PWM Signal Generator

GP-1

User manual

Read the user manual carefully before using this device. Ignorance of this user manual may cause damage to the device or components and sub-assemblies operated by it.

DeltaTech Electronics

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1. Introduction

Pulse Width Modulation – is a method for regulating voltage or current signal. This is achieved by changing constant amplitude pulse width. PWM modulation is widely used among others in DAC conversion, generating output for actuators and even data transmission.

PWM has many applications in automotive electronics. The following is a list of example applications:
- controlling solenoid valves allowing setting required position (eg, turbo pressure control valve, EGR valve adjustment, diesel injection pump quantity adjuster, etc.)
- controlling DC motors, allowing easy adjustment of engine RPM,
- adjusting actuators (eg position of turbocharger vanes position using DC motor, changing geometry of intake manifold in FSI engines),
- transmitting physical measurements data such as position, flow, etc (eg new type of flow meter),
- data transmission (eg blink fault codes in Mercedes cars).

It is advised to have some knowledge of properties and ways of practical PWM usage. Ability to understand information carried by PWM signal can greatly improve engine diagnostics.

2. PWM signal theory

PWM signal is a periodic signal made of only two voltage levels:
- high, usually equal to supply voltage,
- low, usually equal to ground potential.

An example of PWM signal is given in Figure 2.1.

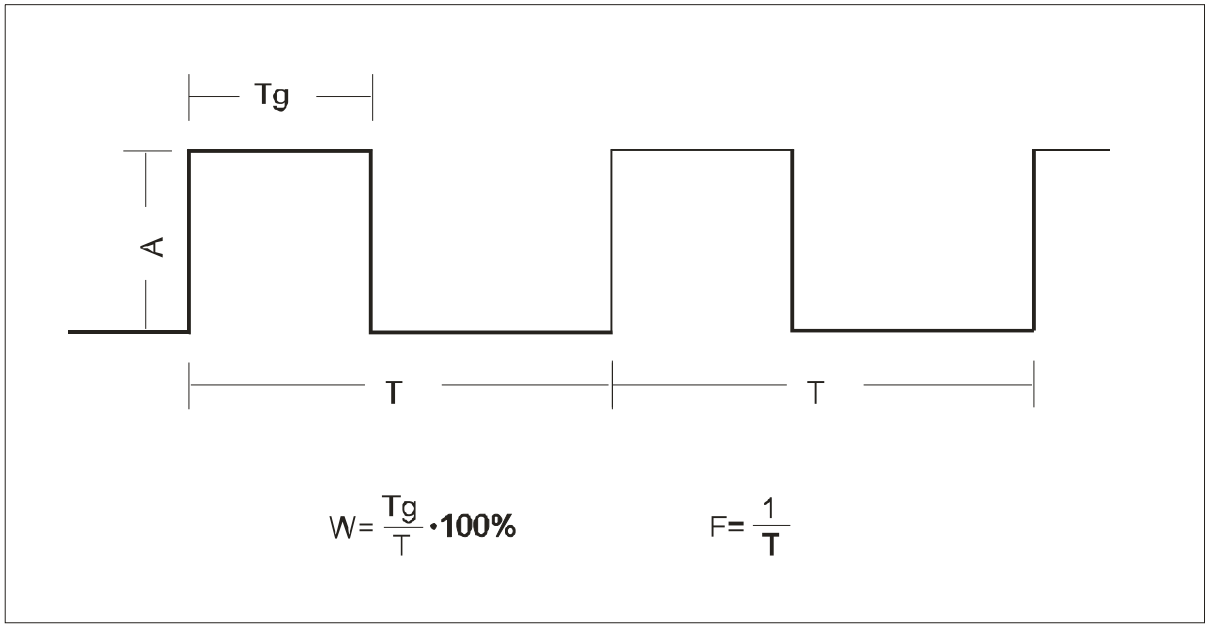


Figure 2.1

This signal is characterized by parameters described in Table 2.1.

