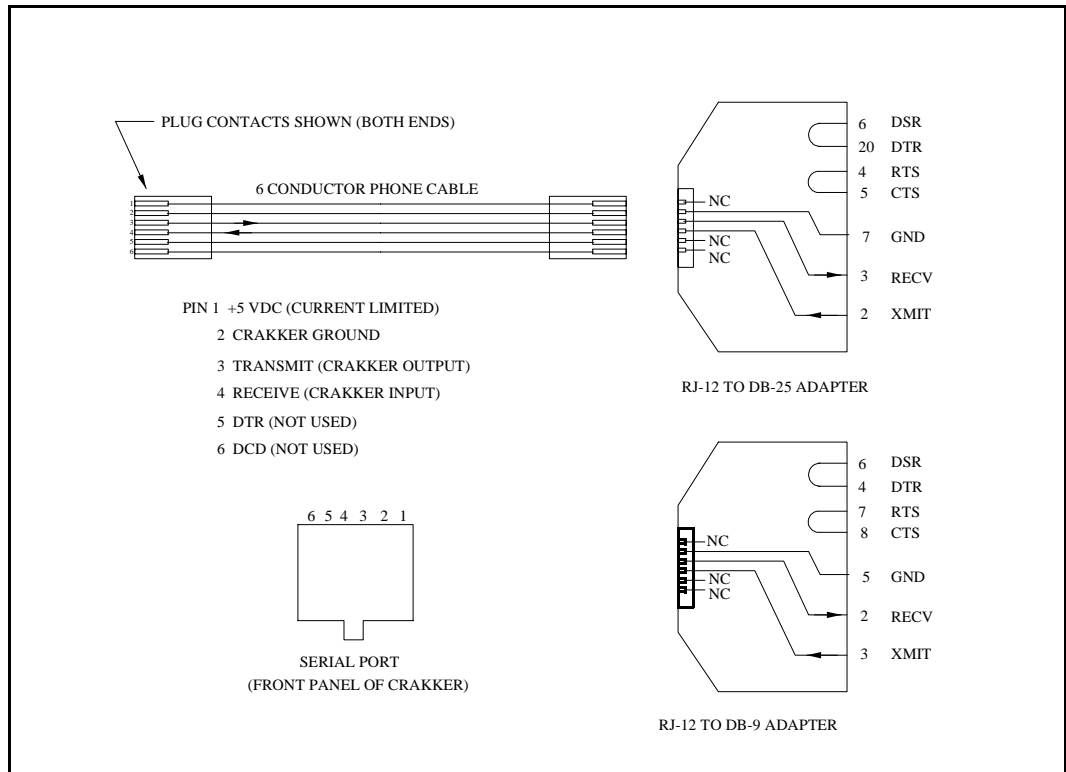
Figure 8.6 Crakker Serial port, cable and adapter wiring details

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Appendix I: Crakker Communications File Listing

After a normal Windows install is complete (Chapter 4), a directory (Folder) containing necessary Crakker Communications for Windows files will exist on your hard drive. Following is a partial listing of some of the files which can be referenced for learning.

CCW.EXE

The main Crakker Communications program

EXAMPLE1.RUN

A sample Run Program which can be opened from within the *Program View* window of CCW.

EXAMPLE1.REC

A sample REC file containing actual data collected by a Crakker. The data file can be opened and viewed from within the *Data View* window of CCW.

EXAMPLE2.RUN

Another sample Run Program which can be opened from within the *Program View* window of CCW.

EXAMPLE2.REC

A second sample REC file containing actual data collected by a Crakker. The data file can be opened and viewed from within the *Data View* window of CCW.

README.TXT

Check for this file (may not be on disk) for late-breaking tips, comments, and other information relative to the Crakker System more current than the last issue of the Crakker User's Manual. This file can be read using Notepad or other text editing software.

