EARTH – MOON – EARTH

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This article intends to give continuity to those already published in this magazine in October and November of 2014.

In this third chapter I intend to describe all pieces of the puzzle that an EME installation could have installed between the antenna and the connector of our transceiver. I will concentrate on the hardware, that is, on how to connect the relays and what types of relays we can use, to be able to work with high powers and an LNA, without anything being damaged (with Murphy's permission).

I will focus on the 144MHz EME band as in the previous articles, but it is perfectly translatable to other higher bands and of course, to an optimized station for terrestrial communications.

1.- LNA (Low Noise Amplifier)

Also known as "Preamplifier", they are very important and are always controversial by the amount of electrical characteristics that they have, all relevant, so I will deal with them more deeply in an upcoming article. For now the only thing I would like to make clear is that it is a very sensitive element, and I will look at two features:

- It has been assumed that in order not to damage it, its input and output connectors should not reach more than 1 mW, in other words 0.001W.

- All possible transients (spurious, spikes, static, etc.) must be avoided, in the both antenna connectors and in the power supply connector.

They are not usually prepared to be outdoors, and as we will see that they have to be as close as possible to the antenna, they have to be installed inside a waterproof box.

You can find LNAs with relays included in a set, but few manufacturers have this product, which supports 1kW and switch over RF detection. In the end the most economical and durable option is to buy the LNA without relays and use external relays and a sequencer for switching.

Powering the LNA and relays from the shack is not usually done through the RX or TX coax, although some LNAs allow it. In EME by the high powers and low losses in the lines, always they are fed by a separate line. It is important to use a coaxial cable for DC power, even if it is a RG58 and try to put some ferrites before the LNA. All induction, transient and RF precautions will be welcome on DC power lines to devices located in the tower.

In FOTO 1, you can see a waterproof box where the isolation relay of the RX and TX lines is installed, the LNA and how the ferrites are set for both devices in the power line.

2.- <u>AMPLIFIERS</u>

As we have seen in the previous articles, part of the losses to go to and return to the Moon are compensated with power by both stations, otherwise you would need huge antennas, like 8 or 16 antennas. In order to work with 2 or 4 antennas we need at least 350W. The standard power used and that will serve as reference is 1kW, although there are stations that use up to 2.5kW. Above 1kW our RX/TX relation will be unbalanced and we will become a crocodile, because 1kW is a standard.

We can find 3 technologies in amplifiers:

Valve amplifiers: These have been the only ones able to achieve high powers for many years, the best known use: 2x4CX250B, GS31B, GS35B, 8877, GU-84B, 3CX1500, etc. They are still manufactured and are in use, both of them commercial and home- made. They are reliable and robust, being almost the only drawbacks their weight, size and the use of Power Supplies at high voltages, 1000V up.

MOSFET amplifiers: This technology is already solid state (SSPA: Solid State Power Amplifier) and uses transistors of the series MRF in parallel until reaching the desired power, they are usually fed to 48VCC. These amplifiers have always been delicate in the settings (paired transistors) and sensitive to over excitations or high SWR, so they needs appropriate protection circuits. There are still commercial firms that manufacture them, designing new models.

LDMOS Amplifiers: This is the latest technology within the SSPA and has not yet been fully developed, uses 48VDC. These amplifiers are not complex to build, characterizing why a pair of LDMOS is able to reach 1kW. They are very robust and better protection circuits (faster) is being developed. It does not have any of the three drawbacks of the valves, so all are advantages and against what some think, they have a clean radiation and are robust. Just be careful with the Switching Power Supply, as it is easy to produce interference in the reception.

The three technologies work properly, with valves and LDMOS being the most used, everything will depend on the opportunity and resources of each one.

These devices usually come complete, with relays for switching and bypass, as well as the integrated Power Supply. Although we will see in the different connection schemes that I propose that you can use the Power Units without relays, which makes the installation cheaper and we get the same results. The only thing we lose is the amplifier bypass option.

3.- COAXIAL CABLES AND CONNECTORS

Regarding the losses of these accessories I will comment on the following article, here I only want to make reference to the power they support and their mechanical considerations.

Connectors: It should be made clear that "PL" type connectors are not suitable at high power 144MHz. To the RX line, which do not have to deal with high power, there are smaller connectors than “N” and also have low losses, such as the "SMA", "BNC", etc.. When we talk of a serious high power station, until 1kW the “N” connector is the king, above “7/8” connectors are used.

But in the TX branch, when we talk of a serious high power station, until 1kW the “N” connector is the king, above 7/8” connectors are used, especially between the amplifier and the antennas, by watertightness, robustness, power, reliability, etc. Just comment that you have to check the features of “N” connectors, because I have found first trades for serious cables like ½ "that do not support 1kW. So you always have to look at the manufacturer's data-sheet, both in their features and the assembly instructions, since each manufacturer has his tricks for a correct assembly.

Also comment that all types of transitions, especially the bent transitions (90º), must be avoided, because a great number of failures and great losses have been verified even in reception. However the bent connectors (90º) are perfectly usable.

<u>Coaxial Cable</u>: In these bands we have to forget the parallel lines used in HF to go from the antennas to our equipment. Regarding losses, which I will try in the following article, you must put money and always choose the best cable that we can afford.

Between the antennas and the LNA, which is the common part of RX and TX, every 0.1dB is GOLD, here we must be “magnanimous”, as I will show you.

In the RX branch after the LNA, any coaxial with low losses will be worth, although it is important to choose cables with "double mesh" to get a better insulation, minimum one RG214 (is similar to RG213, but with double mesh).

In the branch of TX, especially from the amplifier to the antenna you have to avoid cables like the H2000, which features are very fair in 144MHz with 1kW. The lighter cable that we can use is the ECOFLEX 10, LMR400 or similar manufactured in Spain like The LAZSA 2.7-2.7 3048, which support 1.5 kW at 144MHz. The ideal for mechanical robustness is to use ½ "cables up to 1kW and 5/8" if you are going to work with higher powers or you have considerable lengths. To cross the rotor, although it can be done with ½ ", it is not advisable, because it is necessary to make a spiral of at least two turns and still suffers much mechanically. Ecoflex 15 or similar is usually used.

Also tell you that there are some operators that try to avoid the connectors wherever they can, to avoid their losses and hot spots. In this way they usually weld the coaxial cable directly to the excited element. My personal opinion is that the only way to guarantee a correct impedance transition is through connectors, which also allow you, at a given moment, to be able to disconnect to make checks, substitutions, etc. Without having to carry a welder of a elevated power to the top of the tower.

