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LASER DIODE LABS INC NEW BRUNSWICK NJ
LIGHT EMITTING DIODES FOR FIBER OPTIC COMMUNICATIONS.(U)
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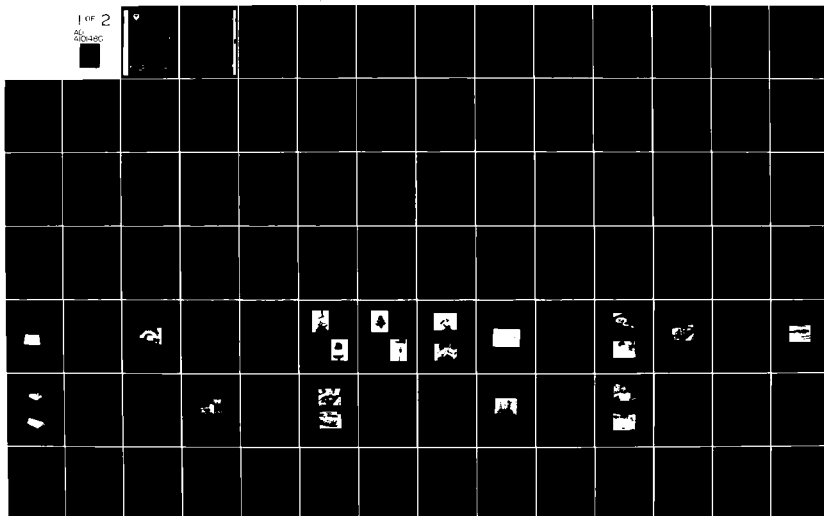
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**RESEARCH AND DEVELOPMENT TECHNICAL REPORT
CORADCOM-76-8135-F**

AD A101480

LIGHT EMITTING DIODES FOR FIBER OPTIC COMMUNICATIONS

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31 MARCH 1981

FINAL REPORT FOR PERIOD SEPTEMBER 1976-FEBRUARY 1981

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This project has been accomplished as part of the U.S. Army Manufacturing Methods and Technology Program which has as its objective the timely establishment of manufacturing processes, techniques, or equipment to insure the efficient production of current or future defense programs.

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SECTION I
INTRODUCTION

The primary objective of this Manufacturing Methods and Technology Engineering Program is twofold. First, the manufacturing methods and techniques necessary for the volume production of the light emitting diode for use in fiber optic communications as outlined in Specification SCS-511 must be developed and implemented to insure the highest degree of device quality and reliability at a reasonable cost. Secondly, verification of device performance and quality for LED's produced in a volume manufacturing environment must be carried out by means of rigorous testing and evaluation in accordance with SCS-511 in order to demonstrate the technical adequacy of the manufacturing methods developed under this contract.

This report describes the techniques and methods used to attain the goals as described above. In particular laser chip concepts and design, package concepts and design, and environmental and electrical testing were key areas and established the emphasis required to achieve the successful completion of the program. The major program objectives include development of the epitaxial process, a coaxial package configuration with fiber pigtail,

the assembly process and test equipment for parameter testing, Burn-in, and life testing of completed devices.

SECTION II

DEVICE DESIGN REQUIREMENTS AND PERFORMANCE SPECIFICATIONS

2.1 Electro-Optical Characteristics.

The performance characteristics of the Light Emitting Diode for Use in Fiber Optic Communications are described in detail in Technical Specification SCS-511. The device may be generally described as a double-hetero-junction (DH) GaAs - GaAlAs etched well incoherent emitter capable of high data rate transmission optimized for an emitting wavelength of 820 nm at room temperature. In addition, a fiber optic pigtail is incorporated into the device in order to permit coupling to the optical link via fiber splicing. An outline of the major electro-optical performance characteristics of the device is shown in Table 1. Table 2 lists the optical characteristics of the fiber pigtail. A more detailed description of the device, including environmental performance and parameter test methods can be found in SCS-511.

2.2 Device Structure

To achieve the electro-optical characteristics outlined in Table 1, a double heterojunction (DH), GaAs-GaAlAs structure having a very thick transparent window layer is employed.

(8135)

TABLE I - PROGRAM GOALS

TEST	CONDITIONS		
	REF-STD	METHOD	REQUIREMENTS
GROUP 1			
Visual & Mechanical	750	2071	-
Tensile Strength (1150)	750	2036A	10 Newtons min.
END POINT TESTS			
Peak Wavelength	845±45nm		
V_f	750	4011	1.9V@ $I_F=100mA$ max
V_{op}	750	4021	3.0V@ $I_F=10\mu A$ min.
Output Power 25°C	75uW @ $I_F = 100mA$ min.		
GROUP 3			
Spectral Width	50nm @ 3db of intensity (max)		
Bandwidth	32MHz @ $I_p = \pm 50mA + 100mA$ DC bias		
Numerical Aperture	0.2 @ $I_F = 100mA$		
Rise & Fall Time	20ns @ $I_p = 100mA, + 5mA$ bias (max)		
Linearity	26db @ $I_p = \pm 50mA, + 100mA$ dc bias		

TABLE 2 - FIBER CHARACTERISTICS

ITT T-202 GRADED INDEX

Attenuation (8200 Å)	8db/KM
Core Diameter	55 μm
Cladding Diameter	125 μm
Jacket Diameter	500 μm
Numerical Aperture (N.A.)	.25
Tensile Strength	10 Newtons
Bending Radius	.5CM

Details of the epitaxial structure required for the production of the etched well emitter are shown in Figure 1. The substrate, region 1, is n-type GaAs doped with Si to $2 \times 10^{18}/\text{cm}^3$ with an EPD $< 1\text{K}/\text{cm}^2$. Region 2 consists of an n-type $\text{Ga}_{.7}\text{Al}_{.3}\text{As}$ window layer through which light generated by the injection of carriers into the lower bandgap active region 3, is coupled to the optical fiber. The low absorption coefficient of the n-type GaAlAs window layer renders it transparent to the 820nm emission from the active region. The bandgap of the $\text{Ga}_{.94}\text{Al}_{.06}\text{As}$ active region, hence the aluminum concentration, determines the peak emission wavelength of the LED. Maximum power efficiency and minimum risetime occur when the active region is doped $\approx 1 \times 10^{18}$ with Ge as indicated by the curves in Figure 2. Region 4, a p-type $\text{Ga}_{.7}\text{Al}_{.3}\text{As}$ layer, serves to confine carriers injected into the active region by virtue of its increased bandgap. Region 5 functions as a contact cap. Aluminum is incorporated in this p-type layer to minimize lateral current flow by increasing its resistivity.

The diameter of the emitting surface is determined primarily by the diameter of the circular contact applied to the surface of region 5 and the sheet resistivities of regions 4 and 5. As shown in Figure 3 by the dashed lines, current is restricted to flow through the active region directly under the circular aperture which has been selectively metallized. To facilitate selective

Epitaxial Structure

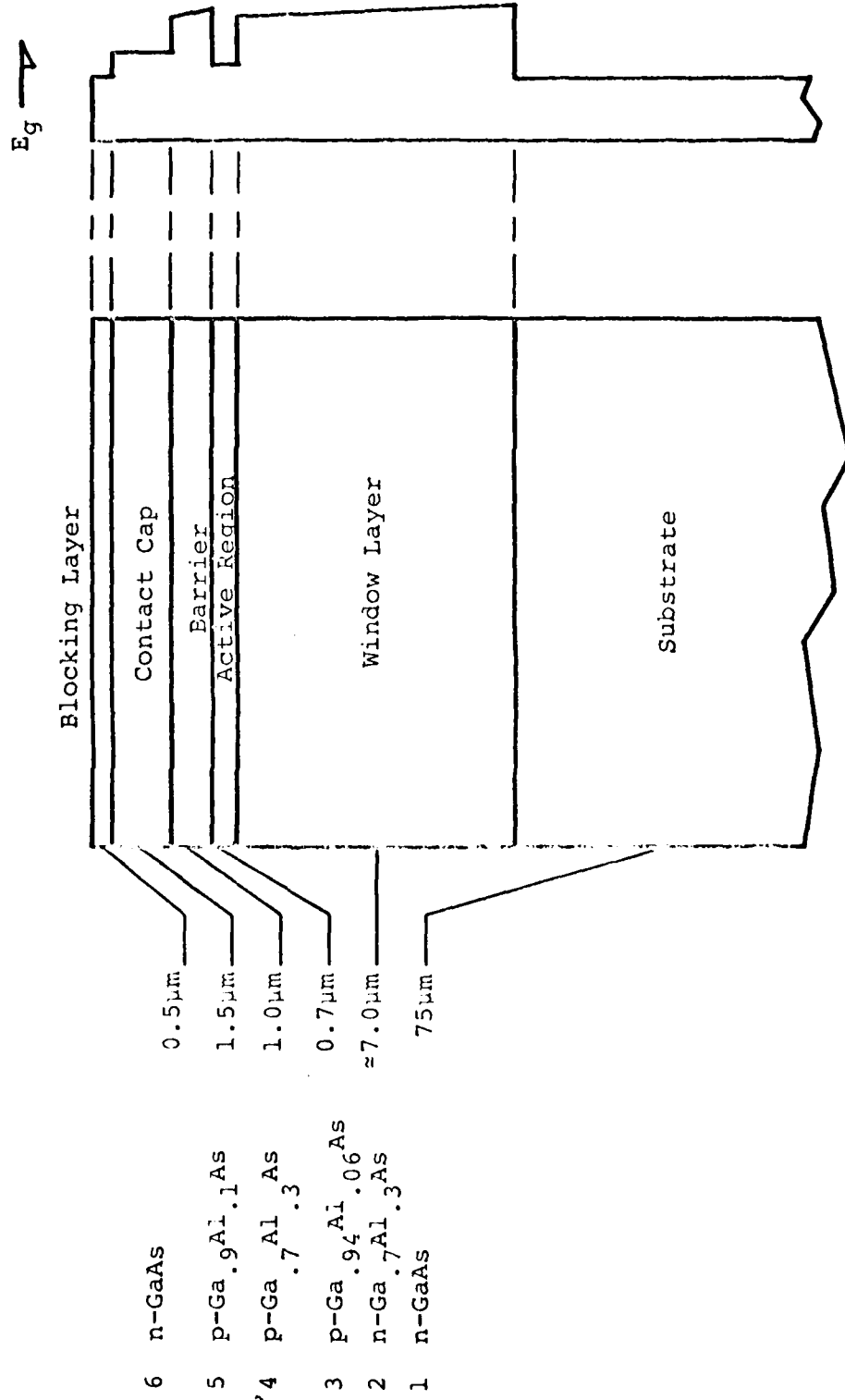
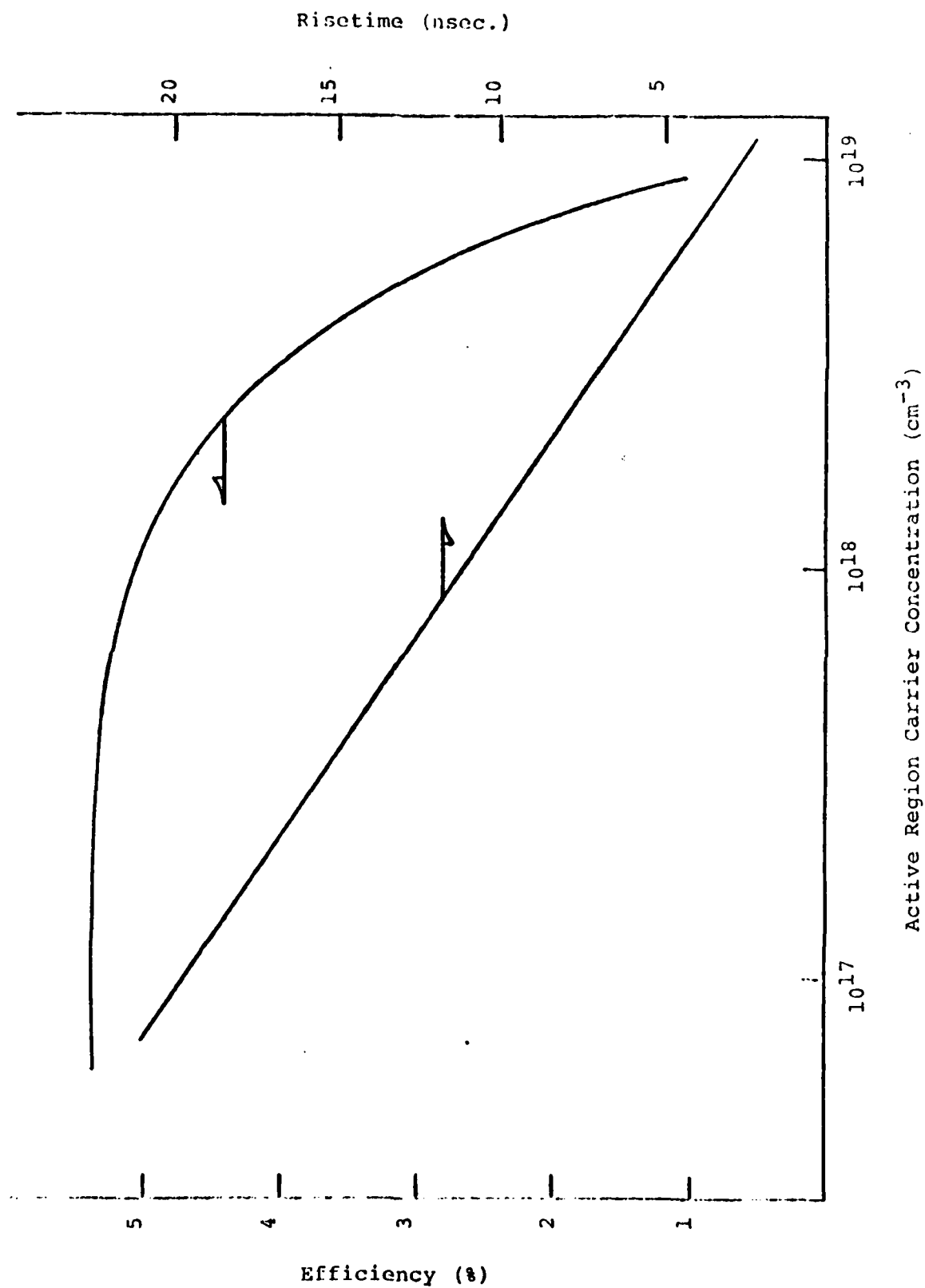


Figure 1 - Schematic Representation of Double Heterojunction Epitaxial Structure for Use in the Fabrication of the Fiber Optic Coupled LED.

Figure 2 - Power Efficiency and Risetime vs. Active Region Doping Level for Germanium Doped LEDs.



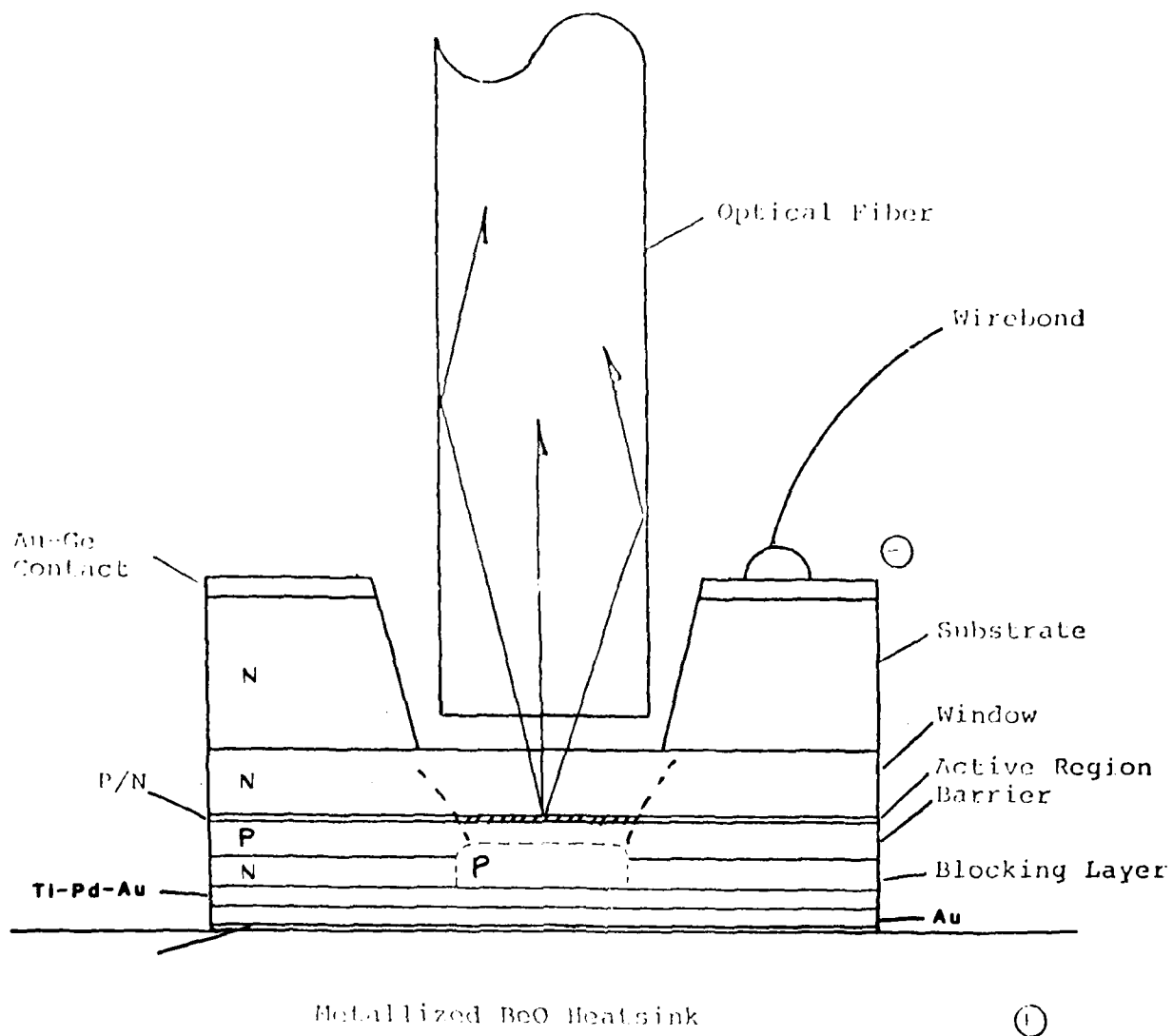


Figure 3 - Chip Configuration for the Manufacture of High Radiance High Speed Fiber Coupled Light Emitting Diodes.

contacting, a 40 μ m hole is etched through region 6, an n-type GaAs current blocking layer. Under forward bias conditions, the P-N junction formed at the interface between region 5 and 6 is reversed biased allowing current to flow only in the region directly below the 40 μ m ohmic contact. Light generated in the active region directly above this circular aperture passes through the transparent window layer and is emitted from the bottom surface of the etched well as shown in Figure 3.

2.3 Package Requirements

Technical Specification, SCS-511, defines the outline package drawing for the etched well light emitting diode. The package is based upon a dual stripline stud configuration and has been modified to accept an optical fiber pigtail.

SECTION III

MANUFACTURING METHODS AND TECHNOLOGY ENGINEERING

3.1 Materials Technology.

3.1.1 Synthesis of Device Structure via LPE.

3.1.1.1 Liquid Phase Epitaxial System.

Liquid phase epitaxy is a complex process in which single crystal layers of semiconductor material are deposited on a single crystal substrate of lattice matched material by precisely controlled cooling of a saturated solution in contact with the substrate. In the case of hetero-epitaxial synthesis of GaAs and GaAlAs layers for LED

fabrication, gallium (Ga) is the preferred solvent and the substrate is normally high quality, low Etch Pit Density, (100)GaAs.

Crystal growth of these structures takes place at temperatures ranging between 750°C and 900°C and must be performed in an inert or reducing atmosphere to avoid the highly detrimental effects of oxygen contamination. The properly designed LPE reactor and support systems must satisfy several criteria in order to yield epitaxial wafers suitable for fabricating double heterojunction geometry LED structures. These criteria are dictated by the uniformity, reliability, and produceability requirements of semiconductor optoelectronic components for volume commercial manufacture. Maximum surface area, layer thickness uniformity, compositional uniformity, and minimum defect density are required. In addition, the as-grown surface morphology of the terminal layer must be compatible with photolithographic processing for the definition and patterning of stripe geometry contacts. Figure 4 shows a block diagram of the epitaxial system in use at Laser Diode Laboratories. This system incorporates several features which have resulted in the optimization of the liquid phase process:

Isothermal Heat Pipe Furnace: The sodium filled isothermal liner eliminates all vertical and horizontal temperature gradients and, hence provides uniform

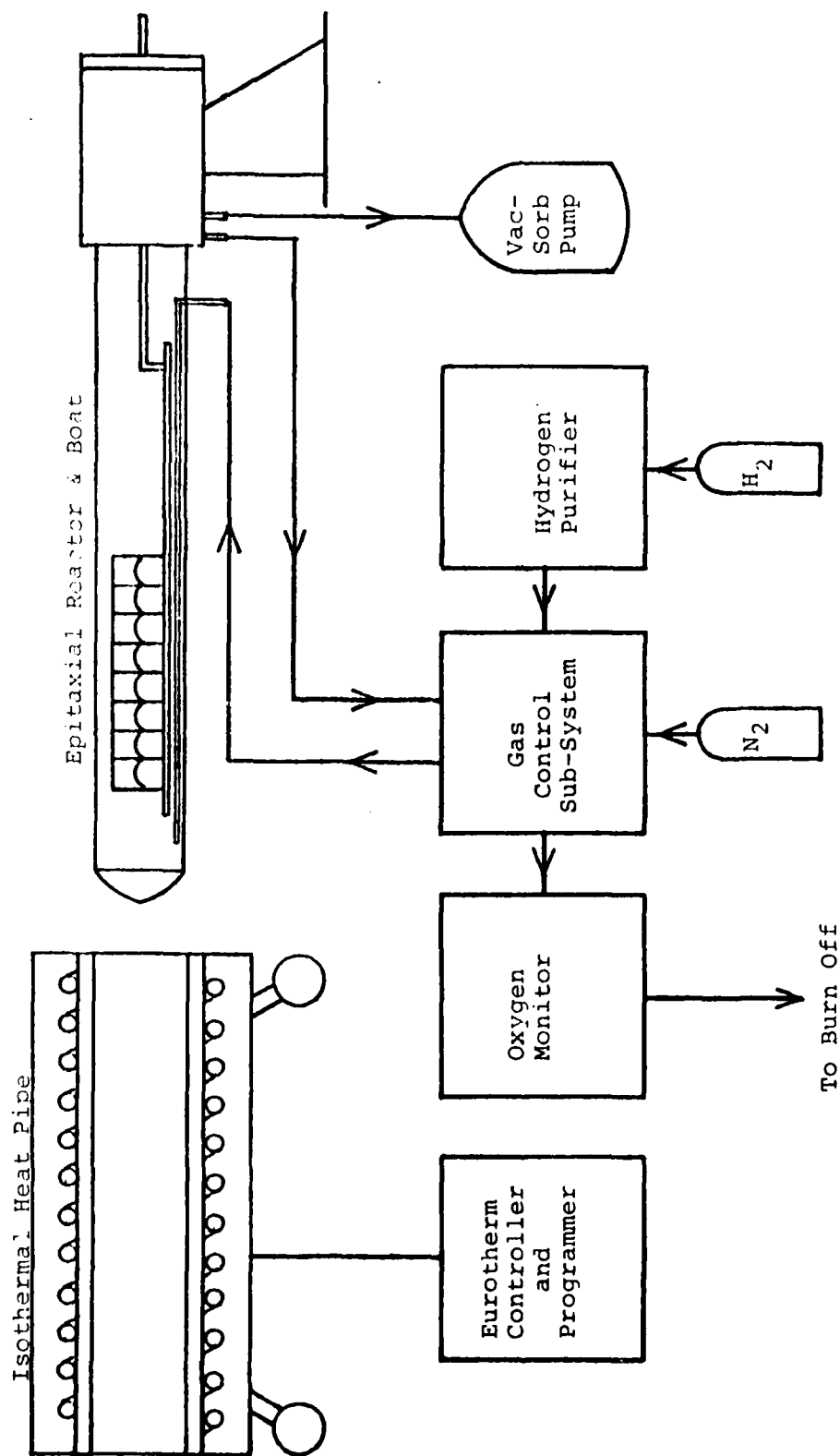


Figure 4 - Block Diagram of Liquid Phase Epitaxial Systems Currently in Use at Laser Diode Laboratories.

deposition rates over the entire surface of the substrate. The isothermal liner also allows the use of large epitaxial boats, therefore, larger epitaxial wafers can be synthesized or more complex structures can be grown.

Vac Sorb Pump: The use of a molecular sieve prior to the start of the run completely removes all traces of oxygen from the growth ambient without the risk of organic contamination.

Oxygen Monitor: The use of a fuel cell apparatus in the output stream of the system allows continuous monitoring of the O_2 content of the system both prior to and during epitaxial synthesis. This apparatus assures system integrity resulting in reproducible growth rates, alloy composition, and defect free growth by preventing the formation of Al_2O_3 in the melt.

In addition to obtaining optimum system performance through improved design concepts, the design and construction of the epitaxial boat is crucial to obtaining high quality hetero-epitaxial material. The ultra high purity, high density graphite boat is shown in the photograph of Figure 5. The eight bin boat utilizes a built-in indexing mechanism for accurate positioning of the substrate in each bin. Also an extra bin is employed to remove excess gallium which may adhere to the surface of the wafer as it is removed from the final melt.

Together, the modified epitaxial reactor and epitaxial

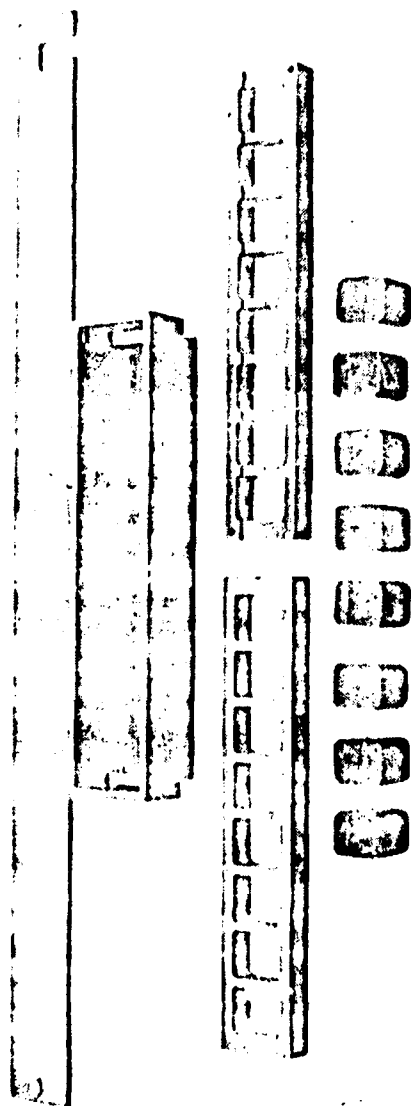


Figure 5 - Photograph of Eight Bin Ultra High Purity Graphite Epitaxial Boat.

boat allow the generation of double heterojunction structures in a manufacturing environment for the volume production of etched well light emitting diodes for fiber optic communications.

3.1.1.2 Growth Process for the Synthesis of the Double Heterojunction Structure.

Epitaxial synthesis of the double heterojunction structure is accomplished according to the sequence of events outlined in the flow chart of Figure 6. Table 3 lists the melt compositions for the growth of the double heterojunction structure used in the fabrication of the light emitting diode. After the appropriate melt ingredients, gallium (Ga) charges, and polycrystalline source wafers, have been loaded into consecutive growth bins, the single crystal (100) GaAs substrate is placed into the slider well of the high purity graphite boat. A graphite cover plate is employed to eliminate surface dissociation of the substrate during equilibration. The boat is then loaded into the quartz growth tube and the system is evacuated by means of the Vac-Sorb pump. Following a short H_2 purge, the system is brought up to the starting temperature of 850°C by rolling the isothermal liner into the growth position. Melt saturation is accomplished during a one hour soak at 850°C during which time enough GaAs is dissolved from the source wafers in order to exactly saturate each melt. This recently developed self-saturation scheme has simplified the growth procedure by eliminating the

Figure 6 - Sequence of Operations for Liquid Phase Epitaxial Synthesis.

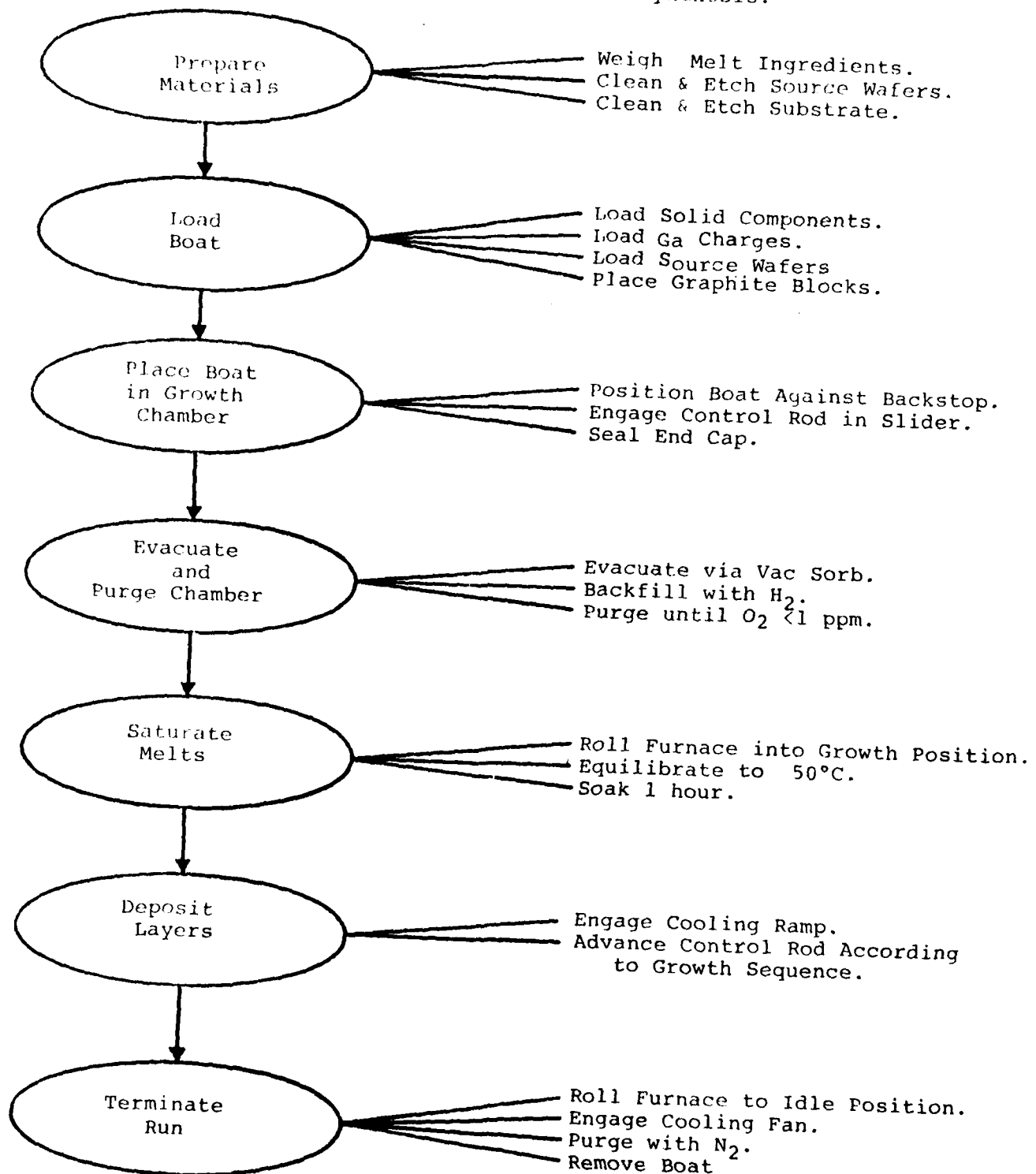


TABLE 3.