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Appendix J: Crakker Communications Help System

Crakker Communications for Windows has been provided with extensive 'Windows' Help for quick access during use. Clicking on the Help buttons on the Button Bar at any time will open the Crakker Help dialog and assist in explaining the operation of the Crakker.

Figure 8.7 CCW Help Buttons
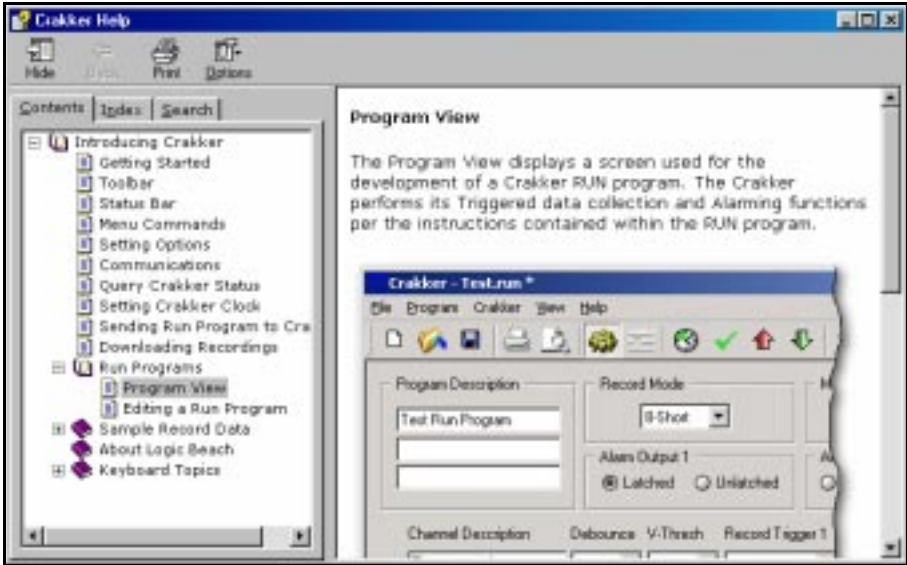
Figure 8.8 A typical Help Screen launched via a Help Button

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Appendix K: Memory Utilization / Loop Rate Theory

