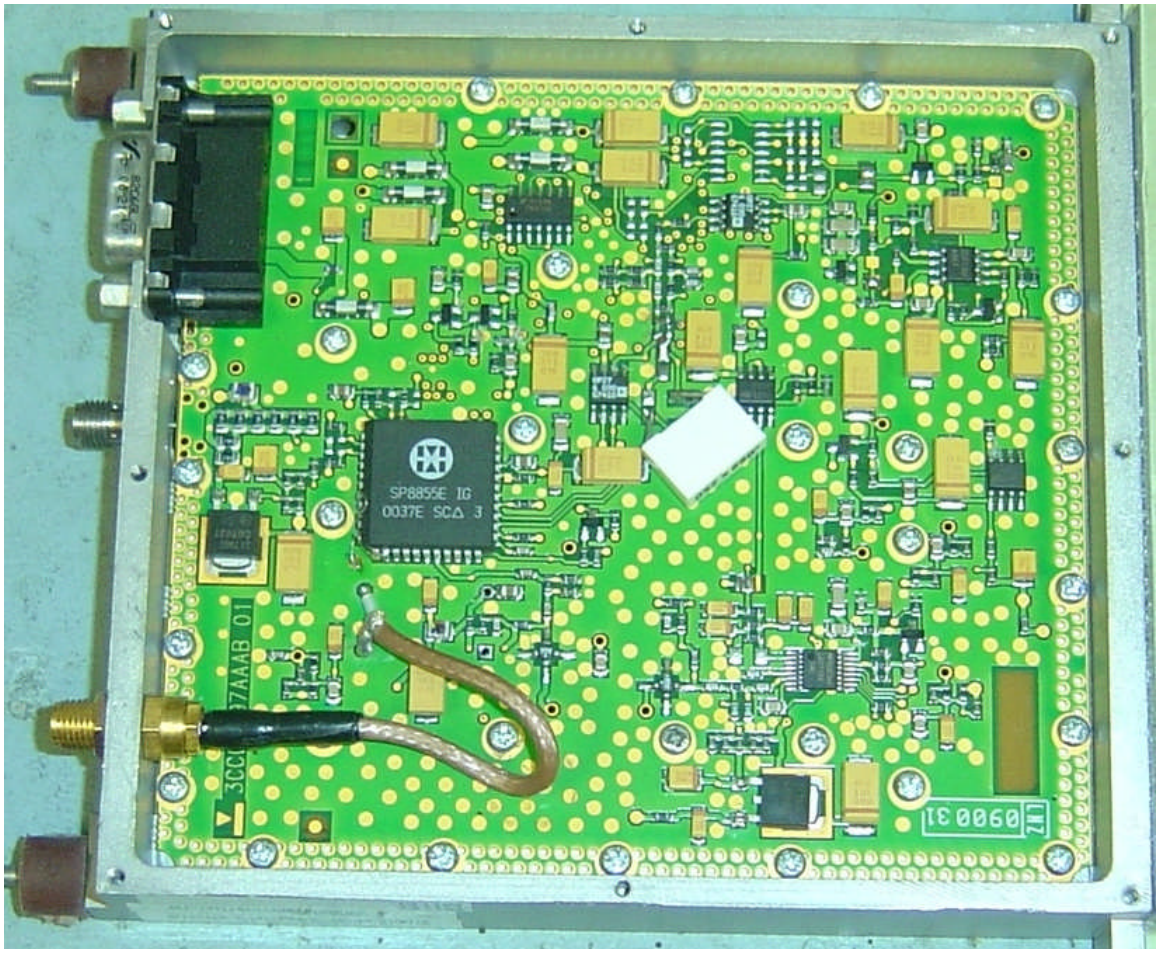
Modification of Alcatel 9400UX Synthesisers
By Roger Ray G8CUB - *Updated*



Many Alcatel Outdoor Units have been purchased, for conversion to 24GHz. For some reason the synthesiser local oscillator is not often used – why?

The following article describes simple modification to this parallel loaded synthesiser, which uses a 10MHz external reference, to give an accurate clean LO. They have successfully been used up to 47GHz final frequency. One possible use, allows one unit to provide an LO for 10GHz and 5.7GHz, just by switching a few pins.

Two different synthesiser chips, are used in different models, Zarlink, or Qualcomm, modification is very similar for each model. In each case the parallel loaded 'slow' loop is used, the 'fast' fractional-n loop is disconnected.

Excellent information on other Alcatel modifications from F4DAY, F6DR0, F1VL and others, together with IC data sheets can be found on the web.

