ICOM IC-905 STUDY

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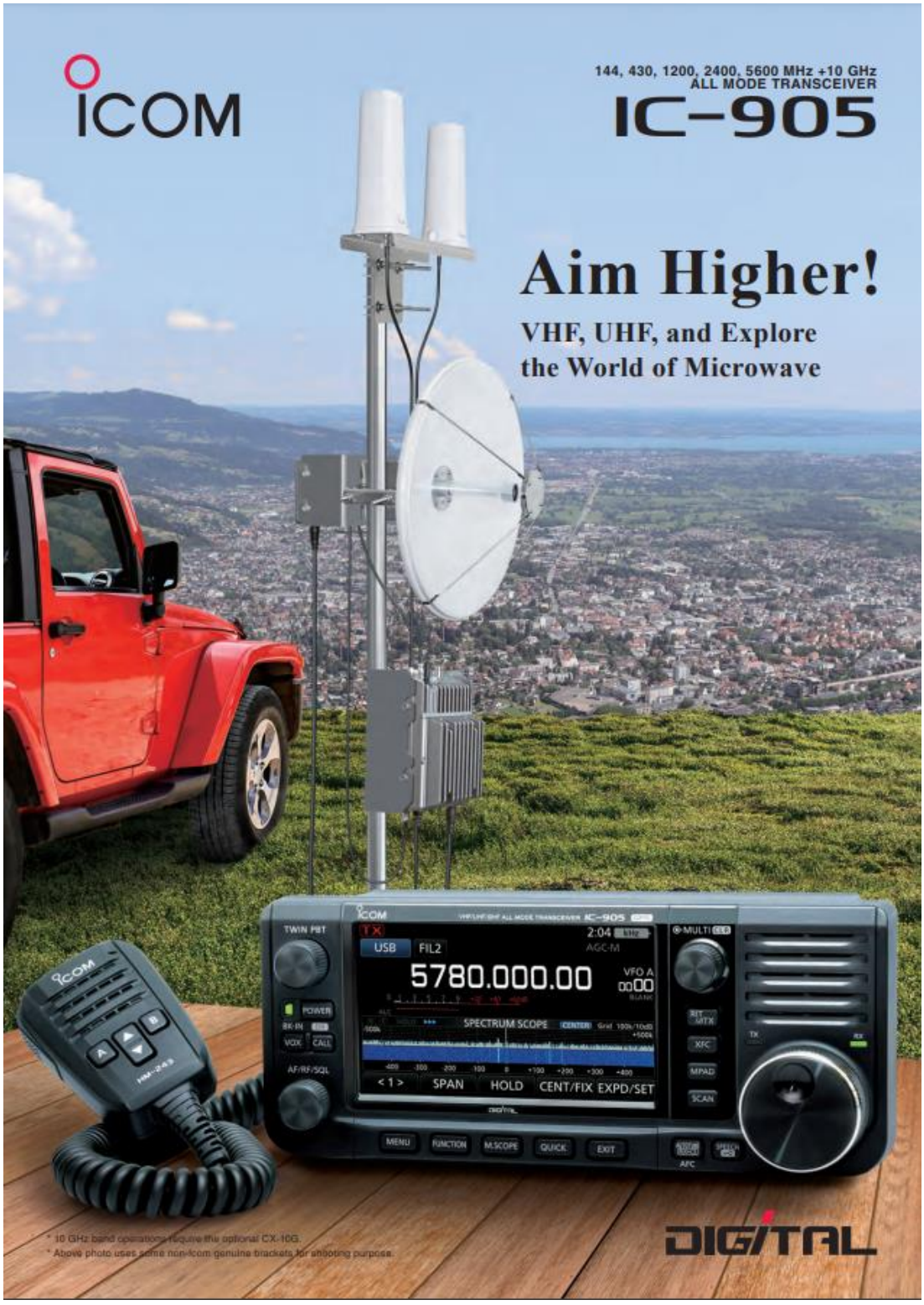
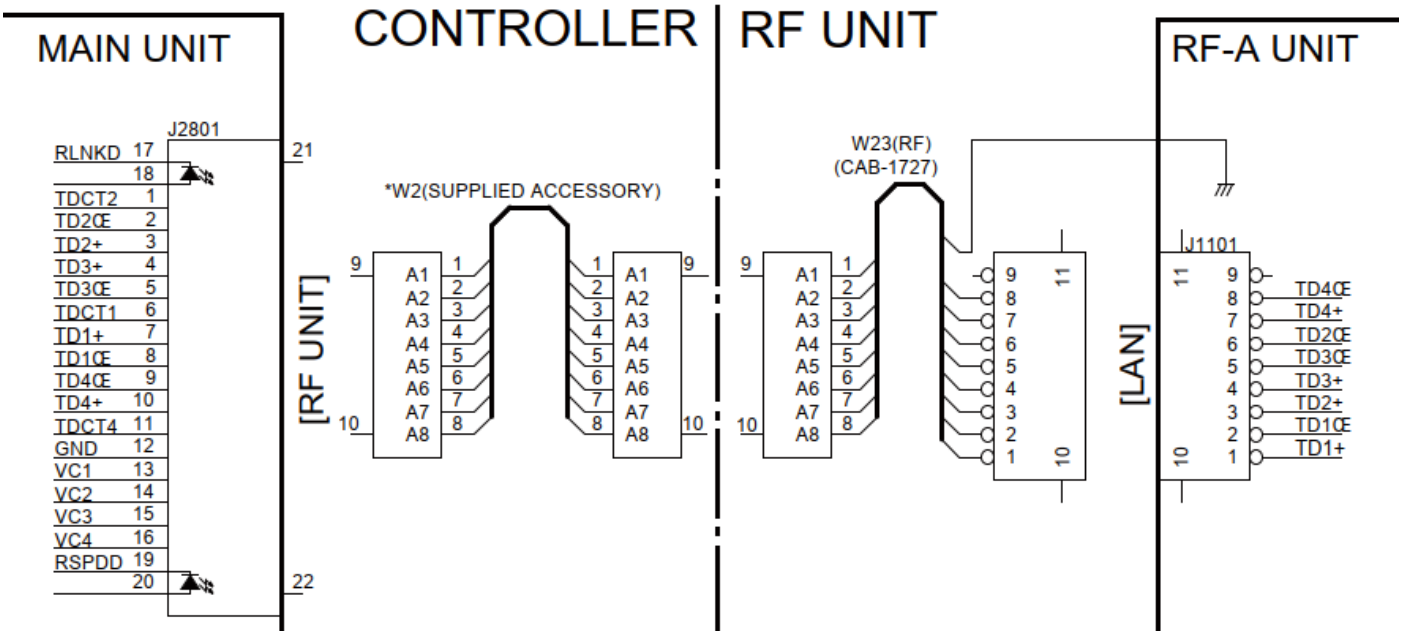
v 29.10.2023





This study consists of (already) hours of schematic diagram and board layout investigation from the Icom IC-905 Service Manual added with googling for the part numbers and datasheets. The study will continue till some concrete tested and documented results exist, so this document is far from complete. Things might be also incorrect or just plain wrong as assumptions has been made. You have been warned. Corrections are welcome!

As the document matures, you can check the version information at the last page.

The main goal of the study and further experiments is to understand the communication protocol between the radio control head and the remote RF Unit, and document the Power-over-Ethernet details how the RF Unit is powered.

The connection media between the controller and the remote unit is standard 4-pair STP ethernet cable and there are standard gigabit-capable ethernet switch chips in both ends interfacing to the cable, which gives a lot of hints what the traffic is.

The study also aims to understand is it possible to operate the IC-905 in a truly remote manner, placing the control unit and the RF unit far from each other and connecting them together through IP link.

