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High Performance Software Controlled Radio Preselector

Tunable Band Pass Filter bank for HF Bands

(revision v2.0.12.10)

The SCR Preselector is featured in the May/June 2008 issue of QEX magazine.

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Features

There are no active switching devices in the signal path therefore it does not contribute to IMD (Intermodulation Distortion) itself.

- Tunable Band Pass Filter bank for HF bands.
- Covering 1.8 to 30 MHz in five bands.
- Digital tuning.
- Very high IP3. Suitable for Software Define Radios.
- Removes the strong signals radiated back to the antenna from SDR quadrature mixers.
- Exceptional stop-band attenuation centered on the adjacent amateur band.
- Large toroid cores T-106 size.
- Porcelain, High Q tuning capacitors.
- Embedded 100dB Broadcast Band Rejection filter.
- PTT feature enables by-pass the preselector allowing connecting in-line to a 100Watts transceiver.
- Complete front-end for your projects.
- Locked to a VFO can perform tracking tuning function.
- Can be controlled from an external digital system.
- Standalone or controlled from a PC through a graphical user interface (GUI).
- Full speed USB v2.0 compliant. Plug and Play.
- The software program on PC runs under Windows 2000, XP, Vista (32 bits) and Windows 7 (32 bits) OS. (Windows 2K users need to update Framework from Windows Update site)
- Dimension: 220mmx165mmx52mm(8.661x6.496x2.047in).

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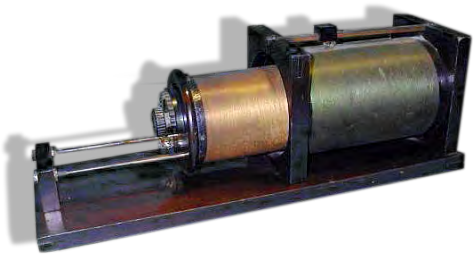
The Preselector an old concept to modern challenges.

The Preselector is an almost forgotten concept as old as the Radio.
It is a unique tool, used for decades in radio design to contribute to selectivity and protect the early stages of the receiver.
With the advent of the new SDR technology and the huge increase of the activity on HF bands, this old concept gives solution to modern



Preselector for wireless. About 1914

The SCR-Preselector — A First Line of Defence

The SCR Preselector is the first stage connected to the antenna system providing narrowband selectivity. It does not includes active devices like transistors and diodes in the signal path, it does not contribute IMD, Intermodulation Distortion, itself and provides safety under the electronic warfare conditions, which exist nowadays on the crowded bands.
On SDR applications, where high linearity is needed its passive design keeps a very high IP3 factor thanks to its passive circuitry design in the signal path that uses large toroid cores and reliable magnetic shielded mechanical low RF resistance relays for tuning and telecom grade relays for switching functions, instead of nonlinear semiconductors that cause distortion and exhibit low tolerance against strong signals and statics.
High Q Porcelain tuning capacitors ensuring that performance does not degrade.
In Direct sampling SDR applications, the SCR Preselector gives protection against false images since the bank filters have an enhanced stop band. These filter has the ability to provide a very sharp transition from pass band to stop band attenuating signals outside band that could mix with the sampling frequency of its Analog to Digital Data Converter.
In addition, the SDR-Preselector incorporates gas discharge tubes to surge suppressor on each antenna input providing safety against static spikes. Furthermore, the unused antenna input is short-circuited to ground.

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The BCB Filter

The SCR Preselector incorporates a Broadcast Band (BCB) high pass filter.
This is a so-called “brick-wall filter,” which attenuates spurious signals from strong AM broadcast stations. Such signals are well known enemies of shortwave receivers.
The BCB filter added to the Band Pass Filters bank stretches its effects into the medium Broadcast Band with a very sharp slope attenuating signals as much as 120dB.
The filter has minimum attenuation of all signals at 1.8 MHz and higher frequencies, including the CW portion of the 160 m band.

Band Pass Filters. The core of the SCR Preselector

A five overlapped bands tunable Band Pass Filter bank shapes the core of the SCR Preselector.

There are no active switching devices in the signal path therefore it does not contribute to IMD (Intermodulation Distortion) itself.

On SDR applications, where high linearity is needed, its passive design keeps a high IP3 factor due that there are no active switching devices in the signal path therefore it does not contribute to IMD (Intermodulation Distortion) itself.

Large toroid cores, reliable magnetic shielded low RF resistance relays for tuning and telecom grade relays for switching functions are used.

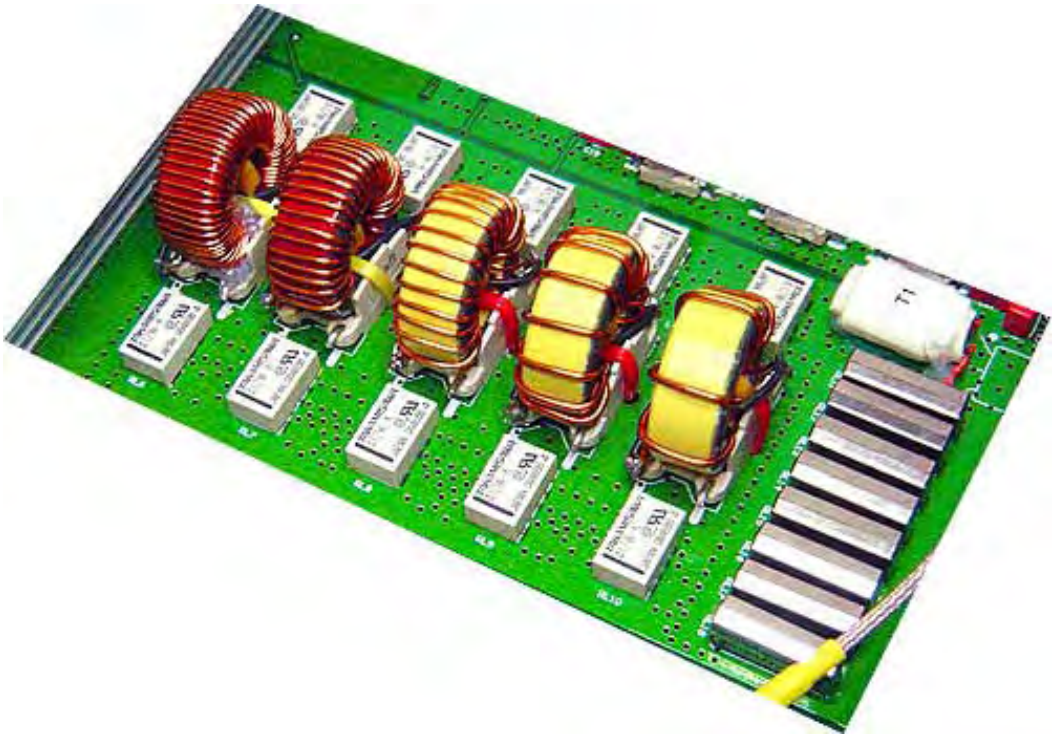
Each filter is a classic serial tuned LC circuit, offering narrow bandwidth with little attenuation, providing an exceptional stop-band attenuation centered on the adjacent amateur band.

Coils are wound on T-106 size toroidal cores to avoid saturation in front of large signals.

Porcelain high Q capacitors ensure that its high IP3 factor performance does not degrade.
A network of 1 pF, 2 pF, 4 pF, 8 pF, 16 pF, 32 pF, 64 pF, 128 pF emulates the variable capacitor needed to tune the series resonant circuit, .

The control program performs this task by adding or subtracting capacitor values in binary fashion, in direct relationship with the tuning knob. Increments or decrements are done in steps of 1, 2, 5 or 10 units, user selectable. Available bands are:

- A) 1.7 MHz to 3 MHz. Stop-Band attenuation centered on 3.700MHz.
- B) 3 MHz to 5 MHz. Stop-Band attenuation centered on 7.100MHz.
- C) 5 MHz to 9 MHz. Stop-Band attenuation centered on 14.00MHz.
- D) 9 MHz to 20 MHz. Stop-Band attenuation centered on 43.00MHz.
- E) 15 MHz to 30 MHz. Stop-Band attenuation centered on 51.00MHz.



