TECHNICAL MANUAL

GATES Series™
AM TRANSMITTERS

GATES ONE - 994 9202 002

GATES TWO - 994 9203 002

GATES FIVE (1-PHASE) - 994 9204 002

GATES FIVE (3-PHASE) - 994 9205 002

T.M. No. 888-2314-001

Printed: 1990

Rev. AF: 06-21-02

Returns And Exchanges

Damaged or undamaged equipment should not be returned unless written approval and a Return Authorization is received from HARRIS CORPORATION, Broadcast Systems Division. Special shipping instructions and coding will be provided to assure proper handling. Complete details regarding circumstances and reasons for return are to be included in the request for return. Custom equipment or special order equipment is not returnable. In those instances where return or exchange of equipment is at the request of the customer, or convenience of the customer, a restocking fee will be charged. All returns will be sent freight prepaid and properly insured by the customer. When communicating with HARRIS CORPORATION, Broadcast Systems Division, specify the HARRIS Order Number or Invoice Number.

Unpacking

Carefully unpack the equipment and preform a visual inspection to determine that no apparent damage was incurred during shipment. Retain the shipping materials until it has been determined that all received equipment is not damaged. Locate and retain all PACKING CHECK LISTs. Use the PACKING CHECK LIST to help locate and identify any components or assemblies which are removed for shipping and must be reinstalled. Also remove any shipping supports, straps, and packing materials prior to initial turn on.

Technical Assistance

HARRIS Technical and Troubleshooting assistance is available from HARRIS Field Service during normal business hours (8:00 AM - 5:00 PM Central Time). Emergency service is available 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, HARRIS CORPORATION, Broadcast Systems Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. Technical Support by e-mail: *tsupport@harris.com*. The HARRIS factory may also be contacted through a FAX facility (217/221-7096).

Replaceable Parts Service

Replacement parts are available 24 hours a day, seven days a week from the HARRIS Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, HARRIS CORPORATION, Broadcast Systems Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a FAX facility (217/221-7096).

NOTE

The # symbol used in the parts list means used with (e.g. #C001 = used with C001).

MANUAL REVISION HISTORY GATES Series™ AM Transmitters 888-2314-xxx			
Rev.	Date	ECN	Pages Affected
A	April 1990	None	Replaced the following pages: Title Page, v, vii, 2-1 thru 2-6, 3-3, 3-4, 4-3, 4-4, 5-1 thru 5-6, J-3, & J-4 Added MRH-1/MRH-2
B	Aug. 1990	None	Replaced the following pages: Title Page, v, *3-5, 3-6*, 4-1 thru 4-4, A-1, B-1, B-2, C-2, E-3, F-1 thru F-3, G-1 thru G-4, J-1, J-2, *J-3, J-4*, J-9 thru J-11, & K-3
C	Aug. 1990	35969	Replaced the following pages: Title Page, MRH-1/MRH-2, C-4, & C-5
D	Aug. 1990	Field Service Request	Replace the following pages: Title Page, MRH-1/MRH-2, & 2-5
E	Sept. 1990	36322	Replace the following pages: Title Page, MRH-1/MRH-2, & all of Section VI
F	Oct. 1990	36415	Replace the following pages: Title Page, MRH-1/MRH-2, & all of Section A
G	Jan. 1991	Errata FS Request	Replace the following pages: Title Page, MRH-1/MRH-2, & all of Section VI
H	June 1991	FS Request	Replace the following pages: Title Page, MRH-1/MRH-2, 2-6, G-2, & J-3
I	July 1991	36962	Replace the following pages: Title Page, MRH-1/MRH-2, and K-3
J	Aug. 1991	36963	Replace the following pages: Title Page, MRH-1/MRH-2, 6-9 to 6-12, & J-9 TO J-11
K	Jan. 1992	37611 & Misc	Replaced Title Page, MRH-1/MRH-2 and all part lists in manual
L	June 1992	37442	Replaced Title Page, MRH-1/MRH-2 and pages 6-14 to 6-17
M	Jan. 1994	38809	Replaced Title Page, MRH-1/MRH-2, page K-3, and all of section VI
N	Feb. 1994	38895	Replaced Title Page, MRH-1/MRH-2, and pages F-4 & F-5
P	July 1994	39302	Replaced Title Page, MRH-1/MRH-2, and all of section VI
R	Dec. 1994	39223	Replaced Title Page, MRH-1/MRH-2, and pages F-4 & F-5
S	July 1995	39125	Replaced Title Page, MRH-1/MRH-2, and all of section VI
T	Jan. 1996	41051R	Replaced Title Page, MRH-1/MRH-2, Table of Contents, 1-2 to 1-4, all of sections 2, 4, & 5
U	Jan. 1996	41051R	Replaced Title Page, MRH-1/MRH-2, and pages 6-15 to 6-19
V	Mar. 1996	TBD	Replaced Title Page, MRH-1/MRH-2, and page 2-9
X	Dec. 1996	41575	Replaced Title Page, MRH-1/MRH-2, iv thru vi, and all of Section C
Y	May 1998	42198	Replaced Title Page, MRH-1/MRH-2, and page 2-4
Y1	10-02-98	42359	Replaced Title Page, MRH-1/MRH-2, page G-6 and all of Section VI
Z	12-22-98	38895A	Replaced Title Page, MRH-1/MRH-2, and all of Section F
Z1	2-15-99	42544	Replaced Title Page, MRH-1/MRH-2, and pages C-4 & C-5.
Z2	2-25-99	42636	Replaced Title Page, MRH-1/MRH-2, and all of Section VI
AA	08-18-99	45024	Replaced Title Page, MRH-1/MRH-2, and all of Section H
AB	12-10-99	45544	Replaced Title Page, MRH-1/MRH-2 and pages 2-4 and 2-5
AC	02-20-00	45748	Replaced Title Page, MRH-1/MRH-2 and all of Section II
AD	10-04-01	47730	Replaced Title Page, MRH-1/MRH-2 and page 3-6
AD1	01-15-02	47924	Replaced Title Page, MRH-1/MRH-2, and all of Section VI
AE	03-05-02	48100	Replace Title Page, MRH1/MRH2, all parts lists and chapter B.
AF	06-21-02	48426	Replace Title Page, MRH1/MRH2, and page C-3

Guide to Using Harris Parts List Information

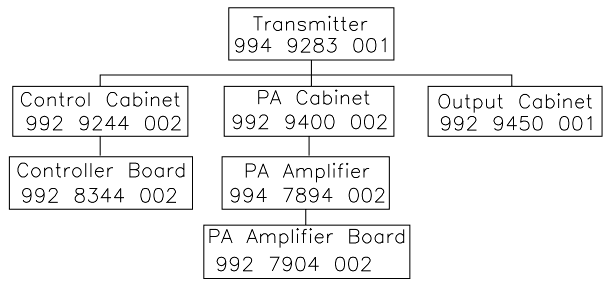
The Harris Replaceable Parts List Index portrays a tree structure with the major items being leftmost in the index. The example below shows the Transmitter as the highest item in the tree structure. If you were to look at the bill of materials table for the Transmitter you would find the Control Cabinet, the PA Cabinet, and the Output Cabinet. In the Replaceable Parts List Index the Control Cabinet, PA Cabinet, and Output Cabinet show up one indentation level below the Transmitter and implies that they are used in the Transmitter. The Controller Board is indented one level below the Control Cabinet so it will show up in the bill of material for the Control Cabinet. The tree structure of this same index is shown to the right of the table and shows indentation level versus tree structure level.

Example of Replaceable Parts List Index and equivalent tree structure:

Replaceable Parts List Index

Table 7−1.	Transmitter	994 9283 001	7−2
Table 7−2.	Control Cabinet	992 9244 002	7−3
Table 7−3.	Controller Board	992 8344 002	7−6
Table 7−4.	PA Cabinet	992 9400 002	7−7
Table 7−5.	PA Amplifier	994 7894 002	7−9
Table 7−6.	PA Amplifier Board	992 7904 002	7−10
Table 7−7.	Output Cabinet	992 9450 001	7−12

⇒



The part number of the item is shown to the right of the description as is the page in the manual where the bill for that part number starts.

Inside the actual tables, four main headings are used:

Table #-#. ITEM NAME - HARRIS PART NUMBER -this line gives the information that corresponds to the Replaceable Parts List Index entry;

HARRIS P/N column gives the ten digit Harris part number (usually in ascending order);

DESCRIPTION column gives a 25 character or less description of the part number;

REF. SYMBOLS/EXPLANATIONS column 1) gives the reference designators for the item (i.e., C001, R102, etc.) that corresponds to the number found in the schematics (C001 in a bill of material is equivalent to C1 on the schematic) or 2) gives added information or further explanation (i.e., “Used for 208V operation only,” or “Used for HT 10LS only,” etc.).

Inside the individual tables some standard conventions are used:

A # symbol in front of a component such as #C001 under the REF. SYMBOLS/EXPLANATIONS column means that this item is used on or with C001 and is not the actual part number for C001.

In the ten digit part numbers, if the last three numbers are 000, the item is a part that Harris has purchased and has not manufactured or modified. If the last three numbers are other than 000, the item is either manufactured by Harris or is purchased from a vendor and modified for use in the Harris product.

The first three digits of the ten digit part number tell which family the part number belongs to - for example, all electrolytic (can) capacitors will be in the same family (524 xxxx 000). If an electrolytic (can) capacitor is found to have a 9xx xxxx xxx part number (a number outside of the normal family of numbers), it has probably been modified in some manner at the Harris factory and will therefore show up farther down into the individual parts list (because each table is normally sorted in ascending order). Most Harris made or modified assemblies will have 9xx xxxx xxx numbers associated with them.

The term “SEE HIGHER LEVEL BILL” in the description column implies that the reference designated part number will show up in a bill that is higher in the tree structure. This is often the case for components that may be frequency determinant or voltage determinant and are called out in a higher level bill structure that is more customer dependent than the bill at a lower level.

HARRIS Broadcast Systems Division
P.O. Box 4290, QUINCY, IL 62305

PARTS ORDER FORM

HARRIS PHONE: 217-222-8200
HARRIS FAX: 217-221-7096

BILLING INFORMATION

CUSTOMER NAME: ______

ADDRESS: ______

______

______

______

TELEPHONE NUMBER: ______

FAX NUMBER: ______

PREFERRED PAYMENT METHOD: ______

FREQUENCY (If required): ______

EQUIPMENT NAME: ______

EQUIPMENT PART NUMBER: ______

EQUIPMENT SERIAL NUMBER: ______

SHIPPING INFORMATION

SHIP TO: (if different from billing information) ______

ADDRESS: ______

______

______

______

TELEPHONE NUMBER: ______

FAX NUMBER: ______

SHIPPING METHOD PREFERRED: ______

GUIDE FOR ORDERING PARTS

Please use the following parts order form, filling is as much information as possible. The complete informaiton will allow double checking the part number for correctness or locating a substitude if the part is not available.
The equipment name, part number, and serial number will be found on the metal ID plate on the back of the unit. The serial number MUST be included for any parts ordered under warranty.
Describe the part using the description in the parts list if possible. Include the schematic information, schematic number, or number of next higher assembly. The next higher assembly is usually a 992-xxxx-00x type.

ITEM #	QTY ORD	HARRIS PART NUMBER	DESCRIPTION OF PART (PART'S NAME, DESCRIPTION, SPECIFICATION FROM PARTS LIST IF AVAILABLE)	SCHEMATIC REFERENCE REFERENCE NAME (e.g. C001, R100, etc)	ITEM USED ON (NEXT HIGHER ASSEMBLY IF KNOWN) (e.g. C001 used on 992 8025 001, SCHEMATIC 839 8099 991)	COMMENTS

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY WARNINGS, INSTRUCTIONS AND REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as reference:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don’t take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

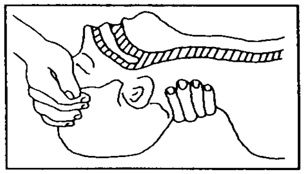
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

(A) AIRWAY

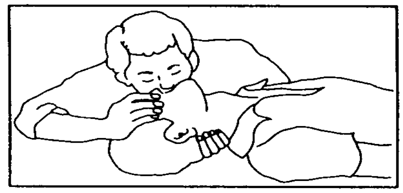
IF UNCONSCIOUS,
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

(B) BREATHING

IF NOT BREATHING,
BEGIN ARTIFICIAL BREATHING

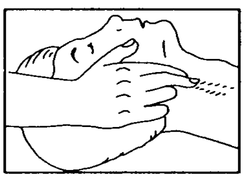


TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

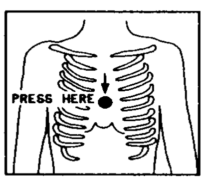
CHECK
CAROTID PULSE



IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

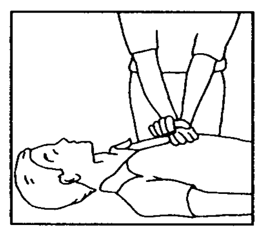
(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES



APPROX. RATE OF COMPRESSIONS --80 PER MINUTE — ONE RESCUER: 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE — TWO RESCUERS: 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is a brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin
    a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
    b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
    c. Treat victim for shock as required.
    d. Arrange transportation to a hospital as quickly as possible.
    e. If arms or legs are affected keep them elevated.

NOTE

If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)
    a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
    b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
    c. Apply clean dry dressing if necessary.
    d. Treat victim for shock as required.
    e. Arrange transportation to a hospital as quickly as possible.
    f. If arms or legs are affected keep them elevated.

REFERENCE:

ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

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SECTION E
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SECTION I
GENERAL INFORMATION

1.1. Introduction

1.1.1. Scope And Purpose

This technical manual contains the information necessary to install and maintain the GATES Series™ AM Transmitters. The various sections of this technical manual provide the following types of information.

Section I, General Information, provides introduction to technical manual contents.

Section II, Installation/operation, provides detailed installation and operation procedures.

Section III, Maintenance, provides preventive and corrective maintenance as well as tuning procedures (alignment procedures).

Section IV, Troubleshooting, provides a listing of the protection devices in the transmitter as well as troubleshooting procedures.

Section V, Transmitter Overall, provides theory of operation of the various sections of the transmitter not covered in later sections.

Section VI, Parts List, provides parts list for the transmitter.

The following sections provide principles of operation, maintenance information, troubleshooting, and parts lists for boards in GATES Series™ transmitter:

Section A, Oscillator
Section B, IPA
Section C, Power Amplifier
Section D, Output Network
Section E, Output Monitor
Section F, PDM Generator
Section G, PDM Amplifier/Pull-Up
Section H, PDM Filter
Section J, Controller
Section K, Interface Board
Appendix L, Test Equipment, provides a list of the test equipment provided and recommended to perform maintenance on the transmitter.

1.2. Specifications

Table 1-1, 1-2, and 1-3 list the specifications of the GATES Series™ transmitters.

NOTE

Specifications subject to change without notice.

Table 1-1. GATES ONE Specifications

POWER OUTPUT:	1000 watts (Rated). Six power levels adjustable between 100-1100 watts. Capable of lower power PSA/PSSA operation.
RF FREQUENCY RANGE:	531 kHz through 1705 kHz. Supplied to one frequency as ordered.
CARRIER FREQUENCY STABILITY:	Crystal control oscillator meets FCC specifications. +/-4 Hz in typical operating environment.
RF OUTPUT IMPEDANCE:	50 ohms unbalanced.
RF OUTPUT TUNING:	Integral network will match a VSWR of 1.5:1 to 1.0:1 at carrier.
RF OUTPUT TERMINAL:	Type N female connector.
CARRIER SHIFT:	Less than 1% at 100% modulation at 1000 Hz.
RF HARMONICS AND SPURIOUS EMISSIONS:	Exceeds FCC and CCIR specifications.
OTHER EMISSIONS:	Meets FCC NRSC 2 when presented with audio signal conforming to NRSC 1 standard.
TYPE OF MODULATOR:	Patented Polyphase PDM.
AUDIO FREQUENCY RESPONSE:	+/-0.5 dB, from 20 to 10,000 Hz (with Bessel filter out).
AUDIO HARMONIC DISTORTION:	Less than 1.0% at 1 kW, 20 to 10,000 Hz @ 95% modulation.
AUDIO INTERMODULATION DISTORTION:	Less than 1.0%, 60/7000 Hz 1:1. Less than 1.5%, 60/7000 Hz 4:1, SMPTE standards at 1 kW operation at 95% modulation.
SQUAREWAVE OVERSHOOT:	Less than 3.5% at 400 Hz.
SQUAREWAVE TILT:	Less than 3% at 20 Hz, 90% modulation.
	Less than 1.5% at 40 Hz, 90% modulation.
NOISE (UNWEIGHTED)	Better than 60 dB below 100% modulation, 1000 Hz at 1kW.
POSITIVE PEAK CAPABILITY:	Greater than 130% positive peak program modulation capability at 1100 watts.
INCIDENTAL QUADRATURE MODULATION (IQM):	30 dB typical below 95% modulation of L+R channel at 1 kHz.
AUDIO INPUT:	Continuously adjustable from -10 to +10 dBm, transformer-less active 600 ohms input.
AC VOLTAGE INPUT:	197-251 VAC, 50/60 Hz, single phase.
OVERALL EFFICIENCY:	Better than 65% at 1000W.
POWER CONSUMPTION:	At 1000 watts carrier, 1538 watts or less at 0% modulation, 2307 watts or less at 100% sine wave modulation, 1923 watts during typical programming.
MONITOR PROVISIONS:	Adjustable to 5 volts nominal RMS modulated output sample at 50 ohms for six power levels from 100 watts to 1100 watts.
REMOTE CONTROL/MONITORING:	Self-contained interface for most remote control systems TTL compatible.
AMBIENT TEMPERATURE RANGE:	-10°C to +50°C AMSL (derate upper limit 2°C per 1000 feet altitude).
AMBIENT HUMIDITY RANGE:	To 95%, non condensing.
AIR FLOW:	500 CFM
HEAT GENERATED:	2756 BTU per hour at 1 KW 100% tone modulation.
ALTITUDE:	Up to 13,000 feet (4000 meters).
SIZE:	72"H X 28"W X 30"D (1830mm X 712 mm X 762 mm).
WEIGHT:	(Unpacked) 400 lbs. (181 kg) - approximate. Domestic packed, 600 lbs. (275 kg) - approximate. Export packed, 700 lbs. (320 kg) - approximate.
CUBAGE:	68.7 cubic feet (2 cubic meters) packed.
NOTE: ALL SPECIFICATIONS TAKEN WITH TRANSMITTER CONNECTED TO TEST LOAD. SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.	

Table 1-2. GATES TWO Specifications

POWER OUTPUT:	2500 watts (Rated). Six power levels adjustable between 250-2750 watts. Capable of lower power PSA/PSSA operation.
RF FREQUENCY RANGE:	531 kHz through 1705 kHz. Supplied to one frequency as ordered.
CARRIER FREQUENCY STABILITY:	Crystal control oscillator meets FCC specifications. +/-4 Hz in typical operating environment.
RF OUTPUT IMPEDANCE:	50 ohms unbalanced.
RF OUTPUT TUNING:	Integral network will match a VSWR of 1.5:1 to 1.0:1 at carrier.
RF OUTPUT TERMINAL:	7/8" EIA male/female flange connector.
CARRIER SHIFT:	Less than 1% at 100% modulation at 1000 Hz.
RF HARMONICS AND SPURIOUS EMISSIONS:	Exceeds FCC and CCIR specifications.
OTHER EMISSIONS:	Meets FCC NRSC 2 when presented with audio signal conforming to NRSC 1 standard.
TYPE OF MODULATOR:	Patented Polyphase PDM.
AUDIO FREQUENCY RESPONSE:	+/-0.5 dB, from 20 to 10,000 Hz (with Bessel filter out).
AUDIO HARMONIC DISTORTION:	Less than 1.0% at 2500 watts, 20 to 10,000 Hz @ 95% modulation.
AUDIO INTERMODULATION DISTORTION:	Less than 1.0%, 60/7000 Hz 1:1. Less than 1.5%, 60/7000 Hz 4:1, SMPTE standards at 2500 watts operation at 95% modulation.
SQUAREWAVE OVERSHOOT:	Less than 3.5% at 400 Hz.
SQUAREWAVE TILT:	Less than 3% at 20 Hz, 90% modulation.
	Less than 1.5% at 40 Hz, 90% modulation.
NOISE (UNWEIGHTED):	Better than 60 dB below 100% modulation, 1000 Hz at 2500 watts.
POSITIVE PEAK CAPABILITY:	Greater than 130% positive peak program modulation capability at 2750 watts.
INCIDENTAL QUADRATURE MODULATION (IQM):	30 dB typical below 95% modulation of L+R channel at 1 kHz.
AUDIO INPUT:	Continuously adjustable from -10 to +10 dBm, transformer-less active 600 ohms input.
AC VOLTAGE INPUT:	197-251 VAC, 50/60 Hz, single phase.
OVERALL EFFICIENCY:	Better than 65% at 2500W.
POWER CONSUMPTION:	At 2500 watts carrier, 3846 watts or less at 0% modulation, 5769 watts or less at 100% sine wave modulation, 4807 watts during typical programming.
MONITOR PROVISIONS:	Adjustable to 5 volts nominal RMS modulated output sample at 50 ohms for six power levels from 250 watts to 2750 watts.
REMOTE CONTROL/MONITORING:	Self-contained interface for most remote control systems TTL compatible.
AMBIENT TEMPERATURE RANGE:	-10°C to +50°C AMSL (derate upper limit 2°C per 1000 feet altitude).
AMBIENT HUMIDITY RANGE:	To 95%, non condensing.
AIR FLOW:	500 CFM
HEAT GENERATED:	6895 BTU per hour at 2500 watts, 100% tone modulation.
ALTITUDE:	Up to 13,000 feet (4000 meters).
SIZE:	72"H X 28"W X 30"D (1830 mm X 712 mm X 762 mm).
WEIGHT:	(Unpacked) 450 lbs. (204 kg) - approximate. Domestic packed, 650 lbs. (298 kg) - approximate. Export packed, 750 lbs. (343 kg) - approximate.
CUBAGE:	68.7 cubic feet (2 cubic meters) packed.
NOTE: ALL SPECIFICATIONS TAKEN WITH TRANSMITTER CONNECTED TO TEST LOAD. SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.	

Table 1-3. GATES FIVE Specifications

POWER OUTPUT:	5000 watts (Rated). Six power levels adjustable between 500-5600 watts. Capable of lower power PSA/PSSA operation.
RF FREQUENCY RANGE:	531 kHz through 1705 kHz. Supplied to one frequency as ordered.
CARRIER FREQUENCY STABILITY:	Crystal control oscillator meets FCC specifications. +/-4 Hz in typical operating environment.
RF OUTPUT IMPEDANCE:	50 ohms unbalanced.
RF OUTPUT TUNING:	Integral network will match a VSWR of 1.5:1 to 1.0:1 at carrier.
RF OUTPUT TERMINAL:	7/8" EIA male/female flange connector.
CARRIER SHIFT:	Less than 1% at 100% modulation at 1000 Hz.
RF HARMONICS AND SPURIOUS EMISSIONS:	Exceeds FCC and CCIR specifications.
OTHER EMISSIONS:	Meets FCC NRSC 2 when presented with audio signal conforming to NRSC 1 standard.
TYPE OF MODULATOR:	Patented Polyphase PDM.
AUDIO FREQUENCY RESPONSE:	+/-0.5 dB, from 20 to 10,000 Hz (with Bessel filter out).
AUDIO HARMONIC DISTORTION:	Less than 0.8% at 5000 watts, typically less than 1.5% at 1 kW, 20 to 10,000 Hz @ 95% modulation.
AUDIO INTERMODULATION DISTORTION:	Less than 1.0%, 60/7000 Hz 1:1. Less than 1.5%, 60/7000 Hz 4:1, SMPTE standards at 5000 watts operation at 95% modulation.
SQUAREWAVE OVERSHOOT:	Less than 3.5% at 400 Hz.
SQUAREWAVE TILT:	Less than 3% at 20 Hz, 90% modulation.
	Less than 1.5% at 40 Hz, 90% modulation.
NOISE (UNWEIGHTED):	Better than 60 dB below 100% modulation, 1000 Hz at 2500 watts to 5000 watts.
POSITIVE PEAK CAPABILITY:	Greater than 130% positive peak program modulation capability at 5600 watts.
INCIDENTAL QUADRATURE MODULATION (IQM):	30 dB typical below 95% modulation of L+R channel at 1 kHz.
AUDIO INPUT:	Continuously adjustable from -10 to +10 dBm, transformer-less active 600 ohms input.
AC VOLTAGE INPUT:	197-251 VAC, 50/60 Hz, three phase or international 341 to 434 VAC. Compatible with WYE or closed delta power sources. AC voltage variation: +5, -10% for full performance. Single phase version accepts 197 to 251 VAC 50/60 Hz.
OVERALL EFFICIENCY:	Better than 65% at 5000W.
POWER CONSUMPTION:	At 5000 watts carrier, 7692 watts or less at 0% modulation, 11538 watts or less at 100% sine wave modulation, 9615 watts during typical programming.
MONITOR PROVISIONS:	Adjustable to 5 volts nominal RMS modulated output sample at 50 ohms for six power levels from 500 watts to 5600 watts.
REMOTE CONTROL/MONITORING:	Self-contained interface for most remote control systems TTL compatible.
AMBIENT TEMPERATURE RANGE:	-10°C to +50°C AMSL (derate upper limit 2°C per 1000 feet altitude).
AMBIENT HUMIDITY RANGE:	To 95%, non condensing.
AIR FLOW:	500 CFM, (14.16 CMM).
HEAT GENERATED:	13790 BTU per hour at 5000 watts, 100% tone modulation.
ALTITUDE:	Up to 13,000 feet (4000 meters).
SIZE:	72"H X 28"W X 30"D (1830 mm X 712 mm X 762 mm).
WEIGHT:	(Unpacked) 500 lbs. (230 kg) - approximate. Domestic packed, 700 lbs. (320 kg) - approximate. Export packed, 800 lbs. (370 kg) - approximate.
CUBAGE:	68.7 cubic feet (2 cubic meters) packed.
NOTE: ALL SPECIFICATIONS TAKEN WITH TRANSMITTER CONNECTED TO TEST LOAD. SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.	

SECTION II
INSTALLATION/OPERATION

2.1. Introduction

This section of the technical manual provides detailed installation procedures and setup instructions for the GATES Series™ AM transmitters.

Under normal conditions, the GATES Series™ Transmitters are shipped completely assembled and ready for installation. However, if adverse shipping conditions are anticipated, certain components may be removed for transport in which case these components will be properly identified with appropriate instructions for reinstalling the components and making wiring connections.

2.2. Unpacking

Carefully unpack the transmitter and perform a visual inspection to determine that no apparent damage was incurred during shipment. Retain the shipping materials until it has been determined that the unit is not damaged. The contents of the shipment should be as indicated on the Packing Check List which accompanies each shipment. If the contents are incomplete or if the unit is damaged electrically or mechanically, notify the CARRIER and HARRIS CORPORATION.

2.3. Returns and Exchanges

Damaged or undamaged equipment should not be returned unless written approval and a Return Authorization is received from HARRIS CORPORATION, Broadcast Transmission Division. Special shipping instructions and coding will be provided to assure proper handling. Complete details regarding circumstances and reasons for return are to be included in the request for return. Custom equipment or special order equipment is not returnable. In those instances where return or exchange of equipment is at the request of the customer, or convenience of the customer, a restocking fee will be charged. All returns will be sent freight prepaid and properly insured by the customer. When communicating with HARRIS CORPORATION, Broadcast Transmission Division, specify the Factory Order Number or Invoice Number.

2.4. General Installation Information

The GATES Series™ Transmitters have been designed for rapid installation. In addition to the 28 inch width by 30 inch depth of the equipment, a minimum of 24 inches should be allowed for maintenance access from both the front and rear of the cabinet. Signal and power wires can be connected through several different entries or any desired combination thereof.

The holes for cable entrance are 2 inches in diameter, and are located at the front and rear bottom of each side panel. These entries provide a means to enter the equipment with wires that are then routed into the base of the equipment.

Input power wires should run to the terminal board installed in the base of the transmitter. Access to this terminal board is gained by removing the cover plate over the face of the contactor chassis. The screws holding the chassis must then be removed and the chassis pulled forward.

The normal air flow through the transmitter is taken in through the back of the unit (at the bottom of the cabinet). Maximum temperature at the base of the transmitter should not be more than 50°C. The air moves from the base of the cabinet into the side panels and into the main enclosure. Air passes over the heat sink fins in the side panels and exits through the holes in the top of the cabinet. This provides efficient chimney action cooling of all the Power Amplifier and Modulator transistors.

The air that enters the main enclosure passes directly over the components dissipating heat and exhausts through the output coils and out the top of the transmitter. The circuit cards and their heat sinks have been designed to provide a chimney action to the maximum extent practical.

NOTE

Note that the two blowers have separate air intakes. One is filtered and the other is not. The unfiltered side is dedicated to the PA side wall. No filter is needed because most of the air passes through the heat sink fins. A small amount of air is channeled in the cabinet to flush the PA Toroids. At approximately one year intervals, the PA heat sink fins should be inspected and cleaned. They may be removed by removing the 10/32 mounting screws.

2.4.1. Power Distribution for Optimum Transmitter Performance

(This section is applicable to the three phase GATES FIVE only, as well as other three phase equipment.)

For many years HARRIS engineers have recommended that the three phase power distribution system should be either a closed delta or WYE configuration to provide better radio and television transmitter performance by helping prevent line unbalance. Operation with substantial voltage unbalance from line to line results in higher than normal signal-to-noise ratio in the transmitter output signal, increased three phase transformer heating, and hot three phase motors.

2.4.1.1. *Overheating from Line Unbalance*

Even a device as simple as a three phase motor should be operated from a power line in which the voltage is balanced within 1%. It takes only a 3.5% line unbalance to produce a 25% increase above normal temperature. A 5% unbalance will cause destructive temperature rises of 50% greater than normal!

Similar characteristics can be expected in the windings of a three phase power transformer down inside the cabinet of your transmitter. Transformers and motors can be designed with extra safety features where thermal rise is limited to acceptable levels; however, in this case, other transmitter parameters cannot be made acceptable at a reasonable cost.

2.4.1.2. *Transmitter Noise Performance*

The most difficult parameter to meet with power line unbalance is transmitter noise performance. Most large transmitters use six-phase or twelve-phase high voltage power supplies. The energy storage capacitors are expensive to install and large stored energies make destructive faults inevitable. A good design will have sufficient energy storage capacitors to meet the specified signal-to-noise but not much more. When the equipment is then operated from an unbalanced line, the power supply ripple frequency will be twice the line frequency instead of six to twelve times. It becomes obvious that it would take three times as much energy storage to achieve the original performance goal.

2.4.1.3. *The Causes of Line Unbalance*

How does a line unbalance occur? It is a rare case in which a large commercial power producer would generate unbalanced voltage, so we must look elsewhere in the system. When you have large single phase power users on a power line this can cause uneven distribution of the line currents in the system. Uneven currents through balanced impedances will result in line-to-line voltage unbalance.

Another likely source of this problem can come from unbalanced impedances in the power distribution system. Unbalanced impedance will always be seen when an "open" delta three phase distribution system is used. Transformer design textbooks clearly show that the voltage regulation of an unbalanced system is poor.

2.4.1.4. *Three Phase Delta Distribution Transformers*

Figure 2-1 shows open and closed delta systems. The closed delta impedance looking into each terminal (A, B & C) is exactly the same; but this is not the case in the open delta configuration. Depending on the impedances of the transformers in the open delta circuit, line voltage unbalance sufficient to impair satisfactory operation of the overall transmitter may result. For this reason, along with their inherent susceptibility to transients, Harris does not recommend the use of open delta systems.

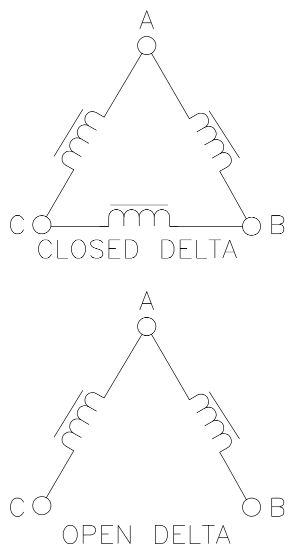


Figure 2-1. Three Phase Delta Distribution Transformers

The only advantage of the open delta is lower initial cost, and this is partially offset by the fact that when only two transformers are used, they must be larger than the three transformers in a closed delta system.

Difficulties have often been experienced with open delta systems; but when a third transformer was added to close the delta, the problems disappeared.

There is another problem which can occur with an open delta system, and that is caused by lightning and switching transients. When lightning strikes or heavy loads are switched on a power distribution system, high voltage transients are propagated throughout the system. Unbalanced impedances will enhance these transients and can cause transmitter damage, particularly to solid state rectifiers.

Many transmitters are located at the end of a long transmission line which is highly susceptible to transient phenomena. Devices such as Metal Oxide Varistors are inexpensive and very effective in reducing over voltage spikes. These units are limited in the amount of energy that can be dissipated, but will handle, if designed properly, very large currents. You can't take a direct lightning hit and still operate, but not many things will. It has been reported by engineers that installation of a third transformer and transient protection devices, have eliminated the difficulty.

2.4.1.5. *Three Phase Wye Distribution Transformers*

The WYE connected system is also considered a symmetrical form of three phase power distribution. All impedances are balanced as seen from each terminal (see Figure 2-2). It is important when using a WYE connected system that the fourth wire (neutral) is connected to the mid-point of the system as shown in the diagram. When this connection is made it provides a path for the zero sequence currents as well as any harmonic currents which are generated due to the rectification of the secondary voltages.

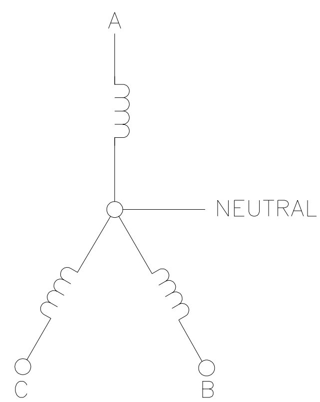


Figure 2-2. Three Phase WYE Distribution Transformers

Today, many transformers are supplied with all of the primary terminals available so that either a delta or WYE connection can be made. Table 2-1 shows the different line-to-line voltages that are available with this configuration.

Delta connected transformer	WYE connected transformer
210	364
220*	380*
230	400
240*	415*
250	433
* Typical voltages in some areas of the world.	

Table 2-1. Typical Line Voltages Delta or WYE

In summary, both symmetrical power distribution systems are satisfactory because of their balanced impedances. Use either a closed delta or a four wire WYE system for maximum transmitter performance. Never use an open delta system just to cut costs - it could cost dearly in the long run.

2.5. General Installation Requirements

The key to a rapid and successful setup is careful planning prior to delivery of the system. HARRIS offers, as an option, engineering services to review and comment on proposed installations. In addition HARRIS offers, as an option, design, fabrication, and installation services to any required level for total integration of the system into a facility.

Lifting Equipment (Fork Lift, etc)	900 lbs (408 kg) capacity
Hand Tools	For opening wooden crates
Shims (2" by 2")	Aluminum, assorted thicknesses
Hand Operated Hole Punch	For adding 0.25" hardware holes to 0.020" thick copper ground strap at transmitter ground connection.

Table 2-2. Special Installation Tools and Equipment

Transformer, Low Level, A20T01	472 1678 000 (1)
Transformer, Power, A19T01	See packing list for part number

Table 2-3. Equipment Supplied with Transmitter and Listed on Packing Check List Supplied with Transmitter

2.5.1. Equipment Placement

The transmitter should be located to permit adequate maintenance access and sufficient ventilation. Primary AC power cables can enter the transmitter at a variety of locations and the specific location of entry will need to be determined on site. The grounding strap between the transmitter and the station earth ground must be properly connected before AC power wiring is attached to transmitter.

2.5.2. Pre-Installation Inspection

Prior to performing the installation of the GATES Series™ transmitter, it should be thoroughly inspected for any connections which may have loosened during shipment.

This is important due to numerous high current connections in the transmitter.

Also check that all ribbon cables are properly locked into their respective printed circuit board connectors.

The mechanical interconnecting integrity of the above mentioned items is essential to the attaining of proper transmitter operation. Although appropriate packaging and shipping precautions are taken prior to the equipment leaving the factory, hardware may, in isolated cases, work loose in transit and result in a failure.

Check for debris or loose hardware, especially around the high current power supply connections.

2.5.3. Equipment Positioning

Following removal of the shipping material, move the cabinet on its skid as near as possible to its permanent position. If shipping bolts have been used, they will be located at each corner of the skid. Remove the bolts from the underside of the skid.

NOTE

Positioning of the cabinet is to be performed by experienced personnel to prevent damage to the equipment or injury to personnel.

With a suitable lifting device, raise one end of the transmitter cabinet sufficiently to permit the placing of three lengths of circular bar stock under the cabinet. In this manner the cabinet can be efficiently and carefully rolled off the skid.

2.5.4. Ground Strap Installation

The importance of a good grounding system and lightning protection can hardly be overemphasized for reasons of personnel safety, protection of the equipment, and equipment performance. The following is only a brief overview.

Lightning and transient energy via the power line or tower connections can impose serious threats to your personal safety as well as damage the equipment. For these reasons you should have a good protective earthing system to divert these forms of energy to earth ground. Proper grounding of the equipment also guards against electrical shock hazards that would exist if the equipment failed in a way which put a hazardous voltage on the chassis.

A good grounding system should include substantial grounding at the tower base using copper ground rods and/or a buried copper ground screen, with copper strap used to connect the tower base to earth ground. A low impedance will help carry lightning current directly into the ground instead of into your building. Additionally, coax shield(s) should be electrically connected to and exit the tower as near to the bottom as practical to minimize the lightning voltage potential carried by the coax into your building.

For coaxes, a single point of entry into the building is best, with all connected to a common grounding plate (or bulkhead panel) having a low impedance connection to the building perimeter ground. Wide copper straps should be used for making the connection from the common grounding plate to earth ground.

A common grounding plate is also the best location for coaxial surge protectors for sensitive equipment such as an STL receiver. Ideally, this plate should also be the entry point for all signal lines, and serve as a single point ground for AC power surge protection.

A good ground system should include perimeter grounding of the transmitter building using copper ground rods and copper strap. There should also be a copper strap running from tower ground to the building perimeter ground.

Good grounding and shielding will help keep stray RF current to a minimum. RF interference usually shows up in one of several ways, intermittent problems with digital or remote control circuits, audio feedback or high pitched noise. Even a small amount of non-shielded wire makes a very efficient antenna for RF and transient energy. If RF is allowed into the audio equipment, it can be rectified and may show up as noise or feedback. Wire and cable shields should normally be connected at both ends to the equipment chassis.

A ground strap attachment point is located on the bottom, right rear, of the cabinet behind the dust cover (uses a 10-32 brass screw with brass washer). Use this connection when utilizing a single point grounding system, attaching your ground strap to the common grounding plate. See 839-7920-044 Gates series Outline drawing.

A grounding stud is also provided near the AC input connections in the lower portion of the transmitter. Use this connection for the power line ground. It is located under the low voltage power supply board.

2.6. Electrical Installation

NOTE

All GATES Series™ transmitters are shipped with A19T1 and A20T1 connected for 251 VAC operation. It is advised that the end user determine the appropriate tap settings during the initial turn-on. In this procedure, the transformer tapping is determined by the resulting DC supply voltage. This ensures that the DC supplies are operated in the desired range.

2.6.1. Power Requirements

The GATES Series™ GATES FIVE (3 phase version) is designed to operate from a 3 phase, 208/240 VAC, 50 to 60 Hz source. Sixty ampere service is required. Use 6 gauge wire for this connection.

The single phase GATES FIVE requires a 100 amp 208/240 VAC, 50 to 60 Hz source. Use 4 gauge wire for this connection.

The GATES TWO requires a 60 amp 208/240 VAC, 50 to 60 Hz source. Use 6 gauge wire for this connection.

The GATES ONE requires a 30 amp 208/240 VAC, 50 to 60 Hz source. Use 8 gauge wire for this connection.

There is no requirement for 120 VAC in any case.

As an option, the low voltage circuits can be powered from a separate circuit breaker. Although not a requirement, this set up sometimes is advantageous for maintenance and troubleshooting. If you choose to wire your transmitter this way, you will need to provide a separate 10 amp circuit breaker.

NOTE

If service voltage is less than 208 VAC, a higher current service may be needed.

Refer to the Outline drawing for mechanical dimensions and wire feed locations.

WARNING

ENSURE THAT ALL AC POWER IS OFF PRIOR TO STARTING THE FOLLOWING INSTALLATION

2.6.1.1. *Procedure.*

For a three phase GATES FIVE, connect 3 phase AC input power from a fused disconnect box or circuit breaker to transmitter cabinet terminal board TB1 terminals 1, 2 and 3. The power source can be either a closed delta (usually 230 to 240 volts) or a WYE (usually 208).

For a four wire WYE system (341 to 434 volts), connect the neutral wire to terminal board TB1 terminal 4. Also for a WYE system ensure that the high voltage transformer has been tapped correctly for the configuration (see the Wiring Diagram for the three phase GATES FIVE transmitter).

For the GATES ONE, GATES TWO, or single phase GATES FIVE, connect AC input power (197 to 251 VAC) from a fused disconnect box or circuit breaker to transmitter cabinet terminal board TB1 terminals 1 and 2.

NOTE

Terminal board TB1 is accessed by removing the four screws which hold the circuit breaker panel to the front of the transmit-

ter and then sliding the circuit breaker panel forward. Terminal board TB1 is located on the floor of the transmitter directly below the AC Power panel. Terminals are numbered left to right.

If you choose to wire your transmitter with separate low voltage and high voltage feeds, you will need to remove the factory installed jumper wires from TB1, and connect a 10 amp service to TB1 terminals 5 and 6.

For the 3 phase GATES FIVE, ensure that the Phase Monitor relay A19K3 is installed

Table 2-4. Interface Board Connections

CONTROL INPUTS	TERMINAL
Low	TB2-1
Two	TB2-2
Three	TB2-3
Four	TB2-4
Five	TB2-5
High	TB2-6
Off	TB2-7
Raise	TB2-8
Lower	TB2-9
Ext Kill (RF mute)	TB2-10
FAILSAFE	TB1-1 and TB1-2
METERING OUTPUTS	**TERMINAL**
PA Voltage	TB2-11
PS Current	TB2-12
Power Output	TB2-13
STATUS	TERMINAL
Low	TB2-15
Two	TB2-16
Three	TB2-17
Four	TB2-18
Five	TB2-19
High	TB2-20
OVERLOAD STATUS	**TERMINAL**
Overload Ind Reset	TB2-14
Auto Cutback	TB2-21
Supply Voltage	TB2-22
Supply Current	TB2-23
Underdrive	TB2-24
VSWR	TB2-25
Audio	TB2-26
Audio	TB2-27
Ground	TB2-28

in the AC Power panel and is adjusted to MIN. See Note below.

NOTE

To adjust the Phase Monitor, remove all power from transmitter and rotate the voltage adjustment screw to your approximate AC line voltage. The actual setting will have to be determined by trial and error. Refer to paragraph 2.7.1.g for adjustment information.

2.6.2. RF Output Connection

Connect the output transmission line from the antenna to the RF OUTPUT connector jack J1 located on top of the transmitter cabinet.

A GATES ONE requires a male type N connector. Specific type N connectors are available for various types of coax.

The GATES TWO and GATES FIVE require a 7/8 EIA flange. Specific connectors of this type are available for various kinds of coax.

2.6.3. Battery Installation

The purpose of the battery on the Controller board (on the swing out panel) is to maintain transmitter operational status during a power interruption. It is not important to install it until you are nearly ready to put the transmitter into regular operation. The transmitter will operate properly without the battery, however, power interruptions lasting more than a few seconds will result in an OFF condition, and all overload lights lit.

A standard 9 volt battery will last about 2 weeks of continuous running with no AC power applied. Alkaline batteries will give the longest shelf life. It is a good idea to change the battery after a long outage or yearly.

2.6.4. Audio Input

Route the audio cable up from the base of the transmitter to the Interface board. The Interface board is located in the lower left portion of the transmitter in the front. Connect the audio input wires to terminals TB2-26 and TB2-27 on the Interface Board. TB2-28 is ground for the audio cable. Refer to Table 2-4 and Figure 2-3.

2.6.5. Remote Control

All remote control connections are made at the Interface board. Cabling for remote control may be routed up from the base of the transmitter.

To prepare wire, strip insulation back approximately 1/4" and twist strands back into their natural position.

A small flat blade screwdriver is an appropriate tool to use to make the connection.

To make connection, align wire in side opening "B" and depress clamp down from opening "A" with tool. Insert wire or component in opening "B" and secure by withdrawing tool.

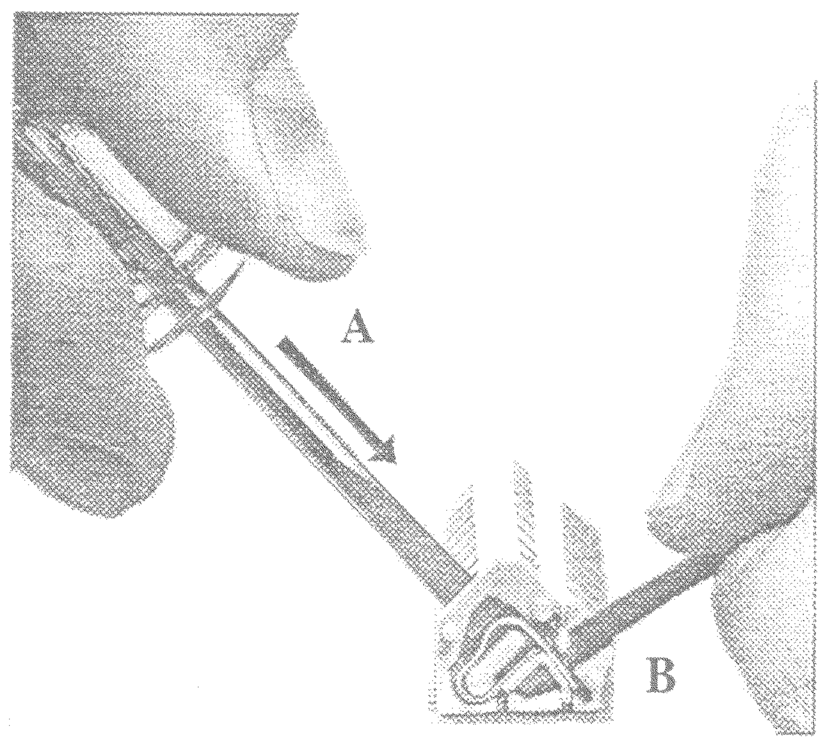


Figure 2-3. Making Connections to WAGO Block

Note: All remote control inputs are activated by applying a momentary ground connection to each desired input. This makes the transmitter directly compatible with open collector type remote control units as well as dry contact systems. With a dry contact (relay) system, you will simply need to momentarily switch each of the desired control inputs to ground in order to cause a function to occur.

The status outputs for power levels and overloads are open collector outputs. These are directly compatible with TTL type inputs, or may be used to drive small relays or other indicating devices as long as the current requirements are 100 ma or less.

To use a status output to drive a small relay, you will need to connect the relay from the status output to a DC power source with a positive voltage between 5 volts and 24 volts. As with any DC powered relay, you should connect a diode across the coil, with the cathode toward the positive supply.

2.6.6. Airflow Sensor Status

In addition to the status outputs described above, transmitters manufactured December 1995 and later are equipped with an Airflow Sensor circuit which includes a status output. A relay contact closure is provided on TB1 on the main Airflow Sensor circuit board, located in the air inlet for A20B1.

All metering samples are positive with respect to ground and are less than 5 volts into a 10k ohm input resistance.

2.6.7. Failsafe Connection

24VAC contactor coil current passes through the Failsafe Interlock terminals. Therefore, high voltage power supply activation requires the presence of a continuous closure across the Failsafe Interlock terminals. Opening of the contacts results in deenergizing the HV contactors.

A connection is required at the Failsafe terminals even if the transmitter will be locally controlled. Switching the transmitter to Local control does not bypass the Failsafe interlock.

Contacts and wiring connected to these terminals should be rated for at least 24 VAC @ 1 amp. Refer to the listing of Interface Board connections in the Table 2-4.

The shield connection for the remote control cabling should be connected to a nearby ground stud or one of the Interface board mounting screws.

2.6.8. Modulation Monitor Sample

An adjustable, 1 to 5 Volt RMS signal source is provided on the Output Monitor board. The Output Monitor board is located behind an access door on the front. Route the cable for the modulation monitor from the base of the transmitter up to the location of the Output Monitor board. The coax will slip into the gap between the transmitter wall and the enclosure for the Output Monitor, RF Oscillator, and PDM Generator.

Connect modulation monitor to the BNC jack on the Output Monitor board A18. Be sure to position the coax safely away from any components which may generate enough heat to melt the insulation on the coaxial cable.

2.7. Initial Turn On Procedure

Before initial turn on, ensure that the following items are checked:

a. Ground strap is properly connected between transmitter and station earth ground.
b. Check for debris/hardware in base of transmitter and in AC Panel.
c. Make sure all hardware connections are tight.
d. AC input wiring is properly connected.
e. Transmitter output is properly terminated into a suitable load capable of handling rated output power (antenna or dummy load).
f. Audio input is properly connected.
g. Monitoring equipment is properly connected.
h. The REMOTE/LOCAL switch on the Controller board (on the swing out panel) should be in the local mode.
i. Be sure the front and rear covers are in place.

2.7.1. Initial Turn On

Important

Temporarily remove F1 from the Interface board. This will disable the contactor circuit for the first part of the turn-on procedure. Fasten the bottom front panel in place with at least two screws.

