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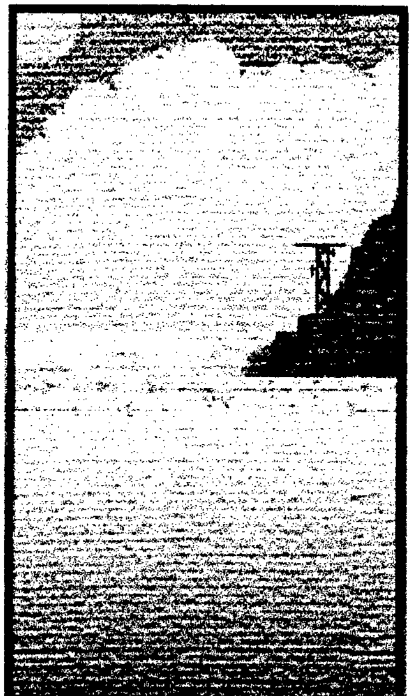
Volume I



HF RADAR

HF RADAR FINAL REPORT

University of Michigan Projects 032882 & 032887

ONR GRANTS: N00014-95-1-0367 & N00014-95-1-0249

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The origins of HF surface wave radar for ocean wave and current measurements began with collaborative work at Stanford University and Scripps Institution of Oceanography in the late 1960's. Two of the participants in this project (Drs. Teague and Vesecky) have worked with HF radar observations of the ocean since these early experiments. Since that time, HF radar as an ocean sensing tool has progressed with increasing acceptance in the oceanography community over the last five years. During this grant a new HF radar design was completed, a prototype unit was constructed and is now being tested over Monterey Bay, California from a field site kindly provided at the Long Marine Laboratory of the University of California at Santa Cruz. This operation is in collaboration with the REINAS project at UC Santa Cruz that is also funded by ONR and the results of the radar measurements are being made available over the internet by the REINAS project. Initial results, including radial current field maps at four frequencies and variations of currents with time are to be presented at the International Geoscience and Remote Sensing Symposium in Singapore during August 1997. This report begins with a overview of the radar, its installation and some preliminary results. This is followed by two sections describing the operating characteristics of the radar and some further results, including measurements of vertical current shear in the top meters of the ocean. Section III contains the bulk of the system description with further information in volume II. The strong support and excellent suggestions from Drs. Dennis Trizna and Frank Herr at the Office of Naval Research are important in the present and future success of the project.

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FINAL REPORT

Experimental Air/Sea Interaction Study of Coastal Waves, Currents and Winds using HF and Microwave Radar, Doppler Lidar and in situ Sensors

and

Equipment for Remote Mapping of Ocean Surface Waves, Currents and Winds with HF Radar

University of Michigan Projects:
032882 & 032837

Office of Naval Research Grants:
N00014-95-1-0367
N00014-95-1-0249

Prof. John F. Vesecky, Principal Investigator

Atmospheric, Oceanic and Space Science Dept.
The University of Michigan

May, 1997

Introduction and Abstract

The origins of HF surface wave radar for ocean wave and current measurements began with collaborative work at Stanford University and Scripps Institution of Oceanography in the late 1960's. Two of the participants in this project (Drs. Teague and Vesecky) have worked with HF radar observations of the ocean since these early experiments. Since that time, HF radar as an ocean sensing tool has progressed with increasing acceptance in the oceanography community over the last five years. A research project to design and build an advanced, multifrequency HF radar began in 1992 with seed money from the University of Michigan and the Environmental Research Institute of Michigan (ERIM). This early phase was followed by a cooperative effort involving Michigan, Stanford and ERIM. From 1995 to date the major funding has come from ONR via the Waves BAA and DURIP programs. This final report presents the results of this ONR funding under the Waves BAA and DURIP programs. During this period a new HF radar design was completed, a prototype unit was constructed and is now being tested over Monterey Bay, California from a field site kindly provided at the Long Marine Laboratory of the University of California at Santa Cruz. This operation is in collaboration with the REINAS project at UC Santa Cruz that is also funded by ONR. Prof. Pat Mantey and Dr. Dan Fernandez of UC Santa Cruz provided much help during the Santa Cruz operations and the results of the radar measurements are being made available over the internet by the REINAS project. A second radar unit is nearing completion and will be integrated and deployed in June 1997. Initial results, including radial current field maps at four frequencies and variations of currents with time, were presented at the American Geophysical Unioin Fall Meeting in San Francisco, December, 1996. Further results are to be presented at the International Geoscience and Remote Sensing Symposium in Singapore during August 1997.

This final report in two volumes is a presentation of results under the funding from ONR grants N00014-95-1-0367 and N00014-95-1-0249. The former was a research grant and so funded labor as well as parts and supplies. The latter was an equipment grant that funded major items of equipment. This report begins with a overview of the radar, its installation and some preliminary results. This is followed by two sections describing the operating characteristics of the radar and some further results, including measurements of vertical current shear in the top meters of the ocean. Section III contains the bulk of the system description with further information in volume II of the report.

The success of this project has come through the efforts of participants at several institutions working in close collaboration. We list them below under their respective institutions.

University of Michigan

Prof. John Vesecky, principle investigator
Peter Hansen, project engineer
Dr. Jason Daida, software development and data analysis
Neil Schnepf, graduate student
Ray Pung, undergraduate research assistant
Heather Hamilton, undergraduate research assistant

Stanford University
Dr. Calvin Teague
Prof. Len Tyler

Environmental Research Institute of Michigan (now ERIM International)
Dr. Robert Onstott
Dr. Robert Shuchman
Dr. Ken Fischer
David Kletzli
Eric Batzdorfer
Robert Hrabec

University of California at Santa Cruz
Prof. Patrick Mantey
Dr. Dan Fernandez
Steve Davenport
Kip Laws

Finally the strong support and excellent suggestions from Drs. Dennis Trizna and Frank Herr at the Office of Naval Research are important in the present and future success of the project.

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PROGRESS REPORT

Multifrequency HF Radar Observations of Coastal Ocean Dynamics

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January, 1997

Abstract

The origins of HF surface wave radar for ocean wave and current measurements began with collaborative work at Stanford University and Scripps Institution of Oceanography in the late 1960's. Two of the participants in this project (Drs. Teague and Vesecky) have worked with HF radar observations of the ocean since these early experiments. Since that time HF radar as an ocean sensing tool has progressed with increasing acceptance in the oceanography community over the last five years. A research project to design and build an advanced, multifrequency HF radar began in 1992 with seed money from the University of Michigan and the Environmental Research Institute of Michigan. From 1995 to date the major funding has come from ONR via the Waves BAA and DURIP programs. During this period a new HF radar design was completed, a prototype unit was constructed and is now being tested over Monterey Bay, California from a field site kindly provided at the Long Marine Laboratory of the University of California at Santa Cruz. This operation is collaboration with the REINAS project at UC Santa Cruz. A second radar unit is nearing completion and will be integrated and deployed in early 1997. Initial results, including radial current field maps at four frequencies and variations of currents with time, were presented at the AGU meeting, December, 1996. This report is a summary of progress to this point, including a brief look at the results from Monterey Bay, collected in autumn, 1997.

Progress Report

I. Radar Design Summary

The radar design is summarized in the block diagram of Fig. 1. It incorporates a number of novel features and many improvements relative to previous HF radar designs. The radar is completely under computer control so that flexible remote operation is possible. The current unit, now at the Long Marine Laboratory of the University of California at Santa Cruz (LML) is operated remotely by logging into the control computer over the internet. The radar currently operates on four frequencies to give measurements of currents at effective depths of from 30 cm below the surface down to about 1.6 meters. Thus, shear in this largely unknown region can be explored and air-sea interaction better understood. The radar uses a pseudo random coded waveform and pulse compression to improve signal to noise ratio relative to simple pulse systems. We think that this type of waveform will allow higher power operation as the potential interference with other users of the HF spectrum will be reduced. These features should lead to larger ranges -- our current goal is a reliable range of 100 km with a transmitter input power of 500 to 1000 watts.

We will now discuss some of the hardware aspects of the system. As shown in Fig. 1, the radar consists of a pulse modulated transmitter, two vertical transmitting antennas, an array of electronically switched receiving loop antennas, and a specialized linear HF receiver, all under computer control. The transmitter is direct-sequence modulated with a pseudo-random pulse train generating a spread-spectrum signal. The transmitter carrier frequency is also rapidly changed (or hopped) among four different values between 4 and 25 MHz. The pseudo-noise or PN code sequence (called the chipping sequence) is also used by the receiver to coherently detect the return pulse train containing the Doppler information.

Transmitter and Transmit Antennas: The transmitter contains a phase stable reference oscillator used for both transmit carrier synthesis and receiver local oscillator injection. The 80 MHz reference carrier is applied to a direct digital synthesizer or DDS. Under computer control, the synthesizer generates any carrier frequency in the HF spectrum, but in our specific application only four FCC approved frequencies are used. The synthesized carrier is applied to a balanced mixer for amplitude modulation by the computer generated PN code discussed earlier. The resulting signal is then applied to two identical solid state amplifier chains, one for the low band signals (4 to 8 MHz), and one for the high band signals (8 to 25 MHz). Each of the two transmit chains has its own 1/4 wave vertical antenna and counterpoise. Each vertical antenna is resonant at two of the frequencies of interest. The transmitter power output is ≈150 watts PEP with capability to add linear amplifiers at a later date.

Receive Antennas: The receive antenna array consists of 8 non-resonant square loops constructed out of ordinary copper pipe supported with PVC plumbing fittings. The spectra from each antenna are coherently added in the computer after the phase is adjusted in order to steer the antenna array main beam direction. Each loop

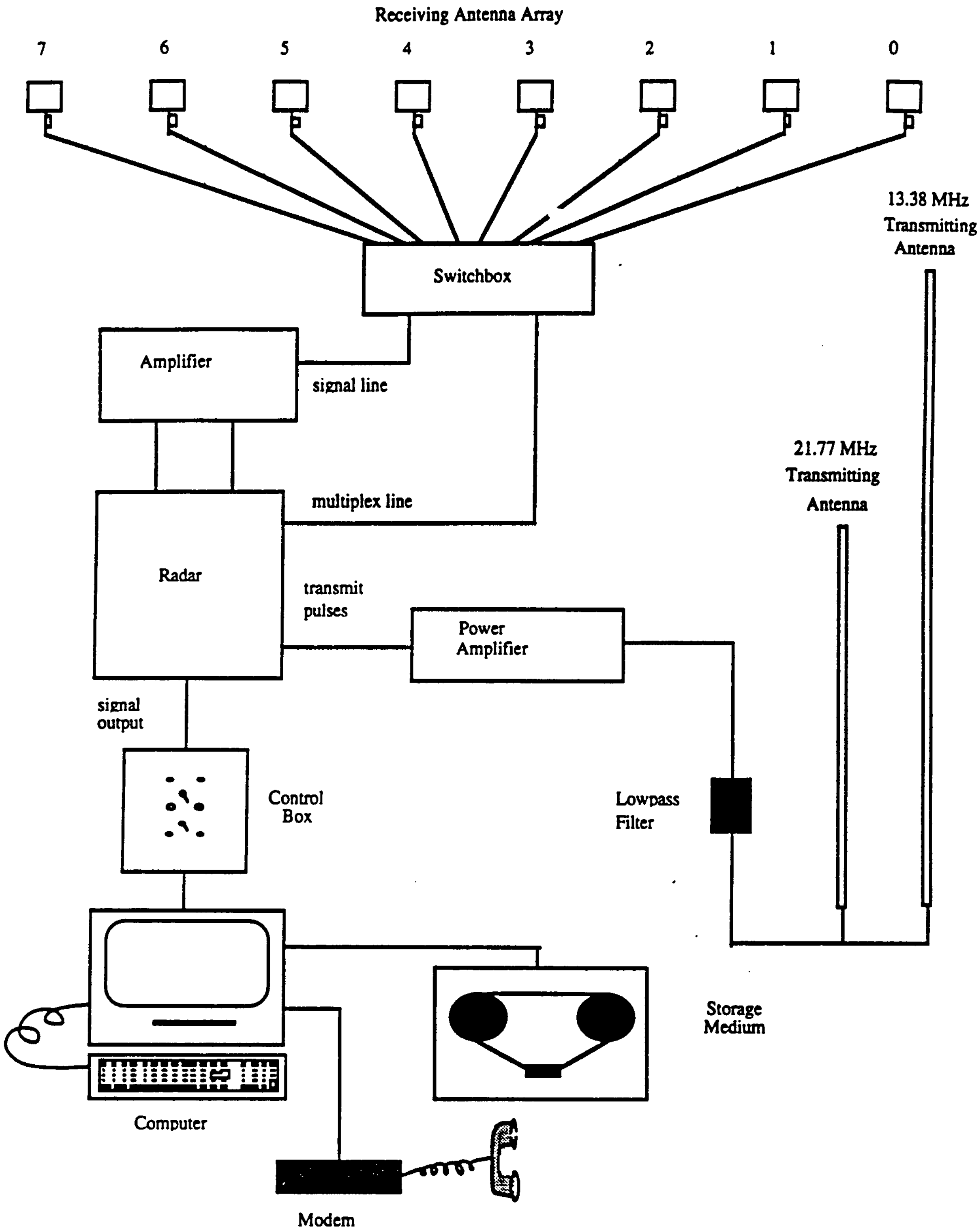

Fig. 1. HF radar system block diagram

is 2.5 ft on a side as dictated by what one gets when cutting a standard 10 foot length of copper pipe into four pieces. Built into the bottom section of the antenna support pipe is a preamplifier containing a blanker circuit to disable the receiver input during the radar transmit pulse time, preventing receiver overload. This blanker functions the same as the pulse blankers in most modern receivers, except that it is done right at the antenna input, rather than at the receiver IF frequency. The preamplifier also includes a bandpass filter to reject out of band signals. Each receive antenna preamplifier output is applied to a solid state electronic 8 by 1 multiplexer controlled by the computer.

Receiver: The receiver is a single conversion design having a computer controlled RF preselector, computer controlled IF gain, and computer controlled post detection bandwidth. The IF is at 40 MHz having a bandwidth of 200 kHz. Phase linearity is an important parameter for the design of the receiver, and considerable attention has been given to the IF filtering in order to provide good phase linearity. Receiver gain is controlled by adjusting an electronic attenuator in the IF amplifier section. This attenuator consists of a set of biased diodes driven by a computer controlled D/A converter. The detection circuit consists of two identical phase detectors driven by in-phase and quadrature 40 MHz reference signals. Both an in-phase and quadrature phase comparison of the radar return signal is required in order to distinguish positive and negative frequencies resulting from approaching and receding ocean waves. The post detection filtering is performed by switched capacitor low pass filters under computer control. The two detected analog baseband signals are sampled and converted to digital information by two identical 12 bit A/D converters.

Controller: The system controller is a microcontroller board having a 68332 processor with 256K of RAM. External to this board are auxiliary interface circuits consisting of several PALs, a serial communications controller (SCC), RS422 line drivers, a background interface and 12 bit D/A and A/D converters. The SCC is used to route the receiver digital data to a Macintosh 7100/66 computer (Power MAC) used for the data analysis. Macintosh-based C/C++ compilers by Metrowerks are used to generate code.

II. Radar Equipment Construction

A single radar is designed to fit in an ECS composite shock mounted cabinet about 3 ft. tall with a 2 x 2 ft. footprint -- see Fig. 2. The cabinet has detachable wheels and can be used as a shipping container for the radar. The control computer, currently a Macintosh Power PC 7100/60, is connected to the radar by several cables. The equipment is mounted within the enclosure in 19" rack panel chassis containing the following (with numbers according to Fig. 2):

2. Spare rack for future needs
3. Radar controller and exciter chassis
4. Radar receiver chassis
5. Radar transmitter chassis
10. Power supplies
6. Mains power control panel.

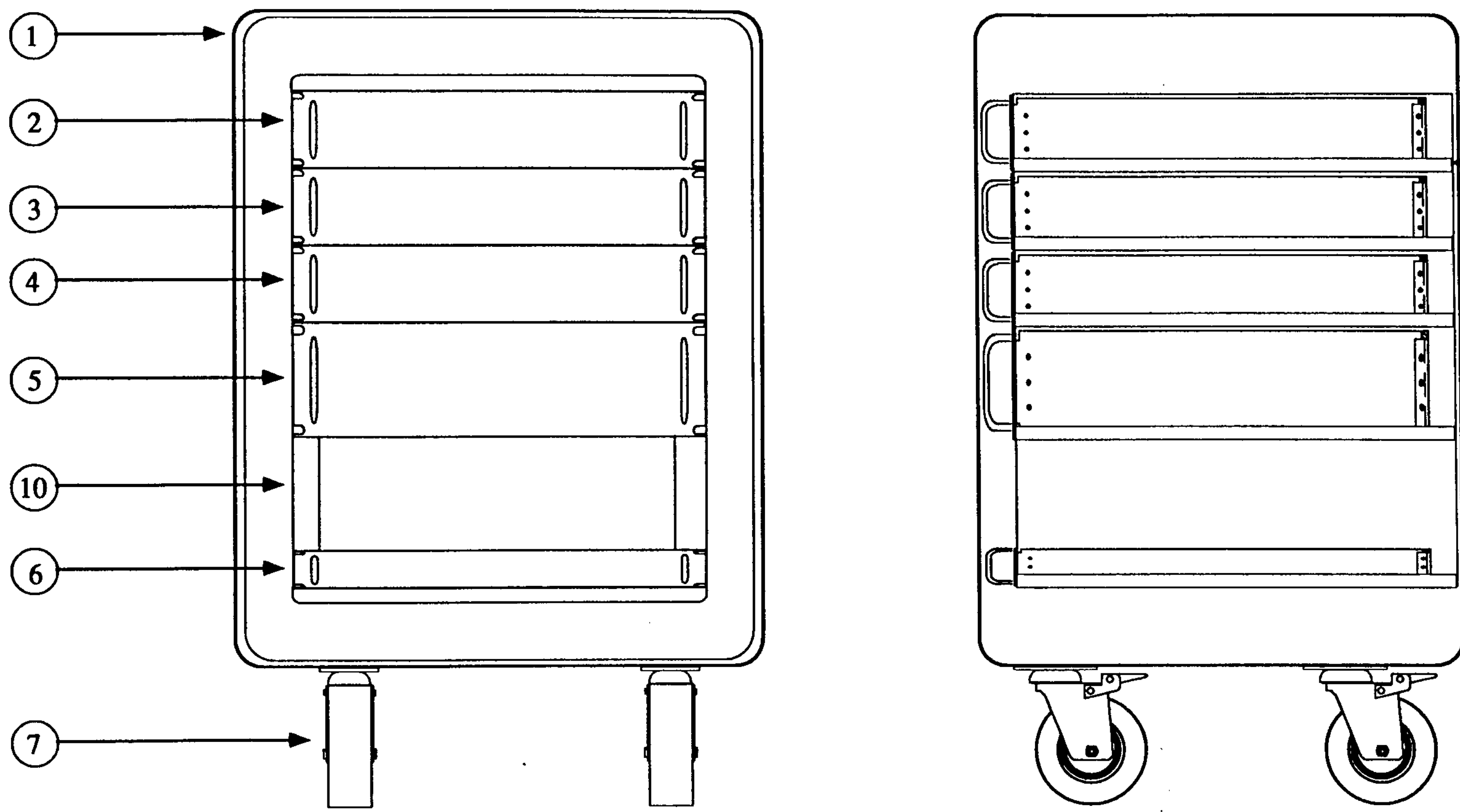

Fig. 2. HF Radar component chassis in shock mount container

Notes:

1. See ERIM document *TBD* for details concerning mounting chassis slides, cable routhing and associated hardware for the ECS enclosure.
2. This document incomplete without parts list 062-0005.

Space Physics Research Laboratory College of Engineering University of Michigan	Transceiver Assembly			
N000149510249	Transceiver Assy	062- 0003	1 of 1	x2

	04-29-96 NS
	04-26-96 NS
RELEASE	
DRAWN	Neil Schnepf
COG ENG	

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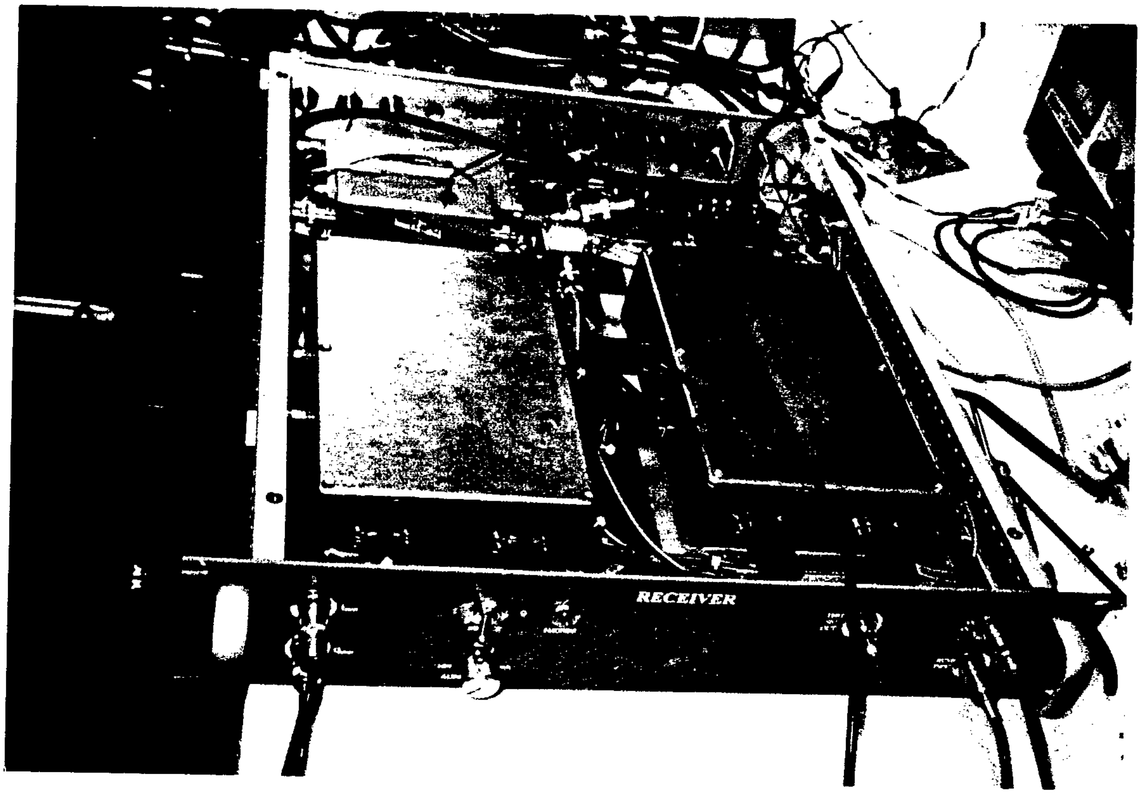
Drawing Page



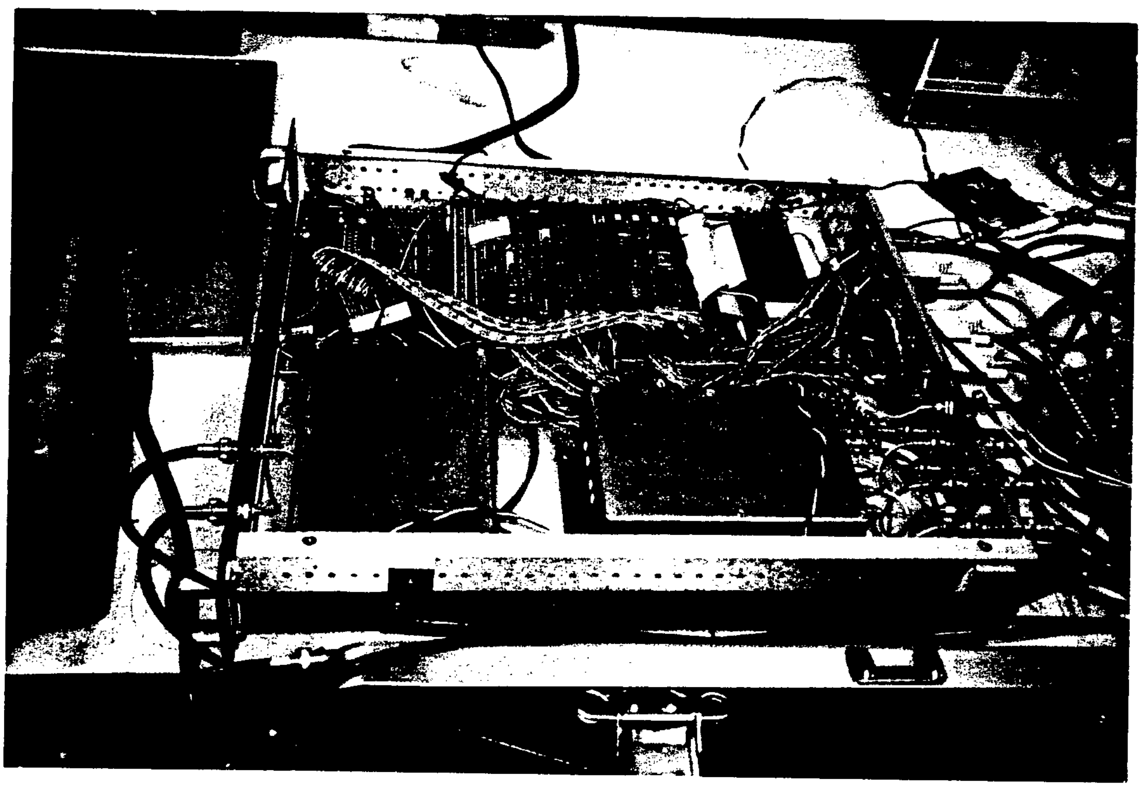


Fig. 3. Receiver (top) and controller-exciter (bottom) chassis with covers off during integration and test at the University of Michigan. Note that the receiver has a speaker so that one can listen to the received signals.

Photographs of the controller-exciter, receiver and transmitter chassis are shown in Figs 3 and 4.

An FCC license application was submitted in April, 1996 after consultation with FCC engineers and we anticipate that it will be granted without modification. It is very similar to license applications that were approved to operate radars along the California coast in the past.

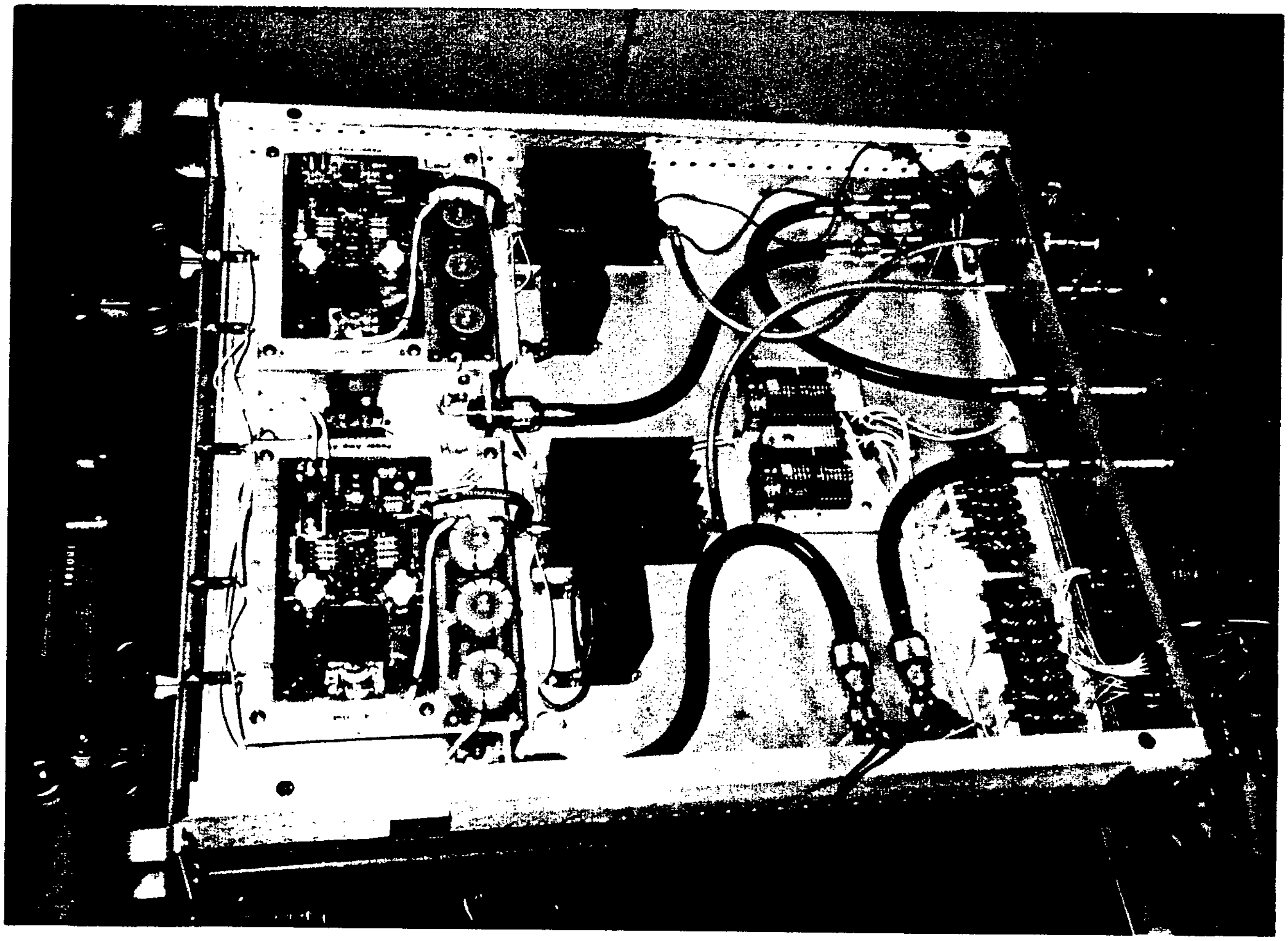


Fig. 4. Radar transmitter chassis during integration and test at the University of Michigan. The red upper and yellow (lower) inductors are part of the low pass filters for the transmitters.

III. Prototype Test Experiment Deployed at Long Marine Laboratory

Typical radar operation parameters are given in Table 1 below.

Table 1. HF Radar Operational Parameters

Radar frequencies	4.8, 6.8, 13.6 and 21.8 MHz
Radar wavelengths	62.5, 44.1, 22.1 and 13.8 m
Receiver antennas	8 element phased array of loops
Transmit antennas	two quarter wavelength verticals using traps to cover two frequencies with a single antenna
Peak power	50 to 100 W input to antenna feed
Range resolution	3 km with 50 kHz bandwidth
Angular resolution	15 to 67° depending on frequency
Maximum range	70 km depending on wave height/wind speed
Angular swath	± 60° from boresight
Sample duration	12 minutes
Sampling rate	up to 5 times per hour

The current location of the radar and coverage area are shown in Fig. 5. This site is kindly provided through collaboration with the REINAS project at UC Santa Cruz (Prof. Pat Mantey, director) and the Long Marine Laboratory of UC Santa Cruz (Steve Davenport, director). A second radar unit will be installed along the coast somewhere between Monterey and Elkhorn Slough, probably at the Moss Landing Marine Laboratory or near the former Ft. Ord beach front sites. In Fig. 6 we show the high band (13.6 and 21.8 MHz.) transmit antenna with the trap for two frequency operation near the upper guy rope connection.

Fig. 7 shows the receive antenna array with 8 elements space out over 50 m. This gives a spacing of half a wavelength at the highest frequency to reduce the effect of grating lobes in the antenna response. Each antenna has a separate preamplifier. The antennas are on a cliff overlooking the ocean at a height of about 15 meters above sea level. This is an ideal location for coupling surface wave energy into and out of the ground wave mode for propagation over the ocean.

Fig. 8 shows a close up of a receive antenna array element with high band antenna and guy ropes in the background. These square loops are about 2.5 ft. on a side and are made of 3/4 inch copper pipe. In Fig. 9 we show the 'trap' (consisting of a coil tuned, by the coaxial cable capacitor running down the left side of the pipe) that enables the high band antenna to operate on two frequencies. The transmit antennas are fed by RG-8U coaxial cable over a run of about 100 m from the transmitter. The receive antenna elements are connected to a multiplex box so that the receiver can be connected sequentially to each element of the antenna array.

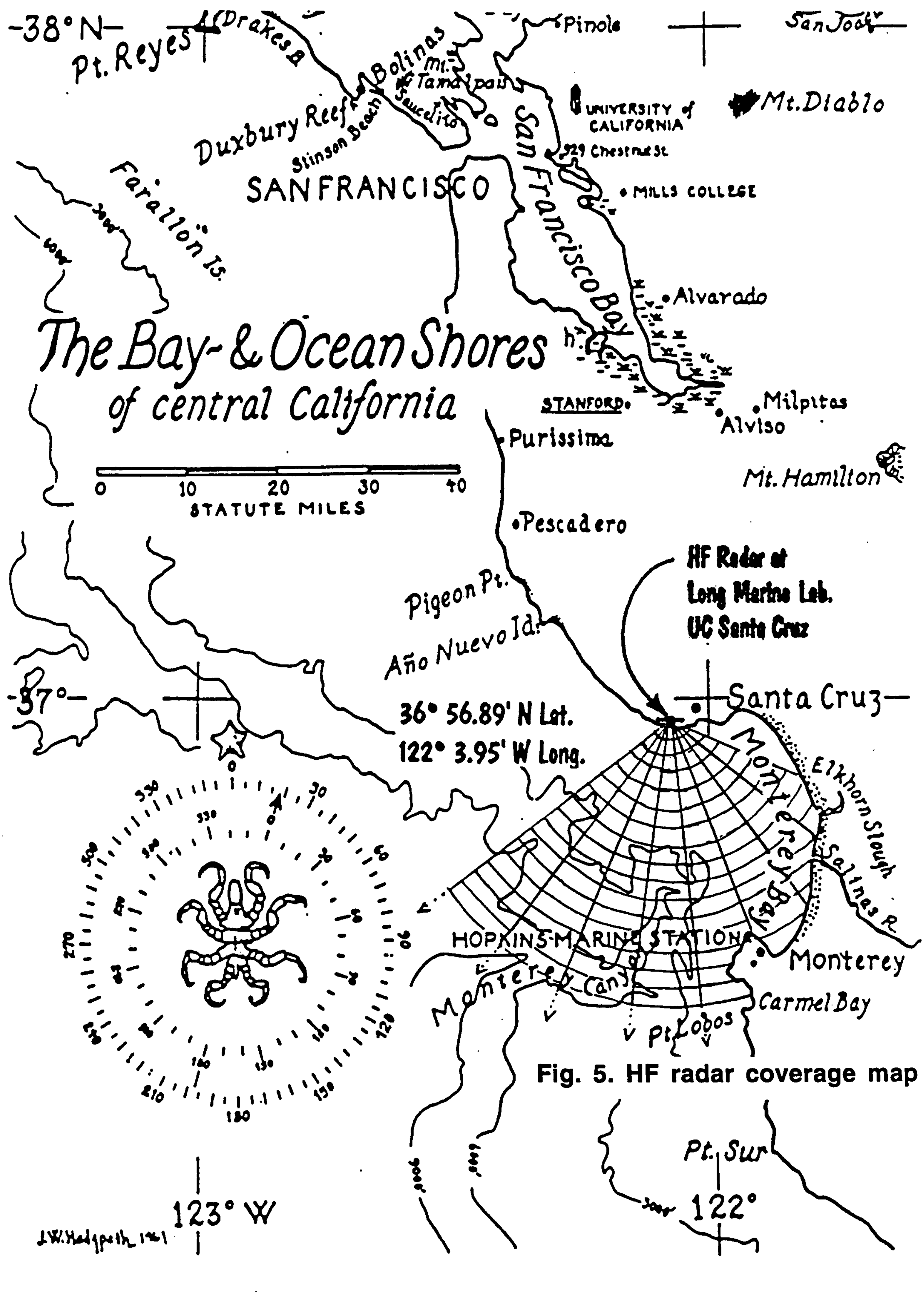


Fig. 5. HF radar coverage map

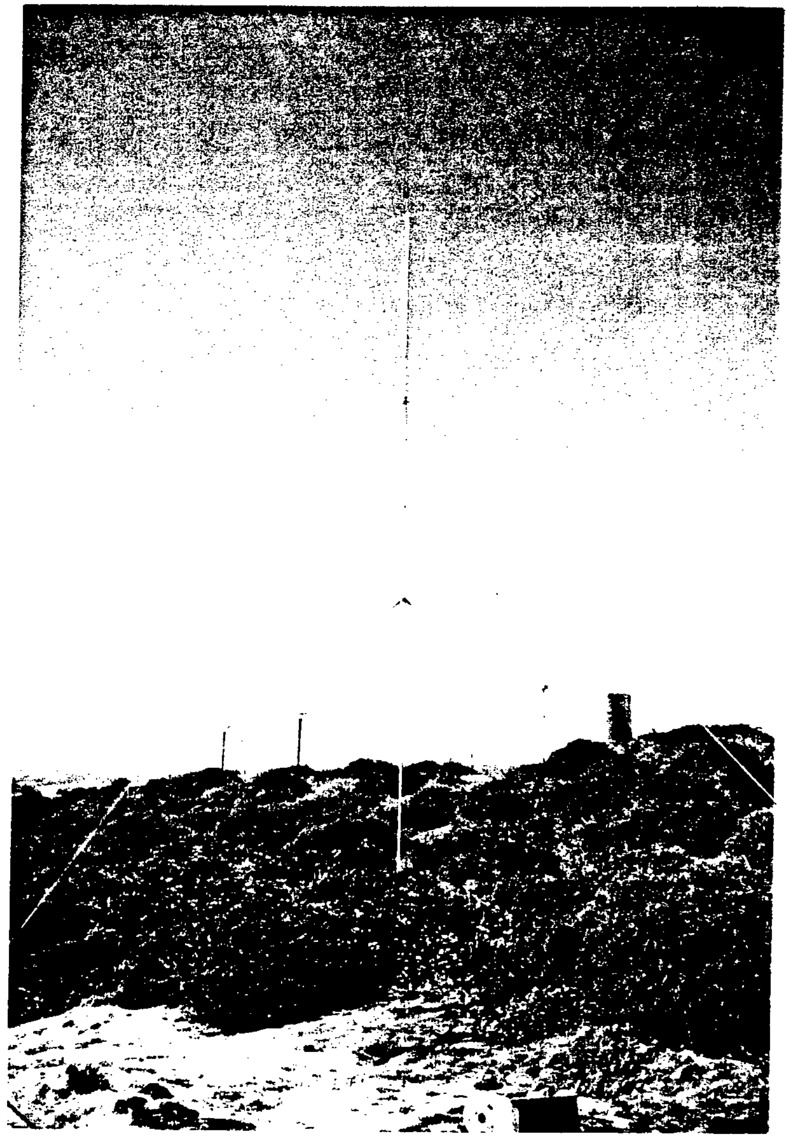


Fig. 6. High band transmit antenna. Note the 'trap' near the upper guy rope connection and the 'capacity hat' at the top to aid multifrequency operation. The antenna height is about 40 ft.

The primary output of the radar is the Doppler spectra of ocean echoes. This spectra is computed from a series of coherent samples taken over some 12 minutes. Thus, the spectral resolution is of the order of 1 to a few millihertz. Such high resolution is necessary to give accurate surface current estimates. An example, of spectra collected by the prototype radar is shown in Fig. 10. The transmit antennas used in this experiment have close to omni-directional patterns in the horizontal plane. The receive antennas have peak responses in directions perpendicular to the array long dimension, i.e. out toward the center of Monterey Bay (see Fig. 5) and in the opposite direction toward the Santa Cruz mountains. The prominent peak at zero Doppler in Fig. 10 is presumably due to land echoes from the back of the antenna array. The locations of the Bragg lines for 6.85 MHz are shown by the vertical dotted lines and the observed first-order Bragg lines are shown in both the lower and upper

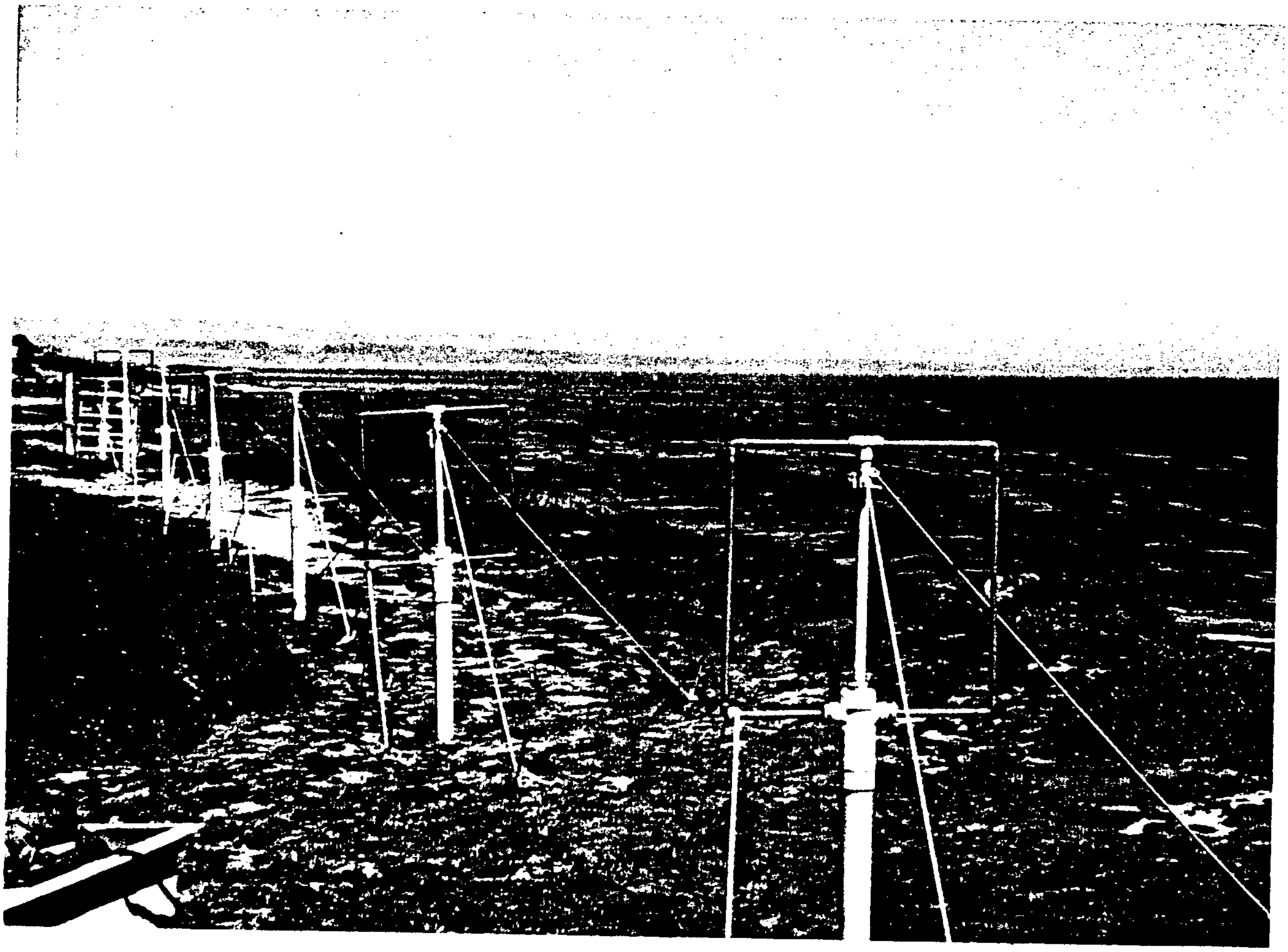


Fig. 7. HF antenna array on the north coast of Monterey Bay at the Long Marine Laboratory of the University of California at Santa Cruz.

panels. The negative Bragg peak is some 5 to 7 dB stronger than the positive peak since the prevailing wind (from the northwest on this particular day) is generating more receding (south traveling) waves than approaching (north traveling waves). Hence, in estimating currents we would use the displacement of the observed Bragg peak from the Bragg peak for still water (dotted line). So far we have simply used the highest SNR peak to make the current estimates. The horizontal lines near ± 0.6 Hz are fits to the spectral level and are used as the noise estimate in calculating SNR for the Bragg peaks.

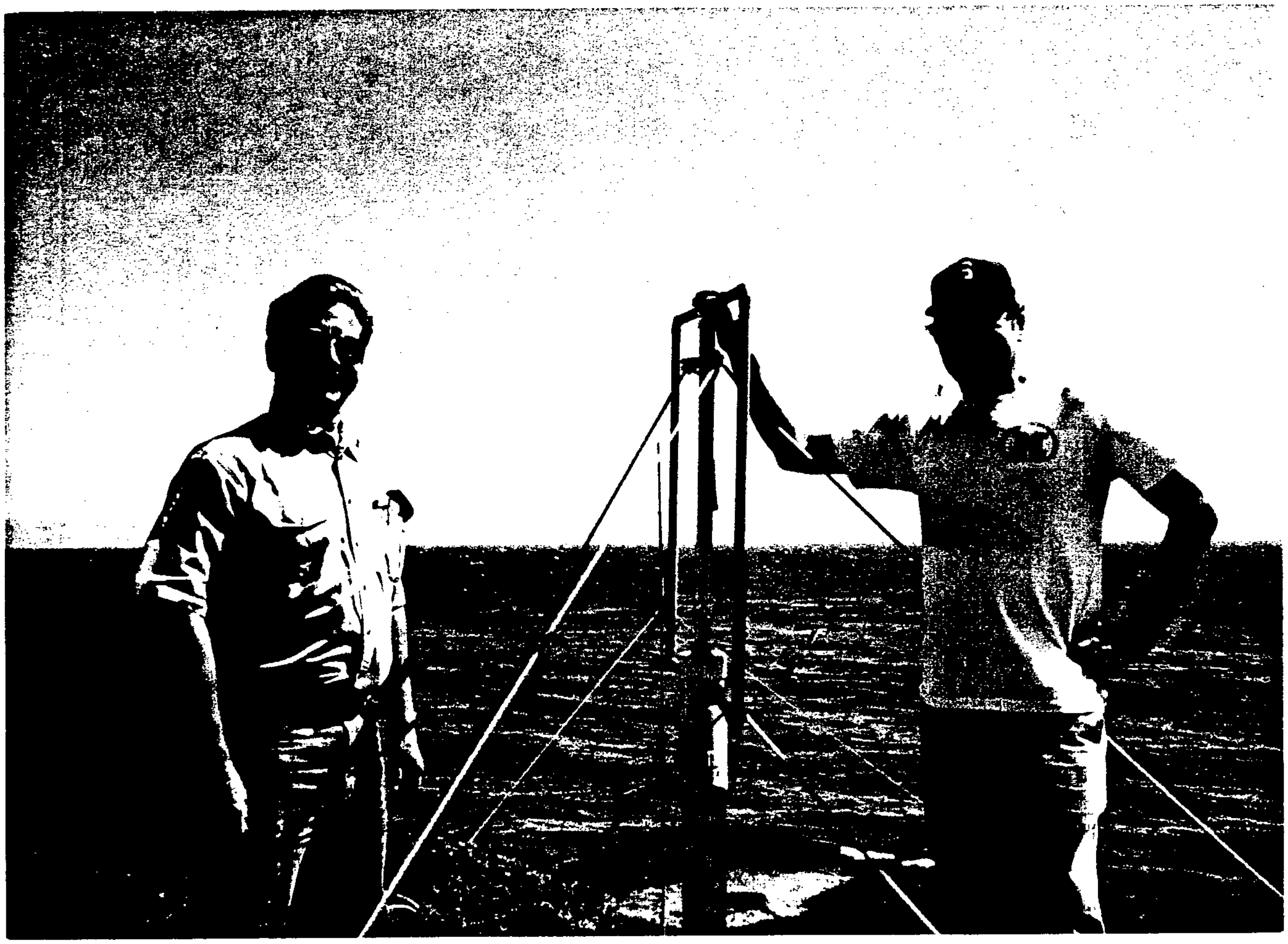


Fig. 8. Close up photo of a receive antenna element during the installation of the initial HF radar unit at Long Marine Laboratory of the University of California at Santa Cruz. Dr. Bob Onstott is on the left and Prof. John Vesecky on the right. The top of the antenna element is about 5.5 ft about the ground.

Before moving on to the initial results in terms of radial current maps we discuss a very necessary activity in effective HF radar operation, namely the use of a transponder to calibrated the amplitude and phase response of the antenna system. Assuming that all antenna elements are perfect is usually too great an assumption to make and leads to errors in the current estimates. Probably the most important effect is antenna pattern distortions and side lobes. These effects can lead to an ocean area with large currents 'leaking' into the estimates of areas with small currents and vice versa. Phase response variations across the receive antenna array can lead to faulty estimation of the spectra from which the current estimates are derived (see discussion above). To avoid these problems it is necessary to put a transponder at known

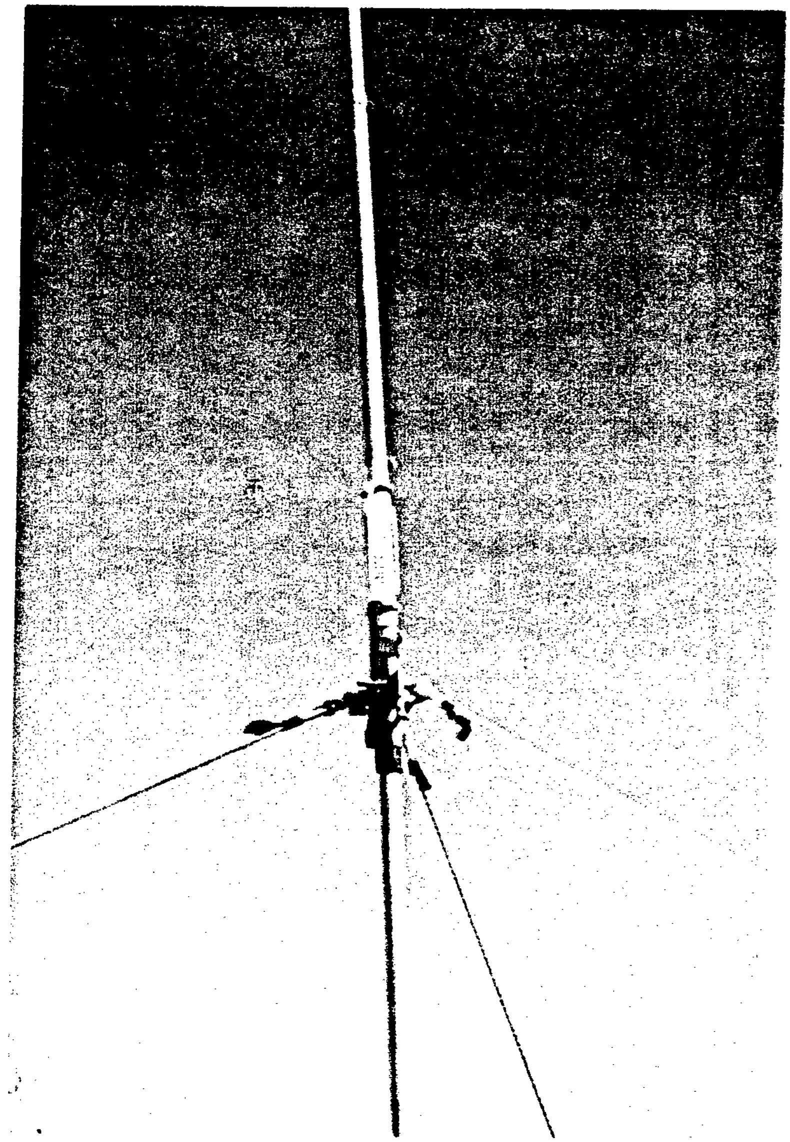


Fig. 9. Trap section of the high band HF antenna. The trap is about 3.5 meters off the ground and the total antenna height is about 5 meters.

locations in the radar coverage area and collect radar echo data from the transponder to allow calibration of the antennas in terms of relative response in both phase and amplitude.

A transponder run was conducted on October 4, 1996 using a transponder constructed by the REINAS project at UC Santa Cruz (Dr. Dan Fernandez and Steve Petersen). Dr. Fernandez also acquired the cooperation of NOAA in providing the NOAA patrol boat, Sharkcat. The transponder was operated from about ten locations near the antenna site, but at different aspect angles relative to the antenna boresight. A sample transponder run spectrum is shown in Fig. 11.

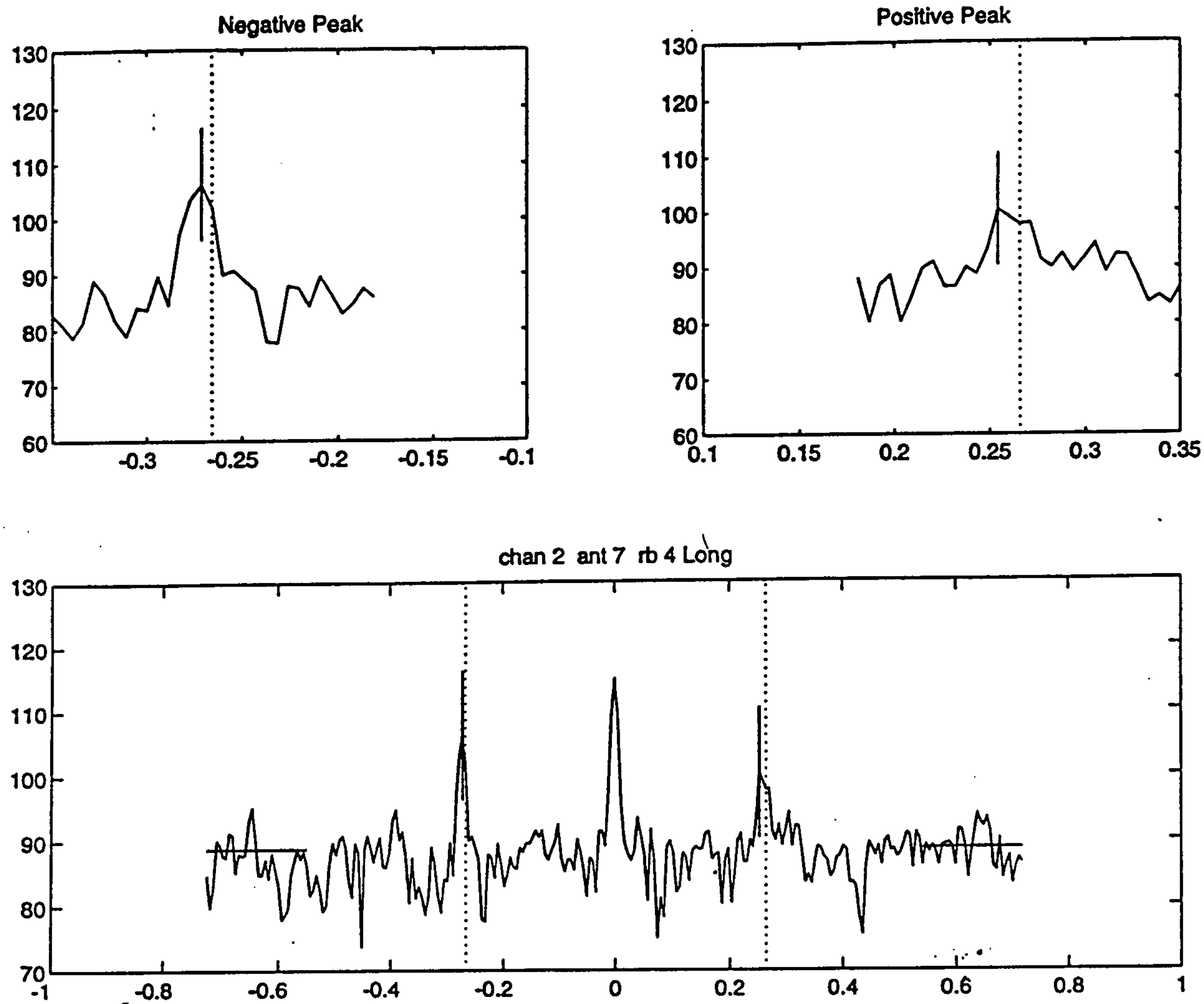


Fig. 10. Typical HF radar spectrum collected from a single antenna at the Long Marine Lab. site at a frequency of 6.85 MHz. Frequency scales are in Hz. The bottom panel shows the complete spectrum ± 0.7 Hz from the center frequency. The spectrum is for range bin 4 centered on a range of 12 km from the antenna site. The large peak at zero Doppler is presumably due to land echoes from the Santa Cruz mountains behind the radar site. The two spectral peaks, magnified in the upper panels, are from receding (negative peak) and approaching (positive peak) waves in Monterey Bay.

The transponder experiment of Oct. 4, 1996 was done in part because of the availability of the NOAA boat. The transponder was still in the prototype stage and had not been fully tested. The transponder worked, but the performance in terms of range was shorter than desired. The data are useful for a first-order current estimation algorithm, but better data quality from a higher power transponder output stage is needed. The transponder is now being modified to increase power and make other improvements. A new series of transponder runs will be done when the second unit is installed early in 1997.

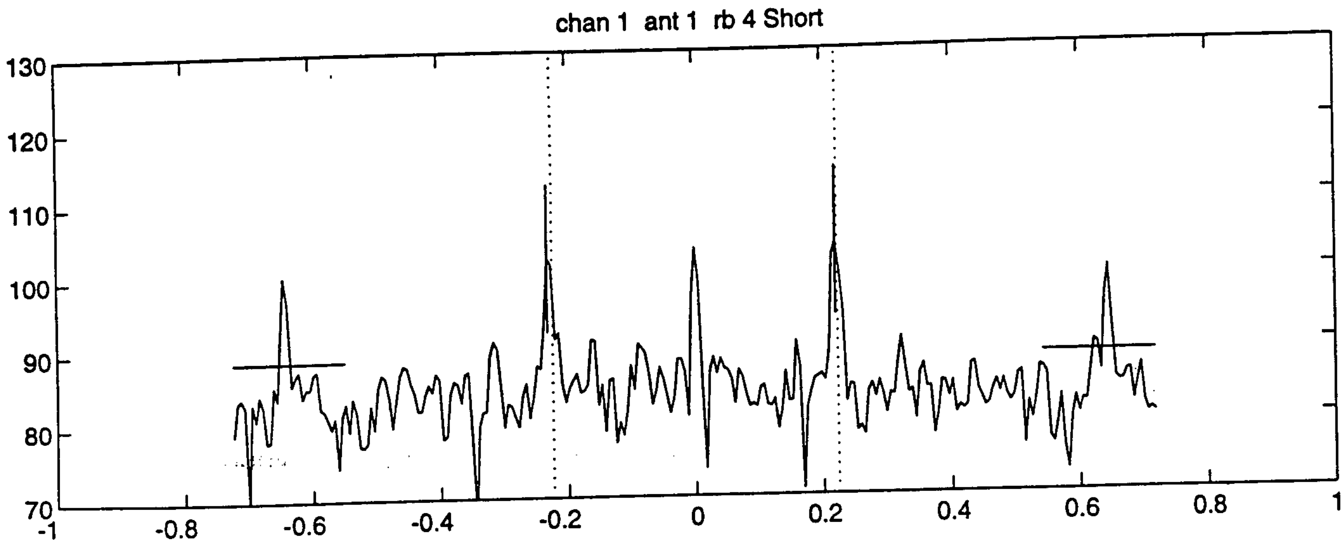


Fig. 11. Typical transponder run spectra. The spectral lines at ± 0.65 Hz are produced by the transponder and are analyzed to calibrate the antenna system in both phase and amplitude. The transmit frequency is 4.85 MHz and receiver antenna 1 was used for reception.

The beam forming algorithm and software development is in its early stages, but has produced initial results. At this stage the transponder data are good enough to allow for first-order phase and amplitude corrections. A prototype beam forming algorithm has been developed along straightforward lines. Matlab is being used as the prototyping software. Display software has also been created so that radial current profiles can be displayed in a geographical context.

Initial results for all four operating frequencies are shown in Fig. 12. These data were collected during the transponder run so we expect the phase and amplitude calibrations to be appropriate since there has been little time for antenna characteristics to change. The results are displayed on a range bin and angle bin grid with 3 km range bins and 15° angle bins. The 3 km range bins do not change with changes in operating frequency, but the angular resolution does change with frequency, increasing with decreasing frequency. Hence the 15° bins are not appropriate for the 4.8 MHz measurement where the angular resolution of the 50 m receive antenna array is only about 70°. Hence, in the 4.8 MHz results we find that the radial currents are very smooth with angle, extending over nearly the whole angular range. As operating frequency is increased, the variations with angle increase as the radars angular resolution is finer. Note also that the range of the radar is about 60 km in this instance. The range is influenced by the wind and may be reduced at low wind speeds.

Now consider the radial current maps in a geophysical context. We see that most of the measurements are receding, i.e. the radial current component is directly toward the south. This makes sense in that the prevailing winds are from the north. On the western side of the radar's coverage we find more variable currents. This also makes sense because it is in this region that there is often more current variability due to the interaction of the California current, flowing from north to south off the coast, with coast related currents influenced by the shore line and possible upwelling driven by winds out of the northwest.

As soon as we have thoroughly verified the beam forming and current estimation software, we plan to put the data products, e.g. Fig. 12, on the REINAS real time environmental measurement system. More useful measurements will be possible when two radars are installed and vector currents can be calculated. We propose to make such an installation and obtain vector currents in Monterey Bay and westward into the Pacific Ocean.

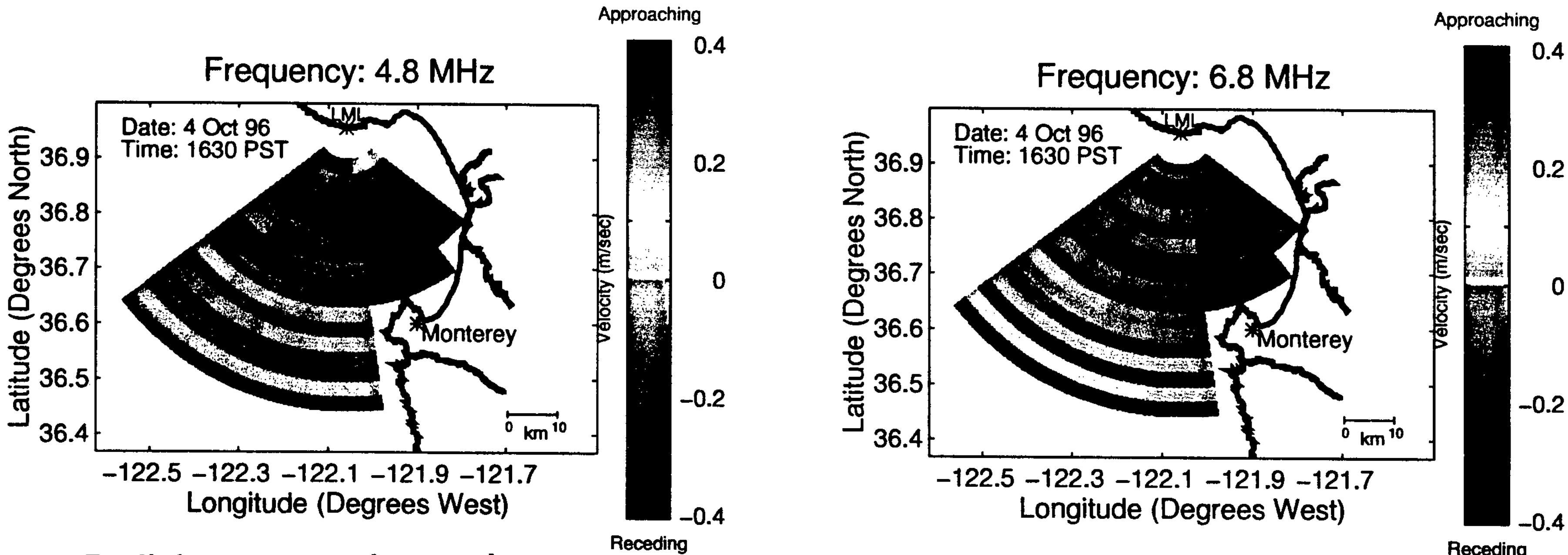
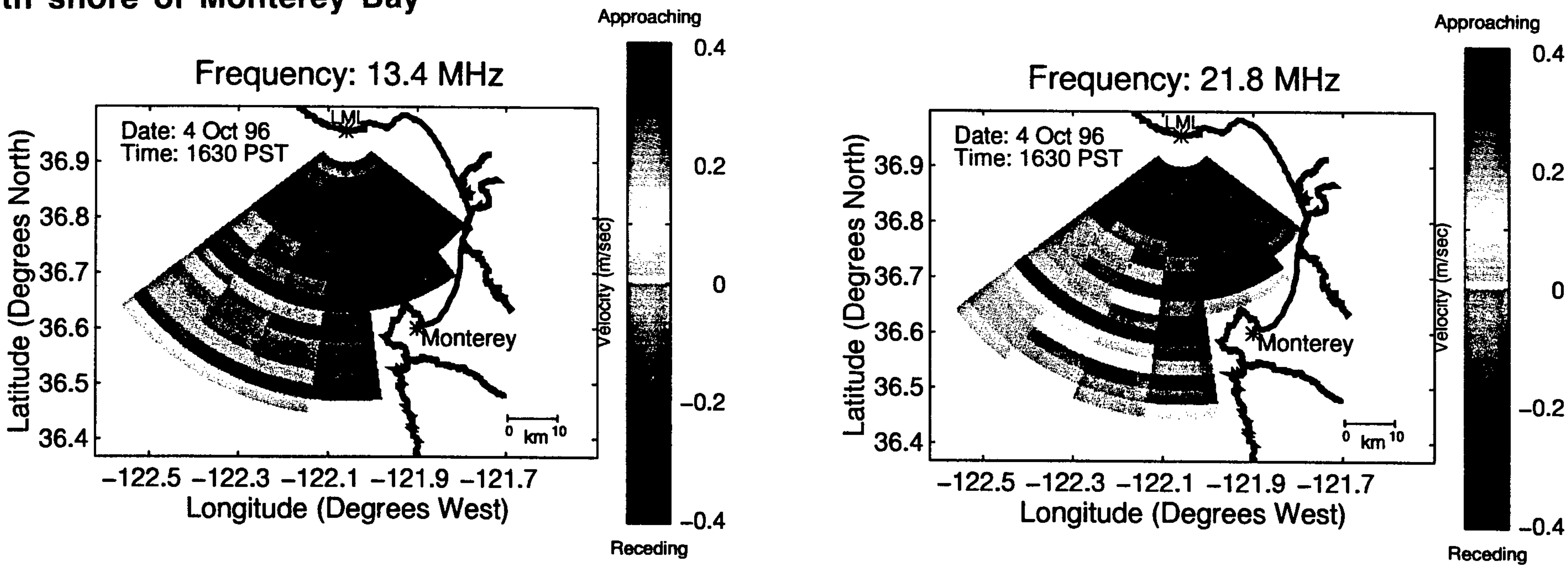


Fig. 12. Radial currents observed at four frequencies from the Long Marine Lab. site on the north shore of Monterey Bay



IV. Observations of Surface Current Vertical Shear

Observations of surface currents in Monterey Bay have revealed that although the currents at depths below 5 meters are primarily controlled by the tides and thus usually have a semi-diurnal (12 hour period) variation, the currents very near the surface are often controlled by local winds which often have a diurnal (24 hour period) due to the land-sea breeze effect. Observations our multifrequency HF radar unit at LML shows the transition between the wind forcing near the surface and the tidal forcing at deeper depths.

Since the radar observations of currents at different frequencies correspond to sensing different wavelength surface waves on the surface and since these waves 'feel' currents at different depths, HF radar observations at different frequencies correspond to the near surface current at different depths. For our HF radar the 'effective depths' of the four radar frequency channels are as follows:

Channel #	Radar Frequency -- MHz.	Resonant Ocean Wavelength -- m	Effective Depth -- m
1	4.8	31.3	1.6
2	6.8	22.0	0.9
3	13.6	11.0	0.5
4	21.8	6.7	0.3

Thus, observations at the four radar frequencies can give one a picture of the current behavior at several depths in the top two meters of the ocean. To illustrate the usefulness of this capability we examined the current variations at two observational frequencies as functions of location and time over a 24 hour period. However, before examining the radar data we describe the wind variations over this period. Fig. 13 shows the wind speed variation at the location of the M1 buoy deployed by the Monterey Bay Aquarium Research Institute and kindly provided via their internet homepage. These data were collected on October 17, 1996 at a location approximately midway between the LML radar site and the Monterey Peninsula shown in Fig. 5 above. Thus, this buoy lies very close to the broadside direction of our HF radar antenna. Fig. 14 shows the wind direction from the M1 buoy. The low winds from the NE in the morning hours, followed by much stronger winds from the NW in the afternoon and early evening hours are typical of the wind fluctuations over Monterey Bay in the spring, summer and autumn. In Fig. 15 we show the tidal height at Moss Landing, on the coast near the middle of Monterey Bay. It shows the typical semi-diurnal variation of the tides in Monterey Bay.

In Figs. 16 and 17 we show HF radar derived, radial currents that correspond to a radial cut in the plots of Fig. 12 as a function of time. The cut displayed in Figs. 16 and 17 is broadside to the antenna array direction and on a bearing of 171° T. These data have been smoothed and correspond to a broad swath across the mouth of Monterey Bay from the LML site southward toward the Monterey Peninsula as shown in Figs. 5 and 12. The range bins correspond to increments of 3 km in range with the middle of Monterey Bay corresponding to about range bin

10 on the plots. In Fig. 16 we show the radial currents from Channel 4 with an effective depth of about 30 cm. They show a strong diurnal variation as also observed by Paduan et al. (1995) in August of 1994, at an effective depth of about 30 cm, about the same as that of our Fig. 16. Here we are able to observe currents deeper below the surface and the results for an effective depth of about 1 meter are shown in Fig. 17. Here, we can see the struggle between the diurnal forcing of the wind and the semi-diurnal forcing of the tides. Near the middle of the bay, range bin 10, we see a clear semi-diurnal variation. We suspect that this variation corresponds to the domination of the tides at a depth of about one meter.

Clearly these are only preliminary results and just for a single day. Yet they clearly indicate a transition from diurnal to semi-diurnal behavior with increasing depth. More careful study, including a second radar unit and use of current measurements from the acoustic Doppler current profiler (ADCP) associated with the M1 buoy, will commence in early 1997.

References

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JFV 2/8/97

Fig. 13. Marine wind speeds observed by the M1 buoy deployed near the center of the mouth of Monterey Bay. The times are local time on 10/17/96. Note the diurnal land-sea breeze variation.

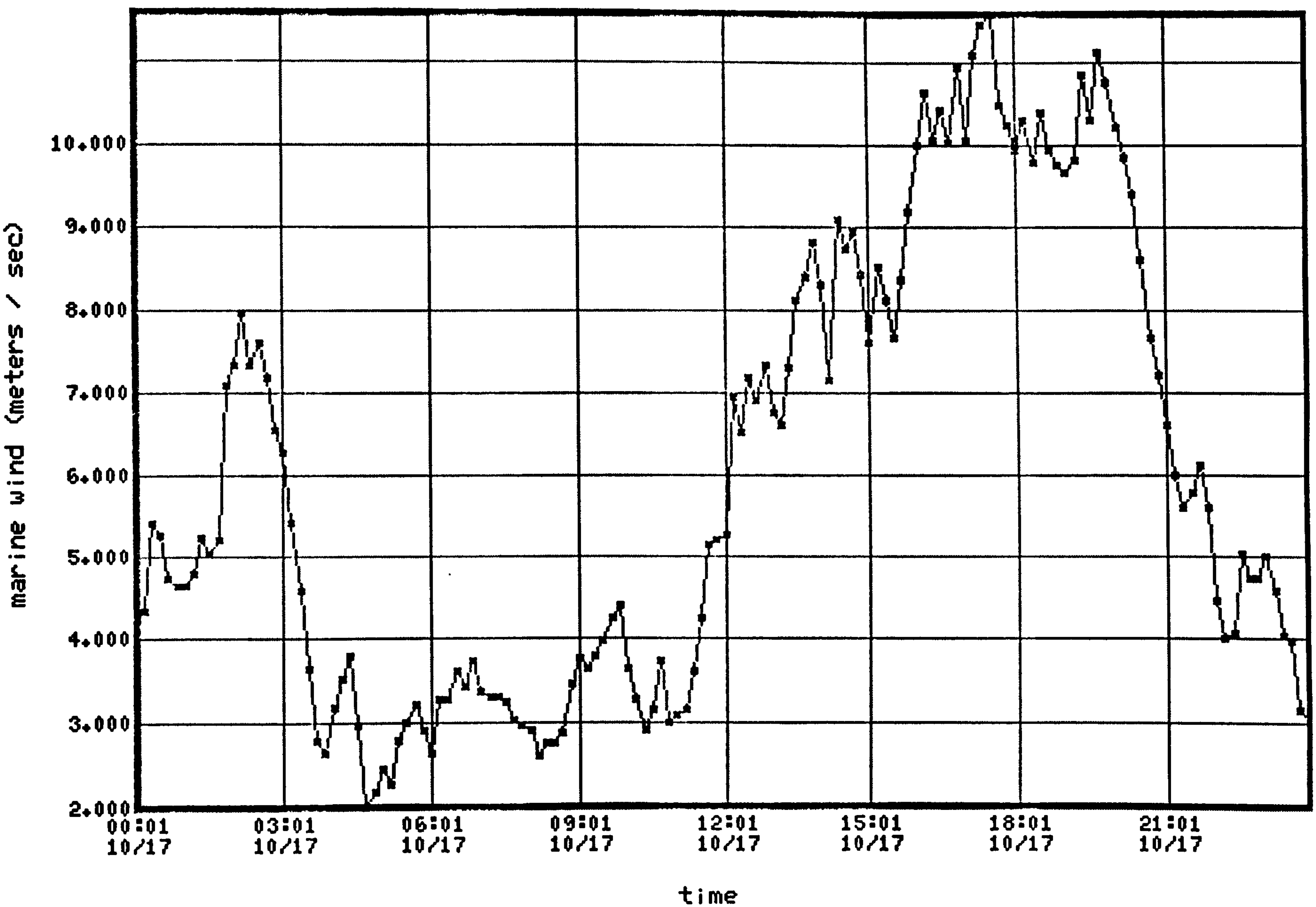
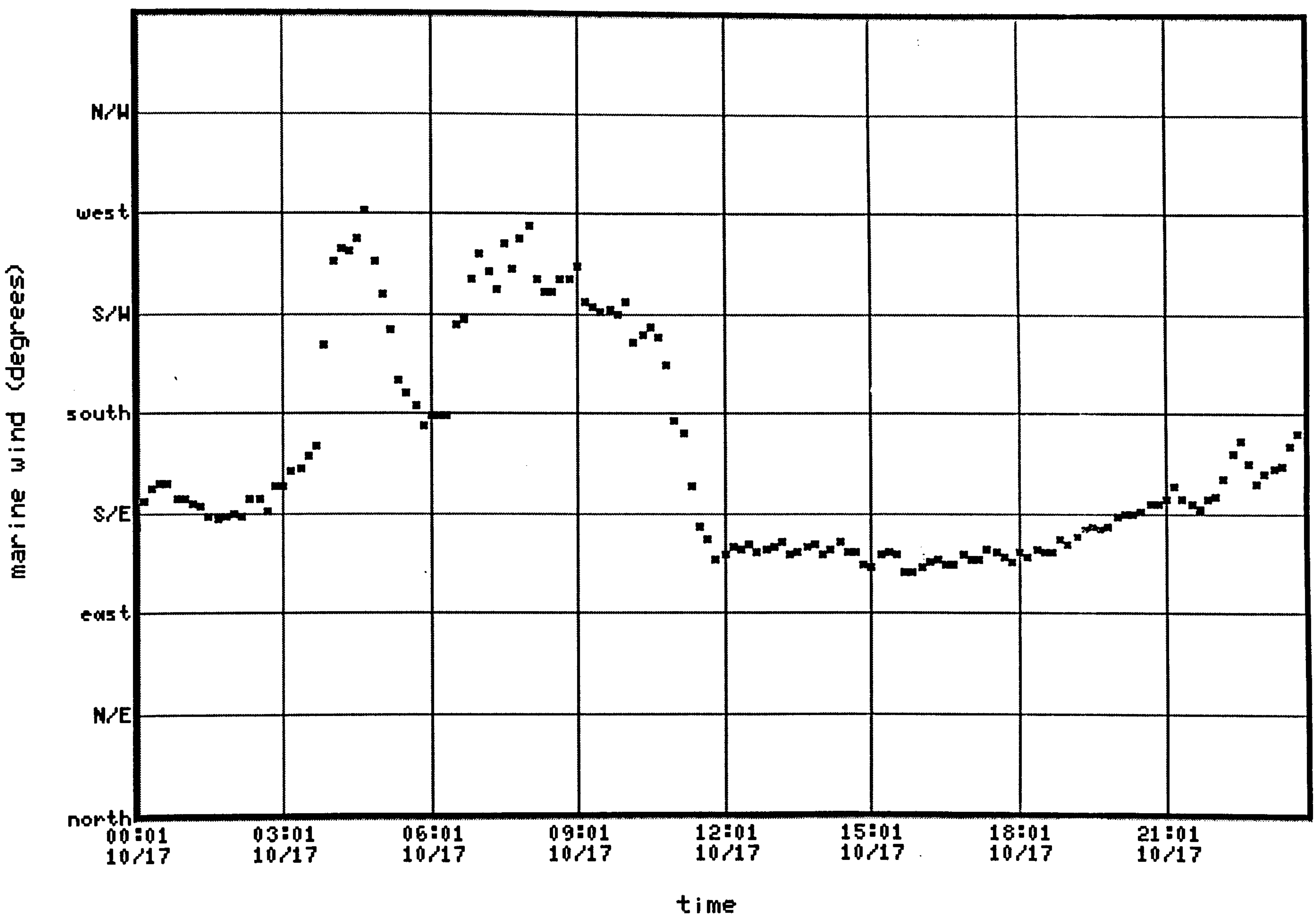


Fig. 14. Marine wind directions observed by the M1 buoy deployed near the center of the mouth of Monterey Bay. Note that the directions are those toward which the wind blows. The times are local time on 10/17/96.



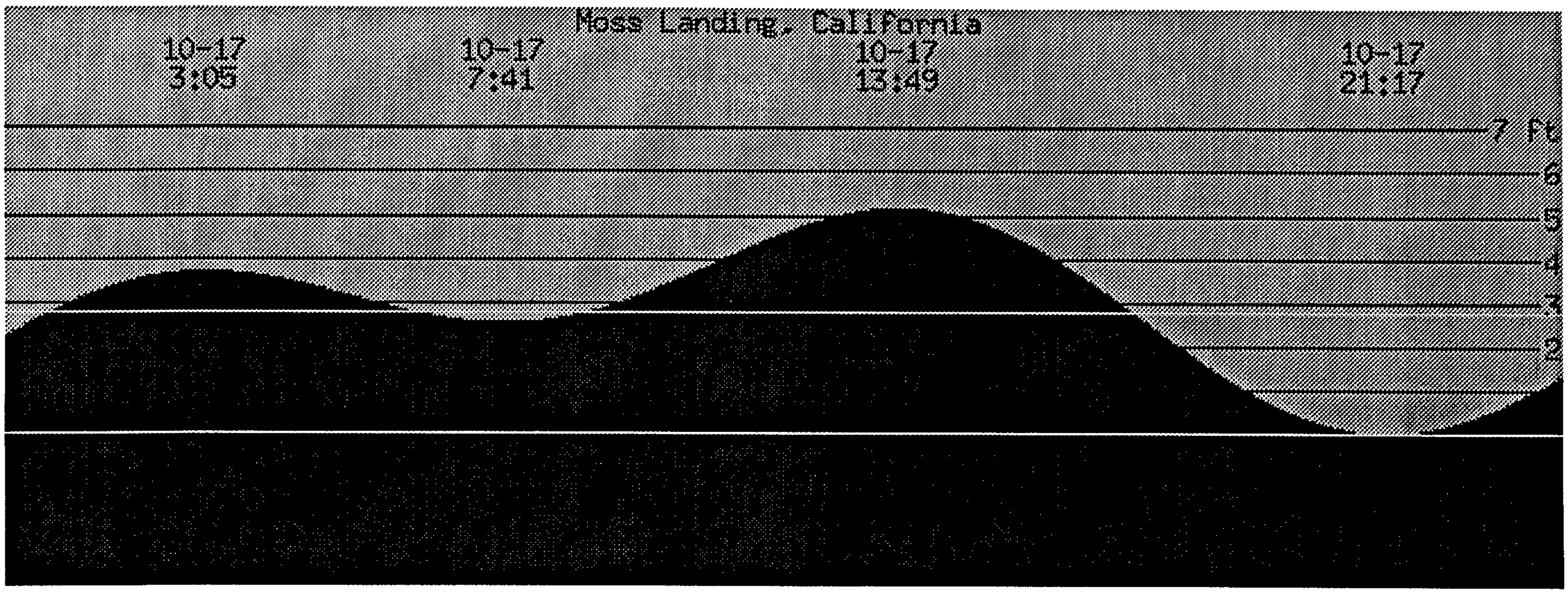


Fig. 15. Tidal height observed at the Moss Landing Marine station on the coast near the center of Monterey Bay. The times are local time on 10/17/96.

Change of Ocean Current Over Time
Channel 4, Broadside
October 17, 1996

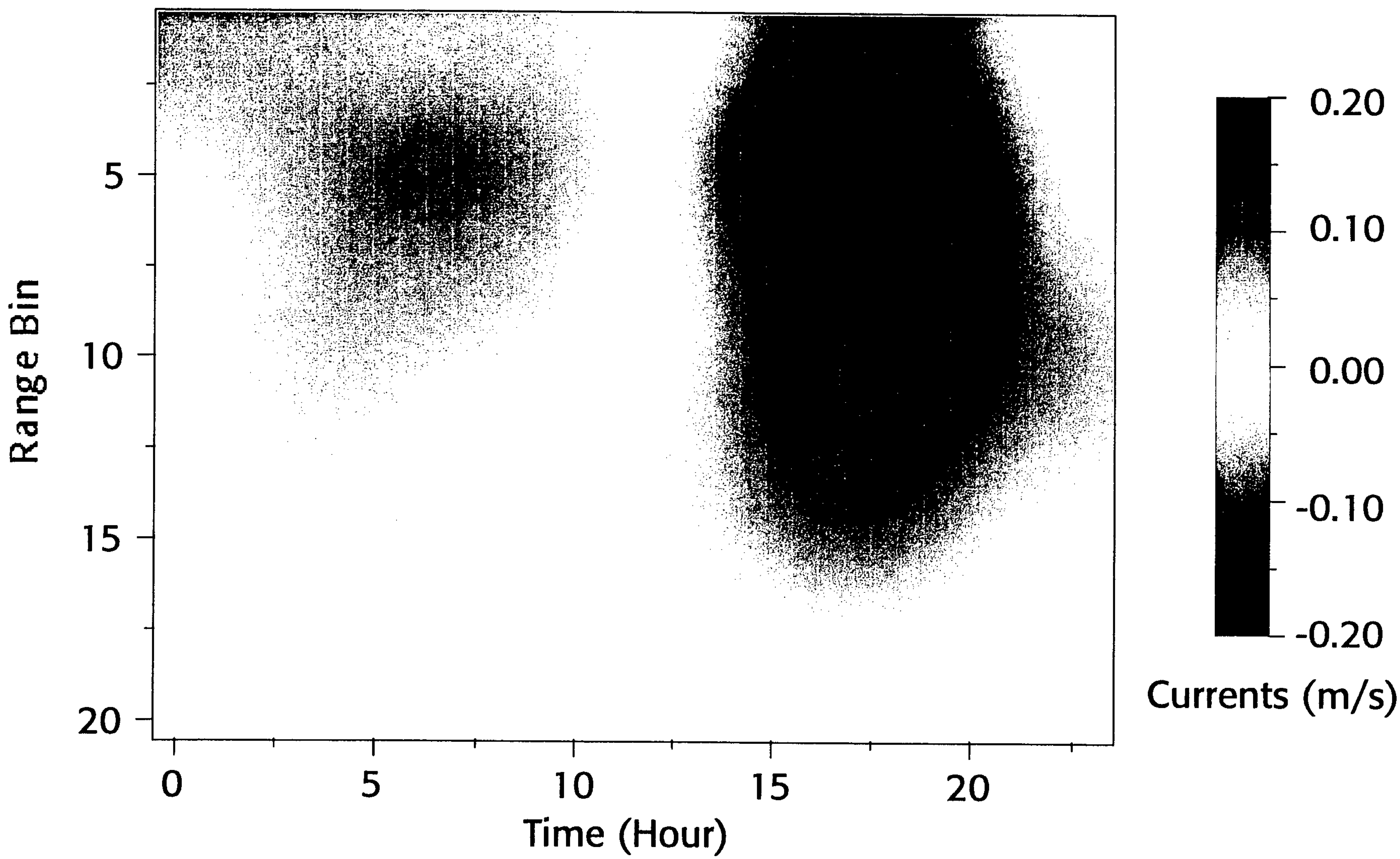


Fig. 16. Radial currents observed by HF radar channel 4 with an effective depth of about 30 cm. Times are local time. Note the strong diurnal variation.

Change of Ocean Current Over Time
Channel 2, Broadside
October 17, 1996

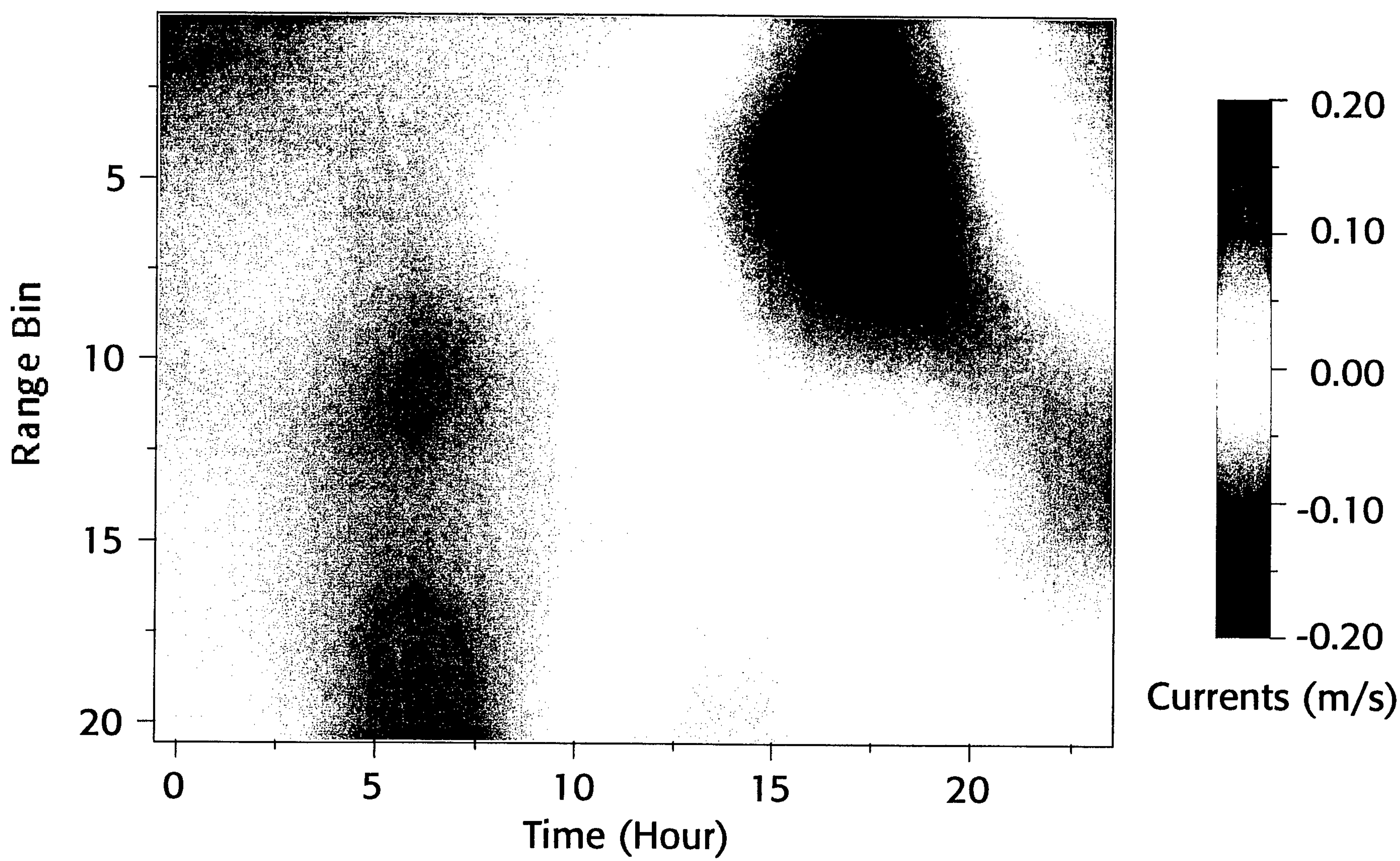


Fig. 17. Radial currents observed by HF radar channel 2 with an effective depth of about 90 cm. Times are local time. Note the combination of diurnal and semi-diurnal variations.

Observations of Near-Surface Ocean Currents at Varying Depths Using a New Multifrequency HF Radar

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Abstract -- A new multifrequency (4-25 MHz) HF radar was installed at the Long Marine Lab. (University of California at Santa Cruz) on the north coast of Monterey Bay CA in July, 1996. This radar is capable of observing near-surface currents at varying depths in the top two meters of the ocean. Observations were made over a ten day period in March, 1997 during which there was a strong land-sea breeze circulation over Monterey Bay. Radial current measurements corresponding to depths of about 0.3, 0.5, 1.0 and 1.4 m were made during this period using HF radar data from four operating frequencies. Fourier analysis of these data shows that very near the surface the strongest periodic component is a diurnal one corresponding to the diurnally varying surface stress from the land-sea breeze. At deeper depths the diurnal component remains, but a semi-diurnal component grows in strength with increasing depth of the current measurement. Thus, multifrequency HF radar combined with deeper current measurements from buoys and moorings are able to investigate the upper layer of the coastal ocean where wind and tidally driven currents struggle for dominance.

OBJECTIVE and INTRODUCTION

The objective of this paper is to investigate the impact of wind stress at the ocean surface and of tidal flows on near-surface currents in the top few meters of the ocean. This work follows on investigations of surface current circulation in Monterey Bay using single frequency HF radars by Paduan and Rosenfeld [1]

A new high-frequency (4-25 MHz) phased-array radar, designed and constructed jointly by the University of Michigan, Stanford University and ERIM International was installed at Santa Cruz, California in July, 1996. After initial equipment checkout and antenna calibration using a transponder (carried on a small boat), regular data collection started in October, 1996. The radar operates on four frequencies in the HF band using vertical transmit antennas, and an array of eight wideband loop receive antennas. Range resolution is about 3 km, and the 48 m phased-array aperture gives an angular resolution at the highest frequency of about 15°. Vertical current shear is estimated by using multiple radar frequencies which are scattered thorough Bragg Resonance by ocean waves of different lengths, which in turn are sensitive to currents at various depths [2 & 3]. For these observations the radar operated on four frequencies: 4.8, 6.8, 13.4 and 21.8 MHz, allowing estimation of the vertical current shear at 'effective' depths of 1.4, 1.0, 0.5 and 0.3 m respectively. The calculation of these effective depths assumes a logarithmic current profile. Further description of the radar's design features and operation is given in a companion paper by Teague et al. in these proceedings [4] and a progress report by Vesecky et al. [5].

OBSERVATIONS

The observational geometry is illustrated in Fig. 1. Radar coverage changes with the wave height of the Bragg resonant ocean waves. With a strong wind the range can be 50 km or more and with weak winds significantly less. Further information is given by references [4 & 5]. The typical resolution cell size is shown for the highest frequency of operation. In normal practice currents would be estimated on a grid that is 1/2 of this size in both range and azimuth. At lower operating frequencies standard (delay and sum) beamforming techniques produce azimuth resolution that is inversely proportional to frequency so that at the lower operating frequencies resolution cells become very large in azimuth angle -- the range cells remain the same size since the radar bandwidth is held constant. In Fig. 1 the azimuth lines are separated by 15°, corresponding to the azimuth resolution at the 21.8 MHz operating frequency. Each resolution cell will contain an estimate of the radial surface current at the four depths mentioned above. These current estimates usually vary over the range ± 0.4 m/s.

Strong Land-sea breeze circulation often dominates the surface wind field over Monterey Bay, especially during the summer. Typically sunlight warms the surface in the Salinas Valley (east of Monterey Bay) beginning at sunrise. The warm ground heats the cooler surface layer of the atmosphere and convection proceeds with rising air over the Salinas Valley. This action in turn causes cool air over Monterey Bay to flow from the sea toward the land. By noon a circulation is established with air flowing from sea to land near the surface and from land to sea at about a kilometer altitude. This process produces westerly surface winds of 8 to 12 m/s by about 4 pm local time. After sunset the air over the ocean cools rapidly and the process reverses due to the relatively warm sea surface at night, but is weaker. For analysis we picked March 7-17, 1997 when the land-sea breeze circulation was strong. Fig. 2 shows the wind speed fluctuations observed at the M1 buoy deployed by the Monterey Bay Aquarium Research Institute (MBARI) and shown in Fig. 1.

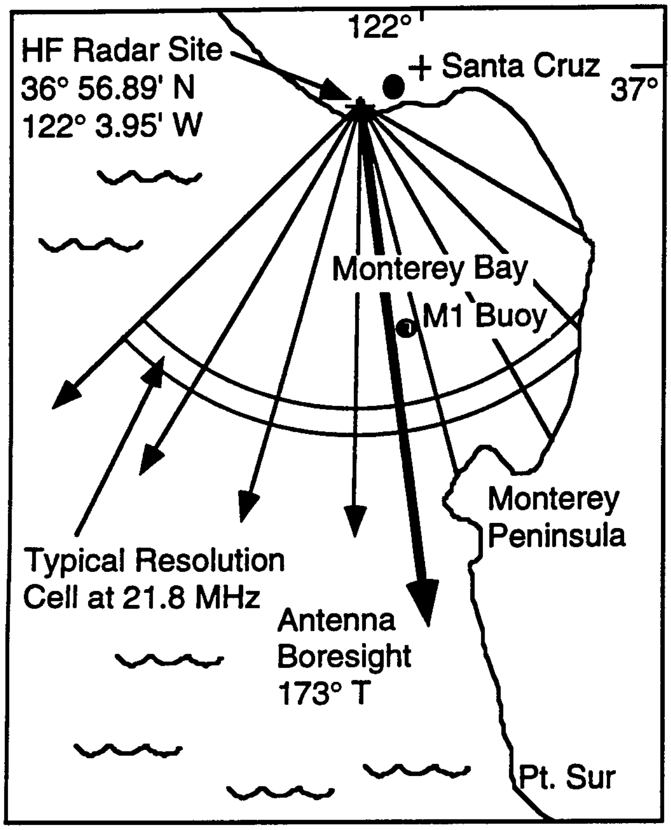


Fig. 1. Observational geometry for the multifrequency HF radar located at the Long Marine Laboratory of the University of California at Santa Cruz.

ANALYSIS and DISCUSSION

To accomplish our objective we assembled a ten day time series of hourly surface current estimates at each of the four radar operating frequencies. Each point in the time series was an average over 5 range bins and three 15° angle bins centered on the M1 buoy location shown in Fig. 1. This average covers a region about 10 km in radius centered on M1. Each of these four time series was Fourier transformed. The resulting magnitudes (not power) of the Fourier components are shown in Fig. 3.

