A Flexible Direct Frequency Synthesiser

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Introduction

- Direct Frequency Synthesis is a method of locking a high frequency to a precise reference, such as a GPS derived 10MHz source
- This presentation covers the basic principles of DFS, and describes the design of of a flexible dual loop DFS

Frequency Locking

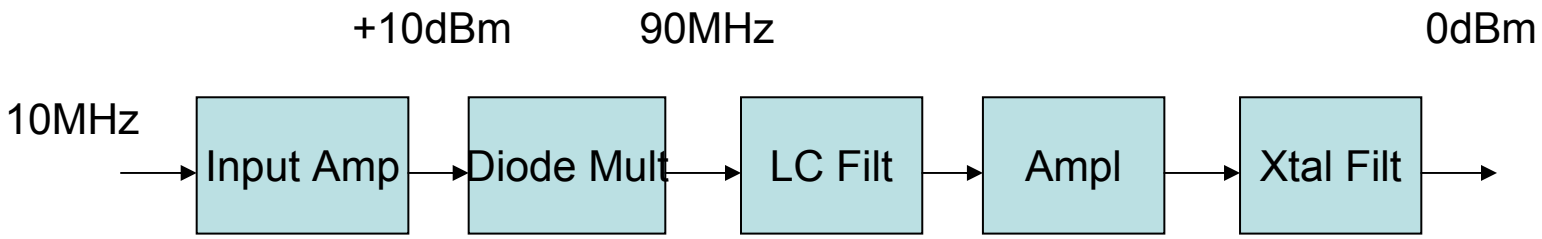
- There are a number of schemes available to amateurs for locking of oscillators to precision sources:
  - Injection locking
  - PLL's
  - CT1DMK Reflock
  - DFS .....etc.....
- All have relative advantages – and disadvantages

Direct Frequency Synthesis

- In a DFS, the 10MHz input is multiplied and divided to create signals that can be mixed together to give the final output frequency
- In theory, the quality of the output signal should be as good as a crystal oscillator
- But good filtering is required at each stage of the process to minimise the products of the multiplication and mixing processes.

A simple DFS

- For that 2304 transverter with a 2m IF – well 90MHz is a good starting frequency (x24)