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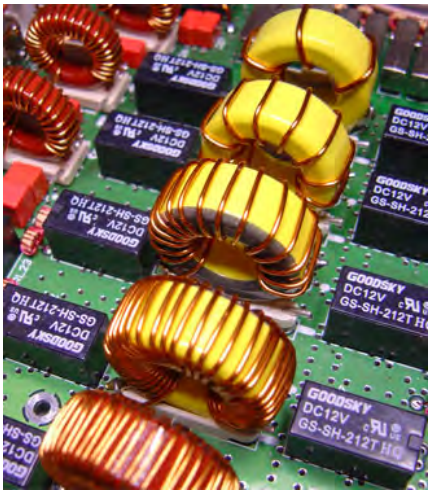

Why large toroid cores for 200 Watts transmitters are used in the SCR Preselector?

The reason is to keep a high IP3 or in other words achieve tolerance to large signals.
That is important on 160m, 80 and 40m bands, especially in multioperator contest or DXpedition situations where large antennas are located in close proximity to the operating receiver.
In SDR applications the high linearity of quadrature mixers are preserved.
On the other hand, large cores reduce the magnetic flux inside the cores and offer high Q (efficiency) values, more than 300, providing narrowband selectivity which improves signal to noise ratio and prevents unwanted signals from reaching the circuits on the receiver side where 2nd order IMD is most often created because the generalized use of nonlinear semiconductors for switching functions.

The joy of operating

Because the dynamic environment in which you operate demands that you exercise the most effective command possible, the SCR Preselector is designed with the most important functions immediately available for adjustment so control knobs and pushbuttons are reduced to minimum possible.

Two main Multi-Function buttons for effortless operation

Two knobs/push-buttons together a dynamic LCD display is located on the front panel for total operation.
The large flywheel-tuning knob with finger hole is the main tuning control.
Pushing it lives the Tuning Function and enters the Function Menu.
On its left hand, a second knob features Band and Function selection.
A combined operation of rotating and pushing knobs lets shift and select all available functions.

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Superb Dynamic LCD Display
A high brightness LCD display of three lines, sixteen characters contains the block diagram of functions its status and dynamic tune value.
Included in the display are Band Select, Tune value, Tune Step, Memory and Antenna selection,

Functions

■ Tuning
The central frequency of preselector is tuned by means of the large flywheel knob labeled “Tune”.
The value, expressed in pF, is show dynamically on the LCD display.
Arrows on display indicates if the frequency shifts up or down. Pushing the tuning knob enters the Functions Menu.
Tuning of the SCR Preselector is simple, just turn the Tune knob and peak the background noise or signal strength.

■ Tuning Steps
Tuning can be incremented or decremented in steps of 1/2/5 and 10 units selecting “Step” in Functions menu.

■ Five Bands selection plus By-Pass
Pushing the smaller knob on the front panel labelled “Band” enters the Band menu. Rotating left or right and pushing again the wanted band is selected. This knob also executes “Select” when the Functions menu is explored.

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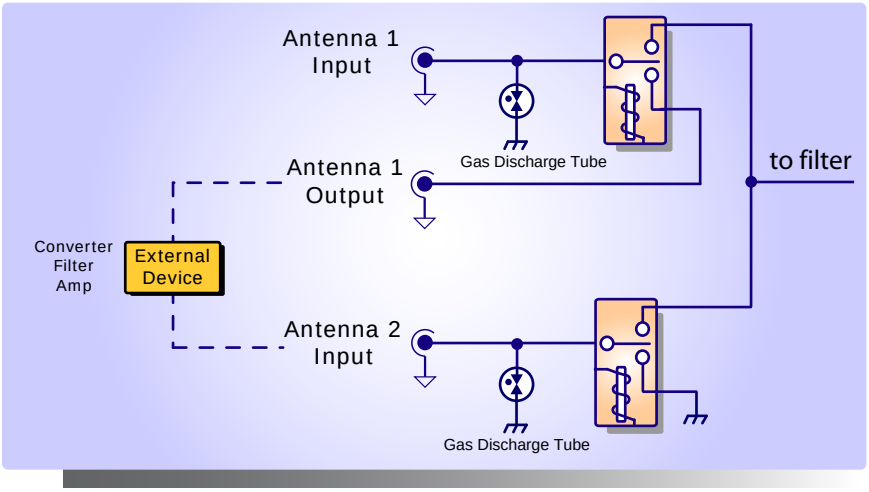
■ Two Antenna Ports plus In Line External Device insertion.

The "ANT1" and "ANT2" BNC antenna sockets on the rear panel allow connection of two different 50Ω antennas, which can be selected through the function menu “ANT”. A separate BNC socket “ANT1 OUT” allows inserting in the preselector line, an external device such as Converter, Amplifier or special Filter, between it and “ANT2” socket.
Gas discharge tubes to surge suppressor are connected to ANT1 and ANT2.



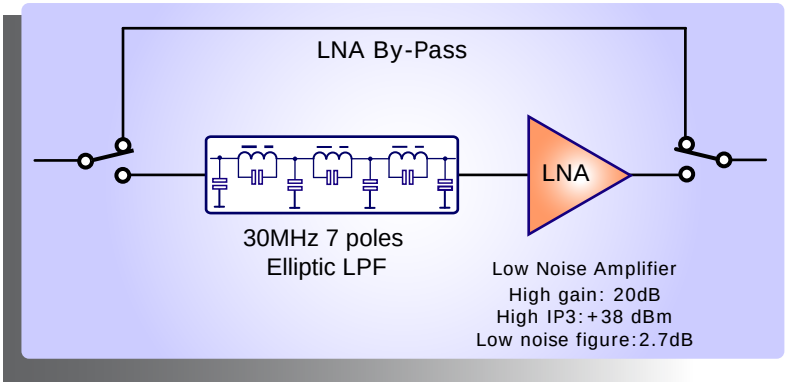
Simplify Diagam of antenna port inputs

■ Four-Level Input RF Attenuator

To adjust the preselector gain, or for comfortable listening to extremely strong local signals, the Attenuator circuit provides 6/12/18 dB of gain reduction plus "0" by-passed. Those attenuation values match the standard calibration of S-Meters.

■ Low Noise Amplifier

The wide variations in noise and signal levels on the HF bands demands a customized approach to the preselector gain.
The SCR Preselector provides and optimized preamplifier for HF bands. If preamplification is not needed, Switching to “A -“ in the Functions menu will bypass the RF preamp stage, routing the RF energy directly to the next stage improving the 3rd-order Intercept Point accordingly.
The SCR Preselector incorporates a 30MHz Low Pass Filter limiting the bandwith of the low noise amplifier Gali74, and high dynamic range MMIC device with an average gain of 20 dB, high IP3 of +38dB and noise figure of 2.7 dB . The gain of the amplifier can be regulated by means of the input attenuator.



■ **Five Read/Write Memories Bank**

Ten memory positions are available through the Functions menu, five positions to storage and five more to recall. The working frequency and all present configurations are storage on the selected memory position.

USB Feature

At any time, the control of the SCR Preselector can be switch to PC, connecting the USB cable to the socket labelled "USB" on the rear panel, Plug and Play feature.
All available functions are replicated on the Graphic User Interface (GUI).

USB 2.0

PTT feature

In order to connect the SCR Preselector in line with a transceiver, a 3.5mm Jack connector on rear panel is provided with the purpose of connect an external PTT signal to by-pass the preselector on transmission switchover avoiding being overloaded. The PTT feature lets to drive an external antenna relay rated for the RF power used. A DIN connector provides 12V DC to drive the external relay.