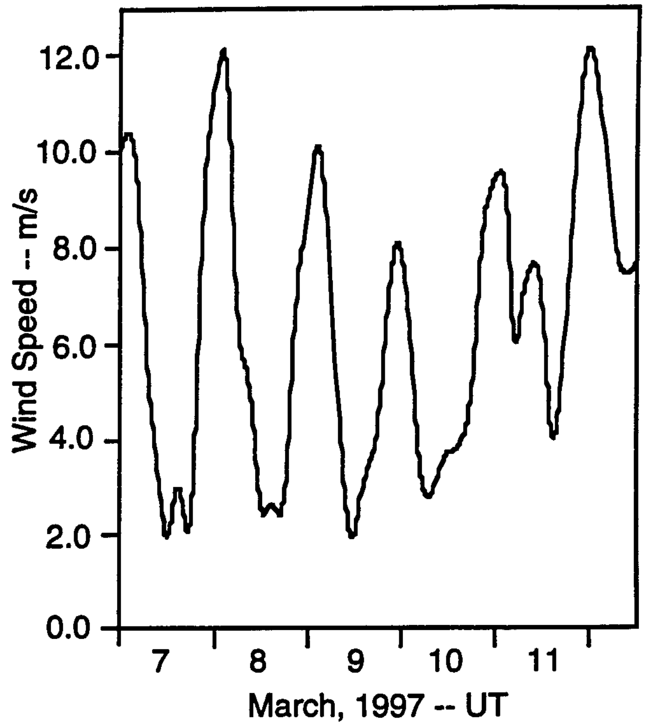
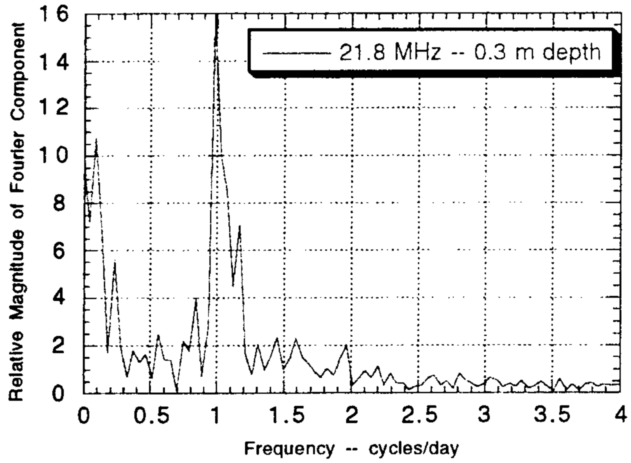
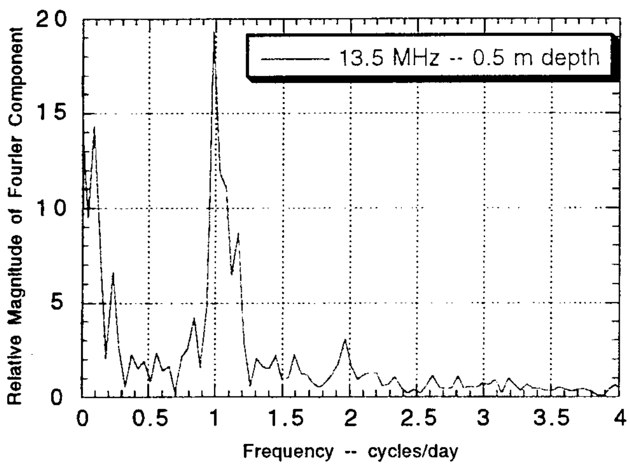
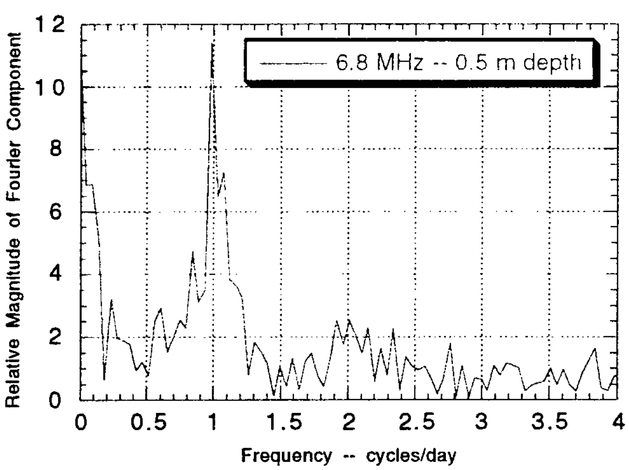


Fig. 2. Wind speed at MBARI moored buoy M1. Note the strong diurnal variation. See Fig. 1 for M1 location.

Moving from the highest operating frequency of 21.8 MHz to the lowest frequency of 4.8 MHz the effective depth of the current measurements range from 30 cm down to 1.4 m. Fig. 3 shows the dominant diurnal variation of these currents for all four dephs. What Fig. 3 also shows is the relative strength of the diurnal (wind driven) and semi-diurnal (tidally driven) currents. There are of course diurnal tidal components, but the semi-diurnal tides dominate in Monterey Bay, e.g. at the Moss Landing tidal gage. At the shallow depth of 30 cm the diurnal variation at 1 cycle/day is nearly 10 times the semi-diurnal variation at 2 cycles per day. Thus, at 30 cm depth the wind stress dominates strongly in driving surface currents. Slightly deeper at 0.5 m, the 13.5 MHz observation still shows the strong diurnal wind forcing, but a semi-diurnal component is now clearly identifiable at 2 cycles/day. At a depth of 1 m (6.8 MHz observation) the diurnal component is reduced in magnitude and the semi-diurnal component has grown in strength to about 20% of the diurnal variation. Finally at 1.4 m depth the diurnal component has fallen further and the semi-diurnal component is about 30% in relative strength.







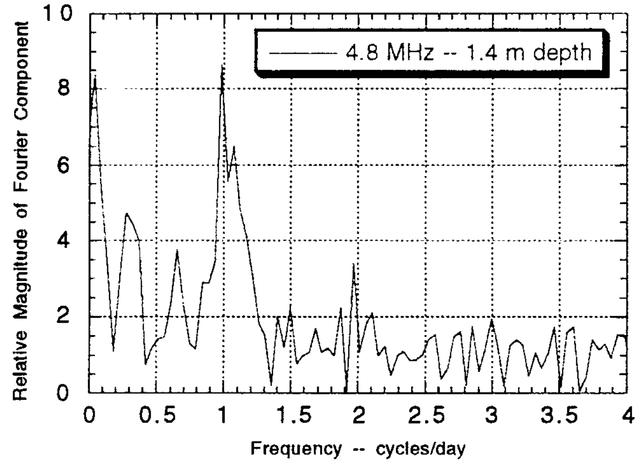


Fig. 3. Spectra of radial currents at depths of 0.3, 0.5, 1.0 and 1.4 m respectively from top to bottom.

CONCLUSIONS

We find that multifrequency HF radar allows observation of the top few meters of the ocean where wind stress dominates very near the surface and tidally driven currents gain in strength as depth increases.

…e combination of HF radar with acoustic Doppler current profilers (ADCP's) on buoys or moorings provides a comprehensive view of the near surface ocean and the processes that transfer momentum and other quantities between atmosphere and ocean.

ACKNOWLEDGMENTS

Field work requires much help; we are grateful to the following: Steve Davenport (Long Marine Lab.) and Prof. Pat Mantey (REINAS project) at the University of California at Santa Cruz. Dr. Don Barrick of CODAR Ocean Sensors Ltd., and the Monterey Bay Aquarium Research Institute. The construction and operation of the radar are supported by the Office of Naval Research, Drs. Dennis Trizna and Frank Herr, technical officers.

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Initial Observations of Ocean Currents, Current Shears and Wind Direction Using Multi-Frequency HF Radar

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A new High-Frequency (4–25 MHz) phased-array radar, constructed jointly by the University of Michigan, the Environmental Research Institute of Michigan and Stanford University, was installed at Santa Cruz, California in July, 1996. After initial equipment checkout and antenna calibration using a transponder carried on a small boat, regular data collection started in October, 1996. Installation of a second HF radar is planned at a site south of Santa Cruz to allow resolution of current vectors. Wind and wave data from moored buoys in the radar field of view, wind sensors at several coastal sites, and current measurements from several CODARs in the Monterey Bay area also are available.

RADAR HARDWARE AND DATA PROCESSING

The radar employs a direct digital frequency synthesizer which is programmable on a pulse to pulse basis, a coded modulation waveform, a pair of omnidirectional trap vertical transmit antennas, and an array of eight wideband loop receive antennas which are sequentially sampled and individually recorded. Conventional beamforming is done by software in the frequency domain, and alternative direction-finding algorithms can be applied to the recorded data. Range resolution is 3 km, and the 48 m phased-array aperture gives an angular resolution at the highest frequency of about 20°. Vertical current shear is estimated by using multiple radar frequencies which are scattered through Bragg resonance by ocean waves of different lengths, which in turn are sensitive to currents at various depths. For this experiment, the radar was programmed to operate on four frequencies between 4.8 and 22 MHz, allowing estimation of the vertical current shear in the upper meter of the ocean surface [1], [2]. Assuming a logarithmic current profile, current is probed at depths ranging from about 1.4 m using 4.8 MHz to about 30 cm using 21.77 MHz [3].

Radar timing, frequency control and data sampling are controlled by an MC68332 microprocessor, and overall radar operation and data processing are done on a Macintosh 7100 computer. Radar data are recorded for about 13 minutes each hour, and the raw data are stored on removable disk cartridges for subsequent analysis. The raw data are processed by partitioning the time series from each frequency, range bin and antenna into several segments, and computing a Fourier transform for each segment. Beam steering is done by applying an amplitude taper and phase shift to the transforms for the 8 antennas and then coherently adding those together, followed by incoherent power summation over the various segments. Doppler shift is estimated by computing the centroid of the stronger of the approaching and receding Bragg peaks, and current is estimated by subtracting the Doppler shift due to the still-water phase velocity of the resonant waves. This procedure is repeated for each beam direction, range bin and frequency.

CURRENT ESTIMATION

Figure 1 shows an example of radar data taken at 1600 PST on 6 March 1997. The radar location is at (0,0), and the x-axis is along the coastline. The radar antenna broadside direction (y-axis) is 173°T. The plots show the received power multiplied by r^3, where r is the range to the ocean surface, normalized by the maximum received power. The height of each

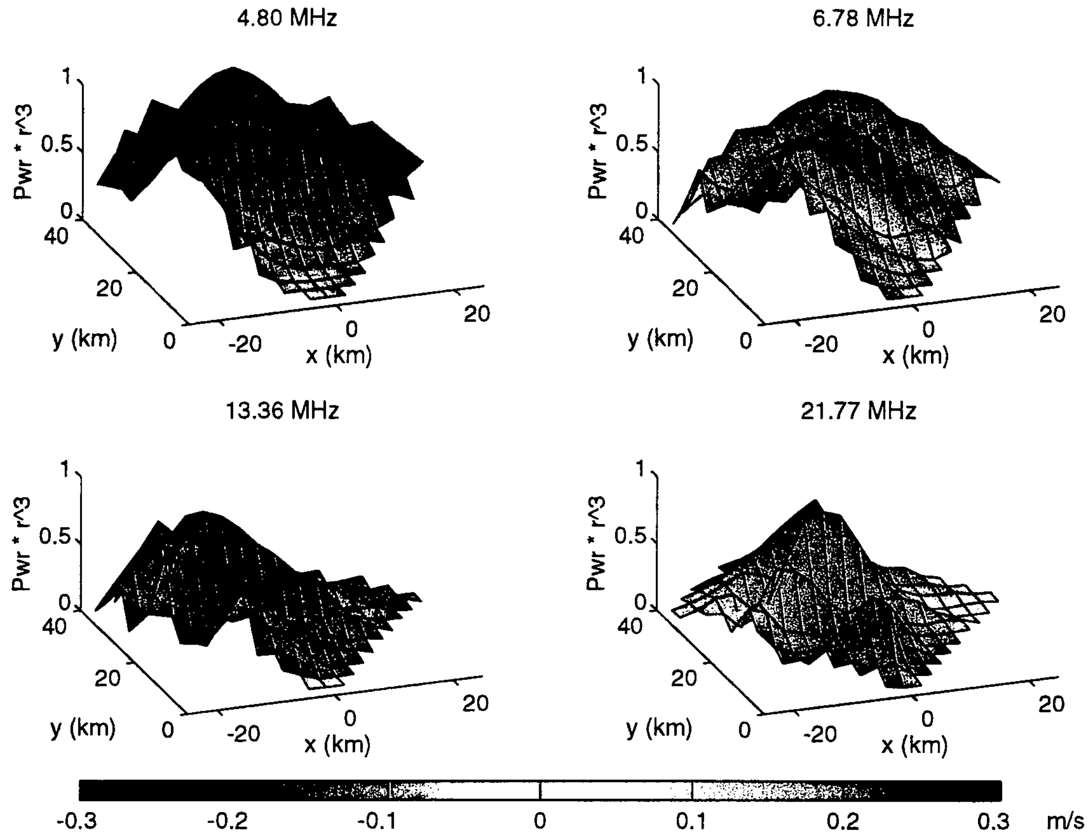

Figure 1: Plots of relative backscatter power and ocean surface current for data collected at 1600 PST on 6 March 1997. The height of the plot surface represents received radar power scaled by r^3 and normalized by the maximum power at each frequency; thus it is proportional to the normalized radar cross-section of the ocean surface at each frequency. The color of the plot surface represents the radial component of the ocean surface current inferred from the Doppler measurements. The scale at the bottom shows the current velocity color-coding ranging from -0.3 to 0.3 m s^{-1}. The radar carrier frequency is indicated above each plot.

plot thus shows the relative radar cross-section of the ocean surface at each radar frequency. The color of the surface indicates the ocean current radial velocity. For these data, the wind at the M1 buoy operated by the Monterey Bay Aquarium Research Institute (MBARI), near the center of the radar field of view, was between 9 and 11 m s^{-1} toward 120°T during the previous 2 hours. Note that the peak of the radar cross-section is generally in the direction of the wind and that it increases as a function of distance from the radar, as one would expect for fetch-limited receding waves. However, the maximum (negative) current is not necessarily in the same direction as the maximum cross-section. Also note that the most negative current is seen farthest from shore at the lowest radar frequency corresponding to a depth of about 1.4 m and moves progressively closer to shore with increasing radar frequency (depth decreasing to about 30 cm).

During the 10 day period of 6–15 March 1997 the quality of the data depends on the operating frequency and time of day. At 4.8 MHz, the noise level shows a strong diurnal variation of almost 20 dB due to the variation in ionospherically-propagated noise which is low during the day and high at night. In addition, the 31 m ocean waves respond quickly to the local wind which typically is stronger during the afternoon than during the night, so the signal-to-noise ratio is much higher during the day. This pattern is seen to a lesser extent at 6.78 MHz. At 13.38 and 21.77 MHz the noise level shows little diurnal variation, but at 21.77 MHz the propagation loss due to a rough sea surface causes lower signals during high wind conditions, even though the ocean waves are high. The use of multiple frequencies allows some optimization of radar operation with time of day and under various wind conditions in addition to enabling an estimation of vertical current shear.

WIND DIRECTION ESTIMATION

The wind direction can be estimated by comparing the approaching and receding backscattered energy. The Bragg peak ratios are calculated from the HF radar return echo at each of the four operating frequencies of the Santa Cruz-based high-frequency radar system. The ratios (which are typically expressed in dB) represent the comparative energies associated with resonant Bragg ocean waves that propagate away from the radar to those that propagate toward the radar. There is a strong connection between the measured Bragg peak ratios at each of these frequencies to the prevailing wind speed and wind direction. The difference in the response of the Bragg peak ratios at multiple wavelengths, however, has not been explored in past studies. For the four radar frequencies represented in this study, the corresponding Bragg resonant ocean wavelengths are: 31.3, 22.1, 11.2, and 6.9 m.

A time period was selected in March where there was a 10 day duration when the winds exhibited a cycle of strong afternoon seabreeze and much weaker winds during the evening and early morning hours. The stronger afternoon winds blew in over Monterey Bay (as measured from MBARI's M1 buoy) from the W-NW and the weaker winds' directions were variable.

Winds that developed over Monterey Bay during these afternoon time periods were very strong, with wind speeds at times in excess of 10 m s^{-1}. Radar measurements of the Bragg peak ratios are shown for this time period from a radar cell that lies in the direction of the buoy from the radar site, but was approximately 12 km closer than the buoy. This closer radar range cell was chosen because it contained a greater number of usable radar runs for the comparison. Figure 2 illustrates high correlation between the Bragg peak ratio at 13.8 MHz. Correlation was similar at 4.8 and 6.78 MHz, but the highest radar frequency of 21.8 MHz had very few usable data points at this location. so any correlation is not apparent at this radar frequency.

Although it is not shown in this plot, it is of interest to note that the Bragg peak ratios indicated a predominance toward onshore (approximately northerly) waves at the lower radar frequencies and offshore waves (especially during the daily wind events) at the 13.38 MHz frequency. The strong daily winds (which blew toward the southeast) appeared to increase the energy in the offshore waves at all of the frequencies to which the radar was sensitive. but the presence of an onshore component at the lower radar frequencies is perhaps indicative of swell propagating onshore from other locations.

The relationship between the wind speed and direction and the ocean gravity wave spectrum has been modelled with a cardioid directional spectrum (e.g. Phillips) and the wind speed and direction both affect the energy associated with the ocean gravity waves at a given angle [4]. This initial study presents some measurements that indicate the fairly large range of ocean gravity waves that respond quickly to wind forcing and points to the utility of multiple frequency high-frequency radar for the measurement of nearshore oceanic wind and wave parameters.

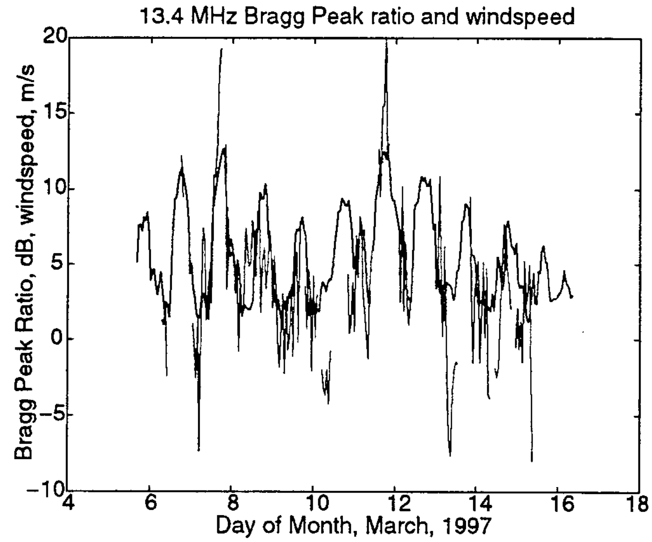

Figure 2: Bragg peak ratio (red) versus wind speed (blue) from MBARI buoy M1 for a 10 day period in early to mid March. The Bragg peak ratio (in dB) represents the energy from the receding ocean waves divided by the energy from the approaching ocean waves. The location at which the radar data were collected corresponds to a point between where the buoy is located and where the radar is stationed, and is approximately due south of the radar and about 12 km from the radar. The radar data were collected at the 13.38 MHz radar frequency, which corresponds to approximately 11 m ocean waves.

We wish to thank Francisco Chavez for use of the MBARI wind data, and Steve Davenport for making the facilities at Long Marine Laborary available for the radar installation.

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LICENSE

Federal Communications Commission
Washington, D.C. 20554 MS 1300 E2

March 18, 1997

Regents of the University of Michigan
Dept. of Atmospheric, Oceanic &Space Science
Attn: Prof. John Vesecky
2455 Hayward Street
Ann Arbor, MI 48109-2143

GRANT-IN-PART

Dear Prof. Vesecky:

This refers to application, File No. 5244-EX-PL-96, for Experimental Radio Station WA2XEJ.

The enclosed authorization shall be considered as a grant of the referenced application unless rejected by a written notice within thirty (30) days from the date of this letter, whereupon the enclosed grant will be vacated. Such rejection should include a statement of the reasons, if any, why the applicant believes that the application should be granted in accordance with the terms requested therein.

You are advised that the Commission was unable to make a finding that the public interest would be served by a grant of the application in the manner requested. The frequency band 13410 - 13440 kHz is not accepted because of potential interference.

Sincerely,

Paul L. Marrangoni

Paul L. Marrangoni
Chief
Experimental Licensing Branch

Attachment:
License WA2XEJ

ATTN: PROF. JOHN VESECKY 2455 HAYWARD STREET, ANN ARBOR, MI 481092143

United States of America
FEDERAL COMMUNICATIONS COMMISSION
EXPERIMENTAL
RADIO STATION CONSTRUCTION PERMIT
AND LICENSE

EXPERIMENTAL (Nature of Service)	WA2XEJ (Call Sign)
XC FX, MO (Class of Station)	5244-EX-PL-96 (File Number)

NAME REGENTS OF THE UNIVERSITY OF MICHIGAN

See Below
(Location of Station)

Subject to the provisions of the Communications Act of 1934, subsequent acts, and treaties, and all requlations heretofore or hereafter made by this Commission, and further subject to the conditions and requirements set forth in this license, the licensee hereof is hereby authorized to use and operate the radio transmitting facilities hereinafter described for radio communications in accordance with the program of experimentation described by the licensee in its application for license.

Frequency	Class Stn	Emission Designator	Authorized Power watts	Tolerance (+/-)

See Attached Page 3

Station Location:

(1) SANTA CRUZ, (SANTA CRUZ) CA - NL 36-56-56; WL 122-03-56
(2) CA
Area Of Operation: WITHIN 2 KM OF THE COAST OF CALIFORNIA

Operation: In accordance with Sec. 5.202(b) of the Commission's Rules.

Special Conditions:

See Attached Page 2

This authorization effective March 18, 1997 and will expire 3:00 A.M. EST April 1, 1999

FEDERAL COMMUNICATIONS COMMISSION

Special Conditions:

(1) In lieu of frequency tolerance, the occupied bandwidth of the emission shall not extend beyond the band limits set forth above.

(2) This authorization is issued for the express purpose of conducting experimental operations described in the related application and required by OFFICE OF NAVAL RESEARCH Contract No. N00014-95-1-0249. The use of this radio station in any other manner or for any other purpose will constitute a violation of the privileges herein authorized. Except as subsequently authorized by the Commission, this radio station shall not be operated after the expiration date of the contract designated in the related application and enumerated above.

(3) The station identification requirements of Section 5.152 of the Commission's Rules are waived.

	Frequency KHz	Class Stn	Emission Designator	Authorized Power watts		Tolerance (+/-)
(1)	2130.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	2130.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	2230.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	2230.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	2430.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	2430.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	2650.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	2650.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	2680.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	2680.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	2840.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	2840.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	4800.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	4800.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	4830.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	4830.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	6780.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	6780.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	7380.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	7380.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	7820.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	7820.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	9150.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	9150.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	9180.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	9180.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	10150.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	10150.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	10180.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	10180.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	12050.00000-12230.00000	FX	50K0P0N	100W	(ERP)	%
(2)	12050.00000-12230.00000	MO	50K0P0N	100W	(ERP)	%
(1)	13380.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	13380.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	13440.00000-13600.00000	FX	50K0P0N	100W	(ERP)	%
(2)	13440.00000-13600.00000	MO	50K0P0N	100W	(ERP)	%
(1)	13800.00000-14000.00000	FX	50K0P0N	100W	(ERP)	%
(2)	13800.00000-14000.00000	MO	50K0P0N	100W	(ERP)	%

	Frequency KHz	Class Stn	Emission Designator	Authorized Power watts		Tolerance (+/-)
(1)	14530.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	14530.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	14560.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	14560.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	14590.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	14590.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	16590.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	16590.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	16620.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	16620.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	18120.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	18120.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	18150.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	18150.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	21770.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	21770.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	21800.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	21800.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	22800.00000	FX	50K0P0N	100W	(ERP)	0.01%
(2)	22800.00000	MO	50K0P0N	100W	(ERP)	0.01%
(1)	25200.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	25200.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	25230.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	25230.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	25260.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	25260.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	27600.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	27600.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	27630.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	27630.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	27660.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	27660.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	29720.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	29720.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	29750.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	29750.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	29780.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	29780.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	30600.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	30600.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	30630.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	30630.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	30660.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	30660.00000	MO	50K0P0N	100W	(ERP)	0.002%

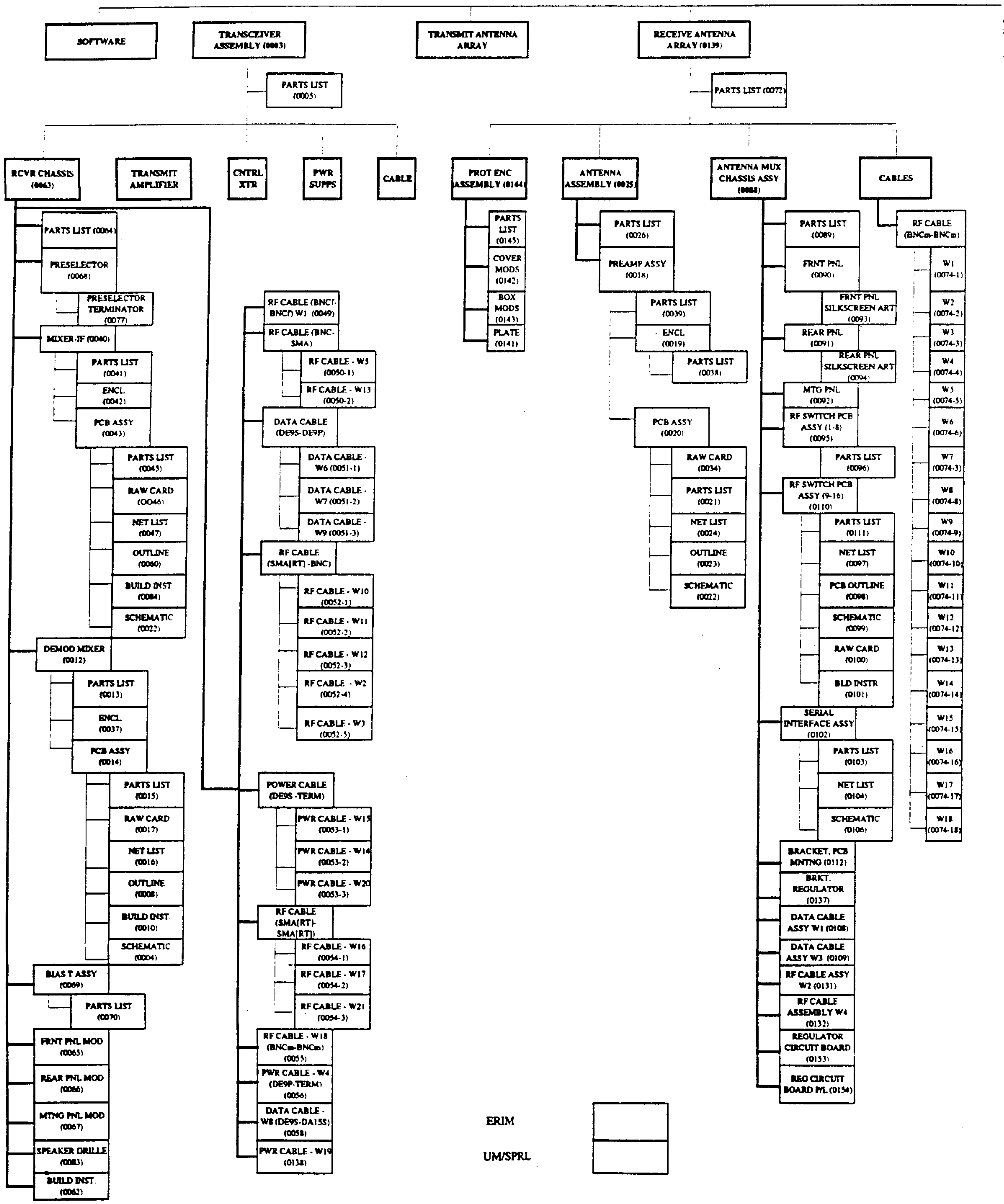
	Frequency KHz	Class Stn	Emission Designator	Authorized Power watts		Tolerance (+/-)
(1)	31900.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	31900.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	31930.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	31930.00000	MO	50K0P0N	100W	(ERP)	0.002%
(1)	31960.00000	FX	50K0P0N	100W	(ERP)	0.002%
(2)	31960.00000	MO	50K0P0N	100W	(ERP)	0.002%

SYSTEM DOCUMENTATION

(U of M)

Drawing Tree
Project: HF Radar
Contract No.: N000149510249

UNIVERS
SPACE PHYSICS
HF RAD



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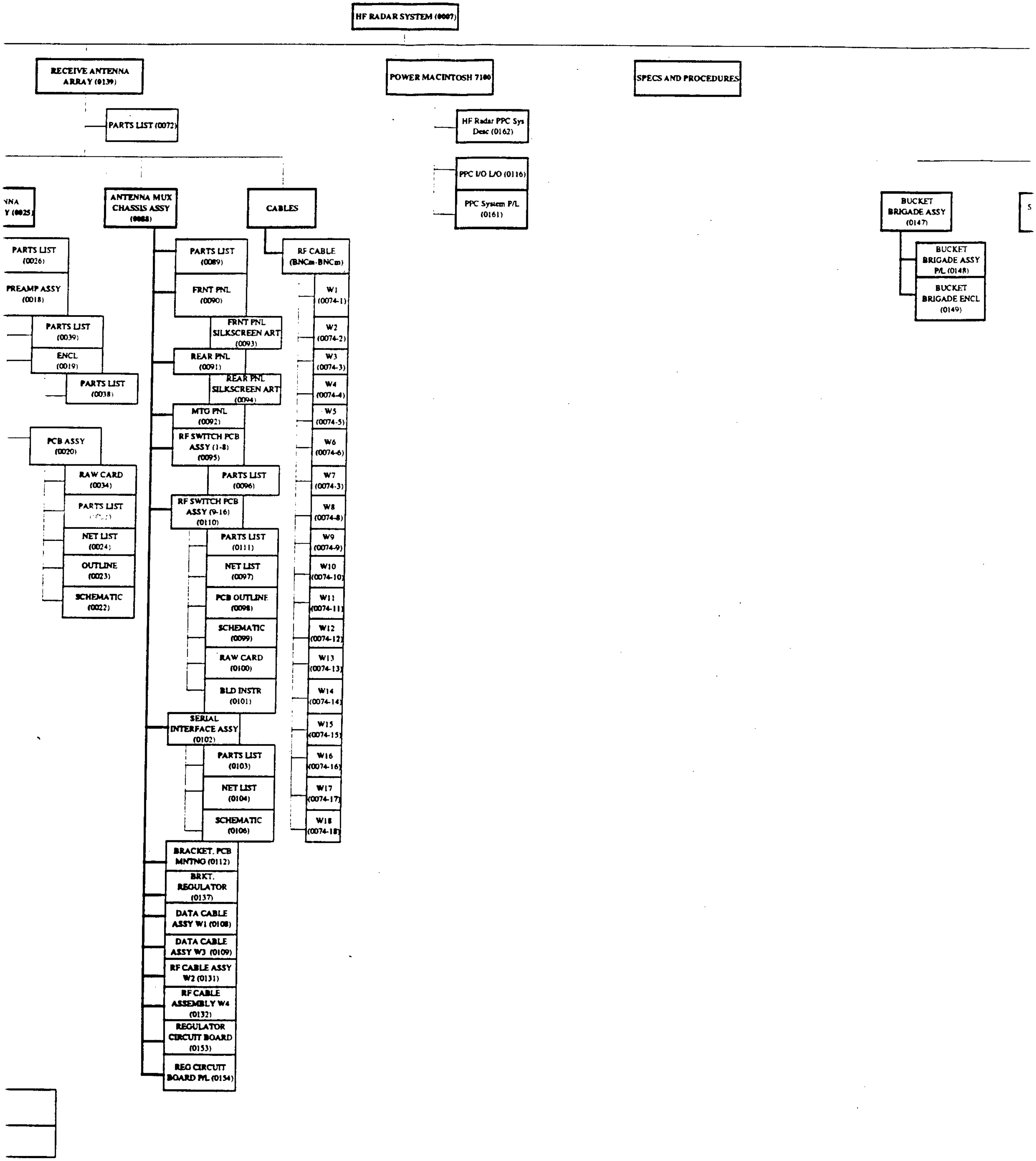
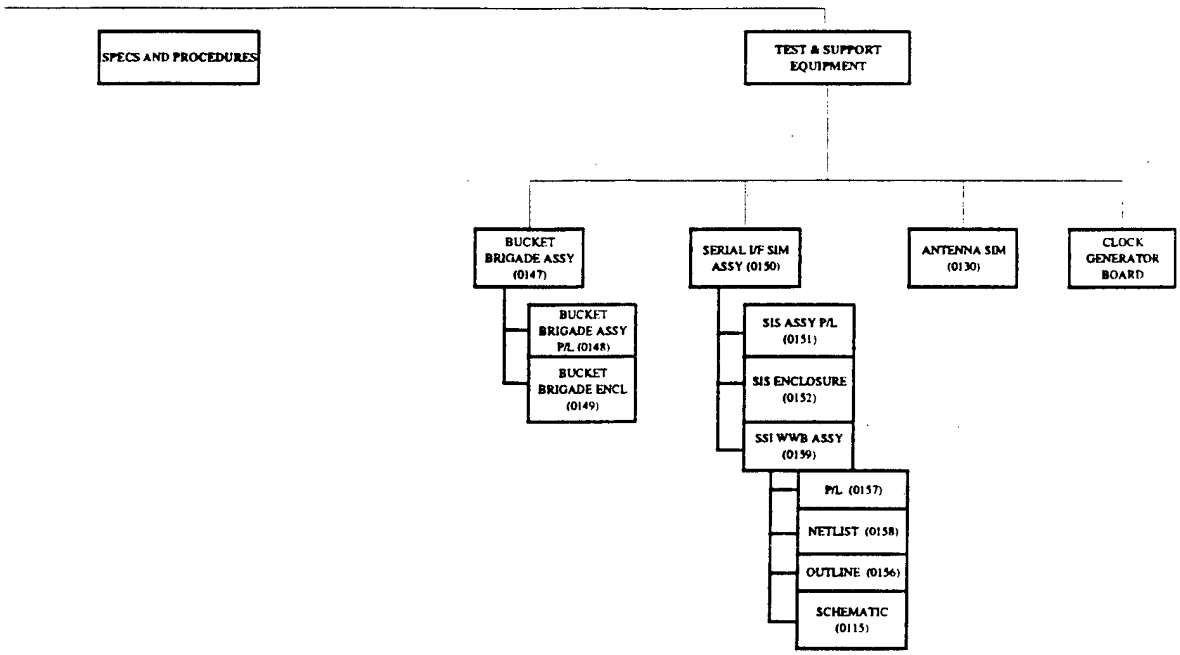
UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY




SPECS AND PROCEDURES
TEST & SUPPORT EQUIPMENT
BUCKET BRIGADE ASSY (0147)
BUCKET BRIGADE ASSY P/L (0148)
BUCKET BRIGADE ENCL (0149)
SERIAL I/F SIM ASSY (0150)
SIS ASSY P/L (0151)
SIS ENCLOSURE (0152)
SSI WWB ASSY (0159)
P/L (0157)
NETLIST (0158)
OUTLINE (0156)
SCHEMATIC (0115)
ANTENNA SIM (0130)
CLOCK GENERATOR BOARD

H F RADAR DRAWING INDEX

Dwg Num	Proto Rev	Field Rev	Date	Dwg title
062-0001		–	2/7/95	HF Radar Drawing Index
062-0002		15	8/31/95	Drawing Tree
062-0003		4	3/5/96	Transceiver Assy
062-0004		F	5/31/95	Demod Mixer Schematic
062-0005		2	3/5/96	Transceiver Assy P/L
062-0006		3	6/7/95	Receiver Block Diagram
062-0007		1	6/7/95	System Block Diagram
062-0008		3	6/7/95	Demod Mixer Layout Sketch
062-0009		–	5/10/96	Radar Block diagram
062-0010	2	1	11/15/95	Demod Mixer Build Instructions
062-0011		–		Unused
062-0012		4	7/18/95	Demod Mixer Assy
062-0013		8	7/18/95	Demod Mixer Assy P/L
062-0014	5	3	7/18/95	Demod Mixer PCB Assy
062-0015	11	8	7/18/95	Demod Mixer PCB P/L
062-0016		2	7/18/95	Demod Mixer PCB Net List
062-0017		–	8/7/95	Demod Mixer PCB Raw Card
062-0018		10	8/8/95	Preamp Assy
062-0019		6	8/8/95	Preamp Enclosure
062-0020		3	8/8/95	Preamp PCB Assy
062-0021		9	8/8/95	Preamp PCB P/L
062-0022		9	8/8/95	Preamp PCB Schematic
062-0023		5	8/8/95	Preamp PCB Outline
062-0024		6	8/8/95	Preamp PCB Net List
062-0025		9	8/10/95	Receiver Antenna Assy
062-0026	5	3	8/10/95	Receiver Antenna Assy P/L
062-0027		6	8/11/95	Inductor Assy
062-0028		1	8/17/95	Ant Mux SI Assy - proto
062-0029		1	8/17/95	Ant Mux SI P/L - proto
062-0030		2	8/17/95	Ant Mux SI Schematic - proto
062-0031		1	8/17/95	Ant Mux SI Net List - proto

Dwg Num	Proto Rev	Field Rev	Date	Dwg title
062-0032				Unused
062-0033				Unused
062-0034		1	8/28/95	Preamp PCB Raw Card
062-0035		1		Unused
062-0036		1	9/14/95	Ant SW Box Mod - proto
062-0037		4	9/27/95	Demod Mixer Enclosure
062-0038		2	9/29/95	Preamp Enclosure P/L
062-0039		7	9/29/95	Preamp Assy P/L
062-0040		10	10/11/95	Mixer-IF Assy
062-0041	8	5	10/11/95	Mixer-IF Assy P/L
062-0042		4	10/11/95	Mixer-IF Enclosure
062-0043		1	10/11/95	Mixer-IF PCB Assy
062-0044	5	3	10/11/95	Mixer-IF Schematic
062-0045		8	10/11/95	Mixer-IF PCB P/L
062-0046		1	10/11/95	Mixer-IF PCB Raw Card
062-0047		2	10/11/95	Mixer-IF PCB Net List
062-0049		2	2/29/96	RF Cable (BNCf-BNCf)
062-0050		4	2/29/96	RF Cable (SMA-BNC)
062-0051		3	2/29/96	Data Cable (DE9S-DE9P)
062-0052		6	2/29/96	RF Cable (SMA[RT]-BNC)
062-0053	5	2	2/29/96	Power Cable (DE9S-Term)
062-0054		8	2/29/96	RF Cable (SMA[RT]-SMA[RT])
062-0055	1	n/a	11/08/96	RF Cable (SMA[RT]-SMA)
062-0056		2	3/7/96	Power Cable (DE9P-Term)
062-0057		1	12/5/95	Receiver Power Summary
062-0058		2	7/3/96	Data Cable (DE9S-DA15S)
062-0059		2	12/20/95	Mfg Proc BNC Pnl/RG316
062-0060		5	1/26/96	Mixer-IF PCB Outline
062-0061		–		Unused
062-0062		1	2/16/96	Build Proc, Rcvr Assy
062-0063	20	15	2/29/96	Rcvr Chassis Assy

H F RADAR DRAWING INDEX

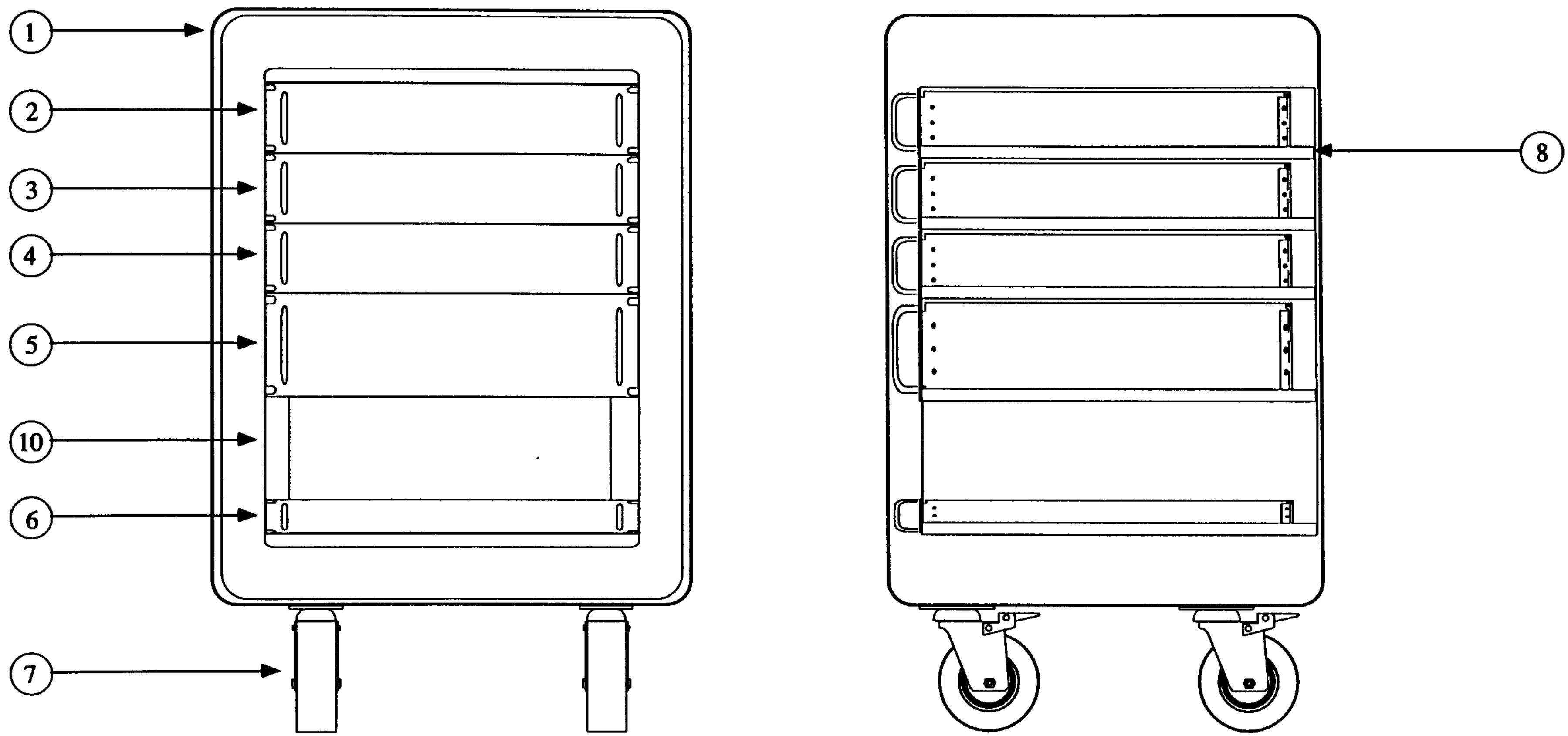
Dwg Num	Proto Rev	Field Rev	Date	Dwg title
062-0064	14	8	2/29/96	Rcvr Chassis P/L
062-0065		10	2/29/96	Rcvr Chassis Frnt Panel Mod
062-0066		9	2/29/96	Rcvr Chassis Rear Panel Mod
062-0067	13	9	2/29/96	Rcvr Chassis Mtng Panel Mod
062-0068		3	2/29/96	Spec, RF Preselector
062-0069		7	2/29/96	Bias T Assy
062-0070		3	2/29/96	Bias T Assy P/L
062-0071		6	2/29/96	Receive Ant Array (Proto)
062-0072		5	2/29/96	Receive Ant Array P/L
062-0073		–		Unused
062-0074		5	2/29/96	RF Cable (BNCm - BNCm)
062-0075		–		Unused
062-0076		2	3/4/96	Mixer-IF Shield Plate
062-0077		–	3/6/96	Preselector Terminator Assy
062-0078		–		Unused
062-0079		–		Unused
062-0080		4	3/7/96	Mfg Proc SMA /RG316
062-0081		–	3/7/96	Mfg Proc SMA angle/RG316
062-0082		2	3/14/96	Cable Mrkng Proc
062-0083		1	3/21/96	Speaker Grill
062-0084		3	3/25/96	Mixer-IF Build Proc
062-0085		2	3/25/96	Concept,Transmit Ant
062-0086		2	3/26/96	Mixer-IF RF Shield Mod
062-0087	6	3	4/12/96	Demod-Mixer Mod
062-0088		–	4/18/96	Ant Mux Chassis Assy
062-0089		5	4/18/96	Ant Mux Chassis P/L
062-0090		–	4/18/96	Ant Mux Frnt Panel Mod
062-0091		–	4/18/96	Ant Mux Rear Panel Mod
062-0092		–	4/18/96	Ant Mux Mounting Panel Mod
062-0093		–	4/18/96	Silk Scrn,Ant Mux,Frnt Pnl
062-0094		–	4/18/96	Silk Scrn,Ant Mux,Rear Pnl

Dwg Num	Proto Rev	Field Rev	Date	Dwg title
062-0095	4	–	4/18/96	Ant Mux RFS 1-8 PCB Assy
062-0096	4	–	4/18/96	Ant Mux RFS 1-8 PCB P/L
062-0097	1	–	4/18/96	Ant Mux RFSwitch PCB Net List
062-0098		–	4/18/96	Ant Mux RFSwitch PCB Outline
062-0099	2	–	4/18/96	Ant Mux RFSwitch Schematic
062-0100	1	–	4/18/96	Ant Mux RFSwitch Raw Card
062-0101		–	4/18/96	Ant Mux RFSwitch Build Proc
062-0102	4	n/a	10/11/96	Ant Mux SI Assy
062-0103		3	4/18/96	Ant Mux SI P/L
062-0104		2	4/18/96	Ant Mux SI Net List
062-0105		–	4/18/96	Unused
062-0106		3	4/18/96	Ant Mux SI Schematic
062-0107		–	4/18/96	Ant Mux Chassis Wiring Diagram
062-0108		–	4/18/96	Ant Mux Data Cable Assy W1
062-0109		–	4/18/96	Ant Mux RF Cable Assy W3
062-0110	4	–	4/18/96	Ant Mux RFS 9-16 PCB Assy
062-0111	4	–	4/18/96	Ant Mux RFS 9-16 PCB P/L
062-0112		–	4/18/96	Bracket,PCB Mounting
062-0113		1	4/22/96	Mfg Proc BNCm/RG 58
062-0114		1	4/26/96	Preamp PCB Mod
062-0115	5	5	5/31/96	S/I Simulator Schematic
062-0116	4	3	6/16/96	PPC Operational Notes
062-0117	3	1	6/27/96	Mixer-IF PCB Mod
062-0118	n/a	1	7/1/96	LOF Schematic - Prototype
062-0119	n/a	1	9/11/96	Ant MUX Preamp Mods
062-0120	n/a	2	9/12/96	Rcvr Ch Adapter Plate
062-0121	2	n/a	9/13/96	LOF Enclosure
062-0122	1	n/a	9/13/96	LOF PCB Assy
062-0123	4	n/a	9/13/96	LOF Enclosure Mtg Plate
062-0124	7	n/a	9/18/96	LOF PCB Assy P/L
062-0125	4	n/a	9/18/96	LOF Assy P/L

H F RADAR DRAWING INDEX

Dwg Num	Proto Rev	Field Rev	Date	Dwg title
062-0126	5	n/a	9/18/96	LOF PCB Outline
062-0127	5	n/a	9/25/96	LOF Assy
062-0128	4	n/a	9/25/96	LOF PCB Schematic
062-0129	1	n/a	9/25/96	LOF PCB Netlist
062-0130	1	1	9/25/96	Rcv Antenna Simulator
062-0131	2	-	11/4/96	Ant Mux Data Cable Assy W2
062-0132	–	–	11/4/96	Ant Mux RF Cable Assy W4
062-0137	–	–	11/7/96	Bracket, Regulator, Ant Mux
062-0138	2	n/a	11/8/96	Power Cable (ZFL Amp)
062-0139	n/a	3	1/7/97	Rcv Ant Array Assy (Field Unit 1)
062-0140	n/a	1	1/15/97	LOF Raw Card
062-0141	n/a	2	2/11/97	Plate, sun shield
062-0142	n/a	2	2/18/97	MUX Prot Enc Cvr Mod
062-0143	n/a	1	2/18/97	MUX Prot Enc Mod
062-0144	n/a	1	2/18/97	MUX Prot Enc Assy
062-0145	n/a	1	2/18/97	MUX Prot Enc Assy P/L
062-0147	–	2	3/28/97	Bucket Brigade Assy
062-0148	–	1	3/28/97	Bucket Brigade Assy P/L
062-0149	–	2	3/28/97	Bucket Brigade Enclosure
062-0150	–	6	3/28/97	SIS Assy
062-0151	–	–	3/28/97	SIS Assy P/L
062-0152		6	4/3/97	SIS Enclosure
062-0153	–	2	4/14/97	Regulator Circuit Board
062-0154	–	2	4/14/97	Reg. Circuit Board P/L
062-0155	–	–	4/15/97	Ant Mux Reg Schematic
062-0156	–	5	4/29/97	SIS WWB Outline
062-0157	–	2	4/29/97	SIS WWB P/L
062-0158	–	2	4/29/97	SIS WWB Netlist
062-0159	–	–	4/30/97	SIS WWB Assy
062-0160	–	–	5/1/97	Rcvr Xfer Function
062-0161	–	–	5/16/97	PPC System P/L

Dwg Num	Proto Rev	Field Rev	Date	Dwg title
062-0162	–	–	5/17/97	PPC System Description



NOTES:

1. See ERIM document *TBD* for details concerning mounting chassis slides, cable routing and associated hardware for the ECS enclosure.
2. This document incomplete without parts list 062-0005.
3. See sheet two of this drawing for physical data on the ECS enclosure and associated components.

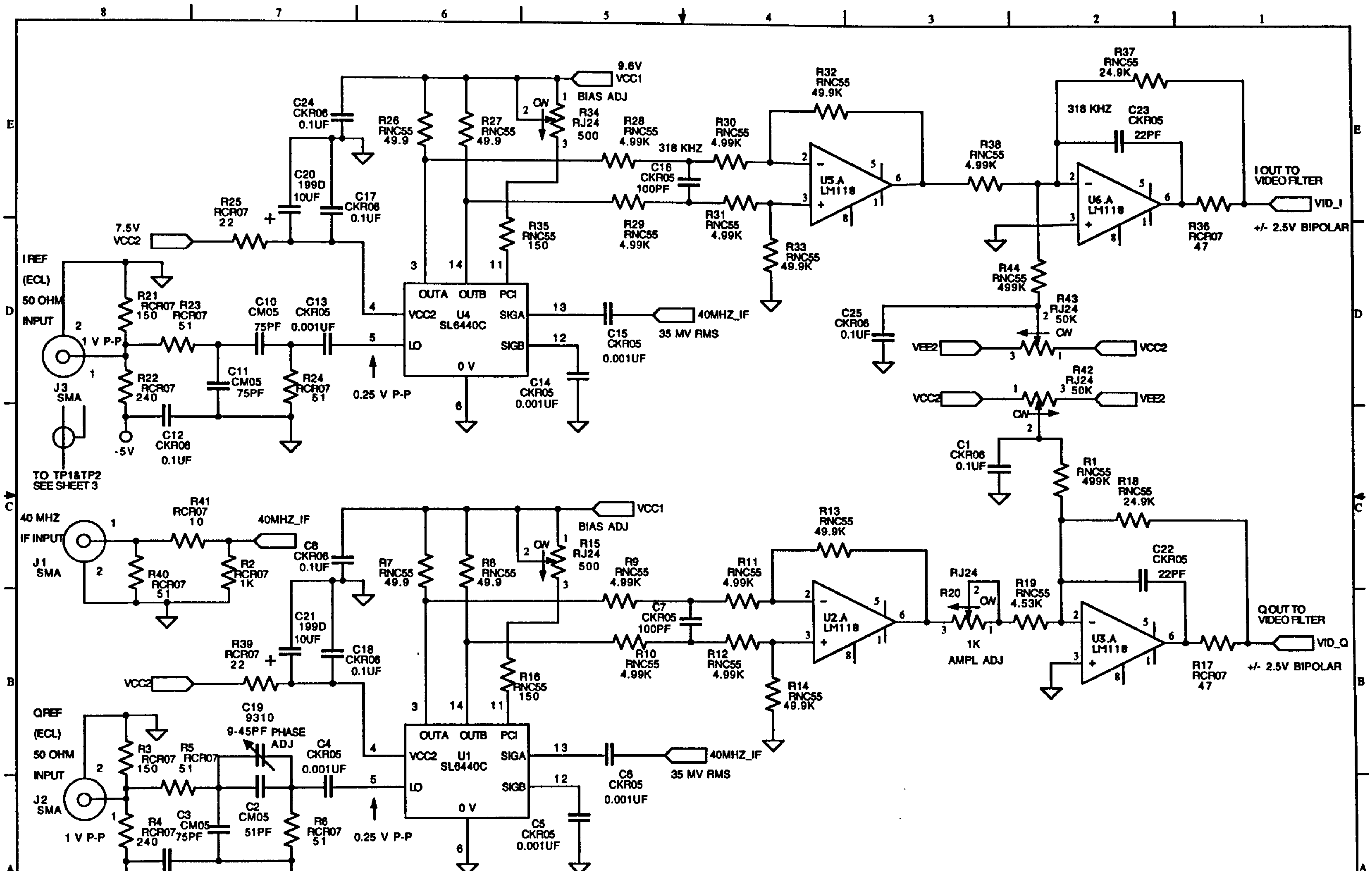
Space Physics Research Laboratory College of Engineering University of Michigan	Transceiver Assembly Layout	REV	04-22-97 NS
		REV	04-29-96 NS
		REV	04-26-96 NS
		RELEASE	
		DRAWN	Neil Schnepf
N000149510249	Transceiver Assy Layout	062- 0003 / 1 of 2 / x4	COG ENG

Drawing Page

ECS ENCLOSURE	Height	Width	Depth	Weight (lbs)
without cover	30.03"	24.28"	22.00"	
with cover	30.03"	24.28"	28.50"	73.40
with cover & wheels	36.42"	24.28"	28.50"	85.40
				85.40
COMPONENTS	**Height**	**Width**	**Depth**	**Weight (lbs)**
blank panel				1.000
receiver				20.000
computer-exciter				18.000
transmitter				20.375
power supply				43.500
power strip				4.250
cables				5.375
				112.500
XCEIVER TOTALS	**36.42"**	**24.28"**	**28.50"**	**197.000**

Space Physics Research Laboratory College of Engineering University of Michigan	Transceiver Assembly Physical Data	RELEASE	04-22-97 NS
N000149510249	Transceiver Assy Physical Data	DRAWN	N. Schnepf
062- 0003	2 of 2 x4	COG ENG	

Drawing Page



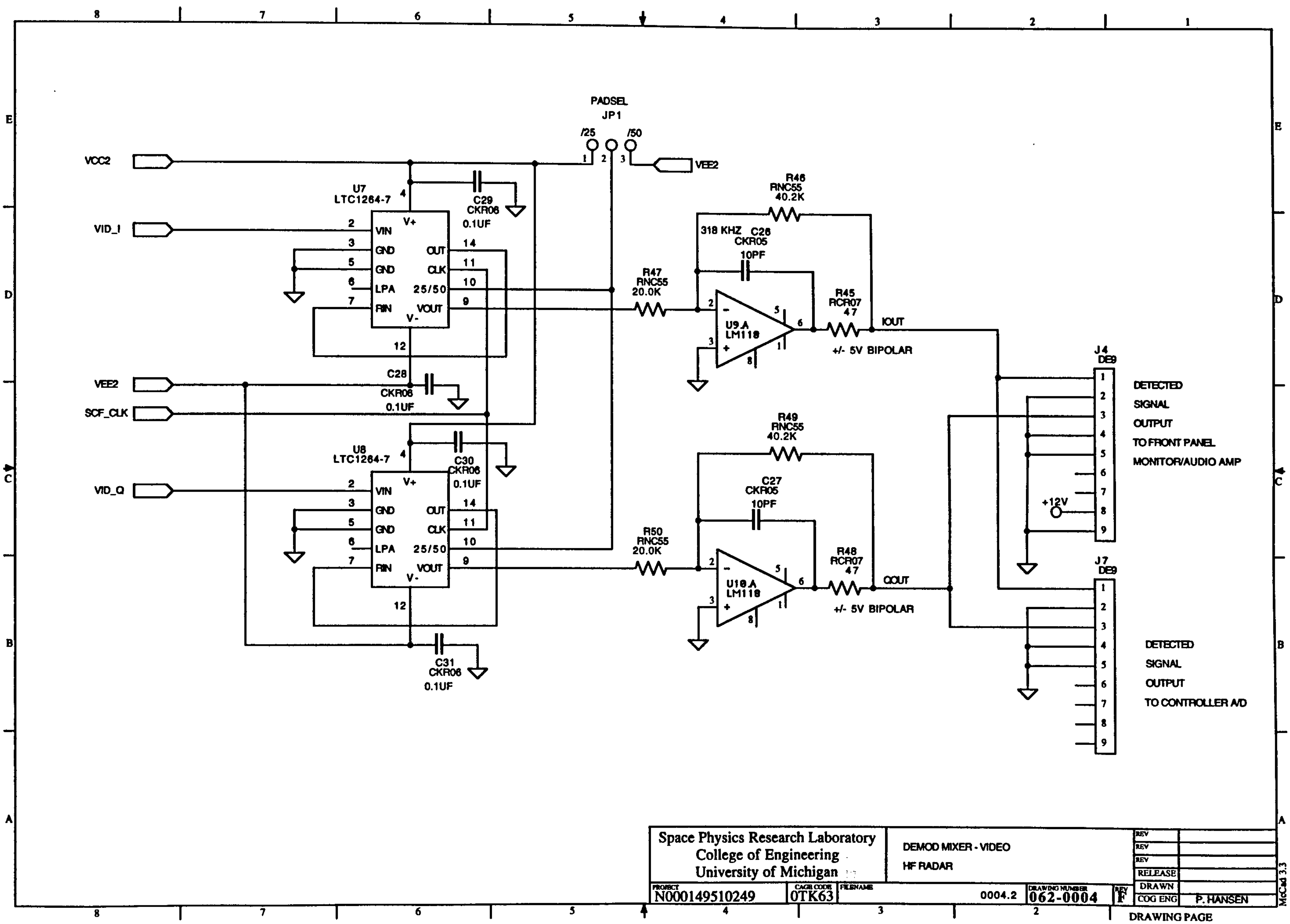
Space Physics Research Laboratory
College of Engineering
University of Michigan

DEMOD MIXER - RF
HF RADAR

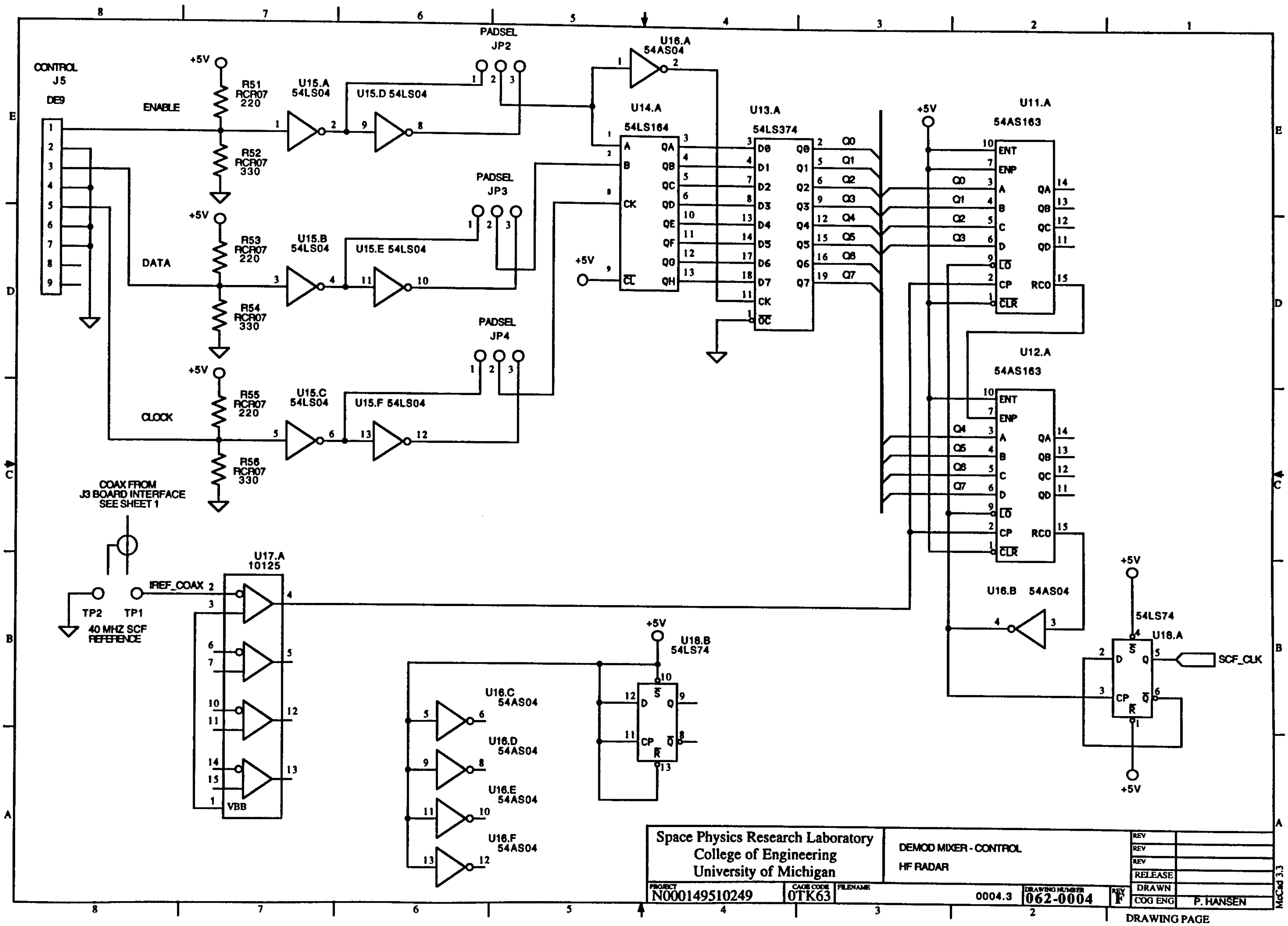
PROJECT	CAGE CODE	FILENAME	DRAWING NUMBER	REV
N000149510249	0TK63	0004.1	062-0004	F

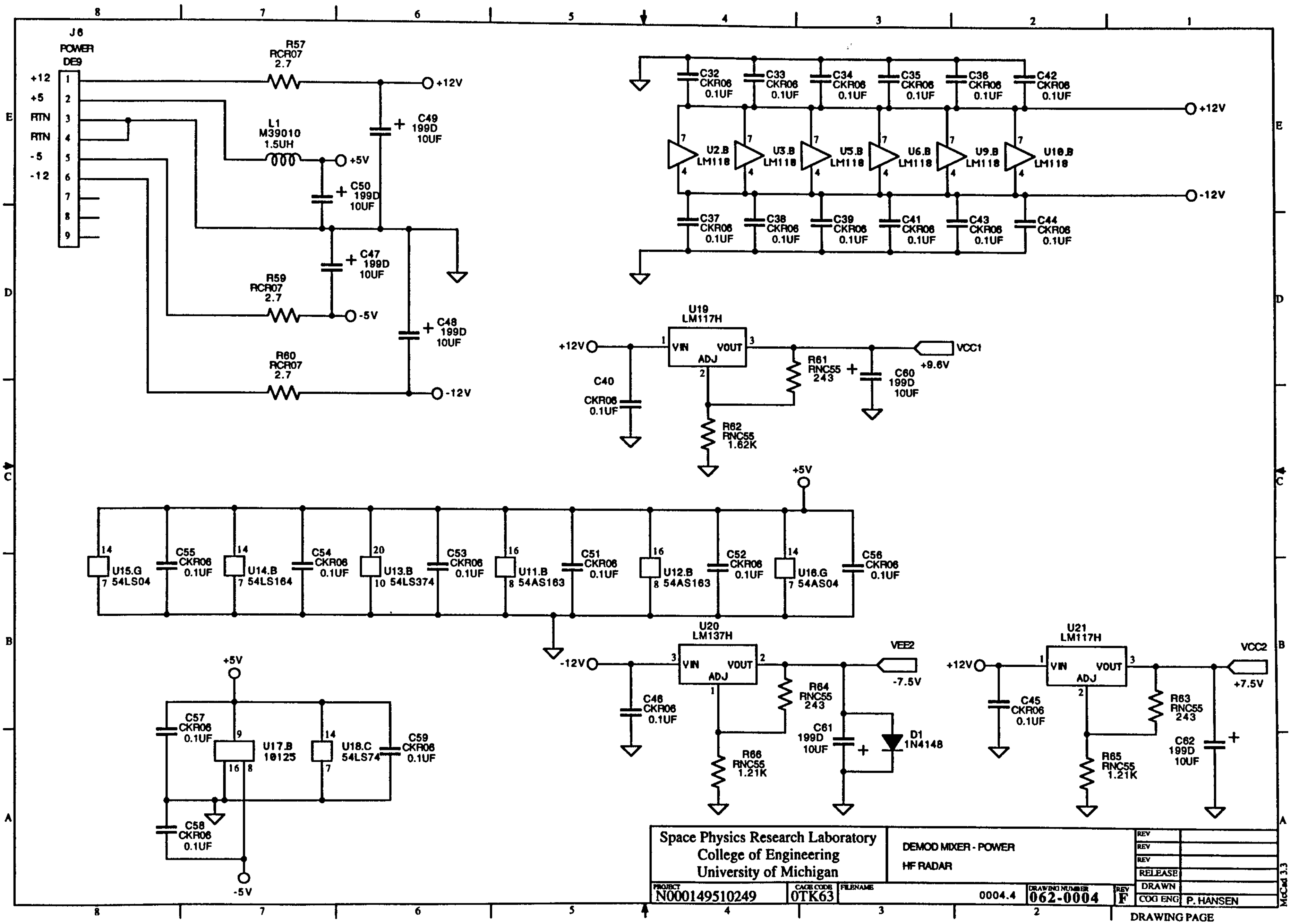
REV	
REV	
REV	
RELEASE	
DRAWN	
COG ENG	P. HANSEN

DRAWING PAGE



PADSEL
JP1
/25
/50
VCC2
VID_I
VEE2
SCF_CLK
VID_Q
U7
LTC1264-7
U8
LTC1264-7
VIN
GND
GND
LPA
RIN
V+
V-
OUT
CLK
25/50
VOUT
C29
CKR06
0.1UF
C28
CKR06
0.1UF
C30
CKR06
0.1UF
C31
CKR06
0.1UF
R46
RNC55
40.2K
318 KHZ
C26
CKR05
10PF
R47
RNC55
20.0K
U9.A
LM118
R45
RCR07
47
IOUT
+/- 5V BIPOLAR
R49
RNC55
40.2K
C27
CKR05
10PF
R50
RNC55
20.0K
U10.A
LM118
R48
RCR07
47
QOUT
+/- 5V BIPOLAR
J4
DE9
+12V
DETECTED
SIGNAL
OUTPUT
TO FRONT PANEL
MONITOR/AUDIO AMP
J7
DE9
DETECTED
SIGNAL
OUTPUT
TO CONTROLLER A/D
Space Physics Research Laboratory
College of Engineering
University of Michigan
DEMOD MIXER - VIDEO
HF RADAR
PROJECT
N000149510249
CAGE CODE
0TK63
FILENAME
0004.2
DRAWING NUMBER
062-0004
REV
F
RELEASE
DRAWN
COG ENG
P. HANSEN
DRAWING PAGE
McCad 3.3


CONTROL
J5
DE9
ENABLE
DATA
CLOCK
+5V
R51 RCR07 220
R52 RCR07 330
R53 RCR07 220
R54 RCR07 330
R55 RCR07 220
R56 RCR07 330
U15.A 54LS04
U15.B 54LS04
U15.C 54LS04
U15.D 54LS04
U15.E 54LS04
U15.F 54LS04
PADSEL JP2
PADSEL JP3
PADSEL JP4
U16.A 54AS04
U14.A 54LS164
U13.A 54LS374
U11.A 54AS163
U12.A 54AS163
U16.B 54AS04
54LS74 U18.A
SCF_CLK
U18.B 54LS74
U16.C 54AS04
U16.D 54AS04
U16.E 54AS04
U16.F 54AS04
U17.A 10125
VBB
IREF_COAX
COAX FROM J3 BOARD INTERFACE SEE SHEET 1
TP2
TP1
40 MHZ SCF REFERENCE
Space Physics Research Laboratory
College of Engineering
University of Michigan
DEMOD MIXER - CONTROL
HF RADAR
PROJECT N000149510249
CAGE CODE 0TK63
FILENAME 0004.3
DRAWING NUMBER 062-0004
REV F
REV
REV
REV
RELEASE
DRAWN
COG ENG P. HANSEN
McCad 3.3
DRAWING PAGE

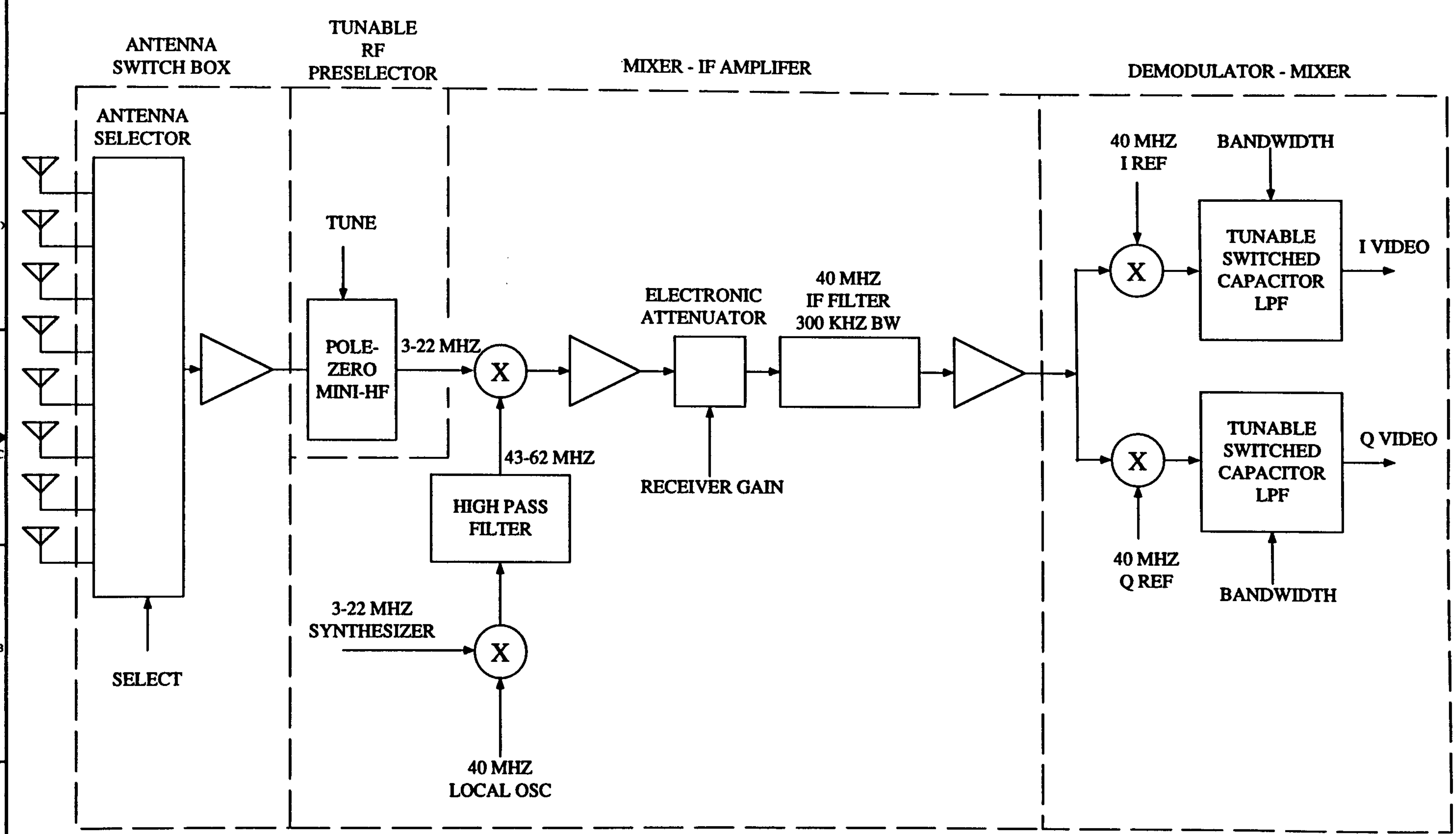

J6
POWER
DE9
+12
+5
RTN
RTN
-5
-12
R57
RCR07
2.7
+12V
L1
M39010
1.5UH
+5V
C49
199D
10UF
C50
199D
10UF
C47
199D
10UF
R59
RCR07
2.7
-5V
C48
199D
10UF
R60
RCR07
2.7
-12V
C32 CKR06 0.1UF
C33 CKR06 0.1UF
C34 CKR06 0.1UF
C35 CKR06 0.1UF
C36 CKR06 0.1UF
C42 CKR06 0.1UF
U2.B LM118
U3.B LM118
U5.B LM118
U6.B LM118
U9.B LM118
U18.B LM118
C37 CKR06 0.1UF
C38 CKR06 0.1UF
C39 CKR06 0.1UF
C41 CKR06 0.1UF
C43 CKR06 0.1UF
C44 CKR06 0.1UF
U19
LM117H
VIN
VOUT
ADJ
VCC1
+9.6V
R61
RNC55
243
C60
199D
10UF
C40
CKR06
0.1UF
R62
RNC55
1.62K
U15.G 54LS04
C55 CKR06 0.1UF
U14.B 54LS164
C54 CKR06 0.1UF
U13.B 54LS374
C53 CKR06 0.1UF
U11.B 54AS163
C51 CKR06 0.1UF
U12.B 54AS163
C52 CKR06 0.1UF
U16.G 54AS04
C56 CKR06 0.1UF
U20
LM137H
VEE2
-7.5V
C46
CKR06
0.1UF
R64
RNC55
243
C61
199D
10UF
D1
1N4148
R66
RNC55
1.21K
U21
LM117H
VCC2
+7.5V
C45
CKR06
0.1UF
R63
RNC55
243
C62
199D
10UF
R65
RNC55
1.21K
C57
CKR06
0.1UF
U17.B
10125
U18.C
54LS74
C59
CKR06
0.1UF
C58
CKR06
0.1UF
Space Physics Research Laboratory
College of Engineering
University of Michigan
DEMOD MIXER - POWER
HF RADAR
PROJECT N000149510249
CAGE CODE 0TK63
FILENAME 0004.4
DRAWING NUMBER 062-0004
REV F
REV
REV
REV
RELEASE
DRAWN
COG ENG P. HANSEN
DRAWING PAGE
McCad 3.3

Parts List
Transceiver Assy
Next Assy:
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:062-0005
Revision:X2

Item	Qty	U/M	Part Number	Description	Mfr/Code
1	1	EA	3113-4	Operating Case	ECS Composites
2	1	EA		Blank panel	ERIM
3	1	EA	062-0063	Receiver Chassis Assy	SPRL
4	1	EA		Controller/Exciter Assy	ERIM
5	1	EA		Transmitter Assy	ERIM
6	1	EA	IBR-12	Power Distribution Assy	Tripplite
7	1	EA	326	Set option removable casters	ECS Composites
8	4	EA		Chassis slides/hardware	
9	1	SET		Inter-chassis cable assemblies	ERIM
10	1	EA		Power supply	ERIM
11					
12					



Space Physics Research Laboratory
College of Engineering
University of Michigan

RECEIVER BLOCK
DIAGRAM
HF RADAR

N000149510249

062- 0006 X3

RELEASE
DRAWN P. HANSEN
COG ENG

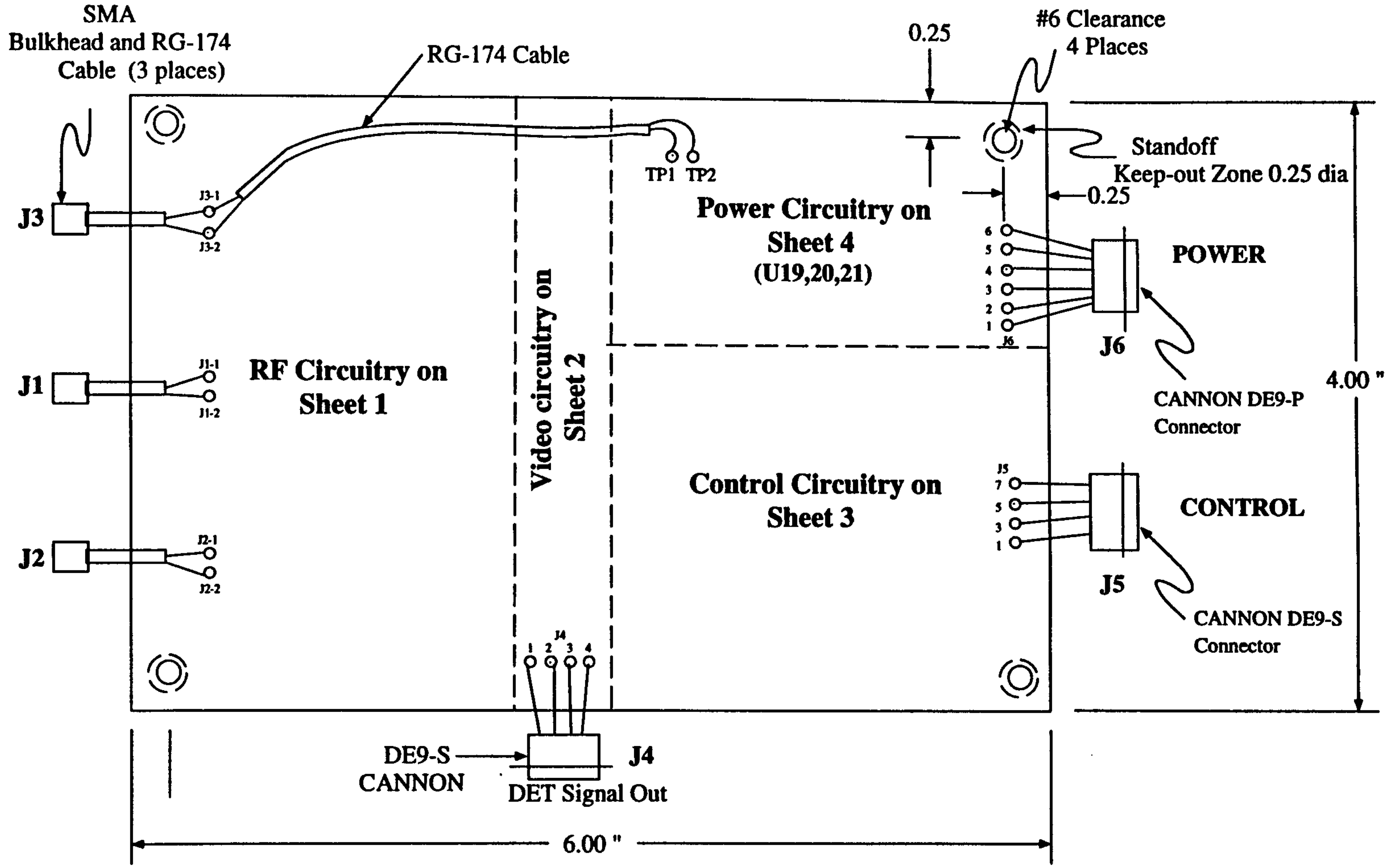
1
Drawing Page

Parts List
HF Radar System
Next Assy: None
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:062-0007
Revision:X2

Item	Qty	U/M	Part Number	Description	Mfr/Code
1	1	EA	062-0161	PPC System P/L	
2	1	EA	062-0003	Transceiver Assembly	UM/SPRL
3	1	EA		Transmit Antenna Array	ERIM
4	1	EA	062-0139	Receive Antenna Array	UM/SPRL
5	1	SET		System Software	UM/SPRL/Stanford
6	4	EA		Test and Support Equipment	UM/SPRL

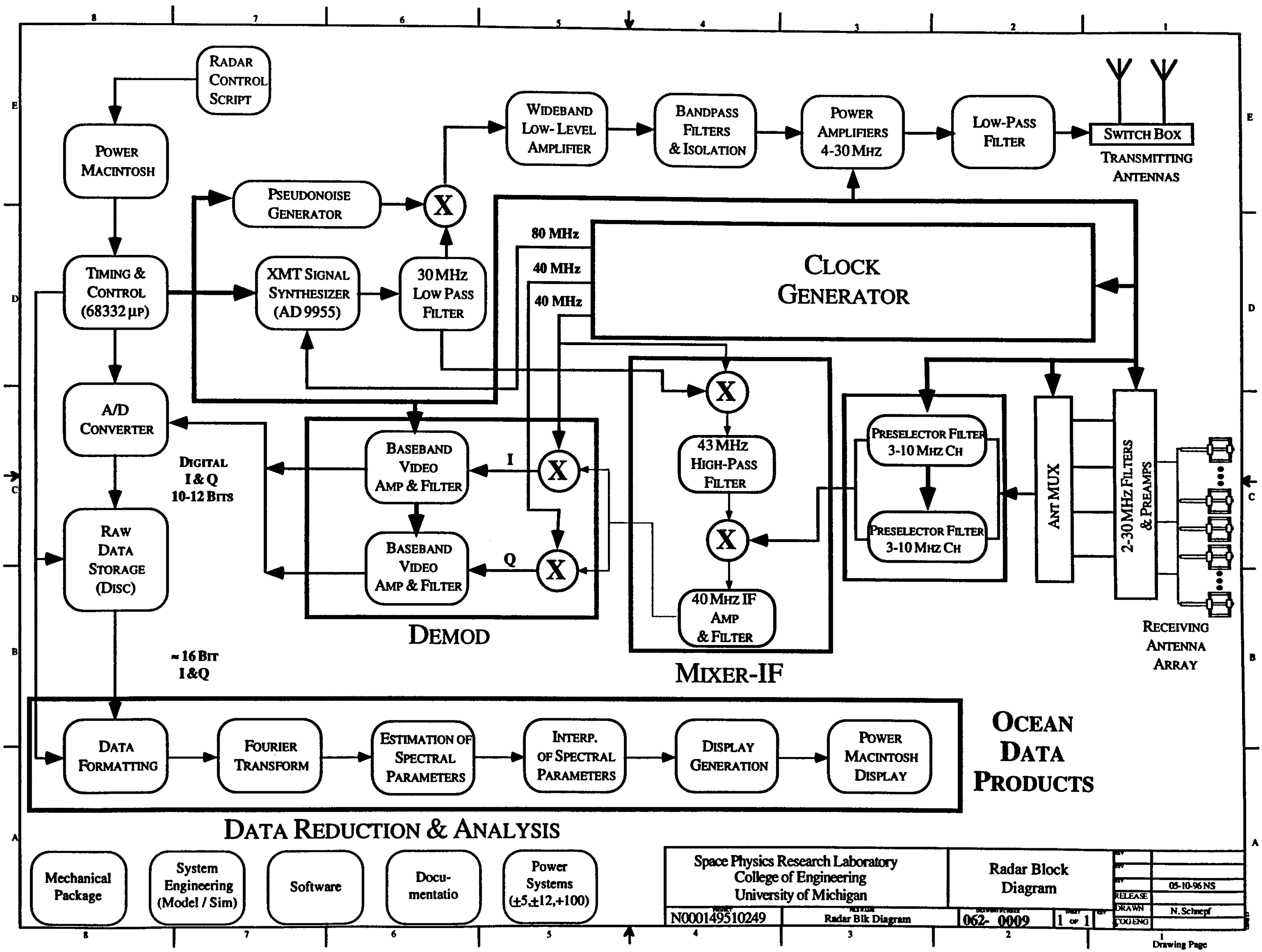


Notes:

1. All external D connectors mate to PCB swage terminals with short lengths of 22 ga wire. Provide pads and 0.075" clearance holes for USECO 2520B terminals in approximate area indicated. Coax cable also terminates to board using USECO 2520B terminals.

Space Physics Research Laboratory College of Engineering University of Michigan	Demod-mixer Layout Sketch	
HFR	Suggested Layout Plan	062-0008 X3

Drawing Page



RADAR CONTROL SCRIPT
POWER MACINTOSH
TIMING & CONTROL (68332 µP)
A/D CONVERTER
RAW DATA STORAGE (DISC)
DIGITAL I & Q 10-12 BITS
≈16 BIT I & Q
PSEUDONOISE GENERATOR
XMT SIGNAL SYNTHESIZER (AD 9955)
30 MHz LOW PASS FILTER
X
WIDEBAND LOW-LEVEL AMPLIFIER
BANDPASS FILTERS & ISOLATION
POWER AMPLIFIERS 4-30 MHz
LOW-PASS FILTER
SWITCH BOX
TRANSMITTING ANTENNAS
80 MHz
40 MHz
40 MHz
CLOCK GENERATOR
BASEBAND VIDEO AMP & FILTER
BASEBAND VIDEO AMP & FILTER
I
Q
DEMOD
43 MHz HIGH-PASS FILTER
40 MHz IF AMP & FILTER
MIXER-IF
PRESELECTOR FILTER 3-10 MHz CH
PRESELECTOR FILTER 3-10 MHz CH
ANT MUX
2-30 MHz FILTERS & PREAMPS
RECEIVING ANTENNA ARRAY
DATA FORMATTING
FOURIER TRANSFORM
ESTIMATION OF SPECTRAL PARAMETERS
INTERP. OF SPECTRAL PARAMETERS
DISPLAY GENERATION
POWER MACINTOSH DISPLAY
OCEAN DATA PRODUCTS
DATA REDUCTION & ANALYSIS
Mechanical Package
System Engineering (Model / Sim)
Software
Docu-mentatio
Power Systems (±5,±12,+100)
Space Physics Research Laboratory
College of Engineering
University of Michigan
Radar Block Diagram
N000149510249
Radar Blk Diagram
062- 0009
1 of 1
05-10-96 NS
RELEASE
DRAWN
N. Schnepf
COG ENG
Drawing Page

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Title: Demod Mixer Build Instructions	FSCM No.:	0TK63
	Drawing No.:	062-0010
	Revision:	X2
	Page	1 of 3
Program: HF RADAR	Contract No.:	N000149510249

This is an uncontrolled HF Radar Document

APPROVAL RECORD

Function	Title - Organization	Name	Signature	Date
Originator	PE - U of M	P. Hansen		
Checker				
Mechanical				
Electrical	PE - U of M			
Software	PE - U of M			
QA	QA - U of M			
Mfg				
Reliability				
Project	PM - SU			
Principal Inv	PI - U of M	J. Vesecky		
Customer				

REVISION RECORD

Revision	Description	Date	Approval
-	Initial Release		

Title: Demod Mixer Build Instructions	FSCM No.:	0TK63
	Drawing No.:	062-0010
	Revision:	X2
	Page	2 of 3
Program: HF RADAR	Contract No.:	N000149510249

Introduction

These instructions are to be used in fabricating the Demod Mixer Assembly (062-0012). Included are instructions to first fabricate the Demod Mixer PCB Assembly (062-0014). This project requires adherance to good commercial practice standards.

Reference drawings:

062-0012	Demod Mixer Assembly
062-0013	Demod Mixer Assembly Parts List
062-0014	Demod Mixer PCB Assembly
062-0015	Demod Mixer PCB Parts List
062-0004	Demod Mixer Schematic (4 sheets)
062-0008	Demod Mixer Layout Sketch
062-0037	Demod Mixer Enclosure
062-0087	Demod Mixer Modifications

PCB Fabrication

Make sure all parts called out on the PCB Assembly parts list 062-0015 are available for assembly.

Refer to the PCB assembly drawing 062-0014, parts list, and layout sketch 062-0008 for references made in the following instructions:

1. Swage and then solder the USECO terminals, item 53 into the PCB at the following locations: J1, J2, J3, J4, J5, TP1, and TP2.

2. Install and solder the power supply components shown on sheet 4 of the schematic. This includes the decoupling networks (R57 thru R60, C47 thru C50) and the three regulators, U19, 20, &21, and the associated resistors and capacitors.

3. Submit the board to engineering for checkout of the power circuitry.

4. After the board is returned from engineering, install the remaining resistors, and capacitors except for trimmer C19, Item 8. It is permissable to clean the board of excess flux at this time.

Title: Demod Mixer Build Instructions	FSCM No.:	0TK63
	Drawing No.:	062-0010
	Revision:	X2
	Page	3 of 3
Program: HF RADAR	Contract No.:	N000149510249

5. Install C19, and the IC sockets. Note that all IC's except for the regulators are installed in sockets. Carefully observe the pin 1 orientation on the sockets - not all ICs face the same way. Do not allow flux to wick into IC sockets. Cleaning of the board should be done very carefully in order to not contaminate the sockets or the trimmer capacitor.

6. Install the short RG-174 coax cable between TP1,2 and J3-1,2 as shown on drawing 062-0008. Use shrink tubing on the coax to prevent the exposed ends of the braid from shorting to adjacent circuitry.

7. Install jumper wires per drawing 062-0087.

8. Visually inspect the board for parts installation accuracy and solder workmanship.

9. Submit the board to engineering for test without the IC's installed.

<u>Final Assembly</u>

Make sure all parts called out on the Demod Mixer Assembly Parts List, 062-0013 are available.

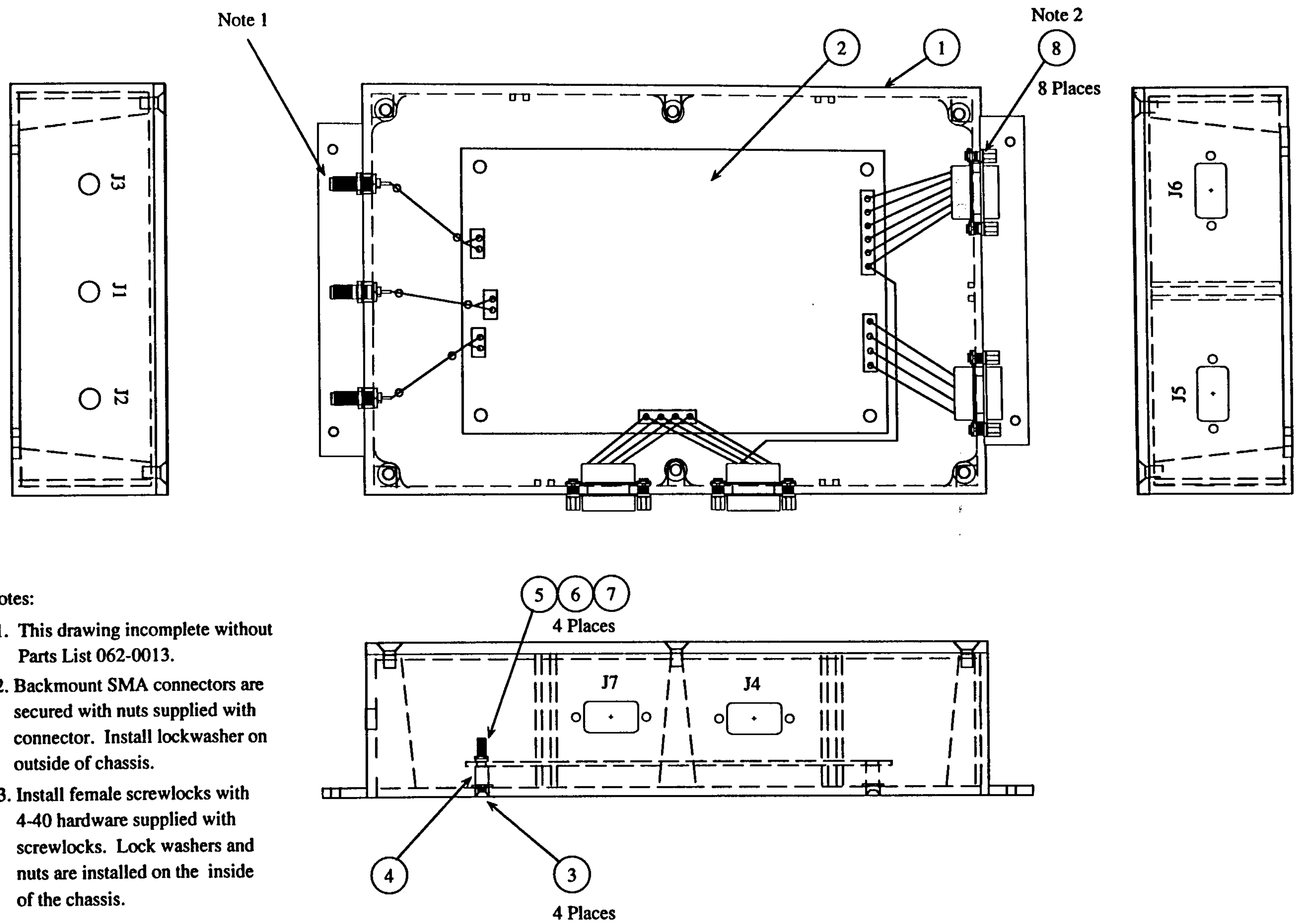
10. Prepare the coaxial connector and D connector pig-tails. Use the chassis 062-0037 as a fixture to trim the pig-tails to length. Temporarily mount the PCB assembly in the chassis using the screws and spacers called out on the assembly parts list, 062-0013. Solder the completed pig-tails and connectors to the PC assembly as detailed on drawing 062-0008.

11. Visually inspect the wiring for parts installation accuracy and solder workmanship.

12. Install the completed PCB assembly into the enclosure by referring to the Demod Mixer assembly drawing, 062-0012 using the material called out on the Assembly parts list, 062-0013. Secure all connectors to the enclosure using the hardware indicated on the drawings.

13. Visually inspect the final assembly.

14. Submit the completed assembly to engineering for final testing.



Notes:

1. This drawing incomplete without Parts List 062-0013.
2. Backmount SMA connectors are secured with nuts supplied with connector. Install lockwasher on outside of chassis.
3. Install female screwlocks with 4-40 hardware supplied with screwlocks. Lock washers and nuts are installed on the inside of the chassis.
4. Rubber stamp J-numbers in locations indicated using items 9 and 10.

