# **Model 5690 Application Note:**

## Tunable HF Notch Filter 1.5 - 30MHz using two Multi-Tune 5690 Tunable Filters

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-3 dB

 $f_2$ 

## Model 5690 Outline

- Netcom's 5690 is a tunable frequency range filter. •
- It consists of a tunable high-pass section in series to a tunable ٠ low-pass section.
- Unlike a regular tunable bandpass filter, where only the center frequency is adjustable, the 5690 Multi-Tune filter is a digitally programmable filter with adjustable passband between any f1 and f2 frequencies.
- f1 and f2 are independently tuned at any frequency, forming a ٠ filter which has a completely adjustable center frequency and bandwidth.
- More information and full specifications can be found at • https://www.netcominc.com/products/5690/
- Besides the application of using a single 5690 unit to have a very large number of f1 and f2 combinations to form a tunable frequency range filter, this model also provides the option to combine two or more 5690 units to form a tunable notch filter at the frequency range 1.5 to 30MHz.



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CONTROL

CONTROL INPUT

SERIAL BUS

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## **Block Diagram**

- This application note examines the performance of using two 5690 tunable filters to implement a single tunable notch at a given frequency fN inside the frequency range 1.5 to 30MHz.
- The first 5690 unit (MT1) is tuned to provide available passband between 1.5MHz and the cutoff frequency f2, so that the selectivity at fN is better than -20dBc relative to f2.
- The second 5690 unit (MT2) is tuned to provide available passband between f1 and 30MHz, so that the selectivity at fN is better than -20dBc relative to f1.
- The two outputs of MT1 and MT2 can either be combined again or driven to A/D converters, so that the processing of the notch filter takes place at the digital side of the receiver.
- The objective of this application note is to find the minimum percentage separation between the Notch Frequency fN and the programmable cutoff frequencies f1 and f2 of the two 5690 units, so that the selectivity at fN is better than -20dBc relative to f1 and f2.
- The following pages display the performance in several tuning instances to form notches at different fN frequencies.





## **Notch Frequency at fN = 2.5MHz**

- High-pass = 1.5MHz
- Low-pass (f2) = 2.1MHz
- fN = f2 + 19% offset
- 2. MT2 Frequency setup:
  - High-pass (f1) = 3.0MHz
  - Low-pass =30.0MHz
  - **fN = f1 16.6% offset**





## **Notch Frequency at fN = 4.0MHz**

#### 1. MT1 Frequency setup:

- High-pass = 1.5MHz
- Low-pass (f2) = 3.4MHz
- fN = f2 + 17.6% offset
- 2. MT2 Frequency setup:
  - High-pass (f1) = 4.8MHz
  - Low-pass = 30.0MHz
  - fN = f1 16.6% offset





## **Notch Frequency at fN = 8.0MHz**

- High-pass = 1.5MHz
- Low-pass (f2) = 6.8MHz
- fN = f2 + 17.6% offset
- 2. MT2 Frequency setup:
  - High-pass (f1) = 9.5MHz
  - Low-pass = 30.0MHz
  - fN = f1 15.8% offset





## **Notch Frequency at fN = 12.0MHz**

- High-pass = 1.5MHz
- Low-pass (f2) = 10.2MHz
- fN = f2 + 17.6% offset
- 2. MT2 Frequency setup:
  - High-pass (f1) = 14.3MHz
  - Low-pass = 30.0MHz
  - fN = f1 16.1% offset





## **Notch Frequency at fN = 18.0MHz**

- High-pass = 1.5MHz
- Low-pass (f2) = 15.3MHz
- fN = f2 + 17.6% offset
- 2. MT2 Frequency setup:
  - High-pass (f1) = 21.4MHz
  - Low-pass = 30.0MHz
  - fN = f1 15.9% offset





## **Notch Frequency at fN = 23MHz**

- High-pass = 1.5MHz
- Low-pass (f2) = 19.6MHz
- fN = f2 + 17.3% offset
- 2. MT2 Frequency setup:
  - High-pass (f1) = 27.3MHz
  - Low-pass = 30.0MHz
  - fN = f1 15.7% offset





## **High-pass section selectivity**

 The high-pass section of the 5690 has average selectivity of 20dBc relative to f1 at f1-14.5% offset that varies between f1-13% and f1-16%.





## **Low-pass section selectivity**

• The low-pass section of the 5690 has average selectivity of 20dBc relative to f2 at f2+15.5% offset that varies between f2+14% and f2+17%.





## Conclusion

- Multiple 5690 Tunable Filters can be used to implement tunable notch filter with greater than 20dBc selectivity, by tuning the cutoffs f1 and f2 appropriately.
- The high-pass section of 5690 has 20dBc selectivity at f1 16% offset.
- The low-pass section of 5690 has 20dBc selectivity at f2 + 17% offset.
- Furthermore, the level of a stronger or weaker interference signal at the notch frequency can be detected at a later digital stage of the SDR receiver that triggers an adjustment of the f1/f2 cutoffs, so that the selectivity is increased or decreased respectively, and the interference is regulated to manageable levels.
- This results to the implementation of a Tunable Notch filter with adaptive selectivity using 5690 Tunable Filters.



# Thank You