Loop Rate Theory

While the Crakker is in the *Record Enabled* mode, it is continually executing the repetitive loop outlined in the *Loop Flow Chart (*Figure 8.9*)*. A fundamental understanding of the steps that the Crakker performs each time it executes one of these loops will help the User in grasping the options available during setup of the Crakker.
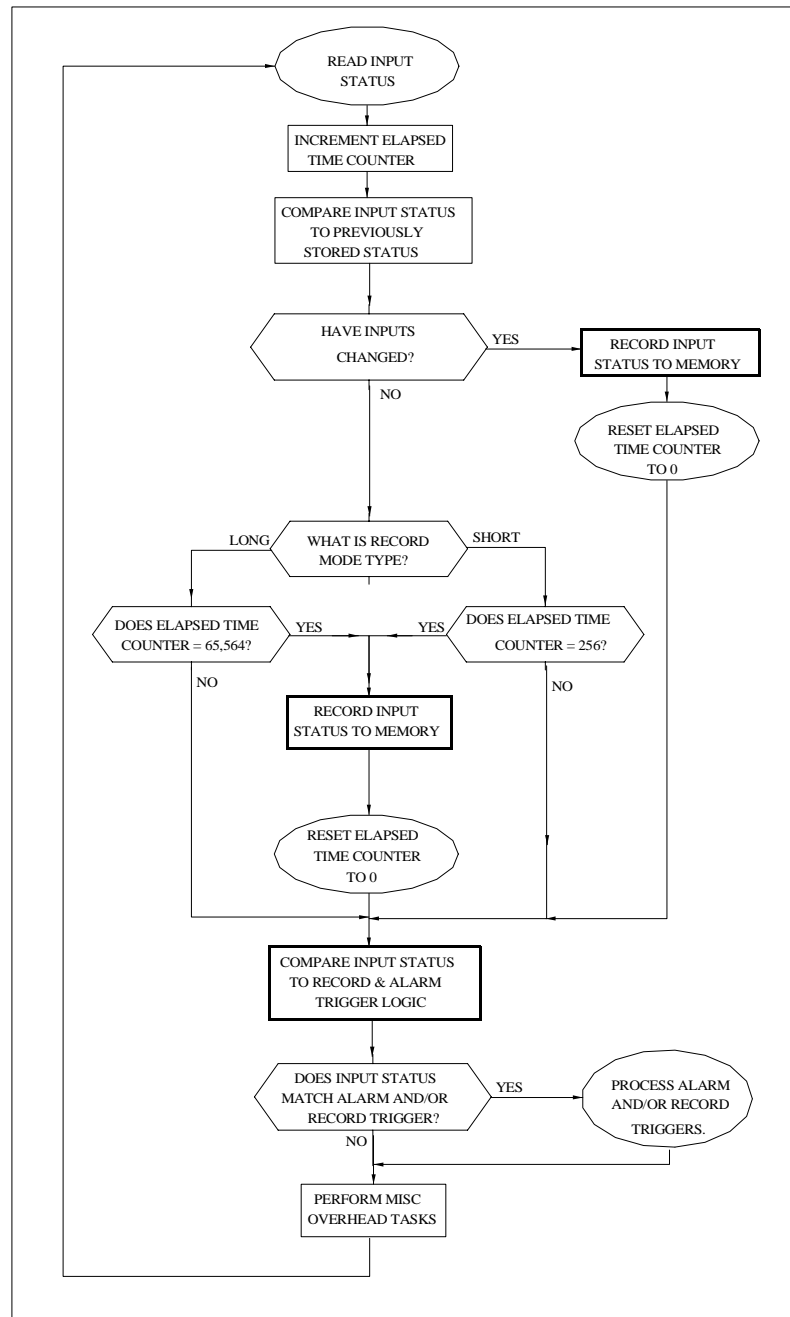
Figure 8.9 Crakker Operational Sequence

At the start of the Record loop, the Crakker latches (reads) the status of the input signals (from the Isolation Pod).

The Crakker then increments a loop counter which keeps track of the number of times the loop has been performed since the Counter was last reset to 0.

The software in the Crakker is designed such that each time around the loop, a fixed amount of time is consumed. Hence, multiplying the Loop Time times the Counter value (number of times around loop) results in an elapsed time since the counter was last reset to 0. This elapsed time is used in a future step.

The Crakker compares the new Input Status to the previously stored Input Status. If the new Status is different than the previously stored Status, the new Status is stored into memory (along with the Elapsed Time) as a Record and the Elapsed Time Counter is cleared to 0.

If the Input Status did not change, the Crakker compares the Elapsed Time Counter value to a COUNTER OVERFLOW value. (In the SHORT RECORDing mode, the value is 255 - one byte, in the LONG mode, the value is 65,535 - two bytes). If the current Counter value equals the OVERFLOW value, the Input Status (and Elapsed Time) is stored to memory as a Record...even though no changes on the inputs may have occurred.

Next, the Input Status is compared to the Alarm Trigger(s), if enabled. If the Input Status matches, the Alarm Output is cycled accordingly.

Then the Input Status is compared to the Record Triggers looking for a match. If a match is found, the Recording LED is cycled accordingly, and the Crakker starts recording Post-Trigger data to memory.

The Crakker then performs a considerable amount of other miscellaneous `housekeeping' tasks (which are not germane to this explanation) then restarts the loop.

The time required to execute one of these loops (in the longest possible route for the configuration) determines the *Loop Rate* (time). The following table (Figure 8.10) illustrates the various resultant Loop Rates possible and their associated speeds and memory capacity.

