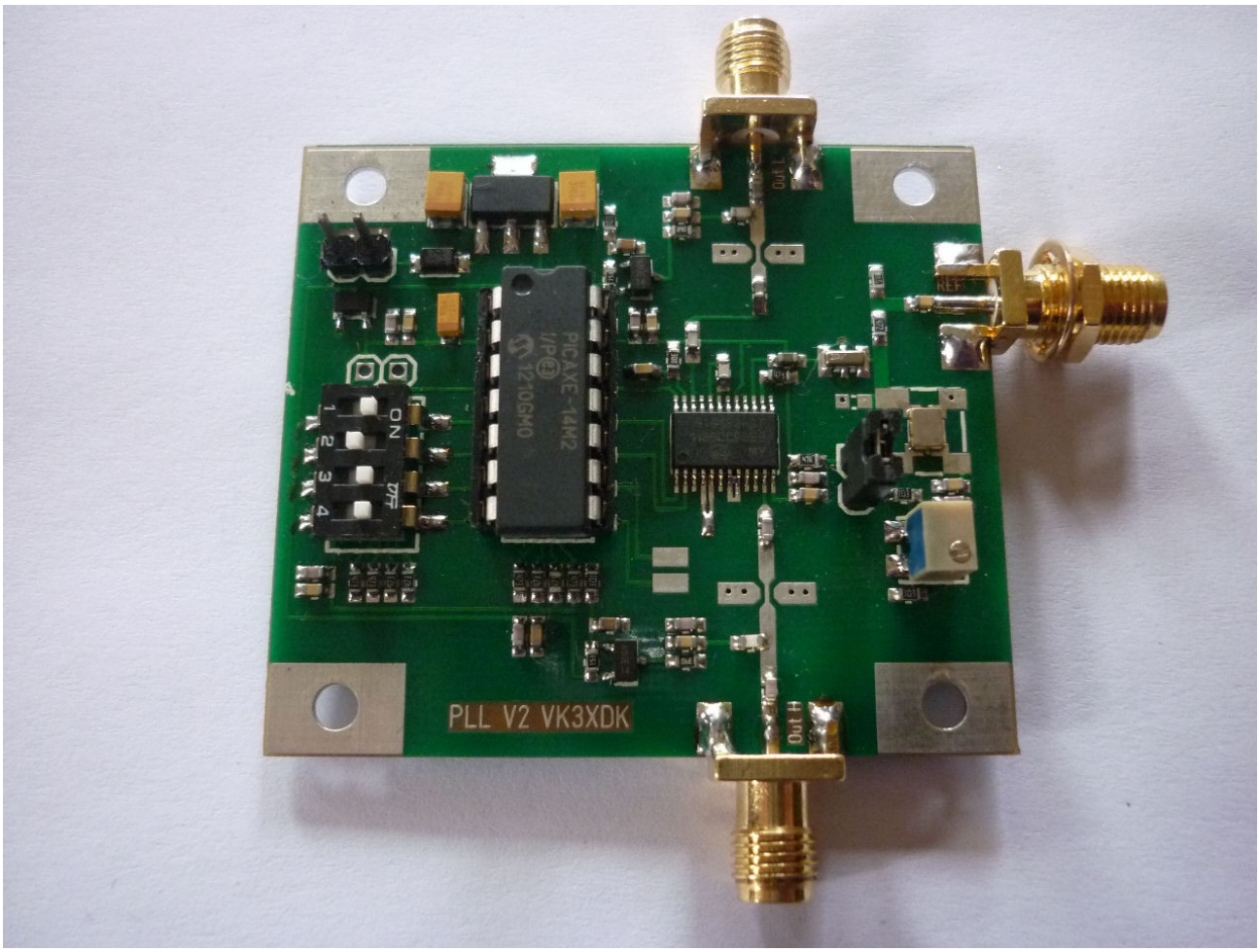
VK3XDK Agile PLL V2

The VK3XDK “Agile PLL V2” is a convenient high performance frequency generator (synthesizer) able to directly produce accurate, stable and low noise signals at frequencies between 380MHz and 2000Mhz.

Typical uses are LO (local oscillator) and sub-multiplier LO generation, direct signal source, weak-harmonic style signal source (above 2000MHz)

Features

-Simultaneously produces 2 separate frequencies (OutL / OutH)
-Output frequencies (OutH only) are easily “on the run” selectable by means of an on-board 4way binary switch.
-TX/RX frequency offsets (OutH only) can be implemented (ie repeater/ duplex offsets)
-Outputs of up to 12dbm are available (Supplied MMIC amplifier/s installed)
-Power supply range of 7.5 to12V @ around 30mA (add around 40mA for each MMIC amplifier installed)
-Small in size, easy to mount and connect. (54mm X 48mm (excluding projections) , SMA input/Outputs)
-Standard frequencies and code can be re-configured (Picaxe 14M2 processor/ Basic programming)
-Uses the versatile si4133 “GT” (programmable reference divider version) odd and non integer MHz are now possible.
-External 10MHz reference port (through panel SMA). Optional on-board 10MHz VTCXO available (ext/int Selectable)



Optional on-board VTCXO version shown.

