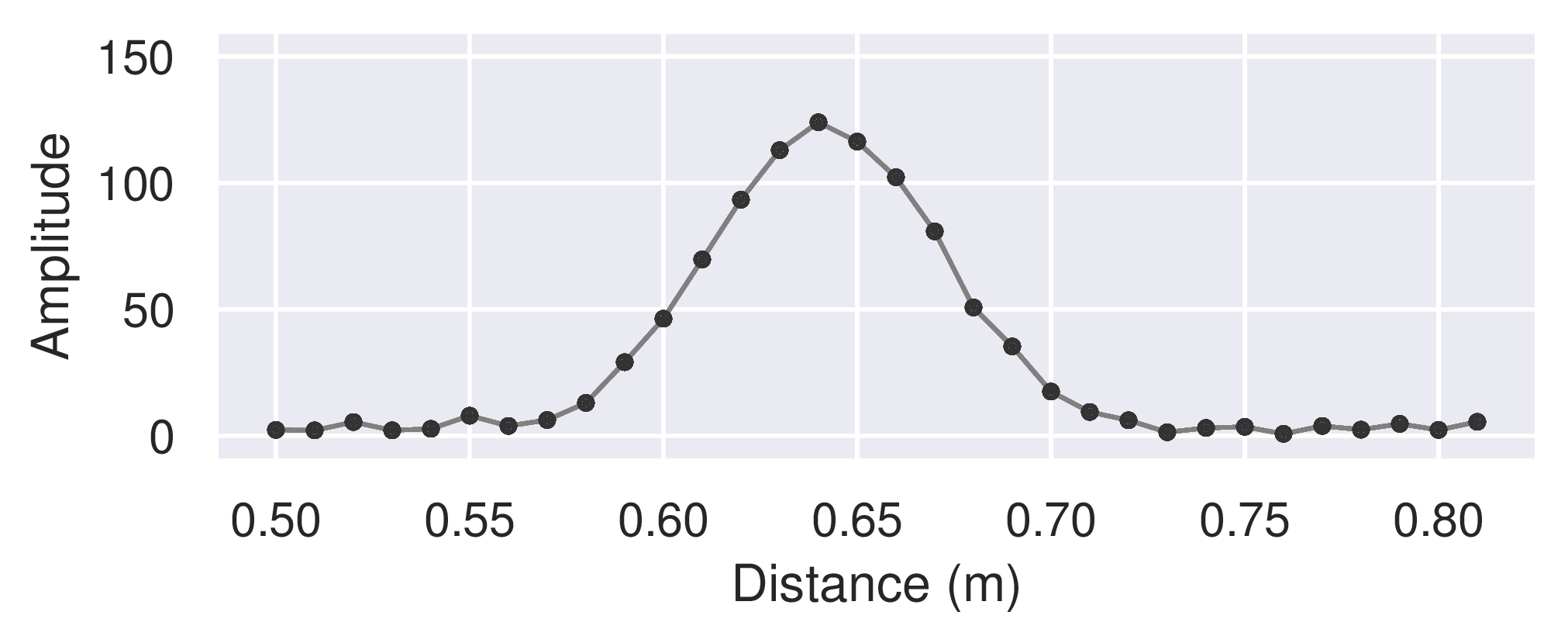
Measurement Range

The sparse IQ service can be configured to measure practically any range of distances in a so-called *sweep*. In other words, a sweep makes up the points in space where reflected pulses are measured.



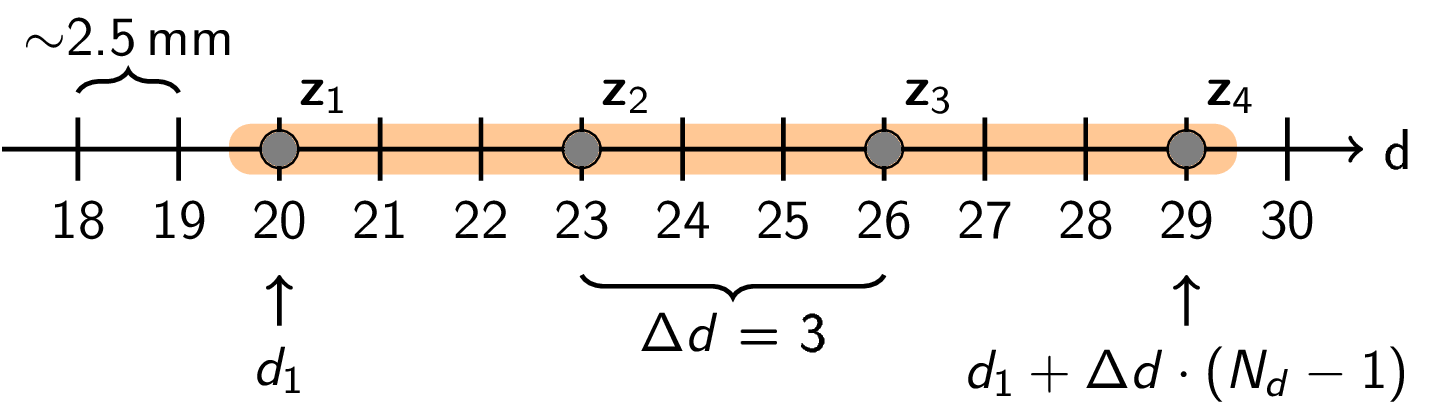
*Figure 1*: Amplitude of a mocked sweep of an environment with a single object.

