OPERATING MANUAL

MHS-5200A Series
dual-channel DDS signal generator

Zhengzhou Ming Wo Electronic Technology Co., Ltd.
Investor Road, New District, Zhengzhou City,
Henan Province No. 96
Tel: 0371-86106382
Fax: 0371-86106382
Website: www.mhinstek.com
E-mail: sales@mhinstek.com

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1 Introduction

MHS-5200A series Direct Digital Synthesis (DDS) instrument generates analog and digital signals in a 0..25MHz frequency range. It can also measure various waveform parameters. It provides a great test and measurement solution to electronic engineers and technicians in teaching and research laboratories, and production facilities.

This instrument is designed around two large scale integrated circuits: a high-speed FPGA and a microcontroller unit. The internal circuitry uses surface mount technology for greatly enhanced noise immunity and service life. Display interface uses a 16x2 character LCD display, divided into two lines. The top line shows the current frequency, while the following line displays additional parameters and settings, corresponding to the front panel key selections.

1.1 Instrument characteristics

- Direct digital synthesis (DDS) technology, FPGA design, low power consumption
- Dual output, with adjustable phase differential
- Linear and logarithmic sweep function, with up to 600 seconds duration
- Selectable output waveform: sine, triangle, square wave, rising and falling sawtooth, variable duty cycle pulse, plus 16 sets of arbitrary waveform customized by the user
- Total of 10 sets of instrument parameters M0 .. M9 (M0 is the default set on power-up)
- Output voltage up to 15Vp-p below 12MHz, up to 8Vp-p above 12MHz
- Sophisticated -20dB attenuator enables amplitude resolution of 1mV
- −/- 120% DC bias function
- Pulse duty cycle adjustment, accurate to 0.1%
- Four variable phase difference TTL outputs
- Measurement capability. Possible measurements are: frequency, period, positive and negative pulse width, duty cycle and counting function

- Four optional frequency measurement gate times, which strike a balance between speed and accuracy
- All parametric EQ calibration can be performed by internal procedures
- Powerful communications features. Completely open communications protocol allows development of third-party applications
- When connected to the PC, the computer can be used to control the instrument. The user can edit arbitrary output waveforms, and download it to the instrument
- The instrument can be equipped with an additional power module, to enable the signal output amplitude of 30Vpp, and the maximum output current of 1A

1.2 Model description

This series of instruments includes four models, differentiated by the maximum frequency of the output sine wave:

MHS-5200-06M sinusoidal signals at frequencies up to 6MHz

MHS-5200-12M sinusoidal signals at frequencies up to 12MHz

MHS-5200-20M sinusoidal signals at frequencies up to 20MIIz

MHS-5200-25M sinusoidal signals at frequencies up to 25MHz

1.3 Technical specifications

1.3.1 Key parameters

Frequency Range	Sine wave	MHS-5200-06M 0Hz..6MHz MIIS-5200-12M 0IIz..12MIIz MHS-5200-20M 0Hz..20MHz MHS-5200-25M 0Hz..25MHz
	Square wave	0Hz..6MHz
	Triangle wave	0Hz..6MHz
	Sawtooth	0Hz..6MHz
	Arbitrary waveform	0Hz..6MHz
	TTL digital signal	0Hz..6MHz
Output modulation	Frequency sweep	
Waveform types	Sine, square, triangle, sawtooth, TTL digital signal wave, Arbitrary	
Waveform Length	1024 points	
Sampling rate	200MSa/s	
Waveform amplitude resolution	8bits	
Minimum frequency resolution	10mHz	
Frequency error	±5×10-6	
Frequency stability	±1×10-6	
Amplitude range (peak to peak)	15mVp-p..15Vp-p (<12MIIz) 15mVp-p..8Vp-p (> 12MIIz)	
Output impedance	50Ω ± 10%	
Amplitude resolution	1mVp-p (-20dB attenuation) 10mVp-p (no attenuation)	
Amplitude stability	±0.5% (per 5 hours)	
Amplitude error	± 1%	10mV (frequency 1KHz, 15 Vp-p)	
Offset range	-120% .. 120% (bias voltage and signal amplitude ratio)	
Bias resolution	1.00%	
Phase range	0 .. 359°	
Phase resolution	1°	

