Data Rate Calculation

Calculations for Data Rates

Inertial Measurement Unit (IMU)

Model Name: Sparkfun SEN-15335

Type of Communication:

Digital

SPI @ 7Mhz, I2C @400 Khz

Data Load Capacity:

- **Accelerometer**:
  - Data per sample: 3 axes×16 bits=48 bits
  - Output Data Rate (ODR): 500 Hz
  - Data rate: 48 bits×500 samples/second= 24000 bits/second
- **Gyroscope**:
  - Data per sample: 3 axes×16 bits=48
  - ODR: 500 Hz
  - Data rate: 48 bits×500 samples/second=24000 bits/second
- **Magnetometer**:
  - Data per sample: 3 axes×16 bits=48 bits
  - ODR: 500 Hz
  - Data rate: 48 bits×500 samples/second=24000 bits/second
- **Total IMU Data Rate**: 24000+24000+24000=72000 bits/second

Atmospheric pressure & Temperature sensor

Model Name: Adafruit BMP280

Type of Communication:

Digital

SPI

Data Load Capacity:

- **Pressure:**
  - Data per sample: bytes (24 bits)
  - ODR: 500 Hz
  - Data rate: 500 samples/second×24 bits/sample=12000 bits/second

- Temperature:
  - Data per sample: bytes (24 bits)
  - ODR: 500 Hz
  - Data rate: 500 samples/second×24 bits/sample=12000 bits/second

Total BMP280 Data rate: 12000+12000 = 24000 bits/second

Thermocouple Amplifier , Qty.2

Model Name: MCP9600

Type of Communication:

Digital

I2C

Data Load Capacity:

- **Thermocouple Temperature:**
  - Data per sample: 2 bytes (16 bits)
  - ODR: 500 Hz
  - Data rate: 500 samples/second×16 bits/sample=8000 bits/second

- **Cold-Junction Temperature:**
  - Data per sample: 2 bytes (16 bits)
  - ODR: 500 Hz
  - Data rate: 500 samples/second×16 bits/sample=8000 bits/second

Total Data rate: 2x8000x8000 = 32000 bits/second

Pressure Transducer, Qty. 2

Model Name:

Festo SPTW-P100R

Type of Communication:

Analog

Data Load Capacity:

Using a 50 Ohm resistor, the output of the pressure transducer will be converter from 4-20 mA, to 0.2 – 1V, usually referred to as 1.1V.

- Arduino Nano has a 10-bit ADC (Analog-to-Digital Converter), which means it can resolve voltage levels into 1024 discrete steps (0 to 1023).
- Voltage Step Size: Step Size= Voltage Range/1024= 1024Voltage Range
- Step Size=(1.0V−0.2V)/1024 = 0.8/1024 = 0.00078125 V per step

- Data rate: 500 samples/second×10 bits/sample=5000 bits/second
- Total : 2*5000 = 10000 bits/second

Total Data Rate

- **Total Data Rate**: 72000+24000+32000+10000= 138000 bits/second
- **Total Data Rate in Bytes**: 138000 bits/second÷8= 17250 bytes/second

Arduino Nano Clock and SPI Speed

Arduino Nano Clock Frequency: 16 MHz

SPI Clock Speed (SCK): With SPI_CLOCK_DIV2,
SCK=16000000 Hz÷2=8 MHz

Effective Transfer Rate: 8 Mbps (8000000 bits/second)

SD Card Write Speed

- Required write speed: 17250 bytes/second
- Typical SPI clock speed for SD card: 4 MHz (with SPI_CLOCK_DIV4)
- This SPI clock speed should be sufficient, assuming the SD card can handle the write speed.

XBee Data Transmission

The XBee S2B module can handle up to 200 kbps.

Data Transfer rate :

Xbee Pro S2b : approx. 200 Kbps = 25 kbytes/s

We'll assume using **unicast** communication and **no encryption**.
We'll choose a common baud rate for the XBee, such as **9600 bits/second**.

Maximum Payload Size (unicast, unencrypted): 84 bytes

Comparing this maximum XBee data rate (25000 Kbytes/second) with the total data rate from the sensors (17,250 bytes/second)