4.- <u>POWER SPLITTERS</u>

If we are going to stack several antennas, we will be forced to use a splitter that supports the power of our amplifier. In the case of only two antennas, which is usually the most used in the expeditions, we can save and emphasize with two cables of 75 ohms of low losses in multiple electrical pairs and join them with a "T" transition.

The classic power splitter is the usual, there are short ones (with the antenna connectors on one end and the output on the opposite end), and long ones (with 2 antenna connectors on each side end and a central output). The choice is conditioned by a mechanical issue in the assembly, to reduce the length of the coaxial between the splitter and the antennas.

This type of splitter can be found in many commercial brands, and they are easy to build with schemes that can be found on the internet, as it only is a mechanical issue. There are even calculation software, depending on the impedance that we want to adapt we can choose the diameters or sections of the tubes to use, as well as their lengths.

If we are going to work with powers greater than 1kW, it is important to consider that the output connector, which supports all power, is 7/8", instead of "N ".

The choice will be conditioned by our mechanical preferences. There are more robust and better finished, since the losses do not differ much.

5.- <u>RX SPLITTER</u>

In a simple EME installation it is usually used the receiver of the transceiver equipment , which connects to an instance of the WSJT. If our receiver has 10 MHz F.I. output we can install an SDR and connect it to an instance of the MAP65. MAP65 is software that allows us to simultaneously decode all EME stations in the bandpass, which we are able to receive within the spectrum assigned for this type of communications. In these conditions we do not need a RX splitter.

But in case we need to connect a classic receiver (with an instance of WSJT) and a SDR (with an instance of MAP65), then we need a RX splitter.

it is usual to carry out a modification of our transceiver to separate the RX of the TX in the band that we are going to work. It is usually a simple modification that we can find on the internet, and with this we have our separate classic receiver. To choose a SDR there are many in the market, but perhaps the most widespread in EME due to its low cost, large frequency range, specific filters and great performance, is the FCDP+ (Funcube Dongle Pro Plus).

A RX splitter with one input and two outputs always has losses of> 3dB for each of the outputs. Certainly someone is thinking that it is a contradiction to look every 0.1dB and now lose > 3dB from an attack. I will demonstrate in the following article that the losses of RX after the LNA are not really significant within limits that I will set.

Apart from the losses, there are other relevant data of the splitters, one of them is the isolation between the ports, which is not very critical, and another the bandwidth for which they are designed, there are hundreds of models. Some RX splitters support some power (2W, 4W, etc.), for our application that is pure RX, this data is not significant.

Finally, I would like to point out that the most used passive splitter are minicircuits, since they are very popular and it is easy to find them by second hand. I use the ZFSC-2-1 (5 to 500 MHz) and the ZX10-2-12 + (2 to 1200 MHz) models. In TABLE-1 you can see the characteristics of an RX splitter, in this case the ZX10-2-12 +, in which I have remarked the line related to the 140MHz band.

Typical Performance Data

Frequency (MHz)	Total Loss[1] (dB)		Amplitude Unbalance (dB)	Isolation (dB)	Phase Unbalance (deg.)	VSWR S	VSWR 1	VSWR 2
	S-1	S-2						
2.00	3.30	3.12	0.18	27.33	0.75	1.03	1.22	1.16
5.00	3.25	3.11	0.14	31.03	0.34	1.02	1.16	1.12
14.00	3.24	3.11	0.13	32.84	0.11	1.02	1.14	1.11
32.00	3.25	3.11	0.13	32.75	0.02	1.02	1.14	1.10
50.00	3.26	3.13	0.13	32.34	0.01	1.02	1.13	1.10
140.00	3.28	3.15	0.13	30.09	0.17	1.03	1.12	1.10
320.00	3.32	3.21	0.12	26.11	0.34	1.05	1.10	1.09
410.00	3.36	3.25	0.11	24.65	0.39	1.06	1.08	1.08
500.00	3.39	3.29	0.10	23.47	0.48	1.07	1.06	1.08
740.00	3.49	3.43	0.06	21.36	0.43	1.08	1.06	1.09
900.00	3.57	3.53	0.04	20.62	0.32	1.09	1.11	1.11
950.00	3.62	3.61	0.01	20.51	0.29	1.09	1.12	1.12
1000.00	3.65	3.62	0.03	20.38	0.27	1.09	1.14	1.13
1100.00	3.75	3.74	0.01	20.29	0.07	1.09	1.18	1.15
1200.00	3.86	3.88	0.02	20.33	0.02	1.08	1.22	1.18

1. Total Loss = Insertion Loss + 3dB splitter loss.

6.- RF FILTERS OR CAVITIES

This piece of hardware is not really imperative if your station is in a place free of RF contamination. . . Hi hi hi Who lives in the middle of an African forest or the Amazon?, We are condemned to live in an increasingly RF contaminated world, so sooner or later a filter will suit us.

As I will tell you in the following article, we are forced to use a LNA for two fundamental reasons, to eliminate losses of the RX line and to improve the NF of our receiver, which is usually about 3 dB in commercial receivers. But as a disadvantage, we will have our LNA amplifying ALL that is in its bandpass, and unfortunately it is not possible to put a narrow filter of 144MHz inside the box of an LNA.

Almost all LNAs try to put some kind of filter at the antenna input, although it is minimal, because this also influences in the final NF figure.

The solution is to install a filter as narrow as possible in the output of the LNA, where we will see that the losses are not so critical. I have installed a resonant cavity of a VHF repeater set to 144.200 MHz, you can see it in the PHOTO 2. It introduces losses of about 2dB. I also installed bypass relays to check their effectiveness.


PHOTO 2

If you ask me if it is effective, I have to say that in EME every detail that adds must be taken into account. Although it adds 0.05dB, it is important in the ability to decode a signal that reaches us 10dB below the noise.

7.- RF PROTECTOR AT THE LNA EXIT

If the installation is well built and we have separated RX and TX lines, this element will not be necessary. But if we do not have them separated and we work with great powers, If a failure of the sequencer or the relay that exists before the LNA happens, could be that we inject RF to the LNA. If this happens, the LNA will smoke.

In order to cover this failure some brands have a RF protector as you can see in PHOTO 3. In this case is a passive circuit with very little insertion loss, about 0.1dB and that will absorb 30W in FM or 50W in SSB. The transmitter will see a very high SWR and its protection circuit will reduce the power out. In addition this device allows the passage of DC through it, in case we feed our LNA through the coaxial, something that is not usually done in a serious EME setup.

PHOTO 3

8.- <u>SEQUENCER</u>

It is an essential element when we work with high power. It is an electronic board with the following connectors:

- Power input (usually 12V).
- Input of PTT (-) or ground (This activates the sequence in both directions).
- 3 or 4 relay contact outputs, free of potential.

