

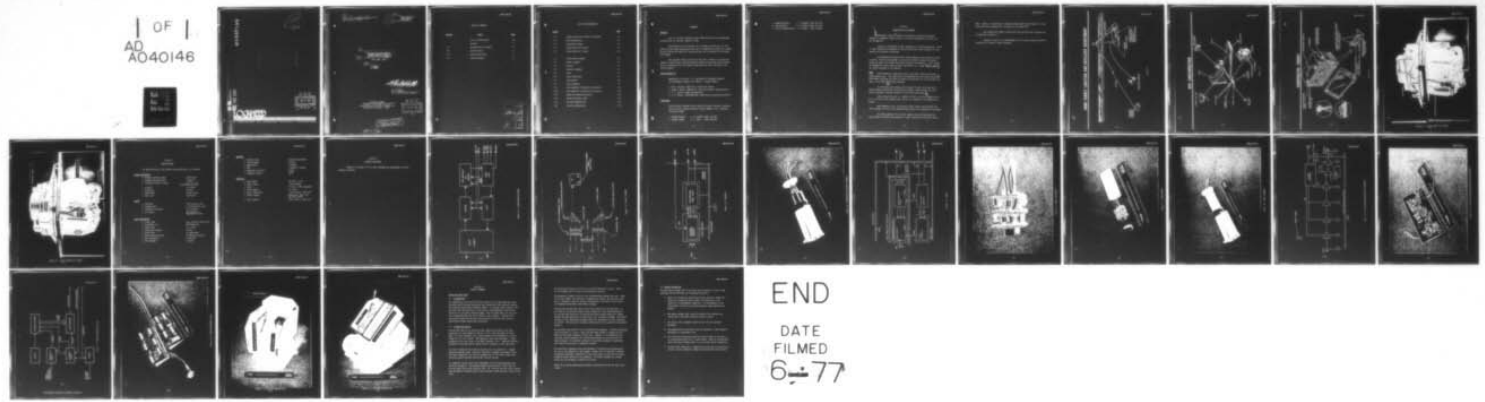
AD-A040 146 LOCKHEED MISSILES AND SPACE CO INC SUNNYVALE CALIF RE--ETC F/G 6/18
EYE-SAFE TRAINING SENSOR. (U)
MAR 77

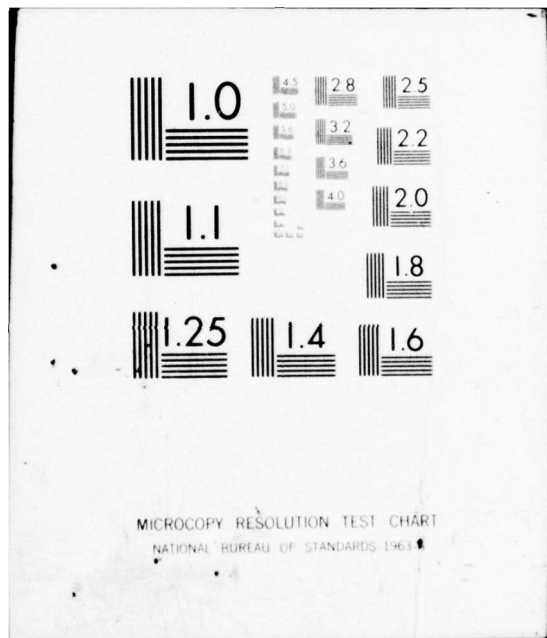
UNCLASSIFIED

LMSC-D461196

DAAK70-76-C-0256
NL

| OF |
AD
A040146





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ADA 040 146

2
NW



ALL INFORMATION CONTAINED
HEREIN IS UNCLASSIFIED

DATE 08-14-2014 BY 60322 UCBAW

DDC
RECEIVED
JUN 3 1977
A

LOCKHEED

MISSILES & SPACE COMPANY, INC • SUNNYVALE, CALIFORNIA
A SUBSIDIARY OF LOCKHEED AIRCRAFT CORPORATION

15 Contract No: DAAK70-76-C-0256 *new*
Code Ident No: 17077

14 LMSC-D461196 ✓
March 1977

6 EYE-SAFE TRAINING SENSOR.
9 FINAL TECHNICAL REPORT.
CDRL ITEM: A003
12 33p

F. D. Schnebly
F. D. Schnebly, Manager

E. T. Price
E. T. Price, Project Leader

TACTICAL SYSTEMS
RESEARCH & DEVELOPMENT DIVISION ✓
Lockheed Missiles & Space Company, Inc.
Sunnyvale, California 94088

DDC
RECEIVED
JUN 3 1977
A

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

402654/5H

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
	List of Illustrations	iii
	Forward	iv
1.0	Introduction and Summary	1-1
2.0	Specifications	2-1
3.0	Hardware Delivered	3-1
4.0	Safety Statement	4-1

SUBSECTION BY	
NOTE	Write Section <input checked="" type="checkbox"/>
DWG	Buy Section <input type="checkbox"/>
CHARACTER	<input type="checkbox"/>
JUSTIFIED	
<i>Put in file</i>	
BY	
DISTRIBUTION/AVAILABILITY CODES	
Dist.	AVAIL. CODE/SPECIAL
A	1

LIST OF ILLUSTRATIONS

<u>Figure</u>		<u>Page</u>
1.1	Target Location & Artillery Adjustment	1-2
1.2	RPV Configuration	1-3
1.3	Cooperative Target	1-4
1.4	Aquila Phase IV/V Sensor	1-5
1.5	Aquila Phase IV/V Sensor	1-6
3.1	System Block Diagram	3-2
3.2	Optics Assembly	3-3
3.3	Receiver	3-4
3.4	Receiver Assembly	3-5
3.5	Laser	3-6
3.6	Laser Electronics	3-7
3.7	Laser Module	3-8
3.8	Laser Assembly	3-9
3.9	Post Amplifier & Detection Electronics	3-10
3.10	Post Amplifier & Detection Electronics	3-11
3.11	Range Processing Electronics	3-12
3.12	Range Processing Logic	3-13
3.13	Eye-Safe Ranging Unit	3-14
3.14	Eye-Safe Ranging Unit	3-15

FOREWORD

ABSTRACT

This is the final technical report describing the work accomplished and goals met for Contract DAAK70-76-C-026.

The objective of this project was to design and build two (2) low-power eye-safe laser ranging units and two (2) cooperative targets for installation on Aquila RPV Phase IV/V sensor payloads for utilization on the Aquila RPV program.

The low-power lasers provide the Army with a means of training personnel to perform laser oriented missions without the extreme ocular hazards that are associated with the present high power YAG laser utilized on the Aquila program.

UNDER CONTRACT TO

Department of the Army, U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia 22060;

- o Ana R. Purcell, DRXFB-PR-3, Contracting Officer
- o James E. Miller, DRSEL-NV-II, Contract Technical Representative
- o T. D. Gossett, AMRDL Representative
- o O. T. Osborne, AFPRO/LMSC-TMD, Administrative Contracting Officer

CONTRACTOR

Aquila RPV-STD Program Office, Tactical Systems, Research & Development Division, Lockheed Missiles & Space Company, Inc., Sunnyvale, California 94088:

- o Program Manager F. D. Schnebly (408) 742-4894
- o Project Leader E. T. Price (408) 742-5301

210125

- o Program Controls J. T. Herlihy (408) 742-7365
- o Cost Controls E. M. Darnall (408) 742-1619
- o Contract Administrator C. F. Banker (408) 742-2004

Section 1

INTRODUCTION AND SUMMARY

High-power, Class ⁴IV lasers are utilized on the Aquila mini-RPV program to accomplish target location, artillery adjustments, and laser target designation.

Lasers are classified by their capability of injuring personnel. Class IV laser radiation is hazardous to the eye from direct beam viewing, and from specular and diffused reflections.

The nominally-calculated Ocular Hazard Range for the Aquila YAG laser is 20 Km. This is only nominal, as the use of optical viewing instruments, within the beam, will extend this hazard distance considerably. Also, because of atmospheric effects upon the beam, calculation of a single "Hazard Range" for safety purposes is not feasible.

^{4/5} LMSC proposed to design and build an eye-safe, Class ¹I, low-power, GaAs ranging laser. This laser would be compatible with the Aquila Phase ^{III}III, ^{IV}IV sensor platforms and could be directly substituted for the high power YAG laser on the Phase ^{IV}IV sensor platform.

^{4/5} The eye-safe laser ranging unit proposed by LMSC, when used with a ground located cooperative retroreflective target, would provide the Army with an excellent training simulator for RPV laser operations.

LMSC received Contract No. DAAK70-76-C-0256 to provide the Army with two (2) eye-safe laser ranging units and two (2) cooperative retroreflective targets.

LMSC designed, built, successfully field tested, and delivered the above hardware and all of the proposed design goals were substantially exceeded.

The design approach of the laser ranging unit was based upon the Aquila Phase IV mission requirements of target location and artillery adjust-

ment. Figure 1.1 illustrates a typical mission scenario and Figure 1.2 illustrates the laser ranging unit's location on the Aquila RPV.

The cooperative target utilized with the eye-safe laser ranging unit is depicted in Figure 1.3.

Figures 1.4 and 1.5 are photographs of the actual hardware delivered installed on a Phase IV sensor platform.

