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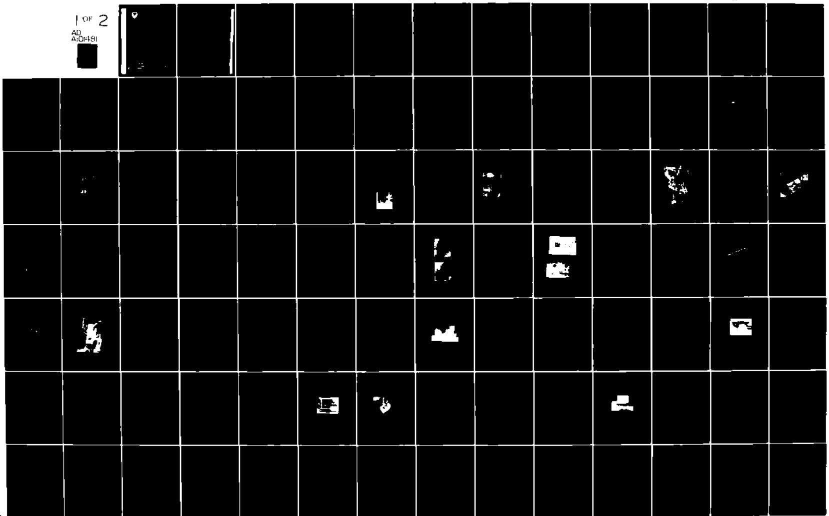

RESEARCH AND DEVELOPMENT TECHNICAL REPORT

CORADCOM-76-0040-F

MANUFACTURING METHODS AND TECHNOLOGY PROGRAM OF INJECTION LASER DIODES FOR USE IN FIBER OPTIC COMMUNICATIONS.

ALBERT GENNARO
LASER DIODE LABORATORIES
1130 SOMERSET STREET
NEW BRUNSWICK, N. J. 08901

31 MARCH 1981

FINAL REPORT FOR PERIOD JULY 1976-FEBRUARY 1981

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: CORADCOM-76-0040-F	2. GOVT ACCESSION NO.: AD-A101 481
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): INJECTION LASER DIODES FOR FIBER OPTIC COMMUNICATIONS	5. TYPE OF REPORT & PERIOD COVERED: Final Report 7/30/76-2/28/81
	6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): Albert Gennaro	8. CONTRACT OR GRANT NUMBER(s): DAAB07-76-C-0040
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Laser Diode Laboratories, 1130 Somerset Street, New Brunswick, N. J. 08901	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2769778
11. CONTROLLING OFFICE NAME AND ADDRESS: USACORADCOM, FT. Monmouth, N. J. 07703, Attn: DRDCO-PC-D (HUN)	12. REPORT DATE: Mar[redacted]81
	13. NUMBER OF PAGES: 152
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Injection Laser Diodes
Fiber Optic Communications
Gallium Aluminum Arsenide
Double Heterojunction Laser Diode

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The design and fabrication of injection laser diodes for use in fiber optic communications is discussed with regard to material synthesis, chip configuration, and device assembly in manufacturing environment. The opto-electronic source is based on the GaAs-GaAlAs double heterojunction structure and consists of a parallel array of lasers formed by the application of triple stripe geometry to the surface of the epitaxial wafer. The

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) monolithic triand of discrete lasing elements is mounted in a high frequency package which incorporates a high quality optical window.

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SECTION I

INTRODUCTION

The primary objective of this Manufacturing Method and Technology Engineering Program is threefold. First, the Injection Laser Diode for use in Fiber Optic Communications as outlined in Specification SCS-516 must be transferred from a developmental device to a manufactured commercial product without adversely affecting the performance characteristics of the device. Secondly, the manufacturing methods and techniques necessary for the production of the laser diode be developed and implemented to insure the highest degree of device quality and reliability at a reasonable cost. Thirdly, verification of device performance and quality for injection lasers produced in a manufacturing environment must be carried out by means of rigorous testing and evaluation 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.

SECTION II

DEVICE DESIGN REQUIREMENTS AND PERFORMANCE SPECIFICATIONS

2.1 Electro-Optical Characteristics.

The performance characteristics of the Injection Laser for use in Fiber Optic Communications are described in detail in Technical Specification SCS-516. The device may be generally described as a double-heterojunction (DH) GaAs - GaAlAs semiconductor laser capable of high data rate transmission at an emitting wavelength of 820 nm at room temperature. In addition, the device must be fiber optic compatible. An outline of the major electro-optical performance characteristics of the device is shown in Table 1. A more detailed description of the device, including environmental performance and parameter test methods can be found in SCS-516. In order to provide for a high degree of fiber optic system integrity through the use of redundancy, the injection laser diode has been designed to consist of a triad of discrete lasing elements contained within a single crystal of semiconductor material. This construction will be referred to as"monolithic triple stripe geometry" throughout this report.

2.2 Device Structure.

To achieve the electro-optical characteristics outlined in Table 1, the narrow cavity (<.5μm) GaAs-GaAlAs

Table 1

Electro-optical Performance Characteristics of the Injection Laser Diode for Fiber Optic Communications.

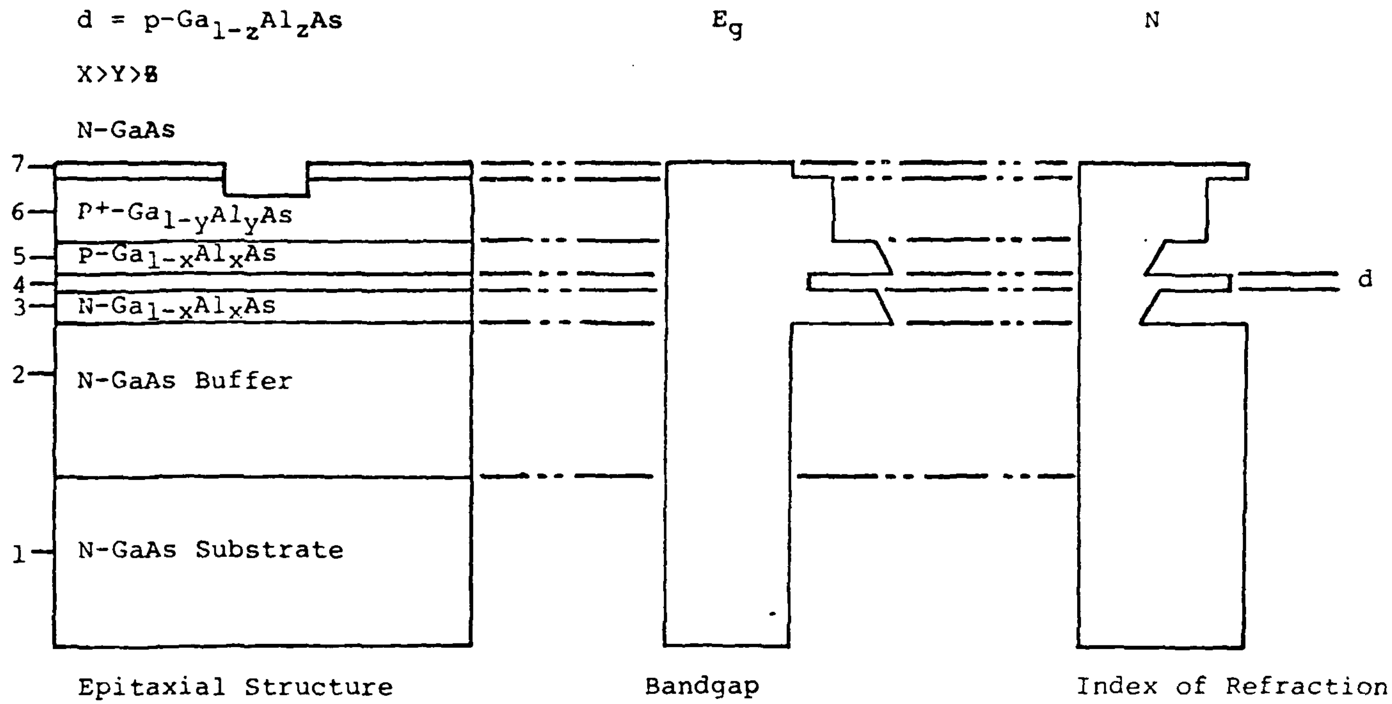
	Min.	Max.	Units
Optical Stripe Width	-	25	μm
Stripe Spacing	120	130	μm
Peak Output Power	200	-	mW
Average Output Power per Stripe	6.3	7.0	mW
Peak Wavelength	800	830	nm
Beam Divergence Parallel to Junction	-	15	degrees
Beam Divergence Perpendicular to Junction	-	40	degrees

Operating Conditions

Ip = 3A max.
Vf = 2.0V max. @ 3A.
Ta = 25°C
tp = 10 nsec
DF = 10%

double heterojunction laser structure has been employed in conjunction with Laser Diode Laboratories' unique stripe geometry current isolation technique. Devices of this structure have demonstrated low threshold current density (<1KA/cm^2), high differential quantum efficiency (>50%), fast rise time (<200 psec), and sufficiently good beam characteristics to satisfy the requirements of most fiber optic systems applications. A schematic diagram of the structure is shown in Figure 1 along with the bandgap, Eg, and index of refraction, n, profiles perpendicular to the plane of the P/N junction.

The substrate, region 1, is n-type GaAs doped with Si to 2 x 10^{18}, with EPD <1K/cm^2. Existing dislocation networks and substrate surface imperfections are terminated by the growth of at least one n-type GaAs buffer layer, region 2, doped with Te to 2 x 10^{18}. Regions 3 and 5 are n-type and p-type GaAlAs respectively. These two layers confine light generated by the injection and recombination of carriers in the active region 3, a p-type GaAlAs layer (Si, 1 x 10^{18}). Light is confined to the waveguide formed by regions 3 and 5 by virtue of the slight decrease in index of refraction at their boundaries with the lower bandgap active layer. The peak emission wavelength of the laser is controlled by the bandgap of the active region, which in turn is a function of the aluminum



Schematic Representation of the Epitaxial Structure for Fabrication of Stripe Geometry Double Heterojunction Injection Laser Diodes.

concentration of this layer. In this case, 8% aluminum in the active region corresponds to approximately 820 nm peak emission wavelength. In order to obtain the low threshold current densities required for high duty cycle operation and for satisfactory high temperature performance, the recombination volume, hence the active region thickness must be kept small. In the case of CW injection lasers with J_{th} typically $<1.5 KA/cm^2$, 'd' is normally 0.3 to 0.4 μm.

Region 6 functions as a contact cap with aluminum incorporated in this p-type Ge doped layer to minimize lateral current flow by increasing its resistivity. Stripe geometry fabrication permits high duty cycle and room temperature CW operation by limiting the lasing region of the active layer to only a small portion of the junction width. This allows heat generated in the 25 μm lasing region beneath the contact stripe to be dissipated throughout the entire bulk of the laser diode pellet. The topmost region 7 consists of lightly doped n-type GaAs. Following photolithographic definition of the contact stripe, 15 to 20 μm wide channels are etched through this current blocking layer. Under conditions of forward bias, current is restricted to flow through the active region only beneath the etched channel. Elsewhere, because the p/n junction formed by interface between regions 6 and 7 is back-biased, the cavity remains unpumped.

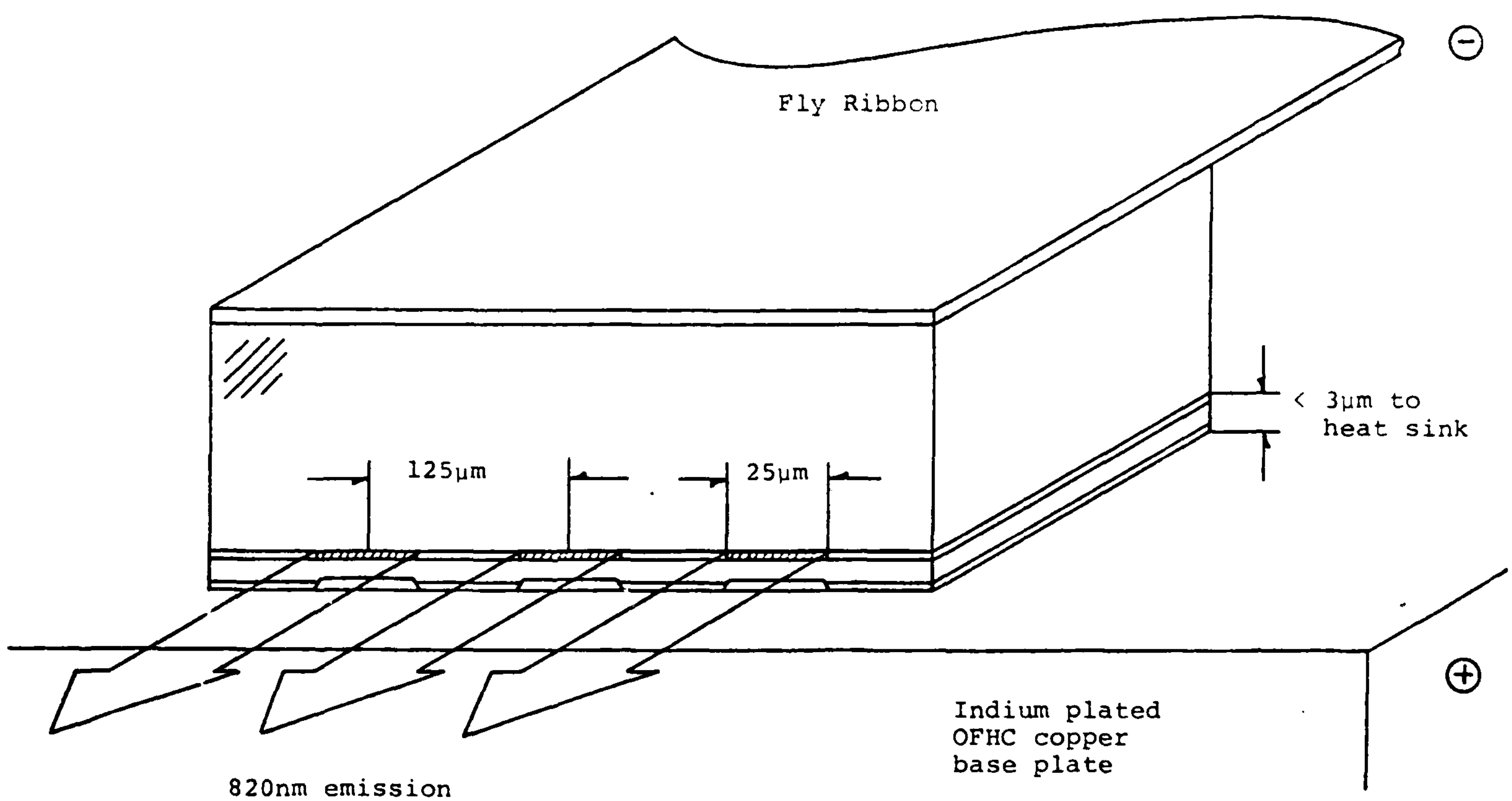
Details of the epitaxial synthesis and wafer processing for monolithic stripe geometry fabrication will be discussed in Section III.

2.3 Array Configuration.

The requirements of SCS-516 dictate the array configuration for the monolithic triple stripe geometry injection laser diode. Figure 2 illustrates the main features of the diode chip. The diode essentially consists of a triad of discrete lasing elements embedded in a single chip of epitaxial GaAs-GaAlAs material. Each element has a maximum optical source size of 25 μm and the elements are spaced at 125 μm intervals to facilitate coupling of each individual element to a triple fiber optic ribbon cable. Monolithic construction is preferred because the high degree of dimensional and compositional uniformity inherent in the hetero-epitaxial process guarantees optimum uniformity of electro-optical parameters among the three discrete lasing elements. In addition, the high degree of uniformity provides perfect geometrical alignment of the elements relative to each other. Fabrication of the monolithic triple stripe geometry array from epitaxially synthesized wafers is discussed in detail in Section III.

2.4 Package Requirements.

During the first quarter of the program, several modifications to the package outline were requested



Monolithic Triple Stripe Geometry Laser Diode
Module Configuration

by ECOM for incorporation into the device design. These modifications to the proposed package configuration involved increasing the height of the pill package base to better facilitate coupling to the fiber cable end ferrule. Also, the overall height was adjusted to allow the use of square optical windows in production. Figure 3 shows the modified package outline drawing with tolerances. A detail drawing showing the laser module mounting position and orientation within the pill package is given in Figure 4. Final configuration of the package parts and a detailed description of their assembly is given in Section III.

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

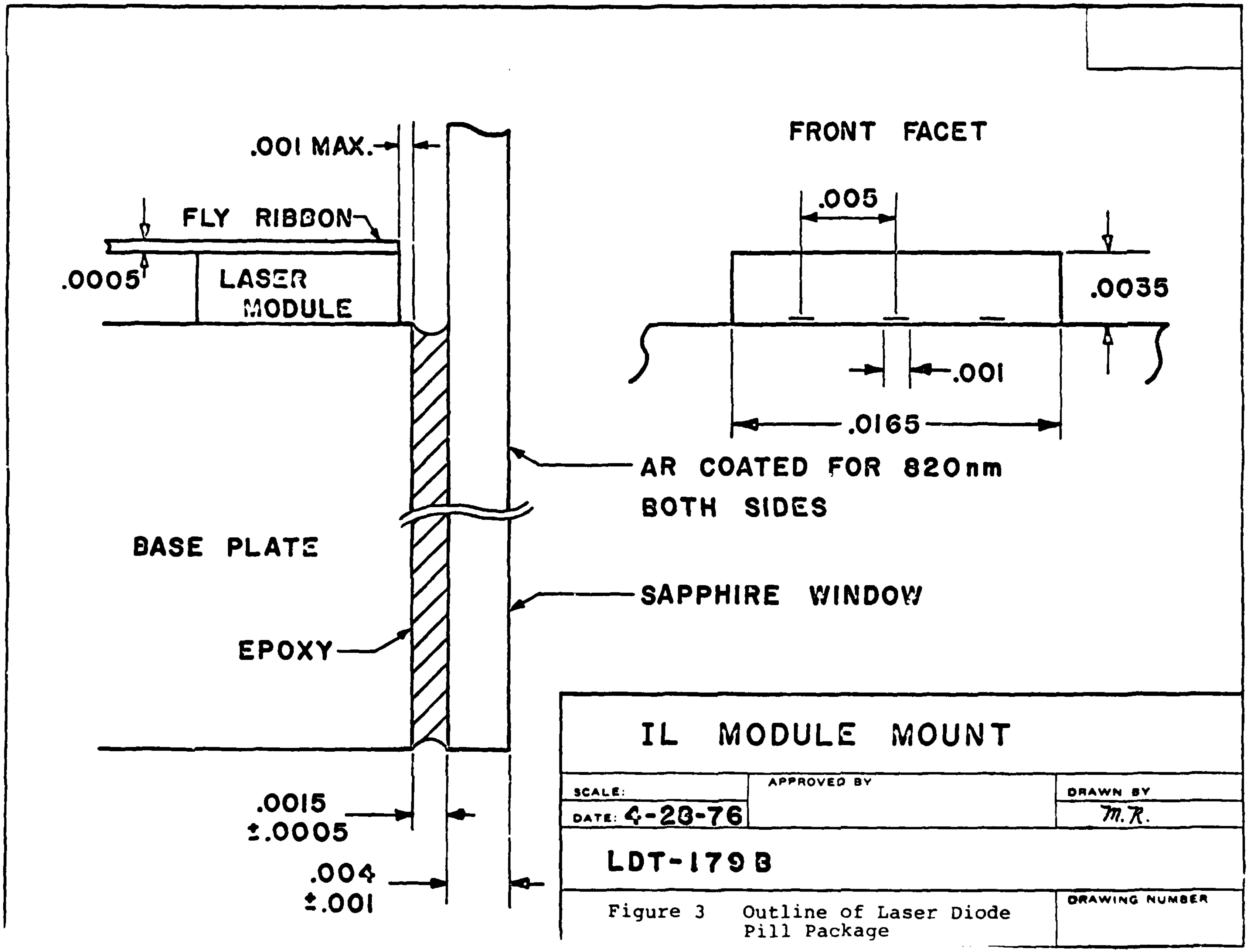
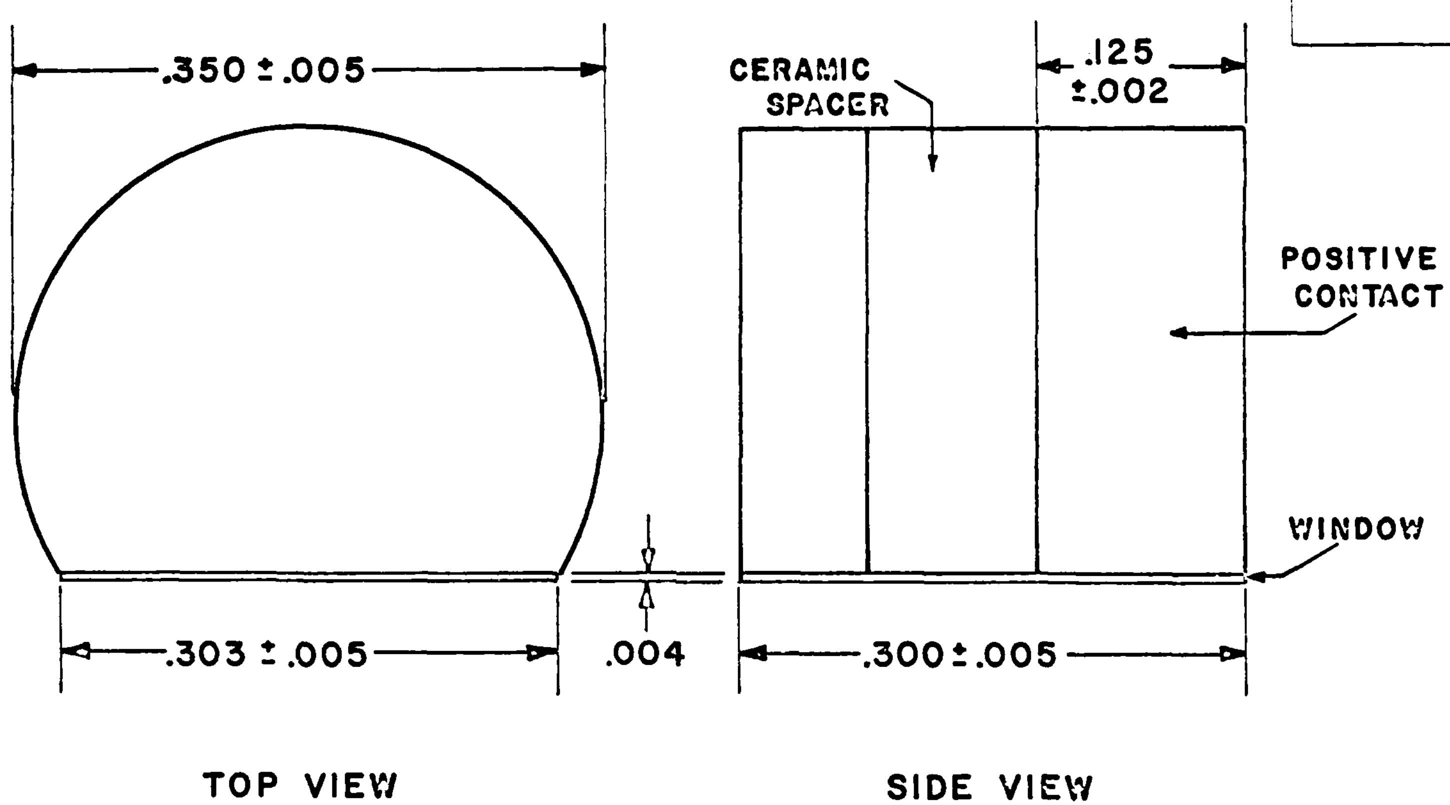


Figure 3 Outline of Laser Diode Pill Package



ALL PURCHASED PARTS WILL BE MADE TO ±.002" TOLERANCE. ASSEMBLY TOLERANCE AS SHOWN ABOVE.

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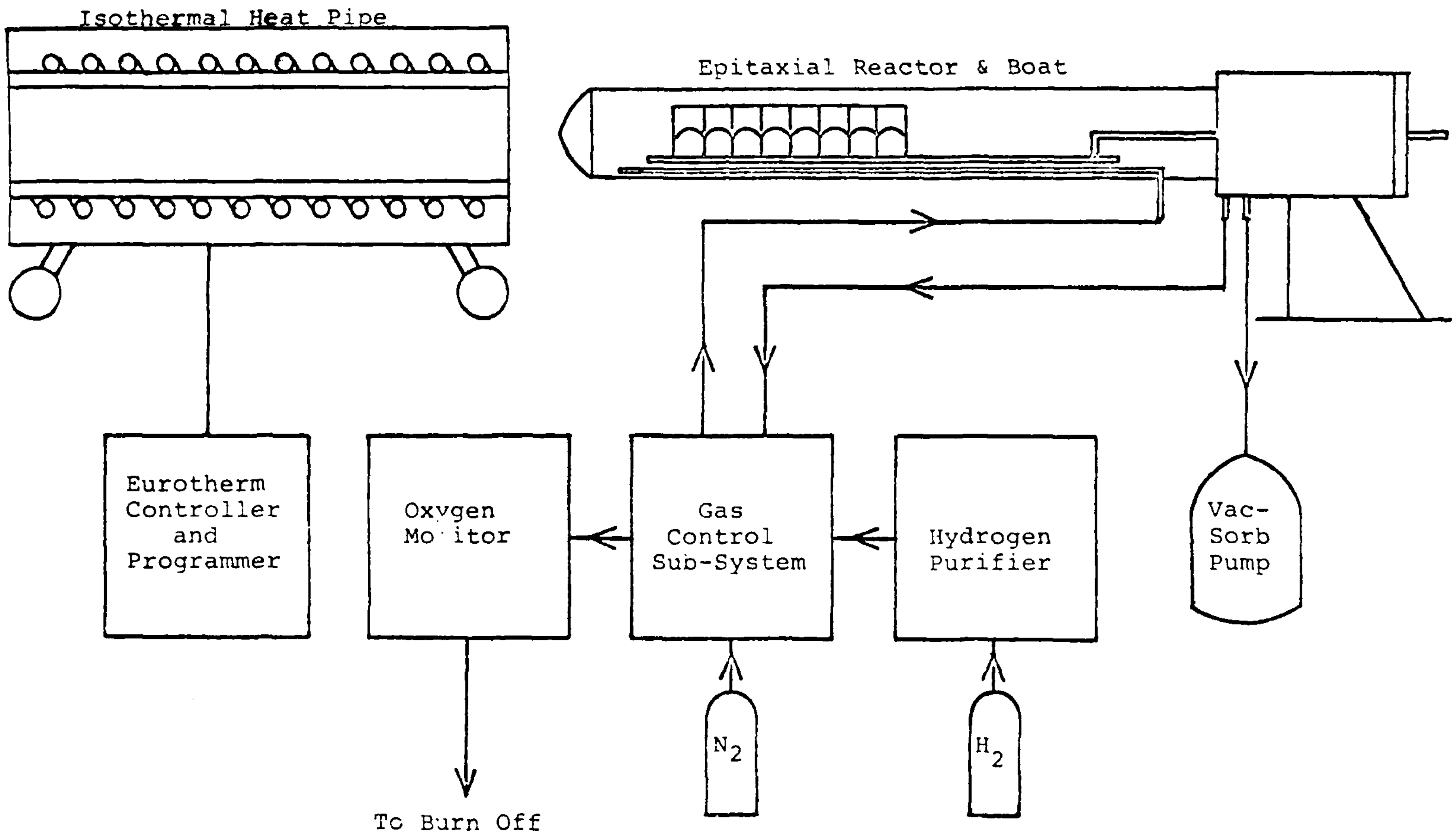
Figure 4 Detail of Injection Laser Module Mount		DRAWING NUMBER

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 monolithic triple stripe geometry laser 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 5 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 elimintates all vertical and horizontal temperature gradients and, hence provides uniform deposition rates over the entire surface of the substrate. The isothermal liner also allows the use of larger epitaxial boats, therefore, larger epitaxial



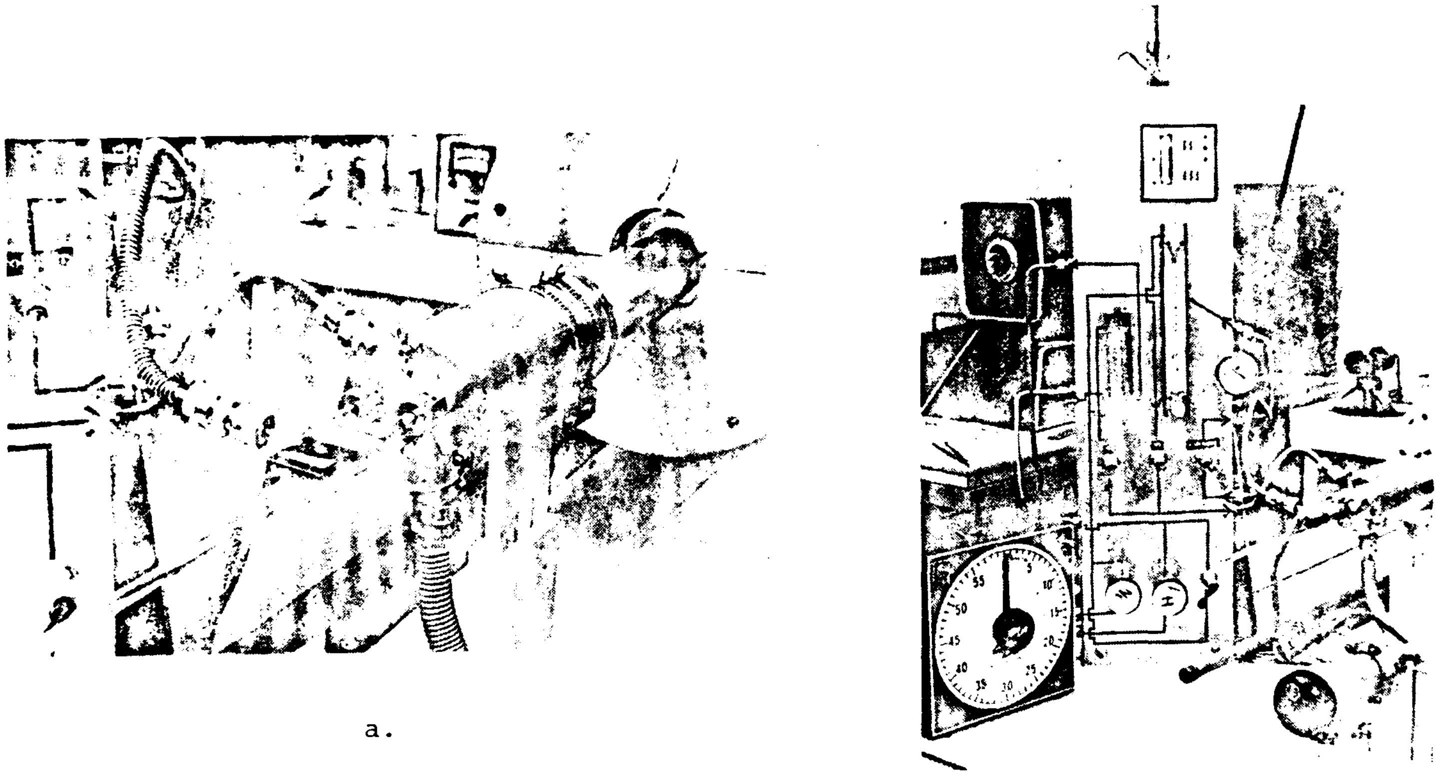
Block Diagram of Liquid Phase Epitaxial Systems Currently in Use at Laser Diode Laboratories.

wafers can be synthesized or more complex structures 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. The 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.