RECORD MODE	ACTIVE CHANS	RECORD TRIGGERS	ALARM TRIGGERS	TIMED TRIGGER	`ANY CHANGE' TRIGGER	LOOP RATE	MAXIMUM WINDOW	FORCED WRITES	TOTAL RECORDS
SHORT	8	0	0	0	0	166 uS	40.5 MINS	42.5 mS	57340
SHORT	8	1	0	0	0	166 uS	40.5 MINS	42.5 mS	57340
LONG	8	1	0	0	0	220 uS	6.3 DAYS	14.4 SECS	38227
LONG	8	1	2	0	0	348 uS	10.1 DAYS	22.8 SECS	38227
LONG	8	3	2	0	0	403 uS	11.7 DAYS	26.4 SECS	38227
SHORT	16	0	0	0	0	243 uS	39.6 MINS	62.2 mS	38227
SHORT	16	1	0	0	0	243 uS	39.6 MINS	62.2 mS	38227
LONG	16	1	2	0	0	455 uS	9.9 DAYS	29.8 SEC	28670
LONG	16	3	2	0	0	505 uS	11 DAYS	33.1 SEC	28670
LONG	16	X	X	1	0	662 uS	14.4 DAYS	43.4 SEC	28670
LONG	16	X	X	0	1	429 uS	9.3 DAYS	28.1 SEC	28670

Figure 8.10 Crakker Mode and related Loop Rates

Memory Utilization

Memory Data Storage Concept

The Crakker record memory can be envisioned as a continuous loop of memory slots or records. As the Crakker is waiting for the pre-programmed Trigger to occur, it is continually writing records to memory per the previously discussed flow chart. When memory fills, it commences writing over the oldest records while constantly waiting for the Trigger to occur.

When a Trigger occurs, writing of records to memory continues until the ratio of pre-Trigger to post-Trigger data specified in the Memory Split section of the Run Program is fulfilled...at which time recording stops.

Memory Consumption

The four Record Modes use a different number of bytes of memory for each stored record. The SHORT mode uses either two bytes (8 channel) or three bytes (16 channel) and the LONG mode uses either three bytes (8 channel) or four bytes (16 channel). Hence, the maximum number of samples that can be stored in memory is a function of the Record Mode.

Recording Window

The Recording Window is the real time that elapses during the filling of memory (to the Memory Saved Before Trigger specification in the Run Program). Per the previously discussed Loop Rate theory, if no transitions occurred on any of the inputs while Recording was enabled, a memory record would be consumed each time the elapsed timer count rolled over. In the SHORT mode this would occur every 256 Loops and in the LONG mode, every 65,536 Loops. The maximum Recording Window can then be calculated from the number of bytes consumed per record, the total number of bytes in memory, and the maximum time per counter overflow (which is the Loop Rate * Counter Capacity).

Obviously, in most cases, the inputs will transition many times during the filling of memory. This will force a write to memory of a record prior to the roll-over of the counter. Ultimately, this will result in a shorter Recording Window than if no transitions occurred. In the other extreme case, where a transition occurred and a record was written to memory every Loop, the Recording Window would be shortened a time defined by the Loop Rate * the total number of Records available in memory. In actuality, the Recording Window will fall somewhere in between these two extremes and is impossible to predict without being able to assess the dynamics of the control system nodes being monitored. For this reason, a massive amount of memory has been supplied integral to the Crakker System Base...allowing it to meet the needs of almost all applications.

Further Explanation And Examples

Memory Roll-over Calculations

In SHORT mode the elapsed time counter size is 8 bits with a roll-over after 256 loops.

In LONG mode the elapsed time counter size is 16 bits with a roll-over after 65,546 loops.