WARNING

THE NORMAL PROCEDURE FOR TRANSMITTER TURN OFF SHOULD BE FOLLOWED IN ORDER TO PROPERLY DISCHARGE THE HIGH VOLTAGE COMPONENTS. TURN OFF THE HIGH VOLTAGE BY DEPRESSING THE OFF BUTTON. IF YOU MUST ENTER THE TRANSMITTER, SET THE REMOTE/LOCAL SWITCH TO LOCAL AND ALLOW THE POWER SUPPLY TO DISCHARGE AS INDICATED BY THE FRONT PANEL METERS. LOW VOLTAGE MAY THEN BE REMOVED BY SETTING THE LOW VOLTAGE CIRCUIT BREAKER TO OFF. DISCONNECT ALL PRIMARY POWER SERVICE. REMOVE THE REAR LIFT OFF PANEL SLOWLY TO ALLOW THE RESISTOR DISCHARGE MECHANISM TO FUNCTION. A GROUNDING STICK IS PROVIDED IN THE TRANSMITTER AND SHOULD BE USED TO ASSURE THAT ALL HIGH VOLTAGE HAS BEEN REMOVED UNDER FAULT CONDITIONS. BE CAREFUL NOT TO GROUND ANY CONNECTIONS WHICH ARE STILL ENERGIZED. THIS WOULD INCLUDE ALL LOW VOLTAGE CIRCUITS IF THE LOW VOLTAGE CIRCUIT BREAKER HAS NOT BEEN SET TO OFF POSITION.

CAUTION

IF ANY ABNORMALITIES ARE ENCOUNTERED IN THE FOLLOWING STEPS, STOP THE PROCEDURE, REMOVE ALL POWER, AND PROCEED TO TROUBLESHOOTING SECTION OF MANUAL.

a. Using a small blade screwdriver or adjusting tool, rotate the LOW power level control pot (located below the LOW power ON switch) several turns counterclockwise. The other pots may be left at the factory settings for now.
b. Apply AC power to transmitter.
c. Set the LOW VOLTAGE circuit breaker A20CB1 to ON position.
d. Verify the +/- 12 volt supply LED's illuminate on the control panel.
e. If you have a 3 phase GATES FIVE, verify red LED on Phase Monitor (in the contactor drawer) is illuminated. If the LED is not illuminated, either the Phase Monitor is not adjusted for the correct line voltage or the phase sequence is backwards. Remove all power and adjust the voltage selector on the Phase Monitor to the lowest setting and re-apply power.
f. If the LED is still not illuminated, remove all power and reverse any two leads in the main disconnect box and re-apply power and verify that the LED is illuminated. Adjust the voltage selector so that the red LED on the Phase Monitor relay illuminates when AC power is applied. In this adjustment, allow for a reasonable sag in line voltage, but do not desensitize it so far that it will be ineffective.

Note: The Phase Monitor relay adjustment is affected only by the particular line voltage. It is not affected by the changing of transformer taps which may be done later.

g. Install screws holding AC Power panel in place.

WARNING

ENSURE ALL VOLTAGE IS REMOVED FROM TRANSMITTER AND ALL POINTS WHERE VOLTAGE HAS BEEN APPLIED ARE GROUNDED BEFORE CHANGING ANY TAPS IN THE FOLLOWING STEP.

h. Use a suitable voltmeter to measure the +/-20 volt supply. A convenient point for checking these voltages is on the PDM

Generator, A15 at the fuses. Measure each voltage with respect to ground. If the voltages are under 19 Vdc, disconnect AC power and re-tap A20T1 to the next lower primary voltage (taps 240, 0).

It is desired that the low voltage supply be between 19 and 23 Vdc both plus and minus. Use a procedure of removing AC power, grounding transformer taps, moving the primary wiring to the next lower increment, then measuring +/-20 volt supplies, to achieve the desired supply voltages.

Note: The transformer tap connections are provided on TB3, terminals 15 through 19. Refer to Figure 2-3 for instructions on using the Wago block terminals. Move the AC connection as deemed appropriate to achieve the desired output voltage.

i. Verify that all overload and fault indicators can be extinguished by pressing the Reset button.

j. Check the RF Drive reading on the Multimeter. It should be close to the values recorded on the factory test data sheet. If it is not, re-check the low voltage transformer tapping. If needed, check the actual RF Drive on the PA module(s) per the procedure in Section C.

k. Confirm that when any of the power ON pushbuttons are depressed they illuminate. The AC contactors in the pull out drawer should not be heard energizing at this time since F1 is not in the Interface board. Also, the PDM KILL and PDM FAULT LED's will light in this condition.

l. Verify that depressing the OFF pushbutton clears all power ON pushbuttons.

m. Disconnect all primary power, and install F1 in place on the Interface board.

n. Reapply primary power.

o. Rotate the multimeter switch to the Supply Voltage position. Depress the LOW power pushbutton. The contactors should close and apply main AC voltage to the high voltage supply. The multimeter should show a voltage in the range of 220 to 270 on the 300 scale.

WARNING

IF CONTACTORS DO NOT CLOSE IN THE PRECEDING STEP, REMOVE ALL POWER FROM TRANSMITTER AND ENSURE FAILSAFE INTERLOCK CONTACTS ARE JUMPERED OR EXTERNAL FAILSAFE HIGH VOLTAGE INTERLOCK CIRCUIT IS PROPERLY CONNECTED. ALSO BE SURE THE REAR PANEL IS SECURELY FASTENED.

p. Switch the multimeter to read Detector Null and verify that the reading is zero.

q. Rotate the Low Power control pot clockwise and observe the PA Voltage, PA Amps, and FWD Power meters, and raise the power until the power level is as stated on the factory Final Test Data Sheets for the Low Power setting.

r. If the Detector Null reading increases from zero, adjust the TUNING and LOADING controls to minimize the reading. This will match the PA to the load impedance you are using.

During the initial tune-up, the null should be found to be well within the range of the TUNING and LOADING controls. If these controls require considerable adjustment, the load impedance on the transmitter is probably not very close to 50 ohms. If considerable adjustment is required, the impedance presented to the transmitter output terminal should be measured and corrected as necessary.

Although the transmitter is designed to match up to a 1.5:1 VSWR, the optimum condition is to terminate it into 50 ohms.

s. Depress Power Level number 2. The power level should increase to near the factory setting for this power level. It probably will not be exactly the same since the Fine Power adjustment has not been made.

t. Adjust the Tuning and Loading controls as necessary to null the Detector Null reading to zero.

u. Compare the present readings against the factory data for any major discrepancies. If any exist, it should be investigated at this time.

v. Progressively step the power level upward by selecting each higher level, check the readings against the Final Test Data Sheets. Adjust the TUNING and LOADING controls to minimize the Detector Null reading to zero.

w. Compare all readings against the Test Data. Since the High Voltage transformer is tapped at 240 +11 from the factory, it will probably be necessary to change the transformer taps accordingly. The need to do this or not is determined by the Supply Voltage reading on the Multimeter. It should be 250 to 265 volts at full power.

A change from one transformer tap setting to the next will produce about a 5% change in DC Supply voltage. For example, moving from 240, +11 to a setting of 240, 0 would result in a DC Supply increase of about 5%.

NOTE

The smaller gauge wiring on the transformer primary is for the fans. These smaller wires should always be left on 240, -11.

If you will be operating the transmitter well below its rated power, then you may leave the High Voltage transformer at it highest primary setting. This will yield the best overall performance if it is to be operating at a reduced power level.

WARNING

ENSURE ALL VOLTAGE IS REMOVED FROM TRANSMITTER AND ALL POINTS WHERE VOLTAGE HAS BEEN APPLIED ARE GROUNDED BEFORE CHANGING ANY TAPS ON THE TRANSFORMER.

x. Look at the range of the Fine Power adjustment using the Raise/Lower switches. It is desirable to set each of the coarse power level pots (LOW through HIGH) with the Fine adjustment in the middle portion of its range.

The PDM Power Level reading on the Multimeter is essentially the power control settings. This reading may serve as a handy reference for each desired power level. These readings should be recorded when the transmitter is initially set up, and used later if you need to troubleshoot a power level change.

y. Check or set each power level according to your needs and compare all readings with the factory test data. Report any major discrepancies to the HARRIS Service Department.

The GATES Series™ incorporates a protective action named Automatic Cutback in which the transmitter will step to each successively lower power in an effort to stay at the highest tolerable power level when there is an overload condition. This is similar to the automatic foldback feature in some transmitters, but is different in that the power level steps down rather than going through a gradual reduction.

Because of the Automatic Cutback feature, it is useful to set all 6 power levels. This way, the transmitter output will remain at a reasonable level should an Automatic Cutback occur. These power levels that you would not ordinarily use may be intermediate power levels, or lower than your normal operating powers.

2.7.2. Modulation Monitor Carrier Level

After each power level has been adjusted, you should set the RF sample level for your Modulation Monitor. If you are not using a modulation monitor at the transmitter, you should leave all of the monitor level controls set fully counter clockwise (minimum output).

The output levels of the monitor circuit are independent of one another, so they may be set in any order. While operating at a particular power level, rotate each corresponding control clockwise to achieve adequate carrier level.

Switching the REMOTE/LOCAL switch (near the battery on the Controller board) to the REMOTE position will enable the remote control circuits and should be in REMOTE position for normal operation. In addition to enabling the remote inputs, the transmitter will mute the RF Oscillator when in an OFF condition.

Note: The PA Voltmeter deflects upward when shut off in the Remote mode. This is a normal function of the RF drive being removed when PA voltage is present.

2.7.3. Application of Audio

Apply audio to the transmitter, and observe the resulting modulation level on the monitor. The audio input sensitivity is factory set for +10dBm, but is continuously adjustable down to -10dbm. If you desire to increase the sensitivity, you may adjust R21 on the PDM Generator.

Audio polarity is important, especially if you operate in stereo. Observe the results on your monitor, and change the audio polarity if the need is indicated.

2.7.4. Remote Meter Calibration

The remote sample outputs of the transmitter are designed to be compatible with most modern day remote control units, with less than 5 volts dc of output into a 10K ohm impedance. There are no internal adjustments for these voltages.

Set the remote control unit's calibration adjustments to match the transmitter's meter readings.

Note: The remote current reading is Supply Current, which is not the same as PA Current. The remote Supply current reading should be calibrated against the Supply Current reading on the transmitter multimeter.

Supply Current actually reads lower than PA Current in normal operation due to the manner in which the PDM system operates.

This concludes the initial turn on procedure.

Refer to sections A through K for individual board controls and indicators.

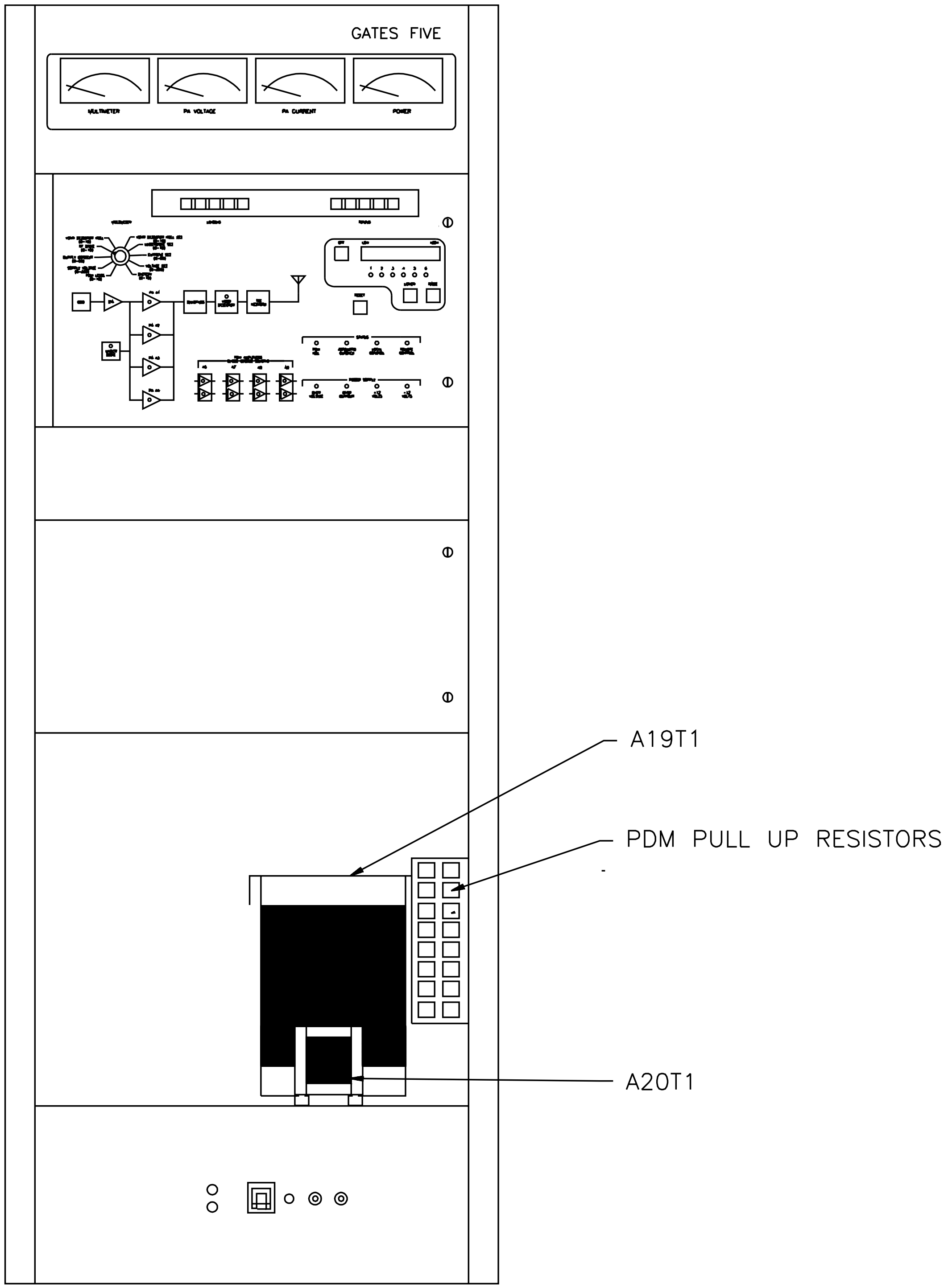


Figure 2-4. Base of GATES Transmitter

CONTROL/INDICATOR	FUNCTION
Power Transformer A19T1 Main	Power Supply transformer for 260 volt dc supply.
PDM Pullup Resistors	Shield shown covering 250 watt resistor(s) used by PDM Pull-up circuits.
Low Voltage Transformer A20T1	Secondary for +20VDC, -20VDC, 24 VAC, and IPA Supply (60/75/90/105/120 Vdc).

Table 2-5. Base of GATES Transmitter

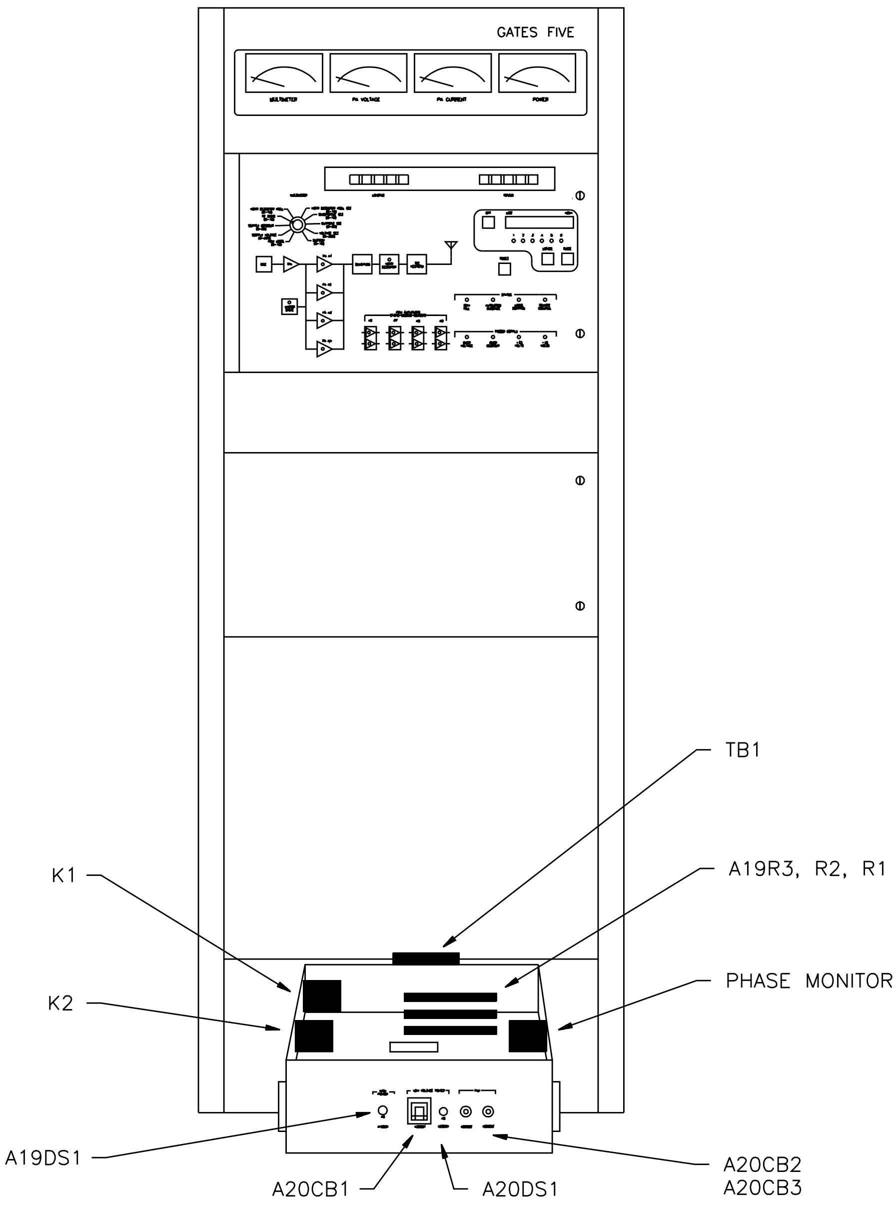


Figure 2-5. AC Power Panel

CONTROL/ INDICATOR	FUNCTION
Relay K1	Relay K1 is used to apply AC to the high voltage transformer through current limiting resistor(s) during the step start sequence.
Relay K2	Relay K2 is used to apply AC mains directly to the high voltage transformer.
Terminal Board TB1	Provides connections for AC input power.
Step Start Resistors A19R3, A19R2, & A19R1	(Only one resistor is used in the single phase transmitter.) The step start resistors limit the power supply surge current on initial turn on.
Phase Monitor	Detects loss of phase on primary AC input power and has capability to detect low primary AC input voltage (3 phase GATES FIVE only).
FAN Circuit Breakers A20CB2 & A20CB3	Protect wiring to fans from over current condition.
Lamp A20DS1	DS1 will illuminate when power is applied to the low voltage circuitry.
Circuit Breaker, CB1	10 Amp circuit breaker to protect the low voltage power supply from an over current condition.
Lamp A19DS1	A19DS1 will illuminate when power is applied from the Main Disconnect Switch (i.e. cabinet is receiving AC power).

Table 2-6. AC Power Panel Controls and Indicators

Table 2-7. GATES ONE
Typical Readings at 1340kHz

Power Output	1000W	800W	600W	400W	200W	100W
PA Volts	92.5	84	74	62	46.5	35
PA Amps	12.5	11.3	10	8.4	6.4	4.9
PDM Level	6.4	5.8	5.1	4.3	3.2	2.4
Supply Voltage	242	244	246	248	252	254
Supply Current	4.8	4.1	3.3	2.5	1.6	1.1
RF Drive	7.4	7.4	7.4	7.4	7.4	7.4
VSWR Detector Null	0	0	0	0	0	0
VSWR Detector Null Set	5.3	5.3	5.3	5.3	5.3	5.3
Underdrive Set	6.4	5.8	5.1	4.3	3.2	2.4
Supply Current Set	8.3	8.3	8.3	8.3	8.3	8.3
Supply Voltage Set	297	297	297	297	297	297
Battery	9.8	9.8	9.8	9.8	9.8	9.8
The readings above are typical readings. Refer to the Factory Test Data Sheets supplied for readings actually obtained during factory tests.						

Table 2-8. GATES TWO
Typical Readings at 800kHz

Power Output	2500W	2000W	1500W	1000W	500W	200W
PA Volts	98.5	90.0	79.0	66.0	50.0	35.0
PA Amps	28.7	26.1	23.0	19.0	14.0	10.0
PDM Level	6.8	6.2	5.5	4.6	3.4	2.4
Supply Voltage	249	250	252	257	260	265
Supply Current	12.0	10.0	8.0	5.0	3.0	2.0
RF Drive	8.9	8.8	8.8	9.0	9.0	9.0
VSWR Detector Null	0	0	0	0	0	0
VSWR Detector Null Set	6.6	6.6	6.6	6.6	6.6	6.6
Underdrive Set	6.7	6.2	5.5	4.5	3.4	2.4
Supply Current Set	23.5	23.5	23.5	23.5	23.5	23.5
Supply Voltage Set	299	299	299	299	299	299
Battery	9.8	9.8	9.8	9.8	9.8	9.8
The readings above are typical readings. Refer to the Factory Test Data Sheets supplied for readings actually obtained during factory tests.						

Table 2-9. GATES FIVE
Typical Readings at 920kHz

Power Output	5000W	4000W	3000W	2000W	1000W	500W
PA Volts	96.0	87.0	76.0	62.0	48.5	37.0
PA Amps	57.5	52.5	46.0	38.5	29.5	22.5
PDM Level	6.7	6.0	5.3	4.5	3.4	2.5
Supply Voltage	247	250	252	255	259	262
Supply Current	24.1	20.0	15.8	12.0	6.8	4.2
RF Drive	8.7	8.7	8.6	8.5	8.4	8.3
VSWR Detector Null	0	0	0	0	0	0
VSWR Detector Null Set	5.1	5.1	5.1	5.1	5.1	5.1
Underdrive Set	6.7	6.0	5.3	4.4	3.3	2.5
Supply Current Set	44.8	44.8	44.8	44.8	44.8	44.8
Supply Voltage Set	297	297	297	297	297	297
Battery	9.8	9.8	9.8	9.8	9.8	9.8
The readings above are typical readings. Refer to the Factory Test Data Sheets supplied for readings actually obtained during factory tests.						

SECTION III
MAINTENANCE

3.1. Introduction

This section provides preventive maintenance information and corrective maintenance procedures. The information contained in this section is to provide guidance for establishing a comprehensive maintenance program to promote operational readiness and eliminate down time. Particular emphasis is placed on preventive maintenance and record-keeping functions. For further information on maintenance of particular board, refer to sections A through K.

3.2. Station Records

The importance of keeping station performance records cannot be overemphasized. Separate logbooks should be maintained by operation and maintenance activities. These records can provide data for predicting potential problem areas and analyzing equipment malfunctions.

3.2.1. Maintenance Logbook

The maintenance logbook should contain a complete description of all maintenance activities required to keep the equipment in operational status. A listing of maintenance information to be recorded and analyzed to provide a data base for a failure reporting system is as follows:

DISCREPANCY Describe the nature of the malfunction including all observable symptoms and performance characteristics.

CORRECTIVE ACTION Describe the repair procedure used to correct the malfunction.

DEFECTIVE PART(S) List all parts and components replaced or repaired and include the following details:

a. Time In Use

B. Part Number

C. Schematic Number

D. Assembly Number

E. Reference Designator

SYSTEM ELAPSED TIME Total time on equipment

NAME OF REPAIRMAN Person who actually made the repair

STATION ENGINEER Indicates Chief Engineer noted and approved the repair of the equipment

3.3. Preventive Maintenance

Preventive maintenance is a systematic series of operations performed periodically on equipment. Because these procedures cannot be applied indiscriminately, specific instructions are necessary. Preventive maintenance consists of six operations: inspecting, feeling, tightening, cleaning, adjusting, and painting.

INSPECT. Inspection is the most important preventive maintenance operation because it determines the necessity for the others. Become thoroughly acquainted with normal operating conditions in order to recognize and identify abnormal conditions readily. Inspect for the following:

Overheating, which is indicated by discoloration, bulging of parts, and peculiar odors.

Oxidation.

Dirt, corrosion, rust, mildew, and fungus growth.

FEEL. Use this operation to check parts for overheating. By this means the lack of proper ventilation or the existence of some defect can be detected and corrected before serious trouble occurs. Become familiar with operating temperatures in order to recognize deviations from the normal range.

TIGHTEN. Tighten loose screws, bolts, and nuts. Do not tighten indiscriminately as fittings that are tightened beyond the pressure for which they are designed may be damaged or broken.

CLEAN. Clean parts only when inspection shows that cleaning is required and only use approved cleaning solvent.

ADJUST. Make adjustments only when inspection shows that they are necessary to maintain normal operation.

PAINT. Paint surfaces with the original type of paint (using prime coat if necessary) whenever inspection shows rust, or worn or broken paint film.

3.3.1. Maintenance Of Components

The following paragraphs provide information necessary for the maintenance of components.

TRANSISTORS. Preventive maintenance of transistors is accomplished by performing the following steps:

Inspect the transistors and surrounding area for dirt as accumulations of dirt or dust could form leakage paths.

Use compressed dry air to remove dust from the area.

WARNING

ALWAYS WEAR SAFETY GOGGLES WHEN USING COMPRESSED AIR.

Examine all transistors for loose connections or corrosion. Tighten the transistor mounting hardware to no more than 5 inch-pounds. Over-tightening the transistor hardware will cause the silicon insulators to curl up on the ends and possibly short through. When replacing a MOSFET transistor, be sure to alternate frequently between the mounting posts to tighten the hardware down evenly. This will minimize the possibility of shorting through an insulator.

CAUTION

IF THE TRANSISTORS IN THE PA OR IPA REQUIRE CHANGING, ENSURE THAT ALL OF THE TRANSISTORS ARE OF THE SAME TYPE NUMBER AND ARE FROM THE SAME MANUFACTURER.

INTEGRATED CIRCUITS. Preventive maintenance of integrated circuits is accomplished by performing the following steps:

CAUTION

USE CARE TO AVOID THE BUILDUP OF STATIC ELECTRICITY WHEN WORKING AROUND INTEGRATED CIRCUITS.

Inspect the integrated circuits and surrounding area for dirt as accumulations of dirt or dust could form leakage paths.

Use compressed dry air to remove dust from the area.

WARNING

ALWAYS WEAR SAFETY GOGGLES WHEN USING COMPRESSED AIR.

CAPACITORS. Preventive maintenance of capacitors is accomplished by performing the following steps:

Examine all capacitor terminals for loose connections or corrosion.

Ensure that component mountings are tight. (Do not over tighten capacitor mounting straps as excessive pressure could cause internal shorting of the capacitors.

Examine the body of each capacitor for swelling, discoloration, or other evidence of breakdown.

Use standard practices to repair poor solder connections with a low-wattage soldering iron.

Clean cases and bodies of all capacitors.

Inspect the bleeder resistors when inspecting the electrolytic capacitors.

FIXED RESISTORS. Preventive maintenance of fixed resistors is accomplished by performing the following steps:

When inspecting a chassis, printed-circuit board, or discrete component assembly, examine resistors for dirt or signs of overheating. Discolored, cracked, or chipped components indicate a possible overload.

When replacing a resistor, ensure that the replacement value corresponds to the component designated by the schematic diagram and parts list.

Clean dirty resistors with a small brush.

VARIABLE TUNING AND LOADING COILS. Lubricate at six month intervals, or as required if binding is evident, the mating surfaces of the ribbon and wiper with HARRIS lubricant (part number 055 0115 007) using a cotton swab to apply the liquid. Follow directions provided with lubricant for proper application techniques. Use sparingly as too much may prove ineffective. This lubricant can also be obtained locally or from CAIG LABORATORIES, INC., Escondido, CA., 92025-0051 under the name of CRAMOLIN R.

FUSES. Preventive maintenance is accomplished by performing the following steps:

When a fuse blows, determine the cause before installing a replacement.

CAUTION

IF ANY OF THE FUSES IN THE GATES SERIES™ TRANSMITTER REQUIRE REPLACING, ENSURE THAT ONLY AN EXACT REPLACEMENT FUSE IS USED. A DIFFERENT MANUFACTURER'S FUSE OF THE SAME SIZE AND/OR RATING DOES NOT FULFILL THE REQUIREMENT FOR EXACT REPLACEMENT.

Inspect fuse caps and mounts for charring and corrosion.

Examine clips for dirt, and, if necessary, clean with a small brush.

If necessary, tighten fuse clips and connections to the clips. The tension of the fuse clips may be increased by pressing the clip sides closer together.

SWITCHES. Preventive maintenance of switches is accomplished by performing the following steps:

Inspect switch for defective mechanical action or looseness of mounting and connections.

Examine cases for chips or cracks. Do not disassemble switches.

Inspect accessible contact switches for dirt, corrosion, or looseness of mountings or connections.

Check contacts for pitting, corrosion, or wear.

Operate the switches to determine if they move freely and are positive in action.

Tighten all loose connections and mountings.

Be sure to include an inspection of the power supply discharge switches located at the bottom of the rear panel opening.

TOROIDS. Inspect the drive transformer assemblies periodically for any signs of stress. These would be T11 and T12 on the IPA and T11, T12, T21, T22, T31, T32, T41, and T42 on the Power Amplifier boards A1 through A4. In particular, check the zener diodes on these transformer assemblies for signs of over dissipation. When over dissipated, these zeners will lose their normal glossy finish. If any of these zeners are found in this condition, check the RF drive system.

The toroids on the backside of the IPA and PA should be inspected when the modules are removed for replacing transistors. A crack or break in any core may cause damage to the transistors of the same quad. The best way of inspecting the toroidal cores is by rotating the core. This will allow a complete visual inspection.

PRINTED-CIRCUIT BOARDS. Preventive maintenance of printed circuit boards is accomplished by performing the following steps:

Inspect the printed circuit boards for cracks or breaks.

Inspect the wiring for open circuits or raised foil.

Check components for breakage or discoloration due to overheating.

Clean off dust and dirt with a clean, dry lint-free cloth.

Use standard practices to repair poor solder connections with a 40 watt soldering iron.

CAUTION

ENSURE THAT THERMAL COMPOUND IS APPLIED TO PLATES OF PA, IPA, AND PDM AMPLIFIER BOARDS BEFORE THEY ARE INSTALLED ON HEAT SINKS AND THAT HARDWARE SECURING BOARD TO HEAT SINK IS PROPERLY TORQUED TO 6-INCH POUNDS. ALSO INSURE NO BURRS OR DIRT PARTICLES ARE ON THE MATING SURFACES.

3.3.2. Air System

The air filter should be cleaned routinely. The intervals between cleaning will depend on the environment.

Replace filter if it is worn out.

3.3.3. GATES Series™ Top Removal Procedure

The GATES Series™ top may have to be removed to change frequency determinant components if a frequency change is required, or any capacitors need replacing.

WARNING

ENSURE ALL POWER IS REMOVED AND NETWORK COMPONENTS ARE SHORTED WITH SHORTING STICK BEFORE PERFORMING THE FOLLOWING PROCEDURE.

a. Make sure all power is turned off and Output Network components are shorted to ground with shorting stick.
b. Disconnect A21L1 in the Output Network from PA module A1 (see Figure 3-2).
c. Remove the eight screws holding RF shield below L2 and remove RF shield from transmitter.
d. Disconnect the tubing which connects A21L7 to the TUNING control, L4 as shown in Figure 3-3.
e. Remove 10-32 Phillips head screw from C3 connector strap that goes to L4 (see Figure 3-3).
f. Separate the two halves of A18P4. This connector is in line with three coaxes which go from the bracket end of A21 L2 to the Output Monitor board (see Figure 3-2).
g. Disconnect gray wire #112 from the HV shorting switch at the upper left of the rear opening.
h. Remove all of the 8-32 screws around the perimeter of top access panel and the eightr screws on the top rear (see Figure 3-1).

CAUTION

THE REMOVABLE TOP ASSEMBLY WEIGHS APPROXIMATELY 46 POUNDS.

i. From the rear of transmitter, pick up on the top and pull complete assembly back about one inch. It may be necessary to pull slightly on top back section to disengage edges from guide slots in corner posts.
j. At this point it may be more desirable to grasp bottom of L2 with one hand and top back section with the other hand. Lift top rear about one inch and pull complete assembly straight back and then down to desired work area.
k. Reinstall the GATES Series™ top by reversing the above procedure.

3.3.4. Low Voltage Supply Adjustment

The Low Voltage power supply outputs need to be in the desired voltage range in order for the transmitter to work properly. One Low Voltage Supply output is +/-20 volts for use by the Controller, PDM Generator, RF Oscillator, PDM Amplifiers, Output Monitor, and Interface board.

The other output from the Low Voltage Supply is for use by the IPA and is 60 to 120

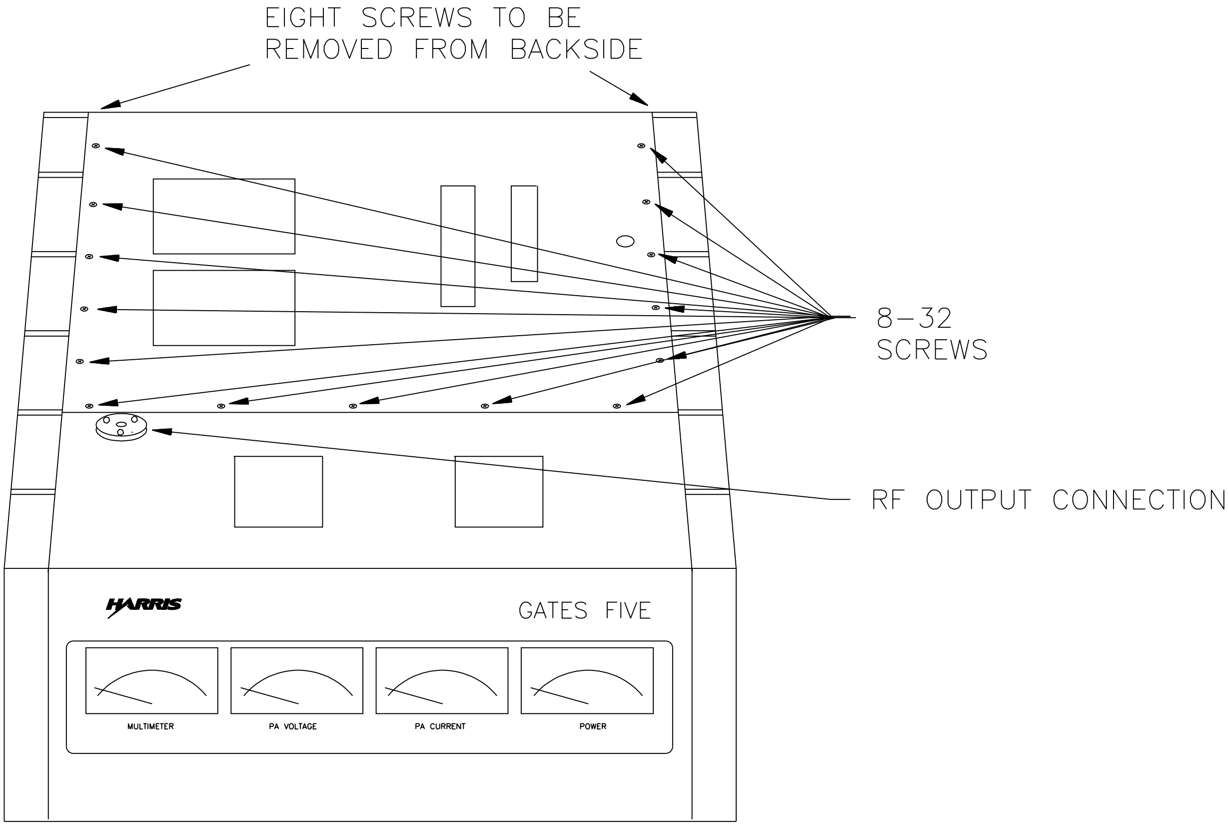


Figure 3-1. Cabinet Top

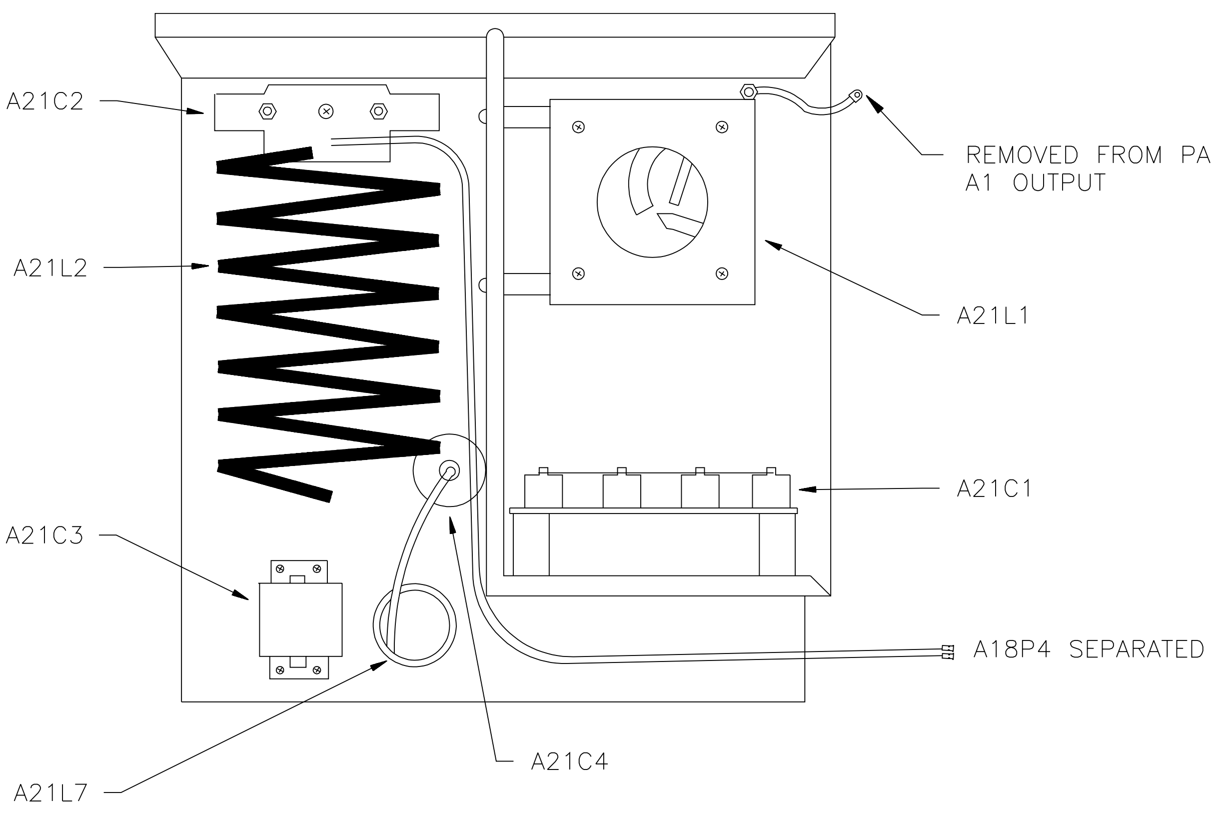


Figure 3-2. Output Network Removed from Transmitter

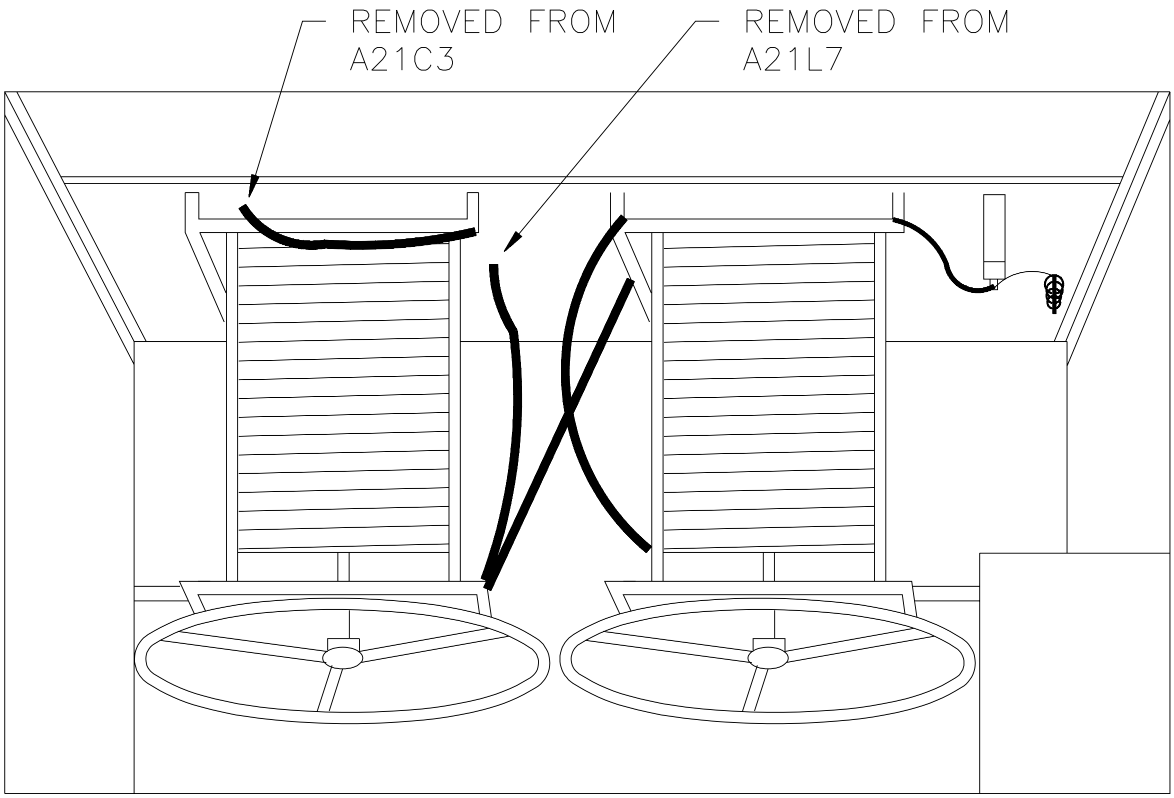


Figure 3-3. Cabinet Top with Output Network Removed

volts depending on the particular needs of the transmitter and frequency.

The primary of the Low Voltage transformer should be tapped correctly in order to produce the desired output from the +/-20 volt section.

A convenient place to measure both voltages is at the fuses on the PDM Generator. Use a suitable voltmeter to measure the +/-20 volt supply. Measure each voltage with respect to ground. If the voltages are under 19 Vdc, disconnect AC power and re-tap A20T1 to the next lower primary voltage (taps 240, 0).

It is desired that the low voltage supply be between 19 and 23Vdc both plus and minus. Use a procedure of removing AC power, temporarily safety grounding transformer taps, moving the primary wiring to the next lower increment, then measuring +/-20 volt supplies, to achieve the desired supply voltages.

Note: The transformer tap connections are provided on TB3, terminals 15 through 19. Refer to Figure 2-3 for instructions on using the Wago block terminals. Move the AC connection as deemed appropriate to achieve the desired output voltage.

3.3.5. High Voltage Supply Adjustment

The High Voltage Supply reading on the multimeter should be in the range of 250 to 265 volts for normal full power operation. Significantly less than this will sacrifice positive peak modulation if operating at or near the transmitter's rated power. Significantly higher than 265 volts will result in Supply Voltage overloads.

WARNING

ENSURE ALL VOLTAGE IS REMOVED FROM TRANSMITTER AND ALL POINTS WHERE VOLTAGE HAS BEEN APPLIED ARE GROUNDED BEFORE CHANGING ANY TAPS ON THE TRANSFORMER.

If the High Voltage reading is too high, the transformer primary needs to be changed to a higher setting.

If the High Voltage reading is too low, the transformer primary needs to be changed to a lower setting.

The Supply Voltage can be changed in approximately 5% increments by changing to the next tap position.

3.3.6. RF Drive Measurement

WARNING

ENSURE THE HIGH VOLTAGE IS TURNED OFF BEFORE PROCEEDING WITH THE FOLLOWING STEPS.

Measure the actual RF drive level with a scope connected to a PA module. Place the oscilloscope probe across R13 or the equivalent terminal of any module.

Attach the probe ground lead to the RF drive ground plane. Do not use the cabinet or chassis ground as this will give an incorrect waveform. Proper drive level should be 26-32 volts peak to peak on all eight inputs of each PA module A1, A2, A3, and A4, with high voltage OFF.

If the RF Drive exceeds 32 volts peak to peak, the tap settings on the low voltage transformer will have to be changed.

WARNING

ENSURE ALL VOLTAGE IS REMOVED FROM TRANSMITTER AND ALL POINTS WHERE VOLTAGE HAS BEEN APPLIED ARE GROUNDED BEFORE CHANGING ANY TAPS IN THE FOLLOWING STEP.

To check if the primary is properly tapped, it is advisable to measure the +/-20 volt supply on the PDM Generator. Measured at the fuses, it should be in the range of 19 to 23 volts. If too high, change the primary setting of A20T1 to a higher position (for example, from 240/0 to 240+11).

If the primary setting is proper, but the RF drive level produced by the IPA is too high, the secondary taps on A20T1 will have to be changed to a lower number to reduce the IPA supply voltage. The transformer secondaries are designated 60/75/90/105/120 Vdc. Moving from the 105 tap to the 90 tap will reduce the IPA supply voltage and the drive level.

3.3.7. IPA Tuning

Adjust A26L2 with a slotted screwdriver for a peak in drive level as measured on the PA modules.

Coarse IPA Tuning coil A26L1 has multiple taps so that A26L2 can be kept within its adjustment range. If the drive does not peak within the range of L2, the tap setting of A26L1 will have to be changed by selecting another tap position.

WARNING

THE IPA CIRCUITRY UTILIZES FAIRLY HIGH VOLTAGES WHICH CAN CAUSE ELECTRICAL SHOCK AND RF BURNS. BE SURE TO DISCONNECT THE PRIMARY POWER AND DISCHARGE ANY RESIDUAL VOLTAGES BEFORE MAKING ANY TAP CHANGES ON A26L1. BE SURE THAT THE SAFETY COVERS ARE IN PLACE ON THE IPA SECTION BEFORE REAPPLYING POWER.

Some of the components in the A26C1 position may not be used. Refer to the Factory Test Data Sheets for the proper amount of capacitance.

If the RF Drive when peaked is lower than 25 volts peak to peak, make sure the IPA is fully working, and that it is not being loaded down by PA failures. Refer to the troubleshooting procedures, as well as the checks of the PA modules.

WARNING

ENSURE ALL VOLTAGE IS REMOVED FROM TRANSMITTER AND ALL POINTS WHERE VOLTAGE HAS BEEN APPLIED ARE GROUNDED BEFORE CHANGING ANY TAPS IN THE FOLLOWING STEP.

If the drive is not low because of a component failure, then the IPA power supply secondary will have to be tapped for a higher voltage output. For example, moving a tap from the 105 volt connection to the 120 volt connection will increase the IPA supply voltage and the RF drive level.

3.3.8. PA Voltage Electrical Zero

Unplug P2 from the PDM Generator so that there will be no PA voltage when the high voltage is energized.

Energize the high voltage by depressing one of the power level buttons. The contactors should energize, and Supply Voltage should appear on the Multimeter.

Adjust R31 on the Controller board to make the PA Voltmeter read zero.

3.3.9. PA Volt Meter Calibration

The PA volt meter can be calibrated against an external meter of known accuracy, using the following procedure.

WARNING

TURN OFF TRANSMITTER AND DISCHARGE HIGH VOLTAGE BEFORE PROCEEDING.

Route some long voltmeter leads to the PA modules through one of the bottom side holes made for a cable entrance.

Connect the positive lead of the volt meter to the 260 volt line of a PA module (L11 or the fuse, for example). Connect the negative lead to the cathode of CR13 on the PA board. This is the same electrical point as the small banana jacks.

Turn the transmitter on at high power. Adjust R76 on the Controller board to make the front panel PA voltmeter agree with the external voltmeter.

Turn off high voltage. Allow discharge of power to zero. Remove voltmeter leads.

3.3.10. PA Current Calibration

The PA AMPS meter can be calibrated against an external meter using the following procedure. The external meter and its leads must be capable of accurately reading at least 12 amps for a GATES ONE, at least 30 amps for a GATES TWO, and at least 60 amps for a GATES FIVE.

WARNING

ENSURE ALL POWER IS REMOVED FROM THE TRANSMITTER BEFORE ATTEMPTING TO ROUTE THE LEADS IN THE FOLLOWING STEPS.

Locate the DC Ammeter where it can be seen from front of transmitter and route its leads through one of the bottom side access holes and up through one of the wiring grommets.

Interrupt the connection between the white, PA supply wires and PA metering shunt (A19R6) on the floor of the transmitter below the IPA. Insert leads from external DC ammeter in series with PA metering shunt and PA supply wires observing proper polarity (positive goes toward the PA shunt).

Be sure the external DC ammeter leads are positioned so they will not short to ground.

If a Clamp On DC Ammeter is used, insure that it is not RFI or EMI sensitive.

Turn transmitter on at HIGH power and adjust the power level to set the reading on the external ammeter on a convenient calibration level.

Adjust A19 R10 (on the floor of the transmitter below the Interface board) to make the PA AMPS meter read the same as the external meter.

3.3.11. Power Supply Current Calibration

The Power Supply current can be calibrated against an external meter using the following procedure. The external meter and its leads must be capable of reading at least 6 amps for a GATES ONE, at least 20 amps for a GATES TWO, and at least 30 amps for a GATES FIVE.

WARNING

ENSURE ALL POWER IS REMOVED FROM THE TRANSMITTER BEFORE ATTEMPTING TO ROUTE THE LEADS IN THE FOLLOWING STEPS.

Locate the DC Ammeter where it can be seen from front of transmitter and route its leads through one of the bottom side access holes and up through one of the wiring grommets, to near the high voltage rectifiers.

Connect the DC Ammeter in series with the supply current shunt resistor A19R7. This is located above the PDM Filter boards. Connect the positive side of the DC Ammeter to the shunt (leave the white wire in place on the shunt).

The negative side of the meter should connect to the black welding cable removed from the shunt.

Turn the transmitter on at HIGH POWER, and adjust the power level to some convenient calibration level.

Note the reading on the external meter, and adjust R25 on the Controller board to make the Supply Current reading on the Multimeter agree with the external meter reading.

