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# The Voltage Controlled Oscillator for Fixed Frequency Acceleration

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The fixed-frequency acceleration VCO [1] uses the basic LC oscillator used in the ppbar VCO [ref. 2]. The tank circuit of the oscillator was modified to extend its frequency range. The coupling to the varactor diode for frequency control was also modified. The coupling arrangement is shown in figure 1. There is a DC coupled input and an AC-coupled input. The nominal DC level at the DC-coupled input is zero. This is done so that the op amp that sums the various inputs to the VCO has a quiescent output of zero volts. An especially stable op amp is used, OP-07. Its limited high frequency response is unimportant because the fast modulation is done via the AC-coupled input.

The AC-coupled input connects directly through a coupling capacitor to the positive biased side of the varactor. The coupling is a high-pass network and allows very fast modulation of the varactor's bias voltage. In operation it was observed that the presence of the AC-coupled modulation had a small effect on the average frequency of the VCO. This undesirable effect is likely caused by some rectification of the modulation signal as the rf voltage summed with the modulation voltage causes some forward conducting in the varactor, thereby changing its bias voltage. A lower rf voltage on the varactor would be preferable.

The full circuit diagram of the VCO is shown in figures 2 and 3. A timing diagram for the delay circuit is shown in figure 4.

<u>The front panel controls are:</u>

| | | |
|---|---|---|
| 1. | OFFSET | adjusts the free-running frequency of the VCO, i.e. the frequency when all inputs are zero. |
| 2. | Fcavity | adjusts the frequency at which the frequency modulation will be zero, this is the frequency $f_1$, which is normally set to the optimum cavity frequency. |
| 3. | df/dv | adjusts the sensitivity to the frequency control inputs. |

<u>The front panel ouputs are:</u>

| | | |
|---|---|---|
| 1. | VCO DC | this monitors the DC-coupled input to the VCO. The sensitivity here is approximately +0.35 MHz/Volt. |
| 2. | VCO AC | this monitors the AC-coupled input to the VCO. The sensitivity here is approximately -0.35 MHz/Volt. |
| 3. | RF ON | a digital level corresponding to the rf on time, TTL. |

The rear panel inputs are:

| | | |
|---|---|---|
| 1. | Fprogram | comes from the B train-driven circuit that computes rf frequency from the magnetic field. The sensitivity to this input is -0.50 MHz/volt. |
| 2. | Fphase | comes from the phase loop amplifier. The sensitivity to this input is -0.10 MHz/Volt. |
| 3. | Finject | comes from the injection loop amplifier. The sensitivity to this input is -0.10 MHz/Volt. |
| 4. | AUX | this input is for the function generator that controls the amplitude of the frequency modulation. The nominal scale factor is one Volt. It corresponds to 50% switching duty factor. The dependence on duty factor is h/2h2 |
| 5. | START | from trigger unit E, START begins $f_1$ time. |
| 6. | STOP | from trigger unit E, STOP ends $f_1$ time after 1 microsecond delay. |

The rear panel outputs are:

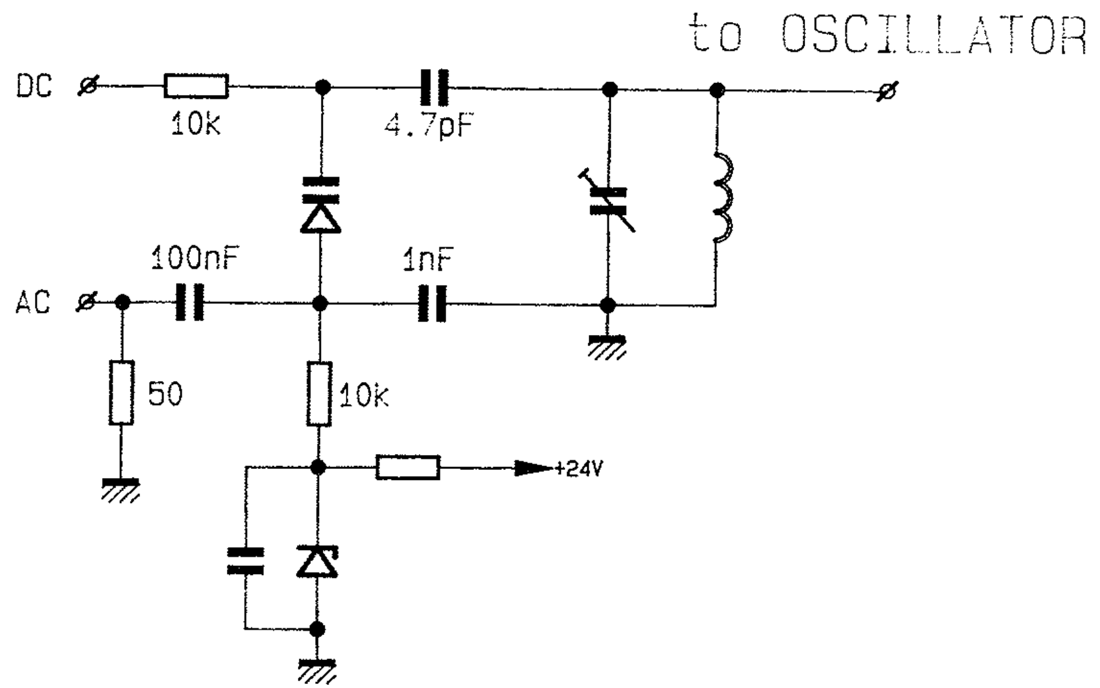
| | | |
|---|---|---|
| 1. | LO out | the local oscillator out, nominal level is 3 dBm. |
| 2. | RF ON (not) | the trigger to the fast rf switch for cavity drive modulation. Open collector. |

