DEVELOPMENT OF AN AUTOMATED DEER DETECTOR

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Development of an Automated Deer Detector

R. Parks Gribble

Battelle Marine Sciences Laboratory
Sequim, Washington

May 2002

Prepared for the
Washington State Department of Transportation
Olympia, Washington
TAD "AA"
Under WSDOT Agreement Y-7711

Battelle, Pacific Northwest Division
of Battelle Memorial Institute

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BACKGROUND

The Washington State Department of Transportation (WSDOT) has a requirement to place detectors that will detect the presence of deer along selected roadways. Battelle Marine Sciences Laboratory was tasked with the design and fabrication of a detector system that would consist of a beam of energy emitted from an emitter that would be received by a detector placed at a maximum distance of 1000 feet along the side of the road. The height of the beam above the ground needed to be approximately 3 feet, and there needed to be a clear line of sight between the emitter and the detector. The design incorporated two emitters, two detectors, and two sign modules into one full system. One set of each would be placed on either side of the roadway, with the distance from the side of the roadway and the type of posts used to be specified by WSDOT. A Family Radio Service (FRS) radio communication system would relay an alarm signal to a traffic warning sign also placed along the side of the roadway. The system needed to be battery powered and capable of being charged by solar power. It also needed to be robust and operate under most all anticipated weather conditions.

OBJECTIVES

The primary purpose of this program was to identify the best technology that would provide the most robust system that is relatively weather independent. Commercial availability and low cost were of prime importance. A single channel or one emitter, one detector, and one sign module was constructed and tested. This single channel system was set up on a test range on Battelle property to determine the correct configuration to be used, and the range, detection sensitivity, weather affects, and robustness were tested.

DELIVERABLES

Deliverables included the following:

- A single channel system, one emitter one detector and one sign module.
- Block diagrams, schematics and report in sufficient detail to allow for installation in the field.

All deliverables are the property of WSDOT.

TASK 1. CHOICE OF BEST TECHNOLOGY

For this task, microwaves, visible lasers, and infrared lasers were considered.

Microwaves

Microwaves can be used to construct an emitter-detector break-beam system. A break-beam system is one in which a beam of energy is transmitted down a straight path toward a detector. The object to be detected interrupts this beam and the detector senses the interruption. The beam from the source will spread depending on the wavelength and the distance it will travel before a

portion of the beam is intercepted by the detector.

MPI Inc., a microwave components manufacturer, was contacted to discuss the possibility of developing a microwave break-beam system. After considering different frequencies and system configurations, a system was proposed. The emitter portion of the proposed system used a 35-GHz Gunn diode emitter. A plastic lens was placed in front of the emitter so that its focal point was located at the source of energy. This system produces a collimated beam that is directed toward the detector. The wavelength at 35 GHz is 0.857 cm. Because a good lens must be at least 10 to 20 wavelengths in diameter, the lens would have to be 8 cm to 16 cm in diameter. This produces a rather large lens that has to be packaged in a weatherproof enclosure. Even with this large lens, the beam would contact the ground well before it reached the detector located 1000 feet down range. This would lead to ground bounce interference. The proposed prototype for a single emitter-detector pair was $18,750.

Because of concerns about packaging a large system, the ground-bounce problem, temperature stability of a Gunn source and the relatively high price, this system was rejected.

Visible Pulsed Lasers

There are many inexpensive visible lasers on the market that can be fabricated into a break-beam system. Most have a wavelength of 630 nm to 650 nm. At this wavelength, scattering caused by rain, fog, dust and snow is a concern. A more powerful emitter can be used to try to overcome this affect, but this will move the laser up to a class III, which is not eye safe. Due to the scattering problem, visible light lasers were rejected.

Near-Infrared Lasers

Near-infrared lasers at a wavelength of 900 nm are readily available and are typically used in rangefinders and surveying equipment. Several Class I, eye-safe, rangefinders were investigated in hopes of finding one that was inexpensive but still versatile enough to be modified into a deer detector. After talking to many different vendors and users of these systems, it became apparent that their operation in rain and fog is limited. Also, because of the high integration of these systems, they are very difficult to modify. It was found the initial cost of the system and subsequent modifications would be too expensive. A near-infrared laser system could be developed by purchasing individual laser components and fabricating a custom system; however, this would be cost prohibitive. Therefore, due to cost and limited effectiveness in rain, snow, and fog, near-infrared lasers were rejected.

Far-Infrared Pulsed Lasers

With a far-infrared pulsed laser at a wavelength of 1550 nm, the effects of scattering due to snow, rain, and fog is greatly reduced. A commercially available Class I, eye-safe device was found. The system uses a pulsed laser, which greatly reduces the power requirements. It is configured into a robust break-beam emitter, detector system that is used by the military. This system was chosen for use in an automated deer detector system because of its small size, low power drain, long range, and ease of packaging.

TASK 2. CHOICE OF BEST AVAILABLE DEVICE FOR SINGLE CHANNEL

Considerations for the best available device for a single channel included size, cost, robustness, power drain, weather dependence, alignment ease, ambient light, modification ease, and willingness of the manufacturer to work with us. Also part of this task was consultation with the WSDOT technical director before purchase of device.

The eye-safe, Class I, pulsed far-infrared laser manufactured by ADC, Inc., was chosen as the best device to test. The salient features are as follows:

- Wavelength 1550 nm
- Pulsed laser with very low current drain, 2.4 mA
- Class I eye-safe laser
- Small physical size and packaged in weather proof cases
- Good lens system with a tightly collimated beam
- Low-pass optical filters to reduce the ambient IR from the sun
- Very low current drain detector; has missing pulse detector circuitry included within package
- 500-meter range.

TASK 3. FABRICATION OF ALIGNMENT SYSTEM AND INSTALLATION IN WEATHER-RESISTANT PACKAGE

A single-channel, far-infrared, break-beam system that can be installed on one side of the roadway to detect deer crossing the roadway and then flash a warning light was developed. This system consists of three modules, an emitter module, detector module, and a sign module. A complete deer detector system, for both sides of the roadway, would utilize two of each of these modules, or six total modules.

Alignment System

An alignment system for both the emitter and detector modules was developed. The alignment system consists of the following:

- A small, inexpensive, two-axis telescope manipulator: The manipulator attaches directly to the emitter and detector by a standard camera mount. This manipulator has proven to be mechanically stable during temperature variations and mechanical vibration.

- A post that attaches the manipulator to an optical bench.

- An optical bench: The optical bench is fabricated from standard 4- by 1 ½ -inch aluminum channel that is stable as a function of temperature. Holes are drilled that allow ¼ X 20 stainless steel screws to attach the optical bench to a NEMA IV fiberglass enclosure. The optical bench also serves as a battery mount.

- An alignment scope: A scope is placed on top of the emitter to view the detector through

plugable holes in the emitter module enclosure. The manipulator is adjusted so that the cross hairs fall on the baffle tube of the detector module. Then, likewise, the alignment scope is placed on top of the detector and the emitter is viewed through plugable holes in the detector module enclosure. The detector's manipulator is adjusted so that the cross hairs fall on the baffle tube of the emitter module.

Weather Resistant Package

All three modules are enclosed in a key lockable NEMA IV fiberglass enclosure that is robust in outside environments. Holes for laser beam, alignment scope, terminal blocks, strain relief, bottom vent, and radios are drilled. Holes for enclosure mounting to a standard 2-3/8-inch diameter steel fence post using U-bolts with the tightening nuts on the inside are also drilled.

Baffle Tubes

Baffle tubes are provided for both the emitter and detector modules. The emitter module has a short baffle tube and the detector has a long baffle tube fabricated out of PVC and PVC fittings. Both baffle tubes have a removable glass window that seals out insects and dust that may interfere with the laser beam. The longer detector module baffle tube is required so that direct sunlight cannot enter the detector except for a limited angle of approximately ±5 degrees.

Radios

Inexpensive FRS radios are used. A telephone conversation with Mr. Alan Hull, Communications Director for WSDOT, confirmed that FRS radios are a good choice for this type of operation. He stated that it is permissible for WSDOT to use FRS radios for this application.

It is suggested that FRS radios that incorporate 38 codes and 14 channels be used in the system to reduce the probability of interference from other FRS users in the area of the automated deer detector systems.

Circuits

A circuit was developed for each of the three modules as follows:

Emitter Module Circuit

The emitter module circuit consists of a Low Drop Out (LDO) voltage regulator that provides 9 V for the emitter. The battery voltage can range from 15 V to 9.2 V without changing the output voltage. A 12-V, 10-AH gel-cell battery was used.

A system test device was designed for installation into the emitter modules. Another regulator and FRS radio receiver was added to each emitter module circuit board. This allows an operator to key a transmitter (another FRS radio tuned to the same frequency of the emitter module radio receiver) from the service vehicle. This procedure shuts down the emitter laser for a short period of time to simulate a broken beam that activates the system so that the warning light will flash,

thus allowing a system check without leaving the vehicle.

A battery test circuit also was designed for installation into all modules. A pushbutton and light-emitting diode (LED) lights were added to the circuit board. When an operator activates the pushbutton, a green or red LED will light. If the green light goes on, the battery does not need recharging. If the red light goes on, then the battery should be recharged.

Both the system test device and the battery test circuit can be added when the circuit boards are professionally manufactured. It is recommended this be done when an additional system is built.

Detector Module Circuit.

The detector module circuit has two LDO regulators on board and a 10-AH gel-cell battery. One regulator is for the detector circuits and the other for the FRS radio. When the detector senses a broken beam, a signal triggers a timer that runs for 4 seconds. This timer turns on the power to the FRS radio and a 500-Hz oscillator. The oscillator modulates the radio transmitter with 500-Hz tone. Another FRS radio in the sign module receives this tone. When the beam comes back on, the oscillator and FRS transmitter turns off and waits for another break in the beam. This configuration reduces the power consumption, because the transmitter is off until a break beam occurs, and then is only on for 4 seconds. The current drain during a break beam is 168 mA, but when the beam is not broken, it drops to 0.64 mA.

Sign Module Circuit

The sign module uses one LDO regulator and a 30-AH sealed lead acid battery. This powers the received only FRS radio and the timing circuits. The timing circuit is arranged so that when the FRS radio receives the 500-Hz signal from the detector module, it turns on the solid-state relay for a programmed amount of time. This time is typically set for 1 minute but may be programmed to other times via a DIP switch on the circuit board. The solid-state relay is wired so that it will turn on the flashing light that uses the 12-V battery voltage.

TASK 4. CONSTRUCTION OF TEST RANGE AND SYSTEM TESTING

A test range 1000 foot long was constructed along the beach on Battelle property. The emitter and detector modules were mounted on 2-3/8-inch diameter, galvanized-steel fence posts. The posts were positioned into the soil using fast-setting, pre-mixed, sack concrete. They were aligned and left to operate 24 hours a day from December 3, 2001, to January 6, 2002, during which time, the temperature, rainfall, and battery voltage was monitored.

The maximum rainfall during the test period was 0.5"/hr, and the temperature varied from 30.5°F to 50.0°F. The battery voltages during this period never dropped to less than 70% of full charge.

During the installation, it was determined that the enclosures themselves needed to be aligned before the internal emitter and detectors, because when mounted on their posts, the enclosures are not necessarily at the same elevation, i.e., the range may be sloping either up or down hill. Therefore, alignment scope mounting fixtures were attached to the top of each enclosure.

Enclosure alignment can now be accomplished by placing the alignment scopes on top of the enclosures, which are then physically adjusted by rotating them on their U-bolts before tightening.

TASK 5. PRODUCT DEMONSTRATION AND DOCUMENTATION

A demonstration to WSDOT personnel was given at the Battelle Marine Sciences Laboratory, Sequim, Washington, site on January 6, 2002. The operation and alignment procedures were demonstrated.

This final report includes documentation of the approach to determining the best system that would meet the specifications required by WSDOT, the fabrication of the actual deer detector system, and then final testing. Also included are appendices on the theory of operation, installation procedures, information on safety, mechanical drawings on mounting posts and on the system itself, listings of the various parts, and computer-aided design (CAD) schematics of the sign module, the detector module, and the emitter modules.

TASK 6. CONSULTATION WITH WSDOT REGARDING FIELD INSTALLATION OF UNITS

At WSDOT direction, assistance will be provided concerning the installation of the system in the field.

CONCLUSION

A viable single-channel, automatic deer detector was fabricated and tested. It has run continuously for a period of approximately 1 month in rainfall up to 0.5"/hr and light fog without failure. After the test period and demonstration to WSDOT personnel, the system underwent modifications to correct problems encountered during the test period. The system has been reinstalled on the test range and has been operating continuously without failure for 4 months.

After installation and analysis of test results of the single-channel system at a WSDOT site, the proper modifications can be identified and installed.

A follow-on program would allow necessary modifications to be made and all circuit boards, including the automatic system test and battery test circuits, to be professionally fabricated. A second set of modules should then be fabricated so that a full system may be deployed.

APPENDIX A.
AUTOMATED DEER DETECTOR THEORY OF OPERATION

AUTOMATED DEER DETECTOR
THEORY OF OPERATION

Introduction

We have all seen light beam door alarms at the front door of local businesses or garage doors in which a light beam is broken when your legs or an automobile interrupts the light path between an emitter and detector. This is referred to as a "break-beam system." These door alarms have a maximum range of only several feet and are transmitting a continuous light beam. They consume a large amount of power and are not battery powered.

The Automated Deer Detector is also a break-beam system. The emitter uses a pulsed, far-infrared beam that is invisible to the human eye and is eye safe. It was developed for military "break-beam" or "trip-line" systems.

A total system consists of two sets of three modules, consisting of an emitter module, a detector module, and a sign module. A set of modules is placed on either side of the roadway at a location where there is a high deer population (see the Deployment Configuration Diagram, Figure 1, in the Installation section). The maximum range of this system is 1000 feet.

Emitter Module

The emitter is a commercial Class I, "eye-safe," pulsed, far-infrared laser (see the Laser Safety Notice in Appendix A). The pulse length is about 200 nanoseconds long occurring 50 times a second. One can imagine a 200-foot-long burst of infrared light traveling at the speed of light occurring every 0.02 seconds. Because of the low duty cycle, the peak power can be raised to high levels to increase the range and still be below the Class I "average" power range. This low duty cycle also reduces the power required. The emitter consumes only 0.0225 watts of power, which allows several months of operation from a single 10-AH gel-cell battery. The wavelength of the emitter is 1550 nm, which is well below human sight and less prone to scattering by rain, snow, fog, and dust. The emitter uses good quality, temperature-stable, glass optics to collimate the beam, and is packaged in an extremely robust environmental package.

The emitter module consists of the pulsed far-infrared laser mounted on an optical bench aimed through a window in the side of a key-lockable, NEMA IV fiberglass enclosure. A 10-AH, 12-V, gel-cell battery and a voltage regulator circuit, automatic system test circuit, and battery test circuit are also housed inside the enclosure (Figure 2). A solar panel and regulator can be added to eliminate periodic battery charging. Windows and mounts are provided for alignment of the enclosure and the emitter. The fiberglass enclosure is attached to a vertical, galvanized-steel pipe if mounted in the "clear" zone, or a wooden breakaway post if mounted outside the "clear zone" (see Installation Section). All orifices to the enclosure are sealed with glass windows or rubber stoppers except for a small, round screen in the bottom to allow the enclosure to vent to the atmosphere.

A baffle tube is located on one side of the enclosure. This tube has a glass window inside to keep bugs, such as spiders, bees, and wasps, from entering the enclosure to make nests. This window can be cleaned by simply unscrewing the PVC pipe fitting and extracting the window for cleaning.

