MADELL TECHNOLOGY CORPORATION

DDS SYNTHESIZED
WY32020 FUNCTION/ARBITRARY SIGNAL GENERATOR

1. Main Features

Features of WY32020

- DDS technology is used for high stability.
- Frequency range 0.01Hz to 20Mhz.
- Sweeping, FSK and FM settings are all digitized no phase jump when frequency changes.
- Single manual trig, external voltage level or edge trig for sweeping, FSK and ASK.
- TTL output can be used as TTL clocks, minimum pulse width 10μs, time precision 0.5μs, and maximum to 100s.
- Communicate with PC through RS-232 serial port.
- Arbitrary waveform generation(AWG) capability(AWG), AWG software is included with the purchase

Packing List

- WY32020 box----------1
- 50Ω terminator----------1
- power cable----------1
- Alligator cable----------1
- BNC cable----------1
- User's manual----------1
- Software(email) ----------1

2. Specifications

2.1 In system waveforms

Sine, square, triangle, up ramp, down ramp, white noise, SIN(X)/X, up exponential, down exponential.

2.2 Arbitrary waveforms

Length 8K(8192) points

Resolution 8bits(1 sign, 7 magnitude)

Sample rate 10MSa/S

Four 8K points waveforms

2.3 Frequency response

Sine: 1mHz～20MHz

Square: 2Mhz

Other waveforms 1mHz～100KHz

Highest resolution 100μHz or 8 bits.

Long term stability 50ppm(0□～40□)

Short term stability: 1ppm(after a short warm up time)

Resolution: 0.05Hz (>100Hz)

100μHz (<100Hz)

2.4 Attenuation of Sine：(50Ω load，1Vp-p output)

<20KHz: -60dBc

20KHz～1MHz: -50dBc

1MHz～10MHz: -40dBc

10MHz～20MHz: -30dBc

2.5 Signals：(50Ω load，1Vp-p output)

Square:

Rising、Falling edges <25ns

Overshoot <5%

Nonsymtricity 2%+20ns

Duty 100kHz, 20%～80%

1MHz, 30%～70%

Triangle, ramps:

Linearity (1KHz) <1%

2.6 Output

Amplitude (No4 load) 2mVp-p～20Vp-p

(50Ω load) 1mVp-p～10Vp-p

Output impudence 50Ω

Adjustment resolution 5%

Flatness of sine waveform 10%

Offset -100%～100% of peak value

2.7 Pulse

50Ωoutput port at ASK modulation, Sync output

Level: TTL

Pulse width: 10μs < tw < 100s

Pulse precision: ±0.5μs

Gap: 10μs < ts < 100s

2.8 Sweeping

Range 0.1Hz～20Mhz

Minimum step 0.1Hz

Rate 10ms～100s

Trig: internal, external, single.

2.9 FSK、ASK

Pulse width、gap 10μs～100s

Trig: internal, external, single.

2.10 Modulation

Internal modulation:
Carrier waveform: default waveforms
Carrier frequency 1mHz～20MHz
Modulation waveform: default waveforms
Modulation frequency 100mHz～10kHz
Modulation frequency stability 50ppm
Modulation depth 0%～120%
External modulation:
Input impedance 1kΩ

AM: at 1Vp-p sine, ±0.4Vp-p external modulation reaches 100% depth.
FM:
Carrier waveform: internal
Carrier frequency: 0.1Hz～20Mhz
Modulation waveform: internal
Modulation frequency: 100mHz～10kHz
Modulation frequency: stability: 50ppm
Frequency shift range: 0.1Hz～20MHz

3 Menu and Operations

This function generator has a back light double line LCD display, keypads and a dial, four BNC connectors.

The "OUTPUT"BNC connector is the signal output connector, output impedance is 50 ohm. The "SYNC. OUTPUT" connector is for TTL level output. It indicates signal timing. This signal can be used as external trig signal on an oscilloscope. The "AM IN" BNC connector is for external modulation signals; The "TRIG IN"BNC connector is for external TTL trig mode.

The dial is multi-functional. Its value corresponds to the blinking number on the LCD display.

3.1 Wave Key

When the "Wave"key is pressed, the LCD shows"WAVEFORM : sin" and sin blinks. The waveform can be selected by turning the dial. The sequence of the waveforms is: sine, square, triangle, rampup, rampdown, noise (pseudo white noise), sin(x)/x, expup, expdown, wave1, wave2, wave3, wave4.