Table 2.1

Parameter symbol	Name	Description
A	Amplitude	Maximum value of the signal, usually amplitude is equal to the supply voltage. PWM signal amplitude is constant.
T	Time period	Depending on application the period can have different values. This parameter is directly related to frequency F.
Tg	Pulse duration	States how long the constant amplitude signal is switched on.
W	Duty cycle	Specifies what percentage of time period is a pulse duration.
F	Frequency	This is defined as a reciprocal of time period T: F = 1/T (number of pulses per unit of time).

The higher PWM duty cycle, the higher power is transmitted to the controlled unit.

Depending on how the control element is connected, there are two types of control:
- GND switching,
- supply voltage switching.

GND switching (switching the ground terminal) is used when the element (load) is tied permanently to supply voltage. Control in this situation is achieved by periodic switching on and off the second terminal to ground by a key (transistor). Figure 2.2 depicts simplified schematics of GND switching control.

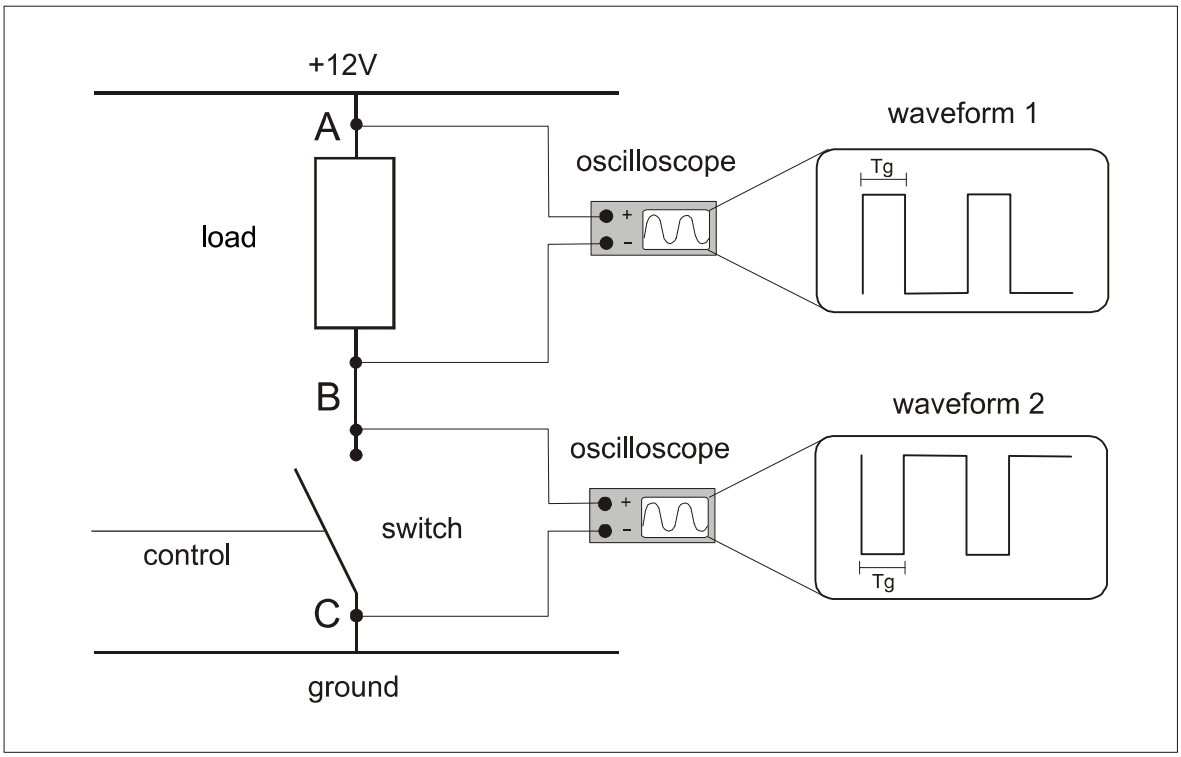


Figure 2.2

Pay special attention to the interpretation of pulse duration (and hence the signal duty cycle) for this type of control depending on where the signal is measured.
When connecting oscilloscope between points A and B, we get a PWM signal where the pulse duration *Tg* is determined by its high state (see waveform 1, Figure 2.2). However, when observing the voltage between points B and C, the pulse duration *Tg* is defined as a low state(see waveform 2, Figure 2.2)

