ZX SERIES ™

ZX2500, ZX3750, ZX5000, ZX7.5 & ZX10

FM BROADCAST TRANSMITTER
888-2595-001

Revision M
June 28, 2016

Manual Revision History

ZX Series FM Transmitter Manual

REV.	DATE	ECN	Pages Affected
A	2009 June		
B	2009 July	P44299	Added service revisions.
C	2009 Dec	58482	Revised Title Page, MRH1, TOC, added Appendix-A
D	2010 Jan	58572	Revised Title Page, MRH1, Sheets 2-15 and 2-16
E	2010 May	58978	Revised to include 7.5 and 10 kW models
F	2010 Aug	59394	Revised Title Page, MRH1, Sheet 4-2
G	2010 Sep	59487	Revised Title Page, MRH, Table 2-2 on Page 2-14
H	2011 Jan	59870	Updated Appendix A-Web Remote Option
J	2011 Dec	61074	Revised Titl Page, MRH, Sheet 4-8
K	2014 May	63717	Rebranded
L	2014 May	63721	Removed addresses section 6.1
M	2016 June	65493	General update

Technical Assistance

Technical and troubleshooting assistance for GatesAir products is available from the field service department during normal business hours 8:00AM to 5:00PM CST.

Telephone *+1-217-222-8200*, FAX *+1-217-221-7086*, email *tsupport@gatesair.com*.

Emergency service is available 24 hours a day, seven days a week, *by telephone only.*

Online assistance, including technical manuals, software downloads, and service bulletins, is available at our Customer Portal http://support.gatesair.com.

For Global Technical Support Information please visit:

http://www.gatesair.com/services/technical-support.aspx

Europe, Middle East and Africa:
24/7 Technical Support+1 217 222 8200
Email tsupport.europe@gatesair.com

Asia:
24/7 Technical Support+1 217 222 8200
Email tsupport.asia@gatesair.com

Address written correspondence to

GatesAir
Field Service Department
3200 Wismann Lane
Quincy, IL 62305, USA.

NOTE: For all service and parts correspondence, please provide the sales order number, as well as the serial number for the transmitter or part in question. Record those numbers here:

_____/_____

Please provide these numbers for any written request, or have these numbers ready in the event you choose to call regarding any service or parts requests. All warranty claims require a serial number to be provided. For out of warranty products, this will help us identify what hardware shipped.

Replaceable Parts Service

The service parts department is available from 8:00AM to 5:00 PM CST Monday - Friday,
and 8:00AM to 12:00PM CST on Saturday.

Telephone *+1-217-221-7500* or email service*partsreq@gatesair.com*.

Unpacking

Carefully unpack the equipment and perform a visual inspection to determine if any damage was incurred during shipment. Retain the shipping materials until it has been verified that all equipment has been received undamaged. Locate and retain all packing check lists. Use the packing check list to help locate and identify any components or assemblies which were removed for shipping and must be reinstalled. Also remove any shipping supports, straps, and packing materials prior to initial turn on.

Returns And Exchanges

No equipment can be returned unless written approval and a return authorization is received from GatesAir. 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 GatesAir, specify the GatesAir order number or invoice number.

Safety

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 be 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 to personnel and equipment, and must be performed only by qualified personnel exercising due care. GatesAir 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/electrical codes and fire protection standards must be observed.

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

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.

WARNING:
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. 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.

First Aid for Electrical Shock

Faulty switches, frayed flexes and defective appliances can all be causes of electrical shock. Even a shock from a domestic current - the type used in the home or the workplace - can cause serious injury or even result in a fatality.

Water is a very efficient conductor of electricity and presents an additional risk. Handling otherwise safe electrical equipment with wet hands, or when standing on a wet floor, greatly increases the risk of electrical shock.

Treatment for Electrical Shock

Before doing anything else, remember that the first priority is personal safety. Do not touch a victim if they are still in contact with the appliance that has caused the shock. If they are still in contact with the electrical source, they will be 'live' and you risk electrocution to yourself.

Turn off the source of the electricity, if possible, to break contact between the victim and the electrical supply. Switch off the supply at the mains or meter point if possible, otherwise remove the plug or wrench the cable free.

Alternatively, you can move the source of the shock away from you and the victim. Stand on some dry, insulating material such as a wooden box, plastic mat or telephone directory. Using a wooden pole or broom, push the casualty's limb away from the electrical source or push the source away from them.

If it is not possible to break the contact using a wooden pole or broom, loop a length of rope around the casualty's ankles or under their arms. Take great care not to touch them while you are doing this. Once you have looped the rope around them, use this to pull them away from the source of the electrical current.

Once you have broken the contact between the victim and the source of the shock, conduct the primary survey - response, airway, circulation, breathing - and treat any urgent condition found. Call immediately for emergency services.

Post as much information as possible at the transmitter site. Posters such as Figure 0-1 on the next page should be prominently displayed near the transmitter. Emergency contact phone numbers and directions to the transmitter site with landmarks in the area should be posted near the transmitter and telephone.

References

It is very important to have a safety plan in place and available personnel that are trained and certified in first aid and CPR. Please refer to the following web sites for more information:

American Red Cross - www.redcross.org

Occupational Safety and Health Administration (OSHA) - www.osha.gov

For countries other than USA, contact health and safety agencies in your area for more information

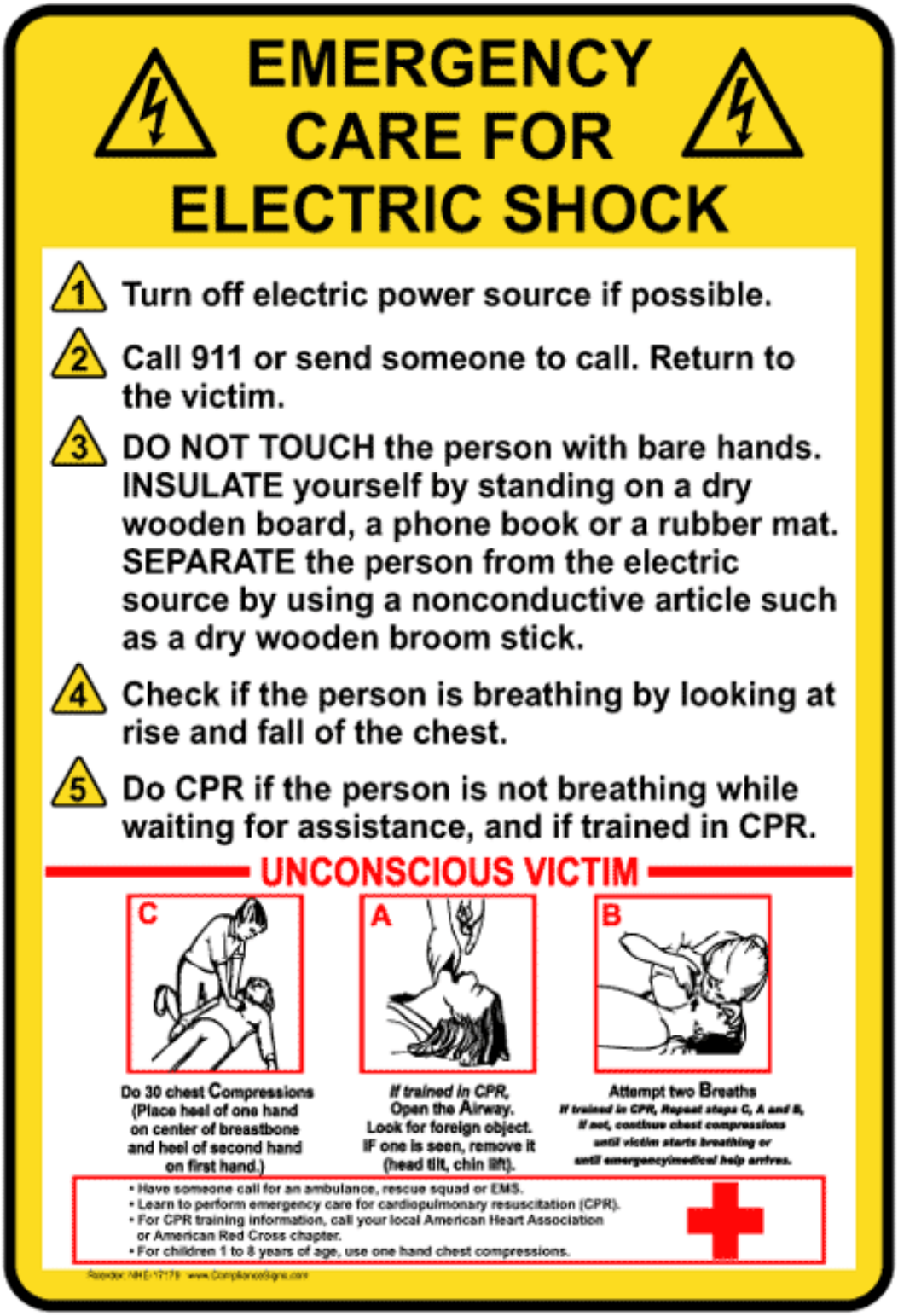


Figure 0-1 Electrical Shock First Aid Poster (Example)

Glossary

AIB - Analog Input Board, An optional circuit card for the modulator section of the low power unit (LPU). It provides the necessary interface to allow the modulator to accept analog video and audio inputs according to the PAL, NTSC, or SECAM standards. Not available in all models.

ADC - Analog to Digital Converter

ASI - Asynchronous Serial Interface, A streaming format used to carry the MPEG transport stream from the network origination point to the transmitter for modulation onto the RF carrier(s).

ATSC - Advanced Television Subcommittee, a digital television standard featuring a single, vestigial-sideband carrier and an 8-VSB modulation constellation. The transport stream format may be either SMPTE310 or ASI. The data rate before forward error correction is 19.392658 Mbit/s. The transmitted data rate with error correction is 32.28 Mbit/s.

Back Porch - The portion of the analog video horizontal line waveform following the sync pulse but before the start of active video. Only used in models that are capable of analog modulation.

Band III - The VHF radio frequency band from 168 MHz to 242 MHz.

Band IV - The UHF radio frequency band from 470 MHz to 860 MHz.

BPF - Band Pass Filter. May also be called a mask filter or critical mask filer. A high power filter centered about the desired channel bandwidth and located at the transmitter output port to eliminate out-of-band intermodulation products arising from the power amplification process.

BTSC - Broadcast Television Systems Committee

CAN - Controller Area Network (CAN or CAN-bus) is a serial communications standard designed to allow micro controllers and devices to communicate with each other.

COFDM - Coded Orthogonal Frequency Division Multiplex. A transmission technique in which the information content of a complete ensemble (multiplex) is divided and modulated onto a multitude of closely neighboring RF carriers within a channel bandwidth (frequency block). The division of the information payload among a large number of RF carriers ensures that each individual RF carrier has a very low data rate (symbol rate). The long symbol period of the individual RF carriers allows the receiver to wait until all delayed signal reflections have arrived and been added to the direct signal (...during a guard interval to be discarded). This permits recovery a stable signal in difficult reception conditions, especially during mobile reception.

CPLD - Complex programmable logic device.

CRC - Cyclic Redundancy Checksum is a procedure for error detection in digital signals. Before distribution to the transmitter, a CRC is computed for the transport stream signal. This CRC is sent in the transport stream. Upon reception at the transmitter site, another CRC is computed from the received transport stream and compared to the transmitted value. If the CRCs are identical, no error has occurred during the distribution to the transmitter site.

DAB Mode - Digital Audio Broadcast is a A digital radio/multimedia standard for transmitting multiple programs within a 1.5 MHz RF frequency block. The original DAB standard has been extended by two different enhancements to the encoding layer: DAB-Plus and DMB. All three standards use the original DAB modulation format in the transmitter (changes are upstream in the encoder). Four different DAB modes exist. VAX model transmitters use DAB mode I.

DAC - Digital Analog Converter refers to a circuit that converts digital values inside the processing stages of the LPU modulator into analog RF waveforms for amplification and transmission by the transmitter.

dBm - Decibels above a milliwatt refers to a logarithmic signal power measurement scale referenced to 1 mW. 0 dBm is equivalent to 1 mW. 10dBm = 10mW, 20dBm = 100mW, 30dBm = 1000mW.

DMB - Digital Multimedia Broadcasting is a modification of the basic DAB system according to ETSI standard (TS 102 427 and TS 102 428) using MPEG-4 (H.264) and BSAC/HE-AAC V2 compression to permit sending of multimedia information (radio, TV, and data casting) to mobile devices such as mobile phones. Originally developed in South Korea.

DNS - The Domain Name System (DNS) is a naming system for computers connected to the Internet or a network. It translates user domain names to the assigned numerical IP addresses.

DUC **-** Digital Upconverter is a circuit in the LPU modulator section that converts the digital modulated baseband signal to the 140 MHz digital intermediate frequency.

Dynamic Delay **-** Refers to a processing function provided in the modulator section to compensate for different delays of the program data stream in the data distribution network between the network origination point and various transmitter sites. A time-stamp contained in the transport stream serves as a reference. The present time is delivered by a GPS receiver at the transmitter (1pps signal, rising slope). Comparing these two sources, the dynamic delay function is able to synchronize the program input to all transmitters over a one-second correction range.

Ensemble **-** The complete information payload being received and processed by the transmitter, typically when transmitting according to the DAB standard. In general, the ensemble includes audio programs, data services, and possibly video content.

ETI **-** Ensemble Transport Interface refers to the transport stream format for DAB/DMB broadcasting (2.048 Mbit/s, G.703) used to send program material from the ensemble provider to all DAB transmitters in a network. The ETI format has two varieties: ETI-NA and ETI-NI.

ETI (NA) **-** Ensemble Transport Interface, Network Adapted Layer, is a protocol suited for transmitting the ETI signal via telecom networks. It has a frame structure that complies with G.704 specifications and contains error protection information (Reed Solomon Code). The bit clock frequency is 2.048 MBit/s.

ETI (NI) **-** Ensemble Transport Interface, Network Independent Layer, is a protocol is suited for transmission with connections that have a low error rate and a constant signal delay. It does not contain any error protection information. The bit clock frequency is 2.048 MBit/s.

EIB **-** ETI Input Board is an optional circuit card for the modulator section of the low power unit (LPU). It provides the necessary interface to allow the modulator to accept ETI transport streams according to the DAB digital transmission standard.

Ethernet **-** Physical interface by which a device may be connected to a LAN and/or the Internet to provide web-based supervision. It generally employs an RJ45 connector.

EVM **-** Error Vector Magnitude is a measure used to quantify the performance of the quality the digital being transmitted. A signal sent by an ideal transmitter would have all constellation points precisely at the ideal locations. However, various imperfections in the signal path cause the actual constellation points to deviate from the ideal locations by finite error vectors. Generally associated with the ATSC modulation standard. Analogous to the modulation error ration (MER) used for the DVB, DAB and other modulation

FEF- Future Extension Frames

FFT- Fast Fourier Transform

FPGA - Field Programmable Gate Array, is an integrated circuit designed to be configured by the customer or designer after manufacturing. FPGAs perform many of the intensive digital processing steps used to synthesize the transmitted RF signal in the LPU modulator section.

GPSS - Global Positioning Satellite System is satellite-based navigation system commonly used for determining position and navigating. In a single frequency network context, it delivers an extremely precise time reference (UTC... universal time coordinated) that is used to synchronize all transmitters.

GUI - Graphical User Interface is a type of user interface that allows users to interact with electronic devices via images rather than text commands. In this application, the user interface provided by a touch screen in dual drive systems or the web-based remote interface served over the Ethernet interface.

Hierarchical Mode - A transmission technique whereby the transmitted data payload is divided into a lower data rate high priority (HP) stream and a higher data rate low priority (LP) stream. Those receivers with difficult reception conditions decode only the more robust HP data stream, while receivers with good reception conditions receive both data streams.

Hot-pluggable - Term to denote that the device in question can be removed while transmitter is operating without suffering damage or causing damage to other devices.

HPF - High Power Filter also referred to as mask filter or critical filter.

HTML - HyperText Markup Language is the predominant markup language for web pages. HTML is the basic building block of web pages.

IP - Internet Protocol

IP Address - Internet Protocol Address is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol (IP) for communication. An IP address serves two principal functions: host or network interface identification and location addressing.

ISP - In-System Programming refers to a GatesAir utility used to update transmitter software.

LCD - Liquid Crystal Display is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals to display text and images. Often used to refer to the blue display screen on the front panel of LPU (low power unit).

LPF - Low Pass Filter. Typically installed close to the transmitter output port. It is used to attenuate out of band emissions at the signal harmonic frequencies arising from the high power amplification process. It may also be referred to as a harmonic filter.

LPU - Low Power Unit. Device that contains modulator (exciter) and amplifier sections. There are several different versions of LPU.

LVDS - Low-Voltage Differential Signalling

Mask Filter - Filter designed to pass a specified frequency band.

MCM - Master Control Module is a circuit board in the TCU (transmitter control unit). TCUs are used in some versions of GatesAir transmitters. Later model transmitters use the MSC2 as a transmitter control device.

MER - Modulation Error Ratio is a measure used to quantify the quality of the digital being transmitted. A signal sent by an ideal transmitter would have all constellation points precisely at the ideal locations. However various imperfections in the signal path cause the actual constellation points to deviate from the ideal locations by finite error vectors. The modulation error ratio quantifies the ratio of the desired signal to the undesired error vectors. MER is typically associated with COFDM modulation formats such as DVB or DAB.

MFS - Mega Frame Sync

MIB - Management Information Base

MIP - Mega frame Initialization Packet

NICAM - Near Instantaneous Companded Audio Multiplex; early form of lossy compression for digital audio.

NIT - Network Information Table

PA - Power Amplifier is an electronic circuit that accepts a low level RF signal and outputs an amplified replica.

PAB - Power Amplifier Block refers to a high power amplifier stage. May refer to the LPU power amplifier section or one or more high power amplification stages external to the LPU. PABs are typically numbered from 1…n with PAB 1 being the highest in the rack.

PC - Personal Computer

PCB - Printed Circuit Board in the transmitter.

PCM - Processor Control Module is a circuit card in the transmitter control unit (TCU). The MCM card provides most of the core control functions, whereas the PCM card controls the user remote & GUI interface. Later model transmitters use the MSC2 instead of the TCU.

PFRU - Precise Frequency Reference Unit is a circuit sub-assembly inside the LPU modulator section responsible for supplying the various high-stability oscillator signals required to synthesize the RF waveform that will be transmitted.

PLL - Phase Locked Loop

PRBS - Pseudo Random Binary Sequence is an endless series of random numbers typically used for transmitter test purposes, often when a valid transport stream does not exist.

PS - Power Supply is a device that supplies DC electrical energy to one or more electric loads, typically via the rectification of an AC mains electrical input.

RF - Radio Frequency refers to an electrical oscillation at the frequency of radio waves in the range of 3 kHz to 300 GHz. In this application, typically a signal in the 168 MHz to 242 MHz frequency range of the VAX transmitter.

RS-485 - TIA/EIA standard for serial multipoint communications lines, also known as EIA-485 and TIA/EIA-485, is a standard defining the electrical characteristics of drivers and receivers for use in balanced digital multipoint systems. The standard is published by the Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA).

RTAC*TM* - Real Time Adaptive Correction is a signal processing technique applied in the modulator signal generation stage which seeks to correct distortions produced in the high power amplification and filtering stages by means of pre-distortion.

RU - Is an abbreviation for rack unit. One rack unit equals 1.75" (44.45mm). The rack unit is used to describe the height of components that will be placed in racks.

SFN - Single Frequency Network is a type of transmission network in which all transmitters are synchronized in frequency and phase (symbol). This transmission technique offers high frequency economy, as a single frequency can be used in a large geographic area.

SMA - SMA connector - consists of a 0.250x36 thread. The male is equipped with a .312 inch (7.925mm) hex nut.

SMPTE 310 - A transport stream format sometimes employed with the ATSC digital television standard. Refers to the set of cooperating standards that label individual frames of video or film with a time code defined by the Society of Motion Picture and Television Engineers.

Static Delay - A delay function provided by the exciter over a manually settable range of 0 to 1000 ms to compensate for differences in signal processing delays or local propagation conditions for individual transmitters in a single frequency network.

Sync (Sync pulse) - Term used in analog broadcasting that refers to the horizontal synchronization pulse in the video waveform which, when transmitted, creates the highest level of peak envelope power in the transmitter.

TCO - Total Cost of Operation

TII - Transmitter Identification Information is a data field transmitted during the null in the DAB RF frame containing transmitter identification information for use by the receiver. Each transmitter in a single frequency network has its own unique TII identifier.

Time Stamps - Data fields in the transmission protocol (e.g. in the ETI signal) containing timing information for the purposes of signal monitoring and synchronization.

TS - Transport Stream refers to a standard format for transmission and storage of audio, video, and data for broadcast systems such as DVB and ATSC. The transport stream specifies a container format encapsulating packetized elementary streams, with error correction and stream synchronization features for maintaining transmission integrity when the signal is degraded. Depending on the digital transmission standard, the transport stream may be in the SMPTE310, ASI, or ETI format.

TPO - Transmitter Power Output refers to the transmitter forward output power level.

TSP - Transport Stream Packet

UDC - Up-Down Converter refers to a circuit in the LPU modulator section that converts an 140 MHz intermediate frequency signal to the final desired VHF RF channel frequency (upconversion) or vice versa (down conversion)

UPS - Uninterruptable Power Supply is a battery-based system designed to provide power during an AC mains failure event.

VGA - Video Graphics Array is a video display standard used by the personal computer industry based on a 640 x 480 pixel resolution. The standard used by the TCU touchscreen in dual drive systems.

VHF - Very High Frequency is the radio frequency range of 30 MHz to 300 MHz. In this application, the 168 MHz to 242 MHz frequency band covered by a VAX transmitter.

WEB - A system of Internet servers that support HTML formatted documents. A device or interface that uses HTML formatted documents transmitted according to the IP protocol, typically over LAN/WAN/Internet servers, but also locally via 1:1 communications.

Table of Contents

Section 1
Introduction

Section 2
Installation

Section 3
Operation

Section 4
Theory of Operation

Table of Contents (Continued)

Section 5
Maintenance and Alignments

Section 6
Troubleshooting

Section 7
Parts List

Appendix A - FM Web Remote Option

Table of Contents

Table of Contents (Continued)

Section 1 Introduction 1

1.1 Manual Contents

This technical manual addresses the following GatesAir ZX series of solid-state radio transmitters:

- ZX2500 – 2.5 kW FM transmitter
- ZX3750 – 3.75 kW FM transmitter
- ZX5000 – 5 kW FM transmitter
- ZX7.5 – 7.5 kW FM transmitter
- ZX10 – 10 kW FM transmitter

NOTE:
This manual does not address the ZX transmitter models listed below:

- ZX500 – 500W FM transmitter
- ZX1000 – 1000W FM transmitter
- ZX2000 – 2000W FM transmitter
- ZX3500 – 3500W FM transmitter

These transmitters are addressed in Instruction Book (888-2594-001).

This manual contains the following sections:

- **Section 1:** Introduction, identifies the versions of the product available and the possible options.
- **Section 2**: Installation, details the procedures to receive, install, and commission the transmitter for use, including an initial turn-on procedure.

- **Section 3**: Operation, describes operation of the equipment and is intended to be the primary section referenced by operating personnel.
- **Section 4**: Theory of Operation, is included to help service personnel to understand the inner workings of the transmitter.
- **Section 5:** Maintenance, lists and explains alignments and adjustments that could be required to maintain the transmitter once in operation.
- **Section 6:** Troubleshooting, is included as a servicing aid to be used along with Sections 4 and 5 by qualified service personnel to identify and correct an equipment malfunction.
- **Section 7:** Parts List, is a comprehensive listing of the components that may be replaced in the field.
- **Appendix A:** FM WEB remote option, proivdes information about the optional WEB remote interface card.

1.2 Features / Benefits

The GatesAir ZX Series of transmitters offers the following useful features and benefits:

- HD Radio capable with on-the-fly switching between FM, FM+HD, or HD mode when used with FlexStar exciter.
- Broadband design to eliminate tuning adjustments from 87.5 MHz through 108 MHz (N+1 capable). Frequency change can be done electronically in seconds with Micro-Max or FlexStar exciter or Digit exciter with external controller.
- Redundant hot-plug RF amplifier modules allow module replacement while transmitter is in operation.
- Redundant hot-plug power supplies modules allow module replacement while transmitter is in operation, including transmitter logic supplies. (each PS module has both 50V and 5V logic supplies)
- Redundant cooling fans allow transmitter to operate at full power for extended periods with a fan failure, while fan tachometer alarm notifies service personnel of failure condition.
- Three independent AC mains inputs per amplifier chassis and regulated power supplies allow transmitter to accept a wide range of single or three phase mains power without concern for line balance or rotation.
- Redundant IPA amplifiers and PA splitters eliminate a single point of failure.
- Non software-based controller for simple, repeatable operation. Does not require UPS or battery to retain settings during AC mains failures.

- EIA rack mounting for easy installation with only 16RU height for 5000W amplifier.
- Optional air plenum available for interface to an external ducted air system.
- Precision directional RF sample port provided for customer use.

1.3 General Product Description

The ZX series of solid state transmitters is designed to synthesize and amplify radiofrequency signals in the FM broadcast band (87.5MHz -108MHz).

The complete ZX transmitter consists of one or more of each of two major assemblies: an FM exciter and the ZX amplifier chassis. These are shown in Figure 1-1.

[001] Exciter
(Flexstar HDX exciter shown)

[002] Amplifier

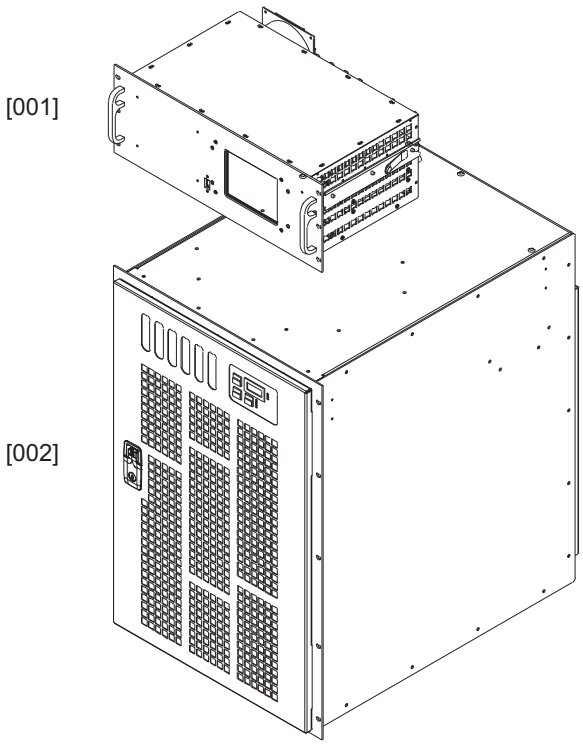


Figure 1-1 Major subassemblies of ZX series transmitter

1.3.1 Exciter

The exciter accepts an audio signal in either analog or digital format and modulates it onto an RF carrier. Depending on the format of modulation, digital HD Radio or traditional FM, the exciter may be any one of these GatesAir exciters:

- Micromax FM – FM exciter with analog modulator.
- Digit CD – Digitally synthesized FM exciter.
- FlexStar HDX - Tri-mode exciter capable of either traditional FM or digital HD Radio transmissions.

1.3.2 Amplifier

The amplifier chassis accepts a low level on-channel RF signal from the exciter and amplifies it to the desired output level for transmission. The transmitter models addressed in this manual have five standard FM power levels: 2500W, 3750W, 5000W, 7.5kW & 10kW.

This manual chiefly addresses the ZX amplifier chassis and the operation of the transmitter as a whole. A manual dedicated to the exciter is provided separately.

1.4 Transmitter Nomenclature

The complete ZX transmitter is named according to the particular combination of exciter and amplifier chassis being employed. The number following the ZX prefix indicates the full nominal FM power level, either in watts for power levels below 5000W or in kilowatts for power levels above 5000W. A suffix of FM, CD, FLX, or HD+ is assigned according to the exciter type.

For example:

ZX5000 = 5000W amplifier with no exciter

ZX5000MX = 5000W amplifier with MicroMax$_{(TM)}$ FM exciter

ZX5000CD = 5000W amplifier with DIGIT CD$_{(TM)}$ digital FM exciter

ZX5000FLX = 5000W amplifier with FlexStar$_{(TM)}$ HDX-FM digital FM exciter (FM only, no HD Radio)

ZX5000HDPL (HD plus) = 5000W amplifier with FlexStar$_{(TM)}$ HDX-FM digital FM exciter (both FM and HD Radio capable)

NOTE:
In addition, the FlexStar exciter may have one or two RF outputs, depending on the model number. The use of dual RF outputs is advantageous in certain applications.

FLX-11 = single FM output

FLX-12 = dual FM outputs

HDPL-21 = single tri-mode output (FM, FM+HD, HD)

HDPL-22 = dual tri-mode outputs

1.5 Tri-mode Operation

All ZX transmitters are designed to operate in any one of three different modes:

1. FM mode = traditional FM modulation
2. FM+HD mode = hybrid mode with analog and digital HD Radio simulcast
3. HD mode = digital HD Radio modulation only

The determination of operating mode is made by the exciter. To transmit a digital HD Radio signal, an HD Radio exciter, such as the FlexStar HDX exciter is required. The ZX amplifier can switch on-the-fly between all three operating modes, as commanded by the exciter through an exciter interface cable.

1.6 ZX Transmitter General Construction

The ZX transmitter features all solid-state construction and utilizes a series of FET-based power amplifier (PA) modules to amplify the RF signal. In addition to RF drive power from the exciter, these PA modules utilize 50V DC power supplied by switchmode power supply (PS) modules. Both the PA and PS modules are hot-pluggable and may be inserted and removed from the transmitter while it is on the air.

[101] Power supply (PS) module

[102] Front door

[103] Power amplifier (PA) module

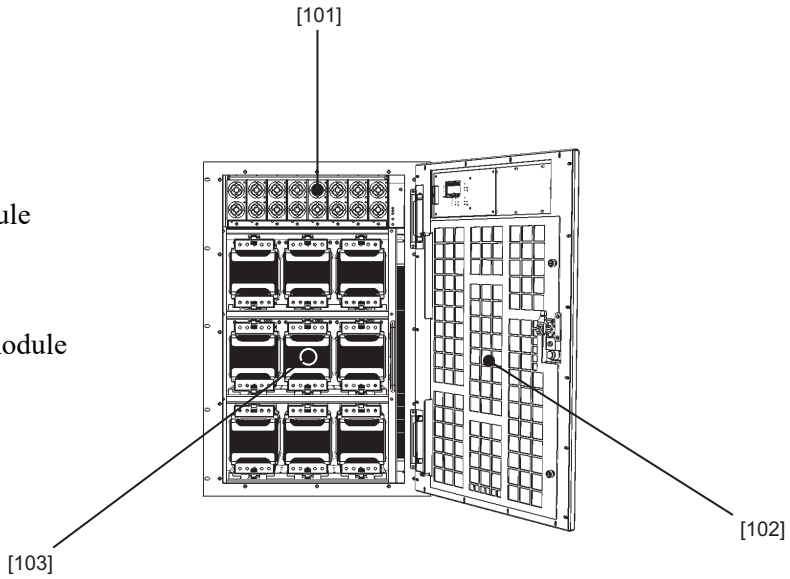


Figure 1-2 PA and PS modules in ZX series amplifier

The number of PA and PS modules, size, weight, and other important parameters vary according to the transmitter model and desired power level. Information on the number of PA and PS modules as a function of transmitter model for power levels of 5000W and below is given below in Table 1-1 and Figure 1-3.

Table 1-1 Complement of Modules vs Transmitter Model

Model	PA Modules*	PS Modules	Cooling Fans
ZX5000	8 + 1	8	5
ZX3750	6 + 1	6	5
ZX2500	4 + 1	4	5

NOTE:
"+1" designation indicates an IPA module: a PA module installed in the IPA position.

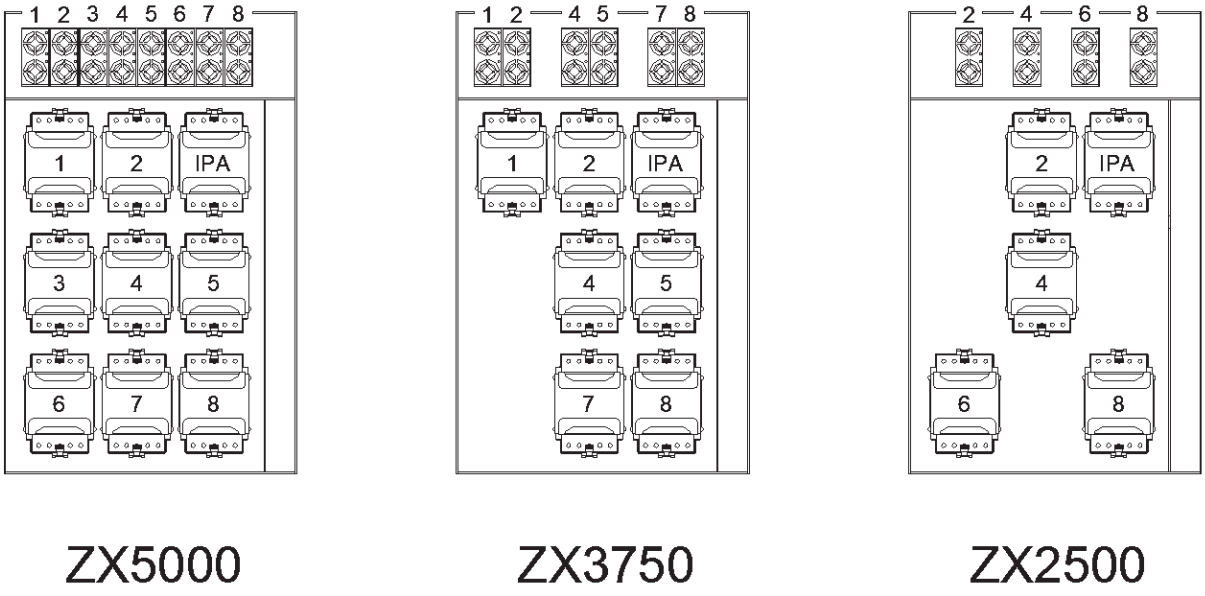


Figure 1-3 Positions of PA and PS modules in various ZX series transmitter models

The transmitter models at 7.5kW and above are made by combining the outputs of multiple ZX3750 or ZX5000 amplifier chassis in an integrated system. The number of amplifier chassis per model is as follows:

ZX7.5 = 2 x ZX3750

ZX10 = 2 x ZX5000

Additional information on important transmitter parameters, such as size, weight, and power consumption, may be found in drawing 839-8464-033 *Outline Drawing, ZX Transmitters* in the drawing package accompanying this manual.

1.7 Simplified Block Diagrams

Figures 1-4 through 1-6 provide simplified block diagrams of the amplifier models discussed in this manual. Figures 1-7 and 1-8 provide a simplified block diagram of the ZX7.5 and ZX10 model transmitters. Consult the exciter manual for a block diagram of the exciter.

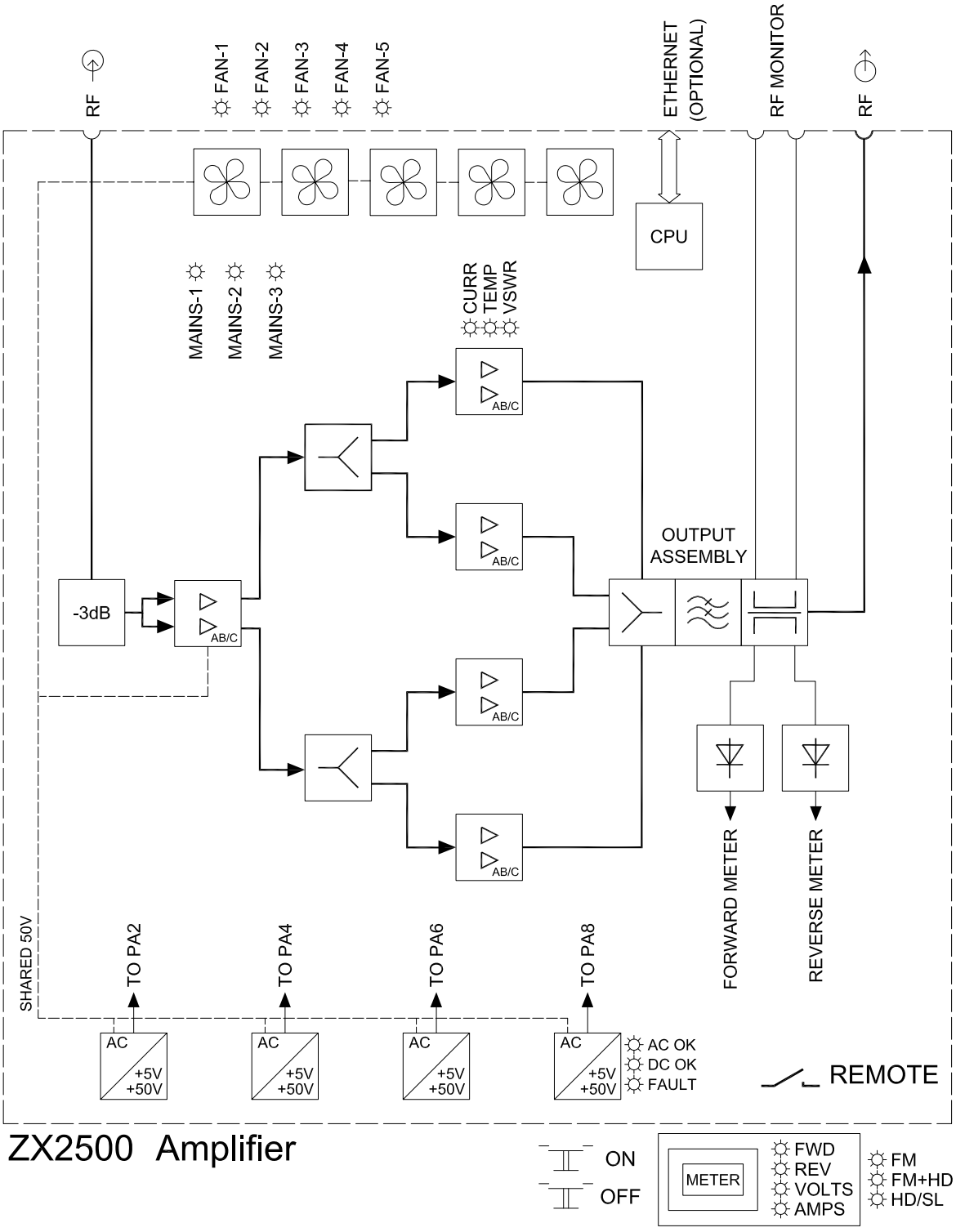


Figure 1-4 ZX2500 amplifier simplified block diagram

WARNING: Disconnect primary power prior to servicing.

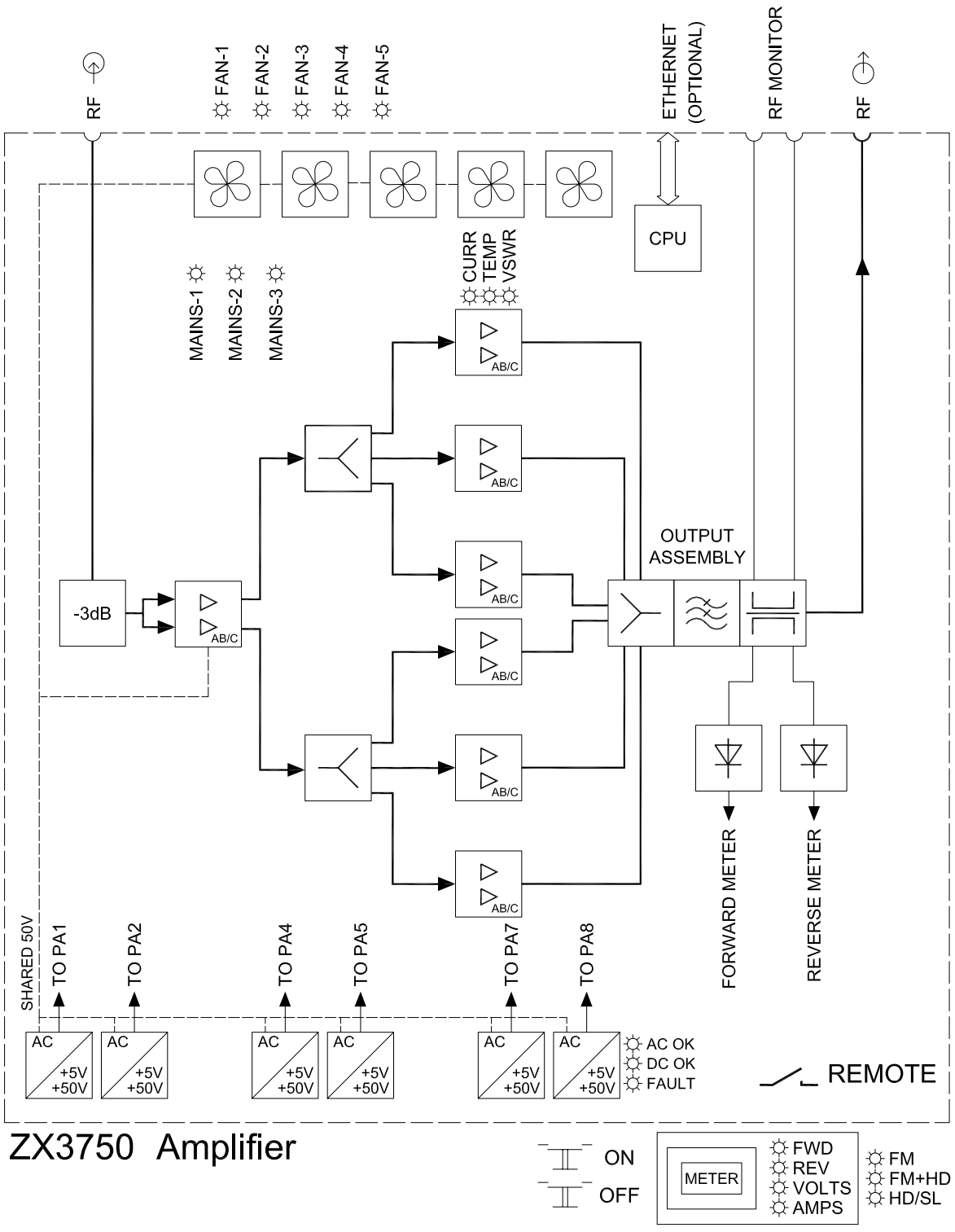


Figure 1-5 ZX3750 amplifier simplified block diagram

WARNING: Disconnect primary power prior to servicing.

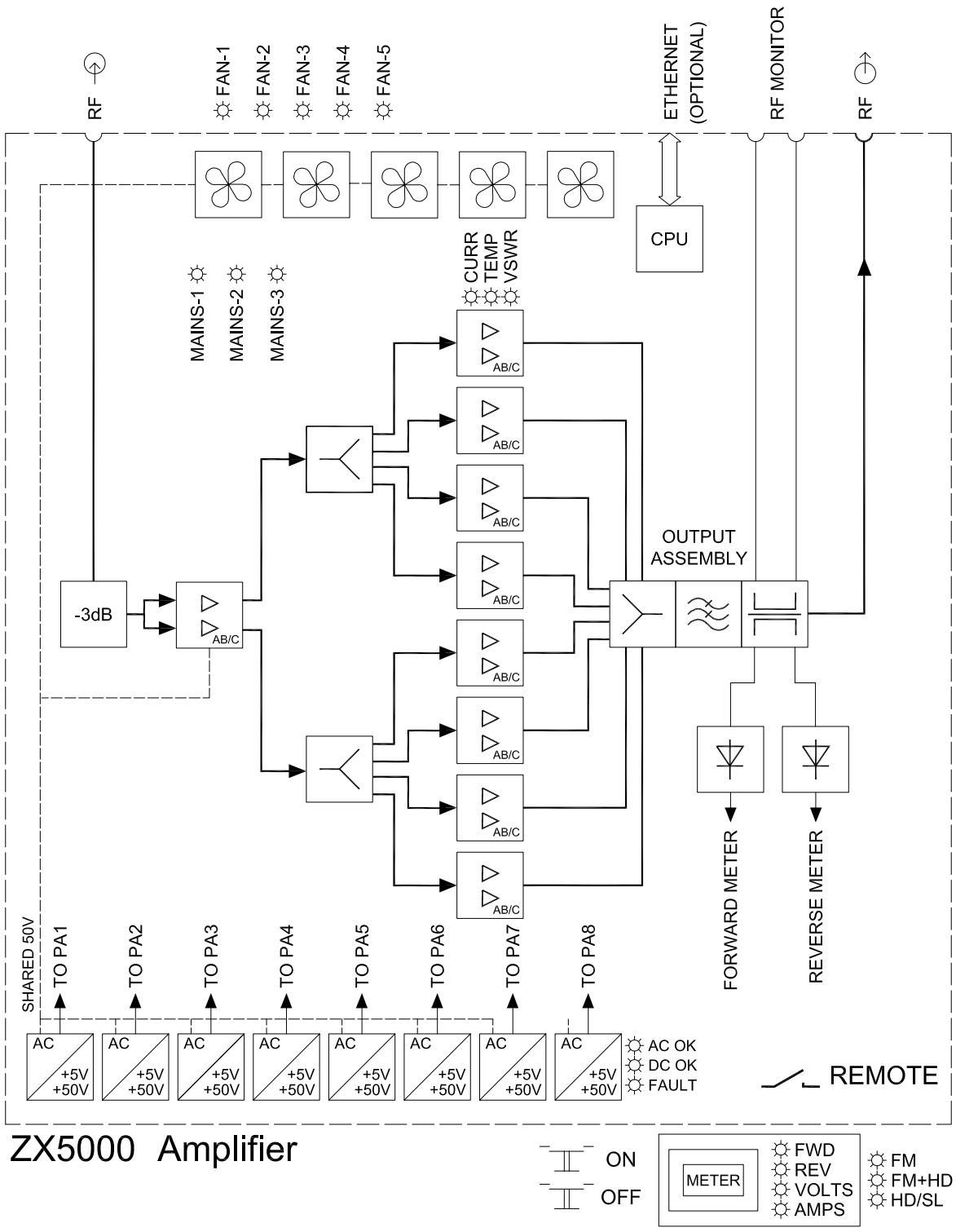


Figure 1-6 ZX5000 amplifier simplified block diagram

WARNING: Disconnect primary power prior to servicing.

