Harbin Broadcasting 50kW DAM Digital Circulating Transmitter High Voltage Application Failure Report

Authors: Zheng Jinyan

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Abstract

The fault was neither a typical +5V DC voltage regulator board failure nor a complete burnout of the low-voltage rectifier bridge. Apart from manifesting as continuous relay switching, the initial failures exhibited no display indication, thereby presenting certain difficulties for complete fault elimination.

Full Text

Fault Analysis of Harbin Guang 50KW DAM Digital Cycle Transmitter Unable to Apply High Voltage

Abstract: This paper investigates a non-typical fault in the Harbin Guang 50KW DAM digital cycle transmitter where high voltage cannot be applied. Unlike conventional failures involving complete burnout of the DC voltage regulator board +5V or the low-voltage rectifier bridge, this fault manifested primarily through continuous relay switching actions. In several initial incidents, the display provided no fault indication whatsoever, significantly complicating comprehensive troubleshooting and resolution.

Keywords: relay; voltage; rectifier bridge

For medium-wave digital modulation transmitters, the inability to apply high voltage constitutes a Class I fault. There are nine categories of Class I faults: (1) external interlock fault; (2) door interlock fault; (3) high-voltage power supply phase loss fault; (4) cable interlock fault; (5) fan fault; (6) RF output monitoring board $±$5V fault; (7) high-voltage power supply overvoltage fault; (8) DC voltage regulator board +5V fault; and (9) DC voltage regulator board B- fault. When Class I faults occur, the transmitter's display typically shows a fault indication that does not clear automatically. However, the 1125KHz host unit, which uses the Harbin Guang 50KW DAM digital cycle transmitter, exhibited this fault without any display indication, making diagnosis and resolution considerably more challenging.

The first occurrence of this fault at the 1125KHz host was on December 6, 2016. Sometimes the unit showed no fault indication; after resetting or cycling low voltage power, the fault display would disappear. The transmitter would operate normally on low voltage, but when high voltage was applied, the following phenomena occurred: (1) The K1 relay would engage while K2 remained inactive, with K1 subsequently switching on and off repeatedly; or (2) Both K1 and K2 relays would engage, but K2 could not maintain its state, causing K1 to begin repetitive switching.

Initially, we suspected poor contact in the K1 relay and replaced it with a new unit (without replacing the relay base). The fault temporarily disappeared. The power-on logic path is as follows: A38(XS1-1) → A38(N2-66 K1 drive) → A38(N23-2) → A38(N23-18) → A38(XS7-11) → A60(X5) → A60(X6-7,8) → K1 energized (JX3-2) → A38(XS8-2, K1 closed, -H, 22V) → A38(N2-17, K1 engaged) → A38(N2-67, K2 drive) → A38(N23-3, K2 drive) → A38(N23-17, K2 drive) → A38(XS7-7, K2 drive) → A38(X6-4,5) → K2 energized (JX3-1) → A38(X8-1) → A38(N2-18, K2 engaged). The logic block diagram is shown in [Figure 1: see original paper].

The specific inspection steps included checking the control board, power sampling board, DC voltage regulator board, and all fuses related to the relays. We also reseated wiring connectors related to K1 and K2 on the control and power sampling boards, and examined the auxiliary contact path for K1 and K2, all of which appeared normal with no loose connections.

2. Fault Handling Process

On March 30, 2017, at 8:40 PM during a thunderstorm, the 1125KHz transmitter experienced the same fault even with power reduced to 18KW. Following the original method, we replaced the relay again (still without replacing the base). After replacement, we tested the unit over twenty times, with the original fault occurring once or twice. The removed relay showed burnt contact surfaces, leading us to suspect the base was the cause. However, due to limited staffing and to avoid prolonged service interruption, we did not replace the base at that time. The main unit returned to service and operated without incident for the following week.

Diagnostic measurements revealed that the voltage from the relay control board to the control board was normal at 5V. The transistors V34 and V35 on the control board also tested normal. To determine whether the fault lay with the relays themselves, we shorted pins 2 and 3 of V11 and V12 on power sampling board A60. When V11 and V12 were shorted, K2 and K1 engaged normally, and released normally when the short was removed, indicating that K1 and K2 were functioning properly. Different operators observed different fault probabilities during startup tests, which led us to suspect the keypad. After removing and inspecting it, everything appeared normal.

On April 6, 2017, following an external power flicker, the 1125KHz transmitter experienced the same fault again. This time, we completely replaced the K2 relay (including its base) and began testing. During all startup tests, approximately 70% exhibited the repetitive switching phenomenon. The varying fault probabilities observed when different personnel operated the startup sequence also raised suspicions about a potential keyboard board issue, but removal and inspection revealed no abnormalities.

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