Figure 1 above shows an example of a sweep with a range spanning from a start point at ~ 0.50 m to an end point at ~ 0.81 m. Here, a total of 32 points were measured with a distance between them of ~ 10 mm, also configurable. The shortest configurable distance between points is ~ 2.5 mm.

The more points that are measured, the more memory is used and the longer it takes to measure the sweep. This may in turn lead to higher overall duty cycle and power consumption. Thus, it is often important to try to minimize the number of points measured, typically achieved by maximizing the distance between the points.

Configuration

For preciseness, the range is configured in a discrete scale with three integer parameters – the **start point** , the **number of points** , and the **step length** . The step length corresponds to the distance between the points (mentioned above). The distance between the points in the discrete scale is ~ 2.5 mm, which is also why the shortest configurable distance between points is just that.



*Figure 2*: An illustration of the sweep *range* concept

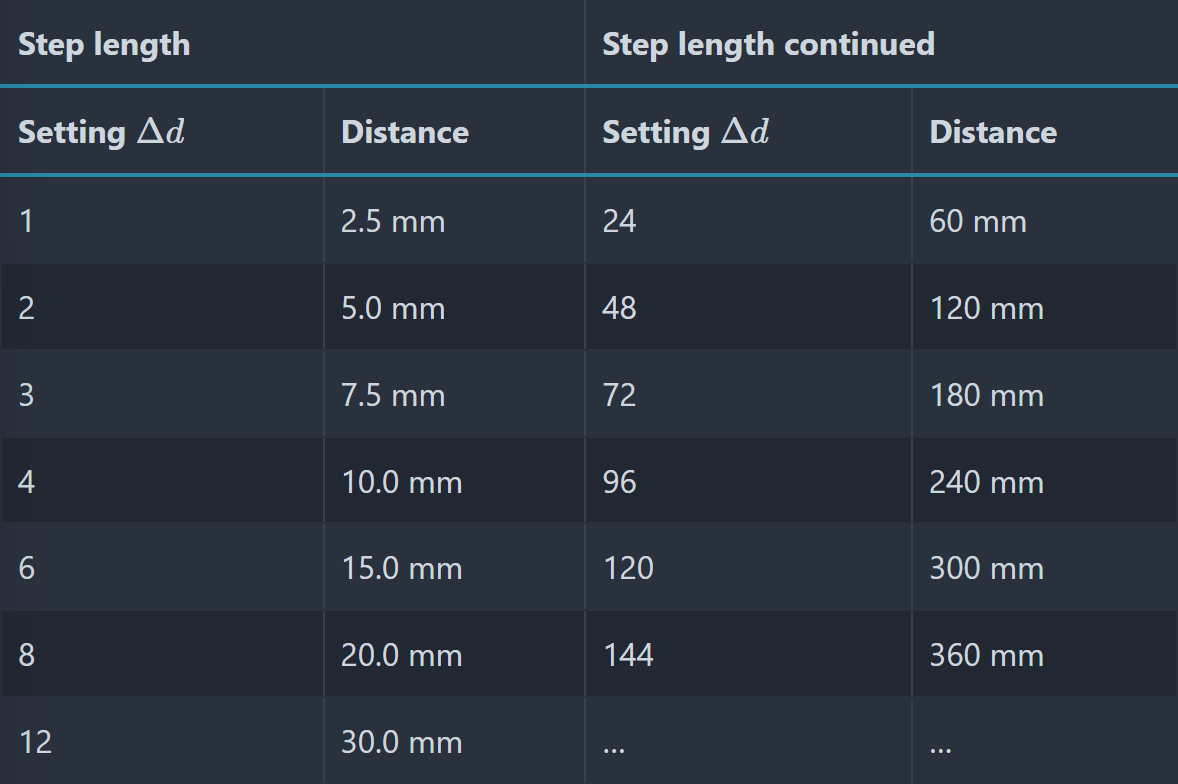
Figure 9 above demonstrates how a range can be set up with these parameters. The start point , the number of points , and the step length = 3. This gives the discrete points {20,23,26,29} which correspond to {50.0mm, 57.5mm, 65.0mm, 72.5mm}.

Note that the possible values for step length are limited.

Limitations

The only limitation on the number of points itself is related to the available buffer size of 4095 complex numbers. The buffer usage is the number of points times the number of sweeps per frame . In short, .

The step length must be a divisor or multiple of 24. The shortest step length, 1, gives a distance between points of ~2.5mm. See the table below for an overview.



