DDS Function generator user manual

Specifications

- Single 12 V DC supply required
- 10 MHz output
- Sine, triangle and square waveforms available
- 10 V p-p amplitude
- +/- 5 V DC offset
- 50 Ohm output
- Logic level square wave output
- External control via serial port
- External control of voltage parameters

Description

The device is an open source, inexpensive, Direct Digital Synthesis function generator. The device is aimed to be used as a stand alone device, or as a module in a larger circuit. The primary aim of the device is to offer reasonable performance at a very low cost, allowing it to be a tool for anyone doing electronics related things.
The project files are available at the following link.

Device appearance

User interface

The device contains the following user interface elements: LCD display, pushable rotary encoder, power switch, mode button, amplitude potentiometer, and offset potentiometer.
The LCD display, rotary encoder, and mode button are connected to the microcontroller. The potentiometers are only interfaced with the analogue section of the device and are not in any way interfaced with the microcontroller.
The device has two main modes of operation:

1. Default manual control mode – The user manually adjust the frequency and waveform
2. Frequency sweep mode – The device continuously sweeps a selected range of frequencies

Default mode

In the default mode turning the rotary encoder increments or decrements the underlined digit. When the rotary encoder is pressed, the scale is changed allowing for the next digit to be modified. Once the most significant digit has been passed, the selected digit is set back to the least significant digit (rolls over). The maximum frequency is 20MHz, but over 10MHz the signal is unstable. The mode button is used to change the waveform.

Sweep mode

To enter the frequency sweep mode, the mode button needs to be pressed until the LCD prompts for a start frequency input. When the start sweep frequency is selected, the mode button can be held again to go to the next step. In the next step, the stop frequency is inquired. The last step is the sweep speed.

There are 8 sweep speeds available:

1. 1000 steps per decade
2. 500 steps per decade
3. 200 steps per decade
4. 100 steps per decade
5. 50 steps per decade
6. 20 steps per decade
7. 10 steps per decade
8. 5 steps per decade

The default value is 4, setting it to 100 frequency steps per decade.
Upon each sweep iteration, the sweep trigger pin is strobed, allowing an oscilloscope to trigger and reset the oscilloscope screen for the next sweep cycle. To exit the sweep mode, the rotary encoder must be pressed. The mode button is not registered while sweeping. The sweep waveform will be the last one set.

Serial port control

The serial port interface is very minimalistic, using only one character at the time. The serial terminal does not transmit any echo or messages back (RX only). The serial port is operated at baud 9600, 8b, no parity. Transmitting digits from 0 to 9 form the next value. Once all the digits have been transmitted, sending a new line or carriage return will cause the device to apply the new frequency value. If there is a need to clear the transmitted value, sending the ‘c’ character (case sensitive) will clear the input. To change the waveform characters from A to C are used (any character will work, it registers the last 3 bits of any character).

The following characters set the following waveforms:

- A – Sine
- B – Triangle
- C – Square wave (D – Also square wave, E – repeats over)

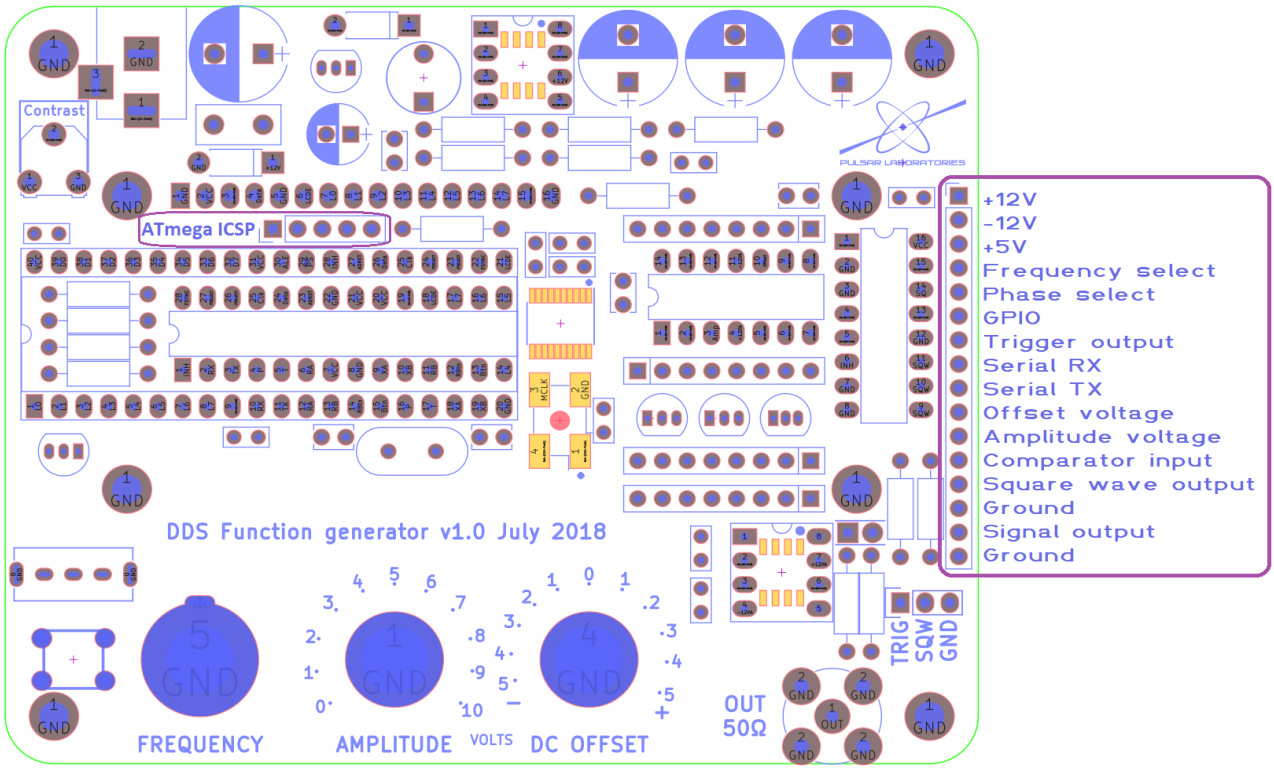
When a new waveform is selected it is only applied with a subsequent frequency change.