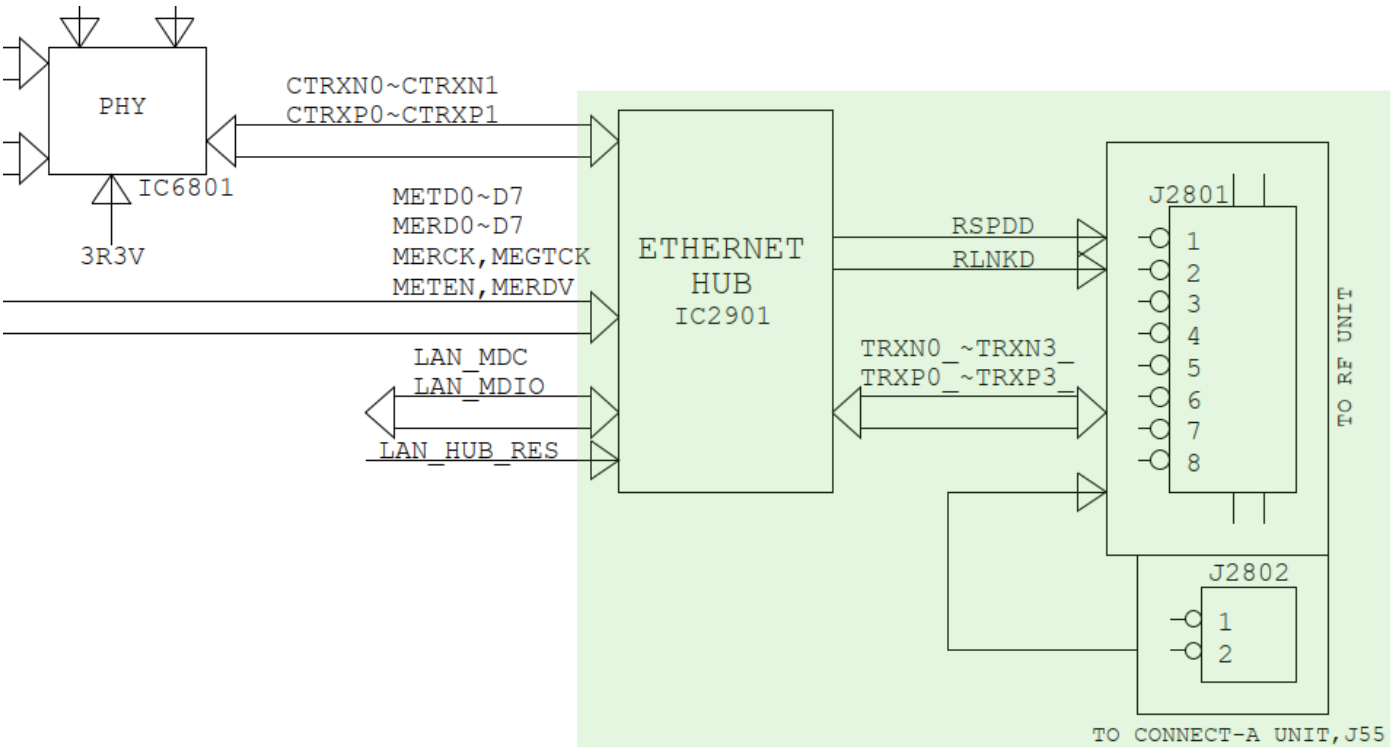
If you find the study interesting, you can support my work with voluntary donations through PayPal: https://paypal.me/erikfinskas

Initial study of communications between the units

Although the Service Manual of Icom IC-905 is partly redacted, the basic information of the connection between the Control Unit and RF Unit is very well there. Also, from the very beginning when information started to spread about the new IC-905, it was clear that the RF Unit is powered by the Control Unit, so initially PoE was of course suspected.

The Control Unit

The service manual nicely lays out the connection components in the General Wiring -section and reveals that the connection truly is ethernet, as generic ethernet components are used. Although an ethernet hub is mentioned, the IC2901 in the Control Unit is a gigabit ethernet switch chip QCA8337 from Qualcomm. It is a very popular switch chip, used in many ethernet switch products as well. It provides both media-dependent (MDI) and media-independent (MII) interfaces.



The onboard FPGA at the Control Unit uses two RGMII/MII (Reduced Gigabit Media Independent Interface) ports of the ethernet switch. The two ethernet ‘connections’ goes to different parts of the FPGA so most likely different traffic originates and terminates to these parts as well.

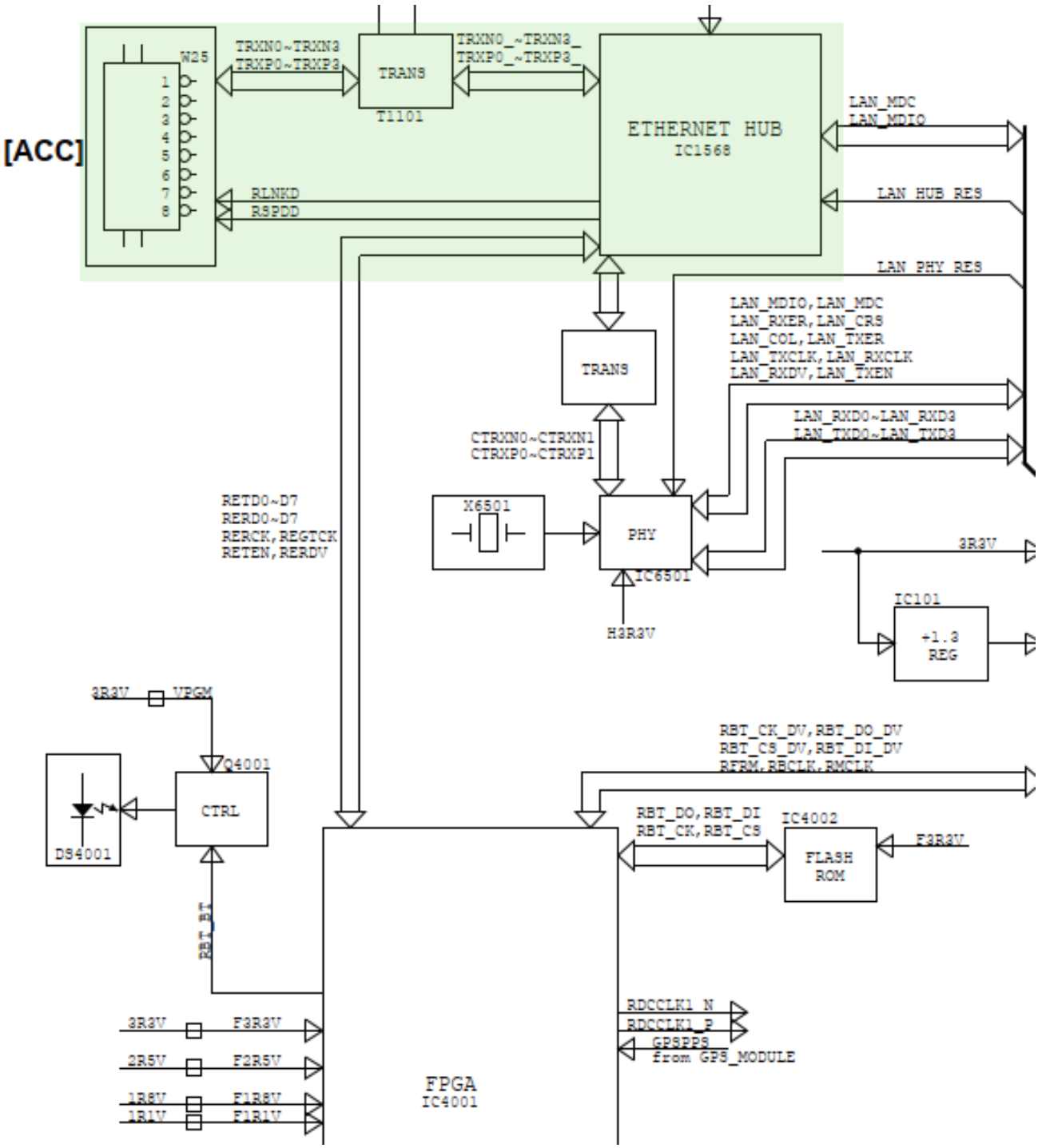
The CAT5-cable connection towards the remote RF Unit connection uses the Port0 MDI (Media-Dependent Interface)

It is interesting that the CPU ‘port’ to the ethernet switch is only 2-pair so 10/100Mbps connection only through the ethernet PHY interface IC6801 (DP83848KSQ) which also is only rated to 10/100Mbps.

