GRA & AFCH

DDS 9910 Arduino Shield

V2

OPERATING INSTRUCTION

Firmware v. 2.13

Rev. A

Use only a power supply with a voltage rating of 7.5 volts or USB to power this device!

GENERAL GUIDE

The device is an expansion board (shield) for Arduino **Mega** based on the ATmega2560 microcontroller with 5-volt logic levels, since the board has logic signal level converters from 3.3V to 5V.

Power is supplied to the device through the Arduino, and connection is made either through the power jack (up to 7.5 volts) or through the USB connector.

To fully operate the device, an I²C OLED display of 0.96 inches is required (optional and not included). The display is powered by 5 volts from the 5v pin on the Arduino.

The device is controlled using three buttons: "MODE", "DOWN", and "UP". (External button connectors PH2.0-2p can be used, if needed).

5-volt USB power input

7.5-volt power input

Figure 1

The AD9910 clocking can be done in three ways:

• Crystal;

• OCXO/TCXO (default);

• Using an external source, when using it, **make sure that capacitor C20 is removed** (Figure 2).

The type and frequency of the clock source must be correctly set in the device settings. All settings are saved in non-volatile memory.

The **output signal** is taken from the SMA connector labeled "RF OUT" on the board.

When using an **external clock source**, the signal is fed to the SMA connector labeled "EXT OSC", when using it, **make sure**
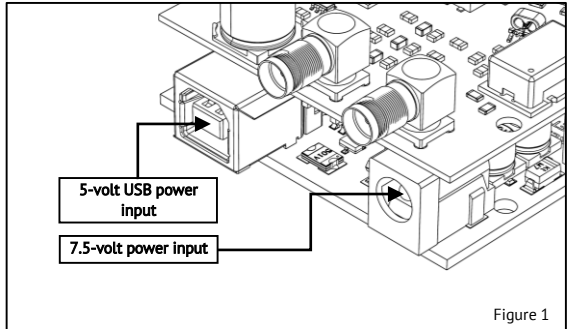

RF OUT

Remove C20 Capacitor, when clocking from external source

EXT OSC

Figure 2

Output RF Transformer

Low-pass RF Filter
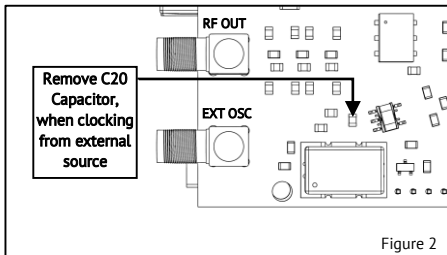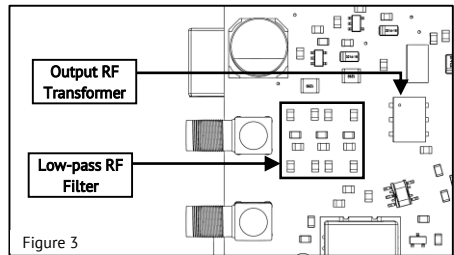
Figure 3

that capacitor C20 is removed (Figure 2). The level of the external clock signal must be within the range of -10 dBm to +4 dBm for a sinusoidal signal. For example, if the signal level from an external generator is +10 dBm, it is necessary to connect it only through an attenuator of at least 6 dBm (10 - 4 = 6). For signals of other waveforms, such as a clipped sine or square wave, the level must be 0.2 – 1 Vpp.

The device contains an output low-pass filter and a matching output transformer, therefore a software limit of 100 kHz is applied to the minimum output frequency of the device (Figure 3).

OPERATION

Main menu:

The "Mode" button moves the cursor in a circular fashion between the options, while the "Up" and "Down" buttons change the selected value, apply the selected option, or enter a submenu. Pressing and holding the "Up" or "Down" buttons for an extended period allows for changing the frequency value by 10 units at a time.

