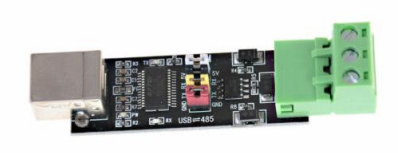
Solis S6 - RS485 Modbus Problems

I have a Solis 4G Mini 2.5kW Inverter that had been 100% reliable for years communicating to an Arduino based data acquisition system (using a MAX485 based RS485 driver) and also occasionally to a PC using Modbus Poll. The data request was primarily using function 04 input register reads for x10 registers beginning at address 3005. Modbus address of inverter set to 01.

Upon simply transferring the Comms connection cable to a brand new Solis S6 GR1P3.6-M inverter (with address also set to 01) it became impossible to obtain any response from the S6. Efforts to communicate were also carried out using a laptop with Modbus Poll application and these USB-RS485 adapters:-

The adapter shown below was used during all the following testing:- (FTDI232RL & MAX485E)



In desperation and after concluding the Inverter comms was defective! a WiFi dongle was purchased, opened, the A-B lines were connected to an RS485 adapter and to my dismay it was found that the WiFi adapter communicated perfectly with the inverter!!

On the scope I could now see communications master request and reply signals and monitor them using RealTerm. It was found that at power up or after pressing the dongles connect button, the very first Modbus interrogation request is :-

010488B800019A4F Which translates to :-

Slave ID: 1 (decimal) | 01 (hexadecimal)

Function: 4 (decimal) | 04 (hexadecimal)

Register Offset: 35000 (decimal) | 88B8 (hexadecimal)

Number Of Registers: 1 (decimal) | 0001 (hexadecimal)

CRC: 20378 (decimal) | 9A4F (hexadecimal)

CRC Should Be: 20378 (decimal) | 9A4F (hexadecimal)

Request: [01] [04] [88B8] [0001] [9A4F]

| | | | | |-> CRC16 (20378)

| | | | |-> Number Of Registers (1)

| | | |-> Register Offset (35000 = 65001)

| |-> Function Code (4)

|-> Slave ID (1)

Register 35000 is the inverter type…and see below, the response is 1010

5.2 Inverter type information parameter address, corresponding function code is 0x04. The following table has the same address with the actual address of the message frame. No need extra offset or transform

Register address (Decimal)	Name	Data type	Remark
35000	SOLIS inverter type definition	U16	definition: 0000---no definition 1010---1phase inverter 1020---3 phase inverter 2030--- 1 phase low voltage energy storage inverter 2031--- 1 phase low voltage AC Couple energy storage inverter 2040---1 phase high voltage energy storage inverter

And the returned response from the Inverter is 01040203F23845 which decodes to:-

Slave ID: 1 (decimal) | 01 (hexadecimal)

Function: 4 (decimal) | 04 (hexadecimal)

Number of Bytes: 2 (decimal) | 02 (hexadecimal)

CRC: 17720 (decimal) | 3845 (hexadecimal)

CRC Should Be: 17720 (decimal) | 3845 (hexadecimal)

One Register Size: 2Byte - 16bit

Request: [01] [04] [02] [DATA] [3845]

| | | | | |-> CRC16 (17720)

| | | |-> 03F2

| | |-> Byte Count (2)

| |-> Function Code (4)

|-> Slave ID (1)

Data: Row Format: Data Type, Signed, Unsigned

(0) (short) 1010 1010

For the purposes of this investigation the same 'inverter type' request command was used (i.e slave address 01, Register read Function 04, Register Address 35000, at 9600B, 1 stop, No Parity). This allows me to compare bit patterns and signal levels to those from a working WiFi stick etc.

FYI:- In RS485 a logic 0 is represented by line B =***low*** and line A = ***high,*** *The RS485 protocol defines high and low differential signals must exceed +0.2 and -0.2V respectively. To present this low state on an oscilloscope I connected the scope low reference ground clip to A, and signal to B - the scope i fully isolated to all other devices or supplies.*

Also Noted:-

At power up with no other connections, the voltages on the A & B terminals measured with a DMM wrt 0v were found to be approx.:

	OnSolis 4G *Mini*	On Solis S6
Voltage on A+ wrt 0v	3.3v	3.3V
Voltage on B- wrt 0v	1.6V	0.12V (but maybe High Z

RS485 input circuitry in the S6 and the Solis 4G Mini series appears to be different (Or my inverter is busted?)