Space Physics Research Laboratory College of Engineering University of Michigan	Demod-Mixer Assembly		11-21-95
			03-12-96 NS
			01-20-97 NS
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	Demod Assy	062-0012 X4 COG ENG	

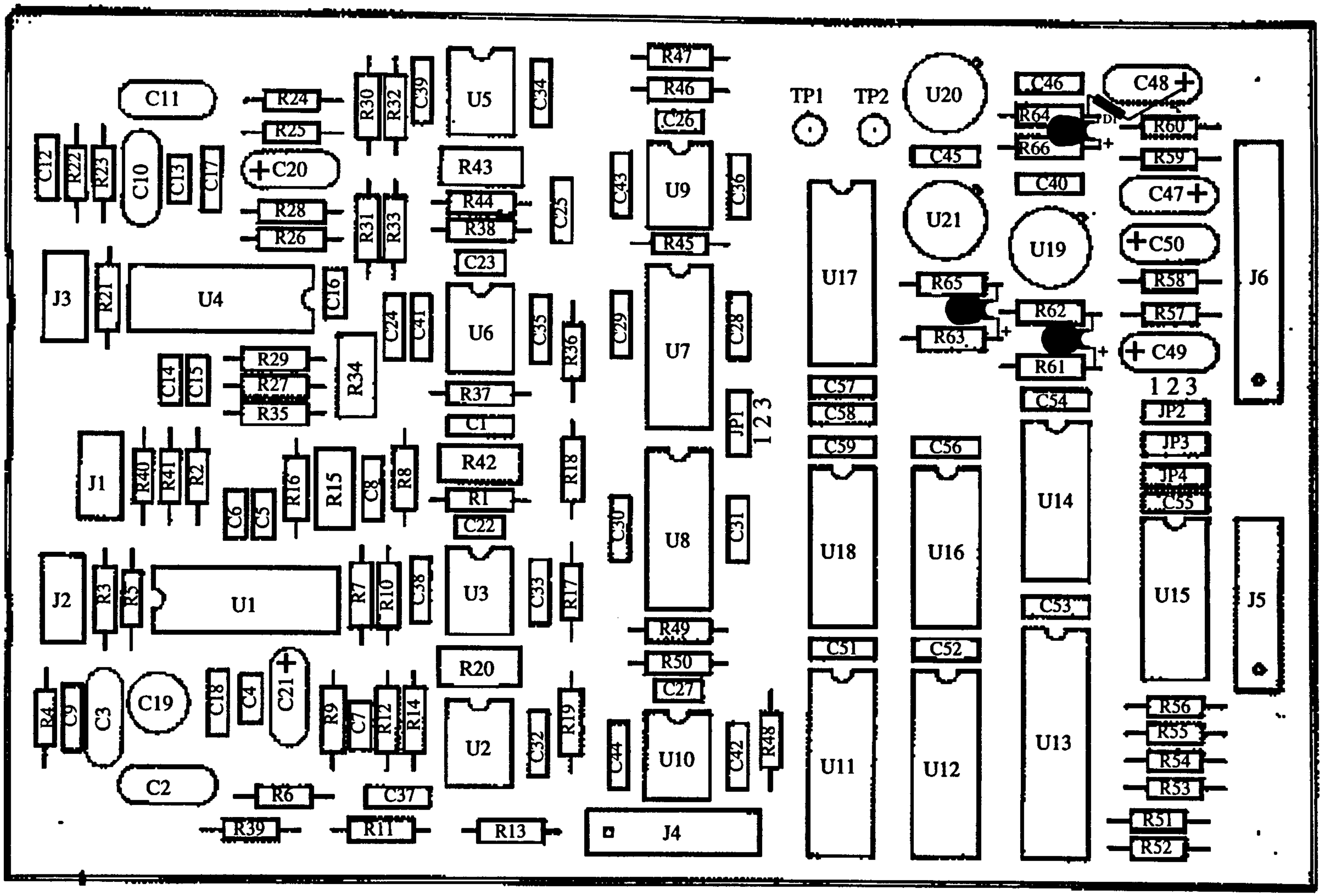
1 Drawing Page

Parts List
Demod Mixer Assy
Next Assy: 062-0037
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Dwg No.:062-0013
Rev: X8

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	1	EA	062-0037	Demod Mixer Enclosure	SPRL	
2	1	EA	062-0014	Demod Mixer PCB Assembly	SPRL	
3	4	EA	MS24693-C29	Screw,CRES,100deg,6-32x0.625"		
4	4	EA		Spacer, thru, #6 x 0.25"		
5	4	EA		Washer, flat		
6	4	EA		Washer, lock		
7	4	EA		Nut, 6-32		
8	4	EA	3341-1S	Jack screw,Short, 4-40x0.13,Kit of 2	3M	
9	1	AR	2850FT	Epoxy,Black	Stycast	
10	1	AR	11	Catalyst		
11	3	EA	80	Lug, Plain, 3/8	Zierek	
12	AR	FT	RG316	Cable,Coax,50 Ohm		
13	1	REF	062-0010	Build Instructions, Demod Mixer	UM/SPRL	



Notes:

This drawing was supplied by the artwork vendor, Huron River Graphics.

Space Physics Research Laboratory College of Engineering University of Michigan	DEMOD PCB ASSEMBLY
N000149510249	Demod PCB Assy
062- 0014	1 of 1 K5
RELEASE	05-01-96 NS
DRAWN	Neil Schnepf
COG ENG	

Drawing Page 1

Parts List
Demod Mixer PCB
Next Assy: 062-0012
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
1	1	EA	CM05ED510F03	Cap,Mica,51pF,500V,5%		C2
2	3	EA	CM05ED750J03	Cap,Mica,75pF,500V,5%		C3,10,11
3	6	EA	M39014/01-1357	Cap,Cer,0.001uF,200V,10%		C4,5,6,13,14,15
4	2	EA	M39014/01-1219	Cap,Cer,100pF,200V,10%		C7,16
5	36	EA	M39014/02-1310	Cap,Cer,0.1uF,100V,10%		C1,8,9,12,17,18,24,25,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,51,52,53,54,55,56,57,58,59
6	2	EA	M39014/01-1201	Cap,Cer,10pF,200V,20%		C26,27
7	2	EA	M39014/01-1327	Cap,Cer,22pF,200V,10%		C22,23
8	1	EA	9310	Cap,Var,5.5pF-45pF,250V	Johanson	C19
9	9	EA	199D106X0025CA1	Cap,Tan,10uF,30V,20%	Sprague	C20,21,47,48,49,50,60,61,62
10	1	EA	1N4148	Diode		D1
10.1	1	EA	IM-2-1.5	Inductor,Molded,1.5uH	Dale	L1
11	4	EA	RNC55J49R9FS	Res,MF,49.9,.125W,1%		R7,8,26,27
12	9	EA	RNC55J4991FS	Res,MF,4.99K,.125W,1%		R9,10,11,12,28,29,30,31,38
13	2	EA	RNC55J2002FS	Res,MF,20.0K,.125W,1%		R47,50
13.1	2	EA	RNC55J4022FS	Res,MF,40.2K,.125W,1%		R46,49
13.2	2	EA	RNC55J2492FS	Res,MF,24.9K,.125W,1%		R18,37
14	2	EA	RJR24CW501M	Res,Var,500,.5W		R15,34
15	4	EA	RCR07G470JS	Res,CC,47,.25W,5%		R17,36,45,48
16	4	EA	RNC55J4992FS	Res,MF,49.9K,.125W,1%		R13,14,32,33
17	1	EA	RNC55J1621FS	Res,MF,1.62K,.125W,1%		R62
18	1	EA	RJR24CW102M	Res,Var,1K,.5W		R20
19	2	EA	RNC55J1211FS	Res,MF,1.21K,.125W,1%		R65,66
20	3	EA	RCR07G2R7JS	Res,CC,2.7,.125W,5%		R57,59,60
21	3	EA	RNC55J2430FS	Res,MF,243,.125W,1%		R61,63,64
22	2	EA	RCR07G241JS	Res,CC,240,.125W,5%		R4,22
23	2	EA	RNC55J4993FS	Res,MF,499K,.125W,1%		R1,44
24	1	EA	RCR07G102JS	Res,CC,1K,.125W,5%		R2
25	2	EA	RCR07G151JS	Res,CC,150,.25W,5%		R3,21

Parts List
Demod Mixer PCB
Next Assy: 062-0012
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
26	2	EA	RNC55J1500FS	Res,MF,150,.125W,1%		R16,35
27	5	EA	RCR07G510JS	Res,CC,51,.25W,5%		R5,6,23,24,40
28	3	EA	RCR07G331JS	Res,CC,330,.25W,5%		R52,54,56
29	1	EA	RNC55J4531FS	Res,MF,4.53K,.125W,1%		R19
30	2	EA	RCR07G220JS	Res,CC,22,.25W,5%		R25,39
31	3	EA	RCR07G221JS	Res,CC,220,.25W,5%		R51,53,55
32	2	EA	RJR24CW503M	Res,Var,50K,.5W		R42,43
33	1	EA	RCR07G100JS	Res,CC,10 Ohm,.25W,5%		R41
34	2	EA	SL6440C/DP	IC,RF Mixer	Plessey	U1,4
35	6	EA	LM318P	IC,OpAmp,DIL	National	U2,3,5,6,9,10
36	2	EA	LTC1264-7CN	IC,Filter,SwitchedCap	LTC	U7,8
37	2	EA	SN74AS163N	IC,Counter,8Bit	TI	U11,12
38	1	EA	SN74LS374N	IC,FF,OctalD	TI	U13
39	1	EA	SN74LS164N	IC,Shift Register,8Bit	TI	U14
40	1	EA	SN74LS04N	IC,Hex Inverter	TI	U15
41	1	EA	SN74AS04N	IC,Hex Inverter	TI	U16
42	1	EA	MC10125L	IC,Quad Translator	Motorola	U17
43	1	EA	SN74LS74AN	IC,FF,DualD	TI	U18
44	2	EA	LM317H	IC,Positive Regulator	National	U19,21
45	1	EA	LM337H	IC,Negative Regulator	National	U20
46	4	EA	69190-403	Jumper Strip	Berg	JP1,2,3,4
47	3	EA	874-10-3	Connector,SMA,Jack,Pnl,R Mtg	Kings	J1,2,3
48	3	EA	205555-2	Connector,DE9-S	Amp	J4,5,7
52	1	EA	205556-2	Connector,DE9-P	Amp	J6
53	20	EA	2520B	Terminal,Non-Insulated	Useco	TP1,2,&All Js/JPs
54	6	EA	ICD8-2T	Socket,IC,8 Pin	Voltrex	
55	8	EA	ICD-14-2T	Socket,IC,14 Pin	Voltrex	
56	3	EA	ICD-16-2T	Socket,IC,16 Pin	Voltrex	
57	1	EA	ICD-20-2T	Socket,IC,20 Pin	Voltrex	
58		AR		Wire,22GA,Stranded		
59		AR	RG-316	Cable,Coax,Miniature		

Parts List
Demod Mixer PCB
Next Assy: 062-0012
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Dwg #:062-0015
Rev:X11

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
60		AR		Shrink Tubing		
61						
62	1	EA	062-0017	PCB,Raw Card,Demod-Mixer	UM/SPRL	
63	1	REF	062-0004	Schematic,Demod-Mixer	UM/SPRL	
64	8	EA		24 Ga buswire with 22 Ga teflon slv		
65	1	REF	062-0087	Modifications, Demod-Mixer PCB	UM/SPRL	

Net List
Demod Mixer PCB
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK73
Drawing No.: 062-0016
Revision: X2

NET LIST for 062-0004E Demod Mixer Wednesday, February 28, 1996 1:24 PM									
NET NAME	PINS								
Q0	U11-3	U13-2							
Q1	U11-4	U13-5							
Q2	U11-5	U13-6							
Q3	U11-6	U13-9							
Q4	U12-3	U13-12							
Q5	U12-4	U13-15							
Q6	U12-5	U13-16							
Q7	U12-6	U13-19							
+5V	C50-1	C51-1	C52-1	C53-1	C54-1	C55-1	C56-1		
	C57-1	C59-1	R51-1	R53-1	R55-1	R58-2	U11-1		
	U11-7	U11-10	U11-16	U12-1	U12-10	U12-16			
	U13-20	U14-9	U14-14	U15-14	U16-5	U16-9			
	U16-11	U16-13	U16-14	U17-9	U18-1	U18-4			
	U18-10	U18-11	U18-12	U18-13	U18-14				
+12V	C32-2	C33-2	C34-2	C35-2	C36-2	C40-1	C42-2		
	C45-1	C49-1	J4-8	R57-2	U2-7	U3-7	U5-7	U6-7	
	U9-7	U10-7	U19-1	U21-1					
-5V	C9-1	C12-1	C47-2	C58-2	R4-2	R22-2	R59-2		
	U17-8								
-12V	C37-1	C38-1	C39-1	C41-1	C43-1	C44-1	C46-1		
	C48-2	R60-2	U2-4	U3-4	U5-4	U6-4	U9-4	U10-4	
	U20-3								
40MHZ_IF	C6-2	C15-2	R2-1	R41-2					
GND	C1-2	C3-2	C5-2	C8-2	C9-2	C11-2	C12-2	C14-2	
	C17-1	C18-1	C20-2	C21-2	C24-2	C25-2	C28-2		
	C29-2	C30-2	C31-2	C32-1	C33-1	C34-1	C35-1		

Net List
Demod Mixer PCB
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

NET LIST for 062-0004E Demod Mixer Wednesday, February 28, 1996 1:24 PM

NET NAME	PINS								
	C36-1	C37-2	C38-2	C39-2	C40-2	C41-2	C42-1		
	C43-2	C44-2	C45-2	C46-2	C47-1	C48-1	C49-2		
	C50-2	C51-2	C52-2	C53-2	C54-2	C55-2	C56-2		
	C57-2	C58-1	C59-2	C60-2	C61-1	C62-2	D1-C		
	J1-2	J2-2	J3-2	J4-2	J4-4	J4-5	J4-9	J5-2	J5-4
	J5-6	J5-7	J6-3	J6-4	J7-2	J7-4	J7-5	JP5-2	
	R2-2	R3-1	R6-2	R14-2	R21-1	R24-2	R33-2	R40-2	
	R52-2	R54-2	R56-2	R62-2	R65-2	R66-2	U1-6		
	U3-3	U4-6	U6-3	U7-3	U7-5	U8-3	U8-5	U9-3	
	U10-3	U11-8	U12-8	U13-1	U13-10	U14-7	U15-7		
	U16-7	U17-16	U18-7						
IOUT	J4-1	J7-1	R45-2	R46-2					
IREF	J3-1	R21-2	R22-1	R23-1					
Q8	U11-7	U13-2							
Q9	U11-8	U13-5							
Q10	U11-9	U13-6							
Q8	U11-7	U13-2							
Q9	U11-8	U13-5							
Q10	U11-9	U13-6							
Q11	U11-10	U13-9							
Q12	U12-7	U13-12							
Q13	U12-8	U13-15							
Q14	U12-9	U13-16							
Q15	U12-10	U13-19							

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

NET LIST for 062-0004E Demod Mixer Wednesday, February 28, 1996 1:24 PM									
NET NAME	PINS								
Q8	U11-7	U13-2							
Q9	U11-8	U13-5							
Q10	U11-9	U13-6							
Q11	U11-10	U13-9							
Q12	U12-7	U13-12							
Q13	U12-8	U13-15							
Q14	U12-9	U13-16							
Q15	U12-10	U13-19							
+5V	C50-2	C51-2	C52-2	C53-2	C54-2	C55-2	C56-2		
	C57-2	C59-2	R51-2	R53-2	R55-2	R58-3	U11-2		
	U11-7	U11-10	U11-16	U12-1	U12-10	U12-16			
	U13-21	U14-9	U14-14	U15-15	U16-5	U16-9			
	U16-11	U16-13	U16-14	U17-10	U18-27	U18-4			
	U18-10	U18-11	U18-12	U18-13	U18-40				
+12V	C32-3	C33-3	C34-3	C35-3	C36-3	C40-2	C42-3		
	C45-2	C49-2	J4-9	R57-3	U2-8	U3-8	U5-8	U6-8	
	U9-8	U10-8	U19-2	U21-2					
-5V	C9-2	C12-2	C47-3	C58-3	R4-3	R22-3	R59-3		
	U17-9								
-12V	C37-2	C38-2	C39-2	C41-2	C43-2	C44-2	C46-2		
	C48-3	R60-3	U2-5	U3-5	U5-5	U6-5	U9-5	U10-5	
	U20-4								
40MHZ_IF	C6-3	C15-3	R2-2	R41-3					
Q8	U11-7	U13-2							
Q9	U11-8	U13-5							
Q10	U11-9	U13-6							

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

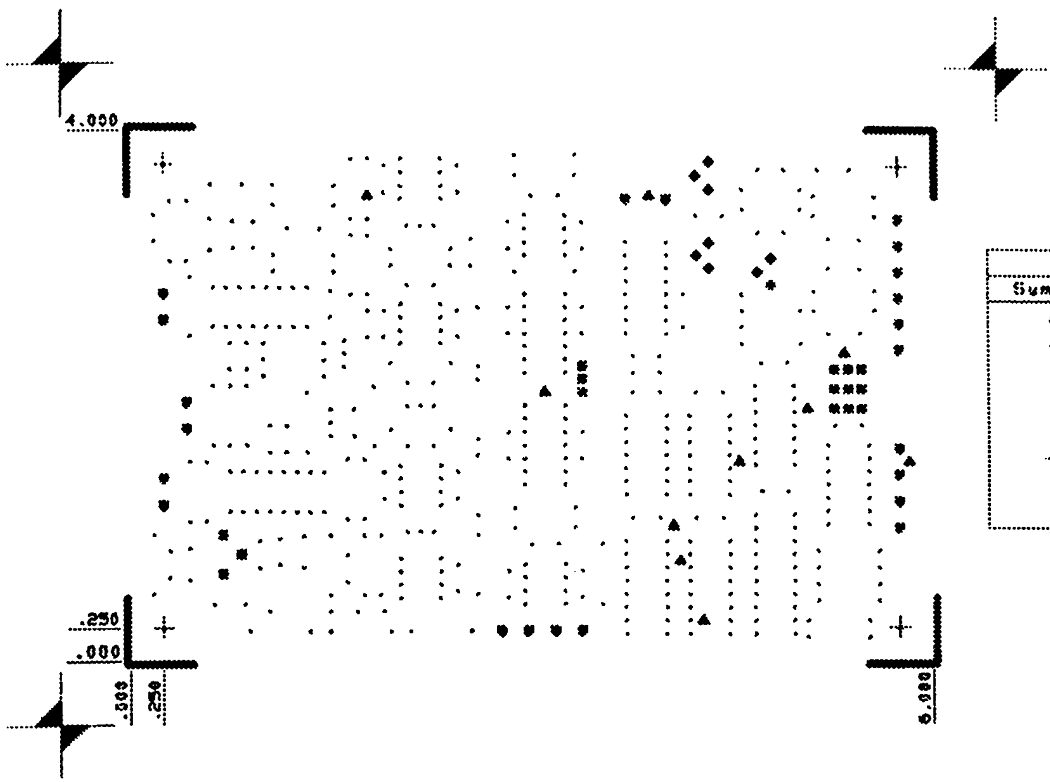
NET LIST for 062-0004E Demod Mixer Wednesday, February 28, 1996 1:24 PM									
NET NAME	PINS								
Q11	U11-10	U13-9							
Q12	U12-7	U13-12							
Q13	U12-8	U13-15							
Q14	U12-9	U13-16							
Q15	U12-10	U13-19							
+5V	C50-2	C51-2	C52-2	C53-2	C54-2	C55-2	C56-2		
	C57-2	C59-2	R51-2	R53-2	R55-2	R58-3	U11-2		
	U11-7	U11-10	U11-16	U12-1	U12-10	U12-16			
	U13-21	U14-9	U14-14	U15-15	U16-5	U16-9			
	U16-11	U16-13	U16-14	U17-10	U18-27	U18-4			
	U18-10	U18-11	U18-12	U18-13	U18-40				
+12V	C32-3	C33-3	C34-3	C35-3	C36-3	C40-2	C42-3		
	C45-2	C49-2	J4-9	R57-3	U2-8	U3-8	U5-8	U6-8	
	U9-8	U10-8	U19-2	U21-2					
-5V	C9-2	C12-2	C47-3	C58-3	R4-3	R22-3	R59-3		
	U17-9								
-12V	C37-2	C38-2	C39-2	C41-2	C43-2	C44-2	C46-2		
	C48-3	R60-3	U2-5	U3-5	U5-5	U6-5	U9-5	U10-5	
	U20-4								
Q8	U11-7	U13-2							
Q9	U11-8	U13-5							
Q10	U11-9	U13-6							
Q11	U11-10	U13-9							
Q12	U12-7	U13-12							
Q13	U12-8	U13-15							
Q14	U12-9	U13-16							

Net List
Demod Mixer PCB
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK73
Drawing No.: 062-0016
Revision: X2

NET LIST for 062-0004E Demod Mixer Wednesday, February 28, 1996 1:24 PM									
NET NAME	PINS								
Q15	U12-10	U13-19							
+5V	C50-2	C51-2	C52-2	C53-2	C54-2	C55-2	C56-2		
	C57-2	C59-2	R51-2	R53-2	R55-2	R58-3	U11-2		
	U11-7	U11-10	U11-16	U12-1	U12-10	U12-16			
	U13-21	U14-9	U14-14	U15-15	U16-5	U16-9			
	U16-11	U16-13	U16-14	U17-10	U18-27	U18-4			
	U18-10	U18-11	U18-12	U18-13	U18-40				
+12V	C32-3	C33-3	C34-3	C35-3	C36-3	C40-2	C42-3		
	C45-2	C49-2	J4-9	R57-3	U2-8	U3-8	U5-8	U6-8	
	U9-8	U10-8	U19-2	U21-2					
-5V	C9-2	C12-2	C47-3	C58-3	R4-3	R22-3	R59-3		
	U17-9								
-12V	C37-2	C38-2	C39-2	C41-2	C43-2	C44-2	C46-2		
	C48-3	R60-3	U2-5	U3-5	U5-5	U6-5	U9-5	U10-5	
	U20-4								
40MHZ_IF	C6-3	C15-3	R2-2	R41-3					
GND	C1-3	C3-3	C5-3	C8-3	C9-3	C11-3	C12-3	C14-3	
Q8	U11-7	U13-2							
Q9	U11-8	U13-5							
Q10	U11-9	U13-6							
Q11	U11-10	U13-9							
Q12	U12-7	U13-12							
Q13	U12-8	U13-15							
Q14	U12-9	U13-16							
Q15	U12-10	U13-19							
+5V	C50-2	C51-2	C52-2	C53-2	C54-2	C55-2	C56-2		



DRILL TABLE			
Symbol	Size	Plated	Qty
▲	.028	P	10
◆	.032	P	9
·	.038	P	485
*	.052	P	15
*	.075	P	22
⌖	.173	U	4

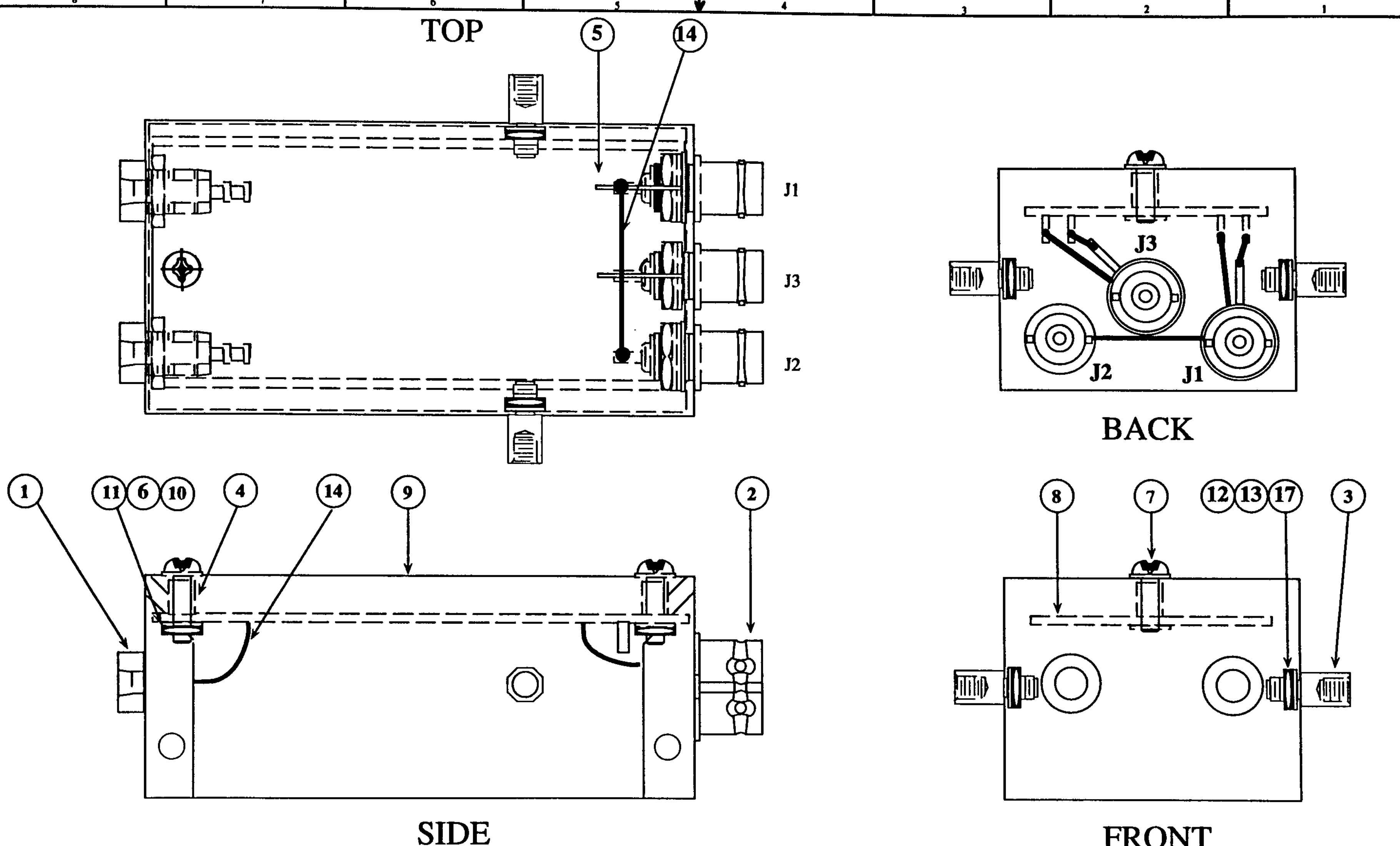
HRG 1895

DRILL

Space Physics Research Laboratory
College of Engineering
University of Michigan

Demod Raw Card

N000149510249 | Demod Raw Card | 062 0017 | 1 of 1



Assembly Notes:

1. Install BNC connectors, item 2, using lugs, item 5, on connectors J1 and J3 as indicated.
2. Install the PCB assembly, Item 8, using hardware items 4,6,7,11, and12.
3. Install Banana jacks, item 1.
4. Connect BNC and banana jacks to the PCB using item 14 per schematic.
5. Ink stamp J1, J2, and J3 on the outside,"back" edge of the enclosure using items 15 and 16.
6. Install standoffs, item 3, using hardware items 12 and 13, to cover.

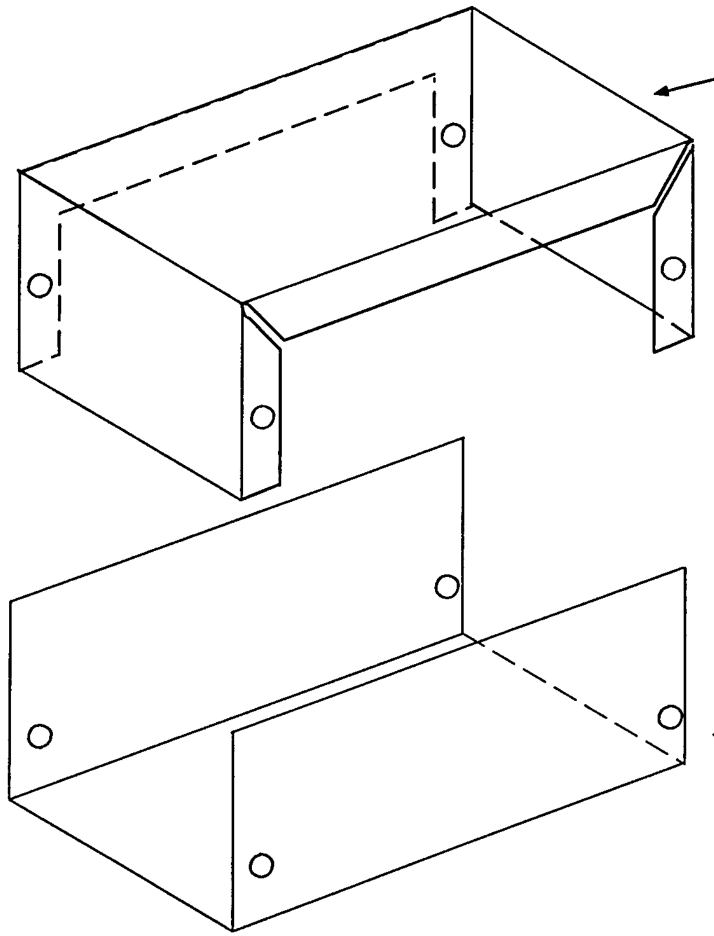
This drawing incomplete without parts list 062-0039.

Space Physics Research Laboratory College of Engineering University of Michigan	Preamp Assembly HF Radar	REV	19-Dec-95 RP
		REV	07-Nov-95 NS
		REV	22-Jan-96 NS/PH
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	062- 0018 k10	COG ENG	

1 Drawing Page

Notes:

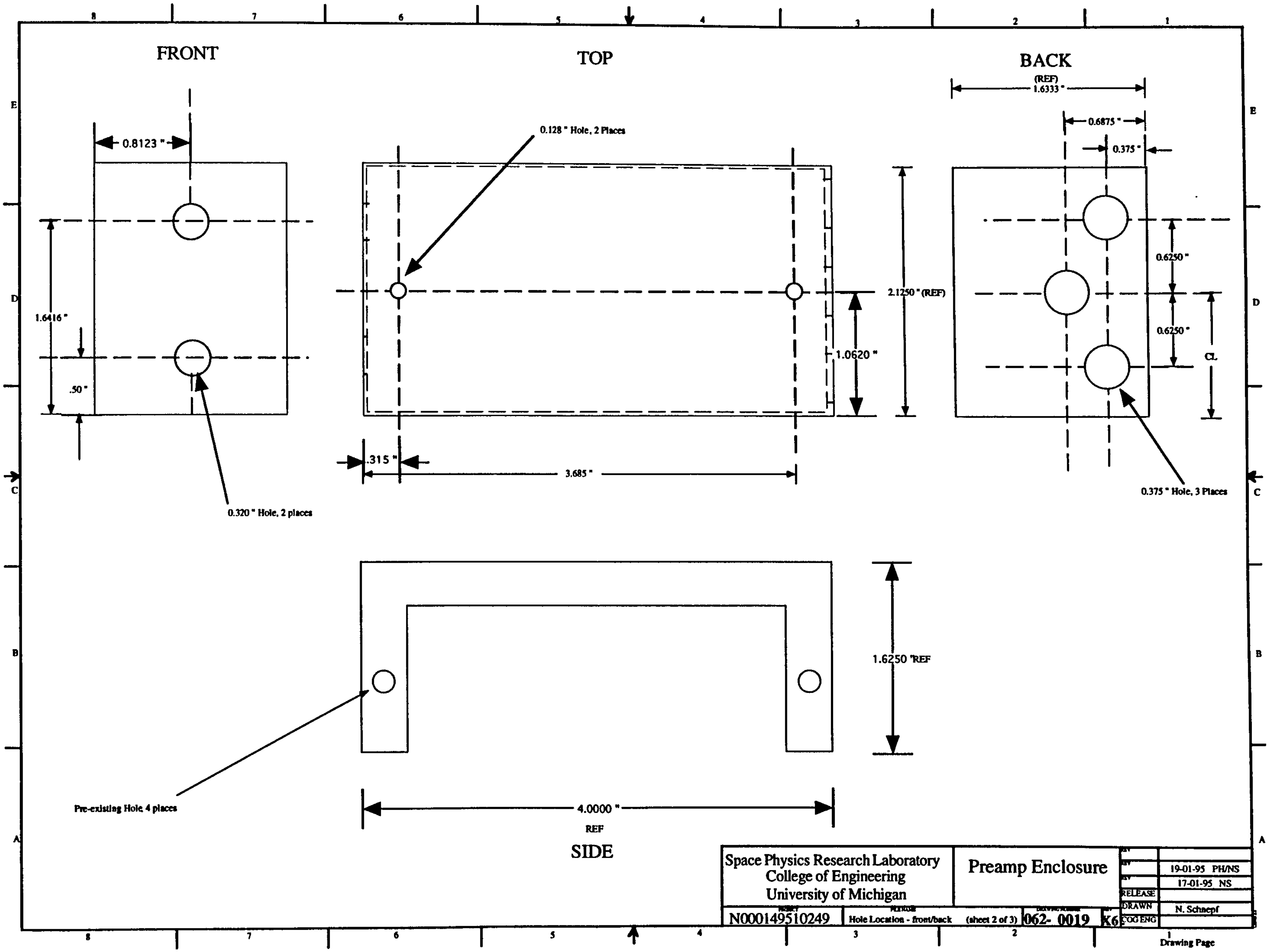
1. This drawing describes modifications to a standard Bud Minibox CU-2102B 4" x 2 1/8 " x 1 5/8 ".

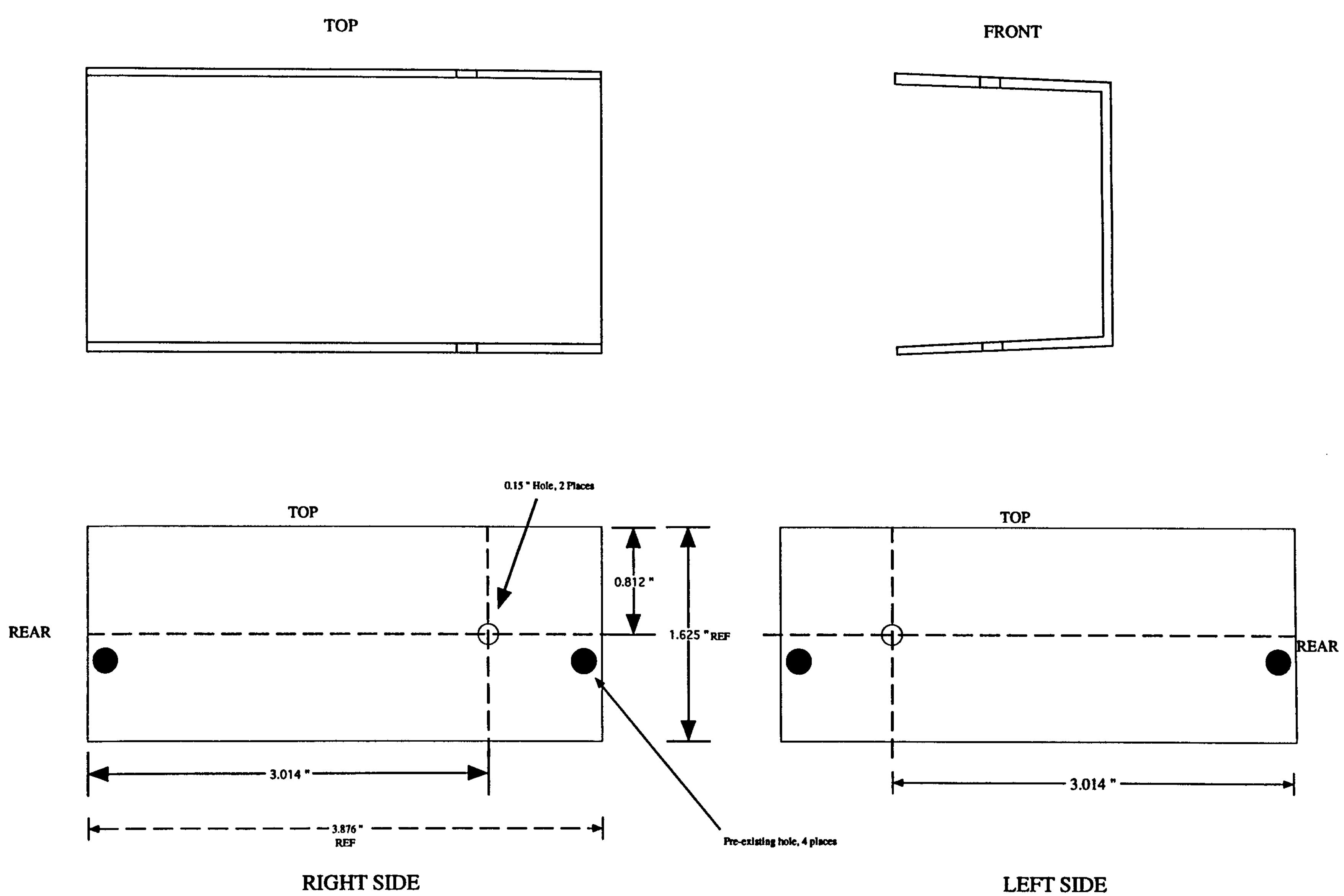


This drawing incomplete without parts list 062-0038.

Space Physics Research Laboratory College of Engineering University of Michigan	Preamp Enclosure	RELEASE	
		DRAWN	N. Schnepf
N000149510249	Perspective View (sheet 1 of 3)	062- 0019	K6

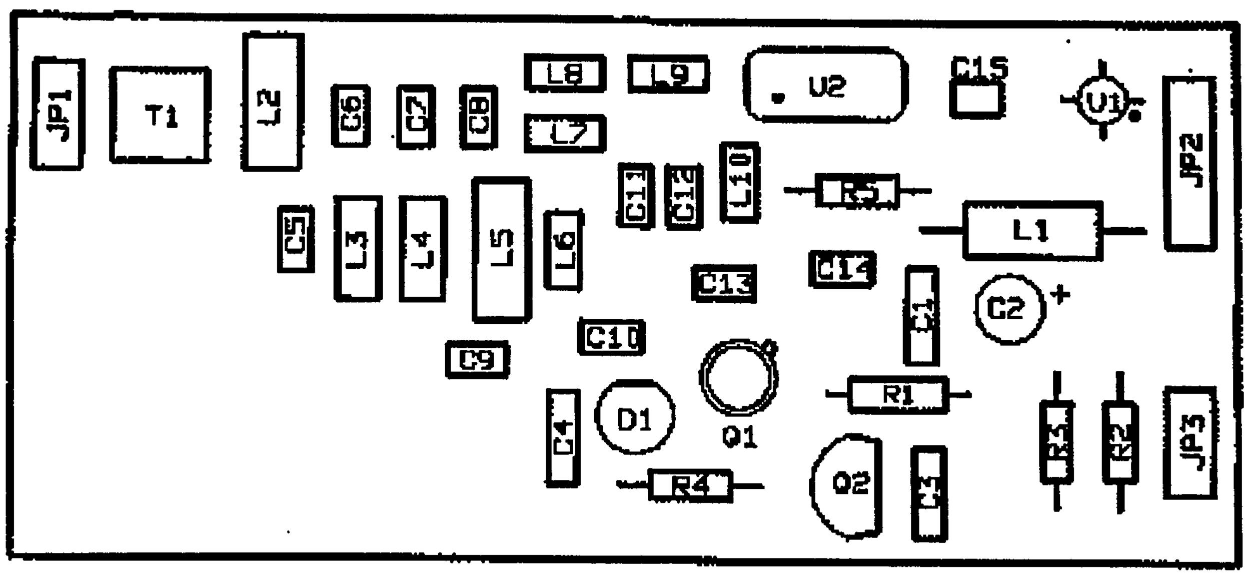
Drawing Page 1


FRONT
TOP
BACK
SIDE
0.8123 "
1.6416 "
.50 "
0.320 " Hole, 2 places
0.128 " Hole, 2 Places
.315 "
3.685 "
1.0620 "
2.1250 " (REF)
(REF)
1.6333 "
0.6875 "
0.375 "
0.6250 "
0.6250 "
CL
0.375 " Hole, 3 Places
1.6250 "REF
4.0000 "
REF
Pre-existing Hole 4 places
Space Physics Research Laboratory
College of Engineering
University of Michigan
Preamp Enclosure
N000149510249
Hole Location - front/back
(sheet 2 of 3)
062- 0019
K6
19-01-95 PH/NS
17-01-95 NS
RELEASE
DRAWN
N. Schaepf
COG ENG
Drawing Page



Space Physics Research Laboratory College of Engineering University of Michigan	Preamp Enclosure		February 5,1996 NS October 25, 1995
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	Hole Location - side (sheet 3 of 3)	062- 0019 K6 COG ENG	

Drawing Page



Notes:

1. This drawing incomplete without parts list 062-0021.
2. This drawing was supplied by the artwork vendor, Huron River Graphics.

Space Physics Research Laboratory College of Engineering University of Michigan		Preamp PCB Assembly	RELEASE 04-16-96 NS DRAWN Neil Schnepf COG ENG
N000149510249	062-0020.1	062- 0020	1 of 2 X

Drawing Page

The basic PCB build sequence is as follows (no separate build instructions or test procedure are provided):

1. Swage the Useco terminals to the bare PCB.

2. Install the rest of the electronic components and solder.

3. Serialize the boards. Using white expoxy ink, rubber stamp "SN 1","SN 2", etc. below the assembly number on each board.

4. Inspect soldering and submit board to engineering for test.

5. The following electrical tests should be performed:
   a. Total input current - should be 78 mA
   b. Current source value - should be 20 mA
   c. Q2 operation: Voltage at Q2 Drain = 0.8 with JP3 short, 0.06 withJP3 open.
   d. Measure input to output gain at 4 frequencies, 4.8, 6.78,13.38, 21.77 MHz. Should be about 5 dB.
   e. Measure filter - 3dB frequencies - should be about 4.2 MHz and 29.1 MHz.
   f. Check on/off attenuation ratio of blanker - should be about 50 dB.
   g. Check minimum discernable signal - should be about -120 dBm for narrow bandwidth.

6. After the bench test is complete, attach the wires called out on the assembly print, 062-0025 and parts list 062-0039 to the terminals.

7. Conformal coat the board using the materials called out on 062-0021 parts list using the 060-0026 instructions.

8. When coating has cured, submit boards to next assembly, 062-0025 for installation into the enclosure.

Space Physics Research Laboratory College of Engineering University of Michigan		Preamp PCB Assembly		RELEASE / DRAWN / COG ENG
N000149510249	062-0020.2	062- 0020	2 of 2	X3

Drawing Page

Parts List
Preamplifier PCB
Next Assy:062-0018
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
1	2	EA	M39014/02-1230	Cap,Cer,0.1uF,100V,10%		C1,4
2	1	EA	199D106X0025CA1	Cap,Tan,10uF,30V,20%		C2
3	1	EA	M39014/01-1358	Cap,Cer,1000pF,200V,20%		C3
4	2	EA	ATC700B751JRW50	Cap,Cer,750pF,50V,5%		C5,9
5	2	EA	ATC700B511JRW100	Cap,Cer,510pF,100V,5%		C6,8
6	1	EA	ATC700B391JRW500	Cap,Cer,390pF,500V,5%		C7
7	2	EA	ATC700B620JRW500	Cap,Cer,62pF,500V,5%		C10,13
8	2	EA	ATC700B201JRW500	Cap,Cer,200pF,500V,5%		C11,12
9	1	EA	M39014/01-1575	Cap,Cer,0.01uF,100V,10%		C14
10	1	EA	ATC200B103MNMS50	Cap,Cer,0.01uF,50V,20%		C15
11	1	EA	HLMP-3000	Diode,LED,GAS	HP	D1
12	6	EA	2520B	Terminal,Non-Insulated	Useco	JP1,2,3
13	1	EA	IM-2-47.0	Ind,Ferrite,47.0uH,10%	Dale	L1
14	2	EA	062-0027-5	Ind,PwdIron,3.3uH,5%	UM/SPRL	L2,5
15	2	EA	062-0027-4	Ind,PwdIron,1.0uH,5%	UM/SPRL	L3,4
16	2	EA	062-0027-1	Ind,PwdIron,0.28uH,5%	UM/SPRL	L6,10
17	2	EA	062-0027-2	Ind,PwdIron,0.42uH,5%	UM/SPRL	L7,9
18	1	EA	062-0027-3	Ind,PwdIron,0.53uH,5%	UM/SPRL	L8
19	1	EA	2N2907	Transistor,PNP,TO-18		Q1
20	1	EA	VN10KM	Transistor,VMOS,TO-237		Q2
21	1	EA	RNC55H45R3FS	Res,MF,45.3 Ohm,1%		R1
22	2	EA	RCR07G470JS	Res,CC,47 Ohm,5%		R2,5
23	1	EA	RCR07G473JS	Res,CC,47K,5%		R3
24	1	EA	RCR07G122JS	Res,CC,1.2K,5%		R4
25	1	EA	T16-6T-X65	Transformer,RF,4:1	Mini-Ckts	T1
26	1	EA	MAV-11	IC,RF Amp	Mini-Ckts	U1
27	1	EA	TFAS-1	Switch,RF	Mini-Ckts	U2
28	1	AR	5750LV-A	Resin,Conformal Coating	Uralane	
29	1	AR	5750LV-B	Curing Agent	Uralane	
30	1	AR	Toluene/MEK	Thinner		
31	1	EA	062-0034	PCB,Raw Card,Preamp	UM/SPRL	

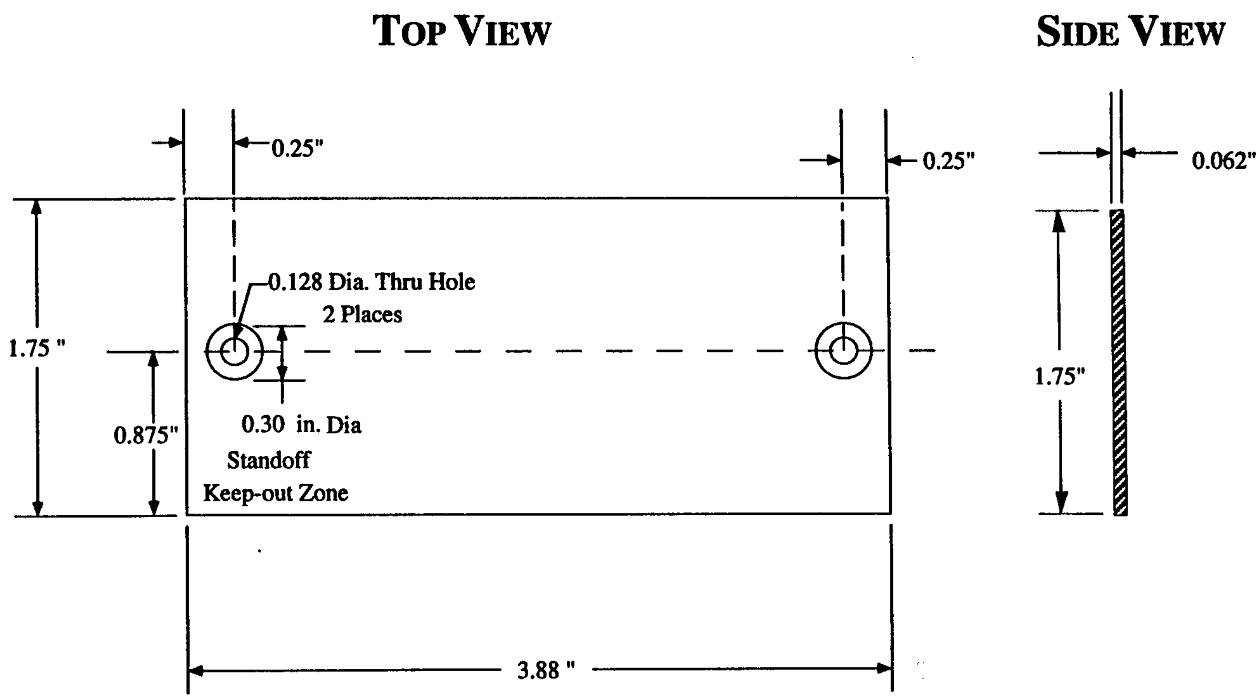
Parts List
Preamplifier PCB
Next Assy:062-0018
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.: 062-0021
Rev:X9

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
32	1	REF	062-0022	Schematic,Preamp	UM/SPRL	
33	1	REF	060-0026	Instructions, Conformal Coating	UM/SPRL	

NOTES:
1. BOARD MATERIAL: 0.062" GLASS EPOXY TYPE GFN.
2. ALL PC TRACES TO BE AT LEAST 0.050" FROM BOARD EDGE.
3. SEE SHEET 2 FOR SUGGESTED LAYOUT.



Space Physics Research Laboratory College of Engineering University of Michigan	PREAMP PCB BOARD OUTLINE	RELEASE	
		DRAWN	R. Pung
N000149510249	0023.1 (Sheet 1 of 2)	062-0023 K5	

NOTES

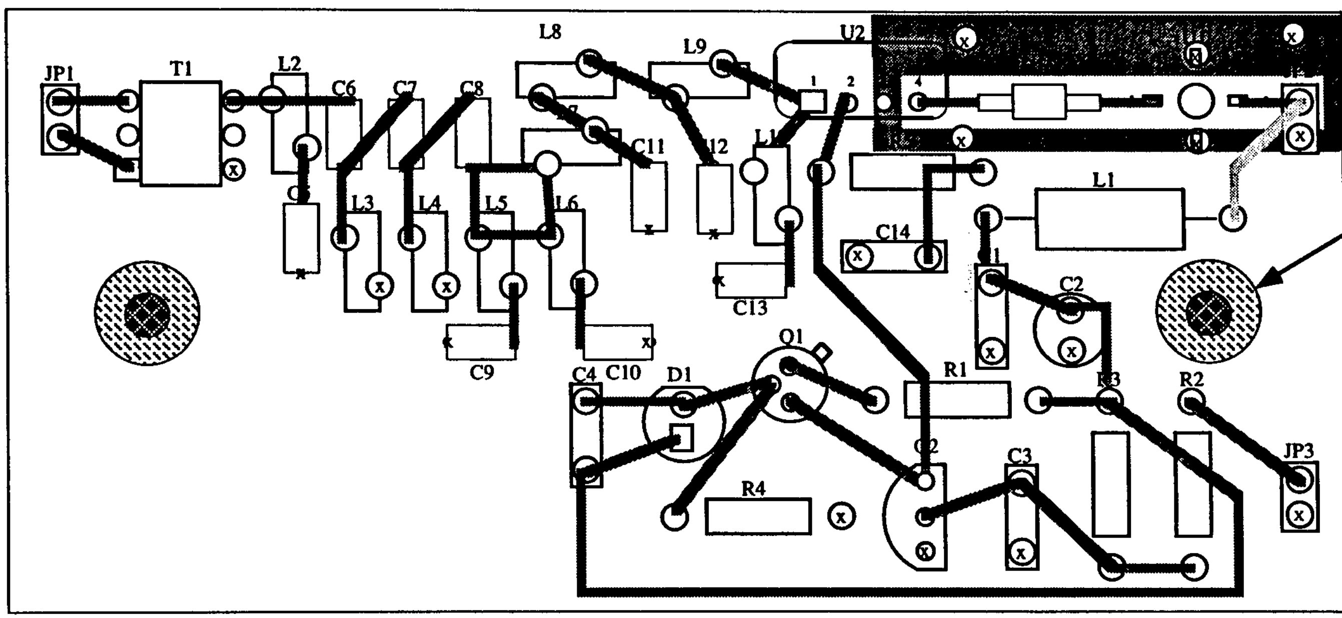
Suggested layout is for two sided 0.062" board. Ground plane on reverse side.

U1 requires 0.150" clearance hole for IC body

Leads on capacitor C15 are trimmed to .1" before installation.

Ⓧ Signifies PTH to Ground Plane

▬ Signifies trace on ground plane side.



Space Physics Research Laboratory College of Engineering University of Michigan	Preamp PC Board Outline		31-Oct-95 NS 08-Nov-95 NS 27-Nov-95 NS
		RELEASE	
		DRAWN	Neil Schnepf
N000149510249	0023.2 (Sheet 2 of 2)	062- 0023 X5	

1 Drawing Page

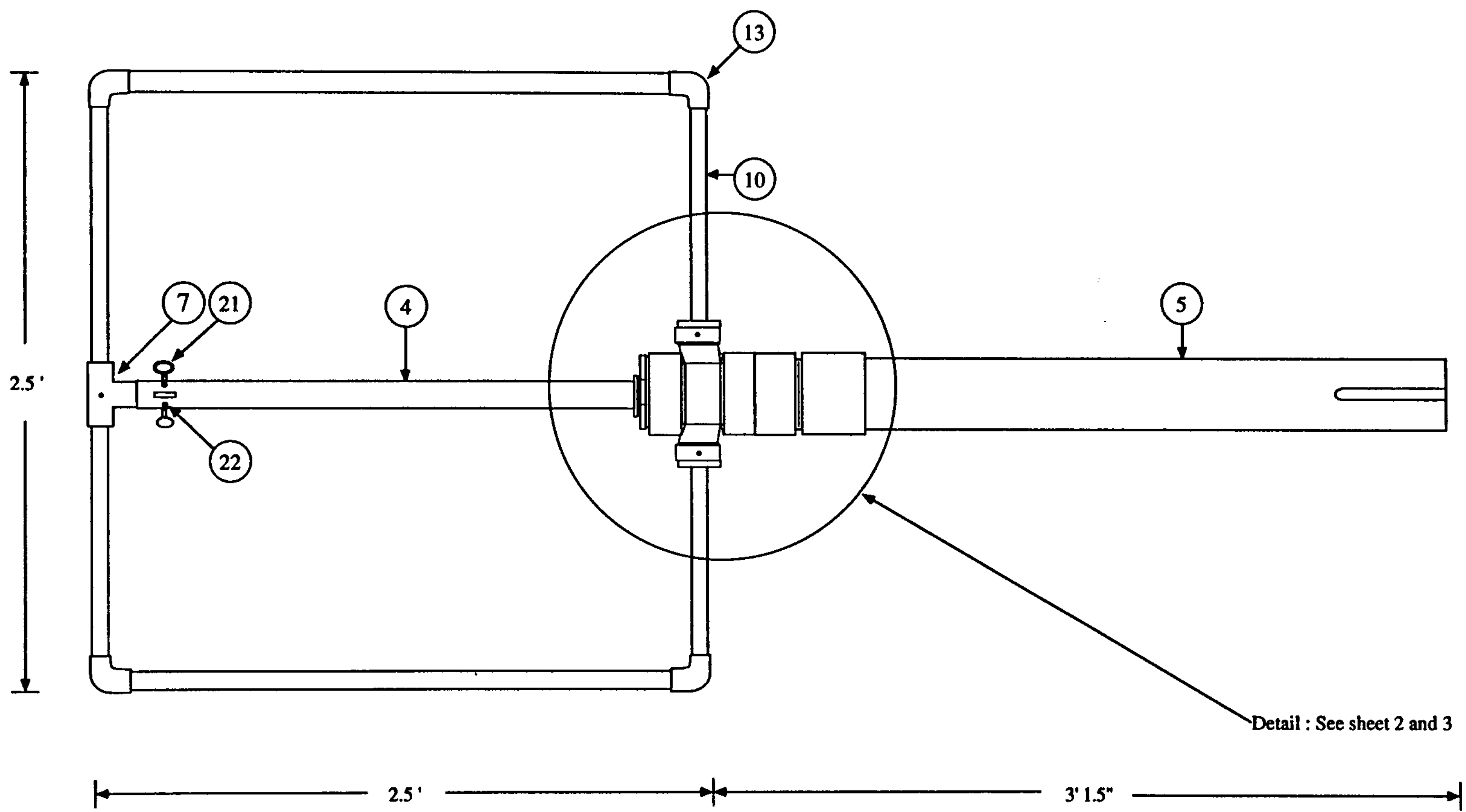
Net List
Preamp
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK73
Drawing No.: 062-0024
Revision: X6

Reference: 062-0022X7 Preamp Sch Tuesday, November 7, 1995 5:04 PM

NET NAME		PINS																		
GND	C1	2	C2	2	C3	2	C5	2	C9	2	C10	2	C11	2	C12	2	C13	2	C14	1
	JP2	1	JP3	1	L3	2	L4	2	Q2	S	R4	2	T1	6	U1	2	U1	4	U2	3
N:1	C6	2	L2	1	T1	4														
N:2	C5	1	L2	2																
N:3	C6	1	C7	2	L3	1														
N:4	C7	1	C8	1	L4	1														
N:5	C8	2	L5	1	L6	1	L7	1												
N:6	C9	1	L5	2																
N:7	C10	1	L6	2																
N:8	C11	1	L7	2	L8	1														
N:9	C15	1	U2	4																
N:10	JP1	2	T1	3																
N:11	JP1	1	T1	1																
N:12	C1	1	C2	1	C4	1	D1	A	L1	1	R1	2	R3	1						
N:13	JP2	2	L1	2	U1	3														
N:14	Q1	E	R1	1																
N:15	Q1	C	Q2	D	R5	2	U2	2												
N:16	JP3	2	R2	2																
N:17	C3	1	Q2	G	R2	1	R3	2												
N:18	C4	2	D1	C	Q1	B	R4	1												
N:19	C12	1	L8	2	L9	1														
N:20	L9	2	L10	1	U2	1														
N:21	C13	1	L10	2																
N:22	C14	2	R5	1																
N:23	C15	2	U1	1																

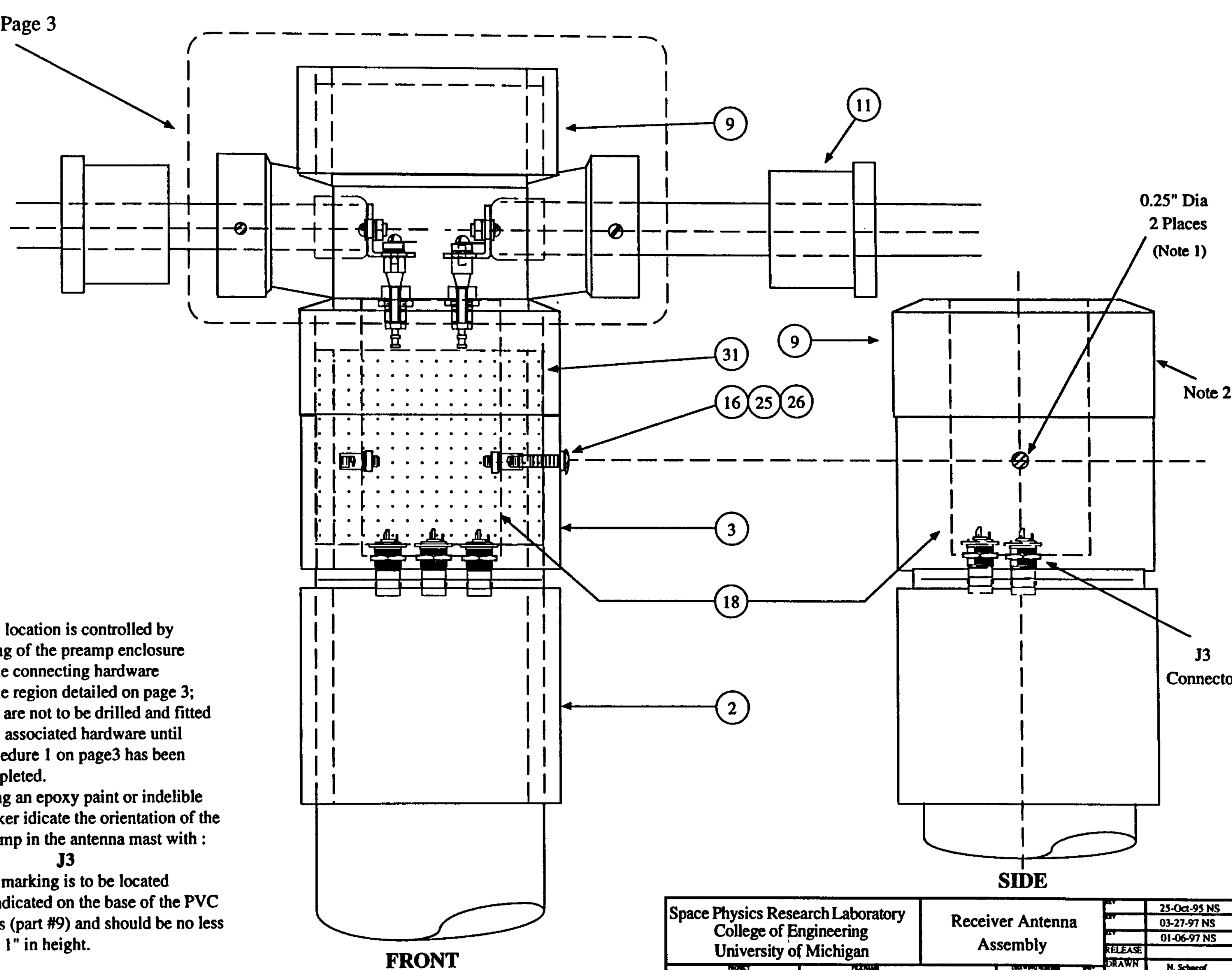


Notes:

1. This drawing incomplete without p/l 062-0026.
2. Apply sealant (item 30) to all exposed mounting hardware (screws, nuts, washers, eye bolts,etc.)

Space Physics Research Laboratory College of Engineering University of Michigan	Receiver Antenna Assembly		04-10-96 NS 01-12-95
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	0025.1 062- 0025 k9	COG ENG	

1
Drawing Page



Notes:

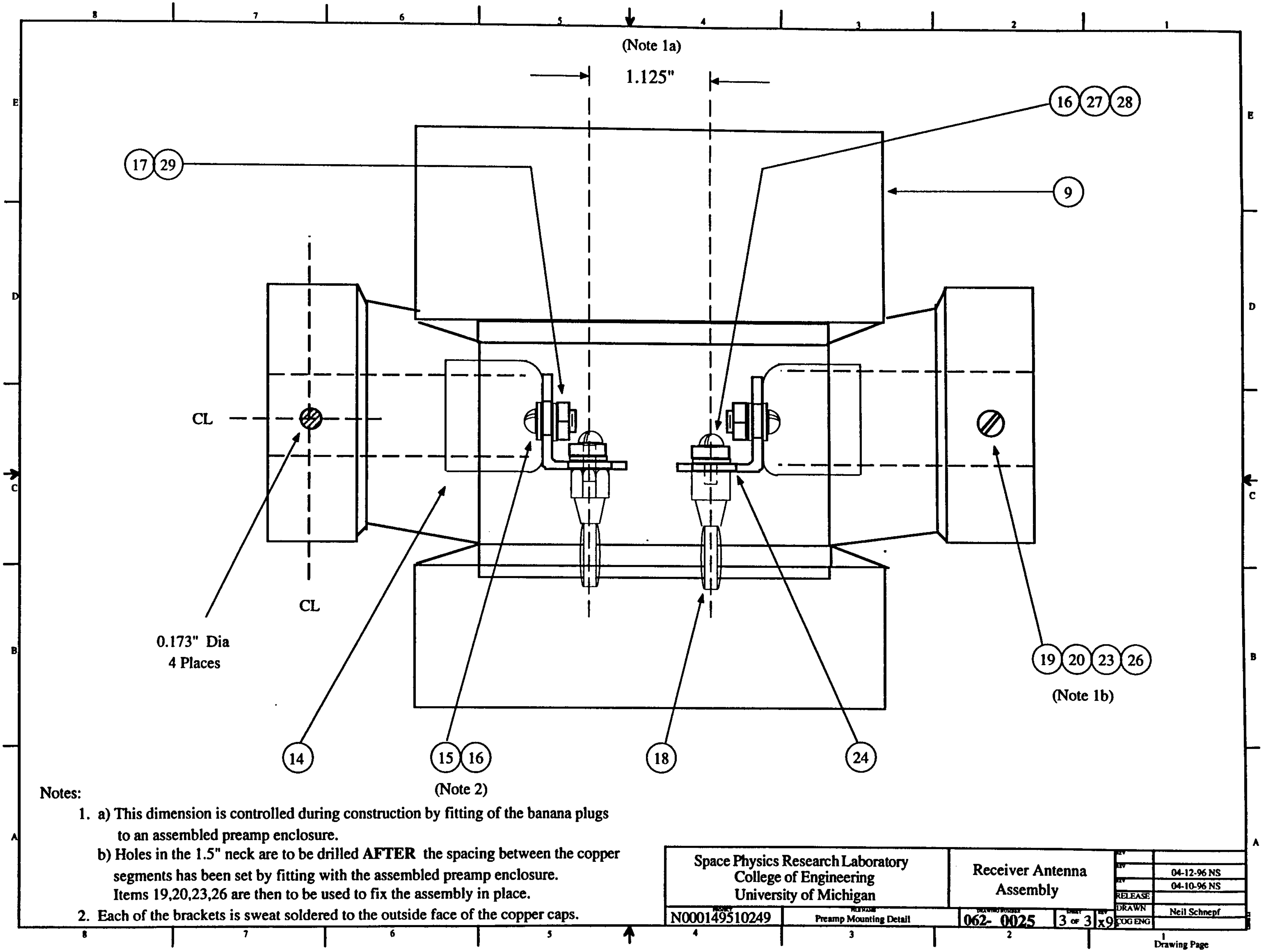
1. This location is controlled by fitting of the preamp enclosure to the connecting hardware in the region detailed on page 3; they are not to be drilled and fitted with associated hardware until procedure 1 on page3 has been completed.
2. Using an epoxy paint or indelible marker idicate the orientation of the preamp in the antenna mast with :

   J3

   The marking is to be located as indicated on the base of the PVC cross (part #9) and should be no less than 1" in height.

Space Physics Research Laboratory College of Engineering University of Michigan	Receiver Antenna Assembly		25-Oct-95 NS 03-27-97 NS 01-06-97 NS
		RELEASE	
		DRAWN	N. Schaepf
N000149510249 | Mast Mounting Detail (Sheet 2 of 3)	062-0025 | x9	COG ENG	

Drawing Page



Notes:

1. a) This dimension is controlled during construction by fitting of the banana plugs to an assembled preamp enclosure.
   b) Holes in the 1.5" neck are to be drilled **AFTER** the spacing between the copper segments has been set by fitting with the assembled preamp enclosure. Items 19,20,23,26 are then to be used to fix the assembly in place.
2. Each of the brackets is sweat soldered to the outside face of the copper caps.

Parts List
Receiver Antenna Assembly
Next Assy:062-0025
Contract #:N000149510249

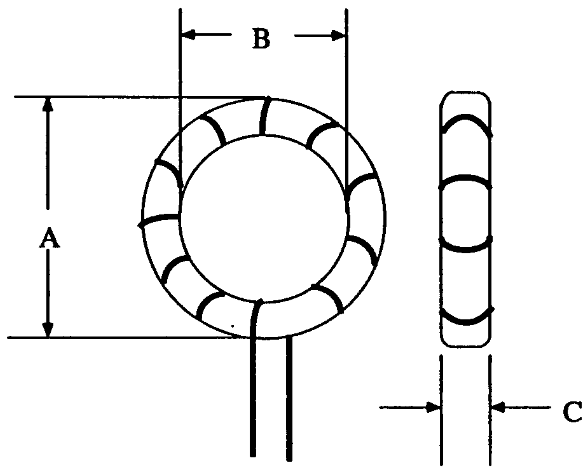
UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Dwg No.:062-0026
Rev:X5

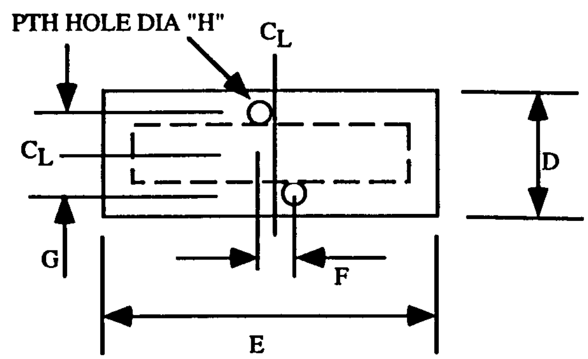
Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
1	1	EA	062-0018	Preamp Assembly	SPRL	
2	1	EA	4804	3" Male PVC threaded coupler	NIBCO	MC
3	1	EA	4803	3" Female PVC threaded coupler	NIBCO	FC
4	27.5	IN	310107	1" Schedule 40 PVC Pipe	Genova	
5	5	FT	98248-50840	3" Schedule 40 PVC Pipe	Crestine	JN
6	10	FT		3/4 " Copper Pipe		
7	1	EA	31410	1" Schedule 40 PVC Tee	Genova	
8	1	EA	4801	3" x 1 1/2" PVC Reducer	NIBCO	
9	1	EA	4835	3" x 1 1/2 " PVC Cross	NIBCO	
10	1	EA		Screw,PH,CRES,8-32 x 2.00"	McMaster-Carr	
11	4	EA	2466	1 " x 1/2 " PVC Reducer Coupling	NIBCO	
12	3	EA	32050	1 1/2" x 1" PVC reducer	Genova	
13	4	EA		3/4 " Copper 90 deg elbow joints		
14	2	EA		3/4 " Copper caps		
15	2	EA		Screw,pan head, CRES, 6-32 x 0.625"		
16	6	EA		Washer,Lock,internal tooth, #6		
17	2	EA		Nut,hex,6-32		
18	2	EA	100	Plug,banana,uninsulated	HH Smith	
19	2	EA		Screw,pan head,CRES, 8-32 x 2.5"		
20	2	EA		Washer,Lock,internal tooth,#8		
21	3	EA	BTE-839	Eye Bolts,turned, 2" length, 3/4" diam	SPC Tech	
22	3	EA		Nut, hex, 3/4"		
23	3	EA		Nut,hex,8-32		
24	2	EA	4336	universal brackets	Keystone	
25	2	EA	MS 51957-32	Screw, pan head,CRES, 6-32 x 0.75"		
26	4	EA	MS 15795-841	Washer,flat, #8		
27	2	EA		Screw, panhead,CRES, 6-32 x 0.5"		
28	2	EA		Washer,flat, #6		
29	2	EA	MS 35338-136	Washer,spring lock		
30	1	EA		silicone sealant		
31	2.5	IN		3" Schedule 40 PVC Pipe		

NOTES:

1. ALL INDUCTORS SPECIFIED ARE WOUND ON POWDERED IRON TOROID CORES
2. CORE MANUFACTURER IS MICROMETALS INC., ANAHEIM, CA.
3. WIND CORE AS SHOWN BEING CAREFUL TO DISTRIBUTE THE WINDINGS AS SPECIFIED.
4. TERMINAL LEADS SHOULD BE DRESSED TO CONFORM TO PCB FOOTPRINT DIMENSIONS.
5. WIRE IS TO BE STRIPPED OF ENAMEL WITHIN 0.1 INCH OF CORE BODY.
6. MEASURE INDUCTANCE AND Q OF COMPLETED COIL USING BOONTON 260 Q METER BEFORE POTTING. REFER TO Q METER MANUAL FOR MAKING INDUCTANCE MEASUREMENTS OF LESS THAN 0.2 UH.
7. IF INDUCTANCE VALUE IS WITHIN ±5%, TIN THE BARE COPPER, AND COAT THE COMPLETED INDUCTOR WITH 5:4 RATIO OF EPON 1815 AND VERSAMID 140.



DASH NO.	CORE PART NO.	NO. OF TURNS	WIRE AWG	CORE COVERAGE %	IND. uH	Q MIN	DIMENSIONS (INCHES)							
							A	B	C	D	E	F	G	H
-1	T25-10	11	26	100	0.28	105	0.26	0.12	0.10	0.15	0.3	0.10	0.10	0.028
-2	T25-10	14	26	100	0.42	120	0.26	0.12	0.10	0.15	0.3	0.10	0.10	0.028
-3	T25-10	16	26	100	0.53	125	0.26	0.12	0.10	0.15	0.3	0.10	0.10	0.028
-4	T30-2	15	26	100	1.0	110	0.32	0.15	0.13	0.15	0.35	0.10	0.15	0.028
-5	T44-2	25	26	100	3.3	125	0.44	0.23	0.17	0.20	0.45	0.10	0.15	0.028
-6	T30-17	6	20	100	0.10	150	0.38	0.21	0.13	0.28	0.45	0.00	0.25	0.038
-7	T30-17	8	22	100	0.158	130	0.38	0.21	0.13	0.28	0.41	0.00	0.25	0.032
-8	T30-17	9	22	100	0.18	130	0.38	0.21	0.13	0.28	0.41	0.00	0.25	0.032
-9	T30-17	15	24	100	0.50	150	0.38	0.21	0.13	0.28	0.40	0.00	0.25	0.028
-10														
-11														
-12														



PCB FOOTPRINT

Space Physics Research Laboratory
College of Engineering
University of Michigan

INDUCTOR ASSEMBLY

N000149510249

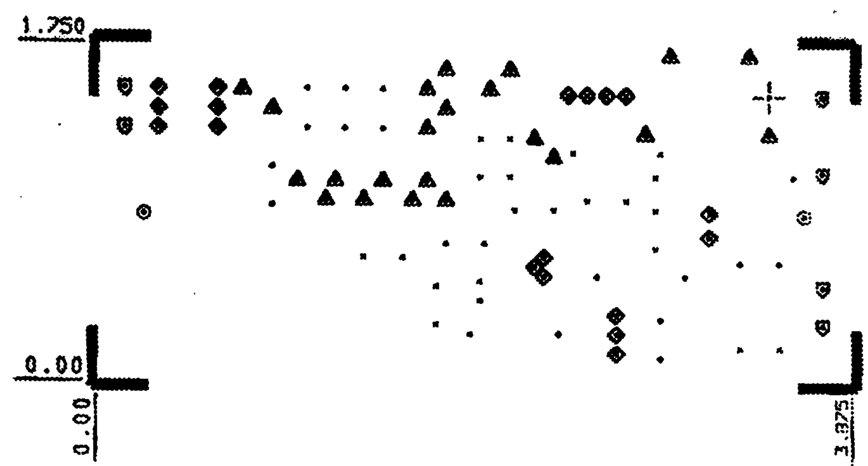
062- 0027

1 OF 1

RELEASE

DRAWN 02-21-97 NS

COG ENG P. HA...EN

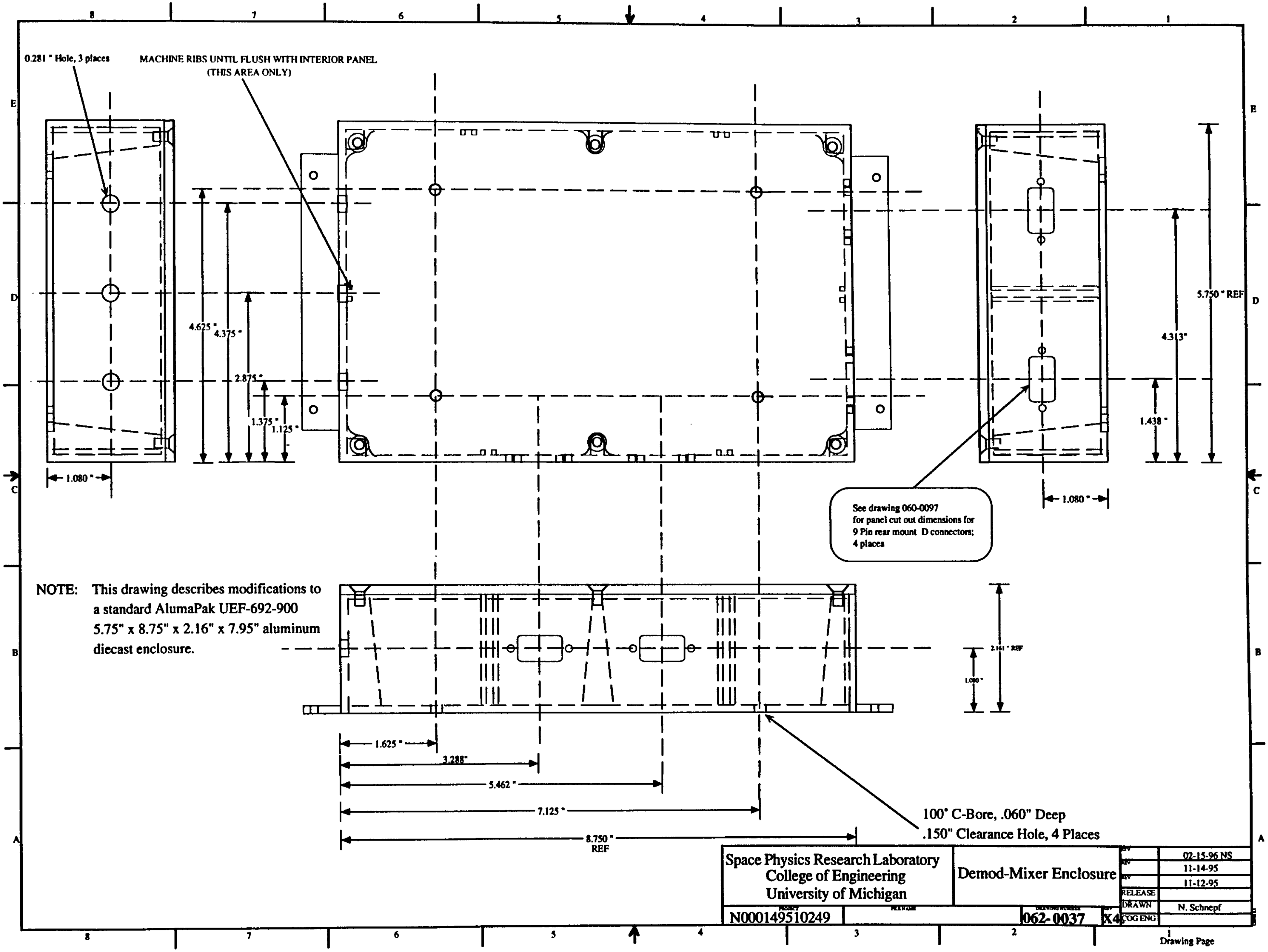


UOFM SPRL 062-0034

HRG 1903
DRILL

DRILL TABLE			
Symbol	Size	Plated	Qty
▲	.028	P	22
◆	.032	P	18
•	.038	P	40
◎	.075	P	6
⊙	.128	U	2
-¦-	.160	U	1

Space Physics Research Laboratory College of Engineering University of Michigan	Preamp Raw Card	
N000149510249	Preamp Raw Card	062- 0034



NOTE: This drawing describes modifications to a standard AlumaPak UEF-692-900 5.75" x 8.75" x 2.16" x 7.95" aluminum diecast enclosure.

Parts List
Preamp Enclosure
Next Assy: 062-0018
Project: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:062-0038
Rev: X2

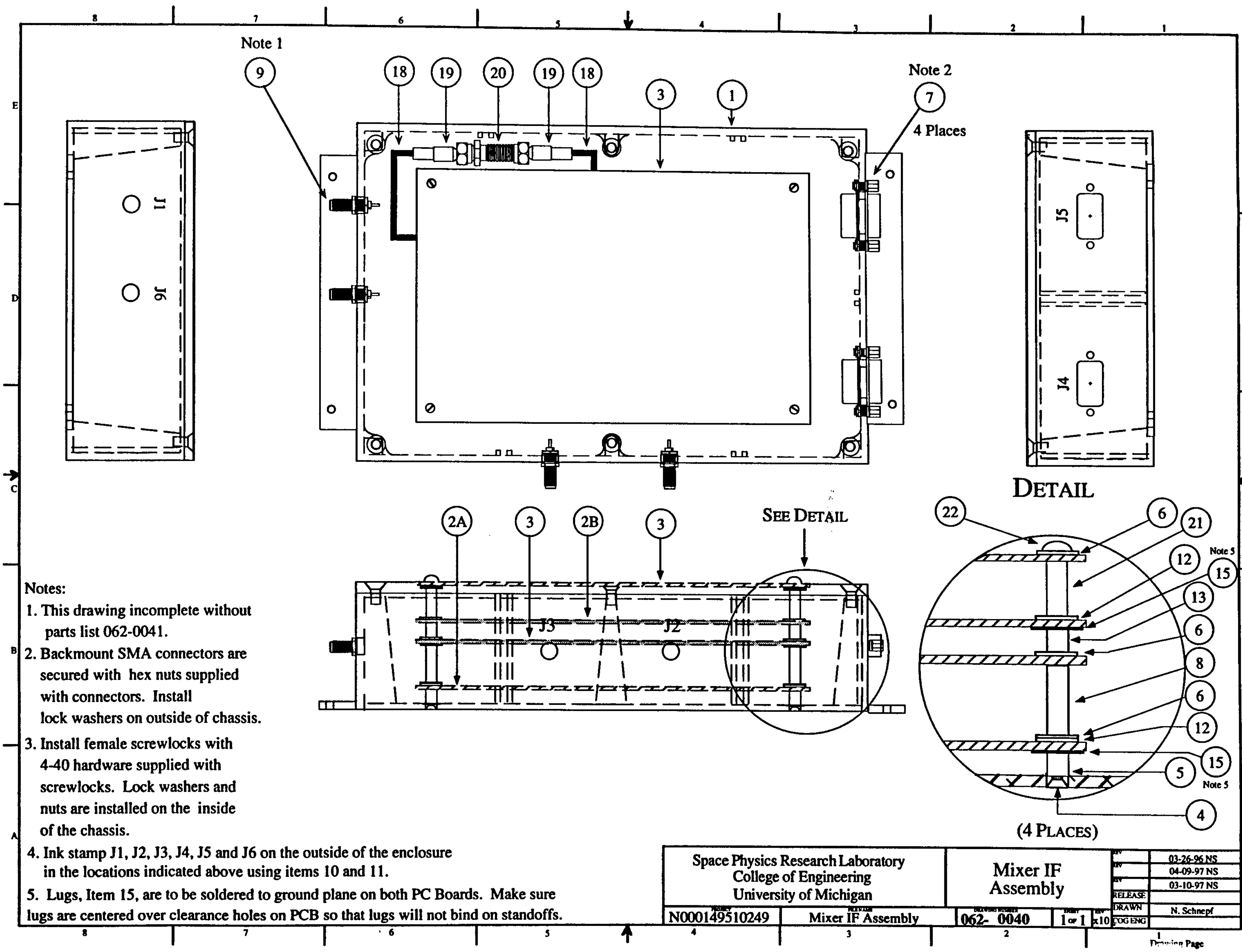
Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	1	EA	CU-2102-B	4" x 2 1/8" x 1 5/8" Minibox	BUD	

Parts List
Preamp Assembly
Next Assy:062-0025
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:062-0039
Rev:X7

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	2	EA	1499-103	Jack,Std,Ins,"D"	HH Smith	
2	3	EA	31-221	Connector,BNC,Front Mtg.	Amphenol	
3	2	EA	8250	Standoff,6-32x0.5	HH Smith	
4	2	EA	RP4-250	Spacer,round,nylon,#4x0.25	SPC	
5	2	EA	31-10152	Lug,Ground	Amphenol	
6	4	EA		Washer,Lock,#4,Int		
7	2	EA		Screw,PH,4-40x0.625		
8	1	EA	062-0020	Preamp PCB Assembly	SPRL	
9	1	EA	062-0019	Preamp Enclosure	SPRL	
10	2	EA		Nut,Hex,4-40		
11	2	EA		Washer,Flat,#4		
12	2	EA		Nut,Hex,6-32		
13	2	EA		Washer, Lock,#6		
14	AR	FT		24 AWG solid bus wire and sleeving		
15	AR	OZ	2850FT	Epoxy,Black	Stycast	
16	AR	OZ	11	Catalyst		
17	2	EA		Washer, flat, #6		



Notes:

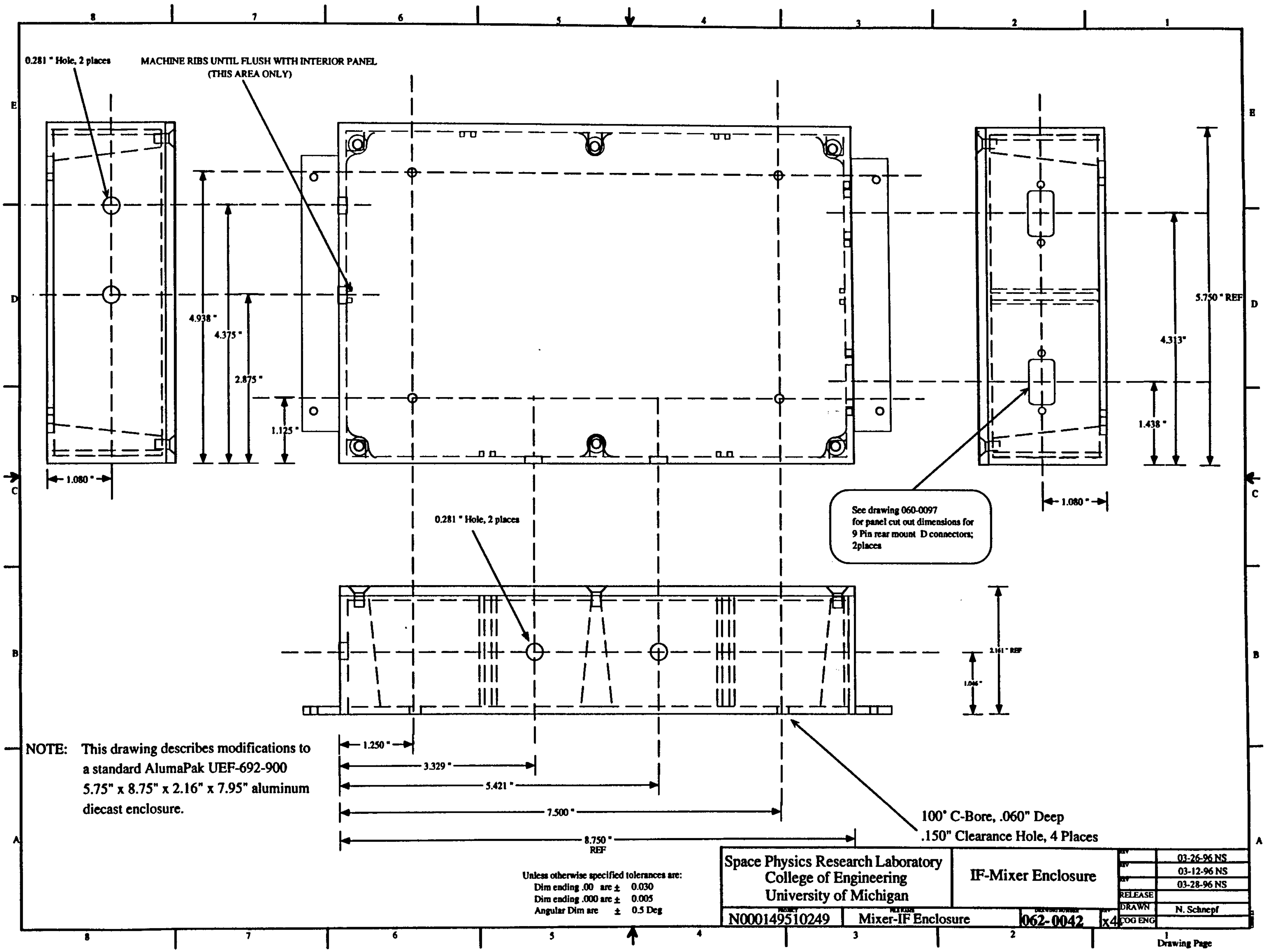
1. This drawing incomplete without parts list 062-0041.
2. Backmount SMA connectors are secured with hex nuts supplied with connectors. Install lock washers on outside of chassis.
3. Install female screwlocks with 4-40 hardware supplied with screwlocks. Lock washers and nuts are installed on the inside of the chassis.
4. Ink stamp J1, J2, J3, J4, J5 and J6 on the outside of the enclosure in the locations indicated above using items 10 and 11.
5. Lugs, Item 15, are to be soldered to ground plane on both PC Boards. Make sure lugs are centered over clearance holes on PCB so that lugs will not bind on standoffs.