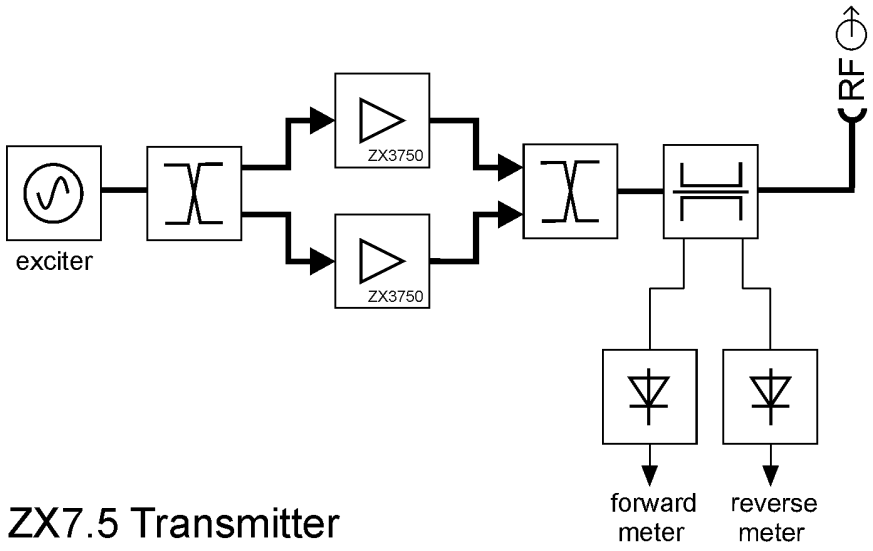


Figure 1-7 ZX7.5 similified block diagram

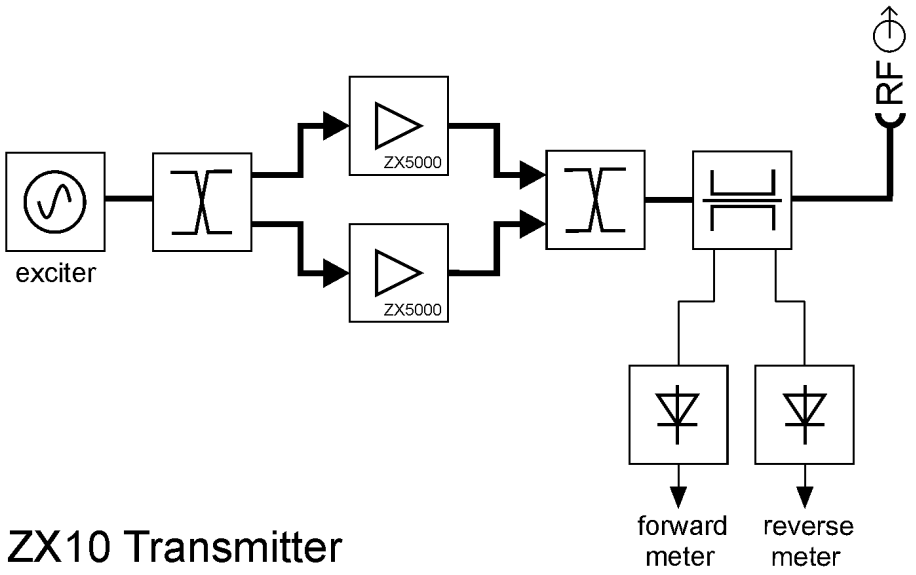
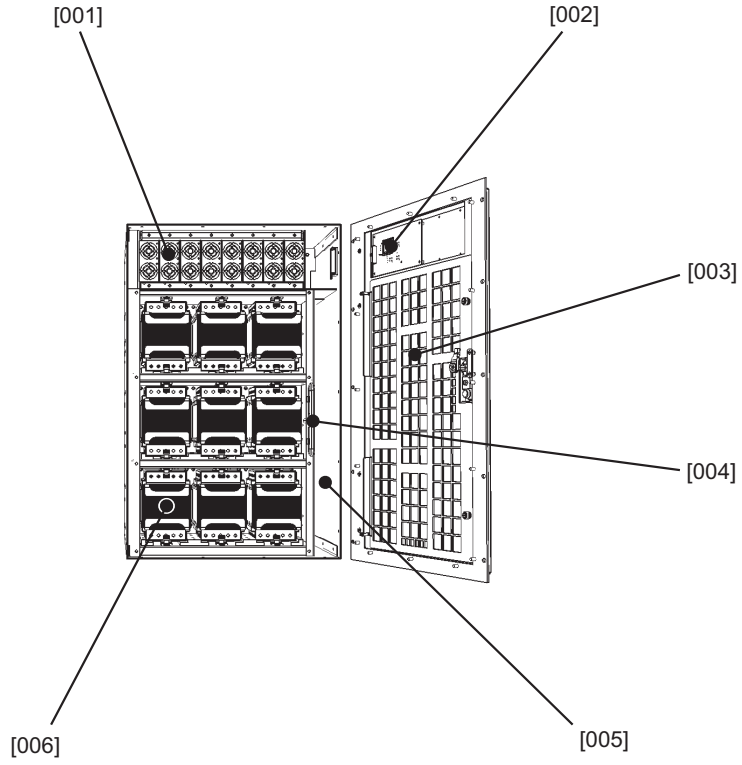


Figure 1-8 ZX10 simplified block diagram

1.8 Major Subassemblies

Figures 1-7 through 1-9 identify some of the major subassemblies contained the ZX series amplifier. Figures 1-10 through 1-14 indentify the major subassemblies found in full-cabinet transmitters with output powers of 7.5kW and above. The role of these subassemblies is discussed in detail in Section 4 – Theory of Operation.



[001] PS module

[002] Controller board

[003] Filter door and air filter

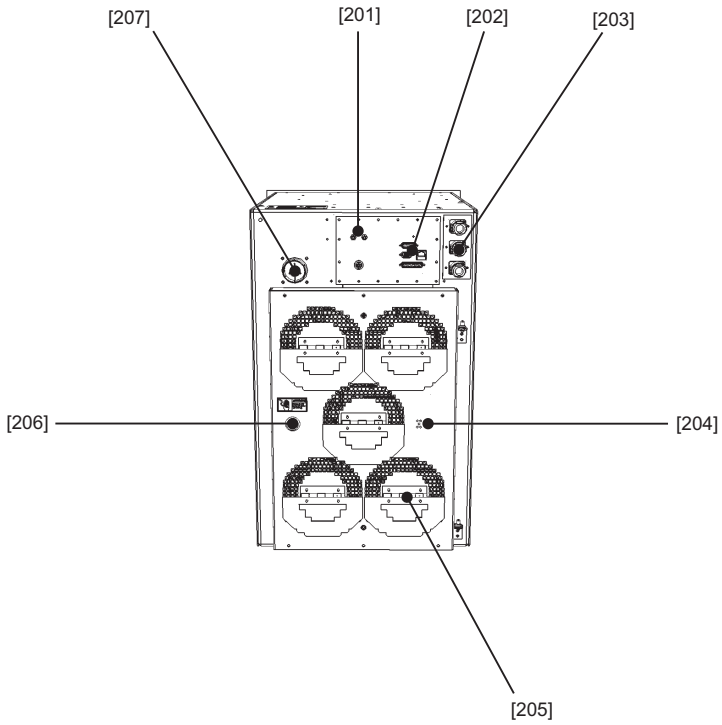
[004] Hex key to open rear door

[005] Air intake plenum leading to output assembly heatsink

[006] PA module

Figure 1-9 ZX5000 amplifier front view with front face removed

WARNING: Disconnect primary power prior to servicing.



[201] User interface subpanel:
RF forward monitor port (SMA-M)
RF reverse monitor port (SMA-M)
RF input port (BNC–F)

[202] User interface subpanel:
Ethernet port (RJ-45)
Exciter interface port (D-sub 15)
System interface port (D-sub 15HD)
Remote control port (D-sub 25)

[203] AC mains inputs:
PowerCon NAC3MPA (ZX5000)
IEC C20 (ZX2500, ZX3750)

[204] Individual fan alarm LEDs

[205] Chassis cooling fan

[206] Hex key latch to open rear door

[207] EIA 1-5/8 flangeless RF output

Figure 1-10 ZX5000 amplifier rear view

[301] AC mains filters (ZX5000)

[302] 8X PS interface board

[303] 2X IPA splitter board

[304] 3dB attenuator assembly

[305] 8X splitter board

[306] PA backplane board

[307] Output assembly (combiner, harmonic filter, and directional couplers)

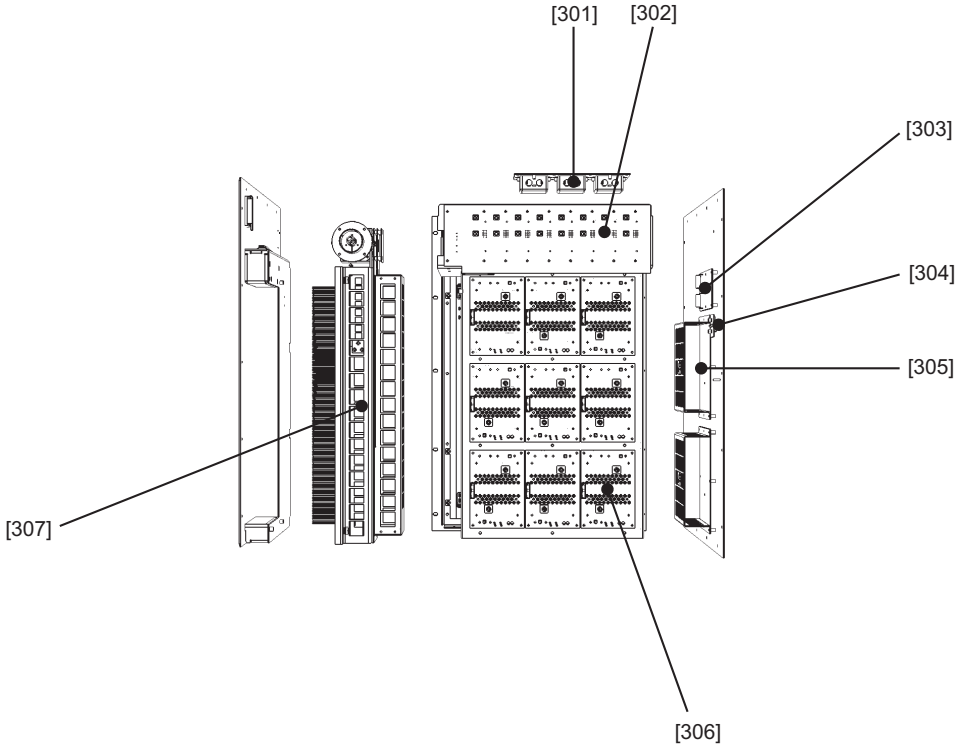


Figure 1-11 ZX5000 exploded interior view

WARNING: Disconnect primary power prior to servicing.

[101] Air exhaust ports

[102] RF output flange

[103] ZX5000 amplifier chassis

[104] ZX5000 amplifier chassis

[105] AC distribution chassis

[106] System metering assembly

[107] Exciter

Exciter switcher: 1RU drawer between upper and lower exciter

[108] Exciter

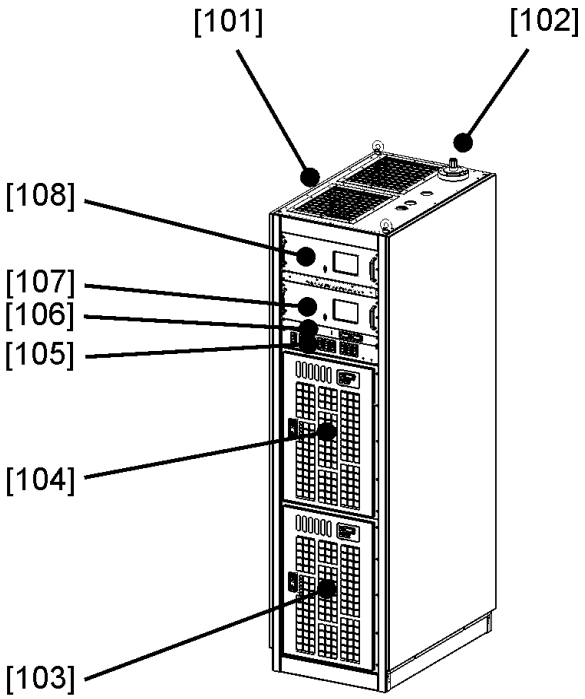


Figure 1-12 ZX10 transmitter front view

[201] RF output flange

[202] Exciters

[203] ZX5000 amplifier chassis

[204] ZX5000 amplifier chassis

[205] 2X hybrid combiner

[206] RF directional couplers

[207] Access door, exciter air compartment

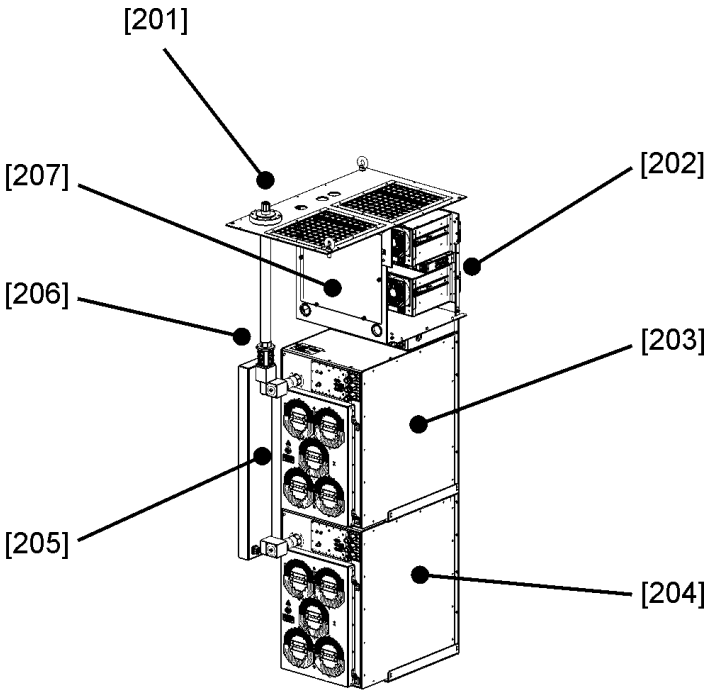


Figure 1-13 ZX10 transmitter rear with cabinet removed

WARNING: Disconnect primary power prior to servicing.

[301] 2.5kW RF load

[302] Component panel (side wall)

[303] Cabinet rear door

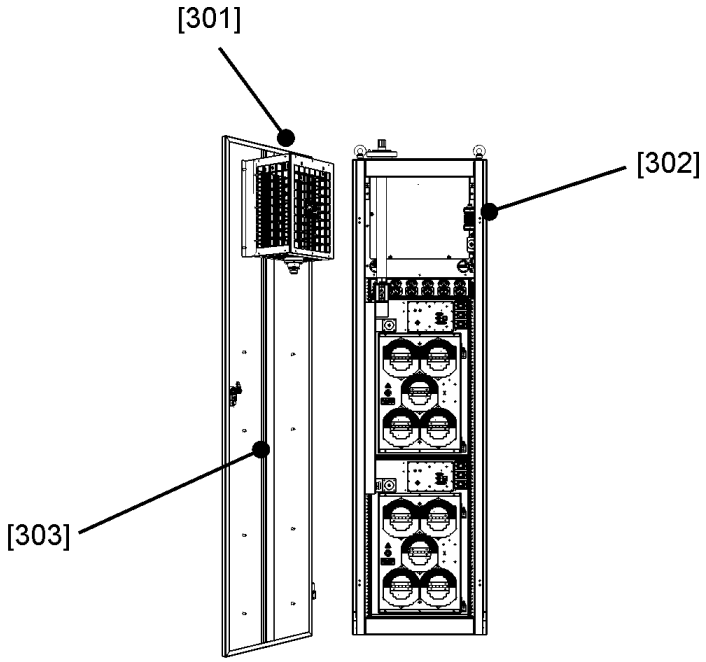


Figure 1-14 ZX10 transmitter with rear door removed

[401] Coaxial transfer relay

[402] Reserve exciter RF test load

[403] 2X splitter RF load

[404] 2X splitter (700W hybrid)

[405] Remote terminal board

[406] 5X HD15 divider board (system interface bus)

[407] 5X DB15 divider board (exciter interface bus)

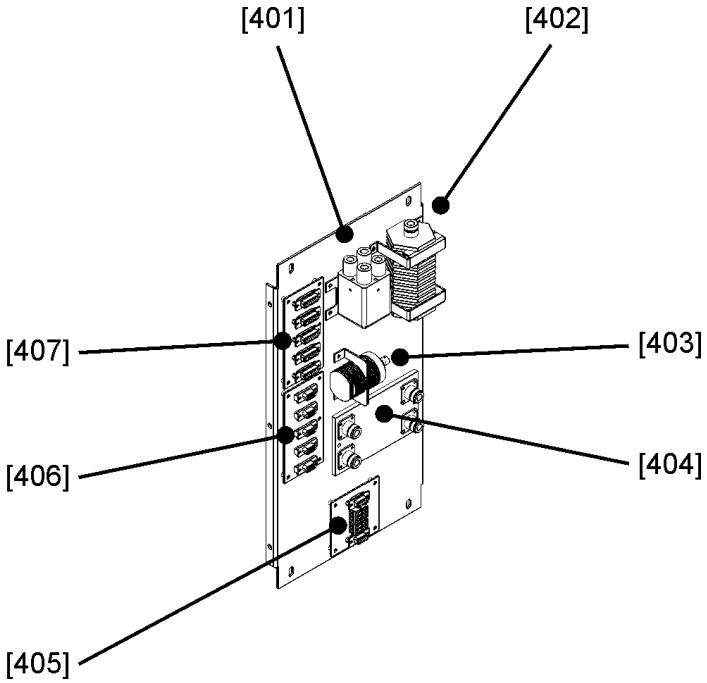


Figure 1-15 ZX10 component panel in rear cabinet

Certain components shown in Figure 1-15 (above) will not be present in certain transmitter models.

1.9 Transmitter Accessories

The exciter and one or more ZX amplifier chassis form the basic ZX transmitter. In addition to these devices, various add-on options are available and may be present in a ZX transmitter system. Inasmuch as these accessories do not significantly change the functioning of the core transmitter itself, it is understood that this manual addresses customized transmitter configurations that may contain one or more of these options.

In the case of a relatively high level of customization, this manual may also be accompanied by a supplemental "customer-special" manual. In the case where conflicting information is presented in the two manuals, the information given by the customer-special manual supersedes any information contained in this manual.

1.9.1 Customized Rack Integration

ZX transmitters up to the 5000W power level are often purchased as stand-alone units and mounted in an equipment rack provided by the customer. Alternatively, GatesAir sometimes provides a complete rack integration package, especially for customers requiring ducted output and/or input air. Transmitters at the 7.5kW level and above are furnished with racks as part of an integrated system.

1.9.2 AC Distribution & Signal Monitor Chassis

A customized AC distribution chassis is sometimes supplied to provide in-rack AC mains distribution with front panel circuit breaker switching. This chassis may also feature a set of front-panel SMA connectors for signal monitoring and/or an emergency off button. One or more AC distribution chassis (as required) are provided as standard equipment for transmitters at the 7.5kW level and above.

1.9.3 Directional Coupler or Wattmeter

Each amplifier chassis features a precision on-board directional coupler, which may be used to calibrate power meters with an average power meter. Alternately, a through-line wattmeter capable of measuring the output power directly may be supplied as an option. Optional external couplers may also be provided to provide additional sample ports for test and monitoring equipment.

1.9.4 Dual-Drive / Main-alternate Switcher

A second exciter and exciter switchover controller are sometimes provided. The operation of the main alternate switcher is addressed in a separate manual.

1.10 Specifications

	P.O. BOX 4290 QUINCY, IL 62305	THIS DOCUMENT CONTAINS PROPRIETARY DATA [illegible]. NO DISCLOSURE, REPRODUCTION, OR USE OF ANY PART THEREOF MAY BE MADE EXCEPT BY WRITTEN PERMISSION.

REVISIONS									
Rev: A	Date: 06/03/09	Dftm: DS	Eng: DS	ECO Number: P43867	Rev: B	Date: 02/13/10	Dftm: DS	Eng: DS	ECO Number: P46612
New Drawing					Add ZX7.5, ZX10				

APPROVALS			
Drawn By: D SPARANO 03/14/09	Eng: D SPARANO	Proj: D SPARANO	Mfg: W OLSON

SPECIFICATIONS FOR ZX TRANSMITTER FAMILY (ZX2500, ZX3750, ZX5000, ZX7.5, ZX10)

Overview: The present document provides a controlled source for specifications for the ZX10, ZX7.5, ZX5000, ZX3750, and ZX2500 models of FM transmitter. This information mirrors some of the information contained in outline drawing 839-8464-033. Many of the exciter-dependent parameters are derived from the data sheets of the respective exciters and are subject to change according to any changes in the exciter design.

ZX Transmitters Specifications – FM models

GENERAL

FM power output range: [1]
ZX2500: 625 W – 2750 W
ZX3750: 950 W – 4125 W
ZX5000: 1250 W – 5500 W
ZX7.5: 1900 W – 8250 W
ZX10: 2500 W – 11000 W

RF output connector: [2]
ZX2500: EIA 1-5/8" flangeless, 50 ohms
ZX3750: EIA 1-5/8" flangeless, 50 ohms
ZX5000: EIA 1-5/8" flangeless, 50 ohms
ZX7.5: EIA 1-5/8" flanged, 50 ohms
ZX10: EIA 1-5/8" flanged, 50 ohms

Excitation: Harris Micromax analog FM exciter.

RF amplifers: MOSFET, broadband (no-tune), hot plug modular, universal (same type all tx models), 4.5 kg.

Power supplies: Switchmode, auto-ranging, hot plug modular, universal, 2.5 kg.

Frequency range: 87.5 MHz - 108 MHz, in 10 kHz increments.

Frequency stability: +/- 3 ppm, 0° C to 50° C (4-minute stabilization period).

Power stability: ≤ +/- 0.25 dB.

Reverse power: Protected against open or short circuit, all phase angles. Capable of operation into infinite VSWR with user-adjustable foldback threshold. Threshold set to 2.5% of FM nameplate power level at factory.

Harmonic / spurious output: Meets or exceeds FCC, Canadian, CE, and Chinese requirements.

Modulation type: Direct carrier frequency modulation.

Modulation capability: +/- 350 kHz.

Asynchronous AM S/N ratio: 50 dB minimum below equivalent 100% amplitude modulation by 400 Hz using 75 µs de-emphasis (no FM modulation present).

Synchronous AM S/N ratio: 40 dB below equivalent 100% amplitude modulation with 75 µs de-emphasis and 400 Hz highpass filter (FM deviation +/- 75 kHz by a 1 kHz sine wave). Higher ratios are obtainable. Refer to Harris Application Note # APN-115-TA.

AC mains requirement: 90 - 264 V[3], 47 - 63 Hz, IEC C14 inlet for exciter and following connections to power amplifier:
ZX2500/3750: 190 - 264 V[4], 47 - 63 Hz, triple IEC C20 inlets. Configurable on-site for single or three-phase connection: 190 - 264 V single phase, 190-264 V delta, 190 - 264 V wye, or 330 - 450 V wye.
ZX5000: Same as 3750 W model except triple PowerCon NAC3MPA inlets.
ZX7.5 and ZX10:
Screw terminal connections.
Option: 190 - 264 V, 47 - 63 Hz, delta
Option: 330 - 450 V, 47 - 63 Hz, wye
Option: 190 - 264 V, 47 - 63 Hz, dual single-phase (top and bottom amplifiers)

Power consumption: (FM mode at nameplate power level)
ZX2500: 4700 W max; 4300 W typical
ZX3750: 7000 W max; 6350 W typical
ZX5000: 9300 W max; 8500 W typical
ZX7.5: 14000 W max; 12700 W typical
ZX10: 18600 W max; 17000 W typical

Power factor (displacement): 0.98 typical.

Phase rotation/balance: all AC inputs independent. Observation of correct phase rotation and balance not required.

[1] VSWR 1.2:1 or less. De-rate to nameplate rating for VSWR up to 1.5:1.
[2] EIA 3-1/8" flanged available as option, ZX7.5 and ZX10.
[3] Certified to 100-240 V nominal range +/- 10% testing margin.
[4] Certified to 208-240 V nominal range +/- 10% testing margin.

Title: SPEC, ZX TRANSMITTER FAMILY	Sheet 1 of 7	Rev: B	Dwg: 817-2350-085

Mains restart: > 80% output power in less than 5 seconds after AC mains failure.
Altitude: 3000 m elevation above mean sea level.
Ambient temperature range: 0 - 50° C at sea level, upper limit de-rated 2° Centigrade per 300 m elevation AMSL.
Humidity: 95%, non-condensing.
Dimensions: Standard 19" (48.3 cm) EIA rack; 1RU = 4.45 cm (1.75")
ZX2500: 16 RU amp + 1 RU exciter, 62 cm (25") depth
ZX3750: 16 RU amp + 1 RU exciter, 62 cm (25") depth
ZX5000: 16 RU amp + 1 RU exciter, 62 cm (25") depth
ZX7.5: 44 RU rack, 96 cm (38") depth
ZX10: 44 RU rack, 96 cm (38") depth
Weight, less exciter (all modules installed):
ZX2500: 67 kg (148 lbs) approx.
ZX3750: 81 kg (179 lbs) approx.
ZX5000: 95 kg (210 lbs) approx.
ZX7.5: 225 kg (500 lbs) approx.
ZX10: 250 kg (550 lbs) approx.
Air cooling: Air input with built-in filter at front. Air exhaust with built-in DC fans at rear. Ducted air exhaust and/or input available as option.
ZX2500: 17 m3/min (600 cfm) approx.
ZX3750: 17 m3/min (600 cfm) approx.
ZX5000: 17 m3/min (600 cfm) approx.
ZX7.5: 34 m3/min (1200 cfm) approx.
ZX10: 34 m3/min (1200 cfm) approx.
Ambient noise: Worst case, 1 m from front face, 1 m above ground. Mounted in rack, no ducted air input or exhaust. Figures in parentheses are for ducted air input and exhaust option.
ZX2500: < 73 dBA (65 dBA)
ZX3750: < 73 dBA (65 dBA)
ZX5000: < 73 dBA (65 dBA)
ZX7.5: < 73 dBA (65 dBA)
ZX10: < 73 dBA (65 dBA)

REMOTE CONTROL

Parallel remote: D-sub 25 female.
Status: open collector, 24 V @ 500 mA max.
Command: active low with internal pull-up.
Telemetry: 0 - 2 V, 2k source impedance.
Security: RF mute and external interlock lines.
ZX7.5, ZX10: D-sub 25 female to each amp chassis and D-sub 9 with screw terminal breakout for system.
Ethernet (optional): RJ45, twisted pair.

WIDEBAND COMPOSITE PERFORMANCE

Inputs: Selectable, balanced/unbalanced, female BNC connector.
Input impedance: Selectable 10k ohms or 50 ohms nominal (resistive).
Input level: 3.5 V p-p (1.24 V rms) nominal for +/- 75 kHz deviation.
FM signal to noise ratio: 80 dB below +/- 75 kHz deviation at 400 Hz with 75 µs de-emphasis, 22 Hz to 500 kHz bandwidth.
Amplitude response: +/- 0.1 dB, 30 Hz to 53 kHz.
Total harmonic distortion (THD+N): 0.02%, 30 Hz to 100 kHz with 75 µs de-emphasis.
Intermodulation distortion: SMPTE: 0.03% (60 / 7000 Hz 1:1) CCIF: All distortion products down 74 dB (reference 14 kHz / 15 kHz tone pair).
Transient intermodulation distortion (DIM): 0.05%, 2.96 kHz square wave / 14 kHz sine wave modulation.
Phase response variation: +/- 0.5° from linear phase, 30 Hz to 53 kHz, limited by measurement equipment (see stereo separation below).
Stereo separation: 50 Hz to 300 Hz: 40 dB; 300 Hz to 15 kHz: 50 dB (as limited by external stereo generator).

MONAURAL MODE (STANDARD)

Input: XLR (female) connector, 600 ohms, balanced, resistive, transformerless.
Input sensitivity: -8 dBm to +12 dBm for +/- 75 kHz deviation at 400 Hz, adjustable.
Amplitude response: +/- 0.5 dB with respect to pre-emphasis curve. Selectable pre-emphasis: flat, 25, 50 or 75 µs.
Harmonic distortion: (THD+N): 0.02%, 30 Hz to 15 kHz with 75 µs de-emphasis.
Intermodulation distortion: SMPTE: 0.03%, 60 Hz / 7 kHz tone pair, 4:1 ratio, 75 µs pre-/de-emphasis; CCIF: All distortion products down 74 dB (reference 14 kHz / 15 kHz tone pair).
Transient intermodulation distortion: DIM: 0.05%, 2.96 kHz square wave / 14 kHz sine wave modulation (flat).
FM signal to noise ratio: 80 dB below +/- 75 kHz deviation at 400 Hz with 75 µs de-emphasis, 22 Hz to 500 kHz bandwidth.

SCA/RBDS/RDS INPUTS (STANDARD)

Number of inputs: Three, female BNC.
Input impedance: 10k ohms, unbalanced.
Input sensitivity: 1.5V p-p (nominal) for 10% injection.
Subcarrier frequency range: 57 kHz to 92 kHz (25 kHz to 92 kHz in monaural operation).
Amplitude response: +/- 0.3 dB, 20 kHz to 100 kHz.

COMPLIANCE

RoHS 2002/95/EC compliant: Yes.
R&TTE 1999/5/EC compliant: Yes.

All specifications referenced to any single output frequency (87.5 - 108 MHz), nominal rated output power, and 50 ohm, isolated, non-reactive load.

Specifications defined in a laboratory environment with high-grade source and demodulation equipment. Standard factory measurement does not include all listed items. Specifications subject to change without notice.

Title: SPEC, ZX TRANSMITTER FAMILY	Sheet 2 of 7	Rev: B	Dwg: 817-2350-085

ZX Transmitter Specifications – CD Models

GENERAL

FM power output range: [1]
- ZX2500: 625 W – 2750 W
- ZX3750: 950 W – 4125 W
- ZX5000: 1250 W – 5500 W
- ZX7.5: 1900 W – 8250 W
- ZX10: 2500 W – 11000 W

RF output connector: [2]
- ZX2500: EIA 1-5/8" flangeless, 50 ohms
- ZX3750: EIA 1-5/8" flangeless, 50 ohms
- ZX5000: EIA 1-5/8" flangeless, 50 ohms
- ZX7.5: EIA 1-5/8" flanged, 50 ohms
- ZX10: EIA 1-5/8" flanged, 50 ohms

Excitation: Harris DIGIT^R CD digital FM exciter.

RF amplifers: MOSFET, broadband (no-tune), hot plug modular, universal (same type all tx models), 4.5 kg.

Power supplies: Switchmode, auto-ranging, hot plug modular, universal, 2.5 kg.

Frequency range: 87.5 - 108 MHz, digitally programmable in 50 Hz increments.

Frequency stability: +/- 150 Hz, 0° C to 50° C ambient temperature range (using internal frequency reference).

Power stability: ≤ +/- 0.25 dB.

Reverse power: Protected against open or short circuit, all phase angles. Capable of operation into infinite VSWR with user-adjustable foldback threshold. Threshold set to 2.5% of FM nameplate power level at factory.

External frequency control: Capable of locking to an external 10 MHz reference for use in FM synchronous applications when fitted with optional DIGIT CD Sync Board (992-9850-001). Sync input requirement: 2.82 V p-p or TTL level. Sync input connector: BNC female.

Harmonic / spurious output: Meets or exceeds FCC, Canadian, CE, and Chinese requirements.

Modulation type: Direct digital synthesis (DDS) using a 32-bit NCO (numerically controlled oscillator).

Modulation capability: 208% (+/- 75 kHz reference standard). Factory programmable in 6 dB increments to +/- 468 kHz.

PLL/AFC overload characteristics: Immune to carrier dropouts caused by high energy, low frequency modulation (program audio is not applied to the VCO).

Modulation indication: Digitally generated peak reading, 0.25% accuracy (at 150% modulation setting), color-coded LED display with baseband over-modulation indicator.

Asynchronous AM S/N ratio: 55 dB minimum below equivalent 100% amplitude modulation by 400 Hz using 75 µs de-emphasis (no FM modulation present).

Synchronous AM S/N ratio: 50 dB minimum below equivalent 100% amplitude modulation with 75 µs de-emphasis and 400 Hz highpass filter (FM deviation +/- 75 kHz by a 1 kHz sine wave).

[1] VSWR 1.2:1 or less. De-rate to nameplate rating for VSWR up to 1.5:1.

[2] EIA 3-1/8" flanged available as option, ZX7.5 and ZX10.

AC mains requirement: 90 - 264 V[3], 47 - 63 Hz, IEC C14 inlet for exciter and following connections to power amplifier:
- ZX2500/3750: 190 - 264 V[4], 47 - 63 Hz, triple IEC C20 inlets. Configurable on-site for single or three-phase connection: 190 - 264 V single phase, 190-264 V delta, 190 - 264 V wye, or 330 - 450 V wye.
- ZX5000: Same as 3750 W model except triple PowerCon NAC3MPA inlets.
- ZX7.5 and ZX10:
  Screw terminal connections.
  Option: 190 - 264 V, 47 - 63 Hz, delta
  Option: 330 - 450 V, 47 - 63 Hz, wye
  Option: 190 - 264 V, 47 - 63 Hz, dual single-phase (top and bottom amplifiers)

Power consumption: (FM mode at nameplate power level)
- ZX2500: 4700 W max; 4300 W typical
- ZX3750: 7000 W max; 6350 W typical
- ZX5000: 9300 W max; 8500 W typical
- ZX7.5: 14000 W max; 12700 W typical
- ZX10: 18600 W max; 17000 W typical

Power factor (displacement): 0.98 typical.

Phase rotation/balance: all AC inputs independent. Observation of correct phase rotation and balance not required.

Mains restart: > 80% output power in less than 5 seconds after AC mains failure.

Altitude: 3000 m elevation above mean sea level.

Ambient temperature range: 0 - 50° C at sea level, upper limit de-rated 2° Centigrade per 300 m elevation AMSL.

Humidity: 95%, non-condensing.

Dimensions: Standard 19" (48.3 cm) EIA rack; 1RU = 4.45 cm (1.75")
- ZX2500: 16 RU amp + 1 RU exciter, 62 cm (25") depth
- ZX3750: 16 RU amp + 1 RU exciter, 62 cm (25") depth
- ZX5000: 16 RU amp + 1 RU exciter, 62 cm (25") depth
- ZX7.5: 44 RU rack, 96 cm (38") depth
- ZX10: 44 RU rack, 96 cm (38") depth

Weight, less exciter (all modules installed):
- ZX2500: 67 kg (148 lbs) approx.
- ZX3750: 81 kg (179 lbs) approx.
- ZX5000: 95 kg (210 lbs) approx.
- ZX7.5: 225 kg (500 lbs) approx.
- ZX10: 250 kg (550 lbs) approx.

Air cooling: Air input with built-in filter at front. Air exhaust with built-in DC fans at rear. Ducted air exhaust and/or input available as option.
- ZX2500: 17 m3/min (600 cfm) approx.
- ZX3750: 17 m3/min (600 cfm) approx.
- ZX5000: 17 m3/min (600 cfm) approx.
- ZX7.5: 34 m3/min (1200 cfm) approx.
- ZX10: 34 m3/min (1200 cfm) approx.

Ambient noise: Worst case, 1 m from front face, 1 m above ground. Mounted in rack, no ducted air input or exhaust. Figures in parentheses are for ducted air input and exhaust option.

[3] Certified to 100-240 V nominal range +/- 10% testing margin.

[4] Certified to 208-240 V nominal range +/- 10% testing margin.

Title: SPEC, ZX TRANSMITTER FAMILY	Sheet 3 of 7	Rev: B	Dwg: 817-2350-085

ZX2500: < 73 dBA (65 dBA)
ZX3750: < 73 dBA (65 dBA)
ZX5000: < 73 dBA (65 dBA)
ZX7.5: < 73 dBA (65 dBA)
ZX10: < 73 dBA (65 dBA)

REMOTE CONTROL

Parallel remote: D-sub 25 female.
Status: open collector, 24 V @ 500 mA max.
Command: active low with internal pull-up.
Telemetry: 0 - 2 V, 2k source impedance.
Security: RF mute and external interlock lines.
ZX7.5, ZX10: D-sub 25 female to each amp chassis and D-sub 9 with screw terminal breakout for system.
Ethernet (optional): RJ45, twisted pair.

COMPLIANCE

RoHS 2002/95/EC compliant: Yes.
R&TTE 1999/5/EC compliant: Yes.

STEREO PERFORMANCE with Digital Input Module

Input data format: AES3-1992 (reference standards: AES5-1984, ANSI S4.28-1984, AES3-1985, ANSI S4.40-1992, and AES3-1992).
Sample rate: Any in range 32 kHz to 56 kHz (32, 44.1 or 48kHz typically output from AES3 devices).
Digital stereo generator: Complete digital composite stereo waveform generated in digital domain from incoming AES3 stereo audio data using a digital signal processor (DSP).
Digital baseband composite limiting: DSP "lookahead" techniques for control of peaks before overmodulation can occur. Active with on-board DSP stereo generator in stereo or monaural mode; pilot carrier and SCA signals unaffected. Limiter on/off and limit setting adjustable from 0 - 18 dB either locally or by standard remote control systems.
Pre-emphasis: 0, 25, 50, or 75 µs, locally selectable.
Stereo separation (sine wave): 65 dB or greater, 10 Hz to 15 kHz.
Dynamic stereo separation (complex waveform): 55 dB or greater, 10 Hz to 15 kHz.
Amplitude response (L or R): 10 Hz to 15 kHz +/- 0.2 dB referenced to selected pre-emphasis curve.
FM signal to noise ratio (L or R): 83 dB below 100% modulation at 400 Hz; measured in DC to 22 kHz bandwidth with 75 µs de-emphasis and DIN "A" weighting. Does not exhibit the subsonic noise associated with analog exciters.
Stereo harmonic distortion: 0.005% or less for any modulating frequency from 10 Hz to 15 kHz, measured in DC to 22 kHz bandwidth with 75 µs de-emphasis.
Intermodulation distortion (L or R): CCIF: 0.02% (14/15 kHz 1:1); SMPTE: 0.025% (60/7000 Hz 1:1).
Transient intermodulation distortion (DIM) (L or R): 0.005% (2.96 kHz square wave / 14 kHz sine wave modulation).
Linear crosstalk: L+R to L-R and L-R to L+R due to amplitude and phase matching of L&R channels (DC - 15 kHz): 85 dB below 100% modulation reference.
Non-linear crosstalk: L+R to L-R and L-R to L+R due to distortion products: 75 dB below 100% modulation reference, DC - 15 kHz.
RBDS/RDS synchronizing signal: 19 kHz quasi-sine wave, nominal 5.6 V p-p, AC coupled, 100 ohm output impedance (unbalanced); for use by customer-supplied, external generator. BNC female connector.
Stereo / monaural mode control: Selectable locally or by standard remote control systems. Zero amplitude pilot in monaural mode.
Emergency analog composite mode: Switchable locally or by standard remote control systems to mute on-board DSP stereo generator and accept analog composite stereo on SCA Port #2. Nominal input sensitivity (all SCA ports in this mode): 3.5 V p-p (1.24 V rms) for +/- 75 kHz deviation. FM signal to noise ratio: 85 dB below 100% modulation. Total composite harmonic distortion: 0.02%.

COMPOSITE INPUT PERFORMANCE with Analog Input Module

Inputs: Two: XLR female balanced (switchable, composite, or monaural), and BNC female unbalanced.
Input impedance: Balanced/unbalanced: 10k ohms nominal (resistive).
Input level: 3.5 V p-p (1.24 V rms) nominal for +/- 75 kHz deviation.
FM signal to noise ratio: 94 dB below +/- 75 kHz deviation at 400 Hz; measured in a DC to 100 kHz bandwidth with 75 µs de-emphasis; DIN "A" weighting. Does not exhibit the subsonic noise associated with analog exciters.
Amplitude response: +/- 0.01 dB, DC to 53 kHz; +/- 0.25 dB, 53 to 100 kHz.
Total harmonic distortion: 94 dB or 0.002% THD over stereo sub-band (DC to 53 kHz).
Intermodulation distortion: CCIF: 0.008% (14/15 kHz 1:1); SMPTE: 0.008% (60/7000 Hz 1:1).
Transient intermodulation distortion (DIM): 0.005% (2.96 kHz square wave / 14 kHz sine wave modulation).
Slew rate: 9 V/µs, symmetrical.
Group delay variation: +/- 5 ns, DC to 53 kHz, +/- 50 ns, 53 to 100 kHz.
Phase response variation: +/- 0.1° from linear phase, DC to 53 kHz.

ANALOG STEREO and SCA PERFORMANCE

NOTE: Analog stereo and SCA performance with the DIGIT™ exciter is defined almost entirely by the program link and external generators.

All specifications referenced to any single output frequency (87.5 - 108 MHz), nominal rated output power, and 50 ohm, isolated, non-reactive load. Specifications defined in a laboratory environment with high grade source and demodulation equipment. Standard factory measurement does not include all listed items. Specifications subject to change without notice.

Title: SPEC, ZX TRANSMITTER FAMILY	Sheet 4 of 7	Rev: B	Dwg: 817-2350-085

ZX Transmitters Specifications – HD models

GENERAL

FM power output range: [1]
- ZX2500: 625 W – 2750 W
- ZX3750: 950 W – 4125 W
- ZX5000: 1250 W – 5500 W
- ZX7.5: 1900 W – 8250 W
- ZX10: 2500 W – 11000 W

FM+HD power output range: [2] (HD signal injection ratio -20 dB)
- ZX2500: 500 W – 2050 W
- ZX3750: 750 W – 3100 W
- ZX5000: 1000 W – 4125 W
- ZX7.5: 1500 – 6200 W
- ZX10: 2000 W – 8250 W

HD power output range: [3]
- ZX2500: 250 W – 950 W
- ZX3750: 375 W – 1450 W
- ZX5000: 500 W – 1925 W
- ZX7.5: 750 W – 2900 W
- ZX10: 1000 W – 3850 W

RF output connector: [4]
- ZX2500: EIA 1-5/8" flangeless, 50 ohms
- ZX3750: EIA 1-5/8" flangeless, 50 ohms
- ZX5000: EIA 1-5/8" flangeless, 50 ohms
- ZX7.5: EIA 1-5/8" flanged, 50 ohms
- ZX10: EIA 1-5/8" flanged, 50 ohms

Excitation: Flexstar HDX Exciter.

RF amplifers: MOSFET, broadband (no-tune), hot plug modular, universal (same type all tx models), 4.5 kg.

Power supplies: Switchmode, auto-ranging, hot plug modular, universal, 2.5 kg.

Frequency range: 87.5 - 108.0 MHz, programmable in 10 kHz steps.

Frequency stability: +/- 150 Hz, 0° to 50°C using high accuracy internal (59.535 MHz) TCXO. 10 MHz input for synchronization to external (GPS) reference. Automatic switching to internal oscillator if external reference fails.

Power stability: ≤ +/- 0.25 dB.

Reverse power: Protected against open or short circuit, all phase angles. Capable of operation into infinite VSWR with user-adjustable foldback threshold. Threshold set to 2.5% of FM nameplate power level at factory.

Harmonic / spurious suppression: Internal harmonic filter meets or exceeds all FCC, IC, CE, Chinese requirements. Meets or exceeds standard NRSC-5A emission limits in all modes.

[1] VSWR 1.2:1 or less. De-rate to nameplate rating for VSWR up to 1.5:1.
[2] VSWR 1.2:1 or less. De-rate to 70% of nameplate rating for VSWR up to 1.5:1.
[3] VSWR 1.2:1 or less. De-rate to 35% of nameplate rating for VSWR up to 1.5:1.
[4] EIA 3-1/8" flanged available as option, ZX7.5 and ZX10.

Modulation types: FM digitally synthesized direct to channel, HD digital direct to channel, FM+HD digital direct to channel.

Operating modes: "On-the-Fly" switching between FM only, HD only, FM+HD modes.

FM modulation capability: Greater than +/- 300 kHz.

Asynchronous AM S/N ratio: 50 dB minimum below equivalent 100% amplitude modulation by 400 Hz using 75 µs de-emphasis (no FM modulation present).

Synchronous AM S/N ratio: 50 dB minimum below equivalent 100% amplitude modulation with 75 µs de-emphasis and 400 Hz high-pass filter (FM deviation +/-75 kHz by a 1 kHz sine wave). Measured at wideband input.

AC mains requirement: 90 - 264 V[5], 47 - 63 Hz, IEC C14 inlet for exciter and following connections to power amplifier:
- ZX2500/3750: 190 - 264 V[6], 47 - 63 Hz, triple IEC C20 inlets. Configurable on-site for single or three-phase connection: 190 - 264 V single phase, 190-264 V delta, 190 - 264 V wye, or 330 - 450 V wye.
- ZX5000: Same as 3750 W model except triple PowerCon NAC3MPA inlets.
- ZX7.5 and ZX10:
  Screw terminal connections.
  Option: 190 - 264 V, 47 - 63 Hz, delta
  Option: 330 - 450 V, 47 - 63 Hz, wye
  Option: 190 - 264 V, 47 - 63 Hz, dual single-phase (top and bottom amplifiers)

Power consumption: (FM mode at nameplate power level)
- ZX2500: 4700 W max; 4300 W typical
- ZX3750: 7000 W max; 6350 W typical
- ZX5000: 9300 W max; 8500 W typical
- ZX7.5: 14000 W max; 12700 W typical
- ZX10: 18600 W max; 17000 W typical

Power Factor (displacement): 0.98 typical.

Phase rotation/balance: all AC inputs independent. Observation of correct phase rotation and balance not required.

Mains restart: > 80% output power in less than 5 seconds after AC mains failure.

Altitude: 3000 m elevation above mean sea level.

Ambient temperature range: 0 - 50° C at sea level, upper limit de-rated 2° Centigrade per 300 m elevation AMSL.

Humidity: 95%, non-condensing.