ARMY TARGET LOCATION AND ARTILLERY ADJUSTMENT

LMSC-D461196

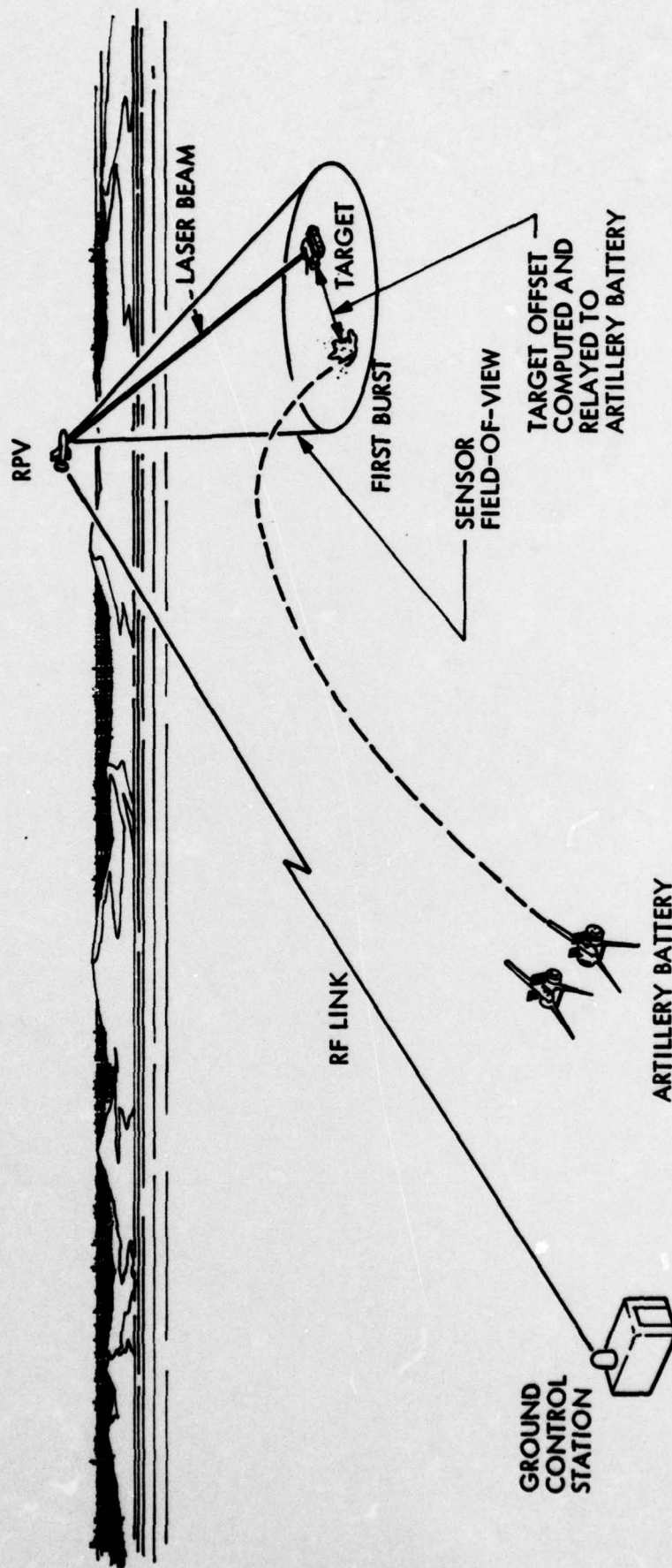


FIGURE 1-1

RPV CONFIGURATION

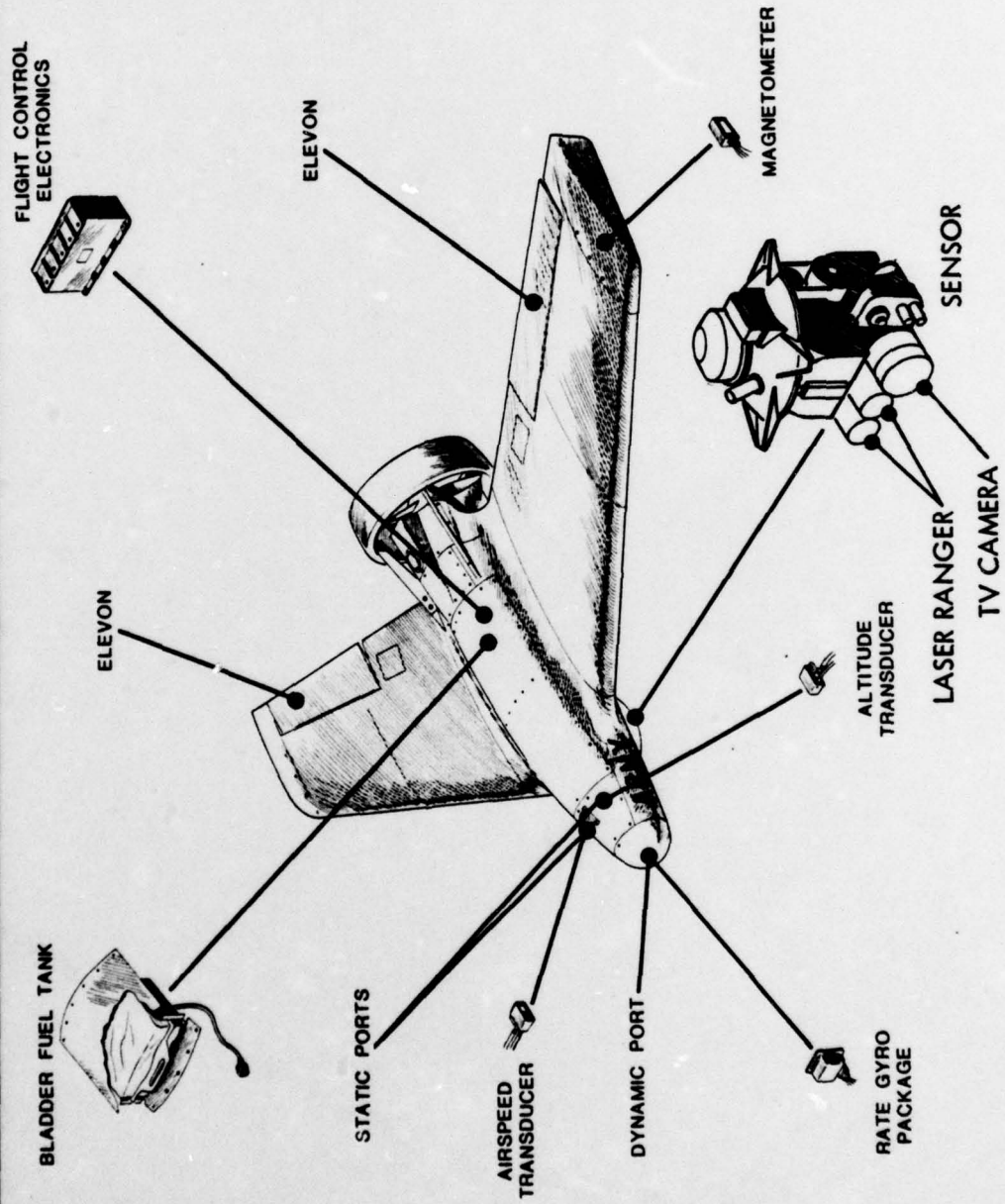


Figure 1-2

COOPERATIVE TARGET

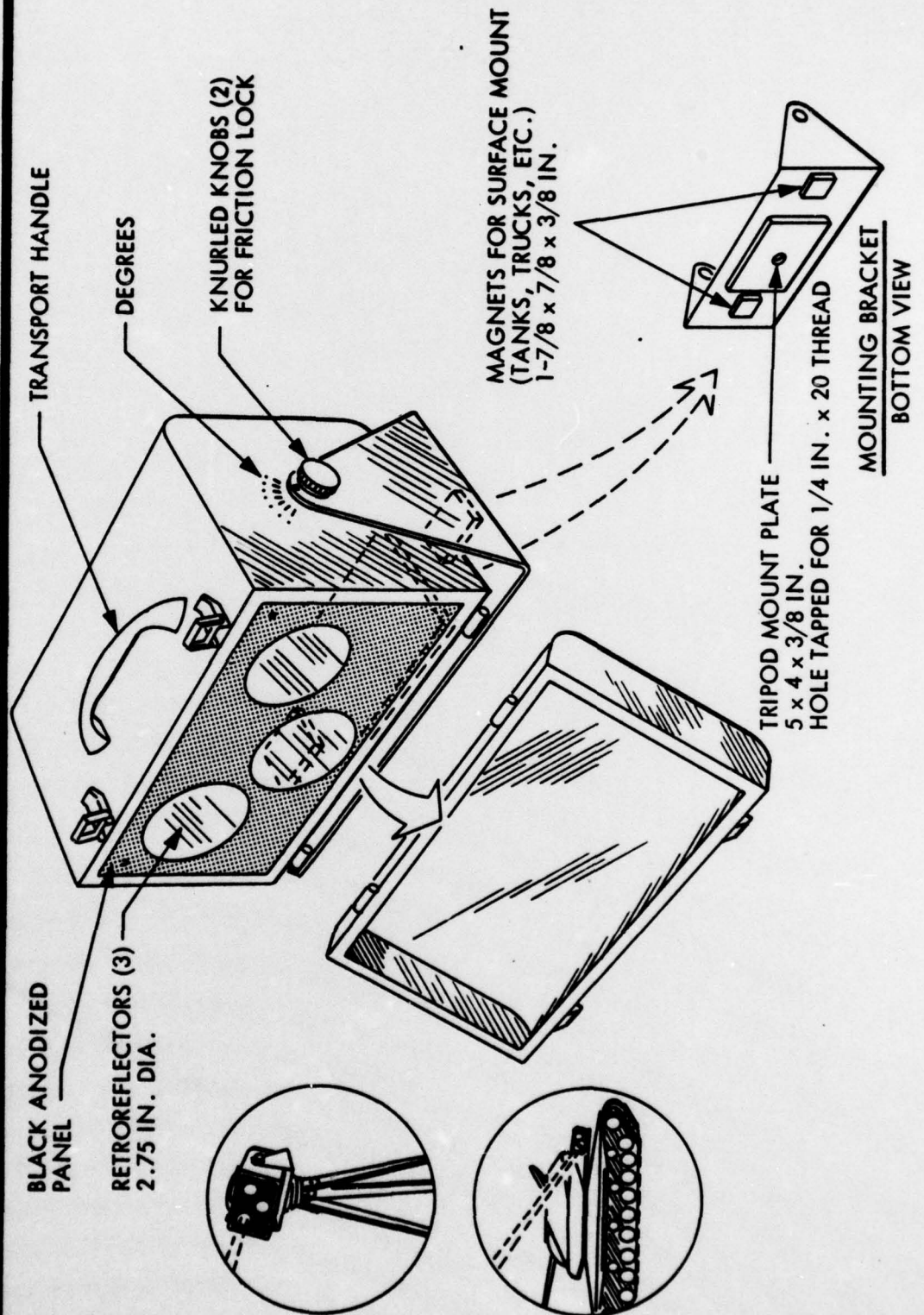
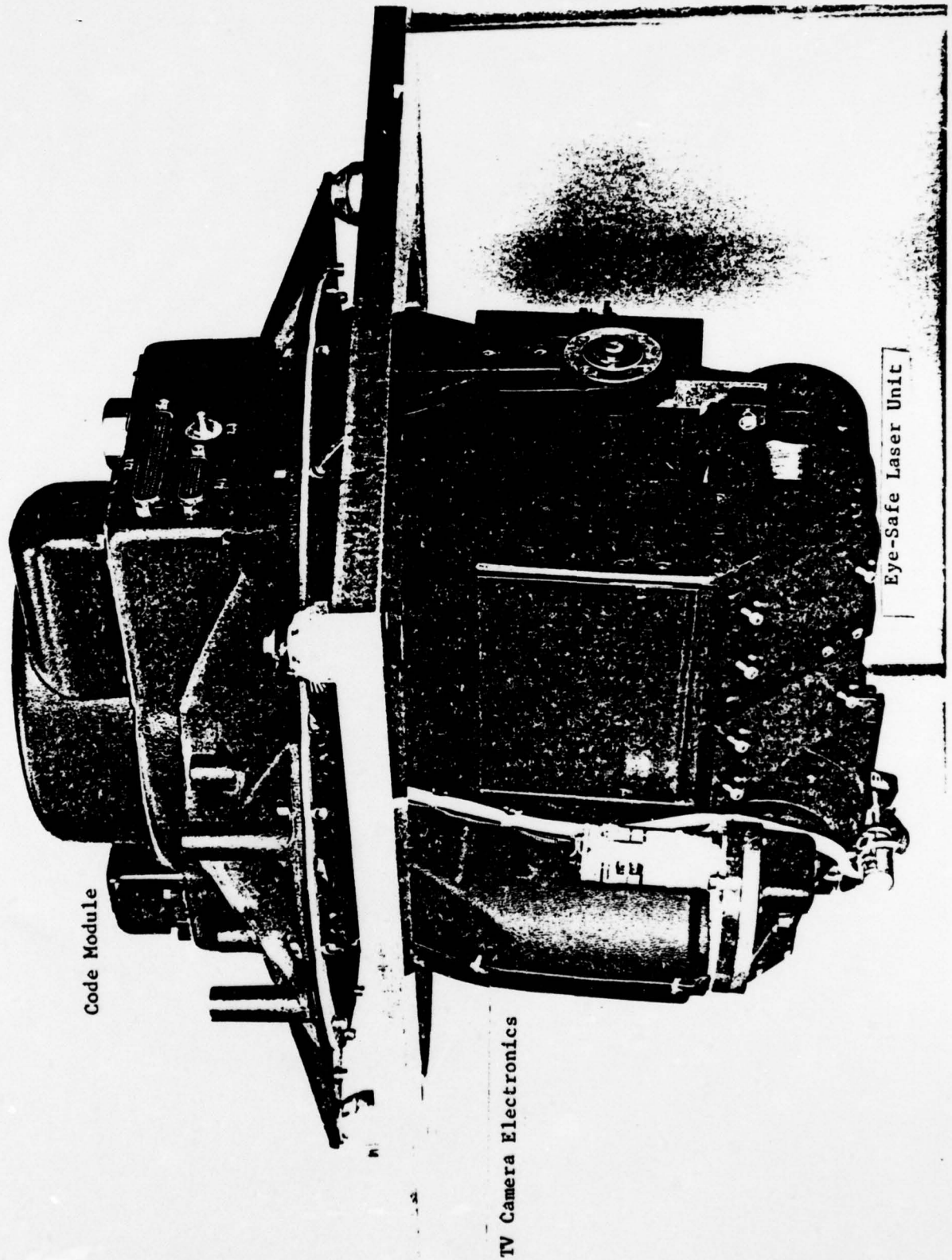


