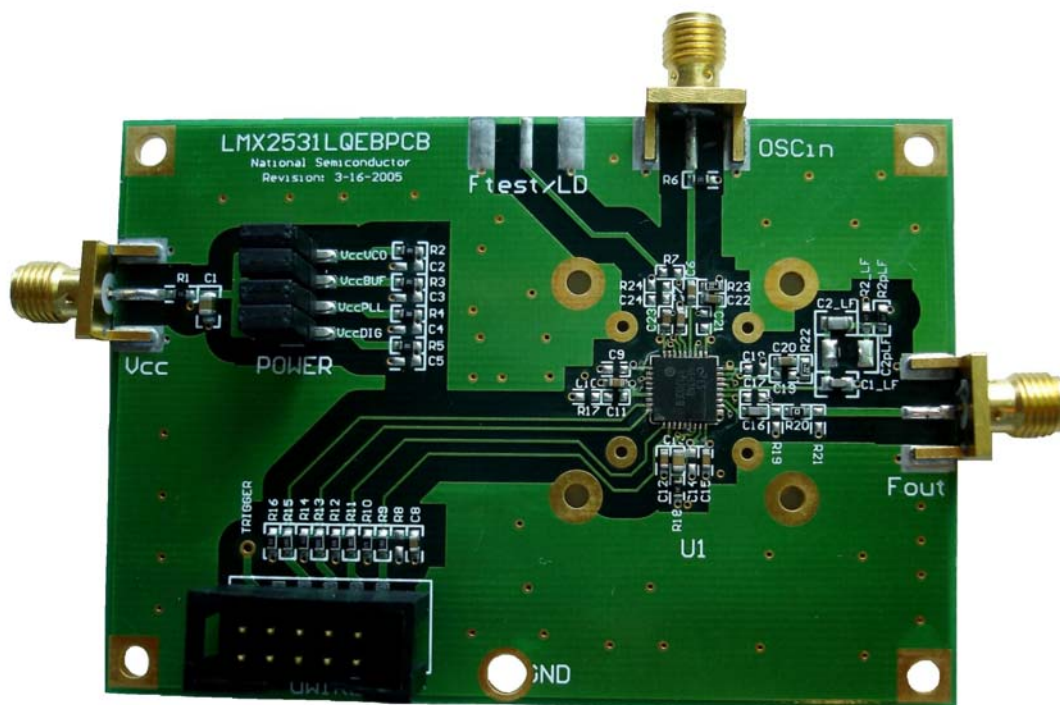




## LMX2531LQ1778E

### Evaluation Board Operating Instructions



National Semiconductor Corporation  
Wireless Communications, RF Products Group

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M/S A-600  
Santa Clara, CA, 95052-8090

LMX2531LQ1778EFPEB Rev 1.20.2006

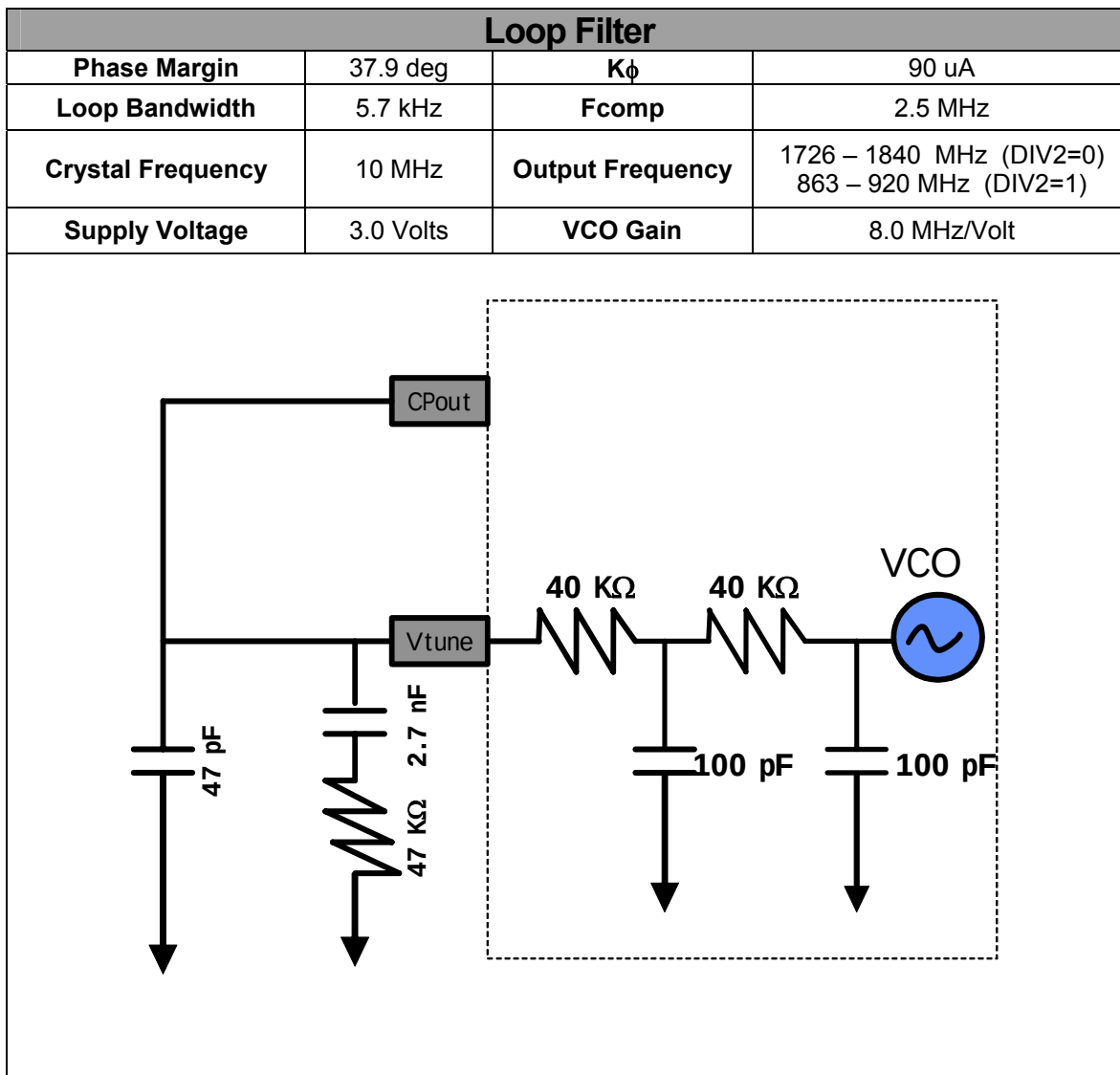
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## General Description