3.3.12. Power Output Calibration

Connect the transmitter into a load with the capability of accurately measuring the power output. This is best done with a calorimetric dummy load, where the water temperature rise is measured against a known flow rate. A second choice is a dummy load and an RF ammeter of known accuracy.

Operate the transmitter at a convenient power level within the capabilities of the test setup.

Calibrate the Power Output meter to the same reading as measured externally using R85 on the Controller board.

3.3.13. Overload Adjustment Procedures

3.3.13.1. *Power Supply Current Overload*

Check the present Power Supply Current reading against the value on the factory test data sheet for the same operating conditions. If the present reading is significantly higher, it will be advisable to investigate the cause before proceeding with the following overload adjustment.

The overload threshold can be set to the same value as recorded on the factory test data sheet, or by checking the trip threshold by modulating it with a tone according to the following procedure.

For setting the overload under modulating conditions, operate the transmitter at 110% of its rated power output (5500 watts for GATES FIVE, 2750 watts for a GATES TWO, and 1100 watts for a GATES ONE).

Modulate with 20 Hz to 100%. Increase the audio level 0.5dB (6%).

Adjust R11 on the Controller board counterclockwise until the transmitter faults, then 1/3 of a turn clockwise from this trip point.

3.3.13.2. *Underdrive Fault*

Note: The Underdrive Fault threshold varies directly with the PDM Level such that the minimum drive requirements are less stringent at low power levels, but require full RF Drive at full power.

The indicated RF Drive level should always be somewhat above the threshold (Underdrive Set) in a normal condition.

With the actual RF Drive having been verified on the PA module(s), the RF Drive reading is adjusted so that it reads sufficiently above the Underdrive Set reading at full power.

Verifying the correct RF drive amplitude (26-32 Vpp) requires checking the PA inputs with a scope. Measure across R13, R14, R23, R24, R33, R34, R43 and R44 for each PA module. For the procedure on checking the drive on the PA module(s), refer to Section C.

After verifying the actual RF drive to be in the normal range, modulate the transmitter to 100% with 400 Hz at 110% power output (5500 watts for GATES FIVE, 2750 watts for a GATES TWO, and 1100 watts for a GATES ONE).

Adjust R143 on the Controller board counterclockwise until the transmitter steps to the next lower power level and displays the Underdrive fault. Then rotate R143 clockwise from the trip point about 2 turns.

3.3.13.3. *VSWR Detector*

You may set the VSWR trip threshold using the value recorded on the factory test data sheets, or may use a more involved process which actually causes the overload circuit to operate.

With the transmitter on, and NO modulation applied, set the LOW power control all the way to zero power output.

Use a clip lead to short across R18 on the Output Monitor board. This will cause the VSWR detector to not be nulled when you bring up RF power.

Gradually increase the power output, and watch the VSWR Detector Null reading come up from zero. Adjust R14 on the Controller board so that the transmitter trips off when the VSWR Detector Null reading reaches 7.5 on the Multimeter.

3.4. Replacing Boards and Replacing Board Components

The following boards may be replaced or have components replaced without the need for adjustments or measurements:

Interface Board
PDM Pull Up boards
PDM Filter board
IPA Power Splitter board
PA Toroid boards

The remainder of the boards have adjustments or frequency determined components. Refer to section on particular board that is being replaced for information on checkout procedures to follow.

NOTE

When board replacement is required, caution must be exercised in tightening both current carrying and non-current carrying surfaces. Non-current carrying tightness should be only a snug fit (i.e. PA module heat sink); while current carrying tightness should be more secure than snug but not over tightened. Remember that relatively fragile printed circuit board surfaces are being tightened and damage to boards can occur if excessive torque is applied.

SECTION IV
TROUBLESHOOTING

4.1. Introduction

This section of the technical manual contains overall troubleshooting procedures for the GATES Series™ AM Transmitter. As needed, references are made to the individualized sections of the manual.

4.2. Definition of Front Panel Indicators

UNDERDRIVE LED When lit is an indication of low or no RF drive to the PA module(s).

VSWR LED Indicates a mismatch at the transmitter output or the TEE section of the Output Network.

SUPPLY VOLTAGE LED The DC output of the high voltage supply has exceeded the maximum threshold of 290 volts.

SUPPLY CURRENT LED The current draw from the high voltage supply exceeded normal values.

AUTOMATIC CUTBACK LED Indicates the transmitter has reduced to a lower power level on its own because of a persisting overload condition.

PDM KILL LED Indicates that the transmitter is being muted by either an external command, or by the transmitter's step start circuitry failing to complete its connections.

PLUS and MINUS 12 VOLTS When lit, indicates presence of Controller supply voltage.

REMOTE LED Indicates that the remote inputs are enabled. This does not inhibit any local control functions.

LOCAL LED Lights when the transmitter can only be controlled locally.

PDM FAULT SENSING The PDM fault sensing LED's indicate a significant imbalance in the PDM operation, resulting in a PDM Amplifier doing more or less than its share of work.

PA FUSE INDICATORS When lit indicate one or more fuses are blown in the corresponding PA module.

AIRFLOW SENSOR In addition, transmitters manufactured in December 1995 and later are equipped with an Airflow Sensor which shuts the transmitter down, and produces an audible alarm in the event a fan failure is detected. This audible alarm is a continuous 2.8 Khz tone, plus a visual indicator provided on one of the Airflow Sensor boards. If the transmitter shuts down due to a fan failure, the transmitter can be turned back on. However, it will shut down in 1 to 2 minutes when the fan failure is again detected.

4.3. Symptom: Transmitter Will Not Turn On - None of the Green LED's on the Power Level Switches are Illuminated

4.3.1. Possible Causes

4.3.1.1. *Loss of AC Power*

Look at the +/-12V LED's on the Controller panel. If these are not illuminated, look at the amber indicators down by the Low Voltage circuit breaker at the bottom of the cabinet. If the circuit breaker is up and both indicators are illuminated, the AC power is getting to the transmitter.

4.3.1.2. *Control Supply Failure*

Loss of the +/-12V supplies, as indicated by the +/-12V LED's being extinguished, points to a failure of one of the regulators (U32 or U33) on the Controller board, or a short circuit on the Controller.

Check fuses F2 and F3 on the Interface board. These are in line with the +/-20 volts to the Controller. A blown fuse most likely indicates excessive current draw by the Controller.

4.4. Symptom: Green Power Level Status LED's Illuminate, but the Primary Contactors Do Not Energize and No Overload LED's Illuminate

The contactors normally produce an audible clunk as they close, and result in Supply Voltage registering on the Multimeter.

4.4.1. Possible Causes

4.4.1.1. *Phase Monitor (3∅ FIVE only)*

Check to see if the LED on the Phase Monitor relay in the contactor drawer is illuminated. If it is not, there may be a loss of phase, low line voltage, or improper adjustment of the Phase Monitor relay. Although less common, there may also have been a phase reversal by the power company.

4.4.1.2. *Blown fuse*

Check fuse F1 on the Interface board. Also make sure 24 VAC is present at F1 anytime AC power is applied to the transmitter.

4.4.1.3. *Open Interlock*

Make sure the rear panel is in position and fastened. Make sure the panel closure actually closes the interlock switch. A "click" should be audible as the panel is pushed shut.

WARNING

BEFORE PERFORMING THE FOLLOWING STEP, DISCONNECT ALL POWER FROM THE TRANSMITTER AND USE GROUNDING STICK TO DISCHARGE ALL POINTS BEFORE TOUCHING THEM.

4.4.1.4. *Failsafe Interlock Open*

A closure should be provided between TB1-1 and TB1-2 of the Interface Board for normal operation. If a remote control system or other equipment is connected to these terminals, check for the closure at the Failsafe terminals. Turn the low voltage OFF and ground the terminals with a grounding stick before using an ohmmeter to check for a closure at TB1-1 and TB1-2.

4.4.1.5. *Interface board Output*

With AC power applied and any of the ON pushbuttons depressed, 24 VAC should appear at TB1-2 on the Interface board. It will not be necessary to install the rear panel for this test.

4.4.1.6. *Open Contactor Circuit*

If the voltage checks okay at TB1-2 in the preceding step, then it is apparent that the K1 coil circuit is open. This would include the back panel interlock, Failsafe, the coil of K1, the Airflow Sensor, and the Phase Monitor relay (3∅ FIVE only).

4.4.1.7. *Contactor Control Signal*

If 24 VAC does not appear at TB1-1 and TB1-2 when any of the ON pushbuttons are depressed, check for the presence of a control signal at R18 on the Interface board. About 5 volts DC should appear on the input side of R18 in an ON condition. If not there, trace its origin at the Controller.

4.5. Symptom: One or Both Primary Contactors Energize, But There Is No Power Output

4.5.1. High Voltage Supply Failure

Check the Supply Voltage on the Multimeter. This should be 250-265 volts with the transmitter in any of the ON modes. If the supply voltage is zero, a High Voltage Supply problem is indicated. Check the step start resistors in the contactor drawer. An open step start resistor would indicate a failure in the high voltage supply, most likely a shorted rectifier.

Also check the condition of the MOV devices on TB2 in the contactor drawer. A blown MOV would be an indication of a significant power line surge or transient.

4.6. Symptom: High Voltage Is Present, But There Is No Power Output

4.6.1. PDM Kill Condition

Check the PDM Power Level reading on the multimeter, and the status of the PDM Kill LED on the front panel. If there is no signal of a closure of the Run contactor (K2), there will be a PDM kill condition. Listen for the closure of K2. It should be heard closing after K1 has closed. Clean the auxiliary contacts of K2.

A PDM Kill can also come from an external device such as an RF contactor in a phasor. Check for an external kill signal and make sure that all RF contactors in the antenna system are fully seated.

4.6.2. PDM Level

Check the PDM Level reading on the Multimeter. If it is zero for all power levels, there may be a failure on the Controller board. Refer to the troubleshooting information in Section J on the Controller.

4.7. Possible Causes For Overloads

4.7.1. Supply Voltage Overload

4.7.1.1. *Supply Voltage Too High*

Check the Supply Voltage reading on the Multimeter. If the transmitter will stay on long enough, compare this reading with the value recorded on the factory test data. Also check the Supply Voltage Set reading on the Multimeter. This is the threshold at which an overload should occur. This is read on the same scale as the Supply Voltage, and is normally 290 volts. This value is determined by the ratio of resistors R10 and R52 on the Controller board.

WARNING

ENSURE ALL AC VOLTAGE HAS BEEN REMOVED FROM THE TRANSMITTER AND THAT THE GROUNDING STICK IS USED TO REMOVE ANY RESIDUAL VOLTAGE THAT MAY BE PRESENT BEFORE THE TAPS ON THE HIGH VOLTAGE TRANSFORMER ARE CHANGED.

If the present Supply Voltage reading is significantly higher, remove all AC voltage being supplied to transmitter and re-tap the high voltage power supply transformer to a higher primary setting. For example, if the transformer is presently tapped to 240/0, change the tapping to 240/+11. This will reduce the supply voltage by about 5%.

If the transmitter has been operating with the proper supply voltage for some time, and only recently increased, check to see if the power line voltage has increased.

4.7.2. Power Supply Current Overloads- At Turn On

4.7.2.1. *Supply Short*

If the transmitter does not try to operate at a reduced power, there may be a High Voltage Supply short. There are two protection modes: The normal response of the protection circuitry is to perform a momentary PDM interrupt. If the high current condition remains, an OFF command is given.

A short of the Supply may be caused by mechanical failure of the safety switch which is normally opened by installation of the rear panel.

Another cause could be a shorted High Voltage filter capacitor.

4.7.3. Power Supply Current Overloads, Continuous Cycling and Automatic Cutback

4.7.3.1. *PDM System Problem*

If the over current problem is affected by the PDM interrupt, but exists upon return of PDM, the transmitter will step to the next lower power. This Automatic Cutback action can continue until the transmitter cycles all the way OFF, or the current drops below a safe value.

Check the Supply Current Set reading on the Multimeter to be sure it is at a normal value as indicated on the factory test data sheet. This reading should not change unless a change has been made to the overload adjustment.

Check the actions of the PA AMPS and Power Output meters at turn on. If they deflect upwards at turn on, it is evident there is current actually flowing in the PA.

Check the PDM Power Level reading on the Multimeter. If the Multimeter is pinned, there is a problem on the Controller. Refer to Section J concerning troubleshooting of the Controller. If the PDM Power Level reading is okay, the problem is in the PDM system.

4.7.3.2. *PDM Generator Outputs High*

Check the outputs of the PDM Generator at the right side of R45, R46, R62, and R63 with a scope or voltmeter. If any of the outputs are continuously high (12 to 14 volts) a PDM Generator problem is indicated. You may also isolate the problem by disconnecting the output (P2) from the PDM Generator. Refer to the troubleshooting procedures in Section F on the PDM Generator if the results indicate the problem resides there.

4.7.3.3. *PDM Amplifier Shorts*

If the Outputs of the PDM Generator are okay, there may be some short(s) on the PDM Amplifiers. Observe the PDM Fault sensing LEDS on the front panel, and refer to Section G, Troubleshooting the PDM Amplifiers.

4.7.3.4. *Supply Current Calibration*

If you have just installed a new Controller board, the Supply Current calibration may have been overlooked. Check this, per the procedure outlined in Section J on the Controller.

Check the Supply Current Set reading on the Multimeter. It would need to be adjusted only if you have just installed a new Controller board.

Also check the condition of the power supply current shunt resistor A19R7, located on the right side wall above the PDM Filter boards. Loose hardware or an open shunt wire would result in Supply Current overloads.

4.7.4. Random Supply Current Overloads With Modulation

4.7.4.1. *Sub-audible Signals*

Random Power Supply current overloads are most likely caused by significant levels of sub-audible signals on the transmitter audio input. The GATES Series™ of transmitters and some modern day audio equipment can pass sub-audible signals. Check your audio sources and the setup of your audio processing.

4.7.5. Underdrive Fault

4.7.5.1. *Low/No Drive*

Check the RF Drive reading on the Multimeter. If low or zero, there is a problem in the RF Drive system.

Oscillator Output. Having no RF drive could be caused by failed RF Oscillator.

Check the status of the green RF Output LED on the Oscillator board. If it is not lit, refer to Section A, Troubleshooting the RF Oscillator.

4.7.5.2. *IPA and PA Transistors*

Another cause for low/no drive may be failed IPA transistors, abnormally low IPA supply voltage, or several shorted PA transistors. Refer to Sections B and C covering the IPA and PA.

4.7.6. VSWR Overload- Continuous VSWR Cycling

4.7.6.1. *Bad Load Impedance*

Continuous VSWR cycling resulting in the Automatic Cutback operation indicates a severe change in the impedance into which the PA is operating. The transmitter will probably stay on at a reduced power, but the VSWR Detector Null reading will be high, depending upon the extent of the problem.

Isolate the problem further as outlined below. If a change in antenna impedance is indicated, it may be due to a failed capacitor or other change in the antenna system. Whether to re-tune the transmitter should depend on the extent and nature of the problem.

If there is a change in antenna impedance due to a change in ground conductivity (resulting from rain), it would be permissible to re-tune the transmitter to match it to the new load impedance.

However, if the impedance change is due to a failing capacitor in the antenna system, it would be best to avoid readjusting the transmitter tuning. Re-tuning the transmitter to match the failing part would probably accelerate the failure.

4.7.6.2. *Antenna Problem*

Connect the transmitter into a dummy load if one is available to determine if the fault is with the antenna system or the transmitter. If the antenna system is a directional array, the VSWR problem may be found to be peculiar to one attenna pattern only.

4.7.6.3. *Output Network*

A faulty capacitor or broken connection in the Output Network may be the cause if the transmitter also does not operate properly into a dummy load. A thorough inspection of the Output Network may reveal the problem. Look for any loose or burned connections, and any physical signs of stress on any of the capacitors.

WARNING

REMOVE ALL AC POWER AND DISCHARGE ALL POINTS WHERE RESIDUAL VOLTAGE MAY REMAIN BEFORE PERFORMING AN INSPECTION OF THE OUTPUT NETWORK.

WARNING

THE VSWR PROTECTION CIRCUIT SHOULD NEVER BE DEFEATED AS A MEANS OF GETTING THE TRANSMITTER BACK ON THE AIR.

4.7.7. VSWR Trips With High Levels Of Modulation and High Power

4.7.7.1. *Improper Tuning and Loading*

If this problem is encountered in the first hours of operation, there may be a setup problem. Refer to the initial turn on procedure and maintenance section where PA Tuning and PA Loading are described.

Check the VSWR Detector Null reading on the Multimeter. This reading should be zero. An increase in the VSWR Detector Null reading would indicate that the load impedance has changed from the initial tune up or that the transmitter tuning or loading has changed (either through front panel adjustment or by a failure of an Output Network component).

4.7.7.2. *Antenna*

If a dummy load is available, try operating the transmitter into it. There should be no significant Detector Null reading when operating into the dummy load, assuming the antenna impedance is close to the dummy load impedance. If the VSWR Detector Null reading reads upscale, there is probably a problem in the antenna system.

4.7.7.3. *Output Network*

If the VSWR problem still exists when operating into the dummy load, there may be a faulty capacitor or connection in the transmitter's Output Network. Check the output spark gap on top of the Loading control to see if it is shorted, and C3 and C4 in the Output Network. These are the components which would affect the impedance seen by the VSWR Detector.

WARNING

THE VSWR PROTECTION CIRCUIT SHOULD NEVER BE DEFEATED AS A MEANS OF GETTING THE TRANSMITTER BACK ON THE AIR.

4.8. Symptom: Remote Control Functions Do Not Work

4.8.1. Possible Causes

4.8.1.1. *Remote/Local Switch*

Check to see that the REMOTE/LOCAL switch on the Controller is in the REMOTE position.

4.8.1.2. *Remote Control Improperly Wired*

Review the installation instructions in Section II. Each remote control input of the transmitter is activated by a momentary closure to ground.

4.8.1.3. *Remote Control Unit Not Functioning*

Check the remote unit to see that it is providing closures to the transmitter. You might use a clip lead to momentarily provide the contact closures at the remote control unit to see which piece of equipment is at fault.

4.8.1.4. *Ribbon Connectors Loose*

Ensure that the ribbon connectors on the Interface board and the Controller are fully seated.

There may be a failed optical isolator on the Controller board. Refer to the Controller troubleshooting procedures in Section J.

4.9. Causes for a PA Volts/PA Amps Ratio Change

This discussion covers causes which might not be apparent based on front panel indications and readings.

4.9.1. No +20 Volts to PDM Amplifier

Loss of the +20 volt supply to a PDM Amplifier should cause one or more PDM Fault LED's to illuminate. To be certain this is not the problem, measure the voltage on the fuses on each PDM Amplifier to make sure +20Vdc is present. If not, trace +20Vdc back to its origin via the Interface board.

4.9.2. Impedance Change

The Output network can cause a change in the PA Volts to AMPS ratio. The PA volts to PA AMPS ratio is affected by the impedance seen by the PA module. If the impedance seen by the PA module changes, whether from an antenna impedance shift or from adjusting the front panel TUNING and LOADING controls, the PA VOLTS/PA AMPS ratio will be affected. Small changes will only cause a ratio change. Large changes will cause VSWR overloads. Check the Detector Null reading on the multimeter. It should be zero.

If the Detector Null reading is zero, but you suspect an Output Network failure, it will be in the L1/C1 and L2/C2 sections. This circuitry is ahead of the VSWR sensing.

A failure of C1 will shift the PA Tuning. Rotate the PA Tuning control to peak the PA current. The PA Amps should peak within three small divisions on the PA Amps meter. If the PA Tuning has to be changed by a considerable amount to peak the PA current, it is indicated that there is a problem with L1/C1. Inspect the C1 capacitors for any physical signs of stress.

A failure of C2 will shift the PA load resistance. You can measure the impedance looking into the Output Network to determine if there is a problem with L2/C2. This is done by connecting an RF bridge in place of the A1 output connection. An RF resistance significantly different than the test data value for "Combiner Load Impedance" would be an indication of an L2/C2 problem if the impedance at the back end of L2 is verified to be 50 ohms j0.

The parallel resonant frequency of L2/C2 may also be checked per the procedure in Section III (Maintenance).

4.9.3. PA Failure

Although a rare condition, an open PA transistor could cause a ratio change without blowing the associated fuse. One way to isolate this problem would be to disconnect PA transistor pairs by removing fuses to see if one particular pair is not drawing any current.

WARNING

TURN THE TRANSMITTER OFF DISCONNECT PRIMARY POWER AND DISCHARGE ALL HIGH VOLTAGE COMPONENTS BEFORE REMOVING A FUSE FROM A PA BOARD.

Pulling one fuse at a time to observe its affect on the transmitter operation is one way to isolate a non-working amplifier. If no change is observed after removing a particular fuse, then it is apparent that you have isolated a bad amplifier.

Another approach is to remove transistors to test them out of circuit as described in the section on the PA modules. However, do not operate the transmitter with any transistors removed.

4.10. Troubleshooting AM Noise

When troubleshooting a noise problem, it is important to know the level and frequency of the noise. Knowing the frequency of the noise, it is possible to isolate the source. The frequency of the noise may be determined by connecting an oscilloscope to the output of most distortion analyzers. The scope display will be the total noise. Measure the period of the noise with the highest amplitude to determine the dominant noise component.

An alternate method of determining the noise frequency is by tuning a distortion analyzer to it. A fully automatic distortion analyzer cannot be used in this way. While measuring the noise, switch the analyzer to the THD mode. Then tune the frequency of the analyzer for a dip in the meter reading on the analyzer. Depending on the number of significant noise frequencies affecting the total noise figure, there may be more than one dip in the analyzer reading. Frequency of the noise may be read from the analyzer frequency settings. An audio spectrum analyzer may also be used for determining both noise frequency and amplitude.

A listening test could be misleading since the dominant noise component may actually be above or below the range of the receiver or human hearing. Following are some hints on solving various noise problems. These are categorized according to frequency.

4.10.1. 50/60 Hz

This is a power line frequency and is not usually a significant noise component in the GATES Series™ transmitter, due to the design of the power supplies. If investigating a 50/60 Hz noise problem, first examine the audio input wiring and make a measurement with the audio cable going directly from the audio generator to the transmitter input terminals. This will eliminate any effects of the patch panel wiring or noise from other audio equipment in the system.

4.10.2. Audio Lines are Normally Balanced

That is, the audio line current does not flow in ground. Grounding of either side of the audio connectors can sometimes result in noise. If it is determined that the 50/60 Hz noise is actually generated in the transmitter, a bad rectifier is suspected. The dominant noise frequency of a single phase full wave rectified power supply is normally twice the power line frequency.

WARNING

ENSURE ALL VOLTAGE HAS BEEN REMOVED AND THE SHORTING STICK HAS BEEN USED TO REMOVE ANY RESIDUAL VOLTAGES BEFORE MEASURING THE RESISTANCE OF ANY RECTIFIERS.

Use an ohmmeter to check each of the rectifier diodes in the HV supply A19CR1, A19CR2, A19CR3, A19CR4 (also A19CR5 and A19CR6 if 3 phase supplied). Also check the block type rectifier bridge (A20CR1) in the +/-20 volt supply.

An open rectifier would also result in a decrease in supply voltage. Also use an oscilloscope to look for any evidence of 50/60 Hz noise in the power supplies. +/-20 volts and a high voltage supply sample appear on the PDM Generator, A15. +/-20 volts is at the fuses of the PDM Generator and the high voltage supply sample is at J1-7.

4.10.3. 100/120Hz

This is the principle noise frequency of all the low level supplies. If 100/120Hz noise is generated in the 3-phase version, you will also need to look for an imbalance having to do with the 3 phase power supply.

Check the balance of the 3-phase AC primary power by using an AC voltmeter. Use caution in this measurement and be sure to measure between all AC legs.

It may also be necessary to check the high voltage rectifiers and interconnecting wires for loose or open connections.

4.10.4. 300/360Hz

In the standard GATES FIVE, which uses a 3-phase HV supply, the principle power supply noise component is 300/360Hz. High noise of this frequency may indicate open filter capacitors or open an connection in the high voltage supply. Another possible cause is a failure in the noise cancellation circuit (U15) on the PDM Generator.

4.10.5. 60 kHz

This can only show up in a wideband audio noise measurement or as a spurious emission 60 kHz above or below the transmitter operating frequency. This could be caused by a significant imbalance in the operation of the Polyphase system. Check the PDM Fault indicators to see if any are lit.

If any are lit, it will be necessary to troubleshoot the PDM Generator (A15) or the PDM Amplifiers (A6 thru A9) for pulse width imbalance. A failure of a PDM Amplifier will also cause a substantial change in power output.

4.10.6. RFI Noise on Audio

Check the audio wiring to the transmitter for proper grounding of the shield at the Interface board. Also make sure that neither audio conductor is grounded. Grounding of either side of an audio line takes away common mode rejection, which is essential in preventing this type of noise.

The GATES Series™ transmitter is designed with extensive RFI filtering on the audio input circuitry and furthermore has a solid state instrumentation input circuit with high common mode rejection.

SECTION V
TRANSMITTER OVERALL

5.1. Introduction

This section of the maintenance manual will present the principles of operation for the individual sections of the GATES Series™ AM Transmitter. Included will be information on AC Power Flow, RF Power Flow, and miscellaneous parts of transmitter not covered in sections A through K.

5.2. Personnel Protection

Extensive interlocking and safety switches have been provided on these transmitters because of the low impedance high current capabilities of these power supplies. The rear access panel to these transmitters are provided with three safety switches. The first safety switch is operated by a small pin protruding through a hole. As you start to remove the rear panel, the interlock interrupts the control voltage to the primary contactors allowing them to de-energize.

Upon further removal of the rear panel, a HV discharge switch will discharge the energy storage capacitors through large resistors for current limiting. Upon opening the rear panel even further, a switch also operated by the rear panel shorts the power supply discharging the voltage remaining on the filter capacitors.

WARNING

THE NORMAL PROCEDURE IN TRANSMITTER TURN OFF SHOULD BE FOLLOWED IN DE-ENERGIZING THIS TRANSMITTER. TURN OFF THE HIGH VOLTAGE BY DEPRESSING THE OFF BUTTON. IF YOU MUST ENTER THE TRANSMITTER, SET THE REMOTE/LOCAL SWITCH ON THE CONTROLLER BOARD TO LOCAL AND ALLOW THE POWER SUPPLY TO DISCHARGE AS INDICATED BY THE FRONT PANEL METERS. REMOVE THE REAR PANEL SLOWLY TO ALLOW THE INITIAL RESISTOR DISCHARGE MECHANISM TO FUNCTION. UPON OPENING THE REAR PANEL FURTHER THE POWER SUPPLY WILL BE SHORTED TO GROUND AND MADE SAFE. A GROUNDING STICK IS PROVIDED IN THE TRANSMITTER TO ASSURE THAT ALL VOLTAGE HAS BEEN REMOVED UNDER FAULT CONDITIONS.

If the above warning is not heeded substantial damage may be done to circuit card foil, grounding switches, and the capacitors themselves. Always allow the voltage to be discharged prior to opening the rear panel. If immediate access is an absolute necessity, it is recommended that the high voltage be turned off, the rear panel be opened approximately 2 inches and be allowed to remain in this position for 2 seconds before being opened further.

5.3. Principles Of Operation

5.3.1. FET'S in the GATES Series™

All of the FET's used in the GATES Series™ operate in a switching mode of operation. In a switching mode, the FET's are either completely ON or completely OFF. The type of FET's used in the GATES Series™ transmitters are well suited for this application because they have a very low and consistent ON resistance, very high OFF resistance, and very fast switching times. The benefit of these characteristics is high efficiency and excellant modulation linearity.

5.3.2. PDM Theory In Brief

Pulse Duration Modulation (PDM) is a high efficiency type of modulator system wherein the modulator operates in a switching mode. Since the FET's have very low ON resistance, very high OFF resistance, and very fast switching times, the modulator efficiency is relatively high.

The basic makeup of the modulator system used in the GATES Series™ transmitters is with the PA, the PDM filter, and the PDM Amplifiers in series. The PDM Amplifiers purpose is to switch the PDM Filter inputs to ground at a 60 kHz rate. For the sake of understanding, a relay could be used for this purpose if it could switch at a 60 kHz rate.

The PDM Filter, which is between the PDM Amplifiers and PA, removes the switching frequency so that the signal provided to the PA is high level DC and audio.

The percentage of time that the PDM Amplifiers are ON varies with changes in pulse width or duty cycle. This change in duty cycle is what causes a change in PA voltage, and is how the PA is modulated. The higher the PDM duty cycle, the higher the resulting PA voltage.

The voltage for the PA is the difference between the high voltage supply (about 260 volts) and the output of the PDM Filter. For a normal full power, unmodulated condition the PDM Filter Outputs will be 100 to 105 volts less than the high voltage supply.

On 100 percent negative modulation peaks, the PDM Amplifiers cease to conduct and there will be no voltage differential across the PA (zero PA volts).

On the highest positive modulation peaks, the PA voltage may reach the 260 volt level if the PDM duty cycle reaches 100 percent.

5.3.3. Polyphase Theory

One inherent drawback to single phase PDM relates to the amount of filtering that is required to remove the PDM switching frequency. Considerable filtering is required to prevent spurious signals from being transmitted. With inadequate filtering, there would be spurious signals above and below carrier, spaced by the PDM switching frequency.

However, a large amount of filtering will also limit the transient response and modulation density of the transmitter. This is most noticeable when modulating with a square wave or with the audio heavily processed. False modulation peaks can occur due to effects of the filtering.

Polyphase PDM was created as a means of achieving the benefits of PDM without the modulation overshoot problems associated with PDM filtering.

In Polyphase PDM, the frequency of the PDM is effectively multiplied by the number of PDM phases. This is very similar to power supplies with multiple phases of rectification. A basic half wave supply operating on 60 Hz will have a ripple frequency of 60 Hz. A full wave supply operating on 60 Hz will have a ripple frequency of 120 Hz. A three phase full wave supply operating on 60 Hz will have a ripple frequency of 360 Hz.

As with multi-phase power supplies, Polyphase PDM requires less filtering to remove the ripple. In the case of the GATES Series™, there are four PDM phases of 60 kHz each. The effect of this is a PDM frequency of 240 kHz. Therefore, the PDM filtering is designed to attenuate 240 kHz instead of 60 kHz. This degree of filtering ensures excellent transient response.

5.3.4. Audio/PDM Signal Flow

Refer to the PDM Flow diagram.

The audio input signal is applied to the PDM Generator, which generates four phases of 60 kHz pulse width modulated signals. These signals are about 13 to 14 volts peak to peak. For further discussion on the operation of the PDM Generator, refer to section F.

The outputs of the PDM Generator are routed to the PDM Amplifiers. The PDM Amplifiers produce switching of the low side of the PA modules through the PDM

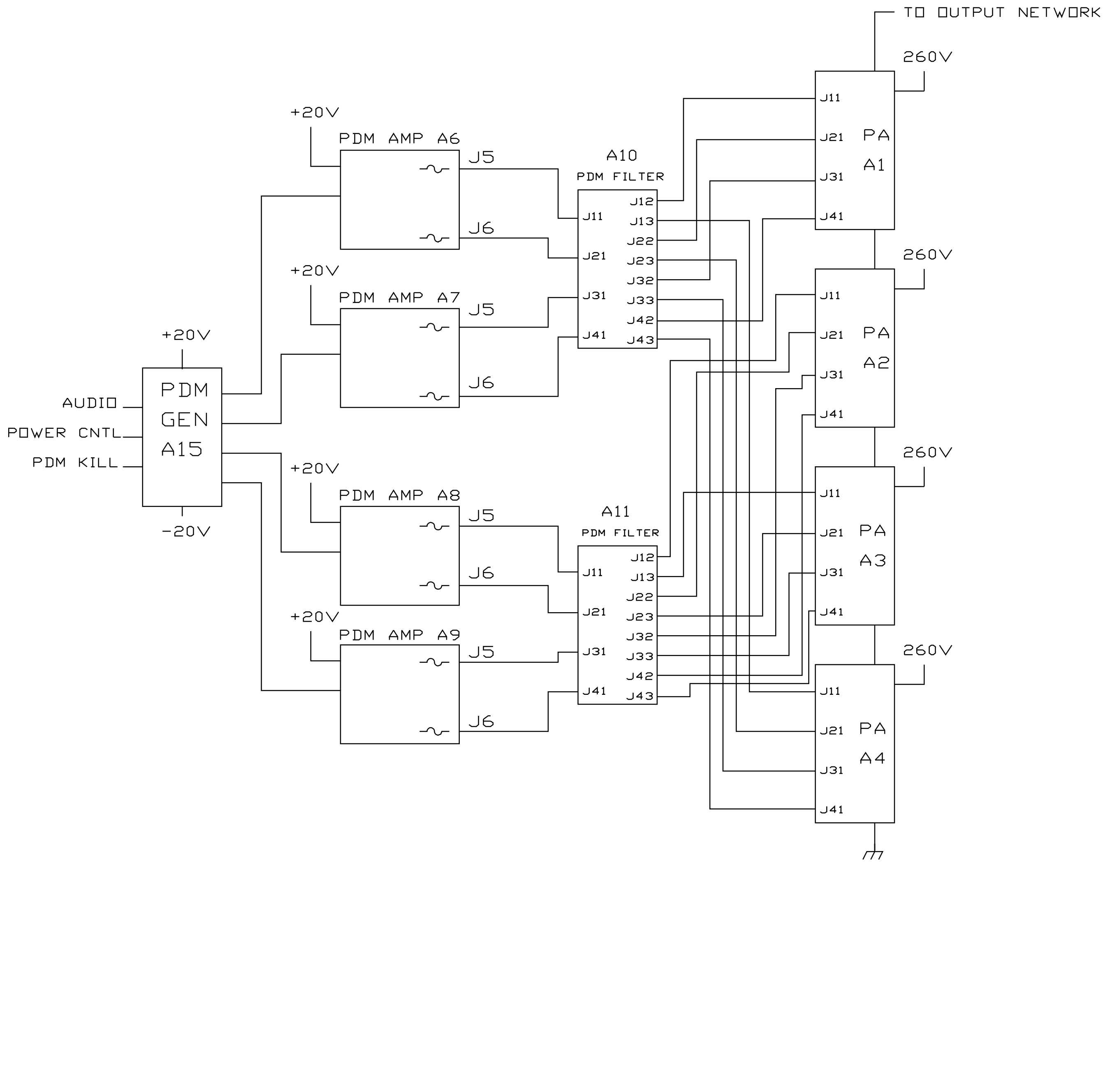


Figure 5-1. PDM Flow Diagram

Filters. For further discussion on the operation of the PDM Amplifiers, refer to section G.

The positive supply inputs of the PA modules are connected directly to the 260 volt supply. The PA voltage is then increased by pulling the low side of the PA toward ground, and decreased by letting the low side increase up to the same potential as the high side (about 260 volts). The PDM amplifiers do this by varying their conduction duty cycle.

PDM Amplifiers A6 and A7 provide output for PA modules A1 and A4 (A4 is not included in a GATES ONE).

PDM Amplifiers A8 and A9 provide output for A2 and A3 (GATES FIVE only).

5.3.5. PDM Loop

Refer to the PDM Loop diagram. This shows the current paths for one specific PDM amplifier circuit and the relationship between the PDM, the PA, and the metering.

The drive signal from the PDM Generator drives the PDM Amplifier transistors (Q19 and Q20) into switching operation via a driver circuit on the PDM Amplifier.

During the ON portion of the 60 kHz pulse, these transistors provide a low resistance path for the PDM Filter to ground. Current flows from ground, through Q19 and Q20, the fuses, the PDM Filter, and the PA.

During the 60 kHz OFF cycle of the PDM Amplifier transistors, current continues to flow in the PA because of the stored energy in the PDM filtering. On the input side of the PDM filter, the voltage rises due to the collapsing field around the PDM Filter coils (otherwise known as flyback). This flyback voltage then creates current flow in the damper diode circuit.

The purpose of the damper diode is to absorb the voltage overshoots by conducting them back into the high voltage supply. The PA voltage is varied by the modulator (PDM) section. This is done by varying the low side of the PA with respect to ground.

Each PA transistor pair produces a square wave in peak to peak amplitude equal to the PA voltage.

Each half of a PA Quad operates 180 degrees out of phase, and provides this differential to the primary of the toroidal transformers. The secondaries of the toroidal transformers are connected in series to the input of the Output Network.

The PA Voltage is metered from the output of the PDM Filter (or low side of the PA) to the 260 volt supply (high side of the PA). The PA Current is metered in line with the 260 volt line to the PA modules.

The Power Supply Current is metered in the return side of the 260 volt supply.

Supply current is less than PA current as a function of the PDM duty cycle. Supply current is metering of the current out of the 260 volt power supply, and PA current is metering of the current actually flowing in the PA.

5.3.6. RF Power Flow

The transmitter's carrier frequency originates from the Oscillator (A16). The output signal drives the Intermediate Power Amplifier (IPA, A5) with 1 to 2 watts of carrier power. The output square wave of the oscillator board is about 16V p-p typically.

The IPA amplifies the carrier signal to the 100-200 watt level and provides the Power Amplifier modules (A1 and A4) with its RF drive. The output of the IPA goes to the IPA Output Network A26, which is a series tuned LC filter. This filter is tuned to series resonance and attenuates the harmonics of the IPA drive signal so that a sinusoidal waveform of the carrier frequency appears at the input of the PA modules. The IPA Output Network is connected to the PA modules by the Splitter board which distributes the RF drive through a separate multi-coax cable to the PA modules.

The RF is then amplified and modulated on the PA modules. The PA Toroid boards (A1A1 and A1A4) combine the RF power from the individual amplifiers on the PA modules and connect to the Output Network (A21).

For a discussion on the theory and setup of the output network, refer to Section D.

5.3.7. Failsafe

The fail-safe interlock, the rear panel interlock switches, the Airflow Sensor, and the Phase Loss Monitor are in series with the start contactor coil (K1). If the rear panel interlock is broken the main contactors will drop out thereby removing high voltage power from the transmitter. The transmitter will not come on if the rear panel interlocks are broken or if the external interlock is broken. No visible indication is provided to display an open interlock, except that the PDM Kill LED will be lit along with the selected power level LED.

5.3.8. AC Power Flow

Primary power for the high voltage circuits enters the transmitter at TB1 terminals 1, 2, and 3. It is then fed in parallel to A19K1 and A19K2. Step start action is obtained by first energizing relay A19K1. This action supplies the primary power through the step start resistors A19R1, A19R2, and A19R3 to transformer A19T1. When relay A19K2 is energized, it shorts out step-start resistors and supplies full AC power to transformer A19T1. This action result in two clunks produced by the contactors during transmitter turn on.

Single phase AC power for the low voltage circuits enters the transmitter at TB1 terminals 5 and 6. It is then fed to circuit breaker A20CB1. When A20CB1 is set to ON, the load side of A20CB1 supplies AC power to A20T1 which is the low voltage power supply transformer.

5.3.9. High Voltage Power Supply

5.3.9.1. *Introduction*

The GATES Series™ AM transmitters contain power supplies with very low impedance and high current capabilities with large amounts of stored energy.

WARNING

DUE TO THE LARGE CURRENT CAPABILITIES OF THESE POWER SUPPLIES UNDER SHORT CIRCUIT CONDITIONS EXTREME CAUTION SHOULD EXHIBITED WHEN TROUBLESHOOTING AND WORKING AROUND THIS TRANSMITTER. ALWAYS DISCONNECT POWER BEFORE OPENING COVER, REAR PANEL, ENCLOSURES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. ENSURE DUST, DIRT AND CHIPS ARE REMOVED FROM CABINET BEFORE POWER SUPPLY OPERATION IS STARTED. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE, OR SERVICE WHEN ALONE OR WHEN TIRED.

The purpose of the High Voltage Power Supply is to supply the high voltage for operation of the power amplifier and modulator circuitry.

The main high voltage transformer is installed in the bottom of the cabinet with the associated rectifiers on the wall directly beside the transformer.

5.3.9.2. *Description*

The GATES Series™ transmitter use full wave bridge rectification. The rectified voltage is capacitive filtered and no series inductive choke is used. Resistors are connected directly across the terminals of each capacitor to provide slow discharge of a capacitor in case the capacitor should not get discharged by normal means.

Some transient protection is provided by MOV's (Metal Oxide Varistor) located at the AC input and across the secondary terminals of the transformers. The purpose of these devices is to clamp the secondary voltage at some voltage in excess of normal

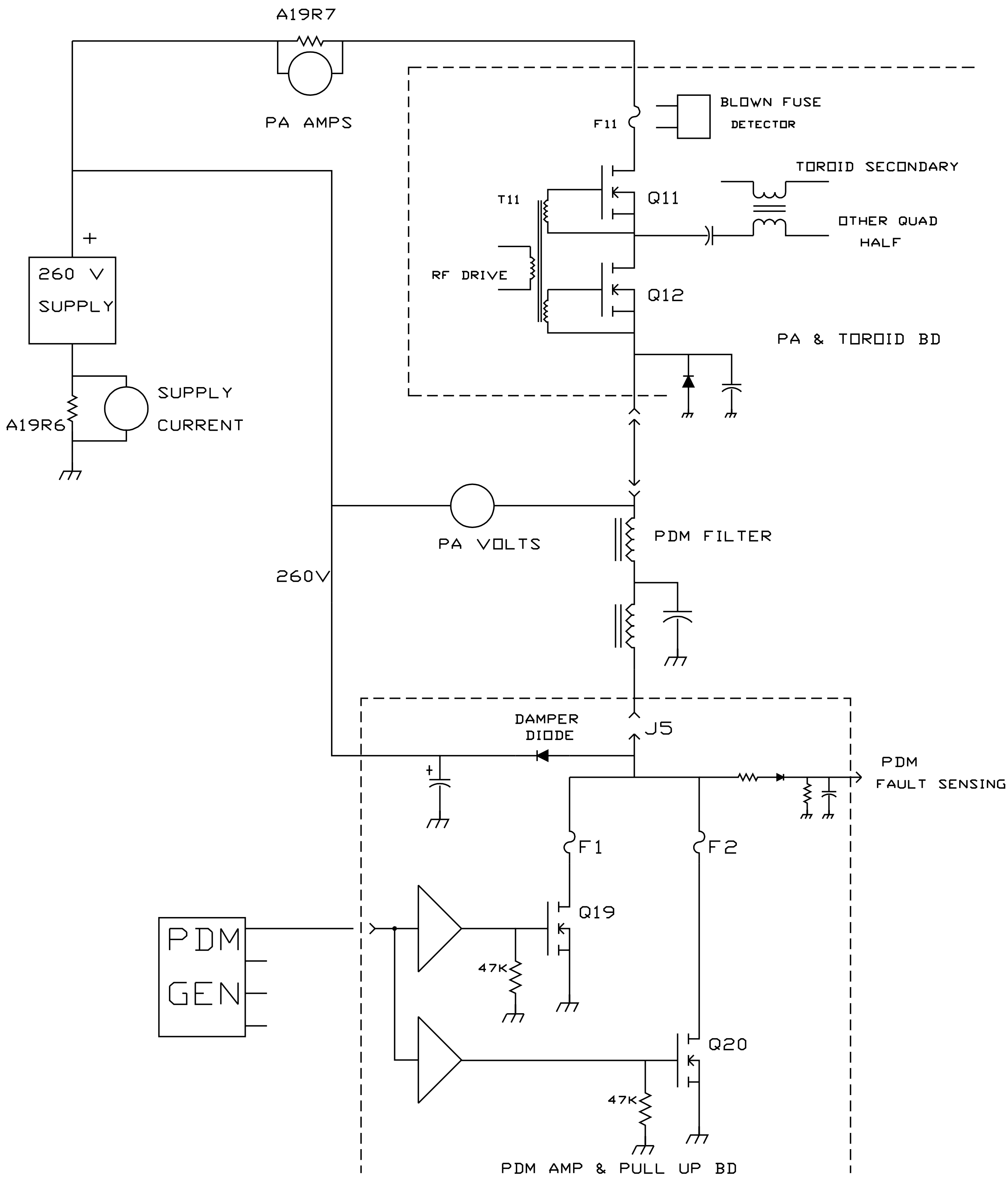


Figure 5-2. PDM Loop

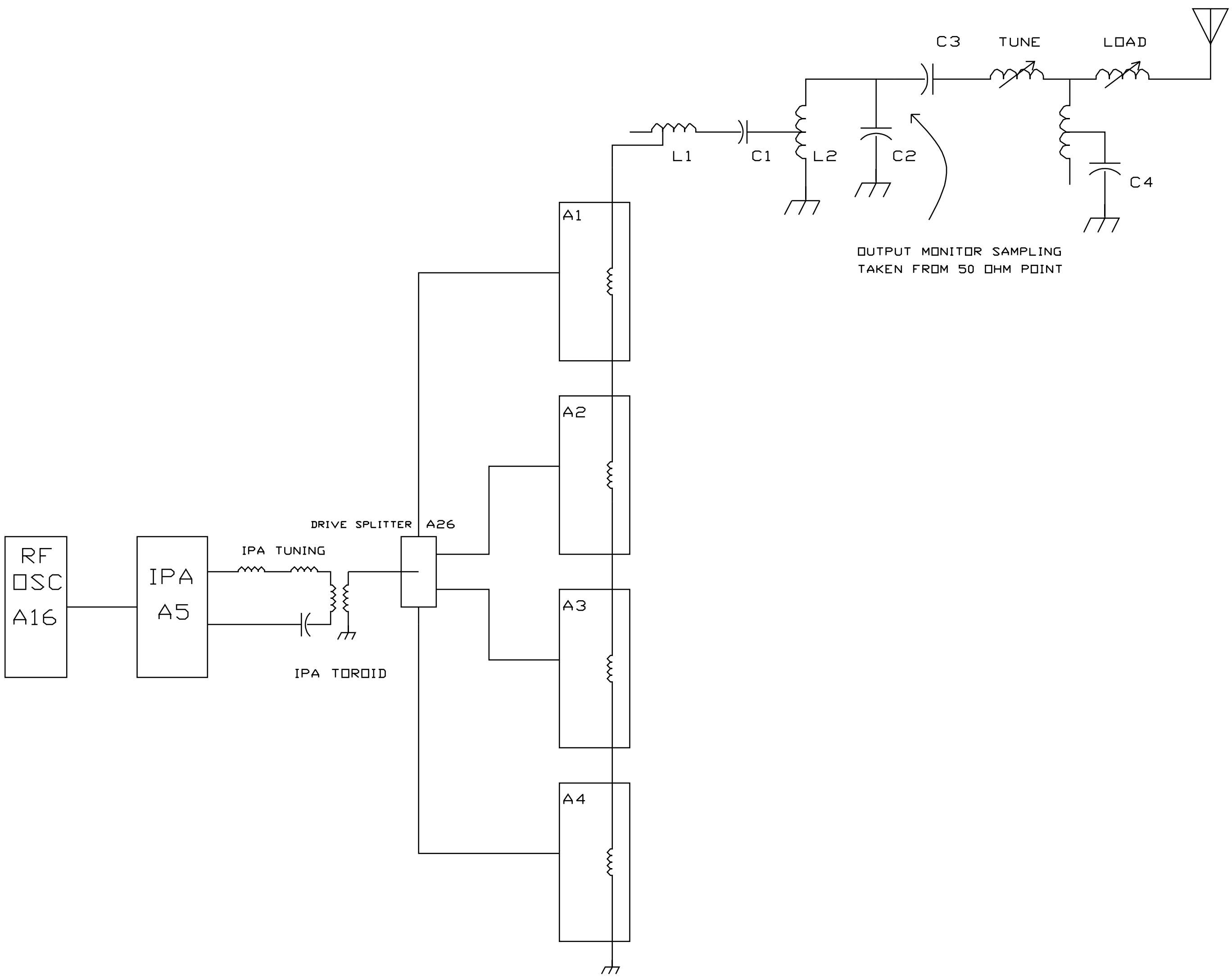


Figure 5-3. RF Flow

operating voltage in case of a high voltage transient coming in the AC power line.

It is recommended that spare MOV's of the appropriate size be carried as spare parts for each transmitter. If severe transient conditions exist on the power line and the MOV fails frequently other transient suppression means should be utilized to eliminate this problem.

The three phase input to the transmitter in the standard GATES FIVE is monitored for correct phase and amplitude. This helps to protect the three phase transformer from damage due to a severe phase imbalance (or loss). This detector monitors all three lines of AC and provides a contact closure when the AC is correct for operation. This contact closure is wired in series with the cabinet interlock.

The negative side of the high voltage power supply is returned to cabinet ground through a shunt resistor A19R7 which is used to measure power supply current.

The positive voltage is applied to the PA modules via connections at the PA Current shunt A19R6.

The supply voltage is set by the primary taps of A19T1 to allow line voltage adjustment from 197 volts to 251 volts with 11 volt steps.

During the turn on sequence resistors are connected in series with the primary of the high voltage transformer to limit the capacitor charging current to a safe value. When the primary voltage builds up to a near normal level, the Run contactor, K2, closes and allows full voltage to be applied to the primary of the transformer.

5.3.10. Low Voltage Power Supply and IPA Power Supply

5.3.10.1. *Introduction*

The purpose of the low voltage power supply is to provide a +/-20 volts supply for all control and driver functions in the transmitter. The Low Voltage Supply is not regulated, however individual boards that require regulation will do on-board regulation for 15 and 12 volt applications. The Low Voltage Supply provides 60 to 120 VDC to the IPA module.

5.3.10.2. *Description*

The IPA and +/-20 volt power supply transformer is A20T1. It has 208/240 inputs plus taps for +/-11 volt variations to compensate for AC line variations. The low voltage secondary of the transformer is center tapped with two MOV's (Metal Oxide Varistor) across the secondary terminals for transient protection the same as on the high voltage power supply.

The center tap of the low voltage secondary is grounded and full wave rectifier diodes rectify each half of the secondary voltage to produce +20 volts at 2 amps maximum and -20 volts at 2 amps maximum.

The IPA portion of A20T1 secondary consists of a common tap plus 5 taps to provide a range of voltages to control the proper RF drive level to the PA modules.

The low voltage power supply is not step/started and is on whenever AC power is applied to the transmitter. If the circuit breaker in the base of the cabinet is ON the pilot light on the front panel in the base of the cabinet will be illuminated.

Since this is a low voltage power supply, there are no interlocks on the rear panel controlling this power supply.

