

## **Designing with the MC68HC908JL/JK Microcontroller Family**

By Yan-Tai Ng  
Applications Engineering  
Microcontroller Division  
Hong Kong

This application note describes design techniques for the Motorola MC68HC908JL/JK family of MCU devices, hereafter referred to as the JL/JK family, or JL/JK for a single device.

For full device specifications, please refer to the data sheets, Motorola order numbers: MC68HC908JL3/H and MC68HC08JL3/H.

### **Introduction**

---

The JL/JK family are popular, low-cost, general purpose MCUs in the Motorola HC08 Family. The JL/JK devices have 4096 or 1536 bytes memory for user code, 128 bytes RAM, crystal or RC oscillator, analog-to-digital converter, 16-bit timer, and is available in various packages. The new generation FLASH memory on the FLASH parts has a program-erase cycle of 10,000 times.

The versatility of the JL/JK makes the device suitable for many applications, and sometimes finding itself in some very noisy environments. These noise and interference problems are made worse by poor circuit design and PCB layout, resulting in intermittent MCU failures and even complete breakdown.

To avoid these undesirable effects, there are some basic techniques that can be applied during circuit design and PCB layout. This application note outlines some recommendations.

The JL/JK family comprises an array of devices with common modules, different size FLASH, ROM, and oscillator options. Table 1 below lists the devices in the JL/JK family:

**Table 1. MC68HC908JL/JK Family**

Device	FLASH (Bytes)	ROM (Bytes)	Oscillator	Pin Count	Comments
MC68HC908JL3	4096	—	XTAL	28 pins	
MC68HRC908JL3	4096	—	RC	28 pins	
MC68HLC908JL3	4096	—	XTAL	28-pins	Operating voltage: 2V to 2.4V
MC68HC908JK3	4096	—	XTAL	20 pins	
MC68HRC908JK3	4096	—	RC	20 pins	
MC68HLC908JK3	4096	—	XTAL	20 pins	Operating voltage: 2V to 2.4V
MC68HC908JK1	1536	—	XTAL	20 pins	
MC68HRC908JK1	1536	—	RC	20 pins	
MC68HLC908JK1	1536	—	XTAL	20 pins	Operating voltage: 2V to 2.4V
MC68HC08JL3	—	4096	XTAL	28 pins	
MC68HRC08JL3	—	4096	RC	28 pins	
MC68HC08JK3	—	4096	XTAL	20 pins	
MC68HRC08JK3	—	4096	RC	20 pins	
MC68HC08JK1	—	1536	XTAL	20 pins	
MC68HRC08JK1	—	1536	RC	20 pins	

**NOTE:**

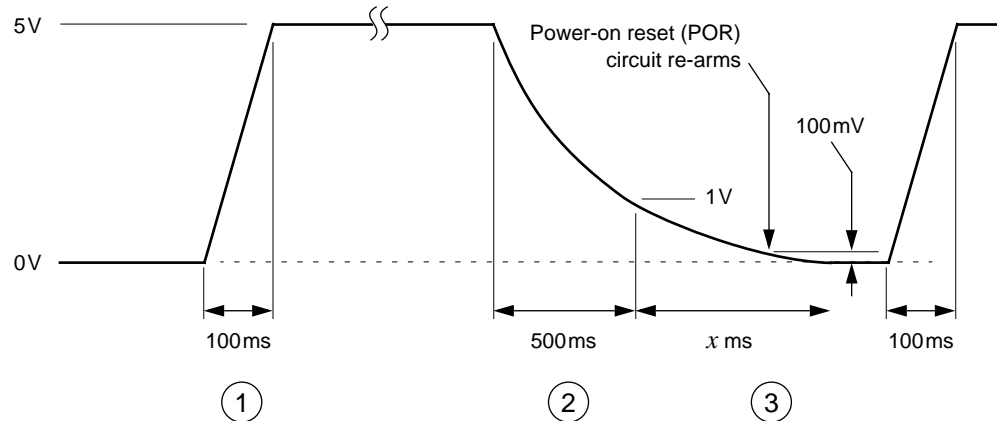
These devices are available in various packages; please refer to the device data sheets for full ordering part numbers.

## Power-Up and Power-Down Requirements

The precautions described below must be followed for MCU power-up and power-down, otherwise unpredictable MCU behavior may occur.