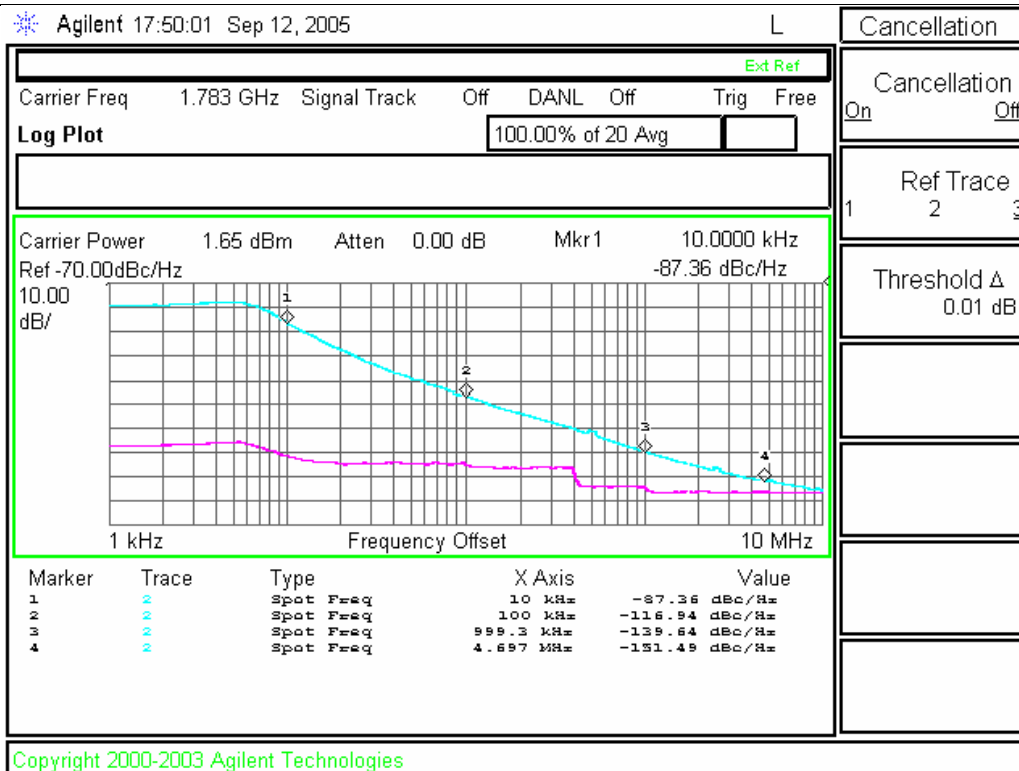
The LMX2531LQ1778E Evaluation Board simplifies evaluation of the LMX2531LQ1778E PLL/VCO synthesizer system. The board enables all performance measurements with no additional support circuitry. The evaluation board consists of a LMX2531LQ1778E device, and a cable assembly.

The cable assembly is bundled with the evaluation board for connecting to a PC through the parallel printer port. By means of **MICROWIRE™** serial port emulation, the *CodeLoader* software included can be run on a PC to facilitate the LMX2531LQ1778E internal register programming for the evaluation and measurement. In addition to this cable assembly, there is a microwire buffer board that ensures that the proper voltage levels are provided to the microwire inputs and also this reduces digital noise from computers through the parallel port.

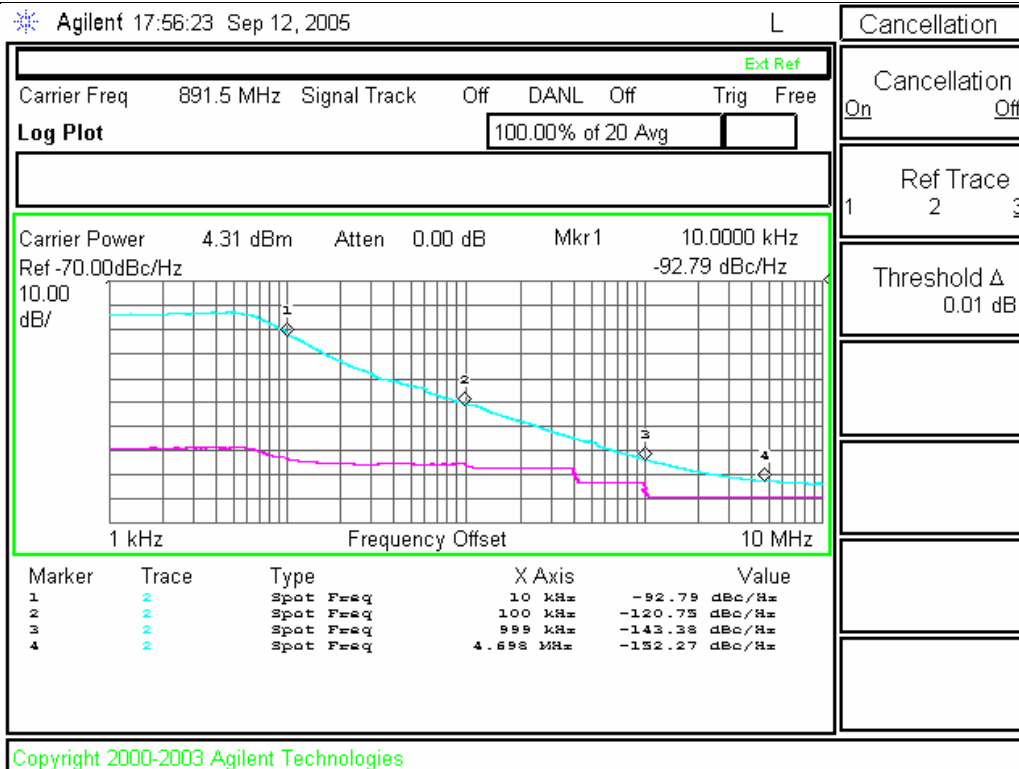


## Phase Noise

Output Frequency = 1783 MHz  
Internal Divide by 2 Disabled (DIV2=0)

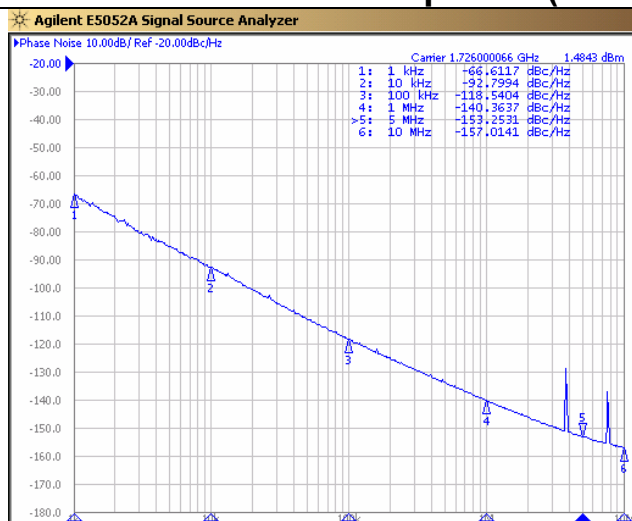


Output Frequency = 891.5 MHz  
Internal Divide by 2 Enabled (DIV2=1)



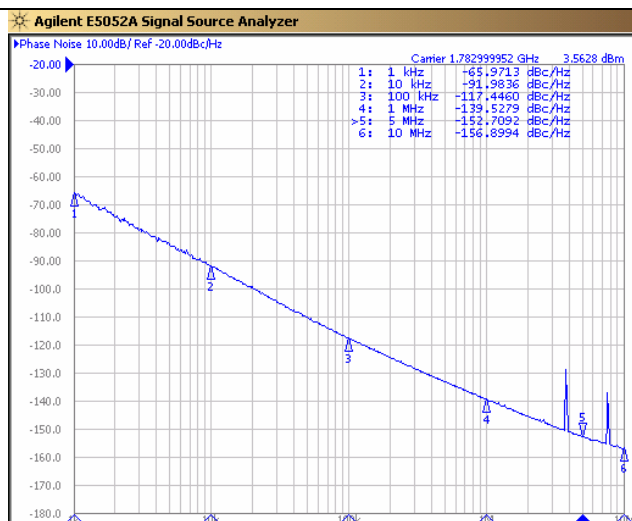
## Phase Noise with Narrow Loop Filter (Internal Divide by 2 Disabled)

Fout = 1726 MHz



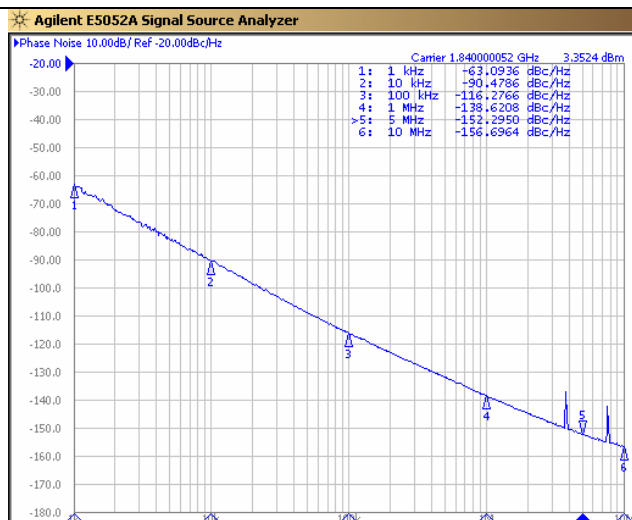
The plots to the left show the true phase noise capability of the VCO. In order to take these plots, a 20 Hz loop bandwidth was used with the E5052 spectrum analyzer. This is the most accurate and state of the art equipment.

