

INSTRUCTION MANUAL

BK PRECISION®

4080 Series

Function and Arbitrary/Function Generators

Model 4084AWG, 4086AWG, 4084, 4085, 4086, 4087



Safety Summary

The following safety precautions apply to both operating and maintenance personnel and must be observed during all phases of operation, service, and repair of this instrument. Before applying power, follow the installation instructions and become familiar with the operating instructions for this instrument.

Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. B&K Precision Corporation assumes no liability for a customer's failure to comply with these requirements. This is a Safety Class I instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. This instrument is grounded through the ground conductor of the supplied, three-conductor ac power cable. The power cable must be plugged into an approved three-conductor electrical outlet. Do not alter the ground connection. Without the protective ground connection, all accessible conductive parts (including control knobs) can render an electric shock. The power jack and mating plug of the power cable meet IEC safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Instrument covers must not be removed by operating personnel. Component replacement and internal adjustments must be made by qualified maintenance personnel. Disconnect the power cord before removing the instrument covers and replacing components. Under certain conditions, even with the power cable removed, dangerous voltages may exist. To avoid injuries, always disconnect power and discharge circuits before touching them.

WARNINGS AND CAUTIONS

WARNING and **CAUTION** statements denote a hazard. Follow all instructions contained in these statements.

A **WARNING** statement calls attention to an operating procedure, practice, or condition, which, if not followed correctly, could result in injury or death to personnel.

A **CAUTION** statement calls attention to an operating procedure, practice, or condition, which, if not followed correctly, could result in damage to or destruction of part or all of the product.

WARNING:	<i>Do not alter the ground connection. Without the protective ground connection, all accessible conductive parts (including control knobs) can render an electric shock. The power jack and mating plug of the power cable meet IEC safety standards.</i>
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WARNING:	<i>To avoid electrical shock hazard, disconnect power cord before removing covers. Refer servicing to qualified personnel.</i>
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CAUTION:	<i>Before connecting the line cord to the AC mains, check the rear panel AC line voltage indicator. Applying a line voltage other than the indicated voltage can destroy the AC line fuses. For continued fire protection, replace fuses only with those of the specified voltage and current ratings.</i>
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1. PRODUCT INTRODUCTION

1.1 Description

The B&K Precision 4080 Series are laboratory grade synthesized function generators with a wide frequency range of up to 120 MHz. Direct digital synthesis (DDS) techniques are used to create stable, accurate output signals for clean, low distortion sine waves and an extensive selection of built-in standard and arbitrary waveforms. The instrument supports AM, FM, FSK, PSK and pulse modulation and linear and logarithmic sweep. Modulation parameters can be set precisely and are adjustable over a wide range. The 4080 Series supports internal and external modulation sources as well as internal, external and gated trigger sources.

All models are capable of generating complex, predefined arbitrary waveforms. Additionally, models 4084AWG and 4086AWG provide the flexibility to create custom waveforms. The AWG module includes an intuitive, graphical Windows based software tool for creating and editing custom arbitrary waveforms and transferring the waveforms to the instrument's non-volatile memory. The software also provides a direct interface to Tektronix® TDS1000, TDS2000 TPS2000 and TDS3000 series digital storage oscilloscopes offering users a convenient means to recreate waveforms originating from the DSO's display or internal memory.

The 4080 Series front-panel operation is straightforward. Parameters can be entered using the knob or directly via the numerical keypad and unit keys.

The instruments are fully programmable via the standard RS232 interface. The command set is SCPI (standard Commands for Programmable Instruments) compatible.

The combination of classical function and arbitrary waveform generator makes this series a versatile solution for many applications in Electronic Test and Design, Sensor Simulation, Education and Training.

1.2 Features

- Direct Digital Synthesis (DDS) architecture
- Wide frequency range of 1 μ Hz ~ 120MHz (model 4087, sine wave only)
- Clean and stable output of very small signals down to 1mV (50 Ω)
- 27 build-in standard and complex waveforms.
- Eight downloadable 16000 point memories for custom arbitrary waveforms (models 4084AWG and 4086AWG only)
- Graphical Arbitrary Waveform Generation Software tool for Microsoft® Windows™ (models 4084AWG and 4086AWG only)
- Convenient data input via knob or numerical keypad.
- Bright, easy to read display using VFD (Visible Vacuum Fluorescent) technology
- Fully programmable via SCPI compatible command set
- 100 MHz Universal Counter with frequency measurement and totalize function

2. SPECIFICATIONS

2.1 Function Generator

Waveform Characteristics

Main Waveforms: Sine, square

Waveform Amplitude resolution: 12 bits

Sample Rate: 200MSa/s (4084, 4084AWG, 4085, 4086, 4086AWG)
300MSa/s (4087)

Sine:

Harmonic Distortion of Sine Wave:

- $\leq -50\text{dBc}$ (frequency $\leq 5\text{MHz}$)
- $\leq -45\text{dBc}$ (frequency $\leq 10\text{MHz}$)
- $\leq -40\text{dBc}$ (frequency $\leq 20\text{MHz}$)
- $\leq -35\text{dBc}$ (frequency $\leq 40\text{MHz}$)
- $\leq -30\text{dBc}$ (frequency $> 40\text{MHz}$)

Total Harmonic distortion: 0.1% (20Hz ~ 100kHz)

Square:

Rise and Fall Time of Square Wave: $\leq 15\text{ns}$

Note: Test conditions for harmonic distortion, sine distortion, rise/fall time: Output Amplitude 2Vp-p, Environmental temperature: 25°C ± 5°C

Build in standard and complex (arbitrary) waveforms:

27 build-in standard and complex waveforms.

Sine, Square, Triangle, Positive Ramp, Falling Ramp, Noise, Positive Pulse, Negative Pulse, Positive DC, Negative DC, Stair wave, Coded Pulse, Full wave rectified, Half-wave rectified, Sine transverse cut, Sine vertical cut, Sine phase modulation, Logarithmic, Exponential, Half-round, SINX/X, Square root, Tangent, Cardiac, Earthquake, Combination

Waveform Length: 4096 dots

Amplitude Resolution: 10 bits

Pulse Wave:

Duty Cycle: 0.1% ~ 99.9% (below 10kHz), 1% ~ 99% (10kHz ~ 100kHz)

Rise/Fall Time: $\leq 100\text{ns}$ (Duty cycle 20%)

DC signal characteristics:

DC range: $\leq 10\text{mV} - 10\text{V}$ (high impedance)

DC Accuracy: $\leq \pm 5\%$ of setting +10mV (high impedance)

Module for user defined arbitrary waveform generation (models 4084AWG and 4086AWG only)

Number of memory locations for arbitrary waveforms: 8

Length of waveforms: 8~16000 points

Resolution of waveform amplitude: 10 bits

Frequency range: 100μHz~100kHz

Frequency Characteristics

Frequency Range:

Main waveforms (sine, square):

Model 4084/4084AWG:	1μHz ~ 20MHz
Model 4085:	1μHz ~ 40MHz
Model 4086/4086AWG	1μHz ~ 80MHz (sine wave) 1μHz ~ 40MHz (square wave)
Model 4087	1μHz ~ 120MHz (sine wave) 1μHz ~ 40MHz (square wave)

All other waveforms:

All models:	1μHz ~ 100kHz
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Frequency Stability: $\pm 1 \times 10^{-6}$ (22°C ± 5°C)

Resolution: 1μHz

Frequency Accuracy: $\leq \pm 5 \times 10^{-6}$ (22°C ± 5°C)

Data entry Units: s, ms, Hz, kHz, MHz

Amplitude Characteristics

Amplitude Range:

4084, 4084AWG: 2mV ~ 20Vpp (open circuit), 1mV ~ 10Vpp (50Ω)
4085

4086, 4086AWG: for Freq ≤ 40MHz: 2mV ~ 20Vpp (open circuit), 1mV ~ 10Vpp (50Ω)
for Freq > 40MHz: 2mV ~ 4Vp-p (open circuit), 1mV ~ 2Vpp (50Ω)

4087: for Freq ≤ 40MHz: 2mV ~ 20Vpp (open circuit), 1mV ~ 10Vpp (50Ω)
for Freq > 40MHz: -76dBm ~ +13.5 dBm (50Ω) or 0.1mV ~ 3Vpp (50Ω)

Max. Resolution: 2μVpp (open circuit), 1μVpp (50Ω)

Amplitude Accuracy: $\pm 1\% + 0.2\text{mV}$ (sine wave relative to 1kHz)

Amplitude Stability: $\pm 0.5\%$ / 3 hours

Flatness:

For amplitude ≤ 2Vpp: $\pm 3\%$ (frequency ≤ 5MHz), $\pm 10\%$ (5MHz < frequency ≤ 40MHz)
For amplitude > 2Vpp: $\pm 5\%$ (frequency ≤ 5MHz), $\pm 10\%$ (5MHz < frequency ≤ 20MHz)
 $\pm 20\%$ (frequency > 20MHz)

Models 4086/AWG, 4087 only: $\pm 1\text{dBm}$ (frequency > 40MHz)

Output Impedance: 50Ω

Output Units: Vpp, mVpp, Vrms, mVrms, dBm

DC Offset Characteristics

Offset Range (open circuit)

Freq \leq 40MHz): $\pm 10\text{V}_{\text{pk}}$ ac + dc (Offset $\leq 2 \times$ peak-to peak amplitude)Freq $>$ 40MHz): $\pm 2\text{V}_{\text{pk}}$ ac + dc (Offset $\leq 2 \times$ peak-to peak amplitude)Resolution: $2\mu\text{V}$ (open circuit), $1\mu\text{V}$ (50Ω)Offset Error: $\pm 5\%$ of setting +10mV (Ampl. $\leq 2\text{V}_{\text{pp}}$ into open circuit) $\pm 5\%$ of setting +20mV (Ampl. $> 2\text{V}_{\text{pp}}$ into open circuit)**AM Characteristics**

Carrier Waveforms: sine or square

Carrier Frequency Range: same as main waveforms

Modulation Source: internal or external

Modulating Waveform: 5 internal waveforms (sine, square, triangle, rising/falling ramp)

Frequency of modulating signal: $100\mu\text{Hz} \sim 20\text{kHz}$ Distortion: $\leq 2\%$ Modulation Depth: $1\% \sim 120\%$ $1\% \sim 80\%$ (frequency $> 40\text{MHz}$, Ampl $> 2\text{V}_{\text{pp}}$ into open circuit)Modulation Error: $\pm 5\% + 0.2\%$ ($100\mu\text{Hz} < \text{frequency} \leq 10\text{kHz}$) $\pm 10\% + 2\%$ ($10\text{kHz} < \text{frequency} \leq 20\text{kHz}$)Amplitude of ext. input signal: $3\text{V}_{\text{p-p}}$ ($-1.5\text{V} \sim +1.5\text{V}$)**FM Characteristics**

Carrier Waveforms: sine or square

Carrier Frequency Range: same as main waveforms

Modulation Source: internal or external

Modulating Waveform: 5 internal waveforms (sine, square, triangle, rising/falling ramp)

Frequency of modulating signal: $100\mu\text{Hz} \sim 10\text{kHz}$

Peak Frequency Deviation: Max. 50% of carrier frequency for internal FM

Max 100kHz (carrier frequency $\geq 5\text{MHz}$) for external FM,
with input signal voltage $3\text{V}_{\text{p-p}}$ ($-1.5\text{V} \sim +1.5\text{V}$)**FSK Characteristics**

Carrier Waveform: sine or square

Carrier Frequency Range: same as main waveforms

Control Mode: internal or external trigger (external: TTL level, low level F1,
high level F2)FSK Rate: $0.1\text{ms} \sim 800\text{s}$ **PSK Characteristics**

Waveform: sine or square

Frequency Range: same as main waveforms

PSK: Phase 1 (P1) and Phase 2 (P2), range: $0.0 \sim 360.0^\circ$ Resolution: 0.1° PSK rate: $0.1\text{ms} \sim 800\text{s}$

Control Mode: internal or external trigger (external: TTL level, low level P1, high level P2)

Burst Characteristics

Waveform: sine or square
 Frequency Range: same as main waveforms
 Burst Counts : 1 ~ 10000 cycles
 Time interval between bursts: 0.1ms ~ 800s
 Control Mode: internal, single or external gated trigger

Frequency Sweep Characteristics

Waveform: sine or square
 Start/Stop Freq.: same as main waveforms
 Sweep Time: 1ms ~ 800s (linear), 100ms ~ 800s (log)
 Sweep Mode: Linear or Logarithmic
 External trigger signal frequency: DC ~ 1kHz (linear) DC~10Hz (log)
 Control Mode: internal or external trigger

Rear Panel Terminals (for modulation and sweep)

Output MOD OUT

Frequency: 100 μ Hz ~ 20kHz
 Waveform: sine, square, triangle, rising/falling ramp
 Amplitude: 5Vp-p \pm 5%
 Output Impedance: 600 Ω

Modulation IN

3 Vpp = 100% Modulation

External Input Trig/FSK/Burst

Level: TTL

Main OUTput

Impedance: 50 Ω
 Protection: Short circuit and overload protected

State Storage Characteristics

Storage Parameters: frequency, amplitude, waveform, DC offset values, modulation parameters
 Storage Capacity: 10 user configurable stored states
 Storage Time: more than 10 years

2.2 Universal Counter

Frequency Range

Frequency Measurement: 1Hz ~ 100MHz
 Totalize mode: 50MHz max

Input Characteristics

Sensitivity

Input attenuator disabled:	50mVrms (f: 10Hz ~ 50MHz), 100mVrms (f: 1Hz ~ 100MHz)
Input attenuator enabled:	0.5Vrms (f: 10Hz ~ 50MHz), 1Vrms (f: 1Hz ~ 100MHz)

Max. Input Voltage Allowed: 100Vp-p (f≤100kHz), 20Vp-p (1Hz~100MHz)

Input Impedance: R>500kΩ, C<30pF

Coupling: AC

Waveform: sine or square

Low Pass Filter: cut off frequency about 100kHz (with internal attenuation: ≤ -3dB)
with external attenuation: ≥ -30 dB (f > 1MHz)

Gate Time Setting: 10ms ~ 10s continuously adjustable

Display Bits: 8 (for gate Time>5s)

Totalize Capacity: ≤ 4.29×10⁹

Control Mode: manual or external gate control

Accuracy: time base error ± trigger error (when signal SNR > 40dB,
trigger error ≤ 0.3)

Time base:

Type: small TCXO

Frequency: 10MHz

Stability: ±1 × 10⁻⁶ (22°C±5°C)

2.3 General

Power Supply 198~242V or 99~121V, Frequency: 47~ 63Hz

Power Consumption: <35VA

Operating Temperature 0° to +40 °C

Operating Humidity 80% R.H

Storage Temperature -40°C to 70°C

Dimensions (W x H x D): 255 mm x 100 mm x 370 mm (10.0 x 3.93 x 14.56 inch)

Weight: 3 kg (6.6 lbs): models 4084, 4084AWG, 4085, 4086, 4086AWG
3.5 kg (7.7 lbs) model 4087

Remote Interface RS232

Accessories included

BNC to alligator cable

BNC to BNC cable

RS232 communication cable

Power line cord

Test report

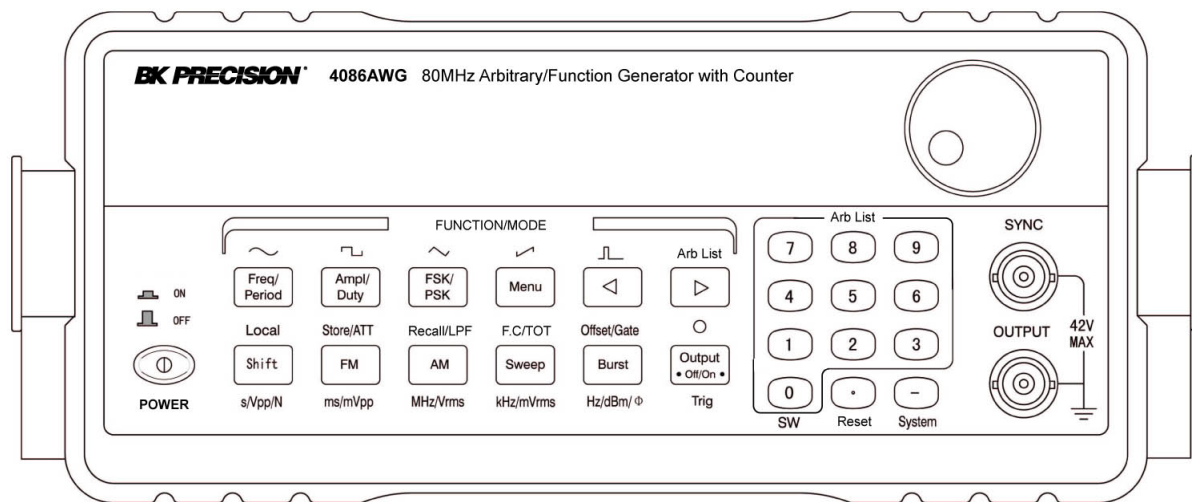
Spare fuse

Installation disk for Arbitrary Waveform Creation Software (models 4084AWG or 4086AWG only)

NOTE: Specifications and information are subject to change without notice. Please visit www.bkprecision.com for the most current product information.