**Power supply  
rise-time**

**Power supply  
fall-time**



Note: Related parameters are specified in the datasheet.

**Figure 1. Power Supply Power-Up/Down Requirements**

**Meeting power-on  
reset requirements**

1. At power-up, supply voltage rise-time should be as short as possible; less than 143ms for 5V operation; best to aim for less than 100ms.
2. At power-down, supply voltage should fall below 1V in less than 500ms.
3. Before power-up again, supply voltage must fall below 100mV for the JL/JK power-on reset circuit to rearm.
4. In addition, keep the external reset pin ( $\overline{RST}$ ) pulled low at least until supply voltage has reached its operating level.

Improper power-up or power-down conditions cause problems for all MCUs, not just the JL/JK. Since the MCU contains a microprocessor and running a program, an improper power-up may cause the MCU to behave erratically and execute runaway codes. In severe cases, devices with electrically erasable memory (e.g. FLASH memory) could experience memory erasure if these power-up and power-down parameters are not taken seriously.

## MCU Clock Generation and Distribution

A reliable, stable and clean reference clock input is very important in MCU application designs, since the clock is the heart of the MCU.

Two oscillator options are available for the JL/JK family: crystal oscillator and RC oscillator. The oscillator option is defined by a mask layer in the silicon and is distinguished by the device part numbering. The crystal oscillator option also supports ceramic resonators and direct clock input.

### Clock distribution

Figure 2 shows how the reference clock is divided and distributed to the main modules inside the JL/JK.

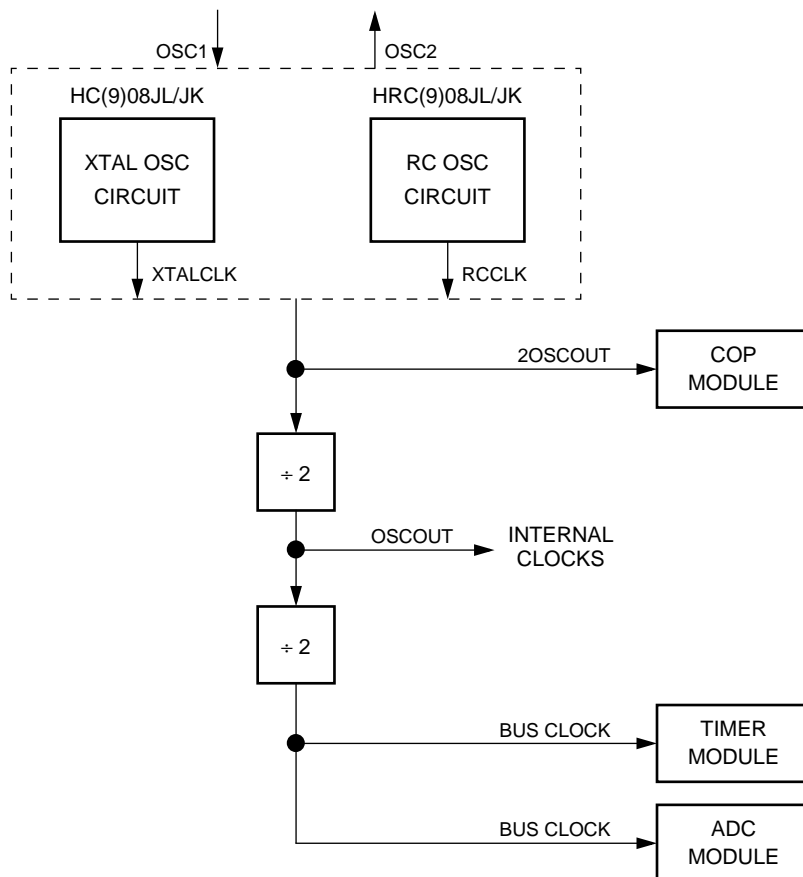


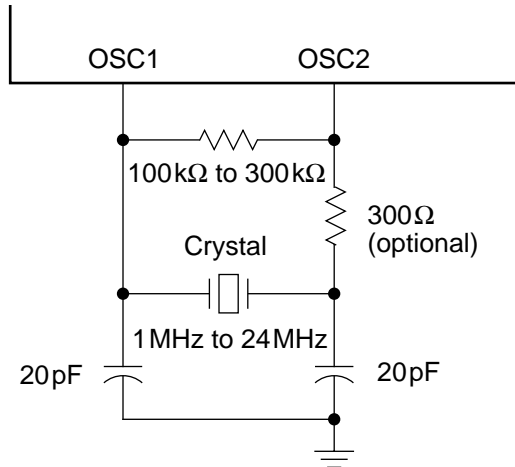
Figure 2. JL/JK Clock Distribution

**Crystal connection between OSC1 and OSC2 pins**

With the crystal oscillator option, the external component values vary slightly for high frequency and low frequency crystals.