With input connected to 60Hz 120VAC line, a record will be written to memory 240 times per second. (4 transitions/cycle * 60 cycles/second).
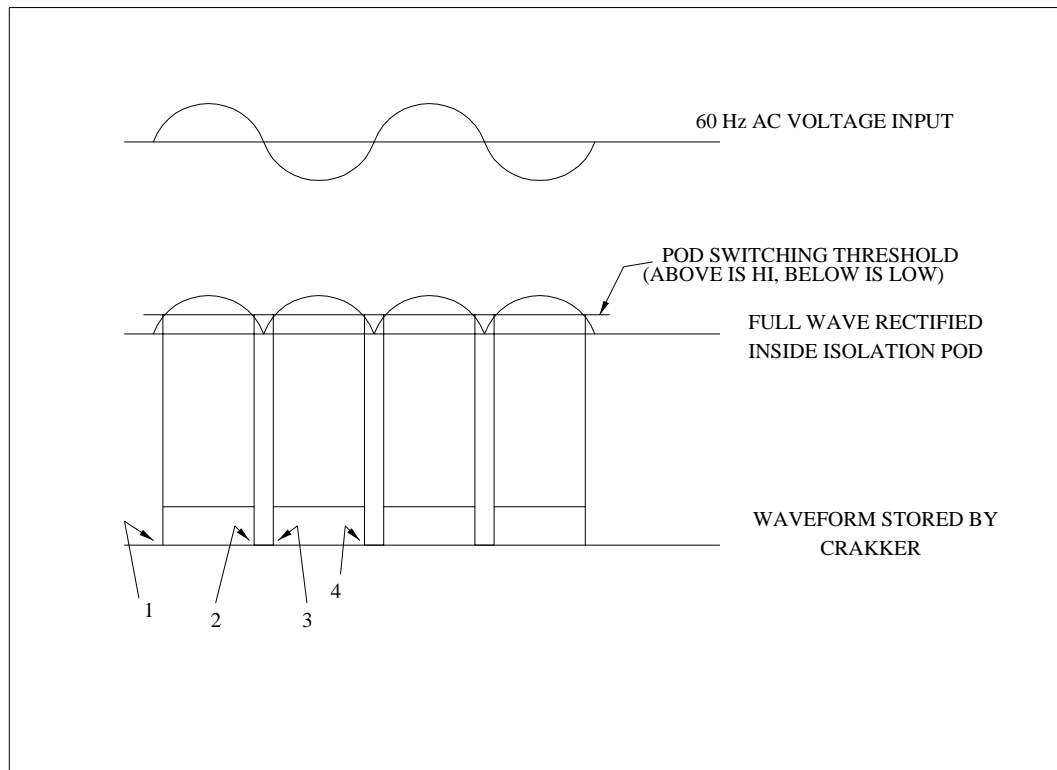
Figure 8.11 Crakker recorded transitions when connected to AC power

Case 1:

A Crakker operating in the 8-SHORT mode has memory capacity of 57,340 records before memory is overwritten. If a single channel is connected to the 60Hz line, 4 transitions will occur per cycle, hence 4 records will be consumed every cycle (Figure 8.11).

   57,340 records / 4 record/cycle = 14,335 cycles

   14,335 cycles / 60 cycles/sec   =   238 seconds

Hence, after 238 seconds (~ 4 minutes), memory will start to be overwritten.

Case 2:

An event occurs every 1 second. How long until memory is overwritten?

Using 16-LONG mode, 28,670 records can be stored. If events occur every 1 second or less, the Crakker will not force a write of a record as the interval elapsed time counter will not overflow - the equation is then simply:

   28,670 records / 1 sec/record   = 28,670 seconds

28,670 seconds (~ 8 hours) until memory starts to be overwritten.

Case 3:

Assume an event occurs every minute as follows:
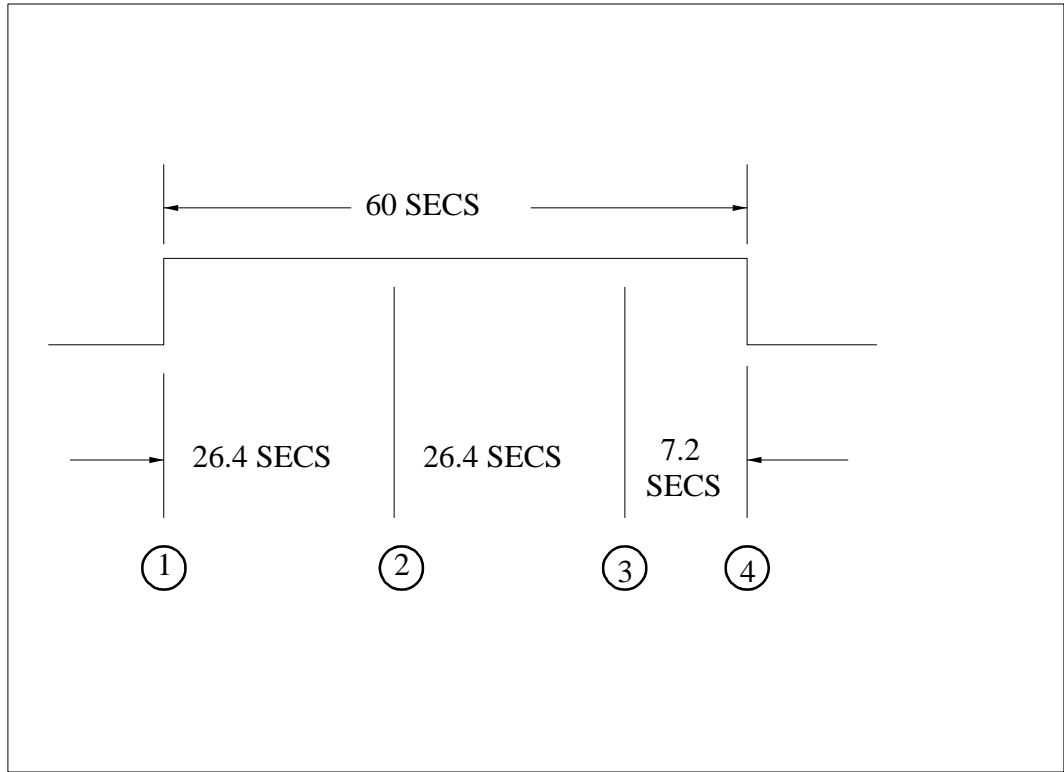
Figure 8.12 Example pulse/event occurring once per minute

If running the Crakker in the 8-LONG (3 record triggers, 2 Alarm triggers) mode, the interval elapsed time counter will overflow every 26.4 seconds and a record will be written (unless a transition occurs which forces a record to be written, then resets the elapse time counter to 0). Every minute 3 records are written to memory, 1 at the signal transition time, and 2 and 3 due to elapsed time counter overflows. In this case the total time before memory is overwritten is:

  38,227 records / 3 records/minute = 12,742 mins = 3.5 days

If the 16-LONG mode (3 Record triggers, 2 Alarm triggers) were used, the elapsed time counter would not overflow until 65,536 * 505us = 33 seconds and only 1 forced write would occur. The total record time for this mode would be:

  28,670 records / 2 records/min = 14,335 mins = 9.95 days

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Appendix L: Crakker Accessories

Ck-Case Crakker Carrying Case

Waterproof, hard-shell Carrying Case for Crakker System Base, two Isolation Pods, leads, and documentation. Very convenient for keeping the system components organized when not in use as well as for transporting.

RPS-1 Rechargable Power Supply

The RPS-1 is a self-contained portable power source with two regulated voltage outputs which are powered from two internal 12VDC 2AH gel-cell batteries. The RPS-1 comes complete with a 120VAC/12VDC recharging adapter and mating connector for direct connection to the Crakker. The RPS-1 can supply the Crakker with field power for approximately 24 hours before recharging is required.

The RPS-1 has two User programmable output power supplies, each capable of delivering up to 300 mA in from 3.5 to 22VDC. The RPS-1 differs from the RBP-12 above in that it is a general purpose power supply that may have other lab and field power applications when not in use with the Crakker.

Miscellaneous

Other miscellaneous supplies and accessories are available from Logic Beach for the Crakker System. Please contact the factory for pricing and availability.

