# DX-200 Digital Medium Wave Transmitter ACC Board (Floating Carrier Control Board) Fault Analysis and Post-Processing Printout

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## Abstract

The ACC control board in the DX-200 all-solid-state medium wave transmitter employs floating carrier control technology, which can effectively conserve energy. Currently, all DX series transmitters adopt this technology, implementing floating carrier control whereby the carrier level varies in accordance with the amplitude of the input audio signal. This maximizes energy savings without compromising reception quality.

## Full Text

## Preamble

### Fault Analysis and Handling of the ACC Board (Floating Carrier Control Board) in the DX-200 Digital Medium-Wave Transmitter

**Abstract:** The ACC control board in the DX-200 all-solid-state medium-wave transmitter employs floating carrier control technology, which effectively saves energy. Currently, the entire DX series of transmitters utilizes this technology to implement floating carrier control, wherein the carrier level varies with the amplitude of the input audio signal. This maximizes energy savings without compromising listening quality.

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## 1. Overview

Our station operates two DX-200 transmitters manufactured by Harris Corporation of the United States. These are air-cooled, fully digital medium-wave AM transmitters whose front-end audio systems employ an ACC floating carrier control system. This control circuit maintains constant sideband power while linearly increasing carrier power with modulation depth, thereby achieving substantial cost savings without affecting listening quality. However, when the ACC floating carrier control board fails during broadcasting, the transmitter loses audio output while retaining carrier output, effectively resulting in dead air. Maintaining broadcast continuity then requires switching the audio input signal path.

The floating carrier control system is illustrated in Figure 1 [Figure 1: see original paper]. The audio processor output signal splits into two paths: one enters the ACC floating carrier control circuit (within the dashed box) and, after processing, outputs a composite audio signal comprising audio, DC, and triangular wave components. Through the full-carrier/floating-carrier control switch S1, the transmitter can be switched between either operating mode. The other path bypasses the ACC board directly to the transmitter interface board and then to the analog audio input board when the ACC board fails. This emergency mode forces the transmitter to operate in full-carrier state for maintaining broadcast continuity, but requires changing jumpers JP7 and JP8 on the "analog input board" from DC mode to AC mode, and adjusting the variable resistor R56 that controls carrier power output to its maximum position to achieve the 2.6V DC level required for full-carrier operation.

## 2. Principle of ACC Floating Carrier Control System

The primary function of the ACC floating carrier control system is to process the audio signal input through terminal J10. The signal passes through a Bessel filter, balanced/unbalanced conversion circuit, differential amplifier U21, and audio driver amplifier. The resulting "audio + DC signal" is combined with the DC signal from the analog input board that controls carrier output power, forming a composite "audio + DC + triangular wave" signal in the analog audio input path. The audio component controls the transmitter's modulation depth, the DC component controls the output carrier level, and the 72 kHz triangular wave improves resolution and reduces quantization distortion after A/D conversion. The amplitude of the 72 kHz triangular wave approximates the quantization voltage of the E-stage.

The A/D conversion control circuit transforms the input analog signal into 12-bit data via A/D converter U16. This 12-bit data is address-stored in memories U9 and U10, and the address output remains 12-bit data that varies with the selected curve. At low modulation (m = 50%), carrier power is typically preset to one-quarter of full carrier power (-6 dB), returning to full carrier power at m = 80% modulation. At one-quarter carrier power, high modulation often occurs, meaning the sideband power is greater than at normal carrier power. This reduces power consumption while maintaining sideband power equivalent to normal carrier operation.

## 3. Faults and Handling

During operation, multiple failures of the floating carrier control board have caused broadcast interruptions. The causes and handling methods are described below.

### 3.1 Power Supply Fault

**Fault Symptoms:** The transmitter had no audio output, only carrier output. Observation of the ACC floating carrier board revealed that the +15V power status indicator DS5 was extinguished, indicating loss of +15V power.

**Fault Cause:** Measurement at test point TP6 of the three-terminal regulator showed zero voltage. The fuse was blown, and the three-terminal regulator U18 (model LT1085CT) was damaged.

**Fault Handling:** The fuse and three-terminal regulator were replaced.

**Fault Analysis:** After replacing the fuse and regulator, power was not immediately applied. A thorough analysis was conducted to identify the root cause. The ACC floating carrier control board receives two low-voltage supplies from the low-voltage power board at terminals J1-4 and J1-6: +18V and -18V. Following the J1-4 path, the +18V power fuse was found blown; however, the voltage at the fuse holder input was 18V, which was normal. The power filter capacitors C51 and C72 before and after the three-terminal regulator U18 were normal, but filter capacitors C121 and C124 were measured and found to have issues. Capacitor C121, an electrolytic filter capacitor, was bulging and leaking. Upon removal and measurement, its insulation was severely degraded, causing damage to the three-terminal regulator and fuse at the moment of power-on.

### 3.2 Audio Signal Control Path Fault

**Fault Symptoms:** When powering on the transmitter at high power, there was no audio output, only carrier output. During switching between high, medium, and low power levels, the transmitter automatically shut down, though any power level could be selected for startup.

**Fault Cause:** The differential amplifier on the ACC floating carrier control board was damaged.

**Fault Handling:** The differential amplifier U21 (AD620) could not be replaced immediately due to time constraints. The system was switched to the backup transmitter, and the ACC floating carrier control board was bypassed. The signal was routed directly to the transmitter's "analog audio input board" through switch S2. However, after switching the signal via S2, the transmitter would not operate. Based on circuit analysis, the operating mode of the "analog audio input board" was changed by switching jumpers JP7 and JP8 from DC mode to AC mode. The DC level controlling carrier power output on the "analog audio input board" was adjusted to maximum via variable resistor R56, after which the transmitter operated continuously in full-carrier mode.

**Fault Analysis:** Upon powered measurement, signal input was present at terminals J10-1 and J10-3, and at the non-inverting and inverting inputs of the differential amplifier. However, no signal appeared after the differential amplifier U21 (AD620). Measurements of surrounding capacitors, resistors, and supply voltages were all normal, leading to the determination that differential amplifier U21/AD620 had failed. After replacement, on-air testing returned normal operation. During transmitter operation, if ACC floating carrier control board failure occurs, the entire board must be bypassed and the audio signal rerouted directly to the "analog audio input board." Simultaneously, jumpers JP7 and JP8 on the "analog input board" must be switched from their original DC operating mode to AC mode, and the variable resistor R56 controlling carrier power output must be adjusted to maximum; otherwise, the transmitter cannot operate normally.

Ensuring reliable, stable, and efficient transmitter operation is paramount for broadcast station maintenance. Equipment maintenance personnel must thoroughly master the working principles of all system components to rapidly analyze fault causes, locate faulty sections, and implement appropriate corrective actions. Preventive measures and early fault detection eliminate issues before they cause interruptions, ensuring high-quality, continuous, economical, and safe operation.

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*Note: Figure translations are in progress. See original paper for figures.*