Initial study of communications between the units (continued)

The RF Unit

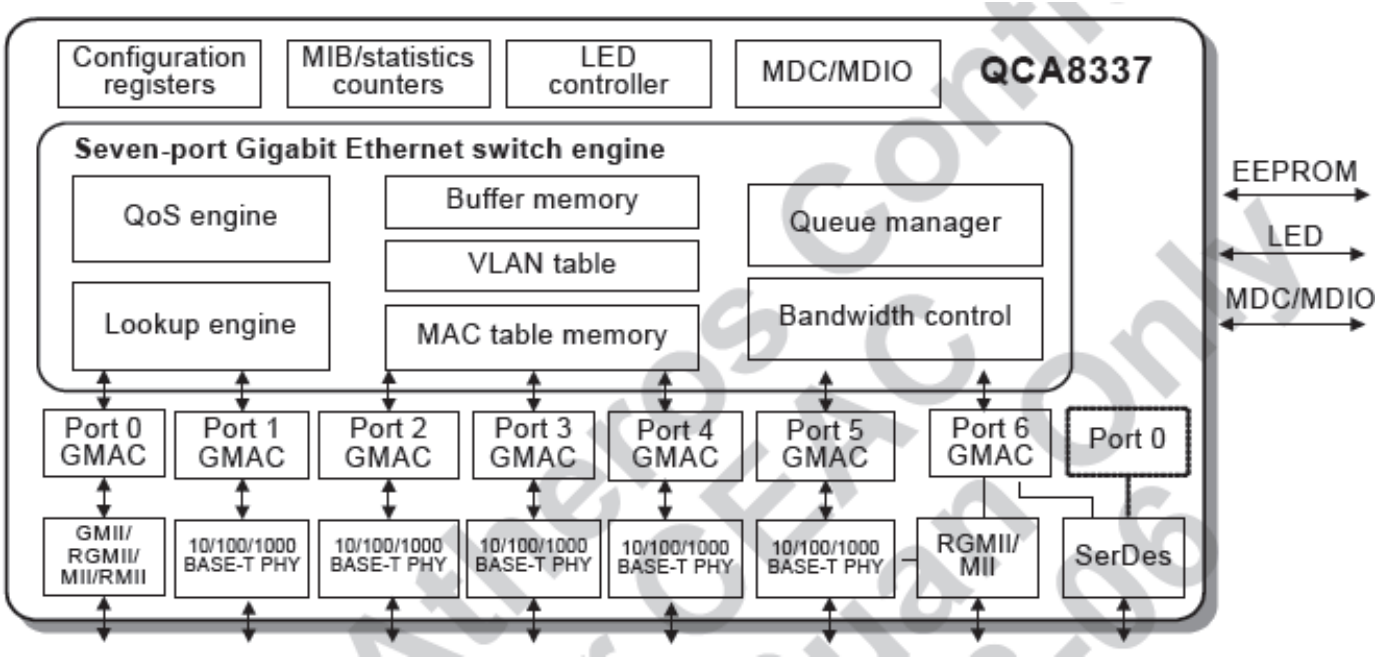
The ‘networking’ part of the RF Unit is very similar to the Control Unit design, same parts and port allocations are used. I won’t repeat same what’s on the previous page, the concept is the same. Also, the concept of an ethernet hub vs. a switch is lost here too.



Initial study of communications between the units (continued)

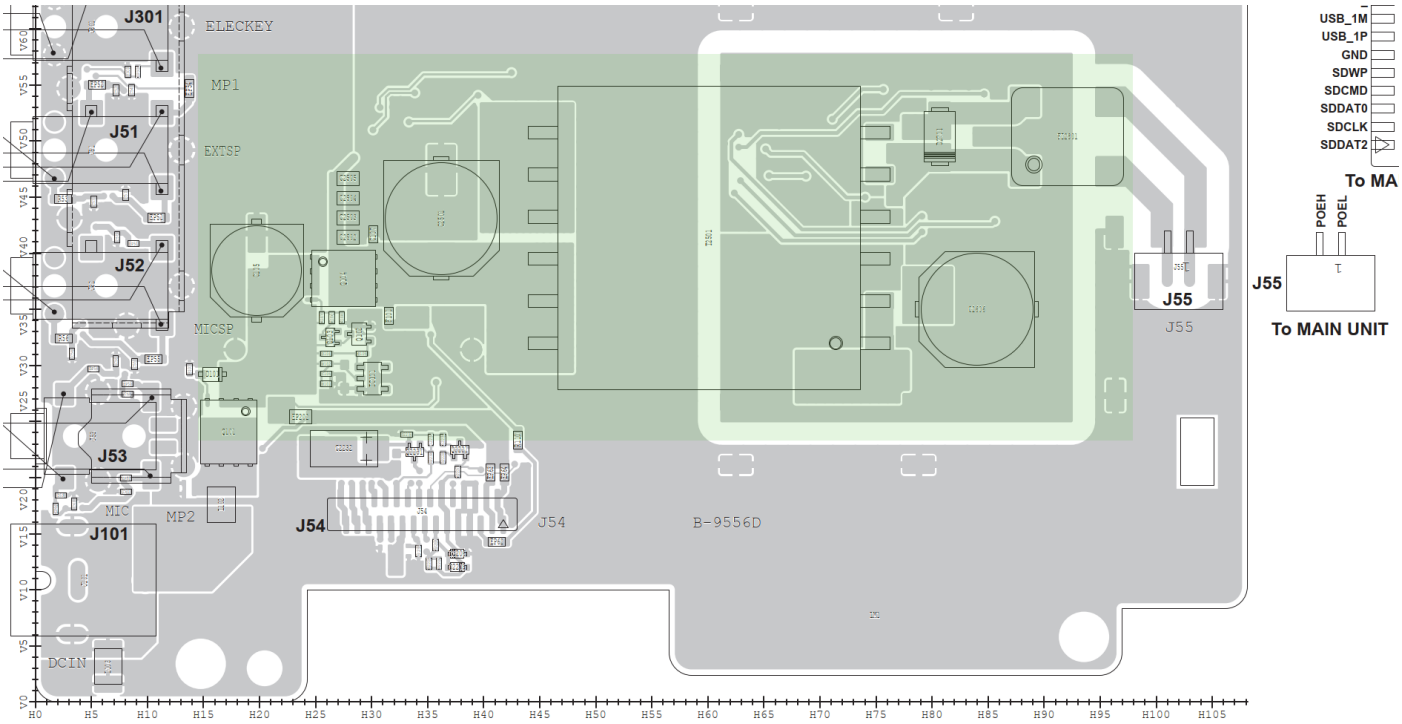
The ethernet switch "hub"

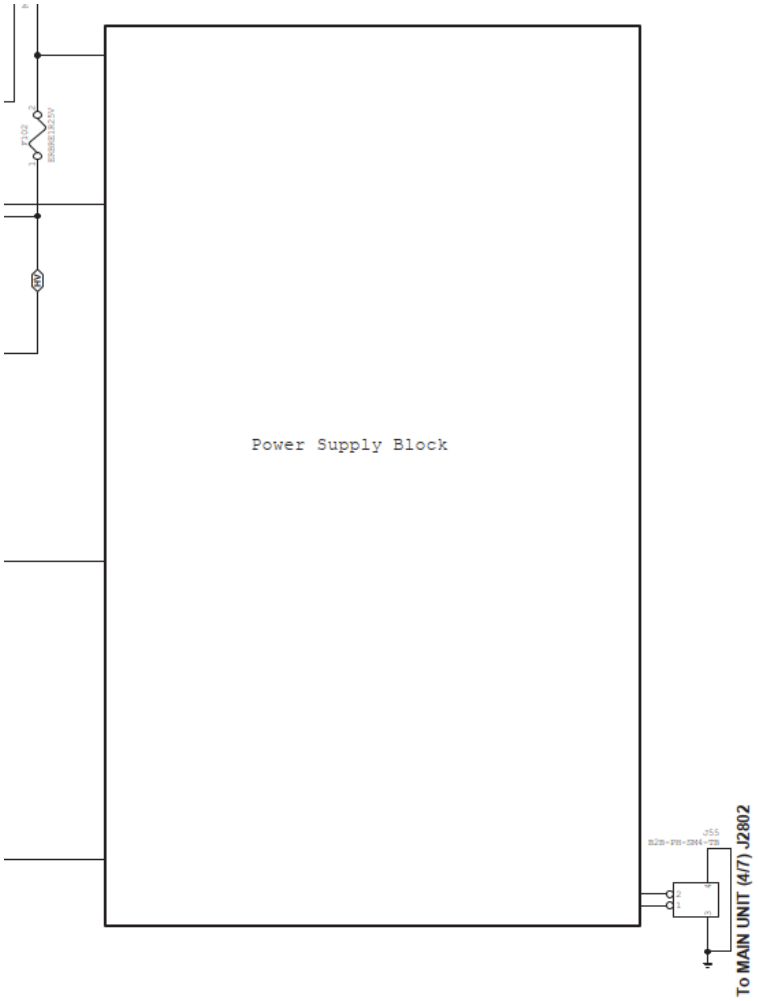
Without further analysis of the communication between the Control Unit and the RF Unit, it is unknown at this stage what kind of ethernet traffic goes back and forth. The switch chip is capable of many different features and switching functions which only can be analysed in this context by sniffing the ethernet traffic.



