

Ron



IBM Field Engineering Handbook

Restricted Distribution

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2260 Display Station
Models 1 and 2

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PREFACE

This handbook contains a troubleshooting flowchart, CRT trouble symptom photos, alignment procedures, and a list of tools, test equipment, and spare parts.

The troubleshooting flowchart gives step-by-step instructions for isolating a 2260 malfunction and making repairs. Malfunctions listed in the flowchart may be verified by referring to the CRT trouble symptom photos. Both abridged and detailed alignment procedures are given. The abridged procedures are given for CE's familiar with 2260 adjustments.

When using this handbook note that:

1. Component designations and statements shown in italics apply to adapter boards only.
2. Horizontal and vertical adjustments must be preceded by the Preliminary Checks and Adjustments given in the beginning of the Detailed Alignment Procedure.
3. Vertical and horizontal alignment procedures should be done in the order given in the detailed alignment procedure:
 - a. vertical size
 - b. horizontal size and linearity
 - c. vertical sync

If performance of only one of the above is required, the preceding adjustment(s) listed should be correct.

Second Edition (August 1968)

This is a major revision of, and obsoletes Y25-0504-0. Changes to text and art are indicated by a vertical line to the left of the change. Note in particular that the AFC Voltage Determination chart on page 27, shown incorrectly in Y25-0504-0, has been replaced.

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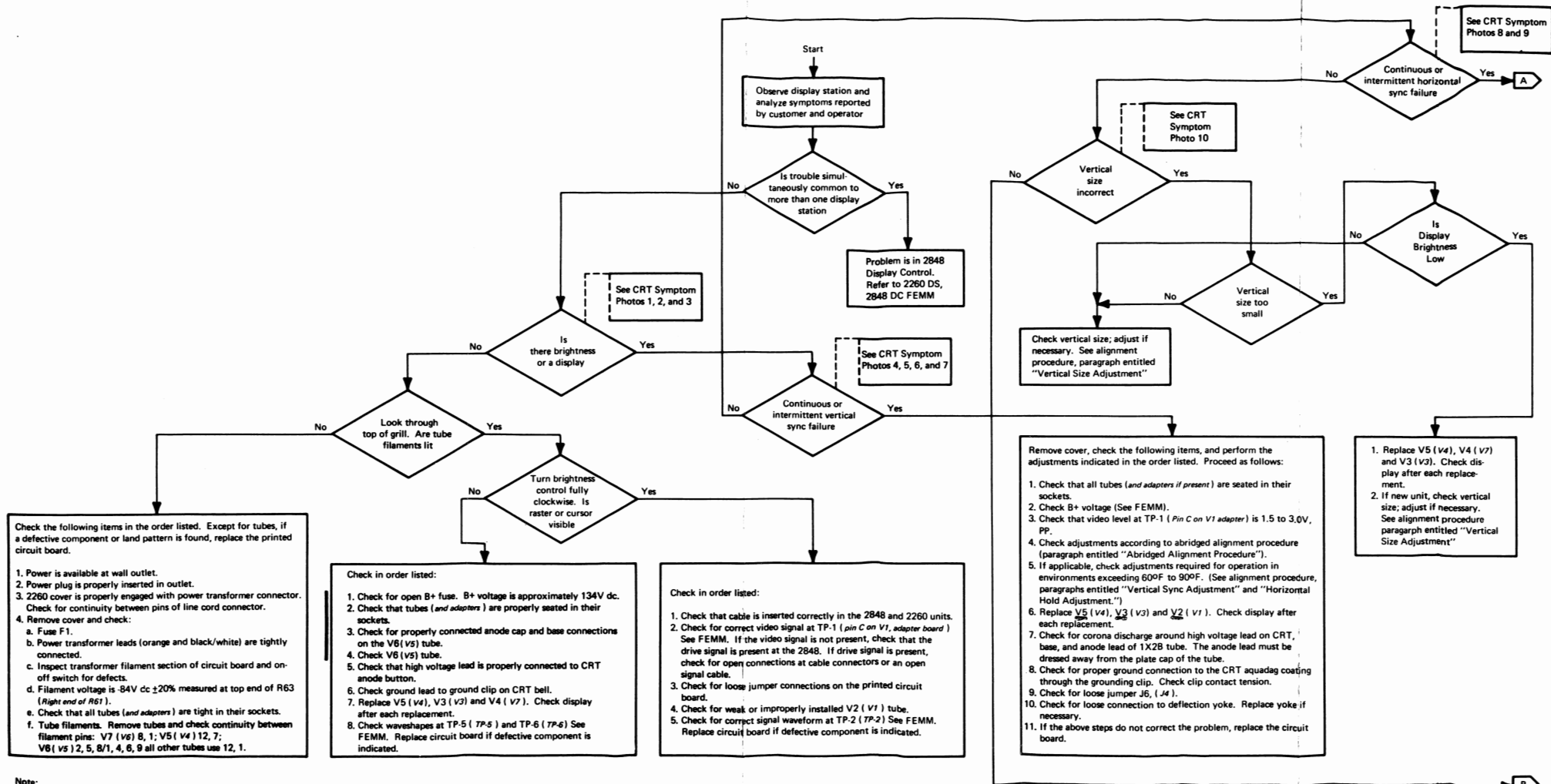
SAFETY

To ensure personal safety and the safety of co-workers, each CE should make it a practice to observe safety procedures at all times. All CE's should become familiar with the general safety practices and the procedures for performing artificial respiration outlined in CE Safety Practices, Form 229-1264. The following precautions are given to remind the CE of particular hazards.

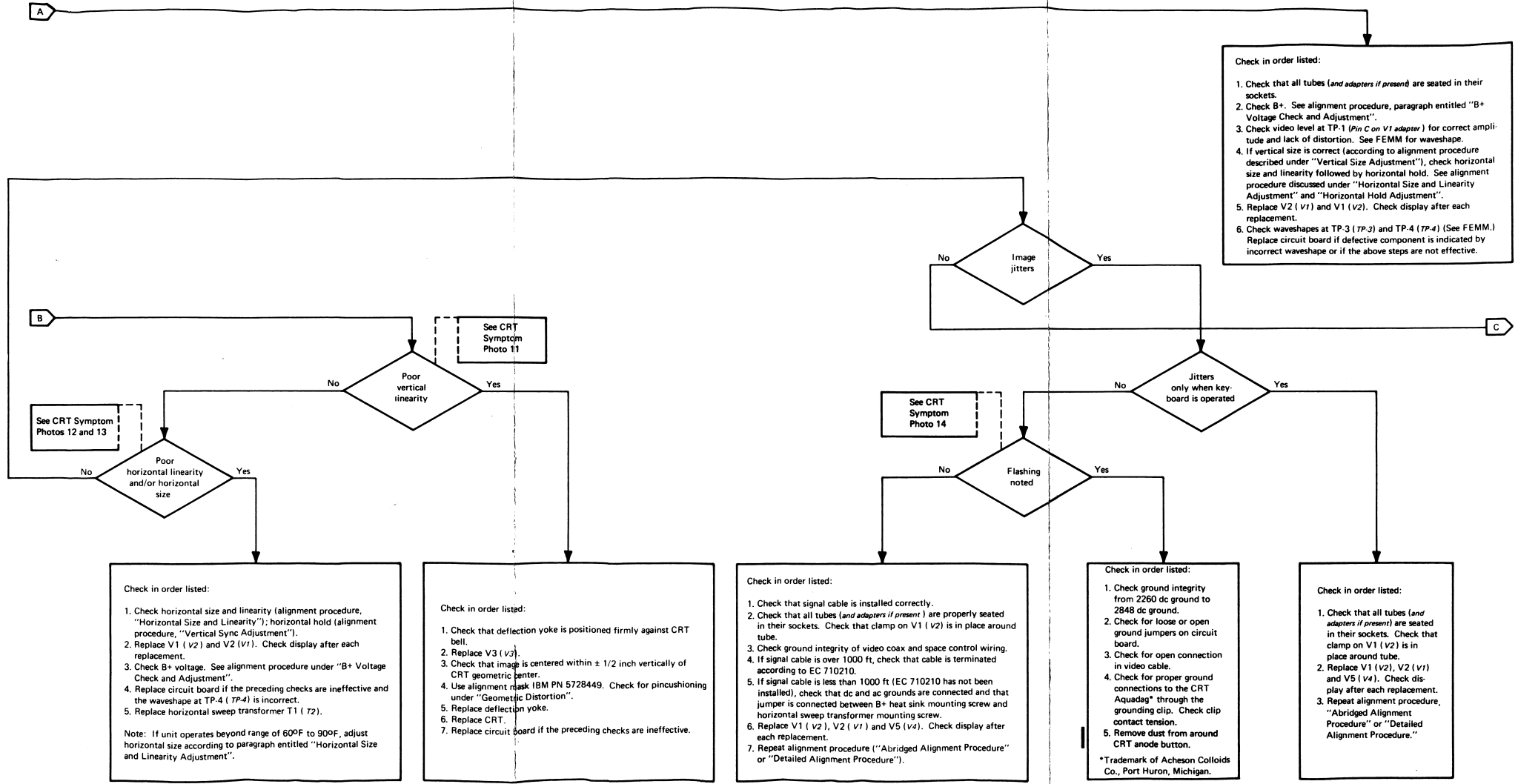
Safety glasses should be worn by all persons in the immediate vicinity of a 2260 operating with the covers removed. Tube puller PN 460820 or equivalent should be used to remove and install tubes on the circuit board assembly. Prime power should be removed a minimum of ten seconds before moving jumpers on the circuit board or otherwise contacting circuit conductors. On the adapter board, C33 should be discharged to ground by grounding the upper end of R55. Never ground the lower end. Jumpers J3, J4, J5, J15 and J16 on the adapter board and jumpers J3, J4, J5, and J6 on the newer level circuit board (5239681)* present exposure to dangerous voltages.

