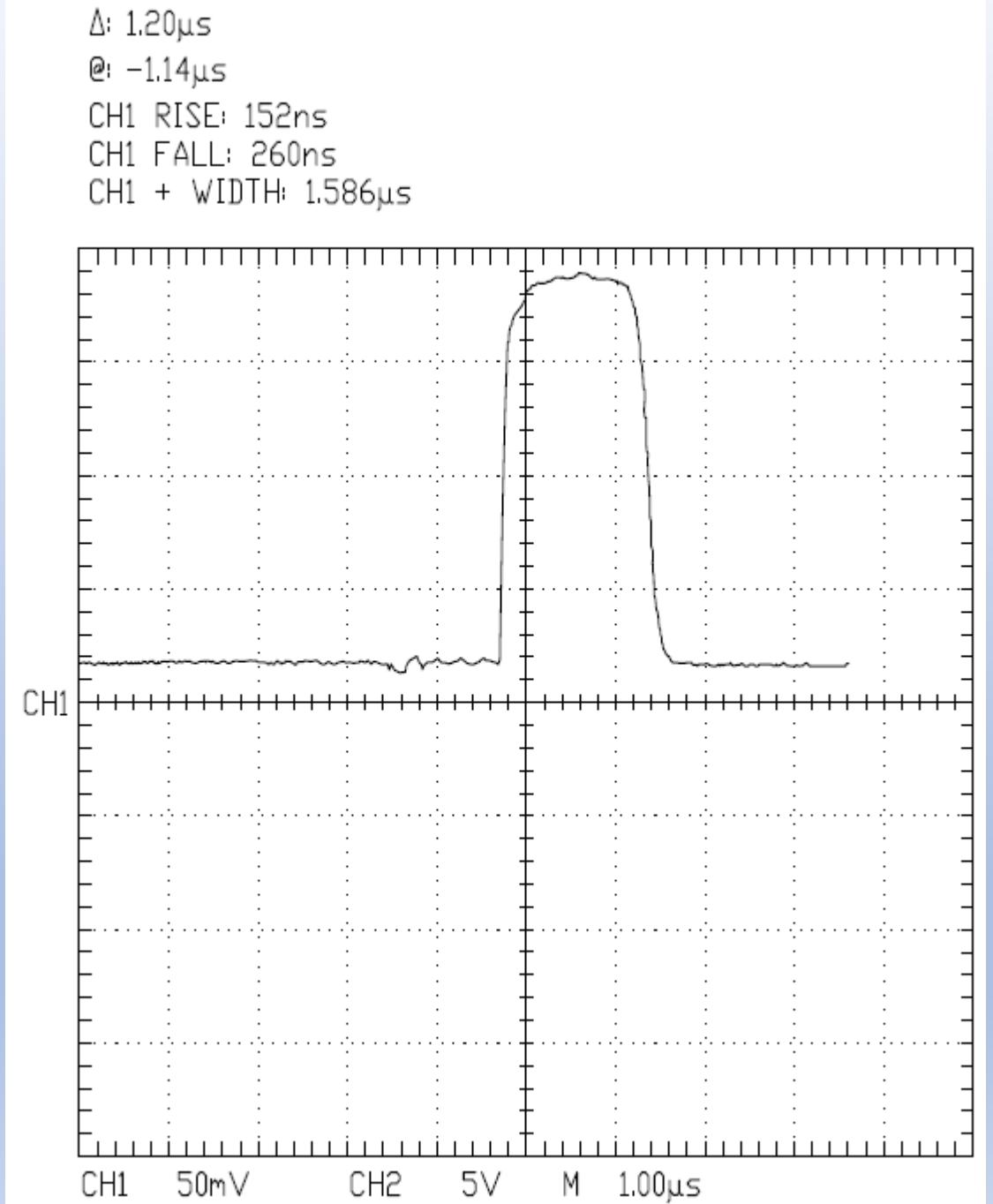
88D Transmitter Alignment

This is an online training version of the 88D alignment normally included in the National Weather Center's training facility

Objectives

- To be able to follow the procedures in the manual
- To properly make normal adjustments to the transmitter
- To successfully align the 88D transmitter
- To verify that the alignment is correct

The Output is the Goal !



The procedure is from the technical manual

NWS EHB 6-511

AF TO 31P1-4-108-112

FAA TI 6345.1 V8

This material is based on revision number 8, dated June 25th of 2020.

You should use the most current manual at all times which can be found at

https://www.roc.noaa.gov/WSR88D/Program/MaintenanceManuals.aspx

TECHNICAL MANUAL

OPERATIONS AND MAINTENANCE INSTRUCTIONS
TRANSMITTER SYSTEM

DOPPLER METEOROLOGICAL RADAR

WSR-88D

UNISYS CORPORATION
CONTRACT 50-DMNW-8-00032

OFFICE OF PRIMARY RESPONSIBILITY:
NATIONAL WEATHER SERVICE RADAR OPERATIONS CENTER

This revision supersedes NWS EHB 6-511 (AF TO 31P1-4-108-112, FAA TI 6345.1 V8), REVISION 7, 11 JANUARY 2017 and subsequent changes: CHANGE 1, 12 JUNE 2017, CHANGE 2, 26 MARCH 2018, and CHANGE 3, 15 JUNE 2019.

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25 JUNE 2020

Assumptions

You can identify components and adjustments in the transmitter. (section 3.2 controls and indicators of manual and Figure FO11-12 and Figure FO11-13 are good references)

You have aligned analog electronic equipment before this, ground based RADAR would be best.

You have the current manual with you.

The transmitter is an Amplifier

- The transmitter receives radio frequency power from the receiver and amplifies it to 700,000 +/- 50,000 Watts.
- The transmitter receives an 8 microsecond RF input from the receiver and outputs a 1.5 or 4.5 microsecond pulse.
- The transmitter operates in pulses. It doesn't continuously amplify.

Single and Redundant RADARs

- Unless otherwise specified, the procedures contained herein apply to the non-controlling channel only.
- Most of the final power amplifier alignment can be performed on the non-controlling channel while the transmitter is connected to its dummy load.
- However, some procedures require the transmitter to be connected to the antenna and the transmitter being aligned to be in the controlling channel.
- In the text of the procedures, the reference designations apply to the single channel configuration and to channel 2 of the redundant configuration.
- When performing these procedures on channel 1, substitute the corresponding reference designations shown
- “add 100 to the unit designator