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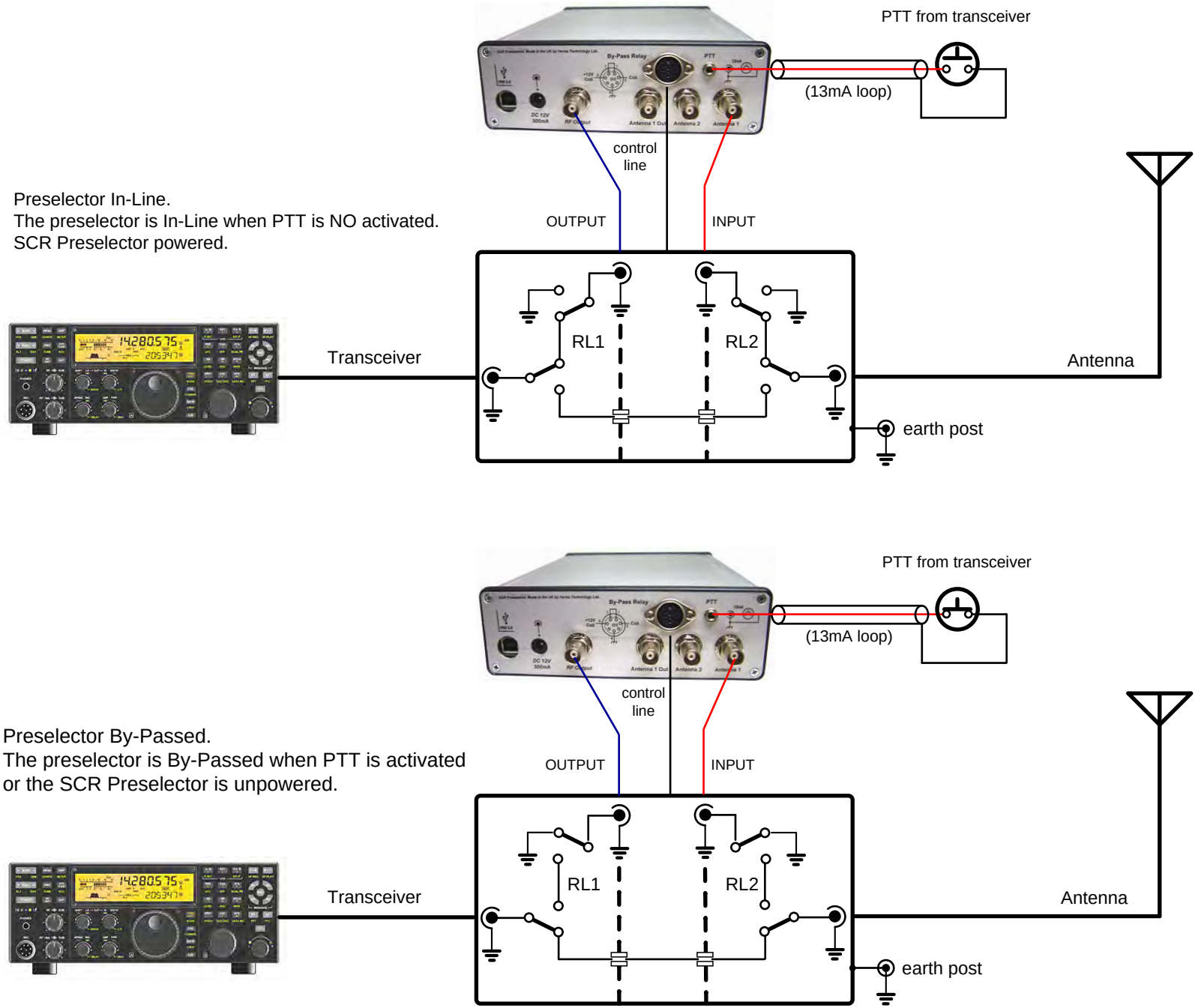
Optional antenna Input/Output By-Pass relay. Dual.

- Frequency range: DC - 60MHz
- Insertion loss: 0.2 dB @ 50 MHz
- Isolation: 60 dB @ 50 MHz
- Power rating: 150 W PEP
- Impedance: 50 Ohm
- SWR: 1.22 @ 50MHz
- Power supply: 12 Volts DC/68 mA
- Switching time:
- Set: 15mS
- Reset: 5mS
- External Dimensions: 40x37x111mm.
- Connectors: SO-239 Transceiver/Antenna; BNC IN/OUT Preselector.



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SCR Preselector. 150W PEP By-Pass antenna relay diagram

The Software Program.

The software program on the PC runs under Windows 2000, XP, Vista32 and Windows 7.
Windows 2K users need to update Framework from Windows Update site.
The user, through the GUI, commands the SCR Preselector in the same way as it does in stand-alone mode.
The program can work at the same time with any SDR software running on the PC, allowing to the user to control both simultaneously.
The SCR-Preselector software doesn't need to be installed; only the USB driver does.
The program offers to the operator the following features:
Selection of one of the five bands plus By-pass mode.
Four attenuator positions; 0dB, -6dB, -12dB, 18dB.
Preamplifier ON/OFF.
Antenna selection switch.
Tuning knob
Tuning steps ×1 ×2 ×5 ×10.
Five memories for each band. Each memory keeps the actual configurations.

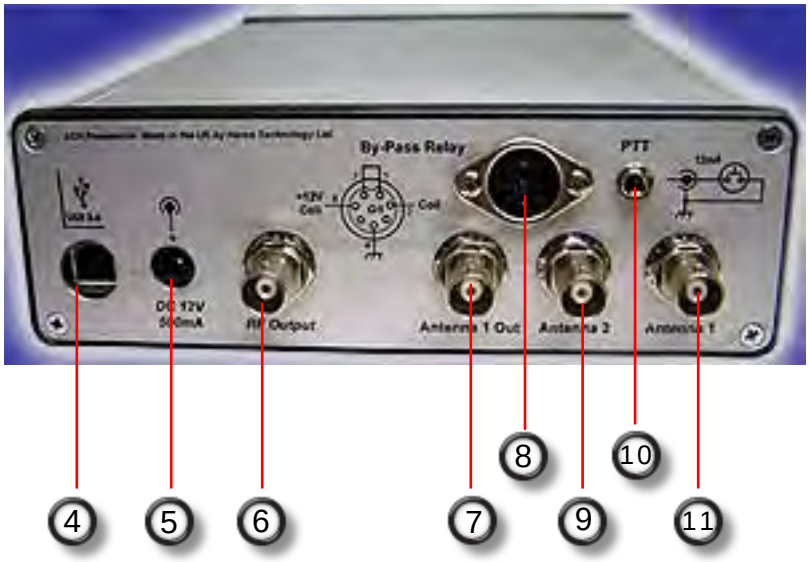
Graphic User Interface. PTT activated.

STAND-ALONE MODE

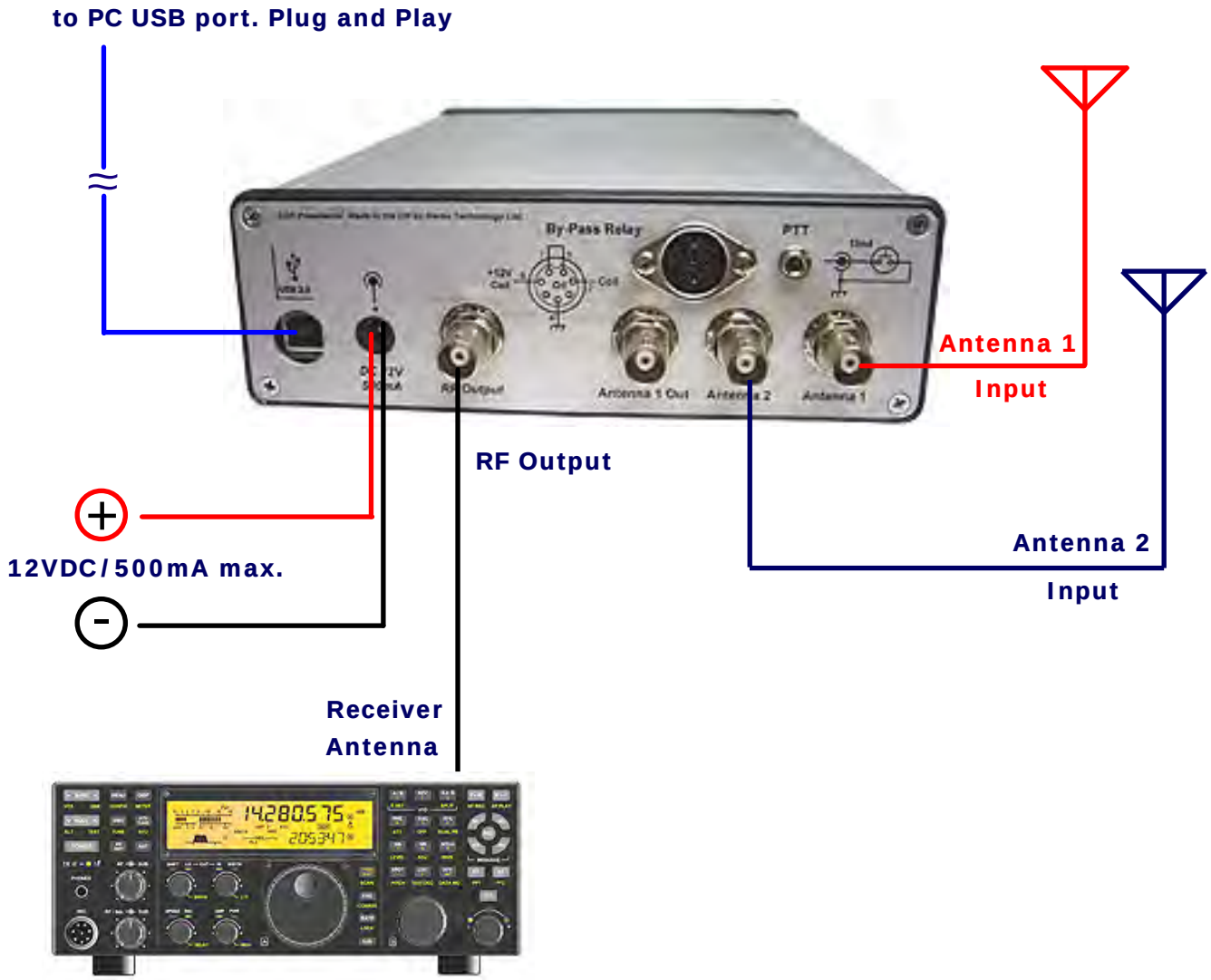
1 - Dynamic LCD Display.

