

Option 12 (Mod FB) for Tektronix 7L5 spectrum analyzer plugin early versions (S/N below B069999)

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Abstract

This document describes how to modify an early version (S/N below B069999) Tektronix 7L5 spectrum analyzer for compatibility with the 7854 mainframe. The modification is very similar in effect to the one described in Tektronix document "7L5 Mod FB" (or microfiche "7L5 Options", Option 12) released for the newer 7L5 (S/N B070000 and above).

Most points of this modification are also applicable to new 7L5's, so owners of these may find this information useful. The modification features:

- Modification can be switched on/off using front panel button
- Change of the plugin readout display mode to enable 7854 acquisition
- Disabling of the dot marker to enable clean 7854 acquisition
- Disabling of the cursor line to enable clean 7854 acquisition
- Modification of readout circuitry to circumvent a bug in 7854 readout display

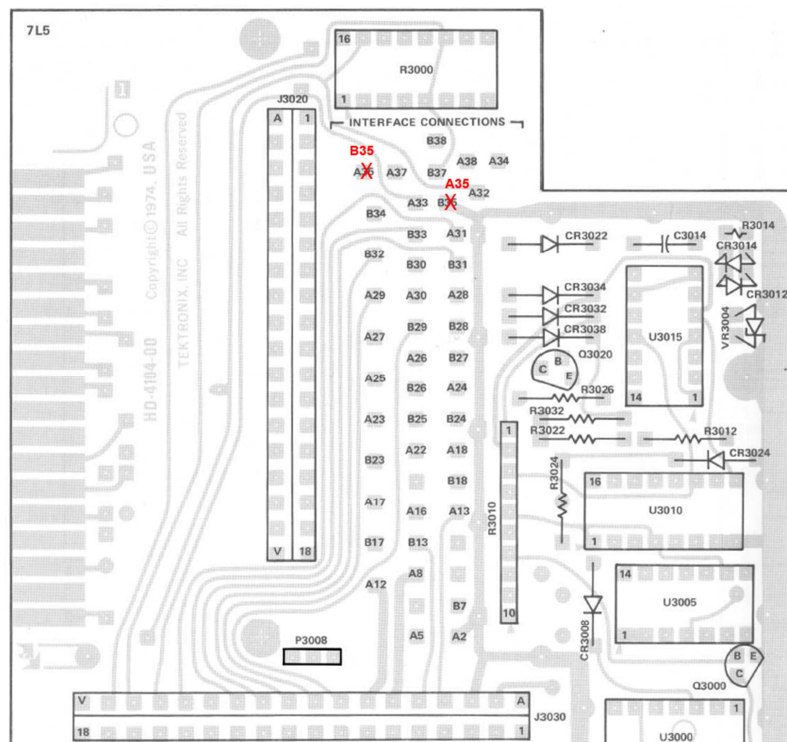
This document should supplement the already existing one titled "Installation of Option 12 in 7L5 module (S/N \geq B070000)", and also makes a few references to it.

