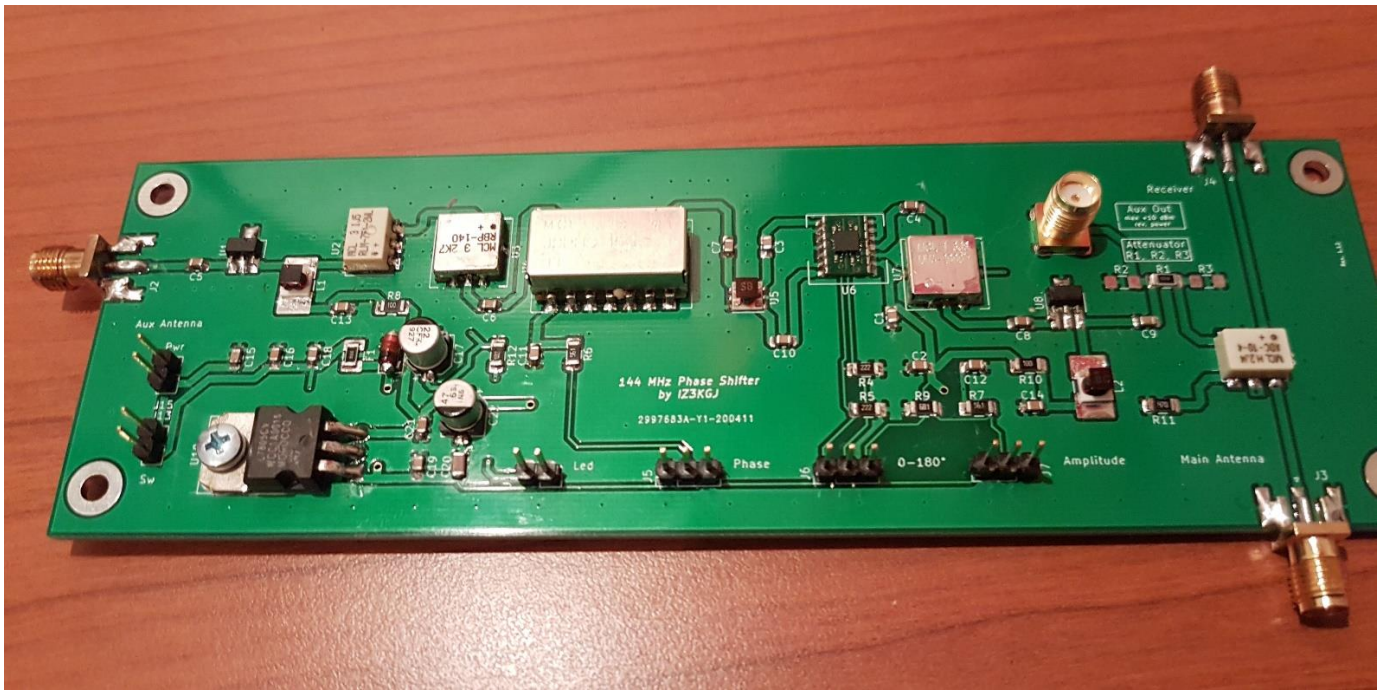


Phase Shifter per i 144 MHz

(monoband, also adaptable to **50 MHz** / 1.8-2.5 MHz / 430 MHz)

(144 MHz Noise Killer, 2 Meter QRM Eliminator, VHF X-Phase, or whatever you want to call this thing! 😉)

As I know, this is the only circuit on the market capable of operations in 144 MHz. Band which noise is increasing day by day…

The operating principles of the Phase Shifter are simple and well known to all: on a receiving system afflicted by interfering signals (noise or other signals that you want to delete such beacons, spurious and even stronger nearby stations!) is injected the same noise (signal) out of phase by 180°. The result is the full (theoretically) suppression of the same. An auxiliary antenna with high directivity able to receive only the interference is mandatory. The best results were given by antennas with the same polarization of the main system and if the noise source is strong or close to the station (lower number of reflections).

Two meters is my favorite band. I like EME, MS as well terrestrial traffic as tropo, etc. My system consists of 4 times 19 elements antenna with a gain of >22.5 dBi. This is followed by a very high dynamic LNA with cavity input, a 3-cells elliptical filter, a step variable attenuator and a transverter. All homebrewed (even if the transverter was just a kit, but it received some mods from me, HI).