Emitter Module Alignment

The proper vertical mounting posts are installed in concrete at the proper location along the roadway so that the modules can be mounted. Three U-bolts with saddles are provided on the back of the enclosure. The enclosure is mounted so that the emitter output beam is located approximately 3 feet above the ground surface. The U-bolts are lightly tightened so that the enclosure is held in place. The alignment scope is then placed on the mount located on the enclosure top. Assuming the detector module has been mounted at the other end of the range, align the enclosure vertically and horizontally so that the cross hairs are located at the center and top of the detector module. Tighten the U-bolts and recheck the enclosure alignment.

Remove the rubber plugs from the alignment ports on the enclosure and place the alignment scope on top of the emitter package. Use the vertical and horizontal translator knobs on the x/y manipulator to align the emitter so the cross hairs align with the detector baffle orifice on the detector module.

Plug the battery wires onto the battery terminals and proceed down to the detector module.

Detector Module

The detector is packaged in the same type of fiberglass enclosure. The detector operates on what is called a "missing pulse discriminator." When the infrared photo detector is illuminated with the infrared beam and receives a pulse of energy at the proper time, the detector output stays on. But if a pulse of infrared does not arrive because an object is blocking the beam, then the detector output turns off.

The circuit board that is housed in the detector module recognizes when the detector output has turned off. This circuit then will turn on an FRS radio, which transmits for 4 seconds. This signal is then received by the FRS in the sign module. The following conditions can occur:

1. If the beam is broken for less than 4 seconds and the detector output comes back on again, the radio will continue to transmit until the 4-second time period has elapsed. This system guarantees that the sign module will receive a signal, even if the beam is broken only momentarily, such as by a fast running deer.

2. If the beam is broken for greater than 4 seconds, the radio will quit transmitting after the 4-second time period has elapsed. This will disable the system if the beam is broken for long periods of time, such as case of failure caused by extremely heavy rain, heavy snow, or dense fog.

3. After the initial break, if the beam is broken again during the 4-second time period, then the radio will continue to transmit for 4 seconds after the last beam break. This will ensure that a signal is sent to the sign module every time the beam is broken, such as when several deer in succession break the beam.

Detector Module Alignment

Alignment of the detector module enclosure is identical to that of the emitter module, except the emitter module now becomes the target for the alignment scope.

Detector Module Baffle

A longer baffle tube is mounted in front of the detector optics. This tube is designed so that direct light from the sun does not shine directly into the detector optics. A setting or rising sun must not be within ±5

degrees horizontally or vertically from shining down the baffle tube. Use caution when installing the system in an east/west orientation. This tube also has a glass window inside to keep insects and dust from entering the enclosure. This window can be cleaned by simply unscrewing the PVC pipe fitting and extracting the window for cleaning.

Sign Module

The sign module is housed inside the same type of enclosure as the other two modules. This module has no orifices or baffles except the two feed-through, strain-relief fixtures and an air vent in the bottom. Inside is a large 30-AH, gel-cell battery to power the circuit board, a flashing solid-state relay light, and a receive-only FRS radio.

When the sign module radio detects the modulated transmitted signal from the detector module, a signal is sent to the circuit board that turns on the solid-state relay. This relay is used to turn on the flashing light. The duration of the flashing light can be programmed to several different times by a DIP switch located on the circuit board. Typically, the duration is one minute. If a number of broken beam events occur during a selected duration time, such as when several deer are breaking the beam in succession, then the light will continue flashing until one minute after the last beam break has occurred. Normally, the radio in the sign module located on the opposite side of the road is tuned to the same frequency, so both flashing lights will go on.

The sign module is mounted to a wooden post by three lag screws inserted from the inside of the enclosure.

It may be possible to mount the sign module on the traffic signpost if approved by the safety officer. If the flashing light is located at a different location than the sign module, then a 14-ga. two-conductor cable must be connected between them. This cable should be buried inside a conduit.

Data Logger

The number of deer that break the beam may be different from the number of times a warning signal has been triggered. This happens when groups of dear break the beam during a duration period as opposed to an individual break. Because of this, two data logger outputs are provided. These data logger signals are provided on two RCA-type connectors on the sign module circuit board, labeled "number of signals" and "number of signs." These are provided for a HOBO event logger. When an event logger is "launched" by a computer, it can be connected to one of the two connectors.

If the "number of signals" is used, the logger will record when and how many times the detector modules transmitted a break-beam signal, indicating the number of deer that have broken the beam. If the "number of signs" is used, the logger will record how many times the flashing light was turned on, indicating the number of alarms that were given.

A HOBO shuttle is also provided so that the event logger may be downloaded without the aid of a computer.

System Specifications

Emitter Module

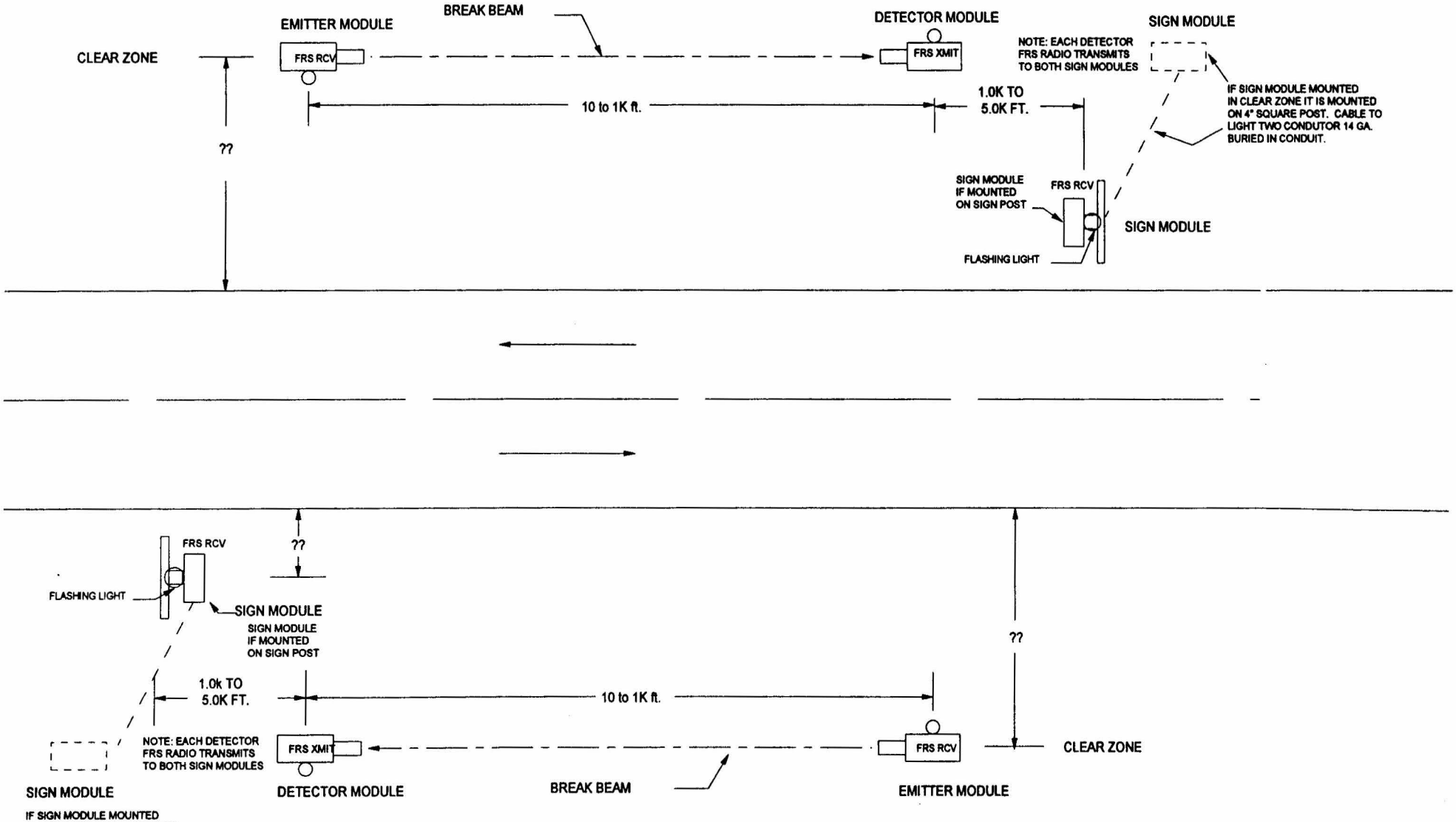
Pulse duration	200 ns
Peak Power	1.6 W
Repetition Rate	50 Hz
Average Power	16 μW
Wavelength	1550 nm
Battery	12 V, 10 AH gel cell
Module Current	2.4 mA (without automatic system test and battery test circuits)

Detector Module

Detector dwell	50 msec.
Battery	12 V, 10 AH gel cell
Radio	FRS Radio (model may vary, depending on type available)
Module Current	Beam ON-0.64 mA. Beam OFF-168 mA (without battery test circuit)

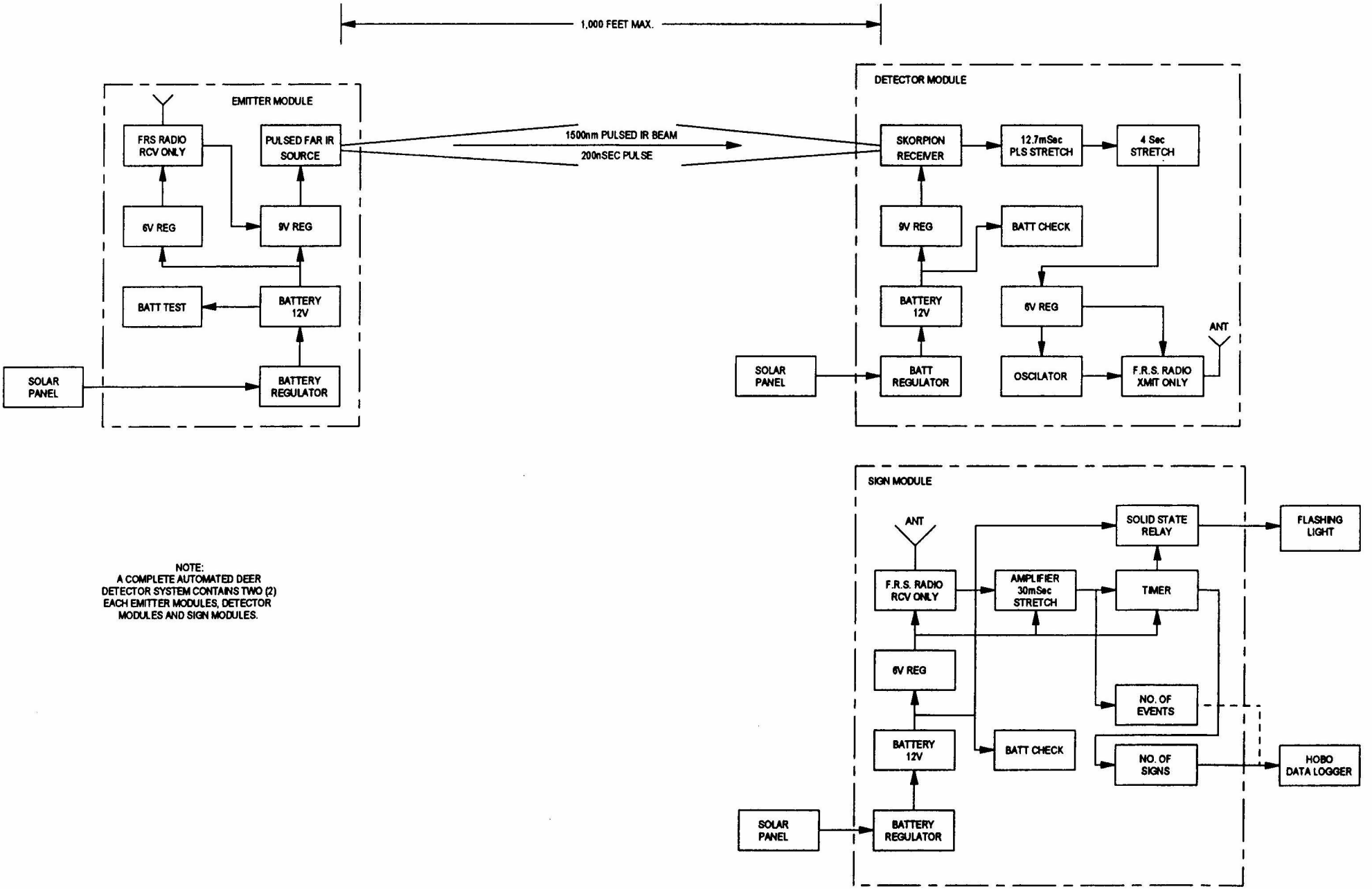
Sign Module

Radio	FRS Radio (model may vary depending on type available)
Battery	12 V, 30 AH sealed lead acid.
Max. Light current	5 A
Module Current	Light OFF-28 mA. Light ON-2.5A (without battery test circuit)



DEPLOYMENT CONFIGURATION

FIG. 1



NOTE:
A COMPLETE AUTOMATED DEER DETECTOR SYSTEM CONTAINS TWO (2) EACH EMITTER MODULES, DETECTOR MODULES AND SIGN MODULES.

SYSTEM BLOCK DIAGRAM

FIG. 2.

APPENDIX B.
INSTALLATION

INSTALLATION

It is assumed that a clear line of site path 36 inches above the surface of the ground will be provided between each emitter and detector. All brush, weeds, and tree limbs in the path must be removed. Also, a clear line of site path between the detector and sign modules must be provided. It is also assumed that the detector module be mounted so that the baffle does not look directly into either the rising or setting sun within ±5 degrees in any direction.

The following items are necessary for a full system installation:

1. 2 ea. Complete emitter modules.
2. 2 ea. Complete detector modules.
3. 2 ea. Complete sign modules.
4. 2 ea. Road signs with flashing light.
5. One alignment scope is required to service several systems deployed in any one district.
6. Two battery chargers are required to service several systems deployed in any one district if solar cells are not used.
7. 8 ea. Solar cells and controllers, if used.

Before deployment, check with the WSDOT district safety officer to determine the location of the "clear zone" and get a deployment configuration authorization. If the modules are to be mounted outside of the "clear zone," breakaway posts for the emitter and detector modules may not be required. The sign module may be mounted on a separate cedar post outside the "clear zone," or on the traffic signs post if authorized. It is assumed the traffic signs post will be mounted inside the "clear zone" and the proper safety precautions exercised.

For a clear zone deployment, the following is required:

1. 4 ea. 2-3/8 x 67 in. galvanized steel fence posts.
2. 2 ea. 4- x 4-in. x 67-in. cedar post.
3. 6 sacks of quick setting concrete.

For a non-clear zone installation, the following items are required:

1. 4 ea. 4- x 6-in. x 42-in. cedar post with a 40-in. 2-3/8-in. galvanized steel fence post attached with 3/8-in. bolts and saddles and a 2-in. diameter hole drilled 26 in. from one end.
2. 2 ea. 4- x 4-in. x 67-in. cedar posts.
3. 6 sacks of quick setting concrete.

Directions:

1. Dig a hole deep enough to bury the posts 24 in. below the surface of the ground and concrete in place.
2. Mount the emitter module onto the post, using the three U-bolts and clamps provided, so that the center of the baffle tube is 36 in. off of the surface of the ground.