2 - Band Selection knob / - Enters Band - Set Band selected.
- Set Function selected. (function mode)

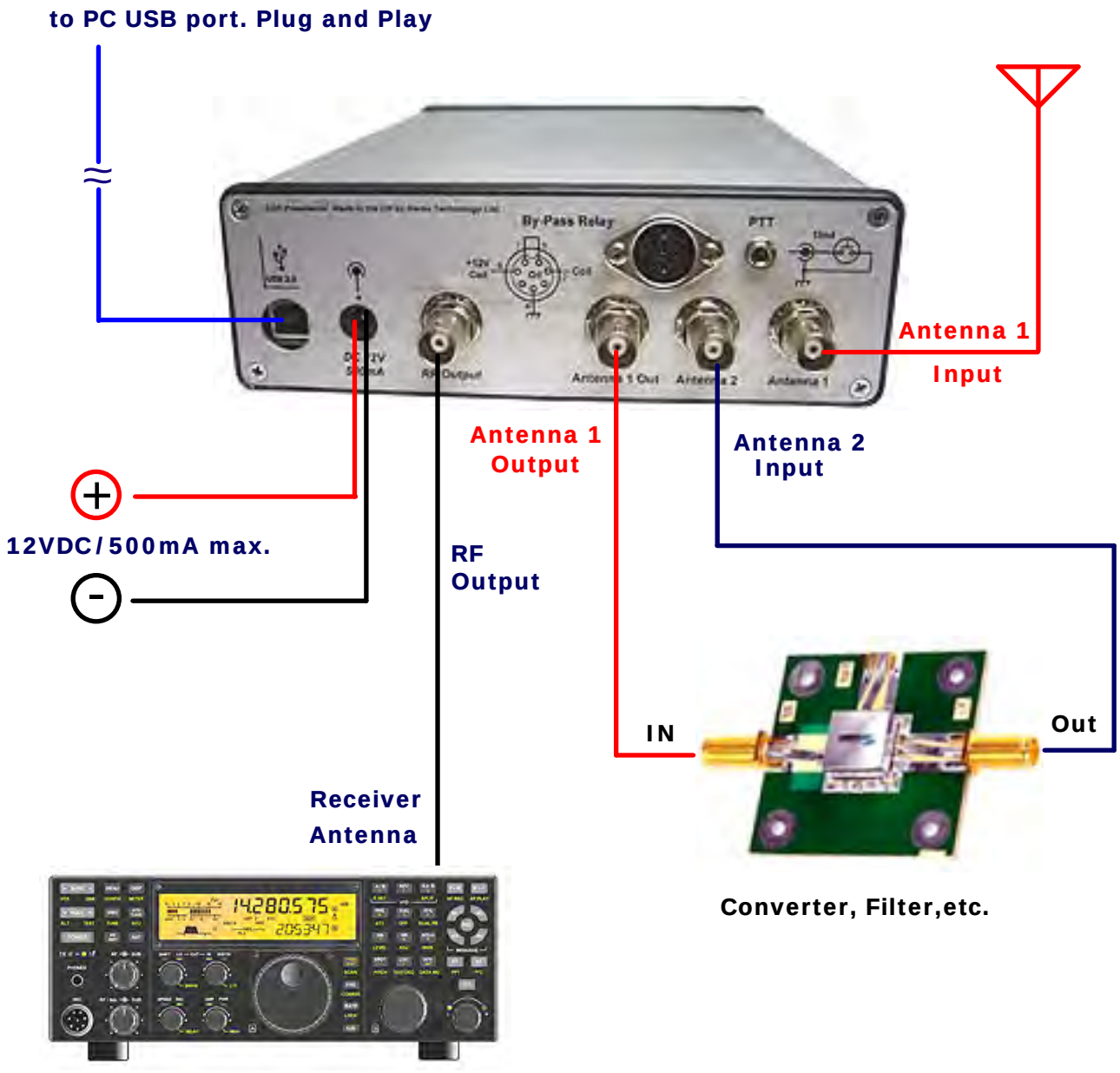
3 - Tuning knob / Enters Function mode / Confirm Memory Read or Write selection.



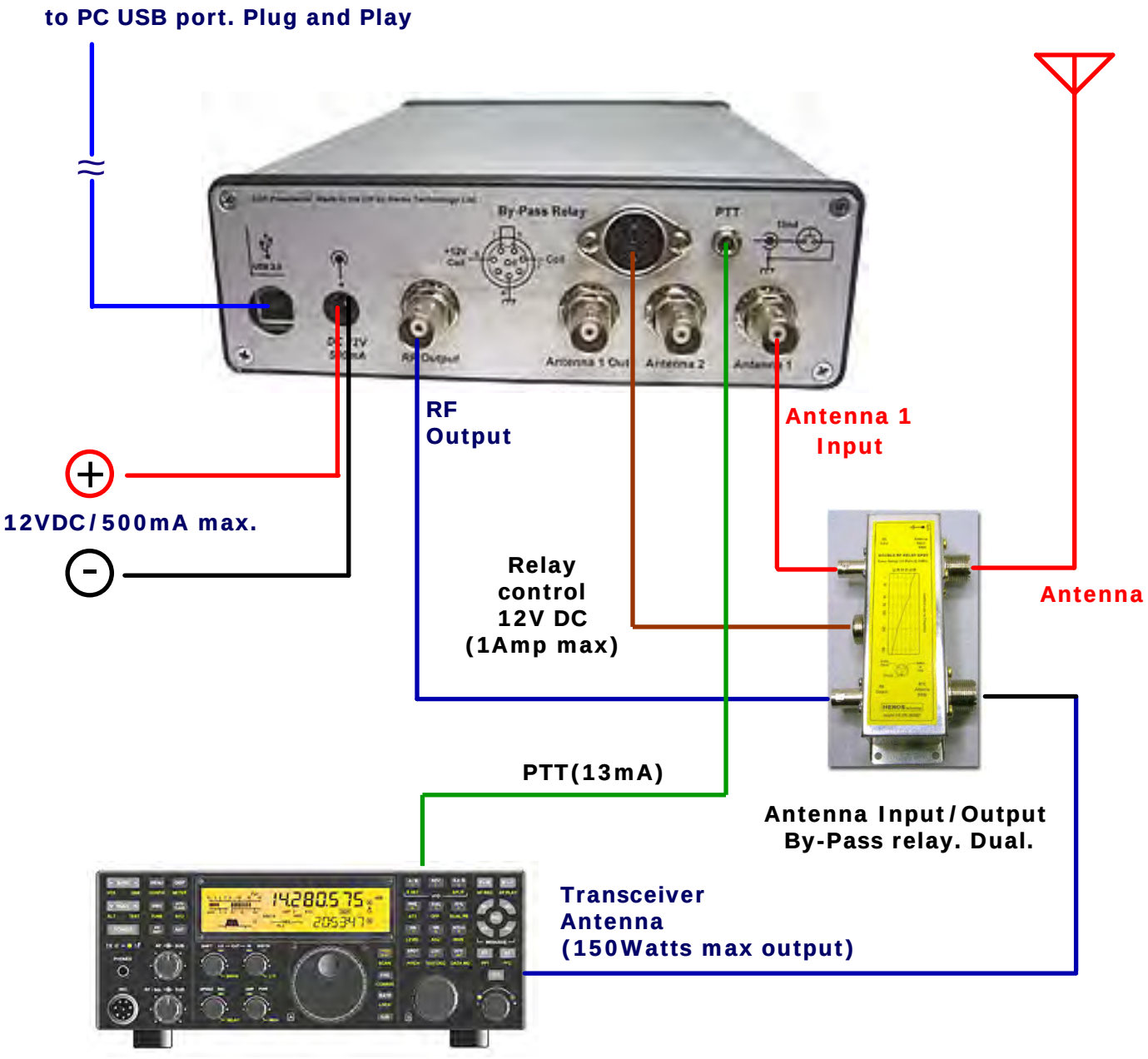
4 - USB connector. Type B.
5 - Power Jack 2.5mm. DC12V/500mA max. —— + ●
6 - BNC connector, RF output 50Ω.
7 - BNC connector, antenna 1 output 50Ω.
8 - DIN connector, Antenna Relay control, 12V DC/1Amp max.
9 - BNC connector, antenna 2 input 50Ω.
10- Jack 3.5mm, PTT switch Input.
11 - BNC connector, antenna 1 input 50Ω.



