

**Models 197, 198A,
651-1, 652-1 & 652-2
Precision Light Choppers**

Instruction Manual

190508-A-MNL-B

FCC Notice

These instruments generate, use, and can radiate radio-frequency energy and, if not installed and used in accordance with this manual, may cause interference to radio communications. As temporarily permitted by regulation, operation of these instruments in a residential area is likely to cause interference, in which case the user at his own facility will be required to take whatever measures may be required to correct the interference.

Company Names

SIGNAL RECOVERY is part of Advanced Measurement Technology, Inc, a division of AMETEK, Inc. It includes the businesses formerly trading as EG&G Princeton Applied Research, EG&G Instruments (Signal Recovery), EG&G Signal Recovery and PerkinElmer Instruments (Signal Recovery)

Declaration of Conformity

These products conform to EC Directives 89/336/EEC Electromagnetic Compatibility Directive, amended by 92/31/EEC and 93/68/EEC, and Low Voltage Directive 73/23/EEC amended by 93/68/EEC.

These products have been designed in conformance with the following IEC/EN standards:

EMC: BS EN55011 (1991) Group 1, Class A (CSP1R 11:1990)
 BS EN50082-1 (1992):
 IEC 801-2:1991
 IEC 801-3:1994
 IEC 801-4:198A8

Safety: BS EN61010-1: 1993 (IEC 1010-1:1990+A1:1992)

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1.1 What is a Light Chopper?

A light chopper is a device incorporating a thin metal rotating blade with a series of apertures. A light beam directed perpendicular to the blade surface is aligned with the apertures so that as it rotates the blade modulates the beam passing through it into a series of “on” and “off” periods. The frequency of this modulation is proportional to the rotational speed and the number of apertures in the blade.

The chopper uses a slotted optical switch, typically located well away from the main beam path, to generate an electrical signal at the same frequency and phase as the modulated light beam. This signal is known as the reference, or synchronizing, output.

The modulated light beam is applied to the experimental system and typically detected by some form of opto-electronic device, such as a photomultiplier or photodiode. The detected signal plus accompanying noise is then applied to a lock-in amplifier or signal averager, with the reference or trigger input being connected to the chopper’s synchronizing output. The lock-in or averager uses the reference signal to uniquely select and measure the signal at the detector caused by the modulated beam, thereby extracting it from the accompanying noise.

In order to handle a wide range of experiments and optical beam diameters it is desirable that the chopper frequency be adjustable. It is also important for the sake of reproducibility that the selected chopper frequency be stable both with time and temperature. These considerations require that the rotational speed of the blade be controlled by a feedback mechanism and that there be some way of defining the speed accurately. In **SIGNAL RECOVERY** choppers this latter condition is satisfied by locking the blade rotation to either an externally applied frequency or to a frequency generated within the chopper from a precision quartz crystal oscillator.

1.2 Key Features and Benefits

SIGNAL RECOVERY light choppers are suitable for a wide range of general-laboratory and OEM applications. Five models offer a selection of chopping frequencies, beam diameters and the choice of integral or remote chopper head operation to suit most applications.

All units in the series use a precision motor control circuit to produce a highly stabilized chopping frequency that is locked to either an externally applied synchronizing input signal or to an internal quartz oscillator. They also all generate synchronizing output signals suitable for driving both **SIGNAL RECOVERY** and other manufacturers’ instruments, such as lock-in amplifiers, boxcar averagers and signal averagers.

The instruments use precision etched blades to ensure good jitter performance and incorporate mechanical protection to reduce the likelihood of damage caused by accidental contact with the blade. A variety of physical mounting options are

available, including free-standing use and attachment to standard optical mounting posts.

In summary these choppers will prove invaluable in any situation requiring high-quality, long-lasting and reliable operation. Their ability to be locked to an external frequency makes them suitable for an even wider range of experiments, as well as allowing extended life in many computer-controlled systems.

1.3 How to Use This Manual

Chapters 2 to 6 of this manual describe each of the models in the range. Although all the units share several common features, it is more practical to describe them individually. Please therefore refer to the chapter describing the particular unit you have purchased for information on how to set it up and use it.

Model 197

Dual Aperture Light Chopper

2.1 Installation & Initial Checks

Upon receipt the model 197 light chopper should be inspected for shipping damage. If any is noted, **SIGNAL RECOVERY** should be notified immediately and a claim filed with the carrier. The shipping container should be saved for inspection by the carrier.

To install the chopper, proceed as follows:

- a) Carefully unpack the chopper and mains power supply unit. The power supply incorporates a slide switch assembly which should be set as follows:-

Set to **230V AC** for use in areas where the prevailing line voltage is in the range 200 - 240 V AC, 50 - 60 Hz

Set to **115V AC** for use in areas where the prevailing line voltage is in the range 100 - 130 V AC, 50 - 60 Hz

A suitable line power cord is provided.

- b) Plug the power output lead from the power supply into the connector marked **Power Unit or 17/20V DC** on the model 197
- e) Set the digital push-button **Set Frequency f₁ Hz** control on the model 197 to read **1000**.
- f) Plug the line cord into the IEC input connector on the power supply unit, and plug the other end into the local line power.
- g) Check that the chopper blade starts to rotate and that the LED locked indicator is initially red. After a short while the indicator should change to green and the motor speed will become steady.
- h) Using an oscilloscope verify that the waveform present at the **Sync Out f₁** output is nominally a 1000 Hz squarewave of 10 V pk-pk when loaded with a high impedance (> 1 MΩ).
- i) Repeat the measurement in section h) but for the signal at the **Sync Out f₂** output, which should also be a squarewave of the same amplitude but at 100 Hz
- j) Turn off the line power and check that the chopper blade stops rotating.

This completes the initial checks. If the indicated results were obtained then the user can be reasonably sure that the model 197 incurred no hidden damage in shipment and is in good working order.

2.2 Operating Instructions

Operating the model 197 is straightforward. Power is applied from the external power supply unit as described in section 2.1 and the required chopping frequency set by adjusting the digital **Set Frequency f_1 Hz** control on the top edge of the unit.

Two apertures are provided (see figure 2-1) allowing one or two light beams to be modulated. The outer aperture (i.e. the aperture closer to the edge of the unit) generates modulation frequencies in the range 150 Hz to 3 kHz, while the inner aperture is used for frequencies one tenth of these values, i.e. in the range 15 Hz to 300 Hz. The unused aperture can be masked by sliding the relevant cover over it using the corresponding slider button.