3. PANEL DESCRIPTION

3.1 Front Panel



3.1.1 Overview of Keys:

Summary: Most keys have multiple functions. Primary functions are written on the key. Simply press the respective key to enable a primary functions. All Function/Mode keys and some of the numerical entry keys have associated secondary functions indicated above each key in blue. To activate a secondary function, press the **【shift】** key followed by the desired key. The bottom row of the Function/Mode keys can be used to enter units directly. The unit is indicated below each key. To enter a unit, enter a numerical value via the numerical keypad then press the corresponding unit key. The unit key also serves as Enter function.

Data entry keys:

Key Name	Main Function	Secondary Function	Key Name	Main function	Secondary Function
0	Input Digit 0	Enter SW mode	7	Input Digit 7	Enable ARB7 waveform ***.
1	Input Digit 1	Enable ARB1 waveform ***	8	Input Digit 8	Enable ARB8 waveform ***
2	Input Digit 2	Enable ARB2 waveform ***	9	Input Digit 9	Not available
3	Input Digit 3	Enable ARB3 wave ***	.	Input decimal point	Reset Unit
4	Input Digit 4	Enable ARB4 waveform***	-	Input negative symbol	Enter system menu
5	Input Digit 5	Enable ARB5 waveform ***	◀	Move arrow key to left *	Select pulse
6	Input Digit 6	Enable ARB6 waveform***	▶	Move arrow key to right **	Select Arblist waveform

- *: Direct number entry: Press this key to clear the least significant bit of the displayed number. Useful for correcting number entry before entry is confirmed with unit key.
 External totalize mode: Press this key to stop counting and display present counting value. Press again to resume counting.

**: External totalize mode: Press this key to reset and resume event counter

*** models 4084AWG and 4086AWG only

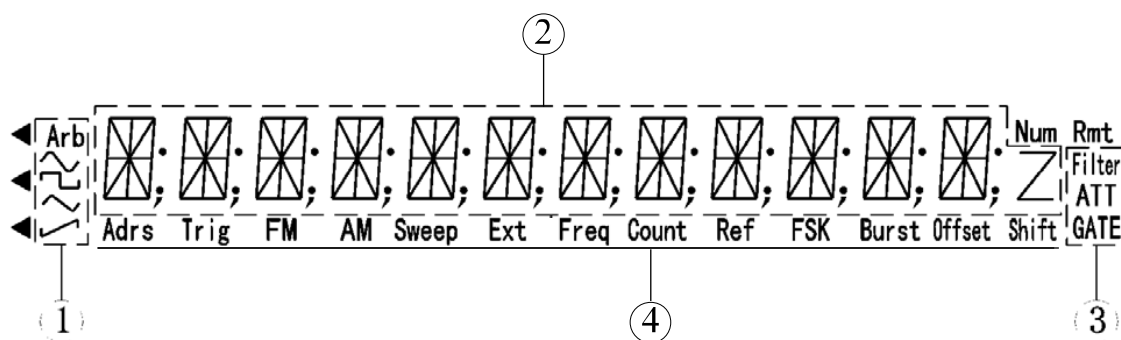
Function/Mode Keys:

Key name	Main Function	Secondary Function	Secondary Function for Counter Mode	Unit Entry
Freq./Period	Toggle between Frequency & Period.	Enable Sine Wave	Not Available	Not Available
Ampl./Pulse width	Amplitude Select.	Enable Square Wave.	Not Available	Not Available
FSK/PSK	FSK/PSK Function Select	Enable Triangle Wave	Not Available	Not Available
Menu	Menu Selection	Enable positive ramp	Not Available	Not Available
FM	Enable FM mode	Enter Storage menu	Attenuation Selection	ms, mVpp
AM	Enable AM mode	Enter Recall menu	Low Pass Select	MHz, Vrms
Sweep	Enable Sweep mode	Enter Counter Mode	Freq. Meas./ Totalize Enable	kHz, mVrms
Burst	Enable Burst mode	DC Offset Select	Gate Select	Hz, dBm

Other Keys:

Key Name	Main Function	Other Function
Output	Main OUTPUT signal On/Off	Generate single trigger in sweep and burst mode
Shift	Select secondary function	Enter units in s, Vpp, N





3.1.2 Display Annunciators:



Display areas:

- ① Waveform Indication
- ② Main Alphanumeric Display
- ③ Frequency Measurement/Totalize Settings
- ④ Instrument states

Waveform states

-  Sine waveform is enabled (,main waveform)
-  Square waveform is enabled (main waveform)
-  Triangle waveform is enabled
-  Ramp waveform is enabled
- Arb Arbitrary waveform mode is enabled

Frequency Measurement/Totalize states

- Filter: Low Pass Filter is enabled
- ATT: Input Attenuator is enabled
- GATE: Gate received trigger

Function Generator states

- Adrs: The instrument is in remote state.
- Trig: Function Generator is waiting for a single trigger or external trigger.
- FM: FM modulation is enabled
- AM: AM modulation is enabled
- Sweep: Sweep mode is enabled
- Ext: Generator is configured for external signal input
- Freq: Frequency measurement function is enabled
- Count: Totalize function is enabled
- FSK: FSK (frequency shift keying) modulation is enabled
- ◀FSK: PSK modulation is enabled
- Burst: Burst mode enabled.
- Offset: DC offset of output signal is not 0.
- Shift: Shift key has been pressed, Shift mode is active
- Rmt: The instrument is in remote state.

3.13 Description of front panel keys**【shift】 key**

Access secondary functions or to enter units “seconds”, Vpp and “N”

Numerical key pad:

Keys are used for direct entry of numerical values. Keys **【0】【•】【-】** are assigned secondary functions to enter the systems menu, reset the unit to its default values or revert to Standard Waveform (“SW”) mode.

【◀】【▶】 arrow keys

The primary function is to move the flashing digit left or right or to select the desired arbitrary waveform from the Arb List (secondary function). When in Counter Mode, these 2 keys are used to start/stop or reset/resume the counter.

【Freq/Period】 key:

Toggle between frequency and period display (primary function) or to enable sine waveform.

【Ampl/Pulse Width】 key:

Display and adjust the amplitude of waveforms or, when in pulse mode, toggle the display

between amplitude and pulse width. The secondary function activates the square waveform

【FSK/PSK】 key:

Toggle between FSK and PSK modulation (primary function). Activate triangle waveform

【Menu】 key:

Enter modulation parameters for FSK, PSK, FM, AM and burst modulation and for sweep mode. When in standard waveform mode (no modulation, main waveforms enabled), this key can also be used to toggle the units for the amplitude display value between Vpp, Vrms and dBm. (Press the Amplitude key first, then the Menu key to toggle between the units). The secondary function enables the ramp waveform.

【FM】 key:

Activate FM modulation (primary function). Enter Storage mode (secondary function). Enter units ms or mVpp after entering the desired value by numerical key pad. In Counter Mode, this key turns the input attenuator on or off.

【AM】 key:

Activate AM modulation (primary function). The secondary function is used to recall and recreate signals stored in status memory. Enter units “MHz and “Vrms” after entering the desired value by numerical key pad. Enable the low pass filter when in Counter mode.

【Sweep】 key:

Activate sweep mode. Select frequency measuring and totalize mode (secondary function) . Enter units kHz or mVrms after entering the desired numerical value directly via the keypad. Use the Shift key to toggle between frequency measurements and totalize mode.

【Burst】 key:

Activate burst mode (primary function). Enter DC offset mode (secondary function). Enter units Hz or dBm. When in frequency measurement mode, press this key to enter the gate time.

【Output】 key

Press this key to toggle the main OUTPUT signal between the ON and OFF state. By default the output is turned on, indicated by the green LED and the currently active wave form is available at the OUTPUT terminal. In Burst or Sweep mode, this key is also used to generate a single trigger.

3.14 Description of menu parameters

Use this key to configure modulation parameters, sweep mode parameters and system parameters. Modulation and Sweep mode: After enabling modulation or sweep mode, press “menu” to configure the related parameters. Each time you press the menu key, the parameter will flash for 1 second, followed by the currently active value of that parameter. Use the knob or numerical keys to enter a new value. Once the parameter is set, press **【menu】** to advance to the next parameter. Continue pressing the menu key to cycle through all parameters. Press **【Shift】【SW】** to return to the main waveform mode and to set the carrier waveform parameters.

Sweep Mode:

MODE —> START F —> STOP F —> TIME —>TRIG

MODE: Select LINEAR or LOGarithmic sweep
 START F: Sweep start frequency
 STOP F: Sweep stop frequency
 TIME: Sweep time
 TRIG: Select trigger source, INTERNAL or EXTERNAL

FM modulation:

FM DEVIA → FM FREQ → FM WAVE → FM SOURCE

FM DEVIA: Peak frequency deviation
 FM FREQ: Modulating signal frequency
 FM WAVE: Modulating signal waveform (sine, square, triangle rising or falling ramp)
 FM SOURCE: Toggle between internal and external modulating signal.

AM modulation:

AM LEVEL → AM FREQ → AM WAVE → AM SOURCE

AM LEVEL: Modulation depth
 AM FREQ: Frequency of modulating signal
 AM WAVE: Modulating signal waveform (sine, square, triangle rising or falling ramp)
 AM SOURCE: Select internal or external modulating signal

Burst modulation:

TRIG → COUNT → SPACE T → PHASE

TRIG: Select trigger source, internal or external
 COUNT: Number of burst cycles
 SPACE T: Burst time spacing
 PHASE: starting phase of the burst

FSK modulation:

START F → STOP F → SPACE T → TRIG

START F: Primary frequency (same as carrier wave)
 STOP F: the second frequency (hop frequency)
 SPACE T: FSK rate
 TRIG: Select trigger source, external or internal

PSK modulation

P1 → P2 → SPACE T → TRIG

P1: phase value #1
 P2: phase value #2

SPACE T: PSK rate
TRIG: trigger mode, internal or external

System Function Mode:

POWER ON —> ADDRESS —> OUT Z —> INTERFACE—>.....

.....BAUD —> PARITY —> BEEP

POWER ON “Power on” state

ADDRESS: set GPIB address (option)

OUT Z: Configure amplitude display value for 50 Ω or high impedance load termination

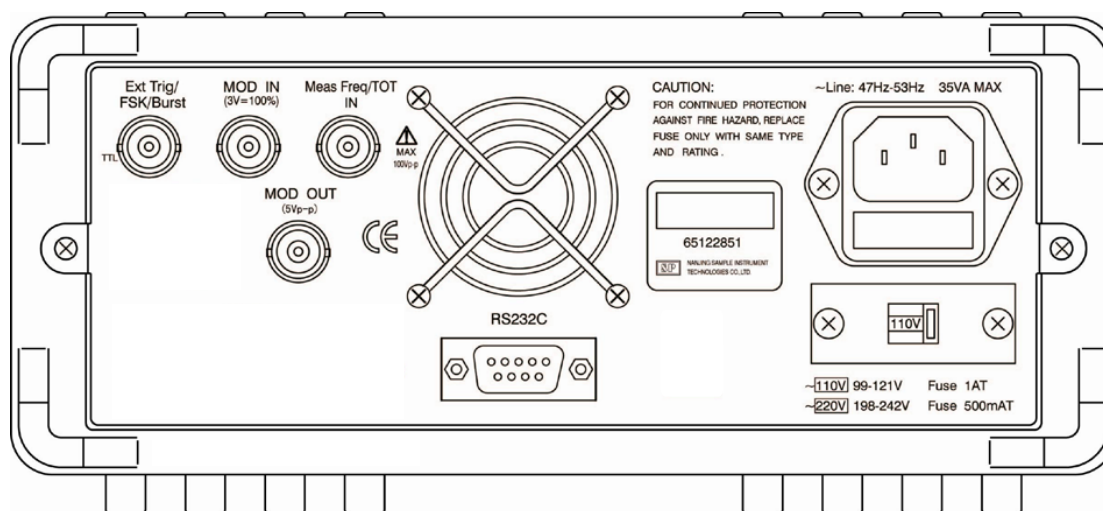
INTERFACE: Select RS232 or GP-IB (IEEE-488) interface (option)

BAUD: Baud rate for the RS232 interface

PARITY: Parity and Data Bits configuration for RS232

BEEP: Toggle the key beep on/off

3.2 REAR PANEL



Ext. Trig/FSK/Burst:

Input Terminal for external trigger signals for FSK/PSK Burst modulation and sweep mode

MOD In

Apply modulating signal for AM and FM to this Input terminal

Meas Freq/TOT In

Input terminal for Universal Counter which operates in frequency measurement or Totalize mode

MOD OUT

The internally generated modulating signal when in AM mode will be available at this output

RS232C

RS232 interface for remote control of instrument (all models) or for download of custom arbitrary waveforms (models 4084AWG and 4086AWG only)

AC Socket and fuse compartment

Connect the supplied power line cord to this receptacle. Make sure to install the appropriate fuse according to the selected AC voltage.

AC Input Selector switch

Set this switch to the corresponding AC voltage in your area

4. OPERATING INSTRUCTIONS

4.1 Installation

This section contains installation information, power requirements and initial inspection and signal connections for the 4080 series generators.

Mechanical Inspection

This instrument was carefully inspected before shipment. Upon receipt, inspect the instrument for damage that might have occurred in transit. If any sign of damage is found, notify your B+K Precision distributor.

Instrument Mounting

The 4080 Series is intended for bench use. The instrument includes a handle adjustable for optimum panel viewing angle. The instrument does not require special cooling when operated within conventional temperature limits.

Power Requirements

The 4080 Series can be operated from any source of 99V to 242V AC and frequency of 48Hz to 63Hz. The maximum power consumption is 35 VA. Replace fuses with the same type, according to the rating indicated on the rear panel of the instrument.

The instrument power fuse is located in a fuse compartment below the AC input receptacle. To access the fuse, first disconnect the power cord and then remove the fuse cartridge.

Power-on procedure

Turn on the instrument by pressing the power key on the front panel of the unit. The display should be flashing “BK PRECISION” for 2 seconds followed by the model number. e.g. “4084AWG” for 1 second. By default, the instrument will enter the standard waveform (“SW”) mode with the frequency set to 10.00000000 kHz and the waveform annunciator displaying the “~” symbol. If the Power ON configuration in the systems menu was modified, the parameters of the last operation before power-down will be displayed.