SCR Preselector connection.
In line with a receiver.



SCR Preselector connection.
In line with a receiver.



SCR Preselector connection.
In line with a Transceiver.

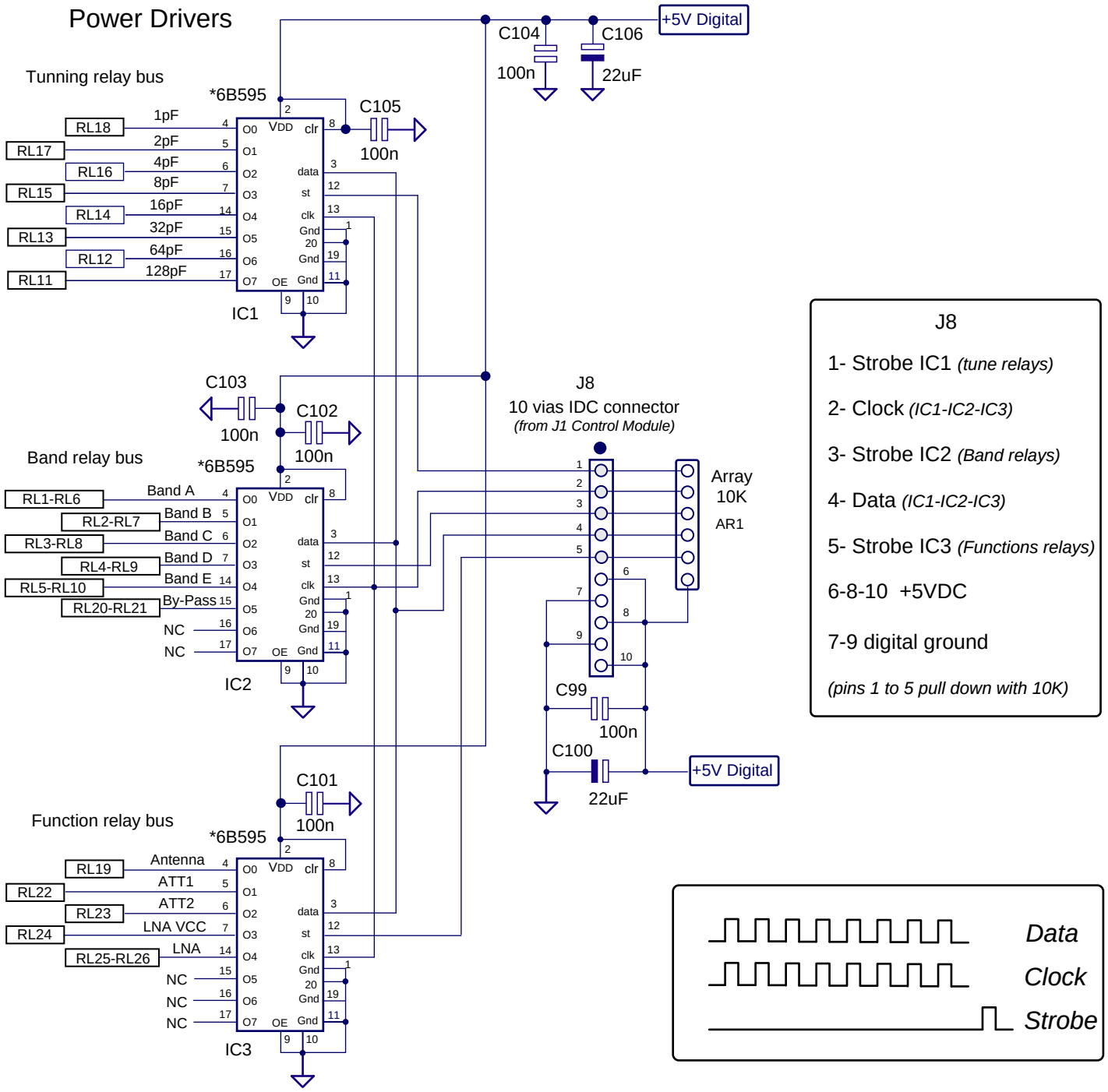
External control

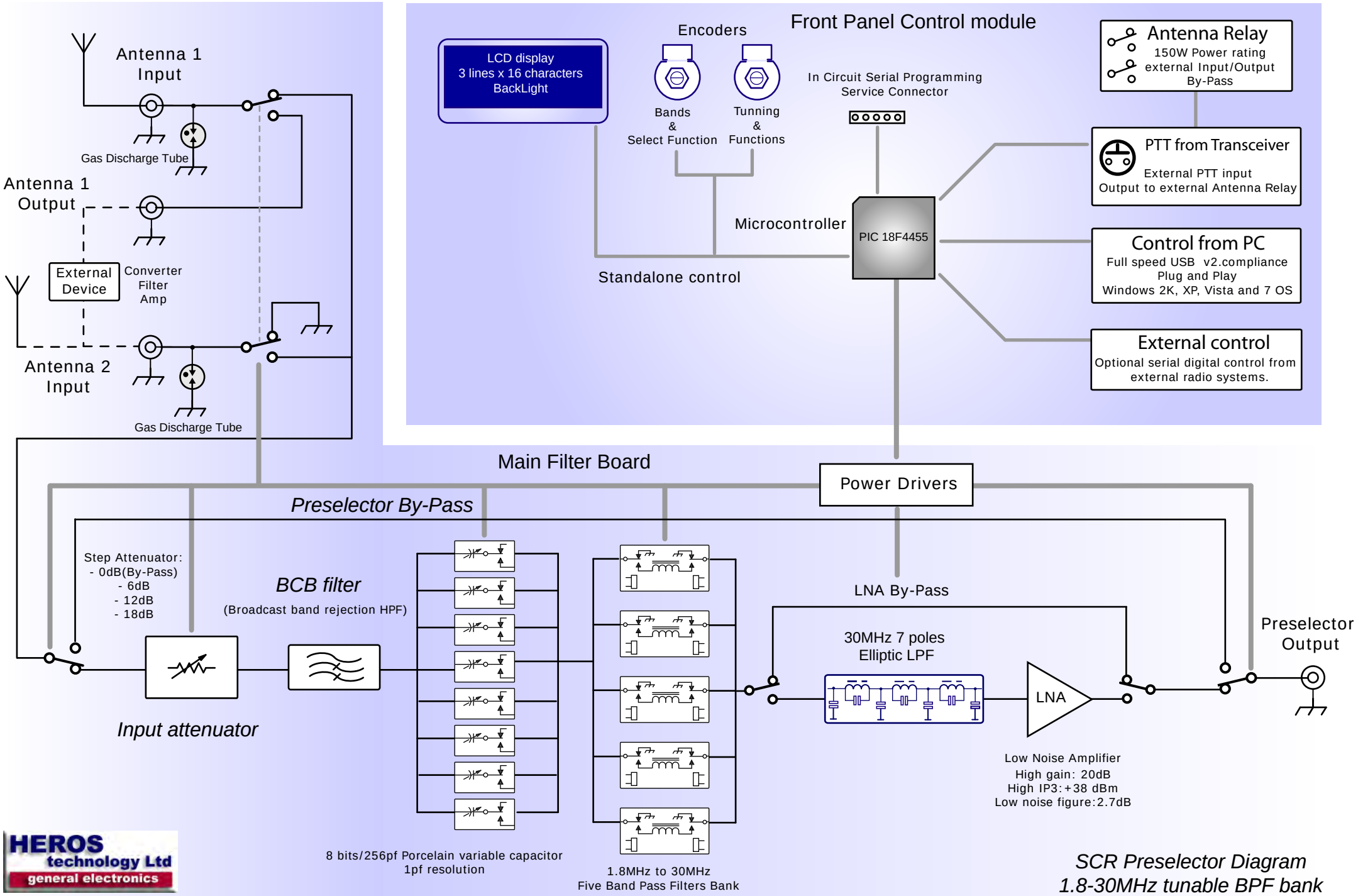
Power drivers can be commanded from any external compatible logic control, due their simple codification. The SCR Preselector incorporates three 6B595 eight bit serial power driver shift registers to interface relays on the main board with the control system.