Reference signals suitable for driving signal recovery instrumentation are available at the **Sync Out f_1** and **Sync Out f_2** outputs. The former gives a signal phase locked to the outer aperture frequency, while the latter is used is when using the inner set of apertures.

The chopper circuitry adjusts the blade rotational speed until the modulating frequency generated by the outer aperture is the same as one of two values, as follows:

Internal Reference

In this case the frequency is set by the digital **Set Frequency f_1 Hz** control on the unit. Hence, for example, if these are set to 1456 then the frequency generated by the outer aperture will be 1456 Hz, while that generated by the inner aperture will be 145.6 Hz.

External Reference

If an external reference signal of suitable amplitude is applied to the **Sync In f_1** input then the unit automatically switches to external reference operation. Hence, for example, if a 2560 Hz waveform is applied then the frequency generated by the outer apertures will be 2560 Hz, while that generated by the inner aperture will be 256.0 Hz.

When the external reference is disconnected then the unit reverts to internal reference mode.

When the generated frequency matches the selected internal or external reference then the LED on the top edge of the unit changes from red to green, indicating a reference lock condition.

CAUTION: Do not make direct contact with the chopper blade while the unit is powered. Do not move the chopper head while the blade is rotating, since gyroscopic forces will increase wear on the motor bearings and thereby reduce motor life.

2.3 Mechanical Dimensions

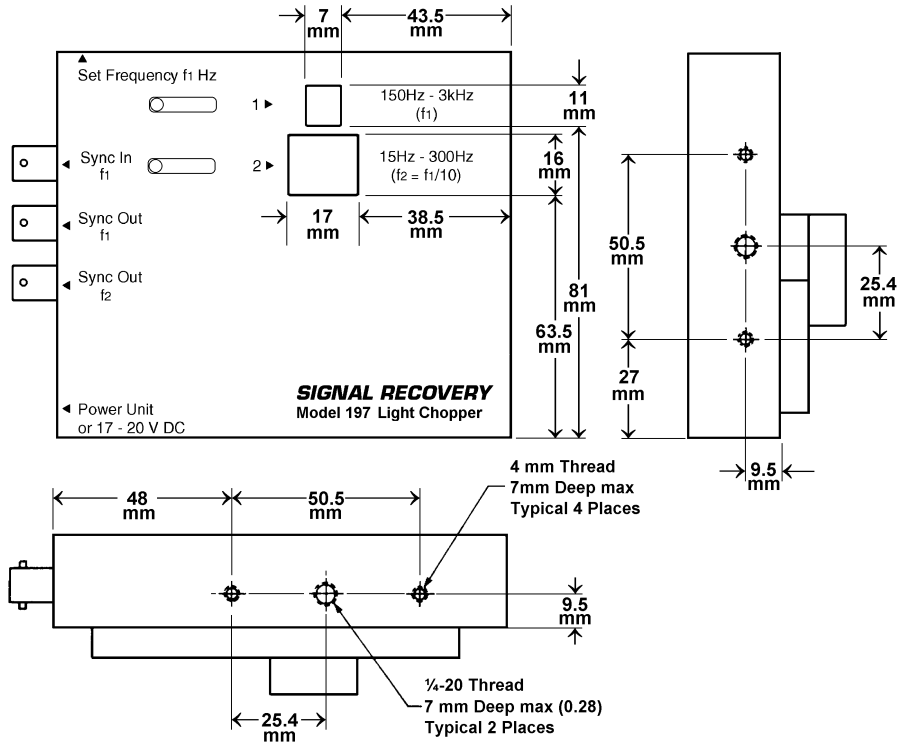


Figure 2-1, Model 197 Mechanical Dimensions

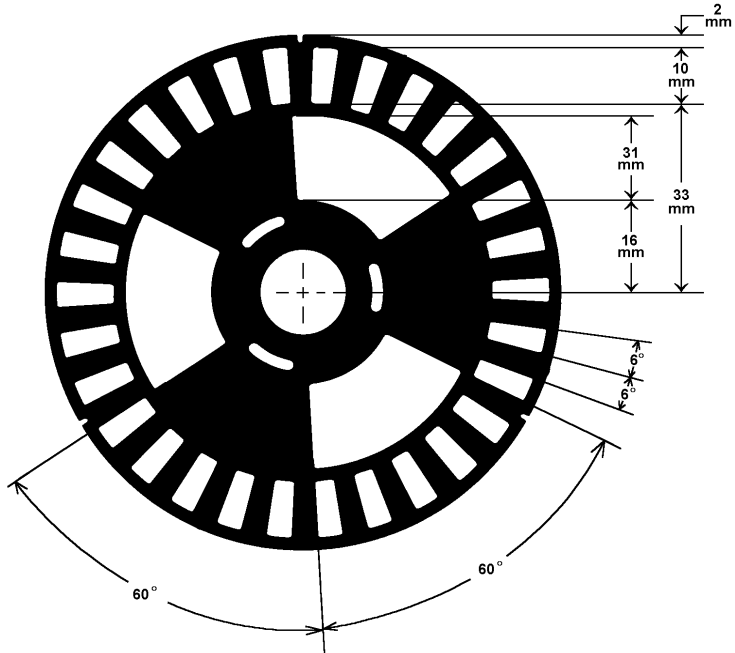


Figure 2-2, Model 197 Chopper Blade Dimensions

2.4 Specifications

Dual-aperture self-contained chopper with internal or external reference frequency.
Two sync outputs.

Frequency

outer sector	150 Hz to 3000 Hz
inner sector	15 Hz to 300 Hz

Control

manual	Digital push-button
external	Application of 0.5 V to 10 V sine or squarewave, 150 Hz to 3000 Hz to Sync In f₁ BNC connector

Internal Frequency

accuracy	±20 ppm at 25 °C
stability	±30 ppm/ °C (range 10 °C to 60 °C)

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

Outer sector	
150 to 500 Hz	blade only: 0.5%; blade + electronics: < 1.5%
500 to 3000 Hz	blade only: 0.5%; blade + electronics: < 1%
Inner sector	
15 to 50 Hz	blade only: 0.5%; blade + electronics: < 1.5%
50 to 300 Hz	blade only: 0.5%; blade + electronics: < 1%

Lock indication

Bicolor LED - red when unlocked and green when locked

Settling Time

7 s nominal at 1 kHz from switch-on;
9 s nominal for frequency change from 150 to 3000 Hz;
30 s nominal for frequency change from 3000 to 150 Hz

Outputs

Sync Out f ₁	10 V pk-pk squarewave at outer sector chopping frequency, 150 - 3000 Hz
Sync Out f ₂	10 V pk-pk squarewave at inner sector chopping frequency, 15 - 300 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.

General

Power Requirements

Via separate power adapter for 110 V AC, 50/60 Hz or 220/240 V AC, 50/60 Hz supply.

Dimensions

Width

4³/₄" (122 mm)

Height

4" (104 mm)

Depth

1³/₄" (44 mm)

Weight

1lb (0.45 kg) excluding power supply

Model 198A

Mixed Beam Light Chopper

3.1 Installation & Initial Checks

Upon receipt the model 198A light chopper should be inspected for shipping damage. If any is noted, **SIGNAL RECOVERY** should be notified immediately and a claim filed with the carrier. The shipping container should be saved for inspection by the carrier.

To install the chopper, proceed as follows:

- a) Carefully unpack the chopper and mains power supply unit. The power supply incorporates a slide switch assembly which should be set as follows:-

Set to **230V AC** for use in areas where the prevailing line voltage is in the range 200 - 240 V AC, 50 - 60 Hz

Set to **115V AC** for use in areas where the prevailing line voltage is in the range 100 - 130 V AC, 50 - 60 Hz

A suitable line power cord is provided.

- b) Plug the power output lead from the power supply into the connector marked **Power Unit or 17/20V DC** on the model 198A
- e) Set the digital **Set Frequency f_1 Hz** control on the top of the unit to read **900**.
- f) Plug the line cord into the IEC input connector on the power supply unit, and plug the other end into the local line power.
- g) Check that the chopper blade starts to rotate and that the LED locked indicator is initially red. After a short while the indicator should change to green and the motor speed will become steady.
- h) Using an oscilloscope verify that the waveform present at the **Sync Out f_1** output is nominally a 900 Hz squarewave of 10 V pk-pk when loaded with a high impedance ($> 1 \text{ M}\Omega$).
- i) Repeat the measurement in section h) but for the signal at the **Sync Out f_2** output, which should also be a squarewave of the same amplitude but at 550 Hz
- j) Repeat the measurement in section h) but for the signal at the **Sync Out ($f_1 + f_2$)** output, which should also be a squarewave of the same amplitude but at 1450 Hz
- k) Turn off the line power and check that the chopper blade stops rotating.

This completes the initial checks. If the indicated results were obtained then the user can be reasonably sure that the model 198A incurred no hidden damage in shipment and is in good working order.

3.2 Operating Instructions

Operating the model 198A is straightforward. Power is applied from the external power supply unit as described in section 3.1 and the required f_1 chopping frequency set by adjusting the digital **Set Frequency f_1 Hz** control on the top edge of the unit.

Two apertures are provided (see figure 3-1) allowing two light beams to be modulated. The outer aperture (i.e. the aperture closer to the edge of the unit) generates modulation frequencies in the range 90 Hz to 1500 Hz, while the inner aperture is used for frequencies in the range 55 Hz to 917 Hz.

Reference signals suitable for driving signal recovery instrumentation are available at the **Sync Out f_1** , **Sync Out f_2** and **Sync Out $f_1 + f_2$** outputs. The first two give signals phase locked to the outer and inner aperture frequencies respectively, while the last one gives a signal at the sum of these two frequencies.

The chopper circuitry adjusts the blade rotational speed until the higher of the two modulating frequencies (i.e. f_1) generated by each aperture is the same as one of two values, as follows:

Internal Reference

In this case the frequency is set by the digital **Set Frequency f_1 Hz** control on the unit. Hence, for example, if these are set to 900 then the frequency generated by the outer aperture will be 900 Hz, while that generated by the inner aperture will be $900 \times \frac{11}{18}$, or 550 Hz.

External Reference

If an external reference signal of suitable amplitude is applied to the **Sync In f_1** input then the unit automatically switches to external reference operation. Hence, for example, if a 900 Hz waveform is applied then the frequency generated by the outer apertures will be 900 Hz, while that generated by the inner aperture will be 550 Hz.

When the external reference is disconnected then the unit reverts to internal reference mode.

When the generated frequency matches the selected internal or external reference then the LED on the top edge of the unit changes from red to green, indicating a reference lock condition.

Mixed beam light choppers, such as the model 198A, are typically used to investigate non-linear optical materials. Two light beams are passed through the two apertures, being modulated by them at frequencies f_1 and f_2 . They are then combined on the sample under investigation. If the sample behaves entirely linearly then the resulting signal will contain only frequency components at f_1 and f_2 , but if there is some non-

linearity then there will also be components of equal amplitude at both the sum ($f_1 + f_2$) and difference ($f_1 - f_2$) frequencies. Consequently the magnitude of the effect can be observed by detecting signals at one of these frequencies, and in order to avoid the low frequency region the sum frequency is usually chosen.

The model 198A therefore has three synchronizing outputs suitable for driving subsequent signal recovery instrumentation. **Sync Out f_1** is used when the unit is used as a single beam chopper with the beam passing through the outer apertures, **Sync Out f_2** is used when the unit is used as a single beam chopper with the beam passing through the inner apertures and **Sync Out ($f_1 + f_2$)** is used in mixed beam applications.

CAUTION: Do not make direct contact with the chopper blade while the unit is powered. Do not move the chopper head while the blade is rotating, since gyroscopic forces will increase wear on the motor bearings and thereby reduce motor life.

3.3 Mechanical Dimensions

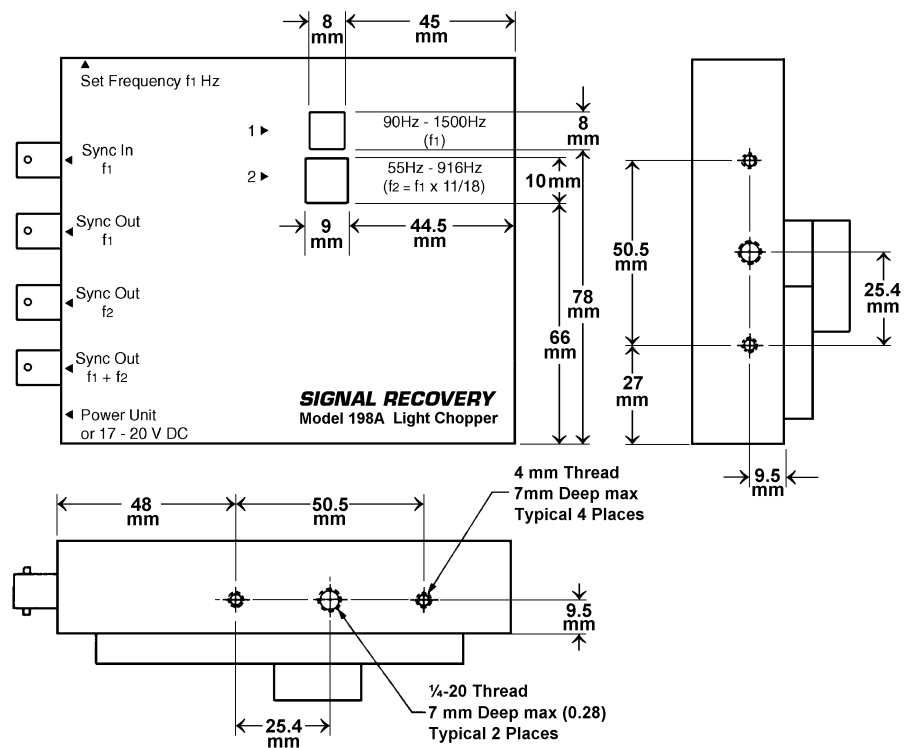


Figure 3-1, Model 198A Mechanical Dimensions

3.4 Specifications

Dual-aperture self-contained mixer chopper with internal or external reference frequency. Three sync outputs.

Frequency

outer sector	90 Hz to 1500 Hz, 18 apertures, f_1
inner sector	55 Hz to 917 Hz, 11 apertures, f_2

Control

manual	Digital push-button
external	Application of 0.5 V to 10 V sine or squarewave, 90 Hz to 1500 Hz to Sync In f_1 BNC connector

Internal Frequency

accuracy	± 20 ppm at 25 °C
stability	± 30 ppm/ °C (range 10 °C to 60 °C)

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

Outer sector	
90 to 140 Hz	blade only: 0.2%; blade + electronics: < 6%
140 to 1500 Hz	blade only: 0.2%; blade + electronics: < 1.5%
Inner sector	
55 to 100 Hz	blade only: 0.2%; blade + electronics: < 8%
100 to 917 Hz	blade only: 0.2%; blade + electronics: < 2%

Lock indication

Bicolor LED - red when unlocked and green when locked

Settling Time

7 s nominal at $f_{\text{sum}} = 1$ kHz from switch-on;
9 s nominal for f_{sum} frequency change from 150 to 2400 Hz;
30 s nominal for f_{sum} frequency change from 2400 to 150 Hz

Outputs

Sync Out f_1	10 V pk-pk squarewave at outer sector chopping frequency, 90 - 1500 Hz
Sync Out f_2	10 V pk-pk squarewave at inner sector chopping frequency, 55 - 917 Hz
Sync Out $f_1 + f_2$	10 V pk-pk squarewave at sum of chopping frequencies, 145 - 2417 Hz
Connectors	BNC
Impedance	10 k Ω . 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

Via separate power adapter for 110 V AC, 50/60 Hz or 220/240 V AC, 50/60 Hz supply.

Dimensions

Width

4³/₄" (122 mm)

Height

4" (104 mm)

Depth

1³/₄" (44 mm)

Weight

1lb (0.45 kg) excluding power supply

Model 651-1

Dual Aperture Light Chopper

4.1 Installation & Initial Checks

Upon receipt the model 651-1 light chopper should be inspected for shipping damage. If any is noted, **SIGNAL RECOVERY** should be notified immediately and a claim filed with the carrier. The shipping container should be saved for inspection by the carrier.

To install the chopper, proceed as follows:

- a) Carefully unpack the chopper head and separate control unit. The control units are shipped configured for the line voltage in the country of destination and are marked to indicate what voltage they are set to. However, if it is necessary to change this setting then carefully remove the four fixing screws securing the top cover of the controller, and remove the cover. Locate the main voltage selection switch adjacent to the transformer and set as follows:-

Set to **250V** for use in areas where the prevailing line voltage is in the range 200 - 260 V AC, 50 - 60 Hz

Set to **120 V** for use in areas where the prevailing line voltage is in the range 100 - 130 V AC, 50 - 60 Hz

Replace the top cover and secure in place using the four screws.

A suitable line power cord is provided.

- b) Plug the power/control lead from the chopper head into the connector marked **CHOPPER HEAD** on the rear of the control unit.
- c) Check that the switch marked **LED** on the rear of the control unit is set to **ON** and that the switch marked **SYNC** is set to **INT**
- d) Set the digital **Chopping Frequency f (Hz)** control on the front of the control unit to read **1000**
- e) Plug the line cord into the IEC input connector on the rear of the control unit, and plug the other end into the local line power.
- f) Turn the **POWER** switch on the rear of the control unit on, by depressing the end marked "I"
- g) Check that the chopper blade starts to rotate and that the green LED **Locked** indicator is initially unlit. After a short while the indicator should light and the motor speed will become steady.

- h) Using an oscilloscope verify that the waveform present at the **Sync f** output is nominally a 1000 Hz squarewave of 10 V pk-pk when loaded with a high impedance ($> 1\text{ M}\Omega$).
- i) Repeat the measurement in section h) but for the signal at the **Sync f \div 10** output, which should also be a squarewave of the same amplitude but at 100 Hz
- j) Turn off the line power and check that the chopper blade stops rotating.

This completes the initial checks. If the indicated results were obtained then the user can be reasonably sure that the model 651-1 incurred no hidden damage in shipment and is in good working order.

4.2 Operating Instructions

Operating the model 651-1 is straightforward. The chopper head is cabled to the line-powered control unit, and the required chopping frequency set by adjusting the digital **Chopping Frequency f (Hz)** control on the front panel of the controller.

Two apertures are provided within the head assembly (see figure 4-1) allowing one or two light beams to be modulated. The outer aperture (i.e. the aperture closer to the edge of the unit) generates modulation frequencies in the range 100 Hz to 3.2 kHz, while the inner aperture is used for frequencies one tenth of these values, i.e. in the range 10 Hz to 3200 Hz. The unused aperture can be masked by positioning a removable beam blocking plate in the correct position.

Reference signals suitable for driving signal recovery instrumentation are available at the front panel **Sync f** and **Sync f \div 10** outputs. The former gives a signal phase locked to the outer aperture frequency, while the latter is used is when using the inner set of apertures.

The chopper circuitry adjusts the blade rotational speed until the modulating frequency generated by the outer aperture is the same as one of two values, as follows:

Internal Reference

In this case the frequency is set by the digital indicator push-buttons on the unit. Hence, for example, if these are set to 1456 then the frequency generated by the outer apertures will be 1456 Hz, while that generated by the inner aperture will be 145.6 Hz.

External Reference

If an external reference signal of suitable amplitude is applied to the **EXT SYNC** input on the rear of the control unit and the **SYNC** switch is set to **EXT** then the unit changes to external reference operation. Hence, for example, if a 2560 Hz waveform is applied then the frequency generated by the outer apertures will be 2560 Hz, while that generated by the inner aperture will be 256.0 Hz.

When the generated frequency matches the selected internal or external reference then the green **Locked** LED on the front panel of the control unit lights, indicating a

reference lock condition.

In cases where the separation between the controller and chopper head needs to be larger than that possible with the standard length of interconnecting cable then one or two extension cables, model 653A, may be used to extend the distance.

When working in optical blackout conditions the **Locked** LED may be extinguished by moving the **LED** slide switch on the rear panel of the controller to the **OFF** position.

CAUTION: Do not make direct contact with the chopper blade while the unit is powered. Do not move the chopper head while the blade is rotating, since gyroscopic forces will increase wear on the motor bearings and thereby reduce motor life.

4.3 Mechanical Dimensions

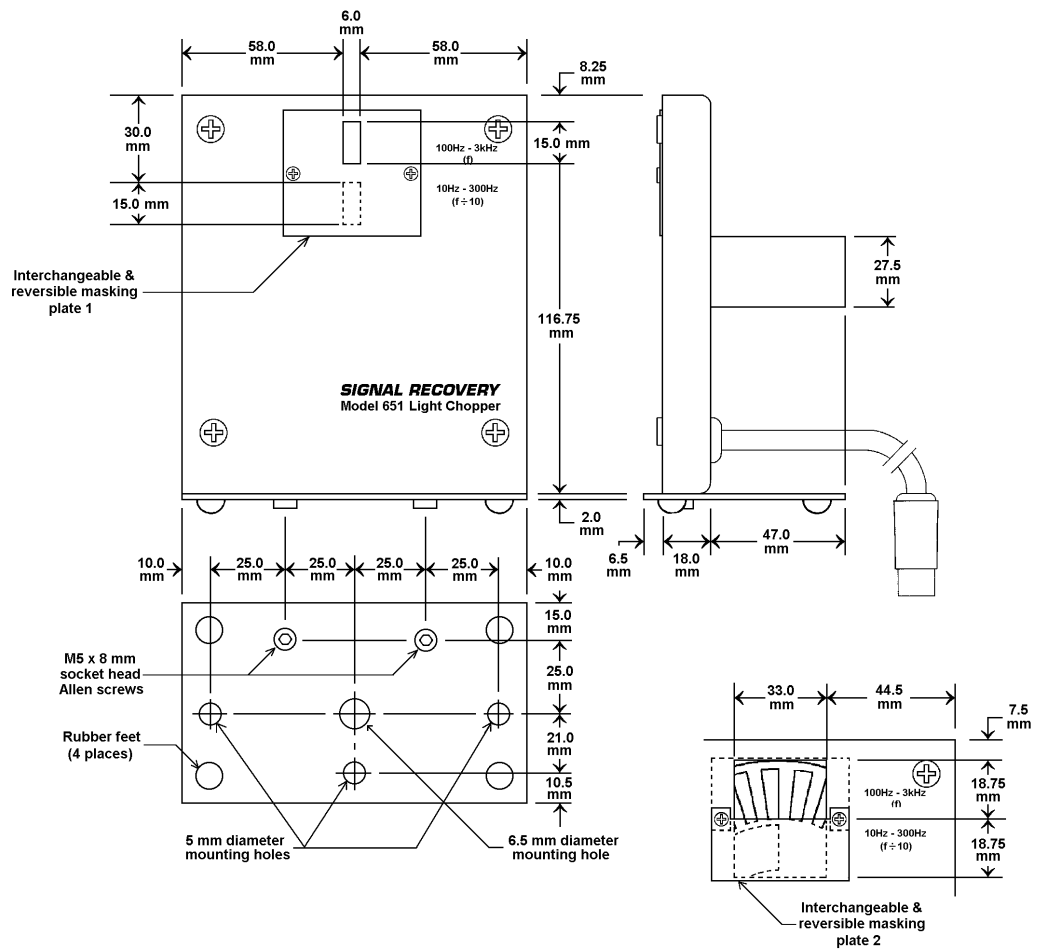


Figure 4-1, Model 651-1 Chopper Head Mechanical Dimensions

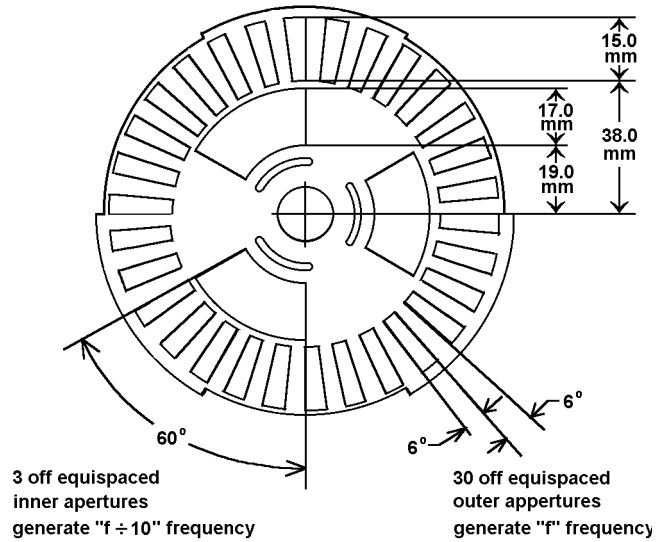


Figure 4-2, Model 651-1 Chopper Blade Dimensions

4.4 Specifications

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

Frequency

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 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 f	10 V pk-pk squarewave at outer sector chopping frequency, 100 - 3200 Hz
Sync f ÷ 10	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.
General	
Power Requirements	110 V AC, 50/60 Hz or 220/240 V AC, 50/60 Hz supply.
Dimensions	
Controller	
Width	6½" (168 mm)
Height	¾" (79 mm)
Depth	9½" (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. One or two of these cables may be used to extend the separation between the controller and chopper head.

