



W.W. Hansen Experimental Physics Laboratory
Stanford University
Stanford, California 94305-4085

Gravity Probe B Relativity Mission

Payload Electronics Manufacturing Report "Lessons Learned ... Gravity Probe" Zentek Scientific

S0975 Rev. -
April, 2004

Approved by:

Approved by:

William Bencze 24 MAY 04 Dorrene Ross 5/28/04
William Bencze, Electronics Mgr.. Date Dorrene Ross, QA Manager Date

ITAR Assessment Performed:

T. Langenstein 24 May '04 ITAR Control Required? ☐ Yes ☒ No
T. Langenstein Date

ARCHIVE COPY

Lessons Learned.....

.....Gravity Probe-B

Assembly of the Payload Electronics:

Telescope Readout Electronics
Experiment Control Unit
SQUID Readout Electronics
Gyro Suspension System

By:

Neil Davies

Zentek Scientific
27738 Industrial Rd.
Hayward, California 94545

A report commissioned by the Gravity Probe-B program at Stanford University, Stanford,
California

1. Summary

Zentek Scientific was surveyed by Rusty Gray and Mike Sisley of Lockheed Martin Missiles and Space (LMMS) Quality Assurance November of 1997 for potential work on the Gravity Probe-B (GPB) payload electronics for Stanford University (SU). This work consisted of assembly of printed wiring boards in accordance with NASA standards. We had just finished up a Blanket Purchase Agreement (BPA) with NASA, Ames for flight assembly and assumed this endeavor would be similar. By April of 1998, Zentek had executed a Blanket Purchase Agreement with LMMS, Sunnyvale and had a set of prints in hand for the Telescope Readout Electronics (TRE). Once completed, the TRE was followed closely by the Experiment Control Unit (ECU) and the SQUID Readout Electronics (SRE). LMMS was responsible to Stanford for the design, and assembly of the TRE, ECU and the SRE. Stanford undertook the task of design for the Gyro Suspension System (GSS). In all cases, LMMS supplied all of the material to Zentek who then performed all of the assembly tasks with the exception of conformal coating and much of the staking. Zentek did not have significant contact with SU until mid-1999.

Initially, it was requested by LMMS that all communications; engineering or administrative, occur through the purchasing representative in Sunnyvale. As this was found to be unworkable, Zentek was able to become acquainted with the following personnel:

QA:	LMMS:	Rusty Gray, Mike Sisley , Dave Seidl, Jim Nix, Carla Barnes, Mitch Baziuk
	SU:	Dorrene Ross
QE:	LMMS:	Tom Clifford, Chuck Fischer (M&P labs)
EE:	LMMS:	Hugh Dougherty, Bill Reeve, Bob Farley (TRE), John Thatcher (ECU), Terry McGinnis (SRE)
	SU:	Dave Manner, Bill Bencze (GSS), Jay Dusenbury , Scott Smader
ME:	LMMS:	Bob Ajitomi
	SU:	Ed Koester
Materials:	LMMS:	Pat Sargent , Jenny Spooner, Ed Lew, Lou Yamanishi, Son Tran

Those names in **bold** were daily contacts and in fact (with consent) we had their home phone numbers in addition to the Stanford Messaging system. Many times, we found ourselves working late into the night and on weekends. After all, to all of us, this endeavor was probably one of the most important things in our lives at that time. Without direct access to these people, information quality suffered and decisions were frustrated.

Assembly work and revision upgrade proceeded intensely until mid 2001. In November of 2003, a problem with the ECU was discovered and the launch date of December 6th, 2003 was scrubbed. A solution was found for the ECU which involved building a second module (with some additions) while waiting for the original to be removed from the spacecraft. The finished module left Zentek on December 18, 2003. The launch date was moved to April 17, 2004 and finally occurred on April 19th of 2004. A contingent from Zentek made the journey to Vandenberg AFB to witness a spectacular liftoff.

2. Zentek Scientific

Zentek is a ***build-to-print*** contract manufacturer and was founded on a kitchen table in November of 1988. At that time we landed a contract with Schlage Lock which lasted a number of years. Much of the experience that Zentek has was gained prior to this while re-establishing the manufacturing capabilities of another company who had some prime contracts with the U.S. Army. We were tasked with recreating Quality Systems and High Reliability Workmanship standards without the handicap of preconceived notions or bad habits. Also a harmonious relationship with DCASMA (DCMA), DCASPRO and DCAA had to be established because these contracts had been guaranteed by the SBA. After passing audits and obtaining the required certifications, we completed and delivered the company's stalled military and commercial contracts. Current information on Zentek can be found at www.ZentekScientific.com. In October of 2003, Zentek was audited for work on ST-7 by NASA's Jet Propulsion Laboratory and was approved (with some deficiencies). The following three pages will serve to summarize our capabilities:

Zentek Scientific Systems

What are we?

Zentek Scientific is a contract manufacturer that principally manufactures electronic assemblies in accordance with customer-supplied prints while conforming to current high-reliability workmanship and quality standards.

Who are our customers?

Most of our end-users have been government or academic. Flight or Payload electronics accounts for as much as 80% of our volume. The balance of our work is either ground support or industrial/commercial. The latter we encounter when those from these sectors have been dissatisfied with vendors' quality, cycle time or disinterest due to low volumes.

What are our capabilities?

Our greatest capability is to assemble articles that meet all of the requirements of the assembly documentation without failure. This may require our assistance with parts procurement, drawing or drawing note generation, manufacturability or producibility issues, or even design and layout.

Workmanship standards are:

NASA-STD-8739.2 (SMT Fabrication and Rework)

NASA-STD-8739.3 (Soldered Electrical Connections)

Quality system standard:

MIL-STD-45208A (Quality System Requirements)

IF FURTHER INFORMATION IS NEEDED, PLEASE DO NOT HESITATE TO CONTACT US. Check out www.zentekscientific.com.

TOM DUKE

QA MANAGER

510-786-1469

EQUIPMENT LIST

5000 square foot facility securable to SECRET
15" Electrovert Econopak 229 Wave soldering machine
Vapor degreaser cleaning system
Aqueous saponifier cleaning system
Alpha Ionograph (cleanliness tester)
Barco Steamager (solderability testing)
Manncorp Automatic Pick & Place
Preciplacer Pick & Place
Binks conformal coating booth
Dynamic wave solder pot
Various static solder pots (Waage)
Hakko and Metcal soldering irons
Technical Devices, Heller, Hepco and Electroprep formers (25 dies)
Unitron ZSB Stereo microscopes (7x - 45x)
Mechanical Inspection Magnifying ring lights (4x)
Ultraviolet inspection station
Blue M oven
House vacuum and dry nitrogen
Cenco vacuum pump and bell jar
De Haart stencil printer
Kingsley wire stamping machine
Bonded stock room
Recording multimeter
Hipot tester
DIMA IR convection reflow oven
Calipers, gauges, torque wrenches, torque screw drivers
Labconco laboratory hood
Potting station
20 megohm-cm D.I. water system
Spectrascan facility ground, heel strap and wrist strap checker
ESD benches, chairs, floor protection and monitoring equipment
Wire rack and tool crib
Customer/government test room with computer and phone
Digital camera with email format
Training video equipment
100 gallon shop compressor
Cambion swage
Receiving inspection station
QA quarantine area
Eubanks 2600 Automatic wire cutter/stripper and despooler
Simco calibration contract

CUSTOMER LIST

<u>CUSTOMER</u>	<u>CONTACT</u>
LOCKHEED MARTIN MISSILES & SPACE	LUCY SPRINGMEYER 408-743-6616 PAUL SMICK 408-743-5554
N.A.S.A., AMES RESEARCH CENTER	MICHAEL STOCK 650-604-1718
JET PROPULSION LABORATORY	ANTHONY LAI 818-354-0473
LOCKHEED MARTIN MISSILES & SPACE (ADVANCED TECHNOLOGY CENTER)	ANTHONY MAGONCELLI 650-424-3438 BOB BUMALA 650-354-5918
EXPERT MICROSYSTEMS	R.BICKFORD 916-989-2018
STANFORD UNIVERSITY (GPB)	DR. BILL BENCZE 650-725-5691 TOM LANGENSTEIN 650-725-1408
L3 ELECTRON DEVICES	FRANK BARTLETT 650-591-8411
LOCKHEED MARTIN MISSILES & SPACE (PALO ALTO)	MIKE SISLEY 650-424-2235
U. C. BERKELEY (SPACE SCIENCES)	DR. BARRY WELSH 510-643-1461

OTHERS AVAILABLE ON REQUEST

3. Manufacturing and Support

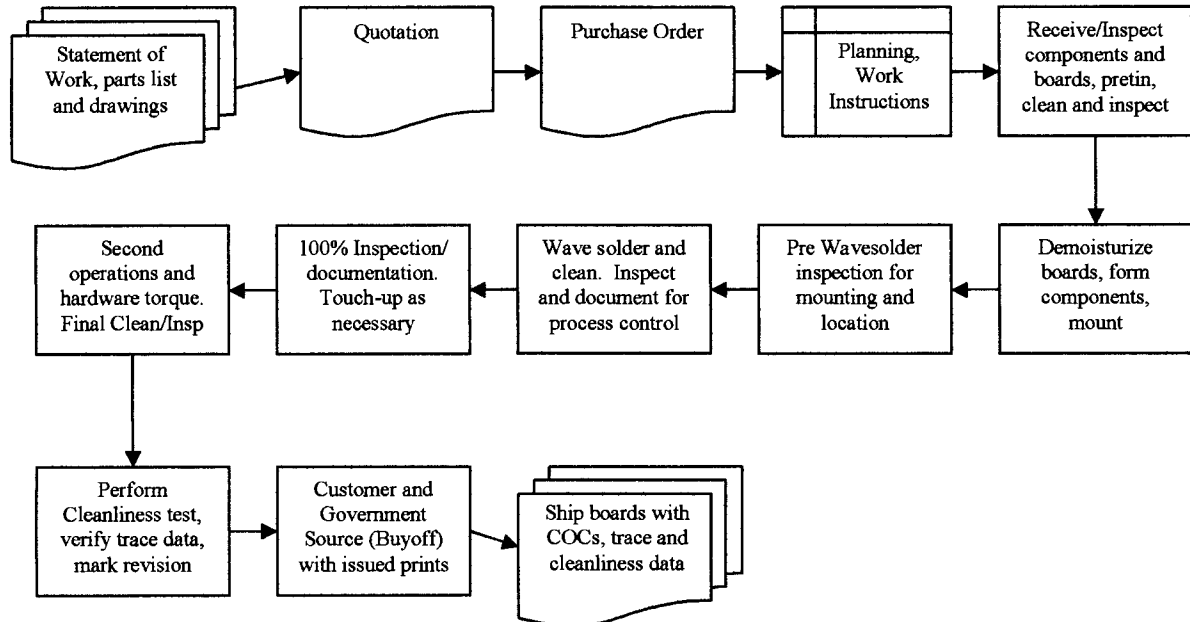
Standard Processes [Surface Mount Technology (SMT) processes not included for brevity]