The control signals needed, Data, Clock and Strobe are addressed to the 10 vias IDC connector J8 on the main board.

Data signals are clocked to the three ICs and each one is latched independently by means of its strobe line.

External signals are routing to IDC connector J8. 5VDC to power external circuitry are available on its pins .




Front Panel Control module
LCD display
3 lines x 16 characters
BackLight
Encoders
Bands
&
Select Function
Tunning
&
Functions
In Circuit Serial Programming
Service Connector
Antenna Relay
150W Power rating
external Input/Output
By-Pass
PTT from Transceiver
External PTT input
Output to external Antenna Relay
Microcontroller
PIC 18F4455
Standalone control
Control from PC
Full speed USB v2.compliance
Plug and Play
Windows 2K, XP, Vista and 7 OS
External control
Optional serial digital control from
external radio systems.
Antenna 1
Input
Gas Discharge Tube
Antenna 1
Output
External
Device
Converter
Filter
Amp
Antenna 2
Input
Gas Discharge Tube
Main Filter Board
Power Drivers
Preselector By-Pass
Step Attenuator:
- 0dB(By-Pass)
- 6dB
- 12dB
- 18dB
BCB filter
(Broadcast band rejection HPF)
LNA By-Pass
30MHz 7 poles
Elliptic LPF
Preselector
Output
LNA
Input attenuator
Low Noise Amplifier
High gain: 20dB
High IP3:+38 dBm
Low noise figure:2.7dB
8 bits/256pf Porcelain variable capacitor
1pf resolution
1.8MHz to 30MHz
Five Band Pass Filters Bank
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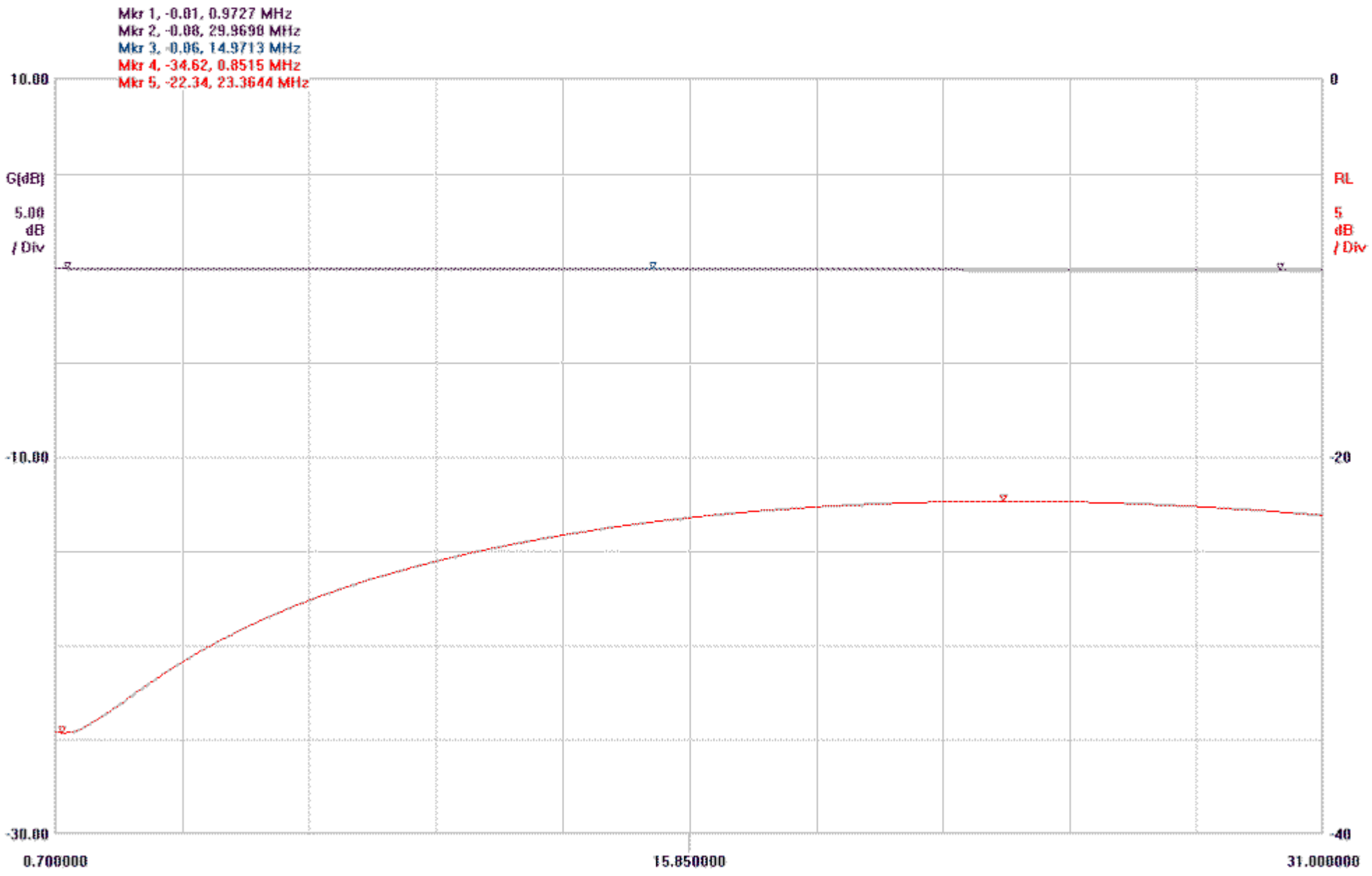
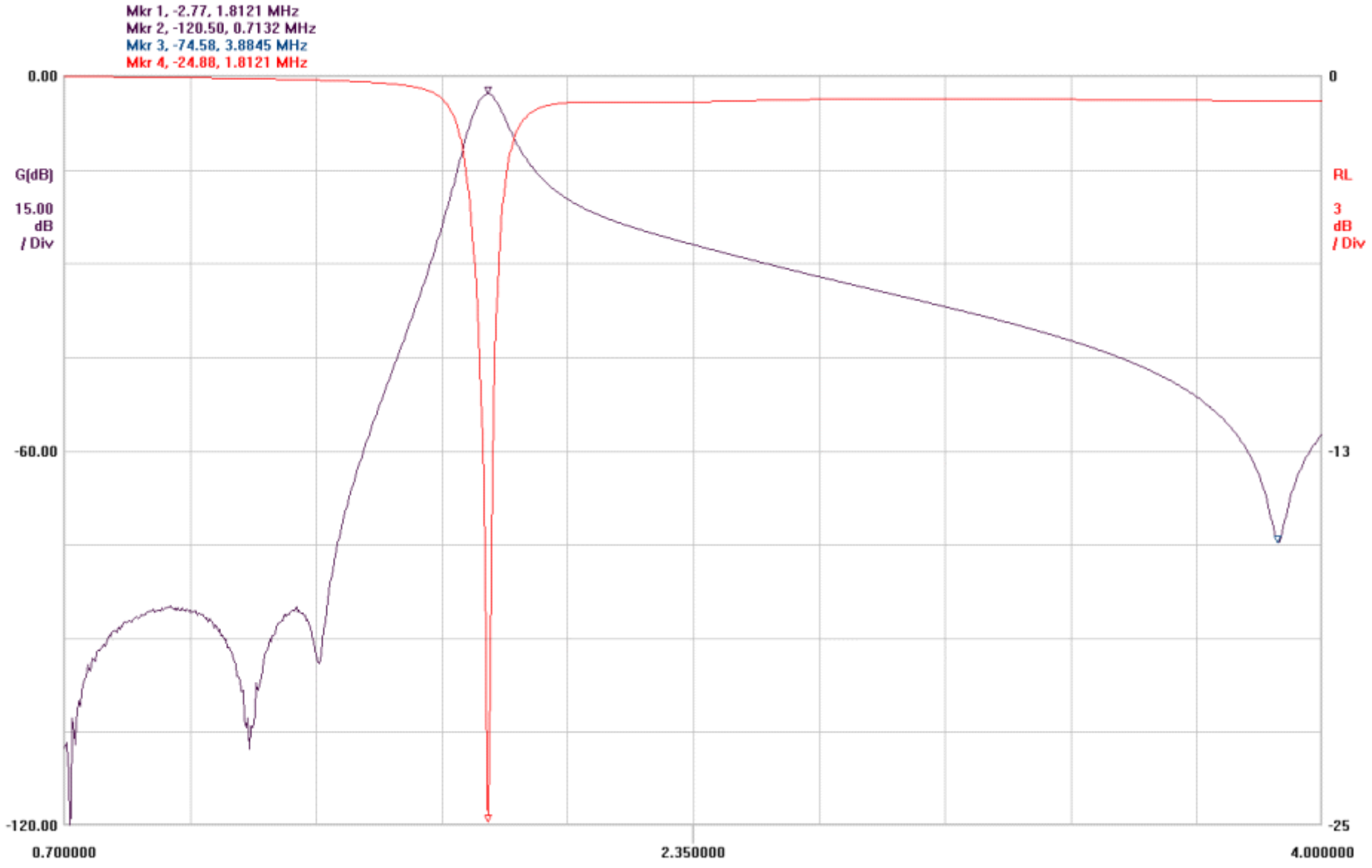
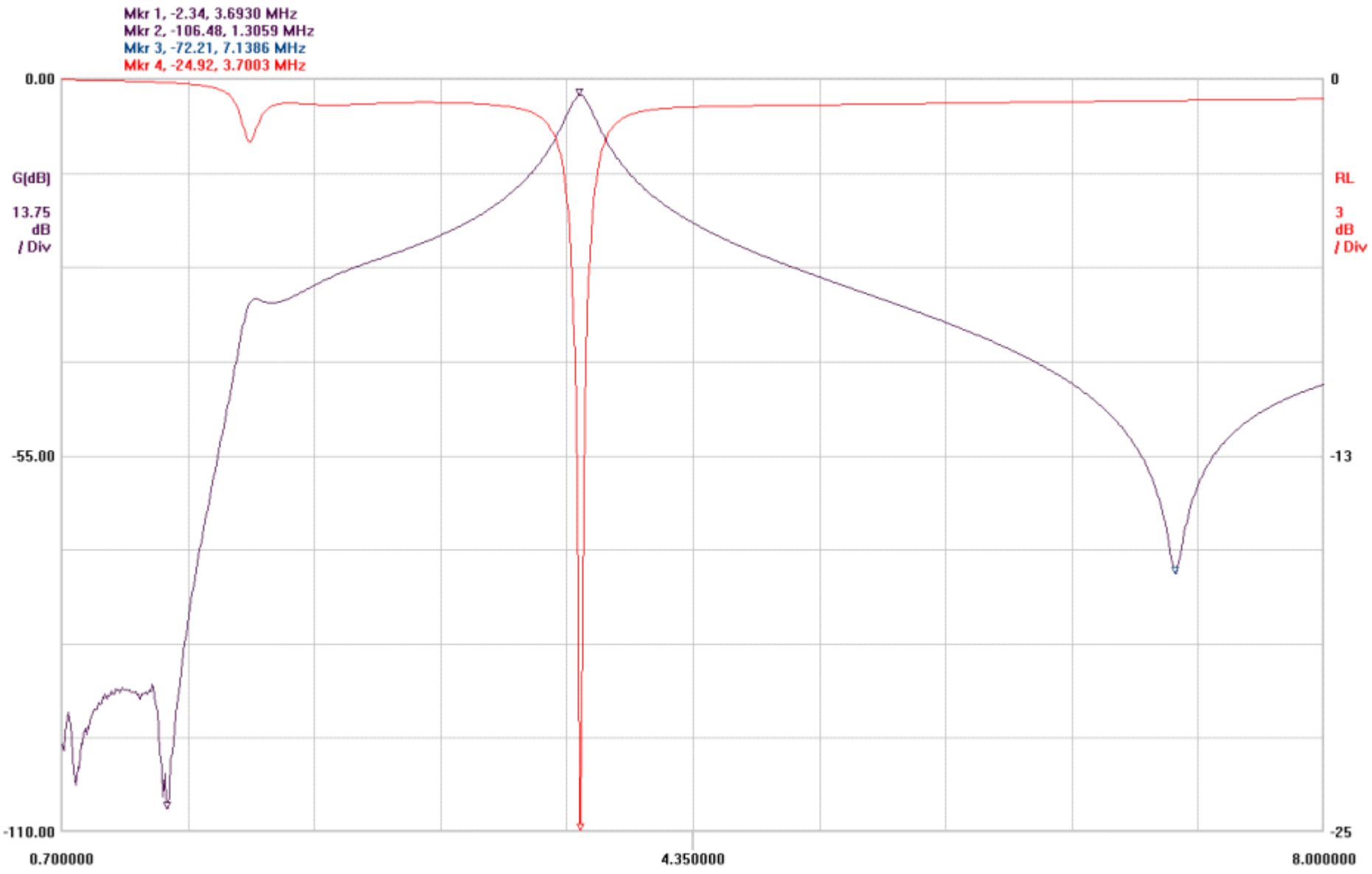
SCR Preselector Diagram
1.8-30MHz tunable BPF bank



