SIGNAL RECOVERY

Dual Beam Ratiometric Measurements using the Model 198A Mixed Beam Light Chopper

APPLICATION NOTE
AN 1005

Introduction

The model 198A mixed beam light chopper can be used in conjunction with the dual reference mode provided by the ***SIGNAL RECOVERY*** model 7260, 7265 and 7280 DSP lock-in amplifiers to build a very cost-effective dual-beam measurement system. This technique can eliminate variations in source intensity over several orders of magnitude, which is especially useful in two common situations:

- If the source output is unstable over time, such as with some discharge lamps.
- If the "source" is the output of a spectrometer with a tungsten-halogen or other lamp as its input and the spectrometer center wavelength is being scanned as part of the experiment.

This application note describes how such a system can be configured.

Experimental Setup

A typical experimental arrangement is shown in Figure1 below.

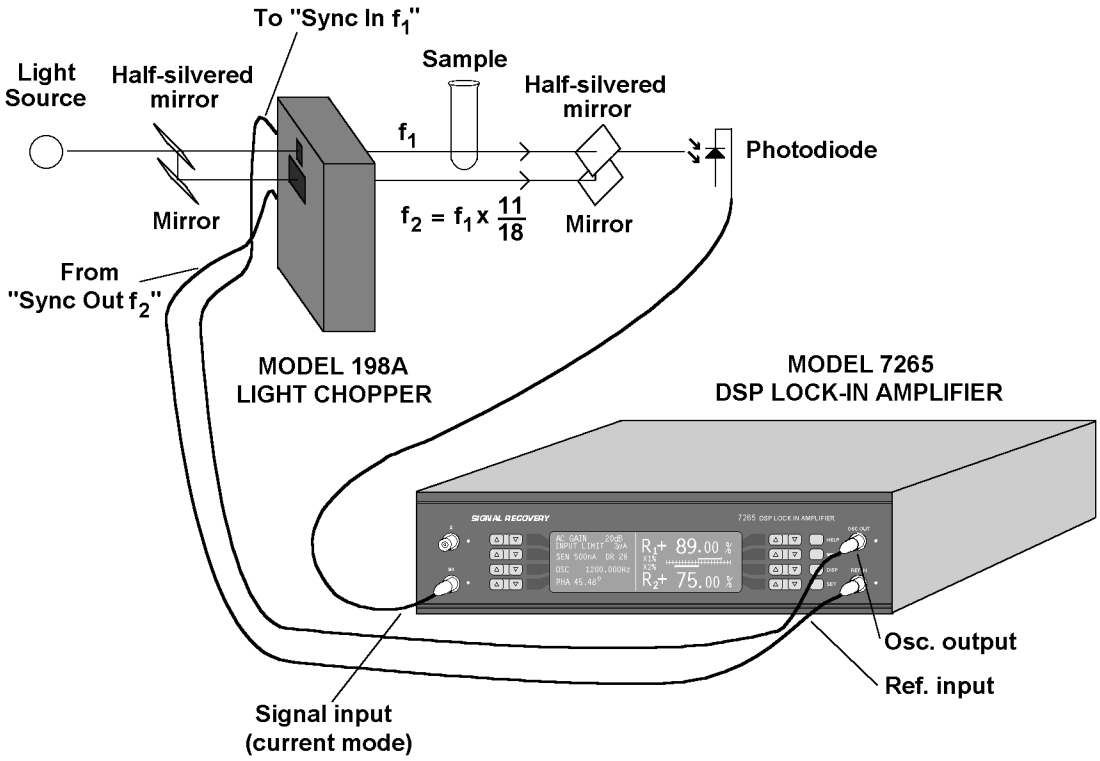

Figure 1, Dual Beam Ratiometric System using Model 198A Light Chopper and Model 7265 DSP Lock-in Amplifier

Description

A focussed light source is split into two beams using either a half-silvered mirror or beam-splitter, with the two beams being aligned so that they pass through the inner and outer apertures of the model 198A. One beam passes through the sample, while the other passes via a reference path that may include ND (neutral density) filters (not shown). Both beams are recombined back onto a single photodiode using a second mirror/beam-splitter combination. Hence there will be two signals at the detector, one at frequency f_1 that is due to the light that passes through the sample and the second at f_2, due to light travelling via the "reference" path.

A 7265 lock-in amplifier is set to the dual reference mode with the internal oscillator set to 360 Hz. The oscillator amplitude is set to 2 V rms and the **OSC OUT** connector coupled to the **Sync In f_1** input on the 198A. The chopper locks to this input, causing the f_1 frequency also to be 360 Hz and thereby satisfying the criterion that one of the signals being detected by the lock-in must be at the internal reference frequency.

The chopper also generates a reference signal at the f_2 frequency, which is coupled back to the lock-in's **REF IN** input. Hence the external reference channel operates at this frequency, which is in this case $360 \times 11/18 = 220$ Hz.

Once the lock-in amplifier's sensitivity and phase controls have been properly adjusted then it indicates in the **R_2** channel (i.e. the internal reference frequency) the magnitude of the signal due to light through the sample, while the **R_1** channel (the external frequency) shows that due to light via the reference path.

The ratio of these two signals is independent over several orders of magnitude to changes in the source intensity, so if the ratio is calculated and displayed using the 7265's **User Equations** menu such variations can be eliminated.

Advantages

The system described is considerably more cost-effective than the traditional approach which required two lock-in amplifiers. Since the same detector and analog signal channel is used for both signals, differential drift between channels is also eliminated. Note, however, that limitations in the performance of the dual reference mode mean that best results are obtained when the experiment is arranged so that the absolute levels of the two electrical signals at f_1 and f_2 differ by no more than a factor of one hundred.

Further Information

Additional information may be found in the following and other ***SIGNAL RECOVERY*** publications, which may be obtained from your local ***SIGNAL RECOVERY*** office or representative, or downloaded from our website at **www.signalrecovery.com**

TN 1000 What is a Lock-in Amplifier?
TN 1001 Specifying a Lock-in Amplifier
TN 1002 The Analog Lock-in Amplifier
TN 1003 The Digital Lock-in Amplifier
TN 1004 How to Use Noise Figure Contours
TN 1005 What is a Boxcar Averager?
TN 1006 Boxcar Averager Specification Comparison
TN 1007 The Incredible Story of Dr D.P. Freeze

AN 1000 Dual-Channel Absorption Measurement with Source Intensity Compensation
AN 1001 Input Offset Reduction using the Model 7265/7260/7225/7220 Synchronous Oscillator/Demodulator Monitor Output
AN 1002 Using the Model 7225 and 7265 Lock-in Amplifiers with software written for the SR830
AN 1003 Low Level Optical Detection using Lock-in Amplifier Techniques
AN 1004 Multiplexed Measurements using the 7220, 7225, 7265 and 7280 DSP Lock-in Amplifiers

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