During the first quarter of the MMTE program, several improvements were made in the design of the epitaxial reactor. Noteable among these improvements were the design and construction of new end cap apparatus shown in the photograph of Figure 6a. The new design can support higher vacuum, and operates with lower background O_2 levels than could be obtained previously. The optimized design now permits evacuation of the growth tube down to 80 microns and a steady state O_2 concentration of 0.1 ppm in the H_2 carrier gas. In addition, an improved gas supply sub-system has been designed for easier use by production personnel and is shown in the photograph of Figure 6b. A schematic indicating its operation is shown in Figure 7. In addition to obtaining optimum system performance through improved design concepts, the design and construction of



a. b.

Figure 6 Photograph of Liquid Phase Epitaxial Reactors at Laser Diode Laboratories.

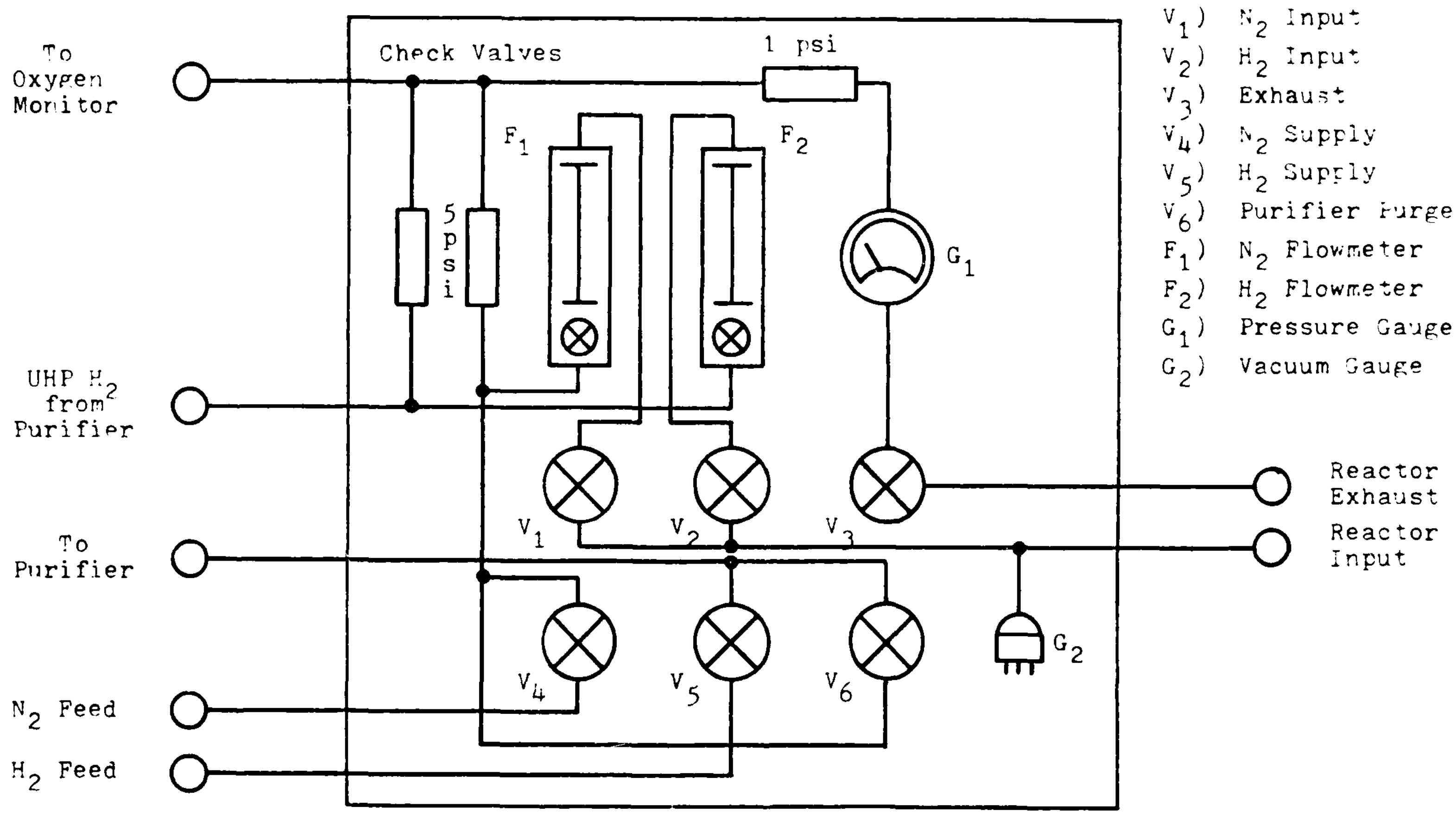


Figure 7 Schematic Diagram of Gas Control Subsystem

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 8. 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 boat allow the generation of double heterojunction structures in a manufacturing environment for the volume production of monolithic triple stripe geometry injection lasers.

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 9. Table 2 lists the melt compositions for the growth of the double heterojunction structure used in the fabrication of the monolithic triple stripe geometry laser 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 (refer to Figure 8). A graphite cover plate is employed to eliminate surface

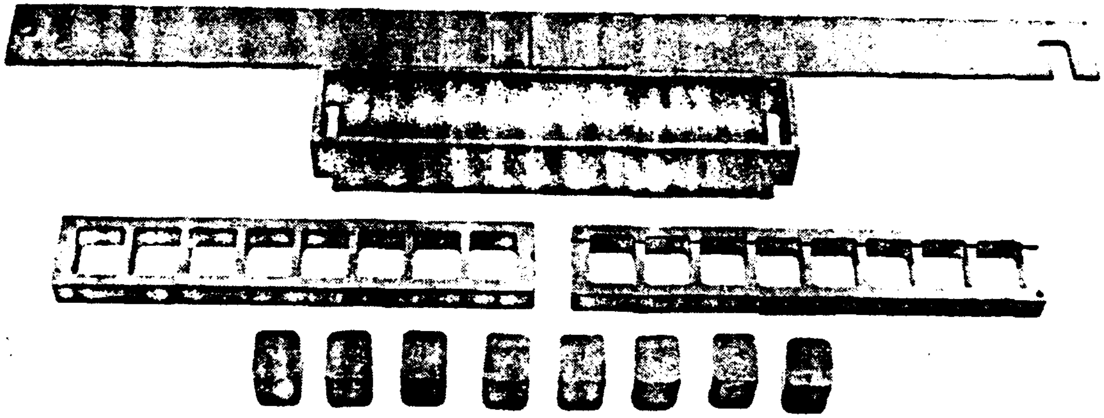


Figure 8 Photograph of Eight Bin Ultra High Purity Graphite Epitaxial Boat.

Figure 9 Sequence of Operations for Liquid Phase Epitaxial Synthesis.

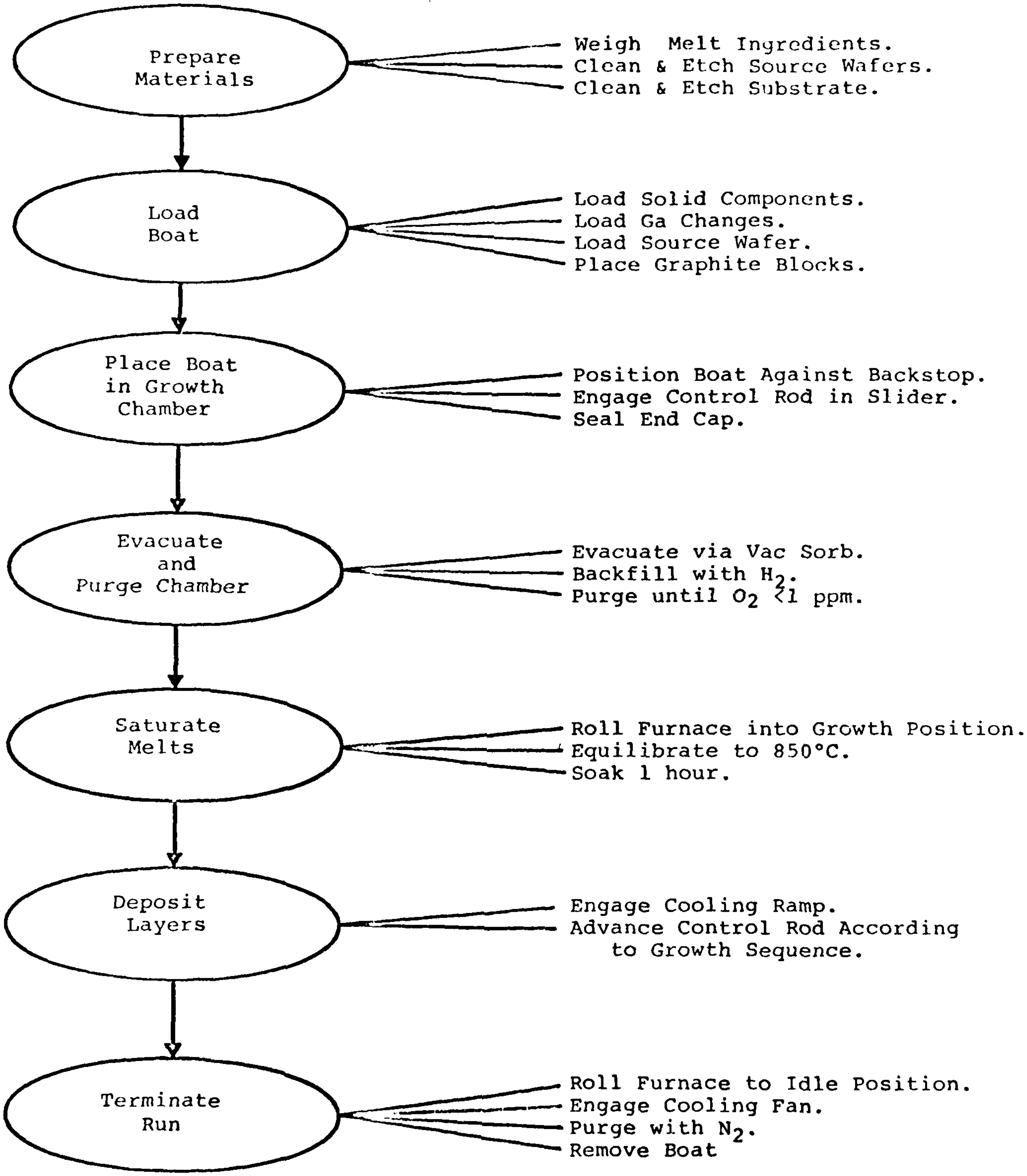


Table 2

Melt Compositions for Double Heterojunction Epitaxial Synthesis.

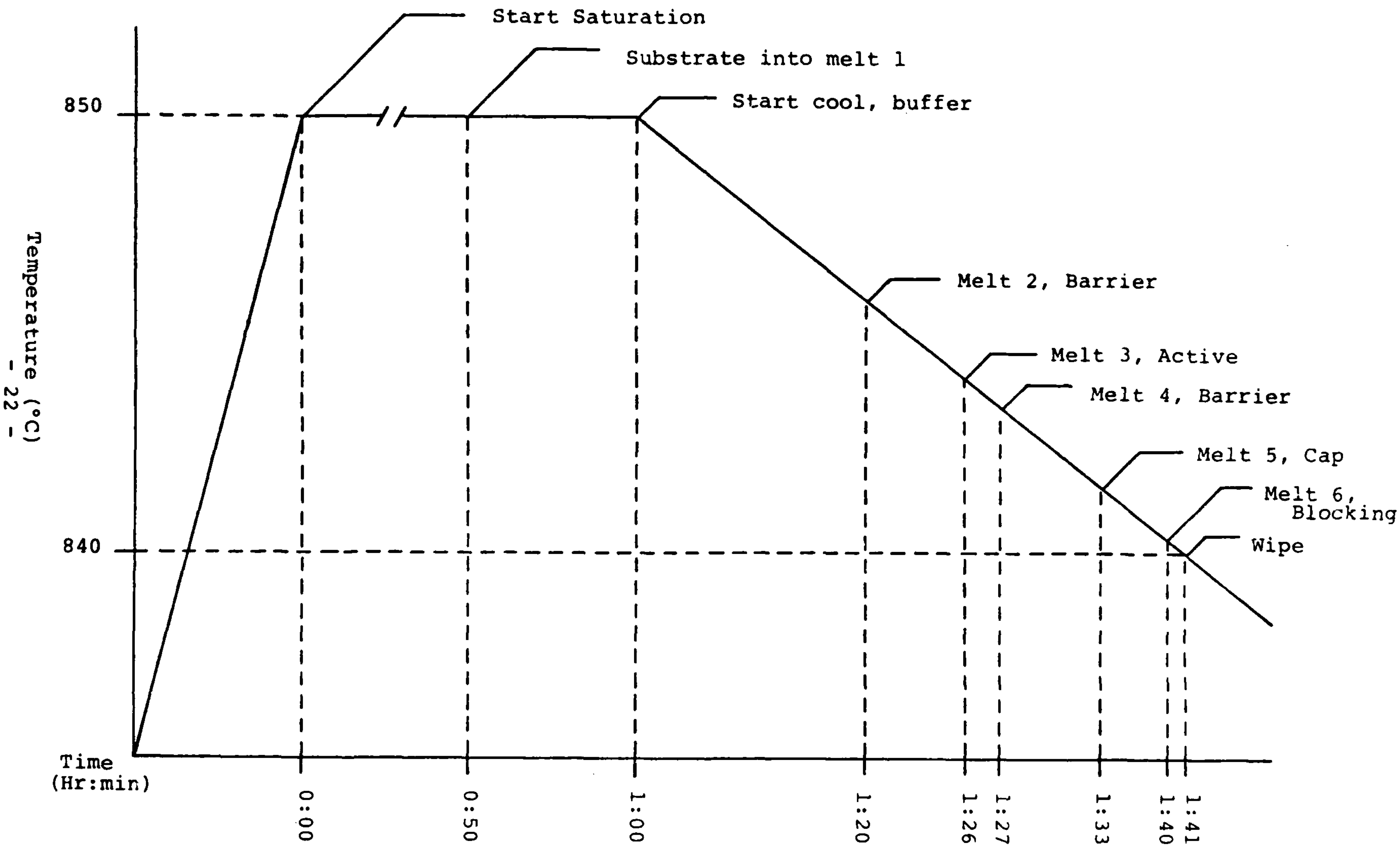
Layer	*GaAs	Ga	Al	Te	Si	Ge
1	0.6K	5.0K	-	1.0	-	-
2	0.6K	5.0K	6.0	1.0	-	-
3	0.6K	5.0K	1.0	-	15.0	-
4	0.6K	5.0K	6.0	-	-	0.1K
5	0.6K	5.0K	0.2	-	-	0.5K
6	0.6K	5.0K	-	-	-	-

* Polycrystalline source wafers.

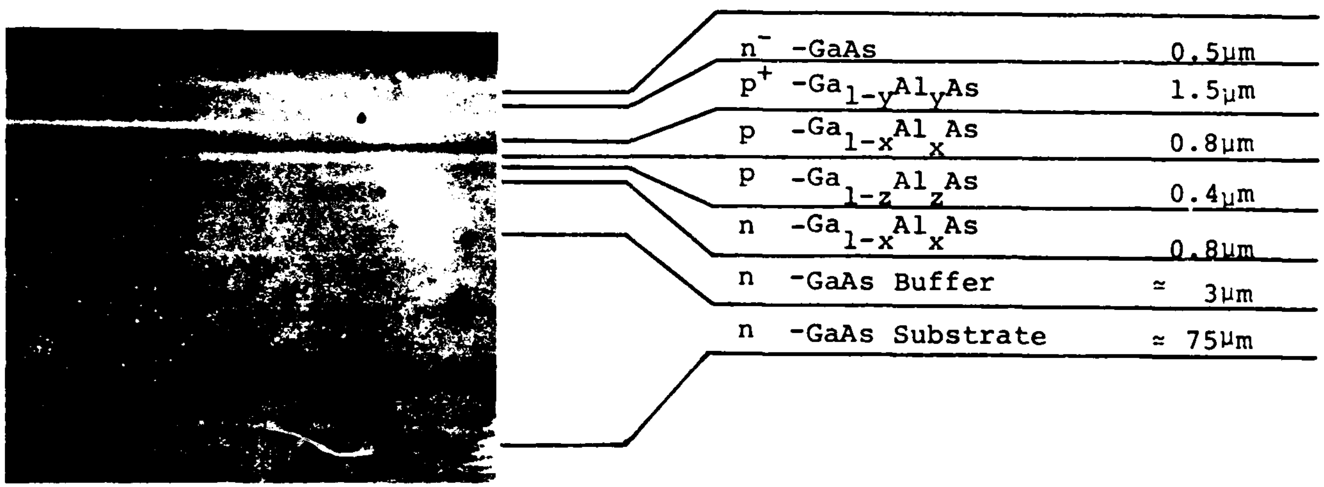
** Weights in mg.

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 need for careful preweighing of GaAs for each melt. In addition, higher quality layers and increased run to run layer thickness reproduceability have been achieved with this technique. Once saturation has been achieved, epitaxial synthesis procedes accoring to the time temperature program shown in Figure 10. 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 reproduceably controlled using this technique. A cleaved and etched cross section of a typical wafer synthesized for use in the fabrication of the monolithic triple geometry laser diodes is shown in Figure 11. In addition to the excellent dimensional and compositional uniformity of the layers, the surface

Temperature program used in the liquid phase epitaxial growth of double heterojunction structures for monolithic stripe geometry laser diodes.



Photograph of typical double heterojunction structure required for the manufacture of monolithic stripe geometry injection laser diodes.



morphology of the heteroepitaxial wafer is characterized by freedom from pit type defects and exhibits a high degree of flatness compatible with the photolithographic processing steps required for the application of stripe geometry to the wafer surface. Photomicrographs of the surface are shown in Figure 12.

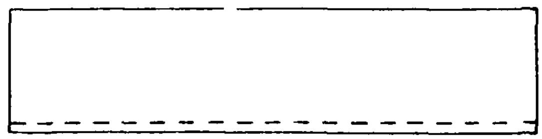
3.1.2 Wafer Processing for Monolithic Triple Stripe Geometry Module Fabrication.

Following liquid phase epitaxial synthesis, the wafer must be processed into individual triple stripe geometry modules. The processing steps required for the fabrication of the modules, are illustrated schematically in the process flow chart, Figure 13. After epitaxial synthesis of the multiheterojunction structure, the wafer undergoes a preprocess cleaning to remove residual Ga from the surface, Figure 13 (a). Approximately .050" of material is cleaved from all four edges creating mutually perpendicular <110> reference planes to be used for channel stripe alignment. The proper <110> alignment plane must be identified prior to epitaxial growth since a V-shaped channel cross section is desired. This is normally accomplished by defining channels on a sample substrate and observing the channels' cross section. Once identification of the $\langle 1\bar{1}0 \rangle$ has been accomplished, the proper alignment plane is known for all substrates cut from a given ingot.

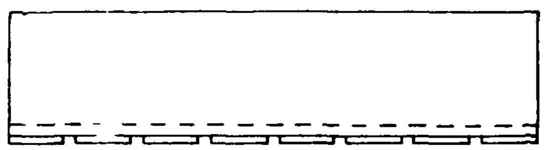
Photolithographic definition of the stripe contact

Figure 12 Surface Morphology of the As-Grown Hetero-epitaxial Wafer.

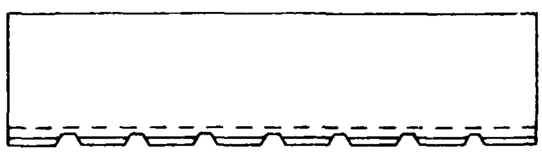
Process flow diagram for the fabrication of monolithic stripe geometry injection laser arrays.



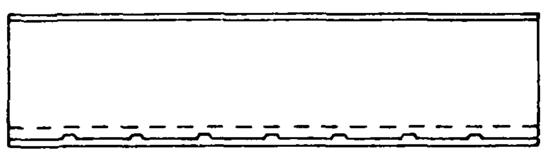
a) Preprocess clean. Wafer edges cleaved along <110> to permit mask registration.



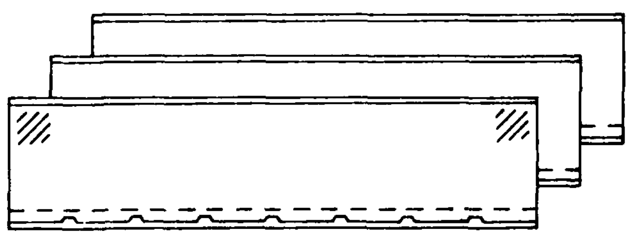
b) Photolithographic definition of stripe geometry contact channels.



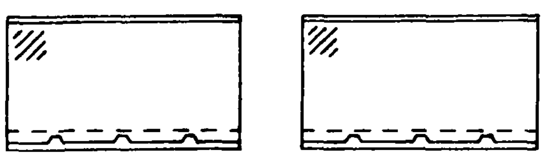
c) Etch through blocking layer to form stripe contact channels.



d) Remove resist, thin wafer to .0035". Evaporate ohmic Sn contact on n-side. Ni-Au plate wafer.



e) Cleave wafer into .010" X .300" slivers. HR and AR coat.



f) Scribe wafer into .0165" discrete triple element modules.

channels is accomplished by aligning the mask reference with the proper <110> direction as indicated schematically in Figure 13 (b).

Photolithographic definition is followed by a 3:1:1, Methanol:Phosphoric: Hydrogen Peroxide etch which removes the n-GaAs blocking layer forming an array of etched 20 μm wide contact channels in the p-GaAlAs contact cap. Parallel contact channels are spaced on .005" centers over the entire surface of the epitaxial wafer as shown in Figure 13 (c).

After removal of the masking resist, the epitaxial wafer is thinned to .0035" and Sn ohmic contacts are evaporated over the n-side of the thinned wafer, Figure 13 (d).

Ni-Au electroplated contacts are applied to both sides of the wafer forming ohmic contact to the exposed p-GaAlAs contact cap in the stripe channels.

Mirror facets are formed by cleaving the epitaxial wafer in the slivers approximately .010" by .300" as indicated schematically in Figure 13 (e).

Cleaving is accomplished with the aid of a diamond scribing apparatus shown in the photograph of Figure 14. The cavity length is accurately and reproduceably controlled by the micro-index control on the vacuum chuck of the scriber.

Reflective coating of the back facet of each sliver is accomplished by vacuum deposition of successive films of SiO (2000Å), Cr (50Å), Au (4000Å), Cr (100Å), and

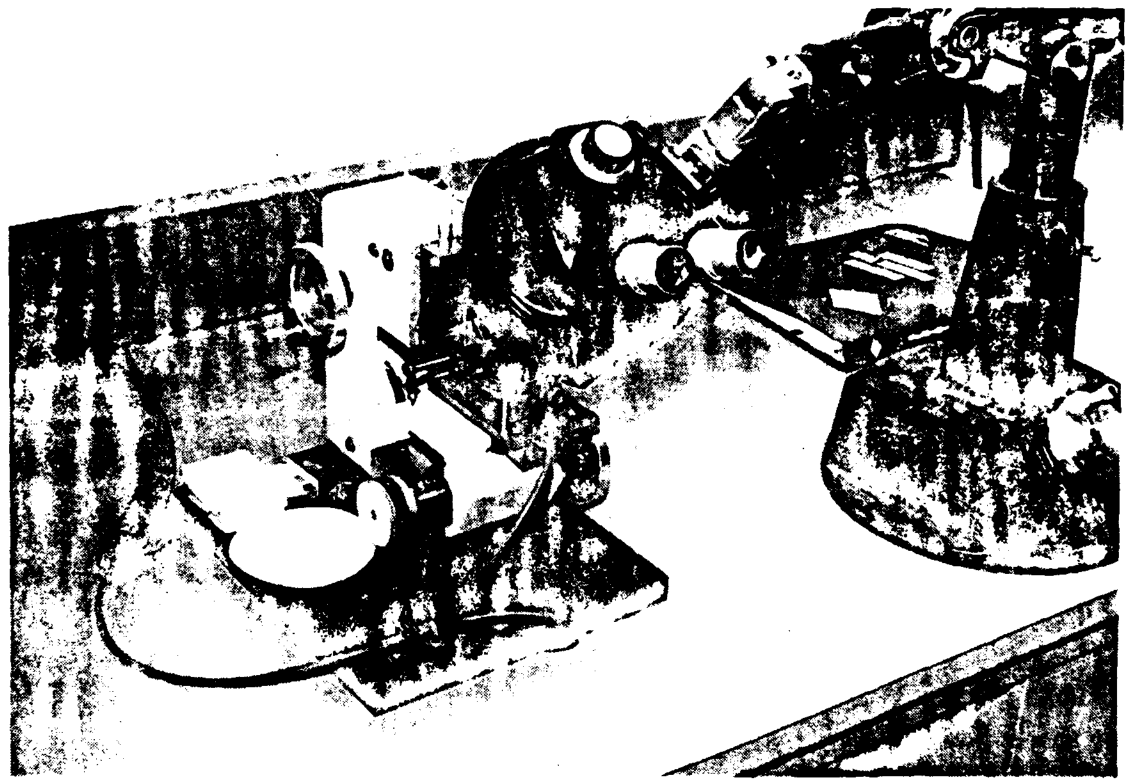


Figure 14 Scribing Apparatus for Cleaving Epitaxial Wafer into Slivers.

SiO (300Å).

Finally, in Figure 13 (f), the individual slivers are cut on .025" centers with a ganged wire saw having a .0035" kerf.

Figure 15 shows an epitaxial wafer to which triple stripe geometry contacts have been applied. Figure 16 shows individual modules after they have been cleaved, coated, and cut to size ready for assembly onto the pill package.

3.2 Packaging Technology.

3.2.1 Package Design.

During the first quarter of the program, finalization of the package design and procurement of pill package blanks for fabrication of the first engineering samples was carried out. The pill package blank consists of a brass negative electrode, an Al_2O_3 ceramic spacer, and an OFHC copper positive electrode which serves as the primary heat sink for the monolithic triple stripe geometry injection laser diode module. These three major components are bonded together through the use of a high temperature alloying technique and are purchased from the supplier as a complete assembly. Engineering drawings for the piece parts are given in Figures 17 , 18 , and 19 . In addition to the package blank, the optical window along with its epoxy preform for attachment make up the remainder of the package parts. Parts drawings for these two components

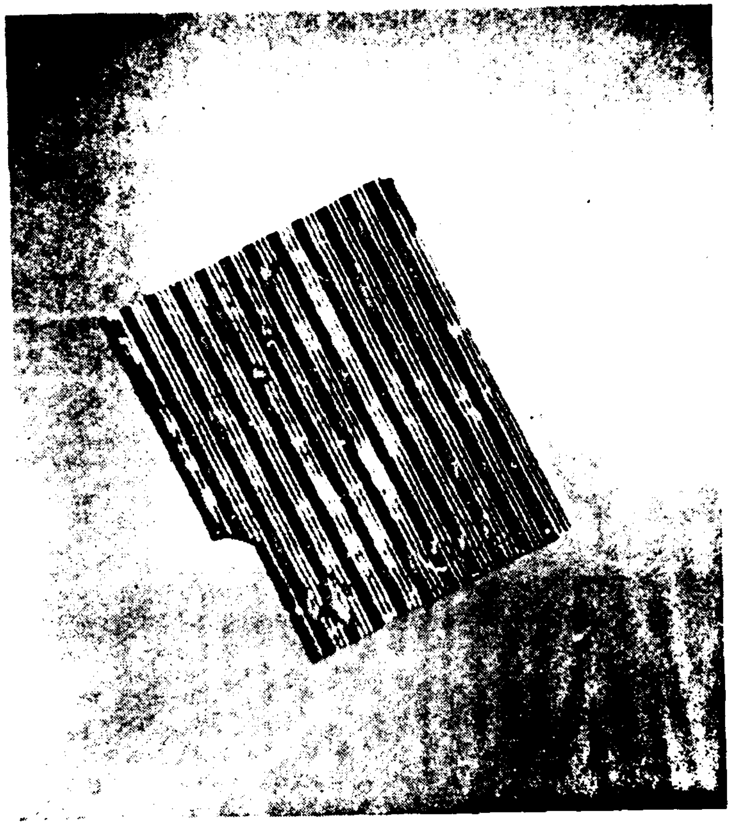


Figure 15 Photograph of Triple Stripe Geometry Applied to Surface of an Epitaxial Wafer.

