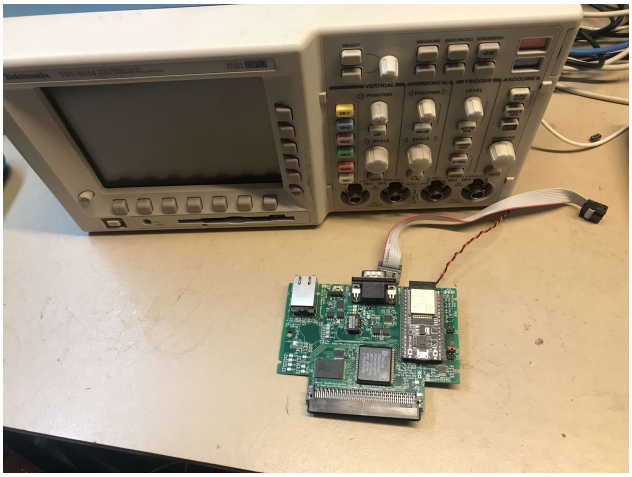
# TDS3000 Second Life Board by TorqueWaveZ.nl

Author: Sicco Dwars

Revision: 1.0, Feb 2021



## Introduction

The TDS3000 Second Life Board was created to solve a couple of issues with ageing Tektronix ‘Digital Phosphor’ oscilloscopes.

* The Real Time Clock / Calendar chip used in these scopes is a Dallas/Maxim DS1742W. It’s directly soldered to the TDS3012/TDS3014/TDS3022/TDS3024/TDS3032/TDS3034/TDS3052/TDS3054 main board, and its internal lithium battery will be totally drained after 15-20 years. The non volatile memory (NVRAM) is no longer persistent after AC power failure, the time date is lost. This is not only a nuisance for the user, it may also prevent booting up and thus render the scope useless. The DS1742W module is obsolete, and left over supplies are exhausted. What’s still available as either ‘new’ or ‘second hand’ on eBay will have a poor battery that will soon be drained – if not drained already. The Dallas/Maxim/TI DS1744W chip with an add-on battery/crystal cap DS9034 PowerCap is a compatible, larger memory NVRAM/RTC SMD component that can be used to replace the legacy DS1742W. But there’s no physical space for its footprint on the mainboard. Cutting open the moulded DS1742W, finding the 3V coin cell battery, and replacing that for a new one is feasible for the highly skilled Dremel user, but it’s not a very elegant solution. Adapter boards from DIP 24 to DS1744W can be used, but these require de-soldering of the old DS1742W module. The TDS3000 Second Life Board has the DS1744W mounted on a plug-in that can be slotted in the backside of the scope, thus offering an easier, elegant repair option. Basic serial I/O, wired and wireless and an Ethernet PHY with RJ45 connector is added to the same board. IEEE488 (GPIB) is not supported though. There’s also no VGA connector for large screen output in this board.

* TDS3VM serial module emulation (without VGA). Or TDS3GM emulation, without GPIB. The legacy TDS3VM plug in module offers RS232 DB9 serial and VGA video connector. The TDS3000 Second Life Board emulates the serial port. It has both a DB9 RS232C connector which is galvanically isolated and it offers a micro USB connector with a serial port via a FT232RQ chip, also isolated. TTL level serial port, not isolated, is also available on a 6 pin header, compatible with FTDI TTL-232R-3V3 cables. Same serial port is wired to a socket for an Arduino ESP32 DevKit4 module. That can be used as WiFi web server or as Bluetooth classic serial profile interface.

* TDS3EM, Ethernet and serial port emulation. The older TDS3000 models, i.e. not the -b and not the -c models do not have Ethernet. A TDS3EM module plugged into the ‘no-suffix’ scopes enables

Ethernet I/O. The TDS3EM has the PHY chip, a flash rom for the MAC address, and the RJ45 connector. Our board has the same rom, the legacy PHY chip MC68160, and RJ45 so that Ethernet can be used. The TDS3EM mode is only enabled with solder jumper JP6 in place, and the MC68160 chip fitted. JP6 and chip U1 (the MC68160) shall not be fitted when the host scope is a -b or -c model, because those have the Ethernet PHY chip on their motherboard.