5.3.11. Airflow Sensor

5.3.11.1. *Introduction*

An air flow sensor circuit, located in the air inlet for both fans, provides protection against a fan failure by sensing wind chill. If a fan fails, the lack of wind chill is detected, and the transmitter shuts down. An audible alarm sounds to signify a fan failure.

5.3.11.2. *Description*

The function of the Air Flow sensor is based on a comparison of voltage outputs from individual temperature sensing devices. One sensing device (U3) is unheated, such that it samples the ambient temperature. There are two other sensors (U2 and U4); one for each fan, and they are heated by resistors R2 and R1, respectively.

If a fan stops running, the corresponding heated sensor increases in temperature, whereas the ambient sensor is unaffected. As the heated sensor increases in temperature, the voltage difference climbs. When the pre-determined threshold is crossed, comparator U1 triggers, and closes the onboard relay, K1. Contacts of this relay interrupt the contactor coil circuit (K1 in the AC drawer). At the same time, the relay provides voltage to the audible warning device and the red led, DS1. Also, the status of the remote contacts change position.

As soon as relay K1 closes, power for the heated sensors is removed. This allows them to cool down so that you may restart the transmitter.

Section VI
Parts List

Introduction

This section of the technical manual contains a list of the replaceable parts for the GATES Series™ AM TRANSMITTER.

Replaceable Parts List Index

Table 6-1. GATES ONE - 994 9202 002

Harris PN	Description	QTY UM	Reference Designators (N)
494 0378 000	CHOKE 0.33UH 10% 780MA	0.0 EA	A01L14 A01L15 A01L24 A01L25 A01L34 A01L35 A01L44 A01L45 FREQ DET
494 0399 000	CHOKE RF 12.0UH	0.0 EA	A18A1L3 FREQ DET
494 0401 000	CHOKE RF 18.0UH	0.0 EA	A18A1L2 A18A1L3 FREQ DET
500 0755 000	CAP, MICA, 270PF 500V 5%	0.0 EA	A18A1C10 FREQ DET
500 0835 000	CAP, MICA, 470PF 500V 5%	0.0 EA	A18A1C10 FREQ DET
500 0841 000	CAP, 750PF 300V 5%	0.0 EA	A18A1C10 FREQ DET
500 0844 000	CAP, MICA, 1000PF 100V 5%	0.0 EA	A18A1C10 FREQ DET
500 0883 000	CAP, MICA, 4700PF 500V 5%	0.0 EA	A01C10 A01C15 A01C20 A01C25 A01C30 A01C35 A01C40 A01C45 FREQ DET
504 0239 000	CAP 2200PF 6KV 5% (291)	0.0 EA	A21C03
504 0240 000	CAP 2700PF 6KV 5% (291)	0.0 EA	A21C03
504 0243 000	CAP 4700PF 6KV 5% (291)	0.0 EA	A21C02
504 0244 000	CAP 5100PF 4KV 5% (291)	0.0 EA	A21C02
504 0256 000	CAP 1000PF 6KV 5% (291)	0.0 EA	A21C03
504 0267 000	CAP 2000PF 5KV 5% (272)	0.0 EA	A21C04
504 0270 000	CAP 7500PF 4KV 5% (291)	0.0 EA	A21C02
504 0354 000	CAP 5100PF 10KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0368 000	CAP 3000PF 3 KV 5% (272)	0.0 EA	A21C04
504 0372 000	CAP 5600PF 4KV 5% (291)	0.0 EA	A21C02
504 0379 000	CAP 4300PF 12KV (293)	0.0 EA	A21C01
504 0382 000	CAP 2400PF 12KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0384 000	CAP 3900PF 3KV 5% (272)	0.0 EA	A21C04
504 0396 000	CAP 6200PF 4KV 5% (291)	0.0 EA	A21C02
504 0410 000	CAP 1200PF 6KV 5% (291)	0.0 EA	A21C03 A21C04
504 0411 000	CAP 1600PF 6KV 5% (291)	0.0 EA	A21C03
504 0418 000	CAP 2700 PF 12KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0419 000	CAP 3300 PF 12KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0420 000	CAP 3900 PF 12KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0424 000	CAP 2000PF 6KV 5% (291)	0.0 EA	A21C03
504 0430 000	CAP 8200PF 4KV 5% (291)	0.0 EA	A21C02
504 0431 000	CAP 9100PF 4KV 5% (291)	0.0 EA	A21C02
504 0432 000	CAP 11,000PF 4KV 5% (291)	0.0 EA	A21C02
504 0433 000	CAP 3600PF 12KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0435 000	CAP 5600PF 10KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0437 000	CAP 7500PF 10KV 5%	0.0 EA	A21C01
504 0442 000	CAP 13,000PF 3KV 5% (291)	0.0 EA	A21C02
504 0443 000	CAP 18,000PF 2KV 5%	0.0 EA	A21C02
504 0444 000	CAP 12,000PF 3KV 5% (291)	0.0 EA	A21C02
504 0445 000	CAP 16,000PF 3KV 5% (291)	0.0 EA	A21C02
504 0453 000	CAP 2400PF 6KV 5% (291)	0.0 EA	A21C03
504 0463 000	CAP 2200PF 12KV 5% (293)	0.0 EA	A21C01
504 0464 000	CAP 1300PF 5KV 5% (272)	0.0 EA	A21C04
504 0465 000	CAP 1500PF 5KV 5% (272)	0.0 EA	A21C04
504 0466 000	CAP 1600PF 5KV 5% (272)	0.0 EA	A21C04
504 0467 000	CAP 1800PF 5KV 5% (272)	0.0 EA	A21C04
504 0468 000	CAP 2200PF 5KV 5% (272)	0.0 EA	A21C04
504 0469 000	CAP 2400PF 5KV 5% (272)	0.0 EA	A21C04
504 0470 000	CAP 2700PF 3KV 5% (272)	0.0 EA	A21C04
504 0471 000	CAP 3300PF 3KV 5% (272)	0.0 EA	A21C04
504 0472 000	CAP 3600PF 3KV 5% (272)	0.0 EA	A21C04
504 0473 000	CAP 910PF 6KV 5% (291)	0.0 EA	A21C03
504 0474 000	CAP 1100PF 6KV 5% (291)	0.0 EA	A21C03

WARNING: Disconnect primary power prior to servicing.

504 0475 000	CAP 1300PF 6KV 5% (291)	0.0 EA	A21C03
504 0476 000	CAP 1500PF 6KV 5% (291)	0.0 EA	A21C03
504 0477 000	CAP 1800PF 6KV 5% (291)	0.0 EA	A21C03
504 0496 000	CAP 4700PF 10KV 5% (293)	0.0 EA	A21C01
504 0497 000	CAP 6200PF 10KV 5% (293)	0.0 EA	A21C01
504 0498 000	CAP 6800PF 10KV 5% (293)	0.0 EA	A21C01
516 0204 000	CAP, RF, 100PF 5KV 10% N750	0.0 EA	A26C01 FREQ DET
516 0205 000	*CAP, RF, 500PF 5KV 20% X5T	0.0 EA	A26C01 FREQ DET
516 0819 000	CAP, RF, 200PF 5KV 10% N3300	0.0 EA	A26C01 FREQ DET
817 0914 253	STRAP, .020 X 1.0 X 6.4IN	0.0 EA	
817 0914 254	STRAP, A21L8 TO L4	0.0 EA	
817 2131 014	FREQ DET CHART, GATES ONE	0.0 EA	SEE THIS CHART FOR XMTR FREQ DET PARTS
839 7920 013	FAMILY TREE, GATES SERIES.	0.0 EA	
917 2131 034	KIT, CE MODIFICATION, GATES 1	0.0 EA	
929 8305 546	XFMR ASSY, 20 TURN	0.0 EA	A26T01
929 8305 642	XFMR ASSY, 17 TURN	0.0 EA	A26T01
929 8305 643	XFMR ASSY, 10 TURN	0.0 EA	A26T01
929 8305 750	XFMR ASSY, 10 TURN	0.0 EA	
939 5695 332	COIL, FIXED 20FC2243	0.0 EA	A21L08 FREQ DET
988 2314 002	DP GATES ONE	1.0 EA	
989 0086 001	PKG LIST GATES ONE VERT	0.0 EA	
989 0086 002	PKG LIST GATES ONE HORZ	0.0 EA	
990 1099 001	R-SK-GATES ONE	0.0 EA	
992 6414 001	CRYSTAL SELECTION LIST	0.0 EA	A16Y1 OSCIL 1 REQD A17Y1 OSCIL OPTION 1 REQD
992 8146 002	OSCILLATOR PKG	0.0 EA	A017 OPTION
994 9202 001	BASIC GATES ONE	1.0 EA	
994 9238 001	R-BK-GATES SERIES	0.0 EA	
994 9239 001	R-PK-GATES ONE	0.0 EA	

Table 6-2. BASIC GATES ONE - 994 9202 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (C)*
992 8143 001	BASIC GATES SERIES XMTR	1.0 EA	
992 8149 001	GATES ONE FINAL PARTS	1.0 EA	
992 8158 001	GATES ONE CONV PARTS	1.0 EA	
999 2620 001	HARDWARE LIST, BASIC, GATES	1.0 EA	

Table 6-3. GATES ONE FINAL PARTS - 992 8149 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (K)*
300 1629 000	SCR, 1/4-28 X 5/16	8.0 EA	
357 0092 000	NUT, HEX 1/4-20 TEFLON	1.0 EA	A21L01
357 0093 000	SCREW, 1/4-20 X 7/8 FHMS	1.0 EA	A21L01
398 0015 000	FUSE,FAST CART .500A 250V	2.0 EA	
398 0016 000	FUSE,FAST CART .750A 250V	2.0 EA	
398 0019 000	FUSE, FAST CART 2A 250V	5.0 EA	
398 0081 000	FUSE,SLO CART 2A 250V	1.0 EA	
398 0402 000	FUSE, RECTIFIER 2A 250V	4.0 EA	
398 0403 000	FUSE, RECTIFIER 3A 250V	10.0 EA	
646 1353 000	NAMEPLATE, XMTR EQUIPMENT	1.0 EA	
817 0914 195	STANDOFF, INSULATED 1.5LG	8.0 EA	#A21C01 #A21C03
817 0914 204	STRAP, CAP TAPPING	4.0 EA	#A26C01
829 8305 616	STRAP, A26L2 TO A26C1	1.0 EA	
829 8305 690	STRAP, A21C1 TO L2.	1.0 EA	#A21L02

829 8305 719	ANGLE, A21C1 MTG	1.0 EA	
839 5695 402	STRAP, A21L1 TO A21C1	1.0 EA	
839 7920 048	STRAP	1.0 EA	
929 8305 650	STRAP, A21C4 TO L7	1.0 EA	
929 8305 687	BRACKET, CAP MTG	2.0 EA	#A21C03
939 5695 403	ANGLE, A21C1 MTG	1.0 EA	
943 3777 014	COIL, FIXED 13 TURN.	1.0 EA	A21L1
943 5450 475	CBL, PA DRIVE COAX 44" LG	1.0 EA	
994 7784 002	COIL CLIP 3/8 RIBBON	1.0 EA	#A21L07
994 7784 003	COIL CLIP 1/2 RIBBON	1.0 EA	

Table 6-4. GATES ONE CONV PARTS - 992 8158 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (Z)*
335 0227 000	WASHER, INSULATING	8.0 EA	#A19CR1 #A19CR2 #A19CR3 #A19CR4
335 0252 000	WASHER, TEFLON	4.0 EA	#A19CR1 #A19CR2 #A19CR3 #A19CR4
358 0004 000	BRACKET RESISTOR MTG	2.0 EA	#A19R21
358 2511 000	STANDOFF, 10-32 X 3/4	1.0 EA	
358 2635 000	CABLE TIE, PUSH MOUNT SNAP IN	2.0 EA	
358 2739 000	PLASTIC CAP 5/8-24.	1.0 EA	#J001
358 3123 000	STUD, BRS 10-32 X 1-1/2	2.0 EA	
384 0705 000	RECT 85A 1000V PIV ESD.	4.0 EA	A19CR1 A19CR2 A19CR3 A19CR4
472 1315 000	XMFR, PWR, 817-2114-001.	1.0 EA	A19T1
516 0200 000	CAP, HV 25PF 7500V 10%	1.0 EA	A18C1
524 0178 000	CAP 860 UF 450V	2.0 EA	A19C1 A19C3
614 0720 000	*TERM BD 6 TERM	1.0 EA	TB001
632 1153 000	AMMETER, 0-20ADC, 4.5",[W]	1.0 EA	M003
632 1158 000	WATTMETER, 0-1500W, 4.5",[W]	1.0 EA	M004
813 5002 048	STDOFF 10-32X7/8 1/2 HEX	1.0 EA	
813 5007 026	STDOFF 6-32X1/2 1/4 DIA.	1.0 EA	
817 0914 097	STRAP, RECTIFIERS	2.0 EA	
817 0914 261	SPACER, .75ODX.256IDX1.7	2.0 EA	
822 0981 011	COVER PLATE	3.0 EA	
822 0981 012	COVER PLATE	1.0 EA	
822 0981 013	COVER PLATE	1.0 EA	
829 8305 026	ANGLE, DIODE	1.0 EA	
829 8305 647	BRACKET H.V. RECT	1.0 EA	#A19CR1
829 8305 648	PLATE H.V. RECT	1.0 EA	#A19CR1
829 8305 713	ADAPTOR, OUTPUT CONN	1.0 EA	#J001
917 0914 167	RECEPTACLE, OUTPUT TYPE N.	1.0 EA	J001
917 0914 207	RES, METERING SHUNT	1.0 EA	A19R6
917 0914 221	XFMR, PHASE ANGLE 28T.	1.0 EA	A18T1
917 2131 006	PHASE ANGLE XFMR.	1.0 EA	A18T2
917 2244 001	SPACER, 1.0 LG .75 DIA.	3.0 EA	
922 0981 079	SHUNT	1.0 EA	A19R7
929 8305 301	CLAMP, MODIFICATION.	4.0 EA	
939 7920 002	METER TRIM.	1.0 EA	
939 8187 001	INSULATOR, PA MODULE	1.0 EA	#A001
943 5479 024	PANEL, REAR ACCESS, GATES ONE.	1.0 EA	
992 5872 006	* PDM PULL UP BOARD *	2.0 EA	A6A1 A7A1
992 5874 011	PWA, PDM FILTER ESD SAFE	1.0 EA	A010
992 8227 001	CBL PKG GATES ONE	1.0 EA	

WARNING: Disconnect primary power prior to servicing.

Table 6-5. GATES TWO - 994 9203 002

Harris PN	Description	QTY UM	Reference Designators (N)
494 0378 000	CHOKE 0.33UH 10% 780MA	0.0 EA	A01L14 A01L15 A01L24 A01L25 A01L34 A01L35 A01L44 A01L45 A04L14 A04L15 A04L24 A04L25 A04L34 A04L35 A04L44 A04L45 FREQ DET
494 0399 000	CHOKE RF 12.0UH	0.0 EA	A18A1L1 FREQ DET
494 0401 000	CHOKE RF 18.0UH	0.0 EA	A18A1L2 A18A1L3 FREQ DET
500 0755 000	CAP, MICA, 270PF 500V 5%	0.0 EA	A18A1C10 FREQ DET
500 0835 000	CAP, MICA, 470PF 500V 5%	0.0 EA	A18A1C10 FREQ DET
500 0841 000	CAP, 750PF 300V 5%	0.0 EA	A18A1C10 FREQ DET
500 0844 000	CAP, MICA, 1000PF 100V 5%	0.0 EA	A18A1C10 FREQ DET
500 0883 000	CAP, MICA, 4700PF 500V 5%	0.0 EA	A01C10 A01C15 A01C20 A01C25 A01C30 A01C35 A01C40 A01C45 A04C10 A04C15 A04C20 A04C25
504 0258 000	CAP 1000PF 20KV 5% (293)	0.0 EA	A21C03 FREQ DET
504 0274 000	CAP 1500PF 10KV 5% (292)	0.0 EA	A21C03 A21C04 FREQ DET
504 0353 000	CAP 3000PF 12KV 5% (293)	0.0 EA	A21C01 A21C02 FREQ DET
504 0354 000	CAP 5100PF 10KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0355 000	CAP 2000PF 20KV 5% (294)	0.0 EA	A21C01 FREQ DET
504 0373 000	CAP 1200PF 10KV 5% (292)	0.0 EA	A21C04 FREQ DET
504 0378 000	CAP 1200PF 15KV 5% (293)	0.0 EA	A21C03 FREQ DET
504 0379 000	CAP 4300PF 12KV (293)	0.0 EA	A21C01 FREQ DET
504 0382 000	CAP 2400PF 12KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0383 000	CAP 1500PF 25KV 5% (294)	0.0 EA	A21C01 FREQ DET
504 0388 000	CAP 3000PF 8KV 5% (292)	0.0 EA	A21C04 FREQ DET
504 0417 000	CAP 910PF 20KV 5% (293)	0.0 EA	A21C03 FREQ DET
504 0418 000	CAP 2700 PF 12KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0419 000	CAP 3300 PF 12KV 5% (293)	0.0 EA	A21C10 FREQ DET
504 0420 000	CAP 3900 PF 12KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0433 000	CAP 3600PF 12KV 5% (293)	0.0 EA	A21C01 A21C02 FREQ DET
504 0434 000	CAP 4000PF 12KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0435 000	CAP 5600PF 10KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0439 000	CAP 9100PF 8KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0440 000	CAP 10,000PF 8KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0441 000	CAP 11,000PF 8KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0446 000	CAP 12,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0447 000	CAP 13,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0448 000	CAP 16,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0449 000	CAP 18,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0460 000	CAP 1100PF 20KV 5% (293)	0.0 EA	A21C03 FREQ DET
504 0461 000	CAP 1300PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0463 000	CAP 2200PF 12KV 5% (293)	0.0 EA	A21C01 FREQ DET
504 0478 000	CAP 1300PF 10KV 5% (292)	0.0 EA	A21C04 FREQ DET
504 0479 000	CAP 1600PF 10KV 5% (292)	0.0 EA	A21C03 A21C04 FREQ DET
504 0480 000	CAP 1800PF 10KV 5% (292)	0.0 EA	A21C03 A21C04 FREQ DET
504 0481 000	CAP 2000PF 10KV 5% (292)	0.0 EA	A21C03 A21C04 FREQ DET
504 0482 000	CAP 2200PF 8KV 5% (292)	0.0 EA	A21C03 A21C04 FREQ DET
504 0483 000	CAP 2400PF 8KV 5% (292)	0.0 EA	A21C03 A21C04 FREQ DET
504 0484 000	CAP 2700PF 8KV 5% (292)	0.0 EA	A21C03 A21C04 FREQ DET
504 0485 000	CAP 3300PF 8KV 5% (292)	0.0 EA	A21C04 FREQ DET
504 0486 000	CAP 3600PF 8KV 5% (292)	0.0 EA	A21C04 FREQ DET
504 0487 000	CAP 3900PF 8KV 5% (292)	0.0 EA	A21C04 FREQ DET
504 0492 000	CAP 1300PF 25KV 5% (294)	0.0 EA	A21C01 FREQ DET
504 0494 000	CAP 1600PF 25KV 5% (294)	0.0 EA	A21C01 FREQ DET
504 0495 000	CAP 1800PF 25KV 5% (294)	0.0 EA	A21C01 FREQ DET
516 0204 000	CAP, RF, 100PF 5KV 10% N750	0.0 EA	A26C01 FREQ DET

516 0205 000	*CAP, RF, 500PF 5KV 20% X5T	0.0 EA	A26C01 FREQ DET
516 0819 000	CAP, RF, 200PF 5KV 10% N3300	0.0 EA	A26C01 FREQ DET
817 0914 253	STRAP, .020 X 1.0 X 6.4IN	0.0 EA	
817 0914 254	STRAP, A21L8 TO L4	0.0 EA	
817 2131 015	FREQ DET CHART, GATES TWO	0.0 EA	SEE THIS CHART FOR XMTR FREQ DET PARTS
839 7920 013	FAMILY TREE, GATES SERIES	0.0 EA	
917 2131 035	KIT, CE MODIFICATION, GATES 2.	0.0 EA	
929 8305 546	XFMR ASSY, 20 TURN	0.0 EA	A26T01
929 8305 642	XFMR ASSY, 17 TURN	0.0 EA	A26T01
929 8305 643	XFMR ASSY, 10 TURN	0.0 EA	A26T01
929 8305 750	XFMR ASSY, 10 TURN	0.0 EA	
939 5695 332	COIL, FIXED 20FC2243	0.0 EA	A21L08 FREQ DET
939 7920 102	MOUNTING ADAPTER	0.0 EA	BOTTOM OUTPUT ADAPTOR
988 2314 003	DP GATES TWO	1.0 EA	
989 0087 001	PKG LIST GATES TWO VERT	0.0 EA	
989 0087 002	PKG LIST GATES TWO HORZ	0.0 EA	
990 1100 001	R-SK-GATES TWO	0.0 EA	
992 6414 001	CRYSTAL SELECTION LIST	0.0 EA	A16Y1 OSCIL 1 REQD A17Y1 OSCIL OPTION 1 REQD
992 8146 002	OSCILLATOR PKG	0.0 EA	A017 OPTION
994 9203 001	BASIC GATES TWO	1.0 EA	
994 9238 001	R-BK-GATES SERIES	0.0 EA	
994 9240 001	R-PK-GATES TWO	0.0 EA	

Table 6-6. BASIC GATES TWO - 994 9203 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (B)*
992 8143 001	BASIC GATES SERIES XMTR	1.0 EA	
992 8149 002	GATES TWO FINAL PARTS	1.0 EA	
992 8159 001	GATES TWO CONV PARTS	1.0 EA	

Table 6-7. GATES TWO FINAL PARTS - 992 8149 002

Harris PN	*Description*	*QTY UM*	*Reference Designators (M)*
300 1629 000	SCR, 1/4-28 X 5/16	8.0 EA	
300 1981 000	SCR, 3/8-24 X 1	1.0 EA	
357 0092 000	NUT, HEX 1/4-20 TEFLON	1.0 EA	A21L01
357 0093 000	SCREW, 1/4-20 X 7/8 FHMS	1.0 EA	A21L01
398 0015 000	FUSE,FAST CART .500A 250V	2.0 EA	
398 0016 000	FUSE,FAST CART .750A 250V	2.0 EA	
398 0019 000	FUSE, FAST CART 2A 250V	5.0 EA	
398 0081 000	FUSE,SLO CART 2A 250V	1.0 EA	
398 0403 000	FUSE, RECTIFIER 3A 250V	10.0 EA	
398 0435 000	FUSE, RECTIFIER 5A 250V	8.0 EA	
646 1353 000	NAMEPLATE, XMTR EQUIPMENT	1.0 EA	
817 0914 092	SPACER	1.0 EA	#A21C02
817 0914 195	STANDOFF, INSULATED 1.5LG	8.0 EA	#A21C01 #A21C03
817 0914 204	STRAP, CAP TAPPING	4.0 EA	#A26C01
829 8305 616	STRAP, A26L2 TO A26C1	1.0 EA	
829 8305 653	STRAP, A21C4 TERMINATION	1.0 EA	
829 8305 690	STRAP, A21C1 TO L2	1.0 EA	#A21L02
829 8305 719	ANGLE, A21C1 MTG	1.0 EA	
839 5695 402	STRAP, A21L1 TO A21C1	1.0 EA	
839 7920 048	STRAP	1.0 EA	
929 8305 650	STRAP, A21C4 TO L7	1.0 EA	

929 8305 687	BRACKET, CAP MTG	2.0 EA	#A21C03
929 8305 694	STRAP, A2A1, TO A3A1	1.0 EA	#A02A01 #A03A01
939 5695 403	ANGLE, A21C1 MTG.	1.0 EA	
943 3777 014	COIL, FIXED 13 TURN	1.0 EA	A21L1
943 5450 475	CBL, PA DRIVE COAX 44" LG	2.0 EA	
994 7784 002	COIL CLIP 3/8 RIBBON.	1.0 EA	#A21L07
994 7784 003	COIL CLIP 1/2 RIBBON.	1.0 EA	

Table 6-8. GATES TWO CONV PARTS - 992 8159 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (AN)*
335 0256 000	WASHER, SHOULDER .765 ID	4.0 EA	#A19CR1 #A19CR2 #A19CR3 #A19CR4
335 0257 000	WASHER, KAPTON .687/1.625	4.0 EA	#A19CR1 #A19CR2 #A19CR3 #A19CR4
357 0092 000	NUT, HEX 1/4-20 TEFLON	1.0 EA	
358 0004 000	BRACKET RESISTOR MTG	2.0 EA	#A19R21
358 2635 000	CABLE TIE, PUSH MOUNT SNAP IN.	2.0 EA	
358 3123 000	STUD, BRS 10-32 X 1-1/2.	1.0 EA	
384 0839 000	RECT 1000PIV 275A 1N4056 ESD	4.0 EA	A19CR1 A19CR2 A19CR3 A19CR4
472 1280 000	XFMR, PWR, 829-8305-087	1.0 EA	A19T1
516 0413 000	CAP, RF, 10PF 7.5KV 10% NPO	1.0 EA	A18C1
524 0341 000	CAP 5100 UF 350WVDC.	2.0 EA	A19C1 A19C3
614 0158 000	TERM STRIP 2 TERM.	1.0 EA	TS002
614 0720 000	*TERM BD 6 TERM.	1.0 EA	TB001
620 0831 000	T ADAPTER BNC UG-274A/U	1.0 EA	J002
620 1906 000	END TERM, 7/8 EIA FLANGE.	1.0 EA	J001
632 1152 000	AMMETER, 0-40ADC, 4.5",[W]	1.0 EA	M003
632 1156 000	WATTMETER, 0-5KW, 4.5",[W]	1.0 EA	M004
813 5001 071	STDOFF 10-32 X 1.75 3.8 HEX	1.0 EA	
813 5007 026	STDOFF 6-32X1/2 1/4 DIA	1.0 EA	
817 0914 101	STANDOFF, HV RECT	2.0 EA	#A19CR1 #A19CR2
817 0914 195	STANDOFF, INSULATED 1.5LG	4.0 EA	
817 0914 261	SPACER, .75ODX.256IDX1.7	2.0 EA	
817 0914 350	STANDOFF, PA GROUND	1.0 EA	
822 0981 009	MULTIMETER SW PLT.	1.0 EA	
822 0981 011	COVER PLATE	2.0 EA	
822 0981 012	COVER PLATE	1.0 EA	
822 0981 013	COVER PLATE	1.0 EA	
829 8305 389	BRACKET, RECTIFIER.	1.0 EA	#A19CR1
829 8305 623	RETAINER, CABLE.	1.0 EA	
839 7920 103	ASSY INSTR, MOD COIL	0.0 EA	
917 0914 222	XFMR, PHASE ANGLE 44T	1.0 EA	A18T1
917 0914 250	RES, METERING SHUNT	1.0 EA	A19R6
917 2131 007	PHASE ANGLE XFMR	1.0 EA	A18T2
922 0981 080	SHUNT	1.0 EA	A19R7
929 8305 301	CLAMP, MODIFICATION	6.0 EA	
929 8305 395	BRKT, H V RECT	1.0 EA	#A19CR2
929 8305 732	XFMR, IPA NEUTRALIZER.	1.0 EA	A26T2
939 7920 017	METER TRIM	1.0 EA	
939 8187 001	INSULATOR, PA MODULE.	2.0 EA	
943 3655 196	HEATSINK, PA	1.0 EA	
943 5479 025	PANEL, REAR ACCESS, GATES TWO	1.0 EA	
992 5868 008	PWA, PA TOROID ESD SAFE	1.0 EA	A4A1
992 5872 007	* PDM PULL UP BOARD *	2.0 EA	A6A1 A7A1
992 5874 009	PWA, PDM FILTER ESD SAFE	1.0 EA	A010
992 8228 001	CBL PKG GATES TWO	1.0 EA	

992 9714 001	PWA, PA MODULE	1.0 EA	
999 2621 001	HARDWARE LIST, GATES TWO CONV.	1.0 EA	

Table 6-9. GATES FIVE, 1PH - 994 9204 002

Harris PN	*Description*	*QTY UM*	*Reference Designators (M)*
494 0378 000	CHOKE 0.33UH 10% 780MA	0.0 EA	A01L14 A01L15 A01L24 A01L25 A01L34 A01L35 A01L44 A01L45 A02L14 A02L15 A02L24 A02L25 A02L34 A02L35 A02L44 A02L45 A03L14 A03L15 A03L24 A03L25 A03L34 A03L35 A03L44 A03L45 A04L14 A04L15 A04L24 A04L25 A04L34 A04L35 A04L44 A04L45 FREQ DET
494 0399 000	CHOKE RF 12.0UH	0.0 EA	A18A1L3 FREQ DET
494 0401 000	CHOKE RF 18.0UH	0.0 EA	A18A1L2 A18A1L3 FREQ DET
500 0755 000	CAP, MICA, 270PF 500V 5%	0.0 EA	A18A1C10 FREQ DET
500 0835 000	CAP, MICA, 470PF 500V 5%	0.0 EA	A18A1C10 FREQ DET
500 0841 000	CAP, 750PF 300V 5%	0.0 EA	A18A1C10 FREQ DET
500 0844 000	CAP, MICA, 1000PF 100V 5%	0.0 EA	A18A1C10 FREQ DET
500 0883 000	CAP, MICA, 4700PF 500V 5%	0.0 EA	A01C10 A01C15 A01C20 A01C25 A01C30 A01C35 A01C40 A01C45 A02C10 A02C15 A02C20 A02C25 A02C30 A02C35 A02C40 A02C45 A03C10 A03C15 A03C20 A03C25 A03C30 A03C35 A03C40 A03C45 A04C10 A04C15 A04C20 A04C25 A04C30 A04C35 A04C40 A04C45 FREQ DET
504 0258 000	CAP 1000PF 20KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0353 000	CAP 3000PF 12KV 5% (293)	0.0 EA	A21C02 A21C04 FREQ DET
504 0354 000	CAP 5100PF 10KV 5% (293)	0.0 EA	A21C02 A21C03 FREQ DET
504 0374 000	CAP 2000PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0377 000	CAP 1500PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0378 000	CAP 1200PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0382 000	CAP 2400PF 12KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0417 000	CAP 910PF 20KV 5% (293)	0.0 EA	A21C03 FREQ DET
504 0418 000	CAP 2700 PF 12KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0419 000	CAP 3300 PF 12KV 5% (293)	0.0 EA	A21C04 FREQ DET
504 0420 000	CAP 3900 PF 12KV 5% (293)	0.0 EA	A21C02 A21C04 FREQ DET
504 0433 000	CAP 3600PF 12KV 5% (293)	0.0 EA	A21C02 A21C04 FREQ DET
504 0435 000	CAP 5600PF 10KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0439 000	CAP 9100PF 8KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0440 000	CAP 10,000PF 8KV 5% (293)	0.0 EA	A21C02 A21C05 FREQ DET
504 0441 000	CAP 11,000PF 8KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0446 000	CAP 12,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0447 000	CAP 13,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0448 000	CAP 16,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0449 000	CAP 18,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0454 000	CAP 1600PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0460 000	CAP 1100PF 20KV 5% (293)	0.0 EA	A21C03 FREQ DET
504 0461 000	CAP 1300PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0462 000	CAP 1800PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0463 000	CAP 2200PF 12KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
516 0204 000	CAP, RF, 100PF 5KV 10% N750	0.0 EA	A26C01 FREQ DET
516 0205 000	*CAP, RF, 500PF 5KV 20% X5T	0.0 EA	A26C01 FREQ DET
516 0207 000	CAP, RF, 25PF 15KV 10% NPO	0.0 EA	A21C01 FREQ DET
516 0208 000	CAP, RF, 50PF 15KV 10% NPO	0.0 EA	A21C01 FREQ DET
516 0209 000	CAP, RF, 100PF 15KV 10% N750	0.0 EA	A21C01 FREQ DET
516 0819 000	CAP, RF, 200PF 5KV 10% N3300	0.0 EA	A26C01 FREQ DET
817 0914 253	STRAP, .020 X 1.0 X 6.4IN	0.0 EA	
817 0914 254	STRAP, A21L8 TO L4	0.0 EA	

817 2131 016	FREQ DET CHART,GATES FIVE	0.0 EA	SEE THIS CHART FOR XMTR FREQ DET PARTS
839 7920 013	FAMILY TREE, GATES SERIES.	0.0 EA	
917 2131 036	KIT, CE MOD, GATES 5, 1PH	0.0 EA	
929 8305 546	XFMR ASSY, 20 TURN.	0.0 EA	A26T01
929 8305 642	XFMR ASSY, 17 TURN.	0.0 EA	A26T01
929 8305 643	XFMR ASSY, 10 TURN.	0.0 EA	A26T01
929 8305 750	XFMR ASSY, 10 TURN.	0.0 EA	
939 5695 332	COIL, FIXED 20FC2243	0.0 EA	A21L08 FREQ DET
939 7920 102	MOUNTING ADAPTER	0.0 EA	BOTTOM OUTPUT ADAPTOR
943 3777 005	COIL, FIXED 45FC 2046	0.0 EA	A21L1
943 3777 014	COIL, FIXED 13 TURN	0.0 EA	A21L1
988 2314 004	DP GATES FIVE 1PH	1.0 EA	
989 0092 001	PKG LIST G5 1PH VERT	0.0 EA	
989 0092 002	PKG LIST G5 1PH HORZ	0.0 EA	
990 1102 001	R-SK-GATES FIVE 1PH	0.0 EA	
992 6414 001	CRYSTAL SELECTION LIST	0.0 EA	A16Y1 OSCIL 1 REQD A17Y1 OSCIL OPTION 1 REQD
992 8146 002	OSCILLATOR PKG	0.0 EA	A017 OPTION
994 9204 001	BASIC GATES FIVE 1PH	1.0 EA	
994 9238 001	R-BK-GATES SERIES	0.0 EA	
994 9241 001	R-PK-GATES FIVE	0.0 EA	

Table 6-10. BASIC GATES FIVE 1PH - 994 9204 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (C)*
992 8143 001	BASIC GATES SERIES XMTR	1.0 EA	
992 8149 003	GATES FIVE FINAL PARTS	1.0 EA	
992 8160 001	GATES FIVE 1PH CONV PARTS	1.0 EA	
999 2619 001	HARDWARE LIST, BASIC, GATES	1.0 EA	

@T = GATES FIVE FINAL PARTS - 992 8149 003

Harris PN	*Description*	*QTY UM*	*Reference Designators (P)*
300 1981 000	SCR, 3/8-24 X 1.	1.0 EA	
357 0092 000	NUT, HEX 1/4-20 TEFLON	1.0 EA	A21L01
357 0093 000	SCREW, 1/4-20 X 7/8 FHMS	1.0 EA	A21L01
398 0015 000	FUSE,FAST CART .500A 250V	2.0 EA	
398 0016 000	FUSE,FAST CART .750A 250V	2.0 EA	
398 0019 000	FUSE, FAST CART 2A 250V	5.0 EA	
398 0081 000	FUSE,SLO CART 2A 250V	1.0 EA	
398 0403 000	FUSE, RECTIFIER 3A 250V	10.0 EA	
398 0435 000	FUSE, RECTIFIER 5A 250V	8.0 EA	
646 1353 000	NAMEPLATE, XMTR EQUIPMENT	1.0 EA	
817 0914 092	SPACER	1.0 EA	#A21C02
817 0914 195	STANDOFF, INSULATED 1.5LG	8.0 EA	#A21C01 #A21C03
817 0914 204	STRAP, CAP TAPPING	4.0 EA	#A26C01
829 8305 616	STRAP, A26L2 TO A26C1	1.0 EA	
829 8305 653	STRAP, A21C4 TERMINATION	1.0 EA	
829 8305 690	STRAP, A21C1 TO L2.	1.0 EA	#A21L02
839 7920 048	STRAP.	1.0 EA	
922 1256 001	PLATE	1.0 EA	#A21C01
922 1256 003	STRAP, L1 TO C1.	1.0 EA	
922 1294 001	PLATE, A21C1 CONTACT	1.0 EA	#A21C01
929 8305 650	STRAP, A21C4 TO L7.	1.0 EA	
929 8305 687	BRACKET, CAP MTG	2.0 EA	#A21C03
929 8305 694	STRAP, A2A1, TO A3A1	1.0 EA	#A02A01 #A03A01
943 5450 475	CBL, PA DRIVE COAX 44" LG	4.0 EA	
994 7784 002	COIL CLIP 3/8 RIBBON.	1.0 EA	#A21L07

994 7784 003	COIL CLIP 1/2 RIBBON	1.0 EA	#A21L01

Table 6-11. GATES FIVE 1PH CONV PARTS - 992 8160 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (AZ)*
357 0092 000	NUT, HEX 1/4-20 TEFLON	1.0 EA	
358 0003 000	BRACKET RESISTOR MTG	4.0 EA	#A19R2
358 0004 000	BRACKET RESISTOR MTG	4.0 EA	#A19R22
358 2492 000	PLUG, SNAP-IN 2-1/2 D HOL	1.0 EA	
358 2511 000	STANDOFF, 10-32 X 3/4	1.0 EA	
358 2555 000	BUSHING, FLANGED .375 ID	2.0 EA	
358 2588 000	FLAT CABLE MOUNT	2.0 EA	
358 2635 000	CABLE TIE, PUSH MOUNT SNAP IN	4.0 EA	
516 0413 000	CAP, RF, 10PF 7.5KV 10% NPO	1.0 EA	A18C1
524 0341 000	CAP 5100 UF 350WVDC	5.0 EA	A19C2 A19C4 A19C6
542 0103 000	RES 20K OHM 5% 12W	3.0 EA	A19R12 A19R14 A19R16
542 0358 000	RES 500 OHM 5% 225W	1.0 EA	A19R22
542 1586 000	RES 2.0 OHM 180W 10%	1.0 EA	A19R2
614 0158 000	TERM STRIP 2 TERM	1.0 EA	TS002
620 0831 000	T ADAPTER BNC UG-274A/U	1.0 EA	J002
620 1906 000	END TERM, 7/8 EIA FLANGE	1.0 EA	J001
632 1151 000	AMMETER, 0-80ADC, 4.5",[W]	1.0 EA	M003
632 1157 000	WATTMETER, 0-10KW, 4.5",[W]	1.0 EA	M004
813 5001 068	STDOFF 10-32X1 3/8 HEX	2.0 EA	
813 5007 026	STDOFF 6-32X1/2 1/4 DIA.	1.0 EA	
817 0914 260	INSULATOR, 1/4-20 X 1.7 L	2.0 EA	
817 0914 350	STANDOFF, PA GROUND	1.0 EA	
822 0981 009	MULTIMETER SW PLT	1.0 EA	
829 8305 623	RETAINER, CABLE	1.0 EA	
839 7920 103	ASSY INSTR, MOD COIL	0.0 EA	
917 0914 223	XFMR, PHASE ANGLE 63T	1.0 EA	A18T1
917 0914 250	RES, METERING SHUNT	1.0 EA	A19R6
917 2131 008	PHASE ANGLE XFMR	1.0 EA	A18T2
917 2244 001	SPACER, 1.0 LG .75 DIA	1.0 EA	
917 2256 074	ASSY, TERM BLK, GATES 5, 1 PH.	1.0 EA	
922 0981 080	SHUNT	1.0 EA	A19R7
922 0981 081	SHUNT	1.0 EA	A19R7
929 8305 089	CLAMP ADJ	6.0 EA	
929 8305 285	STANDOFF 10-32 X 0.75.	2.0 EA	
929 8305 293	BRACKET, SX-2.5 CAP	2.0 EA	
929 8305 732	XFMR, IPA NEUTRALIZER	1.0 EA	A26T2
939 7920 018	METER TRIM	1.0 EA	
939 8187 001	INSULATOR, PA MODULE	4.0 EA	
943 3655 079	HEAT SINK, PDM AMP	1.0 EA	
943 3655 196	HEATSINK, PA.	3.0 EA	
943 5479 026	PANEL, REAR ACCESS, GATES FIVE.	1.0 EA	
992 5868 008	PWA, PA TOROID ESD SAFE	3.0 EA	A2A1 A3A1 A4A1
992 5872 005	* PDM AMP BOARD *	2.0 EA	A008 A009
992 5872 007	* PDM PULL UP BOARD *	4.0 EA	A6A1 A7A1 A8A1 A9A1
992 5874 009	PWA, PDM FILTER ESD SAFE	2.0 EA	A010 A011
992 8291 001	GATES FIVE 1PH UNIQUE PTS	1.0 EA	
992 9714 001	PWA, PA MODULE	3.0 EA	

Table 6-12. GATES FIVE 1PH UNIQUE PTS - 992 8291 001

Harris PN	Description	QTY UM	Reference Designators (E)
335 0256 000	WASHER, SHOULDER .765 ID	4.0 EA	
335 0257 000	WASHER, KAPTON .687/1.625	4.0 EA	
384 0839 000	RECT 1000PIV 275A 1N4056 ESD	4.0 EA	
472 1649 000	XFMR, PWR, 829-8305-735	1.0 EA	
817 0914 101	STANDOFF, HV RECT	2.0 EA	
817 0914 195	STANDOFF, INSULATED 1.5LG	3.0 EA	
829 8305 389	BRACKET, RECTIFIER.	1.0 EA	
929 8305 395	BRKT, H V RECT	1.0 EA	
992 8229 001	CBL PKG GATES FIVE 1PH.	1.0 EA	

Table 6-13. GATES FIVE, 3PH - 994 9205 002

Harris PN	Description	QTY UM	Reference Designators (M)
494 0378 000	CHOKE 0.33UH 10% 780MA	0.0 EA	A01L14 A01L15 A01L24 A01L25 A01L34 A01L35 A01L44 A01L45 A02L14 A02L15 A02L24 A02L25 A02L34 A02L35 A02L44 A02L45 A03L14 A03L15 A03L24 A03L25 A03L34 A03L35 A03L44 A03L45 A04L14 A04L15 A04L24 A04L25 A04L34 A04L35 A04L44 A04L45 FREQ DET
494 0399 000	CHOKE RF 12.0UH.	0.0 EA	A18A1L3 FREQ DET
494 0401 000	CHOKE RF 18.0UH.	0.0 EA	A18A1L2 A18A1L3 FREQ DET
500 0755 000	CAP, MICA, 270PF 500V 5%	0.0 EA	A18A1C10 FREQ DET
500 0835 000	CAP, MICA, 470PF 500V 5%	0.0 EA	A18A1C10 FREQ DET
500 0841 000	CAP, 750PF 300V 5%.	0.0 EA	A18A1C10 FREQ DET
500 0844 000	CAP, MICA, 1000PF 100V 5%	0.0 EA	A18A1C10 FREQ DET
500 0883 000	CAP, MICA, 4700PF 500V 5%	0.0 EA	A01C10 A01C15 A01C20 A01C25 A01C30 A01C35 A01C40 A01C45 A02C10 A02C15 A02C20 A02C25 A02C30 A02C35 A02C40 A02C45 A03C10 A03C15 A03C20 A03C25 A03C30 A03C35 A03C40 A03C45 A04C10 A04C15 A04C20 A04C25 A04C30 A04C35 A04C40 A04C45 FREQ DET
504 0258 000	CAP 1000PF 20KV 5% (293)	0.0 EA	A21C03 FREQ DET
504 0353 000	CAP 3000PF 12KV 5% (293)	0.0 EA	A21C02 A21C03 A21C04 FREQ DET
504 0354 000	CAP 5100PF 10KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0374 000	CAP 2000PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0377 000	CAP 1500PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0378 000	CAP 1200PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0382 000	CAP 2400PF 12KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0417 000	CAP 910PF 20KV 5% (293)	0.0 EA	A21C03 FREQ DET
504 0418 000	CAP 2700 PF 12KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0419 000	CAP 3300 PF 12KV 5% (293)	0.0 EA	A21C04 FREQ DET
504 0420 000	CAP 3900 PF 12KV 5% (293)	0.0 EA	A21C02 A21C04 FREQ DET
504 0433 000	CAP 3600PF 12KV 5% (293)	0.0 EA	A21C02 A21C04 FREQ DET
504 0435 000	CAP 5600PF 10KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0439 000	CAP 9100PF 8KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0440 000	CAP 10,000PF 8KV 5% (293)	0.0 EA	A21C02 A21C05 FREQ DET
504 0441 000	CAP 11,000PF 8KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0446 000	CAP 12,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0447 000	CAP 13,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0448 000	CAP 16,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0449 000	CAP 18,000PF 5KV 5% (293)	0.0 EA	A21C02 FREQ DET
504 0454 000	CAP 1600PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0460 000	CAP 1100PF 20KV 5% (293)	0.0 EA	A21C03 FREQ DET
504 0461 000	CAP 1300PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET

504 0462 000	CAP 1800PF 15KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
504 0463 000	CAP 2200PF 12KV 5% (293)	0.0 EA	A21C03 A21C04 FREQ DET
516 0204 000	CAP, RF, 100PF 5KV 10% N750	0.0 EA	A26C01 FREQ DET
516 0205 000	*CAP, RF, 500PF 5KV 20% X5T	0.0 EA	A26C01 FREQ DET
516 0207 000	CAP, RF, 25PF 15KV 10% NPO	0.0 EA	A21C01 FREQ DET
516 0208 000	CAP, RF, 50PF 15KV 10% NPO	0.0 EA	A21C01 FREQ DET
516 0209 000	CAP, RF, 100PF 15KV 10% N750	0.0 EA	A21C01 FREQ DET
516 0819 000	CAP, RF, 200PF 5KV 10% N3300	0.0 EA	A26C01 FREQ DET
740 0495 000	PHASE MONITOR	0.0 EA	A19K03 OPTION 1 REQD 197 TO 251 VAC 3 PHASE 3 WIRE
740 0837 000	MON, PH 350-440V 3 PH.	0.0 EA	A19K03 OPTION 1 REQD 341 TO 434 VAC 3 PHASE 4 WIRE
817 0914 253	STRAP, .020 X 1.0 X 6.4IN	0.0 EA	
817 0914 254	STRAP, A21L8 TO L4	0.0 EA	
817 2131 016	FREQ DET CHART,GATES FIVE	0.0 EA	SEE THIS CHART FOR XMTR FREQ DET PARTS
839 7920 013	FAMILY TREE, GATES SERIES	0.0 EA	
917 2131 037	KIT, CE MOD, GATES 5, 3W	0.0 EA	
917 2131 038	KIT, CE MOD, GATES 5, 4W	0.0 EA	
929 8305 546	XFMR ASSY, 20 TURN	0.0 EA	
929 8305 642	XFMR ASSY, 17 TURN	0.0 EA	
929 8305 643	XFMR ASSY, 10 TURN	0.0 EA	
929 8305 750	XFMR ASSY, 10 TURN	0.0 EA	
939 5695 332	COIL, FIXED 20FC2243	0.0 EA	A21L08 FREQ DET
939 7920 102	MOUNTING ADAPTER	0.0 EA	BOTTOM OUTPUT ADAPTOR
943 3777 005	COIL, FIXED 45FC 2046	0.0 EA	A21L1
943 3777 014	COIL, FIXED 13 TURN.	0.0 EA	A21L1
988 2314 005	DP GATES FIVE 3PH	1.0 EA	
989 0088 001	PKG LIST GATES FIVE VERT	0.0 EA	
989 0088 002	PKG LIST GATES FIVE HORZ	0.0 EA	
990 1101 001	R-SK-GATES FIVE 3PH	0.0 EA	
992 6414 001	CRYSTAL SELECTION LIST	0.0 EA	A16Y1 OSCIL GATES FIVE 1 REQ'D A17Y1 OPTION 1 REQ'D
992 8146 002	OSCILLATOR PKG	0.0 EA	A017 OPTION
994 9205 001	BASIC GATES FIVE 3PH	1.0 EA	
994 9238 001	R-BK-GATES SERIES	0.0 EA	
994 9241 001	R-PK-GATES FIVE	0.0 EA	

Table 6-14. BASIC GATES FIVE 3PH - 994 9205 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (C)*
992 8143 001	BASIC GATES SERIES XMTR	1.0 EA	
992 8149 003	GATES FIVE FINAL PARTS	1.0 EA	
992 8161 001	GATES FIVE 3PH CONV PARTS	1.0 EA	
999 2619 001	HARDWARE LIST, BASIC, GATES	1.0 EA	

Table 6-15. GATES FIVE 3PH CONV PARTS - 992 8161 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (BB)*
335 0227 000	WASHER, INSULATING	12.0 EA	#A19CR1 #A19CR2 #A19CR3 #A19CR4 #A19CR5 #A19CR6
335 0252 000	WASHER, TEFLON	6.0 EA	#A19CR1 #A19CR2 #A19CR3 #A19CR4 #A19CR5 #A19CR6
358 0003 000	BRACKET RESISTOR MTG	4.0 EA	#A19R2 #A19R3
358 0004 000	BRACKET RESISTOR MTG	4.0 EA	#A19R22
358 2492 000	PLUG, SNAP-IN 2-1/2 D HOL	1.0 EA	
358 2511 000	STANDOFF, 10-32 X 3/4	1.0 EA	
358 2555 000	BUSHING, FLANGED .375 ID	2.0 EA	
358 2588 000	FLAT CABLE MOUNT	2.0 EA	
358 2635 000	CABLE TIE, PUSH MOUNT SNAP IN	4.0 EA	

