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ILIR TASK OF DIGITAL RECOIL TRAVEL MEASUREMENT SYSTEM
(U) ARMY COMBAT SYSTEMS TEST ACTIVITY (PROV) ABERDEEN
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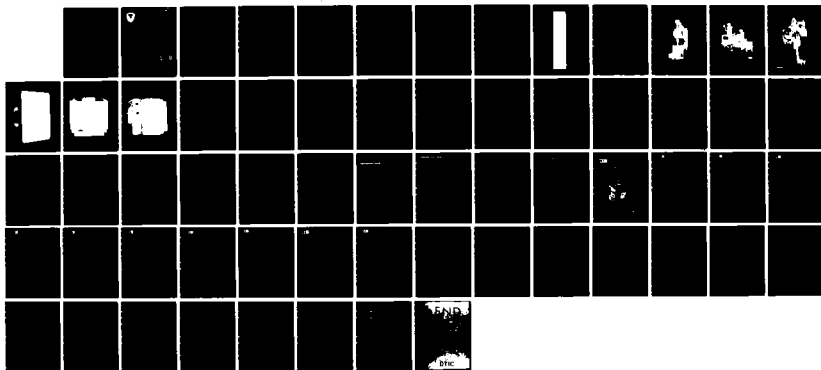
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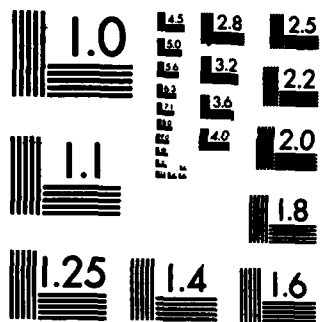
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FINAL REPORT
ILIR TASK
OF
DIGITAL RECOIL TRAVEL
MEASUREMENT SYSTEM

V. A. BETZOLD
C. L. FRANCIS

MEASUREMENTS AND ANALYSIS DIRECTORATE

US ARMY COMBAT SYSTEMS TEST ACTIVITY (PROVISIONAL)
ABERDEEN PROVING GROUND, MD 21005-5059

JULY 1984

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Period Covered:
October 1982 to July 1984

US ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MD 21005-5055

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A study was conducted to improve measurement of large caliber weapon recoil travel. Since the 1950s, a continuous rotation, single turn potentiometer driven by a rack and pinion gear has been used on a variety of weapons. Satisfactory data has been produced by this system, but the data records suffer from a number of problems caused by the potentiometer. Therefore, the potentiometer was replaced by a digital incremental optical shaft encoder.		

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20. Circuitry was developed to interface the encoder output to a digital data acquisition system. Software was then written to process the data at the firing site, and provide a near real-time plot of recoil travel and velocity versus time. Originator supplied Keywords include: Ballistic Test Site Terminal, and Incremental Optical Encoder.

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FOREWORD

The US Army Combat Systems Test Activity (USACSTA (Prov)) (formerly Materiel Testing Directorate (MTD)), Aberdeen Proving Ground (APG), MD, conducted this investigation and prepared this report as part of an effort to improve the quality of ballistic measurements. Acknowledgement is given to Mr. Bryan Mitchell for fabrication and field testing of the Digital Recoil Travel Measurement System.

SECTION 1. SUMMARY

1.1 BACKGROUND

Measurement of weapon recoil travel versus time has been a standard ballistic measurement requirement for many years. Since the 1950s, a continuous rotation, single turn potentiometer driven by a rack and pinion gear has been used on a variety of large caliber weapons. A sample record obtained with this transducer is in Figure 1.1-1. Satisfactory data have been produced by this system, but the data records suffer from a number of problems:

- a. When the potentiometer rotor crosses the gap between the ends of the stator element, an open circuit noise spike is generated.
- b. The potentiometer noise output increases with wear.
- c. The recording bandwidth must be high enough to capture the level change generated by crossing the gap in the stator. This is normally an order of magnitude higher than the actual motion bandwidth.
- d. The record generated by the potentiometer cannot be read directly, but rather must be processed by a computer program which generates a displacement versus time record.

Problems a and b apply equally to analog or digital data acquisition systems. Problem c applies primarily to a digital system where limited memory is used rapidly by the higher sample rate needed to accurately reproduce the gap transition. Problem d applies primarily to an analog system as there is no way to perform the analysis at the test site whereas in a digital system the problem means additional processing time.

Providing the test director with an immediate indication of test results was generally not possible until recently, when the transition from analog to digital data acquisition facilities occurred. The new Ballistic Test Site Terminals (BTST) are digital data acquisition systems which provide the technician with a means to reduce data to engineering units in the field, with the prerequisite that he have a transducer which produces a usable signal and the software to interpret that signal.

The problems with the potentiometer output have been recognized for several years. A digital means of measuring recoil was attempted by J. G. Yeager as detailed in TECOM Report No. DPS-2363, 1967. Mr. Yeager discussed the results of development of an optical measurement system, in which a photoelectric transducer head and coded tape were used to produce a pulse output.

Considering the results achieved by this method and the advances in technology, additional investigation was considered necessary. Elimination of the rack and pinion concept is not of great benefit; after the initial investment in design and fabrication, they last indefinitely and require adjustment infrequently. Replacement of the potentiometer was considered to be the key to improving the measurement.

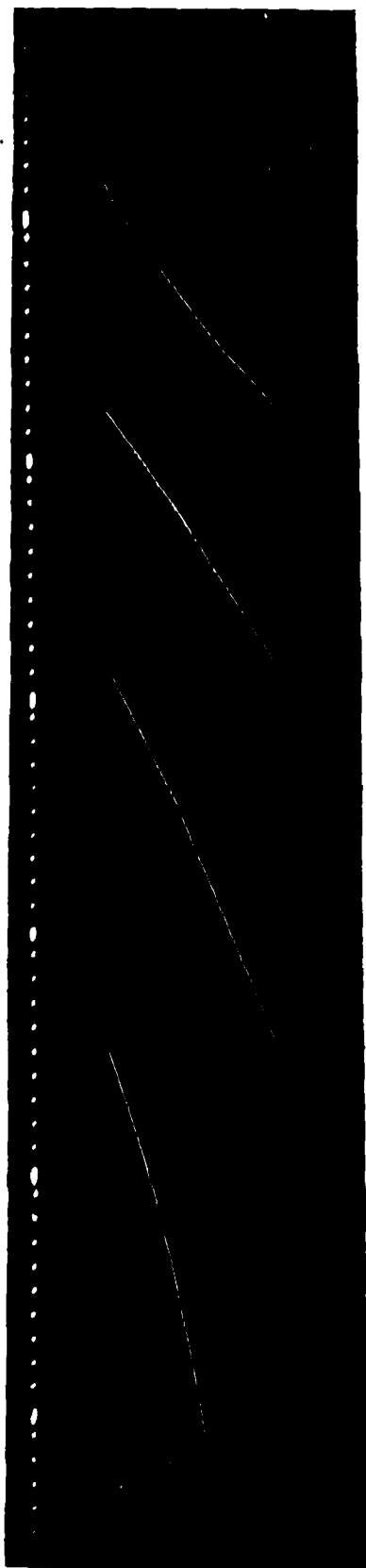


Figure 1.1-1. Recoil travel potentiometer output signal.

1.2 OBJECTIVES

The objectives of this project are to identify an improved recoil travel transducer, and to provide the test director with recoil travel versus time plots in near real time, at the test site.

1.3 SUMMARY OF PROCEDURES

An incremental shaft encoder (fig. 1.3-1, 1.3-2, and 1.3-3) was selected as a replacement for the continuous potentiometer. Circuitry was then developed (fig. 1.3-4, 1.3-5 and, 1.3-6) to interface pulses from the shaft encoder to a Hewlett Packard 1000 computer in the BTST. Finally, software was written to provide recoil distance traveled, a plot of recoil travel versus time, and a plot of recoil velocity versus time.

1.3 (Cont'd)

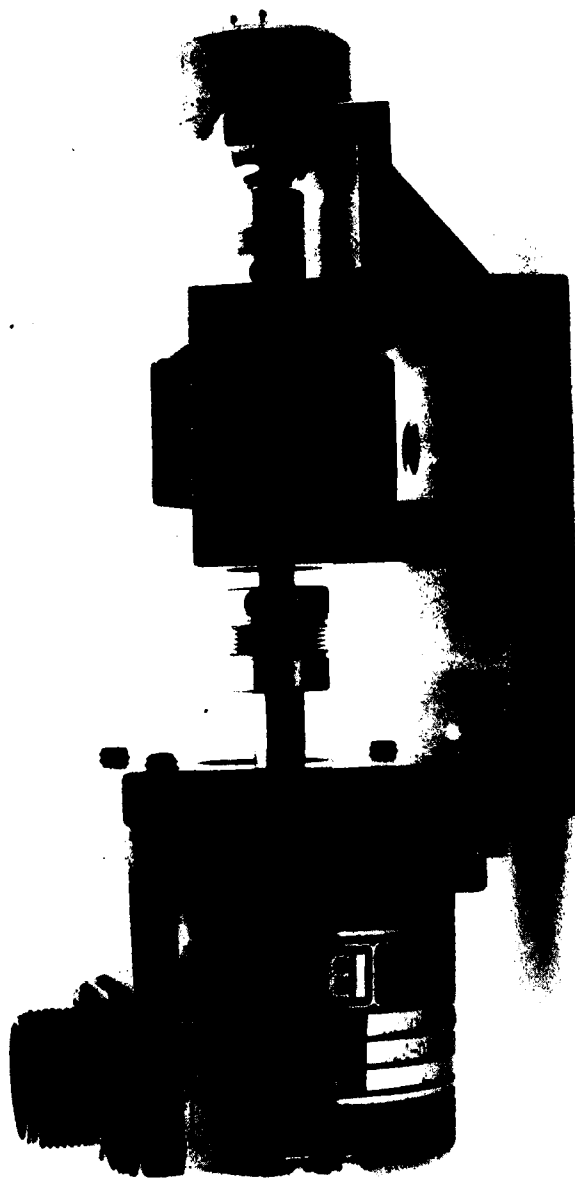


Figure 1.3-1. Incremental shaft encoder and pinion gear mount. (Note flexible shaft couplings.)

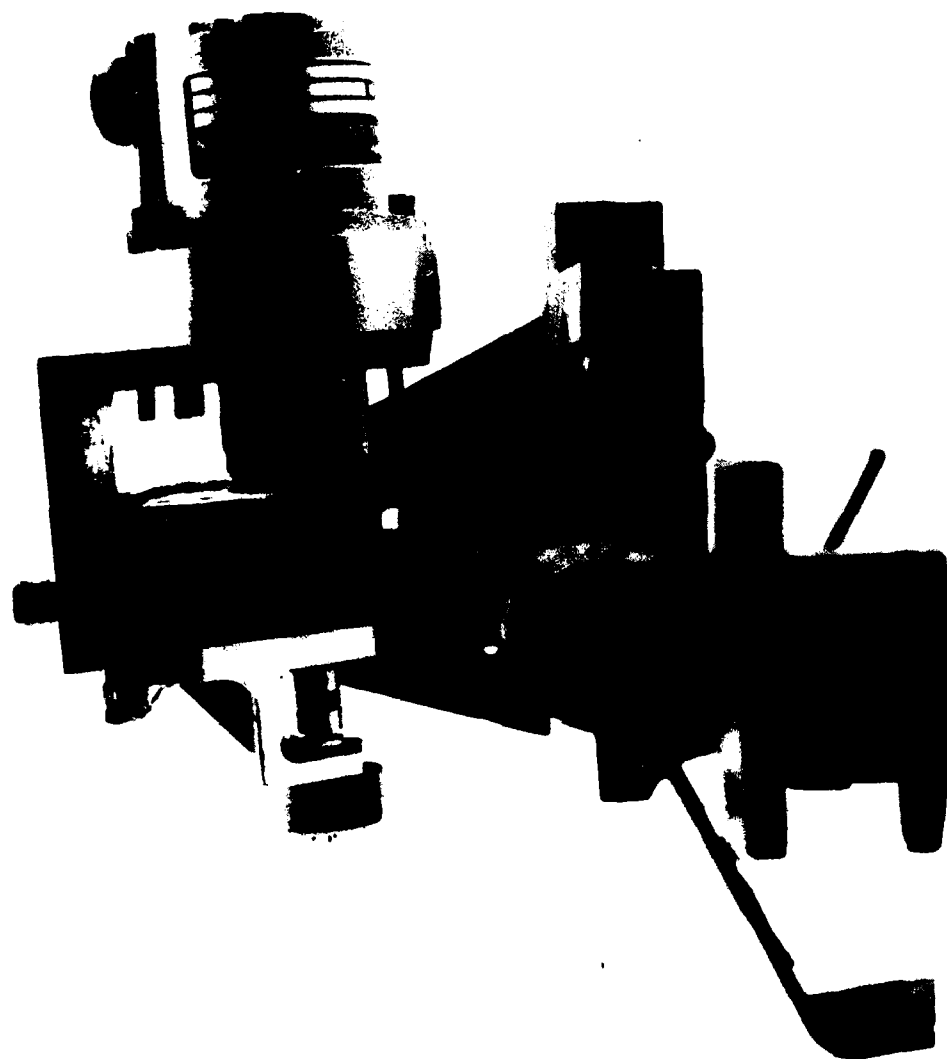


Figure 1.3-2. Incremental shaft encoder on 105-mm M68 recoil travel rack.

1.3 (Cont'd)

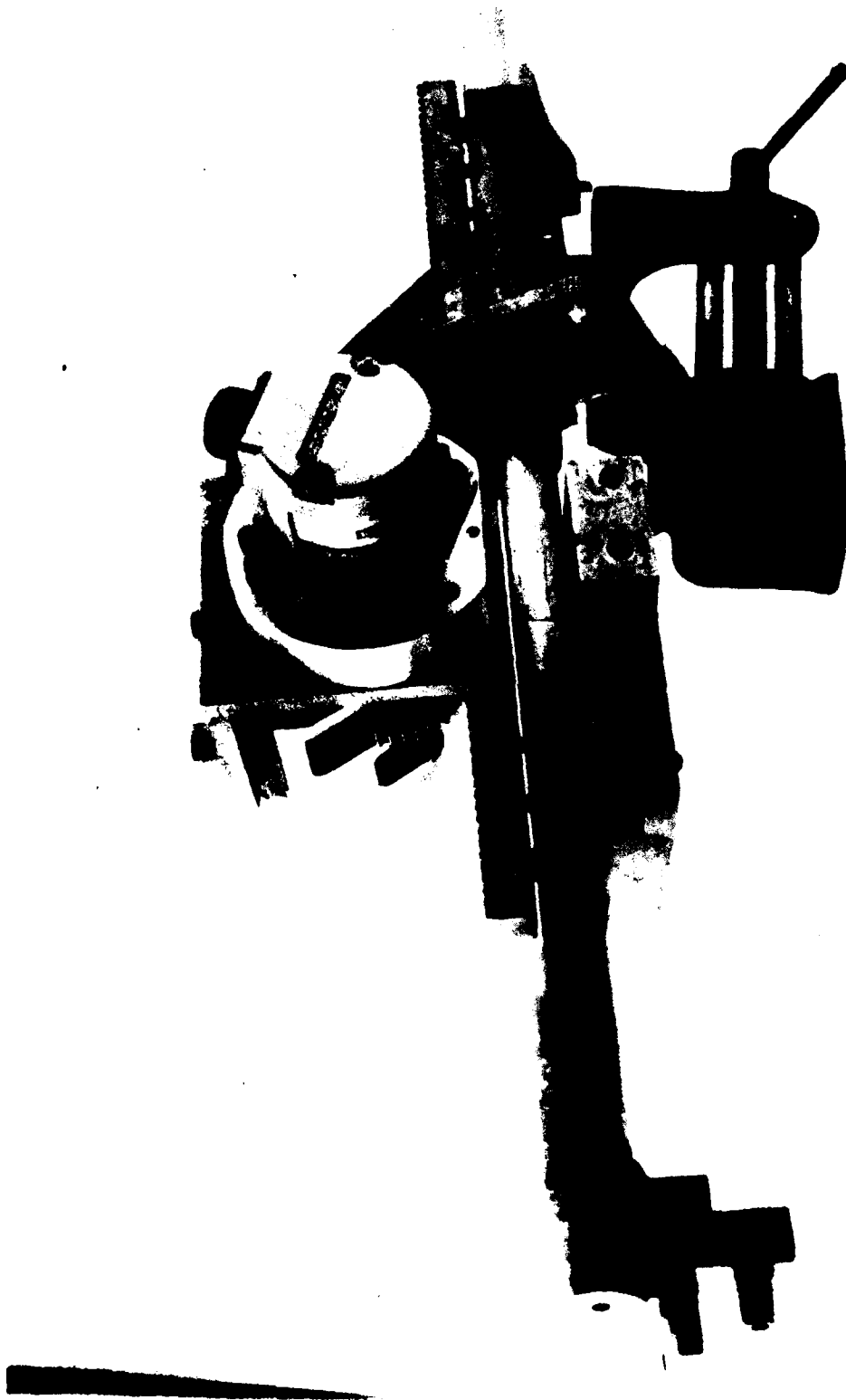


Figure 1.3-3. Incremental shaft encoder on 105-mm M68 recoil travel rack.