This method is similar to supply voltage switching method except the fact that in the second method the element (load) is permanently connected to ground. Control is

achieved by switching the second terminal to supply using a key (transistor). Figure 2.3 shows simplified schematics of supply voltage switching control method.

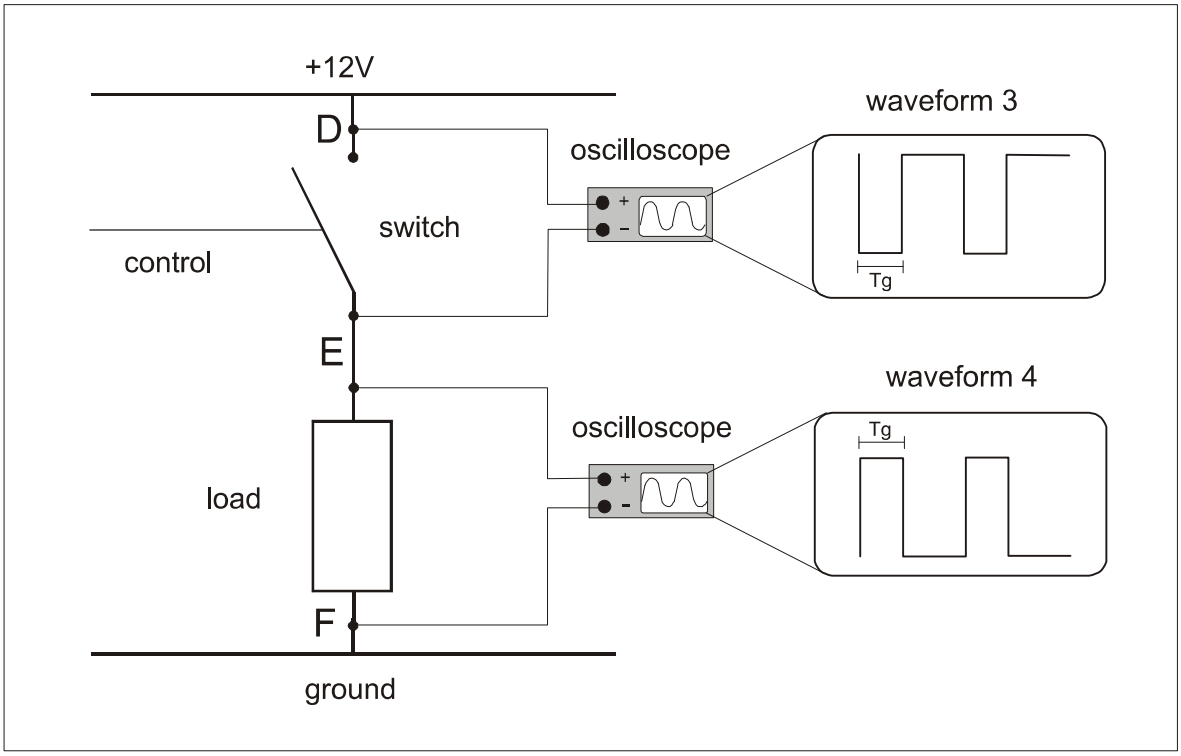


Figure 2.3

Similarly, the interpretation of the pulse duration is dependent on how we observe the control signal.
By connecting the oscilloscope to the D and E, we get the pulse width *Tg* as a low voltage (waveform 3, Fig. 3.2). However, when observing the voltage between E and F the pulse duration *Tg* is seen as a low voltage (waveform 4, Fig. 2.3).