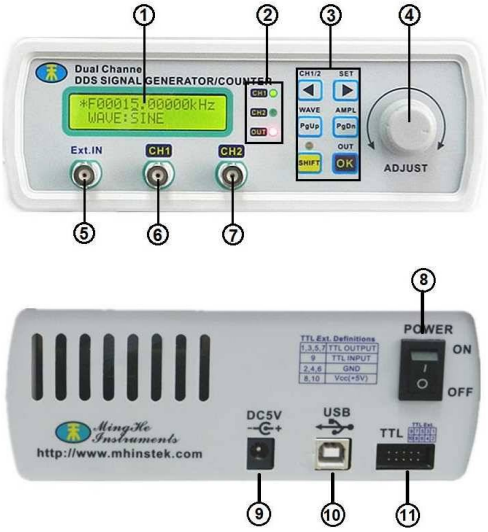
1.3.2 Detailed specifications

Sine wave	Harmonic content	40dBc (below 1MHz), 35dBc (1MHz .. 20MHz)
	Distortion	<0.8% (20Hz .. 20KHz)
Square wave	Rise time	≤20ns
	Overshoot	≤10%
	Duty cycle adjustment range	0% .. 99.9%
TTL	Rise time	≤20ns
	Low level	<0.3V
	High level	1V ..7.5V
Arbitrary waveform	No. of waveforms	16 stored waveforms
	Memory depth/group	1KB/16 groups
Scan	Scan mode	Linear sweep, log sweep
	Scan time	1s .. 600s
	Scan range	Adjustable sweep settings
External measurements	Frequency range (for several selectable gate times)	10s 0.1Hz - 60MHz 1s 1Hz - 60MHz 0.1s 10Hz - 60MHz 0.01s 100Hz - 60MHz
	Input voltage range	0.5Vp-p .. 20Vp-p
	Counting range	0 - 4294967295
	Counting	Manual
	Positive and negative pulse width	10ns resolution, range 10s
	Period	20ns resolution, range 20s
	Duty Cycle	0.1% resolution, measuring range from 0.1% to 99.9%
	Source selection	Ext.IN input (AC signal) TTL_IN input (digital signal)
Memory banks	Quantity	10
	Location	M0 to M9
Interface	Interface type	USB serial port
	Baud rate	57600bps
	Protocol	Line oriented commands, non-proprietary
Power supply	DC	5V
Dimensions	Length×Width×Height	180×190×71mm
Weight	Unit	546g

2 Instrument Description

2.1 External description

MHS-5200A external appearance and user interface is described in Figure 1.



1	LCD1602 LCD	7	CH2 output connector
2	Status Indicator	8	Power switch
3	Operation buttons	9	5VDC power input
4	Rotary knob selector	10	USB connector
5	Ext.In input connector	11	TTL input / output connector
6	CH1 output connector		

Figure 1: MHS-5200A external layout

2.2 Front panel keys

The instrument front panel keys are described in Figure 2. There are six physical membrane keys: five function keys, and a shift key that introduces a secondary operation for the other keys.

CH1/2 ◀	Move the cursor left, or change the current parameter value
SET ▶	Move the cursor right, or change the current parameter value
WAVE PgUp	Next menu selection
AMPL PgDn	Previous menu selection
OUT OK	Confirmation button; also, changes the parameter in the current menu selection
SHIFT + CH1/2 ◀	Channel selector. Channel setting reflected by CH1/CH2 LED indicator
SHIFT + SET ▶	Focus select between the first and second display line, as indicated by the ✱ symbol
SHIFT + WAVE PgUp	Waveform shape selection
SHIFT + AMPL PgDn	Waveform amplitude adjustment
SHIFT + OUT OK	Output enable/disable; status is indicated by the red front panel OUT LED

Figure 2: Front panel user controls

2.3 Instrument display

LCD front panel display, shown in Figure 3, indicates the current frequency setting in the top line. The second line displays current operation and parameter values.

1 Frequency display
2 Selected menu operation / parameter display

Figure 3: Front panel display

The * symbol indicates which values will be modified by the arrow keys and the adjustment knob. In multi-digit parameter values, the current selected digit is indicated by an underline.

3 Operating Instructions

3.1 Unpacking

When you get a new MHS-5200A Series dual-channel DDS signal generator, it is recommended that you follow these steps to inspect the instrument.

1. Check for transportation damage to the shipping box and packing materials. If there is serious damage, keep them until the machine and accessories have passed the acceptance test.

2. Check the complete contents of the box. If the contents do not match the following list or if the instrument is damaged, contact your dealer or manufacturer.

   - MHS-5200A Series dual-channel DDS signal generator
   - 5VDC Power Adapter
   - USB cable
   - Signal coaxial cable, 2pc
   - User Manual and Windows software on CD

3. Check the instrument for damage. If it is damaged or not working properly, or fails performance tests, please contact your dealer or manufacturer.