Normally it has 3 outputs (PTT Transmitter (-), PTT Ampli (-),LNA (+)), some have a fourth output for handling a transverter.

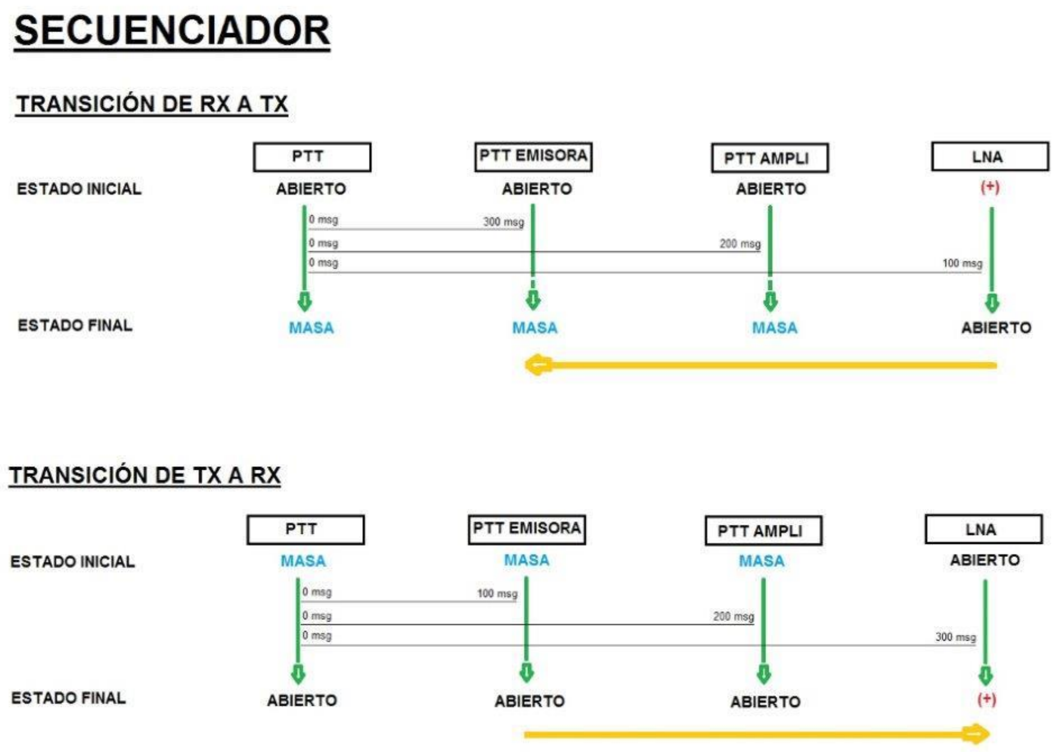
The most important thing is that there can be nothing to set the transceiver into transmission than the "PTT transmitter" output of the sequencer. If the transceiver itself has a button on the front panel that puts it in transmission, you have to cancel it. Therefore all switches, pedals, digital outputs of PCs, interfaces, microphones, etc. Whose mission is to set the transceiver into transmission, must be connected to the "PTT" input of the sequencer.

Its name explains its operation, the output relays will change from on/off state or vice versa sequentially, one after the other. In addition, between the changes of state of the output relays there will always be a timing, which is usually between 100 and 300 milliseconds. This will allow the RF relays to have enough time for their own change of state.

In TABLE - 2, it is possible to see how the sequencer acts in the change of states, because in the transition is where it works. Therefore, the current state and the final state are represented, as the values of their outputs change into the sequence. I have represented it with a timing between outputs of 100msg, but this time is usually programmable.

It is very important that in the design, it happens a power failure, nothing will be energized, even if the PTT is grounded. It is also important that in TX, the relay of the LNA must be de-energized, because if it is designed energized, if a fault of the relay happens, could enter RF.

There are different brands, schemes, etc. The older ones were usually based on time constants marked by capacitors, the safest ones are usually those in which the relays themselves have contacts that give permission to the next output in the sequence. But there are countless designs with time constants marked by the well-known NE555, or by internal clocks of the so-laureated PICs.



We have always take into account a RF-immune design, with type L200 shock and appropriate capacitors at all inputs. It must be taken into account that if it fails, we will smoke the LNA, the amplifier, or in the best case the RF relays contacts.

9.- GROUNDING

In nearly all schemes, for simplicity, it is always obviated. Grounding is one of the most important issue in an installation and I do not want to miss this opportunity without comment.

Let me try to explain how I see a lightning. It is a very high energy radiation and in a very large RF spectrum (bandwidth). When it takes ground close, it is as if we had installed an antenna of many kW of power but that emits in a huge bandwidth, for an instant. What is produced is an electromagnetic field of great magnitudes that tries to induce itself in all the metallic parts around it. In a radius of about 300m you can induce hundreds or even thousands of volts.

Once you understand how it works, the only way to protect against a close lighting is to have all the metallic parts of our radiant system connected to each other with a copper wire, at least 50 mm2 and routing cable until the best ground connection that we can get . In a detached house, if it is well made, you will have a 50 mm2 copper ring with grounding rods around the house and joined to the entire structure. It is important when you make a home take into account this detail.

PHOTO 4

PHOTO 5

It is very interesting that the coaxial cables, before coming into the shack, are also connected to the same earth, as you can see in PHOTO 4. And if you can add a discharger as in PHOTO 5, then better. This is how cell towers are designed and stoically endured the lighting. I have some additional details, such as copper braids bypassing the rotors and bearings, so if a possible lightning strike does not pass through rotor and go through the control cables or deteriorate the moving parts.

In June of 2015 fell 5 lighting in a raw 100m of my antennas (I have the video, in case someone is interested). My neighbor, the next detached house, that has a single mast and a TV antenna, suffered 3 smoked televisions, TV decoders, clock radios, cordless phones, etc. At home, It did not break anything. The neighbor is still trying to understand it, as with the radiant system that I have installed, I did not have the house burning. I was only differentials of some lines tripped. Lucky?, I say that something would influence the grounding system. I hope I never get a direct lighting, but if it happens, I hope to be lucky.

10.- RF RELAYS

This is an important stuff of our EME station, which will allow us to make the RX/TX transition and vice versa, without anything deteriorating.

An RF relay, among all its features, there are four in which we have to concentrate more attention:

- Power rating
- Insulation between connectors
- Insertion losses
- Switching time

To understand these parameters better, in TABLE - 3 are the actual data of the three most used commercial relays, they are from the manufacturer Tohtsu. Understanding its characteristics we will be able to extrapolate to any other RF relay that you find in the market.

