

**OPERATION & MAINTENANCE  
MANUAL**

**REPLACE WELLS 609, 649, 706  
MCB CAMP LEJEUNE**

**CONTRACT # N62470-99-C-4142**

**SECTION 16900**

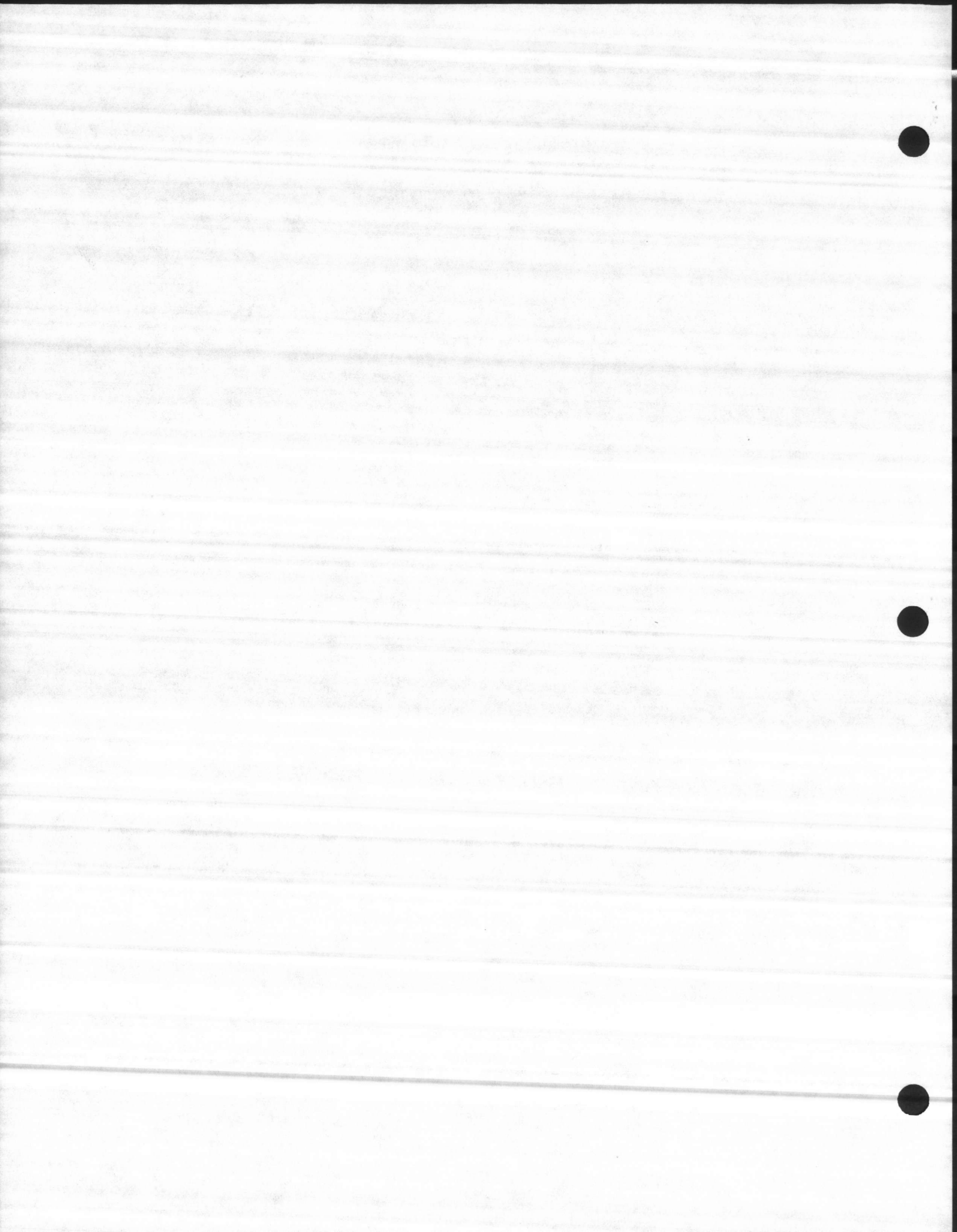
**RAW WATER WELL TELEMETRY AND  
MONITORING SYTEM**

**General Contractor**

**A.C. Schultes of Maryland, Inc.**

**4732 Hwy 258 S**

**Kinston, NC 28504**

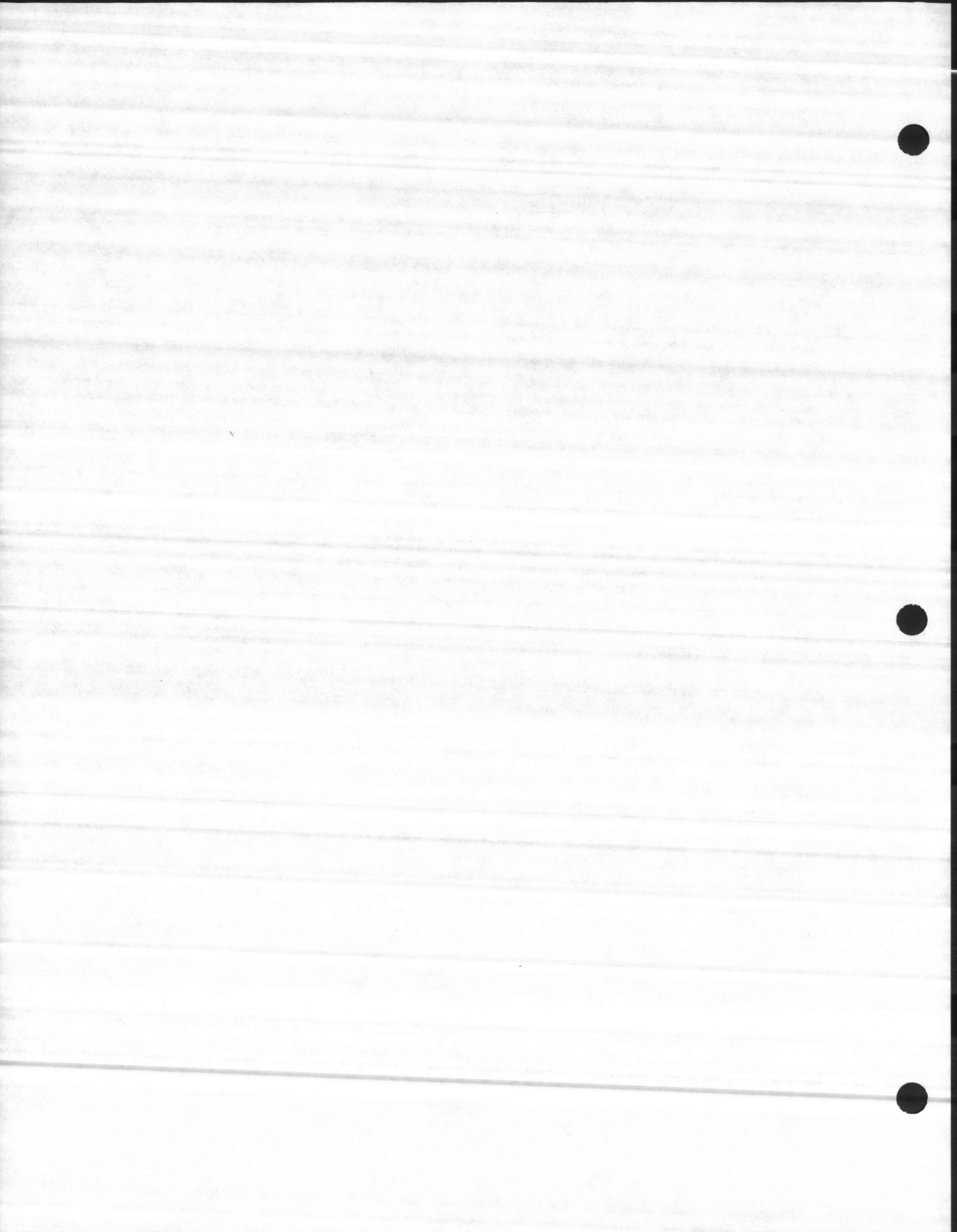


# **RAW WATER WELL TELEMETRY AND MONITORING SYSTEM**

## **SECTION 16900**

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1. Contractor Information
2. Safety Rules
3. Warranty
4. Manual



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# Notes

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## GENERAL CONTRACTOR

**Company Name:** A.C. Schultes of Maryland, Inc.

**Mailing Address:** 4732 Hwy 258 S

**Street Address:** 4732 Hwy 258 S

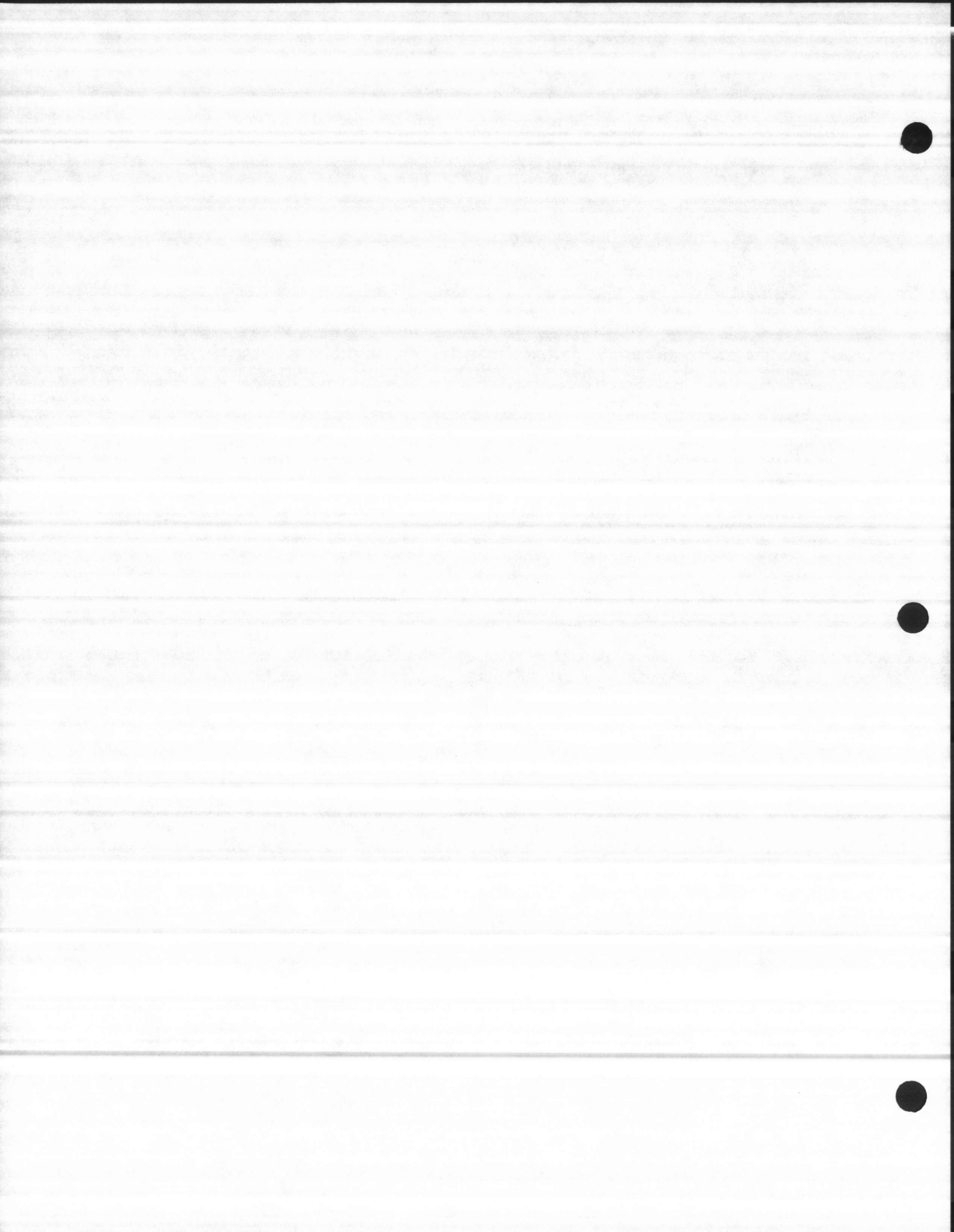
**City, State, Zip:** Kinston, North Carolina, 28504

**Phone Number:** 252-520-6651

**Fax Number:** 252-520-6652

**Primary Contact:** John T. O'Brien





## CONTRACTOR'S INFORMATION

**Company Name:** Process Control Services, Ltd.

**Mailing Address:** P.O. Box 98

**Street Address:** 2200 Seaford Road

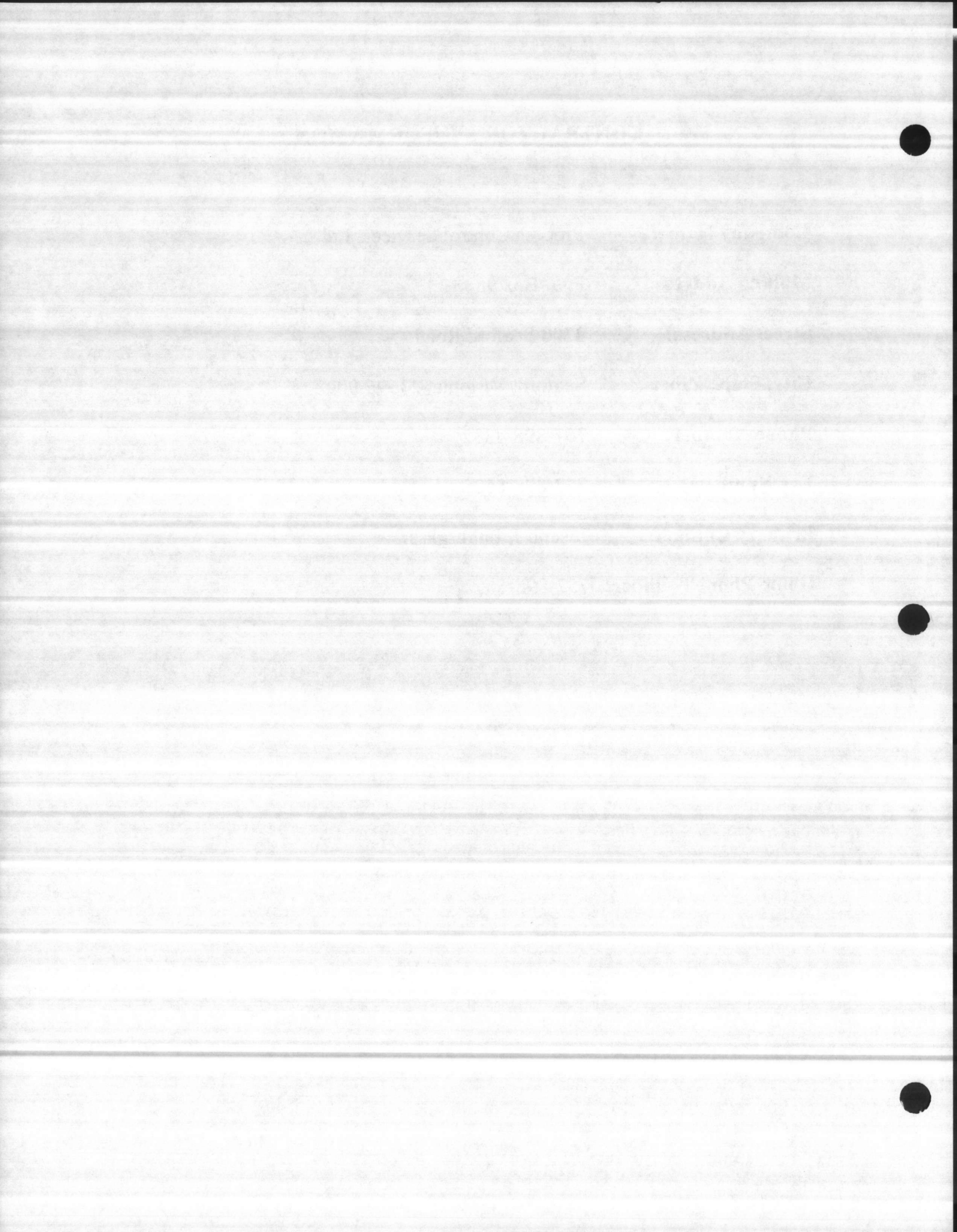
**City, State, Zip:** Seaford, Virginia, 23696-0098

**Phone Number:** 757-898-4332

**Fax Number:** 757-898-8625

**Primary Contact:** Joseph J. Imburgia Jr.

**Home Phone Number:** 757-898-6652



## VENDOR'S INFORMATION

**Company Name:** J.M. Process (Aquatrol Equipment)

**Mailing Address:** 15507 South 70<sup>th</sup> Court

**Street Address:** 15507 South 70<sup>th</sup> Court

**City, State, Zip:** Orland Park, Illinois, 60462

**Phone Number:** (708) 429-4530

**Fax Number:** (708) 429-3092

**Primary Contact:** Jim McDermott



## VENDOR'S INFORMATION

**Company Name:** International Power (Power Supply)

**Mailing Address:** 360 Bernoulli Circle

**Street Address:** 360 Bernoulli Circle

**City, State, Zip:** Oxnard, CA. 93030-5167

**Phone Number:** (805) 981-1188

**Fax Number:** (805) 981-1184

**Primary Contact:** Customer Service



## VENDOR'S INFORMATION

**Company Name:** Motorola Communications and Electronics Inc. (Radio)

**Mailing Address:** 1301 East Algonquin Road

**Street Address:** 1301 East Algonquin Road

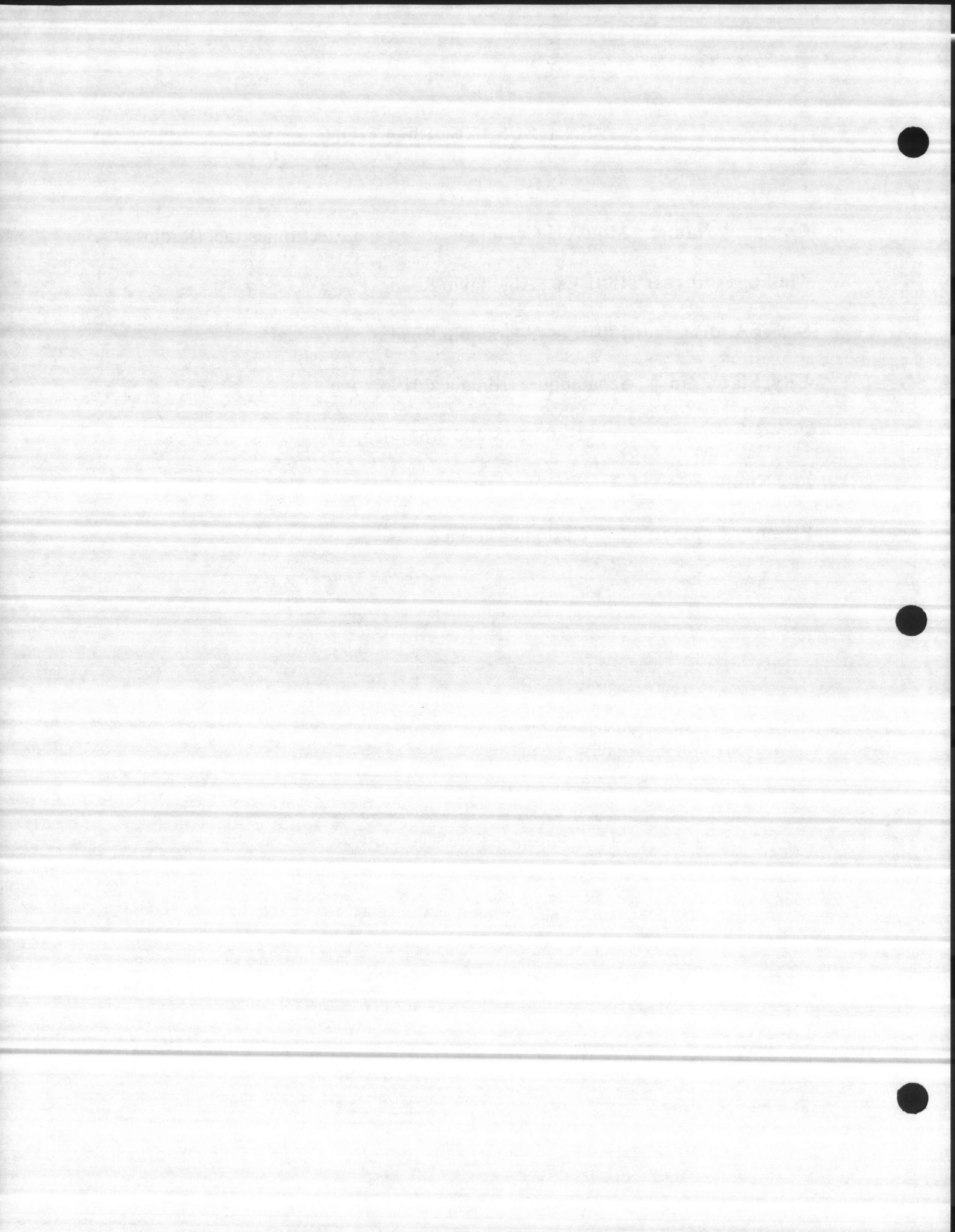
**City, State, Zip:** Schaumburg, Illinois, 60196

**Phone Number:** 1-800-523-4007 (Service)

**Fax Number:**

**Primary Contact:** Customer Service





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## SAFETY

It is the policy of Process Control Services, Ltd., that no work be performed in a manner that is hazardous to personnel or equipment. The majority of accidents are caused by carelessness, fatigue, using improper tools and not following procedures. The majority of injuries are caused by not using sufficient safety precautions. Safety precautions are used to avoid conditions that are unsafe, however they can not replace common sense. Never work in conditions you feel are unsafe.

### Electrical Hazard Information

The amount of voltage you come in contact with is only one of the factors that determine the degree of shock received; voltages as low as 24VAC can cause death. Any device that maintains an electrical potential can cause severe burns.

Those factors that determine your chance of surviving electrical shock are age, size, physical condition, voltage, frequency of current, body resistance, path of current flow and time of current flow.

Your body's reaction to current flow:

1. Current flow between one and six milliamps produces an uncomfortable to painful shock. Injuries and death produced from this level of shock are usually caused by reflex actions.
2. Currents between six and twenty five milliamps can be deadly. The pain becomes intense and the current may prevent you from controlling your muscles. Should this occur you may not be able to release your hand from the current carrying device.
3. Currents between twenty five and fifty milliamps cause your muscles to go into violent contractions resulting in damage to muscles, tendons and in some cases bone structures.
4. Current greater than fifty milliamps can throw your heart rhythm off and stop breathing actions. If the current flow is through the chest area and lasts longer than twenty five milliseconds, there is a good chance that death will occur.



## GENERAL SAFETY RULES

1. Before working on equipment, inspect area and equipment for hazardous conditions. Examples: Wet floor, damaged insulation, frayed wires or improper grounding.
2. Do not wear loose clothing, ties, metal-framed glasses, wristwatches or jewelry when working near energized circuits or rotating machinery.
3. Do not work on equipment when you are mentally or physically tired.
4. Always wear safety glasses when working around power tools or power equipment.
5. Do not work on electrical panels during lightning storms.
6. Become familiar with and use lockout / tag out precautions when working on de-energized equipment.
  - A. Once the breaker is locked or tagged out, verify that power has been disconnected with two separate, reliable sources prior to touching circuits. Note: Multi-phase power sources must be verified between phases as well as from each phase to ground.
  - B. Ensure that all capacitor banks are discharged, even if bleeder resistors are installed.
  - C. Back-feeds or secondary power sources are common within control systems. Check wires that lead to customer terminations; find any secondary sources and use lockout / tag out precautions prior to working on that part of the panel.
7. When possible work with one hand behind your back.
8. When drilling, always know what is behind the surface you are drilling.
9. When energizing motor starters for the first time always close the panel door.
10. Never connect test equipment to high voltage circuits while power is on.
11. Never work on or around electromechanical equipment while under the influence of mind altering drugs.

No guidelines or procedures can take the place of common sense and the need for constant vigilance. Remember that the final responsibility for safety is yours.

**DON'T TAKE UNNECESSARY CHANCES!**





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# Notes

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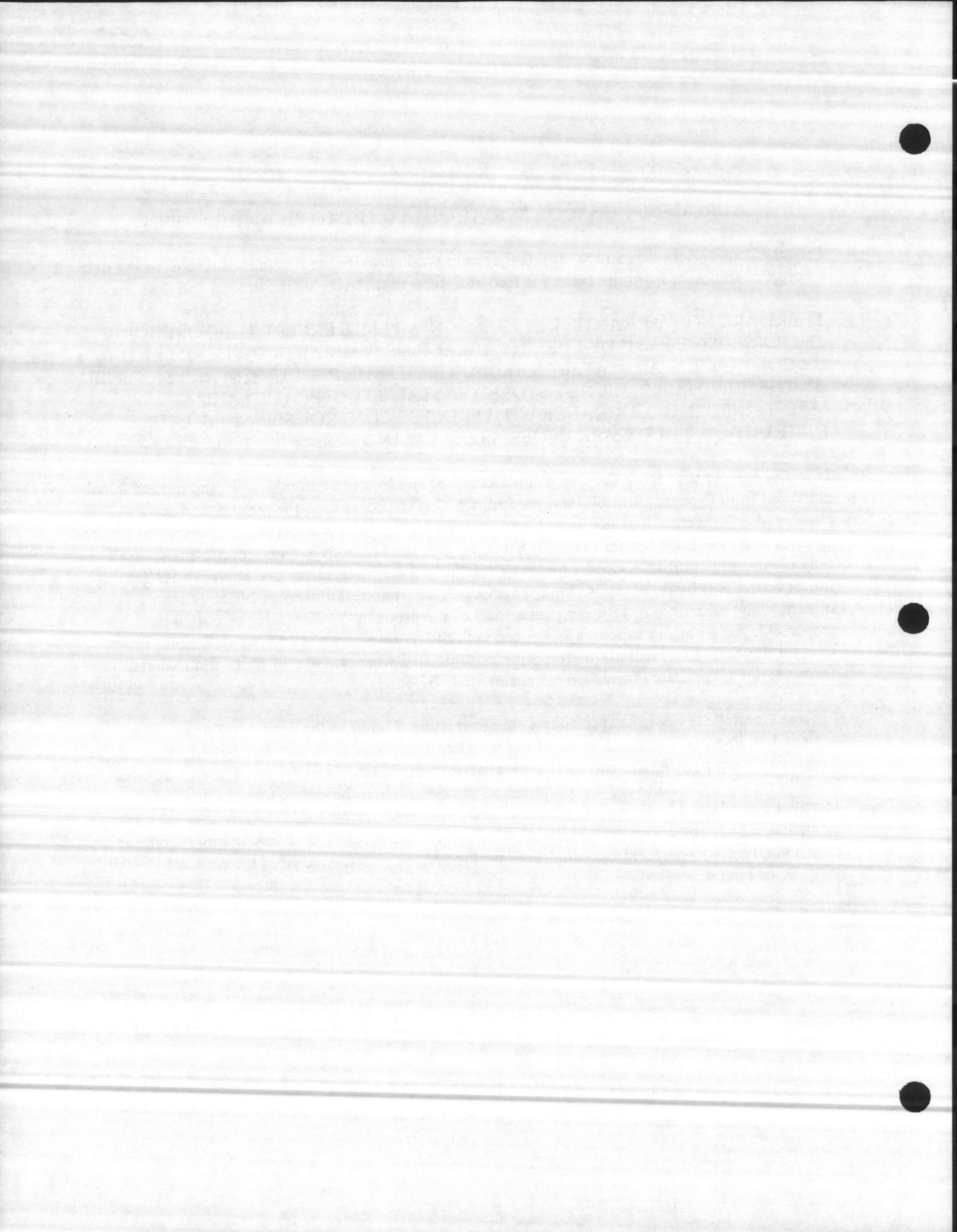
## PROCESS CONTROL SERVICES, LTD., LIMITED WARRANTY

Process Control Services, Ltd. warrants that each product(s) it manufactures and sells on the date of original shipment from the factory is free of defects in material, workmanship and desn.

THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED, EXCEPT THE FOREGOING. THE EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY OR CLAIM IN TORTS OR CONTRACT IS AS STATED HEREINAFTER. IF THE PRODUCT(S) ARE MODIFIED BY THE PURCHASER, OR NOT STORED, INSTALLED, OPERATED AND MAINTAINED IN ACCORDANCE WITH PROCESS CONTROL SERVICES, LTD. INSTRUCTIONS, ALL WARRANTIES ARE NULL AND VOID.

If within one (1) year from the date of installation or eighteen (18) months from the date of initial shipment from Process Control Services, Ltd. whichever occurs first, the purchaser discovers that such product(s) were not as warranted, and promptly returns the product freight prepaid to Process Control Services, Ltd., Process Control Services, Ltd. shall remedy such nonconformance (but only if Process Control Services, Ltd., in its sole judgement, determines that such product(s) were not as warranted) by (at Process Control Services, Ltd. option), adjustment of the purchase price of furnishing, repairing, or replacing, all or part of the product(s). The purchaser shall be responsible for all of the expenses associated with the removal, freight and reinstallation. Process Control Services, Ltd.. will not be responsible for normal wear and tear of parts and materials or for work done, apparatus furnished or repairs made by others.

Process Control Services, Ltd., liability to the Purchaser relating to the product(s) or services provided by Process Control Services, Ltd., whether in contract or in tort, arising out of warranties, representations, instruments, installations, services or defect(s) from any cause, shall be limited exclusively to adjusting the purchase price or correcting the defect(s) and under the conditions as aforesaid. Process Control Services, Ltd. shall not be liable for any special, incidental, indirect or consequential damages of any character resulting in any manner from the furnishing, use, non-performance, improper performance or performance of the products, services, or both described herein.



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## SPECIFICATIONS AND APPLICATIONS OPEN FRAME SERIES

### SERIES DESCRIPTION

The International Power open frame series are a high reliability line of power supplies designed to operate over the wide range of A.C. power sources found worldwide. This feature simplifies your inventory and service consideration by allowing the use of one standard power supply regardless of destination.

These models are designed to meet many domestic and European regulatory agency requirements. If you plan to distribute your products worldwide, obtaining necessary agency approvals can be greatly simplified by specifying the International Power open frame series.

### FEATURES

VDE transformer construction	- Two hour burn-in
100/120/220/230-240VAC input	- Two-year warranty
OVP on 5 volt outputs	- U.L. recognized - File #E84242
± .05% regulation	- CSA Certified - File #LR52143
Remote sense on most outputs	- TUV licenses
Industry standard case size	- Chassis notched for A.C. input
Full rated to 50°C	- Input accepts .110 x .032 fast-on or solder connection
Foldback/current limit	

### SPECIFICATIONS

A.C. INPUT:	100/120/220/230-240 VAC +10% - 13% 47-63 Hz frequency range. See chassis A.C. connection table for jumper and line fusing requirements. Derate output current 10% for 50 Hz operation. Tolerance for 230-240 volt operation is +15% - 10%
D.C. OUTPUT:	Adjustment range ± 5% minimum.
LINE REGULATION:	± .05% for a 10% line change.
LOAD REGULATION:	± .05% for a 50% load change.
TRANSIENT RESPONSE:	Less than 50 μseconds for 50% load change.
OUTPUT RIPPLE:	5 volt to 15 volt units: 5.0mV PK-PK maximum. 24 Volt to 250 volt units: .02% PK-PK maximum.
SHORT CIRCUIT AND OVERLOAD PROTECTION:	Automatic current limit/foldback.
OVERVOLTAGE PROTECTION:	Built-in on all 5 volt outputs. Set at 6.2± .4 volts. Other outputs use overvoltage protection modules.
REMOTE SENSING:	Provided on most models. Open sense lead protection built in on most models.
EFFICIENCY (TYPICAL):	5 volt unit: 45%. 12 and 15 volt units: 55%. 24 through 250 volt units: 60%.
STABILITY:	± .3% for 24-hour period after 1 hour warm up.
TEMPERATURE RATING:	0°C to 50°C full rated, derated linearly to 40% at 70°C.
TEMPERATURE COEFFICIENT:	.01%/°C typical, .03%/°C maximum
VIBRATION:	Per MIL-STD-810D, Method 514.3, Category 1, Procedure 1.
SHOCK:	Per MIL-STD-810D, Method 516.3, Procedure III.
EMI/RFI:	These linear power supplies have inherently low conducted and radiated noise levels. For most system applications they will meet the requirements of FCC Docket 20780 for Class B equipment and VDE 0871 for Class B equipment without additional noise filtering

### SAFETY SPECIFICATIONS

The INTERNATIONAL POWER supplies are designed to meet or exceed requirements for the following specifications: IEC 380, IEC 435, VDE 0730 Part 2, VDE 0804, ECMA-57, CEE 10 Part 2P, UL 1012, CSA 22.2 No. 143, CSA 22.2 No. 154. Specifically, field terminal to terminal spacing is 5.25 mm with 9.0 mm creepage to other metal, leakage current is less than 5.0 μA and dielectric withstanding voltages are 3750 VAC input to chassis, 3750 VAC input to output and 300 VDC output to chassis.

### OVER VOLTAGE PROTECTION (OVP)

An overvoltage protection circuit, commonly referred to as a crowbar, is used to prevent damage to voltage sensitive loads such as TTL logic. Trip point of the OVP is usually set at 115% - 135% of the output voltage. The OVP will short the output terminals upon sensing a fault condition. The primary fuse of the supply will blow if the supply is not foldback current limited. Nuisance tripping of the OVP is a common problem. Noise from input line spikes or load noise can cause an OVP to fire. International Power has provided OVP noise filtering to prevent nuisance tripping and reduced transformer interwinding capacitance to minimize input line susceptibility.

### COMMON-MODE LATCH UP

In certain instances dual power supplies can exhibit a problem known as common-mode latch up. This occurs when the positive supply comes up first and forces a reverse bias condition on the negative supply. The negative supply latches up in a current limit condition. International Power has incorporated a unique anti-latch circuit into every dual power supply which will minimize this problem.

### WARRANTY

International Power warrants each power supply of its manufacture that does not perform to published specifications, as a result of defective materials or workmanship, for a period of two full years from the date of original delivery.

International Power assumes no liabilities for consequential damages of any kind through the use or misuse of its products by the purchaser or others. No other obligations or liabilities are expressed or implied.

### CUSTOMER SERVICE REPAIR

Please follow this procedure when returning product for repair:

Contact International Power for a returned material authorization (RMA) number. The RMA number must appear on all shipping documents and containers. Returns must be freight prepaid. Returns shipped freight collect or without an RMA will not be accepted

International Power                      Phone: (805) 981-1188  
360 Bernoulli Circle                      FAX: (805) 981-1184  
Oxnard, CA 93030-5167

## Remote Sense

Remote sense terminals may be used to compensate for output line losses and provide for a remote point of regulation. *Figure 1* shows the proper termination for a power supply with remote sensing.

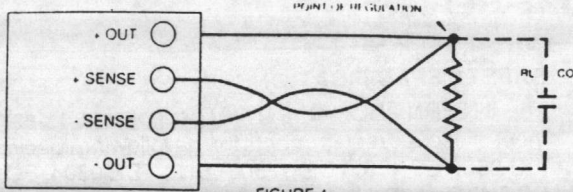


FIGURE 1

Load lines must be sized to prevent an excessive voltage drop from the output to the load. Since the point of regulation is at the load, the power supply must compensate for line losses. Excessive load line losses may affect current limiting, AC line dropout point and OVP margin (if applicable).

Leads should be sized to drop no more than 0.5V — the less the better. Use of a twisted pair or shielded pair for the sense lines is recommended for noise immunity. In problem applications, the use of a small AC decoupling capacitor (.1 to 10 $\mu$  Fd) across the sense terminals is highly recommended. In some applications there may be a tendency for the power supply to oscillate due to the additional phase shift caused by the series resistance and inductance in the load leads. The addition of capacitor Co will reduce output impedance and provide stability. The recommended value of Co is 100 $\mu$  Fd per ampere or 50 $\mu$  Fd per foot and can be the sum of the distributed decoupling capacitors found in most systems. International Power supplies have open sense lead protection on most outputs to protect the load from an overvoltage condition if the sense leads are removed. There is no need to strap the sense terminals to the output terminals in the local sense mode.

## Overvoltage Protection (OVP)

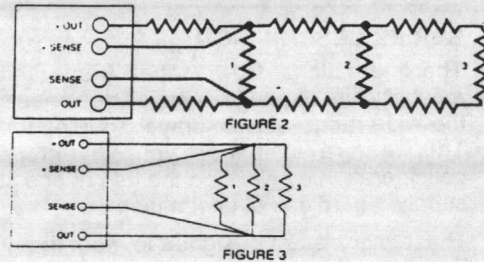
An overvoltage protection circuit, commonly referred to as a crowbar, is used to prevent damage to voltage sensitive loads such as TTL logic. Trip point of the OVP is usually set at 115% - 135% of the output voltage. The OVP will short the output terminals upon sensing a fault condition. The primary fuse of the supply will blow if the supply is not foldback current limited. Nuisance tripping of the OVP is a common problem. Noise from input line spikes or load noise can cause an OVP to fire. International Power has provided OVP noise filtering to prevent nuisance tripping and reduced transformer interwinding capacitance to minimize input line susceptibility.

## Common-Mode Latch UP

In certain instances dual power supplies can exhibit a problem known as common-mode latch up. This occurs when the positive supply comes up first and forces a reverse bias condition on the negative supply. The negative supply latches up in a current limit condition. International Power has incorporated a unique antilatch circuit into every dual power supply which will minimize this problem.

## Grounding

Grounding consideration in designing a power distribution system are often overlooked but can have a significant impact on overall system performance. A single point system ground should be employed where possible to eliminate ground loops and improve regulation.



*Figure 2* shows a simple but *undesirable* connection scheme. Regulation at loads 2 and 3 becomes progressively worse due to voltage drops in the finite wire resistance between loads. *Figure 3* shows an improved connection system in which regulation is maintained at all three loads because wire losses are not cumulative.

## AC Connection and Fusing

The five wire input provides four voltage ranges: 100/120/220/230-240\*\* +10%, -13%. See chassis AC connection table for the jumpering requirements. Extended low line tolerance provides additional drop out margin in areas where line voltages are marginal. Inputs must be fused.

For Use at	AC Input 47-63-Hz			
	100 VAC	120 VAC	220 VAC	230/240 VAC
JUMPER	1 & 3 2 & 4	1 & 3 2 & 4	2 & 3	2 & 3
Apply A.C.	1 & 5	4 & 1	1 & 5	4 & 1

FIGURE 4

\*\*Tolerance for 230VAC operation is +15%, -10%.

## Jumpering Example

*Figure 5* is an example of proper jumpering of the primary for 100/120 VAC operation.

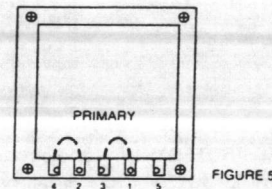


FIGURE 5

## Warranty

International Power warrants each power supply of its manufacture that does not perform to published specifications, as a result of defective materials or workmanship, for a period of two full years from the date of original delivery.

International Power assumes no liabilities for consequential damages of any kind through the use or misuse of its products by the purchaser or others. No other obligations or liabilities are expressed or implied.

## Customer Service/Warranty Repair

Please follow this procedure when returning product for customer service: Contact International Power DC Power Supplies, Inc. for a returned material authorization (RMA) number. The RMA number must appear on all shipping containers. Returns must be returned freight prepaid. Returns shipped freight collect or without an RMA number will not be accepted.

Ship to: International Power,

# Outline and Mounting Drawing

## A Case

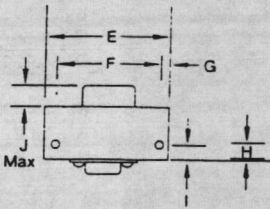
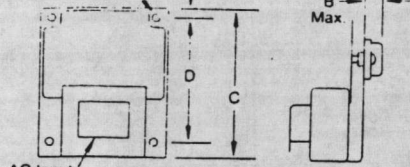
Overall Size: 3.75" x 3.00" x 2.20"

Overall Size 3.75" x 3.00" x 2.20"

Weight 1 lb

WT 1LB

1/8 Dia Mtg Holes  
(6 Places)



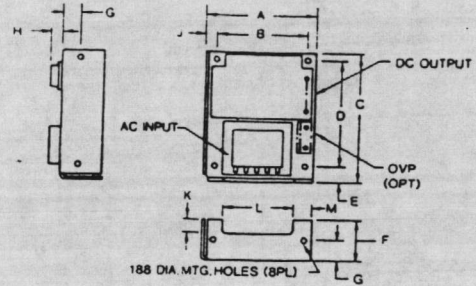
INCH	mm
A	.250 6.35
B	.450 11.43
C	3.75 95.25
D	3.100 78.74
E	3.00 76.20
F	2.500 63.50
G	.250 6.35
H	1.25 31.75
I	.350 8.89
J	.500 12.70

## B Case

Overall Size: 4.87" x 4.00" x 2.10"

Overall Size 123.70mm x 101.60mm x 53.34mm

Weight 2 lbs



INCH	mm
A	4.00 101.60
B	3.375 85.73
C	4.87 123.70
D	4.125 104.78
E	0.50 12.70
F	1.62 41.15
G	0.75 19.05
H	0.450 11.43
J	.038 9.65
K	0.57 14.48
L	2.60 66.04
M	0.794 20.17

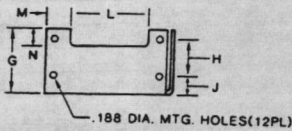
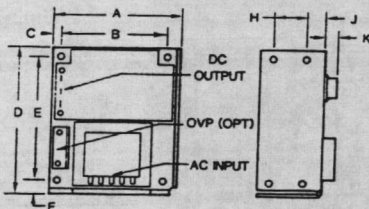
FUSE AT: 0.5/0.25 AMPS FOR 100-120/220-240 VAC

## C Case

Overall Size: 5.62" x 4.87" x 2.95"

Overall Size 142.75mm x 123.70mm x 74.93mm

Weight 4 lbs.



INCH	mm
A	4.87 123.70
B	4.125 104.78
C	0.25 6.35
D	5.62 142.75
E	4.875 123.83
F	0.50 12.70
G	2.50 63.50
H	1.250 31.75
J	0.75 19.05
K	0.450 11.43
L	2.85 72.39
M	1.025 26.04
N	0.665 16.89

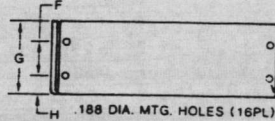
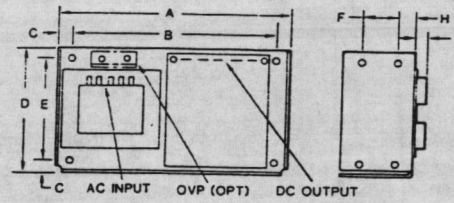
FUSE AT: 1.0/0.5 AMPS FOR 100-120/220-240 VAC

## D Case

Overall Size: 9.00" x 4.87" x 3.28"

Overall Size 228.60mm x 123.70mm x 83.83mm

Weight 7.5 lbs.



INCH	mm
A	9.00 228.60
B	8.000 203.20
C	0.50 12.70
D	4.87 123.70
E	4.125 104.78
F	1.250 31.75
G	2.75 69.85
H	0.75 19.05
J	0.450 11.43

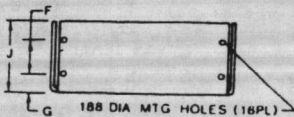
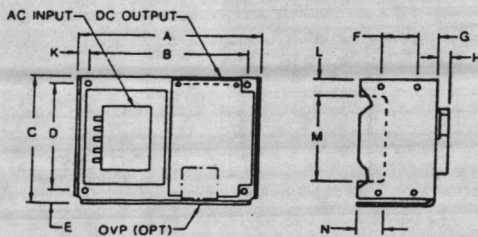
FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240 VAC

## N Case

Overall Size: 7.00" x 4.87" x 3.20"

Overall Size 177.80mm x 123.70mm x 81.28mm

Weight 6 lbs.



INCH	mm
A	7.00 177.80
B	6.250 158.75
C	4.87 123.70
D	4.125 104.78
E	0.50 12.70
F	1.250 31.75
G	0.75 19.05
H	0.450 11.43
J	2.75 69.85
K	0.38 9.65
L	0.640 16.26
M	3.345 84.96
N	1.00 25.40

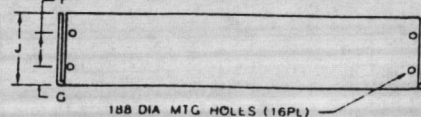
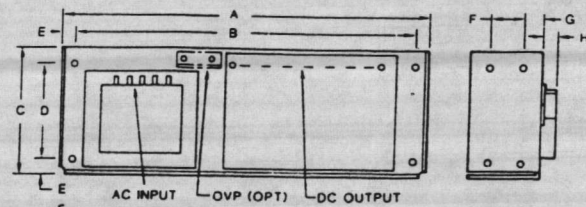
FUSE AT 2.0/1.0 AMPS FOR 100-120/220-240 VAC

## E Case

Overall Size: 14.00" x 4.87" x 3.53"

Overall Size 355.60mm x 123.70mm x 89.66mm

Weight 10 lbs.



INCH	mm
A	14.00 355.60
B	13.000 330.20
C	4.87 123.70
D	4.125 104.78
E	0.50 12.70
F	1.250 31.75
G	0.75 19.05
H	0.650 16.51
J	2.75 69.85

FUSE AT 3.0/1.5 AMPS FOR 100-120/220-240 VAC

# Outline and Mounting Drawings

### F Case

Overall Size: 16.75" x 5.50" x 4.88"  
Weight 19 lbs.

INCH	mm
A	16.75 425.45
B	16.00 406.40
C	4.88 123.95
D	4.125 104.80
E	0.375 9.53
F	5.00 127.00
G	2.50 63.50
H	1.50 36.10
J	3.50 88.90
K	2.50 63.50

188 Dia Mtg Holes (16 Places)

### AA Case

Overall Size: 6.50" x 4.00" x 2.10"  
165.10mm x 101.60mm x 53.34mm  
Weight 2 lbs.

INCH	mm
A	4.00 101.60
B	3.375 85.73
C	6.50 165.10
D	5.750 146.05
E	0.75 19.05
F	0.450 11.43
G	1.62 41.15
H	0.25 6.35
J	0.50 12.70
K	0.955 24.26
L	2.37 60.20
M	0.57 14.48

188 DIA. MTG. HOLES (8 PL)

FUSE AT: 0.5/0.25 AMPS FOR 100-120/220-240 VAC

### BB Case

Overall Size: 7.00" x 4.88" x 2.95"  
177.80mm x 123.95mm x 74.93mm  
Weight 4 lbs.

INCH	mm
A	4.87 123.70
B	4.125 104.78
C	0.25 6.35
D	7.00 177.80
E	6.250 158.75
F	0.50 12.70
G	1.250 31.75
H	2.50 63.50
J	0.75 19.05
K	0.450 11.43
L	0.665 16.89
M	1.025 26.03
N	2.85 72.39

188 DIA. MTG. HOLES (12PL)

FUSE AT: 1.0/0.5 AMPS FOR 100-120/220-240 VAC

### CC Case

Overall Size: 9.38" x 4.87" x 3.28"  
238.25mm x 123.70mm x 83.31mm  
Weight 7 lbs.

INCH	mm
A	9.38 238.25
B	8.375 212.73
C	0.50 12.70
D	4.87 123.70
E	4.125 104.78
F	1.250 31.75
G	2.75 69.85
H	0.75 19.05
J	0.450 11.43

188 DIA. MTG. HOLES (16PL)

FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240 VAC  
HCC512: 3.0/1.5 AMPS FOR 100-120/220-240 VAC

### BAA Case

Overall Size: 10.25" x 4.00" x 2.95"  
260.35mm x 101.60mm x 74.93mm  
Weight 5 lbs.

INCH	mm
A	10.25 260.35
B	9.250 234.95
C	0.50 12.70
D	4.00 101.60
E	3.375 85.73
F	0.37 9.40
G	1.250 31.75
H	0.75 19.05
J	0.450 11.43
K	2.50 63.50

188 DIA MTG HOLES (16PL)

FUSE AT: 1.0/0.5 AMPS FOR 100-120/220-240 VAC

### CBB Case

Overall Size: 11.00" x 4.87" x 3.28"  
279.40mm x 123.70mm x 83.31mm  
Weight 8 lbs.

INCH	mm
A	11.00 279.40
B	7.50 190.50
C	3.00 76.20
D	4.87 123.70
E	4.125 104.78
F	0.50 12.70
G	1.250 31.75
H	0.75 19.05
J	4.50 11.43
K	2.75 69.85

188 DIA MTG HOLES (16PL)

FUSE AT 2.0/1.0 AMPS FOR 100-120/220-240 VAC



**MOTOROLA**

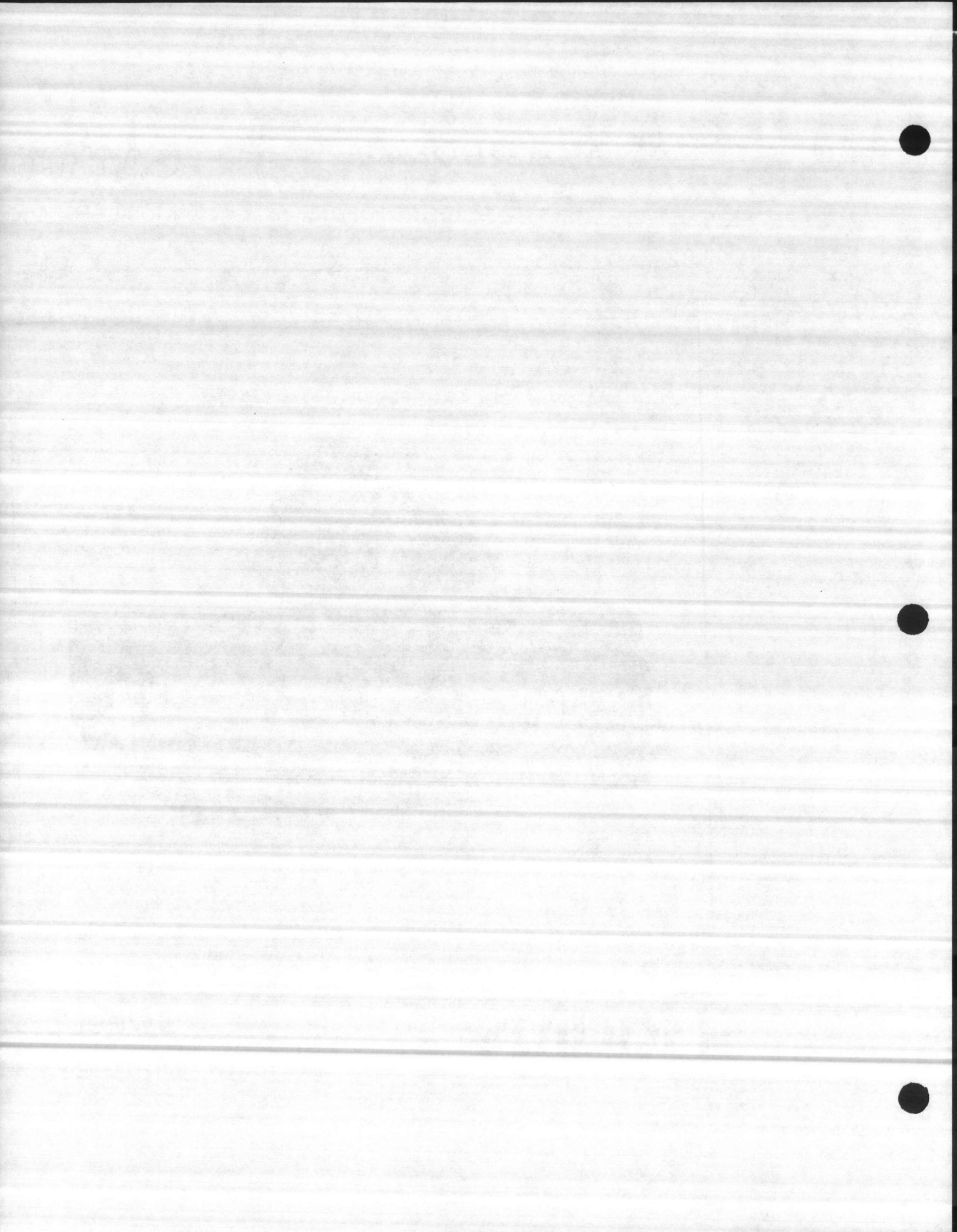
# GM300

Mobile Radios



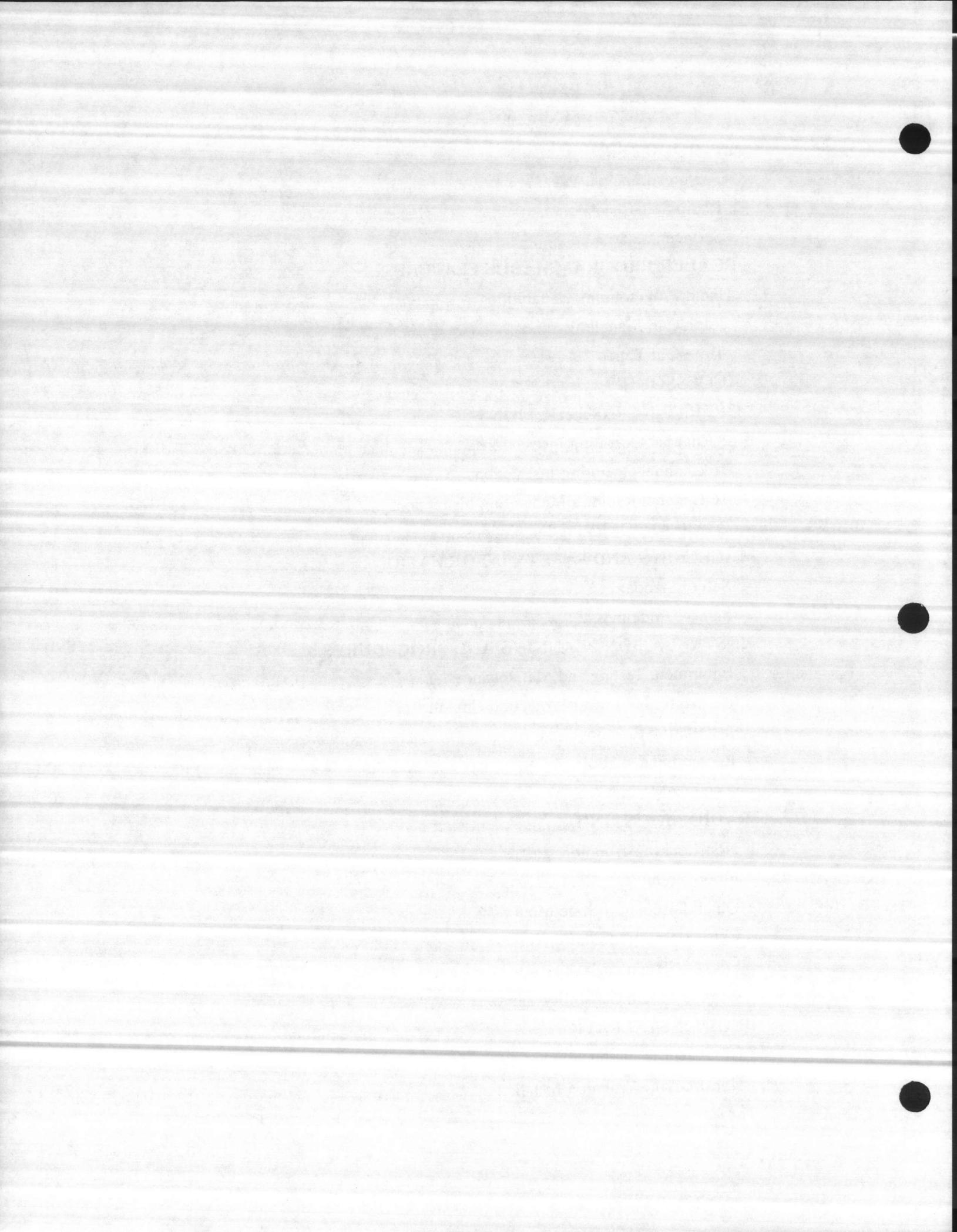
**Radius**<sup>TM</sup>  
A DIVISION OF MOTOROLA

Owner's  
Manual



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## INTRODUCTION

Welcome to the Radius mobile family! Your choice of a Radius mobile means you have selected the highest of standards in design, quality, and performance. This manual is designed to acquaint you with all the features, care, and installation of the Radius mobile to better serve all your communication needs.