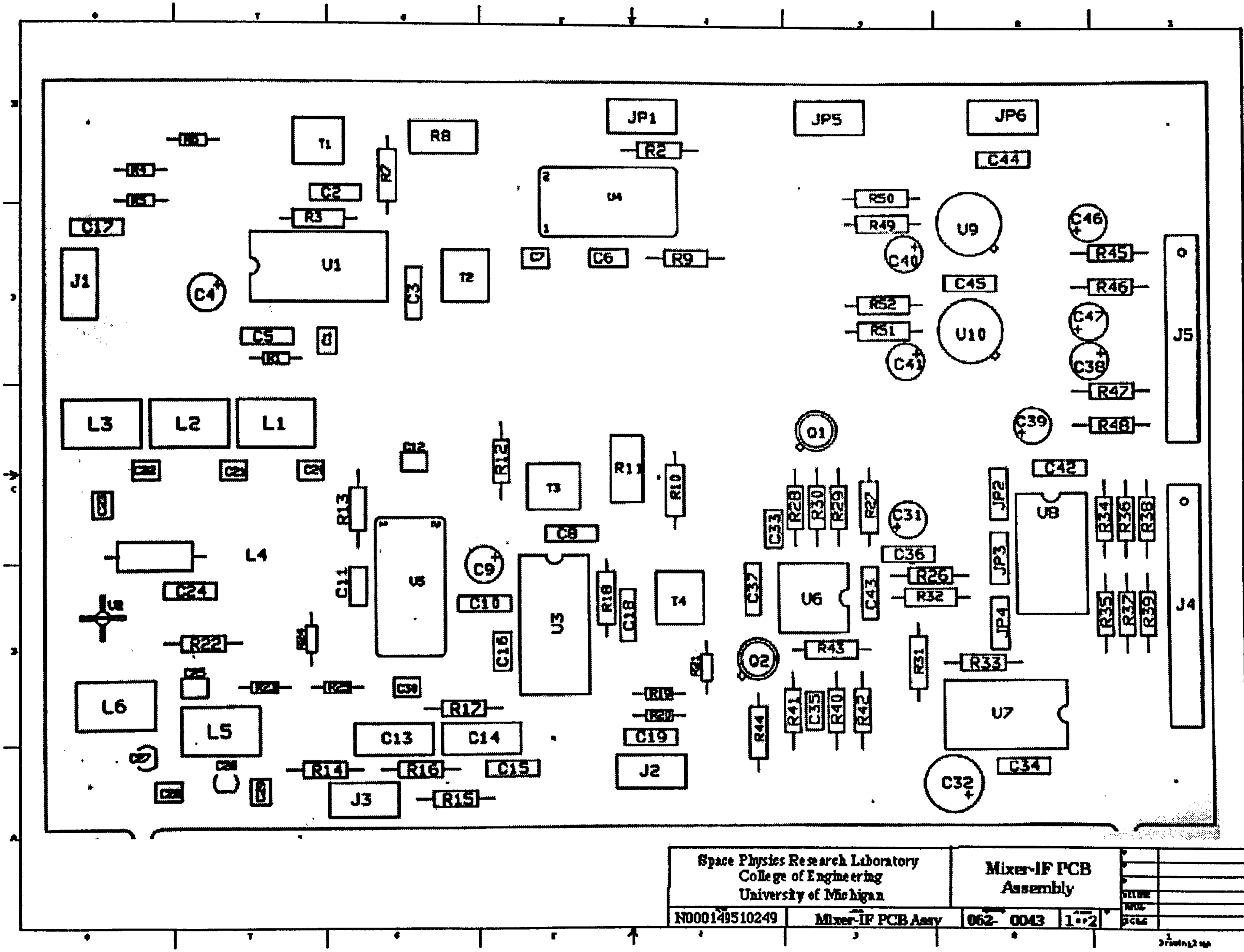
Parts List
Mixer-IFAssy
Next Assy:062-0040
Program:HF Radar
Contract No:N000149510249

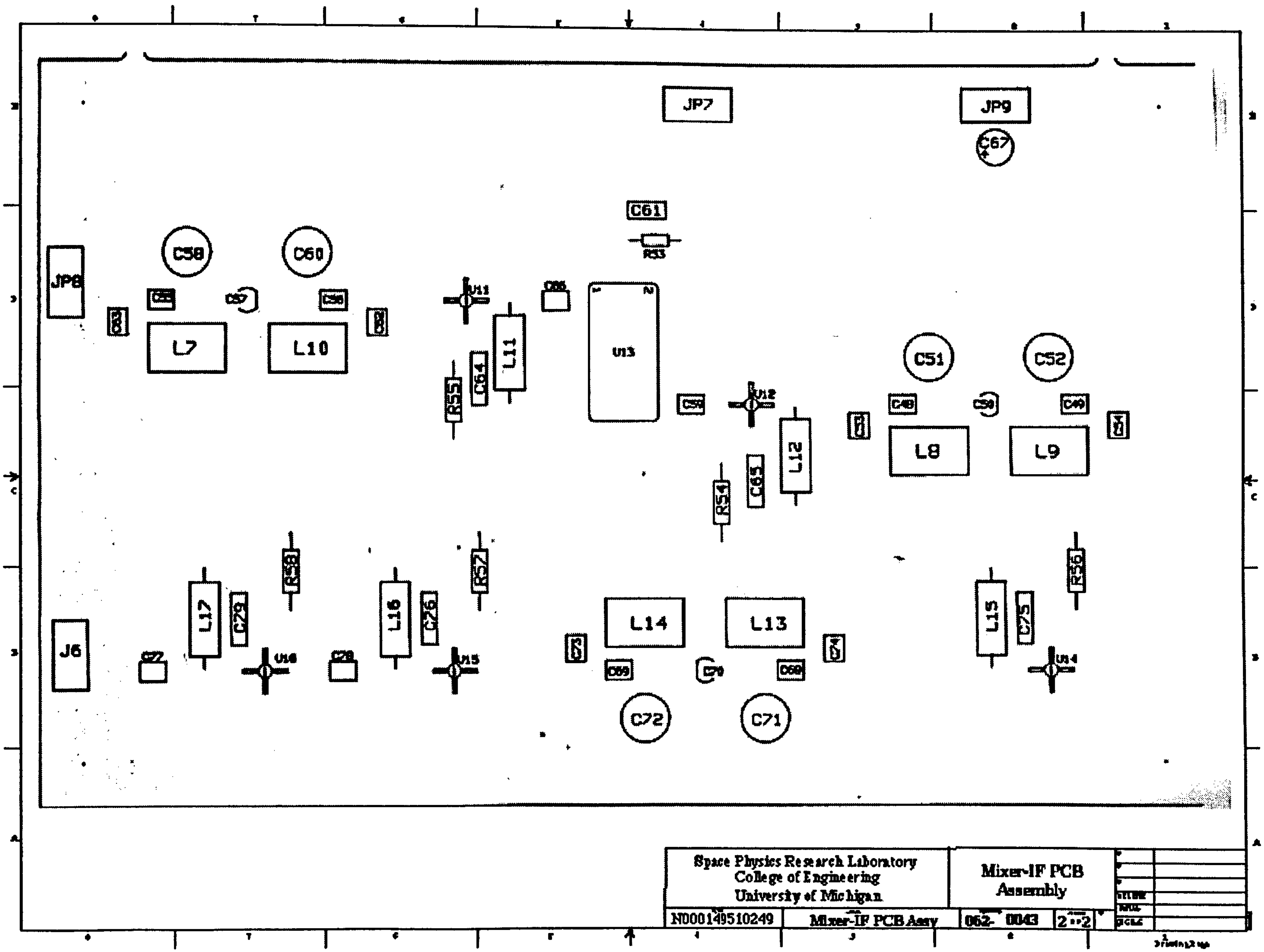
UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LAB

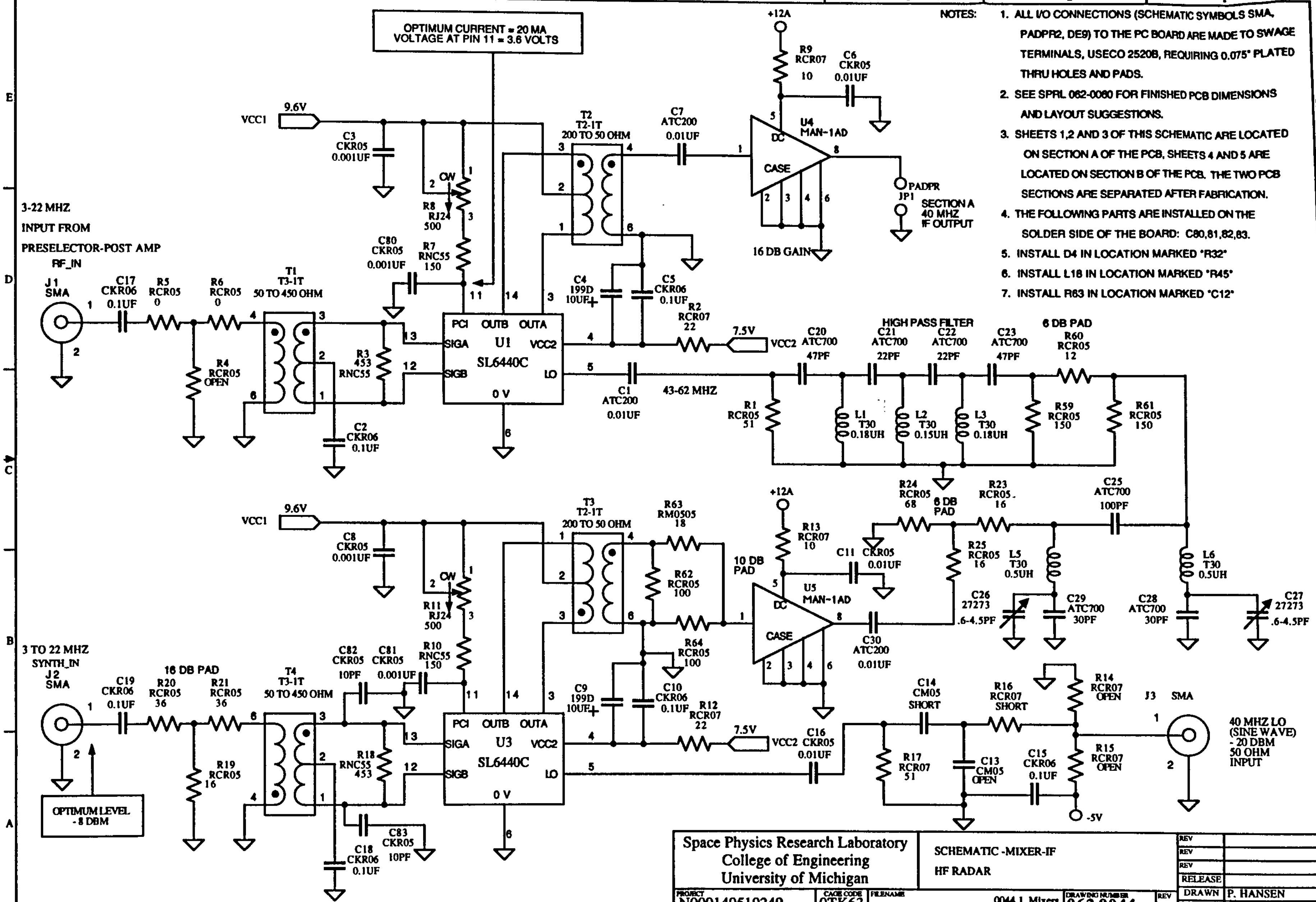
FSCM: 0TK63
Drawing No.:062-0041
Revision:X8

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	1	EA	062-0042	Mixer-IF Enclosure	SPRL	
2	1	EA	062-0043	Mixer-IF PCB Assembly	SPRL	
3	2	EA	062-0076	Shield Plate	SPRL	
4	4	EA	MS24693-C29	Screw,CRES,Flat,100deg,6-32x0.625		
5	4	EA	8501	Spacer,Rnd,Thru,Al,#6 x 0.25	HH Smith	
6	8	EA		Washer, lock, #6		
7	2	EA	3341-1S	Jack screw,Short, 4-40x0.13,Kit of 2	3M	
8	4	EA	8250	Standoff,Hex,thrd,male-fem,6-32 x 0.500	HH Smith	
9	4	EA	874-10-3	SMA,rearmount,blkhd receptacle	Kings	
10	AR	OZ	2850FT	Epoxy,Black	Stycast	
11	AR	OZ	11	Catalyst		
12	8	EA	MS15795-806	Washer,Flat,Stainless, #6 x 0.375 OD		
13	4	EA	8248	Stndoff,Hex,thrd, male-fem,6-32 x .25	HH Smith	
14						
15	8	EA	50	Lug,Plain,#6 x 3/8	Zierek	
16	1	REF	062-0040	Mixer-IF Assembly		
17	1	REF	062-0084	Build Instructions, Mixer I/F		
18	AR	FT	RG316/U	Cable, coax, 50Ω		
19	2	EA	901-9511-3	Connector,SMA,straight,crimp-on	Amphenol	
20	1	EA	901-9209-A	Adapter,SMA,jack-jack,gold plated	Amphenol	
21	4	EA	8423	Spacer,Hex,aluminum,6-32 x 0.5"	HH Smith	
22	4	EA		Screw,panhead, 6-32 x 0.25"		


0.281 " Hole, 2 places
MACHINE RIBS UNTIL FLUSH WITH INTERIOR PANEL (THIS AREA ONLY)
4.938 "
4.375 "
2.875 "
1.125 "
1.080 "
5.750 " REF
4.313"
1.438 "
1.080 "
See drawing 060-0097 for panel cut out dimensions for 9 Pin rear mount D connectors; 2places
0.281 " Hole, 2 places
2.161 " REF
1.046"
1.250 "
3.329 "
5.421 "
7.500 "
8.750 " REF
100° C-Bore, .060" Deep
.150" Clearance Hole, 4 Places
NOTE: This drawing describes modifications to a standard AlumaPak UEF-692-900 5.75" x 8.75" x 2.16" x 7.95" aluminum diecast enclosure.
Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg
Space Physics Research Laboratory
College of Engineering
University of Michigan
IF-Mixer Enclosure
N000149510249
Mixer-IF Enclosure
062-0042
x4
03-26-96 NS
03-12-96 NS
03-28-96 NS
RELEASE
DRAWN
N. Schnepf
COG ENG
1
Drawing Page


JP1
JP5
JP6
T1
R8
R7
C2
R3
C17
J1
U1
C4
T2
C3
U4
C7
C6
R9
R2
C44
R50
R49
C40
U9
C45
R52
R51
C41
U10
C46
R45
R46
C47
C38
R47
R48
J5
C39
C5
L3
L2
L1
C12
R12
T3
R11
R10
Q1
R28
R30
R29
R27
C31
C33
C42
JP2
U8
R34
R36
R38
L4
R13
U5
C11
C9
C8
C10
U3
R18
C18
T4
C37
U6
C43
C36
R26
R32
JP3
JP4
R35
R37
R39
J4
C24
R22
C16
Q2
R43
R31
R33
L6
L5
R17
C13
C14
C15
R19
R20
C19
R44
R41
C35
R40
R42
U7
R14
R16
J3
R15
J2
C34
C32
Space Physics Research Laboratory
College of Engineering
University of Michigan
Mixer-IF PCB
Assembly
N000149510249
Mixer-IF PCB Assy
062- 0043
1 of 2


JP7
JP9
C67
C61
R53
JP8
C58
C60
L7
L10
U11
L11
C64
R55
U13
U12
C59
L12
C65
R54
C51
C52
C48
C49
L8
L9
J6
L17
C29
R58
U16
L16
C26
R57
U15
L14
L13
C72
C71
L15
C75
R56
U14
Space Physics Research Laboratory
College of Engineering
University of Michigan
Mixer-IF PCB
Assembly
N000149510249
Mixer-IF PCB Assy
062- 0043

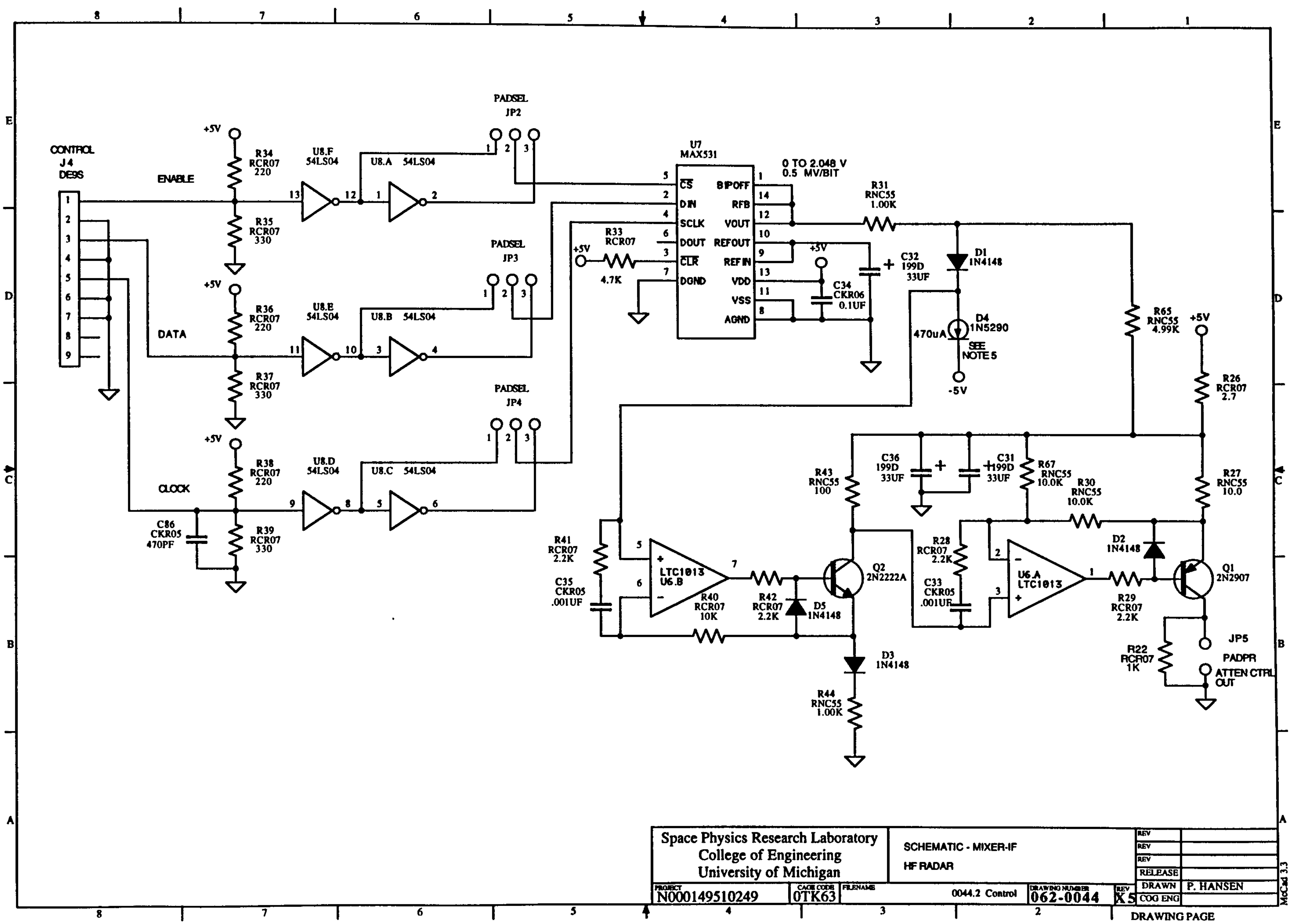


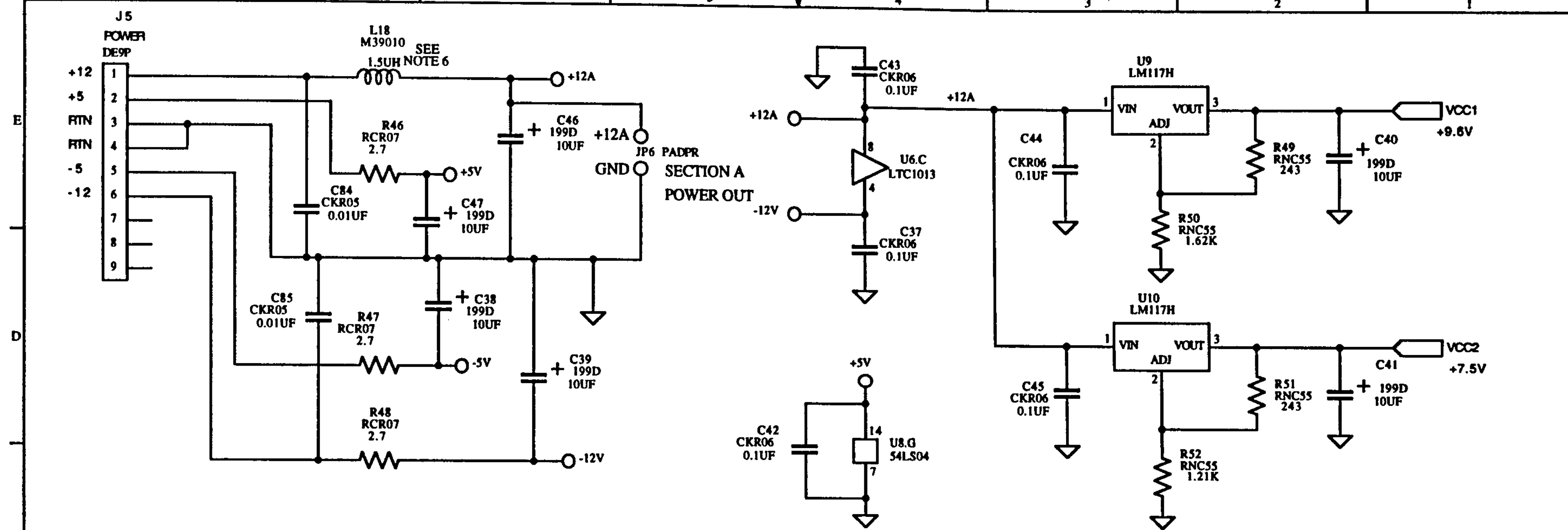
NOTES:

1. ALL I/O CONNECTIONS (SCHEMATIC SYMBOLS SMA, PADPR2, DE9) TO THE PC BOARD ARE MADE TO SWAGE TERMINALS, USECO 2520B, REQUIRING 0.075" PLATED THRU HOLES AND PADS.
2. SEE SPRL 062-0060 FOR FINISHED PCB DIMENSIONS AND LAYOUT SUGGESTIONS.
3. SHEETS 1,2 AND 3 OF THIS SCHEMATIC ARE LOCATED ON SECTION A OF THE PCB, SHEETS 4 AND 5 ARE LOCATED ON SECTION B OF THE PCB. THE TWO PCB SECTIONS ARE SEPARATED AFTER FABRICATION.
4. THE FOLLOWING PARTS ARE INSTALLED ON THE SOLDER SIDE OF THE BOARD: C80,81,82,83.
5. INSTALL D4 IN LOCATION MARKED "R32"
6. INSTALL L18 IN LOCATION MARKED "R45"
7. INSTALL R63 IN LOCATION MARKED "C12"

Space Physics Research Laboratory College of Engineering University of Michigan	SCHEMATIC -MIXER-IF HF RADAR	DRAWN: P. HANSEN
PROJECT: N000149510249	CAGE CODE: 0TK63	FILENAME: 0044.1 Mixers
DRAWING NUMBER: 062-0044	REV: X 5	DRAWING PAGE

McCad 3.3


CONTROL
J4
DE9S
ENABLE
DATA
CLOCK
+5V
R34 RCR07 220
R35 RCR07 330
R36 RCR07 220
R37 RCR07 330
R38 RCR07 220
R39 RCR07 330
C86 CKR05 470PF
U8.F 54LS04
U8.A 54LS04
U8.E 54LS04
U8.B 54LS04
U8.D 54LS04
U8.C 54LS04
PADSEL JP2
PADSEL JP3
PADSEL JP4
U7 MAX531
CS DIN SCLK DOUT CLR DGND
BIPOFF RFB VOUT REFOUT REFIN VDD VSS AGND
0 TO 2.048 V
0.5 MV/BIT
R33 RCR07 4.7K
R31 RNC55 1.00K
C32 199D 33UF
C34 CKR06 0.1UF
D1 1N4148
D4 1N5290
470uA
SEE NOTE 5
-5V
R65 RNC55 4.99K
R26 RCR07 2.7
R27 RNC55 10.0
C36 199D 33UF
C31 199D 33UF
R67 RNC55 10.0K
R30 RNC55 10.0K
R43 RNC55 100
R41 RCR07 2.2K
C35 CKR05 .001UF
LTC1013 U6.B
R40 RCR07 10K
R42 RCR07 2.2K
D5 1N4148
Q2 2N2222A
D3 1N4148
R44 RNC55 1.00K
R28 RCR07 2.2K
C33 CKR05 .001UF
U6.A LTC1013
R29 RCR07 2.2K
D2 1N4148
Q1 2N2907
R22 RCR07 1K
JP5
PADPR
ATTEN CTRL OUT
Space Physics Research Laboratory
College of Engineering
University of Michigan
SCHEMATIC - MIXER-IF
HF RADAR
PROJECT N000149510249
CAGE CODE 0TK63
FILENAME 0044.2 Control
DRAWING NUMBER 062-0044
REV X5
REV
REV
REV
RELEASE
DRAWN P. HANSEN
COG ENG
DRAWING PAGE
McCad 3.3



Space Physics Research Laboratory
College of Engineering
University of Michigan

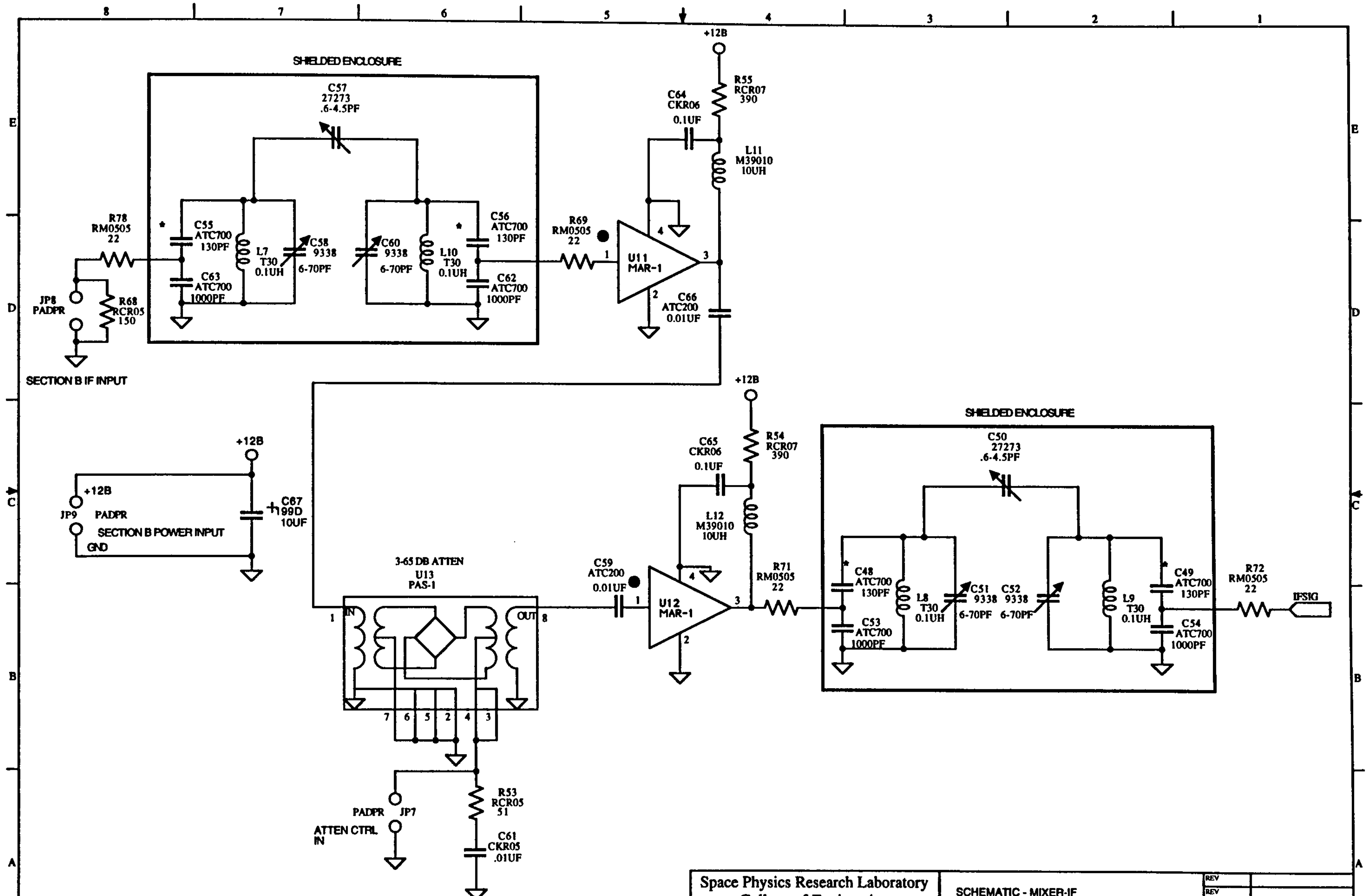
SCHEMATIC - MIXER-IF
HF RADAR

PROJECT	CAGE CODE	FILENAME	DRAWING NUMBER	REV
N000149510249	0TK63	0044.3 Power	062-0044	X5

REV	
REV	
REV	
RELEASE	
DRAWN	P. HANSEN
COG ENG	

DRAWING PAGE

McCad 3.3

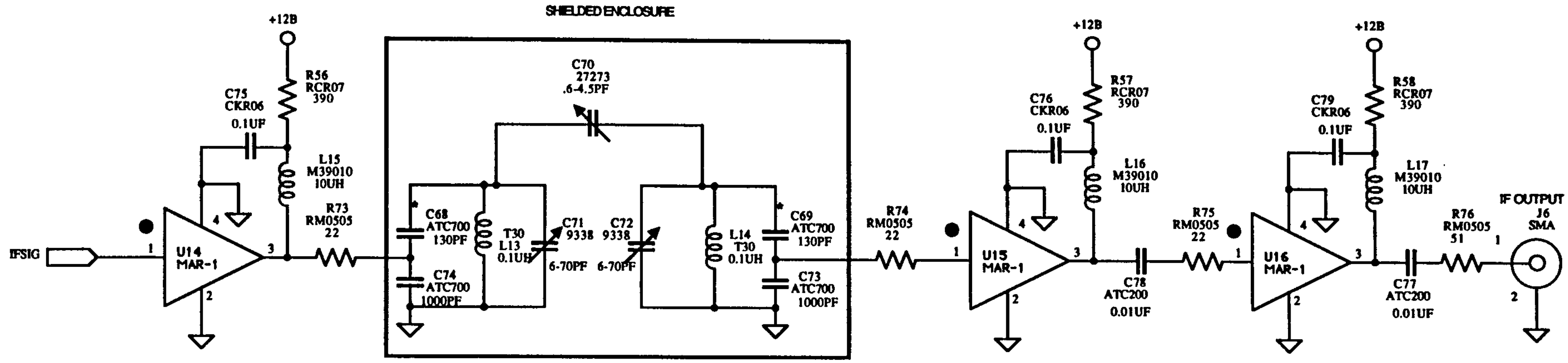


* ADDITIONAL 30 PF ATC 700 CAPACITOR IN PARALLEL WITH THIS 130 PF CAPACITOR MAY BE SELECTED AT TEST TO RESONATE THE INDUCTOR

Space Physics Research Laboratory College of Engineering University of Michigan	SCHEMATIC - MIXER-IF HF RADAR	REV REV REV RELEASE DRAWN P. HANSEN COG ENG
PROJECT N000149510249	CAGE CODE 0TK63 / FILENAME 0044.4 IFI	DRAWING NUMBER 062-0044 / REV X5

DRAWING PAGE

McCad 3.3



* ADDITIONAL 30 PF ATC 700 CAPACITOR IN PARALLEL WITH THIS 130 PF CAPACITOR MAY BE SELECTED AT TEST TO RESONATE THE INDUCTOR

Space Physics Research Laboratory College of Engineering University of Michigan	SCHEMATIC - MIXER-IF HF RADAR		REV	
			REV	
			REV	
			RELEASE	
PROJECT N000149510249	CAGE CODE 0TK63	FILENAME 0044.5 IF2	DRAWN	P. HANSEN
DRAWING NUMBER 062-0044	REV X5		COG ENG	

DRAWING PAGE

McCad 3.3

Parts List
Mixer I/F PCB
Program: HF Radar
Contract No:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
1	7	EA	ATC200B103MNMS50	Cap,Cer,0.01uF,50V,20%	AmTechCer	C1,7,30,59,66,77,78
2	18	EA	M39014/02-1350	Cap,Cer,0.1uF,100V,10%		C2,5,10,15,17,18,19,34,37,42,43,44,45,64,65,75,76,79
2.1	6	EA	M39014/01-1357	Cap,Cer,0.001uF,200V,10%		C3,8,33,35,80,81
3	9	EA	199D106X0025CA1	Cap,Tan,10uF,30V,20%	Sprague	C4,9,38,39,40,41,46,47,67
4	6	EA	M39014/01-1575	Cap,Cer,0.01uF,100V,10%		C6,11,16,61,84,85
6	2	EA	ATC700B470JNMS500	Cap,Cer,47pF,500V,5%	AmTechCer	C20,23
7	2	EA	ATC700B220JNMS500	Cap,Cer,22pF,500V,5%	AmTechCer	C21,22
8	1	EA	ATC700B101KMS500	Cap,Cer,100pF,500V,10%	AmTechCer	C25
9	5	EA	27273	Cap,Var,.6-4.5pF,500V	Johanson	C26,27,50,57,70
10	2	EA	ATC700B300JNMS500	Cap,Cer,30pF,500V,5%	AmTechCer	C28,29
11	2	EA	199D336X0025EE2	Cap,Tan,33uF,30V,20%	Sprague	C32,36
12	6	EA	ATC700B131KNMS300	Cap,Cer,130pF,300V,10%	AmTechCer	C48,49,55,56,68,69
13	6	EA	9338	Cap,Var,6-70pF,250V	Johanson	C51,52,58,60,71,72
14	6	EA	ATC700B102MNMS50	Cap,Cer,1000pF,50V,20%	AmTechCer	C53,54,62,63,73,74
14.1	2	EA	M39014/01-1321	Cap,Cer,10pF,200V,10%		C82,83
14.2	1	EA	M39014/01-1352	Cap,Cer,470pF,200V,20%		C86
14.3	4	EA	1N4148	Diode,Silicon		D1,2,3,5
14.4	1	EA	1N5290	Diode,Current,470uA		D4
15	4	EA	874-10-3	Connector,SMA,Jack,Rear Mtg	Kings	J1,2,3,6
16	1	EA	205555-2	Connector,DE9-S	Amp	J4
17	1	EA	205556-2	Connector,DE9-P	Amp	J5
18	4	EA	205817-2	Screw Lock,Female	Amp	
19	29	EA	2520B	Terminal,Non-Insulated	Useco	JP1,5,6,7,8,9 & SMAs & Ds
20	3	EA	69190-403	Jumper Strip	Berg	JP2,3,4
21	2	EA	062-0027-8	Ind,Toroid,0.18uH	SPRL	L1,3
22	1	EA	062-0027-7	Ind,Toroid,0.15uH	SPRL	L2
23	5	EA	M39010/02A100KP	Ind,Iron,10uH,10%		L11,12,15,16,17
24	2	EA	062-0027-9	Ind,Toroid,0.5uH	SPRL	L5,6
25	6	EA	062-0027-6	Ind,Toroid,0.1uH	SPRL	L7,8,9,10,13,14

Parts List
Mixer I/F PCB
Program: HF Radar
Contract No:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

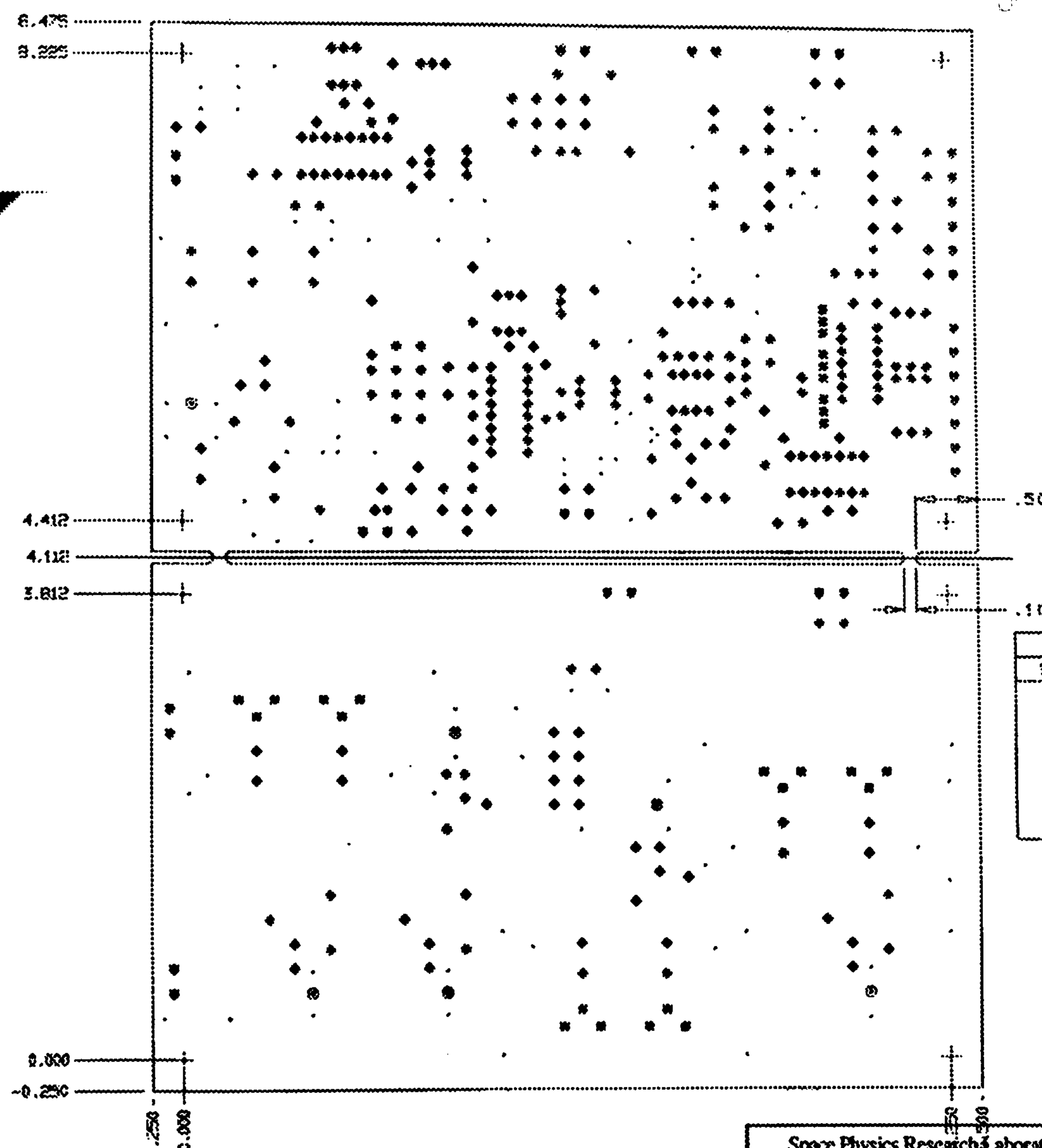
FSCM No.: 0TK63
Drawing No.:062-0045
Revision: X8

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
25.1	1	EA	IM-2-1.5uH	Ind,Iron,1.5uH	Dale	L18
26	1	EA	2N2907A	Transistor,PNP	Motorola	Q1
27	1	EA	2N2222A	Transistor,NPN	Motorola	Q2
28	2	EA	RCR05G510JS	Res,CC,51,.125W,5%		R1,53
29	2	EA	RCR07G220JS	Res,CC,22,.25W,5%		R2, R12
30	2	EA	RNC55J4530FS	Res,MF,453,.125W,1%		R3,18
31	1	EA	RCR05GxxxJS	Res,CC,xx,.125W,5% (SAT - Open)		R4
32	2	EA	RCR05GxxxJS	Res,CC,xx,.125W,5% (SAT - Short)		R5,6
33	2	EA	RNC55J1500FS	Res,MF,150,.125W,1%		R7,10
34	2	EA	RJR24CW501M	Res,Var,500,.5W		R8,11
35	2	EA	RCR07G100JS	Res,CC,10,.25W,5%		R9,13
36	2	EA	RCR07GxxxJS	Res,CC,xxx,.25W,5% (SAT-Open)		R14,15
37	1	EA	RCR07GxxxJS	Res,CC,xxx,.25W,5% (SAT-Short)		R16
38	1	EA	RCR07G510JS	Res,CC,51,.25W,5%		R17
39	3	EA	RCR05G160JS	Res,CC,16,.125W,5%		R19,23,25
39.1	2	EA	RCR05G360JS	Res,CC,36,.125W,5%		R20,21
39.2	1	EA	RCR05G680JS	Res,CC,68,.125W,5%		R24
40	5	EA	RCR07G391JS	Res,CC,390,.25W,5%		R54,55,56,57,58
41	3	EA	RNC55J10R0FS	Res,MF,10.0,.125W,1%		R27,30,67
42	4	EA	RCR07G222JS	Res,CC,2.2K,.25W,5%		R28,29,41,42
43	1	EA	RCR07G103JS	Res,CC,10K,.25W,5%		R40
44	1	EA	RNC55J4991FS	Res,MF,4.99K,.125W,1%		R65
45	1	EA	RCR07G472JS	Res,CC,4.7K,.25W,5%		R33
46	3	EA	RCR07G221JS	Res,CC,220,.25W,5%		R34,36,38
47	3	EA	RCR07G331JS	Res,CC,330,.25W,5%		R35,37,39
48	1	EA	RNC55J1000FS	Res,MF,100,.125W,1%		R43
49	2	EA	RNC55J1001FS	Res,MF,1.00K,.125W,1%		R31,44
50	4	EA	RCR07G2R7JS	Res,CC,2.7,.25W,5%		R26,46,47,48
51	2	EA	RNC55J2430FS	Res,MF,243,.125W,1%		R49,51
52	1	EA	RNC55J1621FS	Res,MF,1.62K,.125W,1%		R50
53	1	EA	RNC55J1211FS	Res,MF,1.21K,.125W,1%		R52

Parts List
Mixer I/F PCB
Program: HF Radar
Contract No:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
53.01	1	EA	RCR07G102JS	Res,CC,1K,.25W,5%		R22
53.02	1	EA	RCR05G151JS	Res,CC,12,.125W,5%		R60
53.03	2	EA	RCR05G101JS	Res,CC,100,.125W,5%		R62,64
53.04	1	EA	M55342M02B18J0M	Res,MF,Chip,18,.05W,5%		R63
53.05						
53.06						
53.07						
53.08	3	EA	RCR05G151JS	Res,CC,150,.125W,5%		R,59,61,68
53.09	7	EA	M55342M02B22J0M	Res,MF,Chip,22,.05W,5%		R69,71,72,73,74,75,78
53.1	1	EA	M55342M02B51J0M	Res,MF,Chip,51,.05W,5%		R76
54	2	EA	T3-1T-X65	Transformer,3:1,CT Sec	Mini-Ckts	T1,4
55	2	EA	T2-1T-X65	Transformer,2:1,CT Sec	Mini-Ckts	T2,3
56	2	EA	SL6440C/DP	IC,RF Mixer	Plessey	U1,3
57	5	EA	MAR-1	Amp,Monolithic	Mini-Ckts	U11,12,14,15,16
58	2	EA	MAN-1AD	Amp,Hi Isolation	Mini-Ckts	U4,5
59	1	EA	LT1013CN8	IC,OpAmp,Dual	Linear Tech.	U6
60	1	EA	MAX531BEPD	IC,DAC,12Bit,DIP	Maxim	U7
61	1	EA	SN74LS04N	IC,HexInv	TI	U8
62	2	EA	LM317H	IC,Positive Regulator	National	U9,10
63	1	EA	PAS-1	Attenuator,Electronic	Mini-Ckts	U13
64	2	EA	ICD-16-2T	Socket,IC,16 Pin	Voltrex	
65	2	EA	ICD-14-2T	Socket,IC,14 Pin	Voltrex	
66	1	EA	ICD-8-2T	Socket,IC,8 Pin	Voltrex	
67	AR	FT		Wire,22GA,Stranded		
68						
69	AR	FT		Shrink Tubing		
70						
71	1	EA	062-0046	PCB,Raw Card,Mixer I/F	UM/SPRL	
72	1	REF	062-0044	Schematic,Mixer I/F	UM/SPRL	
73	3	EA	062-0086	Shield, RF,1" x 2" x 0.5"	UM/SPRL	
74	1	REF	062-0040	Mixer I/F PCB Assembly	UM/SPRL	



U-M SPRL 062-0046
HRG 2012

DRILL & TRIM

DRILL TABLE			
Symbol	Size	Plated	Qty
·	.028	P	94
◆	.038	P	322
■	.052	P	27
✱	.075	P	33
⊗	.100	U	6
+	.156	U	8

BOARD MATERIAL:
0.062" GFN-FR4 GLASS EPOXY
ONE OUNCE COPPER

SOLDER MASK BOTH SIDES
SILKSCREEN COMPONENT SIDE

Space Physics Research Laboratory College of Engineering University of Michigan	Mixer-IF Raw Card		
N000149510249	Mixer-IF Raw Card	062- 0046	1 = 1

Net List
Mixer-IF PCB
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

NET LIST 0044X3 Mixer-IF Tuesday, April 2, 1996 2:35 PM									
NET NAME	PINS								
+5V	C34-1	C42-2	C47-1	R26-1	R33-1	R34-1	R36-1		
	R38-1	R46-2	U7-13	U8-14					
+12A	C43-2	C44-1	C45-1	C46-1	JP6-2	R9-1	R13-1		
	R22-1	R45-2	U6-8	U9-1	U10-1				
+12B	C67-1	JP9-2	R54-1	R55-1	R56-1	R57-1	R58-1		
-5V	C15-2	C38-2	R15-2	R32-2	R47-2				
-12V	C37-1	C39-2	R48-2	U6-4					
ATT_CTRL	JP7-2	R53-1	U13-3	U13-4					
DA_OUT	R31-2	R32-1	R41-1	U6-5					
GND	C2-2	C3-2	C4-2	C5-1	C6-2	C8-2	C9-2	C10-1	
	C11-2	C13-2	C15-1	C18-2	C24-2	C26-2	C27-2		
	C28-2	C29-2	C31-2	C32-2	C34-2	C36-2	C37-2		
	C38-1	C39-1	C40-2	C41-2	C42-1	C43-1	C44-2		
	C45-2	C46-2	C47-2	C51-2	C52-2	C53-2	C54-2		
	C58-2	C60-2	C61-1	C62-2	C63-2	C64-1	C65-1		
	C67-2	C71-2	C72-2	C73-2	C74-2	C75-1	C76-1		
	C79-1	J1-2	J2-2	J3-2	J4-2	J4-4	J4-6	J4-7	
	J5-3	J5-4	J6-2	JP1-1	JP5-1	JP6-1	JP7-1	JP8-2	
	JP9-1	L1-1	L2-1	L3-1	L7-1	L8-1	L9-1	L10-1	
	L13-1	L14-1	R1-2	R4-2	R14-1	R17-2	R19-2		
	R24-1	R35-2	R37-2	R39-2	R44-1	R50-2	R52-2		
	T1-6	T2-6	T3-6	T4-4	U1-6	U2-2	U2-4	U3-6	U4-2
	U4-3	U4-4	U4-6	U5-2	U5-3	U5-4	U5-6	U7-7	U7-8
	U7-11	U8-7	U11-2	U11-4	U12-2	U12-4	U13-2		
	U13-5	U13-6	U13-7	U14-2	U14-4	U15-2	U15-4		
	U16-2	U16-4							

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SPACE PHYSICS RESEARCH LABORATORY

NET LIST 0044X3 Mixer-IF Tuesday, April 2, 1996 2:35 PM				
NET NAME	PINS			
IFINT	C49-2	C54-1	U14-1	
N:1	R7-1	R8-3		
N:2	R7-2	U1-11		
N:3	T2-3	U1-14		
N:4	T2-1	U1-3		
N:5	R3-2	T1-1	U1-12	
N:6	R3-1	T1-3	U1-13	
N:7	C2-1	T1-2		
N:8	R6-2	T1-4		
N:9	R4-1	R5-2	R6-1	
N:10	C4-1	C5-2	R2-1	U1-4
N:11	C24-1	L4-2	R22-2	
N:12	C6-1	R9-2	U4-5	
N:13	C7-1	T2-4		
N:14	C7-2	U4-1		
N:15	R10-1	R11-3		
N:16	R10-2	U3-11		
N:17	T3-1	U3-14		
N:18	T3-3	U3-3		
N:19	C9-1	C10-2	R12-1	U3-4
N:20	J3-1	R14-2	R15-1	R16-2
N:21	C11-1	R13-2	U5-5	
N:22	C12-1	T3-4		
N:23	C12-2	U5-1		
N:24	C13-1	C14-2	R16-1	
N:25	C14-1	C16-2	R17-1	
N:26	C16-1	U3-5		

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NET LIST 0044X3 Mixer-IF Tuesday, April 2, 1996 2:35 PM									
NET NAME	PINS								
N:27	R18-2	T4-1	U3-12						
N:28	R18-1	T4-3	U3-13						
N:29	C18-1	T4-2							
N:30	R21-2	T4-6							
N:31	R19-1	R20-2	R21-1						
N:32	C19-2	R20-1							
N:33	C17-2	R5-1							
N:34	C22-2	C23-1	L3-2						
N:35	C21-2	C22-1	L2-2						
N:36	C20-2	C21-1	L1-2						
N:37	C1-2	C20-1	R1-1						
N:38	C1-1	U1-5							
N:39	JP1-2	U4-8							
N:40	C23-2	L4-1	U2-3						
N:41	C25-1	L5-2	R23-2						
N:42	C25-2	L6-2	U2-1						
N:43	C27-1	C28-1	L6-1						
N:44	C26-1	C29-1	L5-1						
N:45	C30-1	U5-8							
N:46	R23-1	R24-2	R25-1						
N:47	C30-2	R25-2							
N:48	C31-1	C36-1	R26-2	R27-2	R43-2				
N:49	JP5-2	Q1-C							
N:50	C33-2	Q2-C	R43-1	U6-3					
N:51	C33-1	R28-2							
N:52	R28-1	R30-1	U6-2						
N:53	JP2-2	U7-5							

Net List
Mixer-IF PCB
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK73
Drawing No.: 062-0047
Revision: X2

NET LIST 0044X3 Mixer-IF Tuesday, April 2, 1996 2:35 PM										
NET NAME	PINS									
N:54	Q1-E	R27-1	R30-2							
N:55	JP3-2	U7-2								
N:56	JP4-2	U7-4								
N:57	R31-1	U7-1	U7-12	U7-14						
N:58	C32-1	U7-9	U7-10							
N:59	R29-1	U6-1								
N:60	Q1-B	R29-2								
N:61	Q2-E	R40-2	R44-2							
N:62	R42-1	U6-7								
N:63	Q2-B	R42-2								
N:64	C35-2	R40-1	U6-6							
N:65	C35-1	R41-2								
N:66	R33-2	U7-3								
N:67	JP2-3	U8-2								
N:68	JP3-3	U8-4								
N:69	JP4-3	U8-6								
N:70	J4-1	R34-2	R35-1	U8-13						
N:71	J4-3	R36-2	R37-1	U8-11						
N:72	J4-5	R38-2	R39-1	U8-9						
N:73	JP2-1	U8-1	U8-12							
N:74	JP3-1	U8-3	U8-10							
N:75	JP4-1	U8-5	U8-8							
N:76	J5-1	R45-1								
N:77	J5-2	R46-1								
N:78	J5-5	R47-1								
N:79	J5-6	R48-1								
N:80	R49-2	R50-1	U9-2							

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SPACE PHYSICS RESEARCH LABORATORY

NET LIST 0044X3 Mixer-IF Tuesday, April 2, 1996 2:35 PM									
NET NAME	PINS								
N:81	R51-2	R52-1	U10-2						
N:82	C66-2	U13-1							
N:83	C59-1	U13-8							
N:84	C59-2	U12-1							
N:85	C55-2	C63-1	JP8-1						
N:86	C55-1	C57-1	C58-1	L7-2					
N:87	C56-1	C57-2	C60-1	L10-2					
N:88	C56-2	C62-1	U11-1						
N:89	C64-2	L11-2	R55-2						
N:90	C66-1	L11-1	U11-3						
N:91	C65-2	L12-2	R54-2						
N:92	C48-2	C53-1	L12-1	U12-3					
N:93	C48-1	C50-1	C51-1	L8-2					
N:94	C49-1	C50-2	C52-1	L9-2					
N:96	C77-1	J6-1							
N:97	C79-2	L17-2	R58-2						
N:98	C77-2	L17-1	U16-3						
N:99	C78-1	U16-1							
N:100	C68-2	C74-1	L15-1	U14-3					
N:101	C68-1	C70-1	C71-1	L13-2					
N:102	C69-1	C70-2	C72-1	L14-2					
N:103	C69-2	C73-1	U15-1						
N:104	C75-2	L15-2	R56-2						
N:105	C76-2	L16-2	R57-2						
N:106	C78-2	L16-1	U15-3						
RF_IN	C17-1	J1-1							
SYNTH_IN	C19-1	J2-1							

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

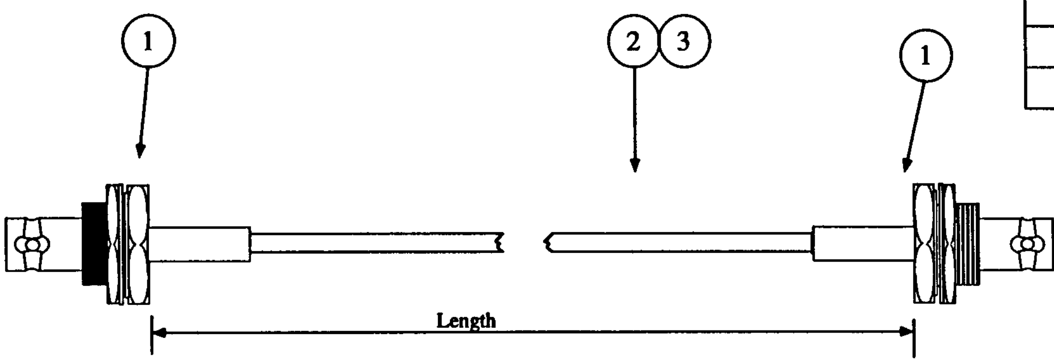
NET LIST 0044X3 Mixer-IF Tuesday, April 2, 1996 2:35 PM									
NET NAME	PINS								
TERM	C61-2	R53-2							
VCC1	C3-1	C8-1	C40-1	R8-1	R8-2	R11-1	R11-2	R49-1	
	T2-2	T3-2	U9-3						
VCC2	C41-1	R2-2	R12-2	R51-1	U10-3				

FABRICATION INSTRUCTIONS:

1. For the first time fabrication, assemble only one connector to one end of the cable. The unfinished cable will be placed in the chassis assembly, the cable routed, and then cut to length before installing the second connector.

2. BNC connectors are attached to cable using Amphenol 227-987 tool with 227-1418 die. Cable preparation is detailed on drawing 062-0059.

3. Mark cables as per guidelines contained in 062-0082 using item 3.



CABLE ASSEMBLIES

Dash No.	Desig-nation	Length	From	Pos	To	Pos
None	W1	3 Ft	Front Panel	J4	Rear Panel	J1

LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	2	31-318	BNC Crimp-On,Blkhd Jk	Amphenol	
2	AR	RG316/U	RG 316 - 50 Ω Coax		
3	2	MLCT 114C	Wire marking tags	SPC Technology	

Space Physics Research Laboratory
College of Engineering
University of Michigan

RF CABLE
(BNCf-BNCf)

N000149510249

062- 0049

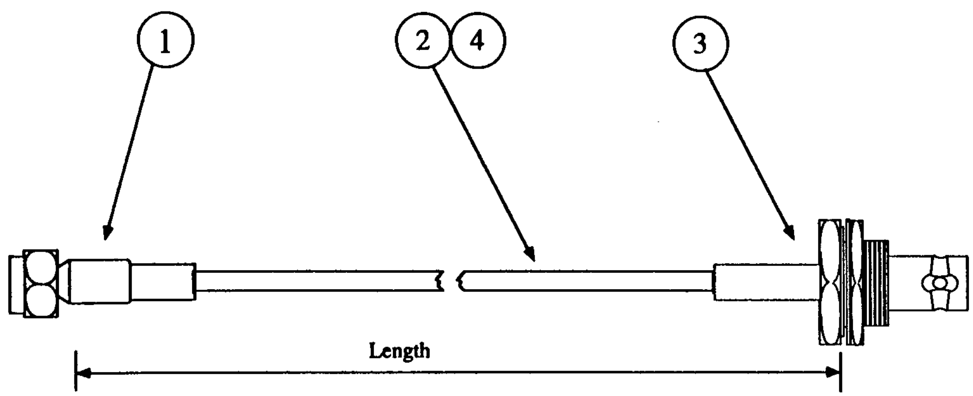
1 of 1 | x2

03-14-96 NS
02-20-96 NS
RELEASE
DRAWN N. Schnepf
COG ENG

Drawing Page

FABRICATION INSTRUCTIONS:

1. For the first time fabrication, assemble only one connector to the cable. The unfinished cable will be placed in the chassis assembly, the cable routed, and then cut to length before installing the second connector.
2. The SMA connectors are attached using the SEALECTRO 50-000-0091 crimp tool with the 0.128 die. Cable preparation is detailed on drawing 062-0080.
3. The BNC connector is attached to the cable using Amphenol 227-987 tool with 227-1418 die. Cable preparation is detailed on drawing 062-0059.
4. Mark cables as per guidelines contained in 062-0082 using item 4.



CABLE ASSEMBLIES

Dash No.	Designation	Length	From	Pos	To	Pos
-1	W5	3Ft	Bias T	J1	Rear Panel	J11
-2	W13	3Ft	Bias T	J2	Front Panel	J6

LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	1	901-9511-3	SMA Crimp-on Coax Conn	Amphenol	
2	AR	RG316/U	RG 316 - 50 Ω Coax		
3	1	31-318	BNC Crimp-on,Blkhd Jk	Amphenol	
4	2	MLCT 114C	Wire marking tags	SPC Technology	

Space Physics Research Laboratory
College of Engineering
University of Michigan

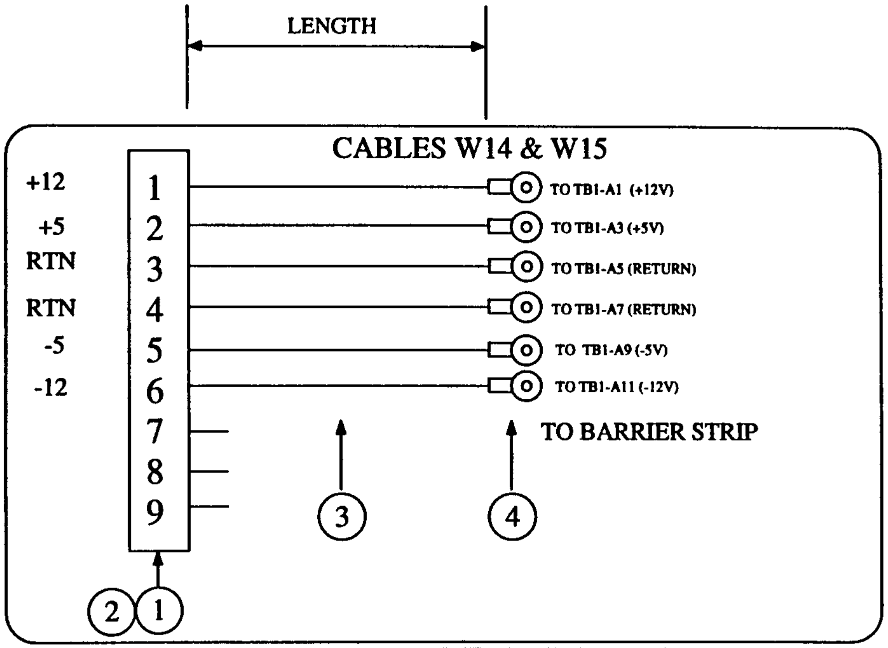
RF CABLE
(SMA to BNC)

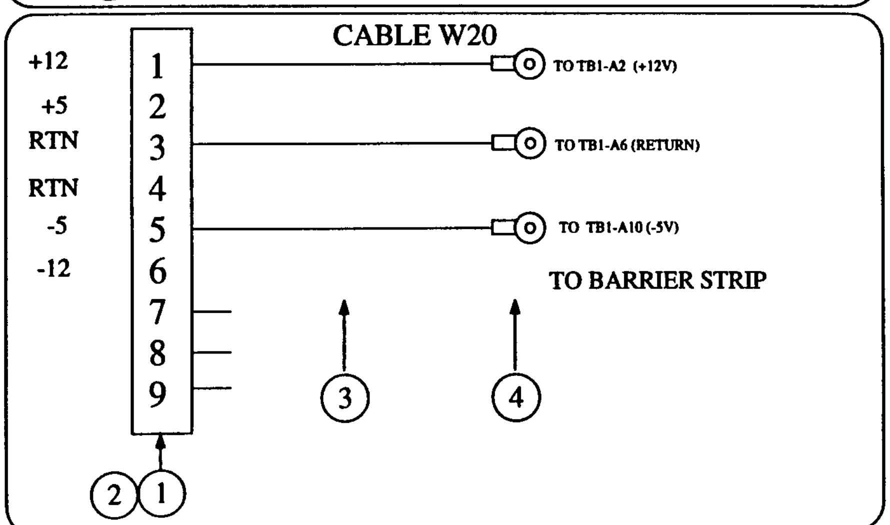
03-19-96 NS
03-14-96 NS
02-20-96 NS
RELEASE
DRAWN N. Schnepf
COG ENG

N000149510249 | 062- 0050 | 1 of 1 | x4

1 Drawing Page

Fabrication Instructions:
1. Crimp contact pins on the wires using M22520/2-01 crimp tool or equivalent.
2. Ring terminals are crimped on wires after wires have been trimmed to proper length at final assembly. Length given in the table is longer than needed for the finished cable.
3. Spot tie wires with ty-wraps at final assembly.





CABLE ASSEMBLIES

Dash No.	Designation	Length	From	Pos	To	Pos	Note
-1	W15	3 Ft	IF	J5	Barrier Strip	A	-
-2	W14	3 Ft	DEMOD	J6	Barrier Strip	A	-
-3	W20	3 Ft	LOFilter	J1	Barrier Strip	A	-

LIST OF MATERIALS FOR EACH CABLE ASSEMBLY

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	1	205555-2	Recept,D type,9 Pin Female	Amp	
2	1	207908-1	Clamp,Box/Lid,w Retainer	Amp	
3	AR	1855	Wire,22ga,Stranded,PVC	Alpha	
4	6	18RA-6	Vinyl Insul. Ring Term.	T&B	
5	AR	TY52315M	Ty-Rap, 1/16-1.5	T&B	

Space Physics Research Laboratory College of Engineering University of Michigan	POWER CABLE (DE9S - Term)	REV	09-26-96 NS
		REV	03-19-96 NS
		REV	11-15-96 NS
		RELEASE	
N000149510249	062- 0053 1 OF 1 X	DRAWN	N. Schnepf
		COG ENG	

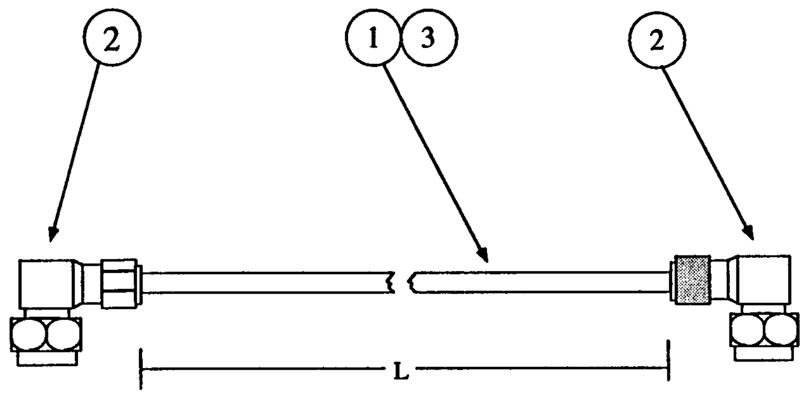
Drawing Page

FABRICATION INSTRUCTIONS:

1. For the first time fabrication, assemble only one connector to the cable. The unfinished cable will be placed in the chassis assembly, the cable routed, and then cut to length before installing the second connector.

2. The right angle SMA connector shield is attached using the SEALECTRO 50-000-0091 crimp tool with the 0.128 die. The center conductor is soldered. Cable preparation and assembly is detailed on drawing 062-0081.

3. Mark cables as per guidelines contained in 062-0082 using item 3 .



CABLE ASSEMBLIES

Dash No.	Desig-nation	Length	From	Pos	To	Pos
-1	W16	3 Ft	ZFL-500LN	Output	IF	J1
-2	W17	3 Ft	DEMOD	J1	IF	J6
-3	W21	3 Ft	IF	J3	LO Filter	J3

LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	AR	RG316/U	RG 316 - 50 Ω Coax		
2	1	901-9531-3	SMA Angle Plug	Amphenol	
3	2	MLCT 114C	Cable ties	SPC Technology	

Space Physics Research Laboratory College of Engineering University of Michigan	RF CABLE (SMA[RT] - SMA[RT])	REV 03-19-96 NS REV 11-08-96 NS REV 04-09-96 NS RELEASE DRAWN N. Schnepf COG ENG
N000149510249	062- 0054	1 of 1 X8

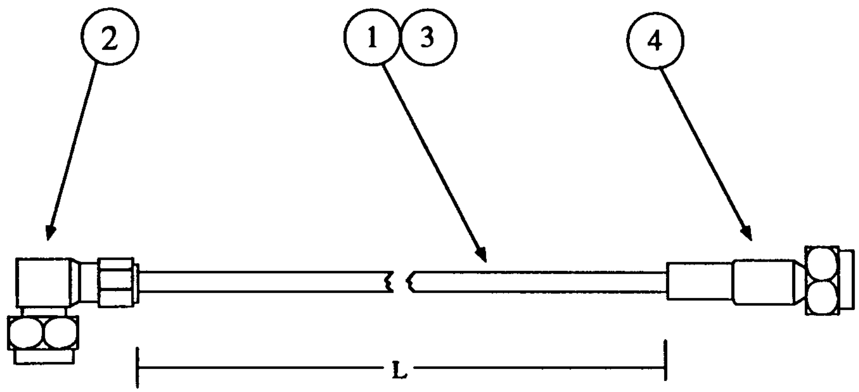
Drawing Page

FABRICATION INSTRUCTIONS:

1. For the first time fabrication, assemble only one connector to the cable. The unfinished cable will be placed in the chassis assembly, the cable routed, and then cut to length before installing the second connector.
2. The right angle SMA connector shield is attached using the SEALECTRO 50-000-0091 crimp tool with the 0.128 die. The center conductor is soldered. Cable preparation and assembly is detailed on drawing 062-0081.
3. The straight SMA connector is attached using the SEALECTRO 50-000-0091 crimp tool with the 0.128 die. Cable preparation is detailed on drawing 062-0080.
4. Mark cables as per guidelines contained in 062-0082 using item 3 .

CABLE ASSEMBLIES

Dash No.	Desig-nation	Length	From	Pos	To	Pos
None	W18	3 Ft	Preselector	RF Output	ZFL-500LN	Input



LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	AR	RG316/U	RG 316 - 50 Ω Coax		
2	1	901-9531-3	SMA Angle Plug	Amphenol	
3	2	MLCT 114C	Cable ties	SPC Technology	
4	1	901-9511-3	SMA Plug, Crimp On	Amphenol	

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RF CABLE
(SMA[RT] - SMA)

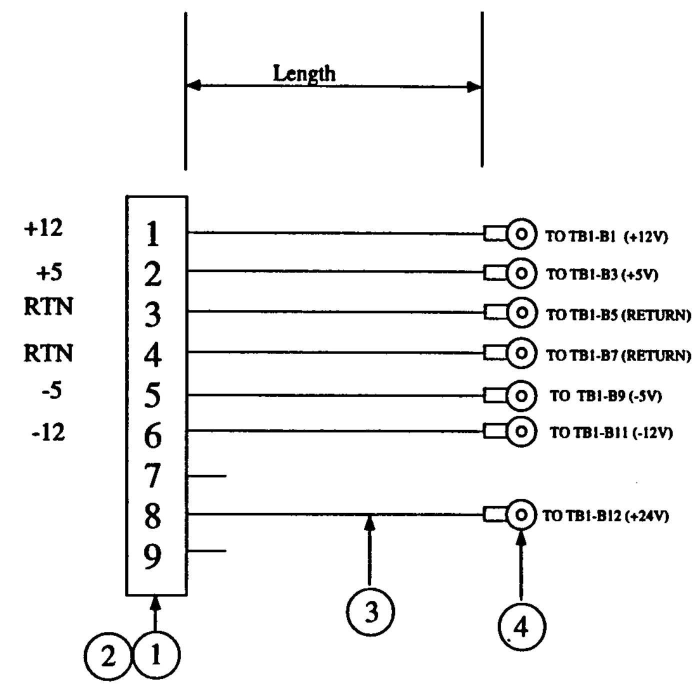
RELEASE 11-08-96 NS
DRAWN N. Schnepf
COG ENG

N000149510249 | 062- 0055 | 1 OF 1

Drawing Page

Fabrication Instructions:

1. Crimp contact pins on the wires using M22520/2-01 crimp tool or equivalent.
2. Ring terminals are crimped on wires after wires have been trimmed to proper length at final assembly. Length given in the table is longer than needed for the finished cable.
3. Spot tie wires with ty-wraps at final assembly.
4. Screwlock kit is used to secure D type connector on rear panel. Connector is back mounted.



CABLE ASSEMBLIES

Dash No.	Designation	Length	From	Pos	To	Pos
None	W 4	2 Ft	Rear Panel	J4	Barrier Strip	B

LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	1	205556-2	Plug,D type,9 Pin,Male	Amp	
2	1	3341-1S	Fem ScrewlkKit4-40x0.13	3M	
3	AR	1855	Wire,22ga,Stranded,PVC	Alpha	
4	7	18RA-6	Vinyl Insul. Ring Term.	T&B	
5	AR	TY5231M	Ty-Rap, 1/16-1.5	T&B	

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University of Michigan

POWER CABLE
(DE9P- Term)

N000149510249

062- 0056 | 1 of 1 | X2

RELEASE 02-20-96 NS

DRAWN N. Schnepf

COG ENG

1
Drawing Page

University of Michigan
Space Physics Research Laboratory

RECEIVER POWER SUMMARY

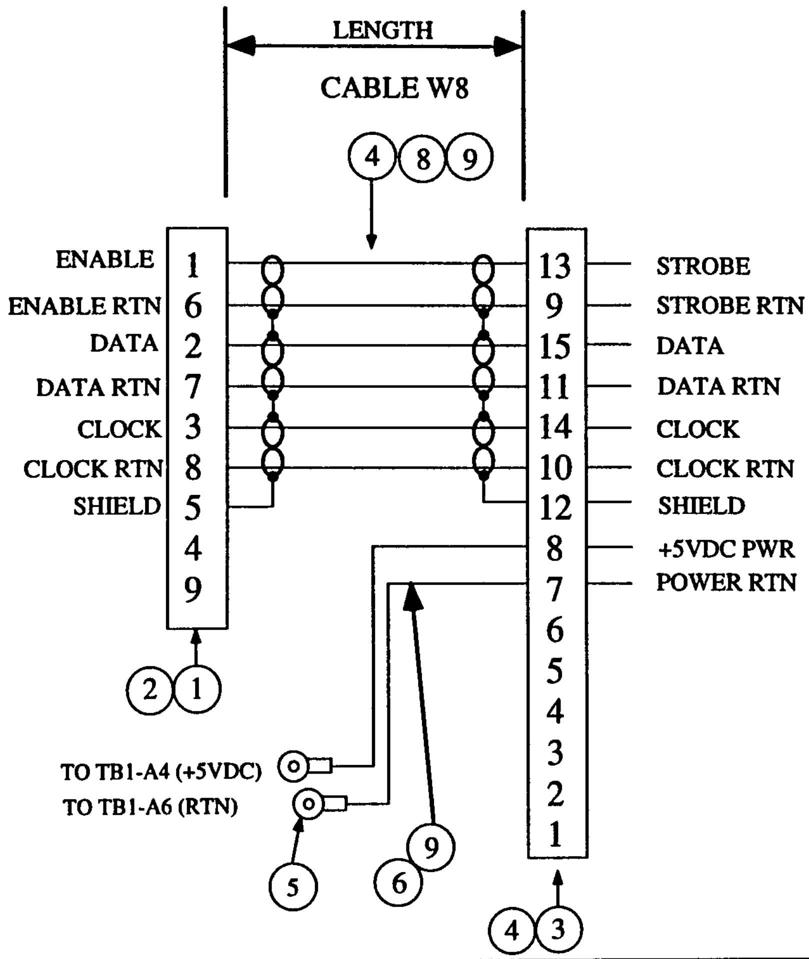
SN1		UNIT (V)					SYSTEM (V)					
COMPONENT	Qty	-5	-12	+24	+12	+5	-5	-12	+24	+12	+5	NOTES
Preamp	8				0.080		0.000	0.000	0.000	0.640	0.000	Estimated
Ant Mux	1				0.200		0.000	0.000	0.000	0.200	0.000	Measured (exclusive of preamps)
Preselector	1					0.800	0.000	0.000	0.000	0.000	0.800	Need to reverify
1st Mixer/IF	1				0.300	0.060	0.000	0.000	0.000	0.300	0.060	Estimated
Demod Mixer	1	0.064	0.064		0.153	0.169	0.064	0.064	0.000	0.153	0.169	Measured
Total Current							0.064	0.064	0.000	1.293	1.029	Total Current
Total Power							0.32	0.77	0.00	15.52	5.15	Total Power
											21.75	RECEIVER TOTAL POWER
SN2		UNIT (V)					SYSTEM (V)					
COMPONENT	Qty	-5	-12	+24	+12	+5	-5	-12	+24	+12	+5	NOTES
Preamp	8			0.073			0.000	0.000	0.584	0.000	0.000	Measured
Ant Mux	1			0.280			0.000	0.000	0.280	0.000	0.000	Measured (exclusive of preamps)
Preselector	1					0.527	0.000	0.000	0.000	0.000	0.527	Measured, 6.78 MHz worst case
LO Filter	1	0.012			0.049		0.012	0.000	0.000	0.049	0.000	Measured
1st Mixer/IF	1	0.001	0.001		0.360	0.084	0.001	0.001	0.000	0.360	0.084	Measured
Demod Mixer	1	0.055	0.056		0.145	0.154	0.055	0.056	0.000	0.145	0.154	Measured
Total Current							0.067	0.057	0.864	0.554	0.765	Total Current
Total Power							0.34	0.69	20.74	6.65	3.83	Total Power
											32.23	RECEIVER TOTAL POWER

FABRICATION INSTRUCTIONS:

1. For the first time fabrication, assemble only one connector to the wires. The unfinished cable will be placed in the chassis assembly, the wires routed, and then cut to length before installing the second connector.
2. Crimp contact pins on the wires using M22520/2-10 tool or equivalent.
3. Daisy chain shield wires together and terminate in indicated pin. Use shrink tubing on exposed shield ends.
4. Spot tie wires with ty-wraps at final assembly.
5. Screwlock kit is used to secure D type connector on rear panel. Connector is back mounted.

CABLE ASSEMBLIES

Dash No.	Designation	Length	From	Pos	To	Pos	Notes
None	W8	2 Ft	Preselector	Ctrl	Rear Panel	J7	



LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	1	205555-2	Recept,D type,9 Pin Female	Amp	
2	1	3341-1S	Fem Screwlk Kit,4-40x.0.13	3M	
3	1	205557-2	Recept,D type, 15 Pin Female	Amp	
4	1	207908-4	Clamp,Box/Lid,w Retainer	Amp	
5	2	18RA-6	Terminal,Ring,#6/22-18	T&B	
6	AR	9462	Cable, TSP,22 GA	Belden	
7	AR	1855	Wire,22ga,Stranded,PVC	Alpha	
8	AR	FIT-350-1/16	Shrink Tubing	Alpha	
9	AR	TY5231M	TY-RAP,1/16-1.5	T&B	

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University of Michigan

Data Cable
(DE9S-DA15S)

N000149510249 | 062- 0058 | 1 of 1 | X2

RELEASE
DRAWN
COG ENG

Drawing Page

Assembly instructions for mating BNC Panel Jack to RG-316 coaxial cable

Connector: Amphenol 31-318
CrimpTool: Amphenol 227-987 with 227-1418 die
Stripping Tool: Ideal Coax #45-162

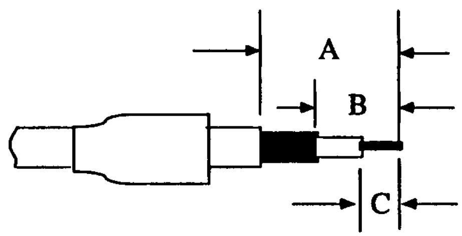
Parts:

Outer Ferrule | Metal Spacer | Teflon Spacer | Female Contact

Directions:

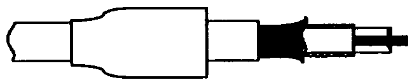
Step 1

Dimensions
A = 0.590"
B = 0.250"
C = 0.156"



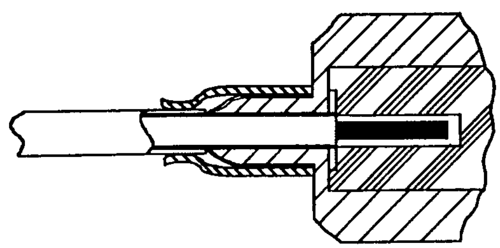
Slide the outer ferrule onto cable as shown. Strip cable to the dimensions shown. Becareful not to nick braid, dielectric, or center conductor. Use the gray Ideal stripper to strip B and C. A can be stripped using the yellow handeled Jensen multifunction crimper/stripper.

Step 2



Flare slightly the end of the cable braid as shown. Slide the metal spacer and teflon spacer over the cable dielectric. The center contact should butt against the dielectric and teflon spacer. Push in the spacer so that the center conductor is sticking past the teflon spacer by 0.10". Crimp the contact on the center using the B die on the Amphenol R/F crimper.

Step 3



Install cable assembly into the body assembly so that the inner ferrule portion of the body slides under the braid. Push the cable assembly forward until contact snaps into place in the insulator. Slide the outer ferrule over braid and up against the connector body. Crimp the outer ferrule using the A die on the Amphenol crimper.

Step 4

Using an ohmmeter, check the cable for shorts between the inner and outer conductor.

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Manufacturing Procedure
BNC Pnl/RG316

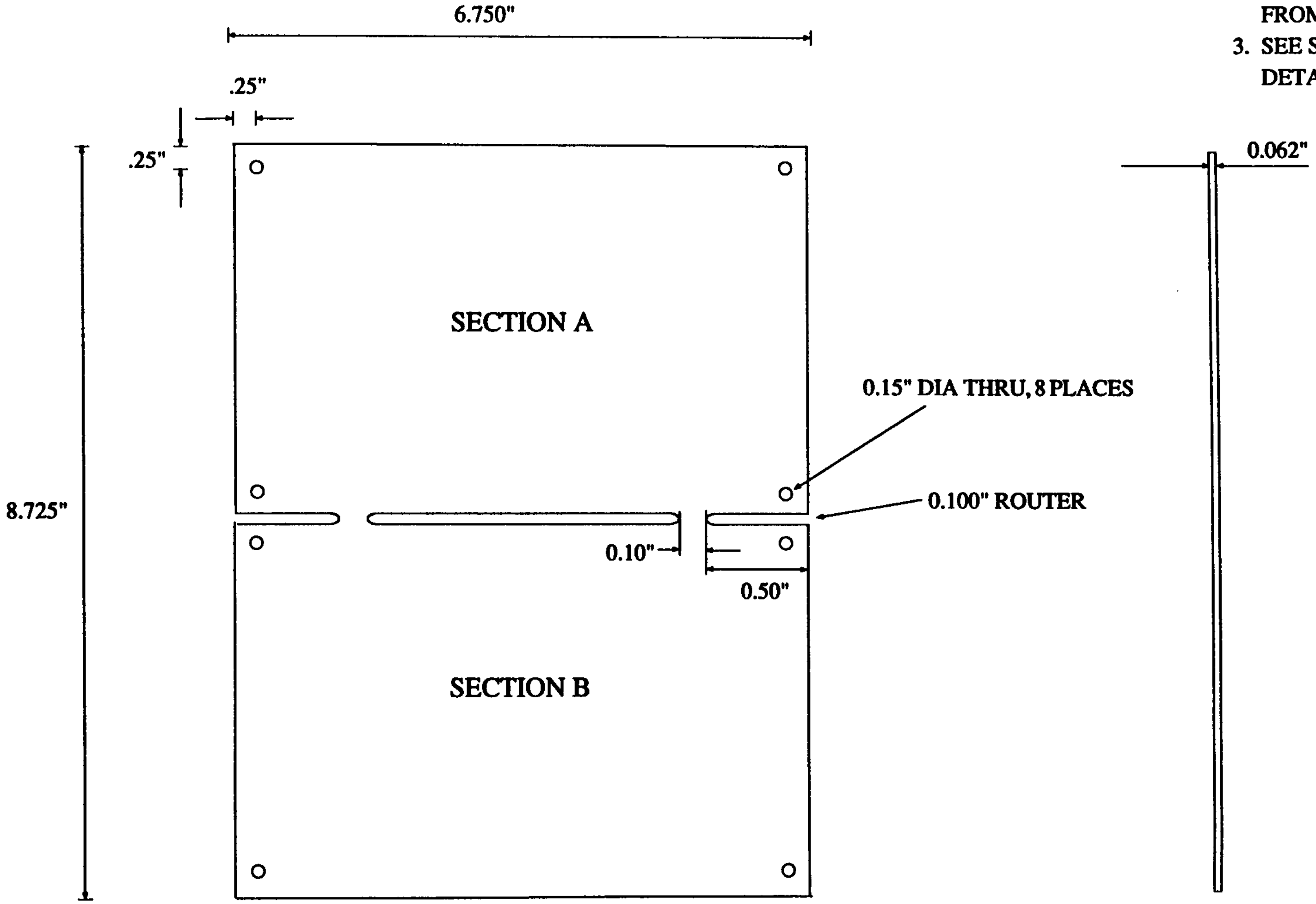
N000149510249 | 062- 0059 | 1 of 1 | x2

RELEASE 02-12-97 NS
DRAWN R. Pung
COG ENG

Drawing Page

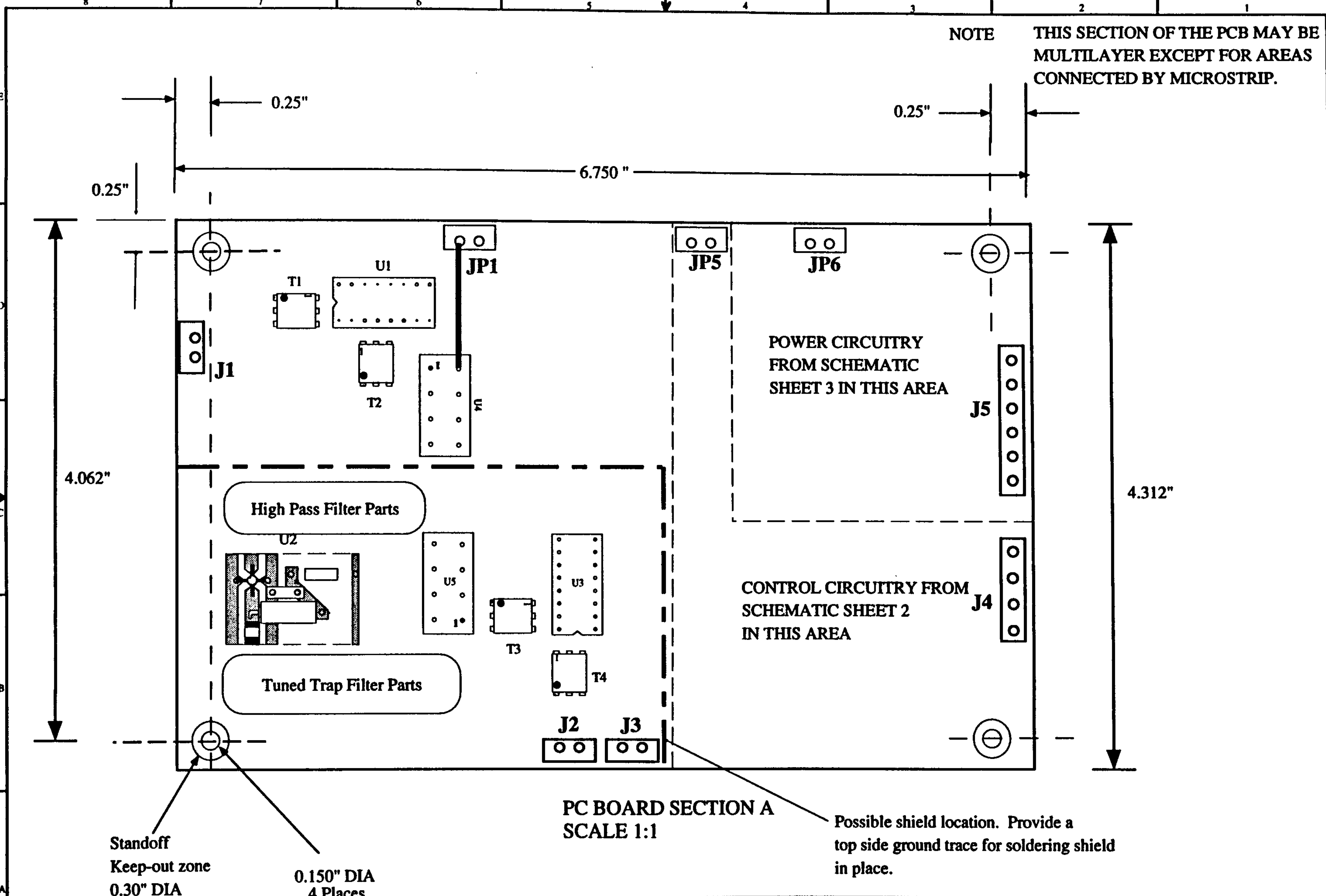
NOTES:

1. BOARD MATERIAL: 0.062" GLASS EPOXY TYPE GFN
2. ALL PC TRACES TO BE AT LEAST 0.050" FROM BOARD EDGE
3. SEE SCHEMATIC 064-0044 FOR CIRCUIT DETAILS



Space Physics Research Laboratory College of Engineering University of Michigan	PCB Outline Mixer-IF		20 Feb 96 NS
			14 Feb 96 PH
			02-01-95 NS
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	0060.1 PCB Outline	062- 0060	1 OF 6 x5

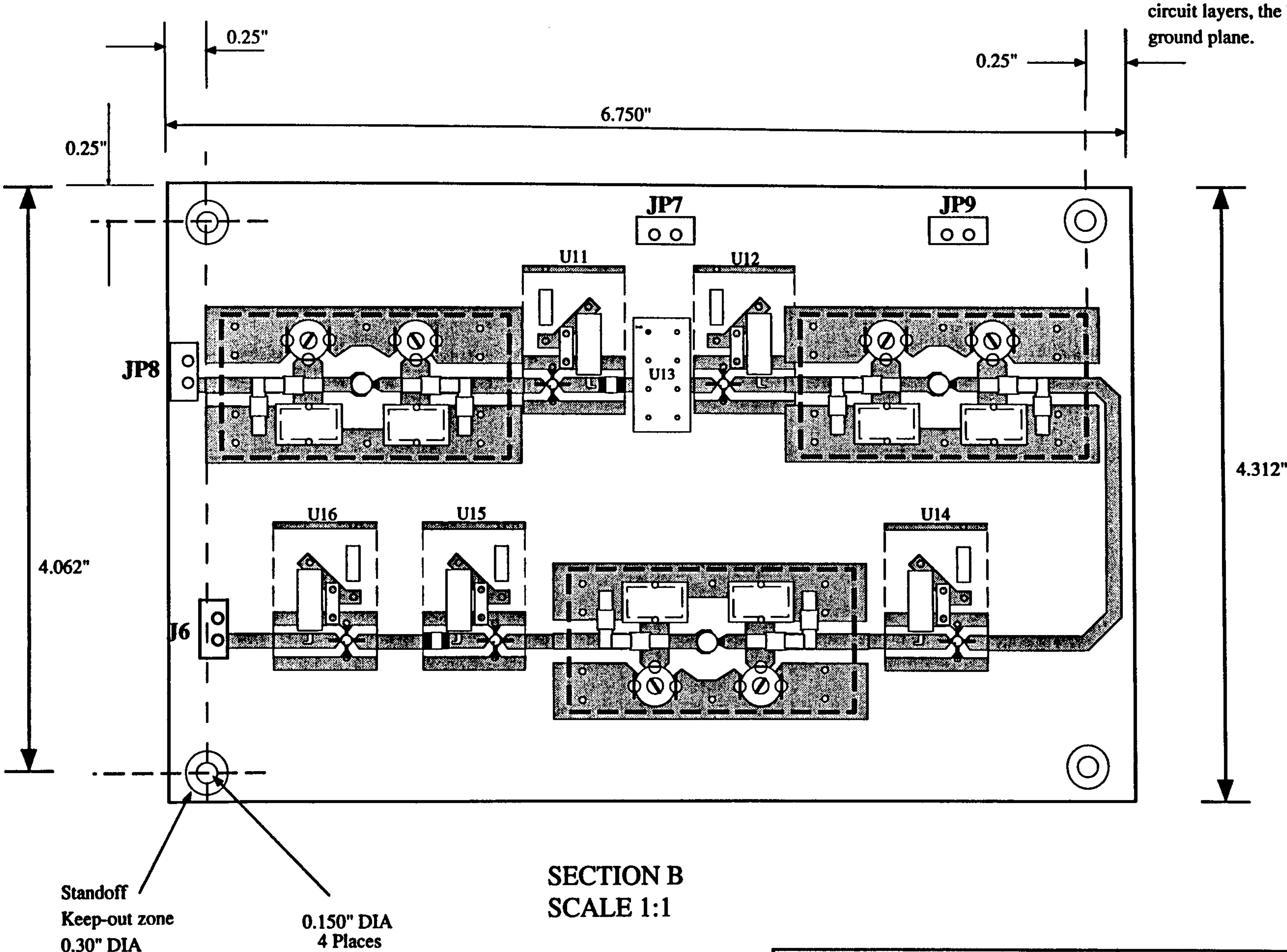
Drawing Page



Space Physics Research Laboratory College of Engineering University of Michigan	PCB OUTLINE Mixer-IF		14 Feb 96 PH 02-08-96 NS
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	0060.2 Sec A	062- 0060	2 of 6 x5

Drawing Page

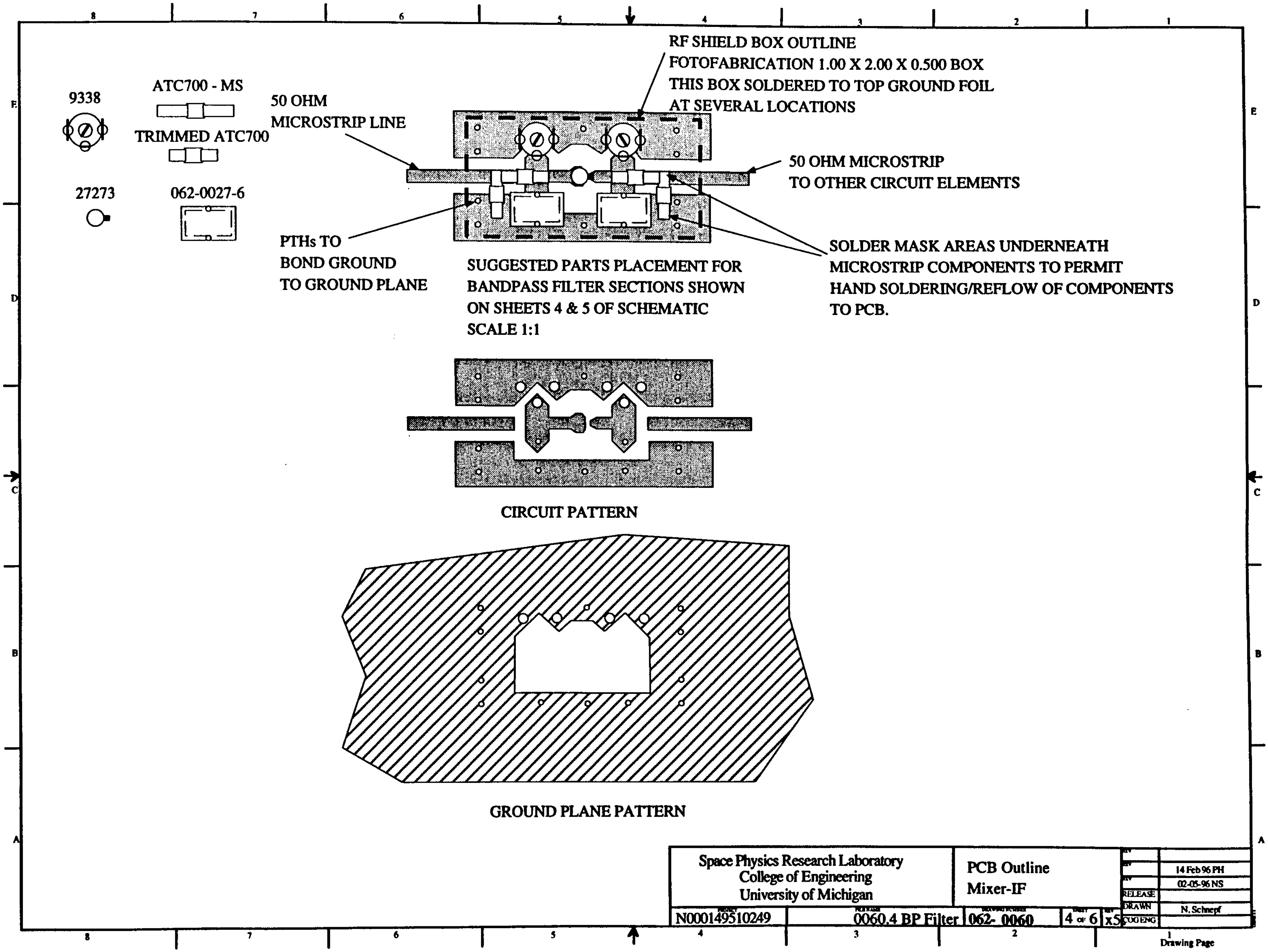
NOTE: This section should be two circuit layers, the bottom layer being ground plane.



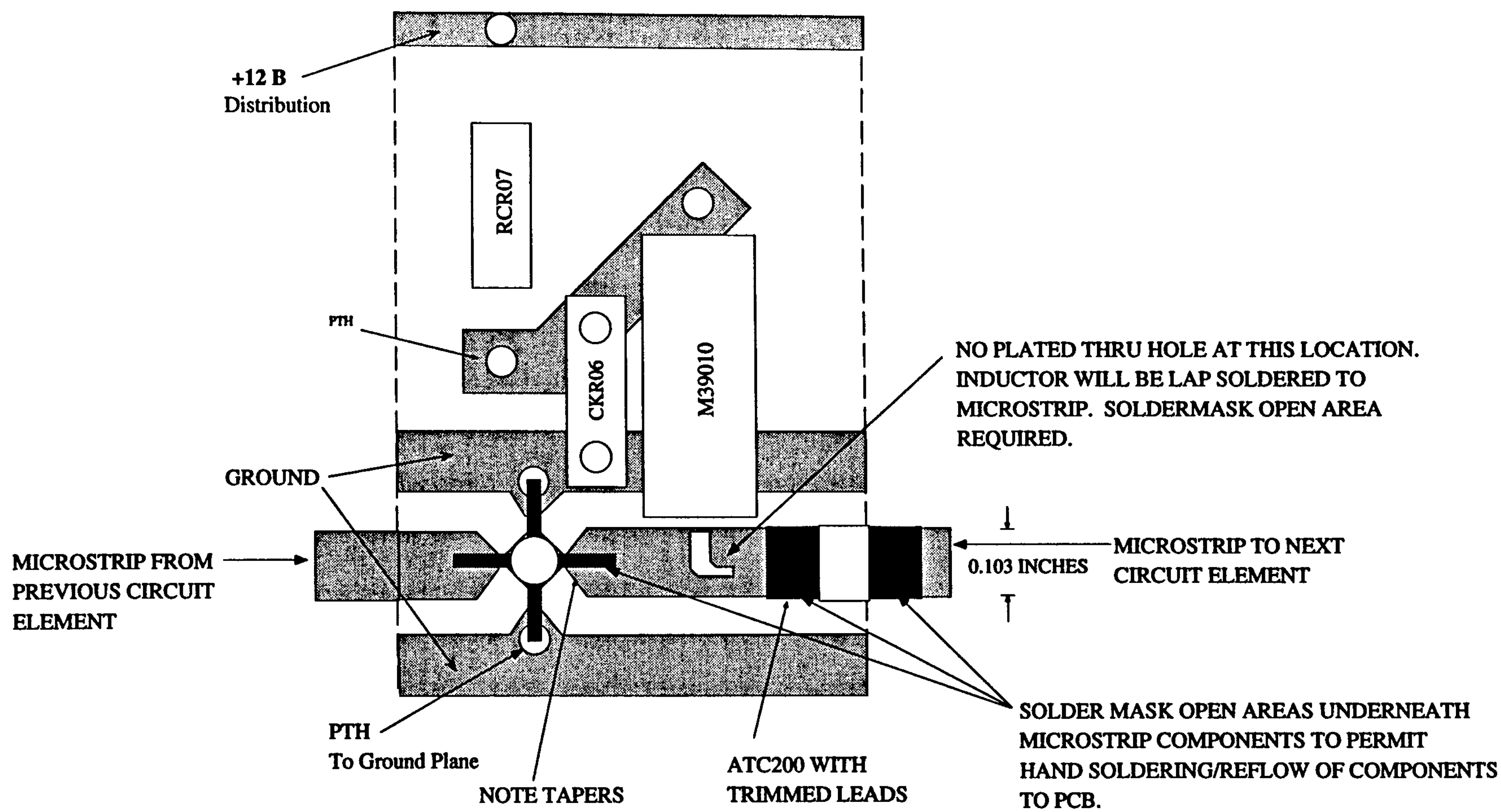
SECTION B
SCALE 1:1

Space Physics Research Laboratory College of Engineering University of Michigan		PCB OUTLINE MIXER-IF	14 Feb 96 PH 02-08-96 NS RELEASE DRAWN N. Schnepf COG ENG
N000149510249	0060.3 Section B	062- 0060	3 of 6 x5

Drawing Page



9338
ATC700 - MS
TRIMMED ATC700
27273
062-0027-6
50 OHM MICROSTRIP LINE
RF SHIELD BOX OUTLINE FOTOFABRICATION 1.00 X 2.00 X 0.500 BOX THIS BOX SOLDERED TO TOP GROUND FOIL AT SEVERAL LOCATIONS
50 OHM MICROSTRIP TO OTHER CIRCUIT ELEMENTS
PTHs TO BOND GROUND TO GROUND PLANE
SUGGESTED PARTS PLACEMENT FOR BANDPASS FILTER SECTIONS SHOWN ON SHEETS 4 & 5 OF SCHEMATIC SCALE 1:1
SOLDER MASK AREAS UNDERNEATH MICROSTRIP COMPONENTS TO PERMIT HAND SOLDERING/REFLOW OF COMPONENTS TO PCB.
CIRCUIT PATTERN
GROUND PLANE PATTERN
Space Physics Research Laboratory
College of Engineering
University of Michigan
PCB Outline
Mixer-IF
14 Feb 96 PH
02-05-96 NS
RELEASE
DRAWN
N. Schnepf
COG ENG
N000149510249
0060.4 BP Filter
062- 0060
4 of 6
x5
Drawing Page



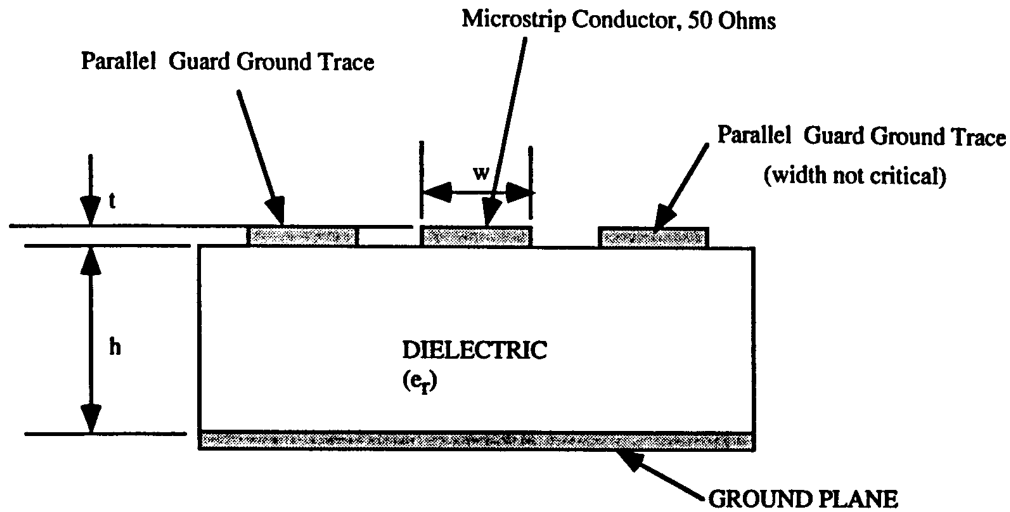
MAR-6 LAYOUT

SCALE : 4x

NOTES:

1. MAR-6 Requires 0.110 diameter unplated clearance hole for amplifier body.

Space Physics Research Laboratory College of Engineering University of Michigan		PCB OUTLINE MIXER-IF		RELEASE 02-14-96 NS DRAWN N. Schnepf COG ENG
N000149510249	0060.5 MAR-6	062- 0060	5 OF 6	x5



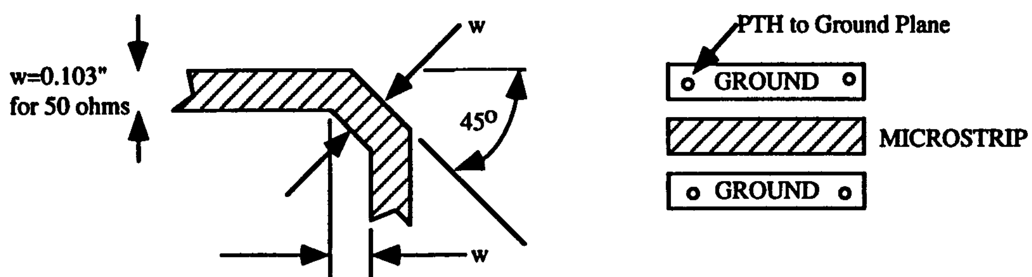
Z_o Ohms	Line Width in mils: 0.062" Board	Line Width in mils: 0.031" Board
50	103	47
55	89	41
60	77	35
65	66	30
70	57	26
75	49	22
80	42	19
85	36	16
90	31	14
95	27	11
100	23	10

MICROSTRIP LINES:

A microstrip line (shown above) is a strip conductor separated from a ground plane by a dielectric medium. Two-sided and multilayer boards use this type of transmission line. If the thickness, width, and height of the line above the ground plane are controlled, the line will exhibit a characteristic impedance of:

$$Z_o=(87/(e_r+1.41)^{0.5})*\ln((5.98h)/(0.8w+t))$$

Where e_r is the dielectric constant of the board. For standard G-10 fiberglass epoxy boards, the dielectric constant is about 5.0. The table gives the characteristic impedance versus line width for 0.062" and 0.031" G-10 board with one ounce copper. For two ounce copper, the widths are nominally 1 to 2 mils narrower.



CHAMFER EXAMPLE

Other Layout Notes:

Abrupt changes in transmission line width creates parasitic effects called step discontinuities. Tapering the transmission lines from 50 ohms down to the amplifier or device lead width helps to minimize this effect. Bends in transmission lines should be avoided when possible. When they must be used, the corners should be chamfered to prevent the bends from acting as extra shunt capacitance. Ground planes should be kept as large and as solid as possible, expecially at the emitter leads of amplifiers/transistors. Plated through holes should be placed directly under the ground leads of these devices.