Fout = 1783 MHz



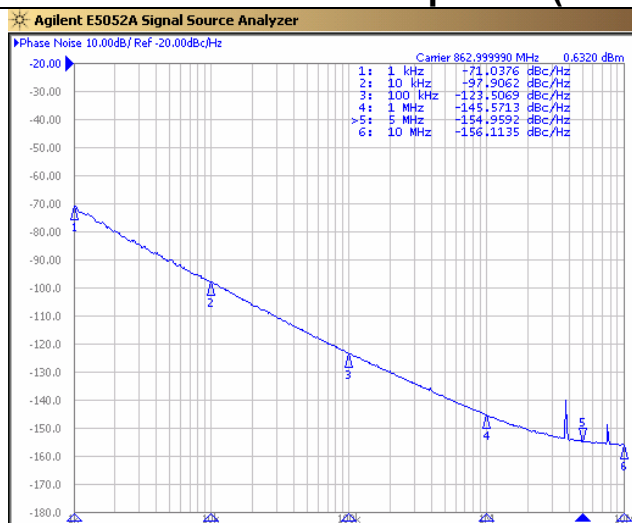
At lower offsets, the measurements are more accurate because the impact of the PLL is removed. At higher offsets, the measurements are also more accurate because the E5052 spectrum analyzer has a much lower noise floor than the E4445A spectrum analyzer. Even though the E4445A has a noise cancellation feature, it only cancels out thermal noise and not cancel out the phase noise if the LO inside this equipment.

Fout = 1840 MHz



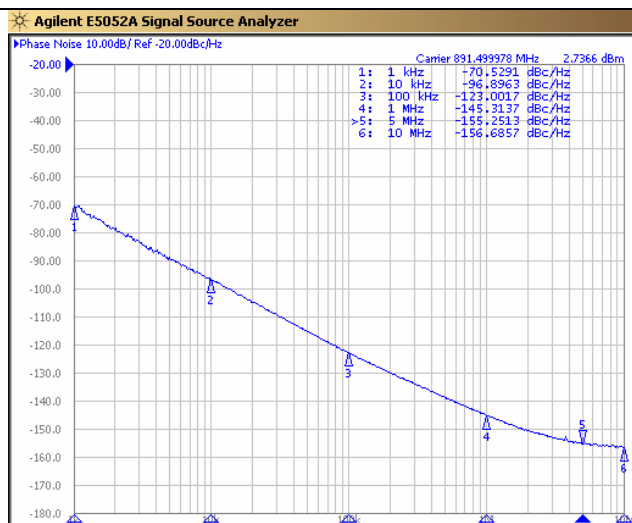
## Phase Noise with Narrow Loop Filter (Internal Divide by 2 Enabled)

Fout = 863 MHz



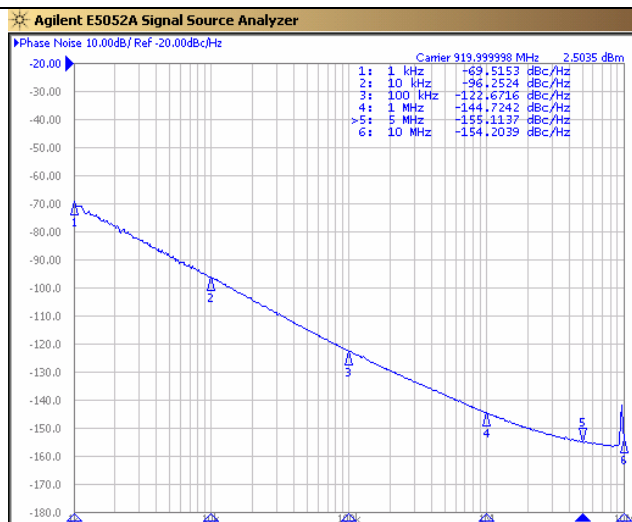
The plots to the left show the true phase noise capability of the VCO. In order to take these plots, a 20 Hz loop bandwidth was used with the E5052 spectrum analyzer. This is the most accurate and state of the art equipment.

Fout = 891.5 MHz

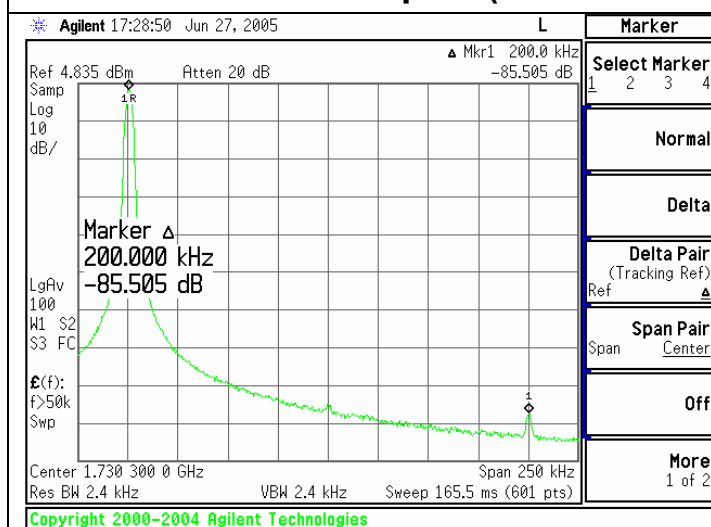


At lower offsets, the measurements are more accurate because the impact of the PLL is removed. At higher offsets, the measurements are also more accurate because the E5052 spectrum analyzer has a much lower noise floor than the E4445A spectrum analyzer. Even though the E4445A has a noise cancellation feature, it only cancels out thermal noise and not cancel out the phase noise if the LO inside this equipment.

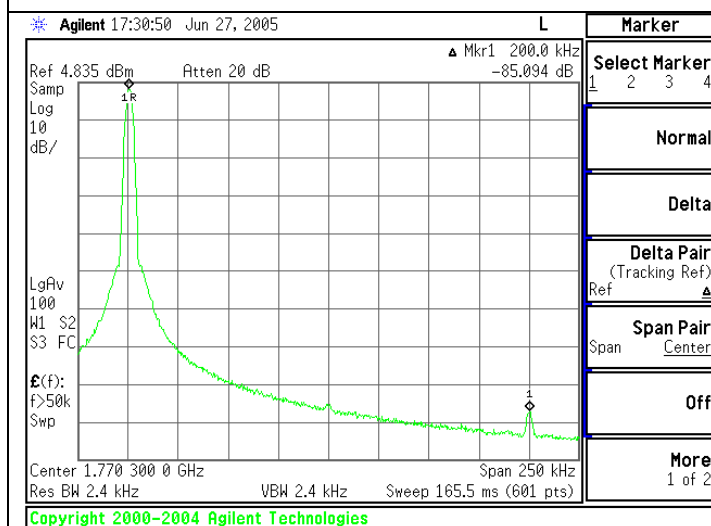
Fout = 920 MHz



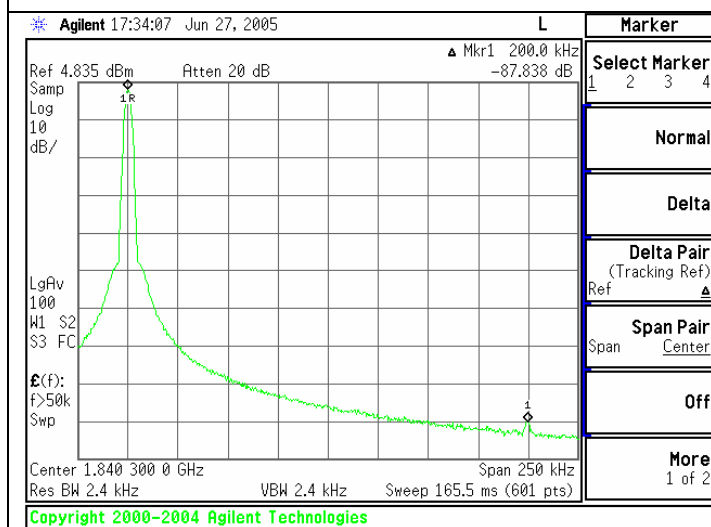
## Spurs (Internal Divide by 2 Disabled)



Spur at 200 kHz offset at a worst case frequency of 1730.2 MHz is -85.5 dBc. Worst case channels occur at exactly one channel spacing above or below a multiple of the crystal frequency.

