

# 650-Series Light Choppers



Model 651-1

## FEATURES

- ◆ Remote chopper heads
- ◆ Quartz crystal frequency accuracy and stability
- ◆ Internal or external frequency reference
- ◆ Sync outputs
- ◆ Choice of 3 models
- ◆ Fully enclosed housings for safety and low noise

## APPLICATIONS

- ◆ Optical absorption, reflection and transmission measurements
- ◆ Dual-beam ratiometric measurements
- ◆ Automatic background subtraction in boxcar averager experiments

## DESCRIPTION

The 650 series of light choppers features a control box with separate chopping heads for remote operation. There are three different models within the range, the 651-1 using a standard dual port chopping head and 652-1 and 652-2 employing a single port micro head for use where space is a prime consideration.

All the models in the range offer precision frequency control via digital push-buttons or by the application of an AC signal to the sync input on the control unit. When used in conjunction with a **SIGNAL RECOVERY** lock-in amplifier, computer control of the chopping frequency can be achieved by use of the lock-in amplifier's oscillator as a drive signal for the chopper and controlling the oscillator frequency from the computer. In all cases, frequency accuracy and stability are excellent. A LED indicator on the front panel gives constant indication of frequency lock. This indicator can, however, be extinguished for those measurements that need to be executed in total blackout conditions.

One special feature of the 650 series choppers is the ability to add extension leads (model 653A) to increase the remote distance between the chopping head and the control unit. Up to two additional leads can be employed, each 2 m long, producing a maximum separation distance between head and controller of 5.5 m (18 ft).

Both the standard head and the micro heads are fully enclosed designs which serve to reduce errors resulting from external air motion and to minimize the risk of accidental damage to the chopping blades.

### Quartz Crystal Frequency Accuracy and Stability

The models 651-1, 652-1 and 652-2, in common with all **SIGNAL RECOVERY** light choppers, uses a quartz crystal oscillator as their primary frequency standard. The oscillator signal is divided down to yield the required chopper frequency, and then the motor speed is continuously adjusted to phase lock the actual chopper frequency to this required value. The result are choppers with an output frequency as stable as any other modern frequency source.

### External Frequency Control

Like many other choppers, the frequency can be controlled externally. However, unlike other units the control is via an applied TTL reference rather than an analog voltage. This means that the modulation frequency generated is exactly that required, and in the case of the dual-aperture model 651-1 allows it to be used in conjunction with the dual reference modes offered by our model 7270, 7124, 7265 and 7280 lock-in amplifiers to implement two-channel source compensation experiments. Figure 1 on page 64 shows the model 198A used in this mode but is equally valid when this is replaced by the 651-1. The application is discussed in detail in Applications Note AN1005 on page 147.

# Light Choppers

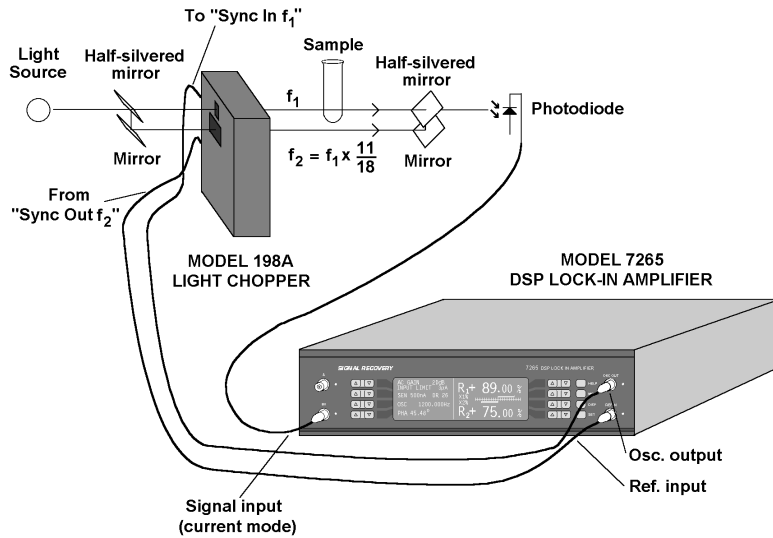
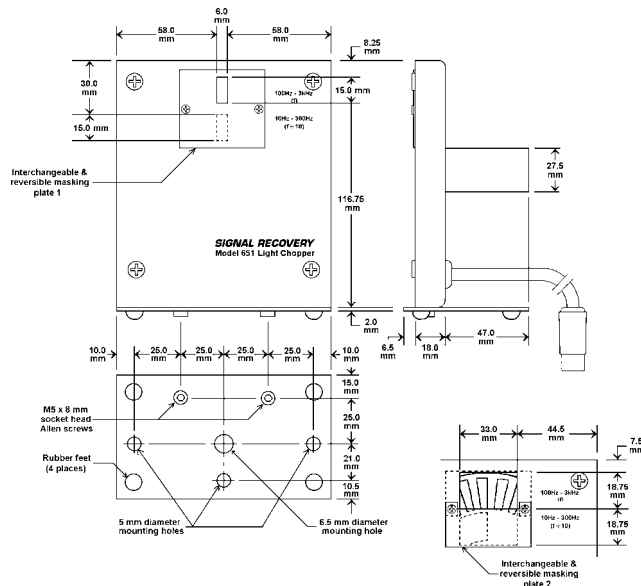