Model 652-1

Micro Head Light Chopper

5.1 Installation & Initial Checks

Upon receipt the model 652-1 light chopper should be inspected for shipping damage. If any is noted, **SIGNAL RECOVERY** should be notified immediately and a claim filed with the carrier. The shipping container should be saved for inspection by the carrier.

To install the chopper, proceed as follows:

- a) Carefully unpack the chopper head and separate control unit. The control units are shipped configured for the line voltage in the country of destination and are marked to indicate what voltage they are set to. However, if it is necessary to change this setting then carefully remove the four fixing screws securing the top cover of the controller, and remove the cover. Locate the main voltage selection switch adjacent to the transformer and set as follows:-

Set to **250V** for use in areas where the prevailing line voltage is in the range 200 - 260 V AC, 50 - 60 Hz

Set to **120 V** for use in areas where the prevailing line voltage is in the range 100 - 130 V AC, 50 - 60 Hz

Replace the top cover and secure in place using the four screws.

A suitable line power cord is provided.

- b) Plug the power/control lead from the chopper head into the connector marked **CHOPPER HEAD** on the rear of the control unit.
- c) Check that the switch marked **LED** on the rear of the control unit is set to **ON** and that the switch marked **SYNC** is set to **INT**
- d) Set the digital **Chopping Frequency f (Hz)** control on the front of the control unit to read **100**
- e) Plug the line cord into the IEC input connector on the rear of the control unit, and plug the other end into the local line power.
- f) Turn the **POWER** switch on the rear of the control unit on, by depressing the end marked "I"
- g) Check that the chopper blade starts to rotate and that the green LED **Locked** indicator is initially unlit. After a short while the indicator should light and the motor speed will become steady.

- h) Using an oscilloscope verify that the waveform present at the **Sync f** output is nominally a 100 Hz squarewave of 10 V pk-pk when loaded with a high impedance ($> 1 \text{ M}\Omega$).
- i) Turn off the line power and check that the chopper blade stops rotating.

This completes the initial checks. If the indicated results were obtained then the user can be reasonably sure that the model 652-1 incurred no hidden damage in shipment and is in good working order.

5.2 Operating Instructions

Operating the model 652-1 is straightforward. The chopper head is cabled to the line-powered control unit, and the required chopping frequency set by adjusting the digital **Chopping Frequency f (Hz)** control on the front panel of the controller.

A reference signal phase locked to the chopper frequency and suitable for driving signal recovery instrumentation is available at the front panel **Sync f**. The **Sync f ÷ 10** output is not used.

The chopper circuitry adjusts the blade rotational speed until the modulating frequency generated by the is the same as one of two values, as follows:

Internal Reference

In this case the frequency is set by the digital indicator push-buttons on the unit. Hence, for example, if these are set to 100 then the frequency generated will be 100 Hz.

External Reference

If an external reference signal of suitable amplitude is applied to the **EXT SYNC** input on the rear of the control unit and the **SYNC** switch is set to **EXT** then the unit changes to external reference operation. Hence, for example, if a 120 Hz waveform is applied then the frequency generated will be 120 Hz.

When the generated frequency matches the selected internal or external reference then the green **Locked** LED on the front panel of the control unit lights, indicating a reference lock condition.

In cases where the separation between the controller and chopper head needs to be larger than that possible with the standard length of interconnecting cable then one or two extension cables, model 653A, may be used to extend the distance.

When working in optical blackout conditions the **Locked** LED may be extinguished by moving the **LED** slide switch on the rear panel of the controller to the **OFF** position.

CAUTION: Do not make direct contact with the chopper blade while the unit is powered. Do not move the chopper head while the blade is rotating, since gyroscopic forces will increase wear on the motor bearings and thereby reduce motor life.

5.3 Mechanical Dimensions

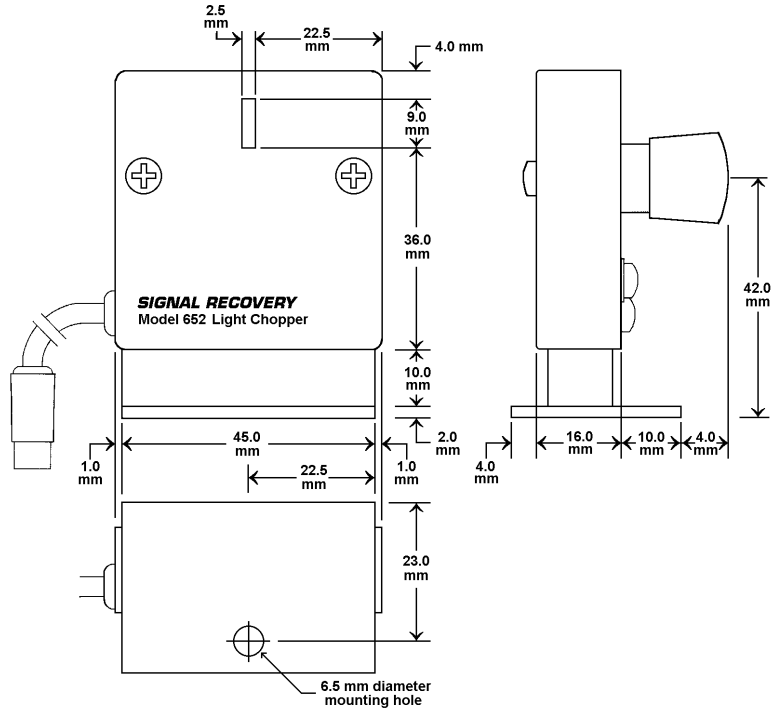


Figure 5-1, Model 652-1 Chopper Head Mechanical Dimensions

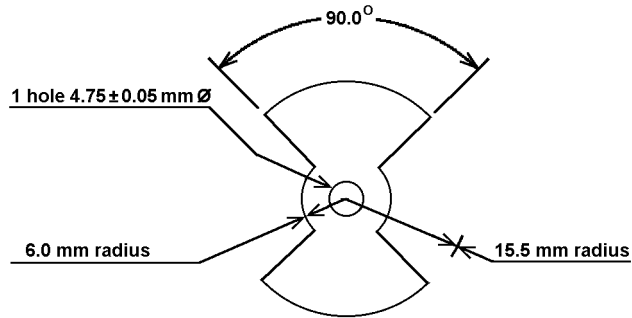


Figure 5-2, Model 652-1 Chopper Blade Dimensions

5.4 Specifications

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

Frequency

2 slots blade generating 30 Hz to 290 Hz

Control	
manual	Digital push-button
external	Application of 0.5 V to 10 V sine or squarewave within the chopper's range 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)	
30 to 50 Hz	blade only: 0.2%; blade + electronics: < 5%
50 to 290 Hz	blade only: 0.2%; blade + electronics: < 2%
Settling Time	<40 s nominal
Outputs	
Sync f	10 V pk-pk squarewave at chopping frequency
Connector	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.
General	
Power Requirements	110 V AC, 50/60 Hz or 220/240 V AC, 50/60 Hz supply.
Dimensions	
Controller	
Width	6½" (168 mm)
Height	3¼" (79 mm)
Depth	9½" (236 mm)
Chopper head, overall, inc. base and feet	
Width	2" (50 mm)
Height	2½" (61 mm)
Depth	1½" (34 mm)
Options	
Model 653A	2 m (6'6") extension cable. One or two of these cables may be used to extend the separation between the controller and chopper head.

