

FG085 miniDDS Function Generator

Manual of Operation

Applicable Models: 08501, 08501K, 08502K, 08503, 08503K

Applicable Firmware Version: 1) 113-08501-120 or later (for U5)

2) 113-08502-041 or later (for U6)

1. Getting Started

Introduction

The FG085 is a low cost versatile function generator capable of producing continuous/frequency sweeping waveforms and servo test signals. It was designed as an easy-to-use tool for electronic hobbyists. The operation of FG085 is extremely straightforward. The following examples will lead you step-by-step through some typical uses.

Data Entry

Setting of FG085 signal parameters is done by pressing the key with a parameter label under it (F/T, for example, for frequency or period). The current display will be cleared and an underline will be shown, indicating place for new value to be typed in. If at the moment you hit a parameter key the cursor is not currently at the parameter just press the key one more time to make the underline shown. Then enter new value using the DATA ENTRY keys. Complete entry by hitting one of the UNITS keys. If an error is made at typing pressing [ESC] key will do backspace to correct it. If no more digits left when [ESC] is pressed it will exit Data Entry and display the previous value.

A cursor focused parameter may also be adjusted incrementally by tuning [ADJ] (rotary encoder).

Examples

1) To set output frequency to 5KHz press the following keys:

[F/T] [5] [KHz]

2) To change output waveform to square wave press [WF] until "SQR" is shown.

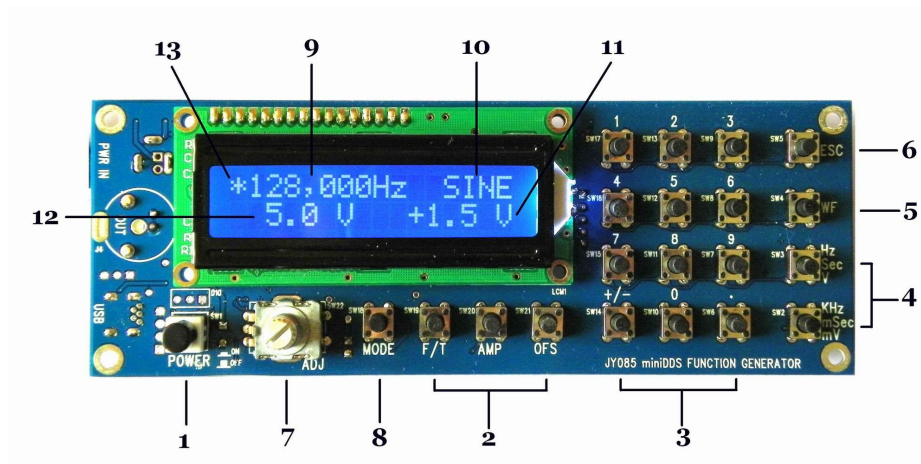
3) To set output amplitude to 3V peak-to-peak press the following keys:

[AMP] [3] [V]

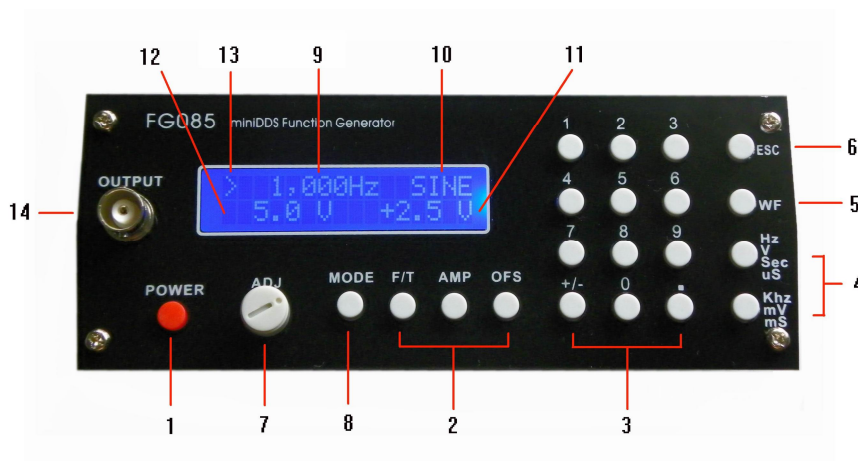
4) To set DC offset to -2.5V press the following keys

[OFS] [+/-] [2] [.] [5] [V]

2. Front Panel Features



Front view of 08501/08502



Front view of 08503

1) Power Switch

The power switch turns the FG085 on and off.