4.2. Main operating modes

“SW” standard waveform mode

In this mode, the generator outputs any of the 27 build-in waveforms, including the 2 “main waveforms” sine and square. This also includes the 8 user programmable arbitrary waveforms (models 4084AWG and 4086AWG only). For most waveforms, you can set frequency, amplitude and DC offset. In this mode, modulation and sweep is not active and all annunciators in status area 4 are turned off. When modulation or sweep is enabled, press **【shift】【SW】** to return to this mode.

Modulation, Pulse and Sweep Mode

In this mode, the generator operates like a conventional function generator and the Arb annunciator is turned off. The user can select one of the modulation modes AM, FM, FSK, PSK, Burst or sweep mode. The 2 main waveforms sine and square can be used as carrier signal.

There is a close, reciprocal relationship between the modulation/sweep mode and the standard

waveform mode used to set the sine or square wave parameters. When one of the modulation modes is active, the parameters of the carrier wave are carried over from the Standard Waveform Settings (for sine or square). Press **【shift】【SW】** to toggle between any of the modulation/sweep modes (to set the modulation parameters) and the standard waveform mode (to define the carrier settings for frequency, amplitude and DC offset). On the other hand, the carrier frequency can also be set in the modulation/sweep menus and if changed, will overwrite the standard waveform frequency setting.

Example: When transitioning from standard waveform mode to FM modulation mode, (by pressing the FM button) the parameters set previously in “SW” mode carry over to the FM mode and are now defining the FM carrier. If the FM carrier frequency in the FM modulation menu is changed, it will also “overwrite” the frequency setting of the standard waveform” settings.

To adjust the duty cycle, enable pulse mode by pressing **【shift】【◀】**. Note that the duty cycle can only be adjusted in pulse mode.

4.3 Waveform Selection:

Enabling common waveforms

Press **【shift】** followed by the waveform key to select one of the 5 common waveforms sine, square, triangle, ramp and pulse. The corresponding waveform annunciator will be displayed in the waveform display area. Note that the instrument operates in Function Generator mode when selecting sine and square and in ARB mode for the remaining functions. (Arb annunciator is lit).

Note: The 5 common waveforms can also be output by selecting the corresponding number from the ArbList in this section.

Example: Press **【Shift】【FSK/PSK】** to enable the triangle waveform

Enabling stored waveforms from the Arb List

Make sure you are in “SW” mode. (All area 4 status annunciators are off). If modulation or sweep is active, press **【shift】【SW】** to return to the standard waveform mode.

Press **【shift】【▶】** to enter the ArbList: Waveform,”6: NOISE” is enabled and appears on the display. Use the knob or the numeric keypad to select one of the 27 stored waveforms from the ArbList according to the table in this section.

Example: To select negative ramp DOWN_RAMP, do the following:

Press **【shift】【▶】** (enter ArbList)

Press **【5】【N】** (enable DOWN_RAMP)

or

select waveform with the knob

Models 4084AWG and 4086AWG only: Locations 28-35 are reserved for the storage of user defined arbitrary waveforms. The display name for these waveforms is ARB1-ARB8. These memory locations can be accessed in one of 2 ways:

- a) Enter the ArbList, then use the knob or the numeric keypad to enable waveforms ARB1 – ARB8
- b) Press **【Shift】** followed by any number between 1-8.

Example: Press **【Shift】【2】** to enable waveform stored in memory location ARB2

Table of stored waveforms (ArbList) and their memory locations

No.	Waveform	Display Name	No.	Waveform	Display Name
1	Sine wave	SINE	15	Half-wave rectified	COMMUT_HA
2	Square wave	SQUARE	16	Sine transverse cut	SINE_TRA
3	Triangle wave	TRIANG	17	Sine vertical cut	SINE_VER
4	Ramp	UP_RAMP	18	Sine phase modulation	SINE_PM
5	Falling ramp	DOWN_RAMP	19	Logarithmic function	LOG
6	Noise	NOISE	20	Exponential function	EXP
7	Pulse wave	PULSE	21	Half-round function	ROUND_HAL
8	Positive pulse	P_PULSE	22	SINX/X function	SINX/X
9	Negative pulse	N_PULSE	23	Square root function	SQU_ROOT
10	Positive DC	P_DC	24	Tangent function	TANGENT
11	Negative DC	N_DC	25	Cardiac wave	CARDIO
12	Stair wave	STAIR	26	Earthquake wave	QUAKE
13	Coded pulse	C_PULSE	27	Combination wave	COMBIN
14	Full wave rectified	COMMUT_FU	28~35*	User programmable Arbitrary waveforms	ARB1~ARB8

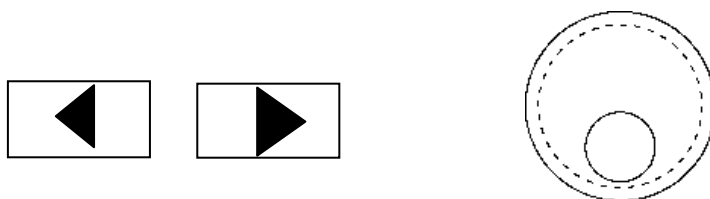
Note:

*No 28~35: memory location for user programmable waveforms, models 4084AWG and 4086AWG only. Refer to chapter 7 for more details

4.4 Data entry

Using the arrow keys and the knob

Use the knob and arrow keys to modify the displayed number.



Use the 【◀】【▶】 keys to move the flashing digits left or right then adjust the value with the knob. Using this method of entry, the output signal will be updated immediately. Move the arrow keys left for coarse adjustment and right for fine adjustment.

To disable the knob, use the 【◀】【▶】 key to move the cursor all the way to the left or right until the digits stop flashing. Now data entry via the knob is disabled.

Direct entry using the numerical key pad

Use the numerical keypad to enter a number with the appropriate unit.

Enter numbers from left to right. Use the 【.】 key to enter a decimal point. Enter 【-】 for negative numbers. Repeatedly pressing this key will toggle between positive (no sign visible) and negative numbers. Numerical entries do not update the output signal until a unit key has been pressed. Once you entered the correct numerical value, press the appropriate unit key to assign a unit and to make the entry effective. The instrument will now output a signal according to the displayed data. For entries not associated with a unit, press the shift key (“N” = “no unit”) to make the entry effective.

Note: Numerical values entered via the keypad are not effective until a valid unit key or shift (“N”) has been pressed.

Entry of invalid key presses or invalid values

If the entered value exceeds the rated range, a beep sound will be heard. If the entered value is below the lower limit, the instrument will automatically change the entry to the lowest possible value. If the entered value exceeds the upper limit, the instrument will automatically revert to the maximum value.

Example: When trying to entering 90MHz in a model 4086 (80 MHz max), a beep will be heard and the value will be forced to 80 MHz.

Invalid keys: A beep sound will inform the user that the key entry is invalid. The instrument will simply ignore the key pressed.

Example: Key **[-]** is pressed when trying to enter a frequency value. The instrument will ignore the entry and respond with a “beep” sound.

4.5 Output Configuration

4.5.1 Set Frequency and Period

The **[frequency/period]** key is used to toggle between Frequency and Period display of the standard waveform or the carrier waveform.

Frequency

Press the **[frequency]** key to display the current frequency value. The value can be modified using the numerical keypad or the knob.

Example: To set a frequency value of 5.8 kHz, enter the following key sequence:

[frequency] [5] [.] [8] [kHz]

or

[frequency] [5] [8] [0] [0] [Hz]

or

use the knob and **[◀] [▶]** keys

The display will be 5.80000000 kHz.

Period Setting:

The signal frequency can also be displayed or entered as a period value. If the current display is frequency, press the **[frequency/period]** key to display the current period value. Values can be entered with the numerical key pad or using the knob.

Example: To set a period value of 10ms, enter the following sequence of keys:

[Period] [1] [0] [ms]

Or

use the knob and **[◀] [▶]** keys

4.5.2 Set Amplitude

Press the **[Amplitude]** key to display the current amplitude value. Modify the value using the knob or the numerical keypad.

Example: Set amplitude to 4.6V peak-to-peak:

Press **[Amplitude] [4] [.] [6] [Vpp]**

or

modify values using the knob and arrow keys

In case of standard waveforms “sine”, “square”, “triangle”, “rising ramp” and “pulse”, numbers can be entered and displayed as Peak-to-peak value (Vpp or mVpp) , root mean square value (Vrms and mVrms) or dBm value.

All other waveforms can only be edited or displayed using Vpp or mVpp units only.

4.5.3 Set DC Offset Voltage

Press **【shift】【offset】** to display the current DC offset value. If the current DC offset value is not equal to zero, the annunciator “Offset” will turn on. The DC offset value can be entered directly or using the knob.

Example: Set an offset value -1.6V peak-to-peak

Press **【shift】【offset】【-】【1】【.】【6】【Vpp】**

or

【shift】【offset】【1】【.】【6】【-】【Vpp】

or

use the knob for value entry

Zero Point Adjustment:

For zero point adjustment of the output signal, using the knob is more convenient than direct entry via the numerical keypad. The transition of the DC offset Voltage from plus to minus sign will be automatic when passing through the zero point. The input range of the signal amplitude and DC offset should satisfy the following equation: $|V_{offset}| + V_{pp}/2 \leq V_{max}$, with the parameters defined as followed:

Vpp is the peak-to-peak value of the amplitude

|Voffset| is the absolute value of the DC offset

Vmax is 10V at high impedance and 5V at 50 Ω load.

The following table shows the corresponding relationship between the Vp-p value of the amplitude and the absolute DC offset value at high impedance:

Vp-p value of AC signal	Absolute value of DC offset
1.001 V ~ 20.00 V	0 ~ (10.000-Vpp/2) V
316.1 mV ~ 1.000 V	0 ~ 2.000 V
100.1 mV ~ 316.0 mV	0 ~ 632.9 mV
31.01 mV ~ 100.0 mV	0 ~ 200.9 mV
2.000 mV ~ 31.00 mV	0 ~ 62.99 mV

4.5.4 Adjustment of duty cycle

If the current waveform is pulse, and the current display value is amplitude, use the **【Ampl/Duty】** button to toggle between Amplitude and Duty cycle display. When the pulse width is displayed, enter a value via the numeric keypad or the knob. The valid range is 0.1% ~ 99.9% for frequencies below 10kHz with a maximum resolution of 0.1%. For frequencies between 10kHz~100kHz the range is 1% ~ 99% and the maximum resolution is 1%.

Example: Enter a duty cycle value of 60.5%

Press **【Pulse】【6】【0】【.】【5】【N】**

or

use the knob and arrow keys

4.5.5 TTL Signal

A TTL signal output is provided on the front-panel TTL terminal. All signals, including modulated signals and arbitrary waveforms (except DC and noise) have an associated TTL signal.

This signal is a TTL “high” when the waveform’s output (on the main terminal) is positive, relative to zero volts. The signal is a TTL “low” when the output is negative. The TTL signal is generated by passing the main output signal through a comparator configured as a Schmitt Trigger. The TTL signal will transition to high or low once the main output signal exceeds a certain threshold value, which causes a time delay between the main output signal and the TTL signal.

4.5.6 Signal Store and Recall

Up to 10 different instrument states can be stored in non-volatile memory. This enables you to recall the entire instrument configuration with a single command from the remote interface or with just a few key presses from the front panel.

The state storage feature “remembers” the function (including arbitrary waveforms), frequency, amplitude, DC offset, duty cycle, as well as any modulation parameters. To recall a stored state, you must use the same memory location used previously to store the state.

The last state of the instrument before power-off is automatically stored in location #0, therefore a total of 11 groups locations ranging from 0 ~ 10 can be recalled.

Example:

Store the current output signal in group location #1:

【Shift】【Store】【1】【N】

The following prompt will be displayed for a few seconds: “STORE 1”

Previously stored signal configurations will be overwritten.

To recall group location #1 and make it the active output signal:

Press **【Shift】【recall】【1】【N】**

The following prompt will be displayed for a few seconds: “RECALL: 1”

The stored signals can be continuously recalled and reproduced by scrolling through each location using the knob.

4.6 Set Modulation and Sweep Parameters

4.6.1. Sweep mode

In the frequency sweep mode, the function generator “steps” from the start frequency to the stop frequency at a sweep rate which you specify. You can sweep up or down in frequency, and with either linear or logarithmic spacing. You can also configure the function generator to output a single sweep (one pass from start frequency to stop frequency) by applying an external trigger. The function generator can produce a frequency sweep for sine or square waveforms.

Press **【Sweep】** to enable the frequency sweep mode. The display shows a preset frequency (start frequency) and the “Sweep” symbol appears in the state display area. The carrier frequency will be displayed and the frequency, amplitude, waveform and DC offset of the carrier signal can be set as described in previous sections of this chapter. The main functions sine or square wave can be selected as a carrier signal.

Press the **【menu】** key repeatedly to cycle through the sweep menu parameters listed below.

MODE —> START F —> STOP F —> TIME —>TRIG

MODE Select LINEAR or LOGarithmic sweep mode

START F sweep start frequency

STOP F: sweep stop frequency

TIME: sweep time

TRIG: Select trigger source INTernal or EXTernal

Each time you press the menu key, the parameter will flash for 1 second, followed by the value of that parameter. Sweep mode parameters can be entered via numerical keypad or the knob. Once the parameter is set, press **【menu】** to advance to the next parameter.

Sweep mode

MODE parameter: Select LINear (No.1) or LOGarithmic (No.2). In linear sweep mode, the output frequency changes in a linear fashion during a sweep, whereas in LOG mode the frequency changes exponentially. The spacing is calculated automatically based on start frequencies, stop frequencies and sweep time.

Start frequency “START F”:

The frequency where the sweep starts is the start frequency.

After displaying “START F” for 1 second, the current start frequency is displayed automatically and can be modified via knob or direct data entry. By default, the start frequency will carry over from the setting for the main wave form

Stop frequency “STOP F”

The sweep stops at the frequency “STOP F”

When the start frequency is lower than the stop frequency, the frequency sweep increases gradually from start frequency (low frequency) to stop frequency (high frequency); When the start frequency is higher than stop frequency, the frequency sweep decreases gradually from the start frequency (high frequency) to stop frequency (low frequency).

The frequency range from start frequency to stop frequency is $1\mu\text{Hz} \sim F_{\text{max}}$ in linear sweep mode and $1\text{mHz} \sim F_{\text{max}}$ in log sweep mode. (F_{max} see specification section for main waveform)

Sweep time “TIME”

The time needed to complete one sweep from start to stop frequency is called sweep time.

The sweep time range is $1\text{ms} \sim 800\text{s}$ in linear sweep mode or $100\text{ms} \sim 800\text{s}$ in LOG sweep mode.

Trigger mode “TRIG”:

A sweep can be triggered internally or externally. The corresponding display values are “1: INT” and “2: EXT”. The default value is INTERNAL trigger. In internal trigger mode, the instrument will continuously sweeps from the start frequency to the stop frequency according to the Sweep parameters. An external trigger signal can be generated in one of two ways.

- a) Press the **【output】** key to trigger a single sweep. The signal frequency will increase/decrease from start frequency to stop frequency, then sweep will stop.
- b) Apply an input trigger signal to the “EXT Trig” terminal on the rear panel. A rising edge will trigger a single sweep. In external trigger mode, symbols “Trig” and “Ext” are displayed in the status field.

Start and stop of sweep

The sweep will start automatically once sweep mode is selected. If you don’t want to output the sweep signal, simply press the **【output】** key to disable the signal output (LED above Output button is OFF). Once all the parameters are set, you can make the sweep signal available at the output by pressing the Output button again. In external trigger mode, the **【Output】** key functions only as a single pulse trigger key, the Output On/Off functionality is now disabled and the output LED will always be lit.