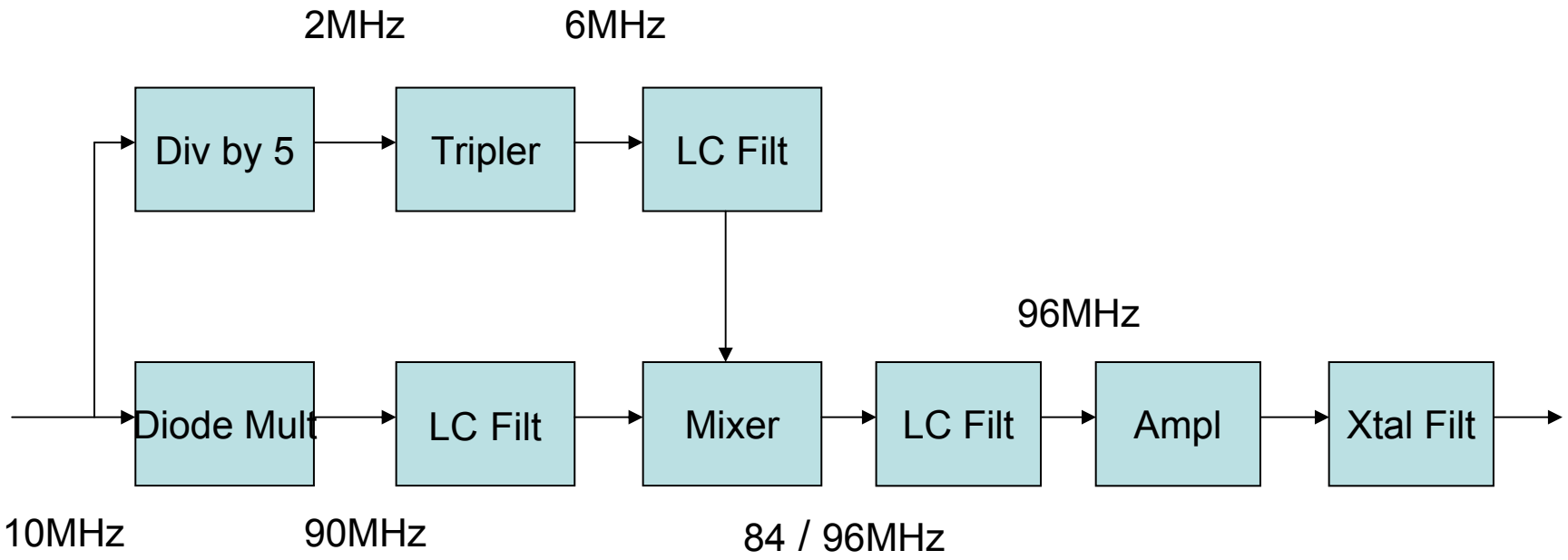


Simple, huh?

Previous designs

- Brian Justin, WA1ZMS – for his extreme microwave work
- Sam Jewell, G4DDK – 96MHz (23cm with 2m IF) – Scatterpoint
- Dave Robinson, WW2R/G4FRE – 90.667MHz for 2320Mhz with 2m IF
- All these designs need further processing to get the output frequency

96MHz DFS – G4DDK



Scope of the single loop DFS

- This method of combining enables several useful LO frequencies to be synthesised:
  - 96MHz - 23cm
  - 90.667MHz – 13cm (2320MHz)
  - 110.667MHz – 1.2mm (24048MHz)

- Also 92MHz and 95 MHz
- But that's about it for 144MHz IF's!