# How to enable the RTC DS1744W chip and how to disable the mainboard DS1742W

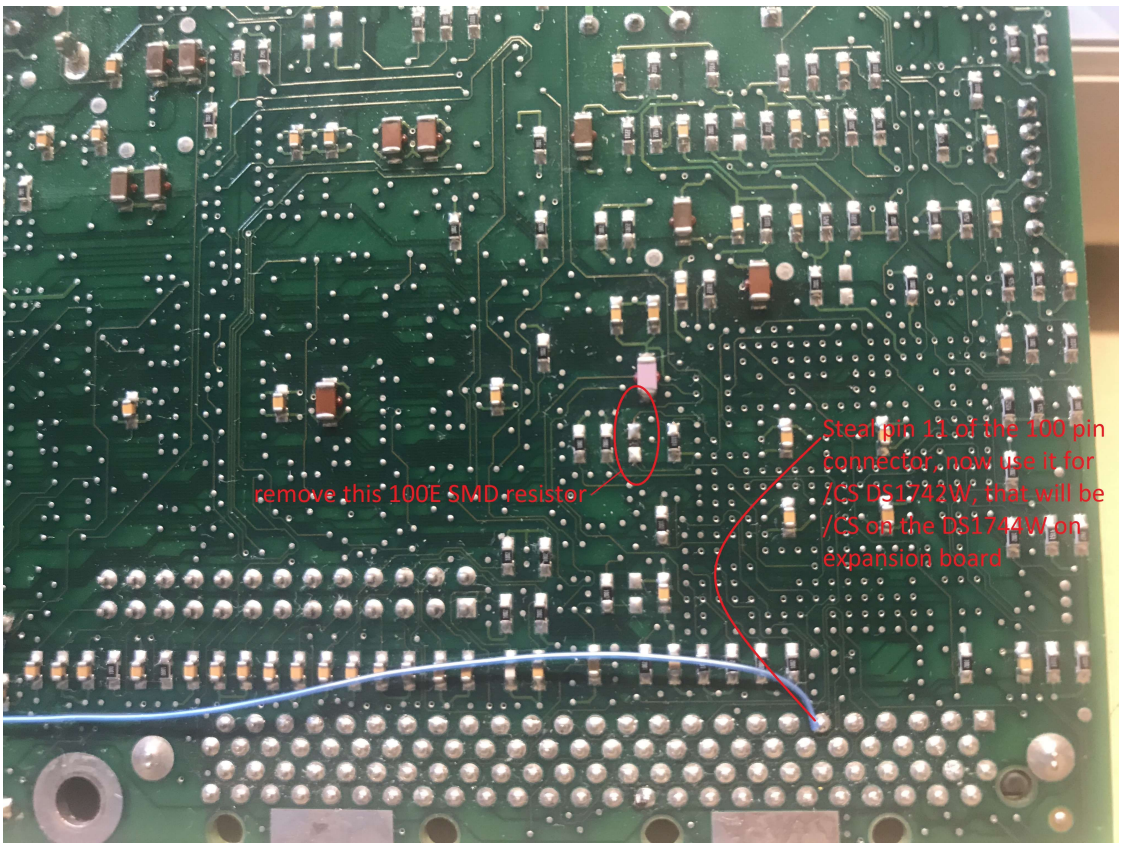
All but one of the 24 DS1742W pins are available on the main board 100 pins expansion module connector. The one pin that's missing is /CS.