Figure 1-3



Code Module

TV Camera Electronics

Eye-Safe Laser Unit

Figure 1-4 AQUILA PHASE IV/V SENSOR
1-6

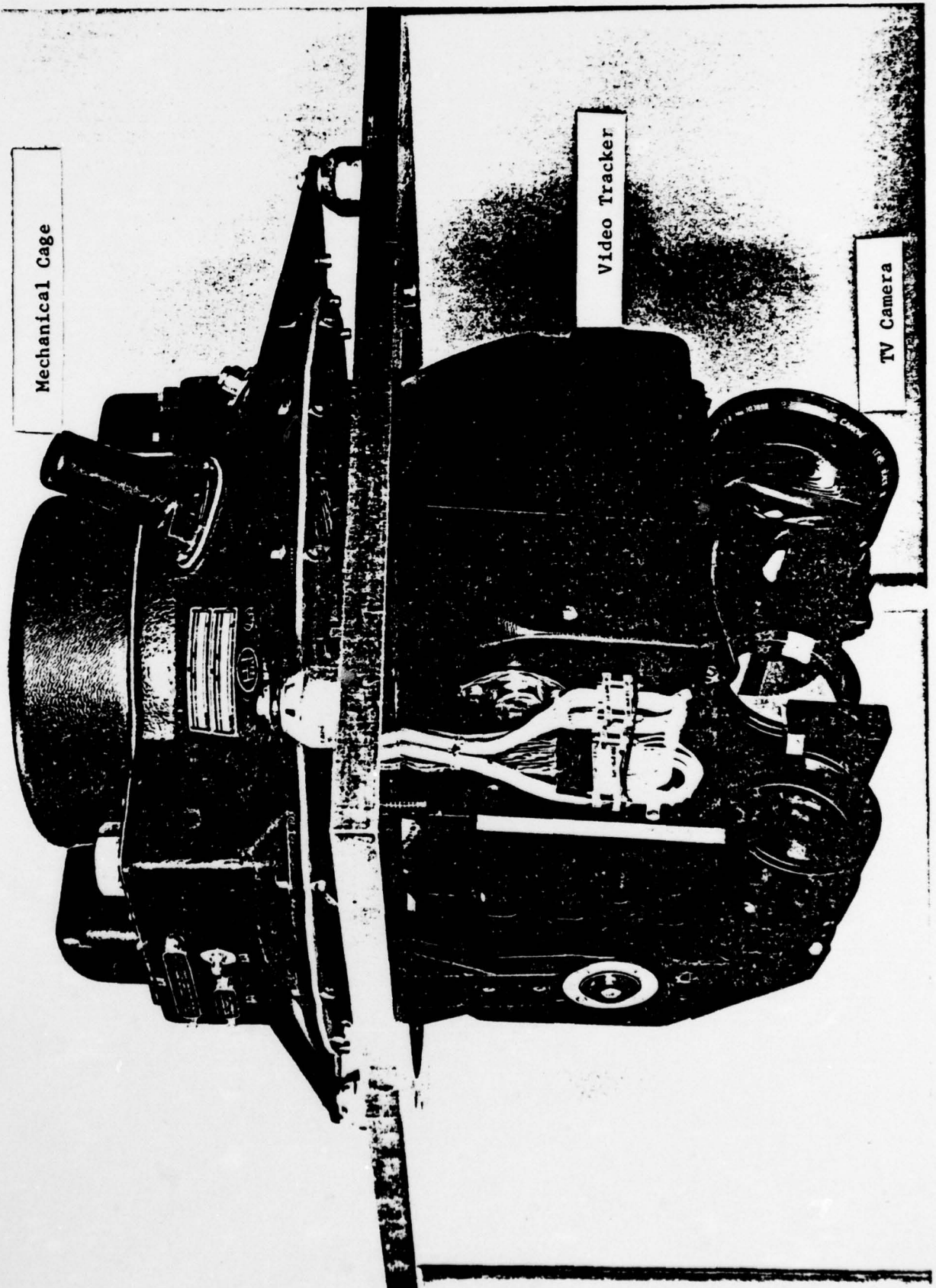


Figure 1-5 AQUILA PHASE IV/V SENSOR
1-7

Section 2
SPECIFICATIONS

The specifications of the ranging system delivered is as follows:

SYSTEM PERFORMANCE

- | | |
|------------------------------|---|
| o Maximum operating range | 3,000 meters |
| o Minimum operating range | 50 meters |
| o Acceptance angle of target | $\pm 45^\circ$ at 3 Km
(horizontal/vertical) |
| o Accuracy | ± 5 meters |
| o Resolution | 5 meters |
| o Sample Rate | 25 per second |
| o Duty cycle | Continuous |

TARGET

- | | |
|------------------------|--------------------------------------|
| o Apertures | 2.875 inch per cube |
| o Configuration | 3 retroreflector array |
| o Deviation accuracies | 2 arc seconds |
| o AR coating | 905 nanometers
magnesium fluoride |

LASER TRANSMITTER

- | | |
|----------------------------|---|
| o Source type | G _a A _s injection diode laser |
| o Wavelength (λ) | 905 nanometers |
| o Source size | 4 x 4 mils |
| o Peak power (output) | 8 watts |
| o Pulse width | 20 nanoseconds |
| o Pulse repetition rate | 25 pulses per second |
| o Beam divergence | 1 millirad |
| o Exit diameter | 2 inches |

RECEIVER

o Detector type	Avalanche photodiode
o Diode diameter	10 mils
o Responsivity	0.14V/ μ W
o NEP	1 nanowatt (50 MHz)
o Bandwidth electrical	30 MHz
o Bandwidth optical	200 Å

INTERFACE

o Input power	+28 VDC, \pm 4 VDC
o Input current	300 milliamps
o Logic	+5 volts, C-MOS compatible
o Input signal Z	51 K ohms
o Output range word	11 bits serial, MSB first
o Output signals	Range word, laser fire and laser enable
o Input signals	Clock, enable, laser fire

Section 3

HARDWARE DELIVERED

Figures 3.1 through 3.14 are block diagrams and photographs of actual hardware delivered.