Modification of Zarlink SP8855E Synthesiser

Example 9.936GHz LO (4968MHz) for 10GHz with 432MHz IF. The synthesiser came from a 23GHz ODU.

This uses a parallel loaded synthesiser, so that no programming is involved.
Reference: External 10MHz
Frequency: LO = 10368 - 432 = 9936MHz (LO on the low side)
Synth. Output - 4968MHz, VCO - 2484MHz, Div by 2 into synth. chip 1242MHz

Using highest reference from 10MHz input = 2MHz
Divide ratio = 1242 / 2 = 621
Set 621 on 'input bus' 0 is pin 11 …bit 10 is pin 1

Bit	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	1	0	0	1	1	0	1	1	0	1

Looking at the SP8855E pinout diagram check the IC with an ohm meter, and find which bus pins on the IC are grounded. Bit 0 is pin 11 …bit 10 is pin 1. On those that need to be a high (1) cut through the pin with a fine sharp pair of cutters. This is the only difficult bit! But is easy with the right cutters. It looks like the pin only has a fine track to the ground plane – it is actually grounded underneath as well! Hence the need to cut the pin. I wired the pins that needed to be high (1) together, then through a 1k resistor to 5V supply, though leaving them o/c may be OK.

For 10MHz reference
Divide by 5 (00000000101) ref. frequency = 2MHz
Standard is divide by 1, so just cut the track to bit 2 (pin36) from 0V and connect to supply as bit 0 (pin38)

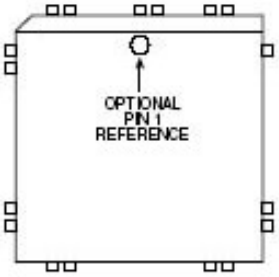
Underside - unsolder the top mounted TCXO pins and remove, and remove one IC 8574T as shown in the picture (alternatively cut through

Add a coax cable to where the TCXO was removed for the external reference signal. Lift the supply pin to the regulator feed the LMX** fast loop which is not used.**

This should give a working synthesiser. Though to give a reasonable phase noise performance it is necessary to change 3 components in the loop filter. Looking at the photograph, remove 2 back to back 1u0 tantalum capacitors next to the OP25 loop filter amplifier. Bridge the pair with a good 68n capacitor. One side of that new capacitor connects only to a resistor and capacitor. Change the resistor to 5k6, and change the capacitor to 4n7. Further experimentation in loop filter values may be beneficial. *See later article on improving the 10GHz synthesiser.*

Looking at the spectrum analyser plots for the 10GHz LO there are some spurs apx. 32kHz either side of the carrier, some work on the additional twin-T filter in the loop circuit, could probably reduce these. The phase noise is certainly not as low as

can be achieved with a crystal oscillator multiplier chain. But, this synthesiser gives adequate performance, using an external reference, and can be completed in about 1 ½ hours.