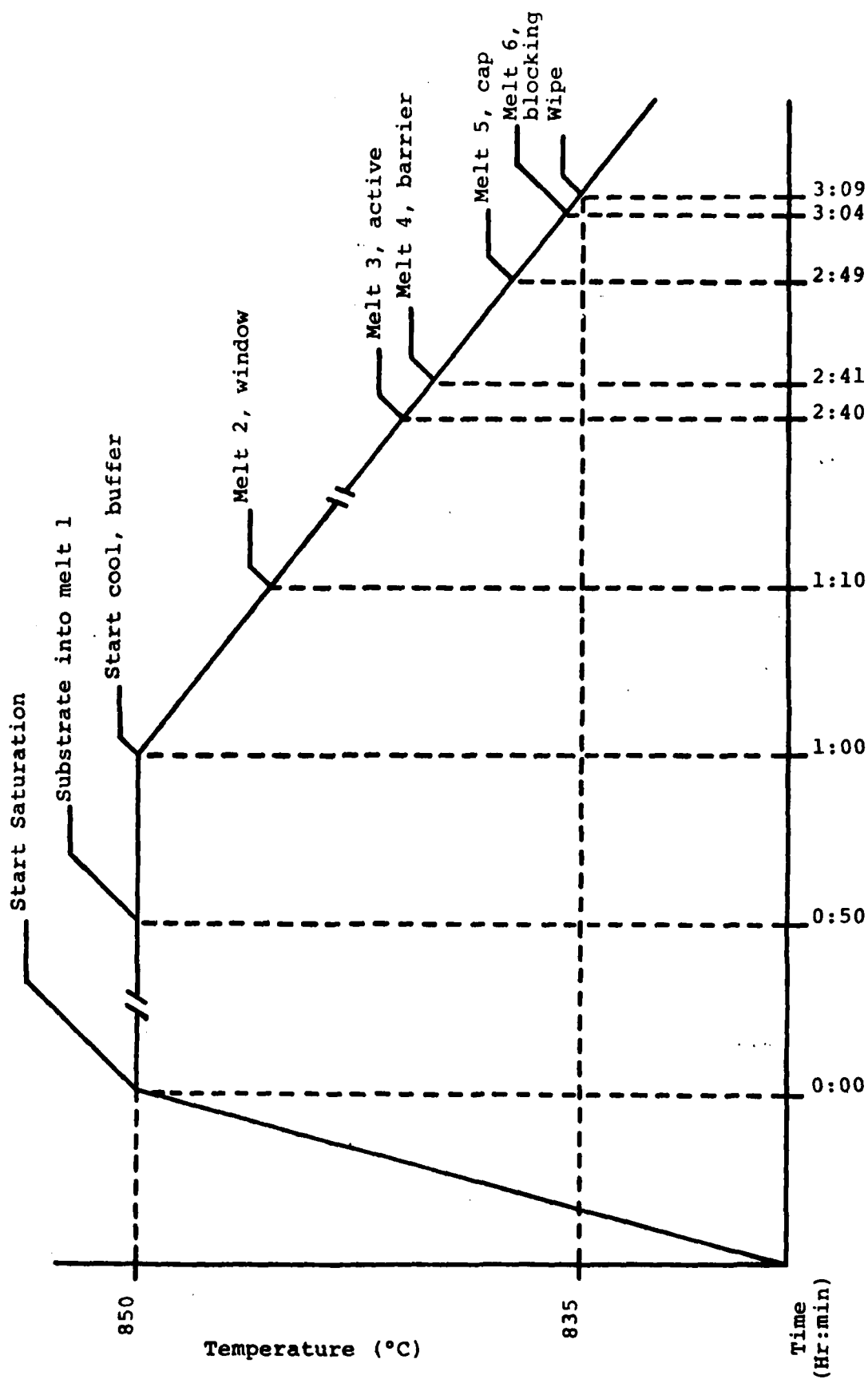
Melt Compositions for Double Heterojunction Epitaxial
Synthesis of Etched Well Light Emitting Diodes.
(Weights in mg.)

<u>Layer</u>	<u>*GaAs</u>	<u>Ga</u>	<u>Al</u>	<u>Te</u>	<u>Si</u>	<u>Ge</u>
1	0.6K	5.0K	-	2.0	-	-
2	1.2K	10.0K	9.0	4.0	-	-
3	0.6K	5.0K	0.8	-	-	20
4	0.6K	5.0K	6.0	-	-	0.1K
5	0.6K	5.0K	1.2	-	-	0.5K
6	0.6K	5.0K	-	-	-	-

* Polycrystalline source wafers.

need for careful preweighing of GaAs for each melt. In addition, higher quality layers and increased run to run layer thickness reproducibility have been achieved with this technique. Once saturation has been achieved, epitaxial synthesis proceeds according to the time temperature program shown in Figure 7. Individual layers are epitaxially deposited by advancing the substrate through the consecutive growth bins for a precisely controlled time interval. Because growth rates for the various melts are well defined for a fixed starting temperature and cooling rate, layer thickness can be accurately and reproducibly controlled using this technique.

Figure 7. Temperature Program Used in the Liquid Phase Epitaxial Growth of Double Heterojunction LED Structures.



WAFER PROCESSING FOR ETCHED-WELL LIGHT EMITTING DIODE
CHIP FABRICATION

In the chip fabrication process, the key to central alignment of the emitting spot on the p-side of the wafer to the etched well on the n-side of the wafer, is a hinged photomask shown in Figure 8. The index step assures repeat positioning and orientation. The mask can be flipped from one side to the other for paired exposure.

As described in the previous section, a GaAs substrate, shown in Figure 9, is processed in the epitaxial system to produce layers as shown in Figure 10. An 800 Å layer of Si_3N_4 is deposited on the blocking layer of the wafer by chemical vapor deposition using a mixture of SiH_4 and NH_3 which is thermally decomposed using N_2 as a carrier gas at 600°C. The SiH_4/NH_3 ratio of 1:5 results in a deposition rate of $\sim 40\text{Å}/\text{Min}$. This step is shown in Figure 11. A photoresist layer is then applied to both sides of the wafer using a spin-on method of 4000 RPM for 40 seconds. This produces a resist film thickness of $\sim 5000\text{ Å}$. The wafer is baked for 20 min at 100°C. Figure 12 shows the wafer with resist on both sides.

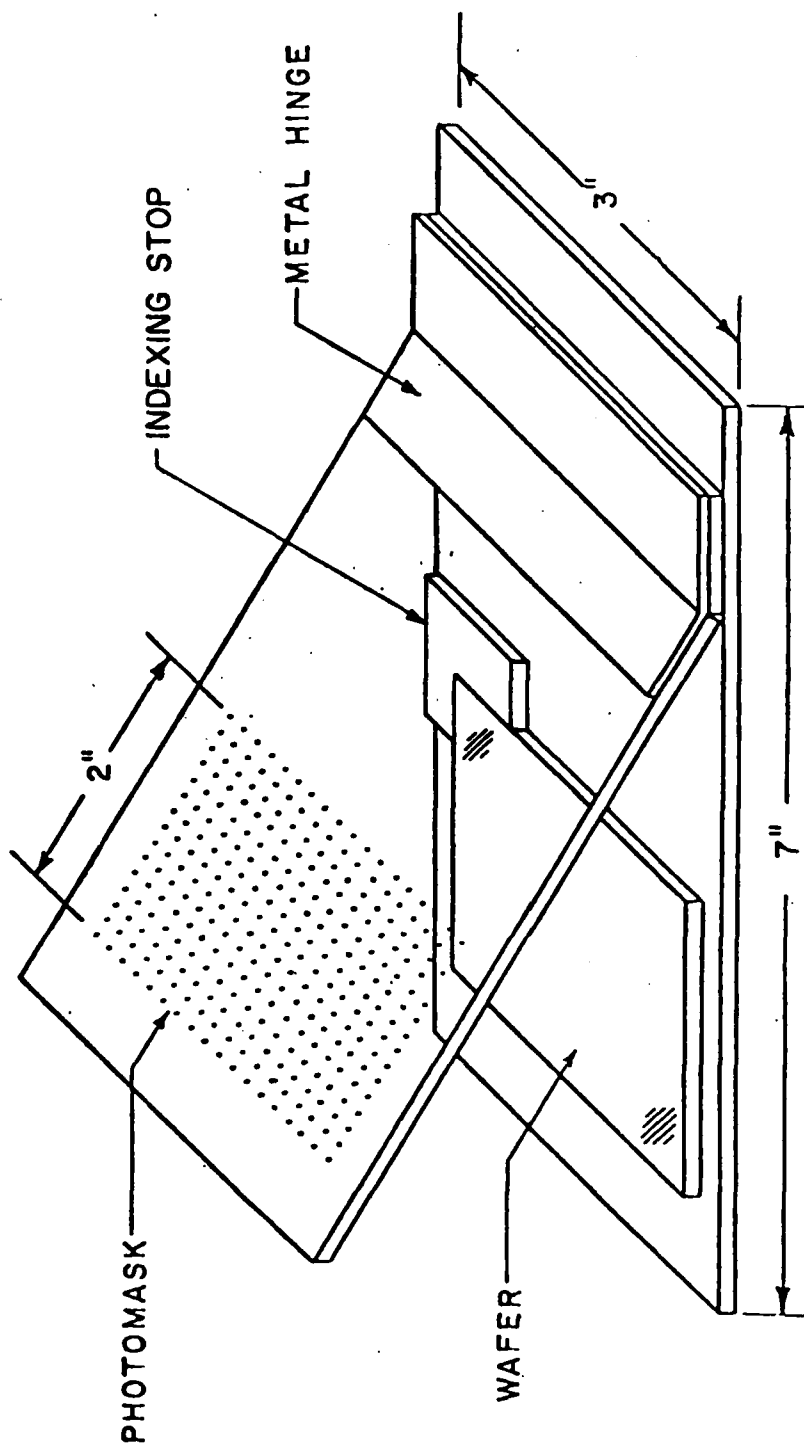
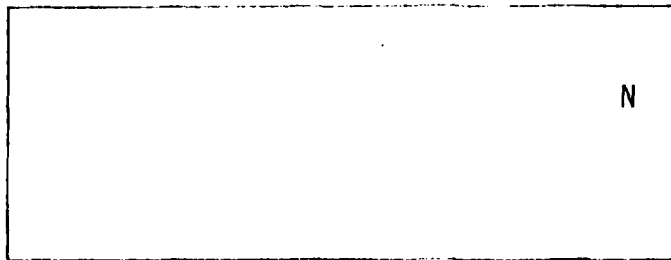
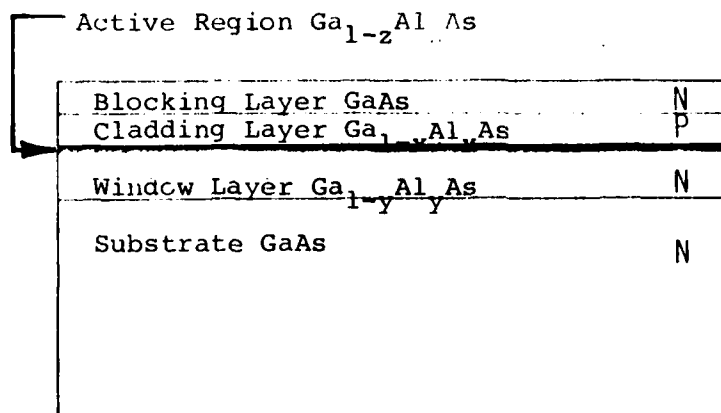


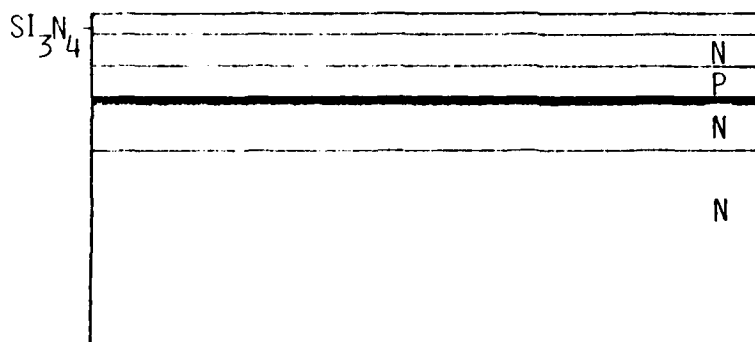
Figure 8 - Sketch of Hinged Photomask.



9. SUBSTRATE



10. L.E.D. STRUCTURE
LIQUID PHASE EPITAXY



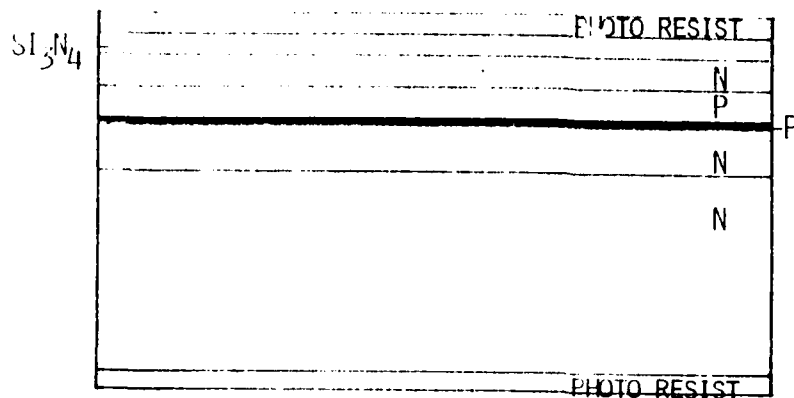
11. P-SIDE Si_3N_4 DEPOSITION

The wafer is placed in the hinged mask, aligning a cleaved edge to the index stop and mask frame. The wafer is placed in the mask p-side up, facing the 40 μm dot pattern. The n-side faces the 9 mil dot pattern. The mask is placed in a UV exposure system and exposed for 25 seconds each side. After development and annealing the wafer appears as in Figure 13.

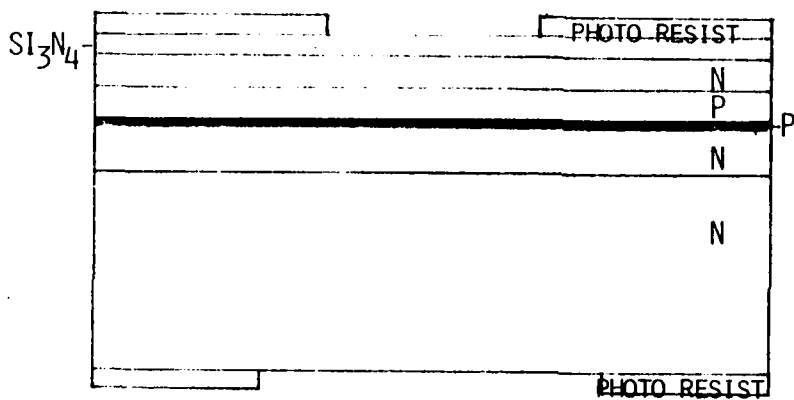
The masked wafer is etched on the n-side for 20 seconds using a 3:1:1 etch. H_2PO_3 , H_2O_2 , H_2O to yield a 9 mil dot pattern $\sim 2 \mu\text{m}$ in depth. During this step the p-side is protected by the Si_3N_4 . The n-side etched wafer is shown in Figure 14.

The p-side of the wafer is plasma etched through the Si_3N_4 to produce a 40 μm dot pattern, as shown in Figure 15. In Figure 16 the photo-resist has been removed from both sides of the wafer. The Si_3N_4 film will allow for a selective Zn diffusion which will penetrate the 40 μm wells opened thru the Si_3N_4 mask.

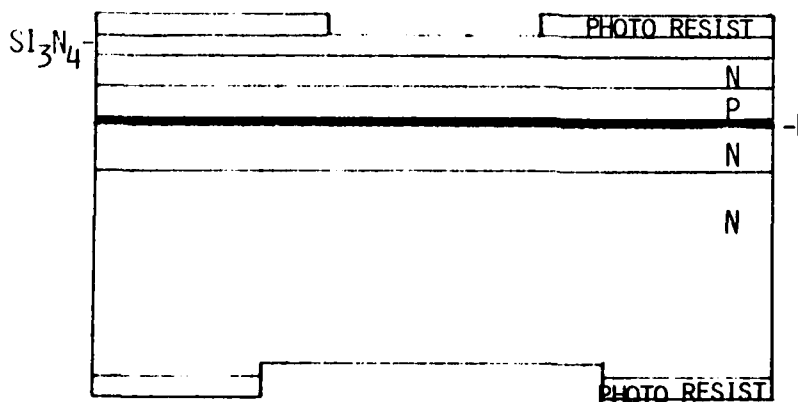
Figure 17 shows the wafer after zinc diffusion. Details of the diffusion furnace are shown in Figure 18. The figure illustrates the semi-sealed ampoule diffusion technique. The furnace is movable, and after the system has been purged and sealed, the furnace is rolled over



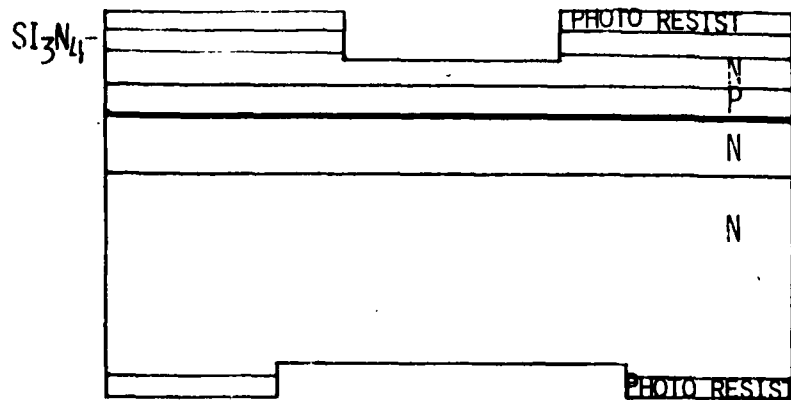
12. P-SIDE AND N-SIDE
PHOTO RESIST



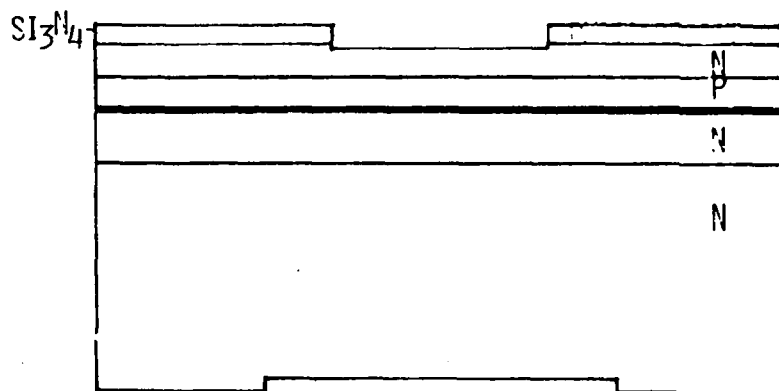
13. DOUBLE SIDED ALIGNMENT
AND EXPOSURE, HINGED
MASK



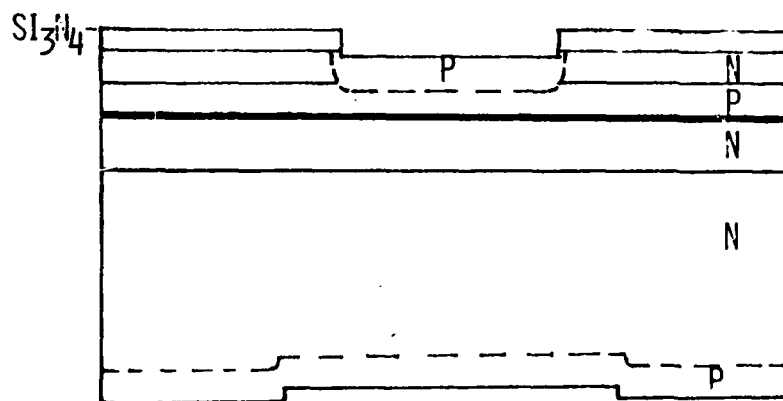
14. N-SIDE WELL DEFINITION
ETCH



15. P-SIDE Si_3N_4 AND CLEAN-UP ETCH



16. PHOTO RESIST REMOVAL



17. SELECTIVE ZN DIFFUSION

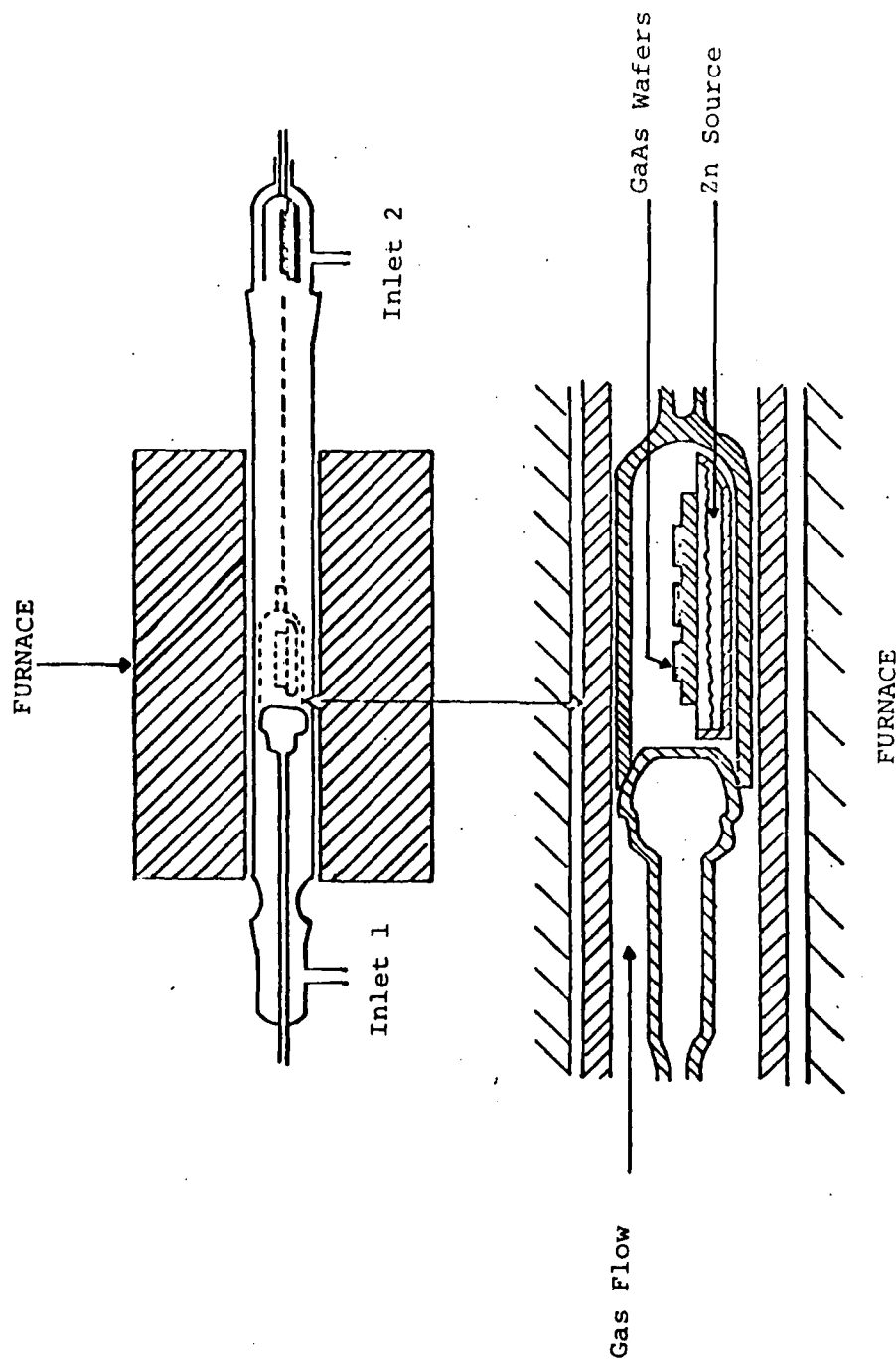


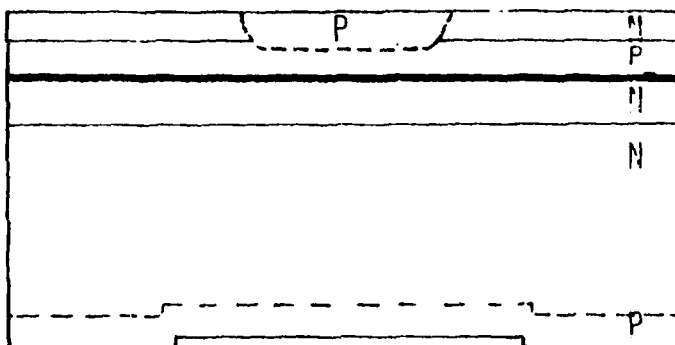
Figure 18 - Detail of Diffusion Furnace.

the ampoule area. At 700°C diffusion temperature, a $1\text{ }\mu\text{m}$ depth can be attained in about 30 minutes. Following the diffusion the Si_3N_4 mask is removed by plasma etching. The wafer at this point is shown in Figure 19. The p-side is then masked with wax so that the n-side diffused skin can be etched in 3:1:1. The etch follows the surface contour, thus retaining the 9 mil diameter dot pattern. This step is shown in Figure 20.

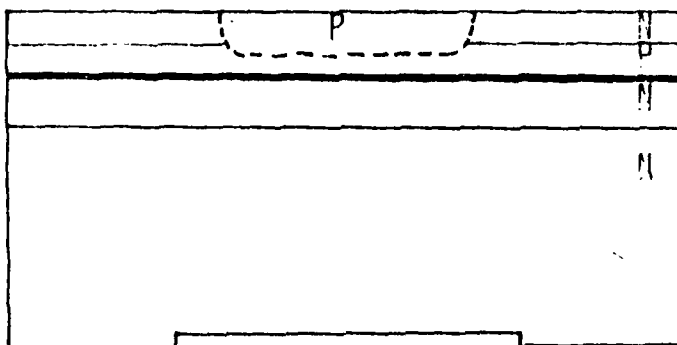
The next step in the process is metallization using standard vacuum technology. $\text{Ti}(500\text{\AA})$, $\text{Pd}(1000\text{\AA})$ and $\text{Au}(1000\text{\AA})$ layers are deposited on the p-side of the wafer, while $\text{AuGe}(1500\text{\AA})$ and $\text{Au}(1000\text{\AA})$ layers are deposited on the n side, as shown in Figure 21.

Photo-resist is applied to the p-side metallization and processed to provide a 24×24 mil aperture on 26 mil centers allowing a 2 mil "street" in the X and Y direction for scribing. The n-side is wax masked, and in an Electro-plating bath, a half-mil thick gold pad is deposited in the 24×24 aperture. These steps are illustrated in Figures 22, 23 and 24.

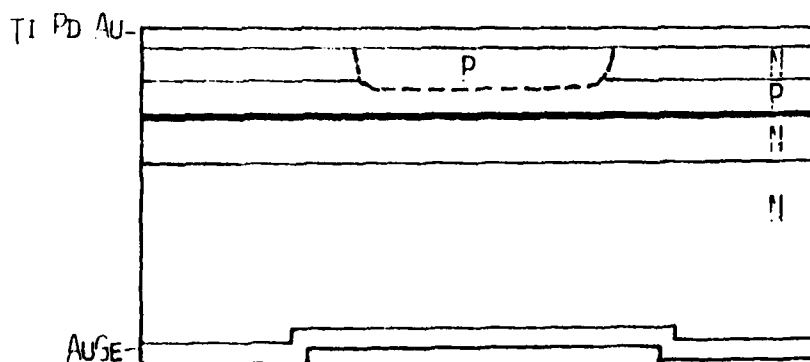
The wafer is further processed by applying photo-resist to the n-side in preparation for the n-side well etching, as shown in Figures 25 and 26. The re-alignment mask has been used to preserve the alignment



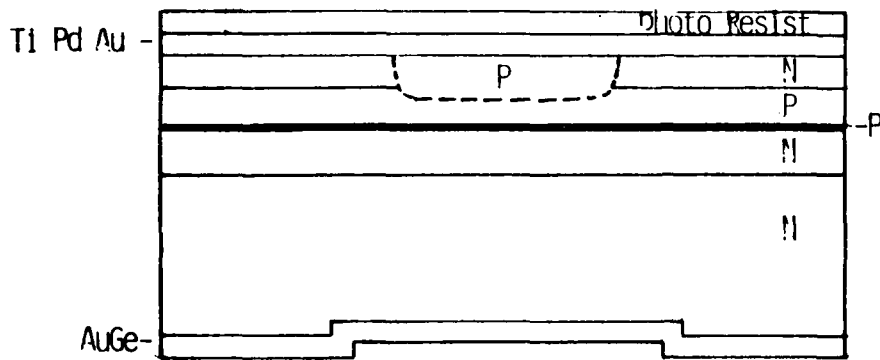
-p 19. Si_3N_4 REMOVAL



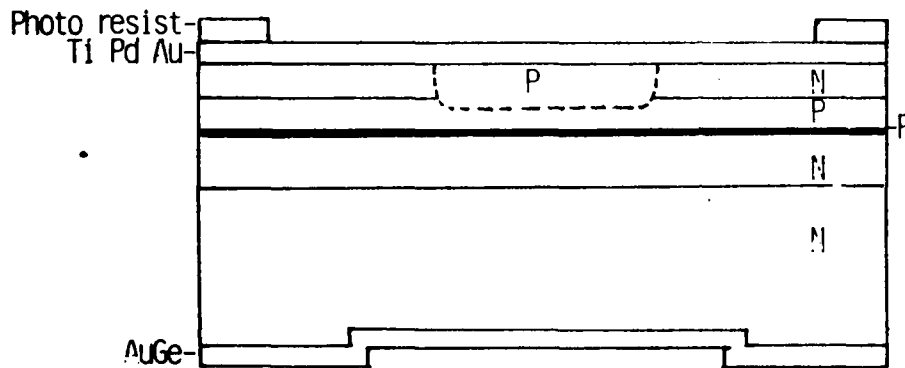
20. N-SIDE CONTOUR ETCH TO REMOVE DIFFUSED SURFACE



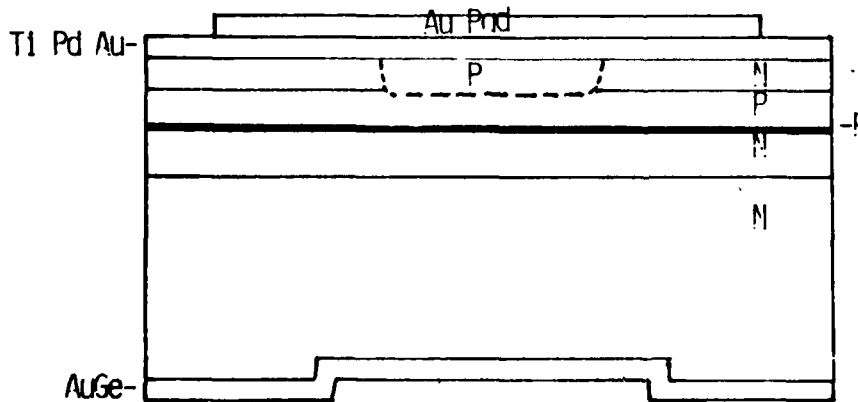
21. P AND N-SIDE METALIZATION



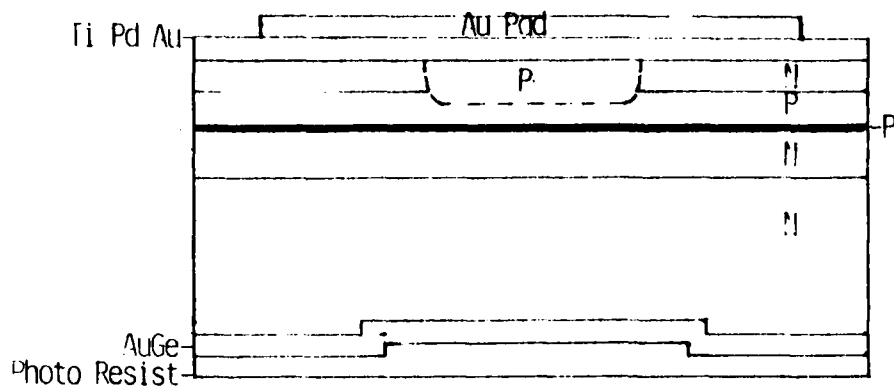
22. P-Side Photo Resist



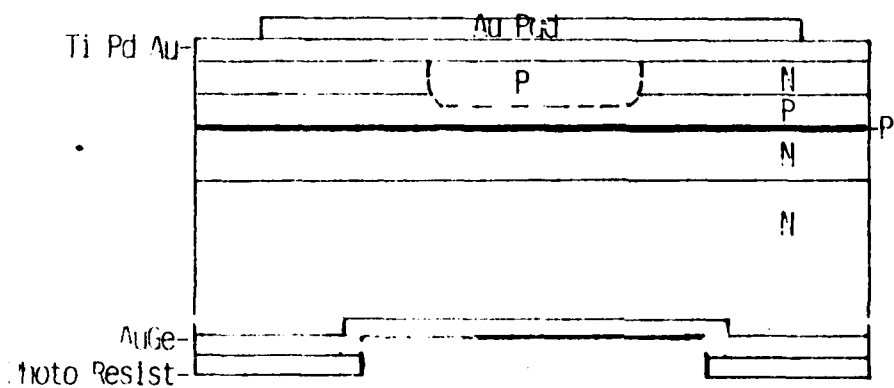
23. P-Side Alignment and Exposure



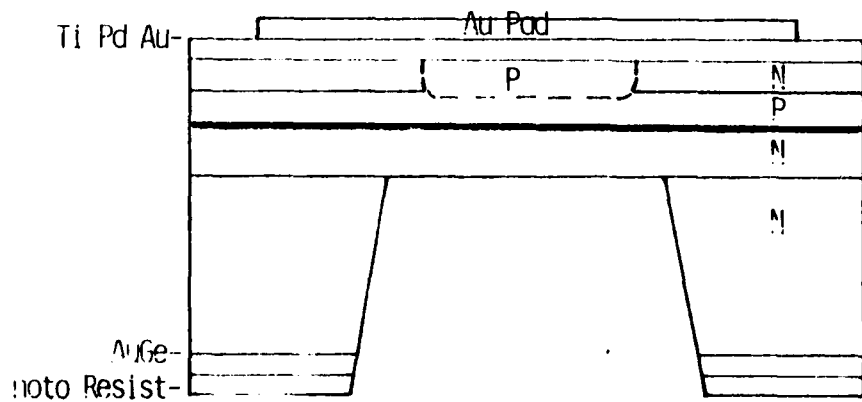
24. P-Side Electro-plated Au Bonding Pad



25. N-Side Photo Resist



26. N-Side Re-alignment and Exposure



27. N-Side Well Etching

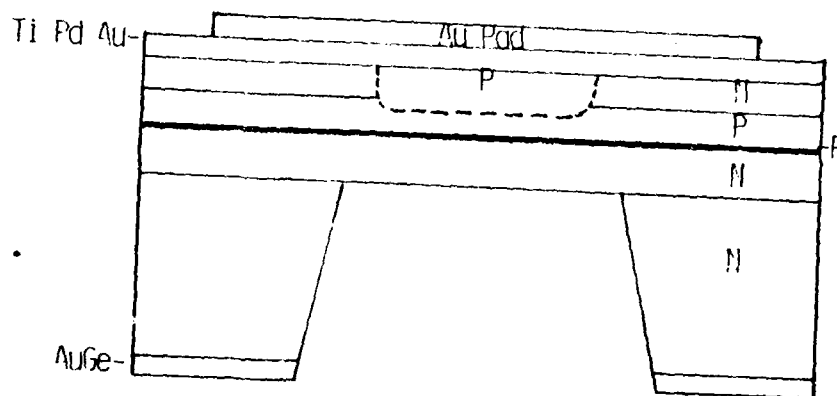
between the 9 mil dot on the n-side to the 40 μ m dot on the p-side.