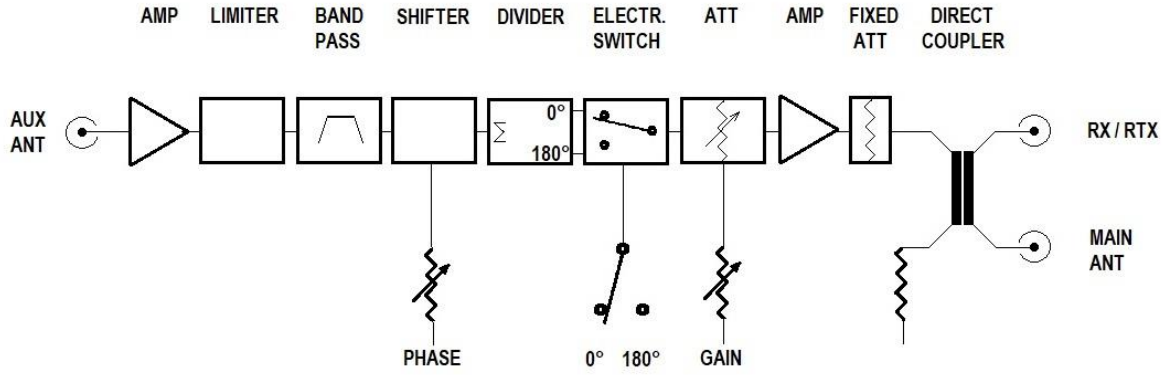
The whole reception chain has been optimized for the best noise floor and dynamic (ability to manage simultaneously very weak and very strong nearby signals).

This work comes from my need to suppress a strong noise (a sort of white one) at 500 meters from home because my reception was completely blocked in its direction (it is quite difficult to work EME when your band noise is S9+10, 24/24, 7/7, isn't it??).

Design criteria:

- **Absolute preservation of the qualitative characteristics of the main system**
- **No loss of receiver sensitivity**
- **High dynamic characteristics, in line with the rest of the rx chain**
- **Second antenna can be used for separate or simultaneous reception with the main system**
- **No insertion loss**
- **Comfortable operations and quick results**

My **solution** :



<u>What this circuit reveals and amplifies, as in all "noise killers", is injected into the receive chain. It is therefore very important to not introduce any distortion or internally generated intermodulation products because they would inevitably be sent to the receiver.</u>

OPERATION:

All the main components come from Minicircuits. Who knows is rear of the high professional level of their products.

The signal, arriving from the auxiliary antenna (which picks up only the interference), enters in a **low noise** high dynamic **amplifier** (IP3 abt. +43 dBm).

To protect the following stages, a **limiter** is then inserted (auxiliary antenna could be very close to the main antenna used with high transmission power).

A **band pass filter** follows. The shifter circuit is intrinsically "broadband". This, for our needs, is never good. It is therefore necessary to filter out all the possible interferences sources (FM broadcasting i.e.) that could enter directly into our receiver!!

The **phase shifter** stage is the real heart of the circuit. This device is simply a gem and allows you to modify with a single knob the phase of the incoming signal of 240°, keeping the output signal stable in amplitude. From an operational point of view, this is fundamental as complicated actions are not necessary with the classic three knobs (classic noise killer circuit) that interact, among other things, tragically one each other! Here you **just adjust the amplitude knob, then the phase knob and that's it! This is a great feature and absolutely necessary on the point of view of the speed while running QSOs**.

After that, a **divider** stage produces two fixed signals: one in phase and the other out of phase exactly 180°. This stage allows the coverage of the part that goes from 240° to 359° in order to operate in all possible conditions. This is followed by a fine **electronic switch,** used to select one of the two outputs mentioned above, maintaining at the meantime the characteristic 50 ohm impedance of the circuit.

Then comes a **variable** pin diode **attenuator** with a range of 40 dB. With a potentiometer on the front panel, you can inject the interfering signal to the exact level required to produce the wanted cancelation.

We then find a **second amplifier** with the same characteristics of the first: low noise and high dynamics.

