Broadcast Electronics
4100 North 24th Street, Quincy, Illinois 62305 USA • Phone (217) 224-9600 • Fax (217) 224-9607 • www.bdcast.com • bdcast@bdcast.com

VPe
Operation Manual

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Revision A
June 18, 2013

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Operation Manual

Broadcast Electronics Product Warranty (Two-Year Limited)

BE hereby warrants all new products manufactured by BE against any defects in material or workmanship at the time of delivery thereof, or that develop under normal use within a period of two (2) years from the date of shipment.

BE reserves the right to repair equipment under warranty with new or refurbished equipment or parts. BE's sole responsibility with respect to any equipment or parts not conforming to this warranty is to replace or repair such equipment upon the return thereof F.O.B. to BE's factory in Quincy, Illinois, U.S.A. In the event of replacement pursuant to the foregoing warranty, only the unexpired portion of the warranty from the time of the original purchase will remain in effect for any such replacement.

This warranty shall exclude the following products, component parts and/or assemblies:

(a) Transmitter power output tubes shall only carry the original manufacturers' or suppliers' standard warranty in effect on their original shipment date.

(b) All computers, computer peripherals, cables, hard disk drives, etc., shall only carry the manufacturers' or suppliers' standard warranty in effect on their original shipment date.

(c) "Components", defined as separate and individual parts (e.g. transistors, integrated circuits, capacitors, resistors, inductors, fans, etc), resold by BE from another manufacturer or supplier, shall only carry a 90 day warranty, effective the date of shipment. Any such 'Components' being returned for warranty claim must be (1) returned in their original packaging and (2) must be in new, unused condition. BE is unable to process or resolve component defects or performance concerns on components that have been soldered, installed, wired or in any way altered from new their new condition.

(d) "Resale Equipment", defined as equipment purchased from another manufacturer or supplier, then resold by BE, shall only carry such manufacturer's or supplier's standard warranty in effect as of the original shipment date. All warranty claims against any and all 'resale equipment' sold by BE must be filed directly with the original equipment manufacturer. BE is unable to process or resolve equipment defects or performance concerns on products or services not manufactured by BE.

This warranty shall not extend to claims resulting from any acts of God, terrorism, war, defects or failures caused by Purchaser or user abuse or misuse, operator error, or unauthorized attempts to repair or alter the equipment in any way.

Under no circumstances shall BE be responsible for indirect, incidental or consequential damages, including, but not limited to transportation costs, non-authorized repair or service costs, downtime costs, costs for substituting equipment or loss of anticipated profits or revenue, incurred by Purchaser, whether based in contract, tort or for negligence or breach of statutory duty or otherwise. The terms of the foregoing warranty shall be null and void if the equipment has been altered or repaired without specific written authorization from BE, or if not installed according to BE's instruction manuals, including, but not limited to, the absence of proper grounding, surge (TVSS) protection on the AC circuit panel or proper lightning protection/grounding on all output circuits, or if equipment is operated under environmental conditions or circumstances other than those specifically described in BE's product literature or instruction manual which accompany the equipment. The warranty shall be voided if the product or subassembly is equipped with a tamper seal and that tamper seal is broken. BE shall not be liable for any expense of any nature whatsoever incurred by the original user without prior written consent of BE. The warranty provided herein shall terminate at the end of the period set forth above. This warranty extends only to the original Purchaser and is not transferable. There are no third party beneficiaries of any of the provisions of

this warranty. If the equipment is described as “used” equipment, it is sold as is and where is and no warranty applies unless authorized in writing.

EXCEPT AS SET FORTH HEREIN, AS TO TITLE AND AS SPECIFICALLY REQUIRED BY LAW, THERE ARE NO OTHER WARRANTIES, OR ANY AFFIRMATIONS OF FACT OR PROMISES BY BE, WITH REFERENCE TO THE EQUIPMENT, OR TO MERCHANTABILITY, FITNESS FOR A PARTICULAR APPLICATION, SIGNAL COVERAGE, INFRINGEMENT, OR OTHERWISE, WHICH EXTEND BEYOND THE DESCRIPTION OF THE EQUIPMENT ON THE FACE HEREOF.

IMPORTANT INFORMATION

EQUIPMENT LOST OR DAMAGED IN TRANSIT

When delivering the equipment to you, the truck driver or carriers' agent will present a receipt for your signature. Do not sign it until you have:

1) Inspected the containers for visible signs of damage and 2) Counted the containers and compared with the amount shown on the shipping papers. If a shortage or evidence of damage is noted, insist that notation to that effect be made on the shipping papers before you sign them.

Further, after receiving the equipment, unpack it and inspect thoroughly for concealed damage. If concealed damage is discovered, immediately notify the carrier, confirming the notification in writing, and secure an inspection report. This item should be unpacked and inspected for damage WITHIN 15 DAYS after receipt. Claims for loss or damage will not be honored without proper notification of inspection by the carrier.

RF PRODUCT TECHNICAL ASSISTANCE, REPAIR SERVICE, PARTS -

Technical assistance is available from Broadcast Electronics by letter, prepaid telephone or E-mail. Equipment requiring repair or overhaul should be sent by common carrier, prepaid, insured, and well protected. If proper shipping materials are not available, contact the RF Technical Services Department for a shipping container. Do not mail the equipment. We can assume no liability for inbound damage, and necessary repairs become the obligation of the shipper. Prior arrangement is necessary. Contact the RF Technical Services Department for a Return Authorization.