Dimensions: Standard 19" (48.3 cm) EIA rack; 1RU = 4.45 cm (1.75")
- ZX2500: 16 RU amp + 1 RU exciter, 62 cm (25") depth
- ZX3750: 16 RU amp + 1 RU exciter, 62 cm (25") depth
- ZX5000: 16 RU amp + 1 RU exciter, 62 cm (25") depth
- ZX7.5: 44 RU rack, 96 cm (38") depth
- ZX10: 44 RU rack, 96 cm (38") depth

Weight, less exciter (all modules installed):
- ZX2500: 67 kg (148 lbs) approx.
- ZX3750: 81 kg (179 lbs) approx.
- ZX5000: 95 kg (210 lbs) approx.
- ZX7.5: 225 kg (500 lbs) approx.

[5] Certified to 100-240 V nominal range +/- 10% testing margin.
[6] Certified to 208-240 V nominal range +/- 10% testing margin.

Title: SPEC, ZX TRANSMITTER FAMILY	Sheet 5 of 7	Rev: B	Dwg: 817-2350-085

ZX10: 250 kg (550 lbs) approx.

Air cooling: Air input with built-in filter at front. Air exhaust with built-in DC fans at rear. Ducted air exhaust and/or input available as option.
- ZX2500: 17 m3/min (600 cfm) approx.
- ZX3750: 17 m3/min (600 cfm) approx.
- ZX5000: 17 m3/min (600 cfm) approx.
- ZX7.5: 34 m3/min (1200 cfm) approx.
- ZX10: 34 m3/min (1200 cfm) approx.

Ambient noise: Worst case, 1 m from front face, 1 m above ground. Mounted in rack, no ducted air input or exhaust. Figures in parentheses are for ducted air input and exhaust option.
- ZX2500: < 73 dBA (65 dBA)
- ZX3750: < 73 dBA (65 dBA)
- ZX5000: < 73 dBA (65 dBA)
- ZX7.5: < 73 dBA (65 dBA)
- ZX10: < 73 dBA (65 dBA)

REMOTE CONTROL

Parallel remote: D-sub 25 female.
Status: open collector, 24 V @ 500 mA max.
Command: active low with internal pull-up.
Telemetry: 0 - 2 V, 2k source impedance.
Security: RF mute and external interlock lines.
ZX7.5, ZX10: D-sub 25 female to each amp chassis and D-sub 9 with screw terminal breakout for system.

Ethernet (optional): RJ45, twisted pair.

COMPLIANCE

RoHS 2002/95/EC compliant: Yes.
R&TTE 1999/5/EC compliant: Yes.

INPUT/OUTPUT SPECIFICATIONS

External frequency control: Parallel I/O control of up to 8 frequencies. Unlimited frequency selection via optional N+1 controller.

AES3 audio inputs: (2) auto-switching AES3 inputs, female XLR, 110 ohms balanced; -2.8 dBfs nominal; Adjustable level from 0 dBfs to -15 dBfs in 0.1 dB steps for +/- 75 kHz deviation; input sample rate 32 to 96 kHz.

Analog L/R inputs: Female XLR, >10K ohms, balanced, resistive; default level +10 dBu for +/-75 kHz deviation. Level adjustable from -10 dBV to +10 dBV.

Analog composite input: (2) BNC inputs (1 balanced, 1 unbalanced); Balanced impedance 10k ohms or 50 ohms (selectable); Unbalanced 10k ohms; Input level: 3.5 V p-p for +/-75 kHz deviation; Adjustable 2 V p-p to 5 V p-p.

SCA audio inputs: (2) inputs combined on one 5-pin XLR female connector (mating male connector supplied); >10k ohms balanced, resistive; +10 dBV nominal for +/- 6 kHz deviation of FM sub-carrier.

External SCA inputs: (2) BNC female, unbalanced; >10k ohm; 1.5V p-p nominal for +/-7.5 kHz (10%) deviation of main carrier; adjustable from 1 V p-p to 4 V p-p.

RBDS data input: D-sub 9-pin female RS-232.

External 10MHz clock input: BNC female, unbalanced, 50 ohm, -10 dBm to +10 dBm.

External 1 PPS clock input: BNC female, unbalanced, 50 ohm, TTL level.

User remote interface: D-sub 25-pin female.

N+1 interface: D-sub 25-pin female.

RF sample out: BNC jack, -66 dBc, post harmonic filter.

19 kHz pilot sync output: BNC female, unbalanced, 50 ohms resistive, sine wave, AC coupled, 4.5 V p-p nominal, unterminated.

Exciter communication ports: (2) D-sub 9-pin female; RS232 protocol, RBDS or VT-100 data.

Exciter ethernet ports: (2) RJ-45 on main processor board; (2) RJ-45 on Exgine board (HD version only); all Ethernet ports 10/100; supports static or dynamic IP address.

Exciter USB port: Front panel USB type-A connector; USB 1.1 / 2.0 compliant; supports configuration save/restore and software updates via flash drive.

STEREO GENERATOR PERFORMANCE (AES3 OR ANALOG INPUTS)

Modes: Stereo, Mono L+R, Mono L, and Mono R; remote controllable.

Pre-emphasis: Selectable 0, 25, 50, or 75 microseconds.

Stereo pilot tone: 19 kHz +/- 0.03 Hz; injection adjustable 0% to 12% in 0.05% steps; 9% nominal. 38 kHz, 57 kHz, 76 kHz, 95 kHz Suppression: 80 dB below +/- 75 kHz deviation.

Stereo separation: 80 dB*/60 dB, 10 Hz to 15 kHz.

Dynamic stereo separation: 80 dB*/60 dB, 10 Hz to 15 kHz*.

Stereo amplitude response: +/- 0.1 dB, 10 Hz to 15 kHz referenced to selected pre-emphasis curve.

Stereo signal to noise ratio (L or R): 85 dB below 100% modulation at 400 Hz; measured in a 10 Hz to 22 kHz bandwidth with 75µs de-emphasis and DIN “A” weighting.

Stereo total harmonic distortion: 0.005%*/0.02%, any modulating frequency 10 Hz to 15 kHz, in bandwidth 10 Hz to 22 kHz with 75µs de-emphasis.

Stereo intermodulation distortion (L or R): CCIF: 0.005%*/0.02% Note 1; (14/15 kHz 1:1), SMPTE: 0.02% (60/7000 Hz 1:1).

Transient intermodulation distortion (DIM): 0.008%*/0.02%; (2.96 kHz square wave / 14 kHz sine wave modulation).

Linear crosstalk: 90 dB below 100% modulation reference (AES3 Input); L+R to L-R or L-R to L+R due to amplitude and phase matching of L&R channels (10 Hz - 15 kHz).

Non-linear crosstalk: 80 dB below 100% modulation reference; L+R to L-R or L-R to L+R due to distortion products.

Audio overshoot: Less than 0.16 dB.

MONO PERFORMANCE (AES3 OR ANALOG INPUT)

Pre-emphasis: Selectable 0, 25, 50 or 75 microseconds.

FM mono signal-to-noise ratio: 94 dB below 100% modulation at 400 Hz; measured in a 10 Hz to 22 kHz bandwidth with 75 µs de-emphasis and DIN “A” weighting.

Amplitude response: +/- 0.05 dB, referenced to selected pre-emphasis curve (no low-pass filter).

Title: SPEC, ZX TRANSMITTER FAMILY	Sheet 6 of 7	Rev: B	Dwg: 817-2350-085

Mono total harmonic distortion: 0.002%*/0.01% THD, 10 Hz to 22 kHz bandwidth.
Mono intermodulation distortion: CCIF: 0.005% (14/15 kHz 1:1); SMPTE: 0.005% (60/7000 Hz 1:1).
Mono transient intermodulation distortion (DIM): 0.005% (2.96 kHz square wave / 14 kHz sine wave).

WIDEBAND ANALOG INPUT PERFORMANCE
FM signal-to-noise ratio: 94 dB below +/-75 kHz deviation at 400 Hz; measured in 10 Hz to 100 kHz bandwidth with 75 µs de-emphasis and DIN "A" weighting.
Amplitude response: +/- 0.005 dB 20 Hz to 53 kHz; +/- 0.03 dB, 53 kHz to 100 kHz.
Total harmonic distortion: 0.002%*/.01% THD over stereo sub-band (10 Hz to 53 kHz) with 75 µs de-emphasis.
Intermodulation distortion: CCIF: 0.005% (14/15 kHz 1:1); SMPTE: 0.005% (60/7000 Hz 1:1).
Transient intermodulation distortion (DIM): 0.005% (2.96 kHz square wave / 14 kHz sine wave modulation).
Slew rate: 11.8 V/µs - symmetrical.
Phase response variation: +/- 0.05° from linear phase, 10 Hz to 100 kHz.
Group delay variation: +/- 5 ns, 10 Hz to 53 kHz, +/- 30 ns, 53 kHz to 100 kHz.

EXTERNAL SCA, RBDS PERFORMANCE
SCA format: Externally generated, analog FM subcarriers within range of 53 - 99 kHz.
SCA sub-band amplitude response: +/- 0.5 dB, 40 kHz to 100 kHz; high-pass filtered.
SCA channel FM signal-to-noise ratio: 80 dB below +/- 6 kHz subcarrier deviation at 400 Hz with 150 µs de-emphasis.
Harmonic distortion: less than 0.2% in audio passband of SCA generator.
Intermodulation distortion: SMPTE (60/7000 Hz, 1:1): 0.2% or less, no pre/de-emphasis, SCA generator low-pass filter bypassed.
Crosstalk, SCA to stereo: 80 dB below 100% modulation, L or R channel with 75 µs de-emphasis.
Crosstalk, stereo to SCA: 80 dB below 100% modulation referenced to +/- 6 kHz deviation and 150 µs de-emphasis.
Crosstalk, SCA to SCA: 80 dB below 100% modulation (referenced to +/- 6 kHz deviation and 150 µs de-emphasis per channel).

DUAL INTERNAL SCA PERFORMANCE
Pre-emphasis: Selectable: 150 µs, 75 µs, none.
Amplitude response: +/- 0.5 dB, 10 Hz to 7.5 kHz; selectable 4.3 kHz or 7.5 kHz low-pass filter.
Subcarrier frequency: 57 kHz to 99 kHz in 1 kHz steps.
Signal-to-noise ratio: 80 dB with 150 µs de-emphasis, 65 dB without de-emphasis at +/- 6 kHz deviation.
Total harmonic distortion: 0.1% 10 Hz to 5 kHz.
SCA deviation capability: +/- 1 kHz to +/- 12 kHz; +/- 6 kHz default.
Injection level: 2 to 20%, adjustable in 0.1% increments.
Spurious & harmonic performance: 2nd harmonic: better than 40 dB below sub-carrier; 3rd harmonic: better than 45 dB below sub-carrier; All other components 50 Hz to 100 kHz: better than 80 dB below subcarrier.

RBDS GENERATOR PERFORMANCE
Subcarrier frequency: 57 kHz, +/- 0.09 Hz.
Injection level: 2 to 20% in 0.1% increments.

HD RADIO™ PERFORMANCE
Compliant with iBiquity and NRSC 5A standards

NOTE: Specifications marked with asterisk (*) were measured using laboratory digital demodulation techniques for product performance verification. All other specifications were measured to the performance limits of currently available production test equipment.

All specifications referenced to any single output frequency (87.5 - 108 MHz), nominal rated output power, and 50 ohm, isolated, non-reactive load.

Specifications subject to change without notice.

HD Radio™ is a trademark of iBiquity Digital Corp.

Title: SPEC, ZX TRANSMITTER FAMILY	Sheet 7 of 7	Rev: B	Dwg: 817-2350-085

Section 2 Installation

2

This section contains information concerning the installation and commissioning of ZX series transmitters.

2.1 Field Services

Some GatesAir customers choose to install their transmitter themselves, while others prefer to have their transmitter installed and/or commissioned by GatesAir or a GatesAir-provided contractor in their region. Contact your GatesAir sales representative for more information on obtaining GatesAir field service assistance.

GatesAir offers the following field service options:

2.1.1 Installation

Service engineers perform complete on-site installation of your transmitter. When ordering installation, you will need to provide GatesAir with detailed information about your facility, such as:

- Information about any remote control system to be installed.
- Information about the availability of a reserve transmitter and any scheduling restrictions (e.g. can only be off-air early morning hours).
- A list of equipment and tools already available on-site.
- Any mechanical layout drawings showing the location of all existing equipment.

2.1.2 Commissioning

If the transmitter is installed by station staff or representatives, you may still have a GatesAir service engineer perform an operational check-out and/or proof of performance of the transmitter. If you require a special test protocol beyond the tests recorded in the factory test data report, please notify GatesAir at your earliest convenience.

2.2 Unpacking

Upon receipt of the transmitter shipment, carefully unpack the transmitter and perform a visual inspection to ensure 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 list. If the contents are incomplete or if the unit is damaged electrically or mechanically, notify the carrier and GatesAir.

NOTE:
Locate and retain the technical manual, drawing package, and factory test data. The factory test data contains information that is vital to installation and operation of the transmitter.

2.3 Returns and Exchanges

Damaged or undamaged equipment should not be returned unless written approval and a Return Authorization is received from GatesAir. 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 GatesAir, specify the GatesAir Order Number or Invoice Number.

2.4 Transmitter Documentation

Prior to installation, this technical manual, the factory test data, and the accompanying drawing package should be studied carefully to obtain a thorough understanding of the principles of operation, circuits, and nomenclature used in the ZX series transmitter.

This will facilitate proper installation and commissioning. Store the documentation, including the factory test data, in a secure location for future reference.

NOTE:
The information contained in the drawing package should be considered the most accurate in the case of a discrepancy.

2.4.1 Installation and Outline Drawings

To aid in the installation process, GatesAir typically provides three key drawings with each transmitter shipment: the *Outline Drawing*, the *System Interconnect* drawing, and the *Mains Interconnect* drawing. Please locate these drawings before proceeding, as they will be referenced several times in the following pages. These drawings are provided in the drawing package accompanying this manual. Depending on the particularities of the transmitter installation, these drawings may be generic –- addressing one or more standard transmitter models -– or site-specific for a customized transmitter configuration. In the case that both generic and custom drawings are provided, the generic drawings are superseded by site/model-specific drawings and should be discarded to prevent future confusion.

2.5 Site Selection

The selection of a proper installation location is essential for guaranteeing equipment longevity and reliability. Do not install the transmitter in places where it may be exposed to mechanical shocks, excessive vibration, dust, water, salty air, or acidic gas.

If outside air is brought into the building it should be well filtered to keep dirt out of the building and the transmitter.

Ambient temperature and relative humidity should always range between the following limits at the installation location:

Ambient temperature: 0 to +50^{o}C

Relative humidity: 5 to 95% non-condensing

2.6 AC Mains Requirements

2.6.1 Transmitters with AC Distribution Chassis

Larger transmitters featuring the in-rack AC distribution chassis require only AC mains connection to this chassis. All AC mains distribution within the transmitter is provided by the chassis and its supporting mains cables. The AC distribution chassis has separate versions for each of these three input voltage options:

- Single-phase 190V - 264V*
- Three-phase “delta” 190V - 264V
- Three-phase “wye” 328V - 456V

NOTE:
As of this printing, the single-phase version has two mains inputs per cabinet: one for the upper amplifier/exciter, one for the lower amplifier/exciter (when present). This arrangement was chosen in the interest of providing AC mains redundancy. Three phase models have a single connection point, but have AC mains redundancy by virture of their three independent phases.

Connection to the AC distribution chassis is made at an insulated terminal block, which may be accessed by pulling the chassis forward in the rack. See Figure 2-1. AC mains cabling from the customer panelboard enters through an access hole in the roof of the transmitter rack and passes along a hollow space near the rack side panel up to the side entry of the AC distribution chassis. A label on the floor of the chassis, next to the terminal block, indicates the proper connection points for the line (L), neutral (N), and physical earth (PE) connectors (where applicable).

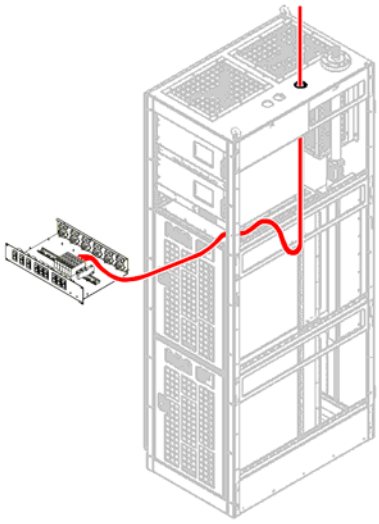


Figure 2-1 AC mains connection to transmitter (transmitter rack side panel removed for clarity

NOTE:
The illustration in Figure 2-1 has been exaggerated for the purpose of clarity. It is not typically necessary to fully disconnect the AC distribution chassis and completely remove it from the cabinet. It is usually pulled forward only the distance necessary to perform the mains connection and the other cables to the chassis remain connected. Removal of the rack side panel is also not required.

2.6.2 Transmitters without AC Distribution Chassis

In the case of lower power transmitters furnished without an AC distribution chassis, the customer is responsible for connecting directly to the various transmitter sub-assemblies. (i.e. exciter and amp). The necessary AC mains distribution may be performed in the customer mains panelboard or possibly an in-rack outlet strip.

The various sub-assemblies in the ZX series transmitter have slightly different AC mains requirements:

The exciter typically requires 120 or 230 VAC 50/60Hz single phase power via an IEC-C14 inlet. Depending on the model of exciter, the selection of the input voltage range (120V, 208V, 230V, etc) maybe automatic (auto-sensing) or may require the changing of connections within the AC inlet assembly. Consult the manual supplied with the exciter for further details.

The ZX2500 and ZX3750 amplifier chassis have three 208-240 VAC 50/60Hz single-phase feeds via IEC C20 inlets. The three inputs are completely independent and may be wired to separate AC phases for increased redundancy.

The ZX5000 amplifier chassis has three 208-240 VAC 50/60Hz single-phase feeds via Powercon NAC3MPA connectors. The use of Powercon connectors is dictated by the greater current requirements of the ZX5000 chassis. The three inputs are completely independent and may be wired to separate AC phases for increased redundancy.

NOTE:
Examine the connectors closely to find the L, N and PE (ground) designations. Connector wiring information can be found on the mains interconnect drawing.

Since the three mains inputs are essentially independent, it is not necessary to observe a certain phase rotation or even phase balance in three phase systems. Additionally, the amplifier chassis can operate indefinitely (at a reduced power) with one or two of the mains inputs missing. The internal power supplies connected to each input will continue to operate provided that the incoming mains power at that input falls within the 190V – 264V range indicated above.

NOTE:
The transmitter and internal power supply modules have been certified by an accredited testing laboratory for a nominal mains voltage range of 208V-240V. This certification requires testing to an over- and undervoltage allowance of +/- 10%. Accordingly, there may discrepancies in certain documents depending on whether the certified nominal voltage range (e.g. 240V) or maximum tested voltage range (240V + 10% = 264V) is specified.

Consult the transmitter *Outline Drawing* and *Mains Interconnect* drawing for information concerning suggested wiring diameters and fusing requirements.

WARNING:
AN EXTERNAL CIRCUIT PROTECTION DEVICE (BREAKER OR FUSE) IS REQUIRED FOR EACH EXCITER AND POWER AMPLIFIER AC INPUT. THIS IS PROVIDED BY THE CUSTOMER IN ACCORDANCE WITH THE MAINS INTERCONNECT DRAWING OR BY GATESAIR IF AN IN-RACK AC DISTRIBUTION CHASSIS IS SUPPLIED. IN THE LATTER CASE, AN EXTERNAL CIRCUIT PROTECTION DEVICE TO COVER THE ENTIRE TRANSMITTER LOAD AT THE MAIN AC DISTRIBUTION POINT IS STILL REQUIRED, IN ACCORDANCE WITH PREVAILING LOCAL SAFETY NORMS.

CAUTION:
WHEN THE TWO OR THREE SINGLE PHASE INPUTS TO THE TRANSMITTER ARE DERIVED FROM A WYE (STAR) MAINS SERVICE, SPECIAL CARE MUST BE PAID TO THE NEUTRAL CONNECTION, AS THE NEUTRAL CONNECTION SERVES AS

THE COMMON VOLTAGE REFERENCE TO ALL THREE PHASES. SHOULD THE NEUTRAL CONNECTION BREAK, THE LINE-TO-LINE VOLTAGE OF EACH PHASE WILL BECOME UNSTABLE AND INVARIABLY RESULT IN SEVERE DAMAGE TO ALL LOADS FROM AN OVERVOLTAGE CONDITION. ACCORDINGLY, ALL NEUTRAL CONNECTIONS SHOULD BE DOUBLE CHECKED FOR INTEGRITY, ESPECIALLY WHEN MODULAR MAINS DISCONNECT PLUGS ARE IN USE. NEVER ALLOW THE NEUTRAL TO BE BROKEN BEFORE THE INDIVIDUAL LINE CONNECTIONS. THIS RECOMMENDATION HOLDS FOR ALL SINGLE-PHASE EQUIPMENT WITH A WYE-DERIVED FEED, NOT JUST GATESAIR ZX TRANSMITTERS.

If using metal conduit, install the AC mains wiring in a separate conduit from all exciter input cables and small signal lines.

2.7 Surge Suppression Devices

GatesAir strongly recommends the use of surge protection devices on the incoming AC mains lines. These devices protect against damages due to transients arising from both natural and man-made sources. (e.g. lightning and inductive load switching). Clear preference is to be given to "series" type surge protection devices -- featuring protection by both a series inductance (choke) and a shunt threshold clamping device -- over simple shunt-only devices. The surge protector must be connected to the building ground system by short, direct connections. In the case where the shunt protection elements are protected by a fuse, it is necessary to periodically check the integrity of the fuse to ensure continued transient protection.

⚠ **CAUTION:**
FAILURE TO FOLLOW THESE RECOMMENDATIONS MAY LEAD TO SHORTENED EQUIPMENT LIFE AND REDUCED RELIABILITY.

2.8 Ground Requirements

Two separate ground connections are required for the ZX series transmitter: an *AC safety ground* and an *RF earth ground*.

*The **AC safety ground*** prevents an electrocution hazard should a dangerous potential from inside the unit accidentally contact an exposed metal surface. This is done by ensuring all metal surfaces have an uninterrupted connection back to the physical earth terminal (PE) at the AC mains service entrance. A physical earth connection is typically tied to the return current terminal either indoors at the main distribution panel

or outside “at the pole” (as dictated by local norms), thus allowing any fault current to safely return to the power source.

The AC safety ground connection is made automatically for the exciter and ZX amplifier via the green/yellow wire on the third prong of the AC input cord. When the exciter and amplifier chassis are connected directly to a user-supplied outlet box or distribution panel, the green-yellow wire from the AC input cord(s) must terminate at the PE terminal at the AC mains source.

In the case of a GatesAir-supplied AC distribution chassis, the green/yellow earth wire from the incoming AC mains service terminates at the PE terminal of the AC distribution chassis (ground symbol inside circle). The individual subassemblies making up the transmitter connect via the green/yellow wire of their mains cords to the same PE terminal on the AC distribution chassis.

When present, a rack buss-bar will also connect to the PE terminal. Individual panels making up the rack cabinet without a solid, permanent connection back to the PE terminal that might be exposed to unsafe voltages (e.g. doors on hinges) will connect to the PE terminal via a wire jumper connection to the buss-bar.

*The **RF earth ground*** prevents damage to the equipment during lightning-induced transients and reduces RF interference to low level circuits in general. An RF ground strap/wire attachment point is located at the rear of the ZX amplifier and exciter chassis. This connection is suitable for use in a single point grounding system, with the ground strap attached to the equipment rack and the rack, in turn, to a common grounding plate.

NOTE:
Observe this important distinction: The AC safety ground ensures that energy originating at the AC mains source is always safely returned to the AC mains source (i.e. prevents electrocution), whereas the RF earth ground ensures that energy “originating in the earth,” such as lightning, safely returns to the earth. Confusion may arise in some cases because the AC safety and RF earth ground circuits may share the same conductor or connection point(s) in some scenarios. To prevent confusion, some sources refer to the AC safety ground as “bonding” and the RF earth ground as “earthing.”

2.8.1 Overview of RF Grounding Practices

The importance of a good RF grounding system and lightning protection cannot 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 personnel safety, as well as damage the equipment. For these reasons, a good protective grounding system to divert these forms of energy to earth ground is imperative. The energy in a lightning strike has a very fast rise time and can have frequency components up to the megahertz range. For this reason, it is always preferred to use straight, direct runs of large, flat conductors so as to minimize inductance and allow the free passage of transient energy to earth. Note that the small cross-section and non-direct path to ground of the green/yellow wire of the AC safety ground make it an unsuitable means for safely diverting the transient energy present during a lightning strike.

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. Coaxial cable 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 cable back to the transmitter building.

Ideally, a common grounding plate (bulkhead panel) with a low impedance connection to building earth ground should be the entry point to the transmitter building for all signal lines, including AC mains. It should serve as a single-point ground for all coaxial and mains surge protection devices. Wide copper straps should be used for making the connection from the common grounding plate to earth ground.

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.

A ground system that has been in place for a long period of time can deteriorate and should be inspected periodically. This is especially true at the point where the ground strap enters or exits the building. All ground connections should be bolted and brazed together.

Good grounding and shielding practices will also help keep stray RF current to a minimum. RF interference usually shows up as intermittent problems with digital/control circuits, spurious radiated emissions, or audio/video noise if analog signals are present. Even a small amount of non-shielded wire makes a very efficient antenna for RF and transient energy. Wire and cable shields should be connected at both ends to the equipment chassis.

2.9 Cooling System Requirements

ZX series transmitters use forced air cooling provided by multiple internal blowers to remove the heat generated by the signal generation and amplification process.

To avoid operational problems due to excessive temperature, the blower openings must not be blocked. The transmitter *Outline Drawing* provides an indication of the relative location of the transmitter blowers and the necessary clearances to respect.

Air input is from the transmitter front with hot air exhaust at the rear of the amplifier. When factory rack integration has been provided, the exhaust air exits through a vent at the top of the rack. An optional intake plenum is available to permit connection to an external ducted air system, if desired. Consult the *Outline Drawing* for the location of the rack intake and exhaust ports with the plenum installed.

When the transmitter components are mounted in pre-existing rack, care must be taken not to overheat the other pieces of equipment already installed in the rack. The exhaust from the ZX amplifier chassis will typically be 10°C to 20°C hotter than the ambient air. In many cases, this may necessitate use of a vented rear rack door or removal of rear rack door altogether. Additionally, sufficient rear clearance must be left behind the ZX amplifier chassis exhaust ports, typically 15cm (6 in.) or greater.

In general, transmitter cooling systems fall into two categories:

An ***open system*** in which the heated transmitter exhaust passes through a dedicated duct to the outside of the transmitter building. The transmitter may receive fresh outside air directly through a separate intake duct or may receive ambient air from the transmitter hall, with the transmitter hall being supplied make-up air from outside via a filtered inlet vent. With an open system, it is imperative to correctly balance the input and output air flow volumes, paying particular attention to the pressure drops in external ducts and providing external blowers to overcome these losses and ensure correct air flow. The ZX transmitter internal air system is designed to supply sufficient air at the required static pressure to cool the transmitter only and all external duct losses must be compensated for by external blowers (this includes the optional intake plenum). Outside air containing salt or pollution must have those items removed by an adequate filtration system, and any pressure drops caused by filtration must also be considered.

A ***closed system*** in which the transmitter exhausts and inputs air directly to and from the transmitter room. The transmitter room is closed to outside air and makes use of air conditioning units to remove the resulting heat buildup. This type of system is recommended in geographic areas with especially salty, sulfuric, or otherwise polluted air. With a closed system, it is imperative to correctly balance the heat load. That is, to size and position the air conditioning units properly to handle the heat generated by the transmitter, ancillary equipment, building lighting, and even solar radiation entering through windows. In may also be desirable to oversize the air conditioning system to include the heat dissipated by the station test load, when in operation.

Figures for both the transmitter heat load and air flow volume are provided in the transmitter *Outline Drawing*. Consult a professional heating and ventilation expert in your area for help in designing the building cooling system.

2.10 Personnel and Equipment Protection

All electrical equipment can pose a safety hazard if not operated properly or if proper safety precautions are not taken. Every care should be taken during the site planning process to maximize personnel protection on site, both during the installation and once the transmitter has been placed into operation. Below is a collection of recommendations to follow to enhance personnel safety on site.

- Post first aid procedures in a visible location.
- Maintain a well-stocked first aid kit in a visible location.
- Post emergency phone numbers next to all site telephones.
- Install fire extinguishers appropriate for extinguishing electrical fires.
- Maintain a file of Material Safety Data Sheets (MSDS) for any hazardous chemicals on premises.
- Restrict site access to unauthorized personnel and post applicable high voltage and non-ionizing radiation hazard warnings.
- Secure all equipment racks to prevent tip over hazards, especially at sites prone to seismic activity.
- When mounting ZX transmitting equipment in a pre-existing rack, be sure to mount equipment low enough in relation to rack center of gravity to prevent a tip over hazard.
- Install mains safety disconnects (pull box or emergency off button) in sight of transmitter so as to permit visual verification of mains status at all times while performing maintenance.
- Provide a means to lock out AC mains while performing maintenance to prevent inadvertent electrocution by a second party.

2.10.1 Safety circuits

The ZX series transmitter has provisions for the following safety connections:

> *RF mute:*
The RF MUTE signal line is available on pin 8 of the 25-pin REMOTE CONTROL connector at the rear of the amplifier chassis. If the RF MUTE line is connected to ground, the power control circuits within the amplifier chassis force its RF output to zero, but the 50V DC circuits and cooling fans continue to operate. An example of a possible connection point for this line would be the position switch in a coaxial switch. The transmitter mutes its output when the switch is in travel, then quickly returns to full power once the transition is complete.

> *External interlock:*
The external INTERLOCK A and B signal lines are available on pins 2 and 3 the 25-pin REMOTE CONTROL connector at the rear of the amplifier chassis or on the remote terminal board in larger models. The two interlock pins must be bridged to turn on the ZX transmitter. In a preconfigured rack, the pins may already be bridged on the remote terminal board at the time of delivery. Otherwise, they are typically bridged inside a factory-supplied "dummy" D-sub 25 connector at the back of the amplifier chassis. The external interlock can be connected to a pair of external contacts such as the thermal cutout switch on the station test load.

> *Emergency off:*
In certain circumstances, the ZX transmitter system may be equipped with an optional emergency shut off button. This button is typically a large red plunger/pushbutton surrounded by a contrasting yellow border. The switch terminal connections of this button may be connected to the external interlock connection described above or brought outside the transmitter cabinet to an AC shutdown mechanism (e.g. contactor or shunt-trip circuit breaker) in the customer's AC mains panel.

2.11 Remote Control Installation

The ZX series transmitter may be remotely controlled by one of three means:

- Via a parallel remote control connection to the 25-pin REMOTE CONTROL connector on the amplifier chassis or the breakout terminals of the remote terminal board on larger models.
- Via an optional web remote interface available at an RJ45 Ethernet connection on the amplifier chassis.
- Via optional SNMP control also available at the RJ45 Ethernet connection.

The following section shows the location and pin assignment information for the major remote control interfaces.

Table 2-1 10/100 BASE T (RJ45, amplfier rear)

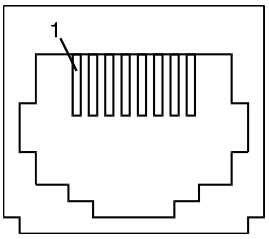
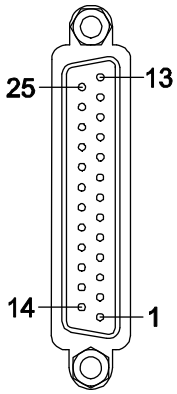
Designation	Remarks	Pin	
C3	RD + Receive Data (positive)	1	
C2	RD - Receive Data (negative)	2	
B3	TD + Transmit Data (positive)	3	
B2	TD - Transmit Data (negative)	6	
NU	Ground	4,5,7,8	

Table 2-2 REMOTE CONTROL (D-sub 25, amplifier rear)

Designation	Remarks	Pin	
GND	Signal ground	1	
INTERLOCK A	Connect to pin 3 to allow transmitter to turn on.	2	Input
INTERLOCK B	Connect to pin 2 to allow transmitter to turn on.	3	Input
TX ON COMMAND	Ground pin to turn transmitter on. (momentary)	4	Input

WARNING: Disconnect primary power prior to servicing.

Table 2-2 REMOTE CONTROL (D-sub 25, amplifier rear)

Designation	Remarks	Pin	
TX OFF COMMAND	Ground pin to turn transmitter off. (momentary)	5	Input
POWER RAISE COMMAND	Ground pin to raise output power. (momentary)	6	Input
POWER LOWER COMMAND	Ground pin to lower output power. (momentary)	7	Input
RF MUTE COMMAND	Ground pin to force output power to zero, but transmitter remains on. (momentary)	8	Input
PA FORWARD POWER METER	2V = 5000W (voltage scaled) 1k source impedance	9	Output
PE REVERSE POWER METER	2V = 500W (voltage scaled) 1k source impedance	10	Output
PA VOLTS METER	2V = 50V (linear scale) 1k source impedance	11	Output
PA AMPS METER	2V = 200A (linear scale) 1k source impedance	12	Output
FM ON STATUS	Open collector 24V @ 100mA max. Ground = FM carriers on	13	Output
HD ON STATUS	Open collector 24V @ 100mA max. Ground = HD carriers on	14	Output
Mode Summary: FM mode = pin 13 ground, pin 14 open HD mode = pin 13 open, pin 14 ground FM+HD mode = pins 13 & 14 ground SL mode = pins 13 & 14 open			
TX OFF STATUS *Note-1	Open collector 24V @ 100mA max. Ground = Tx is switched off	15	Output

*Note-1
Units produced after fall 2010 have this logic inverted to TX ON STATUS. That is, this pin is grounded when the transmitter is switched on and high impedance when the transmitter is switched off.

Table 2-2 REMOTE CONTROL (D-sub 25, amplifier rear)

Designation	Remarks	Pin	
EXCITER OK STATUS	Open collector 24V @ 100mA max. Open = exciter reporting internal fault or exciter switcher reporting emergency exciter switchover. Ground = exciter OK	16	Output
LOW GAIN FAULT (FORWARD POWER LOW)	Open collector 24V @ 100mA max. Ground = forward power too low, APC out of lock	17	Output
REVERSE FOLDBACK FAULT	Open collector 24V @ 100mA max. Ground = reverse power too high, power being reduced	18	Output
RESTARTS EXCEEDED FAULT	Open collector 24V @ 100mA max. Ground = tx locked out because it tried to restart too many times	19	Output
FAN FAULT	Open collector 24V @ 100mA max. Ground = a fan has low rpms	20	Output
LOAD TEMP FAULT (LOAD OVERHEATED)	Open collector 24V @ 100mA max. Ground = a combiner load has exceeded 125^{o}C	21	Output
MODULE SHUTDOWN FAULT	Open collector 24V @ 100mA max. Ground = one or more PA modules are switched off	22	Output

Table 2-2 REMOTE CONTROL (D-sub 25, amplifier rear)

Designation	Remarks	Pin	
AC MAINS LOW FAULT	Open collector 24V @ 100mA max. Ground = one or more mains inputs < 190V	23	Output
MUTE ACTIVE FAULT	Open collector 24V @ 100mA max. Ground = Tx being muted	24	Output
INTERLOCK OPEN FAULT	Open collector 24V @ 100mA max. Ground = TX off because interlock loop is open	25	Output

Table 2-3 Remote Terminal Board (D-sub 9 and screw terminals, cabinet rear area, component panel ZX7.5 & ZX10 only).

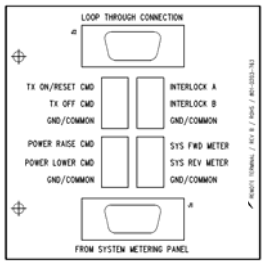
Designation	Remarks	Pin	
GND/COMMON	Signal ground	1	
TX ON/RESET CMD	Ground pin to turn transmitter on.	2	Input
TX OFF CMD	Ground pin to turn transmitter off.	3	Input
POWER RAISE CMD	Ground pin to raise transmitter output power.	4	Input
POWER LOWER CMD	Ground pin to lower transmitter output power.	5	Input
INTERLOCK A	Connect pins A and B to allow transmitter to turn on.	6	Input

Table 2-3 Remote Terminal Board (D-sub 9 and screw terminals, cabinet rear area, component panel ZX7.5 & ZX10 only).

Designation	Remarks	Pin	
INTERLOCK B	Connect pins A and B to allow transmitter to turn on.	GND	Input
SYS FWD MTR	Forward power sample, power scaled. 1k source impedance. 2V = 20kW 1V = 10kW .5V = 5kW	7	Output
SYS REV MTR	Reverse power sample, power scaled. 1k source impedance. 2V = 2000W 1V = 1000W .5V = 500W .25V = 250W	8	Output

2.11.1 Exciter Connections

Connections between the exciter and amplifier chassis must include an RF drive coaxial cable and a D-sub 15 cable for the purpose of logic control. When multiple PA chassis are present, the parallel logic connection to all chassis is made via a five-way DB15 divider board mounted on the transmitter cabinet component panel.

In the case of the FlexStar HDx exciter, the D-sub 15 cable to the exciter has a direct 1:1 connection between the pins at each end. In the case of the Digit or MicroMax exciter, a purpose-built cable with a special pinout is used to ensure the FM mode is selected at all times.

CAUTION:
THE D-SUB 15 CABLE USED FOR THE MICROMAX AND DIGIT EXCITERS HAS A DEFINITE AMPLIFIER END VS. EXCITER END. THAT IS, IT CANNOT BE REVERSED END-TO-END. PAY CAREFUL ATTENTION TO THE CABLE LABELING WHEN INSTALLING THIS CABLE.

When a main/alt exciter switcher is present, a special interface breakout cable is supplied to allow the optional web remote control to switch exciters and monitor switch status.

When special cables (non-straight-through) are provided, a separate schematic is provided in the accompanying drawing package to aid in signal tracing during troubleshooting. When no schematic is provided, it is generally safe to assume that the cable in question is straight-through. (same pinout both ends)

When an exciter is not supplied at the time of purchase, the customer is responsible for fashioning a cable to comply with the minimum requirement that pin 4 always be grounded at the transmitter end to signal a permanent FM mode, and that pins 1 and 9 send the Mute command to the exciter. The exciter must also be internally configured to mute its RF output when a ground potential is NOT present at pin 9 relative to ground (pin 1). Consult the exciter manual for more information.

Table 2-4 EXCITER INTERFACE (D-sub 15, amplfier rear)

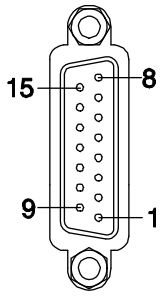
Designation	Remarks	Pin	
GND	Signal ground	1	
EXCITER FORWARD POWER SAMPLE	Exciter forward power reading for (optional) web remote (0-4V linear scale)	2	Input
N/C	No connection	3	n/a
FM_ON_STATUS	Exciter grounds pin to tell PA that drive signal has main FM carrier (continuous closure). **NOTE** - FlexStar HDx-FM or BoostPro	4	Input
HD_ON_STATUS	Exciter grounds pin to tell PA that drive signal has HD carriers (continuous closure). **NOTE** - FlexStar HDx-FM or BoostPro	5	Input

Table 2-4 EXCITER INTERFACE (D-sub 15, amplfier rear)

Designation	Remarks	Pin	
EXC_SUM_FAULT	Exciter grounds pin to signal it has internal alarm, or exciter switcher grounds pin to signal an emergency exciter switchover has occurred.	6	Input
N/C	No connection	7	n/a
PA_APC	Analog voltage from transmitter to control exciter output power. (FlexStar HDx exciter: Typically not used for FM-only service, which utilizes internal AGC/bias voltage power control)	8	Output
MUTE	Transmitter grounds pin to mute exciter output.	9	Output
EXC_B_ON_AIR	Used by main/alt exciter switcher to inform web remote that reserve exciter is selected. logic high = exciter B selected logic low = exciter A selected	10	Input
POS_A_SELECT	Web remote grounds pins to command main/alt switcher to select main exciter.	11	Output
POS_B_SELECT	Web remote grounds pins to command main/alt switcher to select reserve exciter.	12	Output
N/C	No connection	13	n/a
N/C	No connection	14	n/a
EXCITER_READY	Exciter grounds pin to mute transmitter while switching modes (FlexStar HDx exciter only).	15	Input

In the case of a FlexStar HDx exciter being used to transmit HD Radio, an RF sample of the transmitter output for the RTAC correction system must also be installed. Additional cables, an RF splitter, and an attenuator are provided for this purpose. Consult the *System Interconnect* drawing in the accompanying drawing package for more information.

NOTE:
The RF splitter has a bracket designed for mounting to a cabinet rear rack rail behind the amplifier chassis. The splitter can be removed from the angle bracket and rotated as necessary to facilitate mounting.

2.12 System Bus Connections

The system bus port provides a means to connect multiple PA chassis to together for parallel operation in transmitters at the 7.5kW level and above. All PA chassis must have their SYSTEM INTERFACE ports interconnected for the transmitter to operate properly. This interconnection is performed by a five-way HD15 divider board mounted on the transmitter cabinet component panel. There are no user connections on the system bus.

2.13 Initial Start-up Procedure

This procedure provides the steps required to turn on the ZX series transmitter for the first time. It is recommended that installation personnel read the general description in Section 1, the controls and operation material in Section 3, and this procedure before starting.

STEP 1 Carefully inspect transmitter for loose hardware, unconnected wires, missing parts, debris, or other signs of damage from shipment.

STEP 2 If transmitter was supplied with optional rack integration, install rack in a suitable location. Temporarily remove optional air input plenum, as necessary, to facilitate moving transmitter rack through doorways. (where applicable)

a. Secure rack to floor, neighboring racks, as necessary.

b. Connect rack to intake and exhaust ducts, as necessary.

STEP 3 If transmitter was supplied without optional rack integration, mount amplifier chassis and exciter in EIA rack. If transmitter was shipped with all modules in place, modules can be temporarily removed to lighten chassis and facilitate installation.

a. Provide rear-rail and/or under-chassis support as necessary to prevent chassis from warping rack rails over time.

STEP 4 Establish AC mains, RF output, and exciter connections to transmitter. See discussion of these connections earlier in this manual section.

STEP 5 Install all PA and PS modules in transmitter. If transmitter was shipped with all PA and PS modules in place, loosen thumsbscrews on PA modules, insert PA modules fully into sockets, and re-tighten thumbscrews. PA modules may be shipped in a partially-removed "safety" position to prevent connector damage during shipment. PS modules are already fully seated during shipment. Note that PA module thumbscrews need only be finger tight. Do not use a screwdriver to tighten thumbscrews.

NOTE:
The factory test data report shipped with the transmitter contains the serial numbers of the PA modules and their slot locations within the transmitter during factory testing. While it is not critical to operation, the transmitter readings may be closer to the report if the PA modules are placed in the same positions used during factory testing. To correctly duplicate factory conditions, the module serial number tag should be on the left-hand side of the module when inserted into the transmitter.

STEP 6 Ensure these basic requirements have been met before proceeding:

a. Transmitting antenna or terminal resistance (dummy load) of 50 ohms is connected to system RF output.

b. All rack-mounted units have continual AC mains safety ground connection via green/yellow conductor (third prong) back to main safety ground at AC service entrance.

c. Suitable AC mains service connected to transmitter with overload protection (breakers) and surge protection devices installed.

d. Transmitter rack and all rack-mounted units have protective RF earth grounding as necessary.

e. Blower exhaust and air inlet openings are not blocked, and all necessary duct work is in place.

f. Original factory test data sheet shipped with transmitter is on-hand and ready for consultation.

g. External interlock connection closed, either on REMOTE CONTROL connector of a single PA chassis transmitter or on remote terminal board of a larger transmitter.

STEP 7 Switch on mains power to exciter(s). Fan internal to exciter should start.

STEP 8 Switch on mains power to ZX amplifier chassis(s). Small fans internal to power supplies should start automatically.

STEP 9 If tri-mode operation is anticipated, verify FlexStar exciter currently has correct operating mode selected (FM, FM+HD, HD) and transmitter has assumed same mode.

STEP 10 Open front door of amplifier chassis and verify following alarms on controller card:

a. FORWARD POWER LOW: forward power is zero

b. LOW FAN SPEED: all fans have zero rpms (does not include fans internal to PS modules)

c. PA MODULE SHUTDOWN: all PA modules are currently shut down.

d. If RF MUTE ACTIVE is seen with a FlexStar exciter, verify exciter mute is switched off by actuating MUTE soft button on FlexStar main control screen.

e. If INTERLOCK LOOP OPEN is seen, verify dummy plug or suitable remote control connection is in place.

STEP 11 Switch on transmitter via front panel ON button on amplifier chassis. Verify following actions take place:

a. Amplifier starts, as evidenced by sound of rushing air from main DC fans at PA chassis rear.

b. Amplifier front panel STATUS LED changes from red to yellow and ultimately to green after several seconds.

c. Exciter output un-mutes and supplies amplifier with drive power.

d. Amplifier ramps up from zero to full power as indicted by front panel power meter.

STEP 12 Open amplifier chassis front door and verify no red alarm LEDs are being reported on controller board. If alarms are present, consult Section 6 – Troubleshooting of this manual.

STEP 13 Allow transmitter to operate for thirty minutes to warm up.

STEP 14 Inspect output transmission line to antenna for signs of localized heating.

STEP 15 If infrared inspection equipment is available, check AC mains connections, disconnect switches, circuit breakers for signs of excessive heat rise.

STEP 16 Verify all meter readings closely match those recorded on factory test data report. Meter calibration should not normally be necessary. All meters have been calibrated during factory test.

NOTE:
Each transmitter is thoroughly checked out during factory final test, but fine adjustment may be required during installation due to shipping, variations in primary power, antenna systems, or transmission line differences.

STEP 17 If necessary, check power meter calibration and power level settings per procedures in Section 5 – Maintenance of this manual.

STEP 18 If transmitter is transmitting HD Radio carriers (FM+HD mode or HD mode) perform these steps:

a. Check output spectrum for suppression of adjacent channel IMD sidebands per recommended spectrum mask.

b. Activate RTAC correction system via exciter screen as per instructions in exciter manual.

c. Verify RTAC correction system has properly suppressed out-of-band IMD emissions with spectrum analyzer or other monitoring device.

STEP 19 Place transmitter in remote mode via REMOTE ENABLED switch on controller board (reverse side of front door).

STEP 20 Verify correct functioning of station remote control system.

STEP 21 Take complete set of as-installed readings and save for future reference.