3. Using the alignment scope on top of the emitter module, adjust the enclosure so that the scope cross hairs are aligned approximately on the detector module post and lightly tighten the bolts from the inside.
4. Taking the alignment scope, go down range to the detector module posts and mount the detector module enclosure to the post, using the three U-bolts provided.
5. Place the alignment scope on top of the detector enclosure and adjust the enclosure so that the scope cross hairs are aligned at the top center of the emitter module.
6. Taking the alignment scope back to the emitter module, place it on top of the emitter module enclosure again. Realign the enclosure so that the cross hairs fall on the center top of the detector module. Tighten the three U-bolts securely and recheck alignment.
7. Open the emitter module door and place the alignment scope on top of the emitter laser. Unplug the two viewing holes on both sides of the enclosure. When sighting through the viewing holes and alignment scope, adjust the X/Y manipulators adjustment knobs so that the crosshairs fall on the detector modules baffle tube. Remove the alignment scope and replace the two viewing port plugs
8. Taking the alignment scope back down range to the detector module, place the alignment scope on top of the detector module enclosure. Realign the enclosure so that the cross hairs fall on the center top of the emitter module. Tighten the three U-bolts securely and recheck alignment.
9. Open the detector module door and place the alignment scope on top of the detector. Unplug the two viewing holes on both sides of the enclosure. When sighting through the viewing holes alignment scope, adjust the X/Y manipulators adjustment knobs so that the crosshairs fall on the emitter module's baffle tube. Tighten the three U-bolts securely. Remove the alignment scope and replace the two viewing port plugs.
10. Mount the sign module on the cedar post using the three lag screws provided.
11. Bury the 14-ga. wire that runs from the sign module to the road signpost.
12. Fasten the flashing light mount to the top of the sign post, run the sign module wire through the strain relief provided, and connect the white wire to the light's red wire and both the black and green wires to the light's black wire.

Follow the above procedure for the opposite side of the roadway.

The system is now ready to test.

APPENDIX C.
LASER EMITTER SAFETY NOTICE

Laser Emitter Safety Notice
SLB100E5010x
September 7, 2000

The 1550nm laser emitter used in the break beam system has been designed for Class I operation.

Regulation: U.S. Department of Health and Human Services (DHHS) Sections 1040.1 and 1040.11 Publication FDA 88-8035, application for laser products.

Definitions:

- Class I level of laser radiation are not considered to be hazardous
- Class IIIb levels of laser radiation are considered to be acute hazard to the skin and eyes from direct radiation.

- "Accessible emission limits" (AEL) means the maximum accessible emission level permitted within a particular class as set forth in FDA 88-8035.

- "Emission Duration" means the temporal duration of a pulse, a series of pulses, or continuous operation, expressed in seconds during which human access to laser or collateral radiation could be permitted as a result of operation, maintenance or service of a laser product.

- Class II and Class IIIa levels of laser radiation are covered in the regulations but refer to wavelengths less than 710nm and are not considered in this notice.

Laser Emitter Accessible Emission Limits (AELS) Calculations Table	
Wavelength	1550 nm
Type	Pulsed
Peak Emission	1.6 watt
Pulse Duration	2.00E-07 sec max
Repetition Rate	50.00 hz
Average Duration	1.00E-05 sec
Average Power	1.60E-05 watt

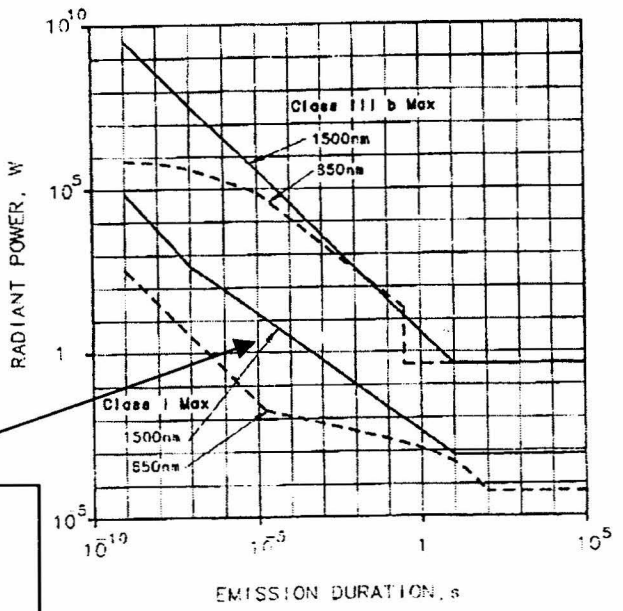
Two comparisons with the regulations need to be performed to establish Class I operation for pulsed laser operation.

- First, the **Average Power** (see table above) must be below **7.9 x 10-4 watts**.

- Second, the **Peak power** and **Average Duration** are used to establish the AEL on Figure 1, "Comparison of Calculated AEL's in Terms of Radiant Power", which is a graph that shows the limits for 1550nm laser operation. The operating point for the emitter is below the applicable curve and the laser is considered Class I, or eye safe. See attached curve.

4.0 **RESULTS**

The AEL's for both 850 nm and 1500 nm are presented graphically in Figure 1. It is assumed that all the radiant power emitted from the laser directly enters the eye and the pupil is uniformly illuminated.

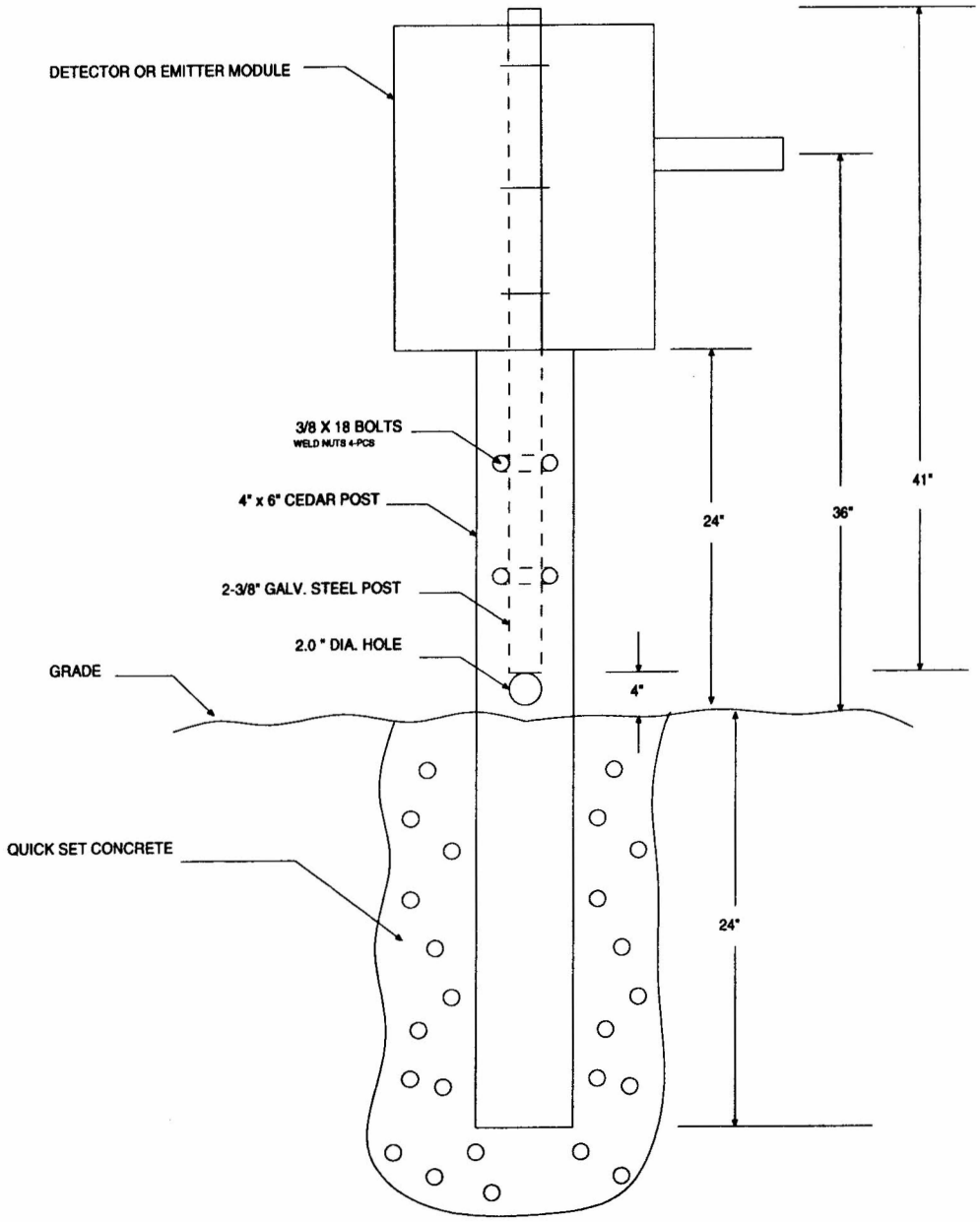


Emitter Operating Point (see table above)

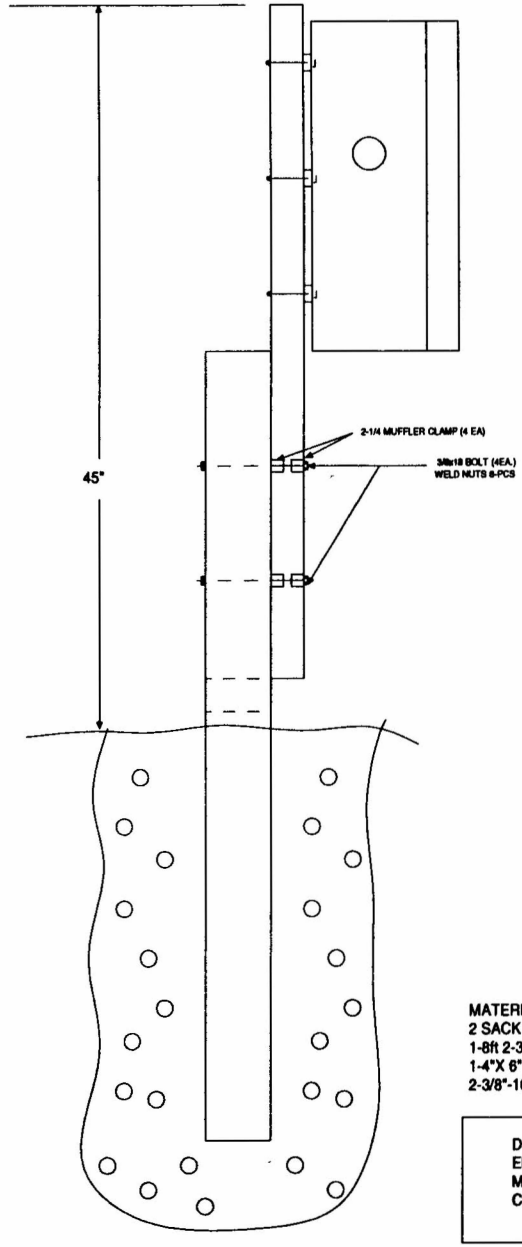
Figure 1: Comparison of Calculated AEL's in Terms of Radiant Power

APPENDIX D.
DEER DETECTOR BREAK-AWAY POST EMITTER AND DETECTOR ENCLOSURE MOUNT

BACK VIEW

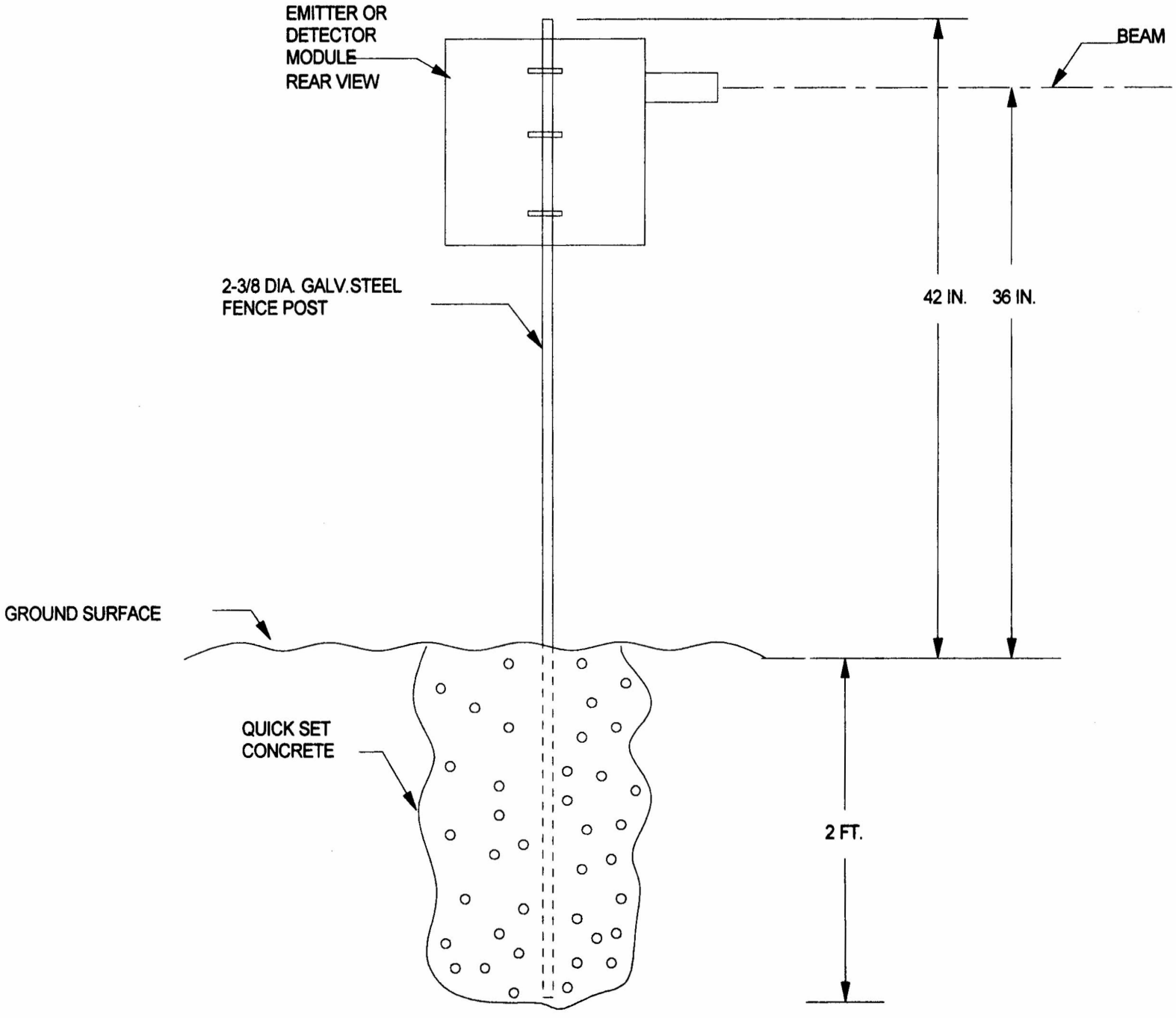


END VIEW



MATERIALS LIST FOR 1 EMITTER & 1 DETECTOR
2 SACK QUICKCRETE
1-8ft 2-3/8 GALVANIZED FENCE POST
1-4"X 6" CEDAR POST
2-3/8"-16 x 8" U-BOLTS, WASHERS & NUTS

DEER DETECTOR BREAK-AWAY-POST
EMITTER & DETECTOR ENCLOSURE
MOUNT
C:\mydocuments\mechdwgs\mmtgpost