CRT's require special handling if removed from the display cabinet, as described in the 2260/2848 *Field Engineering Maintenance* Manual. Before working on the high voltage circuits, the anode of the CRT should be discharged by grounding the anode button to the ground clip on the top center of the frame assembly. A tool with an adequately insulated handle should be used for this purpose. Make contact with the ground clip first, then the CRT button.

*This number is not the part number for the circuit board. It is factory control number and is used for reference only. The number is located on the upper right corner of the circuit board on the component side.



Note:
Component designations and notes shown in italics refer to circuit boards using tube adapters.



See CRT Symptom Photos 12 and 13

See CRT Symptom Photo 11

See CRT Symptom Photo 14

Check in order listed:

1. Check horizontal size and linearity (alignment procedure, "Horizontal Size and Linearity"); horizontal hold (alignment procedure, "Vertical Sync Adjustment").
2. Replace V1 (v2) and V2 (v1). Check display after each replacement.
3. Check B+ voltage. See alignment procedure under "B+ Voltage Check and Adjustment".
4. Replace circuit board if the preceding checks are ineffective and the waveshape at TP.4 (TP.4) is incorrect.
5. Replace horizontal sweep transformer T1 (T2).

Note: If unit operates beyond range of 60°F to 90°F, adjust horizontal size according to paragraph entitled "Horizontal Size and Linearity Adjustment".

Check in order listed:

1. Check that deflection yoke is positioned firmly against CRT bell.
2. Replace V3 (v3).
3. Check that image is centered within ± 1/2 inch vertically of CRT geometric center.
4. Use alignment mask IBM PN 5728449. Check for pincushioning under "Geometric Distortion".
5. Replace deflection yoke.
6. Replace CRT.
7. Replace circuit board if the preceding checks are ineffective.

Check in order listed:

1. Check that signal cable is installed correctly.
2. Check that all tubes (and adapters if present) are properly seated in their sockets. Check that clamp on V1 (v2) is in place around tube.
3. Check ground integrity of video coax and space control wiring.
4. If signal cable is over 1000 ft, check that cable is terminated according to EC 710210.
5. If signal cable is less than 1000 ft (EC 710210 has not been installed), check that dc and ac grounds are connected and that jumper is connected between B+ heat sink mounting screw and horizontal sweep transformer mounting screw.
6. Replace V1 (v2), V2 (v1) and V5 (v4). Check display after each replacement.
7. Repeat alignment procedure ("Abridged Alignment Procedure" or "Detailed Alignment Procedure").

Check in order listed:

1. Check ground integrity from 2260 dc ground to 2848 dc ground.
2. Check for loose or open ground jumpers on circuit board.
3. Check for open connection in video cable.
4. Check for proper ground connections to the CRT Aquadag through the grounding clip. Check clip contact tension.
5. Remove dust from around CRT anode button.

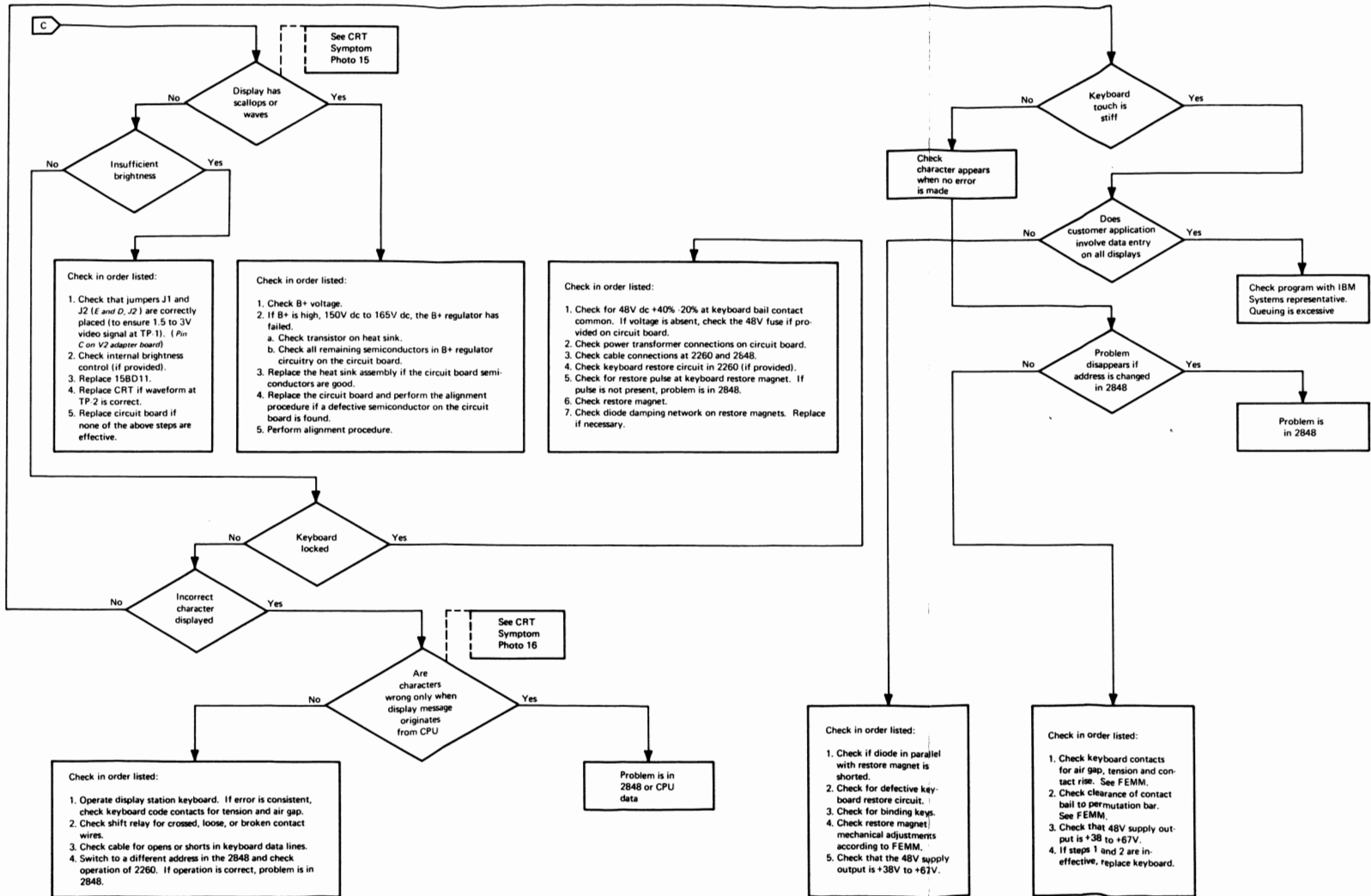
*Trademark of Acheson Colloids Co., Port Huron, Michigan.