I have chosen 12V coils, with N connectors on all ports and their features related to the 150MHz band, these vary according to frequency. The CX-520D ground the opened port. The other two are normal switches. You can see the schemes in PHOTO 6.

TABLA 3

RELÉ	POTENCIA	PÉRDIDAS	AISLAMIENTO	TIEMPO DE CONMUT.
CX-520D	300W	0.15dB	60dB	20ms
CX-600N	1000W	0.1dB	48dB	20ms
CZX-3500	1000W	0.1dB	65dB	20ms

The switching time, in the three relays, is 20ms in the worst case, which is usually in the energizing, having to overcome the spring. The passage from energized to rest is usually faster, in the order of 15ms.

Insertion losses are also similar, between 0.1dB and 0.15dB. So, in this case, it will not be a critical feature in our choice.

Power rating is what their contacts support in closed position. It is a relevant data in a high power system, two of them support 1000W and the third 300W. Although it seems obvious I have to warn that the RF relays are not designed to open or close their contacts in "hot", only with NO power applied to them. The switching must be done in "cold", otherwise your contacts will be damaged, losing their characteristics.

In reference to the isolation we have to pay more attention, to understand the figure that shows us the TABLE - 3.

Although we sometimes find it difficult to assimilate, dB is always a relation between two magnitudes.

Our companion EA3GCV in an article published in May of 2015 in this magazine, It was very easy to interpret the dBs. From the EA3GCV table I have extracted three typical values:

- 65dB: equivalent to a power ratio of 3.162.277,66
- 60dB: equivalent to a power ratio of 1.000.000
- 57dB: equals a power ratio of 501.187,23
- 48 dB: equals a power ratio of 63.095,73

When a relay is used to separate the RX line from the TX line, or if it is used to protect an LNA, as we will see in later schemes, isolation is a relevant data. It is assumed that a LNA will support 1mW in its connectors without burning, which will condition us the choice of the relay, as I explain below.

If a RF relay, in one connector has 1000W and the relay has an insulation of 60dB, in the other connector will appear 1,000,000 times less power, so in the other port will appear 1000/1.000.000 = 0.001W, Or what is the same 1mW. So this relay can be used to isolate my LNA if I use 1000W, because it will see at most 1mW. This is the case of the CZX-3500 relay, which has an even higher insulation, of 65dB, that is 0.001W x 3.162.277,66 = 3162.27W.

Notice that the CX-520D has 60dB of insulation, and we could use this feature, but be careful, the manufacturer tells us that it only supports 300W. Therefore we cannot install it at the output of the amplifier, unless it is only 300W.

The CX-600, with an isolation of only 48dB, will protect our LNA only when in the other connector is 0.001W x 63.095,73 = 63W. However this relay supports in its closed contacts a power of 1000W. This relay should not be used for isolation of an LNA, unless we work with very small power, at the input of the amplifier.

This now seems to be a bit confused, but with the schemes that I show below you will understand where we can fit these valuable pieces, taking into account the characteristics we have described.

One more comment, a RF relay like any other, is mechanically a coil that does the function of electromagnetism, attracting its core when it is energized. When a coil, which is energized, change to the state of desenergized, a polarization voltage is produced at the terminals of the coil which is opposite to the one that supplied it, so that the current passing through tends to not disappear. We see this effect when in the contacts of the switch that opens a small arc or spark appears. This transient is very important, so much that it can damage or cause the malfunction of the near electronic stuff, like the LNA, sequencer, interferences in the audio circuits, etc.

To reduce this effect, it is always important to connect a diode to the same coil terminals, polarized reversed with respect to the supply voltage (called "free-wheeling diode"). Any low current rectifier diode will be valid. The reason is that the reverse voltage that appears on the coil terminals, when it reaches the threshold voltage of the diode (usually between 0.4V and 0.6V), is short-circuited through it, reducing the arc or spark at the contacts of the switch, push-button or relay that supplies it, avoiding major damage to the surrounding electronics.

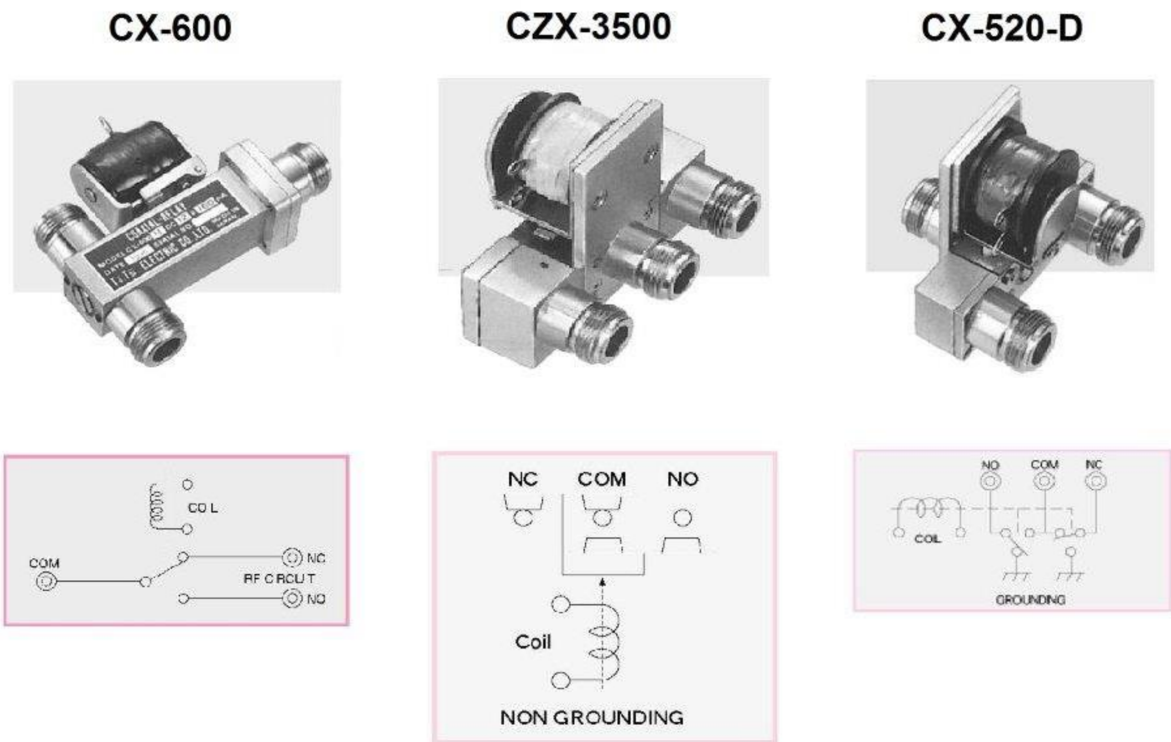


PHOTO 6

11.- <u>CONNECTION SCHEMES BETWEEN THE ANTENNA AND THE EQUIPMENT</u>

Now is when we have to assemble the puzzle, with all the elements I have described above. As I will explain in a later article, the LNA should be set as close to the antennas as you can. If it is a single antenna, if possible, in the excited element. And if they are 2 or 4 antennas stacked, as close as possible to the splitter.

