Converting the Industrial Electronics 1200B oscilloscope into a 405-line TV

Status: design only, not built or tested. Based on the 1200B instruction manual (scanned 3 October 2026) and the VCR139A monitor report, whose circuits it reuses. Figure numbers 01–06 refer to that report.

1 Summary

The 1200B already has most of a 405-line picture monitor: a DG7-5 tube with its EHT, focus and brightness, an HT supply, and two **DC-coupled push-pull deflection amplifiers** that reach 100 kHz. A TV raster needs exactly that: two ramps amplified onto the plates, plus video on the grid.

So the conversion is an **add-on box** (figure S1). It makes the line and field ramps from the video's sync pulses and drives the grid. It feeds the scope's X input, Y input and GRID socket, all of which are already on the front or rear panel. Inside the scope there's **one small change**: a clamp diode across the grid resistor (figure S2b). It's reversible, so the scope can go back to being a scope.

The box reuses the VCR139A monitor's sync separator (fig 01), line timebase (fig 02), field timebase (fig 03 rev B), video amplifier (fig 05) and spot-kill (fig 06). Its deflection amplifiers (fig 04) aren't needed, because the scope's EF36 amplifiers do that job.

Expect a **small, soft, dim picture**: about 48 × 36 mm, with roughly 45–60 lines of real resolution, best in a darkened room. That's the 1950s "scope TV" look. The main risk is whether the X amplifier can swing far enough for full width. §5 explains how to check that in five minutes before building anything.

2 The 1200B, from its manual

Item	1200B
Maker, date	Industrial Electronics, Derby Rd, East Sheen, London SW14. Brochure July 1951; circuit drawn 27 Feb 1952, issue 4 Nov 1954
Tube	Mullard **DG7-5** (CV2175): 7 cm, green, medium persistence (about 50 ms). Our data sheet is in `CRT_Data/`
Y amplifier	V1, V2 **EF36**, cathode-coupled push-pull, single stage, DC to 100 kHz (6 dB down). 100 mV RMS/cm, 1 MΩ input. S1 selects A.C. (0.1 µF) or D.C.
X amplifier	V4, V5 EF36, the same circuit, less sensitive: 140 mV RMS/cm. S4 selects T.B., A.C. or D.C. On A.C. or D.C. the time base is switched out
Time base	V3, a gas-discharge triode, 5 Hz – 20 kHz in 5 ranges, sweep expansion ×8. Not used for the TV
HT	V7 **6X5GT** full-wave: about 430 V at the reservoir, +400 V line (8 + 16 µF C7)
EHT	V6 half-wave from a 650 V winding stacked on the HT winding. The drawing marks 800 V and 500 V (meter-loaded). The final anode is held at about +110 V to match the amplifier anodes, so the plates' mean voltage equals the final anode
CRT heater	Its own 6 V winding (taps at 2 V and 4 V), separate from the valve heaters (two 6.3 V windings)
Brought out	Both plates of each axis and the grid on a terminal board. A GRID socket feeds the grid through **C4, 0.01 µF 1,000 V**, with **R18, 470 k**, to the BRILLIANCE pot. A rear octal socket gives **6.3 V AC and 350 V DC**, intended for the 1400B alignment generator
Power	200–250 V, 40–60 Hz, 40 W, 1 A fuse

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The drawing's voltages were read with a 1,000 Ω/V meter. On the high-resistance EHT chain they read low, so the real EHT is probably higher than marked. The beam voltage (cathode to final anode) is likely **600–900 V**. Measure it (§5); the deflection figures below depend on it.