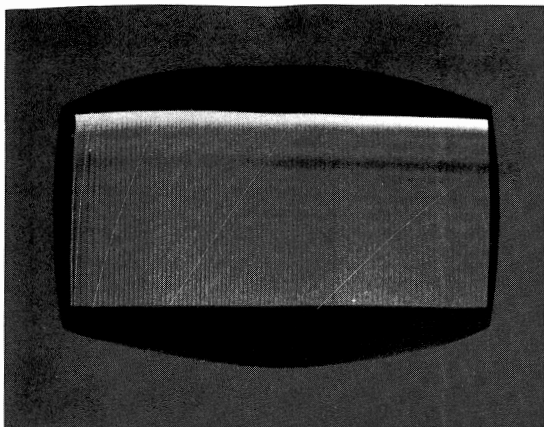
Check in order listed:

1. Check that all tubes (and adapters if present) are seated in their sockets. Check that clamp on V1 (v2) is in place around tube.
2. Replace V1 (v2), V2 (v1) and V5 (v4). Check display after each replacement.
3. Repeat alignment procedure, "Abridged Alignment Procedure" or "Detailed Alignment Procedure."

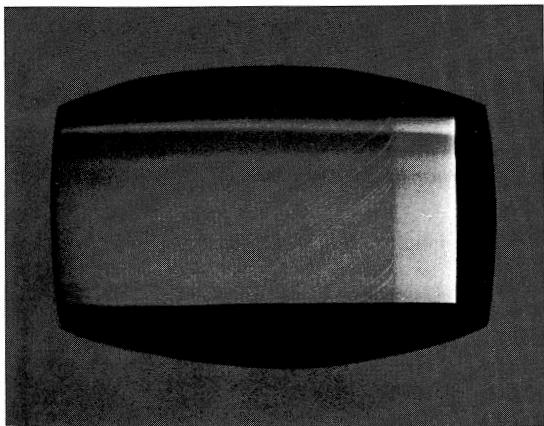
Check in order listed:

1. Check that all tubes (and adapters if present) are seated in their sockets.
2. Check B+. See alignment procedure, paragraph entitled "B+ Voltage Check and Adjustment".
3. Check video level at TP.1 (Pin C on V1 adapter) for correct amplitude and lack of distortion. See FEMM for waveshape.
4. If vertical size is correct (according to alignment procedure described under "Vertical Size Adjustment"), check horizontal size and linearity followed by horizontal hold. See alignment procedure discussed under "Horizontal Size and Linearity Adjustment" and "Horizontal Hold Adjustment".
5. Replace V2 (v1) and V1 (v2). Check display after each replacement.
6. Check waveshapes at TP.3 (TP.3) and TP.4 (TP.4) (See FEMM). Replace circuit board if defective component is indicated by incorrect waveshape or if the above steps are not effective.



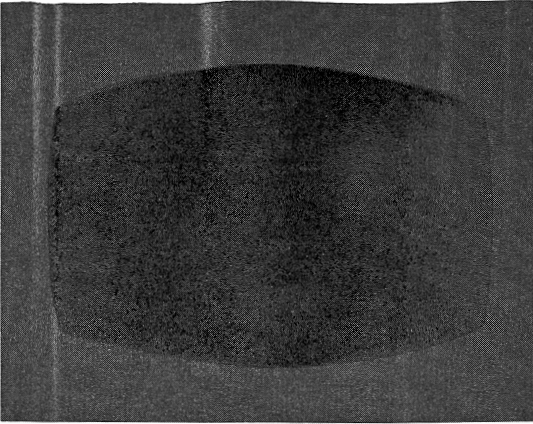


① Raster with Brightness (Synchronized)

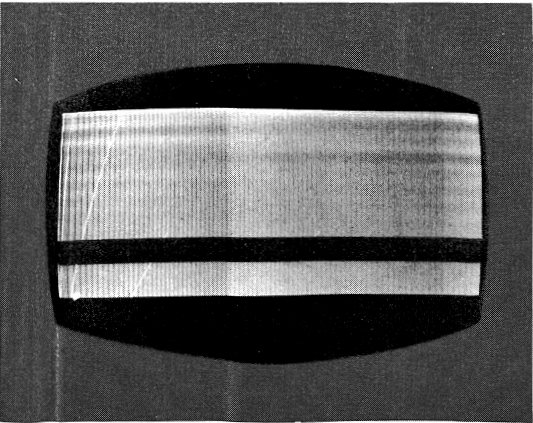


② Raster with Brightness (Not synchronized)

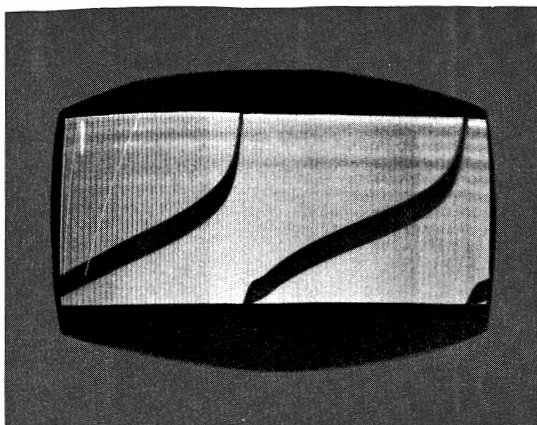
CRT TROUBLE SYMPTOMS



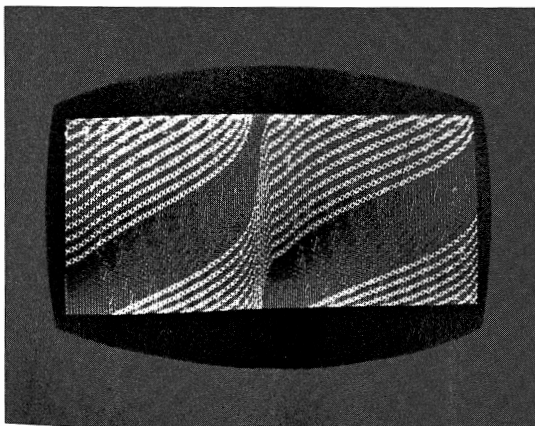
3. Only cursor visible.



4. No vertical sync, without data displayed (see waveshape 5 also).

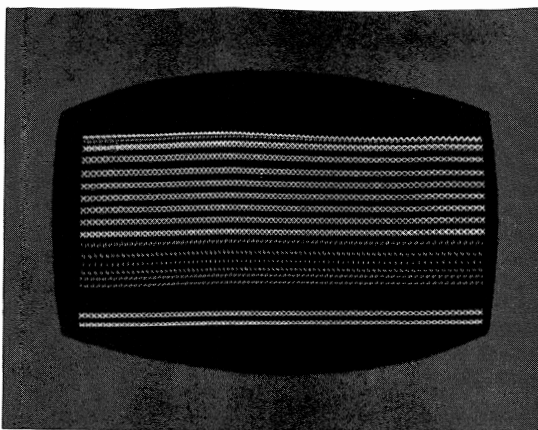


- ⑤ No vertical sync, without data displayed (see waveshape 4 also).