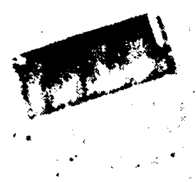


Figure 16 Photograph of Individual Triple Element Modules.

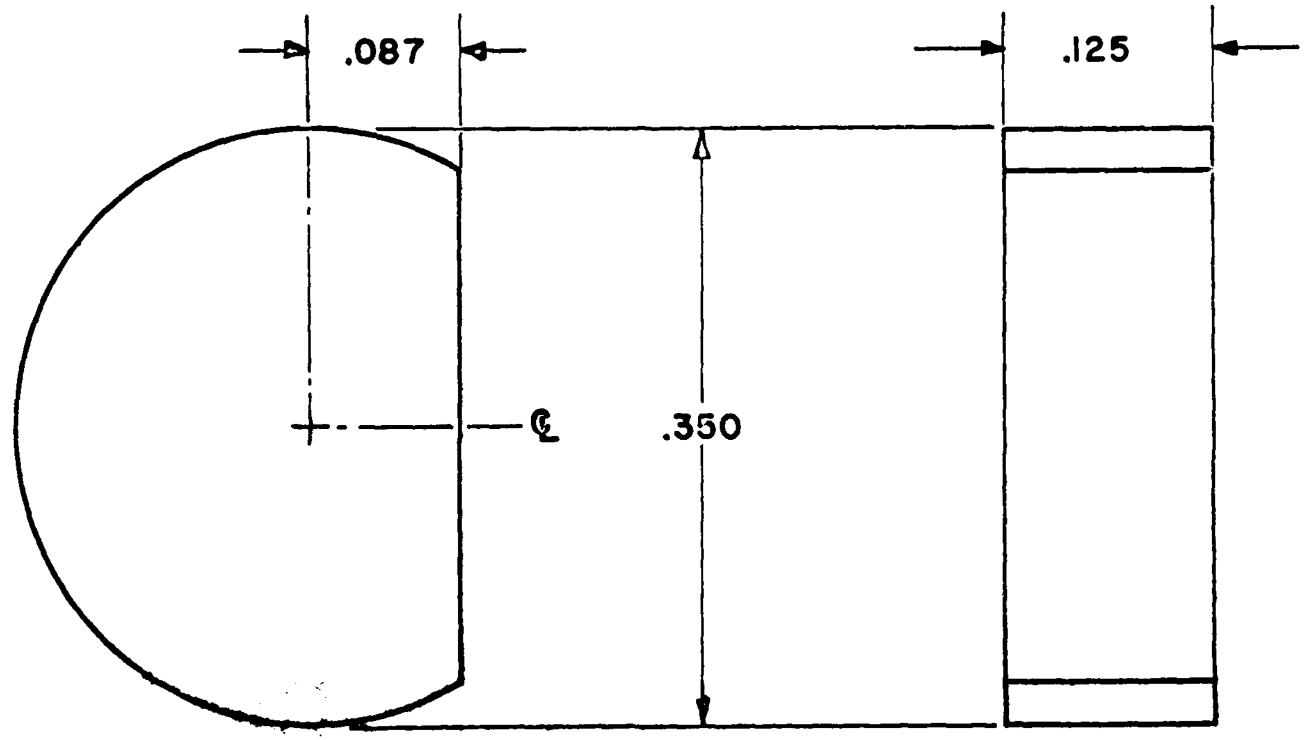


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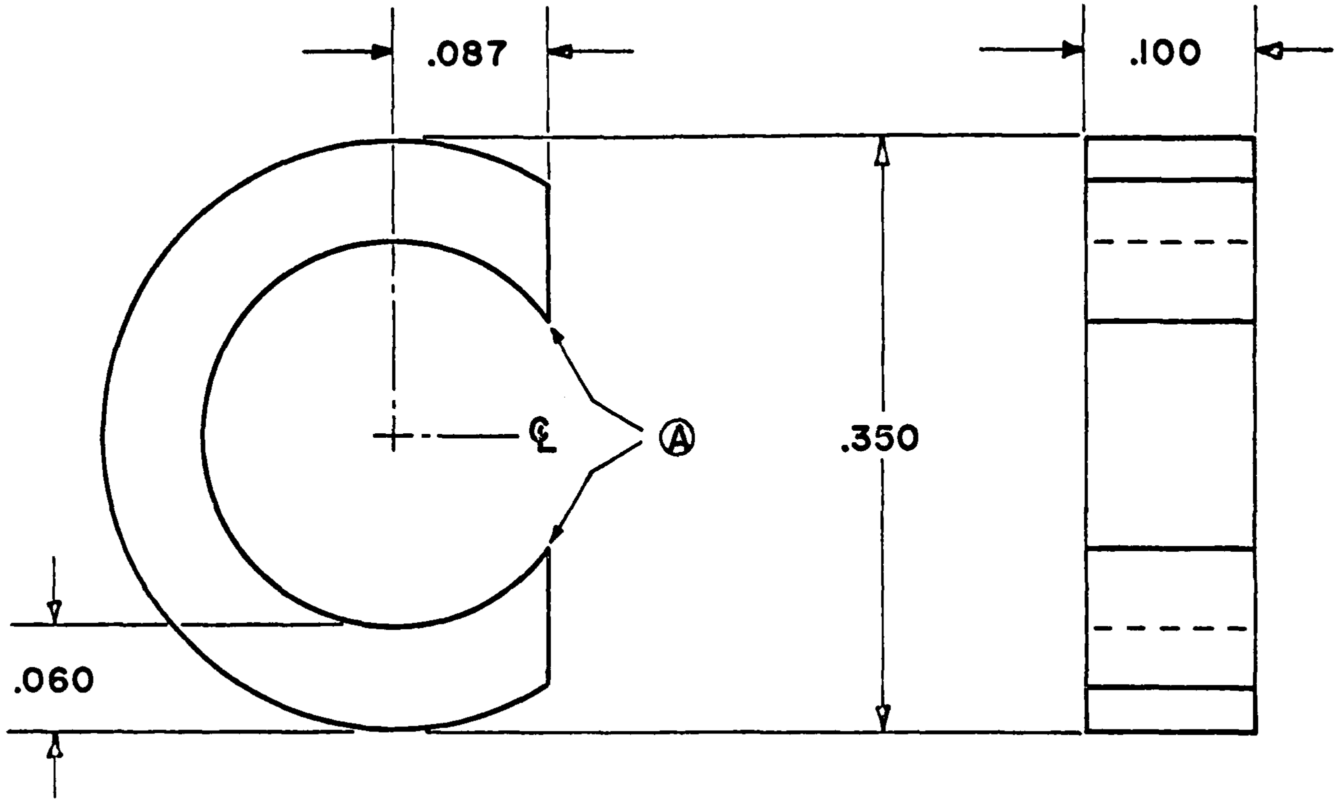
Figure 17 Pill Package - Mounting Base (Positive Electrode)



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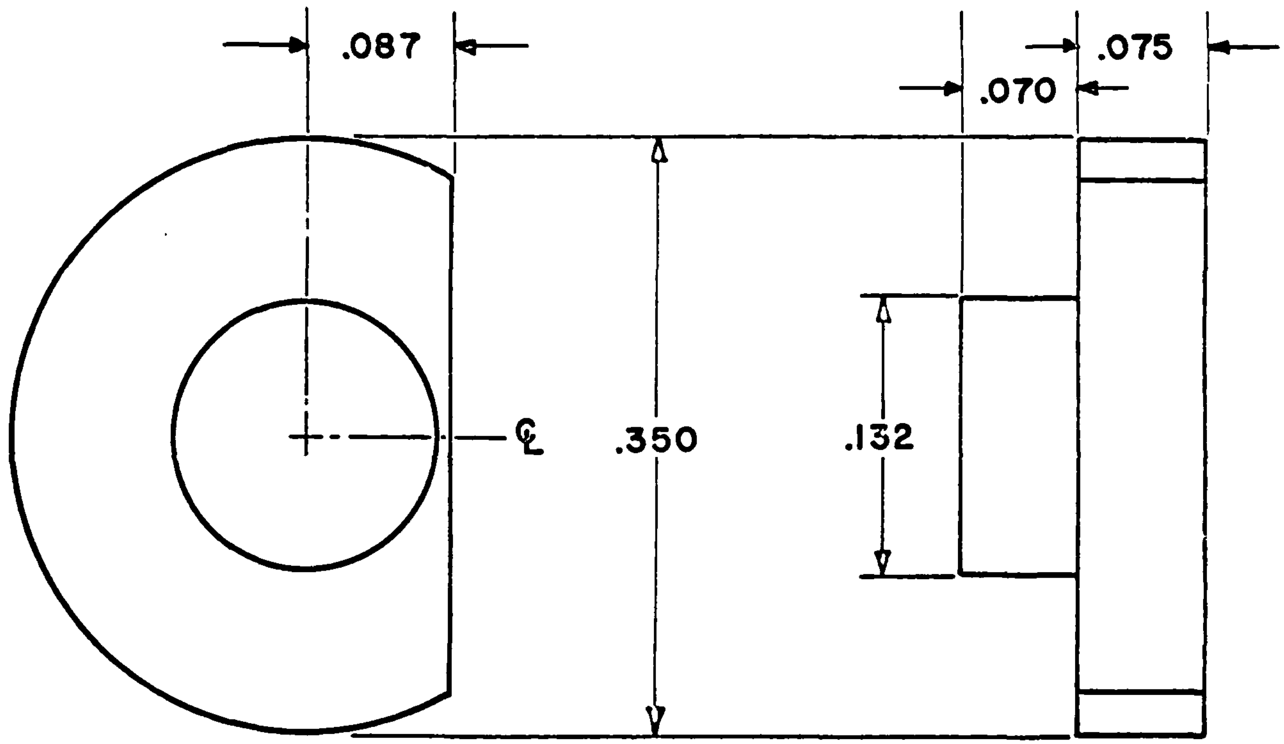
LDT-100C		
		DRAWING NUMBER

Figure 18 Pill Package - Spacer (Ceramic Insulator)

DIETZGEN NO 196MP ACEPROOF "MASTER FORM"



MATERIAL - BRASS

TOLERANCE: ±.002

PILL PACKAGE TOP ELECTRODE		
SCALE: 10X DATE: 9-17-76	APPROVED BY	DRAWN BY M.R.
LDT-180		
		DRAWING NUMBER

Figure 19 Pill Package - Cover Plate (Negative Electrode)

are shown in Figures 20 and 21 and photographs of the window and preform are shown in Figure 22 (a) and (b). The epoxy utilized in this assembly is Ablestik type 539 and is supplied as a stamped preform. Type 539 consists of a non-frozen epoxy applied to both sides of a thin mylar film carrier. Preforms of this type are available in 0.0005" increments up to 0.003" thick. The epoxy is tack free prior to curing and can be stored at 25°C for an indefinite period of time. Curing is accomplished by heating to 110°C for two hours and results in an extremely uniform bond line with a shear strength of 3000 psi. Because extremely thin films of epoxy are applied to the mylar carrier, deformation of the preform during cure is minimized. This feature together with the inherent uniformity of the mylar film carrier makes this an ideal material for the attachment of the optical window to the laser diode pill package.

In a parallel effort, the use of a similar mylar preform as an electrical insulator to be employed in place of the ceramic was actively being investigated. Several advantages to using epoxy preforms for this application have become evident to date. In order to obtain a perfectly flat mounting surface for the 0.004" thick optical window, the front face of the pill package blank must be lapped prior to use. The presence of the ceramic insulator introduces some degree of difficulty in this step owing to the difference in hardness between

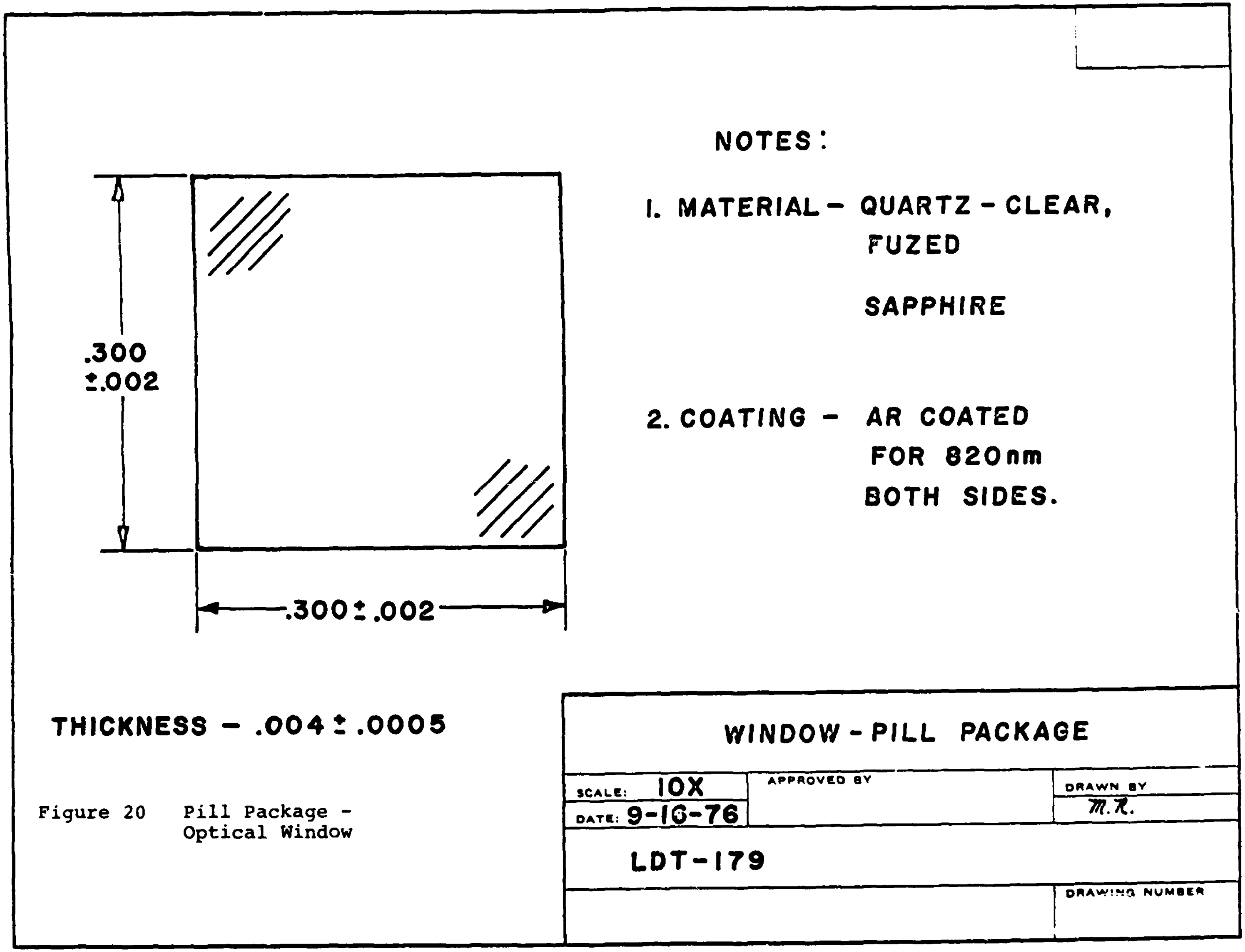
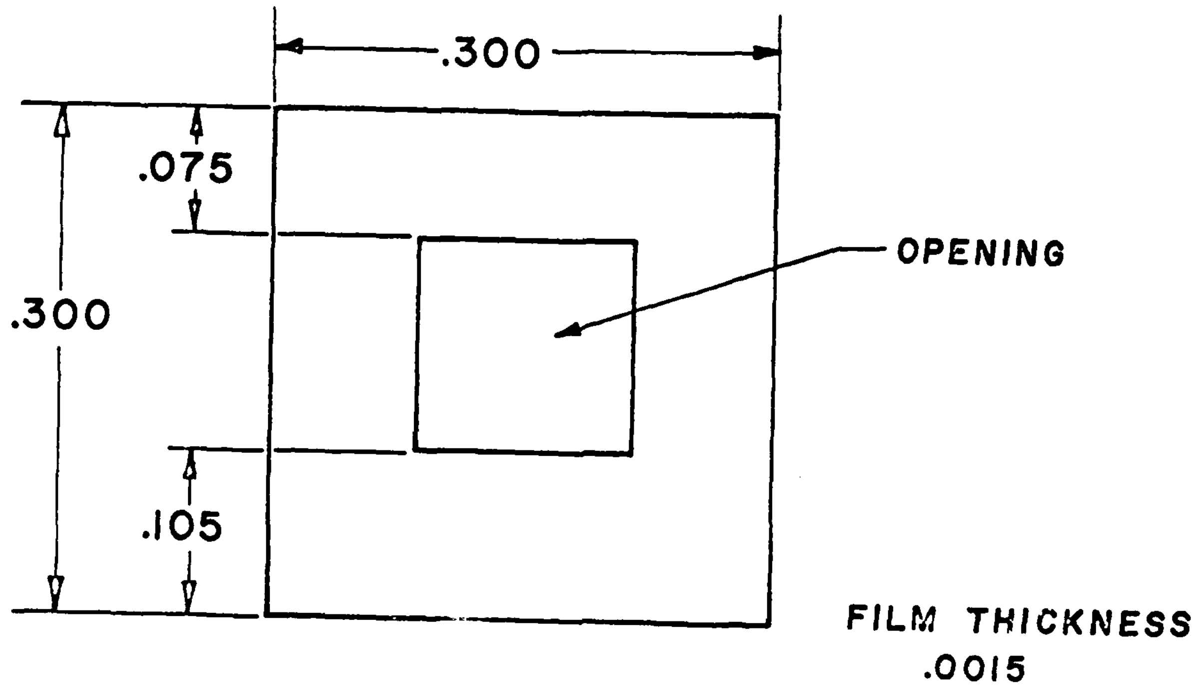


Figure 20 Pill Package - Optical Window



MATERIAL - ABLESTIK
ABLEFILM 539 - TYPE I

Figure 21 Pill Package - Epoxy Preform

PILL PACKAGE — EPOXY PREFORM

SCALE: 10X DATE: 9-1-76	APPROVED BY	DRAWN BY M.R.
LDT-179		
		DRAWING NUMBER

DIETZGEN NO 190MF AGEPROOF MASTER FORM

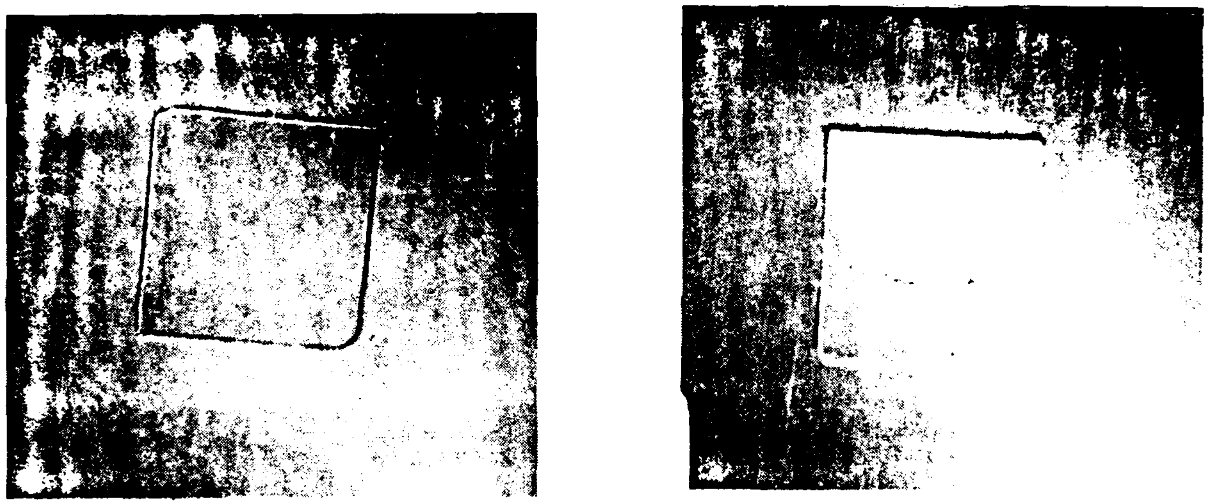
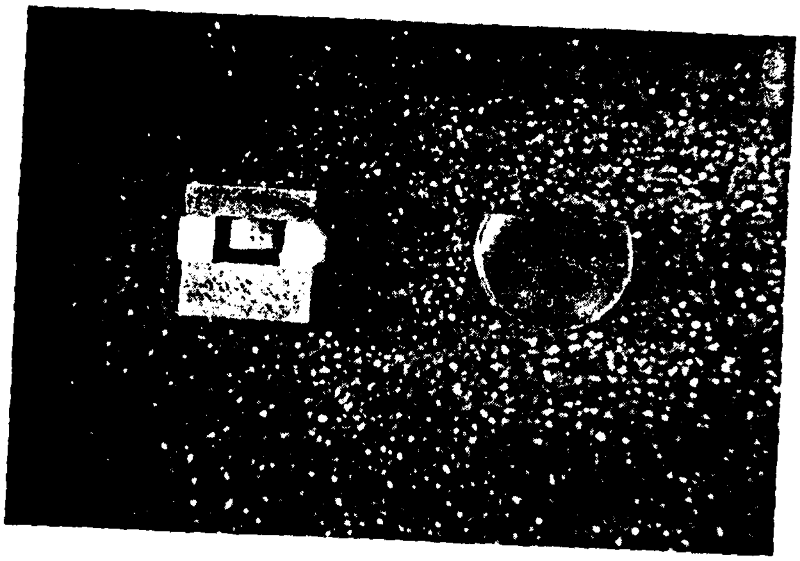


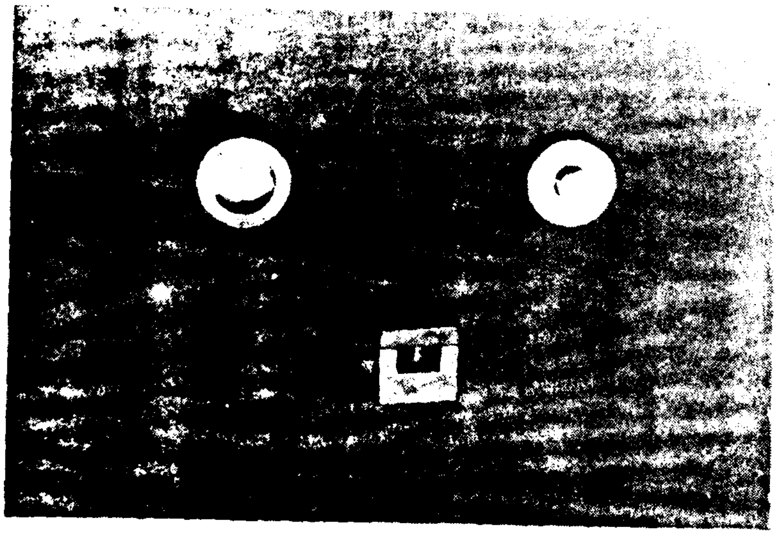
Figure 22   Photograph of Optical Window and Epoxy Preform.

Al_2O_3 and copper. Although perfectly flat mounting faces can be obtained, the lapping must be done carefully to prevent rounding. When the blank is designed for use with an epoxy-mylar insulator, the lapping accomplished with much less difficulty and with a minimum of material removal. In addition, the copper-mylar blank is about one third as costly as its copper ceramic counterpart. Photographs of both types of pill package blanks are shown in Figure 23 (a) and (b).

Experiments have been performed and indicate that packages assembled from all metal parts, with the epoxy preform, can be machined and lapped to provide a smooth surface for window attachment. With this smooth surface, it has been possible to attach the window with a low viscosity UV curing epoxy which allows for a thin epoxy layer on the order of a half mil thickness. This method is preferred to the preform method of window attachment as it provides effective sealing of the window without pressure and temperature, and a cure time of only 15 seconds.



a. Cu-Ceramic Blank. (2.5x)



b. Cu-Mylar Blank. (1.5x)

Figure 23 Pill Package Blanks

3.2.2 ASSEMBLY TECHNIQUES

A blow-up of the basic laser diode pill package is illustrated in Figure 24. The parts are assembled by aligning the upper and lower copper parts with the preform in between, applying moderate pressure to the parts while curing at 110°C for 2 hours. In practice a number of units are assembled and placed in a "vee" shaped fixture which serves to keep the parts aligned while pressure is applied. The fixture is shown in Figure 25. After curing of the epoxy preform, the package is machined to provide the flat window surface as shown in Figure ' . To complete the surface finish for window attachment the machined packages are placed in a rubber pad, such that the flat surface can be placed in contact with a lapping plate. The rubber pad is shown in Figure 27 and the lapping machine in Figure 28 . When the texture of the flat window surface change to a mat finish, the lapping is complete. The pill package blanks are individually inspected and then electroless nickel and gold plated. Next a 2 mil gold fly wire is soldered to the upper electrode center post with 60/40 pb/Sn solder. The mounting area on the bottom electrode is tinned with Indium, the diode chip placed just back of the edge and

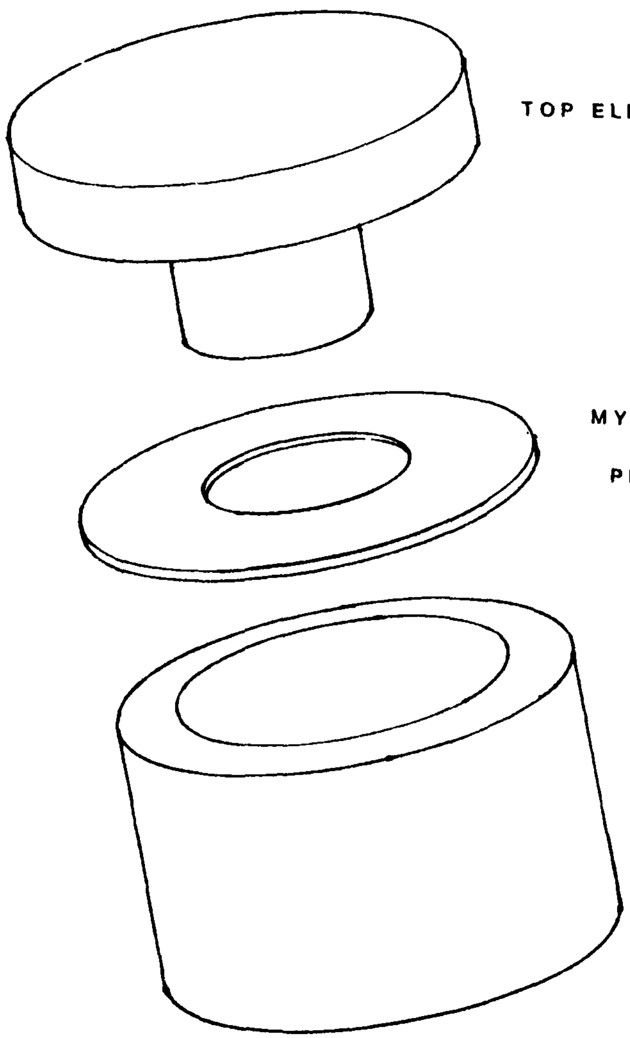


Figure 24 - PILL PACKAGE COMPONENTS

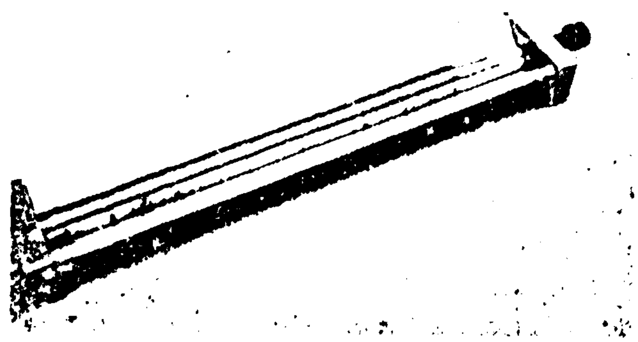


Figure 25- Bonding Fixture with Packages
Clamped for Bonding.

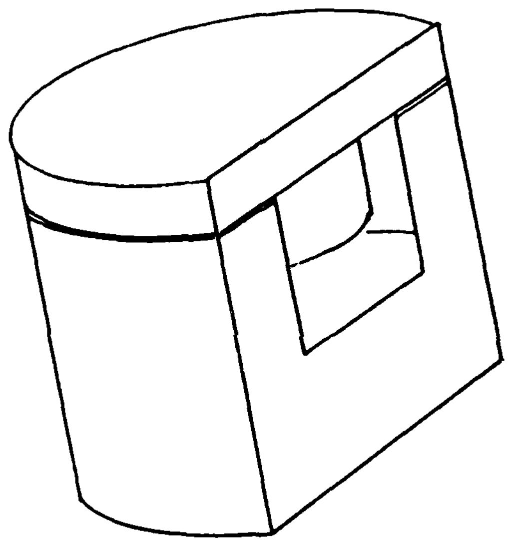


Figure 26.