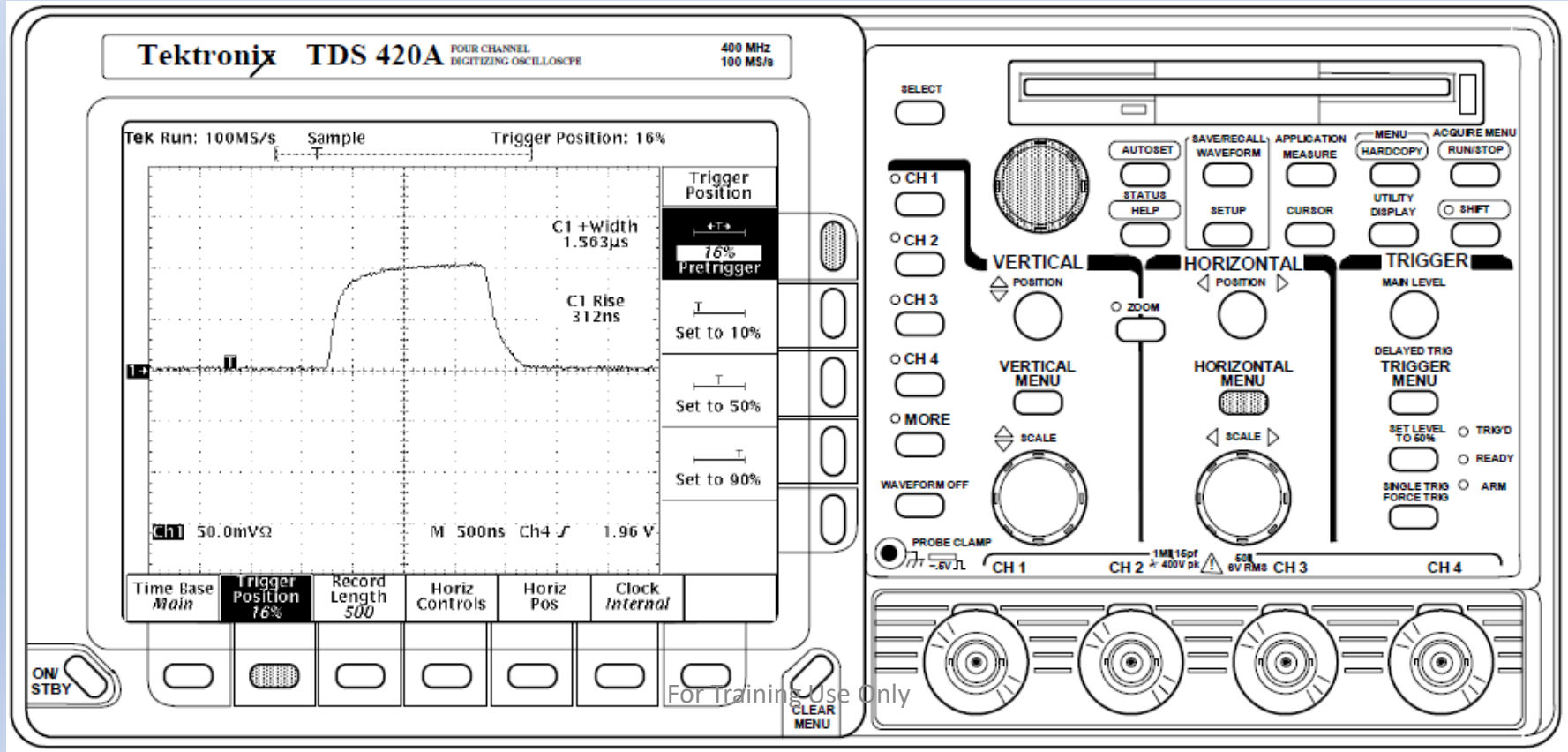
SINGLE CHANNEL OR CHANNEL 2 OF REDUNDANT CONFIGURATION	CHANNEL 1 (REDUNDANT CONFIGURATION ONLY)
All UD3 XX	UD103 XX
1W61	1W161
1AT4	1AT104

Test Equipment Skills

- The 88D program generally assumes the test equipment used is the test equipment the system was deployed with.
- The power meter heads are calibrated per section 3.4.4
- Be mindful of the power meter ranges as they will be destroyed by too much power
  - HP8484A - 70 dBm to -20 dBm
  - HP8481D - 70 dBm to -20 dBm
  - HP8481A - 30 dBm to +20 dBm
  - HP8481H - 10 dBm to +35 dBm

Test Equipment Skills

- Rise time and pulse width are measured with the oscilloscope. You will need to be able to do that with your oscilloscope.
  - Instructions are in the instructions for an analog and a digital scope. Note that the digital scope instructions are for a scope like a TDS 420A



Order of Alignments ref: 5.5.5 Final Power Amplifier Alignments.

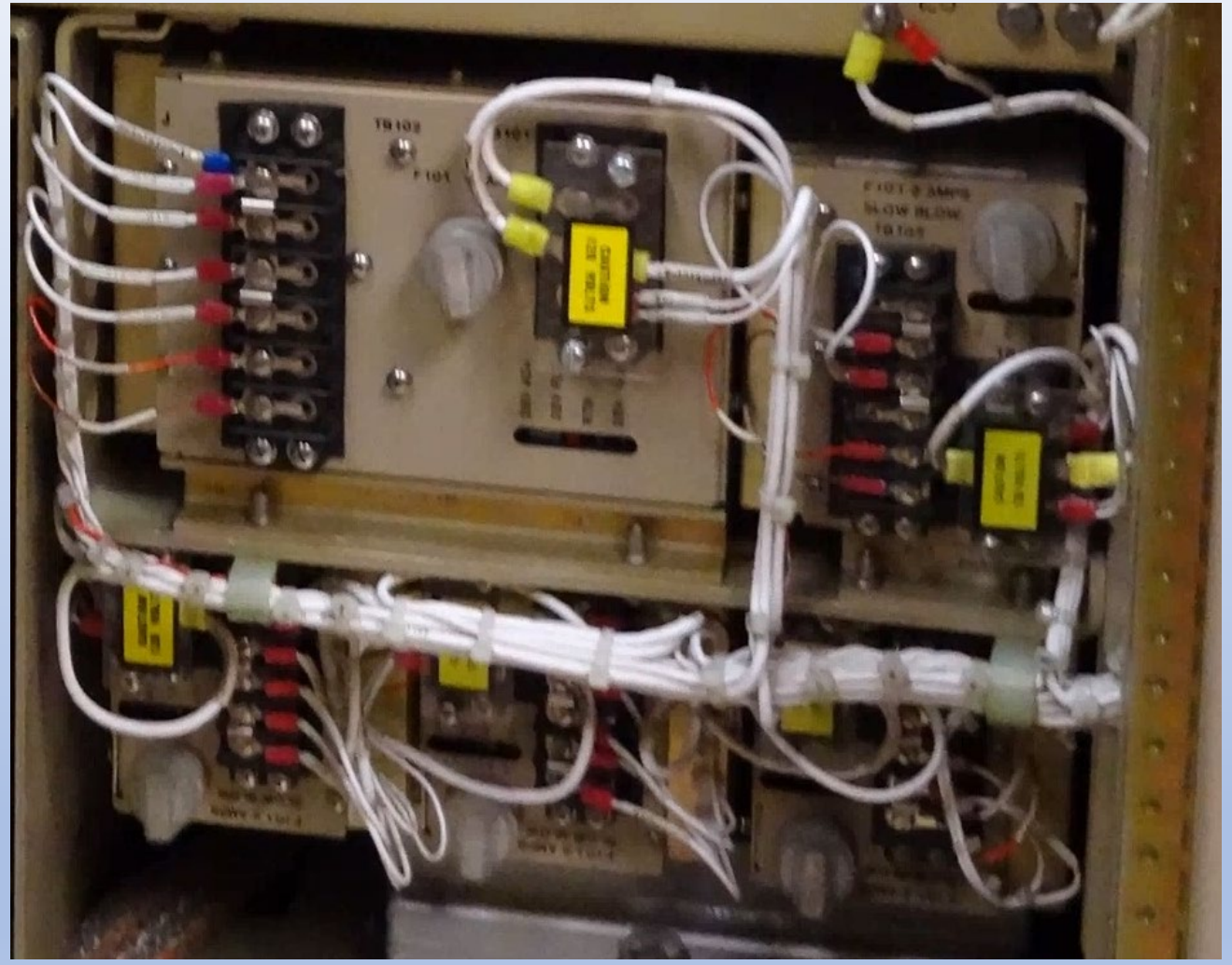
Procedure	Paragraph
Low Voltage Power Supply Alignment	5.5.2
PFN Voltage Calibration	4.5.5.5
Filament Current Adjustment	5.5.3
Focus Coil Current Adjustment	5.5.4
RF Drive Adjustment	5.5.8
RF Bracketing Adjustment	5.5.9
Klystron Transmitter Tuning	5.5.10
Spectrum Bandwidth Measurement	5.5.11
Transmitter Peak Power Out Measurement and Power Monitor Calibration	5.5.6