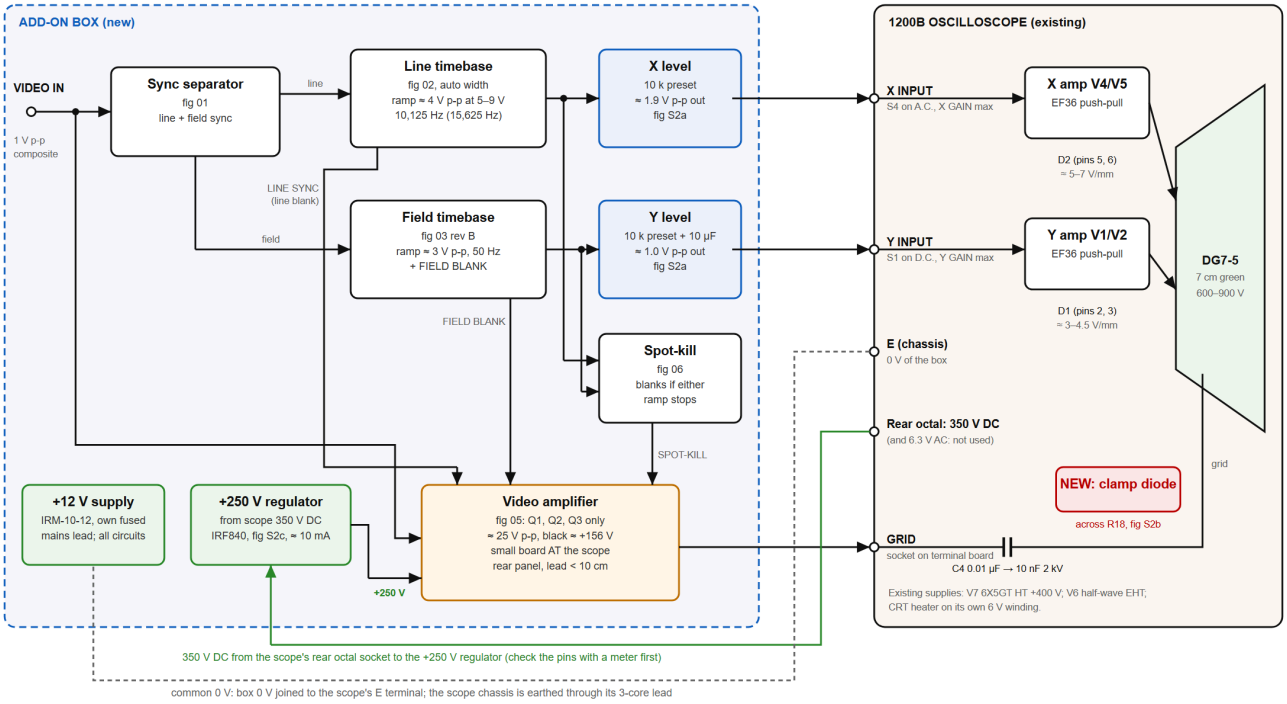
From the circuit: the scope drives **X onto D2** (pins 5 and 6, the less sensitive pair) and **Y onto D1** (pins 2 and 3). The DG7-5 sensitivities (Philips: 6.25 and 4.0 V/mm at 800 V) scale with beam voltage:

Beam voltage	D2 (X)	D1 (Y)
600 V	4.7 V/mm	3.0 V/mm
800 V	6.25 V/mm	4.0 V/mm
900 V	7.0 V/mm	4.5 V/mm

3 How the conversion works (figure S1)

Figure S1: Industrial Electronics 1200B oscilloscope as a 405-line TV, add-on box and connections

The scope keeps its CRT, EHT, HT and X/Y deflection amplifiers. The box makes the ramps and the video drive. Figure numbers are the VCR139A monitor report's.



Picture 48 × 36 mm (4:3) inside the 7 cm screen: X needs ≈ 230–340 V p-p between the D2 plates, Y ≈ 110–160 V p-p on D1 (EHT 600–900 V). Scope sensitivities ±20 %: set the presets on the bench.
Both scope gain pots at maximum: the manual warns they are not frequency-compensated and lose HF part-way round. The internal gas-triode time base is switched out (S4 on A.C.).
Untested design. Recap and check the 1950s scope (report §4) before connecting anything.