2) Parameter Keys

The parameter keys select the parameter to be entered. If cursor is not currently at a parameter pressing the parameter key will first move cursor to that parameter.

3) Data Entry Keys

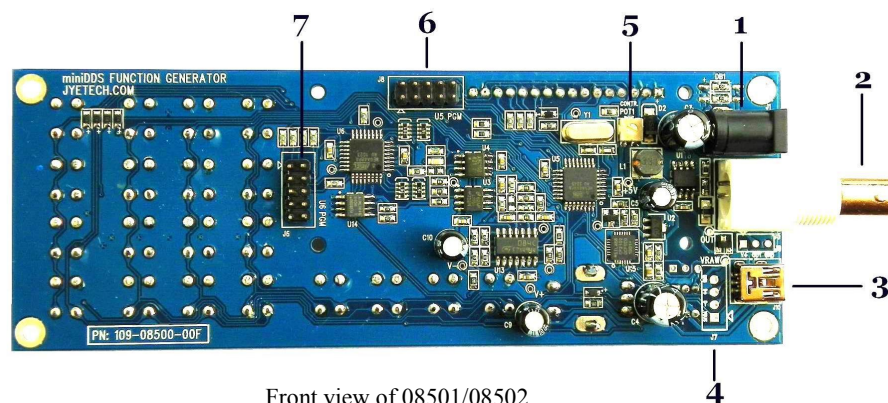
The numeric keypad allows for direct entry of the FG085's parameters. To change a parameter value simply press the parameter key (if cursor is not currently at the parameter press the parameter key twice) and then type a new value. Entries are terminated by the UNITS keys. If an error is made at typing press [ESC] key to correct it (back space). If no more digits left when [ESC] is pressed it will exit Data Entry and display the previous value.

The [+/-] key may be pressed at any time during numeric entry.

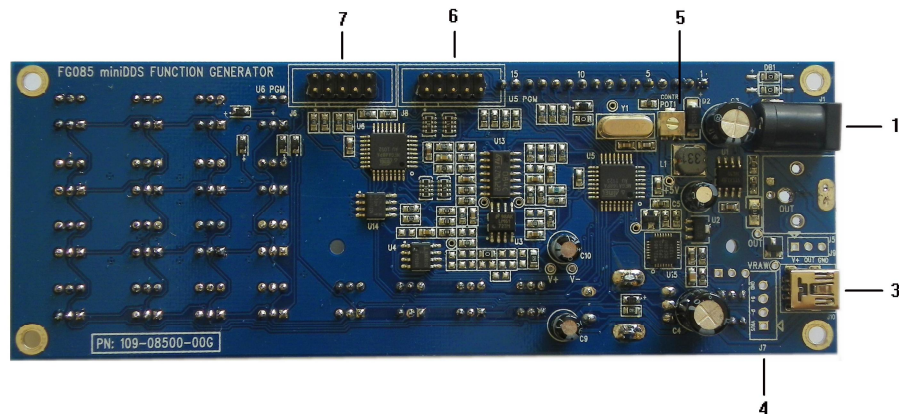
- | | |
|----------------------------------|---|
| 4) Unit Keys | The UNIT keys are used to terminate numeric entries. Simply press the key with the desired units to enter the typed value. |
| 5) Waveform Key | This key selects output waveform. Repeated pressing of this key will go through all available waveforms. |
| 6) ESC key | This key back space typed digits and/or exit current state. |
| 7) Rotary Encoder | Rotary encoder can incrementally adjust a focused parameter up and down. To do this first pressing a parameter key to move cursor the parameter to be changed and then turn the encoder.