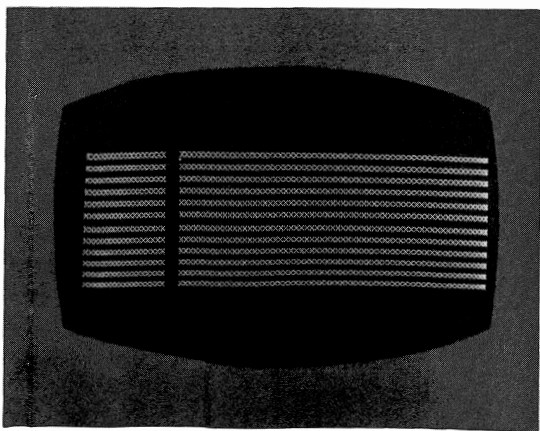


- ⑥ No vertical sync, with data displayed (see waveshape 7 also).

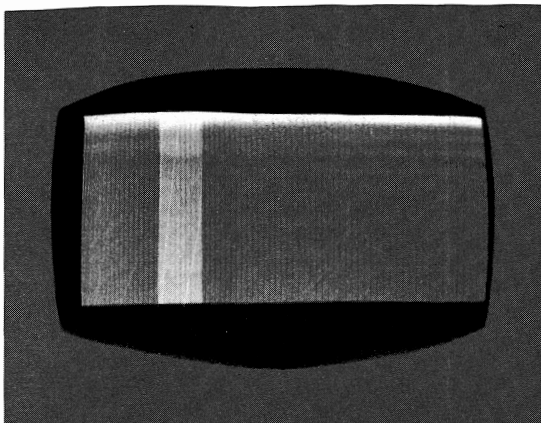
CRT TROUBLE SYMPTOMS



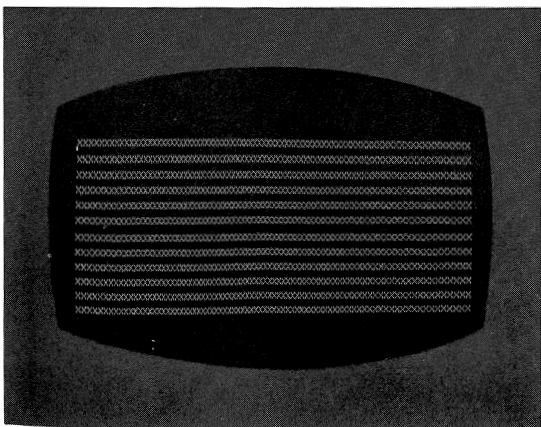
- ⑦ No vertical sync, with data display (see waveshape 6 also).



- ⑧ No horizontal sync, with data displayed.

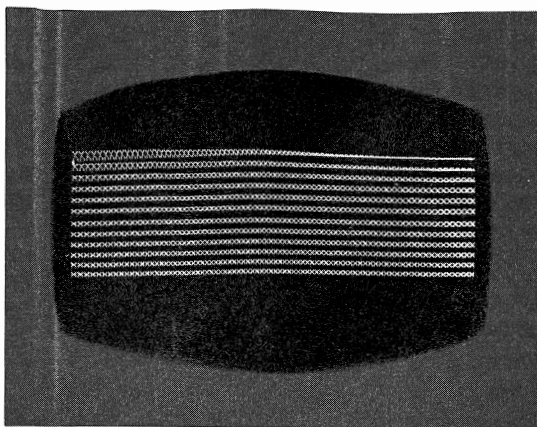


⑨. No horizontal sync, no data displayed. Cursor displayed.

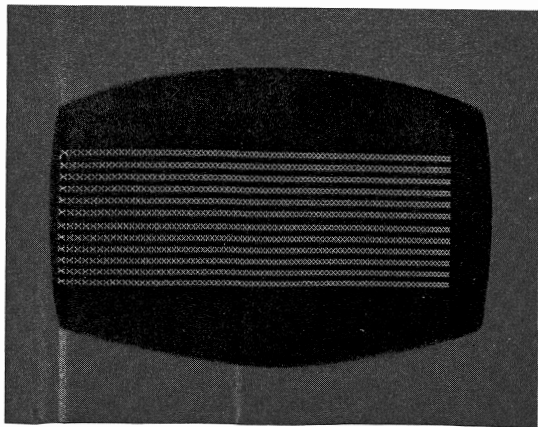


⑩. Vertical size too large.

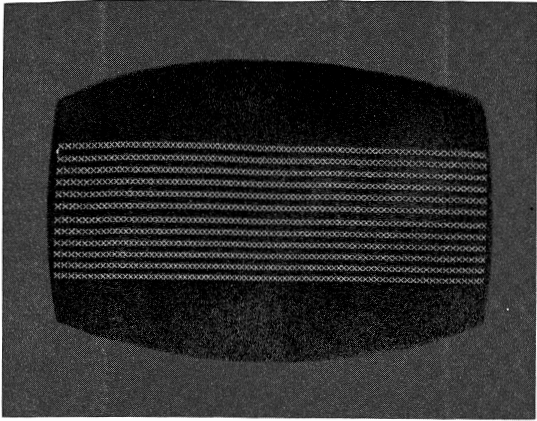
CRT TROUBLE SYMPTOMS



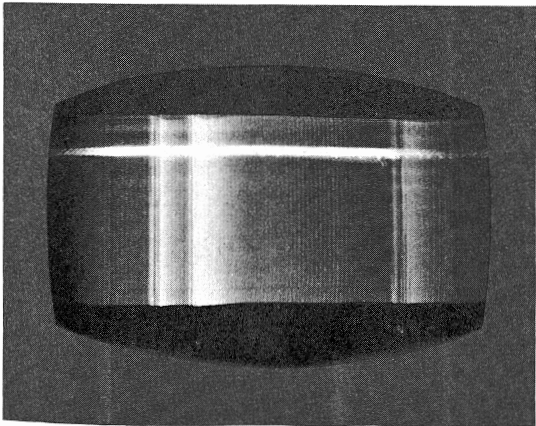
⑪. Poor vertical linearity.



⑫. Poor horizontal linearity.

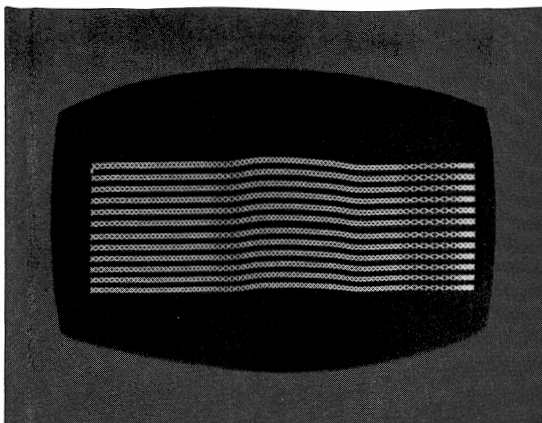


⑬ Horizontal size too large.