**High-frequency crystal**

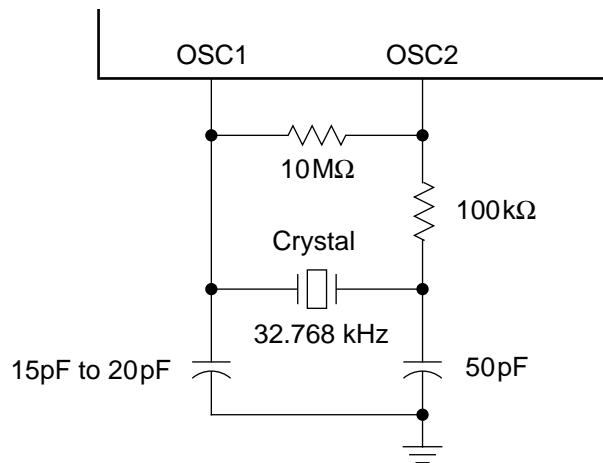
Use the following components when using a high frequency crystal (1 MHz to 24MHz).



**Figure 3. Components for 1 MHz to 24MHz Crystal Oscillator**

**Low-frequency crystal**

Use the following components when using a 32.768kHz crystal.

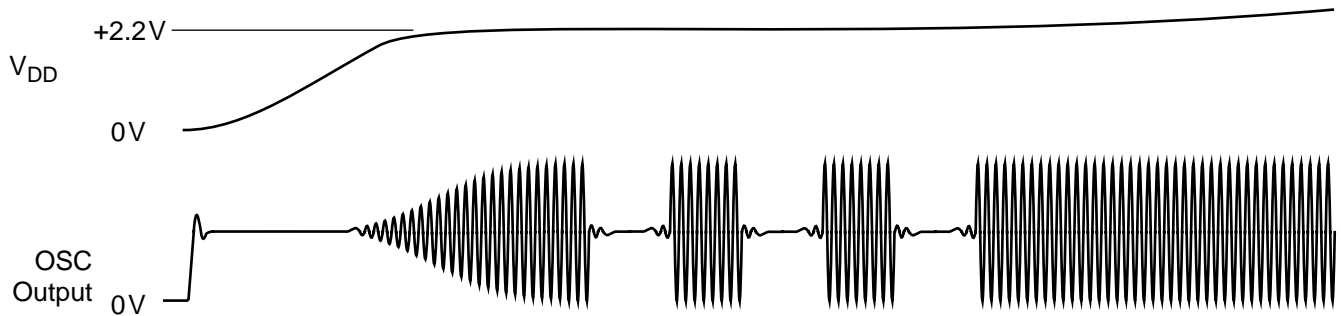


**Figure 4. Components for 32kHz Crystal Oscillator**

## Application Note

### Crystal oscillator start-up time

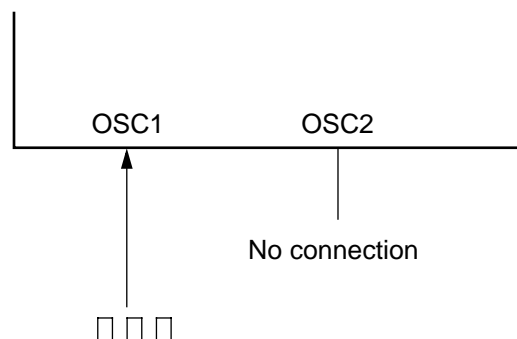
Figure 5 shows the typical crystal start-up waveform for the 5V and 3V JL/JK devices. Notice that the crystal oscillation only becomes stable when the supply voltage rises above the LVI circuit trip point.



**Figure 5. Crystal Oscillator Start-Up**

### External clock drive into OSC1

The alternative input for the crystal oscillator option is to use a square wave from an external oscillator, driven directly into the OSC1 pin, and leaving OSC2 pin unconnected. The square wave should have a 50% duty cycle. Using this method, the maximum clock input is 32MHz, providing a bus frequency of 8MHz. Figure 6 shows the external clock drive.