All sin and square waveforms can reach 20Mhz. All others can reach 1 0 0kHz.

3.2 Freq.

When the "Freq."key is pressed, the LCD shows"fo = 1.0000000 kHz". This is the default frequency. Turn the dial to change the digit that is blinking.

Frequency can also be entered directly with the number keypad. First press the "Enter" key, all frequency digits disappear. Enter the required frequency with the numbered keypads. Press "Enter" again to confirm the entered new frequency. The backward key can be used to delete the newly entered numbers. "Cancel" button can be used to terminate the frequency input mode.

3.3 Amplitude

When the "Ampl." key is pressed, the LCD shows "AMPLITUDE = 100 mV", this is the default value. The amplitude value is the peak to peak value at load of 50 ohm. Maximum amplitude is 10V and minimum 1 mV.

3.4 Duty

When the"duty"key is pressed, the LCD shows"SQUARE DUTY = 50 %". The upper and lower duty limits are 80% and 20% respectively. When the frequency is faster then 1MHz, the duty range will reduce gradually.

3.5 Offset

When the "Offset"key is pressed, the LCD shows"DC OFFSET = 0 %". The upper and lower offset limits are 100% and –100% of the peak value respectively.

3.6 Mode

When the "Mode"key is pressed, the first line of LCD shows"MODE: no modulation", the second line shows"no lin log fsk >".

There are total 9 modulation status: no modulation, linear sweep, log sweep, FSK, ASK, internal FM, internal AM and external AM.

Press the blue buttons underneath the LCD to select the corresponding modulation mode, press ">"to show modes in the next page, press"<" the get back to the previous page.

After getting into a modulation mode, press the corresponding mode key again will get into parameter setting mode. For example, when in linear modulation mode, press "Lin" key again will show "f1 f2 tw ts OK".

Linear sweeping

MODE: linear sweep f1 f2 tw ts OK

f1 : start frequency

f2: stop frequency

tw: sweeping on time

ts: sweeping off time

OK: confirm selection

WY32020 implements frequency sweeping by selecting 500 frequencies between the start and stop frequency.

Sweeping can be positive or negative. It is positive sweeping when the stop frequency is greater than the stop frequency. Sweeping can be linear and log. The 500 frequency points are divided linearly (equal distance) at linear sweeping.

It takes a few seconds for the CPU to compute the sweeping frequency points.

Log sweeping

```
MODE: log sweep
  f1  f2  tw  ts  OK
```

f1： start frequency

f2： stop frequency

tw： sweeping on time

ts： sweeping off time

OK: confirm.

In log sweeping mode, the higher the frequency, the faster the frequency changes.

FSK

```
MODE:   FSK
  f1  f2  tw  ts  OK
```

f1： frequency 1

f2： frequency 2

tw： frequency 1 on time

ts： frequency 2 on time

OK：confirm selection.

In FSK mode frequency shifts between f1 and f2, modulation signal is square waveform. tw and ts can be 100s to 10μs.

ASK

```
MODE:     ASK
  fo     tw  ts  OK
```

fo： carrier frequency

tw： carrier on time

ts： carrier off time

OK: confirm selection.

Modulation signal controls the on and off of the carrier frequency in ASK. Tw and ts can be 100s to 10μs. In ASK mode, the SYNC OUTPUT BNC will output corresponding pulse signals.

Internal FM

```
MODE:  internal  FM
  fo  fm  f d  wa  OK
```

fo： carrier frequency

fm： modulation frequency

fd： max frequency shift

wa： modulation waveform

OK: confirm selection

Similar to linear and log sweeping, 500 frequency points are used to implement frequency modulation.

Internal AM

MODE: internal AM fo fm dp wa OK

fo： carrier frequency

fm： modulation frequency

dp： modulation depth

wa： modulation waveform

OK: confirm.

In this mode, f_0 should be greater than f_m.

External AM

MODE: external AM < intam extam

No setting menu in this mode。The output signal amplitude will be reduced to half to allow enough modulation dynamic range. The carrier frequency is selected with the “Freq.” key.

3.7 Configuration

When the “Config.”key is pressed，the LCD shows“ RS-232, 9600，N，8，1”. The function generator enters in the RS-232 remote control mode。The RS-232 is fixed at 9600 bits，no checking bits，8 data bits，1 stop bit.

The following instructions can be used to send commands to and get status from the function generator through the serial port.

WAVE：SIN, output sine waveform.