1.3 (Cont'd)



Figure 1.3-4. Recoil travel interface unit.

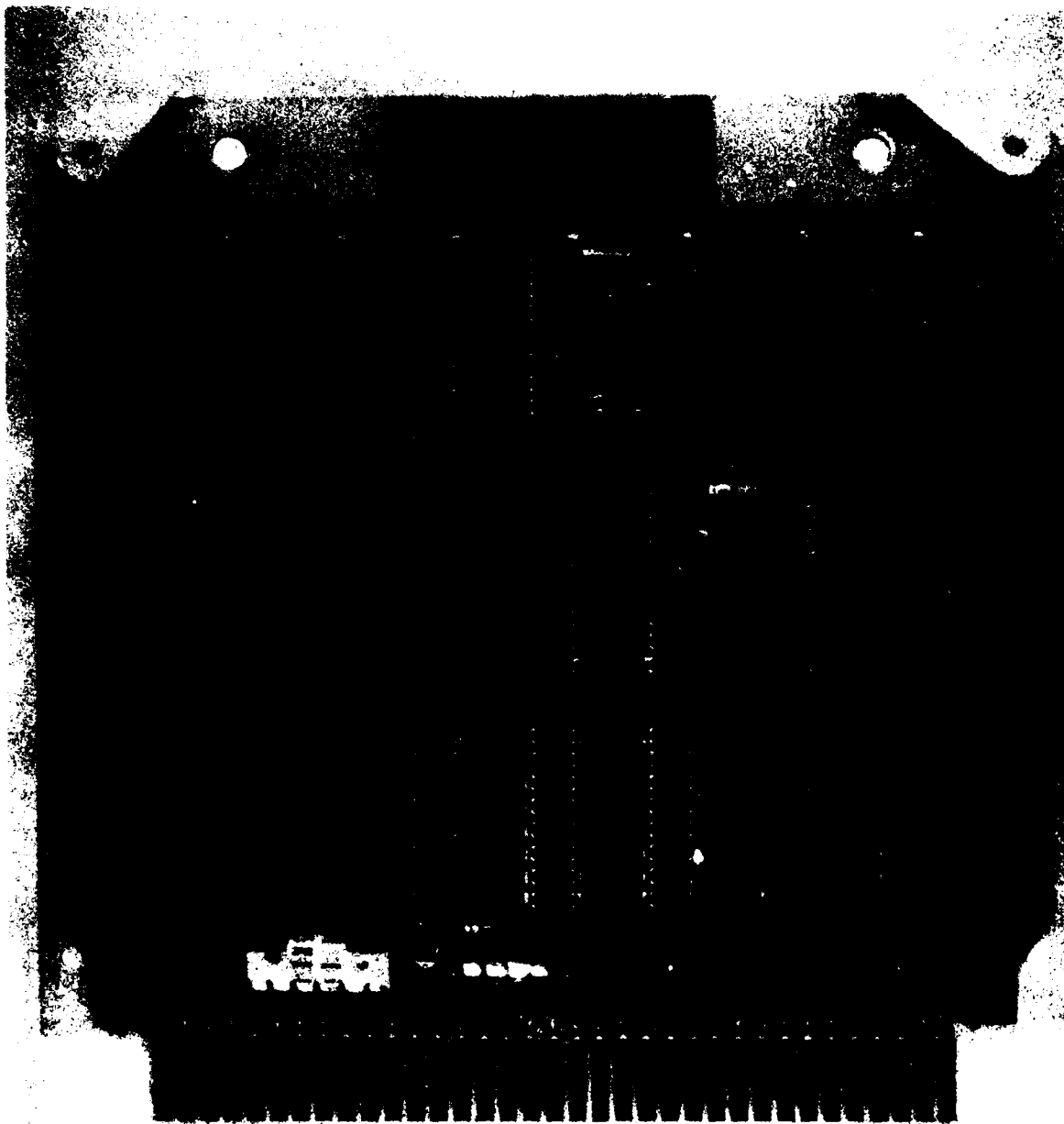


Figure 1.3-5. Recoil travel interface circuit card, component side.

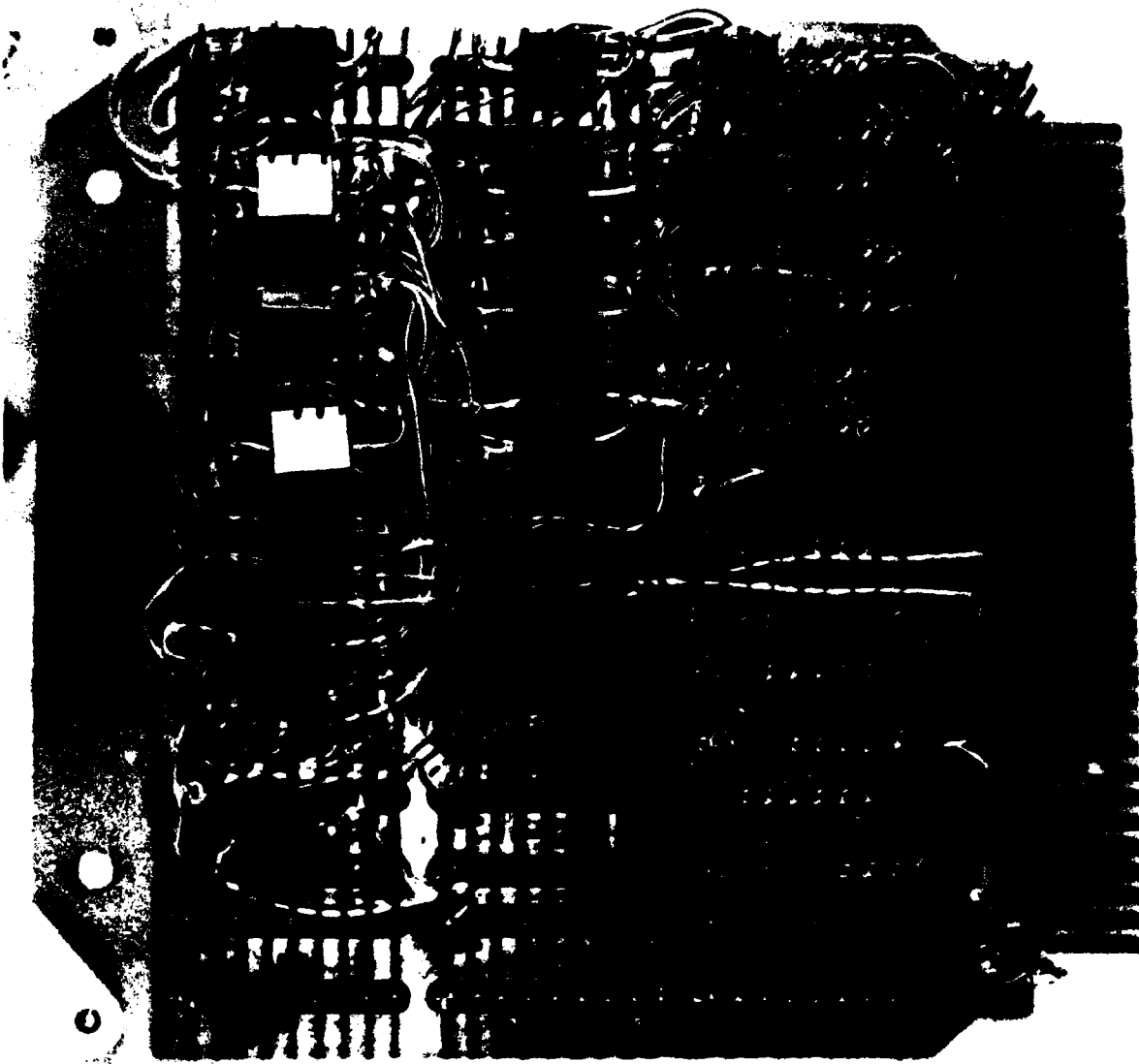


Figure 1.3-6. Recoil travel interface circuit card, wire wrap.

1.4 SUMMARY OF RESULTS

A typical record of recoil travel versus time is shown in Figure 1.4-1. Occasionally, data with obvious discontinuities is acquired, as in Figure 1.4-2. These discontinuities have been found to be the result of a misalignment of the rack and pinion gear. Figure 1.4-3 illustrates a failure to return to zero, which may be a misaligned rack or a failure of the weapon to return to battery. When the technician encounters this situation, firing should be stopped and the problem discussed with the test director.

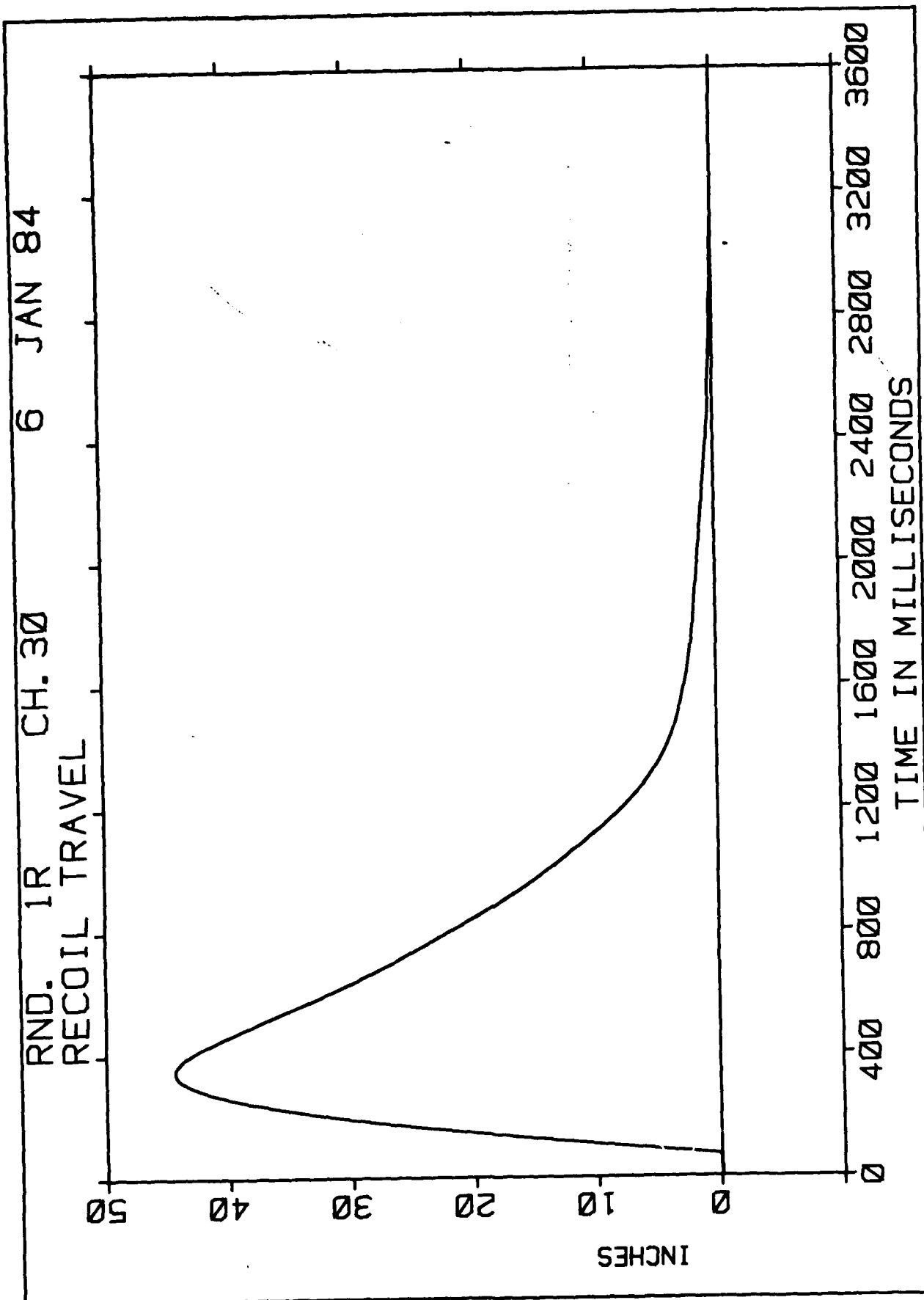


Figure 1.4-1. Recoil travel versus time.

1.4 (Cont'd)

LAT OF M198 HOWITZER
RD NO.2R 23MAY84 M119 CHARGE, 90 MILS ELEV.
CHANNEL: 30 RECOIL DISPLACEMENT

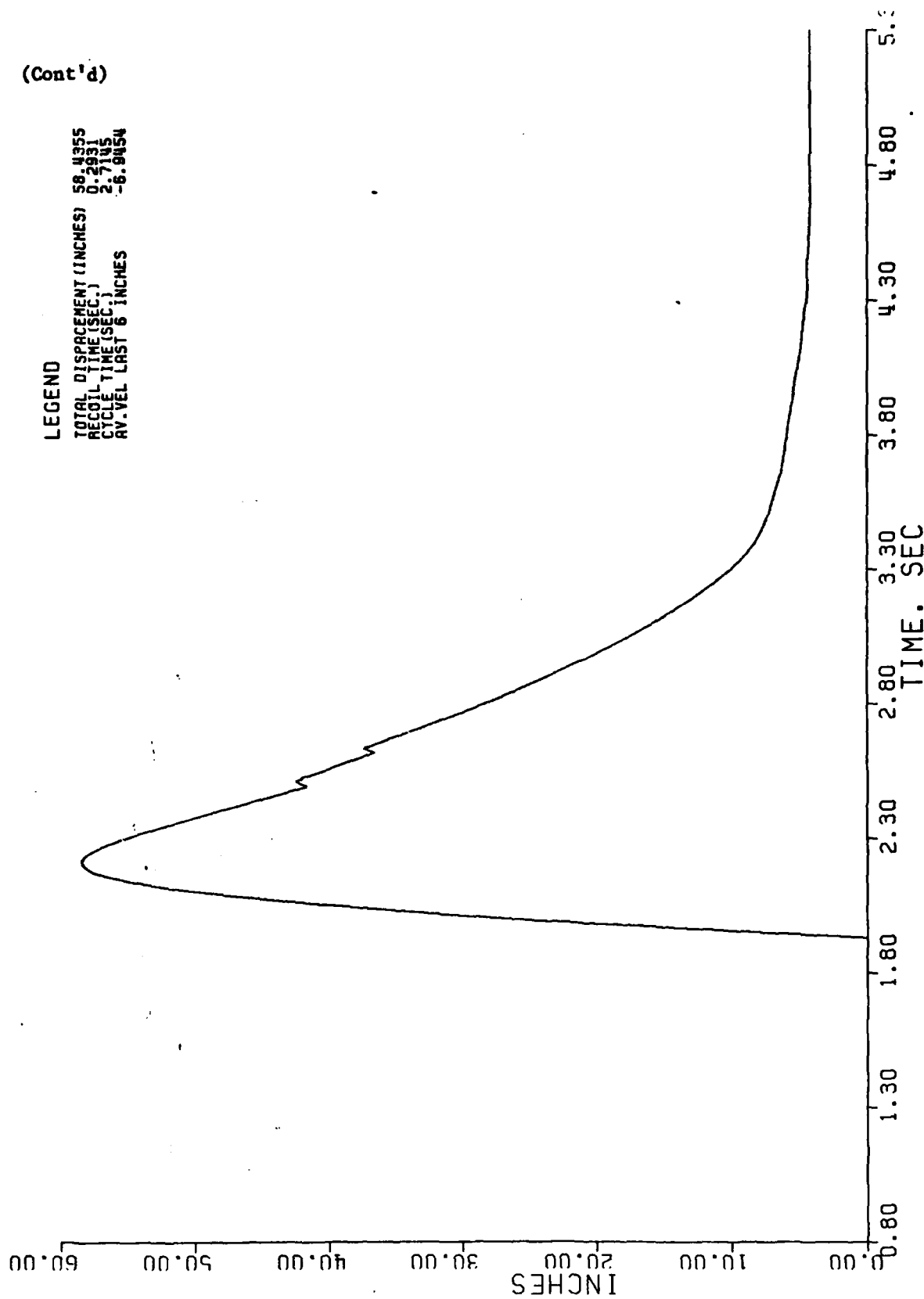


Figure 1.4-2. Recoil travel versus time plot demonstrating effect of misaligned rack on weapon.