The AuGe metal is etched with a KI solution down to the GaAs substrate. A 30% H_2O_2 etch with the pH controlled to 8.5 using NH_4OH prevent oxidation and etch thru of the GaAlAs window layer. The etched well has dimensions of 10 mils in diameter and approximately 4.2 mils in depth. Figure 27 shows the wafer in the etch condition while Figure 28 shows the finished wafer form. Figure 29 shows the p and n-sides in views which depict the essential features more clearly. Figure 30 is a process flow sheet listing the process steps.

3.2 PACKAGE TECHNOLOGY

3.2.1 PACKAGE DESIGN

The basic package was designed around a high frequency transistor package which contained a mounting stud with low inductance "wings" brazed to a BeO insulating substrate. The coaxial design of the LED package using this approach is shown in Figure 31. The added components comprise a ferrule which serves to contain the fiber and a sleeve, which secures the ferrule to the header and maintains fiber alignment.



28. Photo Resist Removal and Finished Device

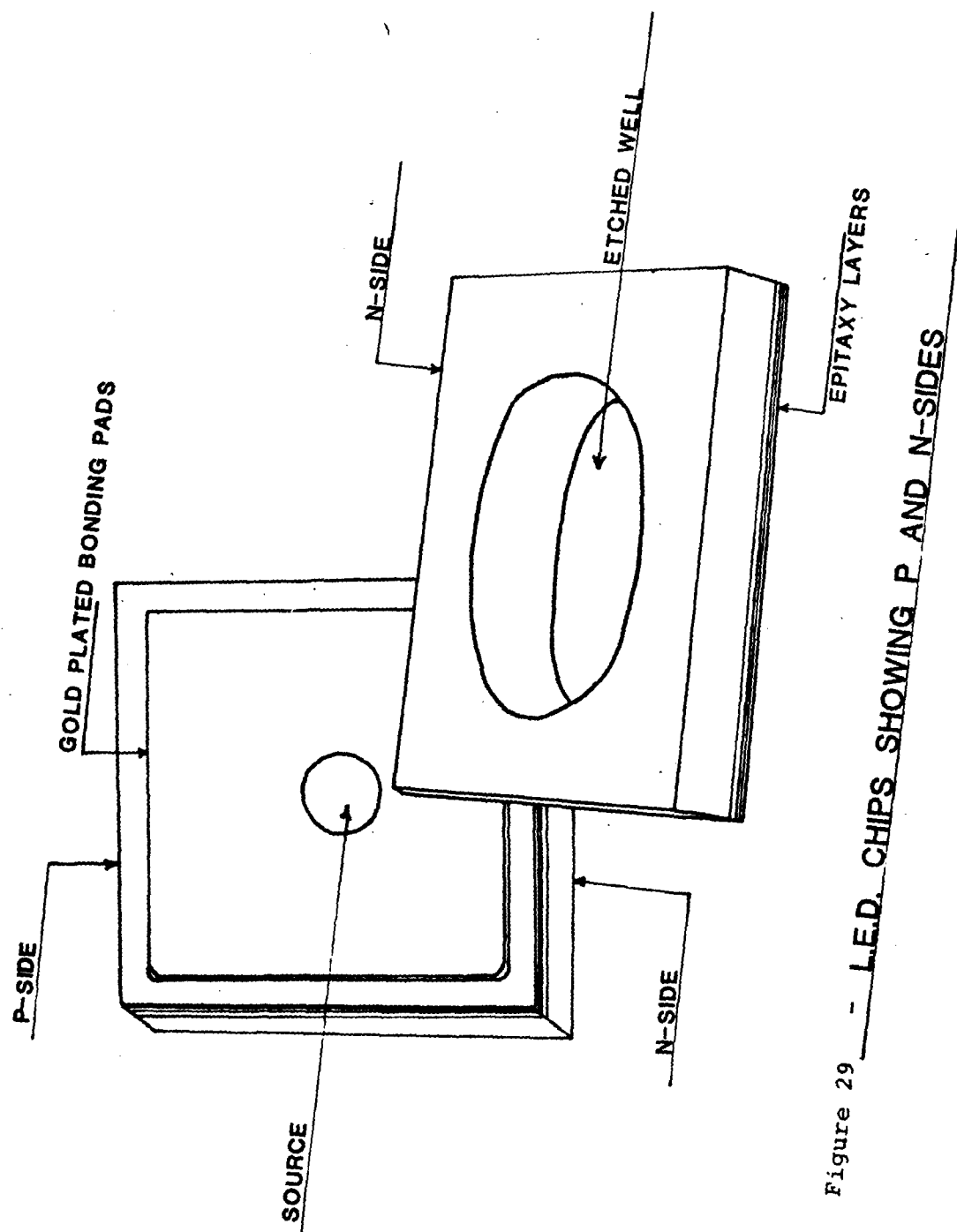


Figure 29 - L.E.D. CHIPS SHOWING P AND N-SIDES

Figure 30 - Process Flow Chart

Run # _____

Date Received _____

Comments:

1. Si_3N_4 Deposition _____
2. Cleaning _____
3. Lapping to 4.5 mils _____
4. N-side Photo-resist _____
5. P-side Photo-resist _____
6. Pre-bake 20 min. _____
7. Alignment & exposure _____
8. Developing _____
9. Post bake 10 min. _____
10. N-side 2 μm etch _____
11. P-side plasma-etch _____
12. (Chemical) Resist removal _____
13. (Plasma) Resist removal _____
14. Selective Zn diffusion _____
15. Si_3N_4 Removal _____
16. N-side contour 2 μm etch _____
17. Metallization cleaning _____
18. P-metallization _____
19. N-metallization _____
20. N-side photo-resist _____
21. N-side realignment _____
22. Exposure & developing _____
23. N-side etching _____
24. P-side electroplated (Au) _____
25. Final clean-up _____
26. Saw mounting _____
27. Dicing 24 mil (centers) _____
28. Saw dismounting _____
29. Cleaning _____
30. Chip Q.C. _____
31. Probe test _____
32. Evaluation _____

COMMENT ON PROCESSING:

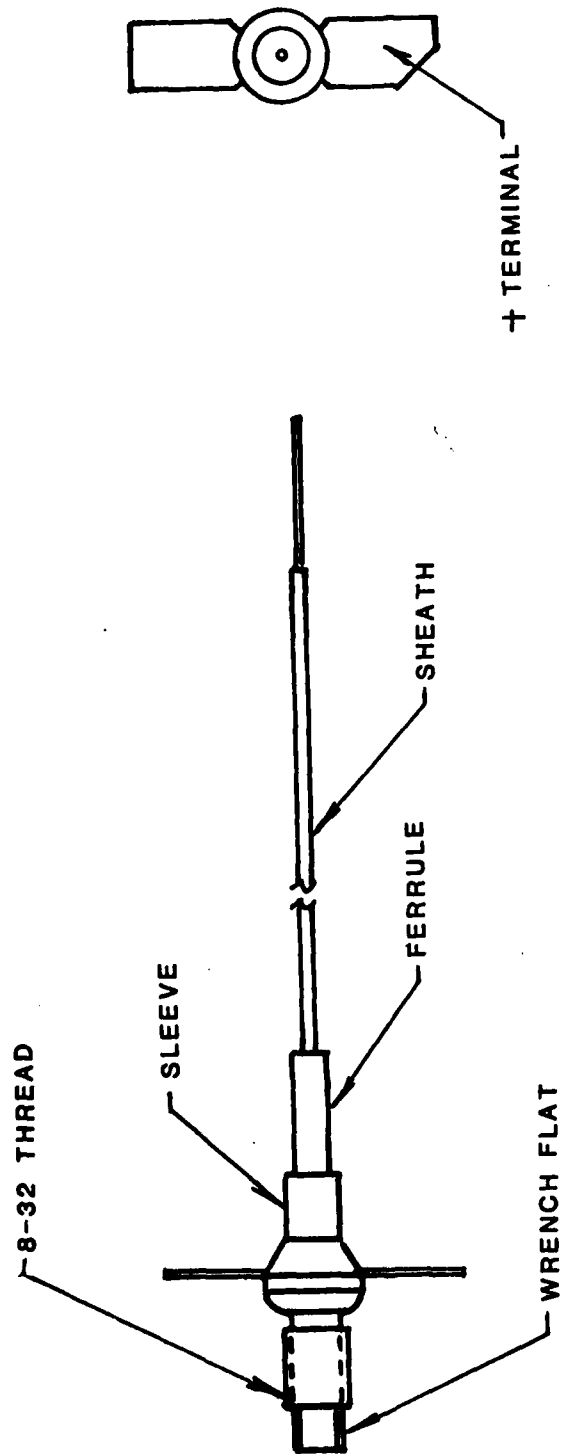


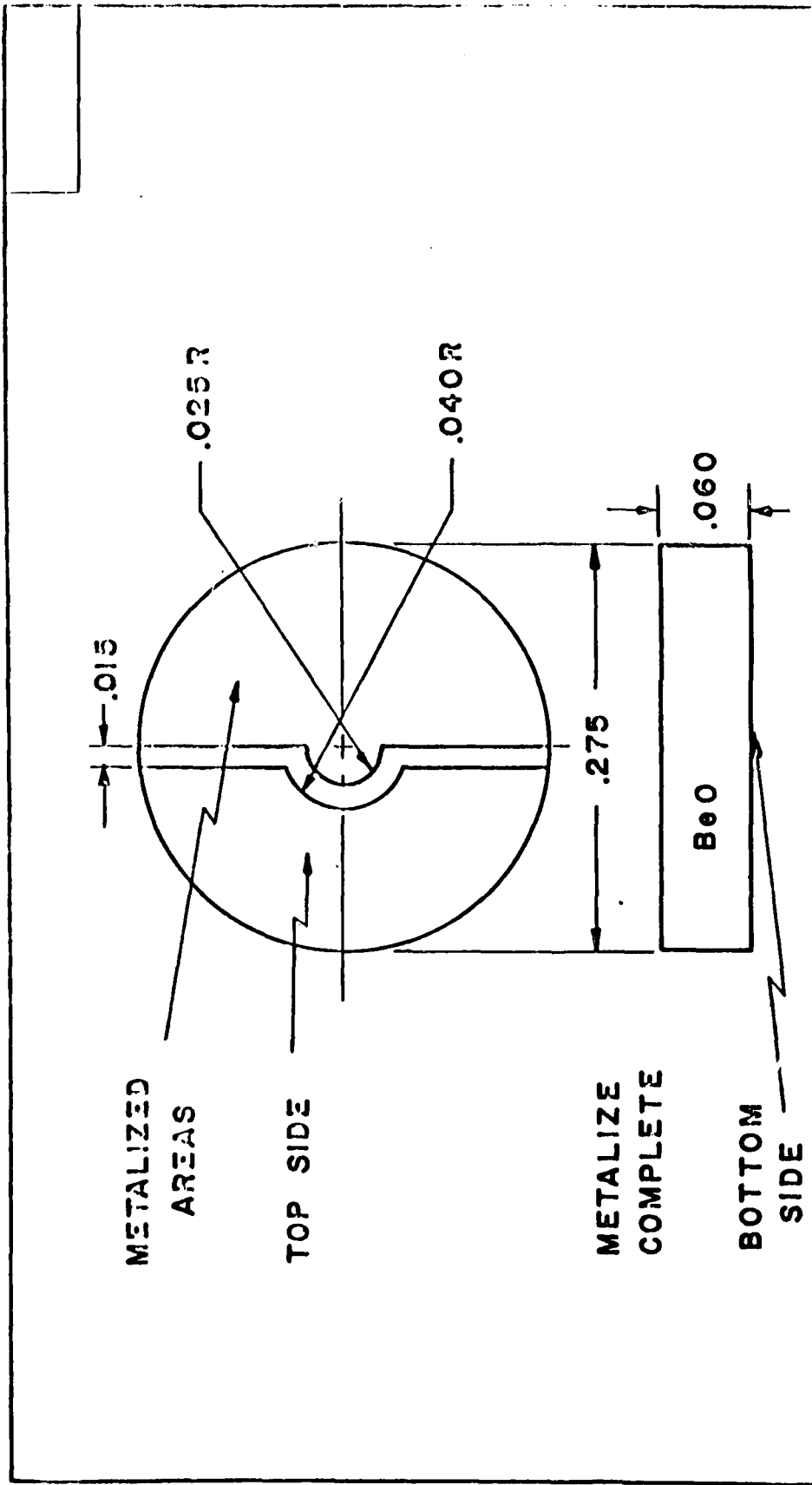
FIGURE 31 - FIBER COUPLED LED

Figure 32 shows details of the BeO substrate indicating the metallized area and central target area for mounting the LED chips. Figure 33 shows the BeO brazed to the copper screw stud and terminals brazed in place. Figures 34, 35 and 36 give details of the stud and terminals. Figure 37 shows the ferrule and sleeve assembly. The sleeve is free to slide along the ferrule and has a slot across the mounting face to enable the sleeve to straddle the terminals brazed to the BeO substrate. Figure 38 illustrates two methods by which the fiber is epoxied to the ferrule. The lower figure illustrates the fiber sheathing epoxied to the ferrule. The upper figure indicates the fiber directly epoxied to the ferrule. This second method provides mode stripping in the fiber cladding and serves to secure the fiber to the ferrule in such a manner as to inhibit fiber movement during the pull test performed on the finished device.

3.2.2

LIGHT EMITTING DIODE ASSEMBLY TECHNIQUE

The LED Assembly Flow Chart in Figure 39 indicates the sequential steps required to assemble the device. The first step in the process is the soldering of the



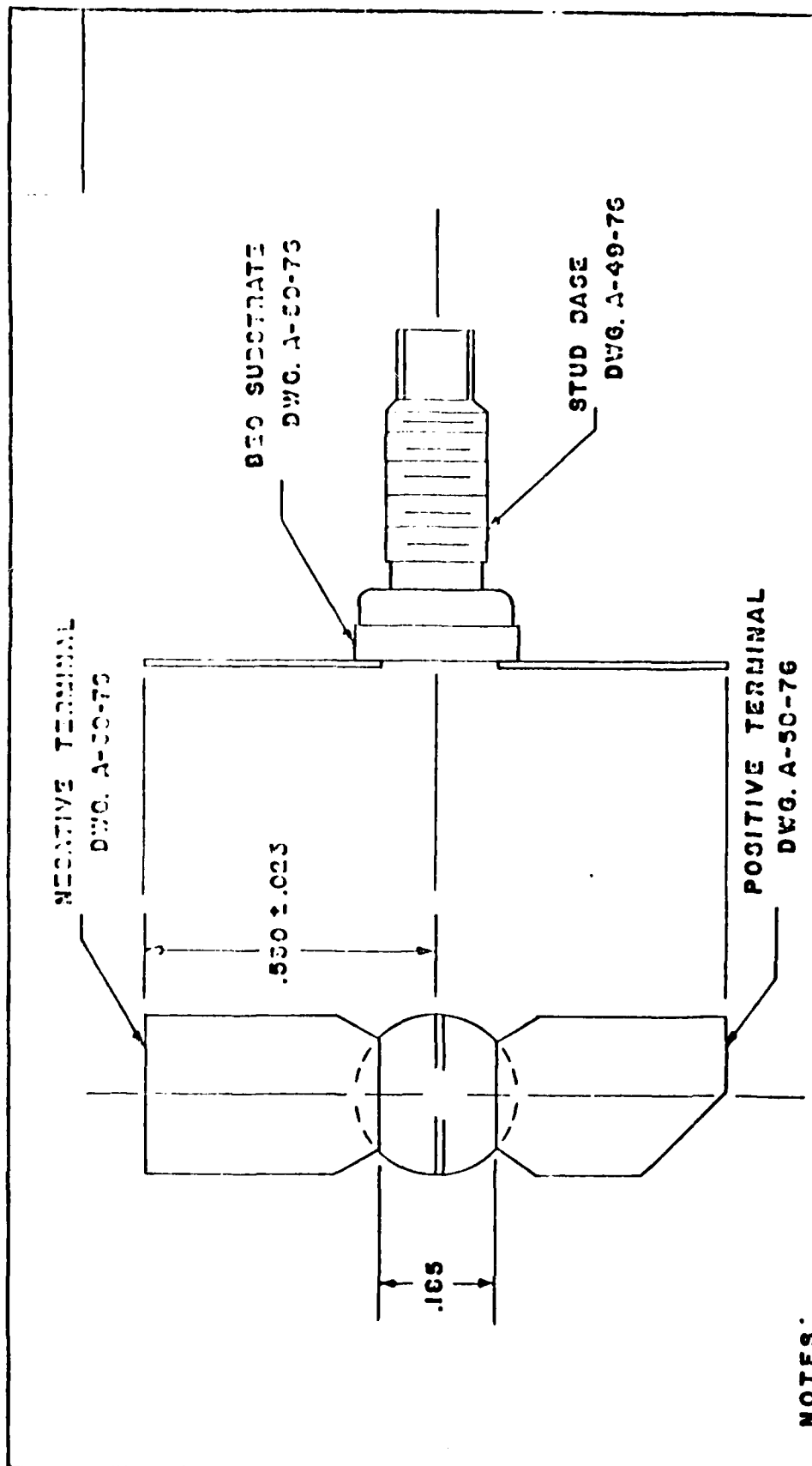
TOL. $\pm .002$

LDT 177 BeO SUBSTRATE

SCALE: 10X	APPROVED BY	DRAWN BY M.R.
DATE: 12-10-76		

Figure 32 - LED Chip Carrier (BeO Substrate).

LASER DIODE LABS. INC.	DRAWING NUMBER
------------------------	----------------



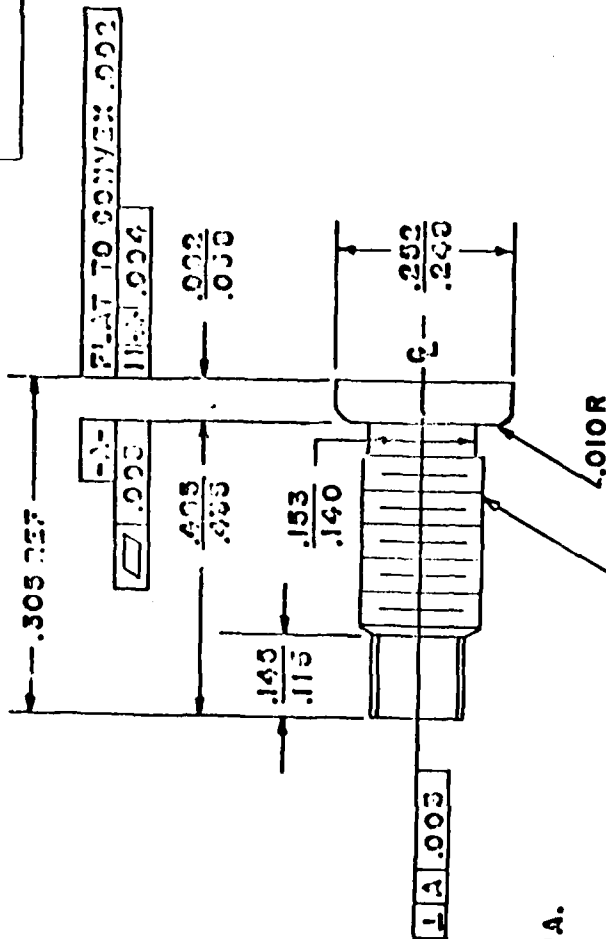
NOTES:

1) ASSEMBLE PARTS WITH BRAZE
AT 600°C MIN.

2) FINISH -

DIE BOND AREA, 150μm. AU ONLY
STUD, 150μm. NI, IMMERSION AU
LEADS, 30μm. AU

LDT 177 STUD ASSEMBLY			
SCALE: 4X	APPROVED BY	DRAWN BY M.R.	
DATE: 12-10-76			
Figure 33 - LED Stud Assembly.			
LASER DIODE LABS. INC.			DRAWING NUMBER



8-32 UNC-2A THREAD

PITCH DIA.

MAX. .1420 MIN. .1300

MAJOR DIA.

MAX. .1620 MIN. .1560

MATERIAL: OFHC OR T6-Cu

NOTES:

- 1) ALL DIA.'S TO BE CONCENTRIC WITH ϕ WITHIN .005 T.I.R.
- 2) .002 MAX. BURR
- 3) COMPLETE THREADS TO WITHIN .040 OF HEAD

LDT 177 STUD BASE

APPROVED BY

4X

SCALE:

DATE: 12-10-70

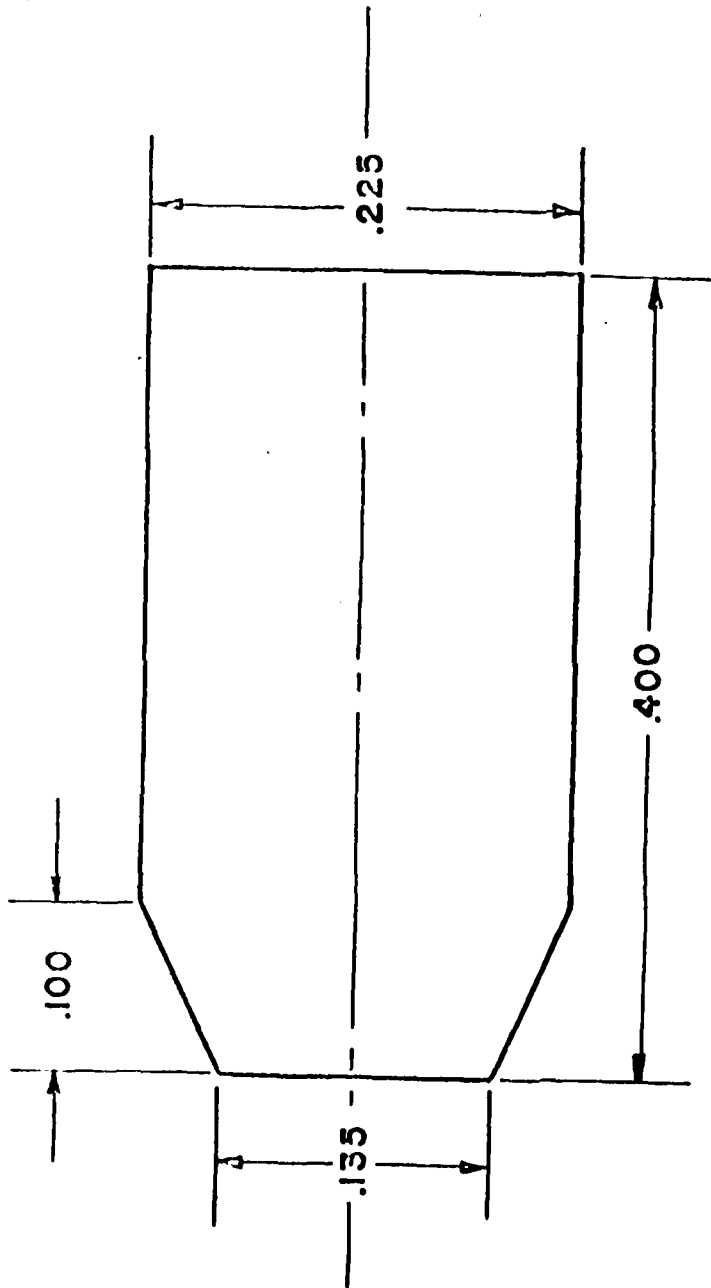
DRAWN BY M.R.

Figure 34 - LED Stud Base.

LASER DIODE LADS. INC.

DRAWING NUMBER

DESIGN NO. 10007 AGEPROOF MASTER FORM



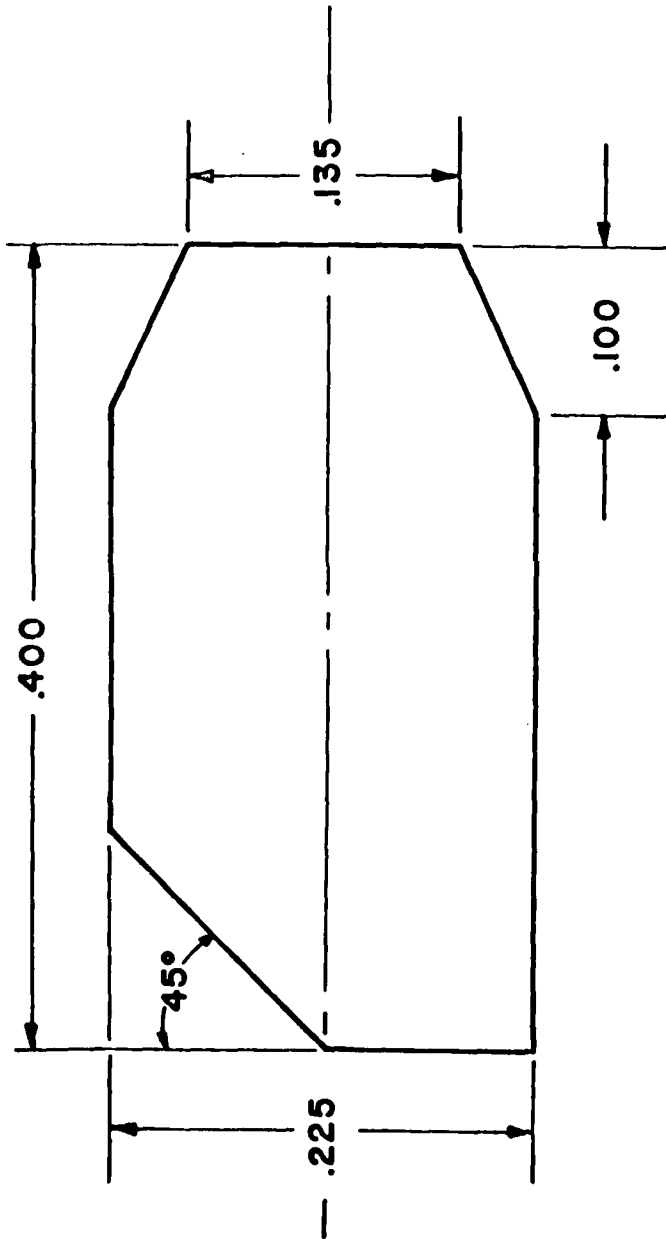
MATERIAL - KOVAR

TOL. $\pm$.002

LDT 177 NEGATIVE TERMINAL

SCALE:	APPROVED BY	DRAWN BY
DATE: 12-10-76		M.R.
Figure 35 - LED Electrode (NEG.).		
LASER DIODE LABS. INC.		DRAWING NUMBER

17-70-1000 APPROOF WATER FORM



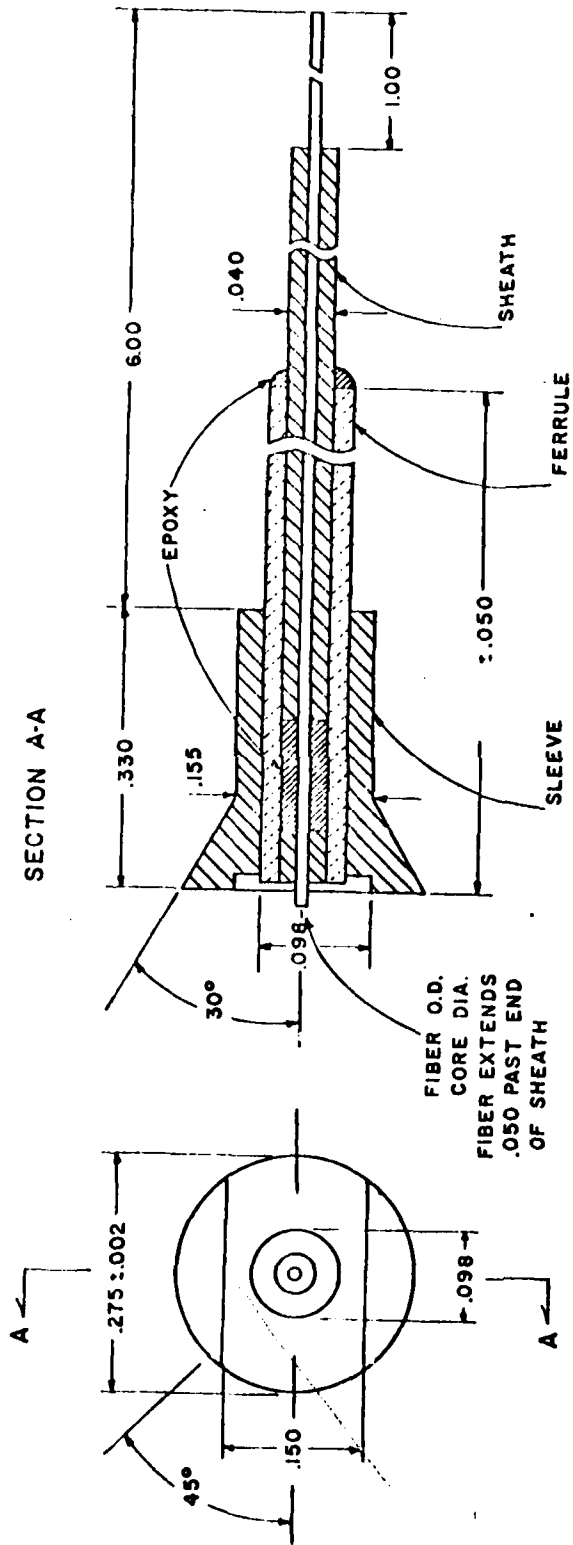
MATERIAL - KOVAR

TOL. $\pm$.002

LDT 177 POSITIVE TERMINAL

SCALE:	APPROVED BY	DRAWN BY M.R.
DATE: 12-10-76		
Figure 36 - LED Electrode (POS.).		
LASER DIODE LABS. INC.		DRAWING NUMBER

100% APPROOF MASTER FORM



FIBER CHARACTERISTICS

CHARACTERISTICS MIN. MAX. UNIT

ATTENUATION (AT λ P) (8200Å)

CORE DIAMETER

CLADDING DIAMETER

PROTECTIVE JACKET DIAMETER

NUMERICAL APERTURE (N.A.)

TENSILE STRENGTH

BENDING RADIUS

LDT 177 FIBER ASSEMBLY

SCALE: 10X	APPROVED BY	DRAWN BY
DATE: 11-23-76		M.R.

Figure 37 - LED Fiber-Ferrule Assembly with Support Sleeve.