### Radius Mobile Features

The following features are standard in all models:

- \* Synthesized, Wide-Band Operation
- \* Multiple Coded Squelch (Private Line and Digital Private Line) Capability
- \* Operator Selectable Channel Scan
- \* Field Programming Capability at Dealer
- \* Mil-Spec 810 C, D and E Performance
- \* Radius High Performance Compact Microphone with Hardware
- \* Non-Locking Trunnion with Hardware
- \* 10 Ft. Power Cable
- \* 12 V DC Negative Ground
- \* 3 Watt Internal Speaker
- \* Rotary Volume Control
- \* Time-Out Timer
- \* On-Hook Monitor Capability
- \* Mini-UHF Antenna Connector
- \* Operator's Card and Owner's Manual

### Radio Self-Check

Every time the radio is turned on, it performs a functional self-check and if necessary, will sound a 5 second warning tone instead of the chirp tone normally heard at power-up. This is an indication that the radio is no longer operating at the exact parameters set in the factory or field and should be serviced immediately.

### Service

Because this unit contains a radio transmitter, most local governments prohibit anyone from making any internal adjustments to the transmitter unless specifically licensed to do so by government regulations. If your radio fails to operate or any operational difficulties should arise, contact your local Motorola Radius dealer.

Proper repair and maintenance procedures will assure efficient operation and long life for this radio.



## DEALER PROGRAMMABLE FEATURES

### Field Programming Capabilities

The Radius GM300 mobile uses non-volatile memory to store customer unique information. If a frequency, squelch code or channel-slaved scan list needs to be changed, it can be done at a service location with Radio Service Software (RSS). The time-out timer can be disabled or changed to any duration from 1 to 255 seconds. The default setting is 60 seconds. It is not necessary to open the radio for reprogramming.

Scanning radios can also be programmed to enable Talk-back Scan or the Priority Sample Rate can be changed. Finally, 16 channel radios are provided with RapidCall Signalling and Expanded Accessory Connector and can be programmed to include a wide variety of features and accessories.

### RapidCall Signalling

16 Channel GM300 mobiles are available with RapidCall, a selective signalling package. Radios can be programmed with an impressive variety of features to improve your efficiency as radio users. These features include: Push-to-Talk Identification (PTT-ID), Emergency, Call Alert, Horn/Lights, Voice Selective Call, and Radio Check.

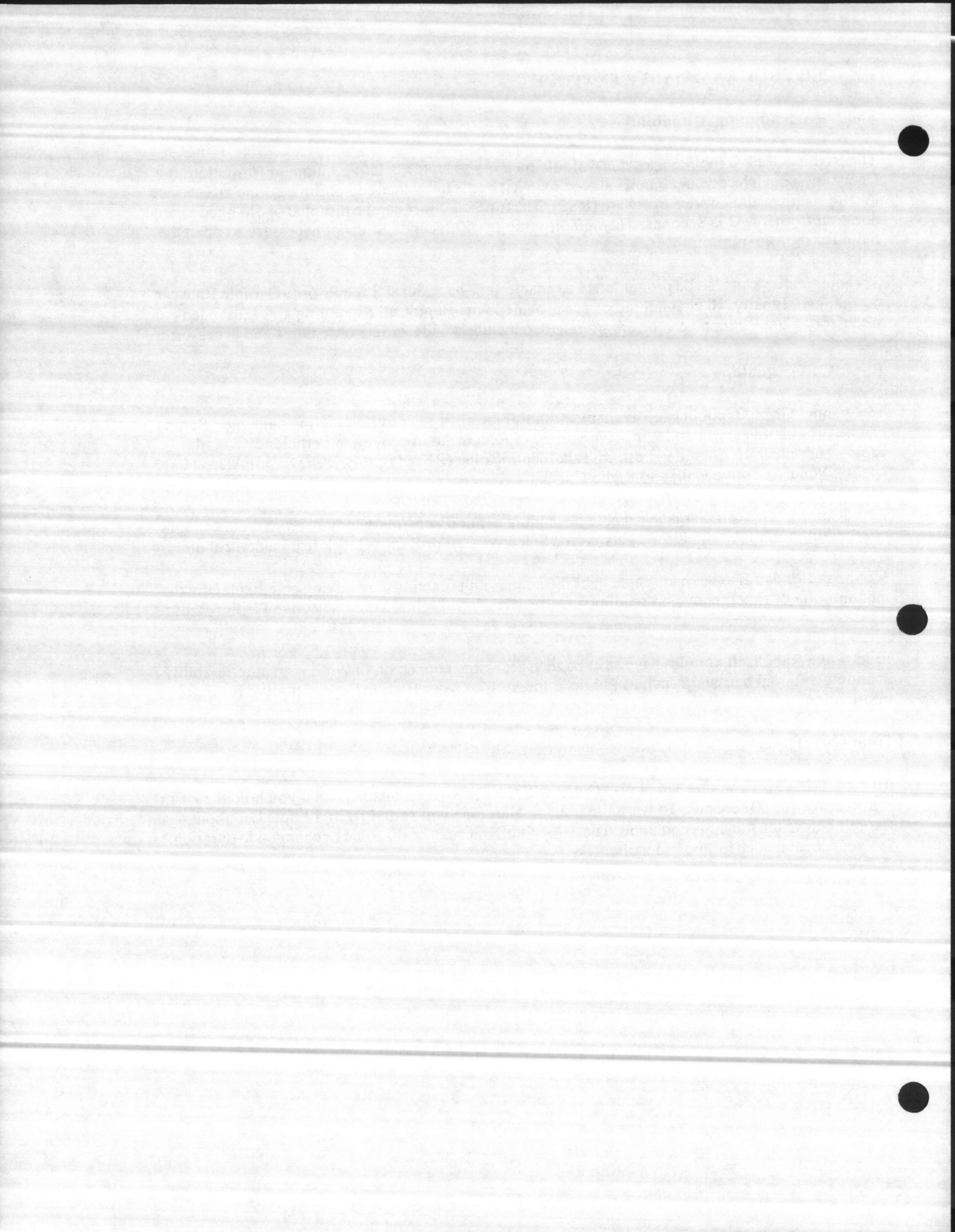
RapidCall mobiles can be made capable of sending a unit ID or Emergency Alert to a control unit or receiving a Call Alert, Horn/Lights, Voice Selective Call or Radio Check from a control unit.

Mobile radios can also be made capable of the control unit functions: receiving and displaying the incoming ID or Emergency and sending a Call Alert, Horn/Lights, Voice Selective Call or Radio Check.

In addition, RapidCall mobiles have an expanded accessory connector, providing greater flexibility in adding external hardware such as Public Address. Ask your Radius Representative for more information.

### Time-Out Timer

All models have a Time-Out Timer (TOT) that will terminate your transmission if you hold the PTT button down for 60 seconds. To warn the user, an alert tone will sound from the speaker about 4 seconds before the transmission is cut. The Time-Out Timer can be disabled or changed in duration. See your local dealer for more details.



## ACCESSORIES

Radius offers several accessories to increase communications efficiency. Many of the accessories available are listed below, but for a complete list, consult your Radius dealer.

### **Antennas:**

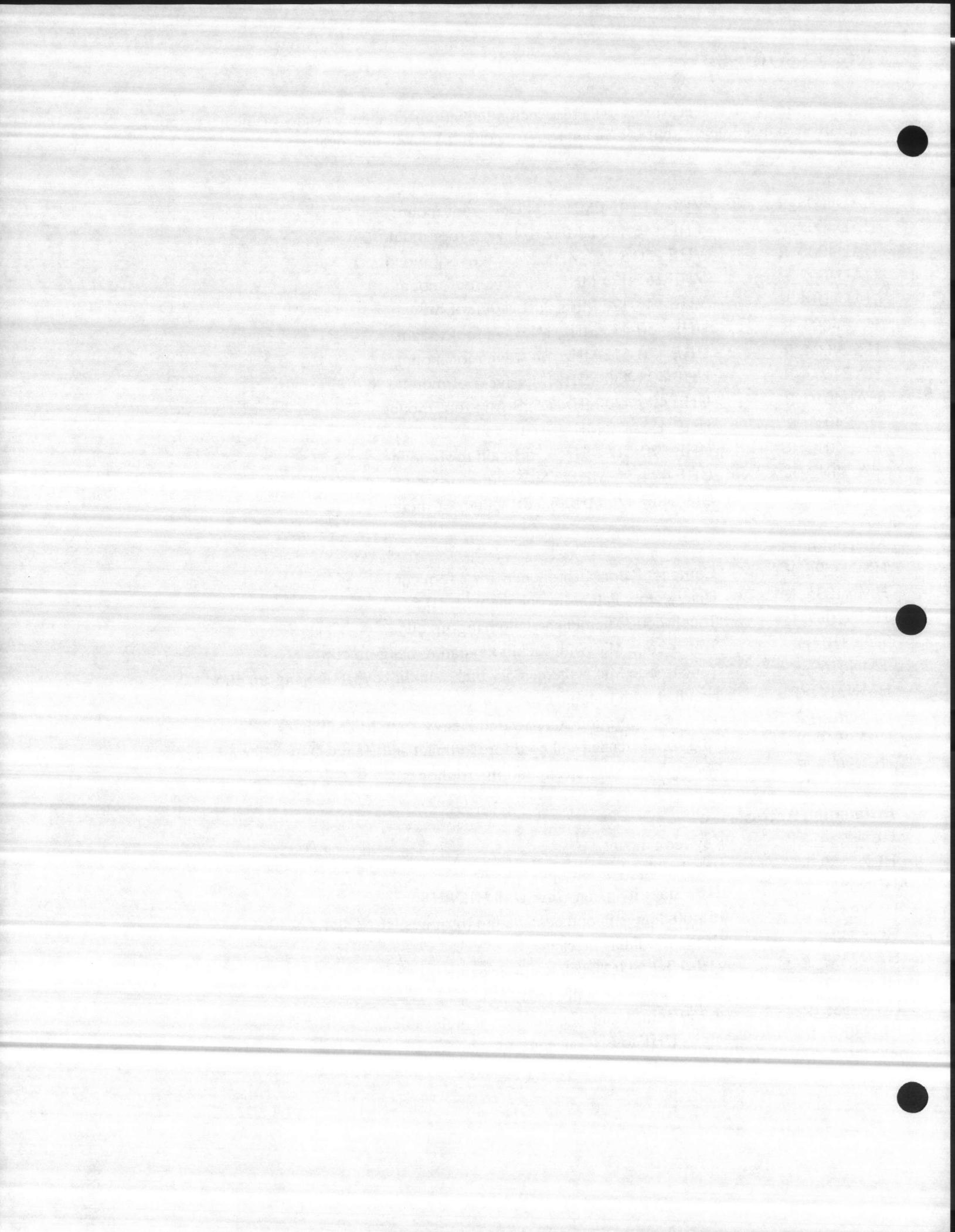
HAD4006_R	VHF 136-144 MHz, 1/4 wave roof mount
HAD4007_R	VHF 146-150.8 MHz, 1/4 wave roof mount
HAD4008_R	VHF 150.8-162 MHz, 1/4 wave roof mount
HAD4009_R	VHF 162-174 MHz, 1/4 wave roof mount
HAD4014_R	VHF 146-172 MHz, 3dB gain roof mount
HAE4003_R	UHF 450-470 MHz, 1/4 wave roof mount
HAE4004_R	UHF 470-512 MHz, 1/4 wave roof mount
HAE4002_R	UHF 403-430 MHz, 1/4 wave roof mount
HAE4010_R	UHF 406-420 MHz, 3.5dB gain roof mount
HAE4011_R	UHF 450-470 MHz, 3.5 dB gain roof mount
HAE4012_R	UHF 470-512 MHz, 3.5dB gain roof mount
HAE4013_R	UHF 494-512MHz, 3.5dB gain roof mount
HAE4019_R	UHF 450-470 MHz, 3.5 dB gain roof mount

### **Microphones:**

HMN3596_R	Compact Palm Microphone with 7 foot cord
HMN1035_R	Heavy Duty Palm Microphone with 10.5 ft. cord
HMN1037_R	Touch-code Microphone with hang-up clip
TDN8305_R	Touch-code Mic. with backlit keypad & hang-up clip
TMN6169_R	Touch-code Mic. with memory dial, backlit keypad & hang-up clip
HMN3141_R	Handset with hang-up cup
HLN9559_R	7 foot coil cord for Compact and Heavy Duty Microphones
HLN9560_R	10.5 foot extended coil cord for Compact and Heavy Duty Microphones
HLN9073_R	Microphone hang-up clip (all microphones)

### **Installation Accessories:**

HLN9284_R	Key lock mount
HLN5189_R	Non-locking bracket
HLN5226_R	Extra stability mount (use with HLN5189)
HLN9450_R	45 - 60 degree floor mount wedge (requires HLN9404)
HLN9404_R	Sleeve mounting bracket
HKN4137_R	VHF/UHF/800 MHz low power cable
HLN5282_R	Mini-U connector (all bands)
HKN9557_R	PL259/Mini-U antenna adapter - 8 inch cable
HLN8027_R	Mini - UHF to BNC antenna adapter
HLN8097_R	Removable slide mount tray package



## ACCESSORIES (cont'd)

HLN8098_R	Radio slide mount tray
.N8099_R	Vehicle slide mount tray
HLN8143_R	Remote mount kit (17 FT. length)
HLN8144_R	Remote mount kit (8 FT. length)
HLN8413_R	Slide mount tray bracket

### **Control Station Accessories:**

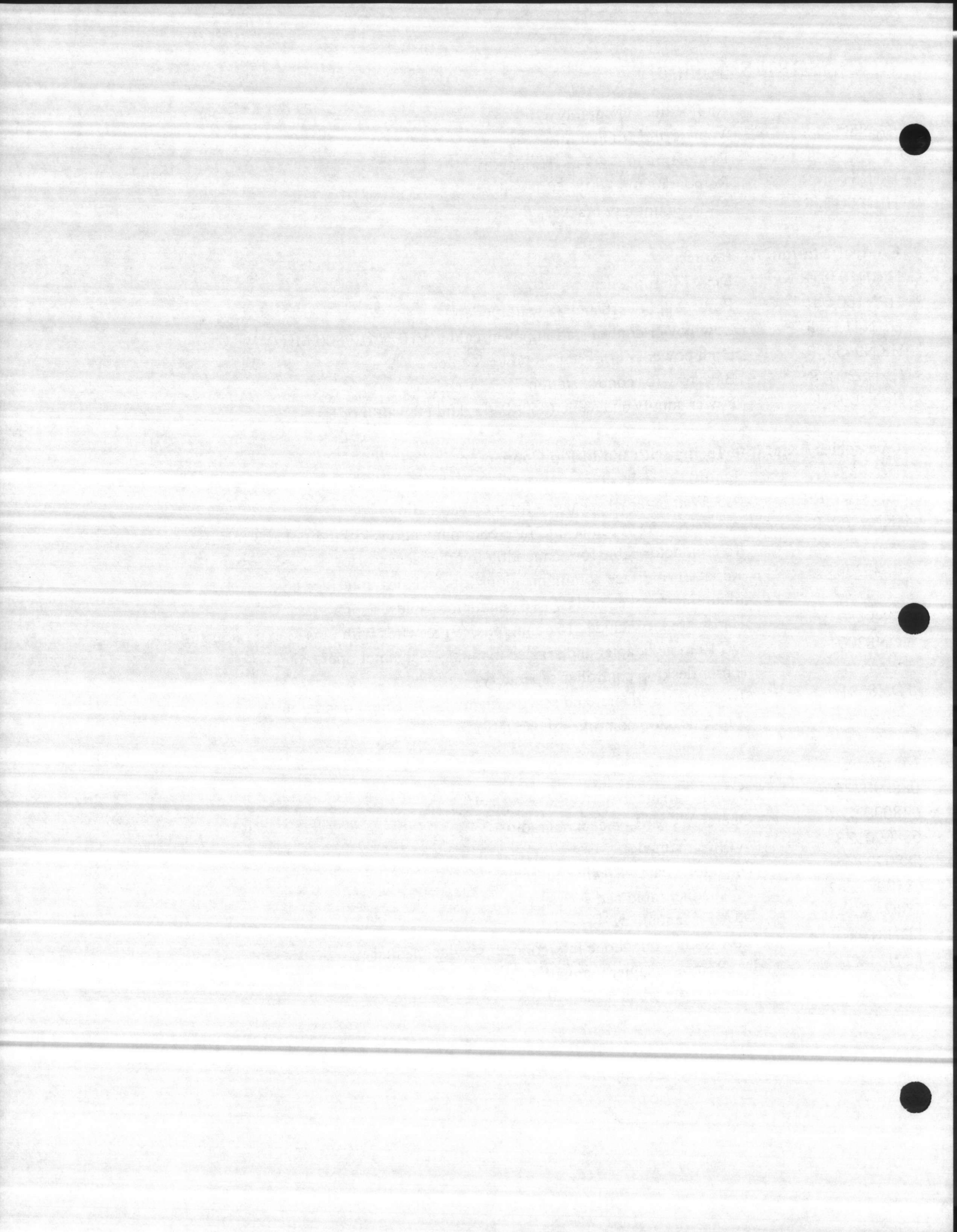
HMN1038_R	Desk Microphone
HPN1007_R	Power supply (10 and 25 watt models)
HKN4139_R	Low power control station power cable (VHF/UHF/800 MHz)
HKN9455_R	High power control station power cable
HLN5292_R	Base tray for control station
HPN4001_R	Power supply and cable (35, 40, 45, and 60 watt models)

### **Accessories / Kits Interfacing with the 16 Pin Connector:**

HKN9327_R	Ignition switch cable
HSN8145_R	7.5 Watt external speaker - for receiver audio
HKN9969_R	Accessory for repeater interface communications kit-additional 3 foot, 16 conductor cable for connection to other accessories
HLN3333_R	Repeater interface communications kit- includes interface box, mounting bracket, and two 16 conductor cables
.N9457_R	Hardware kit-includes 16 conn. pins, (9) 8" wires with pins & extra housing
TDN8300	DC Remote adapter and service manual - 2 channel operation (order desktop controller separately)
TDN8301	Tone remote adapter and service manual - 2 channel operation (order desktop controller separately)

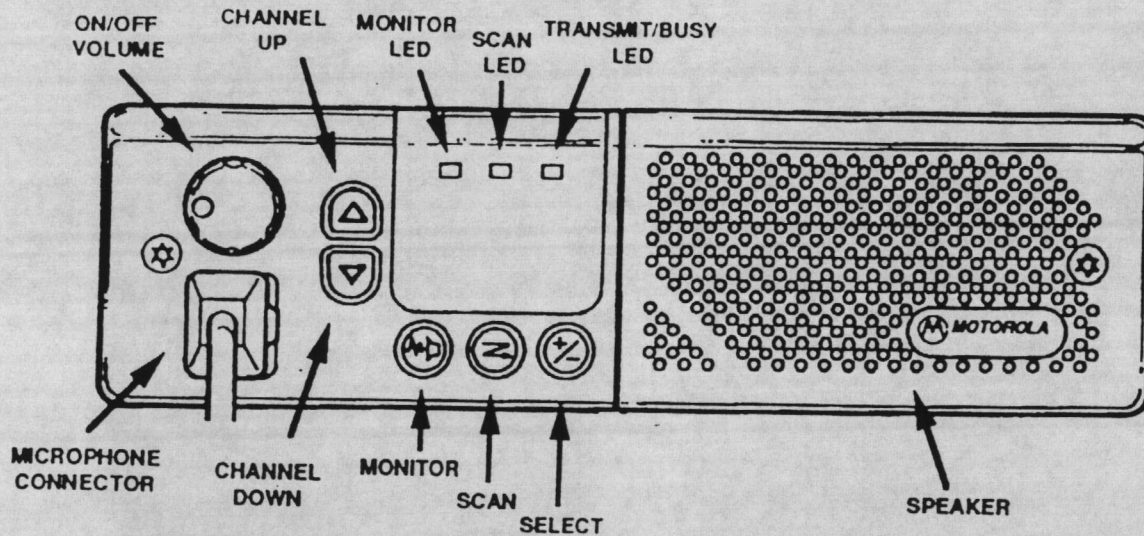
### **Manuals:**

6880902Z09	Owner's manual
6880902Z26	Operator's card - 8 channel radios
6880902Z32	Service manual
6880902Z41	Operator's card - 16 channel radios
6880902Z42	16 Channel rapid call
6880902Z43	DTMF Manual
TDN8198	i50X Radio-Telephone interconnect service manual
TDN8448	DC Remote adapter manual
TDN8449	Tone remote adapter manual





# Operating Instructions for the Motorola Radius® GM300 Conventional FM Radio 8 Channel Model





## To turn the radio on


Turn the ON/OFF VOLUME knob to the right until it clicks. The LED lights will show the last status of the radio and a start-up tone will be heard.


## To receive

Set the volume by turning the ON/OFF VOLUME knob clockwise.

Select the channel by pressing the UP/DOWN button [  ]. An extended press will scroll through the channels.

To monitor a channel, press the MONITOR button [  ] or take the microphone off hook. When in the monitor mode, the amber MONITOR LED will light steadily.

To unsquelch the radio, press and hold the the MONITOR button [  ] for 2 seconds.

To leave the unsquelched mode, press the MONITOR button [  ] again. This will return the radio to the coded squelch (PL/DPL) mode.

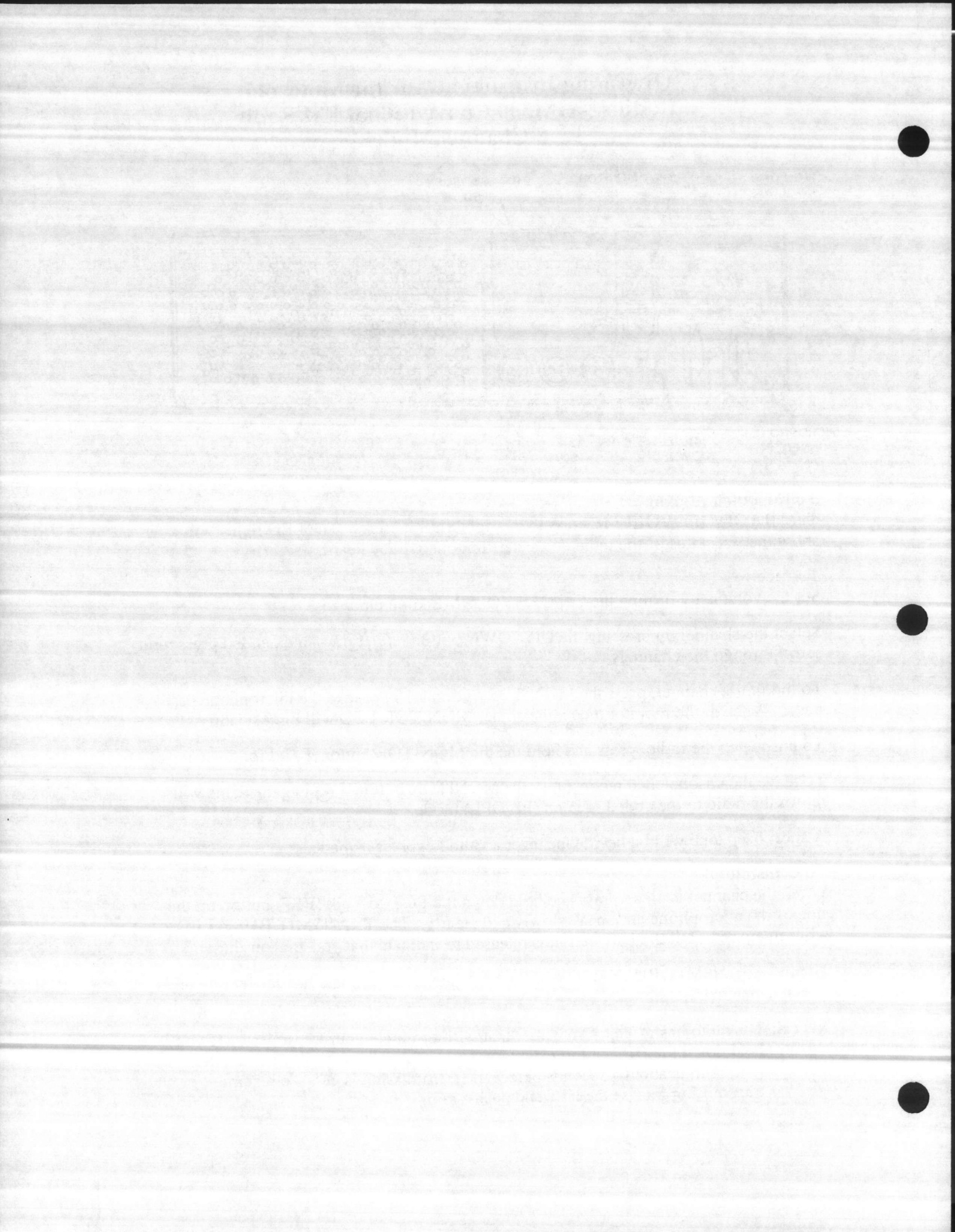
A short beep tone will be heard whenever a valid keypress is made.

## To transmit

When the channel is clear, press and hold down the Push-to-Talk (PTT) button on the side of the microphone and speak slowly and clearly. The TRANSMIT/BUSY LED will remain red until the PTT button is released to indicate that you are "on-the-air".

The red TRANSMIT/BUSY LED will flash whenever there is another carrier on the selected channel.


**NOTE:** The radio has a Time-Out Timer that will terminate your transmission if you hold down the PTT button for over 60 seconds. When this occurs, an alert tone sounds about 4 seconds before the transmission is cut. To resume transmitting release the PTT and push again.



## Channel Scan


The 8 channel GM300 mobile may have a single user scan list which can be programmed from the front panel.

### turn scan on or off


Press the SCAN button [  ]. The radio will only scan when the microphone is on-hook.

The green scan LED will turn on and display segments will light to indicate that scan is functional.





When an active channel is detected, the channel number will be displayed and you will hear the call. To leave scan, press the SCAN button [  ].



### To delete a nuisance channel

While receiving an undesired transmission, hold down the SELECT button [  ] for two seconds and the nuisance channel will be temporary deleted (until scan is exited or the radio is turned off). Priority channels and the home channel cannot be deleted.

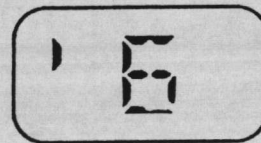
### To respond to scanned channel activity




When the microphone is lifted off-hook, the radio will suspend scanning and return to the channel displayed before entering scan. If you wish to transmit on another channel, press the UP/DOWN button [  /  ] to reach the desired channel. Scan will resume after replacing the microphone on-hook.

### To create or modify the user list


Hold the SCAN button [  ] for 2 seconds until you hear a second chirp tone and the channel number flashes. The displayed channel can be added or deleted from the user scan list by pressing the SELECT button [  ].

A vertical segment in the upper left corner of the display will light and flash alternating with the channel number to indicate that the flashing channel has been added to the scan list. The segment will disappear when the channel is deleted.

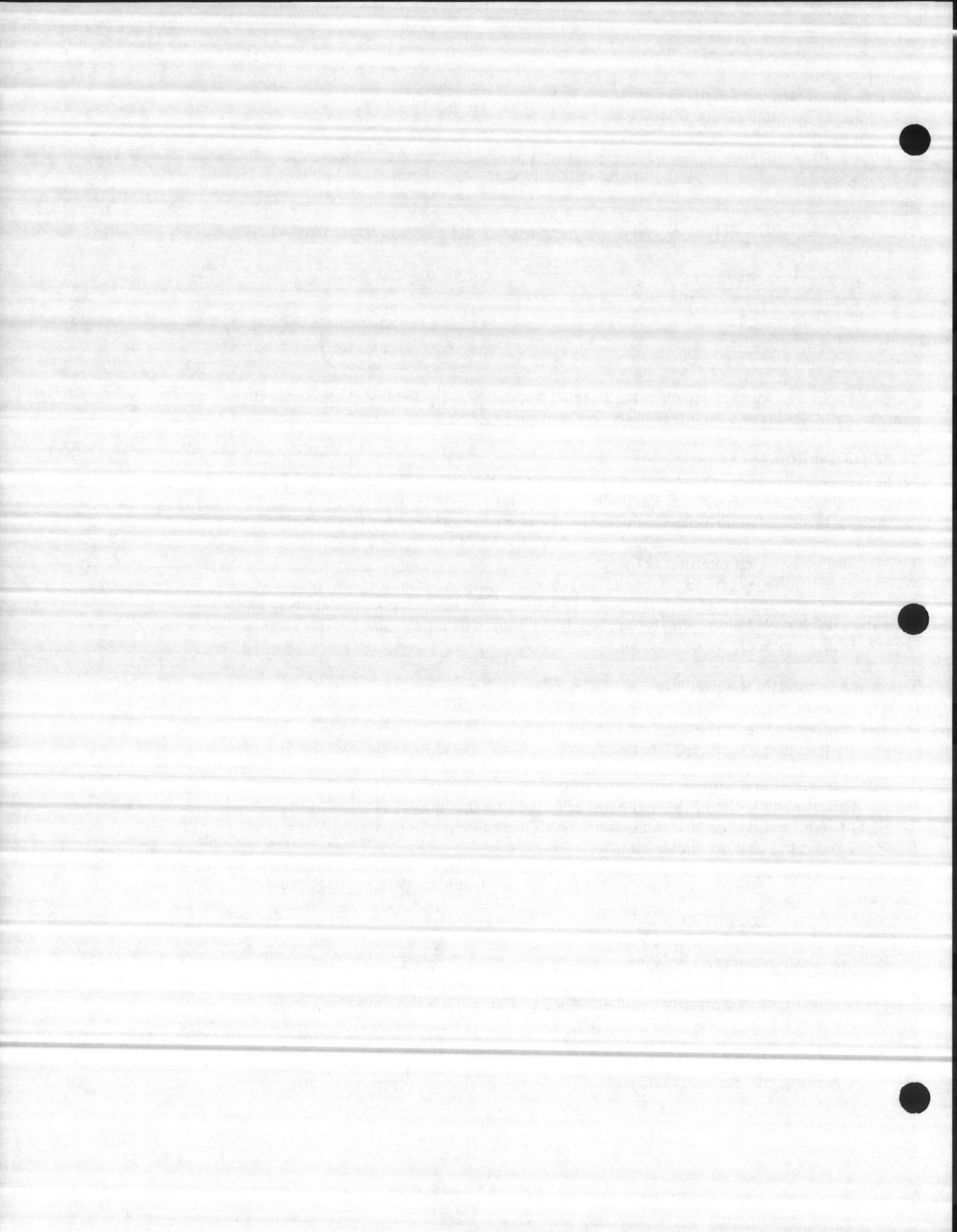


Use the UP/DOWN and SELECT buttons [  /  ,  ] to add or delete other desired channels in the user list.

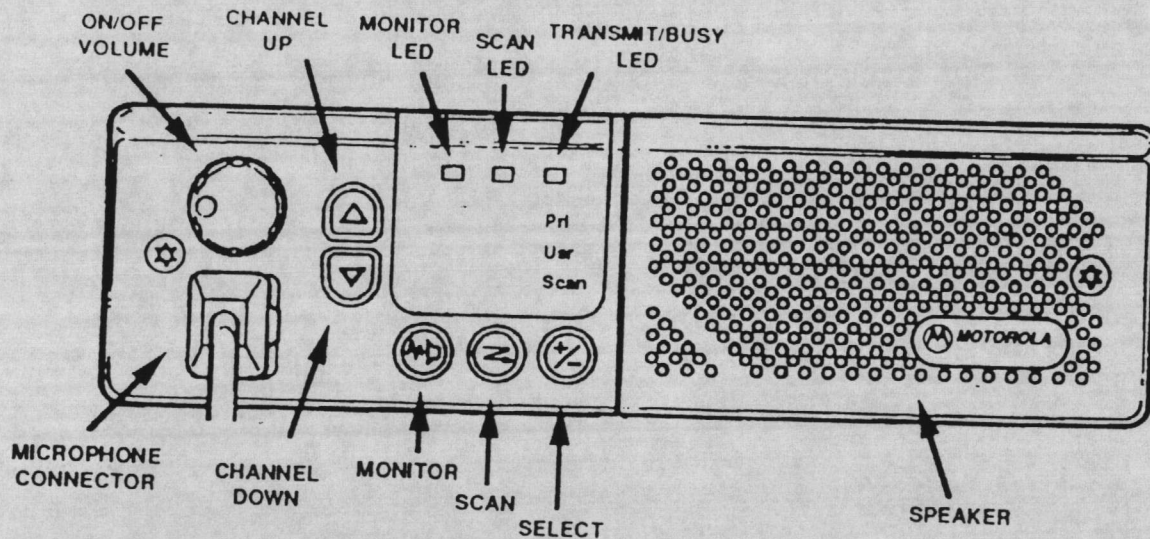
### To select priorities for the user list

Go to the desired channel and hold the SELECT button [  ] down for two seconds. The scan LED will flash to indicate that this is the first priority channel. Repeat the process to select a second priority channel. Priority Two will be indicated by a steady light on the scan LED.

The Priority One channel must be programmed first, followed by the Priority Two channel. Deleting either priority channel will delete both channels simultaneously.



# Operating Instructions for the Motorola Radius® GM300 Conventional FM Radio 16 Channel Model






## To turn the radio on


Turn the ON/OFF VOLUME knob to the right until it clicks. The LED lights will show the last status of the radio and a start-up tone will be heard.


## To receive

Set the volume by turning the ON/OFF VOLUME knob clockwise.

Select the channel by pressing the UP/DOWN button. [  /  ] An extended press will scroll through the channels.

To monitor a channel, press the MONITOR button [  ] or take the microphone off hook. When in the monitor mode, the amber MONITOR LED will light steadily.

To unsquelch the radio, press and hold the the MONITOR button [  ] for 2 seconds.

To leave the unsquelched mode, press the MONITOR button [  ] again. This will return the radio to the coded squelch (PL/DPL) mode.

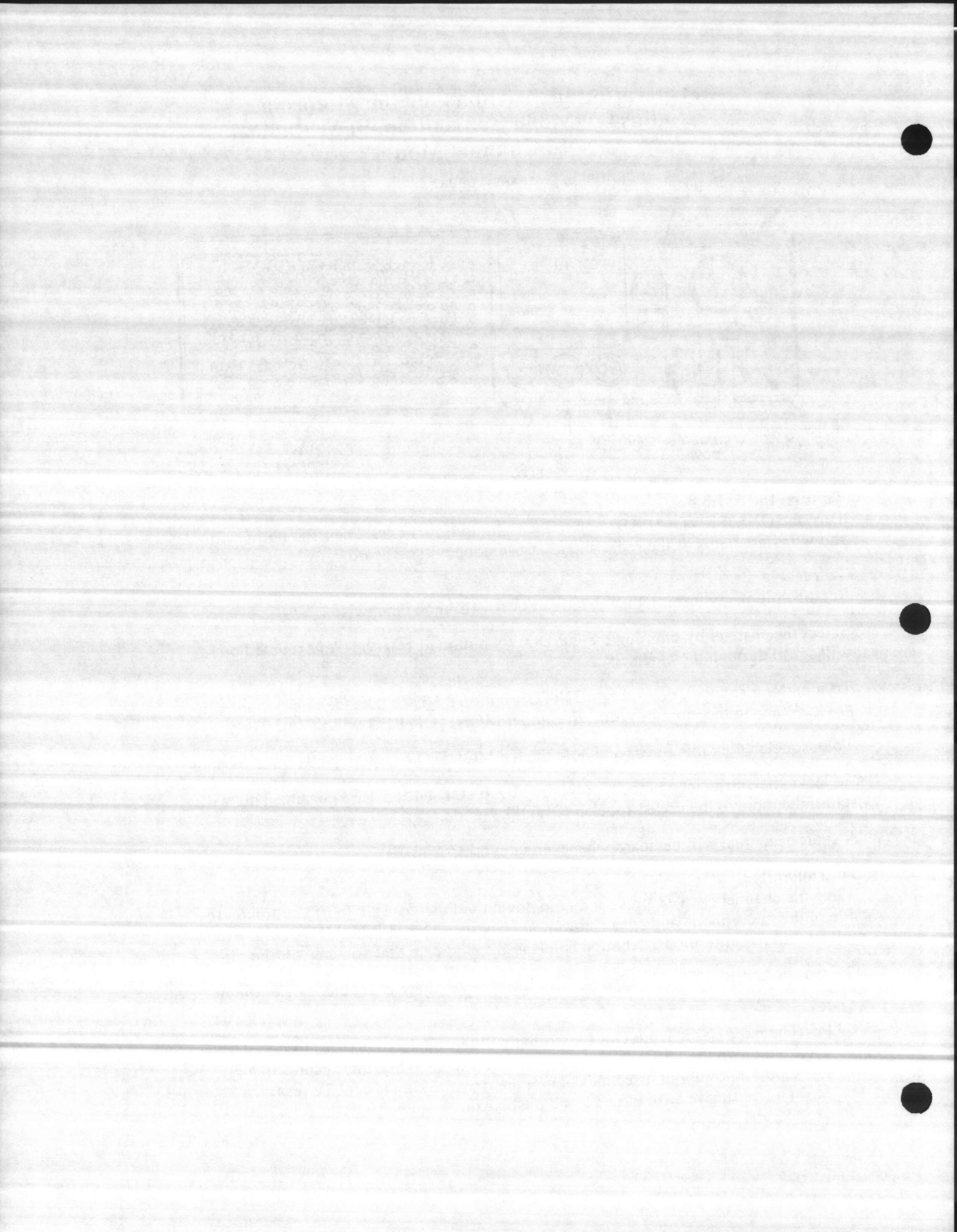
A short beep tone will be heard whenever a keypress is made.

## To transmit

When the channel is clear, press and hold down the Push-to-Talk (PTT) button on the side of the microphone and speak slowly and clearly. The TRANSMIT/BUSY LED will remain red until the PTT button is released to indicate that you are "on-the-air".

The red TRANSMIT/BUSY LED will flash whenever there is another carrier on the selected channel.


**NOTE:** The radio has a Time-Out Timer that will terminate your transmission if you hold down the PTT button for over 60 seconds. When this occurs, an alert tone sounds about 4 seconds before the transmission is cut. To resume transmitting release the PTT and push again.




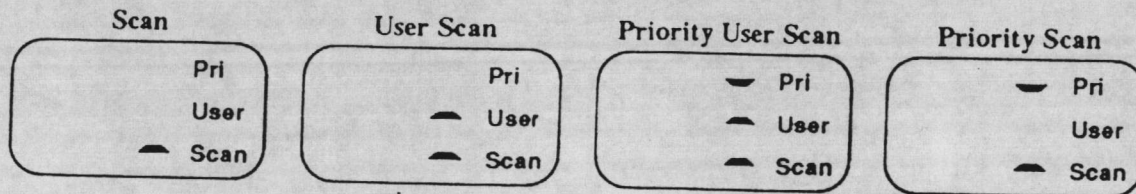
## Channel Scan

The 16 channel GM300 mobile may have a preprogrammed scan list for each active channel and a single user scan list which can be programmed from the front panel.


### To turn scan on or off

Press the SCAN button [  ]. The radio will only scan when the microphone is on-hook.



Green display segments will light to indicate that scan is functional. Use the SELECT button [  ] to advance through the various scan types:




**NOTE:** The first and last displays apply to the preprogrammed scan lists and will be the only types of scan available until a user list is programmed.

When an active channel is detected, the channel number will be displayed and you will hear the call. To leave scan, press the SCAN button [  ].



### To respond to scanned channel activity

When the microphone is lifted off-hook, the radio will suspend scanning and return to the channel displayed before entering scan. If you wish to transmit on another channel, press the UP/DOWN button [  /  ] to reach the desired channel. Scan will resume after replacing the microphone on-hook.

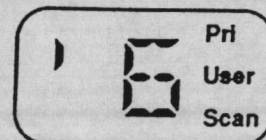
### To delete a nuisance channel




While receiving an undesired transmission, hold down the SELECT button [  ] for two seconds and the nuisance channel will be temporary deleted (until scan is exited or the radio is turned off). Priority channels and the home channel cannot be deleted.

### To create or modify the user list


Hold the SCAN button [  ] for 2 seconds until you hear a second chirp tone and the channel number flashes. The displayed channel can be added or deleted from the user scan list by pressing the SELECT button [  ].

A vertical segment in the upper left corner of the display will light and flash alternating with the channel number to indicate that the flashing channel has been added to the scan list. The segment will disappear when the channel is deleted.

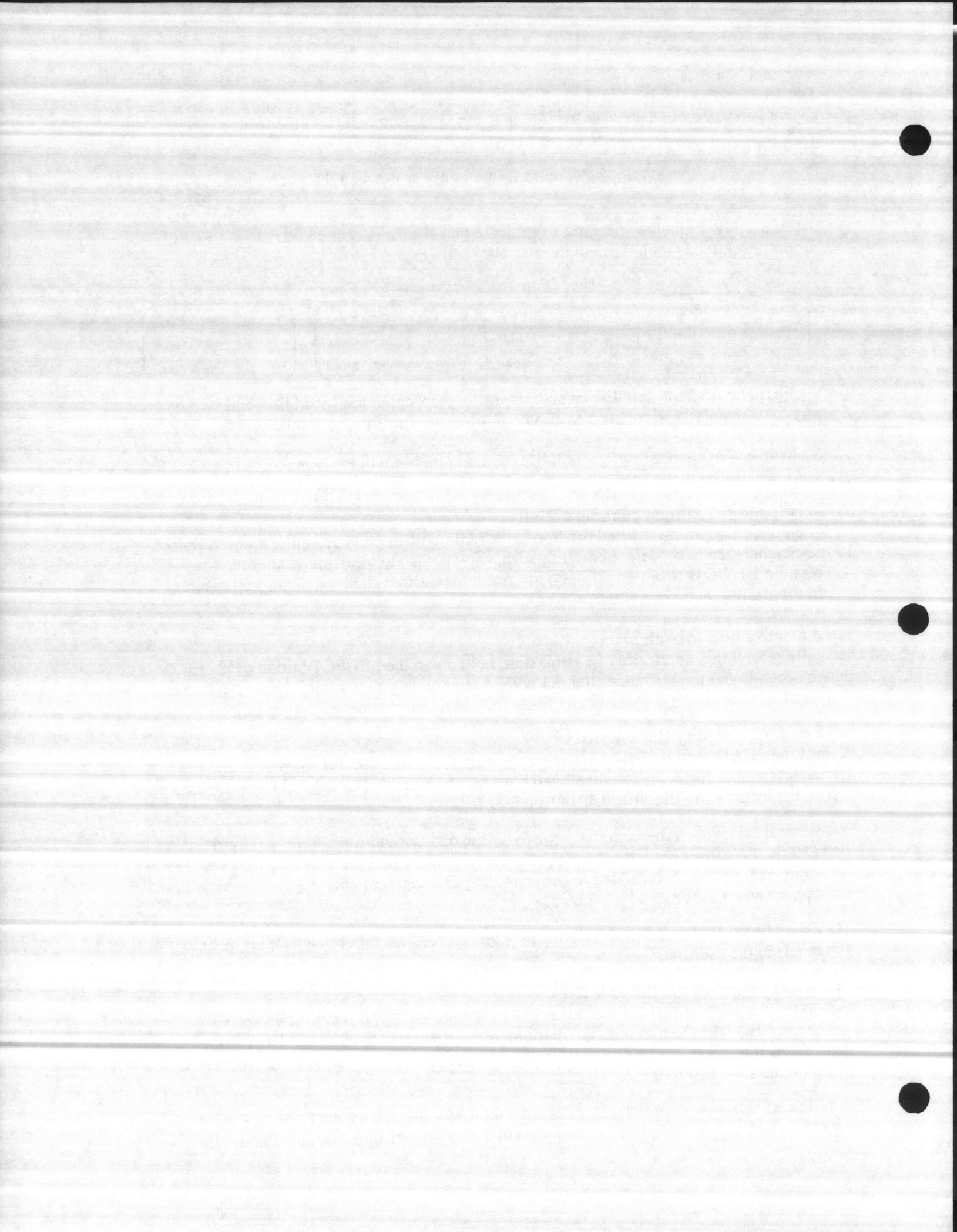


Use the UP/DOWN and SELECT buttons [  /  ,  ] to add or delete other desired channels in the user list.

### To select priorities for the user list

Go to the desired channel and hold the SELECT button [  ] down for two seconds. The scan LED will flash to indicate that this is the first priority channel. Repeat the process to select a second priority channel. Priority Two will be indicated by a steady light on the scan LED.

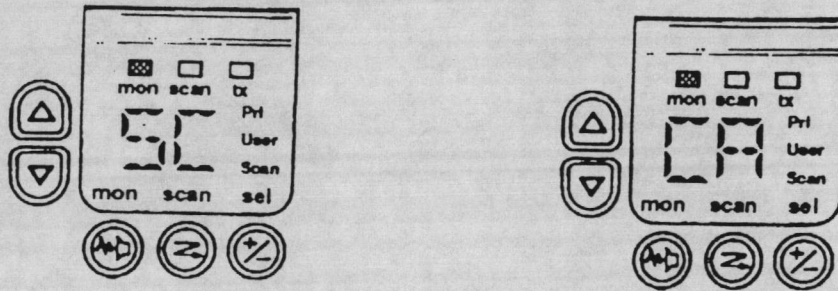
The Priority One channel must be programmed first, followed by the Priority Two channel. Deleting either priority channel will delete both channels simultaneously.





# Operating Instructions for the Motorola Radius RapidCall GM300 Mobile Radios 16 Channel Models

## Mobile (Field Unit) Selective Signalling



The Monitor LED lights steady in normal operation to indicate monitor mode. To indicate an incoming selective call, the Monitor LED will flash and the display will show the appropriate letter abbreviations.

### Receiving a Voice Selective Call

When a Voice Selective Call is received a one-time 2 beep alert tone will sound, the amber Monitor LED will flash and the display will show "SC".


The radio will unmute and a voice message will follow. After the transmission is completed, the radio returns to normal operation.

### Receiving a Call Alert

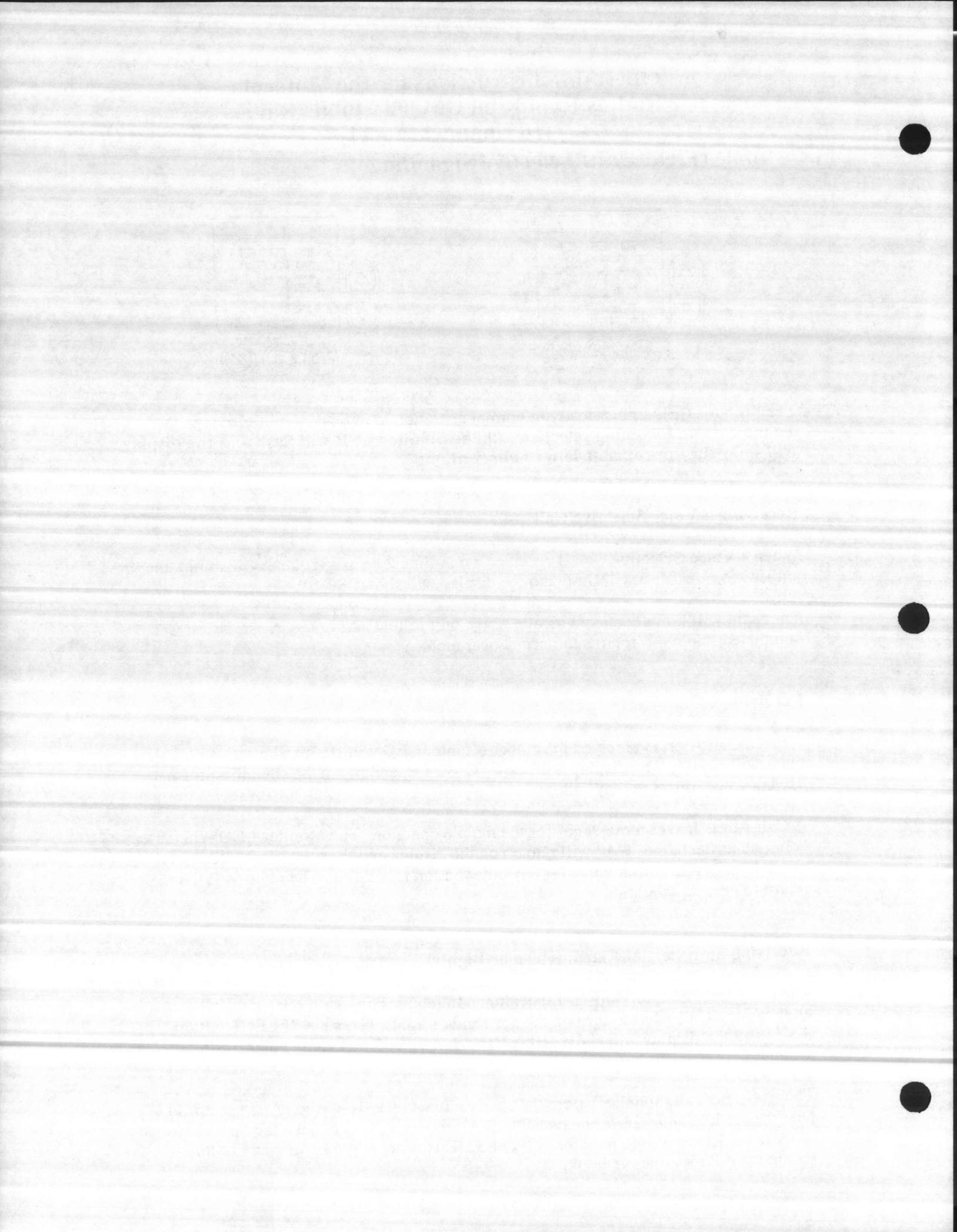
When a Call Alert is received the amber Monitor LED will flash and a series of 4 alert tones will sound. The display will show "CA". Depending on the signalling format used, a voice message may follow.