Emergency and warranty replacement parts may be ordered from the following address. Be sure to include the equipment model number, serial number, part description, and part number. Non-emergency replacement parts may be ordered directly from the Broadcast Electronics stock room at the number shown below.

RF TECHNICAL SERVICES

Telephone: +1 (217) 224-9617
E-Mail: rfservice@bdcast.com
Fax: +1 (217) 224-6258

FACILITY CONTACTS

Broadcast Electronics, - Quincy Facility
4100 N. 24th St. P.O. BOX 3606
Quincy, Illinois 62305
Telephone: +1 (217) 224-9600
Fax: +1 (217) 224-6258
General E-Mail: bdcast@bdcast.com
Web Site: www.bdcast.com

PARTS

Telephone: +1 (217) 224-9617
E-Mail: parts@bdcast.com

RETURN, REPAIR, AND EXCHANGES

Do not return any merchandise without our written approval and Return Authorization. We will provide special shipping instructions and a code number that will assure proper handling and prompt issuance of credit. Please furnish complete details as to circumstances and reasons when requesting return of merchandise. All returned merchandise must be sent freight prepaid and properly insured by the customer.

MODIFICATIONS

Broadcast Electronics, reserves the right to modify the design and specifications of the equipment in this manual without notice. Any modifications shall not adversely affect performance of the equipment so modified.

SAFETY PRECAUTIONS

PLEASE READ AND OBSERVE ALL SAFETY PRECAUTIONS

ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES, POWER TRANSISTORS, OR EQUIPMENT WHICH UTILIZES SUCH DEVICES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. EXERCISE EXTREME CARE AROUND SUCH PRODUCTS. UNINFORMED OR CARELESS OPERATION OF THESE DEVICES CAN RESULT IN POOR PERFORMANCE, DAMAGE TO THE DEVICE OR PROPERTY, SERIOUS BODILY INJURY, AND POSSIBLY DEATH.

DANGEROUS HAZARDS EXIST IN THE OPERATION OF POWER TUBES AND POWER TRANSISTORS

The operation of power tubes and power transistors involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel.

A. HIGH VOLTAGE - Normal operating voltages can be deadly. Additional information follows.

B. RF RADIATION - Exposure to RF radiation may cause serious bodily injury possibly resulting in Blindness or death. Cardiac pacemakers may be affected. Additional information follows.

C. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched. Additional information follows.

D. RF BURNS - Circuit boards with RF power transistors contain high RF potentials. Do not operate an RF power module with the cover removed.

HIGH VOLTAGE

Many power circuits operate at voltages high enough to kill through electrocution. Personnel should always break the primary AC Power when accessing the inside of the transmitter.

RADIO FREQUENCY RADIATION

Exposure of personnel to RF radiation should be minimized, personnel should not be permitted in the vicinity of open energized RF generating circuits, or RF transmission systems (waveguides, cables, connectors, etc.), or energized antennas. It is generally accepted that exposure to "high levels" of radiation can result in severe bodily injury including blindness. Cardiac pacemakers may be affected.

The effect of prolonged exposure to "low level" RF radiation continues to be a subject of investigation and controversy. It is generally agreed that prolonged exposure of personnel to RF radiation should be limited to an absolute minimum. It is also generally agreed that exposure should be reduced in working areas where personnel heat load is above normal. A 10 mW/cm^2 per one tenth hour average level has been adopted by several U.S. Government agencies including the Occupational Safety and Health Administration (OSHA) as the standard protection guide for employee work environments. An even stricter standard is recommended by the American National Standards Institute which recommends a 1.0 mW/cm^2 per one tenth hour average level exposure between 30 Hz and 300 MHz as the standard employee protection guide (ANSI C95.1-1982).

RF energy must be contained properly by shielding and transmission lines. All input and output RF connections, such as cables, flanges and gaskets must be RF leak proof. Never operate a power tube without a properly matched RF energy absorbing load attached. Never look into or expose any part of the body to an antenna or open RF generating tube or circuit or RF transmission system while energized. Monitor the tube and RF system for RF radiation leakage at regular intervals and after servicing.

HOT SURFACES

The power components in the transmitter are cooled by forced-air and natural convection. When handling any components of the transmitter after it has been in operation, caution must always be taken to ensure that the component is cool enough to handle without injury.

Table of Contents

Figures

Tables

1 Overview

This document is intended to give basic operation instructions for VPe systems installed in Broadcast Electronic's digital exciters.

After initial setup, the system is designed to function autonomously without user intervention. Direct control and status inquiries minimally require local IP network access to the VPe system.

Table 1 - Specifications

Parameter	Specification
Environmental	
Temperature	-10°C to +50°C
Altitude	10,000ft (3048M) maximum
Humidity	95% maximum, non-condensing
RF	
RF Feedback Input	0dBm +/- 10dB

1.1 Instructions

Place this manual with your exciter operation manual. Perform the actions listed in order to monitor and operate VPe in an FM broadcast system.

1.2 Theory of Operation

The primary purpose of the VPe system is application of non-linear adaptive pre-correction. This control method improves an FM transmitter's linearity and efficiency, especially when operating high peak to average modulation signals through class AB power amplifiers.