Glancing at the following page one may see the basic steps used to build boards of a mature design:

1. A request for quote (RFQ) providing a statement of work (SOW), prints, drawings and a parts list would be evaluated by quality engineering and sales. The prints or SOW would normally define the workmanship to be in accordance with flight standards such as NASA-STD-8739 and require a quality system at least compliant with MIL-I-45208.
2. A quotation is produced providing price and delivery together with any assumptions such as the provision for a spare board for forming, etc.
3. Work would not start without a Purchase Order which would provide administrative and technical points of contact.
4. In accordance with our quality system, job planning and work instructions would be developed including inspection steps.
5. At the same time components would be received and inspected, cleaned and pretinned. Component certs (COC) and traceability data would be confirmed.
6. Component forming and bare board demohumidizing (baking) is followed by mounting and inspection of parts per the work instructions.
7. The wavesoldering step normally starts with the spare board to adjust wave height, conveyor speed and upper and lower preheat temperatures among other process indicators. A first article would then be run and inspected for solder quality. All process variables are recorded along with any adjustments necessary to produce optimum quality for that particular board. The balance of the order is then run.
8. All boards are cleaned, inspected for conformance to the flight standards and touched up as necessary. Second operations would then be performed which might include the addition of hardware or the installation of modules or other components. Final cleaning and inspection are performed including a cleanliness test. PWA part number and revision level are then marked and component traceability data verified and recorded.
9. The customer then shall inspect each assembly and any documentation used in its manufacture for conformance to the SOW, drawing notes. Sometimes a government representative is delegated to perform this task as part of the formal acceptance of hardware.

10. If any deficiencies are found, corrective action is accomplished on the hardware and on the process that allowed them. If all is well, the hardware is accepted and delivered along with the traceability documentation and test data.

Standard build-to-print model:



These tasks are so apparent and easily costed that purchasing departments treat assembly of PWAs as a commodity.

The Gravity Probe-B payload electronics effort was a **departure** from this model as is illustrated below.

The creation of a printed wiring assembly (PWA) is 100% defined by the approved and issued engineering drawing for that board. This includes a parts list and an assembly drawing with notes. For a mature product, the drawing is (usually) also mature. Through drawing revision, all of the questions that arise during attempts to build it have been answered in the form of additional notes or drawing modifications. This is the essence of **manufacturability** of an item. Does the drawing answer all of the questions an assembler might have in an unambiguous manner? In the case of GPB, none of the designs were mature and in fact most if not all started as revision dash (-) or NC. This is the first attempt to build these items and so a significant amount of time was expended on 'maturing' these drawings so that quality products could be produced. In addition to drawing revision due to manufacturability problems, there was also revision due to electronic design changes as one might expect.

On April 7th 1998, Zentek received parts kits to build the TRE. The plan was that parts would be sent over in kits from LMMS, Palo Alto as they became ready and after orders were placed against the BPA Zentek had with LMMS, Sunnyvale. Upon auditing the kits, there were significant **shortages**; 20% of the parts were missing. Shortages were parts that were on order and not yet arrived at LMMS or parts ordered late because the

list had changed since the parts order had been placed. This is a common problem and did not delay starting the task of building the board. It did impact the cost however because shortages had to be managed as a subset of the job.

Printed wiring board (**PWB**) *design* and layout has a huge impact on whether or not it can be assembled. The TRE was so dense that capillary action of components in contact with each other caused flux to become entrapped and very difficult to remove. Also the lead length of the P1 and J3 connectors was insufficient to protrude past the farside surface of this thick board. As there was no time to order new parts with the correct lead length, **assembly technique must augment design shortfall** by removing just enough solder from the farside fillet to expose evidence of lead end in the plated through hole (PTH). This single oversight added 25% to the assembly time of the TRE. Another problem was the **lack of connector hardware** (and torque specs) and the proper positioning of connectors on the board. After learning that these boards had to fit snugly in the TRE enclosure guides and achieve a mating condition of the connectors, we found it necessary to sacrifice a set of boards and connectors to function as an assembly jig to pre-position connectors prior to soldering. If this was overlooked the natural hardware clearances would have positioned the connectors askew. On one of the connectors, there was a real potential for **electrical shorting of traces** adjacent to the hardware. Occasionally, a component would not fit into the board because of **improper lead spacing** or **wrong component packaging** (e.g. dip I.C. instead of can). A process must then be written and approved to make a round part fit into a square pattern or to part 'dead-bug' a component (to epoxy a radial component upside-down on the board with its leads or haywires routed to and soldered in the proper locations). Assembly processes must be considered during the layout of the PWB and population of the parts list.

One of the requirements for flight hardware is the establishment of component pedigree. Lot-date codes are to be visible and recorded along with reference designator and manufacturer. In some cases the **traceability information was incomplete** and needed to be researched through the LMMS P.O. number. The LMMS personnel were able to reconstruct missing data in all cases and the delays were minimized as the project progressed. Other laborious problems included sorting out multiple date-coded parts (same part number) that were packaged together, solderability of some of the older components and the lack of an identifiable manufacturers' part number on the parts list.

In order to reduce confusion over revision of the drawings and configuration of the PWAs, LMMS proffered that all changes should be contained in a single revision letter change which would be marked after test and acceptance. The decision to **not mark rev letters** immediately after assembly was rapidly set aside because changes were occurring more often than one would have predicted. Each time a set of changes is implemented on a board (even if it only involves the removal and replacement (R&R) of a couple of resistors), Zentek was required to:

1. produce a quotation, receive a PO, create planning
2. receive and inspect the errant board and new parts
3. remove the local conformal coating (if coated)

4. reprocess the PWA (e.g. R&R the components, clean and inspect)
5. remove old revision markings
6. clean and perform cleanliness test
7. bake (Demoisturize) PWA and apply new revision letter
8. change and re-document traceability data
9. entertain customer source inspection, ESD pack, ship and bill

Each time a 'revised' board would leave Zentek, we had to assume it was going to be flown. Thus, after building the TRE, it became a requirement for Zentek to mark revision letters at the time of assembly or rework to aid in the control of changes from both an engineering design and administrative standpoint.

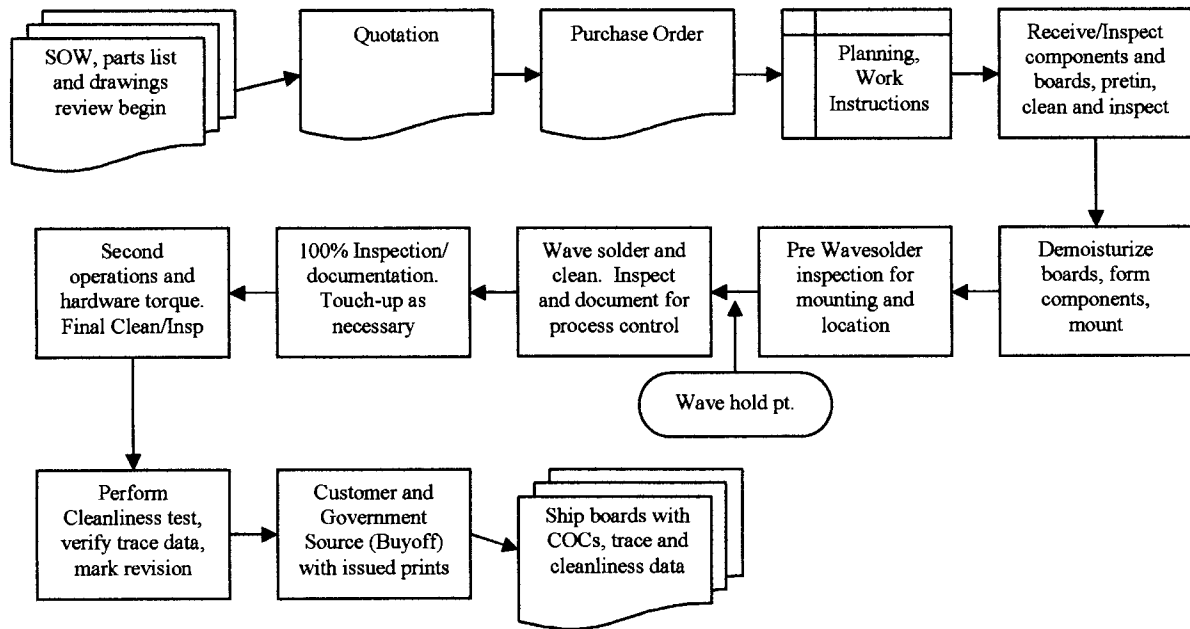
The TRE was challenging because in order to make it manufacturable, not only did the print and parts list have to evolve but so did Zentek's relationship with LMMS. As a result of the issues encountered with the TRE the following occurred:

1. **Stockroom.** Zentek would receive all of the GPB stock and create and maintain our own flight stores. Pretinning of all components could proceed uninterrupted and preliminary board/component fit check could be done. We would do our own kitting and provide shortage data and traceability questions to LMMS.
2. **Engineering review** of the drawings would be performed at Zentek prior to order placement or quoting. When problems were discovered, solutions were proffered so that meetings with Engineering and QA were short and decisive.
3. **VRIC** (Vendor Request for Information or Change) forms were used as the vehicle to communicate, document and approve changes. This is an LMMS document. Discrepancy reports (DR) were also used to document non-conforming material.
4. **Access.** Zentek was allowed unfettered access to some LMMS personnel; the responsible electronics engineer (REE) for each design, a flight components engineer and a stockroom coordinator for traceability data.
5. **Redline** procedure was created with the blessing of QA that provided immediate authorization to proceed with accepted written changes to the drawings or parts list (PL) without having to wait for those changes to become published. However, formal incorporation and issuance of the revised document was mandatory prior to source inspection and shipment.
6. **Wavesolder Hold Point.** This was a self imposed point beyond which the assembly process would NOT proceed until: VRICS were answered,

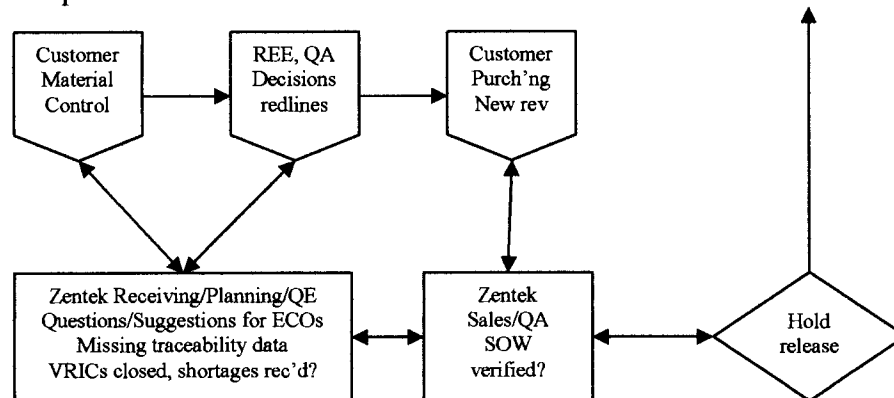
approved redlines were in hand, all trace data was verified and all shortages were filled. It reduced the need to de-solder components from PWAs.