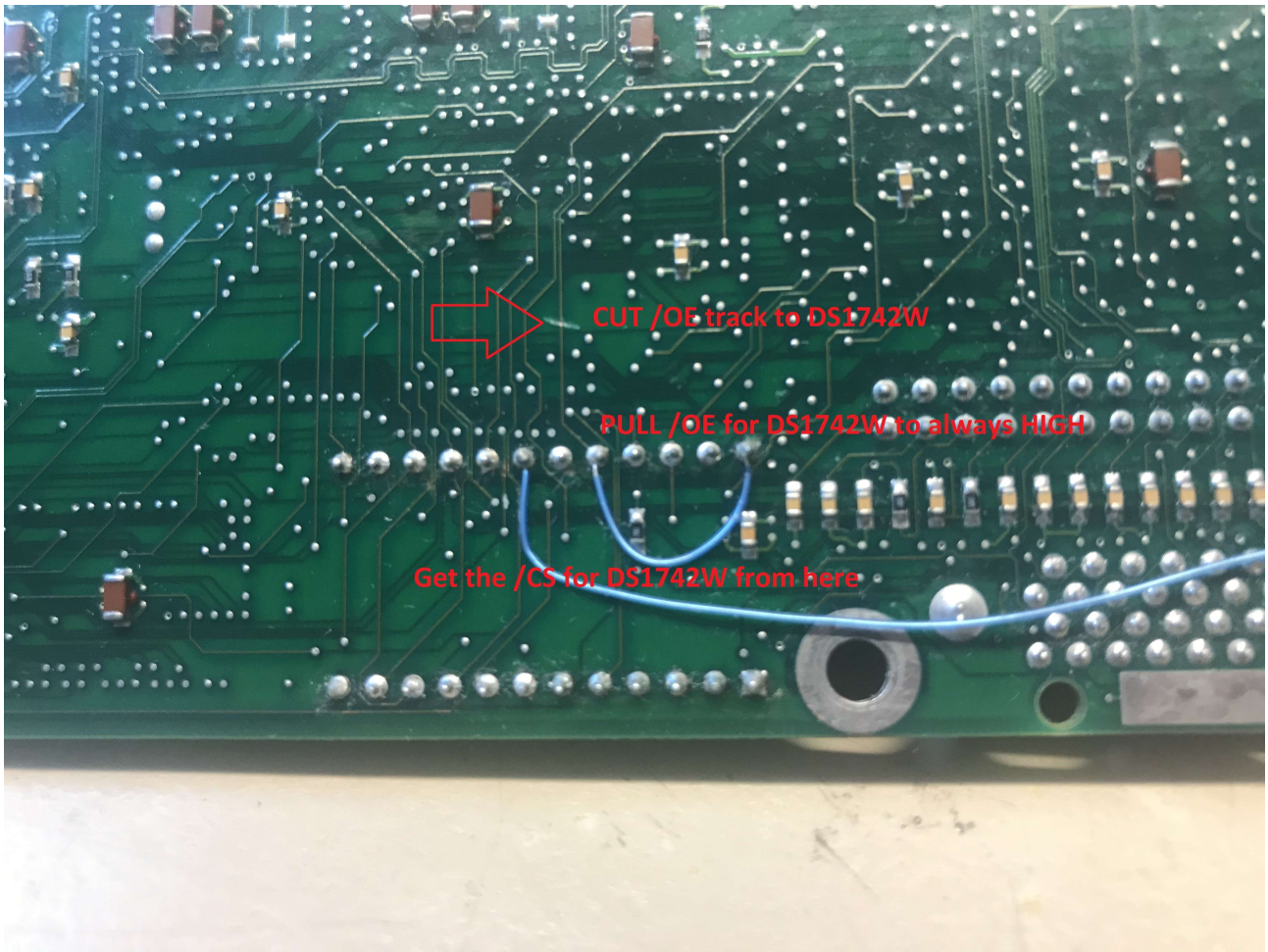
The existing DS1742W must be silenced when the new DS1744W is to take over its role.

Board supports several options for routing the /CS pin to the main board PowerPC, and to mute the old DS1742W. Method 2 in list below is preferred.

1. Hard wire patch method a: A flying lead patch wires takes the existing DS1742W /CS line, pin 18, and connects the same wire to the DS1744W /CS, via jumper JP10. The old DS1742W is to be disabled by either removing it entirely, or by isolating its pin 24 (VDD, +3.3V), or by isolating its /OE pin, pin 20, from its original PCB trace and then wiring that /OE pin to its pin 24, VDD.

2. Hard wire patch method b: same as method above but using a not really used pin of the 100 pin expansion connector. EXTCLK, pin 11, is used when either jumper JP10 or solder jumper JP11 are in. The EXTCLK pin is the clock for the PowerPC XPC860, by removing a 100 ohms SMD resistor under the pin it can be isolated from that EXTCLK function so that it can be used for our DS1744W /CS purpose. This method has the advantage of no flying leads in between boards.