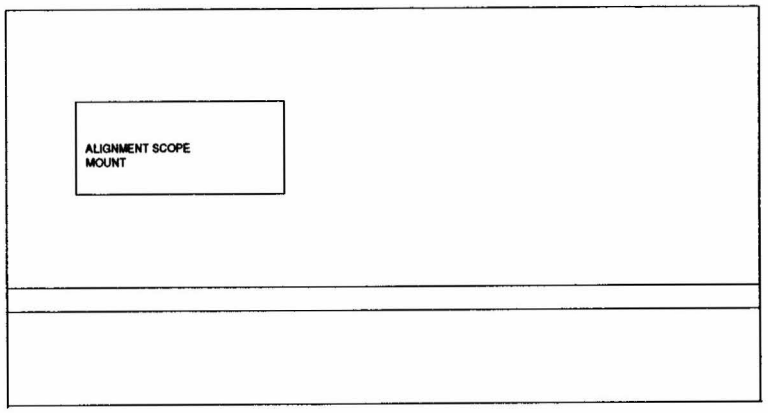


NON-BREAK AWAY POST

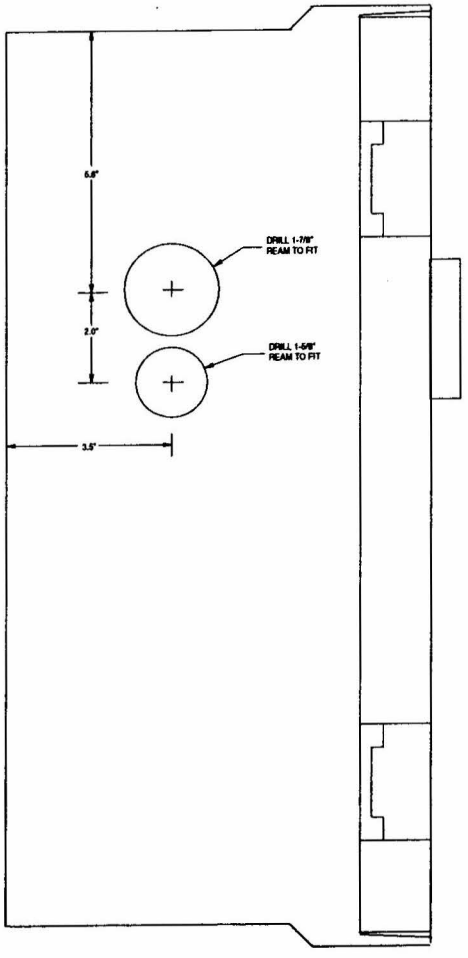
APPENDIX E.
MECHANICAL DRAWINGS

Hoffman ULTRX Type 4X Fiberglass Enclosure
Part No. U-U504020
W/Keylock kit U-UHKL & Insert kit UMH2