7. **Zentek Status Sheets.** Initially LMMS purchasing was tasked with keeping track of the progress of each of the board orders with a status sheet but the usefulness of the data was limited and required interpretation. With their blessing, Zentek was allowed to expand the Status Sheet to include information useful to all including Stanford. Daily to weekly distribution of the Zentek Status Sheet was done electronically and available to all cognizant personnel in engineering, purchasing, material control, QA and management.
8. **Suggestions for Improved Manufacturability.** In August of 1998, soon after the TRE was delivered to LMMS, Zentek compiled a list of generic engineering suggestions to assist designers of the ECU, SRE and GSS.

Standard build-to-print model with hold point added:



Hold point decisions:



From June 1998 to January 2002, the assembly effort continued unabated. The vast majority of the parts were of the leaded variety although when SMT was used it usually involved chip resistors and capacitors. The following production chart (see appendix) provides some detail regarding change activity (revision letters) and the number of times PWAs were in Zentek's possession; returned from LMMS or Stanford (each color change). The left-hand columns show the assembly part number and system, PWA name, responsible engineer, the need for a fixture and the flight quantity (including spares) of PWAs that were assembled. Usually the first drawing was issued without changes (rev NC) and then evolved over time. When revision letters are followed by plus signs it denotes additional changes authorized by redlines or deviations. Instances where colors

change with the same rev letter denote occasions when components are being removed and replaced. PFB denotes pseudo-flight board. Note: some of the more trivial changes such as single component replacement or select-at-test additions were completed and shipped in a couple of days or a week but are being denoted as month-long endeavors.

The High Voltage Amp/Bridge Forward Suspension Unit (8A01879)

This PWA merits comment because it was the most challenging and unique. Zentek worked on this board with Jay Dusenbury (REE) nearly continuously for over two years. Initially two non-flight (NFI) prototypes were built using a mix of commercial and flight-like components to serve as an engineering path finder. A sample of some of the interesting problems follows:

1. The NFI units used many commercial parts that misrepresented the problems that would be faced when building the flight units with flight rated parts. For instance electrical characteristics may change and available packaging certainly changed. This meant that manufacturability issues could not be flushed out until assembly of the flight units was attempted.
2. The coaxial high voltage wire connections were to be made using solder sleeves but the foam insulation was so susceptible to damage from heat that it would melt before the solder in the solder sleeve. The solution was to ask the manufacturer of the solder sleeve (Sumitomo) to make 'solderless' solder sleeves and then solder these connections by hand and then apply the sleeve.
3. A hipot test of the heatsink clips led to the discovery that their nickel plating was flaking off which could cause the FETs that they held to short and fail. Subsequent destructive testing at M&P labs (LMMS) showed a serious lack of plating adhesion. A proper plating process was researched and all of the clips were stripped and re-plated.
4. The HVA used two specialized triaxial connectors that refused to stay assembled. In addition the ground cup was impossible to solder to. Significant mechanical changes were proposed and implemented to improve connector reliability and grounding.
5. Connection to triax connectors was to be made via a flimsy 'flying lead' that was susceptible to breakage by vibration or handling. A 'bridge' was fabricated out of FR-4 to which the lead was staked and PWA handling procedures were developed to preclude damage.

Rework due to Zentek Error

On three occasions, errors were made at Zentek due to lack of control of board or parts list revision. In one case it led to removal and replacement of 17 relays on three boards

because of a single digit error in an updated part number. The part number had been changed and we didn't realized it even though we had the updated drawing and [what we thought were] duplicate parts. Corrective action was implemented that required the revision block of a drawing be checked as part of the SOW at the hold point. This action was effective and prevented further occurrences.

Other Generic Problems Involving Layout, Mounting or Materials

Silk screened reference designators coming off boards
Conductive bodies over traces
Trace cuts and jumpers (haywires) added
Jumpers to leadless parts
Heat dissipative components with no heat conductive site or materials
Lack of component footed pads or standoffs
Re-machining of aluminum standoffs, brackets, straps as necessary to fit
Use of leaded (or leadless) components when site designed for leadless (or leaded)
Use of round lead pattern components when site designed for dual in-line
Some component mounting solutions had to be proven out on the vibration table
RBR resistor bodies or other special components vulnerable to alcohol
Silkscreen errors leading to reversed diodes or mis-clocking of round patterns
Unsupported or precariously supported components
Oil-canning of modules leading to suspect reliability and multiple replacements
Connector to connector dimension critical necessitating creation of assembly fixtures
Revisions to PWAs occurring after conformal coating necessitating coating removal
Outgassing data not provided
Winchester connector epoxy failure necessitating removal/replacement of 15 connectors
Lack of wire lists necessitating build-to-schematic.
Low resistance paths had to be created through plating and bonding
Had to strip and re-plate HV heatsink clips
High component density due to reduced board area in high voltage situations
Failed parts that manufacturer or had repaired that had failed again (x-ray analysis)

Approach to Problem Resolution: *Stewardship of the Assemblies*

Attitude, advocacy and trust are probably the most valuable characteristics of the relationships Zentek formed with Lockheed and Stanford. We became a partner rather than just some 'stuffing house': we had their full support and they had ours. After an initial courtship with TRE, we were given the freedom to create and research and collaborate so that the best, most reliable solutions were brought forward. In fact Zentek found itself coordinating and managing some of the activities. We found ourselves working late nights and weekends and enjoyed it. It is interesting to note that some modern Quality Management Specifications wax philosophic about this issue (see: ISO 9001 clause 5.5.3 or 6.2.2.d or ISO 9004-1).

4. Lessons and Recommendations

Positive:

1. The willingness on the part of QA and Engineering departments at both Lockheed and Stanford to allow us to partner with them was critical to the production of quality flight electronics. **Lesson: It was essential for Zentek to have access to the REE, ME, Material Control and anyone else we needed to talk to.**
2. Creation of the status sheet by purchasing and subsequent expansion and distribution of it by Zentek accomplished many things not least of which was the expediting of critical path issues. **Lesson: Daily to weekly electronic statusing is a valuable communications tool.**
3. The GSS benefited from the manufacturability suggestions by incorporating them into the drawings before rev A. Change activity subsequent to that was limited to electrical design (see production chart). **Lesson: Perform a manufacturability review prior to production even if it means a first article.**
4. The redline procedure was likely the single most time saving procedure created. It allowed events to occur in parallel without having to stop production waiting for released drawings. **Lesson: Use of the redline procedure can help maintain schedule.**
5. The wave solder hold point provided a formal way for work to continue on a set of boards while engineering and manufacturability issues were being resolved. **Lesson: Use of the wave solder hold point can help maintain schedule.**

Negative:

1. The attempt by procurement (Lockheed, Sunnyvale) to treat this effort as mere commodities purchase led to frustration, confusion and delay. They were not able to handle the continuous change activity. We give them a lot of credit as many methods were tried: BPA, credit card, Rapid Procurement, Subcontracts, ATC purchasing, etc. At one point early on, purchasing would take a week to return a call. Eventually Rapid Procurement using 100% email communications coupled with quotations that attempted to predict change activity worked effectively. **Lesson: Building immature designs is dangerous if they are treated as commodities by purchasing.**
2. Zentek could have avoided removal and replacement of 51 relays if it had only checked the final revision of the parts list against the PWA. A single digit change is still a new part. **Lesson: If new parts are received, find out why and don't assume they're duplicates. Check newly issued prints more carefully.**

3. Schedule delays are accumulative so by the time one is actually ready to assemble a board the pressure to compromise is quite high. With ECU, prototyping and production seemed to run in parallel. The production chart shows a minimum number of boards assembled (few spares) and continuous change activity. This 'over-processing' has deleterious effects on the PWA. These days it would be wise to incorporate all changes in a new board layout and procurement of enough spare parts to support the effort. PWB fab houses are capable of 3 day turn around times and you end up with a reliable PWA with no jumpers or dead bugs that been processed only once. **Lesson: Layout and fab a new board.**

Recommendation:

No more incremental change activity occurring on flight boards. This increased cost, strained the schedule and beat-up the boards.

Rather:

1. Perform preliminary manufacturability review **BEFORE** pwbs are purchased.
2. Create a pseudo-flight board (PFB) with **ALL** flight parts that will function as a pathfinder.
3. Cut, jumper and dead-bug as necessary using only redlines.
4. Iterations ok but no traceability, no cleanliness testing, no coatings, no staking, minimal planning, source at destination. Time and material, non-flight quote. Confirm your electrical design. Include full integration if possible.
5. **NOW** build the flight units with a spare or two by:
6. Incorporate all changes in a new flight board layout and all redlines in final drawing revision. **FABRICATE NEW FLIGHT PWBs.** Quote flight firm fixed price.
7. Assemble the flight units a single time. Invoke all the usual requirements (cleanliness, traceability, coating, staking, thermal bonding, etc.).
8. This practice should produce flight hardware of the best possible quality and reliability.