LASER DIODE LABS. INC. DRAWING NUMBER

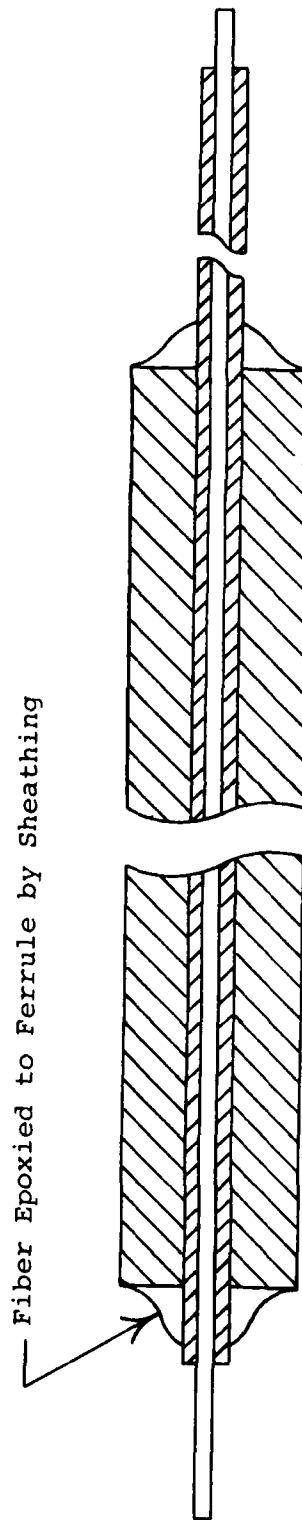
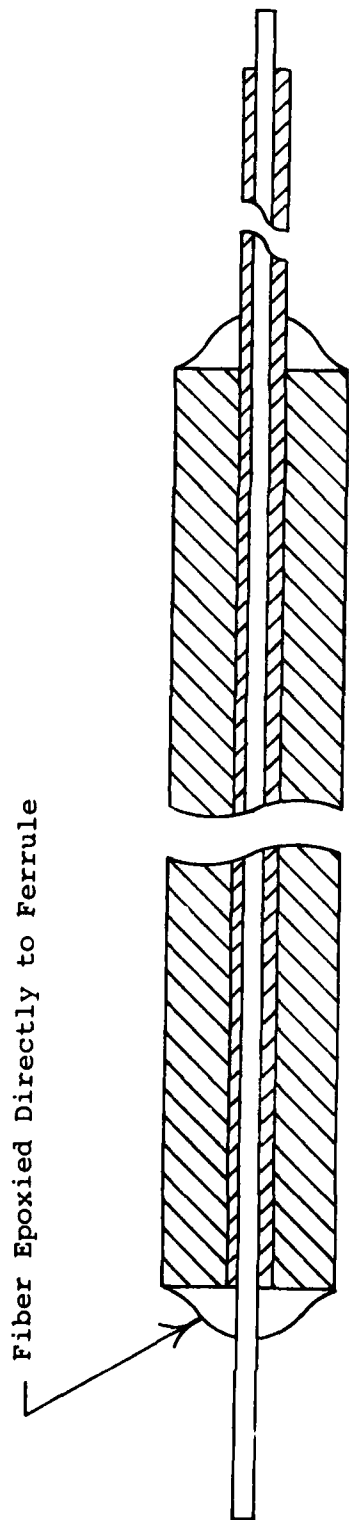


Figure 38 -Fiber Epoxied to Ferrule.

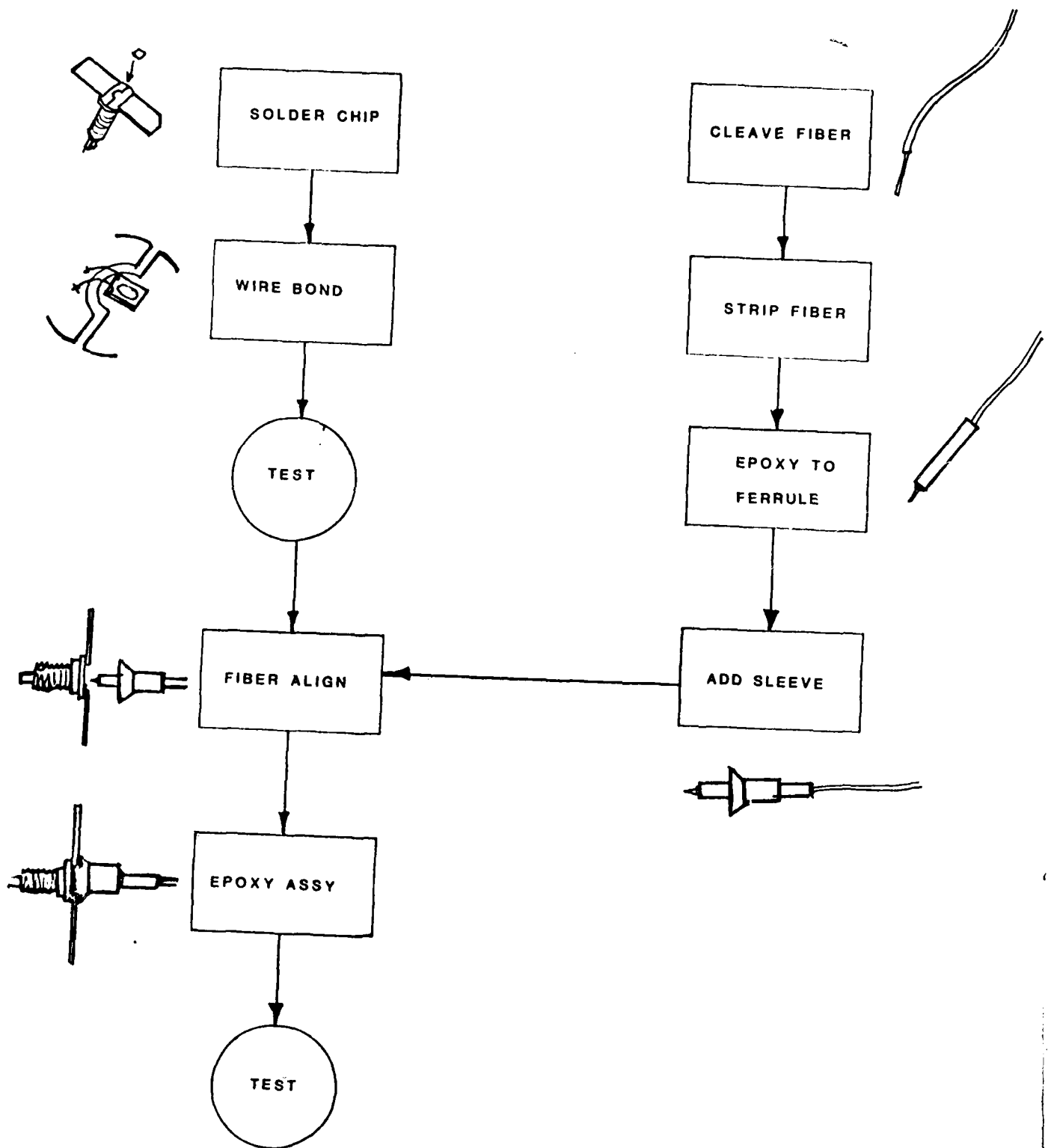


Figure 39 - LED ASSEMBLY FLOW CHART

of the LED chip to the header assembly using the graphite chip soldering fixture shown in Figure 40. Figure 41 shows details of the fixture, namely the fixture body, locating ring, weight, pellet and header. The body and locating ring are machined so that the parts are concentric and provide a central locating hole with respect to the metallized pattern on the BeO substrate. Solder cream, 60/40, Sn/Pb is used as the soldering medium. The boat is passed thru an Infra-Red belt furnace to affect the soldering. After a flux cleaning operation and visual inspection for proper solder flow, the devices are ready for wire bonding. Standard ultra-sonic wire bonding techniques are used to bond 2 mil gold wires from n-side of the chip to the metallized area on the BeO substrate. This double bonding is illustrated in the photo of Figure 42. At this point the device can be tested for essential characteristics and burned-in to assure stability.

Figure 43 is a sketch of the alignment fixture used to align a fiber with the LED chip. A quick insertion socket with finger contacts secures the header assembly in place, while the ferrule clamp, attached to a 3 axis

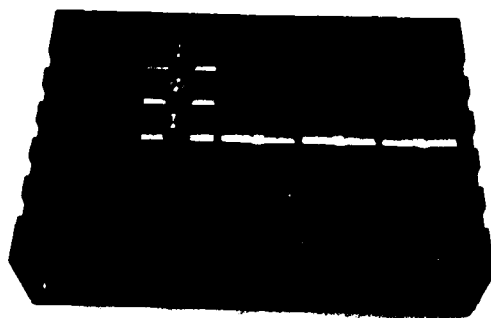


Figure 40 - Chip Soldering Fixture

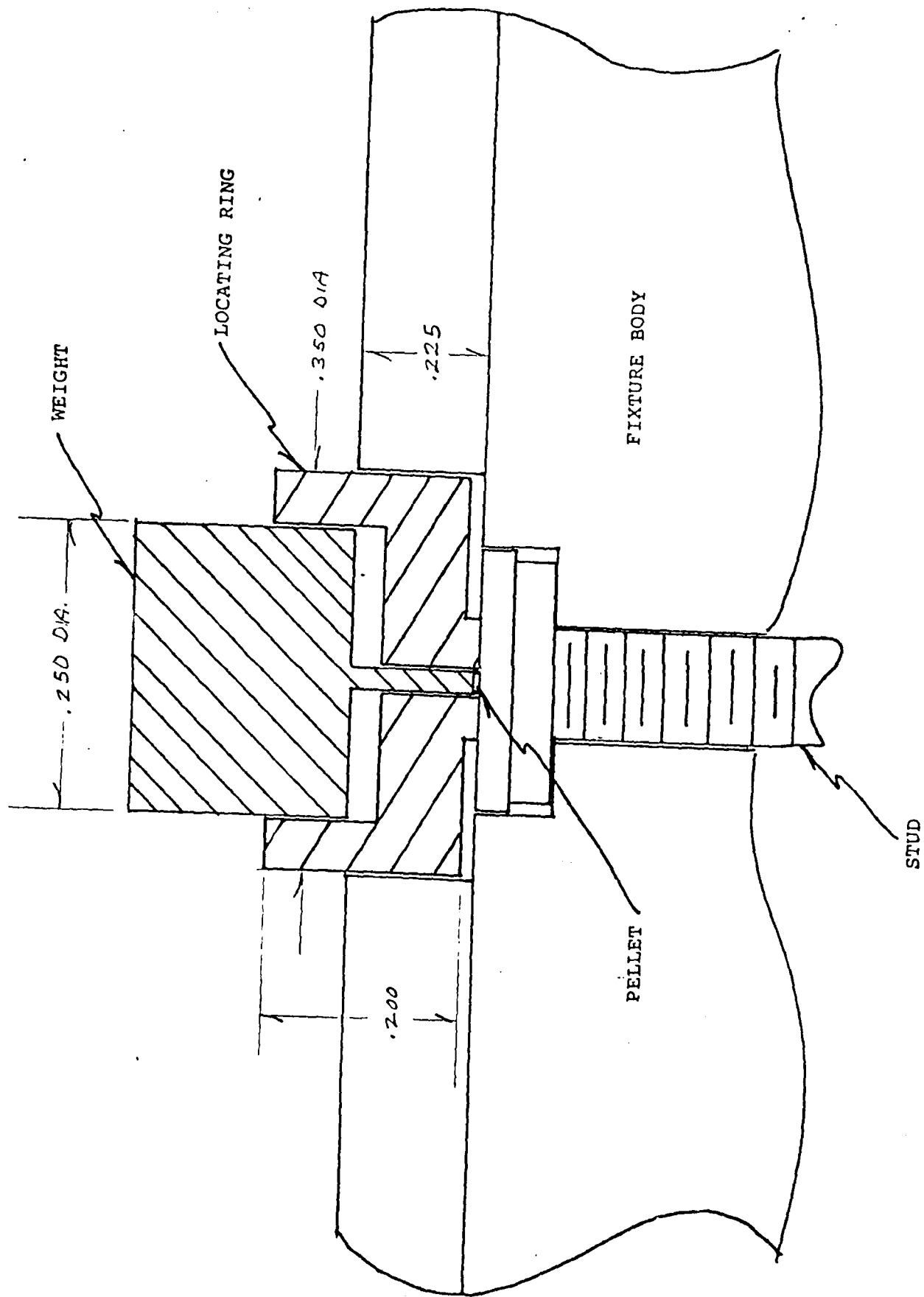


Figure 41 - Detail Chip Soldering Fixture.



FIG. 42 - DOUBLE BONDED CHIP

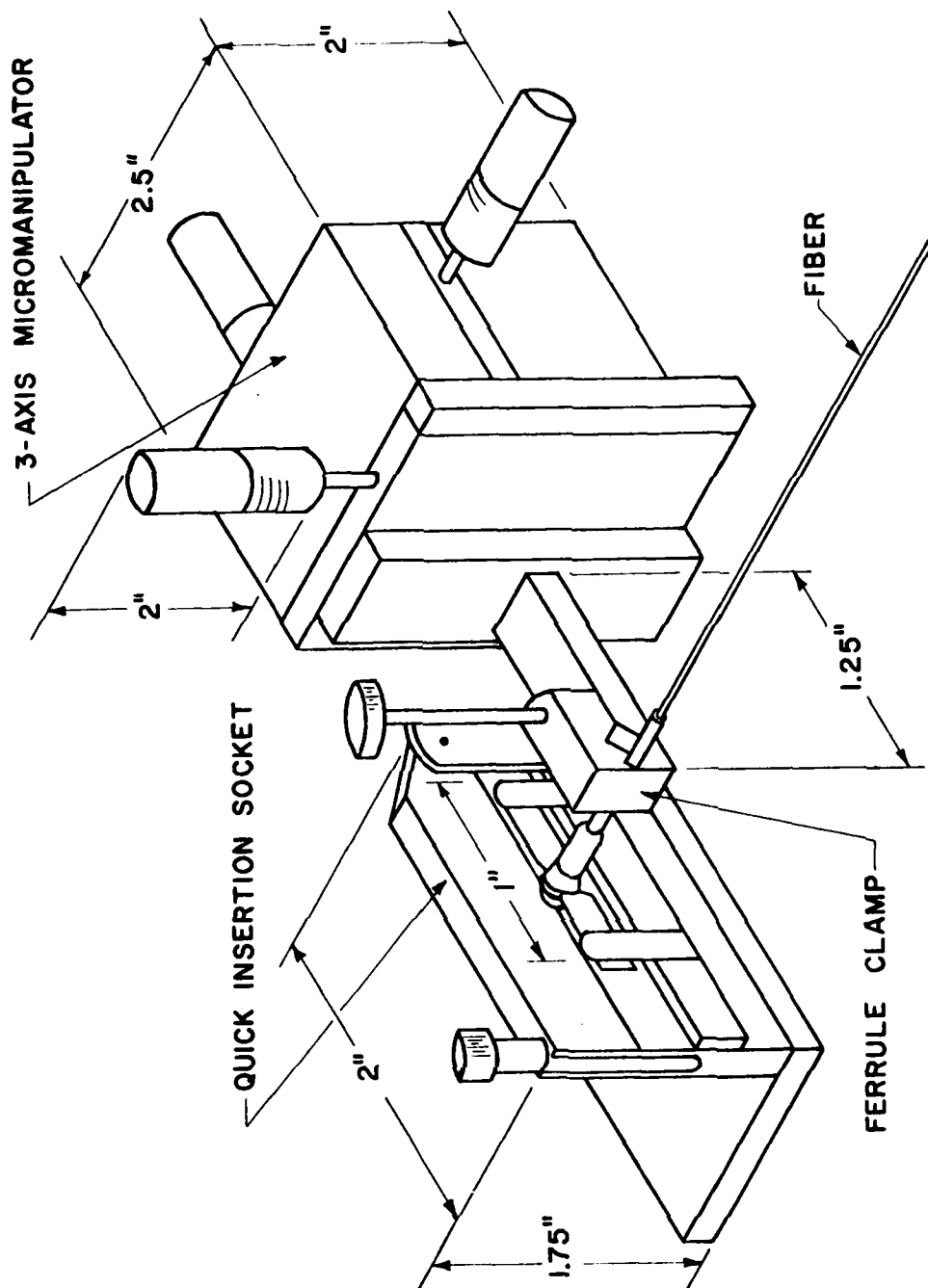


Figure 43 - Sketch of Alignment Fixture.

micromanipulator, holds the fiber ferrule assembly. In practice, the ferrule is placed in the micromanipulator clamp in such a manner that the sleeve may be slid back to expose the fiber protruding from the front of the ferrule. The fiber pigtail is positioned in front of the detector. Under microscopic examination, the fiber is maneuvered in the diode well, while observing the LED power meter for maximum reading with the diode forward biased. By rotating the sleeve on the ferrule, epoxy can be applied to the supporting faces of the sleeve. The sleeve can now be slid forward and placed in contact with the BeO mounting surface. The joint between the sleeve and ferrule is epoxied. The alignment and epoxying steps are illustrated in the photos of Figures 44, 45, 46 and 47. The alignment fixture is shown in the photos of Figures 48 and 49. The completed LED assembly is shown in Figure 50. The key to successful assembly of the fiber, ferrule and sleeve to the header, that is, one which will pass shock, vibration, thermal shock, pull test and moisture resistance, is the proper choice of the epoxy. In particular, moisture resistance is a critical test for epoxies as the original strength of epoxies will generally be degraded by the test.

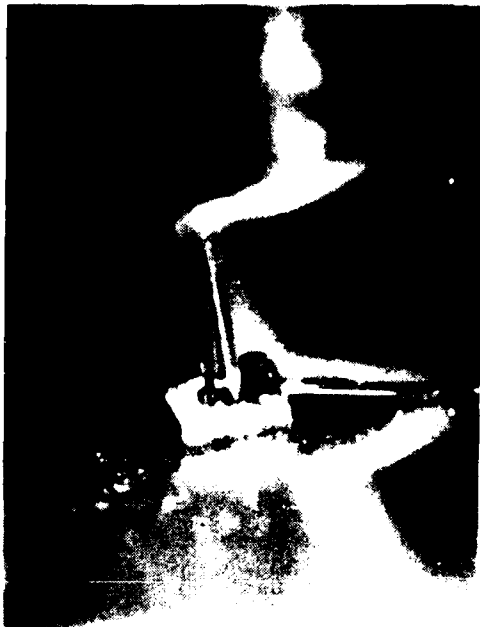


Figure 44 - Fiber Protruding
from Ferrule, Positioned in
Well.

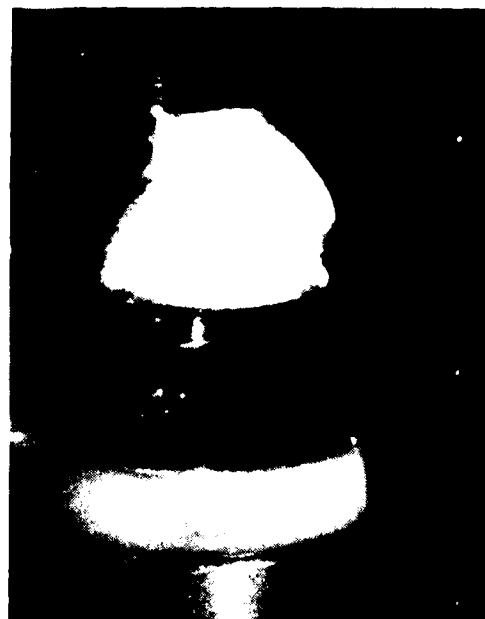


Figure 45 - Epoxy Applied
to Sleeve.

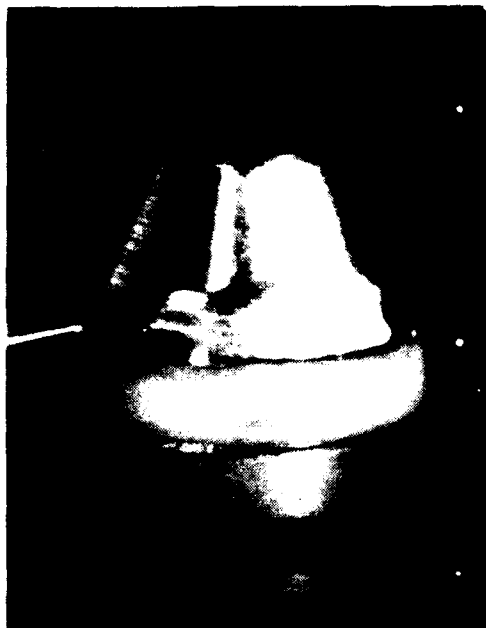


Figure 46 - Sleeve Epoxied
to Header.



Figure 47 - Sleeve Epoxied
to Ferrule.

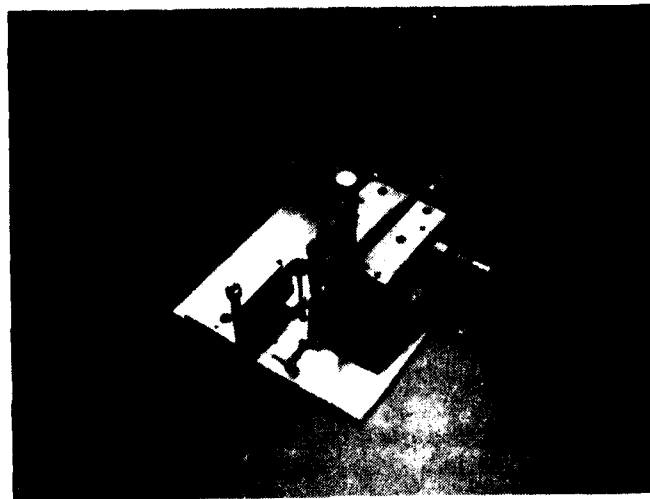


Figure 48 - Alignment Fixture.

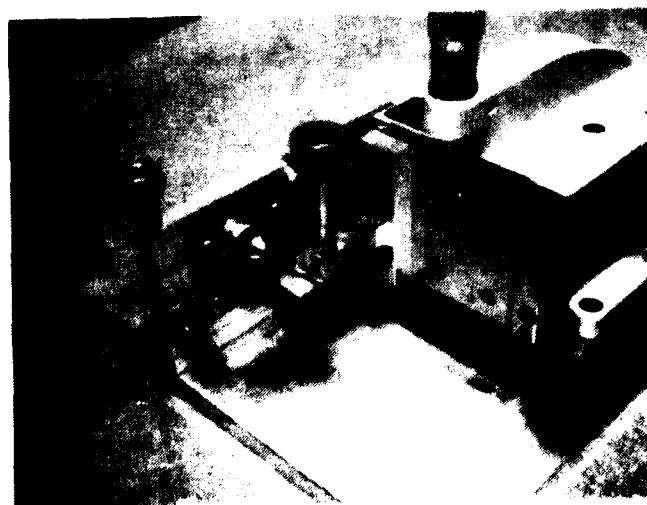


Figure 49 - Alignment Fixture (Close-Up).

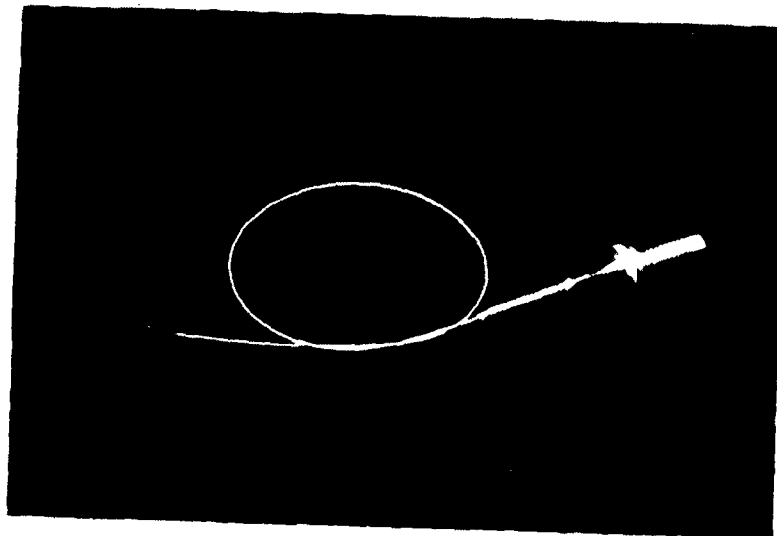


Figure 50 - LED With ITT Fiber.

A formulation by Epoxy Technology, designated X304, fulfilled all the specification requirements resulting in no failures for the environmental tests performed on the devices.

3.3 DEVICE EVALUATION AND TESTING

3.3.1 TEST EQUIPMENT

Fundamental to the testing of the LED devices is the test socket shown in Figures 51 and 52 in a generalized form. The socket allows quick insertion while maintaining rigidity in the closed position.

The equipment shown in Figure 53 is the basis for the peak optical power measurement. The test socket and EG&G detector head are mounted on an optical rail, the digital power readout indicator is to the right, a constant current power supply, with transient suppression of LDL design, is to the left in the photograph. By adjusting the spacing between the test socket and the detector head, unfibered devices can be measured into a particular NA. With an appropriate support for the fiber pigtail in front of the detector, completed devices can be measured. To the rear of the equipment in a mini-mono-chromometer used to spot check peak wavelength. Actual wavelength measurements are made on a 3/4 meter SPEX monochromometer capable of 1 Å resolution.

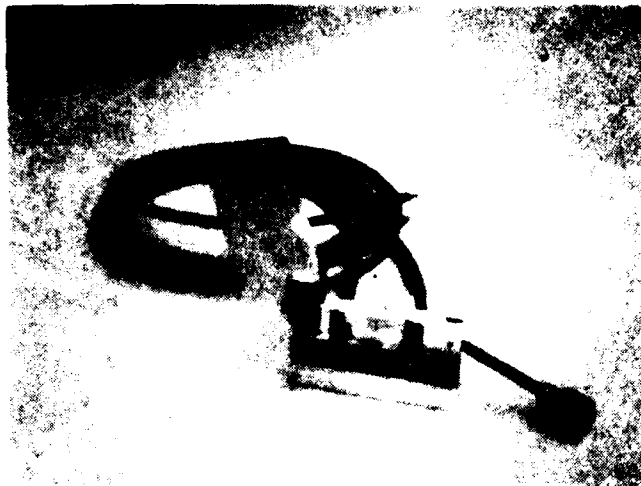


Figure 51 - Test Socket in Open Position.



Figure 52 - Test Socket in Closed and Clamped Position.

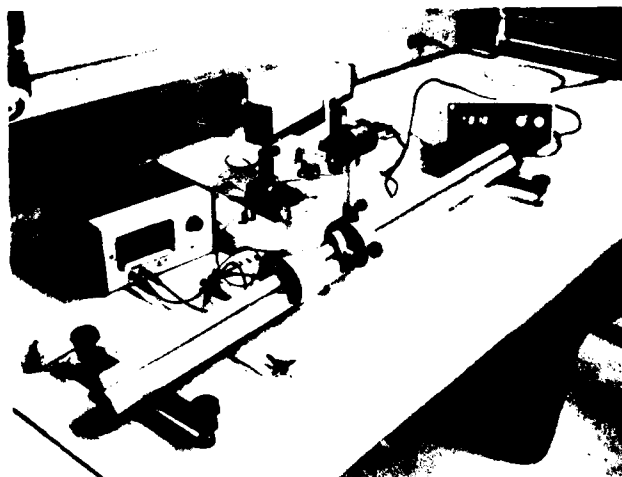


FIGURE 53 - PEAK OPTICAL POWER
MEASUREMENT EQUIPMENT.

The rise and fall time test utilizes the equipment shown in Figure 54 which consists of a clock and power supply box for the driver and LED, the LED driver, the Avalanche Photo Detector and supply and a TEK 465 scope. Also visible in the figure is an optical rail and fixturing for alignment of the LED and detector. Figures 55 and 56 show two views of the driver chassis while Figure 57 is a schematic of the driver circuit. The DC supply contains a 10 MHZ crystal controlled oscillator divided down to 100 KHZ, controls for pulse amplitude and a dual one-shot for applying the trigger and pulse signals. The rise time of the pulse out of the driver is on the order of 3-4 ns at 100 KHZ with a 50% duty cycle. Figure 58 is a block diagram of the equipment connections. In Figure 59, the LED driver is used in a low duty cycle mode to measure wavelength shift as a function of temperature in connection with a heated socket fixture. Figure 60 is a chart recorder plot of the output scan of the Spex 3/4 meter monochromator indicating peak wavelength and 3 db spectral width.

Figures 61 and 62 show the physical set-up of the Linearity test equipment. The test fixture and APD detector are mounted on an optical rail for easy optical alignment.



FIGURE 54 - RISE AND FALL TIME TEST
SET.