For the maximum flexibility I then added a **fixed attenuator**. This is 0 dB by default (no attenuation) but it can be useful to balance the output according to the main system gain (main / auxiliary antenna gain, directional coupler with different characteristics than the on-board one).

The mixing phase with the main receiving line is reached through a **directional coupler**.

The advantages of this choice are several:

- Almost zero insertion loss of the main line
- Capacitive coupling. No direct physical connection
- Output load of the phase shifter amplifier directly on the termination and therefore perfectly matched
- The rx main line maintains the previous conditions of adaptation
- A separate directional coupler is possible via J1 according to the characteristics of the station. (to be applied directly behind the transceiver)
- When the phase shifter is off, it becomes invisible to the main rx line. No interaction, no relays to switches

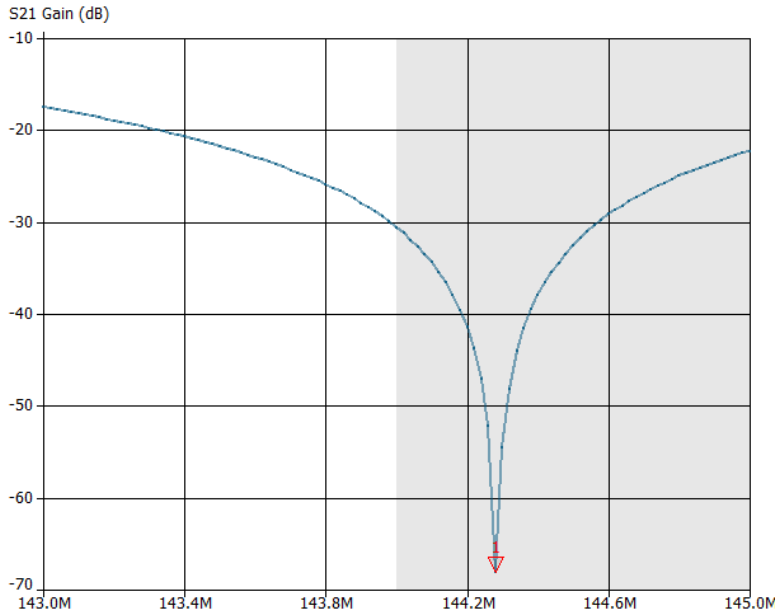
- Exceptional separation between main line and shifter line
- No reirradiation of noise from the shifter to the main antenna thanks to the directivity of the coupler

MEASUREMENTS:

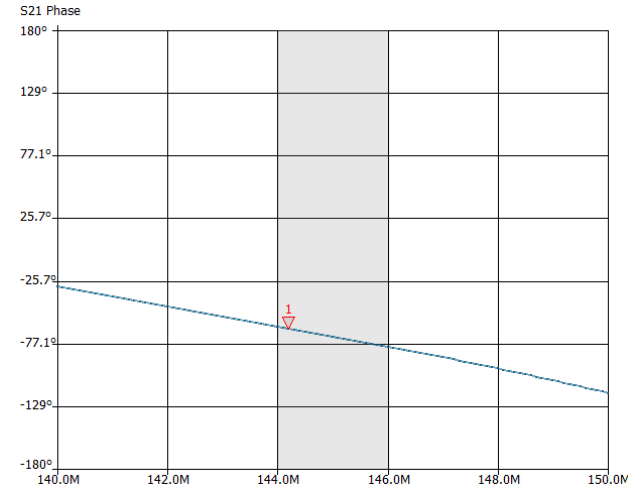
On bench conditions we measured an attenuation of about 70 dB.

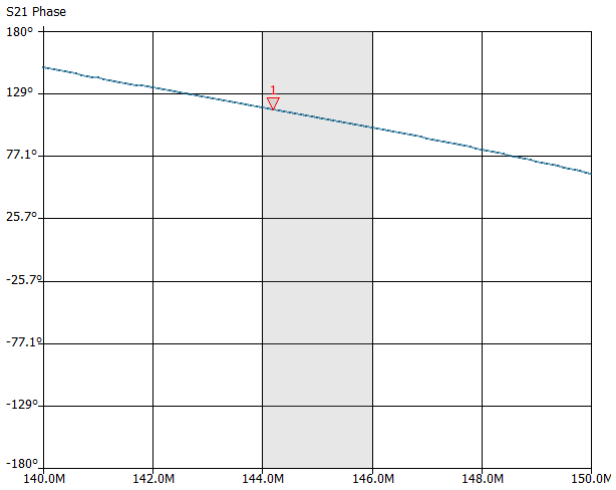
I think that, similar levels “on-air” are difficult to reach as micrometric adjustments of the potentiometers are requested. Values between -20 and -40 dB are easily reachable "on the field". These levels are certainly “well enough”. The stability of the output phase and the level, with repeatable measurements over the time, were confirmed also during the use.