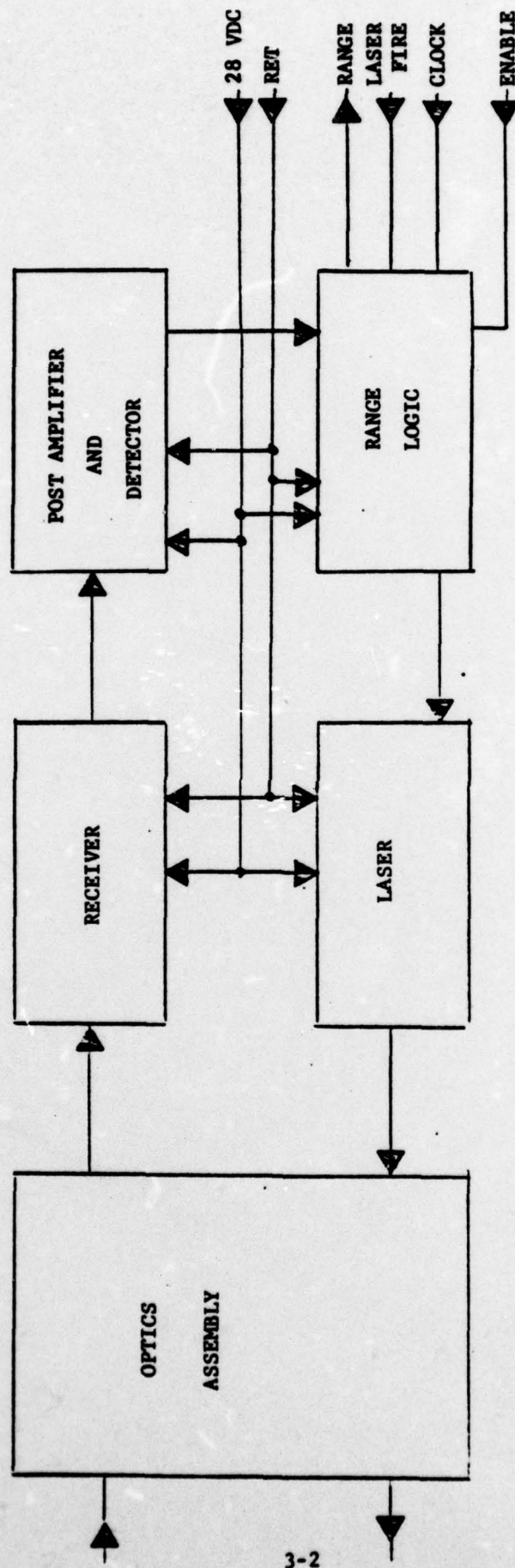


Figure 3.1 SYSTEM BLOCK DIAGRAM

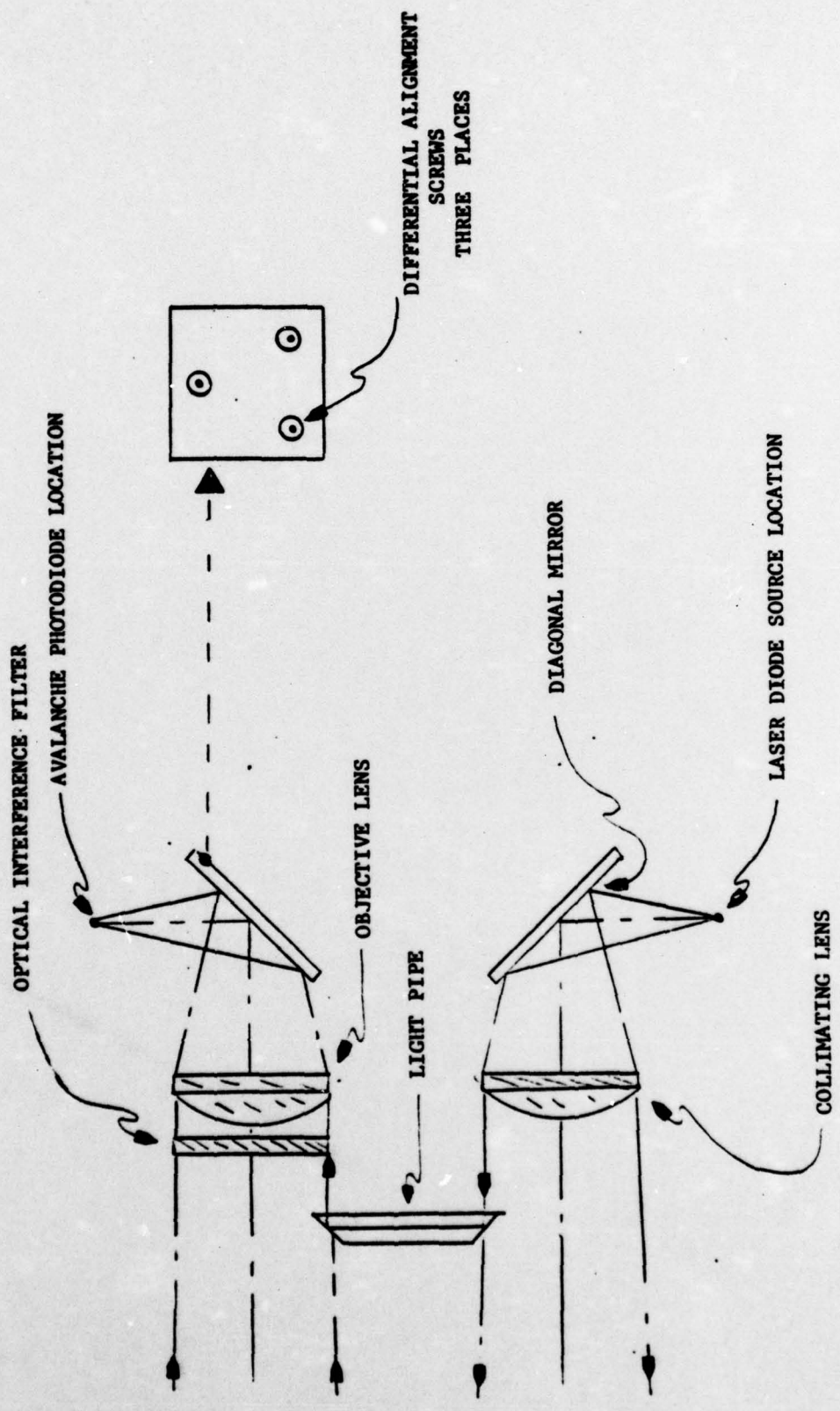


Figure 3-2 OPTICS ASSEMBLY

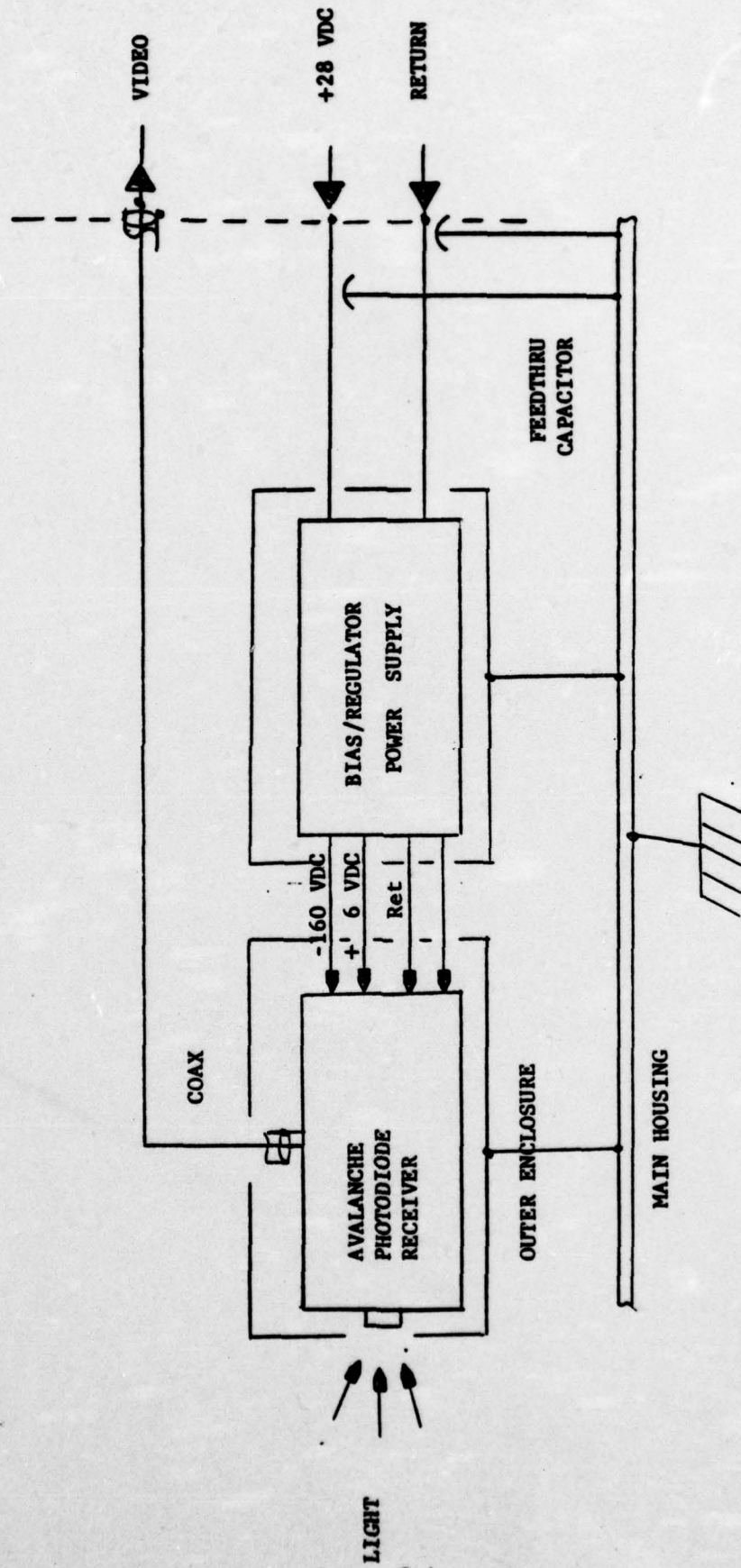


Figure 3-3 RECEIVER

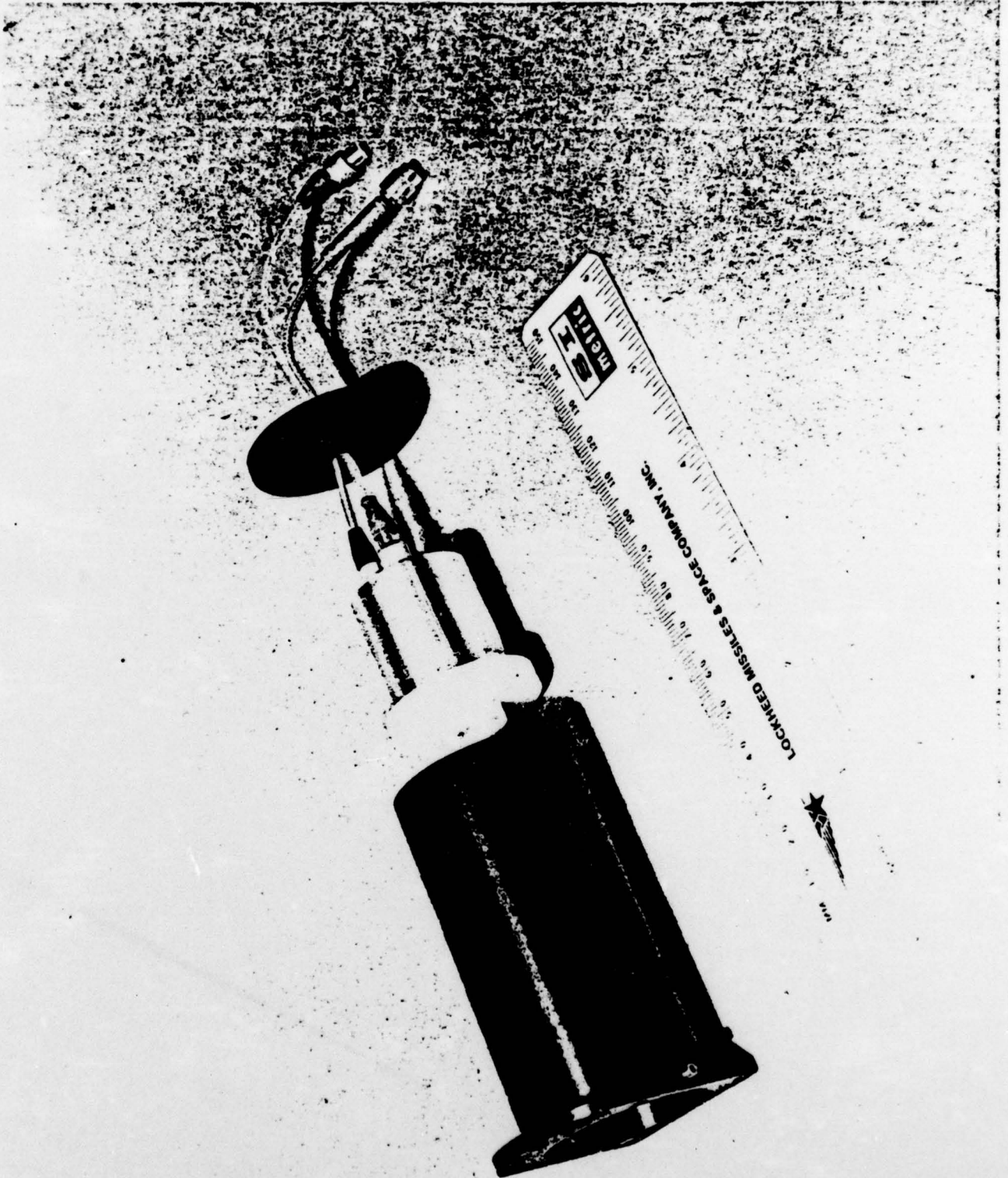


Figure 3-4 PHOTODETECTOR MODULE ASSEMBLY

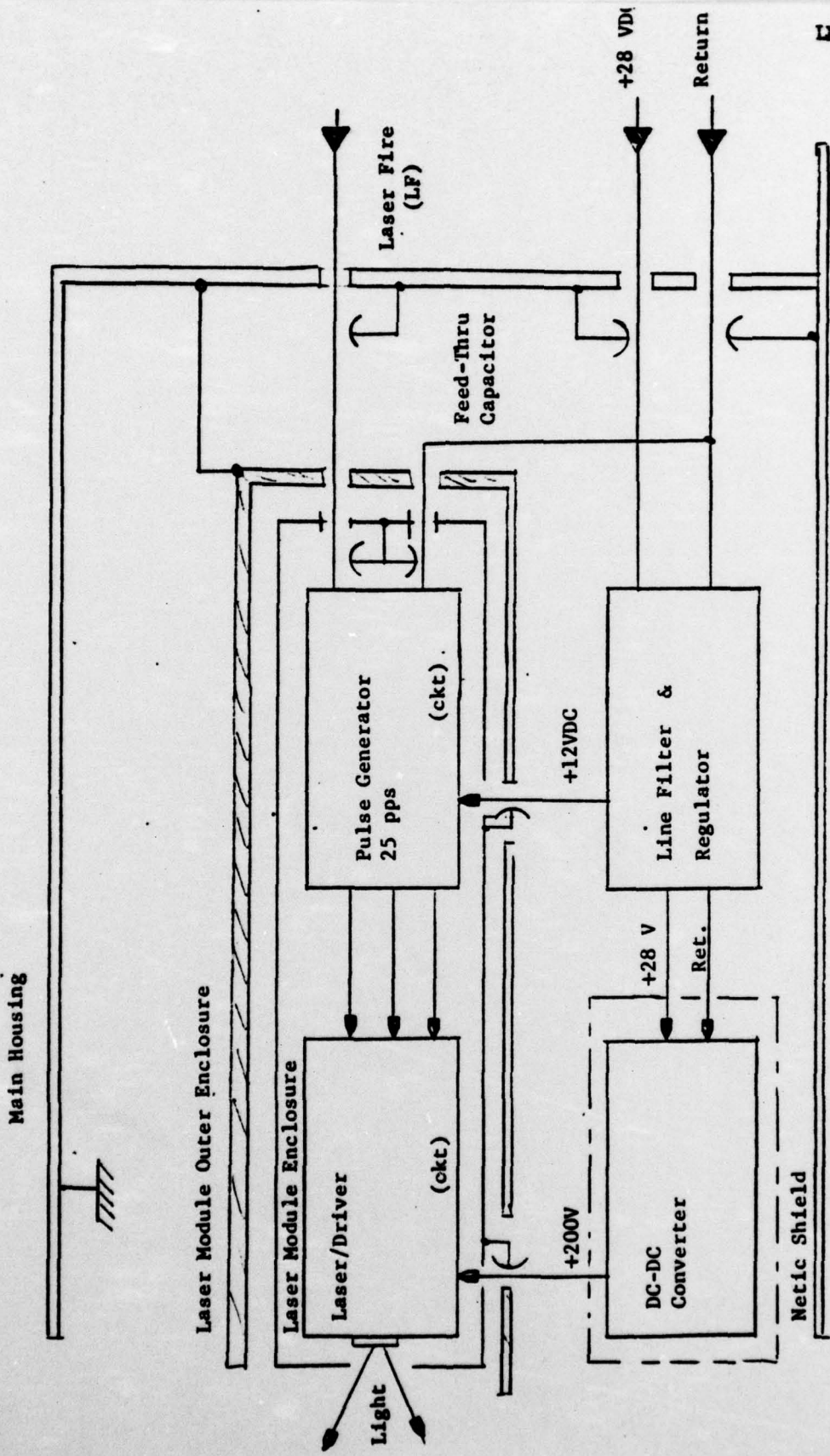


Figure 3.5 LASER

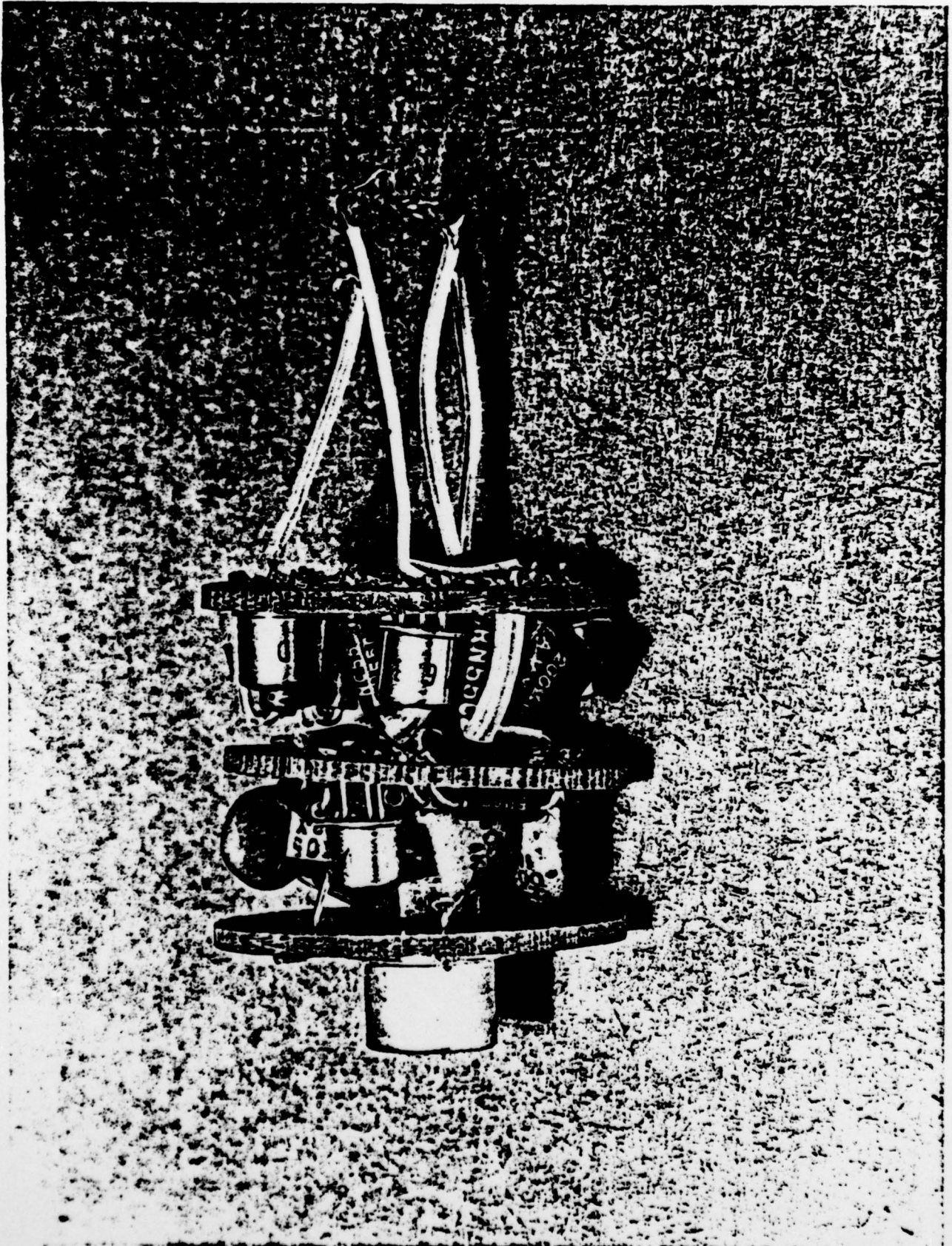


Figure 3-6 LASER ELECTRONICS



Figure 3-7 LASER MODULE

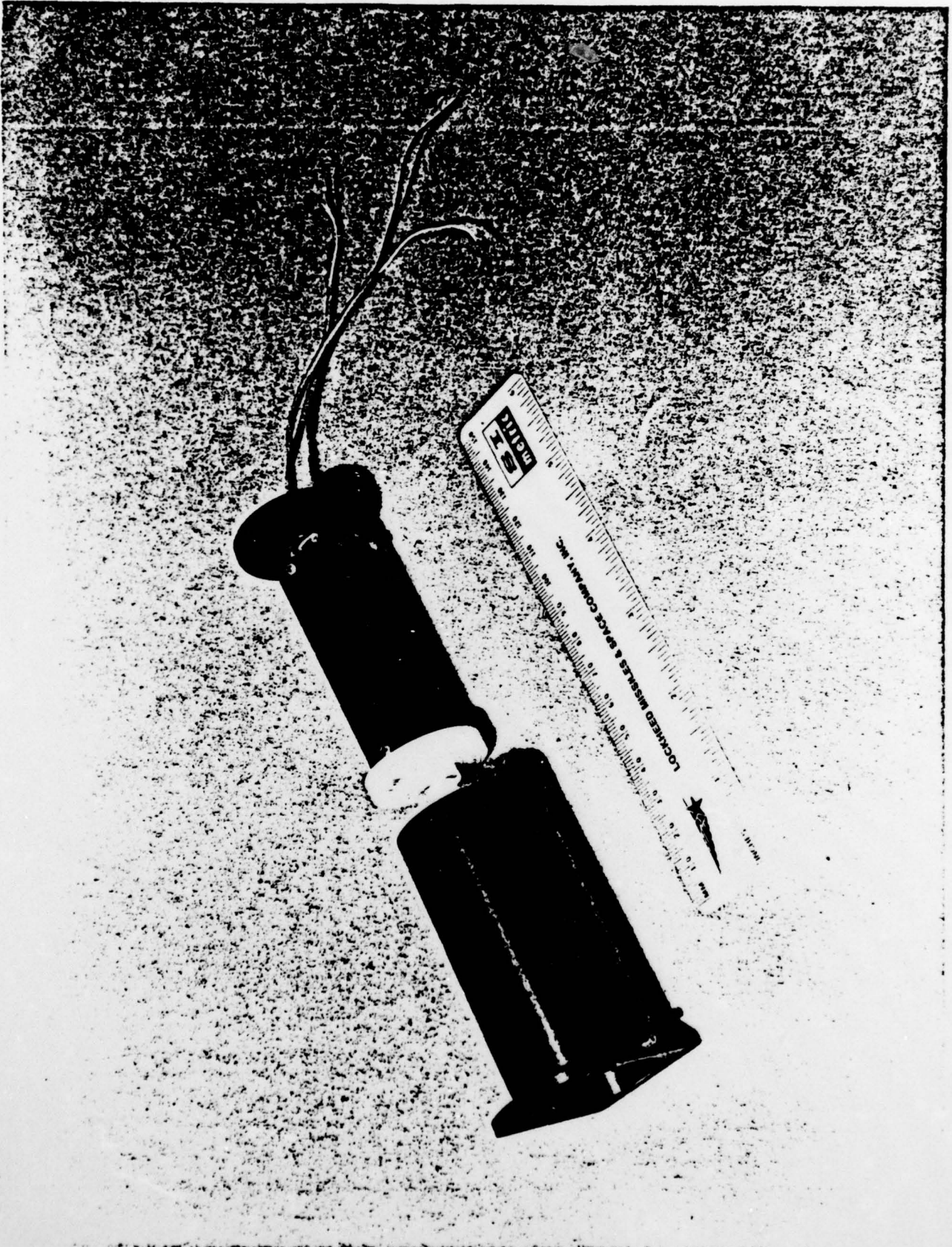


Figure 3-8 LASER ASSEMBLY

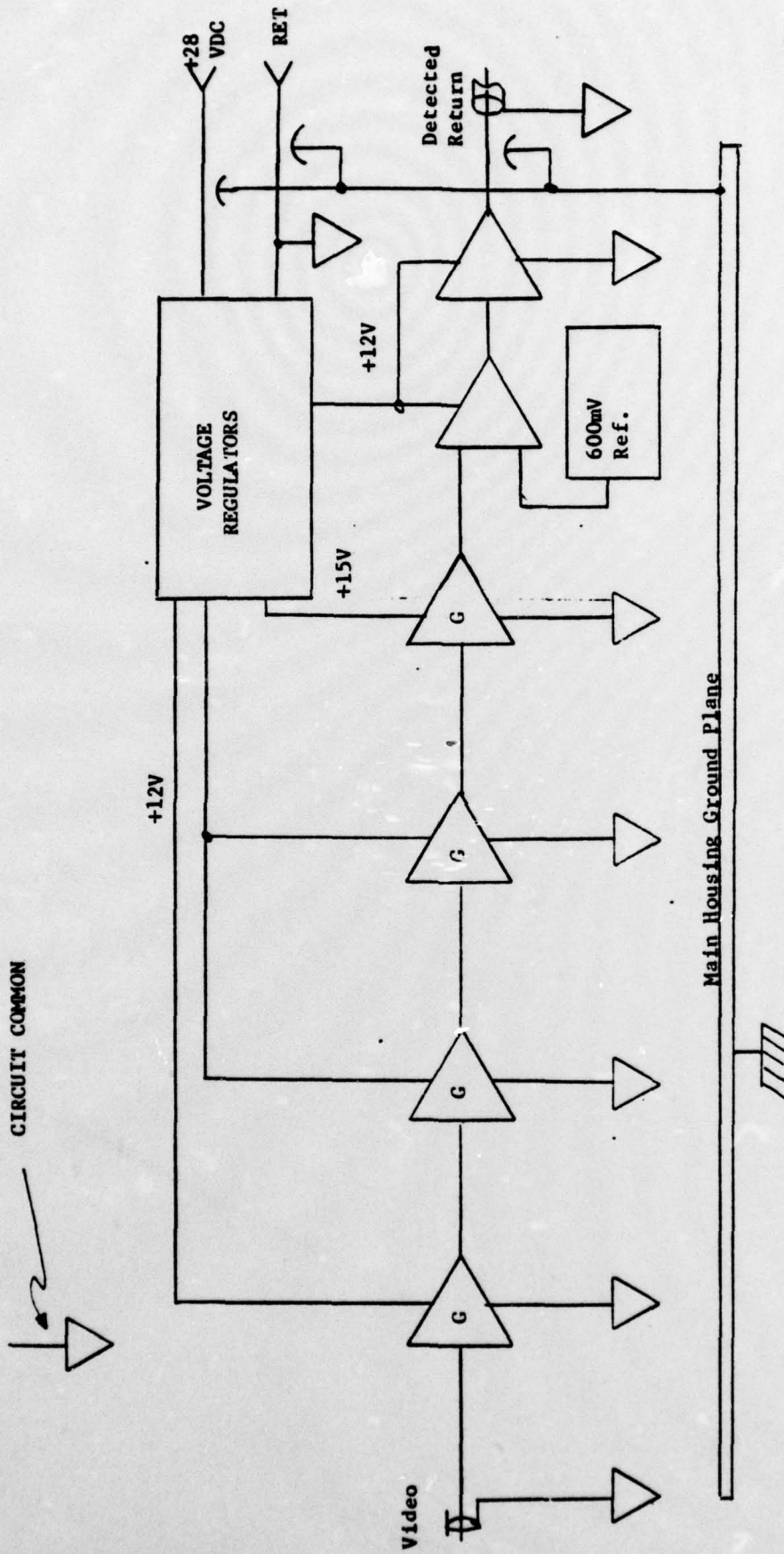


Figure 3-9 POST AMPLIFIER/DETECTOR ELECTRONICS



Figure 3-10 PULSE POST AMPLIFIER/DETECTION ELECTRONICS

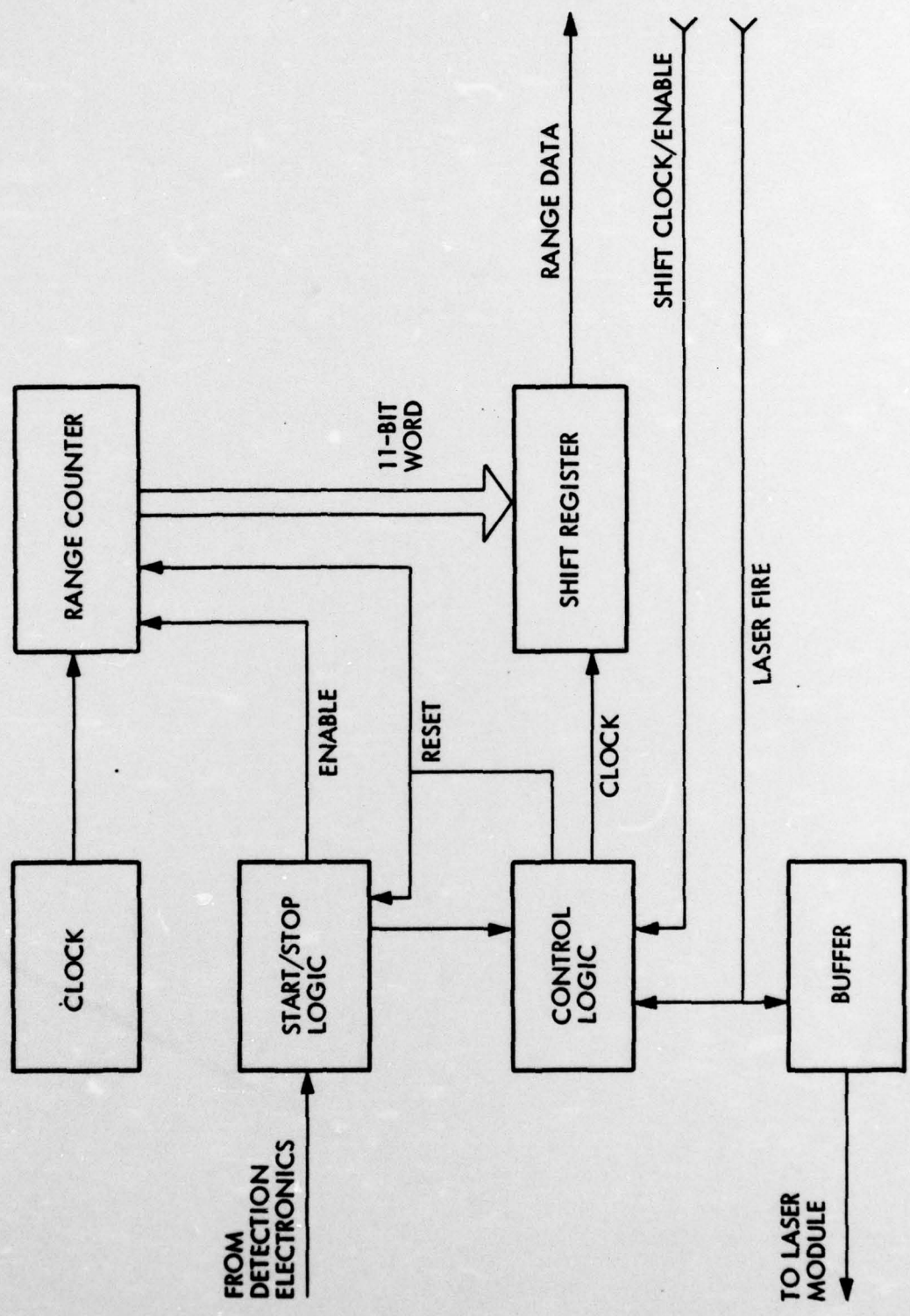


Figure 3-11 RANGE PROCESSING LOGIC

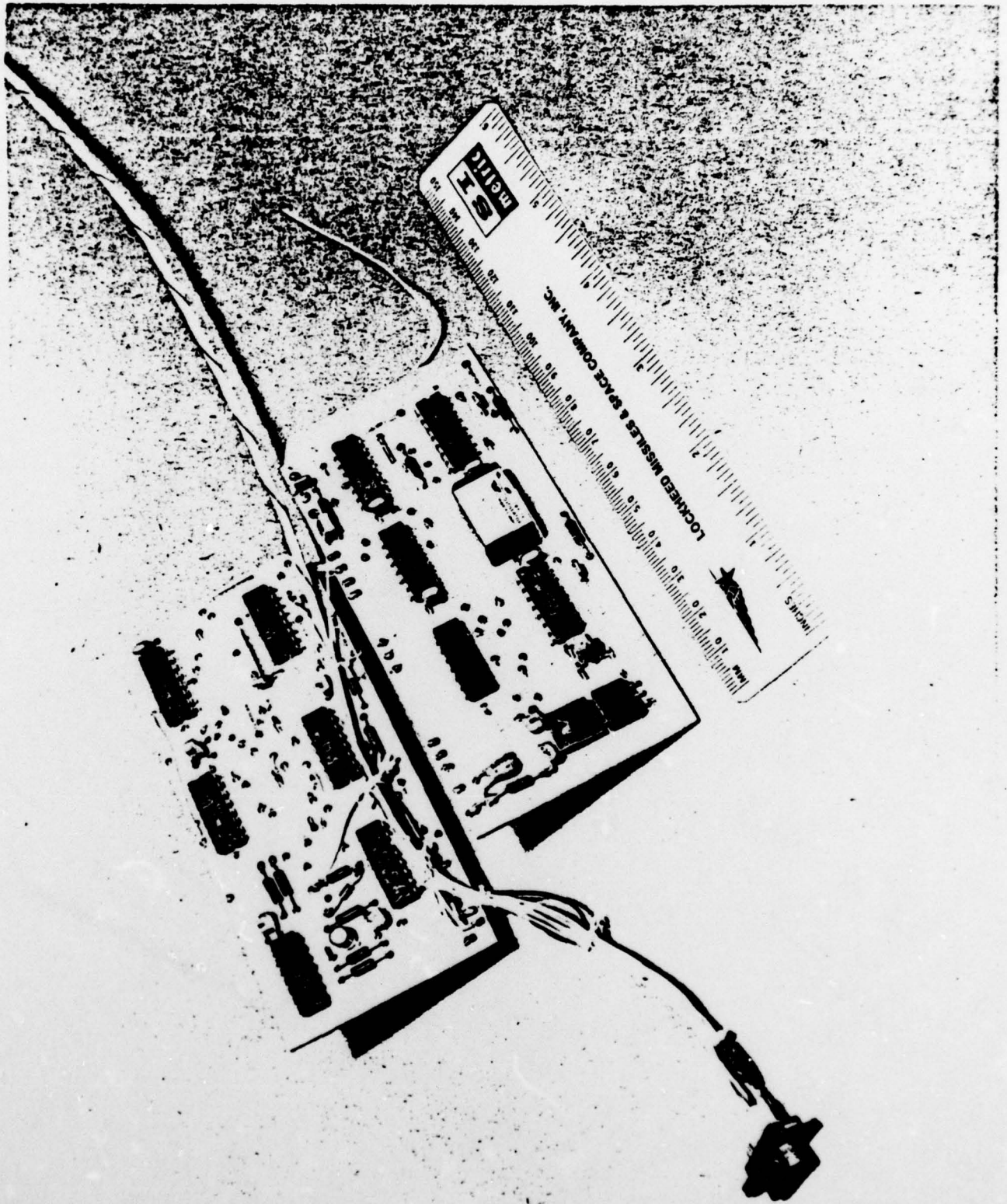


Figure 3-12 RANGE PROCESSING LOGIC

Main Enclosure

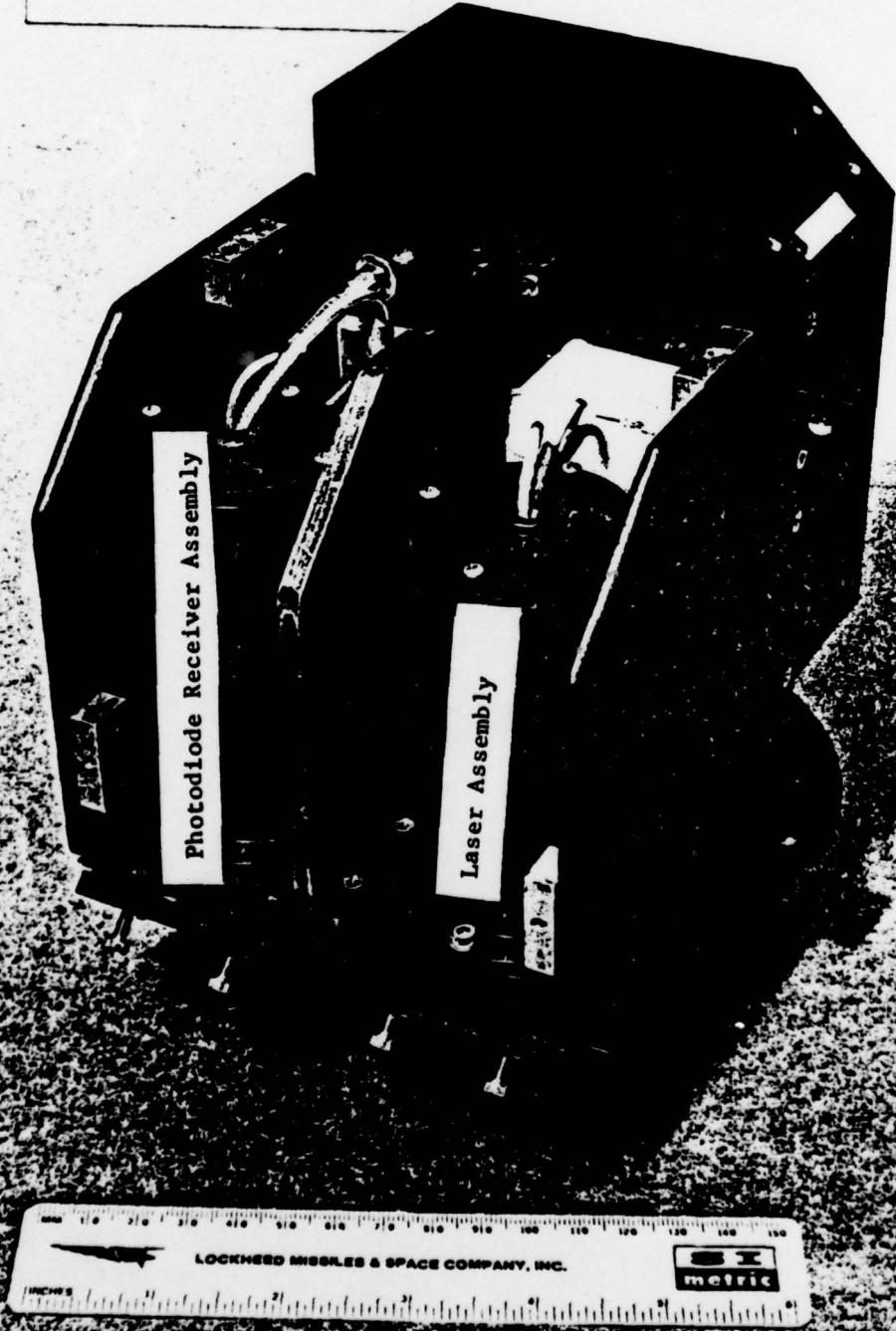


Figure 3-13 EYE-SAFE RANGING UNIT
3-14



Figure 3-14 EYE-SAFE RANGING UNIT
3-15

Section 4
SAFETY STATEMENT

Aquila Eye Safe Laser

4-1 Introduction

The combination of an Aquila RPV with a Phase 4 and 5 high-power YAG laser has many safety problems associated with inadvertant laser emission coupled with possible uncontrolled unmanned flight. To overcome these problems, the eye-safe laser has been built to be directly interchangeable with the YAG laser unit in the Aquila