Introduction

The ATmega328PB megaAVR® 8-bit microcontroller supports Clock Failure Detection (CFD) and auto-switching internal Resistance-Capacitance (RC) oscillator for clock-redundant applications when the CFD bit of the fuse register is enabled. Once the CFD fuse is enabled, the 128 kHz oscillator is enabled, and the CFD circuit works with that clock. This application note introduces the ATmega328PB CFD features and operations. A code example based on the ATmega328PB Xplained Mini Kit can be downloaded from Atmel | START.

Features

- Fuse-Enabled CFD
- External Clock Failure Detection Circuit Works in 128 kHz
- In Case of Failure, the System Clock Will Fall Back to Calibrated RC Oscillator Output
- 1 MHz Fallback Clock
- Interrupt Flag (XFDIF) Available for External Clock Failure
1. **Operations**

- The Clock Failure Detector (CFD) allows the user to monitor the low-power crystal oscillator or external clock signal.
- When the XOSC is working, the ‘CKSEL to clock sel’, as shown in the figure below, will be ‘CKSEL fuse’, which will be selected and the appropriate clock will be used as the system clock.
- XOSC failure is monitored by the CFD circuit, which works in 128 kHz.
- Once the failure is detected, the calibrated RC oscillator is enabled.
- XFDIF interrupt will be raised. This interrupt is enabled by the XFDIE bit of the XFDCSR register.
- If the XOSC fails, the selected clock will be 4'b0010 (hard-coded, as shown in the figure below), which is the value of the calibrated RC. The output of the calibrated RC will be used as the system clock.
- The fallback clock will be 1 MHz. The figure shows system clock generation with CFD mechanism.
- The clock can be modified by changing the prescaler after clock switching.
- CFD will be automatically disabled when the chip enters Power-Save/Down sleep mode and then enabled when the chip returns to Active mode.
- A Reset must be provided to use the original clock source.
- The user can change the clock frequency by configuring the prescaler after switching the clock.
- CFD will be enabled only if the system frequency is above 256 kHz.
- During start-up, CFD will be enabled by default. If the external clock is not provided, the device will automatically switch to the 1 MHz calibrated RC Oscillator output.

![Figure 1-1. System Clock Generation with CFD Mechanism](image-url)
2. Example Project
This application note provides an example that demonstrates the CFD function of the ATmega328PB with an ATmega328PB Xplained Mini Kit. The source code is available for download from Atmel | START.

2.1 Prerequisites
The example project discussed in this document requires:

- Atmel Studio 7.0 or Later
- ATmega328PB Xplained Mini Kit
- Example Source Code Downloaded from Atmel | START

2.2 ATmega328PB Xplained Mini Kit Introduction
The ATmega328PB Xplained Mini Kit is a hardware platform that evaluates the ATmega328PB microcontroller. The evaluation kit integrates an LED, which connects to PB5 of the ATmega328PB chip. For more details about this kit, refer to the 'ATmega328PB Xplained Mini - User Guide'.

2.3 Project Introduction
To run the example project on ATmega328PB Xplained Mini Kit, program the CFD fuse bit by setting ‘Enabled’ and the Clock Selection Fuse bits by setting ‘Ext. clock; Start-up time PWRDWN/RESET: 6 CK/14 CK + 0 ms’, as shown in the figure below.
Once the fuse settings have been set and the example project firmware image is programmed, the ATmega328PB device on the Xplained board works with the external 16 MHz clock and turns on LED0. Once the external 16 MHz clock is shorted, the ATmega328PB's CFD mechanism will detect it. Then, auto-switch to the internal 1 MHz RC oscillator and set the Clock Failure Flag bit, which triggers the LED toggling in this example project, as shown in the figure below.
Figure 2-2. Example Project Firmware Flowchart

Start

System Init

Clock failure flag (Bit 1 of XPARSR) = 1?

No

Yes

Clock switch to internal RC 1 MHz oscillator; toggling LED0 continuously

Set LED0 ON
3. References

- ATmega328PB Data Sheet
- ATmega328PB Xplained Mini Kit
- Atmel Studio
- Atmel | START
## 4. Revision History

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<td>A</td>
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