Sweep configuration example

Sweep parameters are as followed: Frequency range $100\text{Hz} \sim 200\text{kHz}$, sweep time 10s , linear sweep, internal trigger mode.

Set the carrier frequency parameters

Press **【sweep】**

Press **【menu】**

Select “MODE”, wait, then enter **【1】【N】** (linear sweep)

Press **【menu】** to select “START F”, press **【1】【0】【0】【Hz】**

Press **【menu】** to select “STOP F”, press **【2】【0】【0】【kHz】**

Press **【menu】** to select “TIME”, press **【1】【0】【s】**

Press **【menu】** to select “TRIG”, press **【1】【N】**

Hint: The frequency displayed immediately after pressing [Sweep] is the start frequency. Any changes to that value will automatically update parameter “START F”

4.6.2 FM modulation

A modulated waveform consists of a carrier waveform and a modulating waveform. In FM, the frequency of the carrier is varied by the amplitude of the modulating waveform. The function generator will accept an internal or external FM modulating signal.

Press the **【FM】** key to enter into FM mode. The display will indicate the carrier frequency and the “FM” annunciator will be lit. The frequency, amplitude, waveform and DC offset of the carrier signal can be set as described in the previous section. Only the main functions sine or square wave can be selected as a carrier signal.

Press the **【menu】** key repeatedly to cycle through the FM modulation parameters listed below.

FM DEVIA → FM FREQ → FM WAVE → FM SOURCE

FM DEVIA Peak frequency deviation

FM FREQ: Frequency of modulating signal

FM WAVE: Waveform of modulating signal

FM SOURCE Toggle between internal or external modulating signal

Each time you press the menu key, the parameter will flash for 1 second, followed by the value of that parameter. FM modulation parameters can be entered directly or via the knob. Once the parameter is set, press **【menu】** to advance to the next parameter.

Peak frequency deviation “FM DEVIA”

Explanation: The variation in frequency of the modulating waveform from the carrier frequency (center frequency).

Range of deviation: For internal FM modulation, the maximum value should not exceed 50% of the carrier frequency. In external FM mode, the maximum deviation is 10% of the carrier frequency. Additionally, the frequency deviation plus carrier frequency should not exceed the maximum operating frequency of the instrument. ($F_c + F_d \leq F_{max} + 100 \text{ kHz}$) For F_{max} refer to the specifications for main waveforms.

This parameter applies only when “FM SOURCE” is set to “INTernal”.

Modulating signal frequency “FM FREQ”:

The frequency range of the modulating signal is 100μHz ~ 10kHz.

This parameter applies only when “FM SOURCE” is set to “INTernal”.

Modulating signal waveform “FM WAVE”

Waveform of the modulating signal: Waveforms sine, square, triangle, rising and falling ramp can be used as the modulating signal. Waveforms are selected by entering the corresponding number, numbers 1 – 5.

This parameter applies only when “FM SOURCE” is set to “INTernal”.

Modulating signal source “FM SOURCE”:

The modulating signal could be an internal signal and external input signal. The corresponding prompts are “1: INT” and “2: EXT”, the default is INTernal signal. The external modulating signal is applied to terminal “Mod In” on the rear panel (max signal amplitude is 3Vp-p). When

modulating signal source “external” is selected, the symbol “Ext” is displayed and parameters FM DEVIA, FM FREQ and FM WAVE do not apply (disabled)

Start and stop of FM modulation

An FM signal is generated once FM function mode is selected. The instrument will automatically output a signal according to the preset parameters. If you do not want to output the FM signal, simply press the **【output】** key to disable the signal output (LED above Output button is OFF). Once all the parameters are set, you can turn make the FM signal available at the output by pressing the Output button again.

FM example:

Example configuration: Carrier signal is square, frequency is 1MHz, amplitude is 2V, modulating signal is generated internally. Carrier waveform is sine (No. 1), Frequency is 5kHz. Peak frequency deviation is 200kHz.

Press **【FM】**

Press **【frequency】** then **【1】【MHz】** (set carrier frequency)

Press **【amplitude】**, then **【2】【V】** (set carrier amplitude)

Press **【Shift】** and **【square】** (set carrier waveform)

Press **【menu】**, select “FM DEVIA”, enter **【2】【0】【0】【kHz】** (set FM deviation)

Press **【menu】**, select “FM FREQ”, press **【5】【kHz】** (set FM frequency)

Press **【menu】**, select “FM WAVE”, press **【1】【N】** (set FM waveform as sine)

Press **【menu】**, select “FM SOURCE”, press **【1】【N】** (set FM source as internal)

4.6.3 AM modulation

AM stands for amplitude modulation.

Press **【AM】** to enable AM modulation. The carrier frequency and the AM annunciator is displayed. Frequency, amplitude, waveform and DC offset of the carrier signal can be set as described in the previous section of this chapter. The parameters carry over from the parameter settings of the main waveforms sine and square. In AM only sine and square waves can be selected for carrier.

Press the **【menu】** key repeatedly to cycle through the AM modulation parameters listed below.

AM LEVEL—> AM FREQ —> AM WAVE—>AM SOURCE

AM LEVEL: Modulation depth

AM FREQ: Frequency of modulating signal

AM WAVE: Waveform of modulating signal

AM SOURCE: internal or external modulating signal

In AM mode, to ensure normal signal output at 100% modulation depth, the instrument reduces the peak-to-peak value of the carrier by 50%. Only sine and square waves can be selected as AM carrier.

Modulation depth “AM LEVEL”:

The range of modulation depth is 1% ~ 120%.

Modulating frequency “AM FREQ”

Frequency of the modulating signal. Range is 100μHz ~ 20kHz. Parameter does not apply when “AM SOURCE” is set to “EXTernal”

Modulating signal waveform “AM WAVE”:

Waveforms sine, square, triangle, rising and falling ramp can be used as the modulating signal.

Waveforms are selected by entering the corresponding number, numbers 1 – 5. Parameter does not apply when “AM SOURCE” is set to “EXTernal”

Modulating signal source “AM SOURCE”

Select internal signal and external input signal. The number and prompt symbols are 1: INT, 2: EXT. The default of the instrument is internal signal. The external modulating signal is input through the rear panel “Modulation Input” terminal (with a maximum signal amplitude of 3Vp-p).

Enabling and disabling the AM signal:

An AM signal is generated once AM modulation is selected. The instrument will automatically output a signal according to the preset parameters. If you do not want to output the AM signal, simply press the **【output】** key to disable the signal output (LED above Output button is OFF). Once all the parameters are set, you can make the AM signal available at the output by pressing the Output button again.

AM example:

Configuration: carrier signal is square wave, frequency 1MHz, amplitude 2V, internal signal, modulating waveform sine wave (No.1), modulating signal frequency 5kHz, modulation depth 50%:

- Press **【AM】** (activate AM modulation)
- Press **【frequency】** , then **【1】【MHz】** (set carrier frequency)
- Press **【amplitude】** , then **【2】【V】** (set carrier amplitude)
- Press **【shift】** then **【square】** (set carrier waveform)
- Press **【menu】** , select “AM LEVEL”, press **【5】【0】【N】** (set modulation depth)
- Press **【menu】** , select “AM FREQ”, press **【5】【kHz】** (set modulating signal frequency)
- Press **【menu】** , select “AM WAVE”, press **【1】【N】** (set AM wave as sine)
- Press **【menu】** select “AM SOURCE”, press **【1】【N】** (set AM source to internal)

4.6.4 Burst modulation

You can configure the function generator to output a waveform with a specified number of cycles, called a burst. You can output the burst at a rate determined by the internal rate generator or an external signal applied to the rear-panel connector. The function generator can produce a burst using sine or square waveforms.

Press **【Burst】** to enter into burst mode. The carrier frequency and the Burst annunciator are displayed. Frequency, amplitude, waveform and DC offset of the carrier signal can be set as

described in the previous section of this chapter. The parameters carry over from the parameter settings of the main waveforms sine and square. Press the **【menu】** key repeatedly to cycle through the burst menu parameters listed below.

TRIG → COUNT → SPACE T → PHASE

TRIG: Trigger source
 COUNT: Number of cycles
 SPACE T: Burst time spacing
 PHASE: The starting phase of the burst

Select trigger source “TRIG”

Three trigger sources are available. Internal trigger and 2 types of external triggers sources, external gated and single. The corresponding menu parameters are 1: INT, 2: EXT and 3: SINGLE. The default is internal triggering.

a) Internal trigger

When the internal trigger source is selected, the frequency at which the burst is generated depends on parameter SPACE_T, burst count and the burst carrier frequency.

b) Single trigger mode

Generate a single trigger event by pushing the **【output】** key once or by applying a single TTL pulse at the “Ext.Trig” input terminal in the rear panel. A single burst with predefined parameters will be generated.

c) External gated burst mode

The TTL signal applied to “Ext. Trig” input terminal in the rear panel will enable or disable the output of the generator. When the TTL level of the gate signal is high, the generated will generate burst pulses according to the parameters of the set carrier frequency. Burst parameters COUNT and SPACE_T are ignored in this mode. Annunciators “Trig” and “Ext” turn on when this mode is active.

Burst count “COUNT”:

Definition: The number of cycles to be output per burst.

Range: 1 ~10000 cycles in 1 cycle increments. Additionally, the minimum number of cycles must also satisfy $F_C/50\text{kHz} + 1$. Parameter does not apply when “TRIG” is set to “EXTernal”.

Burst spacing time “SPACE T”:

Definition: Time interval between the 2 consecutive groups of bursts (time interval during which there is no burst signal present) Parameter does not apply when “TRIG” is set to “EXTernal” or “SINGLE”.

Range: 0.1ms ~ 800s.

Starting phase of the burst “PHASE”

Burst phase: 0.0° ~ 360.0° in 0.1° increments

Enabling/disabling the burst signal

The generator outputs a burst as soon as the burst key is pressed. The instrument will automatically output a signal according to the preset parameters. If you do not want to output the burst signal, simply press the **【output】** key to disable the signal output (LED above Output button is OFF). Once all the parameters are set, you can make the burst signal available at the output by pressing the Output button again. Note that the output on/off function does not apply when single trigger mode is selected.

Burst example:

Configuration: Burst is sine wave with frequency 20kHz, amplitude 2V, 10 cycles per group, spacing time between each group 10 ms, start phase 90.0°

Press **【burst】** (enter into burst mode)

Press **【frequency】**, press **【2】【0】【kHz】** (set wave form frequency)

Press **【amplitude】**, press **【2】【V】** (set waveform amplitude)

Press **【shift】** and **【sine】** (set waveform)

Press **【menu】**, select “TRIG”, press **【1】【N】** (set trigger mode as internal)

Press **【menu】**, select “COUNT”, press **【1】【0】【N】** (set number of bursts/cycles)

Press **【menu】**, select “SPACE T”, press **【1】【0】【ms】** (set space time)

Press **【menu】**, select “PHASE”, press **【9】【0】【N】** (set the start phase of burst)

4.6.5 FSK modulation

You can configure the function generator to “shift” its output frequency between two preset values using FSK modulation. The rate at which the output shifts between the two frequencies (“carrier frequency” and “hop frequency”) is determined by the internal rate generator or the signal level on the rear-panel ext Trig/FSK/Burst terminal.

Press **【FSK/PSK】** to enable FSK modulation. A preset frequency and the FSK annunciator is displayed. The preset frequency is identical to the “START F” parameter. Any changes automatically update “START-F” and vice versa. Frequency, amplitude, waveform and DC offset of the carrier signal can be set as described in the previous section of this chapter. In FSK/PSK only sine and square waves can be selected as carrier wave.

Press the **【menu】** key repeatedly to cycle through the FSK menu parameters listed below.

START F → STOP F → SPACE T → TRIG

START F: First frequency or carrier frequency

STOP F: Second frequency (hop frequency)

SPACE T: FSK rate

TRIG: Trigger source

Trigger source “TRIG”

Select internal signal and external input signal, 1: INT or 2: EXT. The default of the instrument is

“internal”.

In internal mode, the rate at which the signal shifts between the carrier and hop frequency is determined by the FSK rate.

In external trigger mode, the trigger signal applied to the trigger input terminal on the rear panel determines the FSK rate. Logical “high” of the trigger signal is associated with frequency 2, while the “Low” level of the trigger signal is associated with frequency 1.

Frequency 1 “START F”

The first frequency or carrier frequency.

Frequency 2 “STOP F”

Second frequency or hop frequency

Frequency input range of frequency 1 and frequency 2 is 1μHz ~ Fmax.

Spacing time “SPACE T”:

This parameter sets the FSK rate with a range of 1ms ~ 800s.

FSK example:

Configuration: Sine signal of 2V output amplitude, carrier frequency 20kHz and hopping frequency 600 kHz, FSK rate 10ms

Press **【FSK/PSK】** (enter into FSK function mode)

Press **【Ampl/Duty】**, press **【2】【V】** (set waveform amplitude)

Press **【shift】** and **【sine】** (set waveform)

Press **【menu】**, select “TRIG”, enter **【1】【N】** (set trigger mode as internal)

Press **【menu】**, select “START F”, enter **【2】【0】【kHz】** (set carrier frequency F1)

Press **【menu】**, select “STOP F”, enter **【6】【0】【0】【kHz】** (set hop frequency F2)

Press **【menu】**, select spacing time “SPACE T”, press **【1】【0】【ms】** (set spacing time)

4.6.6 PSK modulation

You can configure the function generator to “shift” its output phase between two preset values using PSK modulation. The rate at which the output shifts between the two phases is determined by the internal rate generator or the signal level applied to the trigger input terminal on the rear-panel.

Press **【FSK/PSK】** twice to enter phase shift keying (PSK) mode. The carrier frequency will be displayed along with the symbol “◀” and “FSK”. Frequency, amplitude, waveform and DC offset of the carrier signal can be set as described in the previous section of this chapter. The parameters carry over from the parameter settings of the main waveforms sine and square. If FSK mode was already active, press this key only once, (this key toggles the modulation between FSK and PSK mode). In FSK mode only sine and square waves can be selected as a carrier signal.

Press the **【menu】** key repeatedly to cycle through the burst menu parameters listed below.

P1 → P2 → SPACE T → TRIG

P1

Phase value #1

P2: phase value #2
 SPACE T PSK rate
 TRIG Trigger source for PSK

Trigger source “TRIG”

Select internal signal and external input signal 1: INT or 2: EXT. The default of the instrument is internal. In internal mode, the phase of the output signal shifts according to the PSK rate parameter. In external trigger mode, the trigger signal is applied to the Ext. Trig” Input terminal on the rear panel. In external trigger mode, the trigger signal applied to the trigger input terminal on the rear panel determines the PSK rate. Logical “high” of the trigger signal is associated with phase value #2, while the “Low” level of the trigger signal is associated with phase value #1.

Phase 1 “P1”

The first start phase value of the PSK output signal.
 Input range of phase 1 and phase 2 is $0.0^{\circ} \sim 360.0^{\circ}$.

Phase 2 “P2”

The second start phase value of the PSK output signal.
 Input range of phase 1 and phase 2 is $0.0^{\circ} \sim 360.0^{\circ}$.

Spacing time “SPACE T”

PSK rate: Range is 0.1ms ~ 800s.

PSK example

Configuration: Sine signals with 600 kHz output frequency, 2V amplitude, phase alternating between 90.0° and 180.0° , PSK rate is 10ms

Press **【FSK/PSK】** (2 times if necessary to enter PSK mode)

Press **【Freq/Period】**, enter **【6】【0】【0】【kHz】** (set waveform frequency)

Press **【Ampl/Duty】**, enter **【2】【V】** (set waveform amplitude)

Press **【shift】【sine】** (set waveform)

Press **【menu】**, select “TRIG”, enter **【1】【N】**, (set trigger mode as internal)

Press **【menu】**, select “P1”, enter **【9】【0】【N】** (set phase 1)

Press **【menu】** key, select “P2”, enter **【1】【8】【0】【N】** (set phase 2)

Press **【menu】**, select “SPACE T”, enter **【1】【0】【ms】** (set PSK rate)

4.7 Set System Parameters

Press **【Shift】** and **【system】** to enter the Systems menu. “SYSTEM” will flash on the display. Repeatedly press **【menu】** to cycle through the system parameters indicated below.

POWER ON —> ADDRESS —> OUT Z —> INTERFACE—>....

.....BAUD —> PARITY —> BEEP

POWER ON “Power on” state
 ADDRESS: set GPIB address (option)
 OUT Z: Configure amplitude display for 50 Ω or high impedance load termination
 INTERFACE: Select RS232 or GP-IB (IEEE-488) interface (option)
 BAUD: Baud rate for the RS232 interface
 PARITY: Parity and Data Bits configuration for RS232
 BEEP: Toggle the key beep on/off

After the selected system parameter flashes for 1 second, the parameter value will be displayed and the value can be edited using the knob or via direct entry using the numerical keypad.

Power on state “POWER ON:

This parameter has 2 possible values, “1: DEFAULT” or “2: LAST STATE”. It determines the initial setting of the instrument after power up. The factory setting is “1: DEFAULT”. The default state is main waveform sine wave, 10kHz, 2Vpp which is identical to the state the instrument is in after pressing “Reset”. When selecting “2: LAST STATE”, the instrument will “remember” the last state the unit was in before power was turned off. The power on state is stored in non-volatile memory, location 0 (see Store/Recall section)

GPIB address “ADDRESS”

The default of GPIB interface address is 1. It can be set within 0 ~ 30.

Output impedance “OUT Z”

The generator has a fixed output impedance of 50 ohms on the OUTPUT terminal. You can specify whether you are terminating the output into a 50 ohm load or an open circuit. Incorrect impedance matching between the function generator and your load will result in amplitude or offset which does not match the specified signal level.

Select “1: HIGH Z” or “2: 50 OHM” according to your load configuration.

“INTERFACE” selection

Select RS232 (“2: RS232”), GPIB (“1: GP-IB”) or USB (“3: USB”). The default is RS232.

“BAUD” rate setting

Set the baud rate for the RS232 interface. Possible baud rates are 9600, 4800, 2400, 1200, 600 and 300. The default rate is 9600 (“1: 9600”)

“PARITY” setting

Set parameters parity bit and number of data bits. Possible configurations are:

None/ 8 data bits (“1: NONE 8 BITS”)

Odd/ 7 data bits (“2: ODD 7 BITS”)

Even/ 7 data bits (“3: EVEN 7 BITS”).

The default setting is None/ 8 data bits.

“BEEP” setting

Turns the key beep on or off. Select OFF(“1: CLOSE”) or ON (“2: OPEN”). The default is ON.

Example for system function setting

Configuration: Set power on state [POWER ON] to default and output impedance to 50Ω

Press **【Shift】【system】** (enter systems menu)

Press **【menu】** , “POWER ON”, press **【1】【N】** (set power on state to default)

Press **【menu】** , select “OUT Z”, press **【2】【N】** (configure for load impedance of 50Ω)

4.8 Universal Counter

Overview of Counter functions

This instrument contains a counter with frequency measurement and totalize functionality which is completely independent from the Arbitrary/function generator section. The range of the frequency measurement function is 1Hz ~ 100MHz. Repeatedly pressing **【Shift】【Count】** will toggle between Frequency measurement and Totalize mode.

Press **【Shift】** and **【F.C./TOT】** once to activate the frequency measurement mode. Symbols “Ext” and “Freq” will be displayed in the state field and “WAITING” will flash on the main display. The unit is now ready to measure and display the frequency of a signal applied to the input terminal “Meas Freq/TOT IN” in the rear panel. When totalize mode is active, symbols “Ext” and “Count” will be displayed on the status field along with the result for the count on the main display (“0” is displayed until a valid signal is detected). The unit is now ready to totalize events represented by the signal applied to input terminal “Meas Freq/TOT IN” in the rear panel

In event counting mode, press the **【◀】** key to start and stop the event counter. When stopped, the current count will be displayed. Press **【▶】** key to reset the event counter to zero and resume counting.

Gate time

Only applies to frequency measurement mode. Press **【Shift】【gate】** to enter a gate time setting. Either the numerical keypad or the knob can be used to enter a gate time value. If the gate is open, the symbol “GATE” is displayed in the counter state field on the right. The range of gate times is 10ms ~ 10s

Low pass filter

By pressing **【Shift】【LPF】** , the input signal will be passed through a low pass filter before being passed onto the counter circuit. The word “Filter” appears on the right display field to indicate that the Low Pass Filter is active.

Attenuation

Press **【Shift】【ATT】** to activate the attenuator which attenuates the input signal by a factor 10:1. “ATT” is displayed on the right to indicate that the input attenuator is active.

5. REMOTE INTERFACE REFERENCE

5.1 Introduction

An Introduction to the SCPI Language

SCPI (Standard Commands for Programmable Instruments) is an ASCII-based instrument command language designed for test and measurement instruments. SCPI commands are based on a hierarchical structure, also known as a tree system. In this system, associated commands are grouped together under a common node or root, thus forming subsystems. A portion of the SOURCE subsystem is shown below to illustrate the tree system.

SOURce:

FREQuency:

STARt {<frequency>|MINimum|MAXimum}

FREQuency:

STARt? [MINimum|MAXimum]

FREQuency:

STOP {<frequency>|MINimum|MAXimum}

FREQuency:

STOP? [MINimum|MAXimum]

SOURce is the root keyword of the command, FREQuency is the second-level keywords, and STARt and STOP are third-level keywords. A colon (:) separates a command keyword from a lower-level keyword.

Preparations for Remote Operation

The Arbitrary/Function Generator series 4080 can be remotely controlled from a PC via the standard RS232 interface. Make sure to configure the RS232 interface to match the settings on your PC by setting the parameters in the Systems menu accordingly. The instrument enters the remote state after any remote command is received at which time all keys except of the **【Local】** key (Shift) are locked. When in Remote mode, the instrument can be returned to Local mode by pressing the **【Local】** key or by sending a “LOCAL instruction via the RS232 interface.

5.2 Overview and syntax of SCPI instructions

This section summarizes the SCPI commands available to program the function generator over the remote interface. Refer to the later sections in this chapter for more details on each command.

Throughout this manual, the following conventions are used for SCPI command syntax.

- Square brackets ([]) indicate optional keywords or parameters.
- Braces ({ }) enclose parameters within a command string.
- Triangle brackets (< >) indicate that you must substitute a value for the enclosed parameter.
- A vertical bar (|) separates multiple parameter choices.

Command Summary

APPLY instruction

APPLy:SINusoid [<frequency>, <amplitude>, <offset>]
 APPLy:SQUare [<frequency>, <amplitude>, <offset>]
 APPLy:TRIangle [<frequency>, <amplitude>, <offset>]
 APPLy:UP_RAMP [<frequency>, <amplitude>, <offset>]
 APPLy:DOWN_RAMP [<frequency>, <amplitude>, <offset>]
 APPLy:NOISe [<frequency>*, <amplitude>, <offset>]
 APPLy:P_DC [<frequency>*, <amplitude>, <offset>]
 APPLy?

*: if waveform is Noise or DC, the frequency data contained in the command is not invalid.

OUTPUT instructions

[SOURce:]
 FUNction SHAPE {SINusoid|SQUare|TRIangle|UP_RAMP|DOWN_RAMP|
 NOISe|PULSE|P_PULSE|N_PULSE|P_DC|N_DC|STAIR|
 C_PULSE|COMMUT_FU|COMMUT_HA|SINE_TRA|
 SINE_VER|SINE_PM|LOG|EXP|ROUND_HAL|
 SINX/X|SQU_ROOT|TANGent|CARDIO|QUAKE|COMBIN}
 FUNction:SHAPE?

[SOURce:]
 FREQuency <frequency>
 FREQuency?

[SOURce:]
 PULSE:DCYCLE <percent>
 PULSE:DCYCLE?

[SOURce:]
 VOLTage <amplitude>
 VOLTage?
 VOLTage: OFFSet <offset>
 VOLTage: OFFSet?

[SOURce:]
 OUTPut:LOAD {50|INFinity}
 OUTPut:LOAD?
 INPUT:FILTER <on|off>
 INPUT:FILTER?
 INPUT:ATTenuator <on|off>
 INPUT:ATTenuator?

*SAV {0|1|2|3|4|5|6|7|8|9|10}. State 0 is the working state of the instrument before power off
 *RCL {0|1|2|3|4|5|6|7|8|9|10}. States 1—10 are user defined working states

RF:STATe <ON/OFF>
 RF:STATe?

MODULATION instructions

[SOURce:]

AM:DEPT_h <depth in percent>
 AM:DEPT_h?
 AM:INTErnal:FUNCTioN {SINusoid|SQUare|TRIangle|UP_RAMP|DOWN_RAMP|}
 AM:INTErnal:FUNCTioN?
 AM:INTErnal:FREQuency <frequency>
 AM:INTErnal:FREQuency?
 AM:SOURce {INTErnal|EXTErnal}
 AM:SOURce?
 AM:STATe {ON|OFF}
 AM:STATe?

 [SOURce:]
 FM:DEVIation <peak deviation in Hz>
 FM:DEVIation?
 FM:INTErnal: FUNCTioN {SINusoid|SQUare|TRIangle|UP_RAMP|DOWN_RAMP|.....}
 FM:INTErnal: FUNCTioN?
 FM:INTErnal: FREQuency <frequency>
 FM:INTErnal: FREQuency?
 FM:SOURce {INTErnal|EXTErnal}
 FM:SOURce?
 FM:STATe {ON|OFF}
 FM:STATe?

 [SOURce:]
 BM:NCYCles <#cycles>
 BM:NCYCles?
 BM:PHASe <degrees>
 BM:PHASe?
 BM:INTErnal: Space <time in second>
 BM:INTErnal: Space?
 BM:SOURce {INTErnal|EXTErnal|SINGLE}
 BM:SOURce?
 BM:STATe {ON|OFF}
 BM:STATe?

FSK instructions

[SOURce:]
 FSKey:FREQuency <frequency>
 FSKey:FREQuency?
 FSKey:INTErnal: Space <time in second>
 FSKey:INTErnal: Space?
 FSKey:SOURce {INTErnal|EXTErnal}
 FSKey:SOURce?

 FSKey:STATe {ON|OFF}
 FSKey:STATe?

PSK instructions

[SOURce:]
 PSKey:PHASe1 <degrees>
 PSKey:PHASe1?

PSKey:PHASe2 <degrees>
 PSKey:PHASe2?
 PSKey:INternal: Space <time in second>
 PSKey:INternal: Space?
 PSKey:SOURce {INternal|EXternal}
 PSKey:SOURce?
 PSKey:STATe {ON|OFF}
 PSKey:STATe?

SWEEP instructions

[SOURce:]
 FREQuency:STARt <frequency>
 FREQuency:STARt?
 FREQuency:STOP <frequency>
 FREQuency:STOP?

 [SOURce:]
 SWEep:SPACing {LINear|LOGarithmic}
 SWEep:SPACing?
 SWEep:TIME <time in second>
 SWEep:TIME?
 SWEep:SOURce {INternal|EXternal}
 SWEep:SOURce?
 SWEep:STATe {ON|OFF}
 SWEep:STATe?

COUNT instructions

[SOURce:]
 FUNcTION:TOTal INITial
 FUNcTION:TOTal STARt
 FUNcTION:TOTal STOP
 FUNcTION:TOTal CLEAR
 FUNcTION:TOTal?

FREQUENCY MEASUREMENT instructions

[SOURce:]
 FUNcTION:FREQuency MEASure
 FUNcTION:FREQuency?
 FUNcTION:FREQuency GATE <time>
 FUNcTION:FREQuency GATE?

TRIGGER instructions

TRIGger:SOURce {IMMediate|EXternal|BUS}
 TRIGger:SOURce?

SYSTEM instructions

*IDN?
 *RST
 *SAV {0|1|2|3|4|5|6|7|8|9|10}
 *RCL {0|1|2|3|4|5|6|7|8|9|10}

RS232 specific instructions

SYSTem:LOCAL
 SYSTem:REMOTE

5.3 Detailed description of SCPI Instructions

APPLy instructions

APPLy instructions are used to directly set the output of the function generator through the remote interface including waveform, frequency and offset. For example, to output a sine wave of 5kHz, 3Vp-p with –2.5V DC offset, the following commands need to be sent:

“APPL:SIN 5.0E+3,3, -2.5”

Instructions of lower level can also be used:

“FUNC:SHAPE SIN”, to output a sine wave

“FREQ 5.0 E+3”, to set frequency as 5kHz

“VOLT 3.0”, to set voltage as 3 VPP

“VOLT:OFFSET -2.5”, to set output offset as -2.5 V

APPLy?

Queries the waveform, frequency, amplitude and offset of current function output. The returned data format is:

“SIN 5.000000000000E+03, 3.000000E+00, -2.500000E+00”

OUTPUT instructions

FUNCTION:SHAPE {SINusoid|SQUare|TRIangle|UP_RAMP|DOWN_RAMP|NOISe.....}

Select output waveform. 27 waveforms are available. In fixed frequency mode, each of the 27 kinds can be selected. In other modes, only sine and square waves can be selected.

FUNCTION:SHAPE?

Check the waveform of current function output. The returned data are SIN, SQU, TRI, UP_RAMP, etc.

FREQuency <frequency>

Set the frequency of function output

FREQuency?

Check the frequency of current main function output. The returned data unit is Hz.

PULSe:DCYClE <percent>

Set the duty cycle of pulse output.

Duty cycle: 0.1%—99.9%, in step of 0.1% ($f \leq 10$ KHz)

1%—99% in step of 1% ($10 \text{ kHz} < f \leq 100 \text{ kHz}$), default value 20%.

PULSe:DCYClE?

Check the duty cycle of current pulse output. The returned value is percentage.

VOLTage <amplitude>

Set the amplitude of the currently active waveform. The amplitude setting should be consistent with the technical specifications. The output amplitude ranges of P_PULSE, N_PULSE, P_DC and N_DC should be $2\text{mVpp} \leq \text{ampl} \leq 10\text{Vpp}$ in high impedance output setting and $1\text{mVpp} \leq \text{ampl} \leq 5\text{Vpp}$ in 50Ω setting. The above value is given based on a DC offset of 0V. If a DC offset is used, refer to the setting of DC offset described in Chapter 4 in this manual

VOLTage?

Check the output amplitude of current main function output.

VOLTage OFFSet <offset>

Set the DC offset. For the relationship between the DC offset and output amplitude, refer to section 4.5.3.

VOLTage OFFSet?

Check the DC offset of main function output.

OUTPut:LOAD {50|INFinity}

Configure the amplitude display value for 50Ω or high impedance (INFinity) load termination. The output amplitude should be consistent with the technical specifications.

OUTPut:LOAD?

Read the current load impedance setting of the function generator.

INPUT: FILTER {ON|OFF}

Enable/disable the low pass filter for the counter

INPUT:FILTER?

Read the current “on/off” state of the low pass filter.

INPUT:ATTenuator {ON|OFF}

Enable/disable Set the input attenuator of the counter

INPUT:ATTenuator?

