218(M) Optical Chopper User Notes

BENTHAM

Overview

The optical chopper, inserted into the path of light incident on the monochromator entrance port, provides an AC light signal, which is recovered with a chopper reference signal

The 218 optical chopper is accompanied with either free standing or modular control electronics to be fitted to the Bentham 417(T) bin.

To the base of the chopper is situated an opto switch, which is equally interrupted by the passage of the chopping blade. This provides a positive going square wave signal of 0.5V peak, coherent with the chopping action, is available from the reference output socket on the front panel of the control electronics unit.

WARNING: THIS DEVICE USES UNPROTECTED MOVING PARTS. AVOID CONTACT WITH THE CHOPPING DISC WHEN IT IS RUNNING. TAKE SPECIAL CARE WHEN USING THE 2-SLOT DISC.

Mechanical

The 218 consists of high quality motor to which should be attached one of a set of four chopping blades. The blade selected depends on the chopping frequency required, as summarised in the following:-

Number of slots	Chopping Frequency
2	5Hz - 200Hz
5	12.5Hz - 500Hz
10	25Hz - 1kHz
30	75Hz - 3kHz

The chopping head may be mounted on a post, screwed down to a flat surface, supported in front of any Bentham monochromator slit using the chopper mounting plate accessory (CMP) or fitted to one of the Bentham illuminators.

Electrical

The chopper head is connected to the controller via five-pin connector, and the 218 powered on. The reference output of the 218(M) should be connected to the reference input of the lock-in amplifier.

Mains Setup

In the case of the 218, using the slide switch mounted on the rear panel of the control electronics
module, select the nominal mains voltage corresponding to the local supply.
The mains fuse is mounted in a drawer underneath the IEC mains inlet. Fuses are 110V-630mA anti-surge; 220V-315mA anti-surge.

Setting the chopping frequency-218

The chopping frequency is set using the knob on the front panel and read directly from the frequency meter.

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Using the chopper

The following factors should be considered when selecting a suitable chopping disc.
1. The chopping frequency required.
2. The size of beam to be chopped.
3. The rotational speed of the motor.

In light measurement systems the optical chopper serves two purposes. Firstly, by periodically interrupting the light beam, it allows use of those detectors (e.g. pyroelectric) which only give a signal when the incident flux is changing. Secondly, by changing the signal from the detector from dc to ac it allows processing and amplification at frequencies above the dc/low frequency region where electronic noise and ambient light leaks would degrade the signal to noise ratio. In general, noise power increases as zero Hz is approached. For modern electronics amplifiers processing signals from optical detectors, the noise spectrum quickly flattens out as the frequency increases with the result that, from a signal to noise viewpoint, chopping frequencies in the range of a few hundred Hz are satisfactory provided that the detector has the necessary speed of response and that the output bandwidth of the signal processing electronics does not exceed the chopping frequency. The final chopping frequency should not be chosen without considering the local power line frequency. Operating at 50Hz(60Hz) is obviously undesirable as there is always interference at these frequencies even in the best shielded systems. Lighting systems produce light modulated at 100Hz(120Hz) so selection of this as a chopping frequency would give little or no rejection of light leaks. The power supplies in electronics units always have some residual ripple at 100Hz(120Hz) and also at 150Hz(180Hz) and other harmonics. Studies carried out at Bentham have identified a quiet point mid way between the 3rd and 4th harmonic of the line supply frequency. Hence our recommended chopping frequency for all our detectors (excluding the pyro-electric DH-Py) is 175Hz where the line frequency is 50Hz and 210Hz where the line frequency is 60Hz. The speed of response of the DHPy limits the chopping frequency to the 10-20Hz range.

Having chosen the chopping frequency the next point to consider is the size of the light beam to be chopped. If the aperture in the chopping disc is smaller than the beam diameter then less than 100% modulation will be achieved with a consequent reduction in signal and degradation of signal to noise ratio. However, care should be taken to check the active diameter of the beam. Often in monochromator illumination systems the light source produces a beam of greater diameter than that which the monochromator will accept and a chopping disc aperture which appears too small from the point of view of the light source is found to be perfectly adequate when the entrance aperture of the monochromator is considered.

You may well find that even after considering the above you are still faced with a choice of discs. The final factor is related to the rotational speed of the motor. Excessively high speeds will shorten motor life - excessively slow speeds will degrade frequency stability. For example, for a chopping frequency at 175Hz it is much better to use the 5-slot disc running at 2100 rpm than the 2 slot disc running at 5250 rpm. The following table shows limiting and recommended frequency ranges for each chopping disc. Number of slots Maximum range (Hz) Recommended range (Hz)

External Control

The chopping frequency can be controlled by applying an analogue voltage to the control input. Connection is made via a 3.5mm jack socket (RS 478-481). Maximum input voltage is 15V,

input impedance is 20k.. The chopping frequency control adjusts the scale factor relating chopping frequency to input voltage.

WEEE statement

Bentham are fully WEEE compliant, registration number is WEE/CB0003ZR. Should you need to dispose of our equipment please telephone 0113 385 4352 or 4356, quoting account number 135419.

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