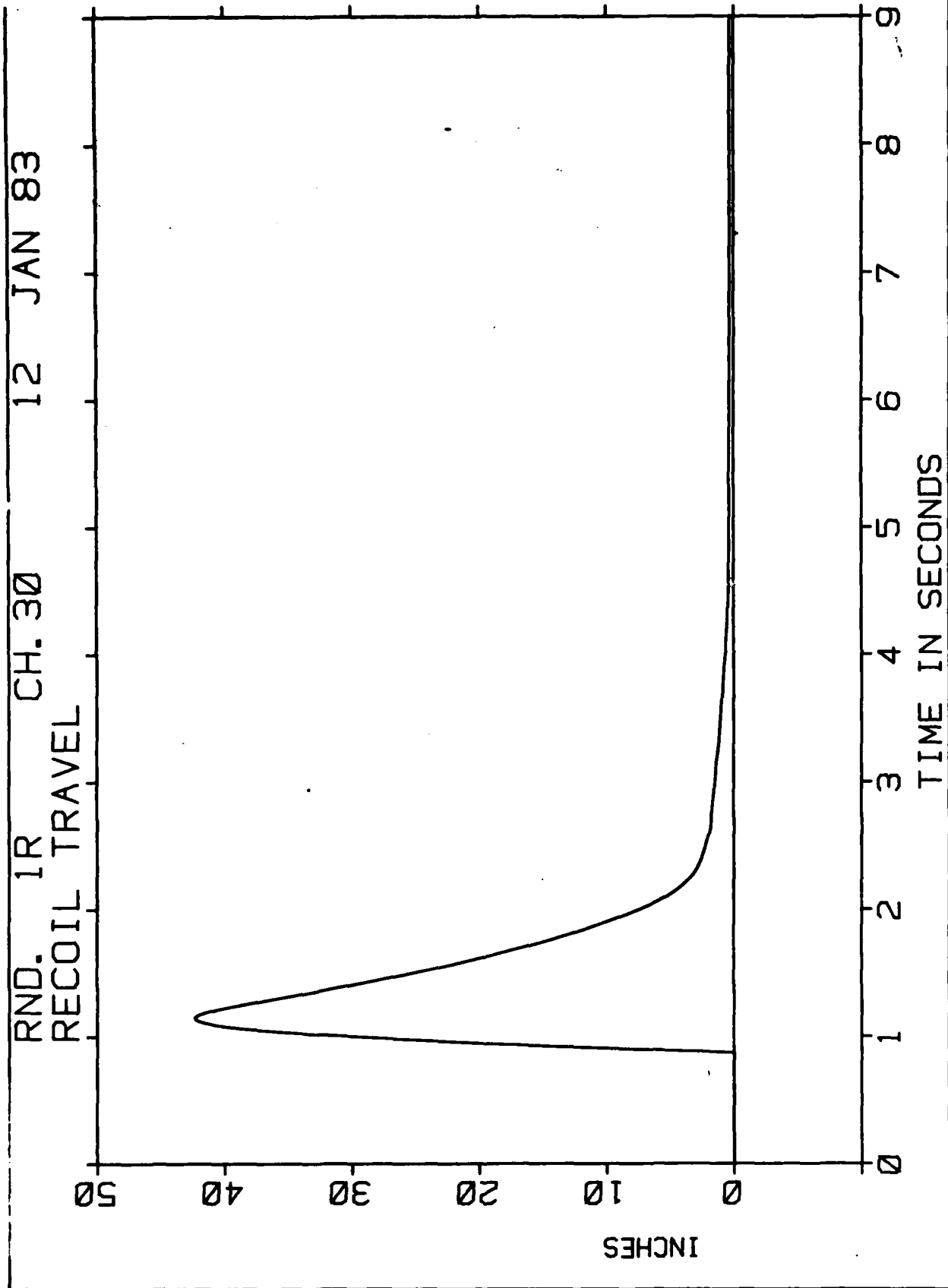


Figure 1.4-3. Recoil travel versus time plot, failure to return to battery.

1.5 ANALYSIS

The digital recoil travel system permits a more detailed analysis of recoil and counterrecoil than the potentiometer method. As a result, some anomalies in recoil travel records not previously observed are currently being investigated. These irregularities appear on displacement versus time records showing the curve passing through zero, indicating counterrecoil motion beyond the recoil start position as shown in Figure 1.5-1. This phenomenon may be the result of an incomplete return to battery on a previous shot(s), resulting in an apparent excessive counterrecoil distance on a successive shot(s) if the gun returns more fully toward battery. The cumulative effect of different recoil starting points must be considered during a test because there is no point of reference between a position on the gun and a numerical output from the incremental shaft encoder circuitry.

RND. 1R CH. 30 29 DEC 83
RECOIL TRAVEL

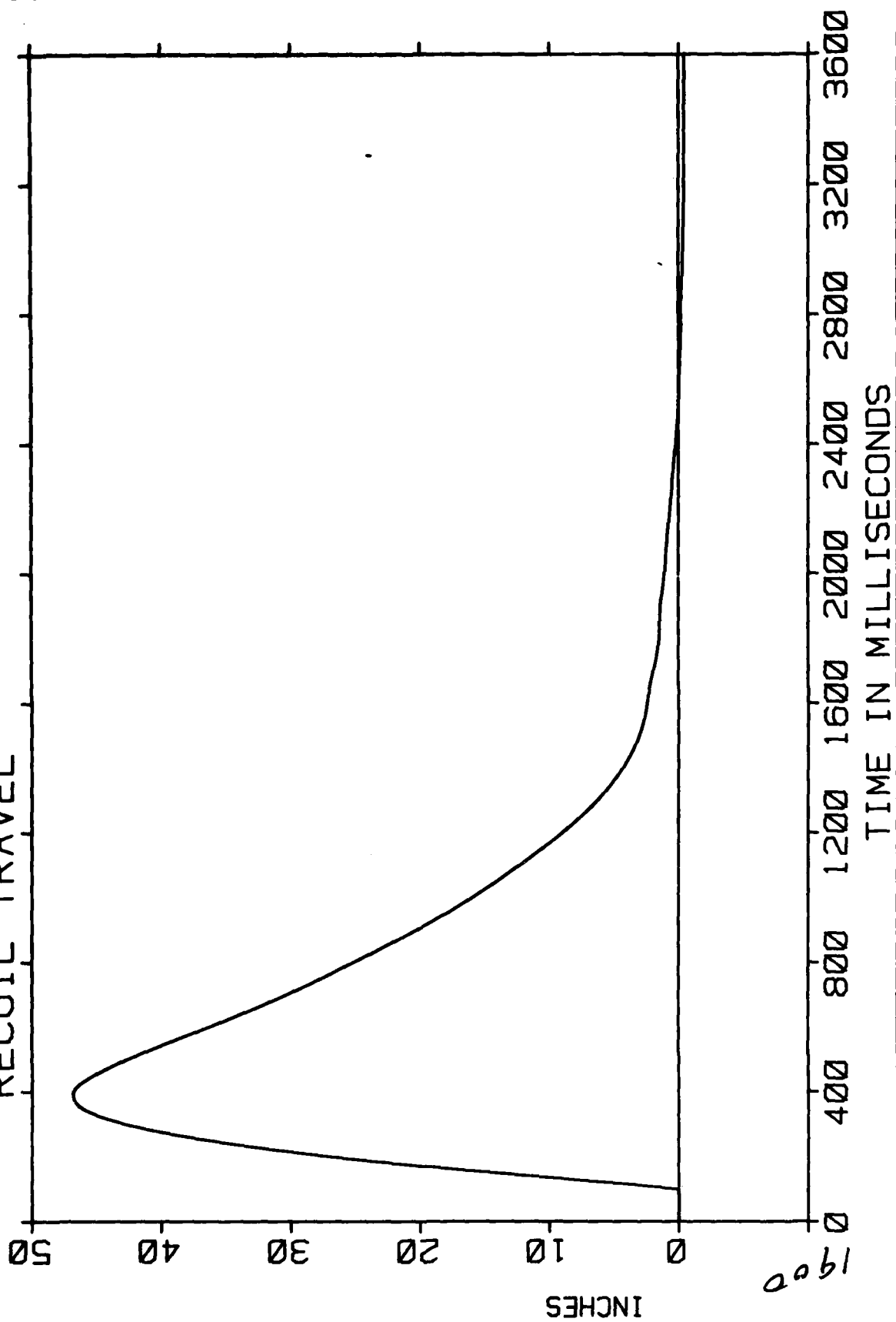


Figure 1.5-1. Recoil travel versus time plot, counterrecoil beyond starting position.

1.6 CONCLUSION

Digital recoil measurement is superior to analog recoil measurement in terms of transducer signal quality and speed of data reduction.

1.7 RECOMMENDATIONS

a. Whenever computer controlled test facilities are available, digital recoil measurements should be the preferred test method.

b. Additional digital recoil circuitry should be fabricated for BTSTs. It may be possible to incorporate the circuitry directly into the Adaptive Sampling Rate Digitizers in the BTSTs.

SECTION 2. GENERAL DISCUSSION OF SYSTEM DEVELOPMENT

2.1 TRANSDUCER SELECTION

An incremental, optical shaft encoder was selected as a digital alternative to a continuous potentiometer. A market search of available encoders produced a wide variety of available models. The design features of interest for this project were:

a. Rugged construction. The shock of weapon firing was expected to be a critical factor.

b. Physical size. A direct replacement of the potentiometer was desired. If an encoder of the proper size could be located, modifications to existing rack and pinion gears would be minimized.

c. Slew speed. During recoil, maximum speed of the pinion gear could cause encoder failure.

d. Pulses per revolution. Consideration of pinion gear diameter versus pulses per revolution was necessary to assure adequate resolution.

e. Electrical signal output. Several hundred feet of cable are typically used during a firing test. A line driver output was considered necessary.

f. Environmental specifications. A -51.1°C (-60°F) to 51.7°C (125°F) temperature range is demanded by some environmental temperature tests.

A BEI Electronics, Inc. heavy duty encoder, shown in Figures 1.3-1, -2, and -3, was selected to satisfy the system requirements. The specific part number ordered was H25D-SB-250-ABC-7830-SM18-5, which is interpretable when compared with the encoder specifications in Appendix B. Briefly, the encoder has the following characteristics.

a. 250 pulses per revolution.

b. Dual quadrature, complementary output channels.

c. 0.25 inch shaft diameter.

d. -40°C to 80°C temperature range.

e. Flat on encoder shaft 0.50 inch by 0.03 inch.

f. Incandescent encoder illumination.

This encoder has performed reliably through extensive 155-mm, 120-mm and 105-mm firing. Initially, an LED was preferred to the incandescent illumination, since durability was thought to be superior with an LED. However, the manufacturer recommended an incandescent lamp, and no failures have been experienced to this date.

2.1 (Cont'd)

Two pinion gear diameters are available for recoil tests, selected according to test specifications. The 7.446 inch and 5.108 inch diameters correspond to 0.0298 inch and 0.0204 inch per pulse, which is considered adequate resolution. Certain weapons will exceed the encoder slow speed specification when the smaller gear is used; however, the amount is not excessive and it is a transient condition.

A flexible shaft coupling (fig. 1.3-1) was added to the encoder to minimize axial and radial loading. The coupling selected is produced by Metal Bellows Corporation, model R3-856, PN 26046.

The -40° C temperature specification for the encoder is not adequate for all environmental chamber tests. The feasibility of applying a thermal element to the inside surface of the encoder is currently being investigated.

2.2 ELECTRONIC INTERFACE CIRCUITRY DESIGN

Pulses from the shaft encoder are not directly compatible with a computer. Interface hardware is required to detect direction of shaft rotation, increment or decrement a counter, and provide a latched signal to the computer interface circuit. A block diagram is shown in Figure 2.2-1.

A schematic drawing of the electronic interface circuitry is shown in Figure 2.2-2. Dual differential receiver U12 receives two output signals in quadrature from the encoder and provides TTL signals to D flip-flop U8. If U8-3 (clock) goes high while U8-2 (D input) is high, then U8-5 ($\overline{IQ}$ output) is high. These conditions exist while the weapon is recoiling. Since U7-2 is high, pulses from the encoder are applied to the B_1 input of one-shot U5. One-shot U5 then generates a 0.6 microsecond pulse at U5-4 ($\overline{IQ}$ output) for each pulse from the encoder. These pulses increment BCD counters U21, U22, U23, and U24.

During counterrecoil, U8-5 is low and U8-6 is high. This results in pulses being applied to the B_2 input of one-shot U5. One-shot U5 generates a 0.6 microsecond pulse at U5-12 ($2Q$ output) for each pulse from the encoder. These pulses then decrement BCD counters U21, U22, U23, and U24.

Following the counter circuitry, 74LS174 latches U18, U19, and U20 ensure that the output data cannot change at the time of computer sampling. There are two examples of latch circuit operation shown in Figure 2.2-3. On the rising edge of the pulse generated by the shaft encoder, U7-3 (increment, recoil) or U7-6 (decrement, counterrecoil) triggers a 0.6 microsecond low pulse from U5-4 (increment) or U5-12 (decrement). The rising edge of an up or down pulse from the shaft encoder also produces a 1.2 microsecond low pulse from U3-4. The computer samples the counting circuit at an interval defined by a software cycle. Sampling is completed when DFLGA goes low, which produces a high pulse of 1.4 microsecond duration at U3-5. There are two requirements to assure proper sampling. First, approximately 20 nanoseconds must be allowed for the counter output to settle after changing count input. Second, approximately 20 nanoseconds must be allowed for the latch output to settle after changing the latch input. When reviewing the timing diagram, it is also important to note that the minimum time period expected between pulses from the encoder for the highest velocity recoil is approximately 100 microseconds. The computer sampling period is approximately 1 millisecond. There is no dependency between the varying rate of pulse output from the encoder and the fixed computer rate of sampling.

In the first timing example in Figure 2.2-3, the computer is signaled that the data input operation is complete on the negative edge of DFLGA. U3-5 then goes high for 1.4 microseconds. The latches are clocked once by U7-8 when U3-4 goes low, latching at the circuit output the most recent counter output. When the counter change does occur, U3-4 stays low for a short period so that the latch is not allowed to update until the counters have settled. U3-5 then goes low, and the latches are again updated, but with the new count.

In this example, since the computer is signaled that the data input operation is complete immediately before a counter change, two latch updates occur.

2.2 (Cont'd)

In the second example in Figure 2.2-3, only one latch update occurs, because the negative going DFLGA transition occurs after the counter change. Regardless of the manner in which the latch update occurs, the computer reads the latch output which was updated at the completion of the previous computer input operation. Latch updates only occur after the computer completes an input operation.