Read the state of the input attenuator (on/off)

*SAV {0|1|2|3|4|5|6|7|8|9|10}

Save as many as 11 input states of the instrument. Among the 11 states, state 0 is used to automatically store the power off setting of the instrument. States 1~10 are user defined.

*RCL {0|1|2|3|4|5|6|7|8|9|10}

Recall one of the states 0 -10.

RF:STATe <ON/OFF>

Enables/Disables main output

RF:STATe?

Reads the current state of the main output

AM instructions

1. To set the carrier of output using APPLy instructions or FUNCtion, FREQuency, VOLTage, VOLTAGE: OFFSet instructions.
2. To set modulating waveform of AM using AM:INTernal: FUNCtion {SINusoid|SQUare|TRIangle.....} instructions
3. To set modulating frequency of AM using AM: INTernal: FREQuency <frequency> instructions.

4. To set the modulation depth of AM using AM: DEPT_h {depth in percent} instructions
5. To set modulating source of AM using AM: SOUR_{ce} {INT_{ernal}|EX_{ternal}} instructions
6. To start AM using AM: STAT_e ON instructions.

AM: DEPT_h {depth in percent}

Set modulation depth of AM. MIN=1%, MAX=120%.

AM: DEPT_h?

Read the current modulation depth of AM.

AM:INT_{ernal}:FUNCT_{ion} {SIN_{usoid}|SQU_{are}|TRI_{angle}.....}

Set the modulating waveform for AM, using modulating waveforms SIN, SQU, TRI UP, RAMP and DOWN_RAMP.

AM:INT_{ernal}:FUNCT_{ion}?

Check current modulating waveform of AM. Return parameters are “SIN”, “SQU”, TRI”, “UP_RAMP”, “DOWN_RAMP”

AM:INT_{ernal}: FREQuency <frequency>

Set frequency of modulating signal of AM. When internal modulating source is selected, the modulating frequency should be $\leq 10\text{kHz}$.

AM:INT_{ernal}:FREQuency?

Read the frequency of the current modulating signal for AM.

AM:SOUR_{ce} {INT_{ernal}|EX_{ternal}}

Set modulating source of modulating signal of AM as internal (INT_{ernal}) or external (EX_{ternal}).

AM:SOUR_{ce}?

Read the current modulating source of AM.

AM:STAT_e {ON|OFF}

Turn AM mode on/off

AM:STAT_e?

Check the “on/off” state of AM mode. The returned data are “0” (OFF) or “1” (ON). In “off” state, the instrument reverts back to fixed frequency mode.

FM instructions

1. To set the carrier of output using APPL_y or FUNCT_{ion}, FREQuency, VOLT_{age}, VOLTAGE: OFFSet instructions.
2. To set modulating waveform of FM using FM: INT_{ernal}: FUNCT_{ion} {SIN_{usoid}|SQU_{are}|TRI_{angle}.....} instructions
3. To set modulating frequency of FM using instruction FM:INT_{ernal}: FREQuency <frequency>
4. To set the modulating deviation of FM using instruction FM: DEV_{iation} <peak deviation in Hz>
5. To set modulating source of FM using the FM: SOUR_{ce} {INT_{ernal}|EX_{ternal}} instruction
6. To start FM using FM: STAT_e ON instruction.

FM:DEV_{iation} <peak deviation in Hz>

Set the modulating deviation of FM. The maximum value should be half of carrier frequency in internal modulating source and 10% of carrier frequency in external modulating frequency. (Should also satisfy the following equation: $F_c + F_d \leq F_{\text{max}} + 100\text{kHz}$)

FM:DEV_{iation}?

Read the current modulating deviation of FM.

FM:INteRnal:FUNCTion {SINusoid|SQUare|TRIangle.....}

Set the modulating waveform of FM using SIN, SQU, TRI UP, RAMP or DOWN_RAMP waveforms.

FM:INteRnal:FUNCTion?

Read the current modulating waveform of FM. The returned data are “SIN”, “SQU”, “TRI”, “UP_RAMP”, “DOWN_RAMP”.

FM:INteRnal:FREQuency <frequency>

Set the frequency of modulating signal of FM. The modulating frequency should be $\leq 10\text{KHz}$ when internal modulating source is selected.

FM:INteRnal:FREQuency?

Read the frequency of current modulating signal of FM.

FM:SOURce {INteRnal|EXteRnal}

Set modulating source of FM signal as internal (INteRnal) or external (EXteRnal).

FM:SOURce?

Read the current modulating source of FM.

FM:STATe {ON|OFF}

Turn on FM mode (ON), turn off FM mode (OFF).

FM:STATe?

Check the “on/off” state of FM mode. The returned data are “0” (OFF) or “1” (ON). It returns to fixed frequency mode in “off” state.

Burst Mode instructions

1. Set the carrier using APPLy instructions or FUNCTion, FREQuency, VOLTage, VOLTAGE: OFFSet instruction.
2. Set number of burst using BM: NCYCles <#cycles> instruction.
3. Set start phase of burst using BM: PHASe <degrees> instruction.
4. Set time interval between two bursts using BM:INteRnal: SPACe <time> instruction.
5. Set trigger source of burst using BM: SOURce {INteRnal|EXteRnal|SINGle} instruction.
6. To turn on burst use the BM: STATe ON instruction.

BM:NCYCles <#cycles>

Set waveform numbers of burst. $\text{MAX} \leq 10000$.

BM:NCYCles?

Check number of bursts.

BM:PHASe <degrees>

Set start phase of burst in $0-360^\circ$ in step of 0.1° .

BM:PHASe?

Check the start phase of burst.

BM:INteRnal: SPACe <time>

Set time interval between two bursts.

BM:INteRnal: SPACe?

Check time interval between two bursts.

BM:SOURce {INteRnal|EXteRnal|SINGle}

Set trigger source of burst as internal (INteRnal), external (EXteRnal) or single (SINGle).

BM:SOURce?

Check current trigger source of burst.

BM:STATe {ON|OFF}

Turn on burst mode (ON) or turn off burst mode (OFF).

BM:STATe?

Check “on/off” state of burst mode. The returned data are “0” (OFF) or “1” (ON). The instrument reverts back to fixed frequency mode in “off” state.

FSK Mode instructions

1. To set the output waveform, amplitude, DC offset and frequency 1 using APPLY instructions or FUNCTION, FREQUENCY, VOLTage, VOLTAGE:OFFSet instructions.
2. set frequency 2 of FSK using FSKey: FREQUENCY <frequency> instruction.
3. set time interval of frequency switching using FSKey:INTernal: SPACe <time> instruction.
4. set trigger source of FSK using FSKey: SOURce {INTernal|EXTernal} instructions.
5. turn on FSK using FSKey: STATe ON instruction.

FSKey:FREQUENCY <frequency>

Set frequency 2 of FSK.

FSKey:FREQUENCY?

Check frequency 2 of FSK.

FSKey:INTernal:SPACe <time>

Set time interval of frequency switching

FSKey:INTernal:SPACe?

Check time interval of frequency switching

FSKey:SOURce {INTernal|EXTernal}

Set trigger source of FSK as internal (INTernal) or external (EXTernal).

FSKey:SOURce?

Check current trigger source of FSK.

FSKey:STATe {ON|OFF}

Turn on FSK mode (ON) or turn off FSK mode (OFF).

FSKey:STATe?

Check the “on/off” state of FSK mode. The returned data are “0” (OFF) or “1” (ON). It returns to fixed frequency mode in “off” state.

PSK Mode instructions

1. To set the output waveform, amplitude, DC offset and frequency using APPLY instructions or FUNCTION, FREQUENCY, VOLTage, VOLTAGE:OFFSet instructions.
2. To set phase 1 of PSK using PSKey: PHASe1 <degrees> instruction.
3. To set phase 2 of PSK using PSKey: PHASe2 <degrees> instruction.
4. To set time interval of phase switching using PSKey:INTernal: SPACe <time> instruction.
5. To set trigger source of PSK using PSKey: SOURce {INTernal|EXTernal} instructions.
6. To turn on PSK using PSKey: STATe ON instruction.

FSKey:PHASe1 <degrees>

Set phase 1 of PSK in 0--360°.

PSKey:PHASe1?

Check phase 1 of PSK

PSKey:PHASe2 <degrees>
Set phase 2 of PSK in 0--360°.

PSKey:PHASe2?
Check phase 2 of PSK.
PSKey:INternal:SPACe <time>
Set time interval of phase switching

PSKey:INternal:SPACe?
Check time interval of phase switching

PSKey: SOURce {INternal|EXternal}
Set trigger source of PSK as internal (INternal) or external (EXternal).

PSKey:SOURce?
Check current trigger source of PSK.

PSKey:STATe {ON|OFF}
Turn on PSK mode (ON) or turn of f PSK mode (OFF).

PSKey:STATe?
Check the “on/off” state of PSK mode. The returned data are “0” (OFF) or “1” (ON). It returns to fixed frequency mode in “off” state.

Sweep Mode instructions

1. To set the output waveform, amplitude, DC offset and frequency using APPLy instructions or FUNction, FREQuency, VOLTage, VOLTAGE:OFFSet instructions.
2. To set start frequency of sweep using FREQuency: START <frequency> instruction.
3. To set stop frequency of sweep using P FREQuency: STOP<frequency> instruction.
4. To set sweep mode using SWEep: SPACing {LINear|LOGarithmic} instruction.
5. To set sweep time using SWEep: TIME <time> instructions.
6. To set trigger source of sweep using SWEep: SOURce {INternal|EXternal} instructions.
7. To turn on sweep using SWEep: STATe ON instruction.

FREQuency:START <frequency>
Set start frequency of sweep.

FREQuency:START?
Check starting frequency of sweep.

FREQuency:STOP <frequency>
Set stop frequency of sweep.

FREQuency:STOP?
Check stop frequency of sweep.

SWEep:SPACing {LINear|LOGarithmic}
Set sweep mode as linear (LINear) or logarithmic (LOGarithmic)

SWEep:SPACing?
Check sweep mode.

SWEep:TIME <time>
Set sweep time.

SWEep:TIME?

Check the sweep time.

SWEep:SOURce {INTernal|EXTernal}

Set trigger source of sweep as internal (INTernal) or external (EXTernal).

SWEep:SOURce?

Check current trigger source.

SWEep:STATe {ON|OFF}

Turn on sweep mode (ON) or turn off sweep mode (OFF).

SWEep:STATe?

Check the “on/off” state of sweep mode. The returned data are “0” (OFF) or “1” (ON). It returns to fixed frequency mode in “off” state.

Counting instructions

FUNcTion:TOTal INITial

Initialize the counter.

FUNcTion:TOTal STARt

Set the counter to start counting.

FUNcTion:TOTal STOP

Set the counter to stop counting.

FUNcTion:TOTal CLEAR

Clear the counted value of the counter.

FUNcTion:TOTal?

Record the current value of the counter.

Frequency Measurement instructions

FUNcTion:FREQuency MEASure

Enable frequency measurement function for the instrument to start a new frequency measurement.

FUNcTion:FREQuency?

Record last frequency value after frequency measurement is finished.

FUNcTion:FREQuency GATE <time>

Set gate time in the range of 10ms to 10s for frequency measurement.

FUNcTion:FREQuency GATE?

Check current gate time for frequency measurement.

Trigger instructions

TRIGger:SOURce {IMMediate|EXTernal|BUS}

Set trigger source or modulating source for available functions as internal (IMMediate), external (EXTernal) or single (BUS).

TRIGger:SOURce?

Check trigger source or modulating source of current function as internal (IMM), external, (EXT) or single (BUS).

System related instructions:

*IDN?

This query will return the instrument’s manufacturer, model number and firmware version.

Example: B+K Precision 4084AWG V1.00

***RST**

Reset instrument to the default state

***SAV {0|1|2|3|4|5|6|7|8|9|10}**

Save as many as 11 input states of the instrument. Among the 11 states, state 0 is used to automatically store the power off setting of the instrument. States 1~10 are user defined.

***RCL {0|1|2|3|4|5|6|7|8|9|10}**

Recall on of the states 0 -10.

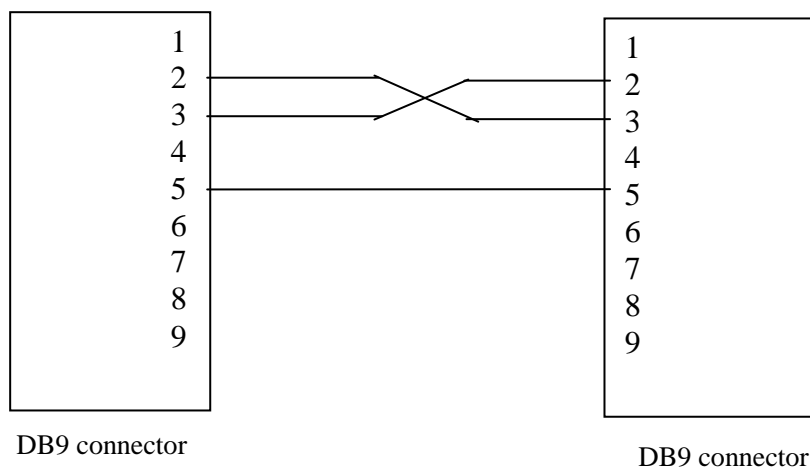
Special instructions for RS232**SYSTem:LOCAL**

This instruction causes the instrument to enter into local state. After receipt of this command, all front panel keys are enabled.

SYSTem:REMOTE

This instruction causes the instrument enter remote state from local state. After receipt of this command, all front panel keys are disabled except of the local key (shift key) which can be used to manually revert to local state.

NOTE: All command strings send to the instrument must terminate with a <new line> character. (0x0A or “\n”).

Wiring diagram of RS232 cable required for remote control (null modem configuration)

6. USER PROGRAMMABLE ARBITRARY WAVEFORM MODULE

Product Overview

In addition to the 27 build-in waveforms, models **4084AWG** and **4086AWG** also provide the capability to generate and store up to 8 user-defined waveforms in non-volatile memory.

This Windows-based software tool offers a graphical user interface that you can use to create, edit, and transfer custom waveforms to the internal memory of the 4084AWG or 4086AWG Function/Arbitrary Generator.

Waveforms can be created in several ways: Users can draw new waveforms with a mouse, edit one of the predefined waveforms, read in waveform parameters from a text file or download waveforms from a TEKTRONIX® digital storage oscilloscope. Once completed, the waveform can be transmitted to the generator and stored in non-volatile memory.

Software Installation

This section describes how to install the Arbitrary Waveform Creation Software using the Install Shield Wizard.

- 1) Insert the Installation CD into the CD-ROM drive.
- 2) Locate setup.exe on the CD-ROM and double-click it.
- 3) Follow the instructions given by the Install Shield wizard.

Launching the Software

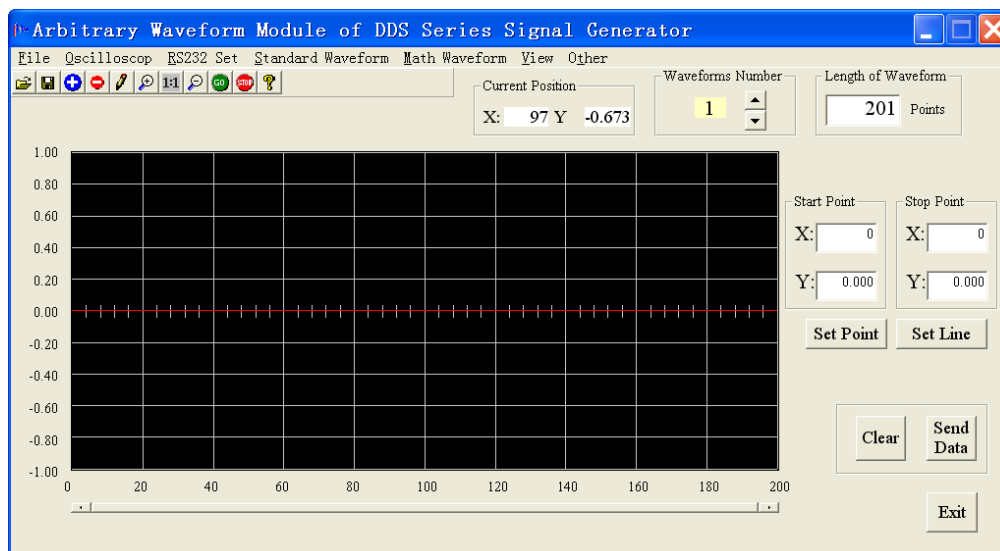
To start the Software you can do one of the following:

- a) Run the application from the Windows Start menu.