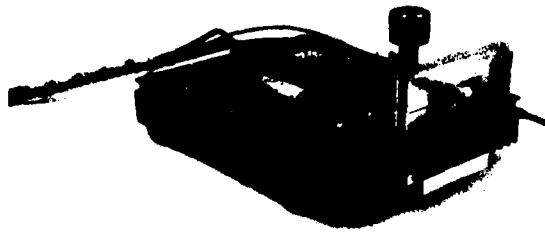


FIGURE 55, DRIVER FRONT VIEW

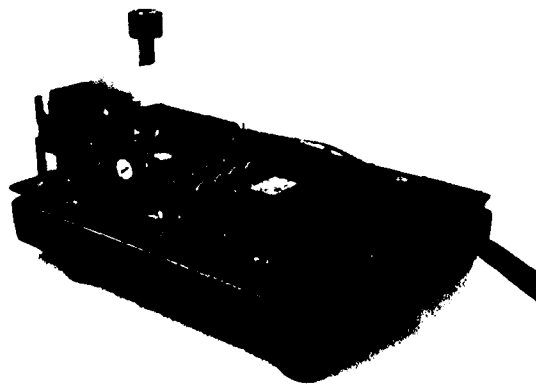


FIGURE 56 - DRIVER REAR VIEW

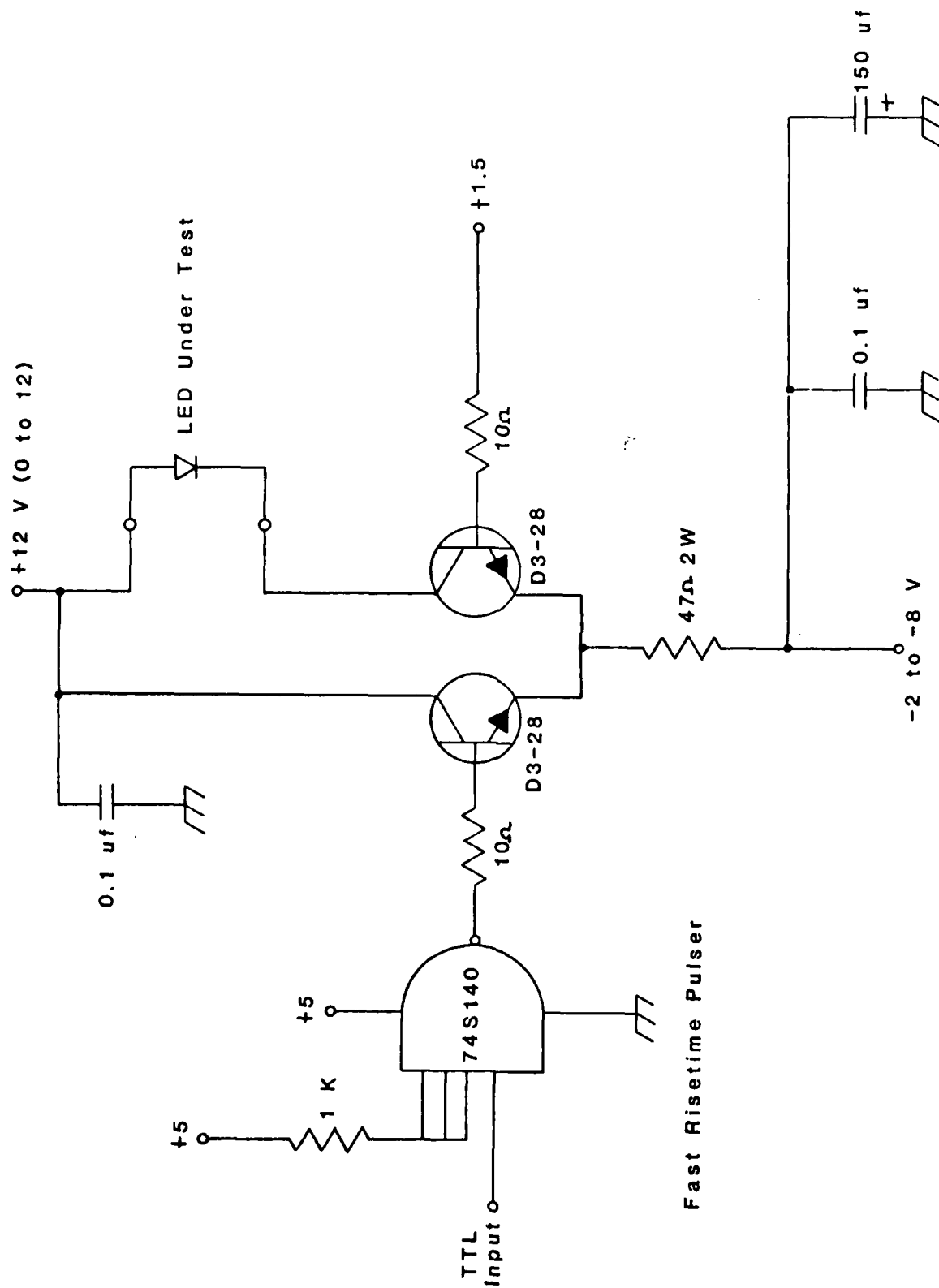


FIGURE 57 -FAST RISETIME HIGH PRECISION LED DRIVER

RISETIME & FALLTIME

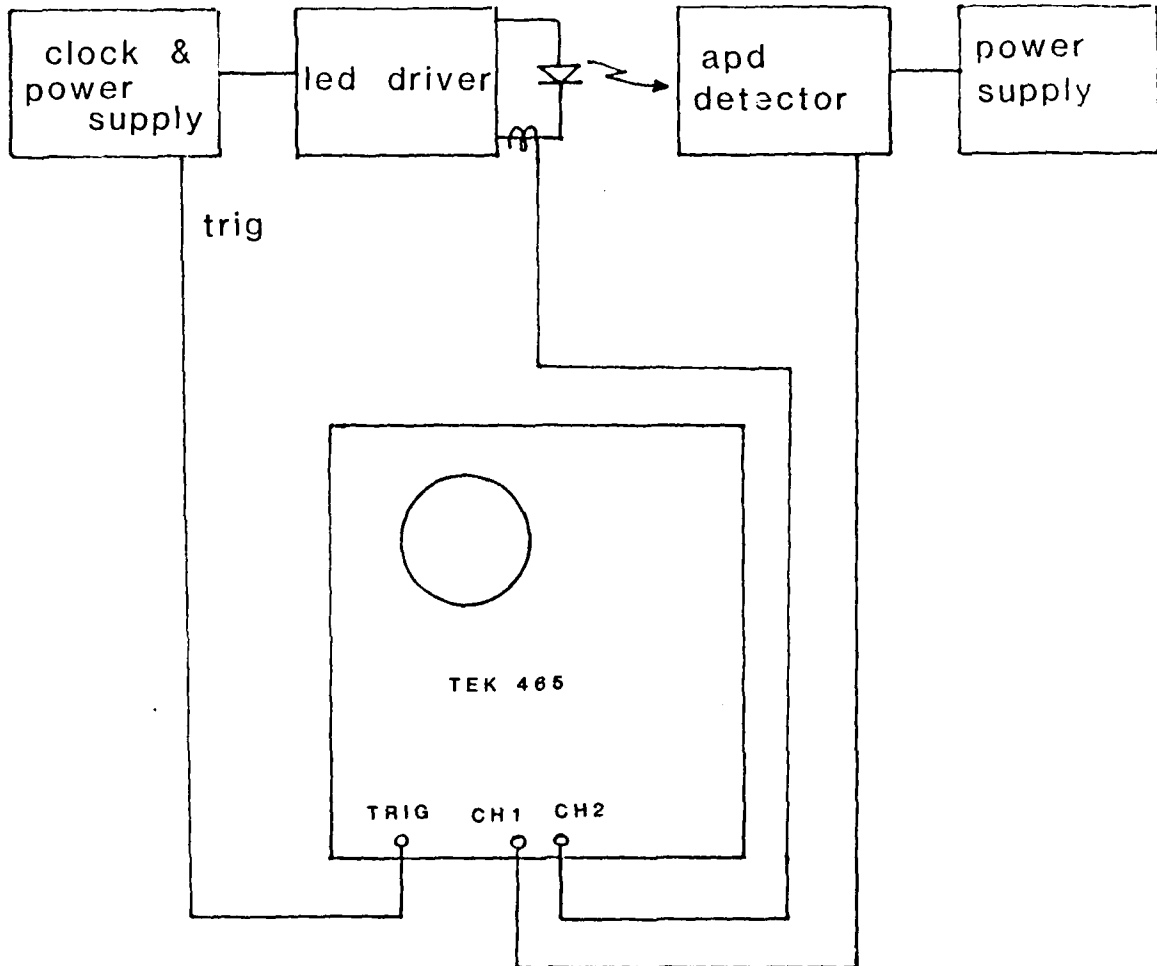


FIGURE 58 - BLOCK DIAGRAM RISE AND FALL TIME TEST

SCALE	APPROVED BY	DRAWN BY
DATE		
- 61 -		DRAWING NUMBER

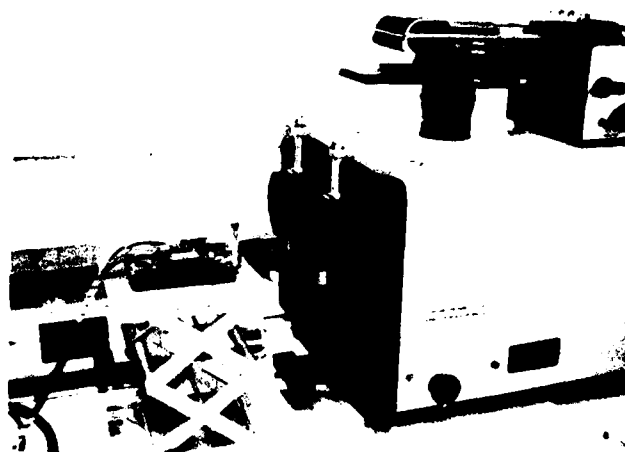


FIGURE 59 - LED DRIVER WAVELENGTH
MEASUREMENT

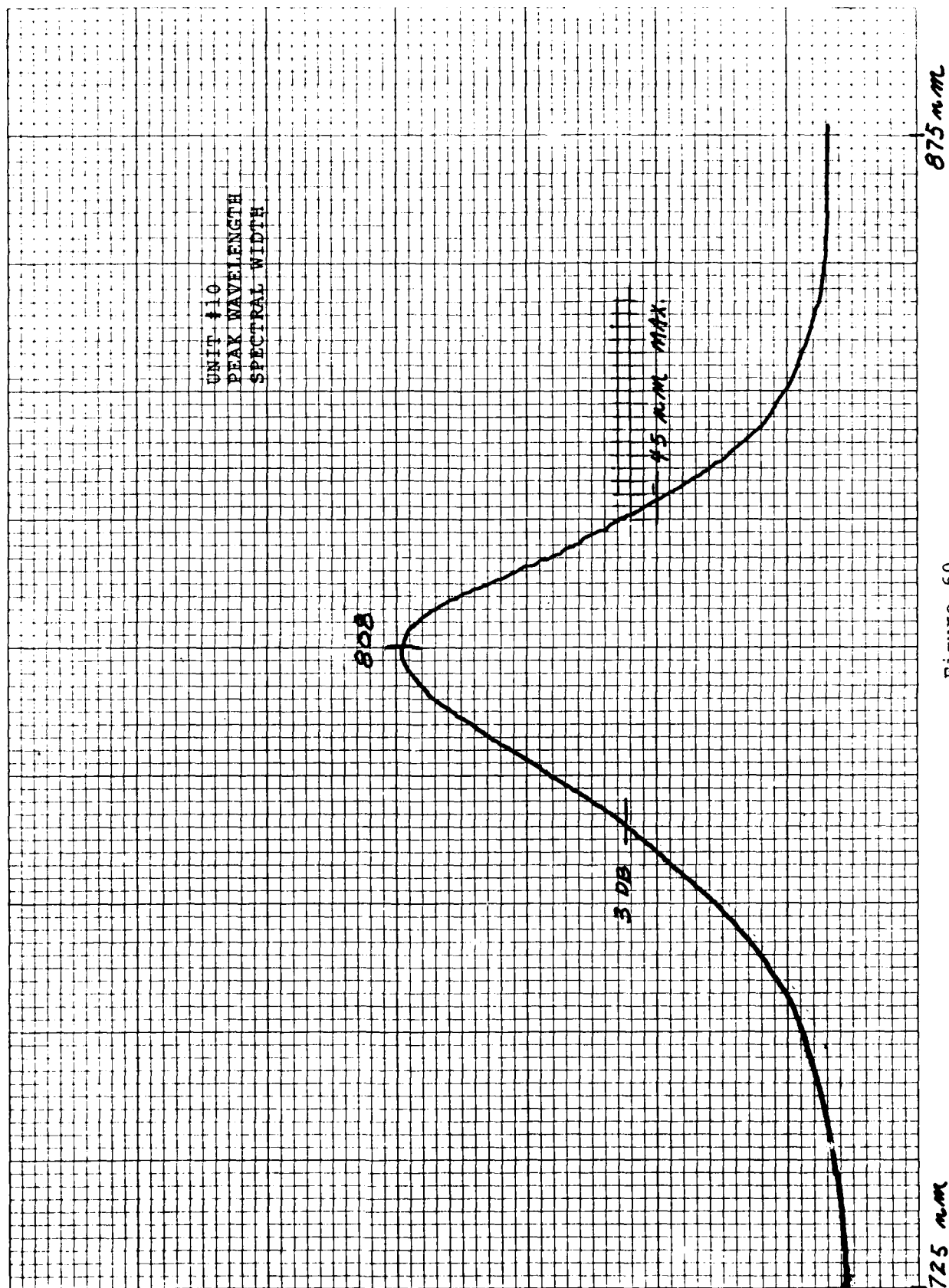


Figure 60

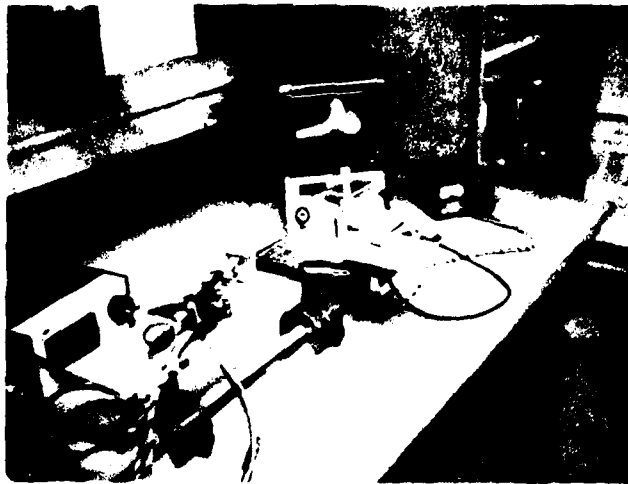


FIG 61-VIEW OF ANALYSER AND DETECTOR

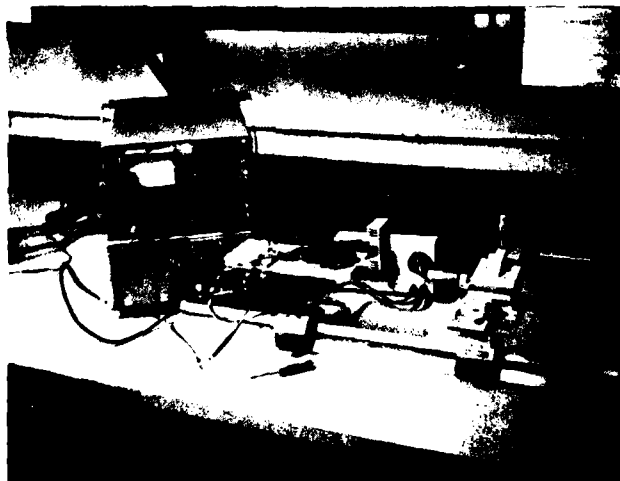
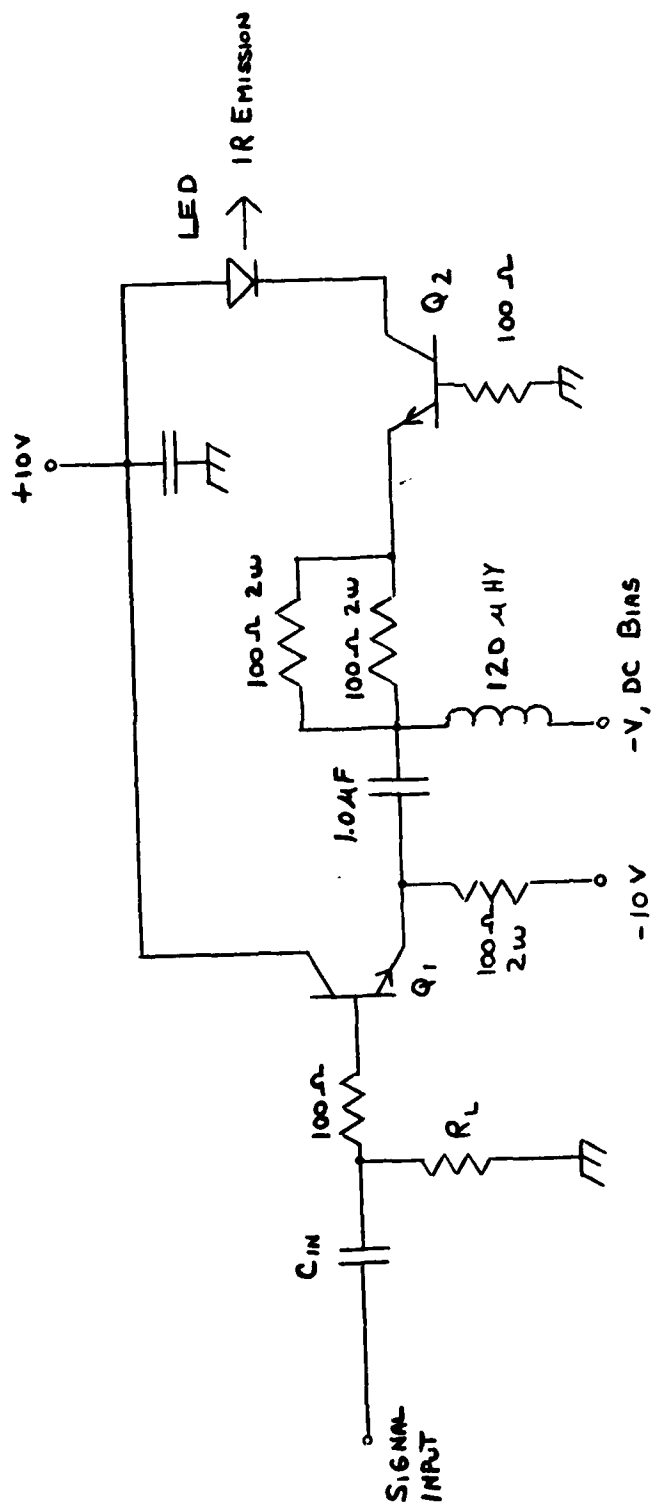


FIG 62 -VIEW OF TEST JIG, SCOPE, GENERATOR
LED PS AND DETECTOR

The TEK 453 scope is used to monitor the applied 1 MHz sine wave and set the signal to the proper level. The test fixture contains the impedance matching circuitry, shown in Figure 63, and the socket to hold the device. Figure 64 shows a typical spectrum analyser trace indicating second harmonic distortion of -35 db. A block diagram of the equipment connections is shown in Figure 65.

The fiber numerical aperture is measured using the Goniometer shown in Figures 66 and 67. The LED is mounted on the rotatable head with the fiber fixed in place. The measurement is determined by setting the Goniometer to 0° then rotating to either side until 90° of the peak reading is attained. The two angles are averaged and the sine of the angle calculated to give the NA of the fiber. Figure 68 shows schematically the test set-up.



Q₁ AND Q₂ D3-28 CTC MICROWAVE TRANSISTOR

Figure 63 -Linearity Test Circuit.

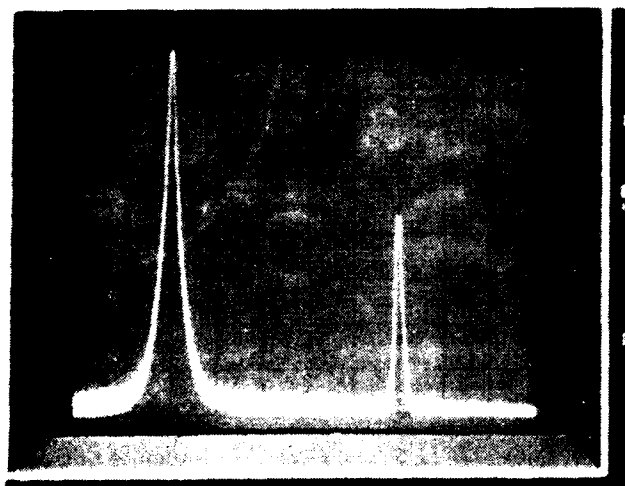
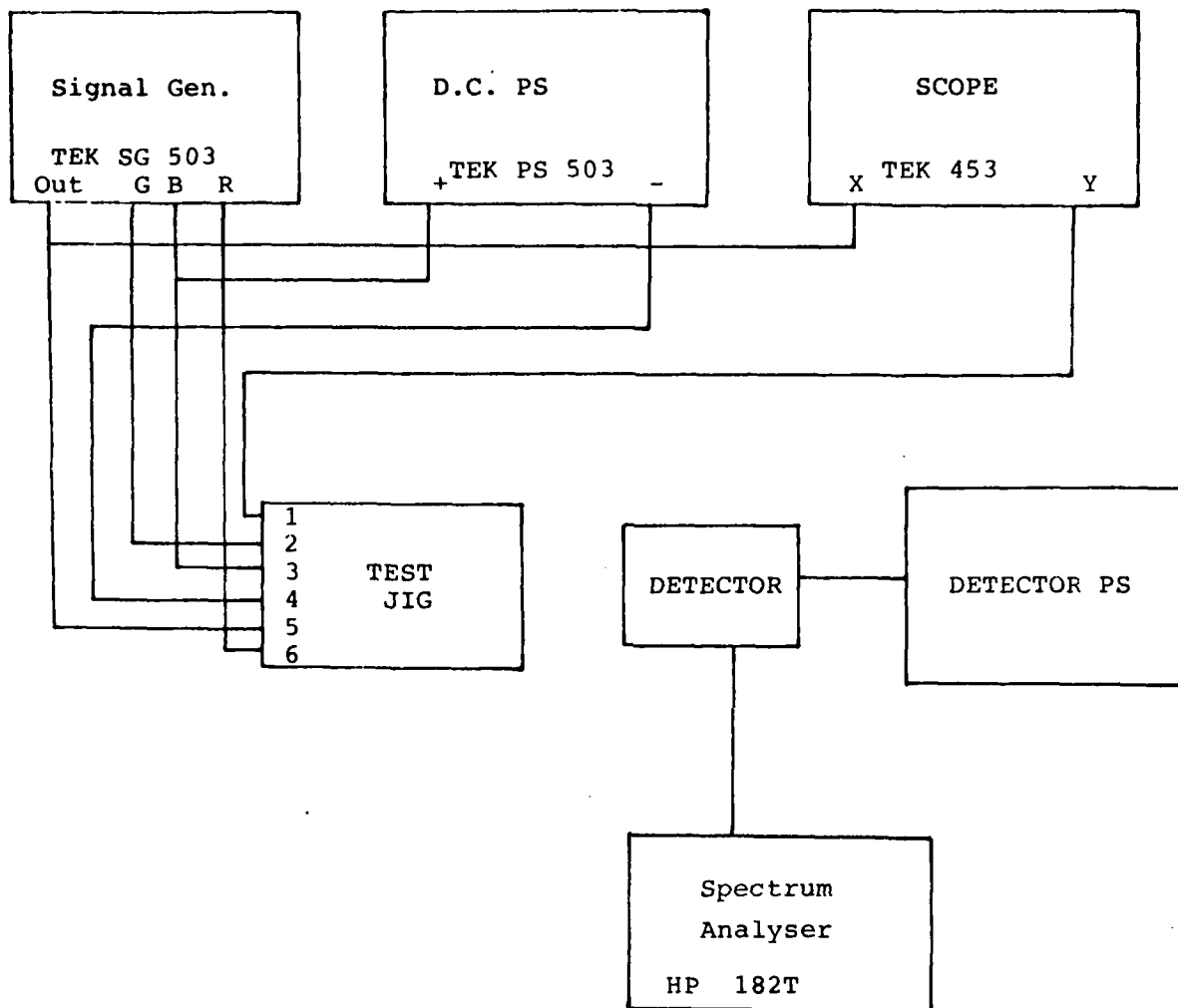


Figure 64 - Linearity Trace.



DRAFTSMAN	DATE	NAME FIGURE 65 LINEARITY TEST		 1130 Somerset St. New Brunswick, N.J. 08901	
APPROVED	DATE				
MAT'L		SCALE	LDL FSCM 57417	DWG SIZE	PART NO

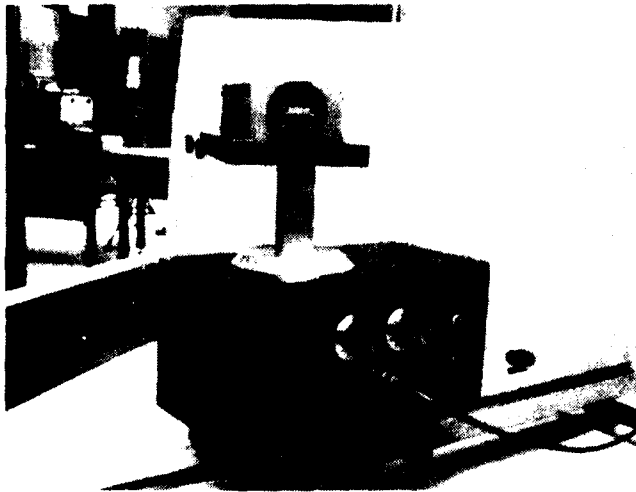


Figure 66 - Photograph of Goniometer Showing Rotatable Head.

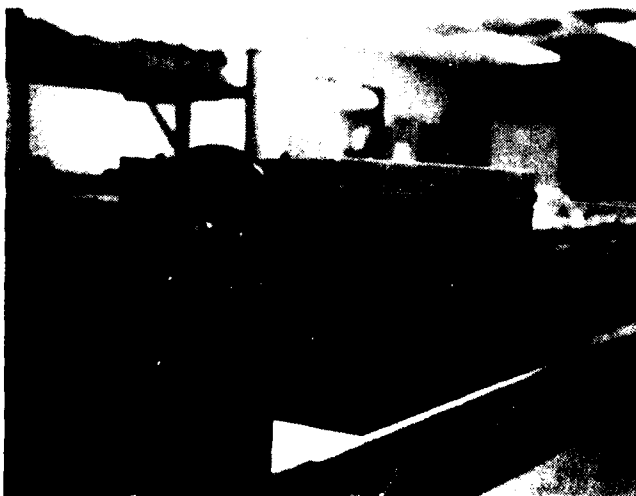
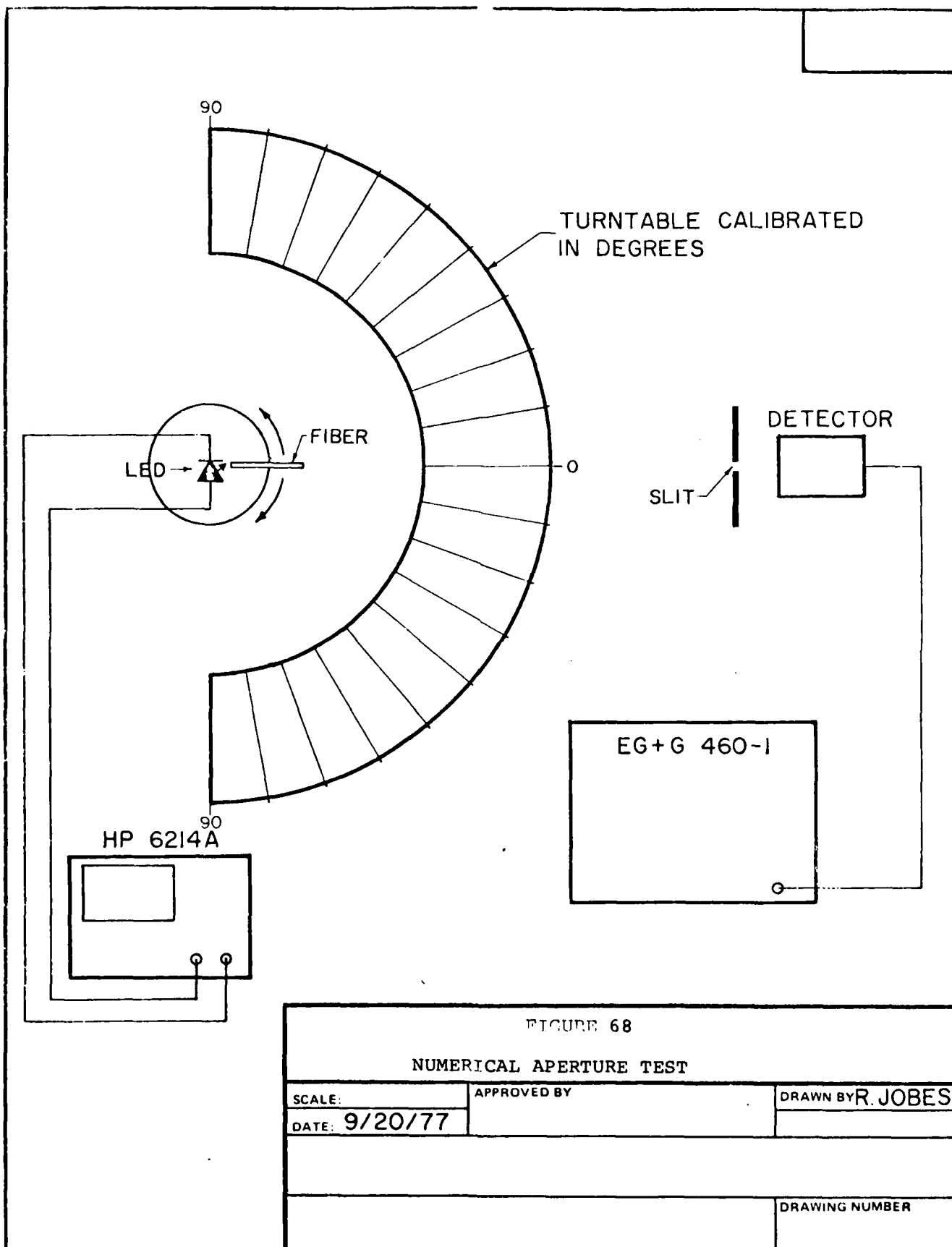


Figure 67 - Photograph of Goniometer Showing Close-Up of Mounting Fixture.



SECTION IV

SUMMARY OF PILOT LINE TEST RESULTS

(8135)

TESTING CYCLE

TESTING CYCLE CONSISTED OF:

PROCESS CONDITIONING

PRE-BURN-IN ELECTRICAL

BURN-IN (168 HRS.)

POST BURN-IN ELECTRICAL

GROUP A INSPECTION

GROUP B INSPECTION

GROUP C INSPECTION

ENVIRONMENTAL TESTS PERFORMED AT:

AMERICAN ELECTRONICS LABORATORY

LANSDALE, PA

FIGURE 69 - TESTING CYCLE

FIGURE 70
FLOW CHART - FIRST ARTICLE (50 Pcs.)

(8135)

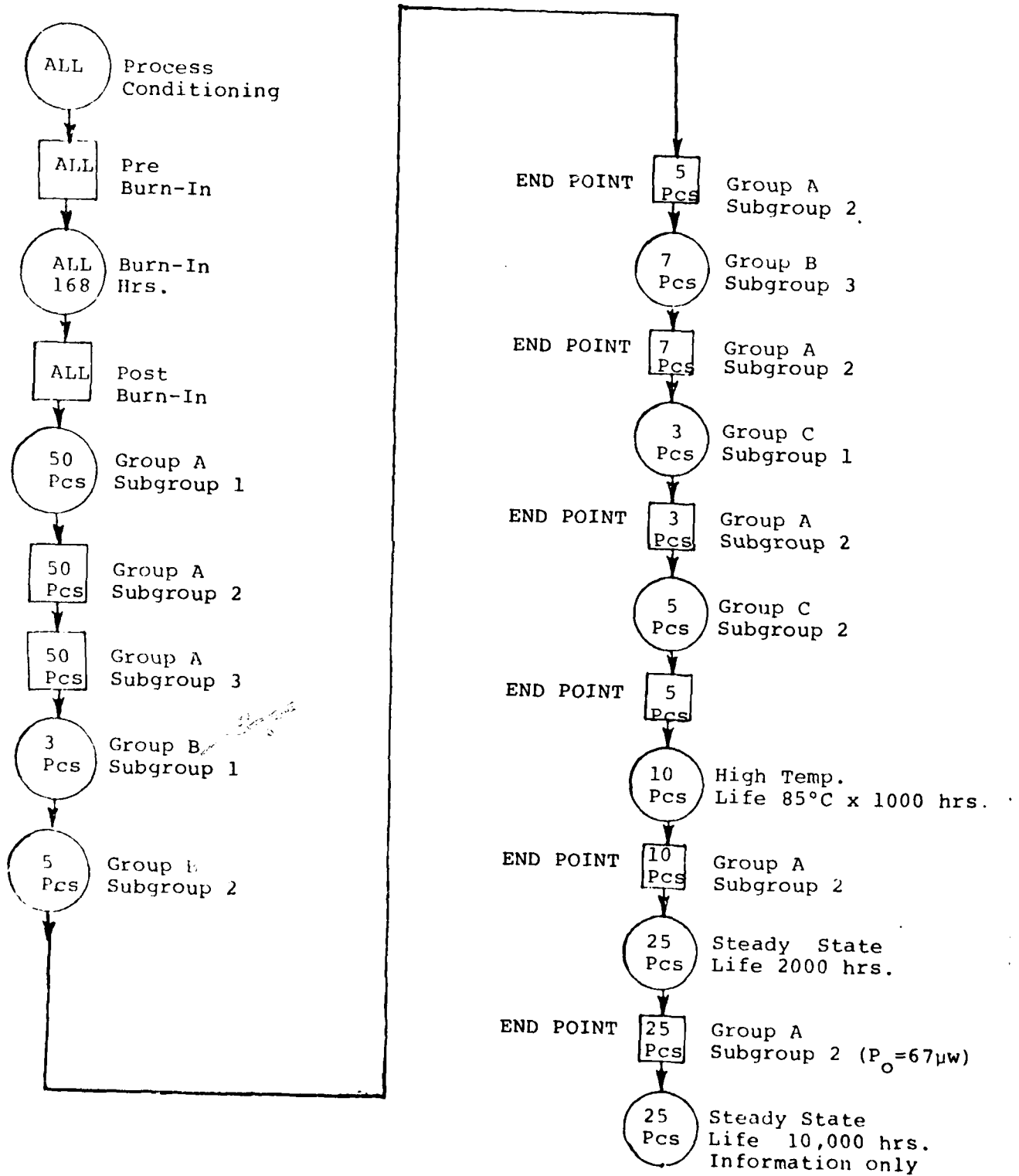
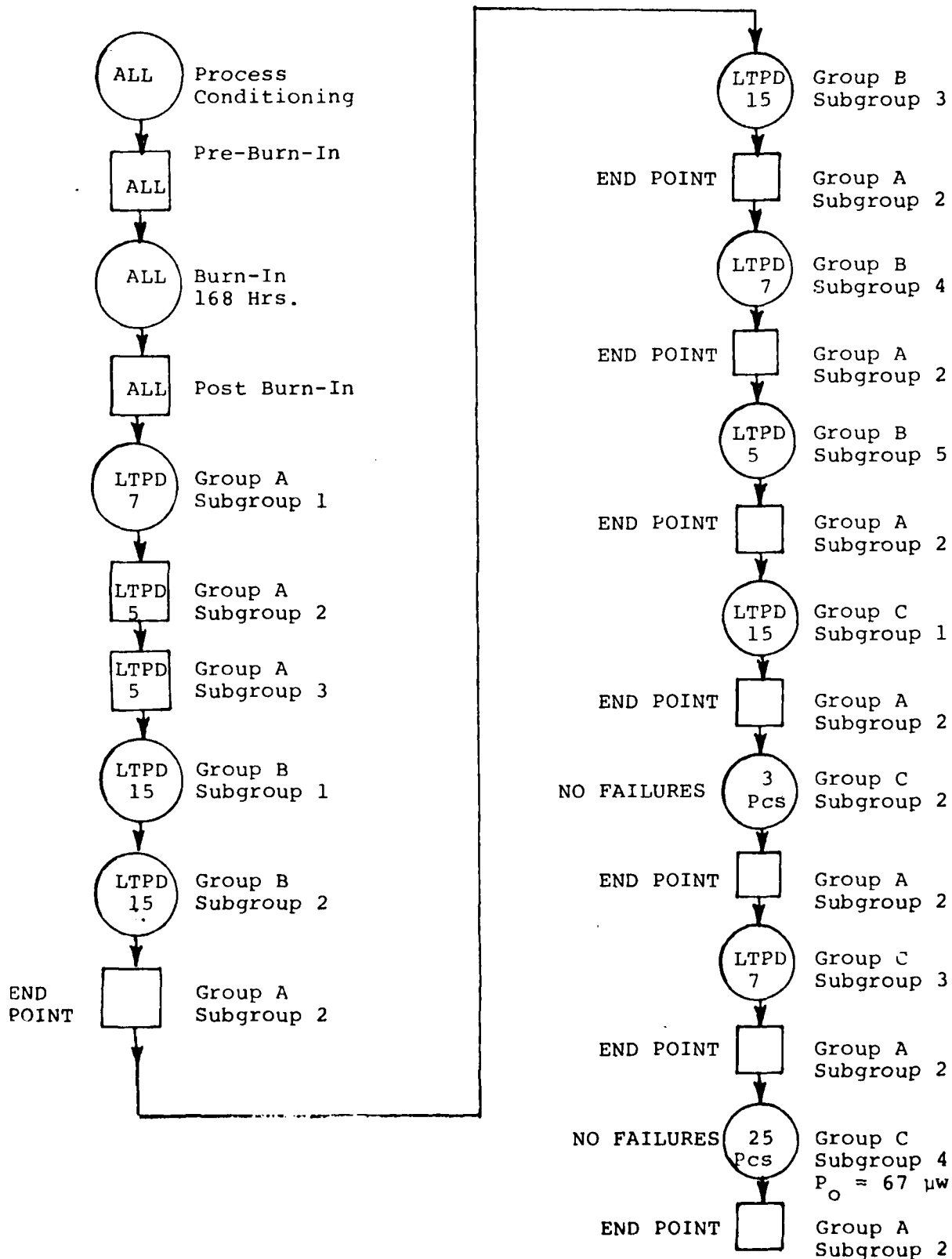