STEP 22 Dispose of shipping materials, as desired. Retain one set of packing materials for major subassemblies in safe, dry location (modules, exciter, amp chassis). These could be useful should it become necessary to return equipment to GatesAir or ship equipment to another site at a future date.

STEP 23 Procedure complete.

Section 3 Operation

3

3.1 Introduction

This section contains information concerning operation of the transmitter and its controls, indicators, and adjustments. Basic procedures for the transmitter operator are included in the second half of this section.

3.2 Controls and Indicators

3.2.1 Front Panel

The front panel of the amplifier chassis contains the basic controls for daily operation of the transmitter.

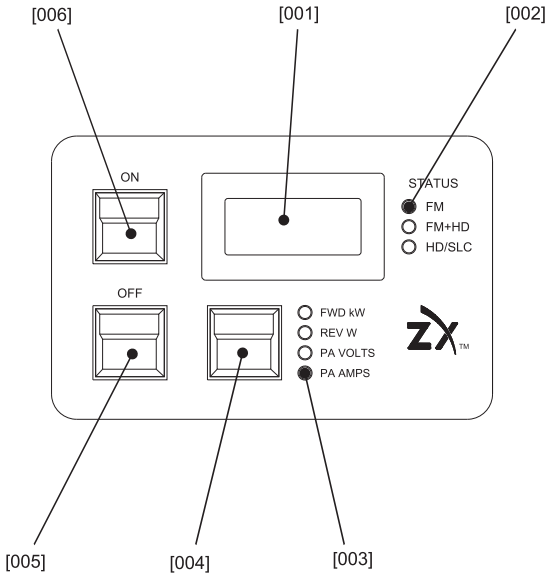


Figure 3-1 Front panel of ZX amplifier chassis.

Table 3-1 Front panel of ZX amplfier chassis

Item	Description
[001]	Multimeter Provides digital readout of important operational parameters.
[002]	STATUS LEDs Indicates the current transmitter mode (FM, FM+HD, HD, or SL) and the current transmitter status. RED = transmitter is switched off. YELLOW = transmitter is switched on, but alarms exist. GREEN = transmitter is switched on and no alarms exist. FM = traditional FM carrier being transmitted. FM+HD = hybrid signal with FM + HD radio simulcast being transmitted. HD = radio carrier only being transmitted. SL = split level combining FM+HD signal with non-traditional injection ratio being transmitted.
[003]	Meter position LEDs Indicates the parameter currently being displayed by the meter. FWD PWR = forward power in kilowatts. REV PWR = reverse power in watts. PA VOLTS = final stage voltage in volts. PA AMPS = final stage current in amperes.

WARNING: Disconnect primary power prior to servicing.

Table 3-1 Front panel of ZX amplfier chassis

Item	Description
[004]	Meter select button Changes the parameter currently being displayed by the meter.
[005]	OFF button Switches the transmitter off.
[006]	ON button Switches the transmitter on.

3.2.2 Controller board

The controller board on the reverse side of the amplifier chassis front door contains additional controls to be used by maintenance personnel.

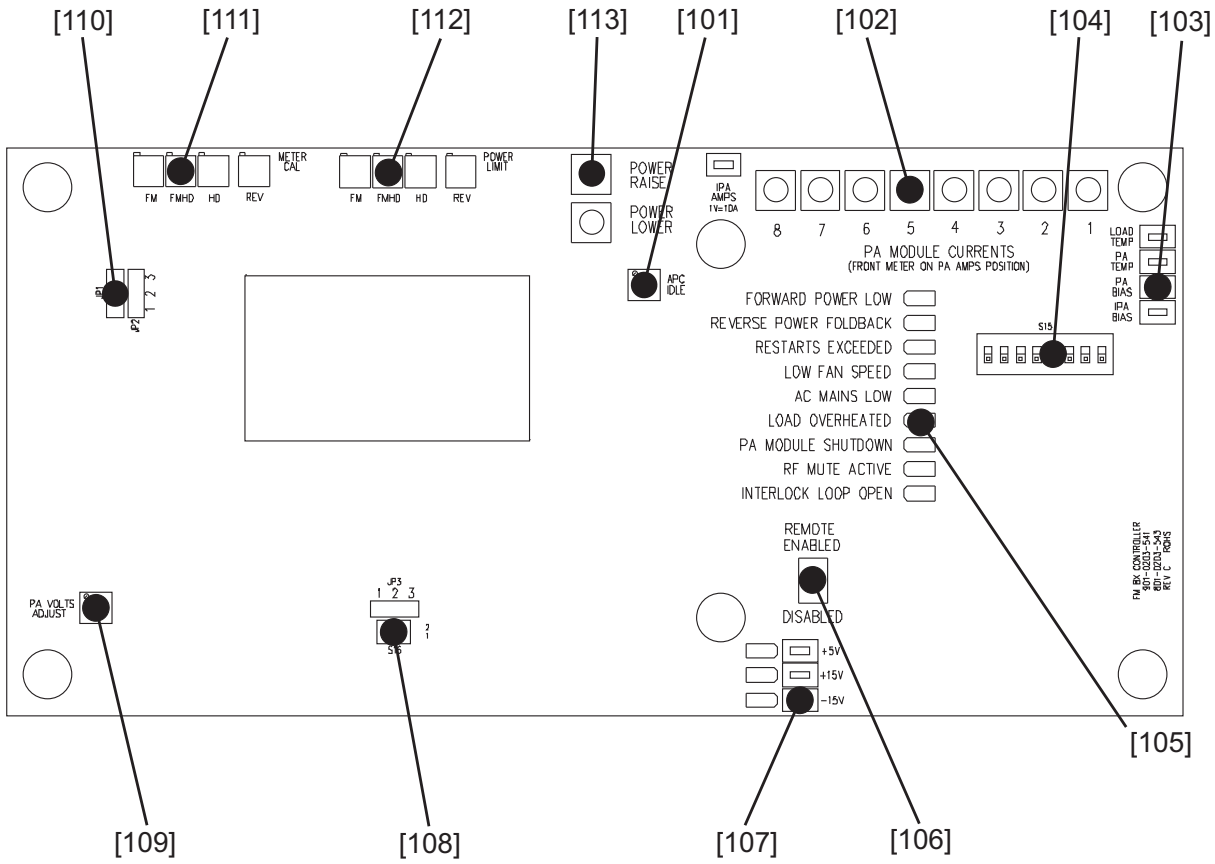


Figure 3-2 Controller board inside amplifier chassis

WARNING: Disconnect primary power prior to servicing.

Table 3-2 Controller board inside amplifier chassis

Item	Description
[101]	APC IDLE potentiometer Adjustment to set the maximum drive level when one or more PA modules are switched off. Consult the APC alignment procedures of Section 5 - Maintenance of this manual for more information.
[102]	PA MODULE CURRENT pushbuttons (1-8) Toggles the front panel meter to read the current level of a single PA module instead of all PA modules when in the PA AMPS position. Can be used to check the current balance among modules.
[103]	Test points A variety of test points to be used with a voltmeter for troubleshooting purposes. IPA AMPS: 0-2V linear scale to indicate 0-20A of IPA current. Reads both halves of the IPA module summed together. (is located to left of PA MODULE CURRENT pushbuttons) LOAD TEMP: 0-2V natural log scale to indicate 0-125C maximum load temperature. Consult the Advanced Functional Check procedure in Section 5 – Maintenance for a scale conversion table. PA TEMP: 0-2V natural log scale to indicate 0-99C maximum PA module temperature. Consult the Advanced Functional Check procedure in Section 5 – Maintenance for a scale conversion table. PA BIAS: Direct sample of the bias voltage being sent to the PA modules. IPA BIAS: Direct sample of the bias voltage being sent to the IPA module.
[104]	S15 - PA MODULE CURRENT meter programming Indicates which PA MODULE CURRENT metering pushbuttons will be active. Allows unused PA module positions in lower power models to be deactivated.
[105]	Alarm LEDs Red LEDs to indicate a variety of alarm conditions. Consult Section 6 – Troubleshooting for more information on the various alarms.
[106]	REMOTE ENABLED / DISABLED switch Disables remote control of the transmitter to permit local-only control during maintenance periods.
[107]	LVPS status Test points and status LEDs to permit checking of the +5V, +15V, and -15V voltages that power the transmitter control logic.

Table 3-2 Controller board inside amplifier chassis

Item	Description
[108]	JP3 and S16 - Module programming Two factory-preset settings that vary according to PA module type and mode of operation. Consult the controller board portion of Section 4 – Theory of Operation for more information on these settings.
[109]	PA VOLTS ADJUST potentiometer Factory-preset adjustment to set the PA module drain voltage to the correct level.
[110]	JP1 and JP2 – APC sample programming Set whether power control circuits track the forward (JP2) and reverse (JP1) samples coming from inside the amplifier chassis or from an external detector. Consult the controller board portion of Section 4 – Theory of Operation for more information on these settings.
[111]	METER CAL potentiometers A series of potentiometers to calibrate the forward power readings for FM, FM+HD, and HD modes and the reverse power reading for all modes. Consult Section 5 – Maintenance for a procedure to adjust these settings.
[112]	POWER LIMIT potentiometers A series of potentiometers to set the maximum power level for FM, FM+HD, and HD modes and the reverse power foldback threshold for all modes. Consult Section 5 – Maintenance for a procedure to adjust these settings.
[113]	POWER RAISE / POWER LOWER pushbuttons Pushbuttons to electronically raise or lower the power level between 10% and the maximum level set by the POWER LIMIT potentiometers. Useful for temporarily lowering power during maintenance /troubleshooting procedures without destroying the POWER LIMIT potentiometer settings.

WARNING: Disconnect primary power prior to servicing.

3.2.3 Internal LEDs

In addition to the alarm LEDs on the controller board, there are other LEDs inside the amplifier chassis that are useful in determining the operational status of the transmitter.

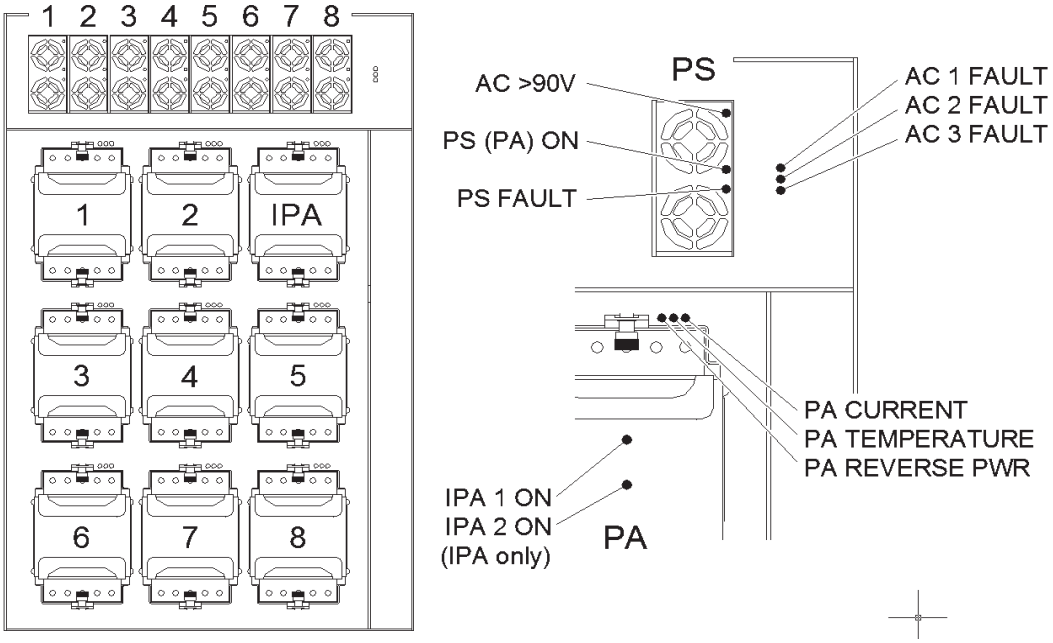


Figure 3-3 LEDs inside amplifier chassis

Table 3-3 LEDs inside amplifier chassis

Item	Description
AC>90V	PS module AC OK LED Indicates that the PS module is receiving AC mains power with a voltage above 90V. This is enough to power the internal +5V transmitter logic, but may not be enough to power the RF amplifier portion (>190V).
PS(PA)ON	PS module DC OK LED Indicates that the particular PS module is switched on and supplying +50V to the corresponding PA module. Consult the numbering of the PA and PS modules on the left to determine the correct correspondence between PA and PS modules.
PS FAULT	PS module fault LED Indicates that the particular PS module has suffered an internal failure and must be replaced.

WARNING: Disconnect primary power prior to servicing.

Table 3-3 LEDs inside amplifier chassis

Item	Description
AC 1 FAULT AC 2 FAULT AC 3 FAULT	AC mains low fault LEDs Indicates one or more AC mains inputs are below the 190V threshold needed for the RF amplifying section to operate.
IPA 1 ON IPA 2 ON	IPA on/off status LEDs Indicates in one or both halves of the IPA module are switched on. Both LEDs are behind the IPA module heatsink and may be seen through the heatsink fins. Because the IPA module accepts the shared voltage of all the PS modules, it is not possible to determine its on/off status via the PS module DC OK LEDs.
PA CURRENT	PA module current overload LED Indicates that the PA module has shut down due to a current draw of more than 22A.
PA TEMPERATURE	PA module temperature overload LED Indicates that the PA module has shut down due to a transistor flange temperature greater than 99C.
PA REVERSE PWR	PA module reverse power overload LED Indicates that the PA module has shut down due to a reverse power at its output of more than 25W approx.

3.3 System Metering Assembly

Transmitter models with an output power of 7.5kW and above have a system metering panel that displays the total system forward and reverse output power.

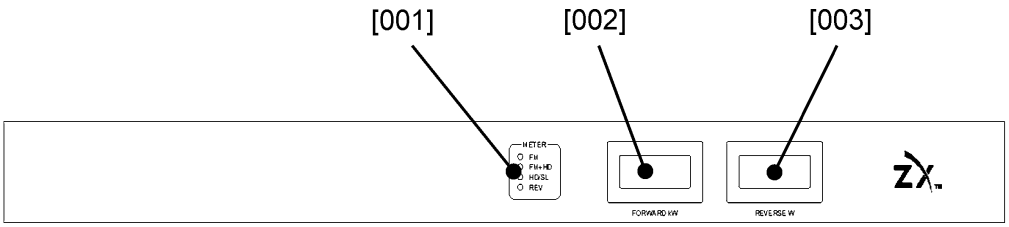


Figure 3-4 System Metering Panel

WARNING: Disconnect primary power prior to servicing.

Table 3-4 ZX system metering assembly

Item	Description
[001]	Calibration potentiometers Provides fine calibration of the forward and reverse power readings. FM = FM mode forward power calibration. FM+HD = FM+HD mode forward power calibration HD = HD or SL mode forward power calibration REV = reverse power calibration, all modes
[002]	Forward power meter Displays the final system output forward power in kilowatts.
[003]	Reverse power meter Displays the final system output reverse power in Watts.

3.4 Basic Operational Procedures

Below are a collection of basic procedures typically performed by the transmitter operator.

NOTE:
The ON, OFF, POWER RAISE, and POWER LOWER pushbuttons are ganged together in the ZX7.5 and ZX10 models whenever all PA chassis are in REMOTE ENABLED mode. Pressing the ON button on any one amplifier chassis will simultaneously turn on all amplifier chassis. It is sufficient to press the ON button on only one chassis (the most conveniently accessible one) when instructed to do so in the procedures below. The same is true for the OFF, POWER RAISE, and POWER LOWER pushbuttons.

3.4.1 ON/OFF Procedure

STEP 1 Power supply internal fans operate whenever AC is applied.

STEP 2 Press front panel ON button.

STEP 3 PA power supplies output 50V DC and fans at rear of chassis start.

STEP 4 Status LED on front panel changes from red to yellow to green.

STEP 5 RF power is ramped up from zero to full power.

STEP 6 Consult front panel meter to verify correct power output level.

STEP 7 Perform Basic Functional Check procedure (see 3.4.4) as desired to assess transmitter status.

STEP 8 Procedure complete.

3.4.2 Power Raise/Lower Procedure

The electronic RAISE/LOWER power control is typically left at or near its maximum setting to achieve the full power level determined by the POWER LIMIT potentiometer(s) on the controller board. It may be desirable at some point to temporarily lower power while tower maintenance is being performed or as a troubleshooting tool.

STEP 1 Select forward power metering position on front panel meter via meter select pushbutton.

STEP 2 Open amplifier front door and locate POWER RAISE and LOWER pushbuttons on controller board (reverse side of front door)

STEP 3 Adjust output power using POWER RAISE or LOWER pushbuttons. With transmitter gain control circuits properly adjusted, it should be possible to vary power from <10% to 100%. Front panel status LED should remain green at all times.

STEP 4 Procedure complete.

NOTE:
Consult Section 5 – Maintenance for procedures for permanently adjusting the power level via the POWER LIMIT potentiometer(s).

3.4.3 Switch Operating Mode Procedure (FlexStar HDX Exciter)

STEP 1 Access mode selection fields on user screen of FlexStar HDX exciter. **[Home>Setup>Output>Next]**

STEP 2 Command exciter to switch to desired mode (FM, FM+HD, HD) by setting **Primary Mode: Main** parameter.

STEP 3 ZX transmitter (amplifier chassis) registers RF MUTE ACTIVE alarm and transmitter power drops to zero.

STEP 4 Transmitting status LED changes on amplifier front panel to reflect new mode selection.

STEP 5 RF MUTE ACTIVE alarm clears and power ramps up from zero to new power level.

STEP 6 Consult Section 5 – Maintenance for power adjustment procedure if power level in new mode is not correct.

STEP 7 Procedure complete.

NOTE:
The power RAISE/LOWER power control setting is preserved while switching transmitting modes. For example, if the transmitter were operating at 65% of the maximum FM setting in FM mode, it would transmit at 65% of the maximum HD setting after switching to HD mode.

3.4.4 Basic Functional Check Procedure

This procedure provides the operator with a basic procedure for assessing the operational status of the ZX series transmitters. It assumes that the transmitter is currently switched on.

STEP 1 Check front panel STATUS LED to verify that correct mode is selected (FM, FM+HD, or HD) and light is green.

GREEN = Amplifier on and no alarms registered
YELLOW = Amplifier on but alarms reported
RED = Amplifier is off

STEP 2 Check forward power reading on front panel multimeter(s) and verify transmitter is currently at desired power level.

STEP 3 Actuate front panel meter select button to review reverse power, PA stage voltage, and PA stage current readings.

STEP 4 Compare meter readings to recorded baseline readings.

NOTE:
To facilitate the evaluation of transmitter meter readings, it may be desirable to attach a small label on or near the transmitter (or inside front door) with the normal, expected readings for forward power, reverse power, PA volts, and PA amps.

STEP 5 If front panel STATUS LED is not green, open amplifier chassis front door and perform following checks:

a. Check alarm LEDs on controller board.

b. Check status of DC OK lights on PS modules.

c. Check status of IPA ON lights inside IPA heatsink.

d. Check status of red LEDs behind each PA module.

NOTE:
Consult Section 3.2 - Controls and Indicators for the location of these indicators.

STEP 6 If alarms are being reported inside transmitter (STEP 5), notify station engineering staff and/or proceed to perform Advanced Functional Check Procedure is Section 5 - Maintenance.

STEP 7 Procedure complete.

WARNING: Disconnect primary power prior to servicing.

Section 4
Theory of Operation

4

4.1 Introduction

This section provides a more in-depth discussion of the operation of the ZX transmitter. Consult Section 1 – Introduction for diagrams to assist in the location of the various subassemblies discussed in this section. Section 4.1 through 4.12 address subassemblies within an individual amplifier chassis. Sections 4.13 through 4.14 address assemblies found inside the transmitter cabinet in ZX7.5 and higher power model transmitters.

4.2 RF Interconnect Wiring Diagram

Consult the appropriate drawing based on the type of amplifier used in your transmitter model:

ZX10 (ZX5000 amplifier) = 839-8464-082
ZX7.5 (ZX3750 amplfier) = 839-8464-084
ZX5000 = 839-8464-082
ZX3750 = 839-8464-084
ZX2500 = 839-8464-086

RF power from the exciter passes through a 3dB attenuator and a two-way Wilkinson splitter. The resulting two outputs drive the inputs of a PA module serving as an intermediate power amplifier (IPA). The IPA backplane has the ability to shut off independently each half of the module in the IPA position for increased redundancy. The isolation provided by the two-way IPA splitter ensures that the deactivation of one half of the IPA module has a minimal impact of the drive level to the other half.

The IPA module is simply a PA module installed in the IPA position. It may be interchanged with any of the other PA modules in the transmitter at any time without restrictions.

The output of each half of the IPA module feeds a Wilkinson power splitter which in turn supplies drive power to the RF input connectors on each PA backplane. The input splitter features isolation between its outputs to keep the drive to each PA module constant as other PA modules are plugged in and pulled out. A ninety degree offset in every other output cable ensures that reflections are absorbed by the splitter ballast loads as PA modules are unplugged.

The RF signal is amplified in the PA modules with a nominal gain of 14 dB to 20 dB, depending on frequency and operating mode. Each PA module utilizes a pair of VHF MOSFETs operating in a push-pull configuration. Consult schematic 843-5569-071 for more details.

The output from the PA modules is passed through the PA backplanes to the RF output assembly and the transmitter output. The RF output assembly is a combination Wilkinson power combiner, harmonic filter, and directional coupler line section. RF samples from the output assembly are used for the internal power metering and for monitoring use by the customer.

4.3 Output Assembly

Consult output assembly schematic based on amplifier chassis type.

ZX5000: 839-8464-080
ZX3750: 839-8464-087
ZX2500: 839-8464-088

The output from the PA modules is passed through RG-142 BNC cables from the PA backplanes to the output assembly. The output assembly is a combination Wilkinson power combiner and harmonic filter. The harmonic filter provides greater than 50 dB attenuation at the second harmonic and greater than 60dB attenuation at the third and higher harmonics to 1 GHz. A ballast load is provided for each input with coupling provided by a quarter-wave balun. Since all ballast loads have a ground reference, no static drain choke is required. The ballast loads are visible from outside of the output assembly with the amplifier rear door open, thereby allowing easy inspection and verification of load integrity. A temperature sensing thermistor on each ballast load signals a fault when the flange temperature of a load exceeds 125 degrees centigrade.

Whenever a combiner imbalance exists, some power will be directed to the ballast loads. This imbalance could be due to a PA module being shut down or removed from the transmitter. When a module is removed, the transmitter continues to produce (n/m) of the original power, where “n” is the number of modules still transmitting and “m” is the total number of modules in the parallel combined stage. Of this power, (n/m)^2 leaves via the transmitter output, while the remainder is directed to the ballast loads.

For example, a ZX5000 with one of eight PA modules removed produces (7/8) or 87.5% (4375W) of the original power with (7/8)^2 or 76.6% (3830W) appearing at the transmitter output and the remainder 10.9% (545W) being dissipated in the ballast loads.

Applying this formula to the various transmitter models yields the following power outputs when a single PA module is removed:

ZX2500 = -2.5 dB (56.3%)
ZX3750 = -1.6 dB (69.4%)
ZX5000 = -1.2 dB (76.6%)

The same rule also applies to combining perfomed outside the PA chassis in an external combiner, yielding the following results for higher power models:

ZX7.5 = -0.8 dB (84.0%)
ZX10 = -0.6 dB (87.9%)

Because both halves of the IPA operate in parallel in all models, the resulting power at the PA chassis output from the loss of one IPA half is always (1/2)^2 = -6dB (25%). Note that the IPA is operated at reduced power and is not exposed to the vagaries of the output transmission line and antenna. Therefore, it can be expected to have a very low risk of failure.

The loss of a single IPA results in the following power outputs for the various transmitter models:

ZX2500 / ZX3750 / ZX5000 = -6dB (25%)
ZX7.5 / ZX10 = -2.5 dB (56.3%)

The loss figures given here should be considered a worst-case scenario. The regulating action of the transmitter automatic power control (APC) will attempt to raise the power output to compensate for the drop. How much loss will be compensated depends on the transmitter power level, the APC setup procedure used, and how close the transmitter is to saturation (FM mode).

Even when all PA modules are installed in the transmitter and operating, power could be wasted in the ballast loads if all modules are not fully balanced in amplitude and phase. For this reason, it is imperative to always use the correct part number PA modules in the transmitter. Do not mix different part number PA modules in the same transmitter, as these may not have the same phase and gain characteristics.

NOTE:
This recommendation does not apply to PA modules with the same 10-digit part number but a different suffix (none, G, or R). These modules may be interchanged.

Every other input cable to the output assembly has an extra ninety degree phase shift. These cables have white identification labels instead of yellow. This phase offset helps the transmitter absorb reverse power appearing at the output and cancels a similar ninety degree offset in the splitter drive cables from the IPA. To maintain the correct phasing and avoid excessive ballast load power, the yellow-labeled splitter and combiner coax cables must always be connected to the top half of the PA backplanes, while the white-labeled splitter and combiner coax cables must always be connected to the bottom half of the PA backplanes.

The output of the RF output assembly is passed outside the transmitter to the station RF system and antenna via an EIA 1-5/8 flangeless connection. RF samples derived from a precision coupler section at the final output are passed to rms detectors on the I/O filter board to drive the internal forward and reverse power meter. An additional RF sample is passed to the user interface subpanel at the transmitter rear for customer use. This monitor sample may be used to drive monitoring equipment and/or the GatesAir RTAC adaptive correction system for HD Radio. The coupling value of the monitor port is listed on the transmitter rear panel and the coupler directivity is typically greater than 35dB.

4.4 AC-DC Interconnect Wiring Diagram

Consult appropriate drawing based on amplifier chassis type:

ZX5000 = 839-8464-081
ZX3750 = 839-8464-083
ZX2500 = 839-8464-085

Each amplifier chassis has three separate AC input connections. Each connection may assigned to a different phase for three phase operation or bridged together for single phase operation. Each AC input features either a IEC C20 inlet (ZX2500, ZX3750) or PowerCon NAC3MPA (ZX5000) connection depending on transmitter model. The use of NAC3MPA connectors for the ZX5000 module is required to meet the higher current demands of this chassis in accordance with CE area regulations.

The AC mains power entering the chassis passes through line filters, either integrated into the mains inlet (ZX2500 and ZX3750) or installed as separate assemblies located on the underside of the roof of the amplifier chassis (ZX5000).

The output of the line filters is supplied to the inputs or a series of power supply (PS) modules plugged into the 8x PS interface board (see also 801-0203-531). The PS modules convert AC mains power in the 190V - 264V range into DC power in the 43V - 53V range up to 1250W (nominally 25A at 50V). The PS modules also produce 5V @ 500 mA (output) to power the logic circuits for the amplifier chassis.

The +50V DC voltage from the PS interface board is distributed to DC cooling fans and to one or more PA backplanes. The PA backplane acts as an interface to the PA module, receiving DC power from the power supplies and communicating logic signals to the transmitter controller board.

The transmitter controller also receives power readings from detectors on the RF output assembly to drive the transmitter power control (APC) circuits and front panel power meter.

The transmitter controller communicates to the outside world via the I/O filter PCB. The I/O filter PCB contains RF filtering devices to prevent externally generated interference and voltage spikes from damaging the transmitter.

4.5 PA Backplane

Consult drawing 801-0203-381

The PA backplane provides all of the necessary support functions to properly operate the RF amplifiers contained on the PA module. These functions include a socket connection with DC inputs and RF outputs and alarm detection with latched shutdown for four different conditions:

a. excessive reverse power at the PA output (>25W),

b. excessive temperature at sensor at MOSFET mounting flange (>99C),

c. excessive DC current into the PA module (>22A), or

d. the PA module is physically removed from the socket.

The presence of a fault condition is indicated by a series of three red LEDs located just behind the upper right-hand corner of the PA module when installed in its position.

4.5.1 PA Reverse Power Alarm

A reverse power RF sample derived by frequency compensated diode CR2-C24 (CR1-C2) is amplified by temperature compensated amplifier U1A (U1B). A diode-or circuit formed by CR4E and CR4F passes along the higher of the two reading to fault

comparator U2C. In a non-faulted state, U2C will have a low output, based on a near zero input at the (+) input at pin 10 and a 2.25V input at the (-) input at pin 11 due to voltage divider R43-R51. U2C will pass to high (faulted) state whenever the (+) input rises above the 2.25V level at the (-) pin (i.e. high reverse power from detector). Positive feedback resistor R38 ensures that output remains high (approx. 3.5V) even after the high reverse power sample condition is resolved. That is, it latches the fault condition. The latched fault indication is cleared when a +5V pulse from the controller on the ON_OFF_RESET line J7-3 is passed to the (-) input and is greater than the +3.5V output signal being passed back to the (+) input via R38.

A high output at U2C is passed via current limiting resistor R39 to light LED DS1 indicating a latched fault condition. It is also passed through steering diode CR5 to override the PA current sample from U2A with a fixed +3.5V level. The PA current sample is normally 0 - 2.5V (0 - 25A). A +3.5V level on the PA current sample line is interpreted by circuits on the PS interface board as a sign to shut down the PA module because a fault condition is present.

4.5.2 PA Temperature Alarm

The operation of the PA temperature alarm is similar to the PA reverse power circuit described in the previous paragraph, except that the sensor signal comes from a thermistor on the PA module, rather than a directional coupler and RF detector. A 50k thermistor on-board the PA module controls the gain of amplifier U1C (U1D) via pin J5-N (J6-N). The temperature variable gain is applied to a 0.1V reference developed by voltage divider R49-R37. The result is a temperature sample based on a natural logarithmic scale and scaled such that the desired trip temperature produces an output of 2.25V. The higher of the two samples (each half of module) is passed on to fault comparator U2B. The operation of U2B is virtually identical to that of U2C, as described in the previous paragraph. The highest reading is also passed via steering diodes CR4A and CR4C to the MAX_PA_TEMP line to the controller via J7-5.

4.5.3 PA Current Alarm

The operation of the PA current alarm is similar to the PA reverse power circuit described in a previous paragraph, except that the sensor signal comes from current shunt R47-R48 and high-side current monitor U3, rather than a directional coupler and RF detector. The current sample is buffered by U2A and sent to fault comparator U2D via CR4G. It is also passed via RFI filter R33-C17-R34 to PA position selector dipswitch S1. Switch S1 applies the PA current reading to one of eight possible PA current sample lines J7-13…J7-20, thereby determining which slot in the chassis the card occupies and which PS module it controls.

4.5.4 Socket Interlock Module Fault Sensor

In addition to the three fault conditions described above, a >3V PA current sample to command a PS module shutdown can also be generated via R1-Q1 whenever the PA module is unplugged and the connection to the ground of the base of Q1 via J5-V, J5-A, J6-V, J6-A is broken

The PA backplane reports a module shutdown status to the controller board (via a comparator on the PS interface board) whenever the 50V from the PS module is not present. This sensing is done by transistors Q2 and Q3. A sample of the 50V passes through voltage divider R3-R4, causing Q2 to conduct and Q3 not to conduct. The MODULE_OFF signal line at J7-9 is common among all backplanes and is configured to report a shutdown alarm on the controller whenever it is grounded at any backplane (PA or IPA).

4.6 IPA Backplane

Consult drawing 801-0203-581

The IPA backplane is essentially the same as the PA backplane discussed earlier, but with the noticeable difference that each half of the IPA module may be shut down independently for greater redundancy. Accordingly, there is an independent set of three fault comparators for each half of the IPA module: U2-B,C,D and U3-B,C,D.

The IPA module does not have its own corresponding PS module, but rather shares the output of all the PS modules from the other PA modules. Accordingly it is not possible to shut down the PS module via a +3.5V current sample, as in the case of the PA backplane. Instead, the +50V DC feed to each half of the IPA module may be shut down independently via PMOS pass FETs Q5 and Q6. When FET Q2 (Q4) is conducting, the gate of Q5 (Q6) is pulled low via R74-R58-R59 (R75-R60-R61) and LED DS1 (DS2) is lit, indicating that +50V is being applied to the IPA module half in question. When Q2 (Q4) no longer conducts, the gate of Q5 (Q6) is pulled high, thereby causing Q5 (Q6) to enter a high impedance state and interrupting the flow of +50V power to the IPA module. Driver FET Q1 (Q3) provides a logic inversion such that a high output from the fault comparators at U2 (U3), provides a low input to the gate of Q2 (Q4).

The same set of three LEDS (DS3, DS4, DS5) is used to signal a fault condition for both halves of the IPA module. They are shared via steering diode network CR6A through CR6F. The status of LEDs DS1 and DS2 is usually sufficient to determine to which half of the IPA module the fault applies (i.e. which LED is off).

The individual PA current samples from each half of the IPA module are summed in amplifier U2A and passed to the IPA_CURRENT sample line via RFI network R40-C13-R41 and J7-12.

Another noticeable difference with the IPA backplane, when compared with the PA backplane is the alarm comparator threshold from voltage divider R45-R66 (R7-R70) is +1.25V instead of +2.5V. This creates alarm thresholds of 83°C instead of 99°C and 14A instead of 24A. This is compatible with the typically lower power operation of the IPA module halves.

4.7 I/O Filter PCB

Consult drawing 801-0203-551

The I/O filter board is located at the rear of the amplifier chassis and serves as the main interface point for connections coming from the front panel controller, exciter, customer parallel remote control, and other amplifiers when used in a multi-amp application.

It also converts RF forward and reverse power samples from the output assembly to DC voltages via rms detectors U2 and U3.

CR1, CR2 & CR9 provide input voltage clamping for signal lines coming from other amp chassis on SYSTEM INTERFACE bus J9. The SYSTEM INTERFACE bus allows multiple amplifier chassis to be ganged together and all share the same on, off, raise, lower, FM mode, HD mode, and power control commands. This allows multiple power blocks to be stacked in parallel to reach power levels beyond 5kW. There are no customer connection points on the SYSTEM INTERFACE bus.

Q2 through Q18 (except Q17) provide conversion from logic high or low levels to open collector outputs for a variety of fault and status conditions at the customer parallel remote control output J1.

Q1 provides a logic low to the exciter when a non-zero PA voltage is detected in this amplifier chassis or any other amplifier chassis connected to the SYSTEM INTERFACE bus. In this way, the exciter un-mutes when any one of multiple PA chassis has PA voltage present (i.e. is ON) in a multi-amp configuration.

NOTE:
The input RF circuit has load resistors capable of safely dissipating the nominal exciter input power when the transmitter is off and the fans are deactivated. However, whenever possible, it is highly recommended the exciter mute function be implemented as a safety precaution.

Q17 provides a ground to this amplifier chassis and all chassis connected to the SYSTEM INTERFACE bus when a “Exciter Ready” mute is being called for by the FlexStar exciter while switching modes.

J3 and J4 provide an interface point for an optional Web Remote daughter board. T1, CR3, and J10 provide the necessary connection interface between the Web Remote Ethernet output and a CAT5 cable from the outside world.

4.8 8X PS Interface PCB

Consult drawing 801-0203-531 page 1

The PS interface board serves as an interface between the plug-in power supply modules and the transmitter chassis. It also serves as an interface point for the cooling fan power and logic connections.

AC mains is input via a series of faston connectors and passed directly to the E and F blades of connectors J1 through J8.

AC sample circuit T1-CR12 produces a sample of the incoming line voltage of one input. This circuit signals an AC fault via comparator U1A and inhibits PS module via Q1 when the incoming AC mains voltage falls below approximately 190V. It is necessary to artificially restrict the AC input range of the PS modules to 190V to prevent excessive current surges during brownout conditions down to 90V, the nominal low voltage cutout point of the PS modules as supplied from their manufacturer. The other two AC inputs have similar circuits as driven by transformers T2 and T3 on subsequent pages of the schematic.

The D1 pin of each PS module is driven by the V_PROG DC voltage passed from the front panel controller via buffer amp U3D (page 4). This voltage can adjust the PS module output voltage over an approximately 43V - 53V range.

Comparator U1B compares the PA8 current sample against a reference from voltage divider R18-R50 and pulls PS control pin D3 low via steering diode CR1A when the PA8 current sample exceeds 3V. This corresponds to a +3.5V fault condition originating in the PA backplane boards, as described previously. The PS module can also be shut down by a low condition originating in CR1B-Q1 due to an AC fault or in CR1B-CR1G-U4A (page 4) when a off condition is received from the front panel controller. Comparator U4A will hold its output low whenever the ON_OFF_RESET (J9-3) line from the controller falls below the +0.8V reference from voltage divider R55-R54.

Comparators U1C and U1D perform a similar function as U1B for PA modules 7 and 6, respectively. Similar circuits for PA modules P5 through PA 1 on pages 2 and 3 of the schematic.

The output of all PS modules are shared via diode-or connection to power the IPA module and cooling fans via the SHARED_50V line. The +5V output of all PS modules are shared via a common connection of their A1 pins. Circuits internal to the PS modules allow these outputs to be tied together without need for external diodes.

A voltage sample of the SHARED_50V line is developed by divider R53-R26 (page 4) and passed by buffer U4C through RFI network R2-C13-R3 and J9-7 to the PA_VOLTS line.

Shared +50V power is passed to the cooling fans at the chassis rear door via connector J10. A FAN_STATE logic level reported from the fan monitor board on the rear door is compared to a +2.5V reference from voltage divider R39-R40 by comparator U4B. U4B provides logic level inversion, converting a low = alarm condition from the fan monitor PCB to a high = alarm condition at its output. This output is passed via RFI network R8-C8-R9 and J9-10 to the FAN_FAULT line to signal that at least one fan has insufficient speed / rpms.

Comparator U4D generates a module fault (PA module shutdown) alarm on the controller board whenever it senses that the MODULE_OFF signal line at J9-9 is being held low by any of the backplane boards.

4.9 5X Fan Monitor PCB

Consult drawing 801-0203-441

The fan monitor PCB provides 50V distribution and fault checking for up to five DC fans. It is designed to work exclusively with the DV6448/12 model fan.

Fault checking for fan 1 is done via the internal tachometer line on J1-3. The signal from the fan tachometer is RFI filtered via network R26-C22 and pre-conditioned via network C17-R31-CR15-Q1. The tachometer sample at the drain of Q1 is a square wave with a frequency proportional to the fan speed in rpms. This signal is analyzed by missing pulse detector U1 with a period equal to approximately 150% of the period at full fan speed. The output of U1 goes low whenever the next transition of the tachometer square wave does not appear before the end of the current period (i.e. fan rpms less than 2/3 of nominal value). This low condition lights alarm LED DS1 on the rear door and is passed via steering diode CR1 and J6-2 to the FAN_STATE logic line. Similar circuits provide the same functionality for fans 2-5.

Jumpers JP1, JP2, and JP3 disable the alarms for fans 2, 4, and 5, respectively, allowing these fans to be permanently removed from lower power models without causing a persistent low fan speed alarm.

4.10 16X Load PCB

Consult drawing 801-0203-321

The 16X load board monitors the flange temperature of the output assembly ballast loads and passes the highest reading on to the transmitter control system for fault checking and telemetry.

Thermistor RT6, attached to the flange of a ballast load, controls the gain of amplifier U1A. The temperature variable gain is applied to a 0.1V reference developed by voltage divider R17-R13. The result is a temperature sample based on a natural logarithmic scale. Similar circuits provide the same functionality for the remaining ballast loads. A diode-or circuit formed by CR1-CR2 ensures that only the high temperature reading is passed via RFI network R20-C17-R21 and J1-11 to the MAX_LOAD_TEMP line.

4.11 PA, IBOC PCB

Consult drawing 843-5569-071

The RF signal is amplified in the PA modules with a nominal gain of 14 – 20 dB, depending on frequency and operating mode. RF drive power enters via J1-C and passes through input matching network C3-C1-T1 to FETs Q1, Q2. Q1 and Q2 operate in push-pull to produce approximately 400-450W FM power into 50 ohm load conditions. Their outputs are impedance transformed via output network C8-C9-L5-T2-C10-C19-C20-C32 and passed to the PA backplane via J1-14,15. 50V DC power is supplied to Q1 and Q2 via choke network C11-L1-C28-L2. A portion of the 50V power is also used to derive a gate bias voltage via bias stabilization network R11-R12-R13-R8-CR1. The gate bias can be modified via a control signal at J1-U via R5. A control voltage of 0V places the module in a positive bias – class AB state, whereas a control voltage below approximately -2V pinches off the amplifier and drives it further into class C for progressively more negative voltages.

Thermistor RT1 controls the temperature sensing circuit on the PA backplane via J1-N.

A socket interlock is provide by a jumper connection between pins J1-A and J1-V. Circuits on the PA backplane will not supply 50V power to module until the J1-A to J1-V connection is satisfied.

4.12 Transmitter Controller PCB

Consult drawing 801-0203-541

The transmitter controller board serves as both the main interface to the user and the principal control point to set the operational state and power level of the whole amplifier chassis. It provides the following major functions:

- Sets the on/off state of the amplifier
- Controls the RF power level via an automatic power control circuit (APC)
- Determines the operating mode (FM/FMHD/HD) and sets the PA and IPA bias voltages accordingly
- Displays meter readings for various parameters
- Signals the existence of fault conditions
- Provides a means to adjust the drain voltage
- Senses the ambient temp at the air inlet

4.12.1 On/Off Control

The transmitter on/off state is held in memory by non-volatile flip flop U13 (page 4). U13 is a type D flip flop. It will change state whenever its clock pin (pin 5) experiences a low-to-high transition. The new output state at pin 3 depends on the state of input D1 at pin 6 when the clock transition occurs. A high logic output corresponds to a transmitter on condition, while a low logic output corresponds to a transmitter off condition. Optoisolators U30A and U30B apply +5V to the D1 input and/or clock input whenever their LED cathodes (pin 2) are grounded via either the local on-off pushbuttons or via a connection to the remote control ON_CMD_BUS and OFF_CMD_BUS if remote control has been enabled.

NOTE:
The on command provided via the front panel pushbutton or remote control interface must be momentary (pulsed). Ensure that any external remote control system is programmed to send a momentary (non-latched) ON command.

The logic output of U13 is shifted via voltage divider network R78-R79 to approximately +2V when logic high and 0V when logic low. This line is diode-or combined with +5V pulses coming from either the auto restart timer U14 or optoisolator U30A controlled by the ON pushbutton and passed through buffer transistor Q13 to increase its ability to drive low impedance loads. The result in the ON_OFF_RESET signal which assumes the following values to command the PA & PS modules in the transmitter chassis:

- 0V = Tx is off. Turn off all PS modules.
- 1V = Tx in on. Turn on all PS modules.
- 4V = Reset all faults.

NOTE:
The values have shifted slightly due to the voltage drop in the diode-or network and the base-emitter junction of Q13.

The logic output of U13 can be overridden and forced to zero by transistor Q7 – comparator U26C if the external interlock line is broken. This forces an emergency transmitter shut down if the external interlock is not satisfied. A similar shutdown will occur via transistor Q8 if the load temperature sensor circuit detects a combiner load temperature in excess of 125 degrees centigrade.

Comparator U26D samples the logic output of U13 and provides a logic high output to signal when the transmitter state is off. This status is available via the remote control interface and also mutes the APC circuit by forcing the output of APC comparator U25A to zero via CR10 (page 3).

4.12.1.1 Auto Restart

The purpose of the auto restart circuit is to send an ON command to restart PA modules that may have shut off during a transient event such as an arc in the output transmission line. The auto restart circuit sends +5V reset pulses from timer U14 at approximately five second intervals whenever all of the following conditions are met:

- Transmitter is latched ON (TX_OFF_STAT is false)
- All PS modules are off. i.e. all PA modules have shut down (TX_ON_STAT is false)
- AC mains power is good (AC_FAULT is false)
- The external interlock is satisfied (ILOCK_FAULT is false)
- The restart circuit has not timed out (RESTART_FAULT is false)

Each of these necessary conditions control the logic state at the gate of transistor Q4 via diode-or network CR4A through CR4E. When the gate of Q4 is logic high for any reason, no restart pulses will be generated by U14. The logic high condition at the gate of Q4 also causes transistor Q5 to conduct, grounding the base of transistor Q1, thereby preventing it from charging capacitor C46. Therefore, capacitor C46 will only charge when the transmitter is in a state calling for restart pulses to be generated. Capacitor C46 charges to a level high enough (+2.5V) to trigger latching comparator U27D after approximately thirty seconds of restart attempts, thereby generating a restart fault and preventing more restart pulses from being generated. If a restart condition is cleared before U27D has flipped state, C46 will discharge within an approximately 30 minute time frame for an almost full charge. The charge in C46 and the state of U27D can be reset by a +5V pulse from the ON pushbutton or remote control on command via optoisolator U30A, capacitors C67-C75, diode CR4F, and transistor Q6.

4.12.2 APC Circuit and Power Level Adjust

(page 3) A forward power sample from either the internal detectors on the I/O filter PCB or an external system detector is selected via the position of jumper JP2 and passed to electronically-controlled variable gain amplifier U27C. The gain of U27C is varied by the amount of resistance provided by variable attenuation U11 in the feedback network R8-U11-R34. The resistance setting of U11 is incremented/decremented according to the grounding of pin 2 (UC = up command) and pin 7 (DC = down command) which is in turn command by the local RAISE/LOWER pushbuttons or the remote control raise/lower commands if remote control is enabled. As the LOWER pushbutton S9 is pressed, U11 decreases its resistance, increasing the gain of U27. Because U27 is inside the negative feedback APC loop, increasing its gain increases the relative strength of the output sample and forces the APC to lower the transmitter power to compensate.

U11 has 64 different attenuator steps, corresponding to a power control step of approximately 1%. The power control steps are logarithmically weighted, with finer steps near the top end of the power adjustment range.

The output from U27C passes through another variable gain stage: U24B with gain being determined by potentiometers R10, R11, R12 and analog switch U6. The gain of U24B changes with each transmitting mode (FM, FM+HD, HD/SL) to set the desired maximum power level via R10, R11, and R12. The relationship between U24B and U27C is described by the following statement:

Potentiometers R10, R11, R12 set the maximum power per mode and the raise and lower buttons allow the transmitter to move between zero and full within that range.

The output from U24B passes through diode-or network CR6-CR9-CR10-CR12 to APC comparator U25A. The gain adjusted forward power sample from U24B is

compared by U25A against a fixed +2V reference from network R109-CR17-C16-R64 unless it is overridden by stronger signal through the diode-or network.

