Introduction

Micrel-Synergy's SY89429/30V frequency synthesizers are designed to be used in various clock subsystems. The Primary function of the product is to synthesize clock frequencies required for systems needing a high quality, low jitter clock source.

The cost of other clock sources, either crystal or SAW oscillators, increase dramatically as precision/frequency requirements of digital systems push into the 100+ MHz arena. Many low cost CMOS frequency synthesizers appeared in the market in the last few years. Unfortunately, these products have relatively high jitter and limited operating frequency range. Therefore, their applications are limited to lower precision/lower frequencies.

SY89429/30V, designed with Micrel-Synergy's high performance ASSET™ Bipolar technology and differential ECL circuit technology throughout, is a perfect low cost alternative to the expensive crystal or SAW oscillators. Unlike other frequency synthesizers, SY89429/30V has extremely low jitter and high supply noise rejection that ECL is famous for.

Because the devices are programmable between 25MHz to 950MHz using a 16MHz crystal, different system frequency requirements can all use the same device. This may dramatically reduce inventory costs and management of additional products otherwise required to achieve these various frequencies. This programmability also makes board/ system speed grading possible as part of the normal production flow without multiple oscillators. This provides higher overall yield and lower manufacturing cost.

In addition to cost savings, there are many other benefits to using the SY89429/30V. Normal system production testing can incorporate frequency margining that is unavailable to fixed frequency designs as in crystal or SAW oscillators. This capability leads directly to higher product quality and reliability. Furthermore, SY89429/30V can be programmed in small steps (1MHz steps with a 16.000MHz crystal). Other precise frequencies can be programmed as well. See section titled "**Advanced Frequency Control Applications**." This ability to provide any frequency eliminates the need for the high cost custom oscillator alternatives.

Throughout this application note we refer to a frequency range of 25MHz to 950MHz. This is only for simplicity reasons and make the application note applicable to both devices.

The VCO range for SY89429V and SY89430V are different. That is, SY89429V has an internal VCO range of 400MHz to 800MHz and an external output frequency of 25MHz to 400MHz. SY89430V has an internal VCO range of 400MHz to 950MHz and an external output frequency of 50MHz to 950MHz.

General Requirements

Operating the SY89429/30V is very simple. Very few low cost external components are required. These low cost external components provide the tuning capability needed to optimize and minimize jitter characteristics in each individual system application. To achieve the best possible performance in jitter and power supply noise rejection, basic high speed design guidelines should be followed.

Power Supply Requirements

SY89429/30V is designed to operate with a single positive supply of either +3.3V or +5V. The FOUT and /FOUT (the differential PECL outputs) will interface to PECL inputs using the same supply voltage. However, SY89429/30V can also be used in a true ECL systems. For this application, please refer to the section titled "**True ECL Design**."

Power Supply Filtering Techniques

As in any high speed integrated circuits, power supply filtering is very important. A 0.1μF high frequency by-pass capacitor should be used between all separate power supply pins and ground. V_{CC1}, V_{CC_QUIET}, V_{CC_TTL} and V_{CC_OUT} should be individually connected to the power supply plane through vias, and a by-pass capacitor should be used for each pin. To achieve optimum jitter performance, better power supply isolation is required. In this case a ferrite bead along with a 1μF and a 0.01μF by-pass capacitor should be connected to each power supply pin. Figure 4 shows the connections of the power supply filtering using ferrite beads.

Termination for PECL Outputs

The differential PECL outputs, FOUT and /FOUT, are open emitter outputs. Therefore, terminating resistors or current sources must be used for functionality. These outputs are designed to drive 50Ω transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize wave-form distortion. There are a few simple termination schemes. Figure 1 shows three simple termination circuits for a +5V system.

Interface for Inputs

The SY89429/30V is designed to interface with TTL compatible signals. All inputs except XTAL1 and XTAL2 are TTL compatible. These inputs have internal pull up resistors. Therefore, any inputs can be left open—open inputs are logical "1" state. Although inputs can be left open, it is recommended that open inputs be connected to a power supply line. These inputs can be connected to a power supply line (V_{CC} for a logical "1") or a ground line (V_{EE} for a logical "0") directly or through series resistors. Alternatively, these inputs can also be driven directly from any TTL compatible signals. XTAL1 and XTAL2 inputs should only be connected to a crystal.