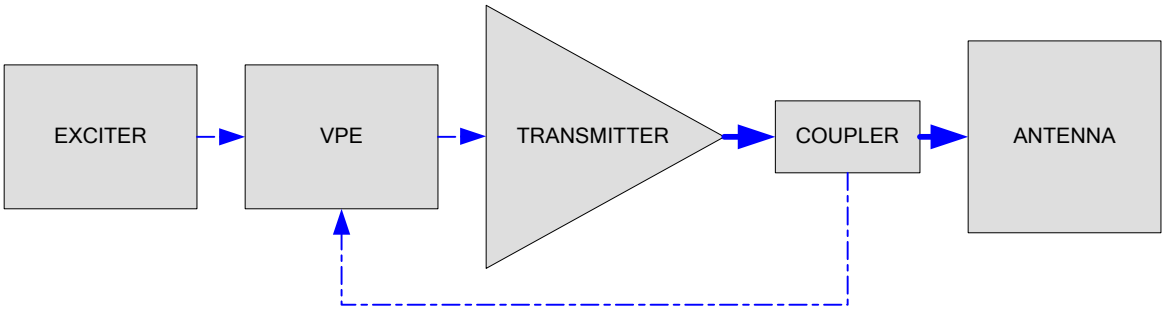

Figure 1 – Transmission System with VPe

To accomplish this control, VPe is inserted in the RF chain between the exciter and power amplification. A feedback signal input to VPe must be sourced from an RF coupler located after power amplification. Adaptive pre-correction algorithms compare the exciter RF to the (distorted) RF output from the transmitter. VPe adds a correction signal to output RF based on the errors in comparison of RF in and feedback. The correction process is intended to be continuous and iterative. Iterations typically take 10 to 15 seconds per cycle, and improvements in spectral intermodulation performance can be observed on the spectrum immediately.

Center frequency changes made in the exciter propagate to VPe via internal digital communications. All other control and monitoring occurs through Ethernet networking. An HTTP graphical user interface can be accessed by directing a web browser to the assigned IP address (192.168.168.168 by default). An SNMP agent is also included in VPe. Access to the MIB and SNMP configurations, including traps, can be gained through the HTTP interface.

1.3 Installation Documents

Please see relevant sections of your exciter's quick installation guide. This guide is delivered with standard BE exciter packages, and can also be found at http://bdcast.com/information-center/application-guides/.

If VPe is not installed in your system, please see the appropriate VPe Upgrade and Quick Installation Guide. This is delivered with any standard VPe upgrade package, and can also be ound at http://bdcast.com/information-center/application-guides/.

1.4 Software Upgrade

Software upgrade guides are posted as technical bulletins on the BE website at http://bdcast.com/information-center/. To view all guides that may have been a part of past technical bulletins, check the application guides section of the BE website.

2 Web Page

VPe is equipped with a built in HTTP web server. This requires networking equipment connections to the appropriate RJ45 connector, and a computer with standard web browser installed. To connect, direct your web browser to the address setting in VPe (setup during initial installation).

MODIFICATION OF ADVANCED SETTINGS MAY CAUSE VPE TO OPERATE IN A WAY THAT DAMAGES TRANSMISSION EQUIPMENT OR CAUSES THE SYSTEM TO FAIL TO MEET LOCAL REGULATIONS. IT IS THE RESPONSIBILITY OF THE SYSTEM ADMINISTRATOR/OPERATOR TO ENSURE SAFE AND ADEQUATE SYSTEM OPERATION THAT MEETS LOCAL REGULATORY REQUIREMENTS.

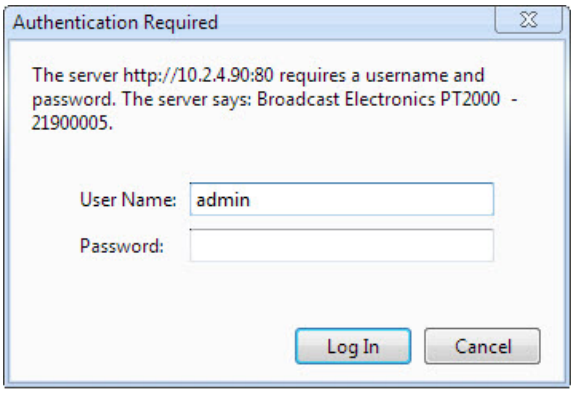

Figure 2 – Web Login

To access the various system elements in the following sections, simply click and hold the desired system element and then drag it to one of the three columns below the diagram as shown for the Adaptive Precorrection block example in Figure 3 below. Graphical frames – such as "REFERENCE" and input/output indicators can also be manipulated in this manner. Also note that in select menus, "+…" to the right may be clicked to expand the interface and see additional options.

