



# AFG-3081/3051

## Arbitrary Function Generator

### FEATURES

- Wide Frequency Range from 1  $\mu$ Hz ~ 80/50MHz
- 1  $\mu$ Hz Frequency Resolution throughout Full Range
- Standard Waveform : Sine, Square, Triangle, Ramp, Pulse, Noise
- Built-in AM, FM, PWM, FSK, Sweep, Burst Functions
- 16bit, 200MSa/s, 1M-Point Deep Arbitrary Waveform
- DWR (Direct Waveform Reconstruction) Capability
- Arbitrary Waveform Editing PC Software
- 4.3" High Resolution LCD Display
- USB, RS-232, GPIB Standard Interfaces

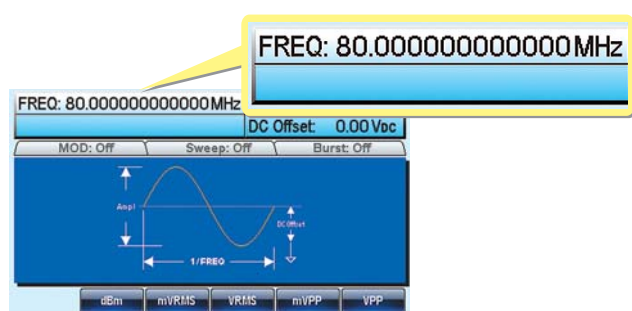
# Fulfilling Your Diversified Waveform Needs

The AFG-3000 Series is an Arbitrary Waveform and Digital-Synthesized Function Generator designed for industrial, scientific research and educational applications. The series comes with a bandwidth of 80MHz for AFG-3081 and 50MHz for AFG-3051. The AFG-3000 Series, featuring 200MSa/s sampling rate, 16-bits vertical resolution and 1M points waveform length, is a very useful and flexible signal source to meet diversified application needs in the market today.

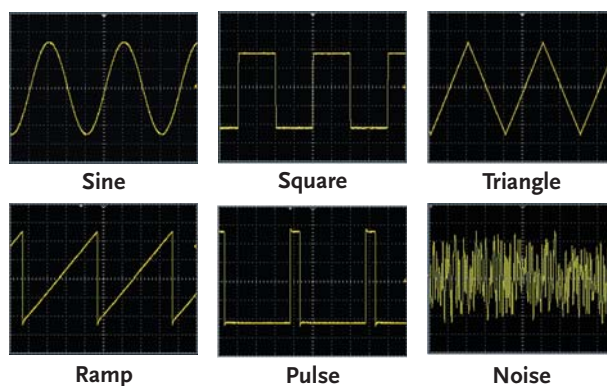
The user-friendly operation, the On-Screen Help, and the multiple ways of arbitrary waveform editing make AFG-3000 just a plug-and-play equipment. The point by point waveform data entry or standard waveform clip piling through front panel operation, the CSV file waveform data download, the direct waveform reconstruction through DSO waveform data import, and the PC software edited waveform download are the 4 ways available for arbitrary waveform editing.

A 4.3-inch high resolution TFT LCD in the AFG-3000 front panel is used to display waveform and set parameters. The large and high-resolution screen is especially useful when the arbitrary waveform construction is done through front panel operation. The impedance of AFG-3000 can be selected between 50 Ohm and Hi-Z to ensure right impedance compatibility between AFG and DUT.

