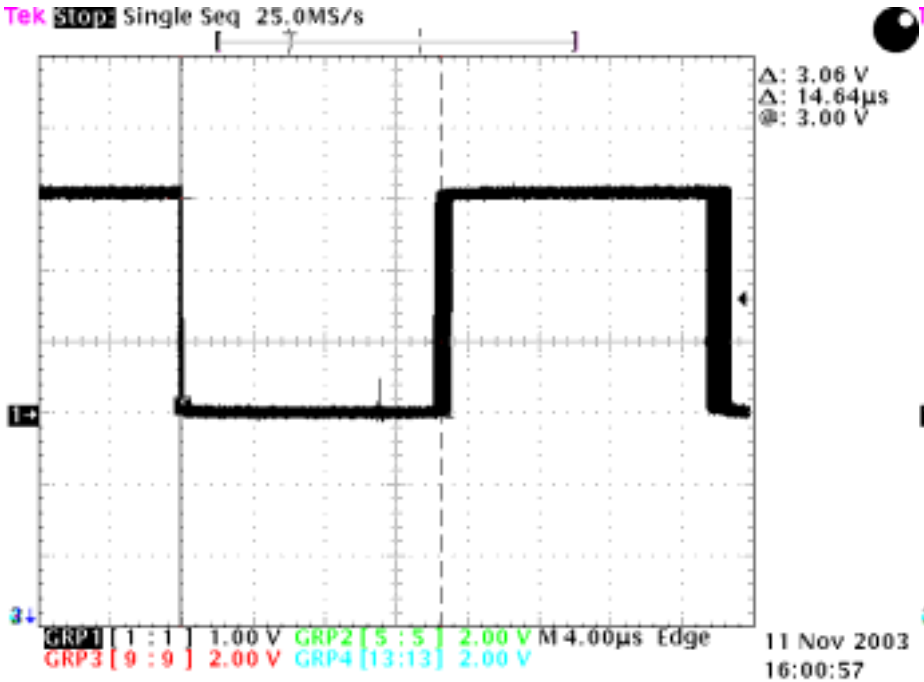
晶振－成品前的抖动测试

MSP430F149ACLK抖动的实例:

