



72-6860

*10MHz PULSE GENERATOR*

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# INSTRUCTION MANUAL

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## Introduction

The 72-6860 is a mains operated, 0.1Hz to 10MHz pulse generator with independent variable 50 $\Omega$  Main and CMOS/TTL Auxilliary outputs. Period, pulse width and delay are each selected by an 8 position range switch, plus a vernier control.

There are no duty cycle limitations and with the use of the Complement switch very stable pulse trains with duty cycles of ~0 to ~100% can be achieved, within the overall period and pulse width limitations. Error lamps indicate illegal settings of the pulse width and pulse delay controls.

The variable 50 $\Omega$  output is controlled by a vernier over two switch-selectable ranges of 0.1V to 1.0V and 1V to 10V (from 50 $\Omega$ ), giving an overall range of 50mV to 5V into a 50 $\Omega$  load.

Operating modes are run, external trigger, external gate, and manual one-shot or gate. The pulse modes are normal, square, double and delayed. The Complement button inverts both the Main and Auxilliary outputs.

A Sync output and a Trigger/Gate input are also provided.

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## Specification

### PERIOD

100ns to 10s (10MHz to 0.1Hz) in 8 overlapping decade ranges, with separate vernier providing continuously variable control within each range.

Jitter: <0.1%.

### PULSE WIDTH

50ns to 5s in 8 overlapping decade ranges, with separate vernier providing continuously variable control within each range. The Overlap lamp lights when the pulse width is set greater than the period.

Jitter: <0.1%.

### PULSE DELAY

100ns to 5s in 8 overlapping decade ranges, with separate vernier providing continuously variable control within each range. The overlap lamp lights when the pulse delay is set greater than the period.

### GATED OPERATION

0.1Hz to 10MHz pulse train, parameters set by Period and Pulse Width controls, starts synchronously with leading edge of Gate input. Last pulse is completed at the end of gating period.

### TRIGGERED OPERATION

DC to 10MHz pulse train in synchronism with external Trigger pulses; pulse width determined by Pulse Width controls.

### DOUBLE PULSE

A second pulse is generated after a delay from the leading edge of the first pulse set by the Pulse Delay controls.

### DELAYED PULSE

The pulse is generated after a delay from the Trigger signal set by the Pulse Delay controls.

### SQUAREWAVE

0.1Hz to 10MHz squarewave, frequency set by the Period controls.

Mark: Space ratio 1:1  $\pm$  10%.


### COMPLEMENT

Inverts both the MAIN (50 $\Omega$ ) and AUX outputs.

## MANUAL

- With Triggered selected: Pressing Manual initiates a single pulse of duration determined by the Pulse Width controls.
- With Gate selected: 0.1Hz to 10MHz pulse train set by the Period and Pulse Width controls for the duration of button depression.

## TRIGGER/GATE IN

- Frequency Range: DC - 10MHz
- Signal Range: Threshold nominally TTL level;  maximum input  $\pm 10V$ .
- Trigger Delay: Typically 100ns from trigger edge to MAIN OUT transition.
- Gate Delay: Approximately 20% of the PERIOD range setting +80ns from gate leading edge to MAIN OUT transition.
- Minimum Pulse Width: >30ns.
- Input Impedance: Typically 10k $\Omega$ .

## MAIN 50 $\Omega$ OUTPUT

- Amplitude: Two switch selectable ranges of 0.1V – 1.0V and 1V - 10V from 50 $\Omega$ . (50mV to 500mV and 500mV to 5V into 50 $\Omega$ ). Adjustable within ranges by a single turn vernier.
- $V_{OUT}$  low: <5% of Amplitude +100mV (1V-10V range).
- Rise/Fall Times: Typically 10ns into 50 $\Omega$  load.  
Maximum 15ns.
- Aberrations: Typically <5%, for output set at >20% of range maximum, into 50 $\Omega$ .

## AUX OUTPUT

CMOS/TTL level, signal with the same timings as MAIN OUT; leads MAIN OUT by typically 15ns.

## SYNC OUTPUT

- Amplitude: A positive going pulse at CMOS/TTL level.
- Timing: Leading edge occurs typically 40ns before the MAIN OUT transition in all pulse modes and typically 10ns after MAIN OUT in Square mode.
- Duration: Typically 30ns.

## GENERAL

- Power: 230V or 115V nominal, 50/60Hz, adjustable internally; operating range  $\pm 14\%$  of nominal; 20VA max. Installation Category II.
- Operating Range: + 5°C to 40°C, 20-80% RH.
- Storage Range: -40°C to 70°C.
- Environmental: Indoor use at altitudes up to 2000m, Pollution Degree 2.
- Safety: Complies with IEC 1010-1.
- EMC: Complies with EN55081-1 and EN50082-1.
- Size: 220(W) x 130(H) x 230(D)mm, excluding feet.
- Weight: 1.6kg.

# Safety

This instrument is Safety Class I according to IEC classification and has been designed to meet the requirements of IEC 1010-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use). It is an Installation Category II instrument intended for operation from a normal single phase supply.

This instrument has been tested in accordance with IEC 1010-1 and has been supplied in a safe condition. This instruction manual contains some information and warnings which have to be followed by the user to ensure safe operation and to retain the instrument in a safe condition.