Adjustment procedure:

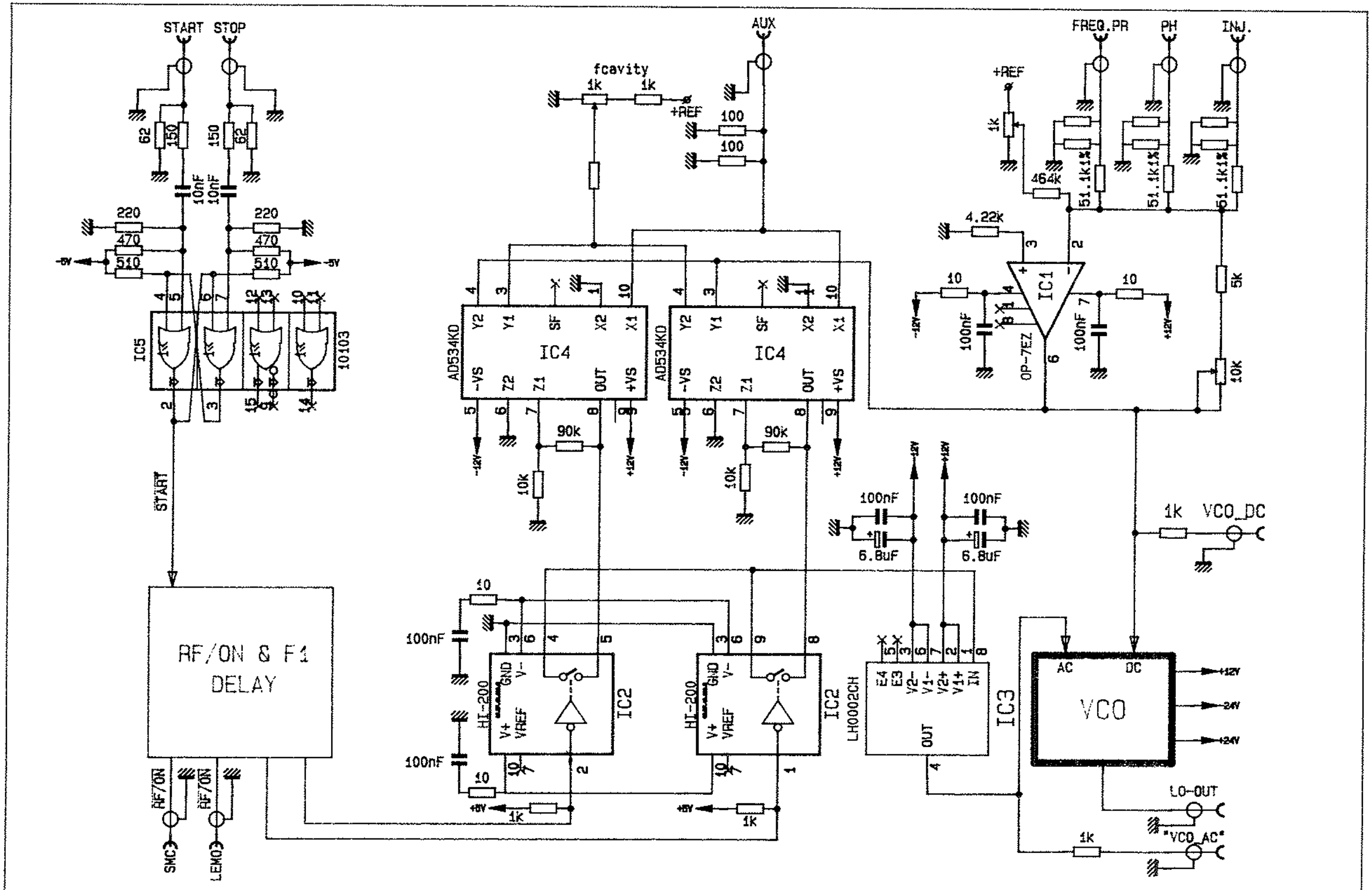
1. With all frequency control inputs open adjust OFFSET for Finfinity (= 189.7 MHz).
2. With Fprogram input set to the frequency program value at injection adjust df/dV to get the injection frequency.
3. With the Fprogram input set to the value for the optimum cavity frequency adjust Fcavity for zero volts peak to peak at the VCO AC monitor output.
4. The level at the AUX input controls the variation of $f_1$ as the frequency control inputs change.