- **Sync separator (fig 01)** takes the composite video and gives line and field sync.
- **Line timebase (fig 02)** makes a 10,125 Hz ramp, about 4 V p-p. Its automatic width loop also handles 625 lines (15,625 Hz) at the same width.
- **Field timebase (fig 03 rev B)** makes a 50 Hz ramp, about 3 V p-p, and FIELD BLANK.
- **X and Y level presets** scale the ramps for the scope's inputs (figure S2a).
- **Video amplifier (fig 05)** drives the GRID socket, with line and field blanking.
- **Spot-kill (fig 06)** blanks the beam if either ramp stops. That matters on this tube: a stationary spot or a single line at TV brightness burns a green phosphor quickly.
- **Power:** a separate +12 V module for the low-voltage circuits, and +250 V for the video amplifier's output stage, regulated down from the scope's 350 V (figure S2c).

Scope settings: S4 (X) on **A.C.**, S1 (Y) on **D.C.**, and both gain controls at **maximum**. The manual warns that the gain pots aren't frequency-compensated and lose high frequencies part-way round, so set the size with the presets in the box instead. The sync selector and time-base controls do nothing in this mode.

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4 Restore the scope first

The scope is 70 years old. Get it working as a scope before connecting anything.

Status, 3 October 2026: the scope was partly restored some years ago. It now powers up with a good trace that runs off both edges of the screen, and all the controls work. The focus control needs attention. The manual's fault guide says a beam that won't focus points at the EHT bleeder chain: **R17, R23, VR7 (FOCUS) and VR8 (BRILLIANCE)**. Check those resistors for drift, and clean or replace VR7 if its track is worn. Work with the power off and the EHT capacitors discharged. Replace VR7 with a pot rated for the voltage, insulated from the panel.

1. **Look first:** the mains lead (3-core, earth bonded to the chassis), fuse, mains tapping (200/220/240 V), and any heat damage or wax leaking from capacitors.
2. **Capacitors:**
    - **C7** (8 + 16 µF, HT reservoir and smoothing, about 430 V): replace with 105 °C parts, **500 V** rated.
    - **C5, C6** (EHT, 0.1 µF): replace with film rated **at least 2 kV**.
    - **C4** (grid coupling, 0.01 µF 1,000 V): it sits across most of the EHT. Replace with **10 nF 2 kV** (figure S2b).
    - **C3 and C1** (0.1 µF input coupling): replace with 630 V film. A leaky C3 would shift the picture sideways.
    - The time-base capacitors C8–C11 aren't used for the TV and can stay.
3. **Valves:** test the four EF36s and pair them. The manual says the two in each push-pull pair should match within about 10 %. A weak valve shows as a shift control that won't centre the spot.
4. **Bring-up:** power it from a variac, starting low, and watch the 6X5 and the EHT rectifier. Then check the HT (about 400 V), a focused spot, and the time base and CAL signal on screen.
5. **Measure the EHT:** cathode to final anode. Use an electrostatic voltmeter or a 1,000 MΩ probe; an ordinary meter loads the chain and reads low. Note it in §13.

Safety: the CRT's cathode, heater and grid sit several hundred volts below chassis, and the EHT capacitors hold their charge. Discharge before touching, and keep one hand in your pocket.

5 Bench checks before building the box

The main risk is X width. A 48 mm wide picture needs about 230–340 V p-p between the D2 plates, depending on the EHT. Each EF36 anode idles at about 110 V on a 400 V supply, through about 64 k (22 k plus part of the shift pot). The pair should manage roughly 300–400 V p-p between its anodes, so width is probably just achievable, but it needs measuring:

1. **Gross swing:** run the scope's own time base at about 10 kHz with X GAIN at maximum. Turn X GAIN (the sweep expansion) up until the trace overfills the screen.
    - **Good:** the trace runs cleanly off both edges.
    - **Short:** bright dots form at the trace ends inside the screen, where the amplifier clips. Measure the trace length at that point: that's the maximum width.
2. **Real line rate:** feed a 10,125 Hz sawtooth into X INPUT (S4 on A.C.), about 2 V p-p, from a signal generator or the PicoScope's generator. Check:
    - **Width** at maximum gain.
    - **Flyback:** the X amplifier is 6 dB down at 100 kHz, so expect about 5–8 µs. 405-line blanking is about 18 µs, so that's fine.
    - **Linearity:** the line should be evenly bright with no compressed end.
3. **Field:** feed a 50 Hz sawtooth of about 1 V p-p into Y INPUT, through 10 µF with S1 on D.C. Check it gives at least 36 mm of height. The Y amplifier drives the more sensitive D1 pair, so this should be

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easy.