Pressing rotary encoder will enter Setting Change state. |
| 8) MODE Key | This key selects FG085's working modes. |
| 9) Frequency (Period) | Display of current output frequency or period. |
| 10) Waveform | Display of current waveform type. |
| 11) DC Offset | Display of current output DC offset. |
| 12) Amplitude | Display of current output amplitude. |
| 13) Cursor | Indication of currently focused parameter. Turning rotary encoder will change this parameter. |
| 14) Function Output (J4) | This is the front output connector. Its output impedance is 50Ω. |

3. Connectors



Front view of 08501/08502



Board view of 08503

- 1) Power Input (J1)** This is the DC power supply input connector. Its center core should be connected to the positive pole of power supply. FG085 is specified for 14V DC. The current capacity of power supply should be greater than 200mA average.
- 2) Function Output (J5)** This is the back output connector. Its output impedance is 50Ω.
- 3) USB (J10)** This provides a connection to PC for waveform data download and instrument control.
- 4) Alternative USB (J7)** This connector allows wiring the USB connection to socket at enclosure.
- 5) Contrast Adjustment** This is a resistor trimmer for LCD contrast adjustment.
- 6) U5 Programming Port (J8)** This is the programming header for the main controller ATmega168 (U5).

Pin-out Description

Pin#	Signal Name	I/O	Function
1	MOSI	I	U5 programming
2	+5V	PWR	
3	NC	-	No connection
4	-	-	Reserved
5	nRST	I	U5 programming
6	-	-	Reserved
7	SCK	I	U5 programming
8	GND	PWR	
9	MISO	O	U5 programming
10	GND	PWR	

- 7) **U6 Programming Port (J6)** This is the programming header for the DDS core controller ATmega48 (U6)

Pin-out Description

Pin#	Signal Name	I/O	Function
1	MOSI	I	U6 programming
2	+5V	PWR	
3	-	O	Sweeping sync pulse
4	-	-	Reserved
5	nRST	I	U6 programming
6	-	-	Reserved
7	SCK	I	U6 programming
8	GND	PWR	
9	MISO	O	U6 programming
10	GND	PWR	

4. FG085 Operations

Power-on

Push down the power switch to turn on FG085. It will first display model name. Then manufacturer/vendor name follows. After displaying firmware versions the unit enters normal working state.

Output

The output amplitude display is only correct when load is in high impedance (much larger than 50Ω). If load impedance is close to 50Ω the output amplitude will be lower than displayed. If load impedance is 50Ω the output amplitude will half of that displayed.

Mode Selection

FG085 can work in one of four different modes. These four modes are:

- 1) Continuous Waveforms (CW) mode
- 2) Frequency Sweeping mode
- 3) Servo Position mode
- 4) Servo Run mode

Pressing [Mode] button will display the mode selection menu.



Tuning [ADJ] will scroll through these modes. The number at the lower-right corner indicates menu position. Pressing [WF] will select the mode displayed. Pressing [ESC] will exit mode selection without change.

Continuous Waveform (CW) Mode

In this mode the generator outputs continuous signal of various waveforms. Signal frequency, amplitude, and DC offset can be independently set by user.

Screen Please refer to Section 2 “Front Panel Features”.

Waveform Selection Waveform selection is done by pressing [WF] key.

Frequency Frequency is set by first pressing [F/T]. The current display will be erased and an underline is shown, allowing user to enter new value. New value is entered with Data Entry keys and followed by one of the Unit keys. Alternatively, frequency can be changed incrementally by using the rotary encoder when it is focused.

Frequency can also be set in period. Press [F/T] key will toggle between frequency and period entry mode.

Frequency Range

In spite of that no limited range is set for frequency entry it should be aware of that there are practical ranges for output frequency due to the low resolution 8-bit DAC and slow sample rate (2.5MSPS). Out of these ranges signal quality will be degraded as larger distortions and jitters appear. The acceptable ranges depend on actual applications. For FG085 output frequency within following range is reasonably good for most applications.

Function	Range
Sine	0 – 200KHz
Square	0 – 10KHz
Triangle	0 – 10KHz
Ramp	0 – 10KHz
Staircase	0 – 10KHz

Maximum Frequency Error

Maximum frequency error depends on sample clock and phase accumulator size. For FG085 the phase accumulator size is 24 bits. Two sampling clocks, 2.5MSPS and 10KSPS, are used. Sample clock is automatically selected based on frequency setting as shown in the table below.