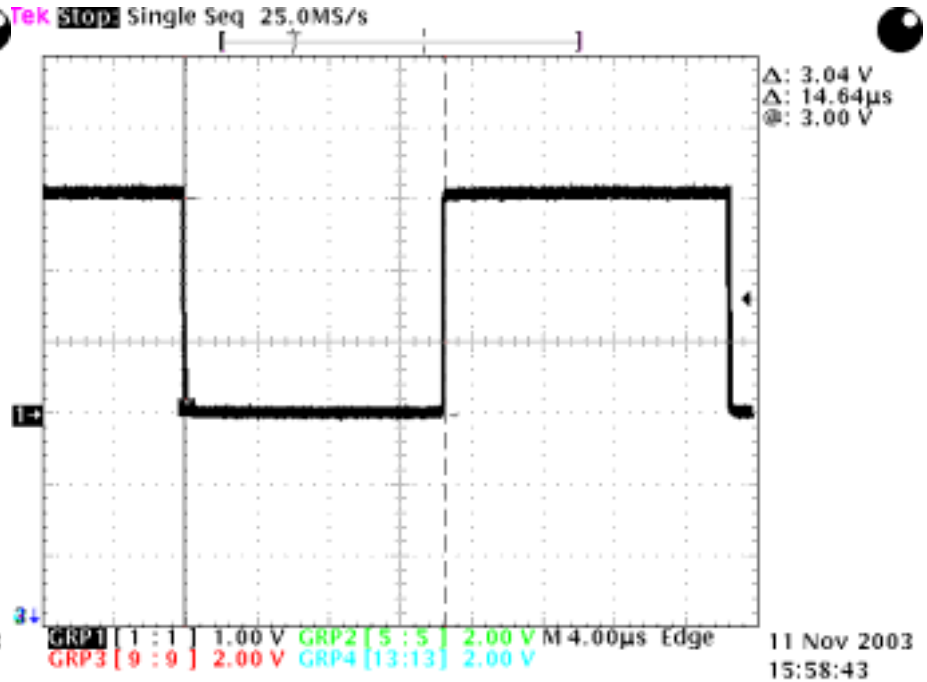
- 不利的抖动性

布局差与抗干扰



- 合理的抖动性

良好的布局

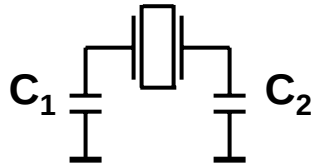


Envelope over 200 runs

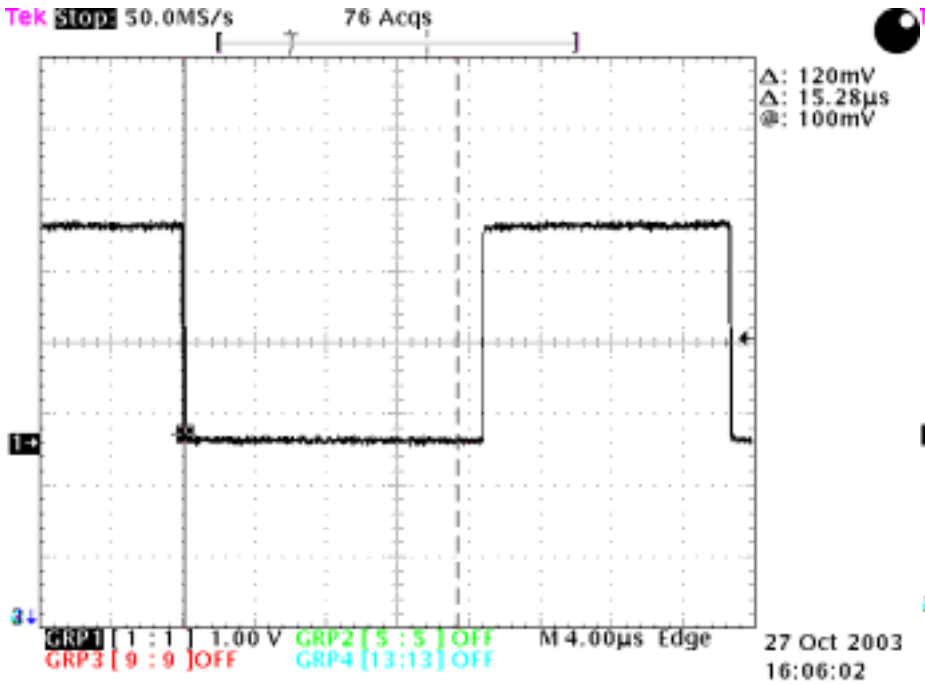
在一定的 条件下测量以上两项内容（在32kHz晶振频率下脉冲发生器的产生探测器的正确使用）

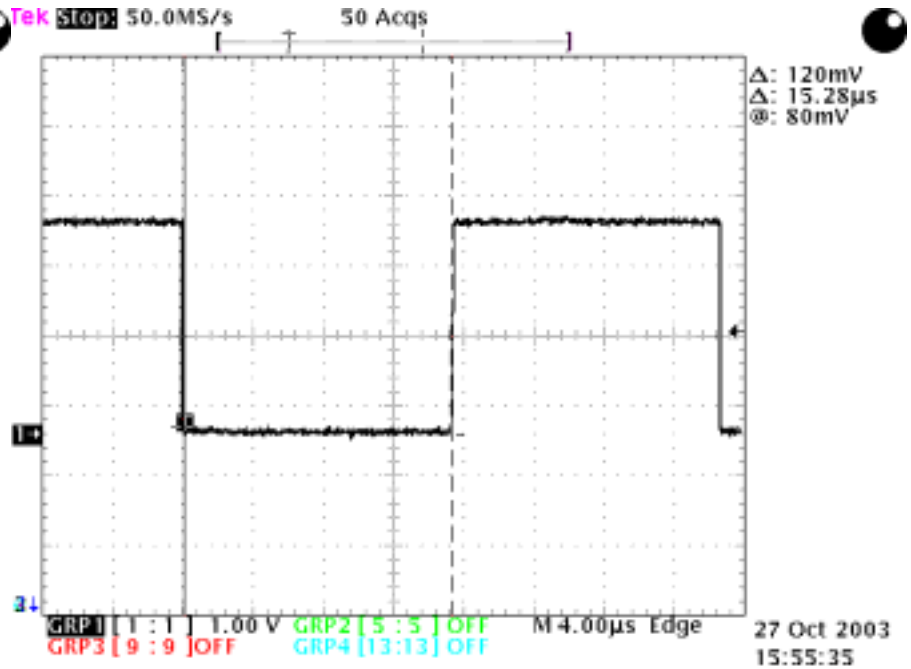
晶振 – 生产前测量占空比

MSP430F149ACK占空比改变的实例:



- 占空比的转变
- 通过改变 C1/C2的比值来修正占空比

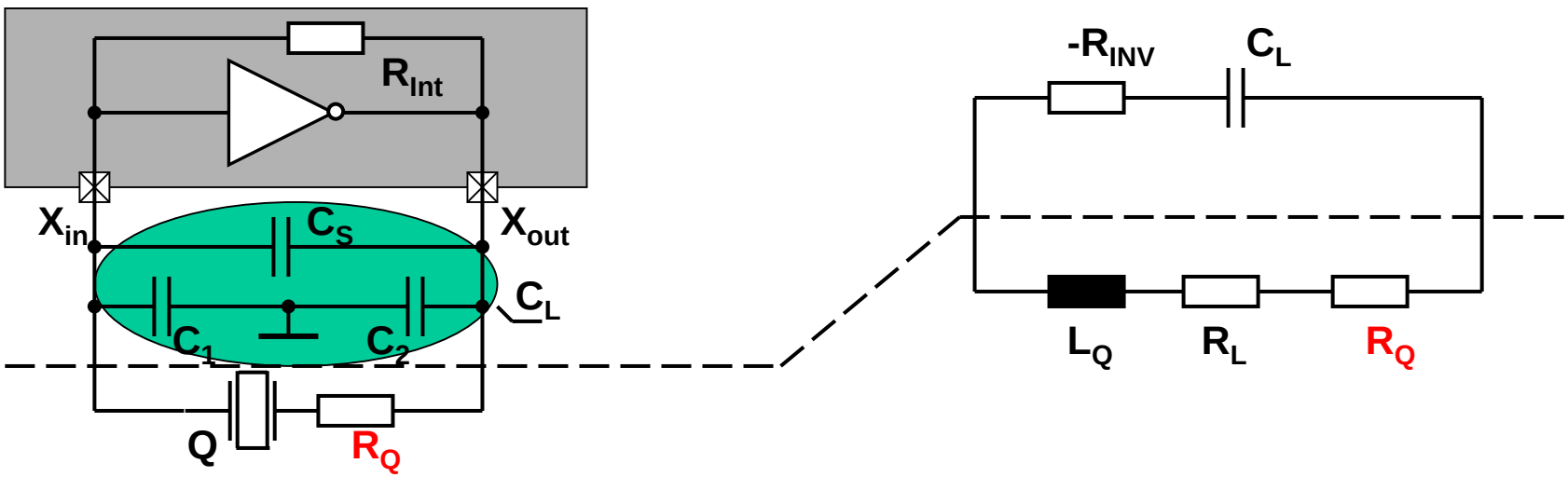




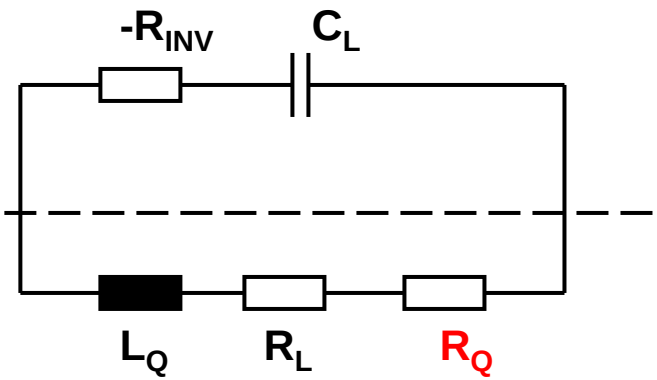
晶振- 生产前测量负阻抗的方法

- 绝大多数uC的晶振故障出现在启动相位期间
- .驱动能力是从小到大的增加
- Crystals show dips in their ESR dependent on drive level and temperature (Drive Level Dependency).
- 由于老化和产品的改变DLD会变化。
- 如果ESR的值达到一定范围（晶振放大小于1），晶振不能启动或处于休眠状态。

>>用负阻抗方法测试启动和振动的可靠性



晶体振荡器的测试 - 负阻抗方法



- 负载电容 C_L 包括C_1, C_2 和三C_S
- 振荡器的变极器放大能力由负阻抗 –RINV替代
- 石英晶体由负载谐振电阻R_L（有效电阻）和有效电抗 L_Q代替

振动的条件 $|-R_{INV}| = R_L + R_{Qmax}$

安全系数 $SF = \frac{R_{Qmax}}{R_{Lmax}}$

安全系数	级别
SF < 1.5	不合适
1.5 ≤ SF < 2	危险
2 ≤ SF < 3	适当
3 ≤ SF < 5	安全
SF ≥ 5	非常安全

MSP 430 1xx and 3xx family Quartz Crystal Specifications and Constraints				
Power Supply	V_{DD}	≥3	<3	[V]
Nominal Frequency	F_L	32.768	32.768	[kHz]
Load Capacitance	C_L	12.5	10.0	[pF]
Rs crystal	typ.	60	35	[kΩ]
Micro Crystal Metal can Packages		MX1V-L2N MS1V-T1K (MS2V-T1S)	MX1V-L2N	
Micro Crystal Ceramic Packages		CC1V-T1A CC4V-T1A		