In car diagnostics both methods are commonly used.

When the load is not tied to any of power supply terminals the method of PWM control does not matter. In this situation the control can be achieved by any of two methods described above.

3. Device specifications

Supply voltage	12...15V DC
Current draw	70 mA (tester only, without load)
PWM Signal Generator	
Frequency range	20Hz…1000Hz
Frequency regulation precision	1Hz
Output amplitude	0V up to supply voltage
PWM mode	ground switching or supply voltage switching
Duty cycle regulation	0%...100%
Duty cycle regulation precision	0.1%
Number of outputs	2
PWM signal measurements	
Input frequency range	20Hz…1000Hz
Input amplitude range	0V up to supply voltage
Voltage threshold	2.5V
Protection	
Voltage	Overvoltage protection for input over 18V
Current	Overcurrent protection 6.3 A (fuse) and short circuit protection.

4. Generator application

GP-1 Generator enables both generation and measurement of the PWM signal. Frequency range matches frequencies commonly used in automotive devices.

PWM generator module can be successfully used to:

- control all kinds of electromagnetic valves widely used in both gasoline and diesel engines (eg EGR valve, turbo pressure relief valve, etc.), allowing to check their operation
- control speed of DC motors,
- control fuel dose or ignition advance in fuel pumps of compression-ignition engines (quantity adjuster or ignition advance valve)
- and for control of other devices which uses PWM signal, both GND-switching or supply switching.

PWM measurement module offers way to obtain frequency and duty cycle of measured signal. It is designed to analyze operation of devices using PWM control signal.

5. Connecting signal to measurement module input

Different ways to connect voltage probe are shown in Figure 5.1.

Variant A represents the most universal way of measuring the PWM signal, independent of the load switching method. Pay attention to correct choice of measurement setting, as this will have significant impact on the calculation of the duty cycle.

Variant B shows the proper connection of the probe and the setting in case of GND-switching controlled device.

Variant C shows the proper connection of the probe and the setting in case of supply voltage switching controlled device.