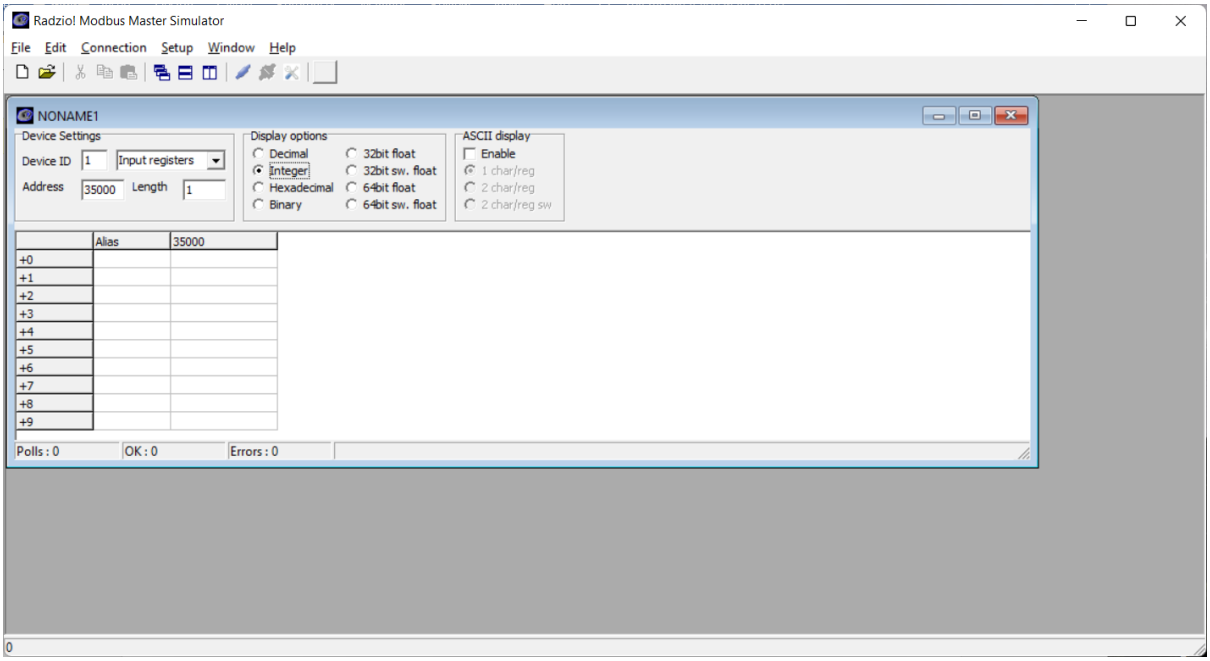
After days of investigations, using different usb-485 converters, PC applications and setups, it was not possible to see a single response to the 010488B80019A4F request (Func 04, Reg 35000, 1 location) on the Solis S6. In all cases, the test setups could reliably connect to a Solis 4G and to an OB115 power meter.

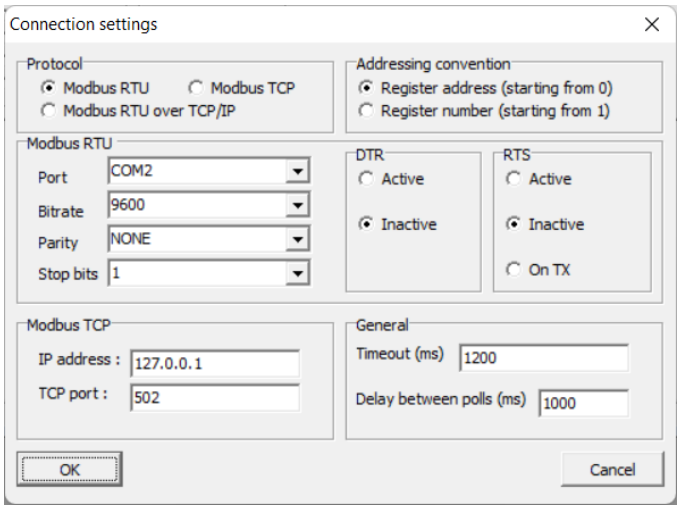
Investigating Successful Communications with the Solis WiFi Stick in place:-

A Solis WiFi stick happily connects to the Solis S6 and publishes data to the Solis Cloud!