A Call Alert "leaves a message" for the mobile operator. The Monitor LED will continue to flash, the "CA" will remain on the display and the alert tones will repeat every 10 seconds until the PTT or any other button is pressed. The radio will then return to normal operation.

### Receiving an External Alarm (Horn or Lights)

The External Alarm or Horn or Lights function requires an alarm relay cable. To enable an incoming Call Alert to turn on the horn and/or lights, press the SELECT button [  ] and the display will show "HL". The duration of the external alarm is 6 seconds.

There will be a slight delay before the horn or lights relay is closed. An operator in or near the vehicle who sees or hears the Call Alert indication will have the opportunity to turn off the External Alarm before it sounds. This is done by pressing any button or taking the microphone off-hook.



## Mobile (Field Unit) Selective Signalling

### Sending an Identification Number

Every time the Push-to-Talk key is pressed, the radio automatically transmits a unit identification (ID) number. While holding the PTT key, a tone may be heard while the unit ID number is being sent out. Do not begin talking until the tone is over.

### Sending an Emergency Alarm

Emergency alarm requires the press of an external footswitch or pushbutton to send the emergency call.

If programmed for STANDARD EMERGENCY, the following will occur:

- The operator will hear a single alert tone when the Emergency is sent by the radio and the transmit LED will light.
- The letters "EE" will appear on the display.
- Five alert tones will sound to indicate the Control unit has received and acknowledged the Emergency. The "EE" will then disappear from the display.
- Messages will be heard over the radio's speaker during the Emergency.
- Monitor and Busy LED's will function normally during the Emergency.
- The only way to cancel the emergency is by pressing Push-to-Talk. No other button press will function normally except Monitor.

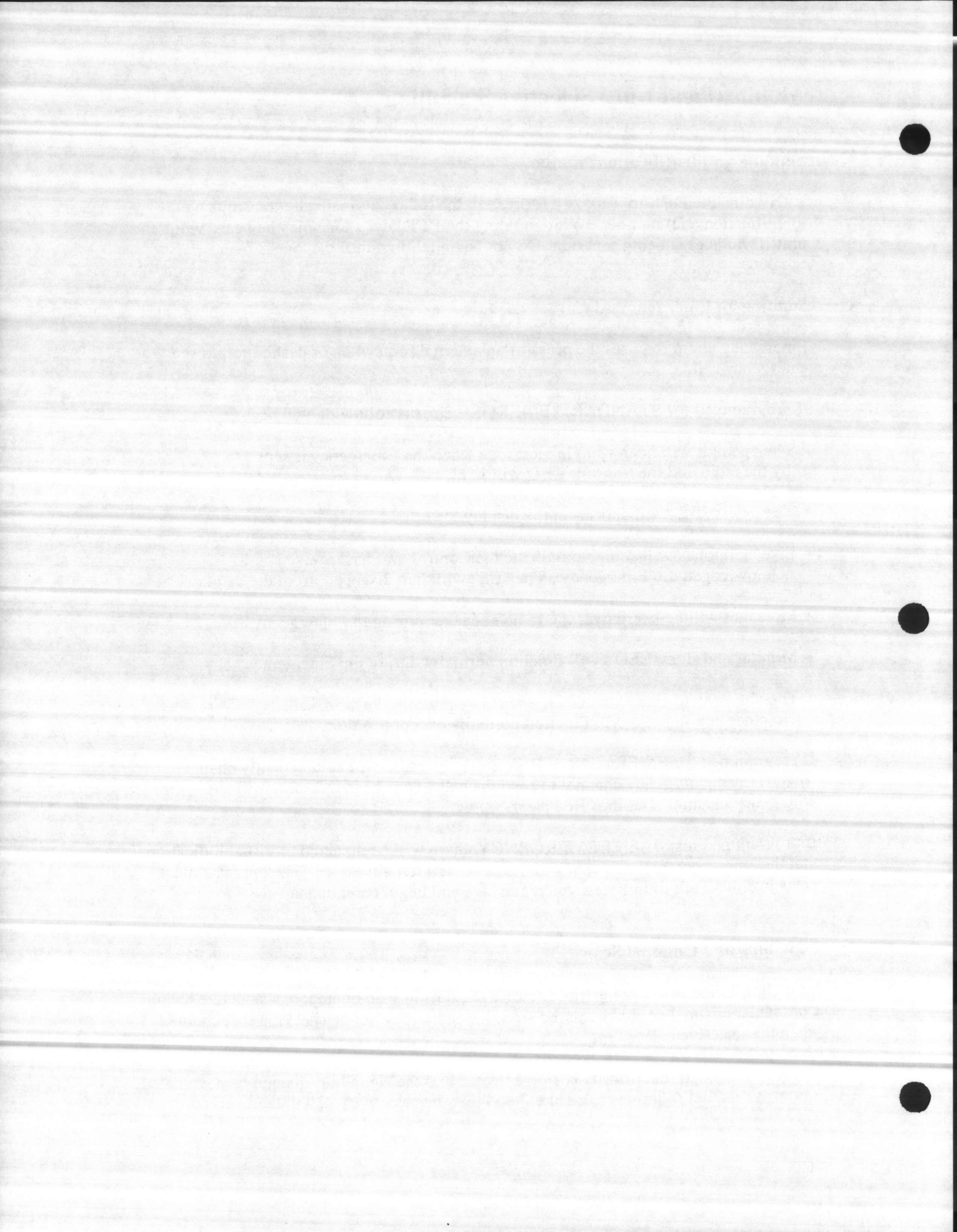
If programmed for EMERGENCY REVERT, the radio will automatically change (revert) to an emergency channel to send the call. The channel display will show the emergency channel after the "EE" clears.

If programmed for SILENT EMERGENCY, there will be no audio or visual indication that the emergency call was sent and the radio will remain muted. The operator must press Push-to-Talk to initiate a voice message and begin receiving again.

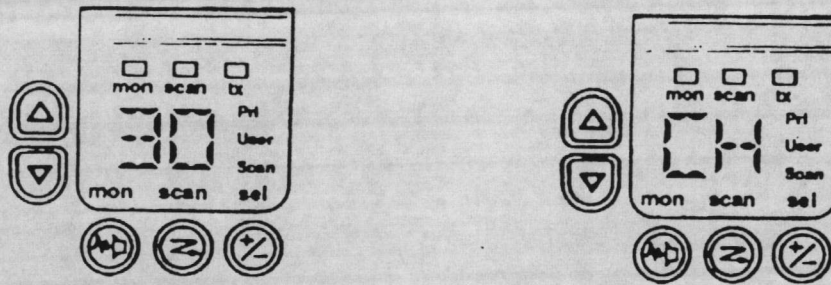
### Signalling and Channel Scan

Signalling and scan are compatible. However, during scan operation, a selective call on a particular channel could be missed since the radio may not be checking that channel when the selective call is sent.

It is recommended that priority scan is selected and the signalling channel be designated a priority channel to improve the likelihood that the selective call will be received.



## Control Unit Selective Signalling



### Display of Incoming Identification Numbers

Whenever an operator in the system presses the Push-to-Talk (PTT) key, the unit identification number (ID) will be shown on the display for 10 seconds or less if another incoming ID is received.

### Activating the Call List for Sending Selective Messages

Pressing the SELECT button will activate the Call List. The most recently used ID number and the call letters will alternately be displayed. The following call letters may be displayed when using a call list.


SC - Voice Selective Call: Call a particular unit or group with a voice message.


CA - Call Alert: Select a unit or group and leave a "call-back" indicator.

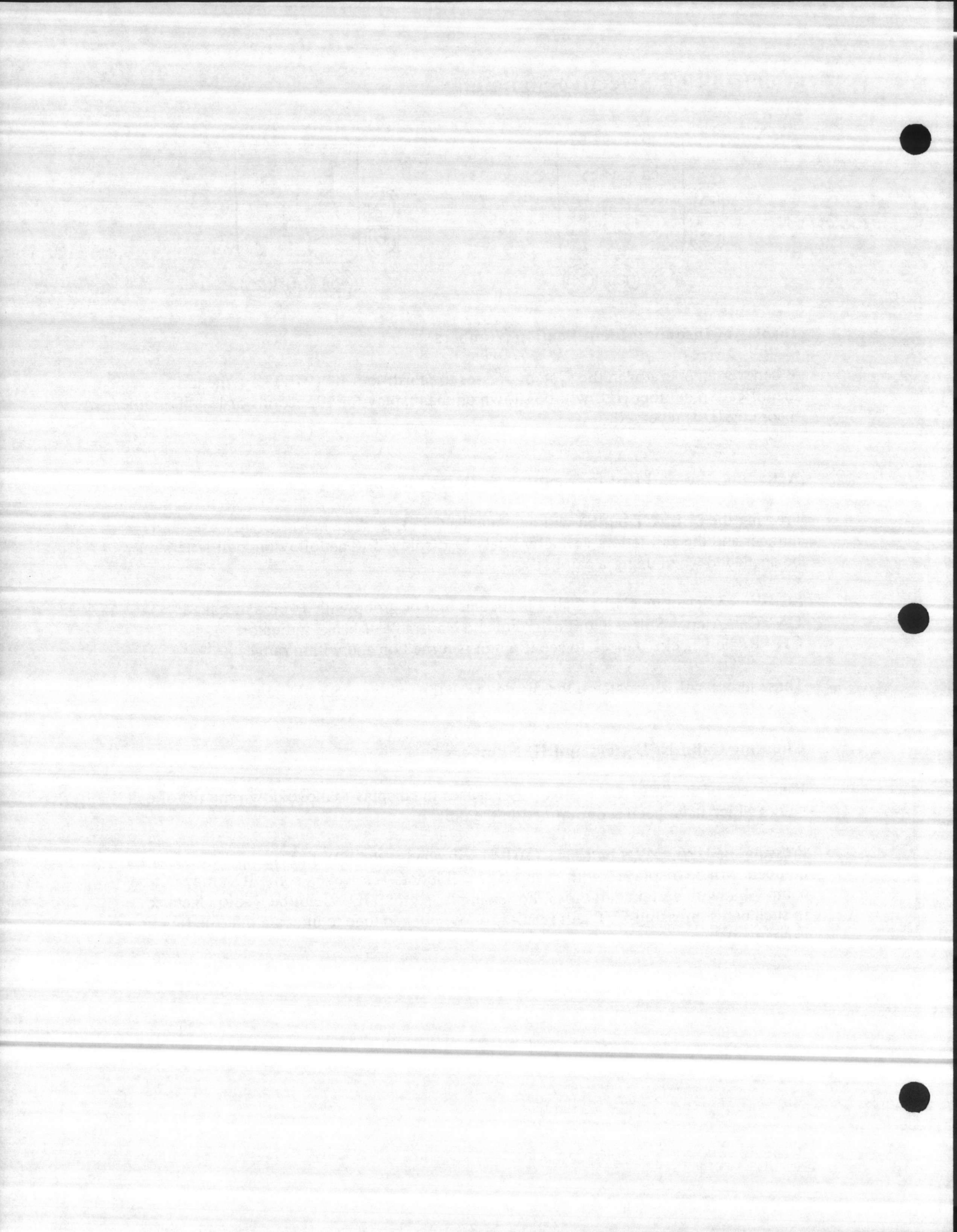
CH - Radio Check: Check to see if a unit is turned on and within range.

These letters will alternate on the display with the unit or group ID number.

### Choosing Call List Letters and ID Numbers

Each press of the SELECT button [  ] causes the display to move down the list of call letters which have been programmed in the unit.

Pressing the UP/DOWN buttons [  ] will change the ID numbers. All Call List ID numbers will be displayed with each set of call letters. However, some ID's may not be compatible with certain call types. For example, a group ID cannot be Radio Checked. In such cases, pressing PTT will result in a low pitched tone to indicate that the function is not available.



## Control Unit Selective Signalling

### Sending a Signalling Message


Once the desired call letters and ID numbers have been selected, pressing PTT will send the message. The display will revert to the preprogrammed transmit channel to send the signalling message and the channel will be briefly displayed while the message is being transmitted.

### Receiving an Acknowledgement

Depending on the signaling format used, the sending radio may look for an acknowledgement from the receiving unit on Call Alert and Radio Check calls.

The sending radio will show an "A" and 4 alert tones will sound if the target unit received and acknowledged the call. If no acknowledge is received, the sending unit will make another 4 tries. If unsuccessful, a "-A" will be displayed and a low pitched tone will sound to indicate no acknowledge.

### Exiting the Call List

The SELECT button [  ] is used to exit the signalling call list. Repeated pressing of the Select button takes one through the sequence of call letters to the channel display for normal operations.

### Receiving an Emergency Alarm

When an emergency alarm is received by the control unit, an alert tone will sound. The display will alternate "EE" and the ID number of the radio sending the emergency.

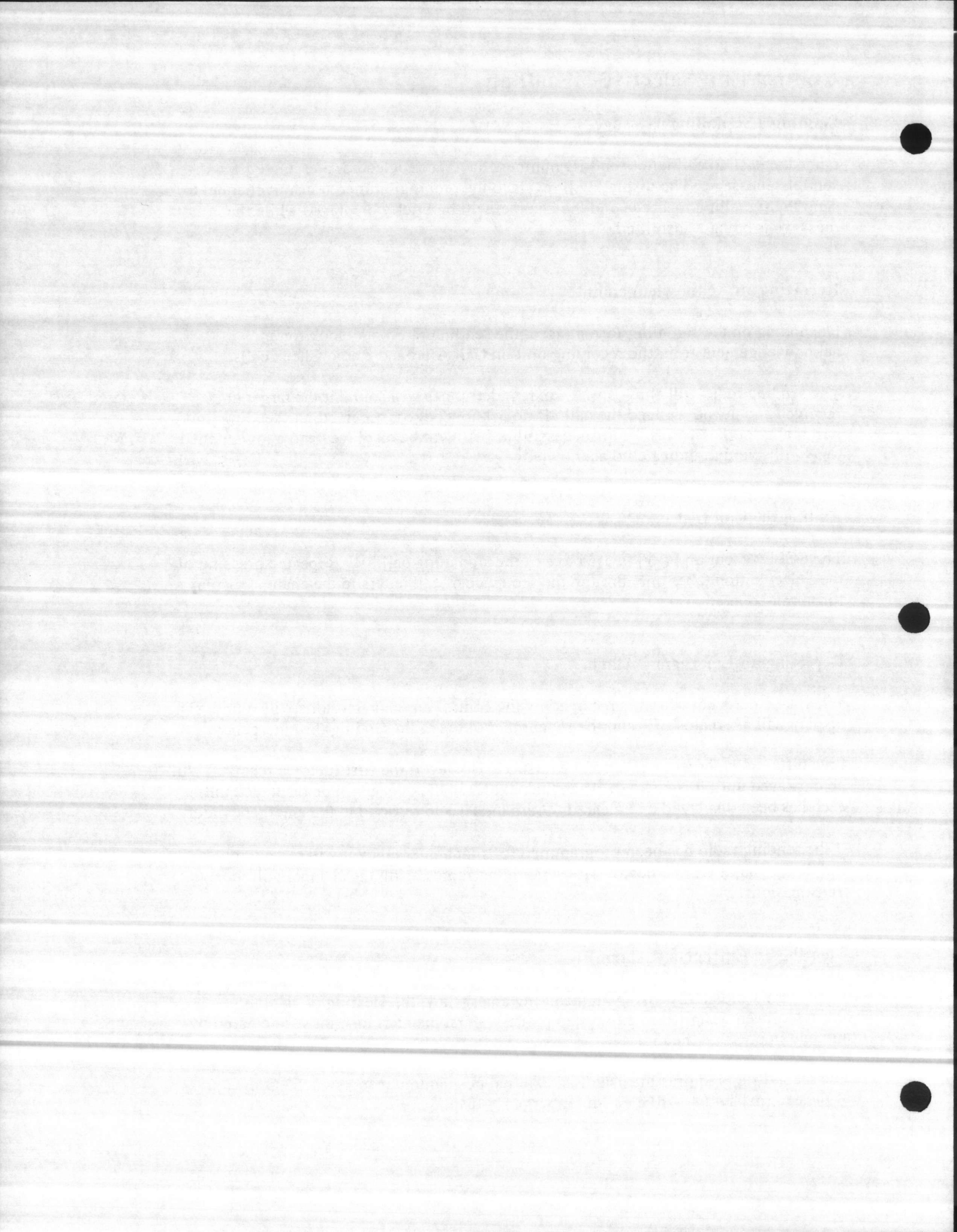
Five different emergency ID's can be queued. However, the first ID to be received will be displayed until it is cleared. Then the next ID in the queue will be displayed until each has been displayed and cleared. Press the PTT to respond to the emergency alert.

If the sending radio has been programmed for silent emergency it will remain muted and no messages will be heard. However, other radios using the channel will receive transmissions.

### Clearing an Emergency Alarm

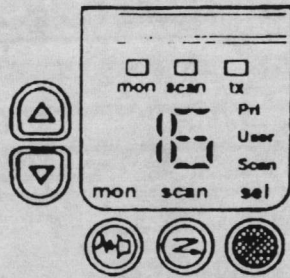
To prevent accidentally losing an incoming emergency, the clearing of an emergency alarm has been designed as a two step process. First the alert tone must be cleared by any button press on the radio.

The second step requires the use of an external pushbutton or footswitch. Only a press of the external switch will clear the Emergency display.






# GM300 ANI Phone Access Operating Instructions



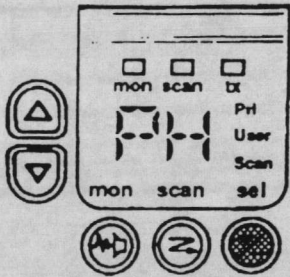
Radio is in normal operating mode.


Check the Busy LED to be sure the channel is free before pressing the Select button. See Note 1.

Press the Select button [  ]. The DTMF access code will automatically be transmitted and "PH" will appear on the display. See Note 2.

A call can be manually dialed using the standard Touch Code microphone. The radio will be in carrier squelch mode.

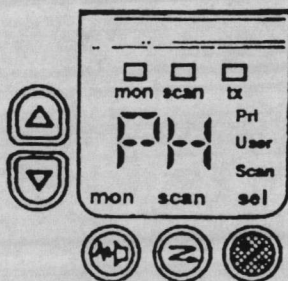
Press Select after the call is completed to send the deaccess code. The radio returns to normal operating mode and its prior monitor or coded squelch state. See Note 3.



Note 1. If you press the Select button [  ] when the channel is busy you will hear a low pitched tone. The radio will revert to monitor mode so you can listen for a free channel. Press the Select button again to send the Access code.



Note 2. If the patch missed the Access code when it was sent, the user would have to press Select twice to reaccess the patch: once to deaccess and again to access. The same case is true for Deaccess.


Note 3: If the radio reverted to monitor mode because of a busy channel before Access, it will return to monitor after Deaccess. Otherwise the radio will return to coded squelch.



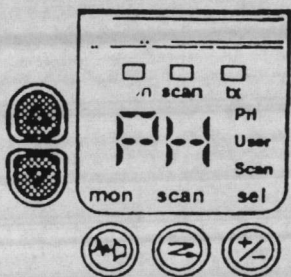
## Phone Memory List

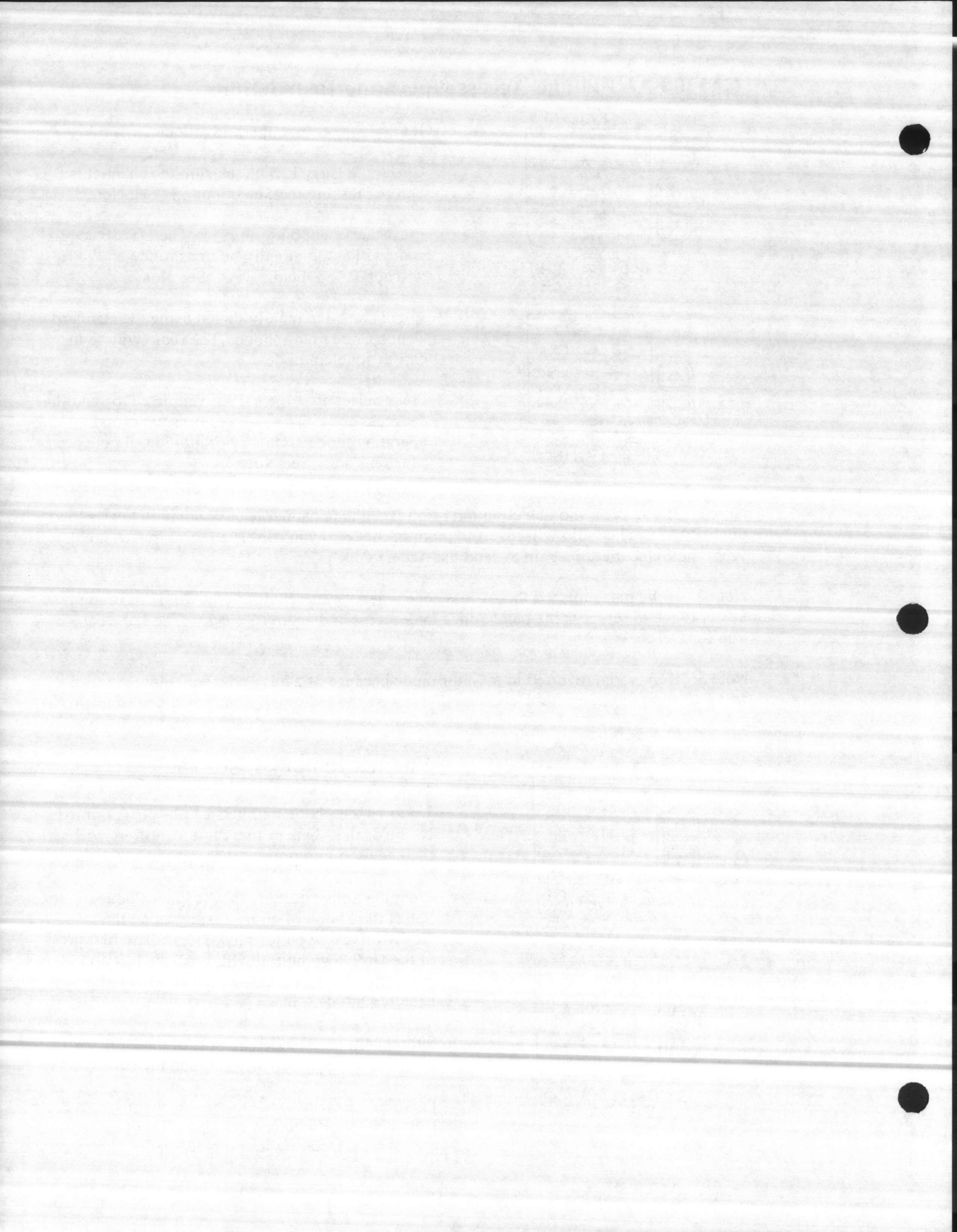
Up to 14 telephone numbers can be programmed by the dealer. One or two digit identifiers will then be used to represent these phone numbers.

Press the Select button [  ] to enter Phone mode. Select the Phone Memory List by using the Up/Down arrow buttons [  ]. The first press of the Up/Down button will recall the last phone number dialed. (This is not saved if the radio has been turned off.)

Subsequent or extended presses of the Up/Down buttons [  ] will step through the list.

Press PTT to send a call to the selected number from the list. Radio reverts back to Phone mode after memory dialing is complete.





## LICENSING AND SAFETY INFORMATION

Your Radius radio operates on FM radio communication frequencies and is subject to the Rules and Regulations of the Local Communications Governing Agencies. These agencies may require that all operators using Private Land Mobile or General Mobile Radio frequencies obtain a radio license before operating their equipment. The operator receives a license for use of the radio equipment under a specific eligibility and on a particular frequency or set of frequencies. To determine eligibility for use of Private Land Mobile Service frequencies contact your local communications governing agency. They will be able to supply information required to properly obtain and complete the license application form.

Agency addresses for several countries are listed below:

In the United States contact:

Federal Communications Commission  
Equipment Approval Services  
P.O. Box 358315  
Pittsburgh, PA 15251-5315  
Tel (301) 725-1585

In Canada contact:

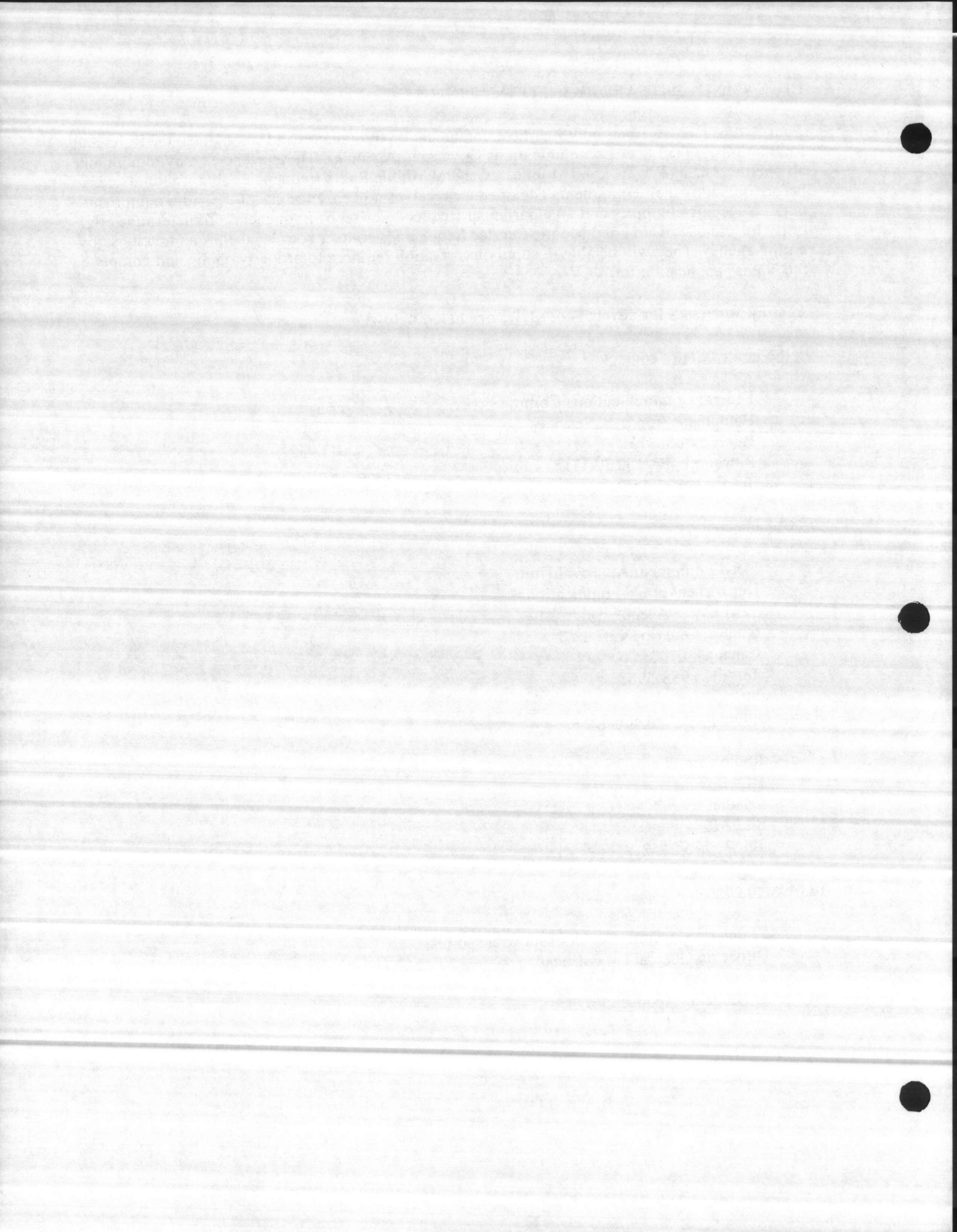
Head Equipment Approval Unit  
Department of Communications  
1241 Clyde Avenue  
Ottawa, Ontario K2C-1Y3  
Canada  
Tel (613) 998-5968

In the United Kingdom contact:

Radio communications Agency  
P.O. Box 20  
London  
SE1 8TZ  
Tel 71 215 2152

In Mexico contact:

Secretaria De Comunicaciones Y Transportes  
Direccion General De Politicas  
Y Normas De Comunicaciones  
Av. Eugenia No. 197-5o. Piso  
Mexico, D.F. 06700



In Singapore contact:

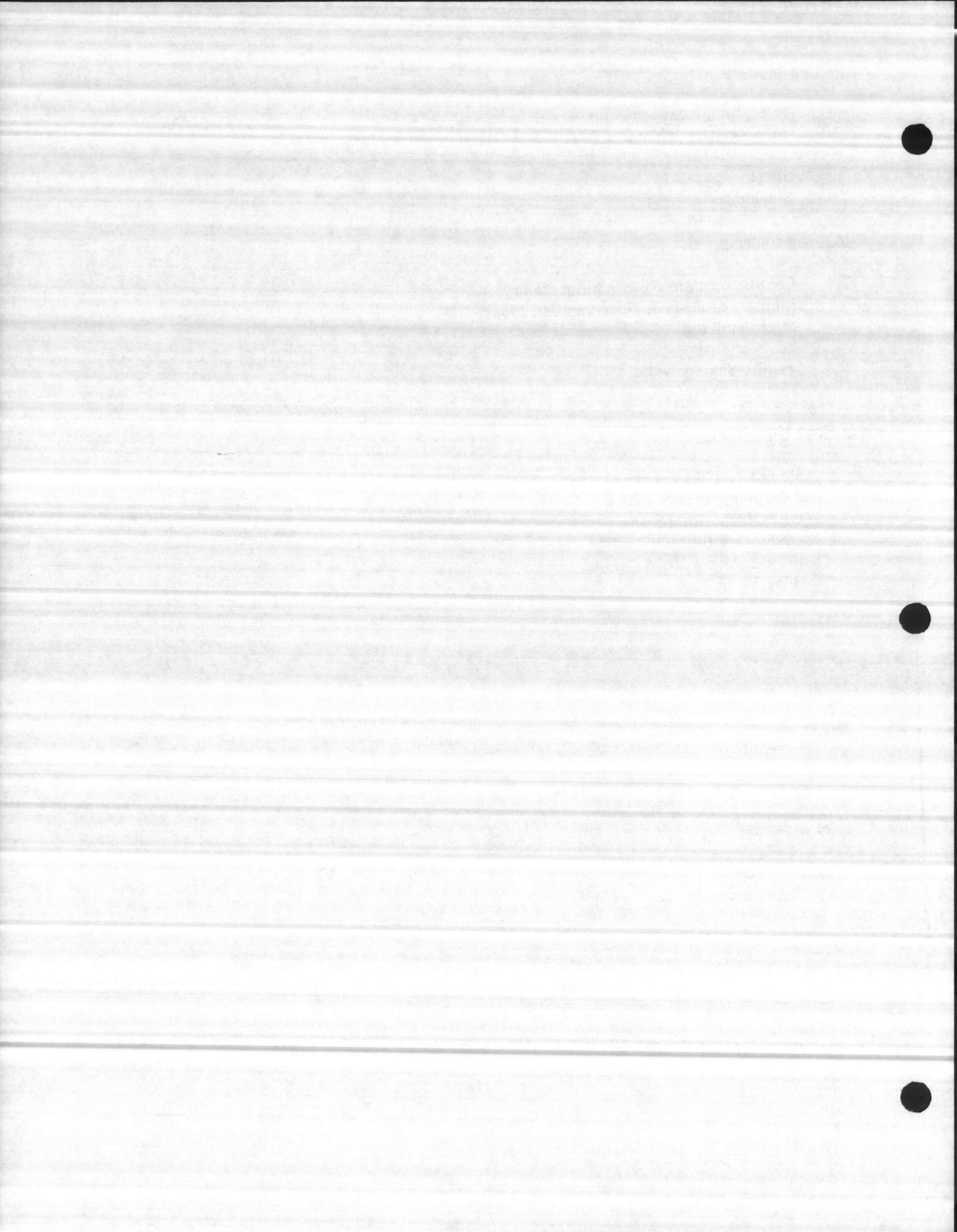
Telecommunications Authority of Singapore  
3rd Storey Comcenter  
31 Exeter Road  
Singapore, 0923  
Singapore

In Japan contact:

Communications Research Laboratory  
Ministry of Posts & Telecommunications  
MKK Building  
7-2, 5-chome  
Yashio, Shinagawaku  
Tokyo, 140 Japan

In Hong Kong contact:

Hong Kong Telecommunications Authority  
Telecommunications Branch  
Post Office, Hong Kong  
6/F Sincere Building  
173 Des Voeux Road Central  
Hong Kong

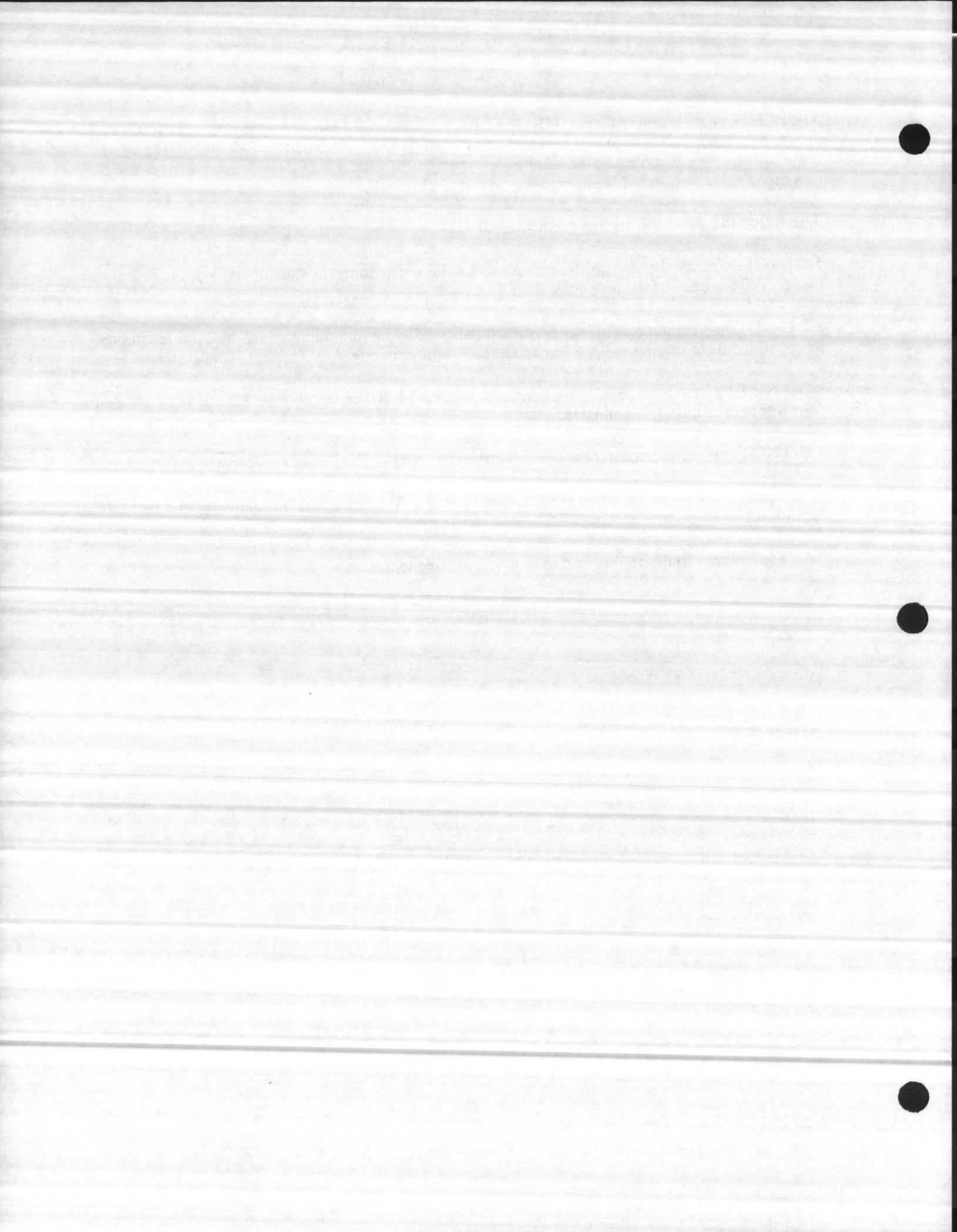


## SAFETY STANDARD

The FCC, with its action in General Docket 79-144, March 13, 1986, has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment. Motorola subscribes to the same safety standard for the use of its products. Proper use of this radio will result in exposure below government limits.

### **The following precautions are recommended:**

- \* **DO NOT** operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.
- \* **DO NOT** operate the transmitter of a fixed radio (base station, microwave, the rural telephone RF equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.
- \* **DO NOT** operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.
- \* **DO NOT** operate the equipment near electrical blasting caps or in an explosive atmosphere.
- \* All equipment must be properly grounded according to Motorola installation instructions for safe operation.
- \* All equipment should be serviced only by a qualified technician.





## SAFETY GUIDELINES:

### INSTALLATION SAFETY WARNING

Consider the occupants' safety when you choose a location for the radio. Do not mount the radio overhead or on a side wall unless you take special precautions.

If someone were to remove the radio and fail to replace it properly, road shock could bump the radio loose, and the falling radio could, in some circumstances, cause serious injury to the driver or a passenger. In a crash, even when properly installed, the radio could break loose and become a dangerous projectile.

If you must mount the radio overhead or on a side wall, give it the added protection of a retaining strap.

### OPERATIONAL SAFETY WARNINGS

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#### WARNING

For vehicles equipped with electronic anti-skid systems, see "ANTI-SKID BRAKING PRECAUTIONS" Publication, Motorola Number 68P81109E34.

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#### WARNING

For vehicles equipped with electronic ignition systems, check the service manual for warnings about the use of two-way radio equipment in the vehicle.

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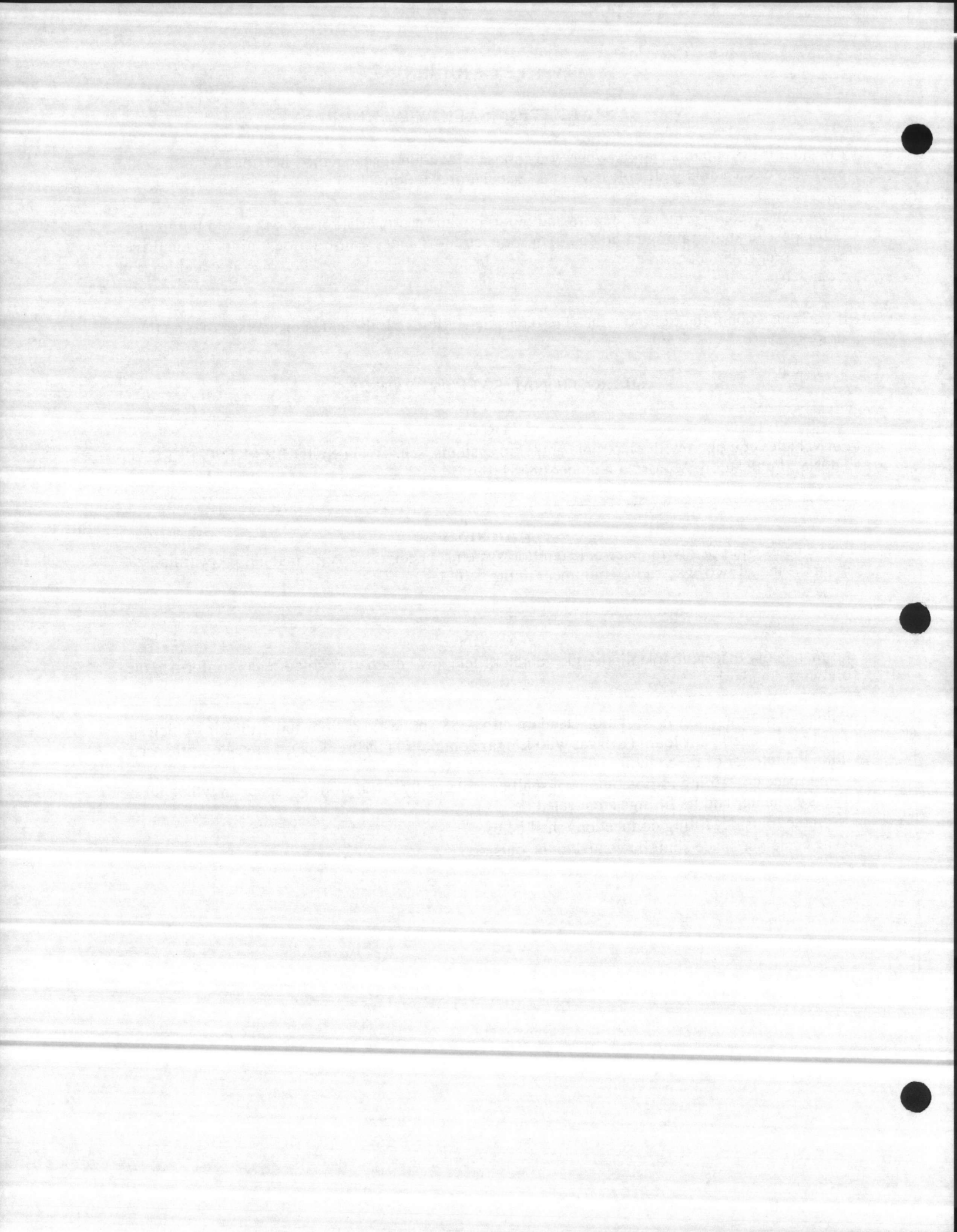
#### WARNING

It is mandatory that radio installations in vehicles fueled by liquefied petroleum gas conform to the following standard:

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National Fire Protection Association standard NFPA 58 applies to radio installations in vehicles fueled by liquefied petroleum (LP) gas with LP gas container in the trunk or other sealed-off space within the interior of the vehicles. This standard requires that:

1. Any space containing radio equipment shall be isolated by a seal from the space in which the LP-gas container and its fittings are located.
2. Remote (outside) fitting connections shall be used.
3. The container space shall be vented to the outside.



## CAUTION

### INSTALLATION OF ANTENNAS WITH MOBILE RADIO EQUIPMENT WITH TRANSMITTER POWER IN EXCESS OF 7 WATTS

**NOTE:** For low power mobile radios (7 watts or less), there are no antenna type or installation restrictions.

**Non-Metallic Body Vehicles** - In non-metallic body vehicles with transmitters at any frequency having a power output in excess of 7 watts, do not install any type of antenna closer than 2 feet in distance from any occupant of the vehicle. Failure to follow this procedure may result in the exposure of the vehicle occupants to radio frequency energy levels higher than recommended by the American National Standards Institute (ANSI).

**Metal Body Vehicles** - In metal body vehicles with transmitters at any frequency having a power output in excess of 7 watts, it is mandatory that when using a glass mount antenna the installation instructions covering the location of the antenna at the top of the front or rear window and the cable routing be followed exactly as described. Failure to follow this procedure may result in the exposure of the vehicle occupants to radio frequency energy exposure levels higher than recommended by the American National Standards Institute (ANSI).

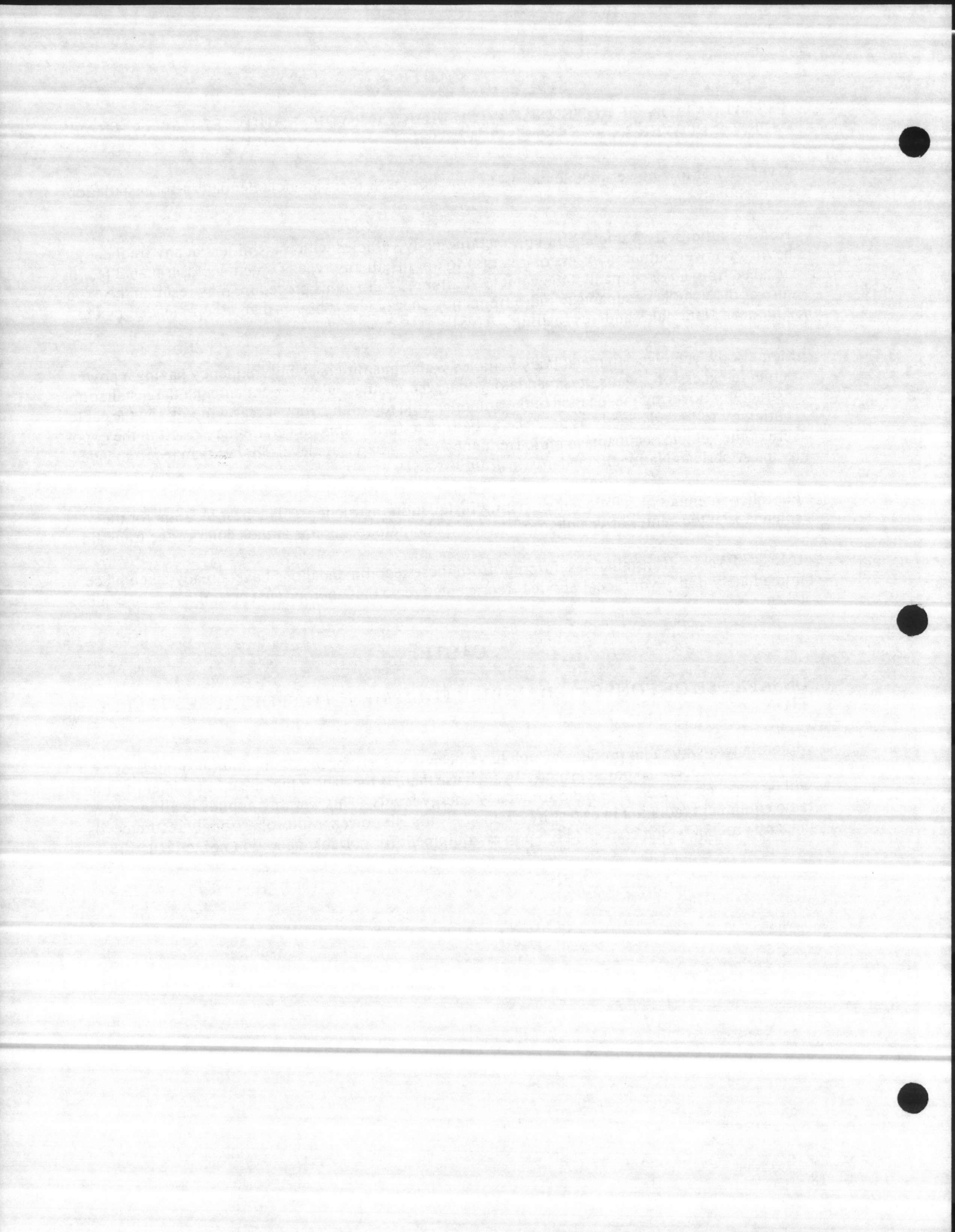
For other antenna types follow the existing installation instructions. The best location for the antenna is at the center of vehicle roof. A good alternate location is at the center of the trunk lid.

**IMPORTANT** - If installations different from these recommendations have already taken place, immediately notify your local Service Representative so that appropriate corrective action can be taken.

## CAUTION

### UNSAFE USE OF CONVERTED MOBILE EQUIPMENT FOR PORTABLE APPLICATIONS

Motorola two-way radio products which have been designed for mobile operation should not be used as battery operated portable units. In such use there is the danger that the user or other persons will be exposed to excessive radio frequency energy levels. This warning applies to all two-way radio equipment radiating in excess of seven (7) watts RF power. Motorola strongly recommends that any product which converts high power equipment for portable operation not to be used.



## INSTALLATION PLANNING AND PROCEDURES

### Testing and Maintenance

Your radio is completely adjusted, tested, and inspected before shipment. However, local governmental regulations may state that a station license be obtained for each radio installation (mobile or base) by the owner of the equipment. The station licensee is responsible for ensuring the transmitter power, frequency, and deviation are within the limits permitted under the station license.

No technician's license is required for installing and maintaining radio equipment. However, the frequency and deviation of the transmitter must be checked on installation and at least once yearly.

### Power Protection Circuitry

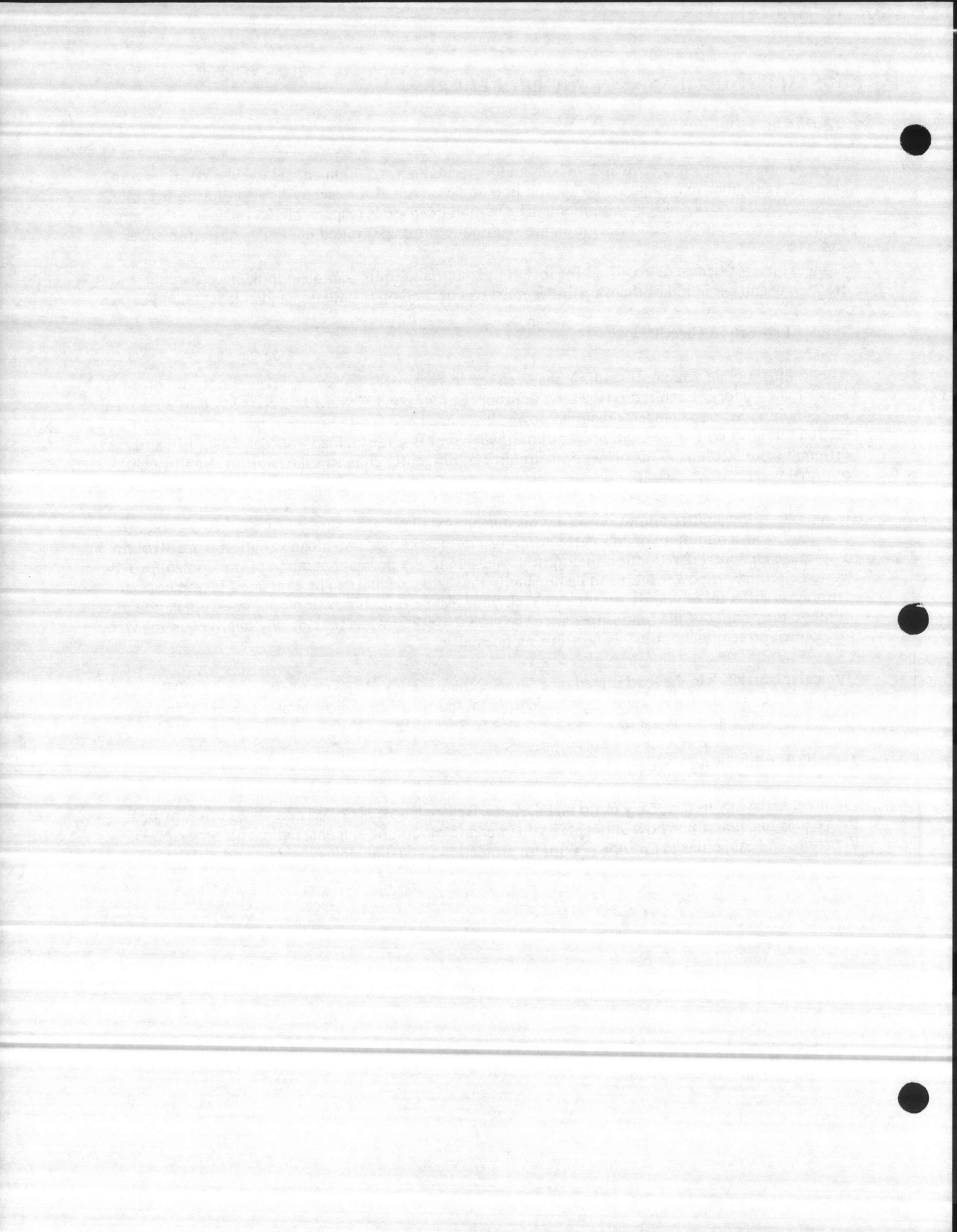
The Radius mobile you are installing has been tested for proper transmitter power output before leaving the factory. Each radio is set to the proper output power level while connected to an accurate 50 ohm load impedance. Once the power level has been set, the internal power control/protection circuitry will reduce the power output whenever it senses a load impedance significantly different from 50 ohms. This protection circuitry significantly enhances the radio's reliability with minimal performance degradation.

If you check transmitter output power levels during installation, be sure you are using a good 50 ohm load, with a minimum of adapters and using short test cables. Any load variation from 50 ohm may cause an apparent reduction in output power due to the normal operation of the control/protection circuitry. If power seems to be unusually low (greater than can be explained by the normal calibration differences you experience), check your test set-up. If power output goes up as you improve the quality of the load impedance (be sure to de-key when making any changes in load), the control/protection circuitry is performing normally.

Typical mismatches in the load impedance (greater than 1.2:1 VSWR) may result in a 10-20% variation in the actual measure power output. Within these limits, the radio operates normally and you should not attempt to service it.

### Installation Planning - Mobile Radios

Planning is the key to fast, easy radio installation. Before a hole is drilled or a wire is run, inspect the vehicle and determine how and where you intend to mount the antenna, radio, and accessories. Plan wire and cable runs to provide maximum protection from pinching, crushing, and overheating.



## Installation Planning - Base/Control Stations

The base/control station option provides the radio with a desk microphone and power supply for use at a fixed location. All operations are the same as the mobile, except for the desk microphone.