FIGURE 71
FLOW CHART - PRODUCTION TESTING

(8135)



(8135)

TABLE 4

PROCESS CONDITIONING - ALL UNITS

CONDITIONS				
TEST	MIL-STD.	METHOD	REQUIREMENTS	TYP. RES.
High Temperature Life	750	1031	85°C x 48hrs.	PASS
Thermal Shock	202	107/A	t _r =-40°C t _H =85°C	PASS
Constant Acceleration	750	2006	1000 6 directions	PASS
PRE BURN-IN				
Peak Wavelength	800-890nm			830±10nm
V _f	750	4011	1.9V@20mA max.	1.55±.05V
V _{BR}	750	4021	3.0V@10µA min.	>3.0V
Output Power 25°C	75µW @ I _F = 100mA min.			100µW(typ) 175µW(max)
BURN-IN	168hrs. @ I _F = 100mA			
POST BURN-IN				
Peak Wavelength	800-890nm Δλ = 5% max.			830±10nm
V _f	750	4011	1.9V max.	1.55±.05V
V _{BP}	750	4021	3.0V min.	>3.0V
Output Power 25°C	75µW@I _F = 100mA min:ΔPo=5% max.			100µW(typ) 175µW(max)

(8135)

DEVICE PLACED IN RTV MOLD
FITTED TO FIXTURE

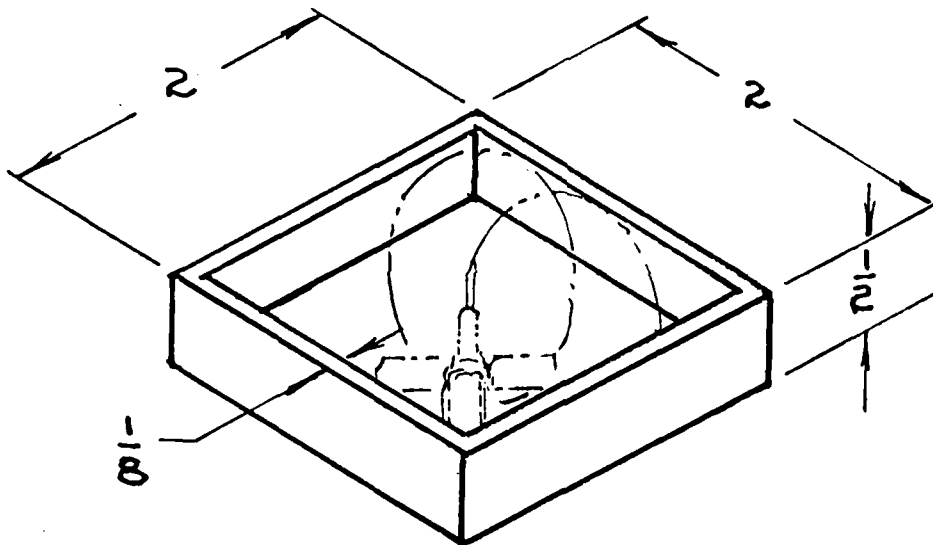


FIGURE 72
ACCELERATION FIXTURE

(8135)

TABLE 5 - TESTING
GROUP A

CONDITIONS				
TEST	MIL-STD	METHOD	REQUIREMENTS	TYP. RES.
SUBGROUP 1				
Visual & Mechanical	750	2071	-	PASS
Terminal Strength (fiber)	750	2036A	10 Newtons min.	PASS
SUBGROUP 2				
END POINT TESTS				
Peak Wavelength	845±45nm			830±10nm
V _f	750	4011	1.9V@I _F =100mA max.	1.55±.05V
V _{BR}	750	4021	3.0V@I _R =10µA min.	>3.0V
Output Power 25°C	75µW @ I _F = 100mA min.			100µW typ. 175µW max.
SUBGROUP 3				
Spectral Width	50nm @ 3db of intensity (max)			46-48nm
Bandwidth	32MH _Z @ I _P = ±50mA + 100mA DC bias			(20-27) TYP=22
Numerical Aperture	0.2 @ I _F = 100mA			0.16
Rise & Fall Time	20ns @ I _P = 100mA, + 5mA bias (max)			(13-18) Typ=16
Linearity	26db @ I _P = ±50mA, + 100mA dc bias			30 (typ), 33 (max)

(8135)

TABLE 6 - TESTING
GROUP B

TEST	CONDITIONS			TYP. RES.
	MIL-STD	METHOD	REQUIREMENTS	
SUBGROUP 1				
Physical Dimensions	750	2071		PASS
SUBGROUP 2				
Solderability	750	2026		PASS
Thermal Shock	750	1051	A-10cycles $t_r = -40^\circ\text{C}$ $t_H = 85^\circ\text{C}$	PASS
End Point	GROUP A	SUBGROUP 2		No Change
SUBGROUP 3				
Shock	750	2016	500g 0.5ms	PASS
Vibration Fatigue	750	2046	-	PASS
Vibration, V.F.	750	2056	-	PASS
Constant Acceleration	750	2006	1000g 6 directions	PASS
End Point	GROUP A	SUBGROUP 2		PASS
SUBGROUP 4				
High Temp. Life	750	1032	85°Cx340hrs.	PASS
End Point	GROUP A	SUBGROUP 2		No Change
SUBGROUP 5				
Steady State Life	750	1027	$I_F = 100\text{mA}; 340\text{hrs.}$	100 μW typ.
End Point	GROUP A	SUBGROUP 2		175 μW max.

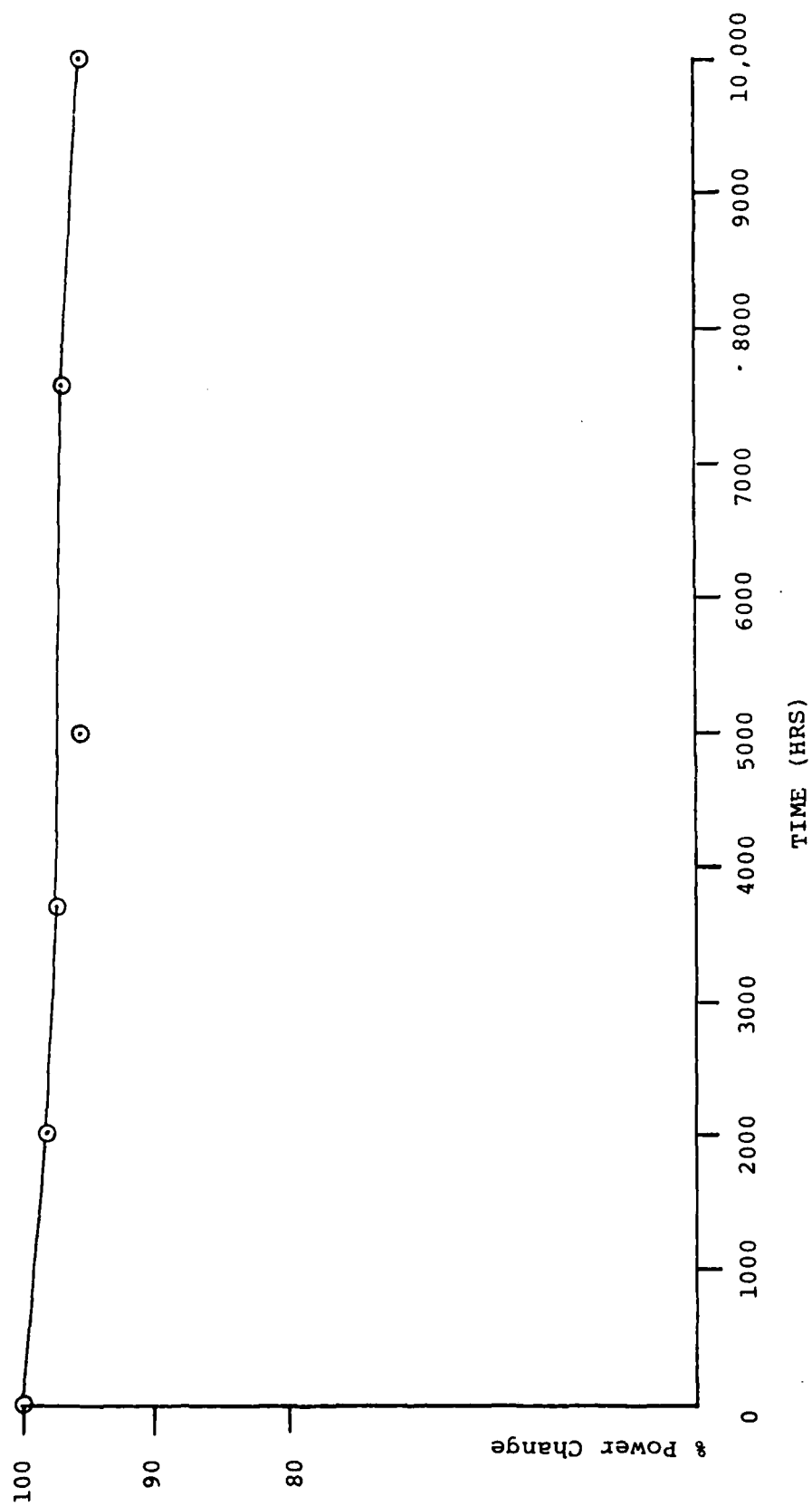
FOR FIRST ARTICLE: SUBGROUPS 1,2&3 ONLY

(8135)

TABLE 7 - TESTING
GROUP C

TEST	MIL-STD	METHOD	REQUIREMENT	TYP. RES.
SUBGROUP 1				
Thermal Shock	750	1051	A_1 -25cycles $t_r=-40^{\circ}\text{C}$ $t_H=85^{\circ}\text{C}$	PASS
End Point	GROUP A	SUBGROUP 2		PASS
SUBGROUP 2				
Solvent Resistance	202	215		PASS
End Point	GROUP A	SUBGROUP 2		PASS
SUBGROUP 3				
High Temp. Life	750	1031	$85^{\circ}\text{C} \times 1000\text{hrs.}$	PASS
End Point	GROUP A	SUBGROUP 2		No Change
SUBGROUP 4				
Steady State Life	750	1026	$I_f=100\text{mA}:2000\text{hrs.}$	$100\mu\text{W typ.}$
End Point	GROUP A	SUBGROUP 2 except $P_O = 67\mu\text{W}$		$175\mu\text{W max.}$

FIG. 73 - 10,000 HR. LIFE TEST (8135)



SECTION V

PILOT LINE RATE REPORT

PROCESS	YIELD %	DEVICES REQ'D.	RATE/HR.
Deliver Devices		250	
Final Electrical Test	90	275	50
Burn-In	100	275	
Pre Burn-In Electrical	80	330	50
Environmental Test	100	330	
Align Fiber, Epoxy	95	347	20
Assemble Fiber-Ferrule	85	400	20
Wire Bond Chip	95	419	48
Chip Mount	80	502	75

TABLE 8 - PILOT LINE RATES

SECTION VI

VOLUME PRODUCTION PLAN

PROCESS STEP	YIELD %	DEVICES/WK	RATE/HR	REQ'D/HR	PEOPLE REQ'D
DELIVER DEVICES		2553			
FINAL ELECTRICAL TESTS	90	2808	50	70	1.4
BURN-IN	100	2808			
PRE BURN-IN ELECTRICAL	80	3369	50	84	1.7
ENVIRONMENTAL TESTS	100	3369			
ALIGN FIBER, EPOXY	95	3538	20	88	4.4
ASSEMBLE FIBER-FERRULE	85	4069	20	102	5.1
WIRE BOND CHIP	95	4273	48	107	2.2
CHIP MOUNT	90	4700	75	118	1.6

TABLE 10 - VOLUME PRODUCTION RATES

TABLE 11

ADDITIONAL VOLUME PRODUCTION REQUIREMENTS

EPITAXIAL REQUIREMENTS

Diode Chips Required per Week	4700
Maximum Number Chips per Wafer	945
Number Good Electrical Chips per Wafer	500
Number Wafers required @ 80% Yield	11

EQUIPMENT REQUIREMENTS

2630 Burn-In Positions @ \$	150.00 per Position
5 Assembly Stations @ \$	4,000.00 per Station
2 Epitaxial Furnaces @	\$22,000.00
Power Measurement Test Set	\$10,000.00

PERSONNEL REQUIREMENT

Engineers	2
Technicians	2
Assembly	17

AD-A101 480 LASER DIODE LABS INC NEW BRUNSWICK NJ
LIGHT EMITTING DIODES FOR FIBER OPTIC COMMUNICATIONS.(U)
MAR 81 A GENNARO DAAR07-7

F/G 9/1

DAAR07-76-C-A135

44

CORADCOM-76-8135-F

END
DATA
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APPENDIX A

PRODUCT CAPABILITY DEMONSTRATION



U. S. ARMY CORADCOM PRODUCT CAPABILITY DEMONSTRATION

CONTRACT DAAB07-76-C-8135

CONTRACT DAAB07-76-C-0040

FEBRUARY 18, 1981

9:00 A.M. - Welcoming Session (Holiday Inn) - T. Stockton

9:30 A.M. - Technical Presentation Program #8135

- Diode Specifications - T. Stockton
- Diode Chip Concepts - T. Stockton
- Packaging and Assembly Concepts - A. Gennaro
- Testing Methods - S. Lerner

10:45 A.M. - Coffee - Q & A Period

11:00 A.M. - Technical Presentation Program #0040

- Diode Specifications - A. Ceruzzi
- Diode Chip Concepts - A. Ceruzzi
- Packaging and Assembly Concepts - A. Gennaro
- Testing Methods - S. Lerner

Q & A Period

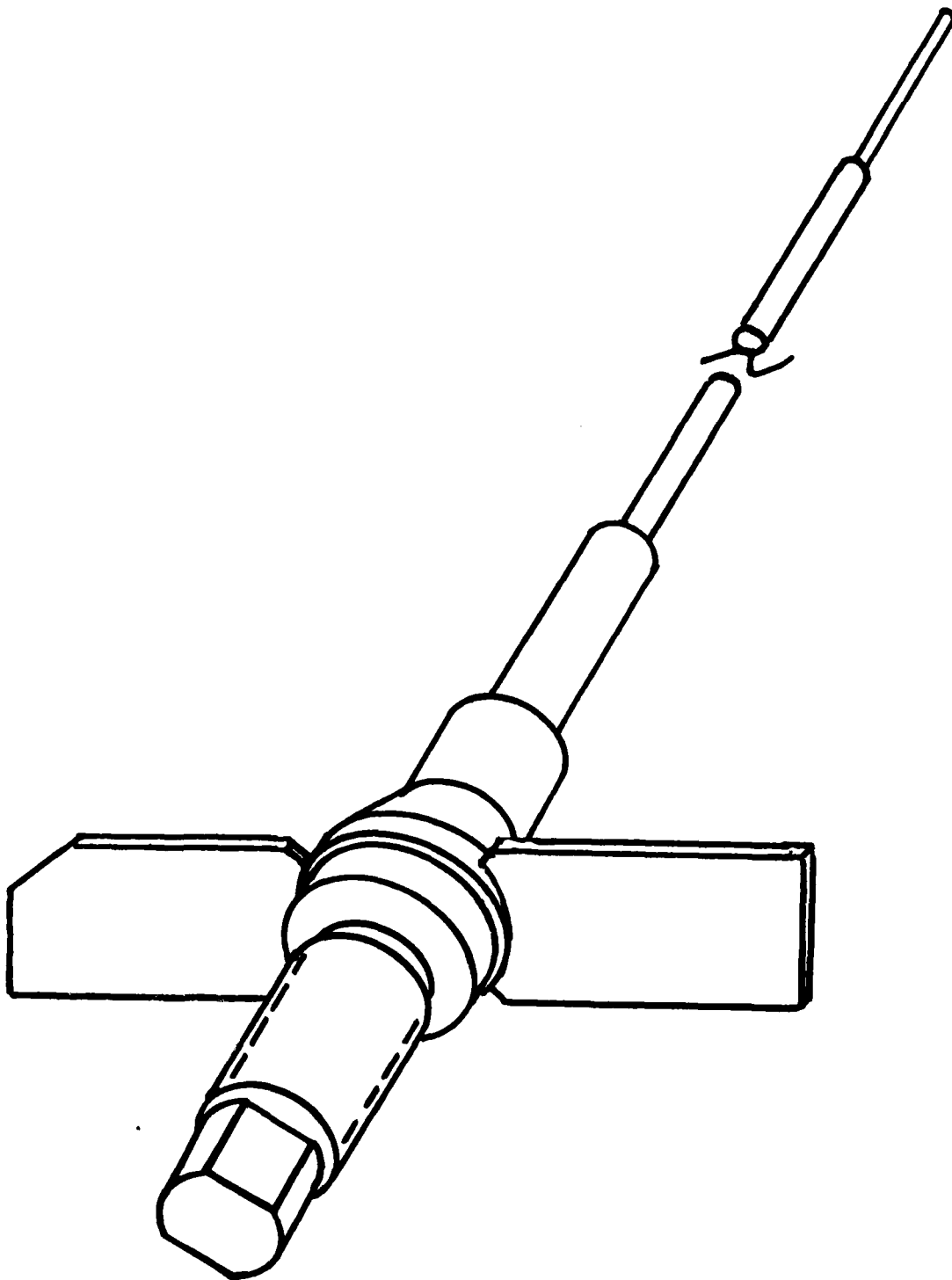
12:00 P.M. - Lunch

1.00 P.M. - Transport to LDL (Provided)

1:30 P.M. - Tour of LDL Facilities

- Demonstration of Diodes

2:30 P.M. - Transport to Holiday Inn (Provided)



CONTRACT DAAB07-76-C-8135

FIBER COUPLED LED

U. S. ARMY CORADCOM SPECIFICATION DAAB07-76-C-8L35
PRODUCT CAPABILITY DEMONSTRATION FEBRUARY 18, 1981

OBJECTIVES

GENERAL MM&T PROGRAM OBJECTIVES

THE ESTABLISHMENT OF THE MANUFACTURING PROCESS,
TECHNIQUES OR EQUIPMENT TO ENSURE EFFICIENT PRODUCTION
OF CURRENT OR FUTURE DEFENSE PROGRAMS.

SPECIFIC OBJECTIVES

DEVELOP AND DEMONSTRATE A FIBER COUPLED LED CAPABLE OF
75 μ W OUTPUT POWER AT 820 NM.

CONTRACT GOALS (LOGISTICS)

- * ESTABLISH MANUFACTURING METHODS AND PROCESSES.
- * ENGINEERING, CONFIRMATORY AND PILOT PRODUCTION PHASES.
- * PILOT PRODUCTION CAPABILITY OF 250 DEVICES.



CONTRACT GOALS (TECHNICAL)

- * ETCHED WELL EMITTER
- * 75 μ W FIBER POWER OUTPUT
- * CO-AXIAL PACKAGE
- * ENVIRONMENTAL CAPABILITY

PROBLEMS ENCOUNTERED AND SOLVED

- * ETCHED WELL PHOTO MASK PROCESS.
- * PACKAGE DESIGN FOR FIBER ATTACHMENT.
- * EPOXIES FOR PACKAGE AND FIBER ASSEMBLY.
- * MECHANICAL STRENGTH OF PACKAGE



PRODUCTION CAPABILITY DEMONSTRATION

REGISTER - FEBRUARY 18, 1981

NAME:	COMPANY:
J. EIDE	ITT
B. HAWKINS	SPECTRONICS DIV., HONEYWELL
JACK HUNTER	CORADCOM U.S. ARMY
LOUIS CORYELL	CORADCOM U.S. ARMY
AL FEDDELER	U.S. ARMY CORADCOM
TED APPLE	CORADCOM
MARK D. SKELDON	NIGHT VISION LABS
LEN FELDBERG	BURNDY CORP.
DAN DAPKUS	ROCKWELL INTERNATIONAL
LOU TOMASETTA	ROCKWELL
GEORGE IRISH	GTE SYLVANIA
MARCUS GARVEY	GTE SYLVANIA
C.J. HWANG	GENERAL OPTRONICS
JOSEPH F. SVACEK	GENERAL OPTRONICS
KEN PEFFLEY	OIS
M. ETTEMBERG	RCA
BOB GILL	LDL President
PETE SCHNEIDER	LDL Executive Vice President
TOM STOCKTON	LDL Vice President E & D
STEVE KLUNK	LDL Sales Engineering Manager
RICHARD KLEIN	LDL Marketing Manager
AL GENNARO	LDL Manager Special Products
ALEX CERUZZI	LDL Manager Development Engineering
ROLLIN BALL	LDL Supervisor E & D
ANDY KAN	LDL Manager E/O Engineering
STEVE LERNER	LDL Manager Quality Assurance

APPENDIX B

SCS-511 Specifications

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

1. SCOPE

1.1 Scope.-- This specification covers the detail requirements for Gallium Aluminum Arsenide (GaAlAs) light emitting diode (LED) devices having a wavelength of 820 nanometers (nm), compatible with fiber optic cables and systems employing the use of fiber optics.

1.2 Maximum operating conditions:-

$$I_F = 150 \text{ mA}$$

$$V_F = 3.0 \text{ V}$$

$$I_R = 10 \mu\text{A}$$

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on the date of invitation for bids or request for proposals, forms a part of this specification to the extent specified herein:

SPECIFICATION

MILITARY

MIL-S-19500 Semiconductor Devices, General Specification for.

STANDARDS

MILITARY

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts.

MIL-STD-750 Test Methods for Semiconductor Devices.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Both title and number or symbol should be stipulated when requesting copies.)

2.2 Other publications.- The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

Laser Parameter Measurements Handbook, by H. G. Heard.

(Application for copies should be addressed to John Wiley & Sons, Inc., New York, N.Y.)

3. REQUIREMENTS

3.1 General description.- The LED devices are heterojunction devices used at a high data rate at a wavelength compatible for fiber optic cables. The device shall have an optical output and be optimized for a wavelength of 820 nm. fiber

3.2 Performance characteristics.- Performance characteristics shall be as specified in Tables III, IV and V and as follows:

3.2.1 Radiant intensity.- Radiant intensity of the unit, prior to the attachment of the optical fiber, shall be a minimum of 2 mW/Sr (See 4.6.3).

3.2.2 Linear source size.- The linear source size of the unit, prior to the attachment of the optical fiber, shall be a minimum of 50 μ m and a maximum of 55 μ m. (See 4.6.2).

3.2.3 Process conditioning.- All units shall be process conditioned. (See Table I and 4.5.1).

3.2.4 Linearity.- With a fundamental of 1 kHz the second harmonic shall be at least 35 db down from the fundamental.

3.2.5 Burn-in.- All units shall be burned-in. (See 4.5.2).

3.3 Design, construction and physical dimensions.- The design, construction and physical dimensions shall be as specified in Figure 1 and herein.

3.3.1 Lead material and finish.- Lead material shall be Kovar or alloy 42 with a hot solder dip finish.

3.3.2 Metals.-- External metal surfaces shall be corrosion resistant or shall be plated or treated to resist corrosion.

3.4 Marking.-- Marking shall be in accordance with MIL-S-19500 except the following information shall be marked on each unit.

- (a) Date code.
- (b) Manufacturer's identification.
- (c) Part number: SCS-511.
- (d) Power output in mW at $I_F = 100$ mA.

3.5 Resistance to solvents.-- When the device is subjected to solvents, there shall be no evidence of: (a) mechanical or electrical damage, (b) deterioration of the materials or finishes, and (c) illegibility of case marking.

3.6 Solderability.-- Leads shall be solderable.

3.7 Thermal shock.-- After being subjected to specified temperature cycling, there shall be no evidence of defects or damage to case, leads, or seals or loss of marking legibility.

3.8 Shock.-- After being subjected to a shock of 500g for .5 msec, there shall be no evidence of defects or damage to leads or seals. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

3.9 Vibration fatigue.-- After being subjected to a vibration with a constant peak acceleration of 20g minimum and a frequency of 60 ± 20 Hz for at least 32 ± 8 hours, there shall be no evidence of defects or damage to case, leads or seals. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

3.10 Vibration, variable frequency.-- After being subjected to a vibration with a constant peak acceleration of 20g minimum and a frequency range between 100 and 2000 Hz, there shall be no evidence of defects or damage to case, leads, or seals. Also, the device shall be electrically operable (see Subgroup 2 of Table II).

3.11 Constant acceleration.-- After being subjected to a constant acceleration of 1000g for 1 minute in each of its orientations, there shall be no evidence of defects or damage to case, leads, or seals. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

3.12 High temperature life.-- After being stored at 85°C for the specified time there shall be no evidence of defects or damage to case, leads or seals or loss of marking legibility. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

3.13 Steady state operation.-- After being subjected to steady state operation ($I_F = 100$ mA) for the specified temperature and time, the device shall be electrically operable (see Subgroup 2 of Table III).

3.14 Moisture resistance.-- After being subjected to the specified humidity and temperature cycling, there shall be no evidence of corrosion of external metal surfaces. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection.- Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection.- Inspection shall be classified as follows:-

- (a) First article inspection (does not include preparation for delivery). (See 4.4).
- (b) Quality conformance inspection. (See 4.5).

4.3 Test plan.- The contractor prepared Government-approved test plan, as cited in the contract, shall contain:

- (a) Time schedule and sequence of examinations and tests.
- (b) A description of the method of test and procedures.
- (c) Identification and brief description of each inspection instrument and date of most recent calibration.

4.4 First article.- Unless otherwise specified in the contract, the first article inspection shall be performed by the contractor.

4.4.1 First article units.- The contractor shall furnish 50 samples for first article inspection.

4.4.2 First article inspection.- The first article inspection shall consist of Table II and all the tests included in the Government-approved test plan (see 4.3), to show compliance with the requirements of Section 3. No failures shall be permitted.

4.4.2.1 Order of testing.- Prior to first article inspection, all units shall have been process conditioned followed by burn-in.

4.5 Quality conformance inspection.- Quality conformance inspection shall consist of the examinations and tests specified for Group A inspection (Table III), Group B inspection (Table IV), and Group C inspection (Table V). The following shall apply:

(a) Prior to performing Group A inspection, all units shall be subjected to the tests specified in paragraphs 4.5.1 and 4.5.2.

(b) If the manufacturer chooses the following option(s) for testing, the sample units that are to be used in Group C inspection shall be designated as such prior to conducting the referenced Group B tests. Moreover, the number of failed diodes to be counted for lot acceptance or rejection as a result of Group C test shall be equal to all failed diodes of the test in Group B inspection, which were predesignated for use in Group C inspection, plus any additional failures occurring during Group C testing.

(1) For subgroup 3 life test in Group C inspection, the manufacturer has the option of using all or a portion of the sample already subjected to 340 hours of Group B life testing for an additional 660 hours of testing to meet the 1,000 hour requirement.

(2) For the thermal shock (temperature cycling) test of Group C inspection, the manufacturer has the option of using all or a portion of the sample already subjected to 10 cycles of Group B thermal shock (temperature cycling) testing for an additional 15 cycles of testing to meet the 25-cycle requirement.

4.5.1 Process conditioning.— Process conditioning shall be performed on 100 percent of the units. The measurements and sequence shall be as specified in Table I.

4.5.2 Burn-in.— Burn-in shall be performed on 100 percent of the units for 168 hours minimum under the following conditions:

$$T_a = 25^{\circ}\text{C}$$

$$I_F = 100 \text{ mA}$$

4.5.2.1 Pre-burn-in measurements.— Prior to burn-in, measurement of the parameters listed in subgroup 2 of Table III shall be performed on 100% of the units at $T_a = 25^{\circ}\text{C}$.

4.5.2.2 Post burn-in measurements.— Post burn-in measurements, listed in subgroup 2 of Table III, shall be performed within 8 hours of the removal of bias conditions (i.e. I_F , I_R) at 25°C . The values observed for each device shall not exceed the following, relative to the pre-burn-in measurements:

$$\Delta P_{\text{opt}} = 1\%$$

$$\Delta T_P = 1\%$$

Table I.— Process conditioning

Test	MIL-STD	Method No.	Details
High temperature life (non-operating)	750	1031	Storage temperature = 85°C Storage time = 48 hours min
Thermal shock	202	107	Test Condition A except $t(\text{high}) = 85^{\circ}\text{C}$; $t(\text{low}) = 40^{\circ}\text{C}$; time at temperature extremes = 15 minutes maximum
Constant acceleration	750	2006	1,000 g

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Table II.- First article inspection

Test	Reqt Para	Method	No. of samples ^{2/}				
			3	5	7	10	25
Group A inspection	as specified	Table III ^{1/}	To be performed on all units.				
Group B inspection	as specified	Table IV ^{1/}					
Subgroup 1			X				
Subgroup 2				X			
Subgroup 3					X		
Group C inspection	as specified	Table V ^{1/}					
Subgroup 1			X				
Subgroup 2				X			
High temperature life	3.12	Method 1031 of MIL-STD- 750 T _a = 85°C for 1000 hrs				X	
Steady state operation life	3.13	Method 1026 of MIL-STD- 750 T _a = 25°C for 2000 hrs ^{3/} I _F = 100 mA					X

^{1/} LTPD values do not apply for first article inspection.

^{2/} No. of samples specified for each column shall be subjected to all the tests of that column.

^{3/} After 2000 hours, the P_{opt} shall equal to be specified.

Table III.- Group A inspection

 $T_a = 25^\circ\text{C} \pm 5^\circ\text{C}$ unless otherwise specified

Test	Condition	Test Method	Min	Max	Units	LTPD
<u>Subgroup 1</u>						7
Visual and mechanical inspection		Method 2071 of MIL-STD-750	See 3.3			
Terminal strength of optical fiber	Test Condition A	Method 2036 of MIL-STD-750	10		Newtons	
<u>Subgroup 2</u>						5
Peak emission wavelength	$I_F = 100 \text{ mA}$	Para. 4.6.4	800	830	nm	
Forward voltage	$I_F = 20 \text{ mA}$	Method 4011 of MIL-STD-750		1.9	V	
Reverse breakdown voltage	$I_R = 10 \mu\text{A}$	Method 4021 of MIL-STD-750	3.0		V	
Output optical power	$I_F = 100 \text{ mA}$	Para. 4.6.8		.100	mw	
<u>Subgroup 3</u>						5
Spectral width (3 db of intensity)	$I_F = 100 \text{ mA}$	Para. 4.6.5	40	45	nm	
Bandwidth	$I_P = \pm 50 \text{ mA}$ +100 mA dc bias	Para. 4.6.7	32	44	MHz	
Numerical aperture	$I_F = 100 \text{ mA}$	Para. 4.6.9		0.3		
Rise and fall time	$I_P = 100 \text{ mA}$ +5 mA dc bias 50 ohm system	Para. 4.6.6	10	20	ns	
Thermal impedance		Para. 4.6.10		20°	C/W	
Linearity	$I_P = \pm 50 \text{ mA}$ +100 mA dc bias	Para. 4.6.11		See 3.2.4		

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Table IV.- Group B inspection

Test	Reqt Para	MIL-STD-750 Method	Conditions	LTPD
<u>Subgroup 1</u>				15
Physical dimensions	3.3	2071	See Figure 1	
<u>Subgroup 2</u>				15
Solderability ^{1/}	3.6	2026	Test Condition A except t(high) = 85°C; t(low) = -40°C 10 cycles; time at temperature extreme - 15 minutes maximum	
Thermal shock (temperature cycling)	3.7	1051		
Moisture resistance	3.3.2,	1021		
End point measurements: Subgroup 2 of Table III	3.14			
<u>Subgroup 3</u>				15
Shock	3.8	2016	Non-operating, 500 g .5 ms	
Vibration fatigue	3.9	2046	Non-operating	
Vibration, variable frequency	3.10	2056	Non-operating	
Constant acceleration	3.11	2006	force applied = 1,000 g	
End point measurements: Subgroup 2 of Table III				
<u>Subgroup 4</u>				7
High temperature life (non-operating) See 4.5(b)	3.12	1032	T _a = 85°C	
End point measurements: Subgroup 2 of Table III				
<u>Subgroup 5</u>				5
Steady state operation life	3.13	1027	I _F = 100 mA at 25°C	
End point measurements: Subgroup 2 of Table III				

^{1/}All devices must have been through the temperature/time exposure in burn-in. The LTPD applies to the number of leads inspected except in no case shall less than 3 devices be used to provide the number of leads required.

Table V.- Group C inspection.

Test	Reqt Para	MIL-STD-750 Method	Details	LTPD
<u>Subgroup 1</u>				15
Thermal shock (temperature cycling) (See 4.5(b))	3.7	1051	Test Condition A ₁ except t(high) = 85°C t(low) = -40°C time at temperature extremes = 15 minutes, min; total test time = 72 hrs,max	
End point measurements: Subgroup 2 of Table III				
<u>Subgroup 2</u>				3 devices (no failures)
Resistance to solvents (See 4.6.1)	3.5	Method 215 of MIL-STD- 202		
End point measurements: Subgroup 2 of Table III				
<u>Subgroup 3</u>				7
High temperature life (non- operating) (See 4.5(b))	3.12	1031	T _a = 85°C for 1000 hours	
End point measurements: Subgroup 2 of Table III				
<u>Subgroup 4</u>				25 devices (no failures)
Steady state operation life	3.13	1026	I _F = 100 mA T _a = 25°C for 2,000 hours	
End point measurements: Subgroup 2 of Table III.				