Control Head CONNECT-A board PoE voltage generation

The PoE voltage is created at CONNECT-A board from the main 13.8VDC power supply J101 through an undocumented part “Power Supply Block” highlighted in green on the board layout. **The voltage generated is unknown at this stage**. The PoE voltage is fed from J55 to the MAIN board J2802 to be injected to the ethernet connection. The PoE voltage pins are floating from the ground of the CONNECT-A and MAIN units. Respectively the J55 pins are assigned as pin1 = POEL and pin2 = POEH indicating the polarity of the output.





Connect-A board J55

pin1 = POEL

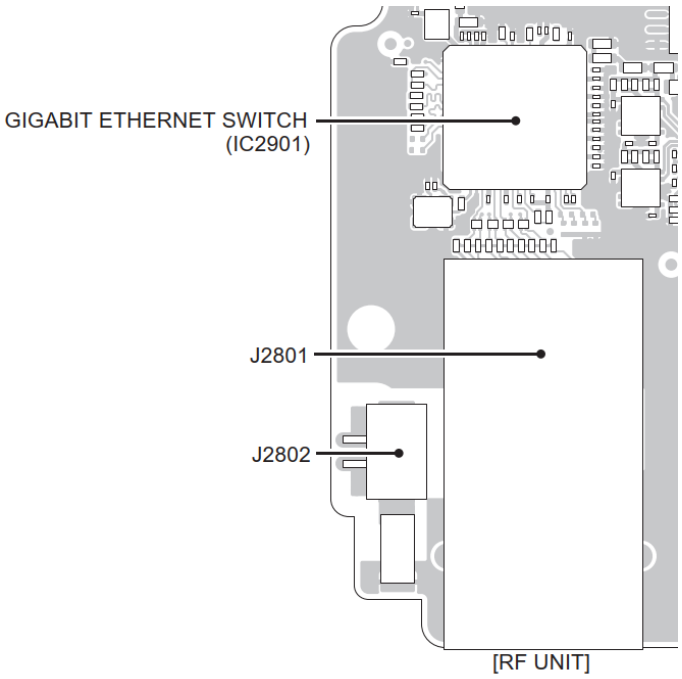
pin2= POEH

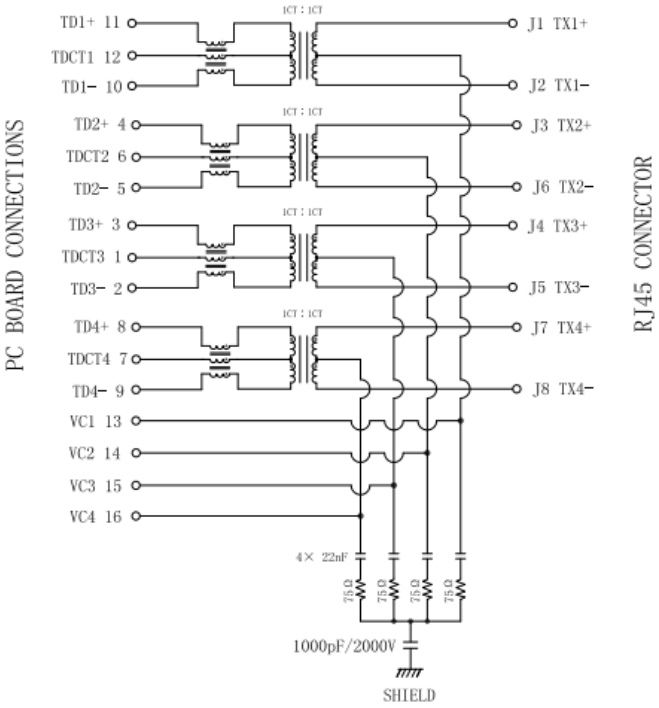
The text colours indicate possible PoE voltage polarity. Red + and Blue -

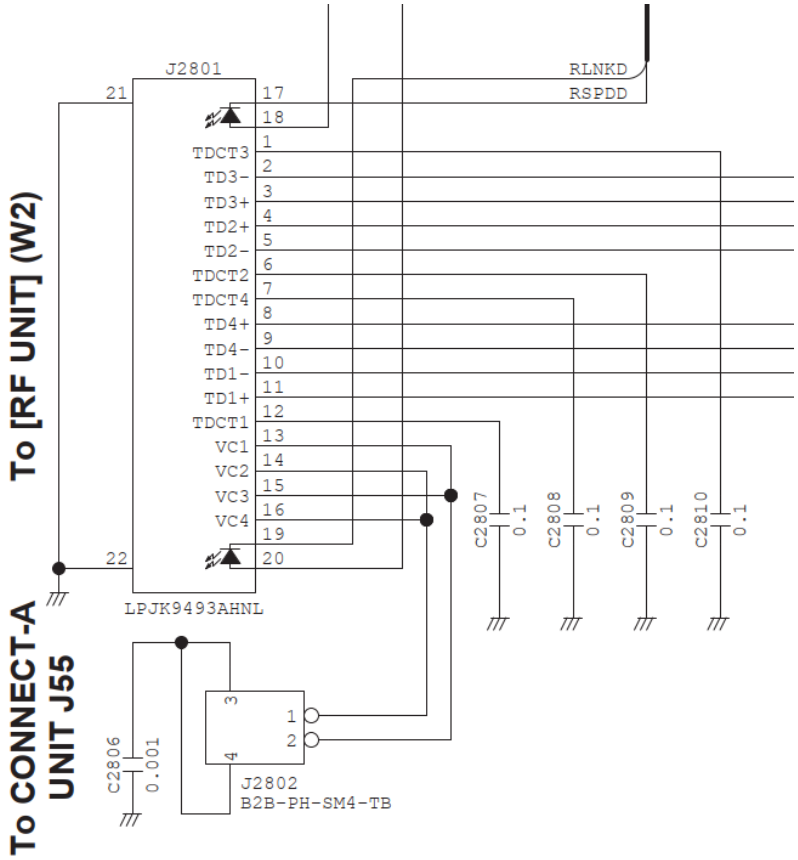
Control Head MAIN board ethernet/PoE interface

In the control head MAIN board, the connector for connecting to the remote RF unit is J2801 which is a one-in-all ethernet RJ45 port including PoE-capable magnetics. Part number for the connector is LPJK9493AHNL, datasheet is available at http://www.link-pp.com/?product/202011027047.html

Outgoing PoE voltage is generated at the CONNECT-A board from the 13.8VDC main power voltage and brought to the MAIN board through J2802 from where it connects directly to the LPJK9493AHNL PoE tap ports VC1,VC2,VC3 and VC4