Space Physics Research Laboratory College of Engineering University of Michigan	PCB OUTLINE MIXER-IF	RELEASE 02-13-96 PH DRAWN P. Hansen COGENG
N000149510249	0060.6 MicroStrip	062- 0060 · 6 of 6 · x5

Drawing Page

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

Title: RECEIVER ASSEMBLY BUILD INSTRUCTIONS	FSCM No.: 0TK63 Drawing No.: 062-0062 Revision: X1 Page 1 of 2
Program: HF RADAR	Contract No.: N000149510249

This is an uncontrolled HF Radar Document

APPROVAL RECORD

Function	Title - Organization	Name	Signature	Date
Originator	PE - U of M	P. Hansen		
Checker				
Mechanical				
Electrical	PE - U of M			
Software	PE - U of M			
QA	QA - U of M			
Mfg				
Reliability				
Project	PM - SU			
Principal Inv	PI - U of M	J. Vesecky		
Customer				

REVISION RECORD

Revision	Description	Date	Approval
-	Initial Release		

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

Title: RECEIVER ASSEMBLY BUILD INSTRUCTIONS	FSCM No.:	0TK63
	Drawing No.:	062-0062
	Revision:	X1
	Page	2 of 2
Program: HF RADAR	Contract No.:	N000149510249

1.0 Applicable Documents

062-0064 Receiver Chassis Assembly Parts List
062-0063 Receiver Chassis Assembly

2.0 Procedure

1. Kit all parts for the chassis assembly per the chassis assembly parts list, 062-0064.

2. Secure all modules, Preselector (1), IF Mixer (2), Demod (3), Bias T (4), Local Oscillator Filter (58) and barrier strip (30) to the chassis' bottom mounting panel (10) using the indicated hardware. Install the jumper plates on the terminal board as called out on the drawing note. See sheet 4 of assembly drawing 062-0063.

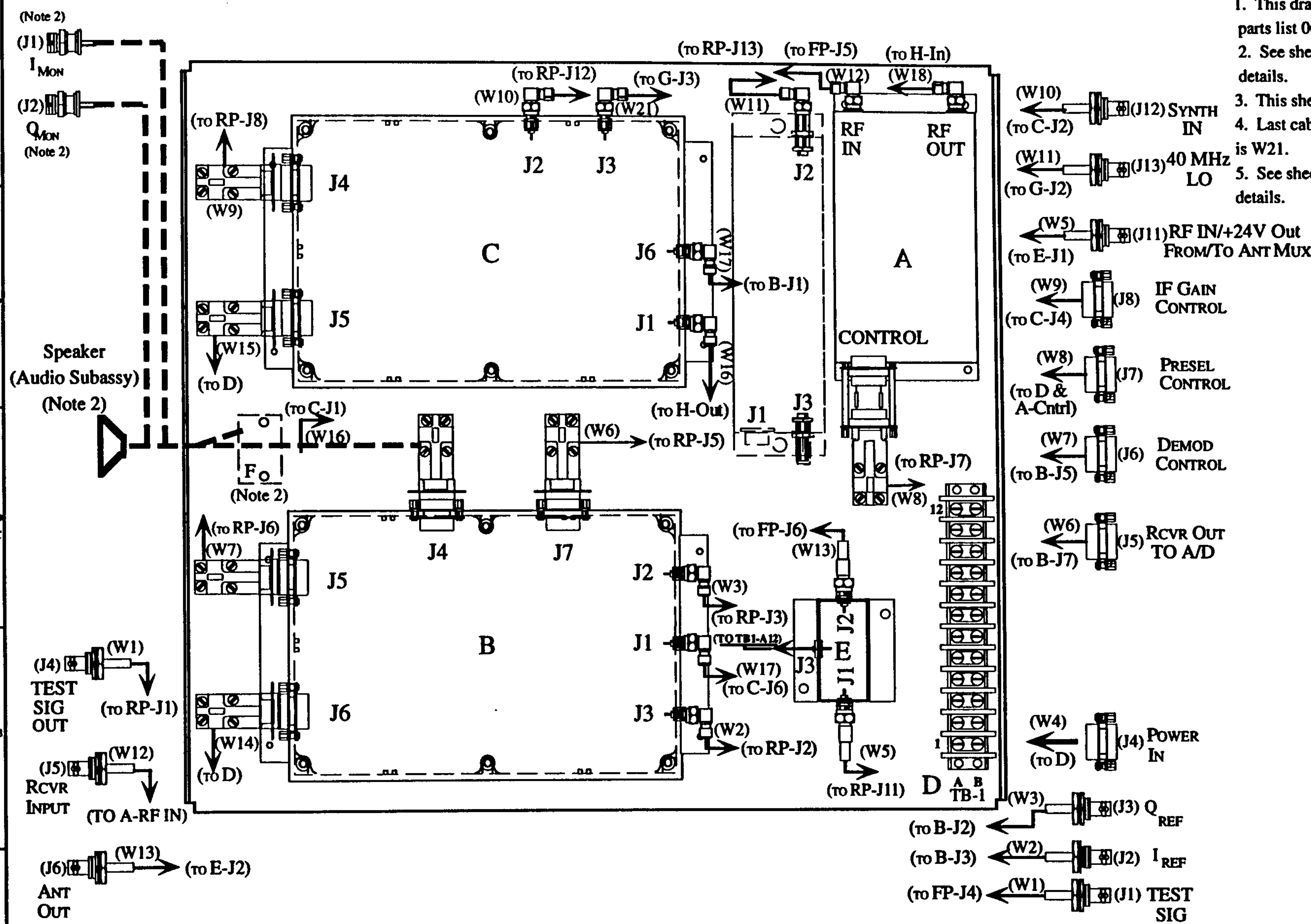
3. Install the prefabricated cable connectors to the rear panel (7) per sheet 3 of the assembly drawing. Route loose wires from assemblies W5, W6, W7, and W8 down the center of the chassis, tying off as needed for connections to modules.

4. Run the bundle of wires consisting of cable assemblies W9, W10, and W11 along the edge of the chassis next to the IF Mixer, picking up assemblies W12 and W18. Another group of coaxial cables, assemblies W16 and W17, will intersect the center bundle after it is routed behind the IF Mixer. The power connections from J4 run along the front of the barrier strip TB-1, near the rear panel.

5. Along the edge of the Demod module bundle cable assemblies W1, W2, W3, W12, and W13. It will be necessary to join with the center bundle of wires, routing them between the Bias T and Demod modules.

6. Once the wire routing has been completed spot tie any additional cables to existing bundles.

NOTES:
1. This drawing incomplete without parts list 062-0064.
2. See sheet 5 for audio amp wiring details.
3. This sheet not to scale.
4. Last cable assembly designation is W21.
5. See sheet 2 for TB-1 wiring details.



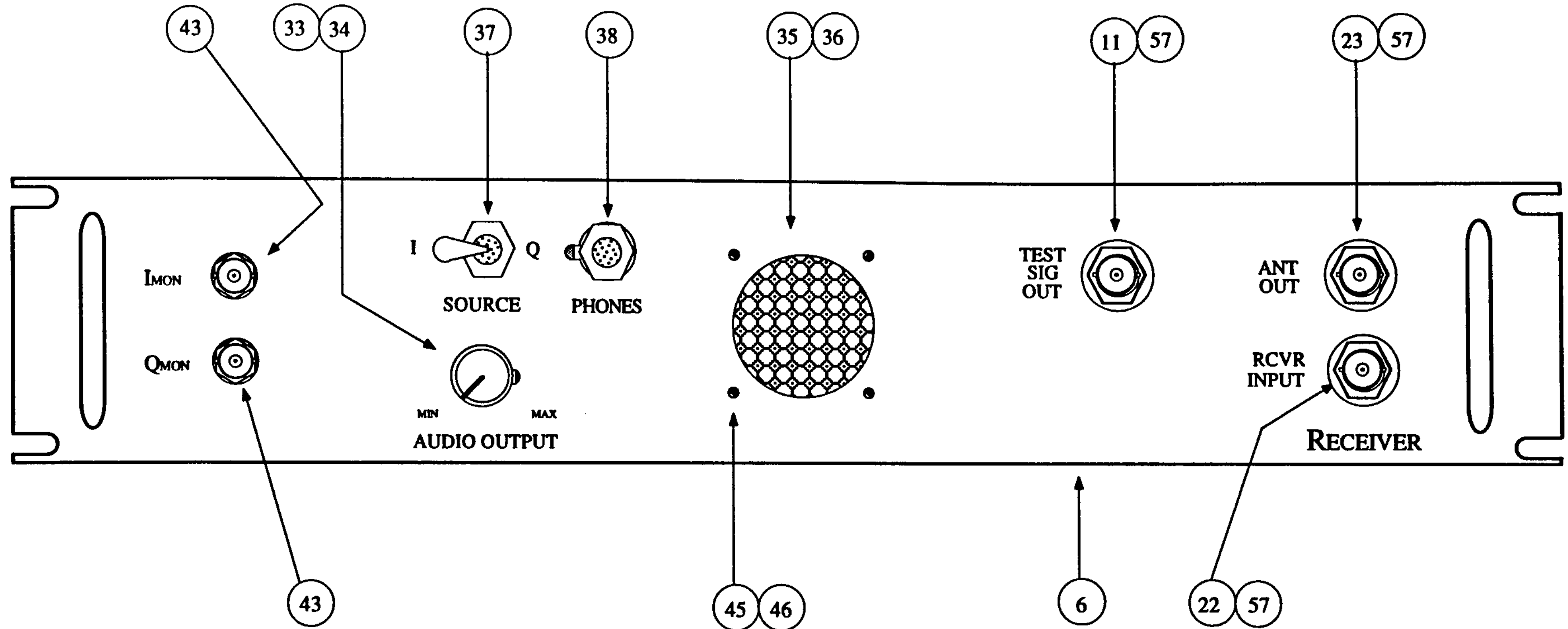
Key:

A = Preselector
B = Demod
C = Mixer/IF
D (or TB-1) = Barrier Strip
E = Bias T
F = Audio Amp
G = Local Oscillator Filter
H = RF Amplifier

FP = Front Panel
RP = Rear Panel

Space Physics Research Laboratory College of Engineering University of Michigan	Receiver Chassis Assembly	REV	11-08-96 NS
		REV	09-26-96 NS
		REV	11-15-96 NS
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	Cable Diagram	062- 0063	1 of 5	x20

1 Drawing Page



Terminal Board to Cable Assembly Connections
"X" denotes ring terminal connection

W20	RFAmp W19	W15	W14	W8	BiasT	TB-1 A	TB-1 B	W4	Voltage
		X	X			1	1	X	+12
X	X					2	2		+12
		X	X			3	3	X	+5
				X		4	4		+5
		X	X			5	5	X	RTN
X				X		6	6		RTN
		X	X			7	7	X	RTN
	X					8	8		RTN
		X	X			9	9	X	-5
X						10	10		-5
		X	X			11	11	X	-12
					X	12	12	X	+24

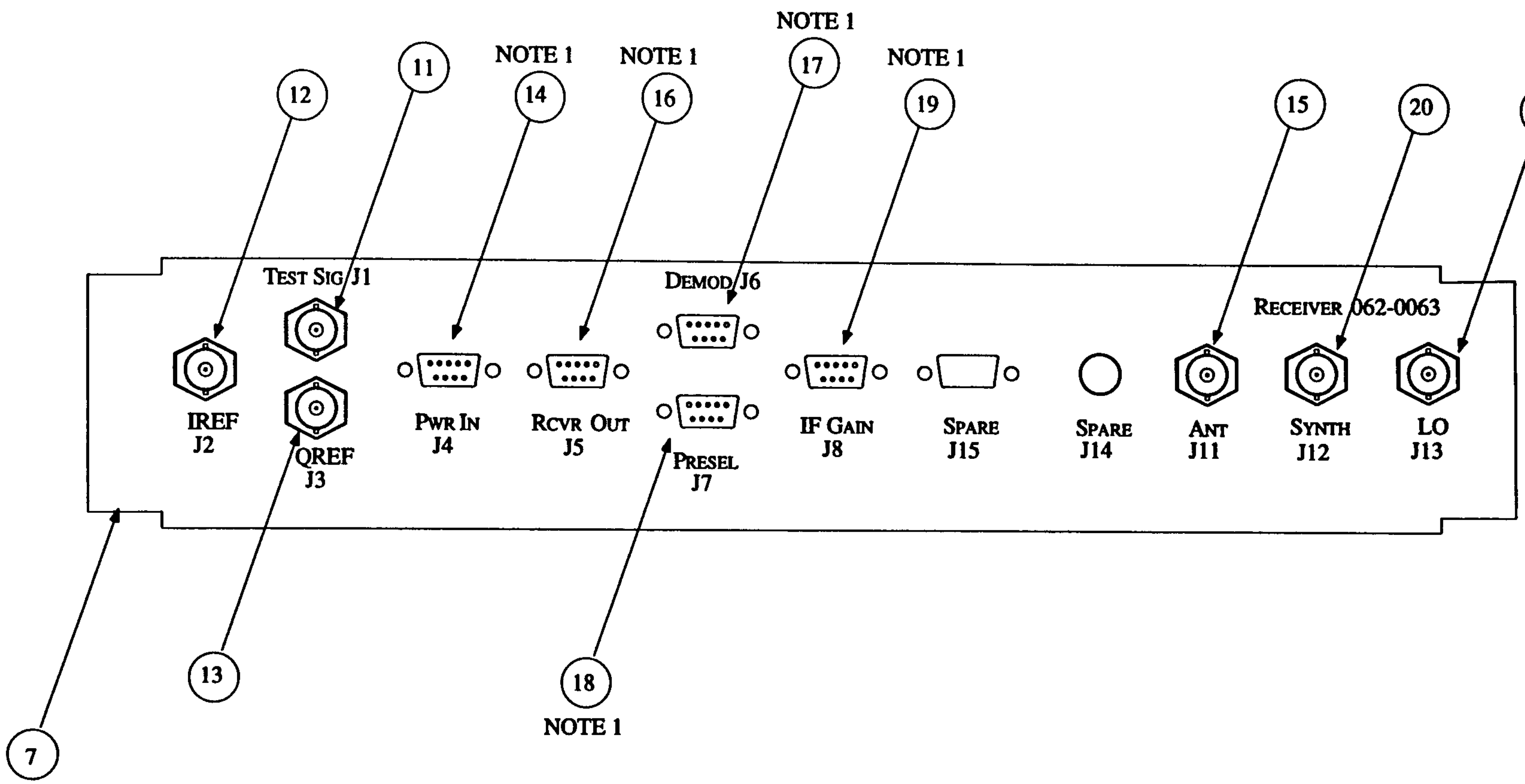
Space Physics Research Laboratory
College of Engineering
University of Michigan

Receiver Chassis Assembly

N000149510249 | Front Panel Detail | 062- 0063 | 2 of 5 | x20

03-25-96 NS
11-11-96 NS
05-01-96 NS
RELEASE
DRAWN N. Schnepf
CUG ENG

1
Drawing Page

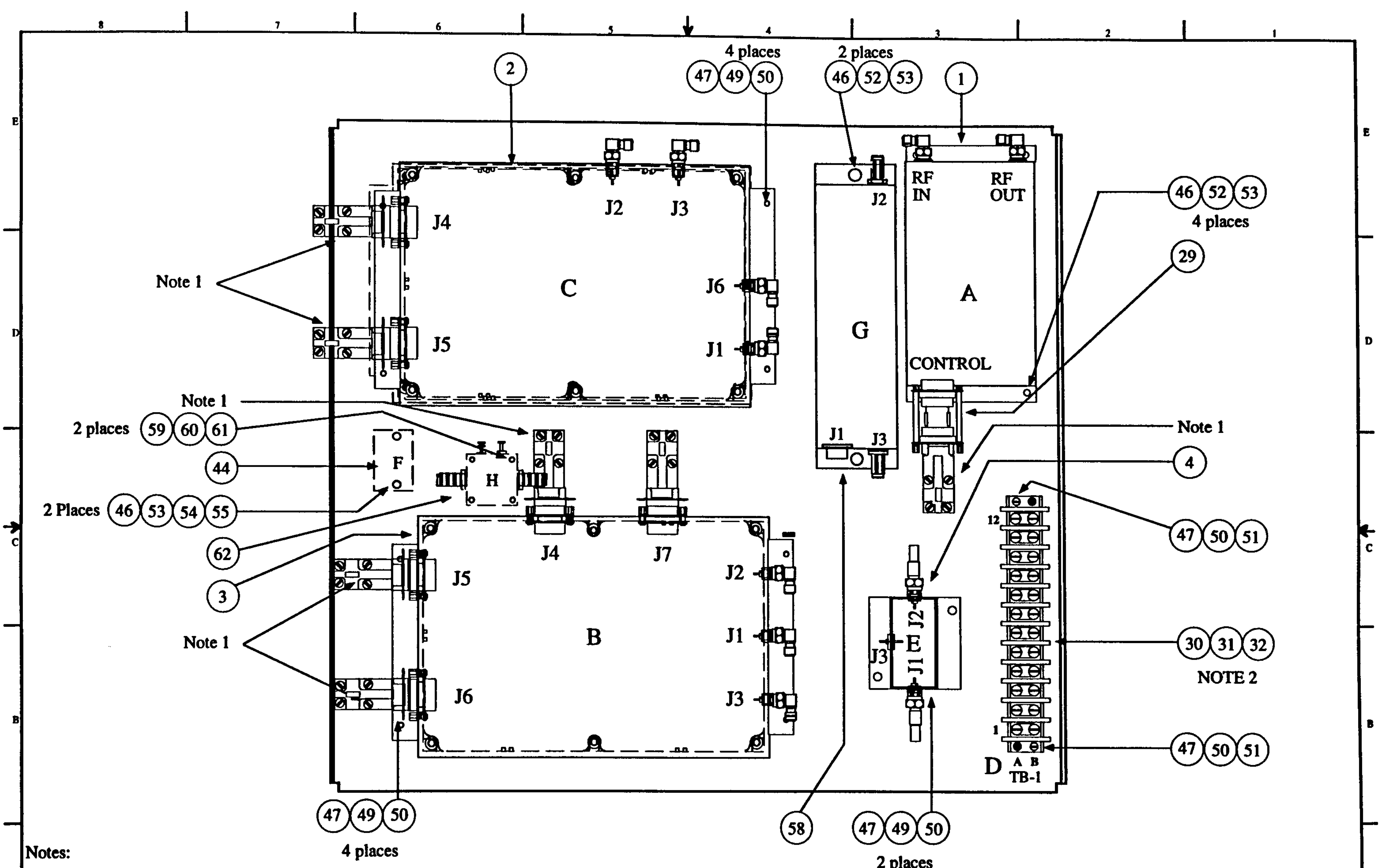


Notes:

1. Backmount D connector cable assemblies using special short jackscrews, 3M Part No. 3341-1S, which are part of each cable assembly.

Space Physics Research Laboratory College of Engineering University of Michigan	RECEIVER CHASSIS ASSEMBLY		03-13-96 NS 04-09-96 NS 03-25-96 NS
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	Rear Panel Detail 062- 0063	3 OF 5 x20	

1
Drawing Page



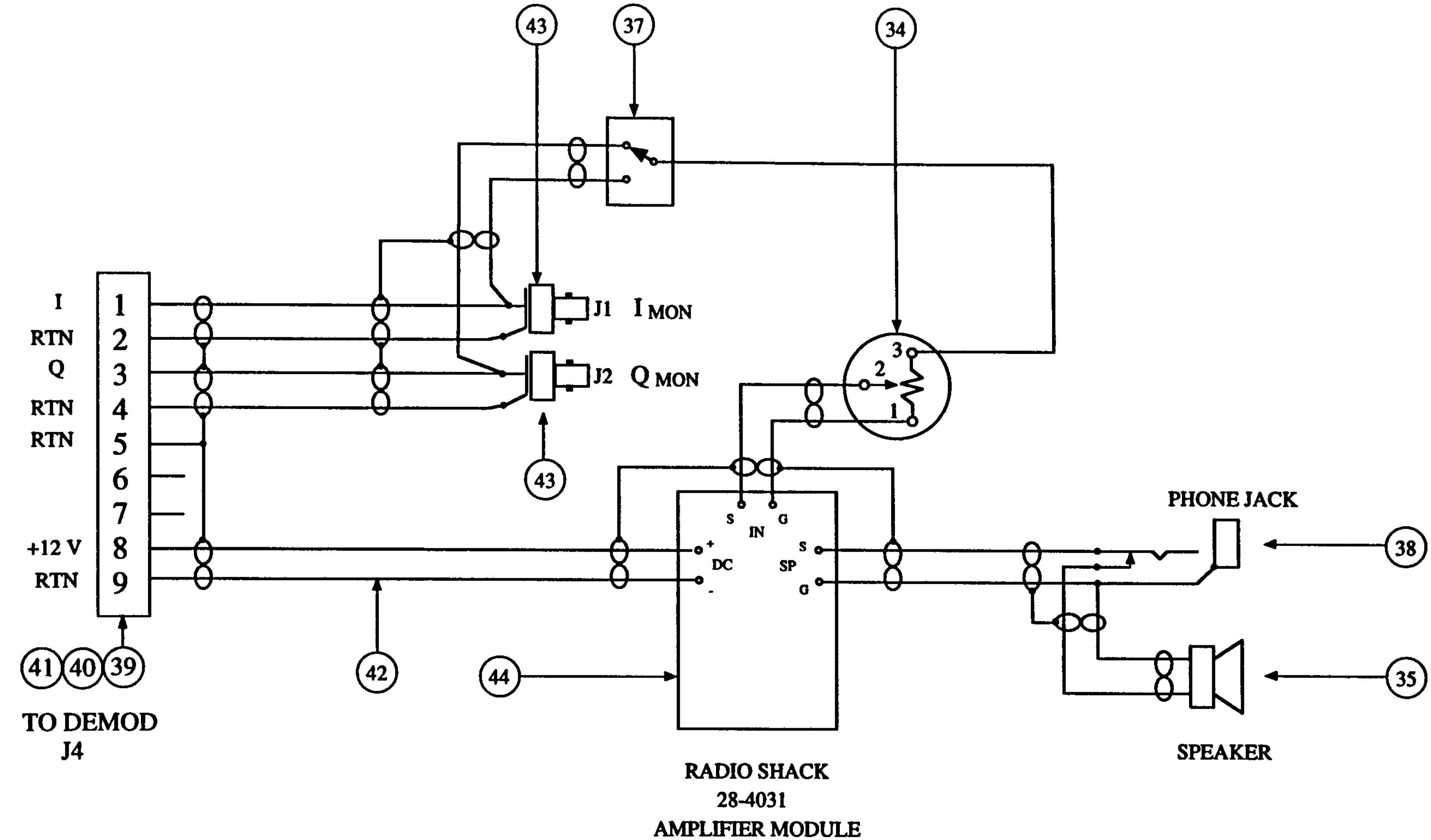
Notes:

1. Subassembly mating connectors and cablebackshells are shown for reference only. They are part of the referenced cable assemblies.

2. Install barrier strip jumper plates, Item 31, on the "B" side of TB-1 to group the power distribution terminals in accordance with the table on sheet 2. The following terminals are grouped: 1-2; 3-4; 5-6-7-8; 9-10. The ring terminals on the cable assemblies are to be installed on top of the jumper plates.

Space Physics Research Laboratory College of Engineering University of Michigan		Receiver Chassis Assembly		REV 04-28-96 NS REV 11-11-96 NS REV 11-07-96 NS RELEASE DRAWN N. Schnepf COG ENG
N000149470249	Mounting Panel Detail	062- 0063	4 of 5	x20

Drawing Page



NOTES:

1. This drawing details the front panel wiring details. All front panel controls and jacks connect to either the audio amplifier module or to the D connector that mates with the Demodulator chassis at J4. This wiring is to be performed after the audio amplifier, Item 44, and Demodulator have been installed on the bottom mounting plate, and the front panel with the controls and jacks are in place.

Space Physics Research Laboratory College of Engineering University of Michigan		RECEIVER CHASSIS ASSEMBLY			03-27-97 NS 04-09-96 NS 02-15-96 NS
				RELEASE	
				DRAWN	N. Schnepf
N000149510249	Audio Amp Wiring Detail	062- 0063	5 OF 5	x20 CGENG	

Parts List
Receiver Chassis Assembly
Next Assy: 062-0003
Prog: HF Radar
Cntrct No.:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICIS RESEARCH LABORATORY

FSCM No.: 0TK63
Dwng No.:062-0064
Rev:X14

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
1	1	EA	062-0068	Preselector, RF	SPRL	A
2	1	EA	062-0040	Mixer-IF Assembly	SPRL	C
3	1	EA	062-0012	Demod Assembly	SPRL	B
4	1	EA	062-0069	Bias Tee Assembly	SPRL	E
5	1	REF	062-0063	Receiver Chassis Assembly	SPRL	
6	1	EA	062-0065	Front Panel Modification	SPRL	
7	1	EA	062-0066	Rear Panel Modification	SPRL	
8	1	EA	062-0067	Mounting Panel Modification	SPRL	
9	1	EA	SB19-3	Chassis Kit	Strongbox	
10	1	EA	BMP-19	Bottom Mounting Panel	Strongbox	
11	1	EA	062-0049	RF Cable (BNC-BNC)	SPRL	W1
12	1	EA	062-0052-4	RF Cable (SMA-BNC)	SPRL	W2
13	1	EA	062-0052-5	RF Cable (SMA-BNC)	SPRL	W3
14	1	EA	062-0056	Power Cable (DE9-TERM)	SPRL	W4
15	1	EA	062-0050-1	RF Cable (SMA-BNC)	SPRL	W5
16	1	EA	062-0051-1	Data Cable (DE9S-DE9P)	SPRL	W6
17	1	EA	062-0051-2	Data Cable (DE9S-DE9P)	SPRL	W7
18	1	EA	062-0058	Data Cable (DE9S-DE9P)	SPRL	W8
19	1	EA	062-0051-3	Data Cable (DE9S-DE9P)	SPRL	W9
20	1	EA	062-0052-1	RF Cable (SMA[RT]-BNC)	SPRL	W10
21	1	EA	062-0052-2	RF Cable (SMA[RT]-BNC)	SPRL	W11
22	1	EA	062-0052-3	RF Cable (SMA[RT]-BNC)	SPRL	W12
23	1	EA	062-0050-2	RF Cable (SMA-BNC)	SPRL	W13
24	1	EA	062-0053-2	Power Cable (DE9-TERM)	SPRL	W14
25	1	EA	062-0053-1	Power Cable (DE9-TERM)	SPRL	W15
26	1	EA	062-0054-1	RF Cable (SMA[RT]-SMA[RT])	SPRL	W16
27	1	EA	062-0054-2	RF Cable (SMA[RT]-SMA[RT])	SPRL	W17
28	1	EA	062-0055-1	RF Cable SMA-SMA[RT]	SPRL	W18
29	1	EA	062-0077	Preselector Terminator	SPRL	
30	1	EA	12-141	Barrier Strip	Cinch	D (TB-1)
31	6	EA	141J-1	Jumper Plate	Cinch	

Parts List
Receiver Chassis Assembly
Next Assy: 062-0003
Prog: HF Radar
Cntrct No.:N000149510249

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SPACE PHYSICIS RESEARCH LABORATORY

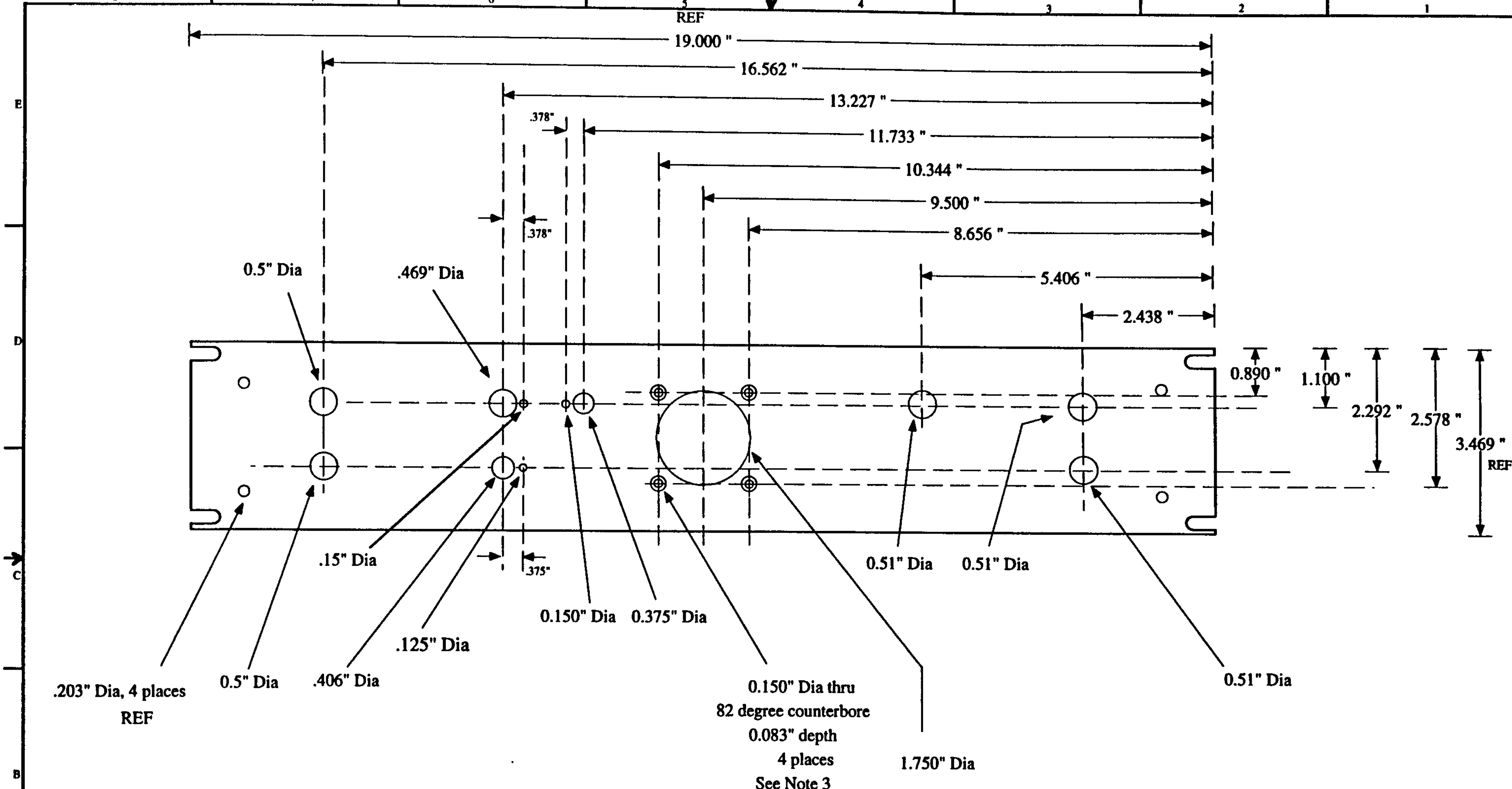
FSCM No.: 0TK63
Dwng No.:062-0064
Rev:X14

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
32	1	EA	MS-12-141	Marker Strip	Cinch	
33	1	EA	KLN700A1/4	Knob	Augat	
34	1	EA	3852A-282-103 A	Cermet Single Turn 10K Potentiometer	Bourns	
35	1	EA	A2WP	Speaker, 2" square, waterproof	Misco	
36	1	EA	062-0083	Speaker Grille	SPRL	
37	1	EA	7101TZQE	Switch, SPDT	C&K	
38	1	EA	12A	Jack,Phone,2 Cond,1/4"	Switchcraft	
39	1	EA	205556-2	Plug, D type, 9 pin Male	Amp	
40	5	EA	747784-4	Jack screw, 4-40,BULK	Amp	
41	1	EA	207908-1	Clamp,Box/Lid,w Retainer	Amp	
42	1	AR	9462	Shielded Cable	Belden	
43	2	EA	KC-79-150	Connector,BNC,Fem,Iso gnd, Rear Mnt	Kings	
44	1	EA	28-4031	Amplifier Module	Radio Shack	F
45	4	EA		Screw,flathead,CRES,6-32x0.5		
46	12	EA		Washer,flat, #6		
47	18	EA		Washer,split lock, #8		
48	6	EA		Nut, 6-32		
49	10	EA		Screw,panhead,CRES,8-32x0.5		
50	12	EA		Washer,flat, #8		
51	2	EA		Screw,panhead,CRES,8-32x0.75		
52	6	EA		Screw,panhead,CRES,6-32x0.5		
53	12	EA		Washer, splitlock ,#6		
54	2	EA		Screw,panhead,CRES,6-32x0.75		
55	2	EA		Spacer, thru, #6 x 0.375		
56	1	REF	062-0062	Build Instructions, Rcvr Assy	SPRL	
57	3	EA	AN960C816L	Washer,flat,300 series stainless,ID 0.515"	McMaster	
58	1	EA	062-0127	Local Oscillator Filter Assembly	SPRL	G
59	2	EA		Screw,panhead,CRES,4-40x1.5		
60	2	EA		Washer,flat,#4		
61	2	EA		Washer,split lock,#4		
62	1	EA	ZFL-500LN	Amplifier,low -noise,linear,0.1-500 MHz	MiniCircuits	H

Parts List
Receiver Chassis Assembly
Next Assy: 062-0003
Prog: HF Radar
Cntrct No.:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICIS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
63	1	EA	062-0138	Amplifier Power Cable	UM/SPRL	W19
64	1	EA	062-0053-3	Power Cable (DE9 - TERM)	UM/SPRL	W20
65	1	EA	062-0054-3	RF Cable (SMA[RT] - SMA[RT])	UM/SPRL	W21



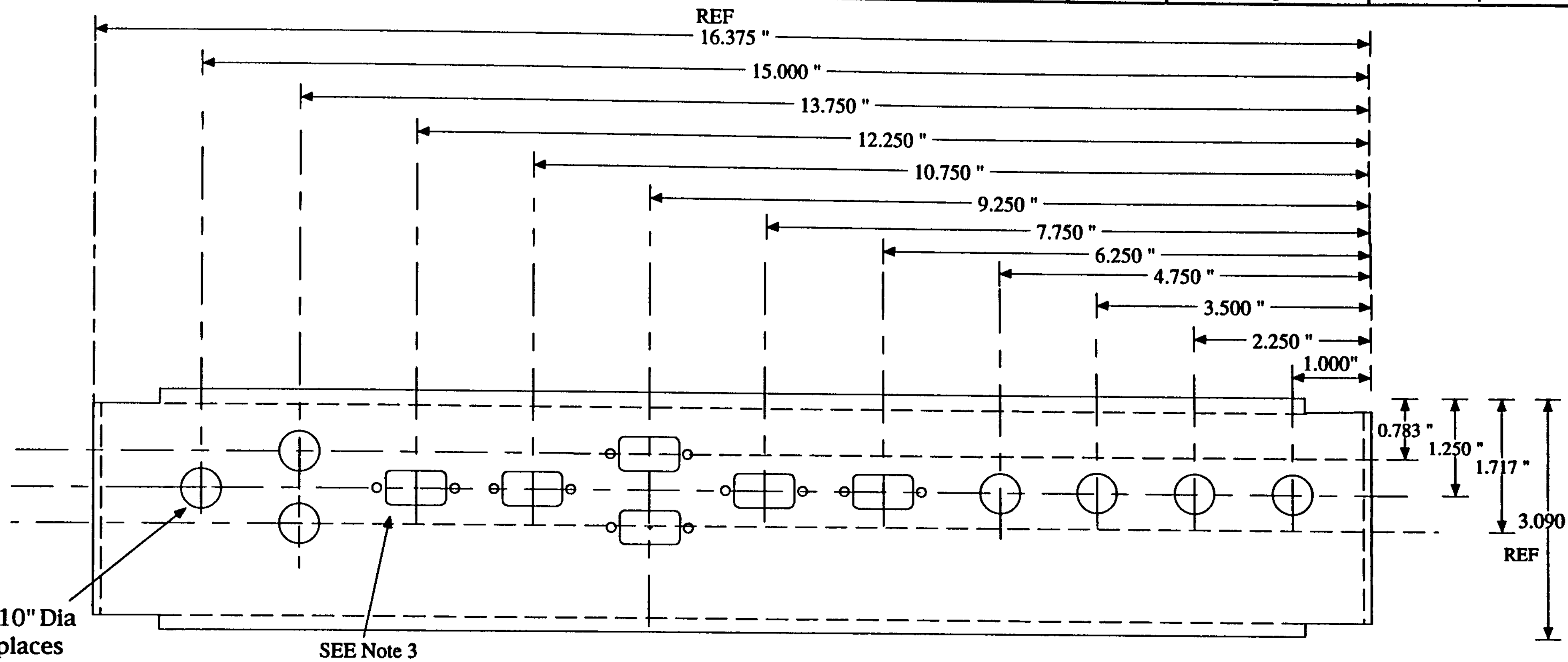
Notes:

1. This drawing details modifications to an FP-3 panel supplied as part of a Strongbox SP-3 chassis kit.
2. Remove all burrs and break sharp edges.
3. **Install speaker grille secured with flathead screws, 4 places, from assembly kit before painting.**
4. Prime and paint both sides using Sherwin Williams Polane T, #F63H13, Instrument Tan
5. Silkscreen nomenclature using White epoxy paint per sheet 2 of drawing 062-0063

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan	Receiver Chassis Front Panel Modification	REV	03-13-96 NS
		REV	03-12-96 NS
		REV	03-18-96 NS
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	Rcvr Ch Frnt Panel Mod	062- 0065	1 of 1 X10 COG ENG

1
Drawing Page



Notes:

1. This drawing details modifications to an IMP-3 interior mounting panel supplied as part of a Strongbox SP-3 chassis kit.
2. Remove all burrs.
3. 9-pin D-connector cut-out (SEE: 060-0097) - 6 places
4. Silkscreen nomenclature per sheet 3 of 062-0063 using black epoxy paint on natural aluminum.

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

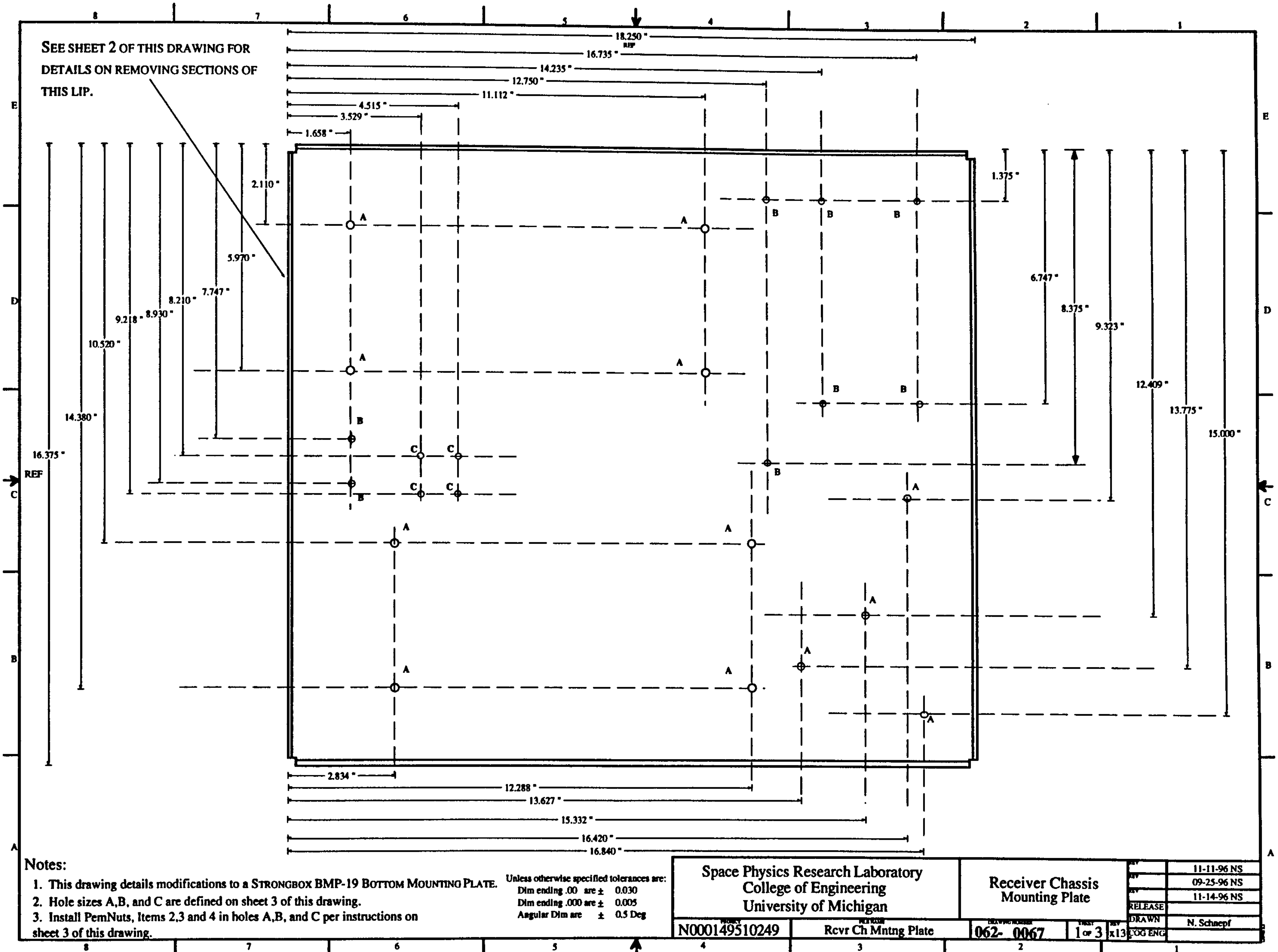
Space Physics Research Laboratory
College of Engineering
University of Michigan

Receiver Chassis
Rear Panel
Modification

REV	03-22-96 NS
REV	03-12-96 NS
REV	11-07-96 NS
RELEASE	
DRAWN	N. Schnepf
COG ENG	

N000149510249 | Rcvr Ch Rr Panel Mod | 062- 0066 | 1 OF 1 | X9

Drawing Page



Notes:

1. This drawing details modifications to a STRONGBOX BMP-19 BOTTOM MOUNTING PLATE.
2. Hole sizes A,B, and C are defined on sheet 3 of this drawing.
3. Install PemNuts, Items 2,3 and 4 in holes A,B, and C per instructions on sheet 3 of this drawing.

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

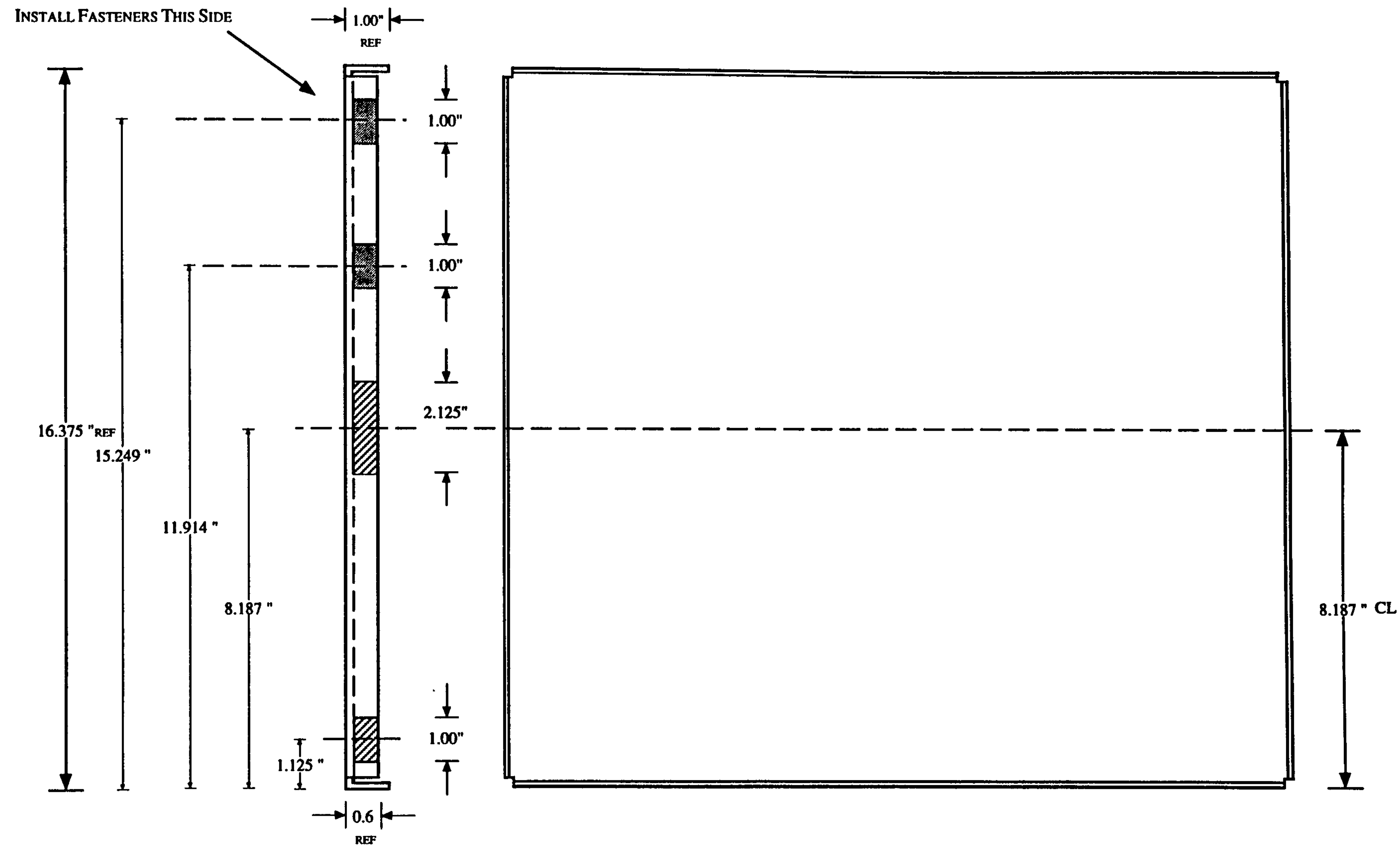
Space Physics Research Laboratory
College of Engineering
University of Michigan

Receiver Chassis
Mounting Plate

REV	11-11-96 NS
REV	09-25-96 NS
REV	11-14-96 NS
RELEASE	
DRAWN	N. Schnepf
COG ENG	

N000149510249 | Rcvr Ch Mntng Plate | 062- 0067 | 1 of 3 | x13

1 Drawing Page



Notes:

Remove lip flush with bottom surface at four shaded locations.
Cutouts are centered about indicated locations.

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan		Receiver Chassis Mounting Plate			03-26-96 NS 03-19-96 NS 04-01-96 NS
				RELEASE	
				DRAWN	N. Schnepf
N000149510249	Cutout Location	062- 0067	2 OF 3 x13	COG ENG	

1 Drawing Page

FASTENER INSTALLATION INSTRUCTIONS:

1. Tolerance for fastener hole sizes are +0.003 -0.000.
2. Do **not** deburr mounting holes on either side of sheet before installing PEM fasteners.
3. Place shank of fastener into mounting hole and apply squeezing force until the head of the nut comes into contact with the sheet.

LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol	Hole Size
1	1	BMP-19	Bottom Mounting Plate	Strongbox		
2	8	CLS-632-3	Fastener, 6-32, Stainless	PEM	B	0.1875
3	12	CLS-832-3	Fastener, 8-32, Stainless	PEM	A	0.213
4	4	CLS-440-3	Fastener, 4-40, Stainless	PEM	C	0.213

Space Physics Research Laboratory College of Engineering University of Michigan	Receiver Chassis Mounting Plate	REV		
		REV	11-07-96 NS	
		REV	04-01-96	
		RELEASE		
		DRAWN	N. Schnepf	
N000149510249	Fabrication Instructions	062- 0067	3 OF 3	x13
		COG ENG		

The specification delineates the requirements and performance of a commercial digitally tunable bandpass filter used for the preselector in the HF Radar Receiver.

Manufacturer:	Pole Zero Corporation 5530 Union Centre Drive West Chester, Ohio 45069 Phone: 513-870-9060
Part Number:	Prototype: MINI-4-30-8,8-SMA-A Field Unit: MN-HF-4-34-8,8-SMA-AB
Serial Number:	Prototype: #A2141A-F Field Unit: #01001AG0
Tuning Range:	Prototype: 4 to 30 MHz Field Unit: 4 to 34 MHz

Description: This preselector consists of two filters which cover the HF bands of interest for this project. The filter bands are separated into two standard Mini-Pole bands: 4 to 10 and 10 to 30 or 10 to 34 MHz. There are 250 linear equally spaced increments across each filter band, resulting in 251 tune words from 00000000 to 11111010. The last 5 tune words for each band are reserved for housekeeping functions. The binary tuning word is determined by the following relationship:

$$\text{Tuneword} = \left(\frac{f_{desired} - f_{low}}{f_{high} - f_{low}}\right) \times 250$$

Strobe:

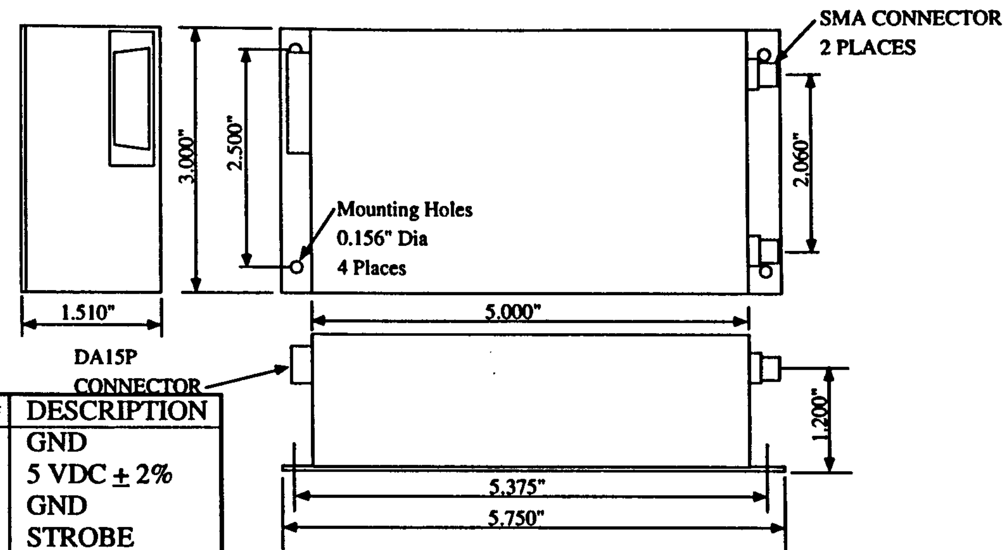
The filter is tuned within 100 uS (4 to 10 MHz) or 10 uS (10 to 30/34 MHz) to the frequency designated by the tune word when the STB line is brought low. Maximum strobe rate is 2 kHz.

RF Power Handling Capability:

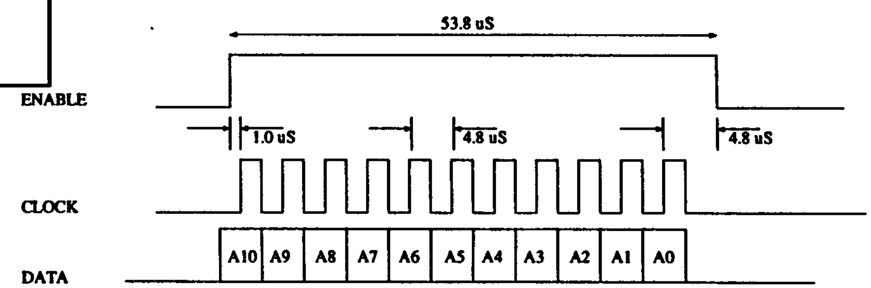
The filters are designed to operate with RF input power levels up to 1 Watt inband. Signals in the filter stop band up to 5 watts at the input will not cause damage to the filter.

Tune Code (A7 thru A0)	Result
00000000 thru 11111010	Lowest tuned frequency Highest tuned frequency
11111011 thru 11111110	RF Isolation (Filter band blanked)
11111111	Power saver mode; all PIN diodes are off

MECHANICAL DIMENSIONS



PIN#	DESCRIPTION
7	GND
8	5 VDC ± 2%
12	GND
13	STROBE
14	SERIAL CLK
15	DATA IN
1-6	UNUSED
9-11	UNUSED



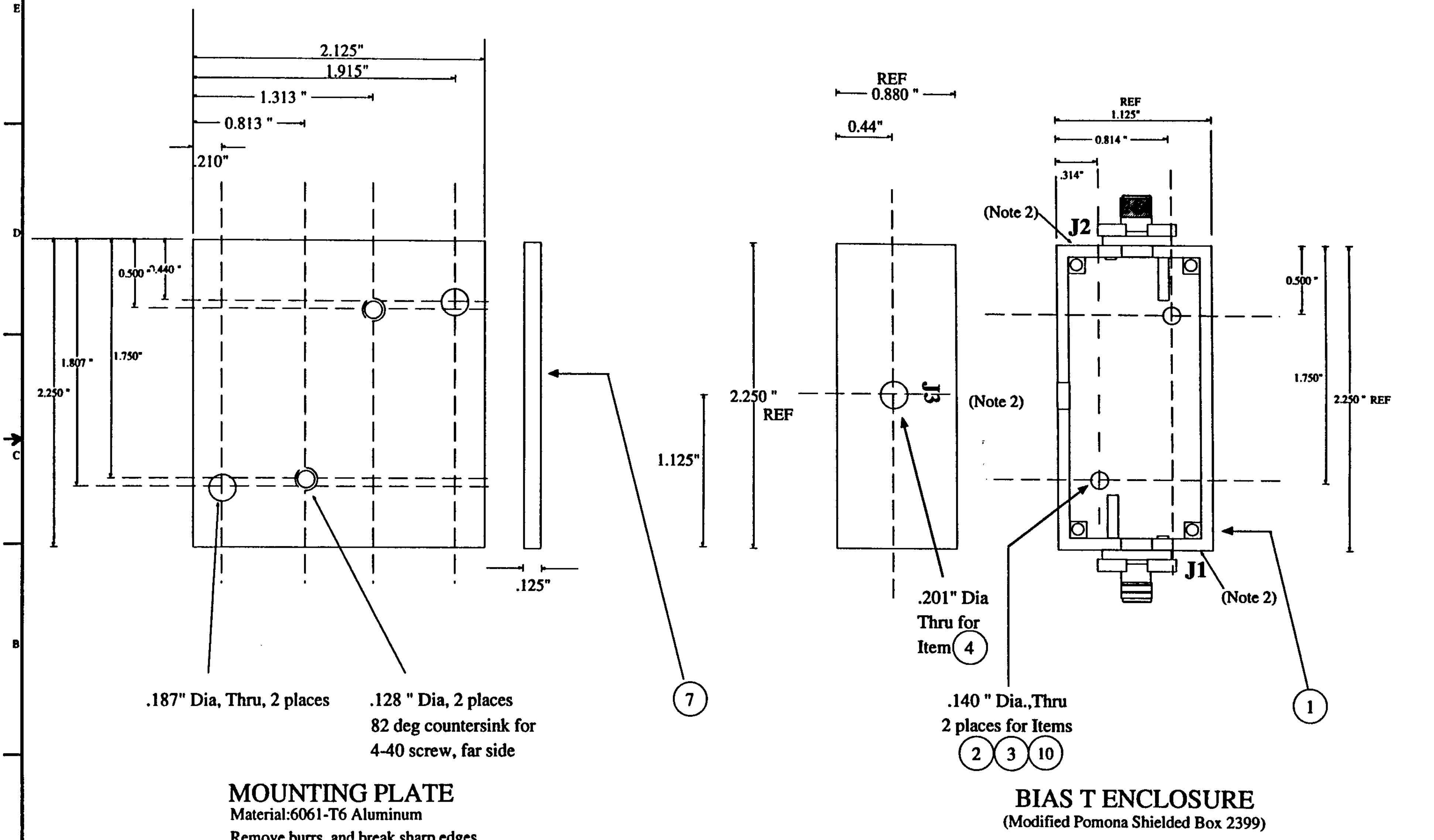
TYPICAL HF RADAR TIMING

Filter Band Selection	A_{10}	A_9	A_8
THRU-PATH	0	0	1
4-10 MHz	0	1	0
10-30/34 MHz	1	0	0
40dB RF Isolation	0	0	0

Note: See drawing 062-0077 for details on the Preselector Terminator Assembly required to properly terminate the control lines of this unit.

Space Physics Research Laboratory College of Engineering University of Michigan	Specification RF Preselector	01-20-97 NS 29 Feb 96 RELEASE DRAWN P. Hansen COG ENG
N000149510249	062- 0068	1 of 1 X3

Drawing Page



Note:

1. This drawing incomplete without parts list 062-0070.
2. Ink stamp J1, J2, and J3 on the outside of the diecast enclosure as shown using items 8 and 9.
3. See sheet 2 for assembly instructions and wiring details.

Unless otherwise specified tolerances are:

Dim ending .00	are ±	0.030
Dim ending .000	are ±	0.005
Angular Dim are	±	0.5 Deg

Space Physics Research Laboratory
College of Engineering
University of Michigan

Bias T Assembly

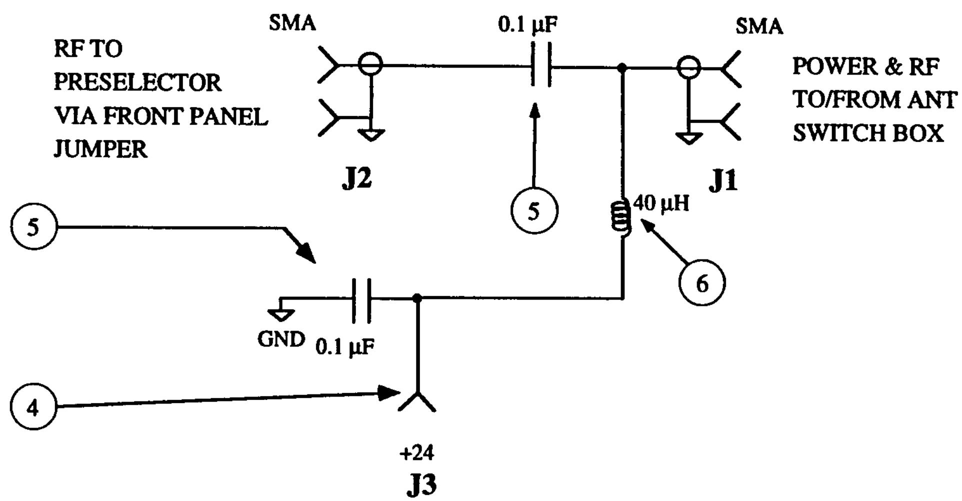
REV	03-04-96 NS	
REV	04-16-96 NS	
REV	04-15-96 NS	
RELEASE		
DRAWN	N. Schnepf	
COG ENG		

PROJECT	FILE NAME	DRAWING NUMBER	SHEET	REV
N000149510249	0069.1	062- 0069	1 of 2	X7

1
Drawing Page

ASSEMBLY INSTRUCTIONS:

1. Mark J numbers on diacast box as indicated on sheet 1, using items 8 and 9.
2. Install terminal, item 4, at J3.
3. Wire electronic components, items 5 and 6, per schematic below. Make capacitor ground connection to closest ground post on end of enclosure.
4. Assemble diecast box to mounting plate using items 2,3, and 10.
5. On the finished assembly, connect a 2 ft long 22 Ga white wire to J3. Install the completed assembly into the receiver chassis assembly per drawing 062-0063. Route the wire from J3 on the Bias T to TB1-B12. Trim the wire to length, and install crimp lug, item 11 before attaching to lug B12 of terminal board TB-1.



Space Physics Research Laboratory College of Engineering University of Michigan	Bias T Assembly		04-28-96 NS
			04-16-96 NS
			02-19-96 NS
		RELEASE	
N000149510249	0069.2	DRAWN	N. Schnepf
062-0069	2 OF 2	X7	COG ENG

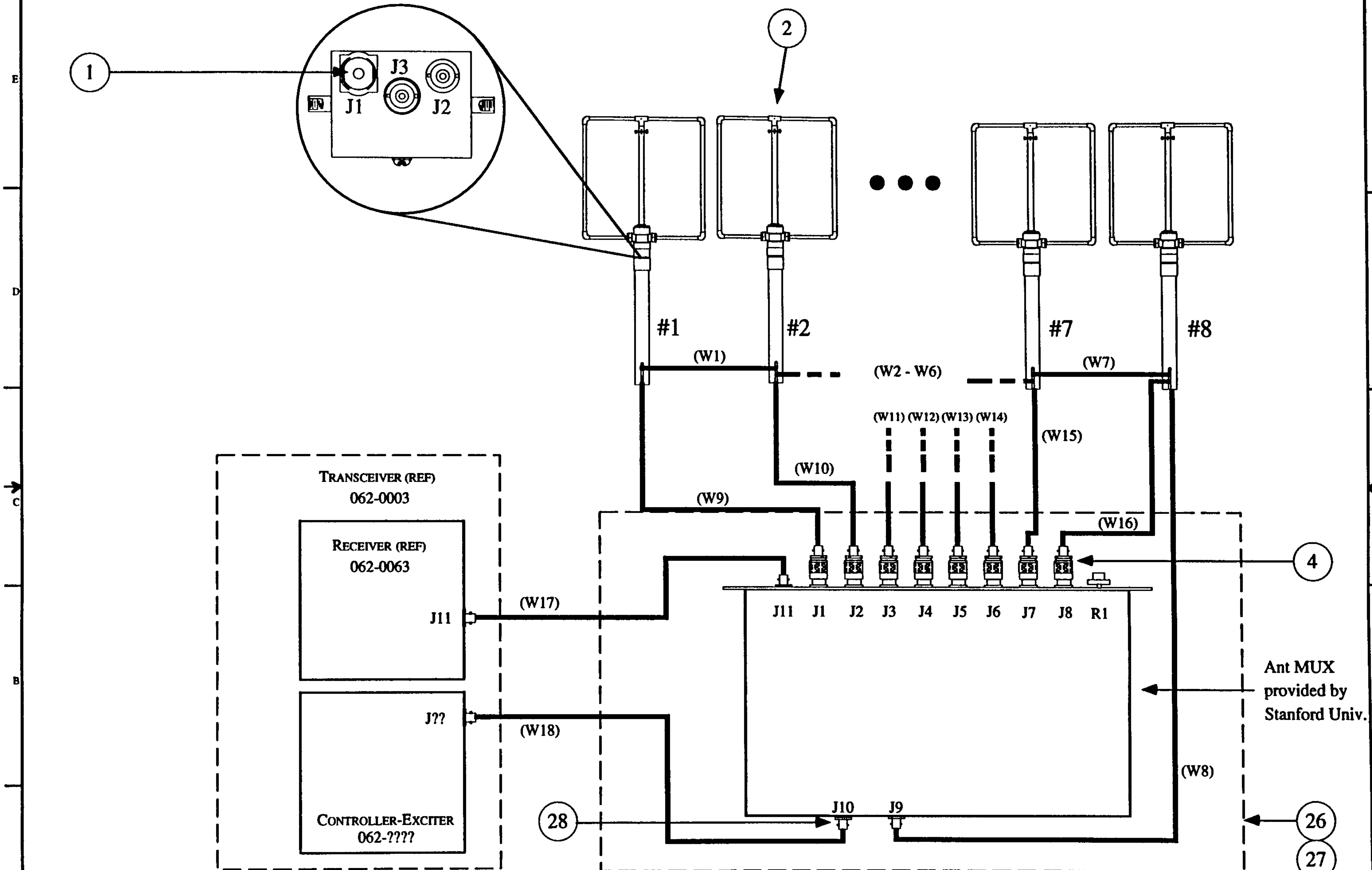
1 Drawing Page

Title:
Bias T Assy P/L
Next Assy:062-0063
Program:HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.: 062-0070
Revision: X3

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	1	EA	2399	Enclosure,Diecast,SMA Connectors	Pomona	
2	2	EA		Screw, 4-40, flat head,0.312		
3	2	EA		Nut,Hex, 4-40		
4	1	EA	1430	Terminal, insulated, molded	USECO	
5	2	EA	M39014/02-1350	Cap,Cer,0.1uF,100V,10%		
6	1	EA	5240	Inductor,40μH,High Current	J.W. Miller	
7	AR	FT	6061T6	Aluminum sheet, .125" thickness		
8	AR	OZ	2850FT	Epoxy,Black	Stycast	
9	AR	OZ	11	Catalyst	Stycast	
10	2	EA		Washer,Lock,Split, #4		
11	1	EA	18RA-6	Ring Terminal,Insulated,#6	T&B	
12	2	FT	1855	Wire,22GA,Stranded,PVC	Alpha	
13						
14						
15						
16						

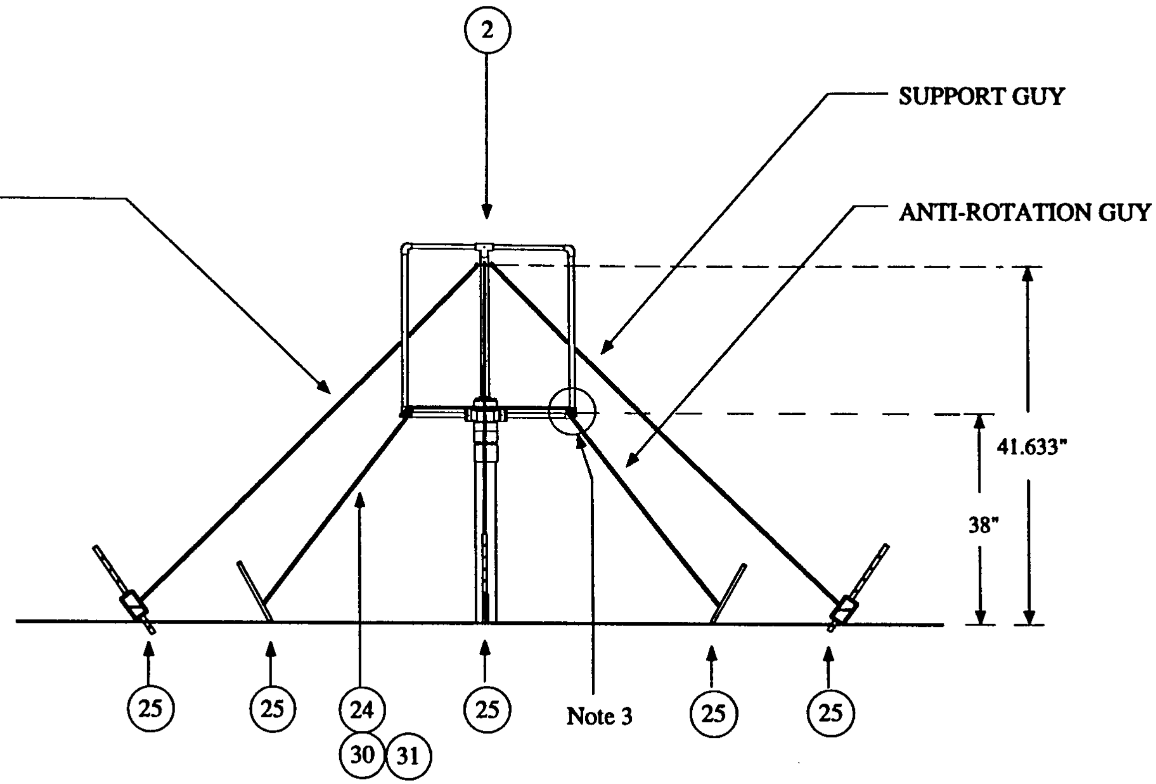


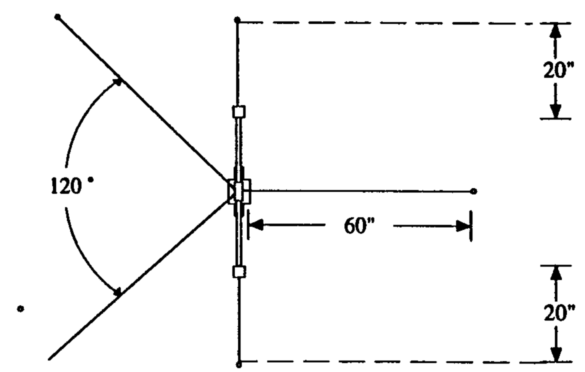
Notes:

1. This drawing incomplete without parts list 062-0072.
2. Spacing between receive antenna array elements is one-half wavelength apart at the highest frequency of operation :
   (300/21.77)/2 = 6.89 m
3. See sheet two for guy rope layout.

Space Physics Research Laboratory College of Engineering University of Michigan	Receive Antenna Array (PROTOTYPE)	REV	07-24-96 NS
		REV	04-30-96 NS
		REV	01-20-97 NS
		RELEASE	
PROJECT N000149510249	FILE NAME Rcv Ant Array Assy	DRAWN	N. Schnepf
DRAWING NUMBER 062- 0071	SHEET 1 OF 2 · REV x6	COG ENG	

1
Drawing Page





Notes:

1. This drawing incomplete without parts list 062-0072.
2. **GUY ROPE PREPARATION:**
   a) measure off lengths appropriate to the type of guy rope (support or anti-rotation) (SEE notes 3 and 4 below).
   b) wrap a piece of electrical tape (item 30) around each end of guy rope section.
   c) cut rope in the center of electrical tape to avoid fraying. leave tape on both sections of rope after cutting.
   d) dip each end of guy rope section in rope sealant (item 29).
3. This guy is one continuous 7' length of rope (item 24) anchored at the two stakes parallel with the long axis of the antenna. Additionally, the rope is wrapped twice about each of the lower 90° copper joints at the points indicated.
4. Horizontal lengths represent ground distances.
5. These support guys are three 8' lengths of rope (item 23) anchored at one end to a metal stake (item 25) and at the other end to an eyebolt at the top of the receive antenna (see side view above).

Space Physics Research Laboratory College of Engineering University of Michigan		Receive Antenna Array Assenbly (Antenna Deployment)		REV 04-21-97 NS REV 07-24-96 NS RELEASE DRAWN 07-23-96 NS COG ENG
N000149510249	Rcv Ant Array Assy	062- 0071	2 of 2	x6

Drawing Page

Receive Ant Array P/L
Next Assy: 062-0007
Program: HF Radar
Contract No.:N000149510249

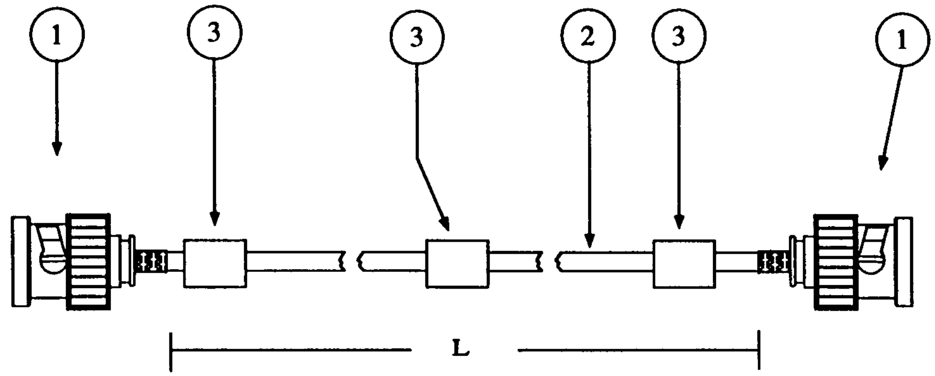
UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:062-0072
Revision:X4

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol	Notes
1	1	EA	KC-89-64	50 Ω Terminator	Kings		
2	8	EA	062-0025	Receiver Antenna Assembly	SPRL		
3	1	EA	062-0088	Antenna Mux Chassis Assy	SPRL		Field Unit Only
4	8	EA	31-216	Adapter, N Plug to BNC jack	Amphenol		Proto Only
5	1	EA	062-0074-1	Cable Assembly, BNC-BNC	SPRL	W1	
6	1	EA	062-0074-2	Cable Assembly, BNC-BNC	SPRL	W2	
7	1	EA	062-0074-3	Cable Assembly, BNC-BNC	SPRL	W3	
8	1	EA	062-0074-4	Cable Assembly, BNC-BNC	SPRL	W4	
9	1	EA	062-0074-5	Cable Assembly, BNC-BNC	SPRL	W5	
10	1	EA	062-0074-6	Cable Assembly, BNC-BNC	SPRL	W6	
11	1	EA	062-0074-7	Cable Assembly, BNC-BNC	SPRL	W7	
12	1	EA	062-0074-8	Cable Assembly, BNC-BNC	SPRL	W8	
13	1	EA	062-0074-9	Cable Assembly, BNC-BNC	SPRL	W9	
14	1	EA	062-0074-10	Cable Assembly, BNC-BNC	SPRL	W10	
15	1	EA	062-0074-11	Cable Assembly, BNC-BNC	SPRL	W11	
16	1	EA	062-0074-12	Cable Assembly, BNC-BNC	SPRL	W12	
17	1	EA	062-0074-13	Cable Assembly, BNC-BNC	SPRL	W13	
18	1	EA	062-0074-14	Cable Assembly, BNC-BNC	SPRL	W14	
19	1	EA	062-0074-15	Cable Assembly, BNC-BNC	SPRL	W15	
20	1	EA	062-0074-16	Cable Assembly, BNC-BNC	SPRL	W16	
21	1	EA	062-0074-17	Cable Assembly, BNC-BNC	SPRL	W17	
22	1	EA	062-0074-18	Cable Assembly, BNC-BNC	SPRL	W18	
23	192	FT	36955T11	Rope,3-strand,poly,5/16" - 3 per antenna - support guys	McMaster-Carr		
24	56	FT	36955T11	Rope,3-strand,poly,5/16" - 1 per antenna - anti-rotation guys	McMaster-Carr		
25	40	EA	9415T16	Stake, round, 18", steel, .75" diameter	McMaster-Carr		
26	1	EA	062-0144	Enclosure Assembly,MUX Protective	SPRL		Field Unit Only

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol	Notes
27	2	EA	KC-99-35	Adapter,BNC,Jack-Plug,right angle,for RG58	Kings		Proto Only J9 & J10 of item 3
28	1	EA	5922A2	Hammer,One-piece,Steel,3 lb.	McMaster-Carr		
29	1	EA	3843T14	Sealer, Rope	McMaster-Carr		
30	1	EA		Tape,Electrical,PVC			



Notes:

1. See drawing 062-0113 for connector assembly instructions.
2. See drawing 062-0082 for cable marking details.

LIST OF MATERIALS

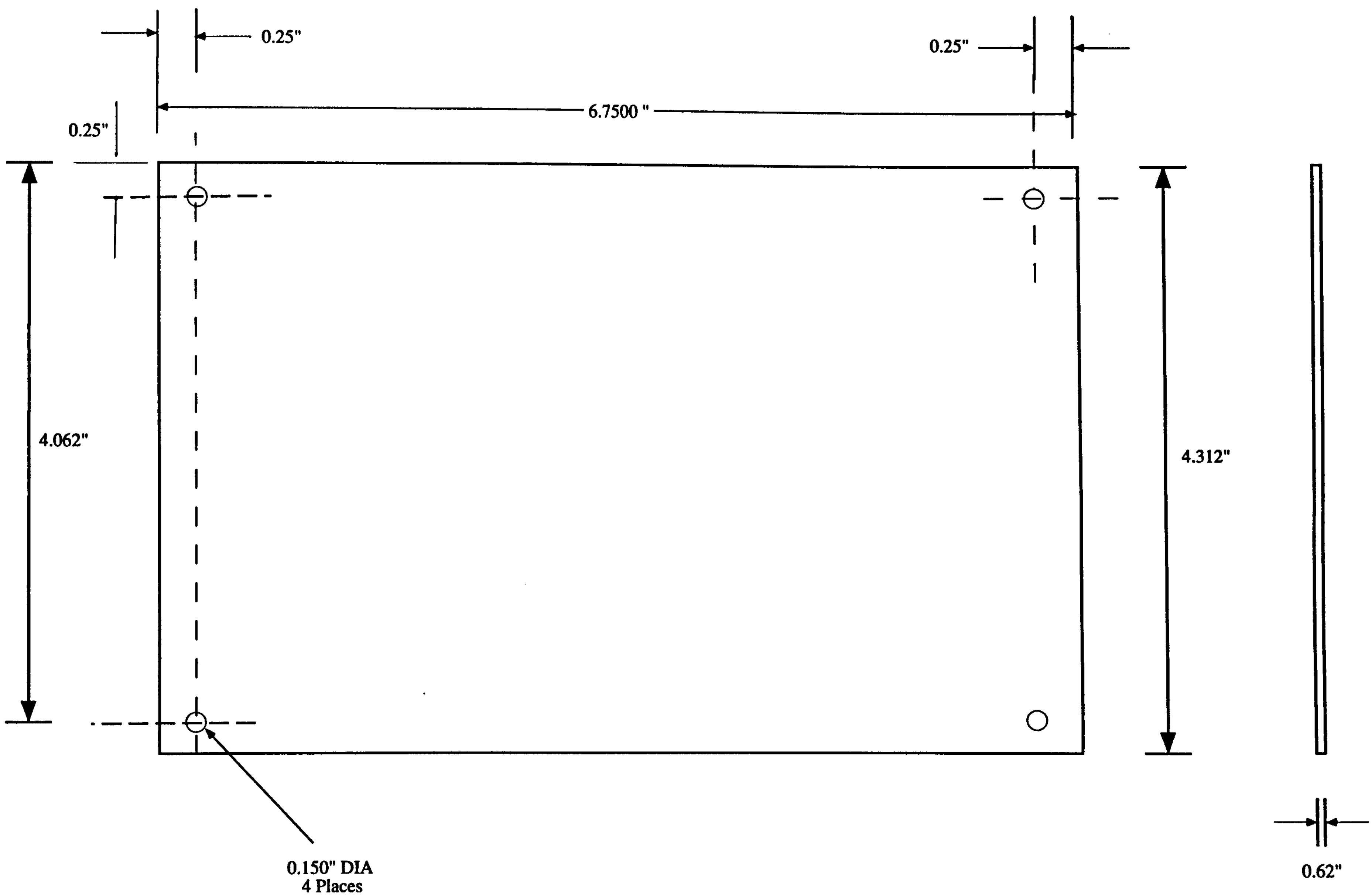
Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	2	225395-1	BNC Plug, crimp-on	Amp	
2	*(see table)*	9058C	RG 58C/U - 50 Ω Coax	Alpha	
3	1	MLCT 114C	Marker/Tie wrap	SPC Tech	

CABLE ASSEMBLIES

Dash No.	Desig-nation	Length	From	Pos	To	Pos (Proto)	Pos (Fld 1)
-1	W1	32'	Preamp 1	J2	Preamp 2	J1	J1
-2	W2	32'	Preamp 2	J2	Preamp 3	J1	J1
-3	W3	32'	Preamp 3	J2	Preamp 4	J1	J1
-4	W4	32'	Preamp 4	J2	Preamp 5	J1	J1
-5	W5	32'	Preamp 5	J2	Preamp 6	J1	J1
-6	W6	32'	Preamp 6	J2	Preamp 7	J1	J1
-7	W7	32'	Preamp 7	J2	Preamp 8	J1	J1
-8	W8	100'	Preamp 8	J2	Ant Switch Box	J9	Preamp Blanking Out
-9	W9	100'	Preamp 1	J3	Ant Switch Box	J1	Ant 1
-10	W10	100'	Preamp 2	J3	Ant Switch Box	J2	Ant 2
-11	W11	100'	Preamp 3	J3	Ant Switch Box	J3	Ant 3
-12	W12	100'	Preamp 4	J3	Ant Switch Box	J4	Ant 4
-13	W13	100'	Preamp 5	J3	Ant Switch Box	J5	Ant 5
-14	W14	100'	Preamp 6	J3	Ant Switch Box	J6	Ant 6
-15	W15	100'	Preamp 7	J3	Ant Switch Box	J7	Ant 7
-16	W16	100'	Preamp 8	J3	Ant Switch Box	J8	Ant 8
-17	W17	500'	Receiver	J11	Ant Switch Box	J11	MUX Common
-18	W18	500'	Contrlr-Exctr	J	Ant Switch Box	J10	MUX Control In
-19	W18	6 INCHES	Front Panel	J5	Front Panel	J4/J6	J4/J6

Space Physics Research Laboratory College of Engineering University of Michigan	RF Cable Assembly (BNCm-BNCm)
N000149510249	RF Cable (BNCm-BNCm)
062- 0074	1 OF 1 x5

	01-14-97 NS
	04-30-96 NS
	04-23-96 NS
RELEASE	
DRAWN	N. Schaepf
COG ENG	



Next Assembly:062-0040

NOTES:
1. Material - 6061T6 Aluminum
2. Break all sharp edges

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

Space Physics Research Laboratory
College of Engineering
University of Michigan

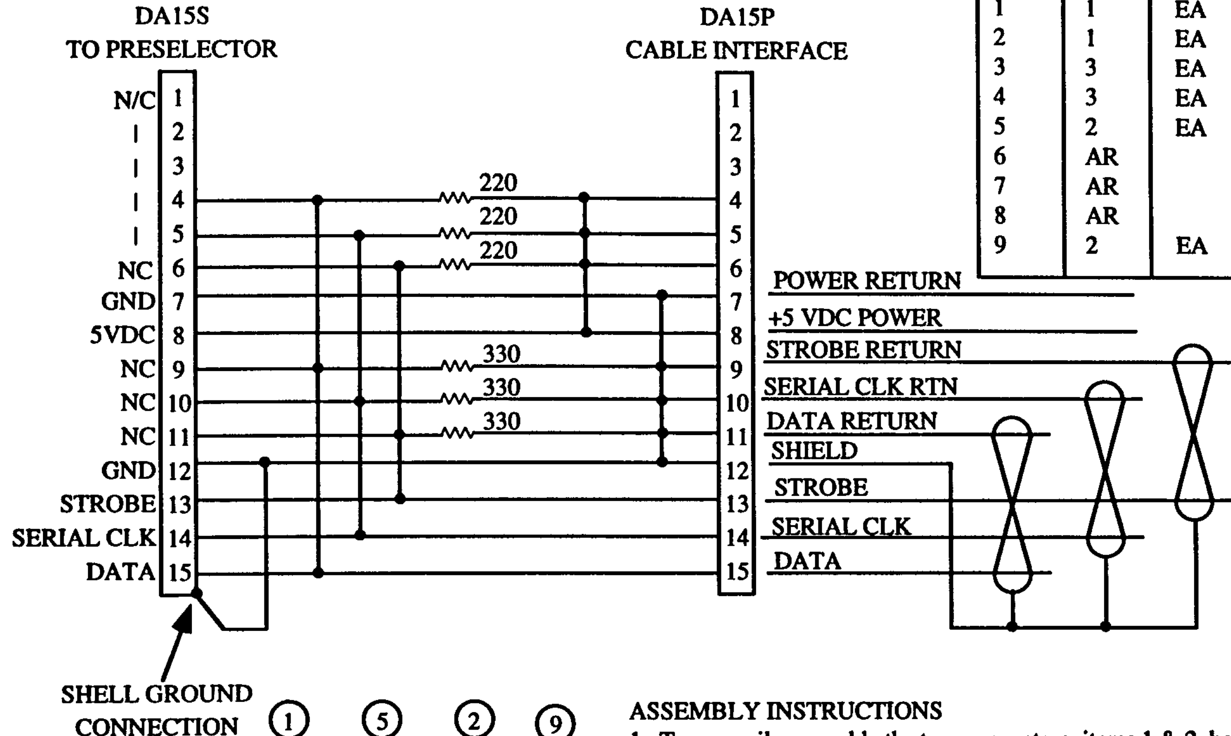
Mixer-IF Shield Plate

04-02-96 NS
RELEASE
DRAWN N.Schnepf
COG ENG

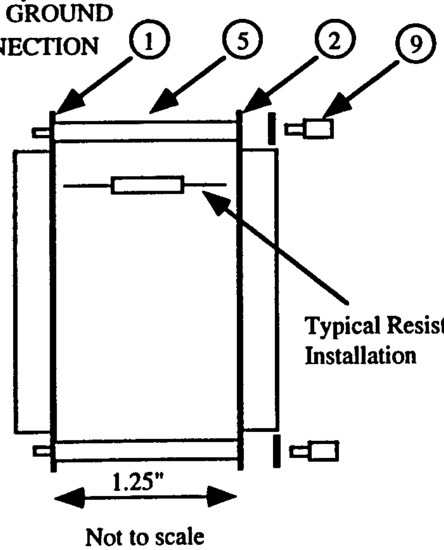
N000149510249
062- 0076
1 of 1
x2

Drawing Page

ITEM	QTY	U/M	PART NO.	DESCRIPTION	MFR
1	1	EA	DAM-15S	Connector,Solder Cup	Cinch
2	1	EA	DAM-15P	Connector,Solder Cup	Cinch
3	3	EA	RCR07G221JS	Resistor,220,.25W,5%	
4	3	EA	RCR07G331JS	Resistor,330,.25W,5%	
5	2	EA	2094	Spacer,Threaded,4-40x1.25	Keystone
6	AR			Wire,22GA, Solid	
7	AR			Shrink Tubing,22GA	
8	AR			Shrink Tubing,1.5 Inch	
9	2	EA	205817-2	Female Screwlock	Amp



WIRING INTERFACE
DETAILS FOR MATING
CABLE



ASSEMBLY INSTRUCTIONS

1. Temporarily assemble the two connectors, items 1 & 2, back to back using spacer, item 5 and 4-40 x 2" hardware.
2. Install resistors, item 3 and 4 per schematic, soldering the resistor to the solder cup.
3. Make the straight thru connections between the connectors using #22 bus wire.
4. Make the jumper connections between pins using #22 bus wire and shrink tubing.
5. Connect the shell of the DAM-15S connector to the ground pin by lap soldering a #22 wire to the shell and connecting it to the indicated pin.
6. Visually inspect and continuity test the assembly.
7. Remove the #4 hardware and spacers.
8. Install the large shrink tubing over the wiring portion and apply heat.

INSTALLATION INSTRUCTIONS

1. Use threaded spacers, item 5 to secure assembly to control connector on RF Preselector.
2. Use female screwlocks and lockwashers, item 9, to secure male D connector to thereaded spacers, item 5.

Space Physics Research Laboratory
College of Engineering
University of Michigan

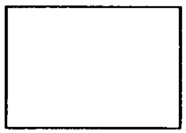
Preselector Terminator Assembly

N000149510249 | 062- 0077 | 1 of 1 | -

Assembly instructions for mating SMA Plug to RG-316 coaxial cable

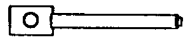
Connector: Amphenol 901-9511-3
CrimpTool: Sealectro 50-000-0091 with 0.128 die
Stripping Tool: Ideal Coax #45-162

Parts:

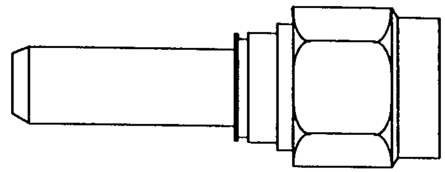


Shrink Tubing

Outer Ferrule



Center Contact

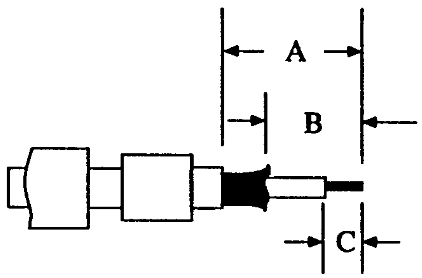


Plug Body Assembly

Directions:

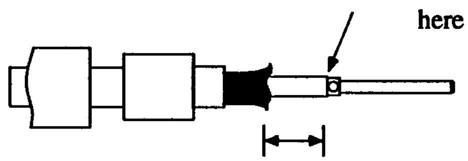
Step 1

Dimensions
A = 0.300"
B = 0.090"
C = 0.090"



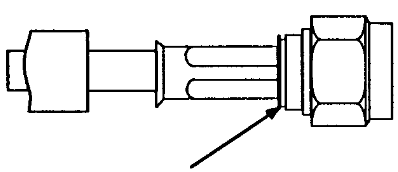
Slide heat shrink tubing and outer ferrule onto cable. Strip cable jacket, braid and dielectric to dimensions shown to the left. All cuts are to be sharp and square.
Important: Do not nick braid, dielectric or center conductor when cutting.
Tin center conductor. Avoid excessive heat to prevent swelling of cable dielectric. Flare end of cable braid slightly as shown to facillitate insertion of inner ferrule.
Important: Do not comb out braid.

Step 2



Solder center contact to cable center conductor as shown. Remove excess solder.
Note: Contact must bottom against dielectric.

Step 3



Install coupling nut and body assembly as shown. Place ferrule against body and crimp with die set indicated above. Place heat shrink tubing over crimp ferrule, against body, and apply heat.

Step 4

Using an ohmmeter, check the cable for shorts between the inner and outer conductor.

Space Physics Research Laboratory College of Engineering University of Michigan	Manufacturing Procedure SMA/RG316		02-12-97 NS
			03-11-96 NS
		RELEASE	
		DRAWN	N. Schnepf
N000149510249	062-0080	1 of 1 x4	

Drawing Page

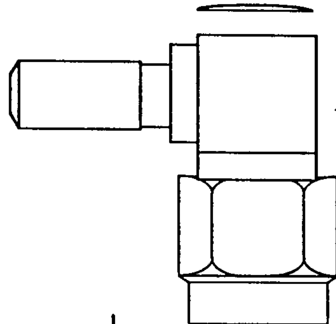
Assembly instructions for mating SMA angle Plug to RG-316 coaxial cable

Connector: Amphenol 901-9531-3
CrimpTool: Sealectro 50-000-0091 with 0.128 die
Stripping Tool: Ideal Coax #45-162

Parts:

Shrin Tubing

Outer Ferrule

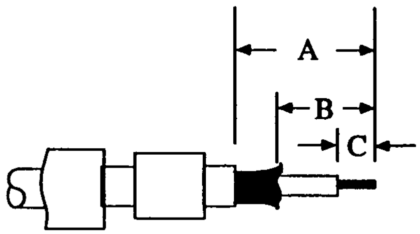


Angle Body Assembly

Directions:

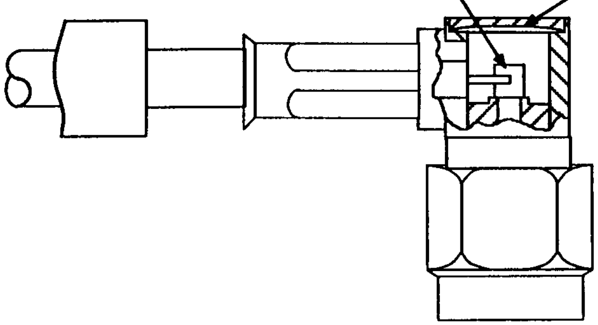
Step 1

Dimensions
A = 0.475"
B = 0.235"
C = 0.090"



Slide heat shrink tubing and outer ferrule onto cable. Strip cable jacket, braid and dielectric to dimensions shown to the left. All cuts are to be sharp and square. **Important:** Do not nick braid, dielectric or center conductor when cutting. Tin center conductor. Avoid excessive heat to prevent swelling of cable dielectric. Flare end of cable braid slightly as shown to facillitate insertion of inner ferrule. **Important:** Do not comb out braid.

Step 2



Place cable dielectric into body and press ferrule against body as shown. Crimp with die set shown above. Solder cable center conductor into contact as shown. Inser cap as shown and dimple or lightly punch center of cap for rentention in body. Place heat shrink tubing over crimp ferrule, against body, and apply heat.

Step 3

Using an ohmmeter, check the cable for shorts between the inner and outer conductor.

Space Physics Research Laboratory College of Engineering University of Michigan	Manufacturing Procedure SMA angle/RG316	RELEASE 03-08-96 NS DRAWN N. Schnepf COG ENG
N000149510249	062- 0081	1 OF 1

Drawing Page

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Title: Cable Marking Procedure Program: HF RADAR	FSCM No.: 0TK63 Drawing No.: 062-0082 Revision: X2 Page 1 of 2 Contract No.: N000149510249

This is an uncontrolled HF Radar Document

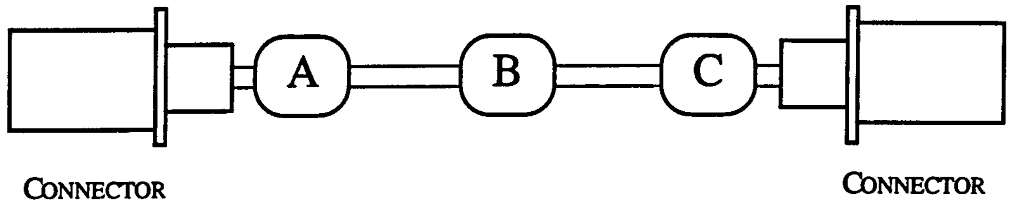
APPROVAL RECORD

Function	Title - Organization	Name	Signature	Date
Originator	PE - U of M	P. Hansen		
Checker				
Mechanical				
Electrical	PE - U of M			
Software	PE - U of M			
QA	QA - U of M			
Mfg				
Reliability				
Project	PM - SU			
Principal Inv	PI - U of M	J. Vesecky		
Customer				

REVISION RECORD

Revision	Description	Date	Approval
-	Initial Release		

Title: Cable Marking Procedure	FSCM No.:	0TK63
	Drawing No.:	062-0082
	Revision:	X2
	Page	2 of 2
Program: HF RADAR	Contract No.:	N000149510249



1. LOCATION:

At each end of the cable assembly, allowing for a reasonable radius of curvature in the cable near the connector, afix a tag (called out on the individual cable assembly). If the cable length is in excess of 10 feet place an additional tag as reasonably close to the midpoint of the assembly as possible.

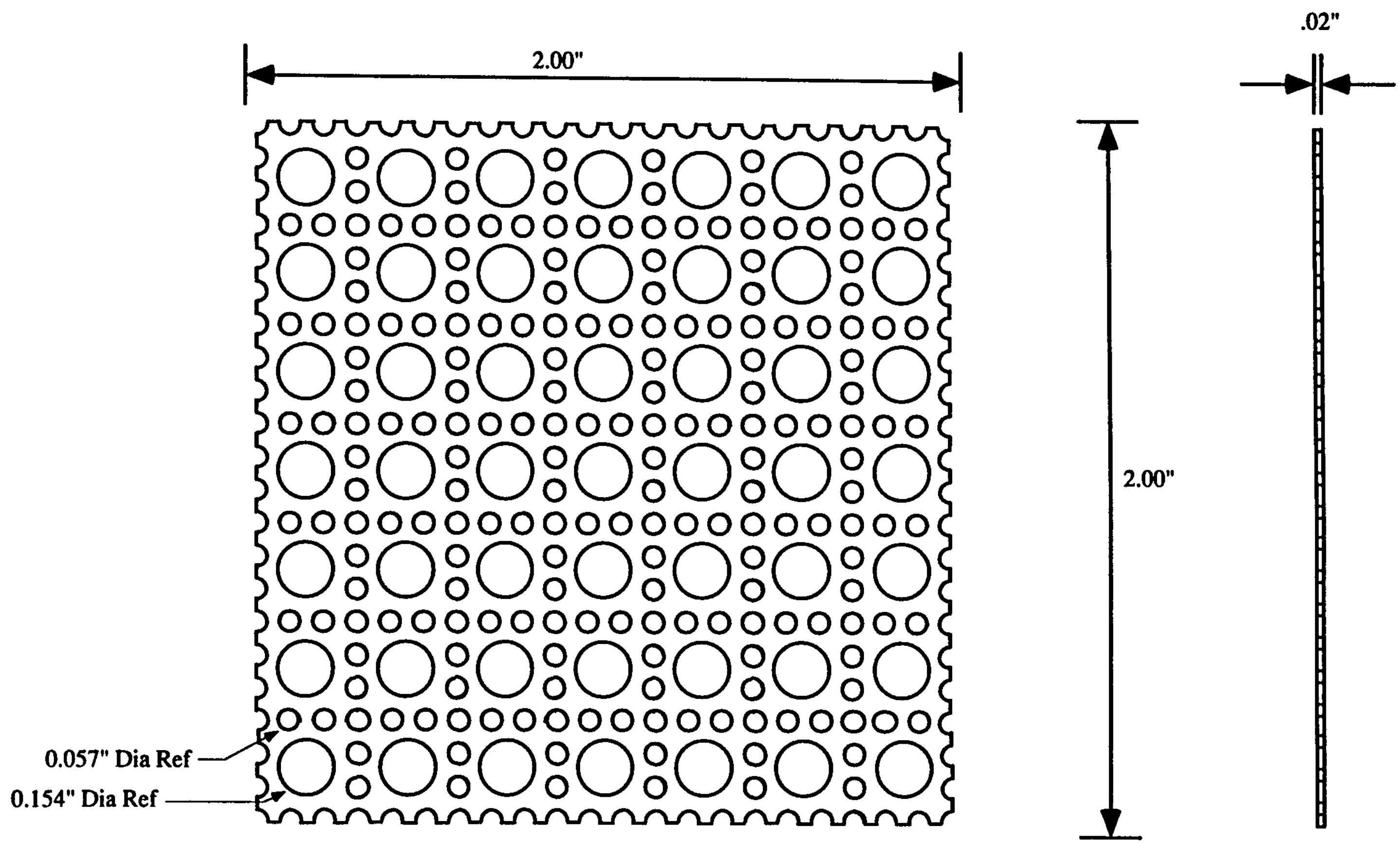
2. FORMAT:

Using an indelible marker, mark the tag with the associated subassembly name and connector designation (typically referenced by J-number), separated by a forward slash. Abbreviations are acceptable when spacing is a constraint as long as they are easily interpreted.