HP44

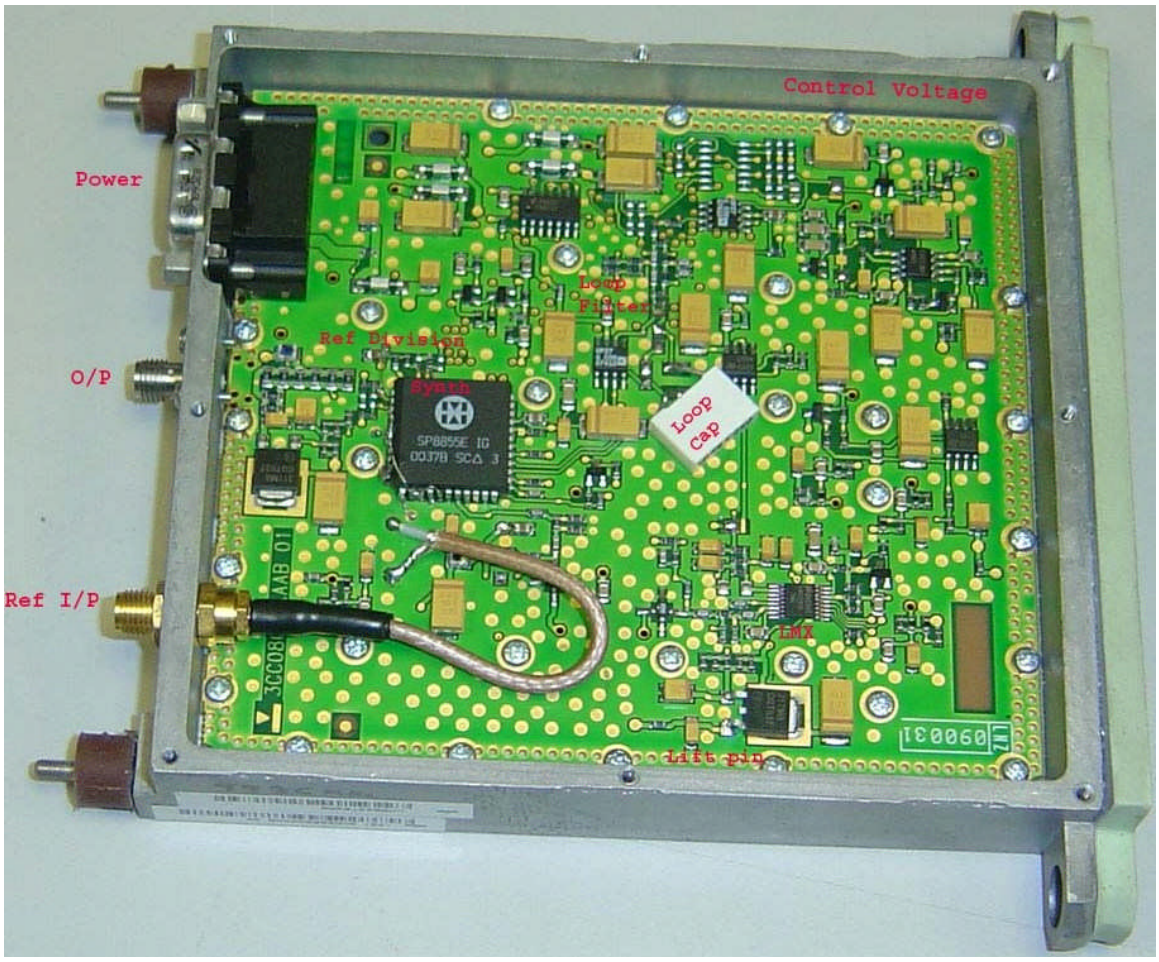
Pin	Description	Pin	Description
1	Input bus bit 10	23	Control Direction
2	Input bus bit 9	24	F_{pd}
3	Input bus bit 8	25	F_{ref}
4	Input bus bit 7	26	+5V
5	Input bus bit 6	27	Ref. osc capacitor
6	Input bus bit 5	28	Ref in/XTAL
7	Input bus bit 4	29	Reference bit 9
8	Input bus bit 3	30	Reference bit 8
9	Input bus bit 2	31	Reference bit 7
10	Input bus bit 1	32	Reference bit 6
11	Input bus bit 0	33	Reference bit 5
12	0V (prescaler)	34	Reference bit 4
13	RF input	35	Reference bit 3
14	RF input	36	Reference bit 2
15	V_{cc} + 5V (prescaler)	37	Reference bit 1
16	V_{ee} 0V	38	Reference bit 0
17	Lock detect output	39	Phase Detect Enable
18	C-lock detect	40	Phase Detect Gain 1
19	Rset	41	Phase Detect Gain 0
20	Charge pump output	42	Input bus bit 13
21	Charge pump ref.	43	Input bus bit 12
22	F_{ref}/F_{pd} enable	44	Input bus bit 11

Two or three band synthesiser!