Disclaimer

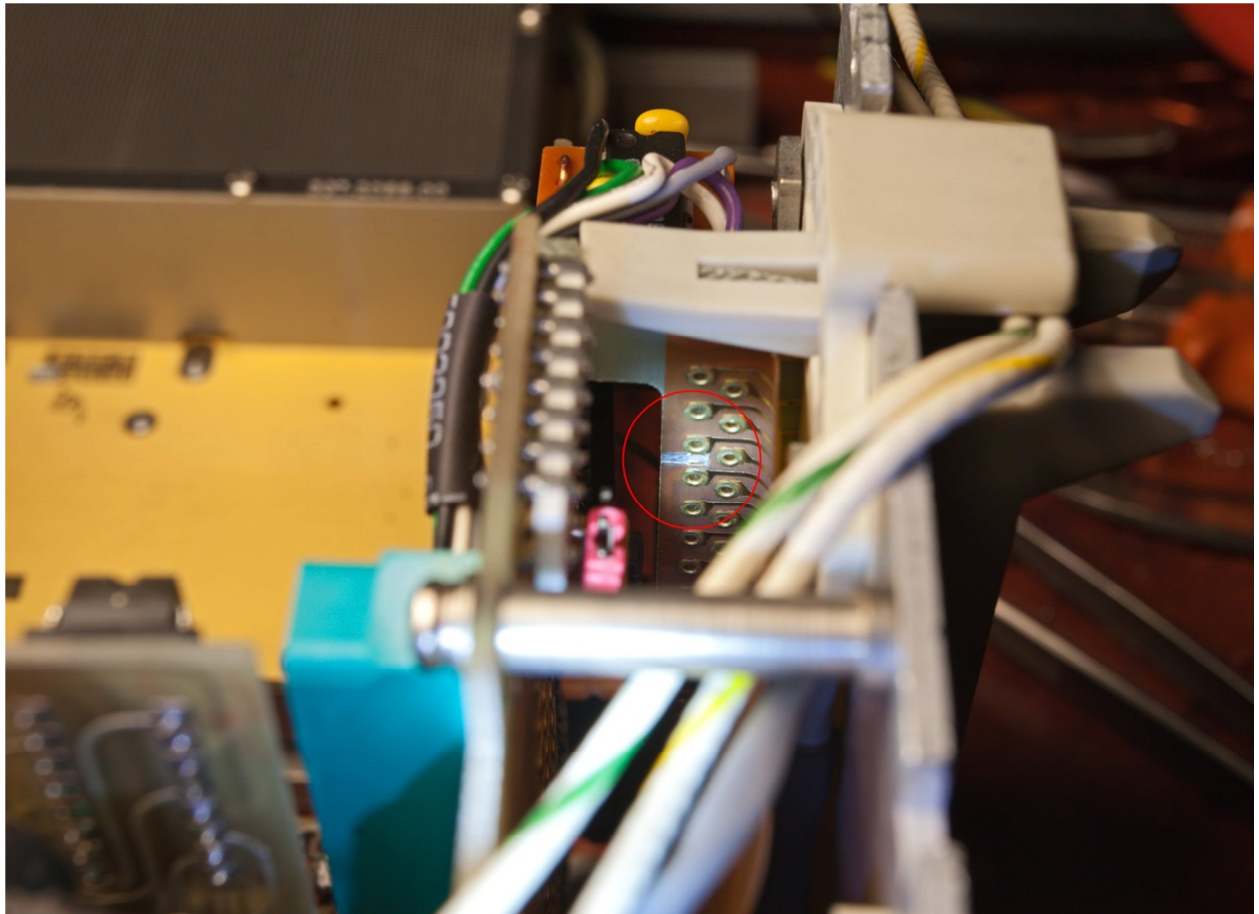
This document is the result of reverse engineering and is by no means an official Tektronix publication. The author provides the instructions with no warranty and takes no responsibility. Suggestions and constructive comments are welcome though.

1. Disabling of plugin readout chopped mode

This change applies to any 7L5 version. I did not investigate the full technical background of this, but the observed behavior is that 7854 is unable to perform any acquisitions from the 7L5 until this change is made (acquisition immediately interrupts with error). The modification cuts the B35 pin of the mainframe vertical slot connector off ground (floating). The 7L5 service manual available from Tek Wiki unfortunately contains a nasty error; pin labels A35 and B35 are swapped on the transverse board layout:

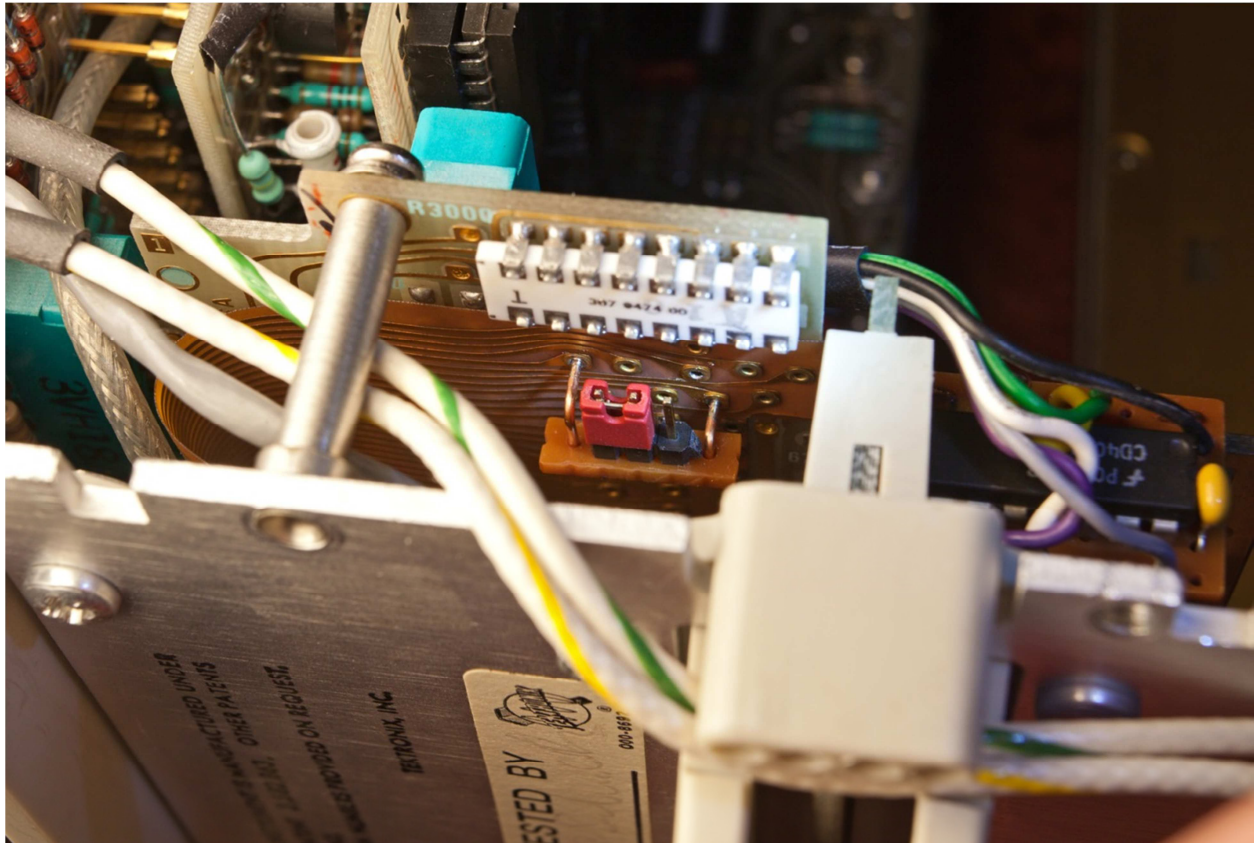


Not noticing this error led many people the wrong way, attempting to cut the ground connection on the transverse board (lifting A35 off ground). The actual grounding of B35 is not on the transverse board, but on the PCB which performs the role of the mainframe vertical slot connector (also explained in "Installation of Option 12 in 7L5 module (S/N \geq B070000)" document). My recommendation for the spot where ground should be cut is on the following photograph:



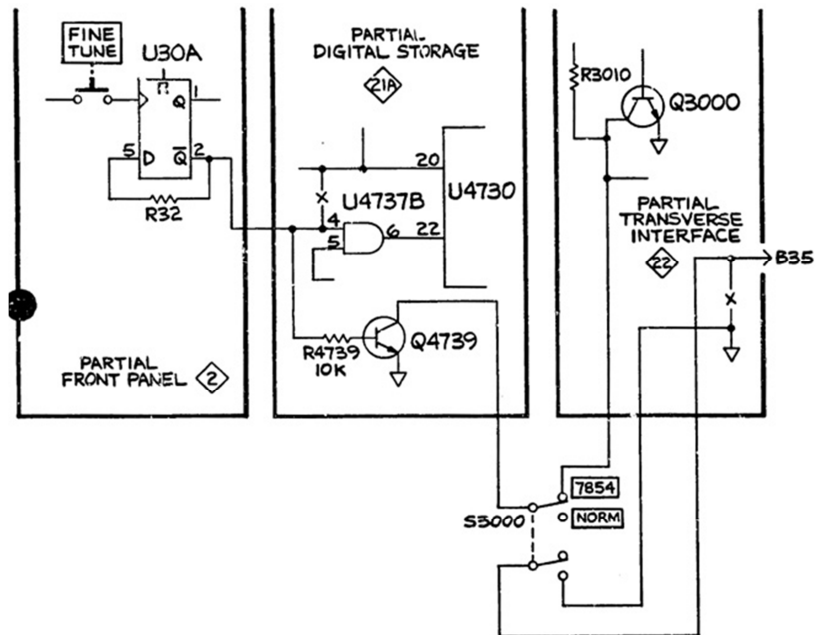
Transverse board and connector PCB (both classic FR4 material) are connected using the polyimide flexible flat cable (brown/orange color), where rivets are used for both electrical contact and mechanical coupling. The ground track that needs to be cut is actually under the polyimide, on the connector PCB (see red circle on the photo above). A small rectangular cut can safely be made on the polyimide here, and the track underneath between the rivets can be severed.