3.2 Startup sequence

1. Connect the provided 5V DC power supply and turn on the instrument using the back panel power switch.
2. Initially, the LCD displays the instrument model and version number (e.g. MHS-5225A R4.10), company name (e.g. MingHe (c) 2015) and serial number of the instrument (e.g. P/N: 52A0123).
3. After startup, the instrument enables the output and activates the front panel user interface.

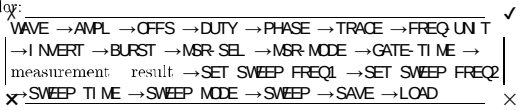
3.3 Operating instructions

This section will detail how to operate the instrument using front panel keys, the rotary selector and the LCD display.

One of two green front panel LED indicators, CH1 and CH2, will be lit, to indicate which channel's parameters are being changed. The selected channel can be changed by the front panel key Shift+◄.

The ✱ indicator on the LCD display shows which parameter is being changed. Initially, it is in the first display line, and the arrow keys and rotary knob change the signal frequency value. The PgUp/PgDn keys change the second line to display the values of other instrument parameters, but those values cannot be changed unless the ✱ indicator is moved to the second line, e.g. by pressing the Shift+► key.

The primary functions, signal waveform and amplitude (Sec. 3.3.1 and 3.3.2), have their own key selectors; other functions are selected by moving through the menu selections by the PgUp and PgDn keys, in the following order:



3.3.1 Selecting CH1 waveform

Press the Shift+Wave button and adjust the output waveform type by turning the "ADJUST" knob. Available waveforms are: sine, square, triangle, rising

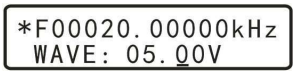
sawtooth, descending sawtooth and 16 arbitrary waveforms, preloaded by the manufacturer. Each of those arbitrary 16 waveforms can also be downloaded from the connected PC host by the user.[1]

3.3.2 Setting CH1 frequency

When the ✱ indicator is in the first line, use the left/right arrow keys to move the cursor to the appropriate decimal digit and turn the "ADJUST" knob to adjust the frequency of the output waveform.

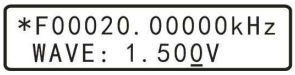
3.3.3 Setting CH1 output amplitude

Press the signal amplitude key SHIFT+AMPL, move the cursor to the appropriate decimal digit and turn the "ADJUST" knob to adjust the peak-to-peak signal amplitude of the output waveform, as shown below:[2]



In the default range setting function mode, the maximum amplitude is 15V, and the minimum amplitude is 0.15V; the incremental step value is 0.01V (10mV).

The -20dB output attenuator may be selected by pressing the OUT OK button. With attenuation, the output signal has a maximum value of 1.500V, the minimum value of 0.015V, and the minimum step is 0.001V (1mV).

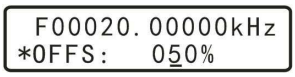


[1] The original manual claims that "Long key press restores the original set of waveforms" but I am unable to replicate that

[2] The original instructions have the picture as shown here, but recent instruments show *AMPL: in the second line, which makes more sense.

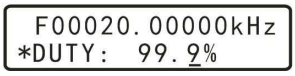
3.3.4 Setting CH1 voltage offset

Change the mode to bias adjustment, and move the cursor to the desired digit, then turn the "ADJUST" knob to adjust the offset parameter.



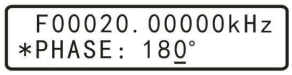
3.3.5 Setting CH1 duty cycle

Change the mode to adjust the duty cycle, move the cursor to the desired decimal digit, then turn the "ADJUST" knob to adjust the duty cycle parameter.



3.3.6 Adjusting phase difference between channels

Change the mode to adjust the phase, move the cursor to the desired decimal position , then turn the "ADJUST" knob to adjust the phase parameter.[3]



3.3.7 Setting the display unit of frequency

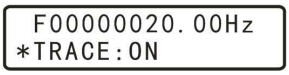
Change the mode to adjust the frequency units of the display, and then select the frequency units of Hz, kHz, or MHz.

[3] The phase difference only makes sense if CH1 and CH2 output the same frequency.

3.3.8 Tracking function

Tracking function is used to synchronize the frequency of CH2 to CH1. The amplitude and duty cycle can also be tracked.

Select the tracking option, and then select TRACE ON or OFF with the OUT OK button. When the tracking function is turned on, output frequency of channel CH2 automatically tracks the frequency of channel CH1. Also, if CH1 and CH2 amplitude is the same before turning tracing on, amplitude tracking feature is turned on. If the duty cycle is the same in both channels, CH1 and CH2 duty cycle will also be automatically tracked.