Frequency [Hz]: The maximum output frequency is limited to 600 MHz, but it is important to note that the maximum output frequency that can be obtained is half of the frequency of the AD9910 core. For example, with a core frequency of 1 GHz, the maximum output frequency cannot exceed 500 MHz. The core frequency can be changed in the "Setup" menu.

Amplitude: [dBm] The signal level can be adjusted from -72 dBm to 0 dBm, or up to +4 dBm if the "DAC current" option in the "Setup" menu is set to "Hi".

Modulation menu - "Mod":

Pressing the "Up" or "Down" buttons when the "Mod" item is selected in the "Main" menu will bring up the "Modulation" menu. This menu allows you to enable amplitude modulation (AM), frequency modulation (FM), or "Sweep" mode for frequency. Changes to the parameters take effect immediately after releasing the buttons, and the "SAVE" menu item is used to save the selected mode and all its parameters to non-volatile memory. The carrier frequencies can be changed in the "Main" menu, and the "EXIT" option is used to return to the "Main" menu.

Type: None – To disable modulation or the "Sweep" mode, set the "Type" parameter to "None".

Type: AM – Amplitude Modulation: The "MFreq" parameter allows for adjustment of modulation frequency from 10 to 100999 Hz with a step size of 1 Hz, while the "Depth" parameter allows for setting modulation depth, also known as modulation index, within the range of 0 to 100% with a step size of 1%.

Type: FM – Frequency modulation: The "MFreq" parameter allows for adjustment of modulation frequency from 10 to 100999 Hz with a step size of 1 Hz, while the "Deviation" parameter allows for setting frequency deviation of the carrier wave within the range of 1 Hz to 100999 Hz with a step size of 1 Hz.

Type: Sweep – Frequency Sweep: The "Start Freq." and "Stop Freq." parameters set the initial and final frequencies within the range of 1 Hz to 600 MHz with step sizes of 1 Hz. It is not allowed to set the initial frequency higher than the final frequency. The "Time" parameter sets the time for the frequency to change from the "Start Freq." value to the "Stop Freq." value. This parameter can take values from 1 to 999, and the units of measurement can be selected from "S" for seconds, "mS" for milliseconds, and "uS" for microseconds. In this mode, the frequency will change first from a lower value to a higher value, and then in the reverse direction - from a higher value to a lower value, and so on until the sweep mode is turned off (**NO-DWELL** mode). Each time the frequency reaches the upper or lower limit ("Start Freq." or "Stop Freq."), a short positive pulse of 3.3 V with a duration of two cycles of the DDS clock will appear on the "DROVER" pin.

Setup menu:

To enter the settings menu, press and hold the "MODE" button for 1 second.

Clock Src: Allows selecting the clock source, with three options available: "XO" - Crystal Oscillator, "TCXO/OCXO" - Temperature Compensated Crystal Oscillator / Oven-Controlled Crystal Oscillator, "EXT OSC" - External clock source. In addition to selecting the clock source in the menu, it is also necessary to ensure that the components listed in the Table 1 are set to the position corresponding to the selected clock source.

Clock source (only one at a time)	Capacitors				Resistors	
	C20	C22	C18, C19	C14, C17	XTAL	REF_CLK
XO - Crystal Oscillator (Z1)	–	–	✔	✖	✔	✖
TCXO - Oscillator 1ppm (Z2)	✔	✖	✖	✔	✖	✔
OCXO - Oscillator 0.1ppm (Z3)	✖	✔	✖	✔	✖	✔
EXT OSC - External Generator	✖	✖	✖	✔	✖	✔

Table 1

✔ means that the component must be installed,
✖ means that the component must be removed,
– means it doesn't matter.

Clock Freq: Allows setting the frequency of the clock source, with different frequencies available for each source:
- For "XO", frequencies of 20 MHz and 25 MHz are available;
- For "TCXO/OCXO", frequencies of 5, 10, 20, 25, 40, and 50 MHz are available;
- For "EXT OSC", it is possible to manually set the frequency in the range of 60 MHz to 3000 MHz with a step of 1 MHz. In addition, an additional parameter "Divider by 2" is available for this source, which allows activating the built-in AD9910 divider by 2 on the signal path from the clock source.