PILL PACKAGE ASSEMBLED AND MILLED

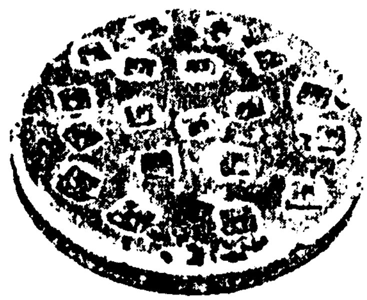


Figure 27.

Rubber Lapping Pad.

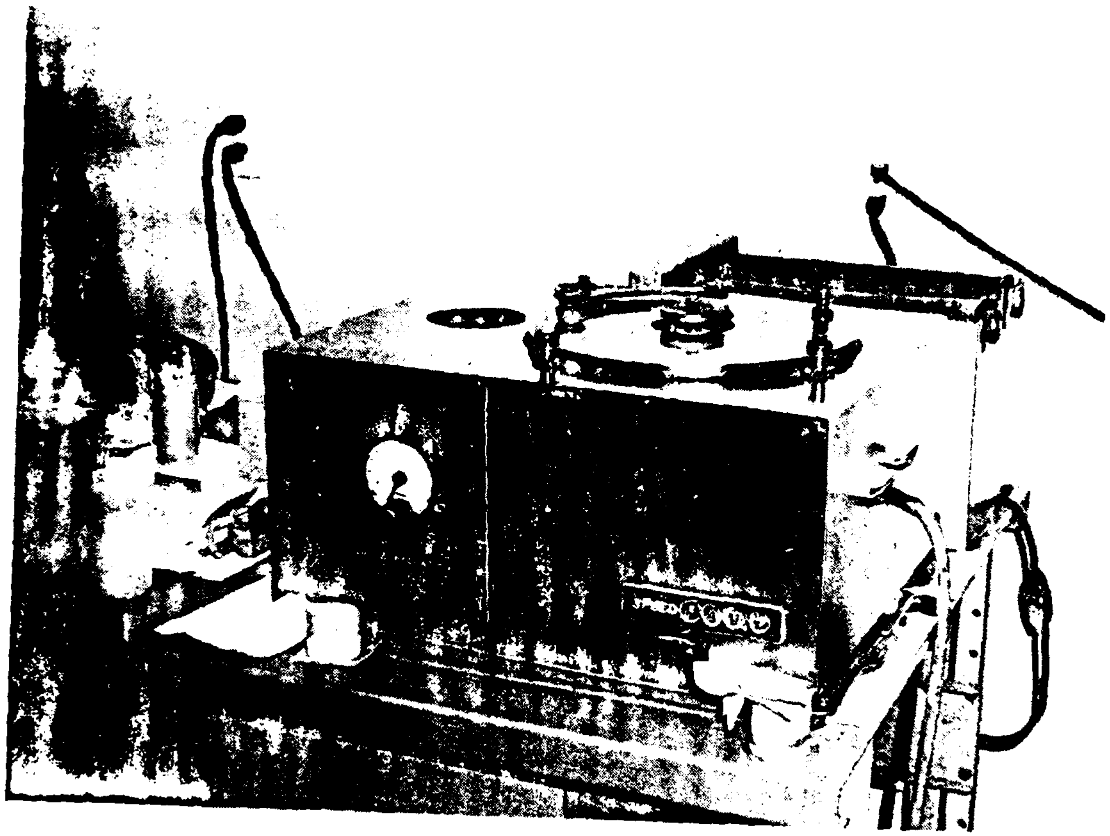


Figure 28 - Photograph of Lapping Apparatus used to Obtain Flat Window Mating Face.

soldered in place. An Indium preform is placed on top of the chip and the free end of the wire of the top electrode shaped to press into the preform. The assembly is reheated to the Indium melting point allowing the preform to melt and make connection to the top of the chip. The P-side of the chip is soldered to the bottom electrode. All the above soldering is performed on a carbon strip type heater. The packaged laser can be tested amd burned in at this point in the assembly. After testing, the window is attached to the package by placing a thin bead of UV epoxy near the outer edge of the flat surface, placing the window on the bead and applying light pressure to the window to cause the epoxy to spread over the flat mounting surface. The epoxy can be observed to spread through the window and can be controlled so as not to flow onto the laser face. After a 2 second cure under a UV lamp, excess epoxy that has flowed around the outside of the package is removed with a solvent. A final cure of 15 seconds secures and seals the window. The window attachment sequence is carried out in a nitrogen dry box to minimize moisture content within the sealed package. The flow chart in Figure 29 shows the sequential steps in the package assembly and diode mounting. The final package configuration is shown in Figure 30 .

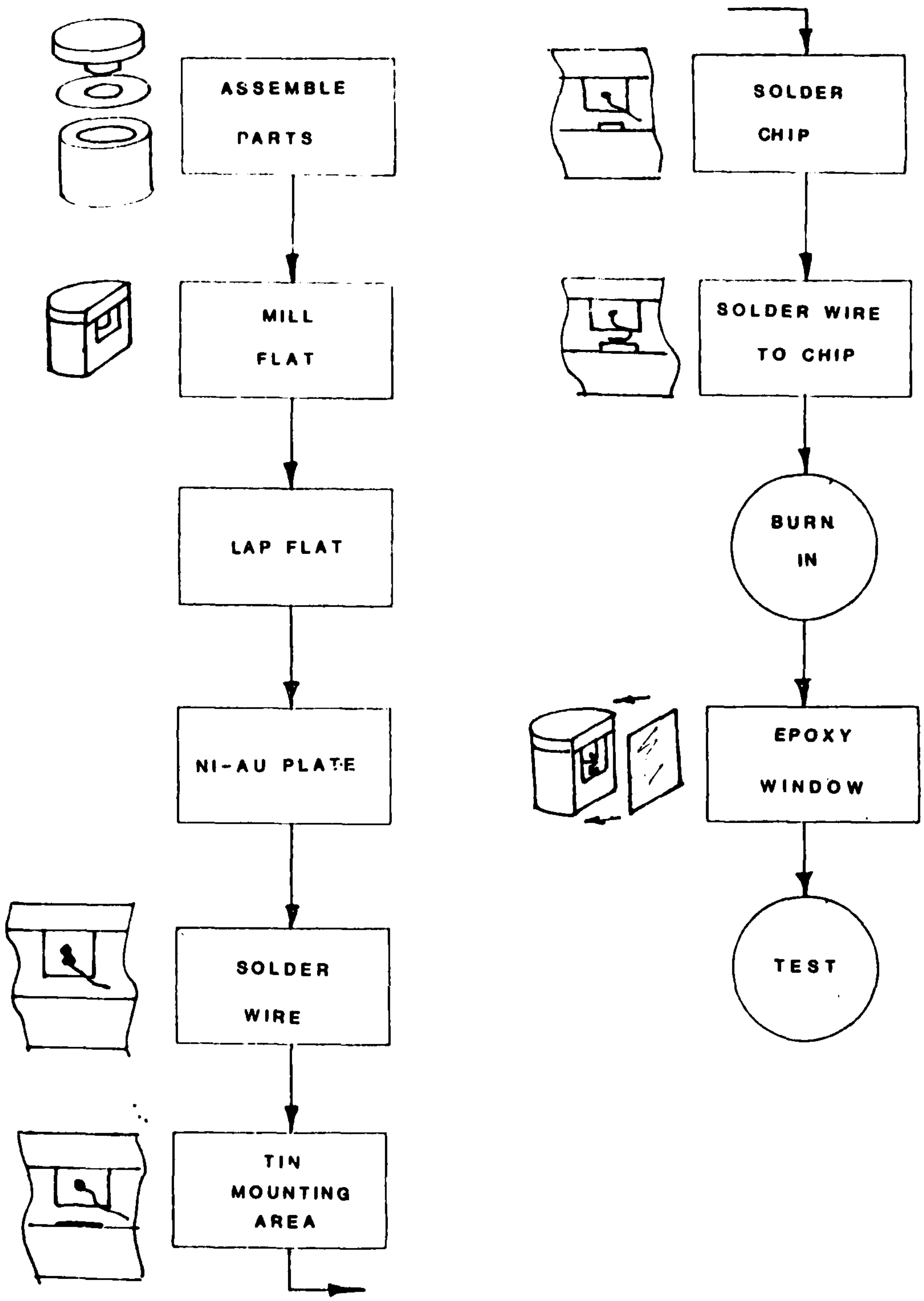


Figure 29 -

PILL PACKAGE-LASER ASSEMBLY FLOW CHART

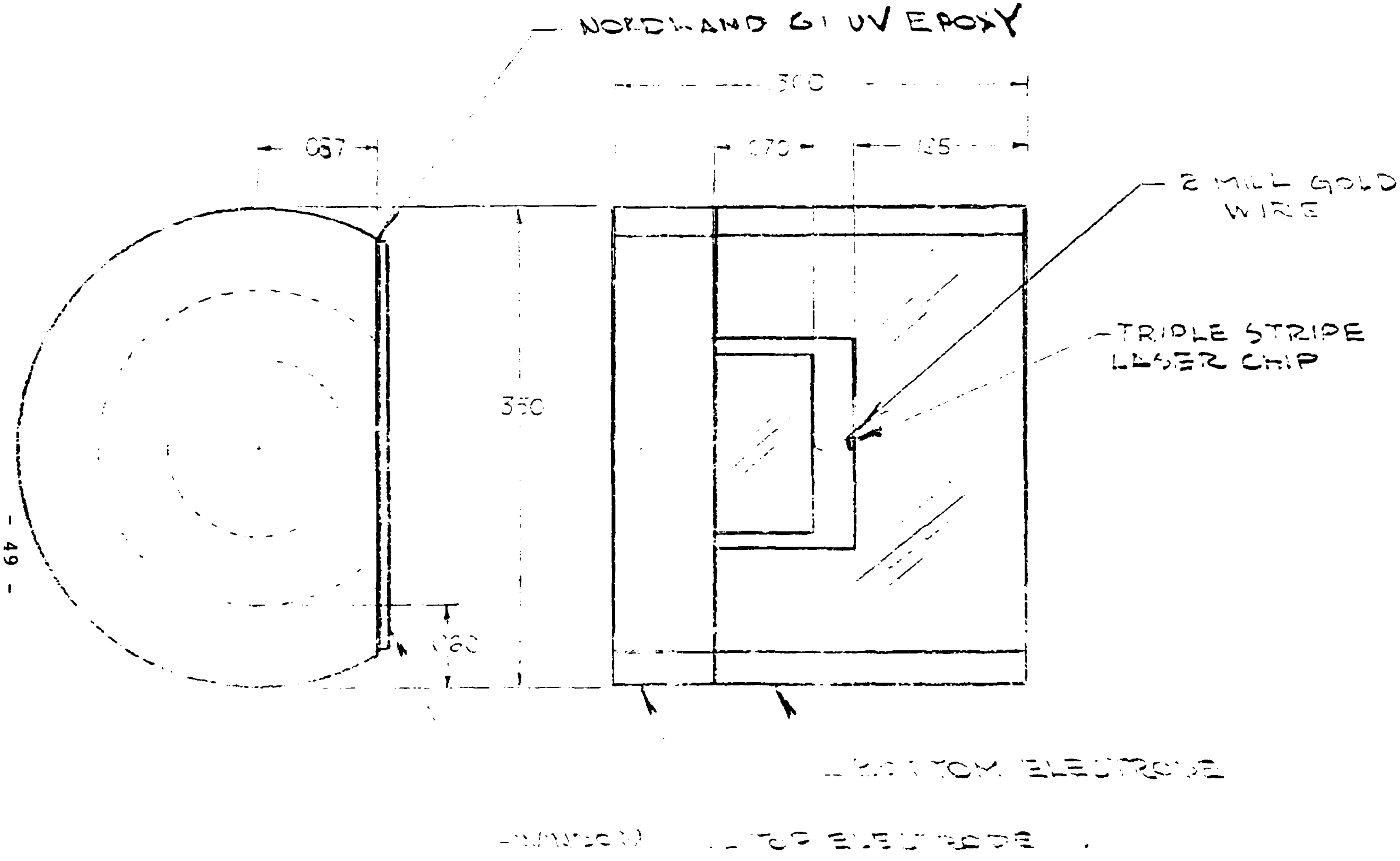


Figure 30 - Completed Package Configuration

3.3 DEVICE EVALUATION AND TESTING

3.3.1 TEST EQUIPMENT

A 10 MHZ pulser capable of delivering drive currents up to 3.0 amperes at a duty factor of 10%, forms the basis for all the electro-optical measurements carried out on the devices. The circuit schematic is shown in Figure 31. The driver consists of two microwave transistors, CD1194 and CD1979, which are cascaded for high current gain. The pulser is triggered with a positive pulse or high logic level at the base of CD1194 through a decoupling capacitor. The diode FD600 is used for protection of the CD1194 from reverse V_{BE} voltages. The current through the laser is controlled by the 50 ohm potentiometer in the emitter circuit of CD1194. The coils in the supply buss are used for high frequency isolation and provide quick recharge speeds for the capacitor in the collector circuits. The pulser test set assembly is shown in Figure 32.

The Burn-In and Life Test Rack uses a different circuit which is shown schematically in Figure 33. The driver consists of two descrete components. A microwave transistor, CTC D3-28 (Q_2), acts as a pre-driver for Siliconix VMOS FET 2N6657 (9_3), which is capable of switching

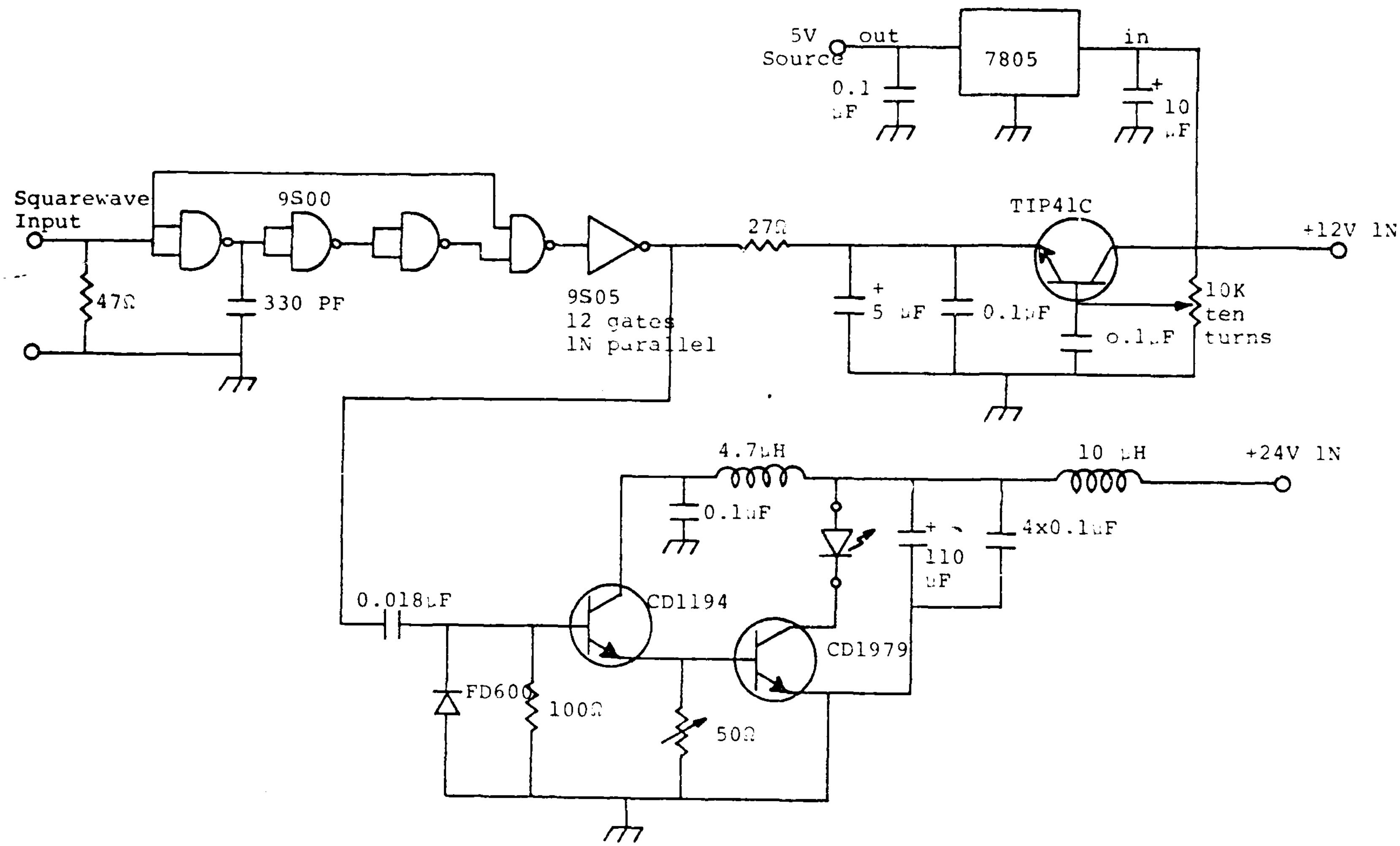


Figure 31. Transistor 10 ns Pulser.

Figure 32 -Transistor Test Pulser Assembly.

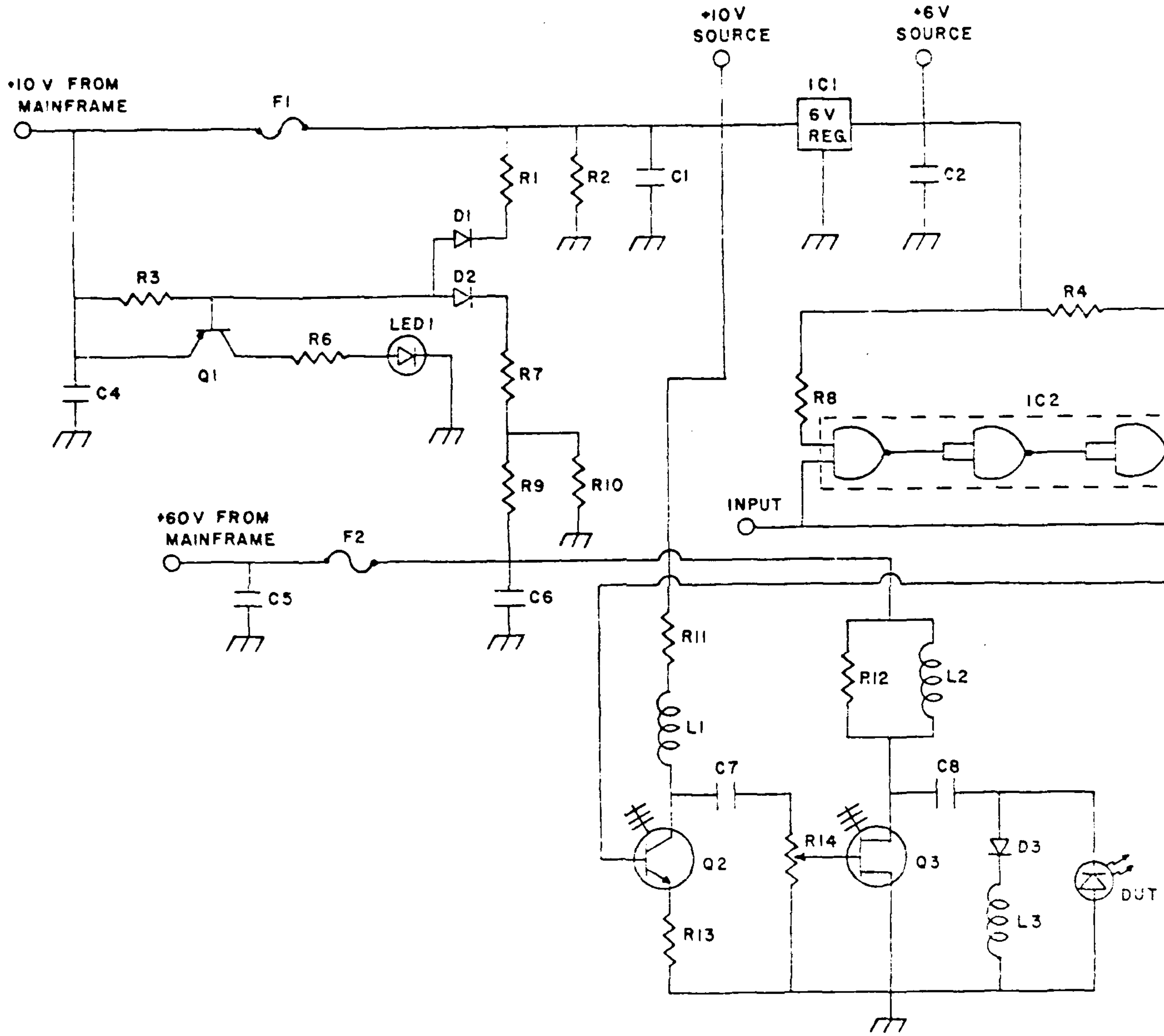
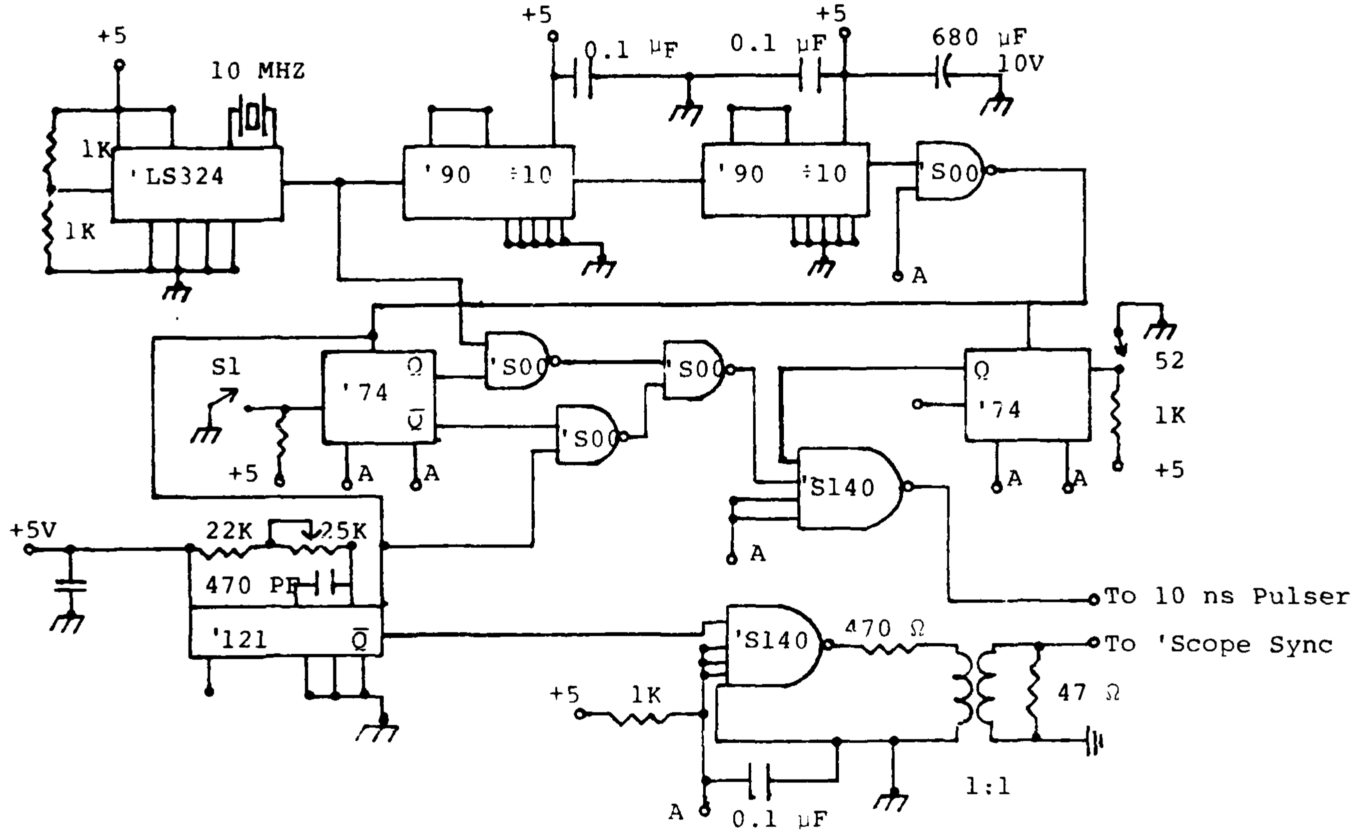


Figure 33 - Revised 10 MHz LLD Driver (Single Position) Circuit Schematic.

in the nano-second range. The circuit is tuned for 10 ns pulse width operation. The input pulse must also have a 10 ns trigger pulse width with a 90% recharge time.

The pulse sequence is started when a high TTL logic level is present at the base of Q_2 turning it "ON". The gate of Q_3 is capacitively switched "OFF" by C7 through R14. The coil L1 begins storing energy from the Collector Current of Q_2. In the drain circuit of Q_3, the coil L2 and capacitor C8 is charging through the 60V supply, diode D8 and Coil L3. The DUT is back biased at this point. After 90% of the cycle, the input logic level goes low and Q_2 turns "OFF". The coil L1 quickly pumps current through C7 which previosuly was discharged and depending on the setting of R14, turns Q_3 "ON". The drain current comes from the DUT through C8 which was charged. The current through L3 is checked by D3. The discharge time of C8 will control the pulse width through the DUT. The sequence begins again when the TTL input goes high.

Figure 34 shows the schematic circuit for the 10 ns clock. Figure 35 is the circuit for a clock buffer for the multi-position rack. A single position board is shown in Figure 36.



Notes:

1. All Caps 0.1 F Unless Otherwise Noted.
2. All Logic 7400 Series TTL.

Figure 34 Clock and Control Circuit for Transistor Pulser.

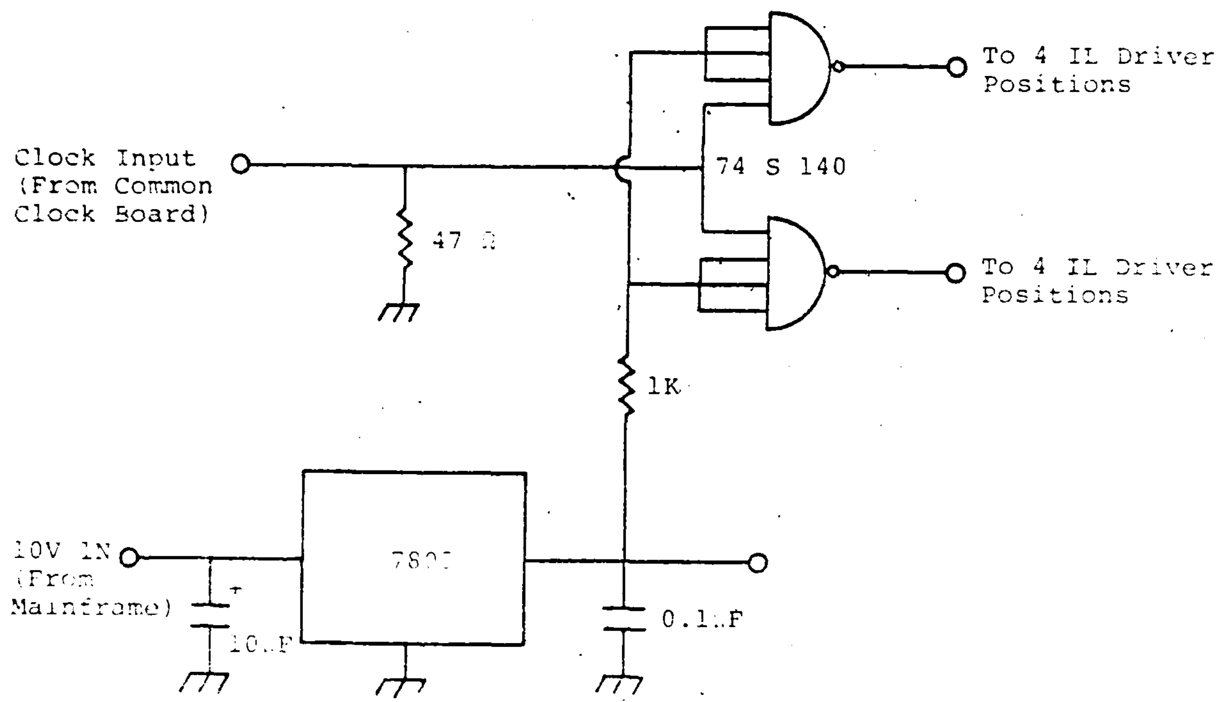


Figure 35, Local Clock Buffer for Burn-In Rack.

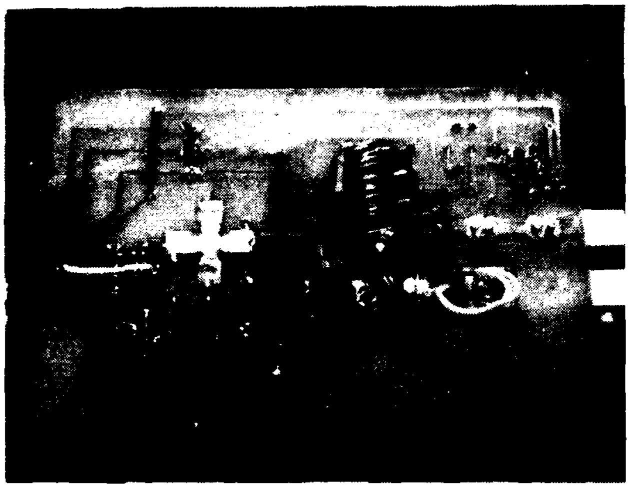


Figure 36 - Burn-In Position Board with Edge Connector Fingers.