3.3.9 External signal input port selection

Select the input port selection mode, and switch the input port selection to Ext.IN for front panel AC signal input, or to TTL.IN for rear panel TTL input.

3.3.10 Measurement function

Several parameters of the input signal can be measured.

- Choose the measurement mode selection, and then turn the knob or click the OUT OK button to switch the measured quantity:

  FREQ F= frequency

  COUNTR C= count

  POS-PWH= positive (logical high) period

  NEG-PWL= negative (logical low) period

  PERIOD T= time period

  DUTY DUTY= duty cycle (percent)

- Proceed to gate time selection menu, and choose one of available gate times: 10s, 1s, 0.1s, or 0.01s. Different gate times trade off frequency measurement accuracy and measurement speed.

- Proceed to next menu; the instrument display will show input measurement results.

3.3.11 Sweep function

- Select the initial sweep frequency settings function, and then adjust the start frequency, e.g. 5kHz as shown below:

- Next, select the final sweep frequency function, and then adjust the final frequency, e.g. 10kHz as shown below:

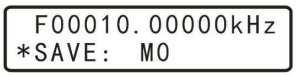
- Next, select the sweep time setting mode, and rotate "ADJUST" knob to adjust the sweep time between 1s and 600s, e.g. to 10s as shown below:

- Next, enter the sweep mode selection screen, and choose between LINE (linear frequency sweep) and LOG (logarithmic sweep).

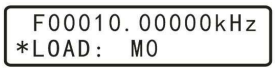
- Finally, enter the sweep control page, then press the OK key to turn on or turn off sweep function. Subsequent OK button presses will pause and continue the scan.

3.3.12 Parameter storage and loading

- To save parameters for later use, select the parameter save function, then rotate "ADJUST" knob to adjust the save location. This instrument has a total of 10 parameter storage locations, M0-M9. On power on, the instrument loads parameter set M0.



- To restore saved parameters, chose the parameter load function, and rotate the "ADJUST" knob to adjust the location to one of the 10 available saved sets, M0-M9. On power on, the instrument loads parameter set M0.



3.3.13 Calibration

Calibration function is performed at the factory. Please consult the factory if calibration is required.

4 Instrument control software

The instrument is provided with large and somehow unwieldy Windows control software. An alternative portable PyQt control program mhdds will be developed.

5 Care and maintenance

1. Make sure to use the provided DC5V power adapter;
2. The instrument display LCD module is fragile and needs to be protected from mechanical and chemical damage. Clean by gently wiping with a soft cloth.
3. The working temperature is -10..50 °C, Storage temperature -20..70 °C, in a dry environment.

4. Do not attempt to disassemble the equipment, destroying the package will void the warranty. There are no user-serviceable parts inside; repairs are to be done only by authorized repair outlets or by returning the item to the factory.

5. Do not allow lighted candles, liquid-filled containers, corrosive chemicals and other unsafe items to be placed on the surface of the instrument, so as not to cause damage to the instrument.

6. The instrument is a fragile and sensitive electronic equipment; do not scratch, touch, press or bump. Avoid child play with this instrument.

7. Do not move the instrument to avoid severe irreparable damage to the internal circuit when the instrument is working properly.

8. If the above conditions were observed, and the instrument still does not work after cycling the power off and on, please contact your supplier.

6 Warranty and service

Thank you for purchasing Ming Wo electronic products. To maximize the use of your new product features, we recommend you take the following few simple steps:

- Read the instructions for safe and efficient use.
- Read the warranty terms and conditions.

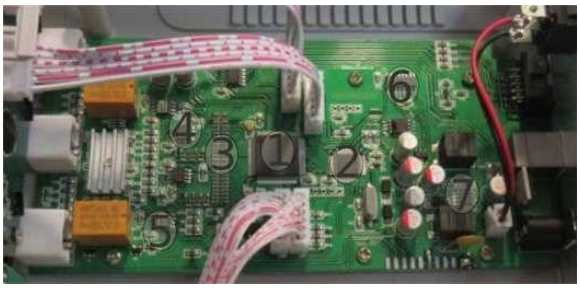
Warranty conditions:

Instrument is warrantied for a period of one year from the shipment date. During the warranty period, the company will repair or replace equipment selected according to the situation. For service, please send the product to the company.