Rev.: E Amendment: /0
Issue Date: February 2000

Input Reference Frequency and On-Chip Crystal Oscillator

The SY89429/30V is designed based on input reference frequency of 16MHz and phase detector frequency of 2MHz. For using other input reference frequencies, refer to section titled "**Advanced Frequency Control Applications**." Using 16MHz reference frequency, the output frequency can be programmed from 25MHz to 950MHz in 1MHz steps. The input crystal oscillator requires only an off-chip 16MHz reference crystal connected between XTAL1 and XTAL2 pins. Figure 3a shows the recommended crystal oscillator circuit.

Using the On-Board Crystal Oscillator

The SY89429/30V features a fully integrated on-board crystal oscillator to minimize system implementation costs. The oscillator is a series resonant, multivibrator type design as opposed to the more common parallel resonant oscillator design. The series resonant design provides better stability and eliminates the need for large on chip capacitors. As the oscillator is somewhat sensitive to loading on its inputs the user is advised to mount the crystal as close to the SY89429/30V as possible to avoid any board level parasitics. To facilitate co-location surface mount crystals are recommended, but not required.

The oscillator circuit is a series resonant circuit and thus for optimum performance a series resonant crystal should be used. Unfortunately most crystals are characterized in a parallel resonant mode. Fortunately there is no physical difference between a series resonant and parallel resonant crystal. The difference is purely in the way the devices are characterized. As a result a parallel resonant crystal can be used with the SY89429/30V with only a minor error in the desired frequency. A parallel resonant mode crystal used in a series resonant circuit will exhibit a frequency of oscillation a few hundred ppm lower than specified, a few hundred ppm translates to KHz inaccuracies. In a general computer application this level of inaccuracy is immaterial. Table 1 specifies the performance requirements of the crystals to be used with the SY89429/30V.

Parameter	Value
Crystal Cut	Fundamental AT Cut
Resonance	Series Resonance*
Frequency Tolerance	±75ppm at 25°C
Frequency/Temperature Stability	±150ppm 0 to 70°C
Operating Range	0 to 70°C
Shunt Capacitance	5-7pF
Equivalent Series Resistance (ESR)	50Ω to 80Ω
Correlation Drive Level	100µW
Aging	5ppm/Yr (First 3 Years)

Table 1. Crystal Specifications

Filter Design

The filter for any Phase Locked Loop (PLL) based device deserves special attention. SY89429/30V provides filter pins for an external filter. A simple three-component passive filter is recommended for achieving ultra low jitter. Figure 3b shows the recommended three-components. Due to the differential design, the filter is connected between LOOP_FILTER and LOOP_REF pins. With this configuration, extremely high supply noise rejection is achieved. It is important that the filter circuit and filter pins be isolated from any non-common mode coupling and placed in the VCC plane.

Generating High-Speed TTL Clock Signals

A high speed PECL-to-TTL translator such as SY10/100ELT23 or SY10/100ELT23L (for +3.3V) may be used to generate high speed TTL compatible signals. High speed PECL-to-TTL translating Clock Drivers such as SY10/100H841/842 or SY10/100H641/646 may be added if multiple copies of such clocks are desired. For 3.3 volt power supply operation, the following PECL-to-TTL translating clock drivers SY10/100H841L/842L or SY10/100H641L/646L may be used. These translators are capable of driving 50pF loads up to 160MHz.

True ECL Design

The SY89429/30V is designed for TTL/PECL systems. However, it can be designed into a pure ECL environment easily. Connect all VCC pins to ground and all GND pins to –3.3V, –4.5V (or –5.2V) power supply line. With this operating condition, FOUT and /FOUT interface directly with normal 100K ECL signals. All other inputs have internal pull up resistors. Therefore, any input can be left open and open inputs are logical "1" state. Although inputs are allowed to be open, it is recommended that open inputs be connected to a power supply line. These inputs can be connected to ground lines (0 volt for a logical "1") or negative power supply lines (–3.3V, –4.5V or –5.2V for a logical "0") directly or through series resistors. These inputs can interface to normal ECL signals with SY100ELT23 for signal translation. Figure 5 shows the schematic with signal translations.