Appendix

Abbreviations

Production Chart

Pictures

Sample Zentek Status sheet (1 of 159)

List of Zentek created part numbers and sample drawings

Abbreviations

ATC	ADVANCED TECHNOLOGY CENTER (LOCKHEED)
BPA	BLANKET PURCHASE AGREEMENT
COC	CERTIFICATION OF CONFORMANCE
DIP	DUAL INLINE PACKAGE
DR	DISCREPANCY REPORT
ECU	EXPERIMENT CONTROL UNIT
ESD	ELECTROSTATIC DISCHARGE
FET	FIELD EFFECT TRANSISTOR
GPB	GRAVITY PROBE-B
GSS	GYRO SUSPENSION UNIT
IC	INTEGRATED CIRCUIT
LMMS	LOCKHEED MARTIN MISSILES AND SPACE COMPANY
ME	MECHANICAL ENGINEER[ING]
NC	NO CHANGE OR NOT CHANGED
NFI	NON FLIGHT ITEM
PFB	PSEUDO-FLIGHT BOARD (FLIGHT PARTS, NO ENVIRONMENTAL)
PL	PARTS LIST
PO	PURCHASE ORDER
PTH	PLATED THROUGH HOLE
PWA	PRINTED WIRING ASSEMBLY (PWB WITH PARTS INSTALLED)
PWB	PRINTED WIRING BOARD (BARE BOARD ONLY – NO PARTS)
QA	QUALITY ASSURANCE
QE	QUALITY ENGINEER[ING]
R&R	REMOVE [THE OLD VALUE] AND REPLACE [WITH NEW VALUE]
REE	RESPONSIBLE ELECTRONICS ENGINEER
REV	REVISION
RFQ	REQUEST FOR QUOTE
SMT	SURFACE MOUNT TECHNOLOGY
SOW	STATEMENT OF WORK
SRE	SQUID READOUT ELECTRONICS
SU	STANFORD UNIVERSITY
TRE	TELESCOPE READOUT ELECTRONICS
VRIC	VENDOR REQUEST FOR INFORMATION OR CHANGE
ZSS	ZENTEK SCIENTIFIC SYSTEMS

PWA #	PWA Name	REE	Ti Fixture	Quantity	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Sep-98	Oct-98	Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99
8A00842 TRE	Analog	Bob Farley		7	C			D		E							
8A00843 TRE	Digital	Bob Farley		7		C	D		D	D							D
8A00856 ECU	GRT Readout	John Thatcher		1							NC		A				
8A00859 ECU	SDT Readout	John Thatcher		1							NC		A				
8A00862 ECU	QBS Heater	John Thatcher		2							NC		A				
8A00865 ECU	Aft GRT	John Thatcher		2													
8A00868 ECU	Latches	John Thatcher		2											NC	A	
8A00871 ECU	Open Loop Heaters	John Thatcher		2											NC	A	
8A00874 ECU	ADC	John Thatcher		2						NC	A						
8A00874GSE	ADC (Non-flight)	John Thatcher		2							NC	A					B
8A00877 ECU	Magnetometer	John Thatcher		2						NC			A				
8A00880 ECU	GMA Monitor	John Thatcher		2							NC						
8A00883 ECU	GMA Valve	John Thatcher		3											A		
8A00886 ECU	Vatterfly	John Thatcher		2											NC	B	
8A00889 ECU	UV Control	John Thatcher		2												A	B
8A00892 ECU	Data Cross-strap	John Thatcher		1							NC						
8A00895 ECU	1553 Interface	John Thatcher		2													
8A00898 ECU	Power Filter	John Thatcher		1					NC	NC			NC	A			
8A00901 ECU	Quiet Motherboard	John Thatcher		3				NC		NC				A			
8A00904 ECU	Aft Motherboard	John Thatcher		1			NC		NC								
8A00944 SRE	Aft SQUID Readout Elect's Aft Converter	Terry McGinnis		3										A		D	
8A00947 SRE	Aft SRE Forward Converter	Terry McGinnis	yes	5													B
8A00950 SRE	Forward SRE Power Supply	Terry McGinnis	yes	3							NC				B		
8A00953 SRE	Forward SRE Digital	Terry McGinnis	yes	3													
8A01040 SRE	Aft SRE Clock Digital	Terry McGinnis	yes	2													
8A01043 SRE	Aft SRE Connector	Terry McGinnis	yes	3													B
8A01046 SRE	Aft SRE Motherboard	Terry McGinnis		4										B	B+		C
8A01049 SRE	Aft SRE Forward Interface	Terry McGinnis	yes	3													A
8A01058 SRE	Forward SRE FLL	Terry McGinnis	yes, two	5													
8A01061 SRE	Forward SRE Auxiliary	Terry McGinnis		5									A		B+		
8A01064 SRE	Forward SRE DAC	Terry McGinnis		5													
8A01067 SRE	Forward SRE BTC	Terry McGinnis		3													
8A01070 SRE	PCA Analog Motherboard #1	Terry McGinnis		4												NC	A
8A01073 SRE	Forward SRE Analog Motherboard #2	Terry McGinnis		4												NC	A
8A01076 SRE	Forward SRE Digital Motherboard	Terry McGinnis		4												NC	A
8A01263 ECU	Power Converter Bracket Assembly	John Thatcher		2									NC	A			
8A01306 SRE	Forward SRE DAC Subsystem	Terry McGinnis	yes	6													
8A01313 ECU	Forward ECU Electronics	John Thatcher		1													
8A01403 ECU	Aft Quiet Filter #1	John Thatcher		1				NC to A					B				
8A01406 ECU	Quiet Filter	John Thatcher		1				NC to A					B				
8A01836 GSS	Forward SRE Motherboard Set	Terry McGinnis		4													
8A01879 GSS	High Voltage Amplifier/Bridge FSU	Jay Dusenbury		17													B
8A01882 GSS	Low Voltage Amplifier FSU	William Bencze		5													
8A01883 GSS	MUX, OSC, Charge Control FSU	J. Kilner		5													
8A01884 GSS	Analog Backup Controller FSU	M. Irwin		5													
8A01885 GSS	Arbiter FSU	William Bencze		5													
8A01886 GSS	A/D D/A FSU	Scott Smader		5													
8A01891 GSS	Forward Comm Link FSU	Scott Smader		5													
8A01892 GSS	Forward Mode Register	Scott Smader		5													
8A01893 GSS	Forward Backplane FSU	William Bencze		5													
8A01897 GSS	Aft Comm Link Aft Control Unit	Scott Smader	yes	5													
8A01898 GSS	Aft Clock Support Aft Control Unit	J. Kilner	yes	5													
8A01899 GSS	Aft Monitor/Timing Aft Suspension Unit	J. Kilner		5													
8A01900 GSS	Aft Test Card	Scott Smader	yes	5													
8A01901 GSS	Aft Backplane Aft Control Unit	Scott Smader		5													
8A02076 SRE	FWD Data Acq. w/FP A/D Conv	Terry McGinnis		5													
8A02079 SRE	Aft SRE Clock Digital w/FP A/D	Terry McGinnis		2													
8A02661 SRE	Forward SRE Test Port	Terry McGinnis		2		209 total boards											

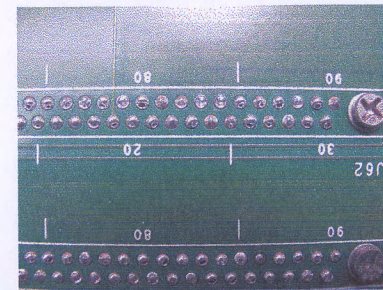
[illegible]

[illegible]

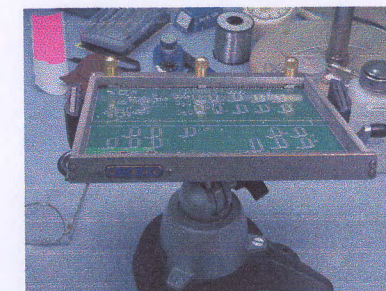
[illegible]

[illegible]