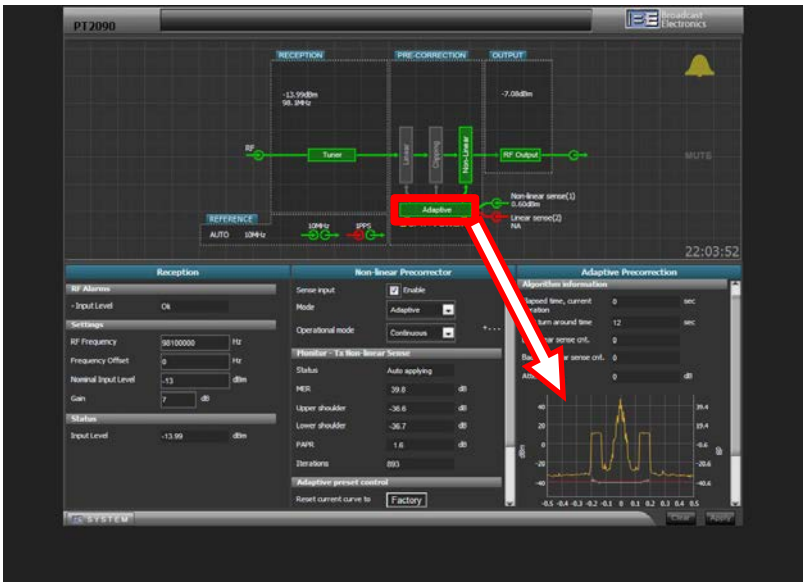

Figure 3 - Typical Drag and Drop

2.1 Reception

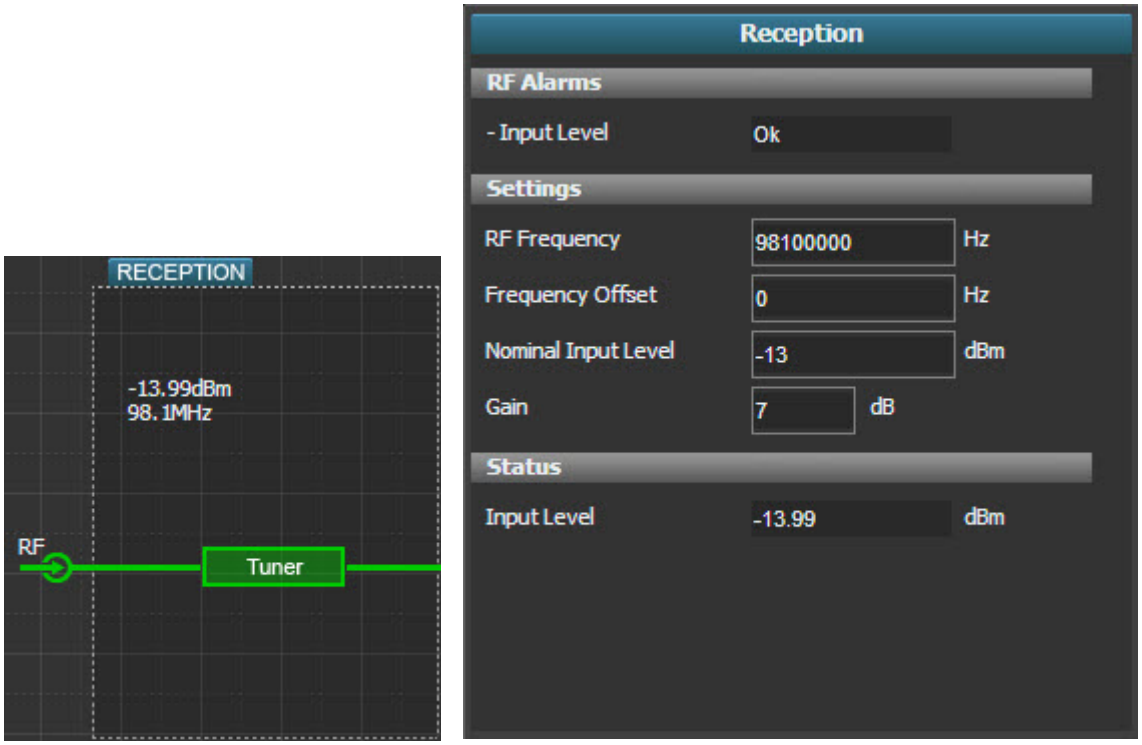

Figure 4 – Reception Control

This system component refers to internal VPe RF input from the exciter RF output.

Input Level alarm will activate if RF is outside the acceptable range. This may occur when the exciter is muted or if the cable between the exciter and VPe is not properly connected.

Settings for proper operation:

1. RF Frequency should automatically change with any frequency change in the exciter.
2. Frequency Offset should be 0.
3. Nominal Input Level setting should be approximately 1 dB higher than the actual input level. Actual level varies based on installation/setup, and the measured level is displayed under Status and Input Level.
4. Gain should be set to 7 dB to maintain correct dynamic range levels.

2.2 Reference

Figure 5 – Reference Control

Reference status and controls of interest in VPe applications relate to 10MHz. Internal and External 10MHz should be "Ok". If the 10MHz indicators are not green/ok there may be a problem with the 10MHz input connection to VPe.

Recommended/Typical settings for Reference controls are shown in Figure 5.