Stand-alone adjustments adjusted as needed

Procedure	Paragraph
Post Charge Regulator Alignments	5.5.7
Transmitter Pulse Width Alignment	5.5.12
VSWR Alignment	5.5.13
Transmitter Power Measurement Path Loss Calibration	5.5.15
Alarm Thresholds	5.5.16
Transmitter Parameter and Adjustment Record Card	5.5.17

Low Voltage Power Supply Alignment

- There are five low voltage power supplies that are checked.
- The voltage is measured at the power supply
- The voltage is measured at an in-circuit test point.
- The meter on the panel is checked and adjusted if needed.



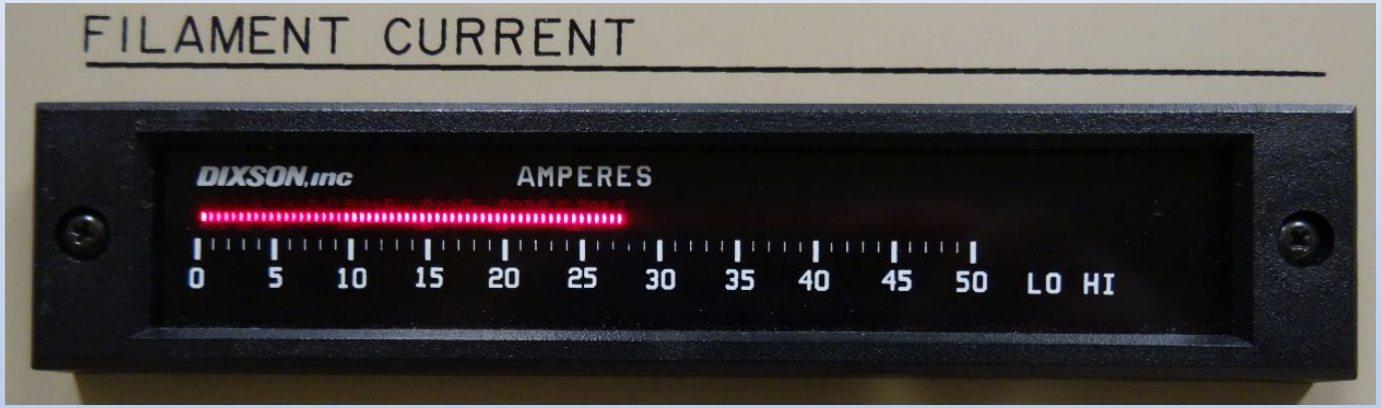
PFN Voltage Calibration

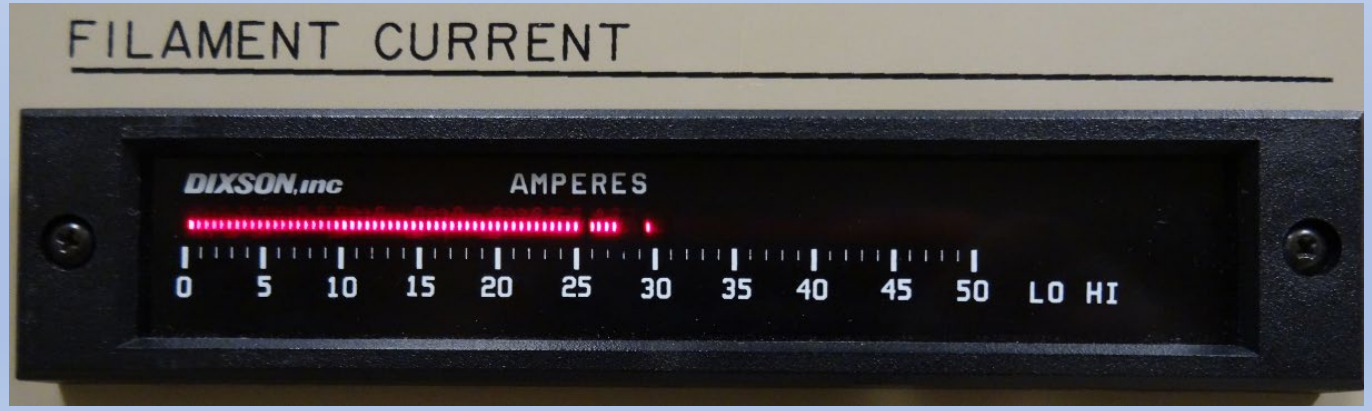
- The transmitter amplifies in pulses.
- The energy for the amplifier is stored in the “Pulse Forming Network”, the PFN
- The voltage on the PFN is displayed on a panel meter.
- The panel meter is checked and adjusted if necessary.

Filament Current Adjustment

- This adjustment sets the heater current for the klystron tube to the correct setting