1901G blowholes.JPG



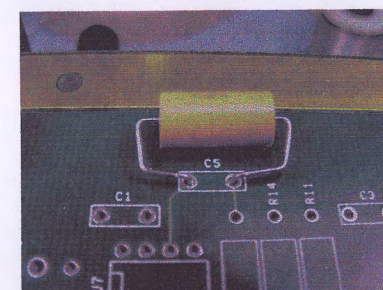
1898fixture.JPG



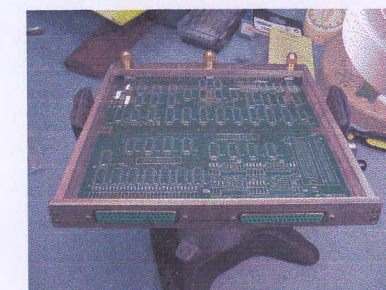
1898fixture2.JPG



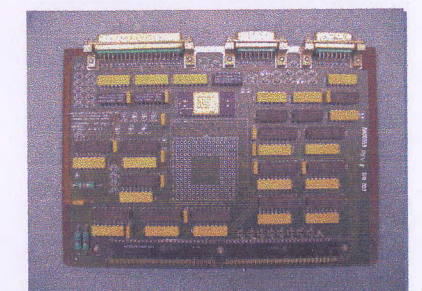
1898C5mounting.jpg



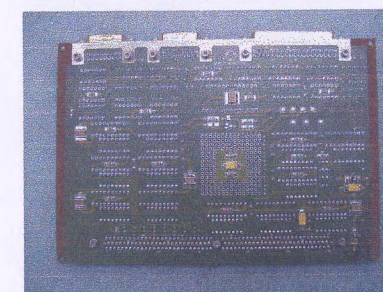
1897fixture.JPG



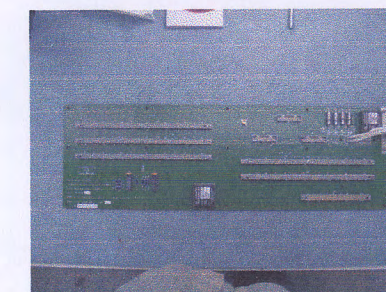
953A no PGA.JPG



953B.JPG



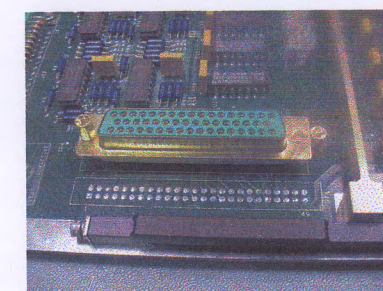
1901H.JPG



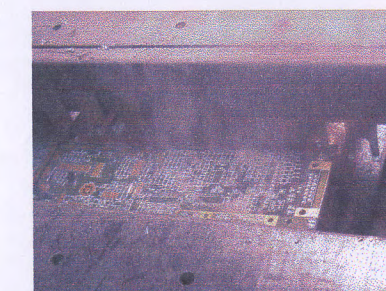
Source Insp (Carla).JPG



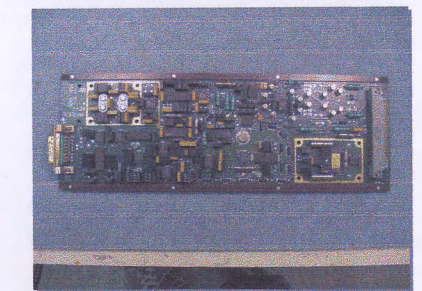
MFR repaired_J75A.JPG



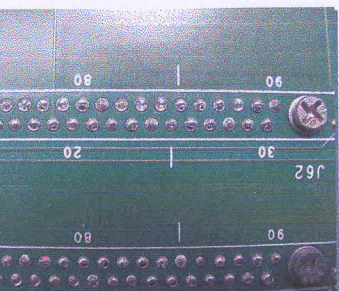
1058A needs fixture.JPG



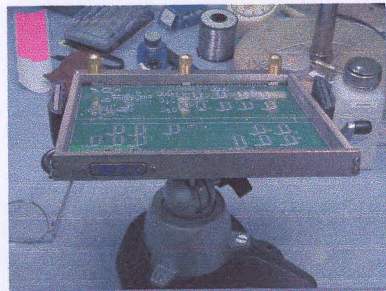
1058 topside.JPG



001G blowholes.JPG



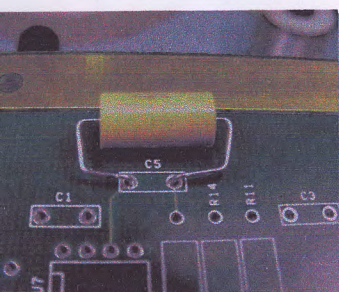
1898fixture.JPG



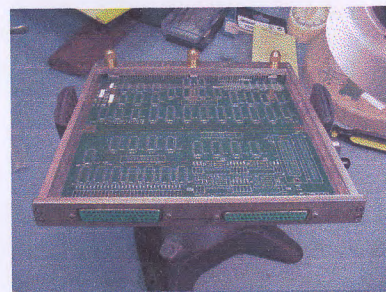
1898fixture2.JPG



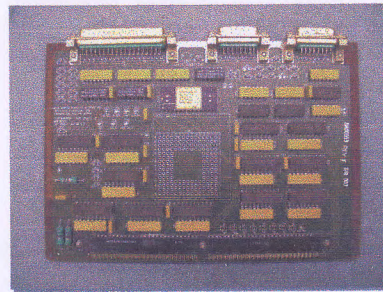
898C5mounting.jpg



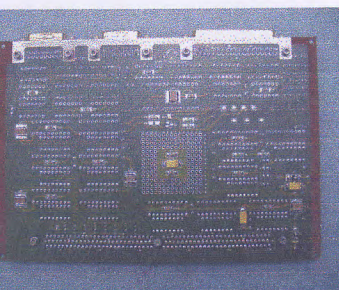
1897fixture.JPG



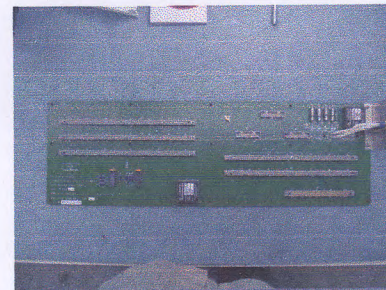
953A no PGA.JPG



953B.JPG



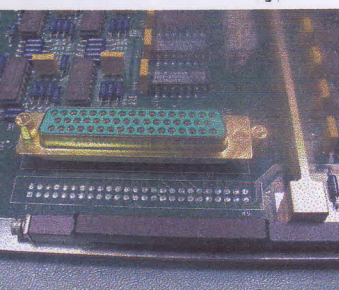
1901H.JPG



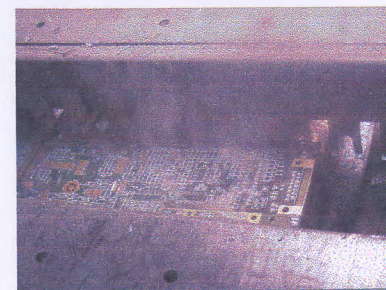
Source Insp (Carla).JPG



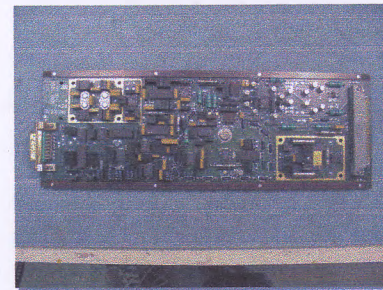
FR repaired_J75A.JPG



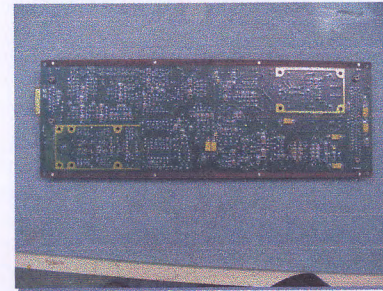
1058A needs fixture.JPG



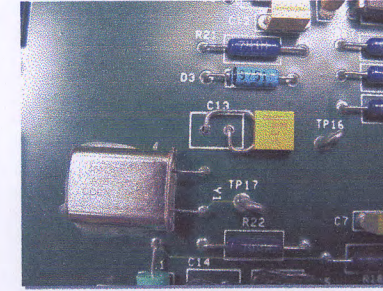
1058 topside.JPG



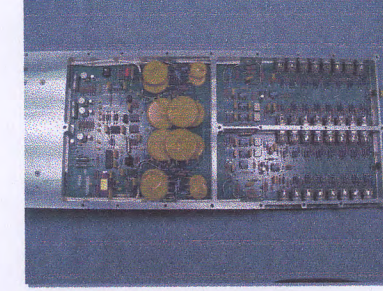
1058 farside.JPG



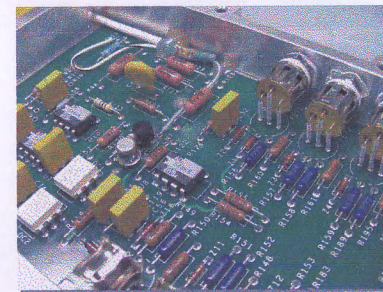
1898 C13 mounting.JPG



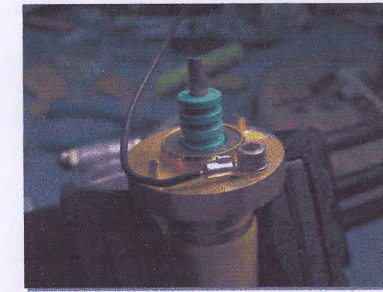
NFI HVA orig CAPs.JPG



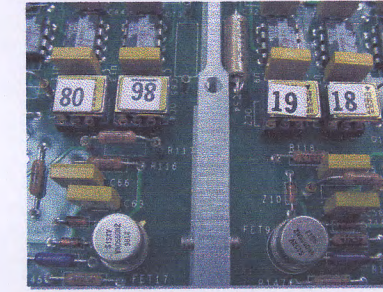
HVA NFI.JPG



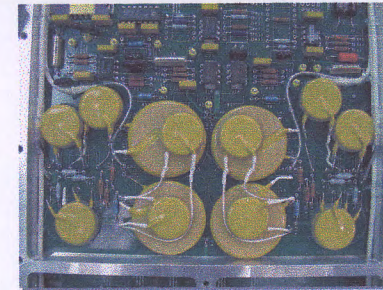
gold-to-gold ground.JPG



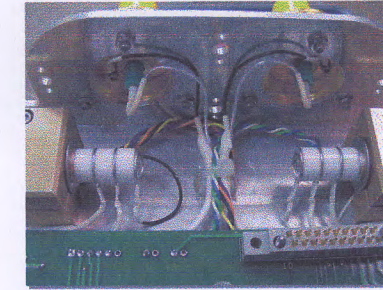
mods to optos.JPG



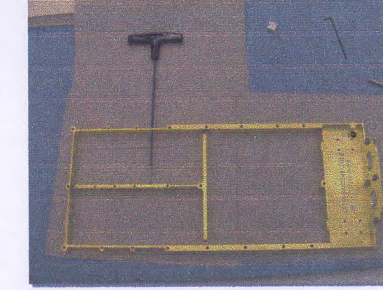
lame arrangement.JPG



vulnerable flying leads.JF



cntr stud install.JPG



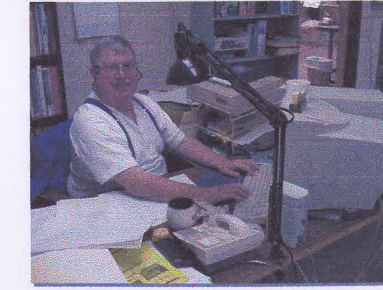
CenterRailStudPlacemer



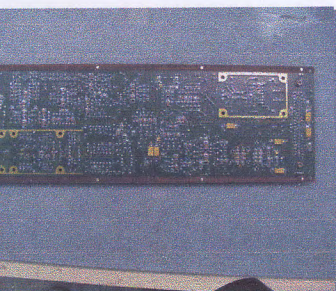
HVAComponentPlaceme



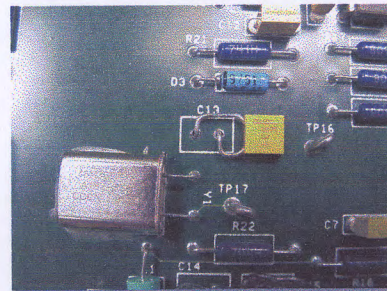
ProcessPlanning.JPG



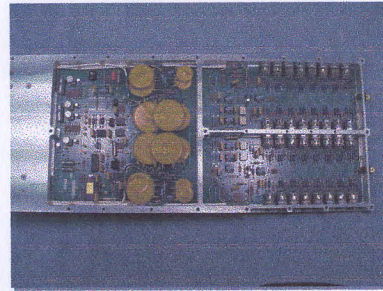
1058 farside.JPG



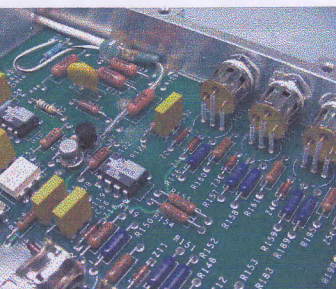
1898 C13 mounting.JPG



NFI HVA orig CAPs.JPG



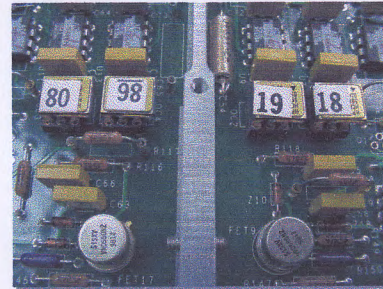
HVA NFI.JPG



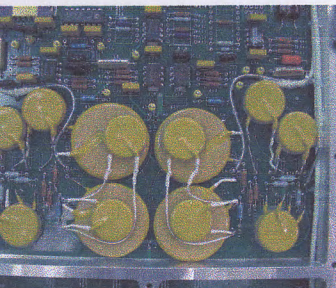
gold-to-gold ground.JPG



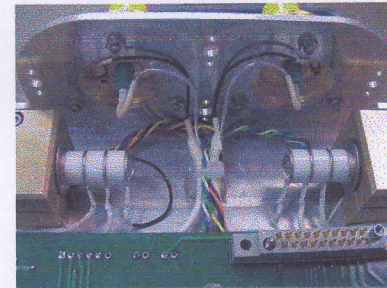
mods to optos.JPG



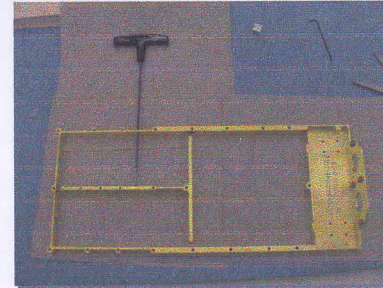
me arrangement.JPG



vulnerable flying leads.JF



cntr stud install.JPG



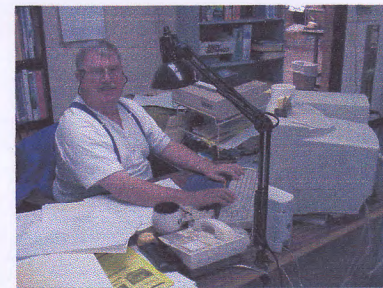
InterRailStudPlacemer



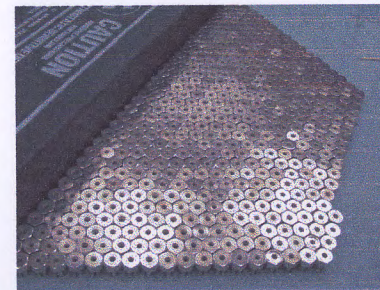
HVAComponentPlaceme



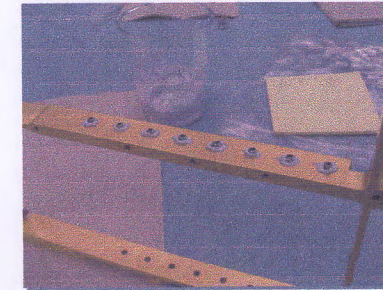
ProcessPlanning.JPG



Heatsinkclips.JPG



NusilApplication.JPG



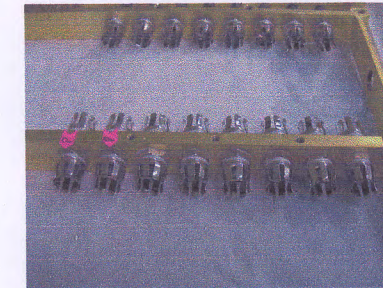
TorqueVerification.JPG



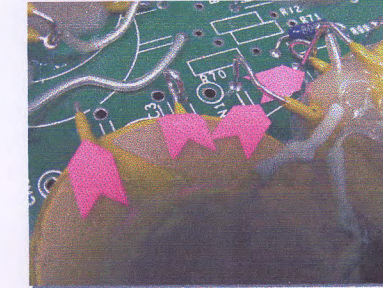
NusilCleaning.JPG



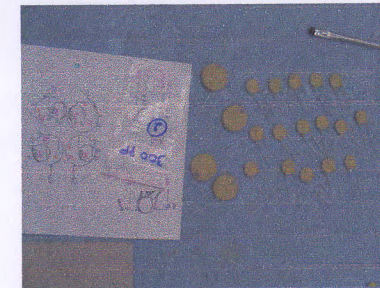
Plating failure at hipot.JP



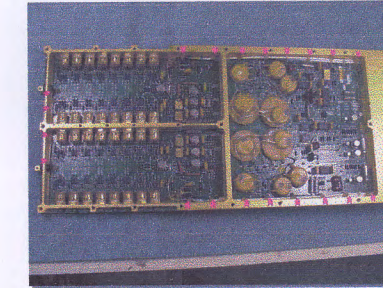
after vibe test.JPG



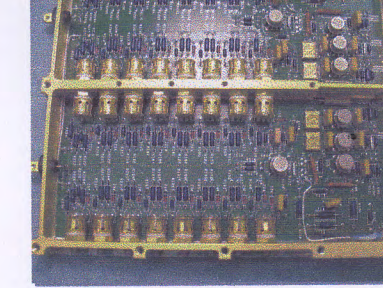
matched sets.jpg



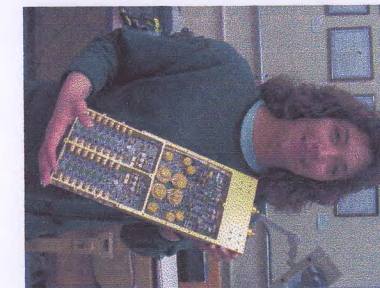
staking sites.JPG



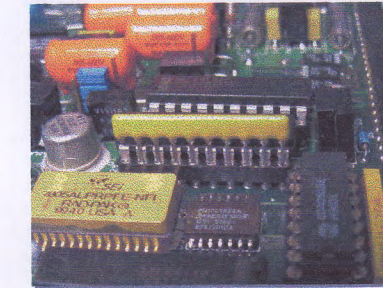
FETs installed.JPG



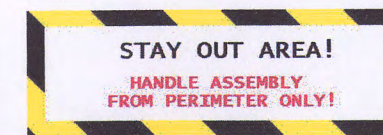
Finished HVA.JPG



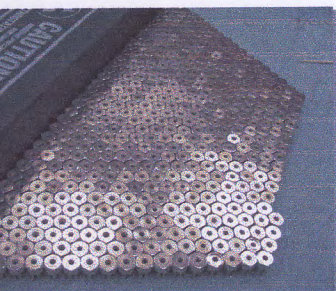
1st try 2076 mod.JPG



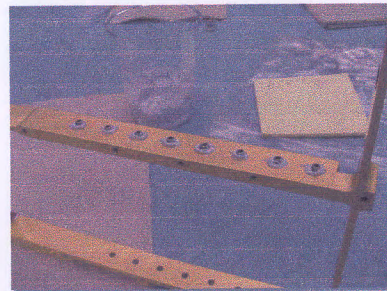
Stay out Area.jpg



Heatsinkclips.JPG



NusilApplication.JPG



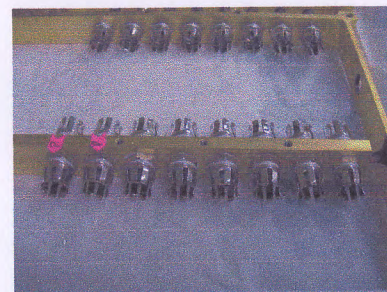
TorqueVerification.JPG



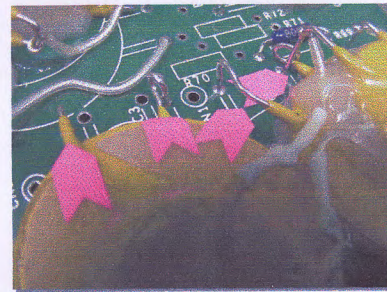
NusilCleaning.JPG



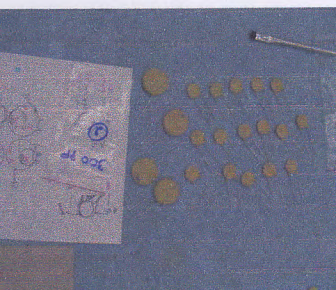
Plating failure at hipot.JPG



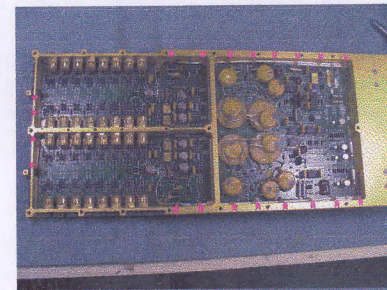
after vibe test.JPG



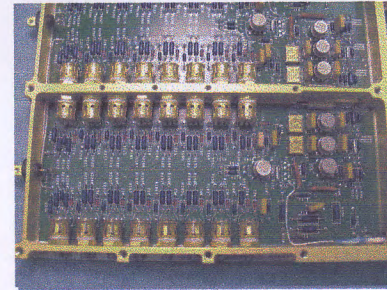
matched sets.jpg



staking sites.JPG



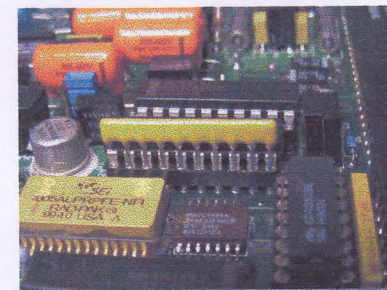