Also note that the output (+) of the sequencer that feeds the LNA, must simultaneously fed (in parallel) the relays that isolate the LNA at its two ends.

All schemes are represented at rest, ie without power in the sequencer and relays. In this state the relays will isolating the LNA, the system is in TX position. This detail is important, because if any relay fails the coil or the power cable, the LNA will always be isolated, and the LNA will not burn.

To better understanding, I'll split the connection schemes into 3 types:

11.1.- RECEIVER AND TRANSMITTER NOT SEPARATED

This is the most common scheme, it is as our transceiver comes from the factory, is the most comfortable but not the safest. As I will comment in section 11.2.

- SCHEME 1: It is the simplest assembly, when our LNA already comes with its own relays. The manufacturer has already warned us that the internal VOX will support a power and that with a sequencer will support another upper. As we are handling high powers, we will have to connect the sequencer.

If we have an LNA without relays and we want to install them ourselves, then we have to choose both relays with enough insulation for the working power and both relays must support the total power. If I install two CX-600Ns, although their contacts support 1000W, they will only protect us if our amplifier is less than 62W. The CX-520D even isolates us to 1000W, its contacts only support 300W, if this is the power of our AMPLI, it will be a good choice. But if our AMPLI is 1000W, we have no choice but to use a pair of CZX-3500.

- SCHEME 2: In this case our LNA is without relays. If we install this scheme, relay 1 supports the full power of the amplifier (CZX-3500). Relay 2 only supports and isolates the power applied to the input of the amplifier (CX-520D). The only drawback is that we have to bring a second coax from the LNA to the input of the AMPLI. This coax is only for RX, and I will comment on the next article on what features must fit.

- SCHEME 3: In case we want to install an SDR receiver, in order to be able to simultaneously decode all the stations that we are able to receive in JT65, we will be worth the relay configuration of the previous scheme, but we have to install a reception splitter in the RX line.

- SCHEME 3A: This option allows working with large powers or in case we intend to overprotect the LNA. At the input of the antenna, where we have all the power of the AMPLI, a second relay is installed that connects the LNA to a 50 Ohm load during TX periods, as the LNA is removed from the power supply, it can also be connected to ground. In this case the insulation of the two relays must be added, and this second relay does not support virtually any power, its function is to increase the isolation.

The same could be done at the output of the LNA, but in this case I have chosen to install a protection that absorbs some power, in case of failure of the relay installed between the equipment and the LNA.