## A. WIDE FREQUENCY RANGE FROM 1 $\mu$ Hz to 80/50MHz



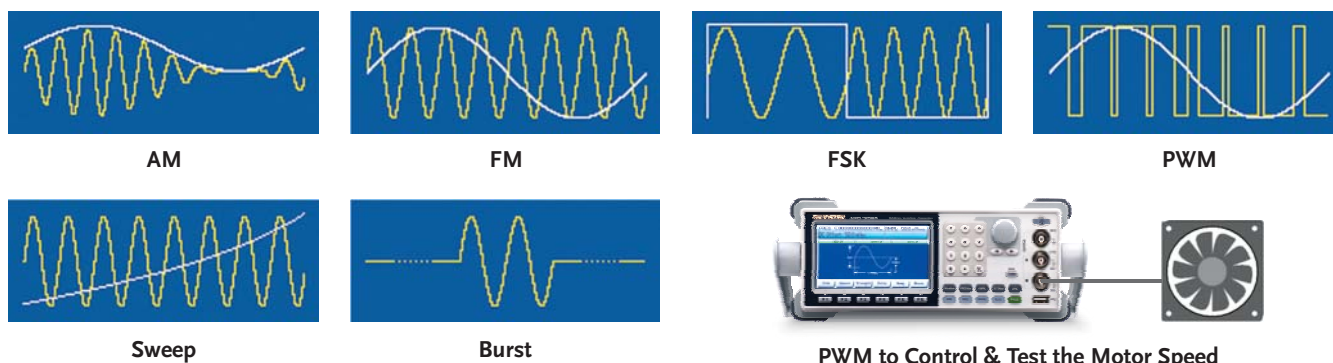
The Minimum 1 $\mu$ Hz Resolution



The AFG-3000 Series arbitrary waveform/ function generator employs direct digital synthesis (DDS) technology to generate and output a variety of stable and precise waveforms. The frequency operates at up to 80MHz (AFG-3081) or 50MHz (AFG-3051), with

a minimum resolution of 1 $\mu$ Hz for the entire frequency range. The built-in standard waveforms include sine, square, triangle, ramp, pulse, noise and other types of waveforms.

## B. MODULATION, SWEEP and BURST FUNCTIONS



The Modulation functions, including AM, FM, FSK and PWM, are provided to cover a broad range of market requirements. A dedicated terminal for the modulating signal output is available in the front panel for modulation monitoring or other control purposes. Either an internal signal or an external signal can be selected to perform the modulation.

FSK is a frequency modulation scheme in which digital information is transmitted through signal frequency variation. The BFSK (binary FSK) modulation, using two frequencies to represent data 1 and 0 respectively, is commonly applied for Call ID and Remote Metering applications.

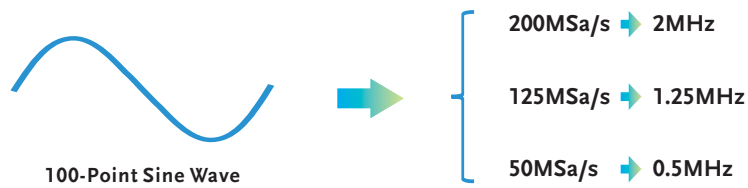
PWM is a digital modulation scheme that can be used to adjust the output power level by controlling the pulse width of the driving signal. The examples include the speed control of motor rotation and the luminance control of LED lighting instrument. With the pulse width

variation of driving signal, the rotating speed of motor and the luminance of LED will change accordingly.

The Sweep function supports three trigger modes of INT, EXT and manual, and two sweep modes of LOG and LIN. Each time a sweep signal is perceived, the function generator will start to sweep through the user-defined frequency range by the frequency variation of either Log curve or Linear curve.

The Burst function supports two modes of Gate and N Cycle. To run burst function, the burst repetitive rate has to be set first, then the time duration of each burst has to be defined under Gate mode, or the number of the waveform cycles in each burst has to be set under N Cycle mode. Under both Gate mode and N Cycle mode, the burst waveform polarity and phase can be controlled.

## C. HIGH 200MSa/s SAMPLING RATE



### High Sampling Rates Achieve Higher Frequency Ranges

The profile of arbitrary waveform is composed of a series of data. The frequency of arbitrary waveform is derived from sampling rate divided by the number of points constructing a complete waveform, i.e.  $\text{frequency} = \text{sampling rate} / \text{the number of points in a waveform}$ . Based on the above, the higher the sampling rate, the higher the arbitrary waveform frequency can be available.

A Sine waveform composed of 100 points waveform data is able to have a 2MHz frequency with 200MSa/s sampling rate, but can only have 1.25MHz frequency with 125MSa/s sampling rate and 0.5MHz frequency with 50MSa/s sampling rate. AFG-3000, possessing a sampling rate of 200MSa/s, is able to generate a waveform up to 100MHz for a simple waveform composed of 2 points of data.