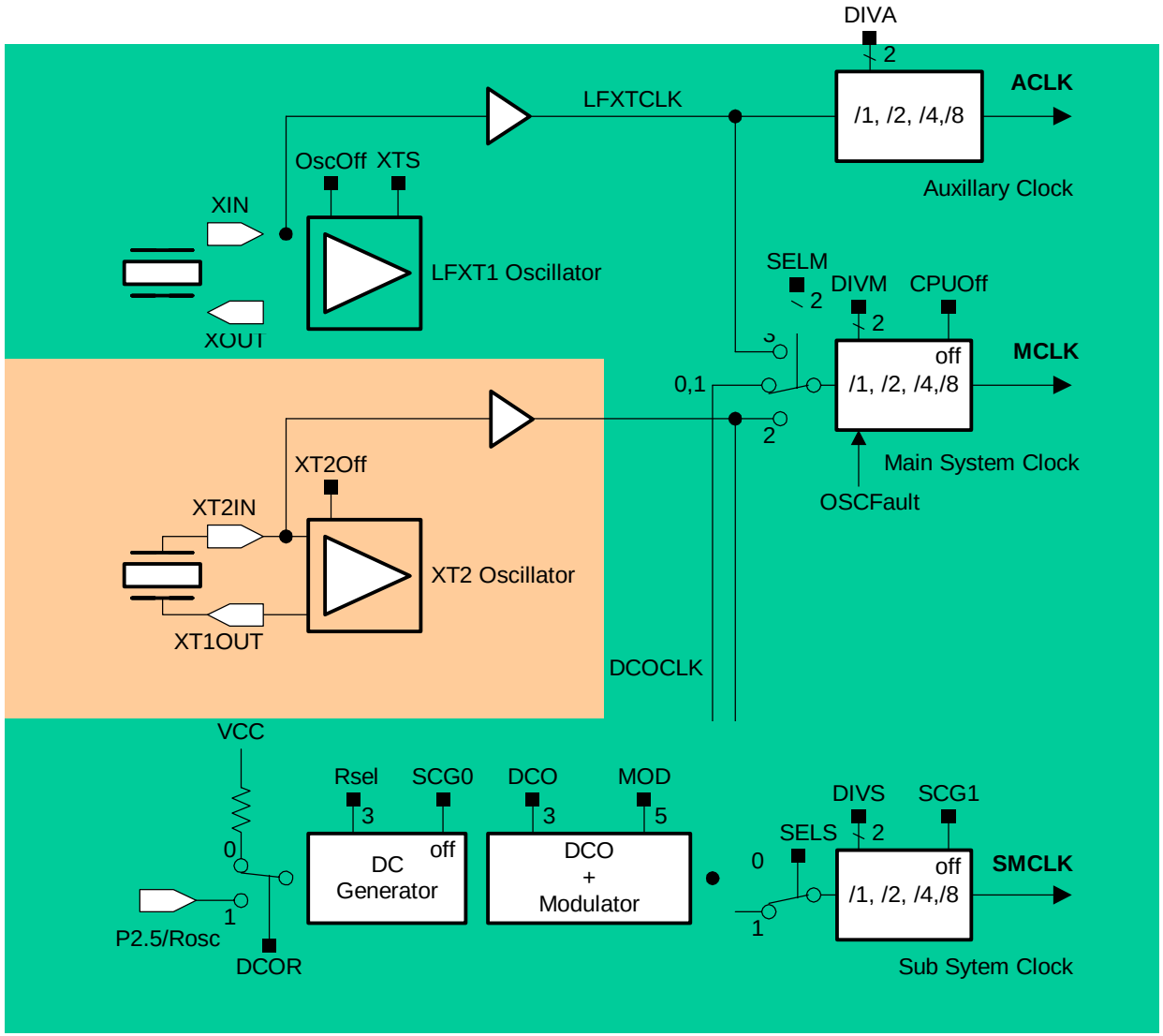
MSP 430 4xx family Quartz Crystal Specifications and Constraints Recommended setting for the internal MSP 430 oscillator is 14pF. Alternative setting for the internal MSP 430 oscillator is 18pF. Do not select 0 pF or 10 pF settings for use with quartz crystals.				
Oscillator Setting		14	18	[pF]
Nominal Frequency	F_L	32.768	32.768	[kHz]
Load Capacitance	C_L	12.5	7.0	[pF]
Rs crystal	typ.	100	100	[kΩ]
Micro Crystal Metal can Packages		MX1V-L2N MS1V-T1K MS2V-T1S	MX1V-L2N MS1V-T1K MS2V-T1S	
Micro Crystal Ceramic Packages		CC1V-T1A CC4V-T1A CC5V-T1A	CC1V-T1A CC4V-T1A CC5V-T1A	