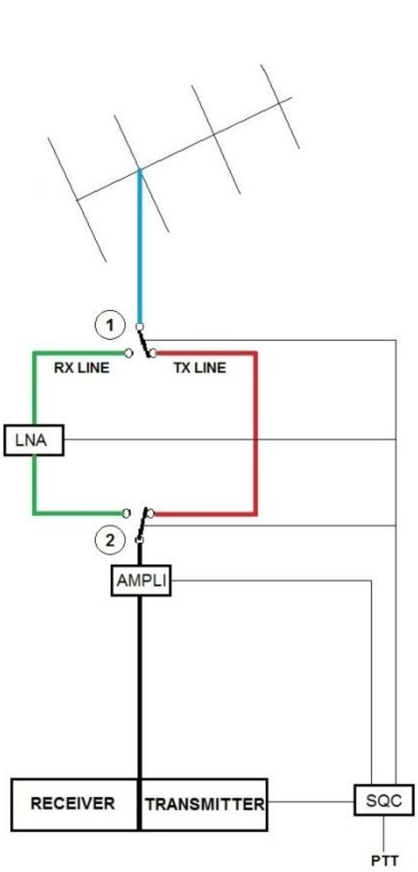


FIGURE - 1

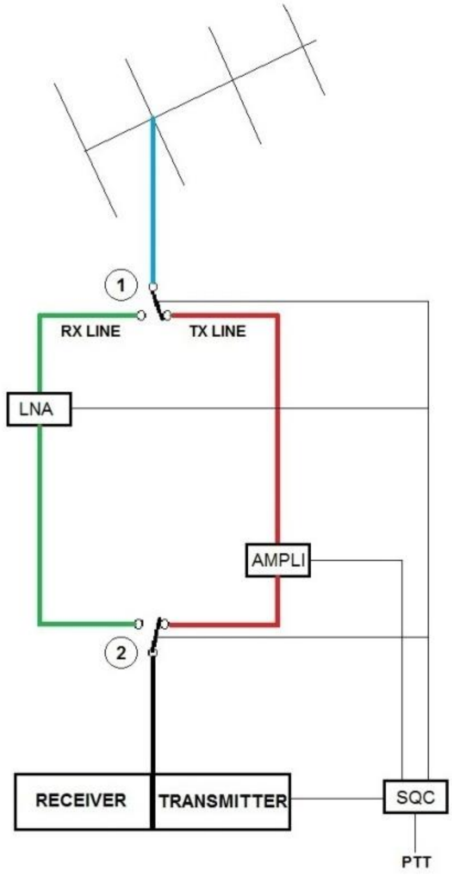


FIGURE - 2

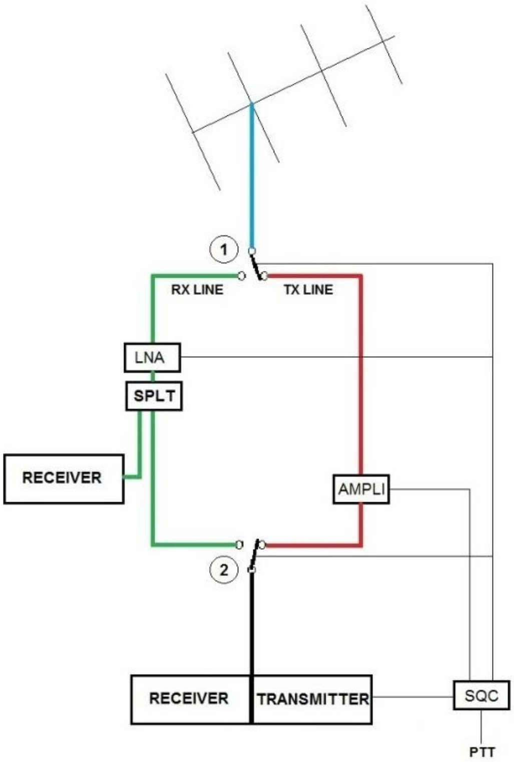


FIGURE - 3

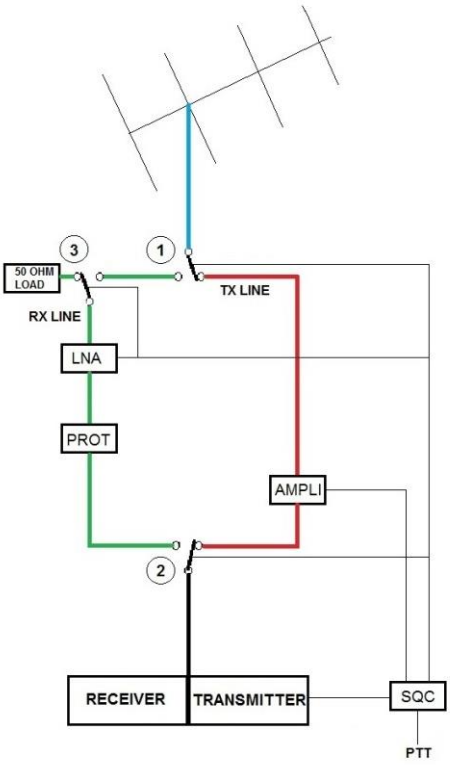


FIGURE - 3A

11.2.- SEPARATE RECEIVER AND TRANSMITTER

This is the most used option of EME stations, because it guarantees that RF will not reach the LNA for its output, besides reducing losses from the LNA to the receiver, when eliminating a relay. The installation is also cheaper.

This separate receiver can be the one of the transceiver we are using, to which we have made a modification separating the RX and the TX, installing a second connector of RX behind the transceiver. This modification is usually not complex and exists for most of the more or less serious SSB equipment. There are some stations that prefer not to make this modification and install other transceiver that use it only as a receiver, removing the microphone and blocking any possibility of transmission. Finally some of us choose to install an SDR.

The only relay that separates the RX and TX must withstand all the power and to have enough insulation, so in all cases it will be the CZX-3500.

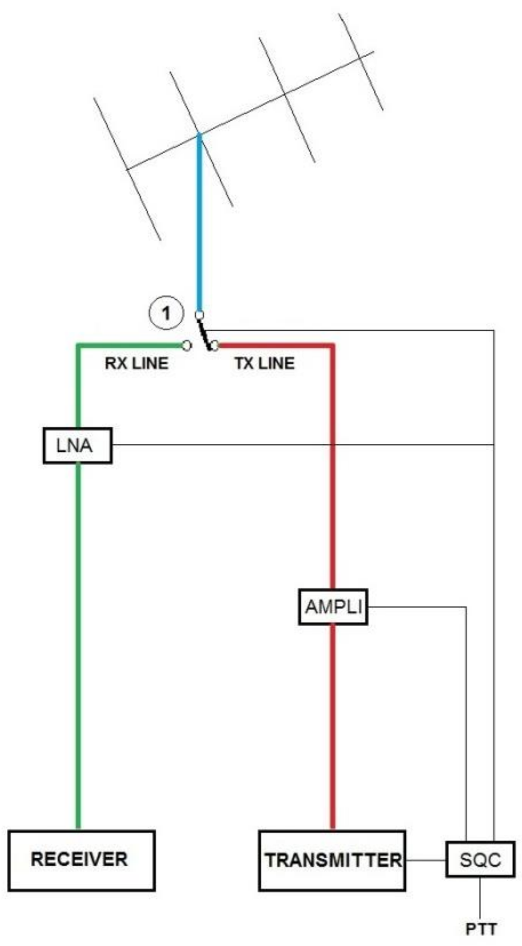


FIGURE - 4

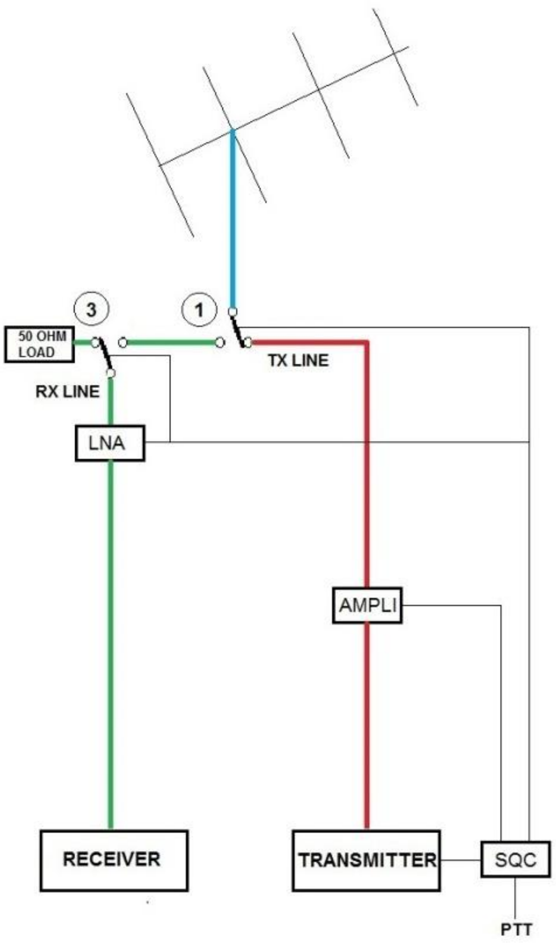


FIGURE - 5

SCHEME 4: As you can see is the simplest and most efficient option of all we have seen, eliminating relays and therefore added problems.

SCHEME 5: This is the previous option in which a second relay has been added behind the main relay of isolation of the RX and TX lines, in order to be able to work with larger powers.

SCHEME 6: This is the scheme I currently have in my EME installation, as you can see I have added a filter between the LNA and the splitter. The filter is a resonant cavity of a VHF repeater set at 145.200MHz (PHOTO 2), which avoids interference from both FM (88-108MHz) and commercial interference above 146MHz.

Behind the splitter I have installed 3 receivers, an IC-PCR1000, the TS-790E and an SDR, the FCDP+. Each classic receiver is routed to an instance of JT65 and the SDR to an instance of MAP65. My experience has shown that according to the type of noise, sometimes spatial, local or simply by temperature, sometimes behaves better one receiver than another. And when we're talking about decoding below the noise, in the end I get the decode or not. Some may criticize me, but I do not change this structure because of the great satisfactions it has given me.