FETs installed.JPG



Finished HVA.JPG



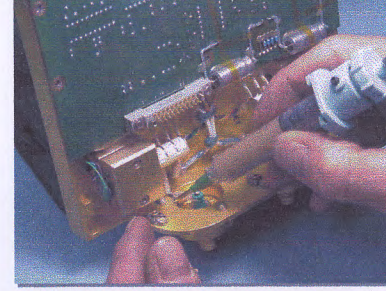
1st try 2076 mod.JPG



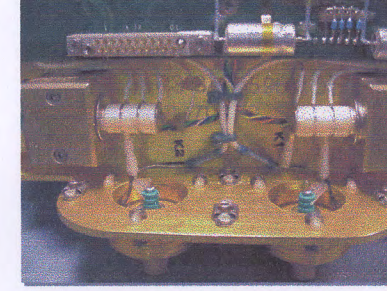
Stay out Area.jpg



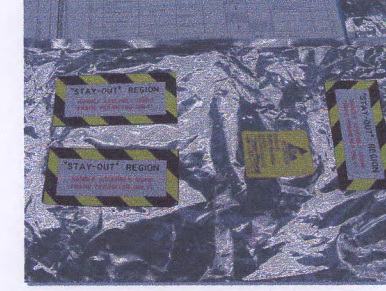
staking HVA wires.JPG



ready for staking.JPG



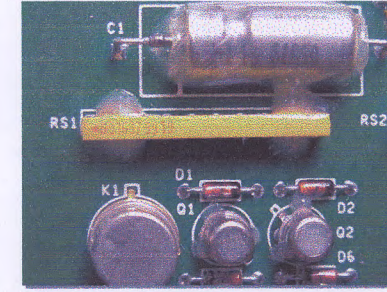
SOA tags applied.JPG



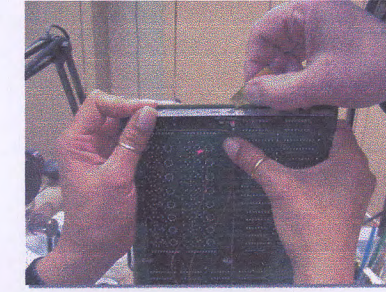
final buyoff.JPG



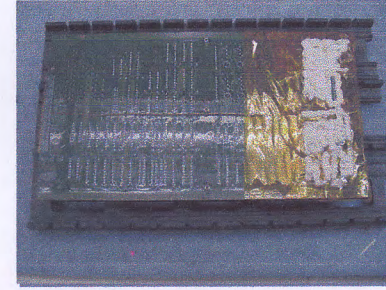
RS1 staking.JPG



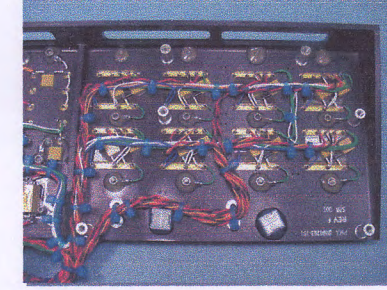
RS1 fail vs. warp.JPG



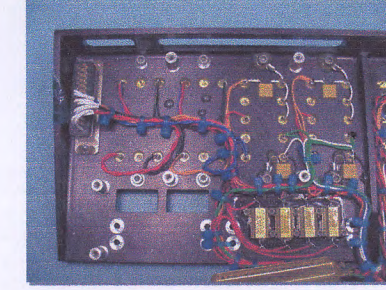
1892 R&R RS1.JPG



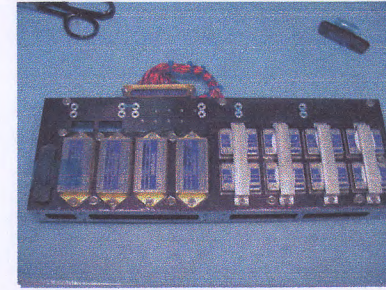
spare 1263 rev F+.JPG



additional caps to gnd.JF



1263 topside.JPG



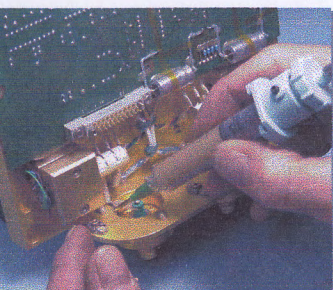
scrubbed launch.JPG



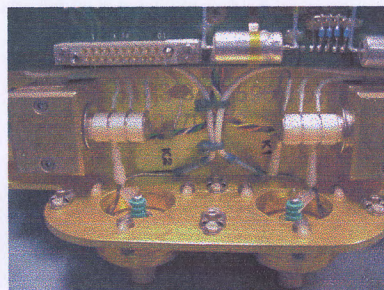
try again tomorrow.JPG



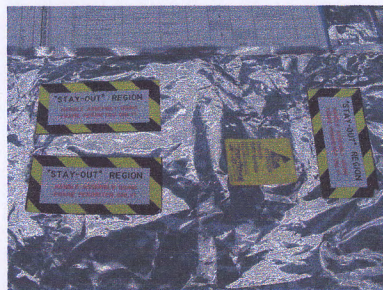
making HVA wires.JPG



ready for staking.JPG



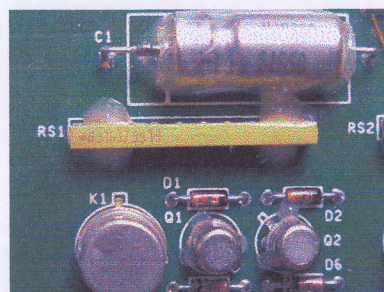
SOA tags applied.JPG



final buyoff.JPG



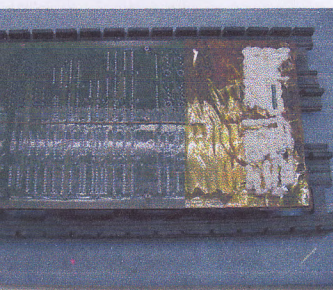
RS1 staking.JPG



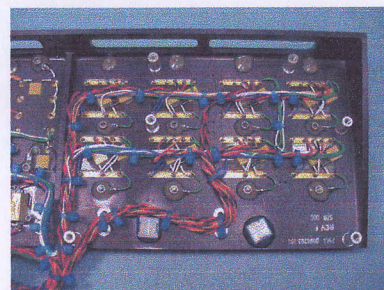
RS1 fail vs. warp.JPG



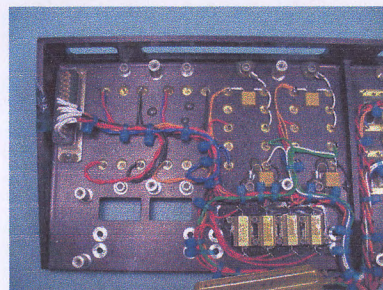
892 R&R RS1.JPG



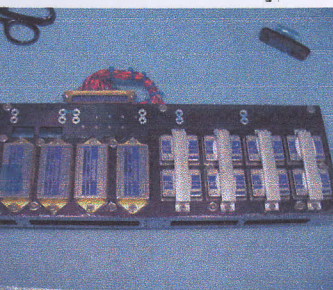
spare 1263 rev F+.JPG



additional caps to gnd.JF



1263 topside.JPG



scrubbed launch.JPG



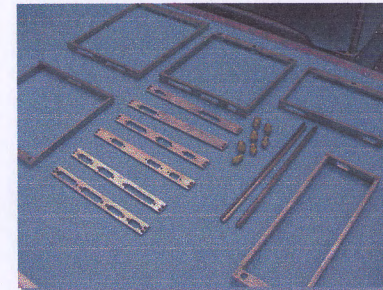
try again tomorrow.JPG



T minus 10.JPG



Titanium fixtures.JPG



	updated: 28MAY99 NJD	Qty: 4	Qty: 2	Qty: 2	Qty: 2	Qty: 3	Qty: 1+1	Qty: 5+1	Qty:
Item No.	TASK (7) PWA NUMBERS:	TASK05 8A01836 assemble	TASK06 8A00877 jumpers	TASK07 8A00872 jumps&R's	TASK08 8A00889 R&R parts	TASK09 8A00883 diodes	TASK10 8A01313 assemble	TASK11 8A01306 assemble	
1	Drawings & RFQ received at supplier (1)	5/19/1999				5/25/1999	2/18/1999	5/26/1999	
2	Supplier quotes to LMMS (2)	5/19/1999				5/24/1999	4/30/1999	5/26/1999	
3	Purchase Order received by supplier	LL 140141 FLT LL 140909 NFI				LL 140469 5/25/99	LL 139880 FLT LL 140471 NFI	LL 140958 FLT LL XXXXXX NFI	
4	Kit sent to supplier (6)	2/23/1999				5/24/1999	3/17/1999	3/29/1999	
5	Kit audit completed by supplier	3/23/1999				5/24/1999			
6	Drawing package evaluation (2)								
7	Planning (work instructions) completed at supplier (3)					5/26/1999			
8	Start Assembly at supplier	4/30/1999				5/25/1999	4/28/1999		
9	Assembly estimate completion date	5/26/1999				5/26/1999	6/7/1999		
10	Wave solder hold point satisfied (4)								
11	Request for missing traceability information								
12	First engineering question(s) submitted								
13	Last Engineering decision(s) received	5/12/1999							
14	Parts shortages scheduled to be filled (5)	4/30/1999					3/27/1999		
15	VRIC # and date:								
16	Revised dwgs, P/L, dwg notes to be issued	rev C				rev B	rev A 5/4/99	rev C	
17	Current Revision in ZSS possession	rev C				rev B	rev nc 12/12/98	rev B 3/22/99	
18	Purchase Order updated with new rev.	5/20/1999				5/25/1999			
19	Source inspection and acceptance (6)	9AM 5/28/99				9AM 5/28/99	9AM 5/28/99		
20	PWA completed (C) and shipped w/shortages (S); (6)	(C) 5/28/99				(C) 5/28/99 diodes expected 5/21/99			
21	PWA on hold, waiting for....						rec'd 5/21/99	current dwgs	
22	PWA released from hold	5/12/1999							
23	Parts-long lead items to be assembled								
24	RMA requested from supplier								
25	RMA sent to LMMS								
26	PWA scrapped by LMMS								
27	ADDITIONAL WORK/POTENTIAL INCREASE IN DOLLARS:								
28	Other:	3 Flt, 1 ENG source requested 5/26/99	DWG notes 29 and 30 form REV B			"Zentek to give this board top priority" per Engineering 5/20/99 source requested 5/26/99	J8 interim inspection requested 5/21/99	5 FLT and 1 GSE	
29	Additional Instructions:								
30	(1) Dwgs start as Rev. NC								