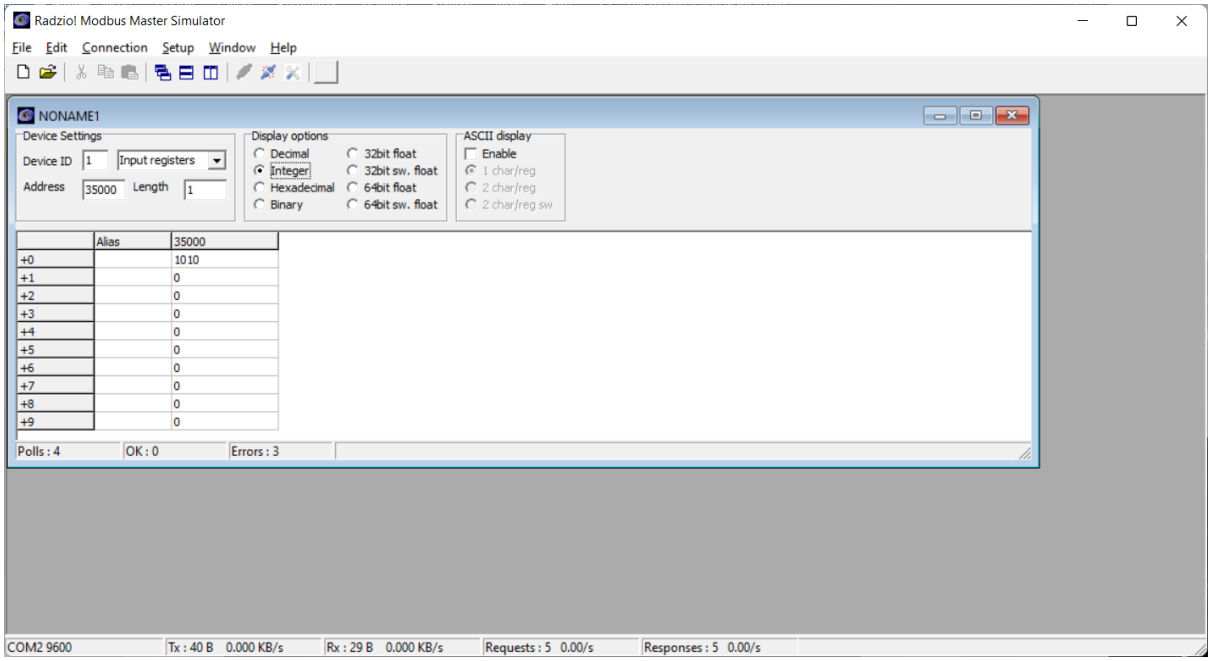
Wires were connected to the sticks A-B lines

Radzio Modbus master simulator was used to interrogate the inverter with a laptop.





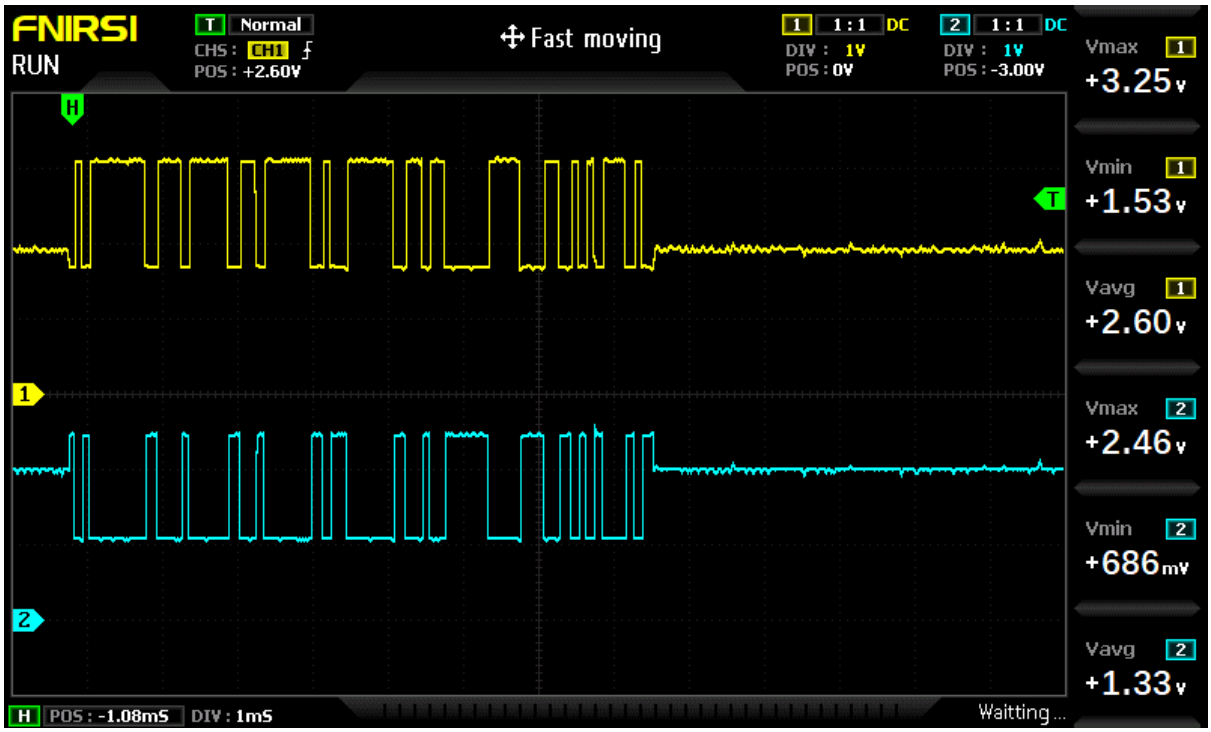
With the Wifi Dongle in place you can see the S6 correctly responds (1010 in register 35000):-