- The adjustment also sets the alarm limits for the current



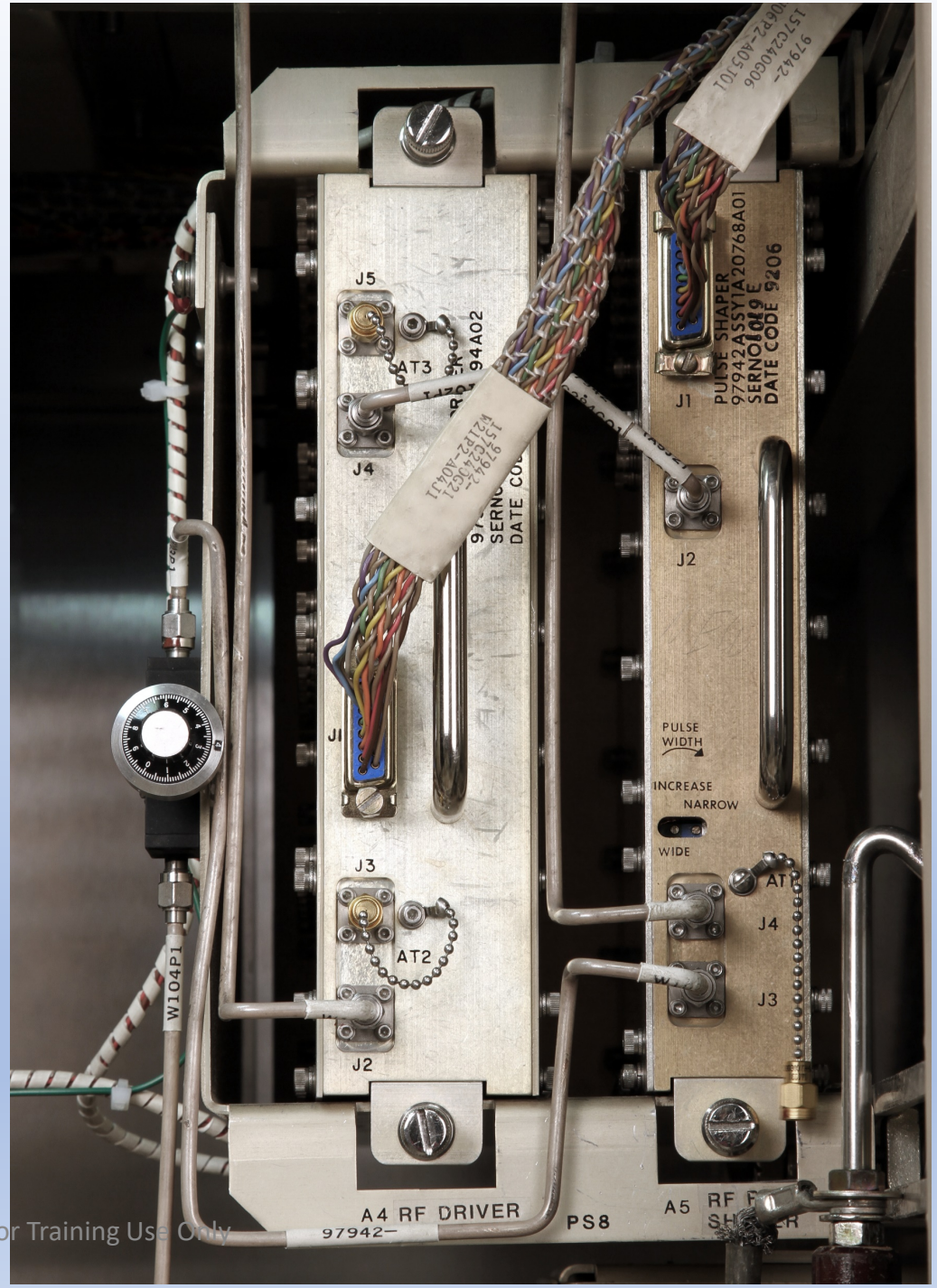


Focus Coil Current Adjustment

- The beam of electrons through the klystron tube is focused by the focus coil.
- The current through the focus coil is adjusted.
- The alarm limits are set.

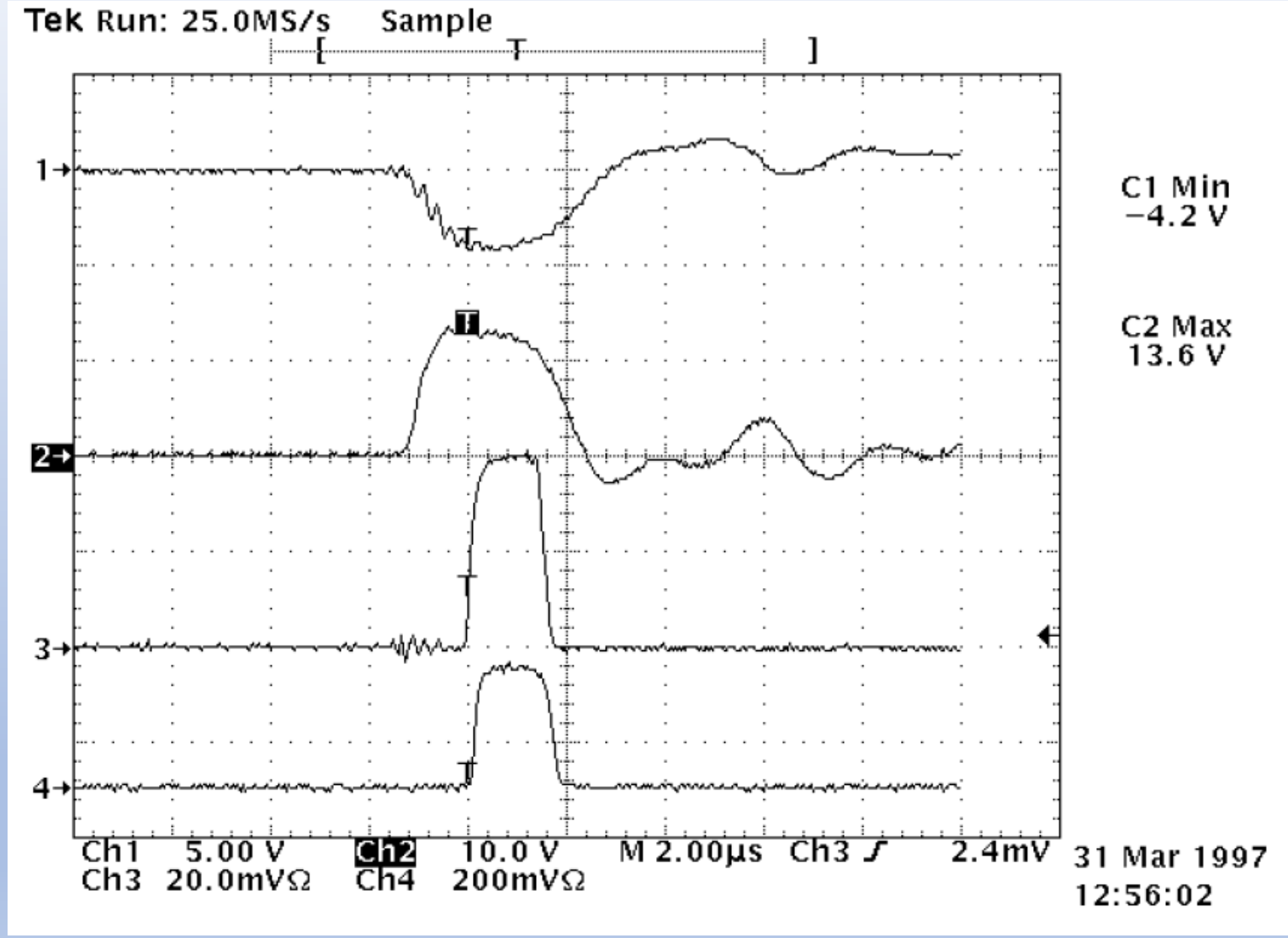
RF Drive Adjustment

- This procedure sets the input to the klystron tube.
- Pulse width in short/narrow
- Pulse width in long/wide
- Input power into the tube is set



RF Bracketing Adjustment

- This procedure sets the time relationship between the enabling of the klystron tube and the input pulse of RF.
- #1 waveform is voltage to the tube
- #2 waveform is current to the tube
- #3 waveform is the output of the tube
- #4 waveform is the input to the tube