MSP430 晶体震荡器 – 1xx

MSP430x11x/12x 基础时钟

MSP430x13x/14x/ 15x/16x 基础时钟

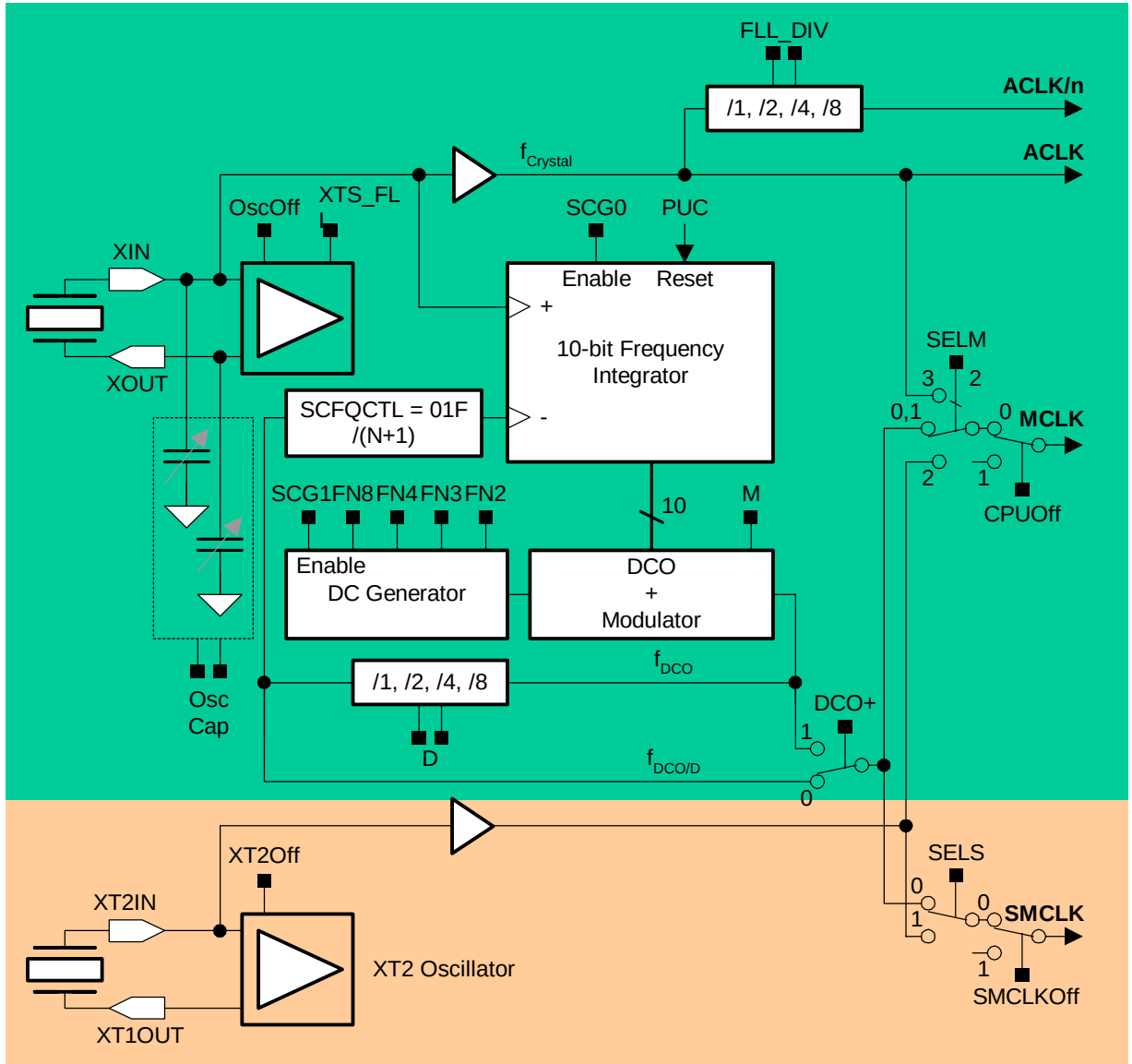
+



MSP430 晶体震荡器 – 4xx

MSP430x41x/42x FLL+

MSP430x43x/44x FLL+



晶体震荡器 – MSP430 震荡器 – Possible tweaks (1xx 32kHz)

改变占空比

- C1, C2 比不是 50/50 >> 调整 C1, C2
- 负载电容布局不均匀 >> 改变布局

长启动时间

- 高 ESR的晶体>> 用低 ESR的晶体, 在 Xout拉低 (见数据手册)
- 晶体需要高的有效负载 (12pF 或更高)

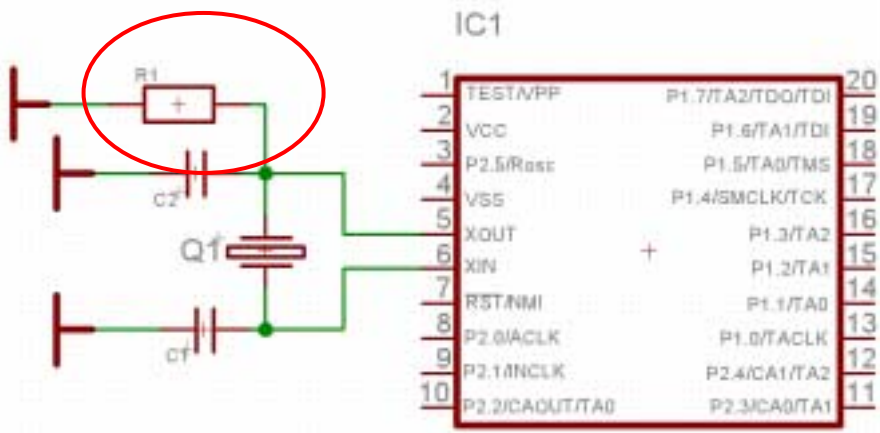
时钟信号的高抖动

- 开关信号与Xin（尤其布局太差）隔离。
- Vcc 去耦差 (l布局/极间偶合电容器)
- Gnd 悬空 (布局)

Clock dropouts

- .增大抖动参数造成振荡减弱

拉低 Xout 增加驱动能力



晶体振荡器 – MSP430 振荡器– 可能发生的 tweaks (4xx 32kHz)

改变占空比

- C1, C2 比不是 50/50 >> 调整 C1, C2
- 负载电容布局不均匀 >>改变布局

长启动时间

- 高 ESR的晶体>>用低 ESR的晶体
- 晶体需要高的有效负载 (12pF 或更高)

时钟信号的高抖动性

- 开关信号与Xin（尤其布局太差）隔离
- Vcc去耦差 (l布局/极间偶合电容器)
- Gnd悬空 (布局）
- .振荡器的灵敏度会随XIN被拉低而下降。

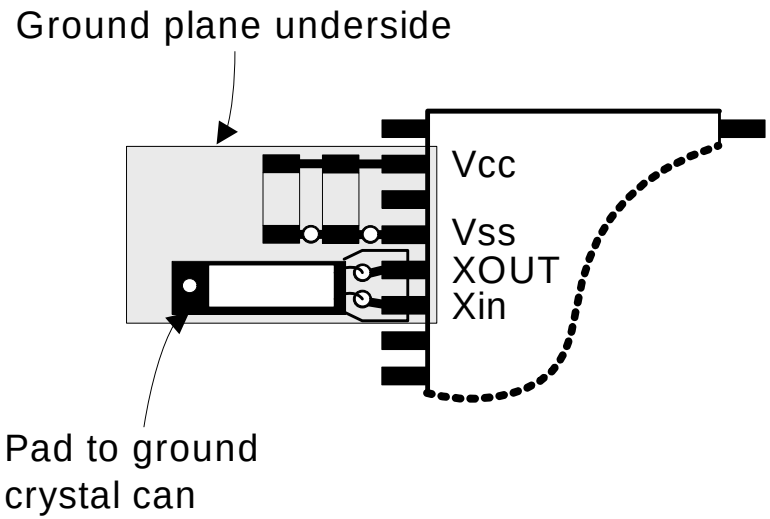
由于综合反馈回路(1MOhm)能稳定振荡器的振幅，振荡器电抗（降低噪音信号的影响）的减少量，增加驱动能力，驱动能力的限制必须考虑！！！！！