2.3 Output

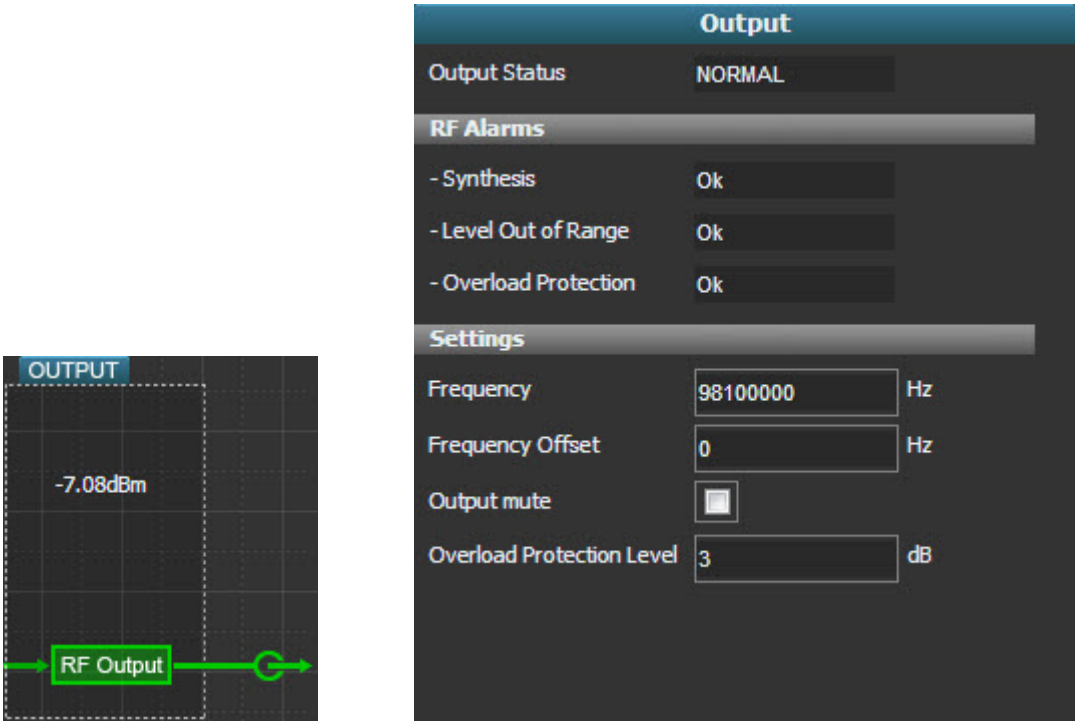

Figure 6 – Output Control

RF Output from VPe is a modified RF input signal with changes based on Precorrection control. Output frequency should match RF input setting, as should Frequency Offset.

Ensure that the mute checkbox labeled "Output mute" is not checked – VPe should not be muted. If it is, please see section 3.2 Troubleshooting Mute immediately.

2.4 Non-linear Precorrector

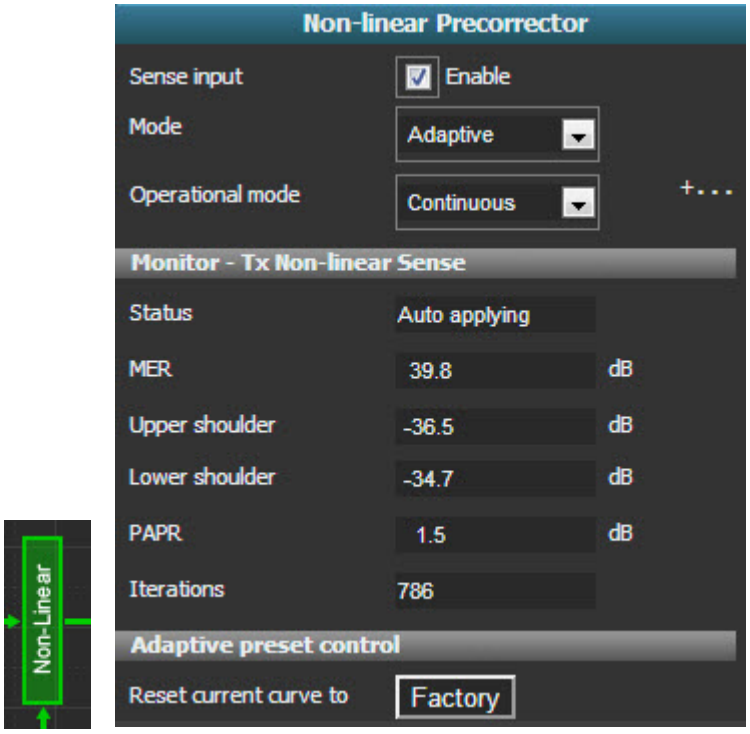

Figure 7 – Non-linear Precorrector Control

Always check Enable for the Non-linear sense input (feedback from the transmission line coupler).

Mode should be set to Adaptive and Operational mode should be Continuous. Other modes should not be used in VPe system installations.

If there are substantial changes to the broadcast system that may affect amplification characteristics, such as swapped power amplifiers in the transmitter, the non-linear precorrector may not adapt to the new characteristics quickly. To get the system running optimally as fast as possible, non-linear precorrection should be reset to a default initial control state. As with initial setup, if possible, the transmission system should be run at total output power into a test load while VPe analyzes and correct the signal.

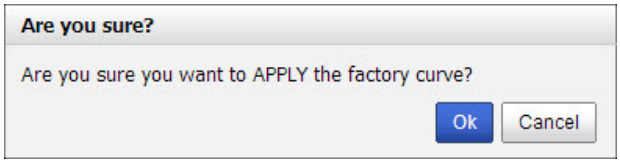

Figure 8 – Resetting the Non-linear Precorrector

To start this adaptation re-initialization, click the "Factory" button which can be seen in the bottom of Figure 7, and click Ok in the dialog box that pops up.