Frequency	Sampling Clock	Maximum Error
> 40Hz	2.5MSPS	0.1490 Hz
≦ 40Hz	10KSPS	0.0005960 Hz

Amplitude Amplitude is set by first pressing [AMP] key. The current display will be erased and an underline is shown, allowing user to enter new value. New value is entered with Data Entry keys and followed by one of the Unit keys. Alternatively, amplitude can be changed incrementally by using the rotary encoder when it is focused.

The displayed amplitude value is peak-to-peak value.

The amplitude range is limited by the DC offset setting since $|V_{ac\ peak}| + |V_{dc}| \leq 10\ V$ (into High-Z).

D.C. Only

The output of the FG085 can be set to a DC level by entering amplitude of 0V. When the amplitude is set to zero the A.C. waveform will be completely shut off and the FG085 may be used as a DC voltage source.

DC Offset

DC offset can be set by first pressing [OFS] key. The current display will be erased and an underline is shown, allowing user to enter new value. New value is entered with Data Entry keys and followed by one of the Unit keys. Alternatively, offset can be changed incrementally by tuning [ADJ] when it is focused.

In general, the DC offset may range between $\pm 5V$, but it is limited such that $|V_{ac\ peak}| + |V_{dc}| \leq 10\ V$ (into High-Z), or $|V_{ac\ peak}| + |V_{dc}| \leq 10\ V$ (into HIGH-Z).

Increment and Decrement

FG085's output frequency, amplitude, and DC offset can be changed incrementally up and down by using the rotary encoder. To do this first move cursor to the parameter you want to change by pressing a parameter key and then turn the rotary encoder clock-wise for increment and counter-clock-wise for decrement.

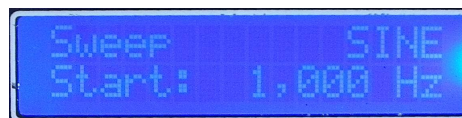
Tip

Incremental step size can be set to any value. To do this directly enter the step size you want and follow by [Hz] or [ms] button. [Hz] button sets step size for frequency adjustment. [ms] button sets step size for time adjustment. Press [Hz] or [ms] will display current frequency or time step size.

Frequency Sweeping Mode

In this mode FG085 generate frequency changing signals. The change range and rate as well as signal amplitude and DC offset are independently set by user.

Screen



Waveform Selection

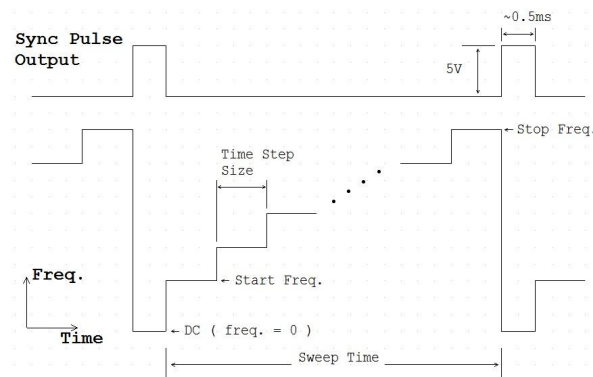
Waveform selection is done by pressing [WF] key.

Range and Rate

Frequency sweeping is actually frequency stepping. Four parameters determine the frequency change range and rate:

- Start Frequency
- Stop Frequency
- Sweep Time
- Time Step Size

The following drawing illustrates their relationships. Frequency change is linear only. The smallest time step is 1ms.



To change these parameters first turn [ADJ] dial to select the parameter you want to change. Then press [F/T] button to enter numbers.

Tip

You can also use buttons [1], [2], [3], and [4] to access these four parameters quickly. Their relationships are:

- [1] - Select/change Start Frequency
- [2] - Select/change Stop Frequency
- [3] - Select/change Sweep Time
- [4] - Select/change Time Step Size

Notes:

1. Start and stop frequencies can only be entered in Hz. The DDS sampling clock is always set to 2.5MSPS. Frequency resolution is about 0.1490Hz (see explanations in CW mode).
2. Sweep time can be entered in Sec or mSec. It is always displayed in "mS".
3. Time step size can be entered in Sec or mSec. It is always displayed in "mS". The allowed range is 1 - 65535.
4. When Sweep Time is less than Time Step Size the actual sweep time becomes $2 * (\text{Time Step Size})$. Frequency sweeping is degraded to outputting start and stop frequency alternatively.