DAC current: The parameter can take two values, "HI" - increases the output signal power by 4 dBm but results in increased harmonic levels and phase noise; "Normal" - reduces the maximum power to 0 dBm but lowers harmonic levels and phase noise.

DDS Core Clock: Allows changing the core frequency. When clocked by "XO" or "TCXO/OCXO", the core frequency can be set from 1000 MHz to 1520 MHz, with the adjustment step depending on the clock source frequency. When clocked by an external source, the core frequency can be set in the range of 60 MHz to 3000 MHz (by setting the clock source frequency and, if necessary, activating the "Divider by 2" parameter). The nominal AD9910 core frequency is 1000 MHz, setting a higher frequency is overclocking, and operation at such a frequency is not guaranteed.

⚠ WARNING   It is not recommended to set the core frequency above 1520 MHz

Offset: Allows adjusting the clock frequency if the deviation from the specified value is known. The clock settings are applied only after selecting the "SAVE" option. The "EXIT" option allows exiting without saving the settings.

SPECIFIACTIONS

|	
Frequency:	100 kHz – 420 MHz (600 MHz*) in 1 Hz step
Spurs max:	-60 dBc
Frequency step:	1 Hz
Output power:	+0 dBm (+4**) to -84 dBm (on 50 Ohm load)
Output level up to:	1 Vpeak-to-peak (at +4 dBm)
Power Supply:	USB or External Power Supply DC 7.5V, 1A
Output filter:	7-th order, 600 MHz cut-off
Modulation frequency for AM (amplitude modulation):	10 Hz to 100 kHz in 1 Hz step
AM modulation depth:	0% to 100% in 1% increments
Modulation Frequency for FM (Frequency Modulation):	10 Hz to 100 kHz in 1 Hz step
FM modulation deviation frequency:	0 Hz to 100 kHz in 1 Hz step
Reference clock sources (on choice):	XO-Crystal Oscillator, TCXO 1ppm, OCXO 0.1ppm, External Oscillator 60 - 3000 MHz
Reference clock input level (EXT OSC)	-10 dBm - +4 dBm, 0.2 – 1 Vpp
Size:	53.2 x 102 x 35 mm

Figure 4
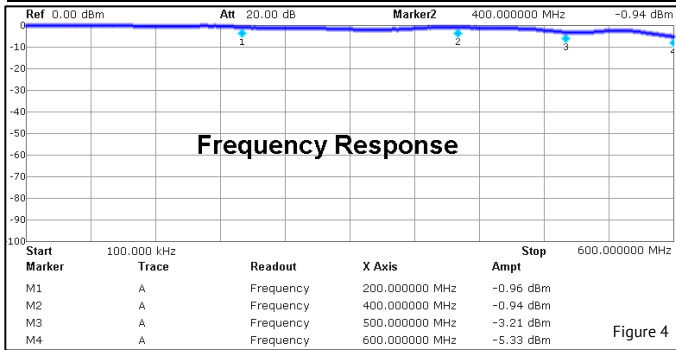
FACTORY RESET

To reset all settings to factory defaults, you should hold down the "Mode" button and apply power to the device while keeping the button pressed.

REMOVING 100 KHz MINIMUM FREQUENCY LIMIT

For experienced users only. All actions are performed at your own risk. Remove transformer T1 and replace it with one capacitor and two resistors (Figure 5), and in the file "DDS-AD9910-Arduino-Shield.ino" set the desired value in Hertz in the line `#define LOW_FREQ_LIMIT 100000`. Installing a capacitor C1_1 with a value of 10 uF will reduce the lower frequency limit to 10 Hz, if you want to reduce the limit even more, then the value of the capacitor should be increased. These modifications will lead to a degradation in the performance of the DDS: the output level will decrease by 3 dBm, and the level of harmonics will increase as the current mirror and a balanced transformer not be used.