Testing the modified 7L5 in classic mainframes I did not find significant differences in behavior with the modification present, so I'd say it's safe to leave it permanent. However, the change can be made reversible by installing a jumper or external switch (as explained in the Mod FB and Option 12 documents) between B35 and ground. The following photo illustrates the jumper solution and recommended connection points:



2. Deletion of the dot marker

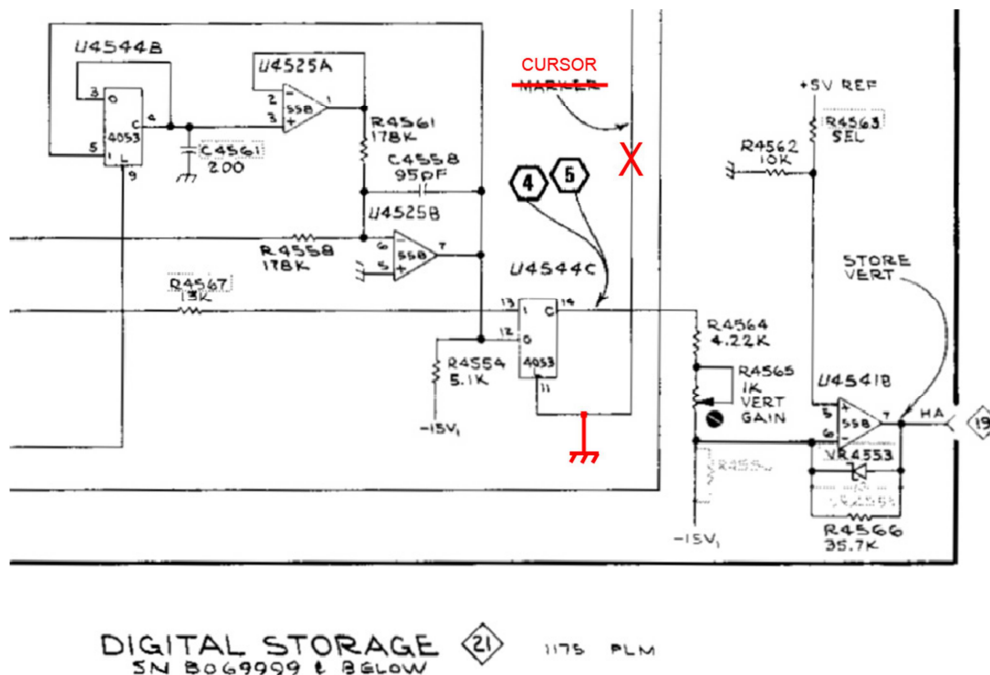
This change applies to any 7L5 version. Connecting the collector of Q3000 (U3000 PIN 6) to ground effectively deletes the dot marker from the display. The signal that drives Q765 will no longer be present.



The schematic above also shows the Tektronix recommendation to use the front panel FINE button to switch the modification on or off. Here Q4739 is added to pull the Q3000 collector low, deleting the marker. This implementation makes the instrument start up with modification switched on (as FINE is normally off after power on). A recommendation on how to connect this is in the last chapter.