Basics of operation

At the heart of the board is a SiLabs si4133 dual band RF synthesizer, the chip has 3 integrated VCO's covering ranges of 62.5 to 1000MHz*, 750 to 1500MHz and 900 to 2000MHz*. The VCO's are PLL locked to a common reference signal of 10MHz (typically).

Serial control of the si4133 is achieved by use of a PICAXE 14M2, this processor was chosen because it provides programming simplicity for those that wish to alter frequencies/performance or incorporate special functions.
All Data (including frequencies) are stored within the PICAXE and are retained after loss of power.

As standard the board is pre-programmed with 17 commonly used frequencies and a further 16 frequencies available by use of the "special function Jumper (SF JMP)" (33 separate Frequencies in total)

OutL - Fixed at 404MHz.
OutH - 16 Frequencies BankA / 16 Frequencies BankB

16 "BankA" frequencies are available and are selected by an on-board 4way SMD. A further 16 frequencies (BankB) are enabled by shorting the "SF JMP" Pins. As Standard BankB=BankA-1MHz, the "SF JMP" can be a remotely mounted mechanical or electronic switch.

It is important to understand the behavior of the VCO's when using the standard (supplied) on-board code.
The si4133 has 3 integrated VCO's covering three frequency ranges,each VCO's center frequency is set with an L-C type oscillator network where the "L" part of the network is external to the chip and adjustable.

-The lower frequencies use a chip-type inductor (L2)
-The mid mid and high frequencies use PCB trace inductors (L5 and L6 respectively), the inductance's can be adjusted by moving the respective "solder-blob short".

Lowering the inductance value raises the center frequency of that particular VCO.

The si4133 has special compensating circuitry which allows the VCO's to lock at a large range of frequencies around the center frequency, continuous coverage (300 to 2000MHz) is NOT available due to the limited range of each VCO and therefore the VCO's should be centered around the frequencies of most interest. (some slight adjustment may be needed in some cases.)

Large temperature variations, vibrations and mechanical shock can affect the VCO's. If needed - temperature changes can normally be compensated for by re-initializing the board (ie re-powering or switching/re-switching frequencies).
It is suggested that "common sense" be applied when choosing the boards mounting location (ie away from fans, power devices, strong interfering signals etc.)

Optional MMIC Amplifiers (supplied)

The output level of both OUT L and OUT H is around -2dbm. For higher output/s there are 2X ERA2 (Minicircuits) MMIC amplifiers. Installation will typically boost the output/s to around 10-12dbm (10-16mW). The amplifiers can be installed on either or both outputs but for best overall performance install only when necessary.

-Installation of these devices requires cut/s to the PCB trace and soldering (please see layout diagram).
-Each MMIC amplifier (when installed) consumes around 40mA

*The lower frequencies (below around 380MHz) require a programmable output division.
*1800MHz to 2000MHz is out of specifications but in practice functions very well.

Reference Signal

The standard board uses an off-board (or optional on-board) 10MHz reference signal, 10MHz has been chosen due to it's popularity and availability. Other reference frequencies can be used with modified software.

External:

Perhaps the most critical part of the system, the often stated "rubbish in- rubbish out" holds very true with this and most other PLL systems, the board does have an on-board reference filter that can help- BUT it is best to have a good reference in the first place.

-A **low phase-noise**, low harmonic sine-wave reference of 7 to 20dbm (5mW to 100mW) has been found to be the best.

Other wave types including "clipped sine-wave" and high slew-rate "square-wave " can be used but are not recommended.

-The boards external reference input impedance is 50ohm.

Quality "Oven" (OCXO) or GPS/ Rubidium oscillators when combined with the VK3XDK Agile PLL V2 can can easily produce sub-Hz stability over the boards range.

Please note:
The external reference signal needs to be present and reasonably settled during the PLL data loading/ initialization.
A pre-programmed and configurable software start-up delay (around 2sec) has been incorporated and is adequate for most "switch-on together" instances, however a slow settling external reference may need a longer delay (OR turn-on sequencing.)

Internal (optional on-board):

An optional on-board VTCXO (voltage/ Temperature controlled oscillator) is available and proves very convenient and more than adequate for many uses. The frequency is able to be finely adjusted by use of an on-board 11Turn potentiometer.

