ÆE20125
10 MHz Sweep DDS
Function Generator

Assembly and
Operation Manual

Table of Contents

Warning

Please read this manual before you assemble and use this kit. Keep it accessible for all users at all times.

Safety Information

Know and follow the applicable regulations for electric devices in your region. In Germany, these are especially VDE 0100, VDE 0550/0551, VDE 0700, VDE 0711 and VDE 0860. Pay attention to the following safety advices:

• Disconnect the power supply before opening the case.

• Work on devices only if you made sure that they are disconnected from any power supply, and any possible charge inside is discharged.

• Devices must only be used if they are mounted in a case in a way that prevents the user from touching any live wires or parts. Disconnect the device from its power supply during assembly.

• Always check the power cords for breaks or damaged insulation. Replace any defective parts immediately.

• Seek advice from a qualified expert if you are not sure about any specific value of a part, an installation procedure, or how to connect accessories.

•Always check if the device is suitable for the intended purpose before putting the unit in use. Seek assistance from a qualified professional or the manufacturer if you are not sure.

• The manufacturer assumes no liability for errors made during assembly or operation.

• Devices that need a supply voltage greater that 24V may be assembled by professionals only, to avoid hazards from improper assembly.

• In schools, educational institutes or workshops, the use of this unit must take place under the supervision of qualified staff.

• Do not put this unit in use in an environment where the risk of fire or explosion or explosive gas, vapor or dust is present.

• If the unit must be repaired, use original parts only. The use of inappropriate parts may lead to a safety risk.

• Avoid working alone.

• Keep electronic parts away from children.

• Do not replace parts with such that does not meet the required parameters. For example: never replace a fuse with another one with higher nominal current!

• Other regulations may apply. Please check the local safety regulations for assembling electronic devices.

Handover of a Device Built From a Kit
(in countries where applicable)

If you hand over a device built from a kit, you legally become the manufacturer. This means you are responsible for complying with the appropriate regulations for electronic devices. All accompanying papers, in particular this manual, must also be passed over. Where necessary (for example in the European Union) you must also publish your identity to the consignee.

Intended Use
(in countries where applicable)

The intended use of this device is the generation of waveform signals for measuring purposes.

• Other uses are not approved!

ESD Warning

What is ESD?

ESD (*Electrostatic Discharge)* is the sudden flow of electricity between two objects caused by contact or an electrical short. It can reach very high voltages of many kV. In some cases even over 100kV!

Warning symbol for an electrostatic sensitive device

Causes of ESD

The main cause of ESD events is static electricity. Static electricity is usually generated through tribocharging, like walking on a rug, ascending from a fabric seat, removing some types of plastic packaging or using non-ESD compliant tools.

Danger of ESD

The high voltage pulse can easily destroy electronic parts. ICs and FETs are very sensitive to high voltage. **Even a short, single touch may destroy a part!**

How do I prevent damage due to ESD?

Always ground yourself while working with electronic parts. A grounded conducting wrist strap and proper anti-static work surface mat will help prevent ESD damage. Also make sure that the soldering iron is grounded and ESD-safe.

AE20125 Sweep DDS Function Generator

The AE20125 Function Generator is capable of producing sine, square and triangle signals with an output frequency from 0.1 Hz to 10 MHz[1], continuously adjustable in 0.1 Hz step over the entire range. The maximum amplitude is 5Vpp. The DC offset is adjustable from -5V to +5V.

Sweep and modulation capabilities: frequency (FSK) and phase (PSK) shift keying. Internal or external modulation source. Adjustable internal frequency, and calculation and display of PLL frequency when used as a timebase for PLL, are some of the advanced functions.

The USB interface[2] allows remote control of the function generator with the included software. The easy, plain text command protocol allows simple integration with external tools and systems. Every function of the device can be remote controlled.

All SMD (Surface Mounted Device) components are already soldered, so the kit is also suitable for beginners in electronics. The comprehensive manual should help answer all questions that may arise during assembly.

Please read the complete manual (especially if you are not yet experienced in electronic engineering) before building the kit.

---

1 *for sine, 2.5 MHz for square and triangle*
2 *optional*

Circuit Description

The AE20125 Function Generator is based upon a Direct Digital Synthesizer (DDS). DDS uses a processor to calculate the output waveform and a Digital-to-Analog Converter (DAC) to create the actual voltage needed to produce a waveform. DDS has the advantage of high accuracy and resolution.

Note: for a comprehensive overview of DDS, an excellent document is available from Analog Devices[1].

The heart of the AE20125 is the AD9833 from Analog Devices (IC2). It is capable of producing sine, square, and triangle waveforms. The 25 MHz crystal oscillator Q1 provides the master clock for the DDS. The output signal of the DDS is discretely constructed from a finite number of steps. This signal always contains unwanted high frequency components. A reconstruction filter is needed to remove these components from the signal. The filter is composed of L1, C4, L2, C5, L3, C11 and R8. As the square wave signal does not require filtering, the filter is disabled with the relay K1 when switched to square wave. The square wave produced by the AD9833 has a different amplitude than the other waveforms, so the divider R14/P4 adjusts it to match the amplitude of the sine and triangle wave.

IC1 is the microcontroller that controls the device. The keys and the LCD are connected to it. The FTDI FT230XS UART-to-USB-Bridge (IC6) provides USB connectivity to the microcontroller.

---

1   *A Technical Tutorial on Digital Signal Synthesis, 1999, http://www.analog.com/static/imported-files/tutorials/450968421DDS_Tutorial_rev12-2-99.pdf*

The reconstructed waveform from the AD9833 is fed into the output amplifier. The high speed current feedback op amp LM6181 (IC3) amplifies the signal to an amplitude of 5Vpp. The high bandwidth of 100 MHz, 100mA output drive capability and the very high slew rate of 2000V/µs makes the LM6181 an ideal choice for this application. P1* and P2* adjusts the output amplitude (0 to 5Vpp) and the DC offset (-5V to +5V). The offset symmetry can be trimmed with P3. C19 decouples the output signal of the AD9833, removing its own DC offset. *Note: This causes a slight attenuation of signals below 12 Hz.*

The supply voltage of 14 to 18V DC is fed through the protection diode D1 and buffered by the electrolytic capacitor C12. The 5V digital supply comes from the linear regulator IC4. The inverter, built around T1-T4, provides the negative supply, IC5 regulates the -5V rail.

A combined analog/digital circuit like this depends on good supply bypassing, ensured by many ceramic and electrolytic capacitors and ferrite beads.

The Sync output and the Mod-In input are respectively protected against overvoltage/overcurrent by R15 and by R18, D2 and D3.

3

Soldering

Please read the following pages if you are not yet experienced in soldering. Good soldering is a matter of practice! Practice on old boards until you feel confident before assembling the kit.

• **The parts are mounted on the silkscreen side of the PCB. Except parts whose designators ends with an asterisk (like S1*). These are mounted on the other side!**

• **Do not inhale the fumes from the flux! Wash your hands after soldering! Wear protective glasses!**

• If you use additional flux, make sure it is suitable for electronics use! Non-suitable flux may contain acid which will damage the traces on the PCB over time.

• Try to solder fast. Heating up for too long may damage the components and the board.

• Solder wire with a diameter between 0.5-0.75mm (0.02"-0.03") is most suitable for through-hole components. Lead solder is easier to use than lead-free solder.

• A clean, non-oxidized tip is essential for good soldering. Use a wet sponge or a metal wool tip cleaner to regularly clean the tip. The metal wool cleaners are superior to a wet sponge as there is no temperature shock.

• When soldering active components (ICs, Transistors, LEDs...), it is very important to prevent overheating the components. They should be soldered in no more than about 5 seconds. In addition, it is important not to confuse the polarity! See the next chapter on individual component types and their correct orientation.

• To solder:

1. Use the tip of the soldering iron to simultaneously heat up the PCB and the component leg.

2. Add solder. It should melt around the component leg.

3. Wait a moment. Then remove the iron.

4. Do not move the part you just soldered for a few seconds while it is cooling down. Moving it may cause the solder joint to crack. With lead solder, the solder joint should be glossy.

5. After soldering, use side cutters to cut the leads straight above the solder joint.

• After you are finished, check all components for correct placement and orientation. Also, check for unintentional shorts on the board. Small solder leftovers may cause shorts which can damage the board or the components.

• Use isopropyl alcohol (IPA) or a specific PCB cleaner fluid to remove flux residues. Flux is corrosive and should not remain on the board.

Component Reference

1 Resistors

To save PCB space, the resistors are mounted standing. To install:

1. Bend the leads in form and put the resistor through the corresponding mounting holes.

2. Bend the leads aside to prevent the resistor from falling out.

3. Solder it accurately on the back side.

4. Cut the remaining leads above the solder joint.
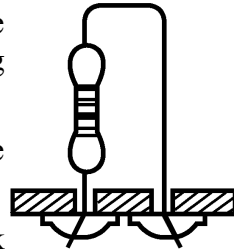
The resistance value is given with colored bands on the resistor. The code consists of four, five or six bands. With four bands, the first two are the base value (see table below), the third is the multiplier to the base value and the fourth is the tolerance. Five-band code uses the first three bands for base value. With six bands, the sixth is the temperature coefficient. The resistor value is:

base value * multiplier   [± tolerance]

There are two possible arrangements for the bands order:
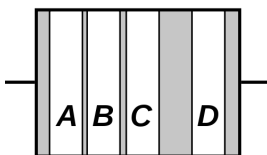
Type A
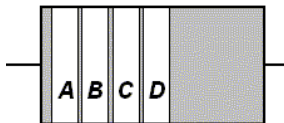
Type B

Color Codes:

Color	Digit	Multiplier	Tolerance ± in %
None	-	-	20
Silver	-	10^{-2}	10
Gold	-	10^{-1}	5
Black	0	10^{0}	-
Brown	1	10^{1}	1
Red	2	10^{2}	2
Orange	3	10^{3}	-
Yellow	4	10^{4}	-
Green	5	10^{5}	0.5
Blue	6	10^{6}	0.25
Purple	7	10^{7}	0.1
Grey	8	10^{8}	0.05
White	9	10^{9}	-

2 Capacitors / Electrolytic Capacitors

Capacitors are soldered the same way as resistors. **Electrolytic capacitors are polar. They must be mounted in the correct orientation! They will be destroyed when installed in reverse polarity and may even burst!**

Please keep in mind that different manufacturers mark the polarity in different ways. The marking may represent the positive or the negative terminal! The actual polarity (+ or -) is printed inside the marker band that points at one of the leads.

7

Capacitance Identification

A three-digit number without letters is the capacitance in pF, calculated this way: $a*10^b$ where a are the first two digits and b is the third digit (105 become $10*10^5$ pF = 1µF). One- or two-digit numbers states the capacitance directly in pF. A number including the letter "n" is the capacitance in nF, where 3n9 is 3.9nF.

Upper-case characters denote the tolerance according to this table:

B	C	D	F	G	H
±0.1pF	±0.25pF	±0.5pF	±1%	±2%	±2.5%

J	K	M	S	Z	P
±5%	±10	±20	+50% -20%	+ 80% - 20%	0% -10%

A number following up indicates the electric strength.

Sometimes you may encounter a number like 0.5, this is the capacitance in µF.

Electrolytic capacitors are usually labeled with the capacitance in µF straight. µ is where the decimal point is: µ33 is 0.33 µF, 3µ3 is 3.3µF and 33µ is 33µF.
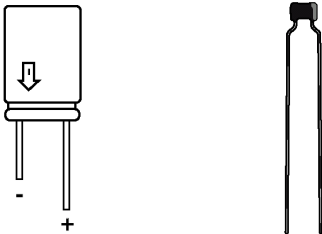
3 Diodes

The circular band on diodes identifies the cathode (negative terminal). The bar depicts the cathode in the symbol. The positive terminal is called the anode.

Diodes are mounted horizontal. Try not to heat up the body of the diode while soldering.
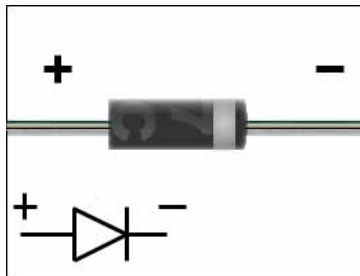
4 LEDs
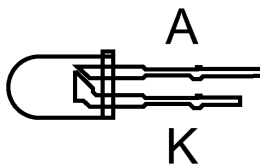
LEDs (light-emitting diodes) must be soldered with respect to the correct polarity as well. The cathode is identified by the short lead and the larger electrode inside.

5 IC-Sockets / ICs

With ICs (integrated circuits), it is essential to observe correct polarity. Most ICs will be damaged or destroyed when mounted incorrectly. The mark on the silkscreen must match the notch on top of the IC.

Pin numbers are counted **counter**-clockwise, starting from the notch.
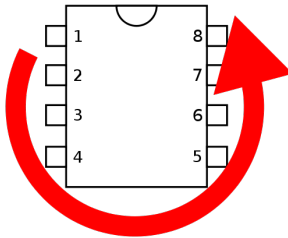
*Note: Please also pay attention to the ESD warnings at the beginning of this manual. ICs are very ESD sensitive. **This applies especially to the AD9833, which can be destroyed even by a minor electrostatic discharge event!***

6 Transistors

Transistors must be mounted in the correct orientation. The flat side of the transistor must match the correspondent side in the silkscreen drawing. The leads may not cross.

Note: field-effect transistors (FETs) are extremely sensitive to ESD.

7 Crystal

The polarity of the crystal is not relevant, but the bottom side of the package is conductive. **To prevent shorts, the crystal should be mounted with a little distance to the board (see the image on the next page).**

GOOD   POSSIBLE SHORT

PCB
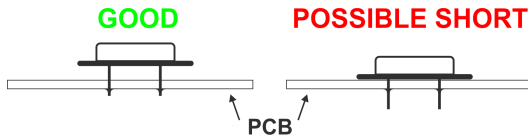
8 Inductors

Inductors are soldered just like resistors. They also use similar color-coding, usually with four bands. The first two are the base value (see table below), the third is the multiplier to the base value and the fourth is the tolerance. The inductor value is:

base value * multiplier   [± tolerance]

Color Codes:

Color	Digit	Multiplier	Tolerance ± in %
None	-	-	20
Silver	-	10^{-2}	10
Gold	-	10^{-1}	5
Black	0	10^0	-
Brown	1	10^1	1
Red	2	10^2	2
Orange	3	10^3	-
Yellow	4	10^4	-
Green	5	10^5	0.5
Blue	6	10^6	-
Purple	7	10^7	-
Grey	8	10^8	-
White	9	10^9	-

9 Relay

The side of the relay marked with a bar corresponds to the side marked with a "1" on the silkscreen. In contrast to the IC marking, the notches have no meaning!
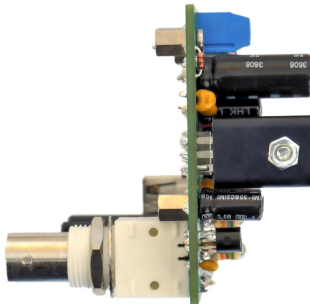
10 Crystal oscillator

Unlike crystals, oscillators are polar. Pin 1 is identified by the pointy edge. The other edges are rounded.

If the oscillator is mounted incorrectly it will cause a short that may damage the device permanently! Please double-check the correct orientation.

11 Heat sink

After the assembly is complete, the heat sink is tightened to IC4.

Assembly

General note

It is essential to work precisely and systematically to minimize the possibility of faults. Check every step, each component placement and orientation, and any solder joint. Follow the assembly order given in the manual.

Take your time - it takes longer to troubleshoot than to prevent faults by working accurately.

The most common reason for a malfunctioning device is wrong component placement: either the component being placed in the wrong place or back to front. Check resistors with a multimeter if you have difficulties reading the color bands.

A common mistake is regarding capacitor labeling, such as n10 = 0.10 nF = 100 pF as opposed to 10 nF. Also, check if all leads of an IC are correctly inserted into the socket. They tend to bend during insertion.

After soldering, inspect the board for what are called cold and dry solder joints. Cold joints occur if the soldering temperature did not exceed the solder's liquidus temperature, or if the flux evaporated before it was applied on the surfaces being soldered. This is usually the result of the soldering iron being used to heat the solder directly, rather than the parts themselves. Dry joints occur when the cooling solder is moved. They often occur because the joint moves when the soldering iron is removed from the joint. When using lead solder, the joint should be smooth, bright and shiny. The joint should be reworked if it is not.

Mounting

1. Solder all of the parts without an asterisk on the side of the board where the silkscreen is. (see the picture on the next page). Wait to insert IC1 in the socket until you have finished the assembly. After all the parts on this side are soldered, please examine the board carefully for shorts, bad solder joints and correct placement. **The LCD will cover them, so you will need to desolder it to fix errors, which takes extra time and effort.** See the previous page for more information.

2. Solder the parts with an asterisk (the LCD, both Alps potentiometers, the BNC and USB connectors, and the tact switches) on the opposite side.

3. Attach the LCD:

    a) Insert the header into the board.

    b) Put the LCD on top of the header.

    c) Fix the LCD with the M2.5 screws and spacer bolts in place.

    d) Solder the header to the board and LCD. See the picture on next page for how it should look like when finished.

4. Insert IC1 into the socket. The notch on the chip must correspond with the silkscreen marking.

Finished Component Side
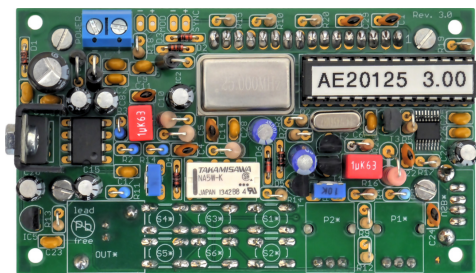
Finished Solder Side, without the LCD
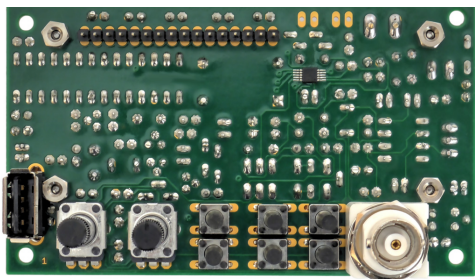
LCD Mounting
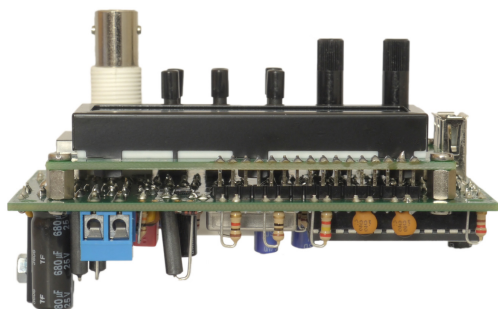
Calibration

An oscilloscope or a multimeter capable of measuring the peak-to-peak value of a square wave is needed for the calibration.

DC Offset Symmetry

To adjust the DC offset:

1. Set the output amplitude potentiometer to minimum

2. Set the DC offset potentiometer in mid-position.

3. Adjust P3 until the output signal is exactly 0V.

Square Wave Amplitude

1. Set up the device to produce a square wave signal with a low frequency (1-10 kHz) and maximum amplitude.

2. Adjust P4 to achieve an amplitude of 5Vpp.

This completes the adjustment procedure.

Troubleshooting Checklist

Check and tick off every step.

☐ Is the polarity of the supply voltage correct?

☐ Is the supply voltage in the range of 14-18V when the device is turned on?

☐ Are all resistors placed right? Check the color bands.

☐ Are the polarities of the diodes correct? The cathode band must match the bar on the silkscreen symbol.

☐ Verify the polarity of the electrolytic capacitors. Keep in mind that the marking on the capacitor can point to the (+) or (-) lead. The actual meaning is printed inside the marking.

☐ Are all ICs in the right place and with correct orientation?

☐ Are all IC leads plugged inside the socket? They can bend and stay outside easily.

☐ Measure the resistance between the power supply input terminals and between the regulated 5V rail and ground - they must not be shorted.

☐ Are there solder bridges on the solder side of the PCB causing shorts? They are easier to find if you hold the PCB toward bright light.

☐ Are there bad/cold/dry solder joints? Jiggle component leads at the solder joint with a pair of tweezers. Re-solder them if any move. If a solder joint looks suspicious, better rework it just in case.

☐ Look if you missed a soldering point. With the USB model, all pads are used.

Power Supply

A 14V-18V DC power supply capable of providing at least 300mA is required. The optional AC adapter, batteries or any other supply that meets this criteria can be used.

Warning: An AC power supply may not be used!

Note: It is advisable to use a current limiting lab power supply when switching on for the first time. Set it to 15V and 300mA. This will help to prevent damage from potential shorts.

Please pay attention to the correct polarity of the power connection!

Case Mounting

Note: This describes the optional case available with the kit.

The case is provided with all necessary cut-outs and labels.

1. Put the extension caps on the tact switches.

2. Join the front panel and the PCB and insert both in the respective brackets. The PCB fits in the brackets behind the front panel.

3. Install and **lightly** tighten the lock nut of the BNC connector.

   The lock nut of the BNC connector must be mounted in the orientation shown below, or it will prevent the case from closing properly.
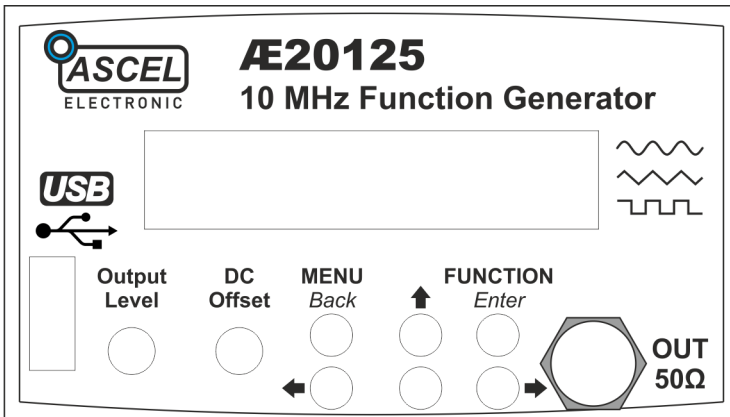
4. The two highlighted brackets on the front side of the top case part should be broken off as they will interfere with the heat sink and C11.
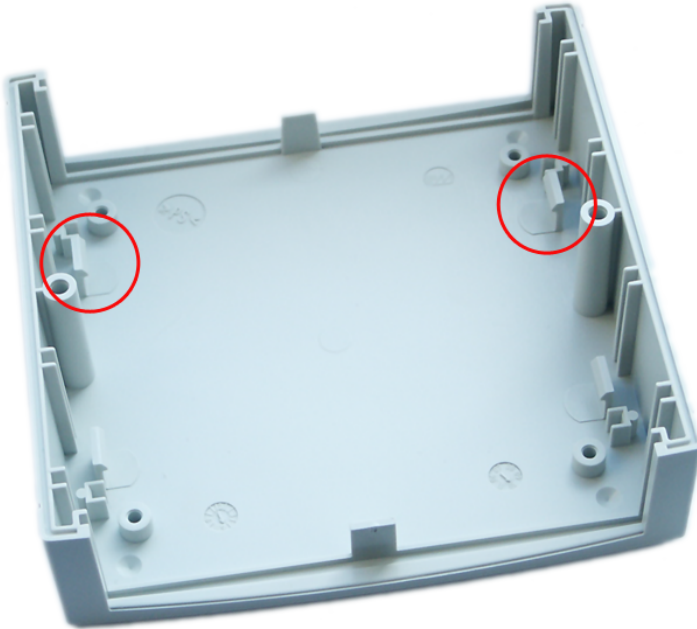
5. Solder four pieces of wire, about 15cm (6") long, to the two Cinch connectors and their ground leads.

6. Put the connector's wires through the appropriate holes in the back plate.

7. Attach the ground leads and solder the wires to the PCB.

8. Fasten the case with the included screws.

This completes the case mounting.

Operation

Menu Structure
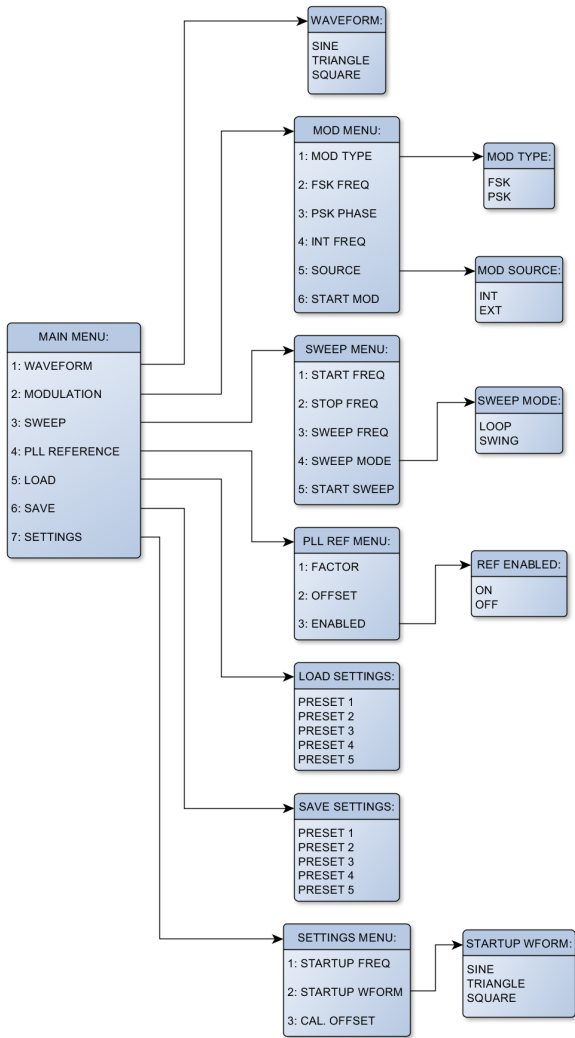
Basic Operation

Frequency

The frequency is adjusted with the arrow keys. The active digit is always blinking. Its value can be changed with ⬆ and ⬇ . Press ⬅ or ➡ to set the active digit.

Waveform

Press **FUNCTION/Enter** to get to the waveform selection menu. Press ⬅ or ➡ to select either sine (**SIN**), triangle (**TRI**) or square wave (**SQR**). **>** appears in front of the selected waveform. Press **FUNCTION/Enter** to apply the selected waveform or **MENU/Back** to cancel.

Amplitude

The amplitude is adjusted with the **Output Level** control. Rotate the control clockwise to increase the amplitude.

DC Offset

The DC offset is adjusted with the **DC Offset** control. In the center position, it is 0V. Rotate the control (counter)clockwise to apply a DC offset up to (-5V) 5V to the output signal.

Menu Control

To access the main menu, press **MENU/Back**. See the diagram for the menu structure. In all menus, the top line of the display shows the active menu title or the menu item that is being adjusted. The bottom line shows the active menu item or the value of the menu item that is being adjusted. Press ⬆ or ⬇ to select the next or previous menu item or increase/decrease an item's value. ⬅ and ➡ moves the cursor in numerical entry menus or selects the active item in selection menus. The selected item is shown with the **➤** symbol.

Press **FUNCTION/Enter** to apply the changes or enter a sub-menu. Press **MENU/Back** to cancel the changes or go back one menu level. When pressed in main menu, this leaves the menus and returns to normal operation.

The Menu

1 WAVEFORM

Use this menu to select the waveform. You can press **FUNCTION/Enter** on the main screen to show it up immediately (see previous page).

2 MODULATION

The AE20125 is capable of frequency (Frequency Shift Keying, **FSK**) and phase modulation (Phase Shift Keying, **PSK**). For the modulation source, an internal frequency can be selected or the external input may be used. The **MODULATION** menu is used to adjust the modulation parameters.

2.1 MOD TYPE

Modulation type can be **FSK** (frequency) or **PSK** (phase).

2.2 FSK FREQ

Here you can select the frequency step used to change the frequency when using **FSK**.

Example: output frequency is 650,000 Hz, FSK FREQ is 5,000 Hz, modulation alternates between 650,000 Hz and 655,000 Hz.

2.3 PSK PHASE

Here you can select the phase step used the change the phase when using **PSK**. The adjustment range is 0.1° - 359.9°. The normal output's phase is always considered as 0°.

2.4 INT FREQ

When internal modulation source is selected, the frequency of the modulation can be adjusted here.

2.5 SOURCE

The modulation source can be selected as internal (**INT**) or external (**EXT**). With internal modulation source, the frequency set at **INT FREQ** is used. With external source, a 5V (TTL) logic signal should be applied to the MOD-IN input.

2.6 START MOD

Starts the modulation. Press **FUNCTION/Enter** again to stop the modulation and return to normal operation.

3 SWEEP

In sweep mode, the output frequency is continuously changed from the start to the stop frequency with the duration derived from the frequency set at **SWEEP FREQ**. Depending on **SWEEP MODE**, after the stop frequency has been reached, the sweep continues backwards or starts over. At the start of every cycle, a short pulse is generated at the SYNC output. The increment used to change the frequency at each step depends on the sweep range (F_{stop}-F_{start}) and the sweep frequency, the lower it is and the smaller the sweep range is, the lesser is the increment.

3.1 START FREQ

The start frequency of the sweep cycle.

3.2 STOP FREQ

The stop frequency of the sweep cycle. If it is lower that the start frequency, the sweep runs "backwards" (from the higher to the lower frequency).

3.3 SWEEP FREQ

The sweep frequency can be adjusted between 0.1 Hz (equivalent to 10 sec sweep cycle duration) and 10 Hz (0.1 sec sweep cycle duration or 10 sweep cycles per second).

3.4 SWEEP MODE

This setting controls the behavior after a sweep cycle is complete. **LOOP** restarts the cycle again with the start frequency, **SWING** lets it run back from the stop to the start frequency.
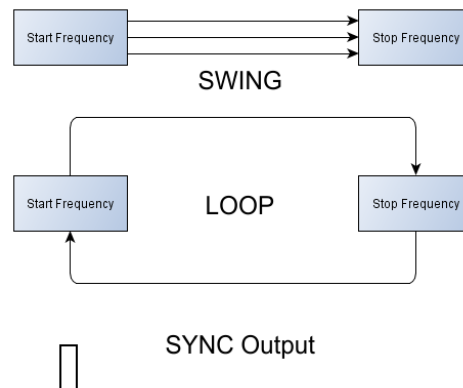
3.5 START SWEEP

Starts sweeping. Press **FUNCTION/Enter** again to stop sweep and return to normal operation. *Note: The keys are polled at the beginning of a sweep cycle only. It may be necessary to hold the key for a little while.*

4 PLL Reference

If the AE20125 is used as the timebase for a PLL, the frequency of the PLL can be calculated and shown directly on the display.

The indicated frequency is calculated as follows:

$$f_{PLL} = (f_{OUT} \cdot FACTOR) + OFFSET$$

4.1 FACTOR

The output frequency is multiplied with this factor. It can be in the range from 1 to 999.9.

4.2 OFFSET

The offset is added to the output frequency. It may be in the range from -1 GHz to +1 GHz.

4.3 ENABLED

Enables or disables the PLL frequency indication. If enabled, it is shown in the bottom display line, below the output frequency.

5 Presets

The AE20125 is capable of storing five presets, each consists of an output frequency and a waveform. To save a preset, first set the frequency and waveform as desired. In the main menu, select **SAVE SETTINGS** then. Select a position (1-5) to save the preset and press **FUNCTION/Enter**. The settings are saved.

To load a preset, select **LOAD SETTINGS** and the appropriate position in the load menu. Press **FUNCTION/Enter** to load this preset.

Note: The saved presets are kept in non-volatile memory.

Note: The frequency and waveform at start-up can be set separately, see the next chapter.

6 Settings

6.1 STARTUP FREQ

The start-up frequency.

Note: The maximum frequency depends on the waveform set in **STARTUP WFORM** *and equals the maximum output frequency for the particular waveform.*

6.2 STARTUP WFORM

The start-up waveform. The selection matches the selection of the output waveform.

6.3 CAL. OFFSET

The accuracy of the AE20125 function generators output frequency is 50ppm (parts per million = 0.0001%). With a sufficiently accurate frequency counter it can be further improved, by entering a calibration offset.

Note: The calibration should be carried out after the unit has reached operating temperature (> 30 min).

7 Firmware Update

To update the firmware, hold **MENU/Back** while switching the generator on. "FIRMWARE UPDATE" is shown. Connect the generator to a PC via USB and use the *Ascel Firmware Update Utility* to update the Firmware.

8 Reset

To reset the device to factory defaults, press and hold **FUNCTION/Enter** and turn the unit on. Release the key when **LOADING DEFAULTS** is displayed.

The following settings will be restored: see next page

Factory Defaults:

Output Frequency:	10,000.0 Hz
Output Waveform:	SINE
Start-Up Frequency:	10,000.0 Hz
Start-Up Waveform:	SINE
Output Frequency Preset 1-5:	10,000.0 Hz
Output Waveform Preset 1-5:	SINE
Calibration Offset:	0
PLL Factor:	1
PLL Offset:	0 Hz
PLL Enabled:	OFF
Sweep Start Frequency:	10,000.0 Hz
Sweep Stop Frequency:	100,000.0 Hz
Sweep Mode:	LOOP
Sweep Frequency:	1.0 Hz
Modulation:	FSK
Modulation Source:	INT
Modulation Frequency:	1.0 Hz
Modulation FSK Frequency:	10,000.0 Hz
Modulation PSK Phase:	0.1°

Circuit Diagram

Part 1/2
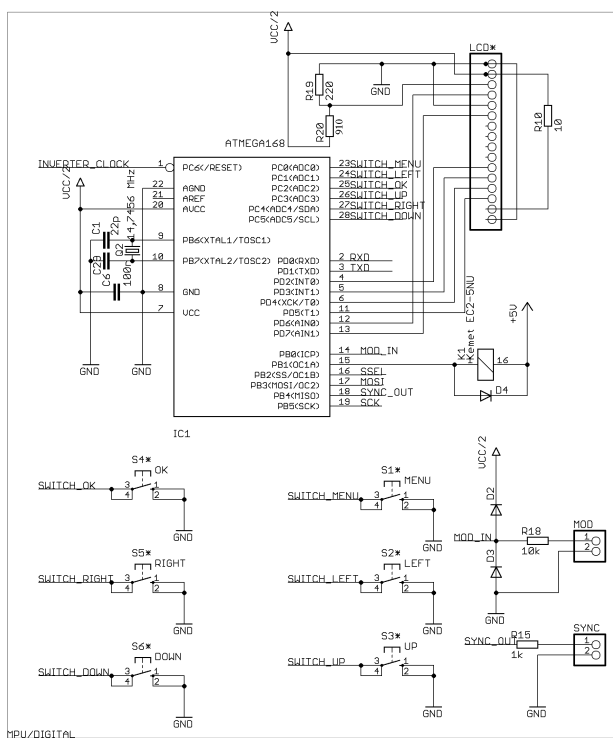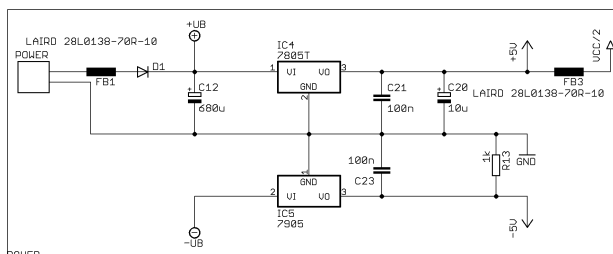
Part 2/2
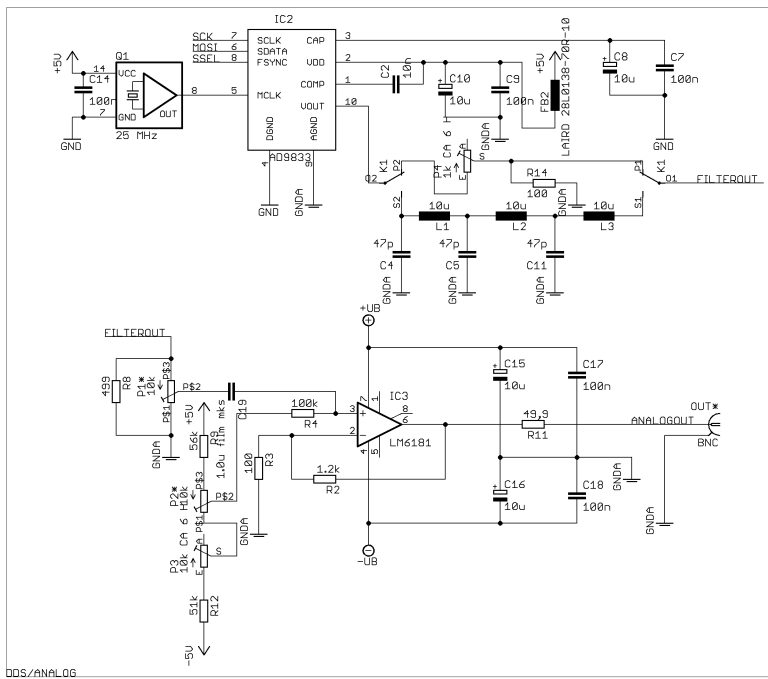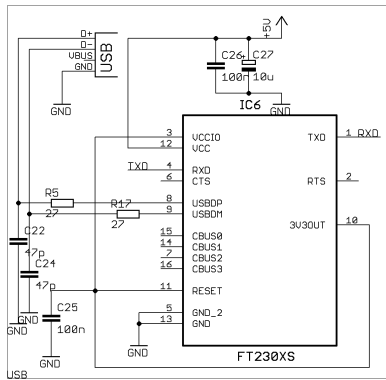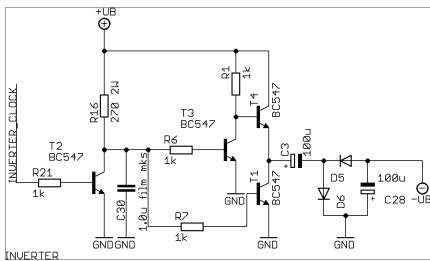
Bill of Materials

Quantity	Parts(s)	Value / Description
8	C6, C7, C9, C14, C17, C18, C21, C23	100nF
1	C2	10nF
3	C4, C5, C11	47pF
2	C3, C28	100µF Electrolytic
5	C8, C10, C15, C16, C20	10µF Electrolytic
1	C12	680µF Electrolytic
2	C19, C30	1µF Film
2	C1, C29	22pF
1	D1	1N4007 Diode
5	D2, D3, D4, D5, D6	1N4149 Diode
3	FB1, FB2, FB3	Ferrite bead
3	L1, L2, L3	10µH
1	K1	Relay
2	MOD, SYNC	Cinch Connector
2	P1*, P2*	ALPS Potentiometer 10K
1	P3	Trimmer 10K
1	P4	Trimmer 1K
1	Q1	Crystal Oscillator 25 MHz
1	Q2	Crystal 14.7456 MHz

Continued on next page

1	R18	10KΩ
1	R2	1.2KΩ
2	R3, R14	100Ω
1	R4	100KΩ
1	R19	220Ω
1	R20	910Ω
1	R8	499Ω
1	R9	56KΩ
1	R10	10Ω
1	R11	49.9Ω
1	R12	51KΩ
1	R16	270Ω 2W
6	R1, R6, R7, R13, R15, R21	1KΩ
1	IC1	IC Socket 28 pin / Microcontroller
1	*IC2*	*AD9833 DDS Waveform Generator (pre-assembled)*
1	IC3	LM6181 Op Amp
1	IC4	7805 Positive Linear Regulator
1	IC5	79L05 Negative Linear Regulator
1	OUT*	BNC Connector
1	LCD*	2x16 Dot-Matrix LCD
1	POWER	Power Connector
6	S1*, S2*, S3*, S4*, S5*, S6*	Tact Switch
4	T1, T2, T3, T4	BC547B
1	-	Header 16-pin *(for LCD mounting)*

USB Models only:

2	C25, C26	100nF
1	C27	10µF Electrolytic
2	C22, C24	47pF
2	R5, R17	27Ω
1	*IC6*	*FT230XS USB UART Interface (pre-assembled)*
1	USB*	USB Type "A" Connector

Other:

- PCB

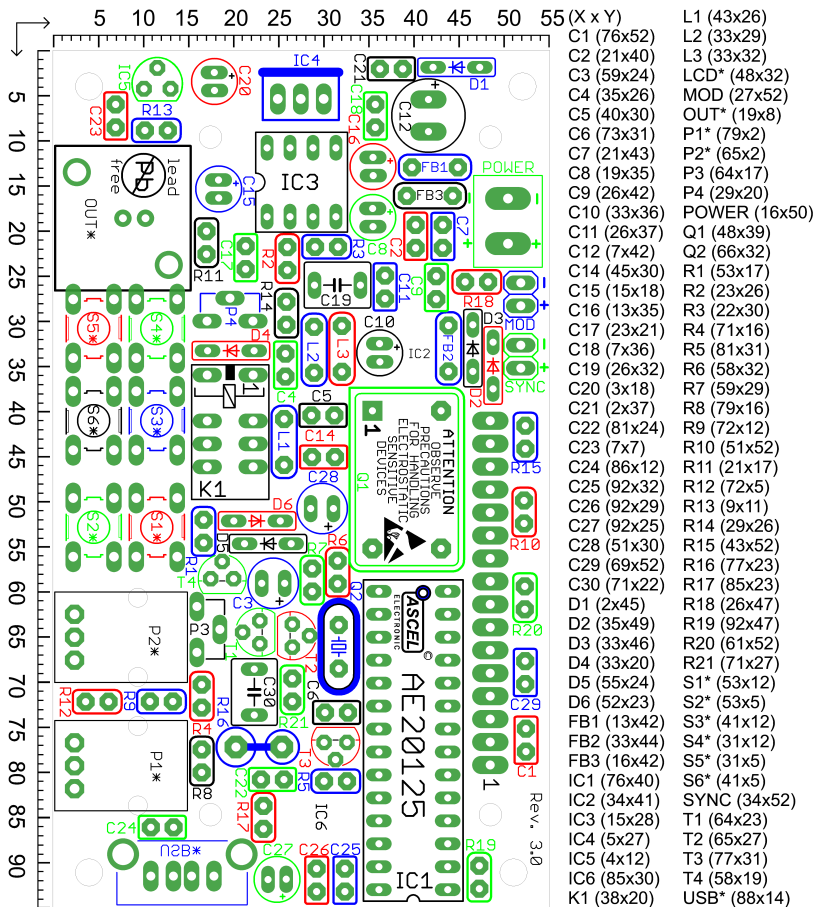- 4 spacer bolts and 8 M2.5 screws for LCD mounting

- Heatsink for IC4 with M4 screw and nut

- *Case and 6 extension caps for the tact switches (optional)*

- *AC adapter (optional)*

⚠️ *Note: Parts whose designator contains an asterisk are mounted on the opposite side of the PCB. See "Assembly" chapter for details.*

Component Placement Diagram

(X x Y)	L1 (43x26)
C1 (76x52)	L2 (33x29)
C2 (21x40)	L3 (33x32)
C3 (59x24)	LCD* (48x32)
C4 (35x26)	MOD (27x52)
C5 (40x30)	OUT* (19x8)
C6 (73x31)	P1* (79x2)
C7 (21x43)	P2* (65x2)
C8 (19x35)	P3 (64x17)
C9 (26x42)	P4 (29x20)
C10 (33x36)	POWER (16x50)
C11 (26x37)	Q1 (48x39)
C12 (7x42)	Q2 (66x32)
C14 (45x30)	R1 (53x17)
C15 (15x18)	R2 (23x26)
C16 (13x35)	R3 (22x30)
C17 (23x21)	R4 (71x16)
C18 (7x36)	R5 (81x31)
C19 (26x32)	R6 (58x32)
C20 (3x18)	R7 (59x29)
C21 (2x37)	R8 (79x16)
C22 (81x24)	R9 (72x12)
C23 (7x7)	R10 (51x52)
C24 (86x12)	R11 (21x17)
C25 (92x32)	R12 (72x5)
C26 (92x29)	R13 (9x11)
C27 (92x25)	R14 (29x26)
C28 (51x30)	R15 (43x52)
C29 (69x52)	R16 (77x23)
C30 (71x22)	R17 (85x23)
D1 (2x45)	R18 (26x47)
D2 (35x49)	R19 (92x47)
D3 (33x46)	R20 (61x52)
D4 (33x20)	R21 (71x27)
D5 (55x24)	S1* (53x12)
D6 (52x23)	S2* (53x5)
FB1 (13x42)	S3* (41x12)
FB2 (33x44)	S4* (31x12)
FB3 (16x42)	S5* (31x5)
IC1 (76x40)	S6* (41x5)
IC2 (34x41)	SYNC (34x52)
IC3 (15x28)	T1 (64x23)
IC4 (5x27)	T2 (65x27)
IC5 (4x12)	T3 (77x31)
IC6 (85x30)	T4 (58x19)
K1 (38x20)	USB* (88x14)

Note: Parts whose designators contains an asterisk are mounted on the opposite side of the PCB. See the chapter "Assembly" for details.

Note: To help locate the right elements, parts and their respective designators are highlighted in the same color.

Scale in mm.

Data Interface

The AE20125 function generator optionally comes with an USB interface which can be used to control all of its functions and read out the measured values. The USB driver creates a virtual serial (COM) port.. This makes integration with external tools and applications very easy.