31	(2) Dwg pkg. eval. eng. questions, eng decisions may start prior to issuance of parts or PO and can continue through assembly completion.								
32	(3) Planning will also evolve to reflect "as built" processes.								
33	(4) Wave solder hold Pt. allows confirmation that nothing will require desoldering; no oversights.								
34	(5) Part shortages can be created by in-process loss, mis-counts, damage or engineering issues.								
35	(6) S=Task completed, except for shortages								
36	C=Task completed.								
37	(7) red denotes rapid procurement								

	updated: 28MAY99 NJD	Qty: 2	Qty: 5	Qty: 4	Qty: 5	Qty: 3	Qty: 5	Qty: 3+1	Qty: 1	Qty: 2
Item No.	TASK (7) PWA NUMBERS:	8A00895 ECU	8A00947 sre priority 7	8A01040 sre priority 5	8A01064 sre priority 14	8A00953 sre priority 12	8A01058 sre priority TBD	8A01067 sre priority TBD	TASK03 8A00892 rebuild	TASK04 8A00862 add R's
1	Drawings & RFQ received at supplier (1)		12/1/1998	advanced copy	2/1/1999	advanced copy			5/19/1999	5/19/1999
2	Supplier quotes to LMMS (2)	8/17/1998	12/2/1998	1/14/1999	2/5/1999				5/19/1999	5/19/1999
3	Purchase Order received by supplier	MWBXF8507X 8-31-98	MWCAD4602X	MWCAB1802X	MWCAC8601H				LL 140137 5/20/99	LL 140138 5/20/99
4	Kit sent to supplier (6)	2/11/1999	1/22/1999	3/11/1999	1/22/1999	2/23/1999			5/21/1999	5/13/1999
5	Kit audit completed by supplier	2/26/1999	2/1/1999	3/18/1999	2/10/1999				5/24/1999	5/13/1999
6	Drawing package evaluation (2)				2/10/1999					
7	Planning (work instructions) completed at supplier (3)									
8	Start Assembly at supplier	3/11/1999							5/25/1999	5/19/1999
9	Assembly estimate completion date	part+1wk	5/31/1999						5/27/1999	5/24/1999
10	Wave solder hold point satisfied (4)		4/26/1999						5/25/1999	
11	Request for missing traceability information									
12	First engineering question(s) submitted									
13	Last Engineering decision(s) received									
14	Parts shortages scheduled to be filled (5)	FPGA	fixture complete	fixture complete	2 burn in items					
15	VRIC # and date:									
16	Revised dwgs, P/L, dwg notes to be issued		rev D 5/13/99	rev C 5/9/99	rev C 5/7/99	rev B 5/27/99			rev B	rev D
17	Current Revision in ZSS possession	rev nc	rev B 1/19/99	rev A 1/21/99	rev A 1/21/99	rev A 1/21/99	nc	nc	rev A	rev B
18	Purchase Order updated with new rev.				TBD					
19	Source inspection and acceptance (6)								9AM 5/28/99	9AM 5/28/99
20	PWA completed (C) and shipped w/shortages (S); (6)								(C) 5/28/99	(C) 5/28/99
21	PWA on hold, waiting for.....	need FPGA no eta		need FPGA eta 6/9/99	rec'd new pwbs 4/28/99 + prelim prints	need FPGA and EPROM eta 6/16/99				
22	PWA released from hold				4/27/1999					
23	Parts-long lead items to be assembled	3								
24	RMA requested from supplier									
25	RMA sent to LMMS									
26	PWA scrapped by LMMS									
27	ADDITIONAL WORK/POTENTIAL INCREASE IN DOLLARS:									
28	Other: waiting for 8A00874 repair in order to proceed with programming			2 w/FPGA 1w/o FPGA	need newly identified parts	FPGA and PROM shortage: no eta data 1-101,1-102, 1 no dash		4-101 + 4-102 = 4-103 (daughter card is the 102	source requested 5/26/99	source requested 5/26/99
29	Additional Instructions:									
30	(1) Dwgs start as Rev. NC									
31	(2) Dwg pkg. eval. eng. questions may start prior to issuance of parts or PO and can continue through assembly completion.									
32	(3) Planning will also evolve to reflect "as built" processes.									
33	(4) Wave solder hold Pt. allows confirmation that nothing will require desoldering; no oversights.									
34	(5) Part shortages can be created by in-process loss, mis-counts, damage or engineering issues.									
35	(6) S=Task completed, except for shortages									
36	C=Task completed.									
37	(7) red denotes rapid procurement									