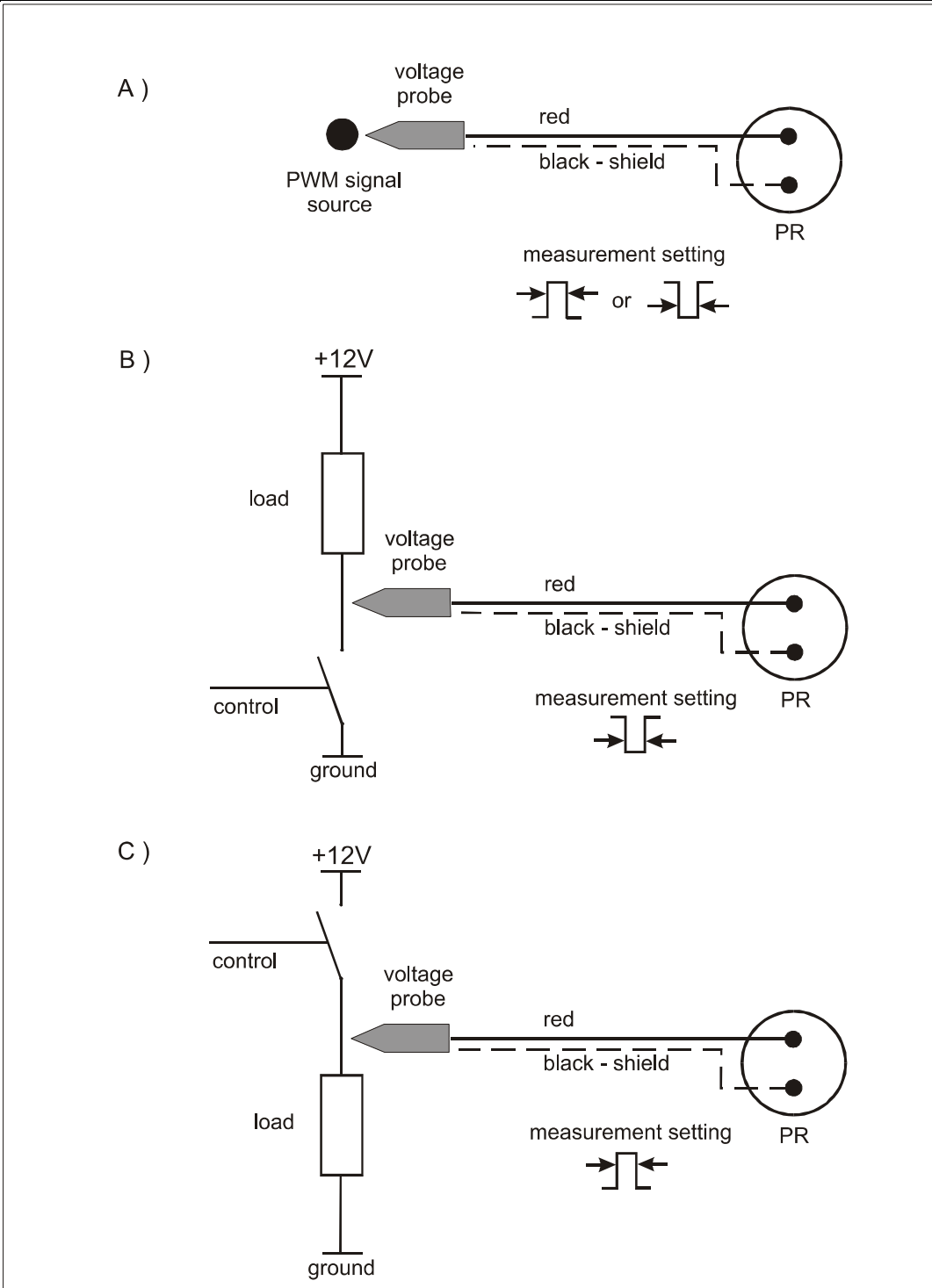

A)
voltage probe
red
black - shield
PWM signal source
PR
measurement setting
or
B)
+12V
load
voltage probe
red
black - shield
control
measurement setting
PR
ground
C)
+12V
control
voltage probe
red
black - shield
load
measurement setting
PR
ground

Figure 5.1

6. Connecting the load to generator output

Different setups of connecting the load to the generator are shown in Figure 6.1.