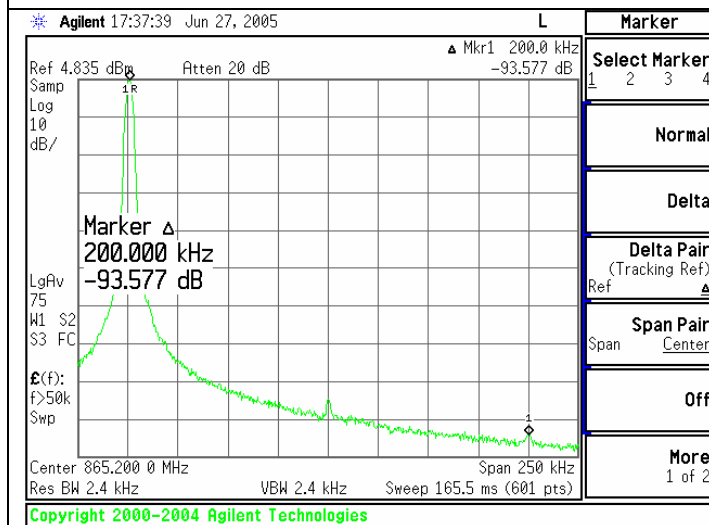


Spur at 200 kHz offset at a worst case frequency of 1770.2 MHz is -85.1 dBc.

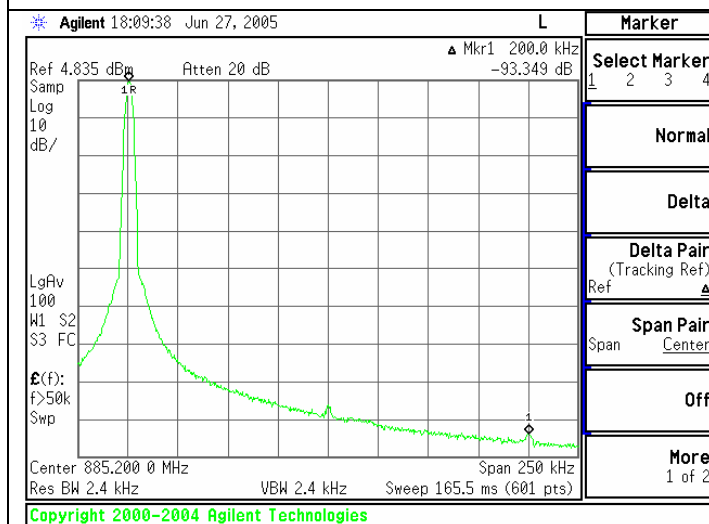


Spur at 200 kHz offset at a worst case frequency of 1840.2 MHz is -87.8 dBc.

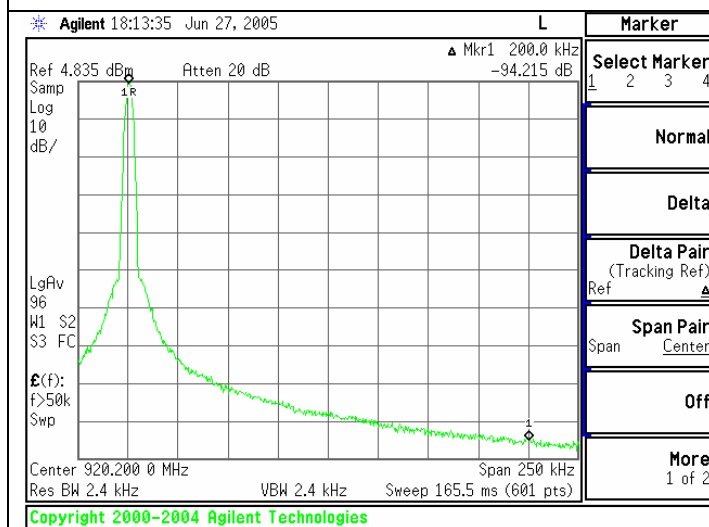
## Spurs (Internal Divide by 2 Enabled)



Spur at 200 kHz offset at a frequency of 865.1 MHz is -93.6 dBc. Since this mode uses the divide by 2 mode, the channel spacing here is actually 100 kHz. The spur at 100 kHz could be eliminated by doubling the channel spacing before the divider. The reason that the spur at 200 kHz is shown is to illustrate the theoretical 6 dB impact of the divider.



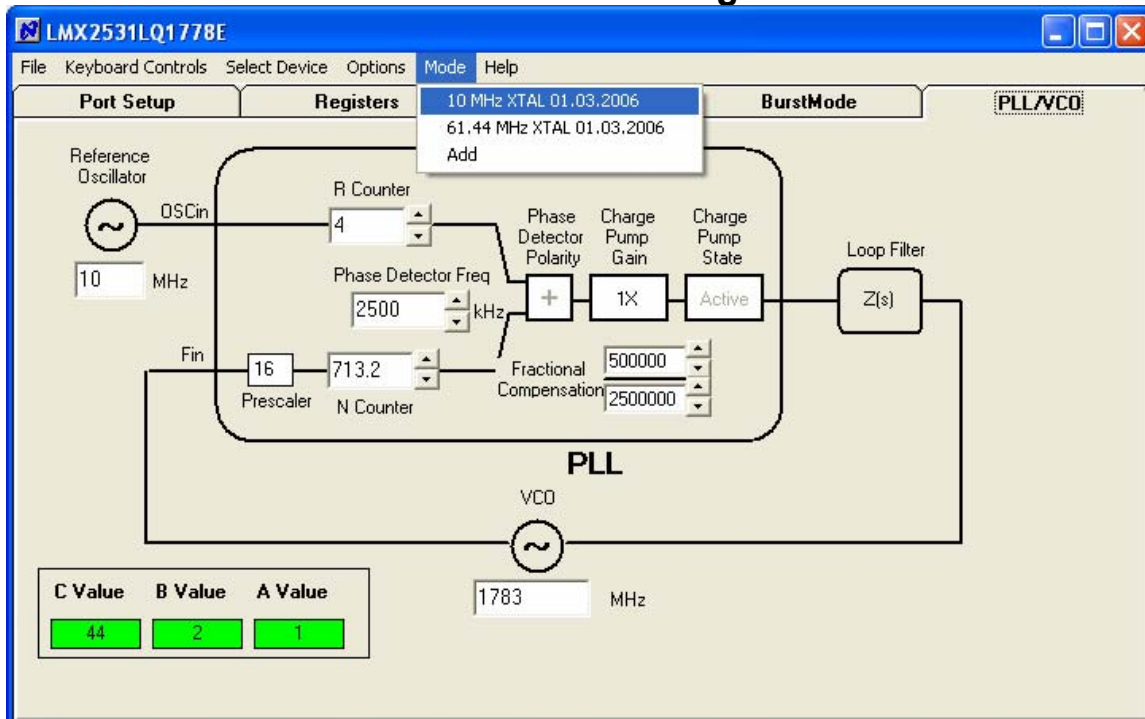
Spur at 200 kHz offset for a frequency of 885.1 MHz is -93.3 dBc.



Spur at 200 kHz offset for a frequency of 920.1 MHz is -94.2 dBc.



