signal input attenuates frequencies far outside the lock-in's operating range (f_{noise}>>100 kHz). In these cases, the reserve can be higher at these frequencies than within the operating range. While this may be a nice specification, removing noise at frequencies very far from the reference does not require a lock-in amplifier. Lock-ins are used when there is noise at frequencies near the signal. Thus, the dynamic reserve for noise within the operating range is more important.

Dynamic reserve in the SR830

The SR830, with its digital phase sensitive detectors, does not suffer from DC output errors caused by large noise signals. The dynamic reserve can be increased to above 100 dB without measurement error. Large noise signals do not cause output errors from the PSD. The large DC gain does not result in increased output drift.

In fact, the only drawback to using ultra high dynamic reserves (>60 dB) is the increased output noise due to the noise of the A/D converter. This increase in output noise is only present when the dynamic reserve is above 60 dB AND set to High Reserve or Normal. However, the Low Noise reserve can be very high as we'll see shortly.

To set a scale, the SR830's output noise at 100 dB dynamic reserve is only measurable when the signal input is grounded. Let's do a simple experiment. If the lock-in reference is at 1 kHz and a large signal is applied at 9.5 kHz, what will the lock-in output be? If the signal is increased to the dynamic reserve limit (100 dB greater than full scale), the output will reflect the noise of the signal at 1 kHz. The spectrum of any pure sine generator always has a noise floor, i.e. there is some noise at all frequencies. So even though the applied signal is at 9.5 kHz, there will be noise at all other frequencies, including the 1 kHz lock-in reference. This noise will be detected by the lock-in and appear as noise at the output. This output noise will typically be greater than the SR830's own output noise. In fact, virtually all signal sources will have a noise floor which will dominate the lock-in output noise. Of course, noise signals are generally much noisier than pure sine generators and will have much higher broadband noise floors.

If the noise does not reach the reserve limit, the SR830's own output noise may become detectable at ultra high reserves. In this case, simply lower the dynamic reserve and the DC gain will decrease and the output noise will decrease also. In general, do not run with more reserve than necessary. Certainly don't use High Reserve when there is virtually no noise at all.

The frequency dependence of dynamic reserve is inherent in the lock-in detection technique. The SR830, by providing more low pass filter stages, can increase the dynamic reserve close to the reference frequency. The specified reserve applies to noise signals within the operating range of the lock-in, i.e. frequencies below 100 kHz. The reserve at higher frequencies is actually higher but is generally not that useful.

Minimum dynamic reserve (Low Noise)

The SR830 always has a minimum amount of dynamic reserve. This minimum reserve is the Low Noise reserve setting. The minimum reserve changes with the sensitivity (gain) of the instrument. At high gains (full scale sensitivity of 50 µV and below), the minimum dynamic reserve increases from 37 dB at the same rate as the sensitivity increases. For example, the minimum reserve at 5 µV sensitivity is 57 dB. In many analog lock-ins, the reserve can be lower. Why can't the SR830 run with lower reserve at this sensitivity?

The answer to this question is - Why would you want lower reserve? In an analog lock-in, lower reserve means less output error and drift. In the SR830, more reserve does not increase the output error or drift. More reserve can increase the output noise though. However, if the analog signal gain before the A/D converter is high enough, the 5 nV/√Hz noise of the signal input will be amplified to a level greater than the input noise of the A/D converter. At this point, the detected noise will reflect the actual noise at the signal input and not the A/D converter's noise. Increasing the analog gain (decreasing the reserve) will not decrease the output noise. Thus, there is no reason to decrease the reserve. At a sensitivity of 5 µV, the analog gain is sufficiently high so that A/D converter noise is not a problem. Sensitivities below 5 µV do not require any more gain since the signal to noise ratio will not be improved (the front end noise dominates). The SR830 does not increase the gain below the 5 µV sensitivity, instead, the minimum reserve increases. Of course, the input gain can be decreased and the reserve increased, in which case the A/D converter noise might be detected in the absence of any signal input.