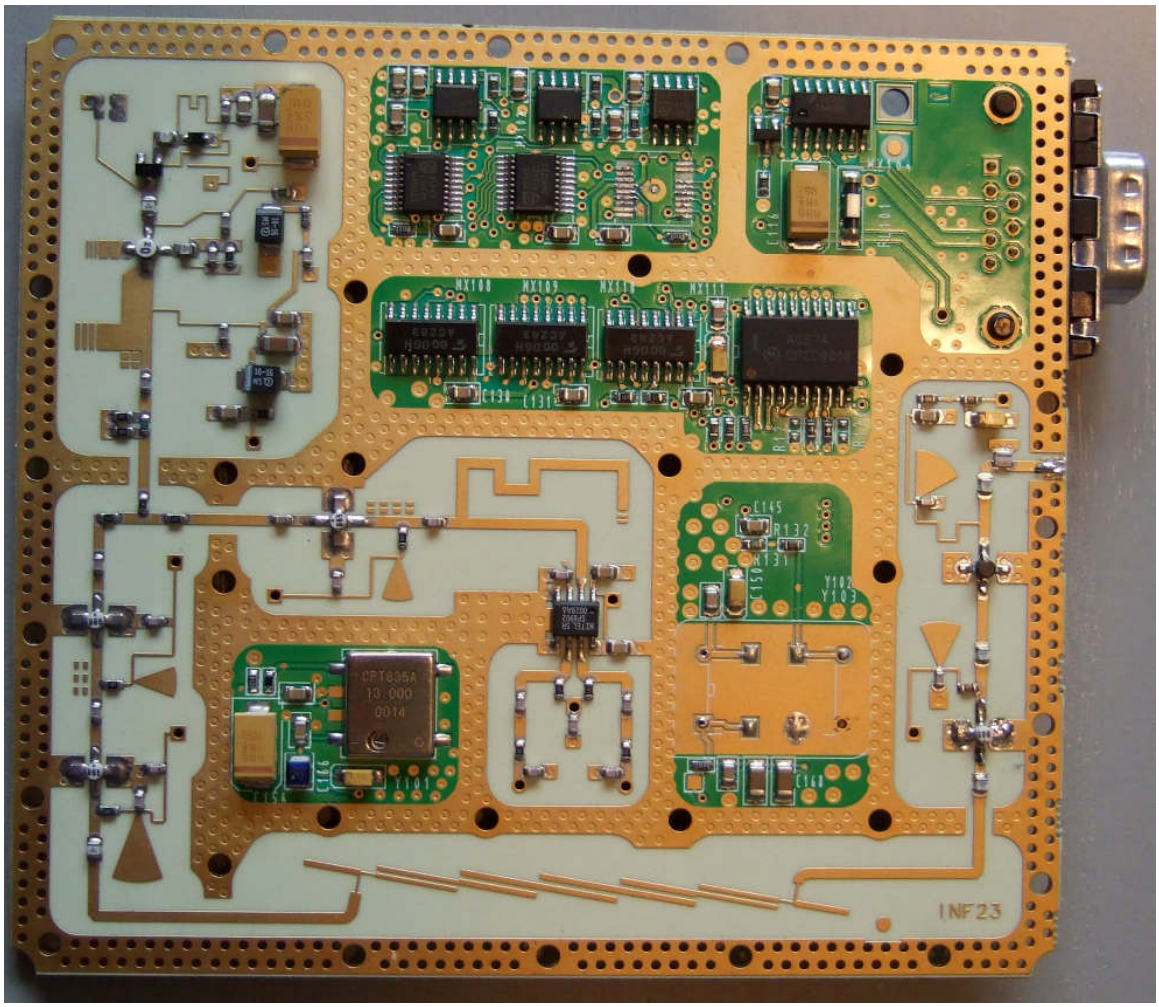
By changing the 8 frequency setting pins it is possible to provide a synthesiser for 10GHz and 5,7GHz.
{The same unit could also do 24GHz with 23cm IF, if the VCO supply voltage is increased to 28V (this works OK)}

10GHz – as described division 621 01001101101
5.7GHz 432MHz IF division 666 01010011010
5.7GHz 144MHz IF division 702 01010111110
24GHz 1296MHz IF division 721 01011000111

Two transistors are all that is needed to do 5.7 / 10GHz, plus a coax relay to switch the output to the 5.7GHz transverter, or doubler in the 10GHz transverter. Group all the pins that are changing to '0' on 5.7GHz, onto 1 npn transistor, and group the pins changing to '1' on to another.