^{1/}Limits of subgroup 2 Table III same except: P_{opt} = to be specified.

4.6 Test methods and conditions.- Conditions and methods of examination and test shall be as specified in Tables I, II, III, IV and V and as follows:

4.6.1 Resistance to solvents.- Resistance to solvents shall be performed in accordance with Method 215 of MIL-STD-202.

4.6.2 Linear source size.- The linear source size can be determined by using a microscope objective and a normal lens (for projection) combination with a magnification of at least 200X. The image shall be scanned in both vertical and horizontal directions with a calibrated silicon photodiode detector (See 6.5) masked with a 0.5 mm slit. The slit shall be positioned perpendicular to the direction scanned. The relative intensity shall be measured until it falls to 90% of its peak value. These boundaries will define the linear source size. (See Figure 2).

4.6.3 Radiant intensity (I).- The unit (driven at $I_f = 100$ mA) is placed a distance of approximately 1.58 centimeters from a calibrated silicon photodiode detector which is masked to a circular area (A) with a radius of 0.5 cm. The optical power output of the unit is then measured and the radiant intensity (see 6.2) is calculated. (See Figure 3).

4.6.4 Peak emission wavelength (λ_p).- Peak emission wavelength shall be measured using a grating spectrometer with a resolution of at least one angstrom.

4.6.5 Spectral width (3 db of intensity).- The spectral width, to its 3 db of intensity points, shall be measured using a grating spectrometer with a resolution of at least 10 Å.

4.6.6 Rise and fall time (t_r , t_f).- An input of 100 mA peak to peak, with a rise and fall time of 5 ns maximum is applied to the unit. The optical output pulse is then recorded.

4.6.7 Bandwidth.- A 100mA peak to peak SF wave with a 100 mA dc bias is applied to the input of the unit. Keeping the input drive current constant, the frequency of the input signal is varied. Measure light output with a silicon photodiode detector to locate the 3 db intensity points to determine bandwidth.

4.6.8 Optical output power (P_{opt}).- A calibrated silicon photodiode detector shall be used to measure the optical output power of the unit. (See 6.5). The distance between the photodiode and the fiber end shall be as small as possible.

4.6.9 Numerical aperture (N.A.).-- The numerical aperture of the optical fiber output shall be determined. Using a calibrated silicon photodiode detector (see 6.5) on a turntable, the detector is rotated through a half angle Θ until the relative intensity of power output falls to 90% of its peak value. (See 6.3).

4.6.10 Thermal impedance.-- With the device mounted on a heat sink capable of being heated above room temperature, it is driven at a (0.1%) duty cycle to minimize self-heating effects. Measurement of peak output wavelength versus temperature from 20°C to 70°C are recorded. In order to take into account its own heating effects, unit is then operated at 100% duty cycle at 20°C with $I_p = 100$ mA and peak output wavelength is recorded. The voltage drop (V_D) across the driven output is then measured. (See 6.4).

4.6.11 Linearity.-- With the device driven at 1 MHz, a spectrum analyzer with resolution of at least 1 KHz coupled to a silicon photodiode, shall be used to measure the second harmonic content.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging and packing.-- Units shall be prepared for delivery as specified in the contract.

6. NOTES

6.1 Abbreviations, symbols, and definitions.-- The abbreviations, symbols and definitions are as follows:

λ_p	peak emission wavelength
ΔF	bandwidth
I	radiant intensity
I_p	average forward current
I_p	input peak current
I_r	reverse current
P_{opt}	optical power output
t_r	rise time
t_f	fall time
V_D	voltage drop
V_r	breakdown voltage (reverse)

6.2 Radiant intensity (I).- Radiant intensity is defined as follows:

$$I = \frac{P_r}{\Omega}$$

where: P_r is power measured by detector

Ω is the solid angle of radiation and equal to

$$2\pi \int_0^{\theta} \sin \theta \, d\theta$$

6.3 Numerical aperture (N.A.).- Numerical aperture is defined as

$$N.A. = \sin \theta$$

6.4 Thermal impedance (Z_t).- Thermal impedance can be calculated taking slope (α) of curve λ_p vs temperature measured in 4.6.10 and the following:

$$Z_t = \frac{\Delta T}{P}$$

where: $P = I_f V_D$

$$\text{and } T = \frac{\Delta T}{\alpha}$$

where: I_f = peak input current (100 mA)

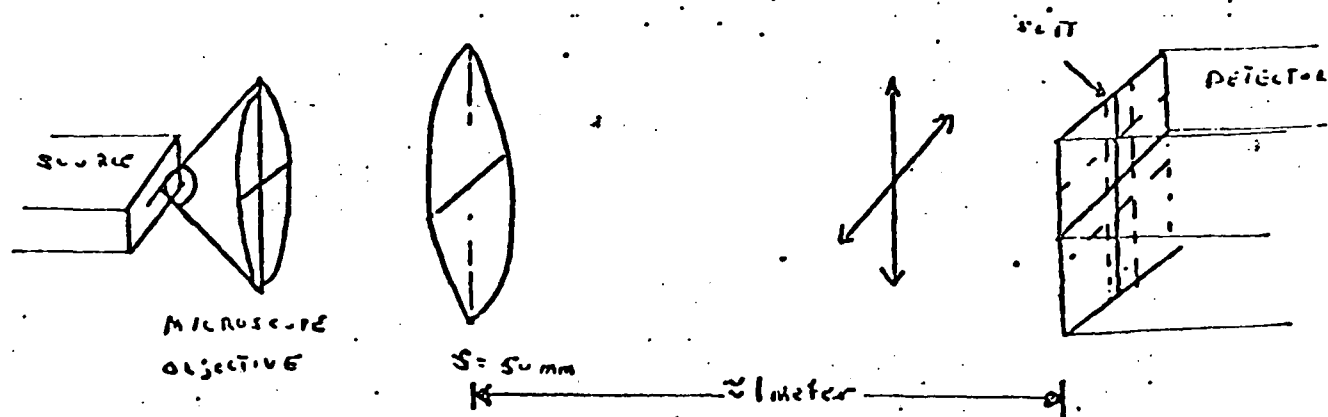
$\Delta T, \Delta \lambda$ taken from graph

6.5 Method for calibration of silicon photodiode detector.- This information can be found pages 180 to 190 in "Laser Parameter Measurements Handbook."

6.6 Fiber characteristics.- The optical fiber segments use in manufacturing the light emitting diode devices shall come from optical fiber lengths having the characteristics shown in Table VI.

Table VI.- Fiber characteristics

Characteristics	Min	Nom.	Max	Unit
attenuation (at λ_p)			50	db/km
core diameter		55	62.5	um
cladding diameter		125		um
protective jacket diameter		500		um
numerical aperture (N.A.)			0.3	
tensile strength	50			Newtons
bending radius		5		mm



FRONT VIEW
OF DETECTOR

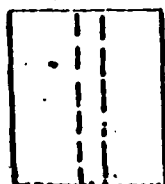
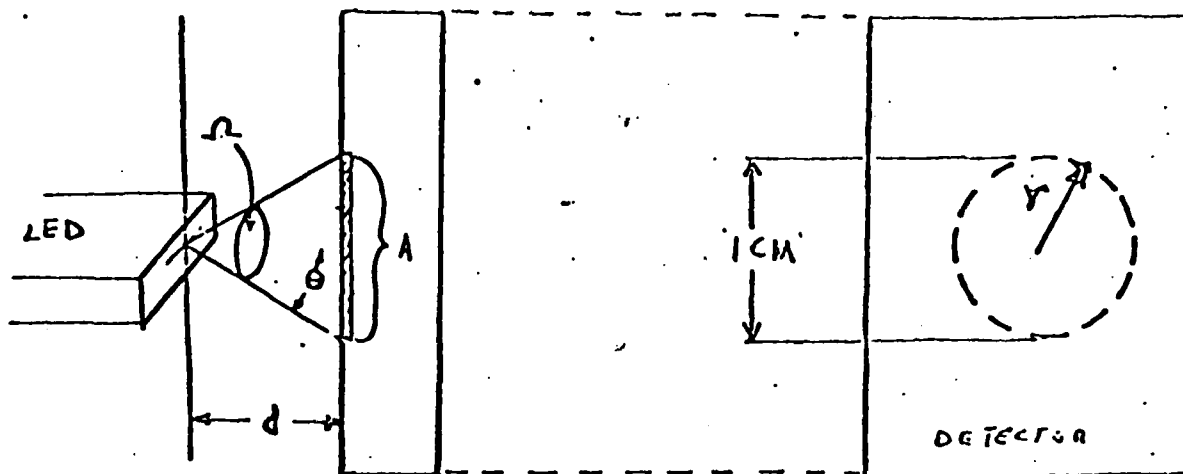


Figure 2. Source and



d = distance from detector ≈ 1.58 cm

Ω = solid angle of radiation

A = circular area of detector exposed to radiation

θ = $\frac{1}{2}$ angle of cone ($\theta \approx 17^\circ$)

r = radius of projection ≈ 0.5 cm

Figure 3 Radiant Intensity

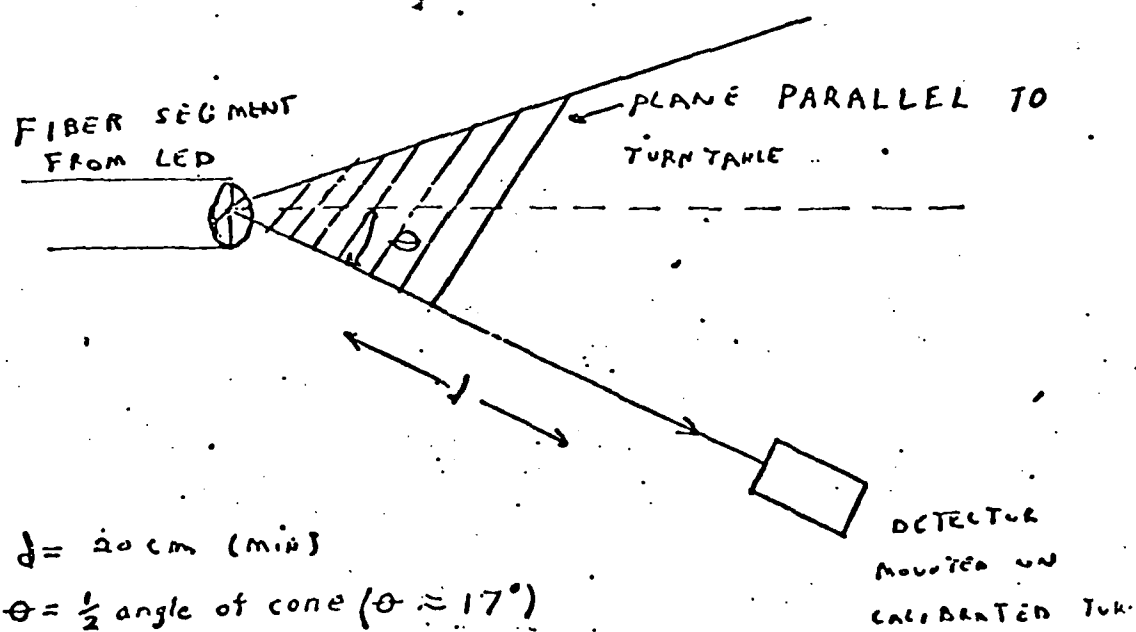


Figure 4. Numerical aperture of optical fiber output

ELECTRONICS COMMAND
TECHNICAL REQUIREMENTS

SCS-511
AMENDMENT-1
29 December 1975

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

Page 9

Table V, Subgroup 2, under Details column for Resistance to solvents, add,
"except solvents used shall be:

- (a) Methyl alcohol, per O-M-232, Grade A.
- (b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.
- (c) Isopropyl alcohol, per TT-I-735, Grade A.
- (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

Page 10

4.6.1 add, "except solvents used shall be:

- (a) Methyl alcohol per O-M-232, Grade A.
- (b) Ethyl alcohol per O-E-00760, Type 1, Grade A.
- (c) Isopropyl alcohol per TT-I-735, Grade A.
- (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

4.6.8 line 1, delete "photodiode" and substitute "photodiode"

Page 11

4.6.10, lines 4 and 5, delete "20°C" and substitute "25°C"

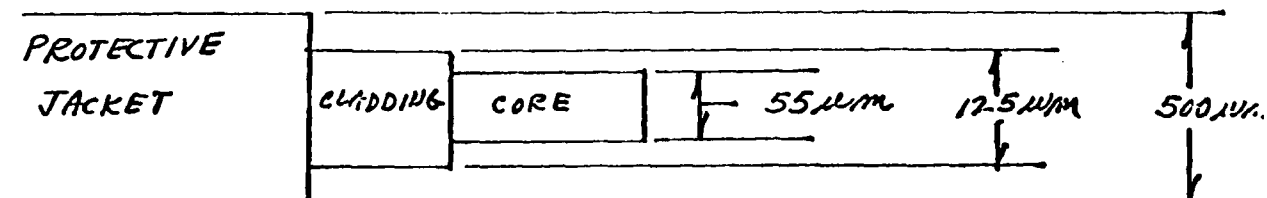
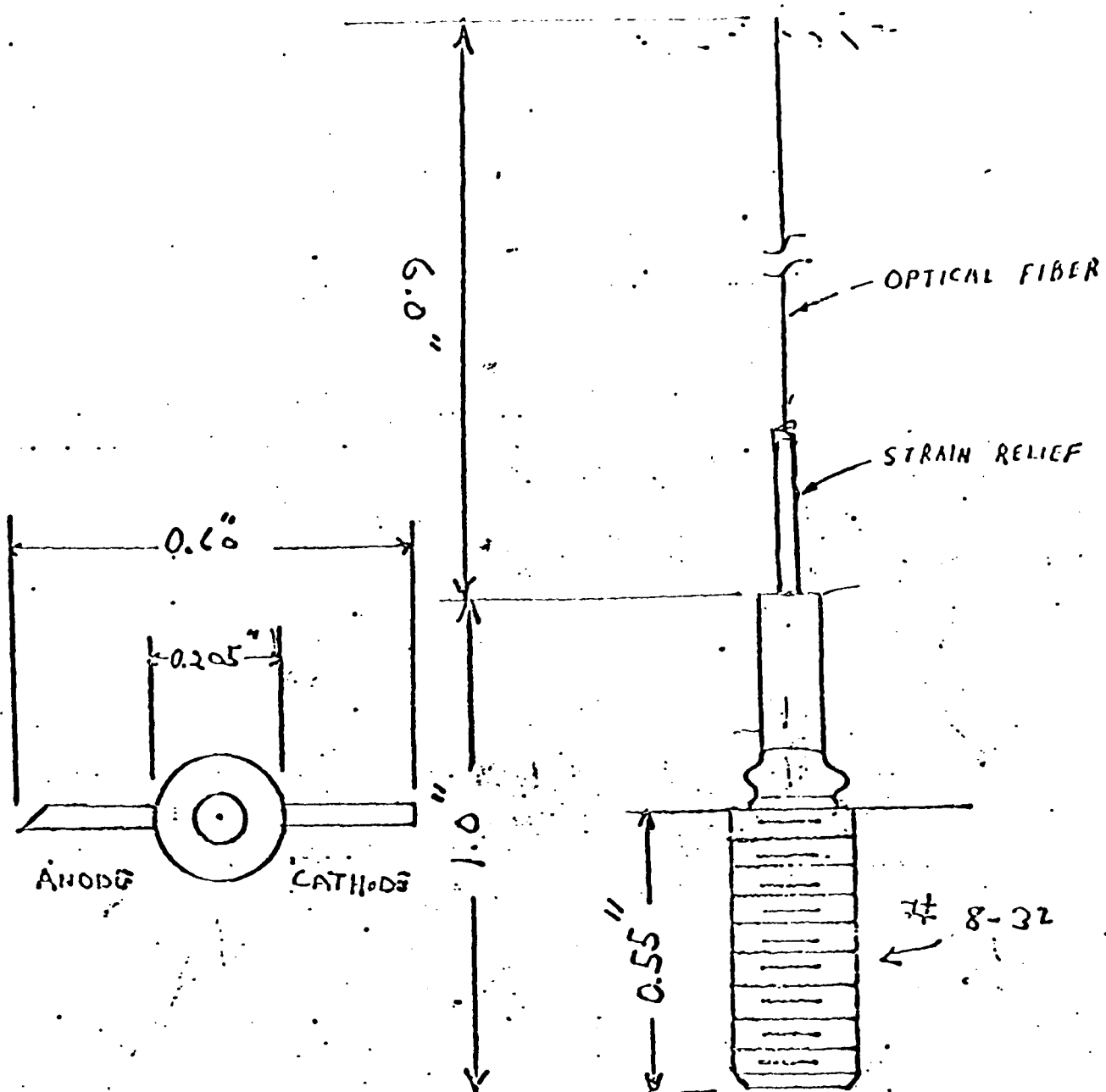


FIG. 1 PHYSICAL DIMENSIONS

STANDARD FORM NO. 64 REV. 1-60 FEDERAL BUREAU OF INVESTIGATION DD FORM NO. 1 (1-60) (GPO 1-10-101)		MODIFICATION OF CONTRACT		PAGE 1 OF 8
1. MODIFICATION NO. 000001		2. EFFECTIVE DATE 1976 16 NOV	3. REQUISITION/PURCHASE REQUEST NO. T-1	4. PROJECT NO. (If applicable)
5. ISSUED BY COMMUNICATIONS CODE WLSH/T		6. ADMINISTERED BY (If other than block 3) DCA/MA, Springfield 240 Route 22 Springfield, MA 07081		
7. CONTRACTOR NAME AND ADDRESS LASER DIODE LABORATORIES, INC. 205 Forrest Street Metuchen, NJ 08817		8. AMENDMENT OF SOLICITATION NO. _____ DATED _____ (See block 9) MODIFICATION OF CONTRACT NO. DAA07-76-C-8135 DATED 76 SEP 30 (See block 11)		
9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS ☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended. Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods: (a) By signing and returning _____ copies of this amendment, (b) By acknowledging receipt of this amendment on each copy of the offer submitted, or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.				
10. ACCOUNTING AND APPROPRIATION DATA (If required) N/A				
11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS (a) ☐ This Change Order is issued pursuant to _____ The Changes set forth in block 12 are made to the above numbered contract/order. (b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12. (c) ☒ This Supplemental Agreement is entered into pursuant to authority of <u>Subsection I, 2 (Changes Article)</u> It modifies the above numbered contract as set forth in block 12.				
12. DESCRIPTION OF MODIFICATION This Modification adds to the contract a third and fourth engineering sample, reduces the quantity of the Pilot Run from five-hundred (500) to two-hundred and fifty (250) units, and changes the scheduled delivery dates. I Section E, Supplies/Line Item Data, is changed as set forth in inclosed DD Form SDA 69E. Section F, Description/Specifications, is amended as follows: Subsection F.2 is changed as follows: Add: Amendment 1 to SCS-511 dated 29 Dec 75. Amendment 2 to SCS-511 dated 4 Aug 76. Amendment 3 to SCS-511 dated 20 September 76. Amendment 4 to SCS-511 dated 12 May 78.				
Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.				
13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 1 COPY to ISSUING OFFICE				
14. NAME OF CONTRACTOR/OFFEROR BY _____ (Signature of person authorized to sign)		17. UNITED STATES OF AMERICA BY _____ (Signature of Contracting Officer)		
15. NAME AND TITLE OF SIGNER (Type or print) 16. DATE SIGNED		18. NAME OF CONTRACTING OFFICER (Type or print) STEPHEN L. THACHER Major, Signal Corps		19. DATE SIGNED

Modification No. P00001 to:
Contract No. DAAH07-76-C-8135

Subsection F.48, Subparagraph 4 is changed as follows:

Change - Commander, US Army Electronics Command, ATTN: DRSEL-CT-LD to
Commander, US Army Electronics Research and Development
Command, ATTN: DELNV-L-C and Commander, US Army Electronics
Command, ATTN: DRSEL-PP-1-PI-1 to Commander, US Army
Electronics Research and Development Command, ATTN: DELSD-
D-PC.

Section H, Supplies Schedule Data, is changed as set forth in inclosed
DD Form SDA 69H.

Section I, Inspection and Acceptance, is amended as follows:

Section I.14

Change - Commander, US Army Electronics Command, ATTN: DRSEL-CT-LD,
Fort Monmouth, NJ 07703 to Commander, US Army Electronics
Research and Development Command, ATTN: DELNV-L-C, Fort
Monmouth, NJ 07703.

Change - Commander, US Army Electronics Command, ATTN: DRSEL-RD-ET-2,
Fort Monmouth, NJ 07703 to Commander, US Army Electronics
Research and Development Command, ATTN: DELNV-L-C, Fort
Monmouth, NJ 07703.

Change - Commander, US Army Electronics Command, ATTN: DRSEL-PP-I-PI-1,
Fort Monmouth, NJ 07703 to Commander, US Army Electronics
Research and Development Command, ATTN: DELSD-D-PC, Fort
Monmouth, NJ 07703.

Section J, Special Provisions, is amended as follows:

Add: Subsection J.10 as follows:

XX J.10 Government Property Material

a. Subject to the "Government Property" provision of this contract (see Section L),
the Government will furnish to the Contractor all of the following property:

<u>STOCK NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u> <u>ALLOWANCE</u>	<u>GROSS</u> <u>ALLOWANCE</u>	<u>APPLIES TO</u> <u>CONTRACT ITEM (SLIN)</u>
N/A	Graded Index Fiber Type ITT GG-02-8	1 Reel (50 Meters)	1 ea	CLIN 0001

Note: Material to be consumed during performance of contract.

Modification No. P00001 to:
Contract No. DAAB07-76-C-8135

b. Delivery of Government furnished property will be made to the Contractor in the manner determined by the Contracting Officer. Government property, including all such property acquired by the Contractor, all non-expendable property, and any expendable items of property not expended in connection with this contract, shall be delivered by the Contractor to the Government, F.O.B. Contractor's plant, and then shipped by Government Bill of Lading in accordance with instructions received from the Contracting Officer, unless the Contracting Officer directs or authorizes the Contractor to dispose of such property otherwise. Disposal instructions regarding scrap or wastage, if any, will be given to the Contractor by the Contracting Officer at a later date.

c. Within thirty (30) days after Government furnished property is determined by the Contractor to be lost, damaged, destroyed, no longer usable, or no longer needed for the performance of the Contract, the Contractor shall notify the Contracting Officer thereof.

d. The Contractor agrees that the Government Furnished Material listed above is sufficient as to quantity to perform the contract.

Section K, Contract Administration Data, is amended as follows:

Delete: Subsection K.2(a) in its entirety and substitute therefore:

The Purchasing Office Representative is:

NAME: CPT Roy W. L'Heureux

ORGANIZATIONAL CODE: DRSEL-PC-C-CS-2(LHE)

TELEPHONE AREA CODE AND NO.: (201)-532-1436

AUTOVON NO.: 992-1436

Section M is amended as follows:

DD 1423 Form, Exhibit B, Item B002 and Exhibit D, D001:

Change - Code W15P7N to W15P8S.

II

PCO responsibility for this contract has changed as follows:

FROM

Mr. Gordon McMain
DRSEL-PC-C-CS-1

TO

Stephen L. Thacher
Major, Signal Corps
DRSEL-PC-C-CS-2(TIA)
Phone: (201)-532-3506

III

Inclusion of the above changes shall be at no additional cost to the Government.
All other terms and conditions of this contract remain in effect.

REF

69F

69E

PART II SECTION I OF THE SCHEDULE SUPPLIES LINE ITEM DATA										PROC INSTRUMENT ID NO. (PIIN)		2. SPIIN		3. PAGE 4 OF 8	
4. ITEM NO.	5. QUANTITY*	6. PURCH UNIT	7. UNIT PRICE	8. TOTAL ITEM AMOUNT*		12. FSCM AND PART NUMBER		13. CIRR							
0001AA	2	LT	\$ H	\$ HSP											
9. SCTY 10. ACRN CLAS	11. NSN	15. NOUN	16. QUANTITY VARIANCE A. OVER B. UNDER	17. ITEM/PROJ MGR	18. SVC/AGENCY USE										
U AA	N	ENGR SAMPLES	% %		C96N0056C9CA/00										
19. DESCRIPTIVE DATA Engineering Samples in accordance with Para. 1.2.12 and 3.1.7 of ECIPPR No. 15, SCS-511 and Subsection F.47. The samples shall be comprised of two submissions: 10 samples for the first submission and 16 samples for the second submission, for a total of 26 samples. Commercial Packaging, Packing and Marking in accordance with Subsection G.4.															
0001AA	4	LT	\$ H	\$ NSP											
9. SCTY 10. ACRN CLAS	11. NSN	15. NOUN	16. QUANTITY VARIANCE A. OVER B. UNDER	17. ITEM/PROJ MGR	18. SVC/AGENCY USE										
U AA	N	ENGR SAMPLES	% %		C96N0056C9CA/01										
19. DESCRIPTIVE DATA Engineering Samples in accordance with Para. 1.2.12 and 3.1.7 of ECIPPR No. 15, SCS-511 and Subsection F.47. The samples shall be comprised of four submissions: 10 samples for the first and third submissions and 16 samples for the second and fourth submissions, for a total of 52 samples. Commercial Packaging, Packing and Marking in accordance with Subsection G.4.															
0001AC	1	LT	\$ N	\$ NSP											
9. SCTY 10. ACRN CLAS	11. NSN	15. NOUN	16. QUANTITY VARIANCE A. OVER B. UNDER	17. ITEM/PROJ MGR	18. SVC/AGENCY USE										
U AA	N	PILOT RUN	% %		C96N0056C9CA/00										
19. DESCRIPTIVE DATA Pilot run comprised of a quantity of five-hundred (500) acceptable units in accordance with Para. 3.1.10 of ECIPPR No. 15, Subsections F.49 and SCS-511. Commercial Packaging, Packing and Marking in accordance with Subsection G.4.															
0001AC	1	LT	\$ N	\$ NSP											
9. SCTY 10. ACRN CLAS	11. NSN	15. NOUN	16. QUANTITY VARIANCE A. OVER B. UNDER	17. ITEM/PROJ MGR	18. SVC/AGENCY USE										
U AA	N	PILOT RUN	% %		C96N0056C9CA/01										
19. DESCRIPTIVE DATA Pilot run comprised of a quantity of two-hundred and fifty (250) acceptance units in accordance with Para. 3.1.10 of ECIPPR No. 15, Subsections F.49 and SCS-511. Commercial Packaging, Packing and Marking in accordance with Subsection G.4.															

*REPRESENTS NET AMOUNT OF INCREASE/DECREASE WHEN MODIFYING EXISTING ITEM NO.

N = NOT APPLICABLE

U = UNDEFINITEZED

NSP = NOT SEPARATELY PRICED

E = ESTIMATED

- (IN QTY AND \$) = DECREASE

+ OR - (IN ITEM NO.) = ADDITION OR DELETION

CIRR: CONTROLLED ITEM RPT RIGHT

SITE
CODES:

S = SOURCE

D = DESTINATION

O = INTERMEDIATE

CONTINUATION SHEET									
PART II SECTION H SUPPLIES SCHEDULE DATA									
4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*			
0001AA +	AA	W15P8S				1 LOT			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0001				
17. DESCRIPTIVE DATA Third Engineering Samples (10 each) SHIP TO: Commander US Army Electronics Research & Development Command ATTN: DELNV-L-C Fort Monmouth, NJ 07703									
DELIVERY: 1 August 78									
0001AA +	AA	W15P8S				1 LOT			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0001				
17. DESCRIPTIVE DATA Fourth Engineering Samples (16 each) SHIP TO: Same as above.									
DELIVERY: 1 September 1978									
0001AB -	AA	W15P7N				1 Lot			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0001				
17. DESCRIPTIVE DATA Confirmatory Samples (25 each) SHIP TO: Commander US Army Electronics Command ATTN: DRSEL-RD-ET-2 Fort Monmouth, NJ 07703									
DELIVERY: 480 Days after effective date of contract.									
0001AB -	AA	W15P8S				1 LOT			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0001				
17. DESCRIPTIVE DATA Confirmatory Samples (25 each) SHIP TO: Commander US Army Electronics Command ATTN: DRSEL-CT-LD Fort Monmouth, NJ 07703									
DELIVERY: 840 Days after effective date of contract.									
0001AB +	AA	W15P7N				1 LOT			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0001				
17. DESCRIPTIVE DATA Confirmatory Samples (25 each) SHIP TO: Commander US Army Electronics Research & Development Command ATTN: DELNV-L-C Fort Monmouth, NJ 07703									
DELIVERY: 1 January 1978									

* REPRESENTS A NET INCREASE/DECREASE WHEN NO + OR - APPEARS AFTER THE ITEM NO.

E = ESTIMATED
 - (IN QTY) = DECREASE
 + OR - (IN ITEM NO.) = ADDITION OR DELETION
 DD FORM PROPOSED (SDA 69H) APR 78

69H

69H

CONTINUATION SHEET				PROJECT IDENTIFICATION NO. (PFIN)		2. CPTN		3. PAGE 6 OF 8	
PART II SECTION H SUPPLIES SCHEDULE DATA									
4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*			
000LAB	AA	W15P7N				1 LOT			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0001				
17. DESCRIPTIVE DATA									
Confirmatory Samples (25 each)									
SHIP TO: Commander									
US Army Electronics Research & Development Command									
ATTN: DELNV-L-C									
Fort Monmouth, NJ 07703									
DELIVERY: 2 January 1980									
000LAC	AA	W15P8S				1 LOT			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0001				
17. DESCRIPTIVE DATA									
Pilot Run									
SHIP TO: Commander									
US Army Electronics Command									
ATTN: DRSEL-CT-LD									
Fort Monmouth, NJ 07703									
DELIVERY: 690 Days after effective date of contract.									
000LAC	AA	W15P8S				1 LOT			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0001				
17. DESCRIPTIVE DATA									
Pilot Run									
SHIP TO: Commander									
US Army Electronics Research & Development Command									
ATTN: DELNV-L-C									
Fort Monmouth, NJ 07703									
DELIVERY: 1 August 1979									
BOOL	AA	W15P8S				1 LOT			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0003				
17. DESCRIPTIVE DATA									
Report on Third Engineering Samples									
SHIP TO: (2 copies) Commander									
US Army Electronics Research & Development Command									
ATTN: DELNV-L-C									
Fort Monmouth, NJ 07703									
and 1 copy to W15P7R									
DELIVERY: 1 August 1978									
BOOL	AA	W15P8S				1 LOT			
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT				
U					0003				
17. DESCRIPTIVE DATA									
Report on Fourth Engineering Samples									
SHIP TO: 2 copies to: Address above									
1 copy to W15P7R									
DELIVERY: 1 September 1978									

* REPRESENTS A NET INCREASE/DECREASE WHEN NO + OR - APPEARS AFTER THE ITEM NO.

E = ESTIMATED

- (IN QTY) = DECREASE

+ OR - (IN ITEM NO.) = ADDITION OR DELETION
DD FORM PROPOSED (SDA 69H) APR 75

CONTINUATION SHEET

PART II SECTION H
SUPPLIES SCHEDULE DATA

4. ITEM NO. COO3	5. ACRN AA	6. SHIP TO W15P7R	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY* 1 LOT
11. SCTY CLAS U	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT 0004	

17. DESCRIPTIVE DATA Final Report

SHIP TO: W15P7R

DELIVERY: Draft due 890 days after effective date of contract.

For additional delivery data, see Exhibit C, Sequence No. C003.

4. ITEM NO. COO3	5. ACRN AA	6. SHIP TO W15P7R	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY* 1 LOT
11. SCTY CLAS U	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT 0004	

17. DESCRIPTIVE DATA Final Report

SHIP TO: W15P7R

DELIVERY: Draft due 1 March 1980.

For additional delivery data, see Exhibit C, Sequence No. C003.

4. ITEM NO. COO4	5. ACRN AA	6. SHIP TO W15P7R	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY* 1 LOT
11. SCTY CLAS U	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT 0004	

17. DESCRIPTIVE DATA General Report

SHIP TO: 2 copies - W15P7R

DELIVERY: 840 days after effective date of contract.

4. ITEM NO. COO4	5. ACRN AA	6. SHIP TO W15P7R	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY* 1 LOT
11. SCTY CLAS U	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT 0004	

17. DESCRIPTIVE DATA General Report

SHIP TO: 2 copies - W15P7R.

DELIVERY: 2 January 1980

4. ITEM NO. EOO1	5. ACRN AA	6. SHIP TO W15P7R	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY* 1 LOT
11. SCTY CLAS U	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT 0007	

17. DESCRIPTIVE DATA Production Capability Demonstration Plan

SHIP TO: W15P7R

DELIVERY: 690 Days after effective date of contract.

* REPRESENTS A NET INCREASE/DECREASE WHEN NO + OR - APPEARS AFTER THE ITEM NO.

E = ESTIMATED

- (IN QTY) = DECREASE

+ OR - (IN ITEM NO.) = ADDITION OR DELETION
DD FORM PROPOSED (SDA 69H) APR 78

CONTINUATION SHEET

1. INSTRUMENT ID NO. (PTIN)

DATA 1-76-0-8135

2. SPTIN

P00001

3.