Sync Pulse Output

A synchronous pulse is output at pin 3 of J6 between the end of a sweep and the start of next sweep. The pulse width is about 0.5ms. Its amplitude is 5V. See drawing above.

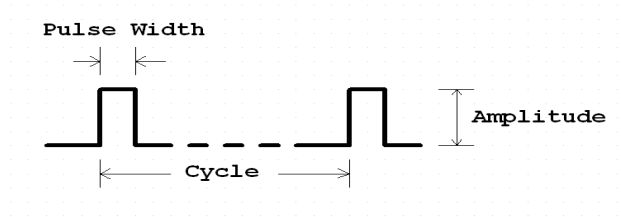
Amplitude See the explanation of "Amplitude" in CW mode.

DC Offset See the explanation of "DC Offset" in CW mode.

Servo Position Mode

In this mode the generator outputs servo control signal with specific pulse width, amplitude, and cycle. All these parameters can be set independently by user.

Servo Control Signal The drawing below shows a servo control signal.



Typically servo signal takes following parameters:

- 1) Cycle: 20ms
- 2) Pulse Width: 1ms – 2ms
- 3) Pulse Amplitude: 5V

The pulse width determines servo position.

Screens

The photo below shows the screens of Servo Position Mode. The first screen shows pulse width in unit of microsecond. The second shows pulse amplitude in unit of volt. Pressing [F/T] will display the pulse width screen and pressing [AMP] will display the amplitude screen.



Pulse Width and Cycle

At pulse width screen pressing [F/T] will erase current display and show an underline, allowing user to enter new pulse width. New pulse width is entered with Data Entry keys and followed by one of the two Unit keys. The value entered is treated as **microsecond** if the unit key [Sec] is used, or as **millisecond** if the unit key [mSec] is used.

Please note that the range of pulse width that user can actually enter is limited by two values, SV.PWmin and SV.PWmax. If the pulse width you input is out of the range defined by SV.PWmin and SV.PWmax then the input will be substituted by the limit numbers. These limiting values can be modified by user (see below). The default values of SV.PWmin and SV.PWmax are 1000 uSec and 2000 uSec respectively.

Servo **signal cycle** can be changed too. This is done by modifying the setting SV.Cycle in Setting Change state (see below).

Pulse Amplitude

At pulse amplitude screen pressing [AMP] will erase current display and show an underline, allowing you to enter new pulse amplitude. Enter new pulse amplitude with Data Entry keys and follow by one of the two Unit keys. The number you entered is treated as **volt** if the unit key [V] is used, or as **mill volt** if the unit key [mV] is used.

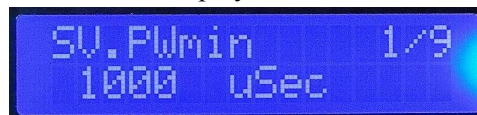
Like pulse width the maximum of amplitude that user can enter is limited by the value of SV.AMPmax. If the amplitude entered is greater than SV.AMPmax then the input will be substituted by SV.AMPmax. The default value of SV.AMPmax is 5.0V. It can also be changed in "Change Setting" state (see below).

Increment and Decrement

At either pulse width screen or amplitude screen user can turn [ADJ] to incrementally change pulse width or amplitude. The step size of incremental change for pulse width is defined by SV.PWinc, another setting that can be modified by user (see below).

Servo Signal Settings

Servo signal settings are a number of EEPROM stored values that affect the behaviour of servo signal generation. These values are user changeable. In order to change these values pressing [ADJ] to enter **Setting Change** state. The following screen will be displayed.



The top line shows a setting name. The bottom line shows its value. The number at top-right corner indicates current menu position.

To change a setting first scroll to that setting by turning [ADJ]. Then press [F/T] to enter a new value.

Pressing [ESC] will exit Setting Change state.

Restore factory default

Factory default settings can be restored by scroll to the last item and pressing [WF] key.

The following table lists the details about servo signal settings.