Choose a location for your base/control station as close as possible to where the antenna cable enters the building. Be sure 117V AC, 60 Hz power is available. Make sure sufficient air can flow around the radio to permit adequate cooling.

## Recommended Tools for Installation

The following tools are recommended for proper installation of your new radio:

- \* Portable Drill
- \* Hammer
- \* Center Punch
- \* 5/16" Hex Nut Driver
- \* 1/4" Hex Nut Driver
- \* Phillips #1 Screwdriver
- \* Phillips #2 Screwdriver
- \* 3/16" Blade Screwdriver
- \* 3/8" Diameter Drill Bit
- \* 5/16" Diameter Drill Bit
- \* 5/32" Diameter Drill Bit

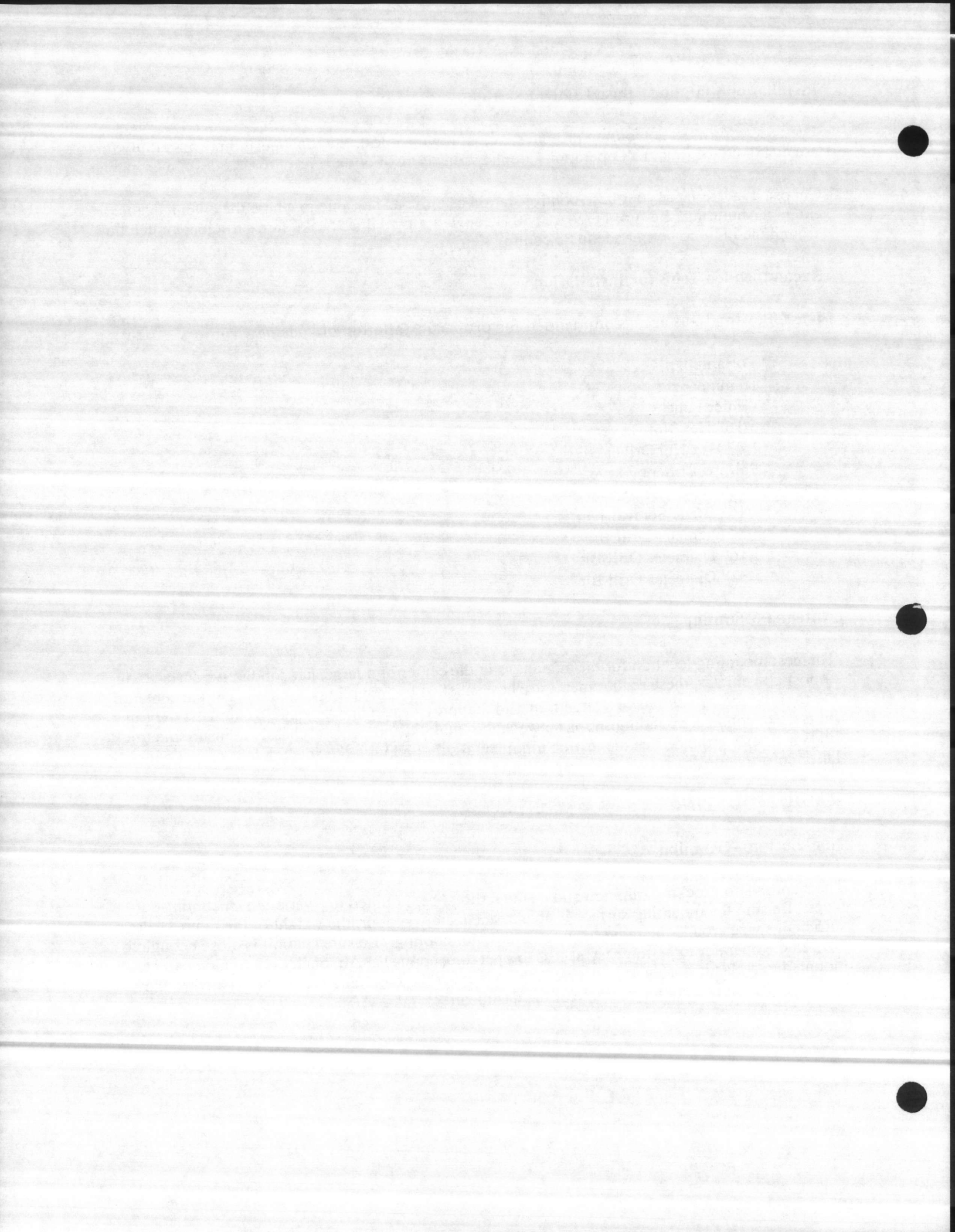
## Antenna Mounting

The best mounting location for the antenna is in the center of a large, flat conductive surface. In almost all vehicles, these requirements are best satisfied by mounting the antenna at the center of the roof. Some vehicles have a large trunk lid that provides a good antenna location. If the trunk lid is used, connect grounding straps between the trunk lid and vehicle chassis to insure the trunk lid is a chassis ground. See the instruction manual supplied with the antenna for complete installation information.

## RADIO MOUNTING

### Non-Locking Trunnion

The standard non-locking trunnion allows the radio to be mounted to a variety of mounting surfaces. Be sure the mounting surface is able to adequately support the weight of the radio. Allow sufficient space around the radio for free air flow for cooling. Be sure the unit is close enough to the vehicle operator to permit easy access to operating controls. Although the trunnion can be mounted to a plastic dashboard, it is recommended that the mounting screws be located so they penetrate the supporting metal frame of the dashboard.





## **Floor Mount**

A floor mount wedge (HLN9450) is available, which allows the radio to be tilted at either 45 or 60 degrees. (HLN9404 - Sleeve mounting bracket is also required).

## **Quick Disconnect Slide Mount**

The quick disconnect slide mount option is provided to allow the easy removal and installation of the radio. This may be desired by the operator for security reasons or to allow the use of one radio in multiple vehicles. This mount securely mounts the radio and makes all electrical connections, including the antenna connection.

## **Extra Stability Mounting Tray**

The optional extra stability mounting tray is used in conjunction with the non-locking trunnion. If the radio is mounted on a rounded surface, you may need to supply and install shim washers (not provided) between the bracket and the mounting surface. Shims are necessary to tilt the radio because the heavy duty bracket blocks the standard trunnion adjustments. Follow instruction provided with the option.

## **Locking Trunnion**

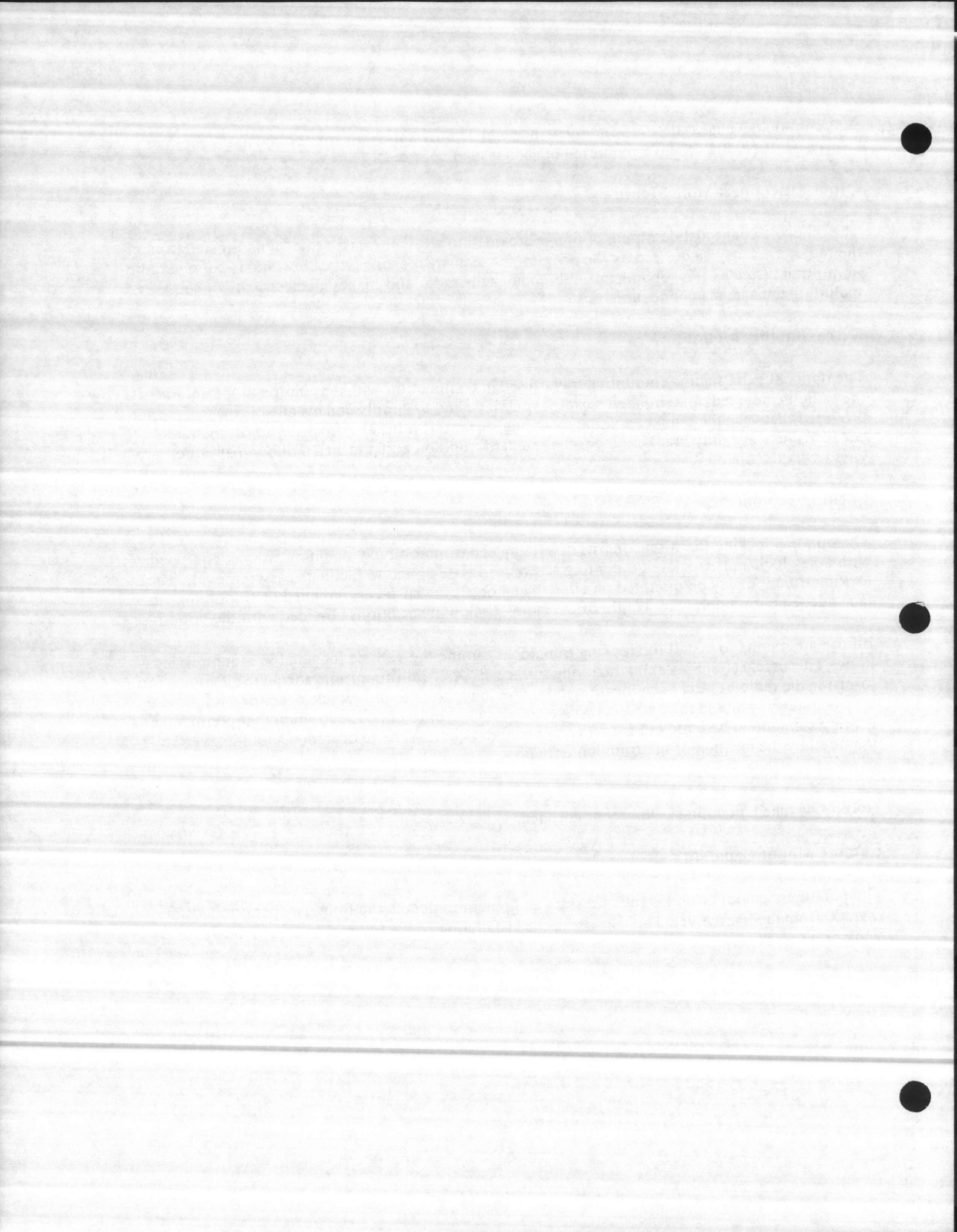
The optional locking trunnion consists of a two-piece trunnion type mounting bracket equipped with a key lock and associated mounting screws and is designed to facilitate easy removal. The locking trunnion may be mounted on either metal or plastic surfaces, provided the mounting surface adequately supports the weight of the radio. Follow instructions provided with the option.

Before attempting to install the locking trunnion, examine the vehicle for suitable mounting locations. This bracket requires a flat mounting surface, 8" X 2" minimum with adequate clearance for inserting the radio. The chosen location should be convenient to the vehicle operator and provide access to the power and the antenna connectors. Be careful to choose a location that permits the locking trunnion to be removed from the mounting bracket. Vehicle operation should never be impaired by the location of the trunnion or radio.

**Note:** Overhead mounting is not recommended.

## **Remote Mount Capability**

The remote mount kit provides the necessary equipment to detach the front panel controls of the GM300 from the transceiver. This allows for the installation of the transceiver box in the vehicle's trunk or under the seat.



## BEGIN INSTALLATION

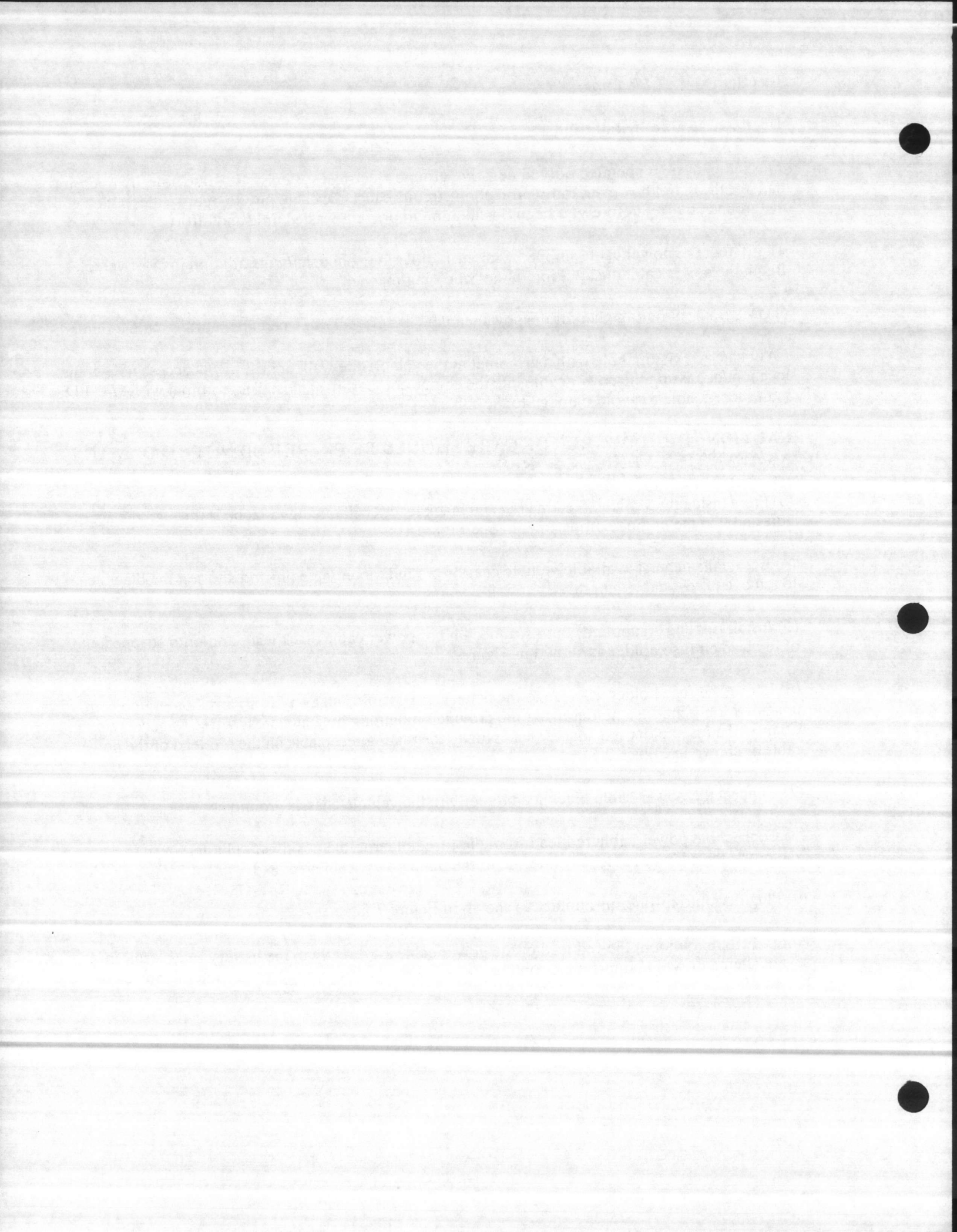
### DC Power Cable Installation

This radio must be operated only in negative ground electrical systems. Reverse polarity does not damage the radio; however, radio protection circuits cause the cable fuse to open. Check the vehicle ground polarity before you begin installation to prevent wasted time and effort.

The 10 foot DC power cable shipped with the radio is long enough for installation in most vehicles. Begin the power cable installation in the following manner:

- (1) Determine a routing plan for the power cable with reference to where the radio is to be mounted.
  - (2) Locate an existing hole with a grommet in the vehicle fire wall, or drill a 3/8" access hole at the location for passing the power cable into the engine compartment. Install a grommet with 1/4" I.D. in the access hole to avoid damage to the cable.
- CAUTION: HIGH DEGREE OF CARE SHOULD BE EXERCISED NOT TO DAMAGE ANY EXISTING VEHICLE WIRES.**
- (3) From inside the vehicle, feed the red and black leads (without lugs attached) through the access hole and into the engine compartment. See Figure 1.
  - (4) Locate the nearest available vehicle chassis ground mounting point and shorten the black lead to remove excess cable length.
  - (5) Install ring lugs (supplied) onto stripped end of power cable black lead, and onto stripped end of red lead on fuse holder as shown in Figure 2.
  - (6) Locate the fuse holder as close to the battery as possible and away from any hot engine component. Mount the fuse holder using the provided mounting hole and dress wires as necessary. Connect the fuse holder red adapter lead plug to the mating receptacle on the red lead of the power cable as shown in Figure 2.
  - (7) Connect the power cable black lead directly to the vehicle chassis ground.
  - (8) Connect the power cable red lead from the fuse holder to the positive (+) battery terminal. Make sure the adapter cable is connected to the main power cable red lead.
  - (9) Plug fuse into in-line fuse holder as shown in Figure 2.

**Note:** Failure to mount the red lead of the power cable kit directly to the battery may result in severe alternator whine interference and cause radio to revert to mode 1 each time the power is turned off.



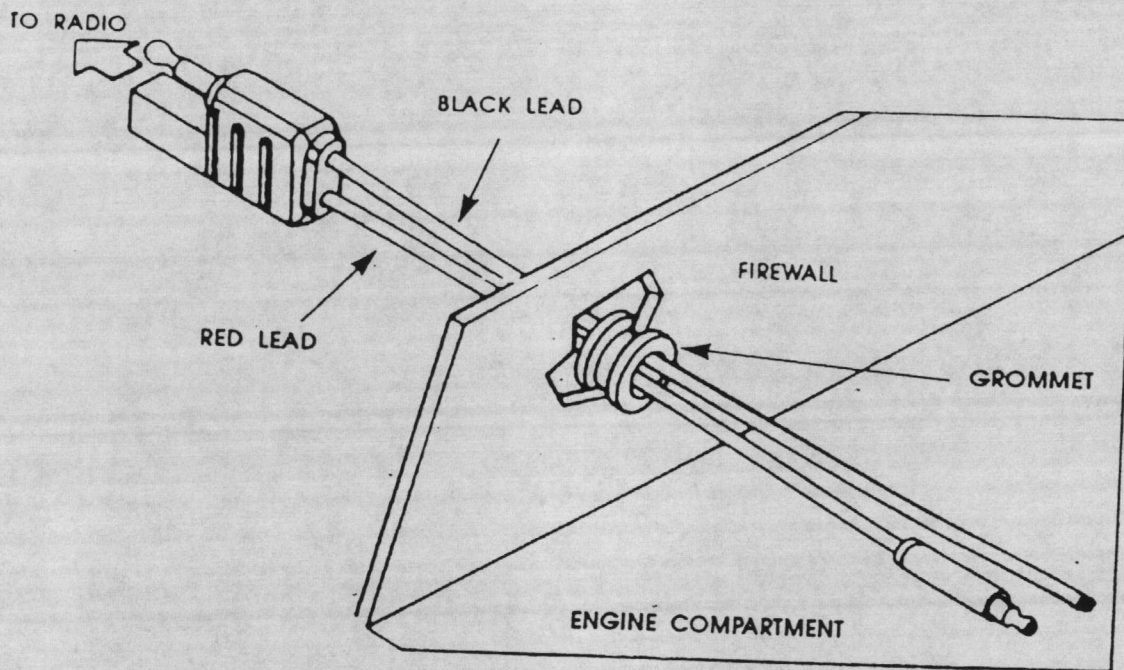


Figure 1. Power Cable Routing into Engine Compartment

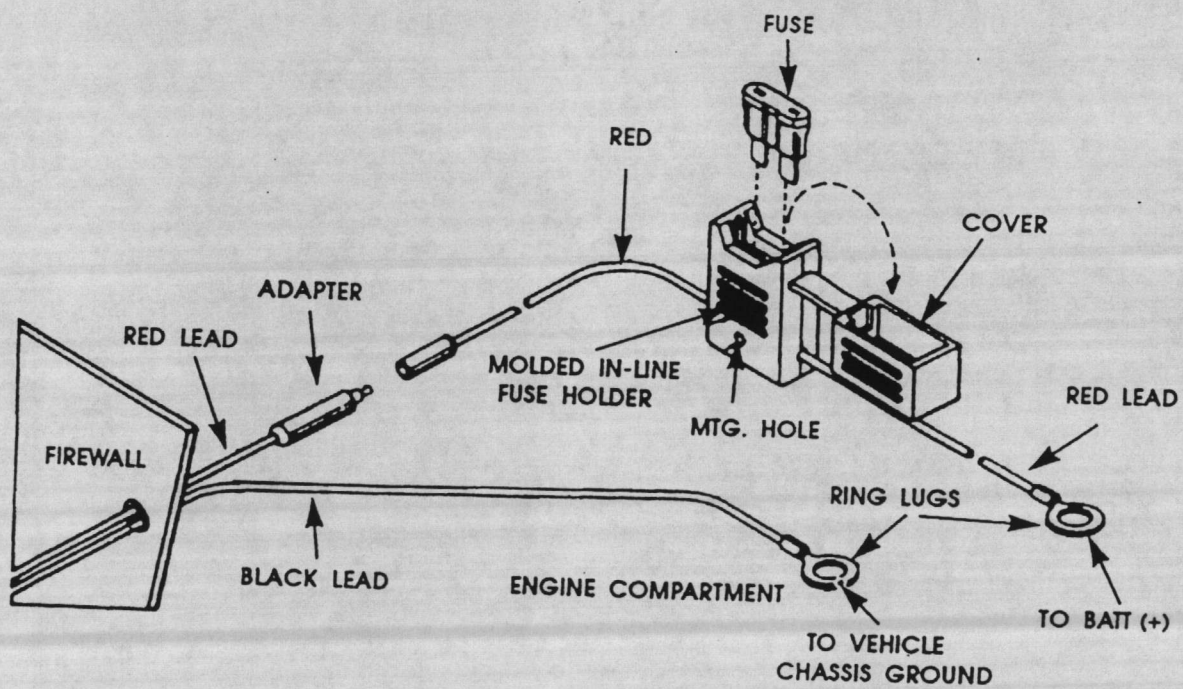
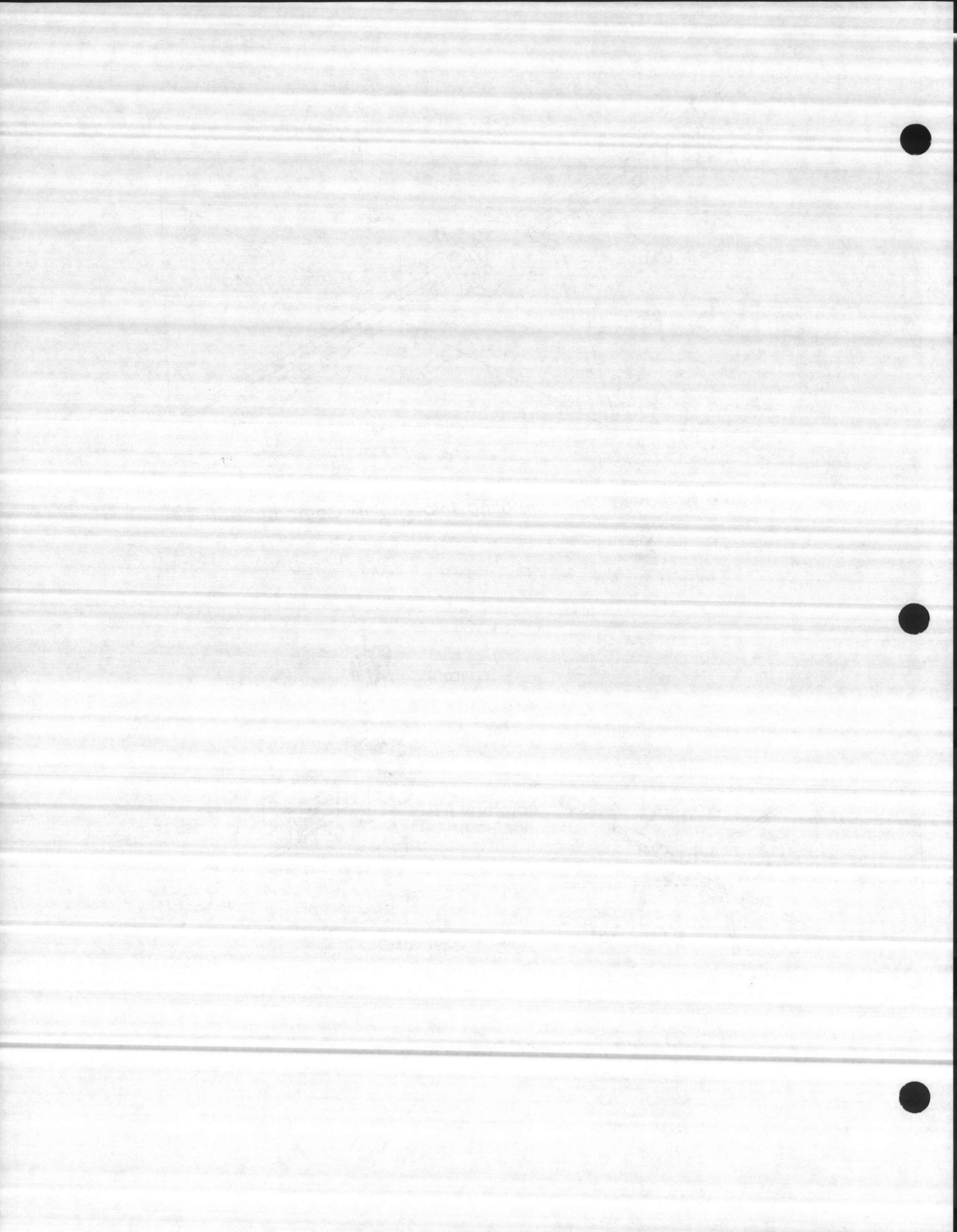


Figure 2. Power Cable Assembly



## NON-LOCKING TRUNNION INSTALLATION

(See Figure 4)

- (1) Select the location to mount your radio either on the **Transmission Hump** or **Under the Dash** (see Figure 4).
- (2) Using the trunnion mounting bracket as a template, mark the positions of the holes on the mounting surface. Use the innermost four holes for a curved mounting surface such as the transmission hump, and the four outmost holes for a flat surface such as under the dash.
- (3) Center-punch the spots you have marked and drill a 5/32" hole at each.
- (4) Secure the trunnion mounting bracket and secure it with the two thumb screws provided.
- (6) To complete your radio installation plug the power cable into the radio power connector (see Figure 3).
- (7) Mount the antenna using the instructions provided with the antenna kit. Run the coaxial cable to the radio mounting location. If necessary, cut off the access cable and install the cable connector.
- (8) Connect the antenna cable connector to the radio antenna connector on the rear of the radio (see Figure 3).
- (9) Mount the microphone clip. Follow instructions provided with the microphone clip.
- (10) Plug the Microphone into the front panel connector. Your microphone has a telephone type connector at the end of its cord. Connect and disconnect your Radio Microphone in the same manner you connect and disconnect your telephone handset.

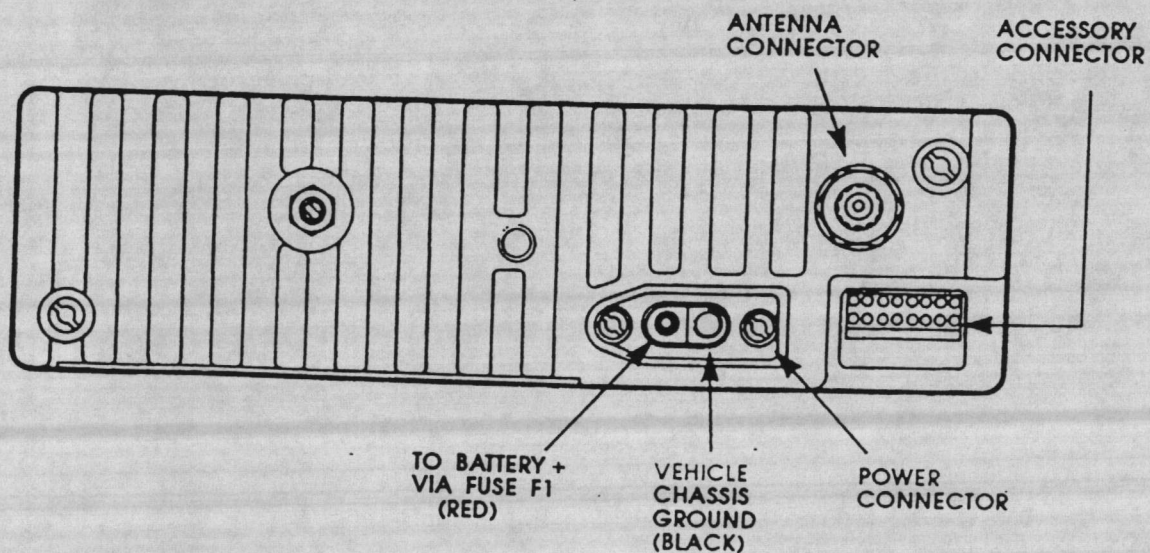
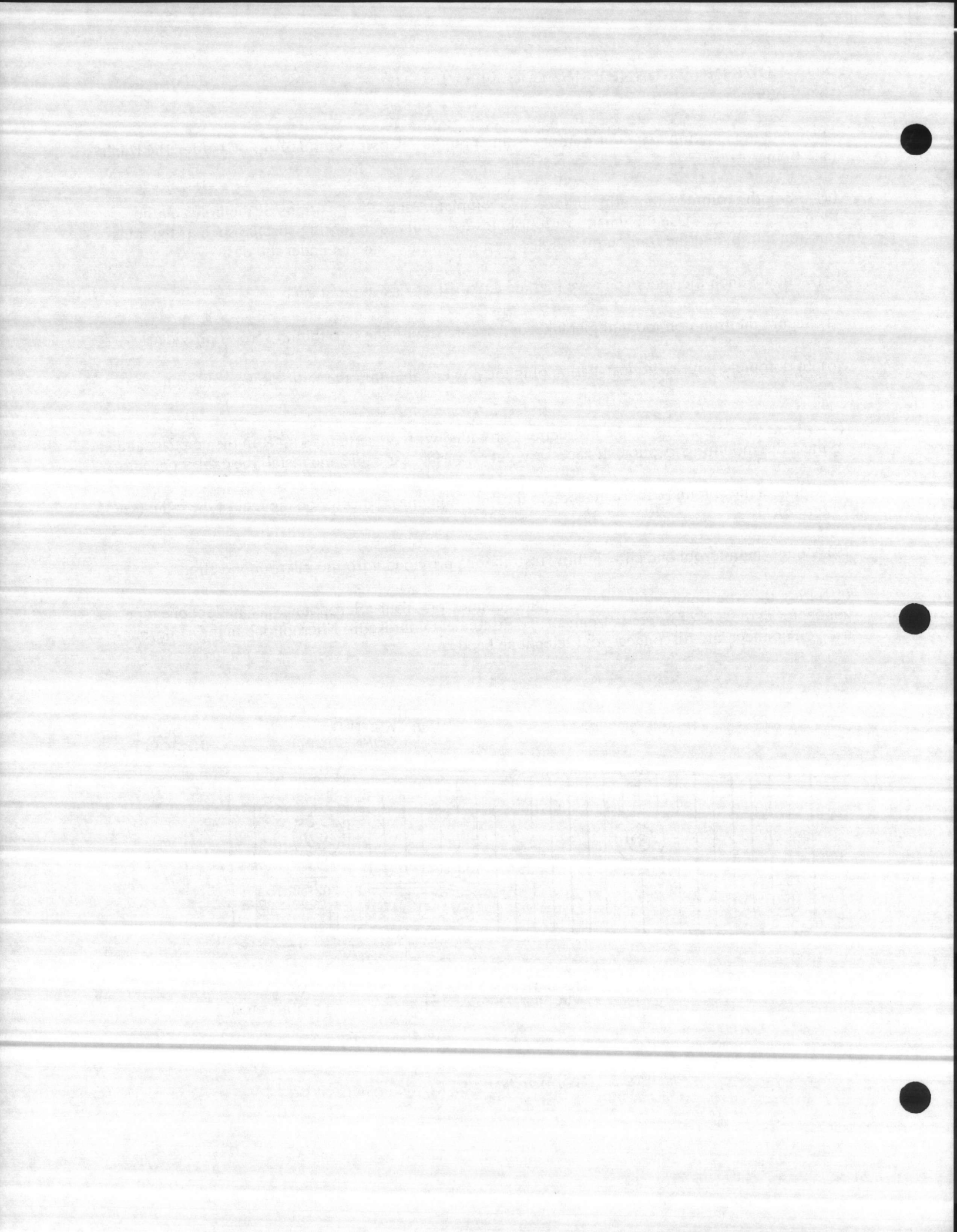


Figure 3. Connections to Radio Rear Panel





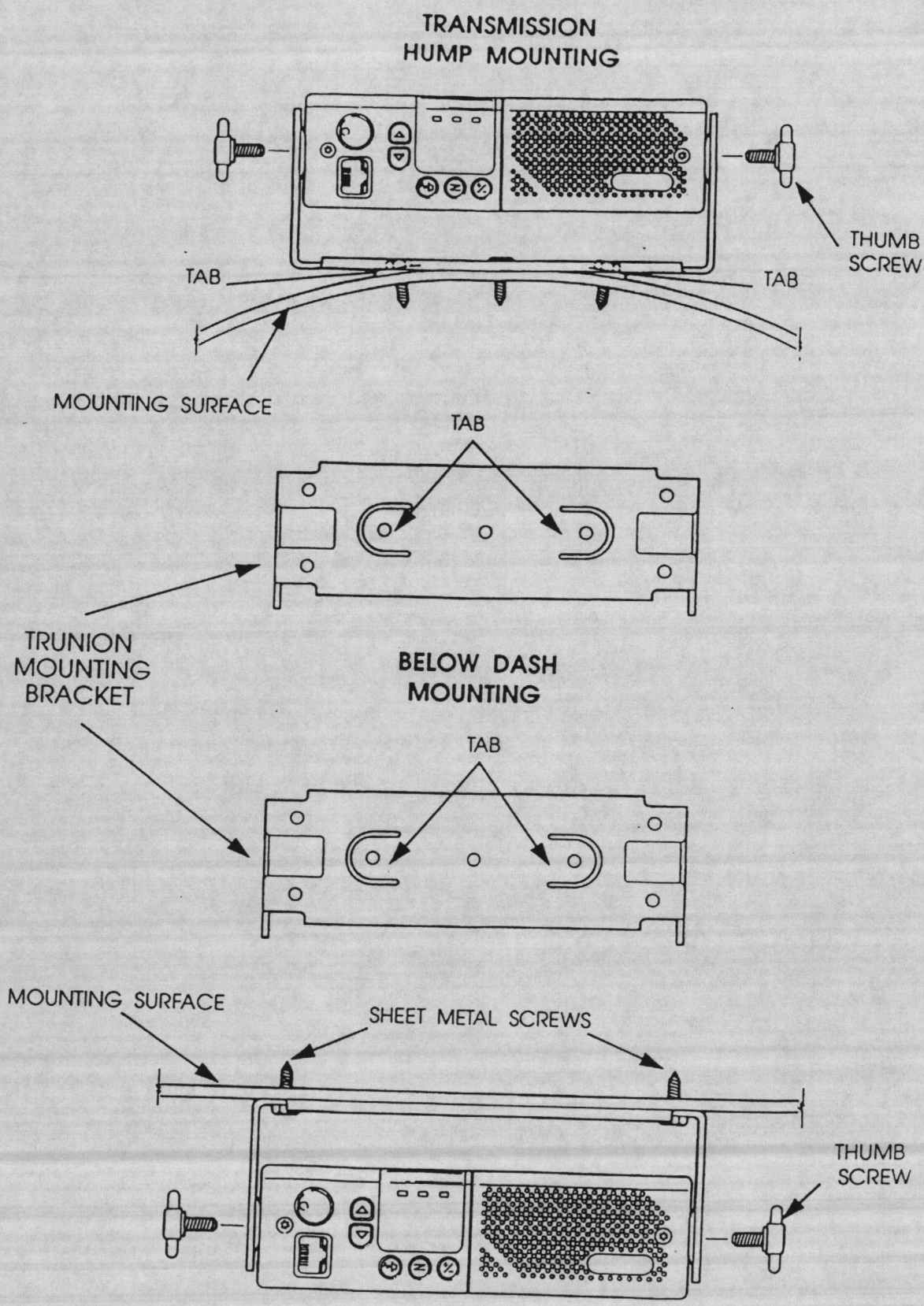
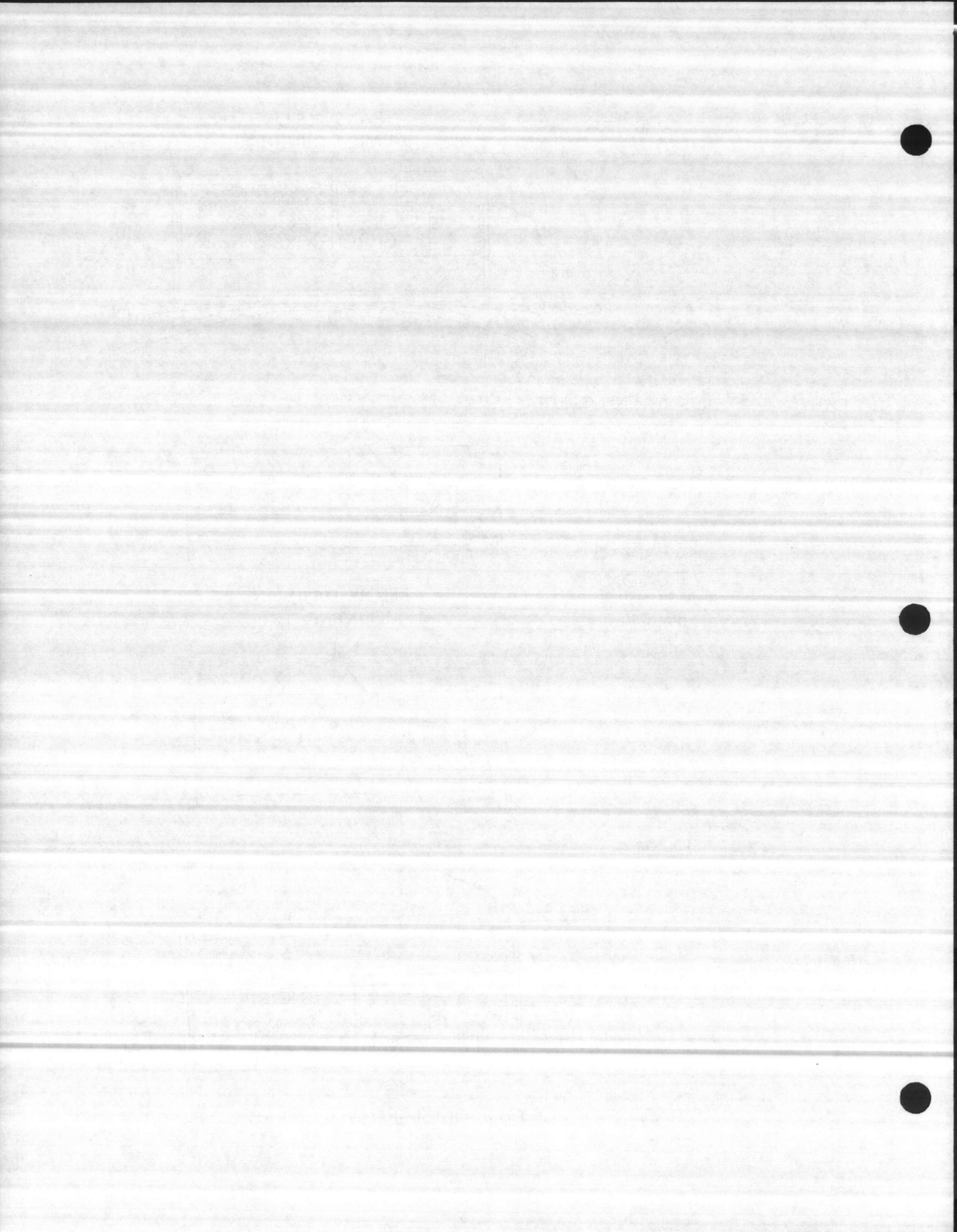


Figure 4. Trunion Mount for Radio



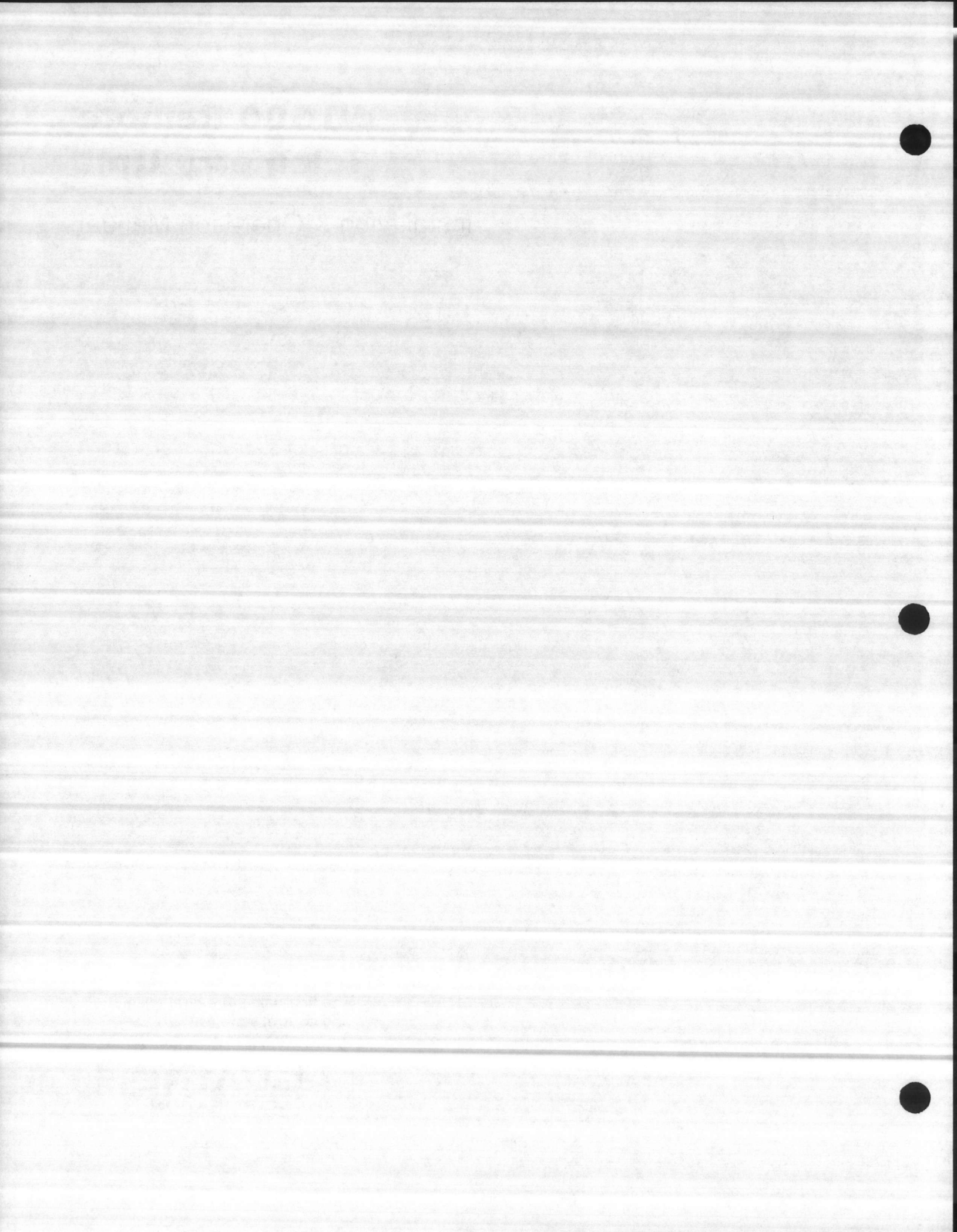
# **W1500 Remote Telemetry Unit**

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Installation & Operation Manual

The first name in digital telemetry  
and control systems.

**AQUATROL**  
CORPORATION



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## 1 Introduction

The T2044 is a remote station for the W1500 SCADA system. It is a single circuit board that contains power supply, modem, 6 analog inputs, 2 analog outputs, 2 high speed pulse accumulators, an RS232C port, telephone and radio connections, battery charger and 16 replaceable I/O modules. Two additional analog inputs are assigned to battery voltage and enclosure temperature. All connections are plug in for ease of board replacement.

### Power:

110V 60Hz, 4 watts (8 watts for battery charging).  
Fused Input.  
12VDC battery optional - charger provided.

### Communication:

300/1200 baud modem with phone line and radio connections usable together. Two wire or four wire circuits.

### Expansion:

50 pin ribbon cable, unbuffered. This must connect to an expansion board within 4 inches of RTU.

## 2 Model Table

Model	Description	Class	Part No.
T2044 A01	300/1200 Baud RTU	3	730801

## 3 Specifications

### Power Sources

AC Input: 120 VAC,  $\pm 20\%$ , 47 to 63 Hertz Transformer mounted on RTU 1/2 amp base, 3 watts

External DC: 11 to 20 VDC, 0.5 amp fused

Rechargeable Battery: Available accessory, 12V 20 ampere/hour, 1/2 amp fuse. RTU provides charging current when AC power is available

Output:  $22 \pm 2$  VDC 120mA Battery back-up for digital input module power or analog input loops

Internal Power Supplies: +5VDC, -5VDC, +12VDC, -12VDC, +24VDC

Power Input Termination: Compression terminals #14 wire

## Communications

Channels: 2 USART's

### Modem Channel:

110-9600 Baud (software selectable)

RS-232 Channel: 110-9600 Baud (software selectable)

Transmission Line: Bell 3002 unconditioned voice grade or equivalent, for standard data rates up to two or four wire connection provided. MOV surge protection device is standard.

Modem: Software selectable to standard FSK 202 type (0-1200bps), or 103 type (0-300bps), narrow band FSK.

Timing: All internal RTU timing is derived from a 20 MHz crystal time base ( $\pm 0.02\%$ ).

Processor: 80C188.

Memory: EPROM: 128K bytes-standard (500K bytes-max) RAM: 32K bytes-standard (500K bytes-max) EEPROM: 8K bytes-standard

Termination Connectors: Elevator clamp pull-apart terminals. Live circuits fully protected.

Wire Gauge: To 14 AWG.

## Physical

Dimensions: (Main Logic Module)  
11.0" H x 12.0" W x 20" D.

Weight: Approximately 4.5 lbs (with 16 modules).

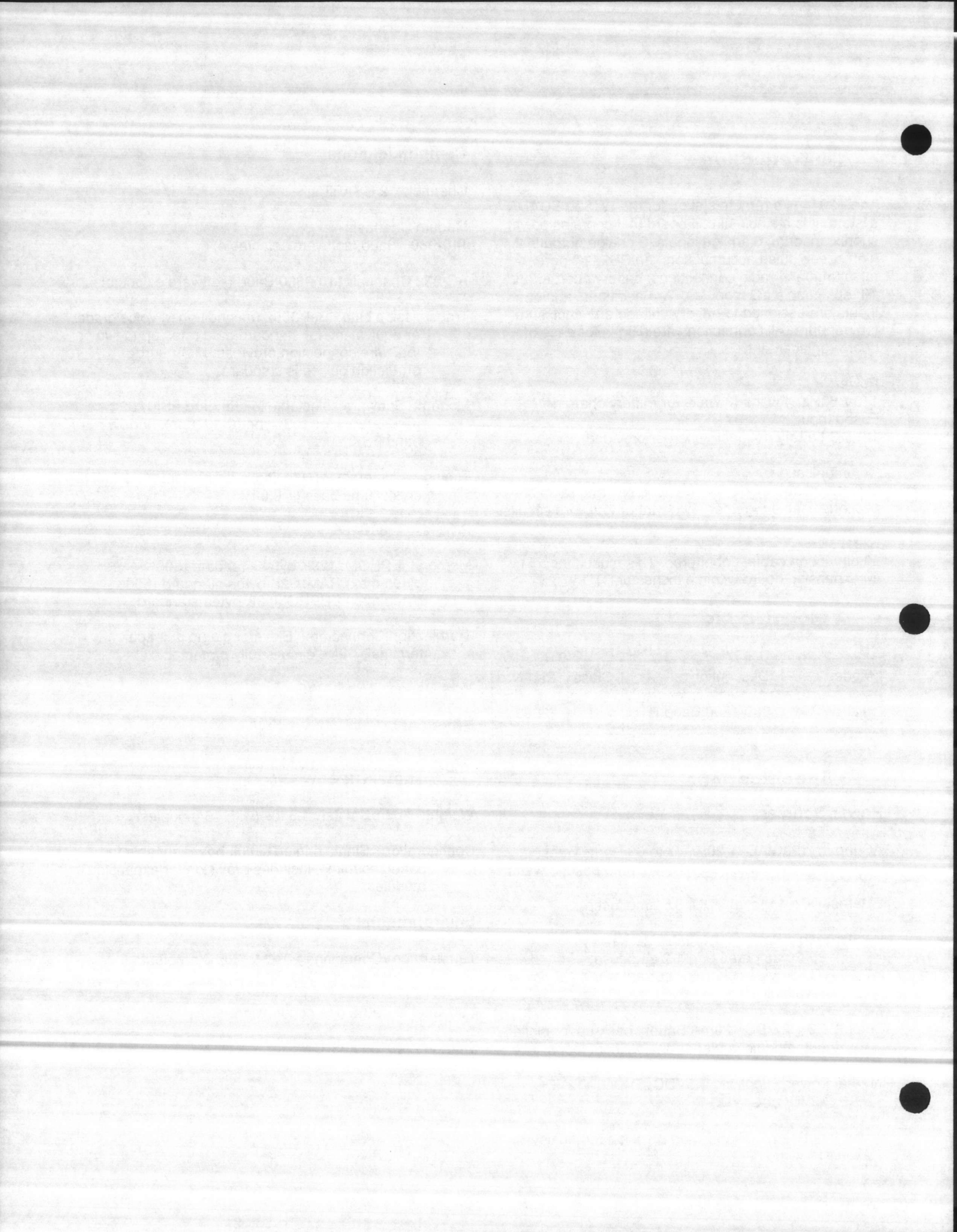
Configuration: Single printed circuit board suitable for panel mounting, includes provision for expansion modules.

## Environmental

Temperature/Operating: 20° C to 70° C ambient (Optional - 40° C to 70°).

Humidity: 0 - 90% non-condensing.

Storage: -40°C to 85°C.





## Input/Output Specifications

(Combination of 16 user configurable I/O)

### Status Inputs\*:

Threshold: Low = 0.1 V, Hi = 8 V (min.).

Filtering: 10 mS debounce.

Isolation: Optical, 600 VDC.

Voltage Supply: 3-32 VDC, 10-36 VAC and 90-140 VAC noise decoupled and fused/derived from primary voltage source.

Isolation Resistance: 100 M ohms or greater.

Termination: Compression type, 2 wires per point.

\*Also, act as pulse inputs, max 20 pps.

### Digital Outputs

Drive Current (Per output): 3A max AC or DC.

Output Type: Optically isolated triac or power transistor.

Voltage (Supply): 5-60 VDC or 24-280 VAC noise decoupled and fused/derived from primary voltage source.

Transient Protection: DV/DT protection internal to I/O.

Termination: Compression type, 2 wires per point.

### Accumulator Inputs

(High speed, refer to status inputs for low speed accumulators)

Channels: 2.

Isolation: Optical, 600 VDC channel to channel.

Filtering: 50 K Hz

Power: Inputs powered by RTU. External contact or transistor must switch 12 VDC @ 7 mA

### Analog Inputs

Channels: 8.

Conversion Technique: Dual slope integration.

Multiplex Scheme: Protected CMOS differential switch.

Resolution: 12 bits plus sign and overflow.

Accuracy\*:  $\pm .05\%$  of full scale.  $\pm 1/2$  lsb @ 25C.

Drift\*: 50 ppm/degrees C.

Input Impedance: 10M ohms minimum.

Ranges:  $\pm 0$ -5v, 1-5V, 4-20 ma, 0-1v software selectable (standard, other ranges available).

Normal Mode Rejection: 60db @ 60Hz.

Max Common Mode Voltage: 90 volts common mode plus sign.

Common Mode Rejection: 80db @ 60Hz.

Filtering: Field programmed 1 to 100%, 1 to 100 sec.

A/D Speed: 7 mS.

Voltage (Supply): 5 VDC noise decoupled and derived from primary volt- age source to power transducers - 50 mA max.

Termination: Compression type 2 or 4 wires per point.

Note: Two of the eight analog inputs connect permanently to battery voltage and RTU enclosure temperature. The remaining six have input termination on J14. The voltage and temperature have high and low set-points, and are telemetered, when enabled.

\*These apply for voltage (e.g. 1-5V) inputs. When used in current-loop configuration, the tolerance and drift of the shunt resistor used must also be considered. These values are, on the standard product, .1% and 50ppm/deg C., respectively.

### Analog Outputs

Channels: 2.

Voltage Output: 0 to 5.12V.

Current Output: 0 to 5.12 V.

Range: 0 to 21 mA.

Maximum Loop Resistance: 850 ohms  
@  $V_{system} = 20v$ .

Resolution: 12 bits.