System Requirements

USB Interface:

- MS Windows®[1]98/ME/2000/XP/Vista/7/8/
  Server 2003/Server 2008/Server 2008 R2/
  Server 2012/Server 2012 R2
  x86/x64

- Mac® OS X®

- Linux

PC-Software:

- MS Windows with .NET® -Framework (at least version 4.0)

---

1   *All trademarks are the property of their respective owners.*

USB Driver Installation

The driver for the virtual serial port must be installed before the software can be used. Drivers for all supported operating systems are included with the device. They can be found in the "Driver" directory on the CD.

Note: Newer Windows OS (starting with Windows 7) can install the driver automatically, if an Internet connection is present.

Note: You can change the number of the COM Port assigned by Windows after the first connection is made, by going to Control Panel / Device Manager and selecting the port. Select Properties / Port Settings / Advanced and assign a new number. It will remain even after the device is disconnected and connected again later.

Software Installation

The PC software can be found in the "Software" directory. Execute setup.exe to install the software. There is also a portable version of the software in the "Portable Software" directory that does not require installation.

Note: The .NET-Framework (at least version 4.0) must be installed prior to the software installation.

Note: The USB driver is initialized on first connection. The software may not respond for a few seconds at this time.

Software Screenshot
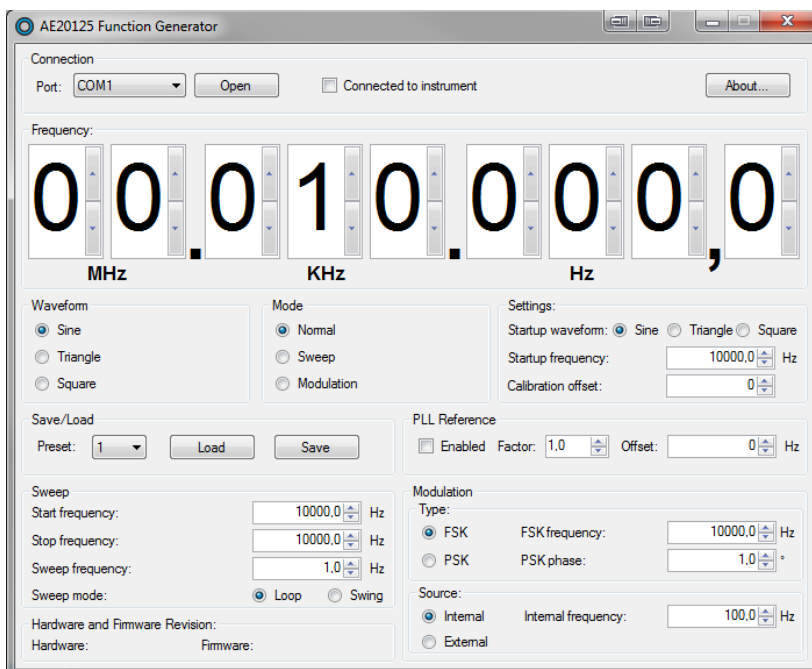
Software Operation

1. Connect the function generator to a PC using a USB A-A cable.

2. Launch the software.

3. Select the correspondent serial port from the list and click "Open". If the connection was successful, "Connected to instrument" will be displayed.

The software offers the same functions as with direct control. See chapter "Operation" for details.

Specifications

Waveforms:	Sine, Square, Triangle	
Max. Frequency:	Sine:	0.1 Hz - 10 MHz
	Square:	0.1 Hz - 2.5 MHz
	Triangle:	0.1 Hz - 2.5 MHz
Adjustment Step:	0.1 Hz over the whole range	
Accuracy:	50ppm (calibratable)	
Max. Amplitude:	5Vpp[1]	
DC Offset:	10V (-5V to +5V)	
Output Impedance:	50Ω	
Display:	2x16 characters dot-matrix LCD	
PC Interface:	USB (optional)	
Supply Voltage:	14-18V DC	
Temperature:	+5°C - +40°C	
Relative Humidity:	< 85% non-condensing	

---

1 *from 5 to 10 MHz, the max. amplitude decreases to about 4Vpp*

Data Format

Format: <ECN>:<CODE>:<DATA>:;

Example: 201:A:100000:;   Set frequency to 10 kHz

<ECN>: ID, always: 201
<CODE>: Data type as follows:

A:↔   **Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100000000]
B:↔   **Waveform** (0: Sine, 1: Triangle, 2: Square)
C:↔   **Mode** (0: Normal, 1: Sweep, 2: Modulation)
D:↔   **PLL Reference Enabled** (0: Disabled, 1: Enabled)
E:↔   **PLL Factor** (in 0.1x)   [Min = 10, MAX = 9999]
F:↔   **PLL Offset** (in 1 Hz)   [Min = -1000000000, MAX = 1000000000]
G:↔   **Start-up Waveform** (0: Sine, 1: Triangle, 2: Square)
H:↔   **Start-up Frequency** (in 0.1 Hz) [Min = 1, MAX = 100000000]
I:↔   **Calibration Offset** (in 1x)   [Min = -10000, MAX = 10000]
J:↔   **Sweep Start Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100000000]
K:↔   **Sweep Stop Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100000000]
L:↔   **Sweep Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100]
M:↔   **Modulation Type** (0: FSK, 1: PSK)
N:↔   **FSK Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100000000]
O:↔   **PSK Phase** (in 0.1°)   [Min = 1, MAX = 3599]
P:↔   **Modulation Source** (0: Internal, 1: External)
Q:↔   **Internal Modulation Frequency** (in 0.1 Hz) [Min = 1, MAX = 10000]
R:↔   **Sweep Mode** (0: LOOP, 1: SWING)
S: <reserved>
T:→   **Get Settings**   [*Data ignored*]
U:←   **Keep Alive**   [*Data ignored*]
V:→   **Return from Sweep/Mod**   [*Data ignored*]
W: <reserved>
X:←   **Hardware Revision**   [*Number*]
Y:←   **Firmware Revision**   [*Number*]
Z:←   **Product ID**   [*Number*]
1:→   **Preset 1 Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100000000]
2:→   **Preset 1 Waveform** (0: Sine, 1: Triangle, 2: Square)
3:→   **Preset 2 Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100000000]
4:→   **Preset 2 Waveform** (0: Sine, 1: Triangle, 2: Square)
5:→   **Preset 3 Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100000000]
6:→   **Preset 3 Waveform** (0: Sine, 1: Triangle, 2: Square)
7:→   **Preset 4 Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100000000]
8:→   **Preset 4 Waveform** (0: Sine, 1: Triangle, 2: Square)
9:→   **Preset 5 Frequency** (in 0.1 Hz)   [Min = 1, MAX = 100000000]
0:→   **Preset 5 Waveform** (0: Sine, 1: Triangle, 2: Square)
To load a preset: *Use the 'Get Settings' command to retrieve Preset 1-5's values. Then use the 'A' and 'B' commands to set the desired frequency and waveform.*