3. Deletion of the cursor line

This change applies only to 7L5 S/N below B069999. The service manual schematic contains another error; cursor line is incorrectly labeled as "MARKER". Storage output multiplexer U4544C (4053) switches between the cursor and spectrum signal, so cutting the cursor line and connecting the control input to ground deletes the cursor. A recommendation on how to connect this is in the last chapter.



Deletion of cursor is necessary only in digital storage mode, as it's not displayed when digital storage is switched off.

4. Modification of the readout circuitry

This change applies to any 7L5 version, and may be of interest mainly to people using the LIN mode of 7L5 (which is particularly useful for noise measurements). This "tiny" readout bug is a real nightmare if you make a lot of average level measurements on the 7854 using LIN mode. It was described by me in the TekScopes mailing group topic titled "7854 readout does not conform to specification? (7L5 problem)", unfortunately with little feedback. To summarize the problem, 7854 + 7L5 combo exhibits the following readout problems:

1. *Incorrect level readout in LIN mode - turning the attenuator should produce the expected 200mV-100mV-50mV-20mV... sequence, but instead 7854 displays 2mV-1mV-5mV-2mV... and so on in circle (zeroes are omitted, units and first digit are fine).*
2. *7L5 readout driving circuitry can be slightly modified to fix the mentioned problem, but although that fixes the display perfectly (and is fully compatible with other mainframes using "classic" readout boards), it breaks the ability of the 7854 storage to correctly obtain a scale factor for acquired waveforms. So to summarize:*
 - *If readout is broken in 2mV-1mV-5mV-2mV... way, 7854 acquire command (at least) captures the same scale factor (2mV-1mV-5mV-2mV...)*
 - *If readout is fixed to show 200mV-100mV-50mV-20mV..., 7854 acquire command displays a warning and sets 1 as the default scale factor*

Technical details:

7L5 uses a non-standard (but still technically perfectly correct) mode to display readout, using all 10 time slots (TS1-TS10). For example the word "200mV" in LIN mode would be encoded in the following way:

- *ROW address: 3221115545*
- *COL address: 0003110012*

where digit position denotes a time slot (from left to right TS1-TS10). For comparison word "-123dBV" in LOG mode would be:

- *ROW address: 2221115545*
- *COL address: 0062346702*

Quick reference to the address table:

<http://w140.com/tekwiki/images/a/a3/Tek7000-readout-charset.jpg>

Column address 0 in TS1 denotes a SKIP operation, it's obvious that the two zeroes in 200mV are coded in TS5 and TS6 (non-standard format) as opposed to standard format that uses TS1 to specify "add one zero" or "add two zeroes" operational addresses. So if 7L5 does a SKIP in TS1, ROW address should make no difference (as long as it's in 1-9 range). On mainframes with classic readout boards (tested on 7633 and 7104) it indeed makes no difference, but on 7854 it painfully breaks stuff:

- *if ROW=2 in TS1, readout correctly displays 200mV-100mV-50mV-20mV... but storage acquire fails to obtain the scale factor*
- *if ROW=3 in TS1 (7L5 factory default), readout breaks and displays 2mV-1mV-5mV-2mV... storage acquires the (broken) scale factor*
- *if ROW=4,5..9 in TS1, readout correctly displays 200mV-100mV-50mV-20mV... but storage acquire fails to obtain the scale factor*

7000/7854 readout specification makes no mention of such nonsense. To add to the confusion, 7L5 service manual mentions Q2325 (page 2-19) that sets ROW=3 in TS1 in LIN mode (although TS1 COL=0 which denotes SKIP), but with no explanation. In LOG mode Q2325 is off and ROW=2.

Obviously the problem cannot be fully fixed, but a partial solution can be implemented:

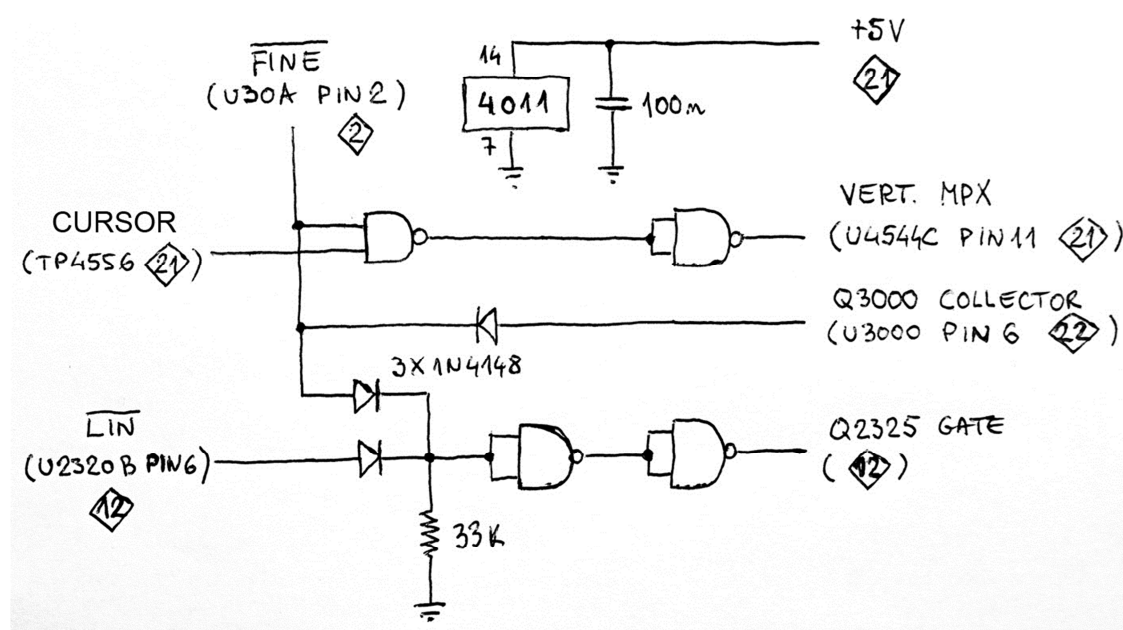
- When 7L5 modification is not active, readout should be adjusted for correct display on the 7854. This way the operator can use this mode to check the actual scale factor of the instrument.
- When 7L5 modification is active, readout should revert back to the “buggy” display, so that 7854 acquire command can at least capture the most significant digit of the scale factor. The correct multiplier of the scale factor (x1, x10 or x100) can be obtained by temporarily switching the modification off (7854 display must be in the SCOPE mode).

This solution seems to be the least of all evils, and if modification on/off switch is implemented using one of the easily accessible front buttons (e.g. the FINE button), it’s not actually that bad in the end. A recommendation on how to wire up this modification is in the last chapter.

5. Wiring up all mentioned modifications

Mod FB and Option 12 documents recommend using the FINE button on 7L5 front panel to switch off the modification (FINE on = modification off). I did not like this and decided to invert it (FINE on = modification on); I wish my instrument to start in unmodified state and display correct LIN readout and dot marker. In this state I adjust controls for taking measurements, and switch the modification on just before invoking 7854 acquisition.

The following schematic uses one 4011 quad NAND gate and a few sidcar parts. It may not be the most optimal solution, but should be good enough:



Wiring instructions:

- ***FINE*** – The choice of \bar{Q} output of U30A is not accidental; resistor R32 is easily accessible at the back side of the front panel PCB, so you can easily solder a wire to it.
- ***+5V*** – Best taken off board 21 together with local ground.
- ***VERT. MPX*** – The track to U4544 PIN11 is inside the multilayer PCB and cannot be cut, so the recommended way is to bend the U4544 PIN11 out of the socket and solder a wire to it.
- ***CURSOR*** – Easily accessible on board 21 (TP4556).
- ***Q3000 collector*** – Easily accessible on the transverse board 22.
- ***Q2325 gate*** – Q2325 is socketed and can be easily removed. It is recommended to carefully bend the gate pin (approx. 1mm away from the plastic case to avoid breaking it off), solder a wire to it and insulate using heat shrinking tube.
- ***LIN*** – Can be taken off Q2325 socket where the gate pin used to be. A piece of heat shrinking tube is recommended to affix this wire together with Q2325 gate wire.

The following photograph shows the looks and recommended placement of the PCB with the 4011. Care should be taken not to obstruct the space required by the left instrument side, once assembled back.