- Reverse power sample from JP1-U24A-CR9 forces the APC to follow the reverse power level (reverse foldback)
- Logic high from TX_OFF_STAT via CR10 forces the APC output to zero when the transmitter is off.
- Logic high from MUTE_FAULT via CR12 forces the APC output to zero when a mute is being requested via the remote control or FlexStar exciter when changing modes.

The output of U25A adjusts the transmitter output power level via R-C ramp circuit R20-C66-U25B and the power control PWR_CTL signal line. This line is either used by the exciter to set its output power level in linear IBOC applications or the IPA bias level in non-linear FM-only applications. Steering diode CR11 allows the PWR_CTL line to be shared by multiple amplifier chassis in multi-amp applications. In such cases, the exciter power setting or IPA bias would following only the highest PWR_CTL level from the multiple chassis.

An APC idle circuit, formed by Q15, R133, R137, Q14, and R135, clamps the power control voltage to a user-adjustable maximum level whenever a PA module is shut down anywhere in the transmitter.In practice, the APC IDLE circuit is typically adjusted so that the average PA module current remains constant both before and after the first PA module is removed at the highest gain frequency. For frequency agile transmitters in N+1 applications, this adjustment is typically performed at the highest gain channel.

Level shifting amplifier U28C shifts the 0 to +3.5V output of U25B to a 0V to -15V level suitable for controlling the gain of the IPA. Jumper JP3 allows the IPA bias level to be variable in the case of FM-only amplification or equal to a fixed 0V level PA bias in the case of IBOC amplification where the exciter controls the transmitter power.

In summary, the complete APC loop is as follows:

1. Transmitter output
2. Forward power sample and detector on I/O board.
3. Raise/lower VGA (U27C)
4. Max power set VGA (U24B)
5. Diode-or network (CR6, CR9, CR10, CR12)
6. APC comparator (U25A)
7. Ramp circuit (U25B)

8. PWR_CTL line to exciter or IPA bias control (U28C)
9. RF amplification by IPA-PA modules with power set by exciter or IPA bias.
10. Transmitter output (loop complete).

Comparators U25C and U25D compare the forward and reverse power samples entering the APC circuit against a fixed +2.25V reference from voltage divider R107-R35 and signals a fault when the forward sample is too low (low gain) or the reverse sample is too high (reverse foldback).

Potentiometer R13 adjusts the gain applied to the reverse power sample by variable gain amplifier U24A, thereby setting the threshold where the reverse power foldback is invoked by the APC circuit.

4.12.3 Operating Mode and Bias Level Control

The transmitter is capable of operating in any one of three modes based on incoming command lines from the exciter. The transmitter determines its operating state via the FM_ON_STATUS and HD_ON_STATUS lines available at the transmitter interface connector of the GatesAir FlexStar HDX exciter. These lines are pulled low by the exciter when the FM carrier or HD carriers are present at the exciter output. These lines are passed via the I/O flter board to the controller via the FM_ON_BUS and HD_ON_BUS signal lines.

The grounding of the FM_ON_BUS status line causes the gate of transistor Q2 to go low, thereby applying a logic high signal to input A of 4-bit decoder IC U12. A similar operation takes place with the HD_ON_BUS line, Q3, and U12-B input. The status of these two lines can select on of three possible transmitter operation modes: FM, FM+HD, or HD/SL according to the following truth table:

Table 4-1 Operating Mode Table

FM_ON_BUS	HD_ON_BUS	FlexStar Mode	TX Mode
false (high)	false (high)	Split Level Mode	HD/SL Mode
true (low)	false (high)	FM Mode	FM Mode
false (high)	true (low)	HD Mode	HD/SL Mode
true (low)	true (low)	FM+HD Mode	FM+HD Mode

The FlexStar exciter split level mode is mapped to the transmitter HD mode via steering diode CR8. This was done because a transmitter operating in split level mode (FM+HD

with non-standard ratio) is most likely to require the standard FM+HD mode as a backup should the main transmitter fail. It is unlikely that it would require an HD-only mode as a backup in a failure scenario. This made making the third mode HD-or-Split Level a logical choice.

The transmitter adjusts the APC set point and forward power meter calibration according its operating mode via the FM_MODE, FMHD_MODE (FM+HD), HD_MODE logic lines to analog switches U6 and U8. These logic lines also activate analog switches U9 and U10 to light front panel LEDs DS1, DS2, and DS3 to indicate the current operating mode (page 6).

The FM_MODE line also activates analog switch U6A to shift the level of the PA bias voltage generated by amplifier U28D. When the FM_MODE line is high, the output of U28 shifts to the -5V level required for class C operation of the "IBOC" style PA modules. Otherwise (FM+HD mode, HD mode, SL mode) the output of U28D is the 0V required for class AB operation.

This feature can be defeated by placing switch S16 in the off position, thereby causing a 0V bias while in the FM mode when using the optional "ZFM" style PA modules. (992-9992-002 or 992-9992-902)

NOTE:
All new ZX amplifiers are supplied with HD-compatible "IBOC" modules unless otherwise specified at time of purchase.

CAUTION:
"ZFM" AND "IBOC" PA MODULES ARE NOT COMPATIBLE AND CANNOT BE USED SIMULTANEOUSLY IN THE SAME TRANSMITTER. BE SURE TO CHANGE THE POSITIONS OF SWITCH S16 IF CHANGING FROM ONE MODULE TYPE TO ANOTHER.

4.12.4 Metering

(page 5) The front panel meter is capable is displaying four operating parameters: forward output power, reverse output power, PA stage voltage, and total PA stage current. The determination as to which parameter is displayed is made by 4-by-1 analog switch U7, which is controlled by four-position ring counter U20. Pushbutton S13 causes counter U10 to increase one count each time it is pressed. Resistor R85 and C49 provide switch de-bouncing. The four possible output lines (Q0-Q3) control the configuration of analog switch U7 and the on/off state of front panel indicator LEDs

DS13, DS14, DS15, and DS16 via driver transistors Q9, Q12, Q11, and Q10, respectively.

When appropriate, decimal point scaling is provided by SPDT switches U18 and U19. Switch U19 activates the third digit decimal point for 1/10 unit reading precision whenever the reverse power, PA volts, or PA current metering options are selected (e.g. 10.0 A). Switch U18 activates the second digit decimal point for a kilowatts reading (1/1000 scale) whenever the forward power metering option is selected (e.g. 5.00 kW).

FORWARD POWER position:

The forward power sample from the rms detectors on the I/O filter board is amplified by variable gain amplifier U24C, the gain of which is set potentiometers R15, R16, R17 and analog switch U8 according to the transmitting mode. This allows for separate metering calibrations for the FM, FM+HD, or HD/SL transmitting modes. The calibrated output of U24C is passed to the parallel remote control interface and squaring multiplier U15. U15 converts the forward power sample from being proportional to voltage (square root of power) to being directly proportional to power level. This output is available for metering via meter selector IC U7.

REVERSE POWER position:

The reverse power sample is processed in a manner similar to the forward power sample described above, except there is a single calibration potentiometer R18 regardless of transmitting mode.

PA VOLTS position:

The PA VOLTS meter reading is simply the PA_VOLTS sample developed by on the PS interface board from the shared 50V line supplying power to the cooling fans and IPA module.

PA AMPS position:

The total PA stage current reading appearing in the PA AMPS metering position is created by a summation of all of the PA1_AMPS through PA8_AMPS sample voltage brought in from the PA backplanes.

(page 2) Comparators U22A compares the PA1_AMPS sample against a +3V reference developed by voltage divider R57-R123. Its output will go low and open analog switch U1A whenever the PA1_AMPS sample exceeds 3V, a condition caused by a +3.5V fault output from the backplane board assigned to PA1. With switch U1A open, the PA1_AMPS sample is not allowed to pass through R39 to the PA_AMPS summing amplifier U28A and U28B.

Similar functionality is provided for PA modules 2 through 8 by the remaining positions in U22, U23, U1, U2.

In addition to the total PA stage current, the current of each individual PA module may be read by means of a series of selector pushbuttons whenever the meter is already in the PA AMPS position. These switches are located on the reverse side of the controller board and may be accessed by opening the front door to the amplifier chassis.

Pushbutton switch S1 activates analog switch U3A and passes the PA1_AMPS sample to the ONE_PA_AMPS signal line, provided that switch S15A is in the ON position. Switch S15 allows the pushbuttons for non-populated module positions to be deactivated in transmitter models without the full complement of modules installed. Steering diode CR2E also passes a logic high level via ONE_PA_MTR to SPDT switch U17 (page 5), thereby causing a substitution of the ONE_PA_AMPS reading (in this case, PA1 AMPS) for the total PA_AMPS reading to be passed on to the meter via U7A.

Pushbuttons S2 through S8 and the remaining positions of U3, U4 provide similar functionality for PA modules 2 through 8.

4.12.5 Fault and Status Signaling

(page 6) Front panel tri-color LEDs DS1, DS2, and DS3 assume one of three states depending on the current operational status:

Green: transmitter is on and no faults are present
Yellow: transmitter is on but faults are present
Red: transmitter is off

Only one of these three LEDs will be lit, according to the current operational mode:

FM Mode: DS1
FM+HD Mode: DS2
HD/SL Mode: DS3

The green segment of LEDs DS1-DS3 is lit from the TX_ON_STAT line via current limiting resistor R22 and analog switches U9A, U9B, or U9C, depending on the current mode. The TX_ON_STAT line will be high whenever the PA_VOLTS sample reports a PA voltage greater than approximately +25V as determined by comparator U26A and voltage divider R80-R100 (page 4).

The red segment of LEDs DS1-DS3 is lit via any one of a variety of fault conditions via diode-or network CR3. If the green segment is also lit (i.e. PA volts present), an orange-yellow output will result. If the green segment is not lit, a red output will result.

Since a LOW_GAIN_FAULT will always be present when the transmitter is off (because the power is indeed low i.e zero), the red segments will always glow when the transmitter is switched off.

LEDs DS4 through DS12 provide signalization of a variety of fault conditions. These LEDs are located on the reverse side of the controller board and may be accessed by opening the front door of the amplifier chassis. This is consistent with a maintenance philosophy that dictates that the front panel LEDs DS1, DS2, DS3 signal the summary status (green = OK, yellow/red = not OK). If a not OK condition is indicated, the technician opens the front door to inspect the unit and determine the origin of the problem.

4.12.6 Load Temperature Fault Sensor

(page 6) Latched comparator U27A toggles from a low (non-fault) to a high (fault) state whenever the MAX_LOAD_TEMP sample arriving at pin 3 exceeds the +2V reference from voltage divider R98-R105 at pin 2. Positive feedback resistor R99 ensures that circuit remains latched with a +3.5V high output even after the high load temperature condition is resolved. A +5V pulse from the ON/OFF/RESET line via CR26 causes the output to toggle back to a low, non-fault state. A MAX_LOAD_TEMP sample of 2V corresponds to the maximum allowable load temperature of 125 degrees centigrade.

4.12.7 Ambient Temperature Sensor

Thermistor RT1 senses the ambient temperature and controls the gain of amplifier U27B. The temperature variable gain is applied to a 0.1V reference developed by voltage divider R96-R2. The result is a temperature sample based on a natural logarithmic scale. The resulting AMB_TEMP sample voltage is interpreted by the optional web remote card to provide a display of the ambient temperature in degrees.

4.12.8 Drain Voltage Adjust

Voltage divider R36-R122-R119 provides a means to set the V_PROG voltage sent to the PS modules to determine their output voltage.

4.13 System Metering Assembly

Consult drawing 801-0203-731

The system metering assembly provides a measurement of the final system RF forward and reverse power level in larger model transmitters.

Forward and reverse power samples from directional couplers at the final system output enter through SMA connectors J5 and J6. Networks R11-L1-C14-R5 and R12-L2-C21-R6 provide frequency compensation to flatten the coupler response over the entire FM frequency band. RMS detector ICs U1 and U2 convert the RF samples to a DC voltage proportional to the square-root of the output power (voltage scaled). Operational amplifiers U6C and U6D provide adjustable signal gain for meter calibration as set by trimmer potentiometers R7 through R10. Potentiometers R7, R8, R9 provide meter calibration for the FM, FM+HD, and HD modes respectively when switched into the circuit by analog switches U6D, U6B, and U8C, as controlled by 2-bit decoder IC U3, Q1, Q2, and the FM_ON abd HD_ON signals coming from the exciter over the system bus.

Multiplier ICs U4 and U5 provide squaring of the forward and reverse DC samples to provide meter readings proportional to power. Operational amplifiers U6A and U6B provide buffered metering samples for remote control telemetry via the J1 REMOTE connector and for the APC power control/web remote circuits in the individual PA chassis via the J3 SYSTEM connector. Networks R91-R90-R19 and R94-R95 scale the forward and reverse DC sample to a level appropriate for the front panel LED meters.

Additional connection lines for the on, off, raise, and lower commands are passed from the system bus (SYSTEM) to the user system remote (REMOTE) and ultimately to the remote terminal board in the rear cabinet area. This provides a convenient parallel remote connection point for the user.

4.14 System Interconnect (multi-PA chassis transmitters)

In larger multi-PA chassis transmitters, multiple amplifier chassis are connected together to function as a single transmitter. This interconnection is done in a way that maximizes redundancy while simultaneously providing simple, intuitive operation. The interconnection between chassis and the system meter assembly is provided by the system bus. All PA chassis and the system metering assembly must be connected to the system bus for the transmitter to operate properly.

4.14.1 Command Sharing

Consult Figure 4-1, below.

In each individual PA chassis, the on/off circuit (U13 on page 4 of 8010203541) responds to a ground connection being presented by either the internal ON button, the

open collector of a FET on the option web remote board (Q1 on page 2 of 8010203391), or a remote ground closure coming in from outside if the REMOTE ENABLED mode has been selected (ON_CMD line passing U5 on page 4 of 8010203541).

When multiple PA chassis are connected together via the system bus, all ON_CMD_BUS lines are bridged. Accordingly all PA chassis will receive an on command when the ON_CMD_BUS line is grounded anywhere. This ground connection could come from any of these sources:

- The ON button on any chassis.
- An ON command issued by the optional web remote card on any chassis
- A grounding of the TX ON CMD command on the remote terminal board.

The same functionality exists for the off, power raise and power raise commands.

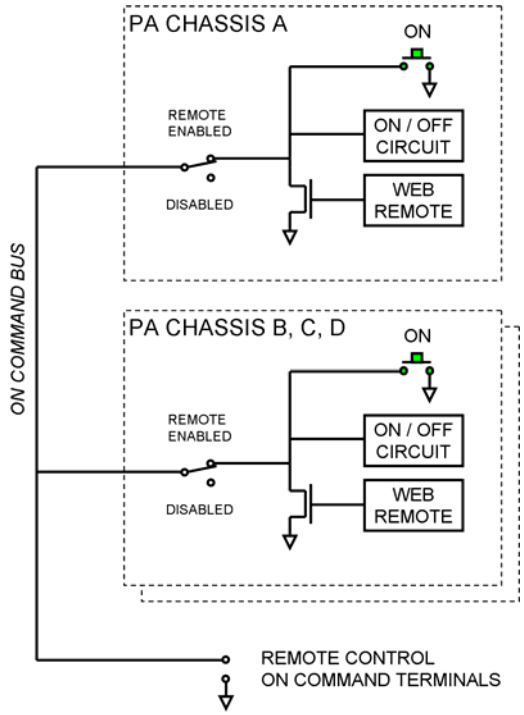


Figure 4-1 Simplified schematic of command sharing (general case of up to four PA chassis)

When the optional exciter main/alt switcher is installed, a similar functionality exists for the exciter A select and exciter B select commands. Pins 11 and 12 of the exciter bus are repurposed by a special break-out cable to carry the command lines REM_A_SELECT and REM_B_SELECT to the J10 USER REMOTE connection at the rear of the exciter main/alt switcher. When these lines are grounded at any point

along their length, the exciter main/alt switcher will respond by changing its exciter selection. This ground connection could come from the optional web remote card in any chassis, or directly to the J10 USER REMOTE connector from an external remote control system installed by the end-user. Steering diodes inside each PA chassis on the lines going to the J10 connector protect the web remote card from potentially damaging voltages should an external remote control by connected incorrectly. This allows the pins of J10 on the exciter main/alt switcher to be shared by two connections in complete safety.

4.14.2 Power Control Sharing

Consult Figure 4-2, below.

In each PA chassis, an AGC comparator (U25A on page 3 of 8010203541) compares a forward power sample from the amplifier's output to a power setting reference. The output of the comparator adjusts the power control circuits of the transmitter to increase or decrease the output power level.

NOTE:
In reality, the APC comparator reference voltage remains fixed at 2V, and the forward power sample is scaled up and down to raise or lower power by making it appear higher or lower than the 2V reference. Figure 4.2 employs the abstraction of showing an adjustable reference voltage for the purpose of simplifying the discussion.

When multiple PA chassis are connected together via the system bus, the outputs from all APC comparators are diode-ORed together (CR11 on page 3 of 801-0203-541) such that the power control for the transmitter – either the internal IPA bias voltage or the exciter APC voltage – will respond only to the highest output signal. The APC circuits from the other chassis will remain dormant, with their output(s) being blocked by their CR11 being in a non-conducting state.

When the APC circuits are aligned per the procedures in Section 5 – Maintenance of this manual, a "dominant" PA chassis is chosen to perform power control. By convention and for convenience, this is usually the PA chassis closest to the exciters. The APC setting in the dominant PA is set to achieve the desired per-chassis power to achieve full transmitter output. All other PA chassis are set approximately 10% lower. This ensures that the power control function for the transmitter will always track the dominant chassis, while the APC circuits in the remaining chassis lie in reserve. Any fine trim adjustments are done on the dominant chassis only, and from a top-level user standpoint, the whole transmitter behaves as if there is only the single APC circuit in operation. The reserve APC circuits spring into action if the dominant PA chassis suffers a failure or its chassis is shut down by the user.

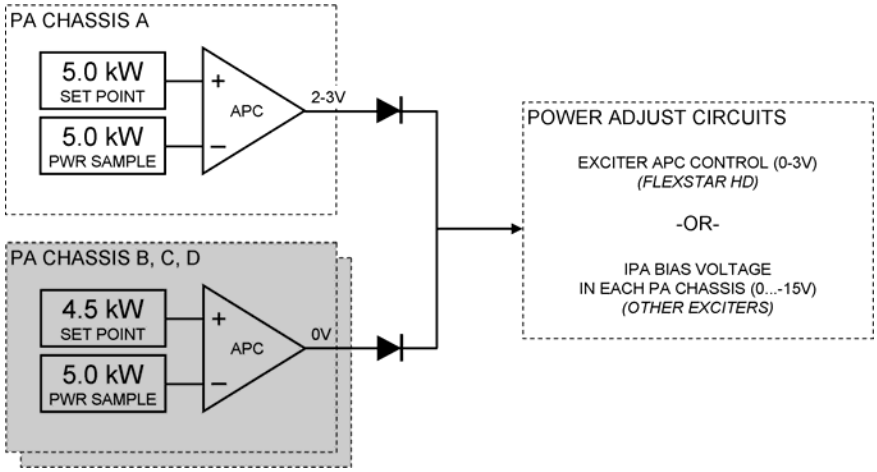


Figure 4-2 Simplified schematic of power control sharing (general case of up to four PA chassis)

As mentioned previously, the POWER RAISE and POWER LOWER pushbuttons are ganged together when all PA chassis are in remote enabled mode. This allows all APC circuits to rise and fall together when the power level is temporarily adjusted via these buttons, thereby preserving at all times the "dominant-vs-reserve" relationship described previously.

Section 5 Maintenance and Alignments

5

5.1 Introduction

This section provides maintenance and alignment information for qualified technical personnel and is divided into four principal parts.

The first part of this section provides a general overview of good maintenance practices.

The second part of this section provides basic maintenance procedures for the operator or first-level technician:

Basic Procedures

- Power amplifier module swap
- Power supply module swap
- Air filter replacement
- PA module heatsink cleaning

The third part of this section provides advanced maintenance procedures for the chief engineer / lead technician:

Advanced Procedures

- Advanced functional check
- APC power level set
- Forward power meter calibration
- Reverse power meter calibration
- Reverse power foldback threshold adjust
- Periodic cleaning and inspection
- Service one PA while other is one air
- Check amplifier balance

WARNING: Disconnect primary power prior to servicing.

The fourth part of this section provides information on the precautions to take when replacing major subassemblies. Detailed procedures are provided for the following operations:

Repair Procedures

Replace PA module amplifier pallet
Replace output assembly
Replace output assembly ballast load

5.2 General Maintenance Guidelines

5.2.1 Personnel Training

A transmitter's performance and longevity will be maximized if it is properly maintained by a well-trained, technically skilled individual. To this end, GatesAir offers a variety of training classes, both specific to ZX series transmitters and general courses on the fundamentals of RF technology. Contact your GatesAir representative or visit the GatesAir website at www.gatesair.com for more information on training offerings.

In addition, the reading materials listed below are valuable sources of information on the fundamental operating principles at work in the ZX series transmitter.

Recommended Reading:

1. This manual in its entirety.
2. NAB Engineering Handbook. Graham A. Jones, David H. Layer and Thomas G. Osenkowsky, ISBN 978-0-240-80751-5
3. The ARRL Handbook for Radio Amateurs. American Radio Relay League, ISBN 0-87259-189-1
4. HD Radio Implementation: The Field Guide for Facility Conversion. Thomas R. Ray, III, ISBN: 978-0-240-81002-7

In addition, in many parts of the world, there are professional societies offering learning material, training courses, and other forms of support to broadcast technicians.

Brazil:

SET – Sociedade Brasileira de Engenharia de Televisão e Telecomunicações

Canada:

CCBE - Central Canada Broadcast Engineers

WABE - Western Association of Broadcast Engineers

Hong Kong:
SBE - Society of Broadcast Engineers - Hong Kong Chapter

India:
BES - Broadcast Engineering Society

Korea:
KOBETA - Korean Broadcast Engineers & Technicians Association

Mexico:
AMITRA - Asociación Mexicana de Ingenieros y Técnicos en Radiodifusión

Phillipines:
SBETP - Society of Broadcast Engineers and Technicians of the Philippines

United States:
SBE - Society of Broadcast Engineers

Uruguay:
ANDEBU – Asociación Nacional de Broadcasters Uruguayos

5.2.2 Recommended Tools and Equipment

To maximize the effectiveness of maintenance personnel, it is important to have the proper set of tools and test equipment for the job. Below is a list of tools and equipment that should be available on site. Note that not all items are specifically required for the ZX series transmitter, but may be useful in general.

Tools:

1. Tool chest with following items
    a. Hex driver set with assorted sizes
    b. Allen key set with assorted sizes
    c. Flat and Phillips (star) screwdriver set with assorted sizes
    d. Drill and drill bit assortment
    e. Tap and die set with assorted sizes
    f. Adjustable wrench(es)
    g. Pipe cutter for rigid transmission line

h. Ratchet wrench with assorted sockets
i. Diagonal cutters
j. Wire strippers
k. Needle-nose pliers
l. General purpose pliers
m. Inspection mirror
n. Fine adjustment screwdriver (“tweaker”)

2. Multimeter with probe leads (ohmmeter, ammeter, voltmeter)
3. Clip lead attachments for multimeter
4. Temperature controlled soldering iron
5. Electronics solder (lead free where applicable)
6. Isopropyl alcohol for solder cleanup
7. Magnifying glass and tweezers if work on SMT components anticipated (otherwise, omit)
8. Clean shop towels and general cleaning products
9. Thermal compound (Wakefield 120-8)
10. Razor blade, rubber roller, or straight-edge to spread thermal compound.
11. Workshop light with clamp, hook
12. Vacuum cleaner with assorted attachments
13. Air compressor
14. Safety goggles

Test Equipment:

1. Stereo modulation monitor (HD Radio monitor where applicable)
2. Radio receiver and/or audio amplifier and speakers to monitor off-air signal
3. Station test load capable of dissipating full transmitter power
4. Frequency counter
5. Hand-held portable through-line wattmeter (Bird Model 43 or equivalent)
6. Precision power checking means at transmitter output
    a. Calorimetric load or
    b. Average power meter and transmitter precision coupler or

c. Calibrated through-line line section

7. Oscilloscope and probe leads
8. Spectrum analyzer (recommended for HD Radio)
9. Network or transmission line analyzer (optional, but useful)

5.2.3 Spares Holding

The ability to quickly resolve any equipment problems is greatly helped by maintaining a complement of spare parts on site. GatesAir offers a variety of ready-made spares kits for the ZX series transmitters addressed by this manual:

(990-1202-002) KIT, MODULE SPARES, ZXB (all models)
(990-1204-001) KIT, BOARD SPARES, ZX5000
(990-1205-001) KIT, BOARD SPARES, ZX3750
(990-1206-001) KIT, BOARD SPARES, ZX2500
(990-1261-001) KIT, BASIC, SPARE PARTS, ZXB (all models)

Consult Section 7 – Parts Lists for a complete description of the contents of these kits.

In addition to these kits, complete output assemblies and populated fan doors may be purchased a la carte. These minimize downtime during servicing by allowing an entire subsystem to be substituted in just minutes. Contact GatesAir for further details.

5.2.4 Safety Precautions

The amplifier chassis is composed of two general zones: the front half, as accessed by the front door and the rear half, as accessed by the rear door.

The front door is hinged and can be opened while the transmitter is running for access to the PA and PS modules. The PA and PS modules may be replaced while the transmitter is operating.

The rear door requires a tool to gain access and should never be opened while the transmitter is operating. It is very dangerous to attempt to make measurements or to replace components in the rear chamber with the mains power applied. Shut off all power before servicing the transmitter, other than replacement of PA and PS modules.

WARNING:
NEVER PERFORM TRANSMITTER MAINTENANCE WHILE ALONE AND/OR NOT FULLY ALERT. SERIOUS BODILY INJURY OR DEATH COULD RESULT FROM FAILURE TO OBSERVE PROPER SAFETY PRECAUTIONS.

5.2.5 Transmitter Logbook

To aid in any future troubleshooting, the transmitter should be monitored (using front panel and/or remote control metering) and the results recorded in a transmitter log at least once a day. This may be done either manually or via a computerized remote control system. This provides a baseline of normal operating parameters against which any future readings might be compared for abnormalities. A copy of the factory test data report should be kept available to provide additional information for comparison purposes.

5.2.6 Maintenance Logbook

The maintenance logbook should contain a complete description of all maintenance activities required to keep the transmitter operational. A list of maintenance information to be recorded and analyzed to provide a database for a failure reporting system is as follows:

DISCREPANCY:
Describe the nature of the malfunction. Include 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. Include the following details:
COMPONENT TIME IN USE
COMPONENT PART NUMBER
COMPONENT SCHEMATIC NUMBER
COMPONENT ASSEMBLY NUMBER
COMPONENT REFERENCE DESIGNATOR

NAME OF REPAIRMAN
Person who made the repair.

STATION ENGINEER
Indicates chief engineer noted and approved the transmitter repair.

5.2.7 Routine Maintenance

Routine maintenance of the ZX series transmitter consists of regular cleaning and the monitoring of power, voltages, and current readings to detect of any deviations that might indicate a developing problem.

To maximize equipment reliability and longevity, it is important to develop and stick to a well designed maintenance routine. Table 5-1, contains a suggested maintenance routine to follow. When indicated by (see procedure), a procedure to follow is provided later in this section.

Table 5-1 Suggested Maintenance Routine

Periodicity	Task
Hourly to daily	➢ Log transmitter readings
Weekly	➢ Review readings and compare with baseline readings and/or factory test data report to detect any deviations.
Monthly to semi-annually	➢ Inspect / replace air internal filter (see procedure) ➢ Inspect / clean PA module heatsink fins (see procedure)
Annually	➢ Periodic inspection and cleaning (see procedure) ➢ Verify power meter calibrations (see procedure) ➢ Verify reserve exciter and exciter switchover functionality ➢ Verify external interlocks (station load temp sensor, patch panel position switch, coax switch interlock, etc.)

5.2.8 MTBF Estimates

The solid state circuits in the ZX series transmitter do not require routine replacement. Below are Mean Time Before Failure (MTBF) estimates for key subassemblies in the ZX series transmitter.

MTBF of major components :

PA Modules = 600,000 hours approx.

Source: calculated from installed fleet

PS Modules = 200,000 hours approx. (including PS module fans)

Source: Lineage Power CAR1248 long form specification

Chassis fans = 90,000 hours approx.

Source: EBM PAPST

WARNING: Disconnect primary power prior to servicing.

5.3 Basic Maintenance Procedures

The maintenance procedures provided in this section may be routinely performed by operators with basic technical skills. No special equipment or training is required.

5.3.1 Power Amplifier (PA) Module Swap Procedure

The PA modules are hot-pluggable and may be swapped at any time while the transmitter is operating. Any PA module may be swapped with a PA module in another position, including the PA module in the IPA position. PA modules may also be rotated 180 degrees and swapped "top to bottom."

Tools required:
None

STEP 1 If a failed PA module is suspected, verify failure by looking for these tell-tale signs:

a. Output power has dropped significantly.

b. Front panel STATUS LED has shifted from green to yellow.

c. PA MODULE SHUTDOWN alarm reported on controller board (reverse side of amplifier front door).

d. PA(PS) ON LED of corresponding PS module extinguished, while others modules are still lit.

NOTE:
The green "ON" status LEDs for the IPA module halves are located behind the IPA module heatsink (seen through heatsink fins).

STEP 2 Open amplifier front door.

STEP 3 Loosen PA module thumb screws immediately above and below affected PA module.

STEP 4 Unplug PA module from transmitter. If not already extinguished, PA(PS) ON LED on corresponding PS module should extinguish. PA MODULE SHUTDOWN LED on controller card should light.

WARNING:
PA MODULES ARE DESIGNED TO HANDLE VERY HIGH TEMPERATURES AND MAY BE EXTREMELY HOT. DO NOT TOUCH MODULE SIDES WITH BARE HANDS AFTER

TRANSMITTER HAS BEEN RUNNING, ESPECIALLY IN HIGH AMBIENT TEMPERATURE ENVIRONMENTS.

STEP 5 Insert replacement PA module. Corresponding power supply should restart immediately upon PA module re-insertion.

STEP 6 Hand-tighten PA module thumbscrews to secure module in place. Do not use a screwdriver.

STEP 7 If desired, use PA MODULE CURRENTS pushbuttons on controller board and front panel meter PA AMPS position to verify new PA module has a current draw similar to all other modules.

STEP 8 Close amplifier front door.

STEP 9 Procedure complete.

NOTE:
The PA MODULE CURRENTS pushbuttons are designed to be accessible with the front door mostly closed and the front panel meter visible. When accessed in this fashion, the physical arrangement of the buttons from 1 to 8 will mimic the physical arrangement of the eight PS modules in the amplifier chassis.

Figure 5-1 Pressing PA Module Currents pushbuttons while viewing meter.

WARNING: Disconnect primary power prior to servicing.

5.3.2 Power Supply (PS) Module Swap Procedure

The PS modules are hot-pluggable and may be swapped at any time while the transmitter is operating. Any PS module may be swapped with a PS module in another position.

Tools required:

Small flat blade screwdriver

STEP 1 If a failed PS module is suspected, verify failure by looking for these tell-tale signs:

a. Output power has dropped significantly.

b. Front panel STATUS LED has shifted from green to yellow.

c. AC>90V light on PS module extinguished and no corresponding AC MAINS LOW fault is being reported.

d. PA(PS) ON LED on PS module extinguished and problem does not change module position when corresponding PA module is replaced / swapped with another.

STEP 2 Open amplifier front door.

STEP 3 Loosen extractor handle retaining screw on PS module lower right corner.

STEP 4 Rotate extractor lever to start PS module extraction from transmitter. If previously lit, AC>90V LED should extinguish. Fans inside power supply will continue to spin for approximately five seconds after mains power has been removed.

WARNING: Disconnect primary power prior to servicing.

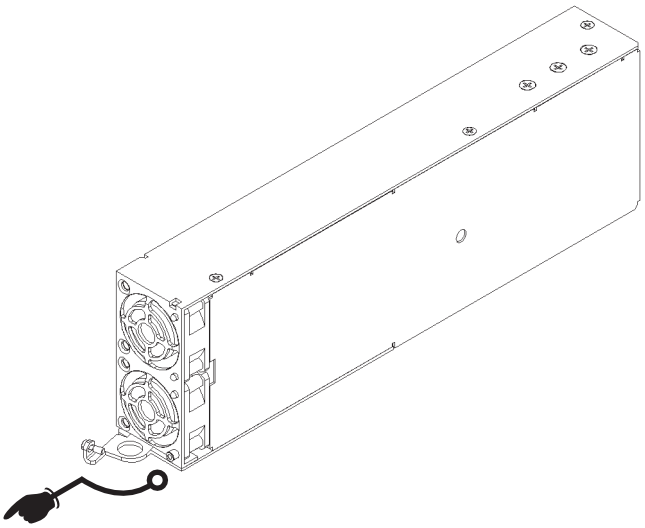


Figure 5-2 PS module extractor lever.

STEP 5 Once extractor lever has been rotated 90 degrees, pull on lever to complete extraction of supply.

STEP 6 Insert replacement PS module. AC>90V and PA(PS) ON LEDs should light automatically once PS module is fully engaged.

STEP 7 Tighten PS module extraction lever to secure replacement PS module in place.

STEP 8 Close amplifier front door.

STEP 9 Verify that transmitter has returned to desired power level and all alarms have been resolved.

STEP 10 Procedure complete.

5.3.3 Air Filter Replacement Procedure

The front door air filter requires periodic replacement when filled with dust. All ZX transmitters are supplied with a spare piece of filter media, so that a new piece may be rotated into service while the first piece is being washed and allowed to dry. Do NOT under any circumstance install a wet or moist filter in the transmitter. Contact GatesAir Service to purchase additional filter media, as necessary.

Tools required:

None

WARNING: Disconnect primary power prior to servicing.

STEP 1 Open amplifier front door.

STEP 2 Open filter retainer door by loosening thumbscrews on reverse side of front door.

STEP 3 Remove filter media from filter retainer frame.

STEP 4 Install replacement media in retainer frame.

STEP 5 Close filter retainer door and tighten thumbscrews.

STEP 6 Gently wash filter media in water until all dust and debris is removed.

STEP 7 Allow filter media to dry and save for use as replacement media next time procedure is performed.

STEP 8 Procedure complete.

5.3.4 PA Module Cleaning Procedure

The PA module heatsinks are designed for high efficiency and therefore do not have large openings for airflow. As a result, it is common for the modules to collect dirt over time. The modules should be cleaned with compressed air on a schedule to be determined on site, depending on the air system, filtering, humidity etc. (at least once a year).

⚠ **WARNING:**
THE PA MODULES ARE DESIGNED TO HANDLE VERY HIGH TEMPERATURES AND MAY BE EXTREMELY HOT. DO NOT TOUCH THE MODULE SIDES WITH BARE HANDS AFTER THE TRANSMITTER HAS BEEN RUNNING, ESPECIALLY IN HIGH AMBIENT TEMPERATURE ENVIRONMENTS.

Tools required:
Air compressor or
Vacuum cleaner with hose & nozzle attachment
Dry paintbrush

STEP 1 Remove PA module from transmitter.

⚠ **CAUTION:**
DO NOT ATTEMPT TO THE CLEAN PA MODULES WITH COMPRESSED WHILE THEY ARE STILL INSTALLED IN THE TRANSMITTER. THIS WILL FORCE DUST DEEPER INTO THE TRANSMITTER.

STEP 2 Blow compressed air into heatsink fins to remove dust buildup. If compressed air is not available, use a vacuum cleaner to suction dust from heatsink.

STEP 3 Use dry paintbrush to dislodge stubborn dust.

STEP 4 Replace PA module in transmitter.

STEP 5 Repeat procedure with remaining PA modules.

STEP 6 Procedure complete.

5.4 Advanced Maintenance Procedures

The maintenance procedures in this section should only be performed qualified technicians with a firm understanding of the operating principles of the ZX transmitter and transmitter technology in general. Do not attempt to perform any of the procedures in this section before having thoroughly read and understood the entirety of this technical manual.

⚠ **WARNING:**
NEVER PERFORM THE PROCEDURES DESCRIBED IN THIS SECTION WHILE ALONE AND/OR NOT FULLY ALERT. SERIOUS BODILY INJURY OR DEATH COULD RESULT FROM FAILURE TO OBSERVE PROPER SAFETY PRECAUTIONS.

5.4.1 Advanced Functional Check

This procedure provides additional steps beyond the Basic Functional Check in Section 3 – Operation to allow a technician perform a more detailed assessment of the operational status of the ZX series transmitter.

Tools required:
Voltmeter

STEP 1 Verify STATUS LED on amplifier front panel is green.

STEP 2 Compare forward power, reverse power, PA volts, and PA amps readings to recorded baseline readings.

STEP 3 Check individual PA module currents via PA MODULE CURRENTS pushbuttons on reverse side of front panel. All currents should be balanced to within +/- 1A.

STEP 4 Check readings at test points on controller board with voltmeter and compare to factory test data report. Log results for future reference.

a. IPA CURRENT: in general should be < 12A

b. MAX LOAD TEMP: in general should be below .6V for a 25C ambient temperature. See Table 5-2 for scale conversion to degrees centigrade.

c. MAX PA TEMP: in general should be below .6V for a 25C ambient temperature. See Table 5-3 for scale conversion to degrees centigrade.

d. PA BIAS: should be either 0V or near -5V depending on module type

1. IBOC modules: -5V in FM mode, 0V otherwise

2. FM modules: 0V

e. IPA bias: should be near 0V…-1V depending on internal vs. external power control

1. With exciter power control: 0V

2. With internal power control -0V to -15V, -1V if at full power on POWER RAISE/LOWER control.

STEP 5 If front panel STAUS LED is not green, perform following checks inside amplifier chassis and consult Section 6 – Troubleshooting for suggestion as to how to proceed.

a. Check alarm LEDs on controller card.

b. Check status of PA(PS) ON lights on PS modules.

c. Check status of IPA ON LEDs inside IPA heatsink.

d. Check status of red LEDs behind each PA module.

STEP 6 Procedure complete.

Table 5-2 PA TEMP test point scale

Max PA temperature (degrees C)	PA TEMP test point (volts)
0	0.14
10	0.17
20	0.20
25	0.23
30	0.26
35	0.30
40	0.35
45	0.40
50	0.47
55	0.54
60	0.63
65	0.74
70	0.86
75	1.00
80	1.16
85	1.34
90	1.55
95	1.79
100	2.06

formula: $T(^{o}C) = 35.294Ln(V) + 75.388$

Table 5-3 LOAD TEMP test point scale

Max load temperature (degrees C)	LOAD TEMP test point (volts)
0	0.12
10	0.13
20	0.15
25	0.16
30	0.18
35	0.20
40	0.22
45	0.25
50	0.28
55	0.32
60	0.36
65	0.41
70	0.47
75	0.54
80	0.62
85	0.71
90	0.81
95	0.92
100	1.06
105	1.20
110	1.37
115	1.56
120	1.77
125	2.00

formula: $T(^{o}C) = 40.858Ln(V) + 98.751$

5.4.2 Forward Power Meter Calibration

Use this procedure to adjust the transmitter forward power meter on either the amplifier chassis door or the system metering assembly, based on calibrated readings from an external precision measuring instrument such as a calorimetric load, through-line type wattmeter, or precision coupler with average power meter.

Tools required:

Calorimetric load or
Precision directional coupler and average power meter or
Calibrated through-line type wattmeter
Small adjustment screwdriver

STEP 1 Obtain calibrated reading of transmitter forward power from external precision measurement source.

STEP 2 Determine operating mode via front panel STATUS LEDs (FM, FM+HD, or HD).

STEP 3 If amplifier chassis reading is to be calibrated, perform these steps

a. Select forward power reading on amplifier front panel meter via meter select pushbutton.

b. Open amplifier front door and locate forward power calibration potentiometer for current operating mode (METER CAL - FM, FMHD, or HD) at upper left of controller board on reverse side of front door.

c. Adjust relevant potentiometer until desired reading is obtained on meter.

d. Close amplifier front door.

STEP 4 If system meter reading is to be calibrated, calibrate reading for current mode via front panel trimmer potentiometer on system metering assembly face to immediate left of meters.

STEP 5 Procedure complete.

5.4.2.1 Precision Directional Coupler

The ZX series transmitter features a precision directional coupler at the output of each amplifier chassis and the final combiner output (where applicable). When used with a quality average power meter, this coupler may be used to calibrate the transmitter meters. A small label indicating the calibrated coupling factor at the test frequency is affixed during final factory test. If the final operating frequency is known at the time of final test, this coupling value will be for that frequency. If the final operating frequency is not known, the coupling will be listed for a nominal test frequency, such as 98 MHz. To convert the coupling value at the test frequency to a new frequency, the following formula can be used:

$C_1(dB) = C_0(dB) + .0866*(f_1(MHz) - f_0(MHz))$

Where:

C_1 = coupling factor in dB at the new frequency
C_0 = coupling factor in dB at original test frequency
f_1 = the new frequency in megahertz

f_0 = the original test frequency in megahertz

EXAMPLE:

If the transmitter lists a coupling of -50.0 dB at 98 MHz, it will have a coupling of -49.56 dB at 103.1 MHz

-49.56 dB = -50.0dB + .0866 * (103.1 – 98)

The coupling factor is entered as an “offset” into the average power meter to obtain a direct metering reading in watts.

5.4.3 Reverse Power Meter Calibration

Use this procedure to calibrate the transmitter reverse power meter only if its measurement calibration is in doubt. This adjustment does not require routine calibration. Refrain from disturbing the reverse meter calibration if the reverse power measured by the external precision measurement source is less than 1% of the transmitter nameplate power level. In such cases, special steps may be required to create a temporary high reverse power reading.

Tools required:

Precision directional coupler (reverse port) and average power meter or
Calibrated through-line type wattmeter (reverse direction)
Small adjustment screwdriver

STEP 1 Obtain calibrated reading of transmitter reverse power from external precision measurement source. If reading is less than 1% of transmitter rated power, perform these steps to generate a sufficient reading.

a. ZX2500 / ZX3750 / ZX5000: lower transmitter power to 2% of nameplate rating, switch off transmitter, break output transmission line, switch on transmitter. Reflected power = forward power = 2%.

b. ZX7.5 / ZX10: lower transmitter power to 2% of nameplate rating, swap REVERSE METER lead and SMA RF load on two ports of reverse meter directional coupler at final system output. Reflected sample is now monitoring forward power = 2%.

STEP 2 If PA chassis meter is to be calibrated, select reverse power reading on amplifier front panel meter via meter select pushbutton, open front door, and locate reverse power calibration potentiometer (METER CAL - REV) on controller board. Adjust potentiometer until deisred reading is obtained on meter.

STEP 3 If system meter reading is to be calibrated, calibrate reverse reading via front panel REV trimmer potentiometer on system metering assembly face to immediate left of meters.

STEP 4 Reverse any steps taken to create temporary high reverse power reading.

STEP 5 Procedure complete.

5.4.4 Set Transmitter Power Level (Case 1: internal transmitter APC control)

Use this procedure when the transmitter power level is being controlled internally via the IPA module bias voltage. This is typically the case when the ZX amplifier is being used strictly for FM-only service.

NOTE:
If the type of power control is unknown, check the position of jumper JP3 on the transmitter controller PC board: position 1-2 is internal control; position 2-3 is external (exciter) control. In the case of external control, consult the alternate procedure immediately following this one. The use of external power control is almost exclusively reserved for use with the FlexStar HDX exciter operating in HD, FM+HD, or tri-mode operation.

NOTE:
For ZX7.5 and ZX10 model transmitters, please also consult section 5.4.6 for additional information on how to adjust the APC control circuits in both PA amplifier chassis.

CAUTION:
IMPROPER ADJUSTMENT OF THIS CIRCUIT COULD RESULT IN DAMAGE TO THE TRANSMITTER. THE TRANSMITTER COMES FROM THE FACTORY WITH THIS ADJUSTMENT ALREADY PERFORMED. USE THIS PROCEDURE ONLY WHEN IT BECOMES NECESSARY TO CHANGE PERMANENTLY THE TRANSMITTER OUTPUT POWER LEVEL FROM THAT ESTABLISHED AT THE TIME OF IN-FACTORY TEST. IF THE TRANSMITTER IS UNABLE TO REACH FULL POWER, RULE OUT ALL OTHER CAUSES BEFORE PROCEEDING TO PERFORM THIS ADJUSTMENT.

NOTE:
It is typical for the gain of the PA modules to drop during the first half hour of operation. This procedure should be performed after the transmitter has reached a thermal steady state.

Tools required:
Small adjustment screwdriver

STEP 1 Verify current operating mode is FM based on amplifier front panel STATUS LED display.

STEP 2 Open amplifier front door and locate POWER RAISE pushbutton on controller board upper edge.

STEP 3 Depress POWER RAISE pushbutton repeatedly until power adjustment circuit has clearly reached top of its range.

STEP 4 Lower exciter power to half its normal value as a safety precaution.

STEP 5 Locate POWER LIMIT – FM potentiometer on transmitter controller board upper edge and dial fully clockwise. FORWARD POWER LOW alarm LED should light, if not already lit before.

STEP 6 Increase exciter power to achieve 103%-105% of desired power level.

STEP 7 Dial POWER LIMIT – FM potentiometer counter-clockwise to lower power to 100% of desired power level.

STEP 8 Verify FORWARD POWER LOW alarm LED has extinguished on controller board.

STEP 9 Increase exciter output power 10% beyond previous setting to ensure transmitter APC has 10% gain reserve margin. Transmitter output power should not change as exciter power is increased.

STEP 10 Actuate controller board POWER RAISE and LOWER pushbuttons to verify it is possible to adjust power over a <10% to 100% range.

STEP 11 Note exciter power level on exciter power meter for future reference.

STEP 12 Remove one PA module and adjust APC IDLE potentiometer to return individual currents of remaining PA modules to pre-fault levels, as measured with front panel meter PA AMPS position and PA MODULE CURRENTS pushbuttons.

NOTE:
This adjustment is typically performed at the highest gain channel (only) for frequency-agile N+1 applications.

STEP 13 Re-insert PA module and verify individual PA module currents remain roughly equal under both pre-fault and post-fault conditions.

STEP 14 Procedure complete.

5.4.5 Set Transmitter Power Level (Case 2: exciter APC control with FlexStar HDX)

Use this procedure when the transmitter power level is being controlled via an analog voltage fed back to the exciter. This is always the case when operating with the FlexStar HDX exciter, except possibly if the FlexStar exciter is being used for FM-only service.