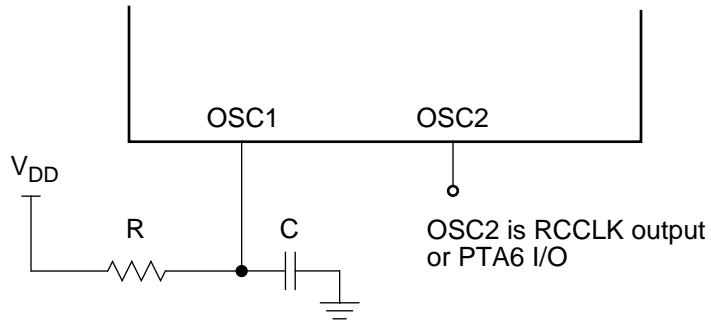


**Figure 6. External Oscillator Drive to OSC1**

**Resistor-Capacitor connection to OSC1**

Figure 7 shows the basic connections for the RC option. Refer to the data sheet for values of R and C versus the desired frequency.

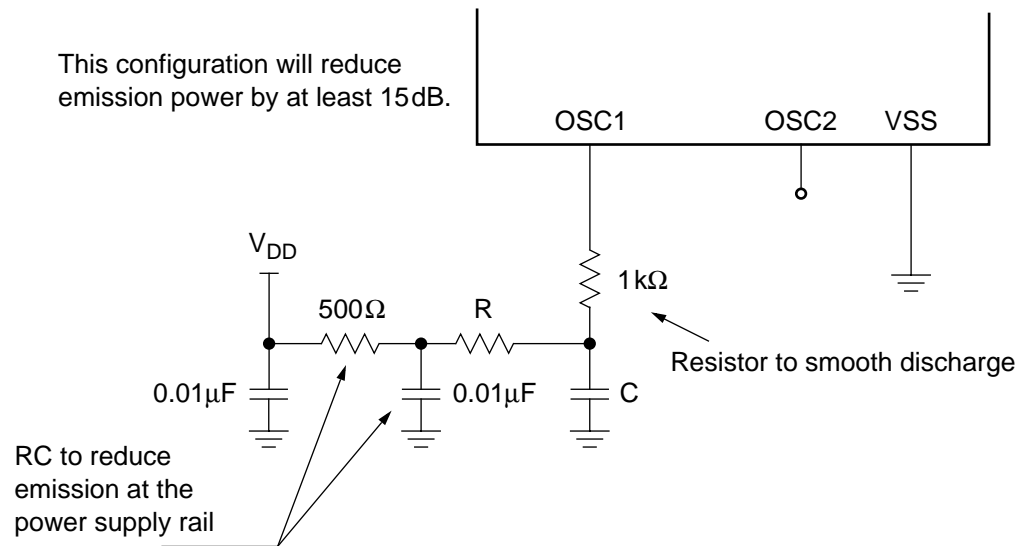
**Basic RC connection**



**Figure 7. RC Oscillator Connection**

To improve noise immunity and reduce switching transients, the component configuration shown in Figure 8 is recommended.