If the device is used as a module in a larger circuit the user interface components can be removed which are:
LCD, rotary encoder, mode button, and both the potentiometers.
If not required, the BNC connector can also be removed.

Pinout

The device contains three pin header connectors:

- External control connector
- Logic level output connector
- ATmega ICSP connector



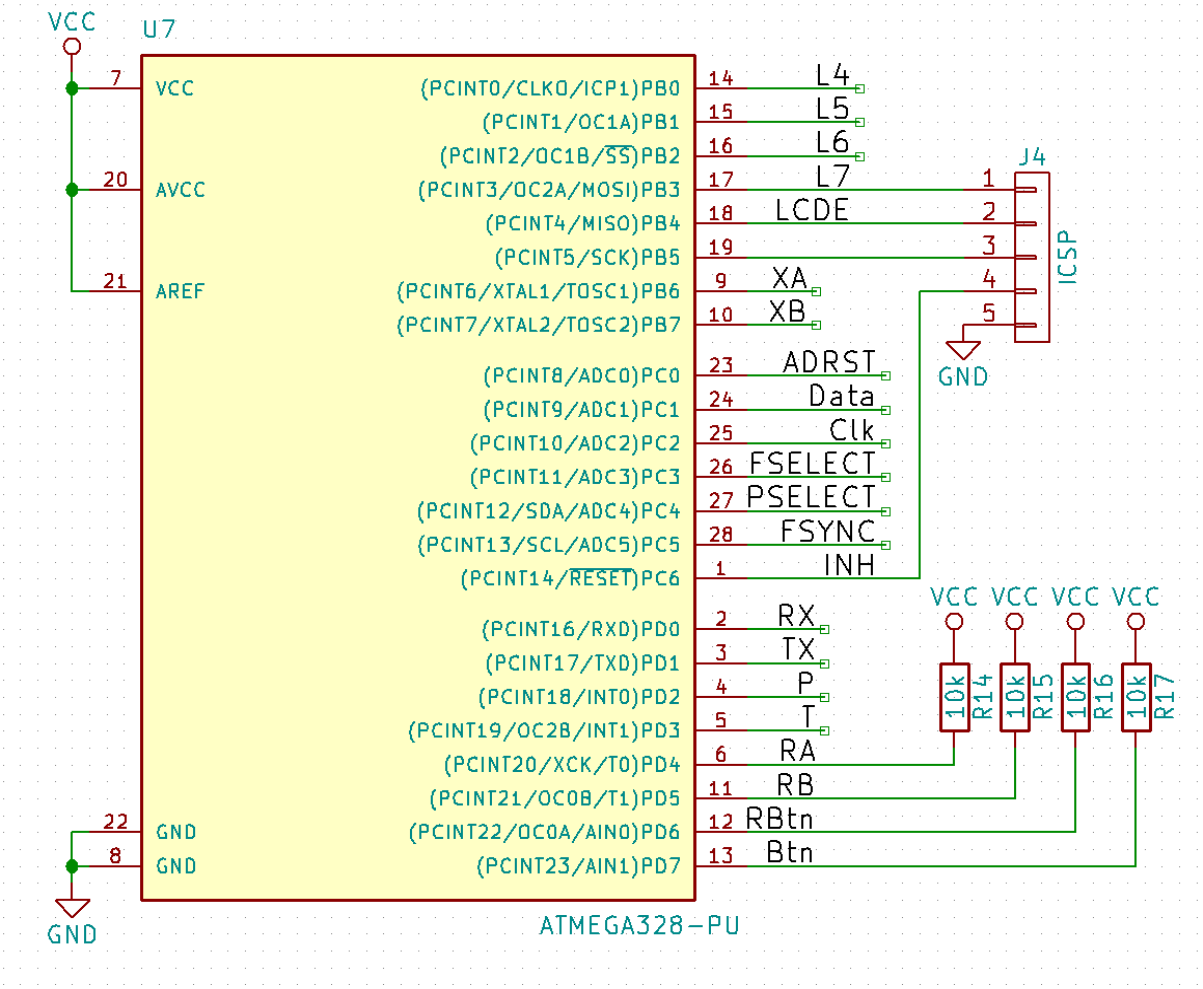
Pin layout

External control pin description:

- +12V, -12V, +5V – Device power rails, if the 12V DC power is not provided by the DC power jack, it can alternatively be provided to the +12V pin
- Frequency select, Phase select – DDS register switch pins
- GPIO – Unused MCU GPIO pin
- Trigger output – Sweep trigger strobe signal
- Serial RX, TX – Serial port interface
- Offset voltage – Offset voltage input-output control (2x multiplier jumper is present near the output opamp)
- Amplitude voltage – Amplitude voltage input-output control
- Comparator input – DDS comparator input
- Square wave output – Logic level square wave output, this output is not DC offset, and the amplitude is halved
- Signal output – Signal output, same as on the BNC connector