Select Start> Programs> BK_Precision>4080 Series Arbitrary Waveform Software\Arb_Process.exe

- b) Go to the folder where you have installed the Arbitrary Waveform Creation Software and double-click on Arb_process.exe.

To exit the application, select File > Exit from the pull down menu



CREATING AND EDITING WAVEFORMS

Create waveforms by loading waveform data from a text file or by using the graphical tools of this Software.

Working with text files

Waveforms can be imported to or exported from a text file with the following format:

The first line contains the number of data points, the consecutive lines the Y axis value of the sampling points.

Example wave1.txt:

```

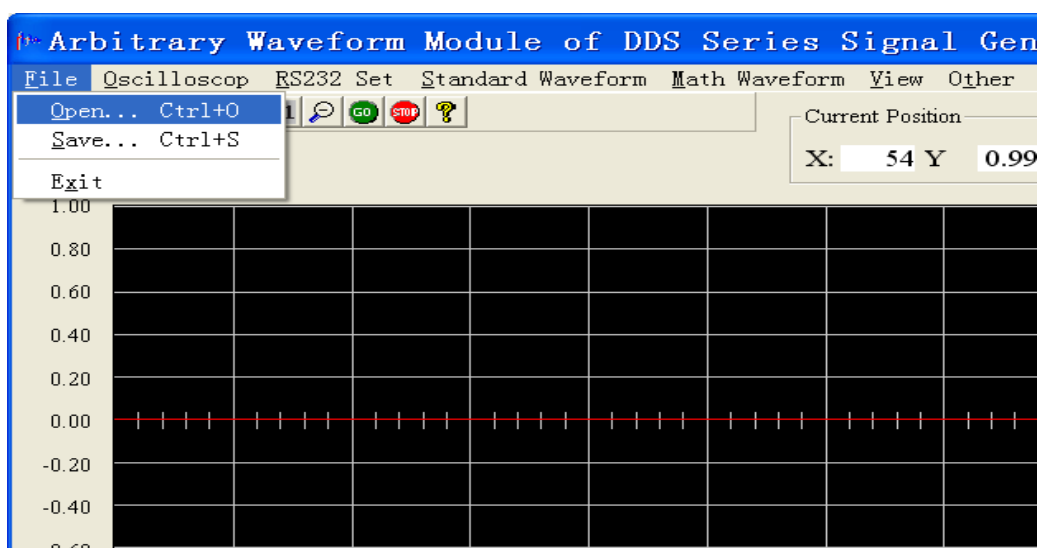
8          (Line 1: length of the waveform)
-0.666     (Line 2: waveform value of point 0)
-0.555     (Line 3: waveform value of point 1)
-0.111     (Line 4: waveform value of point 2)
0.001      (Line 5: waveform value of point 3)
0.123      (Line 6: waveform value of point 4)
0.235      (Line 7: waveform value of point 5)
0.378      (Line 8: waveform value of point 6)
0.654      (Line 9: waveform value of point 7)

```

Only use text editors such as NOTEPAD to create or edit this file.

Saving and opening text files

To save the current waveform as a text file, Select File>Save to and enter a filename. To import waveform data, select “Open” from the File menu. The waveform data will be automatically displayed in the editing window.



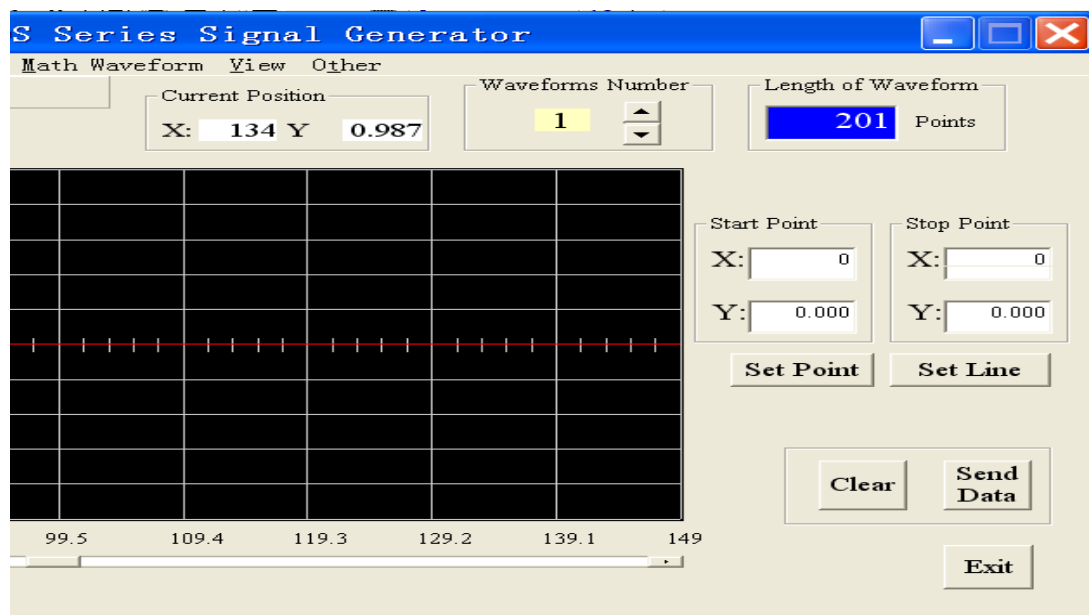
Working with graphical tools

Waveform Parameters

The waveform parameters are represented in the following format: Values of the vertical axis (Y) are normalized to -1.000 ~ 1.000. Values of the horizontal axis (X axis) are 0 ~ length of waveform minus 1.

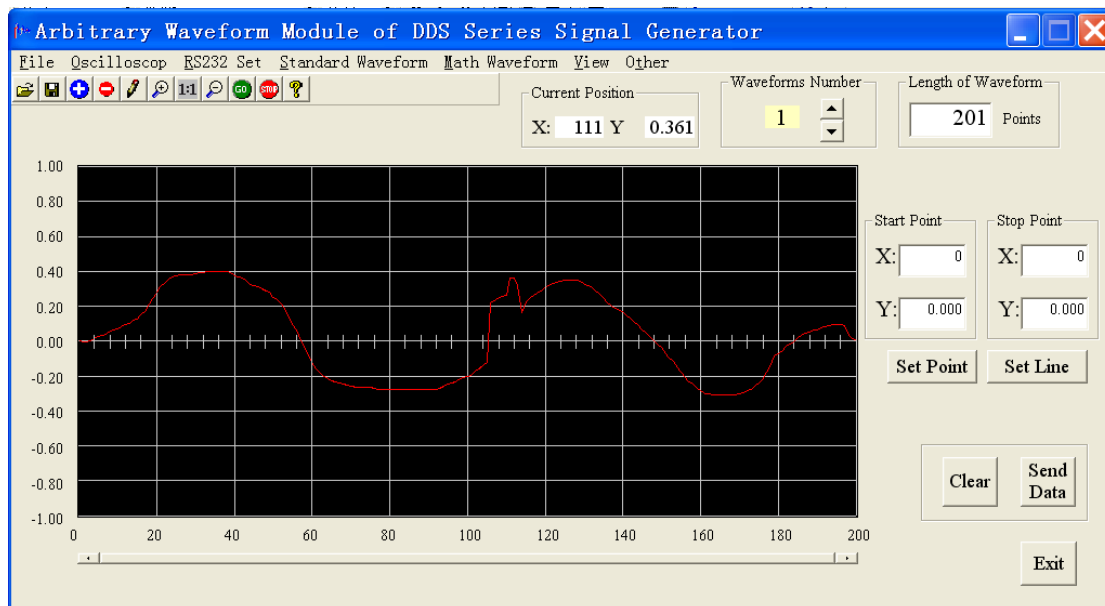
Setting the number of points

The waveform length can be set as required. Input the required number of points in the waveform setup area then press ENTER. The X-axis will be updated accordingly. The minimum number of points is 8, the maximum number is 16000.



Drawing waveforms

Click on the left mouse key then grab and move the default center line to the desired location. The coordinates of the cursor position will be displayed while “drawing”. Release the left mouse key to stop drawing.



Clearing the waveform

To clear all waveforms in the editing area, click the “Clear” waveform button.

Zoom function

To enlarge an area of the waveform, click on the “zoom in” symbol then use the scroll bar below the editing window to view the desired area. You can also use View>Zoom in. To zoom out, click on the “zoom out” symbol on the tool bar or select use View>Zoom.

Click the “1: 1” symbol to restore the default view.

Direct waveform entry

Accurate input of point values

Define a point by entering the (X) and (Y) coordinates in the start point field then click “Set point” to complete the entry. The value of this point will be recorded and displayed in the drawing area.

Accurate input of line segments

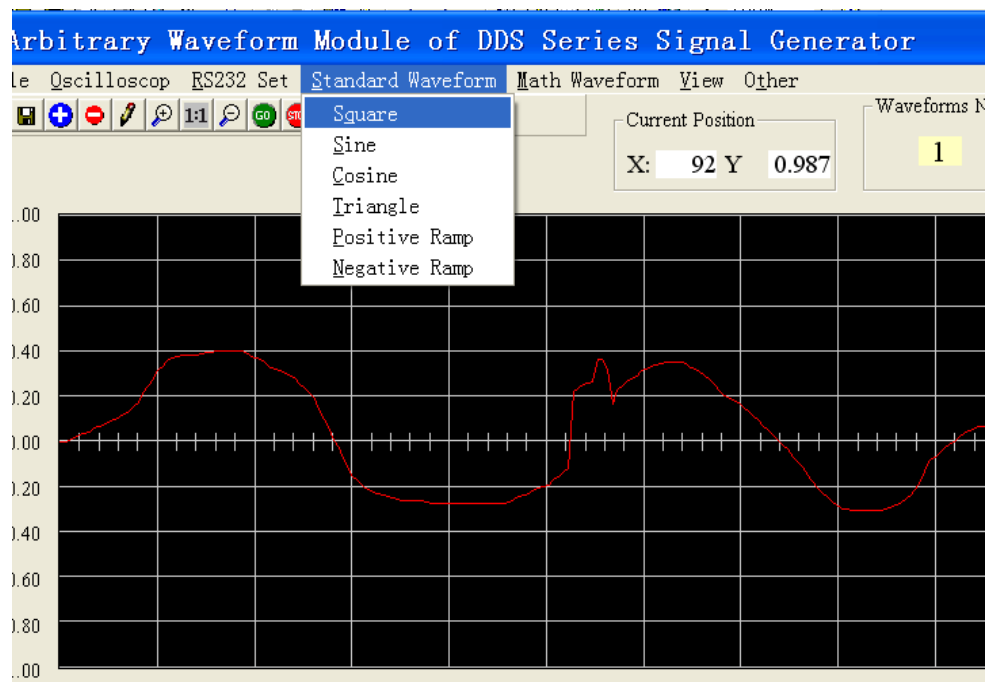
To define a straight line segment, enter the corresponding (X) and (Y) coordinates of the starting point of this line segment in the “start point” field. Enter the (X) and (Y) coordinates for the stop point of the line in the “stop point” field. Click “set line”. The value of this line segment will be automatically calculated and displayed in the drawing area.

Generating standard waveform

6 standard waveforms can be generated: square, sine, cosine, triangle, rising and falling ramp.

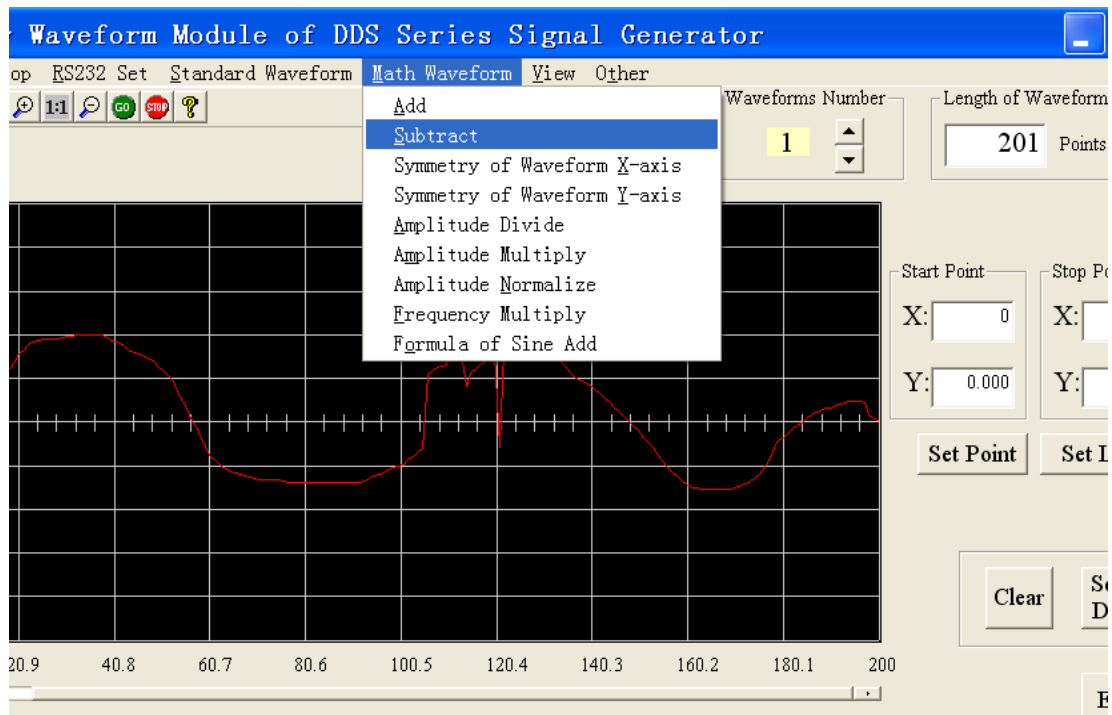
Select a waveform from the standard waveforms menu. The waveform will be displayed

immediately in the editing window.



Modifying existing waveforms with mathematical Functions

Waveforms can be modified by applying one of the following mathematical functions: Addition, subtraction of waveforms, symmetry of Y-axis and X-axis, division and multiplication by a constant.



Add

Add waveform data stored in a text file to the current waveform (displayed on the screen). The resulting new waveform is automatically normalized by dividing the new waveform by 2. To look at it differently, each amplitude value is weighted by a factor 0.5 before the add operation is performed.

If the lengths of the two waveforms differ, the longer length is taken as the length of the new waveform.

Subtract

Subtract waveform data stored in a text file from the current waveform (displayed on the screen). The resulting new waveform is automatically normalized by dividing the new waveform by 2. To look at it differently, each amplitude value is weighted by a factor 0.5 before the subtract operation is performed.

If the lengths of the two waveforms differ, the longer length is taken as the length of the new waveform.

Symmetry of waveform X-axis

Flip the current image around the X-axis to create a mirror image of the previous waveform.

Symmetry of waveform Y-axis

Flip the current image around the vertical center line, which divides the editing screen in half.