**References**

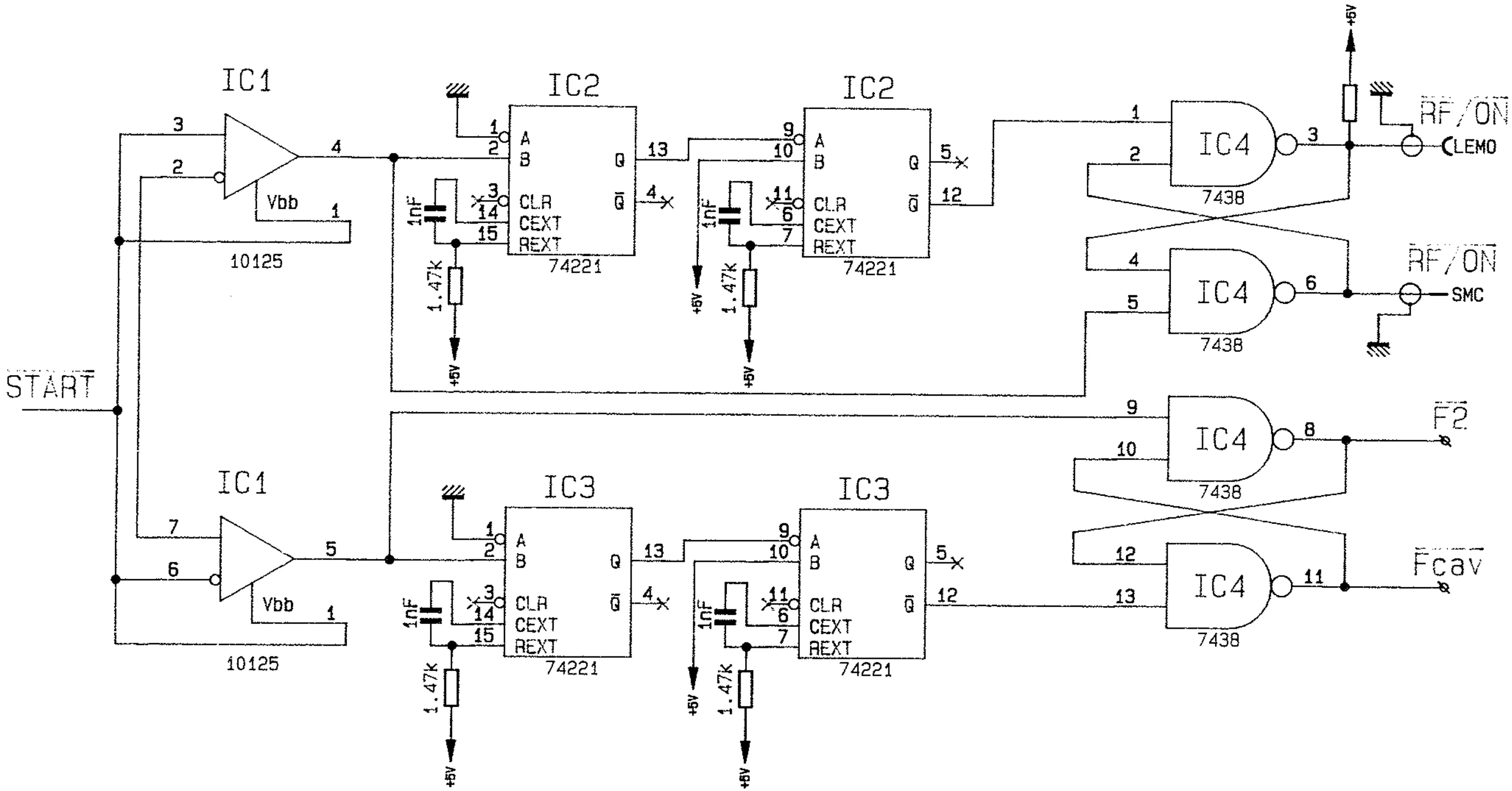

1. "Fixed Frequency Acceleration in the SPS", D. Boussard, M. Brennan, T. Linnecar, CERN SPS/89-11 (ARF)
2. "The Low Noise Oscillator for $p\bar{p}$", U. Wehrle, CERN SPS/ARF/UW/gs Note 83-10.