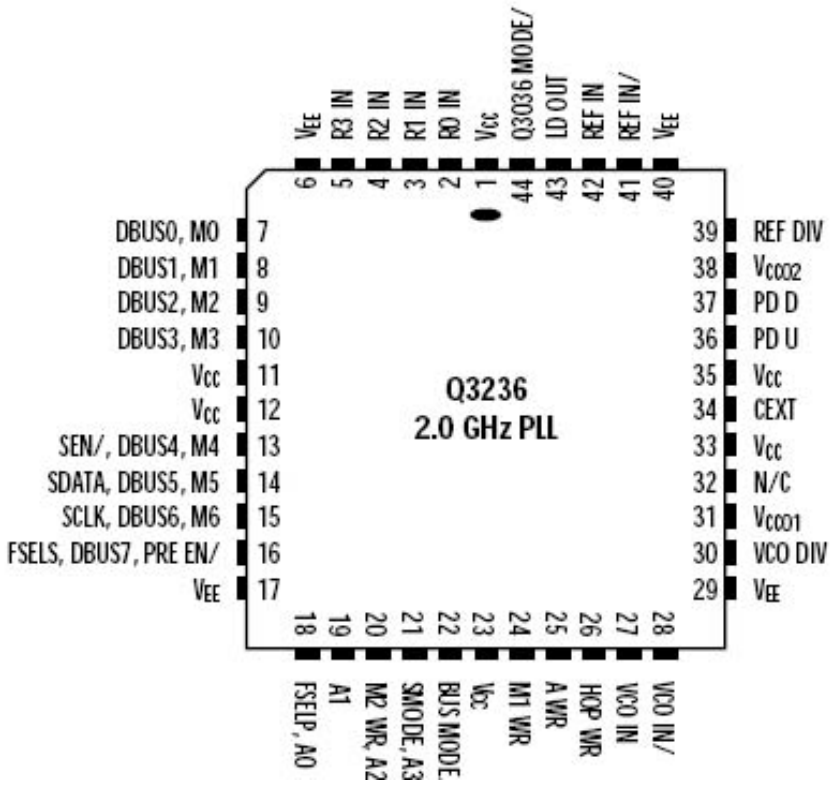


Modified unit with new loop filter values.

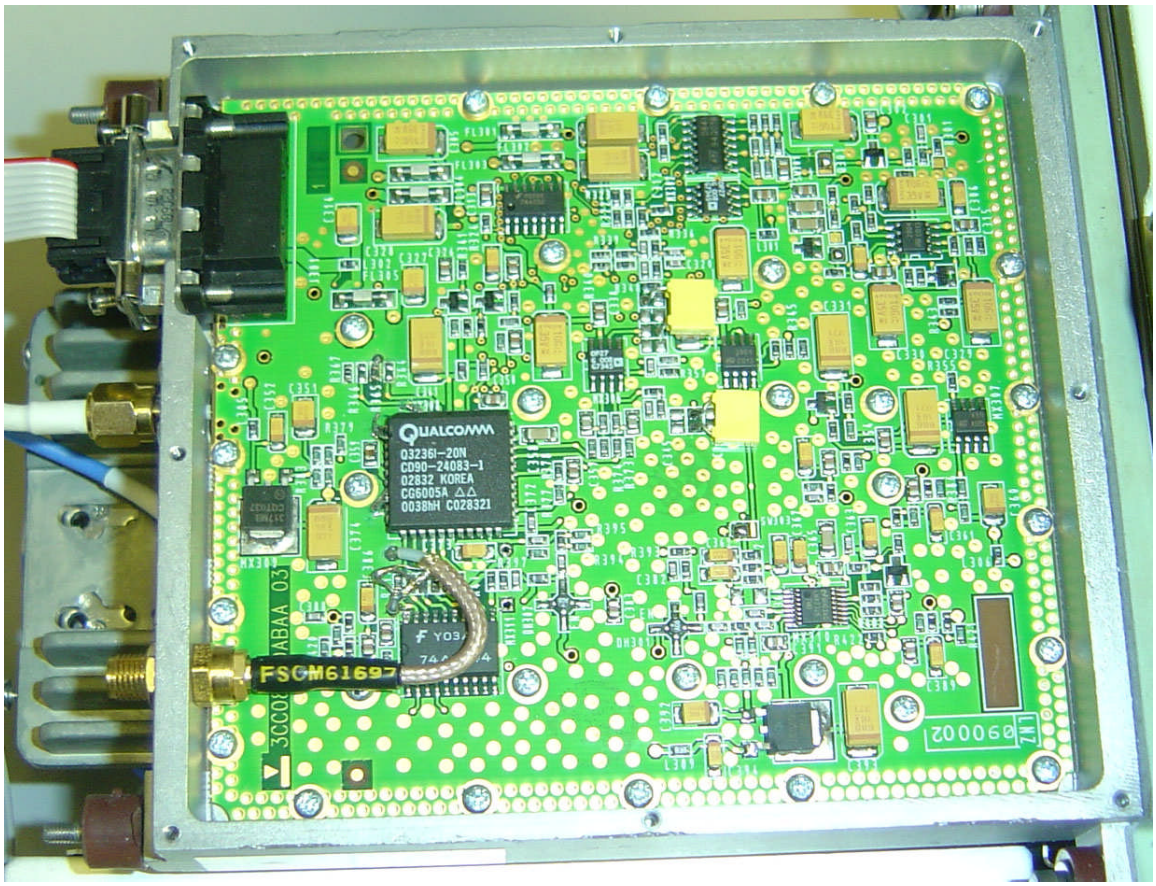


Underside of PCB (Qualcomm) with 8754T IC & TCXO removed

Qualcomm Q3236



Modification of Qualcomm Q3236 Synthesiser



These units provide easy modification for use on 24.048GHz, 432MHz IF high side injection. A 24.5GHz ODU used high side LO injection, so to maintain the operation of the image-rejection mixers, and use the fitted synthesiser for 24GHz, this modification was performed.