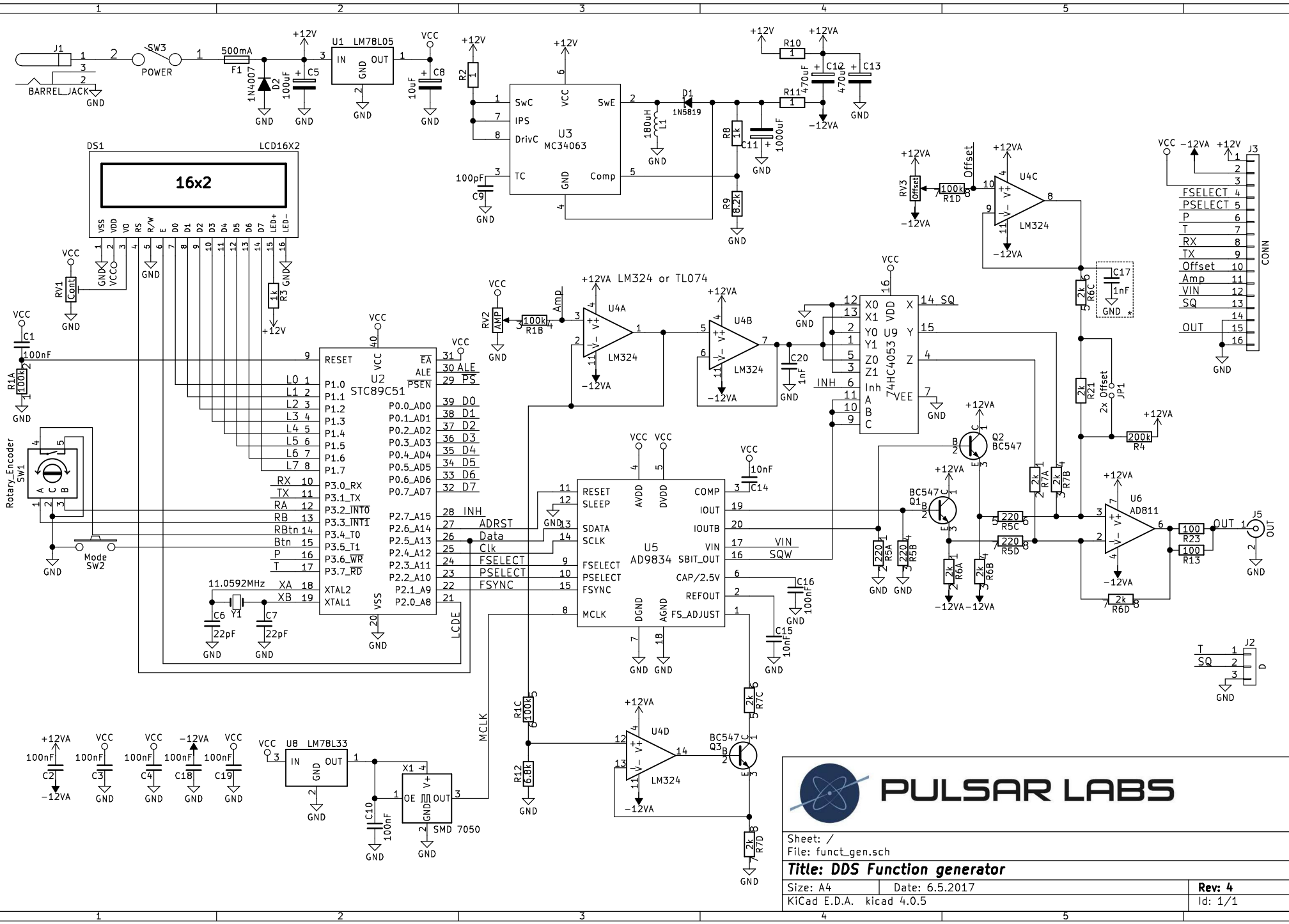
ATmega alternative MCU

The device is designed to use the 89C51 MCU due to its low cost, but alternatively it can also use an ATmega328 by removing the 89C51 socket and installing the ATmega in the smaller socket located inside the 40 pin socket. When using the ATmega, four pullup resistors need to be soldered in the resistor footprints that are otherwise hidden.
When using the ATmega the following MCU substitution schematic applies:



Alternative MCU circuit

By using the ICSP header, the ATmega can be programmed, and a bootloader such as the Arduino bootloader can be installed. Further firmware loading can be achieved via the serial port interface.


J1
BARREL_JACK
SW3
POWER
500mA
F1
1N4007
D2
100uF
C5
U1 LM78L05
IN
OUT
GND
10uF
C8
VCC
+12V
R2
U3
MC34063
SwC
IPS
DrivC
TC
SwE
Comp
VCC
GND
180uH
L1
D1
1N5819
R8
1k
C11
1000uF
R9
8.2k
100pF
C9
R10
R11
C12
470uF
C13
+12VA
-12VA
DS1
LCD16X2
16x2
VSS
VDD
VO
RS
R/W
E
D0
D1
D2
D3
D4
D5
D6
D7
LED+
LED-
RV1
Cont
R3
1k
U2
STC89C51
RESET
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
P3.0_RX
P3.1_TX