## D. 16-BIT AMPLITUDE RESOLUTION



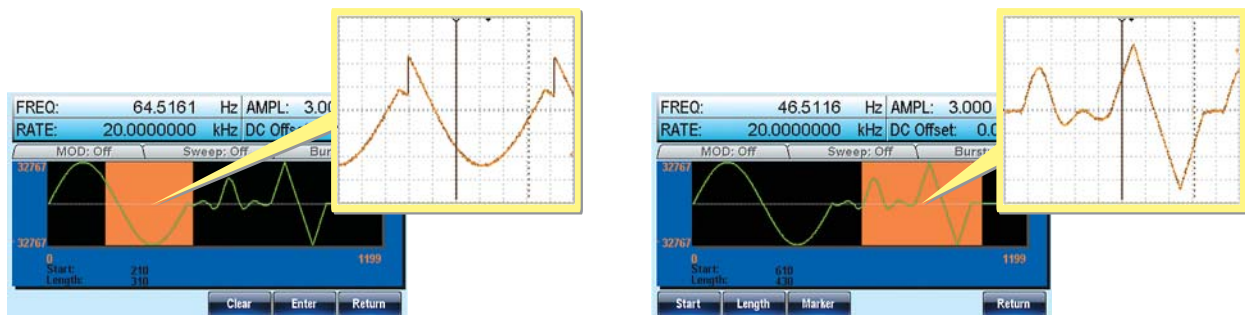
### 16-bit Allows Greater Details

The 16-bit amplitude resolution can display smooth waveforms, while a lower bit resolution will display jagged or less smooth waveforms.

For example, if 10V is divided into 10,000 equal parts, each part would have a resolution of 1mV. When using a 16 bits

resolution, the smallest possible bit resolution is 0.15mV (from 10V). With 16 bits resolution, the 10,000 parts will appear to be a smooth straight line, while the bit resolution of 12 bits would be 2.4mV, greater than the 1mV needed. In this case the straight line would appear like a ladder.

## E. OUTPUT FROM ANY SECTION OF 1M-POINT-LONG WAVEFORMS



### Arbitrary Editing / Output

The AFG-3000 Series provides 10 sets of memory for user save and recall applications. Each set of memory is able to store a set of front panel setting and a set of 1M-point arbitrary waveform data. With 1M long memory, AFG-3000 can store more complex waveforms consisted of more data.

Furthermore, any section of waveform within this 1M memory can be edited or output independently. This is a unique feature allowing more flexibility for user to do waveform storage and extraction.

## F. EASY OPERATION AND FLEXIBLE ARBITRARY WAVEFORM EDITING

The AFG-3000 presents four ways to generate custom arbitrary waveforms from direct front panel operation, PC software, a CSV file loading, and GDS-2000 series oscilloscope input.

### • Front Panel Operation



Panel Operation

Everything from waveform editing, I/O configuring, and panel setting storage and recall can be completed directly through front panel operation. Front panel operation allows users to edit arbitrary waveform, which is correspondingly updated on the screen, a feature of "What You See is What You Get".

### • CSV file Download

|   | A            | B        | C |
|---|--------------|----------|---|
| 1 | Start:       | 0        |   |
| 2 | Length:      | 629      |   |
| 3 | Sample Rate: | 20000000 |   |
| 4 |              | 0        |   |
| 5 |              | 328      |   |
| 6 |              | 655      |   |
| 7 |              | 983      |   |
| 8 |              | 1310     |   |

Supports CSV file

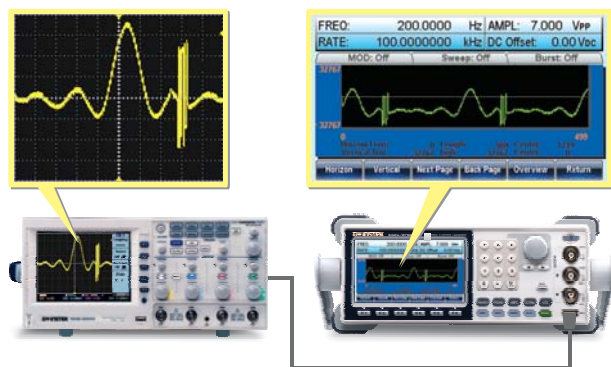
```
% sine wave generation program
result=round(2*pi*5*sin(0.0:0.01:2*pi));
save gensin csv result /ascii;
% end

Start: 0
Length: 629
Sample Rate: 20000000
0
328
655
983
1310
1638
```

From Math Computing Software, Program and Result in CSV File

AFG-3000 supports CSV file editing for arbitrary waveform generation. The CSV file can be created in many ways, including using EXCEL spreadsheet, PC client software, front panel editing or math computing software. The computing result of math software, Octave for example, can be saved into CSV file. Edited CSV file can be downloaded from either USB flash or PC to AFG-3000 for arbitrary waveform output.