sensor package. This eye safe laser will be used for training missions and initial Phase 4 and 5 flights. Coupled with a cooperative target the eye safe laser system will provide very realistic Aquila/laser system operational evaluation.

4-2 System Description

The eye safe laser is an injection type, repetitive pulsed, Ga As laser operating at a wave length of .905 um. It is a very low power (8 watts peak, 12 u watts average) with a pulse length of 20 nonoseconds or a pulse energy of 1.5×10^{-7} joules. The beam has a one m-rad divergence. These parameters place this laser in the ANSI standard Z 136.1 (American National Standard for the Safe Use of Lasers) Class I category or very safe laser.

The laser transmitter unit and the receiver unit are mounted in a rugged, anodized aluminum frame. Each have individual alignment adjustment trains. The laser transmitter and receiver assembly has its own power supply with electrical power obtained from the RPV aircraft system.

As assembled, the eye safe laser subassembly is fully enclosed except for one 8 pin connector. The maximum voltage inside the unit is 200 volts DC for the laser and for the receiver, 150 V. DC. The one lead for each of those high voltages is insulated and is fully enclosed inside the outer cover of the unit.

The electronics section of the unit is also enclosed with a cover. There are no voltages over 24 volts in the electronic section.

The mechanical design of the unit has considered good design practices. There are no sharp edges; the structure is mechanically sound. The eye safe laser unit is designed to exactly replace, mechanically, the Phase IV and V YAG in the Minneapolis-Honeywell POISE Sensor package.

Electrically the eye safe laser will be quite similar to the YAG laser. It will have an electronic DC power supply instead of a self contained battery but the eye safe laser will be isolated from the aircraft electrical system through the same protective circuits built into the sensor package. Electrical failures in the laser/sensor package should not jeopardize the safe operation of the RPV. The electrical isolation protection for the aircraft is considered adequate.

The personnel protection is also considered quite adequate. Placards indicating that the system is a Class 1 laser and that high voltage is present will be placed on the outer container of the laser. However, it is understood that only LMSC trained personnel will perform maintenance on any portion of the sensor package. The external surfaces of the sensor package are completely safe from any electrical or mechanical hazards.

The electrical connectors have been designed to preclude any misconnections by size or pin geometry or cable length. Normal care is required to perform an adequate preconnect inspection to insure that pins are not bent nor debris lodged in either portion of the connector. No lethal voltages are present on any pin (no voltages in excess of 24 volts).

There are no unique operational procedures associated with the eye safe laser itself.

4-3 Safety Conclusions

The RPV sensor package with an eye safe laser installed is safe to both personnel and the RPV under the following conditions.

- a. There is no electrical shock hazard unless special, longer test cables are constructed which permits the sensor unit to be operated in a disassembled condition. All maintenance on the system shall be done by qualified personnel using approved procedures.
- b. The sensor package shall always be handled with extreme care, always with a lens dome protective cover in place.
- c. All mirror train alignment should be done only by qualified personnel.
- d. The maximum hazard associated with the equipment is from improper maintenance or inadequate care.
- e. The electrical protection system for the RPV shall be verified to be in operating order prior to each flight. Under no circumstances shall the sensor package result in loss of RPV control capability.
- f. Emitted laser radiation is completely eye-safe and is classified as a Class I laser, therefore, exempt from operational restrictions.