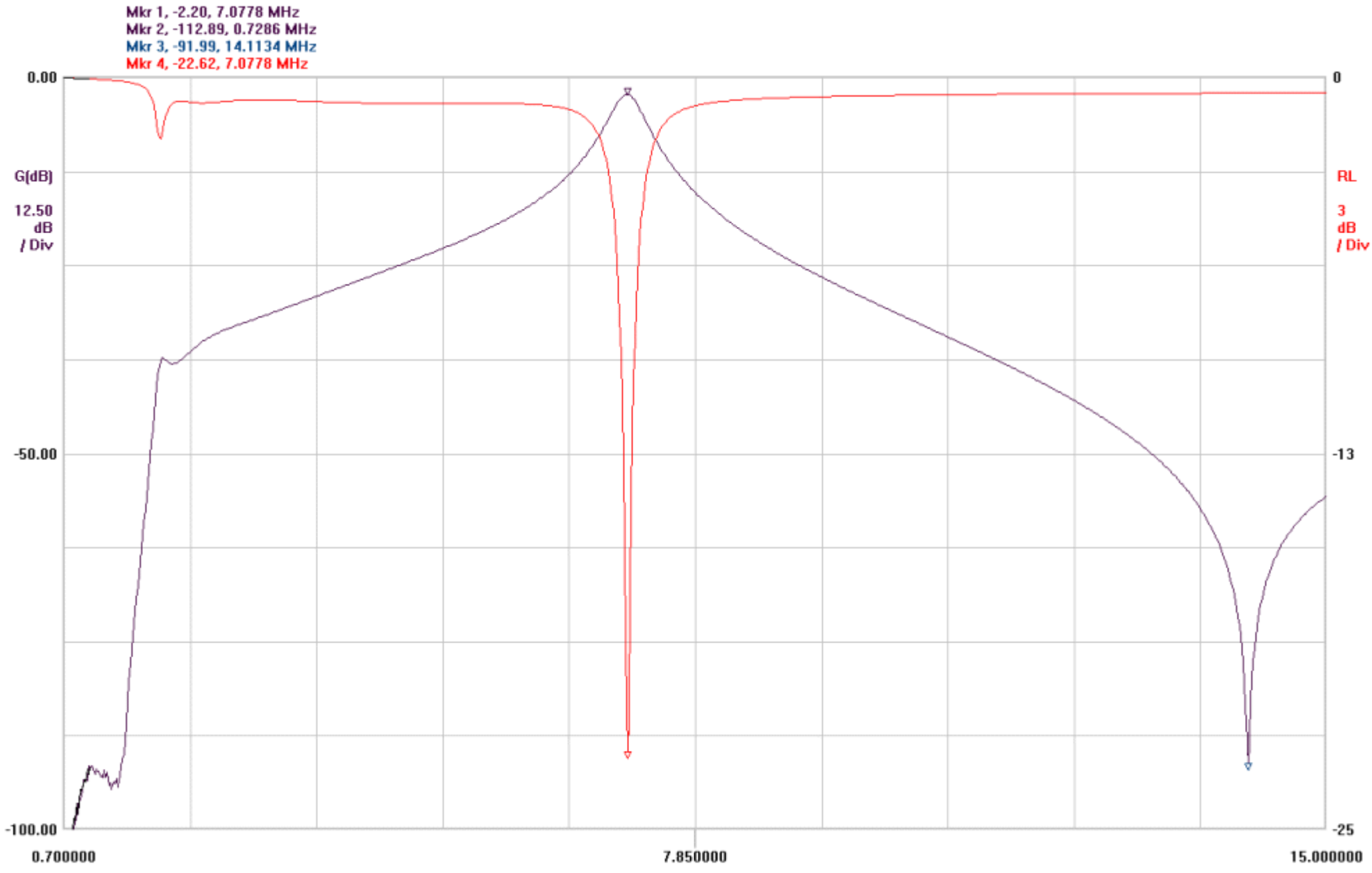
By-Pass mode. Transmission/Return Loos performance.