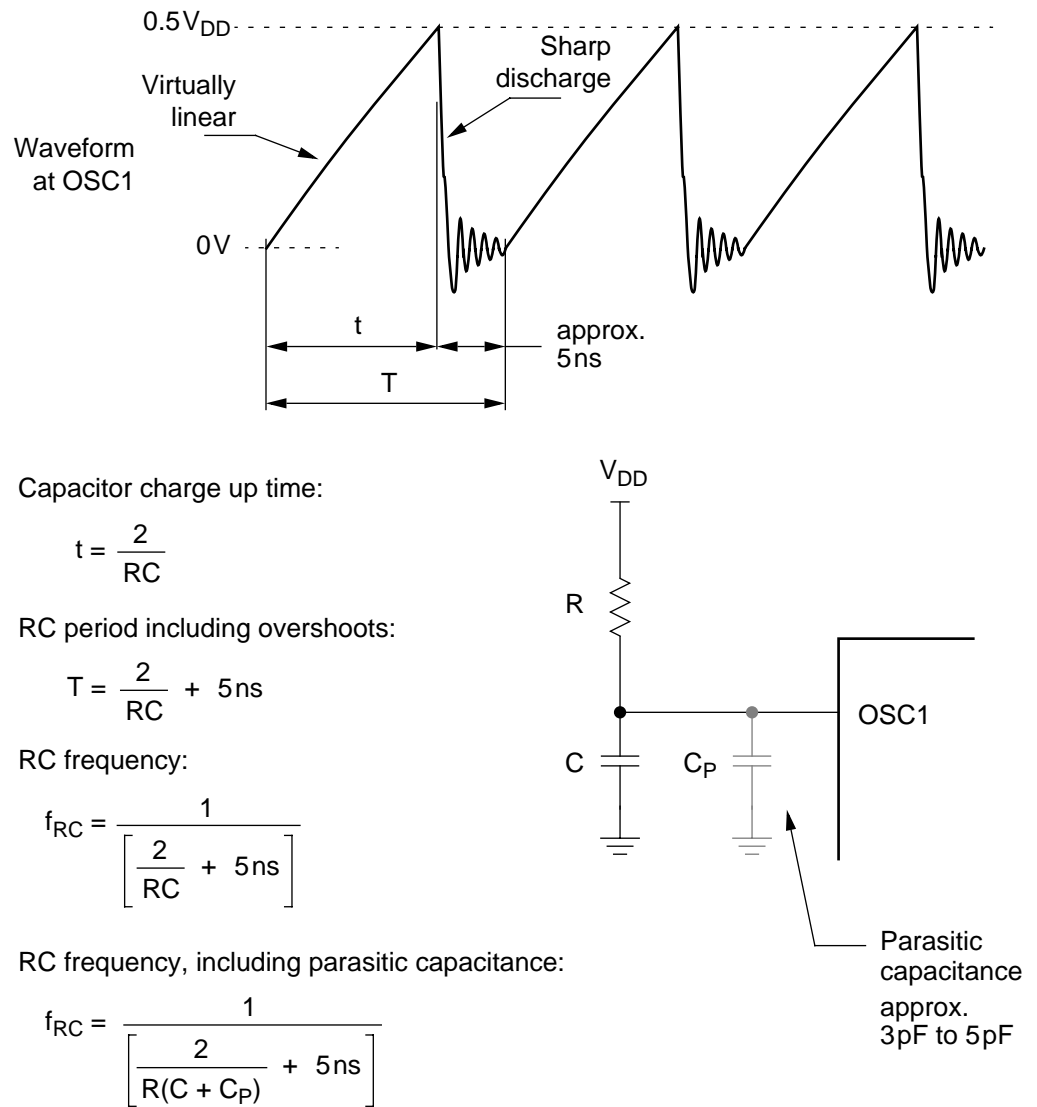
**Better RC connection**



**Figure 8. Improved RC Oscillator Connection**

**Calculating the RC frequency**

Although values of the RC frequency can be obtained from the graph in the data sheet, it is possible to calculate this frequency. Figure 9 shows the typical capacitor charge/discharge curve. The calculation includes overshoot time and any parasitic capacitance.



**Figure 9. RC Frequency Calculation**

## FLASH Memory Block Protection

### The FLASH block protect register (\$FE09)

On the JL/JK FLASH devices, the FLASH memory is block protected after a MCU reset. FLASH program or erase operation is only possible when the FLASH memory is unprotected by writing to the FLASH block protect register at \$FE09 (write \$FF into \$FE09 to unprotect the entire array).

## Replacing FLASH devices with ROM devices

---

The following sub-sections outline the precautions when switching from FLASH with ROM devices.

<b>The USER code</b>	The user code for the FLASH device can be used directly for the ROM device as long as the code does not access any FLASH related registers (i.e. \$FE08 and \$FE09). These registers are reserved locations on the ROM device.
<b>FLASH related registers</b>	The FLASH related registers (\$FE08 and \$FE09) are reserved locations on the ROM device.
<b>Monitor ROM</b>	The monitor ROM program on the ROM device is used for MCU testing only. No FLASH programming operations are available.
<b>Using RC clock option</b>	The RC vs. frequency characteristics are not identical for FLASH and ROM devices. Please refer to the respective data sheets for the RC vs. frequency curves.