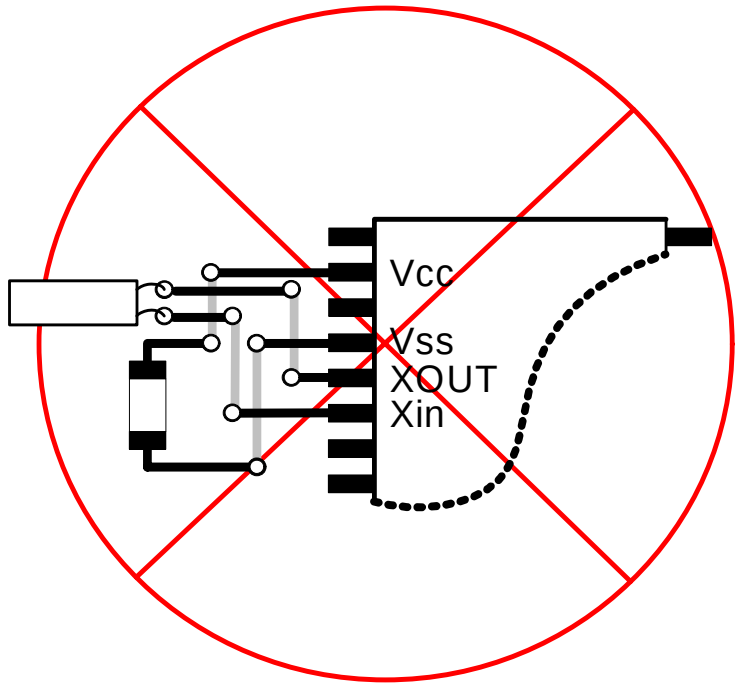
Clock dropouts

- .增大抖动参数造成振荡减弱

PCB 原理图 – 晶振的布局至关重要!

- 0.1uF 和 10uF退耦联合有效抵制 ESD.
- Ground crystal can with ring around leads and no traces under crystal.
- Ground plane underneath crystal