If X falls short, see §10.

6 The add-on box

Build figs 01, 02, 03 rev B, 05 and 06 as in the monitor report, with these changes:

- **Sync separator option:** Addendum A replaces fig 01 with an LM1881 and one transistor (figure S3). Its outputs are the same, so nothing else changes.

- **No fig 04:** the scope's EF36 amplifiers replace the transistor deflection amplifiers.
- **Ramp interface (figure S2a):**
  - **Line ramp:** goes through a 10 k X LEVEL preset to X INPUT. The scope's A.C. coupling (C3 0.1 µF into the 1 MΩ gain pot, τ = 0.1 s) is fine at 10 kHz, and it removes the ramp's 5–9 V offset.
  - **Field ramp:** goes through a 10 k Y LEVEL preset and **a 10 µF non-polar capacitor** to Y INPUT, with S1 on **D.C.** The scope's own A.C. position would bow a 50 Hz ramp by about 10 %. The external 10 µF into 1 MΩ (τ = 10 s) bows it by under 0.2 %.
  - **Starting levels:** about 1.9 V p-p for X and 1.0 V p-p for Y, from the manual's sensitivities (±20 %). Set them on the picture.
- **Video amplifier:**
  - **What to build:** Q1, Q2 and Q3 of fig 05. Leave out fig 05's 10 nF 2 kV capacitor, 1 M resistor, clamp diode and 100 k: inside the scope, C4, R18 and the new diode do those jobs.
  - **Where it goes:** build it on a small board **fixed to the scope's rear panel**, with the lead to the GRID socket under 10 cm. Q2's 10 k load can't drive cable capacitance at video frequencies: 1 m of coax (about 100 pF) would blur the picture to a few hundred kHz.
  - **Blanking:** line sync, field blank and spot-kill reach it as in fig 05.
- **Spot-kill (fig 06):** as designed. If a ramp stops it holds blanking, and the grid clamp then holds the grid about 20 V beyond cut-off.
- **Picture orientation:** if the picture is upside down or mirrored, swap that axis's two plate wires at the CRT base. The shift control then works the other way. Alternatively, invert the ramp in the box.