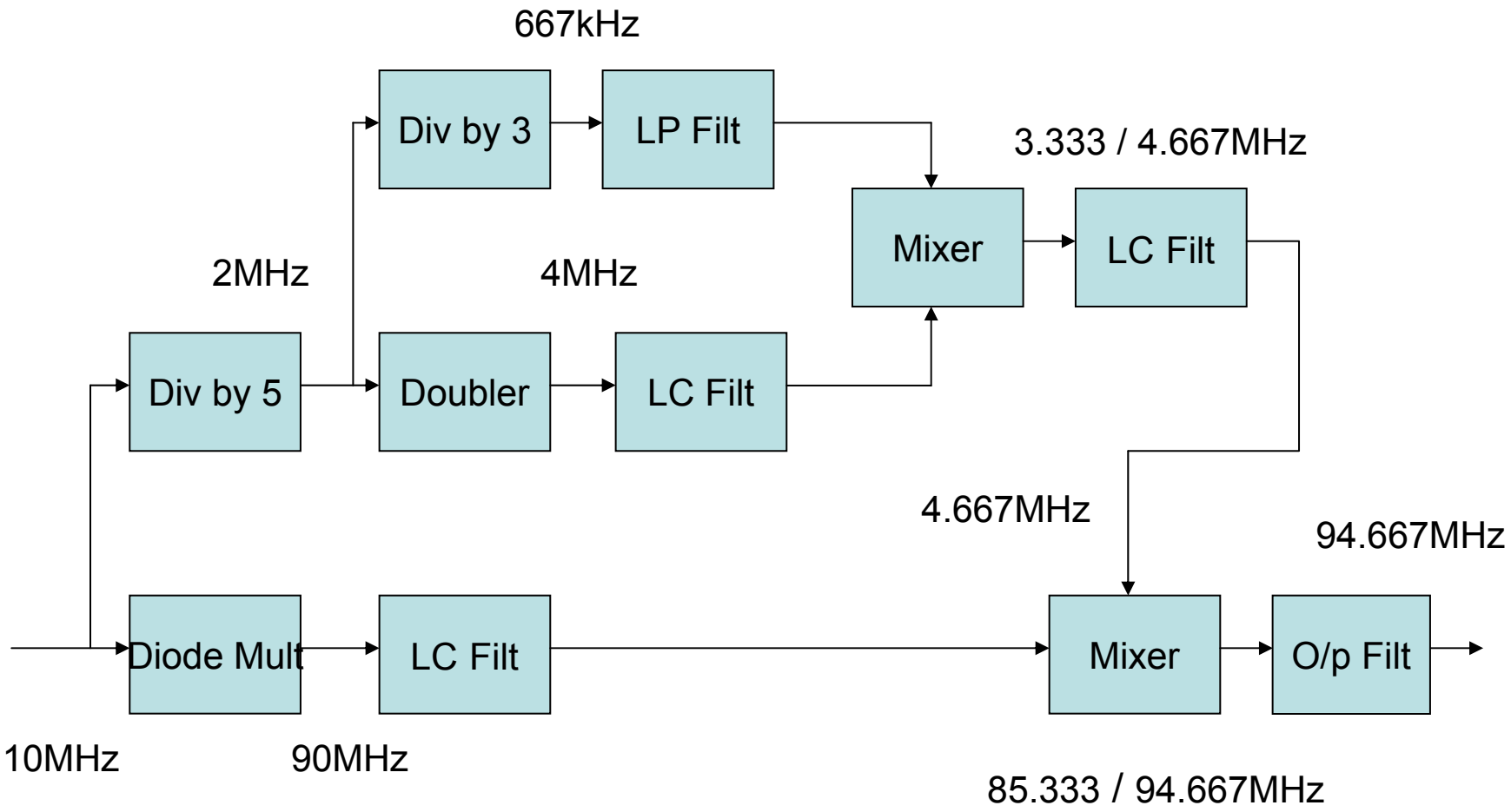
The Dual Loop DFS

- By adding a second divider and mixer loop many more useful frequencies can be produced – but the penalty is more ‘grass’
- WC8VOA uses a DEMI transverter for its 10368 EME station.
- With a doppler shift of ±20kHz max, you need to know where you are!
- Even the MicroLO does not give adequate accuracy or stability for this application

The Dual Loop DFS

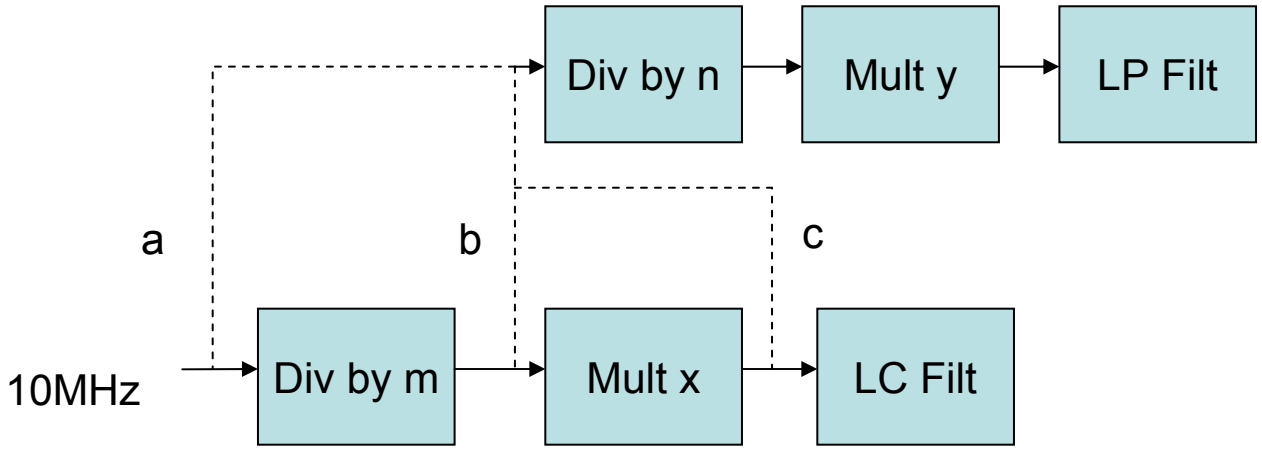
- 183.3333MHz is used as the xtal freq by DEMI – so a DFS at 94.6667MHz could be doubled to provide this input
- To generate the 94.6667MHz requires 90MHz (easy!), 4MHz (also easy) and an additional 667kHz
- 10MHz dvided by 15 gives 667kHz – so that’s easy too!