No pins need to be cut, and no loop filter changes for this application!

Reference: External 5 or 10MHz
Frequency: LO = 24048 + 432 = 24,480MHz
Synth output:6.12GHz, VCO 3.06GHz, Div2 into synth. Chip 1530MHz

For 5MHz Ref., Division = 306

Using 5MHz external reference
R=1, set = 1-1 = 0 (pins 2,3,4,5 low – no change)

For 10MHz reference
R=2, set=2-1 = 1 (pin2 high, use 100Ω resistor in R364 position) – this gives reference frequency of 5MHz, divides 10MHz by 2

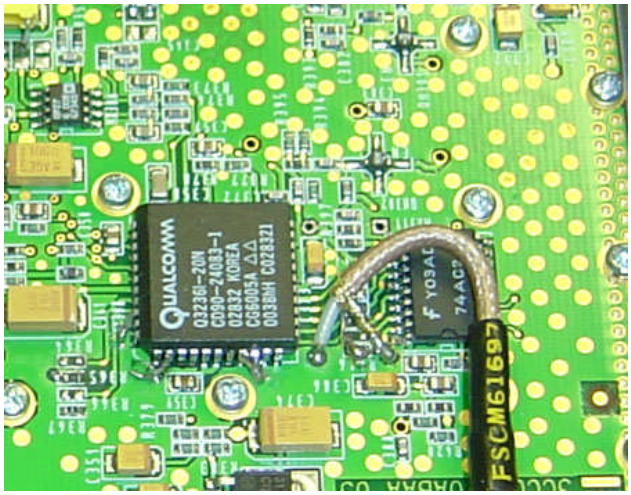
M=30, set 30-1 = 29 (pins 7,9,10,13 high)
A=6 (pins 19,20 high)

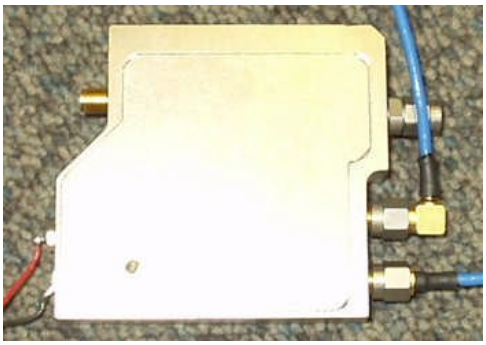
High = not grounded – refer to Q3236 data sheet.

To make this modification:
Top – solder together pins 14 and 15(15 = 0V)
Connect pin 8 to 0V
Remove R411 to R416, connect pins 18, 21 to 0V

Underside - unsolder and remove TCXO (typically 16MHz), plus either remove 1 x IC 8574T as shown. Or alternatively cut through synthesiser pins connecting to that IC – check with an ohm meter (these are then either grounded or left o/c depending on the programming)
Add a coax cable to where the TCXO was removed for the external reference. Lift the supply pin to the regulator feeding the LMX** fast loop which is not used.**

Note with high side conversion 24048 – 24050MHz, gives an IF 432 – 430MHz. Not a problem for the FT817 etc. Just remember to switch to LSB, and use a look up table!





Modification detail of PCB and photo of Tx driver box, just used for it's doubler.

The Qualcomm is much cleaner than the Zarlink with lower phase noise, though this is in part due to the higher reference frequency used. It is of course necessary to use a clean 10MHz reference. An off air standard was not clean enough for 24GHz, while an ovened 10MHz oscillator was fine.

Conclusion

A quickly produced synthesised LO from the Alcatel ODU. In my transverters I have kept the original PSU, feeding a common -60V supply (using 5 x 0.5A 12/12V DC/DC converters).