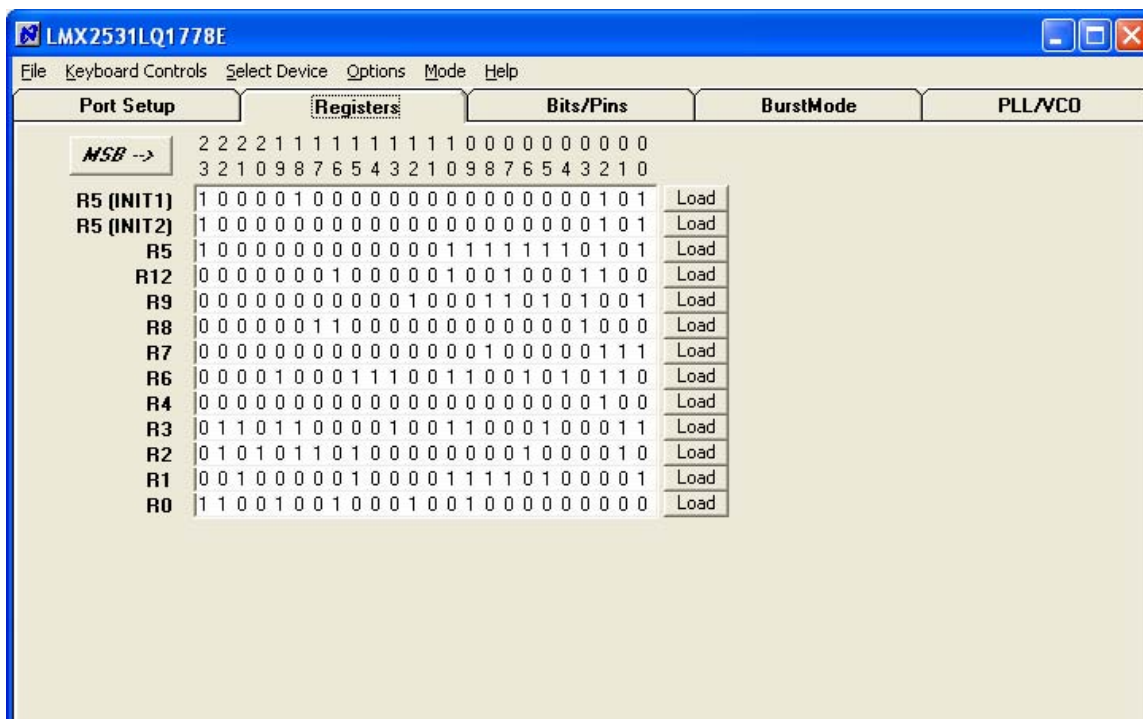
## CodeLoader Settings



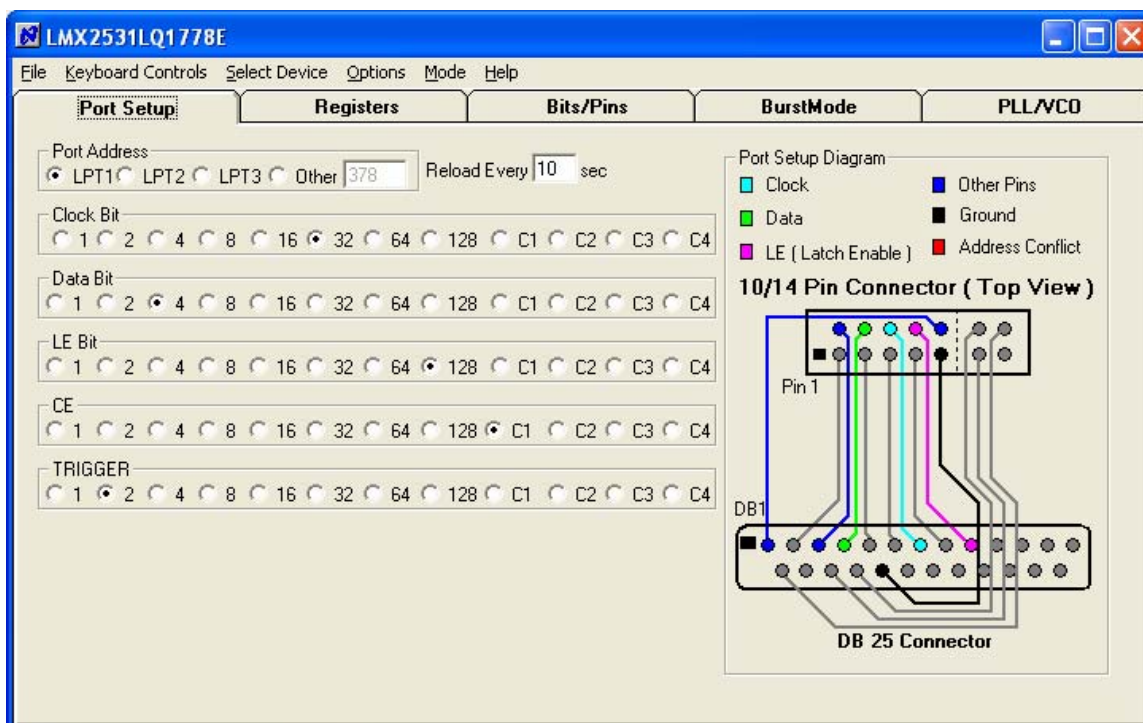
For the CodeLoader program, the default reference oscillator used for these instructions was 10 MHz, but there is a mode for a 61.44 MHz oscillator as well. If the bits become scrambled, their original state may be recalled by choosing the appropriate mode. Note that if the internal divide by 2 is enabled, the VCO frequency still reflects the VCO frequency before the divide by 2.

The screenshot shows the LMX2531LQ1778E CodeLoader Settings window with the 'Bits/Pins' tab selected. The configuration is as follows:

- INITIALIZATION:**
  - ☐ REG\_RST
- VCO OUTPUT:**
  - ☐ DIV2
- POWER CONTROLS:**
  - ☒ EN\_PLL
  - ☒ EN\_PLLLD01
  - ☒ EN\_PLLLD02
  - ☒ EN\_DIGLDO
  - ☒ EN\_VCO
  - ☒ EN\_VCOLDO
  - ☒ EN\_OSC
- VCO PN OPTIMIZATION:**
  - VCO\_ACISEL: 8
- VCO FREQUENCY CAL:**
  - XTLDIV: Divide by 2
  - XTLSEL: <20 MHz
  - XTLMAN: 0
  - ☐ XTLMAN2
- FRACTIONAL CONTROLS:**
  - ☒ FDM
  - ORDER: 3rd Order Modulator
  - DITHER: Strong Dithering
- INTERNAL LOOP FILTER:**
  - ☒ EN\_LPFILTR
  - C3\_4\_ADJ: C3=100pF, C4=100pF
  - R3\_ADJ: 40 Kohm
  - R4\_ADJ: 40 Kohm
- FASTLOCK CONTROLS:**
  - TOC: 0
  - ICPFL: 1X
  - R3\_ADJ\_FL: 0 Ohm
  - R4\_ADJ\_FL: 0 Ohm
- LOCK DETECT:**
  - ☐ LDDIV4
  - FoLD: Disabled
- Program Pins:**
  - ☒ CE
  - ☐ TRIGGER



CodeLoader is set up to load the registers and initialize the part in the correct way. R5 (INIT1) and R5 (INIT 2) are just the R5 register being used to properly initialize the part. So a single CNT+L should load the part.