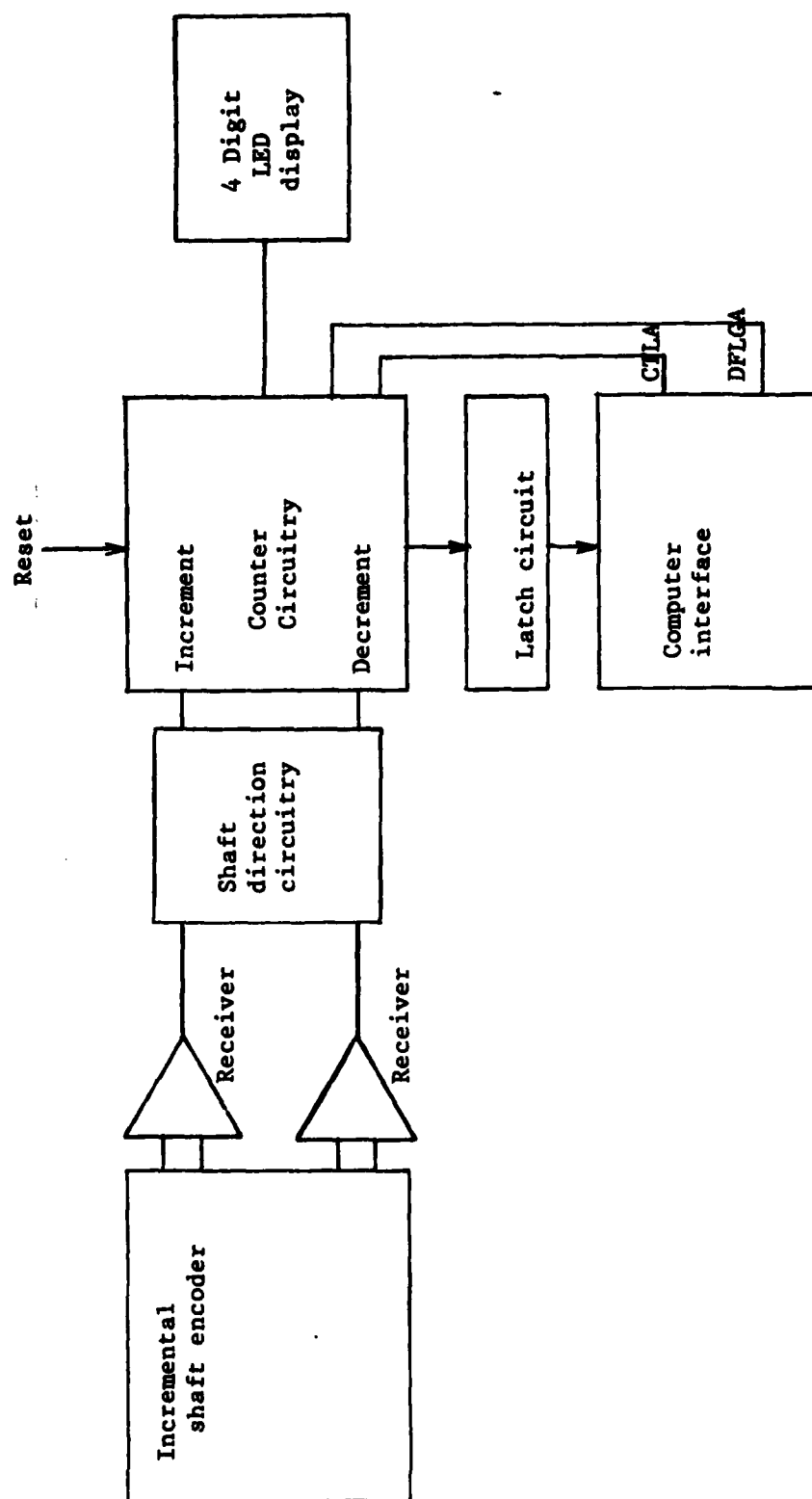
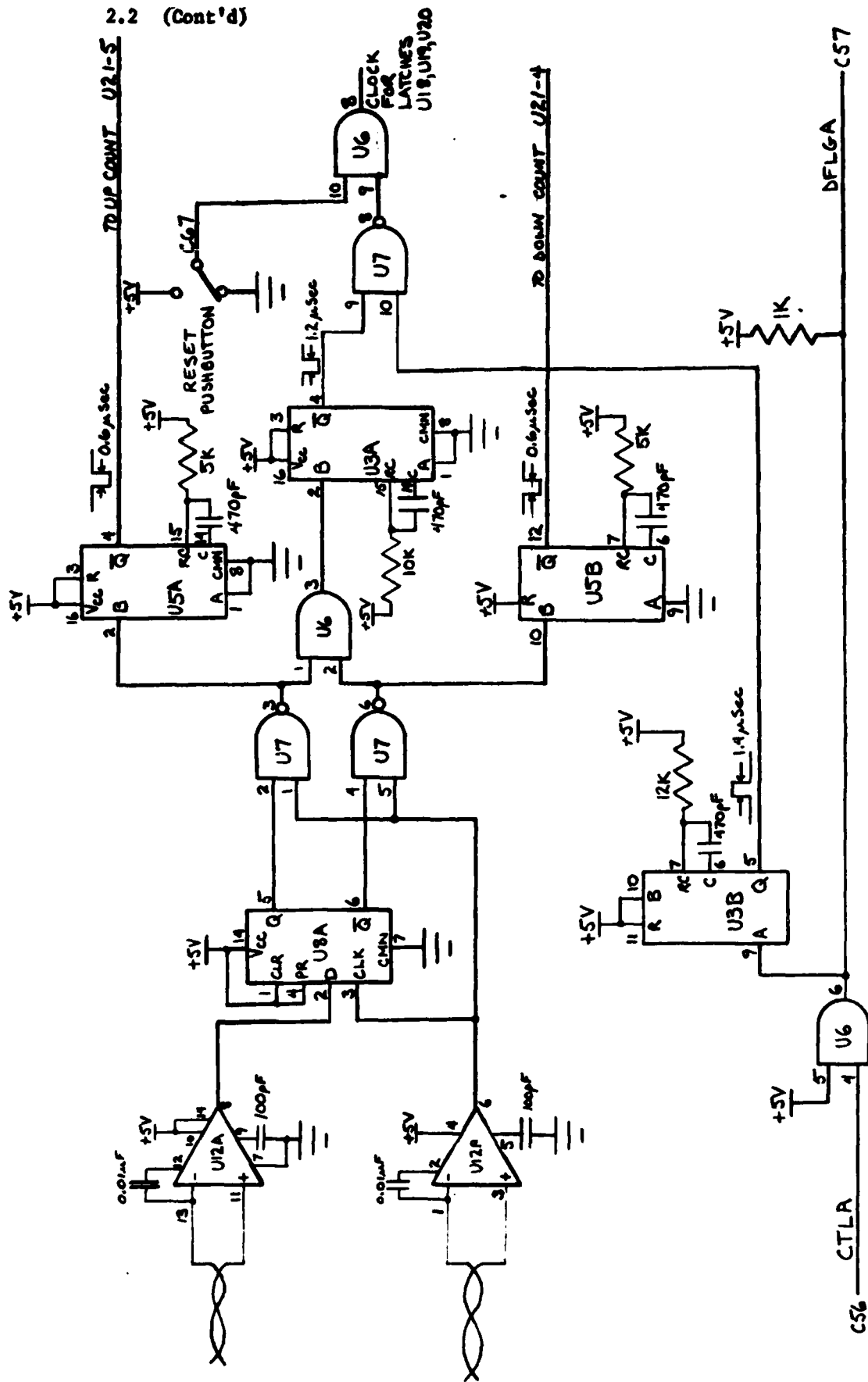


Figure 2.2-1. Recoil travel interface unit, block diagram.

2.2 (Cont'd)



U3, U5 - 74123
 U6 - 7408
 U7 - 5400
 U8 - 5474
 U12 - 8820

Figure 2.2-2.a. Interface unit circuit diagram.

U13, U14, U15, U16 - TIL 3112.2
 U21, U22, U23, U24 - 74192
 U18, U19, U20 - 74LS174 (Cont'd)

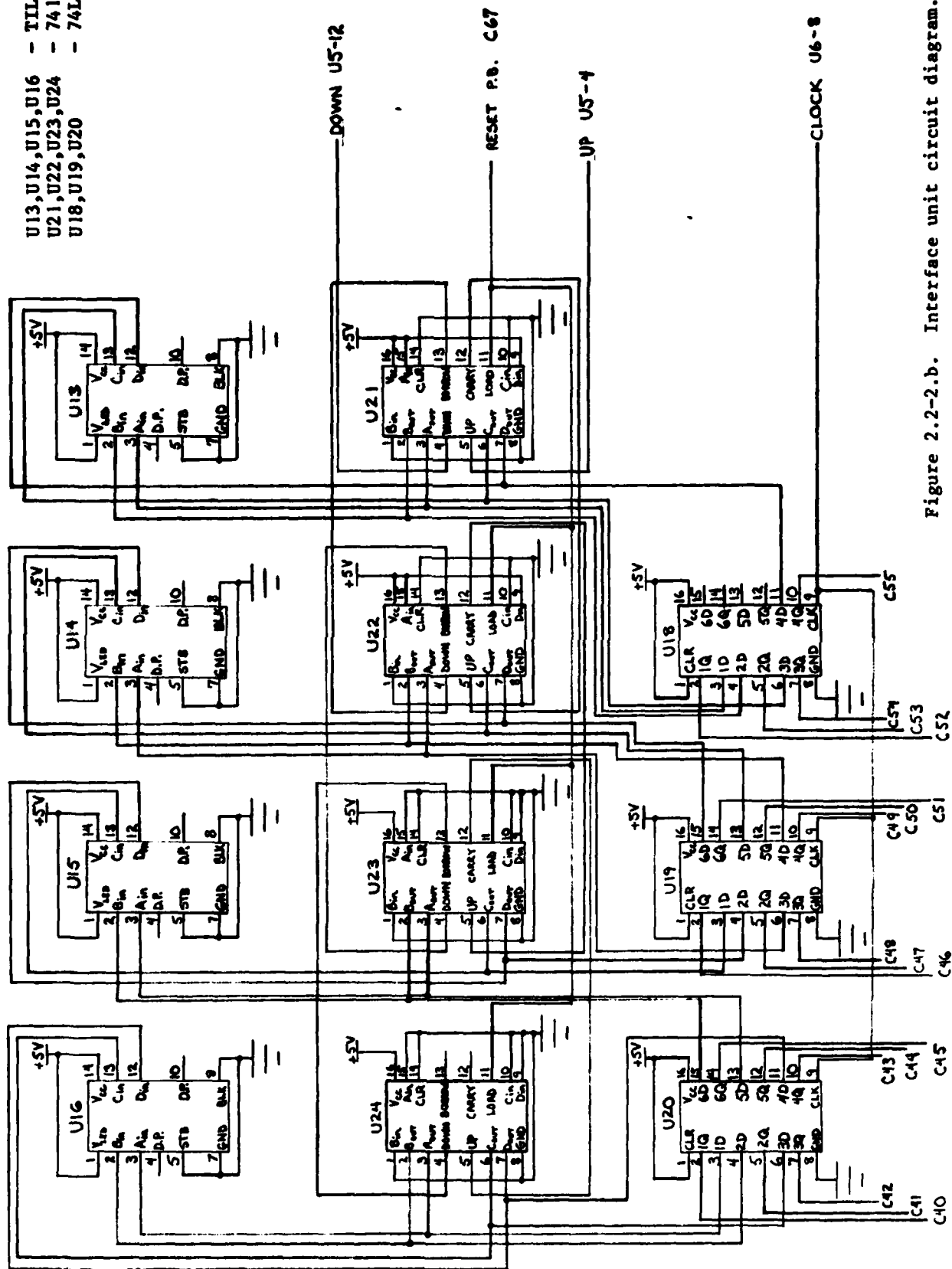
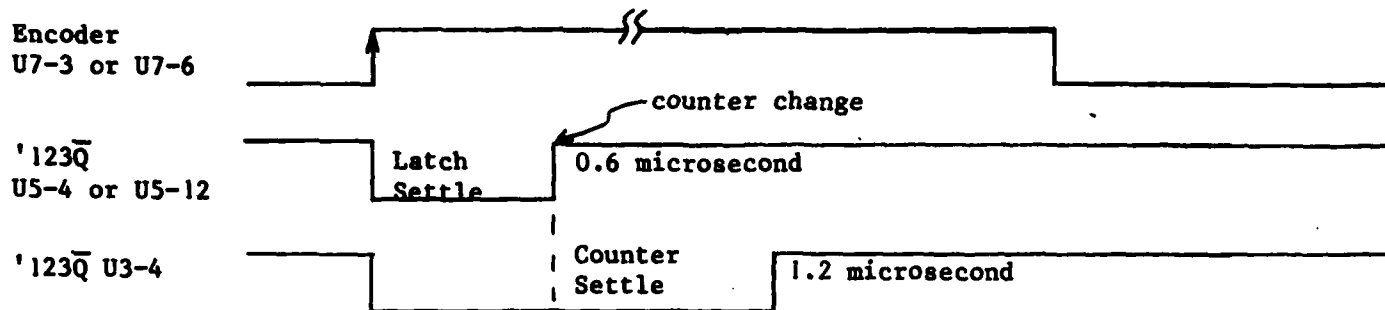
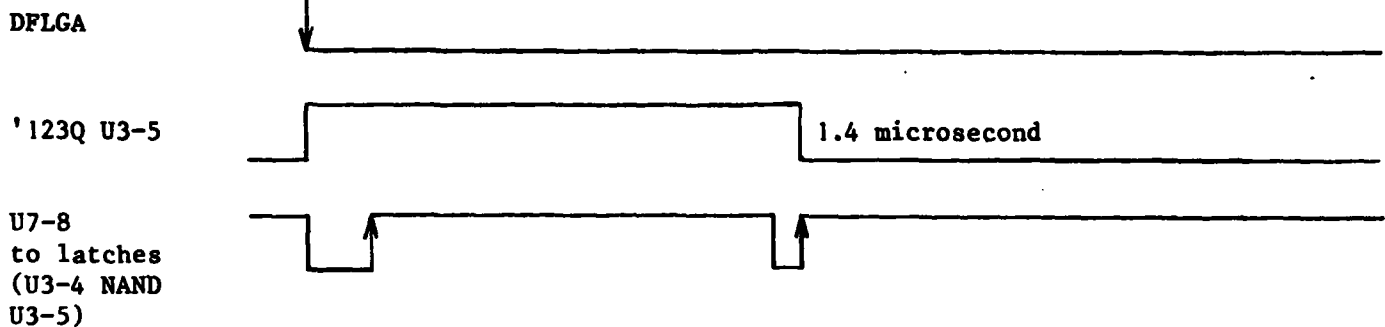


Figure 2.2-2.b. Interface unit circuit diagram.

2.2 (Cont'd)



Example 1:



Example 2:

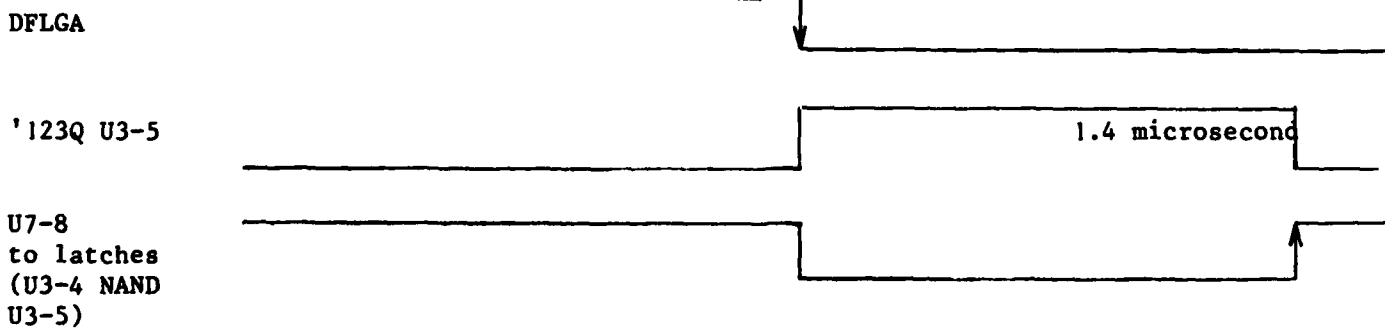


Figure 2.2-3. Interface unit timing diagram.

2.3 SOFTWARE DEVELOPMENT

The philosophy used in the software development was to take the data from the hardware circuitry and format it into a data file which is identical to that produced by a BTST. This format is described in detail in Appendix L of RDI Task Final Report of Research and Development of Software, Ballistic Test Site Terminal, C. L. Francis, Report APC-MT-5952, January 1984. The advantage of this technique is that all of the BTST software is available to plot and process the recoil travel data. The only disadvantage of this technique is that the hardware supports a range of 0 to 9999 counts but the BTST file format supports a range of -2048 to +2047. With the available rack and pinion gears and the anticipated weapon recoil ranges, this is not a problem as long as the reduced range is taken into account.