358 3123 000	STUD, BRS 10-32 X 1-1/2	3.0 EA	
384 0705 000	RECT 85A 1000V PIV ESD	6.0 EA	A19CR1 A19CR2 A19CR3 A19CR4 A19CR5 A19CR6
404 0707 000	SOCKET RELAY OCTAL	1.0 EA	#A19K3
472 1572 000	XFMR, PWR, 817-0914-266	1.0 EA	A19T1
516 0413 000	CAP, RF, 10PF 7.5KV 10% NPO	1.0 EA	A18C1
524 0341 000	CAP 5100 UF 350WVDC.	5.0 EA	A19C1 A19C2 A19C3 A19C4 A19C6
542 0103 000	RES 20K OHM 5% 12W	3.0 EA	A19R12 A19R14 A19R16
542 0358 000	RES 500 OHM 5% 225W	1.0 EA	A19R22
542 1586 000	RES 2.0 OHM 180W 10%	2.0 EA	A19R2 A19R3
560 0049 000	MOV, 275WVAC, 75J, 14MM DISC	3.0 EA	A19RV2 A19RV3 A19RV6
614 0158 000	TERM STRIP 2 TERM	1.0 EA	TS002
614 0720 000	*TERM BD 6 TERM	1.0 EA	TB001
620 0831 000	T ADAPTER BNC UG-274A/U	1.0 EA	J002
620 1906 000	END TERM, 7/8 EIA FLANGE	1.0 EA	J001
632 1151 000	AMMETER, 0-80ADC, 4.5",[W]	1.0 EA	M003
632 1157 000	WATTMETER, 0-10KW, 4.5",[W]	1.0 EA	M004
813 5001 068	STDOFF 10-32X1 3/8 HEX	2.0 EA	
813 5007 026	STDOFF 6-32X1/2 1/4 DIA	1.0 EA	
813 5606 011	STUD, BRS 10-32 X 1	3.0 EA	
817 0914 097	STRAP, RECTIFIERS	3.0 EA	
817 0914 260	INSULATOR, 1/4-20 X 1.7 L	2.0 EA	
817 0914 350	STANDOFF, PA GROUND	1.0 EA	
822 0981 009	MULTIMETER SW PLT	1.0 EA	
829 8305 026	ANGLE, DIODE	1.0 EA	
829 8305 623	RETAINER, CABLE	1.0 EA	
839 7920 103	ASSY INSTR, MOD COIL	0.0 EA	
917 0914 223	XFMR, PHASE ANGLE 63T	1.0 EA	A18T1
917 0914 250	RES, METERING SHUNT	1.0 EA	A19R6
917 2131 008	PHASE ANGLE XFMR	1.0 EA	A18T2
917 2244 001	SPACER, 1.0 LG .75 DIA	4.0 EA	#E032 #C001 #C002
922 0981 080	SHUNT	1.0 EA	A19R7
922 0981 081	SHUNT	1.0 EA	A19R7
929 8305 089	CLAMP ADJ.	6.0 EA	
929 8305 285	STANDOFF 10-32 X 0.75	2.0 EA	
929 8305 293	BRACKET, SX-2.5 CAP	2.0 EA	
929 8305 361	BRACKET, RECTIFIERS	1.0 EA	
929 8305 363	PLATE, RECT.	1.0 EA	
929 8305 732	XFMR, IPA NEUTRALIZER	1.0 EA	A26T2
939 7920 018	METER TRIM	1.0 EA	
939 8187 001	INSULATOR, PA MODULE	4.0 EA	#A001 #A002 #A003 #A004
943 3655 079	HEAT SINK, PDM AMP	1.0 EA	
943 3655 196	HEATSINK, PA	3.0 EA	
943 5479 026	PANEL, REAR ACCESS, GATES FIVE	1.0 EA	
992 5868 008	PWA, PA TOROID ESD SAFE	3.0 EA	A2A1 A3A1 A4A1
992 5872 005	* PDM AMP BOARD *	2.0 EA	A008 A009
992 5872 007	* PDM PULL UP BOARD *	4.0 EA	A6A1 A7A1 A8A1 A9A1
992 5874 009	PWA, PDM FILTER ESD SAFE	2.0 EA	A010 A011
992 8230 001	CBL PKG GATES FIVE 3PH	1.0 EA	
992 9714 001	PWA, PA MODULE	3.0 EA	

Table 6-16. BASIC GATES SERIES XMTR - 992 8143 001

Harris PN	Description	QTY UM	Reference Designators (BK)
026 6010 003	GROMMET STRIP, 0.125	0 FT	
041 6030 014	CHANNEL 1/16 MTL	1 FT	
300 2795 000	SCR, 1/2 - 13 X 1	1.0 EA	#A21L2
300 2883 000	SCR, 3/8-16 X 1-1/2	1.0 EA	#A21L2
358 0003 000	BRACKET RESISTOR MTG	4.0 EA	#A19R1 #A19R4
358 1131 000	NUT W/SPRING 3/8-16	4.0 EA	
358 2140 000	NUT W/SPRING 1/4-20	4.0 EA	
358 2426 000	PLUG, WHITE 2" HOLE	8.0 EA	
358 2470 000	WHEEL	2.0 EA	#A21L4 #A21L5
358 2492 000	PLUG, SNAP-IN 2-1/2 D HOL	3.0 EA	
358 2555 000	BUSHING, FLANGED .375 ID	2.0 EA	
358 2588 000	FLAT CABLE MOUNT	4.0 EA	
358 2742 000	SLEEVE CAP 3-1/8 X 1.38	1.0 EA	#A20C3
358 2995 000	END PLATE, 261 TERM BD	1.0 EA	TB003
358 2996 000	END PLATE, 262 TERM BD	1.0 EA	TB002
358 3123 000	STUD, BRS 10-32 X 1-1/2	4.0 EA	
358 3130 000	STUD, BRS 1/4-20 X 3/4	1.0 EA	
358 3132 000	STUD, BRS 1/4-20 1-1/4	2.0 EA	
358 3300 000	FLAT CABLE MOUNT - BASE	2.0 EA	
358 3301 000	FLAT CABLE MOUNT - COVER	2.0 EA	
358 3660 000	ALLEN, 5/32 HEX, CUSHION GRIP	1.0 EA	
384 0431 000	RECT. 1N4001 ESD	8.0 EA	CR001 CR002 CR003 CR004 CR005 CR006 CR007 CR008
384 0702 000	RECT FW BRIDGE 600V 35A ESD	2.0 EA	A20CR1 A20CR2
384 0813 000	TRANSZORB 73V 1.5KW ESD	2.0 EA	A18CR11 A18CR12
402 0004 000	CLIP, FUSE .812 60A 250V	2.0 EA	#GND ROD
406 0358 000	PILOT LIGHT AMBER	2.0 EA	A19DS1 A19DS2
424 0410 000	GROMMET 1.38 MTG DIA	4.0 EA	
430 0039 000	FAN TARZAN 230VAC 50/60HZ	2.0 EA	A20B1 A20B2
448 0224 000	HANDLE ALUM	2.0 EA	
448 0785 000	AIR FILTER 6.15X12.20X.88	1.0 EA	
464 0169 000	TOOL, TRIMMER ADJUSTMENT	1.0 EA	
472 1678 000	XFMR RECT 817-2131-003	1.0 EA	A20T1
476 0272 000	REACTOR 814 3018 001	1.0 EA	A19L1
492 0309 000	INDUCTOR VAR 28UH	1.0 EA	A26L2
494 0070 000	CHOKE RF 2MHY	1.0 EA	A21L6
516 0081 000	CAP, DISC .01UF 1KV 20%	4.0 EA	C001 C002 C003 C004
524 0313 000	CAP 25,000UF 40VDC	2.0 EA	A20C1 A20C2
524 0341 000	CAP 5100 UF 350WVDC	1.0 EA	A19C5
524 0346 000	CAP, 7400UF 200WVDC	1.0 EA	A20C3
530 0090 000	BRACKET, CAP, 2.5" ID	2.0 EA	#A20C1 #A20C2
530 0092 000	BRACKET, CAP, 3" ID	1.0 EA	#A20C3
540 1600 205	RES 150 OHM 3W 5%	1.0 EA	A19R8
540 1600 308	RES 2K OHM 3W 5%	2.0 EA	A20R1 A20R2
542 0103 000	RES 20K OHM 5% 12W	4.0 EA	A20R3 A19R11 A19R13 A19R15
542 0358 000	RES 500 OHM 5% 225W	1.0 EA	A19R21
542 1586 000	RES 2.0 OHM 180W 10%	2.0 EA	A19R1 A19R4
548 2052 000	RES 130K OHM 2W 1%	1.0 EA	A19R9
548 2400 366	RES 4.75K OHM 1/2W 1%	1.0 EA	A19R19
550 0061 000	POT, 1K OHM 2W 10%	1.0 EA	A19R10
560 0036 000	MOV, 150WVAC, 80J, 20MM DISC	1.0 EA	A20RV2
560 0049 000	MOV, 275WVAC, 75J, 14MM DISC	5.0 EA	A19RV1 A19RV4 A19RV5 A20RV3 A20RV4
560 0054 000	MOV, 95WVAC, 30J, 14MM DISC	1.0 EA	A20RV1
570 0294 000	CNTOR 40A 24VAC 600V 3P	1.0 EA	A19K1

570 0322 000	CNTOR 50A 208/240V 3P	1.0 EA	A19K2
604 0061 000	SW SPDT 15A 125/250 VAC	1.0 EA	A19S4
606 0159 000	CKT BRKR 10A 277V 2P	1.0 EA	A20CB1
606 0467 000	CKT BRKR 2A 1 POLE	2.0 EA	A20CB2 A20CB3
610 0976 000	HEADER, FILTERED 40C 2 ROW	2.0 EA	A24FL1 A24FL2
614 0165 000	TERM STRIP 9 TERM	1.0 EA	TS001
614 0401 000	TERM, INSULATED	4.0 EA	E023 E024 E025 E026
614 0786 000	TERM BD, 2C MODULAR 261	11.0 EA	TB003
614 0787 000	TERM BD, 4C MODULAR 261	4.0 EA	TB003
614 0788 000	TERM BD, 2C MODULAR 262	7.0 EA	TB002
614 0789 000	TERM BD, 4C MODULAR 262	7.0 EA	TB002
620 0124 000	ADAPTER BNC UG306U	1.0 EA	#A018
620 0455 000	ADPT BNC UG492A/U	1.0 EA	#J002
632 1154 000	VOLTMETER, 0-150VDC, 4.5",[W]	1.0 EA	M002
632 1155 000	MULTIMETER, TRISCALE, 4.5",[W]	1.0 EA	M001
646 0973 000	*LABEL, 230V	2.0 EA	#A20B1 #A20B2
646 1253 000	*LABEL WARNING ROTATING BLADES	2.0 EA	
646 1402 000	MARKER STRIP, 6 TERM	1.0 EA	#TB001
650 0028 000	KNOB RD SKIRT 1.135" DIA	1.0 EA	#A12S12
660 0057 000	* BATTERY 9V HEAVY DUTY	1.0 EA	A12BT1
813 5000 011	STDOFF 6-32X1 5/16 HEX	4.0 EA	
813 5001 071	STDOFF 10-32 X 1.75 3.8 HEX	1.0 EA	
813 5001 076	STDOFF 10-32X3 3/8 HEX	4.0 EA	
813 5001 117	STDOFF 10-32X3-1/4 3/8 HE	6.0 EA	
813 5013 068	STDOFF 1/4-20X1 1 RD	1.0 EA	
813 5604 008	STUD BRS 6-32 X 13/16	5.0 EA	
813 5606 007	STUD BRS 10-32 X 3/4	7.0 EA	
813 5606 011	STUD, BRS 10-32 X 1	7.0 EA	
817 0914 026	SPACER	2.0 EA	
817 0914 028	SPACER	1.0 EA	
817 0914 153	CLAMP, COIL TAPPING	1.0 EA	
817 0914 183	PLATE, TAPPING	1.0 EA	
817 0914 216	DAM, AIR	1.0 EA	
817 0914 217	DAM, AIR	1.0 EA	
817 0914 218	DAM, AIR	1.0 EA	
817 0914 219	DAM, AIR	1.0 EA	
817 0914 220	DAM, AIR	1.0 EA	
817 0914 224	DAM, AIR	2.0 EA	
817 0914 231	STUD BRS 10-32 X 3.75	8.0 EA	
817 0914 252	STRAP, A21L4 JUMPER	1.0 EA	
817 0914 261	SPACER, .75ODX.256IDX1.7	2.0 EA	
817 0914 282	INSULATOR, A21L5 MTG	2.0 EA	
817 0914 326	STDOFF, INSULATED	2.0 EA	
817 2131 001	STDOFF	2.0 EA	
817 2131 010	BUSS BAR	1.0 EA	#E034
822 0981 004	METER MTG CLIP	8.0 EA	
822 0981 006	HINGE	1.0 EA	
822 0981 047	GND ROD HANDLE	1.0 EA	#GND ROD
822 0981 082	HINGE DOUBLER PLT PAIR	1.0 EA	
829 8305 022	CHANNEL	2.0 EA	
829 8305 441	STRAP, A21L5 TO J1	1.0 EA	
829 8305 455	GUARD, CIR BKR	1.0 EA	#A20CB1
829 8305 459	ROD, GND	1.0 EA	#GND ROD
829 8305 469	PALLET, SHIPPING	1.0 EA	
829 8305 513	SUPPORT, END	1.0 EA	

829 8305 514	STRAP, INTERCONNECT	1.0 EA	
829 8305 544	SHAFT EXTENSION	1.0 EA	
829 8305 570	DAM, AIR	1.0 EA	
829 8305 587	LOCATION DWG, AIR DAM	0.0 EA	
829 8305 588	LOCATION DWG, AIR DAM	0.0 EA	
829 8305 592	DAM, AIR	2.0 EA	
829 8305 593	DAM, AIR	3.0 EA	
829 8305 598	TUBE, A21L5 TO A21L4	1.0 EA	
829 8305 623	RETAINER, CABLE	1.0 EA	
829 8305 630	BRACKET, AIR DAM	2.0 EA	
829 8305 652	TUBE, A21C3 TO L4	1.0 EA	
829 8305 668	BRACKET, DOOR GND	1.0 EA	
829 8305 669	CONTACT, GND	1.0 EA	
829 8305 684	SUPPORT, HV CONT PANEL	2.0 EA	
839 5695 097	PANEL, HV COVER	1.0 EA	
839 5695 115	COIL, TAPPING	1.0 EA	
839 5695 309	TUBE, A21L5 INTERCONNECT	1.0 EA	
839 5695 314	GRILL, FILTER HOLDER	1.0 EA	
839 5695 339	TUBE, A21L4/5 TO L7	1.0 EA	
839 5695 375	STRAP, CABINET GROUND	1.0 EA	
839 5695 399	HEATSHIELD, STEP START	1.0 EA	
839 7920 010	LOAD AND TUNE CLOSEOUT	1.0 EA	
839 7920 014	DIVIDING SHIELD	1.0 EA	
843 3655 176	SIDE, RIGHT/LEFT	2.0 EA	
843 3655 178	DUCT, AIR	1.0 EA	
843 5141 005	BOTTOM PANEL	1.0 EA	
917 2131 013	LABEL, TRIM STRIP	1.0 EA	#TB002 #TB003
917 2244 001	SPACER, 1.0 LG .75 DIA	4.0 EA	
917 2332 049	INSULATOR, 3/8 D. X 1 LG.	7.0 EA	
922 0981 005	DOUBLER PLATE	1.0 EA	
922 0981 008	DOUBLER PLATE	1.0 EA	
922 0981 024	HINGE	1.0 EA	
922 0981 025	SWITCH BLOCK	2.0 EA	#A19S1 #A19S2
922 0981 026	SWITCH ARM	2.0 EA	#A19S1 #A19S2
922 0981 027	SWITCH PLUNGER	1.0 EA	#19S2
922 0981 028	SWITCH STDOFF	2.0 EA	#A19S1 #A19S2
922 0981 029	SWITCH CONTACT	2.0 EA	#A19S1 #A19S2
922 0981 030	SWITCH PLUNGER	1.0 EA	#A19S1
922 1265 001	BRK'T, TEMP SENSOR MTG	1.0 EA	#A20A1
922 1265 002	BRK'T, TEMP SENSOR MTG	1.0 EA	#A20A1
929 8305 285	STANDOFF 10-32 X 0.75.	2.0 EA	
929 8305 293	BRACKET, SX-2.5 CAP	2.0 EA	
929 8305 303	SIDE, SHIELD LI	1.0 EA	
929 8305 421	COIL ASSY, 6 TURNS	1.0 EA	A21L7
929 8305 539	COIL, TAPPED.	1.0 EA	A26L1
929 8305 606	SHIELD, HEAT	1.0 EA	
929 8305 649	BAR MOD.	1.0 EA	
929 8305 751	STRAP, SHIPPING	2.0 EA	
939 5695 322	SHIELD, SAFETY ASSY	1.0 EA	
939 7920 003	METER PANEL	1.0 EA	
939 7920 005	LOWER FRT PANEL	1.0 EA	
939 7920 006	UPPER FRT PANEL	1.0 EA	
939 7920 008	FRT ACCESS PANEL	1.0 EA	
939 7920 023	METER SHIELD	1.0 EA	
943 3655 071	HEATSINK, IPA MOD.	1.0 EA	

943 3655 079	HEAT SINK, PDM AMP	1.0 EA	
943 3655 177	DUCT, BLOWER MTG	1.0 EA	
943 3655 196	HEATSINK, PA	1.0 EA	
943 3655 217	SHIELD, A21L2	1.0 EA	
943 3655 221	SHIELD, A21C1/L1	1.0 EA	
943 3655 236	COIL ASSY, A21L2 OUTPUT	1.0 EA	
943 3777 001	COIL, VAR. 44VC2345	2.0 EA	A21L4 A21L5
943 5141 001	FRONT TOP	1.0 EA	
943 5141 004	CONTROL PNL	1.0 EA	
943 5141 006	CHASSIS FRT PNL	1.0 EA	
943 5141 053	ENCLOSURE, FRONT	1.0 EA	
943 5141 054	SHIELD, LOAD & TUNE	1.0 EA	
943 5479 019	PANEL, INNER LEFT	1.0 EA	
943 5479 020	PANEL, INNER RIGHT	1.0 EA	
952 8846 052	TOP, CABINET REAR	1.0 EA	
952 9177 001	BASE	1.0 EA	
952 9177 005	CAB BOTTOM	1.0 EA	
992 5868 008	PWA, PA TOROID ESD SAFE	1.0 EA	A1A1
992 5872 005	* PDM AMP BOARD *	2.0 EA	A006 A007
992 5889 002	PWA, IPA PWR SPLITTER,ESD SAFE	1.0 EA	A026
992 8144 001	OUTPUT MONITOR	1.0 EA	A018
992 8145 001	PDM GENERATOR	1.0 EA	A015
992 8146 001	PWA, OSCILLATOR	1.0 EA	A016
992 8147 001	CONTROLLER	1.0 EA	A012
992 8148 001	INTERFACE BD	1.0 EA	A024
992 9146 001	AIRFLOW SENSOR	1.0 EA	A20A1
992 9714 001	PWA, PA MODULE	1.0 EA	
992 9813 001	PWA, IPA BOARD	1.0 EA	A005

Table 6-17. AIRFLOW SENSOR - 992 9146 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (J)*
358 1929 000	JUMPER 1/2 LG 1/8H	1.0 EA	#CR001
358 2997 000	END PLATE,236 TERM MODULE	1.0 EA	#TB001
380 0125 000	XSTR, NPN 2N4401 ESD	1.0 EA	Q001
382 0522 000	IC, LM393N ESD	1.0 EA	U001
382 1685 000	IC, LM35DT ESD	3.0 EA	U002 U003 U004
384 0357 000	RECTIFIER 1N4004 ESD	2.0 EA	CR002 CR005
384 0612 000	DIODE 1N3070 ESD	2.0 EA	CR003 CR004
384 0662 000	LED RED ESD	1.0 EA	DS001
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1.0 EA	XU1
404 0919 000	HEAT SINK, TO-218	2.0 EA	#U002 #U004
516 0453 000	CAP .1UF 100V 20% X7R	4.0 EA	C001 C002 C003 C004
522 0528 000	CAP 470UF 63V 20%	1.0 EA	C006
522 0566 000	CAP 100UF 63V 20%	1.0 EA	C005
522 0573 000	CAP 47UF 63V 20%	1.0 EA	C007
540 1600 218	RES 510 OHM 3W 5%	1.0 EA	R003
544 1662 000	RES 30 OHM 20W 2% TO-220	2.0 EA	R001 R002
548 2400 330	RES 2K OHM 1/2W 1%	4.0 EA	R006 R009 R011 R012
548 2400 401	RES 10K OHM 1/2W 1%	1.0 EA	R013
548 2400 451	RES 33.2K OHM 1/2W 1%	3.0 EA	R005 R008 R010
548 2400 601	RES 1MEG OHM 1/2W 1%	2.0 EA	R004 R007
574 0477 000	RELAY 4 PDT 12VDC 2 AMP	1.0 EA	K001
610 0777 000	HDR 3C 1ROW STRAIGHT	1.0 EA	J001
610 0980 000	HDR 20C 2ROW RT ANG	2.0 EA	J002 J003

614 0790 000	TERM MODULE,1C PC MTG 236	3.0 EA	#TB001
670 0052 000	BUZZER, PIEZO 3-20VDC.	1.0 EA	LS001
843 5400 041	SCH, AIRFLOW SENSOR	0.0 EA	
843 5400 043	PWB, AIRFLOW SENSOR.	1.0 EA	
843 5400 259	COMPONENT LOCATOR, AIR FLOW	0.0 EA	
922 1265 003	CABLE, A20A1 INTERCONNECT	1.0 EA	
999 2834 001	HARDWARE LIST, AIRFLOW	1.0 EA	

SECTION A
OSCILLATOR (A16)

A.1. Principles Of Operation

The oscillator is the frequency determining source. The crystal oscillator stage is a voltage stabilized Pierce circuit operating at 2 or 4 times the carrier frequency. The crystal operates in its parallel resonant mode and meets FCC requirements.

For carrier frequencies of 1250 kHz and below, the crystal operates at 4 times the carrier frequency, and for carrier frequencies above 1250 kHz the crystal operates at 2 times the carrier frequency.

Buffer/squaring amplifier Q2 is lightly coupled to the oscillator and provides a 5 volt square wave to the programmable divider U1. This divider will divide the crystal frequency by 2 or 4 to obtain the carrier frequency.

The divider drives a level shifter U2 which produces a 15 volt square wave. This stage drives the class D output transistor pair Q3 and Q4 which produce about 2 watts of RF drive to the IPA.

Regulator U3 supplies about 16 volt to the Q3/Q4 output stage.

Q6 and Q5 comprise RF drive kill circuits. When the transmitter is shut off in the Remote mode, the RF drive is muted via the RF Kill input to the Oscillator board.

A.2. Replacement/Alignment

A.2.1. Frequency Adjustment

A16C1 trims the carrier frequency at least +/-20 Hz. This should only be adjusted according to a frequency monitoring instrument or service.

A.3. Troubleshooting the RF Oscillator

A.3.1. Symptom: No Output

Possible causes:

A.3.1.1. *Open Fuse/Loss of +20V*

Check the dc voltage on each side of F1. 20 volts should be present anytime AC power is supplied to the transmitter and the low voltage circuit breaker is set to ON.

A.3.1.2. *RF KILL*

The Controller may be sending an RF KILL signal to the oscillator. Check the voltage at the input side of R16. This should be about 5 volts for the oscillator to produce RF. If the voltage at R16 is near zero, then check the RF KILL signal output of the Controller board.

A.3.1.3. *Q1,Q2,CR1*

Using an oscilloscope, check the signals at Q1 and Q2 per the schematic. Frequency of the signals at Q1 and Q2 should be 2 or 4 times the carrier frequency, depending on the jumper wire arrangement at E3-E6. CR1 sets the supply voltage for Q1 and Q2 to 15 volts.

A.3.1.4. *U1,CR4*

The output of U1 at E6 should be a 4-5 volt peak to peak square wave at the carrier frequency. The RF drive muting circuit utilizes the voltage at U1-2 to gate U1 on and off. During a normal on condition, U1-2 should be high (+5 volts). CR4 sets the supply voltage for U1 to be 5.1 volts.

A.3.1.5. *U2*

U2 should provide a voltage level shift from 5 volts peak-to-peak at pin 2 to 15 volts peak-to-peak at pin 7. Both signals should be square waves.

A.3.1.6. *U3*

U3 supplies about 16 volts to Q3 and Q4. Check the voltage at the collector of Q3. U3 may be open if no voltage is supplied to Q3.

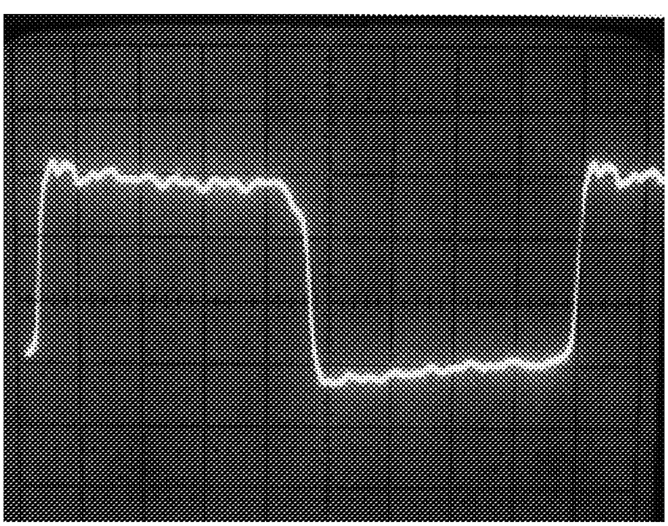


Figure A-1
Oscillator Board Output, 16Vp-p

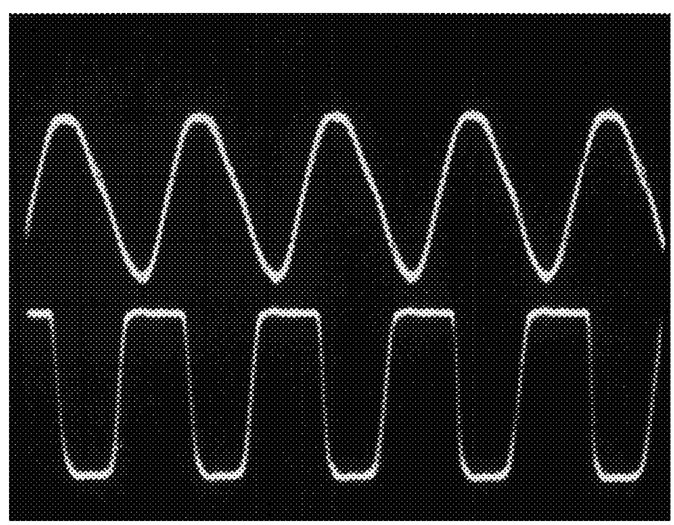


Figure A-2
Upper Trace - Q1-C, 8-12Vp-p
Lower Trace - Q2-C, 4-6Vp-p

WARNING: Disconnect primary power prior to servicing.

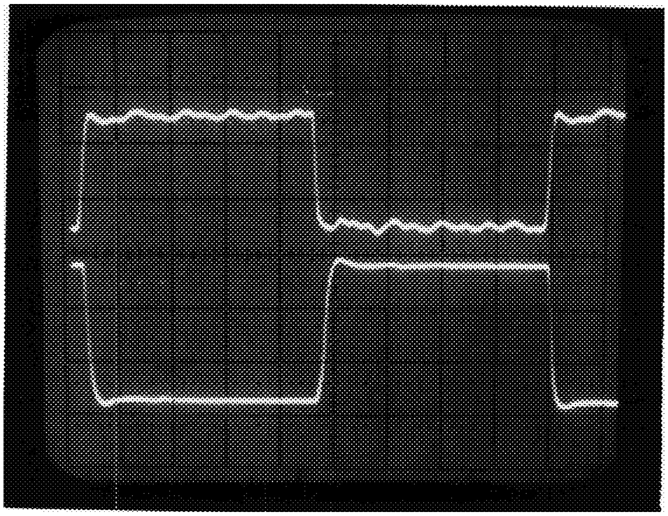


Figure A-3
Upper Trace - E6, 2-3Vp-p
Lower Trace - U2-7, 14Vp-p

PWA, OSCILLATOR - 992 8146 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (R)*
335 0254 000 . .	WASHER, TEFLON #4.	2.0 EA	#U003
380 0083 000 . .	XSTR, 2N2369 ESD	2.0 EA	Q001 Q002
380 0125 000 . .	XSTR, NPN 2N4401 ESD	1.0 EA	Q005
380 0327 000 . .	XSTR, 2N2222A ESD	1.0 EA	Q006
380 0586 000 . .	XSTR, MJE200 ESD	2.0 EA	Q003 Q004
382 0074 000 . .	IC, 7476 ESD.	1.0 EA	U001
382 0475 000 . .	IC, 317 ESD.	1.0 EA	U003
382 1010 000 . .	IC, DS0026CN/MMH0026CP1 ESD	1.0 EA	U002
384 0321 000 . .	*DIODE 5082-2800 ESD	1.0 EA	CR011
384 0357 000 . .	RECTIFIER 1N4004 ESD	3.0 EA	CR006 CR007 CR008
384 0610 000 . .	LED, GREEN ESD	1.0 EA	DS001
384 0612 000 . .	DIODE 1N3070 ESD	5.0 EA	CR002 CR003 CR005 CR009 CR012
386 0135 000 . .	ZENER, 1N4733A 5.1V ESD	1.0 EA	CR004
386 0298 000 . .	ZENER, 1N5352B 15V ESD	1.0 EA	CR001
386 0419 000 . .	ZENER, LM236H 2.5V ESD	1.0 EA	CR010
398 0019 000 . .	FUSE, FAST CART 2A 250V.	1.0 EA	
402 0129 000 . .	CLIP, 1/4 DIA FUSE	2.0 EA	XF001A XF001B
404 0267 000 . .	SOCKET, CRYSTAL HC-13/U	2.0 EA	XY001 XY002
404 0513 000 . .	HEAT SINK PA1-1CB.	2.0 EA	#Q003 #Q004
404 0727 000 . .	HEAT SINK TO-3	1.0 EA	#U003
410 0232 000 . .	INSULATOR TO-3 MICA	1.0 EA	#U003
410 0381 000 . .	INSULATOR .562 X .812	2.0 EA	#Q003 #Q004
414 0087 000 . .	BEAD FERRITE SHIELD	2.0 EA	#L002 #L003
494 0196 000 . .	CHOKE RF 100UH	1.0 EA	L001
500 0761 000 . .	CAP, MICA, 150PF 500V 5%.	1.0 EA	C005
500 0803 000 . .	CAP, MICA, 5PF 500V +/- .5PF. . . .	2.0 EA	C002 C023
500 0837 000 . .	CAP, MICA, 510PF 500V 5%.	1.0 EA	C003
500 0843 000 . .	CAP, MICA, 910PF 100V 5%.	1.0 EA	C013
508 0378 000 . .	CAP .22 UF 100V 10%.	1.0 EA	C010
516 0080 000 . .	CAP DISC .01UF 600V	1.0 EA	C006
516 0375 000 . .	CAP 0.01UF 50V -20/+80% Z5U . . .	3.0 EA	C011 C015 C024

WARNING: Disconnect primary power prior to servicing.

516 0387 000	CAP .47 UF 10V	1.0 EA	C004
516 0453 000	CAP .1UF 100V 20% X7R	4.0 EA	C008 C014 C016 C020
520 0439 000	CAP, AIR VAR 2.4-24.5PF, 500V	2.0 EA	C001 C022
522 0548 000	CAP 10UF 50V 20%	2.0 EA	C017 C018
522 0572 000	CAP 3.3UF 50V 20%	2.0 EA	C009 C012
526 0358 000	CAP 22UF 35V 10%	1.0 EA	C007
540 1600 113	RES 33 OHM 3W 5%	1.0 EA	R024
540 1600 118	RES 51 OHM 3W 5%	1.0 EA	R025
540 1600 124	RES 91 OHM 3W 5%	2.0 EA	R007 R009
540 1600 201	RES 100 OHM 3W 5%	1.0 EA	R014
540 1600 217	RES 470 OHM 3W 5%	2.0 EA	R008 R023
540 1600 218	RES 510 OHM 3W 5%	1.0 EA	R015
548 2400 158	RES 39.2 OHM 1/2W 1%	1.0 EA	R003
548 2400 205	RES 110 OHM 1/2W 1%	1.0 EA	R016
548 2400 218	RES 150 OHM 1/2W 1%	2.0 EA	R018 R019
548 2400 230	RES 200 OHM 1/2W 1%	1.0 EA	R013
548 2400 242	RES 267 OHM 1/2W 1%	1.0 EA	R004
548 2400 251	RES 332 OHM 1/2W 1%	1.0 EA	R026
548 2400 266	RES 475 OHM 1/2W 1%	1.0 EA	R017
548 2400 289	RES 825 OHM 1/2W 1%	1.0 EA	R010
548 2400 301	RES 1K OHM 1/2W 1%	2.0 EA	R005 R012
548 2400 326	RES 1.82K OHM 1/2W 1%	1.0 EA	R028
548 2400 330	RES 2K OHM 1/2W 1%	1.0 EA	R020
548 2400 358	RES 3.92K OHM 1/2W 1%	1.0 EA	R027
548 2400 366	RES 4.75K OHM 1/2W 1%	2.0 EA	R006 R011
548 2400 426	RES 18.2K OHM 1/2W 1%	1.0 EA	R002
548 2400 458	RES 39.2K OHM 1/2W 1%	1.0 EA	R001
604 0904 000	SW, TGL SPDT	1.0 EA	S001
610 0679 000	PLUG, SHORTING, .25" CTRS	1.0 EA	P006
610 0830 000	HEADER, 10 PIN PC RIBBON	1.0 EA	J002
610 0840 000	HDR, STR, 4 PIN, RD	1.0 EA	J003
612 0904 000	JACK, PC MT GOLD PLATED	3.0 EA	#P006
620 1677 000	RECEPTACLE, PC MT, BNC	2.0 EA	J001 J004
839 7920 021	SCHEM, OSCILLATOR	0.0 EA	
843 5141 016	PWB, OSCILLATOR	1.0 EA	
843 5400 268	COMPONENT LOCATOR, OSCILLATOR	0.0 EA	
939 5695 117	XFMR, OSCILLATOR TOROID	1.0 EA	T001
999 2608 001	HARDWARE LIST	1.0 EA	

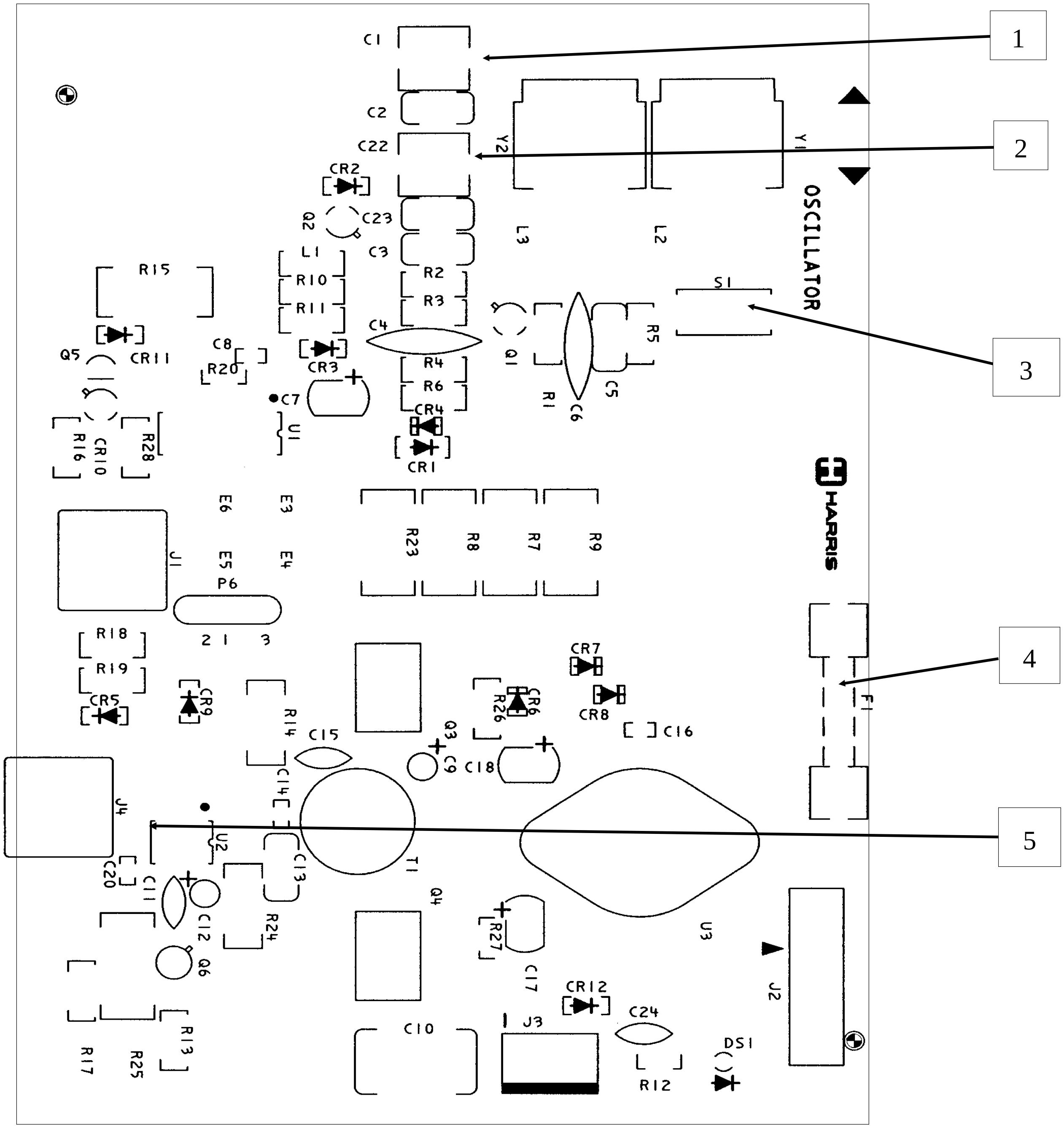


Figure A-4. Oscillator Board A16
Controls & Indicators

Table A-1. Oscillator Board A16, Controls & Indicators

1	Frequency Adjustment A16C1	Adjusts the carrier frequency of approximately +/-20 Hz.
2	Frequency Adjustment A16C22	Adjusts the carrier frequency of Y2 approximately +/-20 Hz.
3	Switch S1	Selects Y1 or Y2 crystal.
4	+20V FUSE A16F1	Protects +20 volt supply from faults within the oscillator.
5	Frequency Sample A16J4	Output for optional Frequency Monitor

SECTION B
IPA (A5)

B.1. Principles of Operation

The IPA Board consists of a class D bridge amplifier using high power MOSFET transistors. This board uses 60-120 volts dc from the IPA power supply. The IPA is driven from the Oscillator through jack J2. The carrier signal is applied to transformer T11 and T12.

Capacitors C11, C12, C13, C14, C16, C17, C18 and C19 RF bypass the IPA DC supply.

Transistors Q11, Q12, Q13 and Q14 are driven into class D operation. Transistors Q11 and Q13 are driven 180 degrees out of phase with respect to Q12 and Q14. During the positive half of the RF cycle Q11 and Q13 are simultaneously on; then during the negative half of the RF cycle Q12 and Q14 are on. This produces a carrier squarewave waveform of twice the supply voltage across terminals E11 and E12. These terminals then connect to the IPA output network.

B.1.1. IPA Tuning Network

The IPA Output Network is a series tuned circuit comprised of A26L1, A26L2, A26C1, and the primary of A26T1. A26T1, along with A26A1 (IPA Power Splitter board) and the housing assembly forms a step down transformer. The low impedance presented by the drive cables is matched by the one turn secondary on the IPA toroid and the Splitter board. The primary consists of several turns of enameled wire wound on a toroid.

B.2. Replacement/Alignment

When replacing the IPA module, be sure an even coating of thermal compound is applied to the mating heat sink surfaces. Be certain to tighten down the captive fasteners which mount the IPA module to the heat sink.

B.3. IPA Tuning and Testing Procedure

WARNING

ENSURE THE HIGH VOLTAGE IS TURNED OFF BEFORE PROCEEDING WITH THE FOLLOWING STEPS.

RF Drive level is measured on the PA modules with an oscilloscope. Place the oscilloscope probe across R13 or the equivalent terminal of any module.

Attach the probe ground lead to the RF drive ground plane. Do not use the cabinet or chassis ground as this will give an incorrect waveform. Proper drive level should be 26-32 volts peak to peak on all eight inputs of each PA module A1, A2, A3, and A4, with high voltage OFF.

If the RF Drive exceeds 32 volts peak to peak, the secondary taps on A20T1 will have to be changed to a lower number to reduce the IPA supply voltage. For example, moving from the 105 tap to the 90 tap will reduce the IPA supply voltage and the drive level.

If the drive level on the PA Module(s) is below 20 Vp-p, the IPA module outputs should be checked with an oscilloscope by connecting the scope probe tip to A5 Q12 or Q13 while only the low voltage is on. There should be an RF square wave at the operating frequency with an amplitude equal to the IPA supply voltage.

If square waves are not found at both Q12 and Q13, refer to the troubleshooting procedures which follow.

If there is no input, the RF Oscillator board or the cabling is probably at fault. Refer to the troubleshooting information in Section A, covering the RF Oscillator.

If only one side of the IPA is producing output, refer to the ohmmeter test procedure.

B.3.0.1. *IPA Tuning*

Adjust A26L2 with a slotted screwdriver for a peak in drive level as measured on the PA modules.

A26L1 is tapped to keep A26L2 within its adjustment range.

Some of the components in the A26C1 position may not be used. Refer to the Factory Test Data Sheets for the proper amount of capacitance.

If the RF Drive when peaked is lower than 25 volts peak to peak, make sure the IPA is fully working, and that it is not being loaded down by PA failures. Refer to the ohmmeter troubleshooting procedure below, as well as the checks of the PA modules.

If the drive is not low because of a component failure, then the IPA power supply secondary will have to be tapped for a higher voltage output. For example, moving a tap from the 105 volt connection to the 120 volt connection will increase the IPA supply voltage and the RF drive level.

B.3.1. Ohmmeter Testing the IPA

WARNING

ENSURE ALL AC POWER HAS BEEN REMOVED FROM TRANSMITTER AND GROUNDING STICK IS USED TO REMOVE ANY RESIDUAL VOLTAGES THAT MAY BE PRESENT PRIOR TO BEGINNING THE FOLLOWING PROCEDURE.

a. Turn off AC power to the transmitter.
b. Remove P3, the molex connector, from A5, the IPA board.
c. Check and remove both fuses. Discard if open. If not, no further testing is needed.
d. If more testing is needed, disconnect one end of the large resistor R11 between Q12 and Q13.
e. Connect an ohmmeter positive lead to the center leg of Q11. Touch the negative lead to the center leg of Q12. The ohmmeter should read greater than 500k. This is a test of Q11.
f. Connect the positive ohmmeter lead to the center leg of Q12. Put the negative lead on JP1. The ohmmeter should read greater than 500k. This is a test of Q12.
g. Refer to paragraphs on Handling MOSFET's and Testing MOSFET's before replacing any transistors.
h. Connect an ohmmeter positive lead to the center leg of Q14. Touch the negative lead to the center leg of Q13. The ohmmeter should read greater than 500k. This is a test of Q14.
i. Connect the positive ohmmeter lead to the center of Q13. Put the negative lead on JP1. The ohmmeter should read greater than 500k. This is a test of Q13.
j. Refer to paragraphs on Handling MOSFET's and Testing MOSFET's before replacing any transistors.

NOTE

Reconnect the large resistor previously disconnected when finished with ohmmeter testing the IPA.

B.4. Handling MOSFET's

Due to the fragile nature of the gate of a MOSFET, special care in their handling is required. The gate junction may be destroyed by static electricity if the static electricity is allowed to discharge through the MOSFET. For example, walking across a carpet to pick up a MOSFET that is not protected by antistatic packaging could result in the destruction of the MOSFET. A static charge could build up on a person as they walk across the carpet. This static charge will eventually have to be discharged. Discharging to the MOSFET could damage the MOSFET.

NOTE

MOSFET transistors which are in circuit in the GATES Series™ transmitters are immune to this damage.

The MOSFET transistors are shipped in antistatic packaging. The transistors should remain in this packaging until they are to be used or tested.

B.5. Testing MOSFET's

The MOSFET's used in the GATES Series™ transmitters may be checked with an ohmmeter. However there is a requirement which restricts the use of some ohmmeters. If the battery voltage is too low (under 3V) or too high (over 20V) the ohmmeter cannot be used. A battery voltage less than 3V will not give an operational check of the transistor and a battery voltage greater than 20V may result in damage to the transistor under test. A Simpson 260, which uses a 9V battery on the Rx10k scale works quite well.

The following test applies to all MOSFET's used in the transmitter, but is not necessarily applicable to MOSFET's used in other equipment.

This test will show how a MOSFET can be switched "on" and "off" by charging and discharging the gate of the MOSFET.

Refer to Figure B-2 for the following test.

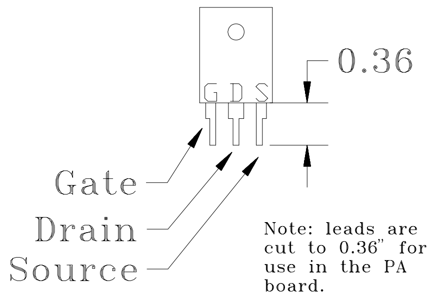


Figure B-2. Outline of MOSFET

Connect the positive lead of the ohmmeter to the source of the transistor. Momentarily connect the negative lead to the gate and then connect it to the source. Then connect the positive lead to the drain. The ohmmeter should read at least 2 megohms.

Remove the positive lead from the drain and momentarily touch it to the gate. Reconnect the positive lead to the drain. The ohmmeter should read very near zero ohms.

CAUTION

IF THE TRANSISTORS IN THE IPA REQUIRE CHANGING, ENSURE THAT ALL OF THE TRANSISTORS ARE OF THE SAME TYPE NUMBER AND ARE FROM THE SAME MANUFACTURER.

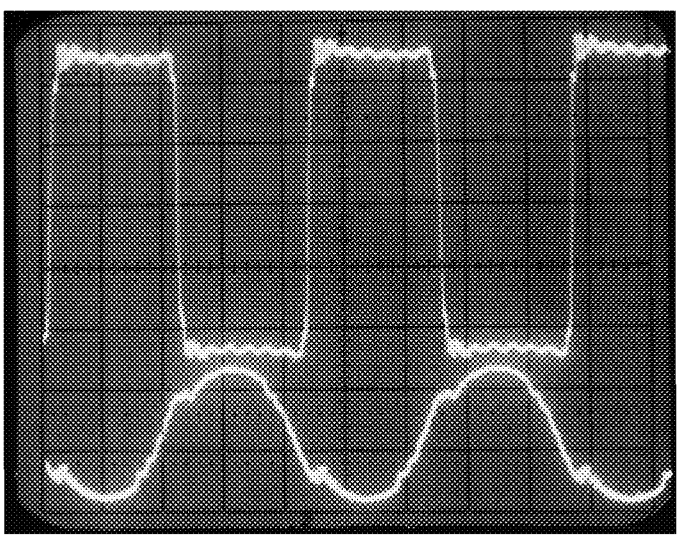


Figure B-1
Upper Trace - Q12 or Q13, 60-120Vp-p
Lower Trace - IPA input, 15-25Vp-p

WARNING: Disconnect primary power prior to servicing.

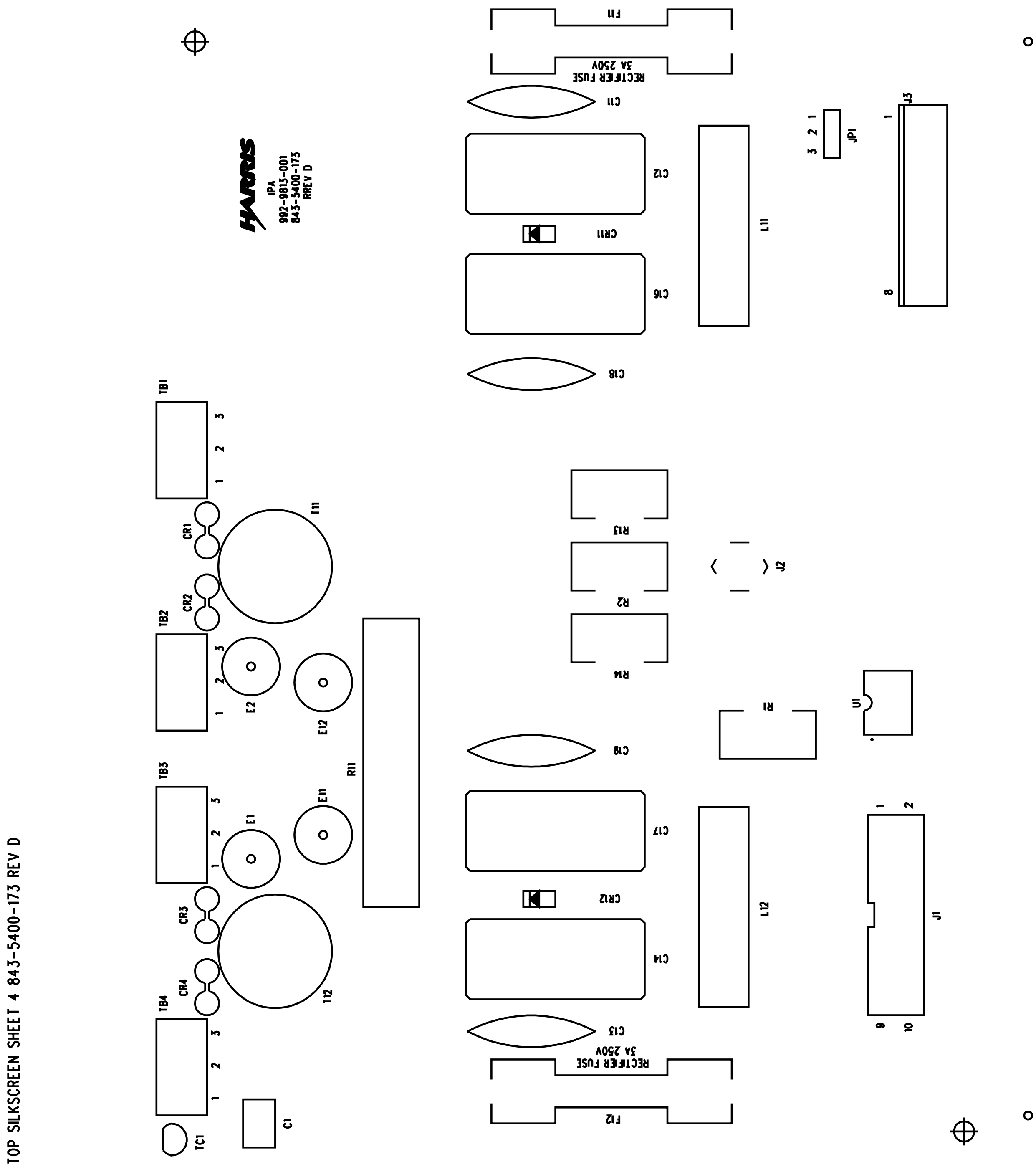


Table B-1. IPA Board A5 & IPA Power Splitter Board A26A1, Controls & Indicators

PWA, IPA BOARD - 992 9813 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (F)*
000 0000 003 . .	FREQUENCY DETERMINED PART	0.0 EA	JUMPER
254 0002 000 . .	WIRE, BUS CU 20AWG.	0.0 FT	
336 0264 000 . .	PIN SPRING	2.0 EA	#R011
350 0047 000 . .	RIVET, POP .125 X .390L	2.0 EA	
358 2837 000 . .	STUD, PC BD 4-40 X 5/16.	2.0 EA	
358 2838 000 . .	STANDOFF 4-40 F/M X .5 LG	2.0 EA	#E011 #E012
380 0681 000 . .	XSTR IRFP350 ESD	4.0 EA	Q011 Q012 Q013 Q014
386 0412 000 . .	ZENER, DUAL 18V 3W ESD	4.0 EA	CR001 CR002 CR003 CR004
398 0403 000 . .	FUSE, RECTIFIER 3A 250V	2.0 EA	F011 F012
402 0129 000 . .	CLIP, 1/4 DIA FUSE	4.0 EA	XF11A XF11B XF12A XF12B
410 0413 000 . .	INSULATOR PAD FOR TO-247. . . .	4.0 EA	#Q011 #Q012 #Q013 #Q014
448 1157 000 . .	PANEL FASTENER FOR PCB, 4-40	2.0 EA	
494 0345 000 . .	CHOKE, RF 1.2 UH	2.0 EA	L011 L012
508 0538 000 . .	CAP .15 UF 400WVDC 5%	2.0 EA	C012 C014
516 0081 000 . .	CAP, DISC .01UF 1KV 20%	2.0 EA	C011 C013
540 1600 008 . .	RES 2 OHM 3W 5%	2.0 EA	R013 R014
540 1600 118 . .	RES 51 OHM 3W 5%	1.0 EA	R002
546 0307 000 . .	RES 1.3K OHM 13W 5%	1.0 EA	R011
610 0831 000 . .	HDR, STR, 8 PIN, RD	1.0 EA	J003
614 0909 000 . .	TERM STRIP, 3C PCB MODULAR 237 . .	4.0 EA	TB001 TB002 TB003 TB004
620 0515 000 . .	RECP, SCREW ON SMC.	1.0 EA	J002
843 5400 171 . .	SCH, IPA BD.	0.0 EA	
843 5400 173 . .	PWB, IPA BD	1.0 EA	
922 1295 052 . .	HEATSINK, MTG TRANSISTOR . . .	1.0 EA	
922 1295 053 . .	SPACER,.	1.0 EA	
939 5695 054 . .	TRANSFORMER, TOROID	2.0 EA	T011 T012

WARNING: Disconnect primary power prior to servicing.