Dual Loop Schema



Flexibility of the Dual Loop DFS

- In addition to the versatility of having 2 loops, there are 3 places where the second loop can pick off its starting signal



Flexibility of the Dual Loop DFS

- Further flexibility comes from:
  - the choice of multiplication factors in each chain
  - the selection of upper or lower side frequency at each mixing process
  - Using different input frequency – 5 or 15MHz for example are common GPSDO outputs

Another example

- 10368MHz transverter with 144MHz IF, requiring 106.5MHz LO
- Two possible schemas from 10MHz:
  - 90MHz + 3 x 5MHz + 3 x 0.5MHz

  or
  - 110MHz – (3 x 1MHz + 0.5MHz)
- Better still in this case is a 15MHz input - 105MHz + (15/10)

Other possible combinations

- 94.75MHz – 902MHz
- 101.75MHz – 3400MHz

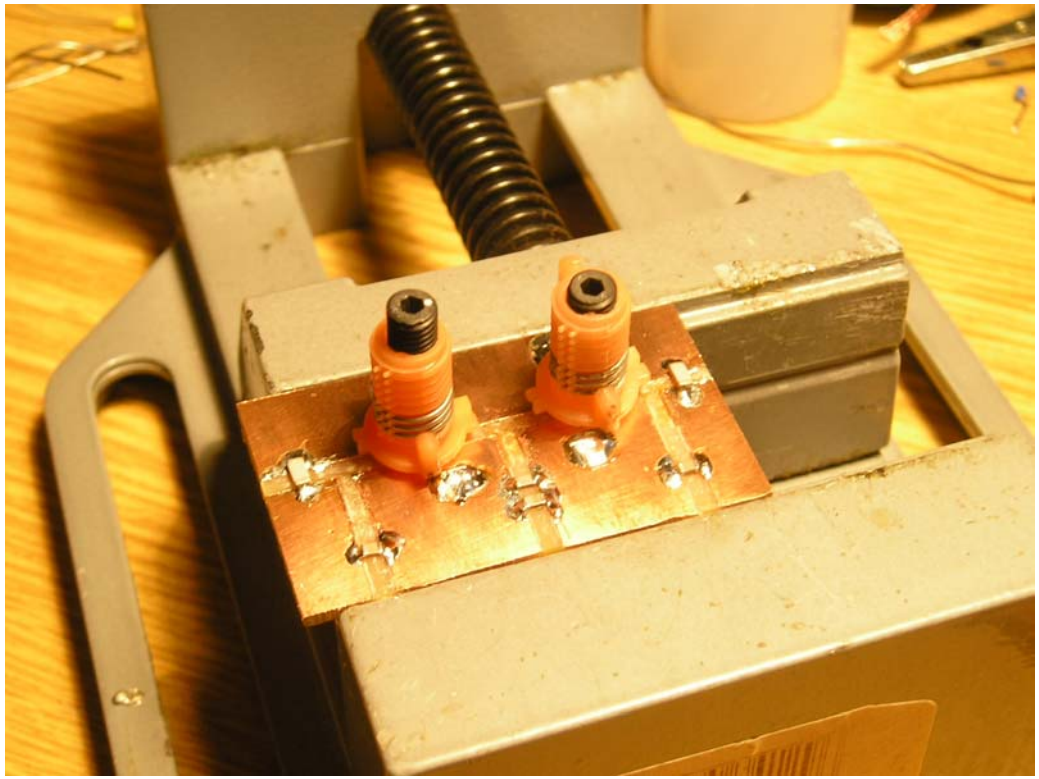
- 95MHz - 2424MHz (JA 13cm),
- 92MHz – 3456MHZ, and
- 104MHz – 5760MHz can all be achieved with single loop DFS systems