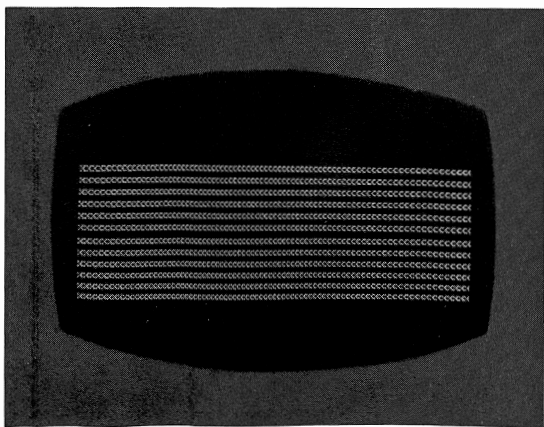


⑭ Jitter and flashing.

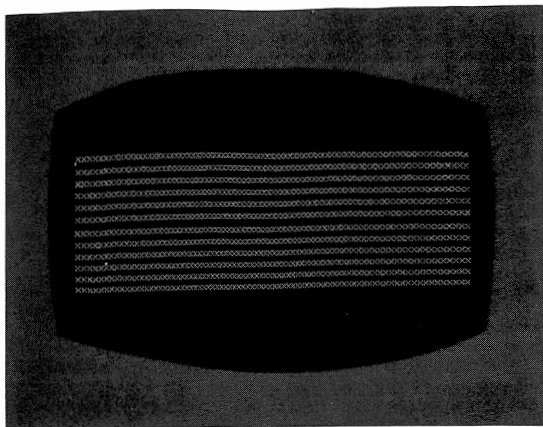
CRT TROUBLE SYMPTOMS



15. Waves, no B+ regulation.



16. Character with bits missing.



⑰ Satisfactorily adjusted display.

TOOLS, TEST EQUIPMENT, AND SPARE PARTS

Note: Part numbers shown in italics refer to adapter boards only.

Tools and Test Equipment

Alignment mask, IBM PN 5728449

Alignment tool, IBM PN 5728554*

Hand tools

Multimeter

Oscilloscope, Tektronix Model 453*

Probe, Tektronix Model P6006*

Probe tip, IBM PN 461090*

Service cord for 60 Hz power source, IBM PN 5719040

Service cord for 50 Hz power source, IBM PN 5214127

Tube puller, IBM PN 460820

Special Equipment

Voltmeters:

ac 0-150V ac, 0-250V ac $\pm 1\%$ tolerance

dc 0-150V dc $\pm 1\%$ tolerance

Spare Parts**

Deflection yoke, IBM PN 5213754

Fuses:

0.5A SB IBM PN 78999 - B+ all boards

3.0A IBM PN (5214150) - 48V supply

3.0A SB IBM PN 338165 - Prime power 60 Hz - 50 Hz

1.6A SB IBM PN 5213806 - Prime power 50 Hz

1.5A IBM PN (11156) - Prime power 50 Hz

3.0A IBM PN (5214299) - Prime power 50 Hz

Tested circuit board assembly:

60 Hz, IBM PN 5239698

50 Hz, IBM PN 5239697

Transistor heat sink assembly, IBM PN 5232944 (5728346)

Tubes:

1X2B, IBM PN 5213747 - *Vert Volt Rect V6*

8B10, IBM PN 5213749 - *Vert osc V3*

15BD11, IBM PN 5213752 - *Horiz osc V2*

17BE3, IBM PN 5214858 - *DAMPEN V4*

21HB5, IBM PN 5213750 - *Horiz output V1*

33GY7, IBM PN 5213748 - *Vert Output V5*

P4 CRT, IBM PN 5214390

P39, CRT, IBM PN 5785647 } *V7*

*New Level
CRT Board*

*or equivalent

**Readily available at the site.

ABRIDGED ALIGNMENT PROCEDURE

Note: Component designations shown in italics refer to circuit boards using tube adapters.

- Check B+ voltage. Typical value at 75°F is 131.4V dc (*133.4V dc*).
- Check that video input level is 1.5 to 3.0V, PP.
- Adjust phase coil; L6 (*L4*) normal; L4 (*L7*) flush. Adjust L5 (*L10*) for a format height of 1.25 inches for 240 character formats or 2.7 inches for 480 or 960 character formats.
- Adjust vertical size using L4 (*L7*) followed by horizontal size and horizontal linearity.

<u>Display Station</u>	<u>Display Control</u>	<u>Nominal Height (")</u>	<u>Nominal Width (")</u>
2260-1	2848-3	3.0*	9.0
2260-2	2848-1	2.5	6.5
2260-2	2848-2	4.5	6.5

*If vertical height greater than 3.5 inches is needed, remove power and move J6 (*J4*) to "expanded".

- Check vertical sync.
 1. Remove power.
 2. Connect J4 (*J6*) to AFC, J5 (*J5*) to "osc plate" and adjust R25a (*R40*) for stable display.
 3. Remove power and move J4 (*J6*) and J5 (*J5*) to "normal".
 4. Apply power and adjust AFC voltage. Typical value is +0.4V dc.

$$\text{Exact AFC voltage} = 1.5333 - \frac{\text{actual line voltage}}{\text{nominal line voltage}} - 0.00166 (\text{°F})$$

- Check horizontal sync. Set horizontal hold R25c (*R19*) at center of holding range for office ambient or full clockwise for temperature extremes.
- Check for geometric distortion. Format center may be adjusted $\pm 1/2$ inch vertically and $\pm 1/8$ inch horizontally from the geometric center of the CRT.
- Check focus.
- Check ground continuity with cover on between ground pin of power transformer to keyboard frame and brightness control shaft.

DETAILED ALIGNMENT PROCEDURE

Note: Component designations and notes shown in italics refer to circuit boards using tube adapters.

Preliminary Checks and Adjustments

1. Remove prime power cable from power source.

CAUTION

The prime power cable should be removed from the power source to prevent accidental damage to the 2848 if, when removing the cover from the 2260, the power plug contacts are accidentally mismatched.

2. Remove brightness control knob, bezel, and display station rear cover.

DANGER

Before proceeding, short CRT anode button to ground clip on top center of circuit board.

3. If this procedure is being performed as a preventive maintenance task, refer to the paragraph entitled "Power On Checks." (Otherwise, continue with step 4.)

DETAILED ALIGNMENT PROCEDURE

4. Set the following potentiometer controls:

<u>Control</u>	<u>Setting</u>
character spacing, R21 (R50)	mid-range
vertical hold, R25a (R40)	mid-range
horizontal size, R25b (R20)	mid-range
horizontal hold, R25c (R19)	fully-clockwise
horizontal linearity, R25d (R23)	mid-range

5. Set alignment coils as follows:

<u>Coil</u>	<u>Setting – outer edge of adjustment core compared to outer edge of coil form</u>
vertical size, L4 (L7)	flush
vertical phase, L5 (L10)	recessed approximately 3/4 inch
vertical oscillator, L3 (L12)	flush

6. Place jumper wires as follows:

<u>Jumper</u>	<u>Connect To</u>
J5	osc plate
J1 (J2A)	(C)
J6 (J4), J4 (J6)	normal
J2 (J16) and J3 (J15)	30 Hz (if Mod 1 2260)
J2 (J16) and J3 (J15)	60 Hz (if Mod 2 2260)

Note: If an adapter is used in the V2 location, verify that jumpers D and E are connected to corresponding pins on adapter in location V1. If there is not an adapter in location V2, pins D and E on adapter in location V1 will be open.

7. Check that all tubes (adapters), jumpers, and sockets are properly located and installed correctly.
8. Dress yellow lead to the CRT socket as far as possible from other conductors and tubes (to prevent degradation of the video amplifier band pass).
Dress leads between V4 and its associated adapter so that they are equidistant from V3, R33, R41, C48, R45, and L10. This will minimize stray coupling.
9. Dress plate lead of V6 (V5) as far as possible from grounded metal.
10. Check that deflection yoke is firmly seated against bell of CRT; avoid over tightening the retaining clamp on the yoke.
11. Turn or push power switch (brightness control) to off position as required. 60 Hz machines require a push action while 50 Hz machines require a turn (counterclockwise).
12. Check that the display is designed for the power source with which it is to be used; verify that proper fuses are installed.