| | | |
|---|---|---|
| | RESP: | |
| | DESIGNER: | |
| FIG-A1 | DRAW: | |
| | MOD1 | |
| | MOD2 | |
| | MOD3 | |
| CERN-SPS-ARF | ACCELERATOR RADIO FREQUENCY | |




| | |
|---|---|
| FIG-A2 | RESP: / DESIGNER: / DRAW: / MOD1 / MOD2 / MOD3 |
| CERN-SPS-ARF | ACCELERATOR RADIO FREQUENCY |




| | | |
|---|---|---|
| | | RESP: |
| | | DESIGNER: |
| FIG-A3 | | DRAW: |
| | | MOD1 |
| | | MOD2 |
| | | MOD3 |
| CERN-SPS-ARF | ACCELERATOR RADIO FREQUENCY | |

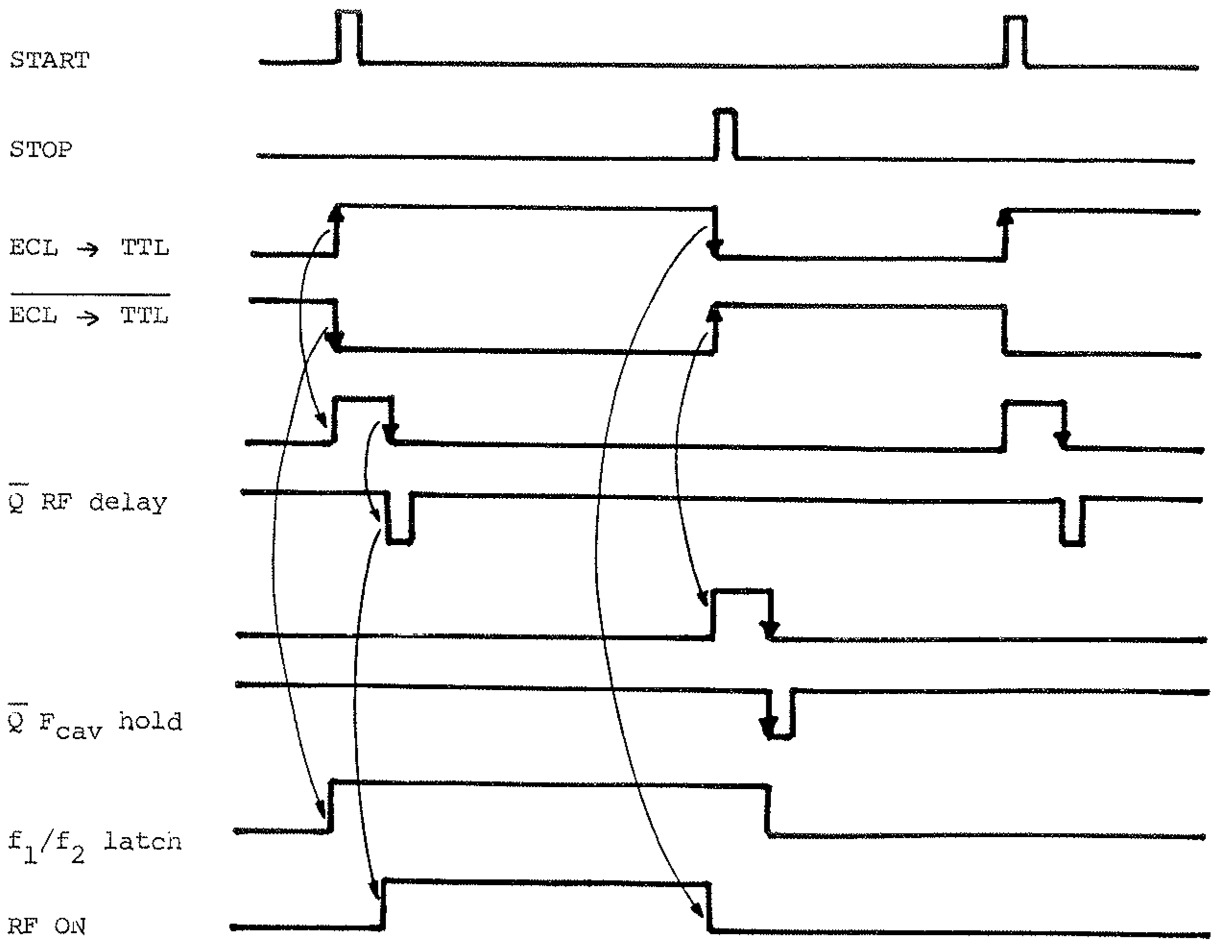



Fig. 4 Timing for RF ON delay and F cavity hold using 7438