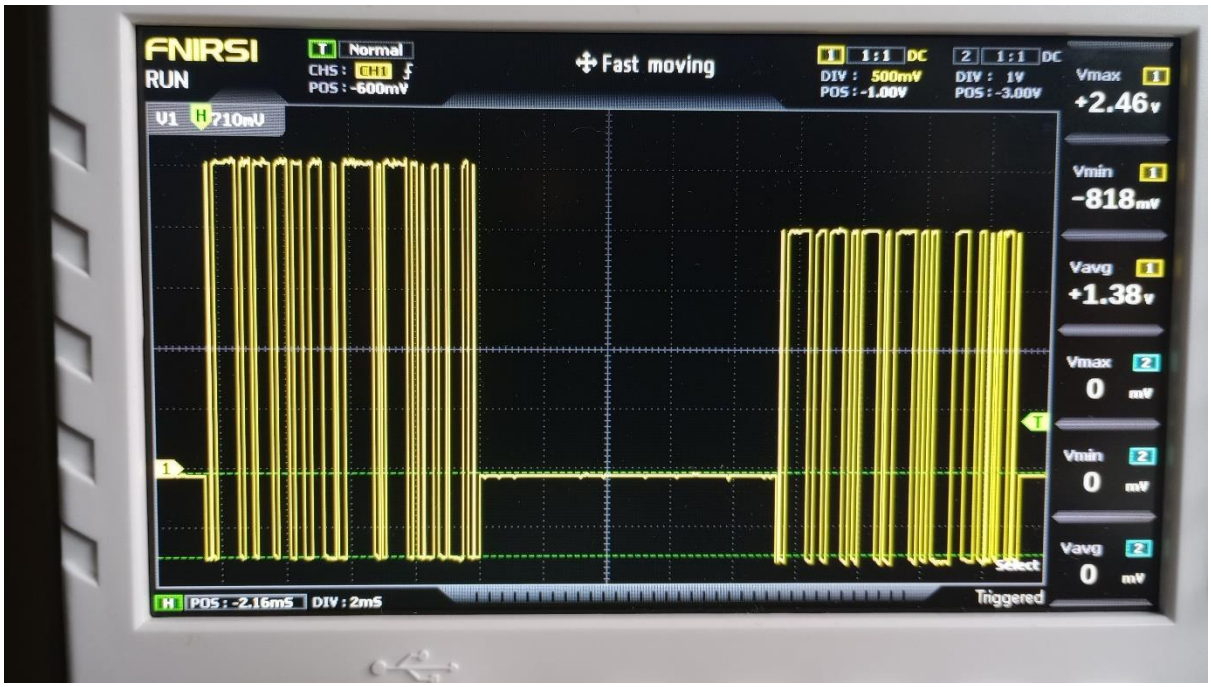
SIGNALS

With WiFi STICK IN PLACE, Piggy backed PC request signal during quiet time

Scope plot of on A (Blue) B (Yellow) WRT S6 0v line. This shows the piggy backed requests signal from a laptop using PC RS485 connection (Radzio Modbus Master Simulator, (Slave 01, 33500, Func 04, 1 reg)