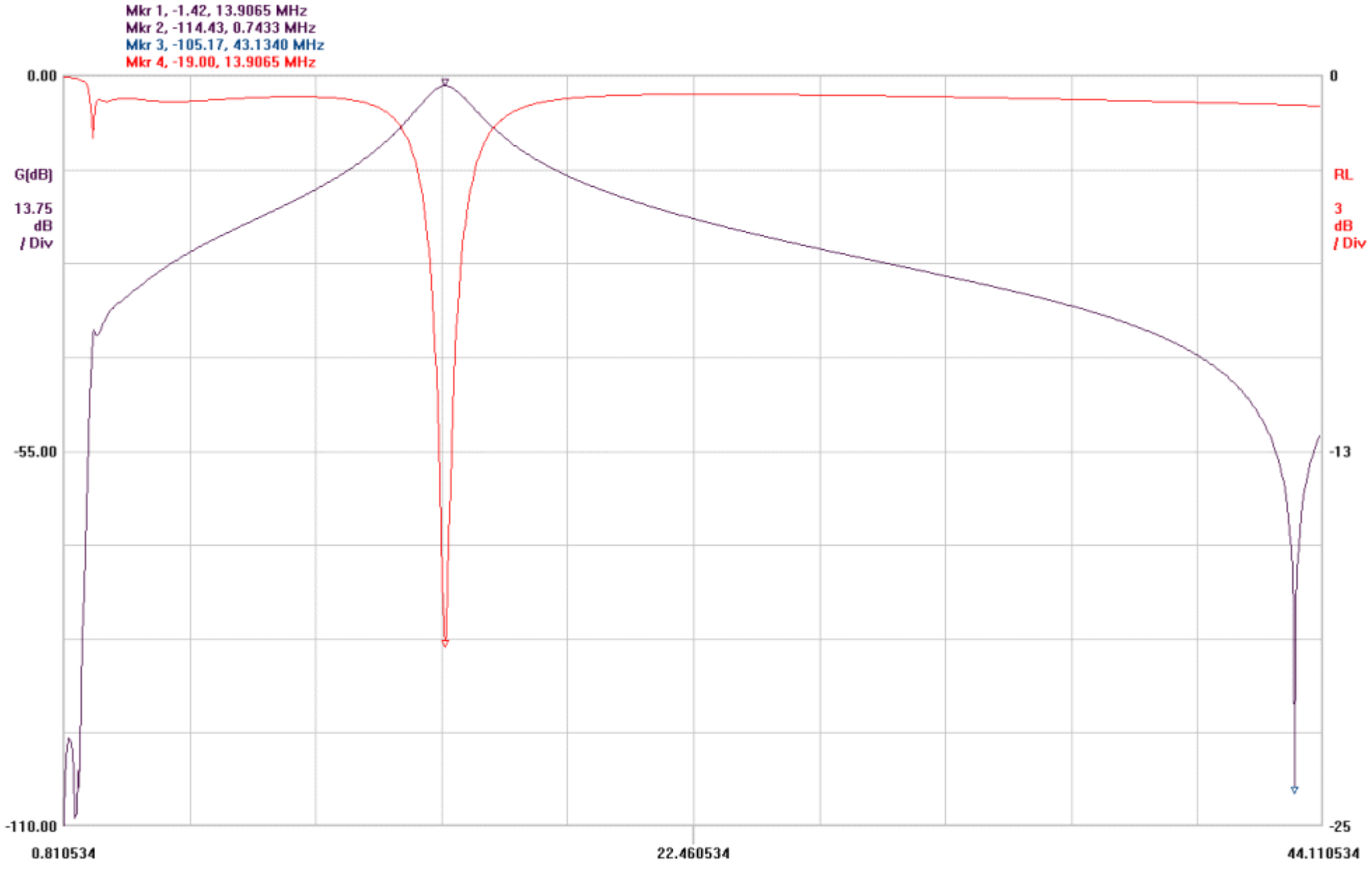
Band A Transmission/Return Loos performance. Stop-band centered on 3.800MHz



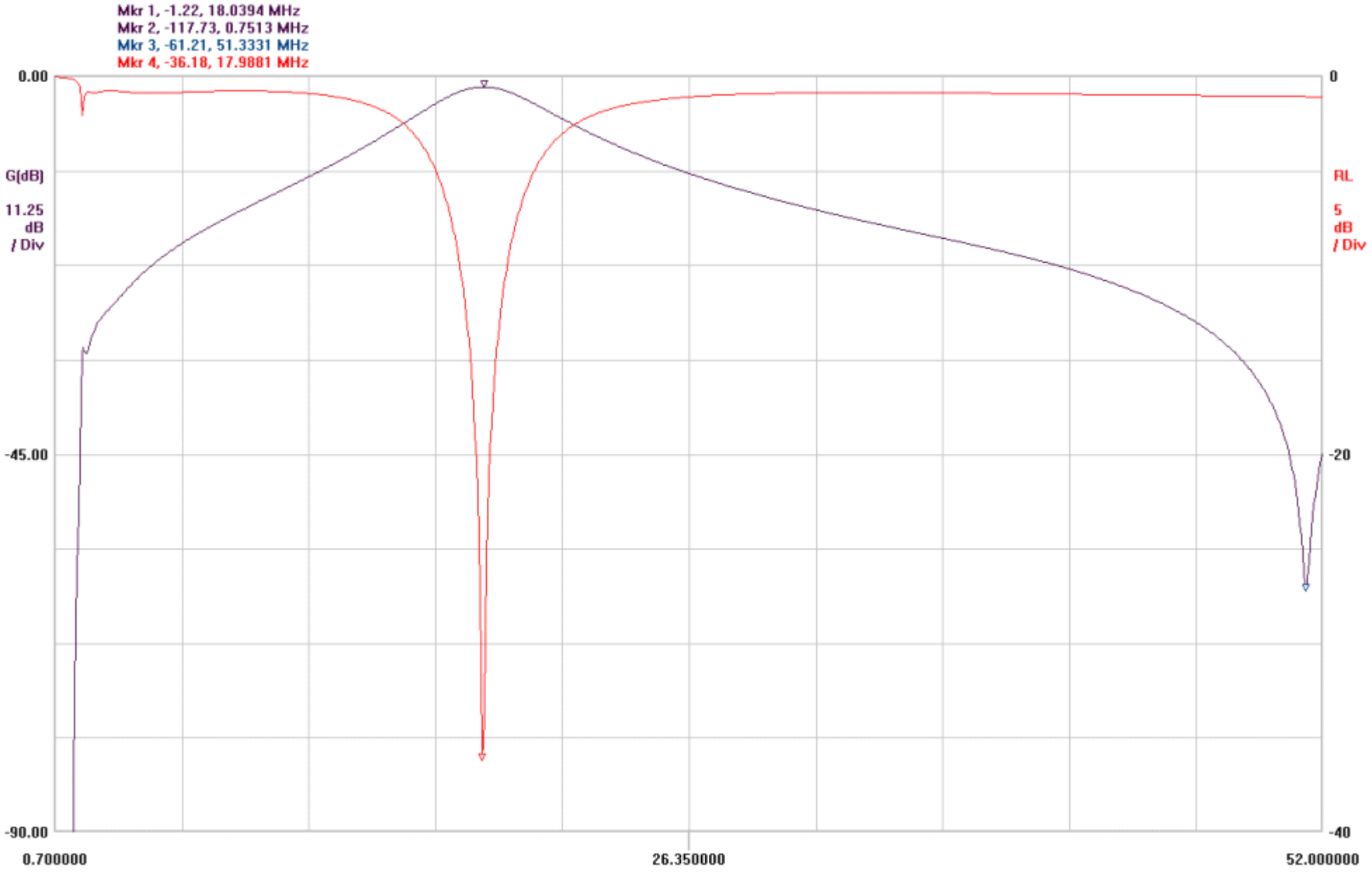
Band B Transmission/Return Loos performance. Stop-band centered on 7.100MHz



Band C Transmission/Return Loos performance. Stop-band centered on 14.10MHz



Band D Transmission/Return Loos performance. Stop-band centered on 43.00MHz



Band E Transmission/Return Loos performance. Stop-band centered on 51.00MHz

NOTES:

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