Setting	Descriptions	Acceptable Range	Default
SV.PWmin	The minimum pulse width allowed	0 – 26000 uSec	1000
SV.PWmax	The maximum pulse width allowed	0 – 26000 uSec	2000
SV.PWmid	Pulse width corresponding to servo nurture position	0 – 26000 uSec	1500
SV.PWinc	[ADJ] step size in Servo Pos mode	0 – 26000 uSec	100
SV.RunStep	Step size of pulse width change in Servo Run mode	0 – 26000 uSec	100
SV.RunRate	Duration of one step in Servo Run mode	0 – 6.5 Second	0.1
SV.Cycle	Servo signal cycle	0 – 26000 uSec	20000
SV.AMPmax	The maximum pulse amplitude allowed	0 – 10.0V	5.0V

When a setting is set to a value out of acceptable range the instrument behaviour is not defined.

Servo Run Mode

In this mode the generator outputs servo control signal with changing pulse width. The pulse width change step, rate, and range are user settable.

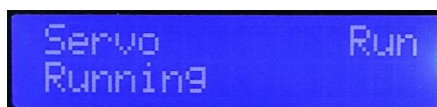
States

When Servo Run mode is first entered it stays at **Ready** state.



In this state a constant signal with pulse width equal to SV.PWmin is generated.

When [WF] button is pressed it transfers to **Running** state.



In this state pulse width will change from SV.PWmin to SV.PWmax incrementally in step defined by SV.RunStep. Once it reaches SV.PWmax it will immediately change in the reverse direction, i.e. from SV.PWmax to SV.PWmin incrementally with the same step size. Pulse width will vary in this way until [WF] key is pressed.

When [WF] key is pressed in Running state the generator will



enter **Hold** state, where pulse width stops varying and maintains the value at the moment [WF] key is pressed.

Change Settings

Settings that affect Servo Run mode behaviour include SV.PWmin, SV.PWmax, SV.RunStep, and SV.RunRate. These settings can be changed by user. Please refer to paragraph titled “Servo Signal Settings” above for details.

5. Firmware Upgrading

From time to time there may be a need to upgrade firmwares in order to add features or improve performance. FG085 contains two AVR micro-controllers from Atmel:

- 1) ATmega168PA (U5), which is the main controller of the instrument.
- 2) ATmega48PA (U6), which is the DDS core.

To upgrade firmware an AVR programmer with compatible programming header is required. For programming header pin-out please refer to tables under section “Connectors”. If the programming header you have has a different pin-out. You need to re-route the signals to make them match. (JYE Tech’s USB AVR Programmer [PN: 07302] is ideal for FG085 programming. Please visit www.jyetech.com for details.)

Download updated firmware files from JYE Tech website (www.jyetech.com) and follow instructions of the programmer you have to carry out firmware upgrading.

About Fuse Bits

AVR micro-controllers contain some fuse bits that configure the chip for specific applications. In most cases these fuse bits should not be touched at firmware upgrading. But if somehow these bits are changed they should be restored as follows.

- 1) ATmega168PA (U5)
 - Extended Fuse Byte: **0b00000111 (0x07)**
 - High Fuse Byte: **0b11010110 (0xD6)**
 - Low Fuse Byte: **0b11100110 (0xE6)**
- 2) ATmega48PA (U6), which is the DDS core.
 - Extended Fuse Byte: **0b00000001 (0x01)**
 - High Fuse Byte: **0b11010110 (0xD6)**
 - Low Fuse Byte: **0b11100000 (0xE0)**

6. Technical Support

For any technical issues or questions in using the instrument please contact JYE Tech at support@jyetech.com. Or post your questions at JYE Tech forum at <http://forum.jyetech.com>.

7. Specification

- Frequency range: 0 – 200KHz (Sine)
- Frequency resolution: 1Hz
- Maximum frequency error:
 - 0.1490 Hz for frequency > 40 Hz
 - 0.0005960 Hz for frequency ≤ 40Hz (CW mode)

- Period resolutions: 1ms
- Amplitude range: 0 – 10V peak-to-peak
- D.C. offset range: -5V – +5V
- Waveform memory length: 256 bytes
- Sample rate: 2.5Msps or 10Ksps
- Output impedance: 50 ohm
- Power supply voltage: 14V DC
- Current consumption: < 150mA (without loading)
- Circuit board size: 155mm X 55mm