NOTE:
For ZX7.5 and ZX10 model transmitters, please also consult section 5.4.6 for additional information on how to adjust the APC control circuits in both PA amplifier chassis.

CAUTION:
IMPROPER ADJUSTMENT OF THIS CIRCUIT COULD RESULT IN DAMAGE TO THE TRANSMITTER. THE TRANSMITTER COMES FROM THE FACTORY WITH THIS ADJUSTMENT ALREADY PERFORMED. USE THIS PROCEDURE ONLY WHEN IT BECOMES NECESSARY TO CHANGE PERMANENTLY THE TRANSMITTER OUTPUT POWER LEVEL FROM THAT ESTABLISHED AT THE TIME OF IN-FACTORY TEST. IF THE TRANSMITTER IS UNABLE TO REACH FULL POWER, RULE OUT ALL OTHER CAUSES BEFORE PROCEEDING TO PERFORM THIS ADJUSTMENT.

NOTE:
It is typical for the gain of the PA modules to drop during the first half hour of operation. This procedure should be performed after the transmitter has reached a thermal steady state.

Tools required:
Small adjustment screwdriver

STEP 1 Determine current operating mode based on front panel STATUS LED display: FM, FM+HD, HD.

STEP 2 Open amplifier front door and locate POWER RAISE pushbutton on controller board upper edge.

STEP 3 Depress POWER RAISE pushbutton repeatedly until power adjustment circuit has clearly reached top of its range.

STEP 4 Adjust exciter max power limit via appropriate LIMIT setting in FlexStar **Home>Setup>More Setup>Next** screen (FM:Limit, FM+HD:Limit, or HD:Limit) until power level just starts to drop. This ensures exciter power is properly restrained during next few steps.

STEP 5 Locate POWER LIMIT potentiometer for current operating mode on transmitter controller board. Each mode has its own power set potentiometer (POWER LIMIT - FM, FMHD, HD).

STEP 6 Dial POWER LIMIT potentiometer for current mode fully clockwise. Transmitter APC power controls rises to its maximum boost setting and a FORWARD POWER LOW alarm is reported, indicating transmitter does not have enough gain to achieve current power set level (i.e. APC is out of range). Transmitter power does not actually rise due to exciter limit adjustment performed previously.

STEP 7 Slowly raise or lower FlexStar exciter limit setting to achieve 103%-105% of desired transmitter power level.

CAUTION:
NEVER RAISE THE FLEXSTAR EXCITER LIMIT SETTING MORE THAN 100 UNITS AT A TIME. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN DAMAGE TO THE PA MODULE FROM A SUDDEN DRIVE SPIKE AS THE NEW LIMIT SETTING TAKES EFFECT.

STEP 8 Adjust POWER LIMIT potentiometer for current operating mode counter-clockwise until power level drops to 100% of desired power level.

STEP 9 Verify FORWARD POWER LOW alarm LED has extinguished.

STEP 10 Increase FlexStar limit setting an additional 100 units to provide some system gain margin.

STEP 11 Actuate controller board POWER RAISE and LOWER pushbuttons to verify it is possible to adjust power over a <10% to 100% range.

STEP 12 Note exciter power level and limit settings for future reference.

STEP 13 Repeat procedure for other operating modes as necessary.

STEP 14 Remove one PA module and adjust APC IDLE potentiometer to return individual currents of remaining PA modules to pre-fault levels, as measured with front panel meter PA AMPS position and PA MODULE CURRENTS pushbuttons.

NOTE:
This adjustment is typically performed at the highest gain channel (only) for frequency-agile N+1 applications.

STEP 15 Re-insert PA module and verify individual PA module currents remain roughly equal under both pre-fault and post-fault conditions.

STEP 16 Procedure complete.

5.4.6 APC Setup for Multiple PA Chassis

This procedure clarifies the setup and alignment of the APC power control for ZX7.5 and higher power models. This alignment procedure is typically performed in the factory and need not be repeated in the field unless a long term change to the desired transmitter power level is required. This procedure should only be attempted if all PA modules operational and with all PA chassis fully warmed up.

The general principles at work are the same as in the alignment of a single-chassis model, but there is the added element of there being two or more APC circuits operating in parallel. Each chassis is adjusted one at a time with a procedure that mirrors the single-chassis case, with the exception that one PA chassis is adjusted for 100% power, while the other is adjusted for 90% power. This ensures that the transmitter power will always follow the APC circuit at 100% and behave as if only a single APC loop were present. The 90% APC circuit remains in reserve and will only become active if the first APC circuit fails or its chassis (only) is switched off.

STEP 1 Verify all PA modules are operational and transmitter has been operating at significant power for at least one half hour to reach a thermal steady state.

STEP 2 Place both PA chassis in REMOTE DISABLED mode via toggle switches on their respective controller cards.

STEP 3 Switch off lower PA chassis via its front panel OFF button.

STEP 4 Adjust upper PA chassis to ½ of desired total transmitter power level. (e.g. adjust to 5kW for a desired 10kW total power level) using appropriate adjustment procedure in Section 5.4.4 or 5.4.5. Limit exciter power when directed to do so in procedure. Measure power using PA chassis front panel meter, not system metering assembly forward meter.

STEP 5 Switch off upper PA chassis and switch on lower PA chassis via their respective ON and OFF buttons.

STEP 6 Adjust lower PA chassis to 90% of setting for upper PA chassis (e.g. adjust to 4.5kW instead of 5kW as previously) using appropriate adjustment procedure in Sections.5.4.4 or 5.4.5. It is not necessary to re-adjust exciter power when directed to do so in procedure. Measure

power using PA chassis front panel meter, not system metering assembly forward meter.

STEP 7 Switch on upper PA chassis via its front panel ON button. Both chassis should be active and power should rise to full desired level at system metering assembly forward power meter. (e.g. 10kW in present example)

STEP 8 Adjust APC LIMIT for current transmitting mode in upper chassis (only) to fine trim total power level.

NOTE:
It is not necessary to fine adjust the lower PA chassis because the transmitter power control is only tracking the upper amplifier APC circuit. The lower amplifier APC circuit is waiting in reserve.

STEP 9 Place both amplifier chassis in REMOTE ENABLED mode on their respective controllers.

STEP 10 Press POWER LOWER and/or POWER RAISE pushbuttons on either controller to verify power is adjustable over a 10%-100% range.

STEP 11 Repeat procedure as desired for other transmitting modes (e.g. FM, FM+HD, HD)

STEP 12 If frequent mode switching is envisioned, fine tune APC LIMIT potentiometer settings for various modes in upper PA chassis (only) to ensure power always returns to 100% for each new mode after switching.

STEP 13 Procedure complete.

5.4.7 Set User Reverse Power Foldback Threshold (ZX2500 / ZX3750 / ZX5000)

Use this procedure to set the user-defined reverse power foldback threshold for all single PA-chassis transmitter models. The user reverse power foldback is designed to reduce power when the average reflected power at the transmitter output exceeds a given level set by the user.

Tools required:
Nut driver 8mm (7/16) (to break output transmission line)
Small adjustment screwdriver

STEP 1 Select reverse power metering position via meter select pushbutton on amplifier front panel.

STEP 2 Press OFF button to switch transmitter off.

STEP 3 Open amplifier front door.

STEP 4 Locate POWER LIMIT - REV potentiometer on upper edge of transmitter controller board.

STEP 5 Disconnect transmission line from transmitter output.

STEP 6 Press ON pushbutton to turn transmitter on.

STEP 7 Power should increase to a level equal to 2.5% of forward power if initial factory adjustment has not been changed.

STEP 8 Adjust potentiometer to limit reverse power to desired foldback level, typically between 1% and 4% of forward power.

STEP 9 Switch transmitter off and restore all equipment to original condition.

STEP 10 Procedure complete.

5.4.8 Set User Reverse Power Foldback Threshold (ZX7.5, ZX10)

The procedure to set the reverse power foldback threshold is slightly different for larger transmitter models in that a false reading of high reverse power can be generated at the system level by swapping the ports on the REVERSE METER directional coupler at the transmitter RF output. This facilitates setting or checking the reverse foldback threshold without actually disconnecting the transmitter output to create high levels of true VSWR.

Tools Required:

Fine adjustment screwdriver

STEP 1 Lower transmitter forward power via controller POWER LOWER button to a level close to desired reverse foldback threshold. (e.g. 2.5% of nameplate power)

STEP 2 Open transmitter rack rear door.

STEP 3 Locate REVERSE METER directional coupler section at final transmitter output.

STEP 4 Swap REVERSE METER sample cable and SMA load between two ports of coupler section. System reverse meter cable is now connected to forward port of coupler. Reverse meter of system metering assembly should read a level comparable to forward power (…because it is now sampling forward power).

WARNING: Disconnect primary power prior to servicing.

STEP 5 Adjust REV APC LIMIT potentiometer in each PA chassis until red REVERSE FOLDBACK alarm just lights on controller board.

STEP 6 Restore all connections to original positions when finished.

STEP 7 Procedure complete.

5.4.9 Periodic Cleaning and Inspection

The ZX amplifier chassis should be periodically opened, inspected for dust buildup, and cleaned. This inspection should also check for signs of progressive damage, such as cracking cables or evidence of heat stress/burning. In the case of a single amplifier chassis transmitter (ZX2500 / ZX3750 / ZX5000), the transmitter must be switched off and mains power removed to perform safely many of the steps given below. In the case or larger model transmitters (ZX7.5 / ZX10), one PA chassis may be shut down and serviced while the other continues transmitting. Please consult the section 5.4.10 for a procedure to follow to safely service one PA chassis at a time.

Tools required:

Workshop light
Vacuum cleaner with hose & nozzle attachments
Hex key set or screwdriver set for tightening mains connections

STEP 1 While transmitter is still operating at full power, inspect all external transmission line sections for localized discolorations or “hot spots” that are warm/hot to the touch.

a. If localized heating is found, switch off transmitter, open transmission line, and inspect for loose bullets (anchor connectors), split bullets, contaminations, or other irregularities.

STEP 2 Press front panel OFF button to switch transmitter off.

STEP 3 Remove all AC mains power to transmitter, including exciter(s).

STEP 4 Take steps to ensure AC mains connection is securely locked out and inadvertent mains re-application is not possible while maintenance is being performed.

STEP 5 Open all mains access panels and inspect all mains connections for tightness, corrosion, or signs of localized burning.

STEP 6 Open transmitter front door and locate hex key in holder to right of PA modules.

STEP 7 Use hex key to open amplifier chassis rear door.

STEP 8 Verify no loose hardware has fallen to bottom of amplifier chassis over time.

STEP 9 Vacuum any dust accumulations from rear chamber of amplifier chassis.

STEP 10 Vacuum any dust accumulations from fins of output assembly. Use long vacuum cleaner attachment as necessary to gain access to heatsink fins via air input plenum on far right side behind front door.

STEP 11 Vacuum any dust accumulations from chassis fan blades and PS module fan blades.

STEP 12 Illuminate inside of transmitter rear chamber and inspect all cables for signs of cracking, abrasions, or heat discoloration.

STEP 13 Inspect all exposed PC boards for signs of heat discoloration or rings of dried solder flux, an indication of partial solder melting.

STEP 14 Inspect splitter boards for any loose, disconnected, or bent ballast loads.

STEP 15 Shine light through combiner cover (but do not remove) to inspect output assembly combiner coils for any corrosion that is crusty or pasty. It is normal for the coils to change color over time. This does not negatively impact their performance, provided it is simple oxidation and not a more aggressive corrosion due to harsh air pollution components.

STEP 16 Verify all push-on (faston) connections are fully seated on PA backplanes, PS interface board, AC mains inputs, etc.

STEP 17 Shine light through combiner support frame to deck of output assembly and inspect ballast loads for burning or cracking.

STEP 18 Close amplifier chassis rear door.

STEP 19 Return hex key to storage position.

STEP 20 If transmitter is ZX7.5 or ZX10, visually inspect 2.5kW RF load on rack cabinet rear door for signs of cracked resistors or other debris.

STEP 21 Remove AC mains lockout precautions and apply AC mains power.

STEP 22 Press front panel ON button to turn transmitter on.

STEP 23 Verify transmitter returns to full power and no alarms are reported.

STEP 24 As desired, use off-air opportunity to verify integrity of all safety interlock circuits such as station load temp sensor, patch panel position switches, coaxial switch position switches, etc.

STEP 25 As desired, use off-air opportunity to operate transmitter into station test load and verify test load integrity.

STEP 26 As desired, use off-air opportunity to verify reserve exciter and exciter switchover functionality (where applicable).

STEP 27 Note any findings and resolutions in station maintenance log.

STEP 28 Procedure complete.

5.4.10 Service one PA chassis while transmitter is on air (ZX7.5/ZX10)

Higher power ZX transmitter models are designed to be serviced without the need to switch the transmitter off completely. Individual PA chassis can be completely shut down and disassembled while others continue transmitting. This procedure describes how to safely prepare an individual PA chassis for servicing while the rest of the transmitter remains on air. It is required for any maintenance procedure involving access to the interior rear chamber of a PA chassis. All operations executed from the front face of the PA chassis, such as PA and PS module swaps, do not require any special precaution and may be performed without following this procedure first.

Tools required:

Adjustable wrench

STEP 1 Remove AC mains power from PA chassis to be serviced via corresponding circuit breakers on AC distribution chassis.

STEP 2 Remove RF drive coax cable from RF INPUT connector at rear of chassis.

STEP 3 Using adjustable wrench, loosen retaining nut and fully insert shorting bolt at RF output of PA chassis to be serviced to eliminate risk of back flow of RF energy should a transmission line arc or combiner load failure occur.

STEP 4 Access rear compartment of PA chassis as desired to perform maintenance.

STEP 5 Reverse previous steps when finished to restore PA chassis to operational condition.

STEP 6 Procedure complete.

5.4.11 Check balance by disconnecting load (ZX7.5/ZX10)

A proper phase and gain balance between PA chassis is required for efficient output combining to take place. Any imbalances result in power being directed to the 2.5 kW

load instead of the antenna output. The phase and gain balance of the ZX transmitter does not normally require adjustment in the field. This procedure provides a quick confirmation that phase and gain balance is correct. Under normal operating circumstances, virtually no power is directed to the combiner load. Therefore, it should be possible to leave the load temporarily disconnected with minimal consequences if all PAs are operational and well balanced. Any power directed to the un-terminated load port of the combiner will be reflected and show up as reverse power at the PA chassis outputs. The balance is therefore judged to be acceptable when disconnecting the combiner load results in minimal change to the PA chassis reverse power readings.

⚠ **WARNING:**
DO NOT DISCONNECT THE LOAD INPUT CABLE WHILE THE TRANSMITTER IS PRODUCING RF POWER. ELECTRIC SHOCK COULD RESULT.

This test is normally performed only in the factory, but may have some troubleshooting value in the field.

Tools required:

None

STEP 1 Record reverse power level on front panel meters of PA chassis to be checked for balance.

STEP 2 Switch transmitter off via front panel off button.

STEP 3 Open transmitter rack rear door.

STEP 4 Disconnect input coax cable from 2.5kW load.

⚠ **WARNING:**
DO NOT DISCONNECT THE LOAD INPUT CABLE WHILE THE TRANSMITTER IS PRODUCING RF POWER. ELECTRIC SHOCK COULD RESULT.

STEP 5 Secure loose cable end such that 7-16 connector inner pin is not touching any metal surfaces.

STEP 6 Close transmitter rack rear door.

STEP 7 Switch transmitter on via front panel ON button.

STEP 8 Observe amount of reverse power on PA chassis meters. If balance is correct, there will be minimal changes with load disconnected. One PA

chassis reading may increase, while others decrease, but total level remains roughly constant. If both reverse power levels increase dramatically, PA imbalance should be suspected. Perform these checks:

a. Verify both PA chassis have similar PA AMPS readings to within +/- 10 A.

b. Verify drive cables to PA chassis have not been replaced with an incorrect length cable.

STEP 9 Switch transmitter off and reconnect load input cable.

STEP 10 Procedure complete

5.5 Special Part Replacement Notes

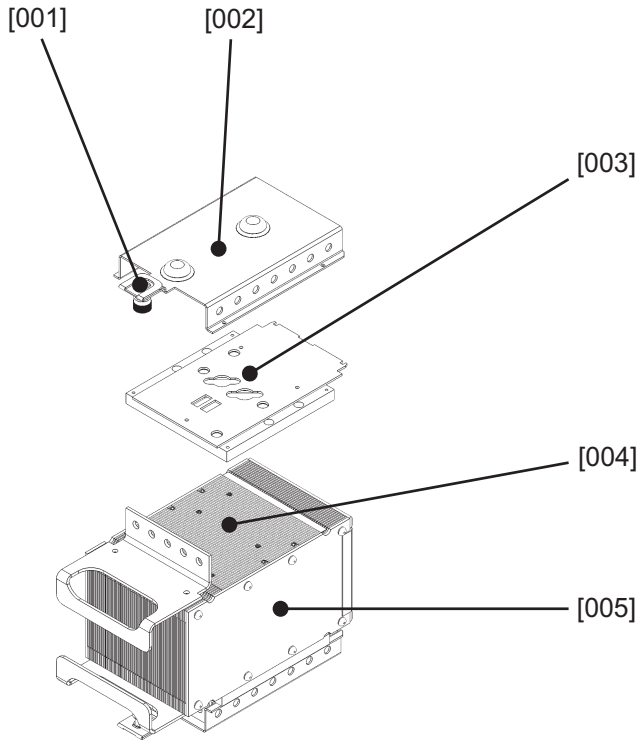
This section contains a collection of notes addressing certain aspects of the replacement of major ZX subassemblies. For additional information consult Section 1 - Introduction for aid in identifying the major subassemblies.

5.5.1 PA Module (992-9992-041G or otherwise)

- See PA module swap procedure earlier in this section.
- Verify that P/N of new module matches old module.
- Do not mix different P/N modules within same transmitter.
- No user adjustments.
- Modules are hot-pluggable; they can be removed and replaced while transmitter is in operation.
- Modules are symmetrical; they can be inserted into transmitter with either side facing up (they cannot be inserted wrong).

5.5.2 PA Amplifier Assembly (PWA, PA) (992-9992-021G or otherwise)

In the event of an RF power MOSFET failure, field replacement of a single transistor is not practical due to the cost of components, time, and test equipment involved in repair and alignment of phase, gain, and response. This is a highly critical area, and if not done correctly, improper module and transmitter operation will occur. Instead, a single amplifier board (1/2 of module) may be replaced by following the procedure given below. The piece to be replaced is illustrated by item [003] in Figure 5-3 below.



[001] Thumbscrew

[002] Amplifier cover

[003] Power amplifier assembly

[004] Mating surface (apply thermal pad or thermal compound)

[005] Aluminum heatsink

Figure 5-3 Removal of PA amplifier assembly from heatsink

If a module has failed with a persistent PA overcurrent fault, there may be uncertainty as to which half of the module has actually failed. This uncertainty can be resolved by removing both PA amplifier covers and looking for obvious cracking, burning of one or both power MOSFETs, or the general presence of a burned smell.

Tools Required:

#1 star (Phillips) screwdriver
7/64 hex key
Thermal compound Wakefield 120-8 or equivalent (404-0899-077) thermal pad
Rubber roller, razor blade, or straight-edge

STEP 1 Obtain replacement power amplifier assembly. Replacement PA board will include thick copper plate under PC board. Do not remove PC board from copper plate.

STEP 2 Remove cover of damaged power amplifier assembly.

STEP 3 Remove (only) larger countersunk screws to free copper plate from larger aluminum heatsink.

STEP 4 Apply thin, but even, coating of thermal compound to bottom of copper plate of replacement amplifier. Level with rubber roller or other straight-edge as necessary. Coverage should be complete, but so thin as to be translucent.

NOTE:
A ready-made thermal pad (404-0899-077) with the correct dimensions for the module heatsink is also available.

STEP 5 Attach replacement power amplifier assembly (copper plate) to Aluminum heatsink. Tolerance on screw holes will assure proper alignment of new PA into transmitter chassis.

STEP 6 Reattach cover.

STEP 7 Procedure complete.

When handling damaged PA modules, please observe the following warning regarding beryllium oxide:

WARNING:
THIS PRODUCT CONTAINS BERYLLIUM OXIDE. THE PRODUCT IS ENTIRELY SAFE PROVIDED THAT THE BEO DISC IS NOT DAMAGED. ALL PERSONS WHO HANDLE, USE, OR DISPOSE OF THIS PRODUCT SHOULD BE AWARE OF ITS NATURE AND OF THE NECESSARY SAFETY PRECAUTIONS. AFTER USE, DISPOSE OF AS CHEMICAL OR SPECIAL WASTE ACCORDING TO THE REGULATIONS APPLYING AT THE LOCATION OF THE USER. IT MUST NEVER BE THROWN OUT WITH THE GENERAL OR DOMESTIC WASTE.

5.5.3 PS Module (736-0445-000)

- Actuate extractor lever to begin removal from chassis.
- See PS module swap procedure earlier in this section.
- No user adjustments.
- Modules are hot-pluggable; they can be removed and replaced while transmitter is running.
- Internal fans will run for approximately five seconds after module is unplugged.
- Contact GatesAir or supply manufacturer for factory repair options.

5.5.4 Transmitter Controller PCB (901-0203-541)

- Replacement boards can come from GatesAir already tuned and tested at nominal power level for your transmitter model. Be sure to request this when ordering a replacement board.
- Match all jumper settings on old board before installing replacement.
- Adjustment of APC set point may be required. Consult power level adjustment procedure earlier in this section.
- Fine calibration of meter readings may be required. Consult meter calibration procedures earlier in this section.
- Verify that 15-pin ribbon cable to front panel multimeter is properly aligned before applying power (i.e. not one pin off). Ribbon cable connectors prior to June 2010 were not keyed and easy to misalign.

5.5.5 PA Backplane PCB (901-0203-381)

- It may be convenient to remove output assembly and/or splitter covers to improve access to these cards for removal.
- Set dipswitch address to match setting on backplane being replaced.
- No user calibrations required.
- Certain mounting screws have a shorter length. Carefully note screw locations while removing PA backplane and shield.
- Verify push-on (faston) DC connectors make snug contact upon connection. Remove connector and gently press closed with pliers if connection is loose.

5.5.6 IPA Backplane PCB (901-0203-581)

- It may be convenient to remove output assembly to improve access to this card for removal.
- Unlike PA backplane, IPA backplane has no dipswitch programming.
- No user calibrations required.

5.5.7 PS Interface PCB (901-0203-531)

- No user adjustments required.

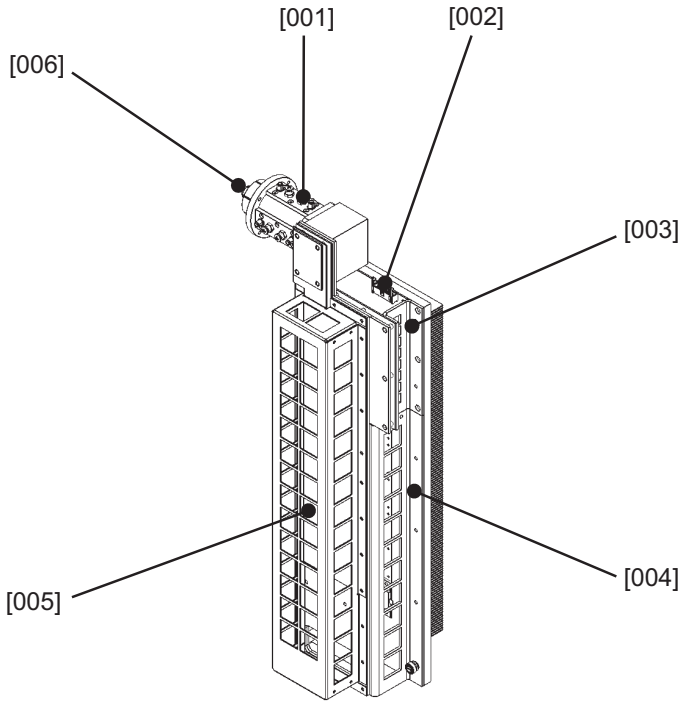
- Verify push-on (faston) DC connectors make snug contact upon connection. Remove connector and gently press closed with pliers if connection is loose.
- Note three fuses for AC MAINS LOW alarm(s). It may not be necessary to remove entire board if only fuse is blown (false AC MAINS LOW alarm).

5.5.8 RF Output Assembly (971-0023-026/027/028)

The entire output assembly lifts out of transmitter and can be replaced as a complete "module" at the user's discretion. A procedure is provided below. To facilitate assembly removal and insertion, it is possible to first remove the user interface sub-panel and support brace on the transmitter rear panel to increase the size of the access hole. However, this is not strictly required, as the output assembly can still be installed without removing these items.

Certain aspects of the output assembly can be serviced in the field, notably the combiner cables and ballast loads. Damaged ballast loads and cables are usually evident from visual inspection. If cables are replaced, make sure that cables are replaced with the exact same type (RG-142 and RG-302). Do not use RG-58, RG-59, RG-223 cable under any circumstances.

Consult Figure 5-4 and Figure 5-5 to become familiar with the major parts of the output assembly.



[001] Directional couplers for forward, reverse metering, customer RF monitor sample.

[002] 20-pin ribbon cable connection to 16X load board.

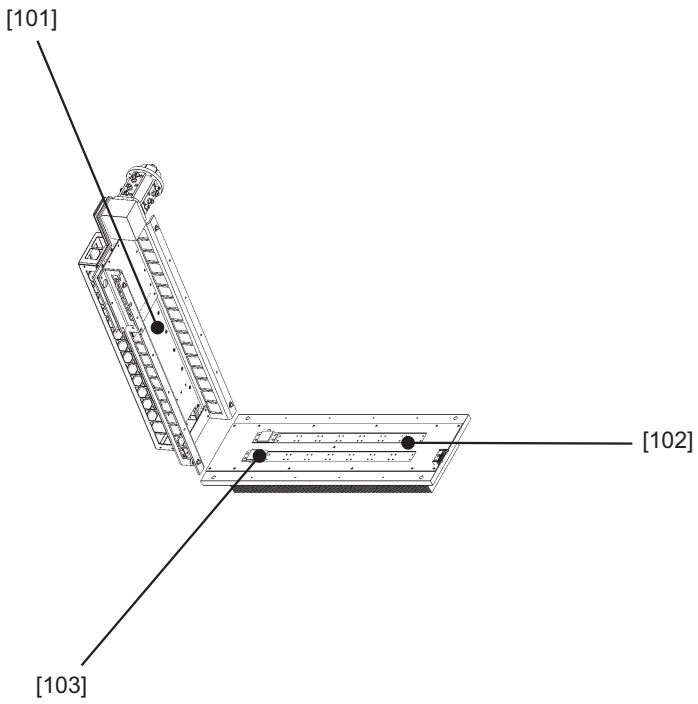
[003] Thumbscrew to secure assembly to transmitter chassis (4 places).

[004] Heatsink base with ballast loads.

[005] Combiner with harmonic filter.

[006] EIA 1-5/8 flangeless RF output.

Figure 5-4 Output assembly



[101] Combiner with combiner support frame.

[102] Heat sink base with 16X load board.

[103] Ballast load.

Figure 5-5 Output assembly opened for servicing.

Tools required:
8mm nut driver (7/16)
SMA nut driver

STEP 1 Switch transmitter off.

STEP 2 Remove AC mains power.

STEP 3 Open transmitter rear door with hex key provided behind front door.

STEP 4 Disconnect BNC coax cables from PA backplane boards to output assembly.

STEP 5 Loosed hose clamp at transmitter RF output and break transmission line.

STEP 6 Disconnect 20 pin ribbon cable to 16X load board. Connector may be found on bottom deck of assembly just behind main RF output and coupler section.

STEP 7 Disconnect mini-coax cables to forward monitor, reverse monitor, forward meter, and reverse meter coupling ports (four cables).

NOTE:
Some users prefer to leave these four cables attached until the output assembly is already outside the chassis. Excess cable length has been provided for these cables for this purpose.

STEP 8 Loosen four black thumbscrews on base of output assembly to free assembly from chassis wall.

STEP 9 Rotate outward bottom end of output assembly base.

STEP 10 Pull RF output connection back inside transmitter chassis and remove entire output assembly from transmitter.

STEP 11 Prepare chassis to accept replacement output assembly by tucking 20C ribbon up out of way e.g. up inside cable connections to PS interface board.

STEP 12 Support replacement output assembly close to transmitter entrance and attach mini-coax cables to forward monitor, reverse monitor, forward meter, and reverse meter coupling ports. If a wrench is used to tighten SMA connections, do not over-tighten. Use only minimum force required to make a snug connection.

STEP 13 Verify new output assembly has SMA loads installed where indicated on forward and reverse meter couplers. If not, transfer SMA loads from original output assembly.

STEP 14 Introduce new output assembly into transmitter at 45 degree angle with bottom of base rotated to right.

STEP 15 Insert RF output connection through rear transmitter wall and rotate output assembly bottom toward left until heatsink base lies flush against transmitter interior wall. Be careful to not crush any cables trapped beneath heatsink base.

STEP 16 Tighten four thumbscrews to attach base to chassis interior wall.

STEP 17 Attach 20C ribbon cable to 16X load board on output assemble lower deck. Look up through air holes in combiner support frame to see and align connection.

STEP 18 Connect BNC cables to PA backplane RF outputs. Ensure that yellow-labeled BNC cables are only attached to “upper” output, while white-labeled BNC cables are only attached to “lower” output on each backplane card. Consult amplifier *RF Interconnect Wiring Diagram* in accompanying drawing package for correct cable connections.

STEP 19 Dress BNC coax cables with cable ties, as desired.

STEP 20 Close transmitter rear door and secure with hex key.

STEP 21 Apply AC mains power.

STEP 22 Press front panel ON button to turn transmitter on.

STEP 23 Check forward and reverse power calibrations per procedures contained earlier in this section.

STEP 24 Procedure complete.

5.5.9 Output Assembly Ballast Load (700-1225-000)

It is easiest to check the integrity of the RF combiner loads when the output assembly is outside of the transmitter chassis. Visually inspect the loads for damage, and replace any faulty components as necessary using the procedure below. In case of doubt, the RF connection to the load may be temporarily lifted with a soldering iron and the load resistance checked with an ohmmeter. The loads should read between 48 and 52 ohms. Replace any load with a resistance value outside this range.

⚠ **WARNING:**
BEWARE OF HOT LOADS IF TRANSMITTER HAS BEEN OPERATING WITH ONE OR MORE PA MODULES REMOVED.

Tools required:
2 star (Phillips) screwdriver
soldering iron and solder
ohmmeter
thermal compound (Wakefield 120-8 or equivalent)
razor blade or other precision straight edge
replacement load P/N 700-1225-000

STEP 1 Remove screws holding combiner support frame to heatsink base.

STEP 2 Flip up combiner board to gain access to load (lower) board. See "Figure 5-5 Output assembly opened for servicing." on page 5-36.

STEP 3 Desolder tabs and remove mounting screws from damaged load.

STEP 4 Remove damaged RF load while observe Beryllium Oxide safety considerations (see warning below).

STEP 5 Apply thin, but even, coating of thermal compound to mounting flange of replacement load. Level with razor blade or other straight-edge as

necessary. Coverage should be complete, but so thin as to be translucent.

STEP 6 Press load to base and wiggle load slightly, as desired, to ensure compound fills all gaps.

STEP 7 Attach replacement load to output assembly heatsink with mounting screws.

STEP 8 Torque mounting screws to 0.9 N-m (8 in-lbs).

STEP 9 Verify load integrity with ohmmeter measurement. Load should read 50 ohms +/- 2 ohms.

STEP 10 Solder tab of replacement load to center conductor of coax cable.

STEP 11 Flip output assembly closed and attach combiner support base to heatsink.

STEP 12 Procedure complete.

When handling damaged RF loads, please observe the following warning regarding beryllium oxide:

WARNING:
THIS PRODUCT CONTAINS BERYLLIUM OXIDE. THE PRODUCT IS ENTIRELY SAFE PROVIDED THAT THE BEO CHIP IS NOT DAMAGED. ALL PERSONS WHO HANDLE, USE OR DISPOSE OF THIS PRODUCT SHOULD BE AWARE OF ITS NATURE AND OF THE NECESSARY SAFETY PRECAUTIONS. AFTER USE, DISPOSE OF AS CHEMICAL OR SPECIAL WASTE ACCORDING TO THE REGULATIONS APPLYING AT THE LOCATION OF THE USER. IT MUST NEVER BE THROWN OUT WITH THE GENERAL OR DOMESTIC WASTE.

5.5.10 RF Splitter (901-0203-511/561/571)

- No user adjustments required.
- Beware of hot loads if transmitter has been operating with one or more PA modules removed.
- Observe yellow/white phasing. Yellow-labeled cables should only connect to the “upper” and white-labeled cables to the “lower” inputs of PA backplane boards.
- In case of doubt, consult amplifier *RF Interconnect Wiring Diagram* in accompanying drawing package for proper cable connections.

5.5.11 I/O Filter PCB (901-0203-551)

- No user adjustments required.
- Be careful not to damage 34 pin headers for web remote card.
- Gain easy access to I/O PCB by removing user interface sub-panel from rear of transmitter.

5.5.12 Web Remote PCB (901-0203-391T)

- No hardware adjustment required, but significant setup required on *config.htm* web page via an Ethernet connection. Consult Appendix A for more information.
- Be careful not to misalign 34 pin headers when plugging card in to I/O PCB.

5.5.13 Fan Monitor PCB (901-0203-441)

- No user adjustments.
- Ensure jumpers in same position as previous board.

5.5.14 Cooling Fans (430-0458-000)

- Ensure finger guard is re-installed with new fan.
- Do not attempt to separate fan from door while it is rotating!
- If a quick swap is desired, entire fan door may be lifted off its hinges, removed from transmitter, and replaced with spare door assembly. A spare fan door assembly is available from GatesAir as an option.

5.5.15 Front Panel Multimeter (632-1201-000)

- Verify that 15-pin ribbon cable is properly aligned before applying power (i.e. not one pin off). Ribbon cable connectors prior to June 2010 were not keyed and are easy to misalign.
- No user adjustments. Do not adjust trimmer on back of meter!

5.5.16 AC Mains Filter (476-0528-000 or 609-0125-000)

- No user adjustments.
- Cannot be repaired in field due to high voltage potting compound inside case.

5.5.17 Front Panel Filter (943-5567-408)

- All ZX transmitters ship with spare filter media.
- Never install a wet or damp filter in transmitter.

5.5.18 2X IPA Splitter (901-0203-591)

- No user adjustments.

5.5.19 Input 3dB Attenuator (971-0023-050)

- No user adjustment.
- Apply thin layer of heatsink compound before mounting attenuator to chassis wall.

5.5.20 System Metering Assembly

- Where possible, record all valid power readings from old metering assembly and calibrate readings to same values upon installing new assembly.
- Forward and reverse meter calibration generally required. Consult calibration procedures earlier in this manual section.

5.5.21 Output Combiner (3dB Hybrid)

- No user adjustments.
- Some minor recalibration of system readings may be required due to minor differences in output couplers.

5.5.22 2.5 kW RF Load

- No user adjustments.
- Visually inspect new unit for physical integrity.
- Check input resistance with multimeter. Resistance should be between 45 ohms and 55 ohms.
- Thoroughly allow old load to cool down before attempting to replace it.

Section 6 Troubleshooting

6

Should difficulties arise with your ZX series transmitter, use the information in this section to help locate and correct the problem.

6.1 Contacting GatesAir Service

Refer to page ii for service and contact information.

To ensure you get the best assistance as quickly as possible, you should have the following items on hand before contacting GatesAir:

- Transmitter factory test data report
- Technical manual and drawing package
- A list of all current meter readings and alarm information

6.2 Troubleshooting Table

This section provides a troubleshooting table for the transmitters covered in this manual. The reader is invited to carefully study the table in its entirety -- even if the transmitter is operating without any problems at the present time. Any reader who can fully understand and visualize the rationale behind all of the entries contained here will be well prepared to diagnose and repair a problem with their transmitter, should one arise in the future.

Table 6-1 Transmitter Front Panel

Symptom	Cause and Solution
MODE LED is green	Transmitter is switched on and operating normally with no alarms being reported.
MODE LED is yellow	Transmitter is switched on but alarms are being reported. Open amplifier front door and inspect alarm LEDs on controller board (reverse side of front door). Consult entries for any reported alarms in Table 6-2.
MODE LED is red	Transmitter is switched off or is switched on but no PS modules are activated (all PA modules are off). Press front panel ON button to start transmitter. If nothing happens, open front door and inspect alarm LEDs on controller board (reverse side of front door). Consult entries for any reported alarms in Table 6-2.
Transmitter power too high or too low	Consult section on *Power Control* later in Table 6-4.
MODE led indicates incorrect mode of transmitter operation relative to exciter	Verify exciter interface cable is proper type and installed between exciter and amplifier. See Section 2 – Installation for more information on exciter interconnect cable.
Transmitter has shut down spontaneously. No front panel lights whatsoever and meter appears dead.	Possible AC mains failure. Verify AC presence by status of AC>90V light on PS modules. Reset external breaker or wait for mains power to return, as applicable. Possible all PS modules removed from transmitter. +5V logic power is supplied by each PS module (diode-OR). At least one PS module must be installed for transmitter control logic to be active. Possible grounding of +5V logic voltage. Open transmitter front door and check status of green +5V LED on controller board (reverse side of front door). Measure +5V with voltmeter as desired. If +5V missing on controller, check seating of ribbon cable to controller. If no problem found, proceed to remove AC mains power from one AC input, such that an AC FAULT LED should be lit on PS interface board. Disconnect internal ribbon cable connections one at a time until +5V is restored and AC FAULT LED lights up. For safety reasons, disconnect mains power each time amplifier rear door is opened, and reapply power once rear door is safely closed. Replace faulty board or cable causing short circuit.

Table 6-2 Controller Board Alarm LEDs

Symptom	Cause and Solution
FORWARD POWER LOW alarm	System gain or exciter drive not sufficient to achieve power level set by POWER LIMIT potentiometer. Check for other alarms that might explain inability to make full power (e.g. PA MODULE SHUTDOWN, REVERSE POWER FOLDBACK). If no other alarms are being reported, check exciter drive level against station log readings. Raise exciter power if exciter level found to be below normal as per log readings. It is normal for this alarm to be present when transmitter is switched off.
REVERSE POWER FOLDBACK alarm	Controller is reducing output power to reverse power below threshold set by POWER LIMIT - REV potentiometer. Check reverse power reading on front panel meter to confirm excessive reverse power condition. Excessive reverse power is indicative of an output transmission line impedance problem external to amplifier chassis. Inspect transmission line for localized heating or other abnormalities. Analyze transmission line and antenna with analyzer at earliest possible opportunity. If problem occurs during winter storm conditions, suspect antenna icing. Problem will resolve itself as ice melts, and power will automatically return to normal. If transmitter is ZX7.5 or larger model and maintenance has just been performed, verify that output shorting bolts have not been inadvertently left in. (bolt at output of each PA chassis / input to combiner)
RESTARTS EXCEEDED alarm	System tried to auto-restart multiple times and failed. Auto-restart occurs when transmitter is switched on but all PS modules have shut down. Transmitter sends fresh on / reset commands every five seconds until at least one PS module remains on. After thirty seconds of unsuccessful restart attempts within a thirty minute timeframe, transmitter stops trying and reports a RESTARTS EXCEEDED alarm. Alarm almost exclusively associated with arcing in output transmission line or antenna. Reduce power via POWER LOWER pushbutton on controller and press ON pushbutton to clear fault and restart transmitter. Reduce power further if arcing continues. Alarm may also occur if transmitter is switched on but all PA modules are unplugged.

Table 6-2 Controller Board Alarm LEDs

Symptom	Cause and Solution
LOW FAN SPEED alarm	One or more chassis fans have not achieved full speed. Consult individual fault LEDs on transmitter rear door to determine which fan is affected. Physical arrangement of fault LEDs on rear door mimics physical layout of fans on rear door. Possible indication that fan bearings are failing. Replace fan at earliest convenience, especially if fan is greater than five years old or is especially noisy. Note that transmitter can run for extended periods with a failed fan. If desired, swap affected fan feed cable with adjacent fan cable on fan alarm board (reverse side of rear door) and verify alarm follows fan/fan cable. If alarm stays in same position, proceed to replace fan alarm board. It is normal for this alarm to be present when transmitter is switched off. It is normal for this alarm to be reported for up to thirty seconds after transmitter start up if all fans do not start instantly.
AC MAINS LOW alarm	One or more AC inputs has voltage below 190V threshold. Inspect AC>90V lights on PS modules and/or AC FAULT LEDs on wall behind PS modules (to right) to determine which input(s) are affected. Consult component locator sticker to right of controller board for aid in locating AC FAULT LEDs in chassis. Possible open circuit breaker(s). Inspect and reset circuit breakers. Verify correct breaker sizing versus recommendations in *Outline Drawing* in accompanying drawing package. Possible open fuse or other failure of mains detection circuit on PS interface board. Each AC mains input has separate detection circuit to trigger an alarm in input falls below 190V.

Table 6-2 Controller Board Alarm LEDs

Symptom	Cause and Solution
LOAD OVERHEATED alarm	Amplifier chassis has shut down because one or more output assembly ballast loads had a temperature above 125C. Suspect incorrectly connected PA output coax cables if maintenance was just performed on transmitter. Consult *RF Interconnect Wiring Diagram* in accompanying drawing package for correct cable hookup arrangement. If cables were not modified, allow transmitter to cool down and reapply power, if alarm occurs instantly, suspect RF interference or other low level circuit failure. Repeat test with RF muted. If fault occurs, proceed to remove output assembly and troubleshoot 16X load board. Consult theory of operation in Section 4 – Theory of Operation and apply heat to thermistors with finger tips (body heat) to observe change in reported temperature readings. If problem only occurs with RF drive applied, switch transmitter off, and inspect transmitter rear chamber for a missing RF shield cover or other abnormality. If problem only occurs after a long time of operation at high power, open transmitter front door, shine light down input air plenum at far right, and inspect output assembly fins for severe obstruction. Remove debris as necessary.

Table 6-2 Controller Board Alarm LEDs

Symptom	Cause and Solution
PA MODULE SHUTDOWN alarm	One or more PA modules have shut down. This could be due to several conditions: > PA module has been removed from socket. Check module insertion. > Corresponding PS module has been removed from socket. Check module insertion. > PA REVERSE POWER alarm has been reported. Verify by checking red LEDs behind PA modules. Consult entry on this alarm in Table 6-3. > PA TEMPERATURE alarm has been reported. Verify by checking red LEDs behind PA modules. Consult entry on this alarm in Table 6-3. > PA CURRENT alarm has been reported. Verify by checking red LEDs behind PA modules. Consult entry on this alarm in Table 6-3. > DC supply cable(s) from PS module to PA backplane have come loose during shipment or transmitter maintenance. Switch transmitter off, open rear door, and inspect red & black DC cables for affected PA module. It is normal for this alarm to be present when transmitter is switched off.
RF MUTE ACTIVE alarm	Transmitter is receiving an RF mute command from either pin 8 of rear panel REMOTE CONTROL connector (ground = mute) or from FlexStar exciter while switching modes (where applicable).
INTERLOCK LOOP OPEN alarm	Transmitter external interlock open due to no connectivity between pins 2 and 3 of rear panel REMOTE CONTROL connector on single PA chassis transmitter or INTERLOCK A-B terminals of remote terminal board in larger model transmitters. Verify supplied dummy plug with jumper between pins 2 and 3 is connected to transmitter if new installation of a single PA chassis transmitter or INTERLOCK A-B pins are jumpered on larger model transmitters. If external interlock has already been connected to station load, coax switch, or patch panel, inspect these devices to determine where loop is being broken.

Table 6-3 Module Alarm LEDs

Symptom	Cause and Solution
PA REVERSE POWER alarm (left LED behind PA module)	PA module has experienced a reverse power level of >25W (peak). If only one PA has alarm, suspect failure of detection circuit on PA backplane or BNC coax cable from PA backplane to output assembly. Switch transmitter off and swap one PA cable from affected PA backplane with one from an adjacent backplane, ensuring to only swap yellow-labeled cables with other yellow-labeled cables and white-labeled cables with other white-labeled cables. Switch on transmitter and see if problem remains with original PA backplane or follows cable to new backplane. If problem remains with backplane, repeat test with second BNC cable swapped from affected backplane. If problem still remains with backplane, replace PA backplane, otherwise remove output assembly and replace faulty BNC coax cable. If all PA modules have same alarm, suspect arcing or other failure in output assembly combiner board or in output transmission line external to transmitter. Reduce power to very low level via POWER LOWER pushbutton on controller board (reverse side of front door), switch transmitter on, and slowly raise power via POWER RAISE pushbutton. Observe REV PWR W (reverse power) reading on front panel. If reading is abnormally high, problem is external to transmitter. If reading remains low until transmitter shuts down all modules suddenly, suspect arcing either internal or external to transmitter. Switch transmitter off, open rear door, and inspect output combiner with strong light for plainly visible carbon tracking or other damage. If none seen, connect transmitter directly to station test load. If problem disappears, problem is external to transmitter. If problem remains, proceed to replace output assembly. If a PA module reports this alarm when a *different* PA module is removed, this could indicate a combiner ballast load problem. Switch transmitter off, open rear door, and inspect ballast loads on bottom deck with powerful light. Remove output assembly and replace any loads with cracking, burning. Consult section 5 – Maintenance for procedures to follow.

Table 6-3 Module Alarm LEDs

Symptom	Cause and Solution
PA TEMPERATURE alarm (center LED behind PA module)	PA module has experienced a transistor flange temperature >99C. Allow module to cool, as necessary, and remove from transmitter. Inspect heat sink for significant obstruction and remove debris, as necessary. Inspect chassis fans for multiple failed units and/or a LOW FAN SPEED alarm on controller board. Replace faulty fans, as necessary. Inspect amplifier front door air filter for significant obstruction. Replace filter with clean one, as necessary. Check amplifier rear door to ensure it was not inadvertently left open. If fault occurs instantly upon transmitter switch on. Suspect faulty PA backplane or thermistor sensor on PA module. Swap affected PA module with PA module from adjacent slot. If problem follows module to new slot, replace PA module. If problem remains in same slot, replace PA backplane board.
PA CURRENT alarm (right LED behind PA module)	PA module has experienced a drain current of >22A. If all PA modules report this alarm simultaneously, problem is most likely excessive exciter drive and/or other power control misalignment. Compare exciter drive level against original factory test data report and adjust as necessary. Verify power control set per procedures in Section 5 – Maintenance. If a single PA module reports this alarm, it most likely has a shorted RF MOSFET. Swap affected PA module with PA module from adjacent slot. If problem follows module to new slot, replace PA module. If problem remains in same slot, replace PA backplane board.