MAIN board connector J2802

pin1 = POEL = VC2 & VC4

pin2 = POEH = VC1 & VC3

MAIN board connector J2801

VC1 = RJ45 pins 1+2 = POEH

VC2 = RJ45 pins 3+6 = POEL

VC3 = RJ45 pins 4+5 = POEH

VC4 = RJ45 pins 7+8 = POEL

TX1+ = RJ45 pin 1

TX1- = RJ45 pin 2

TX2+ = RJ45 pin 3

TX3+ = RJ45 pin 4

TX3- = RJ45 pin 5

TX2- = RJ45 pin 6

TX4+ = RJ45 pin 7

TX4- = RJ45 pin 8

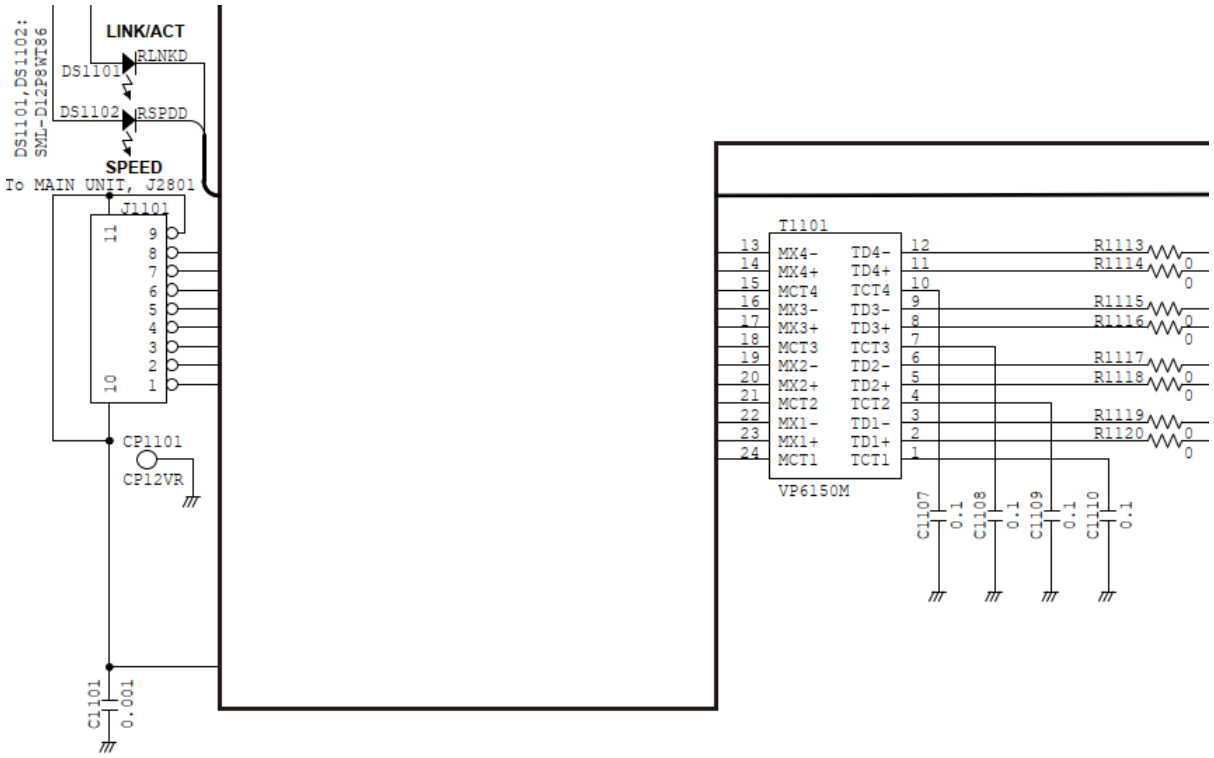
The highlight colours vaguely represent the T-568A pair colours

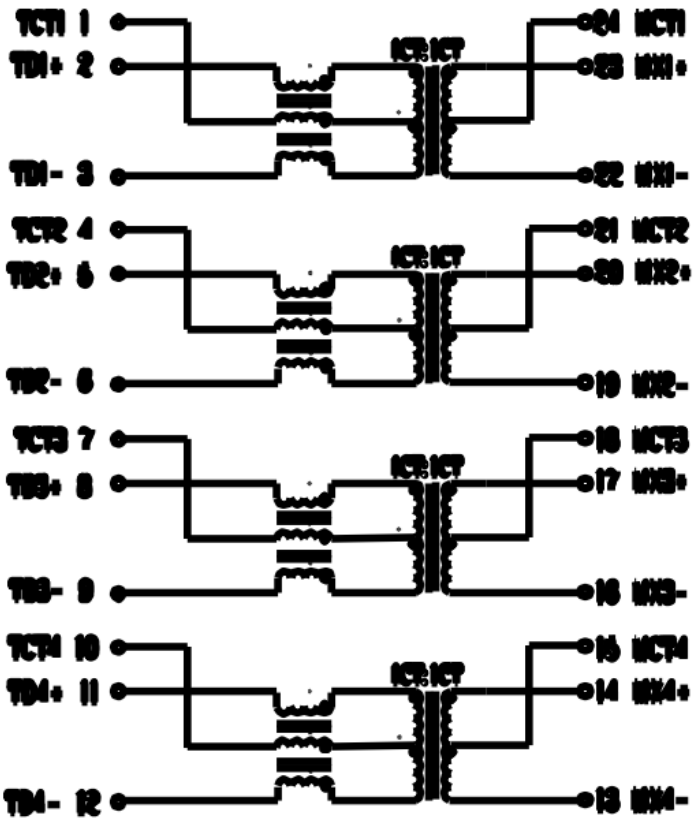
The text colours indicate possible PoE voltage polarity. Red + and Blue -

RF Unit RF-A board PoE interface

At the remote RF Unit REMOTE-A board the ethernet connection from the control head arrives to J1101 ethernet transformer which is connected directly to the ethernet cable without any edge connector. T1101 ethernet PoE-capable transformer extract the PoE voltage and feeds it to an undocumented “Power Supply Block” highlighted in green on the board layout.

T1101 = VP6150M HF Discrete LAN Magnetics PoE 1500mA
https://www.bothhandww.com/product/vp6150m-hf-discrete-lan-magnetics/?lang=en





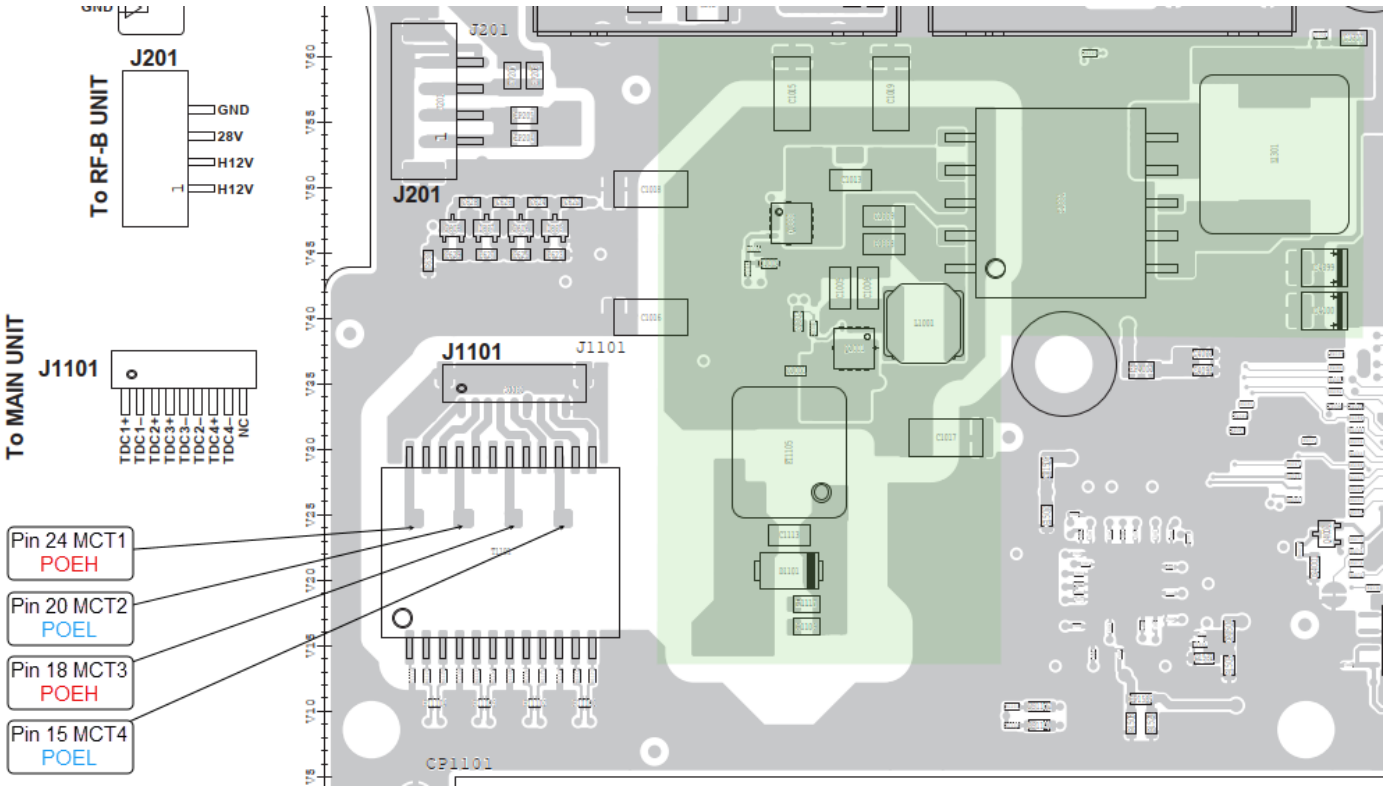
REMOTE-A board T1101 PoE taps

pin24 MCT1 = VC1 = POEH
pin20 MCT2 = VC2 = POEL
pin18 MCT3 = VC3 = POEH
pin15 MCT4 = VC4 = POEL