Advanced Frequency Control Applications

The primary function of these products is to synthesize clock frequencies from 25MHz to 950MHz in 1MHz steps with a 16.00MHz crystal. However, there are many other applications that are not so obvious. Even though the SY89429/30V is said to be able to generate frequencies between 25MHz to 950MHz in 1MHz steps with a 16MHz crystal, output frequency is programmed by properly configuring the internal dividers and can be represented by this formula (See Table 1 for an application example):

$$FOUT = \frac{FXTAL}{8} \times \frac{M}{N}$$

$$Step\ Size = \frac{FXTAL}{8} \times \frac{1}{N}$$

$$FVCO = \frac{FXTAL}{8} \times M$$

where

FXTAL is the crystal frequency or input reference frequency
M is the VCO frequency multiplier (from 128 to 511)
N is the post divider (1,2,4,8, or 16)
FVCO is the VCO frequency (400MHz to 950MHz)

Crystal oscillator frequency is designed to be less than 25MHz using a fundamental crystal. Input frequencies at the low end is limited to above 6.26MHz due to minimum VCO frequency of 400MHz.

Using the FOUT equation, it is very easy to determine what M and N values must be for a certain multiplication factor.

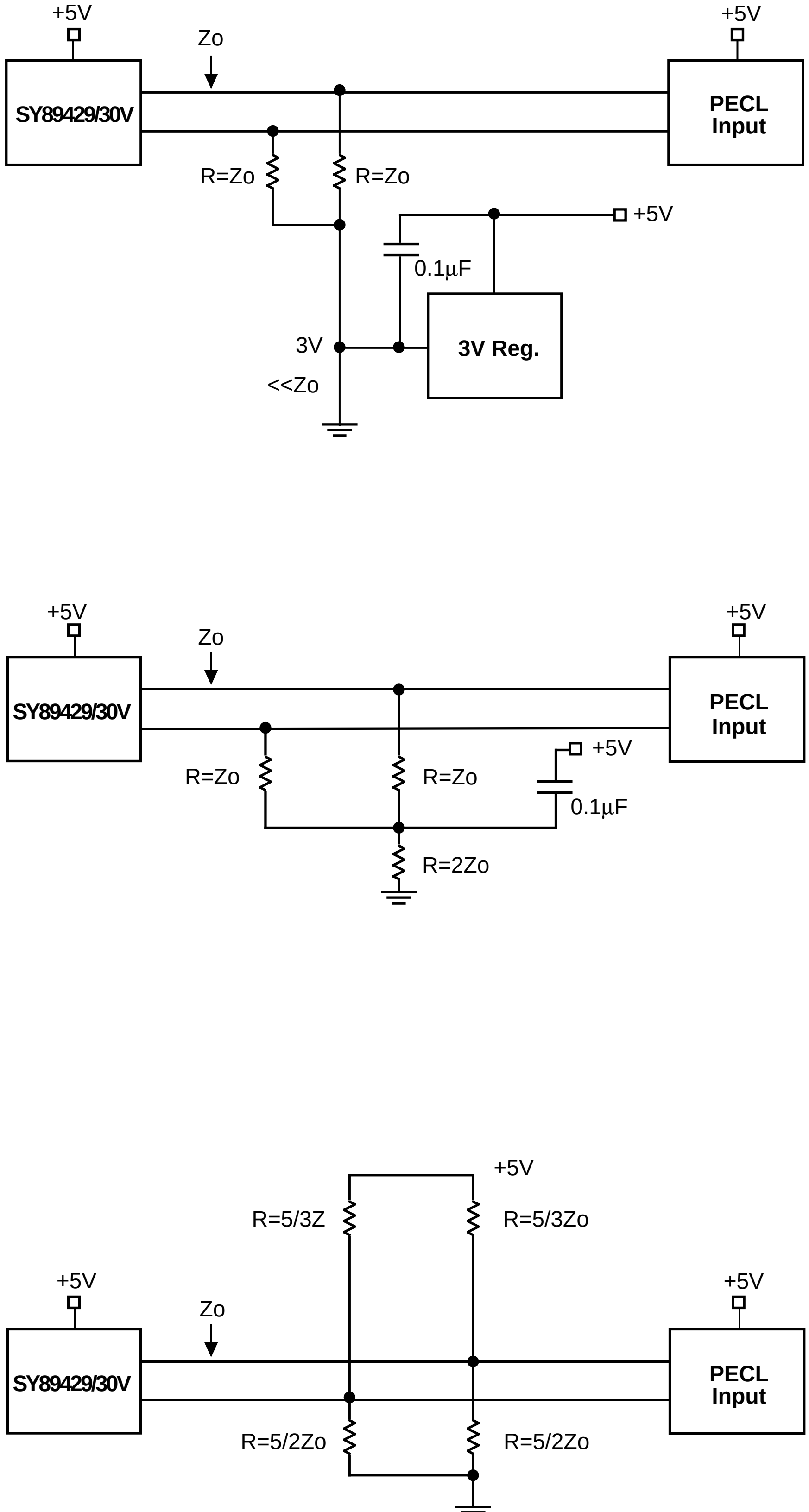

Figure 1. Matched Impedance Termination Schemes for 5V Systems

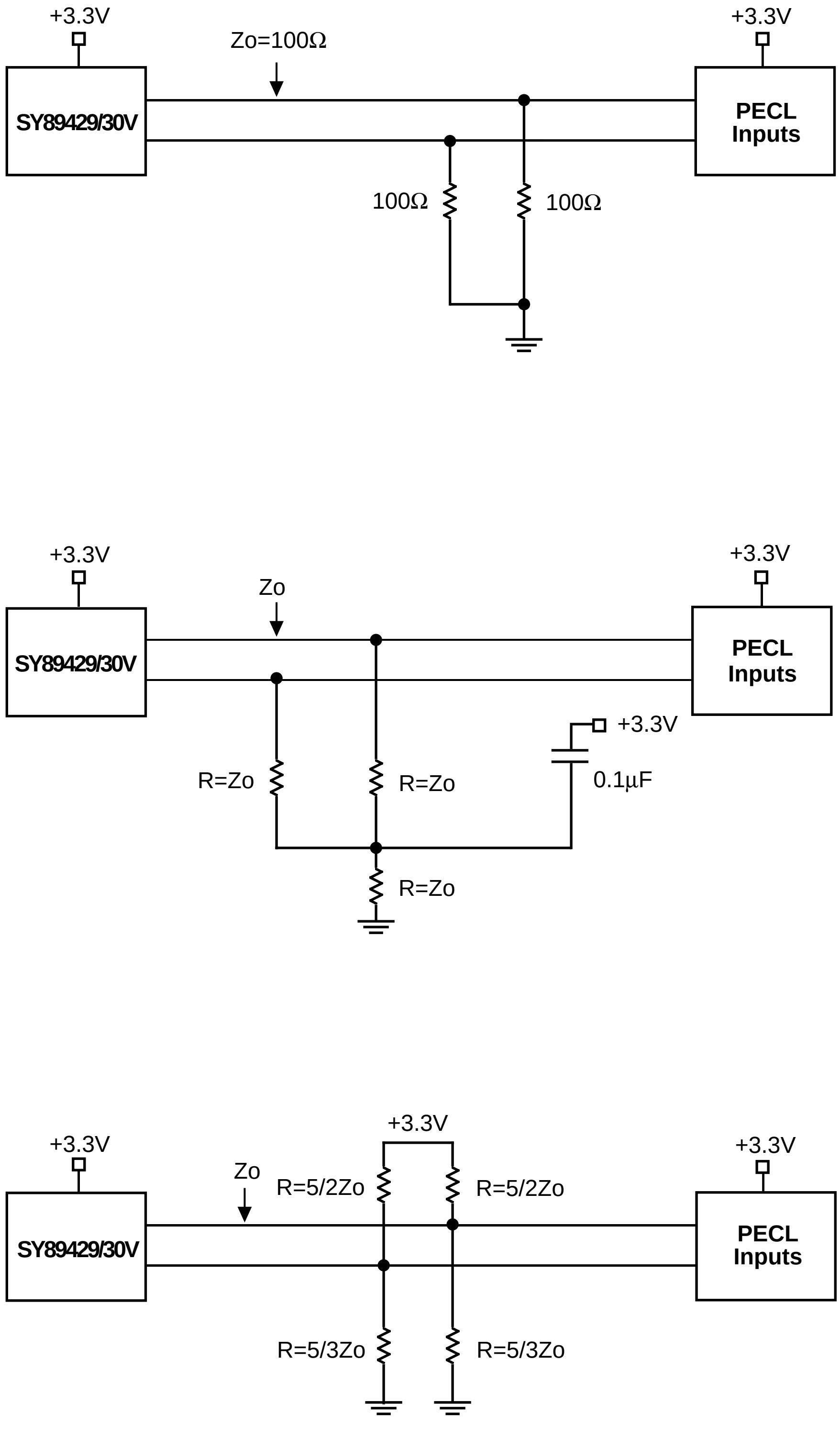

Figure 2. Matched Impedance Termination Schemes for 3.3V Systems

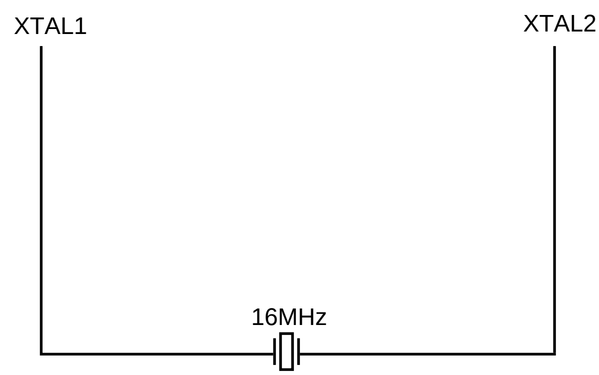

Figure 3a. Recommended External Components for Crystal Oscillator

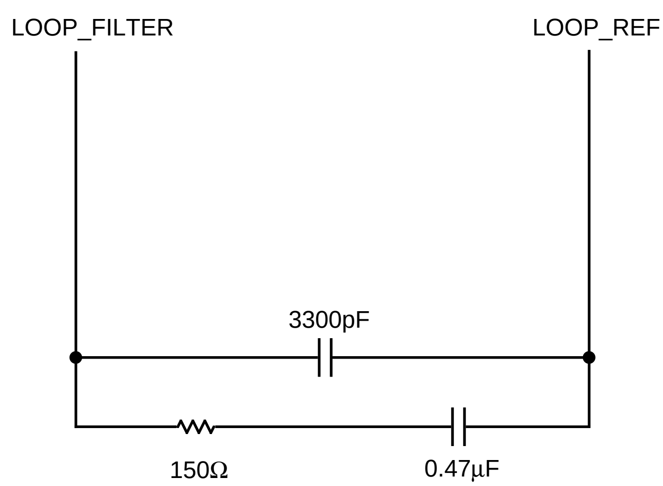

Figure 3b. Recommended Passive Filter Circuit

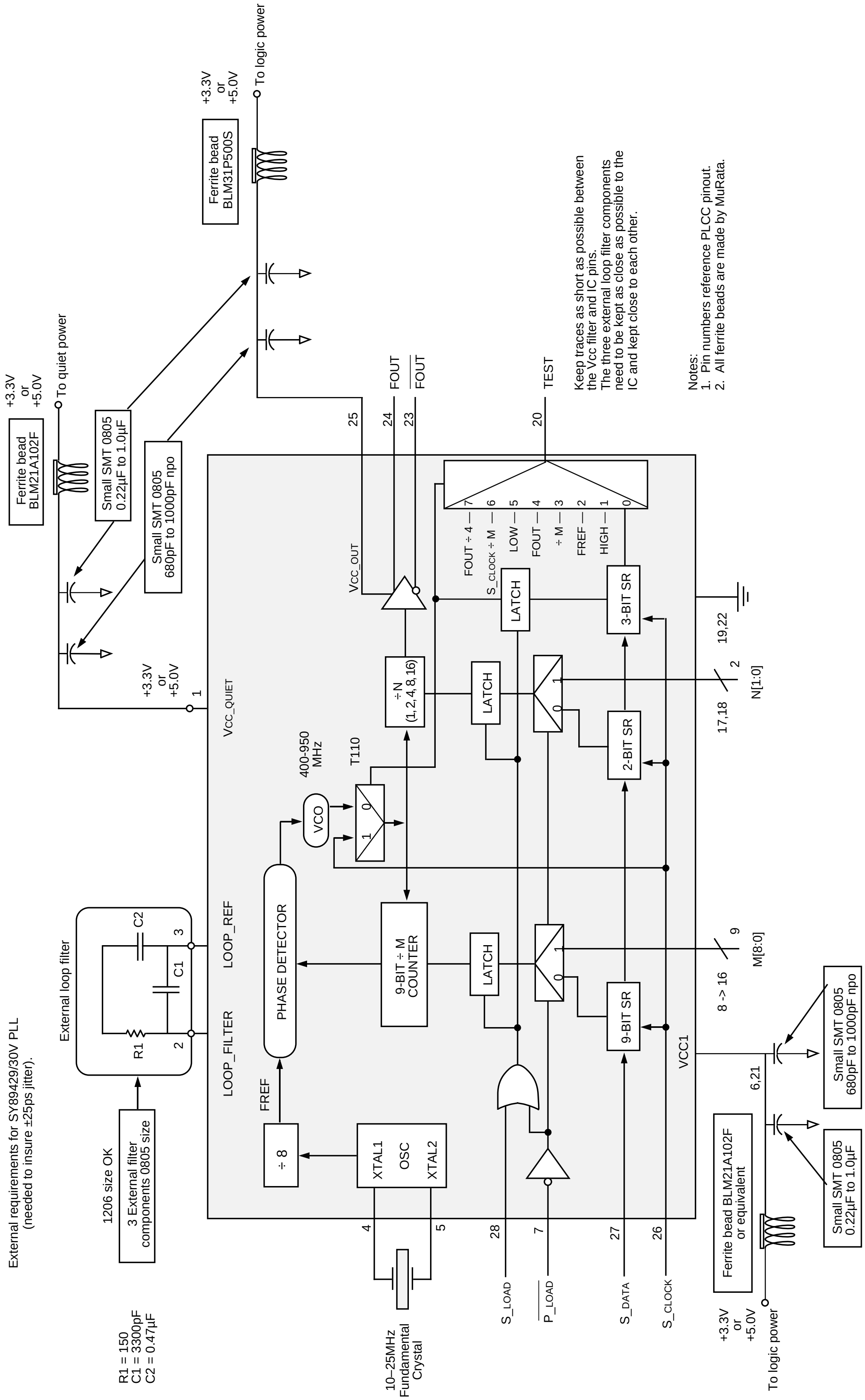

Figure 4. Power Supply Filtering

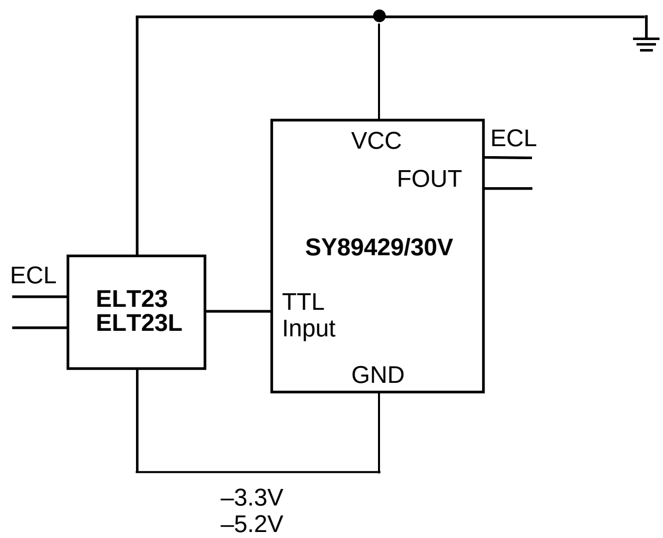

Figure 5. Interfacing to SY89429/30V TTL Inputs with ECL Signals for True ECL Designs

MICREL-SYNERGY 3250 SCOTT BOULEVARD SANTA CLARA CA 95054 USA
TEL + 1 (408) 980-9191 FAX + 1 (408) 914-7878 WEB http://www.micrel.com

This information is believed to be accurate and reliable, however no responsibility is assumed by Micrel for its use nor for any infringement of patents or other rights of third parties resulting from its use. No license is granted by implication or otherwise under any patent or patent right of Micrel Inc.

© 2000 Micrel Incorporated