2.5 Adaptive Precorrection

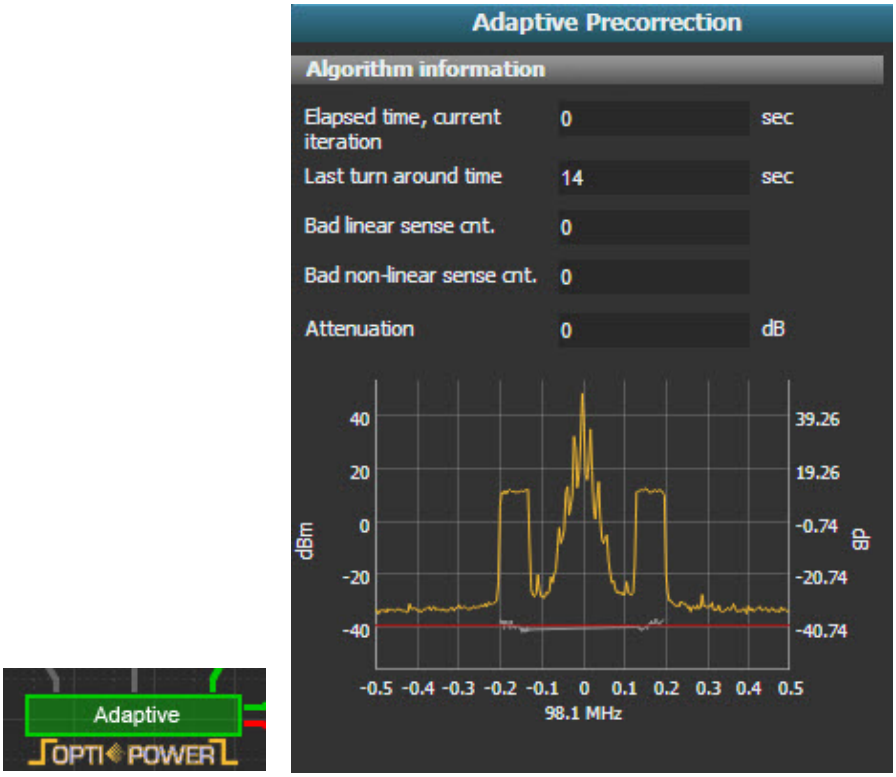

Figure 9 – Adaptive Precorrection Control

The Adaptive Precorrection panel provides various monitoring parameters, including a built-in spectrum analyzer, from analysis of the Non-linear sense feedback RF input. To view a full-page version of the spectrum analyzer as shown in Figure 10 below, simply click anywhere on the smaller version shown in the bottom of Figure 9.