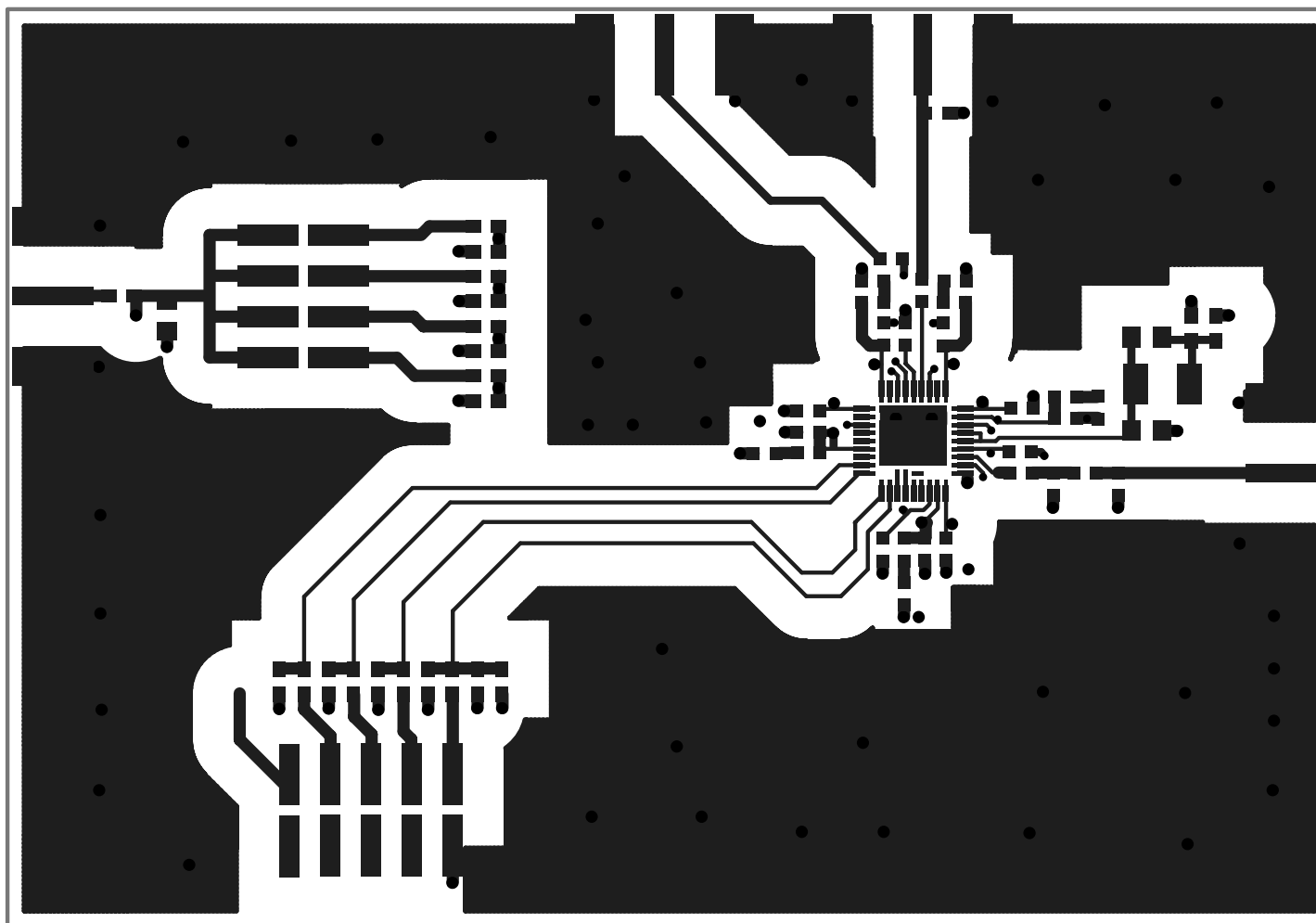
The port setup tells CodeLoader what information goes where. If this is wrong, the part will not program. Although LPT1 is usually correct, CodeLoader does not autodetect the correct port. On some laptops, it may be LPT3.