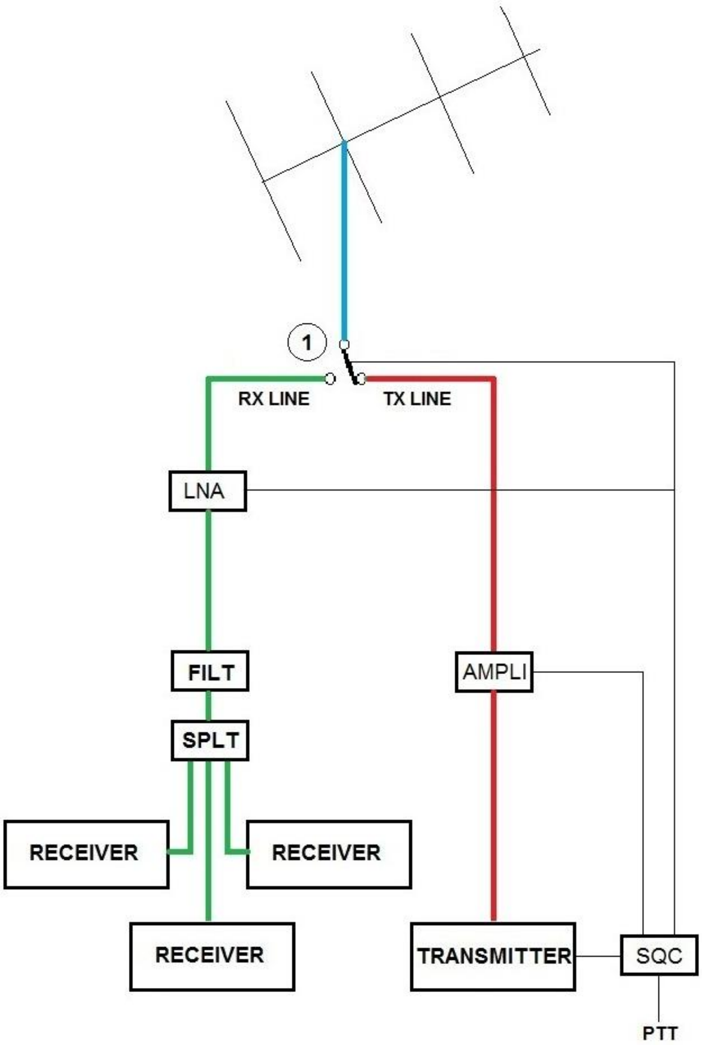


FIGURE - 6

11.3.- <u>XPOL SYSTEM</u>

I did not want to miss the opportunity to show the connection diagrams, in case some fortunate could install antennas of double polarity, well-known like XPOL. In the case of spatial communications, it gives a lot of satisfaction, by eliminating the fading produced by the Faraday Effect and not having to wait to get a contact.

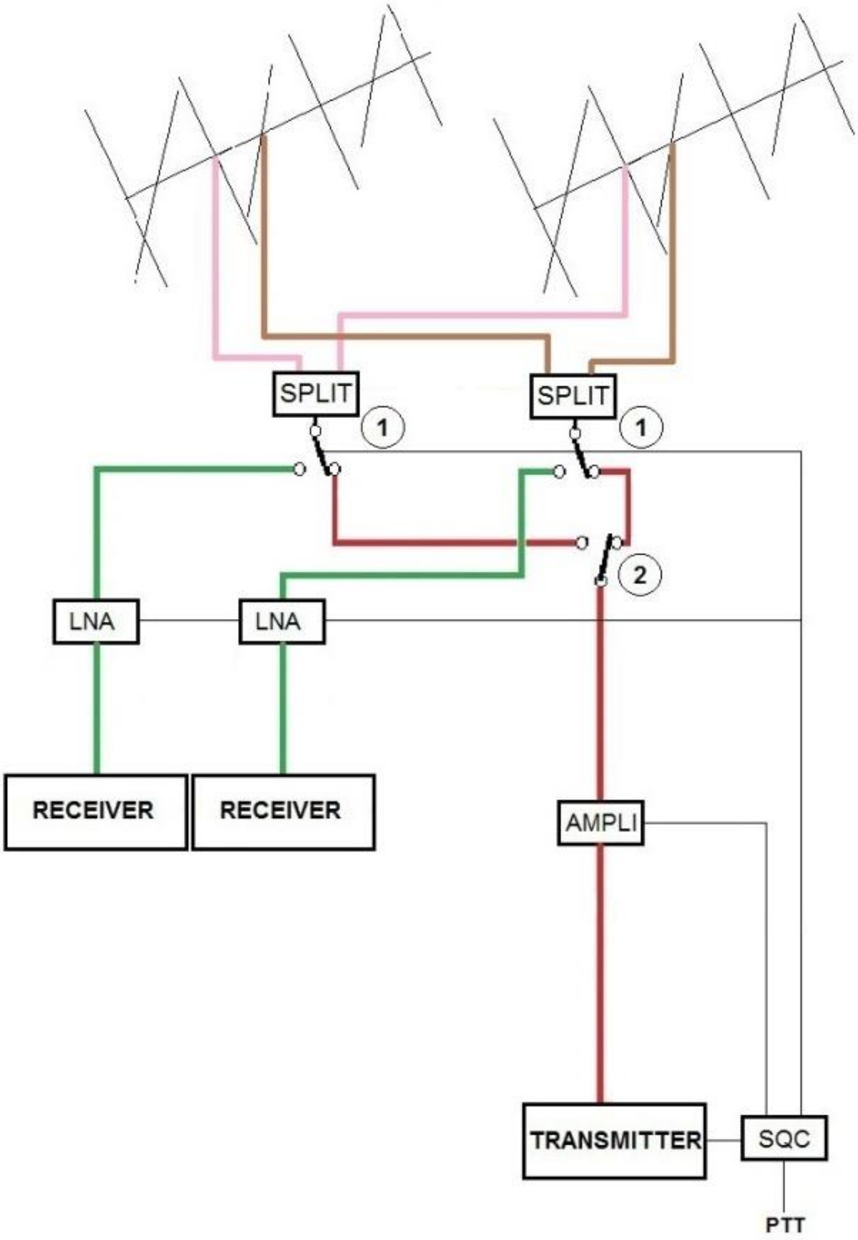


FIGURE - 9

<u>SCHEME 9</u>: The most effective assembly of a XPOLs system is with two simultaneous receivers in phase, type IQ +, which allows the MAP65 instance to receive any live polarization, even knowing with what actual degrees the signals are coming to our antennas. This is the latest technology available today, for RX in an EME station.