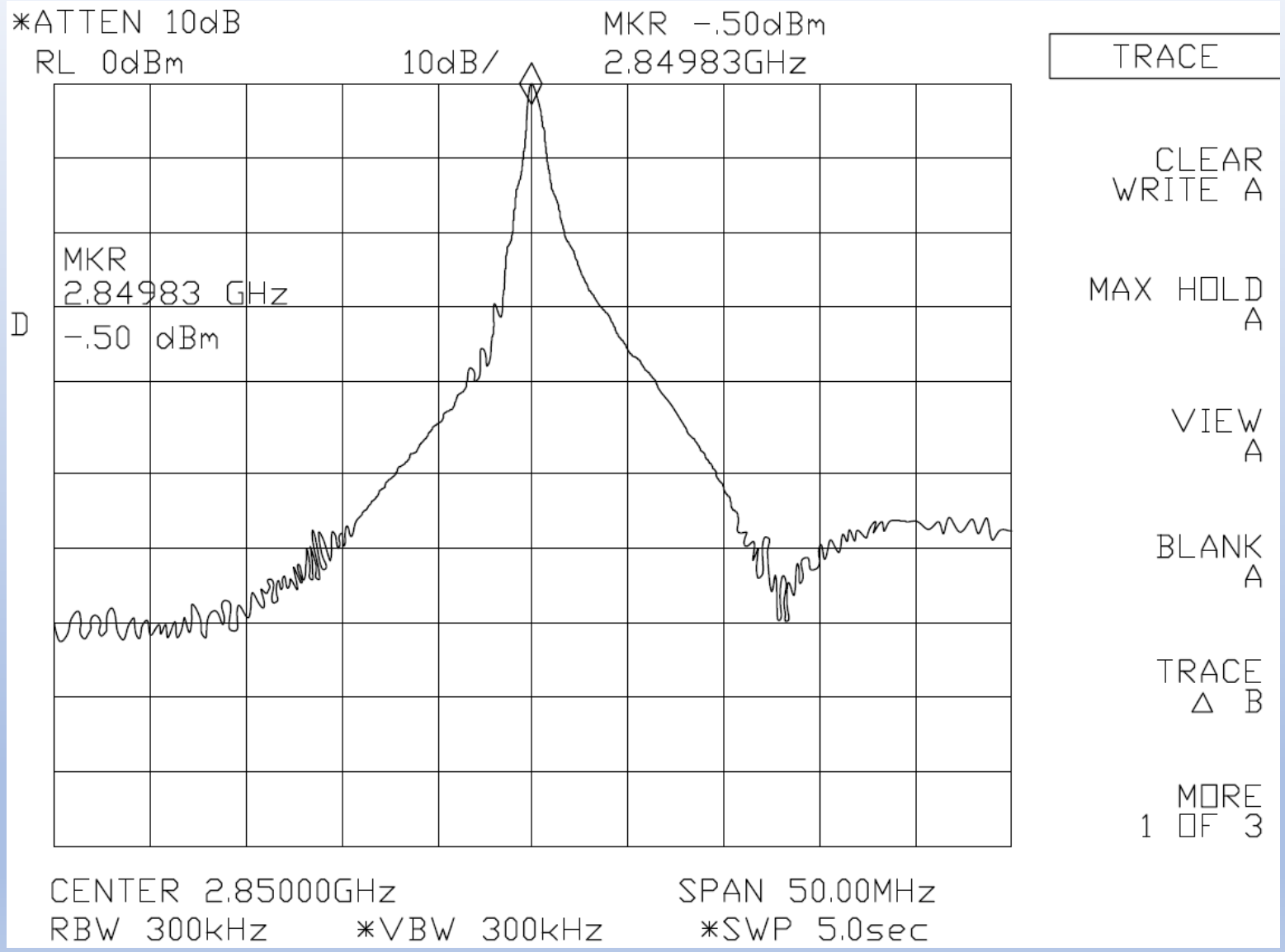


Klystron Transmitter Tuning

- This sets the cavities of the klystron tube
- This sets the pulse width of the output pulse
- This sets the power of the output pulse
- This sets the rise time of the output pulse
- This sets the turn on voltage (PFN)
- This is the balance of multiple variables

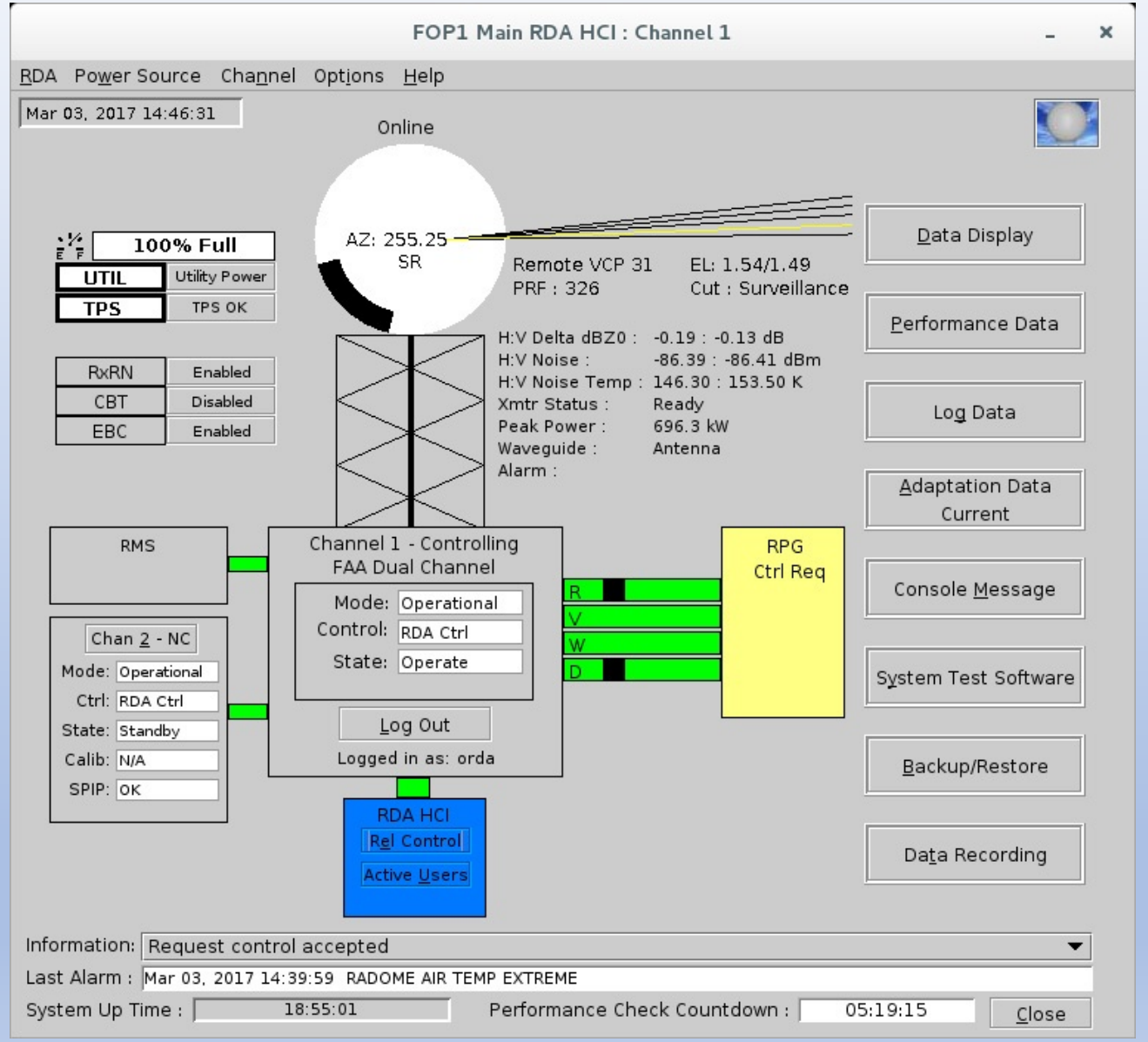
Spectrum Bandwidth Measurement

- With the transmitter tuned, we check the output spectrum bandwidth
- The -40dB half bandwidths are measured
- The -80dB half bandwidths are measured