The differential signal of above is

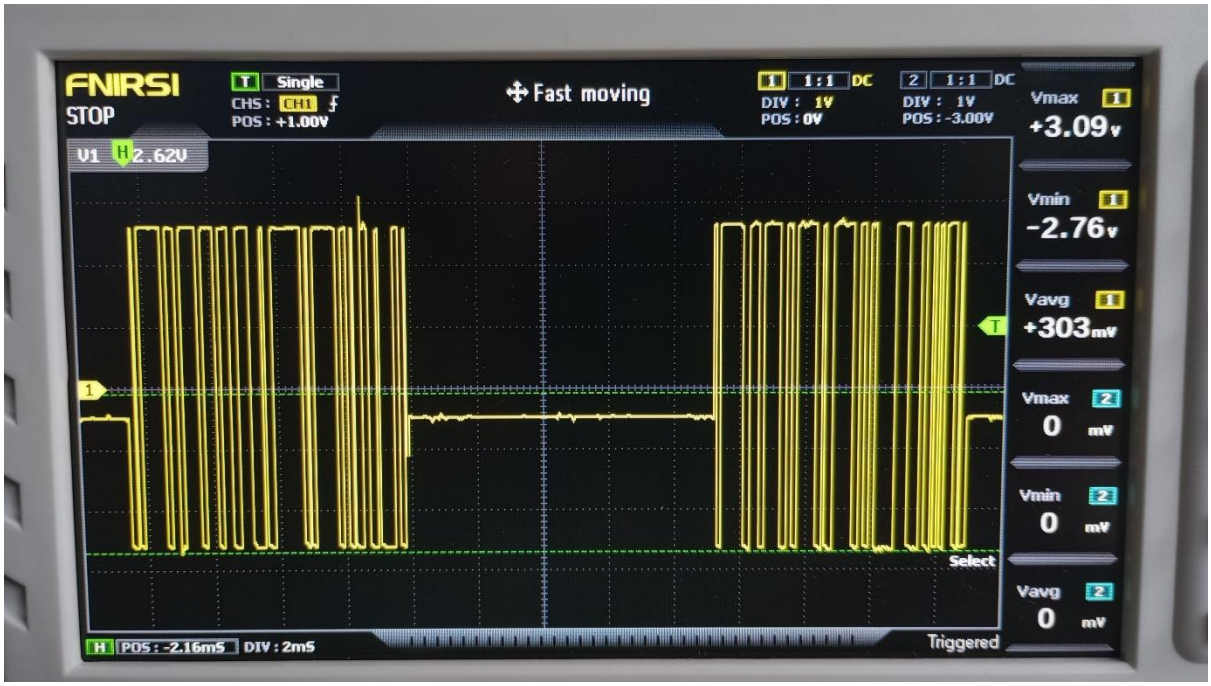


The differential of A- B shows a negative differential peak of approx. -0.7 to -0.8 V and the Positive differential is approx. 2.5V. (A is taken as Low Ref)

WiFi STICK IN PLACE, Wifi stick Signals only. (i.e No piggy backed PC 485 connection)

The SAME Initial data request (Slave 01, 33500, Func 04, 1 reg)

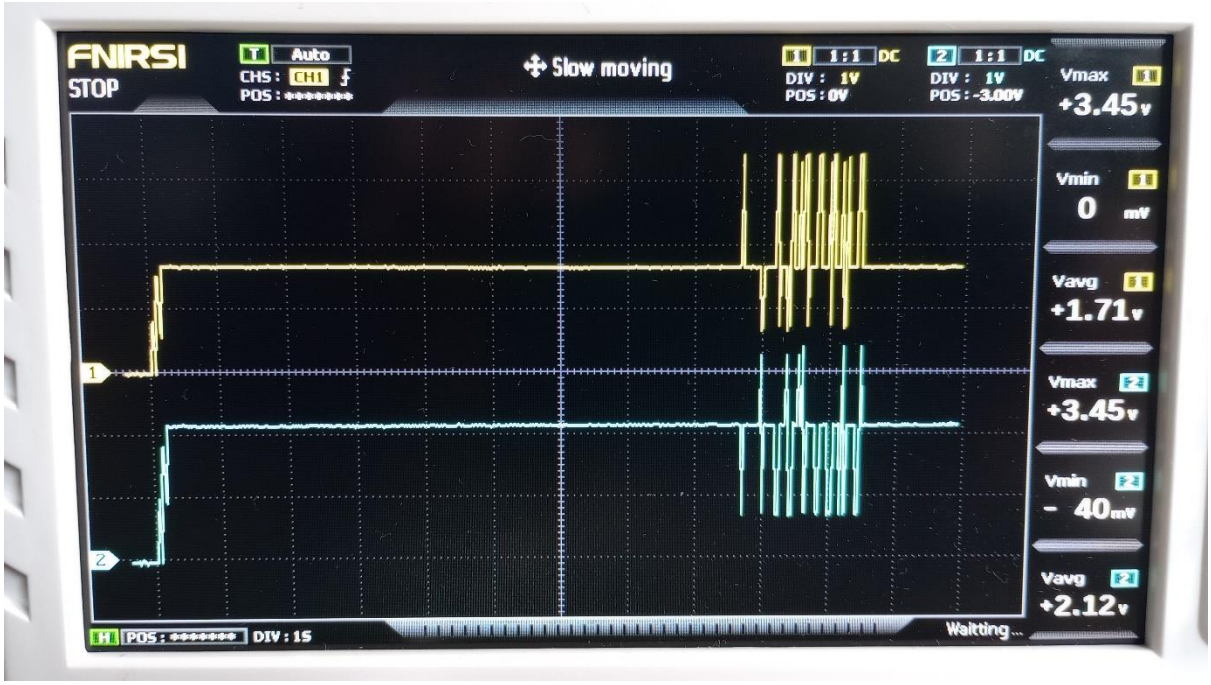
This time the differential signal is much larger, negative differential is approx. -2.5V and positive is also about 2.5V.