WAVE：SQUARE, output square waveform.

WAVE：TRIANGLE, output triangle waveform.

WAVE：RAMPUP, output up ramp waveform.

WAVE：RAMPDOWN down ramp.

WAVE：NOISE, output noise.

WAVE：SINX/X， output SIN（x）/ x

WAVE：EXPUP, output up exponential.

WAVE：EXDOWN, output down exponential.

WAVE：AWG1, output user waveform AWG1

WAVE：AWG2, output user waveform AWG2

WAVE：AWG3, output user waveform AWG3

WAVE：AWG4, output user waveform AWG4

FREQ1000，change output frequency to 1000Hz, in the range of 0.001～20000000

VOLT100， change amplitude to 100mV，in the range of
1～10000

DUTY50, changes duty to 50%，in the range of 20~80%.

OFFSET0, changes offset to zero, in the range of
-100%～+100%。

Maximum instruction length 15 characters. A "return" sign must follow the instruction. Its ASC□ code is 10，or represented by'\ n'in C language. The function generator may freeze if now doing so.

There should be some time gap between two instructions.

3.8 Trig

In sweeping, FSK and ASK modes，in addition to be trigged internally，single or external trigs can also be used.

When the "Trig" key is pressed，the function generator enters into single or external trig mode. The LCD shows"trig" in the lower right corner. When in "MODE" mode, the "MODE" sign changes to "tMODE".

Single Trig

In single trig mode，every press of the "TRIG" key will cause the function generator output a sweeping，FSK or ASK pulses。Pulse width is decided by the tw parameter. In FSK mode：the function generate outputs continuous f2 signal. After trig，it outputs a single pulse signal with width of tw and frequency f1，and ouputs f2 signal afterwards.

In single trig mode, the "SYNC OUTPUT" will send out a TTL pulse synchronized with the signal. This helps external circuits or an oscilloscope to capture the output pulse.

External Trig

In external trig mode，the function generator is "trigged"by the "TRIG IN" BNC input TTL signal. In sweeping mode, every TTL rising edge will generator a sweeping with width of tw. External trig period much be greater than tw；FSK and ASK are controlled by the input TTL signal level. In FSK mode，the function generator outputs f1 in low (0) voltage，outputs f2 in high(1) voltage；In ASK mode，it outputs the carrier signal in low (0) voltage，outputs nothing in high(1) voltage.

Press the "Cancel" key to exit trig mode.

4 Arbitrary Waveform Editing

4.1 General

The arbitrary waveform editing software is need to generator user defined waveforms.

4.2 Software Interface

The software can be operated under Windows interface.

Menus and fast key icons are standard Windows arrangement for easy and fast operation.

4.3 Mouse

Standard windows mouse pads operation.

4.4 File Format

Two file formats: machine format, public format.

Machine format is used to construct and store waveform data. Public format is used to translate waveform data obtained from other devices or software. The extension of machine format file is .awg, and the extension of public format files is .usr. The editing software read files differently according to the extensions.

The storage format of machine files is reserved and not open to the public. Storage of Public files is based on character sequences : the first 10 sequences are file headers. Sequences should be saved in lines. The first sequence represents the data file size, the remain 9 are reserved for later us. It is recommended to fill the reserved sequences with"0"; User defined waveform data is stored from lines of 11 to the end. The length of the data is define by the first sequence in the file header. Every line should have 32 characters separated by ",".

Because waveform data can be generated from different devices or software while the function generator has fixed 8 bits resolution, data normalization should be performed by user software. All data should be in the range of 0~255.

4.5 Menu functions and operation

New

This will clean the screen and reset all settings to default ones.

Open, Save, Save As, Print

There are standard Windows functions.

Undo

This will reset the editing area size and zoom in.

Mark

The software can be used to cut, copy, paste, adding noise, smooth, zoom in and other functions. Before using any of those functions, the editing area should be defined.

Press the "Mark" submenu when a waveform is shown in the graphics area, a vertical line will be shown in the left side of the graphics window. This line can be moved with the mouse. This mark line will disappear if the right mouse button is clicked. Drag the mark line to somewhere and click the right mouse button will define the left side of the editing area. The edit area can be defined by move the mouse to the right and click left mouse button again. The editing area will be inside the newly defined white area. Exit editing mode by click on the "Mark" menu again.

Cut

This will cut the waveform inside the editing area.

Noise

This function adds pseudo white noise to the current waveform. It is not available now.