SECTION C
POWER AMPLIFIER A1 through A4

C.1. Principles of Operation

Each PA board consists of four bridge class D amplifiers with four power MOSFETS in a bridge or quad. The high side of the PA is connected to the high voltage power supply (260 volts) through jack J3.

The low side of each PA quad is connected to the Modulator through jacks J11, J12, J13, and J14. The PA is modulated by varying the PA voltage. The PDM modulator system does this by pulling the low side of the PA toward ground. The PA quads produce more output as the low side is pulled toward ground.

The RF drive enters the board through jack J2, and is relatively constant at all modulation levels.

The following discusses the first quad-bridge amplifier on the PA board and applies to the other three bridges since the circuits are all identical. The series combination of R11 and L13 on one half and R12 and L16 on the other half, parallel resonate the RF drive input.

To prevent the drive level from sagging because of a failure in another quad, isolation is provided by using separate drive cables. For frequencies below 700 kHz, series chokes L14 and L15 are used for further isolation. Swamping resistors R13 and R14 are added for stability for frequencies below 1200 kHz.

260 volts DC is brought to the module on J3 and is fed to each half of the quad via fuses F11 and F12. RF chokes L11 and L12 are placed in series with the 260 volts to allow only dc currents to flow in fuses F11 and F12.

Transistors Q11 and Q13 are driven 180 degrees out of phase with respect to transistors Q12 and Q14 via transformers T11 and T12. During one half of the RF cycle Q11 and Q13 are driven into saturation while Q12 and Q14 are cutoff.

During the other half of the RF cycle Q12 and Q14 are driven into saturation while Q11 and Q13 are in cutoff. This produces a square wave voltage waveform of twice the bridge voltage [jack J3 (260 volts) minus jack J11 (modulator volts)] across the output transformer on the PA Toroid Board.

Capacitors C11, C12, C13, and C14 RF bypass the 260 volt supply on transistors Q11 and Q14. Capacitors C16, C17, C18, and C19 RF bypass the modulator input and also are the last shunt capacitors in the PDM filter.

Diode CR13 prevents the modulator voltage from going below ground.

Blown fuses are detected via diodes CR11 and CR12.

C.2. PA Toroids

The PA Toroid boards combine the RF power produced by the bridge amplifiers on the PA boards. It makes connection to the PA board at terminals E11 and E12 (bridge amplifier 1).

Each transformer (T11, T21, T31, and T41) carries the signal from the bridge amplifier to the output network. The secondary windings of transformers T11, T21, T31, and T41 are in series such that the RF voltage across all of the transformers is summed. The RF current in each toroid's secondary winding is equal.

One end of the secondary windings of A4 is connected to cabinet ground and the other end of the secondary windings is connected to A3, A3 to A2, A2 to A1. A1 is connected to the output network. Thus, the power from each bridge amplifier is summed such that at the end of the power combiner string the transmitter's output power is achieved.

C.3. Replacing a PA Module

When replacing the PA module, be sure an even coating of thermal compound is applied to the mating heat sink surfaces. Be certain to tighten down the captive fasteners which mount the PA module to the heat sink. Be sure the RF drive cable J2 is fully locked into position.

The toroids on the backside of the PA should be inspected when the modules are removed for replacing transistors. A crack or break in any core may cause damage to the transistors of the same quad. The best way of inspecting the toroidal cores is by rotating the core. This will allow a fairly complete visual inspection.

C.4. Troubleshooting the PA Boards

C.4.1. Ohmmeter Testing

WARNING

REMOVE ALL PRIMARY POWER AND DISCHARGE ALL HIGH VOLTAGE COMPONENTS WITH GROUNDING STICK BEFORE PERFORMING THE FOLLOWING PROCEDURE.

All power MUST BE turned off for this test.

The PA module can either be tested with it in the transmitter, but can also be removed from the transmitter for troubleshooting.

Using an ohmmeter on the Rx1 scale, check the fuses on the PA module. Remove ALL EIGHT fuses and discard any open ones. A blown fuse usually indicates one or two transistors have failed.

Use an ohmmeter on the Rx10k scale to check the transistors.

NOTE

Determine which ohmmeter lead is positive in order to perform the following troubleshooting procedure.

Connect the positive lead of the ohmmeter to the middle lead (drain)of a transistor across from a fuse (transistors labeled with an A in figure C-2). The negative lead should be connected to the middle lead of the nearest transistor across from a banana jack (transistors labeled with a B in Figure C-2). For a good transistor, the ohmmeter will read greater than 700k. A shorted one will read near zero the ohmmeter. The transistor which has been tested is the one being touched with the positive ohmmeter lead.

Connect the positive ohmmeter lead to the middle lead of a transistor labeled with a B in figure C-2. Connect the negative lead to the small banana jack located near that transistor (banana jacks are labeled with an C in figure C-2). The ohmmeter will read near 700k ohms for a good transistor. A shorted or leaky transistor will read substantially lower. As before, the transistor being tested is the one being touched with the positive ohmmeter lead.

It is advisable to check all sixteen transistors by the above procedure rather than test only those associated with blown fuses. Once familiar with the procedure, it will only take a short period of time to check all sixteen transistors. By checking all transistors a comparison can also be taken between pairs of transistors for future reference.

Before installing any replacements, refer to the paragraphs on Handling MOSFETs and Testing MOSFET's.

Be sure to put all fuses back in place and replace any open ones with an exact replacement before turning on the transmitter.

WARNING

NEVER ATTEMPT TO OPERATE THE TRANSMITTER WITH ANY PA TRANSISTORS REMOVED. IF REPLACEMENTS ARE NOT AVAILABLE, IT IS NECESSARY TO LEAVE THE SHORTED ONES IN CIRCUIT. THIS WILL KEEP THE TOROIDAL COMBINING IN TACT, AND WILL NOT IMPAIR OPERATION OF THE TRANSMITTER AT A REDUCED POWER LEVEL.

C.5. Handling MOSFET's

Due to the fragile nature of the gate of a MOSFET, special care in their handling is required. The gate can be destroyed by an electrostatic discharge. Please read the enclosed Technical Brief discussing safe handling of transistors and integrated circuits. Among other aspects of ESD control, this publication covers the use of conductive packaging and antistatic wrist bands.

NOTE

MOSFET transistors which are in circuit in the GATES Series™ transmitters are immune to this damage.

The MOSFET transistors are shipped in antistatic packaging. The transistors should remain in this packaging until they are to be used or tested.

C.6. Testing MOSFET's

The MOSFETS used in the GATES Series™ transmitters may be checked with an ohmmeter. However there is a requirement which restricts the use of some ohmmeters. If the battery voltage is too low (under 3V) or too high (over 20V) the ohmmeter cannot be used. A battery voltage less than 3V will not give an operational check of the transistor and a battery voltage greater than 20V may result in damage to the transistor under test. A Simpson 260, which uses a 9V battery on the Rx10k scale works quite well.

The following test applies to all MOSFETS used in the transmitter, but is not necessarily applicable to MOSFETS used in other equipment.

This test will show how a MOSFET can be switched "on" and "off" by charging and discharging the gate of the MOSFET.

Refer to Figure C-1 for the following test. Connect the positive lead of the ohmmeter to the source of the transistor. Momentarily connect the negative lead to the gate and then connect it to the source. Then connect the positive lead to the drain (middle lead). The ohmmeter should read at least 2 megohms.

Remove the positive lead from the drain and momentarily touch it to the gate. Reconnect the positive lead to the drain. The ohmmeter should read very near zero ohms.

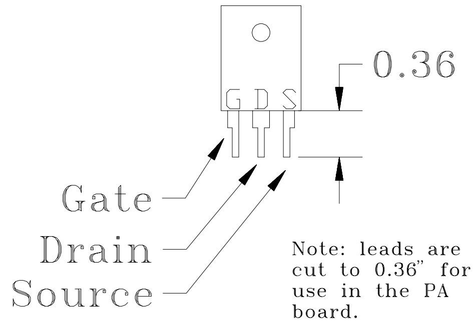


Figure C-1. Outline of MOSFET

C.6.1. Replacing PA Transistors

Although there is no adhesive used in attaching the transistors, you may find that they remain in place after the mounting screw is removed, and the terminals are loosened. However, the transistors should easily pop loose if you apply some leverage to the transistor case. One way to do this is to insert the shaft of a small screwdriver into the mounting hole, then gently pry with the screwdriver.

When installing new transistors, trim the lead length so that the leads extend well into the terminal blocks, but not so far as to bear against the back end. A length of 0.36" works well.

Tighten the transistor mounting screw first, to no more than 5 inch-pounds. Tighten the terminal block screws only after the mounting screw has been tightened.

C.7. Scoping the RF Drive

Measuring the RF drive with a scope can be very meaningful in terms of identifying blown transistors or a general RF drive problem.

A failed PA transistor will usually cause the RF drive level for that particular pair of transistors to drop to a very low value. For this reason, checking the drive levels on the PA module(s) can help to readily identify shorted transistors.

If a large number of PA transistors were to short, it would possibly load down the entire drive system. This will cause all of the PA inputs to be somewhat low in drive, but the inputs with shorted transistors would be very low in drive.

NOTE

Insure that the REMOTE/LOCAL switch located on the Controller board is in the LOCAL position before performing the checks outlined below. When the switch is in the REMOTE position, RF Drive and PDM are muted until the high voltage is turned on. After performing these checks, set the switch back in the REMOTE position.

It is usually advisable to check the RF drive amplitude on the module before turning on the high voltage. It is not usually necessary to readjust the IPA tuning.

RF Drive level is measured on the PA modules with an oscilloscope. Place the oscilloscope probe across R13 or the equivalent terminal of any PA module. The probe tip connects to the side closest to the PA transistors.

Attach the probe ground lead to the RF drive ground plane, which is the end of R13 furthest from the transistors. Do not use the cabinet or chassis ground as this will give an incorrect waveform. Proper drive level should be 26-32 volts peak to peak on all eight inputs of each PA module A1, A2, A3, and A4, with the high voltage OFF.

C.8. RF Drive Phasing Measurement

NOTE

Ensure that the REMOTE/LOCAL switch located on the Controller board is set to the LOCAL position before performing the checks outlined below.

The RF drive phasing measurement may be useful in locating some problems which may be obscure to other means of troubleshooting. Repeated failures of a particular PA transistor set might be caused by a large drive phasing imbalance. Drive phase imbalance could also reduce PA efficiency.

Measurements of the RF drive are made with the transmitter in the OFF mode, but the low voltage supply should be energized. This is the usual condition when the transmitter is ready to be turned on.

For the following procedure, an oscilloscope which can be externally triggered will be required. This will allow examination of the phase relationship between drive signals on the PA.

Connect an oscilloscope across R13 position on a PA module, with the probe tip on the end of R13 closest to the transistors. (Depending on the frequency of the transmitter R13 may or may not be installed,

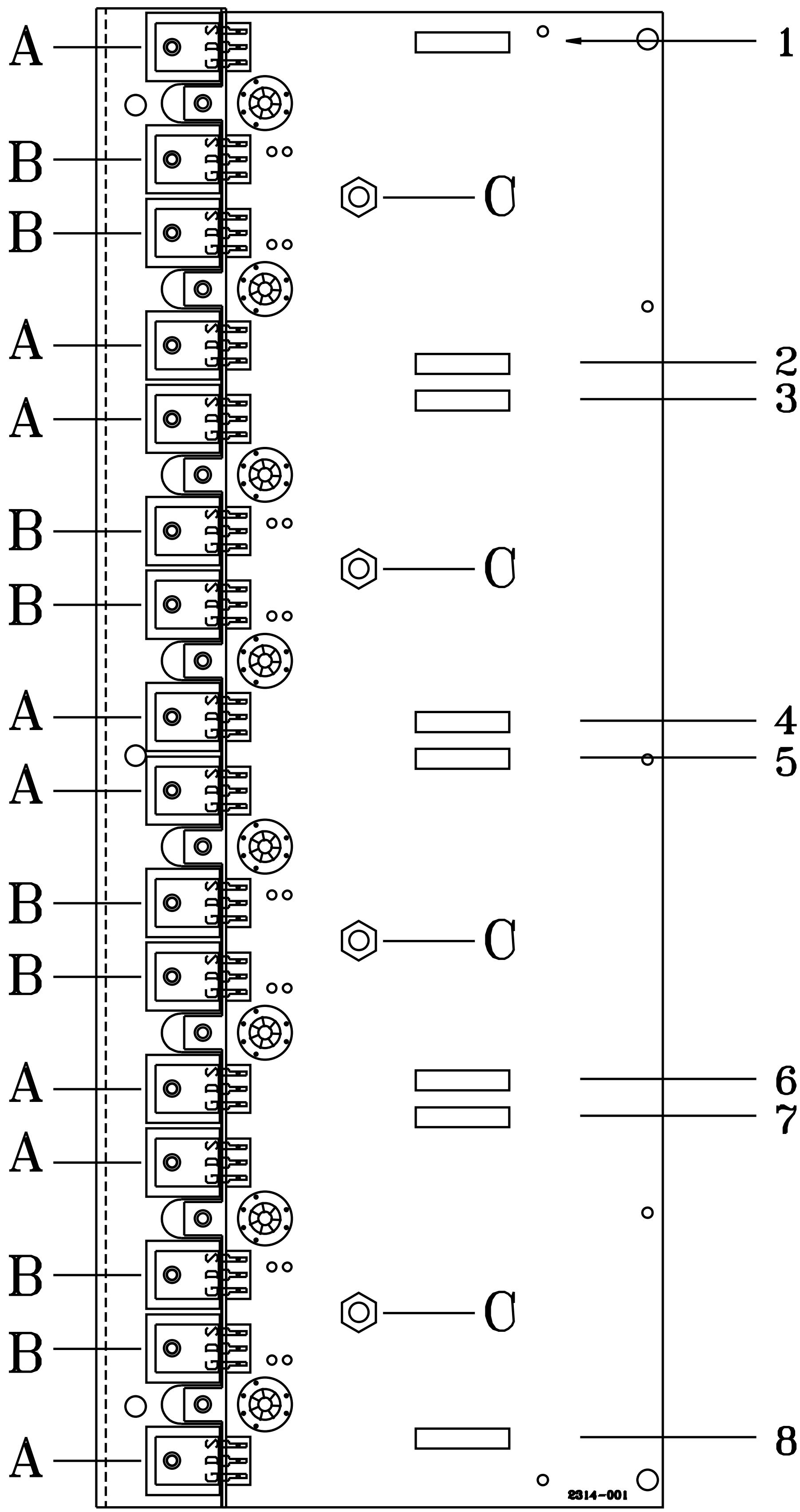


Figure C-2. PA Transistor Identification and Controls and Indicators (Viewed from Component Side of Board)

however the mounting terminals for R13 are always in place.

The voltage across R13 should be 26-32 volts peak-to-peak.

Adjust the horizontal vernier of the oscilloscope so that one full RF cycle occupies a certain number of divisions on the oscilloscope. For example: 7.2 divisions. Each division is then 50 degrees (there are 360 degrees in one cycle).

Use the external trigger input of the oscilloscope and connect it to J4 or R25 on the RF Oscillator.

Adjust the scope triggering, then verify its operation by disconnecting the external trigger input. The oscilloscope should lose sync as this is done.

Increase the vertical sensitivity of the oscilloscope by a step or two. This will cause the trace to go off scale.

Table C-1. PA Module, Controls & Indicators

1 thru 8	PA Current Limiting Fuses	These fuses protect other circuitry in the transmitter should a portion of a PA module fail. As a result of the fusing scheme used in the transmitter, sections of a power amplifier may fail and still allow the remaining sections of the power amplifier to operate properly.
CAUTION		
THESE FUSES ARE SPECIAL RECTIFIER TYPE FUSES ESPECIALLY DESIGNED TO PROTECT RECTIFIERS AND TRANSISTORS. USE OF REGULAR GLASS FUSES DEFEATS THE PROTECTION AND CAN RESULT IN DESTRUCTION OF THE GLASS CASE - POSSIBLY RESULTING IN PERSONNEL INJURY FROM FLYING GLASS OR FROM GLASS PARTICLES THROWN INTO THE TRANSMITTER INTERIOR.		
CAUTION		
THE RECTIFIER TYPE FUSE IS FASTER ACTING THAN THE REGULAR FAST ACTING FUSES AND SO IS USED TO PREVENT CASCADING FAILURES. A PA FAILURE MAY OCCUR WITHOUT UNDUE STRESS ON THE MODULATOR. USE OF THE GLASS TYPE FUSES DEFEATS THIS PROTECTION AND WILL VOID THE WARRANTY.		

Disconnect the vertical input, then adjust vertical positioning so that the oscilloscope trace is exactly in the middle of the screen.

Reconnect the vertical input.

Increase the sweep speed of the oscilloscope. If the scope has a X10 multiplier, use it to make the oscilloscope show 5 degrees per division horizontally (50 degrees divided by 10). Otherwise increase the sweep speed as possible to increase the resolution of the oscilloscope to a value comparable to the 5 degree per division set up.

Adjust the horizontal position of the oscilloscope to place the zero crossing of the RF drive signal in the center of the oscilloscope. The oscilloscope has now been set up to measure degrees of phase shift relative to the drive signal across the R13 position.

Move the oscilloscope probe to R14, the next RF drive test point.

If the oscilloscope trace passes exactly through the center of the screen, the phase of the drive across R14 is the same (0 degrees) as across R13. If the zero crossing on the oscilloscope occurs somewhere other than the center of the screen, then that drive signal differs from the R13 reference by an amount which can be measured according to the calibration setup.

Check the phase of the drive signals across R23, R24, R33, R34, R43, and R44 on each PA module.

Total variation in drive phasing should be no more than +/-5 degrees.

Possible causes for RF drive phase imbalance are:

Failed PA Transistors. A simple ohmmeter check of the transistors will nearly always identify defective ones. Failed transistors should also present problems which are more easily identified than drive phase error, such as reduced power output, PA VOLTS/AMPS ratio change, blown fuse, low RF drive voltage, etc.

Frequency Determined Component Wrong. Check to see that the PA input tuning components such as L14, C10, R11, L13, and R13 are properly soldered and are in good physical condition. If any of these components have recently been installed, recheck their values. To determine if the fault is with the PA module or the drive cable, make an impedance measurement of each drive input.

Bad RF Drive Cable. The RF drive cable consists of eight individual coaxes. If the shield of one coax is open, the drive will be different for one set of transistors. Remove the RF drive cable from the splitter board. An ohmmeter check between all shields on the splitter end of the cable should show zero ohms if the other end is still plugged into the PA. Be sure to flex the cable some to check for intermittent connections.

Bad RF Drive Transformer. If possible, make comparisons between the RF impedance at each PA input (L14, L15, L24, L25, L34, L35, L44, and L45). An input which measures an unusual voltage or phase will also have an unusual impedance. If you have identified an input which has an unusual impedance, you will need to determine the cause. This can be accomplished by swapping transistors, and making comparison impedance measurements while short circuiting the terminals of the RF drive transformers.

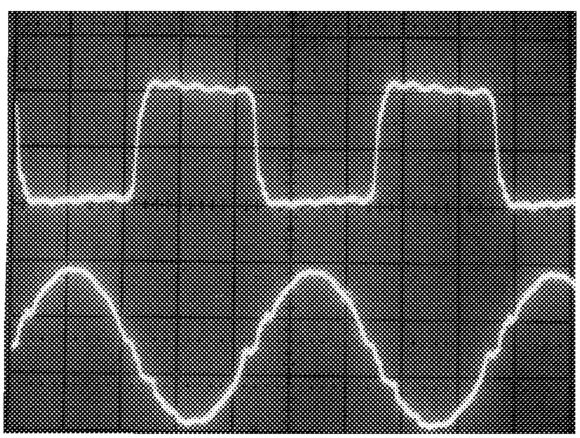


Figure C-3
Upper Trace - PA Output Amplitude Equal to PA Voltage
Lower Trace - PA Inputs, 26-32Vp-p

PWA, PA MODULE - 992 9714 001

Harris PN	*Description*	*QTY UM*	*Reference Designators (H)*
000 0000 010	B/M NOTE:	0.0 EA	C010 C015 C020 C025 C030 C035 C040 C045 L014 L015 L024 L025 L034 L035 L044 L045
350 0037 000	RIVET POP .125X.265	3.0 EA	
354 0309 000	TERM SOLDER	56.0 EA	E002 E003 E004 E005 E006 E007 E008 E009 E010 E013 E014 E015 E016 E017 E018 E019 E020 E023 E024 E025 E026 E027 E028 E029 E030 E033 E034 E035 E047 E048 E049 E050 E051 E053 E054 E055 E056 E057 E058 E060 E061 E063 E064 E065 E067 E068 E069 E070 E072 E073 E074 E075 E076 E077 E078 E079
358 2837 000	STUD, PC BD 4-40 X 5/16	10.0 EA	

WARNING: Disconnect primary power prior to servicing.

			#E011 #E012 #E021 #E022 #E031 #E032 #E041 #E042 E1 AND BELOW F11
358 3032 000	STANDOFF 4-40 1/2L 1/4HEX	10.0 EA	E001 E001A E011 E012 E021 E022 E031 E032 E041 E042
380 0681 000	XSTR IRFP350 ESD	16.0 EA	Q011 Q012 Q013 Q014 Q021 Q022 Q023 Q024 Q031 Q032 Q033 Q034 Q041 Q042 Q043 Q044
382 0355 000	IC, 4N25 ESD	1.0 EA	U001
382 0707 000	IC, LM335AZ ESD	1.0 EA	TC001
384 0020 000	RECTIFIER IN4005 ESD	8.0 EA	CR011 CR012 CR021 CR022 CR031 CR032 CR041 CR042
384 0777 000	RECTIFIER MR504 ESD	4.0 EA	CR013 CR023 CR033 CR043
386 0412 000	ZENER, DUAL 18V 3W ESD	16.0 EA	CR117 CR118 CR119 CR120 CR217 CR218 CR219 CR220 CR317 CR318 CR319 CR320 CR417 CR418 CR419 CR420
398 0403 000	FUSE, RECTIFIER 3A 250V	8.0 EA	F011 F012 F021 F022 F031 F032 F041 F042
402 0129 000	CLIP, 1/4 DIA FUSE	16.0 EA	XF011 XF012 XF021 XF022 XF031 XF032 XF041 XF042
410 0413 000	INSULATOR PAD FOR TO-247	16.0 EA	
494 0395 000	CHOKE 40UH 2 AMP	8.0 EA	L011 L012 L021 L022 L031 L032 L041 L042
494 0398 000	CHOKE RF 10.0UH +/- 10%	8.0 EA	L013 L016 L023 L026 L033 L036 L043 L046
506 0246 000	CAP 0.47UF 63V 5%	1.0 EA	C001
508 0537 000	CAP .047 UF 600WVDC 5%	8.0 EA	C016 C017 C026 C027 C036 C037 C046 C047
508 0538 000	CAP .15 UF 400WVDC 5%	8.0 EA	C012 C014 C022 C024 C032 C034 C042 C044
508 0554 000	CAP 3300PF 600WVDC	8.0 EA	C018 C019 C028 C029 C038 C039 C048 C049
516 0081 000	CAP, DISC .01UF 1KV 20%	8.0 EA	C011 C013 C021 C023 C031 C033 C041 C043
516 0453 000	CAP .1UF 100V 20% X7R	1.0 EA	C050
540 1600 118	RES 51 OHM 3W 5%	8.0 EA	R011 R012 R021 R022 R031 R032 R041 R042
540 1600 123	RES 82 OHM 3W 5%	16.0 EA	R013A R013B R014A R014B R023A R023B R024A R024B R033A R033B R034A R034B R043A R043B R044A R044B
540 1600 417	RES 47K OHM 3W 5%	1.0 EA	R001
610 0830 000	HEADER, 10 PIN PC RIBBON	1.0 EA	J001
610 0873 000	HEADER KIT, 20 PIN EJECT	1.0 EA	J002
612 0301 000	JACK BANANA BRASS	4.0 EA	J011 J021 J031 J041
612 0401 000	JACK, BANANA	1.0 EA	J003
614 0909 000	TERM STRIP, 3C PCB MODULAR 237	17.0 EA	TB001 TB002 TB003 TB004 TB005 TB006 TB007 TB008 TB009 TB010 TB011 TB012 TB013 TB014 TB015 TB016 TB017
817 0914 015	SPACER	1.0 EA	#J003
817 0914 021	SPACER	4.0 EA	#J011 #J021 #J031 #J041
843 5400 161	SCH, PA MODULE	0.0 EA	
843 5400 163	PWB, PA MODULE	1.0 EA	
843 5400 266	COMPONENT LOCATOR,PA MODULE BD	0.0 EA	
922 1295 001	HEATSINK, PA MODULE	1.0 EA	
922 1295 002	SPACER, PA MODULE	1.0 EA	
939 5695 054	TRANSFORMER, TOROID	8.0 EA	T011 T012 T021 T022 T031 T032 T041 T042
999 2889 001	HARDWARE LIST, PA MODULE	1.0 EA	

WARNING: Disconnect primary power prior to servicing.

SECTION D
OUTPUT NETWORK

D.1. Principles of Operation

The Output Network is a Butterworth bandpass filter which passes the carrier frequency but attenuates all harmonics, and a TEE section which matches to a range of impedances on the transmitter output terminal.

The bandpass filter consists of a series resonant LC section (L1-C1), a parallel resonant tank circuit (L2-C2), series capacitor C3, and a portion of the Tuning coil.

In addition to being part of the bandpass filter, the L1 and L2 coils provide adjustments which are used in the factory setup for matching the PA output to the network. The PA combining impedance, as measured looking into the network is roughly 7 ohms per PA module, and a slightly negative reactance depending on carrier frequency.

The TEE matching network, which the Tuning and Loading controls are part of, is designed with a 45 degree phase shift. This results in minimal interaction between the two controls.

The normal input and output impedance for the TEE network is 50 ohms. However, the TEE network is designed with the capability to match an output impedance of up to a 1.5:1 VSWR. This allows the PA module(s) to be tuned to the most desirable impedance, given a range of output load impedances.

The shunt leg of the TEE network functions as a third harmonic trap as well as being a part of the impedance matching.

D.2. Adjustment Procedures

D.2.1. Tuning And Loading Controls

The Tuning and Loading controls are basically to be adjusted for a null in the VSWR Detector Null reading on the multimeter. This adjustment achieves 50 ohm j0 at a certain point in the Output Network.

However, it should also be recognized that it is possible at many frequencies to have a setting of the Tuning and Loading controls which result in obtaining the wrong 50 ohm point. This wrong 50 ohm point would only be found by changing the controls dramatically from the factory setting.

The wrong 50 ohm point is one in which a larger than normal portion of both the Tuning and Loading controls is used. The bandwidth of the network will be reduced, and more stress will occur on the C4 capacitor in the Output Network.

Finding the correct 50 ohm point is a matter of initially setting both coils at minimum inductance, which is with their taps at the top of the coils.

As the coils are then adjusted downward for 50 ohms (whether by impedance measurement or by nulling the VSWR Detector reading), the first setting where 50 ohms is achieved is the correct setting.

D.2.2. Output Network Cold Tuning

The Output Network will not likely require complete adjustment unless you change frequency. The information is included here for that purpose, or for checking of its alignment if there are concerns about its adjustment.

WARNING

ENSURE ALL VOLTAGE HAS BEEN REMOVED FROM TRANSMITTER AND GROUNDING STICK IS USED TO GROUND ALL POINTS WHERE AC OR RF POWER HAS BEEN APPLIED BEFORE PROCEEDING.

The following paragraphs describe a cold tuning procedure for the Output Network. All voltage must be removed from the transmitter in order to cold tune the Output Network. Tuning the Output Network should not be attempted in the presence of an RF field on or near the frequency of the transmitter. For example, the procedure for set up cannot be used while a standby transmitter is on. The presence of an RF field on the same or adjacent frequency will severally impair achieving proper adjustment.

D.2.2.1. *Third Harmonic Trap L7-C4*

Disconnect from the TUNING coil (A21L4) the strap which goes to A21L7, the third harmonic coil. This will separate the third harmonic trap circuit from the rest of the Output Network.

Adjust L7 for resonance (minimum impedance) at the third harmonic of the carrier frequency. This may be accomplished with an RF bridge, vector impedance meter, or any suitable impedance measuring device connected between L7 and ground near A21C4.

Resonance may also be determined with a variable RF generator when used with an oscilloscope and a resistor. Put a 10k ohm resistor in series with the RF signal going to the trap circuit. Connect the oscilloscope with a low capacitive probe to the trap coil. Resonance occurs at the frequency where the amplitude on the oscilloscope is minimum.

D.2.2.2. *Bandpass Filter L2-C2*

Disconnect the strap which connects to the input side (towards rear of transmitter) of A21 C3.

Disconnect the strap which connects to the feedthrough bolt on the enclosure containing A21L1 and A21C1.

Connect an RF bridge, vector impedance meter, or any suitable impedance measuring device between the strap which was disconnected from A21 C3 and ground.

L2-C2 is set for resonance (maximum impedance) at the carrier frequency. Adjust L2 by rotating the entire coil. It will be necessary to loosen mounting hardware in order to accomplish this.

CAUTION

THE RESONANT FREQUENCY OF L2-C2 MUST BE MEASURED ONLY WHEN THE REAR PANEL IS INSTALLED. A FREQUENCY SHIFT OF APPROXIMATELY 4 KHZ WILL BE NOTED WHEN THE REAR PANEL IS OPEN.

Due to the close proximity of the rear panel, it is necessary to have the rear panel installed for reading the exact resonance of L2-C2. L2-C2 should be set to resonance no more than 2 kHz from carrier frequency.

At resonance the impedance of L2-C2 is 2500 ohms or more.

D.2.2.3. *TEE Network - Load and Tune*

Reconnect L2-C2 to A21 C3. The strap to the feedthrough bolt on the L1-C1 enclosure should still be disconnected.

Connect the RF bridge to the bracket (rear) end of A21 L2.

Before beginning the following adjustment procedure, rotate the LOADING coil and the TUNING coil to the right until both stop. This should put the sliding taps of the Tuning and Loading controls at the top of their range. This should put the coils at minimum inductance.

While monitoring the RF bridge, adjust the LOADING and TUNING coils for 50 ohms j0 but do not adjust either coil more than one complete turn without first adjusting the other coil.

Reconnect the strap to the L1-C1 Feedthru bolt. Disconnect PA module A1 from L1. Connect an RF Bridge to L1 (where A1 was disconnected) and ground.

NOTE

Refer to factory test data sheet for data on the PA combining impedance.

D.2.2.4. *L2 Sliding Tap*

The tap on L2 is set for the correct loading of the PA module. The impedance that the

PA module operates into is a complex impedance, with the resistive part being approximately 7 ohms per PA module.

Sliding the tap towards the ground end of L2 will result in heavier loading of the PA.

D.2.2.5. *L1 Tap*

L1 sets the reactive component that the PA modules should operate into. The PA normally sees a negative reactance with a value depending on frequency and performance related conditions.

SECTION E
OUTPUT MONITOR (A18)

E.1. Principles of Operation

The Output Monitor board provides the VSWR detection, the dc voltage sample for the Power Output meter, and an adjustable RF Output sample for the six power levels.

The VSWR detector consists of a circuit to detect any difference between an RF voltage sample and an RF current sample taken from the Output Network at the back end of L2.

The two RF samples are matched up in amplitude and phase on the Output Monitor board by C13 and C15. With these samples being equal in all respects, there is no differential applied to the primary of T1.

However, a change in impedance in the Output Network will alter the amplitude and/or phase relationship of these two signals. This will create a difference signal which T1 will couple to the diode circuit for rectification.

The diode circuit creates a dc voltage which is read on the VSWR Detector Null reading on the Multimeter. This same dc voltage is used by the VSWR trip circuit for transmitter protection.

For the Power Output Meter, the RF current sample is rectified, filtered, and sent to the Controller board.

The Modulation Monitor sample is provided by a toroidal pickup in the Output Network. Relays K1 through K5 switch rheostats in circuit to affect the sample voltage so that the monitor sample may be the same for all six power levels.

E.2. Replacement/Alignment

If the Output Monitor needs to be realigned for any reason or replaced, the following procedure applies.

Before aligning the VSWR detector circuit, it is important that the Output Network be properly tuned for 50 ohms j0 at the bracket at the back end of L2. Refer to the description of Output Network tuning in Section D.

With the Tuning of the Output Network having been verified as good, disconnect plug P1 from the Output Monitor, and connect an RF generator tuned to the carrier frequency across R18. Connect a scope at the junction of L4 and C11.

Adjust trimmer capacitor, C14, to minimize the signal as seen on the scope. This resonates the primary circuit of the VSWR Detector Null transformer, T1.

Plug P1 back in. Turn the transmitter back on, and alternately adjust C13 and C15 to minimize the VSWR Detector Null reading on the multimeter. This matches the VSWR Detector circuit to the 50 ohm tuning of the Output Network.

The monitor sample levels should be set according to the needs of your particular monitor. If you are not connecting a modulation monitor to J3, then leave rheostats R8, R11, R23, R24, R27, and R30 fully counterclockwise. This will result in no power being lost in the rheostats.

E.3. Troubleshooting

E.3.1. Symptom: Detector Null Reading Is High and Cannot Be Adjusted To Zero.

Possible causes:

E.3.1.1. *Bad Load Impedance*

Verify that the load impedance is normal. There should be 50 ohms j0 at the bracket end of L2.

E.3.1.2. *Sample Signal Missing*

Given that the impedance at the L2 bracket is normal, the most likely cause for the problem is that one of the RF samples is missing. Check for presence of RF at both inputs of the detector circuit (J1-5 and J1-7). It takes both inputs, equal in amplitude and phase, to have zero output from this circuit.

If the RF current sample is missing, the Power Meter should also read zero. This might be caused by a broken wire leading up to the toroid, or possibly the protection diode A18CR11 on the toroid assembly A18T1 is shorted. This assembly is located on the bracket end of L2.

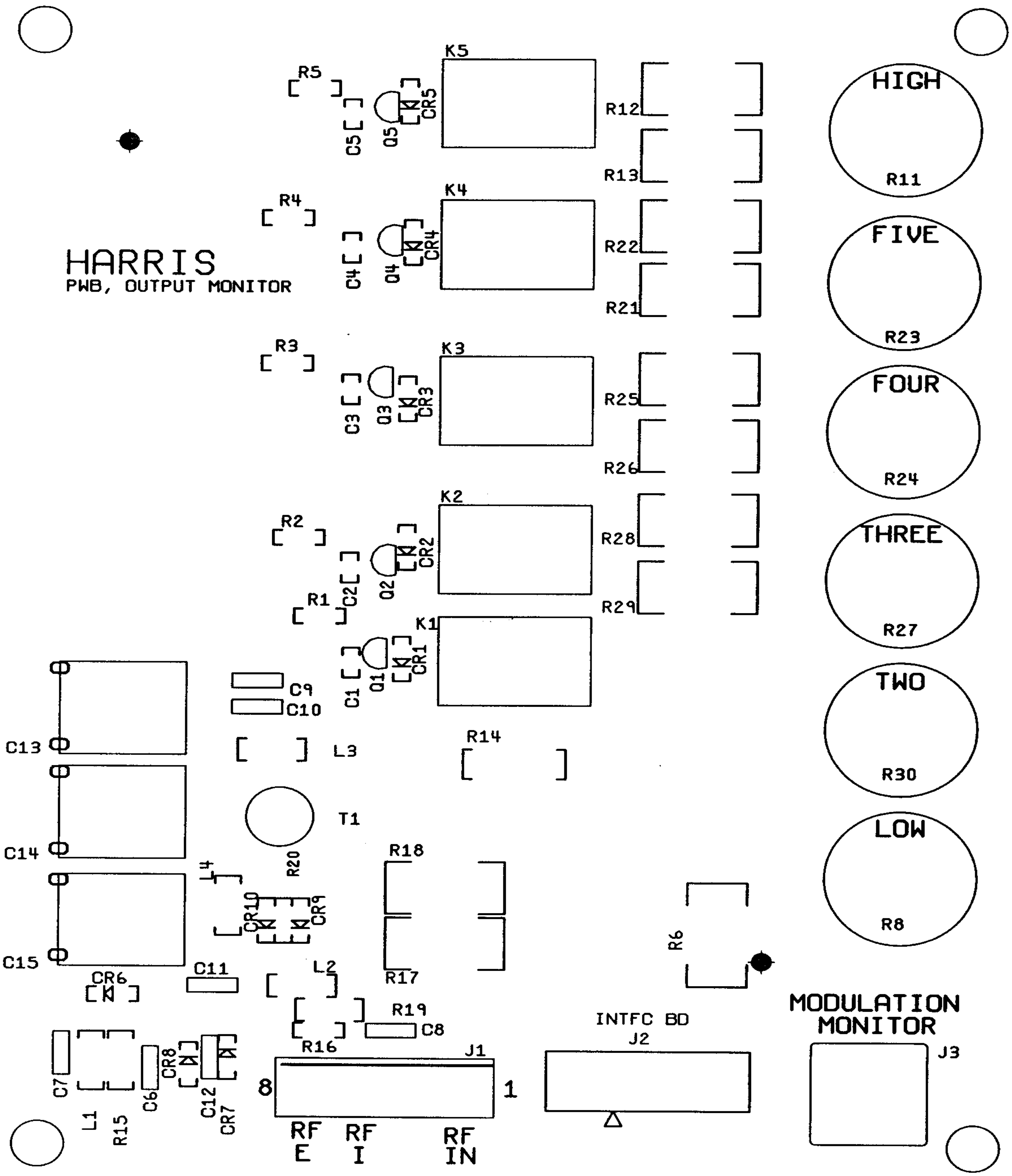


Figure E-1. Output Monitor Board

OUTPUT MONITOR - 992 8144 001

Harris PN	Description	QTY UM	Reference Designators (N)
000 0000 000	SHADOW&PAPER B/M COMPARED	0.0 EA	C009 C010 L002 L003 L004
254 0001 000	WIRE, BUS CU 22AWG	1 FT	
335 0001 000	WASHER NYLON .149 ID	2.0 EA	
357 0056 000	NUT, HEX 4-40 NYLON WHITE	1.0 EA	
357 0066 000	SCREW 4-40 X 1/2	1.0 EA	
380 0125 000	XSTR, NPN 2N4401 ESD	5.0 EA	Q001 Q002 Q003 Q004 Q005
384 0321 000	*DIODE 5082-2800 ESD	2.0 EA	CR006 CR007
384 0612 000	DIODE 1N3070 ESD	7.0 EA	CR001 CR002 CR003 CR004 CR005 CR009 CR010
386 0085 000	ZENER, 1N4740A 10V ESD	1.0 EA	CR008
494 0198 000	CHOKE RF 10MH	1.0 EA	L001
500 0836 000	CAP, MICA, 500PF 500V	1.0 EA	C007
500 0841 000	CAP, 750PF 300V 5%	1.0 EA	C011
500 0844 000	CAP, MICA, 1000PF 100V 5%	1.0 EA	C008
500 0854 000	CAP, VAR, 300-1000PF 175V	3.0 EA	C013 C014 C015
500 0878 000	CAP, MICA, 1500PF 500V 5%	1.0 EA	C006
516 0453 000	CAP .1UF 100V 20% X7R	5.0 EA	C001 C002 C003 C004 C005
516 0891 000	CAP 0.100UF 10% 50V	1.0 EA	C012
540 1600 115	RES 39 OHM 3W 5%	2.0 EA	R017 R018
540 1600 201	RES 100 OHM 3W 5%	8.0 EA	R012 R013 R021 R022 R025 R026 R028 R029
540 1600 207	RES 180 OHM 3W 5%	1.0 EA	R006
540 1600 210	RES 240 OHM 3W 5%	1.0 EA	R014
548 2400 301	RES 1K OHM 1/2W 1%	6.0 EA	R001 R002 R003 R004 R005 R019
548 2400 347	RES 3.01K OHM 1/2W 1%	1.0 EA	R015
548 2400 366	RES 4.75K OHM 1/2W 1%	1.0 EA	R016
548 2400 569	RES 511K OHM 1/2W 1%	1.0 EA	R020
552 0292 000	RHEO 175 OHM 12.5W	6.0 EA	R008 R011 R023 R024 R027 R030
574 0474 000	RELAY SPDT 12VDC 3A	5.0 EA	K001 K002 K003 K004 K005
610 0830 000	HEADER, 10 PIN PC RIBBON	1.0 EA	J002
610 0831 000	HDR, STR, 8 PIN, RD	1.0 EA	J001
620 1677 000	RECEPTACLE, PC MT, BNC	1.0 EA	J003
650 0254 000	KNOB, ROUND	6.0 EA	
839 7920 019	SCHEM, OUTPUT MONITOR	0.0 EA	
843 5141 014	PWB, OUTPUT MONITOR	1.0 EA	
843 5400 258	COMPONENT LOCATOR, OUTPUT	0.0 EA	
917 0914 179	TRANSFORMER, PHASE ANGLE	1.0 EA	T001

SECTION F
PDM GENERATOR (A15)

F.1. Principles Of Operation

The purpose of the PDM Generator board is to produce the pulse width modulated signals which set up the carrier power and to convert the incoming audio to a PDM signal to modulate the transmitter.

The audio input circuitry starting at pins J1-5 and J1-7 is a balanced input terminated in 600 ohms with RFI filtering. Diodes CR1, CR2, CR3 and CR4 act as clamps to prevent the audio signals from going more than +/-15 volts.

Operational amps whose outputs are U1-7, U1-1 and U1-8 consist of a solid state transformer which converts the incoming balanced audio to a single ended signal at pin U1-8. R21 adjusts the audio input gain continuously from -10 dBm to +10 dBm. From there the audio may pass through a Bessel low pass filter through op amps U2-7 and U2-1. Switch 1 determines whether the Bessel filter is in the audio circuitry path or not.

This Bessel filter is switchable and just slightly rolls off the high frequency audio to prevent excessive overshoot of the PDM filter during square wave modulation.

Past S1, multiplier U15 acts as a modulation tracking amplifier and adds the dc from R105 and R107, and the audio through R31 into the power output control U12.

The analog power control signal from the Controller comes in on J1-3, and is amplified by U12. This IC outputs a dc power control signal with audio level tracking up and down with it. U12 provides this signal to the output comparators of the PDM generator. R111 is adjusted to give 0 pulse width when the analog power signal is at minimum.

The triangle wave circuitry of the PDM generator begins with U11, a 240 kHz oscillator whose output is a 5 volt peak-to-peak square wave. This signal is sent to divider U4. It divides the 240 kHz by 4 and produces two 60 kHz square waves whose phase relationship is 90 degrees apart. These two square waves drive the Op Amp integrators, consisting of U7 and U8.

The integrators produce triangle waves which are connected to the output comparators U9 and U10. These comparators develop the four phases of PDM signals using the two phases of dc/audio and the two phases of triangle waves. Each comparator IC produces outputs which are 180 degrees out of phase from each other. This occurs because the two polarities of audio cause comparator action at different halves of the triangle wave cycle.

Since one trangle wave is 90 degrees out of phase to the other, four phases of PDM are developed.

The 4 PDM signals leave the PDM Generator board on J2, and go to the PDM Amplifiers.

The outputs of comparators U9 and U10 are open collector outputs. The supply for the open collector outputs is derived from the emitter follower pair of Q4 and Q5. A HIGH input (about 5 volts) is supplied to J1-1 by the Controller board which will cause Q3 to conduct. This turns off Q6 and allows its collector to rise to +15 volts and the emitter followers Q4 and Q5 will apply about 14 volts to the output circuit.

During a PDM Interrupt a logic 0 is applied to J1-1 by the Controller board and the process above reverses. Zero volts is applied to the output circuit. Diodes CR20-CR23 are used to speed up the discharge of the capacitance of the coaxial cables from the PDM Generator to the PDM Amplifiers.

The +15 volt power supply starts with an RFI filter, L1 and C85. This filter rejects any RF energy that would be coupled in via the 20 volt supply on J1 pin 17 and 19. Diode CR14 prevents the input of voltage regulator U3 from going negative. CR16 on the output of U3 acts as a transient suppressor and prevents the output of the voltage regulator from going above approximately 15 volts. Diode CR15 protects U3 if there should be a short on the input. LED DS1 illuminates to indicate that the 15 volt supply is basically working.

This same discussion applies to the negative 15 volt supply except all the voltage polarities are reversed.

F.2. Replacement/Alignment

If you are replacing the PDM Generator board, or checking its adjustment, the following procedures should be used.

Set one of the front panel Power Level pots fully counter clockwise.

Connect an oscilloscope to an output of the PDM Generator at the right side of R45. This is the same point as the anode of CR23.

Turn the transmitter on at the power level that is set to zero.

Adjust R111 (zero power adjust) so that there is only a very narrow width pulse at the output of the PDM Generator. Then adjust R111 clockwise until the pulse just disappears. There should be no PA current, PA voltage or power output is observed on the front panel meters.

Operate the transmitter at a normal power level with the normal amount of audio applied. Adjust R21 for the desired amount of modulation.

F.3. Troubleshooting PDM Generator

F.3.1. Symptom: No Pulses At J4, Causing Zero Power Output from the Transmitter

Ensure that the REMOTE/LOCAL switch located on the Controller board is set to the LOCAL position before performing the checks outlined below. RF Drive and PDM are turned off when this switch is in REMOTE position and transmitter is turned off. After performing these checks, set the switch back to the REMOTE position.

Possible causes:

F.3.1.1. *Power Setting*

Check the PDM Power Level reading on the Multimeter. An up scale reading should produce pulses out of the PDM Generator.

F.3.1.2. *Loss of Plus and Minus 15 Volts*

Observe the +/-15 volt LEDS (DS1 and DS2) on the PDM Generator. These should be lit whenever low voltage is applied. Measure the +15 volts at the cathode of CR16 and -15 volts at the anode of CR19.

F.3.1.3. *PDM Interrupt*

Check the voltage at the emitter of Q4/Q5 on the PDM Generator. It should be about 15 volts. If it is near zero volts, check for +5 volts at J1-1. This is accessible on R100. The voltage at J1-1 is about 5 volts for normal operation and near zero during a PDM Interrupt. Q5 and/or Q6 may be at fault if 5 volts is present at J1-1, but no +15 volts is present at the emitter of Q4/Q5. A continuous PDM Interrupt signal (J1-1 low) would be the fault of circuitry on the Controller board.

F.3.1.4. *DC/Audio Failure*

Measure the voltage at DIP resistor R17 pin 2 and U1-14. Normally this will be 1 to 2 volts depending on PDM level.

Loss Of Triangle Waves. Using an oscilloscope, check at U9-9 and U10-9 for a 3.6-4.0 volts peak to peak 60 kHz triangle wave. If no triangle waves exist at U9 and U10, check for square waves at U4 pins 2 and 12.

If the square waves exist at U4 pins 2 and 12, but no triangle waves are on U 9 and

WARNING: Disconnect primary power prior to servicing.