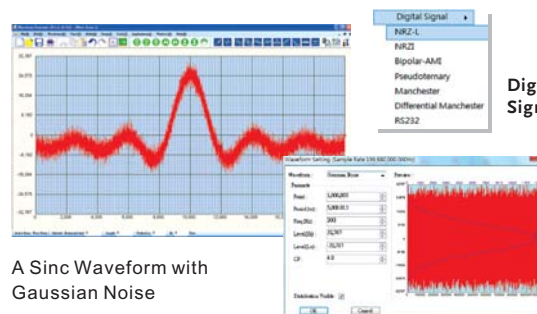
### • Direct Waveform Reconstruction (DWR)



Direct Waveform Reconstruction from the GDS-2000 Series

The AFG-3000 can be directly connected to GW Instek GDS-1000, GDS-2000 and GDS-3000 Serials DSO with USB cable for waveform data download. Under "DSO Link" mode of AFG-3000, the DSO will transfer the captured waveform data from its memory to AFG-3000 for creating an approximative waveform output.

### • Arbitrary Waveform Editing PC Software



A Sinc Waveform with Gaussian Noise

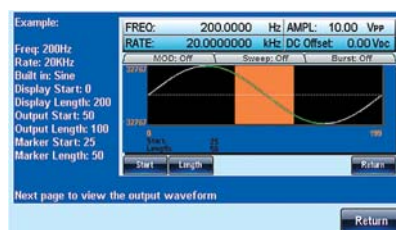
Gaussian Noise

A PC software for AFG-3000 waveform editing is supported. The software contains not only waveform drawing tools but also a wide variety of waveform editing functions, such as waveform arithmetic operations. The most commonly used waveforms, including Rayleigh, Gaussian, Normal Noise, Pseudo Ternary, Bipolar AMI, Manchester, Differential Manchester, RS-232, and NRZ etc., are available in the library for user to tailor specific waveforms as needed.

## G. IMPEDANCE SWITCH & ON-SCREEN HELP



Impedance Switch



On-Screen Help

AFG-3000 allows users to select the suitable impedance between 50 ohm and High-Z, ensuring a right impedance compatibility.

The built-in On-Screen Help allows users to understand AFG-3000 operations and the definition of each function key.

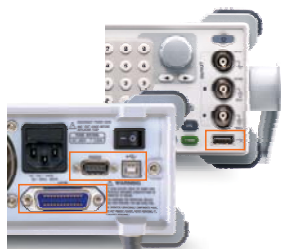


## PANEL INTRODUCTION



1. TFT LCD Panel
2. Number Panel
3. Scroll Knob & Selection Key
4. Power Switch
5. Output Terminals
6. Main Output Switch
7. Function keys
8. Operation keys
9. USB Host
10. Trigger & Modulation Input
11. Mark & Trigger Output
12. Fan
13. GPIB
14. RS-232
15. USB Device

## STANDARD COMMUNICATION INTERFACE



The AFG-3000 provides GPIB, RS-232, and USB as standard communication interfaces. AFG-3000 supports IEEE 488.2 protocol and command for users to integrate system or remotely control the instrument.

## 4.3" HIGH RESOLUTION LCD DISPLAY



The AFG-3000 is equipped with a 4.3" LCD screen of 480 x 272 resolution. In addition to displaying all of the settings on the screen, the large graphic display also allows users to observe complete waveforms at a glance.