## The Low-Voltage MC68HLC908JL/JK

---

The JL/JK family includes three low-voltage devices, with an operating voltage of 2V to 2.4V:

- MC68HLC908JL3
- MC68HLC908JK3
- MC68HLC908JK1

The differences to the 5V and 3V devices are:

- FLASH memory can only be read. Program and erase is achieved at an operating voltage of 5V or 3V.

- There is no low-voltage inhibit circuit. Therefore, no low-voltage reset. The associated register bits are reserved bits.
- Only crystal oscillator or direct clock input is supported.

## PCB Layout for Critical Signals

PCB layout is often overlooked in a majority of cost-sensitive circuit designs. It is surprising that how a signal is routed can affect the overall performance of the circuit on the PCB. The following sub-sections outline some techniques.

### Crystal oscillator connections

Connect these critical components as close as possible to the MCU and with the shortest return path to the MCU ground pin. Each  $V_{DD}$  pin should be decoupled to ground with its own capacitor.

Figure 10 shows examples of PCB layout for the crystal oscillator components.

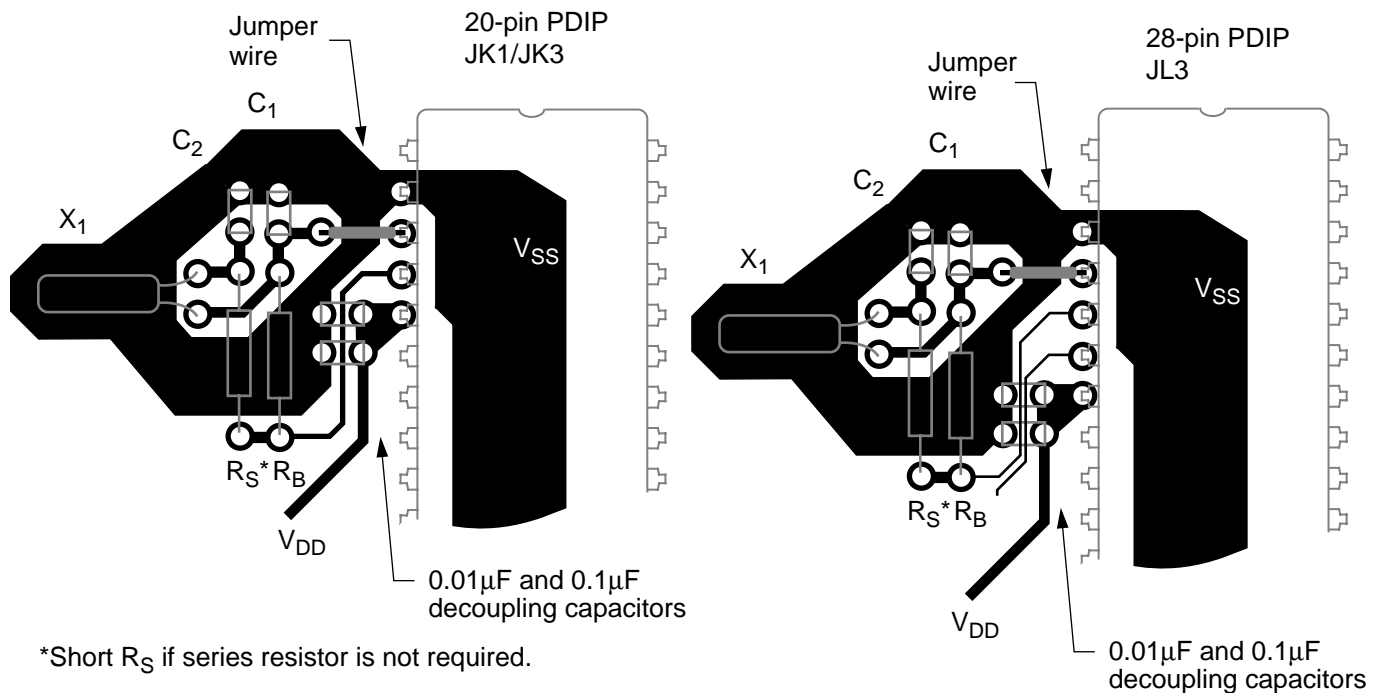
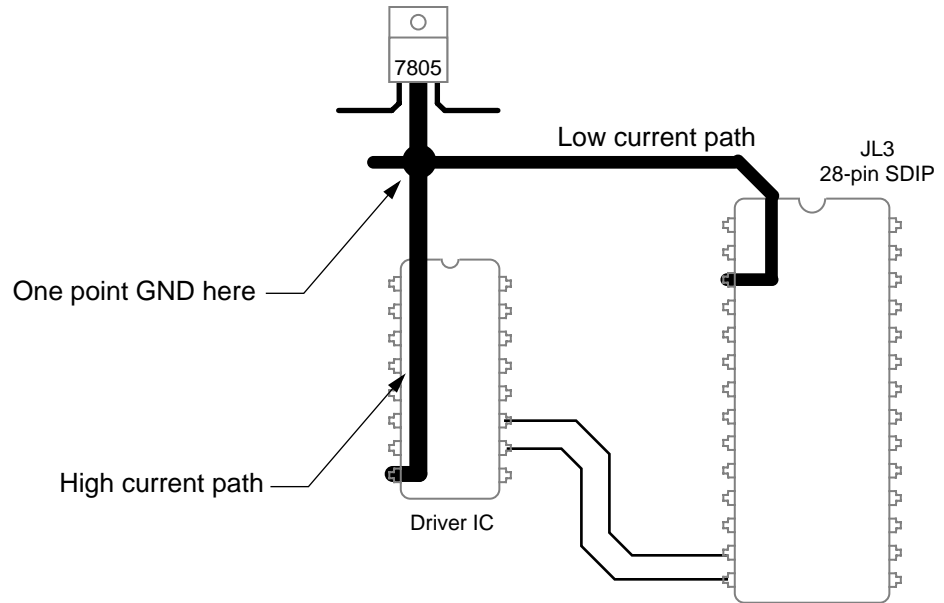


