6.1.4 ADC Clock – clk_{ADC}

The ADC is provided with a dedicated clock domain. This allows halting the CPU and I/O clocks in order to reduce noise generated by digital circuitry. This gives more accurate ADC conversion results.

6.2 Clock Sources

The device has the following clock source options, selectable by Flash fuse bits as shown below. The clock from the selected source is input to the AVR clock generator, and routed to the appropriate modules.

Table 6-1. Device Clocking Options Select

Device Clocking Option	CKSEL[1:0](1)
External Clock (see page 24)	00
Calibrated Internal 4.8/9.6 MHz Oscillator (see page 25)	01, 10
Internal 128 kHz Oscillator (see page 26)	11

Note: 1. For all fuses “1” means unprogrammed while “0” means programmed.

The various choices for each clocking option is given in the following sections. When the CPU wakes up from Power-down or Power-save, the selected clock source is used to time the start-up, ensuring stable Oscillator operation before instruction execution starts. When the CPU starts from reset, there is an additional delay allowing the power to reach a stable level before commencing normal operation. The Watchdog Oscillator is used for timing this real-time part of the start-up time. The number of WDT Oscillator cycles used for each time-out is shown in Table 6-2.

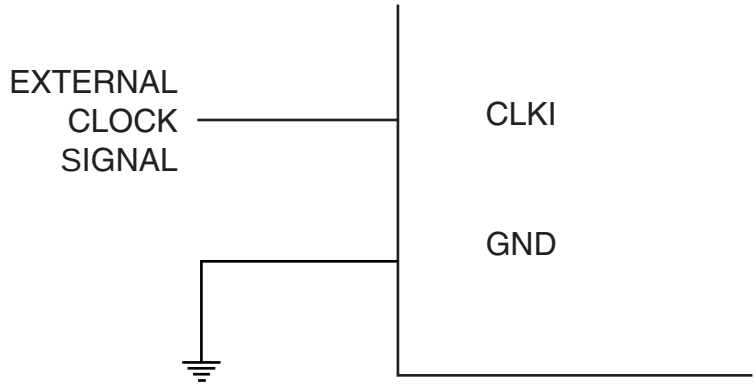
Table 6-2. Number of Watchdog Oscillator Cycles

Typ Time-out	Number of Cycles
4 ms	512
64 ms	8K (8,192)

6.2.1 External Clock

To drive the device from an external clock source, CLKI should be driven as shown in Figure 6-2. To run the device on an external clock, the CKSEL fuses must be programmed to “00”.

Figure 6-2. External Clock Drive Configuration



When this clock source is selected, start-up times are determined by the SUT fuses as shown in Table 6-3.

Table 6-3. Start-up Times for the External Clock Selection

SUT[1:0]	Start-up Time from Power-down and Power-save	Additional Delay from Reset	Recommended Usage
00	6 CK	14CK	BOD enabled
01	6 CK	14CK + 4 ms	Fast rising power
10	6 CK	14CK + 64 ms	Slowly rising power
11	Reserved		

When applying an external clock, it is required to avoid sudden changes in the applied clock frequency to ensure stable operation of the MCU. A variation in frequency of more than 2% from one clock cycle to the next can lead to unpredictable behavior. It is required to ensure that the MCU is kept in Reset during such changes in the clock frequency.

Note that the System Clock Prescaler can be used to implement run-time changes of the internal clock frequency while still ensuring stable operation. Refer to "System Clock Prescaler" on page 26 for details.

6.2.2 Calibrated Internal 4.8/9.6 MHz Oscillator

The calibrated internal oscillator provides a 4.8 or 9.6 MHz clock source. The frequency is nominal at 3V and 25°C. If the frequency exceeds the specification of the device (depends on V_{CC}), the CKDIV8 fuse must be programmed so that the internal clock is divided by 8 during start-up. See "System Clock Prescaler" on page 26. for more details.

The internal oscillator is selected as the system clock by programming the CKSEL fuses as shown in Table 6-4. If selected, it will operate with no external components.

Table 6-4. Internal Calibrated RC Oscillator Operating Modes

CKSEL[1:0]	Nominal Frequency
10(1)	9.6 MHz
01	4.8 MHz

Note: 1. The device is shipped with this option selected.

During reset, hardware loads the calibration data into the OSCCAL register and thereby automatically calibrates the oscillator. There are separate calibration bytes for 4.8 and 9.6 MHz operation but only one is automatically loaded during reset (see section "Calibration Bytes" on page 105). This is because the only difference between 4.8 MHz and 9.6 MHz mode is an internal clock divider.

By changing the OSCCAL register from SW, see "OSCCAL – Oscillator Calibration Register" on page 27, it is possible to get a higher calibration accuracy than by using the factory calibration. See "Calibrated Internal RC Oscillator Accuracy" on page 119.

When this oscillator is used as the chip clock, the Watchdog Oscillator will still be used for the Watchdog Timer and for the Reset Time-out. For more information on the pre-programmed calibration value, see the section "Calibration Bytes" on page 105.