| SPECIFICATIONS            |   |  |   |          |
|---------------------------|---|--|---|----------|
|                           |   | AFG-3081   |   | AFG-3051 |
| WAVEFORMS                 | Standard Waveform   | Sine, Square, Ramp, Pulse, Noise, DC, Sin(x)/x, Exponential Rise, Exponential Fall, Negative Ramp  |   |          |
| ARBITRARY WAVEFORMS       | ARB Function<br>Sample Rate<br>Repetition Rate<br>Waveform Length<br>Amplitude Resolution<br>Non-Volatile Memory<br>User define Output Section<br>User define Mark Output | Built in<br>200 MSa/s<br>100MHz<br>1M points<br>16 bits<br>Ten 1M waveforms *1<br>Any section from 2 to 1M points<br>Any section from 2 to 1M points   |   |          |
| FREQUENCY CHARACTERISTICS | Range   | Sine, Square   | 80MHz   | 50MHz    |
|                           |   | Triangle, Ramp   | 1MHz  |          |
|                           | Resolution  |  | 1 μHz   |          |
|                           | Accuracy  | Stability<br>Aging<br>Tolerance  | ±1 ppm 0 ~ 50℃<br>±1 ppm, per 1 year<br>≤1μHz   |          |
| OUTPUT CHARACTERISTICS *2 | Amplitude   | Range  | 10 mVpp to 10 Vpp( into 50Ω); 20 mVpp to 20 Vpp(open-circuit)   |          |
|                           |   | Accuracy   | ±1% of setting ±1 mVpp (at 1 kHz,>10 mVpp)(into 50Ω)  |          |
|                           |   | Resolution   | 0.1 mV or 4 digits  |          |
|                           |   | Flatness   | ±1%(0.1dB)<10MHz;±2%(0.2dB)10MHz~50MHz;±10%(0.9 dB)50MHz~70MHz;±20%(1.9dB)70MHz~80MHz (sinewave relative to 1kHz) |          |
|                           |   | Units  | Vpp, Vrms, dBm  |          |
|                           | Offset  | Range  | ±5 Vpk ac +dc (into 50Ω); ±10Vpk ac +dc (Open circuit)  |          |
|                           |   | Accuracy   | 1% of setting + 2 mV+ 0.5% of amplitude   |          |
|                           | Waveform Output   | Impedance  | 50Ω typical (fixed); >10MΩ (output disabled)  |          |
|                           |   | Protection   | Short-circuit protected; overload relay auto-matically disables main output                                       |          |
|                           | SYNC Output   | Level  | TTL-compatible into>1kΩ   |          |
|                           |   | Impedance  | 50Ω nominal   |          |
| SINEWAVE CHARACTERISTICS  | Harmonic Distortion *5<br>Total Harmonic Distortion<br>Spurious (non-harmonic)*5<br>Phase Noise   | -60dBc DC~1MHz,Ampl<3Vpp;-55dBc DC~1MHz,Ampl>3Vpp;45dBc 1MHz~5MHz,Ampl>3Vpp;30dBc 5MHz~80MHz,Ampl>3Vpp<br><0.2%+0.1mVrms DC ~ 20 kHz<br>-60dBc DC~1MHz; -50dBc 1MHz~20MHz; -50dBc + 6dBc/octave 1MHz~80MHz<br><-65dBc typical 10MHz, 30kHz band; <-47dBc typical 80MHz, 30kHz band |   |          |

| SPECIFICATIONS              |  |   |   |
|-----------------------------|--|---|---|
|                             |  | AFG-3081  | AFG-3051                                      |
| SQUARE WAVE CHARACTERISTICS | Rise/Fall Time<br>Duty Cycle<br>Overshoot<br>Asymmetry<br>Variable Duty Cycle<br>Jitter  | <8ns *3<br>20%~80%<br>< 5%<br>1% of period+1ns<br>20.0%~80.0% ≤ 25MHz; 40.0%~60.0%, 25~50MHz; 50.0%(Fixed), 50~80MHz<br>0.01% + 525ps < 2MHz; 0.1% + 75ps > 2MHz  |   |
| RAMP CHARACTERISTICS        | Linearity<br>Variable Symmetry   | < 0.1% of peak output<br>0%~100%  |   |
| PULSE CHARACTERISTICS       | Period<br>Pulse Width<br>Overshoot<br>Jitter   | 20ns ~ 2000s<br>8ns ~ 1999.9s; Minimum Pulse Width: 8ns when FREQ≤50MHz; 5% of setting period when FREQ≤6.5MHz ;<br>Resolution: 1ns when FREQ≤50MHz; 1% of setting period when FREQ≤6.5MHz<br><5%<br>100 ppm +50 ps   |   |
| AM MODULATION               | Carrier Waveforms<br>Modulating Waveforms<br>Modulating Frequency<br>Depth<br>Source   | Sine, Square, Triangle, Ramp, Pulse, Arb<br>Sine, Square, Triangle, Up/Dn Ramp<br>2mHz ~ 20kHz<br>0% ~ 120.0%<br>Internal/External  |   |
| FM MODULATION               | Carrier Waveforms<br>Modulating Waveforms<br>Modulating Frequency<br>Peak Deviation<br>Source                                  | Sine, Square, Triangle, Ramp<br>Sine, Square, Triangle, Up/Dn Ramp<br>2mHz ~ 20kHz  | DC ~ 80MHz<br>DC ~ 50MHz<br>Internal/External |
| PWM                         | Carrier Waveforms<br>Modulating Waveforms<br>Modulating Frequency<br>Deviation<br>Source                                       | Square<br>Sine, Square, Triangle, Up/Dn Ramp<br>2mHz ~ 20kHz<br>0% ~ 100.0% of pulse width<br>Internal/External   |   |
| FSK                         | Carrier Waveforms<br>Modulating Waveforms<br>Internal Rate<br>Frequency Range<br>Source  | Sine, Square, Triangle, Ramp, Pulse<br>50% duty cycle square<br>2 mHz ~ 100 kHz<br>DC ~ 80MHz<br>Internal/External  | DC ~ 50MHz                                    |
| SWEEP                       | Waveforms<br>Type<br>Source<br>Start/Stop FREQ<br>Sweep Time<br>Trigger<br>Marker<br>Source                                    | Sine, Square, Triangle<br>Linear or Logarithmic<br>Internal/External<br>100μHz ~ 80 MHz<br>1ms ~ 500s<br>Single, External, Internal<br>Falling edge of Mark signal (Programmable frequency)<br>Internal/External  | 100μHz ~ 50MHz                                |
| BURST                       | Waveforms<br>Frequency<br>Burst Count<br>Start/Stop Phase<br>Internal Period<br>Gate Source<br>Trigger Source<br>Trigger Delay | Sine, Square, Triangle, Ramp<br>1μHz ~ 80MHz *4<br>1 ~ 1000000 cycles or Infinite<br>-360.0 ~ +360.0°<br>1ms ~ 500s<br>External Trigger<br>Single, External or Internal Rate<br>N-Cycle, Infinite : 0s ~ 85s  | 1μHz ~ 50 MHz *4                              |
| EXTERNAL MODULATION INPUT   | Type<br>Voltage Range<br>Input Impedance<br>Frequency  | for AM, FM, Sweep, PWM<br>± 5V full scale<br>10kΩ<br>DC ~ 20 kHz  |   |
| EXTERNAL TRIGGER INPUT      | Type<br>Input Level<br>Slope<br>Pulse Width<br>Input Impedance<br>Latency<br>Jitter  | for FSK, Burst, Sweep<br>TTL Compatible<br>Rising or falling(selectable)<br>> 100 ns<br>10kΩ,DC coupled<br>Sweep: <10us(typical); Burst: <100ns(typical)<br>Sweep: 2.5us; Burst: 1ns; except pulse, 300ps   |   |
| MODULATION OUTPUT           | Type<br>Amplitude  | for AM, FM, Sweep, PWM<br>Range:≥1Vpp; Impedance: >10kΩ typical(fixed)  |   |
| TRIGGER OUTPUT              | Type<br>Level<br>Pulse Width<br>Maximum Rate<br>Fan-out<br>Impedance   | for Burst, Sweep<br>TTL Compatible into 50Ω<br>> 450 ns<br>1 MHz<br>≥ 4 TTL load<br>50Ω typical   |   |
| MARKER OUTPUT               | Type<br>Level<br>Fan-out<br>Impedance  | for ARB, Sweep<br>TTL Compatible into 50Ω<br>≥ 4 TTL load<br>50Ω typical  |   |
| Store/Recall                |  | 10 Groups of Setting Memories   |   |
| Interface                   |  | GPIO, RS-232C, USB Host/Device  |   |
| Display                     |  | 4.3 inch TFT LCD; 480 × 3 (RGB) × 272   |   |
| SYSTEM CHARACTERISTICS      | Configuration Times(typical)<br><br>Arb Download Times(typical)  | Function Change: Standard>102ms,Pulse>660ms,Built-In Arb>240ms<br>Frequency Change: 24ms;Amplitude Change: 50ms;Offset Change: 50ms<br>Select User Arb: < 2s for 1M points; Modulation Change: < 200ms<br>Binary Code: GPIO/RS-232C (115 Kbps), USB(Device); ASC II Code: USB(Host)*6 |   |
| GENERAL SPECIFICATIONS      | Power Consumption<br>Operating Environment<br><br>Operating Altitude<br>Pollution Degree<br>Storage Temperature                | 65VA<br>Temperature to satisfy the specification: 18 ~ 28° C; Operating temperature: 0 ~ 40° C<br>Relative Humidity: ≤80%, 0 ~ 40° C, ≤70%, 35 ~ 40° C; Installation category: CAT II<br>2000 meters<br>IEC 61010 Degree 2, Indoor Use<br>-10 ~ 70° C, Humidity: ≤70%                 |   |
| POWER SOURCE                |  | AC100 ~ 240V , 50 ~ 60Hz  |   |
| POWER CONSUMPTION           |  | 65VA  |   |
| DIMENSIONS & WEIGHT         |  | 265 (W) x 107 (H) x 374 (D)mm, Approx. 4kg  |   |



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