The software assigns channel 30 as the recoil travel channel. The labels, comments, and transducer gage factor are entered into this channel's parameter area. Since there is only one 32 channel BTST, this use of channel 30 generates no conflict with the other data acquisition channels. The data samples are stored in computer memory until the required number is obtained. Then the data samples are reformatted and written to disc in BTST data record format. In addition, a sample to sample difference is generated and stored as channel 31 to provide velocity versus time.

The software generated for this task consists of:

- a. FORTRAN program RCOIL which:
 - (1) Obtains number of samples to be taken.
 - (2) Starts data acquisition on command.
 - (3) Provides options of saving or forgetting data.
- b. HP 1000 assembly language routine READR which:
 - (1) Provides a synchronization pulse at the start of data acquisition cycle.
 - (2) Reads data from hardware using a software timing cycle and stores values in computer memory.
- c. FORTRAN subroutine RTRAN which:
 - (1) Stores available documentation information on disc.
 - (2) Reformats data samples and stores on disc in BTST format as channel 30.
 - (3) Stores sample to sample differences as channel 31.
- d. FORTRAN function JBCD which converts BCD data to 2's-complement binary data.

Listings of the software are contained in Appendix C.

2.4 FUTURE DEVELOPMENTS

2.4.1 Lower Temperature Range Expansion

Weapons are exposed to a variety of environmental conditions during developmental testing. The shaft encoder cited in this report is rated to -40°C (-40°F), and will operate properly for the majority of weapon tests conducted under cold temperature conditions. However, for testing conducted from -40°C to -53.9°C (-40°F to -65°F), addition of a heating element to the shaft encoder is planned. The element is expected to be a thin rubber mat, attached to the inner wall of the encoder. Current to the element will be controlled by a temperature sensor in the encoder, providing a feedback signal to circuitry in the BTST.

2.4.2 Integration into BTST

The standalone circuitry and software generated by this task provided an easy way to test the concept of using a digital shaft encoder to record recoil travel. Each BTST contains an Adaptive Sample Rate Digitizer (ASRD) which is described in detail in Appendix D of RDI Task Final Report of Research and Development of Software, Ballistic Test Site Terminal, C. L. Francis, Report APG-MT-5952, January 1984. If the analog-to-digital (A/D) converter board is removed from the ASRD and an appropriate interface card substituted, then the recoil travel channel can be recorded in the same manner as any other ballistic signal. By integrating the recoil travel into an ASRD channel, this data can now be synchronized with the other channels and all of the triggering and data compression features of an ASRD channel are available. The data word will be changed to 12 bit binary with a range of -2048 to $+2047$ instead of the current 16 bit BCD with a range of 0 to 9999. It should be possible to automatically reset the interface when an ASRD arm command is issued.

SECTION 3. APPENDICES

APPENDIX A - ILIR INVESTIGATION PROPOSAL AND AUTHORIZATION

DISPOSITION FORM

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REFERENCE OR OFFICE SYMBOL

SUBJECT

STEAP-MT-M

FY84 ILIR Program

TO Chief, ~~N&A Division~~ *g*

FROM Chief, M&TM Division

DATE 4 November 1983

CMT 1

G. Thomson/vh/2444

1. Authorization is hereby provided for the following ILIR Project (Encl 1):

TITLE/TRMS No. Digital Recoil Travel Measurement System/7-CO-IL4-API-001

2. This project has been assigned funding in the amount of \$5000 under XO/WO 30595401-02.

3. The special instructions contained in Enclosure 2 are applicable to this ILIR project. Assistance on matters pertaining to this project can be obtained from George Thomson, ext. 2444/2734.

2 Encl
as

Edward V. Somody
EDWARD V. SOMODY

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STEAP-MT-G

SUBJECT
In-House Laboratory Independent Research (ILIR) Projects
Proposals

THRU ~~C, Dal Meas Br~~ *PPD* FROM C, Fld Inst Sec DATE 18 Feb 83 CMT 1
Mr. Betzold/lv/2208

TO C, M&A Div

Attached is an ILIR project proposal.

1 Incl
as

Victor A. Betzold
VICTOR A. BETZOLD

STEAP-MT-G (18 Feb 83)

TO Chief, M&TM Div FROM Chief, M&A Div DATE 24 Feb 83 CMT 2
Mr. Fasig/kjz/4102

Recommend approval of this proposal.

J. W. Fasig
J. W. FASIG

STEAP-MT-G

THRU ~~C, Dal Meas Br~~ *PPD* FROM C, Fld Inst Sec DATE 18 Oct 83 CMT 3
C, M&A Div Mr. Betzold/lv/2208

TO C, M&TM Div

No funding has been received for this project. Completion of this project would vastly improve data acquisition for the LAT of the M198. The amount of \$5,000 is requested for fabrication of hardware and field testing.

Victor A. Betzold
VICTOR A. BETZOLD

1 Encl
nc

A-2

ILIR TASK PROPOSAL

TASK TITLE: Digital Recoil Travel Measurement System

PRINCIPAL INVESTIGATOR: V. A. Betzold

FUNDS REQUIRED: \$10,000

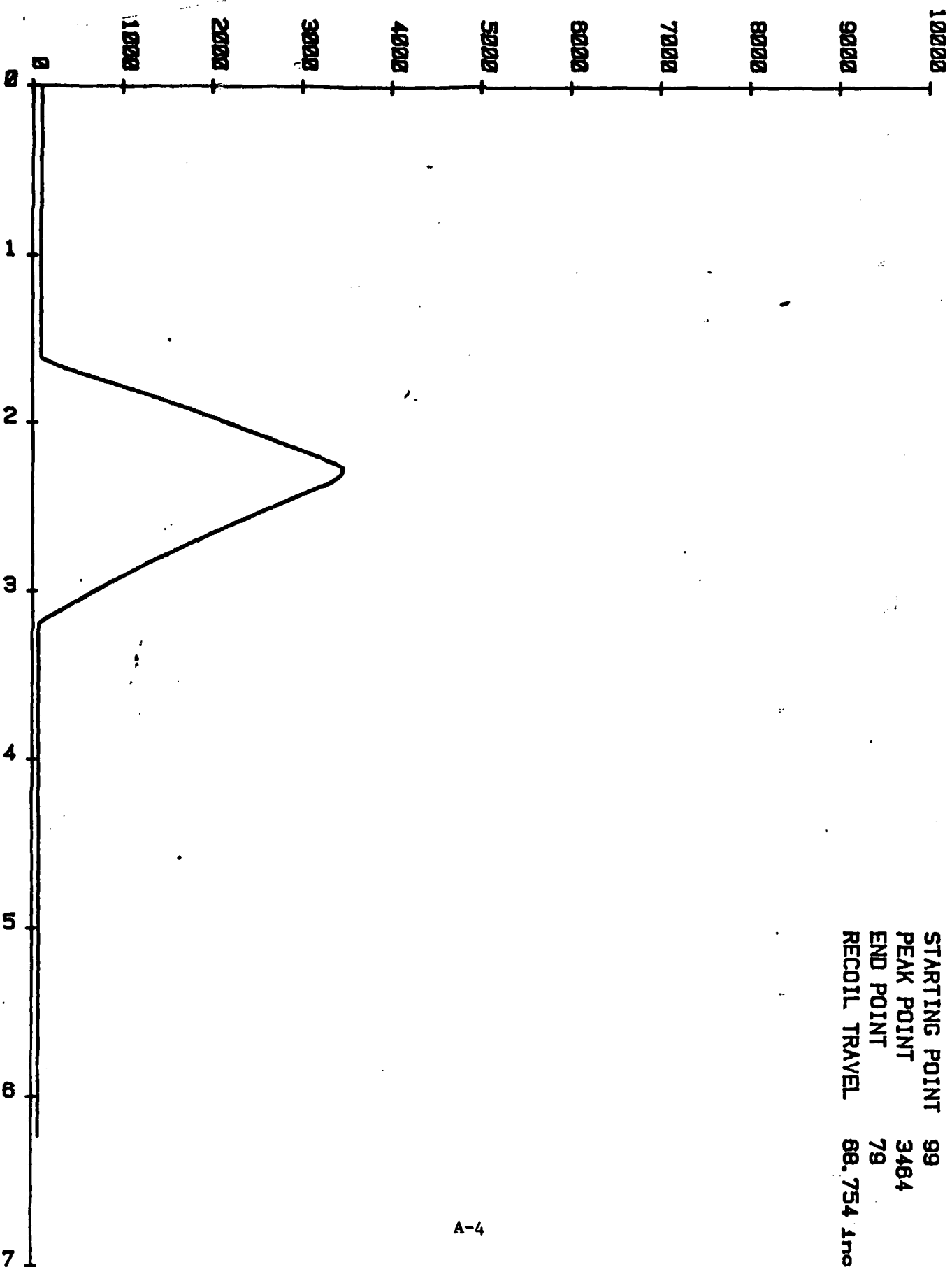
SCHEDULE:

<u>TASK</u>	<u>COMPLETION</u> <u>(Time from start - months)</u>
Hardware/Software Development	4
Field Testing	9
Complete Report	12

DESCRIPTION:

Recoil travel measurement of direct fire and artillery weapons is presently accomplished with analog potentiometers and analog recording facilities. The analog data is then processed at a later date by Analytical Branch. This data acquisition process contradicts the ADAPT concept: process the data on site to provide quality control and immediate feedback to the test director.

The Digital Recoil Travel Measurement System provides a direct interface to the ADAPT system. An incremental shaft encoder is used on the weapon in place of the potentiometers, and increments an up/down counter circuit. This circuit is interfaced to a desktop calculator or Ballistic Test Site Terminal computer, and plots of displacement vs time and velocity vs time can be generated at the test site. A sample plot of displacement vs time is attached. Commercial systems do not exist to meet this requirement.



APPENDIX B - ENCODER SPECIFICATIONS,
CONNECTOR PIN ASSIGNMENTS



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Industrial Encoder
Division

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Goleta, California 93117
(805) 968-0782

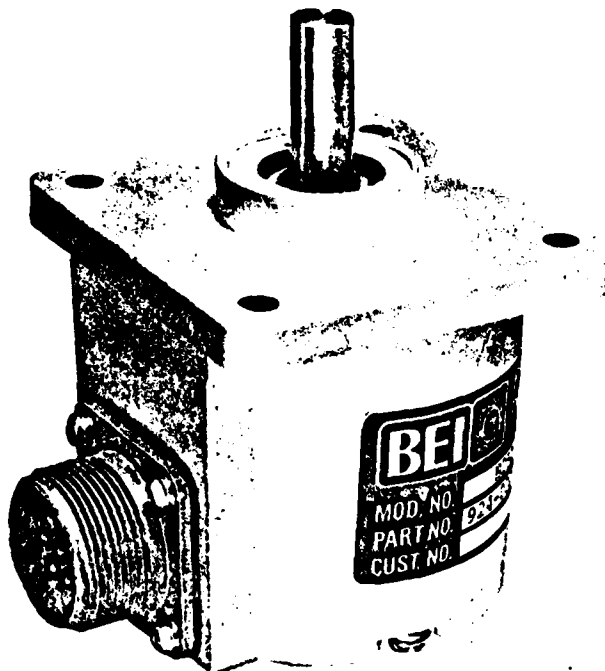
Specification

924 - 02002 - 001

General Specifications

Type H25

Incremental Optical Encoder



ACTUAL SIZE

Notice: The design and specifications of the instruments and accessories illustrated and described in this publication are subject to improvement without notice.

			PREP BY <i>mg</i> Doug McGuire 8/16/80
B	General Update	6/24/80	CHK <i>DL</i> Dale Laplante
A	Paragraph 3.5, Change 36° to 27°	1/23/80	APPD <i>JE</i> Jerry L. Jandt
REV	DESCRIPTION	DATE	© 1979 BEI Electronics, Inc.

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Division7230 Hollister Avenue
Coleta, California 93117
(805)968-0782

TITLE		NO.	Rev
General Specifications Type H25 Incremental Optical Encoder		924-02002-001	
		Sht <u>2</u> of <u>11</u>	B
1.0	Scope: This specification describes the BEI Industrial Encoder Division Heavy Duty Type H25 Incremental Optical Encoder.		
2.0	<u>Mechanical Specifications</u>		
2.1	Dimensions	See Figures 2, 3 and 4	
2.2	Shaft Diameter	Standard: .3747/.3745 Dia. Options: Available with stepped shaft .2497/.2495 Dia.	
2.3	Optional Flat on Shaft	.50 long X .03 deep	
2.4	Shaft Loading	Up to 40 lbs Axial and 35 lbs Radial	
2.5	Shaft Runout	.0005 T.I.R.	
2.6	Starting Torque at 25°C (Standard without shaft seal)	1.0 Oz. In. Max.	
2.7	Starting Torque at 25°C (With optional sealed bearings)	1.5 Oz. In. Max.	
2.8	Starting Torque at 25°C (With optional shaft seal)	5.0 Oz In. Max.	
2.9	Bearings	Class ABEC 7	
2.10	Shaft	416 Stainless Steel	
2.11	Housing and Cover	Die Cast Aluminum	
2.12	Bearing Life (mfg's specifications)	2 X 10 ⁸ Revs at rated shaft loading. 5 X 10 ¹⁰ Revs at 10% of rated shaft loading.	
2.13	Moment of Inertia	4.1 X 10 ⁻⁴ Oz. In. Sec. ²	
2.14	Slew Speed	5000 RPM Max.	
2.15	Weight	13 Oz. Typ.	

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TITLE	General Specifications Type H25 Incremental Optical Encoder	NO. 924-02002-001	Rev B
		Sht <u>3</u> of <u>11</u>	

3.0 Electrical Specifications

- | | | |
|-----|-----------------------|--|
| 3.1 | Code | Incremental |
| 3.2 | Cycles Per Shaft Turn | 1 to 2540 on code disk |
| 3.3 | Supply Voltage | See Table I |
| 3.4 | Current Requirements | TTL 200 Ma Max, 150 Ma Typ
CMOS 150 Ma Max, 125 Ma Typ |
| 3.5 | Output Format | 2 Channels (A and B) in
quadrature $\pm 270^\circ$ electrical
at 10 KHZ. See Figure I. |
| 3.6 | Output Format Options | Index & Complementary outputs
are available |
| 3.7 | Output Options | See Table I |

TABLE I

<u>I.C. Number</u>	<u>Type</u>	<u>Feature</u>	<u>Optional Pull-up Resistor</u>	<u>Output</u>	<u>Supply Voltage $\pm 5\%$</u>
SN7404	T ² L	Totem Pole		16 MA/5V	+5VDC
SN7406	T ² L	Open Collector Hi Voltage	470 Ohms	40 MA/30V	+5VDC
SN74C04	CMOS				5 to 15VDC*
MC680	HTL	Totem Pole			15VDC
MC681	HTL	Open Collector	15K Ohms		15VDC
MC689	HTL	Open Collector Hi-Voltage	15K Ohms	20V	15VDC
DM8830	T ² L	Line Driver			5VDC
MM88C30	CMOS	Line Driver			5 to 15VDC*

*Specify actual voltage



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TITLE		NO.	Rev
General Specifications Type H25 Incremental Optical Encoder		924-02002-001	B
		Sht <u>4</u> of <u>11</u>	
3.8	Illumination	Incandescent Lamp (40,000 hours life) or LED, optional	
3.9	Frequency Response	50 KHZ	
3.10	Frequency Response (Index)	20 KHZ	
4.0	<u>Environmental Specifications</u>		
4.1	Temperature	0 to 70°C Standard -25 to 90°C	
	Operating Storage		
4.2	Shock	50 G's for 11 MSEC duration	
4.3	Vibration	5 to 2000 HZ @ 20 G's	
4.4	Humidity	98% RH without condensation	
5.0	<u>Options</u> (For the following option capability, consult factory for complete specifications)		
5.1	Direction Sensing	Pulse Output X1, X2 or X4	
5.2	Interpolation	Multiplied Square Wave Output X5	
5.3	Dual Resolution	Selectable Output	
5.4	Sinewave	Differential amplified outputs	