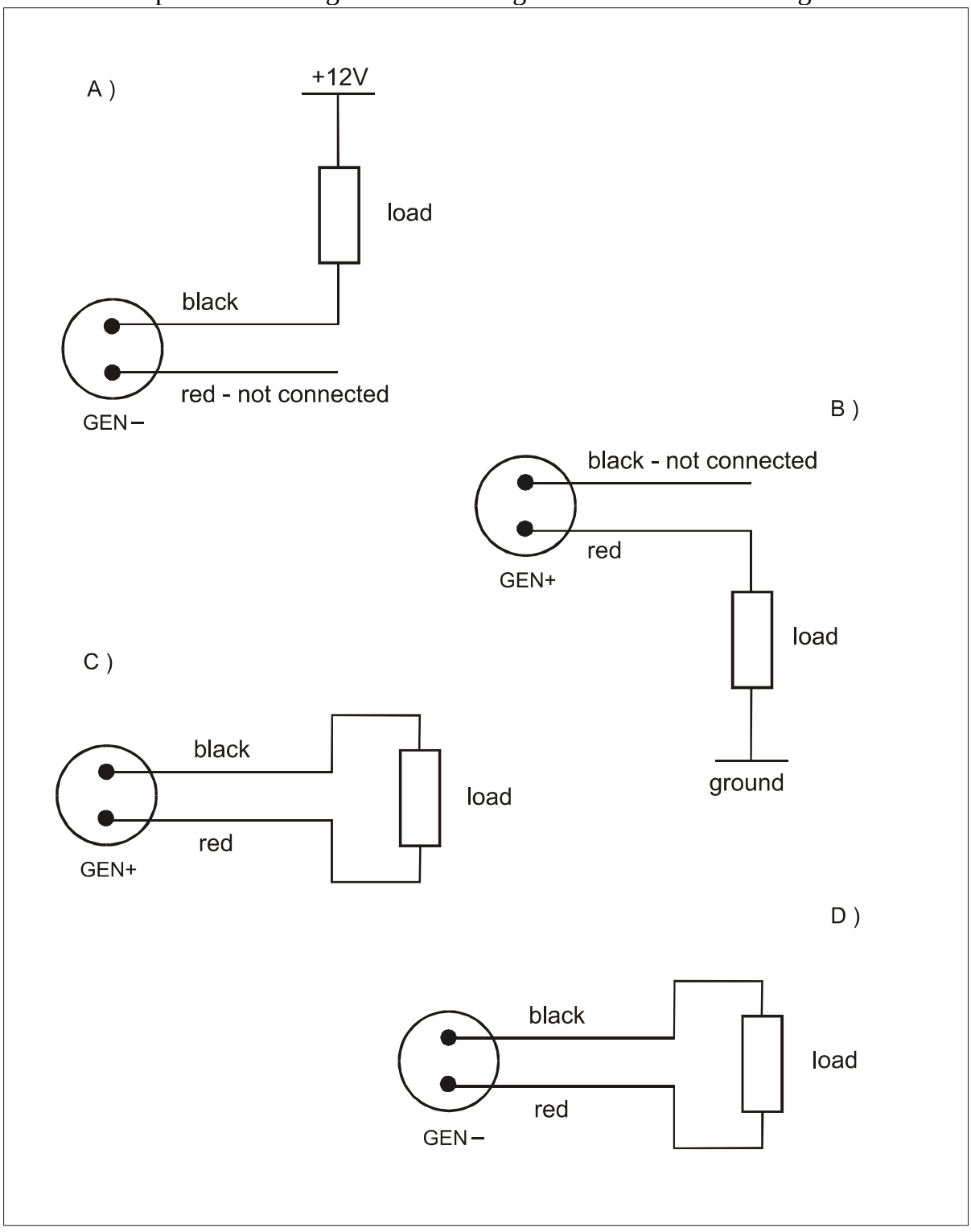


Figure 6.1

Variant A shows situation where the load is permanently connected to power supply. In this case it is necessary to connect only one wire (switched ground terminal) because the second positive terminal is already connected.

Variant B shows situation where the load is permanently connected to ground. There is need to connect only one wire (switched supply terminal). The second terminal (ground) is already connected.

Variants C and D show situation where the load terminals are connected to neither supply voltage nor ground. In this case connect the load to both **GEN+** and **GEN-** outputs.

7. Device operation

The generator is operated with the panel shown in Figure 7.1.