The on-board oscillator can (and needs to) be turned off when an external reference is connected. This is done by removing the "VCXO EN" PCB jumper. The jumper could be changed to a remote switch for convenience.

The currently available on-board oscillator is type: ECS Inc, part number VC-TXO-23SM-100-B
Frequency stability is specified as ±2.5ppm
In a standard (work bench) environment my 24hour tests have shown less than 200Hz drift @ 1656MHz. (most of which is during the initial 10Min.warmup)

Notes

SMD components (especially capacitors) are intolerant to PCB flex- Care needs to be taken with board mounting and when connecting/ disconnecting.

The primary voltage regulator is type LM340MP-5.0 (5V)

Standard Frequencies

BankA (OutH)

No.	Switch Pos.	Frequency (MHz) and typical use.	Locking (as sent)	VCO
1	0000	1104.00 (X3 for 3312MHz Injection (3456 Transverter / 144IF))	YES	M
2	0001	1152.00 (1296Mhz Transverter / 144MHz IF) and many other options (see below)	YES	M
3	0010	1242.00 (X8 for 9936MHz Injection (10368 Transverter / 432IF)	YES	M
4	0011	1278.00 (X8 for 10224Mhz Injection (10368 Transverter / 144IF)	YES	M
5	0100	1296.00 (1296 MHz Signal source, X8 for 10368 signal source)	YES	M
6	0101	1332.00 (X4 for 5328MHz Injection (5760 Transverter / 432IF)	YES	M
7	0110	1336.00 (X18 for 24048MHz Signal source)	YES	M
8	0111	1344.00 (X18 for 24192MHz Signal source)	YES	M
9	1000	1484.00 (X2 for 2968MHz Injection (3400 Transverter / 432IF)	NO*	H
10	1001	1512.00 (X2 for 3024MHz Injection (3456 Transverter / 432IF)	NO*	H
11	1010	1656.00 (X6 for 9936MHz Injection (10368 Transverter / 432IF) , X2 for 3312MHz (3456 Transverter / 144IF))	YES	H
12	1011	1700.00 (X2 for 3400MHz Signal source)	YES	H
13	1100	1776.00 (X3 for 5328MHz Injection (5760 Transverter / 432IF)	YES	H
14	1101	1872.00 (X3 for 5616MHz Injection (5760 Transverter / 144IF)	YES	H
15	1110	1920.00 (X3 for 5760MHz Signal source)	YES	H
16	1111	1971.00 (1971MHz Injection (2403 Transverter / 432IF)	YES	H

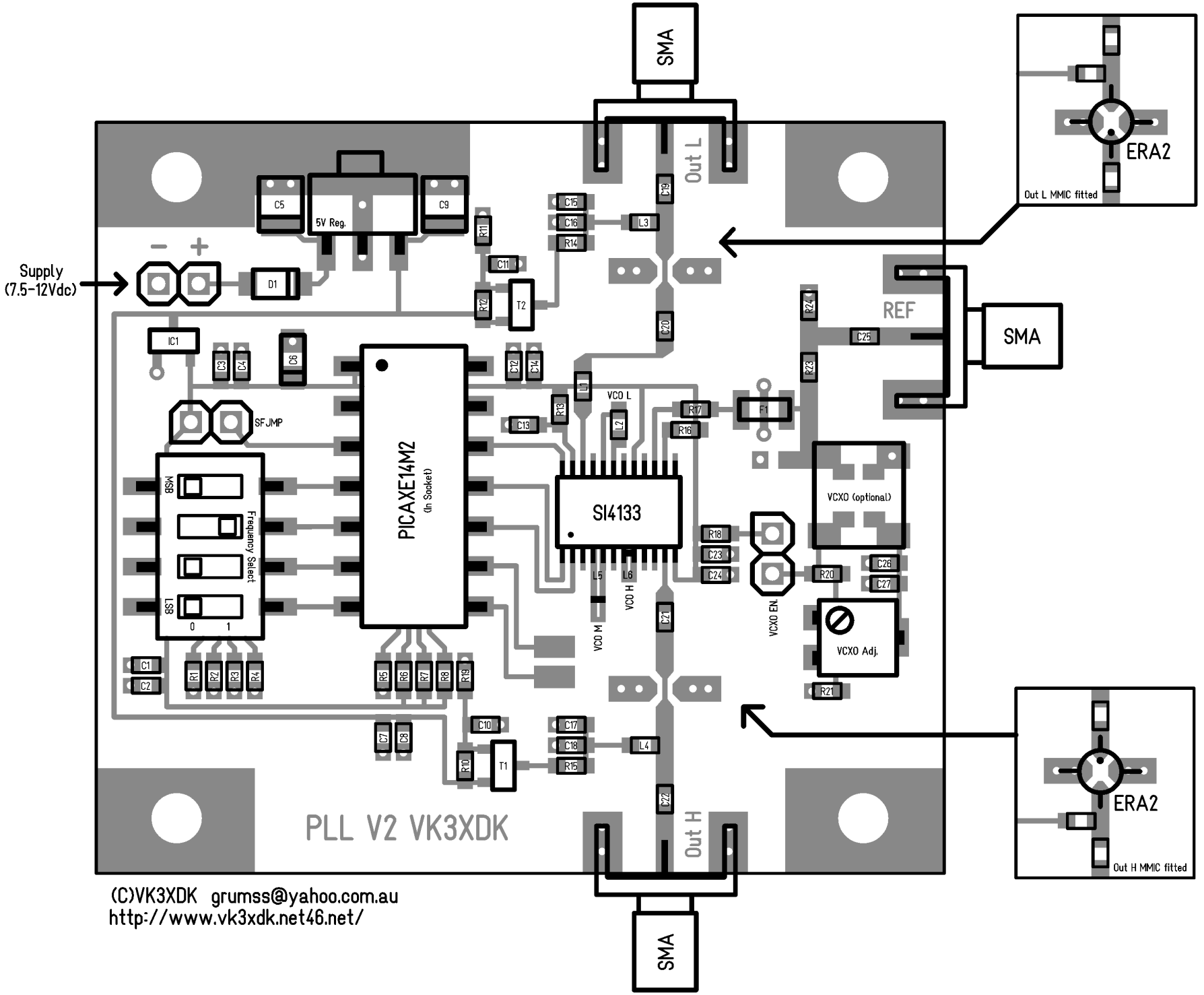
BankB (OutH) (SF JMP shorted)