This is the Single ended view of signals on A and B WRT 0v is

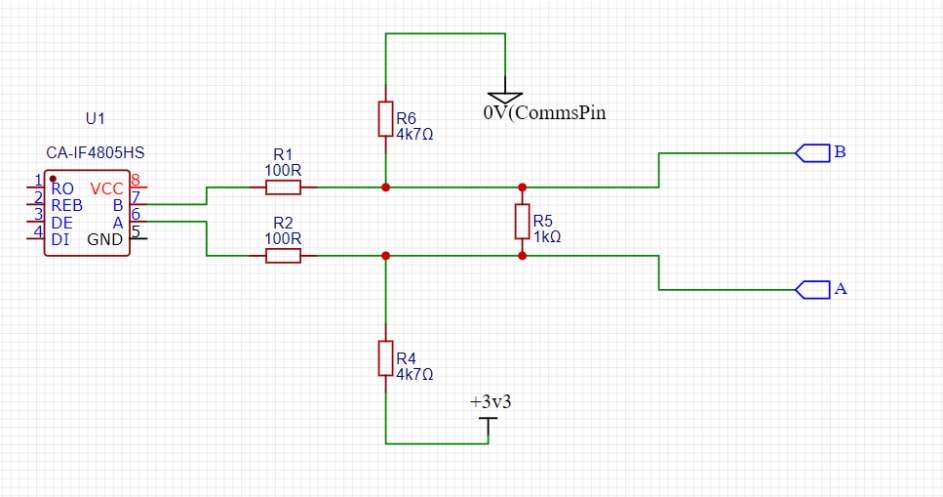
The baseline of both signals is around 1.8(B) and 2.2V (A).

WiFi Stick only – looking at A and B lines during power up



Multiple WiFi stick plug-in cycles showed the initial glitches seen at the leading edge power up are simply connection / power up noise. There was no evidence of logic line control or data flow on the A or B l lines from the instant of stick being plugged in to the first Modbus request as seen in the earlier plots. **Conclusion :-** Nothing appears to be setting the Inverter into say a 'Modbus mode'.

RS485 Circuitry inside the Solis Wifi stick was investigated at and appeared to be this :-



NOTE – this is WiFi stick circuit arrangement appears different to what was mentioned in this article:

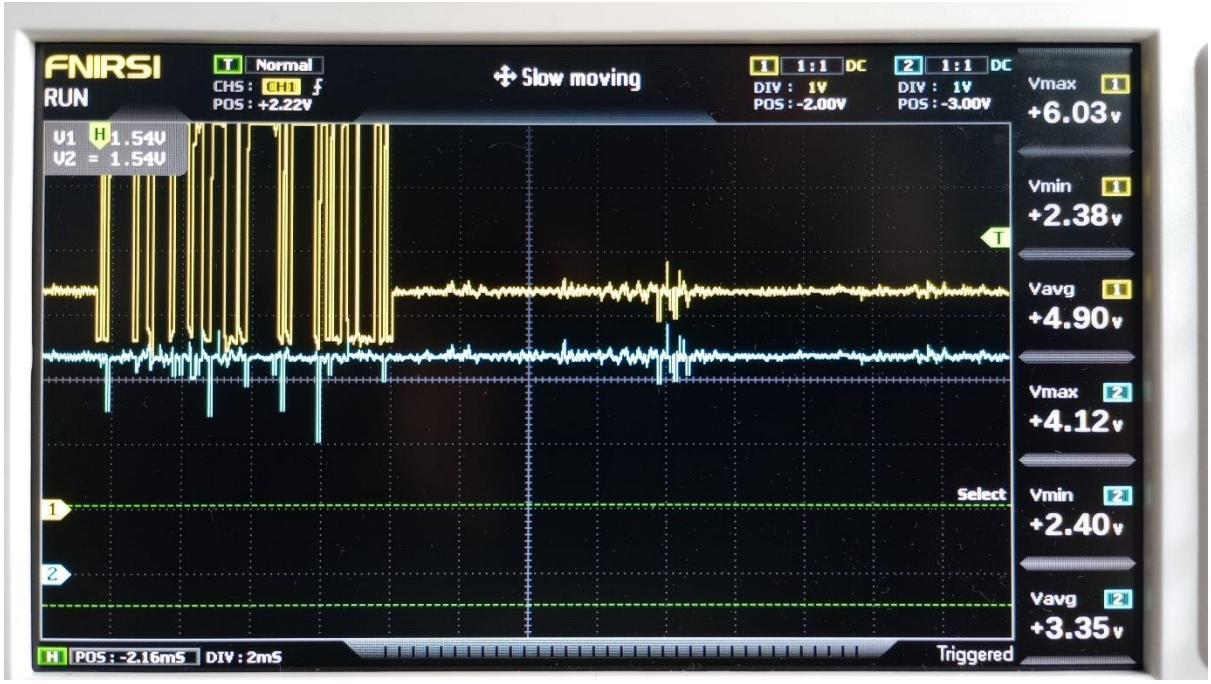
https://www.briandorey.com/post/solar-upgrade-solis-1-5kw-inverter-raspberry-pi-rs485-logging