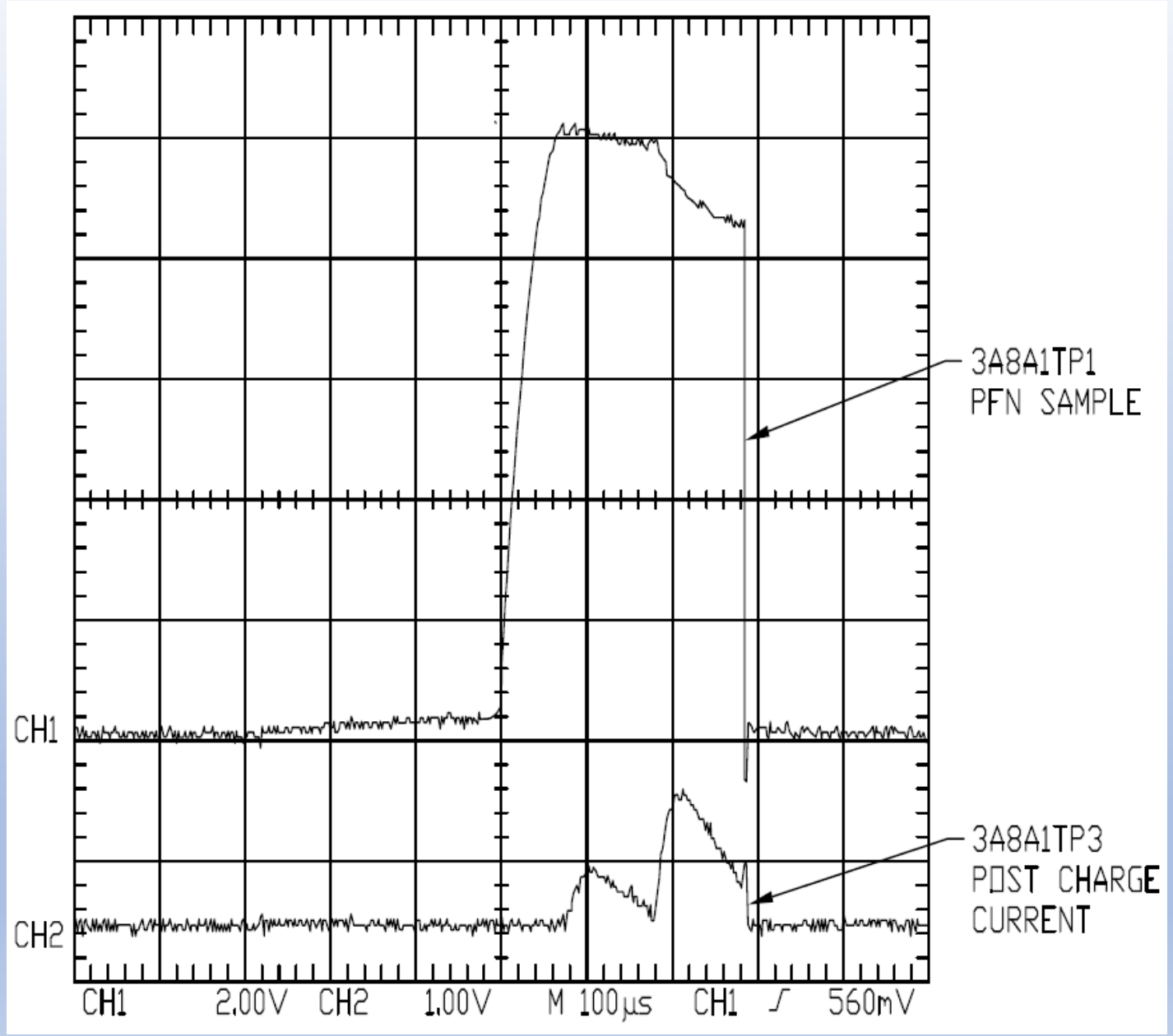
Transmitter Peak Power Out Measurement and Power Monitor Calibration

- The transmitter is now aligned for 700 KW at the tube
- During the alignment we had a test fixture attached. This checks the measurements without the test configuration in place
- The power of the transmitter is remotely measured in the receiver cabinet
- This procedure adjust the measurement made in the receiver to report correctly to the computer