No.	Switch Pos.	Frequency (MHz)	Locking (as sent)	VCO
1	0000	1103.00 (BankA – 1MHz) (independently programmable)	YES	M
2	0001	1151.00 (BankA - 1MHz) (independently programmable)	YES	M
3	0010	1241.00 (BankA - 1MHz) (independently programmable)	YES	M
4	0011	1277.00 (BankA - 1MHz) (independently programmable)	YES	M
5	0100	1295.00 (BankA - 1MHz) (independently programmable)	YES	M
6	0101	1331.00 (BankA - 1MHz) (independently programmable)	YES	M
7	0110	1335.00 (BankA - 1MHz) (independently programmable)	YES	M
8	0111	1343.00 (BankA - 1MHz) (independently programmable)	YES	M
9	1000	1483.00 (BankA - 1MHz) (independently programmable)	NO*	H
10	1001	1511.00 (BankA - 1MHz) (independently programmable)	NO*	H
11	1010	1655.00 (BankA - 1MHz) (independently programmable)	YES	H
12	1011	1699.00 (BankA - 1MHz) (independently programmable)	YES	H
13	1100	1775.00 (BankA - 1MHz) (independently programmable)	YES	H
14	1101	1871.00 (BankA - 1MHz) (independently programmable)	YES	H
15	1110	1919.00 (BankA - 1MHz) (independently programmable)	YES	H
16	1111	1970.00 (BankA - 1MHz) (independently programmable)	YES	H

OutL -fixed at 404MHz (432 Transverter (28MHz IF). VCO L (L2)

1152 MHz options: X2 for 2304MHz, X3 3456MHz, X5 5760MHz, X9 10368MHz, X21 24192MHz

* 1483/1484MHz and 1511/1512MHZ are normally not locking as sent, adjustments to VCO H will usually be needed if these frequencies are required. (L6 increased). 1919MHz and 1970MHz will likely not lock in this case.


SMA
Out L
ERA2
Out L MMIC fitted
Supply
(7.5-12Vdc)
5V Reg.
C5
C9
D1
IC1
C3
C4
C6
SFJMP
MSB
LSB
Frequency Select
0
1
PICAXE14M2
(In Socket)
C15
C16
R14
L3
C19
C11
R11
R12
T2
C20
REF
SMA
C25
R24
R23
C12
C14
L1
VCO L
L2
R13
C13
R17
R16
F1
SI4133
VCXO (optional)
R18
C23
C24
L5
L6
VCO H
VCO M
VCXO EN.
R20
C26
C27
VCXO Adj.
C21
R21
C1
C2
R1
R2
R3
R4
R5
R6
R7
R8
R9
C7
C8
C10
R10
T1
C17
C18
R15
L4
C22
PLL V2 VK3XDK
Out H
ERA2
Out H MMIC fitted
SMA
(C)VK3XDK grumss@yahoo.com.au
http://www.vk3xdk.net46.net/