Stability is as good as the reference, and phase noise is adequate for normal use. Although some improvement in the close in spurs is desirable for high power 10GHz use. ***See later article on improving the 10GHz synthesiser.***

47GHz - Update

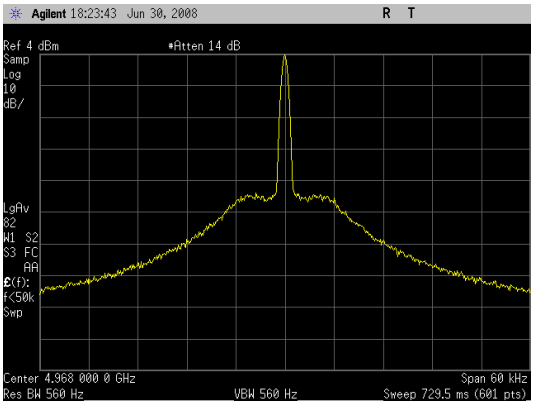
I have now modified a synthesiser for driving the Pasolink 50 for 47GHz. The output for receive into the doubler was 5824MHz. For transmit, I switched the referenced from 10MHz to a ovened Quarzlab crystal on 10.092614MHz. The first QSO on the band only just worked, the signal both ways being very noisy. I soon found the problem, in my haste to throw something together, I had forgotten to change the loop filter! Changing the loop values as described gave a T9 note even at 47GHz.

Different Synthesisers and their tuning range (apx.)

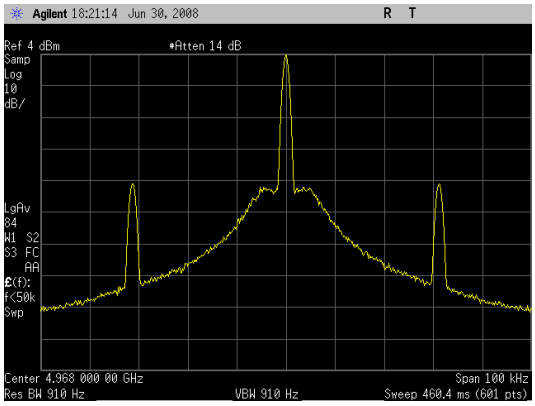
Ex-26GHz unit	**3CC10676AAAB**	**6.0 – 7.0GHz**
Ex-25GHz unit	**3CC10676ABAB**	**6.2 – 7.2GHz**
Ex 38GHz unit?	**3CC08667ABAB**	**6.3 – 7.1GHz**
Ex 23GHz unit	**3CC08667AAAA**	**4.9 – 5.7GHz**
	3CC08692ABAB	**5.6 - 6.5GHz#**
	3CC05823AAAC	**11.25 – 12.3GHz***

*** this one includes the doubler, but I have not managed to make it play ball yet!**
 # makes possible an LO on the low side for 24GHz