B-4



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TITLE

General Specifications
Type H25
Incremental Optical Encoder

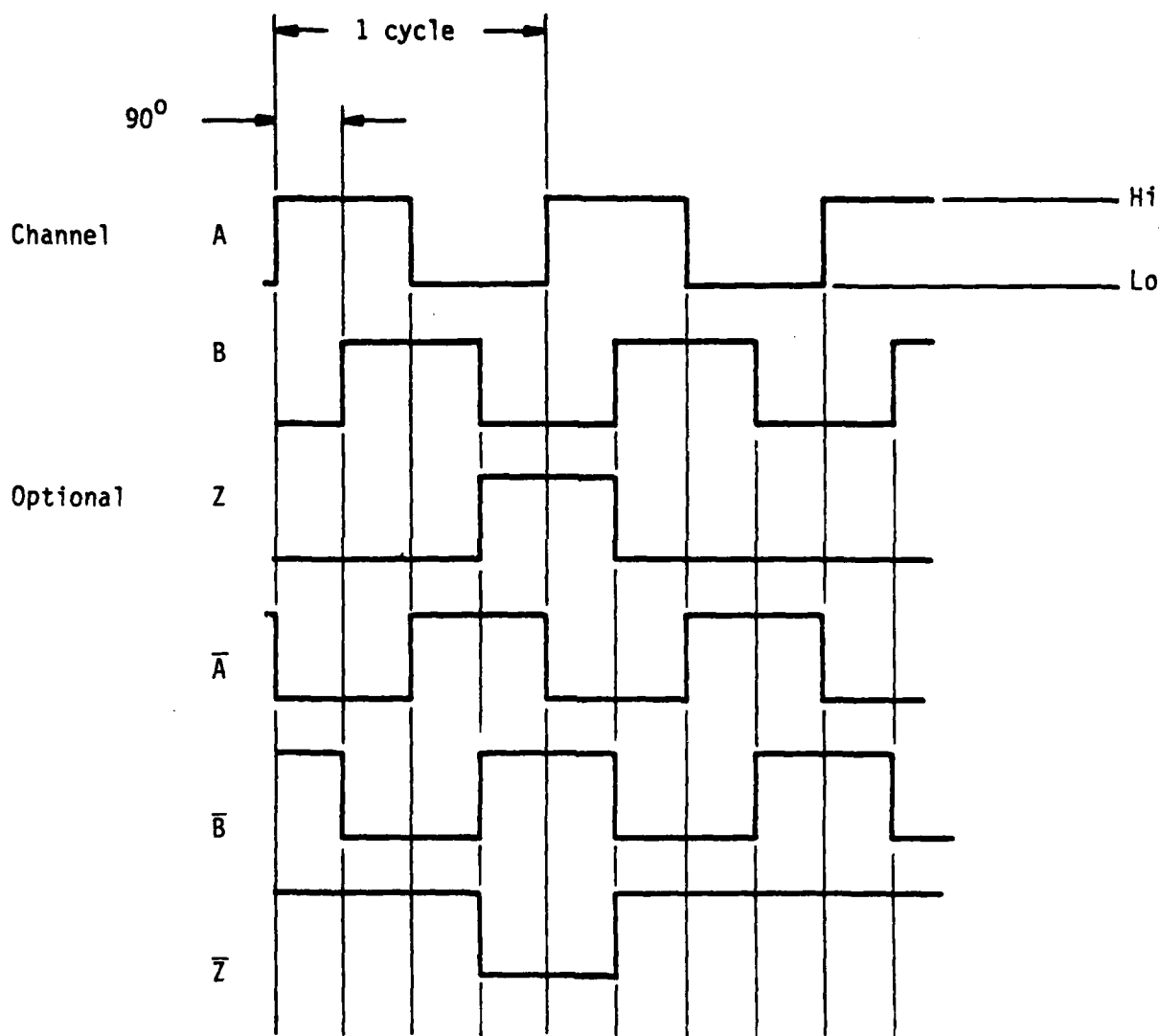
NO.

924-02002-001

Rev

Sht 5 of 11

B

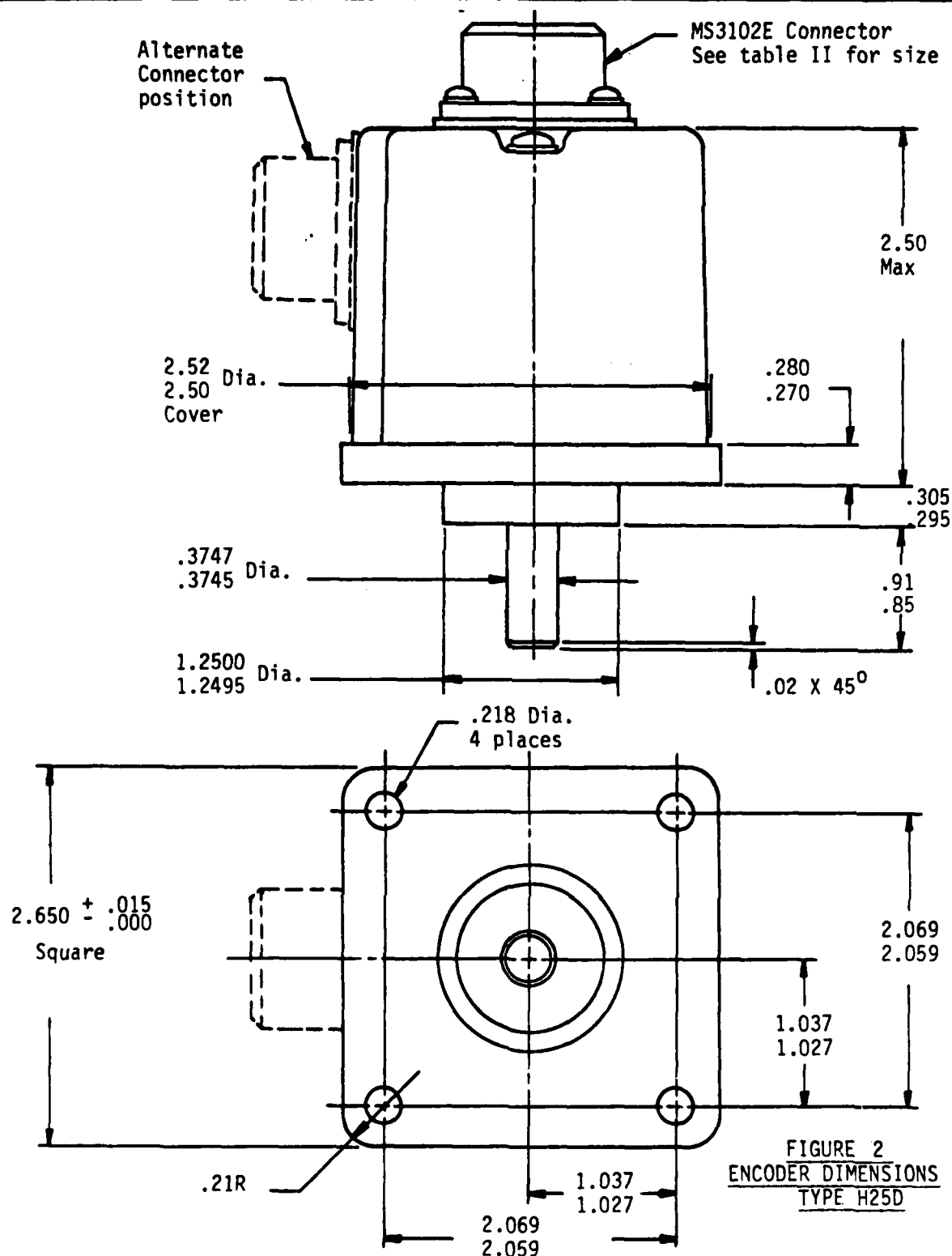


CCW ROTATION
VIEWING SHAFT



FIGURE I
OUTPUT WAVE FORMS

TITLE GENERAL SPECIFICATIONS Type H25 Incremental Optical Encoder	NO. 924-02002-001	Rev B
	Sht <u>6</u> of <u>11</u>	



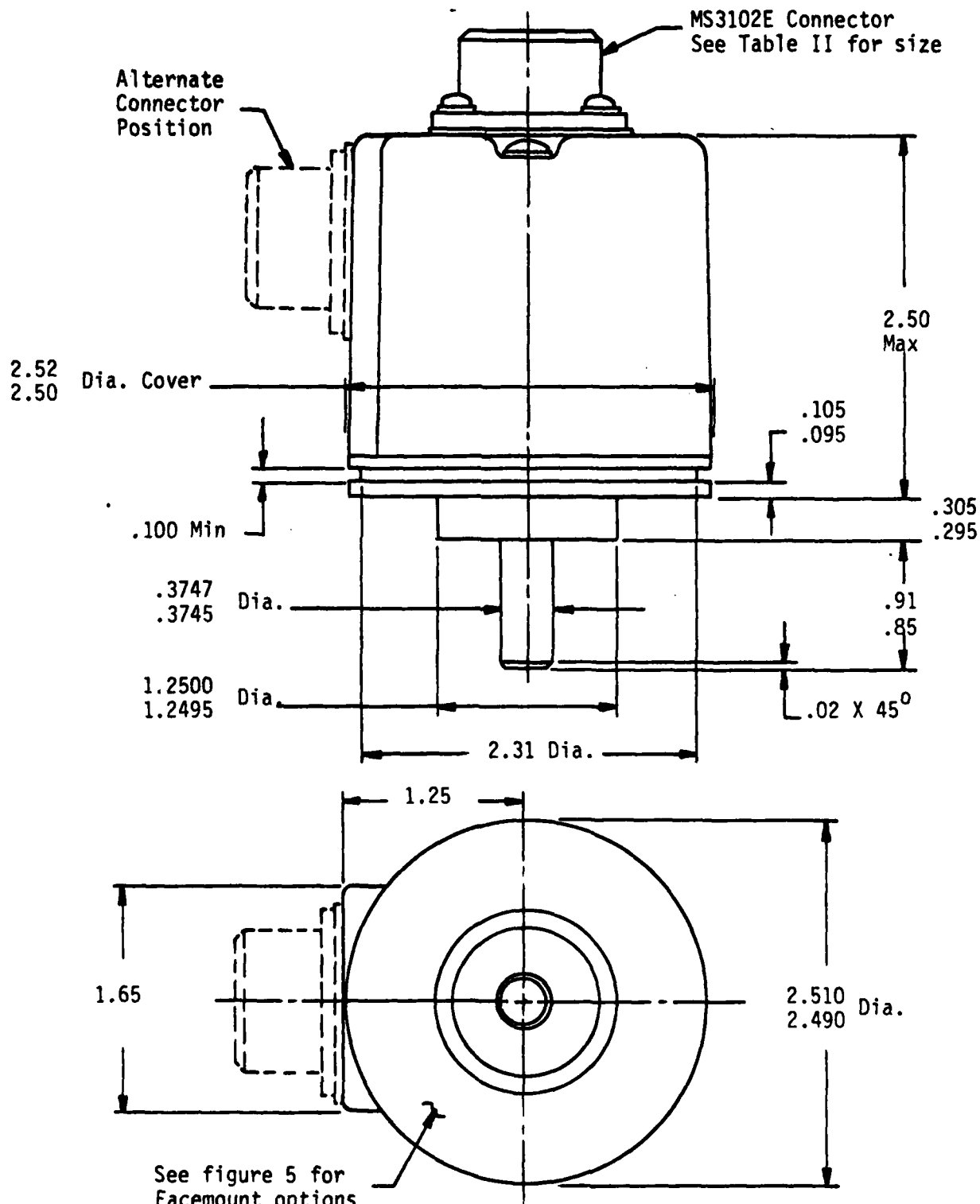


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TITLE	General Specifications Type H25 Incremental Optical Encoder	NO. 924-02002-001	Rev B
		Sht <u>7</u> of <u>11</u>	

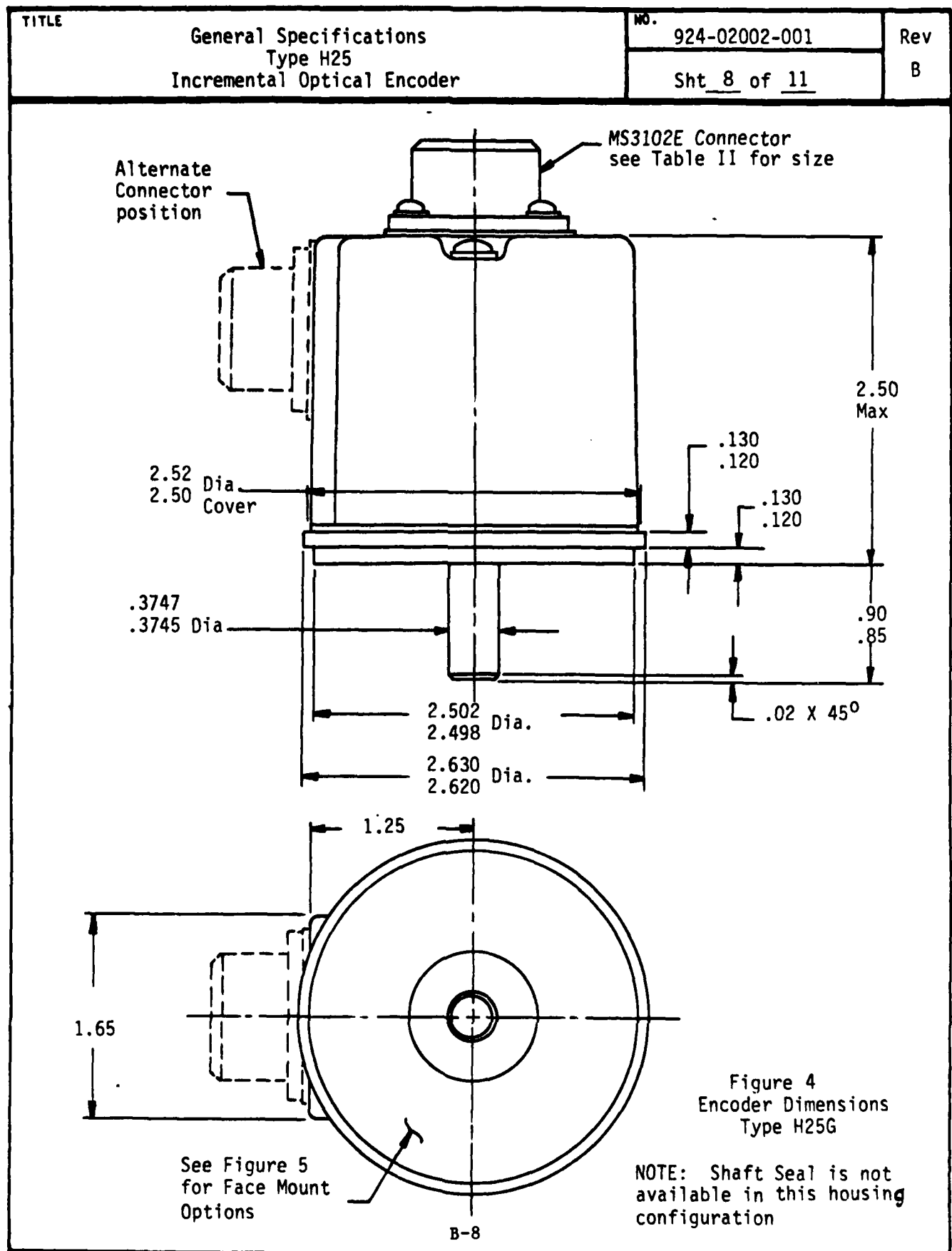


**FIGURE 3 - ENCODER DIMENSIONS
TYPE H25E**



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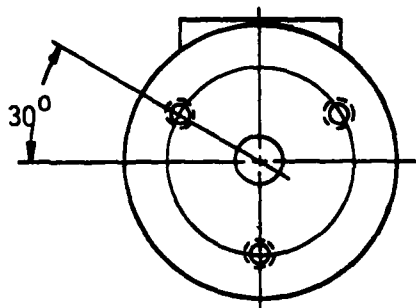
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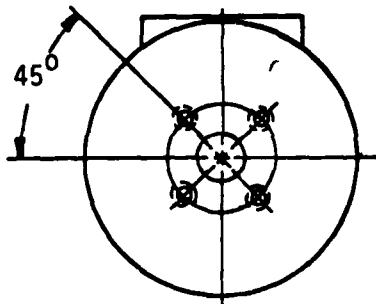
TITLE	General Specifications Type H25 Incremental Optical Encoder	NO.	Rev B
		924-02002-001	
		Sht 9 of 11	

FIGURE 5
Face Mount Options



F1

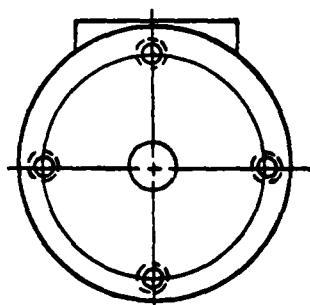
10-32 UNF-2B
.188 Min. Deep
3 places equally spaced on a
1.875 Dia. bolt circle.