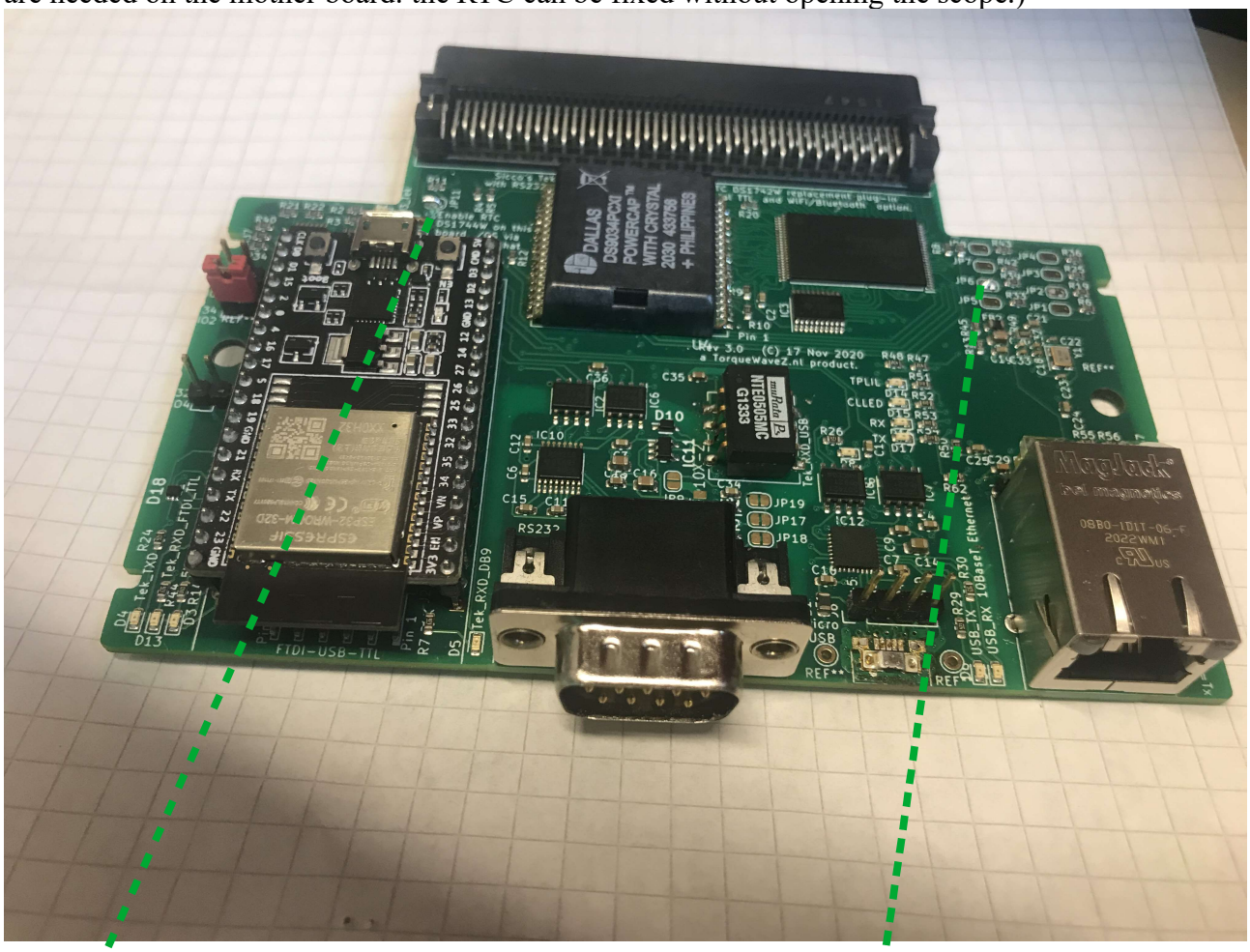

remove this 100E SMD resistor
Steal pin 11 of the 100 pin connector, now use it for /CS DS1742W, that will be /CS on the DS1744W on expansion board


CUT /OE track to DS1742W
PULL /OE for DS1742W to always HIGH
Get the /CS for DS1742W from here

The two pictures above illustrate method 2.