Also Note:- The FTDI USB-485 dongle used in above testing has a 120R resistance across A-B. This is most likely responsible for the reduced differential signal amplitude when interrogating with a PC compared to the signals seen with only the WiFi stick connected.

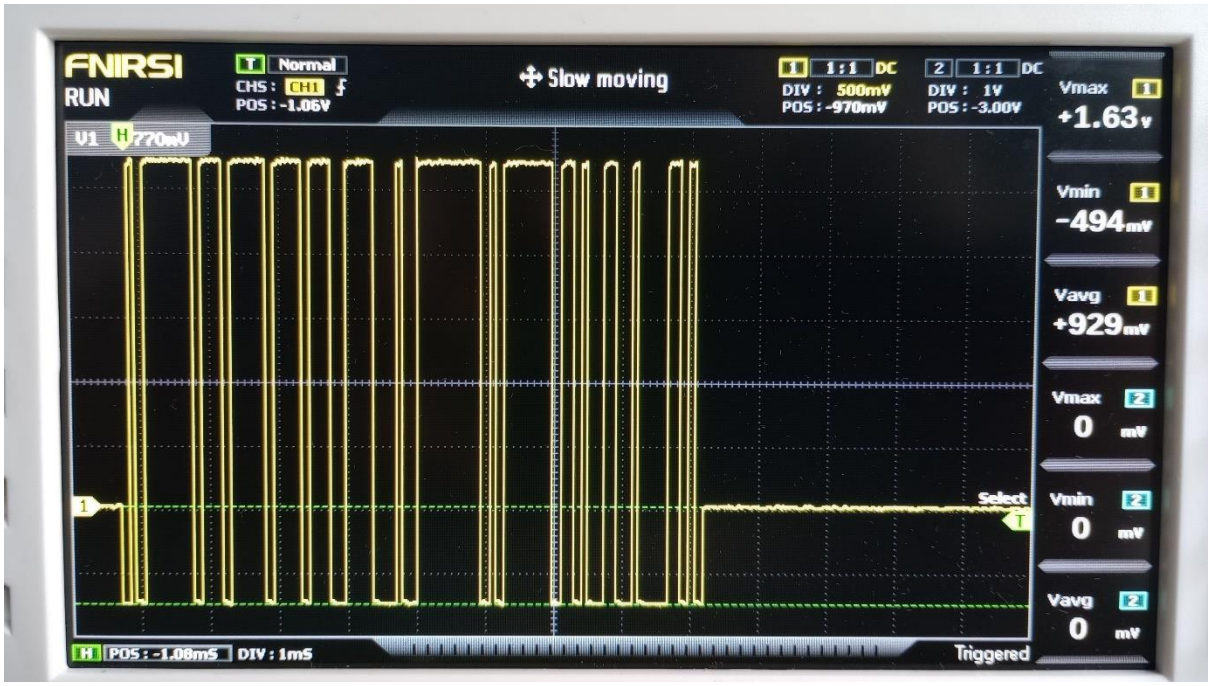
NOW SIGNALS WITHOUT the Solis WiFi Stick in place

This is when things get weird!