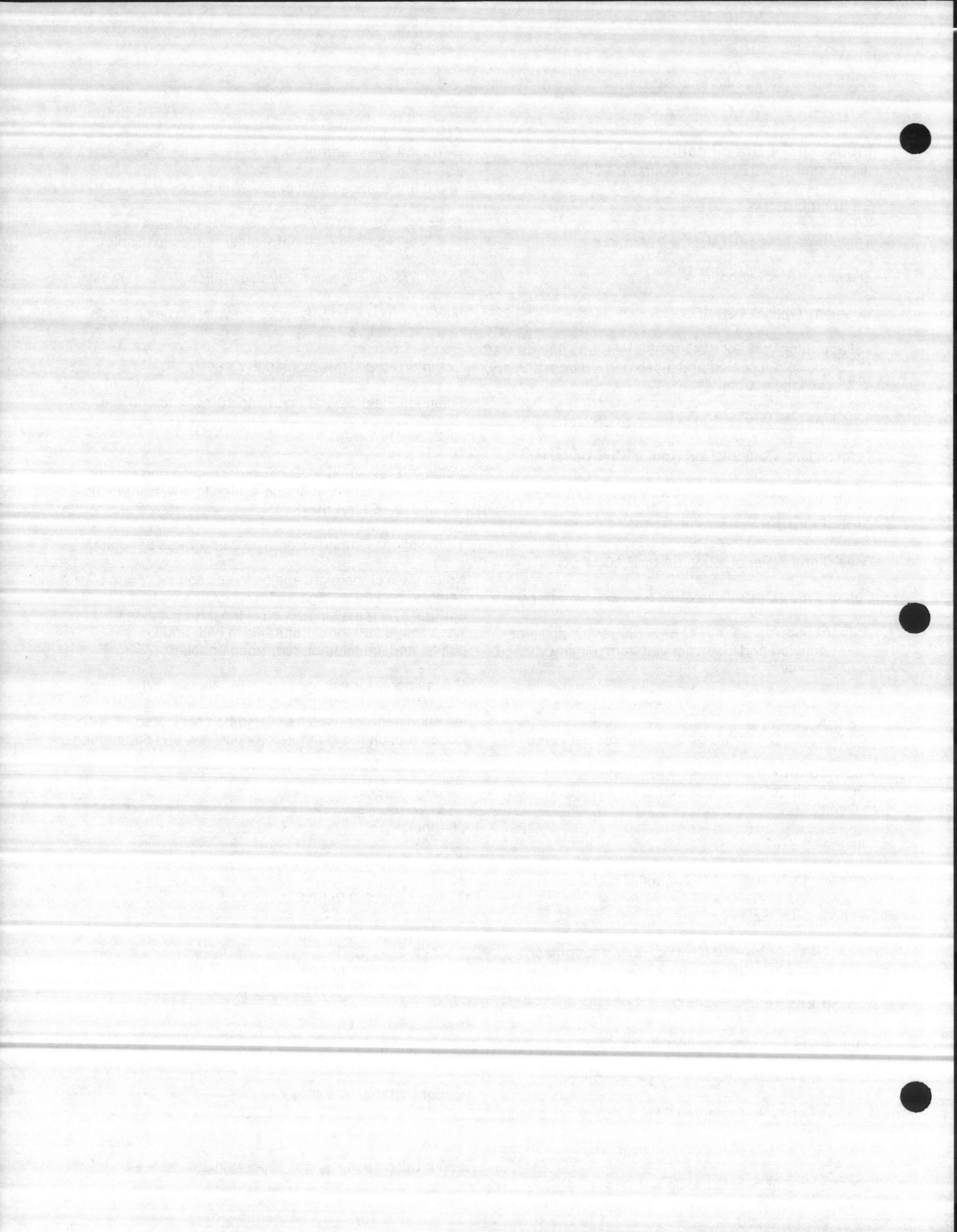
Accuracy: 0.1% of full scale.

Response Time: 5 milliseconds.

Non-Linearity: .05%.

Output Calibration Range: Programmable at setup.

Termination: Compression type, 2 wires per point.



## External Alarm Output

Channels: 1.

Interface: Open drain VFET, 60v @ 200 mA

Output: Normally low signal that goes high on alarm condition. Pin requires pull-up resistor to drive logic inputs.

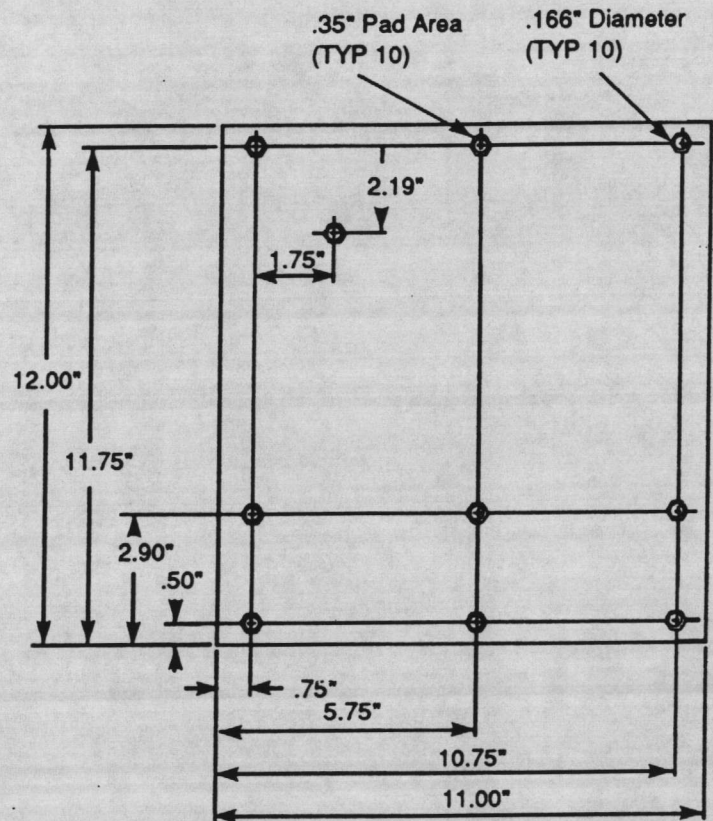
Function: Alarm (high) level indicates:

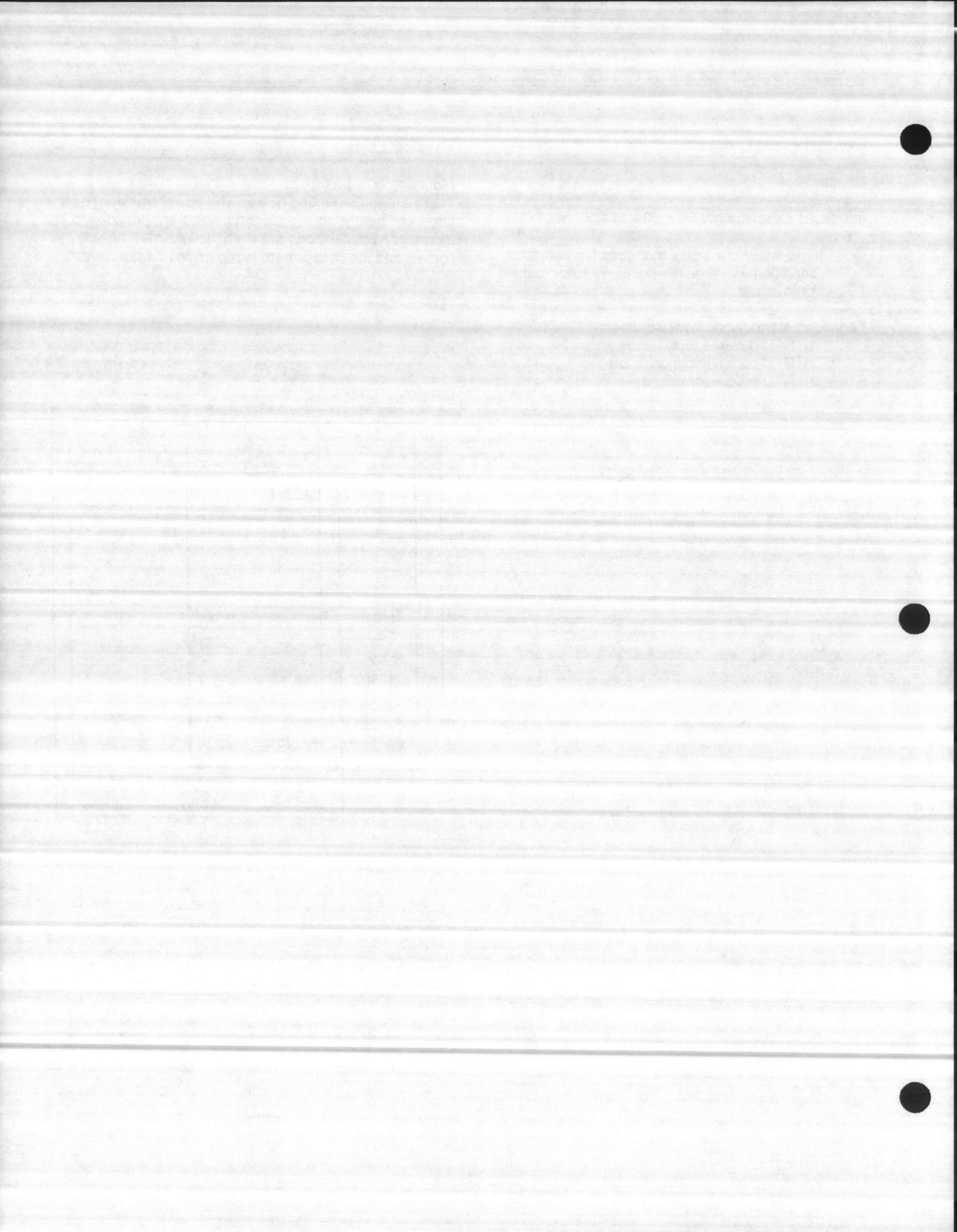
- 1) RTU power supply failure
- 2) RTU communication failure
- 3) RTU processor failure

## Physical Layout

Mounting hole pattern:

There are ten mounting holes. The power transformer is large and heavy, so two diagonal holes are provided to mount it. All dimensions are from the lower left *board* corner, and the hole pattern is repetitive in three rows.





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## 4 System Description

### System

The W1500 is a frequency shift keyed, multi-terminal, polling and quiescent SCADA system capable of addressing 999 remotes. The remote stations are intelligent and serve as data collection and processing points for the central station computer. The system requires a voice grade transmission network, either wire line, radio, or a combination that interconnects all stations. In the simplest configuration, remote stations do not need to hear one another, however, they must all hear the master station and it must hear all remotes.

Various and unique system configurations will require special communications channels so that remotes can hear one another.

The W1500 System may contain a number of repeaters and passive master stations. However, design of such systems must be coordinated by the Aquatrol Engineering Department. The communications network must be carefully designed to support unique configurations.

A polled system is a SCADA system controlled by a master station. The master station calls each RTU in sequence and the RTU replies with all of its data. The master station may poll certain remotes more frequently and may be directed to poll out of sequence. No remote transmits unless requested to do so by the master station. In a polling system, communication is orderly and easy to control since the master acts as a traffic director. If a remote fails to answer, or its reply is obscured by transmission noise, the central station will retry that remote. After three unsuccessful calls, the master registers a data fail, then goes to the next station.

A large polling system with many remotes, and many bits of information in each remote, becomes slow to respond to changing conditions in the system. Communications remain very orderly and accurate, however, it may take several minutes for status changes to be reflected at the master station.

In a large system, quiescent operation may provide a faster response. In quiescent operation, the master station no longer calls remote stations to receive data. Each remote station initiates a call to the master when it receives a contact input when an analog signal exceeds a program value, or after a programmable time delay. A quiescent system USUALLY provides improvement in data flow, but creates a more difficult communications environment. All remotes must hear one another and time their transmissions so as not to interfere with one another. In periods of high activity, when many stations desire to transmit, the communications channel is very busy. In times of low activity, when few stations require the channel, traffic can be very low and allow other com-

munication on the channel such as voice. In quiescent operation a station tries several times (programmable) to reach the master, then outputs a local failure condition.

The W1500 system can use a combination of polling and quiescent operation to enhance the speed of data passed through the system.

### RTU Description

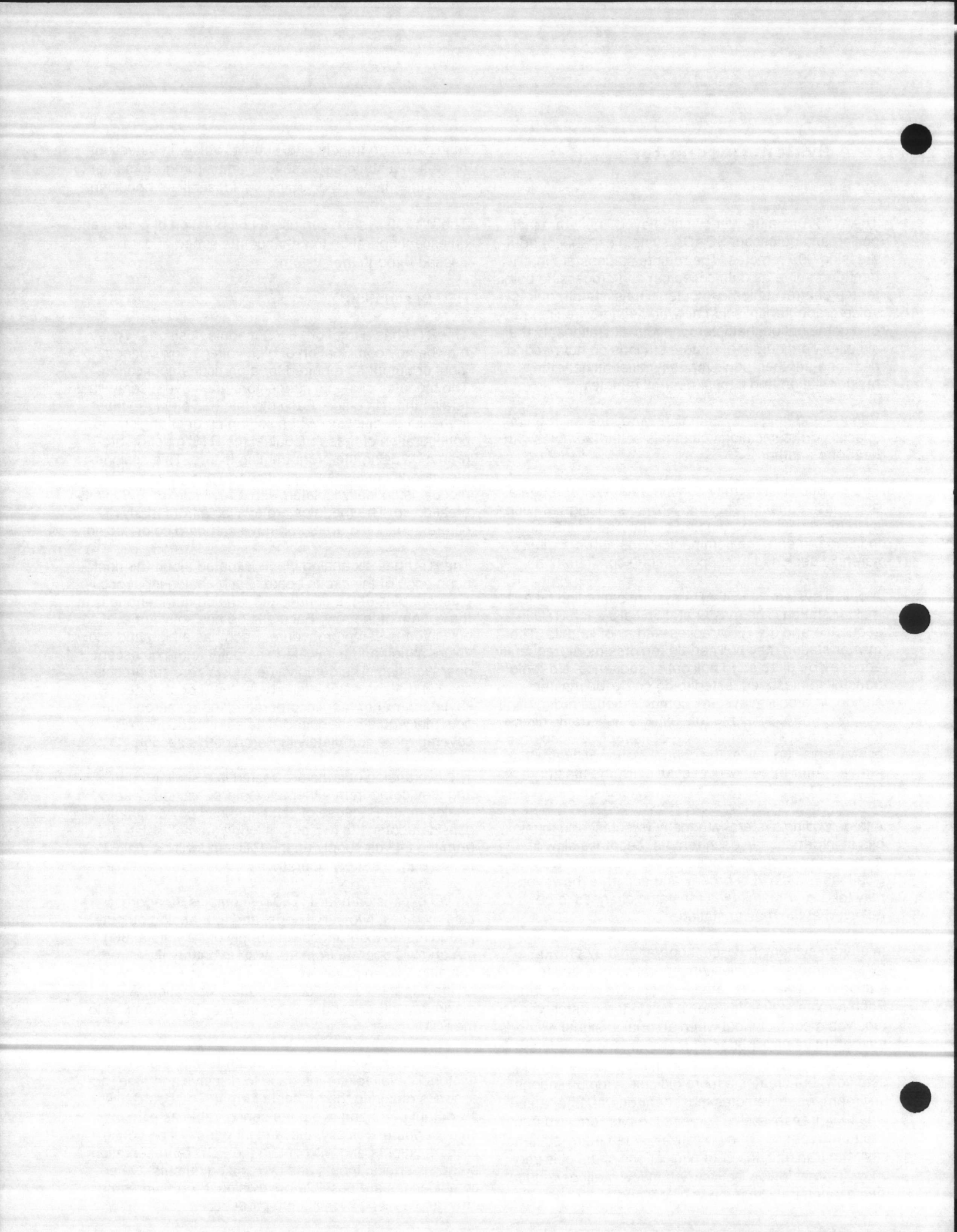
The RTU has a total of 16 I/O module positions. These may be any combination of high voltage, low voltage, input or output as required for a particular application. The modules plug into connectors and have a screw that retains them in place. Each module has a plug-in fuse immediately below it. When setting up or changing the configuration of these modules, the RTU must be programmed using the programming fixture. This assigns the various positions as inputs or outputs. Each RTU module is optically isolated with a minimum of 1500 volts breakdown. The modules are available from many different manufacturers and have standard color coding.

The RTU has six analog inputs situated along the right hand edge of the circuit board. Each analog input occupies four pins of the connectors, analog number one is at the bottom of the row. Each analog has software scaling built into the setup procedure. Each has a high and a low value, a high and a low alarm setpoint and a quiescent operation flag. The setup value allows zero suppression, span and alarm setpoints to be entered or changed by a keyboard, rather than incorporating the numerous trim pots that would be required. The setup procedure is covered more completely in Part II of this section.

The two analog outputs are scaled in a similar manner and they come from either telemetered values or an analog input. Because of self contained power supply considerations, the two output loops are not isolated from the 24 volt supply on the RTU and will be maintained during battery operation.

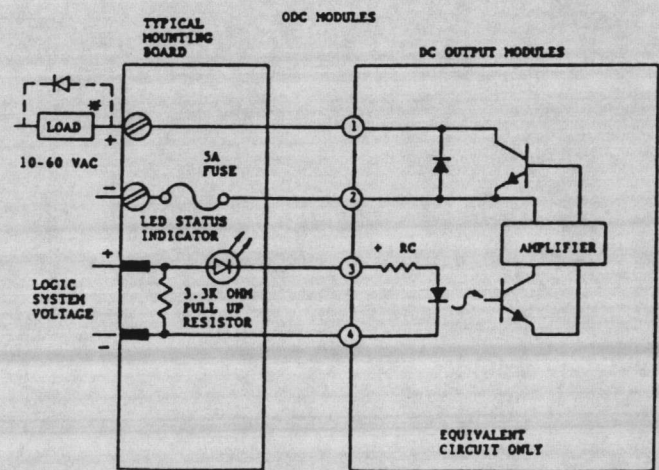
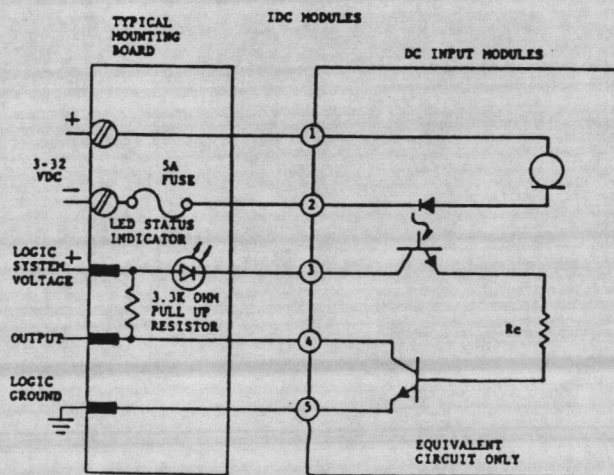
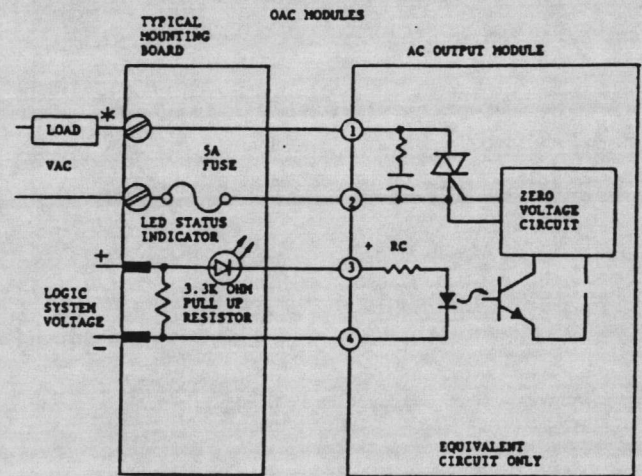
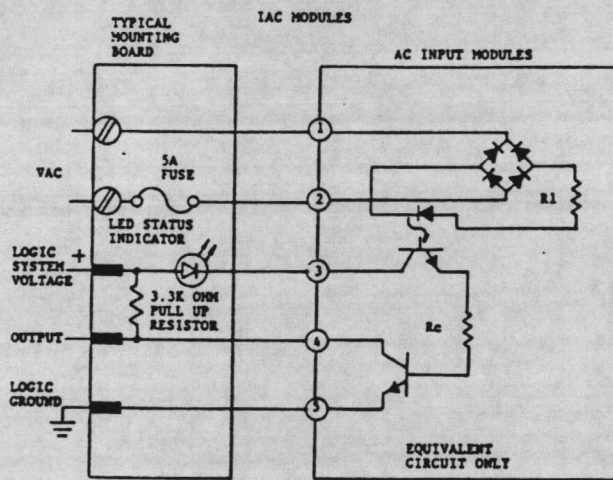
An I/O expansion board (T2047) contains 32 addressable modules, two serial ports, and four analog outputs. It requires an external power supply of 12 volts at 800 mA and will operate from the system battery if desired. It contains its own power supply for the necessary voltages on the expander board during battery operation. A maximum of four expander boards may be connected to the RTU.

A "J" cable expander board (M4003) having eight connectors is available to interface to displays and other accessories requiring the "J" cable format. The board has six output ports and two ports configurable as either input or output. Initially, these eight ports will be configured as outputs and will contain the BCD representation of the six analog inputs and two analog outputs. Other combinations are possible by revising the software and providing a menu in the setup procedure.

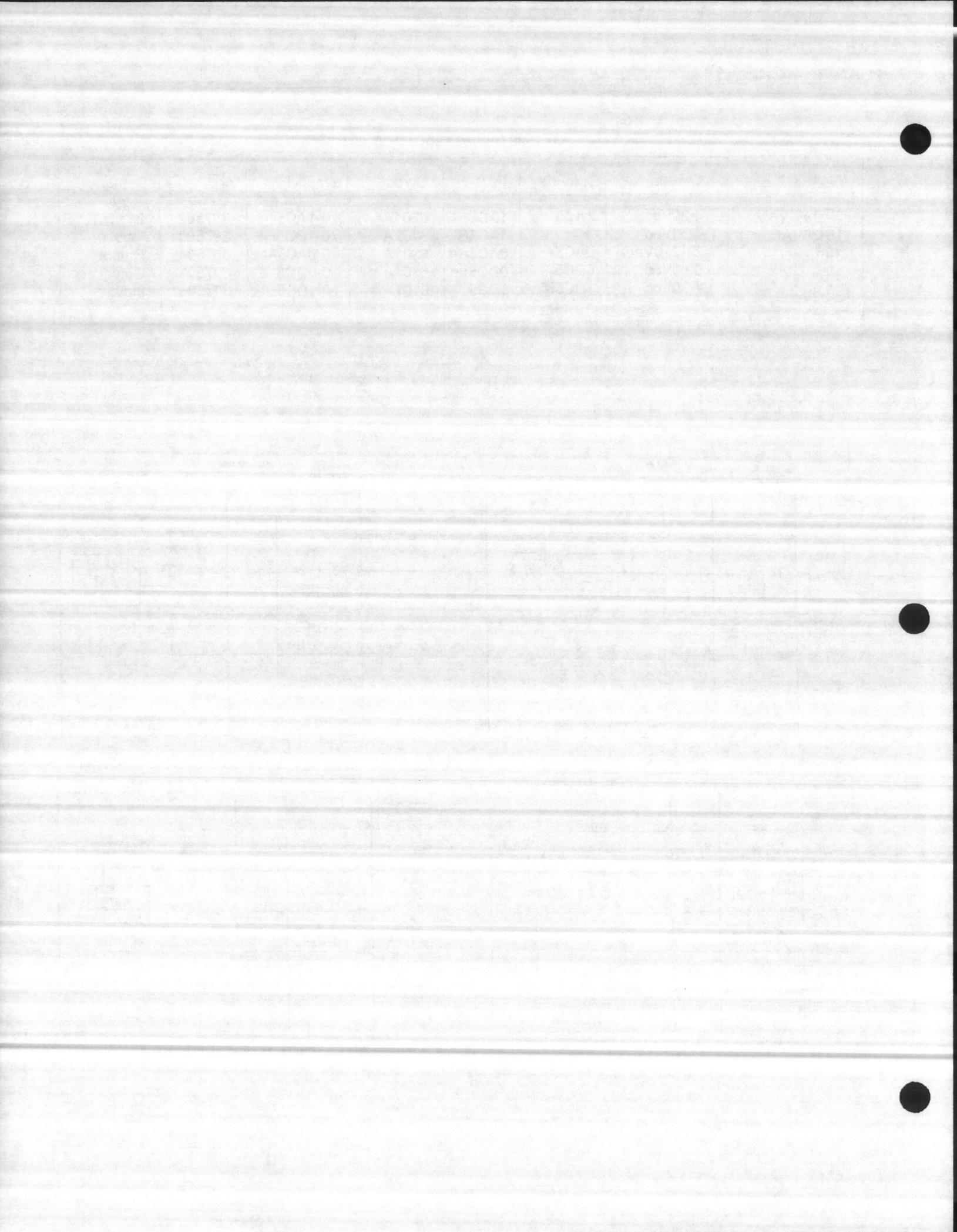


## W1500 Input/Output Modules

Input	Output	Opto-22	P&B	Crydon	Grayhill	Aq. Part #	Remarks
90-140 VAC	4-30Vdc	1AC5	1AC5	6201A	70-1AC5	307502	Input
10-36VAC	4-30Vdc		1AC5E	6402A	70-1DC5HP	307503	Input
3-6Vdc	24-280VAC	0AC5A	0AC5A	6301A	70-0AC5A	307504	Output
3-6Vdc	5-60Vdc	0DC5	0DC5	6301A	70-0DC5	307505	Output
3-32Vdc	4-30Vdc	1DC5B	1DC5	6101	70-1DC5	307506	Input



\* LOAD CAN BE PLACED IN EITHER SIDE OF THE LINE

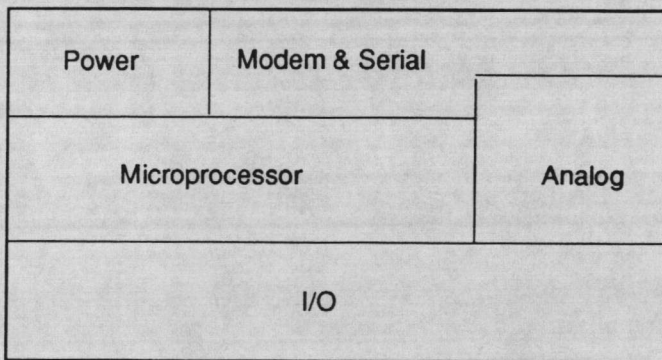




## Block Diagram and Circuit Description

Notice on the block diagram the W1500 is divided into five operational sections. This description will start with the power supply circuit and progress through all six, describing circuit features and setup variables.

RTU Block Diagram



Also, reference application figures on page 13.

### Power Supply and Charger

The first section is the power supply and battery charger. 110 volts AC enters the board through connector J28 terminals 1 and 2, and goes to the transformer. The transformer supplies 18 volts RMS to the bridge rectifier and filter circuit. A portion of the DC voltage goes to the battery charging circuit, while the rest of the 18 volt supply powers the switching power supply. The battery charger circuit supplies approximately 300 milliamps to float charge the battery at 13.5 volts. The battery connects to terminals four and five of connector J28. If no battery is connected, the charger consumes a minimum current; a battery may be added at any time, if it is desired, to add backup. A diode couples the battery voltage into the switching power supply when the AC power fails providing a bounceless transfer to the battery backup supply.

The switching power supply is a forward converter type, and produces  $\pm 12$  volts,  $\pm 5$  volts and +24 volts. The +24 volt supply powers the analog output circuits and the terminal blocks for the I/O modules. It is referenced to circuit ground. This 24 volts may be used to power input modules if no other power is available. Its capacity is 120 mA and it is fused before leaving the circuit board. **DO NOT USE THIS SUPPLY FOR ANY OTHER PURPOSE THAN FIELD CONTACTS ACTUATING INPUT MODULES OR ANALOG INPUT LOOPS.**

The analog circuitry, the RS-232 port, and the modem require + and - 12 volts. Both 12 volt supplies are decoupled and filtered, then connected to the appropriate circuitry. Neither 12 volt supply is available off the circuit board.

The board contains two five volt power supplies, one for

the primary power to all microprocessor circuits and another for external power to analog transducers. The external five volt supply is current limited and appears on the analog input connectors J14. A total of 50 mA is available to power external sensors, this will be described later in the Analog Input Section.

The main five volt power supply is filtered by a capacitor. A filter inductor removes switching power supply transients and decreases the peak current that charges the filter capacitor.

When the incoming AC power fails, U62B and its associated circuitry provide the CPU with a POWER FAIL signal which is available for telemetering, if needed. In addition, U62A and its associated circuitry sense an impending deep discharge condition of the battery. At approximately 10.5 volts, this circuitry will shut off the RTU power supply leaving only a few CMOS gates still powered. This protects the battery from being destroyed in the event of long term AC power failure. The RTU will return to operation immediately when the AC power returns, and begins charging the battery. Pushing the reset button will also cause the power fail circuitry to turn on the RTU, but the battery may be too low to operate successfully.

### Modem and Serial Ports

The RTU contains two serial ports, one port has a 0 to 1200 bits per second modem and the other has an RS-232 driver connected to an eight pin serial connector. The modem channel is the primary communications for the RTU. It will operate on either bell 103 or 202 standard and provides crystal controlled transmit and receive tone frequencies with digital signal processing for secure data reception.

The modem input and output are divided and isolated to drive both a telephone line and radio system. The input presents a high impedance to the radio receiver output, and 120 mV at 600 ohm impedance to the transmitter data input. The modem presents a 600 ohm resistive impedance, transformer coupled to the telephone line, as well as, a high impedance receive input. Ordinarily, the receiver and the transmitter are connected together by jumper J25. When using a four wire telephone system, a radio or a bridging amplifier system removes this shorting connector to separate receiver and transmitter audio circuits. A separate circuit board (M4004) is available for four wire telephone line applications. The telephone line connection is a standard RJ11C six pin modular connector and it includes the "transmit on" signal connected to pins one and six.

The RS-232 serial port is used for the setup and programming panel, as well as, an auto dial modem or programmable controller. This port may have other users defined by software. It supports RS-232C line except for the RI (ring) input.



## Analog Outputs

The RTU has two analog outputs powered from the 24 volt DC power supply. These outputs may be scaled in the setup procedure to any desired engineering units; they are capable of producing 0 to 20 mA. Operational amplifiers buffer and regulate the output circuits and are driven by full 12 bit D/A converters. The digital input value can come from locally derived calculations or telemetered values. The analog outputs are NOT isolated from one another since they come from the same power supply. THEY ARE NOT GROUND REFERENCED.

## Analog Inputs

The RTU contains six external analog inputs and two inputs generated within the RTU itself. The two internal analog signals are the battery voltage, which is monitored at all times by the software, and the RTU temperature which is monitored by an integrated circuit.

The six external analog inputs are bi-polar, full differential inputs. The input range is  $\pm 5$  volts. Each analog signal comes in through a four terminal separable block which carries the differential (+,-) analog signal, analog ground, and five volts for the transducer. Most analog signals require only single ended rather than differential inputs. In this case the negative analog input is jumpered to the circuit ground on the connector. See the application section for single ended differential and shielded cable terminations.

Include one additional wire when it is necessary to power a remote transducer. Use shielded cable for all analog signals and use a separate cable for each input. DO NOT USE THE NEGATIVE INPUT OR THE SHIELD WIRE TO GROUND A REMOTE SENSOR; RUN A SEPARATE GROUND WIRE.

Each analog input has a current scaling resistor to convert current loop signals to a single ended voltage input. Each input has a separate resistor and a two pin shunt connector adjacent to the inputs. REMOVE the shunt plug for voltage input, INSTALL the shunt plug for 4-20 mA operation.

## Digital Inputs and Outputs

The RTU contains space for sixteen input or output modules across the bottom of the circuit board. Each position may contain either an input module or an output module selected from the list as shown below. Select the various modules according to the input voltage required or the output that it must control. The setup or programmer plugged into the RS-232 port determines which of these is input and output and where it appears in the telemetry message. Each output and input

module has a separate fuse located immediately below the module. These fuses are plug in and may be changed or serviced with power connected to the RTU since their circuitry is isolated. Each module has a two terminal external circuit rather than a single connection since many field wiring circuits come to the RTU as two wire circuits.

The RTU provides 24 volts DC for non-powered field contacts. Select an input module that operates on 3-32 volts. (Reference figure on Page 7.) In the applications section notice that J9 and J10 are 24 volt supply lines which will provide 24 VDC to supply the dry contacts for these modules. This 24 volts is fused on the RTU circuit board to protect it from short circuit or a high voltage input. Observing the module input polarity as shown in the application section, connect the +24 volts to the positive side of the desired module then connect the field contact wiring between the module negative terminal and the common on J9 or J10. DO NOT USE OTHER COMMON TERMINATIONS ON THE RTU FOR THIS RETURN PATH SINCE THE TERMINAL ARRANGEMENT AVOIDS GROUND LOOP AND NOISE PROBLEMS.

## High Speed Pulse Accumulators

The high speed pulse accumulators connect at J1. The external drive circuit for these inputs must be capable of switching 12 volts and 7 mA. These pulse accumulators are high speed counters located in the CPU; their count speed is approximately 50 KHz. Each accumulator has a sixteen bit counter allowing it to accumulate 65,000 pulses. The counters are gated at one second intervals for a period of one second. This means a reading is taken about every two seconds from each accumulator. This is the frequency counting mode. If the signal is externally gated, the accumulators may be allowed to roll over or may be reset at the one second interval.

## Diagnostics

The T2044 RTU continuously performs diagnostic procedures on itself, as well as maintaining system-wide performance data. The RTU displays diagnostic results both on the test/programming terminal plugged into the RS-232 port and on the status LED's located on the lower left corner of the circuit board. The eight vertically mounted LEDs and their functions are as follows:

1. Timer status
2. Control status
3. Watchdog
4. Watchdog status
5. Telemetry receive data
6. Telemetry transmit data
7. EEPROM configuration error
8. Unrecoverable error



---

LED's 1 through 3 indicate that the software is running properly. Each lamp represents a different software task and each one should flash continuously. If any of the three LED's does not flash on and off, the RTU is unable to operate.

LED's 4 and 6 indicate that messages are being processed by the software. LED number 4 is on only when data is received on the telemetry channel and LED 6 is on only when the RTU is transmitting data on the telemetry channel.

LED 7 indicates that an error has occurred in the EEPROM configuration memory. Refer to the configuration section and make certain the RTU is configured for the proper number of inputs and outputs. When this is done, press the "S" key; the 7th LED should go off at the end of this operation. To verify configuration is correct, remove power from the RTU for several seconds, then reapply. The EEPROM LED (number 7) should be off. If LED 7 remains on, repeat the above steps several times.

Contact an Aquatrol factory service representative for corrective action.

LED 8 should NEVER be on. It indicates a non-recoverable error either in the EEPROM or the PROM memory of the RTU.

Contact an Aquatrol factory service representative for corrective action.

Additional diagnostic information is available on the CRT terminal or portable computer plugged into the RS-232 port. In section VI, refer to the menu selections "T" and "Z" for instructions on exercising further diagnostic procedures.

Diagnostic information is accumulated constantly by the RTU and does not interfere with normal operation. It is never necessary to remove the RTU from operation, or to start a dedicated diagnostic procedure that occupies the RTU to the exclusion of its normal tasks.



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## 5 Installation and Applications

### Installation

Be sure to read Section 4, System Description for additional information.

### Power

110VAC, 4-8 watts, fused and 12VDC battery. The battery size is calculated in amp hours as follows:

Battery AH = .6 x desired time in hours

Example:           for 24 hour backup  
                  B = .6 x 24 = 14.4 Amp hours

This allows for an RTU with 16 input modules, 2 AO signals, 6 AI transducers, an active RS-232 port, plus a 20 percent safety factor. The largest user is the input modules, so if they are powered externally, or there are less than 16, current drain is lowered.

For an RTU with 4 inputs, 6 AI transducers, an active RS-232 port and 20 percent safety, use:

Battery AH = .25 x desired hours

24VDC - power for input modules, analog outputs, maximum of two 2-wire transmitters. Do not power other circuit boards or relays from this source.

+/- 5VDC - Not available to the RTU, except for expansion boards as designated.

### I/O Modules

Assign inputs first, then outputs as desired, consecutively from left to right. Avoid leaving blank (future) spaces if possible. Assign each module position, and label futures, if desired. If you configure the futures (an acceptable practice) the information will be transmitted, and ProSoft 2000 central system software will show zero, or any desired disabled value for the future signal. Each application uses a different combination of I/O modules which must be specified.

### Communications

The modem channel is 1200 baud FSK, and can go as low as 50 baud, upon special application. The tone frequencies are 1200-2200, or 1070-1270 Hz.

The telephone and radio channels may be used simultaneously, if necessary.

**Caution: Customer installed telephone lines are to be discouraged. However, lengths of up to about 4,000 feet connecting six or fewer stations should**

**be acceptable if installed in accordance with telecommunications standards. Since system layout and installation techniques will vary considerably, Aquatrol cannot take responsibility for problems associated with improper installation. If the user chooses to install lines, we suggest:**

Use an approved wire from a telephone company supply vendor. The wire must contain twisted pairs, and be suitable for the environment where it will be installed. If not certain, it is always safe to use an underground (or direct burial) wire in raceways or conduit above ground. This wire has a soft wax filler, a hard aluminum shield, and a plastic sheath that resists damage. The wax filler prevents accumulation or seepage of moisture, should the cable sheath become cracked or punctured. Always install more cable pairs than needed, the usual minimum should be six, since that is a convenient cable to purchase and install. Maintain a balanced, ungrounded circuit and do not split pairs. Use approved insulated splicing connectors, surge protection, and endpoint terminating connectors.

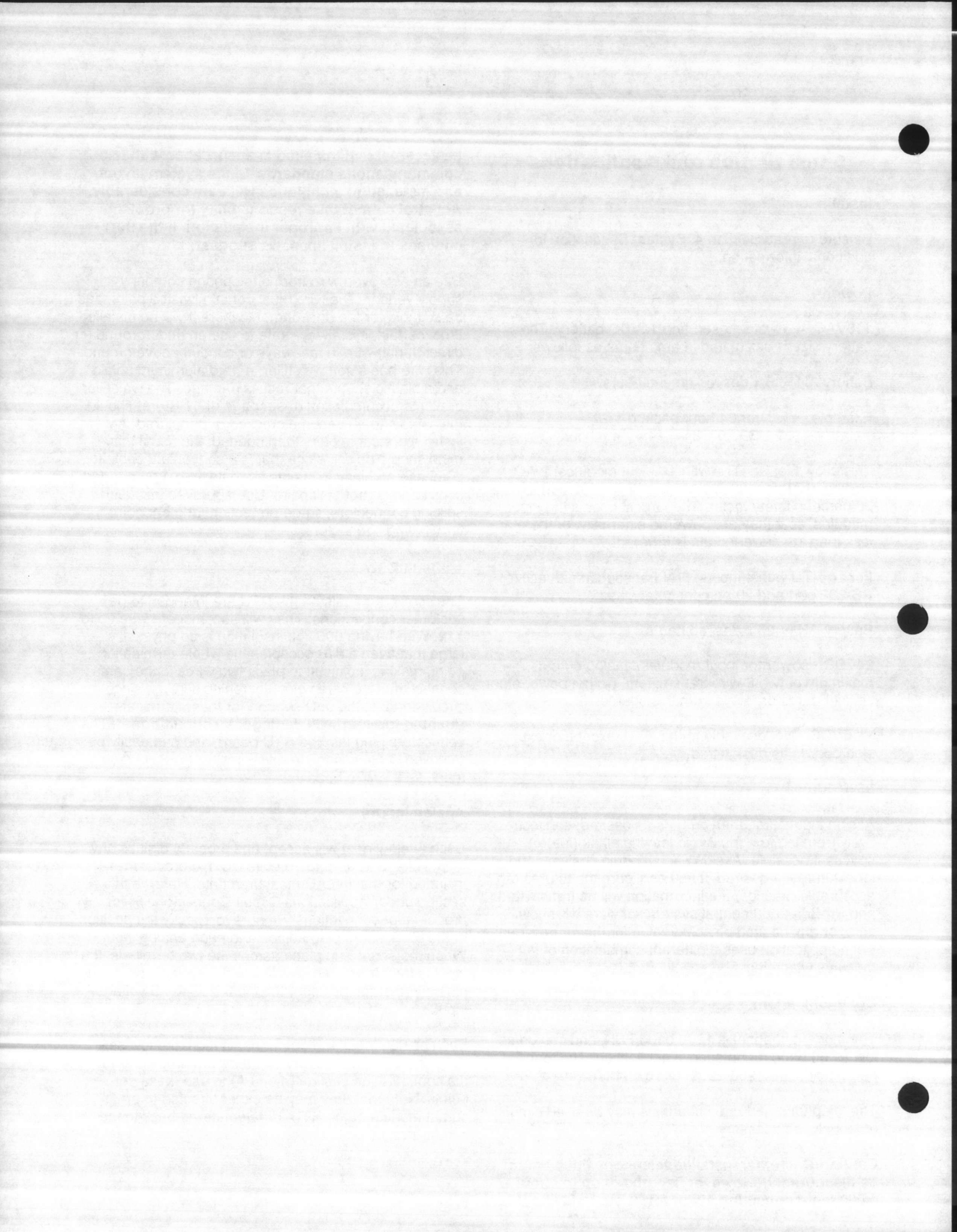
### Terminals

The screw terminals on the RTU are intended to be customer connections. They will accommodate wire up to #12. Wire having 600 volt insulation is so physically large that even a #18 occupies the whole termination point, making it difficult to place two wires in the same connection. Use care when tightening screws, since the circuit board is the only support for these terminals. **Pushing too hard will damage the circuit board.** The connectors plug into the RTU board, and can easily be removed, if necessary, to add wires, or for RTU replacement, tie the wire bundles.

### Analog Inputs

Each analog input will accept and properly digitize any input voltage from -5 to +5 volts DC. No provision is included for making AC measurements. Refer to this section under Applications Circuit Connector J14 for proper input connections. Be sure to specify the position of the black shunt plug adjacent to each analog input. When the shunt is in place across the two terminals, the input is for current sensing. When the shunt is on a one pin only (storage position) the input is -5 to +5 voltage input.

Each analog input and output has a high and low set-point, including the battery and temperature. Refer to the configuration section (menu A) to use these set-points. Note that they may be either directed to an output module at the RTU, or telemetered back to the central station.





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Note: refer to the Applications Circuit Connector J15. Be sure to use this connector, pins one and three, if the analog signals are in use. If no analog inputs are in use, it is not necessary to connect these pins. The other connections of interest on this connector are the fail output and the +24 volt connection.

### Analog Output

See the application circuit for J23. The analog outputs should be self-explanatory, the only point to notice is that neither pin can be grounded because this will disable the output current regulating circuit. These outputs use the 24 volt supply on the RTU, and their current must be figured into the 24 volt consumption when they are used. There is no transient protection on these outputs. **If a non ground output going a great distance or outdoor wire is necessary, use analog Isolator circuits.**

### Expansion Port J3

This expansion port is a 50 pin ribbon cable connector designed to expand the I/O and processing capability of the RTU. **This connection May Not Be Used except to connect to designated expansion boards designed specifically for the RTU.** The cable length from this connection to the expansion board must be less than four inches, so plan enclosure layouts to accommodate this restriction. See Appendix 2 and page 14 for further details on expansion boards.

### Analog Input Expansion Port J22

A 14 pin header for connection of a 8 analog input expansion board. See appendix 2 and page 15 for further details on expansion boards

### Fail Output J15-4

This output indicates an RTU or a communications failure has occurred. It is controlled by software and hardware and produces the following indications:

If the RTU power supply fails, this output will go high, indicating that the RTU can no longer function.

If the microprocessor fails to operate for approximately 12 seconds, this output will go high, indicating the RTU's failure to function.

If the RTU is still operating, and software senses a communication failure, or a change in configuration failure, this output will go high.

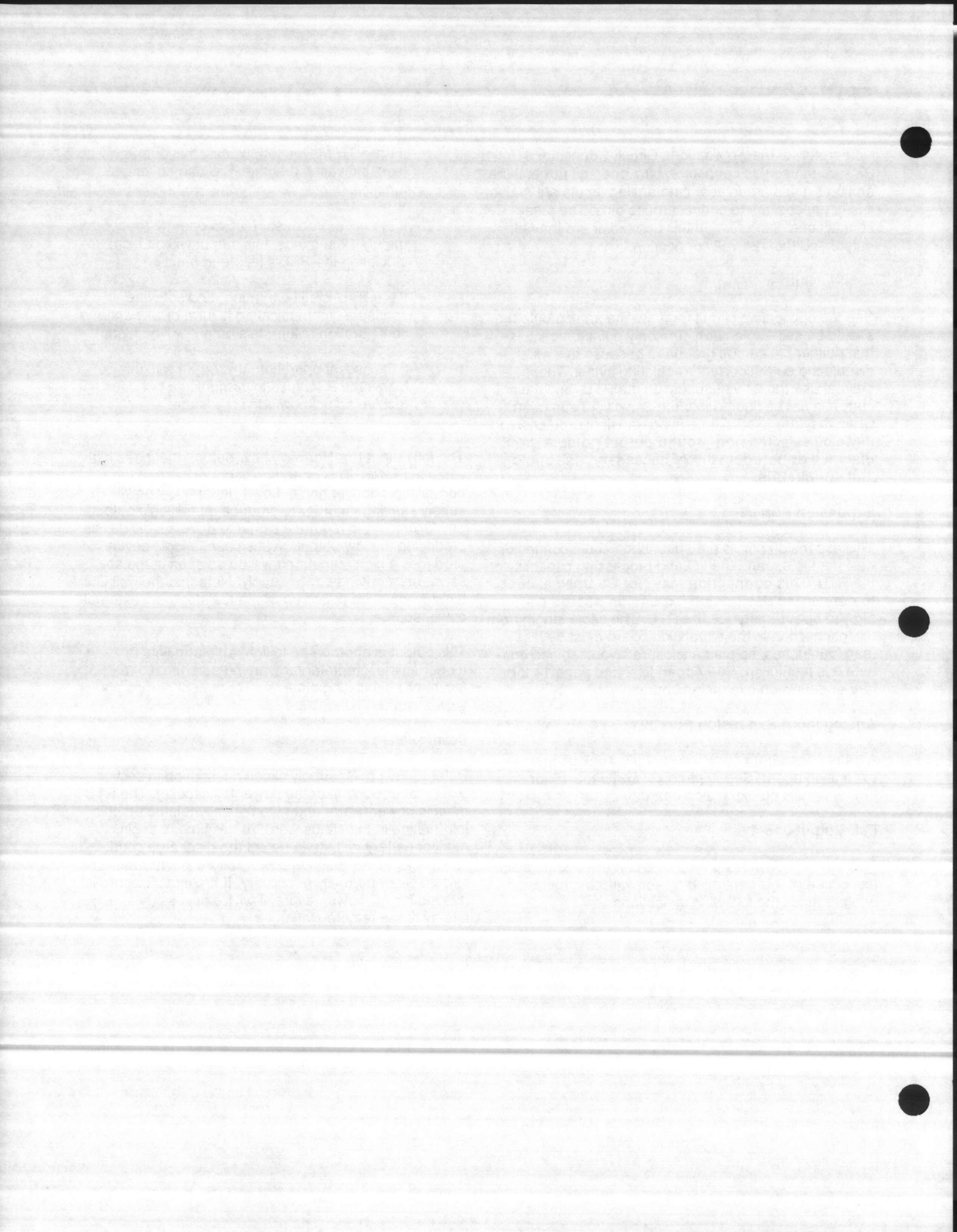
If Quiescent operation, this output will only go high if the RTU tries to communicate but does not receive an acknowledge message.

The fail output is a Normally Low output that goes high when activated. This operation is opposite from the normal logic convention of Low true, to allow power supply sensing. In order to produce a Low logic output, any failure would require a signal to drive a logic device producing the low output. In this case, a logic device produces a high output, and will do so even in the absence of its driving power supply. Note that the Fail Out terminal must be pulled up with a resistor to an external power source.

This output is appropriate to light an alarm light or trigger a time integrator for warning personnel of a failure or for initiating other local control of pumps and/or valves at the RTU location.

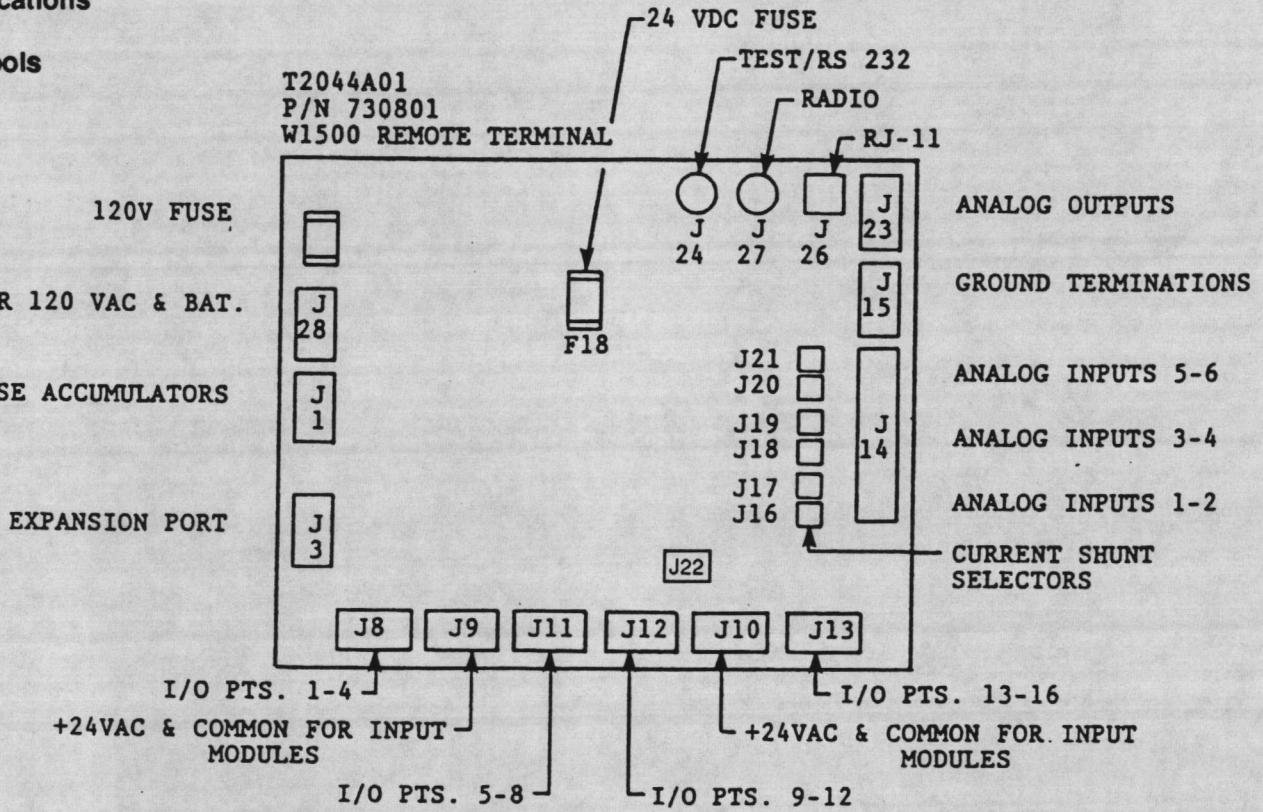
### Power Fail

Refer to the power supply circuit description in section V.A.3, for description of the power fail circuitry. The RTU detects power failure and automatically telemeters this information in the status word. At this time, it begins to monitor battery voltage to detect the discharge condition. No local indication of power failure is available since it is not normally necessary. If a contact closure is needed for AC power failure, it will be necessary to add a relay to the remote station.