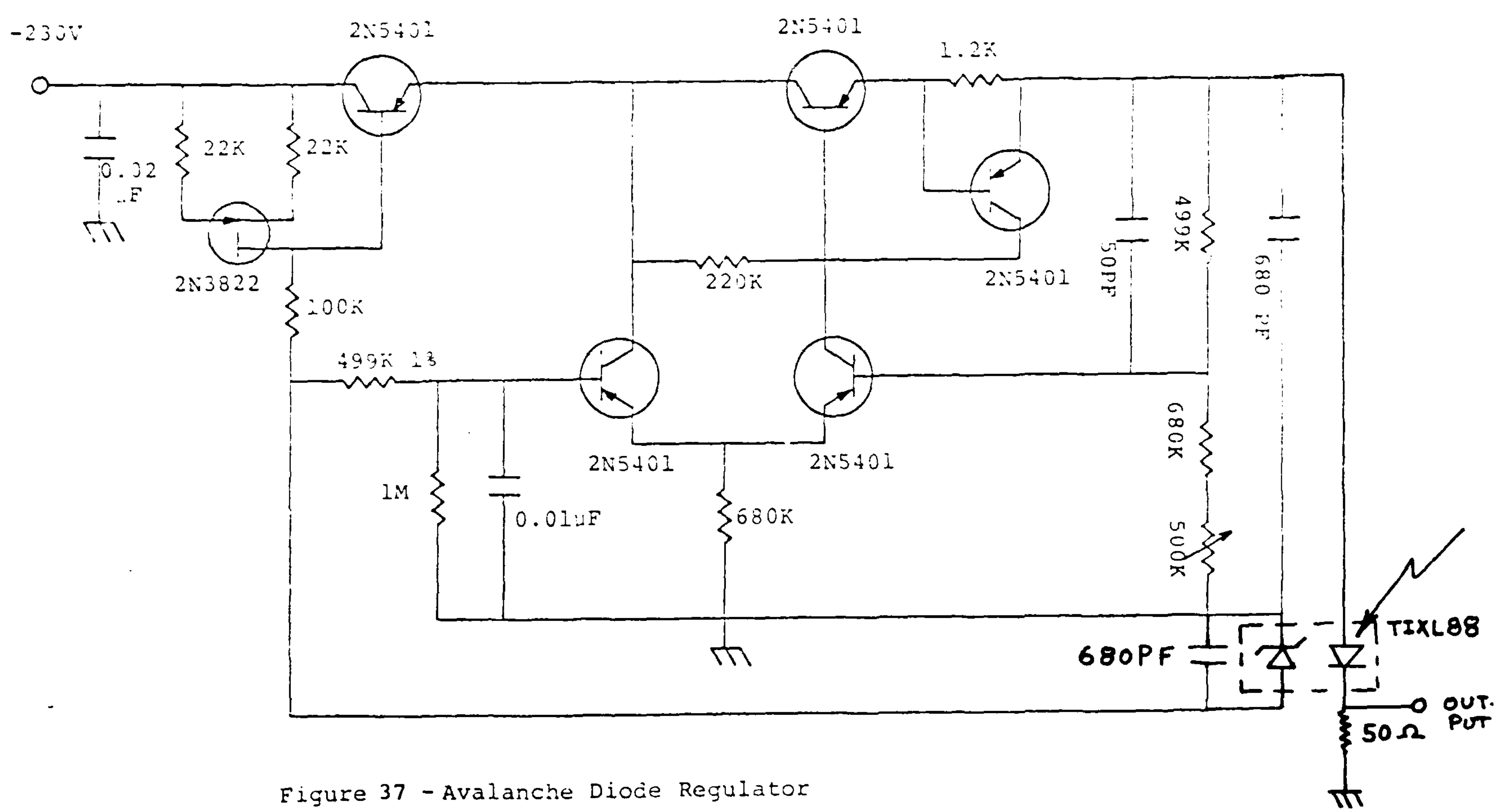


Figure 37 - Avalanche Diode Regulator

The detector circuit shown in Figure 37 is built around a TIXL88 Avalanche Photodiode/Reference Diode pair that have been manufactured to ensure close matching of both the breakdown voltages and temperature coefficients of the two diodes. The APD power Detector System is shown in Figure 38 indicating the essential features of the power supply and detector head. The internal structure of the detector head shown in Figure 39 depicts the layout of the APD and the diffusion film which allows the small active diode area measure a signal proportioned to the power incident upon the 1.09 cm X 0.394 cm aperture as required by SCS-516. Laser light which is incident on the aperture becomes diffused into an approximately lambertian distribution such that the energy in a relatively small angle is proportional to that which is incident upon the aperture. Since the APD's active diameter is 0.762 mm and it is mounted 79 mm from the diffuser, the solid angle subtended is approximately 1.25 degrees and the approximation is much better than the overall precision of the system. The detector box is mounted to the optical rail using standard fixtures including a vertical vernier which permits accurate positioning of the detector. In use, the detector head aperture is

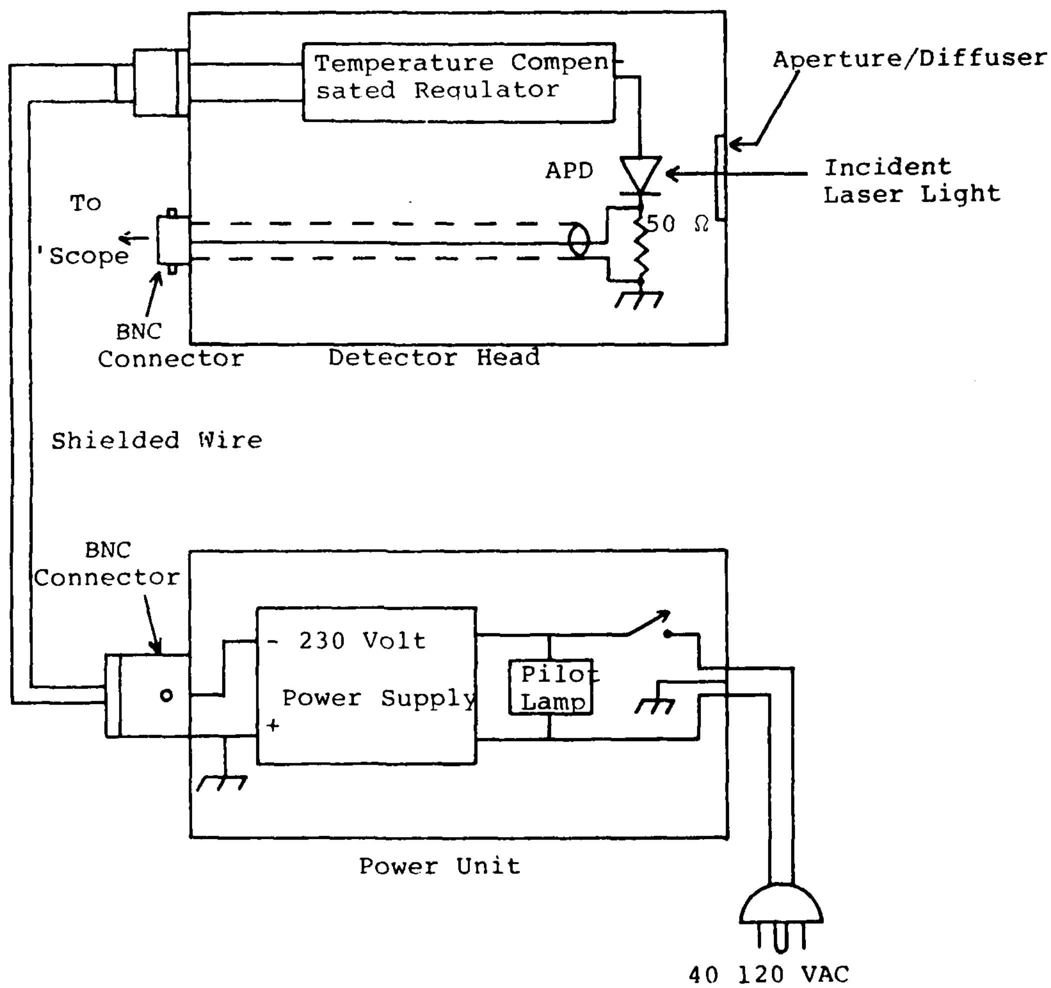


Figure 38 - APD Power Detector System.

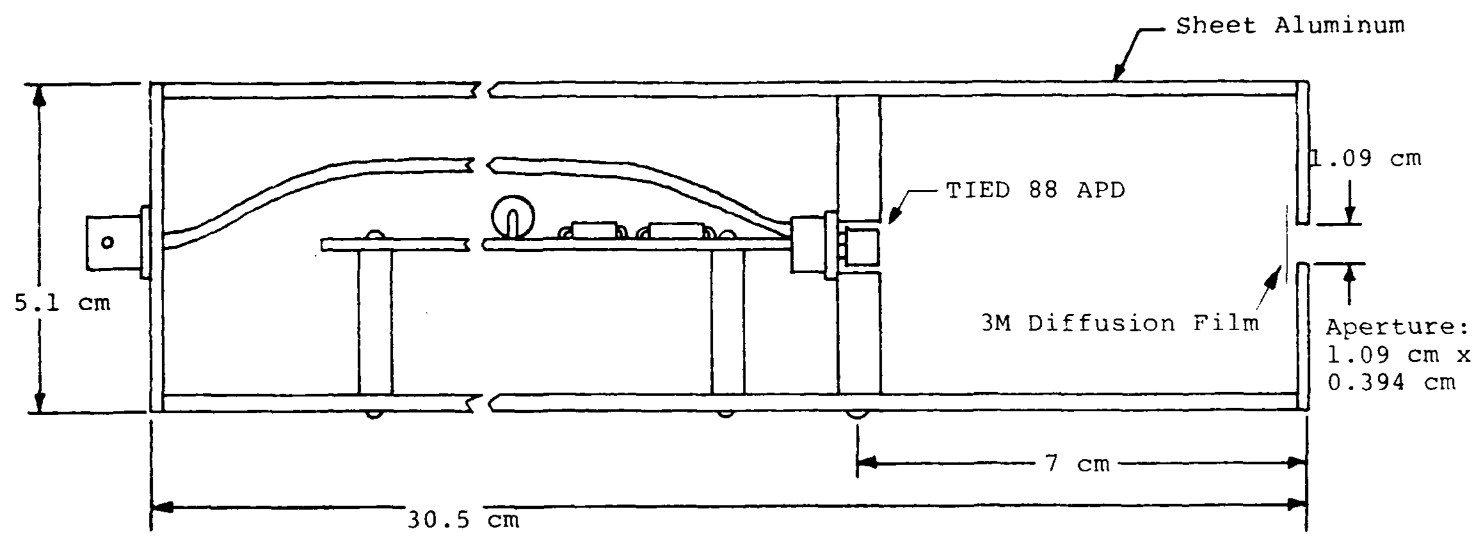


Figure 39 -Internal Structure Power Detector Head.

placed 1.5 cm from the laser to be tested, the power supply is connected and turned on and the detector output is fed to one channel of the sampling oscilloscope. Since the other channel is connected to the current probe in the laser pulser and the 'scope is synchronized to the clock, the oscilloscope trace will, with appropriate calibration factors, read power output vs. drive current.

The far field ("beam pattern") apparatus block diagram is shown in Figure 40. With the 10 ns pulser (Fig 32) mounted atop the goniometer, taking care to locate the laser optical axis on the axis of rotation of the goniometer, the EG&G detector head is located between 65 cm and 75 cm away from the laser (Figure 41) so that its active area subtends a solid angle of less than one degree. The output from the gonimeter drives the XY recorder's X axis and the "chart recorder output" from the EG&G 460 drives the "Y" axis. Once the appropriate scale factors are set up, the head is simply rotated manually (Figure 42) to obtain the desired graph.

Figure 43 shows a similar circuit diagram interfaced with a spectrometer for wavelength and special width measurements.

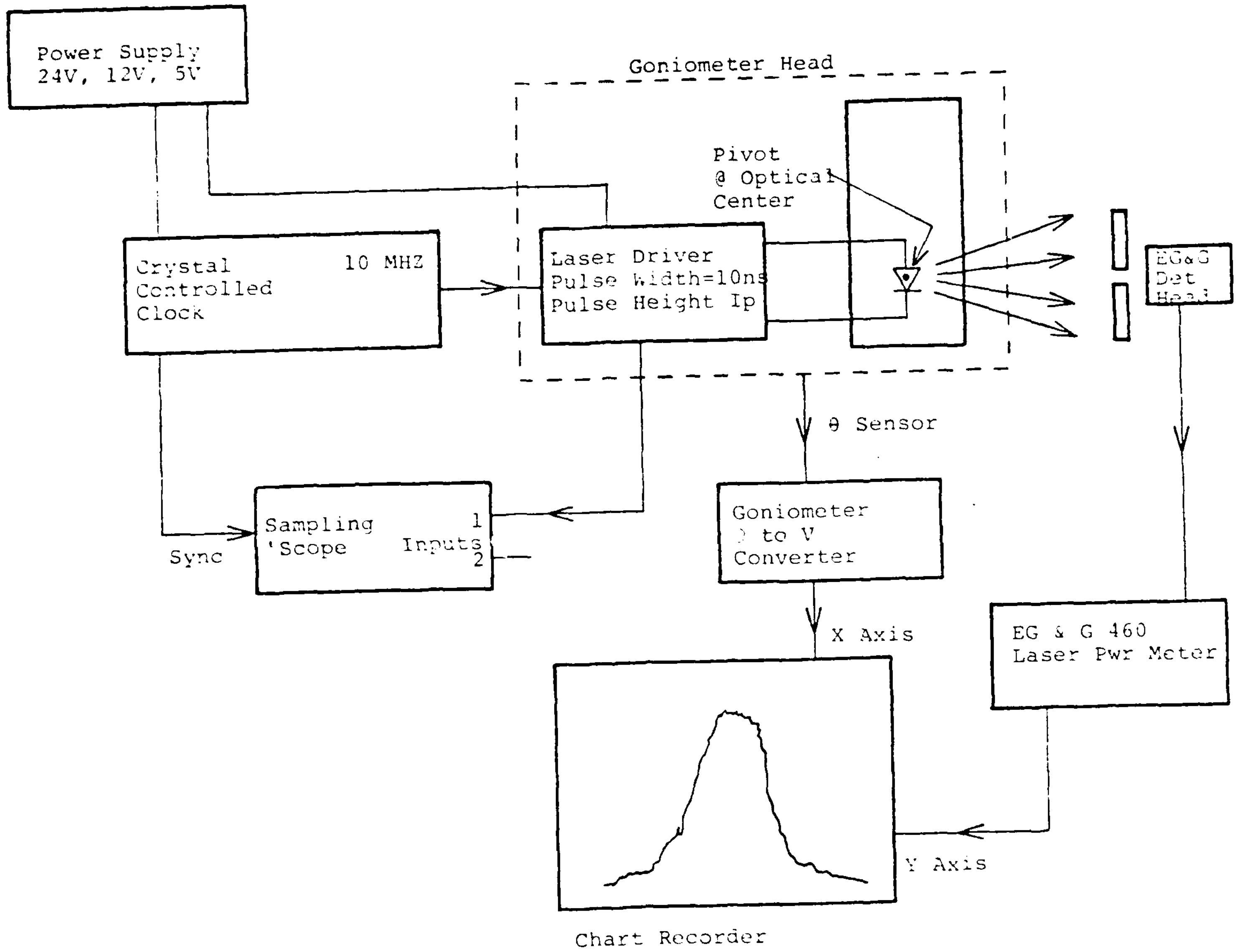


Figure 40 - Measurement of Beam Width.

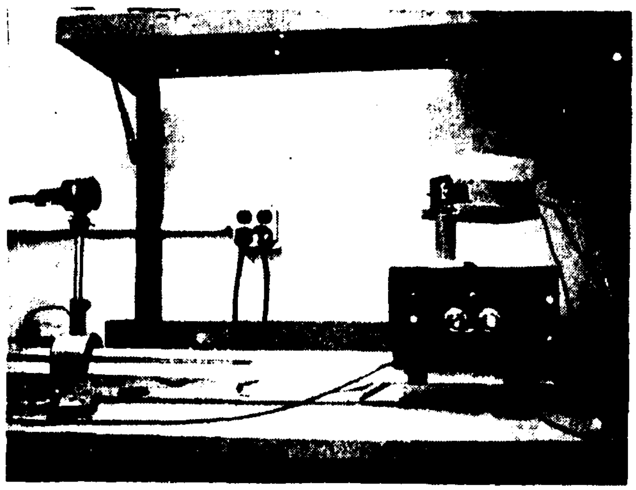


Figure 41 - Photo of EG&G with Pulser on Goniometer on Rail.

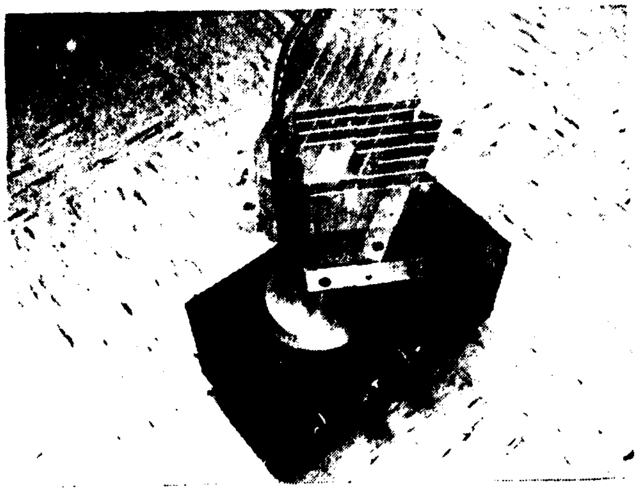
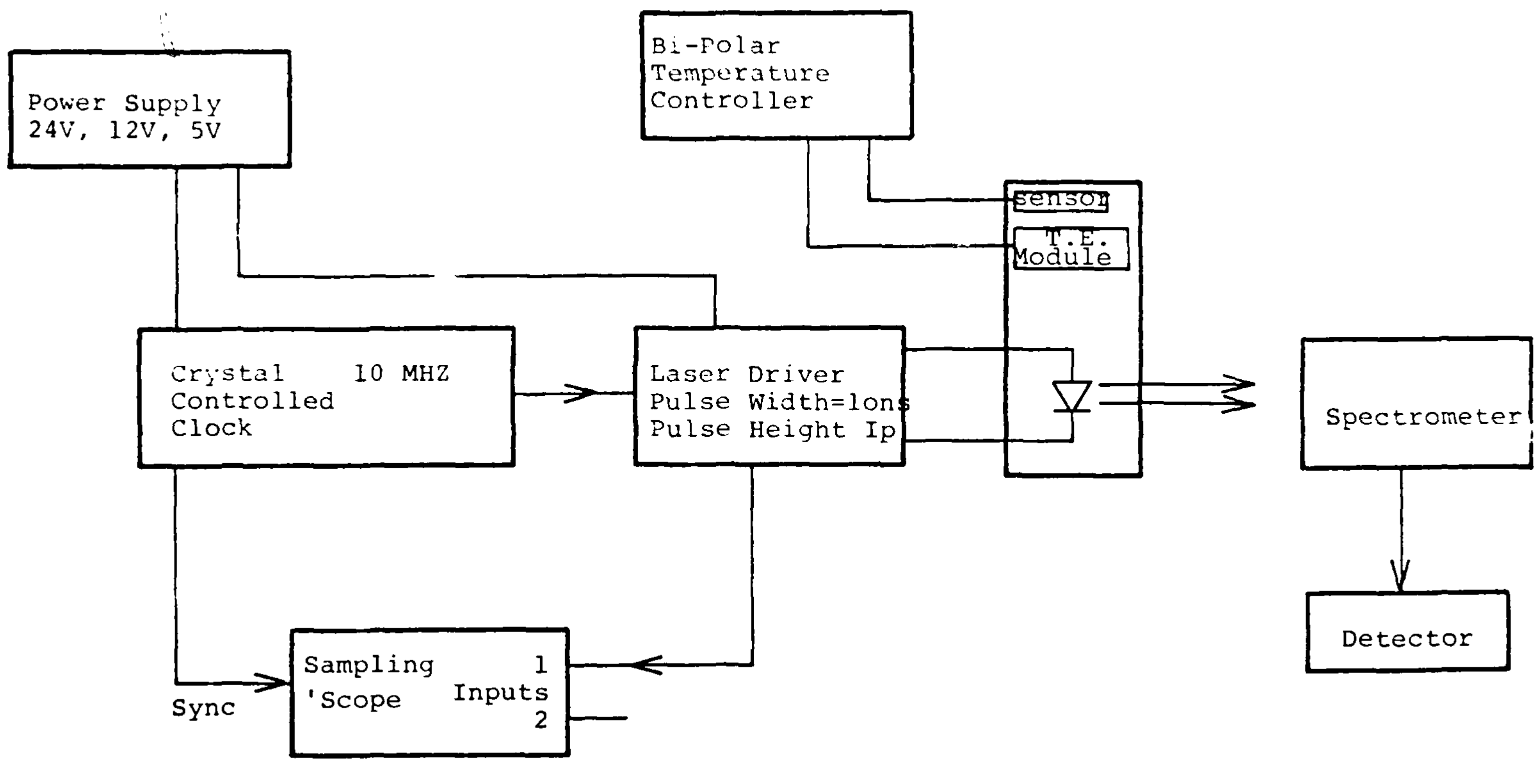


Figure 42 - Double Exposure Illustrating Goniometer Operation.



Measurement of

- Wavelength
- Spectral Width

Figure 43

Figure 44 is a diagram of the stripe width and stripe to stripe uniformity measurement system. With a suitable lens, the triple stripe image is projected on to a screen with a measurement grid as background. This projected image is picked up by a video camera, processed by a video analyser and displayed on a video monitor. Part of the display on the monitor is the intensity pattern which can be gauged for stripe to stripe uniformity. Additionally, the actual stripe images are displayed and gauged against the grid background with the appropriate magnification factor for stripe width and stripe to stripe distance. Figure 45 is a photograph of the video monitor with an actual display. The display illustrates to the left, on the monitor, the intensity of the center stripe. The gridded background is seen with calibration dimensions. Figure 46 shows the block diagram of the I_p and peak power measurement equipment. The previously described components are integrated to form the basis for the test set.

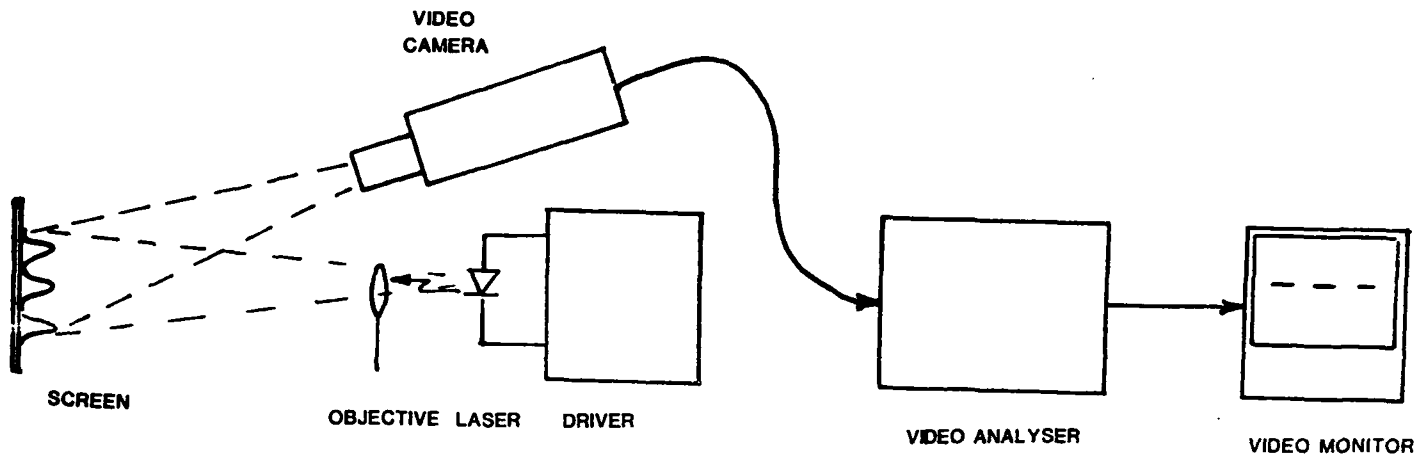


FIG. 44 STRIPE WIDTH MEASUREMENT SYSTEM

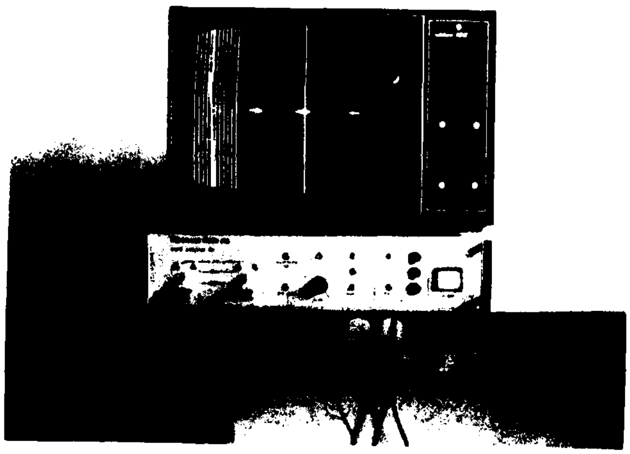


Fig. 45 - Triple Stripe Video Display

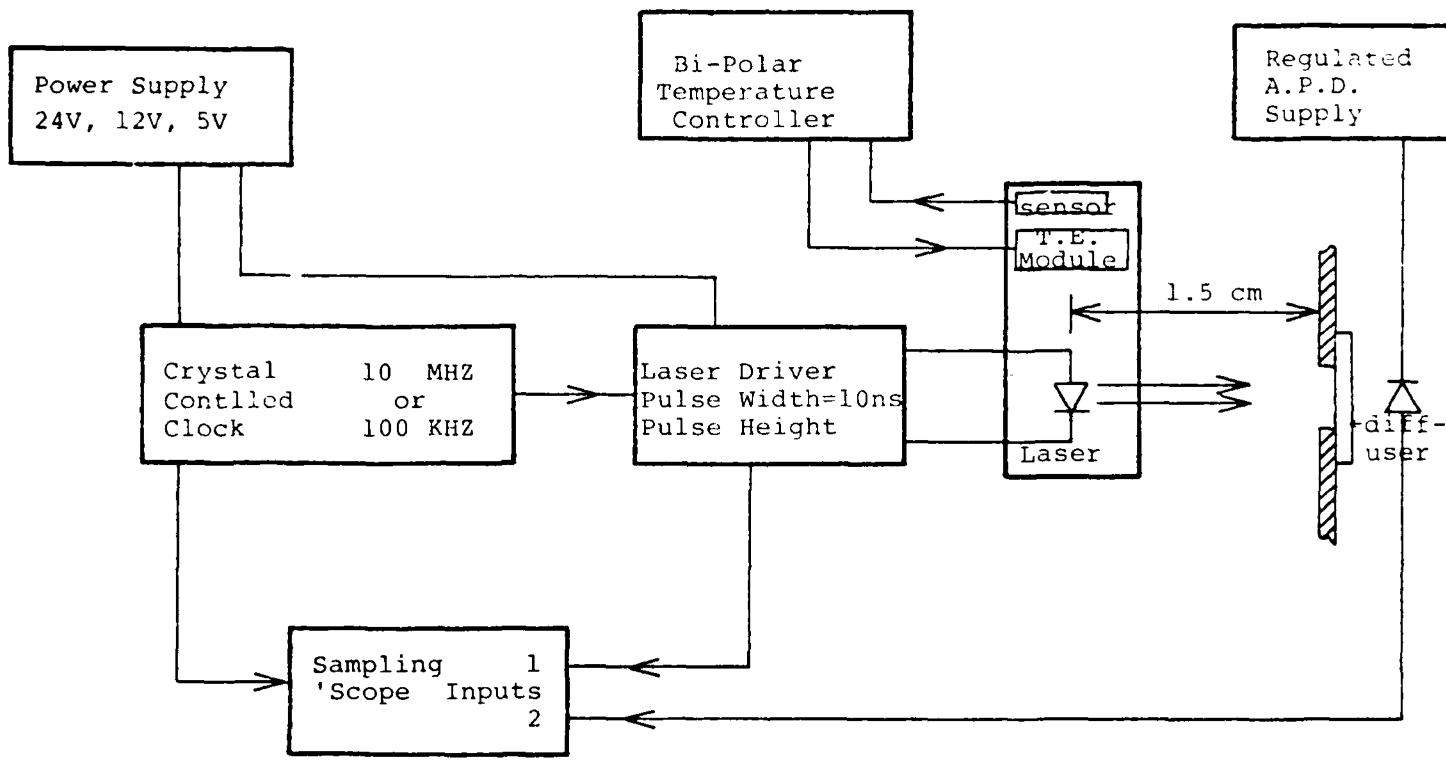


Figure 46. - Measurement of Ip and Peak Power.