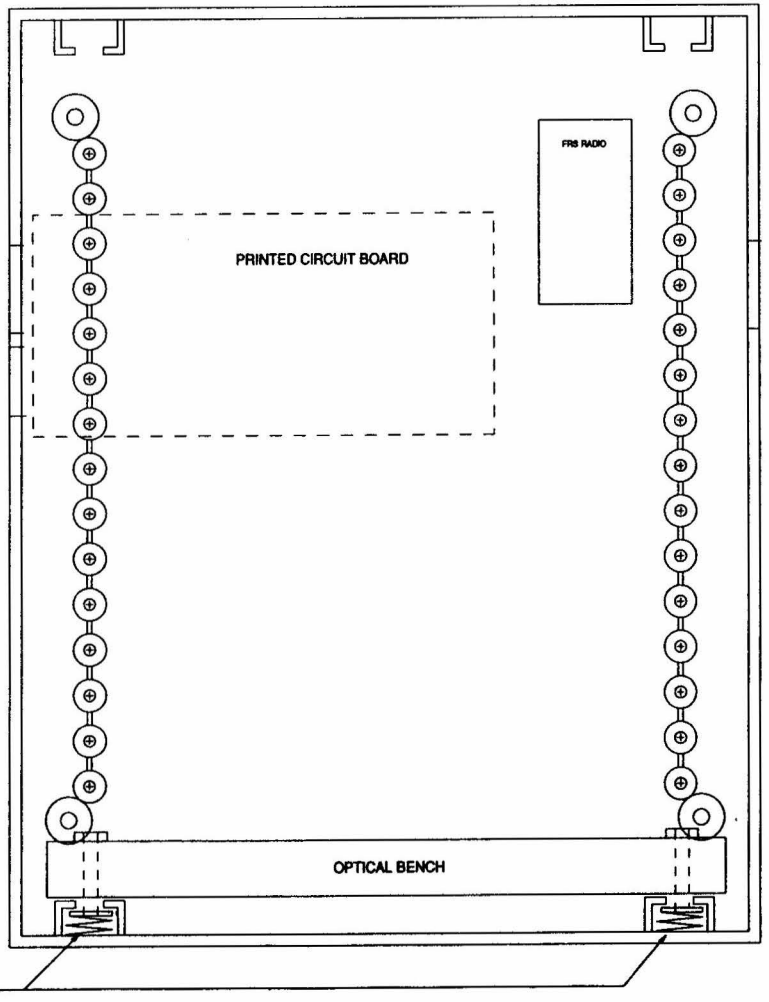
TOP



LEFT SIDE

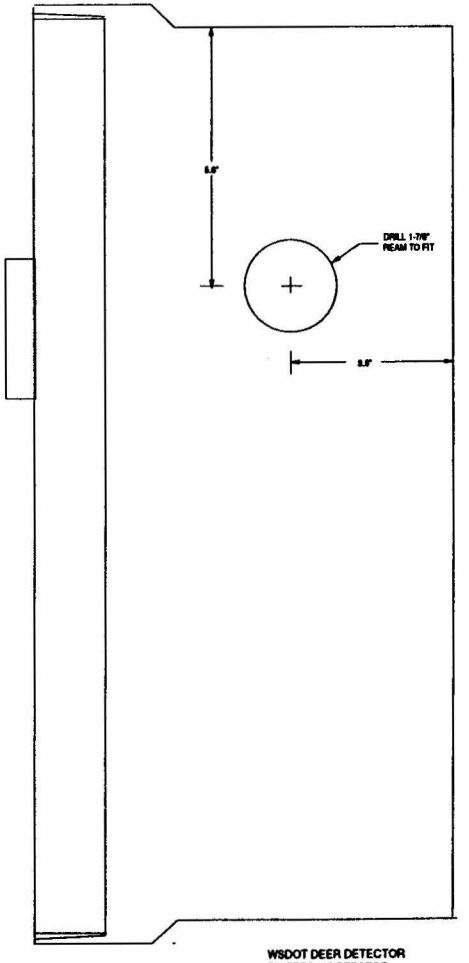


FRONT

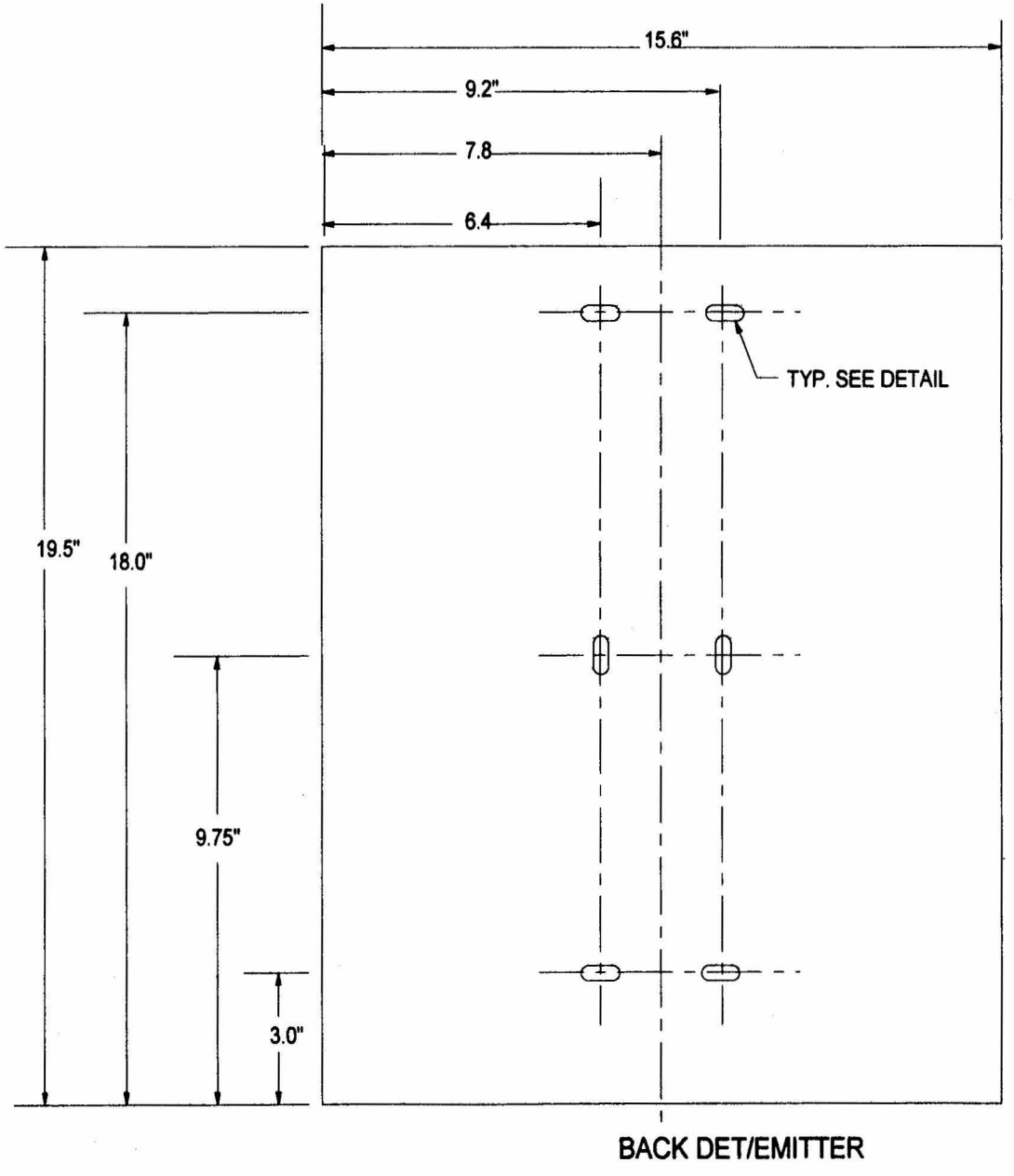


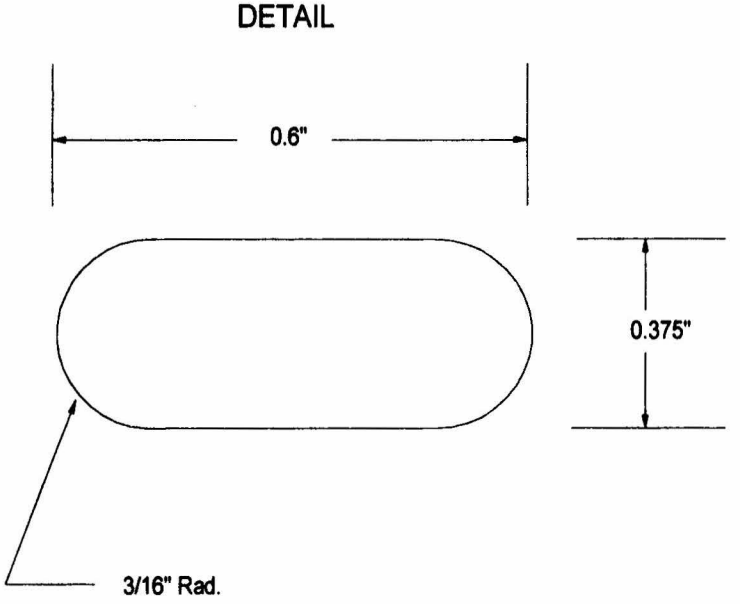
SPRING NUTS

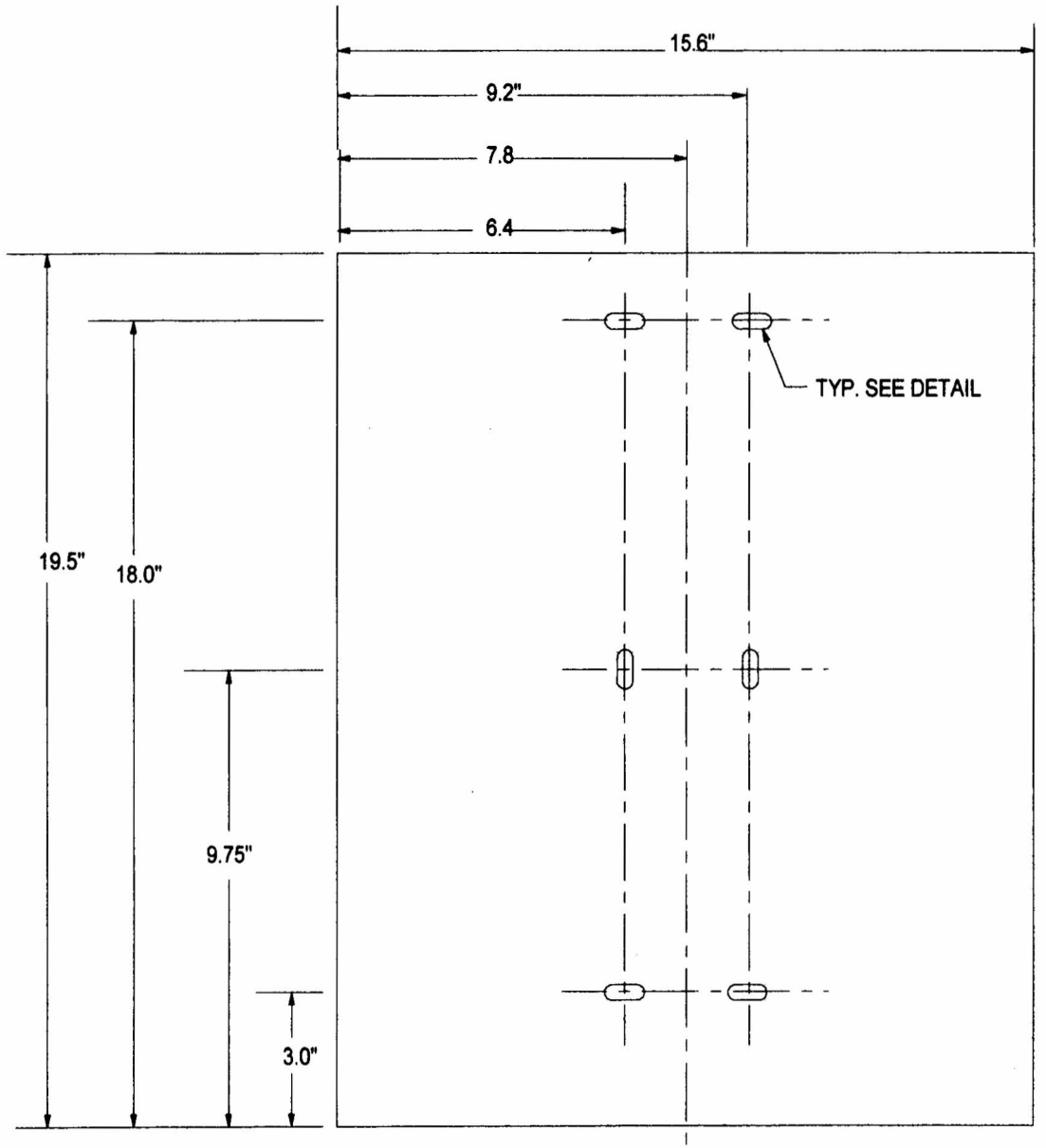
RIGHT SIDE



WSDOT DEER DETECTOR
EMITTER & DETECTOR
MODULES ONLY

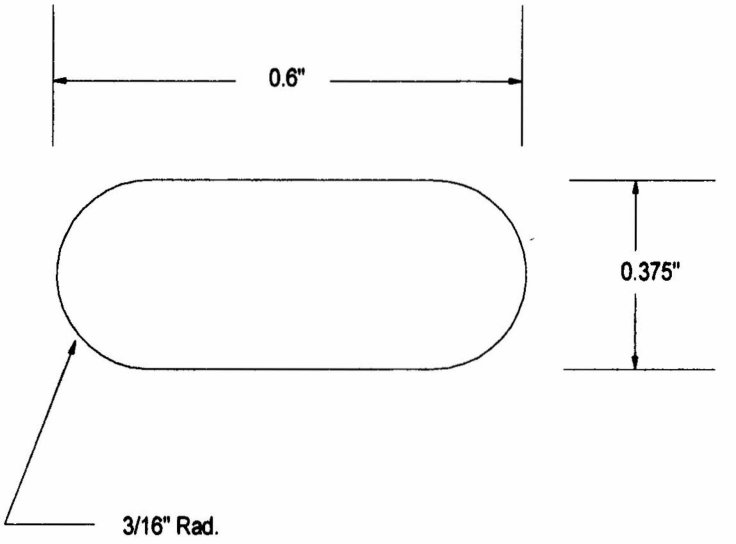

15.6"
9.2"
7.8
6.4
TYP. SEE DETAIL
19.5"
18.0"
9.75"
3.0"
BACK DET/EMITTER

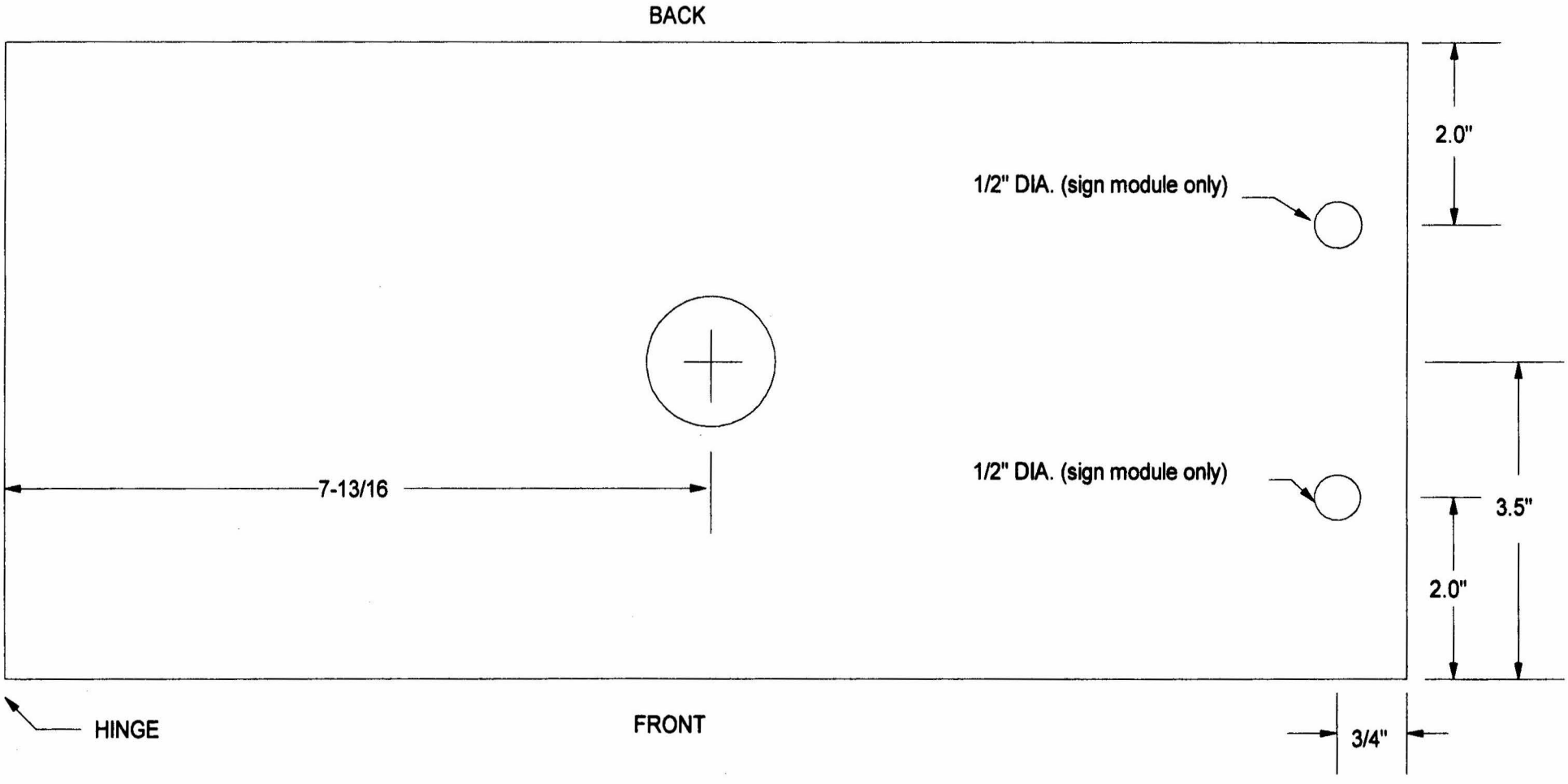

DETAIL
0.6"
0.375"
3/16" Rad.



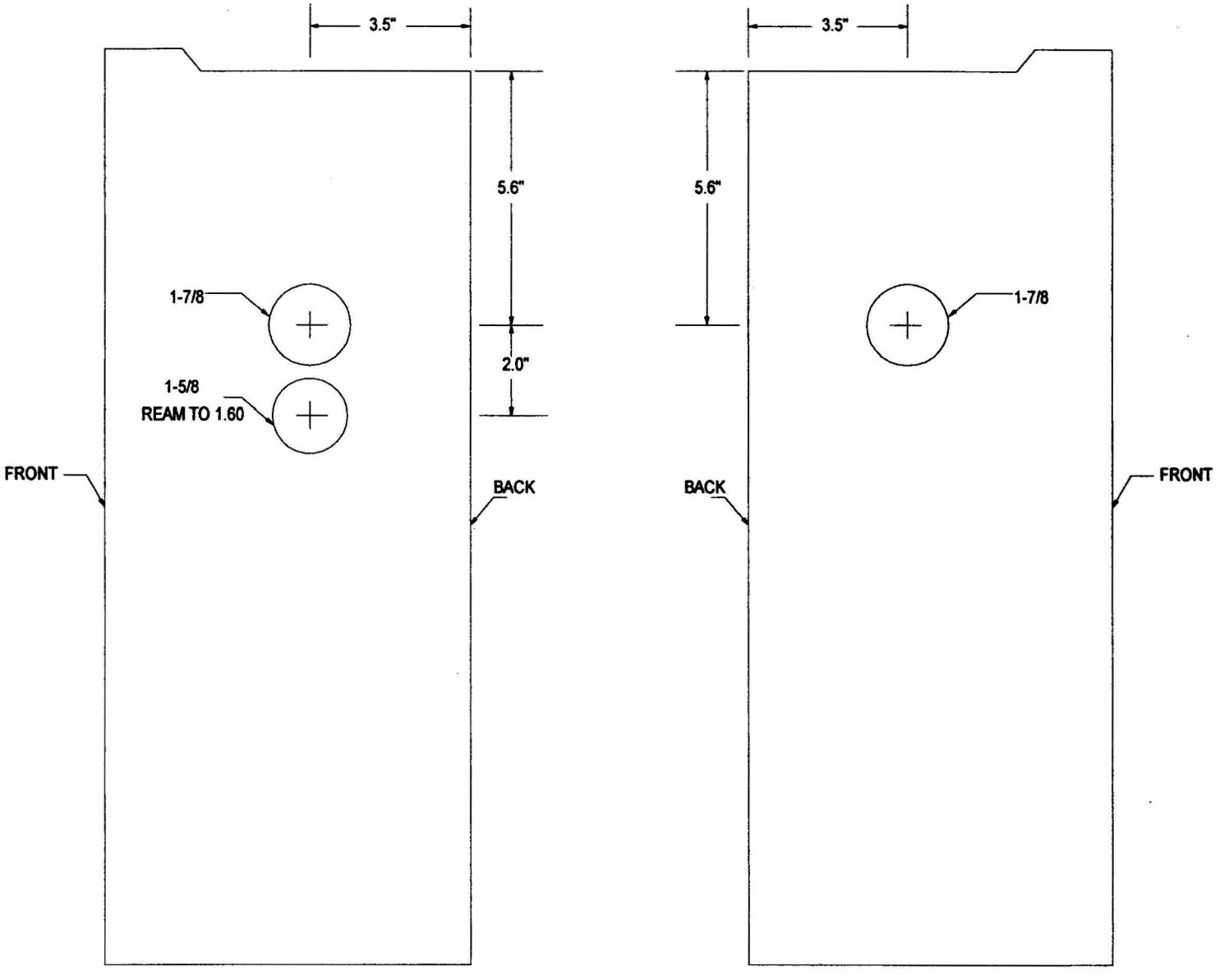
BACK DET/EMITTER

DETAIL

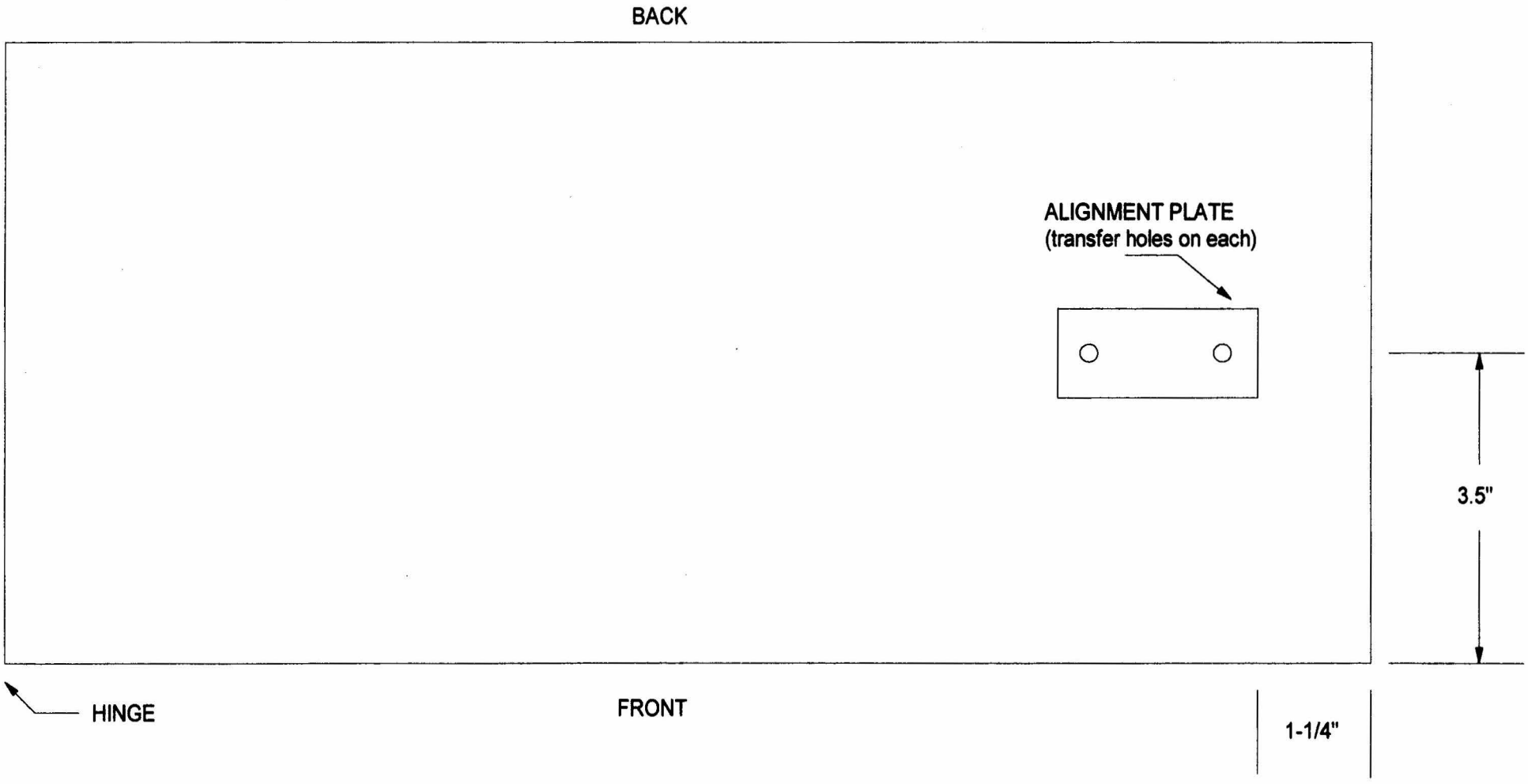



BACK
2.0"
1/2" DIA. (sign module only)
1/2" DIA. (sign module only)
7-13/16
3.5"
2.0"
HINGE
FRONT
3/4"