CAUTION

Check for a black wire marked "6" attached to pin marked "BLK". The black wire provides a dc return path for signal currents from the keyboard circuits. If it is left open, the 100 ohm resistor R4 (R6, on adapter) may be damaged.

Power On

1. Connect ground jumper provided from lower left mounting screw of power transistor heat sink to the rear mounting screw on the horizontal sweep transformer. If the jumper was already in this position it should not be disturbed.

Note: If the signal cable between the 2848 and the 2260 is less than 1000 ft and EC 710202 has been installed, the ground jumper will not be connected.

2. Install video input cable (if not already connected).
3. Attach service power cable PN 5719040 to the power transformer, then plug the other end of cable into prime power source.
4. Turn (or pull) power on switch (brightness control) to apply power to the 2260.
5. Check the operation of the brightness control as follows:
 - a. Display a random selection of characters on the CRT screen; include H, M, O, and 8. Enter characters from keyboard, 2848 CE panel, or by computer program.
 - b. Rotate brightness control R10 (*R10*) fully clockwise and adjust brightness limit control R12 (internal control) until display begins to flicker.

Note: Brightness limit control R12 is not found on adapter board.

- c. Reduce setting of brightness control R10 to normal viewing level.

Note: On Model 1 displays, some flicker may be observed when the screen is completely filled, especially when the unit is operated at high brightness levels. When normal text is displayed, flicker is reduced to a tolerable level.

6. Adjust vertical hold R25a (*R40*) and horizontal hold R25c (*R19*) controls to obtain a stable format.

Voltage Checks

B+ Voltage Check and Adjustment

Note: If B+ voltage has been previously adjusted correctly and has not been accidentally changed, a B+ voltage check only is required.

1. To check the B+ setting:
 - a. Determine the B+ value corresponding to the ambient temperature as indicated in the voltage-temperature chart showing B+ versus ambient temperature. For example, an ambient temperature of 80°F corresponds to a B+ value of 131.8V dc (*133.8V dc*).
 - b. Measure the B+ using service meter and determine if the measured value plus or minus meter tolerance plus or minus 2V equals the value shown on the voltage-temperature chart. In the example, the required B+ value is 131.8V (*133.8V dc*). If a 3% meter is used and the scale in use is 150V full scale, then the correction would be the value indicated on meter $\pm 0.03 \times 150 \pm 2V$, or the indicated value $\pm 6.5V$. If the indicated value were 125.3 (*127.3*) to 138.3 (*140.3*), no adjustment would be necessary.
2. Adjust B+ if measured B+ value is out of tolerance or if it has been accidentally changed. To make the adjustment:
 - a. Check the ambient temperature with a thermometer and determine the required B+ value from the voltage-temperature chart.
 - b. Using a 1% meter, adjust B+ control R74 (*R52*) for value determined from the voltage-temperature chart.

Heater Voltage

Measure heater voltage from top end of R63 (*right end of R51*) to ground. Heater voltage should be in the range of -67.2 to -100.8V dc.

VIDEO LEVEL AND VERTICAL SIZE

Keyboard Voltage

Measure keyboard supply voltage from keyboard bail to contact common. The keyboard supply voltage should be in the range of +38.4V dc to +67.2V dc.

Video Level Adjustment

The video signal required at the signal grid of the video amplifier V2 (V1) for proper operation is 1.5 to 3.0V amplitude peak-to-peak. Operation outside these limits may result in unstable sync or insufficient video.

Adjust input video level as follows:

1. Connect ground clip from scope probe to left side of R3 (pin marked *BLK* on back of V1 adapter).

Note: Ground clip should have an insulating jacket to prevent accidental shorting of adjacent circuitry.

2. Connect probe tip to TP1 (pin C on V1 adapter) and sync scope using a horizontal sweep speed of 5ms per cm. If the composite sync and video waveform amplitude is not in the 1.5 to 3.0V range, move J1 (J2A) and the scope probe to pin A, B or C (A or B) as required to obtain this value.
3. Remove scope probe.

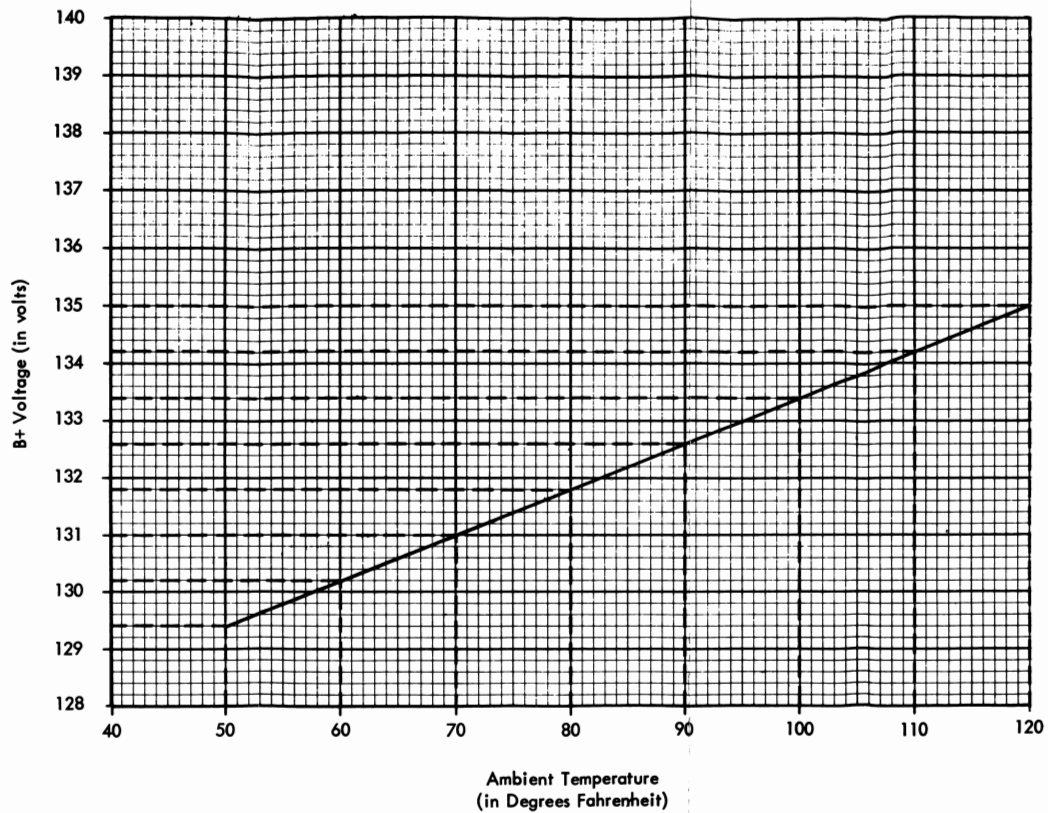
Vertical Size Adjustment

Note: The Preliminary Checks and Adjustments given at the beginning of the alignment procedure must be done before proceeding.