7 The grid clamp, inside the scope (figure S2b)

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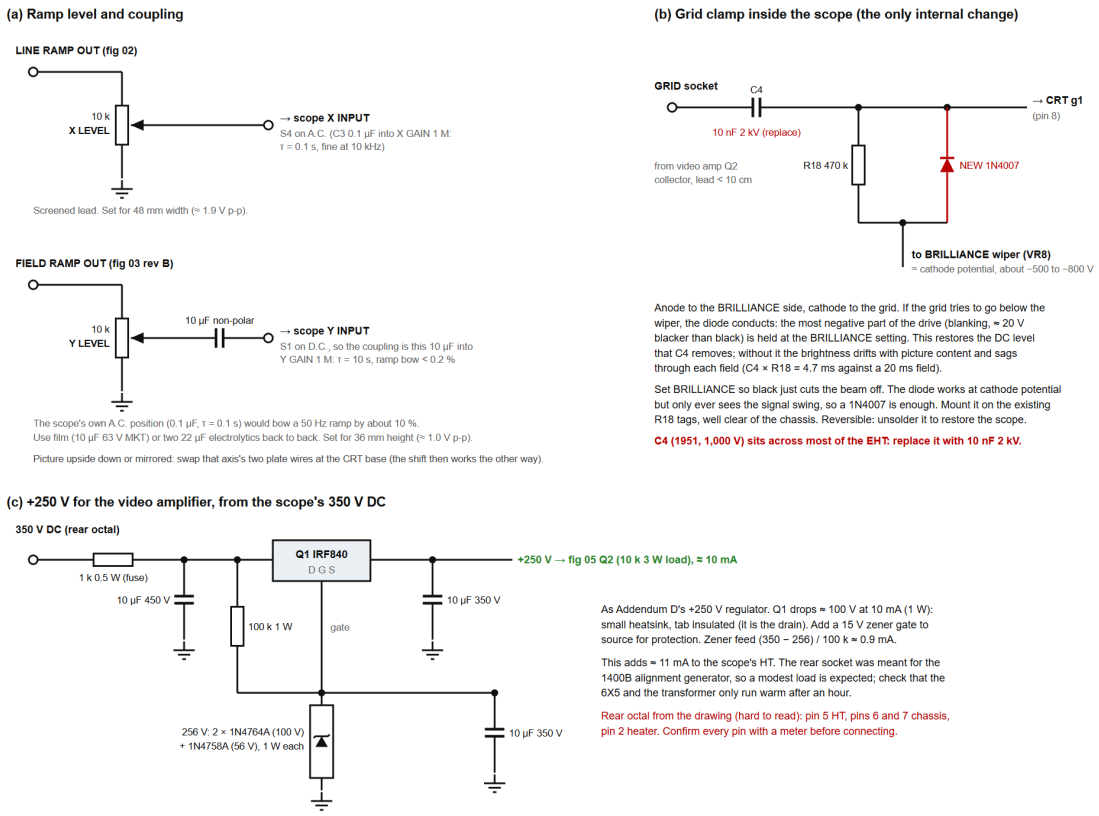
Figure S2: interface details and the one change inside the scope

(a) ramp levels into the scope inputs (b) grid clamp inside the scope (c) +250 V for the video amplifier from the scope's 350 V. Untested starting values.



The scope couples its GRID socket through C4 (0.01 µF) into R18 (470 k) to the BRILLIANCE wiper. That's fine for a scope's bright-up pulses, but it loses the picture's DC level. The time constant is 4.7 ms against a 20 ms field, so brightness would drift with picture content and sag down each field.

The change: a 1N4007 across R18, with its **anode to the BRILLIANCE side and its cathode to the grid**. The most negative part of the drive is blanking, about 20 V blacker than black, and the diode holds it at the BRILLIANCE setting. This is the same grid-side clamp as fig 05.

The diode sits at cathode potential, but only ever sees the signal swing. Fit it on R18's existing tags, clear of the chassis. Set BRILLIANCE so black just cuts the beam off. To restore the scope, unsolder the diode.

8 Power

- **+12 V:** an IRM-10-12 module (12 V 0.85 A) in the box, with its own fused mains lead. Without fig 04 and the CRT heater, the box draws only about 0.1–0.2 A. Don't use the scope's 6.3 V AC: that winding already carries about 1.7 A of valve heaters.
- **+250 V (figure S2c):**
  - **Circuit:** an IRF840 source follower with a 256 V zener reference, fed from the scope's 350 V DC (rear octal). It's the same circuit as Addendum D's +250 V regulator.
  - **Dissipation:** about 10 mA through a 100 V drop, so 1 W. It needs a small heatsink, with the tab insulated because it's the drain.
- **HT load:** about 11 mA extra on the scope's HT. The socket was meant to power an alignment generator, so that should be within the design. Check that the 6X5 and the mains transformer only run warm after an hour.
- **Rear octal pinout:** hard to read on the drawing. It looks like **pin 5 HT, pins 6 and 7 chassis, pin 2 heater**. Confirm every pin with a meter before connecting.
- **0 V:** join the box's 0 V to the scope's E terminal. The scope chassis is earthed through its 3-core lead.