The *maximum measurable distance* (MMD), i.e., the farthest configurable “end point”, is limited by the *pulse repetition frequency* (PRF). The lower the PRF, the longer the MMD.

The PRF also gives the *maximum unambiguous range* (MUR) – the maximum range at which the target can be located while still guaranteeing that the reflected pulse corresponds to the most recent transmitted pulse. Again, the lower the PRF, the longer the MUR.

Caveats

A number of factors affect the actual real world distance of a given range point:

* The refractive index and thickness of materials the radar signal pass through.
* Systematic errors due to process, supply voltage, and temperature variations.
* Reference clock frequency.

Some static offsets can be compensated for by doing a loopback measurement of the “zero point”.

A121 Range-related parameters

**Profiles**: Sets the duration and shape of emitted pulses. Other internal parameters are set up accordingly to maximize the efficiency of the system, which affects the measurement time of a point. Higher numbered profiles use longer pulses, which generally:

* Increases SNR due to increased emitted energy.
* Decreases measurement time for a given configuration.
* Gives the possibility to sample more sparsely, decreasing measurement time and memory usage.

On the flip side, longer pulses also:

* Decreases precision due to lower bandwidth.
* Increases TX to RX leakage length, i.e., how far into the range the transmitted pulse is visible. The closest usable range due to this is referred to as the “close-in distance”.
* Decreases distance resolution (ability to resolve objects close to each other).

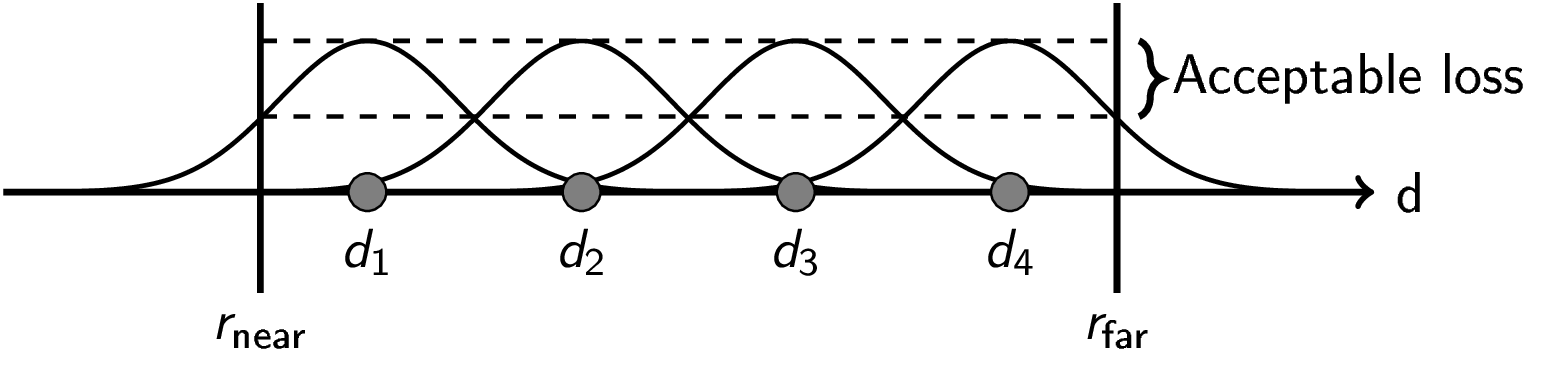
Use the highest profile possible for maximum overall power and time efficiency. If you need to resolve multiple objects, the duration of the pulse must be short enough to give the resolution needed. Finally, lower profiles may give more precise distance measurements.

As distance is a large concern of ours, we most likely want to use a lower profile setting to ensure more precise distance measurements.

**Step length**: The step length should be as long as possible to reduce memory usage and decrease measurement time. It is typically limited by two things:

* Distance measurement trueness: As a rule of thumb, the steps need to be 1/10 to 1/2 of the required trueness. Note that as steps get smaller, other factors such as SNR and pulse duration (profile) have a bigger impact on the general accuracy.
* The profile: If steps are too long, reflecting objects may fall between points, creating “blind spots” in the range.

From here, the **start point** and **number of points** can be set. Just make sure the points cover to . Due to the pulse length (profile), the start and end points does not necessarily have to pass and . See Figure 3 for an example of this. However, keep in mind that distance measurements typically cannot be done in the very edge of the range, so you might have to extend it outside and anyways.



*Figure 3*

A121 Rate-related parameters

**Sweeps per frame (SPF):** Sets the frequency (velocity) resolution. If you need to detect “slow” motions or have a mostly static environment, there is no need to use multiple sweeps per frame (SPF), so set it to 1. Such cases include (inter-frame) presence detection and distance measurements.

For cases where SPF = 1, the sweep rate is not applicable. What matters then is setting the Hardware Accelerated Average Samples (**HWAAS)** to achieve the needed *signal-to-noise ratio* SNR. Keep in mind that measurement time linearly increases with HWAAS, so keeping it as low as possible is important to manage the overall power consumption.