SECTION IV

SUMMARY OF PILOT LINE TEST RESULTS

(0040)

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

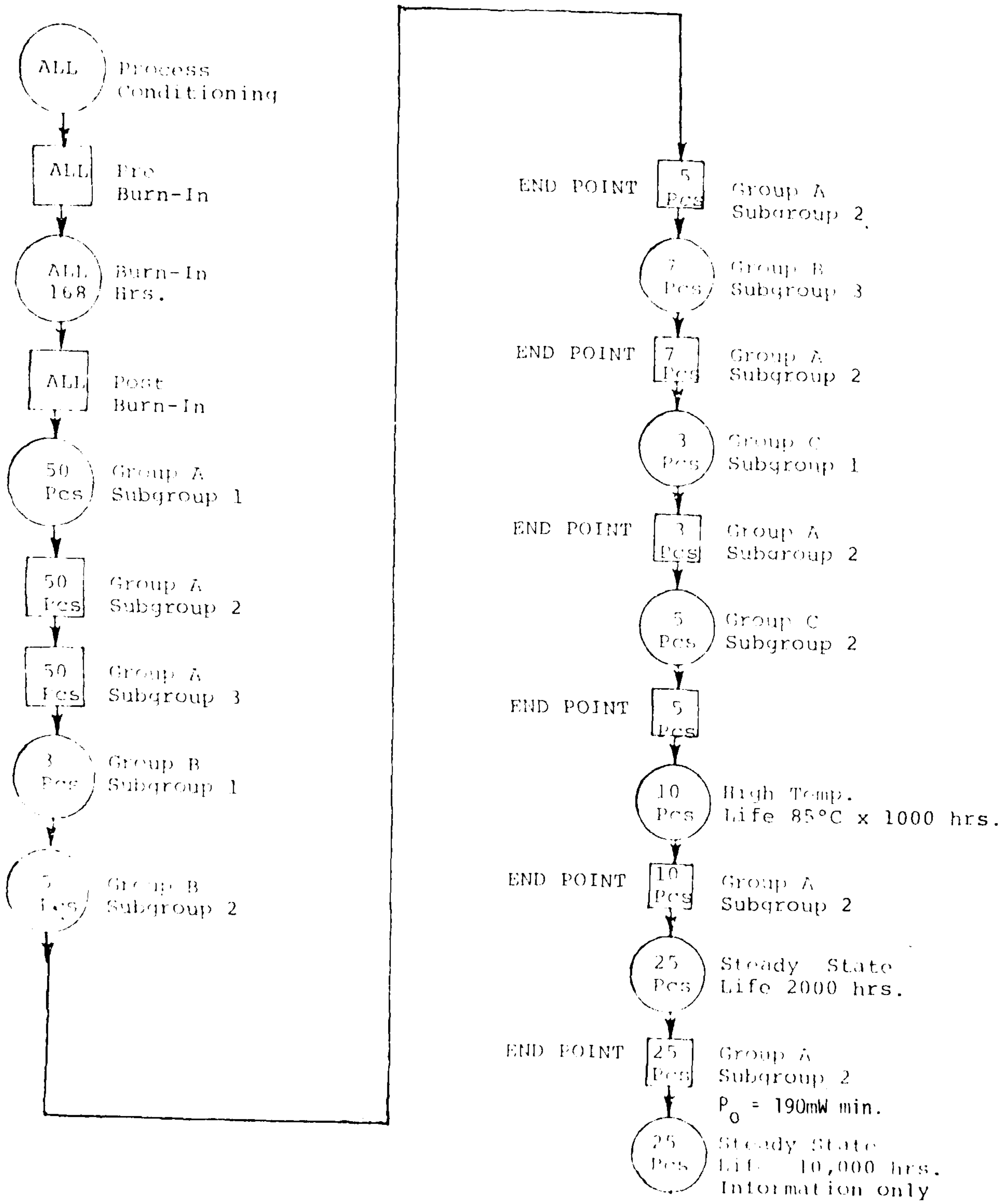
GROUP C INSPECTION

ENVIRONMENTAL TESTS PERFORMED AT:

AMERICAN ELECTRONICS LABORATORY
LANSDALE, PA
&
ASSOCIATED TESTING LABORATORIES
BURLINGTON, MA

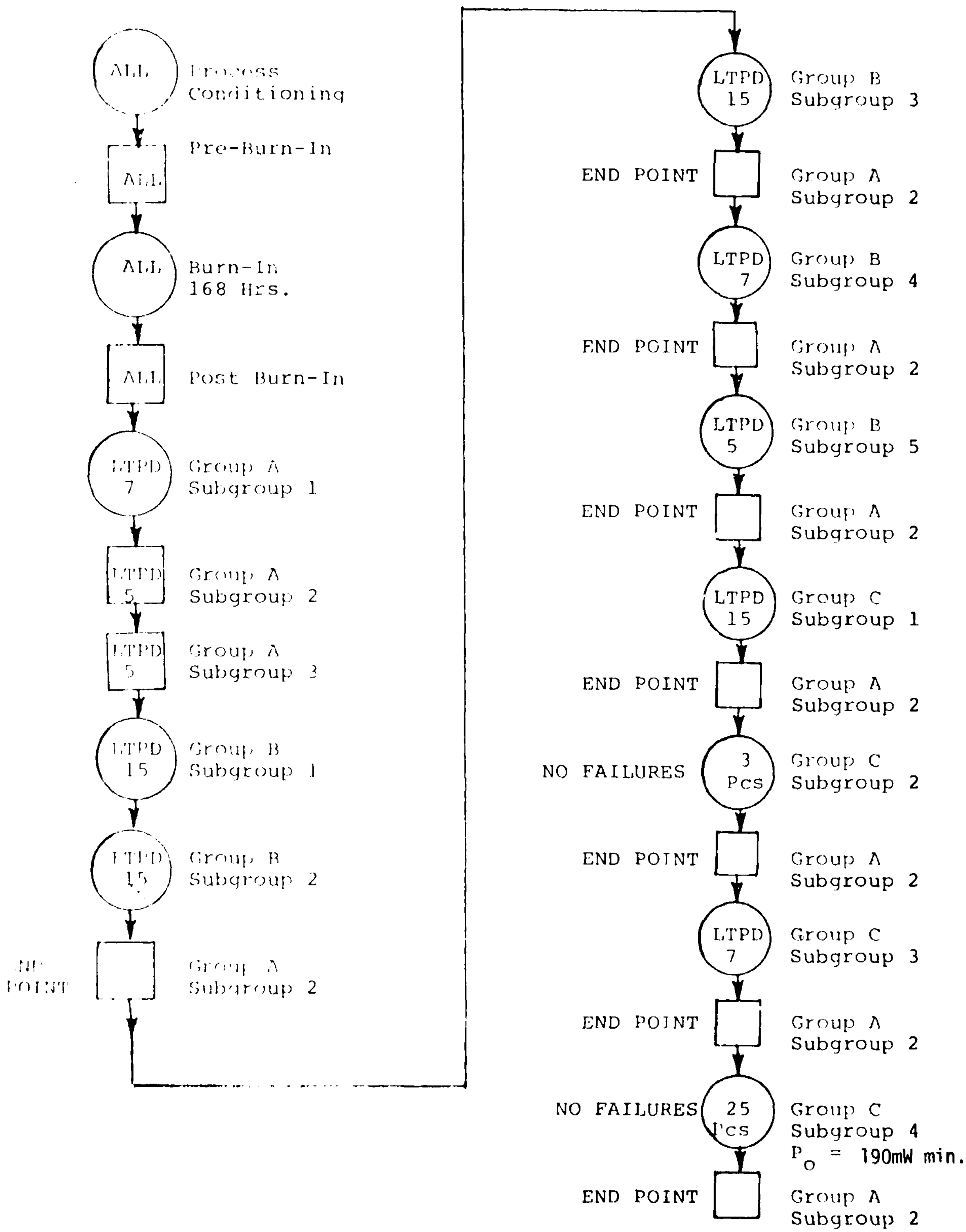
FLOW CHART - FIRST ARTICLE (50 Pcs.)

(0040)



FLOW CHART - PRODUCTION TESTING

(0040)



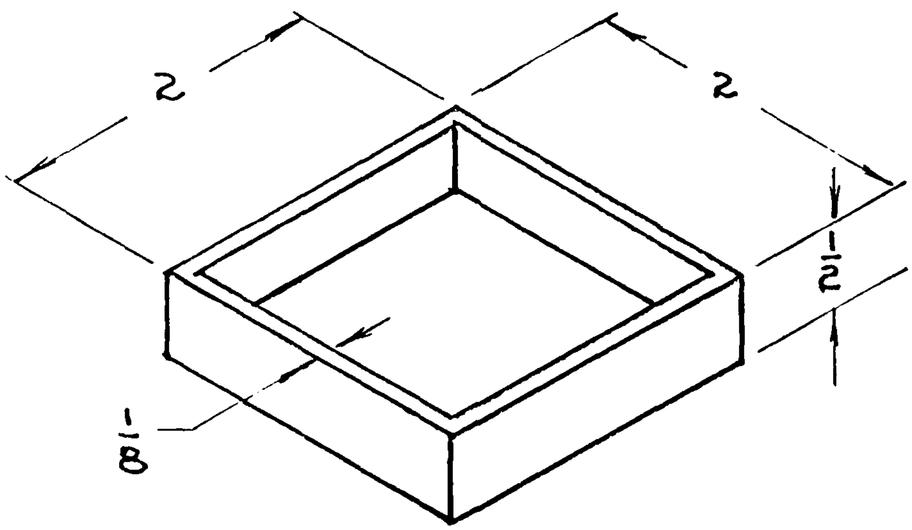
(0040)

PROCESS CONDITIONING - ALL UNITS

TEST	CONDITIONS MIL=STD.	METHOD	REQUIREMENTS	TYP. RES.
High Temperature Life	750	1031	85°C x 48 hrs.	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	800-830 nm			820 nm
Output Power 25°C	200 mw: DF=10%: t_p=10ns: I_p=3A max.			2A
BURN-IN	DF=10%: t_p=10ns; I_p=2A Typ.			
POST BURN-IN				
Peak Wavelength	800-830nm $\Delta\lambda$=5% max.			820 nm
Output Power 25°C	200 mw: DF-10%: t_p=10ns: I=2A Typ.			200 mw

(0040)

CAVITY LINED WITH HARD RUBBER
DEVICES PLACED WINDOW DOWN ON RUBBER
CAVITY FILLED WITH STEEL SHOT



ACCELERATION FIXTURE

(0040)

GROUP A

TEST	CONDITIONS REQUIREMENTS	TYP. RESULTS
SUBGROUP 1		
Visual & Mechanical	MIL-STD-750 Meth. 2071	PASS
Stripe Width	10% DF t_p=10 ns	-
Triple	75 μm Max.	
SUBGROUP 2	END POINT TESTS	
Peak Wavelength	815 ± 15 nm	820 nm
Peak Pulse Output Power	200mw min. @ 2A Typ.	200 mw
SUBGROUP 3		
Beam Width	At 202mw min. at I_p	
a) Junction Plane	15°	13 ± 2°
b) Perpendicular to Junct.	40°	38 ± 2°

(0040)

GROUP B

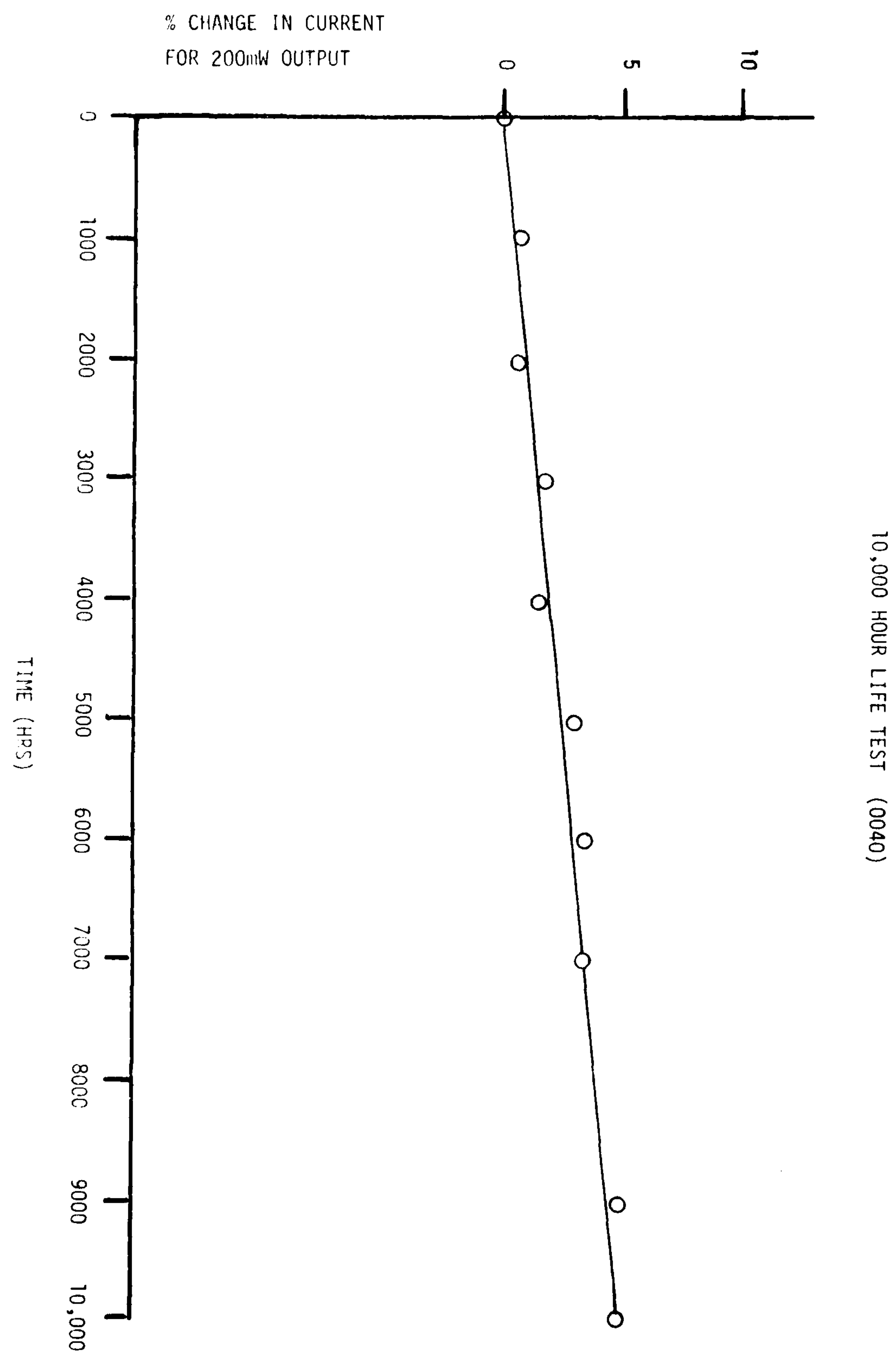
TEST	CONDITIONS MIL-STD	METHOD	REQUIREMENTS	TYP. RES.
SUBGROUP 1				
Physical Dimensions	750	2071		PASS
SUBGROUP 2				
Thermal Shock	750	1051	A-10 cycles	PASS
Moisture Resistance	750	1021		PASS
End Point	Group A - Subgroup 2			NO CHANGE
SUBGROUP 3				
Shock	750	2016	500g 0.5 ms	PASS
Vibration Fatigue	750	2046	-	PASS
Vibration, V.F.	750	2056	-	PASS
Constant Acc	850	2006	1000g 6 dir	
End Point	Group A - Subgroup 2			
SUBGROUP 4				
High Temp. Life	850	1032	82°C x 340 hrs.	PASS
End Point	Group A - Subgroup 2			NO CHANGE
SUBGROUP 5				
Steady State Life (340 Hrs)	750	1027	DF=10% t_p=10ns: I=2A Typ.	
End Point	Group A - Subgroup 2			200mW @ 2A Typ.

For First Article Subgroups 1.2 & 3 Only

(0040)

GROUP C

TEST	MIL-STD	METHOD	REQUIREMENT	TYP. RESULTS
SUBGROUP 1				
Thermal Shock	750	1051	A1-25 cycles	PASS
End Point	Group A Subgroup 2			NO CHANGE
SUBGROUP 2				
Solvent Resistance	202	215		PASS
End Point	Group A Subgroup 2			PASS
SUBGROUP 3				
Hign Temp. Life	750	1031	85°C x 1000 hrs	PASS
End Point	Group A Subgroup 2			NO CHANGE
SUBGROUP 4				
Steady-State Life (2000 Hrs.)	750	1026	DF=10%: t_p=10ns: I=3 A max.	PASS
End Point	Group A Subgroup 2 except Pa=190 mw			200 mw


10,000 HOUR LIFE TEST (0040)
% CHANGE IN CURRENT
FOR 200mW OUTPUT
0
5
10
TIME (HRS)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000

SECTION V

PILOT LINE RATE REPORT

PROCESS	YIELD %	DEVICES REQ'D	RATE/HR		
Deliver Devices		300			
Final Electrical Test	90	330	48		
Burn-In	100	330			
Pre Burn-In Electrical	63	452	48		
Environmental Testing	100	452			
Attach Window	95	475	52		
Wire Bond to Chip	90	522	20		
Chip Mounting	80	627	20		
Wire Bond to Post	95	658	48		
Package Assembly	85	756	200		

TABLE 8 - PILOT LINE RATES

SECTION VI

MASS PRODUCTION PLAN

FOR FIRST WEEK'S PRODUCTION

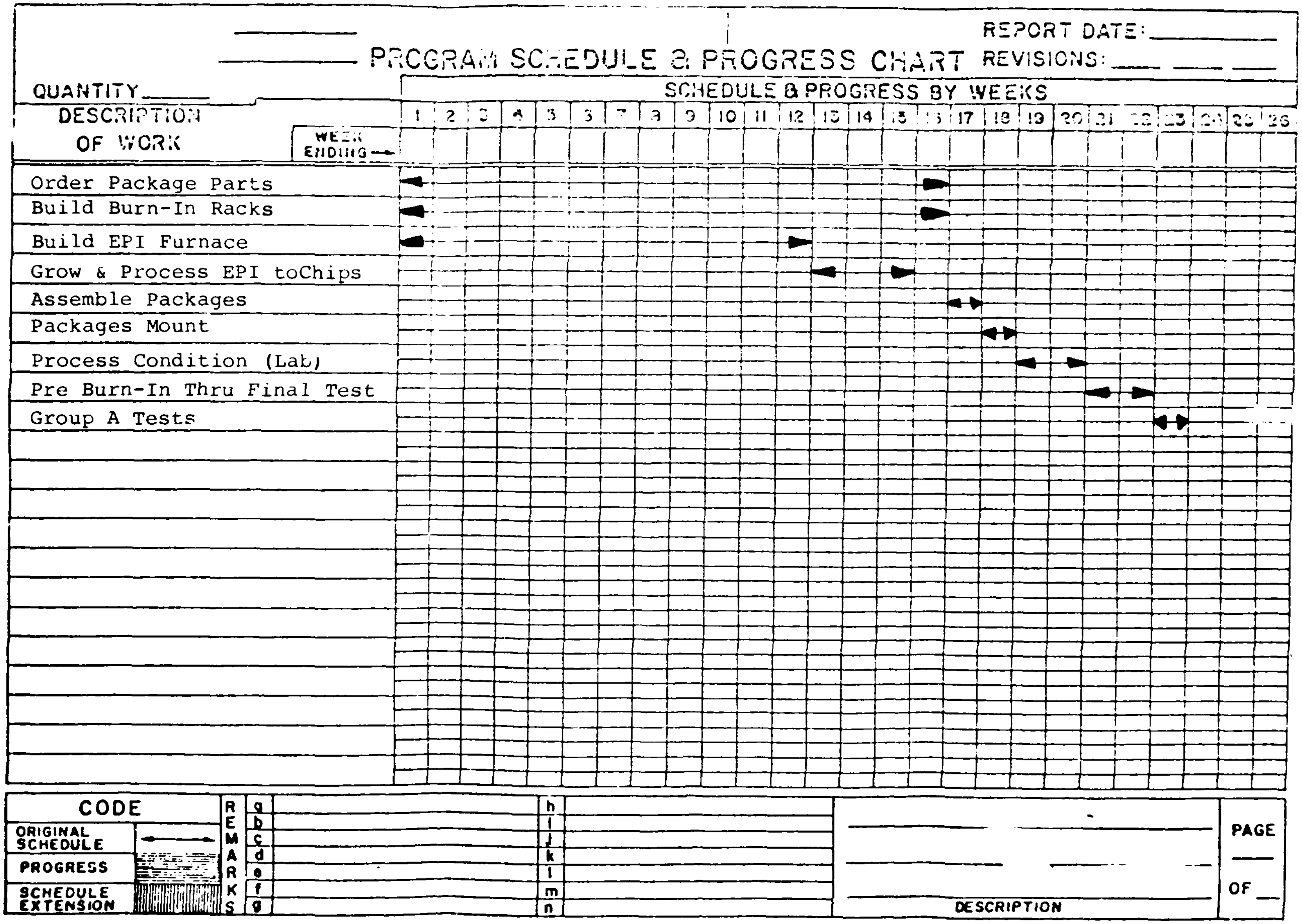


TABLE 9 - VOLUME PRODUCTION SCHEDULE FOR FIRST WEEK'S PRODUCTION

PROCESS STEP	YIELD %	DEVICES/WK	RATE/HR	REQ'D/HR	PEOPLE REQ'D.
Deliver Devices		2553			
Final Electrical Test	90	2808	48	74	1.5
Burn-In	100	2808			
Pre Burn-In Electrical	63	3847	48	101	2.1
Environmental Testing	100	3847			
Attach Window	95	4039	52	67	1.3
Wire Bond to Chip	90	4443	20	111	5.6
Chip Mounting	80	5332	20	133	6.7
Wire Bond to Post	95	5599	48	140	2.9
Package Assembly	85	6439	200	160	1

TABLE 10 - VOLUME PRODUCTION RATES

EPITAXIAL REQUIREMENTS

Diode chips required per week	5332
Maximum number of chips per wafer	2900
Number good electrical chips per wafer	1780
Number wafers required @ 50% yield	6

EQUIPMENT REQUIREMENTS

2630 Burn-In positions @ $ 180 per position

7 Assembly Stations @ $ 2,000 per station

Epitaxial Furnace $22,000

Power Measurement Test Set $10,000

PERSONNEL REQUIREMENT

Engineers	2
Technicians	2
Assembly	21

AD-A101 481 LASER DIODE LABS INC NEW BRUNSWICK NJ F/G 9/1
INJECTION LASER DIODES FOR FIBER OPTIC COMMUNICATIONS.(U)
MAR 81 A GENNARO DAAB07-76-C-0040
UNCLASSIFIED CORADCOM-76-0040-F NL

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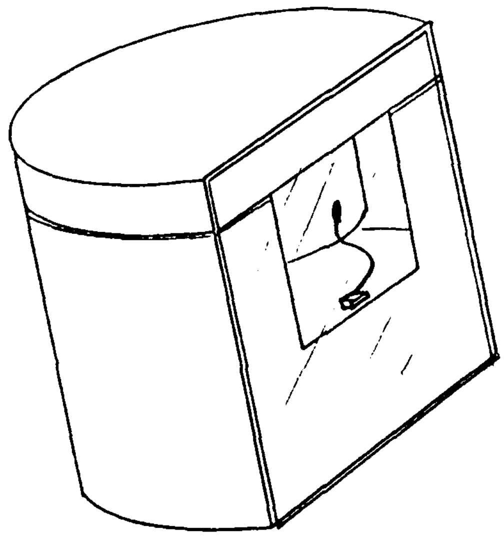
APPENDIX A

PRODUCT CAPABILITY DEMONSTRATION

DEMONSTRATION SCHEDULE

February 18, 1981

9:00 A.M.	-	Welcoming Session (Holiday Inn)
9:30 A.M.	-	Technical Presentation Program #8135
	-	Diode Specifications
	-	Diode Chip Concepts
	-	Packaging and Assembly Concepts
	-	Testing Methods
10:45 A.M.	-	Coffee
11:00 A.M.	-	Technical Presentation Program #0040
	-	Diode Specifications
	-	Diode Chip Concepts
	-	Packaging and Assembly Concepts
	-	Testing Methods
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-0040

TRIPLE STRIPE LASER

U. S. ARMY CORADCOM SPECIFICATION DAAB07-76-C-0040
PRODUCT CAPABILITY DEMONSTRATION, FEBRUARY 18, 1981

OBJECTIVES

GENERAL MM&T PROGRAM OBJECTIVES

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

SPECIFIC OBJECTIVES

DEVELOP AND DEMONSTRATE A RELIABLE MONOLITHIC, LASER ARRAY CAPABLE OF 200 MW PULSED POWER OUTPUT AT 820 MM AND 10% DUTY CYCLE CAPABLE OF BEING INTERFACED WITH A FIBER ARRAY.

CONTRACT GOALS (LOGISTICS)

* ESTABLISH MANUFACTURING METHODS AND PROCESSES.
* ENGINEERING, CONFIRMATORY AND PILOT PRODUCTION PHASES.
* PILOT PRODUCTION CAPABILITY OF 200 DEVICES.

CONTRACT GOALS (TECHNICAL)

* TRIPLE STRIPE MONOLITHIC LASER ARRAY.
* 200 mW PEAK OPTICAL POWER AT 10% DUTY CYCLE.
* WINDOW PACKAGE FOR FIBER INTERFACING.
* ENVIRONMENTAL CAPABILITY

PROBLEMS ENCOUNTERED AND SOLVED

* DESIGN OF NARROW STRIPE PHOTO MASK.

* WINDOW FOF FIBER INTERFACING.

* EPOXIES FOR PACKAGE AND WINDOW ASSEMBLY.

* MECHANICAL STRENGTH OF PACKAGE.

LASER DIODE LABORATORIES, INC

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. ETTENBERG	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-516 SPECIFICATIONS

INJECTION LASER DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

1. SCOPE

1.1 Scope.- This specification covers the detail requirements for Gallium Aluminum Arsenide (GaAlAs) injection laser diodes having a wavelength of 820 nanometers (nm). The injection laser (IL) devices shall incorporate the physical and electrical characteristics compatible with fiber optic cables and systems employing the use of fiber optics.

1.2 Recommended operating conditions: $I_P = 3A$

$T_a = 20°C$

$V_F = 2.0$ V at $I_P = 3A$

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

MILITARY

MIL-C-675	Coating of Glass Optical Elements.
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 documents 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.)

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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 IL devices are double heterojunction (DH) devices used at high data rates at a wavelength of 820 nm and shall be compatible with fiber optic cables. The operating temperature range shall be 20°C to 30°C.

3.2 Performance characteristics.- Performance characteristics shall be as specified in Tables III, IV and V. I_p is the value of the current to obtain peak pulse optical output power equal to 200 mW and shall have a minimum value of 3A. (See 4.6.5). I_p shall be determined for each device. This I_p value shall be the I_p value used for each device throughout the remainder of the document.

3.2.1 Process conditioning.- All units shall be process conditioned. (See 4.5.1).

3.2.2 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 Figures 1, 2, and 3 and herein.

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

3.4 Window.- The window shall contain no strain or cracks over the entire diameter and be free from optical distortion and lens effects over the central 0.303 inch diameter. The window shall be anti-reflection coated on both surfaces for a wavelength of λ = 820 nm. The coating shall conform to the abrasion resistance requirement of MIL-C-675.

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3.5 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-516

3.6 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.

3.7 Solderability.- Leads shall be solderable.

3.8 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.

3.9 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).

3.10 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).

3.11 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 III).

3.12 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).

3.13 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).

3.14 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).

3.15 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).

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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. (See 4.5.1 and 4.5.2).

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 measurement and sequence shall be as specified in Table I.

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

I_p = (See 3.2)

T_a = 20°C

DF = 10%

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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°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 at 25°C. The values observed for each device shall not exceed the following, relative to the pre-burn-in measurements:

$$\Delta \lambda_p = 1\%$$

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

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 minimum
Thermal shock	202	107	Test Condition A except t(high) = 85°C; t(low) = -40°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 Subgroup 1	as specified	Table IV 1/	X				
Subgroup 2				X			
Subgroup 3					X		
Group C inspection Subgroup 1	as specified	Table V 1/	X				
Subgroup 2				X			
High temperature life	3.13	Method 1031 of MIL-STD-750 T_a = 85°C for 1000 hrs				X	
Steady state operation life	3.14	Method 1026 of MIL-STD-750 T_a = 25°C for 2000 hrs I_p = (See 3.2) DF = 10%					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 190 mW minimum.

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Table III.- Group A inspection
T_a = 25°C ± 2°C unless otherwise specified

Test	Condition	Test Method	Min	Max	units	LTPD
Subgroup 1						7
Visual and mechanical inspection		Method 2071 of MIL-STD-750	See 3.3			
Window		4.6.1				
Stripe width	I_p = (See 3.2)	4.6.3				
(a) single	t_p = 10 ns		25		µm	
(b) triple	DF = 10%		75		µm	
Subgroup 2						5
Peak wavelength	I_p = (See 3.2)	4.6.4	800	830	nm	
Peak optical pulse power output	I_p = (See 3.2)	4.6.5	200		mW	
Subgroup 3						5
Thermal impedance	I_p = (See 3.2) t_p = 10 ns	4.6.6	10		°C	
Beam width	I_p = (See 3.2) t_p = 10 ns	4.6.7				
(a) in junction plane			15		angular degrees	
(b) perpendicular to junction				40	angular degrees	

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Table IV.- Group B inspection

Test	Reqt Para	MIL-STD-750 Method	Condition	LTPD
Subgroup 1				15
Physical dimensions	3.3	2071	See Figures 1, 2 & 3	
Subgroup 2				15
Thermal shock (temperature cycling)	3.8	1051	Test Condition A except t(high) = 85°C; t(low) = -40°C; 10 cycles; time at temperature extremes = 15 minutes maximum	
Moisture resistance	3.3.1, 3.15	1021		
End point measurements: Subgroup 2 of Table III				
Subgroup 3				15
Shock	3.9	2016	Non-operating 500 g	
Vibration fatigue	3.10	2046	Non-operating	
Vibration, variable frequency	3.11	2056	Non-operating	
Constant acceleration	3.12	2006	force applied = 1,000 g	
End point measurements: Subgroup 2 of Table III				
Subgroup 4				7
High temperature life (non-operating) (See 4.5(b))	3.13	1032	T_a = 85°C	
End point measurements: Subgroup 2 of Table III				
Subgroup 5				5
Steady state operation life	3.14	1027	I_p = (See 3.2) at 50°C DF = 10% (See 6.2) t_p = 10 ns at R_p = MHz	
End point measurements: Subgroup 2 of Table III				

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Table V.- Group C inspection

Test	Reqt Para	MIL-STD-750 Method	Details	LTPD
Subgroup 1				15
Thermal shock (temperature cycling) (See 4.5(b))	3.8	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				
Subgroup 2				3 devices no failures
Resistance to solvents (See 4.6.2)	3.6	Method 215 of MIL-STD-202		
End point measurements: Subgroup 2 of Table III				
Subgroup 3				7
High temperature life (non-operating) (See 4.5(b))	3.13	1031	T_a = 85°C for 1000 hrs	
End point measurements: Subgroup 2 of Table III				
Subgroup 4				5
Steady state operation life	3.14	1026	I_F = (See 3.2) T_a = 25°C for 2000 hrs DF = 10% (See 6.2)	
End point measurements:[1/] Subgroup 2 of Table III				

1/ Limits of subgroup 2 Table III same except P_{opt} = 190 mW min.