- Custom length Pod Test Leads

- Custom length Isolation Pod to System Base interconnect cables

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Appendix M: Relay Logic `first-out' Detection With The Crakker

Many processes and control systems employ an Alarm/Shutdown Fault Loop (Figure 8.13) consisting of a secondary string of Normally Open relay contacts (K1 thru K5) wired in series with a Normally Closed alarm relay coil (K6). In the event that any of the series relays are de-energized (i.e. a fault occurs on any of the primary circuits powering the coils of relays K1 - K5) the Alarm relay (K6) coil will be de-energized. When relay K6 is de-energized, its Normally Closed contacts spring closed which in turn sounds an alarm (or shuts down the process).

Note that many controls may employ the reverse logic on the Alarm Relay by using the relay's Normally Open contacts.
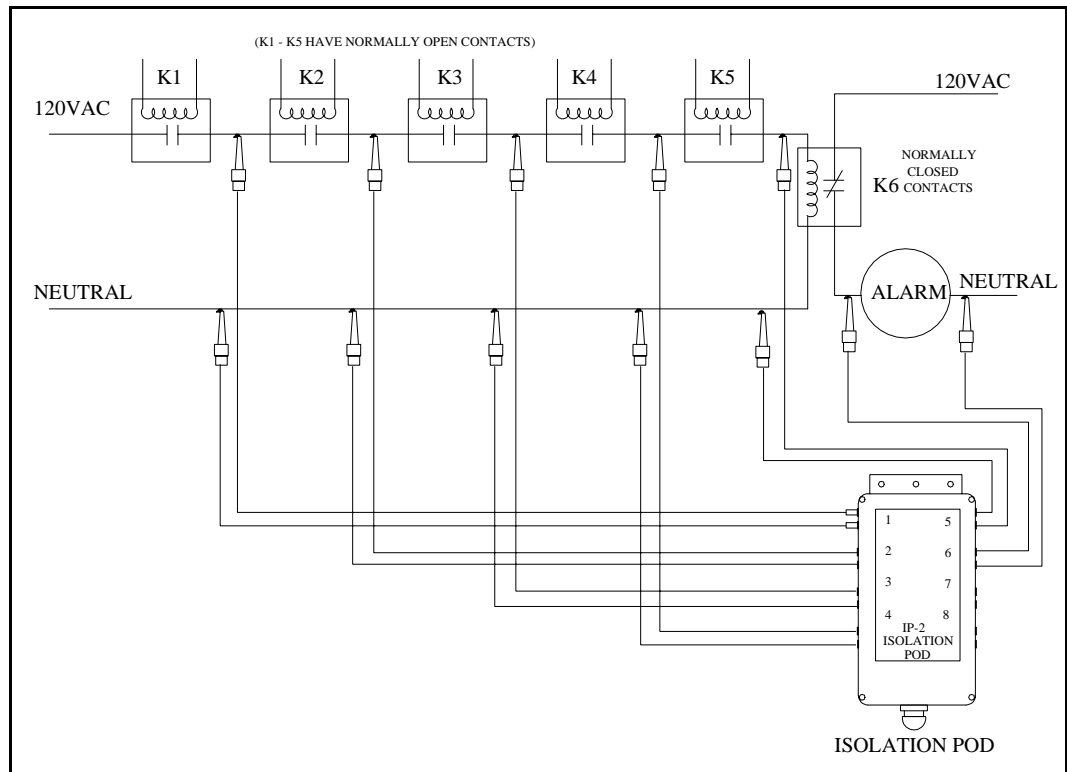
Figure 8.13 Secondary Relay Fault String 'First Out' Pod Connection Example

In many applications, when one fault is detected and the process starts to shut down, other relays in the Secondary fault string also open due to interdependence of parameters being monitored (e.g. a paper web break in a newspaper printing press may initially cause a fault due to detection of broken web, quickly followed by overspeed, followed by low motor drive current, etc.). Detecting which of these faults occurred *first* (hence the term `First Out') can be quite confusing if not impossible to establish (without the Crakker).