Tek TDS3XXX option modules exist that use the EXTCLK pin. Those modules obviously will no longer work when using the method 2 patch that steals pin 11, EXTCLK. The TDS3XXX modules could still be used with flying lead method 1a as outlined above. Note that scratch jumper JP11 must be cut open, and also JP10 must be removed so that the EXTCLK pin 11 is 'floating' again.

(Note – later revisions of this board can use the PowerPC MPC8xx BDM (Background Debug Mode – a sort of JTAG, but different) port for editing flash roms. With that it is possible to disable by software the PowerPC /CS2 line that connects to the DS1742W, and to re-map the /CS6 line that connects to 100 pin connector CE1. With that the existing DS1742 is disabled, and the external DS1744W can be enabled at the same physical memory space (0x02800000) via that CE1 pin. However CE1 we use for the MAC address flash rom on the board already, so when also using Ethernet this trick does not work. The beauty of the method is however that no hardwired patches are needed on the mother board: the RTC can be fixed without opening the scope.)




Jumpers JP10, JP11(solder bridge) for EXTCLK pin 11 to /CS for DS1744W

Solder bridge jumper JP6 for TDS3EM mode

Note: the newer -b and -c models have their EXTCLK pcb traces wired differently. As in no 100E resistor under the PowerPC CPU chip. A similar 'to be removed to free up pin 11' resistor can be found elsewhere in the main board. The pin 11 EXTCLK signal comes from the large MM9595 chip instead, a blue SMD resistor (47 or 33 ohms) in between needs to be removed.

# WiFi or Bluetooth via ESP32 DevKit4

When fitted, and when programmed appropriately, Arduino ESP32 DevKit4 modules can act as Bluetooth serial ports or WiFi interface.

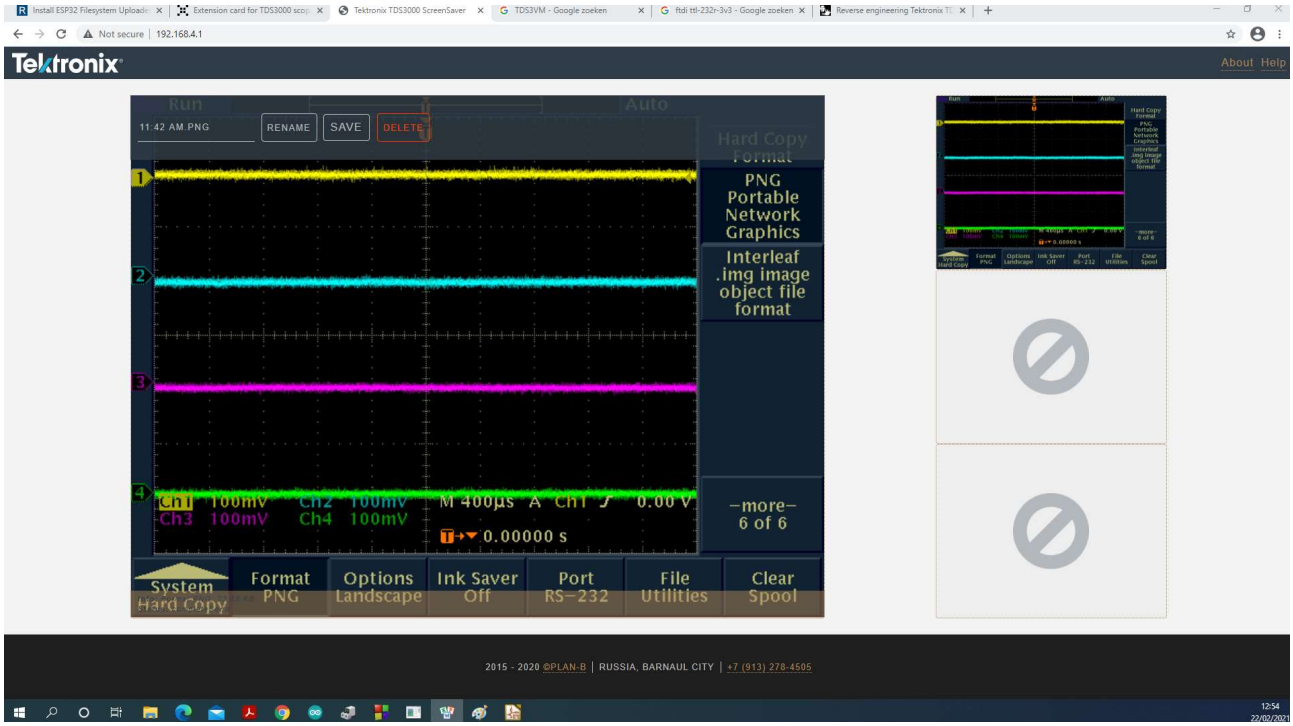
Bluetooth serial uses the classic BT serial profile (so unlikely to work with modern Apple products). The serial port that's made available is either the default serial port or the engineering port. Serial port settings in the TDS3000 (Utility→System I/O → I/O →RS232) must be 38400, no flagging, EOL set to LF. Bluetooth only gives one port in a Windows PC, typically enumerated as the highest of two COMx ports that the PC enumerates automatically after pairing. In Bluetooth mode, jumper JP24 inserted means that the first (engineering) serial port is used. No jumper means the TDS3000 default serial port in used.