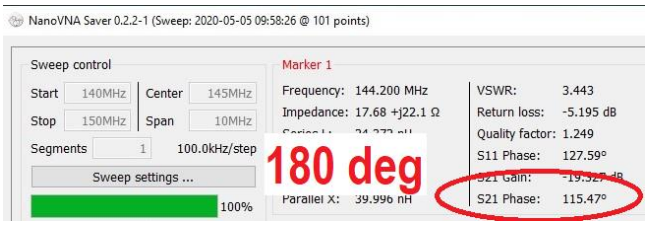
Same signal applied to J2 (ANT AUX input) and J3 (MAIN ANTENNA input). Measured on J4 (To the RECEIVER)



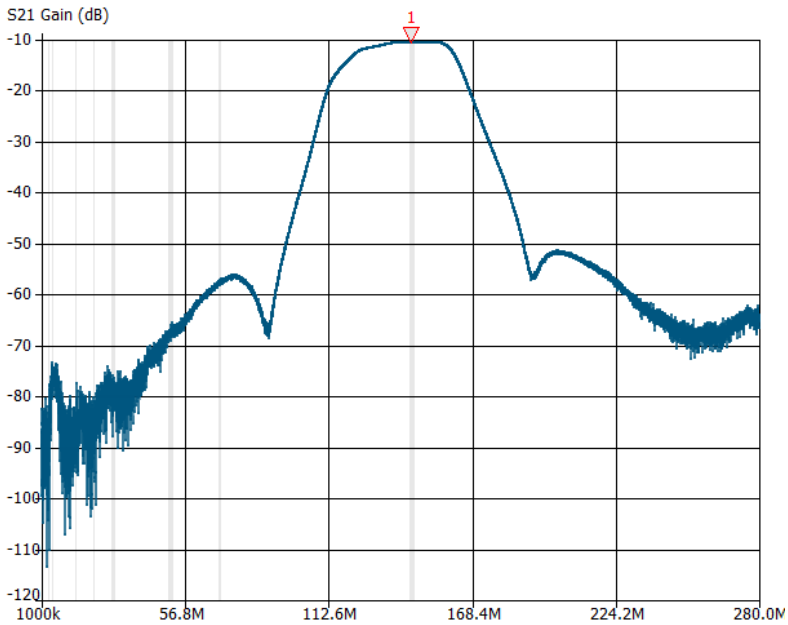
Phase variation S21, switch 0-180 ° @ 144.2 MHz (example):







Bandwidth from 1 to 280 MHz (Marker at 144.2 MHz):



Instruments: Tektronix 495p, tracking, reflectometer bridge, NanoVna, HP 8656b, Tektronix 465

FEATURES:

Power supply	12 V ÷ 13.8 V (max. +14.0 V) stabilized
Current	<350 mA
Amplification range	> -10 dB ÷ < +30 dB (adjustable)
Phase rotation	240 ° +180 ° (max. 420°)
Gain variation based on phase rotation	± 0.3 dB
Main line insertion loss	0.8 dB with within-contained coupler, <0.2 dB with external coupler
I / O 50 Ω	J1: auxiliary output (optional) impedance 50 Ω
	J2: auxiliary antenna input
	J3: main antenna input
	J4: output to receiver

NOTE:

The circuit has been designed for operating only on systems with a separate reception line. Anyway, with an external directional coupler and suitable attenuator, it can also be used on transmission lines up to 10 Watt or more. Beyond this power it is convenient to use a relay to increase the separation (controlled by the radio or by the sequencer).

73, Stefano Marinello IZ3KGJ

iz3kgj@yahoo.it

CONNECTIONS: