

# Arbitrary Function Generator

AFG-2000 Series

## Service MANUAL

GW INSTEK PART NO.



ISO-9001 CERTIFIED MANUFACTURER

**GW INSTEK**

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# S SAFETY INSTRUCTIONS

This chapter contains important safety instructions that should be followed when operating and storing the function generator. Read the following before any operation to ensure your safety and to keep the function generator in the best condition.

## Safety Symbols

These safety symbols may appear in this manual or on the instrument.



Warning: Identifies conditions or practices that could result in injury or loss of life.



Caution: Identifies conditions or practices that could result in damage to the function generator or to other objects or property.



DANGER High Voltage



Attention: Refer to the Manual



Protective Conductor Terminal



Earth (Ground) Terminal



DANGER Hot Surface



Double Insulated



Do not dispose electronic equipment as unsorted municipal waste. Please use a separate collection facility or contact the supplier from which this instrument was purchased.

## Safety Guidelines

General Guideline • Do not place heavy objects on the instrument.

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** CAUTION**

- Do not place flammable objects on the instrument.
- Avoid severe impact or rough handling that may damage the function generator.
- Avoid discharges of static electricity on or near the function generator.
- Use only mating connectors, not bare wires, for the terminals.
- The instrument should only be disassembled by a qualified technician.

(Measurement categories) EN 61010-1:2010 specifies the measurement categories and their requirements as follows. The instrument falls under category II.

- Measurement category IV is for measurement performed at the source of a low-voltage installation.
- Measurement category III is for measurement performed in a building installation.
- Measurement category II is for measurement performed on circuits directly connected to a low voltage installation.
- Measurement category I is for measurements performed on circuits not directly connected to Mains.

---

**Power Supply  
 WARNING**

- AC Input voltage: 100 ~ 240V AC, 50 ~ 60Hz.
- Connect the protective grounding conductor of the AC power cord to an earth ground to prevent electric shock.

---

**Fuse  
 WARNING**

- Fuse type: F1A/250V.
  - Only qualified technicians should replace the fuse.
  - To ensure fire protection, replace the fuse only with the specified type and rating.
  - Disconnect the power cord and all test leads before replacing the fuse.
  - Make sure the cause of fuse blowout is fixed before replacing the fuse.
-

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cleaning the function generator | <ul style="list-style-type: none"> <li>• Disconnect the power cord before cleaning the function generator.</li> <li>• Use a soft cloth dampened in a solution of mild detergent and water. Do not spray any liquid into the function generator.</li> <li>• Do not use chemicals containing harsh products such as benzene, toluene, xylene, and acetone.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Operation Environment           | <ul style="list-style-type: none"> <li>• Location: Indoor, no direct sunlight, dust free, almost non-conductive pollution (Note below) and avoid strong magnetic fields.</li> <li>• Relative Humidity: &lt; 80%</li> <li>• Altitude: &lt; 2000m</li> <li>• Temperature: 0°C to 40°C</li> </ul> <p>(Pollution Degree) EN 61010-1:2010 specifies pollution degrees and their requirements as follows. The function generator falls under degree 2.</p> <p>Pollution refers to "addition of foreign matter, solid, liquid, or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity".</p> <ul style="list-style-type: none"> <li>• Pollution degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.</li> <li>• Pollution degree 2: Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.</li> <li>• Pollution degree 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected. In such conditions, equipment is normally protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity is controlled.</li> </ul> |
| Storage environment             | <ul style="list-style-type: none"> <li>• Location: Indoor</li> <li>• Relative Humidity: &lt; 80%</li> <li>• Temperature: -10°C to 70°C</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Disposal                        | <p>Do not dispose this instrument as unsorted municipal waste. Please use a separate collection facility or contact the supplier from which this instrument was purchased. Please make sure discarded electrical waste is properly recycled to reduce environmental impact.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |



## Power cord for the United Kingdom

When using the function generator in the United Kingdom, make sure the power cord meets the following safety instructions.



E: This lead/appliance must only be wired by competent persons

**WARNING: THIS APPLIANCE MUST BE EARTHED**

**IMPORTANT:** The wires in this lead are coloured in accordance with the following code:

Green/ Yellow: Earth

Blue: Neutral

Brown: Live (Phase)



As the colours of the wires in main leads may not correspond with the coloured marking identified in your plug/appliance, proceed as follows:

The wire which is coloured Green & Yellow must be connected to the Earth terminal marked with either the letter E, the earth symbol  or coloured Green/Green & Yellow.

The wire which is coloured Blue must be connected to the terminal which is marked with the letter N or coloured Blue or Black.

The wire which is coloured Brown must be connected to the terminal marked with the letter L or P or coloured Brown or Red.

If in doubt, consult the instructions provided with the equipment or contact the supplier.

This cable/appliance should be protected by a suitably rated and approved HBC mains fuse: refer to the rating information on the equipment and/or user instructions for details. As a guide, a cable of 0.75mm<sup>2</sup> should be protected by a 3A or 5A fuse. Larger conductors would normally require 13A types, depending on the connection method used.

Any exposed wiring from a cable, plug or connection that is engaged in a live socket is extremely hazardous. If a cable or plug is deemed hazardous, turn off the mains power and remove the cable, any fuses and fuse assemblies. All hazardous wiring must be immediately destroyed and replaced in accordance to the above standard.

# HOW TO USE THIS MANUAL

If you are not sure what type of service operation you should choose, read the *Service Operation List* section and find the chapter which suits your needs. The *Summary of Each Chapter* section gives you an overview of this service manual's contents.

To find a place in the manual which deals with a specific keyword, refer to the *Index* chapter at the end of this service manual.

## Service Operation List

See the following list, decide which operation you might need, and jump to the introduced chapter.

| I want to...                     | Go to...                                                                                                                                                                                     | Page   |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Verify the specifications        | The <i>Verification</i> chapter. We recommend you to verify all listed items at once.                                                                                                        | Page34 |
| Calibrate the function generator | The <i>Calibration</i> chapter. To ensure accuracy, calibrate all listed items at once. We also recommend you to verify the specifications afterward.                                        | Page28 |
| Update the firmware              | The <i>Firmware Update</i> chapter.                                                                                                                                                          | Page49 |
| Replace the fuse                 | The <i>Fuse Replacement</i> chapter.                                                                                                                                                         | Page52 |
| Examine the circuits             | The <i>PCB &amp; Circuit Diagrams</i> chapter.                                                                                                                                               | Page61 |
| Order a part                     | The <i>Parts List</i> chapter. Look up the parts list and find the part name, part number, and quantity. For PCB mounted parts, look into the <i>PCB &amp; Circuit Diagrams</i> chapter too. | Page74 |

# Summary of Chapters

This document consists of the following chapters.

|                                 |                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Safety Instructions             | Describes the important safety instructions that should be followed before, during, and after operating the function generator.                                                                                                                                                                                                                                            |
| How to Use This Manual (page10) | <p>Provides the summary of each chapter in this service manual and shows where to read for various service operations.</p> <ul style="list-style-type: none"> <li>• List of service operations</li> <li>• Summary of chapters</li> </ul>                                                                                                                                   |
| AFG-2000 Overview (page13)      | <p>Helps service engineers become familiar with the function generator. Panel overview and specifications contain all performance data and functionalities. Operation theory shows how the function generator is internally structured.</p> <ul style="list-style-type: none"> <li>• Front and Rear panel</li> <li>• Operation theory</li> <li>• Specifications</li> </ul> |
| Preparation (page24)            | <p>Describes how to set up the function generator to prepare for various service operations. Also lists all the required tools.</p> <ul style="list-style-type: none"> <li>• Package contents</li> <li>• Setting up the function generator</li> <li>• List of equipments for various service operations</li> </ul>                                                         |
| Calibration (page28)            | <p>Describes how to calibrate the function generator using its automatic calibration function.</p> <p>AFG-2000:</p> <ul style="list-style-type: none"> <li>• Output frequency</li> <li>• Sine wave output amplitude</li> <li>• Output DC offset</li> <li>• Square wave amplitude</li> <li>• DUTY calibration</li> </ul>                                                    |
| Verification (page34)           | Describes how to verify the function generator's major functionalities, covering the following items:                                                                                                                                                                                                                                                                      |

|                                           |                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                               |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                           | <ul style="list-style-type: none"> <li>• Output signal frequency</li> <li>• Output signal amplitude</li> <li>• Output offset</li> <li>• Square wave duty and the rise and fall time</li> </ul>                                                                                                                                                                | <ul style="list-style-type: none"> <li>• Frequency counter function verification</li> <li>• modulation and sweep function</li> <li>• Synchronization function</li> <li>• Signal distortion and harmonic distortion</li> </ul> |
| Firmware upgrade (page 49)                | Describes how to upgrade the firmware.                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                               |
| Fuse replacement (page 52)                | Describes how to replace the fuses. <ul style="list-style-type: none"> <li>• Main fuse (stored in the power cord socket)</li> <li>• Sub fuses (mounted on the function generator PCB)</li> </ul>                                                                                                                                                              |                                                                                                                                                                                                                               |
| Disassembly (page 54)                     | Shows how to remove major modules from the function generator. <ul style="list-style-type: none"> <li>• Front frame</li> <li>• Rear frame</li> <li>• Metal frame</li> </ul>                                                                                                                                                                                   |                                                                                                                                                                                                                               |
| AFG-2000 PCB & Circuit diagrams (page 61) | Shows the PCB layout diagrams and circuit diagrams. <ul style="list-style-type: none"> <li>• The power unit circuit</li> <li>• The CPU unit circuit</li> <li>• The EPGA unit circuit</li> <li>• The output and protection circuit</li> <li>• The control and filter unit circuit</li> <li>• The display circuit</li> <li>• The Push button circuit</li> </ul> |                                                                                                                                                                                                                               |
| Parts List (page 74)                      | Shows the diagrams and replacement parts list for the mechanical components used in the function generator. <ul style="list-style-type: none"> <li>• Outer casing</li> <li>• Front panel</li> <li>• Internal structures</li> <li>• AFG-2000 PCB parts</li> </ul>                                                                                              |                                                                                                                                                                                                                               |
| Appendix (page 78)                        | <ul style="list-style-type: none"> <li>• Declaration of conformity</li> <li>• Index</li> </ul>                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                               |

# AFG-2000 OVERVIEW

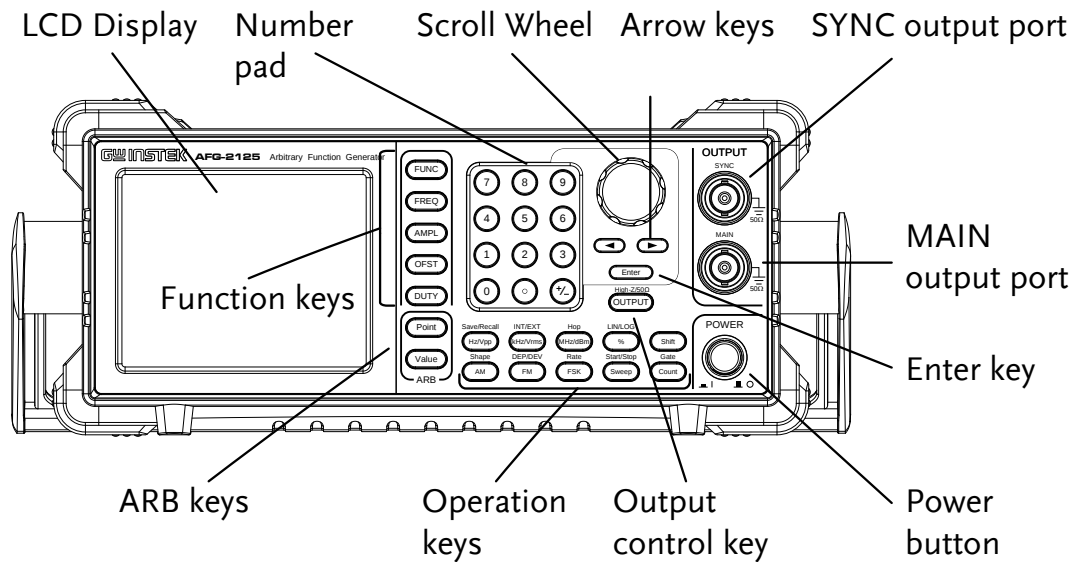
The Overview chapter helps you become familiar with the function generator. The front and rear panel diagrams introduce how the panel items are called. The operation theory describes the function generator’s internal structure, and how the signals are processed. The specifications section lists technical details of the function generator series.

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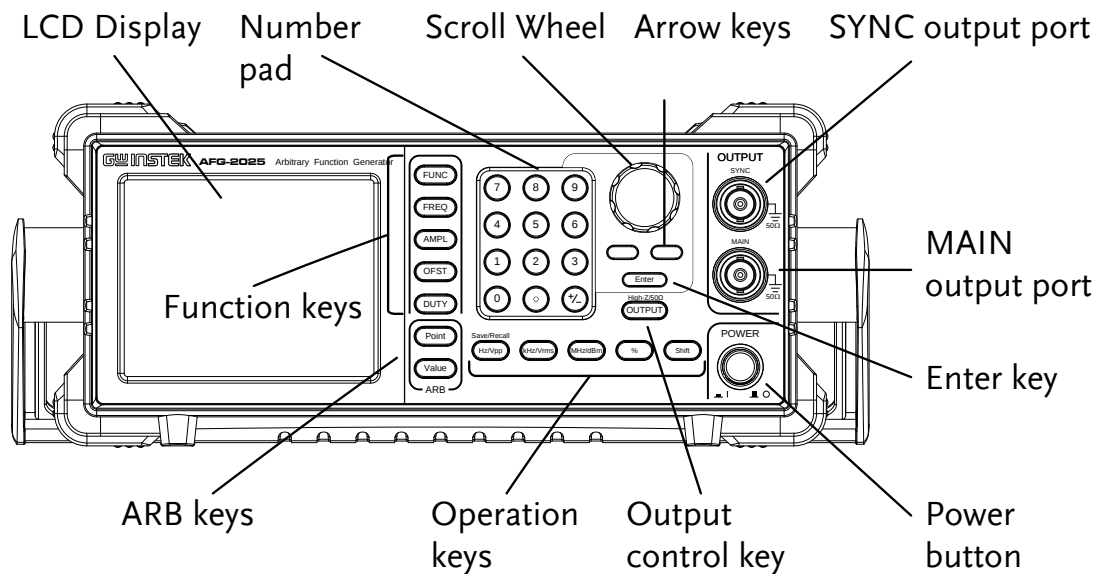
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# Front Panel

## AFG-2105/2112/2125 Front Panel

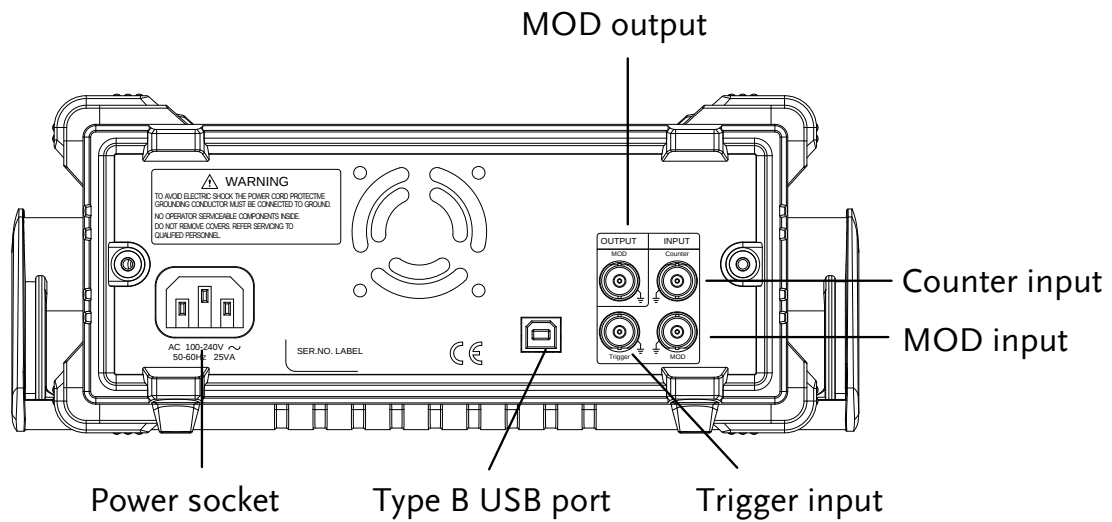


## AFG-2005/2012/2025 Front Panel

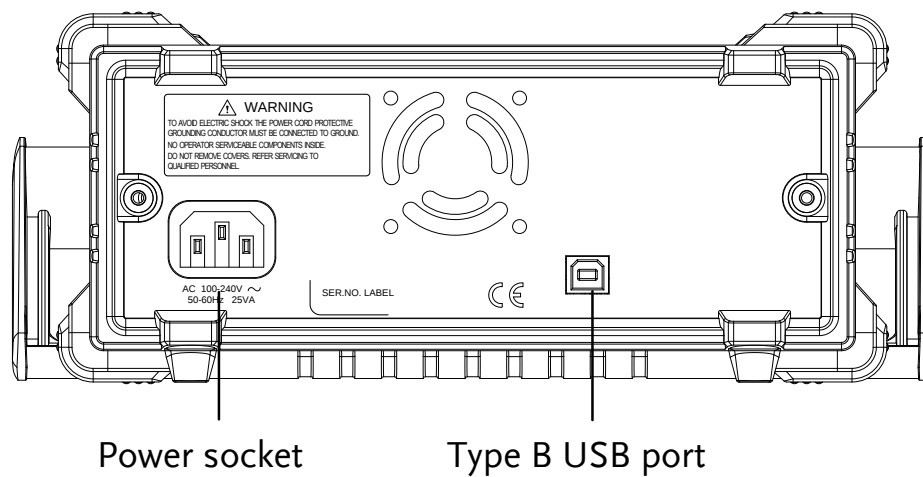


# Rear panel

## AFG-2105/2112/2125 Rear Panel



## AFG-2005/2012/2025 Rear Panel



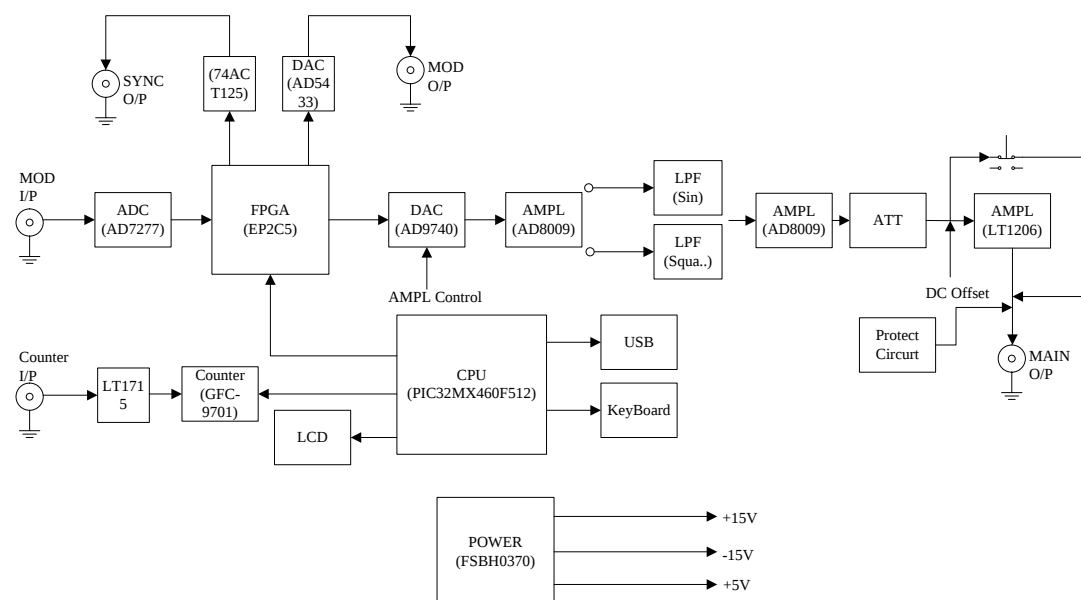
# Operation Theory

## Overview

The function generator consists of the following modules.

- Power process unit
- CPU control unit
- FPGA waveform generator and digital to analog conversion
- Signal amplitude control unit
- Signal offset control unit
- Signal waveform switching unit

## Block diagram



## Power circuit

Through the control of the chip FSBH0370, the switching power supply unit ultimately generates voltages of +15 V/ -15V / +5 V. The +5 V output generates a voltage of 3.3V/1.2V for the FPGA via the regulator, while +15 V/-15V output is used to output the +5 V/-5V for the rest of the electronic circuits after going through the voltage regulator block.

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CPU control circuit             | The CPU plays the role of controlling the entire circuit. It controls the display, keyboard input, the switching of the relays and so forth. All peripheral circuits around the CPU are typical circuits, the application of which can be referred to in their respective data sheets. There is a flash memory chip (U603) with a 3.3V power supply in the periphery to store the CPU operating data, the 8MHz X602 oscillator is used as the system reference clock.                                                                                                                                                                                                           |
| FPGA circuit                    | The FPGA is used to generate DDS waveforms and modulation functions. Various waveforms are generated and completed by the FPGA. Then they are converted into analog signal by the DAC chip and are output via the filter. The power supply voltage for the I/O port is 3.3V and for the intellectual property core, it is 1.2V.                                                                                                                                                                                                                                                                                                                                                 |
| OUTPUT circuit                  | There are two OUTPUTs. One is the main channel output, the other is the synchronized waveform output. The Sync signal varies with respect to the main channel output. Please refer to the AFG user manual for details. The digital stream signal generated by the FPGA is converted to an analog signal via DAC (U401). Then it is passed through a filter to get the final output waveform. However, it still needs to be passed through the attenuation, amplification, and power amplification stage (U302) before it becomes the final output signal. In addition, a self-recovery fuse (TH301) is designed to be in the path of the output circuit to protect the circuit. |
| MOD I/O circuit                 | The modulating (baseband) wave is input from the modulation port to the AD727 chip and gets digitized, and then it along with the clock signal is fed back to the FPGA. The signal is processed by the FPGA and then the final modulated output is generated by the DAC (U201).                                                                                                                                                                                                                                                                                                                                                                                                 |
| Amplitude and DC offset circuit | The CPU passes the amplitude and offset controlling parameters to the FPGA. The FPGA processes them and passes them to U103 to output control to a specific circuit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

# The Principle of Direct Digital Synthesis

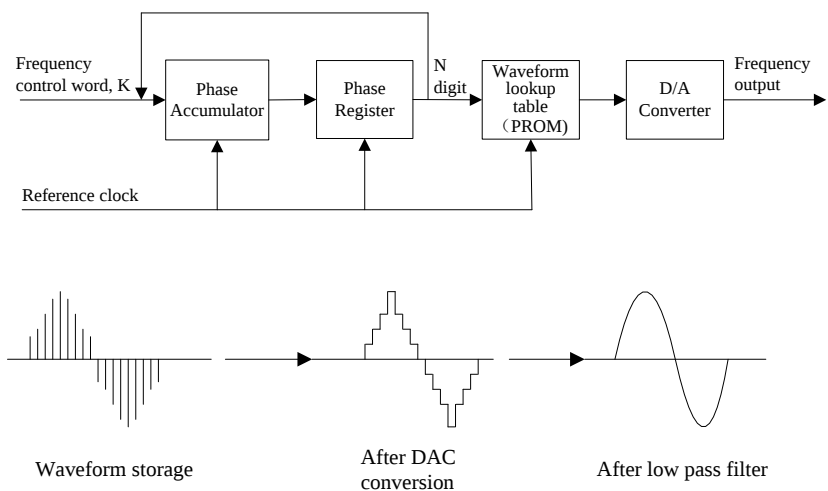
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|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Background | <p>The AFG-2000 series is a kind of digital signal generator source which is based on digital electronic technology. It uses an FPGA as the core of the digital processing. When compared to other digitized systems, it features good control, and can easily include sophisticated control algorithms to generate waveforms for different industrial needs.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Theory     | <p>DDS technology is derived from the concept of phase. It is a technology of directly synthesizing the digital frequency of a desired waveform and mainly achieved through searching a waveform table. By Nyquist sampling theory, we know that when the sampling frequency is greater than two times of the highest frequency of the sampled signal, the digital signal obtained through sampling can restore its original signal by passing through a low-pass filter.</p> <p>A DDS signal generator is mainly composed of a phase accumulator, a phase register, waveform memory, a D/A converter and an analog low-pass filter. Its basic block diagram is shown as below:</p> <p>The reference clock is a highly stable crystal oscillator, where its output is used to synchronize the work of the components of the DDS.</p> <p>The core of the DDS system is the phase accumulator which consists of N-bit adder and an N-bit phase register. It is similar to a simple calculator. When a timed pulse comes, the output in the phase register is increased by a phase increment value of one step length. The adder adds frequency control data and accumulated phase data output from the accumulator register and then sends the result to the end of the data input of the accumulator register. The phase accumulator starts to execute linear phase accumulation. When it accumulates until the full scale, it produces a count overflow. The overflow frequency is the DDS output frequency. The sine lookup table is a programmable read-only memory (PROM). It uses phase as an address to store all the samples that encode a period</p> |

---

of sinusoidal signal. Each address includes amplitude information for the sine wave. Each address corresponds to a phase point from 0 to 360 degrees on the sine waveform. The data obtained from adding the output of the phase register and the phase control word is used as an address for addressing the sine lookup table. The lookup table maps the input address information into the phase amplitude of the sine wave signal and then drives the DAC to output the analog signal. The low pass filter smoothly filters out unwanted sampling components, so that the sine wave signal can be output with pure and clean spectrum.

Diagram



## The Principles of Arbitrary Waveform Creation

### Background

One of the special features for the AFG-2000 Series signal source is the ability to create 4K point arbitrary waveforms. Its basic principle is still derived from DDS technology. The waveform memory can be used by the user to edit the required waveform.

---

**Theory**

For most applications, the function generator will fill the waveform memory by repeating a pattern of the same points or by interpolating points as it is not necessary to create arbitrary waveforms with specific points. For example, if you specify 100 points, each waveform point will be repeated by an average of  $4096/100$  times. For the AFG-2000 series signal generators, you don't have to change the waveform length in order to change its output frequency. You can create a waveform of any length and then adjust the output frequency of the function generator. However, in order to get the best results, we recommend using the entire range of the waveform DAC. (Using all  $\pm 511$ -point amplitude level).

The AFG-2000 arbitrary waveform function can be used to output a frequency up to 20MHz. However, due to bandwidth limitations and aliasing, generally when reaching to the max limit, amplitude will have -3dB attenuation.

---

**Diagram**

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# AFG-2000 Series Specifications

The specifications apply when the function generator is powered on for at least 30 minutes under +20°C~+30°C.

| AFG-2000 models           |                      | 2005                                                                                                                                                            | 2012         | 2025         | 2105        | 2112         | 2125        |
|---------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|-------------|--------------|-------------|
| Waveforms                 |                      | Sine, Square, Ramp, Noise, ARB                                                                                                                                  |              |              |             |              |             |
| Arbitrary Functions       |                      |                                                                                                                                                                 |              |              |             |              |             |
|                           | Sample Rate          | 20 MSa/s                                                                                                                                                        |              |              |             |              |             |
|                           | Repetition Rate      | 10MHz                                                                                                                                                           |              |              |             |              |             |
|                           | Waveform Length      | 4k points                                                                                                                                                       |              |              |             |              |             |
|                           | Amplitude Resolution | 10 bits                                                                                                                                                         |              |              |             |              |             |
|                           | Non-Volatile Memory  | 4k points                                                                                                                                                       |              |              |             |              |             |
| Frequency Characteristics |                      |                                                                                                                                                                 |              |              |             |              |             |
| Range                     | Sine                 | 0.1Hz~5 MHz                                                                                                                                                     | 0.1Hz~1 2MHz | 0.1Hz~2 5MHz | 0.1Hz~5 MHz | 0.1Hz~1 2MHz | 0.1Hz~25MHz |
|                           | Square               | 0.1Hz~5 MHz                                                                                                                                                     | 0.1Hz~1 2MHz | 0.1Hz~2 5MHz | 0.1Hz~5 MHz | 0.1Hz~1 2MHz | 0.1Hz~25MHz |
|                           | Triangle, Ramp       | 1MHz                                                                                                                                                            |              |              |             |              |             |
| Resolution                |                      | 0.1Hz                                                                                                                                                           |              |              |             |              |             |
| Accuracy                  | Stability            | ±20 ppm                                                                                                                                                         |              |              |             |              |             |
|                           | Aging                | ±1 ppm, per 1 year                                                                                                                                              |              |              |             |              |             |
|                           | Tolerance            | ≤ 1 mHz                                                                                                                                                         |              |              |             |              |             |
| Output Characteristics    |                      |                                                                                                                                                                 |              |              |             |              |             |
| Amplitude                 | Range                | 1 mVpp to 10 Vpp (into 50Ω)<br>2 mVpp to 20 Vpp (open-circuit)<br>1 mVpp to 5 Vpp (into 50Ω) for 20MHz~25MHz<br>2 mVpp to 10 Vpp (open-circuit) for 20MHz~25MHz |              |              |             |              |             |
|                           | Accuracy             | ± 2% of setting ±1 mVpp (at 1 kHz)                                                                                                                              |              |              |             |              |             |
|                           | Resolution           | 1 mV or 3 digits                                                                                                                                                |              |              |             |              |             |
|                           | Flatness             | ± 1% (0.1 dB) ≤100kHz<br>± 3% (0.3 dB) ≤5MHz<br>± 5% (0.4 dB) ≤12MHz<br>±20%(2dB)≤20MHz<br>± 5% (0.4 dB) ≤25MHz<br>(sine wave relative to 1 kHz)                |              |              |             |              |             |
|                           | Units                | Vpp, Vrms, dBm                                                                                                                                                  |              |              |             |              |             |
| Offset                    | Range                | ±5 Vpk ac +dc (into 50Ω)<br>±10Vpk ac +dc (Open circuit)<br>±2.5 Vpk ac +dc (into 50Ω) for 20MHz~25MHz<br>±5Vpk ac +dc (Open circuit) for 20MHz~25MHz           |              |              |             |              |             |
|                           | Accuracy             | 2% of setting + 5 mV+ 0.5% of amplitude                                                                                                                         |              |              |             |              |             |
|                           | Impedance            | 50Ω typical (fixed)<br>> 300kΩ (output disabled)                                                                                                                |              |              |             |              |             |
| Attenuator                |                      | —                                                                                                                                                               |              |              |             |              |             |
| SYNC Output               | Protection           | Short-circuit protected<br>Overload relay automatically disables main output                                                                                    |              |              |             |              |             |
|                           | Level                | TTL-compatible into>1 kΩ                                                                                                                                        |              |              |             |              |             |
|                           | Impedance            | 50Ω nominal                                                                                                                                                     |              |              |             |              |             |
|                           | Fan Out              | —                                                                                                                                                               |              |              |             |              |             |

| Rise of Fall Time           |                                              | ≤ 25ns                                      |
|-----------------------------|----------------------------------------------|---------------------------------------------|
| Sine wave Characteristics   |                                              |                                             |
| Harmonic distortion         | -55 dBc                                      | DC ~ 200kHz, Ampl > 0.1Vpp                  |
|                             | -50 dBc                                      | 200kHz ~ 1MHz, Ampl > 0.1Vpp                |
|                             | -35 dBc                                      | 1MHz ~ 5MHz, Ampl > 0.1Vpp                  |
|                             | -30 dBc                                      | 5MHz ~ 25MHz, Ampl > 0.1Vpp                 |
| Square wave Characteristics |                                              |                                             |
| Rise/Fall Time              | ≤25ns at maximum output.<br>(into 50 Ω load) |                                             |
| Overshoot                   | <5%                                          |                                             |
| Asymmetry                   | 1% of period + 1 ns                          |                                             |
| Variable duty Cycle         | 1.0% to 99.0% ≤100kHz                        |                                             |
|                             | 20.0% to 80.0% ≤ 5MHz                        |                                             |
|                             | 40.0% to 60.0% ≤ 10MHz                       |                                             |
|                             | 50% ≤ 25MHz                                  |                                             |
| Ramp Characteristics        |                                              |                                             |
| Linearity                   | < 0.1% of peak output                        |                                             |
| Variable Symmetry           | 0% to 100% (0.1% Resolution)                 |                                             |
| AM Modulation               |                                              |                                             |
| Carrier Waveforms           | —                                            | Sine, Square, Ramp                          |
| Modulating Waveforms        | —                                            | Sine, Square, Triangle                      |
| Modulating Frequency        | —                                            | 2mHz to 20kHz (Int)<br>DC to 20kHz (Ext)    |
| Depth                       | —                                            | 0% to 120.0%                                |
| Source                      | —                                            | Internal / External                         |
| FM Modulation               |                                              |                                             |
| Carrier Waveforms           | —                                            | Sine, Square, Ramp                          |
| Modulating Waveforms        | —                                            | Sine, Square, Triangle                      |
| Modulating Frequency        | —                                            | 2mHz to 20kHz (Int)<br>DC to 20kHz (Ext)    |
| Peak Deviation              | —                                            | DC to Max Frequency                         |
| Source                      | —                                            | Internal / External                         |
| Sweep                       |                                              |                                             |
| Waveforms                   | —                                            | Sine, Square, Ramp                          |
| Type                        | —                                            | Linear or Logarithmic                       |
| Start/Stop Freq             | —                                            | 0.1Hz to Max Frequency                      |
| Sweep Time                  | —                                            | 1ms to 500s                                 |
| Source                      | —                                            | Internal / External                         |
| FSK                         |                                              |                                             |
| Carrier Waveforms           | —                                            | Sine, Square, Ramp                          |
| Modulating Waveforms        | —                                            | 50% duty cycle square                       |
| Modulation Rate             | —                                            | 2mHz to 100 kHz (INT)<br>DC to 100 kHz(EXT) |
| Frequency Range             | —                                            | 0.1Hz to Max Frequency                      |
| Source                      | —                                            | Internal / External                         |

|                        |                       |                                                                                                                                                                                               |                                                                       |
|------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| Frequency Counter      |                       |                                                                                                                                                                                               |                                                                       |
|                        | Range                 | —                                                                                                                                                                                             | 5Hz to 150MHz                                                         |
|                        | Accuracy              | —                                                                                                                                                                                             | Time Base<br>accuracy±1 count                                         |
|                        | Time Base             | —                                                                                                                                                                                             | ±20ppm (23°C ±5°C) after<br>30 minutes warm up                        |
|                        | Resolution            | —                                                                                                                                                                                             | The maximum resolution<br>is:<br>100nHz for 1Hz, 0.1Hz for<br>100MHz. |
|                        | Input Impedance       | —                                                                                                                                                                                             | 1kΩ/1pf                                                               |
|                        | Sensitivity           | —                                                                                                                                                                                             | 35mVrms ~ 30Vms (5Hz to<br>150MHz)                                    |
| Save/Recall            |                       | 10 Groups of Setting Memories (Locations 0~9 only<br>for instrument state, Locations 10~19 only for ARB<br>data)                                                                              |                                                                       |
| Interface              |                       | USB (Device)                                                                                                                                                                                  |                                                                       |
| Display                |                       | LCD                                                                                                                                                                                           |                                                                       |
| General Specifications |                       |                                                                                                                                                                                               |                                                                       |
|                        | Power Source          | AC100~240V, 50~60Hz                                                                                                                                                                           |                                                                       |
|                        | Power Consumption     | 25 VA (Max)                                                                                                                                                                                   |                                                                       |
|                        | Operating Environment | Temperature to satisfy the specification : 18 ~<br>28°C<br>Operating temperature :<br>0 ~ 40°C<br>Relative Humidity:<br>≤ 80%, 0 ~ 40°C<br>≤ 70%, 35 ~ 40°C<br>Installation category : CAT II |                                                                       |
|                        | Operating Altitude    | 2000 Meters                                                                                                                                                                                   |                                                                       |
|                        | Storage Temperature   | -10~70°C, Humidity: ≤80%                                                                                                                                                                      |                                                                       |
|                        | Dimensions (WxHxD)    | 266(W) x 107(H) x 293(D) mm                                                                                                                                                                   |                                                                       |
|                        | Weight                | Approx. 2.5kg                                                                                                                                                                                 |                                                                       |
|                        | Accessories           | GTL-101×1 GTL-101×2<br>Quick Start Guide ×1<br>CD (user manual + software) ×1<br>Power cord×1                                                                                                 |                                                                       |

# PREPARING FOR SERVICE OPERATIONS

The Preparation chapter describes the What (package contents, required equipments) and How (setting up the function generator) to prepare for various service operations.

---

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| Package Contents .....                 | 24 |
| Setting Up the function generator..... | 24 |
| List of Equipment .....                | 26 |

## Package Contents

The list below shows the components included in the purchased function generator.

---

|              |                                                                                                                                                                                                                                                                    |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Main unit    | AFG-2000                                                                                                                                                                                                                                                           |
| Cables       | <ul style="list-style-type: none"><li>• GTL-110x2(Only AFG-2100) GTL-110X1(Only AFG-2000)</li><li>• Power cord x 1</li></ul>                                                                                                                                       |
| Manual       | <ul style="list-style-type: none"><li>CD (User manual) x 1</li><li>Quick Start Guide x 1</li></ul>                                                                                                                                                                 |
| PC interface | <p>The following items are not included in the package but are additionally required when using the AFG-2000's PC interface functionalities.</p> <ul style="list-style-type: none"><li>• USB cable x 1, Type A (host, PC) – Type B (slave, power supply)</li></ul> |

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## Setting Up the function generator

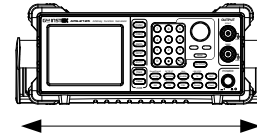
Follow these instructions to properly set up the function generator. Refer to the user manual for more details regarding other operations.

**Background**

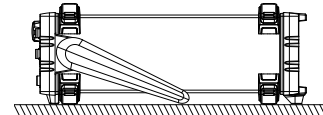
This section describes how adjust the handle and power up the function generator.

**Adjusting the stand**

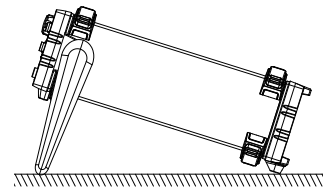
Pull out the handle sideways and rotate it.



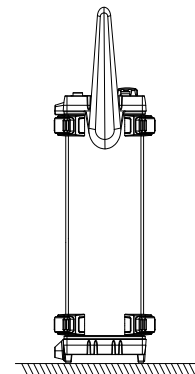
Place the AFG horizontally.



Place the handle upright to tilt the stand.

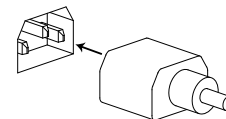


Place the handle vertically to hand carry.

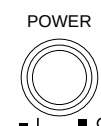


**Power Up**

1. Connect the power cord to the socket on the rear panel.



2. Press the power button on the front panel.



3. The instrument will turn on and load the last settings that were used before the power was turned off.



The function generator is now ready to be used.

## List of Equipment

Here is the list of all equipment used in the service operations.

| Item               | Requirements                                                                                                                                                                                                                                                                                                                                                                               | Used in                                                                                           |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Digital multimeter | <ul style="list-style-type: none"> <li>• DCV accuracy: <math>\pm (0.005\%+0.0006)</math></li> <li>• DCA accuracy: <math>\pm (0.10\%+0.0001)</math></li> <li>• Recommend model: Agilent-34401A</li> </ul>                                                                                                                                                                                   | Measurement and calibration of amplitude and DC offset of signal source                           |
| Frequency counter  | <ul style="list-style-type: none"> <li>• DC coupling: 0.01Hz~120MHz</li> <li>• ACcoupling: 30Hz~120MHz</li> <li>• Accuracy: 8 digits</li> <li>• Recommend model: GW GFC-8131H</li> </ul>                                                                                                                                                                                                   | Measurement of signal source output frequency accuracy                                            |
| Oscilloscope       | <ul style="list-style-type: none"> <li>• Bandwidth: DC~100MHz 2Chanel</li> <li>• Accuracy: <math>\pm (3\% \times \text{reading} + 0.05\text{div} + 0.8\text{mv})</math></li> <li>• Offset: 2mv/div~20mv/div: <math>\pm .5\text{v}</math><br/>50/div~200v/div: <math>\pm 5\text{v}</math><br/>500div~2v/div: <math>\pm 50\text{V}</math></li> <li>• Recommend model: GW GDS-2202</li> </ul> | Signal symmetry, duty cycle, overshoot and output amplitude flatness measurement and calibration. |

|                              |                                                                                                                                                     |                                                            |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| Spectrum Analyzer            | <ul style="list-style-type: none"> <li>• frequency range: 9KHz~3GHz</li> <li>• Recommend: GW GSP-830</li> </ul>                                     | Measuring harmonic distortion                              |
| Low frequency signal source  | <ul style="list-style-type: none"> <li>• frequency range: 0.1mHz~1.2MHz</li> <li>• Recommend model: NF ELECTRONIC INSTRUMENTS 1930A</li> </ul>      | Used for the external modulation input signal              |
| High frequency signal source | <ul style="list-style-type: none"> <li>• frequency range: 9KHz~3.2GHz</li> <li>• Recommend model: Agilent 8648C</li> </ul>                          | Verify the frequency counter function                      |
| Distortion Analyzer          | <ul style="list-style-type: none"> <li>• Recommend model: LEVEAR VP-7723D</li> </ul>                                                                | Verify the signal distortion                               |
| Signal modem                 | <ul style="list-style-type: none"> <li>• Demodulation function: AM/FM/FSK/SWEEP</li> <li>• Recommend model :HP 8902A(Measuring Receiver)</li> </ul> | Verify the signal generator modulation and sweep function. |
| 50 $\Omega$ Load             | <ul style="list-style-type: none"> <li>• Precision <math>50 \pm 1\%</math></li> </ul>                                                               | Used for impedance matching.                               |
| PC                           | <ul style="list-style-type: none"> <li>• Windows XP based PC</li> </ul>                                                                             | PC software installation                                   |
| USB cable                    | <ul style="list-style-type: none"> <li>• TypeA (host, PC) – TypeB (slave, power supply)</li> </ul>                                                  | Firmware upgrade                                           |

# CALIBRATION

The Calibration chapter describes how to calibrate the function generator using its automatic calibration feature. We recommend you to verify the specifications after completing the calibrations.

---

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| Calibration Log.....           | 29 |
| AFG-2000 Calibration Mode..... | 29 |
| Calibration Method.....        | 32 |

## Preparing for Calibration

---



In order to ensure performance accuracy, we recommend you to calibrate all items listed in this chapter at once.

---

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Calibration item | AFG-2000:                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                  | <ul style="list-style-type: none"> <li>• DC zero point calibration of sine wave</li> <li>• DC zero point calibration of square wave</li> <li>• Output amplitude correction of sine wave</li> <li>• Output amplitude flatness correction of sine wave</li> <li>• Output signal amplitude correction of square wave</li> <li>• Output amplitude correction of triangle wave</li> <li>• signal DC offset correction</li> <li>• 1KHz square wave DUTY correction</li> </ul> |

---

|                                          |                                                                                                                                                                                                                                                                                                            |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| When to calibrate the function generator | <ul style="list-style-type: none"> <li>• When using the function generator in a new environment</li> <li>• After replacing one of the major internal modules, such as the front panel or replacing the attenuation resistors on the output circuit (R354, R353, R352, R342, soldering required)</li> </ul> |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

---

|                      |                                                                                                                                                                                                  |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pre-calibration test | <p>To make the calibration more effective, we recommend you to run the following test beforehand.</p> <ul style="list-style-type: none"> <li>• Burn-in test: 4 hours, 20—30°C, RH 65%</li> </ul> |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

---

Calibration  
environment

- Location: Indoor, no direct sunlight, dust free
- Relative Humidity: < 80%
- Temperature: +20°C~+30°C
- Warm-up time: ≥ 30 minutes

Calibration  
equipments

For detailed requirements for the equipments, see page 25.

## Calibration Log

Print out these pages and record the results. Keep it with the function generator.

Model AFG-2000

Serial number \_\_\_\_\_

Date Year \_\_\_\_\_ Month \_\_\_\_\_ Date \_\_\_\_\_

Verified by Name \_\_\_\_\_  
Company/Contact \_\_\_\_\_

Environment Temperature \_\_\_\_\_°C Humidity \_\_\_\_\_%

## AFG-2000 Calibration Mode

AFG-2000 calibration mode

1. Enter the calibration mode

The default password after booting is:

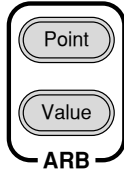


2. At this time the display on the instrument (as shown below) indicates that the instrument has entered into calibration mode.



3. Press the Point button on the panel to set the calibration point. Press the Value button to adjust the calibration value. You can change the calibration

value with the scroll knob or the numeric keys and Enter keys. When adjusting the calibration value, the output of the instrument will make the corresponding change. If the output of the instrument meets the required limits in the calibration table, it indicates that this calibration point is completed. Then move to the next calibration point to continue the calibration.



4. After the values are set, press the **FREQ** key. The instrument will save the calibration values and return to its default interface. At this time the calibration is complete.
5. The total number of calibration points for the AFG-2000 is shown as the following table:

| Point                         | Adjustment Parameters                            | Vpp<br>Adjusted the<br>output value | Vpp_<br>Offset ( $\pm$ )<br>Allowed<br>adjustment<br>offset | The<br>system<br>default<br>Value | Value_<br>Offset ( $\pm$ ) |
|-------------------------------|--------------------------------------------------|-------------------------------------|-------------------------------------------------------------|-----------------------------------|----------------------------|
| DC range measurement with DMM |                                                  |                                     |                                                             |                                   |                            |
| 1                             | DC zero point calibration of sine wave           | 0                                   | 0.001                                                       | 2200                              | 1000                       |
| 2                             | DC zero point calibration of square wave         | 0                                   | 0.001                                                       | 2200                              | 1200                       |
| AC range measurement with DMM |                                                  |                                     |                                                             |                                   |                            |
| 3                             | 3.535Vrms 1kHz sine wave amplitude adjustment    | 3.535                               | 0.017                                                       | 3225                              | 150                        |
| 4                             | 0.8838Vrms_1 1kHz sine wave amplitude adjustment | 0.883                               | 0.004                                                       | 825                               | 100                        |
| 5                             | 0.8838Vrms_2 1kHz sine wave amplitude adjustment | 0.883                               | 0.004                                                       | 3250                              | 100                        |
| 6                             | 220.9mVrms_1 1kHz sine wave amplitude adjustment | 0.2209                              | 0.001                                                       | 820                               | 80                         |
| 7                             | 220.9mVrms_2 1kHz sine wave amplitude adjustment | 0.2209                              | 0.001                                                       | 3300                              | 200                        |
| 8                             | 55.2mVrms_1 1kHz sine wave amplitude adjustment  | 0.0552                              | 0.00027                                                     | 825                               | 80                         |
| 9                             | 55.2mVrms_2 1kHz sine wave amplitude adjustment  | 0.0552                              | 0.00027                                                     | 3300                              | 100                        |
| 10                            | 13.8mVrms_1 1kHz sine wave amplitude adjustment  | 0.0138                              | 0.00015                                                     | 825                               | 80                         |
| 11                            | 13.8mVrms_2 1kHz sine wave amplitude adjustment  | 0.0138                              | 0.00015                                                     | 3250                              | 100                        |
| 12                            | 3.452mVrms 1kHz sine wave                        | 0.0035                              | 0.00015                                                     | 825                               | 50                         |

|    |                                                    |        |          |      |     |
|----|----------------------------------------------------|--------|----------|------|-----|
|    | amplitude adjustment                               |        |          |      |     |
| 13 | 3.452mVrms 1kHz sine wave amplitude adjustment     | 0.0035 | 0.00015  | 3250 | 250 |
| 14 | 0.863mVrms_1 1kHz sine wave amplitude adjustment   | 0.0009 | 0.00015  | 825  | 250 |
| 15 | 0.863mVrms_2 1kHz sine wave amplitude adjustment   | 0.0009 | 0.00015  | 3250 | 300 |
| 16 | 0.354mVrms 1kHz sine wave amplitude adjustment     | 0.0004 | 0.00015  | 1500 | 600 |
| 17 | 5Vrms 1KHz square wave amplitude adjustment        | 5      | 0.025    | 3400 | 150 |
| 18 | 1.25Vrms_1 1kHz square wave amplitude adjustment   | 1.25   | 0.00625  | 870  | 50  |
| 19 | 1.25Vrms_2 1kHz square wave amplitude adjustment   | 1.25   | 0.00625  | 3350 | 150 |
| 20 | 0.3125Vrms_1 1kHz square wave amplitude adjustment | 0.3125 | 0.00156  | 870  | 50  |
| 21 | 0.3125Vrms_2 1kHz square wave amplitude adjustment | 0.3125 | 0.00156  | 3400 | 150 |
| 22 | 78.1mVrms_1 1kHz square wave amplitude adjustment  | 0.0781 | 0.00039  | 870  | 50  |
| 23 | 78.1mVrms_2 1kHz square wave amplitude adjustment  | 0.0781 | 0.00039  | 3400 | 100 |
| 24 | 19.53mVrms_1 1kHz square wave amplitude adjustment | 0.0195 | 0.000097 | 870  | 50  |
| 25 | 19.53mVrms_2 1kHz square wave amplitude adjustment | 0.0195 | 0.000097 | 3450 | 200 |
| 26 | 4.883mVrms_1 1kHz square wave amplitude adjustment | 0.0049 | 0.00005  | 870  | 100 |
| 27 | 4.883mVrms_2 1kHz square wave amplitude adjustment | 0.0049 | 0.0001   | 3350 | 200 |
| 28 | 1.221mVrms_1 1kHz square wave amplitude adjustment | 0.0012 | 0.0001   | 870  | 200 |
| 29 | 1.221mVrms_2 1kHz square wave amplitude adjustment | 0.0012 | 0.0001   | 3350 | 200 |
| 30 | 0.5mVrms 1kHz square wave amplitude adjustment     | 0.0005 | 0.0001   | 1500 | 200 |
|    | DC range adjustment with DMM                       |        |          |      |     |
| 31 | 4.99V DC OFFSET adjustment                         | 4.99   | 0.01     | 225  | 100 |
| 32 | 0V(0.01vpp) DC OFFSET adjustment                   | 0      | 0.002    | 2075 | 30  |
| 33 | 0V(0.1vpp) DC OFFSET adjustment                    | 0      | 0.002    | 2075 | 30  |
| 34 | 0V(1vpp) DC OFFSET adjustment                      | 0      | 0.002    | 2075 | 30  |
| 35 | 0V(10vpp) DC OFFSET adjustment                     | 0      | 0.002    | 2075 | 30  |
| 36 | 0V DC OFFSET adjustment (20M10vpp)                 | 0.02   | 0.003    | 2125 | 30  |

| Measurement with oscilloscope |                                                |       |        |       |      |
|-------------------------------|------------------------------------------------|-------|--------|-------|------|
| 37                            | 50% 1kHz square wave duty adjustment           | 0.5   | 0.003  | 1275  | 150  |
| 38                            | 20% 1kHz square wave duty adjustment           | 0.2   | 0.003  | 2480  | 200  |
| 39                            | 80% 1kHz square wave duty adjustment           | 0.8   | 0.003  | 120   | 120  |
| 80                            | 23M 5VPP Sine wave frequency response          | 5     | 0.1    | 9000  | 1000 |
| 81                            | 25M 5VPP Sine wave frequency response          | 5     | 0.1    | 8000  | 800  |
| 82                            | 23M 2.5VPP Sine wave frequency response        | 2.25  | 0.05   | 10200 | 600  |
| 83                            | 25M 2.5VPP Sine wave frequency response        | 2.25  | 0.05   | 9500  | 600  |
| AC range measurement with DMM |                                                |       |        |       |      |
| 90                            | 2.887Vrms Triangle wave amplitude adjustment   | 2.887 | 0.014  | 3250  | 150  |
| 91                            | 0.722Vrms_1 Triangle wave amplitude adjustment | 0.722 | 0.0036 | 820   | 50   |

## Calibration Method

The following examples illustrate the method how to calibrate the amplitude of a 1kHz sine wave. Other calibration items such as DC offset and square wave duty calibration can also be performed in the same way.

| Calibration item                        | 1kHz sine wave amplitude calibration                                                                                                       |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Required calibration devices and cables | <ul style="list-style-type: none"> <li>• Agilent 34401A</li> <li>• 50 <math>\Omega</math> load</li> <li>• BNC to DMM test cable</li> </ul> |

---

**Connection  
explanation**

1. Enter into calibration mode, and then go to to calibration point 3 (Amplitude calibration of 1kHz sine wave). At this point the output of the main channel will automatically turn on and output a 1kHz sine wave.
2. Adjust the multimeter to the appropriate range and scale. Compare the reading from the multimeter with the value in the calibration table. Reach the correct calibration value by adjusting the calibration value (using the Value key and scroll wheel/numeric keys).

**Note:**

1. Here, for illustration, let the device enter into calibration mode and skip to the calibration point 3. However, it is not recommended to directly skip past calibration point 1 in actual calibration. You should adjust calibration points sequentially from calibration point 1.
  2. Of particular note is that the output of the signal generator must add a 50Ω load, the last chapter of the calibration tables require the use of the 50Ω measurement.
-

# VERIFICATION

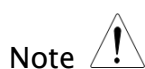
The Verification chapter describes how to make sure the function generator is operating properly by verifying its major functionalities. The verification is intended for a full performance inspection before shipping the function generator to the end user, after major component replacements, or a firmware upgrade.

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## Preparing for Verification

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In order to ensure performance accuracy, we recommend you to verify all items listed in this chapter at once.

---

|                                  |                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| When to verify the specification | <ul style="list-style-type: none"> <li>• When using the function generator in a new environment</li> <li>• After replacing one of the major internal modules, such as front panel or power supply PCB</li> <li>• After updating the firmware</li> <li>• When you need to make sure that the function generator is malfunctioning or not</li> </ul> |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

---

|                                |                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pre-verification test          | <p>To make verification more effective, the following test is recommended before the verification.</p> <ul style="list-style-type: none"> <li>• Burn-in test: 4 hours, 20~30°C, RH 65%</li> </ul>                                                                                                                                                  |
| Verification Environment       | <ul style="list-style-type: none"> <li>• Location: Indoor, no direct sunlight, dust free</li> <li>• Relative Humidity: &lt; 80%</li> <li>• Temperature: +20°C~+30°C</li> <li>• Warm-up time: ≥ 30 minutes</li> </ul>                                                                                                                               |
| Verification equipment         | <ul style="list-style-type: none"> <li>• DMM</li> <li>• Oscilloscope</li> <li>• Frequency counter</li> <li>• Low frequency signal source</li> <li>• High frequency signal source</li> <li>• Distortion meter</li> <li>• Spectrum Analyzer</li> <li>• Modem</li> </ul> <p>Please refer to the last chapter “The list of equipment” for details.</p> |
| When the verification fails... | <ul style="list-style-type: none"> <li>• If verification fails for items such as the output signal amplitude, DC offset or signal flatness fails, perform calibration and verification again by referring to the previous chapter.</li> <li>• For other items, send the function generator back to the factory for repair.</li> </ul>              |

## Verification Log

Print out these pages and record the results. Keep it with the function generator.

|               |                                   |
|---------------|-----------------------------------|
| Model         | AFG-2000                          |
| Serial number | _____                             |
| Date          | Year_____ Month_____ Date_____    |
| Verified by   | Name_____                         |
|               | Company/Contact_____              |
| Environment   | Temperature_____°C Humidity_____% |

## Table of Required Verification Items

| Number                                   | Items                  | Set the source state (Substitute with the commands below) You can manually set the settings if you wish. | Result   | Result Limit (±) |
|------------------------------------------|------------------------|----------------------------------------------------------------------------------------------------------|----------|------------------|
| Verify the output signal frequency (hz)  |                        |                                                                                                          |          |                  |
| 1                                        | Frequency              | source:apply:sin25mahz,2.5vpp,0                                                                          | 25000000 | 450              |
| 2                                        | Accuracy Test          | source:apply:squ 25mahz,2.5vpp,0                                                                         | 25000000 | 450              |
| 3                                        |                        | source:apply:sin 12mahz,2.5vpp,0                                                                         | 12000000 | 216              |
| 4                                        |                        | source:apply:squ 12mahz,2.5vpp,0                                                                         | 12000000 | 216              |
| 5                                        |                        | source:apply:sin 5mahz,2.5vpp,0                                                                          | 5000000  | 90               |
| 6                                        |                        | source:apply:squ 1mahz,2.5vpp,0                                                                          | 1000000  | 18               |
| 7                                        |                        | source:apply:ramp 1mahz,2.5vpp,0                                                                         | 1000000  | 18               |
| Confirm output signal amplitude (rms)    |                        |                                                                                                          |          |                  |
| 8                                        | Output                 | source:apply:sin 1000hz,10vpp,0                                                                          | 3.5      | 0.06363          |
| 9                                        | amplitude confirmation | source:apply:squ 1000hz,10vpp,0                                                                          | 4.95     | 0.09             |
| 10                                       |                        | source:squ:dcycle 50                                                                                     |          |                  |
|                                          |                        | source:apply:ramp 1000hz,10vpp,0                                                                         | 2.85     | 0.05195          |
|                                          |                        | source:ramp:symm 50                                                                                      |          |                  |
| 11                                       |                        | source:apply:sin 1000hz,2.5vpp,0                                                                         | 0.87375  | 0.0159           |
| 12                                       |                        | source:apply:squ 1000hz,2.5vpp,0                                                                         | 1.24     | 0.0225           |
|                                          |                        | source:squ:dcycle 50                                                                                     |          |                  |
| 13                                       |                        | source:apply:ramp 1000hz,2.5vpp,0                                                                        | 0.7117   | 0.013            |
|                                          |                        | source:ramp:symm 50                                                                                      |          |                  |
| 14                                       |                        | source:apply:sin 1000hz,0.625vpp,0                                                                       | 0.2199   | 0.00398          |
| 15                                       |                        | source:apply:squ 1000hz,0.625vpp,0                                                                       | 0.3115   | 0.0056           |
|                                          |                        | source:squ:dcycle 50                                                                                     |          |                  |
| 16                                       |                        | source:apply:ramp 1khz,0.625vpp,0                                                                        | 0.1784   | 0.00325          |
|                                          |                        | source:ramp:symm 50pp,0                                                                                  |          |                  |
| 17                                       |                        | source:apply:sin 1000hz,0.156vpp,0                                                                       | 0.055    | 0.0013           |
| 18                                       |                        | source:apply:squ 1000hz,0.156vpp,0                                                                       | 0.078    | 0.0017           |
|                                          |                        | source:squ:dcycle 50                                                                                     |          |                  |
| 19                                       |                        | source:apply:ramp 1khz,0.156vpp,0                                                                        | 0.045    | 0.00112          |
|                                          |                        | source:ramp:symm 50                                                                                      |          |                  |
| 20                                       |                        | source:apply:sin 1000hz,0.039vpp,0                                                                       | 0.01378  | 0.00056          |
| 21                                       |                        | source:apply:squ 1000hz,0.039vpp,0                                                                       | 0.0195   | 0.000666         |
|                                          |                        | source:squ:dcycle 50                                                                                     |          |                  |
| 22                                       |                        | source:apply:ramp 1khz,0.039vpp,0                                                                        | 0.01125  | 0.00054          |
|                                          |                        | source:ramp:symm 50                                                                                      |          |                  |
| 23                                       |                        | source:apply:sin 1khz,0.01vpp,0                                                                          | 0.003535 | 0.000378         |
| 24                                       |                        | source:apply:squ 1000hz,0.01vpp,0                                                                        | 0.005    | 0.0004           |
|                                          |                        | source:squ:dcycle 50                                                                                     |          |                  |
| 25                                       |                        | source:apply:ramp 1000hz,0.01vpp,0                                                                       | 0.00288  | 0.00037          |
|                                          |                        | source:ramp:symm 50                                                                                      |          |                  |
| Output signal DC offset confirmation (v) |                        |                                                                                                          |          |                  |
| 26                                       | DC offset              | source:apply:sin 1000hz,0.01,4.99                                                                        | 4.99     | 0.09432          |
| 27                                       | confirmation           | source:apply:sin 1000hz,0.01,2.5                                                                         | 2.5      | 0.0495           |
| 28                                       |                        | source:apply:sin 1000hz,0.01,0.63                                                                        | 0.63     | 0.01575          |
| 29                                       |                        | source:apply:sin 1000hz,0.01,0.16                                                                        | 0.16     | 0.0073           |
| 30                                       |                        | source:apply:sin 1000hz,0.01,0.04                                                                        | 0.04     | 0.0052           |

|                                                                    |                   |                                    |         |         |
|--------------------------------------------------------------------|-------------------|------------------------------------|---------|---------|
| 31                                                                 |                   | source:apply:sin 1000hz,0.01,0.01  | 0.01    | 0.00468 |
| 32                                                                 |                   | source:apply:sin 1000hz,0.01,-0.01 | -0.01   | 0.00468 |
| 33                                                                 |                   | source:apply:sin 1000hz,0.01,-0.04 | -0.04   | 0.0052  |
| 34                                                                 |                   | source:apply:sin 1000hz,0.01,-0.16 | -0.16   | 0.0073  |
| 35                                                                 |                   | source:apply:sin 1000hz,0.01,-0.63 | -0.63   | 0.01575 |
| 36                                                                 |                   | source:apply:sin 1000hz,0.01,-2.5  | -2.5    | 0.0495  |
| 37                                                                 |                   | source:apply:sin 1000hz,0.01,-4.99 | -4.99   | 0.09432 |
| 38                                                                 |                   | source:apply:sin 1000hz,0.01,0.01  | 0.01    | 0.053   |
| 39                                                                 |                   | source:apply:sin 1000hz,9,-0.01    | -0.01   | 0.053   |
| 40                                                                 |                   | source:apply:sin 1000hz,4.5,1      | 1       | 0.04275 |
| 41                                                                 |                   | source:apply:sin 1000hz,4.5,-1     | -1      | 0.04275 |
| 42                                                                 |                   | source:apply:sin 1000hz,2,4        | 4       | 0.0855  |
| 43                                                                 |                   | source:apply:sin 1000hz,2,-4       | -4      | 0.0855  |
| 44                                                                 |                   | source:apply:sin 1000hz,1,4.5      | 4.5     | 0.09    |
| 45                                                                 |                   | source:apply:sin 1000hz,1,-4.5     | -4.5    | 0.09    |
| 46                                                                 |                   | source:apply:sin 1000hz,0.5,4.75   | 4.75    | 0.09225 |
| 47                                                                 |                   | source:apply:sin 1000hz,0.5,-4.75  | -4.75   | 0.09225 |
| <b>Signal distortion confirmation(%)</b>                           |                   |                                    |         |         |
| 48                                                                 | Signal distortion | source:apply:sin 1khz,0.01,0       | 0.089   | 0.0801  |
| 49                                                                 | verification with | source:apply:sin 10khz,10vpp,0     | 0.089   | 0.0801  |
| 50                                                                 | distortion meter  | source:apply:sin 1khz,10vpp,0      | 0.089   | 0.0801  |
| 51                                                                 |                   | source:apply:sin 100hz,10vpp,0     | 0.089   | 0.0801  |
| 52                                                                 |                   | source:apply:sin 10hz,10vpp,0      | 0.089   | 0.0801  |
| 53                                                                 |                   | source:apply:sin 100khz,2.5vpp,0   | 0.089   | 0.0801  |
| 54                                                                 |                   | source:apply:sin 10khz,2.5vpp,0    | 0.089   | 0.0801  |
| 55                                                                 |                   | source:apply:sin 1khz,2.5vpp,0     | 0.089   | 0.0801  |
| 56                                                                 |                   | source:apply:sin 100hz,2.5vpp,0    | 0.089   | 0.0801  |
| 57                                                                 |                   | source:apply:sin 10hz,2.5vpp,0     | 0.089   | 0.0801  |
| 58                                                                 |                   | source:apply:sin 100khz,1vpp,0     | 0.089   | 0.0801  |
| 59                                                                 |                   | source:apply:sin 10khz,1vpp,0      | 0.089   | 0.0801  |
| 60                                                                 |                   | source:apply:sin 1khz,1vpp,0       | 0.089   | 0.0801  |
| 61                                                                 |                   | source:apply:sin 100hz,1vpp,0      | 0.089   | 0.0801  |
| 62                                                                 |                   | source:apply:sin 10hz,1vpp,0       | 0.089   | 0.0801  |
| <b>Harmonic distortion confirmation(dbm)</b>                       |                   |                                    |         |         |
| 63                                                                 | Harmonic          | source:apply:sin 5mahz,10vpp,0     | -59     | 22      |
| 64                                                                 | distortion        | source:apply:sin 10mahz,10vpp,0    | -59     | 26.1    |
| 65                                                                 |                   | source:apply:sin 15mahz,10vpp,0    | -59     | 26.1    |
| 66                                                                 |                   | source:apply:sin 20mahz,10pp,0     | -59     | 26.1    |
| 67                                                                 |                   | source:apply:sin 1mahz,2.5vpp,0    | -69     | 17.1    |
| 68                                                                 |                   | source:apply:sin 5mahz,2.5vpp,0    | -59     | 22      |
| 69                                                                 |                   | source:apply:sin 10mahz,2.5vpp,0   | -59     | 26.1    |
| 70                                                                 |                   | source:apply:sin 15mahz,2.5vpp,0   | -59     | 26.1    |
| 71                                                                 |                   | source:apply:sin 20mahz,2.5vpp,0   | -59     | 26.1    |
| 72                                                                 |                   | source:apply:sin 1mahz,1vpp,0      | -69     | 17.1    |
| 73                                                                 |                   | source:apply:sin 5mahz,1vpp,0      | -59     | 22      |
| 74                                                                 |                   | source:apply:sin 10mahz,1vpp,0     | -59     | 26.1    |
| 75                                                                 |                   | source:apply:sin 15mahz,1vpp,0     | -59     | 26.1    |
| 76                                                                 |                   | source:apply:sin 20mahz,1vpp,0     | -59     | 26.1    |
| <b>Verification of the flatness of the output signal amplitude</b> |                   |                                    |         |         |
| 77                                                                 | output            | source:apply:sin 1khz,10vpp,0      | 3.5vrms | 0.06363 |
| 78                                                                 | amplitude         | source:apply:sin 10khz,10vpp,0     | 3.5     | 0.06363 |

|                                                      |                                                                                             |                                                         |          |           |
|------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------|----------|-----------|
| 79                                                   | flatness                                                                                    | source:apply:sin 100khz,10vpp,0                         | 3.5      | 0.06363   |
| 80                                                   | verification                                                                                | source:apply:sin 500khz,10vpp,0                         | 10Vpp    | 0.3       |
| 81                                                   |                                                                                             | source:apply:sin 1mahz,10vpp,0                          | 10       | 0.3       |
| 82                                                   |                                                                                             | source:apply:sin 2mahz,10vpp,0                          | 10       | 0.3       |
| 83                                                   |                                                                                             | source:apply:sin 5mahz,10vpp,0                          | 10       | 0.3       |
| 84                                                   |                                                                                             | source:apply:sin 6mahz,10vpp,0                          | 10       | 0.5       |
| 85                                                   |                                                                                             | source:apply:sin 8mahz,10vpp,0                          | 10       | 0.5       |
| 86                                                   |                                                                                             | source:apply:sin 10mahz,10vpp,0                         | 10       | 0.5       |
| 87                                                   |                                                                                             | source:apply:sin 12mahz,10vpp,0                         | 10       | 0.5       |
| 88                                                   |                                                                                             | source:apply:sin 14mahz,10vpp,0                         | 10       | 1.8       |
| 89                                                   |                                                                                             | source:apply:sin 16mahz,10vpp,0                         | 10       | 1.8       |
| 90                                                   |                                                                                             | source:apply:sin 18mahz,10vpp,0                         | 10       | 1.8       |
| 91                                                   |                                                                                             | source:apply:sin 23mahz,5vpp,0                          | 5        | 0.225     |
| 92                                                   |                                                                                             | source:apply:sin 25mahz,5vpp,0                          | 5        | 0.225     |
| 93                                                   |                                                                                             | source:apply:sin 25mahz,2.5vpp,0                        | 2.5      | 0.1125    |
| 94                                                   |                                                                                             | source:apply:sin 23mahz,2.5vpp,0                        | 2.5      | 0.1125    |
| Square wave duty and rise/fall time verification (s) |                                                                                             |                                                         |          |           |
| 95                                                   | Square wave                                                                                 | source:apply:squ 5mahz,10vpp,0                          | 0.5      | 0.018     |
| 96                                                   | Symmetry                                                                                    | source:apply:squ 1mahz,10vpp,0                          | 0.5      | 0.009     |
| 97                                                   | verification                                                                                | source:apply:squ 100khz,10vpp,0                         | 0.5      | 0.009     |
| 98                                                   |                                                                                             | source:apply:squ 10khz,10vpp,0                          | 0.5      | 0.009     |
| 99                                                   |                                                                                             | source:apply:squ 1khz,10vpp,0                           | 0.5      | 0.009     |
| 100                                                  | rise and fall                                                                               | source:apply:squ 1mahz,10vpp,0                          | 1.25E-08 | 1.125E-08 |
| 101                                                  | time verification                                                                           | source:apply:squ 1mahz,10vpp,0                          | 1.25E-08 | 1.125E-08 |
| 102                                                  |                                                                                             | source:apply:squ 100khz,10vpp,0                         | 1.25E-08 | 1.125E-08 |
| 103                                                  |                                                                                             | source:apply:squ 100khhz,10vpp,0                        | 1.25E-08 | 1.125E-08 |
| 104                                                  | Square wave                                                                                 | source:apply:squ 1mahz,10vpp,0                          | 0.0125   | 0.0125    |
| 105                                                  | overshoot verification                                                                      | source:apply:squ 1mahz,10vpp,0                          | 0.0125   | 0.0125    |
| 106                                                  | Square wave DUTY                                                                            | source:apply:squ 10khz,10vpp,0<br>source:squ:dcycle 20  | 0.2      | 0.018     |
| 107                                                  | verification                                                                                | source:apply:squ 10khz,10vpp,0<br>source:squ:dcycle 80  | 0.8      | 0.018     |
| 108                                                  |                                                                                             | source:apply:squ 1mahz,10vpp,0<br>source:squ:dcycle 20  | 0.2      | 0.04      |
| 109                                                  |                                                                                             | source:apply:squ 1mahz,10vpp,0<br>source:squ:dcycle 80  | 0.8      | 0.04      |
| 110                                                  |                                                                                             | source:apply:squ 5mahz,10vpp,0<br>source:squ:dcycle 20  | 0.2      | 0.04      |
| 111                                                  |                                                                                             | source:apply:squ 5mahz,10vpp,0<br>source:squ:dcycle 80  | 0.8      | 0.04      |
| 112                                                  |                                                                                             | source:apply:squ 10mahz,10vpp,0<br>source:squ:dcycle 40 | 0.4      | 0.04      |
| 113                                                  |                                                                                             | source:apply:squ 10mahz,10vpp,0<br>source:squ:dcycle 60 | 0.6      | 0.04      |
| 114                                                  |                                                                                             | source:apply:squ 20mahz,10vpp,0<br>source:squ:dcycle 50 | 0.5      | 0.04      |
| Frequency counter function verification              |                                                                                             |                                                         |          |           |
| 115                                                  | The setting for the high frequency signal source(8648c): Frequency 150Hz, Amplitude: 34mVpp |                                                         |          |           |
|                                                      | Counter                                                                                     | counter:state on                                        | 15000000 | 2700      |

|     |                                                                                                        |                  |          |       |
|-----|--------------------------------------------------------------------------------------------------------|------------------|----------|-------|
|     |                                                                                                        | counter:gate 0.1 | 0        |       |
| 116 | The setting for the high frequency signal source(8648c): Frequency 150Hz, Amplitude: 200mVpp           |                  |          |       |
|     | Counter                                                                                                | counter:state on | 15000000 | 2700  |
|     |                                                                                                        | counter:gate 0.1 | 0        |       |
| 117 | The setting for the high frequency signal source(8648c): Frequency 150Hz, Amplitude: 600mVpp           |                  |          |       |
|     | Counter                                                                                                | counter:state on | 15000000 | 2700  |
|     |                                                                                                        | counter:gate 0.1 | 0        |       |
| 118 | The setting for the high frequency signal source(8648c): Frequency 150Hz, Amplitude: 1.187Vpp          |                  |          |       |
|     | Counter                                                                                                | counter:state on | 15000000 | 2700  |
|     |                                                                                                        | counter:gate 0.1 | 0        |       |
| 119 | The setting for the low frequency signal source(NF 1930A): Frequency 5Hz(sin wave), Amplitude: 34mVpp  |                  |          |       |
|     | Counter                                                                                                | counter:state on | 5        | 0.009 |
|     |                                                                                                        | counter:gate 1   |          |       |
| 120 | The setting for the low frequency signal source(NF 1930A): Frequency 5Hz(sin wave), Amplitude: 100mVpp |                  |          |       |
|     | Counter                                                                                                | counter:state on | 5        | 0.009 |
|     |                                                                                                        | counter:gate 1   |          |       |
| 130 | The setting for the low frequency signal source(NF 1930A): Frequency 5Hz(sin wave), Amplitude: 1Vpp    |                  |          |       |
|     | Counter                                                                                                | counter:state on | 5        | 0.009 |
|     |                                                                                                        | counter:gate 1   |          |       |

#### Modulation function verification

|     |                                                              |                                                                                                                                                          |        |       |
|-----|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------|
| 131 | AM modulation depth verification (INT)                       | source:apply:sin 5mahz,1vpp,0<br>source:am:state on<br>source:am:source int;source:am:int:freq 1000<br>source:am:depth 50                                | 50     | 0.9   |
| 132 | NF1930A Setting<br>AM modulation depth verification (EXT)    | Frequency: 0.1kHz amplitude: 10Vpp<br>source:apply:sin 5mahz,1vpp,0<br>source:am:state on<br>source:am:source ext<br>source:am:depth 50                  | 50     | 5     |
| 133 | FM frequency deviation verification (INT)                    | source:apply:sin 4.8mahz,1vpp,0<br>source:fm:state on<br>source:fm:source int;source:fm:int:func sin<br>source:fm:int:freq 1000<br>source1:fm:dev 100000 | 100000 | 900   |
| 134 | NF1930A Setting<br>FM frequency deviation confirmation (EXT) | Frequency: 0.1kHz amplitude: 10Vpp<br>source:apply:sin 4.8mahz,1vpp,0<br>source:fm:state on<br>source:fm:source ext<br>source:fm:dev 100000              | 100000 | 10000 |
| 135 | NF1930A Setting                                              | Frequency: 0.1kHz amplitude: 5Vpp                                                                                                                        | 50000  | 5000  |

|     |           |                                                                                                          |
|-----|-----------|----------------------------------------------------------------------------------------------------------|
| 136 | FSK (EXT) | source:apply:sin 4.9mahz,1vpp,0<br>source:fsk:state on<br>source:fsk:source ext<br>source:fsk:freq 5mahz |
|-----|-----------|----------------------------------------------------------------------------------------------------------|

Frequency sweep feature verification

|     |                    |                                                                                                         |        |       |
|-----|--------------------|---------------------------------------------------------------------------------------------------------|--------|-------|
| 137 | Sweep verification | source:sweep:stat on<br>source:freq:start 4800000<br>source:freq:stop 5000000<br>source:sweep:rate 1000 | 100000 | 10000 |
|-----|--------------------|---------------------------------------------------------------------------------------------------------|--------|-------|

Synchronization verification

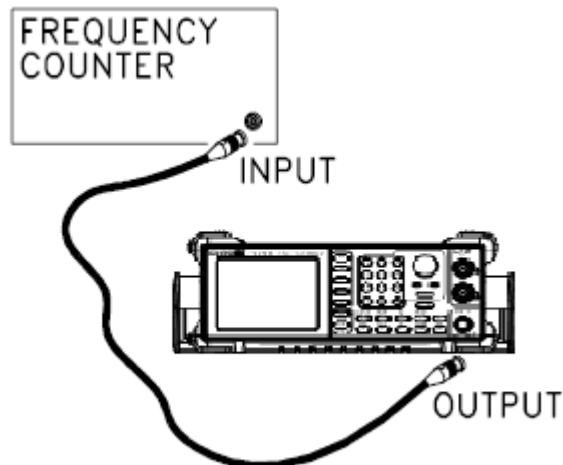
|     |                 |                               |            |            |
|-----|-----------------|-------------------------------|------------|------------|
| 138 | SYNC(Duty)      | source:apply:sin 1mahz,5vpp,0 | 0.5        | 0.018      |
| 139 | SYNC(Rise time) | source:apply:sin 1mahz,5vpp,0 | 0.00000002 | 0.00000002 |
| 140 | SYNC(Fall time) | source:apply:sin 1mahz,5vpp,0 | 0.00000002 | 0.00000002 |
| 141 | MOD OUT         | source:apply:sin 5mahz,1vpp,0 | 8.5        | 1          |

## Signal Output Frequency Verification

|                |            |                    |
|----------------|------------|--------------------|
| Accepted range | Insulation | $\pm 20\text{ppm}$ |
|----------------|------------|--------------------|

|           |                                                                                            |
|-----------|--------------------------------------------------------------------------------------------|
| Equipment | <ul style="list-style-type: none"> <li>• Frequency counter</li> <li>• BNC cable</li> </ul> |
|-----------|--------------------------------------------------------------------------------------------|

Connection

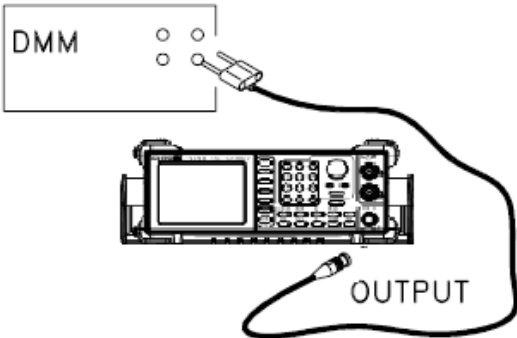


Verifying withstanding

3. Power up the function generator.
4. Set the signal source and output according to the items in the "Verification of the output signal frequency" table.
5. Readout the reading on the frequency counter and compare it with the expected limits in the table.

Frequency verification is completed.

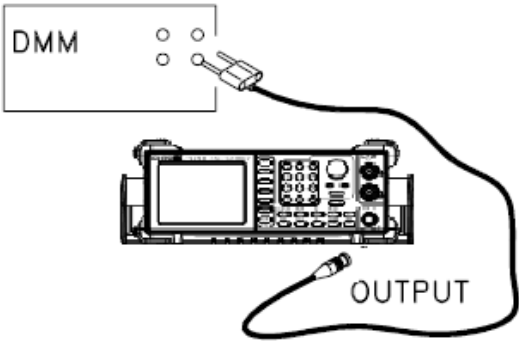
# Output Amplitude Verification

|                                             |                                                                                                                                                                                                                     |                                       |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Accepted range                              | Output accuracy                                                                                                                                                                                                     | $\pm 2\%$ of setting $\pm 1\text{mv}$ |
| Equipment                                   | <ul style="list-style-type: none"><li>• DMM</li><li>• BNC to DMM cable with <math>50\ \Omega</math> load</li></ul>                                                                                                  |                                       |
| Connection                                  |                                                                                                                                   |                                       |
| Configurations                              | <ul style="list-style-type: none"><li>• Set the signal source according to the verification log, then connect the cable to the main channel and turn the output on.</li><li>• Multimeter: AC voltage mode</li></ul> |                                       |
| Verifying output voltage readback accuracy  | <ol style="list-style-type: none"><li>1. Set the DMM range to the highest resolution that it can measure.</li><li>2. Compare the reading on the DMM with the expected results in the table.</li></ol>               |                                       |
| Verifying the output amplifier is completed |                                                                                                                                                                                                                     |                                       |

# DC Offset Output Verification

|                |                                                                                                                |                                                       |
|----------------|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| Accepted range | Output accuracy                                                                                                | $\pm 2$ of setting $+5\text{mV} + 0.5\%$ of amplitude |
| Equipment      | <ul style="list-style-type: none"><li>DMM</li><li>BNC to DMM cable with <math>50\ \Omega</math> load</li></ul> |                                                       |

Connection



Configurations

- Set the signal source according to the verification log, then connect the cable to the main channel and turn the output on  
Multimeter: DC voltage mode

Verifying output DC offset accuracy

1. Set the DMM range to highest resolution of precision that it can measure
2. Compare the DMM reading to the expected results in the table.

Verifying the output of DC Offset accuracy is completed

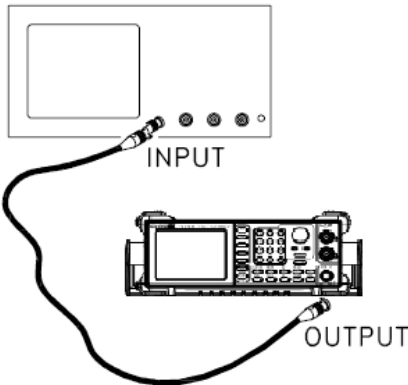
# Output Flatness Verification

|                |                                                                                                                                                                                                                                     |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accepted range | $\pm 1\% (0.1\text{dB}) \leq 100\text{kHz}$<br>$\pm 3\% (0.3\text{ dB}) \leq 5\text{MHz}$<br>$\pm 5\% (0.4\text{ dB}) \leq 12\text{MHz}$<br>$\pm 20\%(2\text{dB}) \leq 20\text{MHz}$<br>$\pm 5\% (0.4\text{ dB}) \leq 25\text{MHz}$ |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Equipment

- DMM
- Oscilloscope
- Test lead and 50  $\Omega$  load

Connection



|                           |                                                                                                                                                                                                                                                                                                                            |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configurations            | <ul style="list-style-type: none"> <li>• Set the signal source according to the verification log, then connect the cable to the main channel and turn the output on.</li> <li>• Measure signal frequencies below 100kHz with the DMM.</li> <li>• Measure signal frequencies above 100kHz with the oscilloscope.</li> </ul> |
| Verifying Output flatness | <ol style="list-style-type: none"> <li>1. Set the range of DMM to highest resolution that it can measure.</li> <li>2. Compare the reading on the DMM and with the expected results in the table.</li> </ol>                                                                                                                |

Output flatness verification is completed

## Signal Distortion Verification

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accepted range                      | <ul style="list-style-type: none"> <li><math>\pm 1\%</math> (0.1 dB) <math>\leq 100\text{kHz}</math></li> <li><math>\pm 3\%</math> (0.3 dB) <math>\leq 5\text{MHz}</math></li> <li><math>\pm 5\%</math> (0.4 dB) <math>\leq 12\text{MHz}</math></li> <li><math>\pm 20\%</math> (2dB) <math>\leq 20\text{MHz}</math></li> <li><math>\pm 5\%</math> (0.4 dB) <math>\leq 25\text{MHz}</math></li> </ul> |
| Equipment                           | <ul style="list-style-type: none"> <li>• Distortion meter</li> <li>• Test cable</li> </ul>                                                                                                                                                                                                                                                                                                           |
| Connection                          |                                                                                                                                                                                                                                                                                                                                                                                                      |
| Configurations                      | <ul style="list-style-type: none"> <li>• Set the signal source according to the verification log.</li> <li>• Connect signal source and distortion meter correctly.</li> </ul>                                                                                                                                                                                                                        |
| Verifying signal distortion results | <ol style="list-style-type: none"> <li>1. Readout the distortion value on the distortion meter.</li> <li>2. Compare the readout on the distortion meter with the expected results in the verification log and determine whether they conform to specification.</li> </ol>                                                                                                                            |

Signal distortion verification is completed.

# Harmonic Distortion Verification

|                                       |                                                                                                                                                                                                                                                                      |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accepted range                        | -55 dBc    DC ~ 200kHz, Ampl > 0.1Vpp<br>-50 dBc    200kHz ~ 1MHz, Ampl > 0.1Vpp<br>-35 dBc    1MHz ~ 5MHz, Ampl > 0.1Vpp<br>-30 dBc    5MHz ~ 25MHz, Ampl > 0.1Vpp                                                                                                  |
| Equipment                             | <ul style="list-style-type: none"> <li>• Spectrum analyzer</li> <li>• Test RF cable</li> </ul>                                                                                                                                                                       |
| Connection                            |                                                                                                                                                                                                                                                                      |
| Configurations                        | <ul style="list-style-type: none"> <li>• Set the signal source in accordance with the requirements in the verification log</li> <li>• Connect signal source and spectrum analyzer correctly.</li> </ul>                                                              |
| Verifying harmonic distortion results | <ol style="list-style-type: none"> <li>1. Readout the difference between the highest harmonic on the spectrum and the signal.</li> <li>2. Compare it with expected value in the verification log and determine whether it conforms to the specifications.</li> </ol> |

Harmonic distortion verification is completed.

# Frequency Counter Function Verification

|                |                                                                                                            |
|----------------|------------------------------------------------------------------------------------------------------------|
| Accepted range | 35mVrms ~ 30Vms (5Hz to 150MHz)                                                                            |
| Equipment      | <ul style="list-style-type: none"> <li>• High frequency signal source</li> <li>• BNC test cable</li> </ul> |
| Connection     |                                                                                                            |

|                |                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configurations | <ul style="list-style-type: none"> <li>• Set the high frequency signal source in accordance with the requirements in the verification log</li> <li>• Turn the on the frequency counter function on the AFG-2000. Make sure the correct gate time is set correctly.</li> <li>• Connect the output of the high frequency signal source to the input port of the frequency counter on the rear panel of the signal generator.</li> </ul> |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                          |                                                                                                                                              |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Verifying the frequency counter function | <ol style="list-style-type: none"> <li>1. Compare the frequency of the readout to the expected frequency in the verification log.</li> </ol> |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|

Frequency counter function verification is completed.

## Internal Modulation Function Verification

|                |                                                                                                                                                                                                                            |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accepted range | <p>AM/FM/FSK Function</p> <p>Carrier Waveforms : Sine, Square, Ramp</p> <p>Modulating Waveforms : Sine, Square, Triangle (FSK 50% duty cycle square)</p> <p>Modulating Frequency: 2mHz to 20kHz (Int)DC to 20kHz (Ext)</p> |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|           |                                                                                     |
|-----------|-------------------------------------------------------------------------------------|
| Equipment | <ul style="list-style-type: none"> <li>• Modem</li> <li>• BNC Test cable</li> </ul> |
|-----------|-------------------------------------------------------------------------------------|

### Connection

|                |                                                                                                                                                                                                                                               |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configurations | <ul style="list-style-type: none"> <li>• Set the signal source to modulation mode in accordance to the requirements in the verification log, and then set the type to internal modulation mode.</li> <li>• Set the modem correctly</li> </ul> |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                         |                                                                                                                                                                                                                       |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Verify the internal modulation function | <ol style="list-style-type: none"> <li>1. Set the DMM range to the highest resolution that it can measure.</li> <li>2. Compare the reading on the DMM with the expected results in the verification table.</li> </ol> |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Internal modulation function verification is completed.

## External Modulation Function Verification

|                               |                                                                                                                                                                                                                                                                               |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accepted range                | Carrier Waveforms : Sine, Square, Ramp<br>Modulating Waveforms : Sine, Square, Triangle (FSK 50% duty cycle square)<br>Modulating Frequency: 2mHz to 20kHz (Int)DC to 20kHz (Ext)                                                                                             |
| Equipment                     | <ul style="list-style-type: none"> <li>• High frequency signal source</li> <li>• Measuring Receiver (modem)</li> <li>• Test cable</li> </ul>                                                                                                                                  |
| Connection                    |                                                                                                                                                                                                                                                                               |
| Configurations                | <ul style="list-style-type: none"> <li>• Set the signal source to external modulation mode in accordance with the requirements in the verification log.</li> <li>• Set the modem correctly</li> <li>• Input the modulating signal from the external signal source.</li> </ul> |
| Verifying the sweep function. | Compare the modulation depth on the modem and modulation depth set on the signal generator. Verify with the expected results on the verification log.                                                                                                                         |

External modulation function verification is completed.

## Sweep Function Verification

|                |                                                                                                 |
|----------------|-------------------------------------------------------------------------------------------------|
| Accepted range | Waveforms: sin/ramp/square<br>Type: Linear or Logarithmic<br>Start/stop: 0.1Hz to Max Frequency |
| Equipment      | <ul style="list-style-type: none"> <li>• Modem</li> <li>• Test cable</li> </ul>                 |

Connection

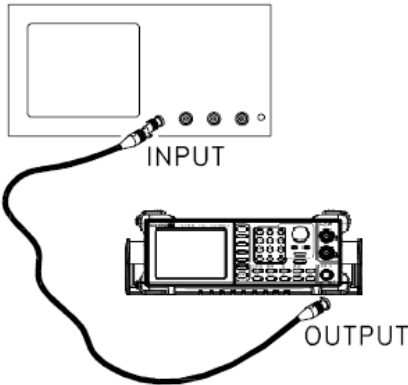
|                       |                                                                                                                                                                            |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configurations        | <ul style="list-style-type: none"><li>• Set the signal source to sweep mode according to the settings in the verification log.</li><li>• Set the modem correctly</li></ul> |
| Verify Sweep Function | Confirm that the frequency sweep function works for the values in the verification log.                                                                                    |

Sweep function verification is completed.

# Synchronization Function Verification

|                |                                                                                                   |                         |
|----------------|---------------------------------------------------------------------------------------------------|-------------------------|
| Accepted range | SYNC Output Level                                                                                 | TTL-compatible into>1kΩ |
|                | Impedance                                                                                         | 50Ω nominal             |
|                | Fan Out                                                                                           | —                       |
|                | Rise of Fall Time                                                                                 | ≤ 25ns                  |
| Equipment      | <ul style="list-style-type: none"><li>• Oscilloscope</li><li>• Test cable and 50 Ω load</li></ul> |                         |

Connection



|                |                                                                                                                                                                                                                                                |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configurations | <ul style="list-style-type: none"><li>• Set the signal source according to the settings in test table sweep mode according to values in the verification log. Output from the main channel.</li><li>• Set the oscilloscope correctly</li></ul> |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                        |                                                                                      |
|----------------------------------------|--------------------------------------------------------------------------------------|
| Verifying<br>Synchronization<br>signal | Compare the reading on the oscilloscope with the results<br>in the verification log. |
|----------------------------------------|--------------------------------------------------------------------------------------|

Synchronization signal verification is completed.

# UPDATING THE FIRMWARE

The Firmware update chapter describes how to overwrite (update) the AFG-2000 firmware via the USB interface. For AFG-2000, send the function generator back to GW Instek in case you need to update its firmware.

|                                     |    |
|-------------------------------------|----|
| Preparing for Firmware Update ..... | 49 |
| Updating the Firmware .....         | 49 |

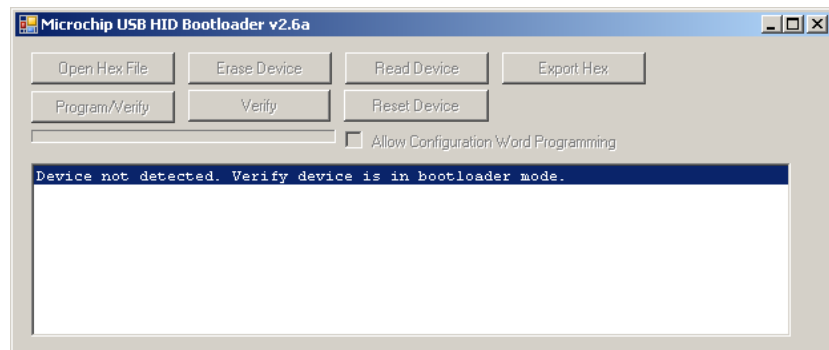
## Preparing for Firmware Update

|                                      |                                                                                                                                                                                                                             |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| When to update the firmware          | <p>You might need to update the firmware in the following cases.</p> <ul style="list-style-type: none"><li>• The AFG-2000 system malfunction</li><li>• Firmware update request from GW Instek or customers</li></ul>        |
| Tools for updating the firmware      | <ul style="list-style-type: none"><li>• Firmware file (provided from GW Instek) and HIDBootLoader.exe software</li><li>• Windows 2000 or XP based PC</li><li>• USB cable, TypeA (host, PC) to Type B (slave, GPD)</li></ul> |
| Updating procedures (details follow) | <p>Updating the firmware file</p>                                                                                                                                                                                           |

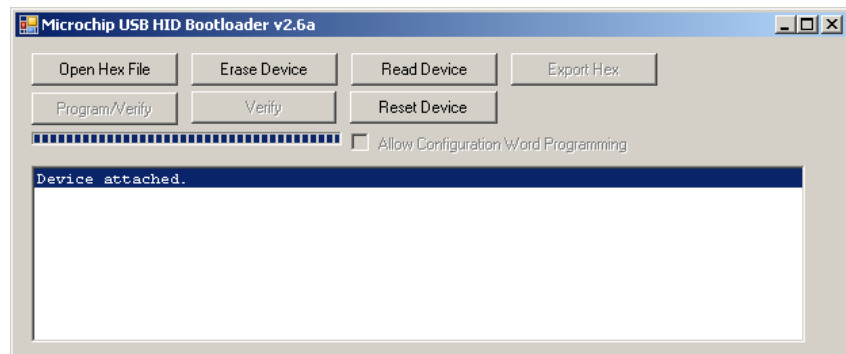
## Updating the Firmware

|                                   |                                                                                                        |
|-----------------------------------|--------------------------------------------------------------------------------------------------------|
| Connecting the function generator | <ol style="list-style-type: none"><li>1. Connect the AFG-2000 to the PC using the USB cable.</li></ol> |
|-----------------------------------|--------------------------------------------------------------------------------------------------------|

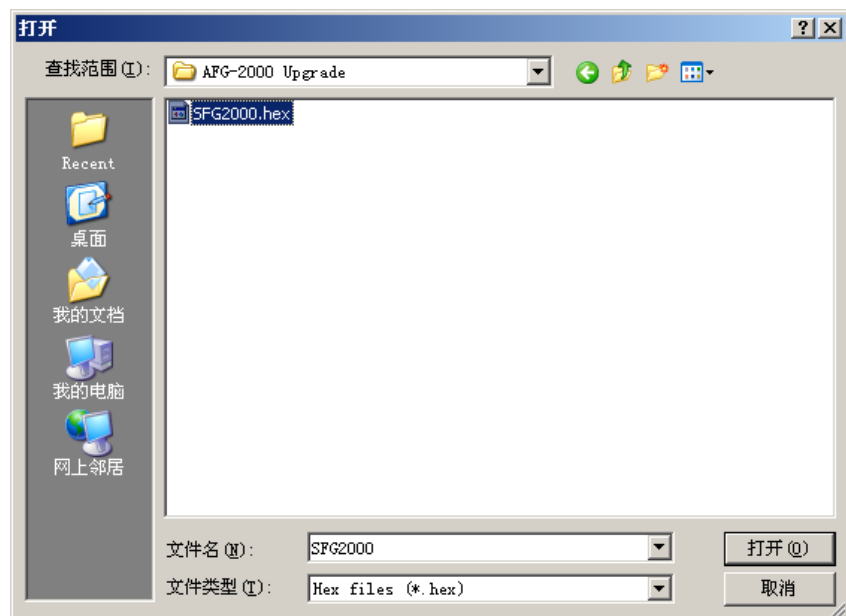
2. Execute the HIDBootLoader.exe software. The startup interface is shown as below:



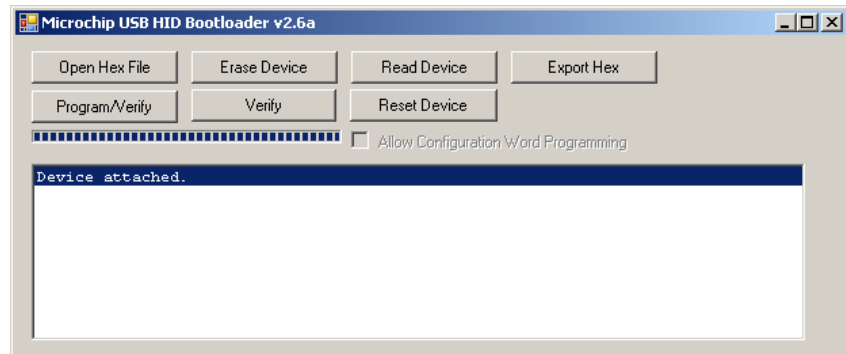
3. Press and hold the Enter key on the AFG-2000, then press the power switch. Release the Enter key after three seconds. The software will detect the AFG-2000. The user interface is shown as below:



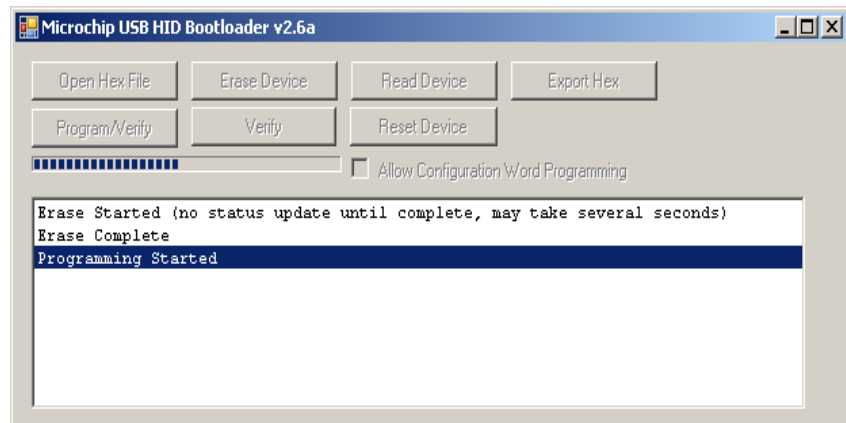
4. Click "Open Hex File" button. Select the file "SFG2000.hex" in the folder from the dialog box.



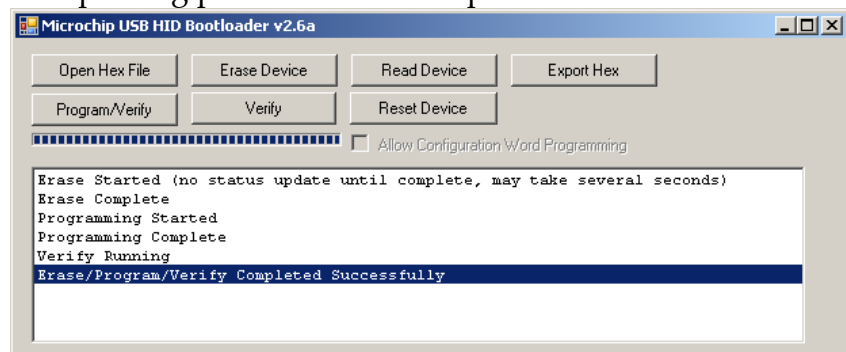
5. After this, the Program / Verify function will be enabled. Click on this button to send the main program to the AFG-2000.



6. The program is updated according to process shown below.



7. Shown below is an example of when the program updating procedure has completed.



8. Click the Reset Device button to restart the AFG-2000.

Updating the firmware is completed.

# REPLACING THE FUSE

The AFG-2000 has only one replaceable fuse which is located on the PCB inside the device. When replacing the fuse, it is necessary to open the outer casing of the device.

---

Replacing the Fuse ..... 52

---

## Replacing the Fuse

---



**WARNING**

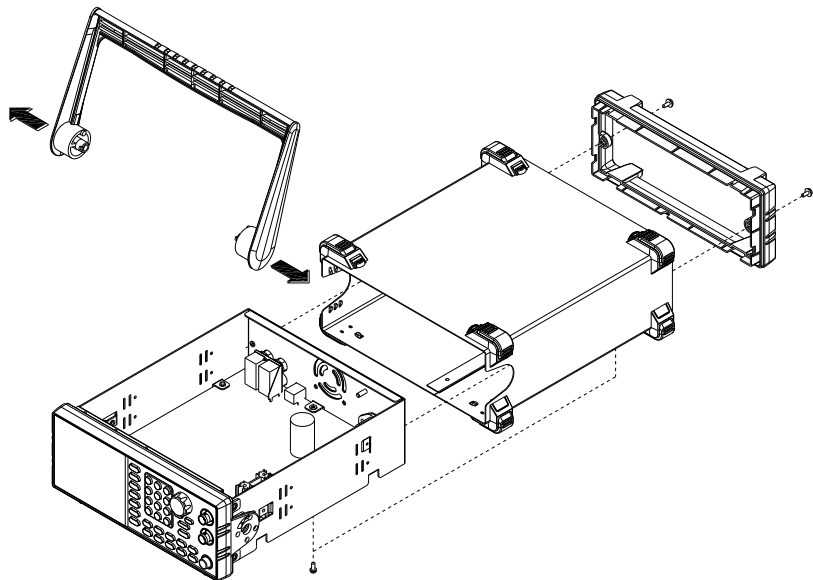
Make sure the cause of the fuse blowout is fixed before replacing the fuse.

---

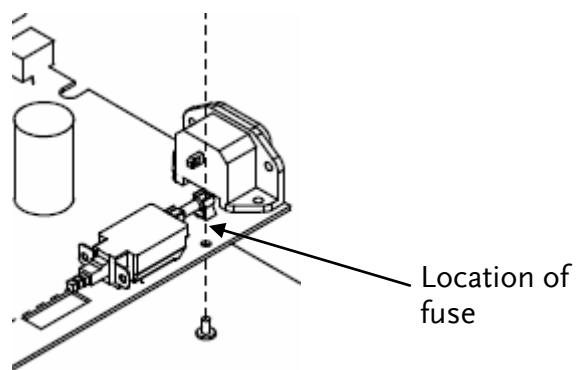
Rating • Slowblow T1.0A/250V

---

Procedures 1. First remove the AFG-2000 outer casing as shown in the picture below.



2. Search for the location of fuse. Remove the broken fuse carefully with a Philips screwdriver, then replace with a new fuse.



Replacing the fuse is completed

# DISASSEMBLING THE FUNCTION GENERATOR

The Disassembly chapter shows how to remove the major units, PCBs, panels, and outer casing, from the function generator. The procedures described in this chapter are intended for parts replacement and board adjustment. The Parts List chapter (page74) shows more details about the mechanical structures of the function generator and thus can be used as a reference.

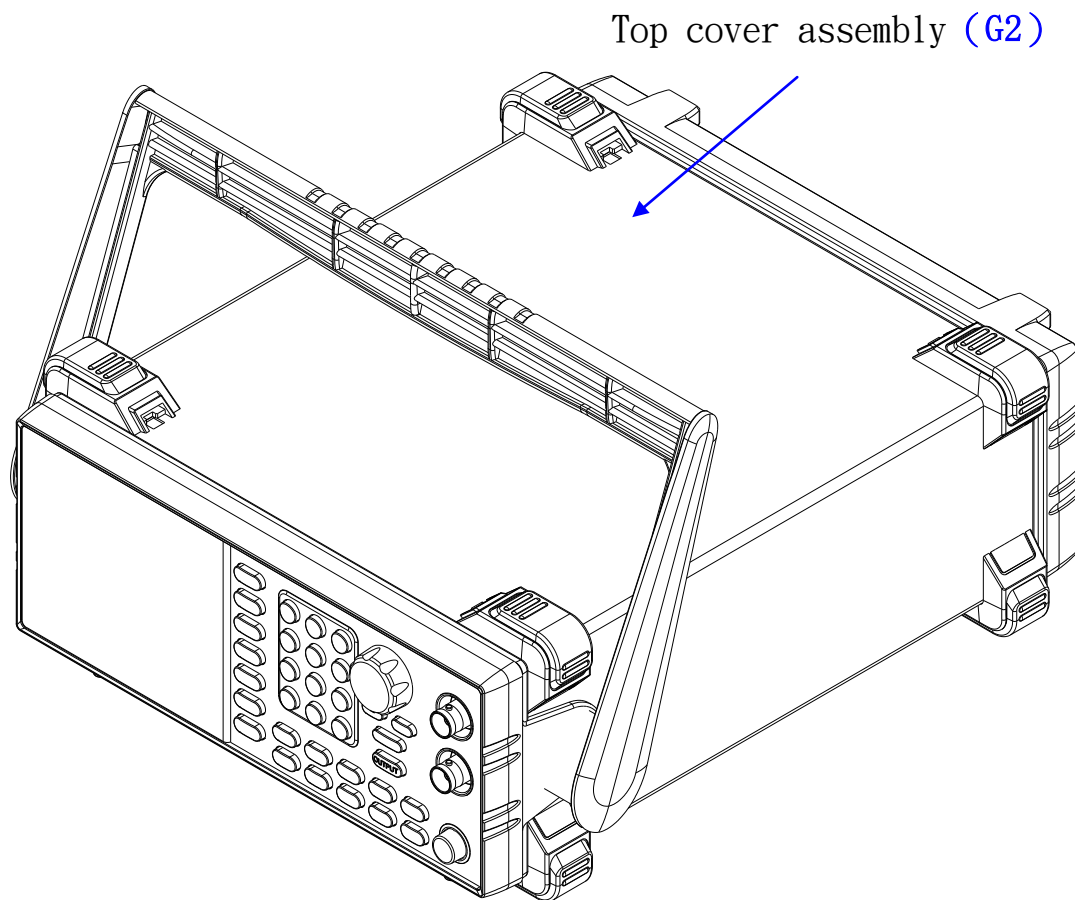
Removing the outer casing .....54

## Removing the outer casing

1. Required tools

|                   |                      |
|-------------------|----------------------|
| Disassembly tools | Phillips screwdriver |
|                   | Hexagon Socket       |
|                   | Needle-nose pliers   |
|                   | Diagonal pliers      |
|                   | Disassembly Manual   |

2. Remove the handle and rear panel.

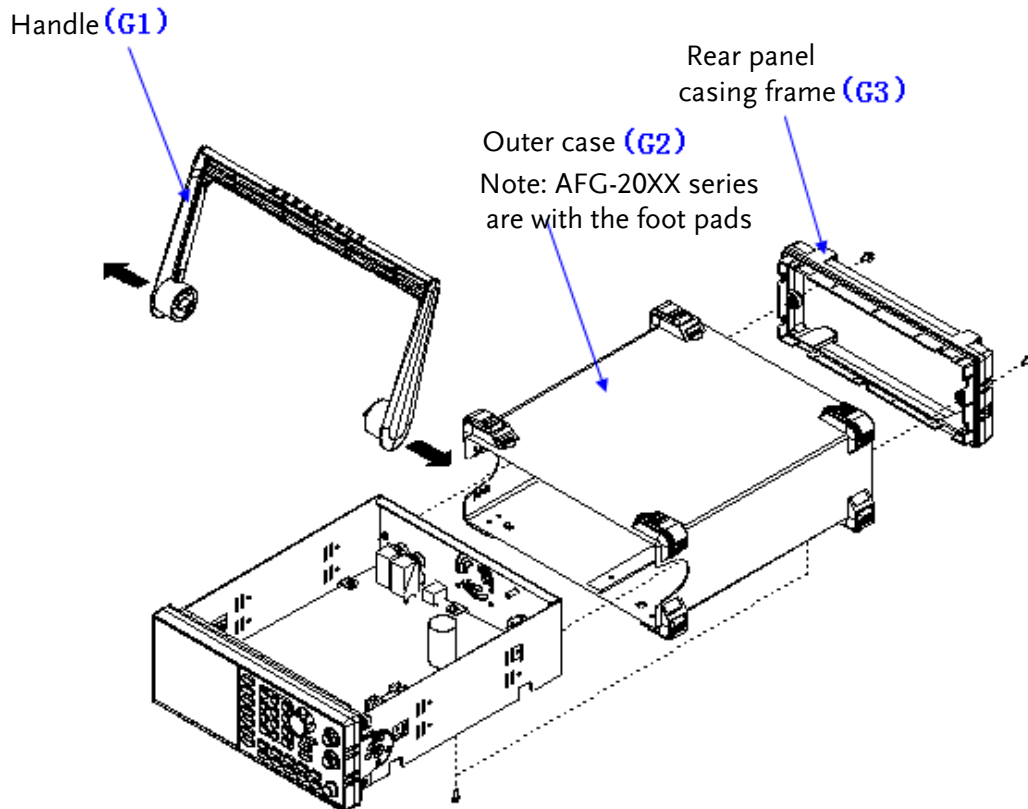


### 3. Remove the rear panel

Disassembly Tool: Phillips screwdriver:

Disassembly process:

1. As shown in the diagram below, pull the handle outward from both sides in the direction of black arrows (G1) to remove the handles (G1).
2. Remove the two screws in the rear panel (G3) using a Phillips screwdriver and remove the rear panel (G3).
3. Remove the screw on the bottom (G2) by using a Phillips screwdriver, and then take off the outer casing (G2).

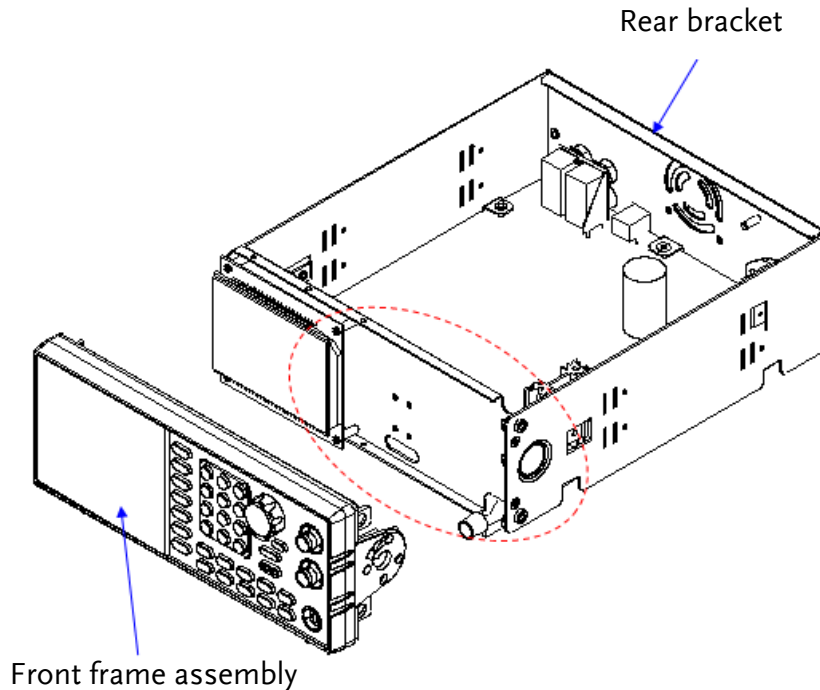


#### 4. Disassembly of the rear panel metal bracket and the front panel

Disassembly tools: Phillips screwdriver, needle nose pliers, diagonal pliers

Disassembly process:

1. Remove all the cables shown within the dotted line that are connected to the PCB and the base. If a cable is welded, use diagonal pliers to cut and remove the cable.
2. Pull outward the left and right clips on the plastic front frame (a total of four). Separate the front frame assembly from the base.

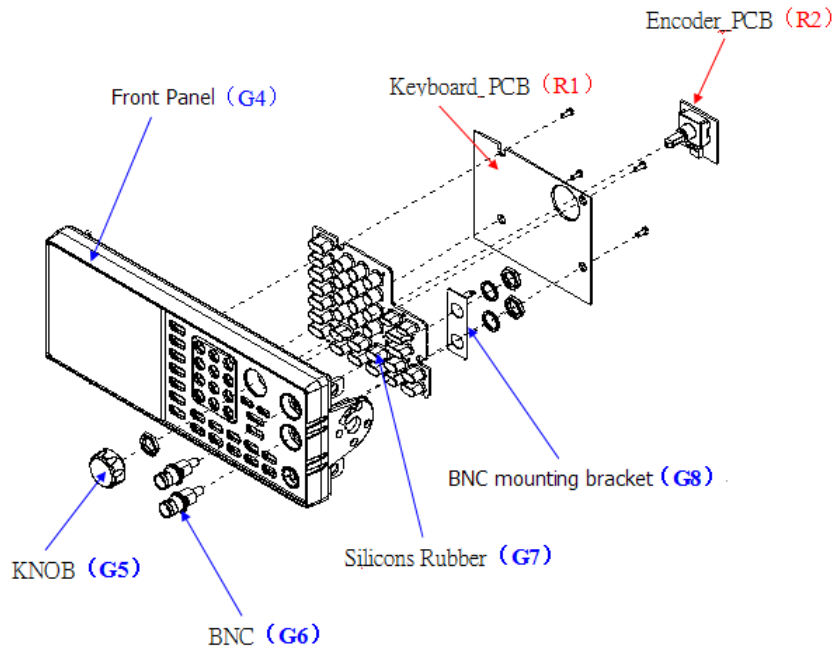


#### 5. Disassembly of the front panel

Disassembly tools: Phillips screwdriver, hex socket, needle nose pliers

Disassembly process:

1. Pull (G5) out with some force, remove (G5);
2. Loosen the nuts fixed to (R2) with a hexagonal socket or needle-nose pliers. Pull (R2) backward, and remove (R2).
3. Loosen the nuts fixed to (G6) with a hexagonal socket or needle-nose pliers. Remove (G6) and (G8);
4. Remove the four screws at the back (R1) with a Phillips screwdriver. Remove (R1) and (G7).
5. Remove (G4)



## 6. Disassembly of the main frame and display

1. Disassembly tools: Phillips screwdriver, diagonal pliers

2. Disassembly process:

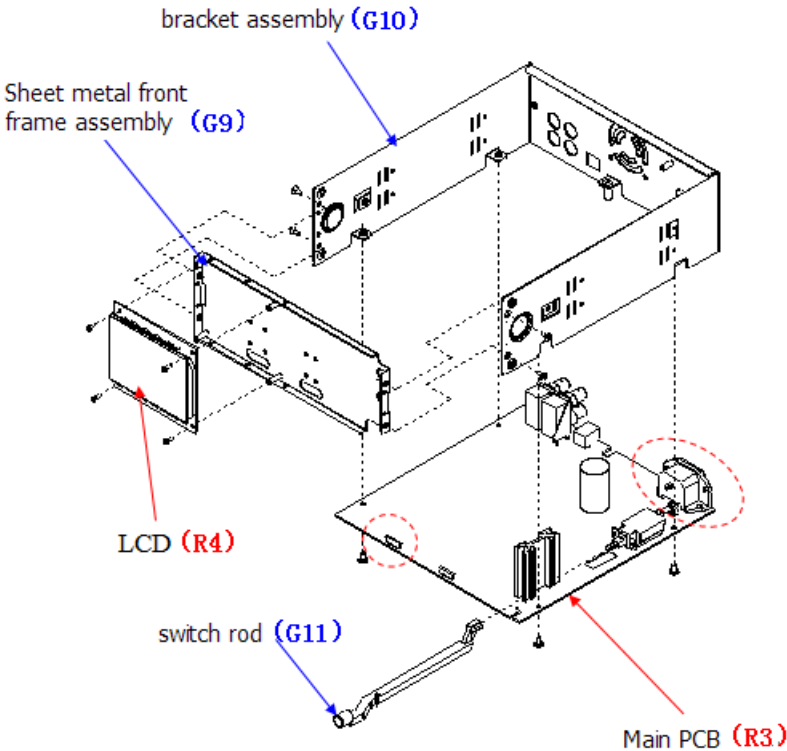
a) Remove all the cables within the dotted lines that are connected to the PCB and the base. If the cable is welded, use diagonal pliers to cut and remove the cable.

b) Remove the four screws in front of (R4) with a Phillips screwdriver.  
Remove (R4)

c) Remove the four screws on both sides of (G9) with a Phillips screwdriver.  
Remove (G9)

d) Remove the four screws at the bottom of (R3) with a Phillips screwdriver.  
Remove (R3) and (G10)

e) Pull (G11) forward with some force to remove (G11).



| Product Material / Component Identification                                                                              |                  |               |           |        |
|--------------------------------------------------------------------------------------------------------------------------|------------------|---------------|-----------|--------|
| Serial NO.                                                                                                               | Item description | Main material | Weight(g) | Remark |
| R1                                                                                                                       | Keyboard_PCB     | PCB           | 26        |        |
| R2                                                                                                                       | Encoder_PCB      | PCB           | 13        |        |
| R3                                                                                                                       | Main PCB         | PCB           | 381       |        |
| R4                                                                                                                       | LCD              | PCB+ glass    | 73        |        |
| R5                                                                                                                       | Power cord       |               | 182       |        |
| R6                                                                                                                       | GTL-101          |               | 120       |        |
|                                                                                                                          |                  |               |           |        |
|                                                                                                                          |                  |               |           |        |
|                                                                                                                          |                  |               |           |        |
| <div><div></div> Rx: Selective Material / composition</div> <div><div></div> Gx: Recyclable Material / composition</div> |                  |               |           |        |

| Product Material / Component Identification                                                                                                                                                                                                                                                                  |                                  |                        |              |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|------------------------|--------------|--------|
| Series No.                                                                                                                                                                                                                                                                                                   | Item description                 | Main material          | Weight ( g ) | Remark |
| G1                                                                                                                                                                                                                                                                                                           | Handle                           | ABS                    | 100          |        |
| G2                                                                                                                                                                                                                                                                                                           | Upper case assembly              | SECC+ABS+ soft plastic | 980          |        |
| G3                                                                                                                                                                                                                                                                                                           | Rear frame assembly              | ABS+ soft plastic      | 80           |        |
| G4                                                                                                                                                                                                                                                                                                           | Plastic front frame assembly     | ABS+Acrylic+PC         | 117          |        |
| G5                                                                                                                                                                                                                                                                                                           | KNOB                             | ABS+SPEC               | 3            |        |
| G6                                                                                                                                                                                                                                                                                                           | BNC                              | Copper                 | 24           |        |
| G7                                                                                                                                                                                                                                                                                                           | Silicon rubber                   | Silicon                | 24           |        |
| G8                                                                                                                                                                                                                                                                                                           | BNC Bracket                      | SPEC                   | 5            |        |
| G9                                                                                                                                                                                                                                                                                                           | Sheet metal front frame assembly | SECC+ Magnetic soil    | 155          |        |
| G10                                                                                                                                                                                                                                                                                                          | Bracket assembly                 | SECC                   | 445          |        |
| G11                                                                                                                                                                                                                                                                                                          | Switch rod                       | ABS                    | 7            |        |
| G12                                                                                                                                                                                                                                                                                                          | Mounting screws                  |                        | 15           |        |
| <div>  Rx: Selective Material / composition                 </div> <div>  Gx: Recyclable Material / composition                 </div> |                                  |                        |              |        |

Disassembly is completed

# AFG-2000 PCB & CIRCUIT DIAGRAM

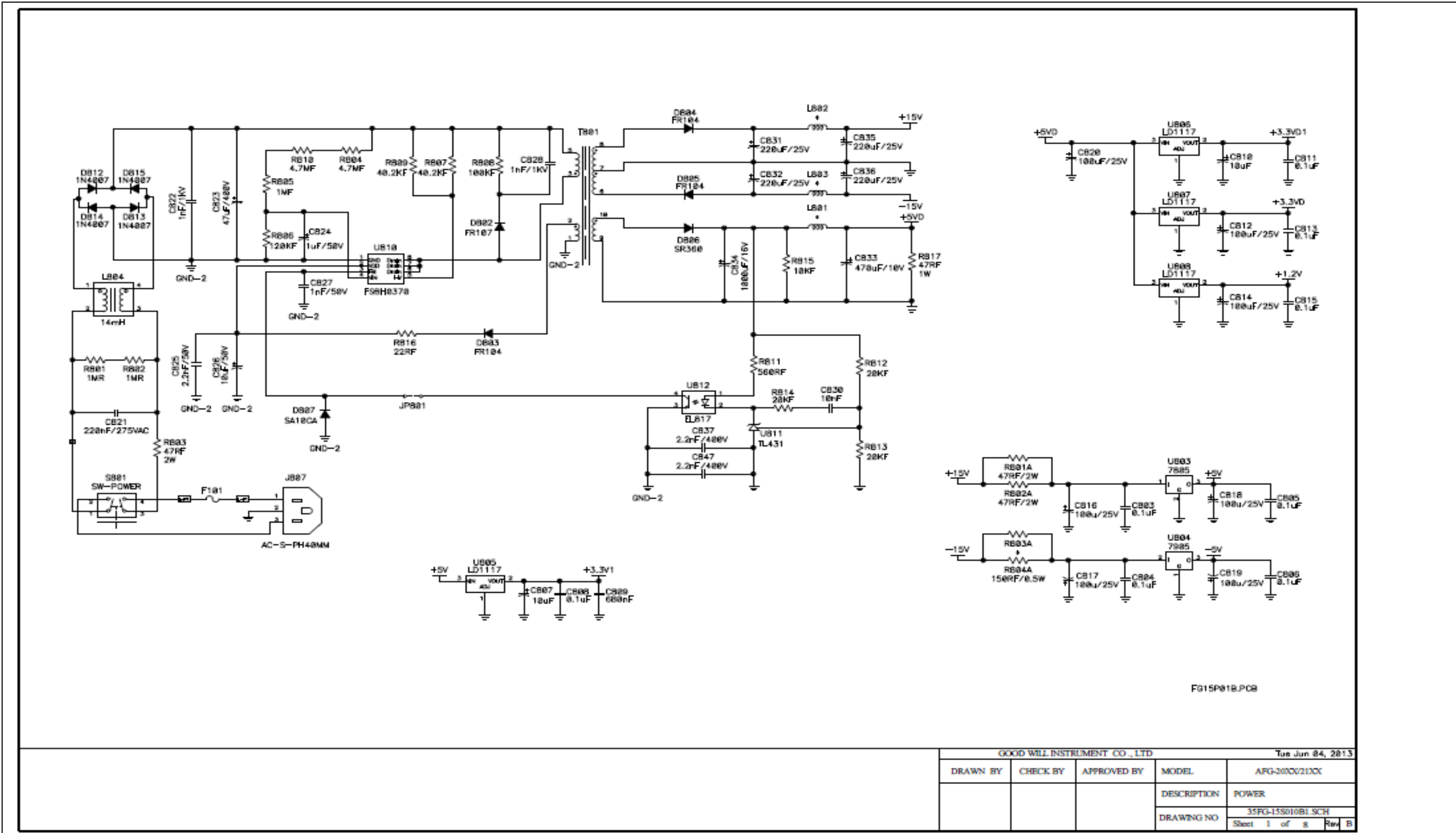
This chapter shows the PCB layout and circuit diagrams used in the AFG-2000. For the list of parts including both the mechanical and PCB parts, see the *Parts List* chapter,

---

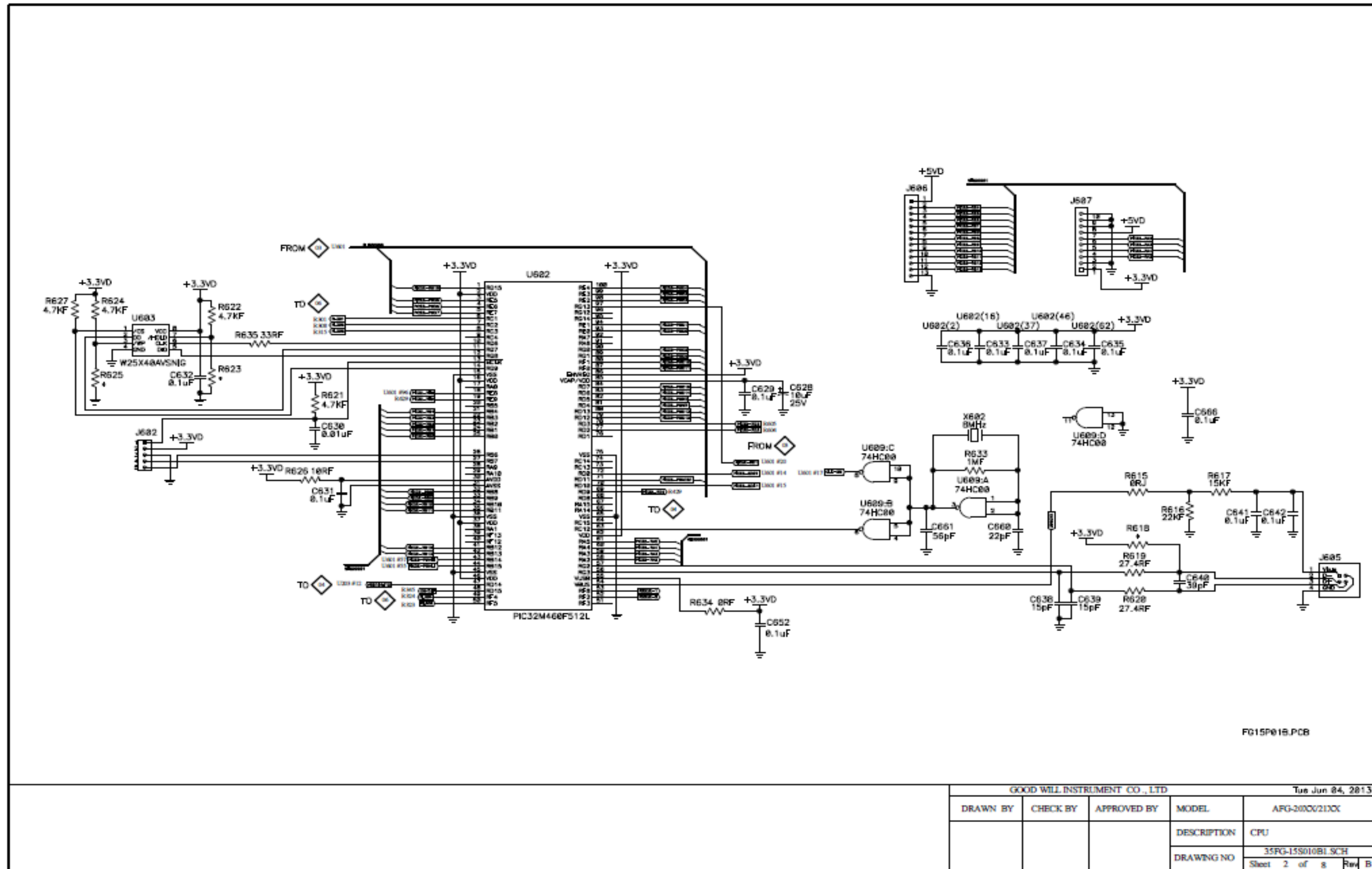
|                                                                     |    |
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| AFG-2000 Push Button Board Layout .....                             | 73 |

# AFG-2000 Power Unit Circuit diagram

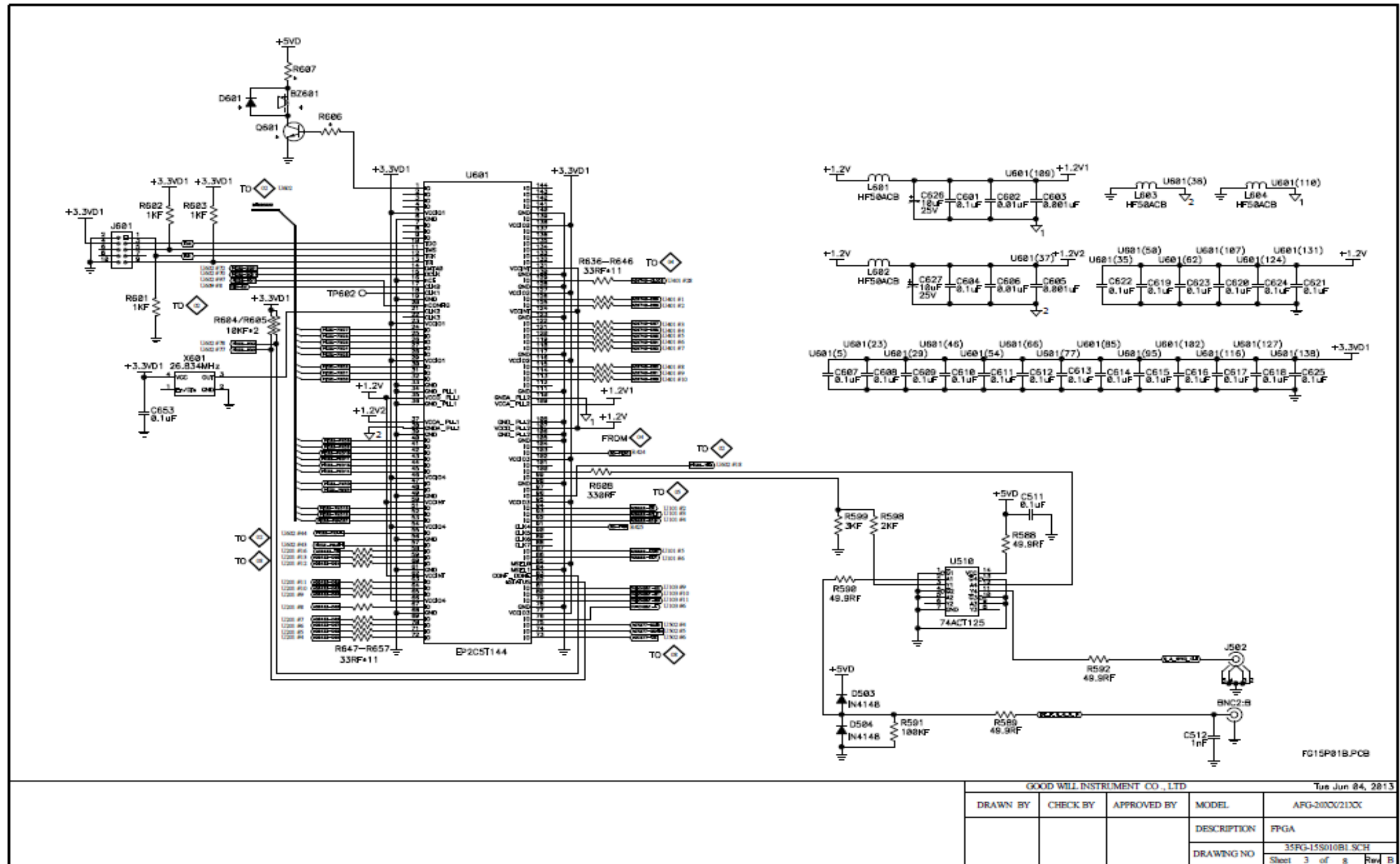
## AFG-2000 1/1 Power circuit diagram



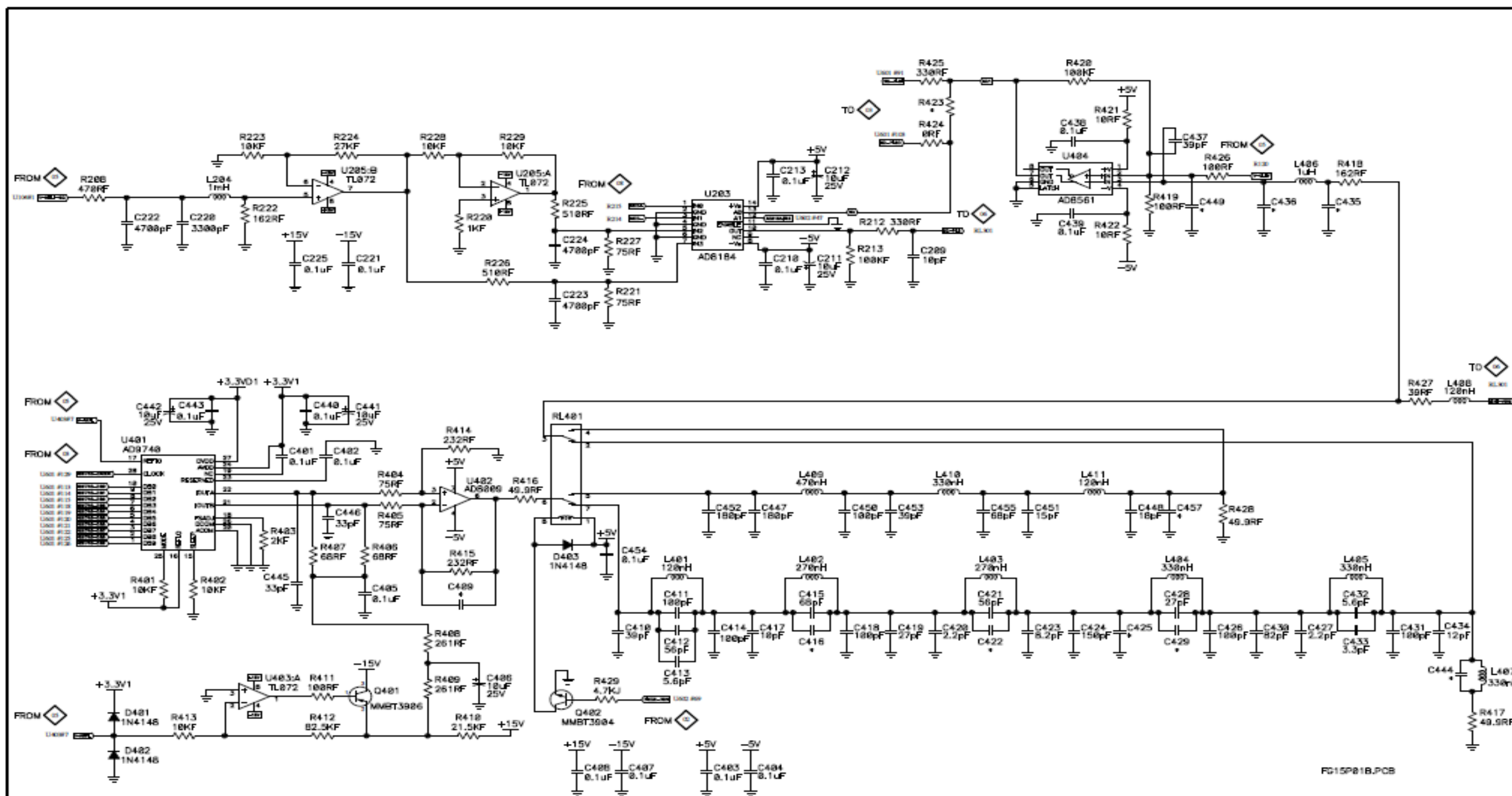
# AFG-2000 CPU Unit Circuit Diagram



# AFG-2000 FPGA Circuit Diagram



## AFG-2000 Main Channel and Filter Circuit Diagram

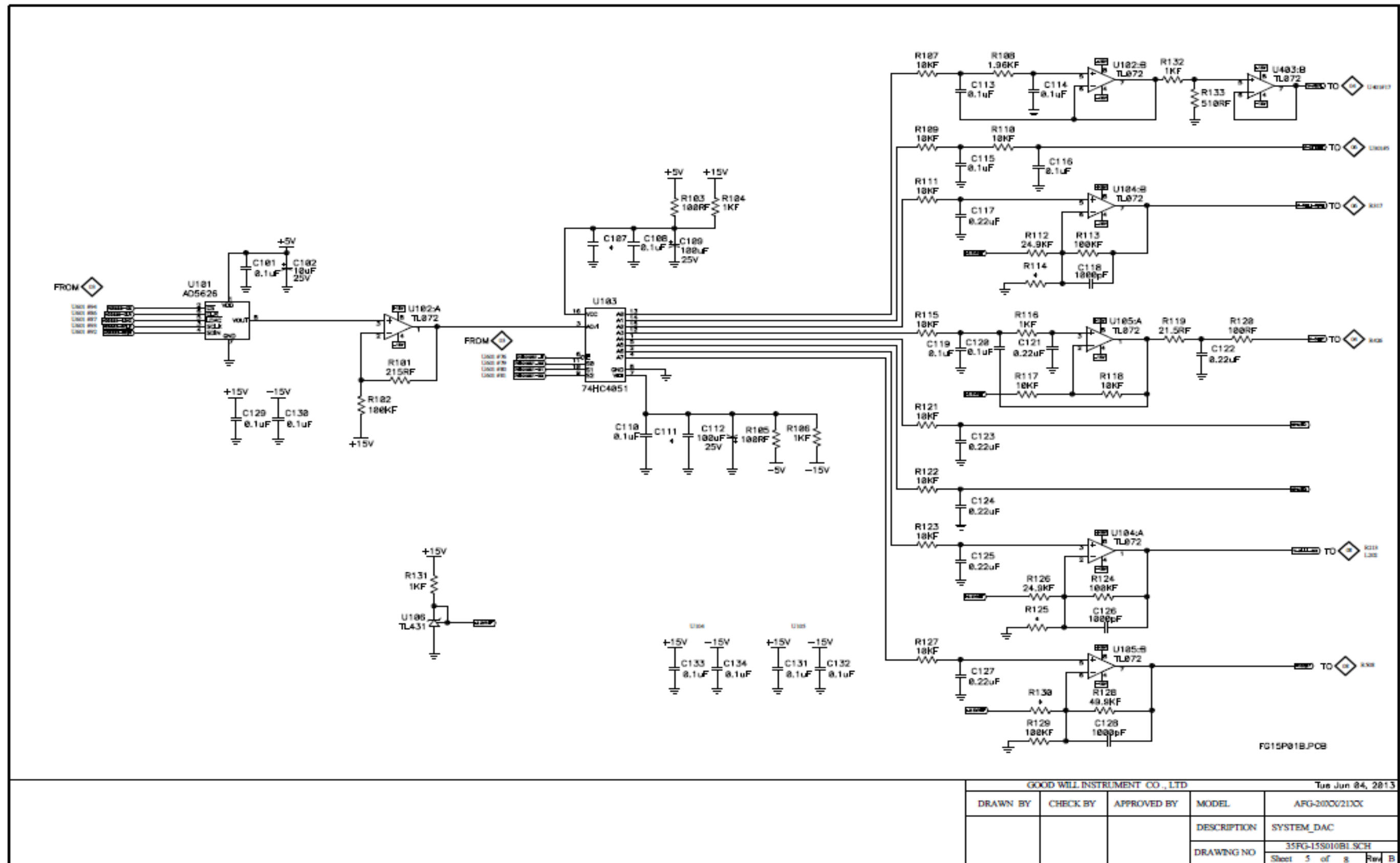


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Tue Jun 04, 2013

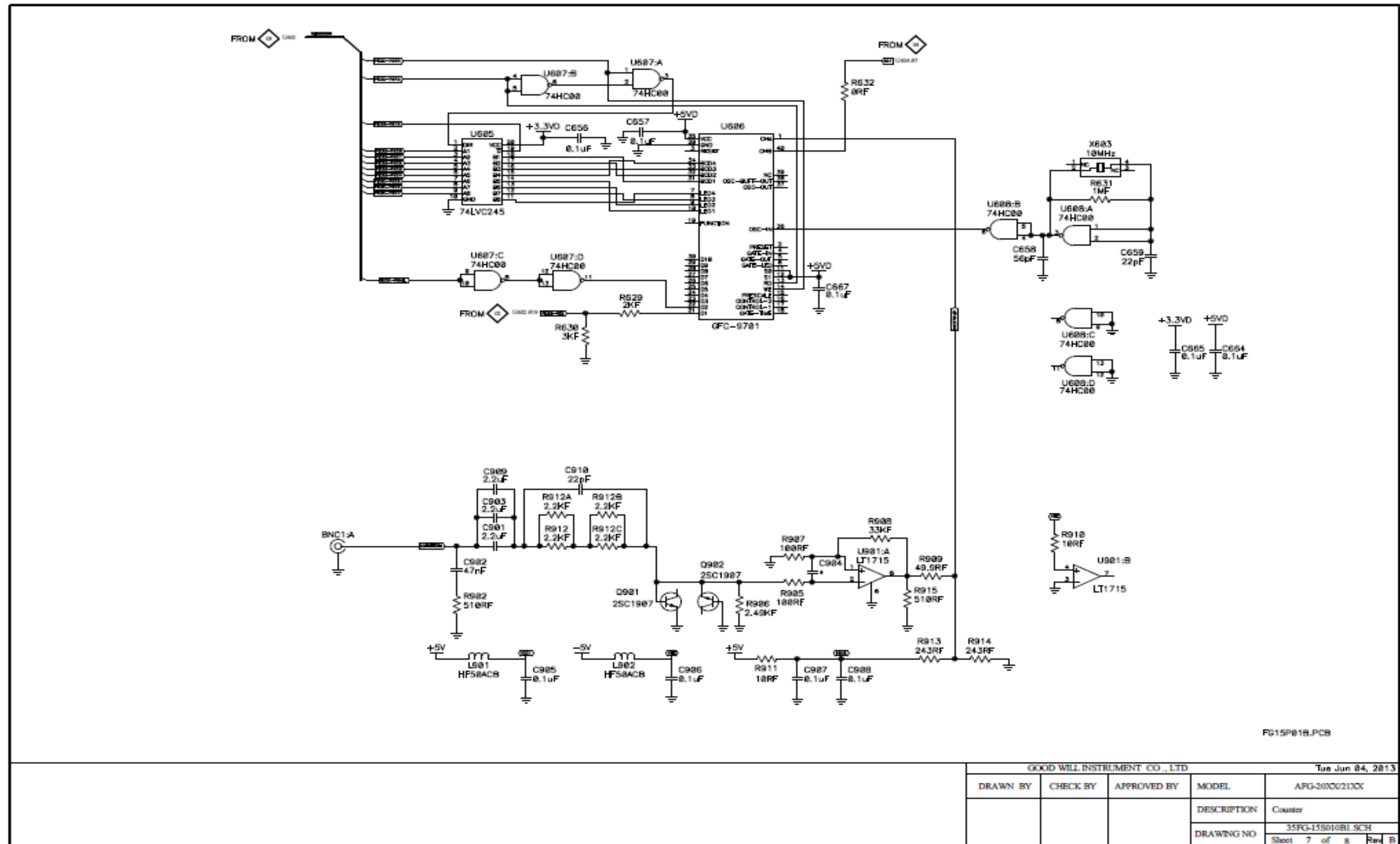
| DRAWN BY | CHECK BY | APPROVED BY | MODEL        | AFG-2000/21XX     |
|----------|----------|-------------|--------------|-------------------|
|          |          |             | DESCRIPTION  | MAIN_DAC_FILTER   |
|          |          |             | DRAWING NO   | 35FG-15S010B1.SCH |
|          |          |             | Sheet 4 of 8 | Rev B             |

# AFG-2000 Amplitude and DC Offset Control Unit Circuit Diagram

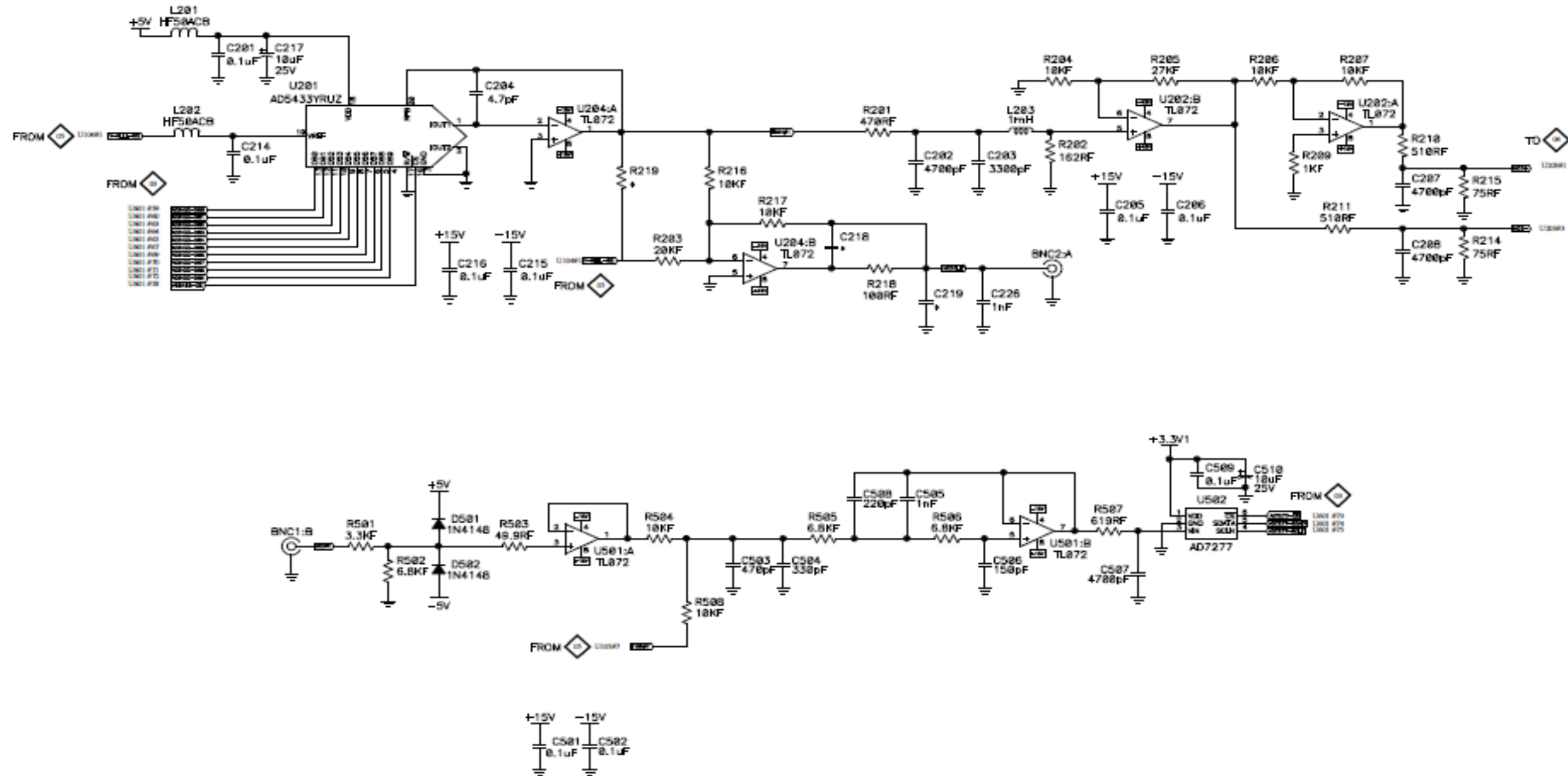


| GOOD WILL INSTRUMENT CO., LTD |          |             |              | Tue Jun 04, 2013     |   |
|-------------------------------|----------|-------------|--------------|----------------------|---|
| DRAWN BY                      | CHECK BY | APPROVED BY | MODEL        | AFG-200X/210X        |   |
|                               |          |             | DESCRIPTION  | AMPLIFIER_OFFSET_ATT |   |
|                               |          |             | DRAWING NO   | 35FG-15S010BL SCH    |   |
|                               |          |             | Sheet 6 of 8 | Rev                  | B |

# AFG-2000 Frequency Counter Function Circuit Diagram



# AFG-2000 Demodulation Function Unit Circuit Diagram



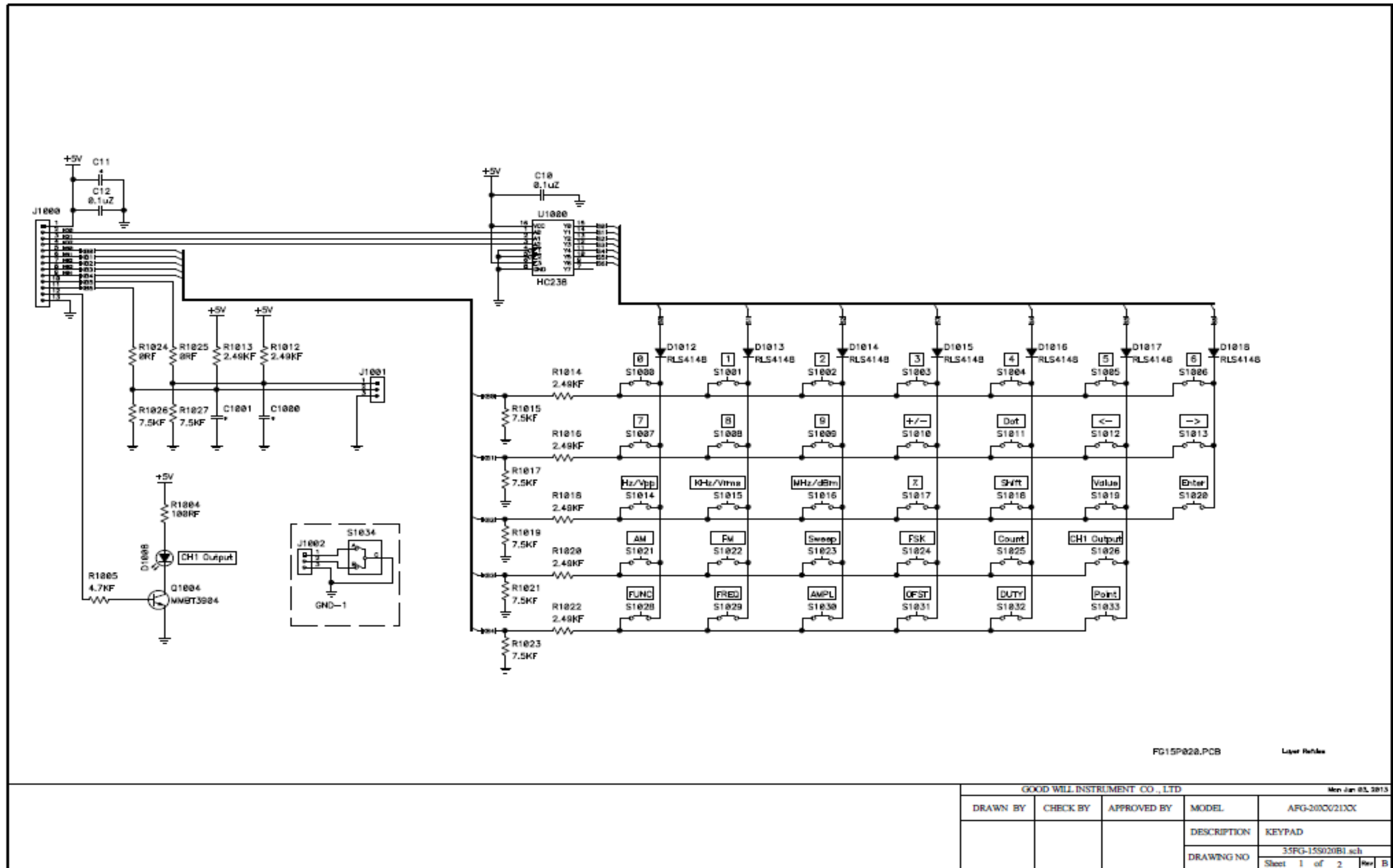
FG15P81B.PCB

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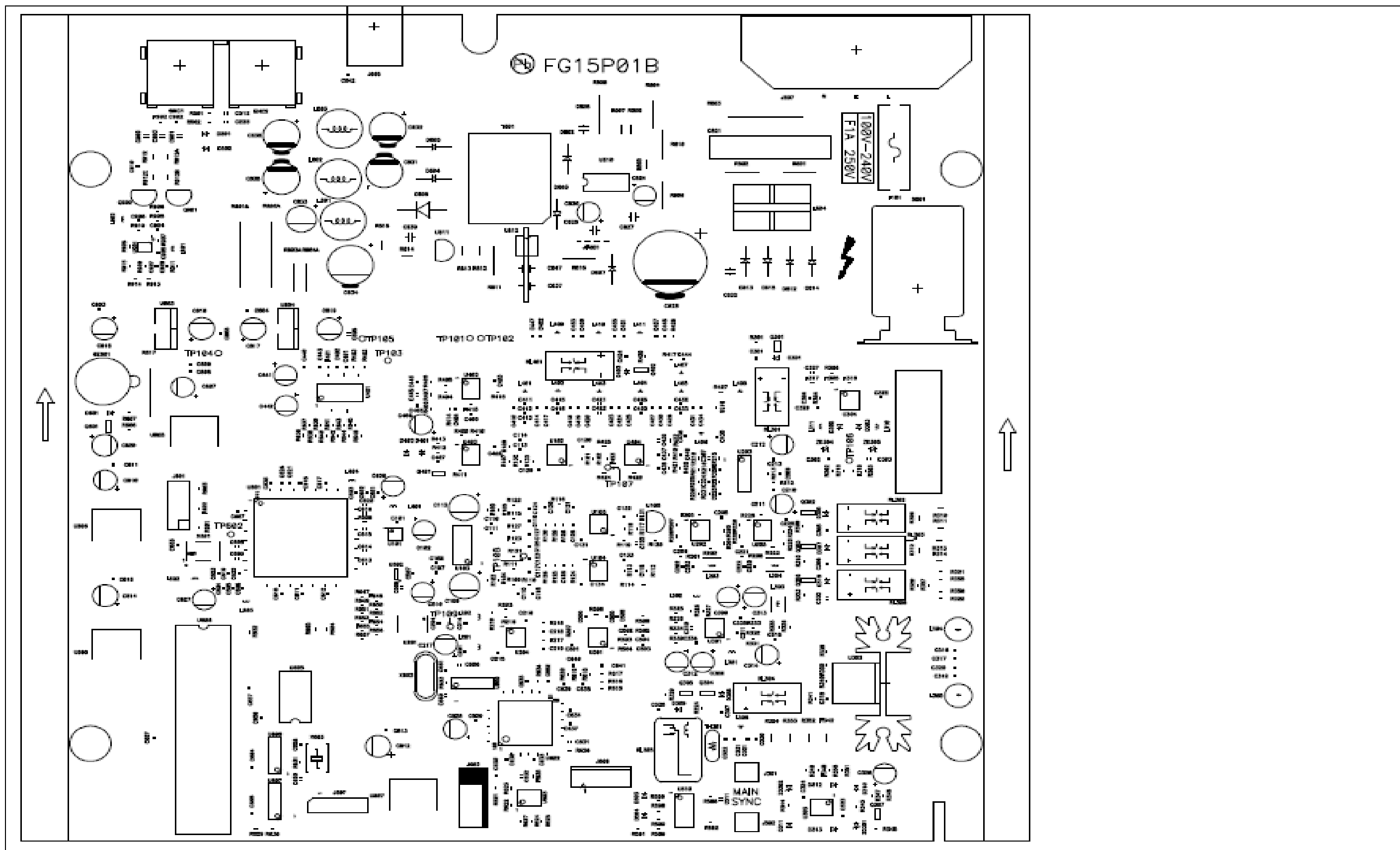
Tue Jun 04, 2013

| DRAWN BY | CHECK BY | APPROVED BY | MODEL        | AFG-2000/21XX     |
|----------|----------|-------------|--------------|-------------------|
|          |          |             | DESCRIPTION  | MOD               |
|          |          |             | DRAWING NO   | 35FG-15S010B1.SCH |
|          |          |             | Sheet 8 of 8 | Rev B             |

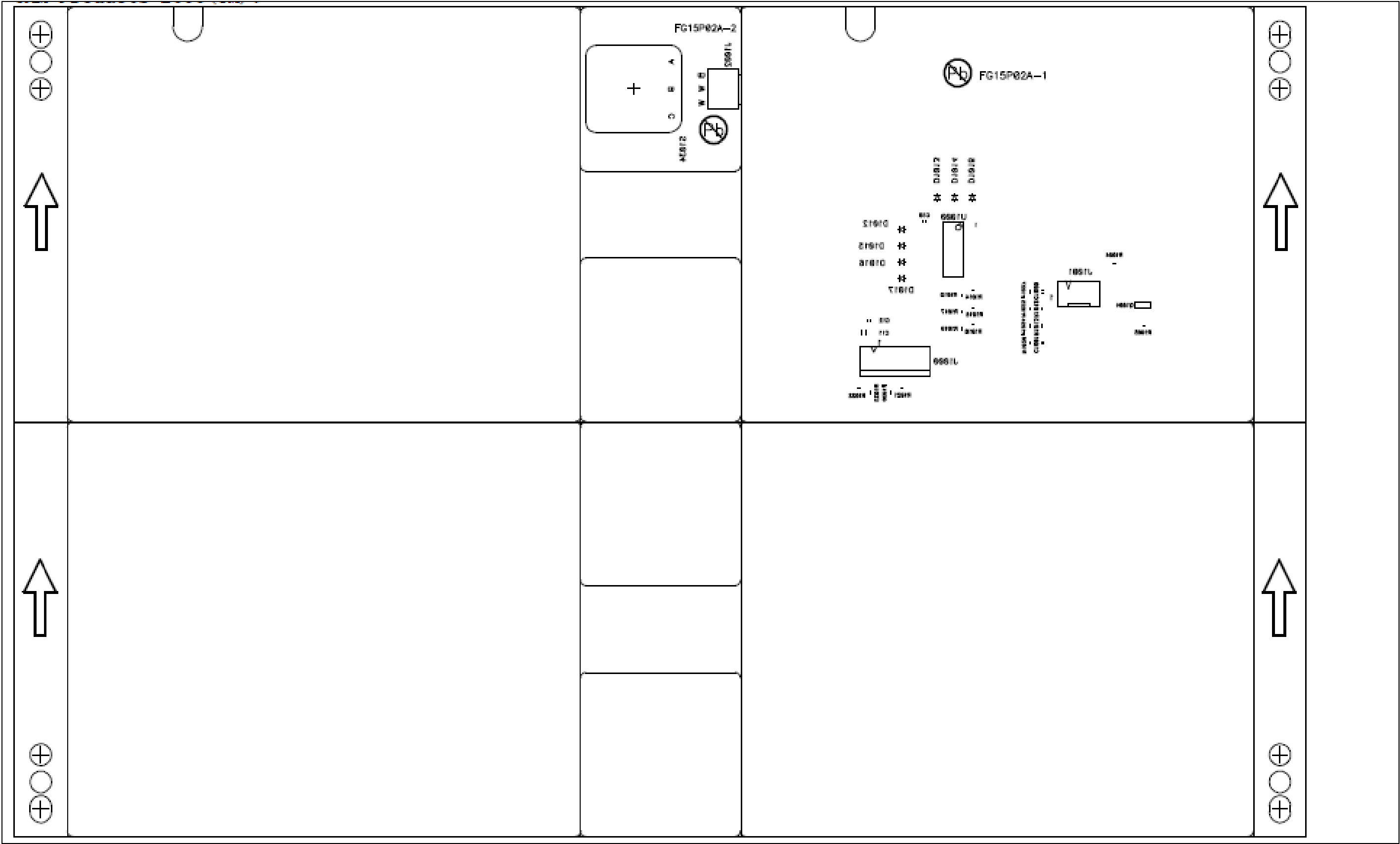
# AFG-2000 Push Button Unit Circuit Diagram



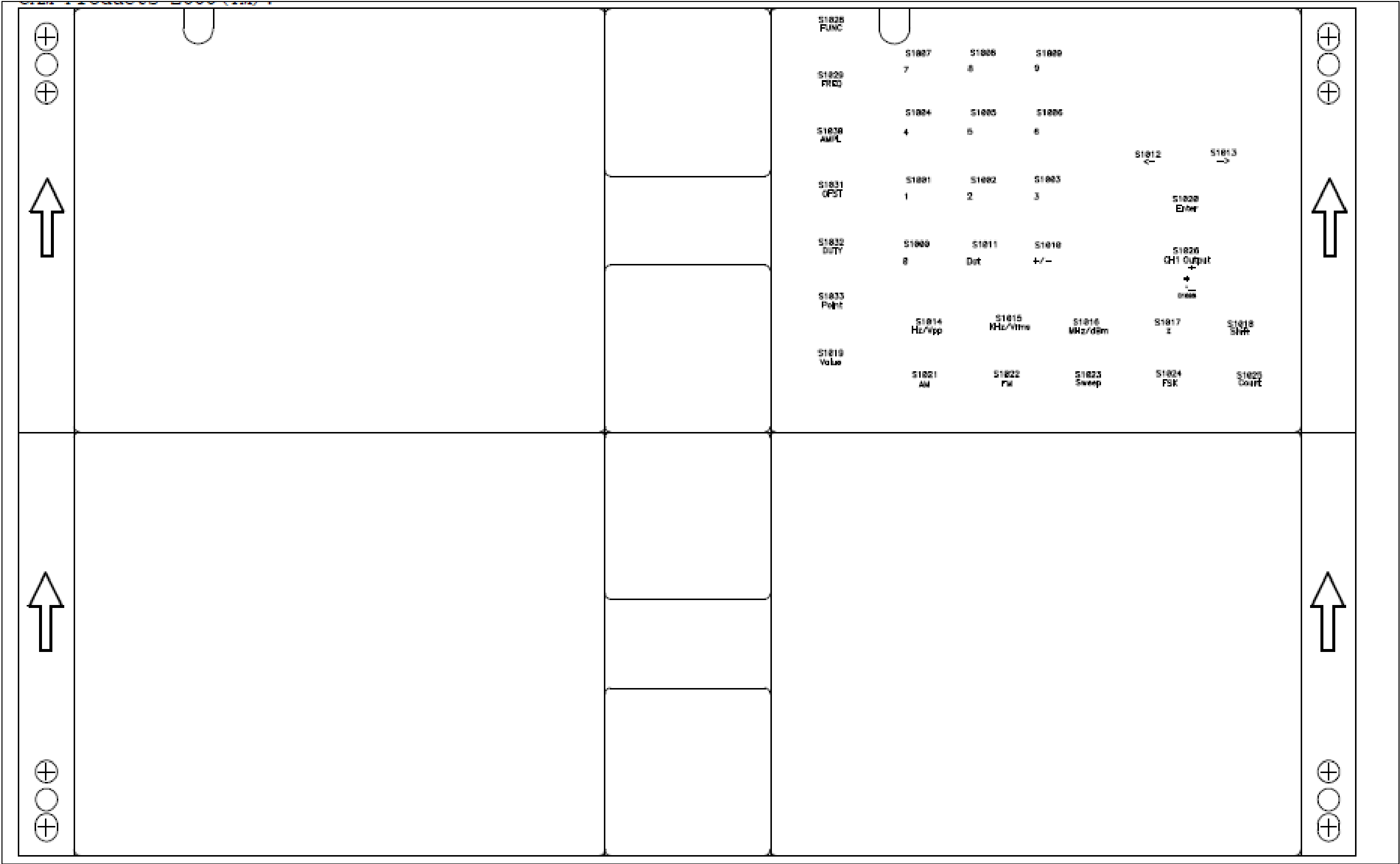
## AFG-2000 PCB Layout of Main Board



AFG-2000 Display Board Layout



AFG-2000 Push Button Board Layout



# PARTS LIST

The Mechanical Parts List chapter shows the diagrams for all replaceable mechanical components used in the function generator, together with their descriptions and part numbers. Use this chapter as a detailed reference for disassembling the power supplies, or for searching for the part number of components that require replacing.

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|                                                                           |    |
|---------------------------------------------------------------------------|----|
| Exploded Diagram of the Entire Machine Front Frame Exploded Diagram ..... | 75 |
| Front Frame Exploded Diagram .....                                        | 76 |
| Metal Frame Exploded Diagram .....                                        | 77 |

Exploded Diagram of the Entire Machine

The exploded diagram shows the following components labeled with circled numbers:

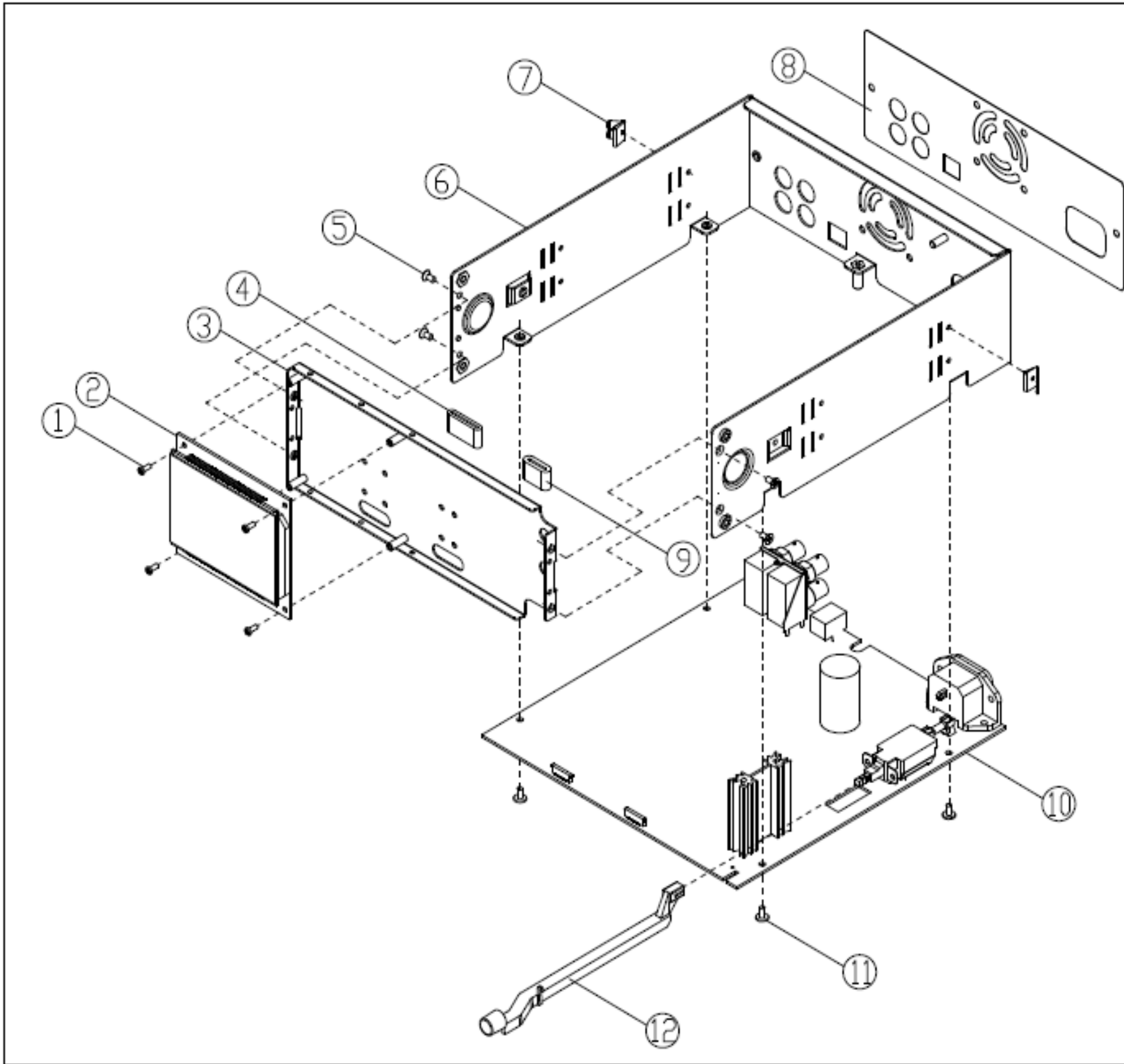
- ①: PC SFG-2000 HANDLE
- ②: SFG-21XX FOOT ASS'Y
- ③: CA SFG-20XX TOP COVER
- ④: RUBBER FOOT
- ⑤: PC SFG-2000 REAR PLATE
- ⑥: BMS-T-3\*6
- ⑦: PMS-T-3\*8

|      |               |                                                |     |
|------|---------------|------------------------------------------------|-----|
| 7    |               | PMS-T-3*8                                      | 1   |
| 6    |               | BMS-T-3*6                                      | 2   |
| 5    | 63RP-AG100901 | PC SFG-2000 Rear Plate, RoHS                   | 1   |
| 4    | 57FC-50G00101 | RUBBER FOOT SFG-2000 ,GRAY ,RoHS               | 2   |
| 3    | 62FG-020UP1A1 | CA SFG-20XX TOP COVER ,RoHS (APG2000系列)        | 1   |
| 3    | 62FG-120UP1A1 | CA SFG-21XX TOP COVER ,RoHS (APG2100系列)        | 1   |
| 2    | 1042-21200201 | SFG-21XX FOOT ASS'Y (廠外加工) ,RoHS (APG-2000系列无) | 4   |
| 1    | 63HD-AG1012A1 | PC SFG-2000 HANDLE ,RoHS                       | 1   |
| ITEM | Part NO.      | Description                                    | QTY |

## Front Frame Exploded Diagram

|      |               |                                                 |     |
|------|---------------|-------------------------------------------------|-----|
|      |               |                                                 |     |
| 10   | 5005-220G0101 | KNOB ,SPG-2000 ,ENCODE SW KNOB ,228 ,GRAY, RoHS | 1   |
| 9    | 4241-14100701 | RF CABLE SMB-BNC 165mm ,RoHS                    | 2   |
|      | 51AF-20200201 | NP AFG-20XX FUNCTION ,RoHS                      | 1   |
| 8    | 51AF-21200201 | NP AFG-21XX FUNCTION RoHS                       | 1   |
| 7    | 62AF-120HP201 | CA AFG-2000 BNC GND PLATE ,RoHS                 | 1   |
| 6    | 13AF-2XXX020  | PCB ASS'Y FG15P020 ,AFG-2000 (DISPLAY)          | 1   |
| 5    |               | BMS-3*6                                         | 4   |
| 4    | 13AF-2XXX020  | PCB ASS'Y FG15P020 ,AFG-2000 (DISPLAY)          | 1   |
|      | 57RB-40G08801 | SILICON RUBBER AFG-20XX KEYPAD ,RoHS            | 1   |
| 3    | 57RB-40G08901 | SILICON RUBBER AFG-21XX KEYPAD ,RoHS            | 1   |
| 2    | 63FP-AG108001 | PC AFG-2000 PLASTIC FRONT FRAME ,RoHS           | 1   |
|      | 51AF-20250101 | NP AFG-2025 MODEL ,RoHS                         | 1   |
|      | 51AF-20120101 | NP AFG-2012 MODEL ,RoHS                         | 1   |
|      | 51AF-20050101 | NP AFG-2005 MODEL ,RoHS                         | 1   |
|      | 51AF-21250101 | NP AFG-2125 MODEL ,RoHS                         | 1   |
|      | 51AF-21120101 | NP AFG-2112 MODEL ,RoHS                         | 1   |
| 1    | 51AF-21050101 | NP AFG-2105 MODEL ,RoHS                         | 1   |
| ITEM | Part NO.      | Description                                     | QTY |

Metal Frame Exploded Diagram



|      |               |                                                        |     |
|------|---------------|--------------------------------------------------------|-----|
|      |               |                                                        |     |
|      |               |                                                        |     |
|      |               |                                                        |     |
| 12   | 63LK-AG100901 | PC AFG-2000 POWER SW JOINT KNOB , RoHS                 | 1   |
| 11   |               | BMS-LOCK-M3*6                                          | 4   |
|      | 13AF-2020010  | PCB ASS'Y FG15P010 , AFG-20XX (CONTROL.)               | 1   |
| 10   | 13AF-2120010  | PCB ASS'Y FG15P010 , AFG-21XX (CONTROL.)               | 1   |
| 9    | 3065-001A2201 | CORE BEAD F5B FS 19*6.5*12-1.3 , RoHS                  | 1   |
|      | 51AF-20200301 | NP AFG-20XX REAR NP RoHS                               | 1   |
| 8    | 51AF-21200301 | NP AFG-21XX REAR NP RoHS                               | 1   |
| 7    | 62PG-120PP101 | CA 99-807-02 EMI SPRING PLATE, RoHS                    | 2   |
| 6    | 62AF-120HP101 | CA AFG-2000 MAIN CHASSIS , RoHS                        | 1   |
| 5    |               | FMS-M3*6                                               | 4   |
| 4    | 3065-001A2101 | CORE BEAD F5B FS 25*6*12-1.3-P.W , RoHS                | 1   |
| 3    | 62AF-120FP101 | CA AFG-2000 FRONT PLATE , RoHS                         | 1   |
|      | 3170-07705411 | LCD MODULE PD1106A , SEGMENT , RoHS<br>(AFG-20xx系列)    | 1   |
| 2    | 3170-07705401 | LCD MODULE KSB1010-01 , SEGMENT , RoHS<br>(AFG-21xx系列) | 1   |
| 1    |               | PMS-M2.5*6                                             | 4   |
| ITEM | Part NO.      | Description                                            | QTY |

# APPENDIX

## Declaration of Conformity

We

**GOOD WILL INSTRUMENT CO., LTD.**

(1) No.7-1, Jhongsing Road, Tucheng Dist., New Taipei City 236, Taiwan

(2) No. 69, Lu San Road, Newarea, Suzhou, Jiangsu, China

declare, that the below mentioned product

**Model Number: AFG-2000**

are herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Law of Member States relating to Electromagnetic Compatibility (2004/108/EC) and Low Voltage Directive (2006/95/EC).

For the evaluation regarding the Electromagnetic Compatibility and Low Voltage Directive, the following standards were applied:

### © EMC

|                                                                                                       |        |                         |
|-------------------------------------------------------------------------------------------------------|--------|-------------------------|
| EN 61326-1: 2006 Electrical equipment for measurement, control and laboratory use -- EMC requirements |        |                         |
| Conducted Emission                                                                                    | ClassB | Electrostatic Discharge |
| Radiated Emission                                                                                     |        | EN 61000-4-2: 2008      |
| EN 55011: 2009 + A1: 2010                                                                             |        |                         |
| Current Harmonics                                                                                     |        |                         |
| EN 61000-3-2: 2006+A2:2009                                                                            |        |                         |
| Voltage Fluctuations                                                                                  |        |                         |
| EN 61000-3-3: 2008                                                                                    |        |                         |
| -----                                                                                                 |        |                         |

### © Safety

|                                            |  |
|--------------------------------------------|--|
| Low Voltage Equipment Directive 2006/95/EC |  |
| Safety Requirements                        |  |
| IEC/EN 61010-1: 2001(Second Edition)       |  |