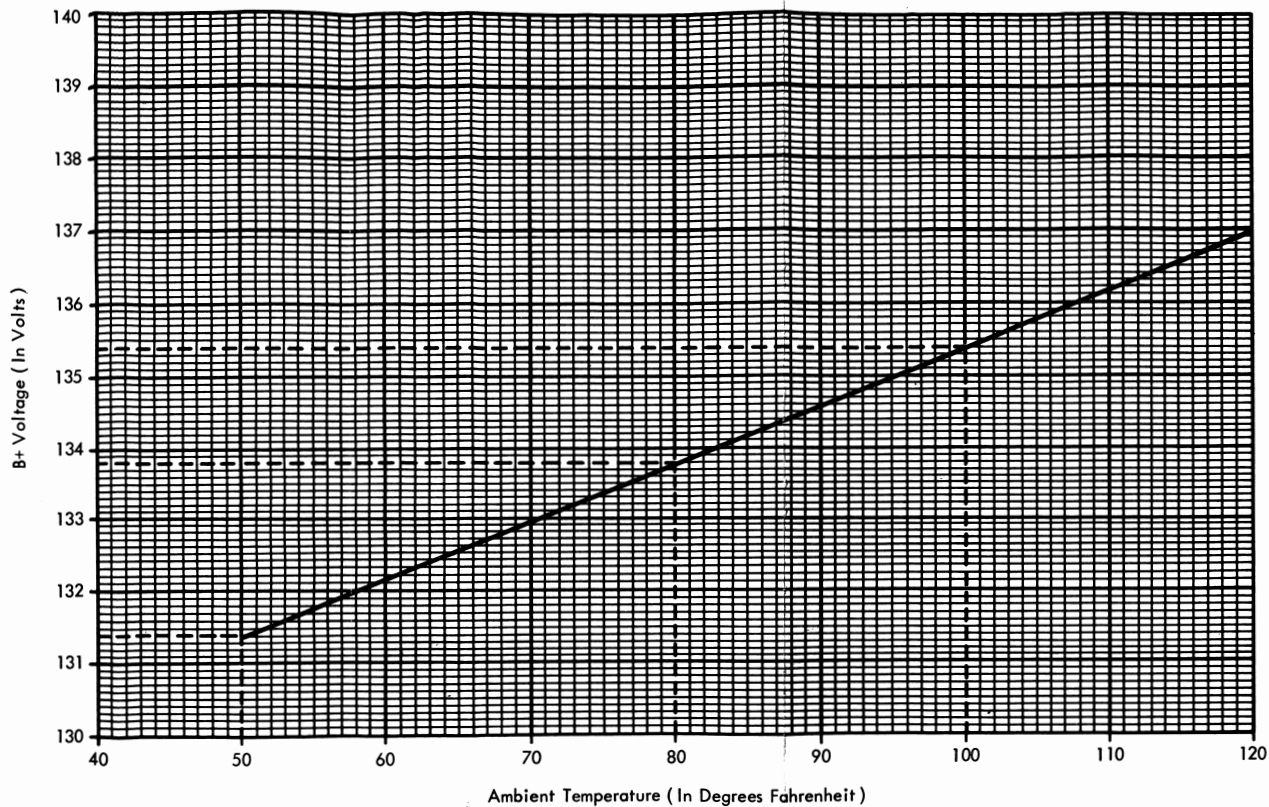
1. Adjust R25a (R40) vertical hold control, and R25c (R19) horizontal hold control, to obtain a stable format.
2. Center image using centering rings on yoke.
3. Adjust L5 (L10) vertical phase control to produce a format height of 2.7 inches if a 480 or 960 character format is used (for 2848 Models 1 and 3 respectively), or 1.25 inches (2848 Model 2) if a 240 character format is used.
4. If necessary, adjust R25a (R40) vertical hold control, to maintain vertical sync.
5. If the 2260 is a Model 2 or if it is a Model 1 to be operated with a vertical size greater than 3.5 inches, turn power off and move J6 (J4) to pin marked "Expanded".
6. If the 2260 is a Model 1 to be operated at the nominal vertical size, leave J6 (J4) on "Normal".
7. Turn power on and allow display to stabilize. Adjust L4 (L7) vertical size control, to give desired vertical size. See Chart below for appropriate values.

Note: If the 2260 is adjusted to the recommended values, overlay mask IBM PN 5728449 will facilitate these adjustments.

Display Model	Control Unit	Nominal Width	Nominal Height	Guaranteed Width Adjustment Range	Guaranteed Height Adjustment Range
2260-1	2848-3	9.0"	3.0"	7.5" to 9.5"	2.8" to 5.0"
2260-2	2848-1	6.5"	2.25"	6.0" to 8.5"	1.9" to 2.4"
2260-2	2848-2	6.5"	4.5"	6.0" to 8.5"	4.0" to 5.0"



VARIATION OF B+ WITH TEMP, ADAPTER BOARDS



Horizontal Size and Linearity Adjustment

Note: The Preliminary Checks and Adjustments given at the beginning of the Alignment procedure and the Vertical Size Adjustment given in the preceding paragraph must be done before proceeding.

1. Adjust R25d (R23) horizontal linearity control so that characters on the left and right edge of the displayed format are approximately equal in width.
2. Readjust R25c (R19) horizontal hold control to maintain horizontal sync.
3. Adjust R25b (R20) horizontal size control to produce desired format width.
4. Readjust R25c (R19) horizontal hold control, if necessary to maintain horizontal sync.
5. Center format as required using centering rings on yoke.
6. Repeat steps 1 through 5 until desired width is attained concurrently with best horizontal linearity. Best horizontal linearity generally occurs when the characters to the left and to the right of center are equal in number.

Vertical Sync Adjustment

Note: The Preliminary Checks and Adjustments given at the beginning of the Alignment procedure, the Vertical Size, and the Horizontal Size and Linearity Adjustments given in the two preceding paragraphs must be done before proceeding.

1. Turn power off and move J4 (J6) to pin marked "AFC". Turn power on and allow one minute for display to stabilize.
2. Adjust R25a (R40) vertical hold control, to obtain a stable display format.
3. Turn power off, move J5 (J5) to "Normal", turn power on, and allow one minute for the tubes to return to normal operating temperature.
4. Adjust L3 (L12) vertical oscillator coil, to obtain a stable format.
5. Turn off power and move J4 (J6) to pin marked "Normal". Turn power on and determine proper AFC voltage according to step 6 or 7.
6. If the 2260 to be aligned is located in an office environment where the temperature remains within 60°F to 90°F, the AFC voltage may be adjusted to +0.4V.
7. If the 2260 is operated at temperatures outside the 60°F to 90°F range, determine AFC voltage as follows:

- a. Measure line voltage using 1% meter.
- b. Determine ambient temperature using thermometer or judgment adequate to give temperature within 10°F.
- c. Using temperature and voltage just measured, solve following equation for AFC voltage or use graph in step d.

$$V_{afc} = 1.533 - \frac{V_{lm}}{V_{ln}} - 0.00166 TA$$

where V_{afc} = Desired AFC voltage
 V_{lm} = Measured line voltage
 V_{ln} = Nominal line voltage
 TA = Ambient temperature in °F.

- d. If a graphical solution is preferred, locate prime power source nominal value on AFC Voltage Determination Graph. This graph is designed for the following prime power sources:

115V ±10%	60 Hz single phase
112.5V ±10%	50 Hz single phase
123.5V ±10%	50 Hz single phase
195V ±10%	50 Hz single phase
220V ±10%	50 Hz single phase
235V ±10%	50 Hz single phase
- e. Read left or right from the appropriate center value, locate the voltage closest to the value measured, and interpolate as required.
- f. Proceed vertically from this point to intercept the temperature curve corresponding to the measured temperature. Interpolate as required.