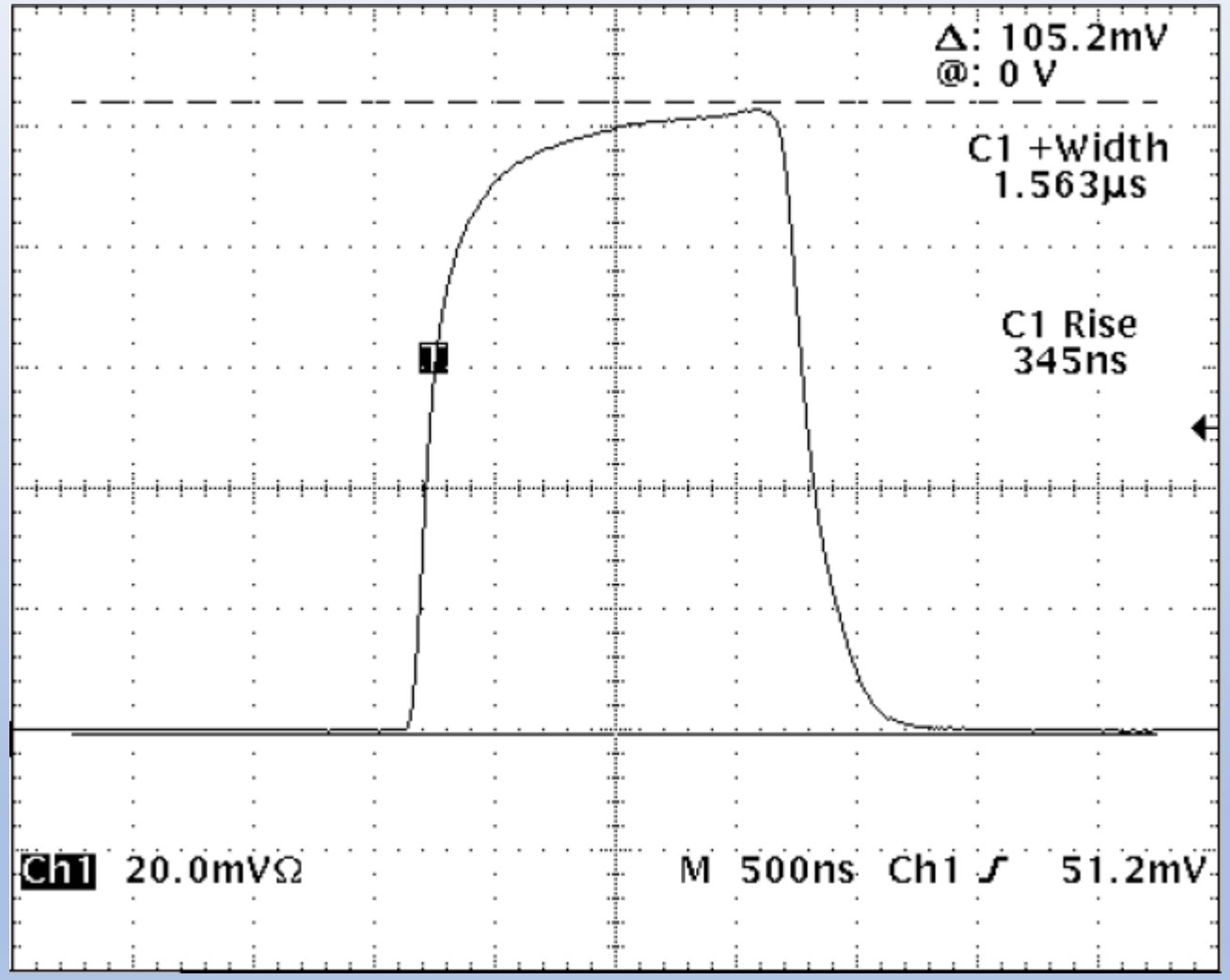
Post Charge Regulator Alignments

- The Post Charge Regulator is a dynamic averaging circuit.
- It is a shunt regulator that is used for pulse to pulse stability of the output.
- The PFN voltage is regulated by the Post Charge Regulator
- The PCR alignment is done to ensure that the regulator operates in it’s active region



Transmitter Pulse Width Alignment

- The procedure sets the -6dB (50%) pulse with of the klystron tube output pulse
- Then the procedure measures the -3dB (71%) pulse width.
- The computer used the pulse with for power calculations and for the “Weather Equation”
- The “Weather Equation” is a formula used to convert the reflective energy to a scale for meteorological use.

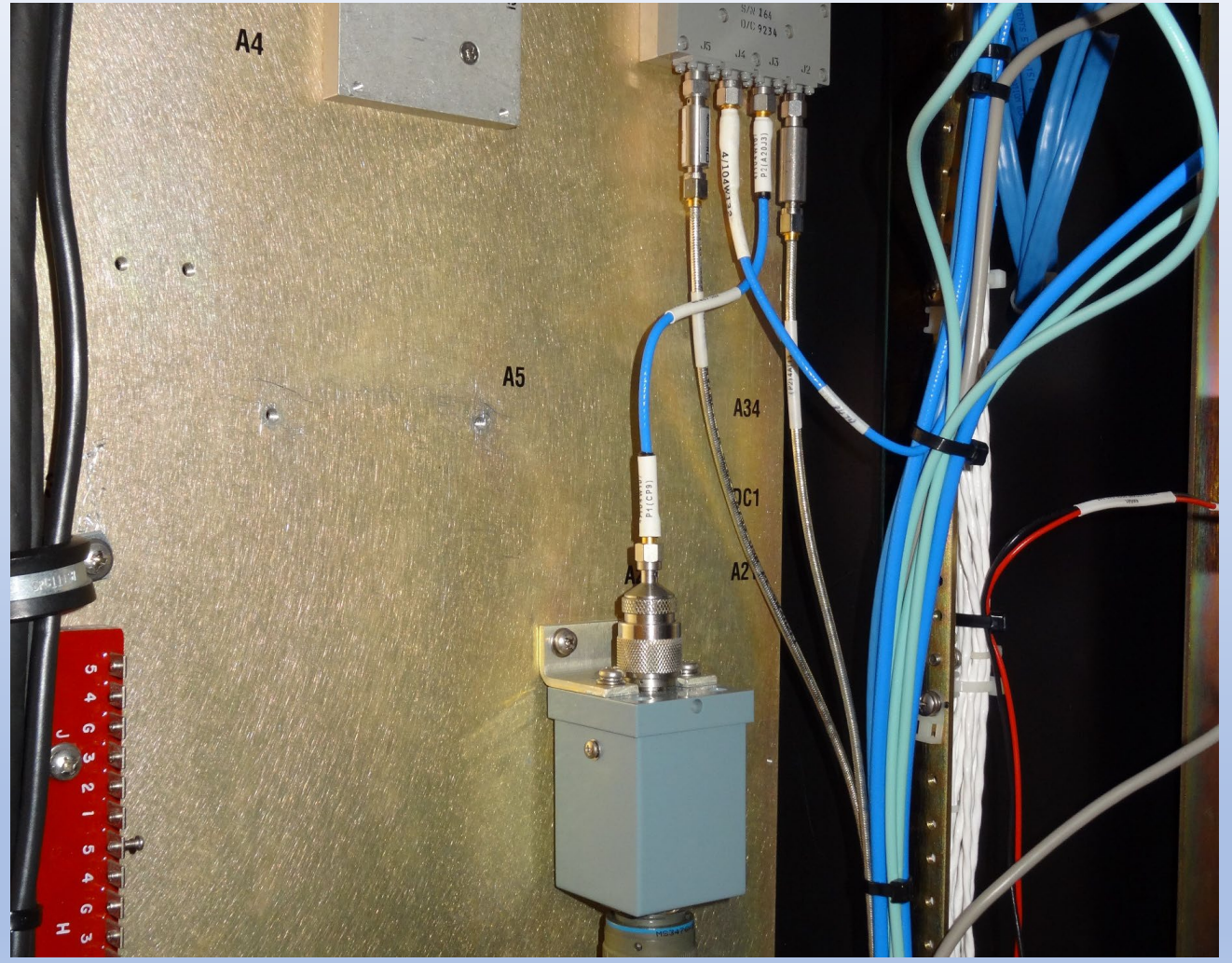


VSWR Alignment

- Reflected power is sampled from two places on the waveguide above the transmitter
- This procedure sets the alarm thresholds for the VSWR limits