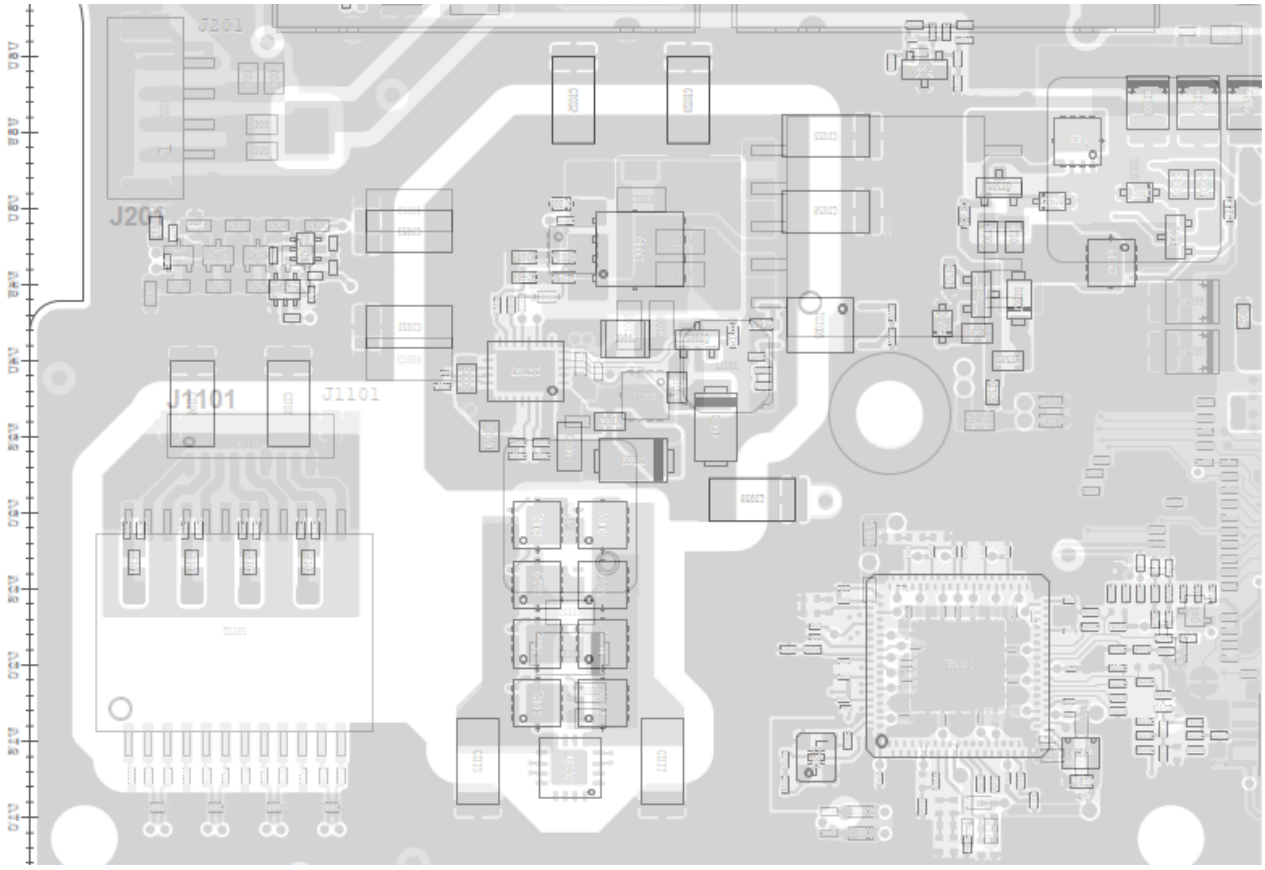
The text colours indicate possible PoE voltage polarity. Red **+** and Blue **-**

RF Unit RF-A board PoE interface (continued)

Visible tracks of the POEH and POEL voltage pins end up under the T1101 component to traces marked with arrows. These tracks do somehow connect to the undocumented “Power Supply Block” part highlighted in green, maybe through some mid-layer via’s inside the board. This is impossible to determine without physical access to an IC-905.



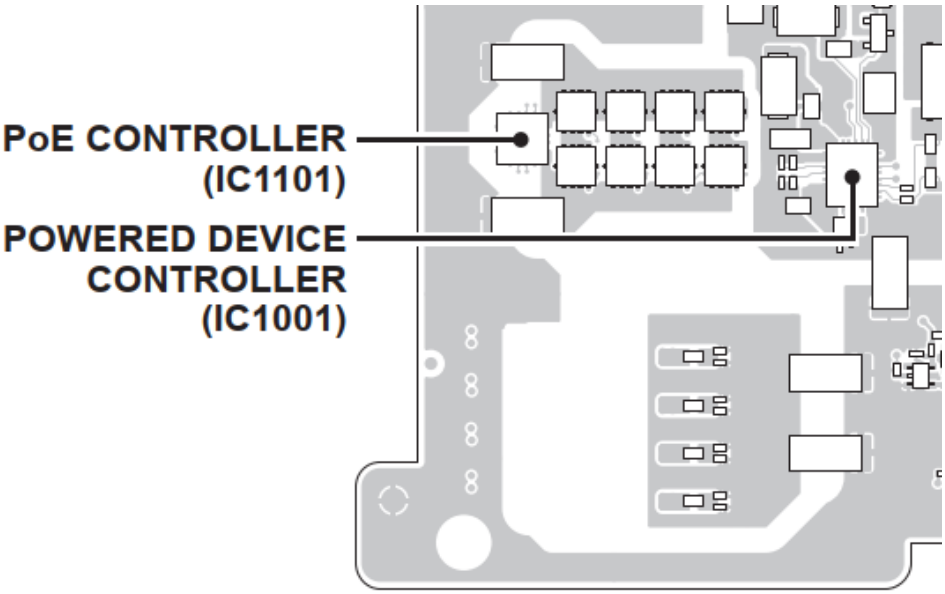
Here is an image of both sides of the board put on top each other to help determining how the signals flow but this neither provides further information about the POEH and POEL signals reaching the Power Supply Module.



RF Unit RF-A board PoE interface (continued)

In the undocumented “Power Supply Block” part of the RF Unit, the Service Manual’s Inside View part points out both a PoE Controller IC1101 and a PoE PD (Powered Device) Controller IC1001 chips on the RF-Unit RF-A board, but any other information related to these are redacted so no part numbers are available.

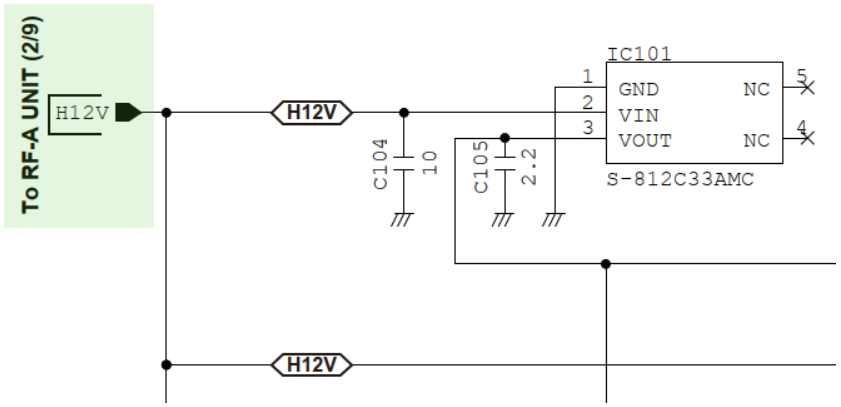
Just based on the information that these parts exist and how they are named, it is possible that Icom follows the 802.3 PoE specifications and the RF Unit appears as a PoE PD (Powered Device) with capabilities of negotiating what kind of power it requires and wants. Further investigation and confirmation of this requires hands-on investigation to find out chip-level information like part numbers to understand what the chips are there for and how they are configured.