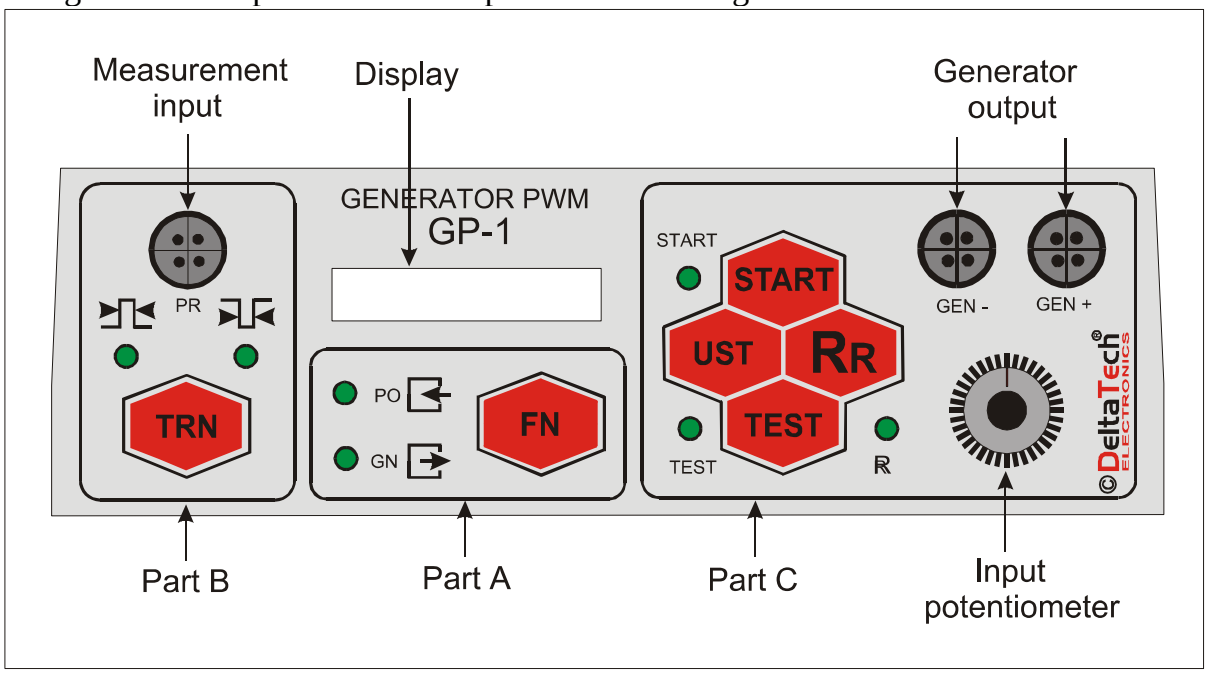


Figure 7.1

The panel consists of three parts:

Part A – changing generator operating mode.

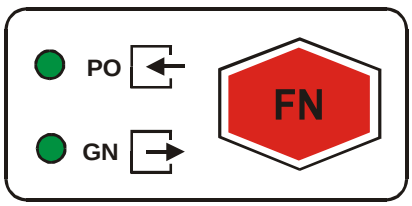


Figure 7.2

Part A enables switching device to measurement mode or generator mode. To switch between these two modes press the **FN** button.
Current operating mode is indicated by **PO** and **GN** lights. **PO** indicator lights up when the measurement mode is active and **GN** indicator lights up when the PWM generating mode is active

Part B – operating measurement module.

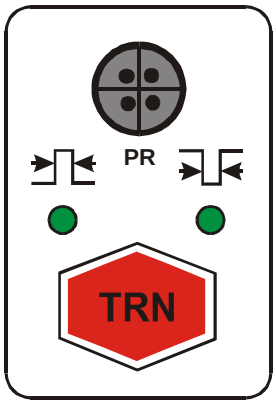


Figure 7.3

Part B allows control of the PWM measurement. Changes of signal connected to **PR** input are properly interpreted so that it is possible to get signal parameters (frequency and duty cycle). **TRN** button switches between two methods of reading the duty cycle. Current choice is shown by indicator lights and
Details on the use of panel components are included in description of device operating modes.

Part C – operating generator module.

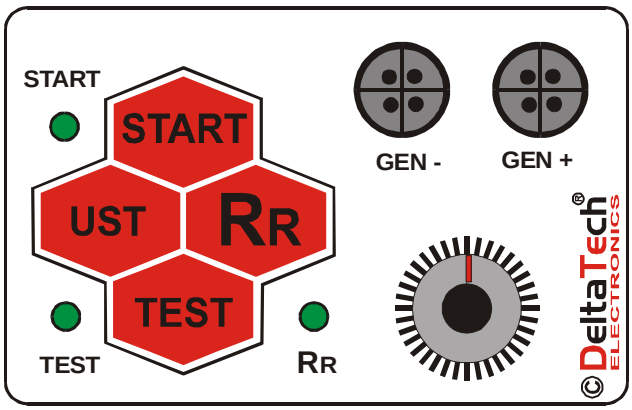


Figure 7.4

Part C of the panel controls PWM generator module.