F2

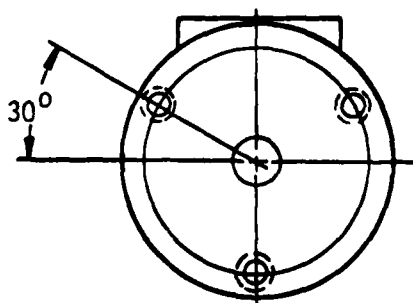
4-40UNC-2B
.250 Min. Deep
4 places equally spaced
on a 1.272 Dia. bolt circle
(.900 square, Ref)

Not available on H25D or H25E



F3

4-40UNC-2B
.250 Min. deep
4 places equally spaced
on a 2.000 Dia. bolt circle



F4

6.32UNC-2B
.250 Min. deep
3 holes equally spaced
on a 2.000 Dia. bolt circle



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TITLE General Specifications Type H25 Incremental Optical Encoder	NO. 924-02002-001	Rev B
	Sht <u>10</u> of <u>11</u>	

TABLE II

STANDARD CONNECTOR TERMINATIONS

CONNECTOR	MS3102E-16S-1P			MS3102E-18-1P	
OUTPUT OPTION	CHANNELS A, B AND Z	CH. A & B WITH COMPLEMENTS	CH. A & Z WITH COMPLEMENTS	PIN	CH. A, B & Z WITH COMPLEMENTS
PIN: A	CH. A	A	A	A	A
B	CH. B	B	$\bar{A}$	B	B
C	CH. Z	$\bar{A}$	Z	C	Z
D	+V	+V	+V	D	+V
E	NO CONN.	$\bar{B}$	$\bar{Z}$	E	NO CONN.
F	GROUND	GROUND	GROUND	F	GROUND
G	CASE GROUND	CASE GROUND	CASE GROUND	G	CASE GROUND
				H	$\bar{A}$
				I	$\bar{B}$
				J	$\bar{Z}$

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TITLE

General Specifications
Type H25
Incremental Optical Encoder

NO.

924-02002-001

Rev

Sht 11 of 11

B

6.0 Ordering Information: Encoder may be specified using the following model numbering system:TYPE:

H = Heavy Duty

H

BASIC SIZE:

25 = 2.500

25

HOUSING CONFIGURATION LETTER:

D = Square Flange (Fig. 2)

E = 2.50 Dia Servo Mount (Fig. 3)

G = 2.62 Dia Servo Mount (Fig. 4)

FACE MOUNT OPTIONS (Fig. 5)

F1, F2, F3, or F4

Blank = None

SHAFT SEAL CONFIGURATION:

SS = Shaft Seal (Not available on H25G)

SB = Seal, Integral with Bearing

Blank = Shielded Bearing

CYCLES PER TURN:

Enter Cycles:

500 = 500 cycles

2500 = 2500 cycles

Etc.

NO. OF CHANNELS:

A = Single Channel

AB = Dual Quadrature Channels

ABZ = Dual with Index

AZ = Single with Index

COMPLEMENTS:

C = Complementary Outputs

Blank = None

OUTPUT I.C.

7404, 7406, 8830 etc. (See Table I)

Followed by "R" = Pull-up Resistor

ILLUMINATION:

Blank = Incandescent (Standard)

LED = Light Emitting Diode (Optional)

OUTPUT TERMINATION LOCATION:

E = End

S = Side

OUTPUT TERMINATION:

M16 = MS3102E16S-1P Connector

M18 = MS3102E18-1P Connector

S = Special Non-Standard Features
specified on purchase order or
customer's spec.

Interface Unit Cannon PlugEncoder Plug

<u>Pin</u>	<u>Function</u>	<u>Pigtail</u>	<u>Cable</u>	<u>Pin</u>
A	Output B	Brown	Brown	A
B	Output A	Red	Red	B
C	Output $\bar{B}$	Orange	Orange	C
D	V+	Yellow	Yellow	D
E	Output $\bar{A}$	Green	Green	E
F	V-	Blue	Blue	F
G	Sen +	White	White	D
H	Sen -	Black	Black	F
J	Case Ground	Shield	Shield	G

Interface Unit and Encoder Connector Terminations.

HEWLETT-PACKARD 1000 COMPUTER INTERFACE CABLE

Edge Connector Pin	D Connector Pin	Function
1	1	Bit 0
2	2	Bit 1
3	3	Bit 2
4	4	Bit 3
5	5	Bit 4
6	6	Bit 5
7	7	Bit 6
8	8	Bit 7
9	9	Bit 8
10	10	Bit 9
11	11	Bit 10
12	12	Bit 11
13	13	Bit 12
14	14	Bit 13
15	15	Bit 14
16	16	Bit 15
Z	22	Command
AA	23	Device Flag
BB	24	Ground

Hewlett-Packard 1000 Computer Interface Connector Terminations

APPENDIX C - SOFTWARE LISTINGS

***** T=00000 IS ON LU 08

```

0001 FTM4
0002 PROGRAM RCOIL(), REV A 2NOV83 CLF
0003 C
0004 C *****
0005 C
0006 C THIS PROGRAM ALLOWS RECOIL TRAVEL DATA TO BE TAKEN USING A SHAFT
0007 C ENCODER, COUNTER CIRCUIT AND 12566B/C COMPUTER INTERFACE. THE
0008 C PROGRAM USES OFF-LINE DRIVER PROGRAM READR TO TAKE THE SAMPLES
0009 C FROM THE COUNTER CIRCUIT AND STORE THEM IN COMPUTER MEMORY. A
0010 C SOFTWARE TIMING LOOP IS USED TO MAKE MEASUREMENTS AT 1.28 MILLI-
0011 C SECOND INTERVALS. THE BUFFER SIZE IS 1K-12K IN 1K INCREMENTS.
0012 C DATA ACQUISITION IS INITIATED UNDER OPERATOR CONTROL. WHEN THE
0013 C BUFFER HAS BEEN FILLED THE DATA IS TRANSFERRED TO DISC BY SBRTH
0014 C RTRAN. RTRAN PLACES THE DATA IN AN ADCHK FORMAT III DATA FILE.
0015 C IN ADDITION THE VELOCITY IS CALCULATED BY DIFFERENCING THE
0016 C DISPLACEMENT DATA.
0017 C
0018 C TO USE THE PROGRAM THE FOLLOWING STEPS SHOULD BE FOLLOWED:
0019 C
0020 C 1. USING THE PA COMMAND MAKE APPROPRIATE ENTRIES FOR PARAMETERS
0021 C 17 - GAGE FACTOR(DISTANCE/COUNT)
0022 C 20 - UNITS
0023 C 22 THRU 24 - TRANSDUCER DESCRIPTION
0024 C 25 THRU 27 - PLOT LABELS & REMARKS
0025 C WHEN FINISHED, SET PARAMETER 1 (SELECTED) TO NO.
0026 C
0027 C 2. AFTER COMPLETING LO & AR FOR THE ASRD CHANNELS, RU,RCOIL
0028 C ENTER THE DATA SIZE DESIRED. WHEN READY TO TAKE DATA, HIT
0029 C CARRIAGE RETURN. IF NECESSARY TO GET OUT TYPE EX.
0030 C
0031 C 3. WHEN DATA ACQUISITION IS COMPLETED, DETERMINE IF DATA IS TO
0032 C BE SAVED.
0033 C
0034 C RU,RCOIL,INTRCTV LU(DFLT=1),DATA DISC LU(DFLT=19),
0035 C DATA START TRACK(DFLT=DIRECTORY)
0036 C
0037 C REV A 28MAR83 CLF ORIGINAL.
0038 C 2NOV83 CLF ADD CHECKS FOR EXIT & SAVING DATA.
0039 C
0040 C *****
0041 C
0042 C DIMENSION IPRM(5)
0043 C COMMON IBUF(12288)
0044 C ***** GET RUN TIME PARAMETERS
0045 C CALL RMPAR(IPRM)
0046 C LU=IPRM(1)
0047 C IF(LU.EQ. 0)LU=1
0048 C LUDK=IPRM(2)
0049 C IF(LUDK.EQ. 0)LUDK=19
0050 C IDTRK=IPRM(3)
0051 C IF(IDTRK.EQ. 0)IDTRK=-1
0052 C ***** GET OPERATOR ENTRIES
0053 C WRITE(1,100)
0054 C 100 FORMAT("ENTER NO OF K-WORDS OF DATA TO TAKE: ")
0055 C READ(1,*)NWORDS
0056 C IF(NWORDS.LT. 1 .OR. NWORDS.GT. 12)GO TO 200
0057 C NWORDS=NWORDS+1024
0058 C ***** CHECK IF READY FOR DATA OR EXIT
0059 C WRITE(LU,120)
0060 C 120 FORMAT("ENTER CARRIAGE RETURN TO TAPE DATA - EX TO TERMINATE: ")
0061 C READ(LU,140)IANS
0062 C 140 FORMAT(A2)
0063 C IF(IANS.EQ. 2HEX)GO TO 200
0064 C ***** TAKE DATA
0065 C CALL READRCOIL(NWORDS)
0066 C ***** CHECK IF DATA IS TO BE SAVED
0067 C 160 WRITE(LU,180)
0068 C 180 FORMAT("SAVE DATA IN MEMORY ON DISC(YE OR NO)? ")
0069 C READ(LU,140)IANS
0070 C IF(IANS.NE. 2HEX .AND. IANS.NE. 2HNO)GO TO 160
0071 C IF(IANS.EQ. 2HNO)GO TO 200
0072 C ***** WRITE DATA TO DISC
0073 C CALL RTRAN(LU,LUDK,IDTRK,NWORDS)
0074 C ***** DONE
0075 C 200 END
0076 C END#

```

***** T=00000 IS ON LU 08

```

0001 ASMB
0002 NAM READR REV B 05JAN84 CLF
0003 *
0004 *****
0005 *
0006 * THIS SUBROUTINE READS THE OPTICAL SHAFT ENCODER RECOIL TRAVEL
0007 * TRANSDUCER AND FILLS A BUFFER WITH THE READINGS.
0008 *
0009 * A SOFTWARE TIMING LOOP IS USED TO GENERATE THE TIMING INTERVAL
0010 * FOR TAKING THE READINGS. IT IS SET TO TAKE A READING EVERY
0011 * 1280 MICROSECONDS(RATE 5 OF THE ASRD).
0012 *
0013 * THE 12566B 12566C CARD MUST BE JUMPED TO PROVIDE:
0014 *
0015 * W1 = B B POSITIVE TRUE COMMAND
0016 * W2 = A A CLEAR DEVICE FF ON POSITIVE EDGE OF FLAG
0017 * W3 = A A STROBE DATA IN ON POSITIVE EDGE OF FLAG
0018 * W4 = DONT CARE
0019 * W5 =
0020 * W8 = IN OUT LATCH INPUTS ON FLAG
0021 * W9 = DONT CARE
0022 * W10 = B 12566B COMPATIBILITY
0023 * W11 = OUT POSITIVE TRUE
0024 * W12 = IN POSITIVE TRUE
0025 * W13 = OUT
0026 *
0027 * REV B 05JAN84 CLF ADD OUTPUT ON BIT 0 TO START EXTERNAL CHANNEL.
0028 * REV A 28MAR83 CLF ORIGINAL.
0029 *
0030 *****
0031 *
0032 ENT READR
0033 EXT $LIBR,$LIBR,ENTR
0034 *
0035 *****
0036 *
0037 * THE MICROCIRCUIT REGISTER SELECT CODE MUST
0038 * BE SET CORRECTLY BELOW FOR THIS SUBROUTINE TO WORK
0039 MCKT EQU 21B
0040 *
0041 *****
0042 *
0043 STOR BSS 2
0044 READR NOP
0045 JSB ENTR
0046 DEF STOR
0047 LDA STOR GET BUFFER ADDRESS
0048 STA IBUFA SAVE ADDRESS
0049 LDA STOR+1,I GET WORD COUNT
0050 CMA,INA NEGATE COUNT
0051 STA COUNT SAVE WORD COUNT
0052 JSB $LIBR SHUT OFF INTERRUPTS
0053 NOP
0054 *
0055 ***** OUTPUT A LOW TO BIT 0
0056 *
0057 CLA CLEAR A
0058 ORA MCKT SEND TO MCKT CARD
0059 *
0060 *
0061 ***** START DATA ACQUISITION LOOP
0062 *
0063 LOOP LDA DELAY LOAD SOFTWARE DELAY LOOP VALUE
0064 STA DELWD SAVE DELAY
0065 ISZ DELWD INCREMENT DELWD
0066 JMF *-1 WAIT
0067 NOP KILL 1 MICROSECOND
0068 STC MCKT,C SET COMMAND & CLEAR FLAG
0069 SFS MCKT CHECK IF DATA IS READY
0070 JMP *-1 IF NOT WAIT
0071 LIA MCKT GET READING
0072 STA IBUFA,I SAVE IT
0073 ISZ IBUFA INCREMENT ADDRESS
0074 ISZ COUNT INCREMENT COUNT
0075 JMP LOOP CONTINUE IF NOT DONE
0076 *
0077 ***** RESTORE A ONE TO BIT 0 OUTPUT REGISTER
0078 *

```

```

0079          CLA          CLEAR A
0080          INA          SET A TO 1
0081          OTA MCKT     SEND TO MCKT CARD
0082          *
0083          ***** DONE
0084          *
0085          CLF MCKT      PREVENT ILL INT
0086          CLC MCKT      PREVENT ILL INT
0087          JSB $LIBX     TURN INT SYSTEM ON
0088          DEF ++1
0089          DEF ++1
0090          JMP READR, I
0091          *
0092          ***** DEFINE CONSTANTS
0093          *
0094          IBUFA BSS 1
0095          COUNT BSS 1
0096          DELWD BSS 1
0097          DELAY DEC -542
0098          END

```

***** T=00000 IS ON LU 08

```

0001 FTN4
0002 FUNCTION JBOD(IWORD), REV A 15SEP82 CLF
0003 C
0004 C*****
0005 C
0006 C THIS FUNCTION TAKES A FOUR DIGIT BINARY CODED DECIMAL(BCD) INPUT
0007 C AND RETURNS THE INTEGER VALUE OF THE FOUR BCD DIGITS.
0008 C
0009 C INPUT ARGUMENT: IWORD - 16 BIT INTEGER WORD CONTAINING FOUR BCD
0010 C DIGITS. IWORD IS NOT CHANGED. THE BCD
0011 C FORMAT IS:
0012 C BITS 15 ..... 0.
0013 C
0014 C
0015 C BIT
0016 C WEIGHT
0017 C
0018 C
0019 C
0020 C
0021 C
0022 C
0023 C
0024 C
0025 C
0026 C
0027 C
0028 C
0029 C
0030 C

```

	8	4	2	1		8	4	2	1										
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

```

0021 C
0022 C
0023 C
0024 C
0025 C
0026 C
0027 C
0028 C
0029 C
0030 C

```

REV A 15SEP82 CLF ORIGINAL

```

0021 C*****
0022 C
0023 C
0024 C
0025 C
0026 C
0027 C
0028 C
0029 C
0030 C

```

ISIGN=0
IF(IWORD.LT.0)ISIGN=1
JBOD=IAND(IWORD,17B) + 10*(IAND(IWORD,360B)/16) +
* 100*(IAND(IWORD,7400B)/256) + 1000*(IAND(IWORD,70000B)/4096)
* + 8000*ISIGN
RETURN
END
END\$

***** T=00000 IS ON LU 08

```
0001 FTN4
0002 SUBROUTINE RTRAN(LU,LUOK,IDTRK,NWORDS), REV A 2NOV83 CLF
0003
0004 *****
0005
0006 THIS SUBROUTINE TRANSFERS THE DATA STORED IN CPU MEMORY
0007 BY SUBROUTINE READR TO DISC. THE DATA IS STORED ON A BTST
0008 DATA LU IN ADCHK FORMAT III AS CHANNEL 30.
0009 IN ADDITION, THE VELOCITY IS CALCULATED FROM THE DATA IN
0010 THE BUFFER AND STORED AS CHANNEL 31.
```

SUBROUTINE ARGUMENTS:

```
0011
0012 LU - LOGICAL UNIT OF OPERATOR TERMINAL
0013
0014 LUOK - DISC LU WHERE DATA IS TO BE STORED
0015
0016 IDTRK - DISC TRACK WHERE DATA IS TO BE STORED
0017 IF -1, DIRECTORY WILL BE USED TO FIND LOCATION
0018
0019 NWORDS - NUMBER OF WORDS OF DATA STORED IN MEMORY
0020
0021
0022
```

The general sequence of the file is as follows:

```
0023 -----
0024 ROUND HEADER
0025 CHANNEL POINTERS
0026 FILE COMMENTS
0027 SPARE
0028 DOCUMENTATION INFORMATION FOR CHANNEL 30
0029 DOCUMENTATION INFORMATION FOR CHANNEL 31
0030 DATA WORDS FOR CHANNEL 30
0031 DATA WORDS FOR CHANNEL 31
0032 REMAINDER OF TRACK IS FILLED WITH ZEROS
0033
0034
0035
0036
0037 -----
```

ROUND HEADER FORMAT - SECTOR 0 OF DATA FILE:

Word	Contents
1 & 2	This is a floating point number which is a count of the number of words in the file including round header, channel pointers, channel documentation and channel data.
3,4	Not used - set to 0.
5 thru 64	ROUND HEADER information in ASCII format taken from sector 6 of track 1 of the data lu. See program HDRR for specific usage of these words. This information can be read using the RH command of ADCHK.

