SATURATION BY NOISE AND CW SIGNALS IN SIS MIXERS

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Saturation (gain compression) can be a serious problem in SIS mixers not designed with appropriate input power levels in mind. Plambeck [1] has pointed out that gain compression is likely to limit the calibration accuracy of observations with the Atacama Large Millimeter Array. SIS receivers have been reported with substantial gain compression at source temperatures as low as 50 K while others have been capable of observing the sun (~6000 K) with only slight gain compression.

For amplifiers, it is well known that equal noise and CW powers produce different degrees of gain compression, and similar behavior is expected in SIS mixers. The established phenomenological theory of saturation by CW signals in SIS mixers agrees well with experimental data [2], even at gain compression levels as high as 3 dB. When saturation is caused by broadband noise, a different approach is required which allows the statistics of the IF output noise to be deduced from those of the input noise. Such a method is described and used to analyze saturation by noise and CW signals in SIS mixers. Generalized saturation curves are given, and also representative results for mixers at several frequencies. Many SIS mixers in current use are expected to exhibit a significant degree of gain compression when connected to a room-temperature source.

It is noted that, even in a receiver which is partially saturated by broadband noise, the response to a small CW test signal may be linear over several decades of power. Hence, linearity of a receiver to a CW test signal does not imply that it is not already partially saturated by the background room temperature input noise.

[1] R. L. Plambeck, "Receiver amplitude calibration for ALMA," ALMA Memo 321, August 27, 2000. (http://www.alma.nrao.edu/memos/)

[2] M. J. Feldman, S.-K. Pan, and A.R. Kerr, "Saturation of the SIS mixer," International Superconductivity Electronics Conference Digest, Tokyo, pp. 290-292, Aug. 1987.

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