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PART II SECTION H
SUPPLIES SCHEDULE DATA

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0001 +	AA	W1517R				1 LOT
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT	
					0007	

17. DESCRIPTIVE DATA Production Capability Demonstration Plan

SHIP TO: W1517R

DELIVERY: 1 August 1979

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0008 -	AA					1 LOT
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT	

17. DESCRIPTIVE DATA Additional Life Testing

DELIVERY: To be completed by 840 days after effective date of contract.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0008 -	AA					1 LOT
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT	
					0008	

17. DESCRIPTIVE DATA Additional Life Testing

DELIVERY: 2 January 1980.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT	

17. DESCRIPTIVE DATA

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT	

17. DESCRIPTIVE DATA

*REPRESENTS A NET INCREASE/DECREASE WHEN NO + OR - APPEARS AFTER THE ITEM NO.

E = ESTIMATED

- (IN QTY) = DECREASE

+ OR - (IN ITEM NO.) = ADDITION OR DELETION
DD FORM PROPOSED (SDA 69H) APR 78

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

Page 9

Table V, Subgroup 2, under Details column for Resistance to solvents, add,
"except solvents used shall be:

- (a) Methyl alcohol, per O-M-232, Grade A.
- (b) Ethyl alcohol, per O-E-C0760, Type 1, Grade A.
- (c) Isopropyl alcohol, per TT-I-735, Grade A.
- (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c)-
above and one (1) part by volume of distilled water."

Page 10

4.6.1 add, "except solvents used shall be:

- (a) Methyl alcohol per O-M-232, Grade A.
- (b) Ethyl alcohol per O-E-C0760, Type 1, Grade A.
- (c) Isopropyl alcohol per TT-I-735, Grade A.
- (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c)-
above and one (1) part by volume of distilled water."

4.6.8 line 1, delete "photodiode" and substitute "photodiode"

Page 11

4.6.10, lines 4 and 5, delete "20°C" and substitute "25°C"

ELECTRONICS COMMAND
TECHNICAL REQUIREMENTS

SCS-511
AMENDMENT-2
4 August 1976
SUPERSEDING
AMENDMENT-1
29 December 1975

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

This amendment forms a part of Electronics Command Technical Requirements SCS-511,
14 August 1975

Page 7

- * Table III, Subgroup 3, under Min column for Spectral width, delete "40".

Page 9

Table V, Subgroup 2, under Details column for Resistance to solvents, add,
"except solvents used shall be:

- (a) Methyl alcohol, per O-M-232, Grade A.
- (b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.
- (c) Isopropyl alcohol, per TT-I-735, Grade A.
- (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

Page 10

4.6.1 add, "except solvents used shall be:

- (a) Methyl alcohol, per O-M-232, Grade A.
- (b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.
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- (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

4.6.8 line 1, delete "phtodiode" and substitute "photodiode"

Page 11

4.6.10, lines 4 and 5, delete "20°C" and substitute "25°C"

SCS-531
AMENDMENT-3

- * 4.6.4 line 2, delete "one angstrom" and substitute "10 angstroms".
- * 4.6.5 line 3, delete "1 angstrom" and substitute "10 angstroms".
- * 4.6.7 line 1, delete "150" and substitute "100".
- 4.6.8 line 1, delete "phtodiode" and substitute "photodiode".

Page 11

4.6.10 lines 4 and 5, delete "20°C" and substitute "25°C".

- * 6.1 insert " V_{br} reverse breakdown voltage" after V_D .
- * 6.1 for V_r , delete "breakdown voltage (reverse)" and substitute "reverse voltage".

Page 13

- * Table VI, for core diameter, delete "125" under Min column and substitute "125" under Max column.

Page 14

Fig. 1, delete ".205" and substitute ".27" max."

NOTE: The margins of this amendment are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous amendment were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous amendment.

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

This amendment forms a part of Electronics Command Technical Requirements SCS-511,
14 August 1975

Page 7

- * Table III, Subgroup 2, for Reverse breakdown voltage, delete "3.0" under Max column and substitute "3.0" under Min column.

Table III, Subgroup 3, under Min column for Spectral width, delete "40".

Page 8

- * Table IV, Subgroup 5, under Conditions column, delete "85°C" and substitute "25°C".

Page 9

Table V, Subgroup 2, under Details column for Resistance to solvents, add,
"except solvents used shall be:

(a) Methyl alcohol, per O-M-232, Grade A.

(b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol, per TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c)
above and one (1) part by volume of distilled water."

Page 10

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(a) Methyl alcohol, per O-M-232, Grade A.

(b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol, per TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c)
above and one (1) part by volume of distilled water."

Page 14

- * Fig. 1, delete ".205"" and substitute ".27" max."

NOTE: The margins of this amendment are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous amendment were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous amendment.

ELECTRONIC RAD COMMAND
TECHNICAL REQUIREMENTS

SCS-511
AMENDMENT - 1.
12 May 1978
SUPERSEDING AMENDMENT - 3
20 September 1976

LIGHT EMITTING DIODE FOR USE IN FIBER
OPTIC COMMUNICATIONS

This amendment forms a part of Electronics Research and Development Technical Requirements SCS-511, 14 August 1975.

Page 7

TABLE III, Subgroup 2, Output optical power delete "0.5 mw" and substitute ".100 mw".

Page 13

Under TABLE VI - Fiber Characteristics add heading titled "Nom" and make the following changes:

Core diameter - delete "125" under Max heading
add "55" under Nom heading
add "62.5" under Max heading

Cladding diameter - delete "150" under Min heading
add "125" under Nom heading

Protective Jacket diameter - delete "1" under Min heading
delete "mm" under Unit heading
add "500" under Nom heading
add "um" under Unit heading

Bending Radius - delete "1.5" under Min heading
add "5" under Nom heading

Page 14

Replace FIG 1 with attached FIG 1 (AMENDMENT - 4).

12 May 1978

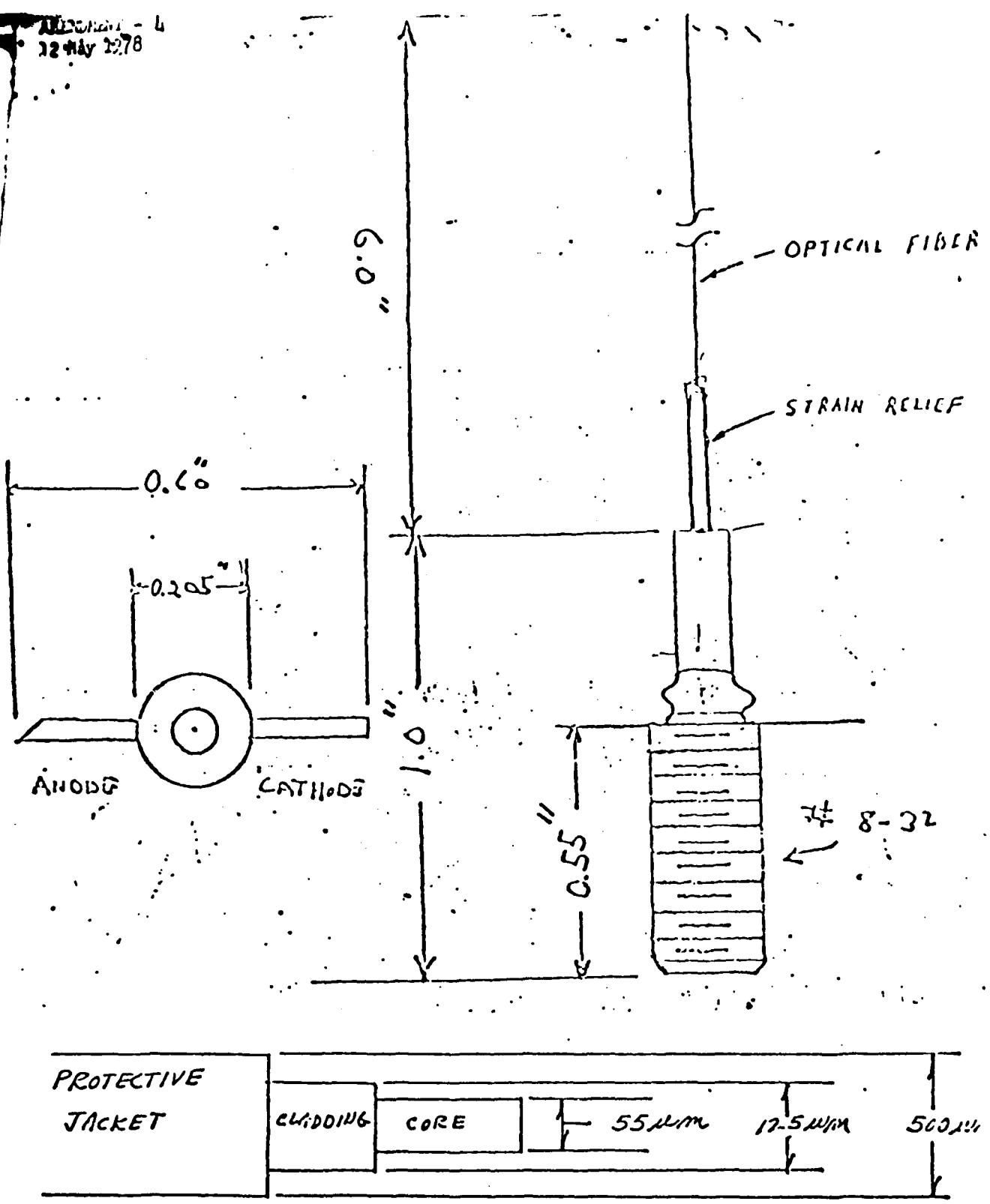


FIG. 1 PHYSICAL DIMENSIONS

CORADCOM
TECHNICAL REQUIREMENTS

SCS-511
AMENDMENT 5
23 Sep 1980
SUPERSEDING AMENDMENT 4
12 May 1978

LIGHT EMITTING DIODE FOR USE IN FIBER
OPTIC COMMUNICATIONS

This amendment forms a part of Electronics Command Technical Requirements SCS-511, 14 August 1975.

Page 2

3.2.4 line 2, delete "35 db" and substitute "26db".

3.3.1 line 2, delete "hot solder dip" and substitute "gold plated".

Page 3

3.4 line (d), delete.

Page 5

4.5.2.2 line 5, delete "1%" and substitute "5%".

Page 7

TABLE III, Subgroup 2, Peak emission wavelength, delete "830" under Max column and substitute "890".

TABLE III, Subgroup 2, Output Optical Power, delete "0.5" under Min column and substitute "0.075".

TABLE III, Subgroup 3, Spectral width, delete "40" under Min column, delete "45" under Max column and substitute "50".

TABLE III, Subgroup 3, Bandwidth, delete "44" under Max Column.

TABLE III, Subgroup 3, Rise and fall time, delete "10" under Min Column.

Page 8

TABLE IV, Subgroup 5, under Conditions Column, delete "85°C" and substitute "25°C".

Page 9

TABLE V, Subgroup 2, under Details column for Resistance to solvents, add "except solvents used shall be:

- (a) Methyl alcohol, per O-M-232, Grade A.
- (b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.
- (c) Isopropyl alcohol, per TT-I-735, Grade A.
- (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

Page 10

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- (a) Methyl alcohol, per O-M-232, Grade A.
- (b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.
- (c) Isopropyl alcohol, per TT-I-735, Grade A.
- (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

4.6.4 line 2, delete "one angstrom" and substitute "10 angstroms".

4.6.5 line 3, delete "1 angstrom" and substitute "10 angstroms".

4.6.7 line 1, delete "150" and substitute "100".

4.6.8 line 1, delete "phtodiode" and substitute "photodiode".

Page 11

4.6.10 lines 4 and 6, delete "20°C" and substitute "25°C".

6.1 insert " V_{br} reverse breakdown voltage" after V_D .

6.1 for V_n , delete "breakdown voltage (reverse)" and substitute "reverse voltage".

Page 13

Under TABLE VI - Fiber Characteristics add heading titled "Nom" and make the following changes:

Core Diameter - delete "125" under Max heading
add "55" under Nom heading
add "62.5" under Max heading

Cladding diameter - delete "150" under Min heading
add "125" under Nom heading

Protective Jacket diameter - delete "I" under Min heading
delete "mm" under Unit heading
add "500" under Nom heading
add "um" under Unit heading

Bending Radius - delete "1.5" under Min heading
add "5" under Nom heading

Page 14

Replace FIG 1 with attached FIG 1 (AMENDMENT 5).

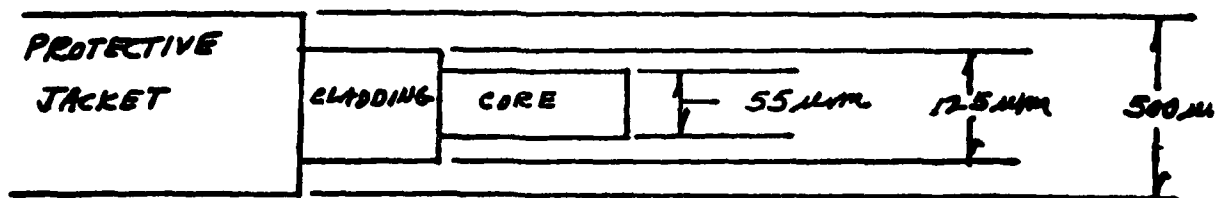
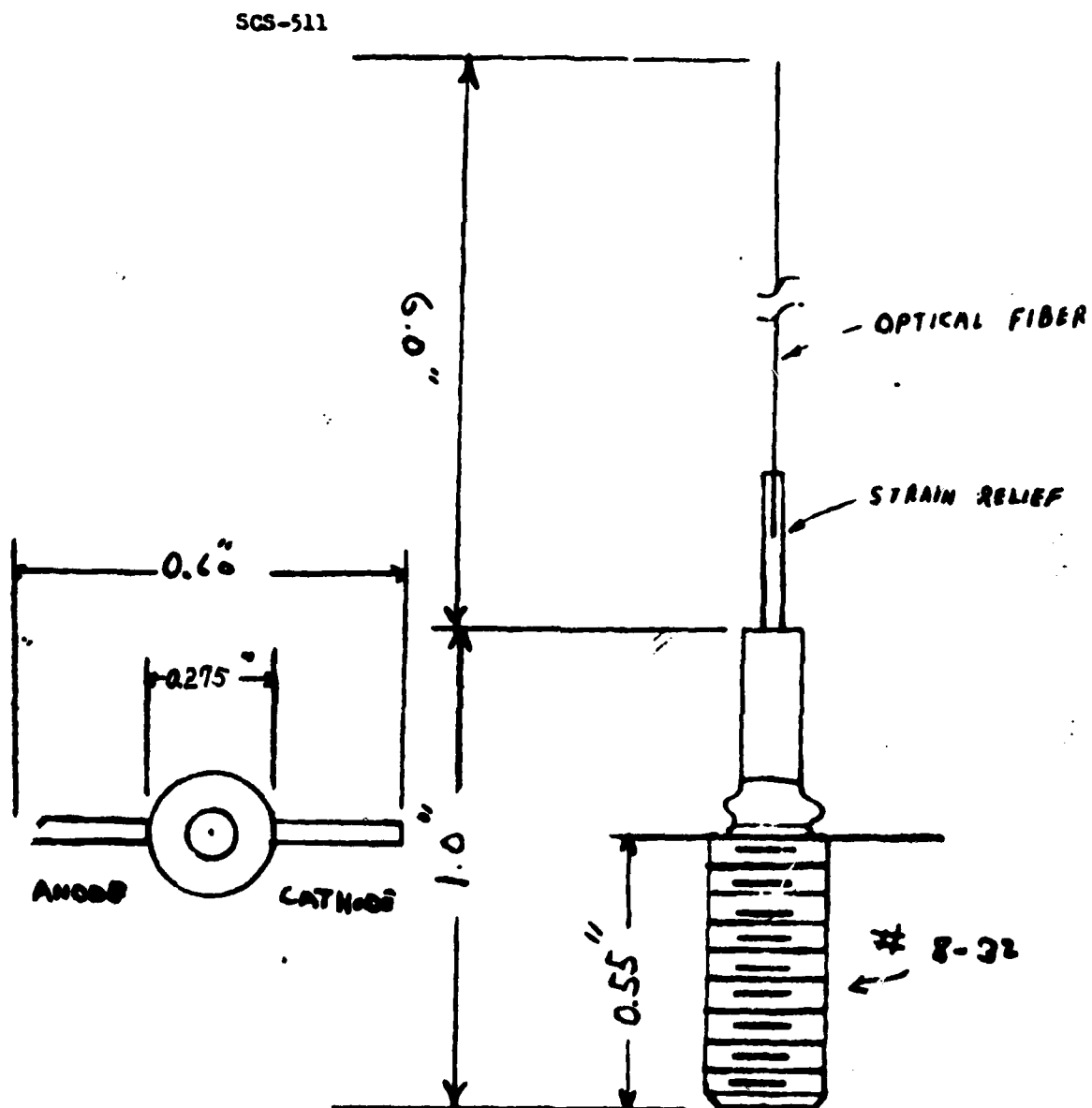
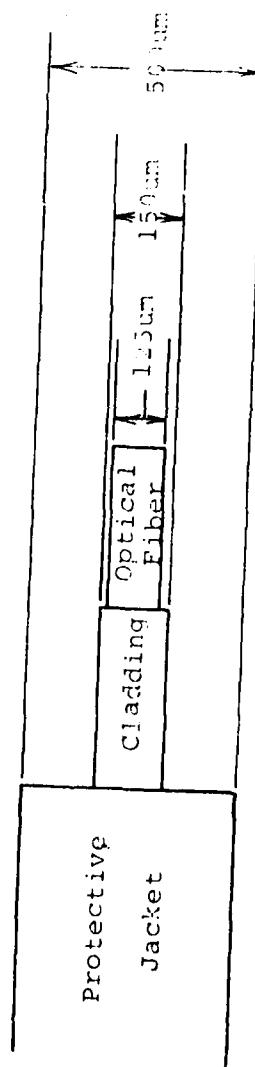
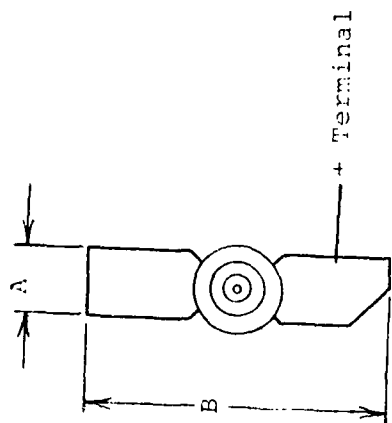
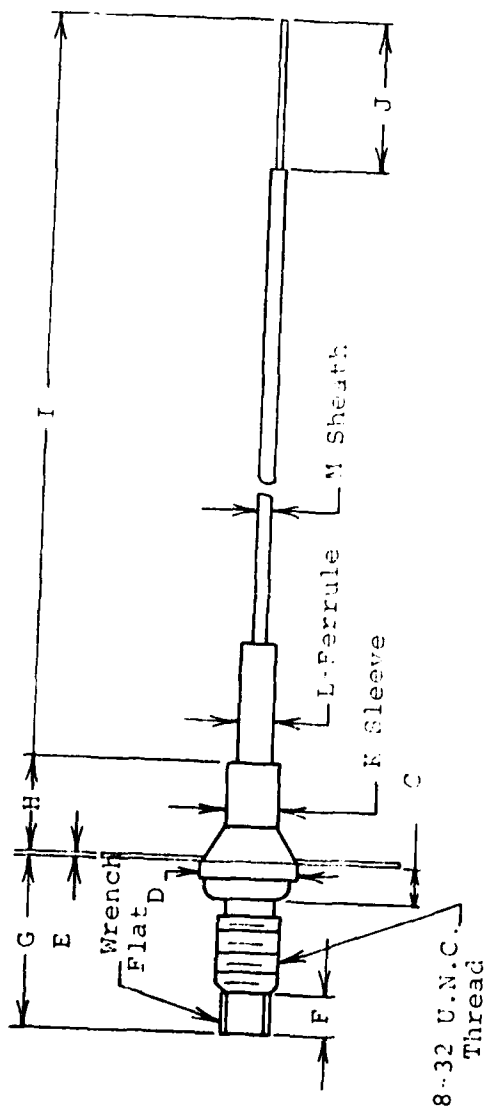


FIG. 1 PHYSICAL DIMENSIONS



SYMBOL	INCHES	
	mm	
A	.225	5.71
B	.875	22.23
C	.060	1.52
D	.275	7.00
E	.005	.127
F	.115	2.93
G	.500	12.70
H	.330	8.38
I	6.00	152.40
J	1.00	25.40
K	.155	3.93
L	.038	.97
M	.01	.25

STANDARD FORM 30, JULY 1966 GENERAL SERVICES ADMINISTRATION FED. PROC. REG. (41 CFR) 1-16.101		AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT		PAGE 1 OF 9
1. AMENDMENT/MODIFICATION NO. DAAB07-76-C-8135, P00002		2. EFFECTIVE DATE See B1k 19		3. REQUISITION/PURCHASE REQUEST NO. N/A
4. PROJECT NO. (If applicable)				
5. ISSUED BY USACORADCOM, Procurement Directorate Proc Div D, Ft. Monmouth, N.J. 07703 Mr. John C. Hunter/DRDCO-PC-D(HUN) (201) 532-1716		6. ADMINISTERED BY (If other than block 5) DCASMA, Springfield 240 Route 22 Springfield, New Jersey 07081		
7. CONTRACTOR NAME AND ADDRESS Laser Diode Laboratories, Inc. 1130 Somerset Street New Brunswick, New Jersey 08901		8. AMENDMENT OF SOLICITATION NO. _____ DATED _____ (See block 9) ☒ MODIFICATION OF CONTRACT ORDER NO. DAAB07-76-C-8135 DATED 76 Sep 30 (See block 11)		
9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS ☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended. Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods: (a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.				
10. ACCOUNTING AND APPROPRIATION DATA (If required) N/A				
11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS (a) ☐ This Change Order is issued pursuant to _____ The Changes set forth in block 12 are made to the above numbered contract/order. (b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12. (c) ☒ This Supplemental Agreement is entered into pursuant to authority of Changes Provision, Subsection 1.2 of the contract. It modifies the above numbered contract as set forth in block 12.				
12. DESCRIPTION OF AMENDMENT/MODIFICATION PROJECT: MANUFACTURING METHODS AND TECHNOLOGY PROGRAM OF LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS. I PART II, THE SCHEDULE, SECTION E is amended as follows: Add SLIN 0001AD to SUPPLIES/SERVICES "0001AD Twenty-five (25) each Light Emitting Diode LDL Part No. IRE 161 No Cost"				
Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.				
13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN <u>1</u> COPY TO ISSUING OFFICE				
14. NAME OF CONTRACTOR/OFFEROR BY _____ (Signature of person authorized to sign)		17. UNITED STATES OF AMERICA BY _____ (Signature of Contracting Officer)		
15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED	
		JOSEPH E. FEENEY		

Contract No. DAAB07-76-C-8135
Modification No. P00002
Laser Diode Laboratories, Inc.
Page No. 2 of 9

II

PART II, THE SCHEDULE, SECTION F, Description/Specifications, is amended as follows:

1. Subsection F.2, Specifications/Drawings Listing - ADD the following Amendment to SCS511:

"Amendment 5 to SCS511 dated 23 September 1980".

2. Subsection F.48, Subparagraph 6 - Delete this paragraph in its entirety and substitute the following:

"6. Additional Confirmatory Sample Test Requirements:

Twenty-five (25) Confirmatory Samples will be subjected to a 2000 Hour Life Test. Upon completion the samples will be retested in accordance with Table II. The Life Test and Table II (Retest) data will be incorporated into the Final Report. The Life Test samples shall be shipped to the Government upon completion of tests."

3. Add the following subparagraph to SECTION F:

"F.50 FINAL REPORT - SUPPLEMENTAL INSTRUCTIONS

The Final Report shall be prepared in accordance with the requirements as specified by CDRL C003. In addition, the report shall contain an Executive Summary, Pilot Line Rate Data, and Life Test Data."

III

PART II, THE SCHEDULE, SECTION H, Deliveries or Performance:

DELETE the contents of this Section in its entirety and SUBSTITUTE the following:

<u>CLIN/SLIN</u>	<u>ITEM</u>	<u>DELIVERY DATE</u>
0001AA	Engineering Samples Total 52 ea (Lot 1,2,3,4)	Received & Accepted Oct 1978
0001AB	Confirmatory Samples 25 each (Lot 1)	21 Nov 1980
	25 each (Lot 2)(Life Test Units)	Not Later Than 27 Feb 1981

Contract No. DAAB07-76-C-8135
 Modification No. P00002
 Laser Diode Laboratories, Inc.
 Page No. 3 of 9

REVISED DELIVERY OR PERFORMANCE SCHEDULE (Cont)

<u>CLIN/SLIN</u>	<u>ITEM</u>	<u>DELIVERY DATE</u>
0001AC	Pilot Run Samples 250 each	16 Jan 1981
0001AD	Light Emitting Diode 25 each LDL Part N-IRE1C1	Not Later Than 27 Feb 1981
0002/A001	PERT	Received & Accepted
0003/B001	Engineering Sample Test Report (For Lots 1,2,3,4)	Received & Accepted
0003/B002	Confirmatory Sample Test Report (For Lots 1 & 2 except Life Test)	Received & Accepted
0004/C001	Monthly Technical Reports Reports for Oct 1976 thru Sep 1980 Oct 1980 Report Nov 1980 Report Dec 1980 Report	Received & Reviewed Not Later Than 10 Nov 1980 Not Later Than 10 Dec 1980 Not Later Than 10 Jan 1981
0004/C002	Quarterly Reports Reports for Dec 1976 thru Aug 1980 Oct 1980 Report	Received & Reviewed Not Later Than 10 Nov 1980
0004/C003	Final Report Draft Final	14 Nov 1980 27 Feb 1981
0004/C004	General Report - DELETED (Incorporated as "Executive Summary in Final Report)	--
0004/C005	Pilot Line Rate Report - DELETED (Incorporated in the Final Report)	--

Contract No. DAAB07-76-C-8135
 Modification No. PQ0002
 Laser Diode Laboratories, Inc.
 Page No. 4 of 9

REVISED DELIVERY OR PERFORMANCE SCHEDULE (Cont.)

<u>CLIN/SLIN</u>	<u>ITEM</u>	<u>DELIVERY DATE</u>
0005/D001	Test Plan (Confirmatory Samples)	Received & Accepted
0006	Production Capability Demonstration	11 Feb 1981
	Draft Invitation Letter	12 Dec 1980
	Industry Invitation Letters (Mailed By)	16 Jan 1981
0007/E001	Production Capability Demonstration Plan	
	Draft	12 Dec 1980
	Final	16 Jan 1981
0008AA	Life Tests	Completion Not Later Than 20 Feb 1981"

IV

PART II, THE SCHEDULE, SECTION I - Inspection and Acceptance -

DELETE the contents of this Section in its entirety and SUBSTITUTE the following;

"I.14 INSPECTION AND ACCEPTANCE

<u>CLIN/SLIN</u>	<u>ITEM</u>	<u>FINAL INSPECTION/ACCEPTANCE PERFORMED BY: *</u>
0001AA	Engineering Samples	Received & Accepted
0001AB	Confirmatory Samples	
	Lot 1	DELNV-L
	Lot 2 (After Life Test)	DELNV-L
0001AC	Pilot Run Samples	
	250 each	DELNV-L
0001AD	Light Emitting Diode	
	25 each	DRDCO-COM-RM-1
0002/A001	PERT	Received & Accepted

Contract No. DAAB07-76-C-8135
Modification No. P00002
Laser Diode Laboratories, Inc.
Page No. 5 of 9

INSPECTION AND ACCEPTANCE (Cont)

<u>CLIN/SLIN</u>	<u>ITEM</u>	<u>FINAL INSPECTION/ACCEPTANCE PERFORMED BY: *</u>
0003/B001	Engineering Sample Test Report	Received & Accepted
0003/B002	Confirmatory Sample Test Report	Received & Accepted
0004/C001	Monthly Technical Reports Oct/Nov/Dec 1980 Reports	DELNV-L
0004/C002	Quarterly Reports Oct 1980 Report	DELNV-L
0004/C003	Final Report Draft Final	DELNV-L DELNV-L
0005/D001	Test Plan (Confirmatory Sample)	Received & Accepted
0006	Production Capability Demonstration Draft Invitation Letter	DELNV-L DRDCO-PC-D
0007/E001	Production Capability Demonstration Plan Draft Final	DELNV-L DELNV-L
0008AA	Life Tests	DELNV-L

*Responsibility codes used are not to be construed as full address identifiers. Full addressees and "SHIP TO" data cited below.

Verification of the capability of the contractor to fabricate the devices at the specified rate for the pilot run will be performed at the factory of the contractor during performance of the pilot run by:

*DELNV-L and/or DRDCO-COM-RM-1

Inspection and Acceptance of the Devices under SLIN 0001AC (pilot run) will be performed at the factory of the contractor by:

*DCASMA

Contract No. DAAB07-76-C-8135
Modification No. P00002
Laser Diode Laboratories, Inc.
Page No. 6 of 9

INSPECTION AND ACCEPTANCE (Cont)

Inspection and Acceptance of SLIN 0008AA will be performed at the factory of the contractor by:

*DCASMA and/or DRDCO-COM-RM-1

Final Inspection and Acceptance of the Production Capability Demonstration, CLIN 0006, will be made at time of demonstration by:

*DELNV-L and/or DRDCO-COM-RM-1 and/or DRDCO-PC-D

Location of demonstration will be as mutually agreed by the contractor and the Contracting Officer prior to Invitation Letter issuance.

Address listings with "SHIP TO" or "MARKED FOR" data shall be used when shipping hardware or software (data) items.

For Code DELNV-L:

SHIP TO:

Property Officer, USA MERADCOM
Bldg 335
Fort Belvoir, VA 22060

MARKED FOR:

Commander
USA ERADCOM
ATTN: DELNV-L (Mr. Skeldon)
Fort Belvoir, VA 22060

For Code DRDCO-COM-RM-1:

Commander
USA CORADCOM
CENCOMS
ATTN: DRDCO-COM-RM-1 (Mr. L. Coryell)
Fort Monmouth, New Jersey

Contract No. DAAB07-76-C-8135
Modification No. P00002
Laser Diode Laboratories, Inc.
Page No. 7 of 9

INSPECTION AND ACCEPTANCE (Cont)

For Code DRDCO-PC-D:

Commander
USA CORADCOM
Procurement Directorate
ATTN: DRDCO-PC-D (Mr. J. C. Hunter)
Fort Monmouth, New Jersey 07703

For Code DCASMA:

DCASMA, Springfield
240 Route 22
Springfield, New Jersey 07681
ATTN: DCRNGSCC-S4 (Mr. J. Martorano)
Contract DAAB07-76-C-0040"

V

PART II, THE SCHEDULE, SECTION K, CONTRACT ADMINISTRATION DATA, is amended as follows:

1. Subsection K.1 - PLACE OF PERFORMANCE, subparagraph 1, DELETE in its entirety and SUBSTITUTE the following:

"1. The work called for herein will be performed by the contractor at the following locations:

<u>ITEM NO.</u>	<u>LOCATION OF</u>	
All	Final Manufacture	New Brunswick, New Jersey 08901
	Packaging and Packing	New Brunswick, New Jersey 08901
	Shipping Point	New Brunswick, New Jersey 08901
	Producing Facilities	Laser Diode Laboratories, Inc., Owner
	Locations	1130 Somerset Street
		New Brunswick, New Jersey 08901
		105 Forrest Street
		Metuchen, New Jersey 08817

Contract No. DAAB07-76-C-8135
Modification No. P00002
Laser Diode Laboratories, Inc.
Page No. 8 of 9

PLACE OF PERFORMANCE (Cont)

Contractor's office which will receive payment, supervise and administer the contract:

1130 Somerset Street
New Brunswick, New Jersey 08901"

2. Subparagraph K.2, subparagraph a., DELETE in its entirety and SUBSTITUTE the following:

"Name: John C. Hunter
Organization: USA CORADCOM
Procurement Directorate
Attn: DRDCO-PC-D(HUN)
Fort Monmouth, New Jersey 07703
Telephone No.: (201) 532-1716/3306
Autovon No.: 992-1716/3306"

VI

PART IV, SECTION M, is amended as follows:

1. DD Form 1423 Data Requirements, pages 58 through 62 revised - copies attached.
2. Add to List of Documents "Amendment 5 to SCS511, dated 23 Sep 1980" (copy attached).

VII

The consideration for this extension in delivery is the additional tasks required to fabricate CLIN 0001AD items.

VIII

PCO responsibility for this contract has changed as follows:

FROM: Stephen L. Thacher
Major, Signal Corps
DRSEL-PC-C-CS-2(THA)
Phone (201) 532-3506

TO: Joseph E. Feeney
Contracting Officer
United States of America
Phone (201) 532-1716

Contract No. DAAB07-76-C-8135
Modification No. P00002
Laser Diode Laboratories, Inc.
Page No. 9 of 9

IX

Inclusion of the above changes shall be at no additional cost to the Government. All other terms and conditions of this contract remain unchanged and in effect.

APPENDIX C

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