## Schematic

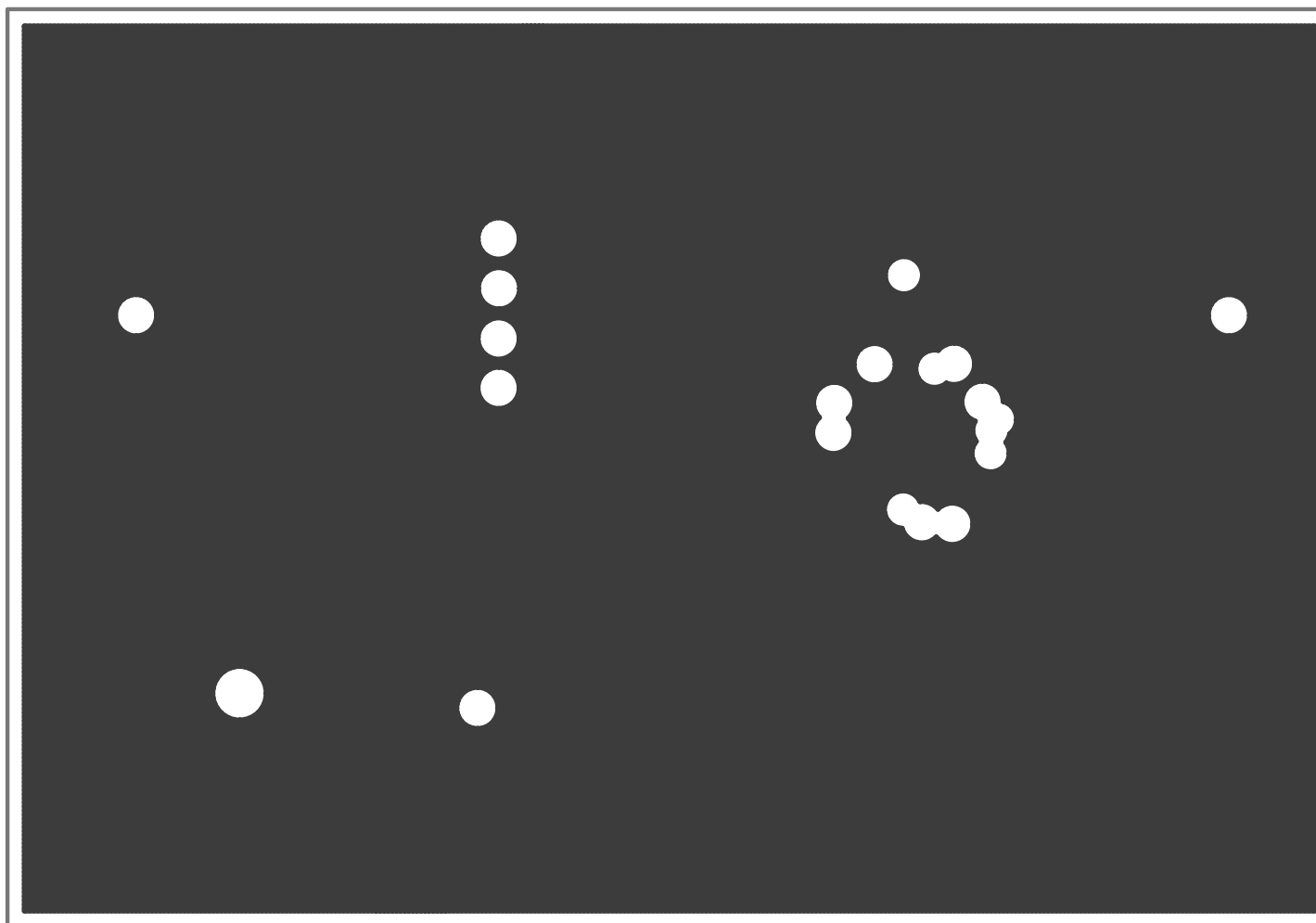


| Bill of Materials |     |                        |                 | LMX2531EB |     |         |                     |                                | Revision 1/3/2006                                                                                |
|-------------------|-----|------------------------|-----------------|-----------|-----|---------|---------------------|--------------------------------|--------------------------------------------------------------------------------------------------|
| Item              | QTY | Manufacturer           | Part #          | Size      | Tol | Voltage | Material            | Value                          | Designators                                                                                      |
| 0                 | 19  | n/a                    |                 |           |     |         |                     | Open Capacitors                | C2pLF, C2, C3, C4, C5, C9, C11, C14, C17, C18, C19, C21, C24, C100, C101, C102, C103, C104, C105 |
|                   | 6   |                        |                 |           |     |         |                     | Open Resistors                 | R7, R8, R17, R19, R21, R24                                                                       |
|                   | 1   |                        |                 |           |     |         |                     | Open Miscellaneous             | Ftest/LD                                                                                         |
| 1                 | 1   | Kemet                  | C0603C470J5GAC  | 603       | 5%  | 50V     | C0G                 | 47pF                           | C1_LF                                                                                            |
| 2                 | 1   | Kemet                  | C0603C101J5GAC  | 603       | 5%  | 50V     | C0G                 | 100pF                          | C16                                                                                              |
| 3                 | 1   | Kemet                  | C0805C272J3GAC  | 805       | 5%  | 25V     | C0G                 | 2.7nF                          | C2_LF                                                                                            |
| 4                 | 2   | Kemet                  | C0603C103J5RAC  | 603       | 5%  | 50V     | X7R                 | 10nF                           | C10, C23                                                                                         |
| 5                 | 4   | Kemet                  | C0603C104J3RAC  | 603       | 5%  | 25V     | X7R                 | 100nF                          | C6, C7, C12, C15                                                                                 |
| 6                 | 2   | Kemet                  | C0603C474K4RAC  | 603       | 10% | 16V     | X7R                 | 470nF                          | C20, C22                                                                                         |
| 7                 | 1   | Kemet                  | C0603C105K4RAC  | 603       | 10% | 16V     | X5R                 | 1uF                            | C8                                                                                               |
| 8                 | 1   | Kemet                  | C0603C475K9PAC  | 603       | 10% | 6.3V    | X5R                 | 4.7uF                          | C13                                                                                              |
| 9                 | 1   | Kemet                  | C0805C106K8PAC  | 805       | 10% | 10V     | X5R                 | 10uF                           | C1                                                                                               |
| 10                | 1   | Vishay                 | CRCW0603000ZRT1 | 603       | 5%  | 0.1W    | Thick Film          | 0Ω                             | R20                                                                                              |
| 11                | 2   | Panasonic              | P.22AHCT-ND     | 603       | 10% | 0.1W    | Thick Film          | 0.22Ω                          | R22, R23                                                                                         |
| 12                | 2   | Vishay                 | CRCW06033R3JRT1 | 603       | 5%  | 0.1W    | Thick Film          | 3.3Ω                           | R1, R18                                                                                          |
| 13                | 4   | Vishay                 | CRCW0603100JRT1 | 603       | 5%  | 0.1W    | Thick Film          | 10Ω                            | R2, R3, R4, R5                                                                                   |
| 14                | 1   | Vishay                 | CRCW0603510JRT1 | 603       | 5%  | 0.1W    | Thick Film          | 51Ω                            | R6                                                                                               |
| 15                | 4   | Vishay                 | CRCW0603103JRT1 | 603       | 5%  | 0.1W    | Thick Film          | 10KΩ                           | R9, R11, R13, R15                                                                                |
| 16                | 5   | Vishay                 | CRCW0603123JRT1 | 603       | 5%  | 0.1W    | Thick Film          | 12KΩ                           | R2pLF, R10, R12, R14, R16                                                                        |
| 17                | 1   | Vishay                 | CRCW0603473JRT1 | 603       | 5%  | 0.1W    | Thick Film          | 47KΩ                           | R2_LF                                                                                            |
| 18                | 1   | Comm Con Connectors    | HTSM3203-8G2    | 2X4       | n/a | n/a     | Metal/Plastic       | Header                         | POWER                                                                                            |
| 19                | 1   | FCI Electronics        | 52601-S10-8     | 2X5       | n/a | n/a     | Metal/Plastic       | Header                         | uWire                                                                                            |
| 20                | 3   | Johnson Components     | 142-0701-851    | SMA       | n/a | n/a     | Metal               | SMA                            | Fout, OSCin, Vcc                                                                                 |
| 21                | 1   | National Semiconductor | LMX2531LQEBPCB  | n/a       | n/a | n/a     | FR4<br>62 mil Thick | PCB Board<br>1st Layer 10 mils | n/a                                                                                              |
| 22                | 1   | National Semiconductor | LMX2531         | LLP36     | n/a | 2.7     | Silicon             | LMX2531                        | U1                                                                                               |
| 23                | 4   | Com Con Connectors     | CCIJ255G        | 2-Pin     | n/a | n/a     | Metal/Plastic       | Shunt                          | Place Across:<br>POWER: 1-2, 3-4, 5-6, 7-8                                                       |
| 24                | 4   | SPC Technology         | SPCS-8          | 0.156"    | n/a | n/a     | Nylon               | Nylon Standoffs                | Place in 4 Holes in Corners of Board                                                             |