The following conditions are not covered under warranty:

- User operation or improper maintenance
- using the software or user interface to provide their own
- unauthorized modification to the instrument

A Instrument internals



1. LCMX02-1200HC lattice FPGA
2. STM8S00 controller
3. R-2R resistor ladder DAC
4. LM358 opamps
5. AD603AR variable gain output amplifiers
6. 74HC140 TTL driver
7. CH340G USB-serial interface

Figure 4: MHS-5200A main circuit board

B MHS-5200A serial protocol

This information is from Al Williams' work at https://github.com/wd5gnr/mhs5200a
The manufacturer claims that the communication protocol is open and non-proprietary, but as of July 2015 this is the only known description.

MHS5200A shows up as normal serial port (e.g., /dev/ttyUSBx on Linux, COM port on Windows), The communication settings are:

- baud rate 57600
- data formatting 8/n/1
- hardware handshake
- \n Unix line terminator, but the program also accepts the CRLF pair

Manufacturer-provided software initiates the communication with the device with the following commands (presumably to probe different device types in the future):

: clear any pending command

:r1c returns :r1c323 (corresponding to firmware 3.23; other versions have been observed up to v.4.10)

:r2c returns :r2c015 (last digits of P/N?)

:r0c returns :r0c52A (model #? 5200A?)

If you get an echo of <CRLF>// // // that probably is an error indication

Cmd	Description	Returns	Notes
:r0c	Read model #	:r0c52A	Start up
:r1c	Read Prod #	:r1c323	Start up
:r2c	Read FW (3.23)	:r2c015	Start up
:sXf	Write frequency for channel X	ok	
:rXf	Read frequency for channel X	:rXfNNNNNNNN	
:sXwN	Select waveform N for channel X	ok	N: 0=sine, 1=square, 2=tri, 3=up, 4=dn, 100=arb0 .. 115=arb15 (also accepts 32 .. 47)
:rXw	Read wave type	:rXwNN	NN=0004 as above, 3247 for arb0..15
:sXd	Write Duty cycle for chan X	ok	
:rXd	Read Duty cycle for chan X	:rXdNNN	
:sXo	Write offset for chan X	ok	Note: 0%=120
:rXo	Read offset for chan X	:rXoNNN	Note 0%=120
:sXp	Write phase for chan X	ok	
:rXp	Read phase for chan X	:rXpNNN	

:sXy	Set atten for chan X	ok	1–0db 0–20db
:rXy	Read atten for chan X	:rXyN	
:sXa	Set amplitude for chan X	ok	
:rXa	Read amplitude for chan X	:rXaNNNN	
:sXb	Set chan X on or off	ok	1–on.0–off
:rXb	Read chan X on or off	:rXbN	
:s3b	Set trace on or off	ok	1–on 0–off
:r3b	Read trace on or off status	:r3b	
:s4b	Select ext in or ttl	ok	0–ext 1–ttl
:r4b	Read ext in or ttl	:r4bN	
:r0c	Read freq/count value	:r0cXXXXXXX	Depends on selected reading type
:sNg	Set gate value	ok	0 (1s). 1 (10s). 2–(.01s). 3–(.1s)
:r1g	Read gate value	:rNg	See above
:s3f	Set Sweep Start	ok	
:r3f	Read Sweep Start	:r3fNNNNNNNN	NN
:s4f	Set Sweep End	ok	
:r4f	Read Sweep End	:r4fNNNNNNNN	NN
:s7bN	Set Line/log	ok	N–1 for lin,0 for log
:r7b	Read line/log	:r7bN	
:s8bN	Start Stop sweep	ok	N=0 for stop,1 for start
:r8b	Read sweep state	:rb8N	
:aXN	Set arbitrary waveform data	ok	There are 16 arbitrary waveforms, X 0..F. Each one is described by 1024 samples in 16 slices, numbered N=0..F. Each slice contains 64 comma-separated 8-bit samples valued 0..255 with 125 as the nominal center.
:s9b	Turn on/off power amp	ok	If equipped; 0=off,1=on
:r9b	Read amp status	:r9bN	

:r1m	Read counter/frequency mode	:rNm	N=Mode (see below)
:s1m	Set mode to counter	ok	
:s0m	Set mode to freq	ok	
:s2m	Set mode to pulse width	ok	
:s3m	Set mode to pulse width	ok	
:s4m	Set mode to period	ok	
:s5m	Set mode duty cycle	ok	
:s5tN	Set sweep time	ok	N is sweep time
:s6bN	Run	ok	0=stop, 1=run only affects counter mode
:r6b	Read run state	:r6bN	
:s5b1	Reset counter	ok	
:r5b	Read reset status	:r5bN	

Functions still unknown:

- Reading back arbitrary storage (if even possible)
- Setting or loading stored setups