CHANNEL POINTERS FORMAT - SECTOR 1 OF DATA FILE:

word	channel	
1,2	0	The pointer contains a real word which is the location of the start of the channel data sector in the start of the data file. If a channel is not selected its value is -1.0. If the channel is selected but no data was taken, its value is 0.
3,4	1	
63,64	31	

FILE COMMENTS - SECTOR 2 OF DATA FILE

This sector is filled with blanks by TRANS. After the data file is created, this sector can be used to record comments on the file.

SPARE - SECTOR 7 OF DATA FILE

0079	C
0080	C
0081	C
0082	C
0083	C
0084	C
0085	C
0086	C
0087	C
0088	C
0089	C
0090	C
0091	C
0092	C
0093	C
0094	C
0095	C
0096	C
0097	C
0098	C
0099	C
0100	C
0101	C
0102	C
0103	C
0104	C
0105	C
0106	C
0107	C
0108	C
0109	C
0110	C
0111	C
0112	C
0113	C
0114	C
0115	C
0116	C
0117	C
0118	C
0119	C
0120	C
0121	C
0122	C
0123	C
0124	C
0125	C
0126	C
0127	C
0128	C
0129	C
0130	C
0131	C
0132	C
0133	C
0134	C
0135	C
0136	C
0137	C
0138	C
0139	C
0140	C
0141	C
0142	C
0143	C
0144	C
0145	C
0146	C
0147	C
0148	C
0149	C
0150	C
0151	C
0152	C
0153	C
0154	C
0155	C
0156	C
0157	C
0158	C

sector words

1,2	1-128
3	1
	2-22
	23
	24-34
	35-36
	37
	38
	39
	40
	41, 42
	43-64

Post event notes. This area is set to ASCII blanks by TRANS for later use by the NO command of ADCHK.

The first selected channels data words follow the notes sector. The location is obtained from the channel pointers in sector 1 of the first track of the data file. The number of words that a channel can take varies from 1024-12288 in 1024 steps.

The data values in memory are in BCD format. Function JBOD is used to convert the values to integer and they are stored in the data file on disc in integer format. The memory values range from 0-9999 but are offset and limited to -2048 to 4047. The rate is added in to produce a data word format identical to a standard ADCCHK data word (FORMAT II).

REV A 29MAR83 CLE ORIGINAL.
2NOV83 CLE MODIFY FOR FORMAT III TO GET ADDED RANGE.

```
DIMENSION MBUF(256),ICOUNT(2),ILBL(17),IUNITS(15)
**** THE DATA VALUES ARE PASSED INTO THIS SUBROUTINE THRU IBUF
COMMON IBUF(12288)
EQUIVALENCE (ICOUNT,ICOUNT(1))
DATA IBLNK/24 /,ICHAN/34/,IREAD/1/,IWRT/2/,IRATE/500000/,
DATA ILBL/2HDE,CHCO,2HIL,2H V,2HEL,CHOC,2HI1,2H ,2HDE,2H+1,2HDC
+ 2HO ,2HER,CHOM,2H C,2H+ ,2HEC/
DATA IUNITS/2H F,2HER,2H S,2HED,2HON,2HI- ,2+2H /,IBRATE/5/
```

```
***** CHECK IF DIRECTORY IS TO BE USED -- USE KDIR AS A SWITCH
***** TO INDICATE IF HEADER IS TO BE USED.
```

```

IFCIDIWK .NEL. -> 000 TO 100
KDIR=1
***** READ DIRECTORY
CALL EXECI(PSW,LOCUS,ME,1,255,1,0)
***** MBUF(2) HAS # OF DATA FILES IN DIRECTORY
***** CHECK FOR FULL DIRECTORY
IF(MBUF(2).LT.127000 TO 40)
WRITE(1,20)
20 FORMAT("DIRECTORY FULL -- TRANSFER NOT INITIATED")
RETURN

```

```

40 NFILE=MBUF(2)
   (ISTR=MBUF(1)*4+3+10+MBUF(NFILE*2+2)
   IDTR=ISTR
****+ CHECK FOR FILLED DISC
   IF(LOOK_GE_15_AND_ISTR_LT_101750) GO TO 120

```

```

0159 IF(LUDK.EQ.18.AND.ISTRK.LT.196)GO TO 120
0160 IF(LUDK.GE.19)NLEFT=1023-ISTRK+1
0161 IF(LUDK.EQ.18)NLEFT=202-ISTRK+1
0162 WRITE(LU,60)NLEFT
0163 60 FORMAT("ONLY ",I4," TRKS REMAIN--CONTINUE(Y OR N)?_")
0164 READ(LU,80)I
0165 80 FORMAT(A1)
0166 IF(I.NE.1HY)RETURN
0167 C ***** CHECK FOR INVALID TRACKS
0168 120 IF(ISTRK.GE.2)GO TO 200
0169 WRITE(LU,140)
0170 140 FORMAT("TRACKS 0 & 1 ARE NOT VALID FOR TR COMMAND")
0171 RETURN
0172 C
0173 C ***** BEGIN TRANSFER PROCEDURE
0174 C
0175 200 WRITE(LU,220)
0176 220 FORMAT("BEGIN TRANSFER.")
0177 C ***** READ HEADER
0178 CALL EXEC(IREAD,LUDK,MBUF,64,1,6)
0179 C ***** SET WORDS 1 & 2 TO TOTAL WORD COUNT
0180 COUNT=768.+FLOAT(NWORDS*2-1)
0181 MBUF(1)=ICOUNT(1)
0182 MBUF(2)=ICOUNT(2)
0183 C ***** ZERO WORDS 3 & 4
0184 MBUF(3)=0
0185 MBUF(4)=0
0186 C ***** SET FIRST 30 ADDRESSES STORED IN SECTOR 1 TO -1
0187 COUNT=-1.
0188 DO 260 I=1,31
0189 J=64+2*I
0190 MBUF(J-1)=ICOUNT(1)
0191 MBUF(J)=ICOUNT(2)
0192 260 CONTINUE
0193 C ***** SET CHANNEL 30 ADDRESS TO 769
0194 COUNT=769.
0195 MBUF(125)=ICOUNT(1)
0196 MBUF(126)=ICOUNT(2)
0197 C ***** SET CHANNEL 31 ADDRESS
0198 COUNT=COUNT+FLOAT(NWORDS)
0199 MBUF(127)=ICOUNT(1)
0200 MBUF(128)=ICOUNT(2)
0201 C
0202 C ***** INSERT DATA FILE NOTES SECTOR (ALL BLANKS)
0203 C
0204 DO 280 J=129,192
0205 280 MBUF(J)=IBLNK
0206 C
0207 C ***** INSERT SPARE SECTOR FOR FUTURE EXPANSION (ALL ZEROS)
0208 DO 300 J=193,256
0209 300 MBUF(J)=0
0210 C ***** WRITE FIRST FOUR SECTORS TO DISC
0211 CALL EXEC(IMRT,LUDK,MBUF,256,ISTRK,0)
0212 C
0213 C ***** INSERT CHANNEL DOCUMENTATION FOR RECOIL TRAVEL (CH 30)
0214 C
0215 C ***** GET CHANNEL SETUP PARAMETERS
0216 ISCTR=3*ICHAN
0217 CALL EXEC(IREAD,LUDK,MBUF,128,0,ISCTR)
0218 C ***** SET CHANNEL 30 TO SELECTED
0219 MBUF(1)=1318
0220 C ***** FILL CHANNEL LOG PARAMETERS
0221 MBUF(129)=ICHAN
0222 DO 320 J=2,64
0223 320 MBUF(128+J)=0
0224 MBUF(151)=IBRATE
0225 C ***** GET SCALE FACTOR(=GAGE FACTOR)
0226 MBUF(163)=MBUF(17)
0227 MBUF(164)=MBUF(18)
0228 MBUF(165)=-4096
0229 MBUF(166)=-4096
0230 MBUF(167)=-4096
0231 C ***** FILL NEXT SECTOR WITH BLANKS
0232 DO 340 J=193,256
0233 340 MBUF(J)=IBLNK
0234 C ***** WRITE NEXT FOUR SECTORS TO DISC
0235 CALL EXEC(IMRT,LUDK,MBUF,256,ISTRK,4)
0236 C
0237 C ***** INSERT CHANNEL DOCUMENTATION FOR RECOIL VELOCITY (CH 31)
0238 C

```

```

0239 C ***** USE SAME VALUES AS CH 30 EXCEPT CHANGE PLOT LABELS AND SCALE FACTOR
0240 C ***** CHANGE PLOT LABEL
0241 DO 360 I=37,53
0242 360 MBUF(I)=ILBL(I-36)
0243 C ***** SET PLOT UNITS
0244 ICNT=1
0245 CALL LOOKS(MBUF(54),ICNT,1)
0246 IF(ICNT.GT.9)ICNT=9
0247 DO 380 I=1,15-ICNT
0248 380 MBUF(53+ICNT+I)=IUNITS(I)
0249 C ***** BLANK REMARKS
0250 DO 400 I=69,102
0251 400 MBUF(I)=IBLNK
0252 C ***** SET CHANNEL NO
0253 MBUF(128)=ICHAN+1
0254 MBUF(129)=ICHAN+1
0255 C ***** SET SCALE FACTOR
0256 ICOUNT(1)=MBUF(163)
0257 ICOUNT(2)=MBUF(164)
0258 COUNT=COUNT/0.00128
0259 MBUF(163)=ICOUNT(1)
0260 MBUF(164)=ICOUNT(2)
0261 C ***** WRITE NEXT FOUR SECTORS TO DISC
0262 CALL EXEC(IMRT,LUOK,MBUF,256,IDTRK,8)
0263 C
0264 C ***** PROCESS DATA FROM MEMORY - CONVERT BCD TO INTEGER
0265 C
0266 DO 500 I=1,NWORDS
0267 IBUF(I)=JBOD(IBUF(I))-2048
0268 IF(IBUF(I).GT.2047)IBUF(I)=2047
0269 IF(IBUF(I).LT.-2048)IBUF(I)=-2048
0270 IF(IBUF(I).LT.0)IBUF(I)=IAND(IBUF(I),3777B)+4000B
0271 IBUF(I)=IBUF(I)+IRATE
0272 500 CONTINUE
0273 C
0274 C ***** TRANSFER DATA TO DISC
0275 C
0276 ISCTR=12
0277 INDEX=1
0278 KAMT=5376
0279 IBAL=NWORDS
0280 ISWTC=0
0281 520 IF(IBAL.LT.KAMT)KAMT=IBAL
0282 CALL EXEC(IMRT,LUOK,IBUF(INDEX),KAMT,IDTRK,ISCTR)
0283 IBAL=IBAL-KAMT
0284 IF(IBAL.EQ.0)GO TO 540
0285 INDEX=INDEX+KAMT
0286 KAMT=6144
0287 IDTRK=IDTRK+1
0288 ISCTR=0
0289 GO TO 520
0290 540 IF(ISWTC.EQ.1)GO TO 700
0291 C
0292 C ***** PROCESS DATA TO GET VELOCITY
0293 C
0294 C ***** REMOVE RATE CODE AND CONVERT BACK TO INTEGER
0295 DO 620 I=1,NWORDS
0296 620 IBUF(I)=(IBUF(I)+16)/16
0297 C ***** GENERATE DIFFERENCE AND CONVERT BACK TO ADCHK FORMAT
0298 DO 640 I=1,NWORDS-1
0299 IBUF(I)=IBUF(I+1)-IBUF(I)
0300 IF(IBUF(I).GT.2047)IBUF(I)=2047
0301 IF(IBUF(I).LT.-2048)IBUF(I)=-2048
0302 IF(IBUF(I).LT.0)IBUF(I)=IAND(IBUF(I),3777B)+4000B
0303 IBUF(I)=IBUF(I)+IRATE
0304 640 CONTINUE
0305 C ***** SET LAST WORD TO ZERO TO KEEP BUFFER SIZE IN 1K INCREMENTS
0306 IBUF(NWORDS)=0
0307 C
0308 C ***** SET UP TO TRANSFER DATA TO DISC
0309 C
0310 ISCTR=KAMT/6+ISCTR
0311 IF(ISCTR.GT.55)ISCTR=0
0312 INDEX=1
0313 IF(KAMT.EQ.6144)IDTRK=IDTRK+1
0314 KAMT=6144-1
0315 IBAL=NWORDS
0316 ISWTC=1
0317 GO TO 520
0318 C

```

```

0319 C ***** ZERO REMAINDER OF TRACK
0320 C
0321 700 IF(KAMT .EQ. 6144)GO TO 800
0322     IBAL=6144-KAMT-64*ISCTR
0323     DO 720 I=1,IBAL
0324 720     IBUF(I)=0
0325         ISCTR=KAMT/64+ISCTR
0326         CALL EXEC(IWRT,LUOK,IBUF,IBAL,IDTRK,ISCTR)
0327 C
0328 C ***** TELL OPERATOR WHERE DATA WENT
0329 C
0330 800 KAMT=IDTRK-ISTRK+1
0331     NWORDS=768+2*NWORDS-1
0332     WRITE(LU,820)NWORDS,LUOK,ISTRK,KAMT
0333 820 FORMAT(15," WORDS TRANSFERRED TO DISK LU",13," TRACK",15/
0334     $ 10X,13," TOTAL TRACKS UTILIZED")
0335 C ***** CHECK IF DIRECTORY WAS USED
0336     IF(KDIR .EQ. 0)RETURN
0337 C
0338 C ***** UPDATE THE DIRECTORY
0339 C
0340 C ***** READ EXISTING DIRECTORY
0341     CALL EXEC(IREAD,LUOK,MBUF,256,1,0)
0342 C ***** MODIFY ENTRIES
0343     NFILE=NFILE+1
0344     MBUF(1)=ISTRK
0345     MBUF(2)=NFILE
0346     MBUF(NFILE*2+1)=ISTRK
0347     MBUF(NFILE*2+2)=KAMT
0348 C ***** WRITE TO DIRECTORY
0349     CALL EXEC(IWRT,LUOK,MBUF,256,1,0)
0350     RETURN
0351     END
0352     END$

```

APPENDIX D - REFERENCES

1. Yeager, J. G., TECOM Report No. DPS-2363, 1967.
2. Francis, C. L., Final Report, EDI Task of Research and Development of Software, Ballistic Test Site Terminal, TECOM Project No. 5-CO-APO-DFW-203. US Army Aberdeen Proving Ground, Report APG-MT-5952, January 1984. (Distribution unlimited. AD 139 956.)

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