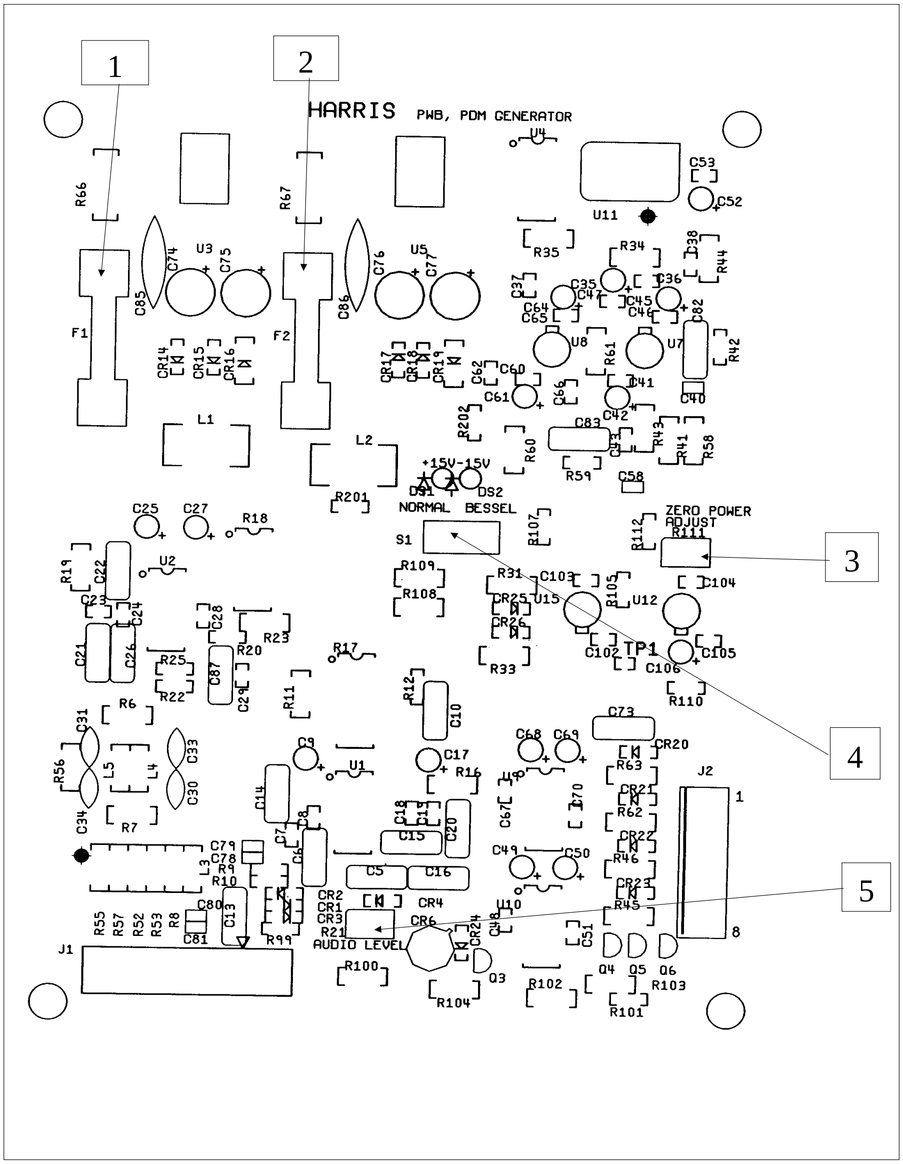


Figure F-1. PDM Generator, Controls and Indicators

Table F-1. PDM Generator, Controls and Indicators

1	+20V Fuse, A15F1	.5 Amp fuse (3AG) used to protect +20 volt supply from over current condition.
2	-20V Fuse, A15F2	.5 Amp fuse (3AG) used to protect -20 volt supply from over current condition.
3	Zero Power Adjust A15R111	
4	Flat/Bessel Select Control, A15S1	Selects type of frequency response transmitter will have. Highest modulation density will be obtained in BESSEL position, while flatter frequency response will be obtained in FLAT position.
5	Audio Input Level Adjustment, A15R21	Adjusts audio input level from -10 to +10 dBm.

U10, U7 and U8 are suspect. These are the integrator amplifiers which take a square wave inputs, and convert them to triangle waves.

If the square waves are not getting to integrator amplifiers U7 and U8, use the oscilloscope to check the output of the 240 kHz oscillator at U11-3. This should be a 240 kHz square wave close to 5 volts peak-to-peak.

If no such signal is present, U4 is possibly at fault. If U11 is working properly, use the scope to check the outputs of U4 at pins 2 and 12.

60 kHz square waves (5 V peak to peak) should be at pins 2 and 12.

F.3.2. Symptom: Imbalance In Output Pulse Widths

Possible causes:

F.3.2.1. *Audio Imbalance*

An imbalance in the two phases of the DC/AUDIO circuitry is characterized by an imbalance in the duty cycle between the two outputs of both threshold comparators U9 and U10. Each dual comparator is driven by one triangle wave and both phases of audio. Any duty cycle imbalance between the two outputs of either U9 or U10 is most likely caused by a failure of U1 or U2 in the DC/AUDIO circuitry.

Measure the voltages at DIP resistor R17 pin 7 and U1-14. These should be 2 volts or less, equal, and opposite in polarity. R17 pin 7 will normally be positive and U1-14 will be the negative mirror image. Major dissimilarities in the voltage at U1-14 and R17 pin 7 are probably caused by a failure of U1.

F.3.2.2. *Triangle Wave Imbalance*

An imbalance in the triangle waves driving the output comparators will result in the outputs of U9 differing from those of U10. If the DC/AUDIO balance is correct, both outputs of U9 will be the same, but will differ in pulse width from the outputs of U10.

Using an oscilloscope, check the triangle waves at U9-5 and U10-5 per Figure F-3. These signals should be exactly the same (except for their phase relationship). Each should be a 3.5-4.0 volt peak to peak 60 kHz triangle wave.

Differences in peak to peak amplitude may be caused by the square wave to triangle wave integrator, U7 or U8.

F.3.3. Symptom: Output(s) At J2 Always In A High State, Causing One or More Pdm Amplifiers to Conduct Full Time

This problem may be found without turning on the high voltage. Identify which output(s) of the PDM generator are at fault by connecting a voltmeter or oscilloscope to R45, R46, R62, and R63. The faulty output(s) will be as much as 14 volts positive if read on a voltmeter, or continuously high if observed on a scope (DC coupled). Refer to Figue F-4.

F.3.4. Symptom: Only One Output High

This is probably a fault of U9 or U10 depending on the output line in question.

F.3.5. Symptom: Two Outputs Are High

If the signals at R45 and R62 are both high, U1 most likely has failed. Check the voltage at U1-14. Normally it is -2 volts or less, but in this case it might be +2 volts or greater.

F.3.6. Symptom: All Four Outputs Are High

Check the PDM Level reading on the Multimeter. If it is excessively high (such as pinned) the problem would be on the Controller in the power level summing circuitry U19.

If the PDM Level is okay, the problem could be caused by U1, U2, U12 or U15 on the PDM Generator. Check the voltage at R17 pin 7. Normally it is +1 to +2 volts, but in this case may be further negative.

Check the output of the audio input amplifier at U1 pin 8. This should be practically zero volts. If it is not, try replacing U1.

If no fault is found with U1, try replacing U12.

U15 may be the cause of the problem if no other is identified.

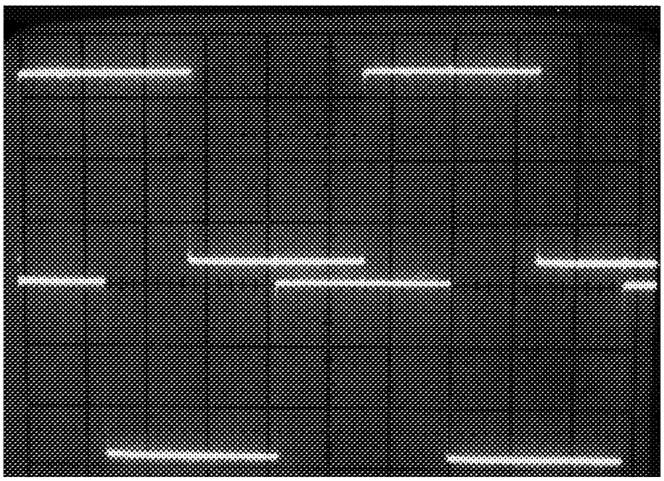


Figure F-2
Upper Trace - U4-2, 5Vp-p
Lower Trace - U4-12, 5Vp-p

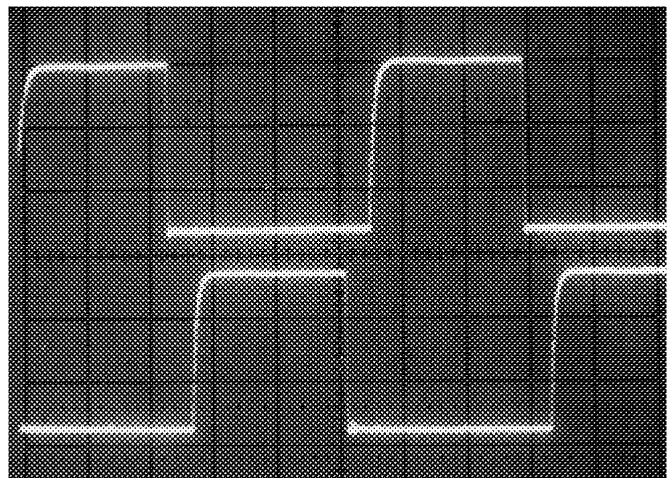


Figure F-4
Upper Trace - R63, right side, 13Vp-p
Lower Trace - R62, right side, 13Vp-p

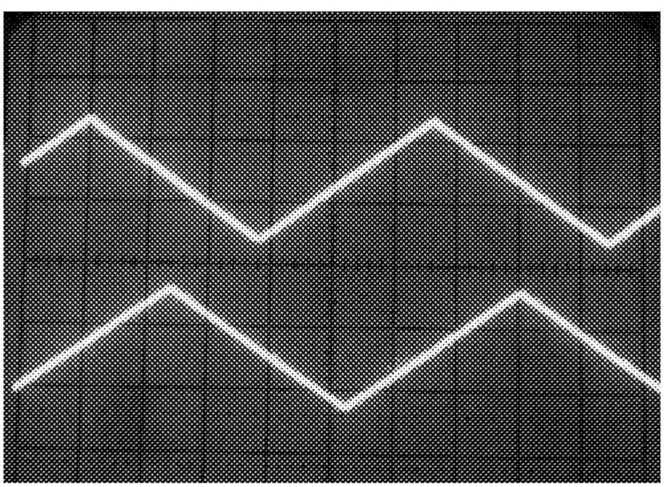


Figure F-3
Upper Trace - U9-5, 3.5-4Vp-p
Lower Trace - U10-5, 3.5-4Vp-p

PDM GENERATOR - 992 8145 001

Harris PN	Description	QTY UM	Reference Designators (Y)
380 0125 000	XSTR, NPN 2N4401 ESD	3.0 EA	Q003 Q004 Q006
380 0126 000	XSTR, PNP 2N4403 ESD	1.0 EA	Q005
382 0184 000	IC, 340T-5/7805 +5V REG ESD	1.0 EA	U006
382 0359 000	IC, 7815 ESD	1.0 EA	U003
382 0360 000	IC, 7915 ESD	1.0 EA	U005
382 0588 000	IC, 4013 ESD	1.0 EA	U004
382 0617 000	IC, LM319 ESD	2.0 EA	U009 U010
382 0711 000	*PRECISION IC MULTIPLIER ESD	2.0 EA	U012 U015
382 1038 000	IC, HA2-2605-5 ESD	2.0 EA	U007 U008
382 1664 000	IC, OP AMP, TL054 ESD	2.0 EA	U001 U002
384 0205 000	DIODE SILICON 1N914/4148 ESD	9.0 EA	CR001 CR002 CR003 CR004 CR020 CR021 CR022 CR023 CR025
384 0321 000	*DIODE 5082-2800 ESD	1.0 EA	CR024
384 0431 000	RECT. 1N4001 ESD	4.0 EA	CR014 CR015 CR017 CR018
384 0610 000	LED, GREEN ESD	2.0 EA	DS001 DS002
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	2.0 EA	CR016 CR019
386 0135 000	ZENER, 1N4733A 5.1V ESD	1.0 EA	CR026
386 0419 000	ZENER, LM236H 2.5V ESD	1.0 EA	CR006
398 0015 000	FUSE,FAST CART .500A 250V	2.0 EA	F001 F002
402 0129 000	CLIP, 1/4 DIA FUSE	4.0 EA	XF001 XF002
404 0250 000	HEAT SINK FOR TO-5 CASE	2.0 EA	#U007 #U008
404 0513 000	HEAT SINK PA1-1CB	2.0 EA	#U003 #U005
404 0674 000	SOCKET, DIP, 14 PIN (DL)	6.0 EA	XR018 XU001 XU002 XU004 XU009 XU010
410 0335 000	INSULATOR SCREW	1.0 EA	#U005
410 0344 000	INSULATOR KAPTON	1.0 EA	#U005
494 0190 000	CHOKE RF 3300UH 80MA	1.0 EA	L003
494 0419 000	IND 1000UH 10%	2.0 EA	L004 L005
494 0445 000	CHOKE HIGH CURRENT 470UH	2.0 EA	L001 L002
500 0759 000	CAP, MICA, 100PF 500V 5%	4.0 EA	C005 C010 C013 C015
500 0787 000	CAP, MICA, 200PF 500V 5%	4.0 EA	C006 C014 C016 C020
500 0827 000	CAP, MICA, 130PF 500V 5%	1.0 EA	C022
500 0832 000	CAP, MICA, 360PF 500V 5%	1.0 EA	C026
500 0836 000	CAP, MICA, 500PF 500V	1.0 EA	C087
500 0838 000	CAP, MICA, 560PF 300V 5%	1.0 EA	C021
500 0844 000	CAP, MICA, 1000PF 100V 5%	1.0 EA	C073
500 1218 000	CAP 820PF 300V 1%	2.0 EA	C082 C083
516 0074 000	CAP, DISC .005UF 1KV 20%	4.0 EA	C030 C031 C033 C034
516 0419 000	CAP .05 UF 500V	2.0 EA	C085 C086
516 0453 000	CAP .1UF 100V 20% X7R	28.0 EA	C007 C008 C018 C019 C023 C024 C028 C029 C036 C037 C038 C041 C043 C046 C047 C048 C051 C053 C060 C062 C065 C066 C067 C070 C102 C103 C104 C105
516 0511 000	CAP 0.47UF 100V 20%	6.0 EA	C040 C058 C078 C079 C080 C081
522 0572 000	CAP 3.3UF 50V 20%	10.0 EA	C035 C042 C045 C049 C050 C052 C061 C064 C068 C069
522 0573 000	CAP 47UF 63V 20%	4.0 EA	C074 C075 C076 C077
526 0049 000	CAP 6.8UF 35V 20%	4.0 EA	C009 C017 C025 C027
526 0342 000	CAP 2.7UF 35V 10%	1.0 EA	C106
540 1356 000	RES NETWORK 10K OHM 2%	1.0 EA	R017
540 1403 000	RES NETWORK 22K OHM 1/4W 2%	1.0 EA	R018
540 1600 015	RES 3.9 OHM 3W 5%	2.0 EA	R066 R067
548 2400 101	RES 10 OHM 1/2W 1%	4.0 EA	R043 R044 R060 R061
548 2400 201	RES 100 OHM 1/2W 1%	4.0 EA	R011 R016 R019 R023
548 2400 205	RES 110 OHM 1/2W 1%	5.0 EA	R052 R053 R055 R056 R100
548 2400 269	RES 511 OHM 1/2W 1%	2.0 EA	R102 R103
548 2400 281	RES 681 OHM 1/2W 1%	2.0 EA	R006 R057

548 2400 285 . .	RES 750 OHM 1/2W 1%	4.0 EA	R045 R046 R062 R063
548 2400 309 . .	RES 1.21K OHM 1/2W 1%.	1.0 EA	R099
548 2400 326 . .	RES 1.82K OHM 1/2W 1%.	1.0 EA	R104
548 2400 330 . .	RES 2K OHM 1/2W 1%	3.0 EA	R101 R201 R202
548 2400 366 . .	RES 4.75K OHM 1/2W 1%.	2.0 EA	R041 R058
548 2400 369 . .	RES 5.11K OHM 1/2W 1%.	2.0 EA	R012 R112
548 2400 377 . .	RES 6.19K OHM 1/2W 1%.	1.0 EA	R107
548 2400 378 . .	RES 6.34K OHM 1/2W 1%.	2.0 EA	R034 R035
548 2400 393 . .	RES 9.09K OHM 1/2W 1%.	1.0 EA	R020
548 2400 401 . .	RES 10K OHM 1/2W 1%	7.0 EA	R007 R008 R022 R025 R031 R033 R108
548 2400 430 . .	RES 20K OHM 1/2W 1%	1.0 EA	R109
548 2400 458 . .	RES 39.2K OHM 1/2W 1%.	2.0 EA	R105 R110
548 2400 601 . .	RES 1MEG OHM 1/2W 1%	5.0 EA	R009 R010 R042 R059 R113
550 0949 000 . .	TRIMPOT 100K OHM 1/2W 10%. . .	1.0 EA	R021
550 0956 000 . .	TRIMPOT 2K OHM 1/2W 10%.	1.0 EA	R111
604 0904 000 . .	SW, TGL SPDT.	1.0 EA	S001
610 0827 000 . .	HEADER, 20 PIN PC RIBBON.	1.0 EA	J001
610 0831 000 . .	HDR, STR, 8 PIN, RD	1.0 EA	J002
610 0933 000 . .	JUMPER, PWB TEST POINT	1.0 EA	TP001
700 1358 000 . .	XTAL OSC 240KHZ +5V CMOS . . .	1.0 EA	U011
839 7920 022 . .	SCHEM, PDM GEN	0.0 EA	
843 5141 017 . .	PWB, PDM GEN	1.0 EA	
843 5400 257 . .	COMPONENT LOCATOR, PDM . . .	0.0 EA	
999 2608 001 . .	HARDWARE LIST.	1.0 EA	

SECTION G
PDM AMPLIFIER/PULL-UP (A6-A9)

G.1. Principles of Operation

G.1.1. PDM Amplifier

The purpose of the PDM amplifier is to switch the PDM filter inputs to ground at a 60 kHz rate, determined by the pulses from the PDM generator.

The signal from the PDM generator is about 13 volts peak-to-peak, and comes in on J2-3 and J2-1 of the PDM Amplifiers. Plug P4 is positioned in 1 to 3 for a 5kW transmitter, and is positioned in 1 to 2 for a 1kW or 2kW transmitter. In the 1 to 3 position, it allows one PDM signal to drive all four transistors on the PDM amplifier. In the other case, this allows two phases of the PDM signal to drive two separate pairs of PDM amplifier transistors.

The PDM input signal passes through isolation resistors R11 and R31 and into current amplifiers U11 and U31. These IC's act as voltage followers and pass the PDM signal to the class B drivers (transistors Q13, Q14, Q15, Q16, Q35, Q36 and Q33 and Q34). Only one half of the PDM amplifier drive circuitry will be discussed; the other half has exactly the same operation.

The push-pull driver transistors Q13 and Q14 are voltage followers. The outputs from U11-3 and -5 are identical. Therefore when the voltage is high, coming out of U11, Q13 will be on; when the signal coming out of U11 is low, Q14 will be on.

Capacitor C14 in the base of transistor Q14 quickly discharges the base of Q14 when turning it off. CR14 clamps the gate voltage of transistor Q19 to approximately 15 volts and acts as a transient suppressor to absorb any voltage transients on the gate of transistor Q19.

Diodes CR12 and CR13 have two purposes. Their first purpose is to provide two diode drops for any offset voltages from transistor Q14 and U11 when the PDM signal is low. Their other purpose is to stand off the high voltage on the gate of Q19 if transistor Q19 should fail drain to gate.

Capacitors C17, C18 and C19 also have two purposes. The first is to pass the 60 kHz signal to turn off Q19; the second is again to prevent the chances of failing driver circuitry beyond CR14 if Q19 should fail, drain to gate. These capacitors then will charge up to the high voltage power supply and CR14 will clamp the voltage on the other side of the capacitors to approximately 15 volts. R21 acts as a pull down and load resistor to help prevent any accidental turn on of Q19.

Transistors Q19 and Q20 are in parallel and will share the current from the PDM filter. When the incoming PDM signal is high, Q19 and Q20 will be on and will short the PDM filter to ground. When the incoming PDM signal is low, transistors Q19 and Q20 will be off and the PDM filter will be un-terminated and its voltage will rise to the power supply voltage.

C23, C46, C47 and R23 form a snubber circuit. This circuit reduces the high voltage overshoot transient when Q19 turns off.

R25, R26, CR19, R27 and C25 form a PDM status indicator for the Controller and the front display panel. This detector is what provides the sample for the PDM Fault LED's.

PDM Pull-Up board fuse A6A1F1/F2 will open in the event of damper diode or PDM Amplifier MOSFET short circuit failures. If a PDM phase line is short circuited on the output side of A6A1F1, there will be 0 voltage sent to the Controller through this circuit on J1 pin 7. If PDM Amplifier MOSFET (Q19 or Q20) or the associated damper diode is short circuited, a higher voltage than normal will be sent to the Controller on J1 pin 7 because A6A1F1/F2 will have opened. The PDM filter makes connection to the PDM amplifiers at jacks J5 and J6.

Damper diode CR1 prevents the voltage at the input side of the PDM filter from rising above the high voltage power supply when the PDM amplifier transistors turn off. The damper diodes make connection to the power supply through the PDM pull up board.

G.1.2. PDM Pull-Up Board

The purpose of the PDM pull-up board is to provide the connection for the damper diode circuit and to reduce distortion at low power levels. Point E2 is connected to the high voltage power supply. It is also bypassed with a large electrolytic capacitor. C1 and C3 also provide additional switching rate bypassing for the damper diode on the PDM amplifier.

As a function separate from PDM pull-up action, fuse A6A1F1/F2 provides over current protection if either the associated PDM Amplifier MOSFET's (Q19 or Q20) or damper diode on the PDM Amplifier module short.

The PDM pull-up signal comes in on J1 from a heavily averaged current source which is formed by A19L1, a two henry choke and A19R20, a 500 ohm resistor. This circuit compensates for stray capacitance in the PDM Amplifier and reduces low power distortion.

G.2. Maintenance

G.2.1. PDM Amplifiers

NOTE

If a PDM AMPLIFIER fails shorted when operating at a reduced power, there will be an increase in the carrier power. The fuses will not necessarily blow because of the relatively low total transmitter power. In this case, it may be impossible to lower the output power to an acceptable level, and the transmitter will have distorted audio. If this condition occurs, the transmitter should be removed from service and maintenance personnel alerted to the problem as quickly as possible. The failed amplifier may be isolated by removing the correct fuses from the PDM Pull Up board.

G.2.2. Gate Drive Checks

NOTE

Ensure that the REMOTE/LOCAL switch located on the Controller board is in the LOCAL position before performing the checks outlined below. When the switch is in the REMOTE position, RF Drive and PDM are disabled.

After performing these checks, set the switch back in the REMOTE position.

Check jumper plug P4 next to the molex connector J2 to ensure it is between the correct terminals for your transmitter.

With only the low voltage on, check the PDM drive to the output transistors of the PDM Amplifiers. Connect an oscilloscope across R21, R22, R41 and R42 on the PDM Amplifiers with the ground side is away from the output transistors.

A 13 volts peak-to-peak 60 kHz pulse should be found at all eight resistors. The resistors are 47,000 ohms, 2 watts each.

When replacing the PDM Amplifier module, be sure an even coating of thermal compound is applied to the mating heat sink surfaces. Be certain to tighten down the captive fasteners which mount the PDM Amplifier module to the heat sink. Be especially sure to tighten the captive fastener which attaches the PDM Pull Up board to the large capacitor.

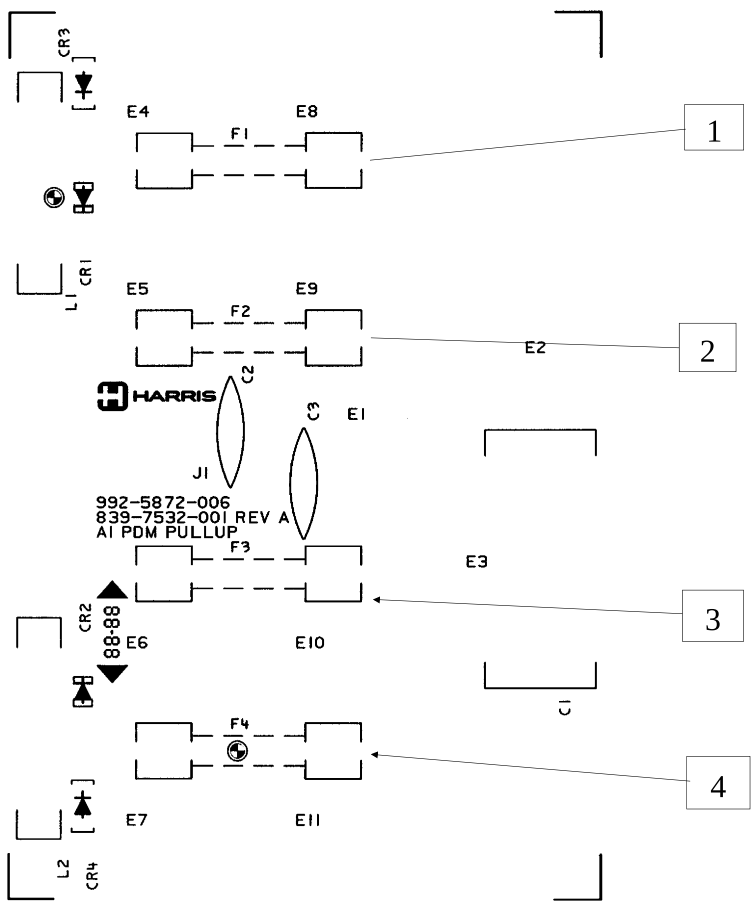


Figure G-1. PDM Pull-Up Board, Controls and Indicators

Table G-1. PDM Pull-Up Board, Controls and Indicators

1,2,3,4	A6A1F1-F4 (A6A1 located at rear of transmitter).	Disconnects the PDM Amplifier/Damper Circuitry from PA Amplifier during an excessive supply current condition.
1,2,3,4	A7A1F1-F4 (A7A1 located at rear of transmitter).	Disconnects the PDM Amplifier/Damper Circuitry from PA Amplifier during an excessive supply current condition.
1,2,3,4	A8A1F1-4 (A8A1 located at front of transmitter).	Disconnects the PDM Amplifier/Damper Circuitry from PA Amplifier during an excessive supply current condition.
1,2,3,4	A9A1F1-4 (A9A1 located at front of transmitter).	Disconnects the PDM Amplifier/Damper Circuitry from PA Amplifier during an excessive supply current condition.

CAUTION

ENSURE THAT THERMAL COMPOUND IS APPLIED TO PLATES OF THE PDM AMPLIFIER BOARDS BEFORE THEY ARE INSTALLED ON HEAT SINKS AND THAT HARDWARE SECURING BOARD TO HEAT SINK IS PROPERLY TORQUED TO 6-INCH POUNDS. ALSO INSURE NO BURRS OR DIRT PARTICLES ARE ON THE MATING SURFACES, AS THESE WILL IMPAIR THE HEAT SINKING.

G.2.3. In-Circuit Ohmmetering the PDM Amp Module (A6 thru A9) MOSFET's

WARNING

REMOVE ALL PRIMARY POWER AND DISCHARGE ALL HIGH VOLTAGE COMPONENTS WITH GROUNDING STICK BEFORE PERFORMING THE FOLLOWING PROCEDURE.

Remove all primary power and discharge all high voltage components with grounding stick.

Check fuses F1-F4 on PDM Pull-Up boards A6A1-A9A1. If open fuses are discovered replace as necessary but complete this troubleshooting procedure prior to reactivating the transmitter.

With the positive lead toward the heat sink, measure across R21, R22, R41, and R42 using ohmmeter. Each should read 47k ohms. If the ohmmeter shows a short, the transistor connected with that resistor has failed. This is only a check of the MOSFET gate circuit to see if it is shorted, but it is usually the only test needed to identify defective transistors.

If the ohmmeter checks across R21, R22, R41 and R42 appear normal, but a PDM Amplifier module is strongly suspected of having a shorted transistor, ohmmeter check the drain circuit.

Remove the PDM pull-up board fuses from A6 thru A9. Check the resistance from E8, E9, E10, and E11 of each board to ground. Each should measure greater than 700k ohms. A low reading indicates that a circuit element attached to the output side of E8, E9, E10 or E11 is probably short circuited. Next measure from the case to ground respectively on Q19, Q20, Q39 & Q40 of modules A6-A9. All should measure at least 2 Meg ohms. A low reading is indicative of a short circuited transistor.

If it is necessary to replace one of the power MOSFET's (Q19, Q20, Q39, or Q40) refer to the paragraphs on Handling MOSFET's and Testing MOSFETS before beginning.

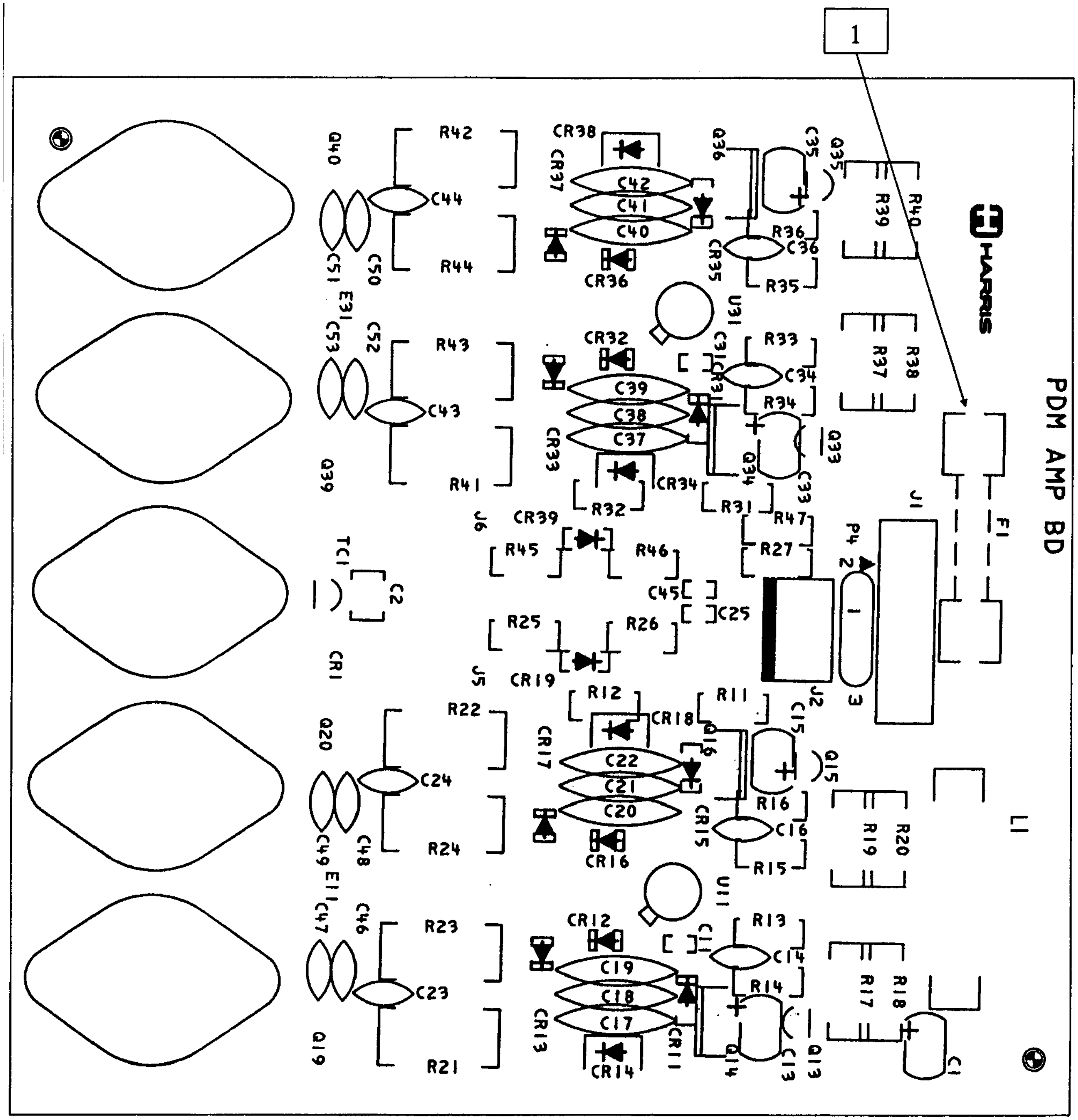


Figure G-2. PDM Amplifiers, A6 thru A9

Table G-2. PDM Amplifiers, A6 thru A9
Controls and Indicators
Controls and Indicators

F1	A6F1 (A6 located at rear of transmitter)	Protects +20 volt supply from over current surges on PDM Amp Board A6.
F1	A7F1 (A7 located at rear of transmitter)	Protects +20 volt supply from over current surges on PDM Amp Board A7.
F1	A8F1 (A8 located at front of transmitter)	Protects +20 volt supply from over current surges on PDM Amp Board A8.
F1	A9F1 (A9 located at front of transmitter)	Protects +20 volt supply from over current surges on PDM Amp Board A9.

G.2.3.1. *Checking Gate Drive*

Apply low voltage only to the transmitter. Make sure the transmitter is off by depressing the OFF pushbutton.

Use an oscilloscope to check the PDM drive signals across R21, R22, R41, and R42 on the PDM Amplifiers A6 thru A9. There should be a 15 volt peak-to-peak 60 kHz pulse at each of the eight locations (only two PDM Amplifiers are used in a GATES ONE or TWO).

If the gate drive is missing on any of the resistors listed, it will be necessary to trace the signal backwards through the amplifier to find where it has been lost. The PDM pulses should not change visibly as they are traced from the PDM Generator to the gates of the PDM Amplifier transistors.

G.3. Handling MOSFET's

Due to the fragile nature of the gate of a MOSFET, special care in their handling is required. The gate junction may be destroyed by static electricity if the static electricity is allowed to discharge through the MOSFET. For example, walking across a carpet to pick up a MOSFET that is not protected by antistatic packaging could result in the destruction of the MOSFET. A static charge could build up on a person as they walk across the carpet. This static charge will eventually have to be discharged. Discharging to the MOSFET could damage the MOSFET.

NOTE

MOSFET transistors which are in circuit in the GATES Series™ transmitters are immune to this damage.

The MOSFET transistors are shipped in antistatic packaging. The transistors should remain in this packaging until they are to be used or tested.

G.4. Testing MOSFET's

The MOSFET's used in the GATES Series™ transmitters may be checked with an ohmmeter. However there is a requirement which restricts the use of some ohmmeters. If the battery voltage is too low (under 3V) or too high (over 20V) the ohmmeter cannot be used. A battery voltage less than 3V will not give an operational check of the transistor and a battery voltage greater than 20V may result in damage to the transistor under test. A Simpson 260, which uses a 9V battery on the Rx10k scale works quite well.

The following test applies to all MOSFET's used in the transmitter, but is not necessarily applicable to MOSFET's used in other equipment.

This test will show how a MOSFET can be switched "on" and "off" by charging and discharging the gate of the MOSFET.

Refer to Figure G-4 for the following test.

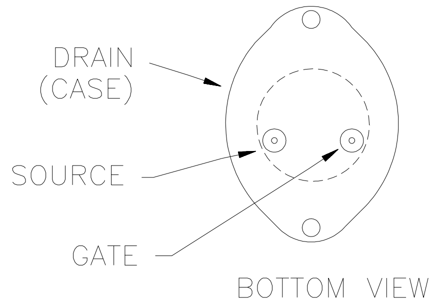


Figure G-4. Outline of MOSFET

Connect the positive lead of the ohmmeter to the source of the transistor. Momentarily connect the negative lead to the gate and then connect it to the source. Then connect the positive lead to the drain (case). The ohmmeter should read at least 2 megohms.

Remove the positive lead from the case and momentarily touch it to the gate. Reconnect the positive lead to the case. The ohmmeter should read very near zero ohms.

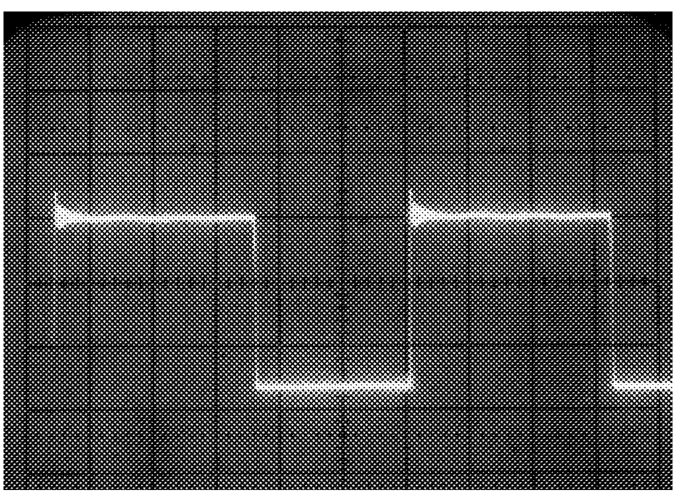


Figure G-3

* PDM AMP BOARD * - 992 5872 005

Harris PN	Description	QTY UM	Reference Designators (AC)
296 0259 000 . .	TUBING TEFLON 18 AWG	0.0 FT	#CR1
304 0087 000 . .	NUT, HEX 4-40	3.0 EA	#CR1 STUD #E11 #E31
308 0003 000 . .	NO 4 FLAT WASHER BRS	13.0 EA	#2CR1 #2Q19 #2Q20 #2Q39 #2Q40 #CR1 STUD #E11 #E31
312 0045 000 . .	WASHER, SPLIT-LOCK 4	8.0 EA	#CR1 #CR1 STUD #E11 #E31 #Q19 #Q20 #Q39 #Q40
312 0051 000 . .	WASHER, SPLIT-LOCK 1/4	2.0 EA	#J5 #J6
335 0104 000 . .	WASHER PLAIN .156 ID	5.0 EA	#CR1 STUD #Q019 #Q020 #Q039 #Q040
358 3032 000 . .	STANDOFF 4-40 1/2L 1/4HEX.	9.0 EA	#Q019 #Q020 #Q039 #Q040 #CR001
380 0125 000 . .	XSTR, NPN 2N4401 ESD	4.0 EA	Q013 Q015 Q033 Q035
380 0587 000 . .	XSTR, MJE210 ESD	4.0 EA	Q014 Q016 Q034 Q036
380 0649 000 . .	* XSTR, IRF350 ESD	4.0 EA	Q019 Q020 Q039 Q040
382 0172 000 . .	*IC, LH0002CH ESD	2.0 EA	U011 U031
382 0707 000 . .	IC, LM335AZ ESD.	1.0 EA	TC001
384 0020 000 . .	RECTIFIER IN4005 ESD.	8.0 EA	CR012 CR013 CR016 CR017 CR032 CR033 CR036 CR037
384 0205 000 . .	DIODE SILICON 1N914/4148 ESD.	6.0 EA	CR011 CR015 CR019 CR031 CR035 CR039
384 0720 000 . .	TRANSZORB 1N6377 15V 5W ESD	4.0 EA	CR014 CR018 CR034 CR038
384 0862 000 . .	RECTIFIER, 400V 30A ESD	1.0 EA	CR001
398 0019 000 . .	FUSE, FAST CART 2A 250V	1.0 EA	F001
402 0129 000 . .	CLIP, 1/4 DIA FUSE	2.0 EA	XF001
404 0250 000 . .	HEAT SINK FOR TO-5 CASE	2.0 EA	#U011 #U031
410 0232 000 . .	INSULATOR TO-3 MICA	4.0 EA	#Q019 #Q020 #Q039 #Q040
410 0382 000 . .	INSULATOR #4 SCREW	4.0 EA	#Q019 #Q020 #Q039 #Q040
410 0384 000 . .	INSULATOR #4 SCREW	6.0 EA	#CR001 #Q019 #Q020 #Q039 #Q040
410 0413 000 . .	INSULATOR PAD FOR TO-247. . . .	1.0 EA	#CR001
494 0395 000 . .	CHOKE 40UH 2 AMP	1.0 EA	L001
506 0246 000 . .	CAP 0.47UF 63V 5%	1.0 EA	C002
516 0032 000 . .	CAP DISC 200 PF 1KV	12.0 EA	C023 C024 C043 C044 C046 C047 C048 C049 C050 C051 C052 C053
516 0375 000 . .	CAP 0.01UF 50V -20/+80% Z5U . . .	4.0 EA	C014 C016 C034 C036
516 0419 000 . .	CAP .05 UF 500V	12.0 EA	C017 C018 C019 C020 C021 C022 C037 C038 C039 C040 C041 C042
516 0453 000 . .	CAP .1UF 100V 20% X7R	4.0 EA	C011 C025 C031 C045
522 0548 000 . .	CAP 10UF 50V 20%.	1.0 EA	C001
526 0351 000 . .	CAP 6.8UF 50V 20%	4.0 EA	C013 C015 C033 C035
540 1600 108 . .	RES 20 OHM 3W 5%	4.0 EA	R023 R024 R043 R044
540 1600 417 . .	RES 47K OHM 3W 5%.	4.0 EA	R021 R022 R041 R042
546 0294 000 . .	RES 150 OHM 2.5W 5%	8.0 EA	R017 R018 R019 R020 R037 R038 R039 R040
548 2400 201 . .	RES 100 OHM 1/2W 1%	2.0 EA	R011 R031
548 2400 218 . .	RES 150 OHM 1/2W 1%	4.0 EA	R014 R016 R034 R036
548 2400 258 . .	RES 392 OHM 1/2W 1%	4.0 EA	R013 R015 R033 R035
548 2400 401 . .	RES 10K OHM 1/2W 1%	4.0 EA	R026 R027 R046 R047
548 2400 442 . .	RES 26.7K OHM 1/2W 1%.	2.0 EA	R012 R032
548 2400 566 . .	RES 475K OHM 1/2W 1%	2.0 EA	R025 R045
610 0679 000 . .	PLUG, SHORTING, .25" CTRS	3.0 EA	P004 P005 P006
610 0830 000 . .	HEADER, 10 PIN PC RIBBON.	1.0 EA	J001
610 0840 000 . .	HDR, STR, 4 PIN, RD	1.0 EA	J002
612 0301 000 . .	JACK BANANA BRASS	2.0 EA	J005 J006
813 5018 027 . .	STDOFF 8-32X5/8 3/8 HEX	1.0 EA	
829 8305 237 . .	INSULATOR, PDM AMP.	1.0 EA	
839 7533 001 . .	SCHEM, A1 PDM PULLUP BD	0.0 EA	
839 7920 046 . .	SCHEM, PDM AMP/PULL-UP	0.0 EA	
843 5400 265 . .	COMPONENT LOCATOR, PDM AMP BD	0.0 EA	
917 0914 077 . .	HEATSINK, PDM AMP	1.0 EA	
943 3655 250 . .	PWB, PDM AMP	1.0 EA	

* PDM PULL UP BOARD * - 992 5872 006

HARRIS P/N	*DESCRIPTION*	*QTY/UM*	*REF. SYMBOLS/EXPLANATIONS*
384 0686 000 . .	DIODE, DSR-3400X ESD	2.0 EA	CR001 CR002
384 0783 000 . .	DIODE MR854 ESD	2.0 EA	CR003 CR004
398 0402 000 . .	FUSE, RECTIFIER 2A 250V	4.0 EA	F001 F002 F003 F004
402 0129 000 . .	CLIP, 1/4 DIA FUSE	8.0 EA	XF001 XF002 XF003 XF004
494 0462 000 . .	CHOKE 40 UH 2 AMP	2.0 EA	L001 L002
508 0539 000 . .	CAP 2 UF 400VDC 10%	1.0 EA	C001
516 0085 000 . .	CAP DISC .03UF 600V	1.0 EA	C003
516 0864 000 . .	CAP DISC .02UF 1KV +/-20%	1.0 EA	C002
612 0301 000 . .	JACK BANANA BRASS	1.0 EA	J001
817 0914 021 . .	SPACER	1.0 EA	#J001
817 0914 294 . .	SCREW	1.0 EA	
839 7533 001 . .	SCHEM, A1 PDM PULLUP BD	0.0 EA	
939 7532 001 . .	ASSY, PWB, PDM PULL-UP	1.0 EA	
999 2135 001 . .	HARDWARE LIST	1.0 EA	

* PDM PULL UP BOARD * - 992 5872 007

HARRIS P/N	*DESCRIPTION*	*QTY/UM*	*REF. SYMBOLS/EXPLANATIONS*
384 0686 000 . .	DIODE, DSR-3400X ESD	2.0 EA	CR001 CR002
384 0783 000 . .	DIODE MR854 ESD	2.0 EA	CR003 CR004
398 0435 000 . .	FUSE, RECTIFIER 5A 250V	4.0 EA	F001 F002 F003 F004
402 0129 000 . .	CLIP, 1/4 DIA FUSE	8.0 EA	XF001 XF002 XF003 XF004
494 0462 000 . .	CHOKE 40 UH 2 AMP	2.0 EA	L001 L002
508 0539 000 . .	CAP 2 UF 400VDC 10%	1.0 EA	C001
516 0085 000 . .	CAP DISC .03UF 600V	1.0 EA	C003
516 0864 000 . .	CAP DISC .02UF 1KV +/-20%	1.0 EA	C002
612 0301 000 . .	JACK BANANA BRASS	1.0 EA	J001
817 0914 021 . .	SPACER	1.0 EA	#J001
817 0914 294 . .	SCREW	1.0 EA	
839 7533 001 . .	SCHEM, A1 PDM PULLUP BD	0.0 EA	
839 7920 046 . .	SCHEM, PDM AMP/PULL-UP	0.0 EA	
939 7532 001 . .	ASSY, PWB, PDM PULL-UP	1.0 EA	
999 2135 001 . .	HARDWARE LIST	1.0 EA	

WARNING: Disconnect primary power prior to servicing.

SECTION H
PDM FILTER (A10 and A11)

H.1. Principles of Operation

The purpose of the PDM filter is to filter the 60 kHz switching waveform coming from the PDM amplifiers and pass the audio and dc components to modulate the PA modules. Each PDM filter board consists of 4 identical low pass filters, each filter has two L-C sections. Part of the second capacitor does not exist on the PDM filter but is located on the PA module where the audio and dc signal is injected into the power amplifier.

Coupling capacitors C15, C25, C35 and C45 couple the PDM filters together to cancel the 60 kHz component, but yet remain a high impedance to the audio component. Resistors R13, R23, R33 and R43 are sampling resistors that are used for metering the PA voltage at each of the four filter outputs.

The outputs of the PDM filters are tied directly to the power amplifier modulation input jacks.

PWA, PDM FILTER ESD SAFE - 992 5874 009 (GATES TWO/FIVE)

HARRIS P/N	*DESCRIPTION*	*QTY/UM*	*REF. SYMBOLS/EXPLANATIONS*
335 0037 000	WASHER NYL 1.9375 ID	16.0 EA	
357 0080 000	NUT, 5/16-18	16.0 EA	#L011 #L012 #L021 #L022 #L031 #L032 #L041 #L042
414 0268 000	CORE FERRITE POT SET	8.0 EA	#L011 #L012 #L021 #L022 #L031 #L032 #L041 #L042
508 0536 000	CAP .033UF 400VDC 5%	4.0 EA	C017 C027 C037 C047
508 0538 000	CAP .15 UF 400WVDC 5%	16.0 EA	C011 C012 C013 C014 C021 C022 C023 C024 C031 C032 C033 C034 C041 C042 C043 C044
508 0539 000	CAP 2 UF 400VDC 10%	4.0 EA	C015 C025 C035 C045
508 0550 000	CAP .1UF 600V 5%	4.0 EA	C016 C026 C036 C046
548 2400 518	RES 150K OHM 1/2W 1%	4.0 EA	R013 R023 R033 R043
610 0840 000	HDR, STR, 4 PIN, RD	1.0 EA	J001
612 0301 000	JACK BANANA BRASS	12.0 EA	J011 J012 J013 J021 J022 J023 J031 J032 J033 J041 J042 J043
817 0914 267	STANDOFF .75X1 INSULATED	8.0 EA	#L011 #L012 #L021 #L022 #L031 #L032 #L041 #L042
817 0914 268	STUD, 5/16-18 PHENONIC	8.0 EA	#L011 #L012 #L021 #L022 #L031 #L032 #L041 #L042
817 0914 281	WASHER, COIL MTG	8.0 EA	
829 8305 745	SUPPORT, COIL MTG.	4.0 EA	
839 5695 419	SCHEM, PDM FILTER	0.0 EA	
843 5400 264	COMPONENT LOCATOR, PDM FILTER	0.0 EA	
929 8305 662	COIL ASSY, 29 TURNS	4.0 EA	#L012 #L022 #L032 #L042
929 8305 663	COIL ASSY, 30 TURNS	4.0 EA	#L011 #L021 #L031 #L041
943 3655 209	PWB, PDM FILTER	1.0 EA	
999 2343 009	HARDWARE LIST	1.0 EA	

PWA, PDM FILTER ESD SAFE - 992 5874 011 (GATES ONE)

HARRIS P/N	*DESCRIPTION*	*QTY/UM*	*REF. SYMBOLS/EXPLANATIONS*
335 0037 000	WASHER NYL 1.9375 ID	16.0 EA	
357 0080 000	NUT, 5/16-18	16.0 EA	#L011 #L012 #L021 #L022 #L031 #L032 #L041 #L042
414 0268 000	CORE FERRITE POT SET	8.0 EA	#L011 #L012 #L021 #L022 #L031 #L032 #L041 #L042
508 0538 000	CAP .15 UF 400WVDC 5%	8.0 EA	C011 C012 C021 C022 C031 C032 C041 C042
508 0539 000	CAP 2 UF 400VDC 10%	4.0 EA	C015 C025 C035 C045
548 2400 518	RES 150K OHM 1/2W 1%	4.0 EA	R013 R023 R033 R043
610 0840 000	HDR, STR, 4 PIN, RD	1.0 EA	J001
612 0301 000	JACK BANANA BRASS	8.0 EA	J011 J012 J021 J022 J031 J032 J041 J042
817 0914 267	STANDOFF .75X1 INSULATED	8.0 EA	#L011 #L012 #L021 #L022 #L031 #L032 #L041 #L042
817 0914 268	STUD, 5/16-18 PHENONIC	8.0 EA	#L011 #L012 #L021 #L022 #L031 #L032 #L041 #L042
817 0914 281	WASHER, COIL MTG	8.0 EA	
829 8305 745	SUPPORT, COIL MTG.	4.0 EA	
839 5695 373	SCHEM, 1KW PDM FILTER	0.0 EA	
839 7920 047	SCHEM, PDM FILTER	0.0 EA	
929 8305 673	COIL ASSY, 42 TURNS	4.0 EA	#L012 #L022 #L032 #L042
929 8305 674	COIL ASSY, 44 TURNS	4.0 EA	#L011 #L021 #L031 #L041
943 3655 209	PWB, PDM FILTER	1.0 EA	
999 2600 001	HARDWARE LIST	1.0 EA	

SECTION J
CONTROLLER BOARD (A12)

J.1. Principles of Operation

The Controller board contains the circuitry for controlling the primary contactors, setting the power level, metering, overload protection, and status indications.