Figure 10. Crystal Oscillator PCB Layout

**Ground return for high-current devices**

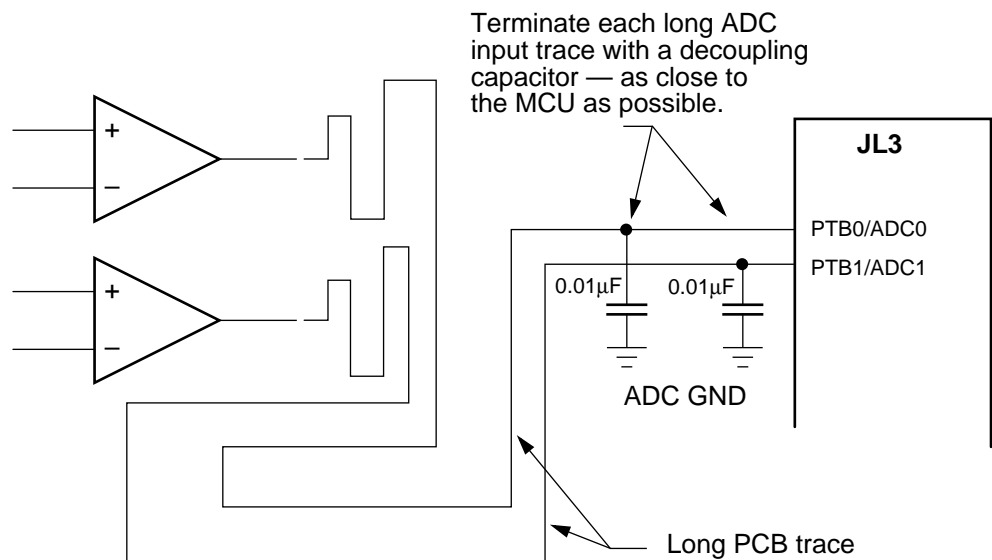
Keep high current return ground paths separate from low current return ground paths, and join them at a single point near the regulator or the power supply input.