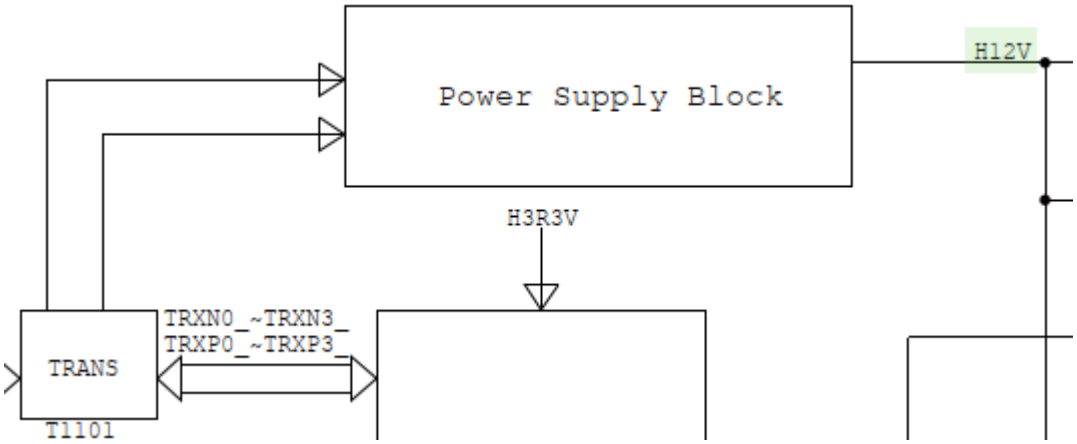


From PoE to useful voltages at the RF Unit

Due to redacted information in the Service Manual, finding useful information requires going back and forth different parts of the manual. Here a mystery signal H12V appears in the RF Unit RF-A unit schematics in part 1/9 and is commented to originate from RF-A UNIT part 2/9. The schematics part 2/9 thus does not have any mention of the H12V signal so it must appear from the undocumented “Power Supply Block”. This could be then confirmed from the block diagrams where H12V is the only output of the “Power Supply Block”.

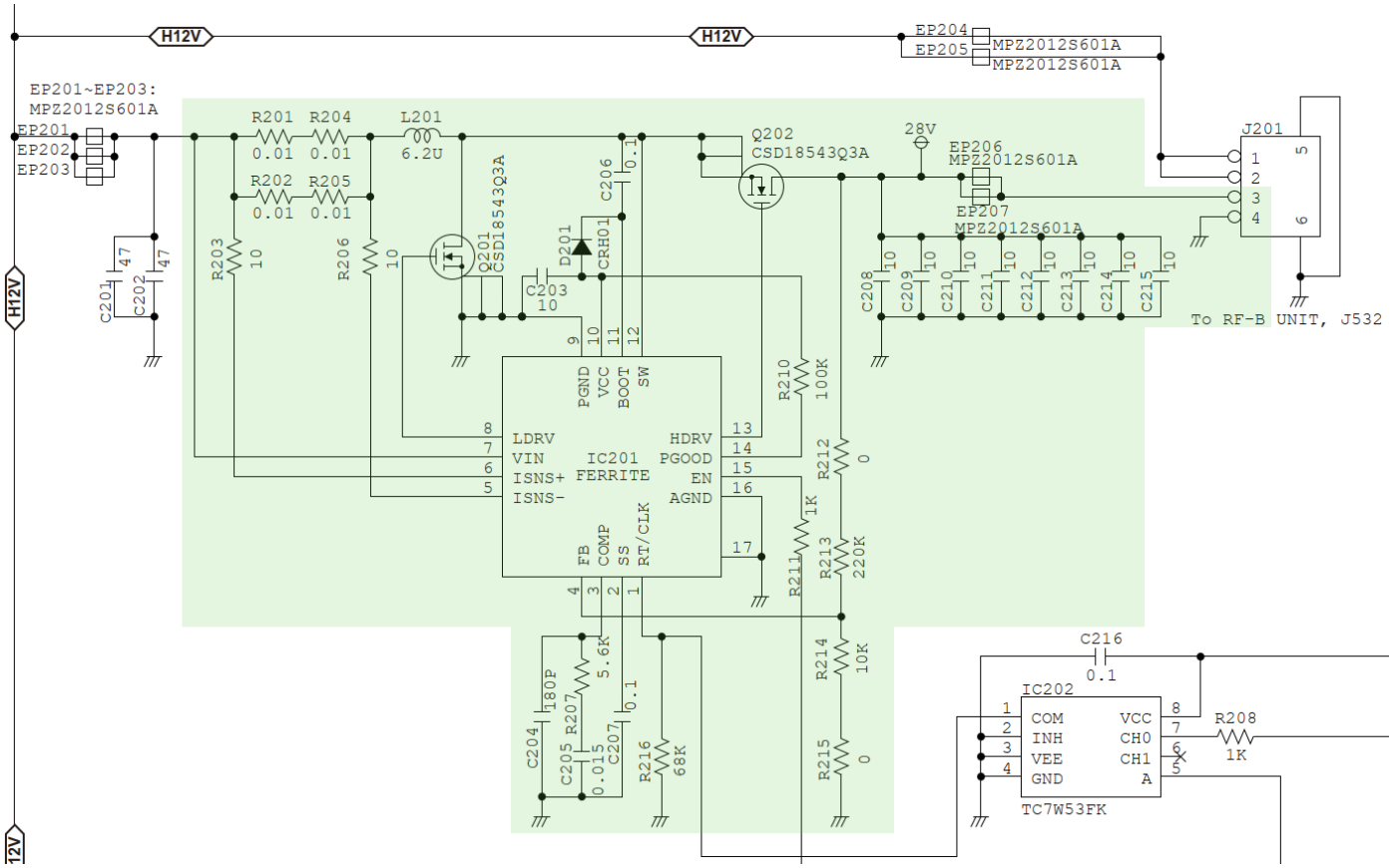
• **RF-A UNIT (1/9)**

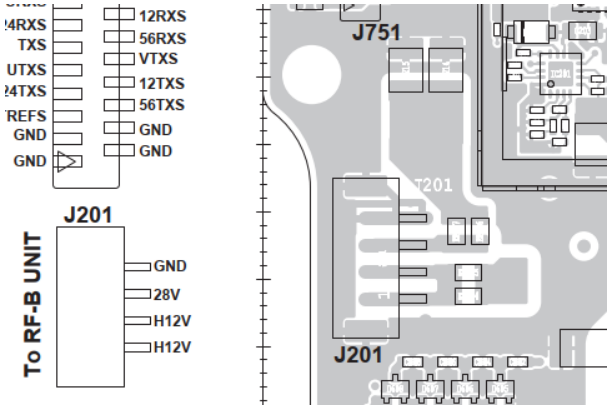


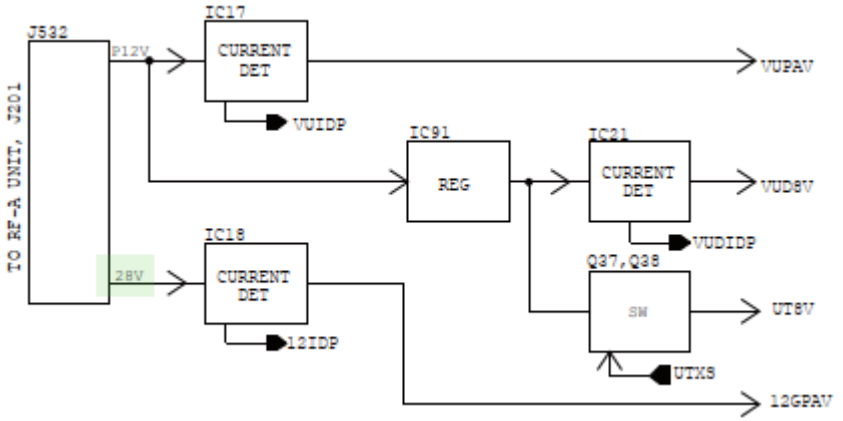


From PoE to useful voltages at the RF Unit (continued)

In addition, there is a +28V voltage available at RF-A unit connector J201 to feed the 1.2GHz PA at RF-B board. Strangely, the 28V is not regulated directly from the PoE voltage but made from the H12V 12V bus with a BUC. This gives a thought that the RF Unit could be powered with direct 12V feed and not through PoE.