Table 6-4 Power Control and Metering

Symptom	Cause and Solution
Forward output power too high	Verify automatic power control (APC) circuit has not been aligned incorrectly. Consult Section 5 – Maintenance for procedure to follow to realign APC circuit.
Forward output power too low	Check front panel STATUS LED for yellow condition. If LED is yellow, proceed to open transmitter front door and inspect alarm LEDs on controller board (reverse side of front door). Consult entries for any reported alarms elsewhere in this table. If LED is green, verify exciter is still producing power level listed in factory test data report and adjust as necessary. If exciter power is only 10%-20% low, transmitter could fall slightly out of APC control but not so much as to cause a FORWARD POWER LOW alarm and yellow STATUS LED. If exciter power is correct but transmitter power is low, consult Section 5 – Maintenance of this manual for procedure to follow to realign APC circuit.
Transmitter power drops as amplifier warms up but MODE status LED is green and no FORWARD POWER LOW alarm reported	Possible transmitter falling slightly out of APC control due to insufficient exciter power. Verify exciter is still producing power level listed in factory test data report. Adjust exciter power as necessary.
Excessive spikes in forward power level (more than +10% over full power) whenever PA or PS modules are inserted	Possible misadjustment of exciter power level and/or APC circuit. Exciter should only have sufficient power to drive transmitter to 110% of desired level. Section 5 – Maintenance of this manual for procedure to follow to realign APC circuit and exciter power level. Possible failure of input 3dB attenuator. Exciter power seems excessive because it is not attenuated by usual 3dB due to a partial failure of attenuator. Attenuators have been seen to fail in way that allows signal through without full attenuation. Remove SMA connection to attenuator and measure pin-to-pin and pin-to-ground resistance with ohmmeter. Resistance should be approx 17 ohms pin-to-pin and 150 ohms each pin-to-ground (two pins). Replace attenuator if any of these measurements are not correct.
Power has dropped to 25% in power amplfier chassis but all PS modules appear to be on (PA/(PS) ON lit)	Possible shut down of one half of IPA. Inspect IPA status LEDs though IPA heatsink fins to determine status. Consult component locator sticker to right of controller board (reverse side of front door) for aid in locating IPA status LEDs. If IPA module shut down has occurred, note any red alarm LEDs behind module and proceed to troubleshoot problem in same way as with any other PA module.

Table 6-4 Power Control and Metering

Symptom	Cause and Solution
Power has dropped to 0% but all PS modules appear to be on (PA/(PS) ON lit)	Possible shut down of both halves of IPA. Inspect IPA status LEDs though IPA heatsink fins to determine status. Consult component locator sticker to right of controller board (reverse side of front door) for aid in locating IPA status LEDs. If IPA module shut down has occurred, note any red alarm LEDs behind module and proceed to troubleshoot problem in same way as any other PA module. Possible exciter failure. Verify exciter is powered up and is producing output power. Verify exciter is not being muted by transmitter (see RF MUTE ACTIVE entry) of has internal alarm. Consult exciter manual for information on troubleshooting problem in exciter.
Individual or total PA current reading(s) on front panel meter significantly higher or lower than factory test data report	Possible misalignment of power meter calibration. PA current readings (PA AMPS) do not require calibration and therefore are much less likely to present an incorrect picture of how hard transmitter is currently working. If PA VOLTS reading still matches factory test report, then PA AMPS reading should be very close also. If readings are significantly different, consult Section 5 - Maintenance for power meter calibration procedure.
Individual PA current reading of from panel meter vary significantly (> +/- 1A)	If a single PA has a current level approximately ½ as great as other PA modules, suspect one half of module is either dead or receiving no drive power. Swap PA module with PA module from adjacent slot. If problem follows PA module to new slot, replace PA module. If problem remains in same slot, switch off transmitter, open rear door, and swap SMA drive coax cable(s) from affected PA backplane with those from an adjacent backplane, ensuring to only swap yellow-labeled cables with other yellow-labeled cables and white-labeled cables with other white-labeled cables. Switch on transmitter and see if problem remains with original PA backplane or follows cable(s) to new backplane. Replace PA backplane or replace SMA coax cable(s) as necessary. If PA modules 1-4 have significantly different current levels than PA modules 5-8, suspect a problem with IPA module or RF splitters. Swap IPA module with any other PA module and repeat measurement to see if balance has improved. If problem not resolved, switch off transmitter, open rear door, and inspect RF splitters (right wall) and/or IPA backplane and associated cables for obvious signs of damage. Replace faulty components, as necessary. If problem surfaces after replacement of a PA module, verify part number of replacement PA module matches original module. Although transmitter can accept both class C (original Z) and class AB (“IBOC”) PA modules (…with change of certain jumper settings), it cannot do so simultaneously. That is, it is not possible to “mix” module types. Modules must be all of one type or the other.

Table 6-4 Power Control and Metering

Symptom	Cause and Solution
PA AMPS reading briefly surges several seconds after transmitter is switched off, then falls to zero	This is normal. This is a false reading and may be safely ignored.
Poor metering linearity on transmitter remote control	Possible incorrect meter scale selected in remote control. Forward and reverse remote telemetry samples provided by amplifier chassis on pins 9 and 10 of REMOTE CONTROL connector are scaled in voltage, not power. User remote control system must have a “squaring” function selected for readings to track correctly. In larger model transmitters, forward and reverse power samples provided on remote terminal board ARE already squared. (proportional to power, not voltage). No squaring function is required.
Transmitter does not respond to raise / lower commands (locally or remote)	Possible transmitter has fallen out of APC control. Inspect reverse side of controller board(s) for FORWARD POWER LOW alarm LED, indicating that APC output has risen to maximum boost level but APC comparator is still not satisfied (due to module or other failure). Issue lower commands repeatedly until APC power setting falls to a level where APC lock is re-established. Verify transmitter has remote mode enabled via toggle switch(es) on reverse side of controller board(s).

Table 6-5 Transmitter Control

Symptom	Cause and Solution
No RJ-45 connectivity on transmitter rear interface panel	Possible no web remote installed. Consult factory test data or original transmitter paperwork to determine if web remote option has been fitted. Possible incorrect IP address. Consult Appendix A of this manual for specific information on web remote troubleshooting.
Persistent exciter fault on remote control	Possible incorrect setting inside exciter or optional main/alt exciter switcher. Exciter fault reported by transmitter is simply passed through from exciter and main/alt switcher via exciter interface cable. Exciter and main/alt switcher should be configured so at to present a ground / 0V on pin 6 of interface cable whenever their status is faulted. Consult separate exciter or exciter switcher manual for instructions on how to proceed. Possible emergency exciter switchover has occurred. Exciter switcher switchover fault status is mapped to appear as an exciter fault.
Transmitter does not respond to on, off, raise, or lower commands from remote control	Possible REMOTE DISABLED status. Open amplifier front door and inspect status of REMOTE ENABLED / DISABLED toggle switch on controller board (reverse side of front door). Switch should be in ENABLED position to enable remote control of the amplifier chassis.
Difficulty interfacing to remote control system	Verify correct signaling levels are being presented to transmitter on REMOTE CONTROL connections at amplifier rear panel and/or terminals of remote terminal board on larger model transmitters. METERING: transmitter outputs analog voltage 0-2V with 1K ohm source impedance. COMMANDS: user presents ground to issue command, open circuit to not issue command. Do not introduce an external voltage (+5V, +12V, etc) into these pins! STATUS: transmitter presents ground to indicate a true condition, open circuit to indicate a false condition. User connects an external voltage 0-24V with suitable pull-up resistor to limit current to 100 mA or less.
Single PA chassis does not respond to on/off commands when other PA chassis on/off buttons are pressed (ZX7.5 or higher power models only)	Possible remote mode disabled on one or more PA chassis. Open amplifier chassis front door and inspect status of REMOTE ENABLED / DISABLED toggle switch on controller board (reverse side of front door). Switch should be in ENABLED position. Possible system bus disconnected. Verify all connections of system interface bus. (HD15 cables)

Table 6-6 Signal Performance

Symptom	Cause and Solution
Poor FM audio performance (FM noise, THD, stereo separation, etc.)	Possible fault in exciter. Consult exciter manual for more information on troubleshooting problem. Amplifier has virtually no impact on transmitted signal metrics in an FM system. Switch to reserve exciter (where applicable).
Poor AM noise performance	If problem is synchronous AM noise (appears only with modulation applied), switch to reserve exciter (where applicable) to determine if problem is internal to exciter. Consult exciter manual for more information on troubleshooting problem. Verify original exciter drive cable supplied with transmitter is still in place. Occasionally, exciter drive cable length has an impact on synchronous AM noise. If problem is asynchronous AM (noise remains after all modulation is removed, including stereo pilot and subcarriers), problem could be in automatic power control system (APC). Verify power control has been aligned correctly by consulting procedures in Section 5 - Maintenance. If problem remains, check +5V test point on controller board (reverse side of amp front door) with oscilloscope for excessive ripple or other abnormality.
Poor mask compliance for HD Radio signal	Possible input overload of spectrum analyzer. Increase input attenuation to analyzer to 10dB. If sideband levels drop dramatically (>10dB), problem is distortion being generated by analyzer overload. Increase input attenuation until optimal tradeoff between sideband level and noise floor is achieved. Possible failure of RTAC system. Verify integrity of RF sample from transmitter output to RTAC input via physical inspection of cables, splitter, attenuator and via consultation of signal strength bargraph on exciter screen. Verify XMTR input to RTAC is currently connected at exciter rear panel. Verify RTAC status is not BYPASS. Possible power level change since RTAC was last updated. If RTAC is being kept in HOLD, change to ADAPT and see if compliance improves. When finished, switch back to HOLD or leave in ADAPT, as desired. If RTAC has an effect (i.e. is working) but is unable to reach goal, verify transmitter output power level is correct and meter calibration is not in error. Check PA AMPS reading (for whole transmitter and individual PA modules) on front panel meter for excessive current, possibly indicating that transmitter is being seriously overdriven. Consult procedures in Section 5 – Maintenance for information checking power meter calibration. *Note:* Do not take excessive sideband levels at the exciter output as a sign that RTAC is not working. In fact, this is generally a sign that RTAC ***is*** working, because the exciter output must be *distorted* (predistorted) to compensate for output stage nonlinearities in the amplifier.

Table 6-7 Output combining (ZX7.5 and higher power models only)

Symptom	Cause and Solution
2.5kW RF load hot	Load is intercepting RF power. This is normal if one PA chassis is switched off or PA chassis output power levels are otherwise unbalanced. If all PA chassis are switched on and indicate equal PA FWD kW power outputs on front panel meters, check for balanced PA AMPS readings as confirmation that forward power calibrations are trustworthy. Verify that all original drive cables are in place and system phasing has not changed.
High reflected power at individual PA chassis outputs but not at final system output on system metering assembly	Possible bad output combiner. Inspect output combiner for localized hot spots or other abnormalities. Remove output combiner and open/inspect for damage. Operate individual amplifier chassis directly into an RF dummy load and proceed to test / check meter calibrations as if each were a standalone transmitter. *Note:* The 2.5kW RF load may be used a dummy load for testing purposes if no other load exists on site, but only up to its 2.5kW nominal rating !
PA chassis forward power levels imbalanced, different than original test data	Possible failure of modules internal to PA amplifier chassis. Verify that all front panel status LEDs are green and no internal faults are being reported. Possible failure of 3dB input attenuator inside PA chassis. Attenuators have been seen to fail in way that allows signal through without full attenuation. Remove SMA connection to attenuator and measure pin-to-pin and pin-to-ground resistance with ohmmeter. Resistance should be approx 17 ohms pin-to-pin and 150 ohms each pin-to-ground (two pins). Replace attenuator if any of these measurements are not correct. Possible failure of drive splitter or drive cables to PA chassis. Swap drive cables and/or splitter outputs between PA chassis RF INPUT connectors and operate each PA chassis one-at-a-time to determine if both have same output power level. Do not operate both PA chassis simultaneously with drive cables swapped because excessive power will be directed to combiner load, possibly causing damage. Suspect failure of splitter or drive cables if a change in power level follows a drive cable swap. Suspect internal failure of PA if no change in power results from a drive cable swap.
Momentary dip in power lasting 1-2 seconds when a PA chassis is shut down	This is normal. Output power may temporarily dip as power control shifts between APC circuits in different chassis.

Section 7
Parts List

7

Replaceable Parts ZX5000 List Index

Replaceable Parts ZX10 List Index

For table above and in tables that follow in this section the (X) or (XX) after the table title part number is the revision level of that bill of material and is for reference only.

WARNING: Disconnect primary power prior to servicing.

7.1 ZX5000 Replaceable Parts List

Table 7-1 XMTR, ZX5000 CONFIG - 995 0035 009 (A)

GatesAir PN	Description	Qty UM	Ref Des
817 2311 030	DWG, FAMILY TREE, ZX5000	0 DWG	
952 9232 034	KIT, ZXB STANDALONE	0 EA	
952 9232 035	EXC INTERFACE CABLE KIT, ZXB TO FLEXSTAR HD	0 EA	
952 9232 036	EXC INTERFACE CABLE KIT, ZXB TO DIGIT/MICROMAX/FM ONLY	0 EA	
9710027006G	FLEXSTAR BOOST AMP	0 EA	
981 0090 006	ASSY, AMPLIFIER, ZX 5000	1 EA	
981 0090 059	ASSY, KIT, BLANK AC MAINS CONNECTORS (POWERCON 20A)	1 EA	
990 1202 002	KIT, MODULE SPARES, ZXB	0 EA	
990 1204 001	KIT, BOARD SPARES, ZX5000	0 EA	
990 1261 001	KIT, BASIC, SPARE PARTS, ZXB	0 EA	
994 9410 005	! EXCITER, DIGIT CD	0 EA	
995 0013 056	FLEXSTAR FM EXCITER (5/6 ROHS)	0 EA	
HARMICROMAXANALOG	MICROMAX EXCITER ANALOG AUDIO	0 EA	
HARMICROMAXDIGITAL	MICROMAX EXCITER DIGITAL AUDIO	0 EA	

Table 7-2 KIT, ZXB STANDALONE - 952 9232 034 (A)

GatesAir PN	Description	Qty UM	Ref Des
408 0212 000	BACKSHELL, D-SUB 15C NO-SHIELD	1 EA	
408 0216 000	BACKSHELL, D-SUB 25C NO-SHIELD	1 EA	
610 1212 000	PLUG, D 15C STRAIGHT SLDRCUP	1 EA	
610 1346 000	PLUG, D, 25 PIN, SOLDER CUP	1 EA	

Table 7-3 EXC INTERFACE CABLE KIT, ZXB TO FLEXSTAR HD - 952 9232 035 (A)

GatesAir PN	Description	Qty UM	Ref Des
256 0246 005	CABLE, DB15M/DB15M 5FT	1 EA	
556 0136 000	ATTEN, SMA, 20DB, 0.5W, 50 OHM	1 EA	
943 5567 239	ASSY, RF SAMPLE SPLITTER	1 EA	
952 9232 033	EXC INTERFACE CABLES, ZXB TO FLEXSTAR (HD & RTAC)	1 EA	

Table 7-4 EXC INTR CABLE KIT, ZXB TO DIGIT/MICROMAX/FM ONLY - 952 9232 036 (B)

GatesAir PN	Description	Qty UM	Ref Des
952 9232 032	EXC INTERFACE CABLES, ZXB TO DIGIT/MICROMAX/FM ONLY	1 EA	

Table 7-5 FLEXSTAR BOOST AMP - 9710027006G (B)

GatesAir PN	Description	Qty UM	Ref Des
250 0628 000	CABLE/ASSY, USB-A, BULKHEAD	0.5 EA	J4
250 0671 000	CORD, AC, 3C, NEMA/IEC PLUG RT ANGLE	1 EA	
346 0711 000	CARD GUIDE, 6LG, GROUNDED	2 EA	
358 3197 000	SLIDES 10 PAIR	1 PR	
396 0261 000	DISPLAY, LCD BLUE	1 EA	
398 0552 000	FUSE, CART 5X20MM 10A SLOW	2 EA	FL1F1 FL1F2
424 0012 000	GROMMET 0.250 GROOVE DIA	1 EA	
430 0192 000	FAN GUARD, 120MM WIRE-FORM	1 EA	
430 0313 000	FAN, 12V 110CFM 119MM SQ	1 EA	B1
430 0321 000	FILTER ASSY, AIR 120MM FAN	1 EA	
544 1704 000	TERM, 50-OHM SMB 1GHZ	1 EA	R1

548 2389 000	RESISTOR, 2.0 OHM 10% 114W	1 EA	R2
609 0003 000	FILTER, RFI POWER ENTRY, IEC	1 EA	FL1
610 1253 000	HDR, MALE 4C 1ROW STRAIGHT	1 EA	J11
646 0665 000	LABEL, INSPECTION	1 EA	
647 0006 000	OVERLAY FLEXSTAR BOOST AMP	1 EA	
736 0444 000	PSU 250W 24V, 5V, +15V, -15V	1 EA	A11
9010207101GT	PWA, 60W VHF PA, TESTED	1 EA	A6
9010207211G	PWA, BOOST AMP CONTROLLER	1 EA	A2
9010207221G	PWA, BOOST DISPLAY INTERFACE	1 EA	A8
917 2435 050	HANDLE, CTLR/DIGIT	2 EA	
922 1344 027	SPACER, DISPLAY	4 EA	
943 5580 030	OVERLAY PANEL FRAME, FLEXSTAR	1 EA	
943 5580 031	TOP COVER, FLEXSTAR	1 EA	
943 5580 032	DIVIDER PANEL, FLEXSTAR	1 EA	
943 5580 035	PLENUM BRACKET, P/A, FLEXSTAR	1 EA	
943 5580 036	ANGLED PLENUM BRACKET, LEFT, FLEXSTAR	1 EA	
943 5580 037	ANGLED PLENUM BRACKET, RIGHT, FLEXSTAR	1 EA	
943 5580 073	SIDE PANEL, FLEXSTAR	1 EA	
943 5580 074	COVER, POWER SUPPLY SECTION	1 EA	
943 5580 078	CHASSIS, BOOST AMP	1 EA	
952 9239 012	ASSY, CABLE FLEXSTAR BOOST AMP	1 EA	

Table 7-6 ASSY, AMPLIFIER, ZX 5000 - 981 0090 006 (E)

GatesAir PN	Description	Qty UM	Ref Des
256 0031 000	CABLE ASSY, FFC, 15C 3 LG	1 EA	
430 0292 000	FAN GUARD, 6.14 DIA.	5 EA	
430 0458 000	FAN, 48VDC 311CFM, 6 DIA	5 EA	
476 0528 000	LINE FILTER, 20AMP 250VAC 1-PH	3 EA	
609 0144 000	RECP, AC IN, 20AMP (POWERCON)	3 EA	
620 3014 000	ADAPTER, BULKHEAD SMA	2 EA	
632 1201 000	PNL MTG, DIGITAL VOLTMETER	1 EA	
646 0665 000	LABEL, INSPECTION	1 EA	
646 1353 000	NAMEPLATE, XMTR EQUIPMENT	1 EA	
736 0445 000	PSU, 48VDC 1200W 90-264VAC	8 EA	A31 A32 A33 A34 A35 A36 A37 A38
901 0203 381	PWA, FM PA BACKPLANE B	8 EA	A11 A12 A13 A14 A15 A16 A17 A18
901 0203 511	PWA, FM 8XB SPLITTER	2 EA	A4A1 A4A2
901 0203 531	PWA, FM 8X PS INTERFACE	1 EA	
901 0203 541	PWA, FM 8X CONTROLLER	1 EA	
901 0203 551	PWA, FM I/O FILTER	1 EA	A2
901 0203 581	PWA, FM IPA BACKPLANE B	1 EA	A10
901 0203 591	PWA, FM 2X IPA SPLITTER	1 EA	A8A2
917 2558 080	PATENT LABEL - FM XMTRS	1 EA	
943 5567 173	SHIELD, PA INTERFACE,	9 EA	
943 5567 406	CONTROL PANEL	1 EA	
943 5567 602	PLATE, FILTER MTG.	1 EA	
943 5567 603	PLATE, CONNECTOR MTG.	1 EA	
943 5567 642	HINGE, FAN CLOSEOUT	5 EA	
943 5567 644	PLATE, FAN CLOSEOUT	5 EA	
943 5567 775	LABEL, REAR ZX5000	1 EA	
943 5567 778	LABEL, COMPONENT LOCATOR, ZX5000 AMPLIFIER	1 EA	
952 9232 057	CABLE KIT, INTERNAL CABLES, ZX5000	1 EA	
971 0023 006	ASSY, BASIC, ZX 16RU	1 EA	
971 0023 028	ASSY, FM 16X OUTPUT ASSEMBLY	1 EA	A5

971 0023 050	ASSY, FM 3DB ATTENUATOR	1 EA	A8A1
988 2595 001	DP, ZX5000 TRANSMITTER	0 EA	
9929992041G	MODULE, DUAL PA, IBOC	9 EA	A20 A21 A22 A23 A24 A25 A26 A27 A28

Table 7-7 ASSY, BASIC, ZX 16RU - 971 0023 006 (B)

GatesAir PN	Description	Qty UM	Ref Des
358 2589 000	MOUNT, RIBBON CABLE, 2”	5 EA	
358 2598 000	CABLE TIE MOUNT, 4-WAY	3 EA	
358 2628 000	CABLE PUSH MOUNT	4 EA	
358 3734 000	SCREWLOCK KIT, DSUB 4-40 HEX	3 EA	
402 0220 000	CLIP, FUSE 13/32 DIA, SOLDER	2 EA	
408 0397 000	GASKET,EMI,11.8MM X 10.7MM, V	143 IN	
448 1033 000	HINGE, CONCEALED	2 EA	
448 1128 000	LATCH, COMPRESSION	1 EA	
448 1149 000	LATCH, FLUSH MOUNT, BLACK	1 EA	
464 0357 000	HEX KEY, 5/16 , ’T’ HANDLE	1 EA	
620 0455 000	ADAPTER, BNC JACK-JACK	1 EA	
822 0922 075	DOOR HINGE PIN	2 EA	
901 0203 441	PWA, 5X FAN MONITOR	1 EA	
943 5567 139	SLIDE, MODULE	6 EA	
943 5567 140	SLIDE, MIDDLE, MODULE	6 EA	
943 5567 376	BASE, PS FRAME	1 EA	
943 5567 377	TOP, PS FRAME	1 EA	
943 5567 378	DIVIDER, PS FRAME	7 EA	
943 5567 379	LEFT SIDE, PS FRAME	1 EA	
943 5567 380	RIGHT SIDE, PS FRAME	1 EA	
943 5567 381	BASE PLATE, PS FRAME	1 EA	
943 5567 400	FRAME, FRONT PANEL	1 EA	
943 5567 401	FRONT PANEL	1 EA	
943 5567 402	PANEL, FRONT DOOR	1 EA	
943 5567 403	SHIELD, FRONT DOOR	1 EA	
943 5567 404	FILTER DOOR	1 EA	
943 5567 405	ANGLE, DOOR MTG.	2 EA	
943 5567 408	FILTER	2 EA	
943 5567 409	STRIKE PLATE, DOOR LATCH	1 EA	
943 5567 421	BULKHEAD	1 EA	
943 5567 422	BASE, PA FRAME	1 EA	
943 5567 423	SHELF, PA FRAME	2 EA	
943 5567 424	TOP, PA FRAME	1 EA	
943 5567 425	PLATE, SHELF	2 EA	
943 5567 426	CHASSIS	1 EA	
943 5567 427	SIDE PANEL, RIGHT	1 EA	
943 5567 428	SIDE PANEL, LEFT	1 EA	
943 5567 429	PLATE, CLOSEOUT	1 EA	
943 5567 465	PANEL, AIR DUCT	1 EA	
943 5567 466	TOP PLATE, AIR DUCT	1 EA	
943 5567 467	BOTTOM PLATE, AIR DUCT	1 EA	
943 5567 468	PLATE, REAR FILLER	1 EA	
943 5567 469	ANGLE, REAR FILLER	1 EA	
943 5567 470	PLATE, OUTPUT CONNECTOR	1 EA	
943 5567 471	ANGLE, REAR DOOR SUPPORT	2 EA	
943 5567 472	ANGLE, DOOR MTG.	2 EA	
943 5567 473	FRAME, REAR DOOR	1 EA	
943 5567 474	PANEL, REAR DOOR	1 EA	
943 5567 519	PLATE, SPRING MTG.	1 EA	

943 5567 531	SPRING, PS FRAME	1 EA	
943 5567 542	LABEL, HOT MODULE	1 EA	

Table 7-8 ASSY, FM 16X OUTPUT ASSEMBLY - 971 0023 028 (C)

GatesAir PN	Description	Qty UM	Ref Des
275-252-000	TERM, 50 OHM, SMA PLUG 1 WATT	3 EA	
300 2819 000	SCR, THUMB 6-32 X 1/2	1 EA	
303 4203 008	SCREW MACH M3-0.5 X 8	12 EA	
303 4203 010	SCREW MACH M3-0.5 X 10	6 EA	
308 0009 000	.25 FLAT WASHER BRS	3 EA	
354 0039 000	SOLDER LUG, FLAT, #6 CL HOLE	16 EA	
358 0473 000	HOSE CLAMP, SST, SAE-28	1 EA	
646 0665 000	LABEL, INSPECTION	1 EA	
700 1225 000	TERMINATION 50 OHM 800W FLANGED	16 EA	
801 0203 283	PWB, 16X COMBINER JUNCTION	1 EA	A5A2
801 0203 293	PWB, 16X COMBINER ANCHOR	1 EA	
801 0203 523	PWB, FM 16X COMBINER	1 EA	A5A1
901 0203 321	PWA, 16X LOAD	1 EA	A5A3
917 2142 027	CONNECTOR, MOD 1-5/8 EIA	1 EA	
917 2435 033	INSULATOR, 10KW COMB 1-5/8	3 EA	
943 5567 464	HEATSINK	1 EA	
943 5567 582	PLATE, BACKING	1 EA	
943 5567 627	BASE, COMBINER	1 EA	
943 5567 628	SPACER PLATE	1 EA	
943 5567 629	CLOSEOUT PLATE	1 EA	
943 5567 630	SHIELD, COMBINER	1 EA	
943 5567 632	COVER PLATE	1 EA	
943 5567 636	HOUSING, COMBINER OUTPUT	1 EA	
943 5567 637	INNER CONDUCTOR	1 EA	
943 5567 638	SPACER, OUTPUT	1 EA	
943 5567 771	COIL 1, FM 16X COMBINER	1 EA	
943 5567 772	COIL 2, FM 16X COMBINER	1 EA	
943 5567 773	COIL 3, FM 16X COMBINER	1 EA	
943 5567 774	COIL 4, FM 16X COMBINER	1 EA	
943 5567 787	LABEL, COUPLER LABELS KIT	1 EA	
943 5567 864	BODY, COUPLER	1 EA	
943 5567 865	CLOSEOUT PLATE	1 EA	
943 5603 041	ASSY, LBAND COUPLER PLATE	3 EA	
943 5603 055	SPACER, 030 LBAND COUPLER	3 EA	
952 9232 058	CABLE KIT, FM 16X OUTPUT ASSEMBLY	1 EA	

Table 7-9 DP, ZX5000 TRANSMITTER - 988 2595 001 (A)

GatesAir PN	Description	Qty UM	Ref Des
888 2595 001	TM, ZX FM TRANSMITTERS, B SERIES	1 DWG	
917 2323 044	DWG PKG, ZX5000	1 EA	

Table 7-10 MODULE, DUAL PA, IBOC - 9929992041G (A)

GatesAir PN	Description	Qty UM	Ref Des
302 0051 000	SCR, 4-40 X 3/16	8 EA	
302 0105 000	SCR, 6-32 X 5/16	4 EA	
302 0411 000	SCR, 6-32 X 3/8	16 EA	
314 0003 000	WASHER, SPLIT-LOCK 4	8 EA	
314 0005 000	WASHER, SPLIT-LOCK 6	20 EA	
357 0128 000	BUTTON, GLIDE, NYLON, 0.75 DIA	4 EA	
404 0899 007	PAD, THERMAL INTERFACE	2 EA	

448 1081 000	GASKET, EMI/RFI SHIELDING	0.5 FT	
448 1082 000	GASKET, EMI/RFI SHIELDING,	0.75 FT	
646 0665 000	LABEL, INSPECTION	1 EA	
922 1260 178	SHIELD, PA	2 EA	
939 8168 057	HANDLE, MODULE	2 EA	
943 5467 004	ASSY, MODULE HEATSINK	1 EA	
9929992021G	PWA, PA, IBOC	2 EA	A1,A2

Table 7-11 KIT, MODULE SPARES, ZXB - 990 1202 002 (A)

GatesAir PN	Description	Qty UM	Ref Des
736 0445 000	PSU, 48VDC 1200W 90-264VAC	1 EA	
9929992041G	MODULE, DUAL PA, IBOC	1 EA	

Table 7-12 KIT, BOARD SPARES, ZX5000 - 990 1204 001 (B)

GatesAir PN	Description	Qty UM	Ref Des
632 1201 000	PNL MTG, DIGITAL VOLTMETER	1 EA	
901 0203 381	PWA, FM PA BACKPLANE B	1 EA	
901 0203 441	PWA, 5X FAN MONITOR	1 EA	
901 0203 511	PWA, FM 8XB SPLITTER	1 EA	
901 0203 531	PWA, FM 8X PS INTERFACE	1 EA	
901 0203 541	PWA, FM 8X CONTROLLER	1 EA	
901 0203 551	PWA, FM I/O FILTER	1 EA	
901 0203 581	PWA, FM IPA BACKPLANE B	1 EA	
901 0203 591	PWA, FM 2X IPA SPLITTER	1 EA	

Table 7-13 KIT, BASIC, SPARE PARTS, ZXB - 990 1261 001 (A)

GatesAir PN	Description	Qty UM	Ref Des
385 0059 000	RECTIFIER, BRIDGE, DF10S, ESD	1 EA	
398 0495 000	FUSE, CART 5X20MM 0.2A SLOW	5 EA	
430 0458 000	FAN, 48VDC 311CFM, 6 DIA	1 EA	
464 0357 000	HEX KEY, 5/16 , 'T' HANDLE	1 EA	
556 0101 000	ATTENUATOR, 3.00DB, 150W,	1 EA	
559 0055 000	THERMISTOR, 50K OHM 5% 1206	2 EA	
604 1111 000	SW PB GRAY MOM W/O LED	1 EA	
604 1119 000	SW PB RED MOM W/O LED	1 EA	
604 1152 000	SW PB GRN MOM W/O LED	1 EA	
620 2633 000	TERMINATION SMA MALE	1 EA	
700 1225 000	TERMINATION 50 OHM 800W FLANGED	1 EA	
943 5567 408	FILTER	2 EA	

7.2 ZX10 Replaceable Parts List

Table 7-14 *!XMTR, ZX10 CONFIG - 995 0035 013 (A P)

GatesAir PN	Description	Qty UM	Ref Des
939 8221 031	PNL, 19.0X1.718X0.125 HF142	0 EA	
939 8221 032	PNL, 19.0X3.468X0.125 HF142	0 EA	
939 8221 033	PNL, 19.0X5.218X0.125 HF142	0 EA	
952 9232 043	CABINET CABLES, ZX7.5/ZX10, DUAL HD EXCITERS	0 EA	
952 9232 044	CABINET CABLES, ZX7.5/ZX10, SINGLE HD EXCITER	0 EA	
952 9232 045	CABINET CABLES, ZX7.5/ZX10, DUAL FM EXCITERS	0 EA	
952 9232 046	CABINET CABLES, ZX7.5/ZX10, SINGLE FM EXCITER	0 EA	
952 9232 171	CABLE ASSY, AC MAINS	6 EA	AC1 AC2 AC3 AC4 AC5 AC6
9710027006G	FLEXSTAR BOOST AMP	0 EA	
981 0090 006	ASSY, AMPLIFIER, ZX 5000	2 EA	
981 0090 091	KIT, ZXB WEB REMOTE OPTION	0 EA	
981 0090 097	XMTR, BASIC, ZX10 (ZX7.5)	1 EA	
981 0090 110	ASSY, AC DIST. ZX10, 1PH	0 EA	
981 0090 111	ASSY, AC DIST. ZX10, 3PH, WYE	0 EA	
981 0090 112	ASSY, AC DIST. ZX10, 3PH, DELTA	0 EA	
981 0193 001	M/A SWITCHER	0 EA	
988 2595 004	DP, ZX10 TRANSMITTER	1 EA	
990 1202 002	*KIT, MODULE SPARES, ZXB	0 EA	
994 9410 005	! EXCITER, DIGIT CD	0 EA	
995 0013 056	FLEXSTAR FM EXCITER (5/6 ROHS)	0 EA	
HARMICROMAXANALOG	MICROMAX EXCITER ANALOG AUDIO	0 EA	
HARMICROMAXDIGITAL	MICROMAX EXCITER DIGITAL AUDIO	0 EA	

Table 7-15 FLEXSTAR BOOST AMP - 9710027006G (B 5)

GatesAir PN	Description	Qty UM	Ref Des
250 0628 000	CABLE/ASSY, USB-A, BULKHEAD	0.5 EA	J4
250 0671 000	CORD, AC, 3C, NEMA/IEC PLUG RT ANGLE	1 EA	
346 0711 000	CARD GUIDE, 6LG, GROUNDED	2 EA	
358 3197 000	SLIDES 10 PAIR	1 PR	
396 0261 000	DISPLAY, LCD BLUE	1 EA	
398 0552 000	FUSE, CART 5X20MM 10A SLOW	2 EA	FL1F1 FL1F2
424 0012 000	GROMMET 0.250 GROOVE DIA	1 EA	
430 0192 000	FAN GUARD, 120MM WIRE-FORM	1 EA	
430 0313 000	FAN, 12V 110CFM 119MM SQ	1 EA	B1
430 0321 000	FILTER ASSY, AIR 120MM FAN	1 EA	
544 1704 000	TERM, 50-OHM SMB 1GHZ	1 EA	R1
548 2389 000	RESISTOR, 2.0 OHM 10% 114W	1 EA	R2
609 0003 000	FILTER, RFI POWER ENTRY, IEC	1 EA	FL1
610 1253 000	HDR, MALE 4C 1ROW STRAIGHT	1 EA	J11
646 0665 000	LABEL, INSPECTION	1 EA	
647 0006 000	OVERLAY FLEXSTAR BOOST AMP	1 EA	
736 0444 000	PSU 250W 24V, 5V, +15V, -15V	1 EA	A11
843 5580 082	WIRING DIAGRAM FLEXSTAR BOOST AMP	0 DWG	
9010207101GT	PWA, 60W VHF PA, TESTED	1 EA	A6
9010207211G	PWA, BOOST AMP CONTROLLER	1 EA	A2
9010207221G	PWA, BOOST DISPLAY INTERFACE	1 EA	A8
917 2435 050	HANDLE, CTLR/DIGIT	2 EA	

922 1344 027	SPACER, DISPLAY	4 EA	
943 5580 030	OVERLAY PANEL FRAME, FLEXSTAR	1 EA	
943 5580 031	TOP COVER, FLEXSTAR	1 EA	
943 5580 032	DIVIDER PANEL, FLEXSTAR	1 EA	
943 5580 035	PLENUM BRACKET, P/A, FLEXSTAR	1 EA	
943 5580 036	ANGLED PLENUM BRACKET, LEFT, FLEXSTAR	1 EA	
943 5580 037	ANGLED PLENUM BRACKET, RIGHT, FLEXSTAR	1 EA	
943 5580 073	SIDE PANEL, FLEXSTAR	1 EA	
943 5580 074	COVER, POWER SUPPLY SECTION	1 EA	
943 5580 078	CHASSIS, BOOST AMP	1 EA	
952 9239 012	ASSY, CABLE FLEXSTAR BOOST AMP	1 EA	

Table 7-16 ASSY, AMPLIFIER, ZX 5000 - 981 0090 006 (J P)

GatesAir PN	Description	Qty UM	Ref Des
414 0344 000	CORE, EMI SUPRESSION, 0.275 ID	4 EA	
430 0292 000	FAN GUARD, 6.14 DIA.	5 EA	
430 0458 000	FAN, 48VDC 311CFM, 6 DIA	5 EA	
476 0528 000	*LINE FILTER, 20AMP 250VAC 1-PH	3 EA	
609 0144 000	RECP, AC IN, 20AMP (POWERCON)	3 EA	
646 0665 000	LABEL, INSPECTION	1 EA	
646 1353 000	NAMEPLATE, XMTR EQUIPMENT	1 EA	
736 0445 000	PSU (SW) 48VDC 1200W 90-264VAC	8 EA	A31 A32 A33 A34 A35 A36 A37 A38
839 8464 081	WIRING DIAGRAM, AC-DC INTERCONNECT, ZX5000 AMPLIFIER	0 DWG	
839 8464 082	WIRING DIAGRAM, RF INTERCONNECT, ZX5000 AMPLIFIER	0 DWG	
901 0203 381	PWA, FM PA BACKPLANE B	8 EA	A11 A12 A13 A14 A15 A16 A17 A18
901 0203 511	PWA, FM 8XB SPLITTER	2 EA	A4A1 A4A2
917 2558 080	PATENT LABEL - FM XMTRS	1 EA	
943 5567 173	SHIELD, PA INTERFACE,	9 EA	
943 5567 602	PLATE, FILTER MTG.	1 EA	
943 5567 603	PLATE, CONNECTOR MTG.	1 EA	
943 5567 642	HINGE, FAN CLOSEOUT	5 EA	
943 5567 643	PIN RETAINER , HINGE	5 EA	
943 5567 644	PLATE, FAN CLOSEOUT	5 EA	
943 5567 775	LABEL, REAR ZX5000	1 EA	
943 5567 778	LABEL, COMPONENT LOCATOR, ZX5000 AMPLIFIER	1 EA	
952 9232 057	CABLE KIT, INTERNAL CABLES, ZX5000	1 EA	
971 0023 006	ASSY, BASIC, ZX 16RU	1 EA	
971 0023 028	ASSY, FM 16X OUTPUT ASSEMBLY	1 EA	A5
9929992041G	MODULE, DUAL PA, IBOC	9 EA	A20 A21 A22 A23 A24 A25 A26 A27 A28

Table 7-17 ASSY, BASIC, ZX 16RU - 971 0023 006 (F P)

GatesAir PN	Description	Qty UM	Ref Des
256 0031 000	CABLE ASSY, FFC, 15C 3 LG	1 EA	
357 0127 000	RAIL, GUIDE/SLIDE (CUSTOM)	18 EA	
358 2589 000	MOUNT, RIBBON CABLE, 2"	5 EA	
358 2598 000	CABLE TIE MOUNT, 4-WAY	3 EA	
358 2628 000	CABLE PUSH MOUNT	4 EA	
358 3734 000	SCREWLOCK KIT, DSUB 4-40 HEX	3 EA	
402 0220 000	CLIP, FUSE 13/32 DIA, SOLDER	2 EA	
408 0397 000	GASKET,EMI,11.8MM X 10.7MM, V	83 IN	
408 0568 000	GASKET, RFI, D-PROFILE, PRE-CUT	1 EA	

448 1033 000	HINGE, CONCEALED	2 EA
448 1128 000	LATCH, COMPRESSION	1 EA
448 1149 000	LATCH, FLUSH MOUNT, BLACK	1 EA
464 0357 000	HEX KEY, 5/16 , 'T' HANDLE	1 EA
610 1068 000	KEYING PLUG	2 EA
620 0455 000	ADAPTER, BNC JACK-JACK	1 EA
620 3014 000	ADAPTER, BULKHEAD SMA	2 EA
632 1201 000	PNL MTG, DIGITAL VOLTMETER	1 EA
822 0922 075	DOOR HINGE PIN	2 EA
901 0203 441	PWA, 5X FAN MONITOR	1 EA
901 0203 531	PWA, FM 8X PS INTERFACE	1 EA
901 0203 541	PWA, FM 8X CONTROLLER	1 EA
901 0203 551	PWA, FM I/O FILTER	1 EA
901 0203 581	PWA, FM IPA BACKPLANE B	1 EA
901 0203 591	PWA, FM 2X IPA SPLITTER	1 EA
917 2558 080	PATENT LABEL - FM XMTRS	1 EA
943 5567 376	BASE, PS FRAME	1 EA
943 5567 377	TOP, PS FRAME	1 EA
943 5567 378	DIVIDER, PS FRAME	7 EA
943 5567 379	LEFT SIDE, PS FRAME	1 EA
943 5567 380	RIGHT SIDE, PS FRAME	1 EA
943 5567 381	BASE PLATE, PS FRAME	1 EA
943 5567 400	FRAME, FRONT PANEL	1 EA
943 5567 401	FRONT PANEL	1 EA
943 5567 402	PANEL, FRONT DOOR	1 EA
943 5567 403	SHIELD, FRONT DOOR	1 EA
943 5567 404	FILTER DOOR	1 EA
943 5567 405	ANGLE, DOOR MTG.	2 EA
943 5567 406	CONTROL PANEL	1 EA
943 5567 408	FILTER	2 EA
943 5567 409	STRIKE PLATE, DOOR LATCH	1 EA
943 5567 421	BULKHEAD	1 EA
943 5567 422	BASE, PA FRAME	1 EA
943 5567 423	SHELF, PA FRAME	2 EA
943 5567 424	TOP, PA FRAME	1 EA
943 5567 425	PLATE, SHELF	2 EA
943 5567 426	CHASSIS	1 EA
943 5567 427	SIDE PANEL, RIGHT	1 EA
943 5567 428	SIDE PANEL, LEFT	1 EA
943 5567 429	PLATE, CLOSEOUT	1 EA
943 5567 465	PANEL, AIR DUCT	1 EA
943 5567 466	TOP PLATE, AIR DUCT	1 EA
943 5567 467	BOTTOM PLATE, AIR DUCT	1 EA
943 5567 468	PLATE, REAR FILLER	1 EA
943 5567 469	ANGLE, REAR FILLER	1 EA
943 5567 471	ANGLE, REAR DOOR SUPPORT	2 EA
943 5567 472	ANGLE, DOOR MTG.	2 EA
943 5567 473	FRAME, REAR DOOR	1 EA
943 5567 474	PANEL, REAR DOOR	1 EA
943 5567 519	PLATE, SPRING MTG.	1 EA
943 5567 531	SPRING, PS FRAME	1 EA
943 5567 542	LABEL, HOT MODULE	1 EA
943 5567 807	PANEL, I/O	1 EA
971 0023 050	ASSY, FM 3DB ATTENUATOR	1 EA

Table 7-18 ASSY, FM 16X OUTPUT ASSEMBLY - 971 0023 028 (C P)

GatesAir PN	Description	Qty UM	Ref Des
10	B/M NOTE:	0 DWG	
275-252-000	TERM, 50 OHM, SMA PLUG 1 WATT	3 EA	
300 2819 000	SCR, THUMB 6-32 X 1/2	1 EA	
303 4203 008	SCREW MACH M3-0.5 X 8	12 EA	
303 4203 010	SCREW MACH M3-0.5 X 10	6 EA	
308 0009 000	WASHER, FLAT 1/4 BRASS (ANSI REGULAR)	3 EA	
354 0039 000	SOLDER LUG, FLAT, #6 CL HOLE	16 EA	
357 0037 000	SCREW 6-32 X .25 BHMS	0 EA	
358 0473 000	HOSE CLAMP, SST, SAE-28	1 EA	
646 0665 000	LABEL, INSPECTION	1 EA	
700 1225 000	TERMINATION 50 OHM 800W FLANGED	16 EA	
801 0203 283	PWB, 16X COMBINER JUNCTION	1 EA	A5A2
801 0203 293	PWB, 16X COMBINER ANCHOR	1 EA	
801 0203 523	PWB, FM 16X COMBINER	1 EA	A5A1
817 2350 086	TEST SPEC, ZX RF SUBASSEMBLIES	0 DWG	
839 8464 080	SCH, FM 16X OUTPUT ASSEMBLY	0 DWG	
901 0203 321	PWA, 16X LOAD	1 EA	A5A3
917 2142 027	CONNECTOR, MOD 1-5/8 EIA	1 EA	
917 2435 033	INSULATOR, 10KW COMB 1-5/8	3 EA	
943 5567 464	HEATSINK	1 EA	
943 5567 582	PLATE, BACKING	1 EA	
943 5567 627	BASE, COMBINER	1 EA	
943 5567 628	SPACER PLATE	1 EA	
943 5567 629	CLOSEOUT PLATE	1 EA	
943 5567 630	SHIELD, COMBINER	1 EA	
943 5567 632	COVER PLATE	1 EA	
943 5567 636	HOUSING, COMBINER OUTPUT	1 EA	
943 5567 637	INNER CONDUCTOR	1 EA	
943 5567 638	SPACER, OUTPUT	1 EA	
943 5567 771	COIL 1, FM 16X COMBINER	1 EA	
943 5567 772	COIL 2, FM 16X COMBINER	1 EA	
943 5567 773	COIL 3, FM 16X COMBINER	1 EA	
943 5567 774	COIL 4, FM 16X COMBINER	1 EA	
943 5567 787	LABEL, COUPLER LABELS KIT	1 EA	
943 5567 864	BODY, COUPLER	1 EA	
943 5567 865	CLOSEOUT PLATE	1 EA	
943 5603 041	ASSY, LBAND COUPLER PLATE	3 EA	
943 5603 055	SPACER, 030 LBAND COUPLER	3 EA	
952 9232 058	CABLE KIT, FM 16X OUTPUT ASSEMBLY	1 EA	

Table 7-19 MODULE, DUAL PA, IBOC - 9929992041G (B 5)

GatesAir PN	Description	Qty UM	Ref Des
302 0051 000	SCREW, PHMS 4-40 X 3/16 SST	8 EA	
302 0411 000	SCR, 6-32 X 3/8	16 EA	
314 0003 000	LOCKWASHER, SPLIT #4 SST (ANSI)	8 EA	
314 0005 000	LOCKWASHER, SPLIT #6 SST (ANSI)	16 EA	
357 0128 000	BUTTON, GLIDE, NYLON, 0.75 DIA	4 EA	
404 0899 007	PAD, THERMAL INTERFACE	2 EA	
448 1081 000	GASKET, EMI/RFI SHIELDING	1.25 FT	
646 0665 000	LABEL, INSPECTION	1 EA	
943 5567 766	ASSY, STACKED FIN HEATSINK	1 EA	
943 5567 888	SHIELD, PA	2 EA	
9929992021G	PWA, PA, IBOC	2 EA	A1 A2

Table 7-20 XMTR, BASIC, ZX10 (ZX7.5) - 981 0090 097 (D P)

GatesAir PN	Description	Qty UM	Ref Des
358 1866 000	BUMPER, MOLDED	2 EA	
358 3976 000	BOLT, EYE, 1/2-13 X1, ZINC PLATE	2 EA	
448 0957 000	HINGE DOOR POSITIONING	2 EA	
448 1149 000	LATCH, FLUSH MOUNT, BLACK	1 EA	
620 0276 000	ADAPTER 1-5/8 IN.	1 EA	
646 1252 000	LABEL CAUTION HOT SURFACE	1 EA	
700 1412 000	TERMINATION, 30 WATT HIGH PWR	1 EA	
901 0203 781	PWA, 5X DB15 DIVIDER	1 EA	
901 0203 791	PWA, 5X HD15 DIVIDER	1 EA	
939 8016 076	OUTER COND, 1-5/8 22.0LG	1 EA	
939 8017 076	INNER CND,1-5/8 21.125LG	1 EA	
939 8222 021	BAR, GROUNDING	1 EA	
943 5567 556	WELDMENT, RACK CABINET	1 EA	
943 5567 561	ASSY., REAR DOOR	1 EA	
943 5567 562	RAIL, RACK CABINET	4 EA	
943 5567 564	PLATE, CLOSEOUT	1 EA	
943 5567 577	ANGLE, SUPPORT	4 EA	
943 5567 984	PANEL, COMPONENT MTG.	1 EA	
943 5567 985	TOP PLATE, RACK CABINET	1 EA	
943 5567 986	PANEL, EXHAUST AIR	2 EA	
943 5568 008	LABEL, ZX CABINET WARNINGS	1 EA	
943 5568 011	LABEL, ZX10 SYSTEM LABELS KIT	1 EA	
943 5607 001	BRACKET, 30W LOAD	1 EA	
971 0023 179	EXHAUST AIR CLOSEOUT COMPARTMENT	1 EA	
971 0023 180	FM 2X CABINET COMBINER	1 EA	
981 0090 070	ASSY, ZX SYS METERING	1 EA	
981 0090 093	ASSY, 2.5KW RF LOAD	1 EA	
992 7285 243	SIDE PANEL KIT, PLAT, 36	1 EA	
992 9944 001	HYBRID, 700W	1 EA	

Table 7-21 DP, ZX10 TRANSMITTER - 988 2595 004 (A P)

GatesAir PN	Description	Qty UM	Ref Des
888 2595 001	TM, ZX FM TRANSMITTERS, B SERIES	1 DWG	
917 2323 048	*DWG PKG, ZX10	1 EA	

Table 7-22 *KIT, MODULE SPARES, ZXB - 990 1202 002 (A P)

GatesAir PN	Description	Qty UM	Ref Des
736 0445 000	PSU (SW) 48VDC 1200W 90-264VAC	1 EA	
9929992041G	MODULE, DUAL PA, IBOC	1 EA	

Appendix A - FM Web Remote Option

A

A.1 Introduction

This appendix provides information on the GatesAir FM Web Remote, a purchase option for the ZX series of FM transmitters. The information is organized in a structure that mirrors the larger transmitter manual: there are subsections addressing the following topics:

1. Introduction
2. Installation
3. Operation
4. Theory of Operation
5. Maintenance
6. Troubleshooting
7. USB Flash Drive

A.1.1 General Product Description

The FM Web Remote provides extended metering and control of the ZX series of FM transmitters via a standard web browser and Ethernet/IP connection. This allows the transmitter to be monitored and controlled anywhere in the world via the Internet, including in a mobile environment via handheld Internet appliances and smart phones. The serial IP data stream used to update the main web page may also be used by custom web pages created by the user or a third-party remote control system, when properly programmed to communicate with the correct protocol. Three levels of password protection are provided: "guest" (monitor only), "operator" (monitor and commands), and "expert" (access configuration settings). As of this printing, the web remote has been tested to be compatible with the following popular browsers: Internet Explorer, Firefox, Opera, Safari, Chrome.