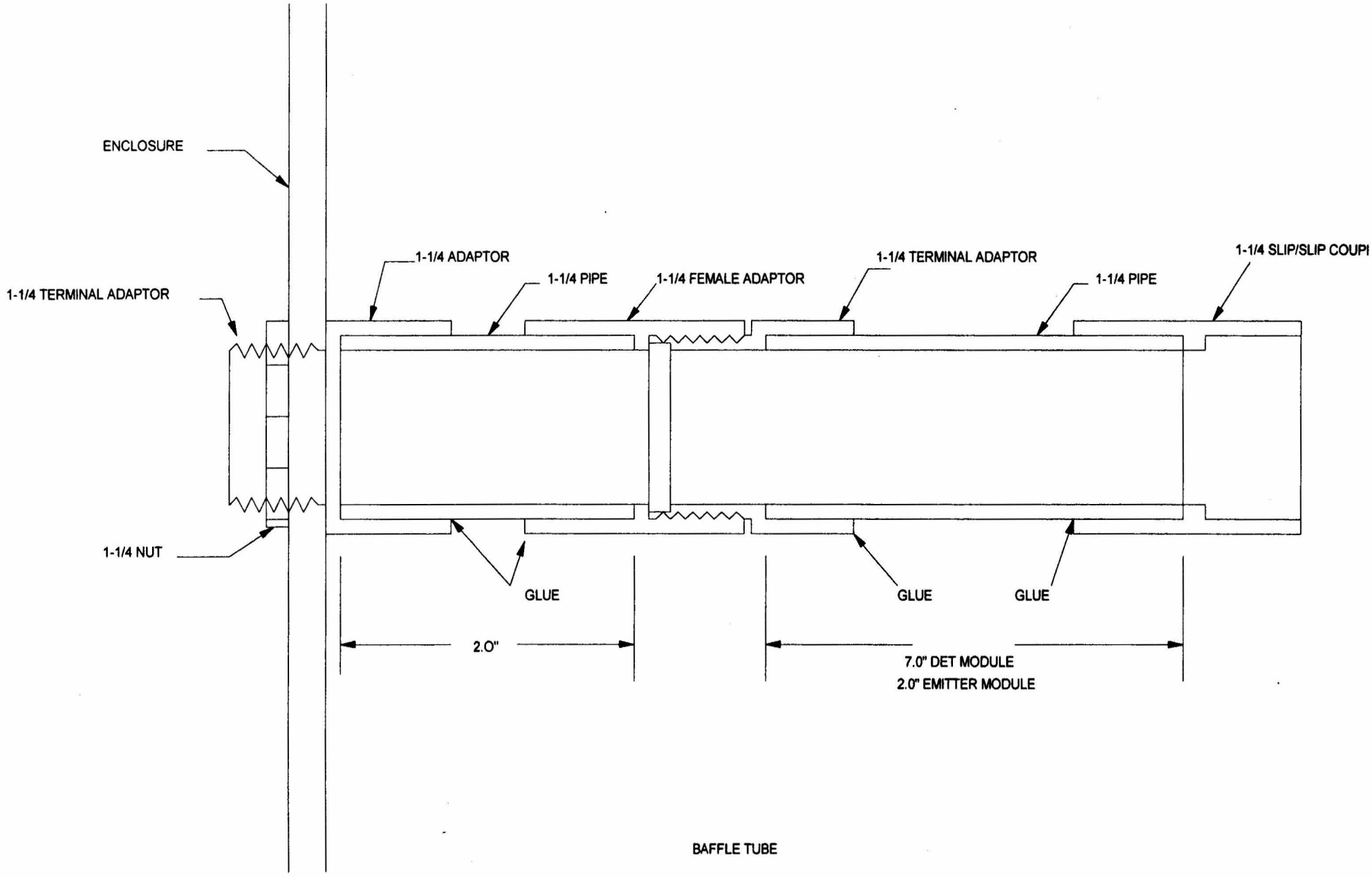
ALL BOTTOM

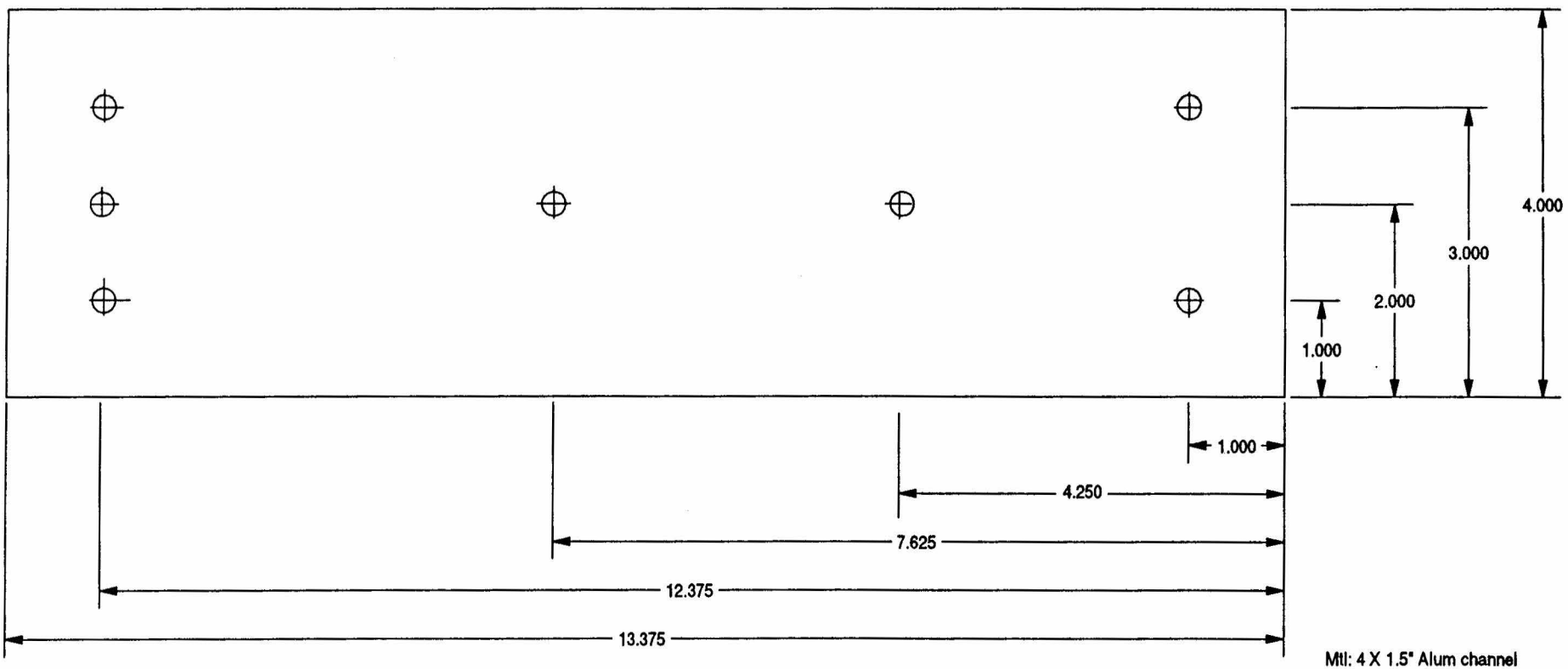


EMITTER AND DETECTOR SIDES



ALIGNMENT PLATE MOUNTING
(emitter & detector modules only)

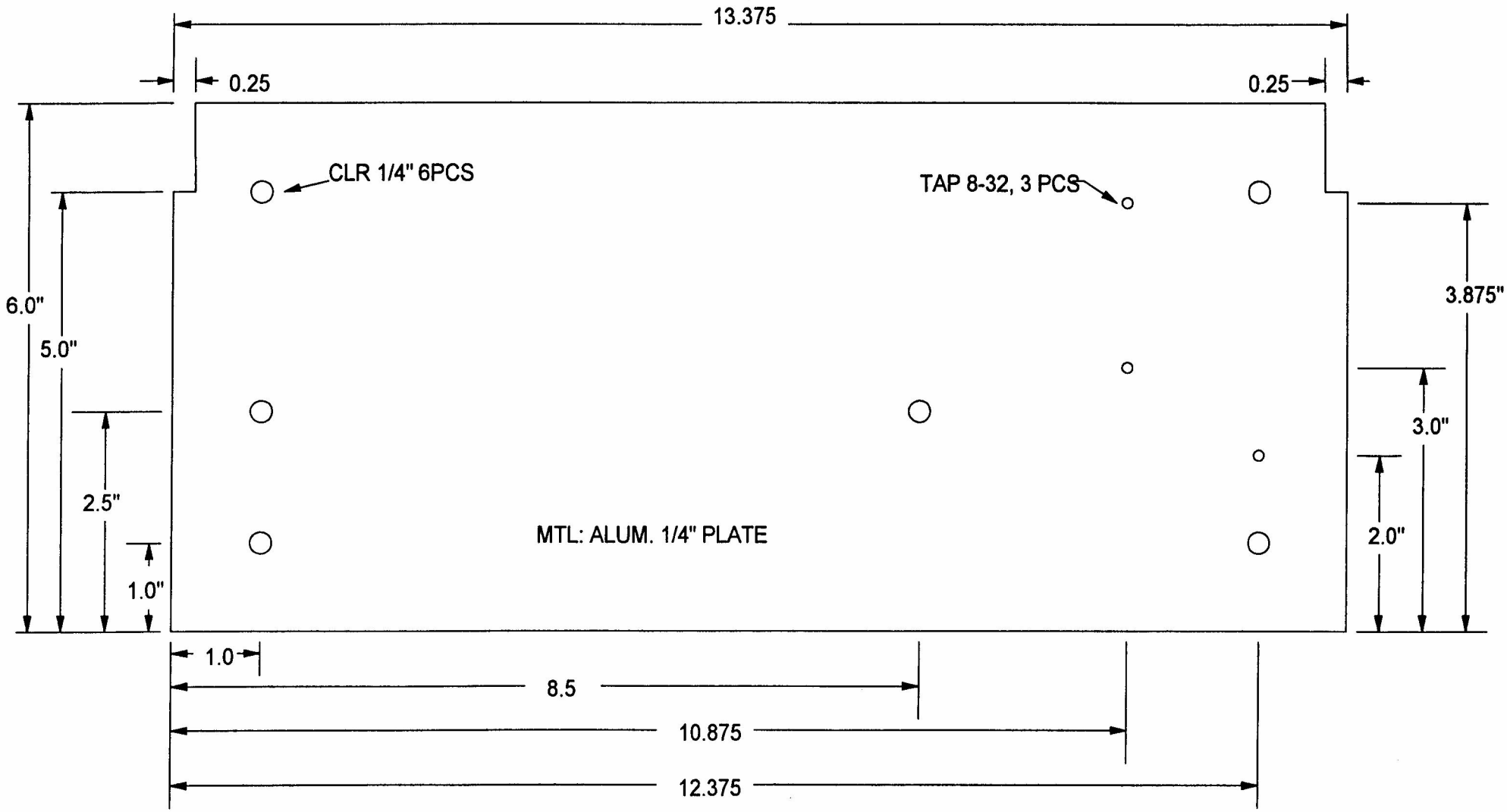

ENCLOSURE
1-1/4 TERMINAL ADAPTOR
1-1/4 NUT
1-1/4 ADAPTOR
1-1/4 PIPE
1-1/4 FEMALE ADAPTOR
1-1/4 TERMINAL ADAPTOR
1-1/4 PIPE
1-1/4 SLIP/SLIP COUPI
GLUE
GLUE
GLUE
2.0"
7.0" DET MODULE
2.0" EMITTER MODULE
BAFFLE TUBE



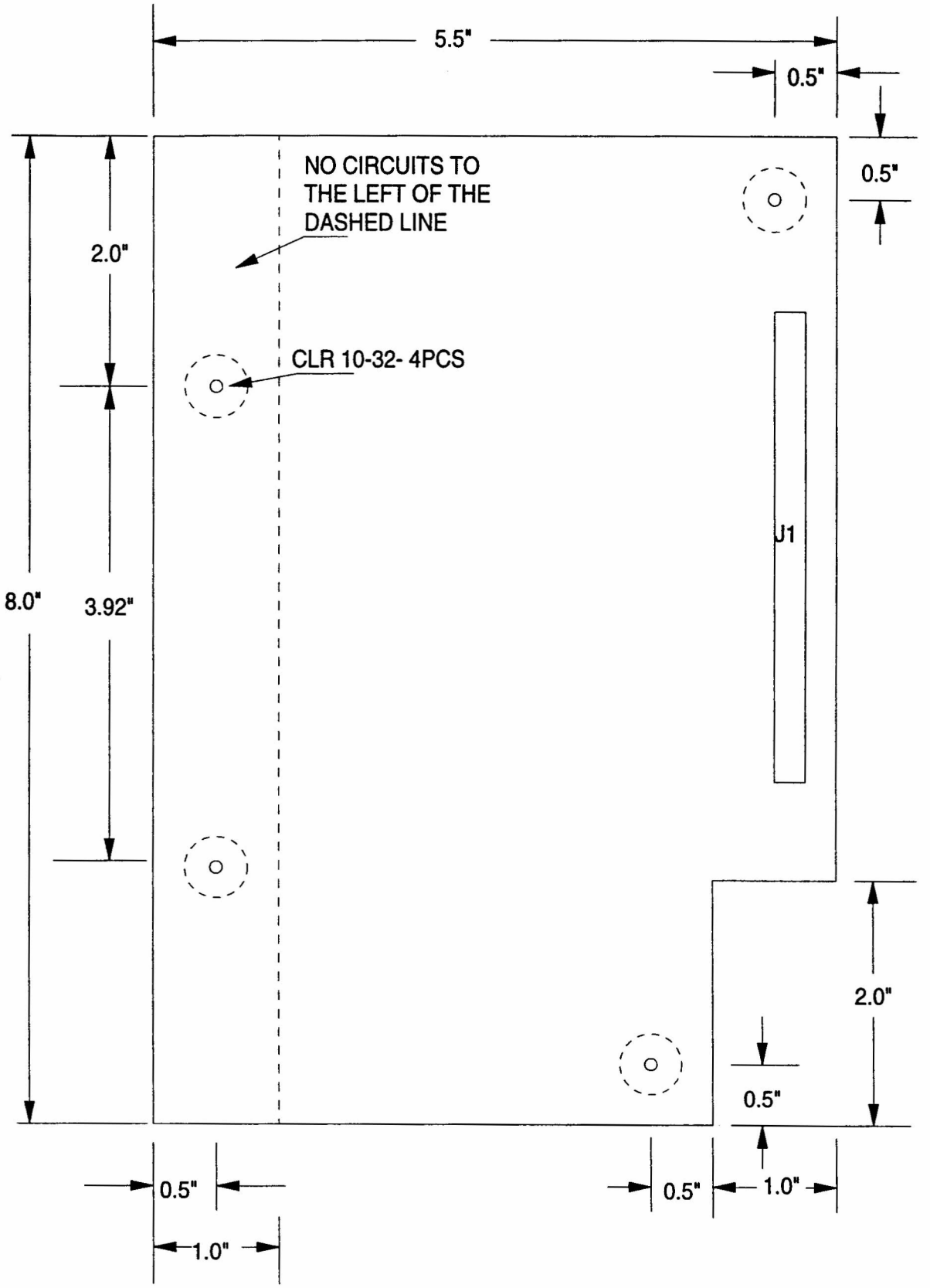
Mtl: 4 X 1.5" Alum channel
drill all holes 17/64" dia.

ACCESSORIES:
4 EA. 1/4 X 20 SPRING NUTS.
5 EA. 1/4 X 20 X 1.0" S.S. MACHINE SCREWS.
4 EA. 1/4 X 20 X 21/4" S.S. MACHINE SCREWS.