Model 652-2

Micro Head Light Chopper

6.1 Installation & Initial Checks

Upon receipt the model 652-2 light chopper should be inspected for shipping damage. If any is noted, **SIGNAL RECOVERY** should be notified immediately and a claim filed with the carrier. The shipping container should be saved for inspection by the carrier.

To install the chopper, proceed as follows:

- a) Carefully unpack the chopper head and separate control unit. The control units are shipped configured for the line voltage in the country of destination and are marked to indicate what voltage they are set to. However, if it is necessary to change this setting then carefully remove the four fixing screws securing the top cover of the controller, and remove the cover. Locate the main voltage selection switch adjacent to the transformer and set as follows:-

Set to **250V** for use in areas where the prevailing line voltage is in the range 200 - 260 V AC, 50 - 60 Hz

Set to **120 V** for use in areas where the prevailing line voltage is in the range 100 - 130 V AC, 50 - 60 Hz

Replace the top cover and secure in place using the four screws.

A suitable line power cord is provided.

- b) Plug the power/control lead from the chopper head into the connector marked **CHOPPER HEAD** on the rear of the control unit.
- c) Check that the switch marked **LED** on the rear of the control unit is set to **ON** and that the switch marked **SYNC** is set to **INT**
- d) Set the digital **Chopping Frequency f (Hz)** control on the front of the control unit to read **1000**
- e) Plug the line cord into the IEC input connector on the rear of the control unit, and plug the other end into the local line power.
- f) Turn the **POWER** switch on the rear of the control unit on, by depressing the end marked "I"
- g) Check that the chopper blade starts to rotate and that the green LED **Locked** indicator is initially unlit. After a short while the indicator should light and the motor speed will become steady.

- h) Using an oscilloscope verify that the waveform present at the **Sync f** output is nominally a 1000 Hz squarewave of 10 V pk-pk when loaded with a high impedance ($> 1 \text{ M}\Omega$).
- i) Turn off the line power and check that the chopper blade stops rotating.

This completes the initial checks. If the indicated results were obtained then the user can be reasonably sure that the model 652-2 incurred no hidden damage in shipment and is in good working order.

6.2 Operating Instructions

Operating the model 652-2 is straightforward. The chopper head is cabled to the line-powered control unit, and the required chopping frequency set by adjusting the digital **Chopping Frequency f (Hz)** control on the front panel of the controller.

A reference signal phase locked to the chopper frequency and suitable for driving signal recovery instrumentation is available at the front panel **Sync f**. The **Sync f ÷ 10** output is not used.

The chopper circuitry adjusts the blade rotational speed until the modulating frequency generated by the is the same as one of two values, as follows:

Internal Reference

In this case the frequency is set by the digital indicator push-buttons on the unit. Hence, for example, if these are set to 1000 then the frequency generated will be 1000 Hz.

External Reference

If an external reference signal of suitable amplitude is applied to the **EXT SYNC** input on the rear of the control unit and the **SYNC** switch is set to **EXT** then the unit changes to external reference operation. Hence, for example, if an 800 Hz waveform is applied then the frequency generated will be 800 Hz.

When the generated frequency matches the selected internal or external reference then the green **Locked** LED on the front panel of the control unit lights, indicating a reference lock condition.

In cases where the separation between the controller and chopper head needs to be larger than that possible with the standard length of interconnecting cable then one or two extension cables, model 653A, may be used to extend the distance.

When working in optical blackout conditions the **Locked** LED may be extinguished by moving the **LED** slide switch on the rear panel of the controller to the **OFF** position.

CAUTION: Do not make direct contact with the chopper blade while the unit is powered. Do not move the chopper head while the blade is rotating, since gyroscopic forces will increase wear on the motor bearings and thereby reduce motor life.