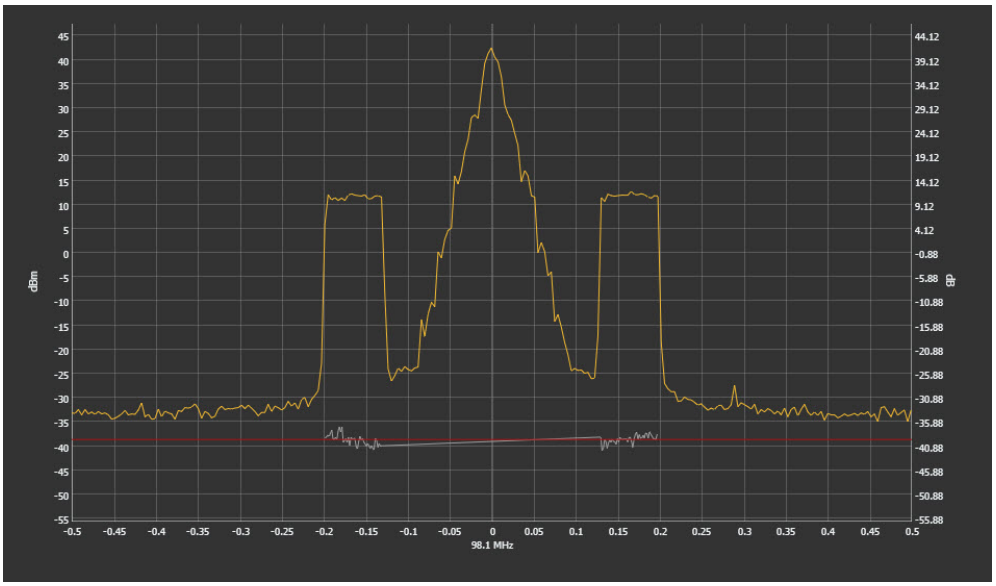

Figure 10 – Built-in Spectrum Analyzer

3 Troubleshooting

3.1 Events and Alarms

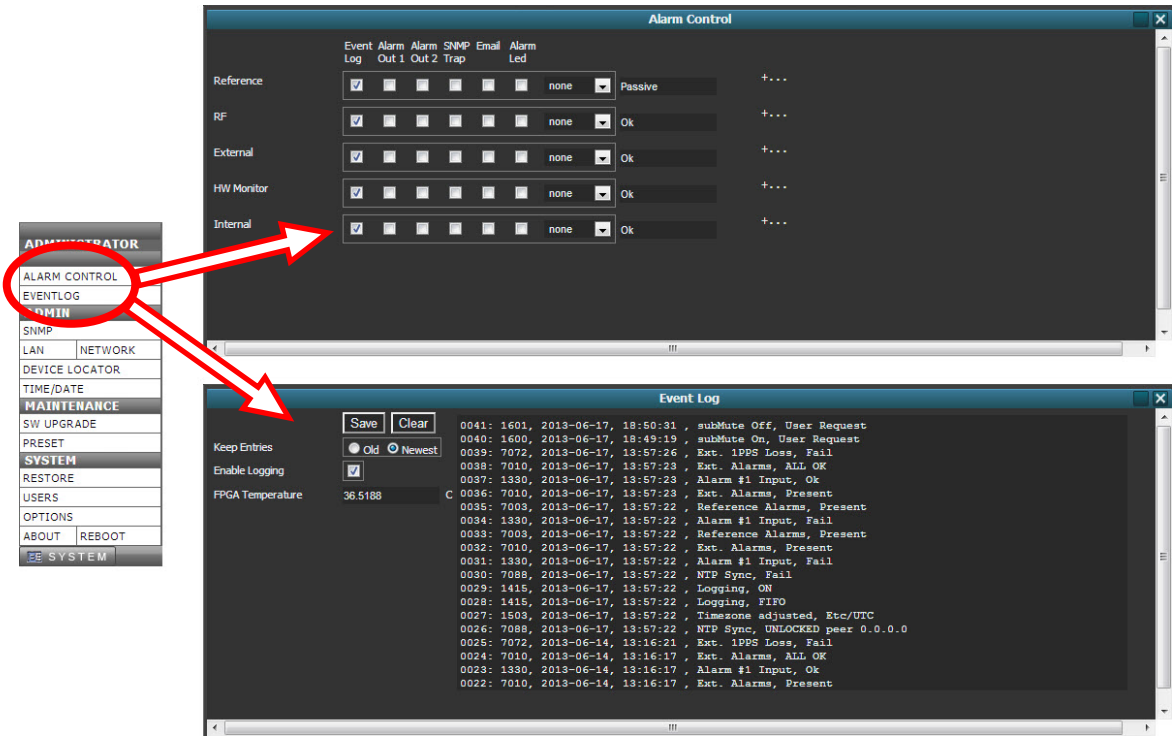

Figure 11 – Alarm Control and Event Log

VPe allows very specific control over alarm notifications and automatic responses to any active alarms. By default, all alarm activations are logged in the internal Event Log. Through use of Alarm Control shown in Figure 11, alarm notifications for unutilized systems can be disabled or have the notification escalated to SNMP traps, Email notifications, or even trigger mute or reboot of the VPe system.

3.2 Mute

An RF output mute in VPe can be easily monitored by dragging the MUTE indicator (right side of the system block diagram) to one of the control columns, see Figure 12.

IF VPE IS MUTED FOR ANY REASON, MUTE THE EXCITER BEFORE ATTEMPTING TO RESUME OPERATION. FAILURE TO DO THIS MAY RESULT IN AN INITIAL SPIKE IN TOTAL POWER OUT THAT CAN DAMAGE EQUIPMENT.