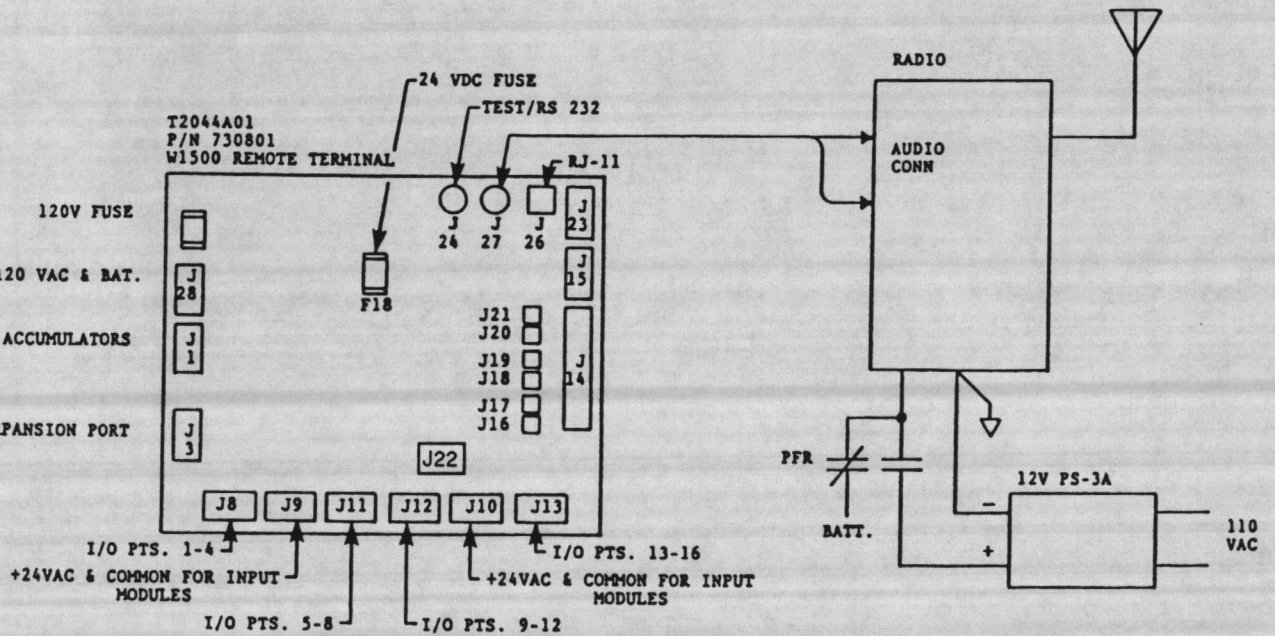


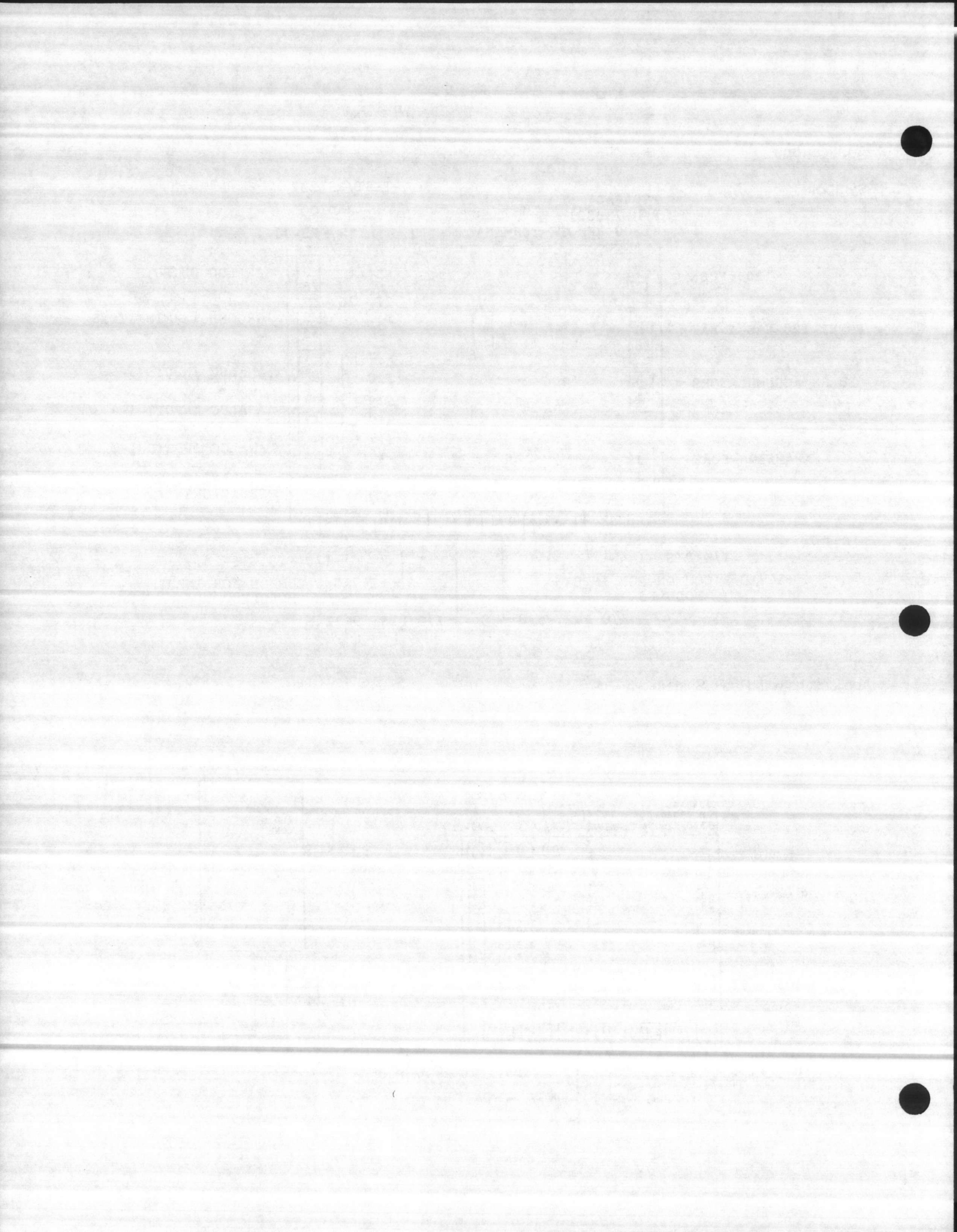
**Applications**

**Symbols**

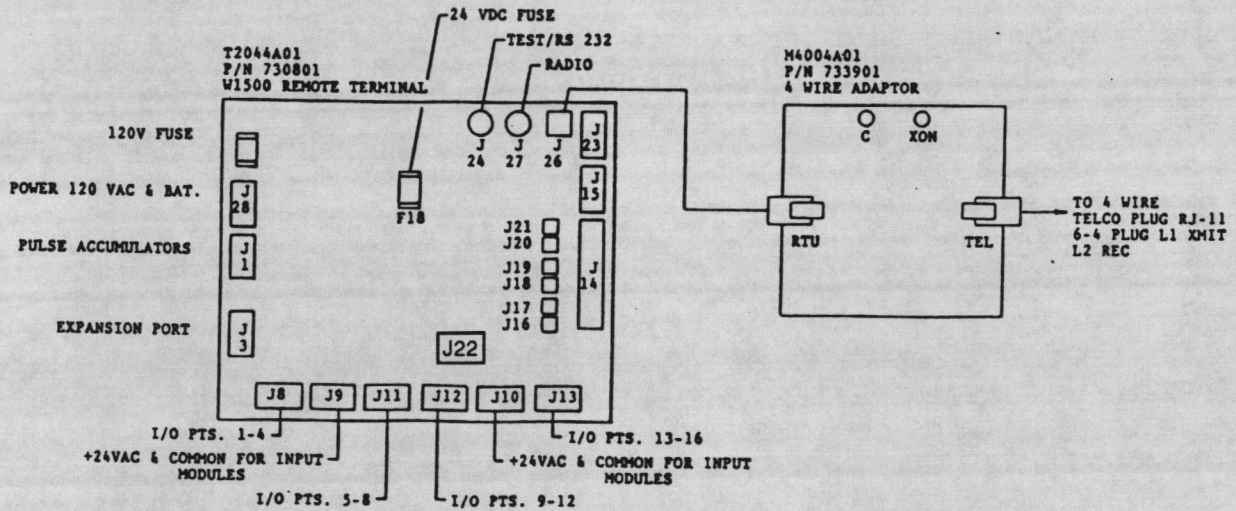


**Applications with Radio System**

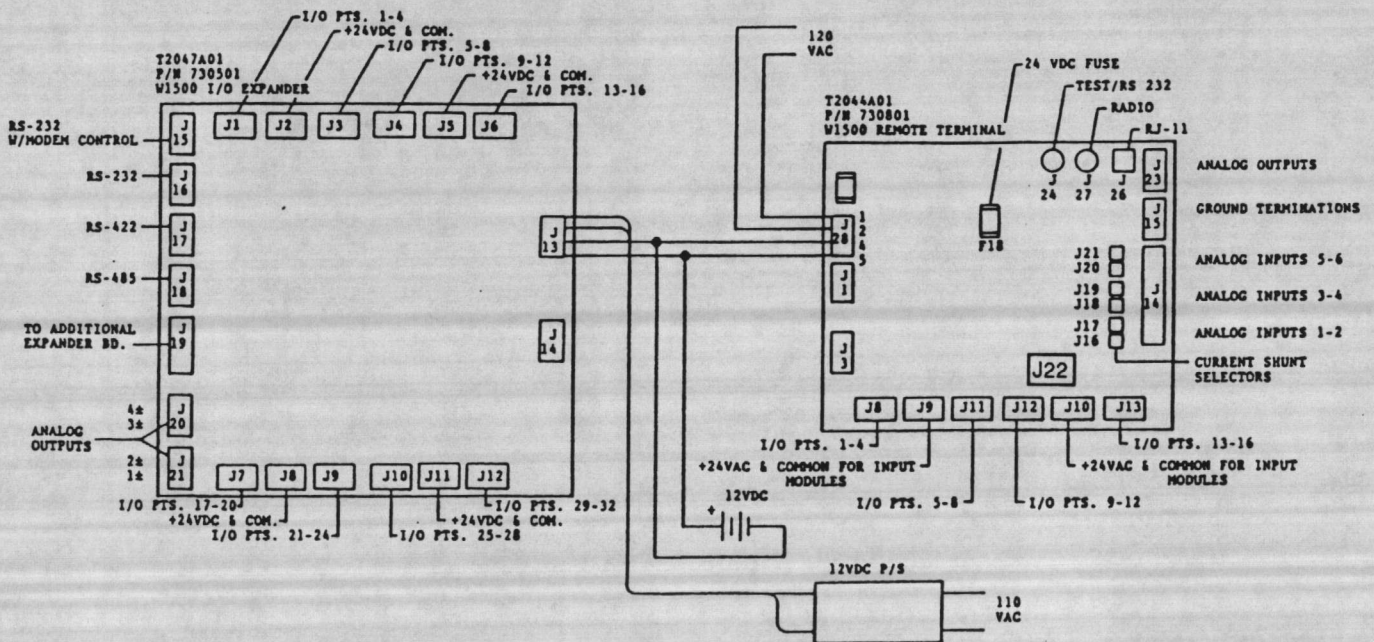


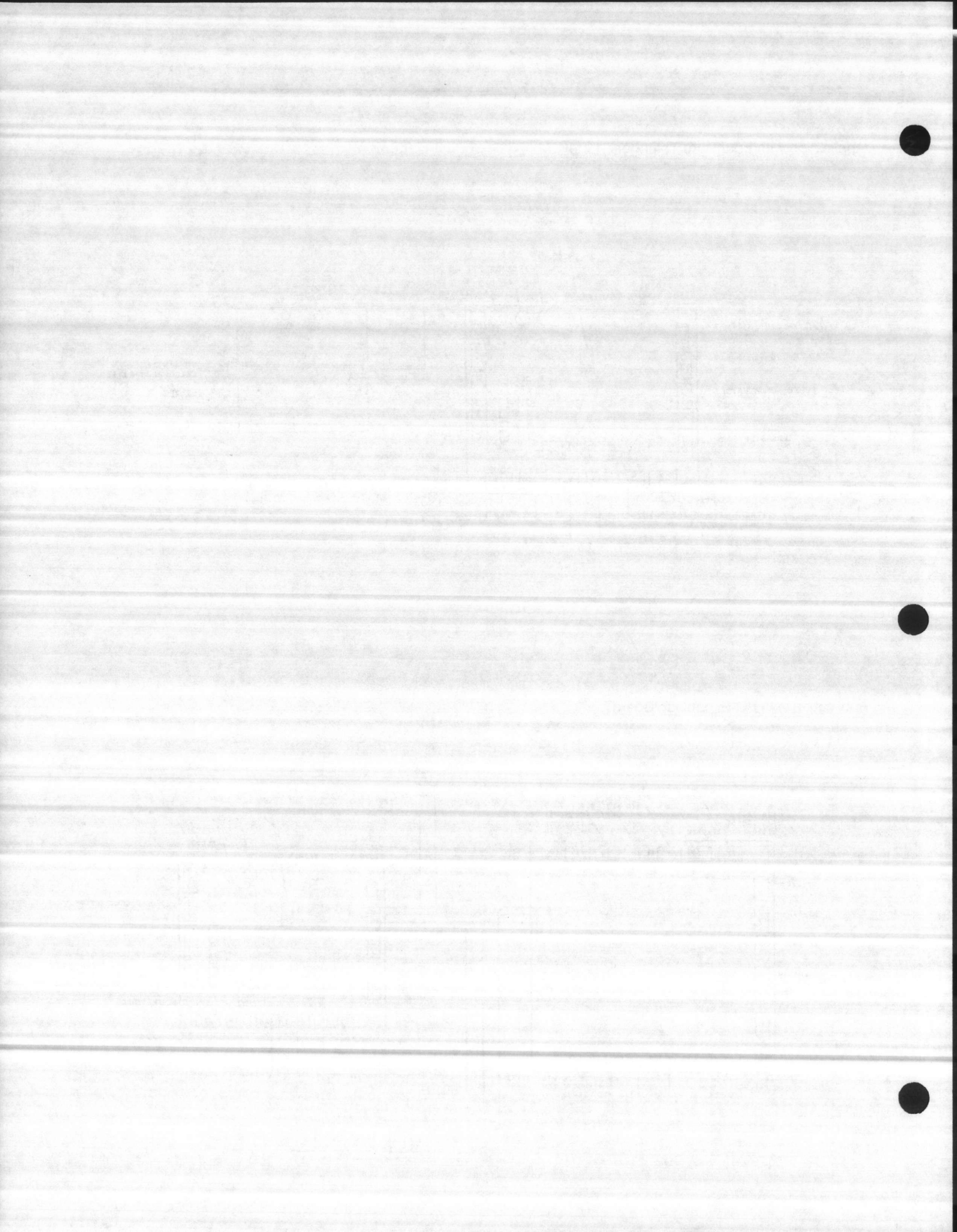


## Application with Four Wire Telephone Line

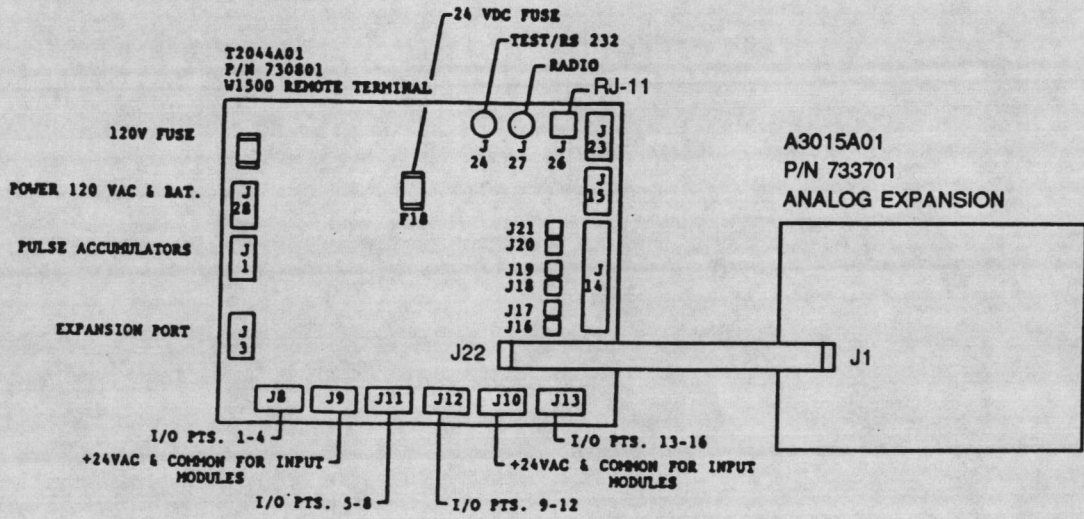


## Application with I/O Expansion Board





Applications with Analog Expansion Board

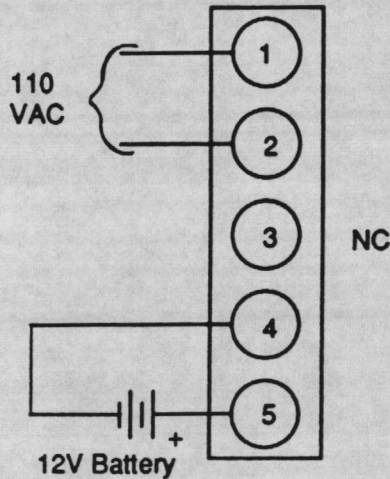




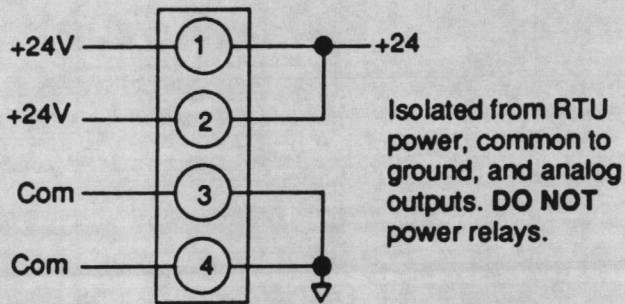


## Connector Assignments

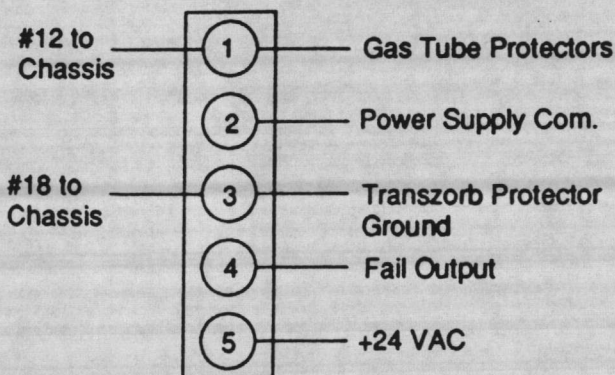
J28: 110V and 12VDC



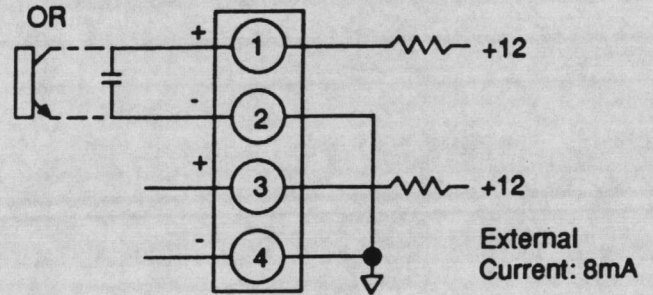
J9 and J10: +24VDC for input modules



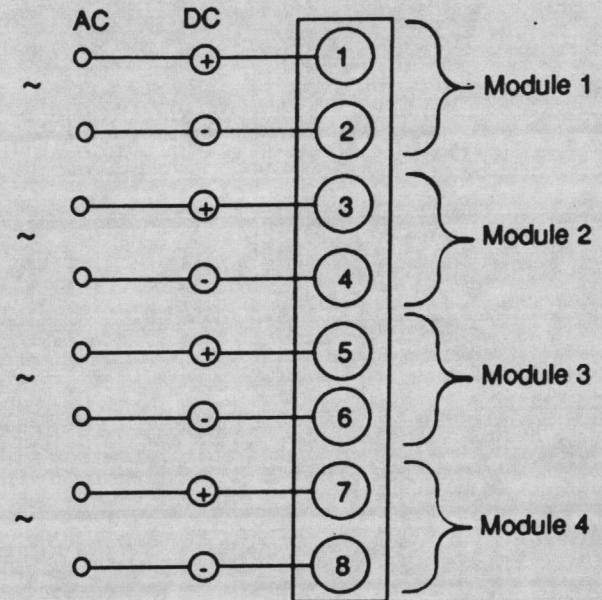
J15: Protective ground and data fail



J1: High speed pulse accumulators



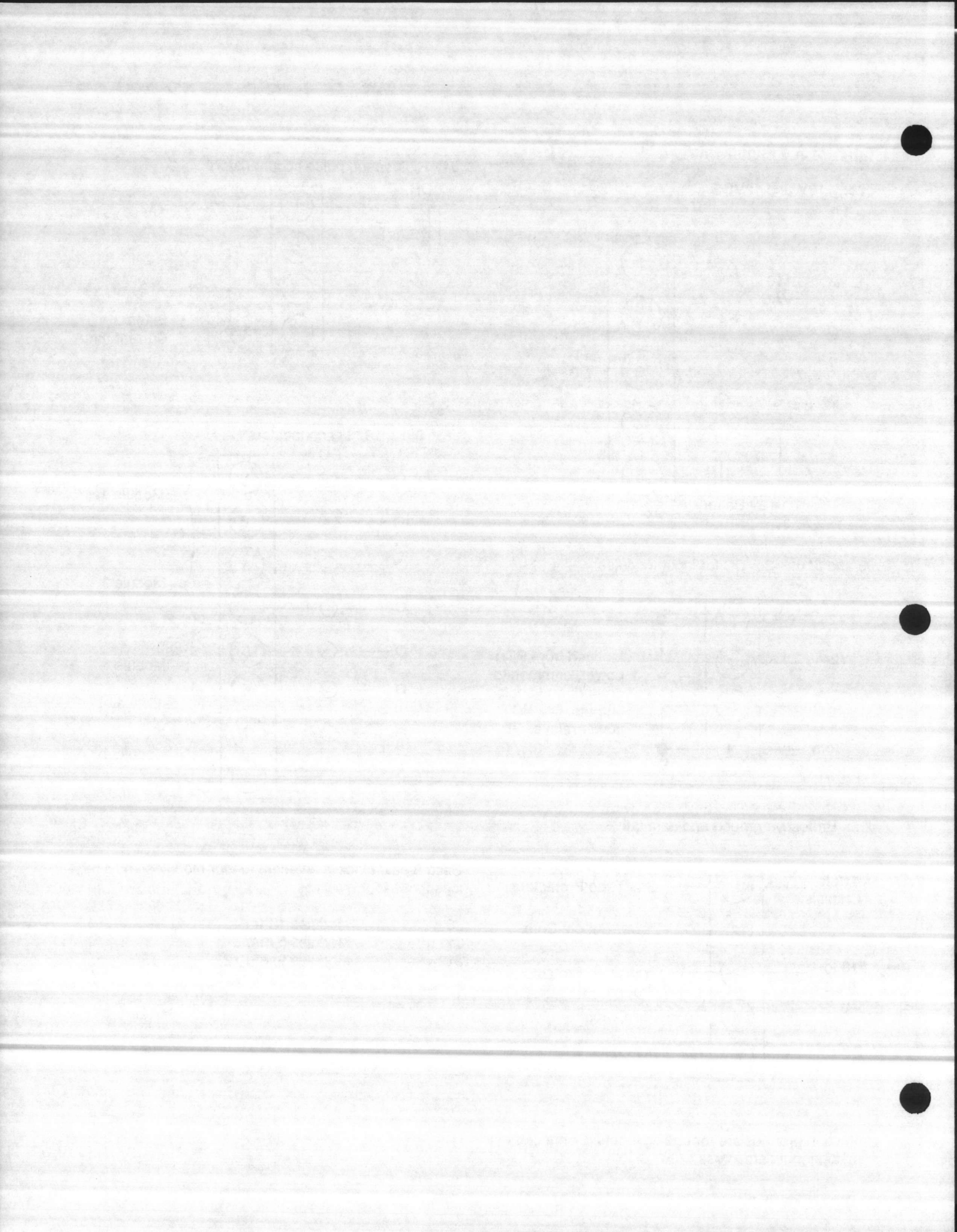
J8, 11, 12, 13: I/O connectors



Each 8 pole block is adjacent to four modules and services those four modules.

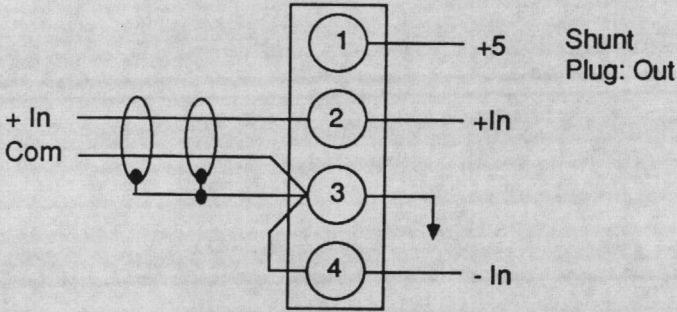
J8 - Modules 1 thru 4  
 J11 - Modules 5 thru 8  
 J12 - Modules 9 thru 12  
 J13 - Modules 13 thru 16

Protection grounds are for analog inputs. Connect these if analog inputs are in use.

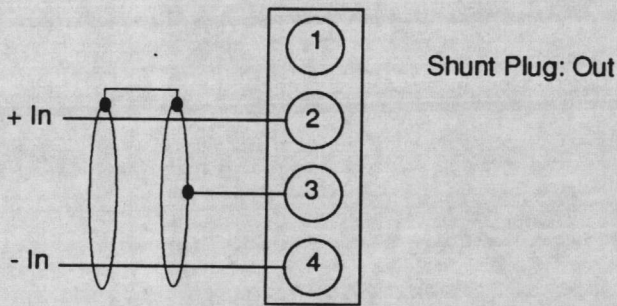


J14: Analog Inputs

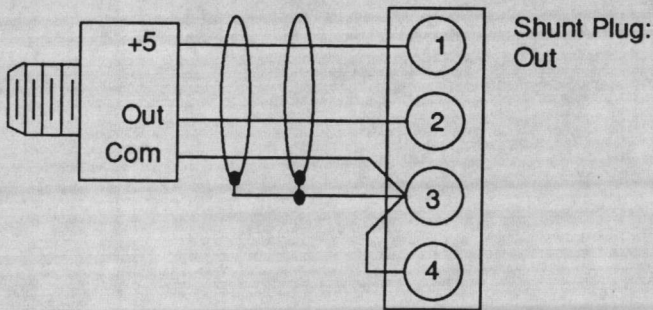
24 pin connectors; each four pins are one analog input.  
 Analog 1 is on pin 1 which is at the bottom.  
 Other analogs repeat in the same sequence.



Single ended analog input, shielded cable.



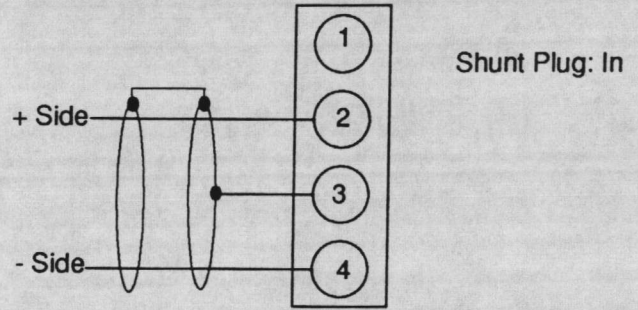
Floating (differential) signal, shielded cable



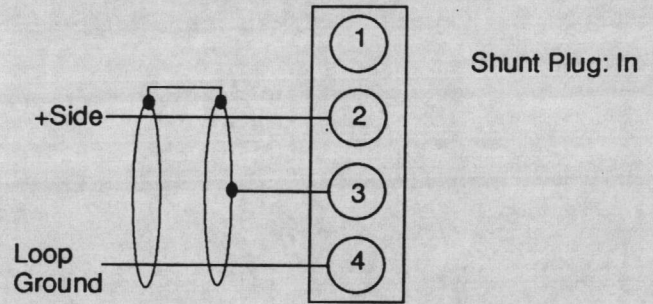
Single ended, 3 wire, powered transducer, shielded wire.

NOTE: Each plus (pin 1) has 5V (50mA total) non-isolated power for transducers.

J14: Analog inputs (continued)

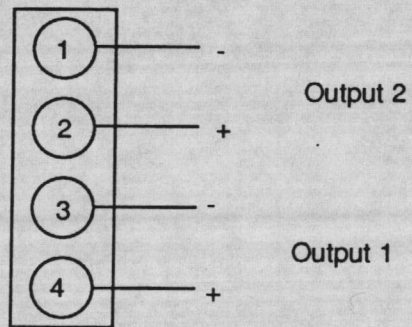


Current loop (4-20mA) input, floating loop

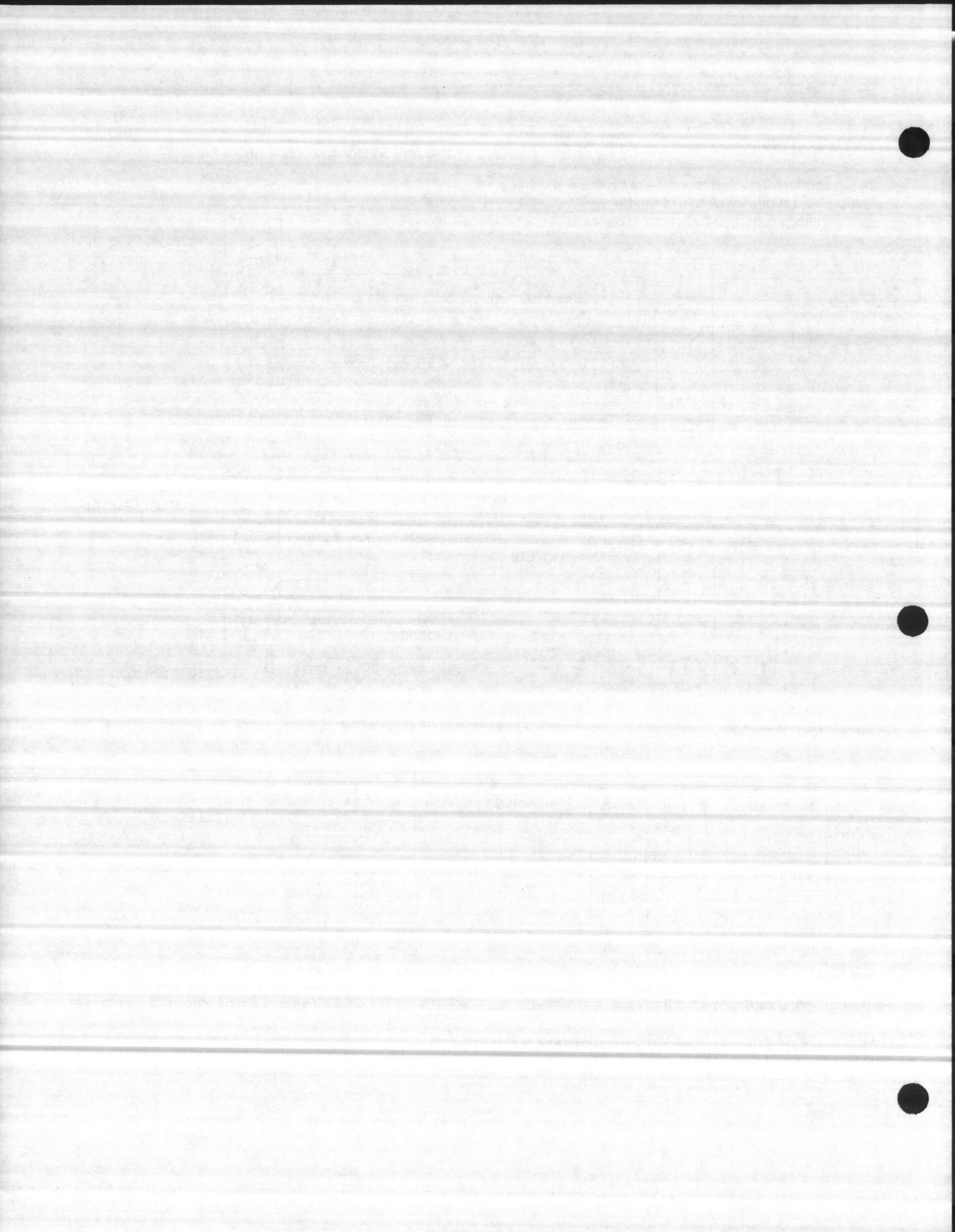


Current loop input, RTU is at end of grounded loop

J23: Analog output

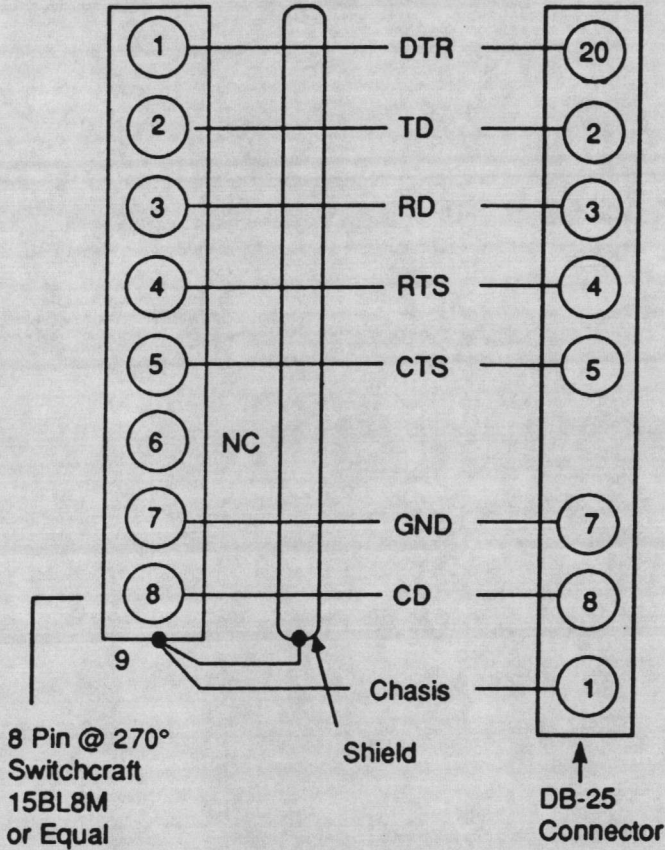


**Do NOT** ground either side of circuit, current sensing is in negative line.

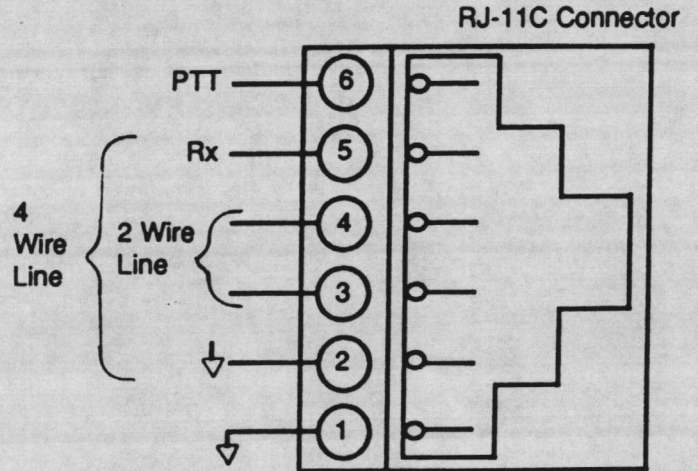


**J24: RS232 Serial port**

Use 100% shielded, non-paired cable such as Belden #9539, 9537.



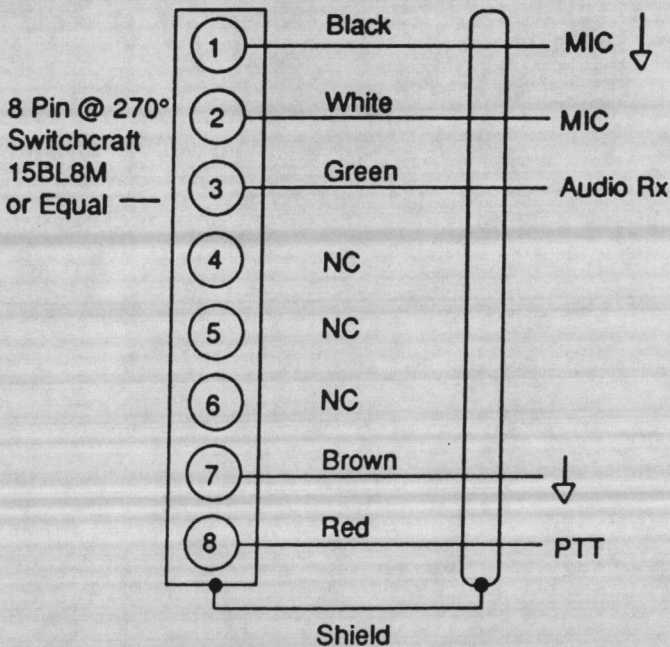
**J26: Telephone connector**

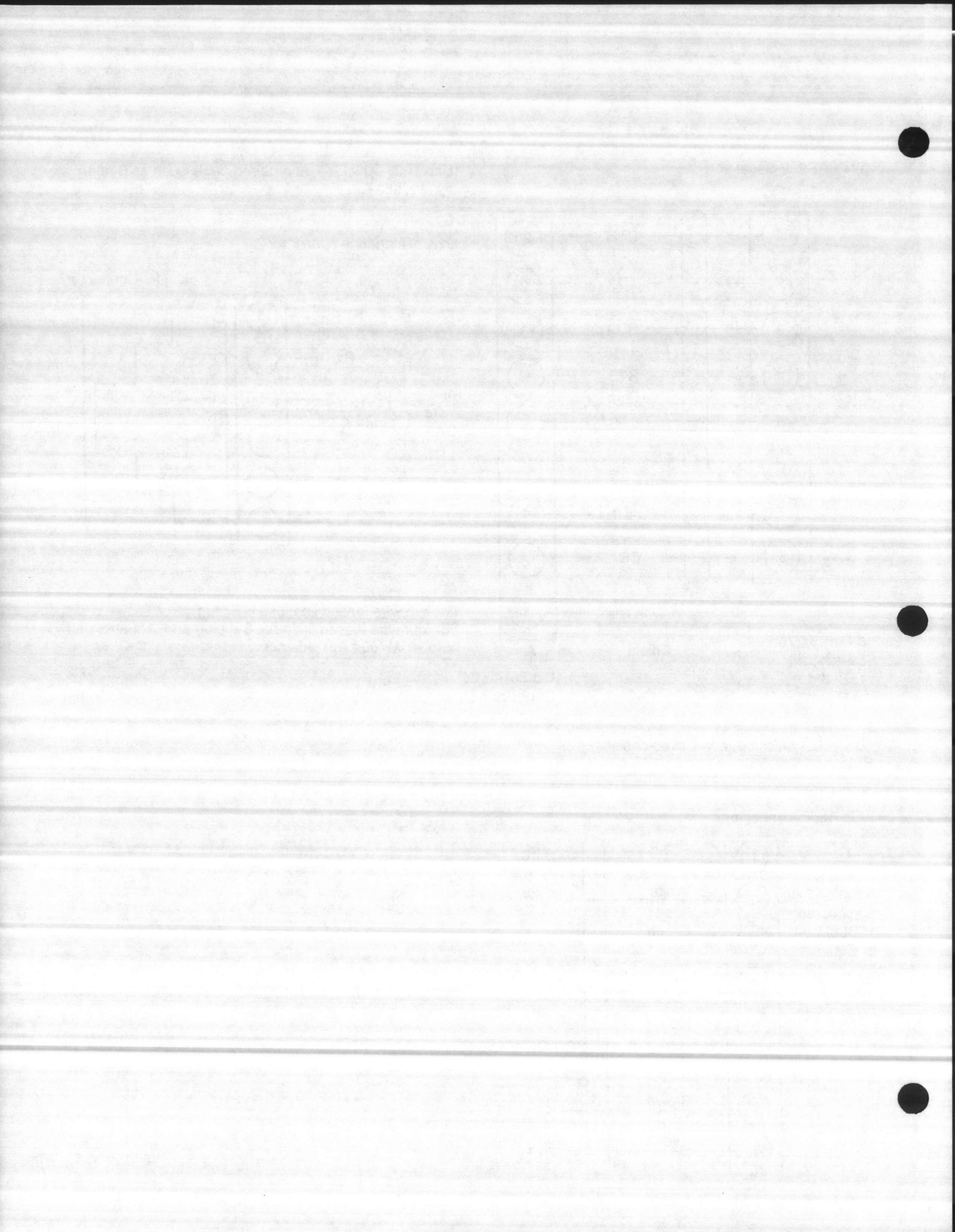


For two wire leased line, use 6-2 plug  
 For four wire leased line, use 6-4 plug and Aquatrol part number M4004 A01 adapter.

Use 100% shielded, non-paired cable  
 Belden #9539, 953

**J27: Radio connector**





## 6 Configuration

### Getting Started

The W1500 RTU must be configured for its operation. It may be set up either by a portable programming panel plugged into the RS-232 port, (see Applications Symbols Section, page 13, J24) or over the telemetry line from the central station. It is best policy to program the RTU for the first time using the portable panel, then make any desired changes over the line from the central station. This allows the operator to tune system response for his particular application, or to make seasonal changes in pumping schedules, tank levels, and so forth.

### Setup Operation

A list of the setup commands begins on page 19; each one will be described in detail and in order shown. The setup may be changed at any time, the RTU will continue operating during any setup command. When the desired setup has been entered, the SAVE command places it in permanent storage where it can only be changed by another SAVE command. The RTU can undergo periods of extended power outage or storage, and will begin operating as before, when power returns. The RTU stores its setup information in semi-permanent semiconductor memory which does not require any external power, including batteries, to maintain its information.

### Portable Terminal

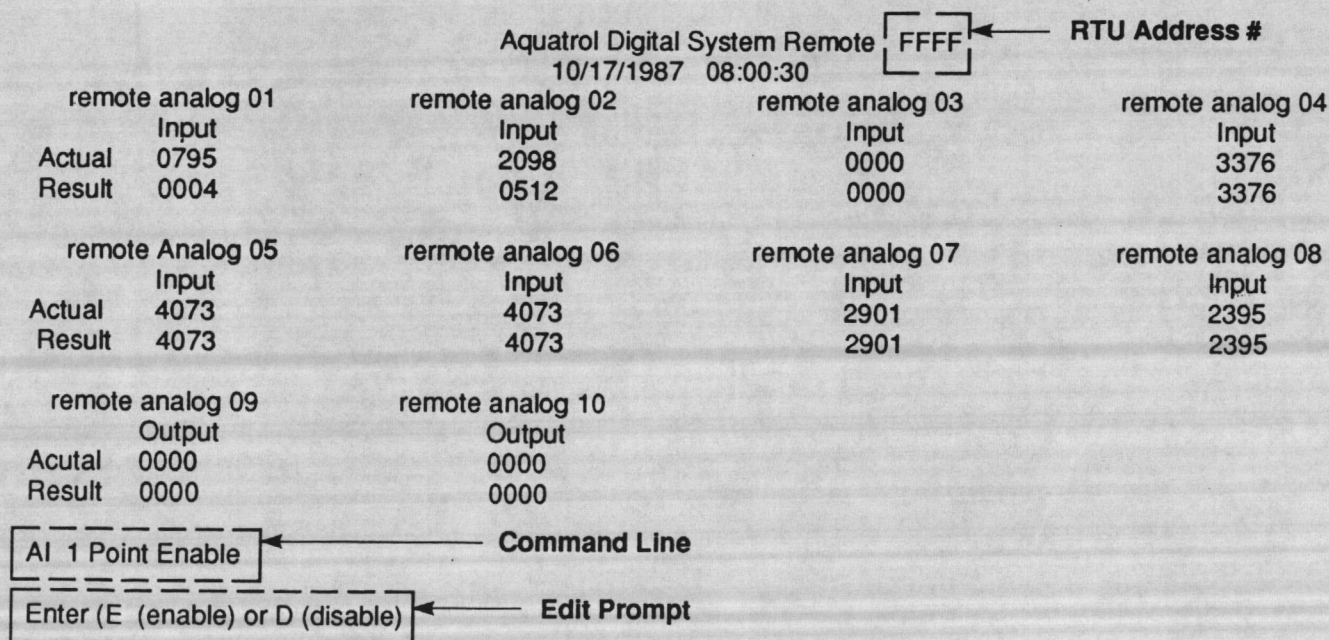
Any portable RS-232 terminal or laptop computer that has at least a 25 X80 screen can be used to interface with the w1500 RTU. All configuration software is RTU resident so no special program disk is needed. If you are using a portable or laptop computer, use the communications program supplied by Aquatrol. This will allow access to the RTU. Use the following criteria for communication:

Baud rate- 9600  
 Data bits- 7  
 Stop bits- 1  
 Parity- 0  
 Rx buffer- 100  
 Tx buffer- 2000

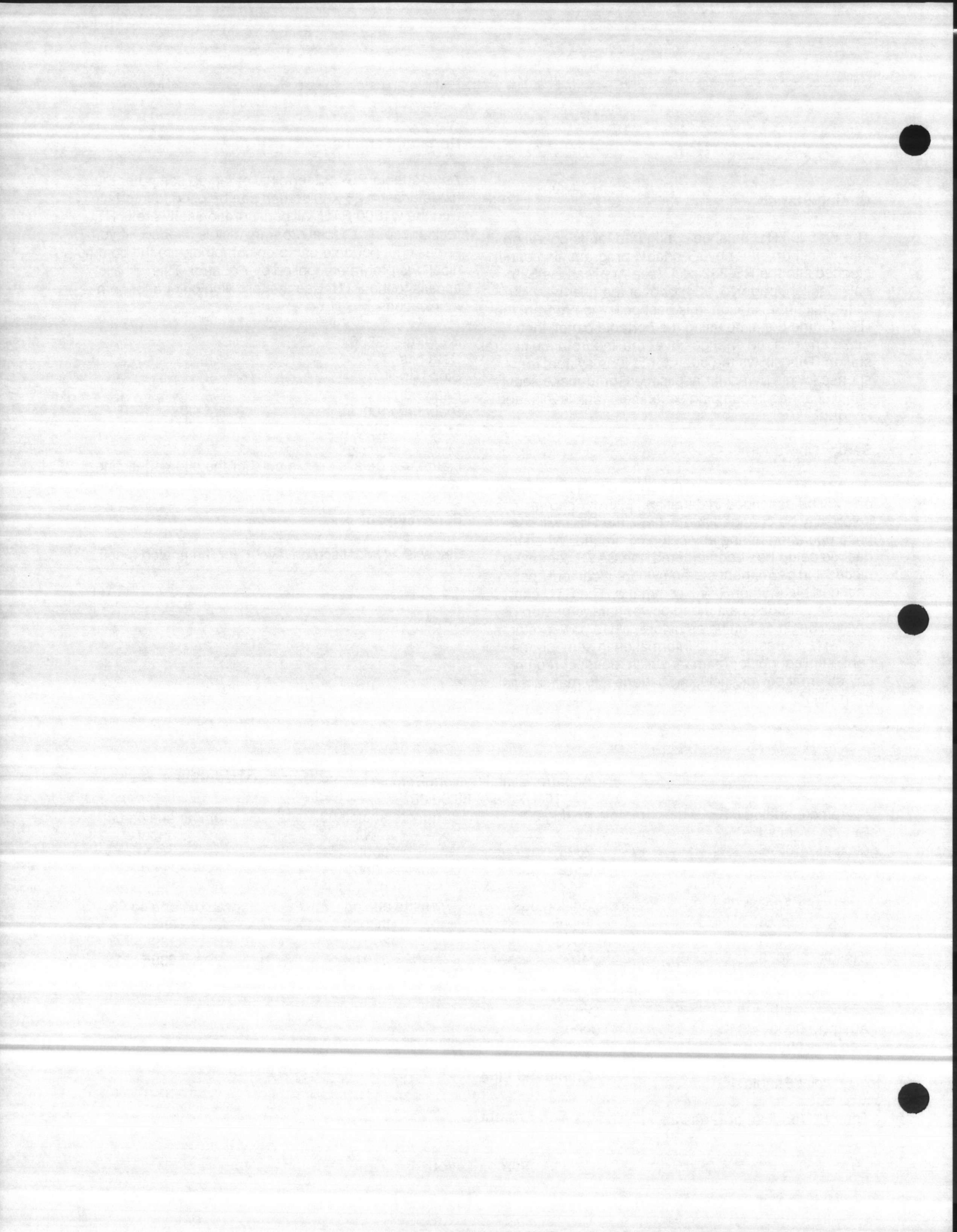
Figure J24 details the pin outs for the interconnecting cable .

### Screen layout

Below is a typical screen layout for the analog menu.



Screen Layout





"Aquatrol Digital Systems remote" and the actual RTU address number will be at the top of the screen, with the date and time listed below it. If the particular sub-menu has an active data screen associated with it (like the analog menu shown) this information will appear in the center body of the screen. RTU configuration, analog, digital and other screens that show active status of the RTU. Sub-menu items under each menu that actually allow you to configure the RTU appear on the command line in the lower left portion of the screen. Scrolling thru these sub items is accomplished by using the arrow keys. Edit prompts will appear directly below the command line in the lower left portion of the screen. Refer to the editing section for further information on editing.

### Editing

Editing can be accomplished in any menu item (except EEPROM Data Programming) by selecting the E key. The edit prompt will appear below the command line (see section on screen layout) and give a choice or range of data to select from. After you have made your selection, press the enter key to record the edited value. If you wish to terminate the edit function without any changes, press the escape (ESC) key.

### Menu

The RTU contains a MENU system to simplify the setup procedure. The operator can quickly go through the selections with a minimum number of keystrokes and only change those items necessary. There are four major menu categories and 25 sub item categories. Each major category is accessed by a combination of the Shift key and a number key. The major menu and sub item categories are listed below:

Shift 0 - EEPROM data programming commands

I - Initializes the default values in EEPROM.

R - Restores the current values to memory.

S - Saves the current setup to EEPROM.

Shift 1 - RTU data entry

A - Selects the analog menu for display or editing

C - Selects CONFIGURATION for display or edit.

D - Selects the digital menu for display or editing.

E - Enters the EDIT mode to change data.

F - Fail timer diagnostics (service only).

Q - Selects full screen display or command and edit lines only.

V - Displays the program version and date.

Z - Displays the program diagnostic information

Shift-2 - Control template data entry.

Reference Appendix 1, if applicable.

Shift 3 - RTU setup data.

C - Change the value for CLOCK and DATE.

E - Enter the EDIT mode to change data.

H - Displays a range of memory on the screen.

K - Displays serial line communication variables.

N - Displays the NEXT page of memory.

T - Displays communication status information.

Q - Selects Full screen display mode.

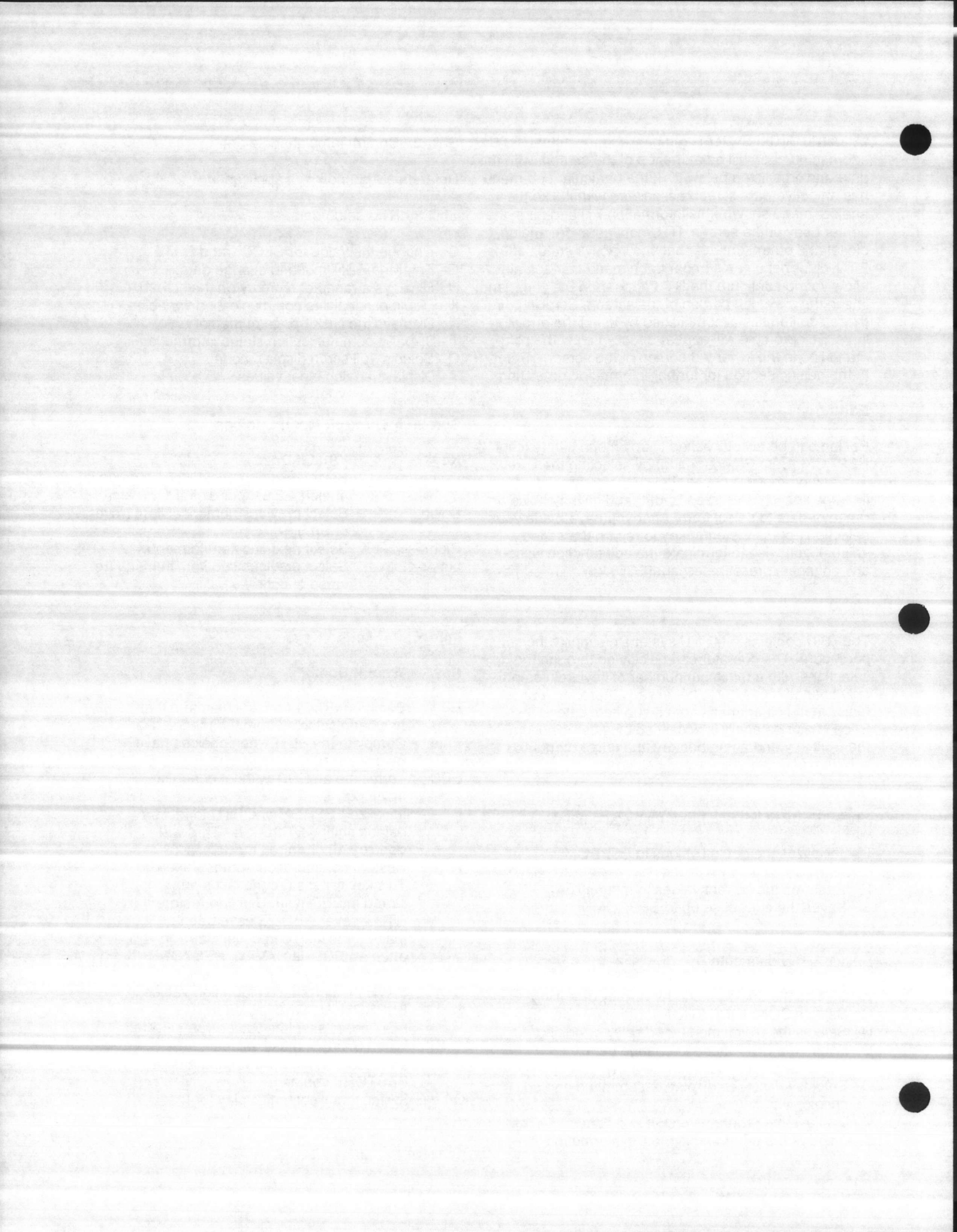
Y - Displays analog input values.