HORIZONTAL HOLD/GEOMETRIC DISTORTION

8. Connect ground lead of scope probe to circuit board ground plane near TP5 (TP5).
9. Connect scope probe to TP5 (TP5). Use probe tip PN 461090 to minimize stray pickup from adjacent circuitry.
10. Adjust scope to read dc voltage, 100 mv/cm at a horizontal sweep speed of 10 usec/cm.
11. Note that as the scope probe is moved about, the 6 usec pulse observed on the scope changes in amplitude. Hold the scope probe in the position that results in minimum pulse amplitude.
12. Adjust L3 (L12) vertical oscillator coil to provide an AFC voltage as determined in step 7 above, measured approximately 2 usec before the pulse. This completes the vertical oscillator adjustment. Do not readjust R25a (R40) vertical hold control.
13. Remove scope probe and interrupt sync for 10 seconds by removing the yellow lead from input pin on circuit board (or by removing yellow lead from V1 adapter). When lead is reconnected, the display should promptly pull into sync.
14. Turn power off for 1 minute. When power is turned on, the display should sync within 60 seconds.
15. If the display fails to sync properly, check the following list for possible troubles:
 - a. V3 (V3), 8B10, V5 (V4), 33GY7, or V2 (V1), 15DB11.
 - b. Deflection yoke.
 - c. Loose jumper, J6 (J4).
 - d. Tube (or adapter) loose in its socket.
 - e. Input video signal distorted or of improper amplitude.
 - f. Corona around the high voltage lead at the CRT or at the base of V6 (V5).
 - g. Poor ground on the Aquadag coating through grounding clip, PN 5719370.
 - h. Deflection yoke is not positioned against the bell of the CRT.

After the cause of the trouble has been isolated and corrected, repeat the vertical sync adjustment (paragraph entitled "Vertical Sync Adjustment"). If the trouble cannot be found, replace the circuit board. After the circuit board has been replaced, repeat the entire detailed alignment procedure.

Horizontal Hold Adjustment

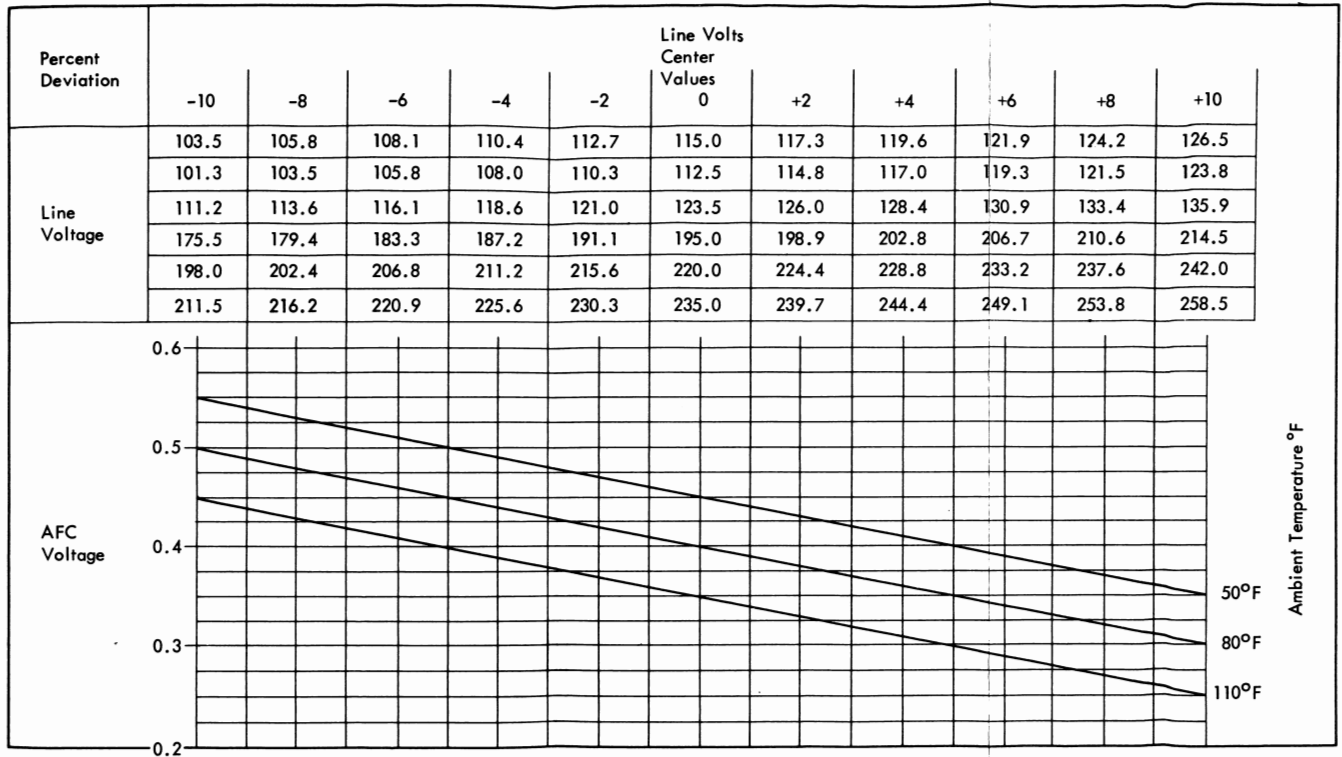
If the display operates in office ambient conditions, the horizontal hold control, R25c (R19) should be adjusted to the midpoint of the hold in range.

If the display must operate in the 50°F to 110°F temperature range, then the horizontal hold control, R25c (R19) should be turned fully clockwise and left in that position.

Geometric Distortion

If, with the display format centered, geometric distortion in the form of pin cushion or barrel distortion is observed, it may be minimized by shifting the format. To accomplish this:

1. Move the format vertically $\pm 1/2$ inch to equalize the distortion on the top and bottom of the format. Use the centering rings on the deflection yoke to make this adjustment.
2. If necessary, the format may be moved horizontally $\pm 1/8$ inch to equalize distortion on the left and right edge of the format by use of the centering rings.



Notes: Top row line voltage values apply to domestic units; remaining voltages apply to world trade units.

3. If the distortion appears excessive after the above adjustments, use alignment mask, PN 5728449, as follows:
 - a. If necessary, adjust the format size to the appropriate recommended size.
 - b. Place the alignment mask over the format with the two adjacent sides of the format contained between the two heavy rectangles on the alignment mask corresponding to the format size in use.
 - c. Check that the two adjacent edges of the format are contained between the two heavy rectangles. Repeat for each remaining pair of adjacent sides.
 - d. If the format edges exceed the tolerance limits by an excessive amount, the yoke should be replaced.
 - e. If the format size was adjusted to make these measurements or the yoke was replaced, the display should be realigned.

Focus Adjustment

Focus is a function of the following parameters: vertical size, deflection yoke, CRT, anti-glare coating, focus voltage, and brightness level.

If brightness is adjusted to give a reasonable contrast level without blooming, the focus voltage remains as the only controllable parameters. Best focus is a compromise between best edge and best center focus. Focus voltage can be changed by adjusting R14 (R80), located below and to the left of the large center hole in the circuit board. *(On circuit boards with tube adapters, the focus control is located on the bracket just above the brightness control.)*

Criteria for satisfactory focus is that all characters are legible at the extreme edges of the display. Some lack of sharp definition is permissible. If satisfactory focus is not attainable with the focus control R14 (R80), replace the yoke and/or the CRT. If the yoke is replaced or size adjustments are made in the process, the alignment procedure should be repeated.

Video Peaking Adjustment

Video peaking coil, L2 (L11) should be adjusted while observing several check characters at minimum brightness level. Adjust to obtain the best overall brightness of the check characters. This adjustment will have little or no effect when long video cables are in use because of the integrating effect of the long cables and corresponding loss of high frequency components of the video signal. Variation in brightness of alternate dots and simultaneous dot pairing is caused by the display control unit and cannot be corrected or adjusted in the display unit.

Rear Cover Replacement

Turn unit off and remove service cord (and control knob if used during alignment). Return ground jumper between transistor heat sink assembly and horizontal sweep transformer mounting screw to the position it was found in originally. (See "Power On", step 1.)

CAUTION

Before replacing rear cover, be certain power cord is not connected to prime power. Reinstall rear cover and verify continuity of frame ground system by checking with ohmmeter from ground pin on service plug to keyboard frame, and to shaft of brightness control. Check from each voltage pin to keyboard frame to verify no connection exists.

CUT ALONG DOTTED LINE

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