Connecting the Crakker Portable Logic/Timing Analyzer to the electrical nodes as shown in Figure 8.13 will allow detection of the first relay to open.

In the setup of the Crakker Run Program for the example circuit shown, Triggering on actuation of the Alarm (Rising Edge or HIGH type trigger) will trap the series relay string logic and timing to memory.

In the Data Display collected from this circuit (Figure 8.14), it is obvious that relay K4 opened first. At the same time that relay K4 opens, voltage is lost at relay K5 hence it simultaneously indicates low. In the trip sequence, it can also be seen that relay K3 opened some 17mS later. The opening of relay K3 was probably just a follow-on result of the failing control sequence. In the timing diagram, the vertical

lines (red) aligned with relay K6's Lo to Hi transition marks the trigger as a result of the alarm relay actuation.
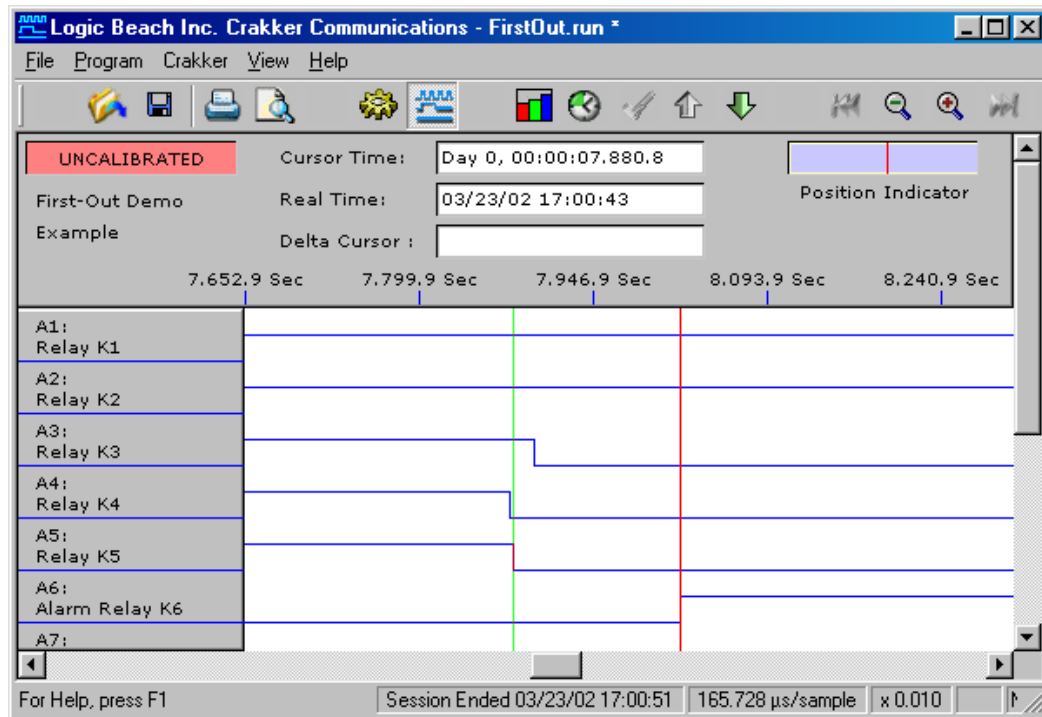
Figure 8.14 'First-Out' Detection Relay Sequence

Another technique which would give the complete sequence of openings of the relays associated with the Secondary fault string is to monitor the individual Primary Fault circuits powering the Secondary Fault relays (assuming that they are driven by an electrical signal and not a mechanical actuation such as an RPM governor). This could be readily implemented by clipping Pod input leads across each of the Primary Fault circuit relay coils or switches (as opposed to their contacts in the Secondary relay string as described above). As in the above example, an additional Pod channel can then be connected across the Alarm Relay (K6) coil or contacts for use in Triggering.

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