WiFi and serial at the same time is not possible (not enough space in the ESP32 kits).

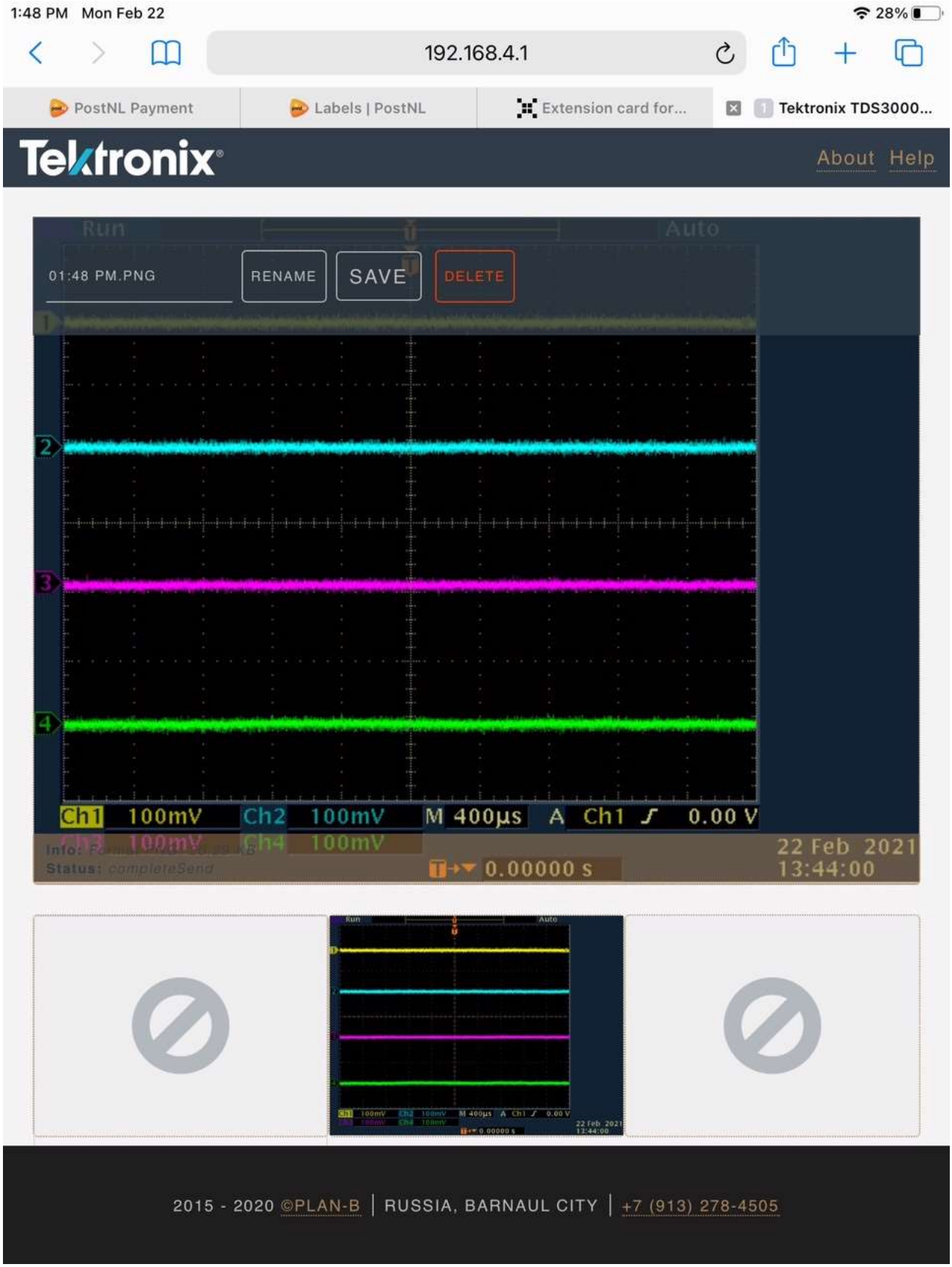
WiFi AP mode is based on the Stas_last work, project file tek_ws.7z, on page https://www.eevblog.com/forum/testgear/reverse-engineering-tektronix-tds3gv-module-for-tds3000-series-oscilloscopes/msg3090231/#msg3090231.