EXAMPLE:

Cable assembly W17 (062-0054-2) connects the DEMOD connector J1 with the IF-Mixer connector J6. It's specified length is less than 10 feet and therefore only requires two tags, A and C.

Tag A	DEMOD/J1
Tag B	W17/062-0054
Tag C	IF/J6



Note:

1. Material is Reynolds "Do-it Yourself" aluminum stock as shown.

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan	Speaker Grille	04-29-96 NS
N000149510249	Speaker Grille	062- 0083 · 1 of 1

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Title: Mixer-IF Build Instructions	FSCM No.:	0TK63
	Drawing No.:	062-0084
	Revision:	X3
	Page	1 of 7
Program: HF RADAR	Contract No.:	N000149510249

This is an uncontrolled HF Radar Document

APPROVAL RECORD

Function	Title - Organization	Name	Signature	Date
Originator	PE - U of M	P. Hansen		
Checker				
Mechanical				
Electrical	PE - U of M			
Software	PE - U of M			
QA	QA - U of M			
Mfg				
Reliability				
Project	PM - SU			
Principal Inv	PI - U of M	J. Vesecky		
Customer				

REVISION RECORD

Revision	Description	Date	Approval
-	Initial Release		

Introduction

These instructions are to be used in fabricating the Mixer-IF Assembly (062-0040). Included are instructions to first fabricate the Mixer-IF PCB Assembly (062-0043). This project requires adherance to good commercial practice standards.

Reference drawings:

062-0040	Mixer-IF Assembly
062-0041	Mixer-IF Assembly Parts List
062-0076	Mixer-IF Shield Plate
062-0043	Mixer-IF PCB Assembly
062-0045	Mixer-IF PCB Parts List
062-0046	Mixer-IF PCB Raw Card
062-0044	Mixer-IF Schematic (5 sheets)
062-0042	Mixer-IF Enclosure
062-0117	Mixer-IF PCB Modification

PCB Fabrication

Make sure all parts called out on the PCB Assembly parts list 062-0041 are available for assembly. Also, the Mixer-IF Enclosure, 062-0042 should be available for installation of connectors and interface wiring.

PCB Modification Notes:

The circuit design has been modified without changing the PC board artwork. For this reason, several changes to the PC board need to be made before component assembly is started. All modification instructions in this procedure appear in italics. Perform the following operations on PCB 062-0046 per modification drawing 062-0117.

0.1. Using a Dremel tool and rotary cutting wheel, make cuts no wider than the cutting wheel thickness in the traces on section B at the locations shown in the modification drawing. These cuts should be perpendicular to the trace.

0.2. Using an Exacto knife, carefully remove the solder mask on either side of the cuts just made in step 1. Remove enough solder mask to allow *chip resistors (items 53.09 and 53.1 on parts list 062-0045 Revision X5) to be soldered to the exposed lands in later assembly steps.*

0.3. Tin the exposed lands prepared in step 2.

Refer to the PCB assembly drawing 062-0040, PCB parts list 062-0045, and schematic 062-0044 for references made in the following instructions:

1. Swage and then solder the USECO terminals, item 19 into the PCB at the following locations: J1, J2, J3, J4, J5, J6, JP1, JP5, JP6, JP7, JP8, and JP9.

2. Install and solder the power supply components shown on sheet 3 of the schematic. This includes the decoupling networks (*L18*, R46 thru R48, C38,39,46,47) and the two regulators, U9 and U101, and the associated resistors and capacitors. Do not install U6 or U8 at this time.

Assembly Modification Note:

2.01 L18 is installed in the slot marked "R45".

3. Submit the board to engineering for checkout of the power circuitry.

Note: Completion of the PCB assembly will be carried out in two steps. All parts except for socketed ICs and trimmer capacitors will be installed. The board will be cleaned of solder flux, and then the unsealed components will be installed.

4. Install the rest of the PCB components except for the following:

    U1, U3, U6, U7, U8, and their sockets.
    Trimmer capacitors C26, C27,C50, C51, C52, C57, C58, C60, C70, C71, C72

    Note: It will be necessary to trim the excess lead length from the stripline ATC capacitors, items 1, 6, 7, 8, 12, and 14. The location where the capacitor is to be installed on the PCB should be pre-tinned, the capacitor leads trimmed, and then the capacitor laid in place and the solder reflowed. Similarly, the leads on the stripline

MAR-6 amplifiers, item 57, should be trimmed before the reflow solder operation.

Assembly Modification Notes: *The majority of the design changes are summarized here. These steps do not need to be performed in sequence, but should be checked off as they are completed:*

4.1 Capacitors C80, C81, C82 and C83 are added to the solder side of the board. The other components need to be installed first in order to have device leads to wrap the capacitor leads on. Use sleeving as required.
4.2 Capacitor slot C13 is open
4.3 Place a jumper wire in resistor slot R16
4.4 Resistor slot R14 is open
4.5 Resistor slot R15 is open
4.6 No amplifier is to be installed in location U2.
4.7 Inductor slot L4 is open
4.8 Add RC05 resistors R59, 60, and 61 to form an attenuator in place of U2. It will be necessary to remove solder mask and tin the PC trace areas before installation of these resistors.
4.9 Chip resistor R63 is installed in location marked "C12"
4.10 Resistors R62 and R64 are soldered to the "C12" pads on one end, and the ground trace directly above "C12" on the other end.
4.11 Diode D3 is connected in series with resistor R44 and installed in slot "R44". Stand up these two components. Check diode polarity against the schematic diagram.
4.12 Install diode D4 in resistor slot "R32". The cathode goes to the - 5V trace.
4.13 Resistor R31, diode D1, and resistor R65 are connected together, and will stand up with no connections to the board. The R31-D1 series components are installed in the two holes for resistor slot "R31". Check diode polarity against the schematic diagram. The free end of resistor R65 is connected to the right side of resistor R43.
4.14 The two outside ends of potentiometer R66 are connected across capacitor C31. The arm on the pot is used as a tie point for one end of R67. The other side of R67 is connected to the end of R29 that is connected to U6-pin2.
4.15 Diode D2 is added on the solder side of the board between R29 feedthru and R27 feedthru.
4.16 Capacitors C84 and C85 are added to the swage terminals at J5.
4.17 Resistor R68 is added across swage terminals at JP8.

4.18 Diode D5 is added on the solder side of the board between R42 feedthru and R44 / Q2 emitter feedthru.
4.19 Using the same technique as in the previous step, chip resistor R70 and capacitor C59 are installed vertically in the C59 location.
4.20 Resistor R67 is installed on the solder side of the board between R28 feedthru and C31+ feedthru.
4.21 Resistors R69,71,72,73,74,76,and 78 are additional chip resistors that are reflow soldered in the previously prepared modification pad areas per the modification drawing.
4.22 Resistor slot R22 is open
4.23 Capacitor slot R24 is open
4.24 Capacitor C86 is installed across swage terminals J4-5 to J4-6.
4.25 Resistor R22 is installed on the component side of the board between the Q1 collector via and the "L" shaped ground bus that has no other components connected to it.

5. All components installed at this time are sealed, and the board may be cleaned of flux and inspected.

6. Install the sockets for U1, U3, U6, U7, and U8. Also install the trimmer capacitors C26, C27,C50, C51, C52, C57, C58, C60, C70, C71, C72. Carefully observe the pin 1 orientation on the sockets - not all ICs face the same way. Do not allow flux to wick into IC sockets. Additional cleaning of the board should be done very carefully in order to not contaminate the sockets or the trimmer capacitors.

7. Visually inspect the board for parts installation accuracy and solder workmanship.

8. Separate the two board sections. Avoid placing stress on the entire board, but rather apply the separation force at the two attachment points between the sections. Trim the excess PCB material using a small file.

Final Assembly

Note: Make sure all parts called out on the IF- Mixer Assembly Parts List, 062-0041 are available. In the following steps, the wiring between board sections will be performed. Plan on providing enough service loop on the wires to allow the top board (section B) to be lifted up and rotated forward in order to gain access to the lower board (section A) when mounted in the enclosure. The shield plate, 062-0076 is installed between the two PC board sections as indicated on the assembly drawing.

1. Refering to the Mixer-IF assembly drawing, 062-0040, temporarily mount Section A of the PCB assembly in the chassis using the screws and spacers called out on the assembly parts list, 062-0041.

2. Install short lengths of RG-174 coax cables between the Useco terminals and panel mount SMA connectors J1, J2, J3 and J6, Item 15 on the PCB parts list 062-0045. Use shrink tubing on the coax to prevent the exposed ends of the braid from shorting to adjacent circuitry. The shield on the SMA connector end is terminated in a Zierek solder lug, Item 15 on 062-0041.

3. Connect the two D connectors, J4 and J5 (Items 16 and 17 on 062-0045) to the marked Useco standoffs on Section A of the PCB using 22 gauge wire.

Note: It is not necessary to install the shield plate when making connections to section B of the PC board in the following steps. However, be aware that the shield plate will be in place at final assembly.

4. Temporarily install section B on the standoffs to determine the lengths of wire needed in the following steps.

5. Install a short piece of RG-174 coax between terminals JP1 on section A, and JP8 on section B. Correctly mate the ground and signal connections on the two boards.

6. Install small lengths of 22 ga insulated wire between JP5 on Section A and JP7 on section B. Observe the ground and signal connections. The wires may be twisted together for neatness.

7. Similarly, connect JP6 on the A section to JP9 on the B section using 22 ga insulated wire.

8. Visually inspect the wiring for installation accuracy and solder workmanship.

9. Perform final installation of the spacers and shield plate to make sure the wires are sufficient length and are able to be dressed properly.

10. Ink stamp the J-numbers on the outside of the enclosure using Stycast Epoxy ink, Items 10 and 11 on 062-0041. See assembly drawing 062-0040 for the J-number location. The numbers go above the connectors.

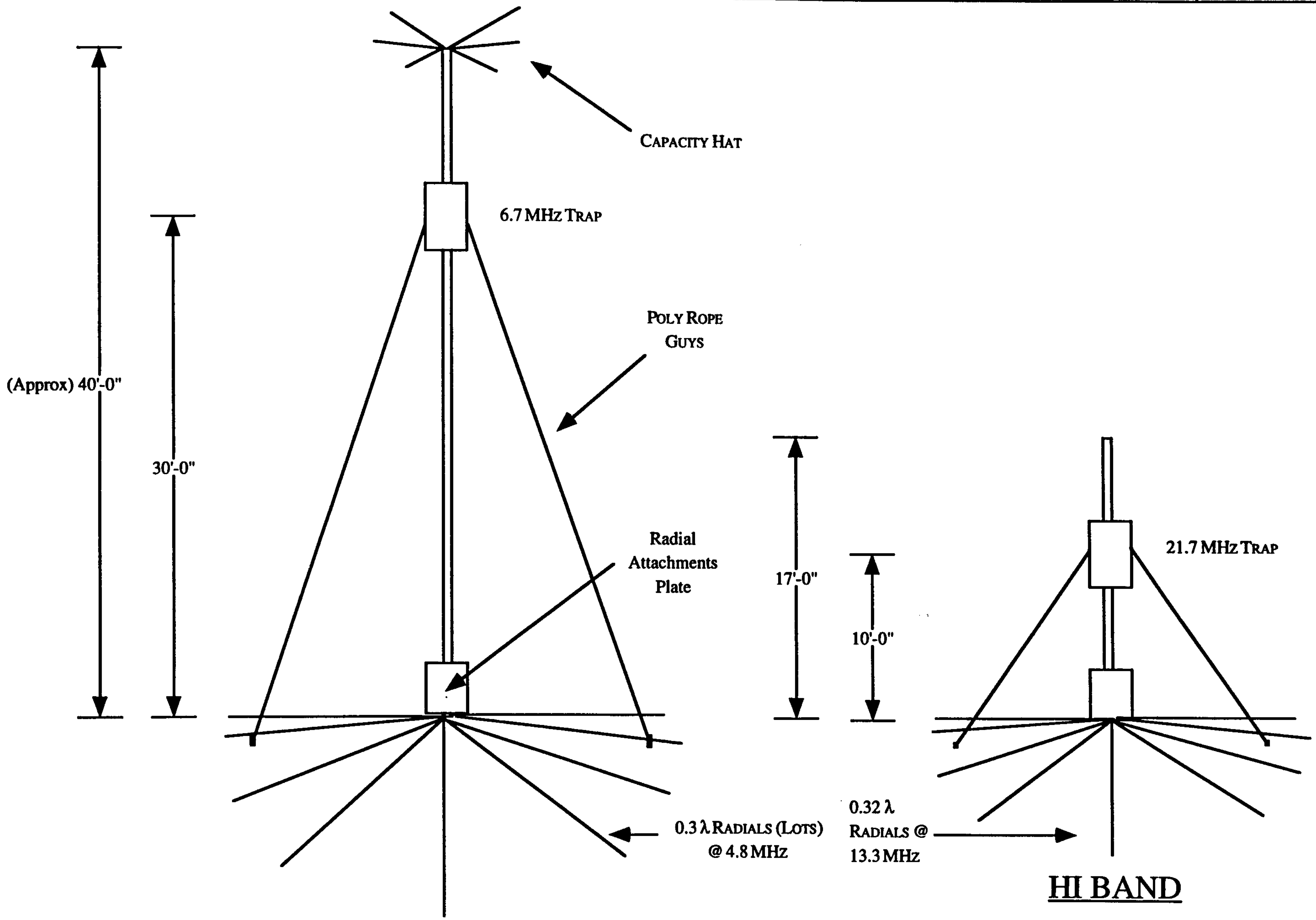
11. Submit the completed assembly along with the un-installed ICs to engineering for preliminary testing.

12. After the testing is complete, install the three shield covers 062-0086 over the filter sections on section B of the PCB. Carefully fold each of the cover sides at the crease mark, making a small box with clearance holes adjustment of the trimmers.

13. Pre-tin the three locations on the PCB where the covers are to be installed.

14. Place each cover on the PCB over the filter components observing the correct orientation of the holes relative to the trimmers. Reflow solder at each of the four corners of each of the three covers. Only tack the corners in case the covers need to be removed after final alignment.

15. Submit the assembly to engineering for final IF aligment.



Space Physics Research Laboratory College of Engineering University of Michigan	TRANSMIT ANTENNA		05-12-97 NS 03-25-96 NS
N000149510249	Antennae Configuration	062- 0085	1 OF 2 x2
		DRAWN	N. Schnepf

Drawing Page

TRANSMIT ANTENNA NOTES

ANTENNA CONSTRUCTION:

Telescoping aluminum tubing
Stainless steel hose clamps

TRAP CONSTRUCTION:

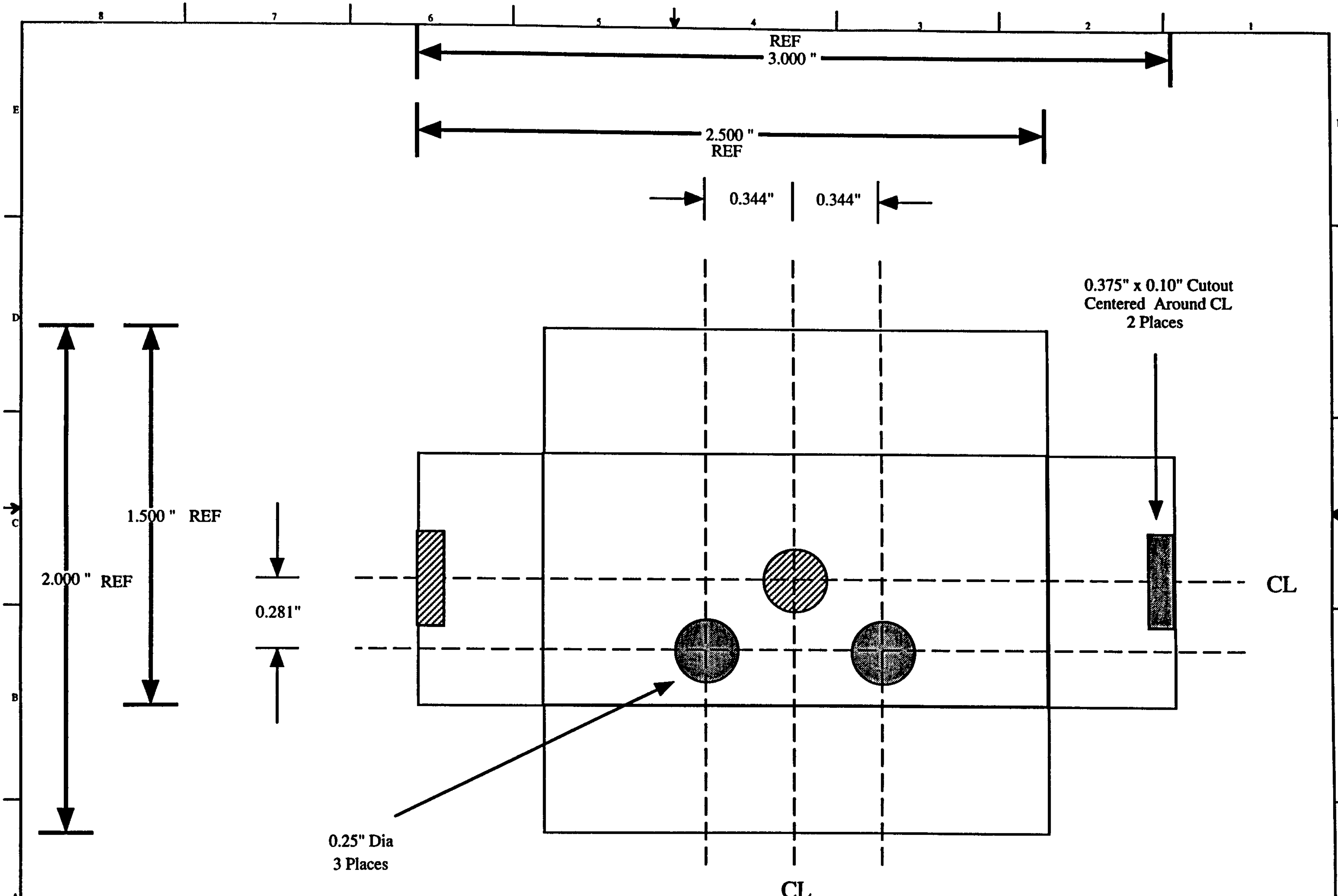
Tubular insulator section
Coaxial cable capacitor
Air Wound Coils
All connections weather protected
Stainless hardware

INSTALLATION:

1. Radial attachment plate with hinged, insulated coupler.
2. Polyproplene guy ropes to driven pipe guy anchors.
3. Radials : 8, 22 Ga wires held at the ends with tent stakes.

Space Physics Research Laboratory College of Engineering University of Michigan		TRANSMIT ANTENNA		05-12-97 NS 03-25-96 NS
			RELEASE	
			DRAWN	N. Schnepf
N000149510249	Antenna Notess	062- 0085	2 OF 2	x2	COG ENG	

Drawing Page



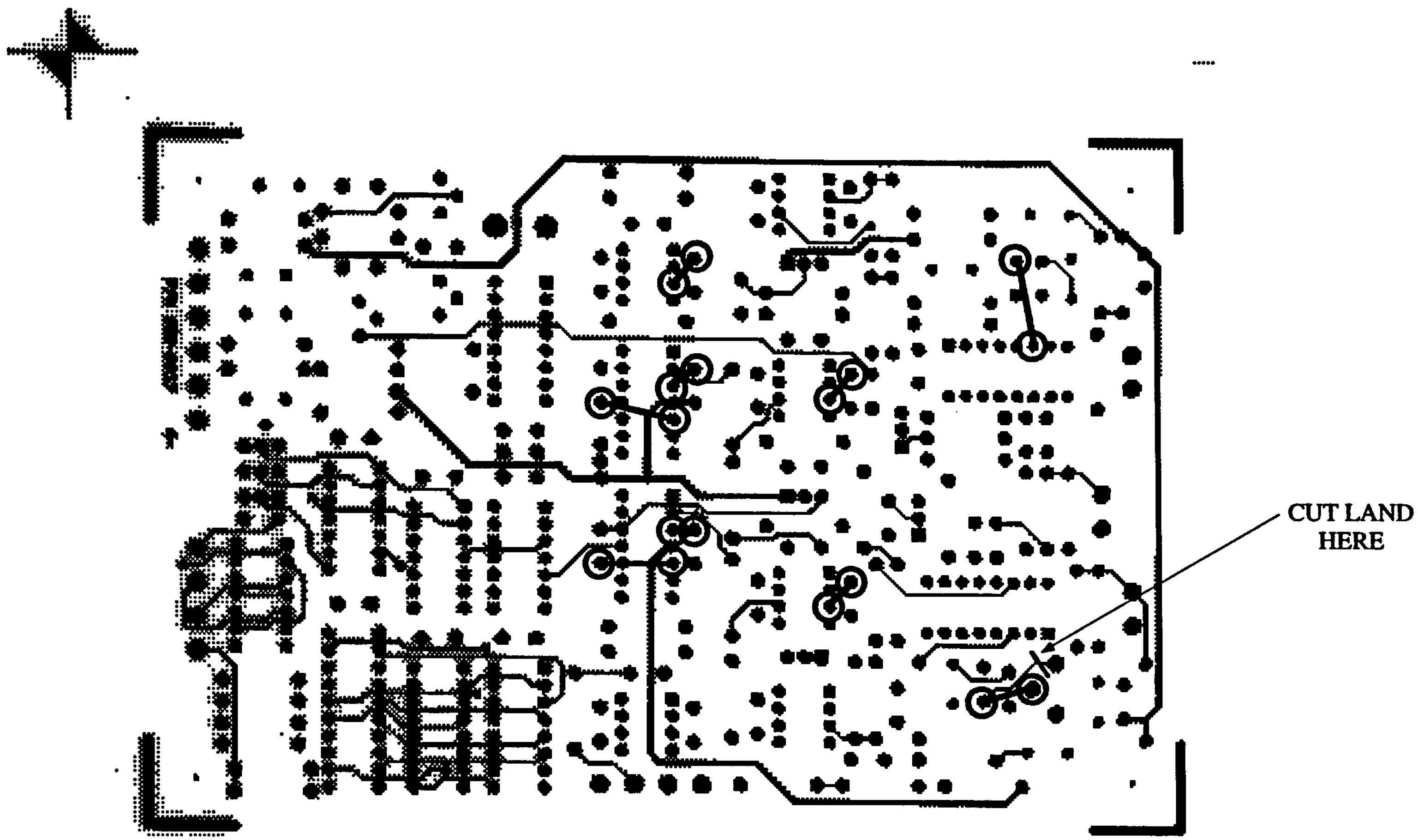
Notes:
This drawing is a modification to a Fotofabrication 1.000" x 2.000" x 0.500" standard RF shield.

Unless otherwise specified tolerances are:

Dim ending .00 are	±	0.030
Dim ending .000 are	±	0.005
Angular Dim are	±	0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan	Mixer-IF RF Shield Mod	REV 04-08-96 NS REV 03-26-96 NS RELEASE DRAWN N Schnepf COG ENG
N000149510249	Mixer-IF RF Shield Mod	062- 0086	1 of 1	x2

1
Drawing Page



SOLDER SIDE

Notes:

1. This drawing details modifications to the Demod-Mixer PCB Assembly (062-0014) and supplements the Demod Build Instructions (062-0010).
2. This drawing incomplete without parts list 062-0015.
3. Connections are made as indicated in red with item 64.

Space Physics Research Laboratory College of Engineering University of Michigan	DEMOD-MIXER MODIFICATIONS	REV 11-07-96 NS REV 04-16-96 NS REV 04-15-96 NS RELEASE DRAWN Neil Schnepf COG ENG
N000149510249	DEMOD-MIXER MODIFICATIONS	062-0087 · 1 of 1 · X6

Drawing Page

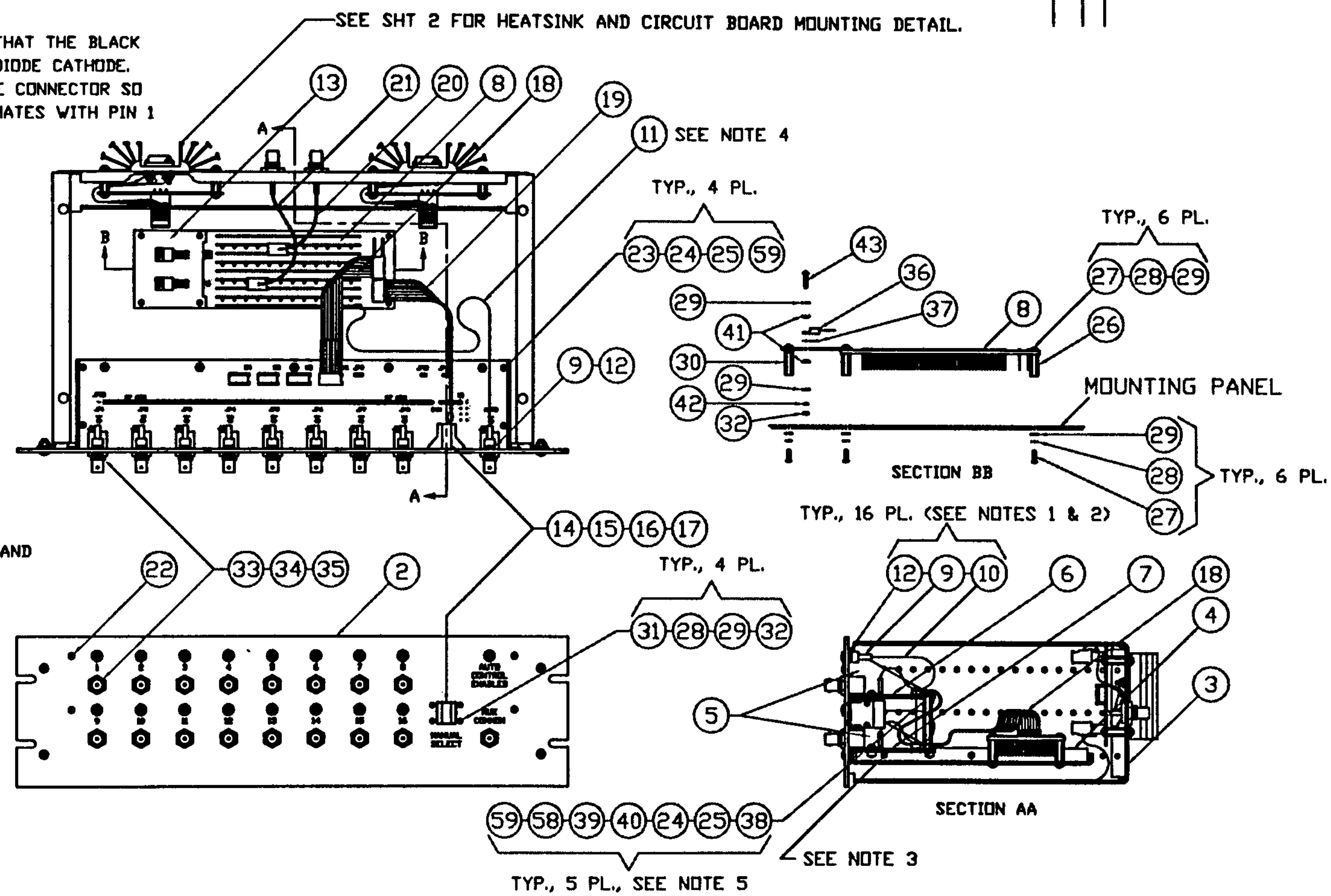
NOTES

1. TRIM LED LEAD LENGTH TO 0.25 BEFORE INSTALLATION.
2. ORIENT CONNECTOR SO THAT THE BLACK LEAD MATES WITH THE DIODE CATHODE. ON THE PCB, ORIENT THE CONNECTOR SO THAT THE BLACK WIRE MATES WITH PIN 1 ON ALL JP HEADERS.

FLAT SIGNIFIES CATHODE

LED DETAIL REAR VIEW

3. MOUNT THE BOTTOM PANEL IN THE 2ND HOLE OF THE SIDE PANEL.
4. WIRE PAIR TERMINATES ON HEADER H7:
   BLACK WIRE TO PIN 2,
   WHITE WIRE TO PIN 15.
5. EACH SPACER STACK IS MADE UP OF 2-ITEM 39 AND 1 ITEM 58.



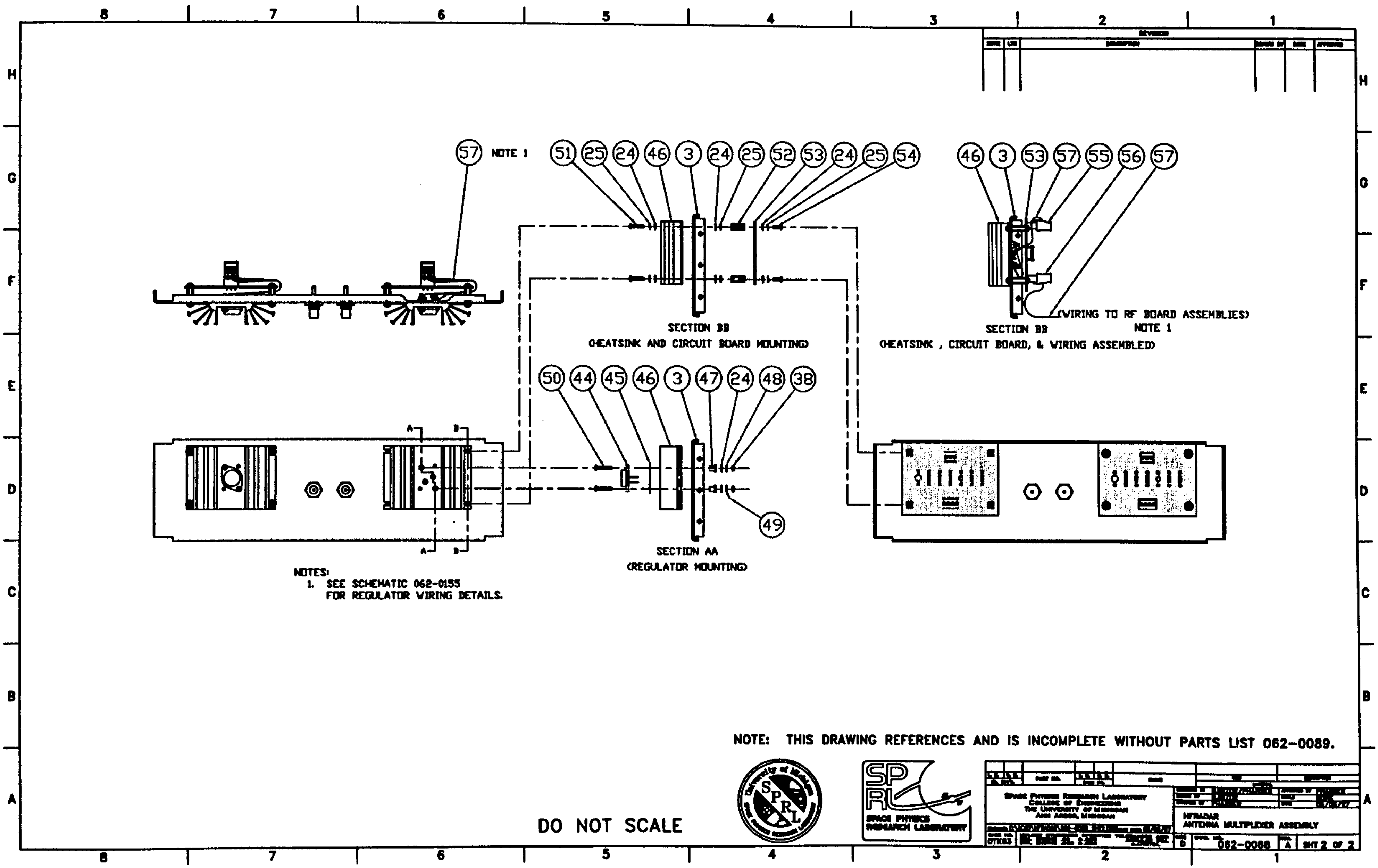
NOTE: THIS DRAWING REFERENCES AND IS INCOMPLETE WITHOUT PARTS LIST 062-0089.

DO NOT SCALE

SPACE PHYSICS RESEARCH LABORATORY

HFRADAR ANTENNA MULTIPLEXER ASSEMBLY

062-0088 A SHT 1 OF 2


57 NOTE 1
51 25 24 46 3 24 25 52 53 24 25 54
SECTION BB
(HEATSINK AND CIRCUIT BOARD MOUNTING)
46 3 53 57 55 56 57
(WIRING TO RF BOARD ASSEMBLIES)
NOTE 1
SECTION BB
(HEATSINK , CIRCUIT BOARD, & WIRING ASSEMBLED)
50 44 45 46 3 47 24 48 38
49
SECTION AA
(REGULATOR MOUNTING)
NOTES:
1. SEE SCHEMATIC 062-0155 FOR REGULATOR WIRING DETAILS.
NOTE: THIS DRAWING REFERENCES AND IS INCOMPLETE WITHOUT PARTS LIST 062-0089.
DO NOT SCALE
SPACE PHYSICS RESEARCH LABORATORY
HFRADAR
ANTENNA MULTIPLEXER ASSEMBLY
062-0088
SHT 2 OF 2

Parts List
Antenna Mux Assembly
Next Assy: 062-0071
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

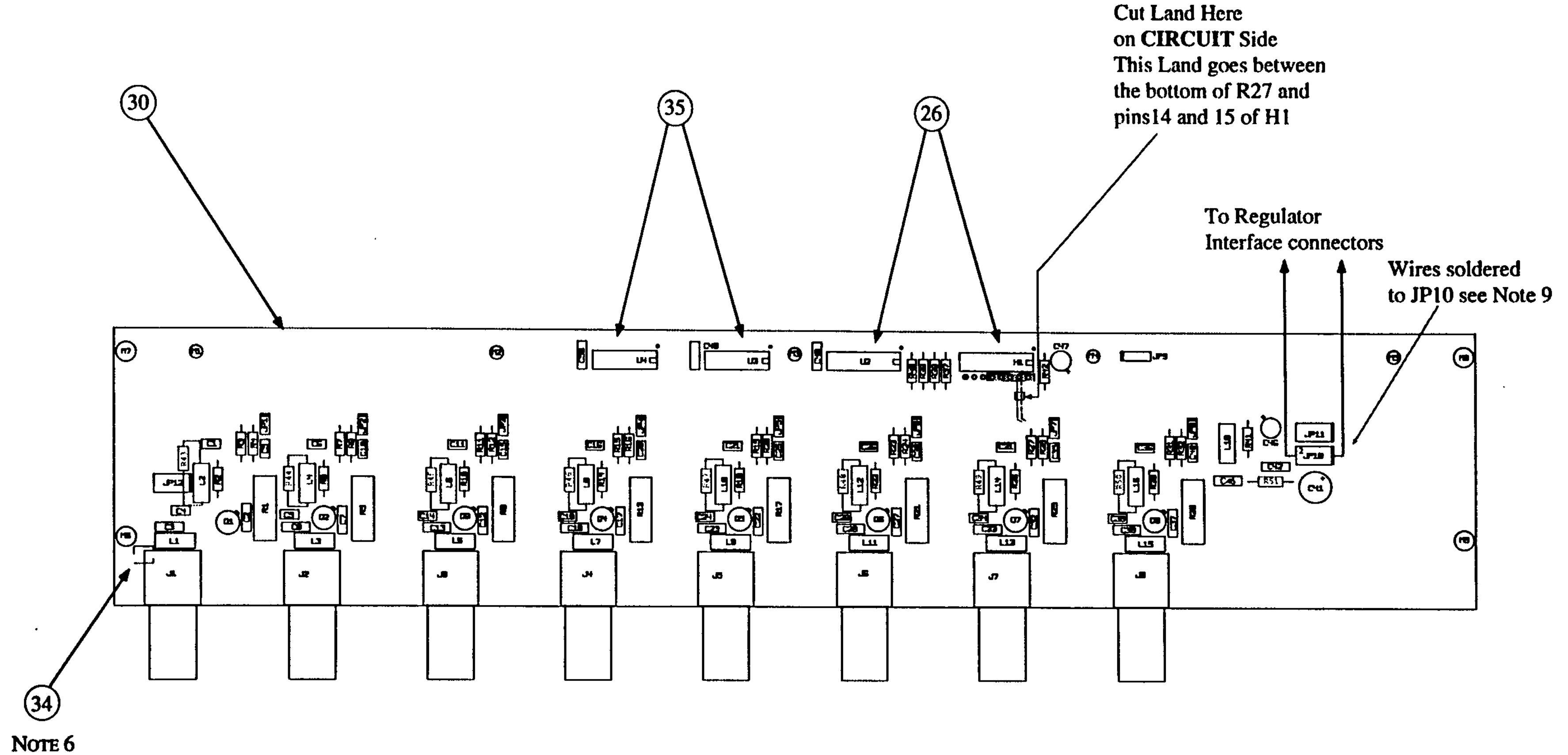
FSCM No.: 0TK63
Dwg #:062-0089
Rev:X5

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol/Notes
1	1	EA	SB9-5-SAC	Rack Mount Chassis Kit/Solid Cover	Strongbox	
2	1	EA	062-0090	Front Panel Modification	UM/SPRL	Modification to Strongbox Kit, Item 1
3	1	EA	062-0091	Rear Panel Modification	UM/SPRL	Modification to Strongbox Kit, Item 1
4	1	EA	060-0092	Mounting Panel Modification	UM/SPRL	Modification to Strongbox Kit, Item 1
5	2	SET	062-0112	Bracket,PCB Mounting	UM/SPRL	1 SET=1 Right & 1 Left Bracket
6	1	EA	062-0095	RF Switch PCB Assy 1-8	UM/SPRL	
7	1	EA	062-0110	RF Switch PCB Assy 9-16	UM/SPRL	
8	1	EA	062-0102	Serial Interface Assembly	UM/SPRL	
9	17	EA	HLMP-D105	LED, High Intensity,T1 3/4	HP	Allied Stock #782-0155
10	16	EA	CNXCE-21-8	Cable,LED-Header,8 in	Visual Com	W5-W20
11	1	EA	CNXCX-21-24	Cable,LED-Wire,24 in	Visual Com	W21
12	17	EA	CMC 321 RTP	Lens,LED,5mm	Visual Com	
13	1	EA	062-0137	Bracket,Regulator Mounting	UM/SPRL	
14	1	EA	0T50-03M0	Switch,Hex,Thumbwheel,Backmt	Cherry	Digi-Key Stock # CH176-ND
15	1	SET	0609-0970	End Caps,Thumbwheel,T50 Series	Cherry	Digi-Key Stock # CH186-ND
16	1	EA	0012-0640	Rod Assy,1 Module,T50 Series	Cherry	Digi-Key Stock # CH258-ND
17	1	EA	0012-0744	Fastener,Rod Assy	Cherry	Digi-Key Stock # CH262-ND
18	1	EA	062-0108	Ant Mux Data Cable Assy	UM/SPRL	W1
19	1	EA	062-0131	Ant Mux Data Cable Assy	UM/SPRL	W2
20	1	EA	062-0109	Ant Mux RF Cable Assy	UM/SPRL	W3
21	1	EA	062-0132	Ant Mux RF Cable Assy	UM/SPRL	W4
22	4	EA		Screw,CRES,FH,82 deg,6-32x0.375		
23	8	EA		Screw,CRES,PH,6-32x0.375		
24	46	EA	MS15795-805	Washer,Flat,Small,#6		
25	42	EA	MS35338-136	Washer,Lock,Split,#6		
26	4	EA	2204	Spacer,threaded,hex,4-40 x 0.75	Keystone	Newark Stock # 89F1937
27	12	EA		Screw,CRES,PH,4-40 x 0.375		
28	16	EA		Washer,Lock,Int,#4		
29	20	EA		Washer,Flat,#4		
30	2	EA	1809	Spacer,threaded,hex,4-40 x 0.875	Keystone	Newark Stock # 89F1940

Parts List
Antenna Mux Assembly
Next Assy: 062-0071
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol/Notes
31	4	EA		Screw,CRES,FH,82 deg,4-40 x 0.375		
32	6	EA		Nut,Hex,4-40		
33	19	EA	AN960C816L	Washer,Flat,Stainless,.514 ID	(McMaster)	BNC Washer
34	1	PKG	31-5652	Nut, 0.5-28	Amphenol	BNC nut, 100 per pkg
35	1	PKG	31-5653	Washer,Lock,0.5	Amphenol	BNC Lock Washer,100 per pkg
36	2	EA	LM317T	IC, Positive Regulator-TO-220	National	
37	2	EA	60-11-8302-1674	Insulator,Thermal,TO-220	Chomerics	
38	9	EA		Nut,Hex,6-32		
39	10	EA	4025	Spacer,Nylon,Thru,#6 x 5/8	HH Smith	
40	5	EA		Screw,CRES,PH,6-32 x 2.50		
41	4	EA	3049	Washer,Shoulder,Nylon, #4	Keystone	DigiKey Stock # 3049K-ND (100 pc pkg)
42	2	EA		Washer,Split,#4		
43	2	EA		Screw,CRES,PH,4-40 x 0.5		
44	2	EA	LM317K	IC,Positive Regulator,TO-3	National	
45	2	EA	188823F00000	Insulator,Thermal,INSIL-8,TO-3	Aavid	Allied # 619-1004
46	2	EA	198540B00000	Heatsink,TO-3	Aavid	Digikey #HS117-ND
47	4	EA	341K-ND	Bushing,Nylon,#6,.170dia x.25	Digikey	
48	2	EA		Washer,Int Tooth,#6		
49	2	EA		Lug,Solder,Int Tooth#6		
50	4	EA		Screw,CRES,PH,6-32x0.75		
51	8	EA		Screw,CRES,PH,6-32x0.625		
52	8	EA	8424	Spacer,Hex,6-32x0.625	HH Smith	
53	2	EA	062-0153	Board,Circuit,Regulator	UM/SPRL	
54	8	EA		Screw,CRES,PH,6-32x0.375		
55	2	EA	860903	Plug,Vertical,3 Terminal	Beau	Newark Stock # 92F1803
56	2	EA	850904	Plug,Vertical,4 Terminal	Beau	Newark Stock # 92F1804
57	AR	FT		Wire,22AWG,White,PVC		
58	5	EA	4025	Spacer,Nylon,Thru,#6x5/8	HH Smith	Modified Length=0.563
59	14	EA		Washer,Flat,Nylon,#6,.312"OD		



Notes:

1. This drawing incomplete without Parts List 062-0096
2. Install swage terminals, Item 25, at JP10,11, and 12.
3. Install 2 terminal header, Item 23, at JP1 thru 8.
4. Install 3 terminal header, Item 24, at JP 9.
5. Install sockets, Item 26 at H1, U2,3, and 4.
6. Install Kapton tape between PCB land and BNC connector spacer tab.
7. Submit board for test before conformal coating.
8. Conformal coat board per procedure 060-0026.
9. See RFS Schematic (062-0099) for wiring details.

Space Physics Research Laboratory College of Engineering University of Michigan	RF Switch 1-8 PCB Assembly	04-17-97 NS 03-31-97 NS 03-11-97 NS
N000149510249	062- 0095	1 of 1 x4

Drawing Page 1

Parts List
RF Switch 1-8 PCB
Next Assy: 062-0095
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Dwg #:062-0096
Rev:X4

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
1	9	EA	M39014/01-1575	Cap,Cer,0.01uF,100V,10%		C1,6,11,16,21,26,31,36,45
2	20	EA	M39014/02-1310	Cap,Cer,0.1uF,100V,10%		C2,3,7,8,12,13,17,18,22,23,27,28,32,33,37,38,42,48,49,50
3	8	EA	M39014/01-1357	Cap,Cer,0.001uF,200V,10%		C5,10,15,20,25,30,35,40
4	8	EA	M39014/01-1341	Cap,Cer,120pF,200V,10%		C4,9,14,19,24,29,34,39
5	1	EA	199D336X0025EE2	Cap,Tan,25uF,30V,20%	Sprague	C41
6	2	EA	199D106X0025CA1	Cap,Tan,10uF,30V,20%	Sprague	C46,47
7	17	EA	IM-2-47.0	Ind,Ferrite,47uH,10%	Dale	L1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,18
8	0	EA	5240	Ind,Ferrite,40uH	Miller	L17
9	8	EA	2N2907A	Transistor,PNP		Q1,2,3,4,5,6,7,8
10	8	EA	RCR32G820JS	Res,CC,82,1W,5%		R1,5,9,13,17,21,25,29,
11	8	EA	RCR07G122JS	Res,CC,1.2K,.25W,5%		R2,6,10,14,18,22,26,30
12	8	EA	RCR07G821JS	Res,CC,820,.25W,5%		R3,7,11,15,19,23,27,31
13	8	EA	RCR07G103JS	Res,CC,10K,.25W,5%		R4,8,12,16,20,24,28,32
14	0	EA	RCR05GxxxJS	Res,CC,SHORT,.125W,5%		R33,36
15	0	EA	RCR07G100JS	Res,CC,10,.25W,5%		R34
16	0	EA	RCR05GxxxJS	Res,CC,OPEN,.125W,5%		R35
17	4	EA	RCR07G472JS	Res,CC,4.7K,.25W,5%		R37,38,39,40
18	2	EA	RCR07G2R7JS	Res,CC,2.7,.25W,5%		R41,42
19	0	EA	MAN-1LN	Amp,RF,LO Noise,	MiniCkts	U1
20	1	EA	SN74LS138N	IC,3 to 8 Decoder	TI	U2
21	2	EA	SN7407N	IC,Hex Inv,OC	TI	U3,4
22	8	EA	31-5640	Connector,BNC,PC Mount,Rt Angle	Amphenol	J1,2,3,4,5,6,7,8
23	8	EA	69190-402	Header,2 Terminal	Berg	JP1,2,3,4,5,6,7,8
24	1	EA	69190-403	Header,3 Terminal	Berg	JP9
25	6	EA	2520B	Terminals,Non-Insulated,Swage	Useco	JP10,11,12
26	2	EA	ICD-16-2T	Socket,IC,16 Pin	Voltrex	H1, Sockets for U2
27	1	AR	5750LV-A	Conformal Coating	Uralane	
28	1	AR	5750LV-B	Curing Agent	Uralane	
29	1	AR	Toluene/MEK	Thinner		

Parts List
RF Switch 1-8 PCB
Next Assy: 062-0095
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
30	1	REF	062-0100	PCB,Raw Card,RF Switch	UM/SPRL	
31	1	REF	062-0099	Schematic,Ant Mux RF Switch	UM/SPRL	
32	1	REF	060-0026	Instructions, Conformal Coating	UM/SPRL	
33	1	REF	062-0101	Build Instructions,RF Switch PCB	UM/SPRL	
34	AR	IN		Kapton tape		
35	2	EA	ICD-14-2T	Socket,IC,14 Pin	Voltrex	U3,U4
36	8	EA	RCR07G561JS	Res,CC,560√,.25W,5%		R43,44,45,46,47,48,49,50
37	1	EA	RCR07G510JS	Res,CC,51√,.25W,5%		R51
38						
39						
40			Note: 0 in quantity column indicates part not used on this assembly			

Net List
RF Switch PCB
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

NET LIST From Schematic 062-0099x1 AntMux RF Switch Wednesday, November 13, 1996 4:13 PM									
NET NAME	PINS								
ANTSEL0	C5-2	JP1-1	R2-2	R4-1	U3-2				
ANTSEL1	C10-2	JP2-1	R6-2	R8-1	U3-4				
ANTSEL2	C15-2	JP3-1	R10-2	R12-1	U3-6				
ANTSEL3	C20-2	JP4-1	R14-2	R16-1	U3-8				
ANTSEL4	C25-2	JP5-1	R18-2	R20-1	U3-10				
ANTSEL5	C30-2	JP6-1	R22-2	R24-1	U3-12				
ANTSEL6	C35-2	JP7-1	R26-2	R28-1	U4-2				
ANTSEL7	C40-2	JP8-1	R30-2	R32-1	U4-4				
+5V	C47-1	C48-1	C49-1	C50-1	R37-1	R38-1	R39-1		
	R40-1	R42-2	U2-6	U2-16	U3-14	U4-14			
+5V IN	H1-16	R42-1							
+8V	C1-1	C6-1	C11-1	C16-1	C21-1	C26-1	C31-1		
	C36-1	C46-1	L2-2	L4-2	L6-2	L8-2	L10-2	L12-2	
	L14-2	L16-2	L18-2	R41-1					
+8VIN	H1-12	H1-13	JP11-1	R41-2					
+12V	C41-1	C42-1	H1-14	H1-15	JP10-1	L17-2	R1-1		
	R3-1	R4-2	R5-1	R7-1	R8-2	R9-1	R11-1	R12-2	
	R13-1	R15-1	R16-2	R17-1	R19-1	R20-2	R21-1		
	R23-1	R24-2	R25-1	R27-1	R28-2	R29-1	R31-1		
	R32-2	R34-1							
ANT0	C3-1	J1-1	L1-1						
ANT1	C8-1	J2-1	L3-1						
ANT2	C13-1	J3-1	L5-1						
ANT3	C18-1	J4-1	L7-1						
ANT4	C23-1	J5-1	L9-1						
ANT5	C28-1	J6-1	L11-1						
ANT6	C33-1	J7-1	L13-1						

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NET LIST From Schematic 062-0099x1 AntMux RF Switch Wednesday, November 13, 1996 4:13 PM									
NET NAME	PINS								
ANT7	C38-1	J8-1	L15-1						
COMOUT	C44-1	J9-1	L17-1						
GND	C1-2	C2-2	C4-2	C5-1	C6-2	C7-2	C9-2	C10-1	
	C11-2	C12-2	C14-2	C15-1	C16-2	C17-2	C19-2		
	C20-1	C21-2	C22-2	C24-2	C25-1	C26-2	C27-2		
	C29-2	C30-1	C31-2	C32-2	C34-2	C35-1	C36-2		
	C37-2	C39-2	C40-1	C41-2	C42-2	C43-2	C46-2		
	C47-2	C48-2	C49-2	C50-2	H1-2	H1-4	H1-6	H1-8	
	H1-10	H1-11	J1-2	J2-2	J3-2	J4-2	J5-2	J6-2	
	J7-2	J8-2	J9-2	JP10-2	JP11-2	JP12-2	R35-2		
	U1-2	U1-3	U1-4	U1-6	U2-4	U2-8	U3-7	U4-5	U4-7
	U4-9	U4-11	U4-13						
MA0	H1-1	R40-2	U2-1						
MA1	H1-3	R39-2	U2-2						
MA2	H1-5	R38-2	U2-3						
MA3	H1-7	JP9-3							
MA3-	H1-9	JP9-1							
N:1	C2-1	L1-2	R1-2						
N:2	C3-2	L2-1	Q1-C						
N:3	C4-1	Q1-B	R2-1						
N:4	JP1-2	R3-2							
N:5	C8-2	L4-1	Q2-C						
N:6	C9-1	Q2-B	R6-1						
N:7	JP2-2	R7-2							
N:8	C7-1	L3-2	R5-2						
N:9	C12-1	L5-2	R9-2						
N:10	C13-2	L6-1	Q3-C						
N:11	C14-1	Q3-B	R10-1						

Net List
RF Switch PCB
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

NET LIST From Schematic 062-0099x1 AntMux RF Switch Wednesday, November 13, 1996 4:13 PM									
NET NAME	PINS								
N:12	JP3-2	R11-2							
N:13	C18-2	L8-1	Q4-C						
N:14	C19-1	Q4-B	R14-1						
N:15	JP4-2	R15-2							
N:16	C17-1	L7-2	R13-2						
N:17	C22-1	L9-2	R17-2						
N:18	C23-2	L10-1	Q5-C						
N:19	C24-1	Q5-B	R18-1						
N:20	JP5-2	R19-2							
N:21	C28-2	L12-1	Q6-C						
N:22	C29-1	Q6-B	R22-1						
N:23	JP6-2	R23-2							
N:24	C27-1	L11-2	R21-2						
N:25	C32-1	L13-2	R25-2						
N:26	C33-2	L14-1	Q7-C						
N:27	C34-1	Q7-B	R26-1						
N:28	JP7-2	R27-2							
N:29	C38-2	L16-1	Q8-C						
N:30	C39-1	Q8-B	R30-1						
N:31	JP8-2	R31-2							
N:32	C37-1	L15-2	R29-2						
N:33	C45-1	U1-1							
N:34	C43-1	R34-2	U1-5						
N:35	R33-1	U1-8							
N:36	U2-15	U3-1							
N:37	U2-14	U3-3							
N:38	U2-13	U3-5							
N:39	U2-12	U3-9							

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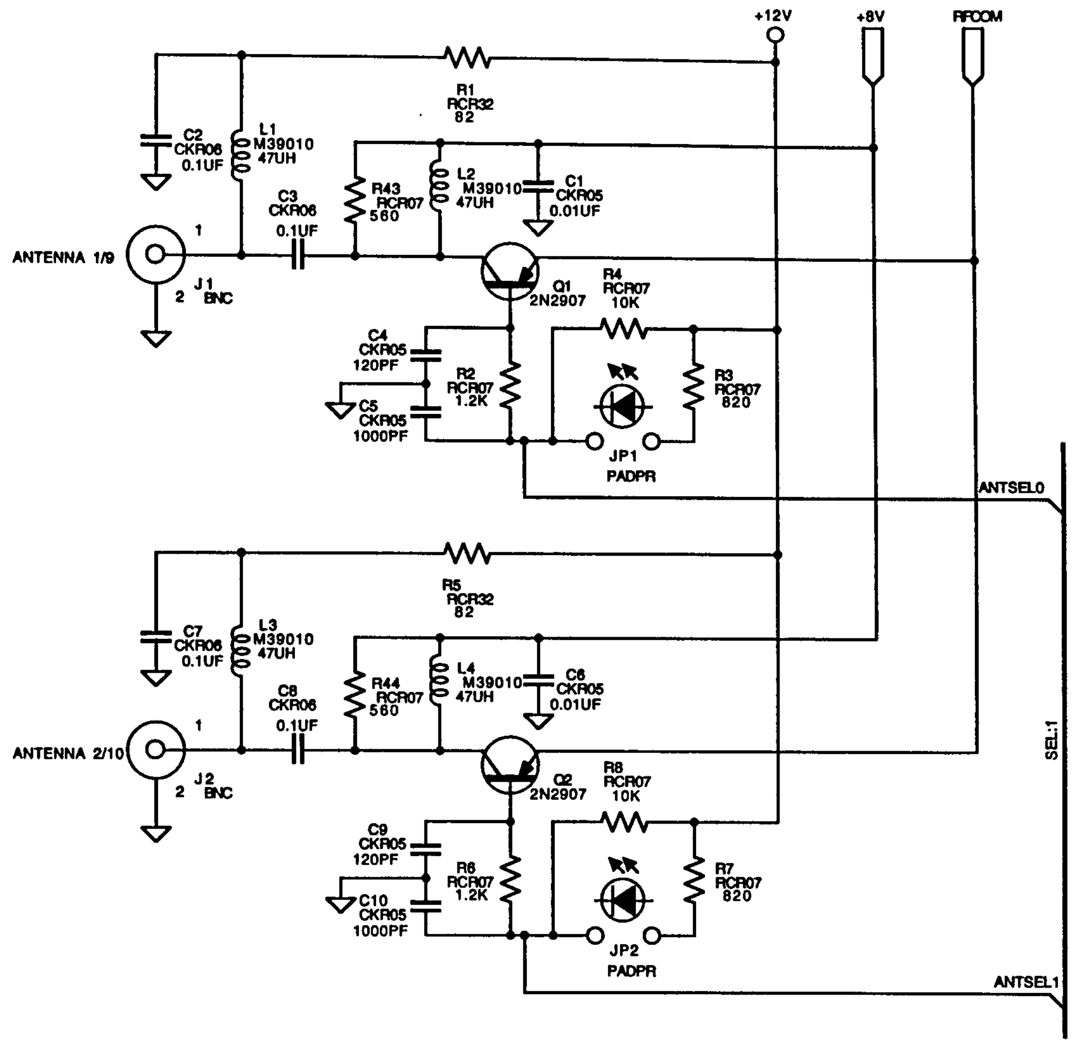
NET LIST From Schematic 062-0099x1 AntMux RF Switch Wednesday, November 13, 1996 4:13 PM									
NET NAME	PINS								
N:40	U2-11	U3-11							
N:41	U2-10	U3-13							
N:42	U2-9	U4-1							
N:43	U2-7	U4-3							
N:44	JP9-2	R37-2	U2-5						
N:45	R33-2	R35-1	R36-1						
N:46	C44-2	R36-2							
RFCOM	C45-2	JP12-1	L18-1	Q1-E	Q2-E	Q3-E	Q4-E	Q5-E	
	Q6-E	Q7-E	Q8-E						



Space Physics Research Laboratory College of Engineering University of Michigan	SCHEMATIC ANTENNA MULTIPLEXER - RF SWITCH 1 & 2	REV REV REV RELEASE DRAWN COG ENG
PROJECT N000149510249	CAGE CODE 0TK63 · FILENAME 0099.1 · DRAWING NUMBER 062-0099 · REV X 2	

DRAWING PAGE

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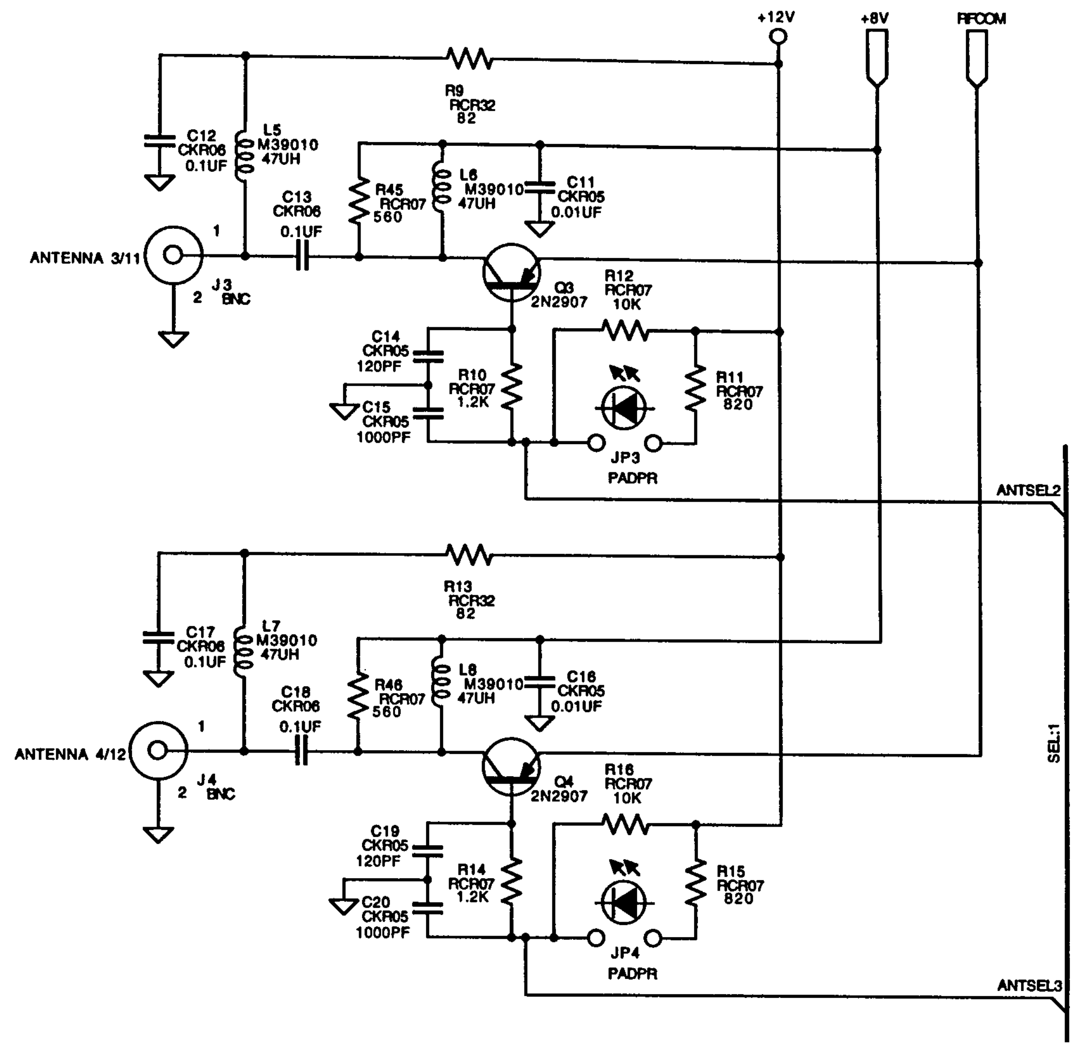


Space Physics Research Laboratory
College of Engineering
University of Michigan

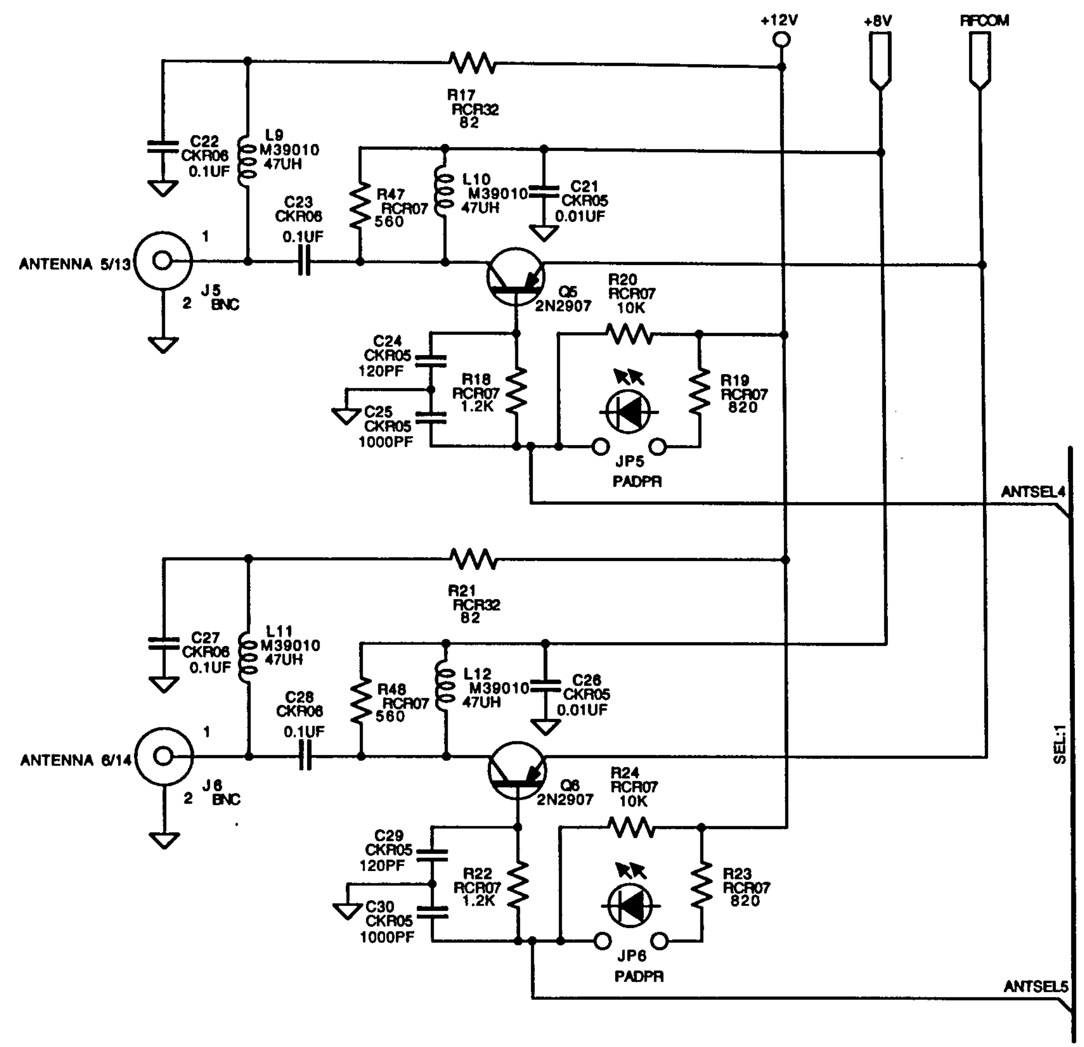
SCHEMATIC
ANTENNA MULTIPLEXER - RF SWITCH 3 & 4

PROJECT	CAGE CODE	FILENAME		DRAWING NUMBER	REV
N000149510249	0TK63		0099.2	062-0099	X 2

REV
REV
REV
RELEASE
DRAWN
COG ENG

DRAWING PAGE

McCad 3.3



Space Physics Research Laboratory
College of Engineering
University of Michigan

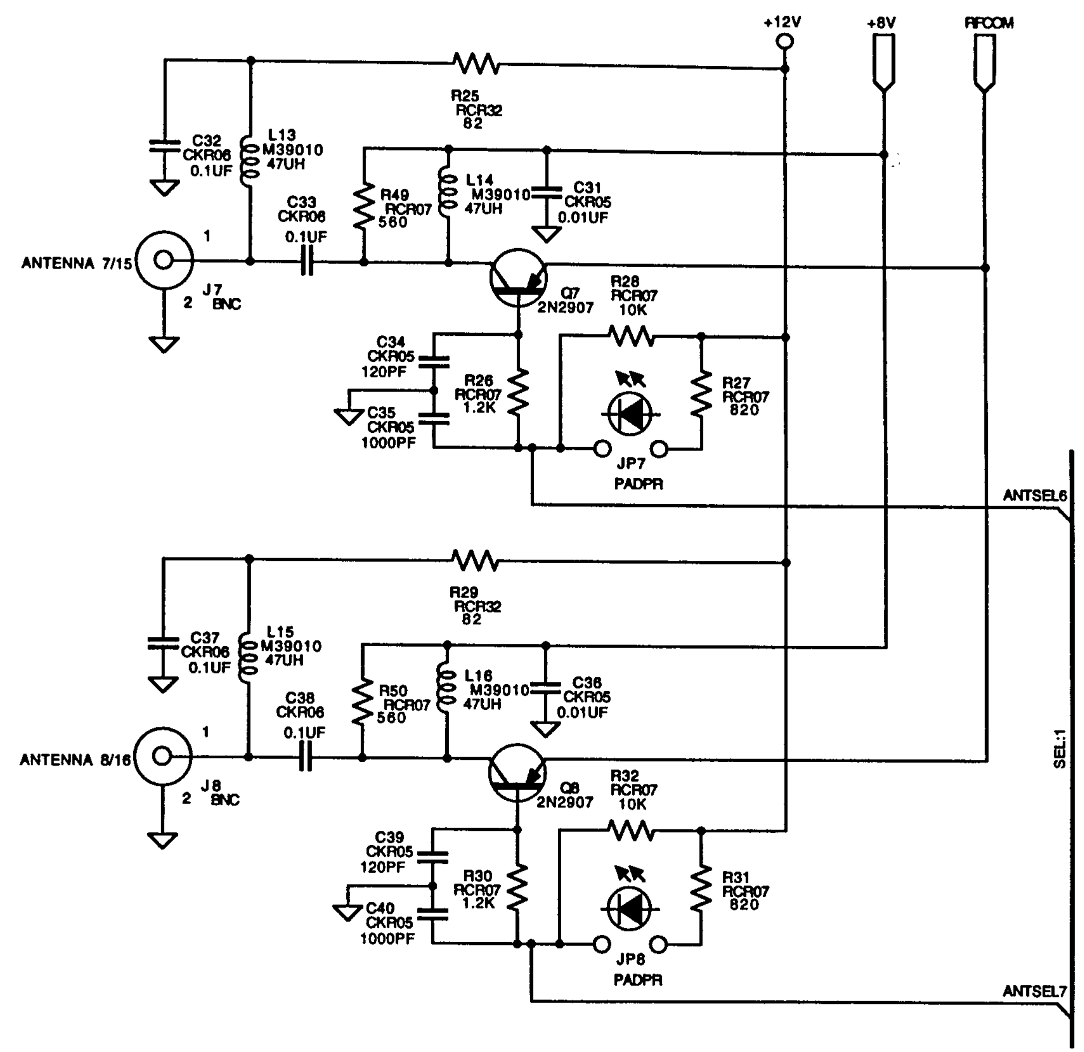
SCHEMATIC
ANTENNA MULTIPLEXER - RF SWITCH 5 & 6

PROJECT	CAGE CODE	FILENAME	DRAWING NUMBER	REV
N000149510249	0TK63	0099.3	062-0099	X 2

REV	
REV	
REV	
RELEASE	
DRAWN	
COG ENG	

McCad 3.3

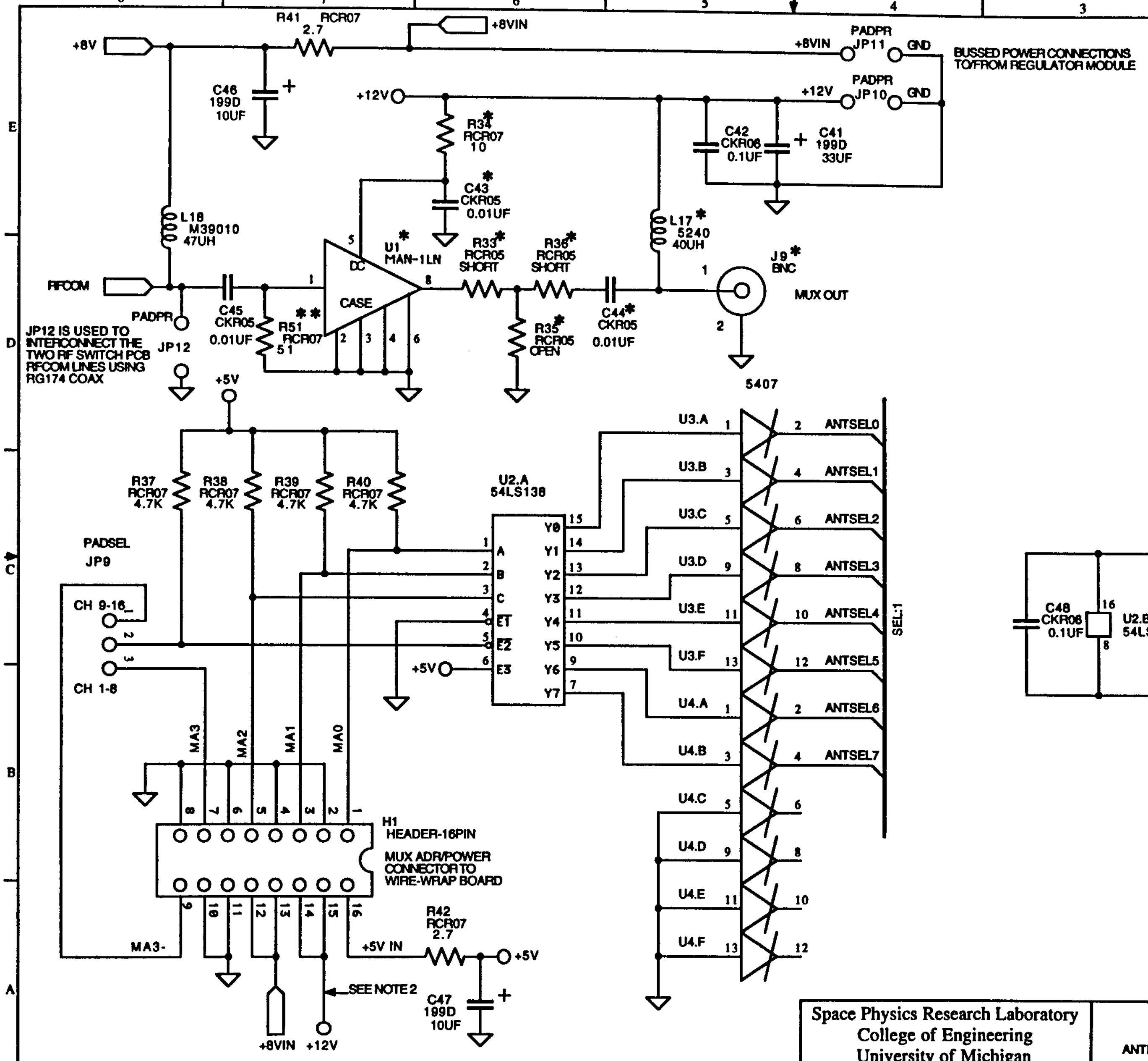
DRAWING PAGE



Space Physics Research Laboratory College of Engineering University of Michigan	SCHEMATIC ANTENNA MULTIPLEXER - RF SWITCH 7 & 8	REV REV REV RELEASE DRAWN COG ENG
PROJECT N000149510249	CAGE CODE 0TK63	FILENAME 0099.4
DRAWING NUMBER 062-0099	REV X 2	

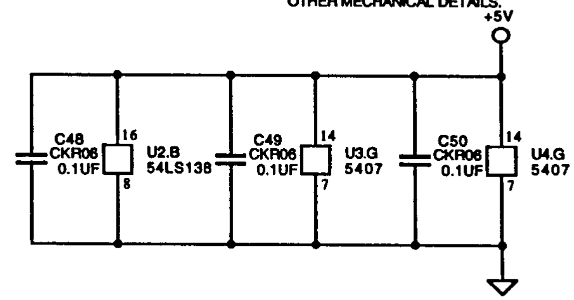
DRAWING PAGE

McCad 3.3



NOTES:

1. THIS SCHEMATIC IS USED FOR BOTH VERSIONS OF THE RF SWITCH ASSEMBLY. THE 1-8 VERSION DOES NOT HAVE THE PARTS MARKED WITH AN ASTERISK. RESISTOR R51, MARKED WITH A DOUBLE ASTERISK, IS USED TO TERMINATE THE RF COM LINE AND IS USED ON THE 1-8 VERSION ONLY. THE 9-16 VERSION CONTAINS ALL PARTS INDICATED ON THE SCHEMATIC EXCEPT FOR R51.
2. HEADER H1 IS USED TO BUS THE CONTROL SIGNAL TO BOTH BOARDS FROM THE SERIAL CONTROLLER WIREWRAP BOARD. THE 1-8 VERSION HAS THE 12 VOLT CONNECTION TO HEADER PINS 14 AND 15 DISCONNECTED
3. PAD - PAIRS JP10,11, AND 12 ARE POWER AND SIGNAL I/O POINTS USING USECO 2520B SWAGE TERMINALS AND REQUIRING 0.075" PLATED THRU HOLES AND PADS.
4. PAD - PAIRS JP1 THRU JP8 ARE FOR INSTALLATION OF BERG 69190-402 TWO TERMINAL HEADERS. AN INTERCONNECT JUMPER CABLE WILL GO TO FRONT PANEL MOUNTED LED INDICATORS. THE SILKSCREEN FOR THE JP1 THRU JP8 LOCATIONS SHOULD INDICATE THE DIODE POLARITY. A "+" NEXT TO THE ANODE CONNECTION IS ACCEPTABLE.
5. PAD-SEL JP9 IS FOR INSTALLATION OF A BERG 69190-403 THREE TERMINAL HEADER.
6. SEE SPRL DRAWING 062-0098, "RF SWITCH BOARD OUTLINE" FOR DETAILS ON BNC CONNECTOR PLACEMENT, I/O CONNECTION LOCATIONS, AND OTHER MECHANICAL DETAILS.

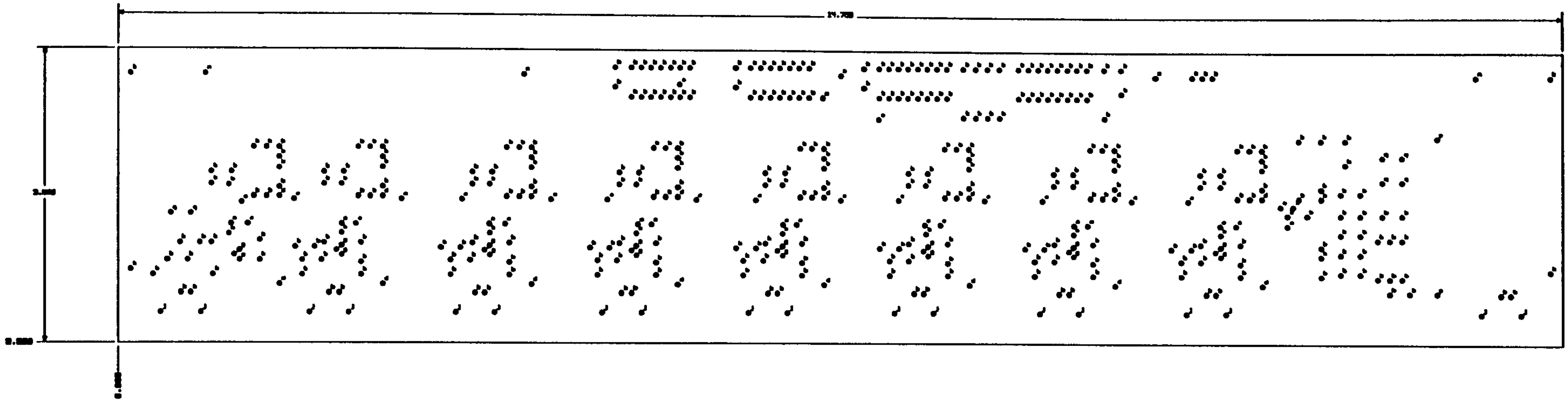


Space Physics Research Laboratory College of Engineering University of Michigan	SCHEMATIC ANTENNA MULTIPLEXER - RF AMP
PROJECT N000149510249 · CAGE CODE 0TK63 · FILENAME 0099.5	DRAWING NUMBER 062-0099 · REV X2

REV / REV / REV / RELEASE / DRAWN / COG ENG

DRAWING PAGE

McCad 3.3



U-M SPRL 062-0100

DRILL LEGEND			
SIZE	SYM	COUNT	PLATED
0.028	a,g	68	y
0.038	b	307	y
0.045	p	2	y
0.052	d	16	y
0.075	q	6	y
0.080	j	18	y
0.125	n	5	n
0.185	k	4	n

TOTAL HOLES: 418

Notes:

BOARD MATERIAL:
0.062" GFN-FR4 GLASS EPOXY
ONE OUNCE COPPER
SOLDERMASK BOTH SIDES
SILKSCREEN COMPONENT SIDE

Space Physics Research Laboratory
College of Engineering
University of Michigan

RF Switch
PC Raw Card

N000149510249

062- 0100

1 of 1

X1

RELEASE

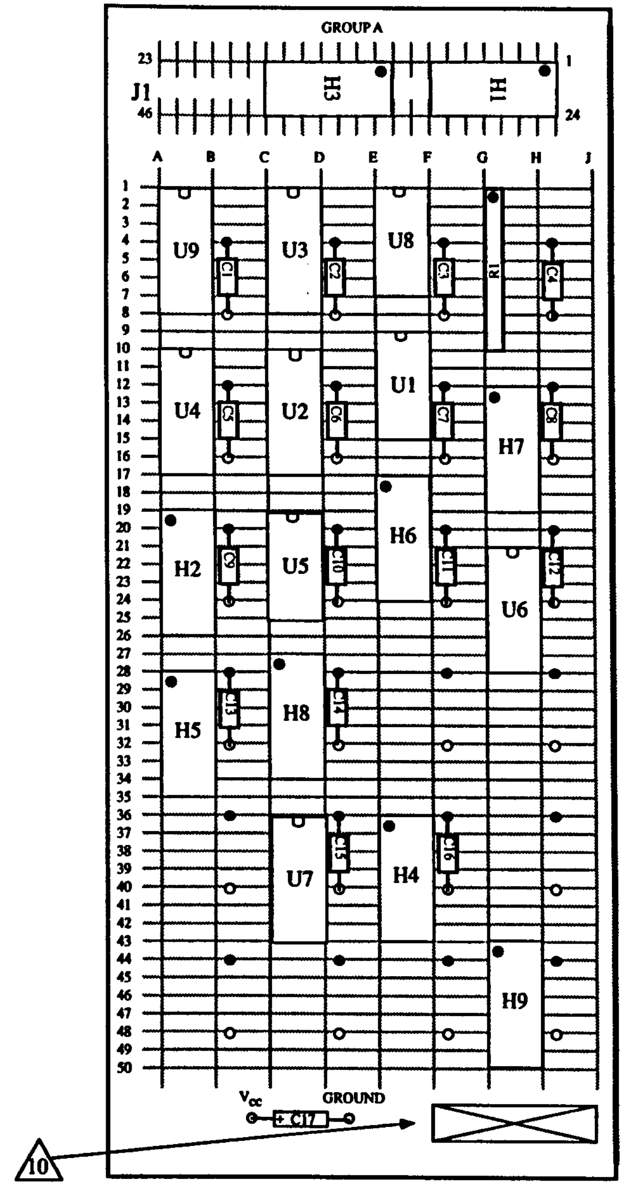
DRAWN

COG ENG

Drawing Page

Assembly Notes:

1. Install swage terminals, Item 20, in holes marked V_{CC} and GROUND.
2. Install capacitor C_{17}, Item 3, observing polarity.
3. Solder capacitors C1-C16, Item 2, in the locations indicated.
4. Install components on headers H2, H5, H6, H7, H8 and H9 per schematic 062-0106. Header H4 and H5 will have coax cables attached later as part of interconnect wiring. Header H9 will be wired to a regulator bracket at final assembly.
5. Install wire wrap markers, Items 18 & 19 over wire wrap pins at locations shown. U1, U5, and U8 are 14 pin ICs, the rest are 16 pin.
6. Wire wrap the board using net list 062-0104. When doing the VCC and GND connections, do not wrap one continuous string as indicated in the net list, but make connections from the indicated IC pin number to the NEAREST VCC or GND pin.
7. Install ICs U1-U9
8. Install headers H2, H5, H6, H7, H8 and H9.
9. Install Resistor SIP R1.
10. Identify board with part number, 062-0102, in location shown.



THIS DRAWING IS INCOMPLETE WITHOUT PARTS LIST 062-0103.

Next Assy: 062-0088

Space Physics Research Laboratory College of Engineering University of Michigan	ANTENNA MUX SERIAL INTERFACE ASSEMBLY - FIELD UNIT	
N000149510249	0TK63	Ant MUX SI Assy
062- 0102	x4	

REV	03-11-97 NS
REV	10-11-96 NS
RELEASE	Not Released
DRAWN	
CUG ENG	P. Hansen

Printed: 2

1 Drawing Page

Parts List
Ant Mux Serial I/F
Next Assy: 062-0088
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Dwg #:062-0103
Rev:X3

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
1	1	EA	8136-UG1-9	Wire Wrap Board	Augat	
2	16	EA	M39014/02-1310	Cap,Cer,0.1uF,100V,10%		C1-16
3	1	EA	199D106X0025CA1	Cap,Tan,10uF,30V,20%		C17
4	3	EA		Header - 16 Pin I/O	UM/SPRL	H1,3,4
5	1	EA		Header-RC	UM/SPRL	H2
6	1	EA		Header-Bias	UM/SPRL	H5
7	1	EA		Header-123	UM/SPRL	H6
8	1	EA		Header-LED-Driver	UM/SPRL	H7
9	1	EA		Header-2R	UM/SPRL	H8
10	1	EA	M8340106K4701GC	Resistor,Sip,4.7K		R1
11	2	EA	SN74LS04N	IC,Hex Inv	TI	U1,8
12	1	EA	SN74HC595N	IC,Shift Register	TI	U2
13	1	EA	SN74LS157	IC,Quad 2 to 1 Mux	TI	U3
14	2	EA	SN74LS123N	IC,One Shot,Dual	TI	U4,6
15	1	EA	LM319N	IC,Comparator,Dual	National	U5
16	1	EA	SN75123N	IC,Line Driver	National	U7
17	1	EA	SN74HC161N	IC,Counter	TI	U9
18	3	EA	ID14-100	Wire Wrap Marker,14 Pin	Wrap-ID	
19	15	EA	ID16-100	Wire Wrap Marker,16 Pin	Wrap-ID	
20	2	EA	1432-9	Terminal, Swage	USECO	
21	1	REF	062-0102	Assy,AntMux,SI	UM/SPRL	
22	1	REF	062-0104	Net List,AntMux SI	UM/SPRL	
23	1	REF	062-0106	Schematic,AntMux SI	UM/SPRL	
24	1	EA		Header-Reg	UM/SPRL	H9

Net List
Ant. Mux Serial I/F
Program: HF Radar
Contract:N000149510249

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SPACE PHYSICS RESEARCH LABORATORY

NET LIST 0106x2 Ant Mux SI Thursday, November 7, 1996 9:42 AM									
NET NAME	PINS								
+8V	H3-12	H3-13	H9-1	H9-4					
+12V	H3-14	H3-15	H9-3	H9-7					
GND	H1-2	H1-4	H1-6	H1-8	H3-2	H3-4	H3-6	H3-8	
	H3-10	H3-11	H4-2	H4-4	H5-9	H5-12	H5-13	H5-15	
	H7-5	H9-9	H9-10	H9-11	H9-13	H9-14	H9-15	U1-7	
	U1-11	U1-13	U2-8	U2-13	U3-8	U3-15	U4-1	U4-8	
	U4-9	U5-6	U6-1	U6-8	U6-9	U6-10	U7-1	U7-2	
	U7-3	U7-4	U7-8	U7-10	U7-11	U7-12	U7-13	U8-7	
	U8-13	U9-3	U9-4	U9-5	U9-6	U9-8			
MA0	H3-1	U3-12							
MA1	H3-3	U3-9							
MA2	H3-5	U3-7							
MA3	H3-7	U3-4	U8-1						
MA3-	H3-9	U8-2							
MAN/AUTO	U3-1	U6-4							
N:1	H2-2	H2-16	U4-7						
N:2	H2-15	U4-6							
N:3	H2-14	U4-14							
N:4	H2-3	H2-13	U4-15						
N:5	H5-2	H5-3	H5-16	U5-5					
N:6	H5-4	H5-5	H5-14	U5-10					
N:7	H5-6	H5-10	U5-4	U5-9					
N:8	H8-15	U2-14	U4-2	U4-10	U5-7	U6-2			
N:9	H8-16	U1-1	U5-12						
N:10	U1-2	U1-3	U7-6						
N:11	H5-7	H5-8							
N:12	H4-1	U7-7							

Net List
Ant. Mux Serial I/F
Program: HF Radar
Contract:N000149510249

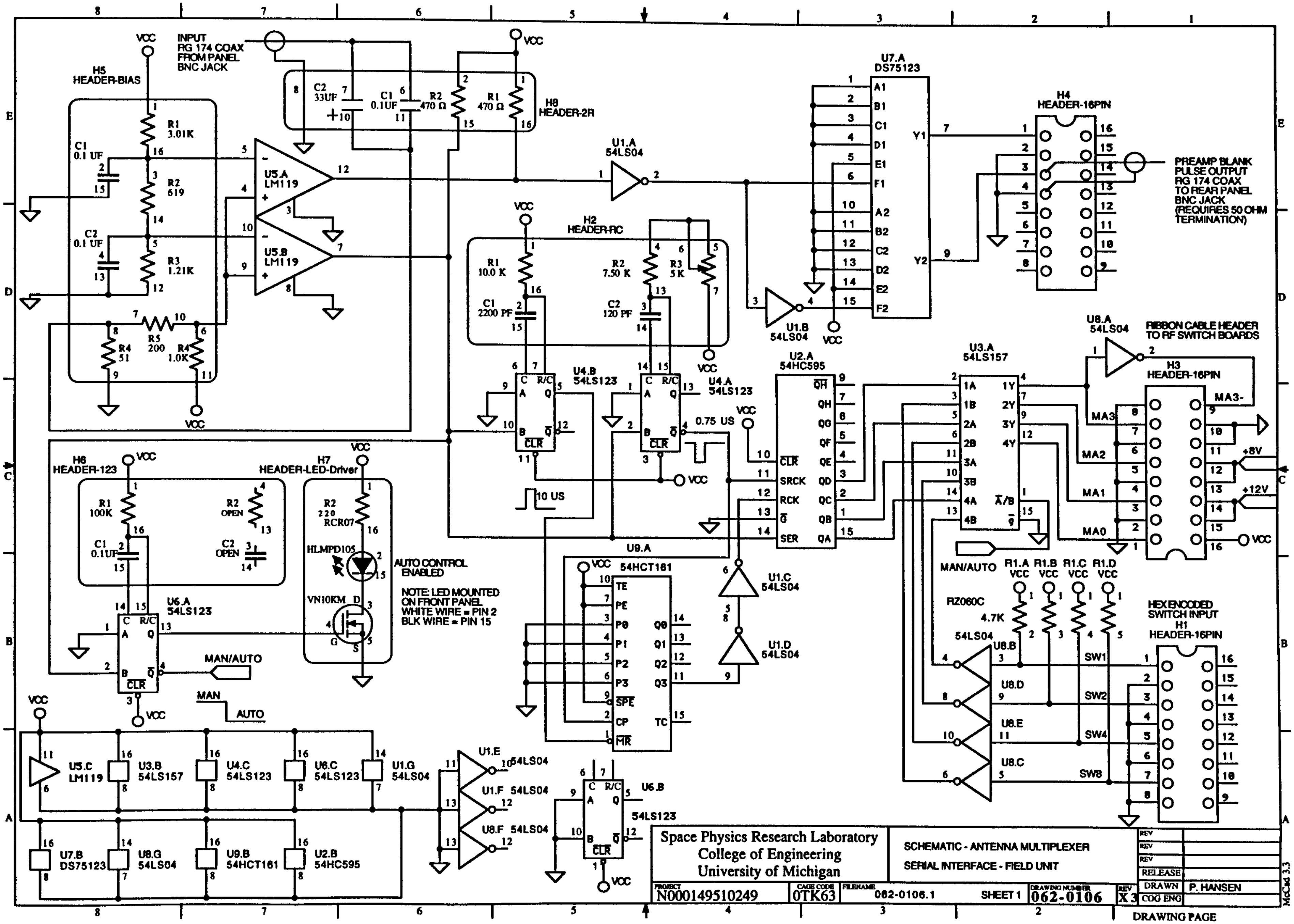
UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

NET LIST 0106x2 Ant Mux SI Thursday, November 7, 1996 9:42 AM									
NET NAME	PINS								
N:13	H4-3	U7-9							
N:14	U1-6	U2-12							
N:15	U1-5	U1-8							
N:16	U1-9	U9-11							
N:18	U4-5	U9-1							
N:20	U2-11	U4-4	U9-2						
N:21	H2-4	H2-5	H2-6						
N:23	H9-2	H9-16							
N:24	U2-3	U3-2							
N:25	U3-13	U8-4							
N:26	U3-10	U8-8							
N:27	U3-6	U8-10							
N:28	U1-4	U7-15							
N:29	U3-3	U8-6							
N:30	U2-2	U3-5							
N:31	U2-1	U3-11							
N:32	U2-15	U3-14							
N:33	H6-15	U6-14							
N:34	H6-2	H6-16	U6-15						
N:35	H7-4	U6-13							
N:36	H7-3	H7-15							

Net List
Ant. Mux Serial I/F
Program: HF Radar
Contract:N000149510249

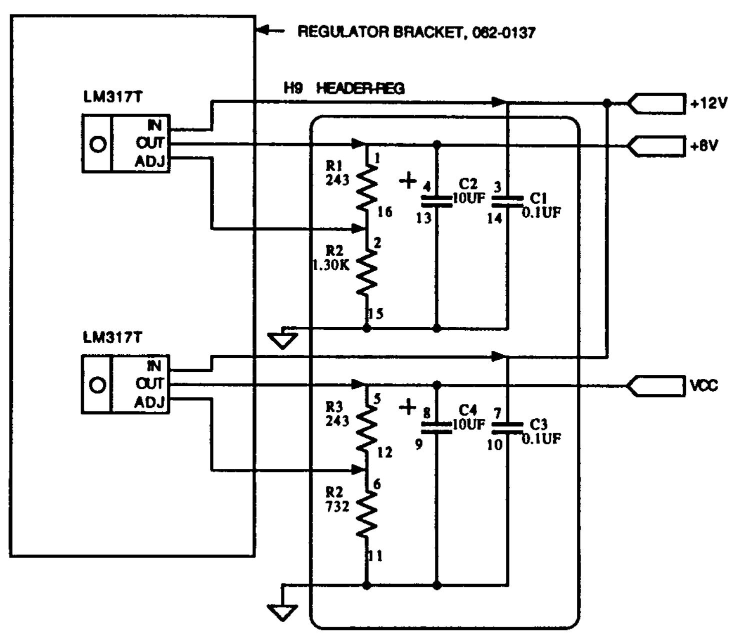
UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

NET LIST 0106x2 Ant Mux SI Thursday, November 7, 1996 9:42 AM									
NET NAME	PINS								
N:37	H7-2	H7-16							
N:38	H9-6	H9-12							
SW1	H1-1	R1-2	U8-3						
SW2	H1-3	R1-3	U8-9						
SW4	H1-5	R1-4	U8-11						
SW8	H1-7	R1-5	U8-5						
VCC	H2-1	H2-7	H3-16	H5-1	H5-11	H6-1	H7-1	H8-1	
	H8-2	H9-5	H9-8	R1-1	U1-14	U2-10	U2-16	U3-16	
	U4-3	U4-11	U4-16	U5-11	U6-3	U6-11	U6-16	U7-5	
	U7-14	U7-16	U8-14	U9-7	U9-9	U9-10	U9-16		


Space Physics Research Laboratory
College of Engineering
University of Michigan
SCHEMATIC - ANTENNA MULTIPLEXER
SERIAL INTERFACE - FIELD UNIT
PROJECT N000149510249
CAGE CODE 0TK63
FILENAME 062-0106.1
SHEET 1
DRAWING NUMBER 062-0106
REV X3
REV
REV
REV
RELEASE
DRAWN P. HANSEN
COG ENG
DRAWING PAGE
McCad 3.3
INPUT RG 174 COAX FROM PANEL BNC JACK
H5 HEADER-BIAS
H8 HEADER-2R
H2 HEADER-RC
H4 HEADER-16PIN
PREAMP BLANK PULSE OUTPUT RG 174 COAX TO REAR PANEL BNC JACK (REQUIRES 50 OHM TERMINATION)
RIBBON CABLE HEADER TO RF SWITCH BOARDS
H3 HEADER-16PIN
H6 HEADER-123
H7 HEADER-LED-Driver
AUTO CONTROL ENABLED
NOTE: LED MOUNTED ON FRONT PANEL WHITE WIRE = PIN 2 BLK WIRE = PIN 15
HEX ENCODED SWITCH INPUT H1 HEADER-16PIN
U5.A LM119
U5.B LM119
U1.A 54LS04
U7.A DS75123
U1.B 54LS04
U4.B 54LS123
U4.A 54LS123
U2.A 54HC595
U3.A 54LS157
U8.A 54LS04
U9.A 54HCT161
U1.C 54LS04
U1.D 54LS04
U6.A 54LS123
U6.B 54LS123
MAN/AUTO
RZ060C 4.7K
0.75 US
10 US
+8V
+12V
VCC

NOTE:

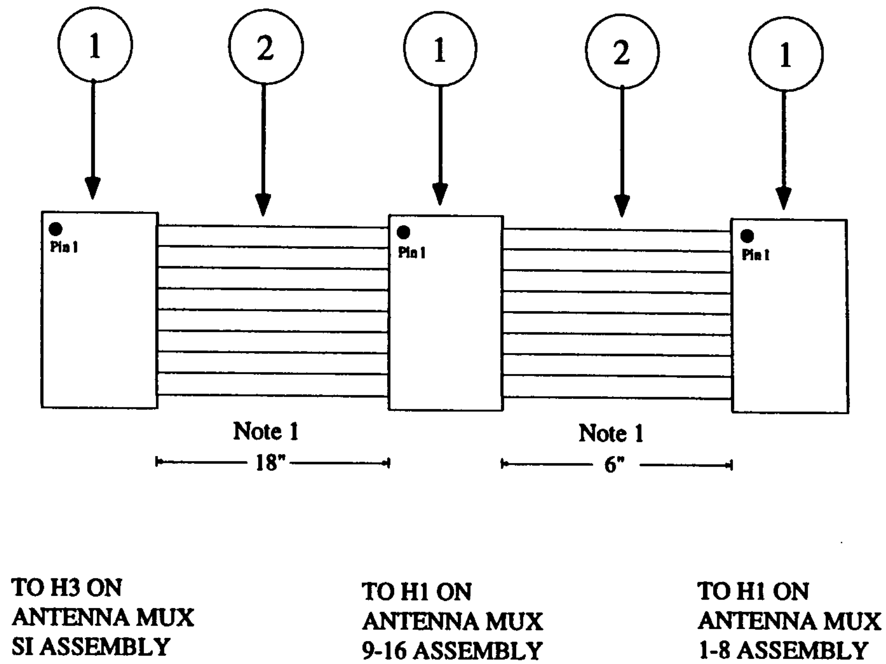
REGULATORS ARE MOUNTED ON BRACKET AND WIRED TO HEADER H-9 AS SHOWN.



