I2C Debug Session Report: Single-Axis Sensor Debugging

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Summary

This document outlines the steps taken to debug the I2C communication issues with a single-axis sensor on a Raspberry Pi. Below is a detailed account of the process, observations, and resolutions.

Initial Steps

Converted the existing Bend Labs polled demo script to Python for execution on an RPi.
The script ran for a few minutes, displaying repeated inaccurate values before stopping due to an “input/output error” or "remote I/O error" (indicating an I2C NACK).
The evaluation kit provided by Bend Labs gives consistent, accurate readings, so we know the sensor is capable.

Debugging Efforts

Modified the initialization sequence and some logic:

- Reset Pin Adjustment: Set the reset pin low, waited, set it high, and waited again during initialization. This modification stopped the initial I/O errors, but not the NACK.
- Alternative Reset Pin Adjustment: Setting the reset pin high, waiting, then low, and waiting caused the sensor to enter a bad state, making it undetectable by the RPi until a reboot.

Data Ready Pin Usage:

- Introduced a wait for the data ready pin to go low (indicating data has been read) before reading again, replacing the simple time delay. This approach showed a few accurate readings before stopping again.

Baud Rate Adjustment:

- Decreased the RPi’s baud rate greatly, but the same problem persisted.

Two-Axis Sensor Test:

- Tested the two-axis sensor using the exact same method, which worked without issues and gave consistent, accurate readings with the same initialization sequence.

Oscilloscope Analysis:

- Connected an oscilloscope to record and replicate the initialization sequence used in the evaluation kit. Directly copied the initialization sequence, resulting in a not acknowledged error during the second write operation directly following a read. To address this, we attempted to wait for the data ready pin to go low after the first write, but the data ready pin never went low due to a NACK.

Simplified Initialization:

- Removed the newly added initialization steps and tried changing the sampling rate with no change.
- Implemented a run command into every loop following a read for the latest data, before pausing for a small delay. This approach resolved the issue, allowing continuous operation and accurate raw data readings.

Additional Observations

Byte Reading and Writing:
When reading a different number of bytes than expected by the sensor, the output would become overwritten or corrupted because the internal pointer was not reset between runs of the I2C sequence. Attempting to read and print a different number of bytes led to repeated values from the previous read until the pointer exhausted its range, causing an unusual repeating pattern. These issues are atypical for I2C devices and were not observed in the two-axis sensor.

Multi-Device I2C Bus:
Now that the sensor is operating, it appears that this sensor does not perform well when other I2C devices are on the bus. When a run command is sent to another device with a different address, it should ignore any other writes but instead it accepts any data from the bus and goes into a bad, incommunicable state.
Currently working on validating the I2C buffer chip to control signals passed to the sensor to prevent it from entering a bad state.

Conclusion

The successful resolution involved simplifying the initialization process and adjusting the sampling rate to fit the specifications of the wrist sensor system. The final implementation includes reading the data, issuing the run command, and introducing a small delay, which returns stable, accurate readings.

Further observations noted issues with reading varying byte counts, indicating a potential internal pointer reset issue within the sensor. Additionally, the sensor's performance degrades in the presence of other I2C devices on the bus. This aspect is being addressed by validating the I2C buffer chip to control the signals passed to the sensor, aiming to prevent it from entering a bad state.