Figure 1, Using the Model 198A (651-1 may be substituted) with a Model 7265 to implement a dual-channel source compensation experiment

## Model 651-1 Dual Aperture Light Chopper

The model 651-1 uses the standard head. This is a dual port design allowing two optical beams to be modulated simultaneously at different frequencies,  $f_1$  and  $f_2$ . Two reference (sync) outputs are made available at the control unit, corresponding to  $f_1$  and  $f_2$ , for use with signal recovery processing electronics, such as a lock-in amplifier.

Two small blanking plates are provided with the standard head and one of these allows either the top port or the bottom port to be blanked off to reduce the effect of any stray light passing through the unused path. The second plate provides some measure of beam restriction when using large diameter beams on the higher frequency (and therefore smaller aperture) port. The standard head is supplied complete with a flat base plate to allow it to be used in a free standing mode on a bench type surface. A special feature of this support allows the head to be used in the horizontal plane for modulating vertical beams. The base plate can be removed and standard optical mounting posts employed instead if preferred.



Model 651-1 Mechanical Dimensions

## Specifications - Model 651-1

### General

Dual-aperture remote head chopper with internal or external reference frequency. Two sync outputs.

Frequency	10 Hz to 3200 Hz
outer sector	100 Hz to 3200 Hz
inner sector	10 Hz to 320 Hz
Control	
manual	Digital push-button
external	Application of 0.5 V to 10 V pk-pk sine or squarewave, 100 Hz to 3200 Hz to EXT SYNC BNC connector
Internal Frequency	
accuracy	±30 ppm at 25 °C
stability	±50 ppm/ °C (range 10 °C to 30 °C)

Jitter (measured pk-pk and presented as a % of a full cycle)

outer sector	
100 to 200 Hz	blade only: 0.2%; blade + electronics: < 7%
200 to 400 Hz	blade only: 0.2%; blade + electronics: < 4%
400 to 2500 Hz	blade only: 0.2%; blade + electronics: < 1.5%
2500 to 3200 Hz	blade only: 0.2%; blade + electronics: < 2%
inner sector	
10 to 20 Hz	blade only: 0.2%; blade + electronics: < 0.7%
20 to 40 Hz	blade only: 0.2%; blade + electronics: < 0.4%
40 to 250 Hz	blade only: 0.2%; blade + electronics: < 0.2%
250 to 320 Hz	blade only: 0.2%; blade + electronics: < 0.3%

Lock indication green LED when locked - can be extinguished

Settling Time <40 s nominal

### Outputs

Sync Out 1 10 V pk-pk squarewave at outer sector chopping frequency, 100 - 3200 Hz

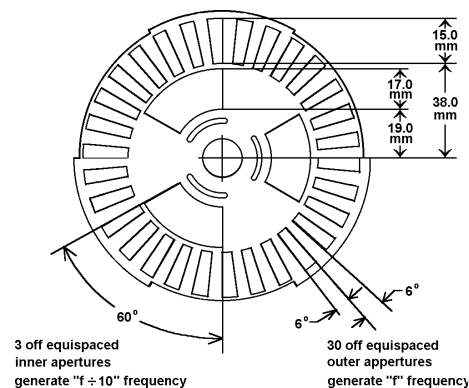
Sync Out 2 10 V pk-pk squarewave at inner sector chopping frequency, 10 - 320 Hz

Connectors BNC  
Impedance 10 kΩ. Note that although the output voltage is 10 V pk-pk, the high output

impedance means that the outputs can be directly connected to the external reference input of any **SIGNAL RECOVERY** lock-in amplifier without causing problems.

