56 Sparta Avenue • Newton, New Jersey 07860
(973) 300-3000 Sales • (973) 300-3600 Fax
www.thorlabs.com

THORLABS

MC2F57 - July 1, 2016

Item # MC2F57 was discontinued on July 1, 2016. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

OPTICAL CHOPPER SYSTEM AND CHOPPER WHEELS

► **Crystal-Stabilized, Phase-Locked Feedback Loop Suppresses Low Frequency Drift and Pulse Jitter**

► **Manual, USB, and External Trigger Controller**

► **7 Blades Covering Frequencies from 1 Hz to 10 kHz**

MC1F10

MC1F2   MC1F15   MC1F30

MC1F60   MC1F100   MC2F57

MC2000 Optical Chopper System
Includes Controller,
Chopper Head, 10-Slot Blade
and Interface Cable

MC2000

Hide Overview

OVERVIEW

Features

Screenshot of the English GUI

- Crystal-Stabilized, Phase-Locked Feedback Loop Suppresses Low Frequency Drift and Phase Jitter
- Harmonic, Subharmonic, and Fractional Harmonic Chopping with Sum and Difference Reference Outputs
- Microprocessor Controlled
- 2-Frequency Blades Available for Pump-Probe and Other Nonlinear Experiments
- Save and Recall User Setups in Non-Volatile RAM
- USB Interface
- Control Software Package Available

The MC2000 Optical Chopper, utilizing advanced features to meet the most demanding applications, is a rotary chopper that is composed of a control console, motor head assembly and slotted chopper wheel. The MC2000 uses a phase-locked loop (PLL) motor speed control design to precisely maintain the chopping speed and phase relative to a reference signal. An internal, crystal-stabilized, frequency synthesizer provides an accurate and stable reference frequency for stable long-term performance.

An optical switch is used to get the reference signal when the chopper blades pass through and interrupt the beam path. The switch incorporates

MC2000 Optical Chopper System Performance	
Chopping Frequency, with Various Blades	1 Hz – 10 kHz
Frequency Drift	<20 ppm/°C
Ext. Reference Compatibility	TTL/CMOS
Frequency Resolution	0.01 Hz (2-Slot Blade) 1 Hz (All Other Blades)
External Reference Signal Synchronization	
Harmonic	2 to 15X
Subharmonic	1/2 to 1/15X

Chopper Wheel Options			
Item #	**# of Slots**	**Chopping Frequency**	**Phase Jitter Max/Typ.[c]**
MC1F2[a]	2	1 Hz – 99 Hz	0.05° rms (Max)
MC1F10[b]	10	20 Hz – 1 kHz	0.42°/0.13° rms
MC1F15	15	30 Hz – 1.5 kHz	0.68°/0.27° rms
MC1F30	30	60 Hz – 3 kHz	1.10°/0.45° rms

an LED with a wavelength range of 850 nm - 940 nm that is operated at the 15 mA threshold current to minimize light output from the LED.

Unlike conventional, open-loop speed control designs, the PLL speed control circuit also allows the MC2000 chopper to be synchronized to external reference signals, including other MC2000 choppers and reference sources such as DSP lock-in amplifiers. Please see the *Operations* tab for more details on the MC2000 chopper and its applications.

The MC2000 design features a high quality, rare earth magnet, DC motor. The photo-etched optical chopper wheel blade is made of 0.01" thick blued clock spring steel for high precision. The compact optical head has a wide base for extra stability, and the base is slotted for two 1/4"-20 mounting screws on 2" centers. The interface cable uses circular snap-on LIMO connectors for easy setup.

The MC2000 controller includes a 240 x 128 pixel graphics display for setting and monitoring chopper functionality. All of the functions are accessible through a front panel control knob with turn and push control. Multiple user setups can be easily saved and recalled from non-volatile memory. A USB interface is included as a standard feature for remote PC control of the MC2000. A software package with a GUI to control the MC2000 can be downloaded from the *Software* tab. The package also supports controlling the MC2000 via programs written in C++ or LabVIEW.

Current owners of an MC2000 controller may upgrade the unit with the newest firmware release, which can be downloaded by clicking on the link on the *Software Downloads* tab. Please note that the system must remain powered on and in an idle state until the firmware update is complete.

Please Note: The MC2000 should be shielded from stray light sources because light contamination in the optical sensor will cause jitter.

MC1F60	60	120 Hz – 6 kHz	1.10°/0.78° rms
MC1F100	100	250 Hz – 10 kHz	1.30°/1.10° rms
MC2F57	Outer: 7 Inner: 5	Outer: 14 – 700 Hz Inner: 10 – 500 Hz	0.38°/0.08° rms

- Please note the MC1F2 two-slot blade was updated to a newer version on September 21, 2011. This new blade is compatible with all units. If you purchased the older blade, please note that it can only be used with firmware version 3.11 and older. If you would like to update to the latest firmware and own the older style blade, please contact Tech Support for a free MC1F2 blade exchange.
- The MC1F10 blade is supplied with the unit. All other blades specified may be purchased separately through Thorlabs.
- Measured using internal reference signal.

Hide Specs

SPECS

Optical Head Specifications	
Chopping Blade Diameter	Ø4.0" (Ø101.6 mm)
Chopping Blade Thickness	0.010" (0.254 mm)
Mounting Base	1/4"-20 (or M8) Clearance Slots Spaced 3.0" (Compatible with Thorlabs Breadboards)
Mounting Hole	1/4"-20 with 1/4" Max Screw Depth
Blade Specifications	
Chopping Blade Slots[d]	
MC1F2[a]	2
MC1F10 (Default Blade)	10
MC1F15	15
MC1F30	30
MC1F60	60
MC1F100	100
MC2F57	7 Outer, 5 Inner
Slot Angle	
MC1F2	180°
MC1F10 (Default Blade)	36°
MC1F15	24°
MC1F30	12°
MC1F60	6°
MC1F100	3.6°
MC2F57	51.4° Outer, 72° Inner

Physical Features	
Dimensions (W x H x D)	5.8" x 2.8" x 12.5" (147 mm x 71 mm x 317.5 mm)
Input and Output Connectors	BNC
Menu Control	Twist / Push-Button Knob
Input Power Connection[e]	IEC Connector
Weight	5 lbs (9.1 lbs Shipped Weight)
Operating Temperature	10 – 40 °C
Display Type	240 x 124 Pixel LCD Graphics Display
Frequency Resolution	0.01 Hz (2 slot blade) 1 Hz (all other blades)
Power Supply	
Supply Type	Linear
Voltage Selection	115 / 230 VAC Switchable
Input Voltage	100/115 VAC ± 10%, 230 VAC ± 10%
Line Frequency	50 – 60 Hz
Input Power	20 VA Max
Fuse Ratings	250 mA @ 115 VAC 125 mA @ 230 VAC
Fuse Type	IEC60127-2/III (250 V, Slo-blo Type 'T')
Fuse Size	5 x 20 mm

Performance Specifications	
Chopping Frequency	
MC1F2 (2 slot)	1 Hz – 99 Hz
MC1F10 (10 slot, Default Blade)	20 Hz – 1 kHz
MC1F15 (15 slot)	30 Hz – 1.5 kHz
MC1F30 (30 slot)	60 Hz – 3 kHz
MC1F60 (60 slot)	120 Hz – 6 kHz
MC1F100 (100 slot)	250 Hz – 10 kHz
MC2F57 (2f slot)	Outer: 14 – 700 Hz Inner: 10 – 500 Hz
Phase Jitter (@ Max Frequency)	
MC1F2 (2 slot)[a]	0.05° rms Max
MC1F10 (10 slot, Default Blade)	0.42° rms (0.13° rms Typ.)
MC1F15 (15 slot)	0.68° rms (0.27° rms Typ.)
MC1F30 (30 slot)	1.10° rms (0.45° rms Typ.)
MC1F60 (60 slot)	1.10° rms (0.78° rms Typ.)
MC1F100 (100 slot)	1.30° rms (1.10° rms Typ.)
MC2F57 (2f slot)	0.38° rms (0.08° rms Typ.)
Frequency Drift	<20 ppm/°C
Chopping Range	
Harmonic	2 to 15x
Sub-Harmonic	1/2 to 1/15x
Input/Output Specifications	
Ext. Input Compatibility	TTL/CMOS
Ext. Input Voltage Range[b]	0 – 5 V

Input High	>2 V
Input Low	<0.8 V
Ext. Input Impedance	200 Ω
Ref Out Compatibility	TTL/CMOS
Ref Out Voltage Range[b]	0 – 5 V Typical
Ref Out Impedance	200 Ω
Min Load Impedance[c]	500 Ω
Ref Out Signals	Inner/Outer Slot Chopping Blade, Synthesizer, Sum & Diff Frequencies
Ref Out Selection	Selectable Menu or USB command 'O'
Communications	
Communications Port	USB
Protocol	USB (RS232 Emulated)
Baud Rate	115,200 (fixed)
Data Bits	8
Stop Bits	1
Parity	None
Handshaking	None

- Please note the MC1F2 two-slot blade was updated to a newer version on September 21, 2011. This new blade is compatible with all units. If you purchased the older blade, please note that it can only be used with firmware version 3.11 and older. If you would like to update to the latest firmware and own the older style blade, please contact Tech Support for a free MC1F2 blade exchange.
- The reference output and external input is short circuit protected by limiting the current to 25 mA. Overvoltage and undervoltage protection is available, but continued use will degrade or damage the unit.
- The Min Load Impedance represents the smallest allowable terminating resistance. Applying lower impedances will cause the short circuit protection to limit the output voltage. Continued use in this mode will cause circuit degradation and eventual circuit failure.
- The MC1F10 blade is supplied with the unit. All other blades specified may be purchased separately through Thorlabs.
- The MC2000 is shipped with a 120 VAC US style power cord and the MC2000-EC is shipped with a 230 VAC power cord for use in Europe.

[Hide Pin Diagrams](#)

PIN DIAGRAMS

Controller Front Panel

Click to Enlarge
The front panel of the MC2000 offers two female BNC ports, one for an external input and one for the reference output. Pin diagrams for both ports are shown below.

Controller Back Panel

Click to Enlarge
The back panel of the MC2000 offers a USB 2.0 port and a male HR10-7R-6S interface connector. Pin diagrams for both connectors are shown below.
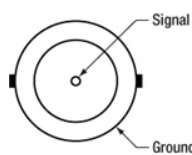
Chopper Back Panel

Click to Enlarge
The chopper head back panel offers a male
HR10-7R-6S interface connector. The included
HR10-7R-6S cable connects the chopper head to
the back panel of the controller. The pin diagram
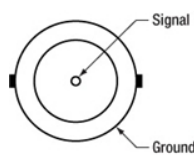for the connnector is shown below.

External Input[a]
BNC Female

a. TTL/CMOS, 200 Ω Input
Impedance, 0 - 5 V Input Range

Reference Output[b]
BNC Female

b. TTL/CMOS, 200 Ω Output
Impedance, 0 - 5 V Input Range,
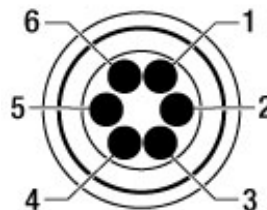500 Ω Min Load Impedance

Computer Connection
USB Type B[c]

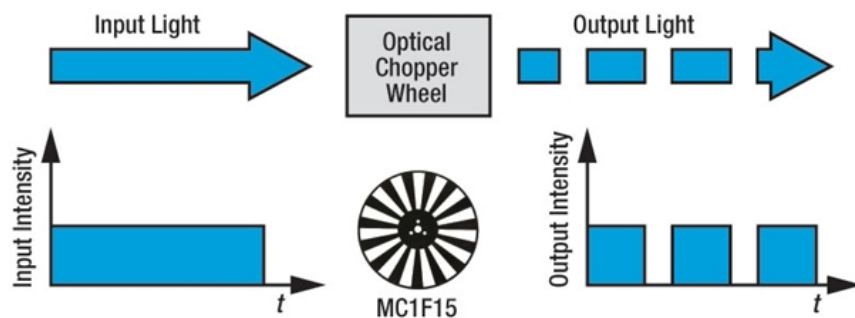c. USB 2.0 Type A to B Cable

Interface Connector
HR10-7R-6S

Pin	Description	Pin	Description
1	Motor +	4	Feedback Sensor
2	Motor -	5	Phase Sensor
3	VCC	6	Ground

Hide Operation

O P E R A T I O N

Operation

An optical chopper is an electromechanical instrument that periodically interrupts a beam of light. The MC2000 Optical Chopper is a rotary type composed of a control console, motor head assembly, and slotted chopper wheel.

Applications

Unlike conventional, open-loop speed control designs, the PLL speed control circuit also allows the MC2000 chopper to be synchronized to external reference signals, including other MC2000 choppers and reference sources such as DSP lock-in amplifiers.

For more advanced measurements, the MC2000 can lock to a harmonic, sub-harmonic, or fractional-harmonic of an external reference frequency. The on board microprocessor is used to multiply the external reference up to the 15th harmonic or to divide the reference down to the 15th sub-harmonic. By combining both the frequency multiplication and division together, a fractional harmonic can be obtained.

MC2F57 2
Frequency Blade

In order to maximize the slope of the signal as the blade rotates (i.e., minimize the time to fully open or closed), the beam should be focused onto the widest portion of the slot in the chopper blade.

The MC2000 also supports 2-frequency chopping from a single chopper blade (shown at right). A special blade is available with 7 outer slots and 5 inner slots. This slot combination allows a single beam to be split and individually modulated for ratiometric experiments. Another example application is a pump-probe experiment where the pump beam is modulated at the outer frequency while modulating a probe beam at the inner frequency. The MC2000 provides the sum and difference frequencies of the 2-frequency blade for accurate lock-in detection of the frequency-mixed response.

Hide Language Option

LANGUAGE OPTION

Screenshot of the Chinese GUI

New Chinese Language Option
As part of our new multilingual interface initiative, we have released the MC2000 with a Chinese language display option. The display can be changed by sending a command using the command line language through the USB interface. The language display setting is stored in the unit's non-volatile memory. Current MC2000 controllers can be upgraded with the new display language by down loading the newest firmware release found on the *Software Downloads* tab.

Hide Software Downloads

SOFTWARE DOWNLOADS

Software with GUI for Remote Operation and Firmware Updates for the MC2000 Chopper Controller

Software
Version 1.0

Software package to control the MC2000. The installer includes the necessary drivers. This software package is compatible with the lastest firmware for the system and supports writing programs to control the MC2000 using C++ or LabVIEW.

Firmware
Version 3.15/4.15

The MC2000 hardware has been revised several times and each revision requires different firmware versions. Hardware versions 3.0 and 4.0 are eligible for the firmware update available below.

To determine your hardware version, please attempt to update the firmware. Users of version 1.0 or 2.0 devices will be prompted that the firmware cannot be updated. All version 1.0 and 2.0 devices are out of warranty, and are no longer compatible with the latest

firmware.

Software ⬇   Software ⬇

Hide Optical Chopper System

Optical Chopper System

MC2000

- Harmonic, Subharmonic, and Fractional Harmonic Chopping
- Sum and Difference Reference Outputs
- 10-Slot Blade Included (MC1F10, See Below)

Compatibility with Other Vendors

The MC2000 is also compatible with other manufacturer's blades. Select Scitec Instrument blades, including the 300D3/30, 300D8/60, 300D4/7, and 300D53/60 will work with this chopper, but due to slight variations in the design, not all functions will be available. Please note that we do not guarantee the functioning of other manufacturer's blades with our chopper head and damage may occur.

Existing MC2000 controllers can be upgraded by downloading the newest firmware release. Please note that the system must remain powered on and in an idle state until the firmware update is complete.

The MC2000 is shipped with a 120 VAC power cord for use in the United States while the MC2000-EC is shipped with a 230 VAC power cord for use in Europe. If you require a different power cord, please contact Tech Support prior to ordering.

Part Number	Description	Price	Availability
MC2000-EC	Optical Chopper System with MC1F10 10-slot (36°) Chopper Blade, 230 VAC Power Cord	$1,200.00	Today
MC2000	Optical Chopper System with MC1F10 10-slot (36°) Chopper Blade, 120 VAC Power Cord	$1,200.00	Today

Hide Optical Chopper Wheels

Optical Chopper Wheels

Click to Enlarge							
Item #	MC1F2	MC1F10	MC1F15	MC1F30	MC1F60	MC1F100	MC2F57
Slots	2	10	15	30	60	100	7 Outer / 5 Inner
Frequency	1 - 99 Hz	20 Hz - 1 kHz	30 Hz - 1.5 kHz	60 Hz - 3 kHz	120 Hz - 6 kHz	250 Hz - 10 kHz	2 Frequencies
Laser Beam Diameter[a]							
Max. Possible[b]		13.23 mm (0.521")	9.25 mm (0.364")	4.86 mm (0.191")	2.49 mm (0.098")	1.51 mm (0.06")		
Max. Center[c]	26.1 mm (1.028")	10.32 mm (0.406")	6.9 mm (0.272")	3.45 mm (0.136")	1.73 mm (0.068")	1.04 mm (0.04")	14.96 mm (0.589")	14.35 mm (0.565")
Max. Slot[d]		6.34 mm (0.249")	3.99 mm (0.157")	1.89 mm (0.074")	0.92 mm (0.036")	0.55 mm (0.02")		

- In order to maximize the slope of the signal as the blade rotates (i.e., minimize the time to fully open or closed), the beam should be focused onto the widest portion of the slot.
- The largest beam diameter that can pass through the widest portion of the chopper wheel slot, indicated by the red circle in the drawing to the right.
- The largest beam diameter that can pass through the center of the chopper wheel slot, indicated by the green circle in the drawing to the right.

Click to Enlarge

- The largest beam diameter that can pass through the narrowest portion of the chopper wheel slot, indicated by the blue circle in the drawing to the right.

Spot Size Reference Drawing

Thorlabs offers a number of different blades to extend the range of the chopping frequency. A standard 10-slot blade (MC1F10) is included with the MC2000. 2-slot, 15-slot, 30-slot, 60-slot, 100-slot, and 2-frequency blades are also available. Our blades are manufactured from 0.01" thick blued clock spring steel.

The MC2000 also supports 2-frequency chopping from a single chopper blade. A special blade is available with 7 outer slots and 5 inner slots. This slot combination allows a single beam to be split and individually modulated for ratiometric experiments. Please see the *Operation* tab for more details.

Please note the MC1F2 two-slot blade was updated to a newer version on September 21, 2011. This new blade is compatible with all units. If you purchased the older blade, please note that it can only be used with firmware version 3.11 and older. If you would like to update to the latest firmware and own the older style blade, please contact Tech Support for a free MC1F2 blade exchange.

Part Number	Description	Price	Availability
MC1F2	2 Slot Blade for Optical Chopper, 1 to 99 Hz	$58.90	Today
MC1F10	10 Slot Blade for Optical Chopper, 20 to 1,000 Hz	$41.80	Today
MC1F15	15 Slot Blade for Optical Chopper, 30 to 1,500 Hz	$41.80	Today
MC1F30	30 Slot Blade for Optical Chopper, 60 to 3,000 Hz	$41.80	Today
MC1F60	60 Slot Blade for Optical Chopper, 120 to 6,000 Hz	$41.80	Today
MC1F100	100 Slot Blade for Optical Chopper, 250 to 10,000 Hz	$45.80	Today
MC2F57	2 Frequency, 7 Outer/5 Inner Slot Blade for Optical Chopper	$60.00	Today

Visit the *Optical Chopper System and Chopper Wheels* page for pricing and availability information:
https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=287