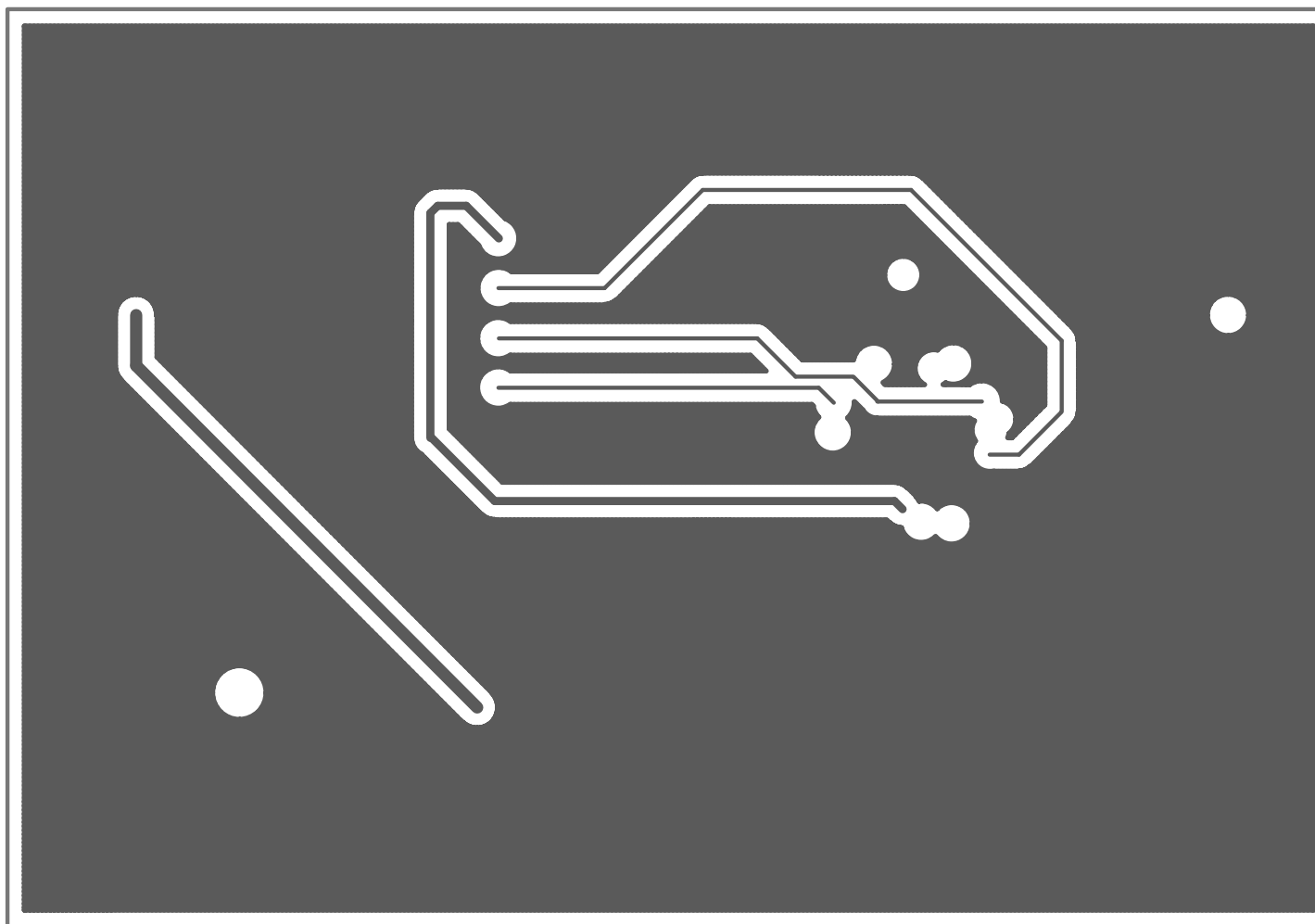
## Top Layer



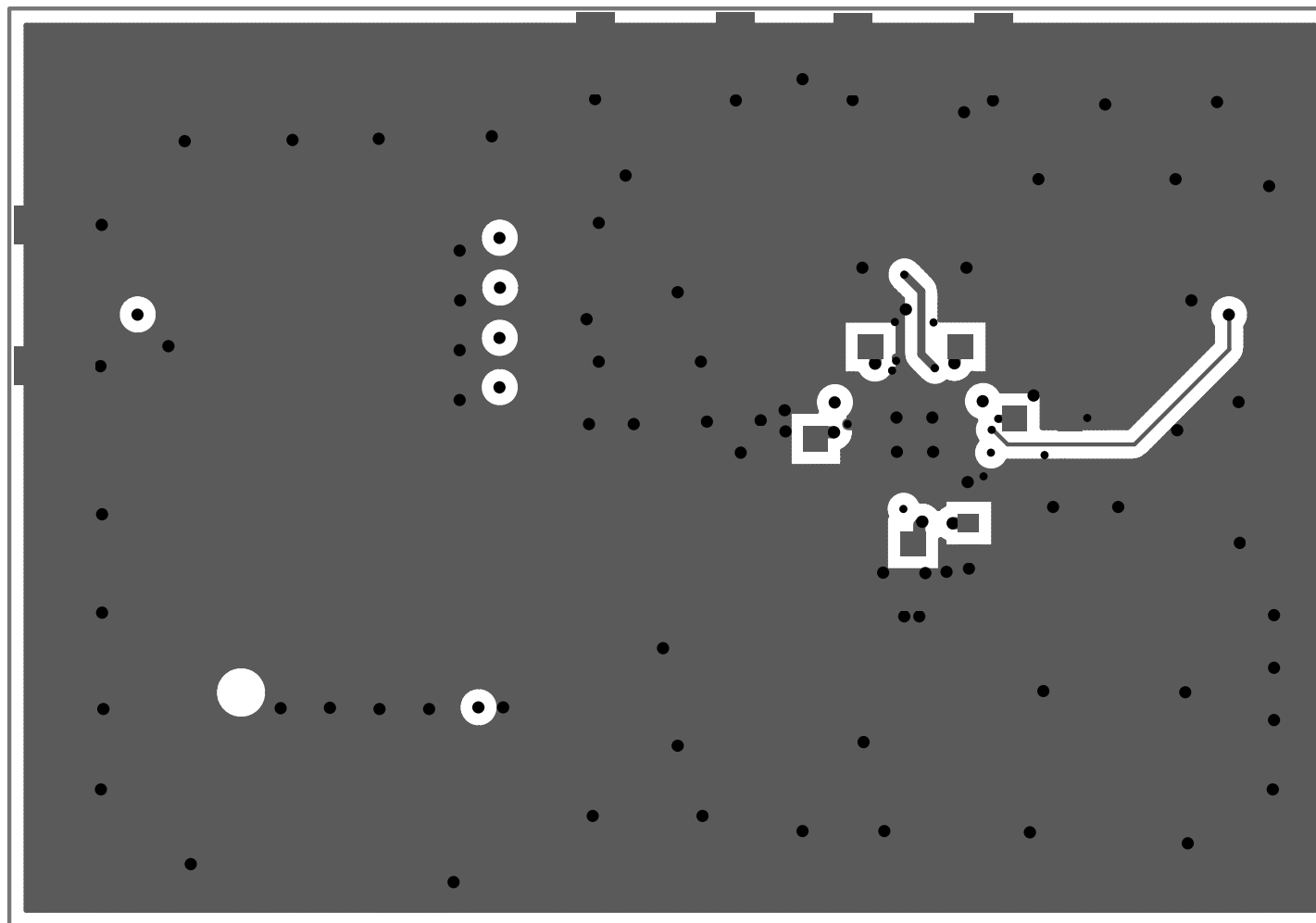
## Mid Layer 1 "Ground Plane" (15 Mils Down FR4)



## Mid Layer 2 "Power"



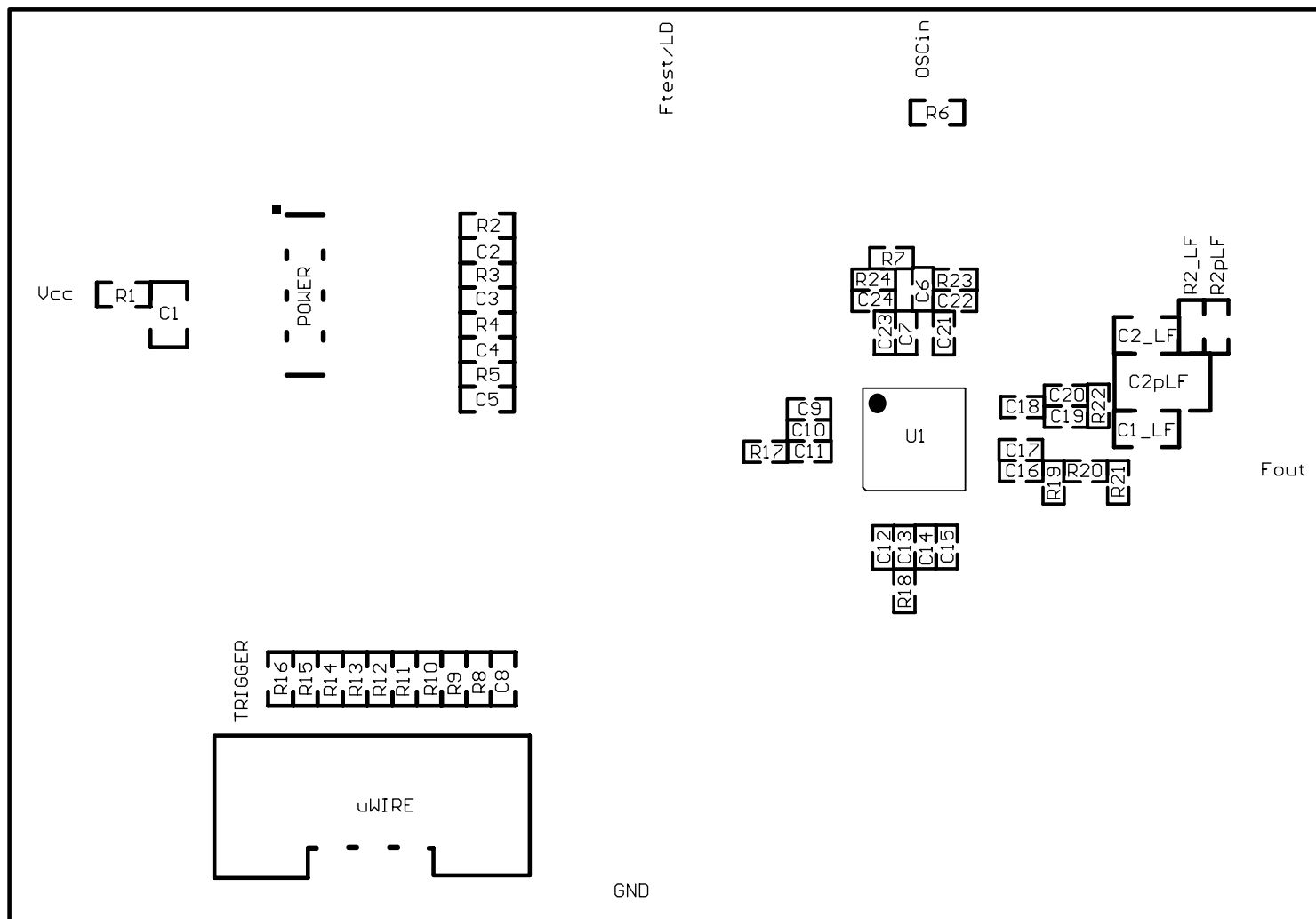
### Bottom Layer "Signal"



**Note:** Total Board Thickness = 61 mils



## Top Build Diagram



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