### Scrolling Through Menu Choices

Key	What It Does
Up ↑	Select next numerical item in group i.e. analog 1,2,3... or digital 1,2,3 etc.
Down ↓	Select previous numerical item (reverse of Up).
Right →	Select next sub item in menu.
Left ←	Select previous sub item in menu (reverse of right →).

### Immediate Action Keys

Key	What It Does
E	Begin an EDIT of a particular item that has been selected from the menu.
Enter	Complete the EDIT when choices have been entered.
ESC	Terminate an EDIT without changing anything.
I	Initialize EEPROM and RTU to factory default settings. <b>Caution - This will destroy all changes made.</b>
R	Restore configuration from EEPROM. This key will restore the last setup stored in EEPROM. Use it to restore the RTU if several EDITS have been made for testing purposes. <b>Caution - once an EDIT is SAVED, RESTORE will not recover the previous setup.</b>
S	SAVE the current configuration values in EEPROM. Use this key after EDITing, to save the values you selected. When SAVED, these values are used during power up and after a RESTORE command.
Q	Switch to full screen display for menu



items (A)nalog, (D)igital and control screens  
 The "Q" key alternates between a clear screen and the menu screen. If display messages have been enabled (Menu "Z"), they will appear instead of a clear screen. This key is a two position toggle key.

### Menu Sub-Item Descriptions

In this section, the menu keys are in alphabetical order. After each key you will find a list of sub-item selections followed by the display they produce. Select from the numbered items using the right and left arrow keys as defined above.

An example from the analog setup menu (A) will illustrate the procedure:

"A" to start the analog menu.

The display shows: AI 1 point ENABLED. The sub-item "point" will display on the screen, followed by its present condition in capital letters "ENABLED" and preceded by its type: Analog Input 1 (AI1).

Press the right arrow key to select sub-item number 2. You will see the words "TYPE INPUT". This shows the analog is configured as an input. Pressing the RIGHT arrow key continues through the numbered sub items in the analog menu.

Pressing the UP arrow key selects analog numbers 2 through 10, while remaining on the desired sub-item.

Try these menu selections on the keyboard now, to become familiar with the action of the menu and arrow keys.

Following is a list of all menu and sub item selections for the RTU.

Note: The "EDIT PROMPT" shown below each sub item shows the choices to be made when editing that item. On the screen the sub item will display in lower case letters, while the edit PROMPT will be in capital letters. After each sub item listed below, one selection in the EDIT PROMPT is capitalized, while the other is lower case. The capitalized choice is the automatic default value the RTU will select unless another value is added and SAVED in the EPROM.

This reduces the time necessary to program an RTU, since all the most commonly used values are already programmed. The operator does not need to display and edit every function within the RTU, only those which he requires for any particular station.

### A) Analog Setup Data (Shift I)

This menu defines the configuration of each analog signal in the RTU. Type A to enter this menu. The first item will show:

AI (n) point ENABLED

The (n) is the number and it is changed by the UP and DN arrow keys. If the point is an output, it will show as:

AO (n) point ENABLED

<u>Sub-Item</u>	<u>Edit Prompt</u>
1) Point	ENABLED/disabled

Disabling an analog results in the ANALOG DISABLED value (see item #17) being used as the computed value for this analog. For an input, this would be the value scaled and returned in communications. For an output, this value is placed in the output.

2) Type INPUT/output

This field defines an analog point as input or output. Editing a point from an input to an output will change the number of AI's and AO's maintained under B - REMOTE group type. **CAUTION - when changing type, be sure that the address field matches the analog address on the board, or the system will not perform as expected.** See ADDRESS subgroup (item #20).

3) Transmit Analog ENABLED/disabled

This field, if enabled, will cause the value to be returned in the telemetry communications message.

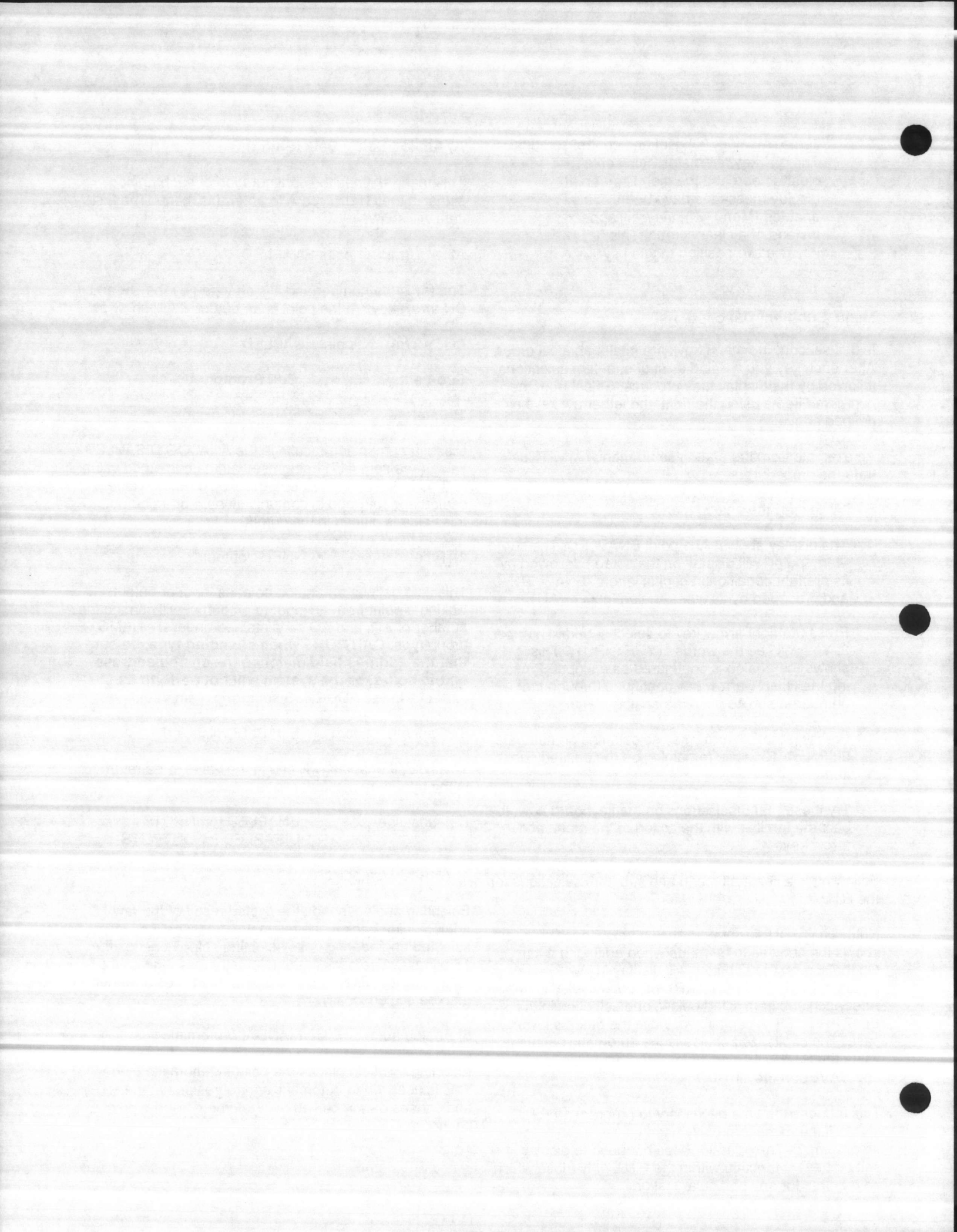
Default value ENABLED for INPUTS  
 DISABLED for OUTPUTS

4) ANALOG/setpoint

Selecting analog, sends the scaled result of the raw analog value back in the telemetry message, i.e., in selected engineering units selecting setpoint sends the 16 bit raw value back in the telemetry message so the data can work directly with 16 bit data in Prosoft rather than be scaled locally.

5) Analog auto MANUAL/Automatic

Enabling this field places the point in automatic mode. This is used when automatic control resides at the RTU, and causes data received over telemetry for the point to be ignored.



6) Quiescent enabled/DISABLED

If this item is enabled and the RTU is in quiescent mode, (Menu B-2) the RTU will initiate a call to the central for setpoint violations.

7) Setpoint check enabled/DISABLED

If enabled, this will replicate the action of an analog setpoint module. When the analog exceeds the high setpoint for the SETPOINT DELAY (Item #18), the high setpoint digital output energizes. When the setpoint minus the setpoint deadband is greater than the current value for the delay time, the output is cleared. The opposite happens for a low setpoint and its associated digital output. If the low and/or high digital output (items #14 and #15) number is zero, no actual output will occur, but the alarm will be maintained internally.

8) Value Range full range/POSITIVE

This indicates whether an analog value can be over the FULL RANGE -9999 to 9999 or be limited to POSITIVE values. Enabling this field will set to full range.

9) Location INTERNAL/external

This allows the user to select whether the analog (digital) value used in software is from the RTU or received over telemetry. See Item #9.

10) Filter Constant (n) (1 - 999)

This value filters the amount of change per update period (one second) for analog values. The change in an analog value is divided by this number and added to the filtered value for scaling. On the next update, the remaining change is again divided, and re-calculated. This repeats until the entire change is accounted for, or it is less than the filter constant. The default value is one, which allows the total change for each update. This filter is a digital integrator and removes spikes or rapid excursions from an analog signal. It does not employ R-C time constants or analog filtering in the signal path.

11) Low Gain -9999 - 9999

This is the constant that will result when the analog signal is zero. Default value 0

Note:

address #23 Battery Vltg. low gain 0 = 0 Volts

address #24 Temperature low gain -460 = 0 Fahrn.

12) High Gain -9999 - 9999

This is the constant that will result when the analog signal is maximum, or 4095. Default value 4095.

Note:

address #23 Battery Vltg. high gain 199 = 19+ Volts

address #24 Temperature high gain 441 = 150 Fahrn.

NOTE: Setting the LOW and HIGH GAIN values establishes a digital ZERO and SPAN for the input signal. The result shows on the test screen as "RESULT" and it is the value used for setpoint checking and telemetering. The equation is as follows:

$$\text{Value} = (\text{LOW GAIN} + (\text{RAW VALUE} * (\text{HIGH GAIN} - \text{LOW GAIN}) + \text{MAX}/2) / \text{MAX}$$

13) Low Setpoint -9999 - 9999

This is the lower scaled value that will cause a quiescent call, or generate a digital output if checking is enabled. (See item #6) Default value -9999

14) High Setpoint -9999 - 9999

This is the high scaled value that will cause a quiescent call, or generate a digital output if checking is enabled. Default value 9999

15) Setpoint Deadband 0 - 9999

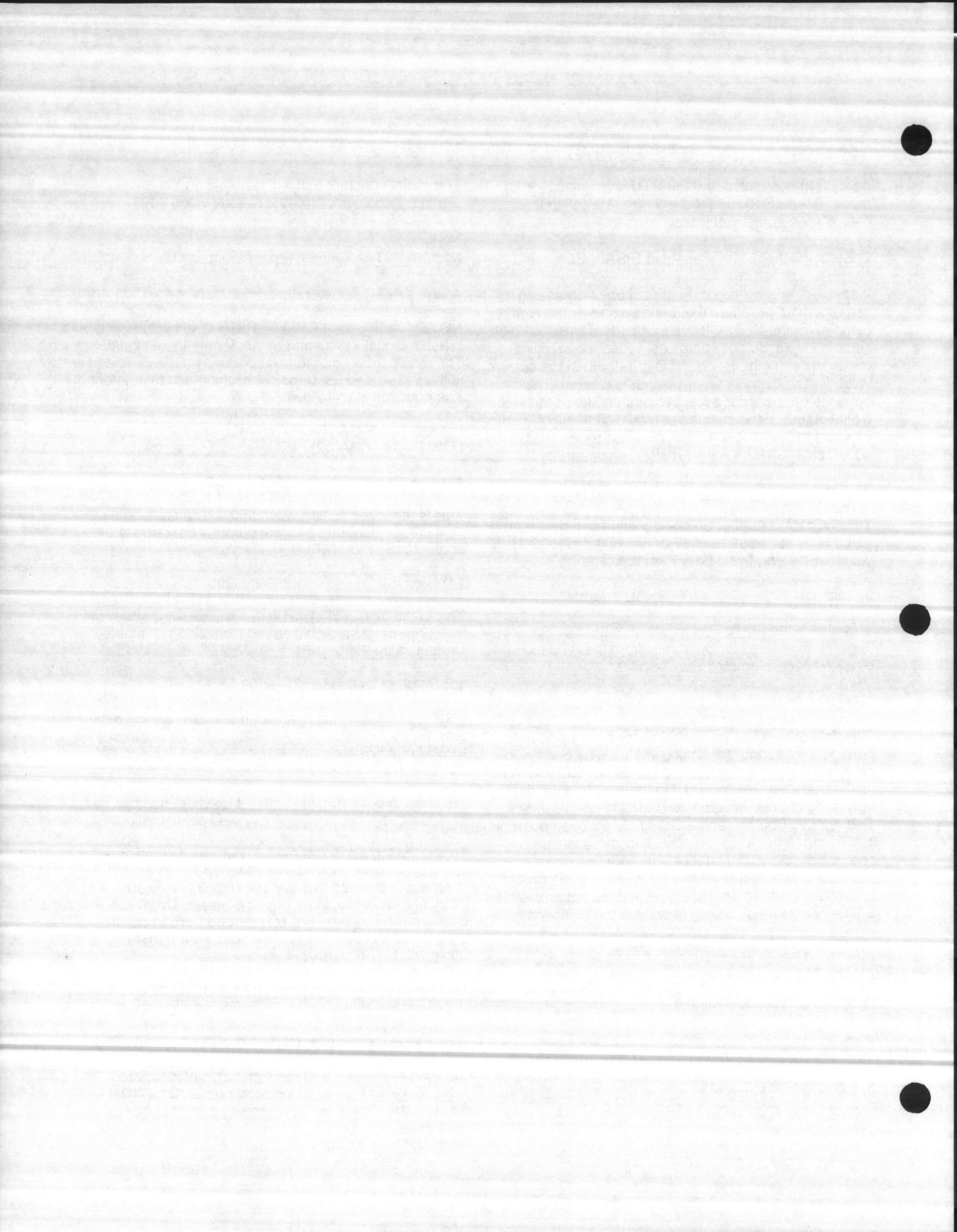
If setpoint checking is enabled, the scaled analog must drop below high setpoint - deadband for an alarm to clear. For a low alarm to clear, the scaled value must rise above low setpoint + deadband. Default value 1

16) Low Setpoint Digital 0 - Maximum number DI/O configuration

This is the logical digital module number as configured in the system which will be set/cleared if the setpoint checking is enabled and the low setpoint is violated. An index of 0 will result in no physical output. **CAUTION - Be sure the digital point referenced here is configured as an output. Default value 0, which means there will be no output.**

17) High Setpoint Digital 0 - Maximum number DI/O configuration

This is the logical digital module number as configured in the system which will be set/cleared if setpoint checking is enabled and the high setpoint is violated. An index of 0 will result in no physical output. **CAUTION - Be sure the digital point referenced here is configured as an output. Default value is 0, which means there will be no output.**



18) Setpoint Delay 0 - 9999 seconds

This is the time duration during which a setpoint must be exceeded for a digital output to be set/cleared when setpoint checking is enabled. Default value 1

19) Analog Disabled Value -9999 > 9999

This is the value that will be used for this analog signal when the point is disabled (See Item #1). Default value 0.

20) Scale Factor 1.00 - 9.99 (decimal places assumed)

Multiplier that further scales analog values returned over telemetry. Allows returning actual units if local value is some factor of real value. Default value is 1.00 returns actual data.

21) BCD Scale Factor 1.00 - 9.99 (decimal places assumed)

This constant scales values greater than 999 for output to LED's connected to "J" cable board. Note - only if "J" cable board is enabled on the system.

Default value is 4.00 results in output of 0 - 999 for data scaled 0 - 4095.

22) Logic Address 1 - ??

The location in software of analog (digital) as compared to physical location. Allows user to select an analog (digital) value to be used in software that has a different physical location. Normal use is to allow setpoint data to be used in software that is received from the central terminal unit rather than local data.

23) Physical Address 1 - 14

Analog inputs are addressed 1 - 8 with one starting at location J14 on the RTU. Analog outputs are addressed 9 - 14 with 9 and 10 being on main RTU at location J23 and the next four on the expansion board if present.

NOTE: AI with an logical address of 23 is Battery Voltage which has a Multiplier of 1, a Low Gain of 0, and High Gain of 199. Allogical address 24 is Temperature, has a Multiplier of 1, a Low Gain of -460 and a High Gain of 441.

24) Flow Totalization Enabled/DISABLED

Enables or disables flow totalization function for the specified analog. See Item 25

25) Flow Total Type 00 - 01

This sub item selects whether the analog should be to collect flow totals. If the user enables this feature (select a type other than 00) and selects the appropriate

engineering units, the RTU software will calculate a totalized flow based on the flow rate from the analog value and the time that analog value was present. The RTU does 6 second updates so the flow total should reflect a highly accurate value without the need of a hardware totalizer on the final element device providing the analog signal. Currently, only flow type enabled is GPM to gal. Select 01 for gallons.

26) Long Flow Enabled/DISABLED

If flow totalization is enabled this feature allows for the selection of either a 16 or 32 bit integer to be returned in the telemetry message.

Disabled - 16 bit (3 significant digits) integer.  
Enable - 32 bit (6 significant digits) integer.

27) Flow Scale Factor 0 - 9999

This sub item allows the user to select a scaling factor to return a value that is a multiple of the actual value for display and transmission back to the central terminal unit.

28) Flow Totalizer ##

Display only. Displays the accumulated flow total selected in flow total type and scaled by Item # 25. Total may be cleared by selecting edit and responding YES to the request to clear total.

### (C) Remote Setup Data (Shift 1)

This is the information that defines the remote. This menu contains the address, number of inputs and outputs of each type, mode of operation, types of peripheral hardware and an I/O mask for setup.

The number of inputs and outputs of each type must match the central station configuration. If the configurations do not match, the RTU will respond to telemetry queries, but will not use the outputs sent to it.

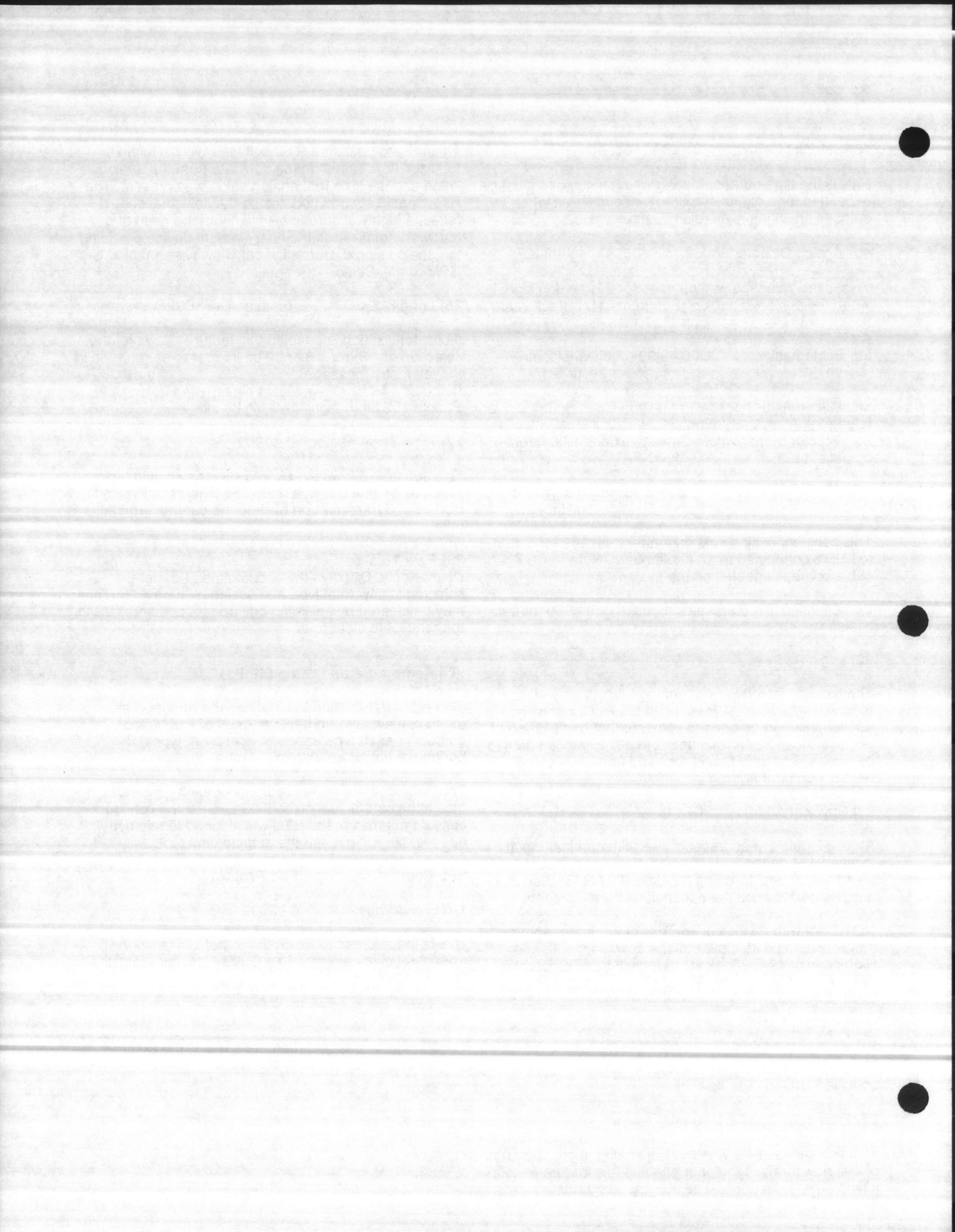
<u>Sub-Item</u>	<u>Edit Prompt</u>
-----------------	--------------------

1) TEL Address	0 - 9999
----------------	----------

This is the address to which the remote will respond when it receives a query. In a Quiescent transmission, it calls with this address.

2) Tel Link Address	0 - 9999
---------------------	----------

If dual address enabled (Item # 4), this is the address that datas will be sent to by the RTU.





3) Telemetry Mode      quiescent/POLLED

Enabling places the remote in quiescent mode, wherein the remote initiates calls on change of status for those points selected. The remote will still answer polls while in quiescent mode. This selection provides a single entry to start or suspend quiescent operation, thus allowing the operator to retain all the setpoint values and quiescent selections entered in other menus.

4) Dual address      DISABLED/enabled

Reference Item #2. ASllows the user to select if the RTU should retransmit data to a location other than the central terminal unit.

5) Data Fail Output      DISABLED/enabled

Allows user to select RTU data fail to be output thru connector J15 for local alarm/light.

6) Data Fail Time      0 - 9999

Elapsed time, in seconds, of loss of communication between the RTU and the central terminal unit prior to energizing the data fail output. Default value = 180 seconds.

7) Digital inputs      nn

This is the number of digital input points on the RTU. Maximum is 16, if only main RTU exists. An additional 32 exist if an expansion board is present, assuming no digital outputs. Minimum of 0. Default 8

8) Digital outputs      nn

This is the number of digital output points on the RTU. Maximum is 16, if only main RTU exists. An additional 32 exist if an expansion board is present, assuming no digital inputs. Minimum of 0. Default 8

9) Analog Inputs      nn

This is the number of analog inputs in use on the RTU. Maximum possible is 8 with a minimum of 0. Only 6 of these are usable as input addresses 1 - 6, as addresses 7 and 8 are dedicated to temperature and battery voltage.

10) Analog Outputs      n

Maximum of 2 on main RTU with 4 additional on an expansion board. Minimum of 0. Addressed starting at 9 - 14. Default 2

11) Number of Expansion Boards      0 - 4 are valid

Specify the number of expansion boards present. Default 0

(12) "J" Cable Expansion      enabled/DISABLED

If enabled, then the first 8 analogs configured in the system will be output to the 8 LED's connected to the "J" Cable board.

**(C) Real Time Clock Setup Data (Shift 3)**

The RTU contains a real time clock which maintains the current date and time. This command sets the current date and time. To change, use the "EDIT" key and select either "D" date or "C" clock time. Type in the desired numbers, no punctuation is needed (colons).

DATE mm/dd/yy      CLOCK hh:mm:ss

**(D) Digital Setup Data (Shift1)**

This menu displays and defines the configuration of each digital I/O point in the remote. Each item selected shows the digital point number and its type. For instance, the first item, point, will show:

DI(n) Point ENABLED

The (n) is the number, and it is changed by the UP and DN arrow keys. If the point is an output, it will show as:

DO(n) Point ENABLED

**Sub- Item**

**Edit Prompt**

1) Point      ENABLED/disabled

Disabling a digital point results in the disabled value (#12) being used as the input/output value for this digital. For an input, this would be the value to be returned in communications, and for an output it will be the value sent to the output module.

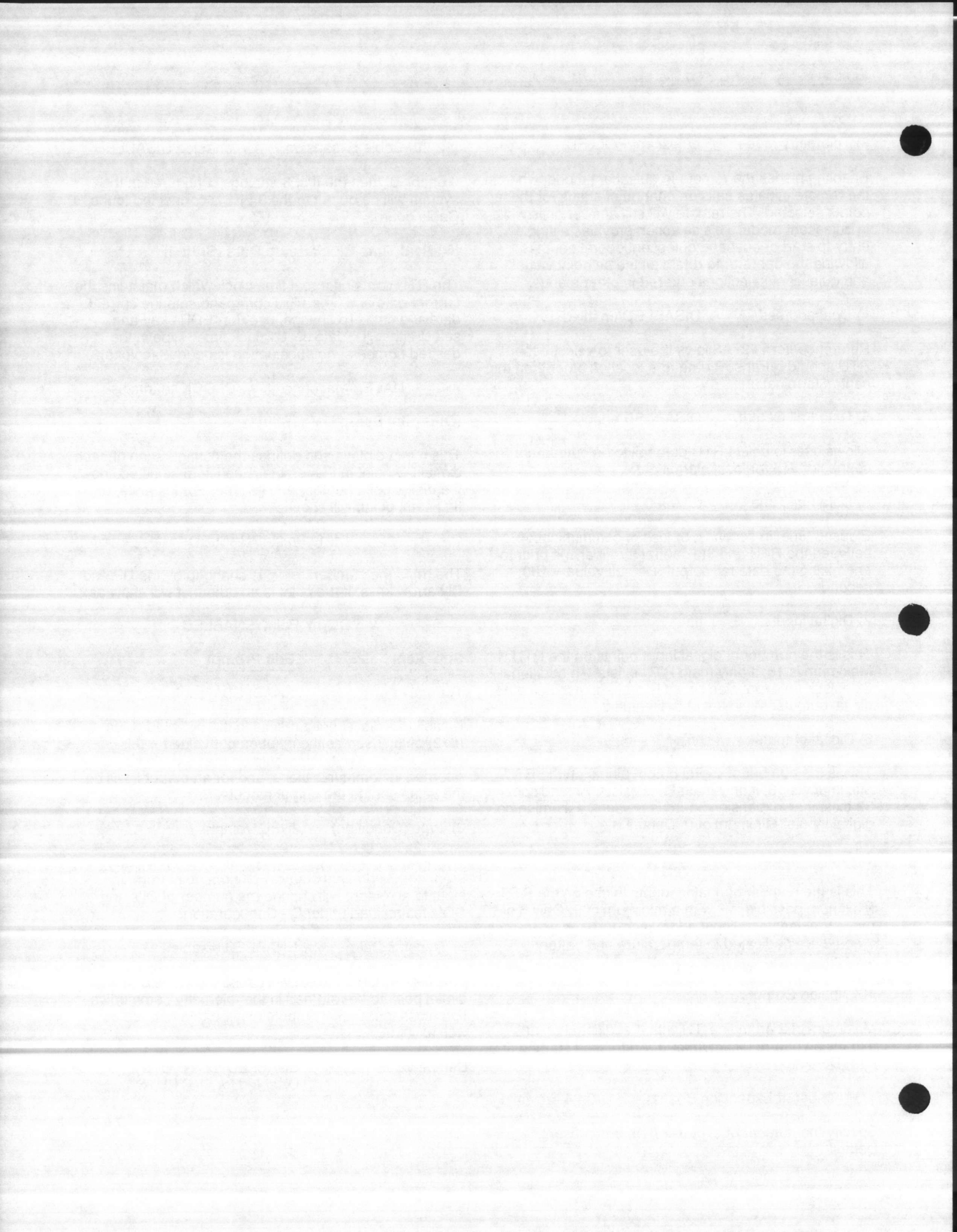
2) Type (Condition)      INPUT/output

This field tells how this digital point is currently configured, and its present status. Editing a point from an input to an output will change the number of DI's and DO's maintained under C - Configuration.

3) Transmit Data      ENABLED/disabled

This field, when enabled, will cause the value of this digital point to be returned in the telemetry communication message. Digital outputs may be telemetered as well as input.

Default value      ENABLED for INPUTS  
Disabled for OUTPUTS



4) Manual-Auto auto/MANUAL

Enabling this field places the point in automatic mode. This is used when automatic control of this point resides at the RTU. Data transmitted over telemetry to this point will be ignored in AUTOMATIC mode.

5) Quiescent enabled/DISABLED

If this field is enabled and the RTU is in quiescent mode (menu B-2) a change in status will initiate a call to the central station.

6) Normal State OPEN/closed

This field allows each I/O point to be specified as normally open or closed. Enabling this item will treat a closed circuit as an off condition.

7) Time Count enabled/DISABLED

Enabling this field allows the remote to accumulate time on and time off for this point. The remote accumulates total time in state, current time in state, and time in state, last time in this state.

It also accumulates the on/off transitions, or starts. This selection is mutually exclusive with pulse count, enable only one of these features. See Items 16 - 19.

8) Pulse Count enabled/DISABLED

Enabling this field causes the remote to accumulate pulse counts up to a maximum rate of 20 pulses per second. The remote accumulates total pulses, current number of pulses in the last six seconds, and number of pulses in the previous six seconds. This selection is mutually exclusive with time count, enable only one of these features. (1 - 16 only.)

NOTE: This feature is available only on the digital points addressed on the main board of the RTU.

9) Logical Address 1 - ??

Location in software of analog (digital) as compared to physical location. Allows user to select an analog (digital) value to be used in software that has a different physical location. Normal use is to allow setpoint data to be used in software that is received from the central terminal unit rather than local data.

10) Physical Address

This is the physical hardware address for this digital point. Hardware addresses on the main board start at 01 for position M1 and range through 16 at M16.

11) COS Delay enabled/DISABLED

Change of status delay. This field requires that a contact be in a given state for this period of time before it is acknowledged as being in this state by the remote. Available only on digitals on main RTU. Default value 0

12) Debounce Delay enabled/DISABLED

This field requires that a contact be in a given state for this period of time before it is acknowledged as being in this state by the remote. Available only on digitals on main RTU. Default value 0

13) Disabled Value enabled/DISABLED on/OFF

This is the value that will be used for a digital point when it is disabled. This value will be returned in the telemetry messages, and sent to output modules if the point is a digital output. (See item #1) This value is modified by the normal state selection, menu item #6.

14) Clear Pulse and Time Counters

This field allows clearing of the counters associated with this point. Edit the field and respond to query with a Y to clear the counters.

15) Location Internal/external

Allows user to select whether the analog (digital) value used in software is from the RTU or received over telemetry. Reference Item #9.

16) Total Count enabled/DISABLED

When enabled this function accumulates run time of the point i.e., amount of time contact is closed or open (see Item 17). The new accumulated value is returned in each telemetry transmission. When disabled only the current time in state since the last transition is stored. See Item 19 for scaling.

17) Time LOW/high

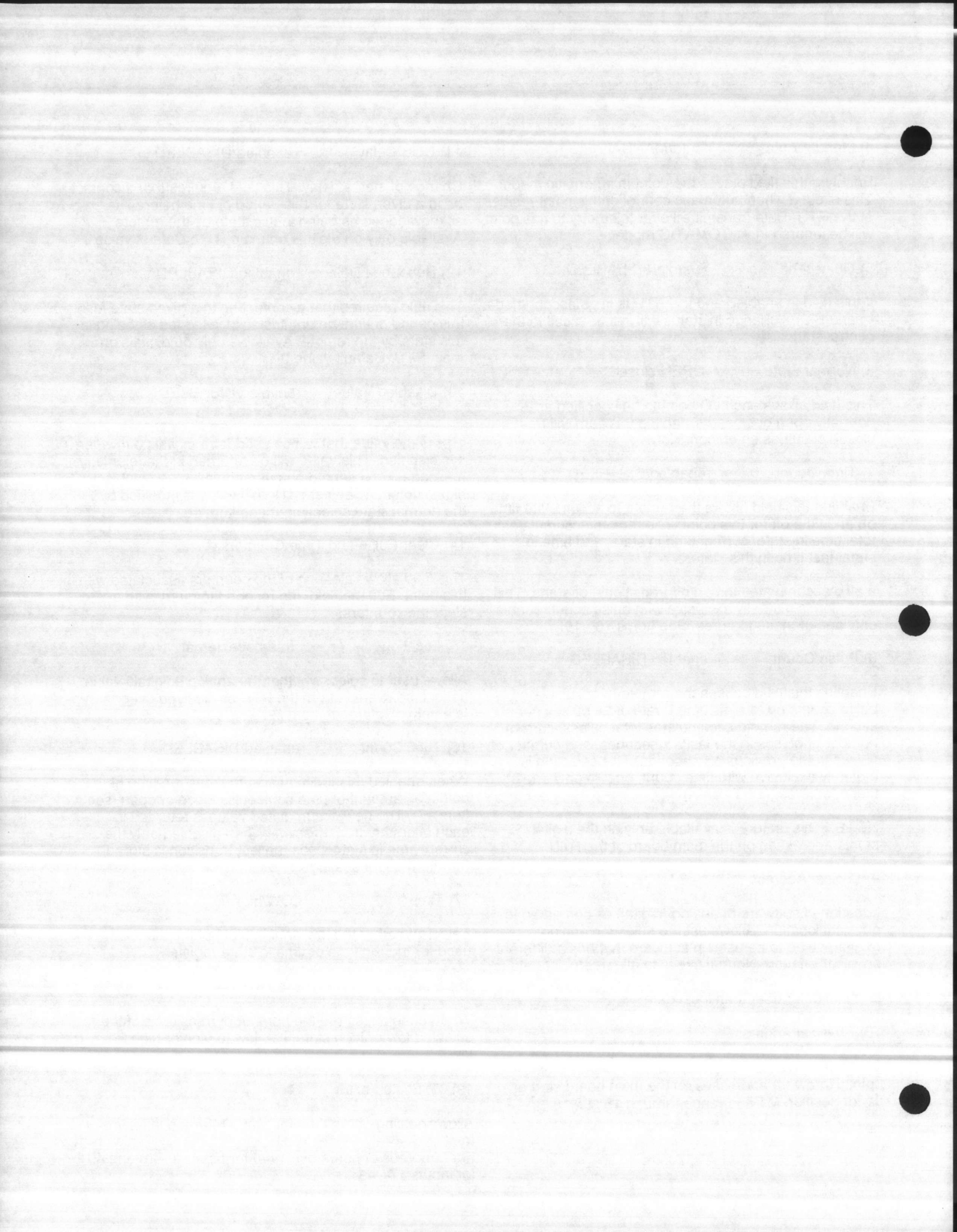
Selects whether the low or high state of the input is used for the run time or time in state register.

18) Starts enabled/DISABLED

When enabled, stores the number of transitions of the selected low or high state, i.e., low to high or high to low.

19) T/P Scale Factor ####

Allows scaling of run time message returned in telemetry. For hundreds of hours use 1440 for inputs 1 - 16 and 40 for inputs 17 - 48.



**(K) Current Configuration of Communications Ports (Shift 3)**

Up arrow toggles between TEL (telemetry) and TEST SET, these are the only two selections for the up and down arrows.

<u>Sub-Item</u>	<u>Edit Prompt</u>
1) Tx-on Delay (Transmit on delay)	0 - 9999

This is the delay time in centiseconds that the remote will wait after turning request to send ON before starting to transmit the message. Use this for radio systems having long carrier delays.

2) Tx-off Delay (Transmit off delay)	0 - 9999
--------------------------------------	----------

This is the delay time in centiseconds that the remote will wait after transmitting the last character of a message before turning RTS off.

NOTE: These delays are minimum. The actual delay may be this amount plus 50 cs.

3) Inter Call Delay	0 - 9999
---------------------	----------

Future use for quiescent operations to maintain a minimum time between calls from a single remote.

4) Baud Rate	0 - 9999
--------------	----------

Transmission rate for telemetry channel. Select 300 or 1200. Transmission rate for testset normally 9600 baud.

5) Data Bits	0 - 9
--------------	-------

The number of bits per character transmitted. Use 7 for the RTU controllers, and 8 for Prosoft-2000. See table below for settings.

6) Stop Bits	0 - 9
--------------	-------

Number of bit times before the next character is transmitted. See table below for settings.

7) Parity (Type of parity)	0 - 9999
----------------------------	----------

- 0 = no parity
- 1 = odd parity
- 2 = even parity

See table below for settings.

8) Rx-Buffer	0 - 9999
--------------	----------

Size of the receive buffer in the interrupt routine.

9) Tx-Buffer	0 - 9999
--------------	----------

Size of the transmit buffer in the interrupt routine.

10) Modem Type	0 - 9
----------------	-------

Initialization for RTU modem on telemetry channel.

0 = originate	bell 103	300 BAUD
1 = answer	bell 103	300 BAUD
2 =	bell 202	1200 BAUD
3 =	bell 202	1200 BAUD with equalizer

NOTE: For a change to take effect, this data must be saved to EEPROM and the RTU powered off and restarted.

**Normal Setup**

TEL Tx on delay	25 CS
TEST SET Tx on delay	n/a
TEL Tx off delay	6 CS
TEST SET Tx on delay	n/a
TEL Inter-call Delay	20 CS
TEST SET Inter-call Delay	n/a
TEL Baud Rate	1200
TESTSET Baud Rate	9600
TEL Data Bits	7
TESTSET Data Rate	7
TEL Stop Bits	1
TESTSET Stop Bits	1
TEL Parity	0
TESTSET Parity	0
TEL Rx Buffer	450
TESTSET Rx Buffer	100
TEL TX Buffer	450
TESTSET Tx Buffer	2000
TEL Modem Type	2
TESTSET Modem Type	n/a

**(T) Telemetry Quiescent Setup Data and Performance Information**

<u>Sub-Item</u>	<u>Edit Prompt</u>
-----------------	--------------------

1) Current Call Address	##
-------------------------	----

Destination address of last message received over the telemetry channel. This shows the master station activity.

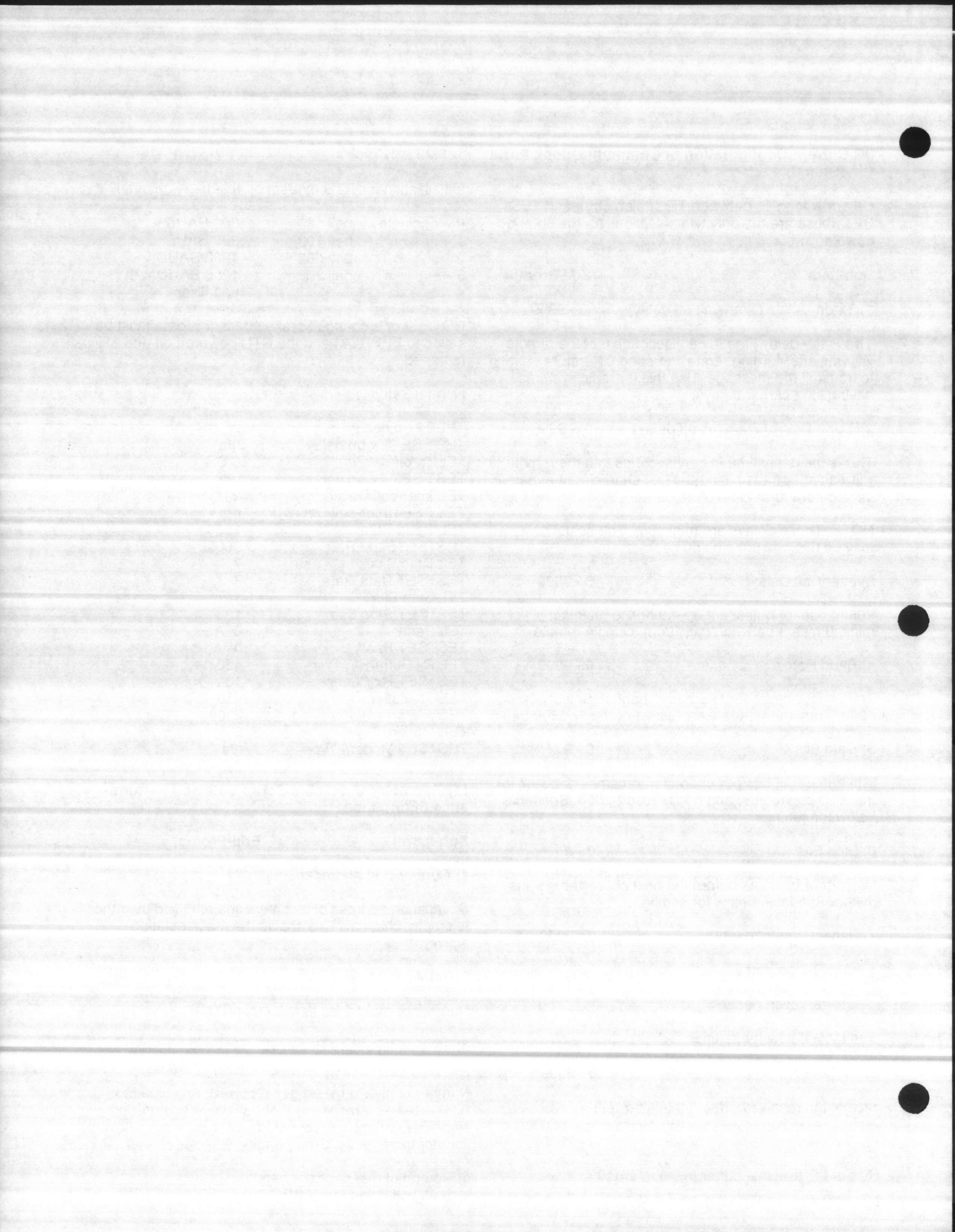
2) Total messages sent	##
------------------------	----

Number of messages sent by this RTU

3) Invalid Messages Received	##Valid Messages Received ##
------------------------------	------------------------------

Number of invalid messages received. Any time the RTU receives a message that has the synchronizing character, but misses one of the error conditions, this counter increments. Error conditions include:

- a) No end of message sequence
- b) Data validation fails - CRC error



Number of valid messages received increments for every message received that passes validation tests. This reflects the number of messages heard by this RTU that contain proper beginning and end of message sequences, and on which the CRC validation is correct.

4) Non ACK Collisions                      ## CD Collisions ##

In quiescent mode, these are the RTU's attempt to indicate the type of collision that occurred.

Non ACKnowledged collisions are those that occur when the remote has not received a response from the master indicating that it received the transmission.

Carrier Detect collisions indicate that another source was transmitting immediately after the RTU stopped. This indicates that the message was probably corrupted.

5) TEL Q Retries                              UNUSED

6) Quiescent CD Off Delay                ## (\* 50 msec)

Time to wait in milliseconds since last message was received, before remote can initiate a transmission.

Default 4 = 200 ms

7) TEL Q Collision Delay                ## (\* 50 msec)

Delay computed by the remote after it determines a collision has occurred, before it will attempt another transmission.

8) Quiescent End of Message Delay ## (\* 25 msec)

Delay after message has been sent to wait before checking to see if another source is also talking.

Default 1 = 25 ms

9) Quiescent Acknowledge Delay ##(\* 50 msec)

Waiting time for an acknowledge from the central station, before indicating a collision.

Default 40 = 2 seconds

**(V) T2044 Version Number and Date (Shift 1)**

Displays the EPROM version number

**(Q) Selective Enable of RTU Information to be Displayed on Terminal Screen (Shift 1)**

**(Z) These messages are test and diagnostic information used to troubleshoot a system. (Shift 1)**

**Sub-Item**

**Edit Prompt**

1) Handheld Testset                      enabled/DISABLED

This removes all cursor positioning for data to terminal. Intended use for two line hand held testset. Currently not usable, as many messages will exceed the line length of twenty characters.

2) Telemetry TX and RX DATA    ENABLED/disabled

Enabling this item will cause the messages received and sent over the telemetry channel to be displayed.

3) Control Tick Counters                enabled/DISABLED

Displays the one second counter for telemetry control, I/O control and PID tasks.

4) Control Debug                            enabled/DISABLED

Enabling this item displays the messages passed from control to telemetry.

5) Display Clock                            ENABLED/disabled

Enabling this item displays the real time clock.

6) DIO Debug                                enabled/DISABLED

Tells whether manual, auto or required is being selected for use as actual digital value to be output.

- 1 = manual
- 2 = auto
- 3 = required

7) Telemetry Header Data                enabled/DISABLED

Enabling this item displays the decoded message header. This includes source, destination, message type, and any message parameters, if present.

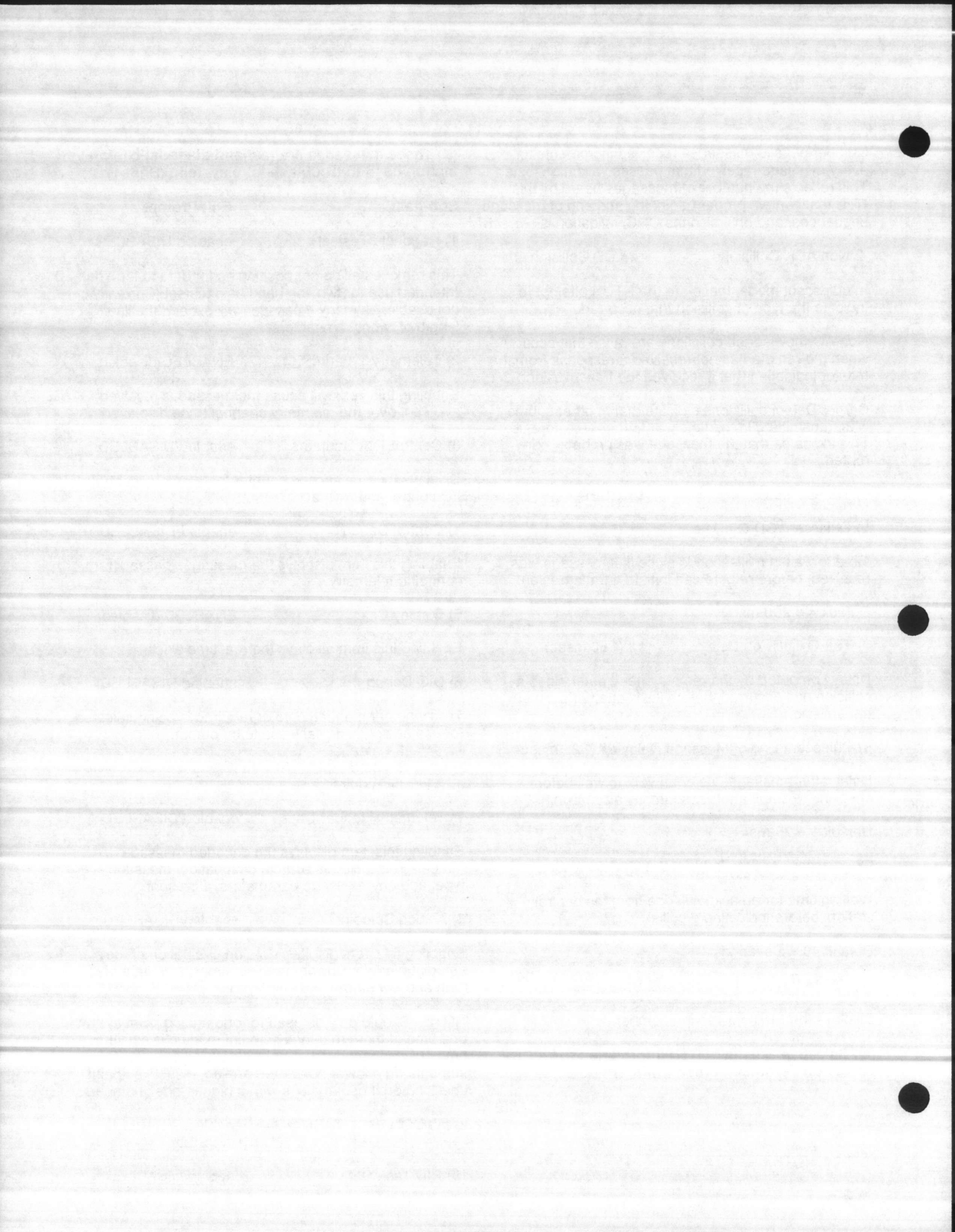
8) Analog Setpoint Data                enabled/DISABLED

Enabling this item displays data on evaluation of the setpoint module. Current reading, timer, and state of high and low alarms are displayed.

NOTE: Should only be used for one analog point at any one time. If more than one setpoint module is active at a time only highest number point's data will remain. To see data on a lower numbered analog, disable setpoint checking on those analogs with a higher index number.

9) I/O CONTROL TASK Data                enabled/DISABLED  
UNUSED

10) PID Task Data                            enabled/DISABLED





11) Idle Count                              enabled/DISABLED

Displays count of the number of times the testset task gets to execute. The testset task is the lowest priority task and only runs when no other task needs the processor.

12) Level Control                            enabled/DISABLED

13) Pump Sequence                        enabled/DISABLED

14) Pump Request                         enabled/DISABLED

15) Quiescent Debug Data                enabled/DISABLED

16) Quiescent Debug                      enabled/DISABLED

17) Quiescent Cos Timer                 enabled/DISABLED

**Quick Setup**

1. Power on RTU.

2. Connect terminal on comm port

If the program is operating the terminal will display "RTU data entry....." and the top 3 lights of D3 will be blinking

- D3      lights
- 1-3    multi-tasking timers
- 4      watchdog
- 5      Rx receive data
- 6      Tx transmit data
- 7-8    configuration and EEPROM errors

3. Select the "C" menu (Shift 1).

4. Using the right arrow keys edit the items to have the following values:

- TEL address                              1
- Digital Inputs                            16
- Digital Outputs                           0
- Analog Inputs                            8
- Analog Outputs                          2
- Expansion board                         0
- J cable board                             0

5. Initialize the remote ( Shift 0) then press "I" key. The system will respond "DONE".

6. The RTU will now respond to telemetry calls.

7. Select Shift 1,D and set digital I/O point as inputs outputs pulse counter or time counter; set delay values and normal state..