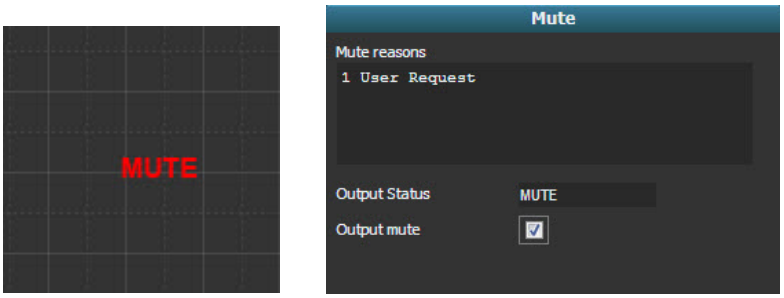

Figure 12 – Mute Status

FXI WITH IBOC AND VPE
SYSTEM CONNECTIONS BLOCK DIAGRAM

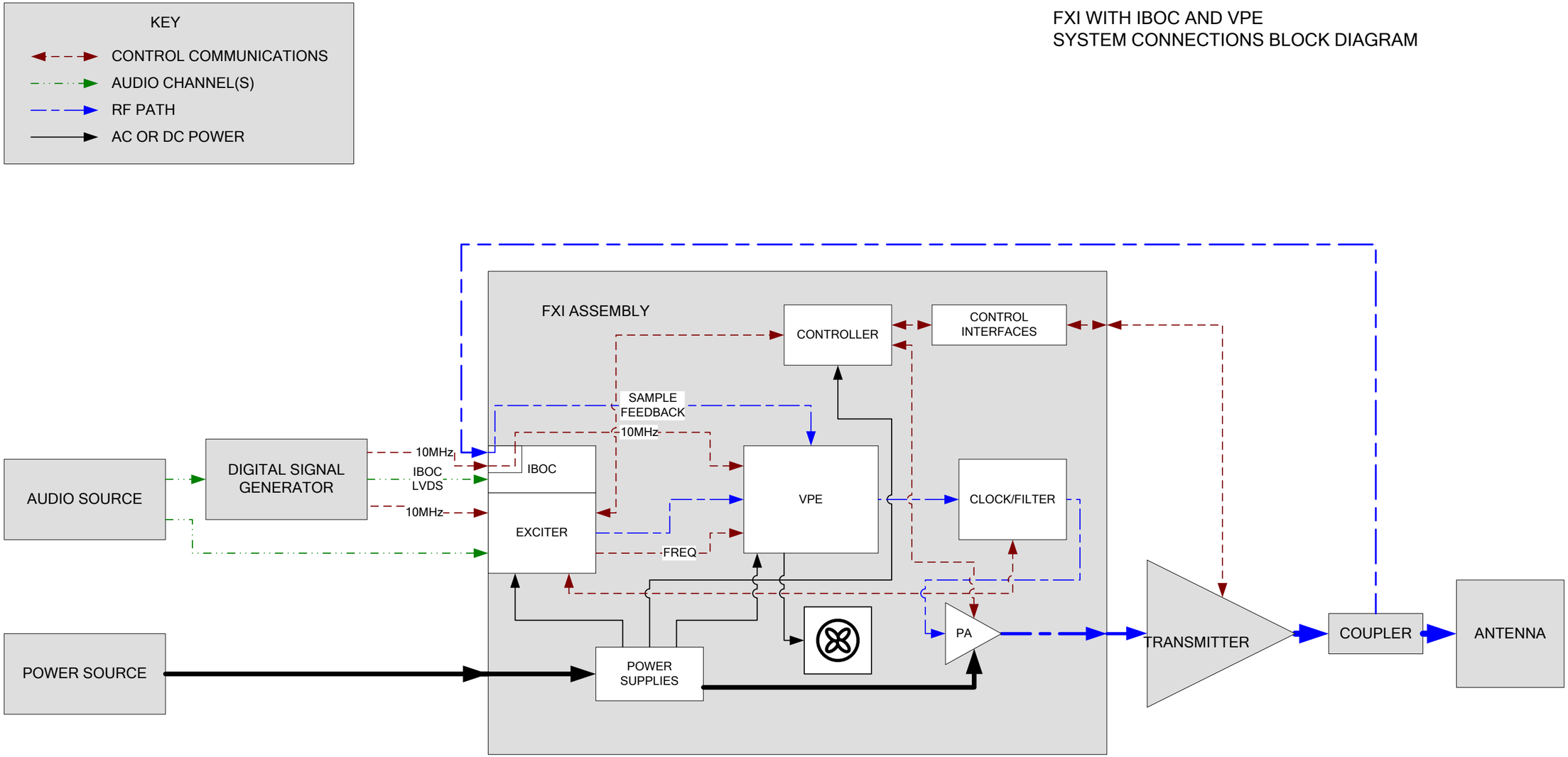

Figure 13 – VPe in IBOC FXi System Block Diagram

FXI WITH EXGINE AND VPE
SYSTEM CONNECTIONS BLOCK DIAGRAM

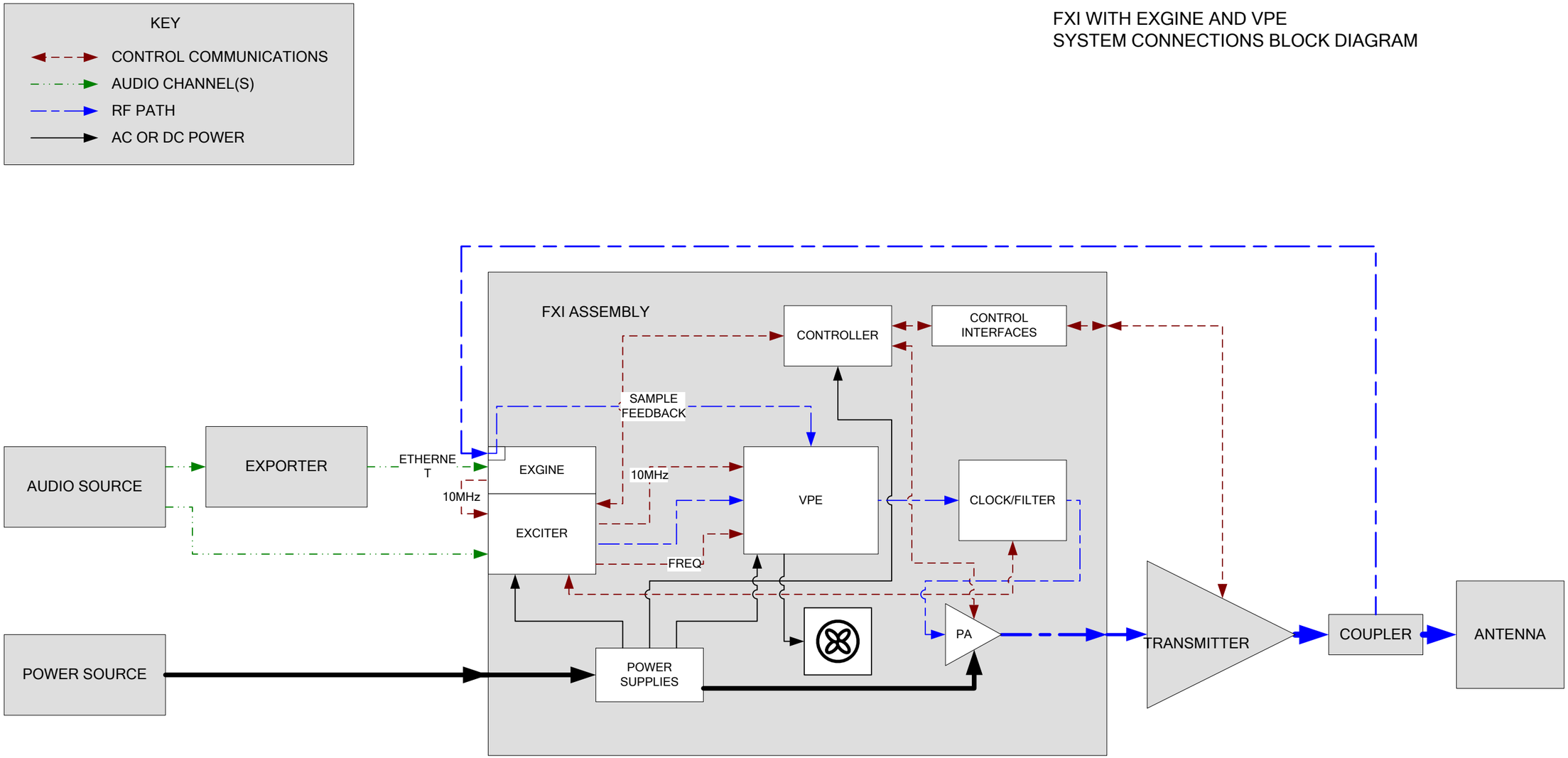

Figure 14 – VPe in Exgine FXi System Block Diagram