Icom IC-905 PoE vs standard 802.3 PoE

Derived out of the available IC-905 documentation, Icom PoE looks very much like the newest PoE standard, PoE++ or 802.3bt

Icom's implementation of the PoE feed for IC-905 RF unit uses all four pairs, which is the case also with PoE++

At this stage when I do not have an IC-905 accessible, this is just guessing and assuming and needs to be verified. Though it gives a lot to think about, if the unit could be powered using a standard COTS PoE++ switch.

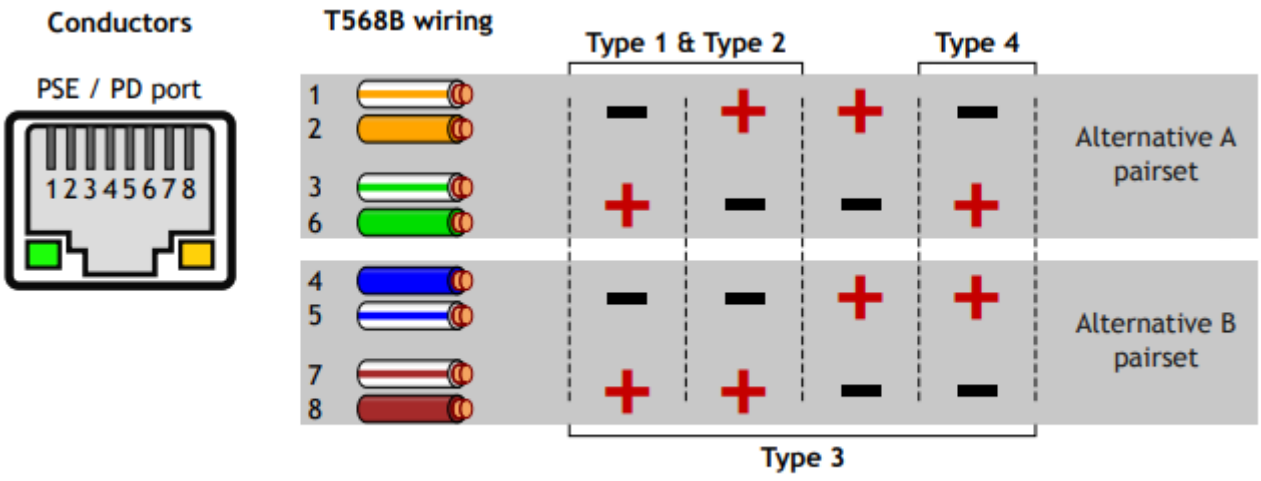
It's noteworthy to mention that the PoE voltage generation seems not to have any no brains, it is just a static power supply. Per PoE++ protocol, there is a handshake phase between the PSE and PD devices during which the capabilities and requirements are exchanged. Therefore, experimenting with the Icom PoE needs to be done with extra care not to blow or damage things inside the Control Unit.

PoE PSE stands for PoE Power Sourcing Equipment, so essentially a power supply which feeds a PoE PD, PoE Powered Device

Icom IC-905 PoE pinout for the interconnect cable between the control head and the RF unit

The 802.3bt PoE++ standard document is available at
https://ethernetalliance.org/wp-content/uploads/2018/04/WP_EA_Overview8023bt_FINAL.pdf

The 802.3bt standard allows multiple different polarity alternatives. Icom PoE implementation with the current information would fall under the type 3 polarity, or the third option from the left.



PSE pinout configuration and permissible power supply polarity

RF Unit Accessory connector

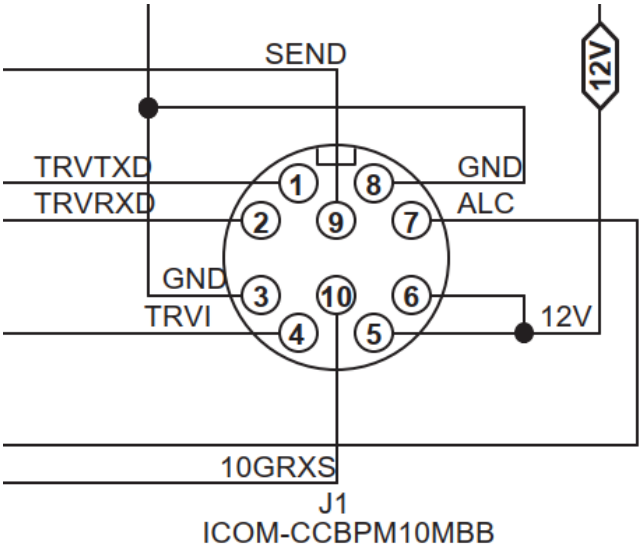
The accessory connector on the RF Unit provides some basic signals for connection to maybe external PA's or other accessories. It is mainly used to interface to the 10GHz unit CX-10G.

Based on the schematic diagram, in addition to the documented signals, there are also 'undocumented' signals TRVTXD (pin 1), TRVRXD (pin 2), TRVI (pin 4), 12V (pins 5+6) and 10GRXS (pin 10) which are apparently used to talk with CX-10G but can be maybe used for something else as well.

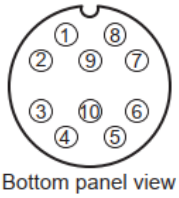
The connectors are not very easy to find and I got only one hit using multiple combinations of the connector part number.

Socket
CCBPM10MBB-KCP7001
https://www.ods-tech.com/en-gb/product/15976

Plug
CCBDF10FBB-KLS7001
https://www.ods-tech.com/en-gb/product/16058



[ACC]

ACC	Pin No.	Port name	Description		Specification
10-pin  Bottom panel view	1	NC	–		–
	2	NC	–		–
	3	GND	Connects to ground.		–
	4	NC	–		–
	5	NC	–		–
	6	NC	–		–
	7	ALC	ALC voltage input.		Input impedance: 10 kΩ or more Input level: –4 ~ 0 V Input voltage: 30 V or less Input current: 0.5 mA or less
	8	GND	Connects to ground.		–
	9	SEND	Input	When this pin goes to ground, the transceiver transmits.	Voltage: 30 V or less Reverse voltage: 80 V Open circuit voltage: 5 V Voltage (TX): –0.5 ~ +0.8 V Current flow: Maximum 2.27 mA
			Output	This pin goes low when the transceiver transmits.	
	10	NC	–		–

Plan Of Actions

This is a random order list of what needs to happen to go forward with the study about Icom IC-905 and its networking capabilities etc.

- Buy/borrow/beg for an Icom IC-905 setup to continue deep-dive study.
- Build PoE isolators to sniff the traffic without breaking anything (backup solution: Pull cable out from J2802 at Control Head MAIN unit, it stops feeding the PoE voltage to the cable)
- Measure voltage at Control Head Connect-A Unit J55 (PoE voltage)
- Start to design (maybe) necessary PoE power injector to power the RF Unit from elsewhere than the Control Unit
- Figure a way to create latency to the connection and see if it has any effects.
- Observe how the Control Unit behaves when the RF Unit is not connected.
- Find out is gigabit connection between the units necessary or would it work also with 100Mbit/s speed.
- Through ethernet traffic sniffing, observe the ethernet L2/L3 parameters; how many MAC addresses appear and what kind of IP addressing is used and what kind of traffic goes back and forth.
- Build a NAT between the units with network equipment like Mikrotik routers (Swiss army knife for networking) and see if it still works.
- Find out if someone has opened an IC-905 and has pictures of the chips in the undocumented “Power Supply Blocks”.
- In addition of understand the networking and PoE part of the remote connection, study how to modify the RF Unit with separate antenna connections for 144/432/1296MHz bands.
- Buy more tea.

Document versions

Date / version number	Notes
29.10.2023	Initial published version