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9 What the picture will be like

	Expected
Size	48 × 36 mm (4:3) in the 7 cm screen. It could go a little bigger if the X amplifier allows
Sharpness	The DG7-5's spot is about 0.7 mm at low current and larger at TV brightness: **about 45 resolvable lines vertically and 60 elements across**. Faces and test-card shapes are recognisable; small text isn't
Brightness	Dim. The screen rating (3 mW/cm^2) allows about 50 mW over the raster, about 60 µA of beam at 800 V. View it in a darkened room
Persistence	Medium, about 50 ms: no flicker at 50 Hz, with slight smearing on movement
Interlace	Set by the field ramp's timing, as on the monitor. It hardly matters at this resolution
625 lines	Also works. Fig 02 keeps the width, and the 8 µs flyback fits inside 625-line blanking (about 12 µs), just

10 If the X amplifier can't reach full width

1. **Accept a smaller picture:** 40 × 30 mm needs a sixth less swing.
2. **Turn the tube 90°** in its clamp and swap the plate wiring, so the line scan goes onto the **more sensitive D1 pair** and the field onto D2. Full width then needs only 140–220 V p-p from the X amplifier, and the field needs 170–250 V p-p from the Y amplifier, which has swing to spare at 50 Hz. Check the CRT's leads are long enough first. This is still reversible.
3. **Raise the X amplifier's swing** by lowering its anode loads. That changes the scope, so treat it as a last resort.

11 Commissioning

1. Scope restored and checked (§4). Bench checks done (§5).
2. Build and test the box on a bench supply. Check the ramps, sync and blanking on a scope with 405-line video applied: the test-pattern generator or the standards converter.
3. Fit the grid clamp diode and the new C4. With BRILLIANCE turned down, connect the X and Y ramps. Bring BRILLIANCE up until a raster just shows, then adjust the X and Y LEVEL presets for 48 × 36 mm and centre it with the scope's shift controls.
4. Connect the video. Set BRILLIANCE so black just cuts off, then adjust FOCUS. The manual notes focus and brilliance interact on the DG7-5, so go back and forth.
5. Pull the line ramp lead: spot-kill must blank the screen within a fraction of a second. Repeat for the field.
6. Leave it running for an hour, then check the 6X5, the mains transformer and the IRF840.

12 Parts, beyond the monitor report's figs 01, 02, 03 rev B, 05 (Q1–Q3) and 06

Part	Qty	Note
10 nF 2 kV film	1	New C4
0.1 µF 2 kV film	2	New C5, C6 (EHT)
0.1 µF 630 V film	2	New C1, C3
8 µF + 16 µF 500 V 105 °C	1 each	New C7 (separate cans are fine)
1N4007	1	Grid clamp
10 k preset	2	X and Y LEVEL
10 µF 63 V MKT film (or 2 × 22 µF electrolytic back to back)	1	Y coupling
IRF840, heatsink, insulating kit	1	+250 V regulator

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1N4764A (100 V 1 W)	2	256 V reference
1N4758A (56 V 1 W)	1	256 V reference
15 V zener	1	IRF840 gate protection
100 k 1 W, 1 k 0.5 W	1 each	Regulator
10 µF 450 V, 10 µF 350 V	1, 2	Regulator
IRM-10-12 module	1	+12 V
Octal plug	1	Rear power socket
Screened lead, phono or BNC plugs		Ramp leads

13 Open items

Item	Result
Beam voltage, cathode to final anode	___ V
FOCUS fault (R17, R23, VR7, VR8)	Found 3 Oct 2026; ___
Maximum clean X trace length (§5 step 1)	Runs off both edges of the screen (3 Oct 2026). Still to check: no bright dots at the ends, at about 10 kHz
X at 10,125 Hz: width at 2 V p-p, flyback time	___ mm, ___ µs
Y at 50 Hz: height at 1 V p-p	___ mm
Rear octal pins confirmed (HT, chassis, heater)	___
6X5 and mains transformer temperature after 1 hour with the box	___
Decision: full width on D2, or turn the tube 90° (§10)	___

Appendix: the 1200B circuit (from the manual, rotated upright)

The scan's pages are upside down and the circuit is sideways. This is page 17, turned upright. Some values are hidden under the old tape repair; the component list on the left covers most of them.