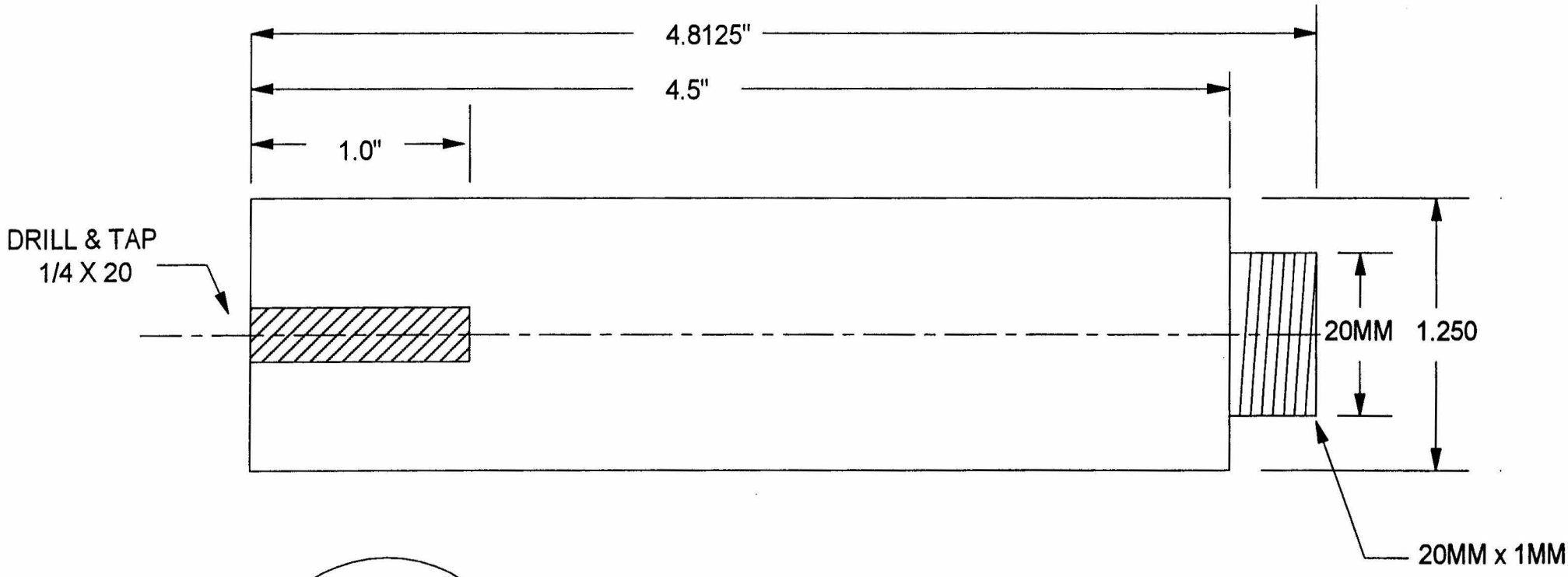
Deer Detector Base Plate
mydocuments\deer det dwgs\baseplate.fcw
11/17/01

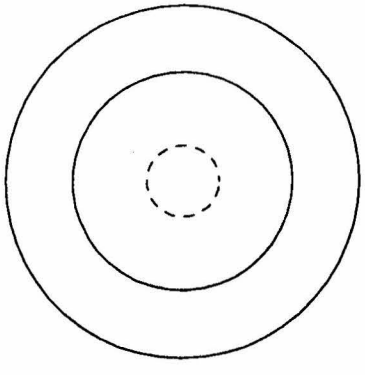


SIGN MODULE BASE PLATE



BATTELLE NORTHWEST
WSDOT AUTOMATED DEER DETECTOR
CIRCUIT BOARD DIMENTIONS





MTL. BRASS

WSDOT DEER DETECTOR
GIMBAL POST
C:fcad32gimbalpost 11/13/01

APPENDIX F.
PARTS LISTS

WSDOT AUTOMATED DEER DETECTOR					
SIGN MODULE PARTS LIST					
ELECTRONIC PARTS					
Designator	**Description**	**Manufacturer**	**Part No.**	**Price ea.**	**Ext. Price.**
BC-1	System battery charger 400mA	Power Sonic	PSC-12800A	$ 36.00	$ 36.00
BC-2	System battery charger 4A	Power Sonic	PSC-124000A	$ 105.00	$ 105.00
B1	Battery, 12Volt, 31AH, Sealed lead acid.	Solar Electric Systems	SES 12SC31	$ 74.00	$ 74.00
LP1	Flashing Lamp Target Tech Inc.	Federal Signal	951	$ 161.00	$ 161.00
FRS	FRS Radio	Radio Shack	21-1804	$ 30.00	$ 30.00
SP	Solar Panel.	Not specified			
R/C	Regulator/controller.	Not specified			
TB-1	Barrier Terminal Block, 6-position.	Cinch	Newark	Estimate	$ 1.50
SR-1,SR-2	Strain Relief.	Hubbell	PG-9, Newark 91F2308	$ 1.79	$ 1.79
CB	Circuit Board.	See drawing.		Estimate	$ 25.00
FH	Fuse Holder		Newark	Estimate	$ 1.50
F1	Fuse 7.5A		Local Purchase	Estimate	$ 1.00
SSR	Solid State Relay	Cydon, D1D07	DigiKey CC1036ND	$ 44.34	$ 44.34
Cable	14ga. Three wire outdoor, 75'		Local Purchase	Estimate	$ 30.00
CIRCUIT BOARD COMPONENTS					
Designator	**Description**	**Manufacturer**	**Part No.**	**Price ea.**	**Ext. Price.**
B1,B2,	Ferrite Beads.	Fair-Rite, Newark	2743001112-TR	$ 0.01	$ 0.01
C1,C4,C5,C8, C11,C12,C14	Capacitor, 0.01uF, 50V, Ceramic X7R.	Kemet, Newark	C315C103K5R5CA	$ 0.01	$ 0.09
C2,C3,C6,C15	Capacitor, 10uF, 25V, Tantalum.	Kemet, Newark	T352E106K0215AS	$ 0.06	$ 0.54
C7,C9	Capacitor, 0.68uF, 50V,Ceramic X7R.	Kemet, Newark	C330C684K5R5CA	$ 0.94	$ 1.88
C10,C13	Capacitor, 0.1uF, 100V, Ceramic, COG	Kemet, Newark	C350C104J1G5CA	$ 4.23	$ 8.46
J1	Terminal Block, 8 position	Radio Shack	276-1388A	$ 2.29	$ 2.29
J2,J3	RCA, Phone Jack	Radio Shack	Estimate	$ 1.00	$ 2.00
P1	Potentiometer, ceramet, 10K.	Bourns 3299W	Newark	$ 1.71	$ 1.71
Q1,Q2	Transistor MOFET	Supertex	TN0102N3	Estimate	$ 4.00
R1	Resistor, 121K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R2	Resistor, 82.5K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R3	Resistor, 3.32K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R4	Resistor, 499, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R5	Resistor, 82.5K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R6	Resistor, 27.4K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R7,	Resistor, 49.9, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03

R8	Resistor, 150K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R9	Resistor, 90.9K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R10,R12	Resistor, 49.9K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.06
R11	Resistor, 22ohm, carbon film 5%		Newark	$ 0.01	$ 0.01
R13	Resistor, 2.2K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R14	Resistor, 10K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R15,R16	Resistor, 100K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.06
R17	Resistor, 499, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
U1,U5	Regulator, LT1129CT	DigiKey	LT1129CT-ND	$ 4.00	$ 4.00
U2,	Dual Amplifier LT 1013CN8	DigiKey	LT1013CN8-ND	$ 7.33	$ 7.33
U3	CD4047BE	DigiKey	296-2053-ND	$ 1.02	$ 1.02
U4	CD4536BE	DigiKey	296-3534-5-ND	$ 1.60	$ 1.60
U5	CD4011BE	DigiKey	296-2031-5-ND	$ 1.60	$ 1.60
		MECHANICAL PARTS			
Designator	**Description**	**Manufacturer**	**Part No.**	**Price ea.**	**Ext. Price.**
Enclosure	ULTRX, Type 4X, Fiberglass.	Hoffman	U-U504020	$ 225.00	$ 225.00
	Key Lock Kit	Hoffman	U-UHKL	$ 32.95	$ 32.95
	Insert Kit	Hoffman	U-UMH2	$ 15.26	$ 15.26
Air Screen	Snap-In Vent Plug	VPMP	Newark 95N3644	Estimate	$ 1.00
Optical Bench	Shop made	See Drawing			
Spring Nuts	4 ea, ¼ x 20	Assortment	Local Purchase	Estimate	$ 2.50
S.S. Bolts	S.S. 1/4 X 20	Assortment	Local Purchase	Estimate	$ 1.00
Washer, Flat	S.S. 1/4"	Assortment	Local Purchase	Estimate	$ 1.00
Washer, Lock	S.S. 1/4", Lock	Assortment	Local Purchase	Estimate	$ 1.00
Nuts	S.S. 1/4 X 20	Assortment	Local Purchase	Estimate	$ 0.20

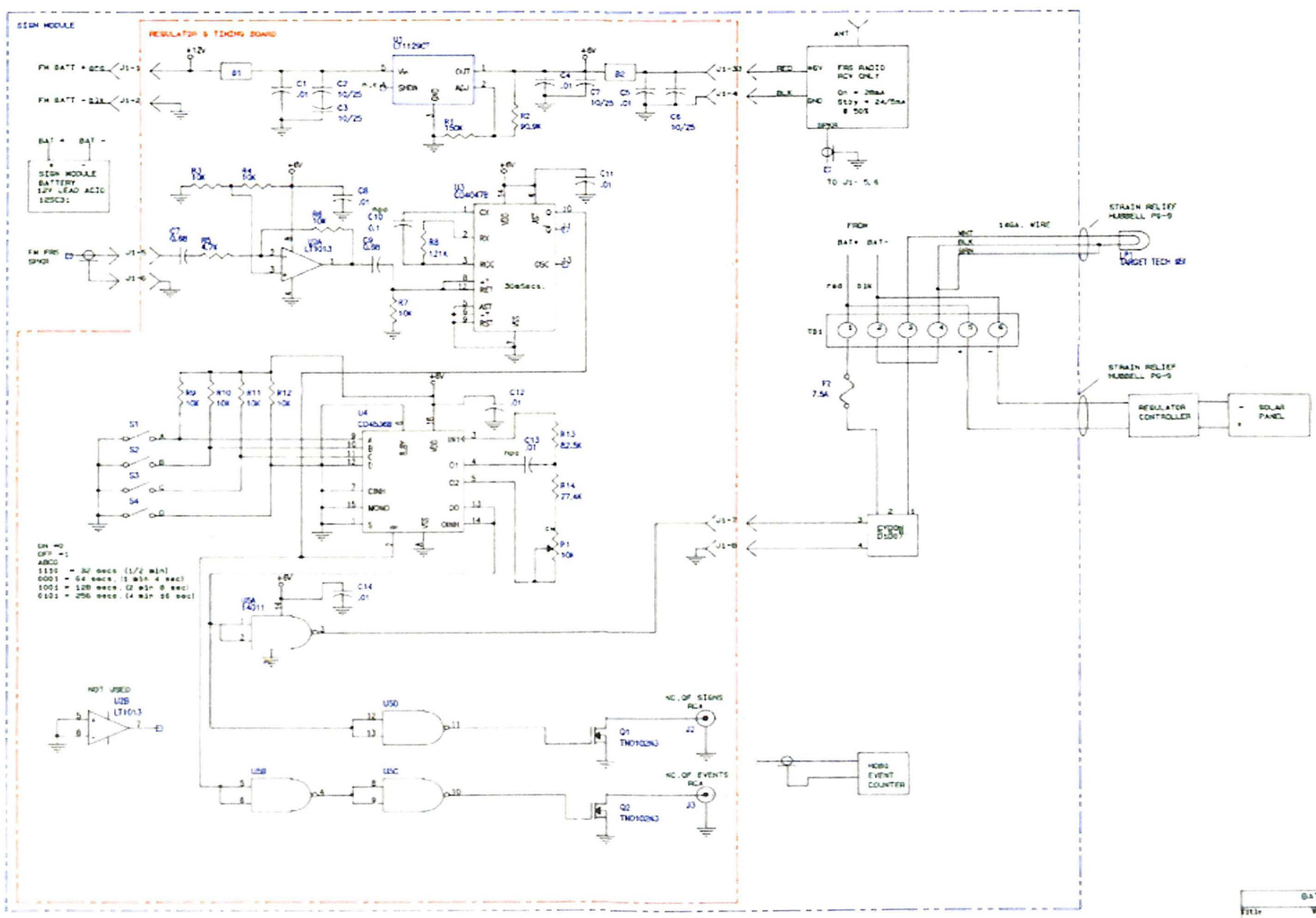
WSDOT AUTOMATED DEER DETECTOR					
EMITTER MODULE PARTS LIST					
ELECTRONIC PARTS					
Designator	**Description**	**Manufacturer**	**Part No.**	**Price ea.**	**Ext. Price.**
B1	Battery, 12Volt, 10AH, gell, cell.	Power-Sonic	PS12100	$ 41.50	$ 41.50
L1	Laser Emitter Assembly.	ADC	Skorpion SLB1000001A	$ 1,309.00	$ 1,309.00
FRS	FRS Radio.	Audiovox	1438	$ 30.00	$ 30.00
SP	Solar Panel.	Not specified			
R/C	Regulator/controller	Not specified			
TB-1	Barrier Terminal Block.	Cinch 4-140	Newark 28F2308	$ 1.39	$ 1.39
SR-1	Strain Relief.	Hubbell PG-9	Newark 91F2308	$ 1.79	$ 1.79
CB	Circuit Board.	See drawing.	Estimated cost	$ 25.00	$ 25.00
CIRCUIT BOARD COMPONENTS					
Designator	**Description**	**Manufacturer**	**Part No.**	**Price ea.**	**Ext. Price.**
B1,B2,B3	Ferrite Beads.	Fair-Rite	2743001112-TR	$ 0.05	$ 0.15
C1,C4,C8,C10,C12,C13,C14,C15	Capacitor, 0.01uF, 50V, Ceramic X7R.	Kemet, Newark	C315C103R5CA	$ 0.01	$ 0.08
C2,C3,C5,C6,C7,C9,C11	Capacitor, 10uF, 25V, Tantalum.	Kemet, Newark	T352E106K0215AS	$ 0.06	$ 0.42
D1	LED, RED	HLMPC	Newark	$ 0.47	$ 0.47
D2	LED, GRN	HLMPC	Newark	$ 0.47	$ 0.47
J1	Terminal Block, 8 position	Radio Shack	276-1388A	$ 2.29	$ 2.29
P1	Potentiometer, ceramet, 10K	Bourns 3299W	Newark 01F8320	$ 1.71	$ 1.71
R1	Resistor, 121K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R2	Resistor, 82.5K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R3	Resistor, 3.32K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R4	Resistor, 47K carbon 5%	RN55D	Newark	$ 0.03	$ 0.03
R5	Resistor, 90.0K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R6	Resistor, 150K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R7	Resistor, 1K, carbon 5%.	RN55D	Newark	$ 0.03	$ 0.03
R9	Resistor, 1K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R8,,R11.R13	Resistor, 10K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.09
R10,R12	Resistor, 20K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.06

R13	Resistor, 33.2K, metal film 1%	RN55D	Newark	$ 0.03	$ 0.03
R15,R14	Resistor, 2.2K,carbon 5%	RN55D	Newark	$ 0.03	$ 0.06
S1	Switch Pushbutton S.P.S.T.	EG1315-ND	DigiKey	$ 2.02	$ 2.02
U1,U2.	Regulator, LT1129CT	LT1129CT-ND	DigiKey	$ 4.00	$ 4.00
U3	Quad, Amplifier LT1014CN	LT1014CN-ND	DigiKey	$ 9.38	$ 9.38
		MECHANICAL PARTS			
Designator	**Description**	**Manufacturer**	**Part No.**	**Price ea.**	**Ext. Price.**
Enclosure	ULTRX, Type 4X, Fiberglass.	Hoffman	U-U504020	$ 225.00	$ 225.00
	Key Lock Kit	Hoffman	U-UHKL	$ 32.95	$ 32.95
	Insert Kit	Hoffman	U-UMH2	$ 15.26	$ 15.26
X, Y Gimbal	Slow motion adaptor.	Orion Telescope	7033	$ 32.95	$ 32.95
Scope mount	Scope mount	ADC Inc.	mount	$ 35.00	$ 35.00
Glass Window	40mm, uncoated.	Edmund Ind. Optics	B270	$ 30.20	$ 30.20
Air Screen	Snap-In Vent Plug	VPMP	Newark 95N3644		
Gimbal Post	Shop made	Dwg. No.		$ 94.00	$ 94.00
Optical Bench	Shop made	Dwg. No.			
Spring Nuts	4 ea, ¼ x 20	Local Purchase		$ 0.98	$ 3.98
Test Pipe Plugs	2 ea. 1-½"	Local Purchase		$ 1.00	$ 2.00
PVC Electrical Fittings	2 ea.1-1/4 Terminal Adaptors		Local Purchase	$ 1.20	$ 2.40
PVC Electrical Fittings	1 ea. 1-¼ Female Adaptors		Local Purchase	$ 1.20	$ 1.20
PVC Electrical Fittings	1 ea. 1-¼ Slip/Slip Coupler		Local Purchase	$ 1.20	$ 1.20
PVC Electrical Fittings	12" 1-¼ pipe		Local Purchase	$ 1.00	$ 1.00
Battery posts and strap	Shop made	See Drawing			
Bolts	S.S. 1/4 X 20	Assortment	Local Purchase	Estimate	$ 2.50
Washers	S.S. 1/4 flat	Assortment	Local Purchase	Estimate	$ 1.00
Washer	S.S. 1/4" lock	Assortment	Local Purchase	Estimate	$ 1.00
Nuts	S.S. 1/4 X 20	Assortment	Local Purchase	Estimate	$ 1.00
Brass Screw	Flat head 6 X 32	4 ea.	Local Purchase	Estimate	$ 0.20