8. Select Shift 1, A and setAnalog scaling, setpoints, and filter factors.

9. SAVE your choices

**Command Quick Reference**

**Shift 1A                    Analog Data**  
(Q will give a full screen display)

(                    for characteristics -                    for point)

<u>Sub-Item</u>	<u>Default</u>
Point	ENABLED
Type	INPUT
Transmit Analog	I = ENABLED 0 = DISABLED
Analog/Setpoint	ANALOG
Analog Auto	MANUAL
Quiescent	DISABLED
Setpoint Check	DISABLED
Value Range	DISABLED
Location	INTERNAL
Filter Constant	1
Low Gain	0
High Gain	4095
Low Setpoint	-9999
High Setpoint	9999
Setpoint Deadband	1
Low Setpoint Digital	0
High Setpoint Digital	0
Setpoint Delay	1
Analog Disabled Value	0
Scale Factor	1.00
BCD Scale Factor	4.00
Logical Address	"n"
Physical Address	"n"
Flow Total Type	00
Flow Scale Factor	1.00
Flow Totalizer	"##"
Flow Accumulator	"##"
Flow Remainder	"##"

**Shift 1 C                    Remote Setup Data**

<u>Sub-Item</u>	<u>Default</u>
TEL Address	"n"
Tel Link Address	00
Telemetry Mode	POLLED
Dual Address	DISABLED
Data Fail Output	DISABLED
Data Fail Time	180
Digital Inputs	8
Digital Outputs	8
Analog Inputs	8
Analog Outputs	2
Number of Expansion Boards	0
"J" Cable Expansion	DISABLED



**Shift 3 C Real Time Clock Setup Data**

DATE: mm/dd/yy      CLOCK: hh:mm:ss

**Shift 1 D Digital Setup Data**

<u>Sub-Item</u>	<u>Default</u>
Point	ENABLED
Type (Condition)	INPUT
Transmit Date	1 = ENABLED 0 = DISABLED
Manual-Auto	MANUAL
Quiescent	DISABLED
Normal State	OPEN
Time Count	DISABLED
Pulse Count	DISABLED
Logic Address	"n"
Physical Address	"n"
COS Delay	DISABLED
Debounce Delay	DISABLED
Disabled Value	DISABLED
Clear Pulse and Time Counters	INTERNAL

**Shift 3 K Current Configuration of Communications Ports**

Normal Setup

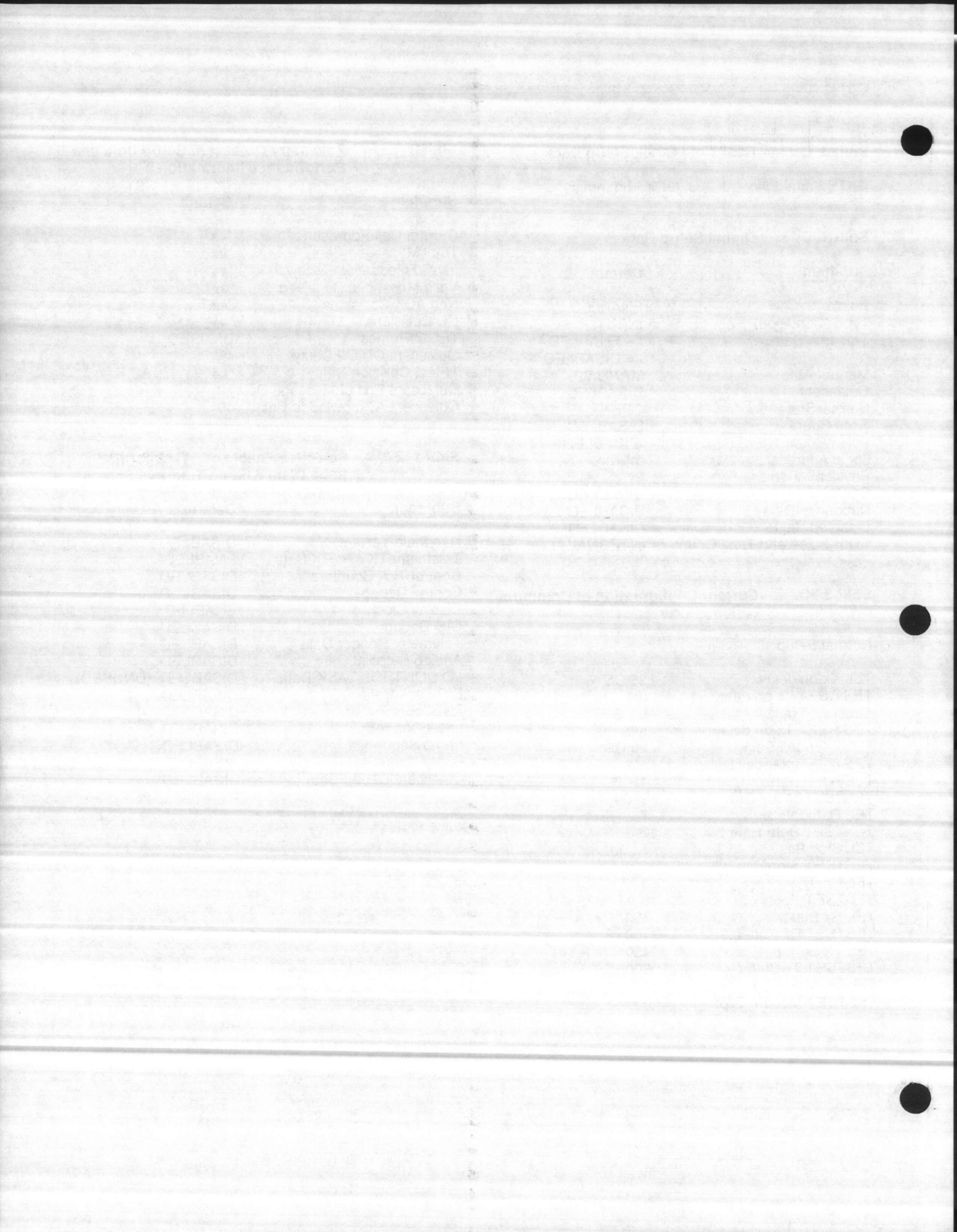
TEL Tx on delay	25 CS
TEST SET Tx on delay	n/a
TEL Tx off delay	6 CS
TEST SET Tx on delay	n/a
TEL Inter-call Delay	20 CS
TEST SET Inter-call Delay	n/a
TEL Baud Rate	1200
TESTSET Baud Rate	9600
TEL Data Bits	7
TESTSET Data Rate	7
TEL Stop Bits	1
TESTSET Stop Bits	1
TEL Parity	0
TESTSET Parity	0
TEL Rx Buffer	450
TESTSET Rx Buffer	100
TEL TX Buffer	450
TESTSET Tx Buffer	2000
TEL Modem Type	2
TESTSET Modem Type	n/a

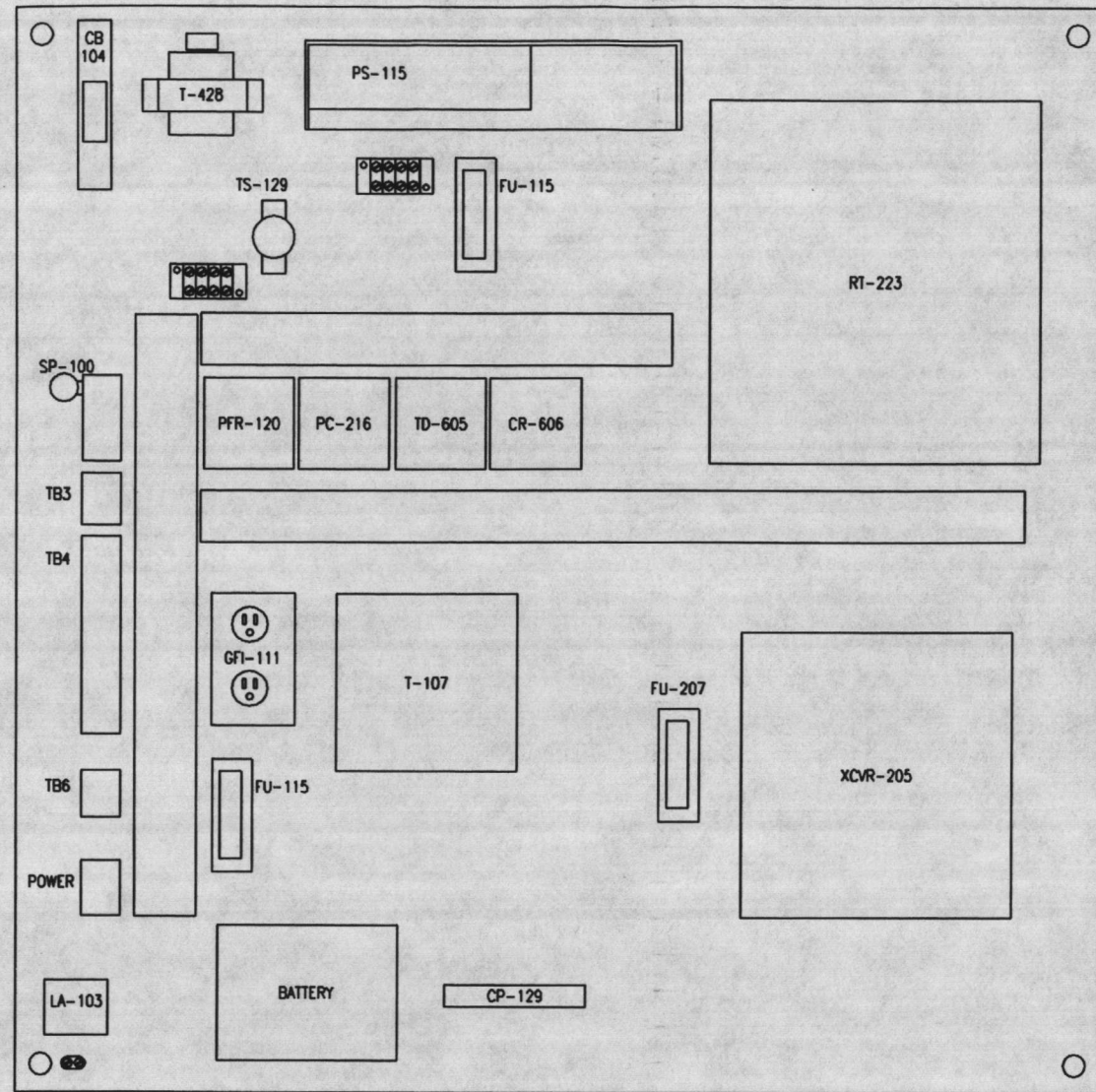
**Shift 3 T Telemetry Quiescent Setup Data and Performance Information**

<u>Sub-Item</u>	<u>Default</u>
Current Call Address	"###"
Total Messages Sent	"###"
Invalid Messages Received	"###"
Valid Messages Received	"###"
Non ACK Collisions	"###"
CD Collisions	"###"
TEL Q Retries	UNUSED
Quiescent CD Off Delay	4
TEL Q Collision Delay	"###"
Quiescent End of Message Delay 1	
Quiescent Acknowledge Delay	40

**Shift 1 Z Selective Enable of RTU Information to be Displayed on Terminal Screen**

<u>Sub-Item</u>	<u>Default</u>
Handheld Testset	DISABLED
Telemetry TX and RX Data	ENABLED
Control Tick Counters	DISABLED
Control Debug	DISABLED
Display Clock	ENABLED
DIO Debug	DISABLED
Telemetry Header Data	DISABLED
Analog Setpoint Data	DISABLED
I/O CONTROL TASK Data	DISABLED (UNUSED)
PID Task Data	DISABLED
Idle Count	DISABLED
Level Control	DISABLED
Pump Sequence	DISABLED
Pump Request	DISABLED
Quiescent Debug Data	DISABLED





ENCLOSURE: HOFFMAN NEMA 4X FIBERGLASS, 36x36x12  
 CHASSIS PANEL: HOFFMAN 36x36

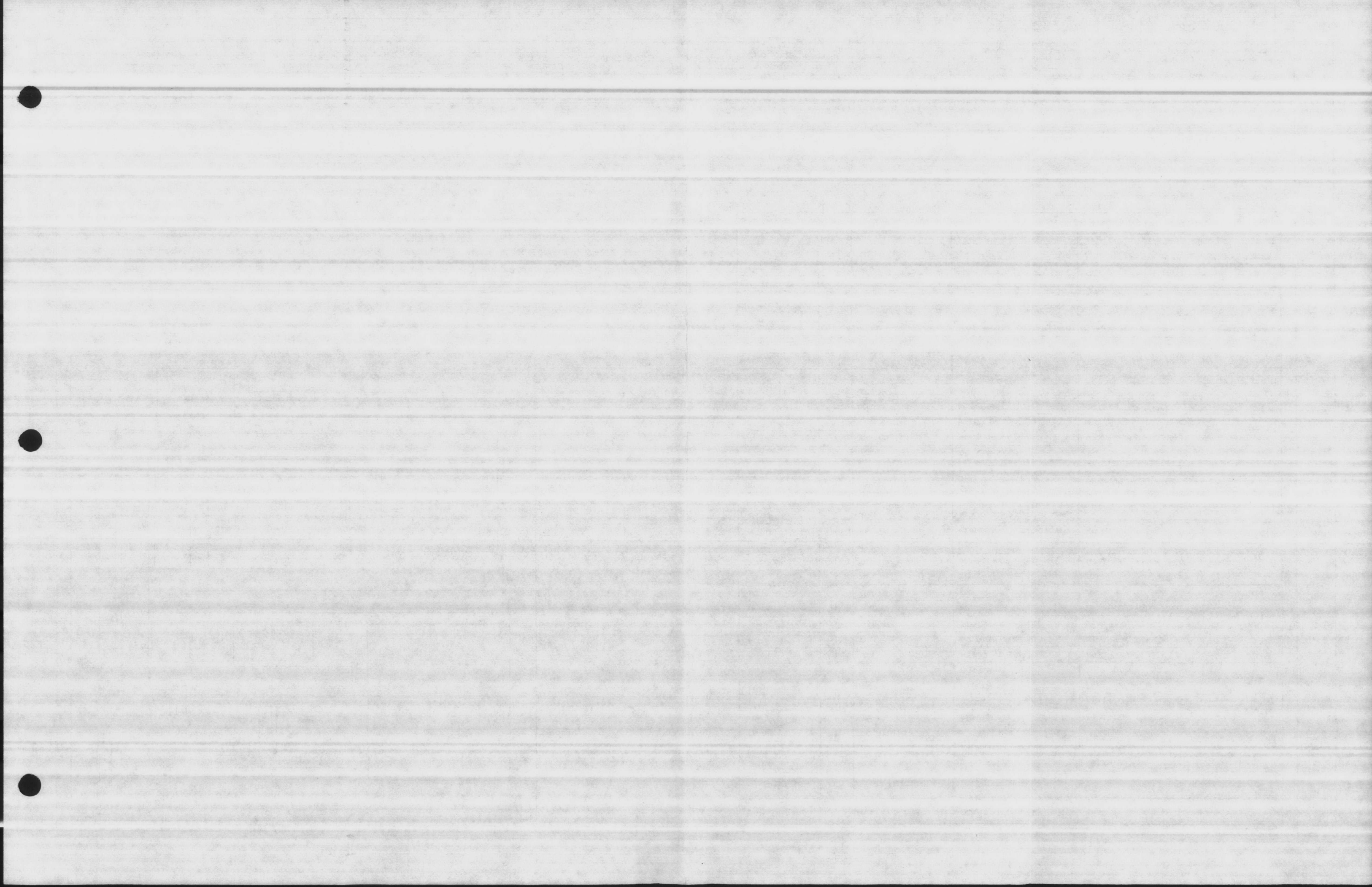
PARTS LIST

TAG NO.	QTY	PART NUMBER	DESCRIPTION	REMARKS
SP-100	1	V130LA10	G. E. SURGE SUPPRESSOR	VARISTOR
LA-103	1	1250-32	JOSLYN LIGHTNING ARRESTOR	
CB-104	1	THQC1115WL	G. E. CIRCUIT BREAKER	15 AMP
FU-108	1	FNM-4	BUSS FUSE	4 AMP 250 V
T-107	1	9T58K2913	GENERAL ELECTRIC TRANSFORMER	120-240/120-240, 500 VA, TERMINALS
GFI-111	1	XXX	RECEPTICAL	15 AMP, 120 VAC, GFCI
FU-115	1	FNM-3	BUSS FUSE	3 AMP 250 V
PS-115	1	XXX	INTERNATIONAL POWER SUPPLY	12VDC, 10.2 AMP
PFR-120	1	XXX	IDEC POWER FAILURE RELAY	RELAY, 120VAC 3PDT, CONT. 10A/120V
TS-129	1	XXX	THERMOSWITCH	OPENS @ 90° F, CLOSES @ 50° F
CP-129	1	010050C1	WATLOW HEATER ASSEMBLY	28 WATT CONDENSATION PROTECTION
XXX	X	XXX	XXX	XXX
XXX	1	XXX	XXX	XXX
XCVR-205	1	XXX	MOTOROLA RADIO	142.525 MHz, 20 WATTS
FU-207	1	FNM-7	BUSS FUSE	7 AMP, 250 V
PC-216	1	708120	AQUATROL W1500 POWER CONTROL	WITH RELAY
RT-223	1	T2044	AQUATROL W1500 REMOTE TERMINAL	
T-428	1	AT72D	HONEYWELL TRANSFORMER	120/24 40 VA
TD-605	1	RTE-B11-12VDC	IDEC TIME DELAY	DELAY ON MAKE, 12 VOLTS DC
CR-606	1	RR3BU-12VDC	IDEC RELAY	RELAY, 12VDC 3PDT, CONT. 10A/120V
	5	SR3B-05	IDEC RELAY SOCKET	
ANTENNA	1	MYA-1405	MAXRAD ANTENNA	142.525 Hz., 5 ELEMENT, 100 FT. COAX AND CONNECTORS
CAB	1	A-36H3612GQRLP	HOFFMAN ENCLOSURE 36x36x12	NEMA 4X, WITH PANEL A-36P36
	6	IAC5E	MODULE, INPUT	10-36 VAC
	2	ODC5	MODULE, OUTPUT	5-60 VDC

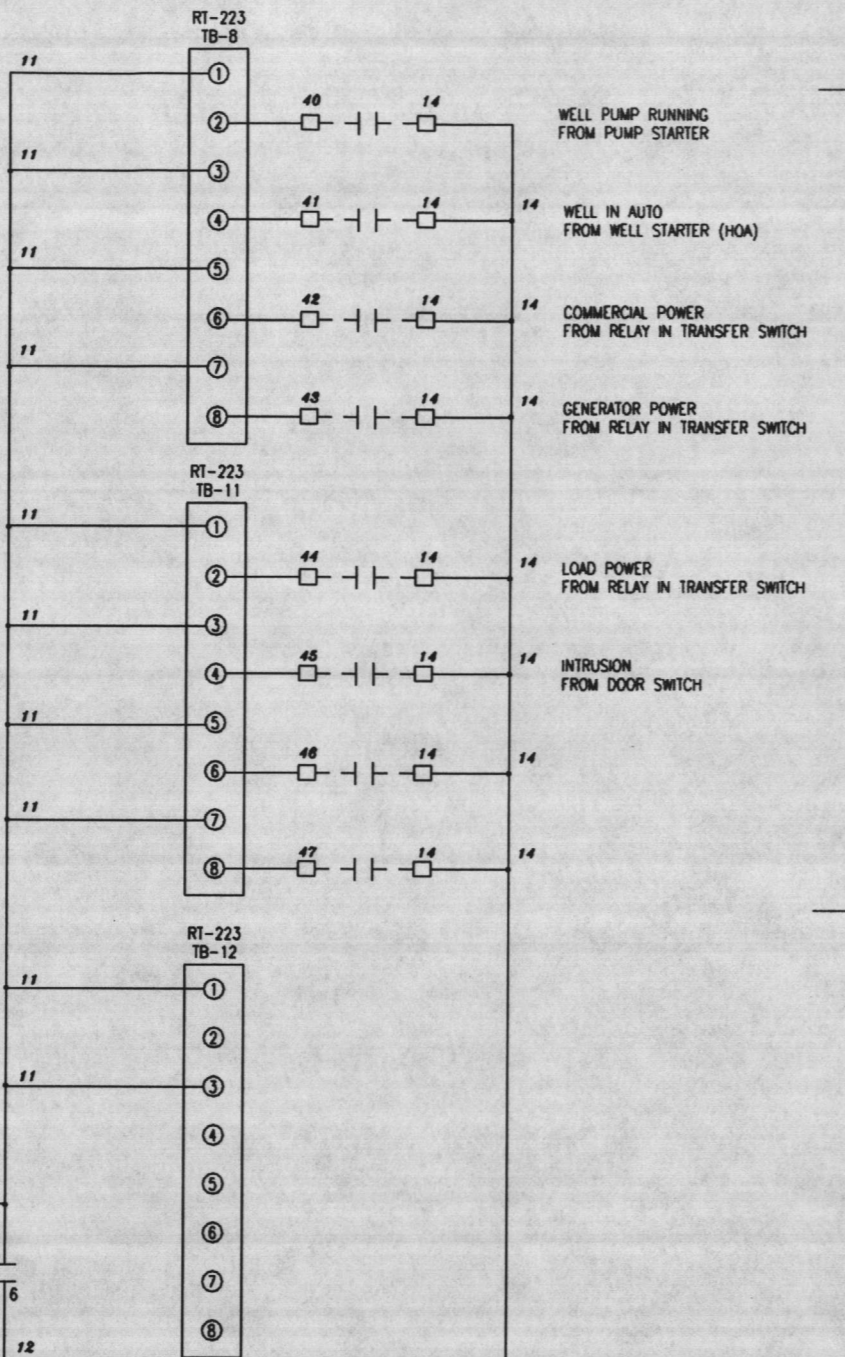
REVISIONS				REVISIONS			
DATE	LTR	FREQ	DESCRIPTION	DATE	LTR	FREQ	DESCRIPTION

Process Control Services, Ltd.  
 2200 SEAFORD ROAD  
 SEAFORD, VA 23698  
 (757) 898-4332  
 (757) 898-8625 FAX

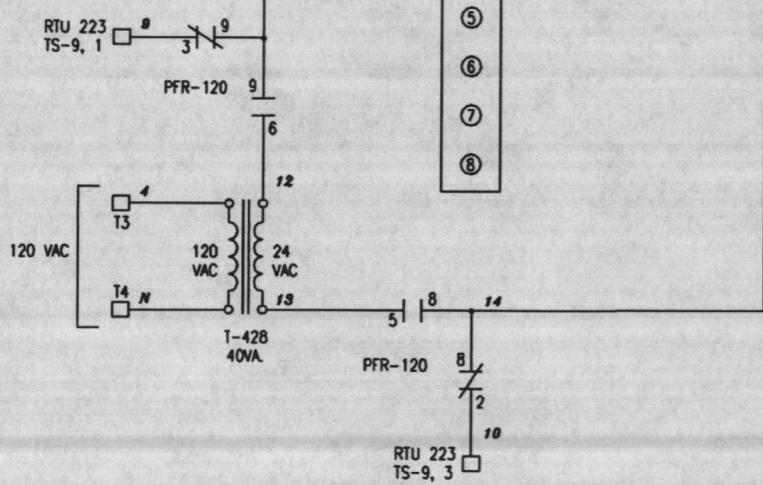
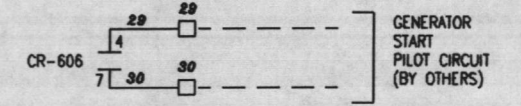
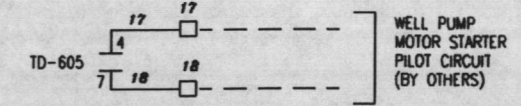
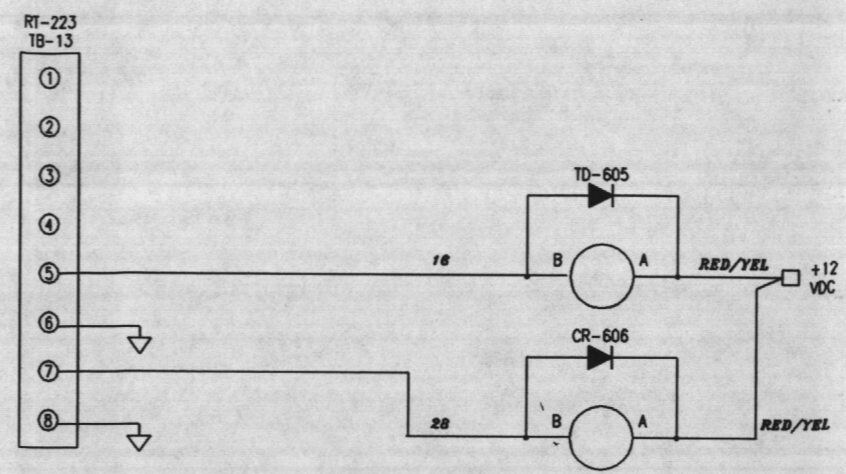
PC2003		CAMP LEJEUNE, NORTH CAROLINA	
APPROVALS	DATE	PROJECT TITLE	REPLACE RAW WATER WELLS FOR HADNOT POINT
Drft.		DRAWING TITLE	PANEL LAYOUT AND BILL OF MATERIALS
Engr.		SCALE	AS SHOWN
Check		DRAWING NO.	PC2003-1
Proj. Eng.	IMBURGIA 7/00	SIZE	D
Sup'n		SHEET	1 OF 4
Manager	IMBURGIA 7/00		



8 7 6 5 4 3 2 1



DRY CONTACTS BY OTHERS

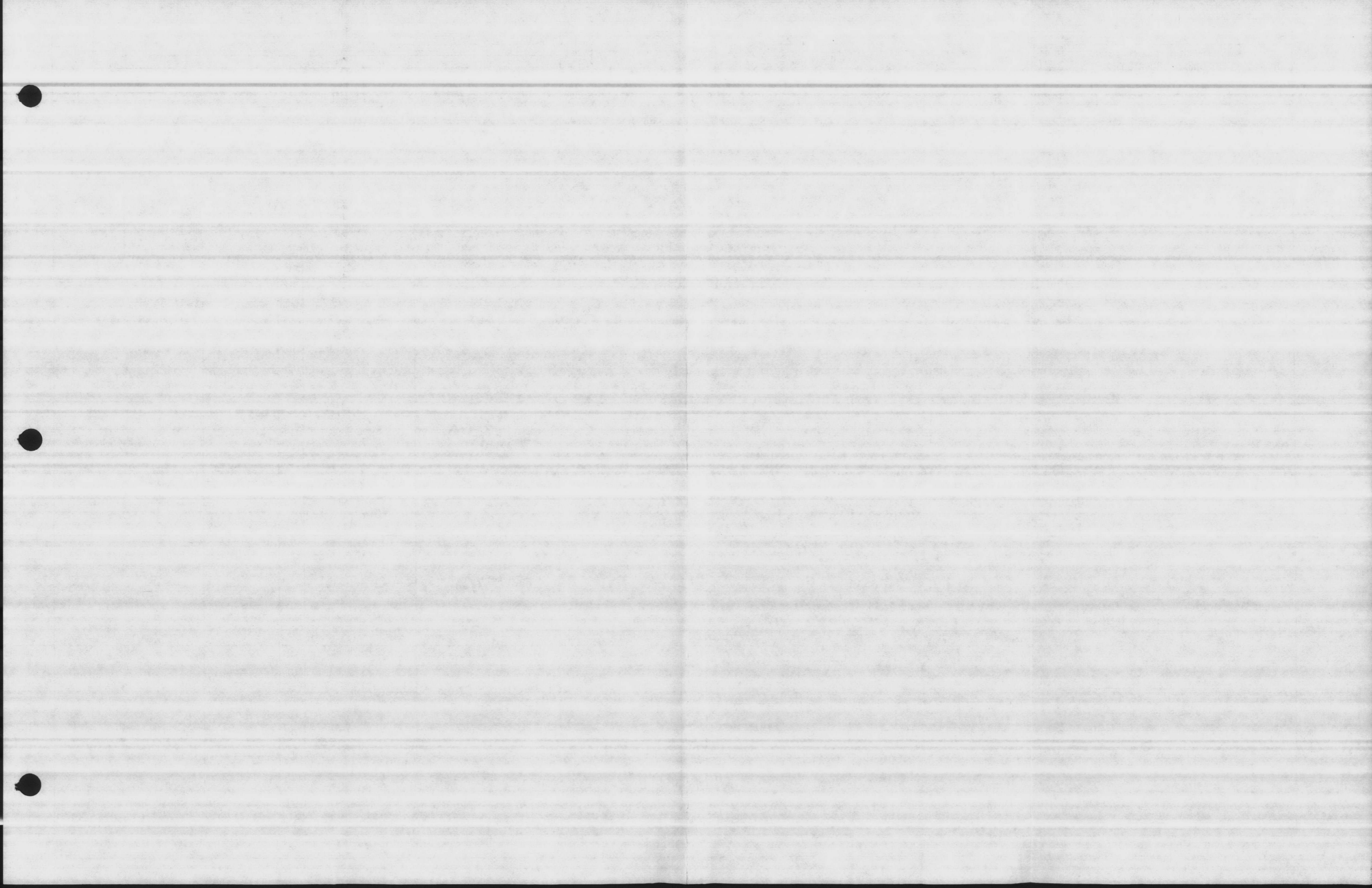


REVISIONS				REVISIONS			
DATE	LTR	FREQ	DESCRIPTION	DATE	LTR	FREQ	DESCRIPTION

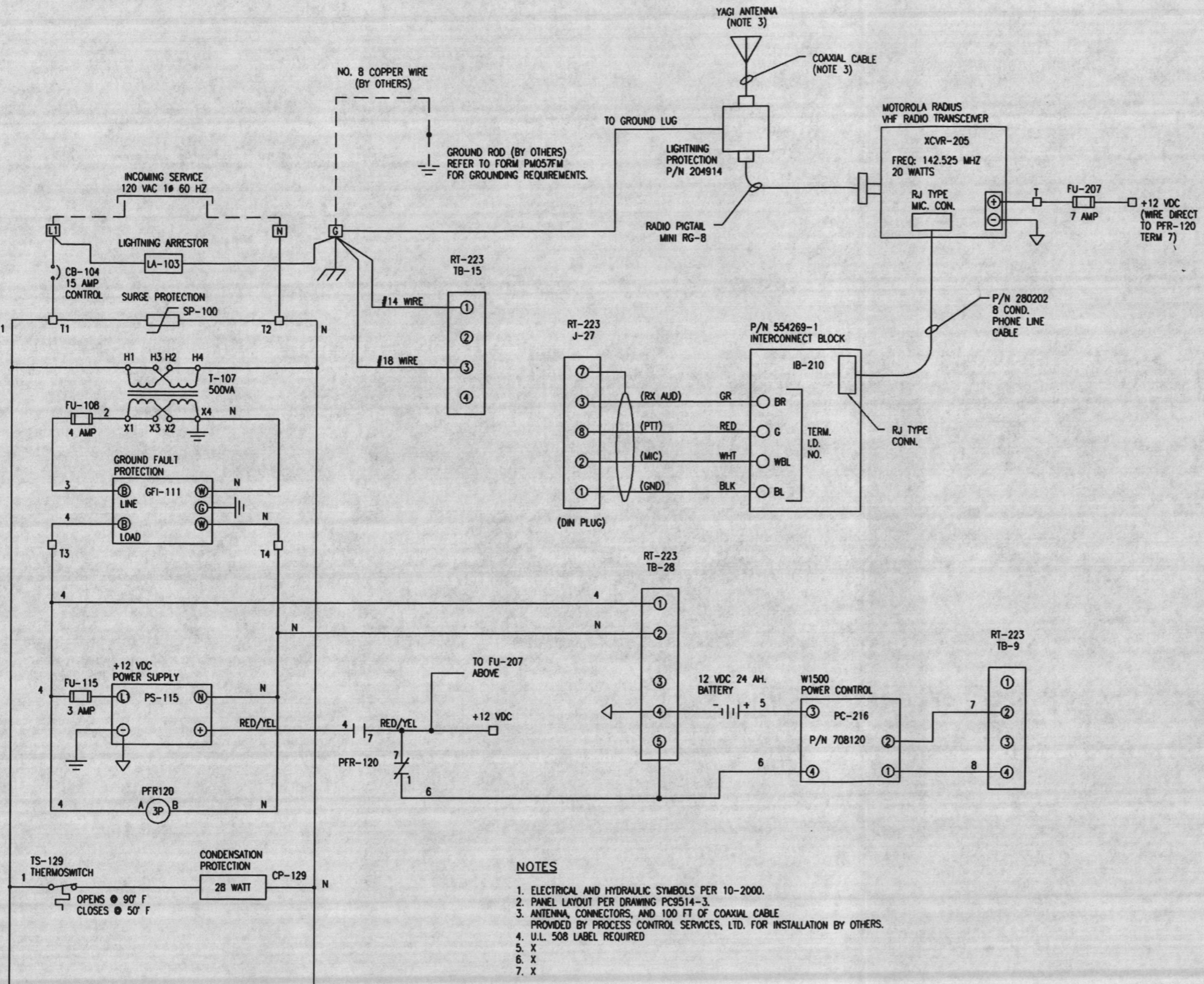
Process Control Services, Ltd.  
 2200 SEAFORD ROAD  
 SEAFORD, VA 23696  
 (757) 898-4332  
 (757) 898-8625 FAX

WORK ORDER NO.	PC2003	PROJECT TITLE	CAMP LEJEUNE, NORTH CAROLINA
APPROVALS	DATE	PROJECT TITLE	REPLACE RAW WATER WELLS FOR HADNOT POINT, 609, 649 & 706
Draft.		DRAWING TITLE	INPUT/OUTPUT WIRING
Engr.		DRAWING NO.	PC2003-2
Check		SIZE	D
Proj. Eng.	IMBURGIA 7/00	SHEET	2 OF 4
Sup'n			
Manager	IMBURGIA 7/00		

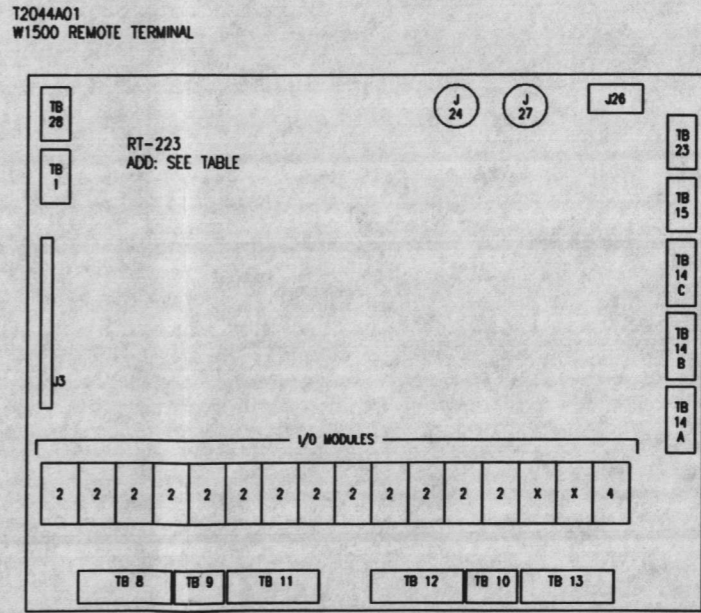
8 7 6 5 4 3 2 1







- NOTES**
1. ELECTRICAL AND HYDRAULIC SYMBOLS PER 10-2000.
  2. PANEL LAYOUT PER DRAWING PC9514-3.
  3. ANTENNA, CONNECTORS, AND 100 FT OF COAXIAL CABLE PROVIDED BY PROCESS CONTROL SERVICES, LTD. FOR INSTALLATION BY OTHERS.
  4. U.L. 508 LABEL REQUIRED
  5. X
  6. X
  7. X

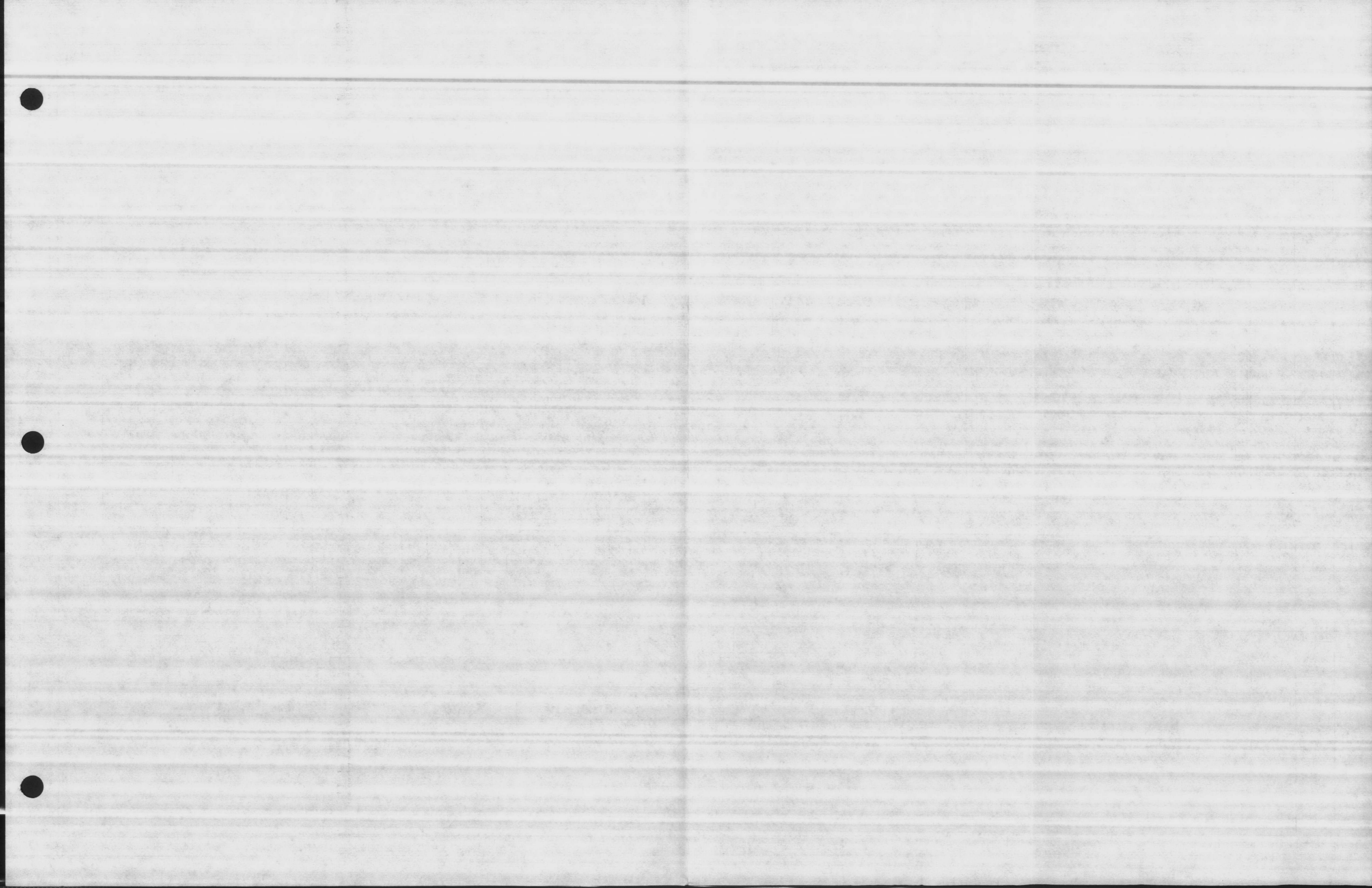


- W1500 I/O MODULES**
1. 90-140 VAC IACS
  2. 10-36 VAC IAC5E
  3. 24-280 VAC OAC5A
  4. 5-60 VDC ODC5
  5. 3-32 VDC IDC5
  - X. UNUSED

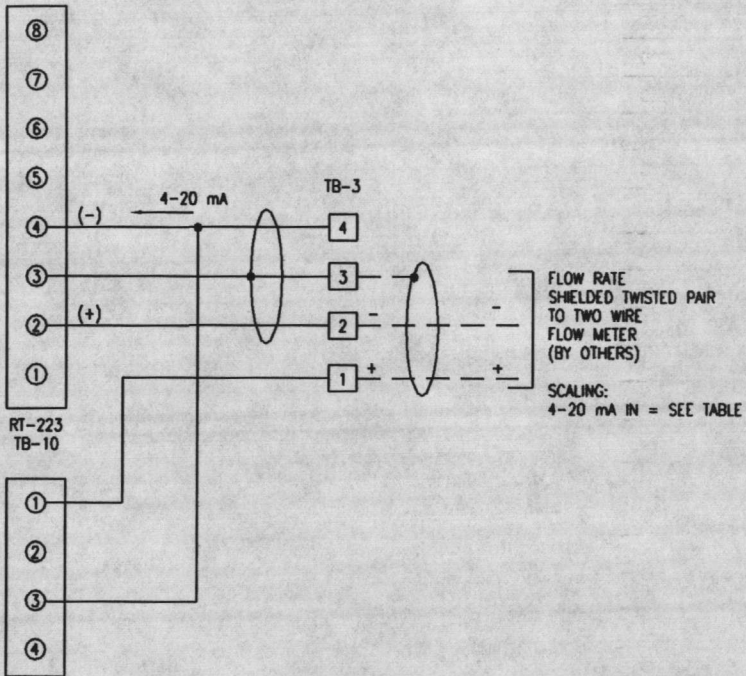
REVISIONS				REVISIONS			
DATE	LTR	FRD	DESCRIPTION	DATE	LTR	FRD	DESCRIPTION

Process Control Services, Ltd.  
 2200 SEAFORD ROAD  
 SEAFORD, VA 23698  
 (757) 898-4332  
 (757) 898-8625 FAX

APPROVALS		DATE		CAMP LEJEUNE, NORTH CAROLINA	
Draft				PROJECT TITLE	REPLACE RAW WATER WELLS FOR HADNOT POINT
Engr.				DRAWING TITLE	RTU WIRING AND LAYOUT
Check				SCALE	20
Proj. Eng.	IMBURGIA	7/00		SIZE	D
Sup'n				DRAWING NO.	PC2003-3
Manager	IMBURGIA	7/00		SHEET	3 OF 4



RT-223  
TB-14A



UNIT	WELL SITE	ADDRESS	FLOW RATE GPM
A	BLDG. 5186	107	0-250
B	BLDG. 607	108	0-200
C	BLDG. 622	109	0-300
D	LCH-4009	110	0-450
E	BLDG. 616	111	0-200
F	LCH-4007	112	0-250
G	BLDG. 654	113	0-200
H	BLDG. 613	114	0-200
I	BLDG. 629	115	0-200
J	BLDG. 641	116	0-315
K	BLDG. 620	117	0-160
L	BLDG. 709	118	0-225
M	BLDG. 710	119	0-200
N	BLDG. 711	120	0-150
O	BLDG. 663	121	0-300
P	BLDG. 642	122	0-156
Q	BLDG. 652	123	0-200
R	BLDG. 606	124	0-345
S	BLDG. 609	119	ADVISE
T	BLDG. 628	120	0-150
U	BLDG. 661	121	0-175
V	BLDG. 662	122	0-200
X	BLDG. 640	123	0-290
Y	BLDG. 632	124	0-250
Z	BLDG. 623	125	0-300
AA	BLDG. 633	126	0-200
AB	BLDG. 649	127	ADVISE
AC	BLDG. 706	128	ADVISE
AD	BLDG. XXX	XXX	XXX
AE	BLDG. XXX	XXX	XXX
AF	BLDG. XXX	XXX	XXX
AG	BLDG. XXX	XXX	XXX
AH	BLDG. XXX	XXX	XXX

JOB PC2003

JOB PC2003 INSTALLED ON THIS JOB FURNISHED UNDER JOB NUMBER PC9813

JOB PC2003

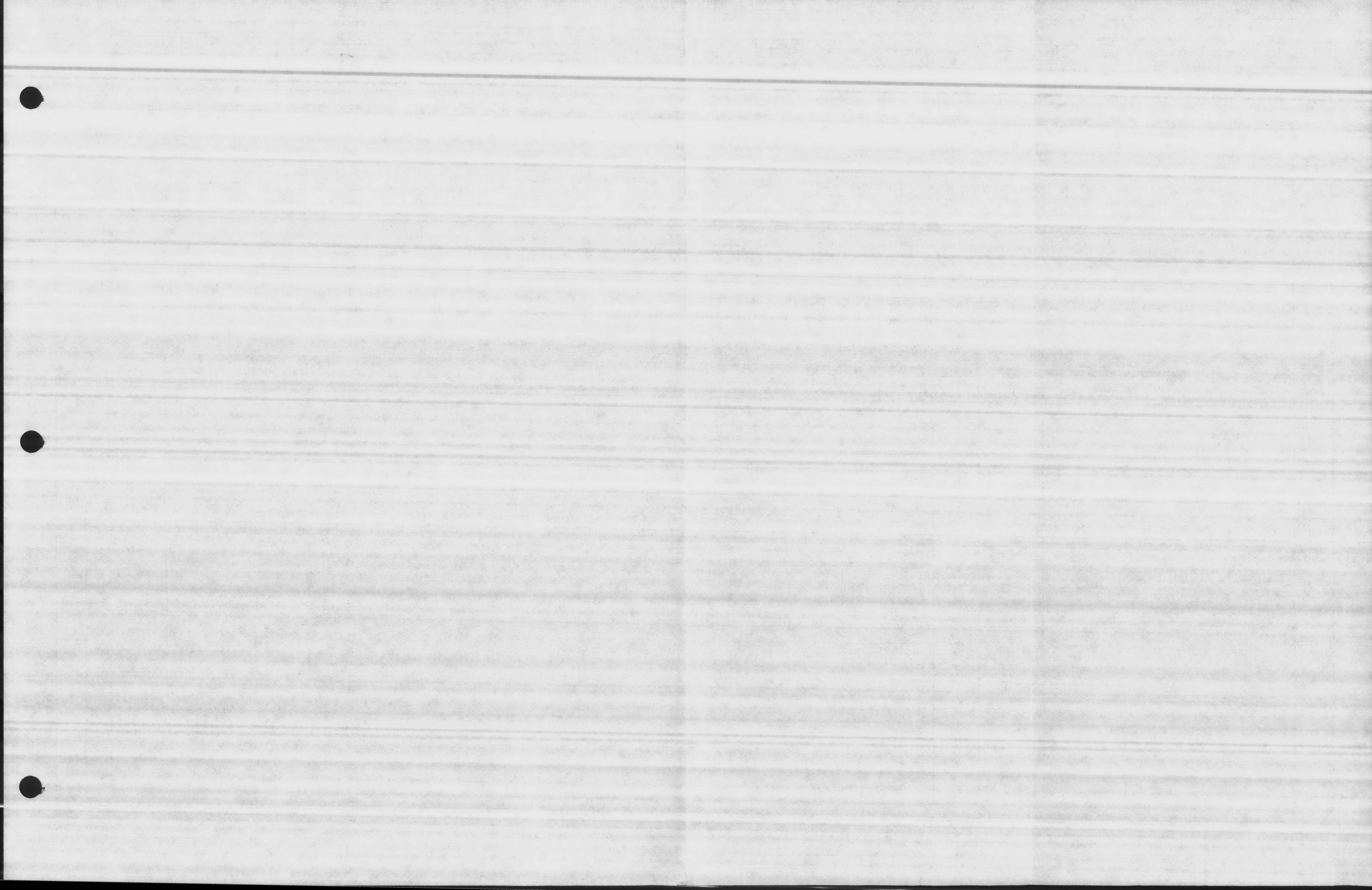
NOTE:  
This job has three wells which two telemetry units are furnished under this contract and one unit was furnished under a previous contract with S.H. Barner, Inc.  
Please contact the Contracting Office to obtain the other telemetry unit.  
Please advise the flow rate for the new well pumps.

REVISIONS				REVISIONS			
DATE	LTR	FREQ	DESCRIPTION	DATE	LTR	FREQ	DESCRIPTION

Process Control Services, Ltd.  

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 SEAFORD, VA 23096  
 (757) 898-4332  
 (757) 898-8625 FAX

JOB ORDER NO. PC2003		CAMP LEJEUNE, NORTH CAROLINA	
APPROVALS	DATE	PROJECT TITLE	
Draft		REPLACE RAW WATER WELLS FOR HADNOT POINT	
Engr.		DRAWING TITLE	
Check		ANALOG WIRING, RTU TABLE	
Proj. Eng.	IMBURGA 7/00	SHEET NO. 20	SIZE D
Sup'n		DRAWING NO. PC2003-4	
Manager	IMBURGA 7/00	SHEET 4 OF 4	LAYER REV



8

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2

1

### 1. CONNECTOR INSTALLATION

STRIP CABLE CAREFULLY. (SEE FIG. 1)

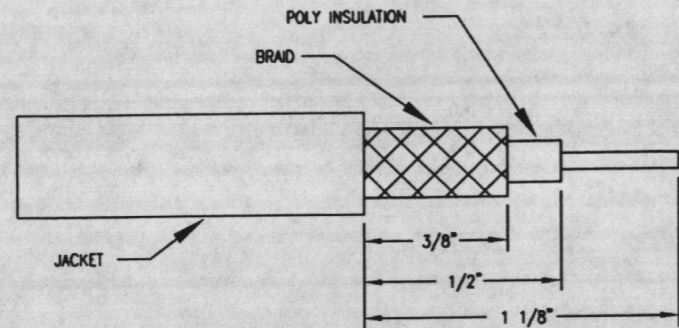


FIGURE 1

IN THE CENTER CONDUCTOR BEFORE ASSEMBLY. PUT THE BARREL OF THE CONNECTOR ON THE CABLE NOW. (SEE FIG. 2)

THREAD THE CONNECTOR OVER THE CABLE. IT WILL TURN HARD. ENSURE THAT NO BRAID WIRES PROTRUDE OVER THE END OF THE POLY INSULATION.

OBSERVE THE BRAIL THROUGH ALL FOUR HOLES.

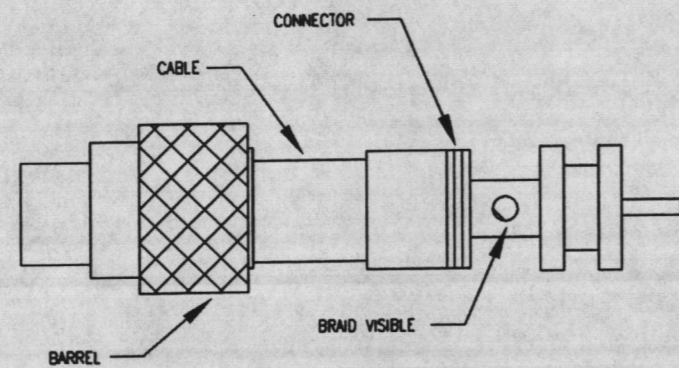


FIGURE 2

SOLDER WITH A LARGE IRON (200-400 WATTS) ALL FOUR HOLES. ENSURE THE SOLDER WETS THE BRAID AND ADHERES TO THE CONNECTOR BODY.

SOLDER THE CENTER PIN CAREFULLY. DO NOT GET SOLDER ON THE OUTSIDE OF THE PIN. FILL THE END WITH SOLDER, DO NOT LEAVE A VOID.

SCRAPE THE ROSIN FLUX OFF THE CENTER PIN.

### 2. ANTENNA LOCATION

**WARNING: DO NOT ATTEMPT TO MOUNT ANTENNA NEAR POWER LINES. ANTENNA CONTACTING POWER LINES MAY BE HAZZARDOUS AND CAN CAUSE DEATH.**

LOCATE THE ANTENNA IN AN AREA FREE OF OBSTRUCTIONS. THE MAST THAT SUPPORTS IT SHOULD BE THE ONLY METAL OBJECT NEARBY.

IF OTHER ANTENNA, LIGHT POLES, GUY WIRES, OR METAL SURFACES ARE NEARBY, MOUNT THE ANTENNA 3 FEET ABOVE THE HIGHEST POINT.

IF THIS IS NOT POSSIBLE, MOUNT THE ANTENNA SO THAT IT HAS AT LEAST 4 FEET OF CLEARANCE HORIZONTALLY TO ANY METAL OBJECT. THIS DOES NOT INCLUDE THE FRONT OF THE ANTENNA, IN THE DIRECTION OF TRANSMISSION (SEE FIGURE 3). NO METAL OBJECT MAY BE LOCATED IN THIS DIRECTION. DO NOT AIM THE ANTENNA INTO A TANK, BUILDING, HILL, COOLING TOWER, OR ANY SUCH OBSTRUCTION. YOU MUST FIND A WAY TO MOUNT THE ANTENNA EITHER HIGHER THAN, OR ON TOP OF SUCH AN OBSTRUCTION.

### 3. ANTENNA INSTALLATION

MOUNTING- THE ANTENNA ELEMENTS (RODS) SHOULD BE VERTICAL. MOUNT ANTENNA ON POLE USING BRACKET SUPPLIED. IF POLE IS WOODEN, GROUND MOUNTING BRACKET WITH #8 WIRE TO 12' ROD AT BASE OF POLE.

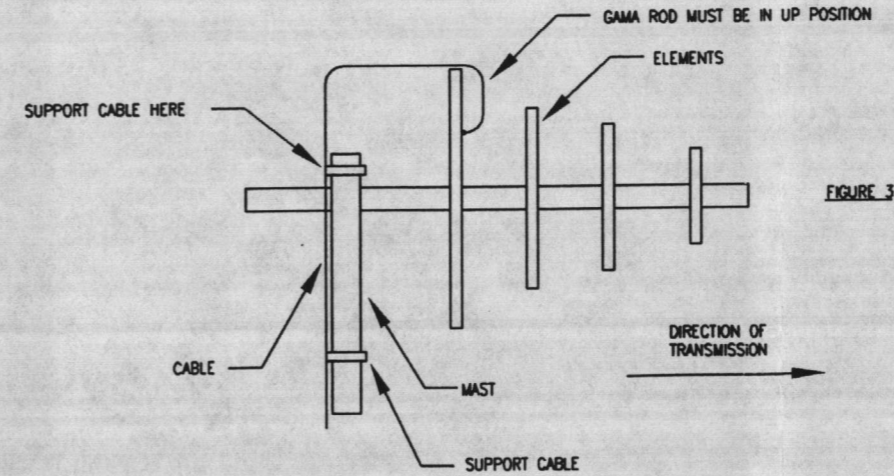


FIGURE 3

CONNECT CABLE TO ANTENNA. TIGHTEN CONNECTOR BARREL FIRMLY AND COAT ENTIRE WITH SILICONE RUBBER.

SUPPORT CABLE ON MAST NEAR ANTENNA. DO NOT PUT STRESS ON ANTENNA CABLE CONNECTOR, IT IS NOT DESIGNED FOR SUPPORTING CABLE.

AIM ANTENNA TO MASTER STATION. SHORTEST ELEMENTS POINT IN DIRECTION OF TRANSMISSION (SEE FIGURE 3).

#### REVISIONS

DATE	LTR	FREQ	DESCRIPTION	BY	CHECK	APPRO	DATE	LTR	FREQ	DESCRIPTION	BY	CHECK	APPRO

#### REVISIONS

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 (757) 898-4332  
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JOB NO. PC2003		CAMP LEJEUNE, NORTH CAROLINA	
APPROVALS	DATE	PROJECT TITLE	REPLACE RAW WATER WELLS FOR HADNOT POINT, 609, 649 & 706
Draft		DRAWING TITLE	INSTALLATION AND SERVICE DATA
Engr.		SCALE	20
Check		DRAWING NO.	PC2003-S1
Proj. Eng.			
Sup'n			