Smooth

This function smoothes the current waveform. It is not available now.

Zoom

Zoom into the marked waveform area. Click on “Undo” to exit.

Trace

A cross-hair mark will show the x and y position on the waveform.

Freehand, Line

Using these functions to draw arbitrary waveforms.
It can be used to draw spikes and pulses.

Mouse will be limited inside the graphics area in these modes.

In Freehand mode, a waveform is constructed by mouse the mouse while press down the left button.

In Line mode, a waveform is constructed by individual straight lines. Every click of the left mouse button will finish the current line and start a new one.

Click on the left mouse button above or bellow the waveform will add spikes at that point.

Click the right mouse button to exit these modes.

Waveform Download

The generated waveform needs to be downloaded to the function generator flash memory.

The waveform can be downloaded into any of the four wave1～wave4 storage areas。Modify the Delay time to suit fast or slow computers. The default delay of 10000 can fit most situations.

The size of the storage area is 8K (or 8192 bytes) for every waveform. The downloaded waveform data must be 8192 bytes. Otherwise, the software will issue errors.

Options

Decide to use which com port from 1 to 4.

4.6 Generate Waveforms from Math Equations

Waveforms can also be generated form oscilloscopes or data loggers. Since they have different storage formats,
data have to be normalized and saved in usr format.

This section talks about waveform generation from math equations. Actually, any programming language can be used to do this. Here we only talks about how to use QBASIC and C languages to generate waveforms. A small user program is needed to perform this work.

BASIC Example Program

Awgfile.bas:

```
'1.awg will hold a sine modulation waveform
 AWGMEMORYLENGTH = 8192
'define variables
DIM AWGWAVEFORM   AS    INTEGER
'open file to save
 OPEN "1.awg" FOR OUTPUT AS #1  'file name
'write file header
```

```
  PRINT #1, AWGMEMORYLENGTH  'character seuqnece
  FOR N = 0 TO 8
     PRINT #1, 0
  NEXT
 'write waveform data
  P = 0
  TEMP$ = " "
 'equation computation, data is 8bits , value 0 ~ 255
   FOR N = 0 TO AWGMEMORYLENGTH - 1
       AWGWAVEFORM = 128 + 127 * .5 * (1 + .9 *
  COS(2*3.1415926#  *  N  /  (AWGMEMORYLENGTH/2))*     SIN(2  *  3.1415926#  *N  /
  (AWGMEMORYLENGTH/32)
 'save data in awg format
  TEMP$ = TEMP$ + STR$(AWGWAVEFORM) + ","
 P = P + 1
 IF P = 32 THEN   '32 characters in every line, separated by a , sign.

    PRINT #1, TEMP$
    P = 0
    TEMP$ = " "
 END IF
 NEXT
 PRINT #1, TEMP$  'fill the remain characters
 'end
 CLOSE #1  'close file
```

C Example Program

awgfile.c

```
 /* 2.awg an oscillating waveform will be generated in this program.  */
# include <stdio.h>
# include <stdlib.h>
# include <conio.h>
# include <math.h>
/* Define data length */
# define AWGMEMORYLENGTH  8192
 /* define variables */
unsigned char awgwaveform;
int p = 0;
 /* subroutine to save data */
void savedatatofile(FILE *fp,unsigned char data);
void main(void)
 {
    long i;
   FILE *fp;
/*  save to file */
  fp = fopen("2.awg","w+"); /* open data file 2.awg */
/*  write data header  */
  fprintf(fp,"%d\n",AWGMEMORYLENGTH); /*data heaher*/
  for(i=0;i<9;i++)    /* fill remaining 9 header sequences */
    fprintf(fp "%d\n",0);

/*    equation computation, 8bits , value 0 ~ 255,  save in awg format*/
```

```
    for(i=0;i<AWGMEMORYLENGTH;i++)
     {
      awgwaveform =
128+127*(sin(2*M_PI*i/(AWGMEMORYLENGTH/16.))*exp(-(float)i/(AWGMEMORYLENGTH/8.)));
      savedatatofile(fp,awgwaveform);
    }

   fclose(fp); /* close data file*/
}
/*subroutine to save data in awg format*/
void savedatatofile(FILE *fp, unsigned char data)
{
  fprintf(fp,"%d,",data);
  p++;
  if(p>=32)  /*  32 bytes in a line, seperated by "," */
    {
     p=0;
     fprintf(fp, "\n");
    }
}
```