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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 Window.- Visual inspection shall be made to insure there are no cracks or optical distortions in the window.

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

4.6.3 Stripe width.- The stripe width 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 the junction plane with a calibrated ITT Phototube #F4000 (see 6.3), masked with an 0.5 mm slit. Slit shall be 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 stripe width. (See Figure 4).

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

4.6.5 Peak optical pulse power (P_{opt}).- P_{opt} is measured using a calibrated ITT Phototube #F4000 terminated into 50 ohms positioned at a distance of 1.5 cm with a rectangular aperture of width .39 cm and length 1.03 cm. (See Figure 6). (See 6.3).

4.6.6 Thermal impedance.- With unit mounted on a heat sink capable of being heated above room temperature, it is driven at 0.1% duty cycle to minimize self-heating effects. Measurements of peak output wavelength (λ_p) versus temperature (T) from 20°C to 40°C are recorded. In order to take into account its own heating effect, unit is then operated at 20°C and at 10% duty cycle. The peak output wavelength is then recorded under these conditions. The voltage drop (V_D) across the output of the unit is then measured. (See 6.2).

4.6.7 Beam width.- A calibrated ITT Phototube #F4000 (see 6.3), shall be mounted on a turntable and masked with a small aperture so that is angular resolution is at least one degree. The distance between the unit and the detector shall be at least 20 cm. The relative intensity shall be measured until its value falls down to 50% of its peak value. This area will define the beam width. The beam width in angular degrees is measured in both the junction plane and in the plane perpendicular to the junction plane. (See Figure 5).

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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:

DF	duty factor
I_p	input pulse current
P_{opt}	peak pulse optical power output
T_a	ambient temperature
t_p	pulse width at 3 db point
R_p	pulse repetition rate
V_F	forward voltage
λ_p	peak wavelength

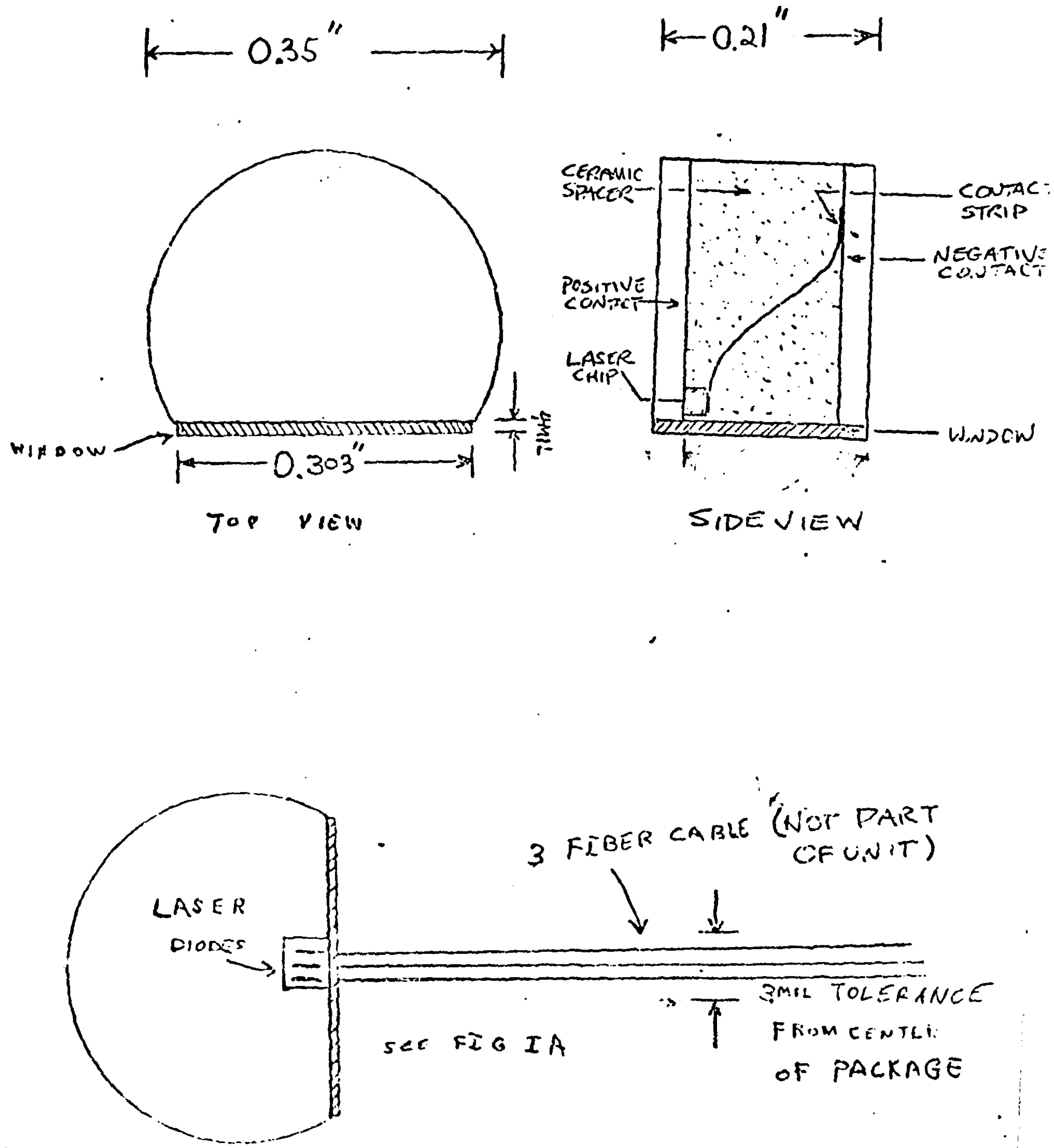
6.2 Calculation of thermal impedance (Z_t).- Thermal impedance can be calculated by taking the slope (α) of the curve λ vs temperature measured in 4.6.6 and the following:

$$Z_t = \frac{\Delta T}{\Delta P} \quad \text{where } \Delta P = I_p \times VD \times DF \text{ and } DF = T_p \times t_p$$

$$\Delta T = \frac{\Delta \lambda}{\alpha} \quad \text{- where } \Delta T \text{, and } \Delta \lambda \text{ are taken from graph}$$

6.3 Method for calibration of ITT phototube #F4000.- This information can be found on pages 180 to 190 in "Laser Parameter Measurements Handbook." Manufacturer's calibration is acceptable if traceable to an NBS standard.

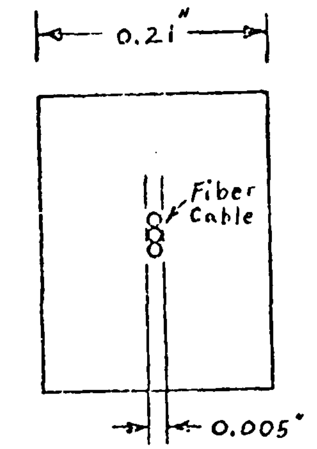
DAAB07 76 C-0040



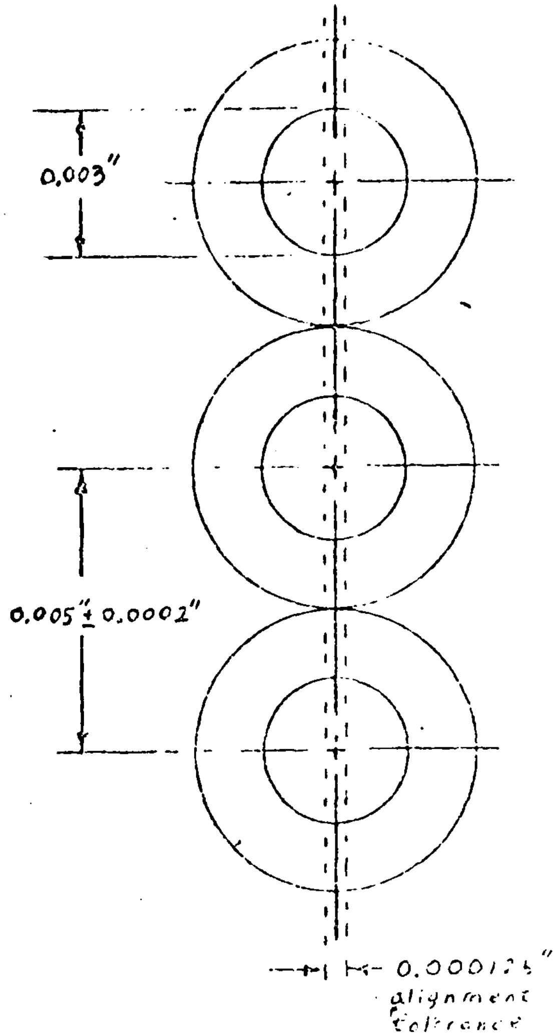
NOTE: DIMENSIONS ARE MAXIMUM

FIG. 1. Laser package

DAAB07 70 C-0040



Fiber cable aligned with injection laser



Optical Fiber Cable

Figure 1A. Fiber cable (NOT PART OF UNIT)

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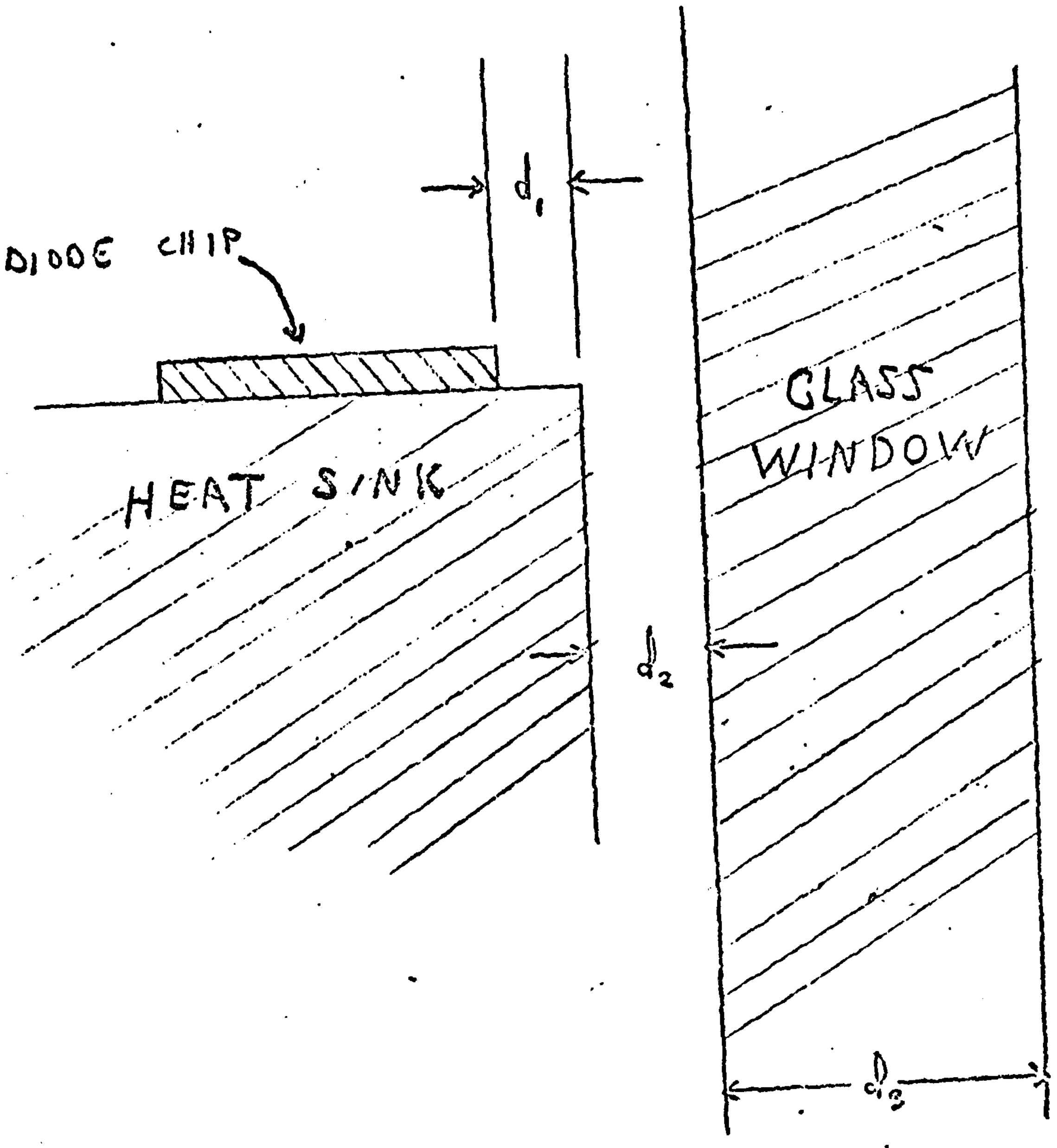

(MAX) d_1 = 1 MIL (0.0254 MM)

d_2 = 1.5 MIL (0.0381 MM) ± .5 MIL

(MIN) d_3 = 3 MIL (0.1016 MM)

(MAX) = 5 MIL

Figure 2. Mounting dimensions

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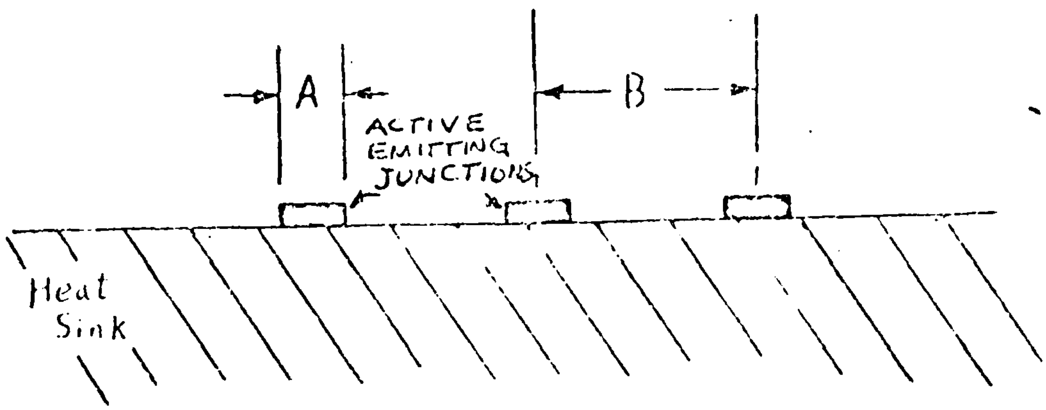
TRIPLE STRIPE GEOMETRY



DIMENSION	INCHES	μM
A(MAX)	0.001	25
B	0.005 ±0.0002	125 ±5

FIG. 3 FRONT VIEW OF DIODE ASSEMBLY

DAAB07 76 C-0040

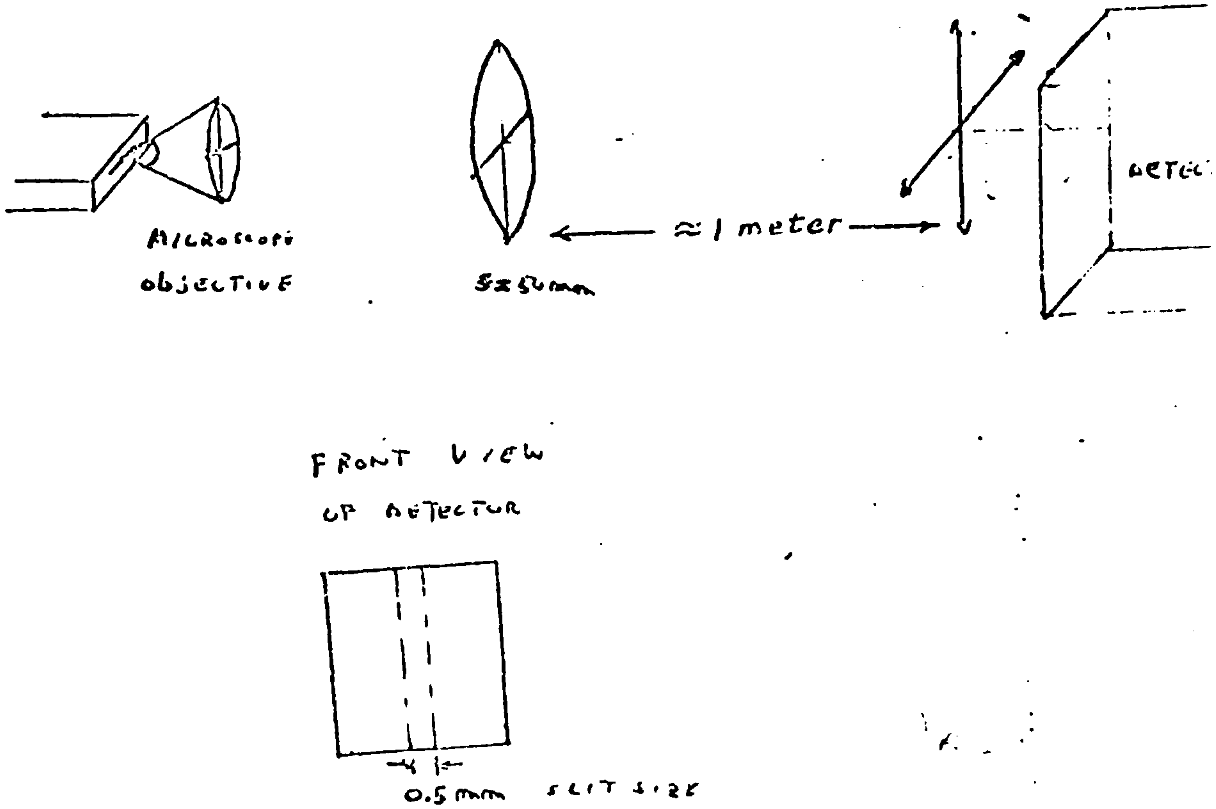
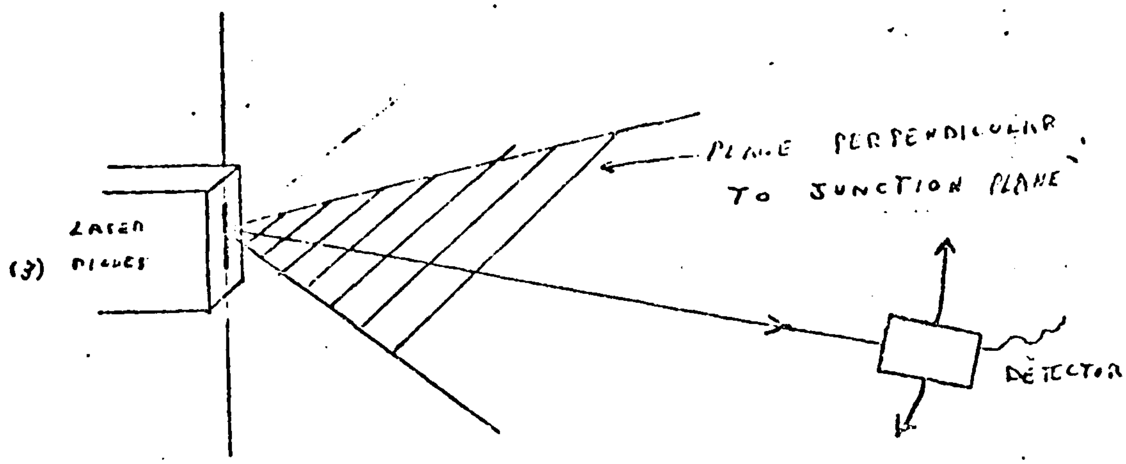


Figure 4. Stripe width

DAAB07 76 C-0040



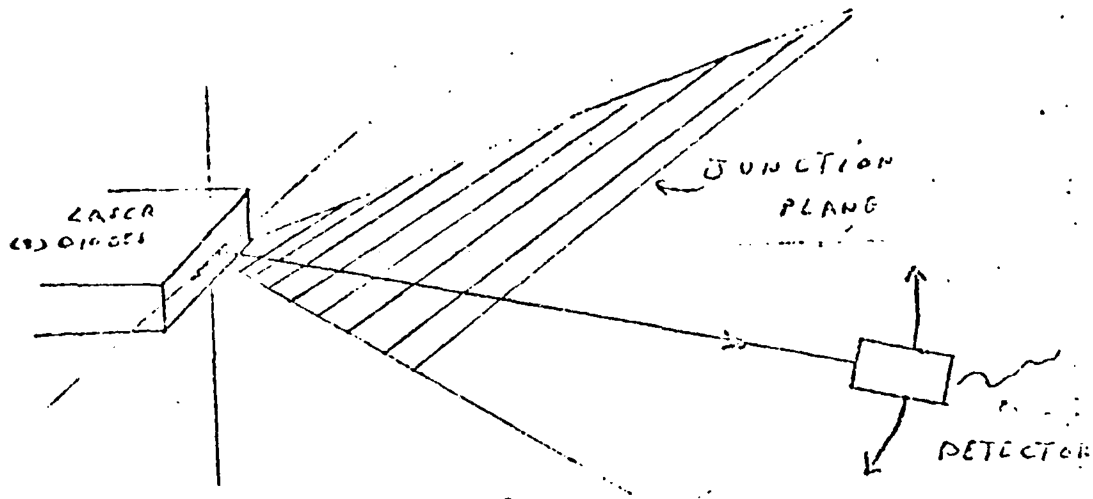


Figure 5. Beam width

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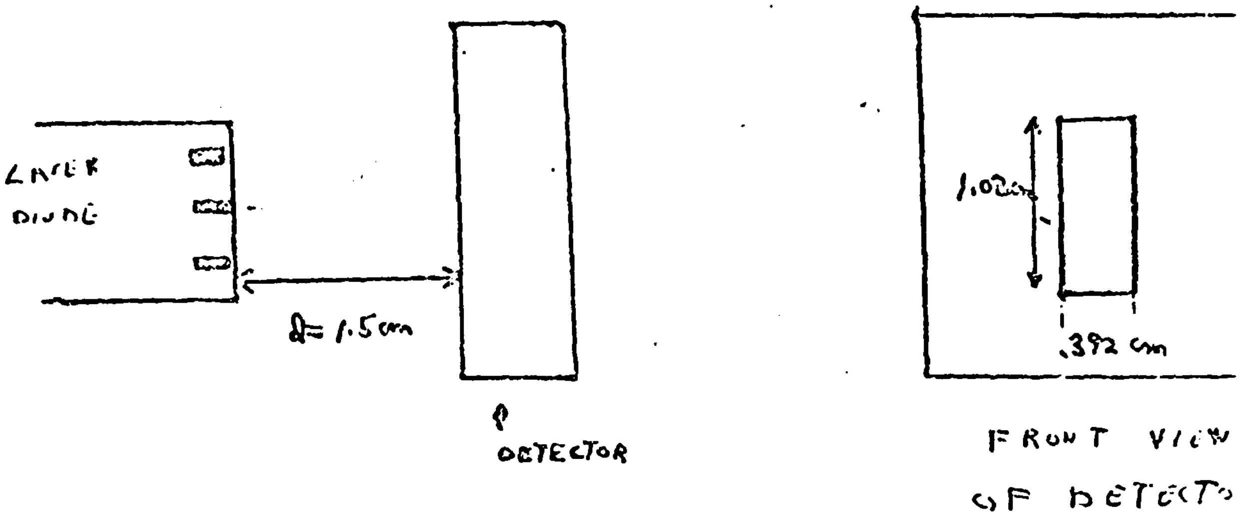

FIG. 6 LASER POWER MEASUREMENTS

DAAB07 76 C-0040

ELECTRONICS COMMAND
TECHNICAL REQUIREMENTS

SCS-516
AMENDMENT-1
29 December 1975

INJECTION LASER DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

Page 1

1.2 line 2, delete "20°C" and substitute "25°C"

Page 2

3.2 line 3, delete "minimum" and substitute "maximum"

3.4 delete and substitute:

"3.4 Window.- The window shall contain no strain or cracks over that portion which is in the optical path (area of input radiation incident on the injection laser chip). This portion of the window shall also be free from optical distortion and lens effects. The window shall be anti-reflection coated on both surfaces for a wavelength of λ = 820 nm. The coating shall conform to the abrasion resistance requirement of MIL-C-675."

Page 3

3.7 delete in its entirety.

3.14 line 2, delete "(I_F = 100 mA)"

Page 5

4.5.2 line 4, delete "20°C" and substitute "25°C"

Page 8

Table III, Subgroup 3, Thermal impedance, under units column, delete "°C" and substitute "°C/W"

Page 9

Table IV, Subgroup 5, under Condition column, delete "50°C" and substitute "25°C" for I_p

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Page 10

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 11

4.6.1 Add, "This test shall be performed prior to attaching the window to the case."

4.6.2 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."

4.6.5 line 3, delete ".39 cm" and substitute ".394 cm"
line 3, delete "1.03 cm" and substitute "1.09 cm"

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

Page 19

Fig 6 Front view of detector, delete "1.03 cm" and substitute "1.09 cm"
Delete ".392 cm" and substitute ".394 cm"

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INJECTION LASER DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

Page 8

Subgroup 1 - Stripe width (a) single - change "25 mm minimum" to "25 mm maximum."

Stripe width (b) triple - change "75 mm minimum" to "75 mm maximum."

Subgroup 3 - Thermal impedance - change "10° c/w minimum" to "10° c/w maximum."

Beam width (θ) in junction plane - change "15 angular degrees minimum" to "15 angular degrees maximum."

INJECTION LASER DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

Page 8

To Table III - Subgroup 3, add:

Test	Condition	Test Method	Min	Max	Units
Average Optical Power Output Per Stripe	I_p = (see 3.2) t_p = 10 ns	4.6.8 & 6.4	6.3	7.0	mW

Page 11

4.6.8 Power Uniformity from Stripe to Stripe

Laser stripe must be magnified to 200 x using a lens that has a f number of 1.2. The projected images of each of the three junction faces must be tested for average power using a silicon photodiode.

Page 12

6.4 Definition of average optical power

Average optical power = Peak optical power / 10

Average optical power/stripe = 1/3 average optical power.

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED PROC REG (41 CFR) 1-16.101

MODIFICATION OF CONTRACT

PAGE 1 OF 2

1. MODIFICATION NO: P00001
2. EFFECTIVE DATE: See Block 19 below
3. REQUISITION/PURCHASE REQUEST NO: N/A
4. PROJECT NO (If applicable):

5. ISSUED BY — CODE W15P7T
COMMUNICATIONS SYSTEMS PROCUREMENT BRANCH
DIR OF PROCUREMENT, CERCOM, FT MONMOUTH,
NJ 07703; Buyer/Symbol: Captain L'Heureux
DRSEL-PC-C-CS-2(LHE) Phone: 201-532-4775

6. ADMINISTERED BY (If other than block 5) — CODE S310LA
DCASMA - Springfield
240 Route 22
Springfield, NJ 07081

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code) — CODE 4D331 — FACILITY CODE
LASER DIODE LABORATORIES, INC.
205 Forrest Street
Metuchen, NJ 08817

8. ☐ AMENDMENT OF SOLICITATION NO. ________
DATED ________ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DAAB07-76-C-0040
DATED 76 JUN 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 ACKOWLEDGMENT 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

CONTRACTOR'S COPY

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 Mutual Agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF MODIFICATION

I

This Supplemental Agreement is entered into by the parties to amend the basic Specification (SCS-516) as well as to redefine the Pilot Production Run (CLIN 0001AC).

II

Section E - Supplies/Services is amended as follows:

Delete: Block 19 in its entirety.

Add: Pilot Run shall consist of fifty (50) each Single Stripe, fifty (50) each Double Stripe, and two-hundred (200) each Triple Stripe units in accordance with SCS-516 dated 29 December 75 and Amendment No. 4 to SCS-516 dated 4 November 77.

Section F - Description/Specification is amended as follows:

Subsection F.49, Paragraph 2c - Delete "The capacity of each operation" and substitute therefore "The minimum capacity of each operation."

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 1 COPY TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR: LASER DIODE LABORATORIES, INC. — 17. UNITED STATES OF AMERICA

BY ________ (Signature of person authorized to sign) — 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
		STEPHEN L. THACHER Major, Signal Corps	

Section F - Description/Specification is amended as follows (Cont'd):

Subsection F.49, Paragraph 2d

Delete "The yield of each operation at the specified rate"

and substitute therefore "The estimated yield of each operation at the specified rate."

Subsection F.2

"Add" - Amendment No. 4 4 Nov 77 to SCS-516.

III

PCO responsibility for subject contract is hereby transferred from Mr. Gordon E. McMain to Major Stephen L. Thacher, DRSEL-PC-C-CS-2(THA) 201-532-3506.

IV

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

ELECTRONICS COMMAND
TECHNICAL REQUIREMENTS

SCS-516
AMENDMENT-4
4 NOVEMBER 1977
SUPERSEDING
AMENDMENT-3
15 JULY 1976

INJECTION LASER DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

This amendment forms a part of Electronics Command Technical Requirements SCS-516
15 August 1975

Page 1

1.2 line 2, delete "20°C" and substitute "25°C"

2.1 add the following under SPECIFICATIONS

"FEDERAL

O-E-00760	Ethyl Alcohol (Ethanol); Denatured Alcohol; Proprietary Solvents and Special Industrial Solvents.
O-M-232	Methanol (Methyl Alcohol).
TT-I-735	Isopropyl Alcohol."