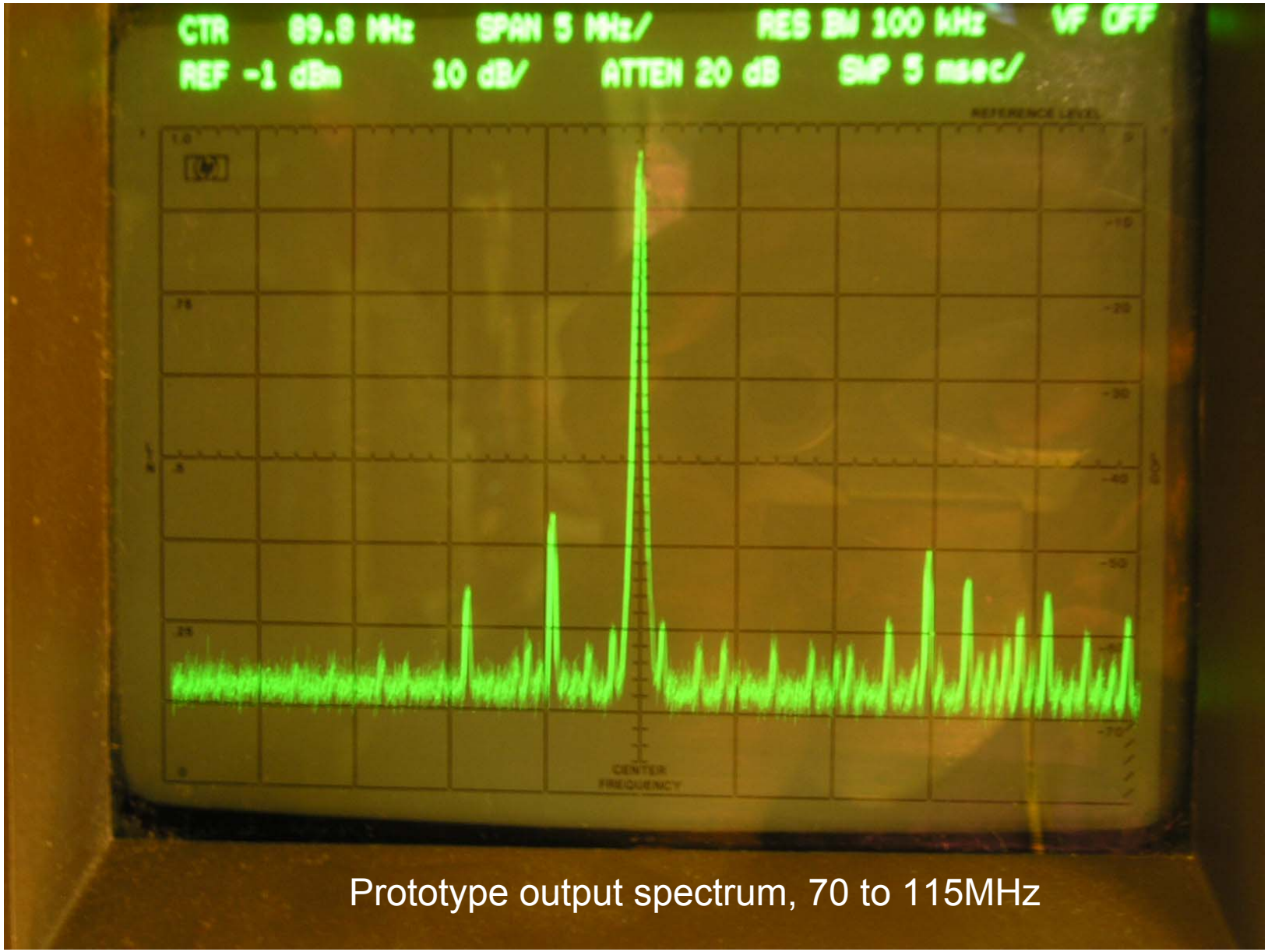
Performance Achieved

- So far a prototype breadboard has been built – not a pretty sight!
- Output spurious are approx -45dBc
- Currently translation to a PCB design is in hand – 148 x 74 x 30mm case.
- It is expected that this will result in a 10 to 15dB improvement in spurious products visible in the output spectrum

Performance Achieved

Prototype filter testing





Prototype output spectrum, 70 to 115MHz

Conclusion

- I have shown that a complex frequency can be derived from a precision source
- Further work is needed to complete a usable solution for the VOA station
- I hope to report on this work, and have the DFS unit available at MUD this year.