For the project to run, Arduino extension SPIFFS must be loaded, as per https://randomnerdtutorials.com/install-esp32-filesystem-uploader-arduino-ide/

Following those project examples, the ESP32 will act as WiFi access point with SSID "Tek-AP" and join key "12345678". It will present a web page on 192.168.4.1. Also on iPads, iPhones etc. When pressing the TDS3000 print button the web page will update, or alternatively the print button action can be initiated from the webpage. (relevant TDS3000 settings:  under 'Hard Copy' the printer is set to 'Port RS-232' and 'Format PNG', with serial port settings as per above, i.e. 38400, None, LF.)



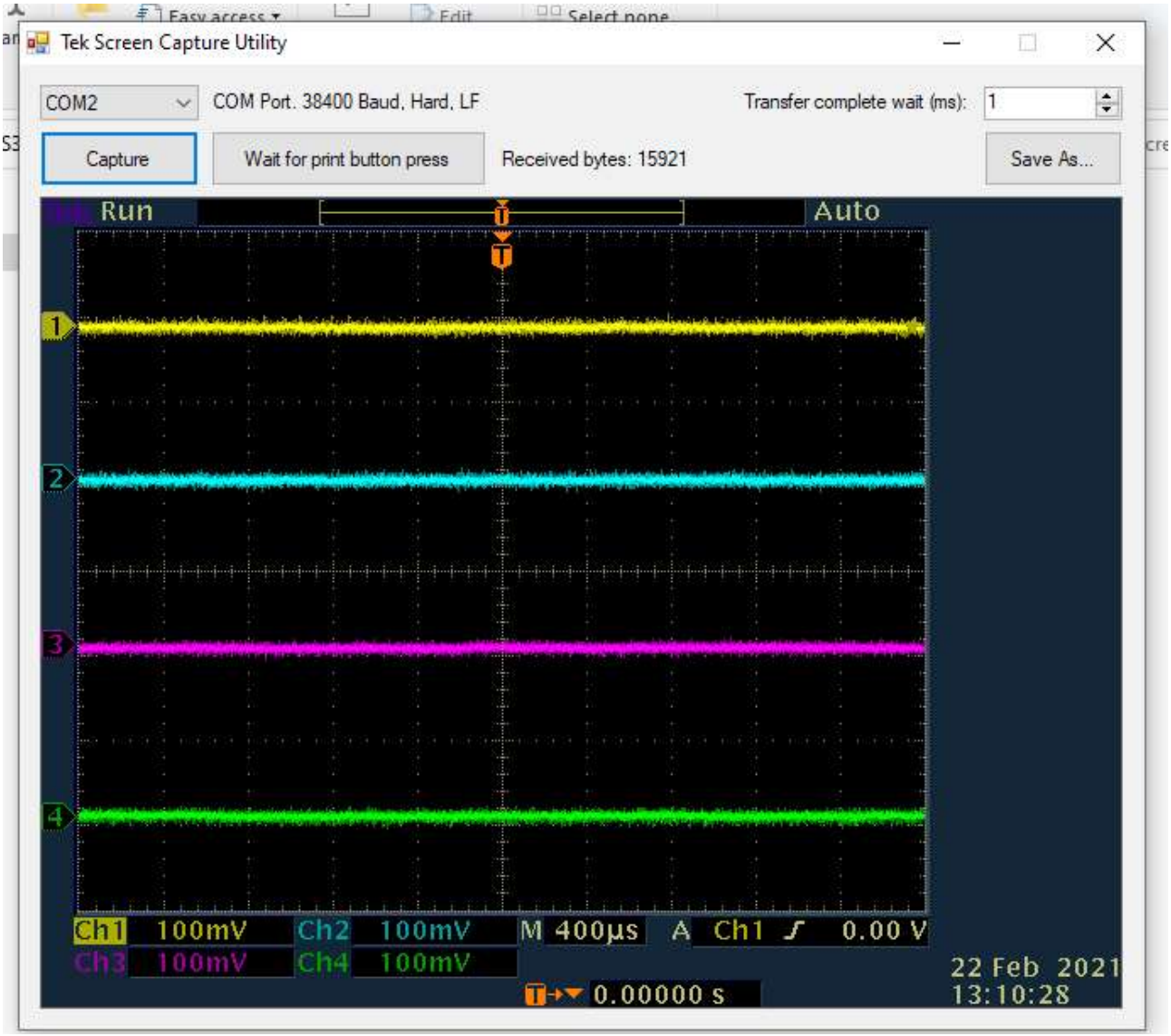
WiFi AP web page on an iPad:



# Serial port screen capture

Tools by Tektronix and National Instruments (LabView, VISA etc) that use the serial RS232 port on with a TDS3VM, TDS3EM or TSD3EM should work equally well when using this board. The following might be of interest also:

Using Windows PC tool TDSScreepCap.exe and either the RS232 DB9 port, or the USB port, or the Bluetooth port, anything printed to the TDS3000 serial port can be presented (and screen dumped) on the PC screen. Tool downloadable at [www.mattmillman.com/tools/tdsscreencap](www.mattmillman.com/tools/tdsscreencap) .



# Serial port MCONFIG bandwidth edits for firmware up to 3.39

See EEVBLOG on TDS3000 BW hacks, search terms PITBULL and MCONFIG.

# Clearing the NVRAM

The DS1742/DS1744 NVRAM chips hold not only time/date but also store scope settings so that when powering up again, the most recent settings return. The NVRAM contains sections that are different for the TDS30X2 (dual channel models) and the TDS30X4 (four channel models). Just swapping plug-in units from 2 channel to 4 channel units can cause trouble. Corrupt NVRAM data may lead to inability to boot normally.

It is thus wise to reset the NVRAM with the following procedure:

Power off, press and hold button “B TRIG”, power on while holding “B TRIG”, wait until the full boot-up finishes, and only then release the “B TRIG” key. The scope will show just one channel. Other channels can be enabled from here on. That’s because large parts of the NVRAM memory is set to default values. Not all though, some Ethernet settings do survive.

# Calibrate / Compensate Signal Paths

New NVRAM means new “signal Path Compensation” is due. Let unit warm up for at least 30 minutes, disconnect probes, then go UTILITY, System Cal, Cal, OK Compensate Signal Paths. This takes a minute or two. After that, DC offsets in all channels should be gone.

# System Devel

Hold down SELECT while power-on resetting. Release when scope shows traces. This enables the “Devel” menu under UTILITY. With that the running hours can be reset, annoying beeps (“Audio Feedback”) on keystrokes and button turning can be (de)activated and other features can be enabled.

# Ethernet settings

DHCP or fixed IP, see example settings on next page.

Note NVRAM settings have an impact on proper functioning of Ethernet port. When corrupted, Ethernet may not work. As a last resort, the clipon PowerCAP DS9034 that’s piggy backed on the DS1744W can be clicked off, which eventually clears the memory after an hour or so.

# Relevant scope settings