Amplitude Divide

Divide the amplitude of the current waveform by an integer value. The value can be positive or negative (but not zero)

Amplitude multiply

Multiply the amplitude of the current waveform by an integer value. The value can be positive or negative (but not zero)

Frequency multiply

Multiply the timebase value of the current waveform by an integer value. The value must be positive (but not zero). An integer value of 2 will double the frequency

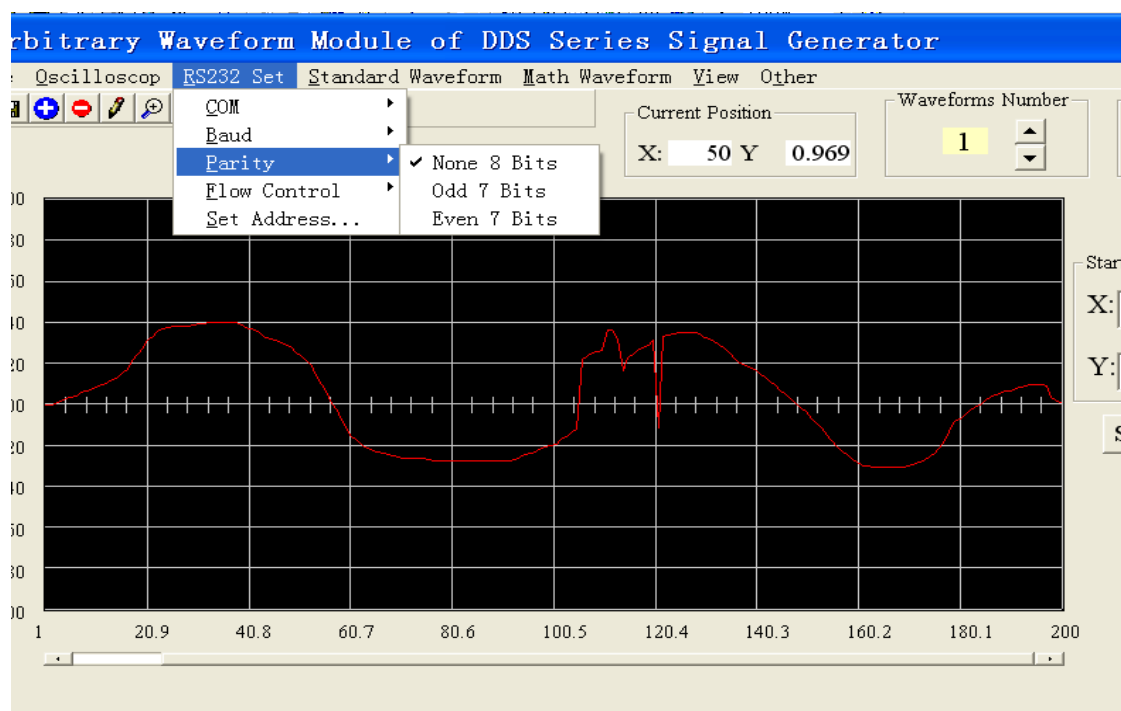
Formula of sine add

Add 2 sine waves according to the predefined formula $1*\sin(x) + a*\sin(b*x)$. Choose parameters a and b. The first sine wave in the equation cannot be edited.

TRANSFERRING WAVEFORM DATA TO THE 408XAWG

RS232 communication setup

- 1) Connect the computer to the 4084AWG or 4086AWG using the RS232 cable included.
- 2) Set the RS232 parameters of the Arbitrary Waveform Creation Tool
- 3) Set the RS232 parameters in the Systems menu of the 4080 series generator. Make sure the “COM port”, “Baud rate” and “parity” and Flow control parameters match that of the Software settings.



Select a memory location

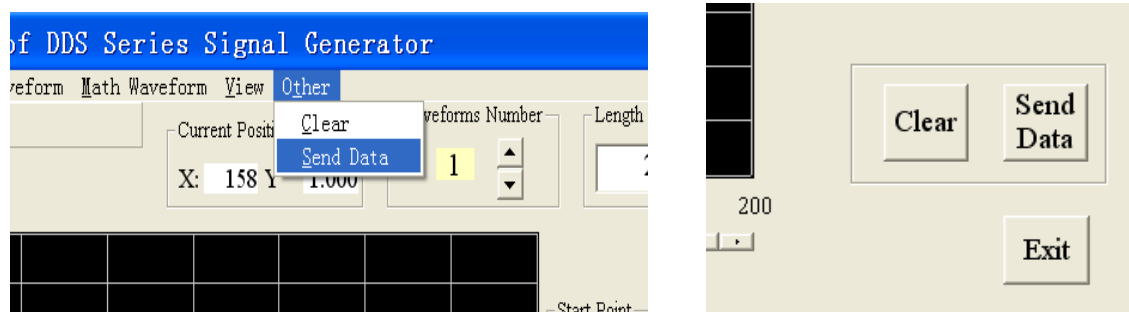
Models 4084AWG and 4086AWG offer 8 memory locations for storing user defined arbitrary waveforms. Numbers 1 – 8 in the waveform number field of the software correspond to “ARB1” – “ARB8” on the instrument side which are located at positions 28 to 35 on the Arblist (see chapter 4, section 3).

Arblist location	Press <Shift> +	Display Name
28	1	ARB1
29	2	ARB2
30	3	ARB3
31	4	ARB4
32	5	ARB5
33	6	ARB6
34	7	ARB7
35	8	ARB8

Transfer of waveform in current editing area

Initiate a waveform transfer to the 4080 series generator by clicking the “Send Data” button or

Selecting Other>Send Data from the menu. A pop-up window will indicate the progress of the data transfer. The window will automatically disappear once the data was downloaded successfully. If the download was unsuccessful due to communication problems, a pop message will appear prompting the user to verify the setup and settings of the communication link.



Example:

Draw a waveform with a 1024 point length and transfer the data to memory location “ARB1”.

- 1) Connect the computer and the instrument using the supplied RS232 cable and configure the RS232 parameters on the instrument and software side. Make sure the parameters match
- 2) Set waveform length as 1024 points.
- 3) Create a waveform
- 4) Set “Waveform Number” to 1
- 5) Click on the “Send Data” button
- 6) After the transfer completed successfully, press [Shift][Shift] [1] on the instrument to select and enable waveform “ARB1” (the first Shift key press puts the instrument into Local mode)

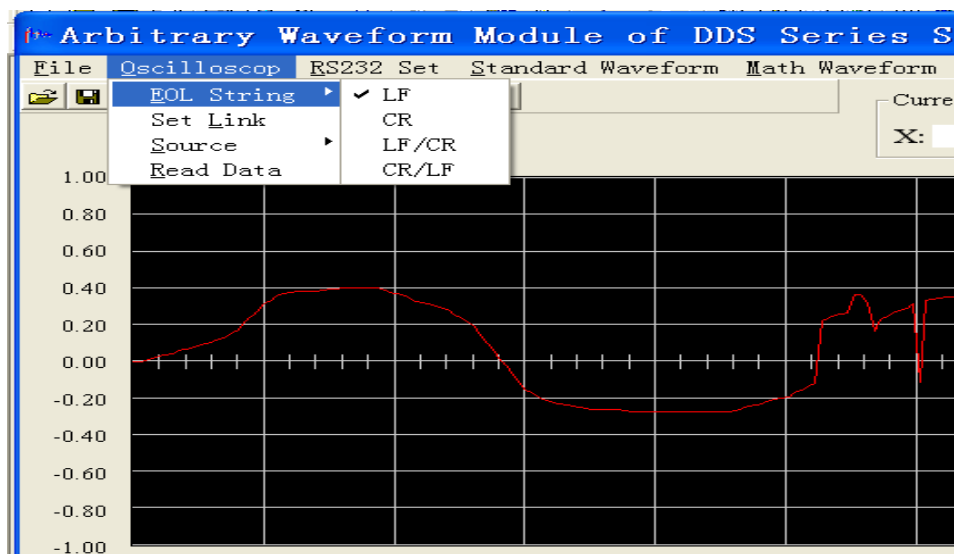
Note: If ARB1 was already enabled, the output of the generator will be updated immediately with the new waveform data as soon as the download is complete

READING DATA FROM A TEKTRONIX® DIGITAL STORAGE OSCILLOSCOPE

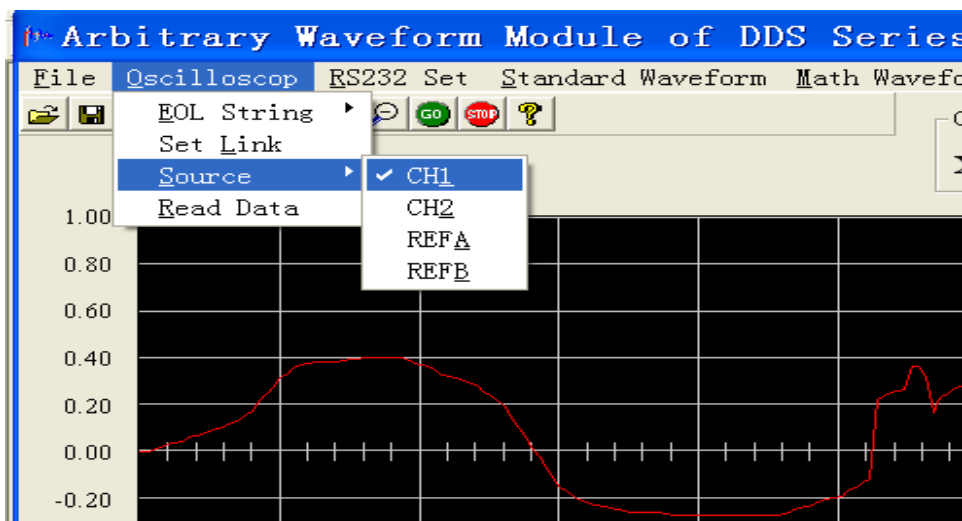
This tool allows the direct transfer of waveform data from a Tektronix digital storage oscilloscope to this Software. The data can originate from the oscilloscope’s screen display (channel 1 or channel 2) or internal memory where the reference waveform from channel 1 or 2 is stored. The Software is compatible with TDS1000, TDS2000, TPS2000 and TDS3000 series oscilloscopes equipped with a RS232 interface.

Download instructions:

- 1) Connect the computer and digital storage oscilloscope (DSO) using an RS232 cable.
- 2) Set the communications parameters for the DSO. Refer to the oscilloscope’s manual for setup instructions. Make sure that the RS232 parameters under “menu RS232 set” match that of the Arbitrary waveform Creation Software. Additionally set the “EOL” or “End of Line” string in the oscilloscopes menu. Supported termination strings are <CR>, LF or a combination of the two, <CR><LF> or <LF><CR>
- 3) Set the RS232 parameters and EOL string on the Software side. Make sure parameters “communications address”, “Baud rate”, “parity”, “flow control” and “EOF character string” matches that of the oscilloscope settings.



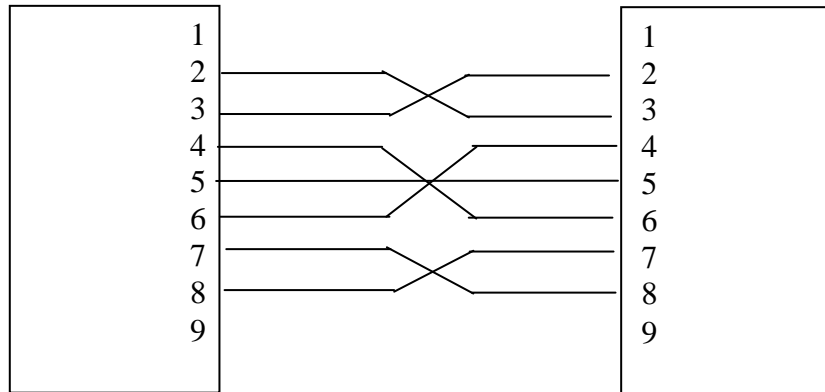
- 4) Click “Set Link” in the “oscilloscope” menu of the software to check the communications link between software and oscilloscope. A pop-up window will indicate successful communication; otherwise, the operation will result in an error message. This operation will also automatically populate the waveform length field based on the oscilloscope’s internal storage memory.
- 5) Select the Source of the data to be read from the oscilloscope
- 6) Select the desired data source from oscilloscope menu>Source. Refer to your oscilloscope’s user manual for data sources available.



- 7) Read the oscilloscope data from the source selected: Click on “read data” in sub-menu oscilloscope”. A pop-up window will appear to display the current status of the transfer. The pop up window will automatically disappear once transmission was completed successfully and the downloaded data will automatically be displayed in the Software’s editing window.

Requirement for RS232 cable connecting the TEKTRONIX oscilloscope and 408xAWG

Refer to the oscilloscope's instruction manual. For the TEKTRONIX series digital storage oscilloscopes, a null modem (cross over) using 2 handshake lines is recommended.



7. APPENDIX

BK PRECISION®	Declaration of CE Conformity according to EEC directives and NF EN 45014 norm	CE
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	Responsible Party	Alternate Manufacturing Site
Manufacturer's Name:	B&K Precision Corporation	B&K China 1364
Manufacturer's Address:	22820 Savi Ranch Pkwy. Yorba Linda, CA 92887-4610 USA	

Declares that the below mentioned product

Product Name: Function/ Arbitrary Generator, Programmable DDS Function Generator

Part Numbers: 4084, 4084AWG, 4085, 4086, 4086AWG, 4087

complies with the essential requirements of the following applicable European Directives:

Low Voltage Directive 73/23/EEC (19.02.73) amended by 93/68/EEC (22.07.93) Electromagnetic Compatibility (EMC) 89/336/EEC (03.05.88) amended by 92/68/EEC (22.07.93)

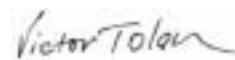
and conforms with the following product standards:

LVD	EN61010-1:2001, EN61010-031:2002
EMC	EN61326: 1997+A1: 1998+A2: 2001+A3: 2003 EN55022: 1998+A1:2000+A2 EN61000-3-2: 2000 EN61000-3-3: 1995+A1:2001 EN55024: 1998+A1: 2001+A2:2003

This Declaration of Conformity applies to above listed products place on the EU market after:

January 31 2007

Date



**Victor Tolan
President**

Service Information

Warranty Service: Please return the product in the original packaging with proof of purchase to the address below. Clearly state in writing the performance problem and return any leads, probes, connectors and accessories that you are using with the device.

Non-Warranty Service: Return the product in the original packaging to the address below. Clearly state in writing the performance problem and return any leads, probes, connectors and accessories that you are using with the device. Customers not on open account must include payment in the form of a money order or credit card. For the most current repair charges please visit www.bkprecision.com and click on “service/repair”.

Return all merchandise to B&K Precision Corp. with pre-paid shipping. The flat-rate repair charge for Non-Warranty Service does not include return shipping. Return shipping to locations in North American is included for Warranty Service. For overnight shipments and non-North American shipping fees please contact B&K Precision Corp.

B&K Precision Corp.
22820 Savi Ranch Parkway
Yorba Linda, CA 92887
www.bkprecision.com
714-921-9095

Include with the returned instrument your complete return shipping address, contact name, phone number and description of problem.

Limited Three-Year Warranty

B&K Precision Corp. warrants to the original purchaser that its products and the component parts thereof, will be free from defects in workmanship and materials for a period of **three years** from date of purchase.

B&K Precision Corp. will, without charge, repair or replace, at its option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form of a sales receipt.

To obtain warranty coverage in the U.S.A., this product must be registered by completing a warranty registration form on www.bkprecision.com within fifteen (15) days of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. The warranty is void if the serial number is altered, defaced or removed.

B&K Precision Corp. shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitations of incidental or consequential damages. So the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

B&K Precision Corp.
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Yorba Linda, CA 92887
www.bkprecision.com
714-921-9095

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