If we do not have an IQ +, we could install two normal receivers. I know of a station that has installed two units of the PCDP+, so we will receive both polarities simultaneously, but the program will not inform us of the angle at which we receive the signal.

As you can see in the diagram everything is complicated, I have represented two antennas to see the need for two power splitters, one for each polarity.

Each power splitter has a high isolation relay type CZX3500 to separate the RX and TX lines.

Each RX line goes to an LNA, which must be identical LNAs and great gain, since the IQ + needs at its input about 25dB for a correct operation. The TX line goes to a high power and low isolation type CX-600 relay, which selects the polarity with which it is intended to transmit, which does not always coincide with what is received (in EME, nothing is easy). Some EME station has replaced this last relay by a phasing system that allows to transmit with circular polarization, as advantage Faraday will not affect us and the loss of 3dB with the stations of linear polarity can be compensated with power of the AMPLI.

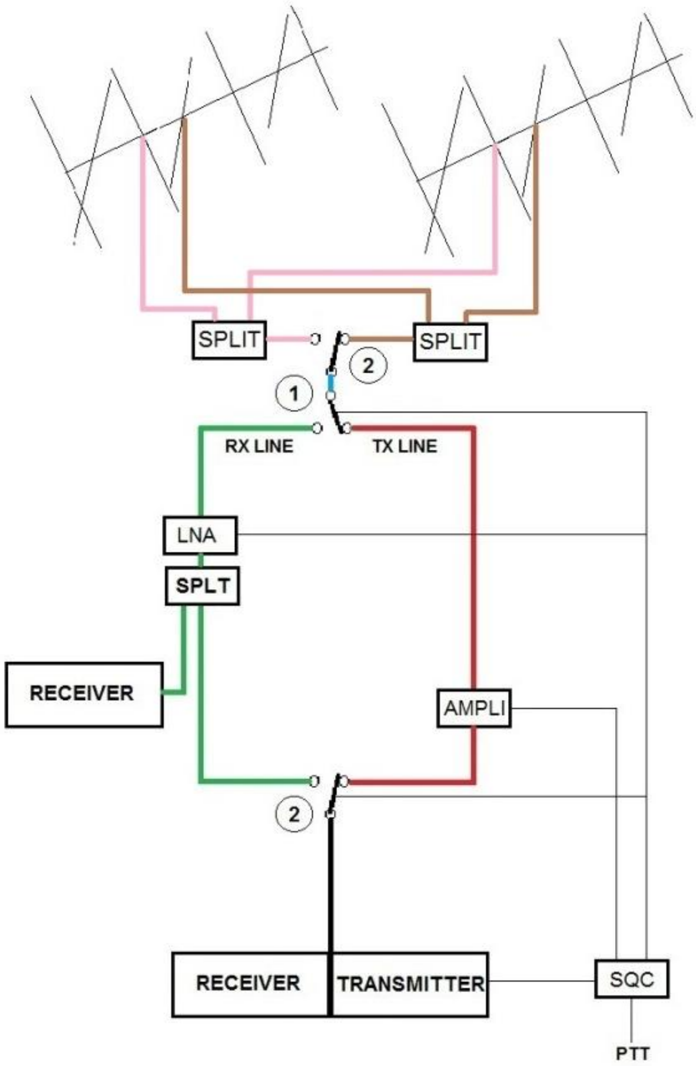


FIGURE - 7

<u>SCHEME 7</u>: In case we cannot have an IQ + receiver, we can install one high isolation relay and one LNAs, then we can also enjoy the double polarity but not simultaneously. We can receive a period with one polarity and the next with the opposite, this way let us know in which we get the best signal, this will do with relay 2, which will be high power and low insulation type CX-600. Likewise, using this relay, we will choose the transmission polarity that suits us.

At the output of this relay we will install a high isolation relay, type CZX-3500 to separate the RX and TX lines, so we will use our station as we have seen in diagrams 1, 2, 3 and 3A.

<u>SCHEME 8</u>: This schematic is a variant of the above scheme, in which we use an only power splitter and one more power relay. We will not have any additional advantage or disadvantage. We will choose one of the options according our necessity.

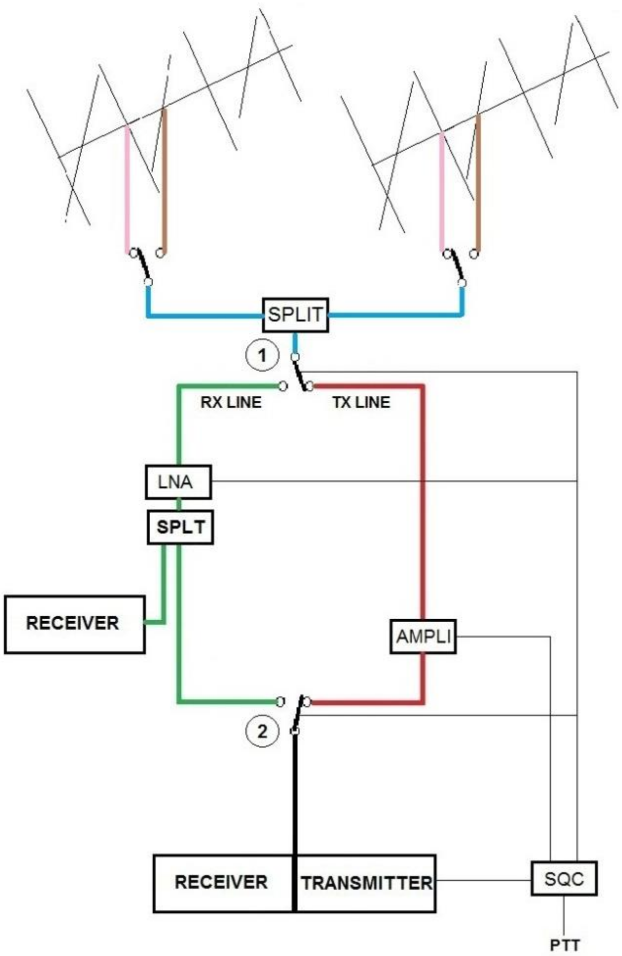


FIGURE - 8

In this case, the relay is installed as close as possible to the excited ones of each polarity, in the own boom of each antenna, by means a relay of high power and low insulation type CX-600. By means of this relay we will choose in both antennas the polarity that interests us and we route the signal to a single splitter, from here we will be able to choose any scheme of the 1 to 6 that we have discussed previously.

I tried to make the schemes as simple as possible, with colors and few additions, so that you can choose the most interesting for your installation.

It is my wish to have been able to fulfill the objectives that I marked at the beginning of the article and that those who have in mind to install an EME station at 144MHz someday feel the Moon a little closer.

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