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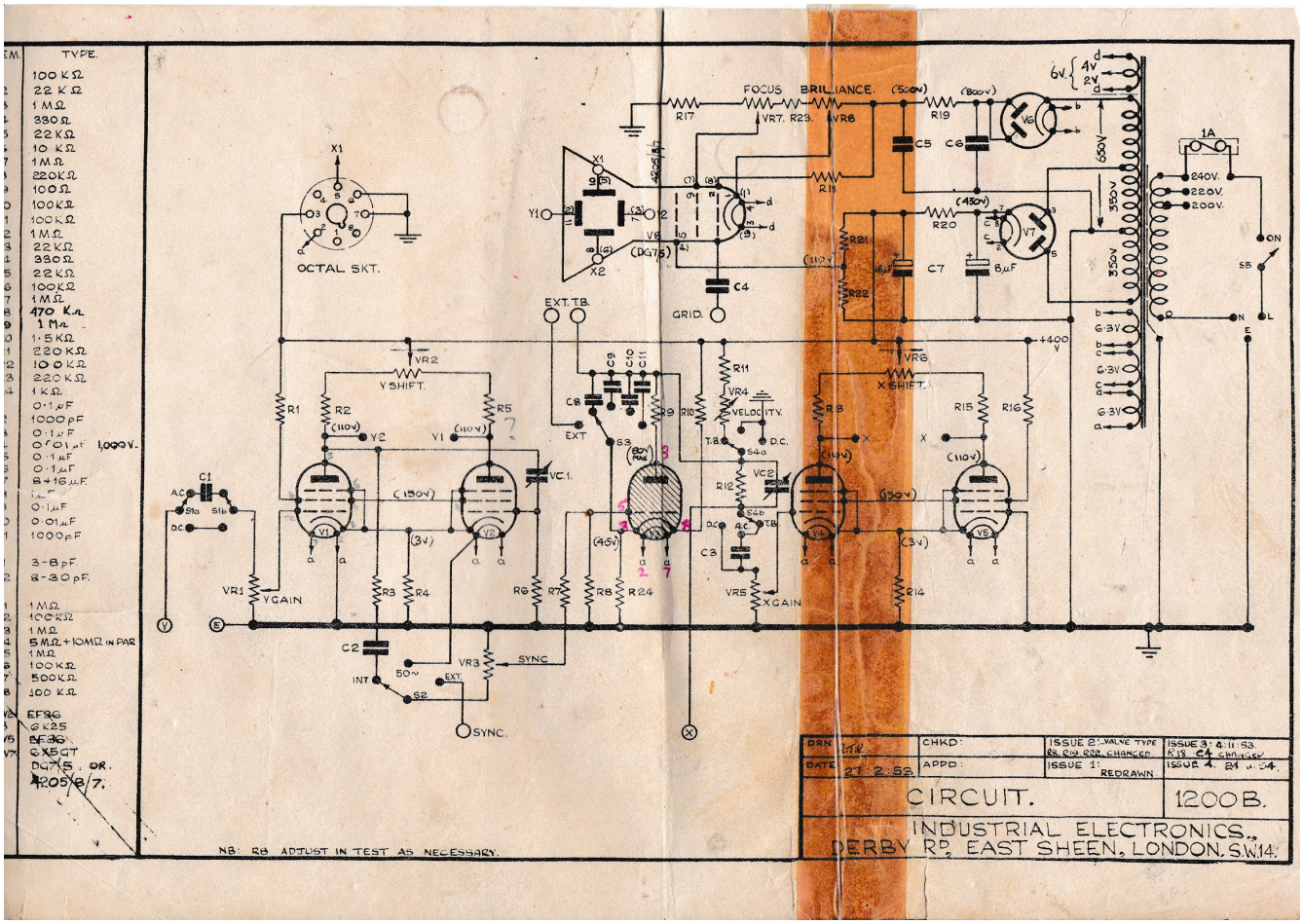

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