Page 2

3.2 line 3, delete "minimum" and substitute "maximum"

3.4 delete and substitute:

"3.4 Window.- The window shall contain no strain or cracks over that portion which is in the optical path (area of input radiation incident on the injection laser chip). This portion of the window shall also be free from optical distortion and lens effects. The window shall be anti-reflection coated on both surfaces for a wavelength of λ = 820 nm. The coating shall conform to the abrasion resistance requirement of MIL-C-675."

Page 3

3.7 delete in its entirety

3.14 line 2, delete "(I_F = 100 mA)"

Page 5

* Add the following paragraph:

"4.4.2.2 Procedure in case of test equipment failure or operator error. If a device is believed to have failed as a result of faulty test equipment or operator error, the failure shall be entered in the test record which shall be submitted to the Government along with a complete explanation verifying why the failure is believed to be invalid. The Government will then decide whether or not the failure is due to a valid part defect. If the Government rules that the failure is invalid, a replacement device from the same inspection lot may be added to the sample. The replacement device shall be subjected to all those tests to which the discarded device was subjected prior to its failure and to any remaining specified tests to which the discarded device was not subjected prior to its failure."

* Add the following subparagraph to paragraph 4.5:

"(c) Procedure in case of test equipment failure or operator error. If a device is believed to have failed as a result of faulty test equipment or operator error, the failure shall be entered in the test record which shall be submitted to the procuring activity along with a complete explanation verifying why the failure is believed to be invalid. The procuring activity will then decide whether or not the failure is due to a valid part defect. If the procuring activity rules that the failure is invalid, a replacement device from the same inspection lot may be added to the sample. The replacement device shall be subjected to all those tests to which the discarded device was subjected prior to its failure and to any remaining specified tests to which the discarded device was not subjected prior to its failure."

4.5.2 line 4, delete "20°C" and substitute "25°C"

Page 6

* 4.5.2.2 line 6, delete "$\Delta P_{opt} = 1\%$" and substitute "$\Delta P_{opt} = 5\%$"

* Table III, delete and substitute the following:

"Table III.- Group A inspection
T_a = 25°C ± 2°C unless otherwise specified

Test	Condition	Test Method	Min	Max	Units	LTPD
Subgroup 1						7
Visual and mechanical inspection		Method 2071 of MIL-STD-750	See 3.3			
Window		4.6.1				
Stripe width	I_p = (See 3.2)	4.6.3				
(a) single	t_p = 10 ns			25	μm	
(b) double	DF = 10%			50	μm	
(c) triple				75	μm	
Subgroup 2						5
Peak wavelength	I_p = (See 3.2)	4.6.4	800	830	nm	
Peak optical pulse power output	I_p = (See 3.2)	4.6.5				
(a) single			65		mW	
(b) double			130		mW	
(c) triple			200		mW	
Subgroup 3						5
Thermal impedance	I_p = (See 3.2)	4.6.6				
(a) single	t_p = 10 ns			30	°C/W	
(b) double				15	°C/W	
(c) triple				10	°C/W	
Beam width	I_p = (See 3.2)	4.6.7				
(a) in junction plane	t_p = 10 ns			15	angular degrees	
(b) perpendicular to junction				40	angular degrees	
Power uniformity from stripe to stripe	I_p = (See 3.2) t_p = 10 ns	4.6.8		10%	1/	

1/ Any device in which the relative power output of the weakest stripe is less than 90% of the relative power output of the most powerful stripe shall be rejected.

Page 9

Table IV, Subgroup 5, under Condition column, delete "50°C" and substitute "25°C" for I_p

Page 10

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 11

4.6.1 Add, "This test shall be performed prior to attaching the window to the case."

4.6.2 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."

* 4.6.3 delete and substitute:

"4.6.3 Stripe width. The stripe width size can be determined by using a closed circuit TV based system. A 40X microscope objective shall be used to project an image with magnification of at least 200X of the laser on a sheet of metric graph paper. This image, after being reduced in intensity by insertion of suitable attenuation in the laser beam path is in turn picked up via the TV camera. The combined images of the laser and the grid shall be displayed on the screen of the TV monitor. Since the stripe spacing is determined with a high degree of accuracy by the photolithographic mask, the magnification of the projection system may readily be determined. The stripe width may, therefore, be measured directly without requiring XY calibration of the TV system. An oscilloscope shall be used to monitor the video waveform and insure that the TV camera is not being saturated."

* 4.6.5 delete and substitute:

"4.6.5 Peak optical pulse power (P_{opt}) - P_{opt} is measured using a calibrated avalanche photodiode diode system terminated into 50 ohms positioned at a distance of 1.5 cm with a rectangular aperture of width 0.39 cm and length 1.03 cm. (See Figure 6 and paragraph 6.3)."

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

* 4.6.7 delete and substitute:

"4.6.7 Beam width. With the laser mounted in a rotatable pulser, the detector head of a calibrated E.G. & G. model 460 is placed at least 65 cm away to obtain an angular resolution of at least one degree. The relative intensity shall be measured until its value falls to 50% of its peak value. This area will define the beam width. The beam width in angular degrees is measured in both planes parallel and perpendicular to the junction. (See Figure 5)."

Page 12

* Add the following new paragraph:

"4.6.8 Power uniformity from stripe to stripe. Using a CCTV system as outlined in 4.6.3, the video waveform from the TV camera shall be monitored on an oscilloscope. The peaks of the video waveform correspond to the relative powers from the individual stripes.

* 6.3 delete and substitute:

"6.3 Method for calibration of the avalanche photodiode (APD) system. Using ten representative triple stripe lasers pulsed at low duty cycle, measurements shall be made with both the APD and an NBS traceable ITT F4000 tube. In both cases the separation between source and detector shall be as small as possible to insure collection of all the energy and good correspondence. Correlation of these data will give a calibration factor for the APD system."

Page 13

* Add new paragraph:

"6.3.1 Method for relative calibration of the TV system amplitude response. Focus the TV camera on a standard grey scale with known reflectance values. The resulting video waveform voltages monitored on an oscilloscope will correspond proportionally to these valves and will permit drawing a relative calibration curve for the amplitude response of the TV system."

Add the following paragraph:

"6.4 Calculation of average optical power.

Average optical power = $P_{opt}/10$

Average optical power/stripe = 1/3 average optical power."

Page 13

FIG 1. Delete FIG 1. and substitute new FIG. 1.

Page 14

FIGURE 1A. Delete "0.21" dimension and substitute ".300 ± .005"

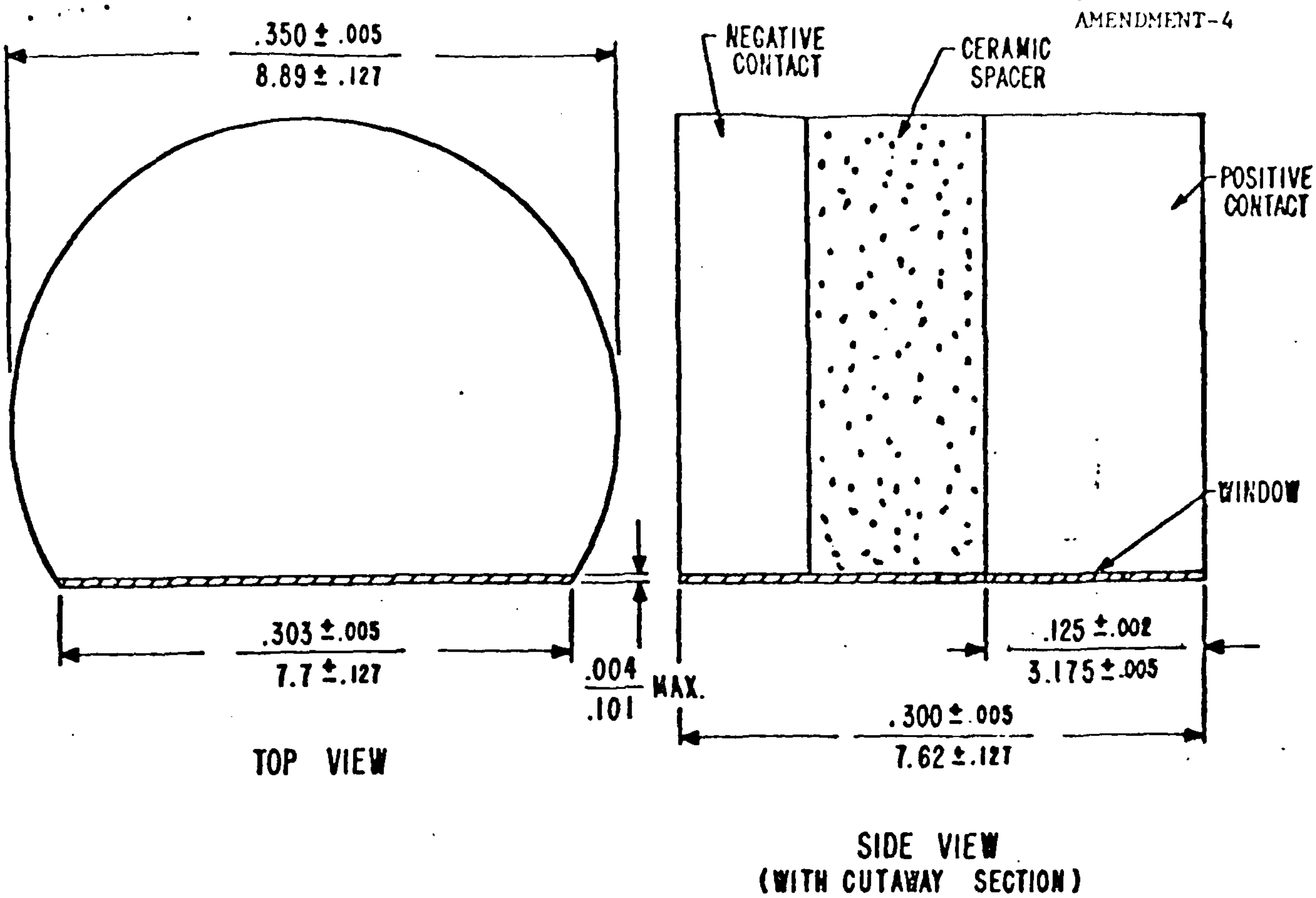
Page 17

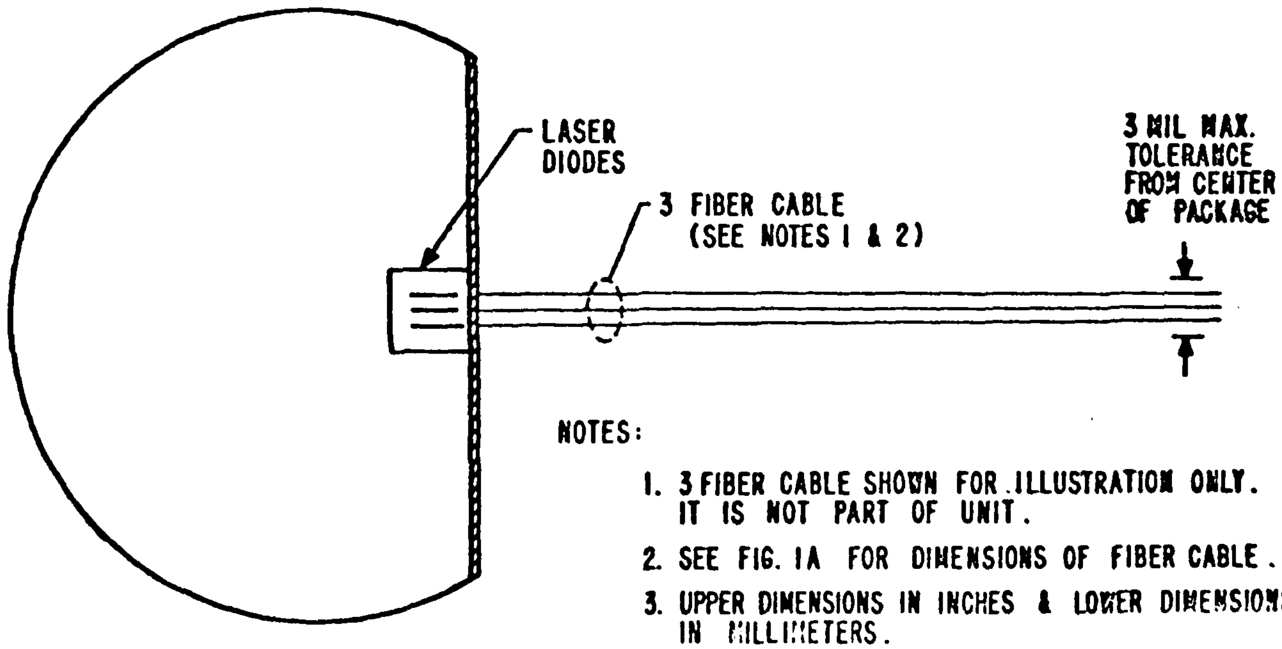
* Figure 4, delete in its entirety.

Page 19

FIG 6 Front view of detector, delete "1.03 cm" and substitute "1.09 cm"
Delete ".392 cm" and substitute ".394 cm"

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.





NOTES:

1. 3 FIBER CABLE SHOWN FOR ILLUSTRATION ONLY. IT IS NOT PART OF UNIT.
2. SEE FIG. 1A FOR DIMENSIONS OF FIBER CABLE.
3. UPPER DIMENSIONS IN INCHES & LOWER DIMENSIONS IN MILLIMETERS.

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG (41 CFR) 1-16.101

MODIFICATION OF CONTRACT

PAGE 1 OF

1. MODIFICATION NO. P00002
2. EFFECTIVE DATE See Block 19 below
3. REQUISITION/PURCHASE REQUEST NO. N/A
4. PROJECT NO. (If applicable)

5. ISSUED BY CODE W15P7T
COMMUNICATIONS SYSTEMS PROCUREMENT BRANCH, DIRECTORATE OF PROCUREMENT, CERCOM, FT MONMOUTH, NJ
Buyer Symbol: Captain L'Heureux, DRCPM-PC-C-0S-2 LHE

6. ADMINISTERED BY (If other than block 5) CODE
DCASMA-Springfield
240 Route 22
Springfield, NJ 07081

7. CONTRACTOR NAME AND ADDRESS CODE 4D351 FACILITY CODE
(Street, city, county, state, and ZIP Code)
LASER DIODE LABORATORIES, INC.
205 Forrest Street
Metuchen, NJ 08817

8. ☐ AMENDMENT OF SOLICITATION NO.
DATED (See block 9)
☒ MODIFICATION OF CONTRACT NO. DAAB07-76-C-0040
DATED 76 JUN 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 ACKOWLEDGMENT 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 Subsection L.2 (ASPR 7-103.2 Changes).
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF MODIFICATION

I

Section H, Deliveries or Performance, and Modification A00001 dated 8 September 1977, are amended as follows:

CLIN	Delivery Days After Effective Date of Contract FROM	TO
0001AB - Confirmatory Samples	600	720
0001AC - Pilot Run	810	930
0003 (B002) Test Report on Confirmatory Samples	600	720
0004 (C003) Final Report	930	1050
0004 (C004) General Report Step II	930	1050
0004 (C005) Pilot Line Rate Report	600	720
0006 - Production Capability Demonstration	870	990
0007 (E001) Production Capability Demonstration Plan	810	930
0008 - Additional Life Testing	930	1050

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 1 COPY TO ISSUING OFFICE

14. NAME OF CONTRACTOR LASER DIODE LABORATORIES, INC.
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) JOHN A. BEEKMAN
19. DATE SIGNED 1978 MAR 20

30-101-01

☆ U.S. GOVERNMENT PRINTING OFFICE: 1967—

Modification No. P00002 to:
Contract No. DAAB07-76-C-0040

II

The consideration for this extension in Delivery Schedule is the additional tasks required to fabricate one and two stripe devices as outlined in Modification P00001 to this Contract (currently awaiting execution by Contractor).

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.

GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

MODIFICATION OF CONTRACT

PAGE 1 OF 2

1. MODIFICATION NO. P00003
2. EFFECTIVE DATE: See Block 19 below
3. REQUISITION/PURCHASE REQUEST NO.: N/A
4. PROJECT NO. (If applicable)

5. ISSUED BY: COMMUNICATIONS SYSTEMS PROCUREMENT BRANCH, DIRECTORATE OF PROCUREMENT, FT MONMOUTH, NJ 07703 — CODE W15P7T
Buyer/Symbol: CPT Roy L'Heureux/ DRSEL-PP-C-CS-2(LHE) Phone: 201-532-1412

6. ADMINISTERED BY (If other than block 5) — CODE S3101A
DCASMA, Springfield
240 Route 22
Springfield, NJ 07081

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code) — CODE 4D331 — FACILITY CODE
LASER DIODE LABORATORIES, INC.
205 Forrest Street
Metuchen, NJ 08817

8. ☐ AMENDMENT OF SOLICITATION NO. ____
DATED ____ (See block 9)
☒ MODIFICATION OF CONTRACT NO. DAAB07-76-C-0040
DATED 76 JUN 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 ACKOWLEDGMENT 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 ____
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF MODIFICATION

Contract DAAB07-76-C-0040 is changed as follows:

I

Section F, Description/Specifications, is amended as follows:

Section F.48, Subparagraph 4:

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-I-PI-1 to Commander, US Army Electronics Research and Development Command, ATTN: DELSD-D-PC.

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 ____ COPIES 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
1978 MAY 16

Modification P00003 to:
Contract No. DAAB07-76-C-0040

Section H, Items 0001AB, B002, D001:

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.

Section H, Items C001, C002, C004, C005, E001

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

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 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)-532-1412

Section M is amended as follows:

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

Change Code W15P7N to W15P8S.

Modification P00003 to:
Contract No. DAAB07-76-C-0040

II

PCO responsibility for this contract has changed as follows:

FROM	TO:
Mr. Gordon McMain DRSEL-PC-C-CS-1	STEPHEN L. THACHER Major, Signal Corps DRSEL-PC-C-CS-2(THA) Phone: (201)-532-3506

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-0040, P00004
2. EFFECTIVE DATE	See Blk 19
3. REQUISITION/PURCHASE REQUEST NO.	N/A
4. PROJECT NO. (If applicable)	
5. ISSUED BY — CODE W15BAY	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) — CODE S3101A	DCASMA, Springfield 240 Route 22 Springfield, New Jersey 07081
7. CONTRACTOR NAME AND ADDRESS — CODE 40331 — FACILITY CODE	Laser Diode Laboratories, Inc. 1130 Somerset Street New Brunswick, New Jersey 08901

RECEIVED NOV 20 1980

8.
☐ AMENDMENT OF SOLICITATION NO. ______ DATED ______ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DAAB07-76-C-0040 DATED 76 Jun 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 L.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 INJECTION LASER DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS.

PART II, THE SCHEDULE, SECTION E is amended as follows:

Add SLIN 0001AD to SUPPLIES/SERVICES

"0001AD Three (3) each LASER STACKS
LDL Part No. IRE 167 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 1 COPY TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR — BY (Signature of person authorized to sign)	[signature]
15. NAME AND TITLE OF SIGNER (Type or print)	THOMAS E. STOCKTON, V.P. ENGINEERING
16. DATE SIGNED	10 Nov 80
17. UNITED STATES OF AMERICA — BY (Signature of Contracting Officer)	[signature]
18. NAME OF CONTRACTING OFFICER (Type or print)	JOSEPH E. FEENEY
19. DATE SIGNED	17 NOV 1980

U.S. GOVERNMENT PRINTING OFFICE: 1977-247-346

II

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

1. 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."

2. 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:

CLIN/SLIN	ITEM	DELIVERY DATE
0001AA	Engineering Samples Total 26 each (Lot 1 & 2)	Received & Accepted Nov 1977
0001AB	Confirmatory Samples 25 each (Lot 1)	Received & Accepted 3 July 1979
	25 each (Lot 2) (Life Test Units)	Not Later Than 27 Feb 1981

Contract No. DAAB07-76-C-0040
Modification No. P00004
Laser Diode Laboratories, Inc.

REVISED DELIVERY OR PERFORMANCE SCHEDULE (Continued)

CLIN/SLIN	ITEM	DELIVERY DATE
0001AC	Pilot Run Samples	
	50 each Single Stripe Units	Received & Accepted 15 Aug 1980
	50 each Double Stripe Units	Received & Accepted 24 Sep 1980
	200 each Triple Stripe Units	5 Dec 1980
0001AD	LASER STACKs - 3 each	Not Later Than 27 Feb 1981
0002/A001	PERT	Received & Accepted
0003/B001	Engineering Sample Test Report (For Lots 1 & 2)	Received & Accepted
0003/B002	Confirmatory Sample Test Report (For Lots 1 & 2 except Life Test)	Received & Accepted
0004/C001	Monthly Technical Reports	
	Reports for July 1976 thru Sep 1980	Received & Reviewed
	Oct 1980 Report	Not Later than 10 Nov 1980
	Nov 1980 Report	Not Later than 10 Dec 1980
	Dec 1980 Report	Not Later than 10 Jan 1981
0004/C002	Quarterly Reports	
	Reports for Sep 1976 thru Aug 1980	Received & Reviewed
	Oct 1980 Report	Not Later Than 10 Nov 80
0004/C003	Final Report	
	Draft	14 Nov 1980
	Final	27 Feb 1981

REVISED DELIVERY OR PERFORMANCE SCHEDULE (Continued)

CLIN/SLIN	ITEM	DELIVERY DATE
0004/C004	General Report - DELETED (Incorporated as "Executive Summary" in Final Report)	--
0004/C005	Pilot Line Rate Report - DELETED (Incorporated in the Final Report)	--
0005/D001	Test Plan (Confirmatory Sample)	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

CLIN/SLIN	ITEM	FINAL INSPECTION/ACCEPTANCE PERFORMED BY: *
0001AA	Engineering Samples	Received & Accepted
0001AB	Confirmatory Samples	
	Lot 1	Received & Accepted
	Lot 2 (After Life Test)	DELNV-L

INSPECTION AND ACCEPTANCE (Continued)

CLIN/SLIN	ITEM	FINAL INSPECTION/ACCEPTANCE PERFORMED BY: *
0001AC	Pilot Run Samples	
	Single Stripe Units	Received & Accepted
	Double Stripe Units	Received & Accepted
	Triple Stripe Units	DELNV-L
0001AD	Laser Stack Units	DELNV-L
0002/A001	PERT	Received & Accepted
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	DELNV-L
	Final	DELNV-L
0005/D001	Test Plan (Confirmatory Sample)	Received & Accepted
0006	Production Capability Demonstration	DELNV-L
	Draft Invitation Letter	DRDCO-PC-D
0007/E001	Production Capability Demonstration Plan	
	Draft	DELNV-L
	Final	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.

INSPECTION AND ACCEPTANCE (Continued)

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 Triple Stripe Units (pilot run) will be performed at the factory of the contractor by:

*DCASMA

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.

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

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

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

INSPECTION AND ACCEPTANCE (Continued)

For Code DRDCO-COM-RM-1:

Commander
USA CORADCOM
CENCOMS
ATTN: DRDCO-COM-RM-1 (Mr. L. Coryell)
Fort Monmouth, New Jersey 07703

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:

ITEM NO.	LOCATION OF	
All	Final Manufacture	New Brunswick, New Jersey 08901
	Packaging and Packing	New Brunswick, New Jersey 08901
	Shipping Point	New Brunswick, New Jersey 08901

Contract No. DAAB07-76-C-0040
Modification No. P00004
Laser Diode Laboratories, Inc.
Page No. 8 of 9

CONTRACT ADMINISTRATION DATA (Continued)

ITEM NO.	LOCATION OF	
	Producing Facilities Locations	Laser Diode Laboratories, Inc., Owner 1130 Somerset Street New Brunswick, New Jersey 08901 105 Forrest Street Metuchen, New Jersey 08817

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:

DD Form 1423 Data Requirements, pages 51 through 56 revised - copies 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

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.

Initiating Activity: CORADCOM/CENCOMS
Prev Allot No.: 2162035 6627510 P5297 2510 S28043
JCH/gms

APPENDIX C

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Princeton, NJ 08540
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1049 Camino Dos Rios
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Thousand Oaks, CA 91360
ATTN: Dr. P.D. Dapkus

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Technology Research Center
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El Segundo, CA 90245
ATTN: H.D. Law

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Palo Alto, CA 94303
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San Diego, CA 92152

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Bedford, MA 01730
ATTN: Dr. J. [illegible]

Reliability Analysis Center
ATTN: RBRAC (Mr. I. Krulac)
Griffiss AFB, NY 13441

Commander, Rome Air Development Center
ATTN: RADC/DCCT (Mr. P.Sierak)
Griffiss AFB, NY 13441

Commander
US Army Satellite Communications Agency
Fort Monmouth, NJ 07703
ATTN: DRCPM-SC-3

Commander
US Army Avionics Research and
Development Activity
ATTN: DAVAA-D
Fort Monmouth, NJ 07703

ITT Electro-Optical Products Div
7635 Plantation Road
Roanoke, VA 24019
ATTN: Mr. R. McDevitt

Hughes Aircraft Corp
Tucson Systems Engrg. Dept.
PO Box 8[illegible]
Tucson, AZ 85734
ATTN: Mr. D. Fox

Tri-Tac Office
ATTN: TT-DA (Mr. C. Arnold)
Fort Monmouth, NJ 07703

Advisory Group on Electron Devices
ATTN: Secy, Working Group D(Lasers)
201 Varick Street
New York, NY 10014

Raytheon Company
Communications Systems Directorate
Equipment Division
528 Boston Post Road
Sudbury, MA 01776
ATTN: Mr. T. Kelly

General Optronics Corp
3005 Hadley Road
South Plainfield, NJ 07080
ATTN: P.W. Hankin

Motorola, Inc.
High Frequency and Optical Products Div
5005 East McDowell Road
Phoenix, AZ 85008
ATTN: J.C. Herman

The Plessey Company, LTD
Allen Clark Research Center
Caswell, Towcester
Northants, England NN12 8EQ
ATTN: R. Davis

Commander
Naval Ocean Systems Center
Code 4400
San Diego, CA 92152
Attn: Mr. R. Lebduska

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Harris Government Comm Systems Div.
P.O. Box 37
Melbourne, FL 32901
Attn: Mr. R. Tainter

ITT Defense Communications Division
492 River Road
Nutley, NJ 07110
Attn: Dr. P. Steensm.

GTE Products Corp
Communications System Division
189 B Street
Needham Heights, MA 02194

Commander
Naval Avionics Facility
Code D831
Indianapolis, IN 46218
Attn: Mr. R. Katz

Mitre Corp.
P.O. Box 208
Bedford, MA 01730
Attn: Mr. R. Hazel

National Bureau of Standards
Electromagnetic Tech Div
Boulder, CO 80303
Attn: Dr. G. Day

Defense Logistics Agency
Attn: DESC-EMT (Mr. A. Hudson)
Dayton, OH 45444

Commander
Air Force Avionics Laboratory
Attn: AFAL/AAD-2 (Mr. K. Trumble)
Wright-PattersonAFB, OH 45433

CDR, US Army Signals Warfare Lab
Attn: DELSW-OS
Arlington Hall Station
Arlington, VA 22212

CDR, US Army Signals Warfare Lab
Attn: DELSW-A[illegible]
Arlington Hall Station
Arlington, VA 22212

Commander
US Army Logistics Center
Attn: ATCL-MC
Fort Lee, VA 2[illegible]

Commander
US Army Training & Doctrine Command
Attn: ATCD-TEC
Fort Monroe, VA 23651

Commander
US Army Training & Doctrine Command
Attn: ATCD-TM
Fort Monroe, VA 23651

NASA Scientific & Tech Info Facility
Baltimore/Washington Intl Airport
P.O. Box 8757
Baltimore, MD 21240

CDR, US Army Research Office
Attn: DRXRO-IP
P.O. Box 12211
Research Triangle Park, NC 27709

Director
U.S. Army Material Systems Analysis Actr.
Attn: DRXSY-MP
Aberdeen Proving Ground, MD 21005

Advisory Group in Electron Devices
201 Varick Street, 9th Floor
New York, NY 10014

Commander
ERADCOM
Fort Monmouth, NJ 07703
Attn: DEL[illegible]-D

Commander
ERADCOM
Fort Monmouth, NJ 07703
Attn: D[illegible]SD-I-S

Commander
CECOM
Fort Monmouth, NJ 07703
Attn: DRSEL-COM-D

Commander
CECOM
Fort Monmouth, NJ 07703
Attn: DRSEL-SEI

Commander
CECOM
Fort Monmouth, NJ 07703
ATTN: DRSEL-COM-RM-1 (Mr. L. Coryell)
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Washington, DC 20390

Rome Air Development Center
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Washington, DC 20310

Director
US Army Human Engineering Labs
Aberdeen Proving Ground, MD 21005

CDR, AVRADCOM
Attn: DRSAV-E
P.O. Box 209
St. Louis, MO 63166

Director
Joint Comm Office (TRI-TAC)
Attn: TT-AD (Tech Docu Cen)
Fort Monmouth, NJ 07703

Dir., US Army Air Mobility R&D Lab
Attn: T. Gossett, Bldg. 207-5
NASA Ames Research Center
Moffett Field, CA 94035

HQDA (DAMI-TNE)
Washington, DC 20310

Deputy for Science & Technology
Office, Assist Sec Army (R&D)
Washington, DC 20310

Commander, DARCOM
Attn: DRCDE
5001 Eisenhower Avenue
Alexandria, VA 22333

END

DATE

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