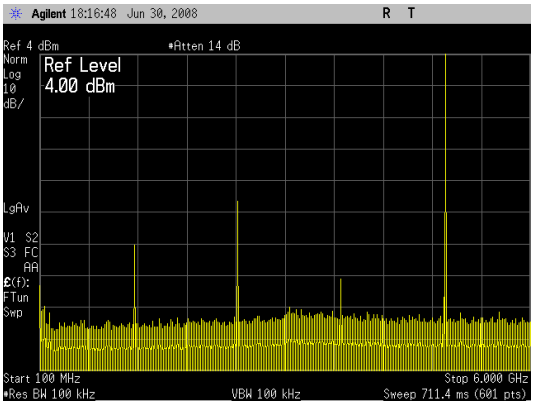
10G (4.968GHz) Synth 60kHz Span



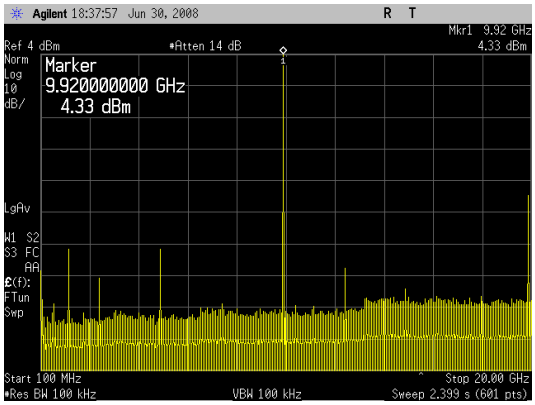
10G (4.968GHz) Synth 100kHz Span



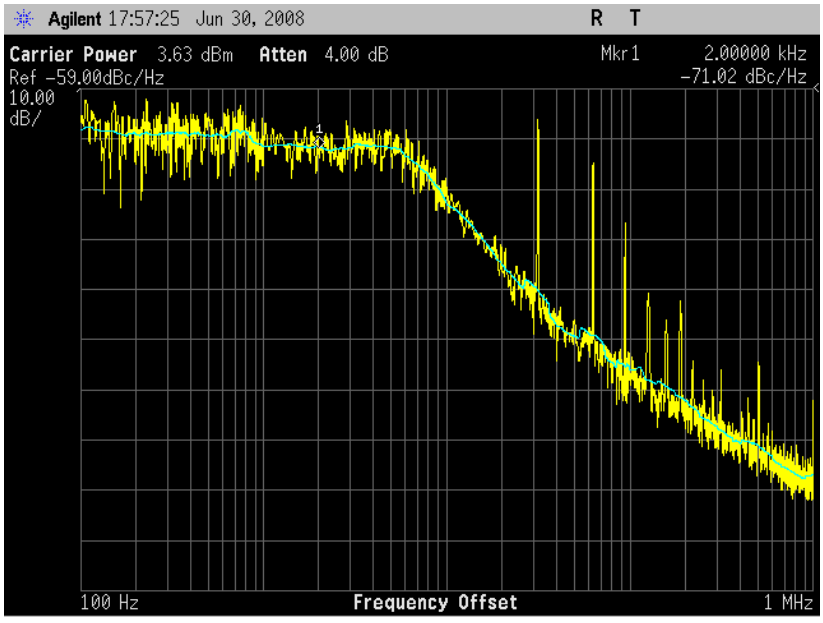
10G (4.968GHz) Synth 0.1 – 6GHz Span



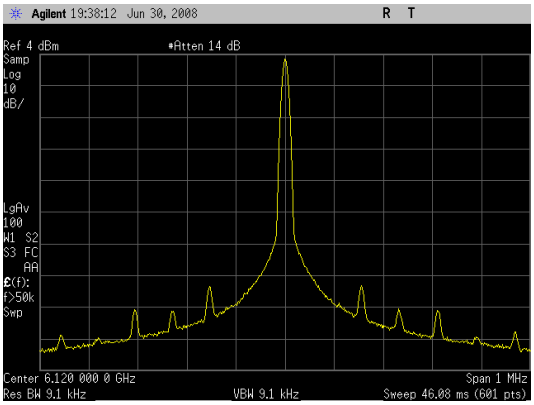
10G (4.968GHz) Synth After Doubler



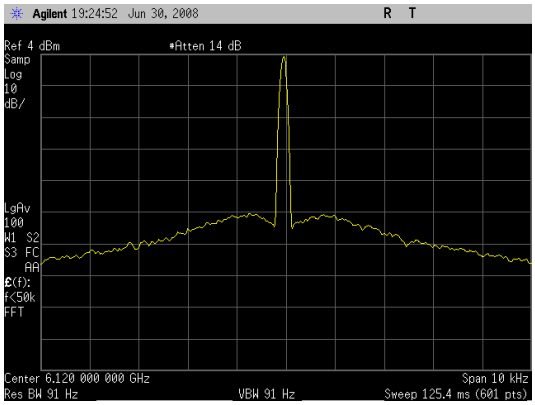
10GHz (4.968GHz) Synth Phase Noise



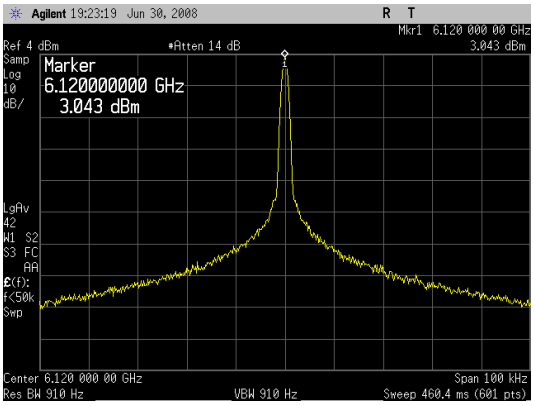
24G synth (6.120GHz) 1MHz Span



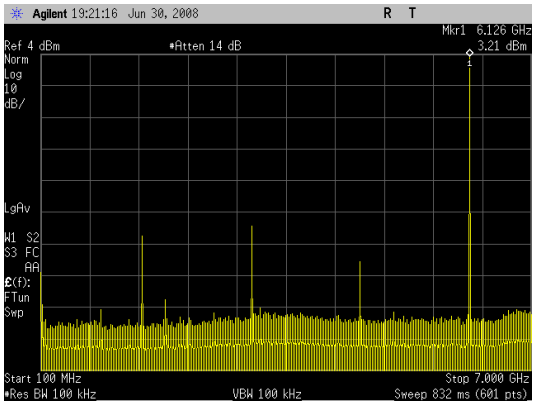
24G 10kHz Span



24G 100kHz Span



24G synth (6.120GHz) 0.1-7GHz



24G synth (6.120GHz) Phase Noise