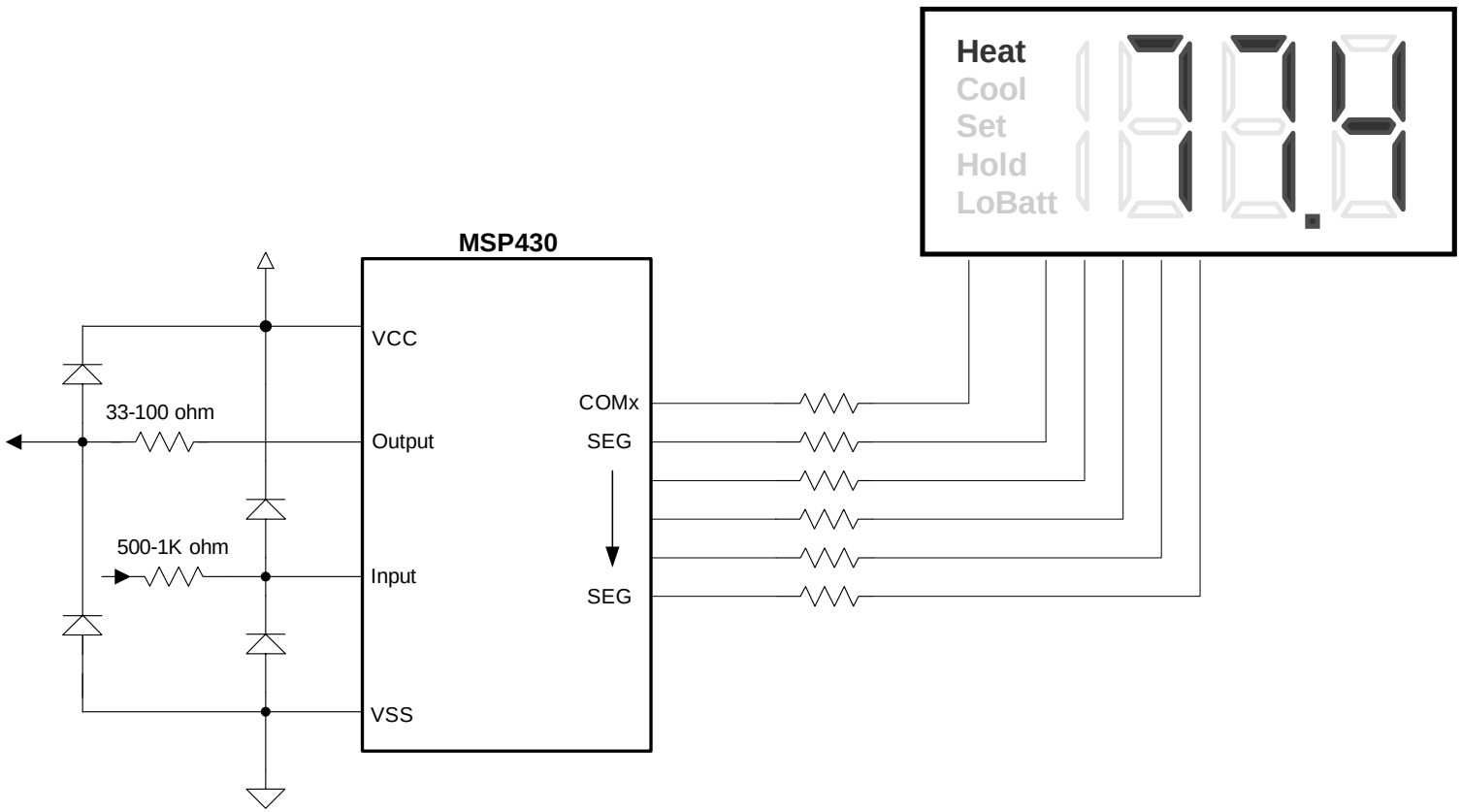




保持线/导线尽可能的短。 Also keep supply lines short because inductance can cause overshoot.

ESD/EMI – 管脚保护

- 级数 R 最基本. Also helps reduce Vcc ringing at power-up (inductance) - can also be combined with diodes.
- 稳压器像变阻器，半导体闸流管，TVS二极管等等在最后关头时用。



Project：实时时钟

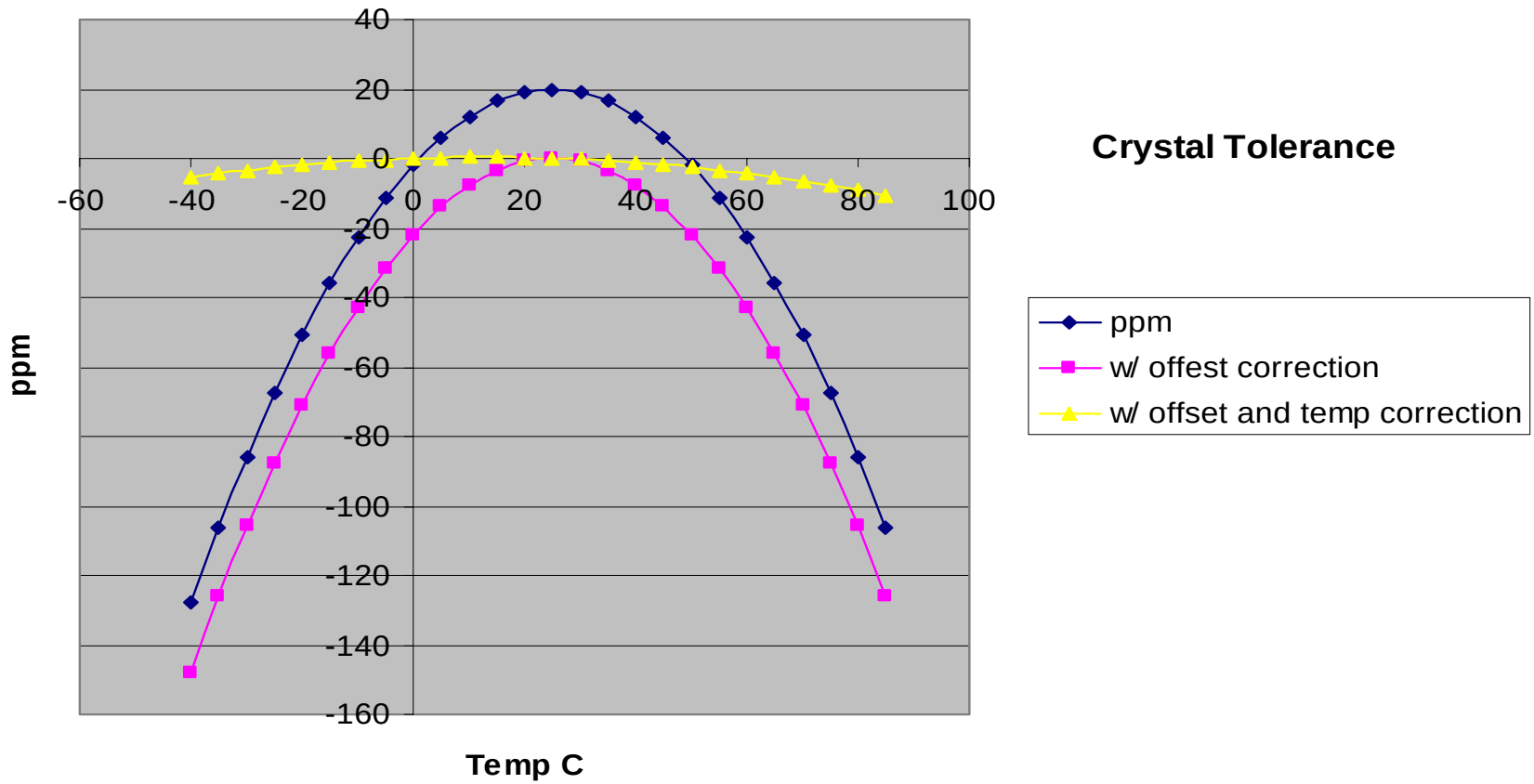
典型 Hi-Z 晶体数据表 (Microtune)