P3.2_INT0
P3.3_INT1
P3.4_T0
P3.5_T1
P3.6_WR
P3.7_RD
XTAL2
XTAL1
P0.0_AD0
P0.1_AD1
P0.2_AD2
P0.3_AD3
P0.4_AD4
P0.5_AD5
P0.6_AD6
P0.7_AD7
P2.7_A15
P2.6_A14
P2.5_A13
P2.4_A12
P2.3_A11
P2.2_A10
P2.1_A9
P2.0_A8
EA
ALE
PSEN
INH
ADRST
Data
Clk
FSELECT
PSELECT
FSYNC
LCDE
11.0592MHz
Y1
C6
22pF
C7
22pF
C1
100nF
R1A
100k
Rotary_Encoder
SW1
Mode
SW2
U5
AD9834
RESET
SLEEP
SDATA
SCLK
FSELECT
PSELECT
FSYNC
MCLK
AVDD
DVDD
DGND
AGND
COMP
IOUT
IOUTB
VIN
SBIT_OUT
CAP/2.5V
REFOUT
FS_ADJUST
C14
10nF
C16
100nF
C15
10nF
U4A
U4B
U4C
LM324
LM324 or TL074
RV2
AMP
Amp
100k
R1B
C20
1nF
RV3
Offset
100k
R1D
74HC4053
X0
X1
Y0
Y1
Z0
Z1
Inh
A
B
C
VDD
VEE
X
Y
Z
SQ
INH
C17
1nF
R6C
2k
R21
2k
JP1
2x Offset
Q2
BC547
Q1
BC547
R4
200k
R7A
2k
R7B
2k
R5C
220
R5D
220
R5A
220
R5B
220
R6A
2k
R6B
2k
R6D
2k
U6
AD811
R23
100
R13
100
OUT
J5
J3
CONN
FSELECT
PSELECT
P
T
RX
TX
Offset
Amp
VIN
SQ
OUT
J2
T
SQ
D
U8 LM78L33
X1
SMD 7050
C10
100nF
R1C
100k
R12
6.8k
U4D
BC547
Q3
R7C
2k
R7D
2k
C2
C3
C4
C18
C19
100nF
PULSAR LABS
Sheet: /
File: funct_gen.sch
Title: DDS Function generator
Size: A4
Date: 6.5.2017
Rev: 4
KiCad E.D.A. kicad 4.0.5
Id: 1/1