Figure 5
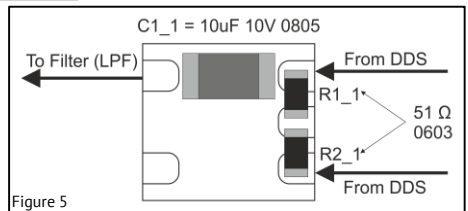
website: www.gra-afch.com	**firmware**: www.github.com/afch/DDS-AD9910-Arduino-Shield	**video compilation of firmware:** youtu.be/beSsurZ8JgU

Input Power Supply
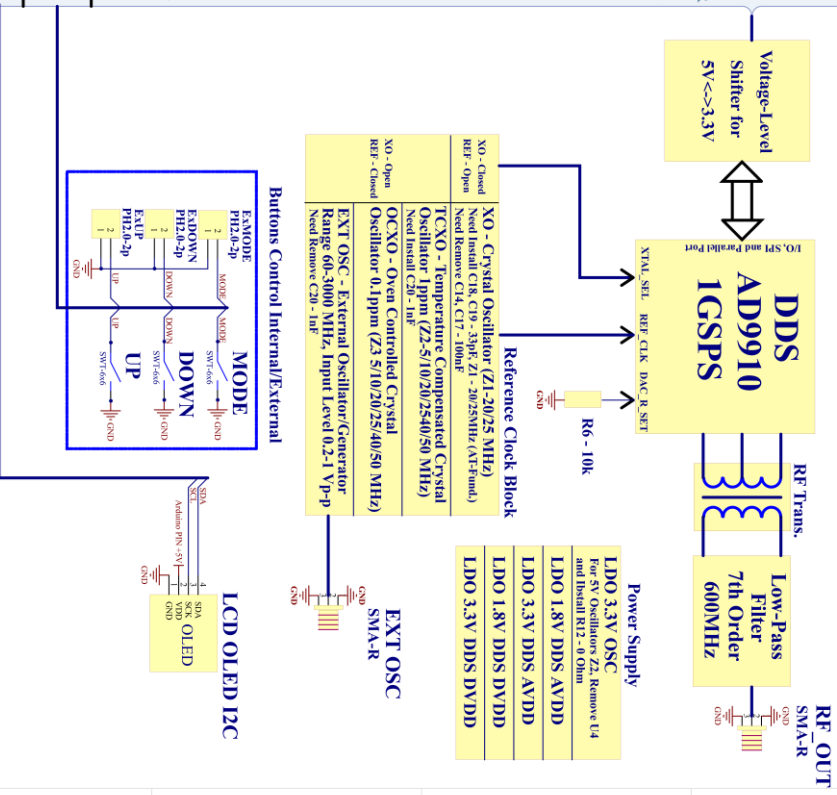## 7.5 VDC 1A or USB

Attention! you cannot use an external power supply with a voltage greater than 7.5V, because the high voltage to high heat LDO on the Arduino board and the board may be damaged. It is also not recommended to use a power supply unit less than 6.5V since a voltage margin is needed to stabilize the LDO 5V voltage on the Arduino board.
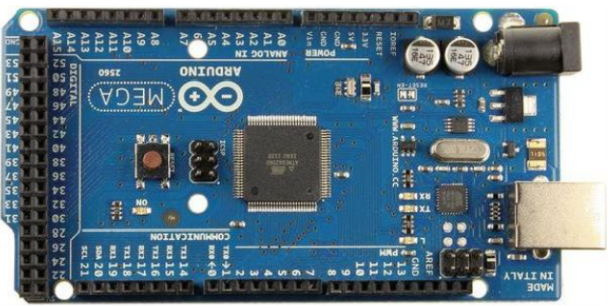
ARDUINO MEGA/DDS PINOUT