Package Size		DS26	DS15	DS10	
Nominal frequency	F_L	32.768	32.768	32.768	kHz
Load capacitance 1)	C_L	8.2	8.2	8.2	pF
Frequency tolerance 2)	$\Delta F/F$	+/-20	+/-20	+/-20	ppm
	$\Delta F/F$	+/-30	+/-30	+/-30	ppm
	$\Delta F/F$	+/-100	+/-100	+/-100	ppm
Series resistance typ./max.	R_S	30 / 42	35 / 50	45 / 60	kΩ
Motional capacitance typ.	C_1	2.1	2.1	2.1	fF
Static capacitance typ.	C_0	0.9	0.9	0.9	pF
Drive level max.	P	1.0	1.0	1.0	µW
Quality factor min.	Q	55'000	45'000	38'000	
Insulation resistance min.	R_i	500	500	500	MΩ
Aging first year max.	$\Delta F/F$	+/-3	+/-3	+/-3	ppm
Turnover temperature	T_0	25 +/-5	25 +/-5	25 +/-5	°C
Frequency vs. temperature	$\Delta F/F_0$	$-0.035\ ^{ppm}/_{°C^2}\ (T - T_0)^2$ +/-10%			ppm

晶体温度

偏移量 25 C = +/- 20ppm, 系数= ΔT^3 x -0.035 ppm

最大温度允许误差 3%.



Project: Harmonics Measurement

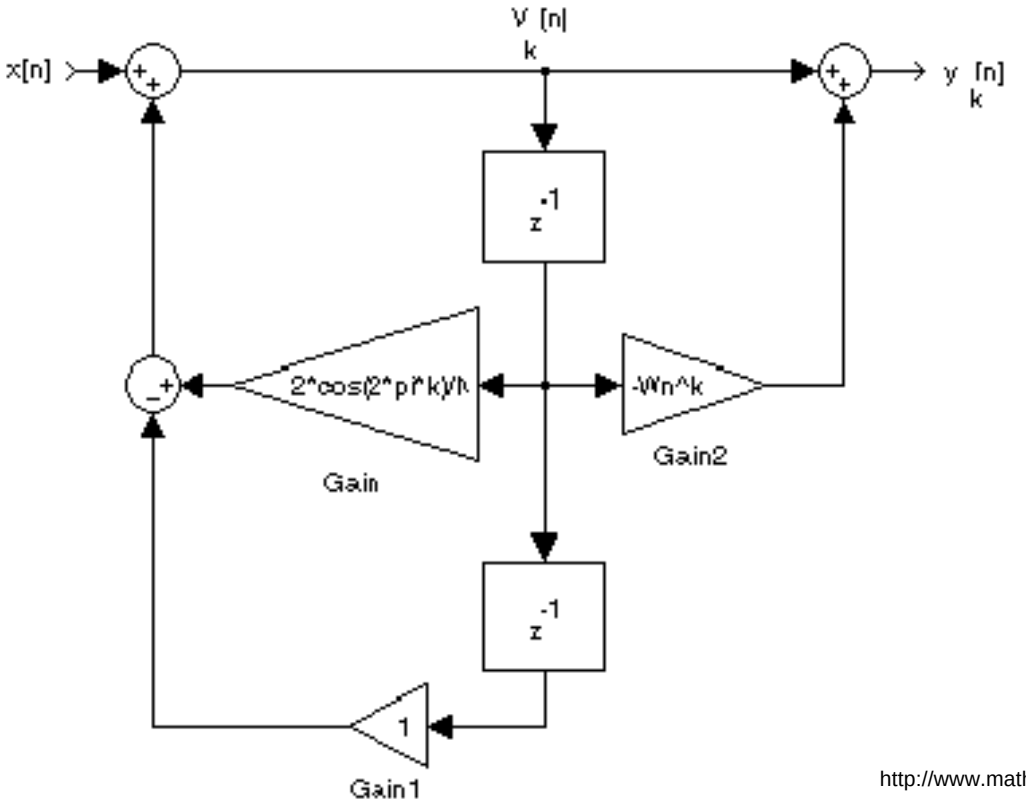
Real world DSP on the MSP430

- Electricity meter makers are trying to compete through adding features, to offset lower prices for basic functions.
- Measuring the first few harmonics is a useful addition, as it gives an indication of load quality. The third and fifth harmonics are generally considered adequate.
- The MSP430s with a hardware multiplier can perform this function, in addition to other measurements - voltage, current, power, energy, power factor, frequency, etc. - for a three phase meter.

Goertzel 滤波器的要素

goertzel 实现如下的转移函数

$$H_k(z) = \frac{1 - W_N^k z^{-1}}{1 - 2\cos\left(\frac{2\pi}{N}k\right)z^{-1} + z^{-2}}$$



其中N是信号长度， *k* 是二维傅立叶变换级数.

K与矢量i到k=i-1有关

转移函数的信号流向图

http://www.mathworks.com/access/helpdesk/help/toolbox/signal/goertzel.shtml

它是这样实现的：

$$v_k[n] = x[n] + 2\cos\left(\frac{2\pi k}{N}\right)v_k[n-1] - v_k[n-2]$$

当 $0 \le n \le N$ 时

$$X[k] = y_k[N] = v_k[N] - W_N^k v_k[N-1]$$

k对一个特殊K计算X[k], Goertzel 运算法则 需要 4N 个实数相乘和4N个实数相加. 虽然它比二维傅立叶变换计算效率低, Goertzel 法则用递归的方法计算

W_N^k and $\cos\left(\frac{2\pi k}{N}\right)$

当且仅当n=N. 二维傅立叶变换没有用递归因而必须孤立而复杂的计算每一项