WSDOT AUTOMATED DEER DETECTOR					
DETECTOR MODULE PARTS LIST					
ELECTRONIC PARTS					
Designator	**Description**	**Manufacturer**	**Part No.**	**Price ea.**	**Ext. Price.**
B1	Battery, 12Volt, 10AH, gell, cell.	Power-Sonic	PS12100	$ 41.50	$ 41.50
L1	Detector Assembly.	ADC Inc.	Skorpion SLB100D001A	$ 1,096.00	$ 1,096.00
FRS	FRS Radio.	Radio Shack	21-1804	$ 30.00	$ 30.00
SP	Solar Panel.	Not specified			
R/C	Regulator/controller.	Not specified			
TB-1	Barrier Terminal Block, 4-position.	Cinch 4-140, Newark 28F2308		$ 1.39	$ 1.39
SR-1	Strain Relief.	Hubbell	PG-9, Newark 91F2308	$ 1.79	$ 1.79
CB	Circuit Board.	See drawing.	Estimated Cost	$ 25.00	$ 25.00
CIRCUIT BOARD COMPONENTS					
Designator	**Description**	**Manufacturer**	**Part No.**	**Price ea.**	**Ext. Price.**
B1,B2,	Ferrite Beads.	Fair-Rite, Newark	2743001112-TR	$ 0.01	$ 0.02
C1,C4,C7,C8,C9,C11,C14 ,C18,C19	Capacitor, 0.01uF, 50V, Ceramic X7R.	Kemet Newark	C315C103K5R5CA	$ 0.01	$ 0.09
C2,C3,C5,C12,C13, C15,C17,C20,C21	Capacitor, 10uF, 25V,Tantalum.	Kemet, Newark	T352E106K021AS	$ 0.06	$ 0.54
C6,C10,C16	Capacitor, 0.01uF, 200V,Ceramic, COG	Kemet, Newark	C330C103J2G5CA	$ 0.67	$ 2.01
J1	Terminal Block, 8 position	Radio Shack	276-1388A	$ 2.29	$ 2.29
P1	Potentiometer, ceramet, 5K.	Bourns 3299W	Newark 01F8299	$ 1.71	$ 1.71
P2	Potentiometer, ceramet, 1K.	Bourns 3299W	Newark 01F8297	$ 1.71	$ 1.71
R1	Resistor, 121K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R2	Resistor, 82.5K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R3	Resistor, 3.32K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R4	Resistor, 499, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R5	Resistor, 82.5K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R6	Resistor, 27.4K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R7,	Resistor, 49.9, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R8	Resistor, 150K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R9	Resistor, 90.9K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R10,R12	Resistor, 49.9K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.06
R11	Resistor, 22ohm, carbon film 5%	RN55D	Newark	$ 0.03	$ 0.03
R13	Resistor, 2.2K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R14	Resistor, 10K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
R15,R16	Resistor, 100K, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.06
R17	Resistor, 499, metal film, 1%.	RN55D	Newark	$ 0.03	$ 0.03
U1,U5	Regulator, LT1129CT	DigiKey	LT1129CT-ND	$ 4.00	$ 8.00
U2,U6	CD4047BE	DigiKey	296-2053-ND	$ 1.02	$ 2.04
U3	CD4011BE	DigiKey	296-2031-5-ND	$ 1.60	$ 1.60
U4	CD4536BE	DigikKey	296-3534-5-ND	$ 1.60	$ 1.60

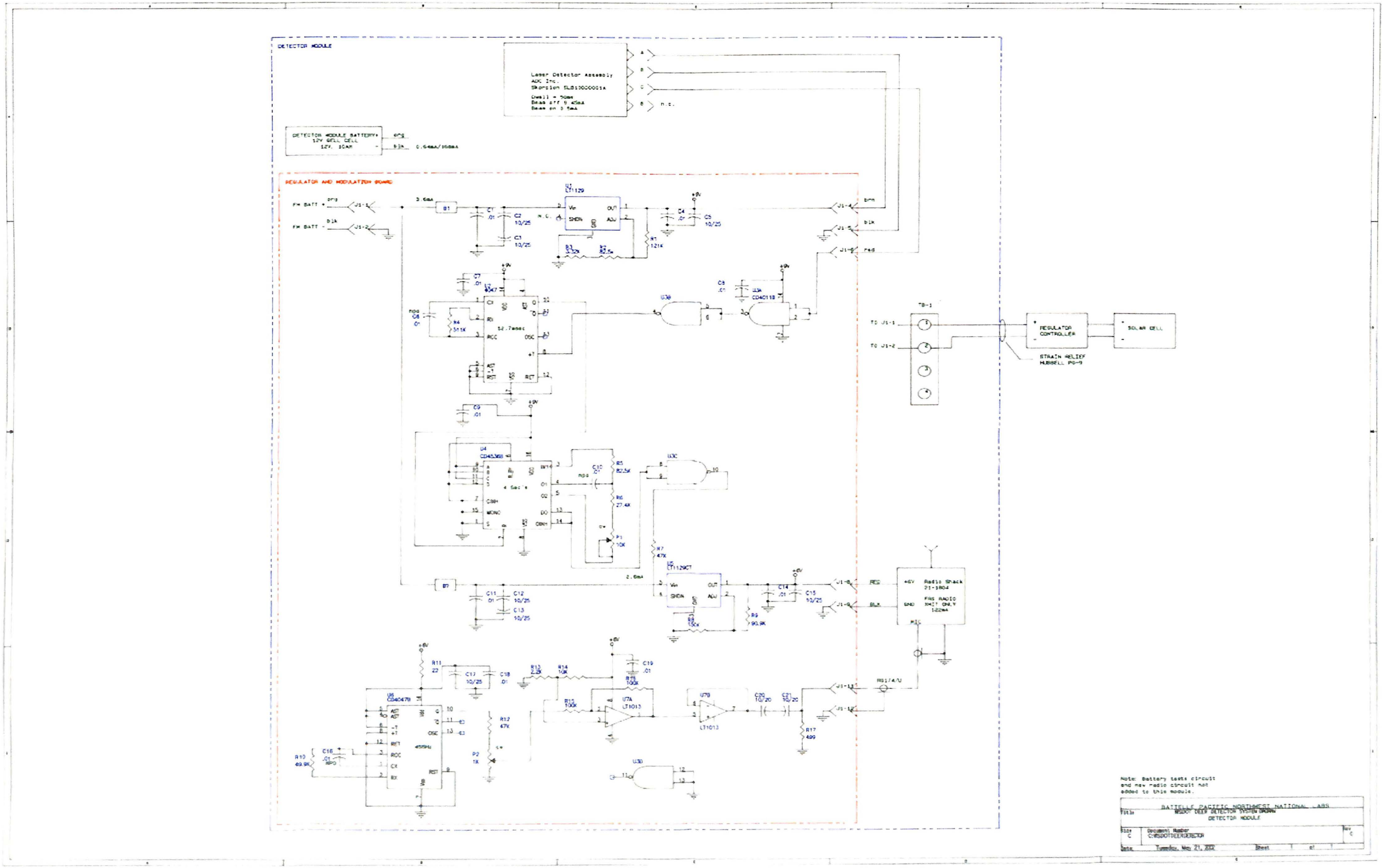
U7	LT1013, Dual amplifier	DigiKey	LT1013CN8-ND	$ 7.13	$ 7.13
		MECHANICAL PARTS			
Designator.	**Description**	**Manufacturer**	**Part No.**	**Price ea.**	**Ext. Price.**
Enclosure	ULTRX, Type 4X,	Hoffman	U-U504020	$ 225.00	$ 225.00
	Key Lock Kit	Hoffman	U-UHKL	$ 32.95	$ 32.95
	Insert Kit	Hoffman	U-UMH2	$ 15.26	$ 15.26
Glass Window	40mm, uncoated	Edmund Ind. Optics	B270	$ 30.20	$ 30.20
X, Y Gimbal	Slow motion adaptor.	Orion Telescope Inc.	7033	$ 32.95	$ 32.95
Scope mount	Scope mount	ADC Inc.	Mount	$ 35.00	$ 35.00
Air Screen	Snap-In Vent Plug	VPMP	Newark 95N3644		
Gimbal Post	Shop made	See drawing	Local purchase	$ 94.00	$ 94.00
Optical Bench	Shop made	See drawing			
Spring Nuts	4 ea, ¼ x 20		Local purchase	$ 0.98	$ 3.98
Test Pipe Plugs	2 ea. 1-½"		Local purchase	$ 1.00	$ 2.00
PVC Electrical Fittings	2 ea. 1-1/4" Terminal Adaptors		Local purchase	$ 1.20	$ 2.40
PVC Electrical Fittings	1 ea. 1-¼ Female Adaptors		Local purchase	$ 1.20	$ 1.20
PVC Electrical Fittings	1 ea. 1-¼ Slip/Slip Coupler		Local purchase	$ 1.20	$ 1.20
PVC Electrical Fittings	12" 1-¼ pipe		Local purchase	$ 1.00	$ 1.00
Battery posts and strap	Shop made	See Drawing			
Bolts	S.S. 1/4 X 20	Assortment	Local purchase	Estimate	$ 2.50
Washer, Flat, ¼"	S.S. 1/4" Flat	Assortment	Local purchase	Estimate	$ 1.00
Washer, Lock	S.S. Lock	Assortment	Local purchase	Estimate	$ 1.00
Nuts	S.S. 1/4" X 20	Assortment	Local purchase	Estimate	$ 1.00
Screws, Brass	Flat Head 6 X 32	4 ea.	Local purchase	Estimate	$ 0.20
Nuts	S.S. 1/4 X 20	Asortment	Local purchase	Estimate	$ 1.00

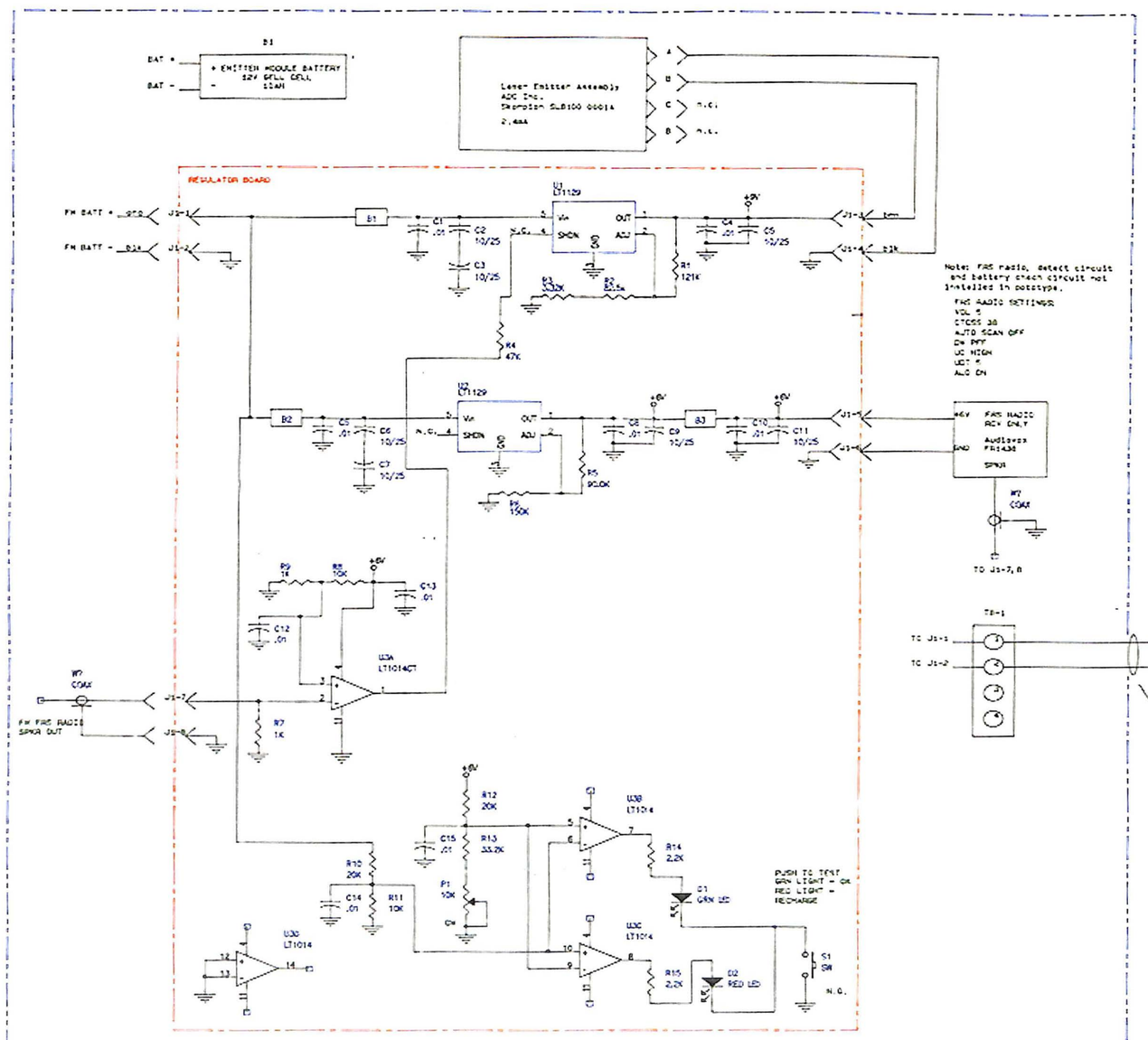
APPENDIX G.
SCHEMATIC DRAWINGS: SIGN MODULE, DETECTOR MODULE, AND EMITTER MODULE



BATTELLE PACIFIC NORTHWEST NATIONAL LABS

Title	WSDOT DEER DETECTOR SYSTEM DRAWN SIGN MODULE
Size C	Document Number C:\WSDOT\DEER\DETECTOR_SIGN MODULE
Rev 0	
Date	Tuesday, April 02, 2002
Sheet	1 of 1


DETECTOR MODULE
Laser Detector Assembly
DETECTOR MODULE BATTERY
12V GELL CELL
REGULATOR AND MODULATION BOARD
LT1129
CD4047
52.7msec
CD45368
4 Sec/s
CD4011B
LT1129CT
CD4047B
LT1013
TB-1
TO J1-1
TO J1-2
REGULATOR CONTROLLER
SOLAR CELL
STRAIN RELIEF
HUBBELL PG-9
Radio Shack
21-1804
FRS RADIO
MIC
RG174/U
Note: Battery tests circuit
and new radio circuit not
added to this module.
BATTELLE PACIFIC NORTHWEST NATIONAL LABS
Title
DETECTOR MODULE
Size
C
Document Number
Rev
C
Date
Sheet
1
of
1



BATTELLE PACIFIC NORTHWEST NATIONAL LABS

Title	REDOT DEER DETECTOR SYSTEM DRAWI EMITTER MODULE	
Size C	Document Number C:\REDOT\DEERDETECTOR\EMITTER MODULE	Rev 0
Date: Tuesday, May 21, 2002	Sheet 1 of 1	