6.3 Mechanical Dimensions

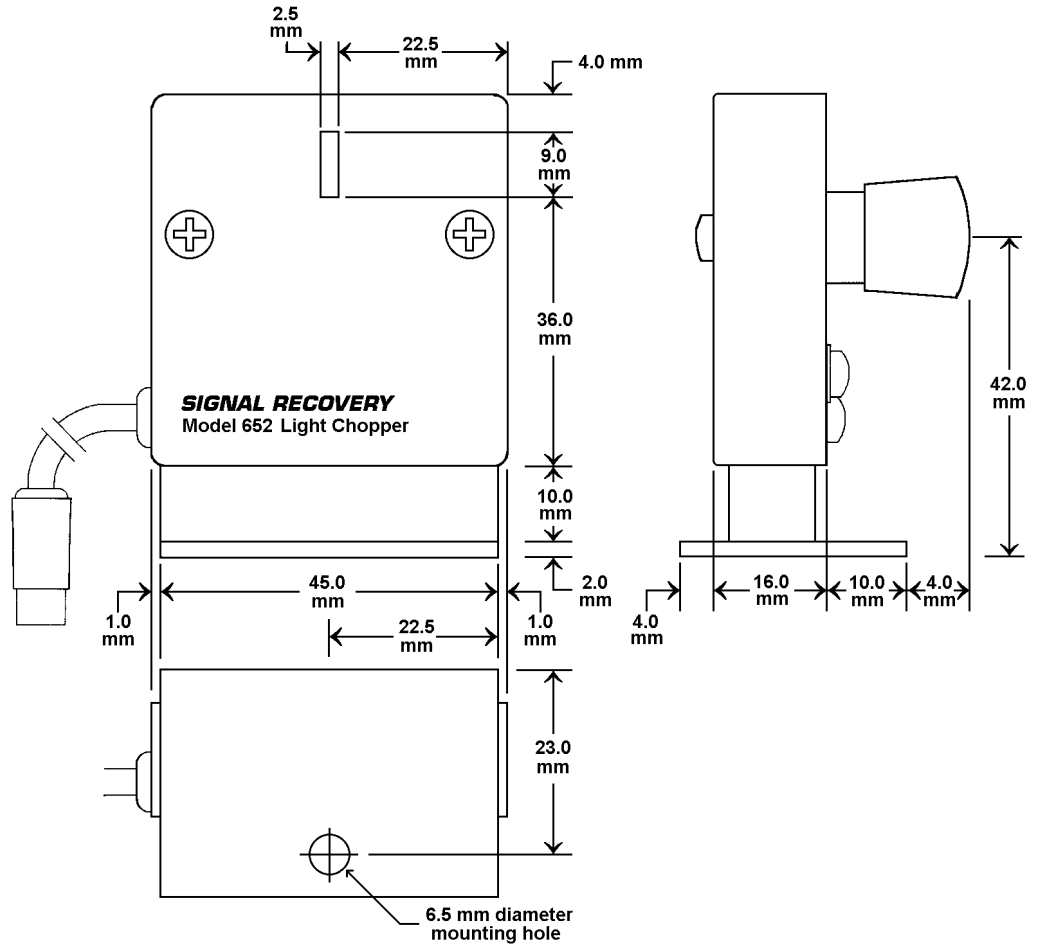


Figure 6-1, Model 652-2 Chopper Head Mechanical Dimensions

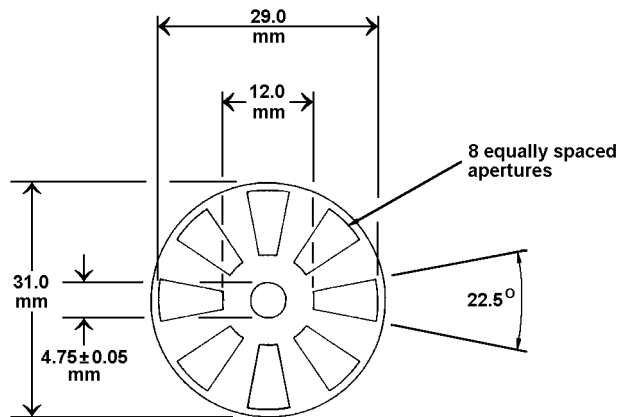


Figure 6-2, Model 652-2 Chopper Blade Dimensions

6.4 Specifications

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

Frequency	8 slots generating 60 Hz to 1100 Hz
Control	
manual	Digital push-button
external	Application of 0.5 V to 10 V sine or squarewave within the chopper's range 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)	
60 to 100 Hz	blade only: 0.2%; blade + electronics: < 6%
100 to 1100 Hz	blade only: 0.2%; blade + electronics: < 2.5%
Settling Time	<40 s nominal
Outputs	
Sync f	10 V pk-pk squarewave at chopping frequency
Connector	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.
General	
Power Requirements	110 V AC, 50/60 Hz or 220/240 V AC, 50/60 Hz supply.
Dimensions	
Controller	
Width	6½" (168 mm)
Height	¾" (79 mm)
Depth	9½" (236 mm)
Chopper head, overall, inc. base and feet	
Width	2" (50 mm)
Height	2½" (61 mm)
Depth	1½" (34 mm)

Options

Model 653A

2 m (6'6") extension cable. One or two of these cables may be used to extend the separation between the controller and chopper head.

WARRANTY

AMETEK SIGNAL RECOVERY, a part of AMETEK Advanced Measurement Technology, Inc, warrants each instrument of its own manufacture to be free of defects in material and workmanship for a period of ONE year from the date of delivery to the original purchaser. Obligations under this Warranty shall be limited to replacing, repairing or giving credit for the purchase, at our option, of any instruments returned, shipment prepaid, to our Service Department for that purpose, provided prior authorization for such return has been given by an authorized representative of AMETEK Advanced Measurement Technology, Inc.

This Warranty shall not apply to any instrument, which our inspection shall disclose to our satisfaction, to have become defective or unusable due to abuse, mishandling, misuse, accident, alteration, negligence, improper installation, or other causes beyond our control. This Warranty shall not apply to any instrument or component not manufactured by AMETEK Advanced Measurement Technology, Inc. When products manufactured by others are included AMETEK Advanced Measurement Technology, Inc equipment, the original manufacturers Warranty is extended to AMETEK Advanced Measurement Technology, Inc customers. AMETEK Advanced Measurement Technology, Inc reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. THIS WARRANTY IS IN LIEU OF, AND EXCLUDES ANY AND ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AS WELL AS ANY AND ALL OTHER OBLIGATIONS OR LIABILITIES OF AMETEK ADVANCED MEASUREMENT TECHNOLOGY, INC, INCLUDING, BUT NOT LIMITED TO, SPECIAL OR CONSEQUENTIAL DAMAGES. NO PERSON, FIRM OR CORPORATION IS AUTHORIZED TO ASSUME FOR AMETEK ADVANCED MEASUREMENT TECHNOLOGY, INC ANY ADDITIONAL OBLIGATION OR LIABILITY NOT EXPRESSLY PROVIDED FOR HEREIN EXCEPT IN WRITING DULY EXECUTED BY AN OFFICER OF AMETEK ADVANCED MEASUREMENT TECHNOLOGY, INC.

SHOULD YOUR EQUIPMENT REQUIRE SERVICE

- A. Contact your local AMETEK SIGNAL RECOVERY office, agent, representative or distributor to discuss the problem. In many cases it may be possible to expedite servicing by localizing the problem to a particular unit or cable.
- B. We will need the following information, a copy of which should also be attached to any equipment which is returned for service.
- | | |
|---|---|
| 1. Model number and serial number of instrument | 6. Symptoms (in detail, including control settings) |
| 2. Your name (instrument user) | 7. Your purchase order number for repair charges (does not apply to repairs in warranty) |
| 3. Your address | 8. Shipping instructions (if you wish to authorize shipment by any method other than normal surface transportation) |
| 4. Address to which the instrument should be returned | |
| 5. Your telephone number and extension | |
- C. If you experience any difficulties in obtaining service please contact:

SIGNAL RECOVERY Service
AMETEK Advanced Measurement Technology, Inc
801 South Illinois Avenue
Oak Ridge
TN 37831-2011, USA

Phone: +1 865 483 2121
Fax: +1 865 483 0396
E-mail: service@signalrecovery.com

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