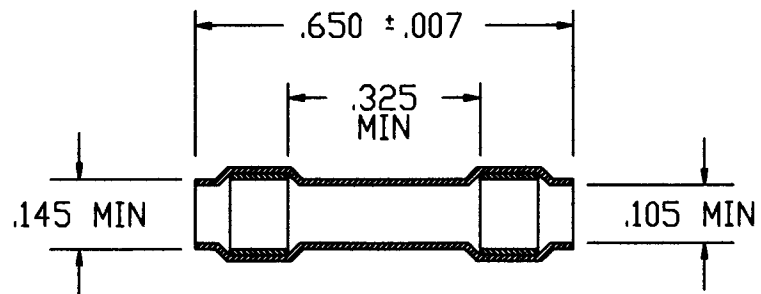
VRIC Number	Date	End Item	Description	DRs
Z001	6/8/1998	8A00842, 3	Traceability note needs to call out 'manufacturer' as a requirement (supplied with distributor data only).	
Z002	6/8/1998	8A00842	Connector hardware shorts to PWA pads-analyses shows ok, use as is	
Z003	6/10/1998	8A00842, 3	Farside lead protrusion insufficient-use as is and take pictures	R52130,1
267473	6/22/1998	8A00842	PL ambiguity re: C102	
267474	6/22/1998	8A00842	Parts marking ambiguity: MIL part number vs. manufacturers part number and PL	
267475	9/30/1998	8A00877	Component lead spacing and PWB site don't match	
267476	11/13/1998	8A00865	Request to ship short components	
267477	11/18/1998	8A00859	Interference between components	
267478	12/2/1998	8A00865	Request to ship short components	
267479	12/17/1998	8A01263	Crimping certification requirements for Zentek personnel	
267480	1/20/1999	8A00950	Component lead spacing and PWB site don't match	
267481	3/10/1999	8A00886	Potential cracking of glass bead lead seals on relays	
267483	4/21/1999	8A00947	No LMMS QA acceptance tag on bare boards	
267484	4/27/1999	8A00947	Board markings dissolving	R55228
267485	5/27/1999	8A01836	No date codes	
267486	6/7/1999	8A00947	Retaining epoxy on connector pins dissolving in alcohol	
267488	8/16/1999	8A01064	PWB reinforcement rails delaminate from boards	R55273
267489	8/20/1999	8A00895	Board markings dissolving	R55275
267490	11/17/1999	8A02079	PWBs tarnished	
267491	11/17/1999	8A00898	An undocumented jumper has been soldered onto PWA received back from LMMS	
267492	1/21/2000	8A01900	PCBs lack solder mask on solder side	
260941	3/1/2000	8A01890	board revision incorrect	
260942	3/10/2000	8A00901	void	
260943	1/25/2000	8A01901	Excessive board outgassing due to PWB supplier process problem	R74521
260944	1/31/2000	8A01899	Turrets too large to fit into PWB	
260945	2/4/2000	8A01898	Component lead spacing and PWB site don't match	
260946	2/4/2000	8A01898	Component lead spacing and PWB site don't match	
260947	2/21/2000	8A00859	Engineer's email direction to be incorporated into updated print	
260948	2/17/2000	8A00859	Dimension correction	
260949	2/17/2000	GSS dwgs	drawing corrections on 8 assembly designs	
260950	2/17/2000	8A01058	Hardware mods	
260951	2/18/2000	8A01897	drawing review 18 changes	
260952	2/22/2000	8A01898	4 PL changes	
260953	2/22/2000	8A01897	Connector has broken jackpost	
260954	2/24/2000	8A00889	Helicoil tangs had not been removed	

VRIC Number	Date	End Item	Description	DRs
Z001 (sic)	3/2/2000	8A01058	Material shortages	
Z002 (sic)	3/6/2000	8A01058	8 note changes affecting drawing/PL match	
Z003 (sic)	3/9/2000	8A01058	PL quantity and descriptions adjustment	
277021	3/13/2000	8A01899	Test point gauge change	
277022	3/20/2000	8A01891	Hardware mods	
277023	3/20/2000	8A01058	Parts marking ambiguity: MIL part number vs. manufacturers part number and PL	R74534
277024	3/20/2000	8A01058	Parts marking ambiguity: MIL part number vs. manufacturers part number and PL	
277025	3/20/2000	8A01058	Parts marking ambiguity: MIL part number vs. manufacturers part number and PL	
277026	3/21/2000	8A01058	Parts marking ambiguity: MIL part number vs. manufacturers part number and PL	
277028	3/22/2000	8A01058	Component lead spacing and PWB site don't match	
277029	3/24/2000	8A01893	25 various changes to drawing notes	
277030	3/24/2000	8A01882	14 various changes to drawing notes	
277031	3/27/2000	8A01058	Degraded mylar sleeving on capacitors	
277032	3/27/2000	8A01882	Solder splashes on gold plated parts	
277033	3/29/2000	8A01058	Component lead spacing and PWB site don't match. Reference designators on board but not on PL.	
277034	3/31/2000	8A01058	Solder splashes on gold plated parts	
277035	4/14/2000	8A01883	Improper swage on turrets due to oversized holes. Will use ZSS-680	
277036	4/14/2000	8A01879	Component lead spacing and PWB site don't match	
277037	4/17/2000	8A01891	Helicoil dye contaminating boards	
277038	4/19/2000	8A01883	Parts found on schematic but not on PL	
277039	4/20/2000	8A01883	Unreadable board markings	
277040	4/26/2000	8A01882	Various drawing note mods	

Zentek Created Part Numbers

Zentek Part Number	Description
ZSS237-01	HV connector with 2ea #2-56 threaded holes
ZSS680-01	TFE component standoff 0.125" dia x 0.06" long
ZSS680-02	TFE component standoff 0.125" dia x 0.10" long
ZSS680-03	TFE component standoff 0.125" dia x 0.15" long
ZSS707-00	Ring lug, gold plated, #2 stud size, AWG 26
ZSS707-01	Ring lug, gold plated, #2 stud size, AWG 24
ZSS707-02	Ring lug, gold plated, #4 stud size, AWG 22
ZSS707-03	Ring lug, gold plated, #6 stud size, AWG 22
ZSS707-XX-NG	Ring lug, tin-lead flash
ZSS680-01	test point, soldered buss wire, loop offset
ZSS680-02	test point, soldered buss wire, loop centered
ZSS101-01	solderless sleeve
ZSS580-01	heat sink clip, Nickel Plated
ZSS580-02	heat sink clip, Gold Plated
ZSS238-01	jumper, non-insulated, double camel back, tinned 22 AWG buss wire
ZSS238-02	jumper, insulated, double camel back, tinned 22 AWG buss wire
ZSS280-01	insulator disk, hv capacitor, FR-4, 0.030" thick, for 100 pF HV cap
ZSS280-02	insulator disk, hv capacitor, FR-4, 0.030" thick, for 200 pF HV cap
ZSS280-03	insulator disk, hv capacitor, FR-4, 0.030" thick, for 300 pF HV cap
ZSS780-01	bridge, triax wire support, make from ZSS280-03

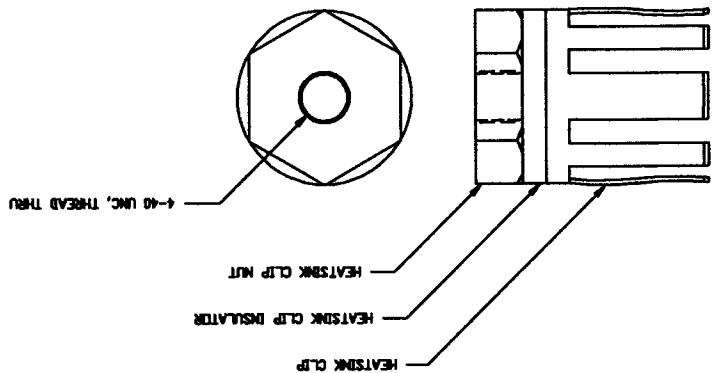
NOTES: UNLESS OTHERWISE SPECIFIED
 1. MAKE FROM SUMITOMO PART # H-M-2-06.



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND TOLERANCES ARE: FRACTIONS DECIMALS ANGLES $\pm$ " .XX = .01 $\pm 1^\circ$		CONTRACT NO.		ZENTEK Scientific Systems	
MATERIAL: SEE NOTE 1.		APPROVALS	DATE		
FINISH		DRAWN GPCD	11/15/00	SIZE B	FSCN 013E4
DO NOT SCALE DRAWING		APPROVED		DWG NO. ZSS101-01	REV. A
		QA		SCALE 5:1	
				SHEET 1 OF 1	

DO NOT SCALE DRAWING		SCALE 4:1		SHEET 1 OF 1	
FINISH		B 013E4		ZSS580-	
SEE NOTE 1.		FSCN		DVG NO.	
MATERIAL		APPROVED		REV. A	
DRAWN GPCD		DATE		HEATSINK CLIP	
APPROVALS		TITLE		ZENTEK Scientific Systems	
UNLESS OTHERWISE SPECIFIED		CONTRACT NO.			
DIMENSIONS ARE IN INCHES		DATE			
FRACTIONS DECIMALS ANGLES		DATE			
± = .005 ± .01		DATE			

DASH #	-02
CONFIGURATION	NICKEL AND GOLD PLATE
	NICKEL PLATE ONLY



- NOTES: UNLESS OTHERWISE SPECIFIED
1. MAKE FROM IERC PART # TX0522ND
 2. STRIP OFF NICKEL/CHROME PLATING.
 3. ELECTROLESS NICKEL PLATE (.0001 in.) PER MIL-C-2674E.
 4. FOR -02 GOLD PLATE PER MIL-G-45204C, TYPE 3, 50-100 micro-inches.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----