Using a Comms connector plug , (i.e No WiFi stick connected) and connecting A+B lines from the FTDI USB-RS485 dongle showed the following signals (Yellow=B, Blue= A) measured wrt the S6 0V pin:-



these signals when measured differentially look like this:-

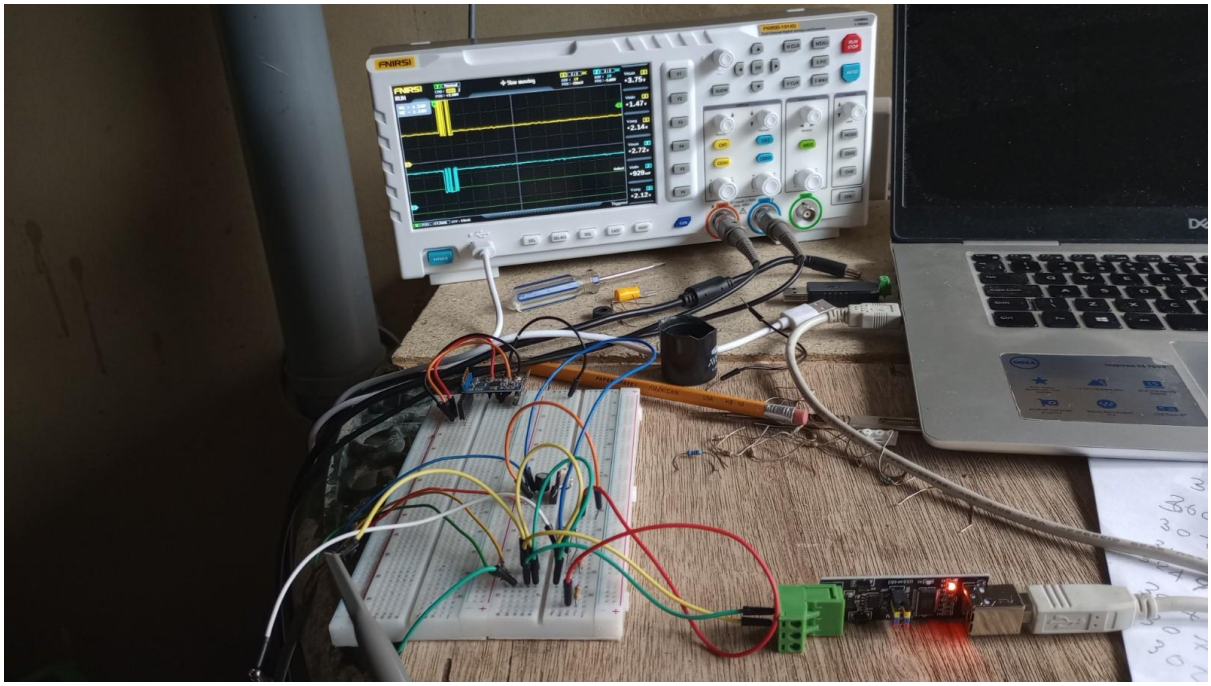


You would think this differential signal satisfies the +200mV and -200mV RS485 logic thresholds, however **the S6 fails to respond.** The bit pattern is identical to that shown when the WiFi stick sends the same command.

Note also:- *the interrogating laptop (running Radzio Modbus Master Simulator), was battery powered and therefore effectively isolated. Joining the S6 and RS485 adapter grounds was also tested – No difference, the S6 DOES NOT RESPOND.* ***Plugging the same signal into a Solis 4G mini works perfectly and using same hardware to an OB115 Power meter also works 100%*** **!!!**

Replicating the Pull Up / Pull Down circuitry in the Solis WiFi Stick

The 4k7 Pull up (on A) and 4k7 Pull down (on B) bias resistors plus a 1k termination resistor and 3v3 regulator were added to replicate the circuitry seen inside the Solis Mk3 Wifi Stick (see earlier)



(it's appreciated that the FTDI USB to RS485 adapter used here is a 5V device however I initially tried a 3v3 pullup since the S6 input seems to have a 3v3 signal bias on A signal line).

Signals now looked like this (A =Blue, B=Yellow). The flat line on A now shows a waveform.

The A and B signals now appear to at least display waveforms when measured single endedly WRT 0V, However STILL NO RESPONSE from the S6! Adding the bias resistors clearly has some effect

BUT THEN !!!!

It was then noticed when the pullup on the A line was disconnected the Solis Replied !!!!

Pulling up the A inputs 4k7 to 5V caused the Solis to reply but could still be intermittent.

Clearly these resistances and the resulting signal levels appear to be critical on an S6 – OR maybe I have a flaky inverter?

TO BE CONTINUED !!

SUMMARY !

So far I AM SEING SOM REALLY WEIRD DIFFERENCES IN COMMS SIGNALS ON A SOLIS S6 compared to a SOLIS 4G.