Space Physics Research Laboratory College of Engineering University of Michigan	SCHEMATIC - ANTENNA MULTIPLEXER SERIAL INTERFACE - FIELD UNIT	REV / REV / REV / RELEASE / DRAWN: P. HANSEN / COG ENG
PROJECT: N000149510249	CAGE CODE: 0TK63	FILENAME: 062-0106.2 SHEET 2 DRAWING NUMBER: 062-0106 REV: X3

DRAWING PAGE

McCad 3.3



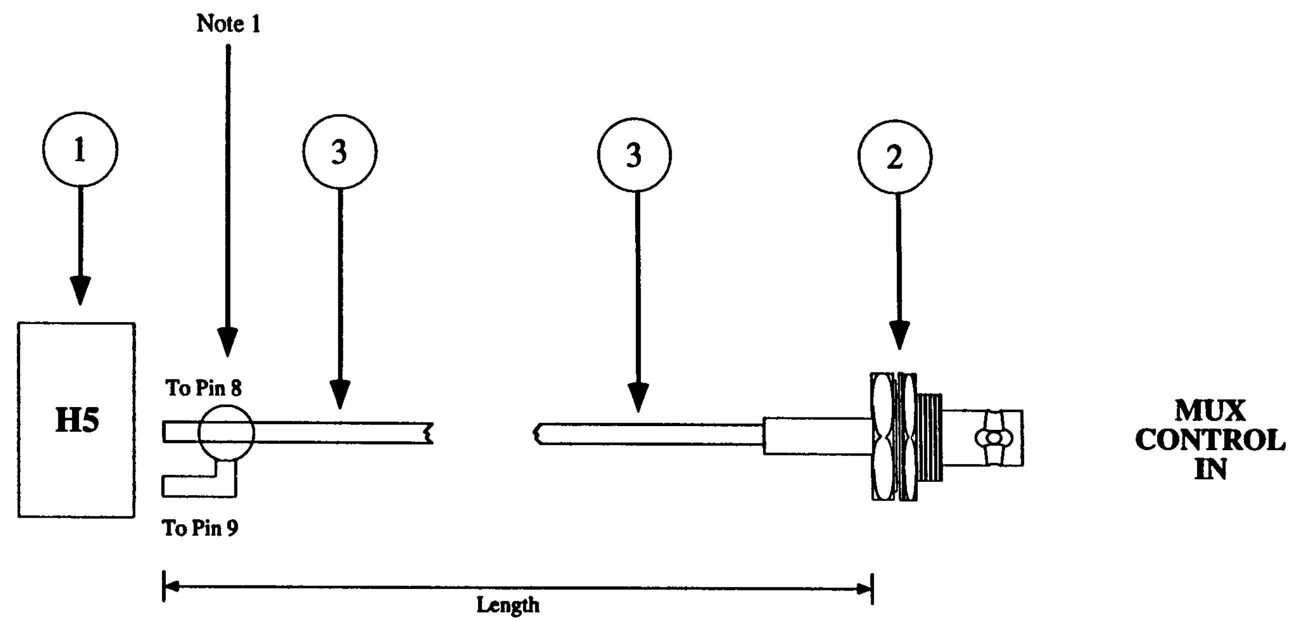
Notes:

1. Install ribbon cable connectors on cable as shown.
2. Continuity test to verify connections.

LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code
1	3	CA-16IDP-1B	16-pin IDC Connectors	Circuit Assembly
2	AR	3850/16	Cable,Ribbon,28Ga,16C	ALPHA

Space Physics Research Laboratory College of Engineering University of Michigan	Antenna MUX Data Cable Assembly W1		01-06-97 NS
		RELEASE	
		DRAWN	N. Schnepf
		CUG ENG	
N000149510249	Ant MUX Data Cable Assy W1	062- 0108	1 OF 1



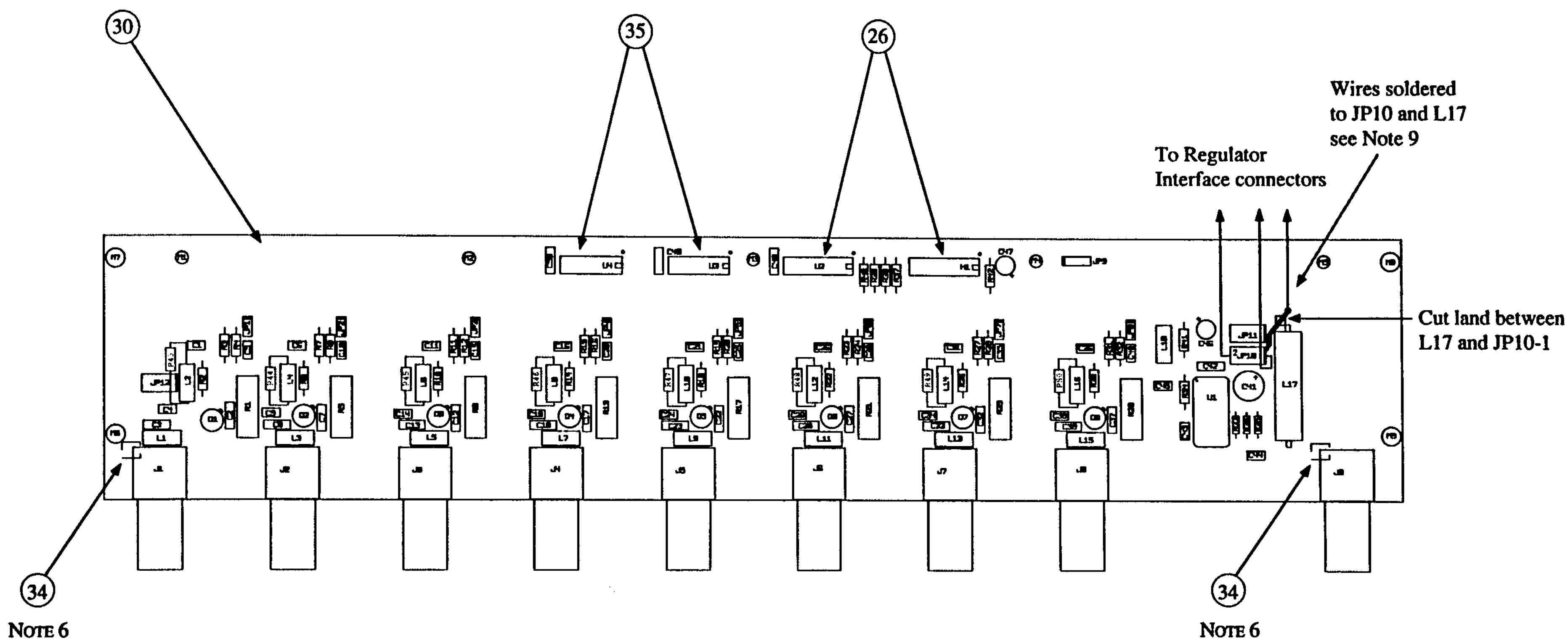
LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	Ref	Note 1	16-pin IDC Header		H5
2	1	31-318	BNC Crimp-On,Blkhd Jk	Amphenol	
3	*tbd*		RG 174 Coax		
4			Shrink tubing	Alpha	
5	AR		Lacing Cord	Nomex	

Notes:

1. Pig tail and shrink tubing : attach to header H5 on SI board (SEE: SI schematic (062-0106)) and secure with lacing cord.
2. The BNC connector (item 2) is attached to the cable using an Amphenol 227-987 tool with 227-1418 die. Cable preparation is detailed on drawing 062-0059.

Space Physics Research Laboratory College of Engineering University of Michigan	Antenna MUX RF Cable Assembly W3		01-06-97 NS
N000149510249	Ant MUX RF Cable Assy W3	062- 0109	1 of 1



Notes:
1. This drawing incomplete without Parts List 062-0111
2. Install swage terminals, Item 25, at JP10,11, and 12.
3. Install 2 terminal header, Item 23, at JP1 thru 8.
4. Install 3 terminal header, Item 24, at JP 9.
5. Install sockets, Item 26 at H1, U2,3, and 4.
6. Install Kapton tape between PCB land and BNC connector spacer tab.
7. Submit board for test before conformal coating.
8. Conformal coat board per procedure 060-0026
9. See RFS Schematic (062-0099) for wiring details.

Space Physics Research Laboratory College of Engineering University of Michigan	RF Switch 9-16 PCB Assembly	REV 04-17-97 NS REV 03-31-97 NS REV 03-11-97 NS RELEASE DRAWN COG ENG
N000149510249	062- 0110	1 OF 1 x4

Drawing Page

Parts List
RF Switch 9-16 PCB
Next Assy: 062-0110
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
1	11	EA	M39014/01-1575	Cap,Cer,0.01uF,100V,10%		C1,6,11,16,21,26,31,36,43,44,45
2	20	EA	M39014/02-1310	Cap,Cer,0.1uF,100V,10%		C2,3,7,8,12,13,17,18,22,23,27,28,32,33,37,38,42,48,49,50
3	8	EA	M39014/01-1357	Cap,Cer,0.001uF,200V,10%		C5,10,15,20,25,30,35,40
4	8	EA	M39014/01-1341	Cap,Cer,120pF,200V,10%		C4,9,14,19,24,29,34,39
5	1	EA	199D336X0025EE2	Cap,Tan,33uF,30V,20%	Sprague	C41
6	2	EA	199D106X0025CA1	Cap,Tan,10uF,25V,20%	Sprague	C46,47
7	17	EA	IM-2-47	Ind,Ferrite,47uH,10%	Dale	L1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,18
8	1	EA	5240	Ind,Ferrite,40uH	Miller	L17
9	8	EA	2N2907A	Transistor,PNP		Q1,2,3,4,5,6,7,8
10	8	EA	RCR32G820JS	Res,CC,82,1W,5%		R1,5,9,13,17,21,25,29,
11	8	EA	RCR07G122JS	Res,CC,1.2K,.25W,5%		R2,6,10,14,18,22,26,30
12	8	EA	RCR07G821JS	Res,CC,820,.25W,5%		R3,7,11,15,19,23,27,31
13	8	EA	RCR07G103JS	Res,CC,10K,.25W,5%		R4,8,12,16,20,24,28,32
14	2	EA	RCR05GxxxJS	Res,CC,SHORT,.125W,5%		R33,36
15	1	EA	RCR07G100JS	Res,CC,10,.25W,5%		R34
16	1	EA	RCR05GxxxJS	Res,CC,OPEN,.125W,5%		R35
17	4	EA	RCR07G472JS	Res,CC,4.7K,.25W,5%		R37,38,39,40
18	2	EA	RCR07G2R7JS	Res,CC,2.7,.25W,5%		R41,42
19	1	EA	MAN-1LN	Amp,RF,LO Noise,	MiniCkts	U1
20	1	EA	SN74LS138N	IC,3 to 8 Decoder	TI	U2
21	2	EA	SN7407N	IC,Hex Inv,OC	TI	U3,4
22	9	EA	31-5640	Connector,BNC,PC Mount,Rt Angle	Amphenol	J1,2,3,4,5,6,7,8,9
23	8	EA	69190-402	Header,2 Terminal	Berg	JP1,2,3,4,5,6,7,8
24	1	EA	69190-403	Header,3 Terminal	Berg	JP9
25	6	EA	2520B	Terminals,Non-Insulated,Swage	Useco	JP10,11,12
26	4	EA	ICD-16-2T	Socket,IC,16 Pin	Voltrex	H1, Sockets for U2
27	1	AR	5750LV-A	Conformal Coating	Uralane	
28	1	AR	5750LV-B	Curing Agent	Uralane	
29	1	AR	Toluene/MEK	Thinner		

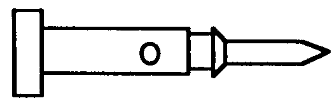
Parts List
RF Switch 9-16 PCB
Next Assy: 062-0110
Prog: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Item	Qty	U/M	Part #	Description	Mfr/Code	Symbol
30	1	REF	062-0100	PCB,Raw Card,RF Switch	UM/SPRL	
31	1	REF	062-0099	Schematic,Ant Mux RF Switch	UM/SPRL	
32	1	REF	060-0026	Instructions, Conformal Coating	UM/SPRL	
33	1	REF	062-0101	Build Instructions,RF Switch PCB	UM/SPRL	
34	AR	IN		Kapton tape		
35	2	EA	ICD-14-2T	Socket,IC,14 Pin	Voltrex	U3,U4
36	8	EA	RCR07G561JS	Res,CC,560Ω,.25W,5%		R43,44,45,46,47,48,49,50
37	2	AR	RG316/U	Cable,coaxial,50 Ω,RG 316	Pasternack	
38	1	EA	RCR07G510JS	Res,CC,51√,.25W,5%		R51

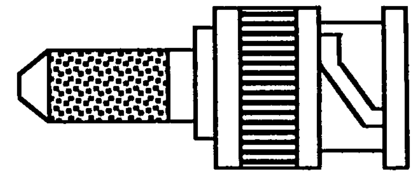
THESE INSTRUCTIONS DETAIL THE PROCEDURE FOR MATING A BNC MALE CONNECTOR TO RG-58 COAXIAL CABLE USING AN AMPHENOL CTL-1 CRIMPER.

Parts:



Male Contact

Outer Ferrule

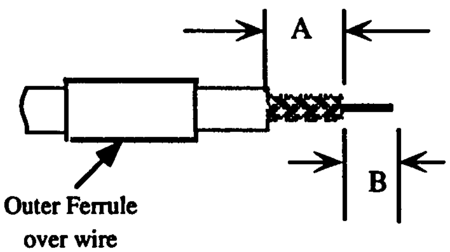


Connector Body

Directions:

Step 1

Dimensions
A = .325"
B = .100"

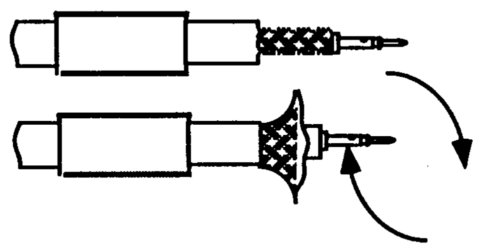


Slide the outer ferrule over the cable as shown. Use the large black coaxial cable stripper to strip sections A and B. Strip the cableaccording to the dimensions. Be careful not to nick or damage the braid, dielectric, or center conductor.

Step 2

figure A

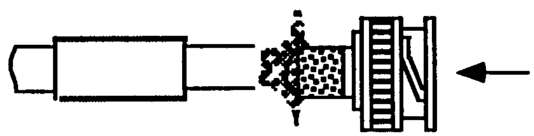
figure B



Slide the male contact over section B of the coaxial cable as shown in figure A. Using an Amphenol CTL-1 crimper, .068 die size, crimp the male contact to section B. Give a slight tug to make sure it is secure. Next, rotate the male contact so the braided wire is slight flared and the dielectric is shown as in figure B.

Step 3

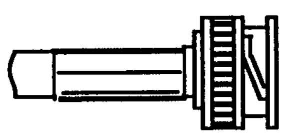
figure C



Slide the Connector body over the male contact and the dielectric making certain that none of the braided wires get caught in between. These wires should wrap around the outside of the bottom of the connector body as shown in figure C. Push, the body so that is locks to the male connector.

Step 4

figure D

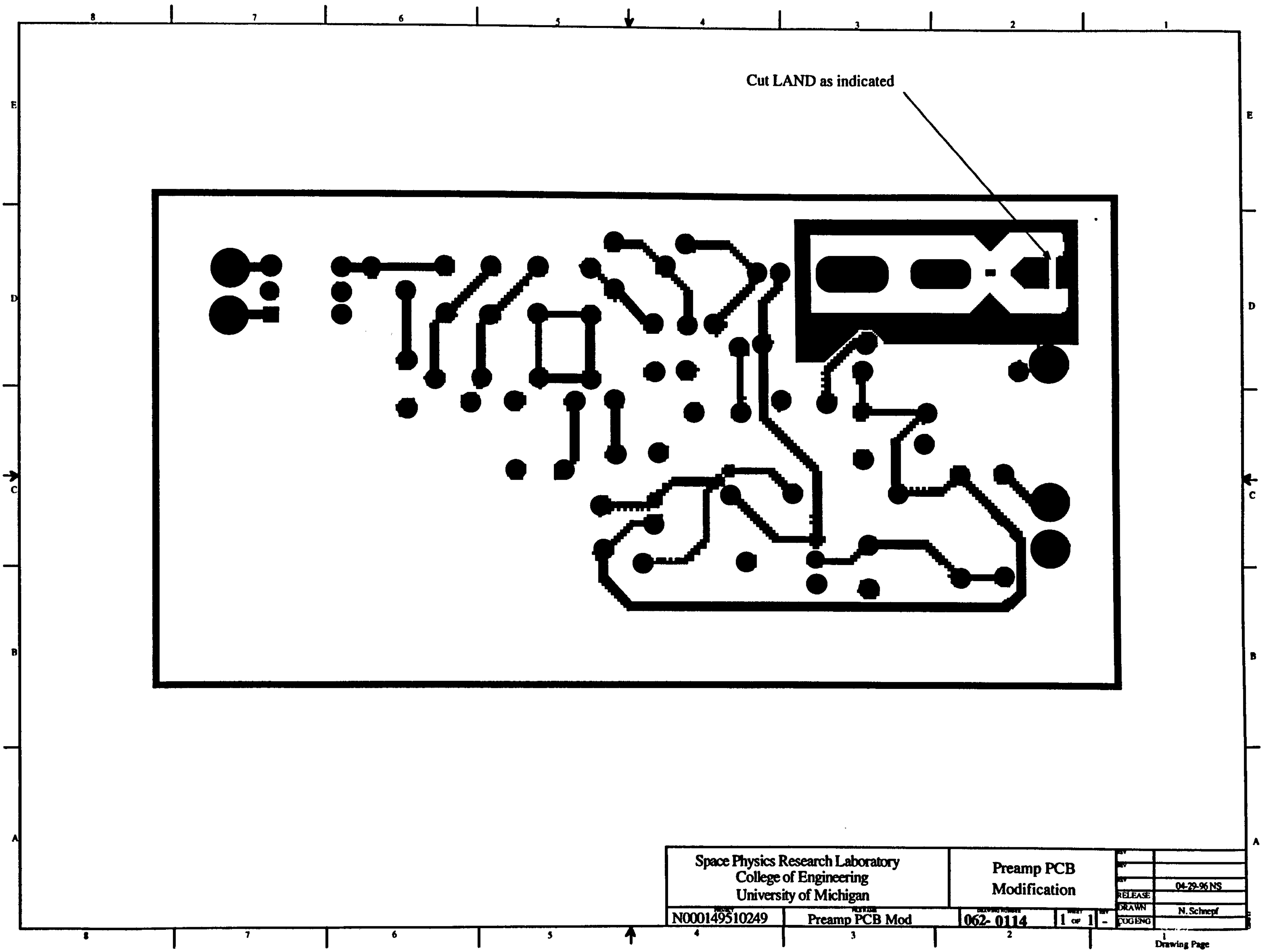


Slide the outer ferrule upward so the it covers the braided wired and is in contact with the connector body as show in figure D. Make sure that no braided wires get caught inside of the connector body. Crimp the outer ferrule with the Amphenol CTL-1crimpers using size .213 die.

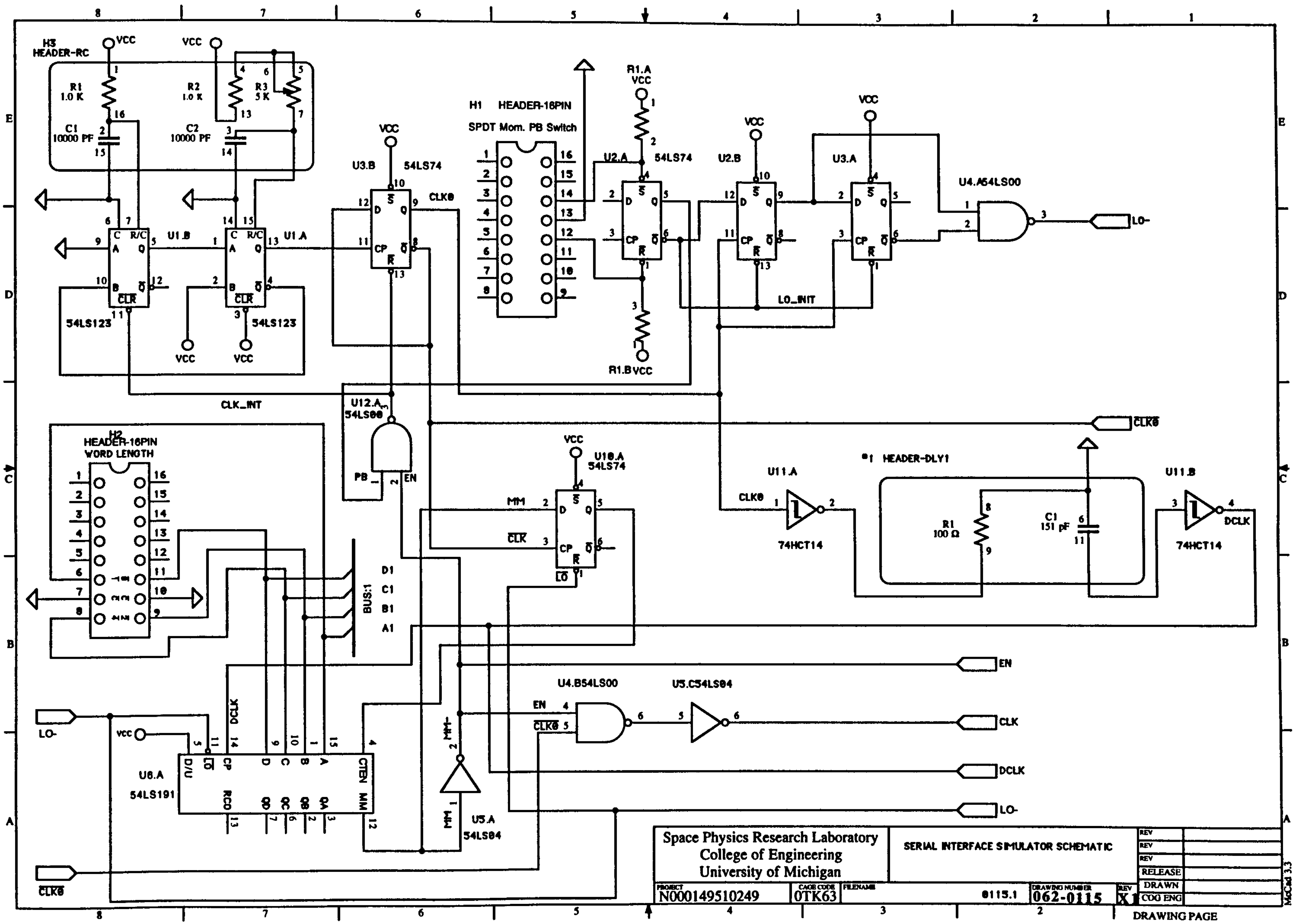
Step 5

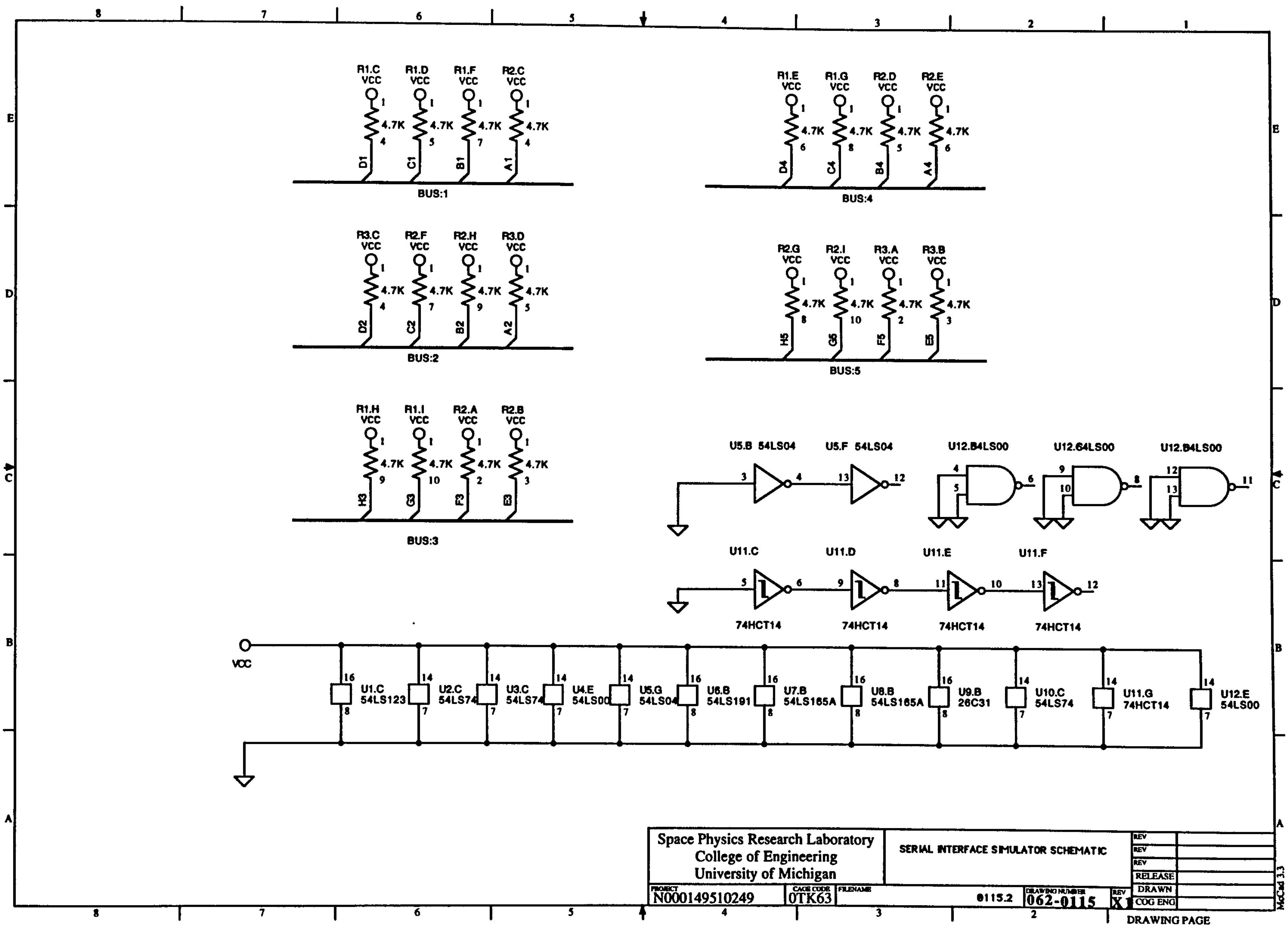
Check the cable for shorts between the inner conductor and the outer conduction. If there are no shorts the cable is good. If any shorts are found, the cable must be reassembled.

Space Physics Research Laboratory College of Engineering University of Michigan		Manufacturing Proc. BNCm/RG-58		04-22-96 NS
			RELEASE	
			DRAWN	Heather Hamilton
N000149510249	MP-BNCm/RG 58	062- 0113	1 OF 1	

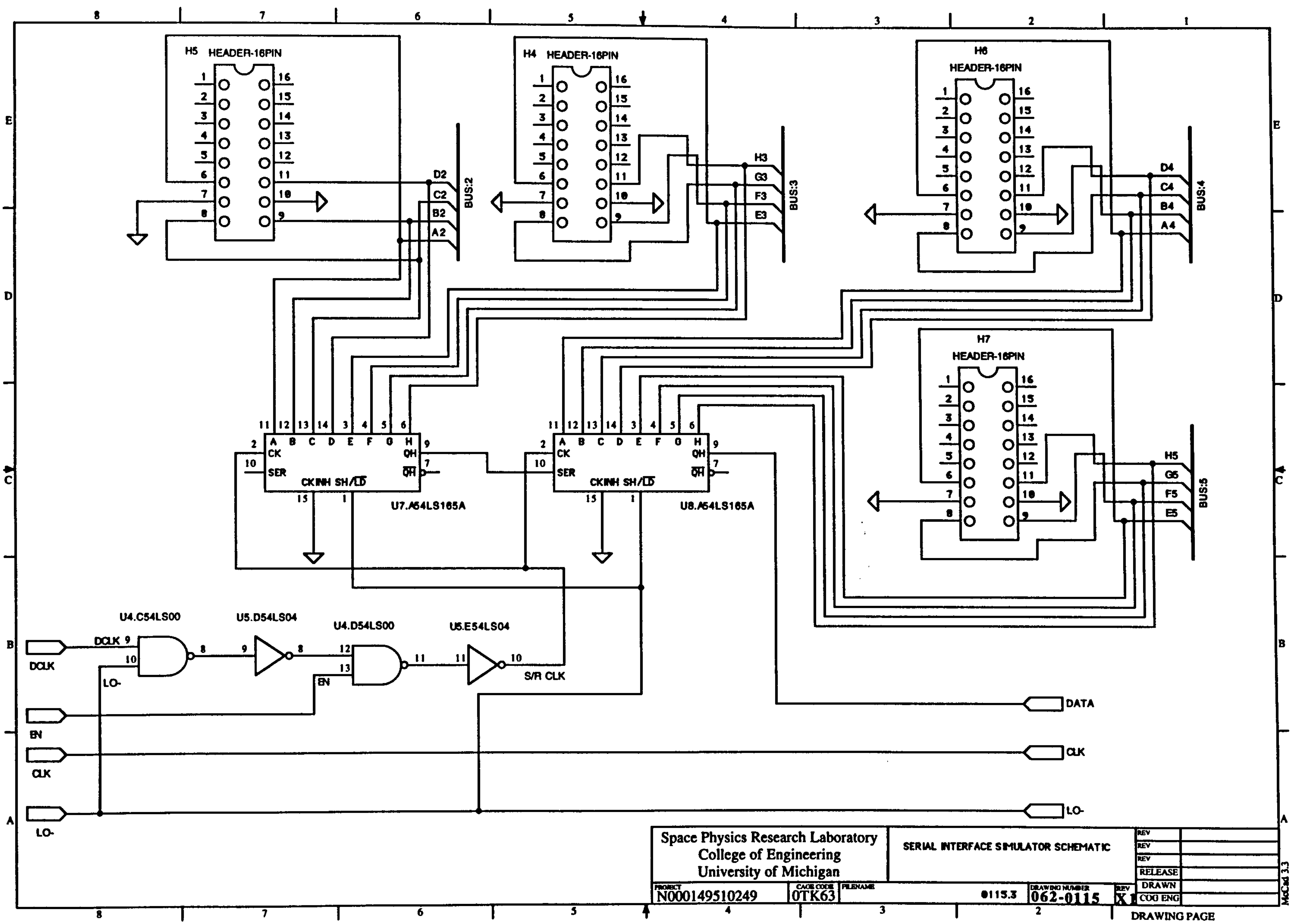


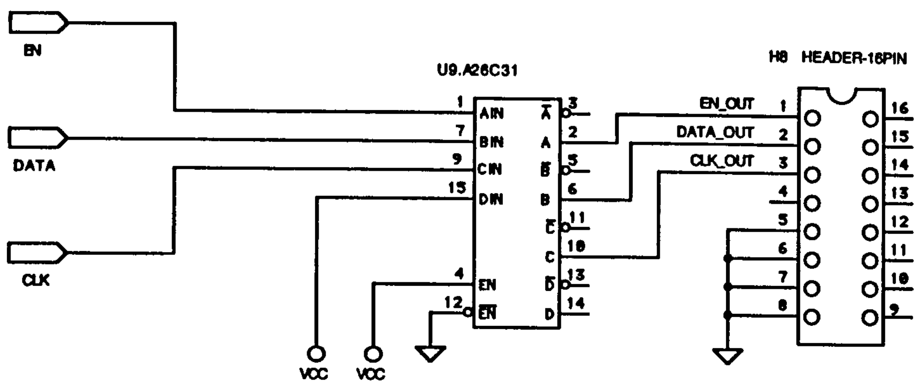
Cut LAND as indicated
Space Physics Research Laboratory
College of Engineering
University of Michigan
Preamp PCB
Modification
N000149510249
Preamp PCB Mod
062- 0114
1 OF 1
-
RELEASE
04-29-96 NS
DRAWN
N. Schnepf
COGENG
Drawing Page


H3 HEADER-RC
R1 1.0 K
C1 10000 PF
R2 1.0 K
R3 5 K
C2 10000 PF
U1.B
U1.A
54LS123
CLK_INT
U3.B 54LS74
CLK0
U12.A 54LS00
PB
EN
H1 HEADER-16PIN
SPDT Mom. PB Switch
R1.A VCC
R1.B VCC
U2.A 54LS74
U2.B
U3.A
LO_INIT
U4.A54LS00
LO-
CLK0
H2 HEADER-16PIN WORD LENGTH
BUS:1
D1
C1
B1
A1
U10.A 54LS74
MM
CLK
LO
U11.A
74HCT14
#1 HEADER-DLY1
R1 100 Ω
C1 151 pF
U11.B
DCLK
EN
U4.B54LS00
U5.C54LS04
CLK
DCLK
LO-
U6.A 54LS191
U5.A 54LS04
VCC
Space Physics Research Laboratory
College of Engineering
University of Michigan
SERIAL INTERFACE SIMULATOR SCHEMATIC
PROJECT N000149510249
CAGE CODE 0TK63
FILENAME 0115.1
DRAWING NUMBER 062-0115
REV X1
REV
RELEASE
DRAWN
COG ENG
DRAWING PAGE
McCad 3.3



R1.C VCC 4.7K D1
R1.D VCC 4.7K C1
R1.F VCC 4.7K B1
R2.C VCC 4.7K A1
BUS:1
R3.C VCC 4.7K D2
R2.F VCC 4.7K C2
R2.H VCC 4.7K B2
R3.D VCC 4.7K A2
BUS:2
R1.H VCC 4.7K H3
R1.I VCC 4.7K G3
R2.A VCC 4.7K F3
R2.B VCC 4.7K E3
BUS:3
R1.E VCC 4.7K D4
R1.G VCC 4.7K C4
R2.D VCC 4.7K B4
R2.E VCC 4.7K A4
BUS:4
R2.G VCC 4.7K H5
R2.I VCC 4.7K G5
R3.A VCC 4.7K F5
R3.B VCC 4.7K E5
BUS:5
U5.B 54LS04
U5.F 54LS04
U12.B4LS00
U12.64LS00
U12.B4LS00
U11.C
U11.D
U11.E
U11.F
74HCT14
74HCT14
74HCT14
74HCT14
VCC
U1.C 54LS123
U2.C 54LS74
U3.C 54LS74
U4.E 54LS00
U5.G 54LS04
U6.B 54LS191
U7.B 54LS165A
U8.B 54LS165A
U9.B 26C31
U10.C 54LS74
U11.G 74HCT14
U12.E 54LS00
Space Physics Research Laboratory
College of Engineering
University of Michigan
SERIAL INTERFACE SIMULATOR SCHEMATIC
REV
REV
REV
RELEASE
DRAWN
COG ENG
PROJECT
N000149510249
CAGE CODE
0TK63
FILENAME
0115.2
DRAWING NUMBER
062-0115
REV
X1
DRAWING PAGE
McCad 3.3


H5 HEADER-16PIN
H4 HEADER-16PIN
H6 HEADER-16PIN
H7 HEADER-16PIN
BUS:2
BUS:3
BUS:4
BUS:5
D2
C2
B2
A2
H3
G3
F3
E3
D4
C4
B4
A4
H5
G5
F5
E5
U7.A54LS165A
U8.A54LS165A
CKINH SH/LD
SER
CK
QH
U4.C54LS00
U5.D54LS04
U4.D54LS00
U5.E54LS04
DCLK
LO-
EN
CLK
S/R CLK
DATA
Space Physics Research Laboratory
College of Engineering
University of Michigan
SERIAL INTERFACE SIMULATOR SCHEMATIC
PROJECT N000149510249
CAGE CODE 0TK63
FILENAME
0115.3
DRAWING NUMBER 062-0115
REV X1
REV
REV
REV
RELEASE
DRAWN
COG ENG
DRAWING PAGE
McCad 3.3



Space Physics Research Laboratory
College of Engineering
University of Michigan

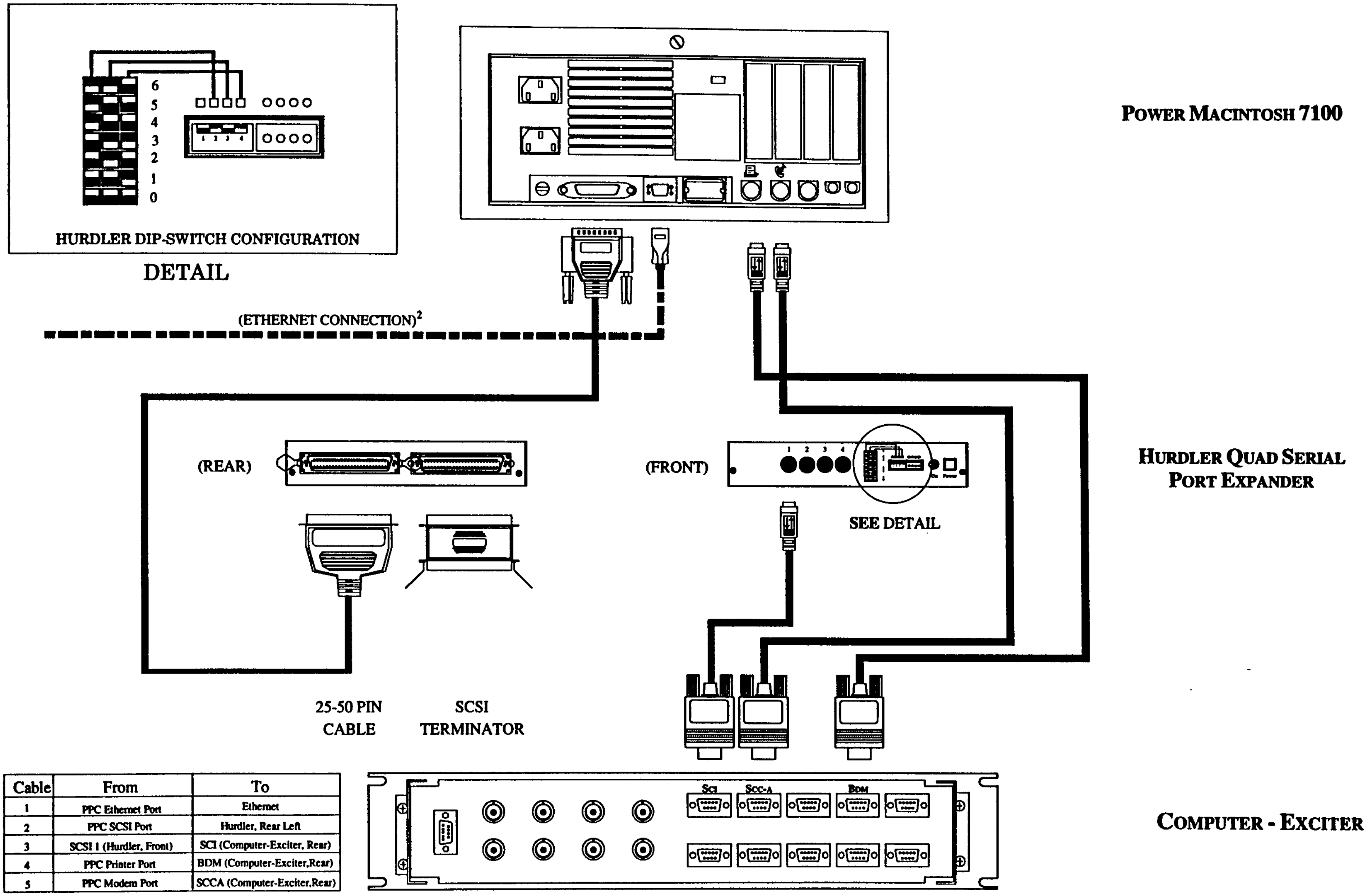
SERIAL INTERFACE SIMULATOR SCHEMATIC

PROJECT N000149510249 | CAGE CODE 0TK63 | FILENAME 0115.4 | DRAWING NUMBER 062-0115 | REV X1

REV
REV
REV
RELEASE
DRAWN
COG ENG

DRAWING PAGE

McCad 3.3



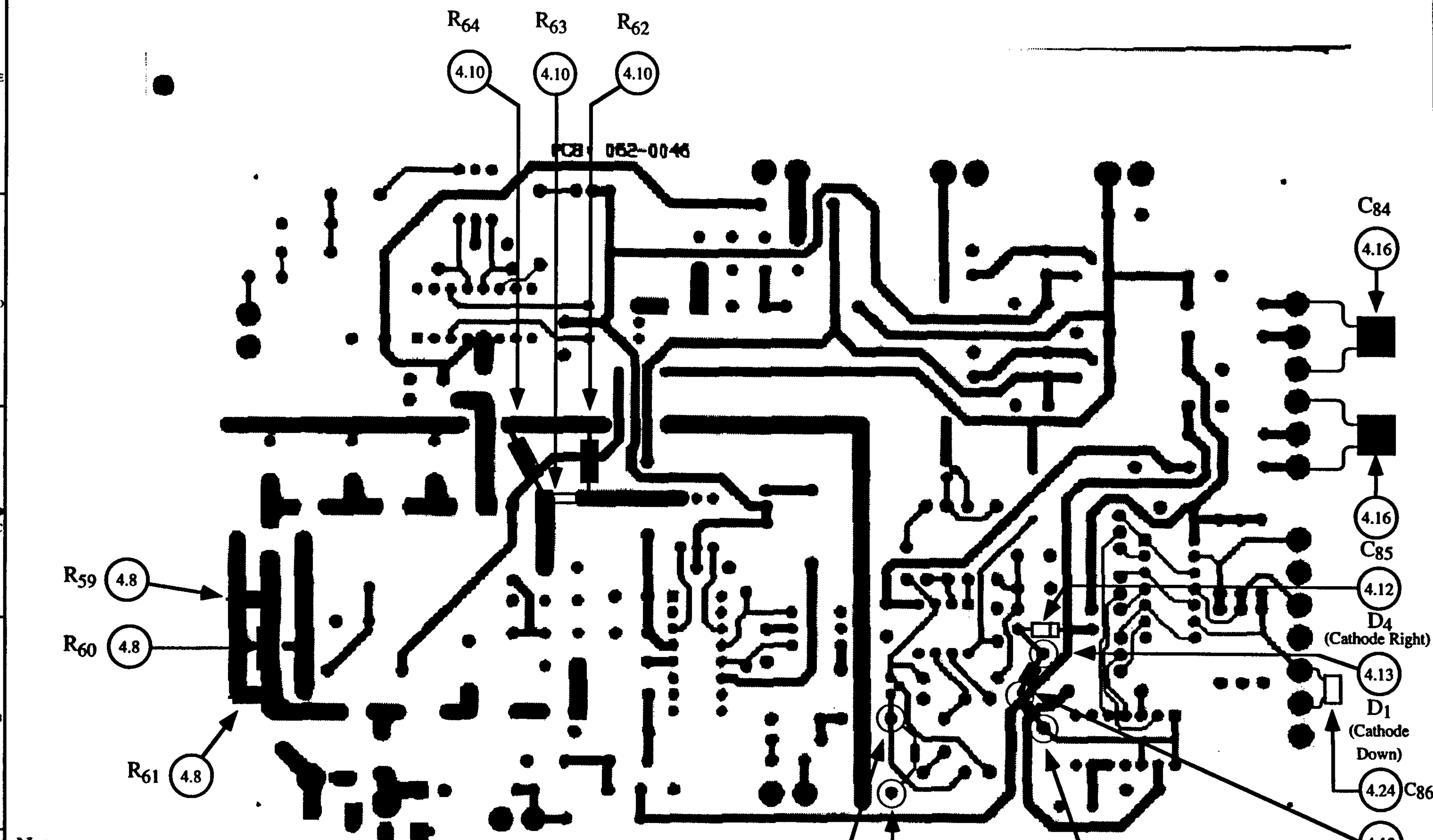
Cable	From	To
1	PPC Ethernet Port	Ethernet
2	PPC SCSI Port	Hurdler, Rear Left
3	SCSI 1 (Hurdler, Front)	SCI (Computer-Exciter, Rear)
4	PPC Printer Port	BDM (Computer-Exciter,Rear)
5	PPC Modem Port	SCCA (Computer-Exciter,Rear)

Notes:

1. For radar-mode computer operation and guidelines see : 062-0162.
2. For component part # information see: 062-0161.

Space Physics Research Laboratory College of Engineering University of Michigan	Power Macintosh 7100 I/O Layout	RELEASE	06-17-96 NS
N000149510249	PPC I/O L/O	DRAWN	N. Schnepf
062-0116	1 of 1 x4	COG ENG	

Drawing Page

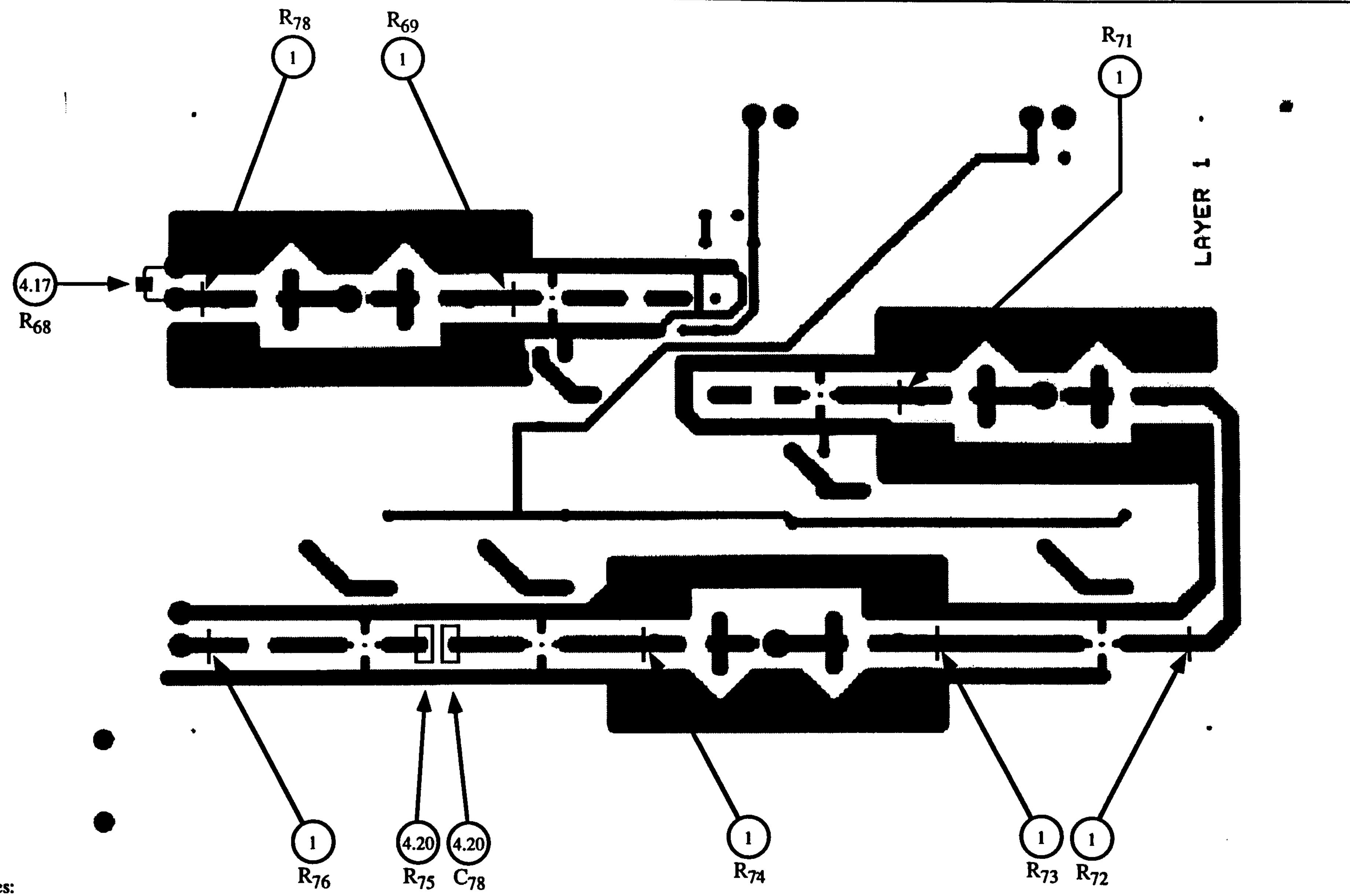


Notes:

1. SEE assembly modification notes in build procedure 062-0084.
   Balloon number refers to step number in procedure.

Space Physics Research Laboratory College of Engineering University of Michigan	MIXER-IFPCB MODIFICATION COMPONENTSIDE "A" BOARD	REV	03-14-97 NS
		REV	10-07-96 NS
		RELEASE	
N000149510249	Mixer-IF PCB Mod	062- 0117	1 OF 3	x3	DRAWN: Neil Schnepf
			CUGENG

1
Drawing Page

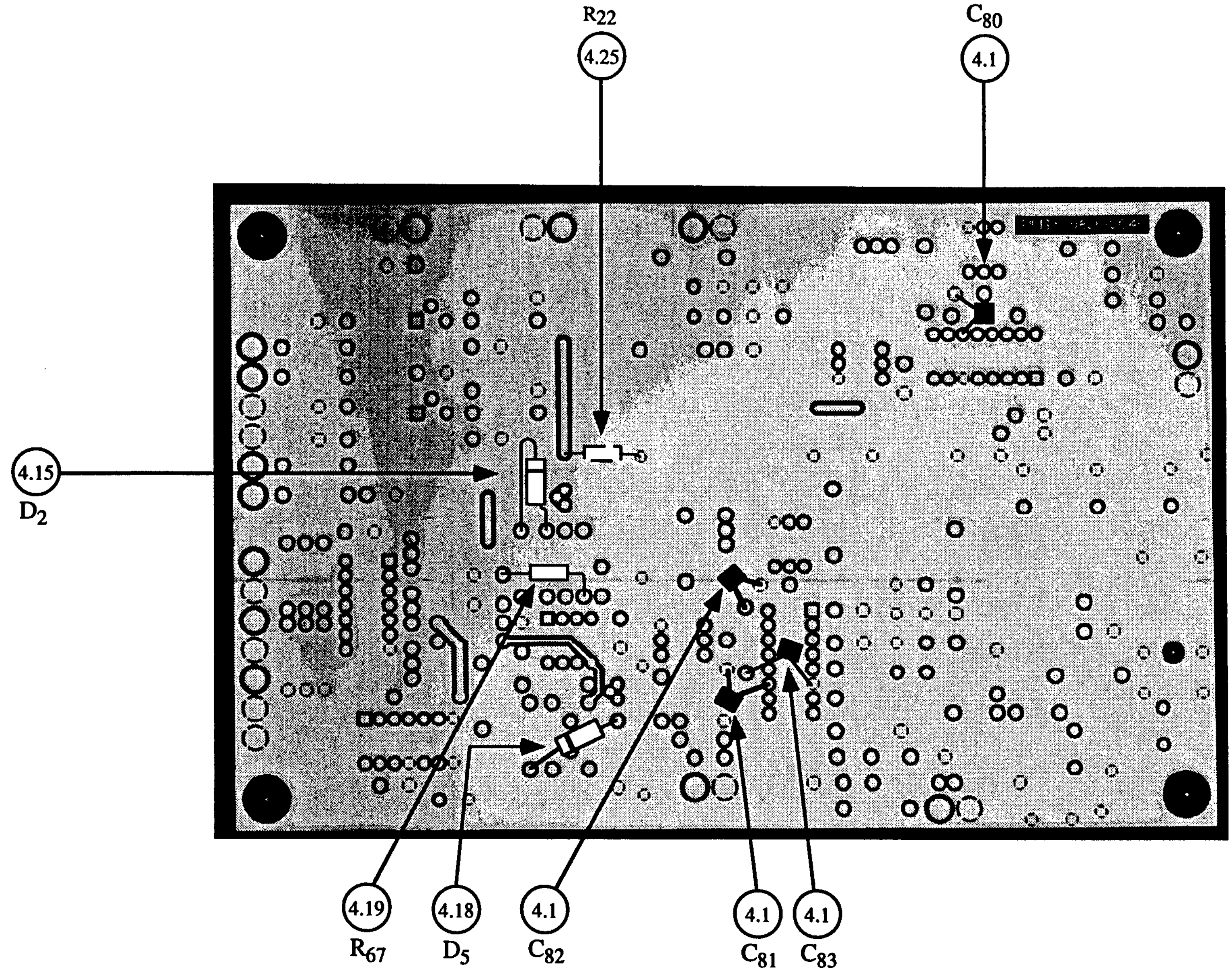


Notes:

1. Cut land and install indicated resistor at these locations.
SEE PCB Modification notes #0.1, 0.2, 0.3, and 4.21
in build procedure 062-0084.

Space Physics Research Laboratory College of Engineering University of Michigan	Mixer-IF PCB Modification COMPONENT SIDE "B" BOARD	REV	03-14-97 NS
		REV	10-08-96 NS
		RELEASE	
		DRAWN	Neil Schnepf
N000149510249	Mixer-IF PCB Mod	062- 0117 | 2 of 3 | x3	MFG ENG

Drawing Page

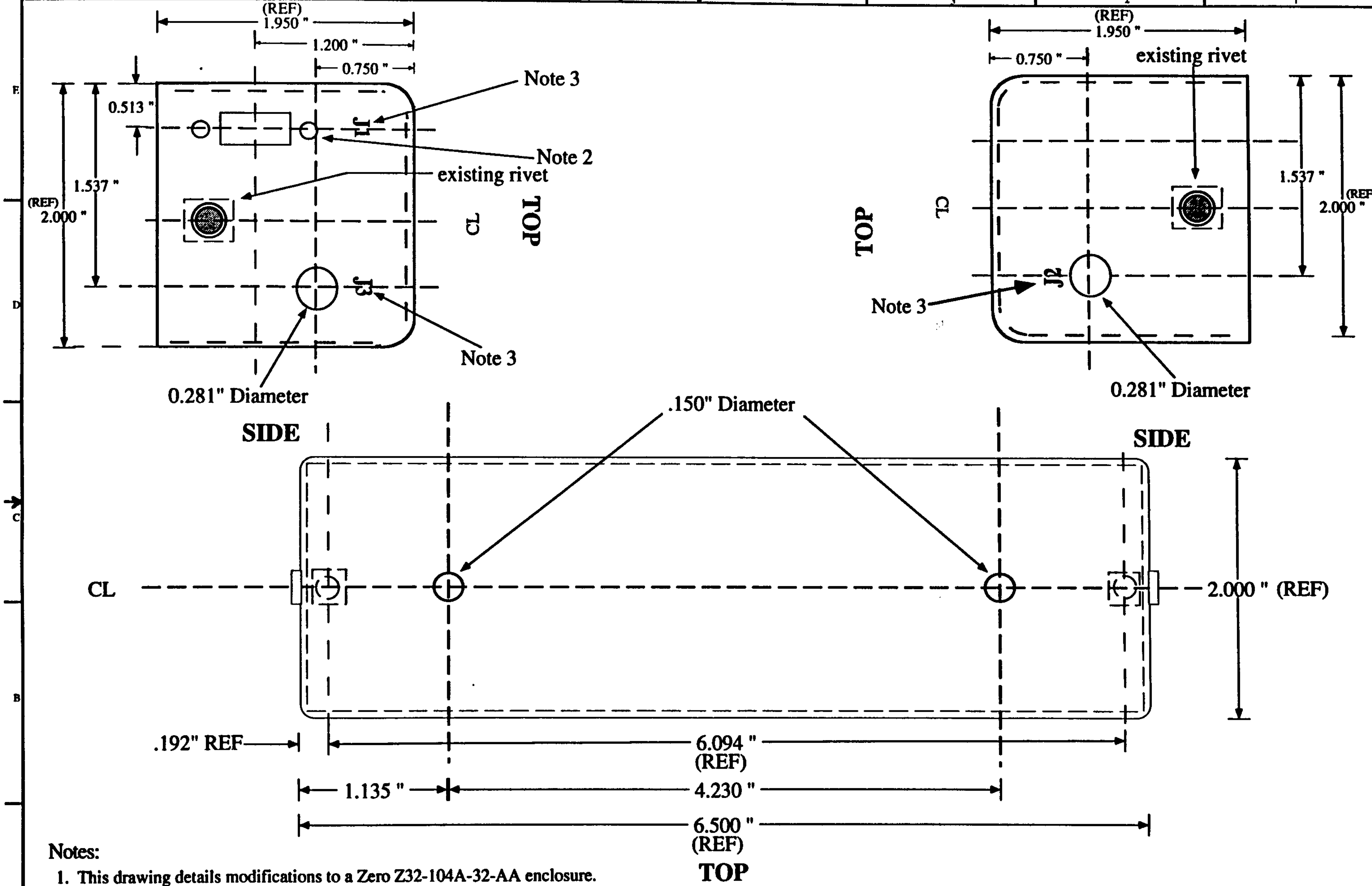


Notes:

1. Capacitor symbol:

Space Physics Research Laboratory College of Engineering University of Michigan	Mixer-IF PCB Modification SOLDER SIDE "A" BOARD	REV	
		REV	03-14-97 NS
		REV	10-08-96 NS
		RELEASE	
		DRAWN	Neil Schnepf
N000149510249	Mixer-IF PCB Mod	062- 0117 — 3 OF 3 — x3	COG ENG

Drawing Page



Notes:

1. This drawing details modifications to a Zero Z32-104A-32-AA enclosure.
2. Cut-out for 9-pin rear mount d-connector.
   See : 060-0097.
3. Rubber stamp J-numbers in locations indicated using items 12 and 13.

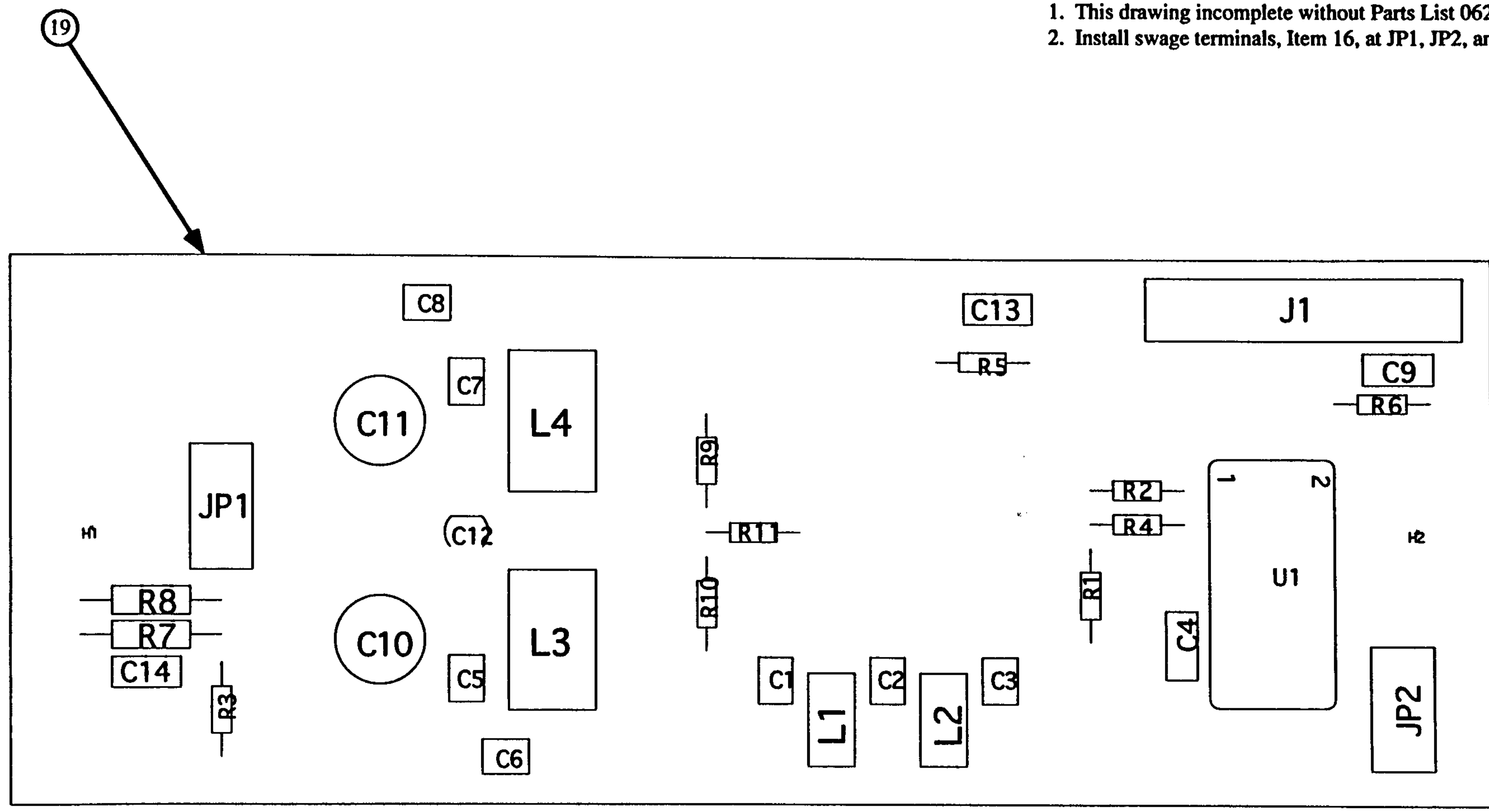
Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan		LOCAL OSCILLATOR FILTER ENCLOSURE	
N000149510249	LOF Enclsoure	062- 0121	1 of 1 x2

RELEASE
DRAWN N. Schnepf, H. Hamilton
COG ENG

1 Drawing Page

Notes:
1. This drawing incomplete without Parts List 062-0124
2. Install swage terminals, Item 16, at JP1, JP2, and J1.



Space Physics Research Laboratory
College of Engineering
University of Michigan

LO Filter PCB Assembly

N000149510249

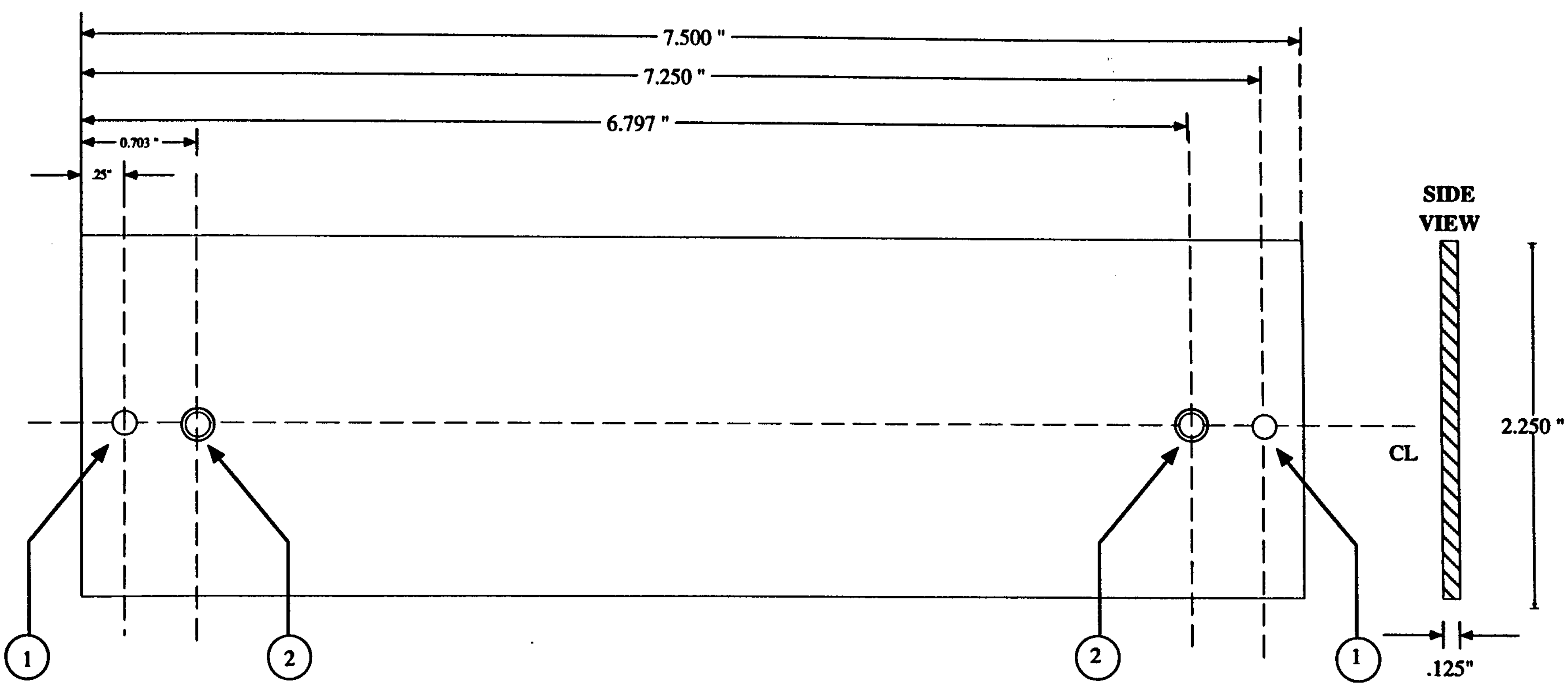
062- 0122

1 of 1

X1

RELEASE
DRAWN
COG ENG

Drawing Page



NOTES:

1. 0.150" Dia Thru
2. 100° c-bore, .060" deep
   .177" Clearance hole, 2 places
3. Break all sharp edges & remove burrs.
4. Material: 6061T6 Aluminum or equivalent

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan		LOCAL OSCILLATOR FILTER MOUNTING PLATE	REV 03-05-97 NS REV 11-14-96 NS RELEASE DRAWN N.Schaepf, H. Hamilton COG ENG
N000149510249	LOF Mntng Plate	062- 0123	1 OF 1 x4

Drawing Page

Parts List
LOF PCB
Program: HF Radar
Contract No:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

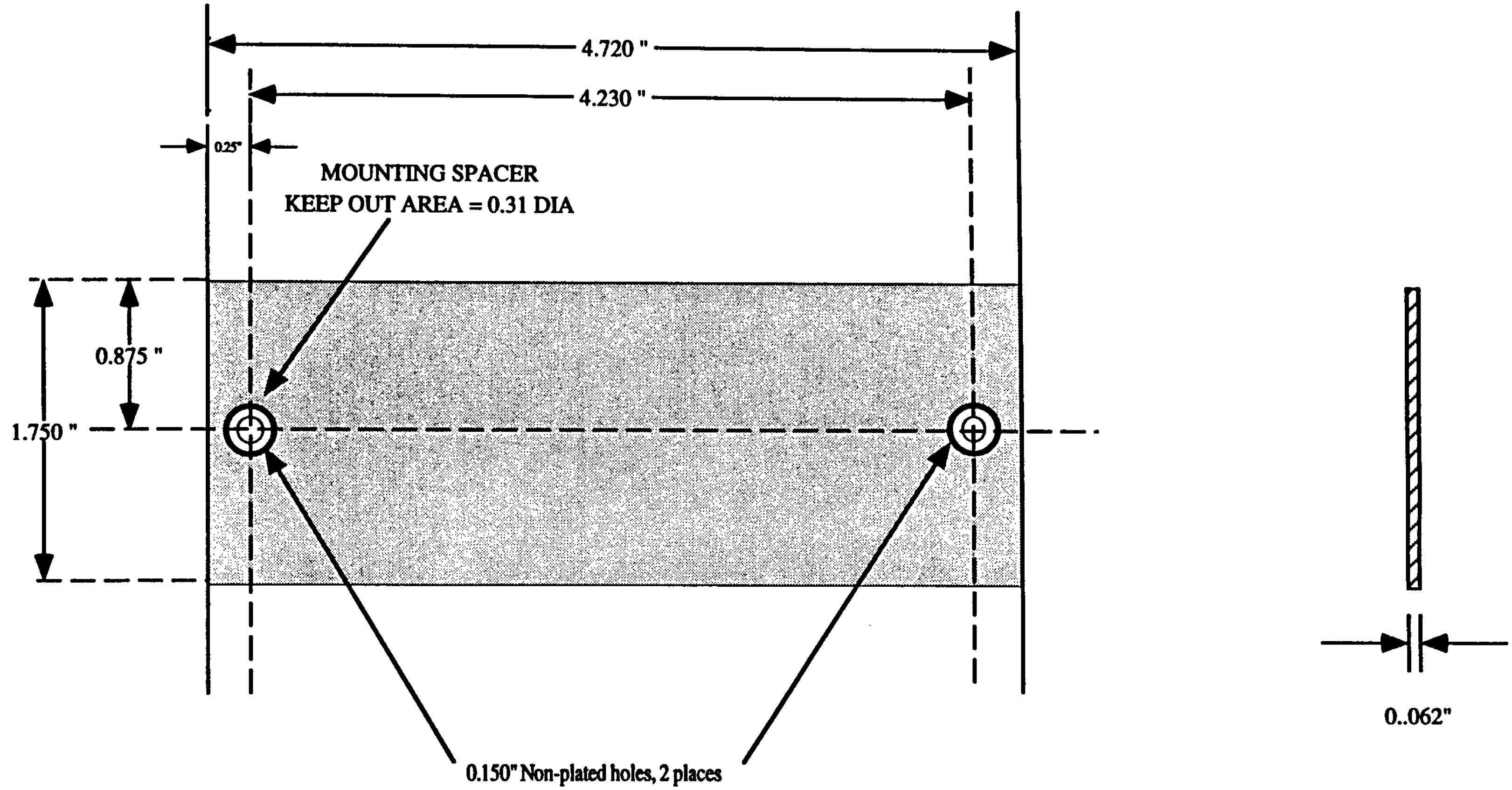
Item	Qty	U/M	Part#	Description	Mfr/Code	Symbol
1	2	EA	ATC700B470JNMS500X	Cap, Cer, 47pF, 500V	AmTechCer	C1, C3
2	3	EA	ATC700B151JNMS500X	Cap, Cer, 150pF, 500V	AmTechCer	C2, C5, C7
3	2	EA	ATC700B102MNMS50X	Cap, Cer, 1000pF, 50V	AmTechCer	C6, C8
4	4	EA	M39014/01-1575	Cap, Cer, .01uF, 100V, 10%		C4, C9, C13, C14
5	2	EA	9338	Cap, Var, 6-70pF, 250V	Johanson	C10, C11
6	1	EA	27273	Cap, Var,0.6-4.5pF, 500V	Johanson	C12
7	2	EA	062-0027-6	Ind, PwdIron, .1uH, 5%	UM/SPRL	L3, L4
8	2	EA	062-0027-1	Ind, PwdIron, .28uH, 5%	UM/SPRL	L1, L2
9	2	EA	RCR05G390JS	Res, CC,39, .125W 5%		R1, R2
10	1	EA	RCR05G220JS	Res, CC, 22, .125W 5%		R3
11	3	EA	RCR05G100JS	Res,CC, 10, .125 W 5%		R4,R5,R6
12	1	EA	RCR07G241JS	Res, CC, 240, .25W, 5%		R7
13	1	EA	RCR07G151JS	Res, CC,150, .25%, 5%		R8
14	2	EA	RCR05G360JS	Res, CC, 36, .125W, 5%		R9, R10
15	1	EA	MAN-1LN	Amplifier	Mini-Ckts	U1
16	8	EA	2520B	Terminal,Swage	Useco	
17	1	REF	062-0128	Schematic, LOF Field Unit	UM/SPRL	
18	1	REF	062-0122	LOF, PCB Assembly	UM/SPRL	
19	1	EA	062-0140	PC Board, Local Osc. Filter	UM/SPRL	
20	1	EA	RCR05G160JS	Res,CC,16,.125W,5%		R11

PARTS LIST
LOF Assy
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:062-0125
Revision: X4

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	1	EA	062-0122	LOF PCB Assy	SPRL	
2	1	EA	062-0121	Local Oscillator Filter Enclosure	SPRL	
3	1	EA	062-0123	LOF Mounting Plate	SPRL	
4	2	EA	874-10-3	SMA,receptacle,bulkhead,rear mnt	Kings	J2,J3
5	2	EA	MS24693-C29	Screw,CRES,FH,100deg,8-32x0.625"		
6	2	EA		Screw,CRES,PH,6-32 x 0.5"		
7	2	EA		Spacer, thru, #6 x 0.25"		
8	2	EA		Washer, flat, #6		
9	2	EA		Washer, lock #6		
10	2	EA		Nut, 6-32		
11	8	EA	205817-1	Screw lock, female	Amp	
12	AR	OZ	2850FT	Epoxy,Black	Stycast	
13	AR	OZ	11	Catalyst		
14	2	EA	80	Lug, Plain, 3/8	Zierek	
15	1	EA	205556-2	DE9-P, connector	Amp	J1
16	1	AR	RG316	Cable,Coax,Miniature, 50 Ω		
17						
18						

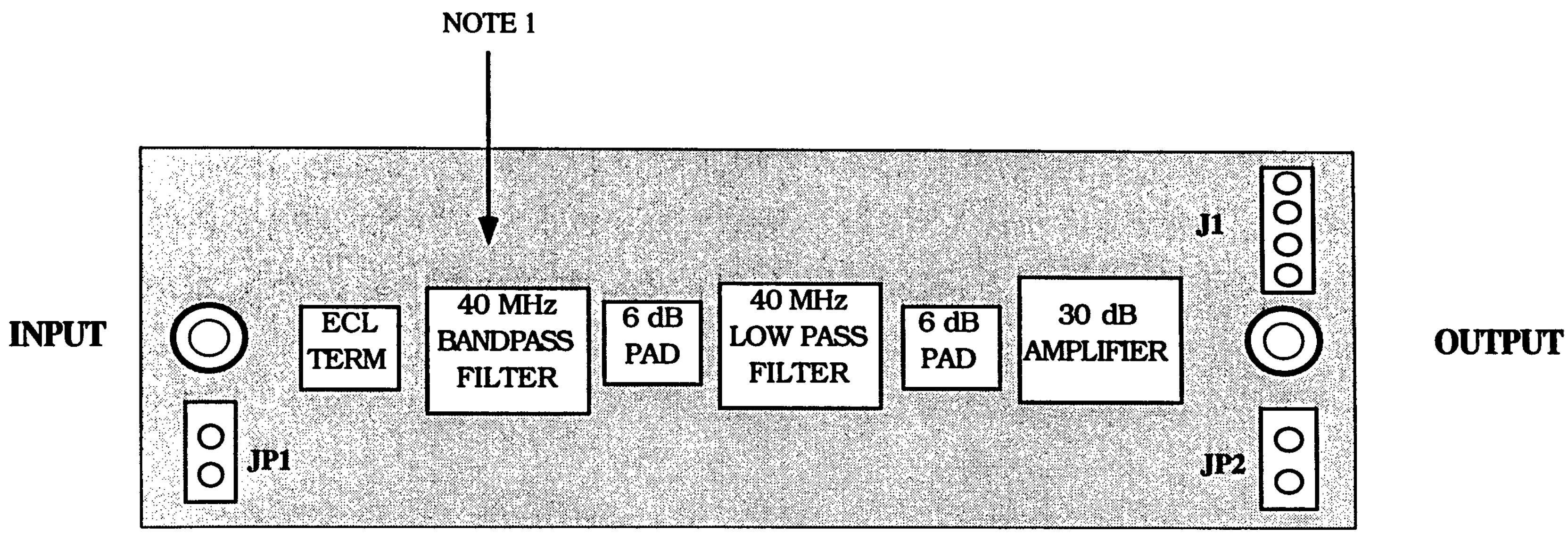


NOTES:

1. BOARD MATERIAL: 0.062" GLASS EPOXY TYPE GFN
2. ALL PC TRACES TO BE AT LEAST 0.050" FROM BOARD EDGE
3. SEE SCHEMATIC 064-0128 FOR CIRCUIT DETAILS

Space Physics Research Laboratory College of Engineering University of Michigan	LOCAL OSCILLATOR FILTER PCB OUTLINE	01-17-97 NS
		RELEASE
N000149510249	062- 0126	1 OF 4 X5
	DRAWN	H. Hamilton, N. Schnepf

1
Drawing Page



SUGGESTED LAYOUT
COMPONENT SIDE

Notes:

1. The circuitry in this area is identical to that detailed in HRG 2012 (UofM/SPRL documents 062-0046 and 062-0060 - SEE ALSO sheets 3 and 4 of this drawing).
2. Areas designated JP1, JP2, and J1 are for USECO 2520B swage terminals requiring 0.075 dia plated thru holes and 0.150 dia pads.

Space Physics Research Laboratory
College of Engineering
University of Michigan

LOCAL OSCILLATOR FILTER
PCB OUTLINE

01-16-97 NS

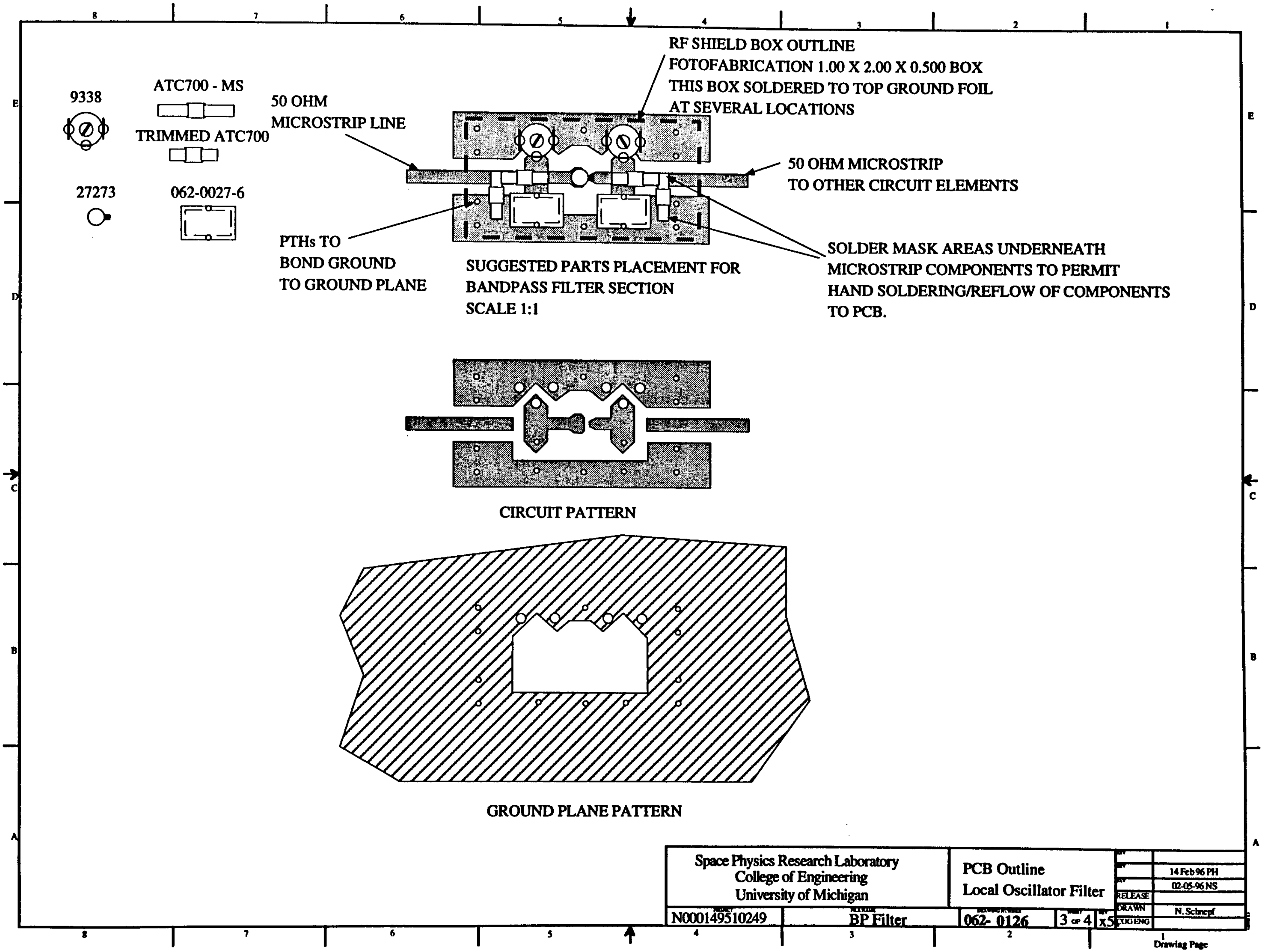
RELEASE

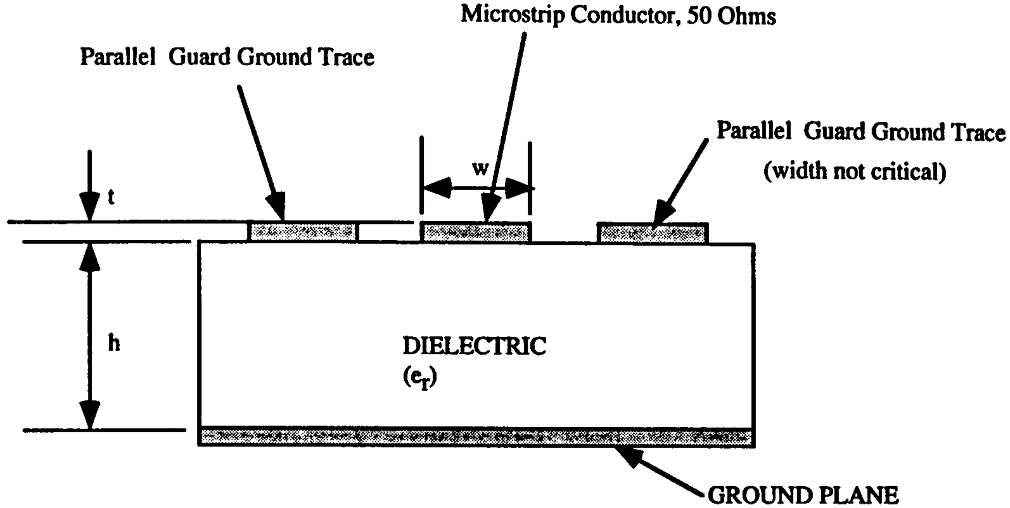
DRAWN H. Hamalian, N. Schnepf

COG ENG

N000149510249 | LOF PCB L/O | 062- 0126 | 2 of 4 | X5

Drawing Page


9338
ATC700 - MS
TRIMMED ATC700
27273
062-0027-6
50 OHM
MICROSTRIP LINE
RF SHIELD BOX OUTLINE
FOTOFABRICATION 1.00 X 2.00 X 0.500 BOX
THIS BOX SOLDERED TO TOP GROUND FOIL
AT SEVERAL LOCATIONS
50 OHM MICROSTRIP
TO OTHER CIRCUIT ELEMENTS
PTHs TO
BOND GROUND
TO GROUND PLANE
SOLDER MASK AREAS UNDERNEATH
MICROSTRIP COMPONENTS TO PERMIT
HAND SOLDERING/REFLOW OF COMPONENTS
TO PCB.
SUGGESTED PARTS PLACEMENT FOR
BANDPASS FILTER SECTION
SCALE 1:1
CIRCUIT PATTERN
GROUND PLANE PATTERN
Space Physics Research Laboratory
College of Engineering
University of Michigan
PCB Outline
Local Oscillator Filter
14 Feb 96 PH
02-05-96 NS
RELEASE
DRAWN
N. Schnepf
CUGENG
N000149510249
BP Filter
062- 0126
3 OF 4
x5
1
Drawing Page



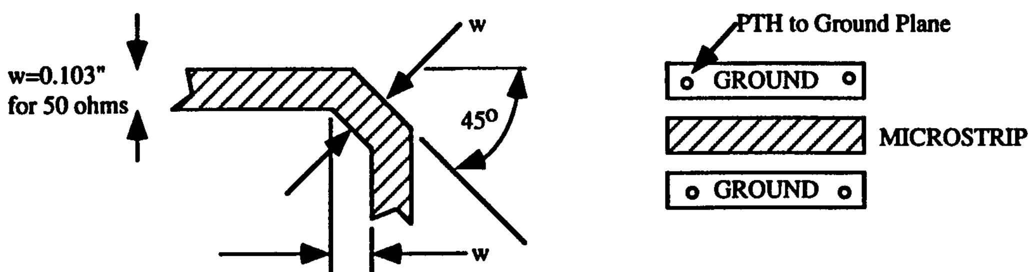
Z_o Ohms	Line Width in mils 0.062" Board	0.031" Board
50	103	47
55	89	41
60	77	35
65	66	30
70	57	26
75	49	22
80	42	19
85	36	16
90	31	14
95	27	11
100	23	10

MICROSTRIP LINES:

A microstrip line (shown above) is a strip conductor separated from a ground plane by a dielectric medium. Two-sided and multilayer boards use this type of transmission line. If the thickness, width, and height of the line above the ground plane are controlled, the line will exhibit a characteristic impedance of:

$$Z_o=(87/(e_r+1.41)^{0.5})*\ln((5.98h)/(0.8w+t))$$

Where e_r is the dielectric constant of the board. For standard G-10 fiberglass epoxy boards, the dielectric constant is about 5.0. The table gives the characteristic impedance versus line width for 0.062" and 0.031" G-10 board with one ounce copper. For two ounce copper, the widths are nominally 1 to 2 mils narrower.



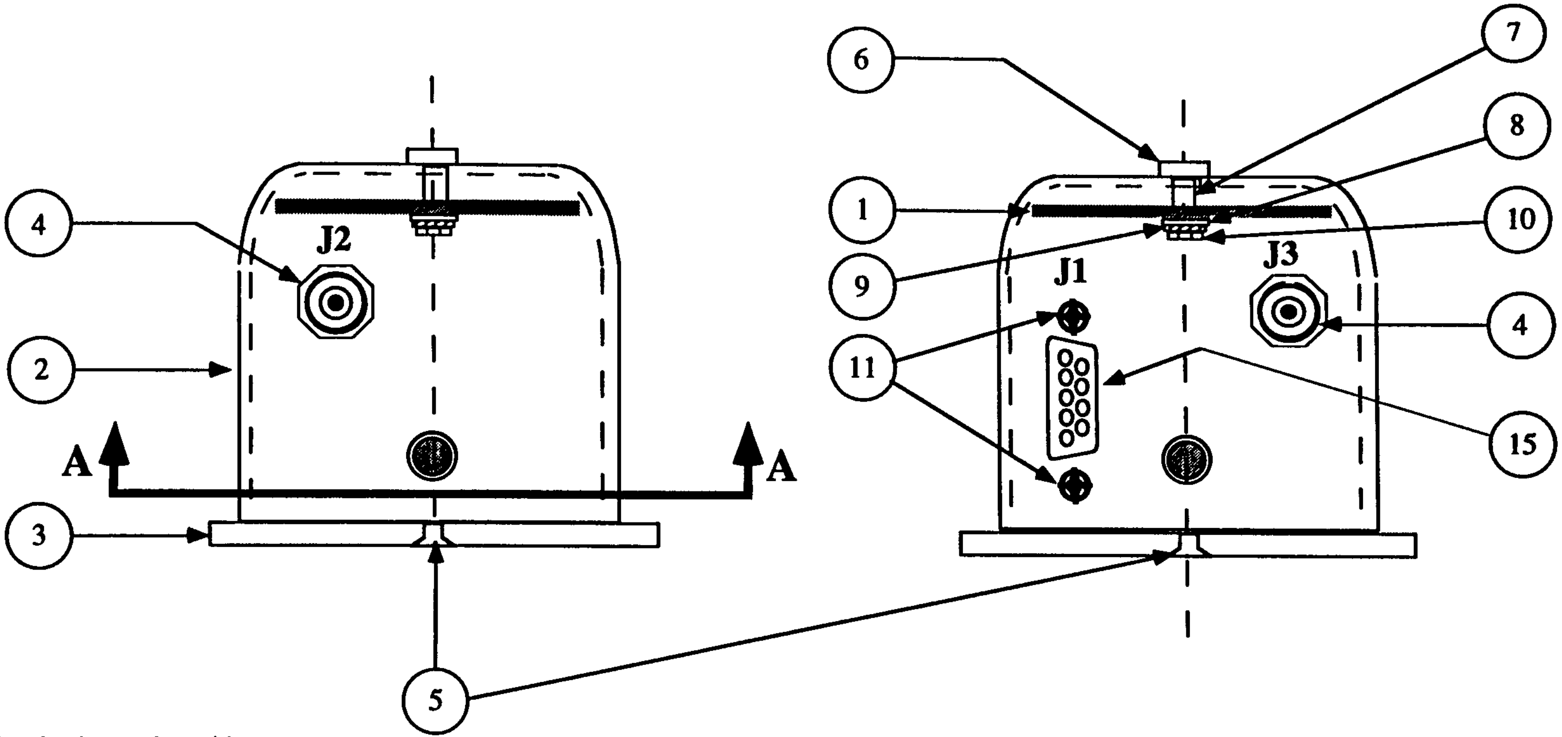
CHAMFER EXAMPLE

Other Layout Notes:

Abrupt changes in transmission line width creates parasitic effects called step discontinuities. Tapering the transmission lines from 50 ohms down to the amplifier or device lead width helps to minimize this effect. Bends in transmission lines should be avoided when possible. When they must be used, the corners should be chamfered to prevent the bends from acting as extra shunt capacitance. Ground planes should be kept as large and as solid as possible, expecially at the emitter leads of amplifiers/transistors. Plated through holes should be placed directly under the ground leads of these devices.

Space Physics Research Laboratory College of Engineering University of Michigan		PCB OUTLINE Local Oscillator Filter		RELEASE 02-13-96 PH
N000149510249	MicroStrip	062- 0126	4 OF 4	DRAWN P. Hansen

Drawing Page



Notes:

1. This drawing incomplete without Parts List 062-0125.
2. Backmount SMA connectors are secured with nuts supplied with connector. Install coax shield termination lug, item 14 on inside of chassis.
3. Install female screwlocks with hardware supplied with screwlocks. Lock washers and nuts are installed on the inside of the chassis.
4. Rubber stamp J-numbers in locations indicated using items 12 and 13.