- Arduino PIN50, PIN12 - DDS SDO
- Arduino PIN51, PIN11 - DDS SDIO
- Arduino PIN52, PIN13 - DDS SCLK
- Arduino PIN10 - DDS CS
- Arduino PIN9 - IO_RESET
- Arduino PIN4 - DDS PF0
- Arduino PIN3 - DDS PF1
- Arduino PIN2 - DDS PF2
- Arduino PIN3 - DDS DRHOLD
- Arduino PIN43 - DDS SYNC_SMP_ERR
- Arduino PIN45 - DDS PLL_LOCK
- Arduino PIN47 - DDS RAM_SWP_OVR
- Arduino PIN46 - DDS SYNC_CLK
- Arduino PIN44 - DDS PDCLK
- Arduino PIN42 - DDS DROVER
- Arduino PIN40 - DDS OSK
- Arduino PIN38 - TXENABLE

- Arduino PIN22 - DDS D0
- Arduino PIN23 - DDS D1
- Arduino PIN24 - DDS D2
- Arduino PIN25 - DDS D3
- Arduino PIN26 - DDS D4
- Arduino PIN27 - DDS D5
- Arduino PIN28 - DDS D6
- Arduino PIN29 - DDS D7
- Arduino PIN37 - DDS D8
- Arduino PIN36 - DDS D9
- Arduino PIN35 - DDS D10
- Arduino PIN34 - DDS D11
- Arduino PIN33 - DDS D12
- Arduino PIN32 - DDS D13
- Arduino PIN31 - DDS D14
- Arduino PIN30 - DDS D15
- Arduino PIN39 - DDS F0
- Arduino PIN41 - DDS F1

- Arduino PIN5 - DDS EXT_PWR_DWN
- Arduino PIN6 - DDS IO_UPDATE
- Arduino PIN7 - DDS DRCTL
- Arduino PIN3 - MASTER_RESET
- Arduino PIN2 - Button UP
- Arduino PIN1 - Button DOWN
- Arduino PIN0 - Button MODE
- Arduino PIN3 - Button MODE

- Arduino PIN20, A4 - LCD SDA
- Arduino PIN21, A5 - LCD SCL
- Arduino PIN +5V

Voltage-Level Shifter for 5V<->3.3V

I/O, SPI and Parallel Port

DDS AD9910 1GSPS

XTAL_SEL   REF_CLK   DAC_R_SET

Reference Clock Block

XO - Crystal Oscillator (Z1-20/25 MHz)
REF - Open
Need Install C18, C19 - 33pF, Z1 - 20/25MHz (AT-Fund).
Need Remove C14, C17 - 10nF

XO - Closed
REF - Open
Need Install C18, C19 - 33pF, Z1 - 20/25MHz (AT-Fund).
Need Remove C14, C17 - 10nF

XO - Closed
REF - Closed

TCXO - Temperature Compensated Crystal Oscillator - 1ppm (Z2-5/10/20/2540/50 MHz)
Need Install C20 - 1nF

OCXO - Oven Controlled Crystal Oscillator 0.1ppm (Z3 5/10/20/25/40/50 MHz)
Need Install C20 - 1nF

EXT OSC - External Oscillator/Generator Range 60-3000 MHz, Input Level 0.2-1 Vp-p
Need Remove C20 - 1nF

R6 - 10k

Buttons Control Internal/External

EXMODE
PH2.0-2p

EXUP
PH2.0-2p

EXDOWN
PH2.0-2p

MODE
SW7-6x6

UP
SW5-6x6

DOWN
SW6-6x6

LCD OLED I2C

Arduino PIN +5V
SDA
SCL
VDD
GND
OLED

EXT OSC
SMA-R

Power Supply
LDO 3.3V OSC
For 5V Oscillators Z2, Remove U4
and Install R12 - 0 Ohm

LDO 1.8V DDS AVDD
LDO 3.3V DDS AVDD
LDO 1.8V DDS DVDD
LDO 1.8V DDS DVDD
LDO 3.3V DDS DVDD

RF Trans.
SMA-R

Low-Pass Filter 7th Order 600MHz

RF_OUT
SMA-R

Title	DDS9910 v2.0 Rev. B 27.03.2023		
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