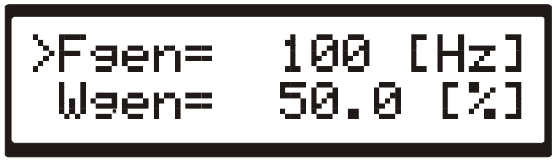
Use buttons to select desired action. The meaning of individual buttons are descripted below:
- **START** – enables or disables signal generation on GEN- and GEN+ outputs.
- **UST** - press this button to switch between parameters controlled by the input knob (frequency and duty cycle),
- **Rr** – changes input precision (coarse/fine).
- **TEST** – press this button to enable or disable test mode – cyclic enabling and disabling output test signal with the preset parameters.

Detail are included in description of each device operating modes.

8. Device operating modes

After connecting the power supply the tester shows the welcome screen.

This screen is displayed for 3 seconds, then the device automatically switches to generator mode and displays parameters of generated PWM signal.



To switch between generator and measurement mode use **FN** button. The corresponding **PO** (measurement) or **GN** (generator) indicator lights will light up.

8.1 PWM signal measurement mode

When measurement mode is active there are two measured values displayed on the screen:
- frequency
- duty cycle.

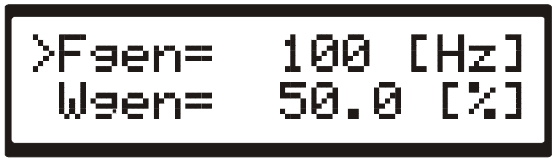
The measurement module detects a change of signal connected to **PR** input (see Figure 7.3) if the signal exceeds the threshold of 2.5V. The voltage lover than 2.5 V is treated as a low level, and the higher as a high level.

As already mentioned in section 2, depending on the PWM control method the duty cycle is interpreted as time of the signal in low or high state. For measurement module to give adequate result it is necessary to set required operating mode.
The current interpretation method is signaled by two indicator lights:
-  means the duty cycle denotes time of signal remaining in high state,
-  means the duty cycle denotes time of signal remaining in low state.

By pressing the **TRN** button it is possible to change between these two modes. Selecting the right interpretation method affect correctness of measured PWM parameters readout.

8.2 PWM signal generator mode

When PWM generator is active there are two signal parameters displayed on the screen:
- frequency
- duty cycle.



By pressing the **UST** button (see Figure 7.4) you may select one of the parameters for adjustment – frequency or duty cycle. Current choice is indicated by the  symbol on the left.
Use input knob to adjust parameter value. To change input precision (coarse/fine) use **Rr** button. Depending on the selection the changes will be made in small or large steps. Current iput precision is indicated by **Rr** light. This indicator lights up when small steps (fine adjustment) is selected.

START button toggles on and off signal generator connected to GEN- and GEN+ outputs. **START** indicator will light up when the generator is operating

If the output draw by the connected device exceeds limit, the overcurrent protection will turn off the output (to protect both the generator and connected device) and the **START** indicator begins to blink. Press the START button to resume PWM signal generation.

Use **TEST** button to start test procedure based on cyclic turning on and off PWM signal with preset parameters in order to check the element connected to the **GEN-** and **GEN+** output.

Warning !!!

The warranty do not cover any damage caused by incorrect use.

DeltaTech Electronics company is liable up to the amount paid for the device and is not responsible for any damage and consequences of misuse.

DeltaTech Electronics Company has do their most in order to write this manual properly, but can not guarantee that it does not contain any errors. During any workshop activities please always refer to vehicle service manuals, local regulations and laws, workplace and fire safety rules.