**Figure 11. Ground Return for High Current Devices**

**Long signal paths to ADC pins**

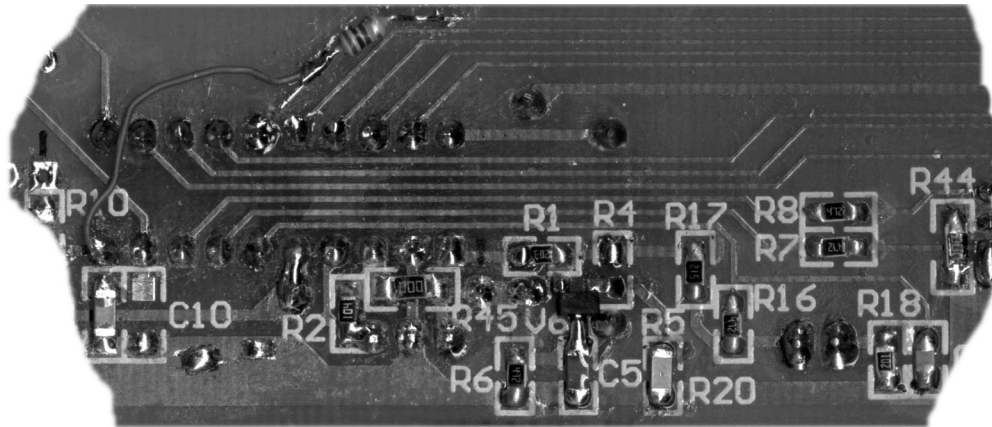
Terminate a long PCB trace carrying analog signal with a decoupling capacitor — at the MCU ADC input pin (see Figure 12 and Figure 13).



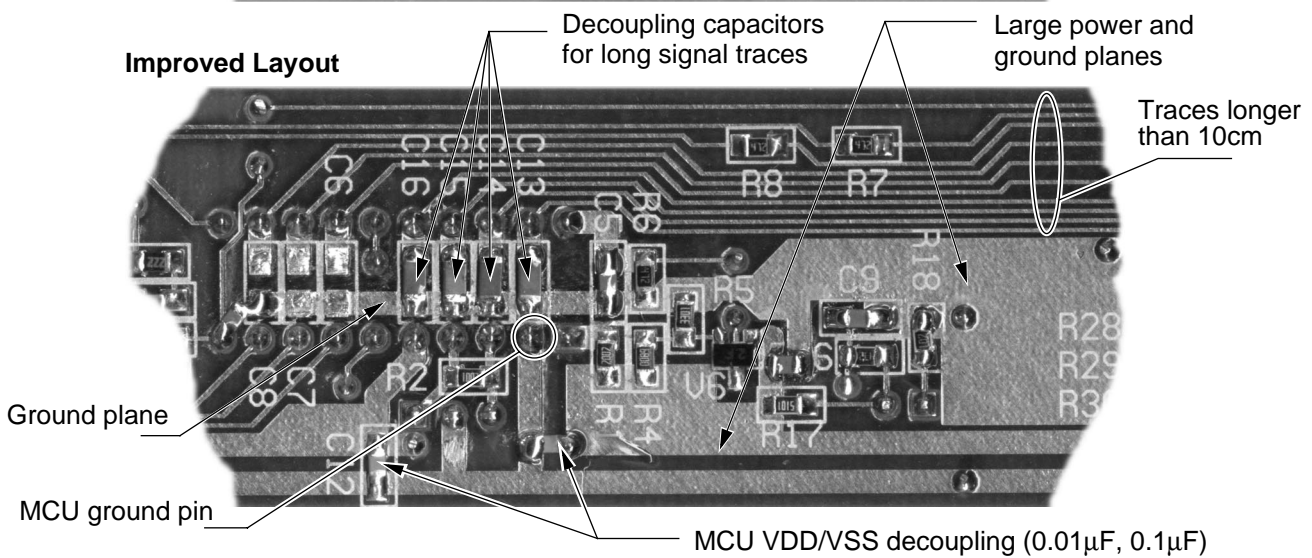
**Figure 12. Long Analog Signal Paths**

# Application Note


## Previous Layout



## Improved Layout



**Figure 13. Example PCB Layout**

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

### How to reach us:

**USA/EUROPE/Locations Not Listed:** Motorola Literature Distribution; P.O. Box 5405, Denver, Colorado 80217. 1-303-675-2140 or 1-800-441-2447

**JAPAN:** Motorola Japan Ltd.; SPS, Technical Information Center, 3-20-1, Minami-Azabu, Minato-ku, Tokyo 106-8573 Japan. 81-3-3440-3569

**ASIA/PACIFIC:** Motorola Semiconductors H.K. Ltd.; Silicon Harbour Centre, 2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong. 852-26668334

**Technical Information Center: 1-800-521-6274**

**HOME PAGE:** <http://www.motorola.com/semiconductors/>



© Motorola, Inc., 2001

AN2158/D