Practically everything on Sheet 1 of the Controller schematics has to do with power control.

Sheet 2 covers metering sample voltages, overload sensing, overload status, and overload counting.

Sheet 3 shows the +/-12 volt regulators, a power-up reset circuit, and the PA and PDM Fault sensing circuits.

J.1.1. Coarse Power Level Control

The power level latching circuitry consists of U4, U5, and U6. See sheet 1. These are type D flip flops, any one of which is set by selecting one of the power levels. Energizing of one of the power level control inputs with a logic zero sets the corresponding flip flop Q output to a high condition.

NOR gates U7, U8, U9, U10, U11, and U12 reset the other flip flops so that only one Q output is high at a time. In a transmitter ON mode, all but one of these NOR gates will have LOW outputs. The one with a HIGH output is the one associated with the active flip flop, ie. the power level that has been selected. During the Automatic Cutback function, the NOR gates are put in a neutral mode (output open) via the tri-state input. This allows the flip flops to function in a shift register mode.

Quad transistor packs U34 and U35 are driven by the flip flop Q outputs. In turn, these transistors energize the LEDS, and supply a voltage source for the power level setting potentiometers and remote status.

A power change or turn on sequence from remote control is as follows: The input side of an optical isolator is energized by connecting the low side of one of the inputs to ground (U1 pin 2 for example). The high side is connected to +12 volts if the Remote/Local switch is in Remote.

The output side of the optical isolator (U1 pin 15 in this example) applies a logic zero to the tri-state input of NOR gate U7 to put its output in a neutral condition. At the same time, the low output from the optical isolator is applied to the preset input of flip flop U4 (pin 4). This forces the Q output (pin 5) to a high condition (near +12 volts).

The Q output from the flip flop drives the base of an emitter follower circuit formed by U34. For LOW power, U34 pin 3 will be high (about 11 volts). It provides current for the power level indicator LED in the LOW switch, a source voltage for the power level control pot R54, and provides an output to the Interface board to be used by the Output Monitor and remote status lines.

The outputs from the power level setting potentiometers are brought together into a summing amplifier, U19. The input of U19 is a virtual ground, and since only one pot has a voltage source at any given time, the pots do not interact with each other.

Sections of U19 amplify and sum the coarse power controls with the fine power circuit consisting of U38, U14, U15, U16, U17, and U18. Explanation of the Fine Power circuit is covered later.

J.1.2. Contactor Control

When any power level is energized, there will be current through R91, which is common to the LED's of all power levels.

The voltage developed across R91 biases Q6 to an ON state. This in turn biases Q1 ON, and a high signal (near 12 volts) is sent to the Interface board where it is used to drive the circuit which will energize the start contactor.

At the same time as the start signal is given, a PDM kill is applied by a circuit formed by Q4, Q7, and Q8. A PDM kill is used during step start to prevent the high voltage supply from being loaded during the step start sequence.

As the voltage on the primary of the high voltage transformer comes up from zero, it quickly reaches a level where Run contactor (K2) will energize. This is a 200 to 240 volt contactor with its coil directly across the primary of the high voltage transformer.

Upon closure of the Run contactor (K2), the base of Q4 is grounded via the K2 auxiliary contacts. This causes Q4 to shut off and the PDM Kill LED to extinguish. Q7 turns ON, thereby shutting Q8 OFF, and the transmitter power level comes up from zero.

J.1.3. Fine Power Control

The Fine Power Control circuit, consisting of U38, U14, U15, U16, U17, and U18 provides for remote and front panel trimming of the power level.

Flip Flop U38 serves the purpose of summing the output of a pulse generator formed by a section of U19, de-bouncing the Raise/Lower switches, and stopping the up/down counting circuit once the upper or lower limit is reached.

U14 and U15 are Up/Down counters which provide a 8 bit digital output which changes as the Fine Power circuit is operated. At the extreme low end if its adjustment range, the outputs of U14 and U15 will all be low (near zero volts). At the upper end of the Fine Power adjustment range, all outputs of U14 and U15 will be high (near 12 volts).

U16 and U17 are gates which detect the upper and lower extremes of the adjustment range. By detecting an "all zeros" or "all highs" condition, U16 and U17 provide outputs which stop any further pulses from getting through U13.

U18 is a digital to analog converter which takes the 8 bit digital output from U14 and U15, and uses it to vary a dc level to U19 pin 13. The output from U19 on pin 14 is thus determined by the 8 bit digital word and a voltage provided by the coarse power controls through another section U19.

J.1.4. Metering

Voltage samples representing Power Supply Voltage, Power Supply Current, PA Voltage, RF Drive, and the VSWR Detector enter the U20 and U21 on the Controller. See sheet 2. These sample voltages are amplified and go to the appropriate meters and overload circuitry.

J.1.5. Overload Circuitry

U22 is the overload comparator which determines if a parameter is out of tolerance based on input from the various voltage samples and the threshold settings determined by the overload pots.

If a parameter is out of tolerance, U22 gives a logic high output. This initiates the protective action and clocks the corresponding flip flop (U23 and U24) which in turn light the corresponding LED indicator. In most cases, this protective action is a PDM Interrupt.

In the case of the Supply Voltage overload or a sustained Supply Current overload, a contactor OFF command is given via one section of U37.

The other overload functions result in only momentary breaks in the carrier (a result of a PDM Interrupt), and can automatically step the power output down if needed to maintain an on air status.

U25 and U26 comprise the overload timer. This sets the minimum carrier interrupt time for about 6 to 8 milliseconds in the event of an overload. When an overload comparator output goes HIGH, U25 gets clocked. As a result, U25 pin 8 goes low.

After a time period determined by R34, R35, and C11, the output of U26 follows its input, and goes LOW. The LOW signal resets U25 via pin 13, the clear input.

U27 and U28 count the number of overloads in an approximate 15 second window. If the counter, U27, counts up to four overloads within the 15 second window set by U28, the power output will step to the next lower level and light the Automatic Cutback LED.

The stepping back of the power levels is accomplished by the power level selection flip flops operating in a shift register mode. Automatic Cutback occurs when the tristate enable line (pin 2 of U7-U12) is pulled low and the Clock inputs of U4-U6 make a transistion to a high state. When clocked, the Q output of the flip flops goes to the same state as the D input was at the time the clock signal occurred. With the way U4-U6 are connected, this results in a progressive stepping down of the power level as the flip flops are clocked.

In the event the overload persists even at a reduced level, the transmitter will continue the Automatic Cutback action and step to the next lower level. If conditions are good at this level, it will remain there until manually switched to another level. The transmitter will not attempt to go back to the higher power on its own.

Completely persistent overloads, such as having no RF drive, will result in the transmitter cycling all the way down to the OFF condition.

J.1.6. Other Fault Detection

U31 amplifies an input from the PA fuse detectors, and light an LED corresponding to which PA module has one or more open fuses. Under normal conditions, the fuse sensing circuit of the PA modules will not affect the voltage at the inputs of U31. However, if a PA fuse is blown, the fuse detector circuit will pull the input voltage on U31 low. When the inverting input (-) voltage goes lower than the non-inverting (+) input, the output goes positive and energizes the corresponding PA fuse LED on the front panel.

U29, U30, U39, and U40 are comparators for detecting an imbalance in the PDM system, and light the PDM Fault LEDS accordingly. One level of comparators senses that a PDM Amplifier voltage sample has gone low. This would most likely be an indication of a short in a PDM Amplifier which has not yet caused a PDM Pull Up fuse to blow.

The other level of comparators sense an open fuse condition. This is done by comparing the PDM sample voltage against a power level reference (PDMREF) provided by U20. If the sample voltage goes above the threshold voltage provided by U20, the corresponding output of the IC illuminates the LED.

J.1.7. Controller Supply Voltages

Regulators U32 and U33 provide a +/-12 volt source for the Controller board. The unregulated DC input is a nominal 18 volts.

LEDS DS22 and DS23 provide a front panel indication of the presence of +/-12 volts.

Various integrated circuits on the Controller board are isolated from the +12 volt line by a diode. Integrated circuits powered in this manner have a positive supply designated as +12A, +12B, +12C, etcetera. The purpose of this diode isolation is to reduce the drain on the battery in conditions where the regulated supply is not present.

The 9 volt battery holds the memory status for the power level settings, fine power adjustment, and overload status. A standard 9 volt battery will last about 2 weeks under continuous operation with no AC power present.

DS21 is an LED in line with the battery output. This serves as a steering diode to isolate the battery from the regular Controller supply, and to serve as an indicator of excessive current draw from the positive supply on the Controller. If this LED is on brightly, there is probably a component on the board which is drawing an excessive amount of current.

J.2. Replacement/Alignment Procedures

If you are replacing the Controller board, or have other reasons to check its setup, the following section will guide you.

J.2.1. PA Voltage Electrical Zero

Unplug P2 from the PDM Generator so that there will be no PA voltage when the high voltage is energized.

Energize the high voltage by depressing one of the power level buttons. The contactors should energize, and Supply Voltage should appear on the Multimeter.

Adjust R31 to make the PA Voltmeter read zero.

J.2.2. PA Volt Meter Calibration

The PA volt meter can be calibrated against an external meter of known accuracy, using the following procedure.

WARNING

TURN OFF TRANSMITTER AND DISCHARGE HIGH VOLTAGE BEFORE PROCEEDING.

Route some long voltmeter leads to the PA modules through one of the bottom side holes made for a cable entrance.

Connect the positive lead of the volt meter to the 260 volt line of a PA module (L11 or the fuse, for example). Connect the negative lead to the cathode of CR13 on the PA board. This is the same electrical point as the small banana jacks.

Turn the transmitter on at high power. Adjust R76 to make the front panel PA voltmeter agree with the external voltmeter.

Turn off high voltage. Allow discharge of power to zero. Remove voltmeter leads.

J.2.3. Power Supply Current Calibration

The Power Supply current can be calibrated against an external meter using the following procedure. The external meter and its leads must be capable of reading at least 6 amps for a GATES ONE, at least 20 amps for a GATES TWO, and at least 30 amps for a GATES FIVE.

WARNING

ENSURE ALL POWER IS REMOVED FROM THE TRANSMITTER BEFORE ATTEMPTING TO ROUTE THE LEADS IN THE FOLLOWING STEPS.

a. Locate the DC Ammeter where it can be seen from front of transmitter and route its leads through one of the bottom side access holes and up through one of the wiring grommets, to near the high voltage rectifiers.

b. Connect the DC Ammeter in series with the supply current shunt resistor A19R7. This is located to the front of the high voltage rectifiers. Connect the positive side of the DCAmmeter to the shunt (leave the white wire in place on the shunt).

c. The negative side of the meter should connect to the black welding cable removed from the shunt.

d. Turn the transmitter on at HIGH POWER, and adjust the power level to some convenient calibration level.

e. Note the reading on the external meter, and adjust R25 on the Controller board to make the Supply Current reading on the Multimeter agree with the external meter reading.

J.2.4. Power Output Calibration

Connect the transmitter into a load with the capability of accurately measuring the power output. This is best done with a calorimetric dummy load, where the water temperature rise is measured against a known flow rate. A second choice is a dummy load and an RF ammeter of known accuracy.

Operate the transmitter at a convenient power level within the capabilities of the test setup.

Calibrate the Power Output meter to the same reading as measured externally using R85 on the Controller board.

J.3. Overload Adjustment Procedures

J.3.1. Power Supply Current Overload

Check the present Power Supply Current reading against the value on the factory test data sheet for the same operating conditions. If the present reading is significantly higher, it will be advisable to investigate the cause before proceeding with the following overload adjustment.

The overload threshold can be set to the same value as recorded on the factory test data sheet, or by checking the trip threshold by modulating it with a tone according to the following procedure.

For setting the overload under modulating conditions, operate the transmitter at 110% of its rated power output (5500 watts for GATES FIVE, 2750 watts for a GATES TWO, and 1100 watts for a GATES ONE).

Modulate with 20 Hz to 100%. Increase the audio level 0.5dB (6%).

Adjust R11 counterclockwise until the transmitter faults, then 1/3 of a turn clockwise from this trip point.

J.3.2. Underdrive Fault

For the Underdrive fault, a comparison is made between the RF Drive level reading and a threshold which is a function of power level. The RF Drive level reading is what is adjusted during the alignment procedure.

The RF Drive level reading should always be somewhat higher than the Underdrive Set reading.

If you are replacing the Controller board, and already know that the actual RF Drive level is okay, you will only need to duplicate your normal reading for High power.

A more in depth check of the overload function requires verifying the correct RF drive amplitude (26-32 Vpp) is present across R13, R14, R23, R24, R33, R34, R43 and R44 for each PA module. For the procedure on checking the drive on the PA module(s), refer to Section H.

After verifying the actual RF drive to be in the normal range, modulate the transmitter to 100% with 400 Hz at 110% power output (5500 watts for GATES FIVE, 2750 watts for a GATES TWO, and 1100 watts for a GATES ONE).

Adjust R143 clockwise until the transmitter trips to the next lower power level and displays the Underdrive fault. Then rotate R143 counterclockwise from the trip point about 2 turns.

J.3.3. VSWR Detector

You may set the VSWR trip threshold using the value recorded on the factory test data sheets, or may use a more involved process which actually causes the overload circuit to operate.

With the transmitter on, and NO modulation applied, set the LOW power control all the way to zero power output.

Use a clip lead to short across R18 on the Output Monitor board. This will cause the VSWR detector to not be nulled when you bring up RF power.

Gradually increase the power output, and watch the VSWR Detector Null reading come up from zero. Adjust R14 so that the transmitter trips off when the VSWR Detector Null reading reaches 7.5 on the Multimeter.

J.4. Troubleshooting the Controller

Numerous components are duplicate types in control, status, metering, and overload functions. This can be advantageous in terms of isolating a problem and getting back on the air in the event of a component failure.

The Chart of Functions lists the IC types used and their functions. Those designated by an asterisk (*) are for status indications or metering, and not necessary to the operation of the transmitter at any power level. Therefore, any of these could be transferred to a needed function where a failure occurred if no replacement was immediately available.

J.4.1. Symptom: Will Not Respond To An On Command

(None of the status LED's on the power level switches illuminate.)

Possible Causes:

J.4.1.1. *Controller Supply Failure*

Check the status of the +/-12 volt indicators. Measure the +/-12 volts on the Controller board. Feel the regulators U32 and U33. If one is hot, it probably means there is a shorted component loading the supply down on the Controller.

J.4.1.2. *Failed flip flop circuitry*

Check the operation of U4, U5, and U6 or replace them. Also check or replace NOR gates U7, U8, U9, U10, U11, and U12. A logic zero on the outputs of the NOR gates will hold the flip flops in an OFF mode.

J.4.2. Symptom: PDM Power Level Signal Cannot Be Controlled

Possible causes:

Check to see if there is a PDM Kill or overload condition. Check or replace U19.

J.4.3. Symptom: Multimeter Is Pinned Far Left or Right

Check to see if it matters which position the meter switch is in. If it does not, replace U20 on the Controller. Otherwise, both U20 and U21 are suspect.

J.4.4. Symptom: Some Remote Control Functions Do Not Work

Possible causes:

Optical Isolator Failure. Failures in this area would probably inhibit only those inputs with defective optical isolators. Ohmmeter test the input side of U1, U2, and U3 on the Controller board. These should test as diodes. Otherwise, measure across each optical isolator input on the Controller to see if a voltage is being applied as the remote control circuits are activated.

Chart of Functions

(Continued on next page)

U1*	ILQ-1	Remote LOW through FOUR power level control
U2*	ILQ-1	Remote FIVE, SIX, OFF, and EXT KILL control
U3*	ILQ-1	Remote Raise, Lower, and Indicator Reset
U4	74C74	LOW and TWO power selection flip flop
U5	74C74	THREE and FOUR power selection flip flop
U6	74C74	FIVE and HIGH power selection flip flop
U7	CD4048	LOW power level selection
U8	CD4048	TWO power level selection
U9	CD4048	THREE power level selection
U10	CD4048	FOUR power level selection
U11	CD4048	FIVE power level selection

Chart of Functions

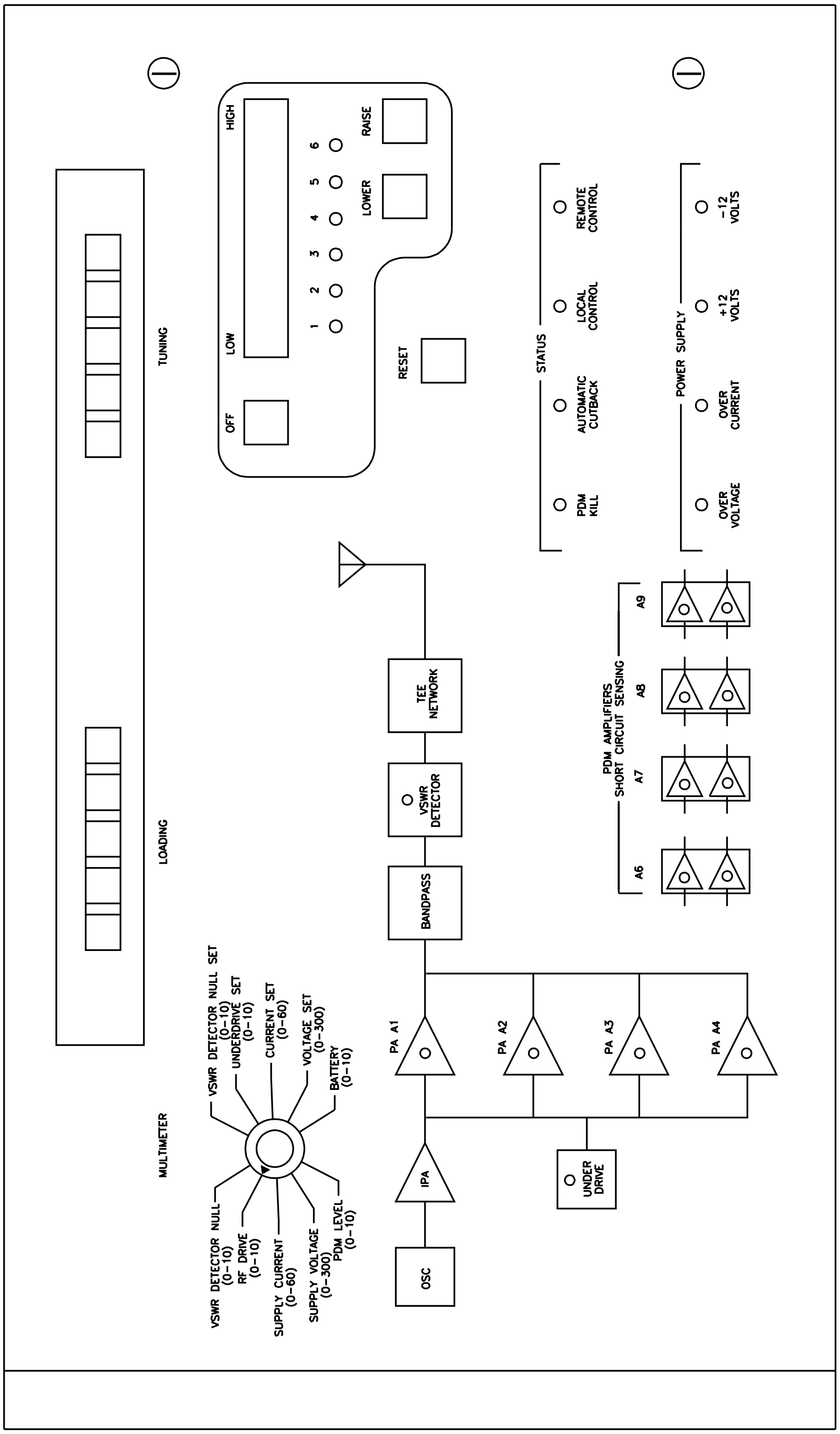


Figure J-1. Controller Front Panel

U12	CD4048	HIGH power level selection
U14*	74C193	Fine Power Up/Down counter
U15*	74C193	Fine Power Up/Down counter
U16*	CD4048	Fine Power Upper Limit detector
U17*	CD4048	Fine Power Lower Limit detector
U18*	DA0808	Fine Power D/A converter
U19	TLO74	Power Control Summing Amplifier
U20*	TLO74	Metering Amplifier
U21	TLO74	Metering Amplifier
U22	LM339	Overload Comparator
U23*	74C74	Sup Volt/Sup Cur Ovld flip flop
U24*	74C74	Underdrive/VSWR Ovld flip flop
U25	74C74	PDM Kill Timer/Auto Cutback flip flop
U26	MC14541	PDM Kill Timer
U27*	74C175	Overload Counter
U28*	MC14541	Overload Counter Reset Timer
U29*	LM339	PDM Fault Detector A6
U30*	LM339	PDM Fault Detector A7
U31*	TLO74	PA Fuse detector
U32	MC7812	Positive 12 volt regulator
U33	MC7912	Negative 12 volt regulator
U38*	74C74	Fine Power Control flip flop
U39*	LM339	PDM Fault Detector A8
U40*	LM339	PDM Fault Detector A9
* Not necessary to the operation of the transmitter at any power level.		

CONTROLLER - 992 8147 001

Harris PN	Description	QTY UM	Reference Designators (W)
250 0476 000 . .	CABLE ASSY 12C 1.8" 22AWG. . . .	1.0 EA	P003
354 0309 000 . .	TERM SOLDER	9.0 EA	#UNIT 4 5 6 VIS PA COMB
358 2751 000 . .	SPACER, LED MOUNT .150 LG . . .	22.0 EA	
358 2836 000 . .	BATTERY HOLDER 9 VOLT	1.0 EA	XBT001
380 0125 000 . .	XSTR, NPN 2N4401 ESD	8.0 EA	Q004 Q005 Q006 Q007 Q008 Q009 Q010 Q011
380 0126 000 . .	XSTR, PNP 2N4403 ESD	2.0 EA	Q001 Q003
380 0678 000 . .	*XSTR, ARRAY QUAD 2222 ESD .	4.0 EA	U034 U035 U036 U037
382 0371 000 . .	IC, MC7912CT ESD	1.0 EA	U033
382 0406 000 . .	IC, MC7812CT ESD	1.0 EA	U032
382 0465 000 . .	IC, 74C74 ESD	7.0 EA	U004 U005 U006 U023 U024 U025 U038
382 0521 000 . .	IC, 339 ESD.	5.0 EA	U022 U029 U030 U039 U040
382 0594 000 . .	*IC TL074ACN ESD	4.0 EA	U019 U020 U021 U031
382 0646 000 . .	* IC DAC0808 ESD	1.0 EA	U018
382 1011 000 . .	IC, 14541/4541 ESD	2.0 EA	U026 U028
382 1014 000 . .	IC, 74C193/40193BE ESD.	2.0 EA	U014 U015
382 1015 000 . .	IC, CD4048B ESD	8.0 EA	U007 U008 U009 U010 U011 U012 U016 U017
382 1070 000 . .	IC, ILQ-1 OPTO-ISOLATOR ESD. .	3.0 EA	U001 U002 U003
382 1072 000 . .	IC, 14175/40175 ESD.	1.0 EA	U027
384 0431 000 . .	RECT. 1N4001 ESD	4.0 EA	CR036 CR042 CR043 CR051
384 0610 000 . .	LED, GREEN ESD.	3.0 EA	DS007 DS022 DS023
384 0611 000 . .	LED, RED ESD	19.0 EA	DS001 DS002 DS003 DS004 DS005 DS006 DS009 DS010 DS011 DS012 DS013 DS014 DS015 DS016 DS017 DS018 DS019 DS020 DS021
384 0612 000 . .	DIODE 1N3070 ESD	36.0 EA	CR001 CR002 CR003 CR004 CR006 CR007 CR008 CR011 CR014 CR015 CR016 CR017 CR019 CR018 CR020 CR021 CR022 CR023 CR024 CR025 CR026 CR028 CR029 CR030 CR031 CR032 CR033 CR034 CR040 CR041 CR044 CR045 CR048 CR049 CR050 CR052
384 0679 000 . .	LED, YELLOW ESD	1.0 EA	DS008
384 0719 000 . .	TRANSZORB 1N6373 5V 5W ESD	2.0 EA	CR027 CR053
384 0720 000 . .	TRANSZORB 1N6377 15V 5W ESD	2.0 EA	CR005 CR047
384 0838 000 . .	TRANSZORB 1N6380 36V 5W ESD	2.0 EA	CR054 CR055
386 0106 000 . .	ZENER, 1N4737 7.5V ESD.	1.0 EA	CR035
404 0513 000 . .	HEAT SINK PA1-1CB.	2.0 EA	#U032 #U033
404 0674 000 . .	SOCKET, DIP, 14 PIN (DL)	22.0 EA	XU004 XU005 XU006 XU019 XU020 XU021 XU022 XU023 XU024 XU025 XU026 XU028 XU029 XU030 XU031 XU034 XU035 XU036 XU037 XU038 XU039 XU040
404 0675 000 . .	SOCKET, DIP, 16 PIN (DL)	15.0 EA	XU001 XU002 XU003 XU007 XU008 XU009 XU010 XU011 XU012 XU014 XU015 XU016 XU017 XU018 XU027
506 0232 000 . .	CAP .01UF 100V 5%	1.0 EA	C002
506 0234 000 . .	CAP .0022UF 100V 5%	3.0 EA	C011 C012 C074
516 0453 000 . .	CAP .1UF 100V 20% X7R	68.0 EA	C001 C003 C005 C006 C015 C016 C018 C019 C020 C021 C022 C023 C024 C026 C027 C028 C029 C030 C032 C033 C034 C035 C036 C037 C038 C039 C040 C041 C042 C043 C044 C045 C046 C047 C048 C049 C050 C051 C052 C053 C054 C055 C056 C057 C058 C059 C060 C063 C064 C065 C066 C069 C070 C071 C073 C076 C077 C078 C079 C080 C081 C082 C083 C084 C085 C086 C087 C088
522 0548 000 . .	CAP 10UF 50V 20%.	4.0 EA	C061 C062 C067 C068
526 0050 000 . .	CAP 1UF 35V 20%.	1.0 EA	C014
526 0097 000 . .	CAP 47UF 35V 20%.	2.0 EA	C007 C010
526 0342 000 . .	CAP 2.7UF 35V 10%	1.0 EA	C013

526 0350 000 . .	CAP 3.9UF 35V 10%	1.0 EA	C009
526 0351 000 . .	CAP 6.8UF 50V 20%	2.0 EA	C008 C017
526 0358 000 . .	CAP 22UF 35V 10%.	1.0 EA	C004
526 0362 000 . .	CAP 10UF 50V 20%.	2.0 EA	C025 C075
540 1332 000 . .	RES NETWORK 100K OHM	3.0 EA	R056 R063 R100
540 1356 000 . .	RES NETWORK 10K OHM 2%	7.0 EA	R007 R027 R042 R051 R061 R064 R081
540 1357 000 . .	RES NETWORK 1000 OHM 2% . . .	3.0 EA	R041 R049 R059
540 1360 000 . .	RES NETWORK 47K OHM 2%	1.0 EA	R048
540 1367 000 . .	RES NETWORK 2000 OHM 2% . . .	2.0 EA	R073 R074
540 1386 000 . .	RES NETWORK 10K OHM 2%	2.0 EA	R053 R121
540 1493 000 . .	RES NETWORK 100K OHM	2.0 EA	R038 R145
548 2400 201 . .	RES 100 OHM 1/2W 1%	5.0 EA	R024 R033 R132 R134 R142
548 2400 266 . .	RES 475 OHM 1/2W 1%	1.0 EA	R117
548 2400 285 . .	RES 750 OHM 1/2W 1%	3.0 EA	R028 R044 R091
548 2400 301 . .	RES 1K OHM 1/2W 1%	15.0 EA	R026 R045 R046 R077 R079 R082 R087 R095 R097 R098 R104 R110 R128 R130 R136
548 2400 318 . .	RES 1.5K OHM 1/2W 1%.	1.0 EA	R139
548 2400 330 . .	RES 2K OHM 1/2W 1%	4.0 EA	R002 R004 R030 R050
548 2400 337 . .	RES 2.37K OHM 1/2W 1%.	2.0 EA	R052 R135
548 2400 347 . .	RES 3.01K OHM 1/2W 1%.	3.0 EA	R047 R075 R103
548 2400 369 . .	RES 5.11K OHM 1/2W 1%.	2.0 EA	R043 R086
548 2400 385 . .	RES 7.5K OHM 1/2W 1%.	5.0 EA	R001 R003 R010 R012 R039
548 2400 393 . .	RES 9.09K OHM 1/2W 1%.	1.0 EA	R078
548 2400 401 . .	RES 10K OHM 1/2W 1%	28.0 EA	R006 R021 R023 R029 R032 R035 R090 R092 R099 R105 R106 R107 R108 R109 R111 R112 R118 R119 R122 R125 R126 R127 R131 R133 R137 R138 R146 R147
548 2400 405 . .	RES 11K OHM 1/2W 1%	1.0 EA	R008
548 2400 430 . .	RES 20K OHM 1/2W 1%	4.0 EA	R034 R080 R083 R084
548 2400 442 . .	RES 26.7K OHM 1/2W 1%.	1.0 EA	R020
548 2400 447 . .	RES 30.1K OHM 1/2W 1%.	1.0 EA	R140
548 2400 466 . .	RES 47.5K OHM 1/2W 1%.	3.0 EA	R019 R089 R124
548 2400 493 . .	RES 90.9K OHM 1/2W 1%.	1.0 EA	R036
548 2400 501 . .	RES 100K OHM 1/2W 1%	12.0 EA	R005 R018 R065 R068 R070 R072 R093 R096 R116 R123 R129 R141
548 2400 509 . .	RES 121K OHM 1/2W 1%	3.0 EA	R088 R094 R102
548 2400 526 . .	RES 182K OHM 1/2W 1%	2.0 EA	R037 R144
548 2400 601 . .	RES 1MEG OHM 1/2W 1%	9.0 EA	R009 R013 R015 R022 R040 R066 R069 R071 R113
550 0949 000 . .	TRIMPOT 100K OHM 1/2W 10%. . .	3.0 EA	R025 R085 R143
550 0956 000 . .	TRIMPOT 2K OHM 1/2W 10%.	1.0 EA	R076
550 0958 000 . .	TRIMPOT 10K OHM 1/2W 10%. . . .	3.0 EA	R011 R014 R031
550 0995 000 . .	POT 5K OHM 1/4W 10%	6.0 EA	R054 R055 R057 R058 R060 R062
600 0601 000 . .	SW, ROTARY 1 POLE 12 POS	1.0 EA	S012
604 1066 000 . .	SW, PC MT SLIDE SPDT	1.0 EA	S005
604 1111 000 . .	SW PB GRAY MOM W/O LED	3.0 EA	S002 S003 S004
604 1119 000 . .	SW PB RED MOM W/O LED.	1.0 EA	S001
604 1120 000 . .	SW PB GRN MOM W/GRN LED . . .	6.0 EA	S006 S007 S008 S009 S010 S011
610 0854 000 . .	HEADER, 40 PIN PC RIBBON	2.0 EA	J001 J002
610 0903 000 . .	HDR, STR, 12 PIN, SQ	1.0 EA	J003
839 7920 001 . .	SCHEMATIC, CONTROLLER	0.0 EA	
843 5141 013 . .	PWB, CONTROLLER	1.0 EA	
843 5400 256 . .	COMPONENT LOCATOR, CTLR BOARD	0.0 EA	
999 2618 001 . .	HARDWARE LIST	1.0 EA	

WARNING: Disconnect primary power prior to servicing.

SECTION K
INTERFACE BOARD (A24)

K.1. Principles of Operation

The Interface Board provides the Audio Input, Failsafe, and remote control connections. Additionally, the Interface board is a central connection point for many of the connections between the Controller, PDM Generator, RF Oscillator, Output Monitor, PDM Amps, and PA boards.

U1 and Q3 are the contactor driver components. U1 accepts a DC level input from the Controller, and drives triac Q3. Q3 then passes 24 VAC current to the start contactor.

K1, Q1, and Q2 determine if the transmitter is to switch to the optional standby RF Oscillator. In a normal condition, transistor Q2 is biased ON by an output sample from the Oscillator board. Q1 is then held OFF by Q2.

If the RF Oscillator fails to produce RF when it is supposed to be ON, Q2 shuts off and allows Q1 to energize K1. The energizing of K1 puts the optional standby RF Oscillator into operation.

Also included on the Interface board are the remote status transistor packs U2, U3, and U4. These provide open collector outputs which are able to drive TTL status inputs of many remote control systems, or a small DC relay or other indicating device.

K.2. Replacement/Alignment

There are no adjustments to be made to the Interface board. However, the board must either have provisions for the standby oscillator installed, or jumpers installed if this option is not used.

K.3. Troubleshooting

K.3.1. Symptom: Green Power Level Status LED's Light On Controller, But The Contactors Do Not Energize

K.3.1.1. *Open Interlock*

If you have determined that this is not caused by an open interlock, failsafe, or phase monitor relay (A19K3), then the problem may be on the Interface board.

K.3.1.2. *24 VAC Missing*

Make sure that 24VAC is getting to fuse F1. If it is not, there is a problem in the wiring from the low voltage transformer.

K.3.1.3. *ON Command Missing*

Check to see if you are getting a DC control signal to the input side of optical isolator, U1. A convenient check point is R18. If it is not present, the Controller board may not be providing the ON signal.

K.3.1.4. *Bad Triac or Optical Isolator*

Check to see if you are getting voltage at TB1-16. If AC voltage is present at the fuse, but not at TB1-16, then the problem resides on the Interface board.

Replace U1 and/or U2 if the above tests do not conclude that the problem is elsewhere.

WARNING: Disconnect primary power prior to servicing.

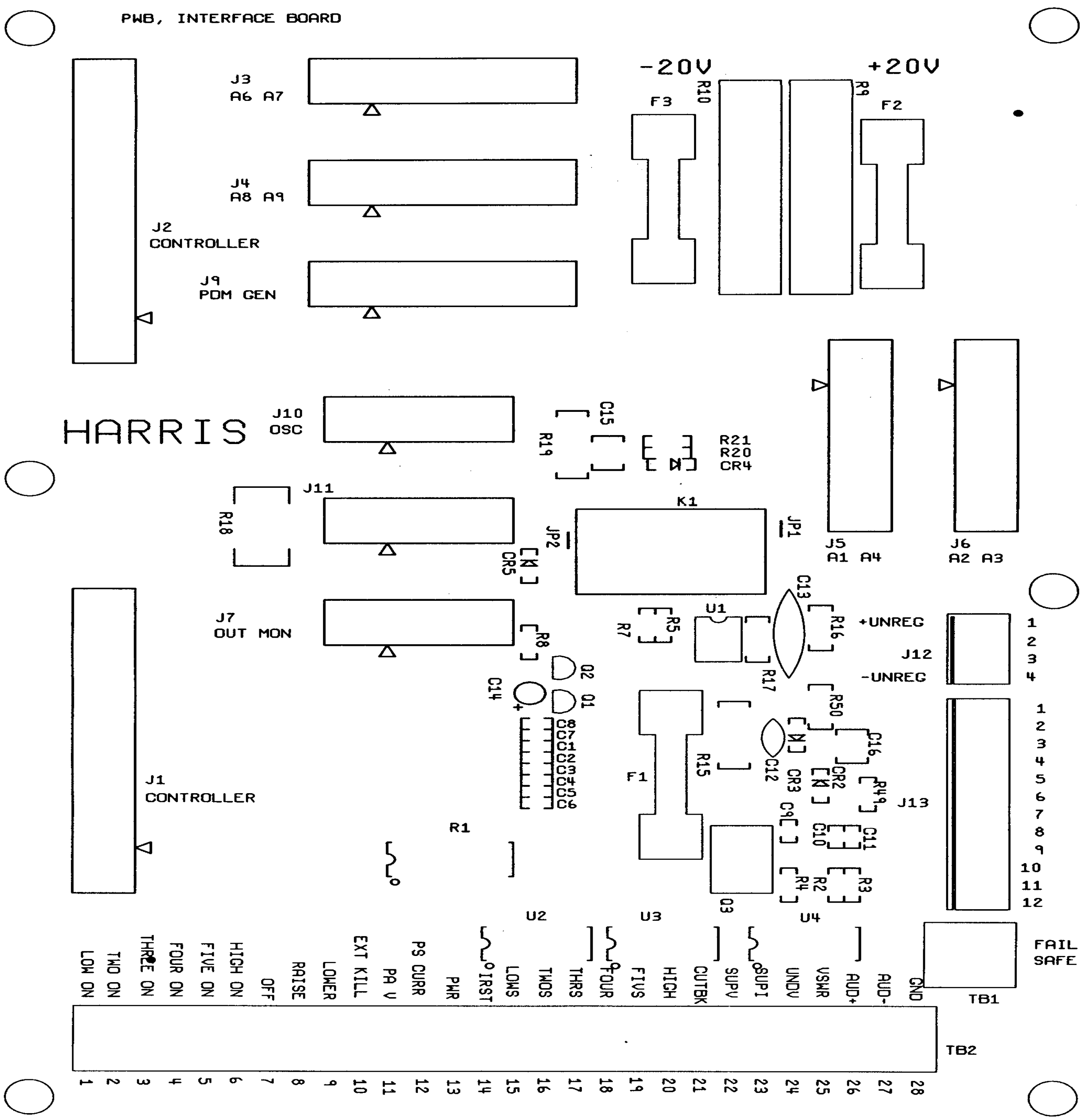


Figure K-1. Interface Board

INTERFACE BD - 992 8148 001

Harris PN	Description	QTY UM	Reference Designators (N)
000 0000 002	APPEARS ON A HIGHER LEVEL	0.0 EA	R005 R007 R008 C014 Q001 Q002 CR005 K001 J011
358 2997 000	END PLATE,236 TERM MODULE	2.0 EA	TB001 TB002
380 0678 000	*XSTR, ARRAY QUAD 2222 ESD	3.0 EA	U002 U003 U004
384 0612 000	DIODE 1N3070 ESD	2.0 EA	CR002 CR004
384 0704 000	TRIAC DRIVER MOC3020 ESD	1.0 EA	U001
384 0844 000	RECT BCR5AM/BT136-500 ESD	1.0 EA	Q003
386 0135 000	ZENER, 1N4733A 5.1V ESD	1.0 EA	CR003
398 0016 000	FUSE,FAST CART .750A 250V	2.0 EA	F002 F003
398 0081 000	FUSE,SLO CART 2A 250V	1.0 EA	F001
402 0129 000	CLIP, 1/4 DIA FUSE	6.0 EA	XF001 XF002 XF003
404 0674 000	SOCKET, DIP, 14 PIN (DL)	3.0 EA	XU002 XU003 XU004
494 0386 000	CHOKE RF 1.50UH	1.0 EA	L001
494 0394 000	CHOKE 6.80UH	1.0 EA	L002
500 1227 000	CAP, MICA, 6800PF 100V 5%.	1.0 EA	C017
506 0246 000	CAP 0.47UF 63V 5%	2.0 EA	C015 C016
516 0375 000	CAP 0.01UF 50V -20/+80% Z5U	1.0 EA	C012
516 0419 000	CAP .05 UF 500V	1.0 EA	C013
516 0453 000	CAP .1UF 100V 20% X7R	12.0 EA	C001 C002 C003 C004 C005 C006 C007 C008 C009 C010 C011 C028
522 0391 000	CAP 1000UF 16V 20%	1.0 EA	C018
540 1357 000	RES NETWORK 1000 OHM 2%	1.0 EA	R001
540 1600 115	RES 39 OHM 3W 5%	1.0 EA	R015
540 1600 201	RES 100 OHM 3W 5%	1.0 EA	R018
542 0055 000	RES 15 OHM 5% 12W	2.0 EA	R009 R010
546 0295 000	RES 50 OHM 3.25W 5%	1.0 EA	R019
548 2400 237	RES 237 OHM 1/2W 1%	2.0 EA	R016 R017
548 2400 301	RES 1K OHM 1/2W 1%	4.0 EA	R002 R003 R004 R049
548 2400 311	RES 1.27K OHM 1/2W 1%.	1.0 EA	R050
548 2400 434	RES 22.1K OHM 1/2W 1%.	1.0 EA	R021
548 2400 469	RES 51.1K OHM 1/2W 1%.	1.0 EA	R020
610 0827 000	HEADER, 20 PIN PC RIBBON	5.0 EA	J003 J004 J005 J006 J009
610 0830 000	HEADER, 10 PIN PC RIBBON	2.0 EA	J007 J010
610 0832 000	CONN 12 PIN PC MT.	1.0 EA	J013
610 0840 000	HDR, STR, 4 PIN, RD	1.0 EA	J012
610 0854 000	HEADER, 40 PIN PC RIBBON	2.0 EA	J001 J002
614 0790 000	TERM MODULE,1C PC MTG 236	30.0 EA	TB001 TB002
839 7920 012	SCHEM, INTERFACE.	0.0 EA	
843 5141 015	PWB, INTERFACE	1.0 EA	
843 5400 260	COMPONENT LOCATOR, INTERFACE	0.0 EA	

WARNING: Disconnect primary power prior to servicing.

APPENDIX L
TEST EQUIPMENT

L.1. Introduction

This appendix contains a list of the test equipment recommended to perform general maintenance and troubleshooting of the GATES Series™ transmitters.

1. An oscilloscope with 15 MHz or higher bandwidth
2. A VOM with an ohmmeter battery voltage between 3 and 18V
3. A low distortion sinewave audio generator
4. A noise/distortion meter

Electrostatic Discharge Control: A Guide To Handling Integrated Circuits

Technical Brief | January 1994 | TB52

This paper discusses methods and materials recommended for protection of ICs against ESD damage or degradation during manufacturing operations vulnerable to ESD exposure. Areas of concern include dice prep and handling, dice and package inspection, packing, shipping, receiving, testing, assembly and all operations wurhere ICs are involved.

All integrated circuits are sensitive to electrostatic discharge (ESD) to some degree. Since the introduction of integrated circuits with MOS structures and high quality junctions, safe and effective means of handling these devices have been of primary importance.

If static discharge occurs at a sufficient magnitude, 2kV or greater, some damage or degradation will usually occur. It has been found that handling equipment and personnel can generate static potentials in excess of 10kV in a low humidity environment; thus it becomes necessary for additional measures to be implemented to eliminate or reduce static charge. Avoiding any damage or degradation by ESD when handling devices during the manufacturing flow is therefore essential.

ESD Protection and Prevention Measures

One method employed to protect gate oxide structures is to incorporate input protection diodes directly on the monolithic chip. However, there is no completely foolproof system of chip input protection in existence in the industry.

In areas where ICs are being handled, certain equipment should be utilized to reduce the damaging effects of ESD. Typically, equipment such as grounded work stations, conductive wrist straps, conductive floor mats, ionized air blowers and conductive packaging materials are included in the IC handling environment. Any time an individual intends to handle an IC, in any way, they must insure they have been grounded to eliminate circuit damage.

Grounding personnel can, practically, be performed by two methods. First, grounded wrist straps which are usually made of a conductive material, such as Velostat or metal. A resistor value of 1 megohm (1/2 watt) in series with the strap to ground completes a discharge path for ESD when the operator wears the strap in contact with the skin. Another method is to insure direct physical contact with a grounded, conductive work surface.

This consists of a conductive surface like Velostat, covering the work area. The surface is connected to a 1 megohm (1/2 watt) resistor in series with ground.

In addition to personnel grounding, areas where work is being performed with ICs, should be equipped with an ionized air blower. Ionized air blowers force positive and negative ions simultaneously over the work area so that any nonconductors that are near the work surface would have their static charge neutralized before it would cause device damage or degradation.

Relative humidity in the work area should be maintained as high as practical. When the work environment is less than 40% RH, a static build-up condition can exist on nonconductors allowing stored charges to remain near the ICs causing possible static electricity discharge to ICs.

Integrated circuits that are being shipped or transported require special handling and packaging materials to eliminate ESD damage. Dice or packaged devices should be in conductive carriers during all phases of transport and handling. Leads of packaged devices can be shorted by tubular metallic carriers, conductive foam or foil.

Do’s and Don’ts for Integrated Circuit Handling

Do’s

Do keep paper, nonconductive plastic, plastic foams and films or cardboard off the static controlled conductive bench top. Placing devices, loaded sticks or loaded burn-in boards on top of any of these materials effectively insulates them from ground and defeats the purpose of the static controlled conductive surface.

Do keep hand creams and food away from static controlled conductive work surfaces. If spilled on the bench top, these materials will contaminate and increase the resistivity of the work area.

Do be especially careful when using soldering guns around conductive work surfaces. Solder spills and heat from the gun may melt and damage the conductive mat.

Do check the grounded wrist strap connections daily. Make certain they are snugly fitted before starting work with the product.

Do put on grounded wrist strap before touching any devices. This drains off any static build-up from the operator.

Do know the ESD caution symbols.

Do remove devices or loaded sticks from shielding bags only when grounded via wrist strap at grounded work station. This also applies when loading or removing devices from the antistatic sticks or the loading on or removing from the burn-in boards.

Do wear grounded wrist straps in direct contact with the bare skin never over clothing.

Do use the same ESD control with empty burn-in boards as with loaded boards if boards contain permanently mounted ICs as part of driver circuits.

Do insure electrical test equipment and solder irons at an ESD control station are grounded and only uninsulated metal hand tools be used. Ordinary plastic solder suckers and other plastic assembly aids shall not be used.

Do use ionizing air blowers in static controlled areas when the use of plastic (nonconductive) materials cannot be avoided.

Don'ts

Don't allow anyone not grounded to touch devices, loaded sticks or loaded burn-in boards. To be grounded they must be standing on a conductive floor mat with conductive heel straps attached to footwear or must wear a grounded wrist strap.

Don't touch the devices by the pins or leads unless grounded since most ESD damage is done at these points.

Don't handle devices or loaded sticks during transport from work station to work station unless protected by shielding bags. These items must never be directly handled by anyone not grounded.

Don't use freon or chlorinated cleaners at a grounded work area.

Don't wax grounded static controlled conductive floor and bench top mats. This would allow build-up of an insulating layer and thus defeating the purpose of a conductive work surface.

Don't touch devices or loaded sticks or loaded burn-in boards with clothing or textiles even though grounded wrist strap is worn. This does not apply if conductive coats are worn.

Don't allow personnel to be attached to hard ground. There must always be 1 megohm series resistance (1/2 watt between the person and the ground).

Don't touch edge connectors of loaded burn-in boards or empty burn-in boards containing permanently mounted driver circuits when not grounded. This also applies to burn-in programming cards containing ICs.

Don't unload stick on a metal bench top allowing rapid discharge of charged devices.

Don't touch leads. Handle devices by their package even though grounded.

Don't allow plastic ''snow or peanut'' polystyrene foam or other high dielectric materials to come in contact with devices or loaded sticks or loaded burn-in boards.

Don't allow rubber/plastic floor mats in front of static controlled work benches.

Don't solvent-clean devices when loaded in antistatic sticks since this will remove antistatic inner coating from sticks.

Don't use antistatic sticks for more than one throughput process. Used sticks should not be reused unless recoated.

Recommended Maintenance Procedures

Daily

Perform visual inspection of ground wires and terminals on floor mats, bench tops, and grounding receptacles to ensure that proper electrical connections via 1 megohm resistor (1/2 watt) exist.

Clean bench top mats with a soft cloth or paper towel dampened with a mild solution of detergent and water.

Weekly

Damp mop conductive floor mats to remove any accumulated dirt layer which causes high resistivity.

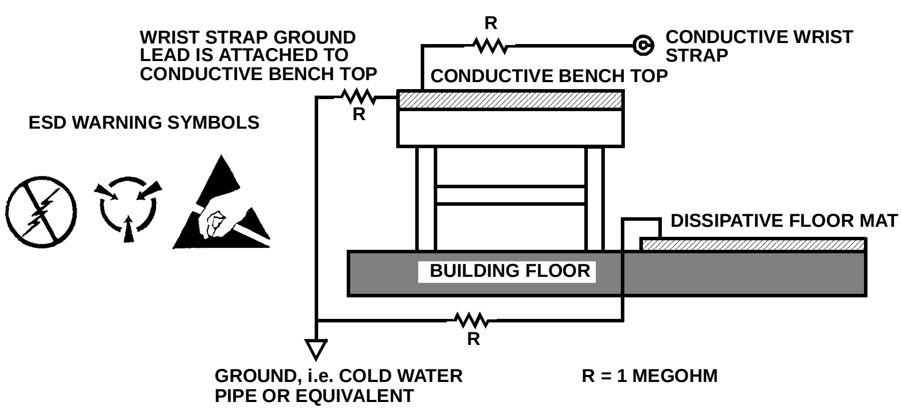
Annually

Replace nuclear elements for ionized air blowers.

Review ESD protection procedures and equipment for updating and adequacy.

Static Controlled Work Station

The figure below shows an example of a work bench properly equipped to control electro-static discharge. Note that the wrist strap is connected to a 1 megohm resistor. This resistor can be omitted in the setup if the wrist strap has a 1 megohm assembled on the cable attached.



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