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

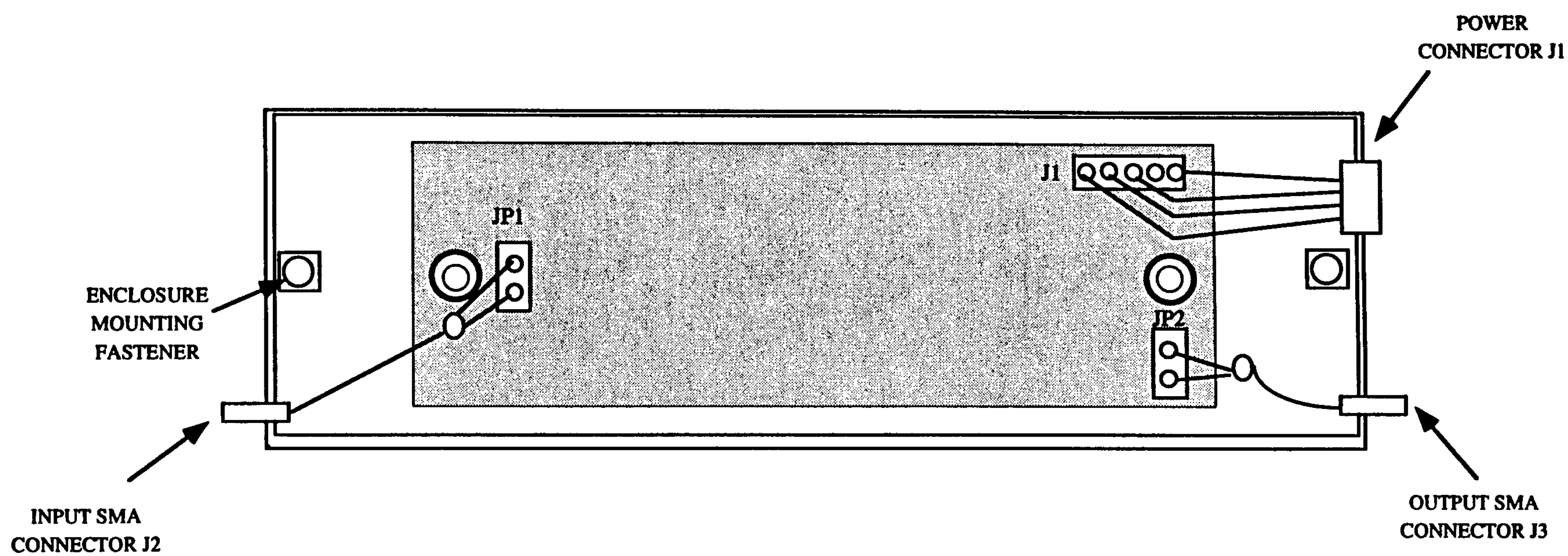
Space Physics Research Laboratory
College of Engineering
University of Michigan

LOCAL OSCILLATOR FILTER ASSEMBLY

N000149510249 | LOF Assy | 062- 0127 | 1 of 2 | x5

01-17-96 NS
RELEASE
DRAWN N. Schnepf, H. Hamilton
COG ENG

1
Drawing Page



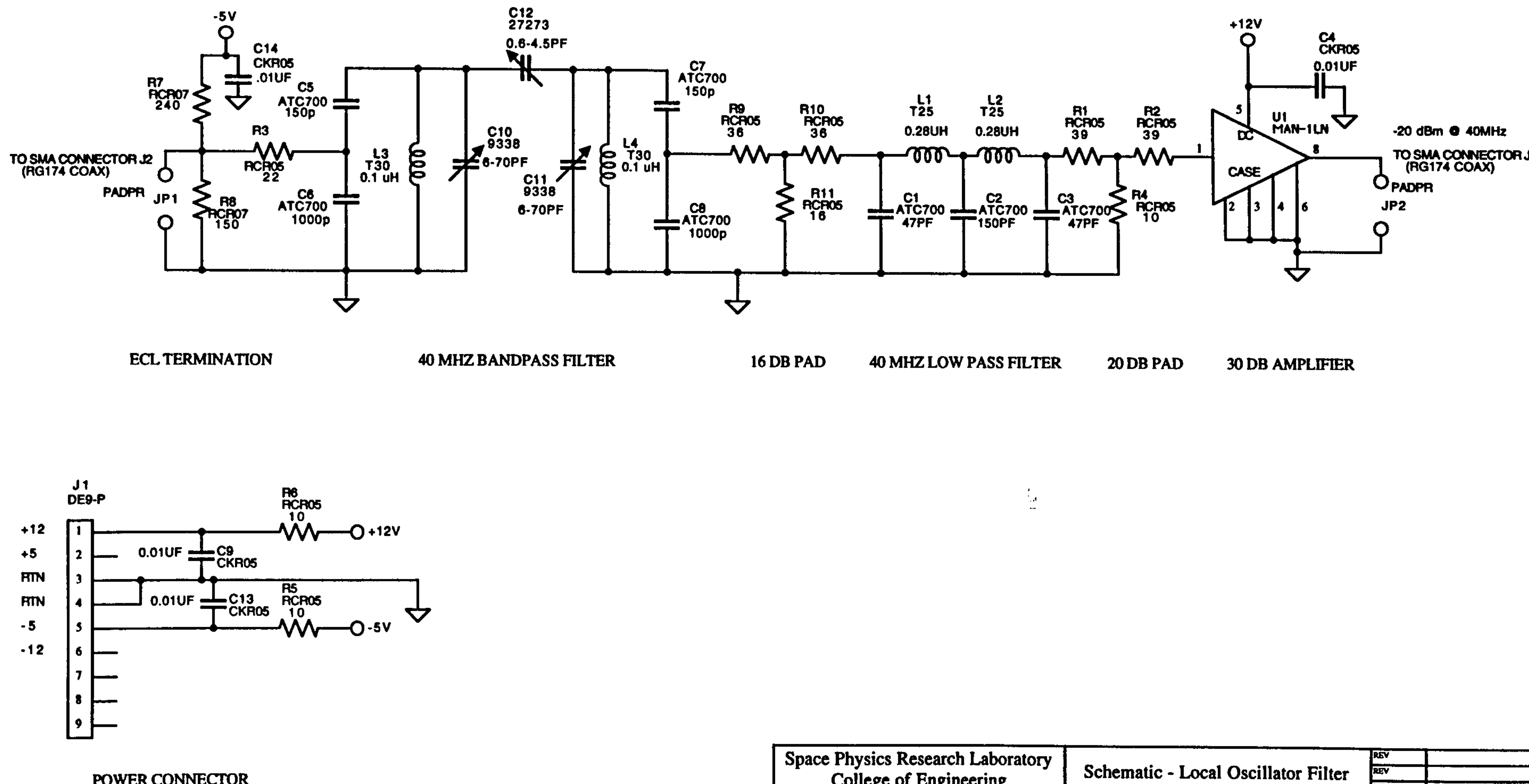
SECTION A-A

Space Physics Research Laboratory College of Engineering University of Michigan	Local Oscillator Filter Assembly	RELEASE	01-16-97 NS
		DRAWN	H. Hamilton, N. Schnepf
N000149510249	062- 0127	2 of 2	x5

Drawing Page

NOTES:

1. ALL I/O CONNECTIONS (SCHEMATIC SYMBOLS PADPR & DE9) TO THE PC BOARD ARE MADE TO SWAGE TERMINALS, USECO 2520B, REQUIRING 0.075" PLATED THRU HOLES AND PADS.
2. SEE SPRL 062-0126 FOR FINISHED PCB DIMENSIONS AND LAYOUT SUGGESTIONS.



Space Physics Research Laboratory College of Engineering University of Michigan	Schematic - Local Oscillator Filter Field Unit	REV REV REV RELEASE	
PROJECT N000149510249	CAGE CODE 0TK63	FILENAME	DRAWING NUMBER 062- 0128 · REV X3 · DRAWN P. Hansen · COG ENG

DRAWING PAGE

McCad 3.3

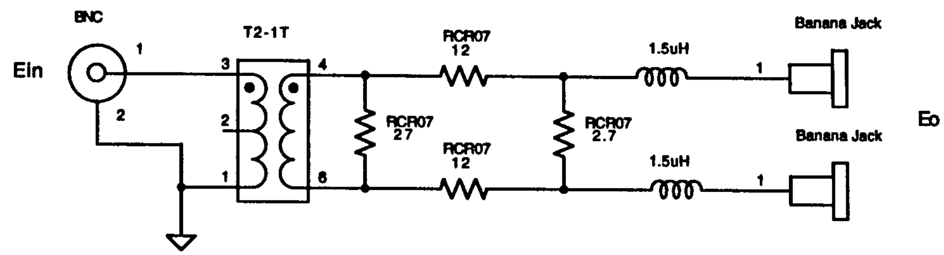
Title: LOF Net List
Next Assy:062-0126
Program: HF Radar
Contract No.: N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH
LABORATORY

FSCM No.: 0TK63
Drawing No.: 062-0129
Revision: -

Reference: 0128x1 LOF Schematic Monday, November 11, 1996 9:51 AM

NET NAME	PINS																			
+12V	C4	1	R6	2	U1	5														
-5V	C14	1	R5	2	R7	1														
GND	C1	2	C2	2	C3	2	C4	2	C6	2	C8	2	C9	2	C10	2	C11	2	C13	1
	C14	2	J1	3	J1	4	JP1	1	JP2	1	L3	2	L4	2	R4	2	R8	2	R11	2
	U1	2	U1	3	U1	4	U1	6												
N:1	C5	2	C6	1	R3	1														
N:2	C5	1	C10	1	C12	1	L3	1												
N:3	R9	2	R10	1	R11	1														
N:4	C7	2	C8	1	R9	1														
N:5	C1	1	L1	1	R10	2														
N:6	C2	1	L1	2	L2	1														
N:7	C7	1	C11	1	C12	2	L4	1												
N:8	JP1	2	R3	2	R7	2	R8	1												
N:9	C9	1	J1	1	R6	1														
N:10	C3	1	L2	2	R1	1														
N:11	JP2	2	U1	8																
N:12	R2	2	U1	1																
N:13	R1	2	R2	1	R4	1														
N:14	C13	2	J1	5	R5	1														



NOTES:

1. THEORETICAL TRANSFER FUNCTION: Eo= 0.05 Ein = -26 DB

2. MEASURED ATTENUATION:

   4.8 MHZ: -26 DB

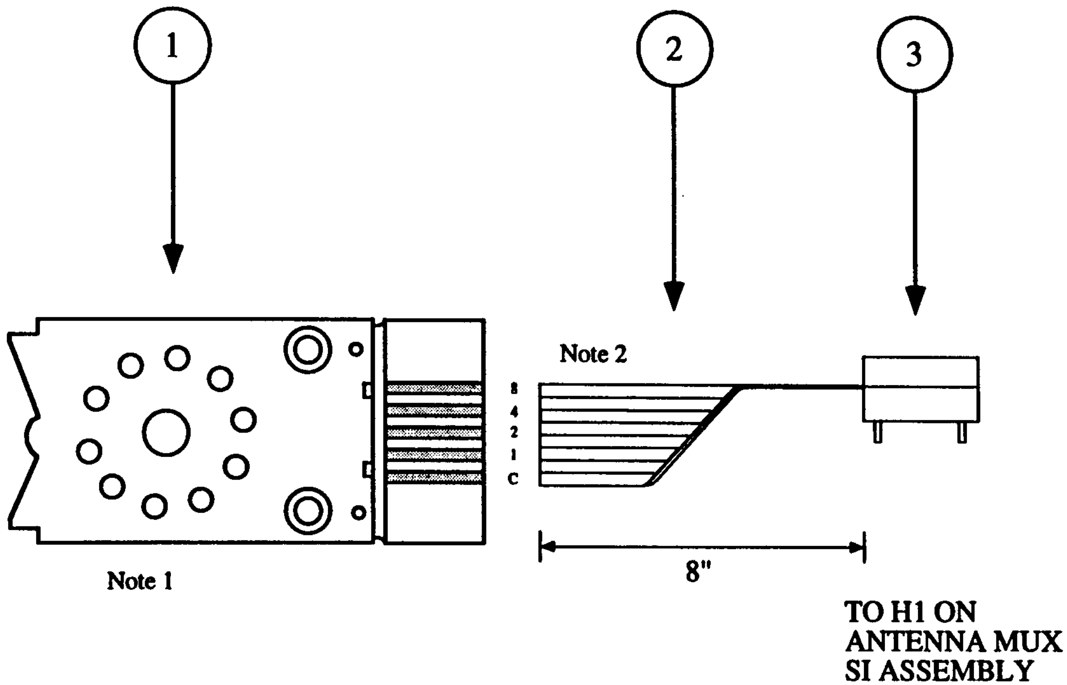
   6.78 MHZ: -25.6 DB

   13.38 MHZ: -24.4 DB

   21.77 MHZ: -23.2 DB

Space Physics Research Laboratory College of Engineering University of Michigan	SCHEMATIC - RECEIVE ANTENNA SIMULATOR	REV	
		REV	
		REV	
		RELEASE	
PROJECT N000149510249	CAGE CODE 0TK63	DRAWN	P. Hansen
FILENAME	DRAWING NUMBER 062-0130 REV	COG ENG	

McCad 3.3



WIRE LIST	
H1 PIN #	THUMBWHEEL SWITCH
1	1
3	2
5	4
7	8
8	C

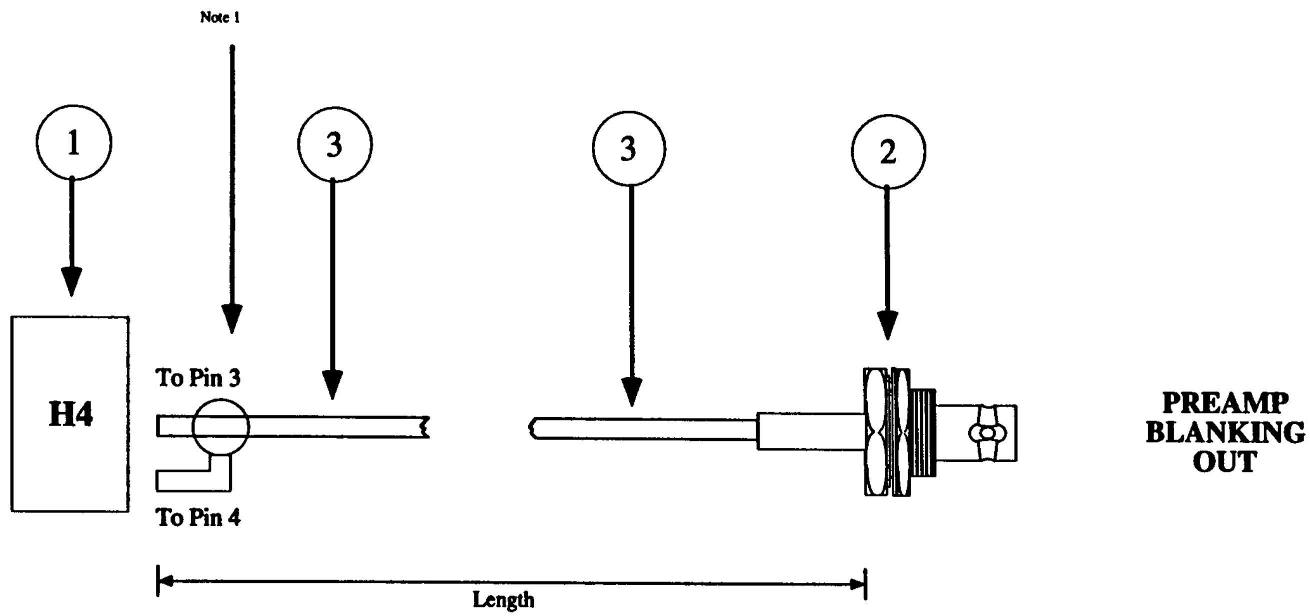
Notes:
1. Thumbwheel switch is part of antenna MUX assembly 062-0088.
2. Split ribbon cable and connect every other wire to each of the five connectors on the Thumbwheel's PCB flange as per wire list. Extra wires are to be trimmed and tied back.
3. Continuity test wiring.
4. After continuity testing, Kapton tape the extra wires, fold the ribbon back on the connector and secure with ty-rap (item 4).

LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	1	T50	Thumbwheel,submin.	Cherry	
2	AR	3850/16	Cable,Ribbon,28Ga,16C	Alpha	
3	1	CA-16IDP-1B	16-pin IDC Connectors	Circuit Assy Corp	
4	1	TY52315M	Ty-Rap	T&B	

Space Physics Research Laboratory College of Engineering University of Michigan	Antenna MUX Data Cable Assembly W2	03-11-97 NS 01-06-97 NS RELEASE DRAWN N. Schaepf COG ENG
N000149510249	Ant MUX Data Cable Assy W2	062-0131	1 of 1	x2

Drawing Page



Notes:

1. Pig tail and shrink tubing : attach to header H5 on SI board (SEE: SI schematic (062-0106)) and secure with lacing cord.
2. The BNC connector (item 2) is attached to the cable using an Amphenol 227-987 tool with 227-1418 die. Cable preparation is detailed on drawing 062-0059.

LIST OF MATERIALS

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	Ref	Note 1	16-pin IDC Header		H4
2	1	31-318	BNC Crimp-On,Blkhd Jk	Amphenol	
3	*tbd*		RG 174 Coax		
4			Shrink tubing	Alpha	
5	AR		Lacing Cord	Nomex	

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Antenna MUX RF
Cable Assembly W4

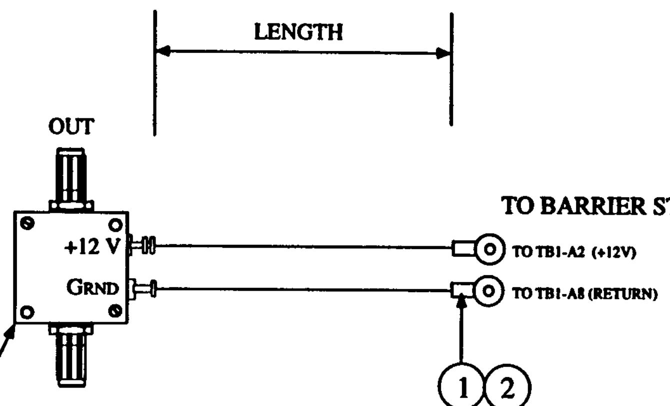
N000149510249 | Ant MUX RF Cable Assy W4 | 062-0132 | 1 of 1

RELEASE 01-06-97 NS
N. Schnepf

Drawing Page

Fabrication Instructions:

1. Crimp contact pins on the wires using M22520/2-01 crimp tool or equivalent.
2. Ring terminals are crimped on wires after wires have been trimmed to proper length at final assembly. Length given in the table is longer than needed for the finished cable.
3. Twist wires (approximately 5 twists per foot) at final assembly.



CABLE ASSEMBLIES

Dash No.	Designation	Length	From	Pos	To	Pos	Note
None	W19	3 Ft	ZFL-500LN	Pwr	Barrier Strip	A	-

LIST OF MATERIALS FOR EACH CABLE ASSEMBLY

Item	Qty	Part No.	Description	Mfr/Code	Symbol
1	AR	1855	Wire,22ga,Stranded,PVC	Alpha	
2	2	18RA-6	Vinyl Insul. Ring Term.	T&B	

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POWER CABLE
W19

N000149510249

062- 0138

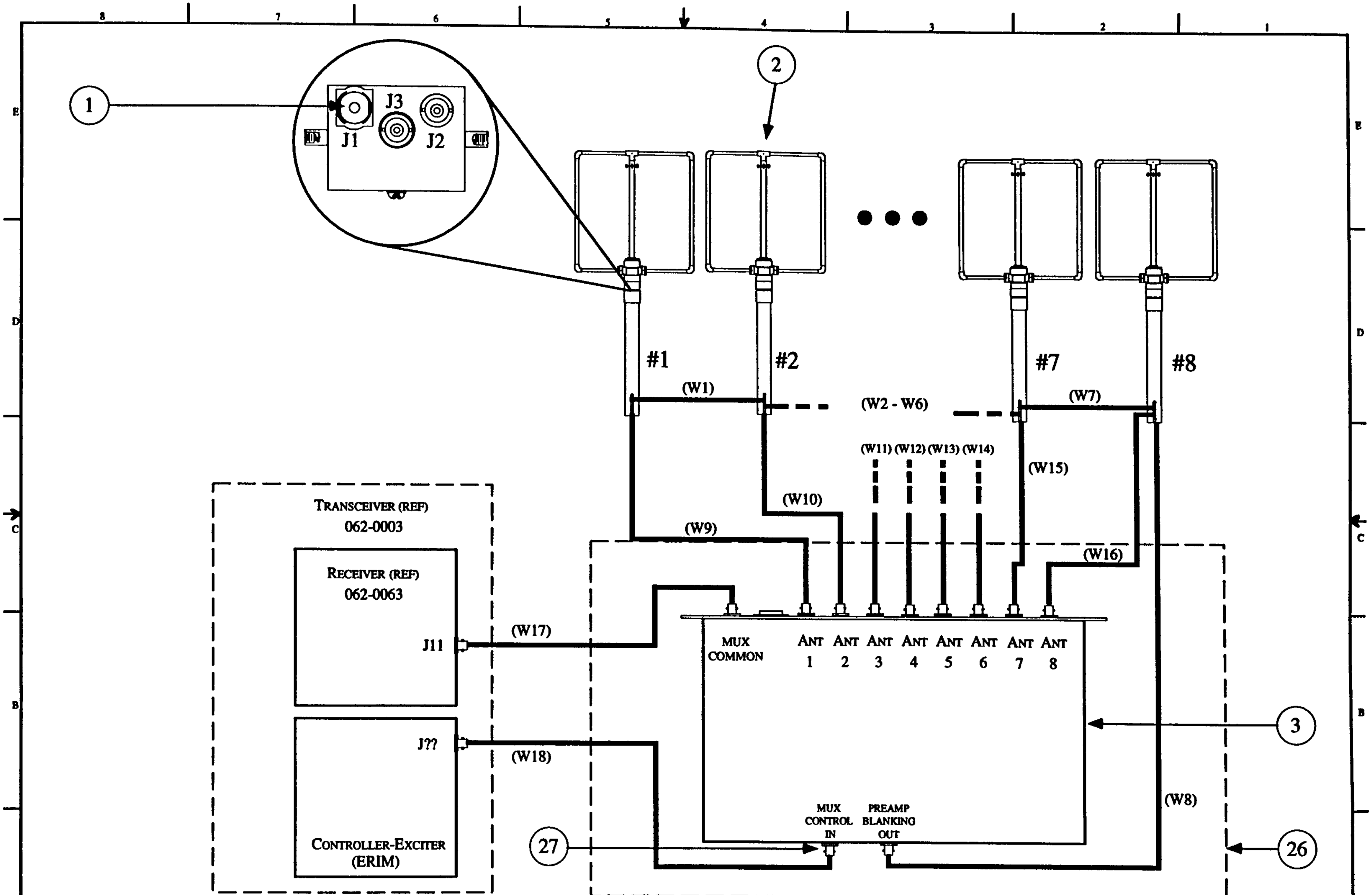
1 of 1

RELEASE

DRAWN N. Schnepf

COG ENG

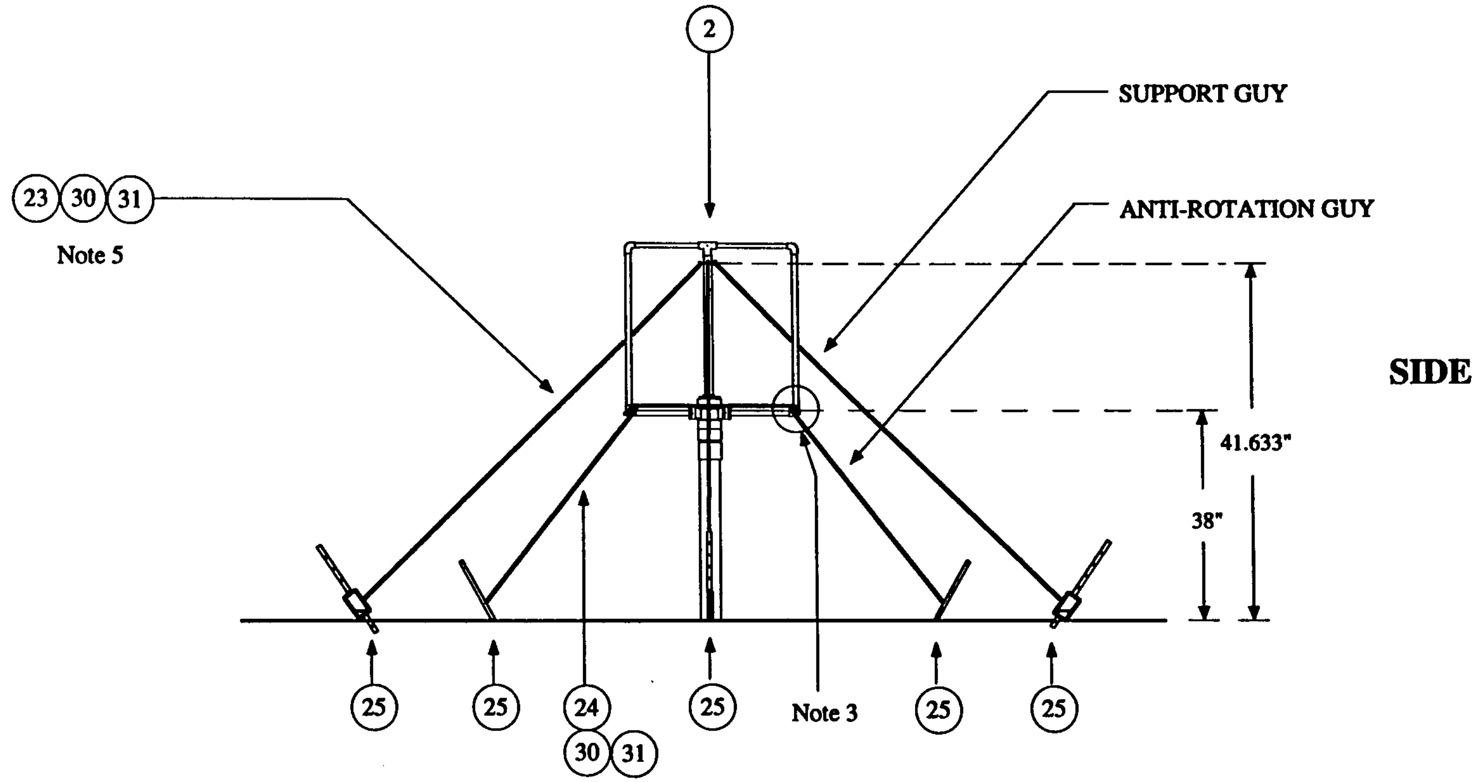
1
Drawing Page

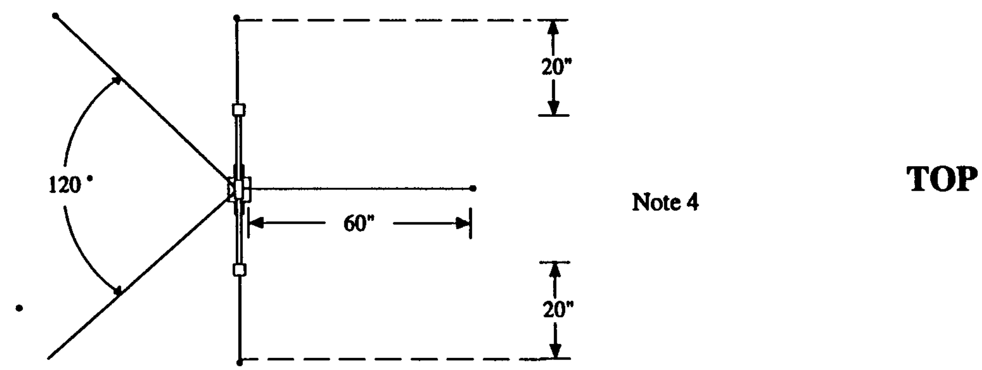


Notes:

1. This drawing incomplete without parts list 062-0072.
2. Spacing between receive antenna array elements is one-half wavelength apart at the highest frequency of operation :
   (300/21.77)/2 = 6.89 m
3. See sheet two for guy rope layout.

Space Physics Research Laboratory College of Engineering University of Michigan	Receive Antenna Array FIELD UNIT (SN2)	REV	02-19-97 NS	
		REV	01-14-97 NS	
		REV	01-06-97 NS	
		RELEASE		
N000149510249	Rcv Ant Array Assy	062- 0139	1 of 2	x3
		DRAWN	N. Schnepf	
		COG ENG		



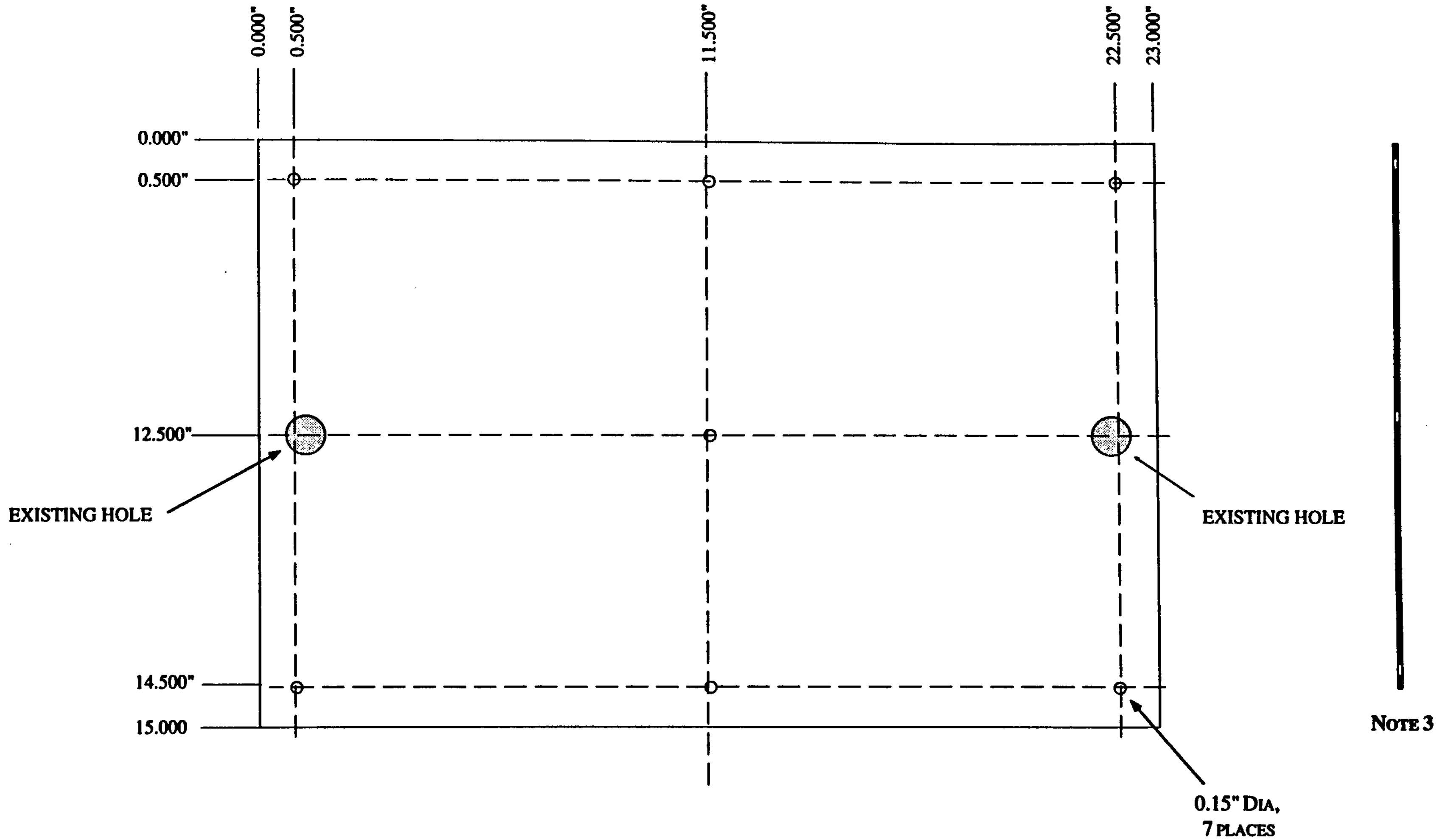


Notes:

1. This drawing incomplete without parts list 062-0072.
2. **GUY ROPE PREPARATION:**
   a) measure off lengths appropriate to the type of guy rope (support or anti-rotation) (SEE notes 3 and 4 below).
   b) wrap a piece of electrical tape (item 30) around each end of guy rope section.
   c) cut rope in the center of electrical tape to avoid fraying. leave tape on both sections of rope after cutting.
   d) dip each end of guy rope section in rope sealant (item 29).
3. This guy is one continuous 7' length of rope (item 24) anchored at the two stakes parallel with the long axis of the antenna. Additionally, the rope is wrapped twice about each of the lower 90° copper joints at the points indicated.
4. Horizontal lengths represent ground distances.
5. These support guys are three 8' lengths of rope (item 23) anchored at one end to a metal stake (item 25) and at the other end to an eyebolt at the top of the receive antenna (see side view above).

Space Physics Research Laboratory College of Engineering University of Michigan	Receive Antenna Array Assembly (Antenna Deployment)	REV	
		REV	02-19-97 NS
		REV	07-24-96 NS
		RELEASE	
		DRAWN	07-23-96 NS
N000149510249	Rcv Ant Array Assy	062- 0139	2 of 2 x3 COG ENG

1
Drawing Page



NOTES:

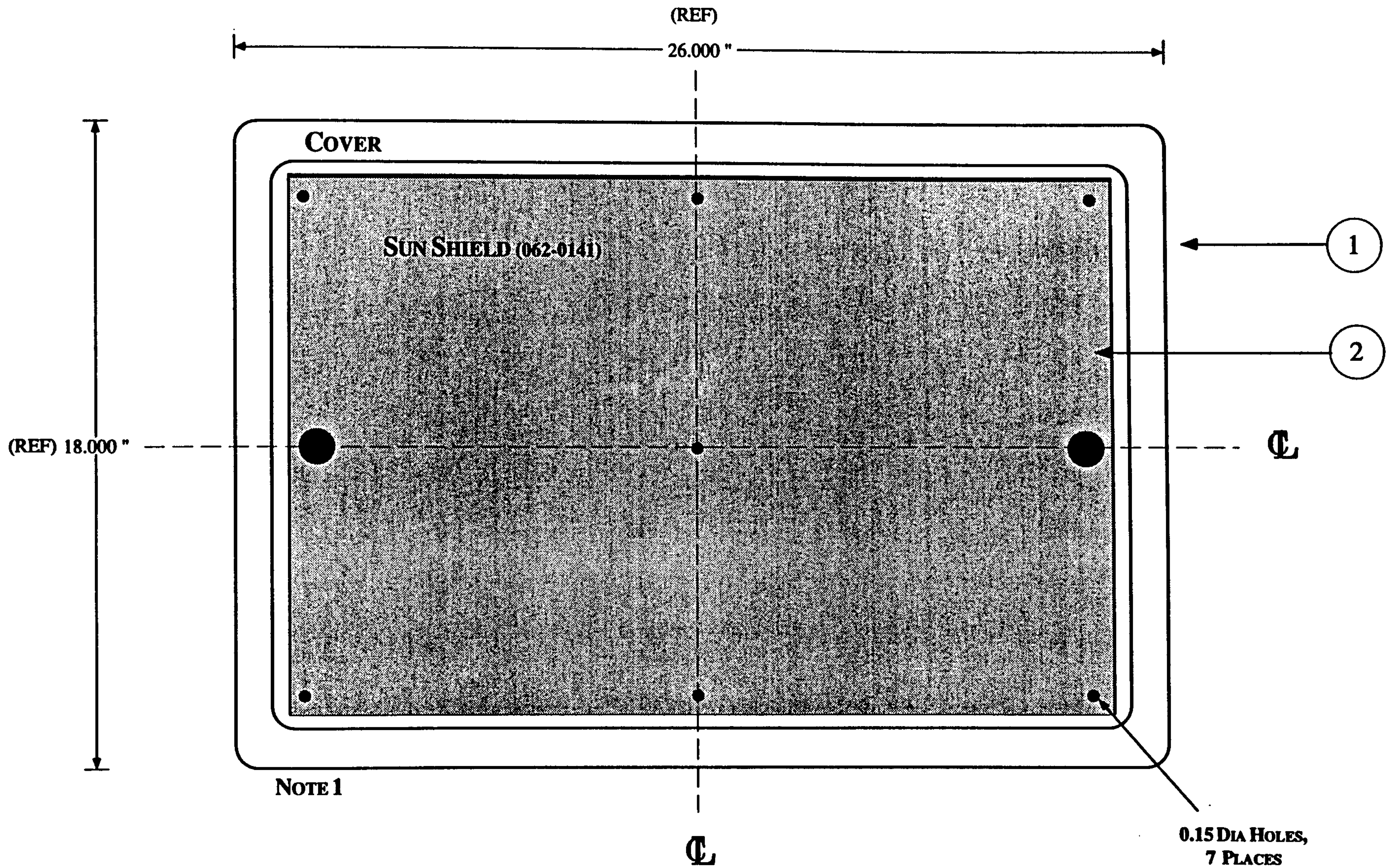
1. Material: 6061T6 Aluminum
2. Round all corners on plate and break sharp edges.
3. Plate dimensions: 22.000" x 14.000" x 0.062" (L x W x T)
4. Plate thickness not drawn to scale.

Unless otherwise specified tolerances are:

Dim ending .00 are	±	0.030
Dim ending .000 are	±	0.005
Angular Dim are	±	0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan		PLATE, SUN SHIELD	RELEASE	03-27-97 NS
			DRAWN	N. Schnepf
N000149510249	Plate, sun shield	062- 0141	1 of 1	x2

Drawing Page



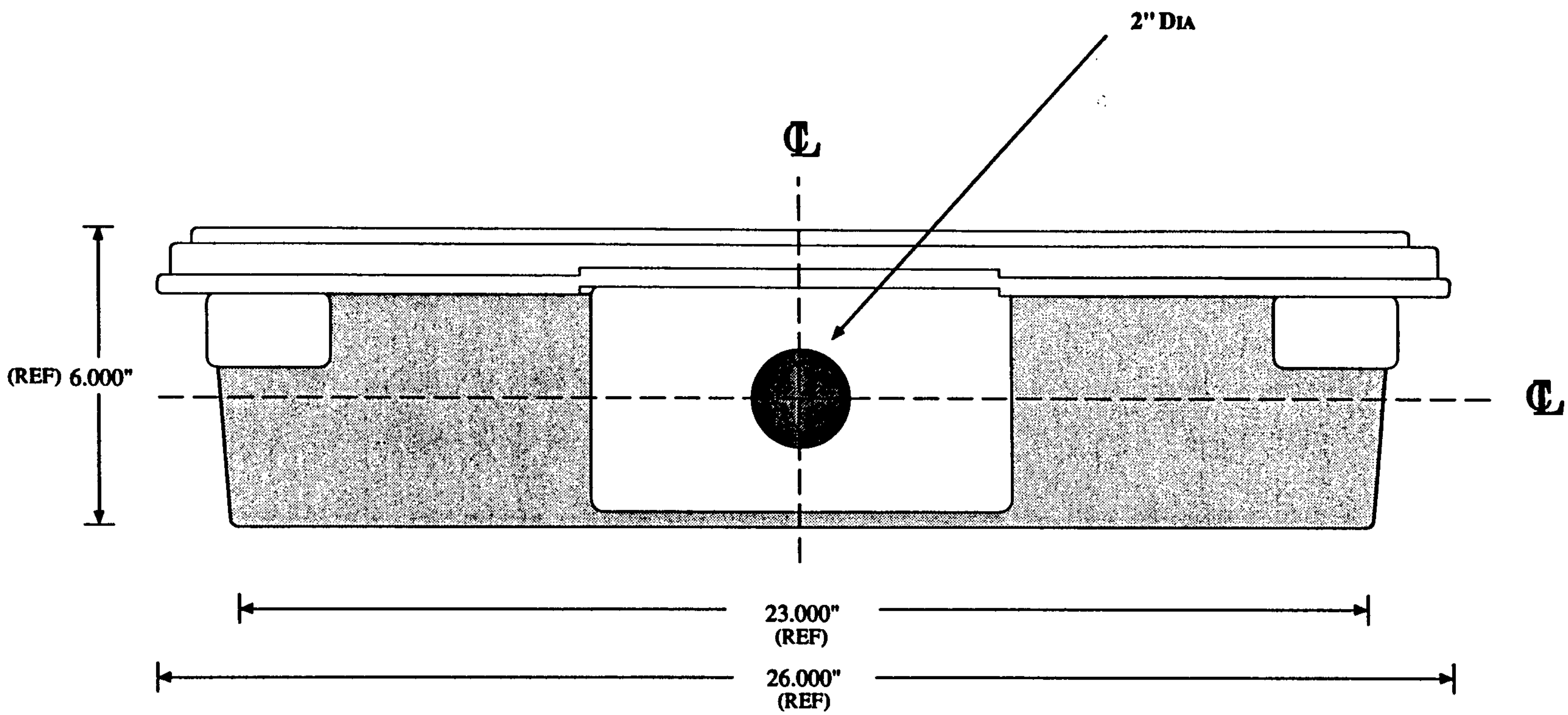
NOTES:

1. This drawing details modifications to a 4533T23 plastic lid for a 4533T42 heavy-duty poly storage box.
2. Using 062-0141 metal plate as a template, drill matching 0.15 diameter thru holes at 7 locations as shown.

Unless otherwise specified tolerances are:

Dim ending .00	are ±	0.030
Dim ending .000	are ±	0.005
Angular Dim are	±	0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan		MUX PROTECTIVE ENCLOSURE COVER MODIFICATIONS	RELEASE 03-27-97 NS DRAWN N. Schnepf COG ENG
N000149510249	MUX Prot Enc Cvr Mods	062- 0142	1 OF 1 x2



NOTES:

1. This drawing details modifications to a 4533T25 heavy-duty poly storage box.
2. Punch a 2" diameter thru hole on the side of the box as indicated.

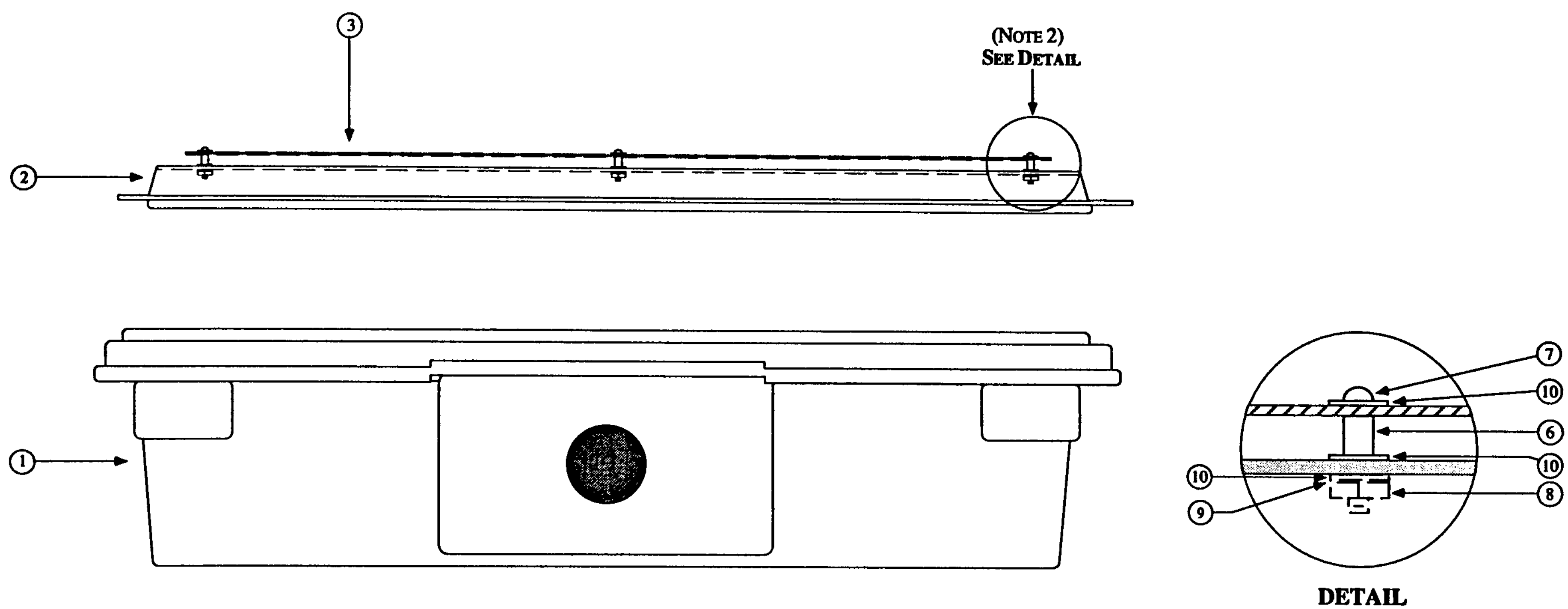
Unless otherwise specified tolerances are:

Dim ending .00	are ±	0.030
Dim ending .000	are ±	0.005
Angular Dim are	±	0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan		MUX PROTECTIVE ENCLOSURE MODIFICATIONS - BOX	
N000149510249	MUX Prot Enc Box Mods	062- 0143	1 of 1

RELEASE
DRAWN N. Schnepf
COG ENG

1
Drawing Page



NOTES:

1. This drawing incomplete without parts list 062-0145.
2. Mounting assembly components (items 6-10) are used to secure the sun shield (item 3) to the top of the cover (item 2) at 9 locations (see: 062-0142). See DETAIL for arrangement of components.

Space Physics Research Laboratory College of Engineering University of Michigan		MUX PROTECTIVE ENCLOSURE ASSEMBLY	
N000149510249	MUX Ins Plate Assy	062- 0144	1 OF 1

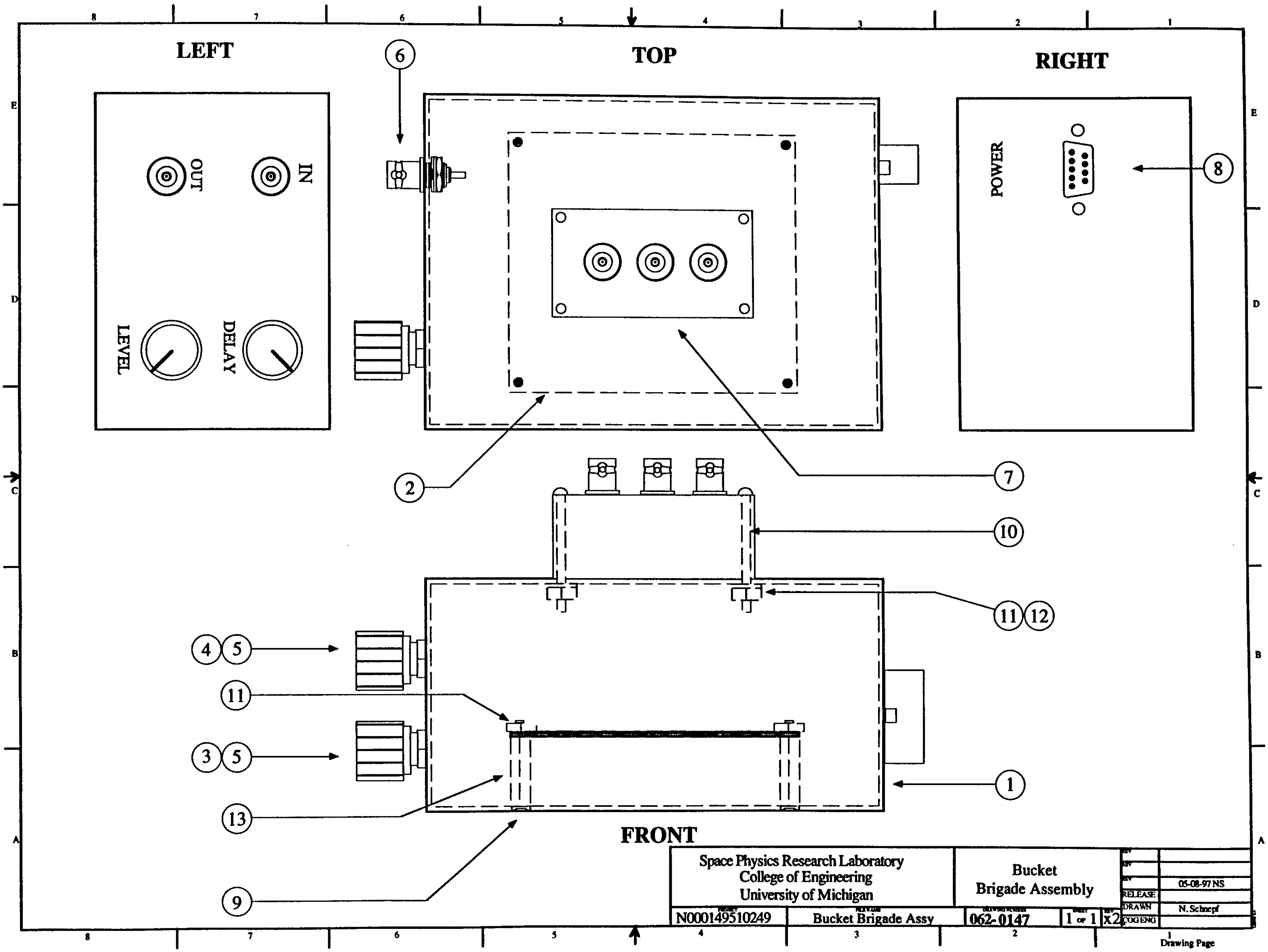
RELEASE	
DRAWN	N. Schnepf
COGENG	

MUX Prot Enc Assy
Parts List -
Next Assy:
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:0145
Revision:-

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	1	EA	4533T42	Heavy-duty poly storage box (white)	McMaster-Carr	
2	1	EA	4533T23	Cover for storage box (white)	McMaster-Carr	
3	1	EA	062-0141	Plate, sun shield	SPRL	
4	1	EA	062-0142	Cover modifications	SPRL	
5	1	EA	062-0143	Storage box modifications	SPRL	
6	9	EA	4007	Spacer,nylon,thru,#6 x 0.25"	HH Smith	
7	9	EA		Screw,machine,PH,CRES,phillips,6-32 x 0.75"		
8	9	EA		Nut,hex,#6		
9	9	EA		Washer,lock,internal tooth, #6		
10	27	EA		Washer,flat,#6		
11						
12						

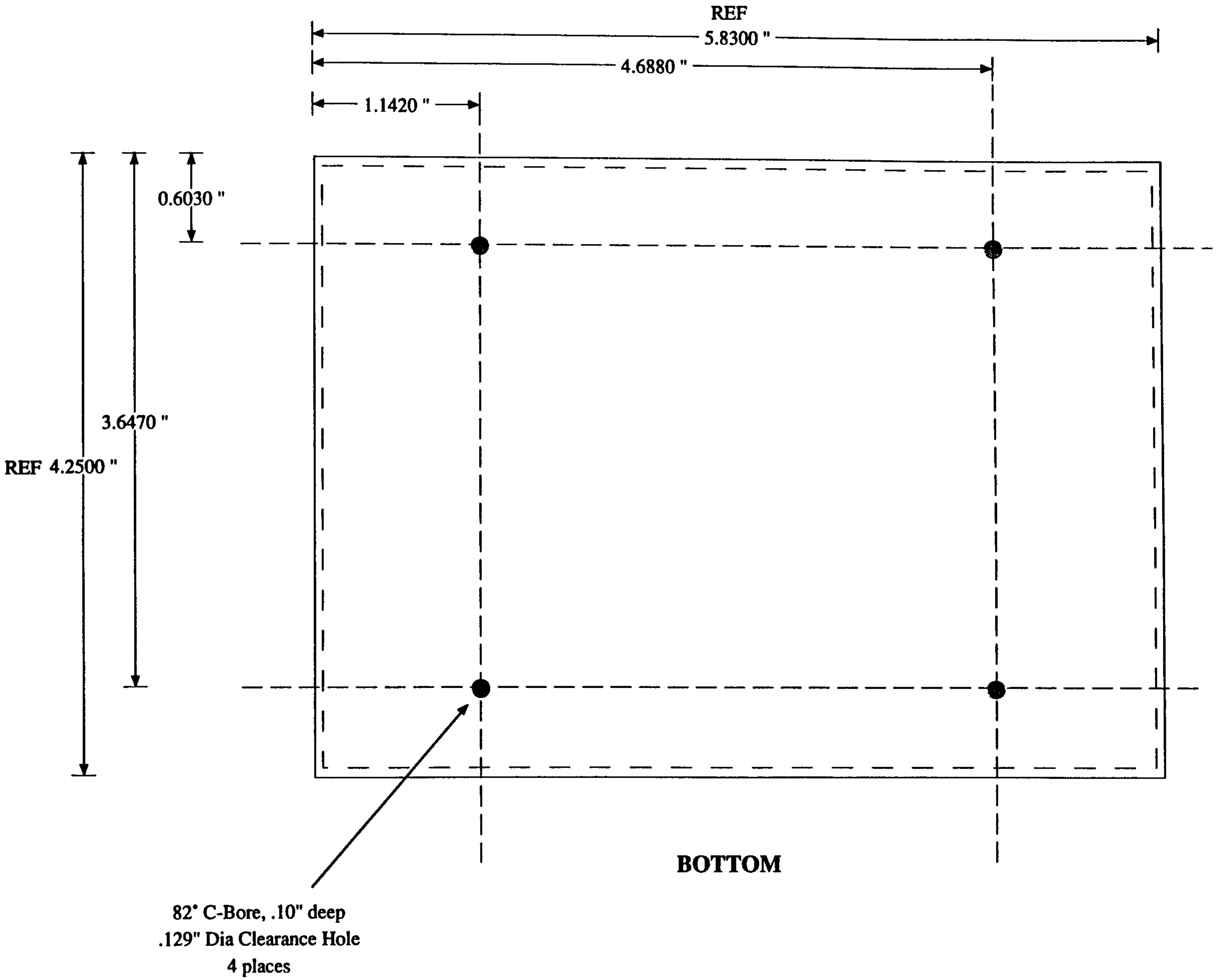

LEFT
TOP
RIGHT
FRONT
OUT
IN
LEVEL
DELAY
POWER
1
2
3 5
4 5
6
7
8
9
10
11 12
11
13
Space Physics Research Laboratory
College of Engineering
University of Michigan
Bucket
Brigade Assembly
N000149510249
Bucket Brigade Assy
062-0147
1 of 1
X2
05-08-97 NS
RELEASE
DRAWN
N. Schnepf
COG ENG
Drawing Page

Parts List
Bucket Brigade Assy
Next Assy:
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:062-0148
Revision:-

Item	Qty	U/M	Part Number	Description	Mfr	Symbol
1	1	EA	AN-1307	Box,aluminum,NEMA 4	Bud	
2	1	EA		Bucket Brigade Circuit Board	Stanford	
3	1	EA	3852 A-28 2 - 033 A	Potentiometer, Single Turn,5K	Cermet	
4	1	EA	3852 A-28 2 - 063 A	Potentiometer, Single Turn,50K	Cermet	
5	2	EA	KLN700A1/4	Knob,Straight Knurl w/ Top and Side Indicator Line - Aluminum - Natural	Allied	
6	2	EA	31-221	Connector,BNC,Fem, Rear Mnt	Amphenol	
7	1	EA	ZAD-1H	Frequency mixer, .5 - 500 MHz	Mini-Circuits	
8	1	EA	205556-2	Connector, DE9-P	Amp	
9	4	EA	91771A113	Screw,machine,flat head, phillips, 18-8 stainless steel, 4-40 x 0.75"	McMaster - Carr	
10	4	EA	91792A119	Screw,machine, pan head,slotted,18-8 stainless steel, 4-40 x1.5"	McMaster - Carr	
11	8	EA		Nut,hex,4-40		
12	4	EA		Washer,lock,4-40		
13	4	EA		Standoff,male-female,hex,threaded,4-40x.875"		
14						
15						



Note:

1. This drawing represents modifications to an AN-1307 BUD box.

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

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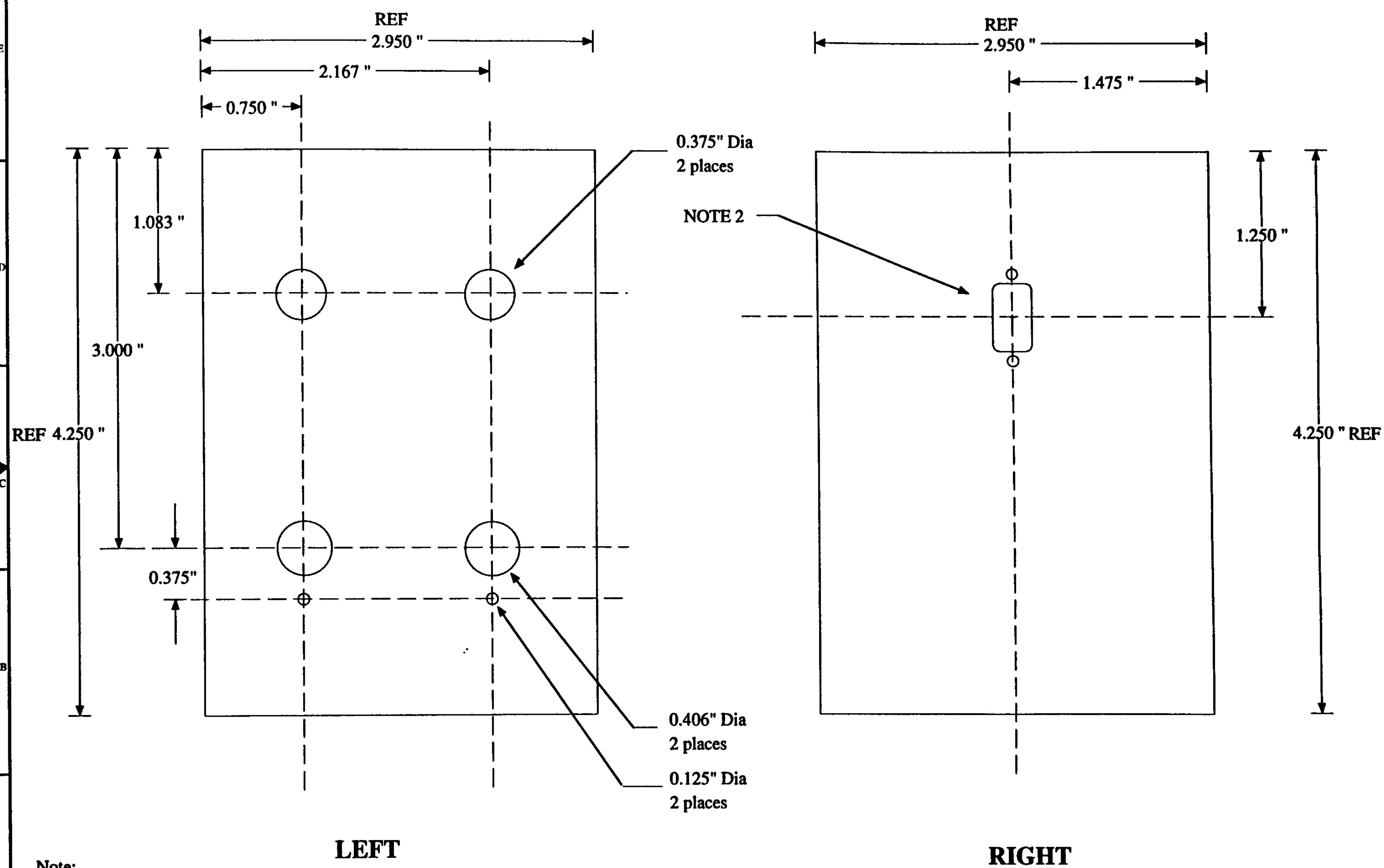
University of Michigan

Bucket Brigade
Enclosure
Bottom

N000149510249 | Bucket Brigade Enc | 062- 0149 | 1 of 3 | x2

RELEASE 05-08-97 NS
DRAWN N. Schnepf
CUG ENG

Drawing Page



Note:

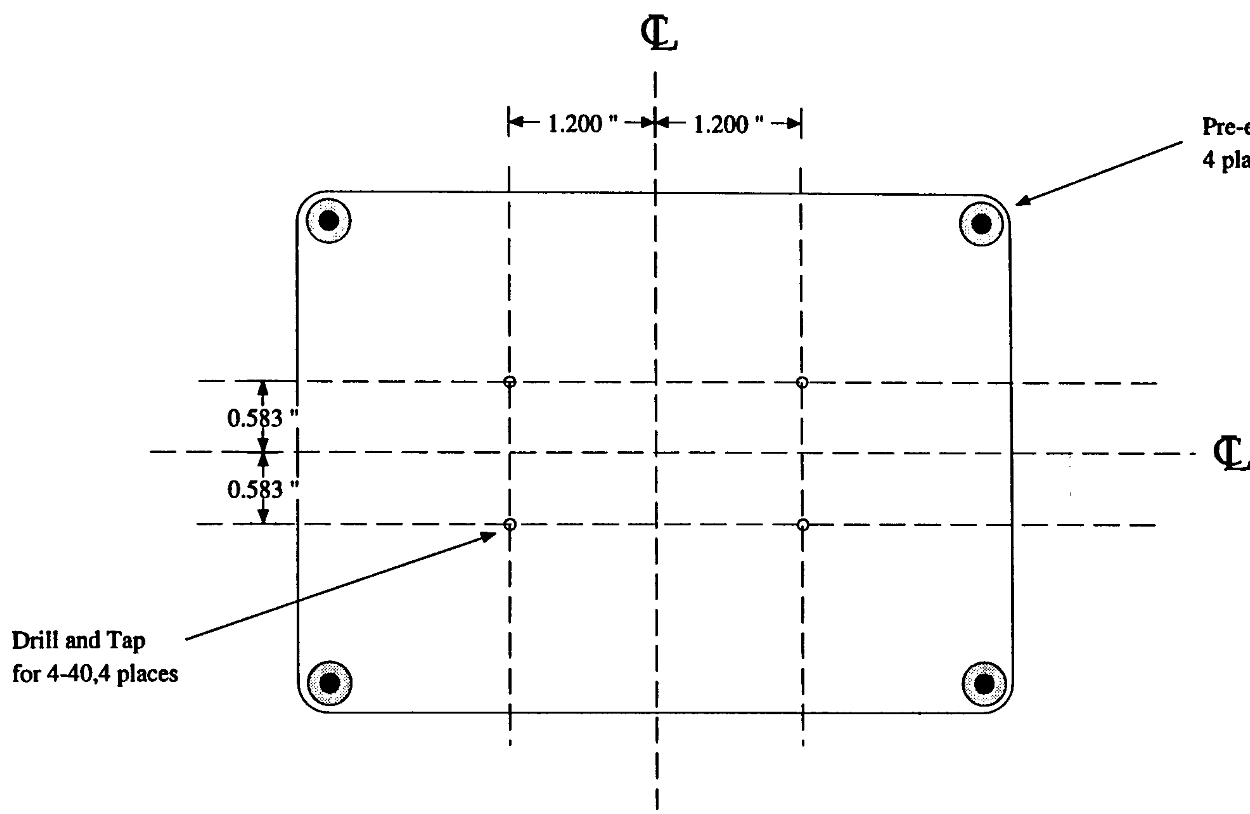
1. This drawing represents modifications to an AN-1307 BUD box.
2. See drawing 060-0097 for panel cut out dimensions for 9-pin rear mount D connectors.

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan		Bucket Brigade Enclosure Side	
N000149510249	Bucket Brigade Enc	062- 0149	2 of 3 x2

RELEASE 05-08-97 NS
DRAWN N. Schnepf
COG ENG

1
Drawing Page



LID

Note:

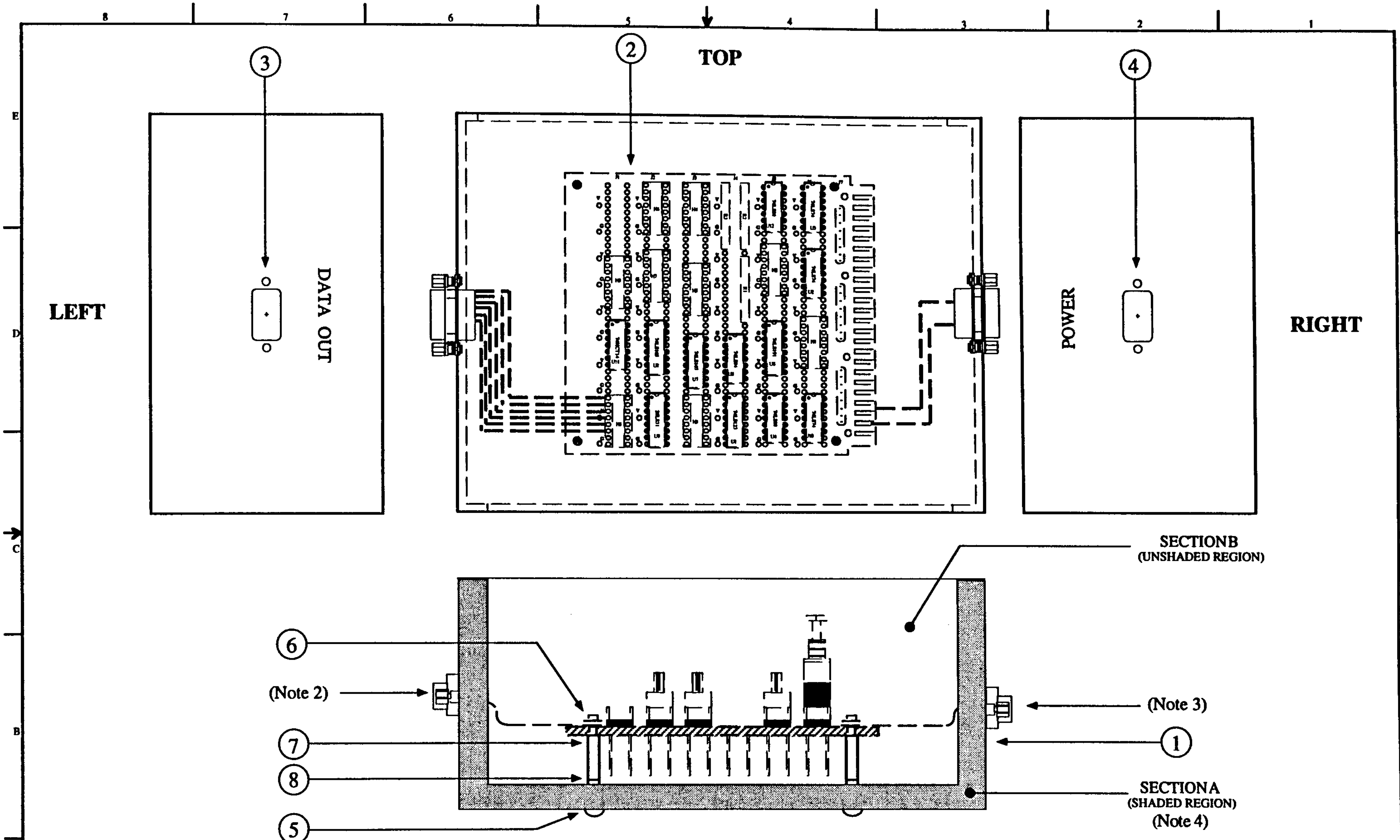
1. This drawing represents modifications to an AN-1307 BUD box.

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan		Bucket Brigade Enclosure Cover	
N000149510249	Bucket Brigade Enc	062- 0149	3 of 3 x2

RELEASE	05-08-97 NS
DRAWN	N. Schnepf
COG ENG	

1 Drawing Page

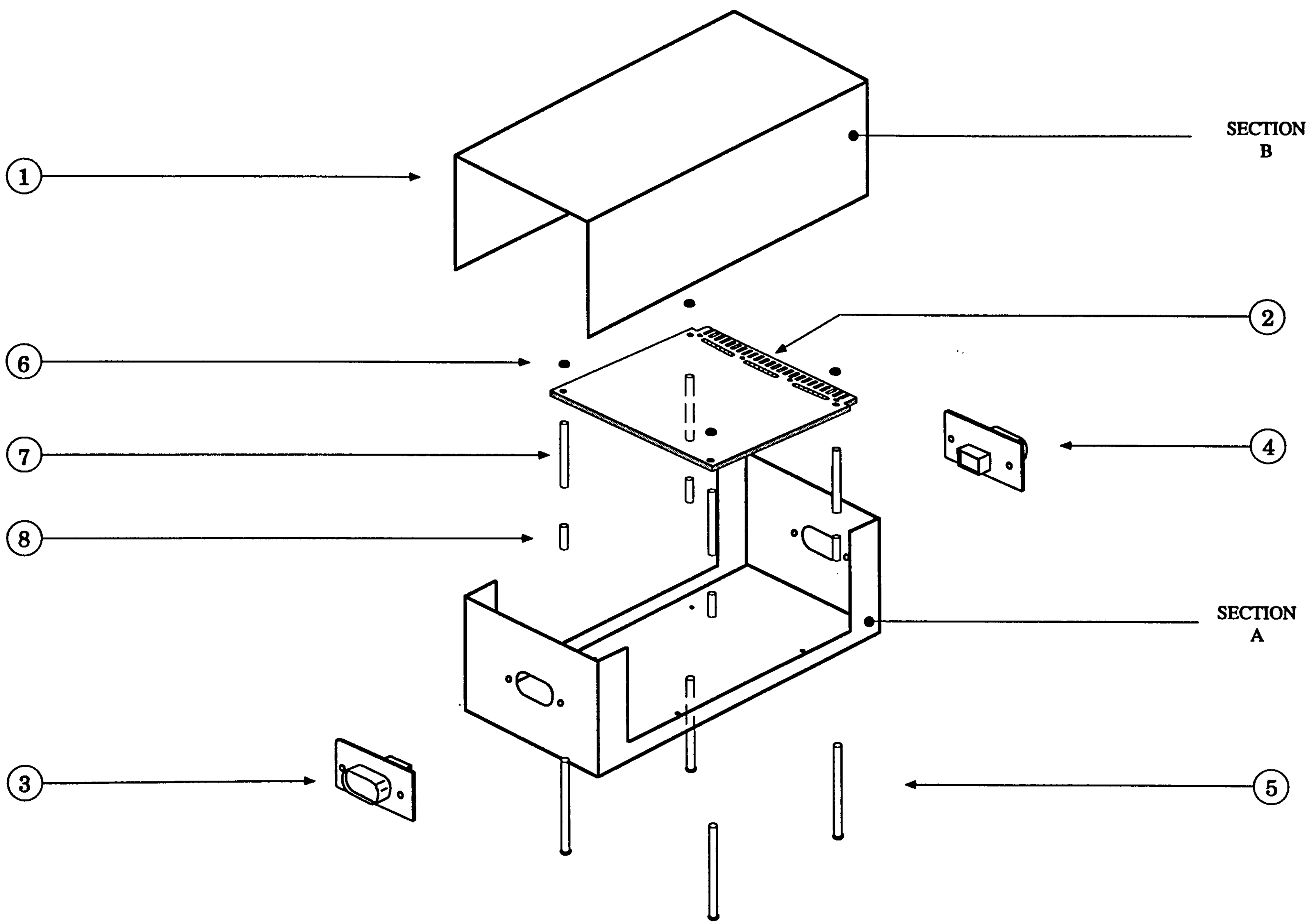


Notes:

1. This drawing incomplete without parts list 062-0151.
2. See cable drawing 062-0051-2 (Data Cable W7) for reference.
3. Wire using Power Cable (W1, 062-0053-1) pin assignments for -5V and RETURN.
4. Attach wire wrap board (item 2) and mounting hardware to section A of enclosure (item 1).

Space Physics Research Laboratory College of Engineering University of Michigan	Serial Interface Simulator Assembly	RELEASE	05-15-97 NS
		DRAWN	N. Schnepf
N000149510249	SIS Assy	062- 0150	1 OF 2 X6

Drawing Page



Space Physics Research Laboratory College of Engineering University of Michigan		Serial Interface Simulator Assembly	05-16-97 NS
N000149510249	SIS Assy	062- 0150	2 OF 2 x6

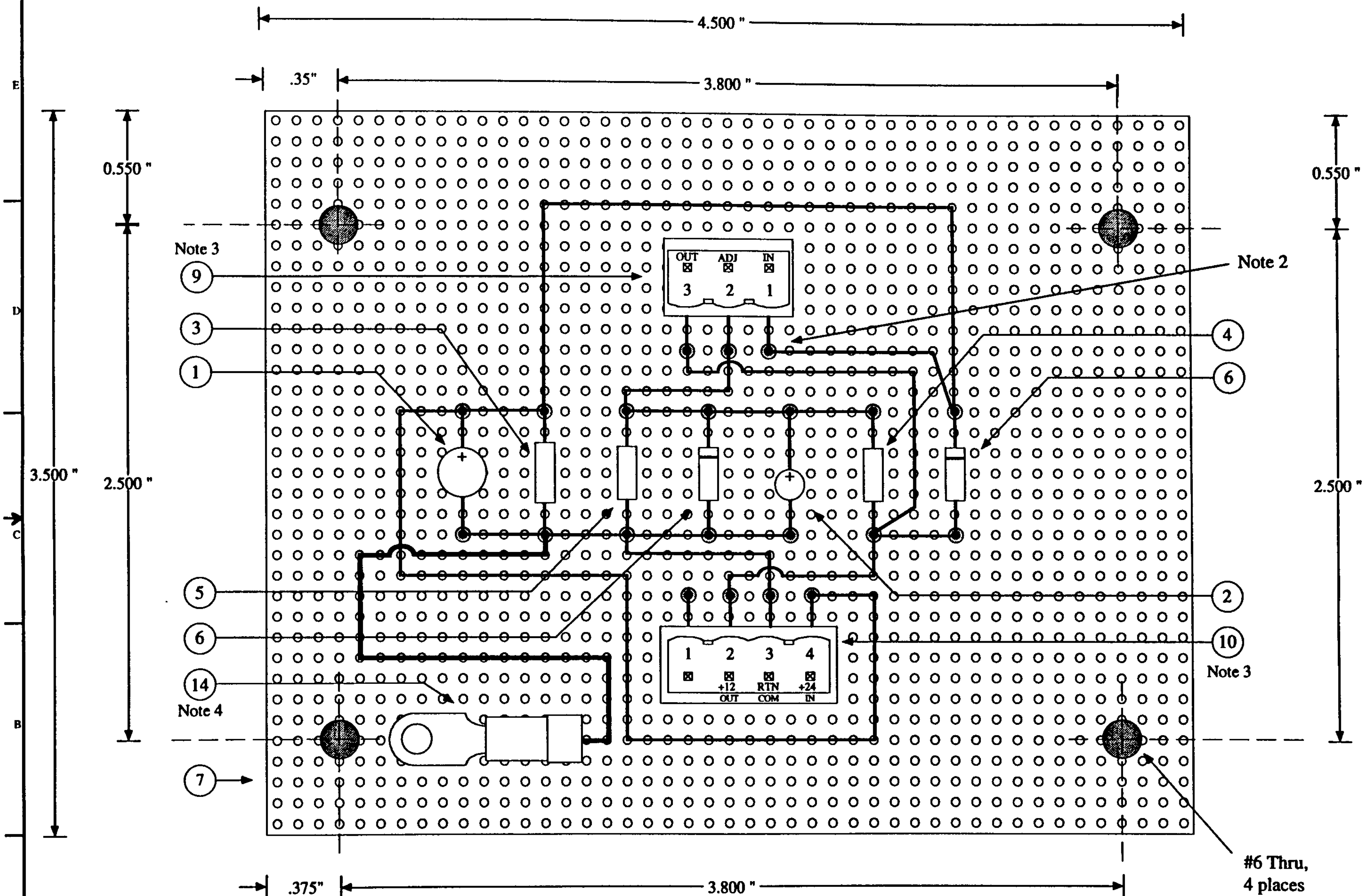
Drawing Page

Parts List
Serial I/F Assy
Next Assy:
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:062-0151
Revision:-

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	1	EA	062-0151	SIS Enclosure	BUD	
2	1	EA	062-0156	SIS WRB Outline	SPRL	
3	1	EA		D-connector,plug - Data	SPRL	
4	1	EA		D-connector,socket - Power	SPRL	
5	4	EA		Screw		
6	4	EA		Nut,hex,#6		
7	4	EA		Standoff		
8	4	EA		Standoff		
9	AR	IN		Wire,22 gauge		
10						
11						
12						
13						
14						
15						
16						
17						
18						



Note:
1. This drawing incomplete without parts list 062-0154.
2. Terminal, swedge (item 8), 21 places, .090" dia thru hole.
3. Epoxy (item 13) components 9 and 10 to perf board (item 7).
4. Attach ground lug (item 14) to stand off between lock and flat washers as indicated.

Unless otherwise specified tolerances are:
Dim ending .00 are ± 0.030
Dim ending .000 are ± 0.005
Angular Dim are ± 0.5 Deg

Space Physics Research Laboratory College of Engineering University of Michigan	Regulator Circuit Board	04-30-97 NS RELEASE DRAWN N. Schnepf COG ENG
N000149510249	Regulator Circuit Board	062- 0153 · 1 of 1 · x2

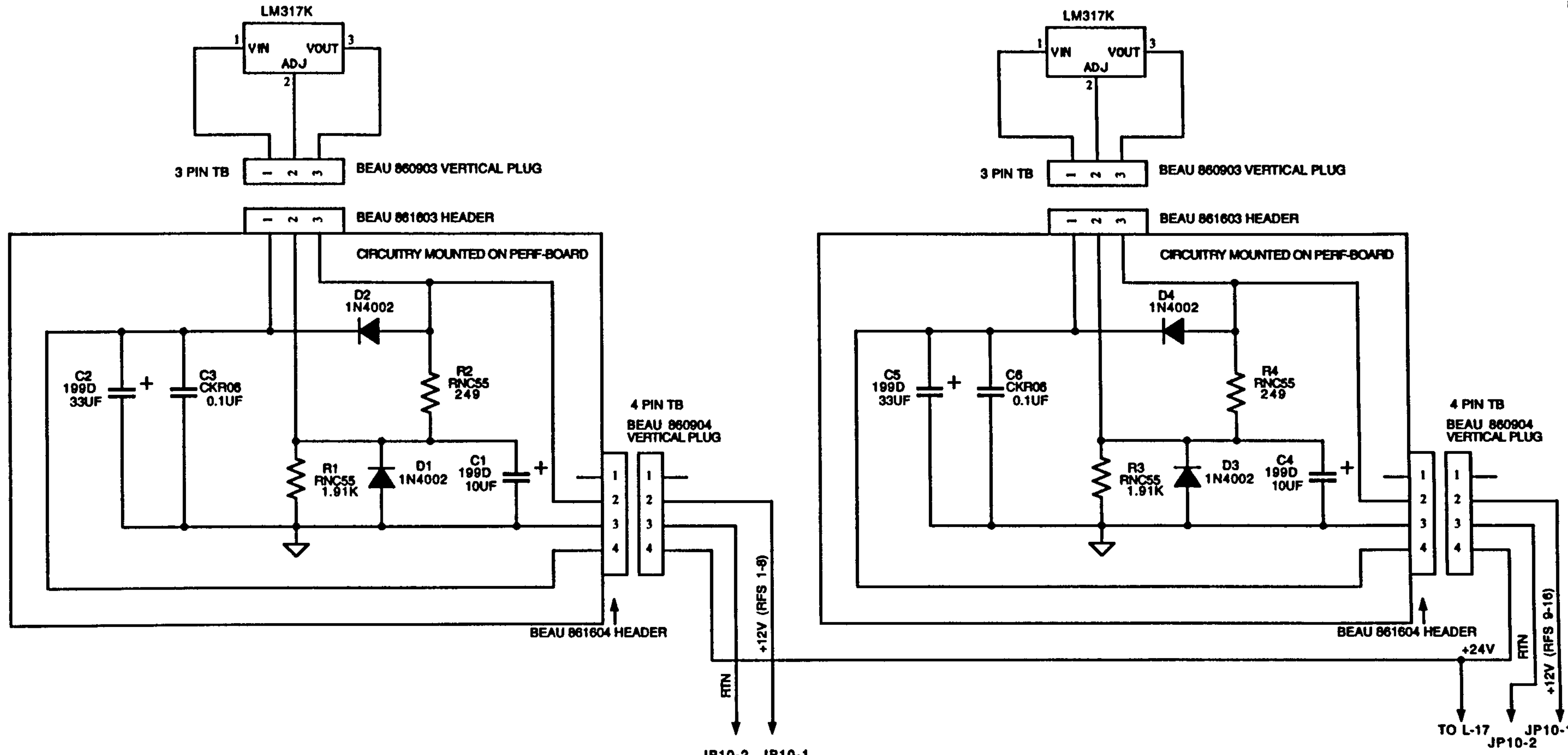
Drawing Page 1

Reg Circuit Board
Parts List -
Next Assy:
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:062-0154
Revision:x2

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	1	EA	199D336X0025EE2	Cap,Tan,33uF,25V,20%	Sprague	C2
2	1	EA	199D106X0025CA1	Cap,Tan,10uF,25V,20%	Sprague	C1
3	1	EA	M39014/02-1310	Cap,Cer,0.1uF,100V,10%		C3
4	1	EA	RNC55J2490FS	Res,MF,249,.125W,1%		R2
5	1	EA	RNC55J1911FS	Res,MF,1.91K,.125W,1%		R1
6	2	EA	1N4002	Diode,Silicon		D1,2
7	1	EA		Perf Board, 4.5 in X 3.5 in	Vector	
8	21	EA		Terminal, Swage		
9	1	EA	861603	Header, Closed, 3 Term	Beau	
10	1	EA	861604	Header, Closed, 4 Term	Beau	
11	AR	FT		Wire,22 GA, Bare		
12	AR	FT		Sleeving,Teflon		
13	AR	OZ		Epoxy, two-part		
14	1	EA	18RA-6	Terminal, ring	Thomas & Betts	
15						
16						
17						
18						



CONNECTIONS ON 1-8 RF SWITCH PCB ASSEMBLY

NOTE: HEADER H1 PINS 14 & 15 CONNECTION TO +12 BUS ARE DISCONNECTED ON THIS RF SWITCH PCB ASSEMBLY BY CUTTING A TRACE ON THE SOLDER SIDE OF THE BOARD.

CONNECTIONS ON 9-16 RF SWITCH PCB ASSEMBLY

NOTE: LAND BETWEEN L-17 AND JP10-1 IS CUT ON THIS RF SWITCH BOARD ONLY. THE +24 VOLT SUPPLY IS AVAILABLE AT THIS POINT.

Space Physics Research Laboratory
College of Engineering
University of Michigan

SCHEMATIC, ANTENNA MULTIPLEXER REGULATOR

PROJECT	CAGE CODE	FILENAME	DRAWING NUMBER	REV
N000149510249	0TK63		062-0155	X1

REV	
REV	
REV	
RELEASE	
DRAWN	P. HANSEN
COG ENG	

DRAWING PAGE

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SIS WWB00
Parts List -
Next Assy:
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.:0157
Revision:2

REFERENCE	VALUE	NAME	SHAPE	PINS		
		HEADER-DLY1				
H1		HEADER-16PIN	VDIP	16		
H2		HEADER-16PIN	VDIP	16		
H3		HEADER-RC	VDIP	16		
H4		HEADER-16PIN	VDIP	16		
H5		HEADER-16PIN	VDIP	16		
H6		HEADER-16PIN	VDIP	16		
H7		HEADER-16PIN	VDIP	16		
H8		HEADER-16PIN	VDIP	16		
R1	4.7K	RZ060C	SIP10	10		
R2	4.7K	RZ060C	SIP10	10		
R3	4.7K	RZ060C	SIP10	10		
U1		54LS123	VDIP	16		
U2		54LS74	VDIP	14		
U3		54LS74	VDIP	14		
U4		54LS00	VDIP	14		
U5		54LS04	VDIP	14		
U6		54LS191	VDIP	16		
U7		54LS165A	VDIP	16		
U8		54LS165A	VDIP	16		
U9		26C31	VDIP	16		
U10		54LS74	VDIP	14		
U11		74HCT14	VDIP	14		
U12		54LS00	VDIP	14		

Drawing No. 062-0157.

Net List
SIS WWB
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

NET NAME	PINS							
A1	H2-6	R2-4	U6-15					
A2	H5-6	R3-5	U7-11					
A4	H6-6	R2-6	U8-11					
B1	H2-9	R1-7	U6-1					
B2	H5-9	R2-9	U7-12					
B4	H6-9	R2-5	U8-12					
C1	H2-8	R1-5	U6-10					
C2	H5-8	R2-7	U7-13					
C4	H6-8	R1-8	U8-13					
D1	H2-11	R1-4	U6-9					
D2	H5-11	R3-4	U7-14					
D4	H6-11	R1-6	U8-14					
E3	H4-6	R2-3	U7-3					
E5	H7-6	R3-3	U8-3					
F3	H4-9	R2-2	U7-4					
F5	H7-9	R3-2	U8-4					
G3	H4-8	R1-10	U7-5					
G5	H7-8	R2-10	U8-5					
H3	H4-11	R1-9	U7-6					
H5	H7-11	R2-8	U8-6					
#NAME?	U3-8	U3-12	U4-5	U10-3				
CLK	U5-6	U9-9						
CLK_0	U2-11	U3-3	U3-9	U11-1				
CLK_INT	U1-11	U3-13	U12-3					
CLK_OUT	H8-3	U9-10						

Net List
SIS WWB
Program: HF Radar
Contract:N000149510249

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SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK73
Drawing No.: 062-0158
Revision: X2

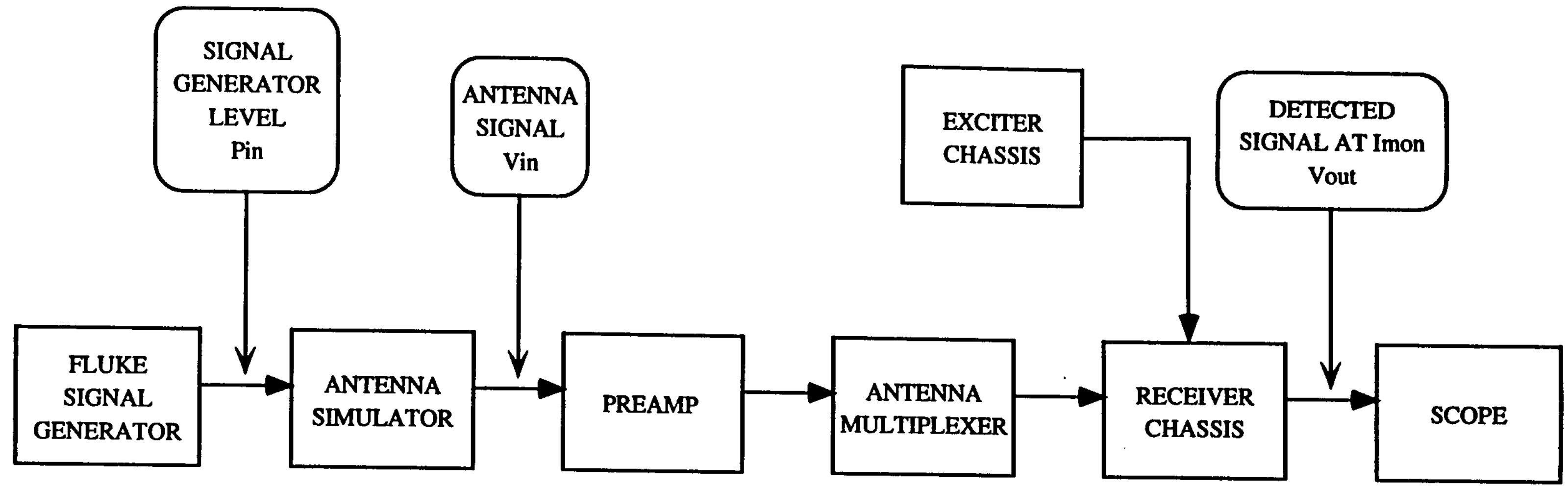
NET NAME	PINS							
DATA	U8-9	U9-7						
DATA_OUT	H8-2	U9-6						
DCLK	U4-9	U6-14	U11-4					
EN	U4-4	U4-13	U5-2	U9-1	U12-2			
EN_OUT	H8-1	U9-2						
GND	#1-6	#1-8	H1-13	H2-7	H2-10	H3-14	H3-15	H4-7
	H4-10	H5-7	H5-10	H6-7	H6-10	H7-7	H7-10	H8-5
	H8-6	H8-7	H8-8	U1-6	U1-8	U1-9	U1-14	U2-7
	U3-7	U4-7	U5-3	U5-7	U6-8	U7-8	U7-15	U8-8
	U8-15	U9-8	U9-12	U10-7	U11-5	U11-7	U12-4	
	U12-5	U12-7	U12-9	U12-10	U12-12	U12-13		
LO-	U4-3	U4-10	U6-11	U7-1	U8-1	U10-1		
LO_INIT	U2-6	U2-12	U2-13	U3-1				
MM	U5-1	U6-12	U10-2					
N:2	U2-9	U3-2	U4-1					
N:3	U3-6	U4-2						
N:4	H1-14	R1-2	U2-4					
N:5	H1-12	R1-3	U2-1					
N:6	U4-6	U5-5						
N:7	U1-4	U1-10						
N:8	U1-1	U1-5						
N:9	H3-3	H3-7	U1-15					
N:10	H3-4	H3-5	H3-6					
N:11	H3-2	H3-16	U1-7					
N:12	U1-13	U3-11						
N:15	U4-8	U5-9						

Net List
SIS WWB
Program: HF Radar
Contract:N000149510249

UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK73
Drawing No.: 062-0158
Revision: X2

NET NAME	PINS							
N:16	U5-4	U5-13						
N:17	U4-11	U5-11						
N:19	U11-6	U11-9						
N:20	U6-4	U10-5						
N:21	U11-8	U11-11						
N:22	U11-10	U11-13						
N:23	U7-9	U8-10						
N:24	U4-12	U5-8						
N:30	#1-9	U11-2						
N:31	#1-11	U11-3						
PB	U2-5	U12-1						
S/R CLK	U5-10	U7-2	U8-2					
VCC	H3-1	H3-13	R1-1	R2-1	R3-1	U1-2	U1-3	U1-16
	U2-10	U2-14	U3-4	U3-10	U3-14	U4-14	U5-14	
	U6-5	U6-16	U7-16	U8-16	U9-4	U9-15	U9-16	
	U10-4	U10-14	U11-14	U12-14				



SN 1

(DATA TAKEN 20 SEPT 1996)

TYPICAL SIGNAL LEVELS			
Pin dBm	Vin uV	Receiver Gain Code	Vout Volts P-P
-80	1	1000	10
-70	3	900	11
-60	10	800	13
-50	30	700	6

NOTE: MINIMUM RECEIVER GAIN = 700, MAXIMUM USABLE RECEIVER GAIN = 1000

SN 2

(DATA TAKEN 01 MAY 1997)

TYPICAL SIGNAL LEVELS			
Pin dBm	Vin uV	Receiver Gain Code	Vout Volts P-P
-77	1.66	1600	10

NOTE: MINIMUM RECEIVER GAIN = 1100, MAXIMUM USABLE RECEIVER GAIN = 1600

Space Physics Research Laboratory
College of Engineering
University of Michigan

RECEIVER TRANSFER FCN

N000149510249 | Rcvr Xfer Function | 062- 0160 | 1 OF 1

RELEASE | DRAWN 05-01-97 NS | COG ENG

Drawing Page

Parts List: PPC System
Next Assy:
Program: HF Radar
Contract No.:N000149510249

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

FSCM No.: 0TK63
Drawing No.: 062-0161
Revision:-

Item	Qty	U/M	Part Number	Description	Mfr/Code	Symbol
1	1	EA	7100/80	PPC 7100 80MHz with 1Gb HD	Apple	
2	1	EA	1705	17" Color Monitor	Apple	
3	1	EA		Hurdler external quad serial port extender	Creative Solutions	
4	1	EA		Iomega external 1Gb Jaz drive	LaCie	
5	2	EA		16Mb SIMMs		
6	1	EA		SCSI terminator		
7	1	EA		25-50 pin SCSI interface cable		
8	3	EA		DIN 8M to DIN 8F Printer Extension - 25'		
9	3	EA		DB9M to DIN 8M - 6'		
10	1	EA		FriendlyNet connector	Asante'	

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SPACE PHYSICS RESEARCH LABORATORY

Title: HF Radar PPC System Description	FSCM No.: 0TK63
	Drawing No.: 062-0162
	Revision: -
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Program: HF RADAR	Contract No.: N000149510249

This is an uncontrolled HF Radar Document

APPROVAL RECORD

Function	Title - Organization	Name	Signature	Date
Originator	PE - U of M	N. Schnepf		
Checker				
Mechanical				
Electrical	PE - U of M			
Software	PE - U of M			
QA	QA - U of M			
Mfg				
Reliability				
Project	PM - SU			
Principal Inv	PI - U of M	J. Vesecky		
Customer				

REVISION RECORD

Revision	Description	Date	Approval
-	Initial Release		

UNIVERSITY OF MICHIGAN SPACE PHYSICS RESEARCH LABORATORY

Title: HF Radar PPC System Description	FSCM No.: 0TK63 Drawing No.: 062-0162 Revision: - Page 2 of 7
Program: HF RADAR	Contract No.: N000149510249

PPC SYSTEM DESCRIPTION

Table of Contents

1.0 CONFIGURATION

The minimum PPC configuration required for operation of the HF Radar System will be described in the following sections.

1.1.1 All of the listed software (excluding system files) are bundled on the *Santa Cruz Data-Prog* JAZ cartridge.
1.1.2 File location is not important except where noted below.

1.2 SOFTWARE

1.2.1 System 7.5.5
1.2.2 **BDM_Load_PPC**
1.2.3 **Versaterm 5.0.3** (and all associated support files)
NOTE: When installing the folder containing the versaterm files drop it into the system folder; all of the system extensions will be added automatically.
1.2.4 **term_data 5.0.3** (this must be present in the preferences folder under the system folder.)
1.2.5 HURDLER/HUSTLER software (use the ***CSI serial installer 1.04*** on the set-up disc provided with the hardware)
1.2.6 **RadarCommander_PPC_1.3.1d1**
1.2.7 **radar2.A.binary** (specific to SN1)
1.2.8 **radar3.A.binary** (specific to SN2)
1.2.9 If the IOMEGA JAZ DRIVE is being used with the system ***silverlining lite*** must also be installed - this is provided on the set-up disc provided with the hardware
1.2.10 **AppleScript** extension (this SHOULD be included with 7.5.5)

1.3 HARDWARE

The following list describes the Macintosh personal computer and associated equipment which forms a part of the HF Radar System. See drawing 062-0116 for information on how to interconnect this equipment.

1.3.1 Power Macintosh 7100/66
1.3.2 32 MB physical RAM
1.3.3 700 MB internal hard drive
1.3.4 Iomega JAZ drive

1.3.5 Hurdler quad serial port expander
1.3.6 25-50 pin SCSI interface cable
1.3.7 50-pin SCSI terminator
1.3.8 3 cables : DIN 8M to DIN 8F Printer Extension - 25'
1.3.9 3 cables : DB9M to DIN 8M - 6'
1.3.10 Asante FriendlyNet connector

2.0 APPLICATION CONFIGURATION

The application configuration required for proper system operation is as follows:

2.1 Versaterm 5.0.3
2.1.1 Configuring for Hurdler/Hustler:
2.1.1.1 under the EDIT menu select 'edit sessions'
2.1.1.2 select 'CSI-1 (Port C)' and click on the configure button beneath Comm Toolbox'
2.1.1.3 for 'Current Port' scroll through selections and click on 'CSI SCSI 5 port 1'

3.0 SUPPORT APPLICATIONS

3.1 Although not essential for radar system operation the following applications are suggested for inclusion during system set-up to allow for data analysis and visualization
3.1.1 Canvas 3.5.4
3.1.2 Matlab
3.1.3 Microsoft Word 5.01 (or 6.0)
3.1.4 Microsoft Excel
3.1.5 Netscape Navigator
3.1.6 CodeWarrior 8 (or higher)

4.0 ANALYSIS/VISUALIZATION SOFTWARE

4.1 Coherent Add (Matlab and/or C version)
4.2 Radial Current Map Generator (ERIM software)

5.0 SYSTEM OPERATION

Notes in the following sections are intended to outline the operation of the HF Radar System. Versions for both the Prototype system (SN1) and the Field system (SN2) are included.

5.1 PPC Radar Commander Operations Notes - Prototype System

5.1.1. Under Apple-Communications menu select **Versaterm 5.0.3.**

5.1.2. Under Apple-Communications menu select **BDMLOAD_PPC**.

5.1.3. Under the Edit Menu (BDMLOAD_PPC) select **RESET332** (command-R).

5.1.4. Under the Commands Menu (Versaterm) issue a 'clear memory'

5.1.5. Open the **Radar1** folder.

5.1.6. Double click on **radar2.A.binary**.
(If an error message occurs while loading:

5.1.6.1 return to Versaterm

5.1.6.2 under FILE select 'send file'

5.1.6.3 open **radar2.A.scode**)

5.1.7. Select the Versaterm window

5.1.7.1 type 'g3000' at the 332Bug prompt

5.1.7.2 to **STOP** program hit ANY key **NOTE**: This should not be done until the **END** of a data run.

5.1.8 Under the Apple-Communications menu select **Radar Commander_PPC**.

5.1.9 Under RADAR select 'stop radar' (command-K)

5.1.10 Alter radar configuration parameters as required and then transfer using 'send' (which is available either under the respective parameter set up windows or under the RADAR menu).

5.1.11 Under RADAR select 'start radar' (command-R)

5.2 PPC Radar Commander Operation Notes - System SN2

5.2.1 Start-up

5.2.1.1 Apply power to all Radar System Components

5.2.1.2 Load *Versaterm 5.0.3* , *BDM_LOAD,* and *Radar Commander_PPC_1.3.1d1*

5.2.2 Initialization

5.2.2.1 Select the **CSI serial port** from the *Versaterm* sessions palette (note: if no sessions palette appears when *Versaterm* is first loaded go to the *Versaterm* **sessions** menu and select **Show Sessions.**)

5.2.2.2 Bring *BDM_Load* to the foreground

5.2.2.3 under the **Edit** menu select **Reset**
(note: *Versaterm* will respond with a reset tone and a **332Bug** prompt will appear on the *Versaterm* **modem port** sessions screen.)

5.2.2.4 bring the *Versaterm* window to the foreground by clicking on the **modem port** tile and type at the **332Bug** prompt :
bf3000 e000 0 <CR>

5.2.2.5 reselect *BDM_Load*

5.2.2.6 go to the **File** menu and select **open**

5.2.2.7 when the **file menu box** appears select the appropriate binary file to download
(note: The operations file is *radar3.A.binary*. Upon completion *BDM_Load* will respond with a signal beep.)

5.2.3 Execution

5.2.3.1 the current code is written so that operation commences after load.

5.2.3.2 refocus on the Radar Commander Console

5.2.3.3 use COMMAND-K to stop radar operation

5.2.3.4 adjust radar operation parameters from menus as required

5.2.3.5 use COMMAND-R to begin radar operation.

5.2.4 Shut-down

5.2.4.1 return focus to the Versaterm window

5.2.4.2 re-select the CSI Serial Port tile

5.2.4.3 type COMMAND-H to initiate a 'hang up' command to that port

5.2.4.4 all currently running software and hardware can now be turned off