**Dimensions**  
 Controller  
 Width 6½" (168 mm)  
 Height 3¼" (79 mm)  
 Depth 9¼" (236 mm)  
 Chopper head, overall, inc. base and feet  
 Width 4¾" (122 mm)  
 Height 6" (150 mm)  
 Depth 2¾" (72 mm)

**Options**  
 Model 653A 2 m (6'6") extension cable



**Model 651-1 Blade Dimensions**

**General**

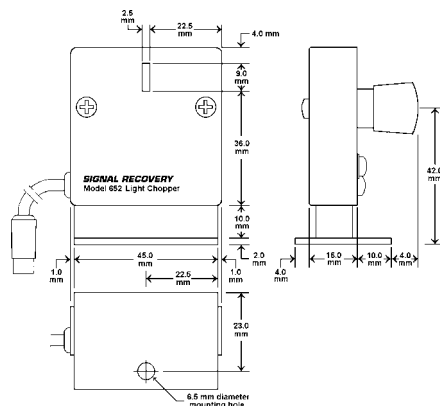
**Power Requirements** 110 V AC, 50/60 Hz or 220/240 V AC, 50/60 Hz supply. State which voltage is required when ordering

## Models 652-1 and 652-2 Micro Head Light Choppers

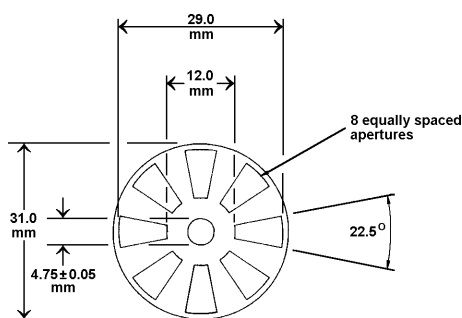
The models 652-1 and 652-2 utilize a micro head. This is a single port modulator for use where space is limited. The former uses a 2-slot chopping disc and the latter an 8-slot disc to achieve a different frequency range. Micro heads can be employed as free standing modulators on a bench type surface, or can be supported on standard mounting hardware.



**Model 652-1**



**Models 652-1 and 652-2 Mechanical Dimensions**



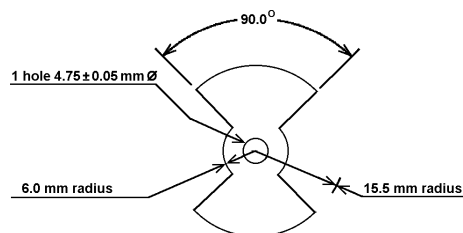
**Model 652-2 Blade Dimensions**

## Specifications - Models 652-1 and 652-2

**General**  
 Single aperture remote head chopper with internal or external reference frequency. Sync output.

**Frequency**  
 652-1 2 slots, 30 Hz to 290 Hz  
 652-2 8 slots, 60 Hz to 1100 Hz

<b>Control</b>	manual external	Digital push-button Application of 0.5 V to 10 V pk-pk sine or squarewave within the chopper's range to EXT SYNC BNC connector
<b>Internal Frequency accuracy</b>	±30 ppm at 25 °C ±50 ppm/ °C (range 10 °C to 30 °C)	
<b>stability</b>		
<b>Jitter (measured pk-pk and presented as a % of a full cycle)</b>		
652-1	30 to 50 Hz	blade only: 0.2%; blade + electronics: < 5%
652-2	50 to 290 Hz	blade only: 0.2%; blade + electronics: < 2%
652-1	60 to 100 Hz	blade only: 0.2%; blade + electronics: < 6%
652-2	100 to 290 Hz	blade only: 0.2%; blade + electronics: < 2.4%
<b>Lock indication</b>		green LED when locked - can be extinguished



**Model 652-1 Blade Dimensions**

# Light Choppers

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## Specifications

### Models 651-1 and 651-2 (continued)

Settling Time <40 s nominal

**Outputs**  
Sync Out 1 10 V pk-pk squarewave at chopping frequency

Connector BNC

Impedance 10 k $\Omega$ . Note that although the output voltage is 10 V pk-pk, the high output impedance means that the outputs can be directly connected to the external reference input of any

**SIGNAL RECOVERY**  
lock-in amplifier without causing problems.

### General

Power Requirements 110 V AC, 50/60 Hz or 220/240 V AC, 50/60 Hz supply. State which voltage is required when ordering.

### Dimensions

Controller

Width 6½" (168 mm)

Height ¾" (79 mm)

Depth 9½" (236 mm)

Chopper head, overall, inc. base and feet

Width 2" (48 mm)

Height 2½" (62 mm)

Depth 1½" (35 mm)

### Options

Model 653A 2 m (6'6") extension cable