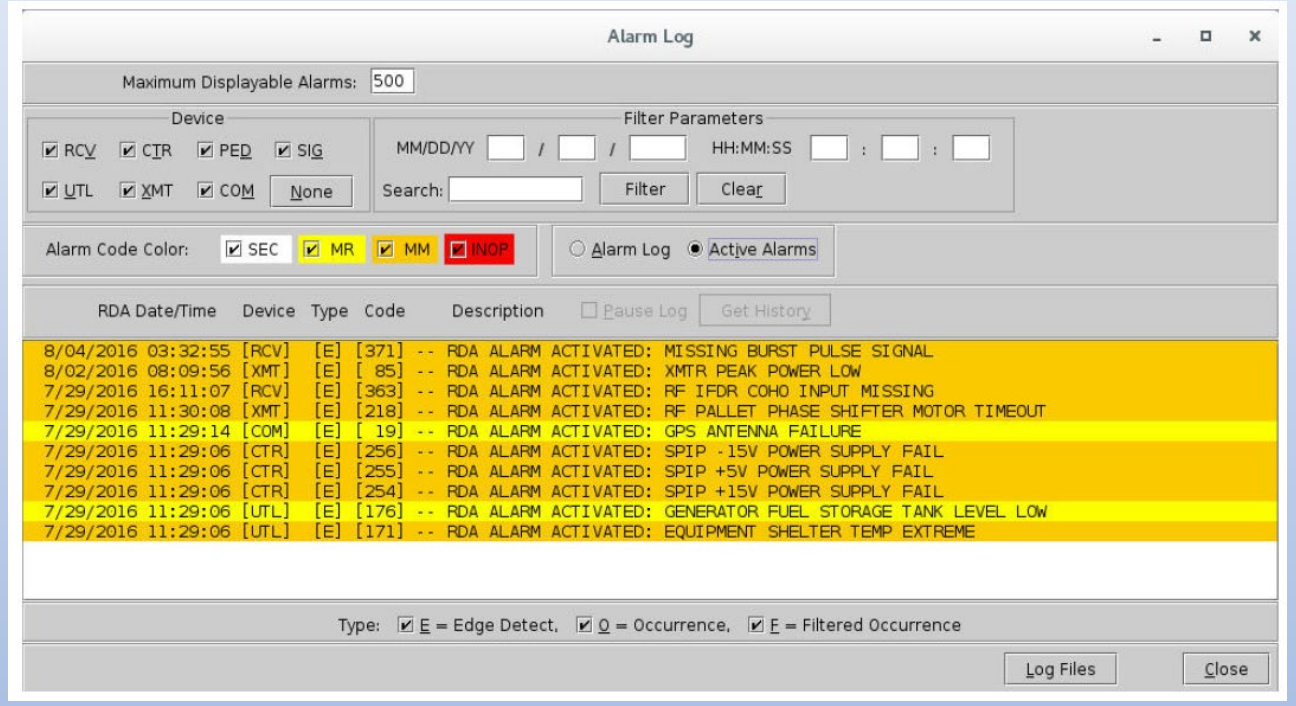
Transmitter Power Measurement Path Loss Calibration

- The transmitter power is monitored by a power reading device in the receiver cabinet.
- The device converts the power to a DC voltage.
- The DC voltage is measured by another device.
- The loss from the klystron tube to the measuring device is measured by this procedure.
- The scale to convert the DC voltage to power is done by this procedure



Alarm Thresholds

- The “MOD OVERLOAD” and the “MOD INVERSE CURRENT” alarms may interfere with tuning the transmitter
- This procedure sets the alarm limits for these two alarms



Transmitter Parameter and Adjustment Record Card

- The transmitter has a simple meter on the front that can be used to check conditions.
- The “Transmitter Parameter” card list the parameters and the operational limits
- With the system running in a known condition, the card is updated with that systems readings.
- This provides the technician with a reference

3A1S9 POS	TRANSMITTER PARAMETER	M4 READING (SP/PRF D5)	HIGH VOLTAGE	OPERATIONAL LIMITS
1	+5 VDC PS		OFF/ON	5.0 +/- 0.5 V
2	+15 VDC PS		OFF/ON	15.0 +/- 0.5 V
3	-15 VDC PS		OFF/ON	-15.0 +/- 0.5 V
4	+28 VDC PS		OFF/ON	28.0 +/- 1.0 V
5	+45 VDC PS		OFF/ON	45.0 +/- 1.5 V
6	+280 VDC PS		OFF/ON	240 - 370 V
7	FPA FILAMENT PS		OFF/ON	40 - 70 V
8	FPA FILAMENT VOLTAGE		OFF/ON	NAMEPLATE +/- 2.0 V
9	FPA FOCUS COIL PS		ON	40 - 85 V
10	FPA VACUUM PUMP PS		OFF/ON	2.75 - 4.00 KV
11	FPA CATHODE CURRENT		ON	20 (PRF S1) - 95 mA (PRF D8)
12	FPA BEAM VOLTAGE		ON	20 (PRF S1) - 95 KV (PRF D8)
13	MOD INVERSE CURRENT		ON	2.0 (PRF S1) - 20 mA (PRF D8)
14	PFN CHARGE CURRENT		ON	0.5 (PRF S1) - 4.5 A (PRF D8)
15	REGULATOR CURRENT		ON	5.0 - 20.0 mA
16	OFF	DATE:	NAME:	

Safety Concerns

NWS EHB 6-511

SAFETY SUMMARY

1. GENERAL SAFETY INSTRUCTIONS.

This manual describes physical and chemical processes which may cause injury or death to personnel, or damage to equipment if not properly followed. This safety summary includes general safety precautions and instructions which must be understood and applied during operation and maintenance to ensure personnel safety and protection of equipment. Prior to performing any task, the WARNINGs, CAUTIONs, and NOTEs included in that task shall be reviewed and understood.

NWS EHB 6-513

SAFETY SUMMARY

1. GENERAL SAFETY INSTRUCTIONS.

This manual describes physical and chemical processes which may cause **SEVERE INJURY** or **DEATH** to personnel, or damage to equipment if not properly followed. This safety summary includes general safety precautions and instructions that must be understood and applied during operation and maintenance to ensure personnel safety and protection of equipment. Prior to performing any task, the WARNINGs, CAUTIONs, and NOTEs included in that task shall be reviewed and understood.

WARNING

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in injury to, or **DEATH** of, personnel or long term health hazards.

CAUTION

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

NOTE

Highlights an essential operating or maintenance procedure, condition, or statement.

Alignment specific safety concerns

- HEARING LOSS (TRANSMITTER)
  - Wear ear protection when the transmitter center cabinet door is opened for extended periods or while tuning the klystron. Hearing loss can occur from prolonged exposure to high noise.
- MICROWAVE RADIATION PRECAUTIONS
  - The WSR-88D generates and detects electromagnetic energy at a transmitted frequency between 2.7 GHz and 3.0 GHz. This non-ionizing radiation is concentrated in the antenna beam. The potential hazard of this radiation to personnel is biological heating. Intense microwave radiation (power densities greater than 300 mW/cm2) can result in biological damage such as the formation of cataracts or other opacities in the eyes and “cook” internal organs.
    - Ref: 6-511 4.5.8 Radiation Leakage Check & 6-513 6.4.6.8 Radiation Leakage Check.
- RESTORE ALL INTERLOCKS
  - Restore all interlock switches to normal operating condition immediately upon completion of work on the unit involved.
- DO NOT USE FERROUS TOOLS OR INSTRUMENTS NEAR KLYSTRONS
  - Do not use steel or iron tools near klystrons. Such tools may be pulled from the technicians grasp and cause damage to the tube.

Location of parts of this lesson

Link to the NWSTC page = https://training.weather.gov/nwstc/

Link to the NWSTC RADAR page = https://training.weather.gov/nwstc/NEXRAD/

Link to the 88D Transmitter Alignment =
https://training.weather.gov/nwstc/NEXRAD/transmitter/index.html
Under the "Transmitter Alignment" you will find a PDF documents of sub-parts of the alignment and an associated link to a video of voice over of the material. The idea is that you will have access to the documents that is used in the video in case the screen is not as readable as you would like. Videos examples used in the presentation will also be there.

If you have any issues, please contact one of the RADAR Team listed at
https://training.weather.gov/nwstc/homepage/contact.html
Start with the name with the "(L)" listed to the side of the name.

This is the last slide