In addition to webpage-based control, the web remote also responds to SNMP v1 GET and SET commands. It can be set to send a generic trap and/or e-mail notification when a user-adjusted low power alarm threshold is passed.

The physical implementation of the web remote is a 76mm x 102mm PC board that plugs into the transmitter I/O board via a pair of 34-pin headers. It receives its power from the I/O board and consumes approximately 150mA at 4V to 5V DC. See Figure A-1 for a photo of the web remote installed on the I/O board.

The web remote provides monitoring and control not only for the amplifier chassis but also the GatesAir Flexstar Main/Alt Controller (981-0193-001) and ZX System Metering Panel (981-0090-070) via the normal D-sub connections to these units, when present.

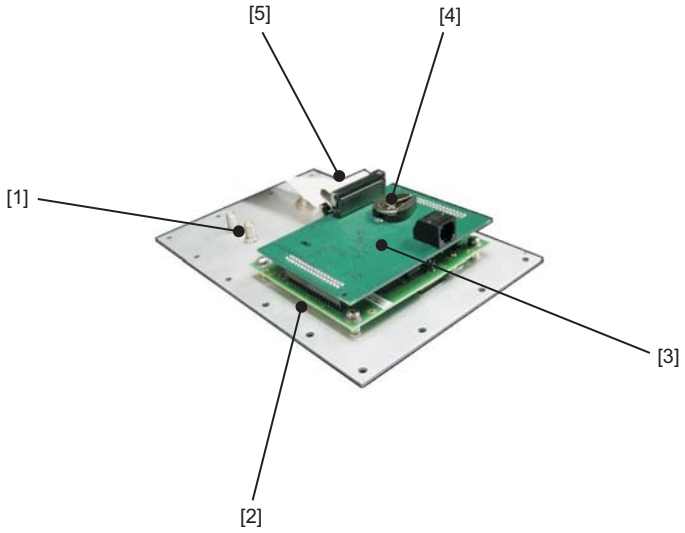


Figure A-1 Physical appearance of FM Web Remote board.

[1] I/O panel removed from rear face of amplifier chassis. (reverse face shown, normally inside chassis).

[2] I/O PC board (901-0203-551).

[3] FM Web Remote PC board (901-0203-391T).

[4] 3V lithium coin-cell battery for on-board clock (660-0068-000).

[5] 50C ribbon cable connection to rest of amplifier chassis.

A.2 Installation

A.2.1 Internet Security

The FM Web Remote is designed for use in a LAN environment. It has a moderate level of password protection but does not employ packet encryption. Accordingly, it should not be hooked directly to the Internet without additional precautions being taken.

A typical application of the web remote is at a remote transmitter site, but as part of a 'virtual LAN' (VPN) with connection via special routers employing encryption chosen by the LAN owner/operator. The web remote remains connected to the router with a fixed IP address and fixed port forwarding. The web remote uses these ports.

- HTTP: 80
- SNMP: 161
- SNMP Trap: 162
- SMTP: 25

The port selections given above are fixed. If two or more web remotes are to be used behind a single firewall, it will be necessary to use a router with port address translation and assign each web remote its own HTTP port (e.g. 8080. 8081, 8082, etc.)

With this type of installation, the router owns the external IP address and a domain name, if desired. The web remote port is simply appended to the router IP address with a colon.

e.g.

- http://myharristransmitter.com:8081
- http://69.234.123.78:8081

NOTE:
The port number may be omitted if it is the default value of 80.

The internal e-mail (SMTP) notification routine does not provide for username/ password authentication to access an SMTP server. If no SMTP server is available, small PC-based SMTP servers are available for approximately US $50. PostCast Server by Gate Comm Software would be a good example. When necessary, the e-mail notification generated by the web remote may be forwarded by the local SMTP server and/or other intermediate servers in order to add password protection or circumvent a DNS (spam) blacklist for a particularly demanding recipient.

The SNMP implementation is per SNMP v1 with separate read and write communities. In addition the write community, a special user-defined value between 0-255 must be written during the SET operation for the desired command to be issued. This provides an additional level of security. The SNMP GET, SET, and TRAP functions can be disabled via the user configuration page.

A.2.2 Installation Procedure

The FM Web Remote is typically installed in the amplifier chassis by factory personnel prior to delivery. However, it is possible that the need may arise to add the web remote as an upgrade to a unit already operating in the field. In such a case, follow the installation procedure below from step 1. Otherwise, start at step 10.

STEP 1 Remove AC mains power from amplifier chassis.

STEP 2 Remove I/O panel from rear face of amplifier chassis to gain access to reverse side of I/O PC board.

STEP 3 Locate pair of 34 pin headers on reverse side of I/O board.

STEP 4 Note position of 50C ribbon cable headers on both I/O and web remote boards. Both connectors should be immediately next to each other when web remote card is properly oriented. (i.e. not on opposite corners).

STEP 5 Carefully press web remote card onto 34 pin headers observing correct orientation as described above. Be careful to not misalign or bend any pins.

STEP 6 Locate extra 50C connector at end W35 ribbon cable from amplifier chassis.

STEP 7 Plug W35 into web remote card. W35 should connect to both I/O and web remote PC boards simultaneously.

NOTE:
Amplifier chassis produced prior to January 2010 do not have the extra 50C connector at the end of W35. For this reason, an additional 50C is provided in the 981-0090-089 upgrade kit. If you have not received this cable and require it complete installation, please contact your GatesAir representative.

STEP 8 Physically re-install I/O panel in amplifier chassis.

STEP 9 Apply AC mains power to amplifier chassis.

STEP 10 Connect CAT5 cable to Ethernet port on I/O panel of amplifier chassis. If connection is 1:1 to a PC, use a crossover cable. Otherwise, use a straight cable.

STEP 11 Attempt to access configuration page via procedure in section A.5.1. Default password is "expert". Default IP address is 192.168.1.99 unless otherwise indicated.

NOTE:
To access the web remote for the first time, there are two different options:

- 1:1 connection to PC: Use a crossover type cable, and the PC should have its IP address manually set to 192.168.1.xx, where xx is 0-255, but not 99.
- Connection to router: Some router types use a default address of 192.168.1.1. (e.g. LINKSYS) In such a case, the web remote may be connected directly to the router via a straight (non-crossover) cable.

STEP 12 If web remote will not respond to IP address of 192.168.1.99, perform an expert reset per procedure in section A.5.3.

STEP 13 On configuration page, set IP address to final desired address. Where indicated, access router configuration page and set port 80 forwarding to web remote IP address. Set other user parameters per information given in Table A.5.1.

STEP 14 Access main page via procedure in section A.3.1.

STEP 15 Verify web remote properly commands and monitors transmitter.

STEP 16 Change configuration settings as desired until satisfied with all aspects of web remote operation (passwords, SMTP, SNMP, etc).

STEP 17 Record all configuration settings on paper and store in safe place for future reference. (passwords, addresses, etc)

STEP 18 Procedure complete.

A.3 Operation

All monitoring, logging, and commands are on a single, straightforward, main web page. Use this procedure to access the main page.

A.3.1 Access main page

STEP 1 Open web browser on PC.

STEP 2 Enter IP address of web remote (preceeded by *http://)* on address line and press RETURN.

STEP 3 Empty page with "PASSWORD?" prompt should be displayed.

Figure A-2 Main page awaiting entry of password key.

STEP 4 Enter "guest" or "operator" password key in box at upper right. Status bar should change color and readings should instantly display upon successful input of full password. If guest key was used, all command buttons will be blanked out. If operator key was used, all command buttons will be operational.

Figure A-3 Main page after successful entry of key.

STEP 5 Erase last letter of password key from input box at upper right at any time to pause readings. Restore key to cancel pause and resume operations.

STEP 6 Press command buttons as desired to affect transmitter operation.

STEP 7 Press MAIL button to generate auto e-mail message populated with current readings.

NOTE:
The automated e-mail feature requires that a valid e-mail client be previously installed and activated on the PC accessing the web remote. This automated e-mail facilitates the tasks of logging transmitter readings by allowing the user to simply archive the populated e-mail in an e-mail folder for future reference. It also provides an easy means to communicate transmitter readings to GatesAir Customer Service personnel.

STEP 8 Procedure complete.

Table A-1 Elements on main page.

STATUS BAR	
STATUS BAR (top compartment)	Provides a space to enter password key (right), displays transmitter ID name (center), and changes color to provide at-a-glance assessment of transmitter status. [Green/Yellow/Grey/White] [Green] = transmitter is switched on with no active faults. [Yellow] = transmitter is switched on but has active faults. [Grey] = transmitter is switched off. [White] = web remote is awaiting password or has lost serial data link.

METER READINGS	
SYSTEM FWD kW	Transmitter system forward output power. This reading is obtained from an RF detector in the ZX System Metering Panel (981-0090-070), when installed. If the system metering panel is marked as NOT installed on the configuration page, this reading is a repetition of the PA FORWARD WATTS reading from the RF detectors inside the amplifier chassis.
SYSTEM REV kW	Transmitter system reverse output power. This reading is obtained from an RF detector in the ZX System Metering Panel (981-0090-070), when installed. If the system metering panel is marked as NOT installed on the configuration page, this reading is a repetition of the PA REVERSE WATTS reading from the RF detectors inside the amplifier chassis.

Table A-1 Elements on main page.

STATUS	Operational status of amplifier chassis. [ON/OFF/FAULT/???] [ON] = Transmitter is switched on. [OFF] = Transmitter is switched off. [FAULT] = Transmitter is switched on but has active faults. [???] = Web remote is awaiting input of a valid password or has lost serial data link.
MODE	Transmitting mode of amplifier chassis. [FM/FMHD/HD/SL] [FM] = analog FM modulation [FMHD] = combined FM+HD mode [HD] = digital HD Radio mode [SL] = Split Level Combining mode
AMBIENT TEMP	Ambient temperature in degrees centigrade. Sensor is on transmitter controller PCB on reverse of front door.
EXCITER	Exciter currently on air as reported by Flexstar Main/Alt Switcher (981-0193-001), when installed. [A/B] If the main/alt switcher is marked as NOT installed on the configuration page, exciter A is always reported.
EXCITER WATTS	Exciter forward power in watts, obtained from DC sample supplied by exciter via exciter interface cable.
PA FWD WATTS	Forward output power of amplifier chassis in watts. Detector is on I/O PC board.
PA REV WATTS	Reverse output power of amplifier chassis in watts. Detector is on I/O PC board.
PA VOLTS	Drain voltage of PA modules in volts as reported from PA backplane boards.
PA AMPS	Total current of PA modules in amperes, (final stage, no IPA) as measured on controller board.
IPA AMPS	IPA module current in amperes, as reported from IPA backplane board.
PA AMPS (1-8)	PA module currents in amperes, as reported from PA backplane boards.
MAX PA TEMP	Maximum PA module temperature in degrees centigrade, as reported from PA backplane boards.
MAX LOAD TEMP	Maximum combiner load temperature in degrees centigrade, as reported from combiner load board in output assembly.

FAULT INDICATIONS	
POWER LOW (AGC NOK)	AGC has come unlocked due to failure of a PA, exciter, other module, or because transmitter is switched off. (AGC is used synonymously with APC)
REVERSE FOLDBACK	Power is being automatically reduced due to excessive RF reverse power (VSWR) measured at output.
RESTARTS EXCEEDED	Auto-restart circuit has locked out due to multiple unsuccessful restart attempts.

Table A-1 Elements on main page.

LOW FAN SPEED	One of more fans reports low rpms, either due to an internal failure or because transmitter is switched off.
AC MAINS LOW	Incoming AC mains is below 190V shutoff threshold on one or more AC inputs.
LOAD OVERHEATED	Amplifier chassis switched off because one or more combiner loads exceeded 125C shutoff threshold.
PA MODULE SHUTDOWN	One or more PA modules have switched off, either due to a failure or because transmitter is switched off.
RF MUTE ACTIVE	RF output is being inhibited by a closure of external mute line on 25-pin remote control interface or by exciter.
INTERLOCK LOOP OPEN	Amplifier is being commanded off by an interruption of external interlock line on 25-pin remote control interface on remote terminal board.
REMOTE DISABLED	Amplifier chassis is in “local” (REMOTED DISABLED) mode as set by switch on transmitter controller board on reverse of front door. NOTE: This will prevent the SNMP trap and/or e-mail notification from being sent if the transmitter drops below the RF < ALARM THRESHOLD.
EXCITER FAULT	Exciter is reporting an internal fault via exciter interface cable, or an emergency exciter switchover has occurred.

COMMAND BUTTONS	
ON	Switches transmitter on.
OFF	Switches transmitter off.
RAISE	Raises transmitter output power.
LOWER	Lowers transmitter output power.
EXC A	Commands exciter switcher to select exciter A. (when installed)
EXC B	Commands exciter switcher to select exciter B. (when installed)
CLEAR	Erases all log entries.
MAIL	Generates an automated e-mail populated with current transmitter readings and last ten log entries. **NOTE:** requires a valid e-mail application installed on PC viewing webpage.

EVENT LOG	
SERIAL NUMBER (lower compartment, upper right)	Transmitter serial number, as entered on configuration page. GatesAir Customer Service may ask you for this number if you call for assistance. This helps us locate your records.
EVENT LOG	Readout of transmitter log with entries in chronological order (most recent at top). Entries are in dd mmm yy hh mm ss format. e.g. 10 NOV 09 20:10:55 equals 9 November 2010 - 8:10:55 PM A list of all log entries is found below in Table A.3.2.

Table A-2 List of transmitter log messages.

LOG MESSAGES	
RF > OK THRESHOLD	Transmitter RF output power has risen above RF WARN and RF ALARM thresholds as set on configuration page.
RF < WARN THRESHOLD	Transmitter RF output power has fallen below RF WARN threshold as set on configuration page.
RF < ALARM THRESHOLD	Transmitter RF output power has fallen below RF ALARM threshold as set on configuration page. **NOTE:** An SNMP trap and/or e-mail notification is sent (if enabled) when this message appears.
ON COMMAND	Transmitter ON command line was actuated from any of these sources: • this web remote, • the front panel ON button, • the D-sub 25 remote control interface, • another amp chassis in larger systems, • the remote terminal board in larger systems.
OFF COMMAND	Transmitter off line was actuated from any source.
RAISE COMMAND	Transmitter raise line was actuated from any source.
LOWER COMMAND	Transmitter lower line was actuated from any source.
LOG CLEARED	Transmitter log was cleared via a command from CLEAR button.
POWER LOW (AGC NOK)	Transmitter Automatic Gain Control (AGC) dropped out of a locked condition. The term 'AGC' as used here is synonymous with 'APC'. **NOTE:** This log entry will not be recorded if due to transmitter simply switching off.
LOW FAN SPEED	One or more cooling fans reported low rpms. **NOTE:** This log entry will not be recorded if due to transmitter switching off or during first minute of transmitter startup while fans come up to speed.
PA MODULE SHUTDOWN	One or more PA modules switched off. **NOTE:** This log entry will not be recorded if due to transmitter simply switching off
AC MAINS LOW	Incoming AC mains fell below ~190V shutoff threshold on one or more AC inputs.
AC MAINS OK	Incoming AC mains rose back above 190V threshold.
LOAD OVERHEATED	Amplifier switched off because one or more combiner loads exceeded 125C shutoff threshold.
INTERLOCK LOOP OPEN	Amplifier switched off because of interruption of external interlock line.
INTERLOCK LOOP OK	External interlock line closed again.
RF MUTE ACTIVE	RF output was inhibited by a closure of external mute line.

Table A-2 List of transmitter log messages.

RF MUTE END	External mute line opened again.
REVERSE FOLDBACK	Transmitter output power was automatically reduced due to high reverse power (VSWR) measured at output.
REVERSE FOLDBACK OK	Reverse foldback condition cleared.
RESTARTS EXCEEDED	Auto-restart circuit locked out due to multiple unsuccessful restart attempts.
EXCITER FAULT	Exciter reported an internal fault or an exciter switchover occurred because of a fault condition.
EXCITER OK	Exciter fault condition cleared.
REMOTE DISABLED	Amplifier chassis was placed in “local” REMOTE DISABLED mode via switch on reverse side of front door controller board.
REMOTE ENABLED	Amplifier chassis was returned to REMOTE ENABLED mode.
EXCITER B SELECTED	Exciter main/alt switcher switched over to exciter A.
EXCITER A SELECTED	Exciter main/alt switcher switched over to exciter B.
FM MODE SELECTED	Transmitter was switched to FM mode by Flexstar exciter. **NOTE:** When no Flexstar exciter is present, the transmitter is hard-wired permanently into FM mode via shorted pins on the exciter interface cable.
FM+HD MODE SELECTED	Transmitter was switched to FM+HD mode by Flexstar exciter.
HD MODE SELECTED	The transmitter switched to HD mode by Flexstar exciter.
SL MODE SELECTED	The transmitter switched to SL mode by Flexstar exciter.

A.4 Theory of Operation

The FM Web Remote features a Microchip PIC18F97J60 microcontroller running a modified version of the Microchip V4.02 TCP stack and a custom made application to interface to the ZX series of transmitters. An on-board real time clock with 3V coin-cell battery maintains the current time, even in the absence of AC mains power. An on-board EEPROM maintains non-volatile storage of the transmitter log and various configuration settings. An on-board RJ11 jack provides for in-circuit programming in the factory. Should a software upgrade be required in the field, the preferred method is to unplug the card from the I/O board and plug in a replacement board sent in advance from the GatesAir factory. A small green LED at the lower edge of the card blinks once a second when the web remote is operating correctly. This LED is not visible from outside the amplifier chassis, but can be used to assess the functioning of the web

remote during bench testing or other troubleshooting operations when the card is visible.

The web remote serves out a main HTML status page that receives updated readings via an AJAX data stream on port 80. This data stream may be also used by customized external pages created by the user or by third-party remote control systems, if suitably programmed. This is addressed in greater detail in files provided on the accompanying USB flash drive (7320514000-2). The web remote also responds to SNMPv1 GETs and SETs on port 161 and can send a generic trap on port 162. A simple e-mail notification with a text message link pointing back to the web remote IP address can be sent on port 25.

The web remote has only a moderate level of security and is designed to be used in a secure LAN setting or paired with a router to provide a firewall / encryption / security if use over the Internet is envisioned. Because use with a router is envisioned, a reset button in the amp chassis can forcibly reset the web remote to an IP address of 192.168.1.99 - an address compatible with many popular routers.

A.5 Maintenance

The FM Web Remote has no user hardware adjustments and requires no periodic cleaning or replacement of consumable materials.

Several key maintenance procedures are provided below:

- Access configuration page
- Perform simple reset
- Perform expert reset
- Change clock battery
- Calibrate clock speed
- Use Microchip Ethernet Discoverer utility

A.5.1 Access Configuration Page

Purpose: A single configuration page contains all user-adjustable settings. It may be accessed using the "expert" level password.

Special Tools: PC with web browser.

STEP 1 Open web browser on PC.

STEP 2 Enter IP address of web remote on address line with suffix "/config.htm". For example: http://192.168.1.99/config.htm.

STEP 3 Configuration page with password pop-up prompt should display.

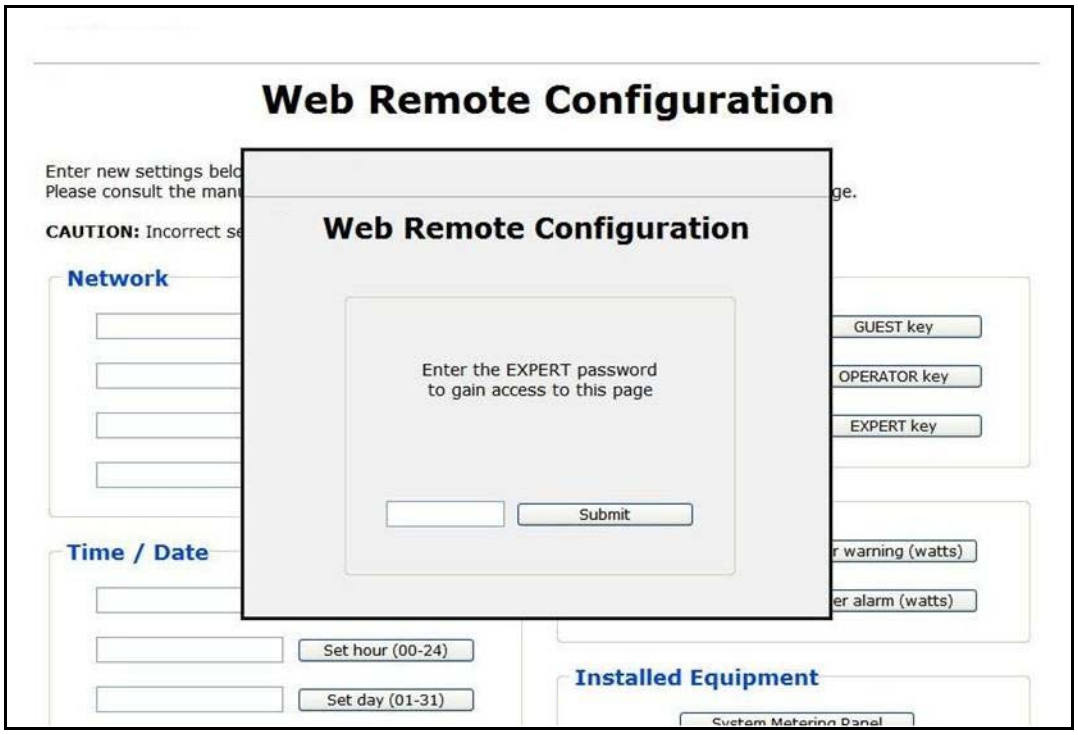


Figure A-4 Configuration page with password prompt.

STEP 4 Enter "expert" level password key in box at center and press SUBMIT button. Default expert level password is "expert".

STEP 5 Pop-up box should disappear, revealing all configuration settings.

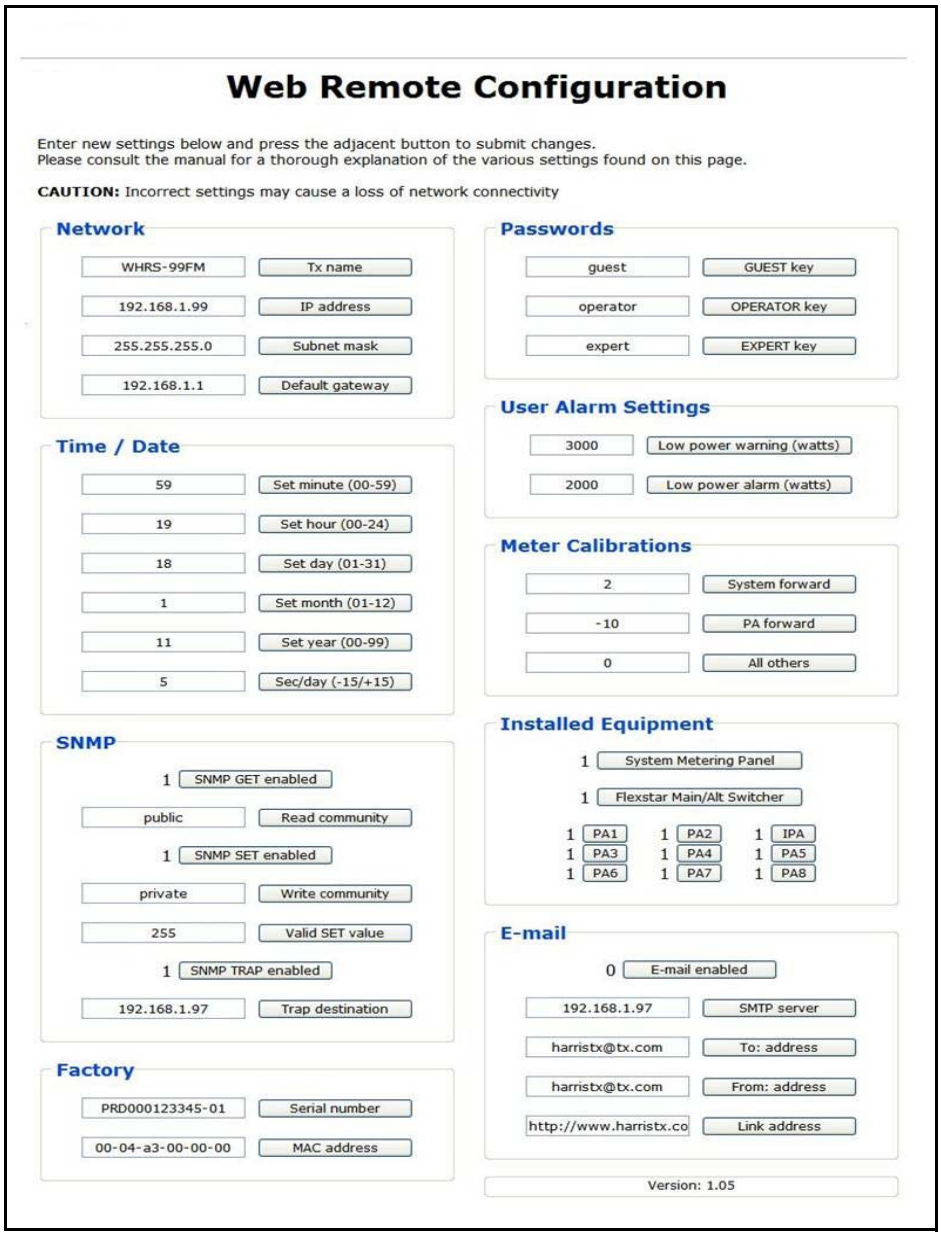


Figure A-5 Configuration page

STEP 6 Change settings, as desired, and press labeled button to right of modified field to submit change for permanent storage in memory.

NOTE:
The corresponding button should be pressed after each field is changed. Otherwise, the changes will not be saved.

CAUTION:
INCORRECT SETTINGS COULD CAUSE A LOSS OF BOARD CONNECTIVITY. CAREFULLY READ TABLE A.5.1 TO UNDERSTAND THE IMPLICATIONS OF CHANGING EACH PARAMETER.

STEP 7 Toggle "E-MAIL Enabled" button off-on to send a test e-mail message, as desired.

STEP 8 Toggle "SNMP Trap Enabled" button off-on to send a test trap, as desired.

STEP 9 Procedure complete.

Table A-3 List of settings on configuration page.

CONFIGURATION SETTINGS	
TX NAME	The identification name for the transmitter. Since this name also doubles as the NETBIOS name for the web remote, it is limited to 15 characters and cannot contain spaces.
IP ADDRESS	The IP address of the web remote. A change of this setting could cause a loss of board connectivity.
SUBNET MASK	The subnet mask of the web remote. A change of this setting could cause a loss of board connectivity.
DEFAULT GATEWAY	The IP address of the PC/router/device through which the web remote sees the rest of the LAN/Internet. A change of this setting could cause a loss of board connectivity.
SET MINUTE, HOUR, DAY, MONTH, YEAR	A means to set the current log for the on-board clock used to time stamp log entries. **NOTE:** the MINUTE button will also reset the seconds to 00 when pressed.
SEC/DAY	The number of seconds added to /subtracted from the clock each day. A means to fine trim the clock speed. See section A.5.5 for an adjustment procedure.
EMAIL ENABLED	Activates the e-mail notification in case of an RF < ALARM THRESHOLD condition. Toggling this setting from 0(off) to 1(on) will cause a test email to be sent.
SMTP SERVER	The IP address of the SMTP server responsible for forwarding the e-mail notification.
TO: ADDRESS	The target e-mail address for the e-mail notification.
FROM: ADDRESS	A from: address to populate the e-mail notification address header. This can be a fictitious address. It is required because some e-mail servers will reject a message with this field left blank. The from: address can be used to identify the sending transmitter. e.g. GatesAir_ZX@Mt_Alto_site.com
LINK ADDRESS	A link to the web remote main page appearing in the body on the e-mail notification. If the full address is written (starting with http://...) the link should appear in the received e-mail as fully “clickable”, thereby allowing the recipient to easily navigate to the main page, especially in small/mobile devices.

Table A-3 List of settings on configuration page.

SERIAL NUMBER	The transmitter serial number. This is typically entered in the factory and does not require updating in the field. GatesAir Customer Service may ask you for this number if you call for assistance. This helps us locate your records. If the web remote is moved to a new transmitter, be sure to update this field.
MAC ADDRESS	The MAC address of the web remote. This is typically entered in the factory and does not require updating in the field. A change of this setting could cause a loss of board connectivity. **CAUTION:** If you need to ask why a MAC address might need to modified, you should not modify it!
GUEST KEY	The basic level password. This allows access to main web page, but no transmitter commands. The default guest level password is "guest".
OPERATOR KEY	The main level password. This allows full access to main web page, including the transmitter command buttons. The default operator level password is "operator".
EXPERT KEY	The administrator level password. This allows access to the configuration web page. The default expert level password is "expert".
LOW POWER WARNING	The threshold in watts for the RF < WARN THRESHOLD fault. **NOTE:** This threshold is measured against the system forward power reading, not the PA forward power reading. This distinction becomes important in larger model transmitters.
LOW POWER ALARM	The threshold in watts for the RF < ALARM THRESHOLD fault. This fault condition will cause an SNMP trap and/or e-mail notification to be sent (when enabled). **NOTE**: This threshold is measured against the system forward power reading, not the PA forward power reading. This distinction becomes important in larger model transmitters.
INSTALLED EQUIPMENT	Allows the web remote to be customized to different transmitter models and systems by zeroing out those units not installed. If the ZX System Metering Panel is installed, the SYSTEM FORWARD/ REVERSE POWER readings come from detectors in the metering panel, otherwise they are repetitions of the PA WATTS readings from the RF detectors inside the amplifier chassis. If the Flexstar Main/Alt Switcher is installed, the active exciter status (A/B) is taken from the switcher. Otherwise, exciter A is reported as active always.
METER CALIBRATIONS	Allows the meter readings to be finely adjusted to compensate for fabrication tolerances. Individual calibration adjustments are provided for the System Forward and PA Forward readings. A general calibration factor for all other readings is also provided. The calibration factor units are scaled in +/- tenths of a percent. e.g. -10 = -1.0%, +24 = +2.4%
SNMP GET ENABLED	Enables the transmitter to be queried by SNMP GET commands.
READ COMMUNITY	The SNMP READ community for GET commands.
SNMP SET ENABLED	Enables the transmitter to be commanded by SNMP SET commands.

Table A-3 List of settings on configuration page.

WRITE COMMUNITY	The SNMP WRITE community for SET commands.
VALID SET VALUE	As an added security measure, the value "written" by the SNMP SET must match this value. Otherwise, no command will be issued.
SNMP TRAP ENABLED	Enables alarm notification of an RF < ALARM THRESHOLD fault via a generic SNMP trap. Toggling this setting from 0(off) to 1(on) will cause a test trap to be sent.
SNMP TRAP ADDRESS	The destination IP address of the trap notification.
VERSION	The software version of the web remote.

A.5.2 Perform Simple Reset

Purpose: Issues simple reset of microprocessor. Essentially the same as cycling power to card.

Special Tools: Small plastic screwdriver.

STEP 1 Locate WEB RESET hole on I/O panel at upper rear face of amplifier chassis. (See Figure A.6)

STEP 2 Press button continually with small plastic adjustment tool or similar item for ten seconds. Maintain button depressed continually for full ten seconds.

STEP 3 Web remote processor resets and will resume operation within seconds of button release.

STEP 4 Procedure complete.

Figure A-6 Reset of web remote via WEB RESET hole on I/O panel.

A.5.3 Perform Expert Reset

Purpose: To be used if the IP address and/or configuration settings need to be reset and expert password has been forgotten or connectivity has otherwise been lost.

The expert reset restores these key settings to factory default values:

- IP address = 192.168.1.99
- Subnet mask = 255.255.255.0
- Default gateway = 192.168.1.1
- Default MAC = 00-00-00-00-00-00

Additionally, the expert reset primes the onboard EEPROM to be overwritten upon the next bootup of the web remote card. If DC power to the card is cycled before any values are modified on the configuration page, all parameters are overwritten with their factory values (not just the three IP addresses mentioned above). To prevent this global overwrite from happening, access the configuration page immediately after performing an expert reset and toggle any setting on the page to force a cancellation of the complete factory reset of the entire web remote.

Special tools: Small plastic screwdriver.

STEP 1 Locate WEB RESET hole on I/O panel at upper rear face of amplifier chassis. (See Figure A.6)

STEP 2 Press button momentarily with small plastic adjustment tool or similar item three times within a five second window. (Exit ramp: If at this point you want to abort the expert reset of parameters and passwords and you have login capability to expert level, access the configuration page immediately after performing the three button pushes and toggle any setting on the page to force a cancellation of this feature. IP address will still be reset.)

NOTE:
To complete the full reset of all parameters: cycle power or press simple reset: press and hold the same WEB RESET, through the hole as before in step 2, for 10 seconds or more.

STEP 3 Web remote memory resets IP address, subnet mask, default gateway, and expert password to values listed above.

STEP 4 If a complete reset of all web remote stored parameters is NOT desired, proceed immediately to the web remote configuration page at 192.168.1.99/config.htm and change IP address and/or expert password to desired values. The global memory overwrite features is automatically cancelled when any parameter is changed on the configuration page.

STEP 5 Procedure complete.

NOTE:
The full expert reset causes the MAC address to default to a generic value of 00-00-00-00-00-00. This can cause a problem if there are multiple web remote units that have had their MAC reset to the default factory value on the same LAN subnet. You can edit the MAC on the configuration page. Consult local IT staff or the factory for additional information. The factory will need the serial number of the web remote board in order to look up the original MAC.

A.5.4 Change Clock Battery

Purpose: The on-board 3V Lithium battery has an expected lifetime of over 10 years. If it becomes exhausted, the internal clock will reset to 1 Jan 00 after an AC mains failure.

Special tools: Small screwdriver to pry out battery.

NOTE:
This procedure is ideally performed with the transmitter off air and all mains power removed. Wait until a scheduled maintenance period to perform this procedure. Consult Figure A.1 for a photo of battery location / appearance.

STEP 1 Remove AC mains power to transmitter.

STEP 2 Remove amplifier chassis I/O panel.

STEP 3 Locate 3V battery on web remote PC board.

STEP 4 Pry battery loose with small screwdriver.

STEP 5 Insert new battery.

STEP 6 Reinstall I/O panel in amplifier chassis.

STEP 7 Reapply AC mains power to amplifier chassis.

STEP 8 Procedure complete.

A.5.5 Calibrate Clock Speed

Purpose: If no special precautions are taken, the on-board clock in the web remote can slip several seconds a day. To prevent this, the user can fine trim the clock speed to add or subtract several seconds a day. This adjustment occurs at midnight each night.

Special tools: High quality clock for comparison purposes.

STEP 1 While accessing main page, issue on command via ON button to create a log entry.

STEP 2 Note log entry time stamp as compared to quality external clock.

STEP 3 Access configuration page and recalibrate on-board time to correct value, as desired.

STEP 4 Repeat steps 1 and 2 several hours or several days later.

STEP 5 Note if on-board clock has lost or gained seconds relative to quality external clock.

STEP 6 Extrapolate rate of gain/loss to 24 hour time period. e.g. 1 sec lost in 12-hour period = +2 second adjustment required per 24-hour period.

STEP 7 Increment/decrement SEC/DAY time adjustment field on configuration page.

STEP 8 Recalibrate on-board time to correct value as desired.

STEP 9 Procedure complete.

A.5.6 Use Microchip Discoverer Utility

Purpose: The USB flash drive supplied with the web remote contains a small application called Microchip Ethernet Discoverer. This program can be useful for

locating a web remote with an unknown IP address, but is limited to detecting only web remotes connected to the same subnet. (1:1 PC connection or sharing same router)

Special tools: Microchip Ethernet Discoverer.exe

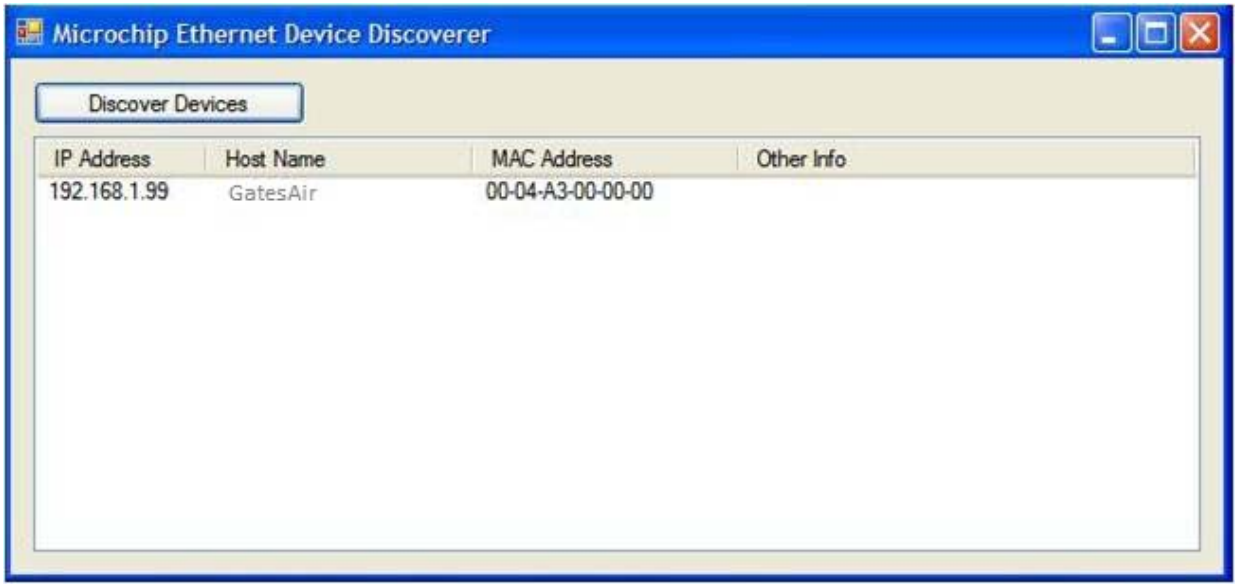


Figure A-7 Web discover results window.

STEP 1 Launch discoverer application on PC installed on same LAN as web remote.

STEP 2 Press Discover Devices button.

STEP 3 Consult results window to determine current IP address of web remote.

STEP 4 Attempt to contact web remote on current IP address or perform an expert reset to change IP address to more convenient value.

STEP 5 Procedure complete.

A.6 Troubleshooting

Table A-4 Web Remote Troubleshooting

Symptom	Cause and Solution
Cannot connect to web remote. Web browser displays “cannot display page” error message.	Possible incorrect IP address. Enter correct IP address and press F5 to refresh browser page. If IP address cannot be located, perform expert reset of web remote card to reset IP address and password. See section A.5.3 for more information. Possible connectivity problem. If connected to router as gateway, check router for activity. Access router configuration page and verify all settings are correct.
Main page remains dark, "-------" is displayed where transmitter name should be, and all readings display '999'.	Incorrect execution of Javascripts on web page or Javascipts have been disabled in web browser settings. Check browser settings and "enable scripts". **NOTE:** if the web page is a locally stored page (hard drive) as described in the accompanying USB flash drive, this problem can also be caused by no connectivity due to an incorrect web remote IP address or the web remote server on the far end being off-line.
Incorrect time recorded in new log entries.	Possible incorrect setting of on-board clock. Access configuration page and update time information. If on-board clock consistent loses or gains seconds over course of days/weeks, update clock speed trim value via procedure in section A.5.5. Possible extended AC mains failure. It has been noted that the clock accuracy will suffer slightly during extended periods on backup battery power.
Time format is stuck on 24 hour ‘military’ format. e.g. 5:00pm = 17:00	This is normal. Time and date format for log entries is not adjustable.
Cannot send SNMP test trap to NMS manager.	Possible firewall interference. Verify port 162 is not being blocked by an intervening firewall. Possible incorrect trap address. Verify correct IP address of trap destination.

Table A-4 Web Remote Troubleshooting

Symptom	Cause and Solution
Cannot send test e-mail to target PC.	Possible firewall interference. Verify port 25 is not being blocked by an intervening firewall. Possible DNS (spam) blacklist. Verify IP address of web remote is not being blocked by recipient. Possible authentication required. Verify SMTP server and/or recipient does not require authentication. (username, password). If so, install local SMTP server on LAN to serve as intermediary to pass message on to more demanding server with required credentials.
All Log entries all have 'undefined' and '63' in their fields.	On-board clock has gone into battery backup mode due to sagging DC voltage from chassis. This occurs if main DC voltage to card is less than 125% of battery voltage. Turn off transmitter, remove AC panel, and check DC voltage coming into card with multimeter (J2-33). Voltage could theoretically sag due to short circuit somewhere on card and current limiting action of PTC resettable fuses. Locate and rectify short circuit condition.
'Service Unavailable' (and nothing else, plain white page) error message returned from web remote in browser window.	Cause unknown. Attempt simple and/or expert reset procedure in section A.5.2 or 3. Contact GatesAir Service for possible updated troubleshooting strategies.

A.7 USB Flash Drive

A USB flash drive (7320514000-2) is supplied with the FM Web Remote. It contains the following files:

1. Microchip Ethernet Discoverer.exe - a utility that may be useful to determine the IP address of a lost web remote.
2. GATESAIR-TX-ZXB-MIB.mib - a text copy of the SNMP MIB for the web remote in ASN.1 format.
3. Enhanced.htm - a special version of the web remote with dual language support. Also included in the folder are dictionary files for various languages: Spanish, French, Portuguese, Russian, and Chinese. This allows the user to choose which languages to display. Instructions on how to set up the enhanced version are included in an accompanying readme file.
4. Large.htm - a special version if the web remote suitable for creating a full screen power meter display. An accompanying readme file provides additional information.

5. Starter.htm - a simplified web remote page that serves as a starting point for those users that wish to create their own customized web remote display. An accompanying readme file provides instructions on how to get started.
6. Protocol.txt - a text file with details on the communication protocol of the web remote for those users who wish to interface it to an external device.

It is anticipated that the contents of the USB flash drive will evolve over time and may include additional files not listed here. The user is encouraged to fully explore the contents of the flash drive to learn about the latest ways to extend the functionality of their GatesAir FM Web Remote.

Support Contacts: http://www.gatesair.com/services.aspx
Customer Portal: http://support.gatesair.com

GatesAir has office locations around the world. For locations and contact information see:
http://www.gatesair.com/company/contact-us.aspx