This instrument has been designed for indoor use in a Pollution Degree 2 environment in the temperature range 5°C to 40°C, 20% - 80% RH (non-condensing). It may occasionally be subjected to temperatures between +5°C and -10°C without degradation of its safety. Do not operate while condensation is present.

Use of this instrument in a manner not specified by these instructions may impair the safety protection provided. Do not operate the instrument outside its rated supply voltages or environmental range.

## **WARNING! THIS INSTRUMENT MUST BE EARTHED**

Any interruption of the mains earth conductor inside or outside the instrument will make the instrument dangerous. Intentional interruption is prohibited. The protective action must not be negated by the use of an extension cord without a protective conductor.

When the instrument is connected to its supply, terminals may be live and opening the covers or removal of parts (except those to which access can be gained by hand) is likely to expose live parts. The apparatus shall be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance or repair.

Any adjustment, maintenance and repair of the opened instrument under voltage shall be avoided as far as possible and, if inevitable, shall be carried out only by a skilled person who is aware of the hazard involved.

If the instrument is clearly defective, has been subject to mechanical damage, excessive moisture or chemical corrosion the safety protection may be impaired and the apparatus should be withdrawn from use and returned for checking and repair.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders is prohibited.

Do not wet the instrument when cleaning it.

The following symbols are used on the instrument and in this manual:-



**Caution** -refer to the accompanying documentation, incorrect operation may damage the instrument.



alternating current.



terminal connected to chassis (ground).

This instrument has been designed to meet the requirements of the European EMC Directive 89/336/EEC.

Compliance was demonstrated by meeting the test limits of the following standards:

### **Emissions**

EN50081-1 (1992) Generic emission standard for residential commercial and light industry. Test methods and limits used were:

- a) EN55022 Conducted, Class B
- b) EN55022 Radiated, Class B

### **Immunity**

EN50082-1 (1992) Generic immunity standard for residential, commercial and light industry. Test methods and limits used were:

- a) EN60801-2 (1993) Electrostatic Discharge, 8 kV air discharge.
- b) IEC801-3 (1984) RF Field, 3 V/m.
- c) IEC801-4 (1988) Fast Transient, 1 kV peak (AC line) and 0.5kV peak (signal lines).

### **Cautions**

To ensure continued compliance with the EMC directive the following precautions should be observed:

- a) connect the instrument to other equipment using only high quality, double-screened cables.
- b) after opening the case for any reason ensure that all signal and ground connections are remade correctly before replacing the cover. Always ensure all case screws are correctly refitted and tightened.
- c) In the event of part replacement becoming necessary, only use components of an identical type, see the Service Manual.

# Installation

## Mains Operating Voltage

The operating voltage of the instrument is shown on the rear panel. Should it be necessary to change the operating voltage from 230V to 115V or vice-versa, proceed as follows:

1. Disconnect the instrument from all voltage sources.
2. Remove the 4 screws which hold the upper and lower case halves together and lift off the case upper.
3. Remove the 4 screws which hold the power supply printed circuit board to the case lower.
4. Change the appropriate zero-ohm links in the pcb:  
Link LK1 only for 230V operation  
Link LK2 and LK3 only for 115V operation
5. Refit the pcb to the case lower, ensuring all connections (especially safety earth) are remade as before, and refit the case upper.
6. To comply with safety standard requirements the operating voltage marked on the rear panel must be changed to clearly show the new voltage setting.

## Mains Lead

### **WARNING! THIS INSTRUMENT MUST BE EARTHED**

Any interruption of the mains earth conductor inside or outside the instrument will make the instrument dangerous. Intentional interruption is prohibited.

## POWER

The OPERATE switch turns the instrument on. The switch is on the secondary side of the mains transformer. Disconnect from the AC supply by unplugging the mains cord from the back of the instrument or by switching off at the AC supply outlet; make sure that the means of disconnection is readily accessible. Disconnect from the AC supply when not in use. The OPERATE lamp lights to show when the instrument is on.

## PERIOD, PULSE WIDTH and DELAY CONTROLS

Period, pulse width and pulse delay are each set by the appropriate 8-position switch and vernier control; the vernier provides continuous adjustment across the selected range.

The appropriate Overlap lamp lights when the pulse width or pulse delay is set greater than the period.

The operation of the period, pulse width and pulse delay controls depends on the operating mode selected, see below.

## MODE SELECTION

The operating mode is selected by the FUNCTION/MODE control in combination with the Run-Triggered-Gated switch.

### Run Modes

When Run is selected the generator free-runs as described below; external inputs are disconnected.

With **Pulse** selected the frequency and pulse width are set by PERIOD and PULSE WIDTH controls respectively; PULSE DELAY is inoperative.

With **Square** selected a squarewave is generated at a frequency set by the PERIOD controls; PULSE WIDTH and PULSE DELAY are inoperative.

With **Double Pulse** selected two pulses are generated in each period; period and pulse width are set by the PERIOD and PULSE WIDTH control respectively. The second pulse is generated after a delay from the leading edge of the first pulse set by the PULSE DELAY control.

With **Delayed Pulse** selected a single pulse is generated in each period starting after a delay with respect to the SYNC OUT signal set by the PULSE DELAY controls +40ns. Frequency and pulse width are set by the PERIOD and PULSE WIDTH controls respectively.

### Triggered Modes

For the Triggered modes described below the trigger is derived from either an external signal applied to the TRIGGER/GATE IN socket or by pressing the Manual button. Pulse width is set by the PULSE WIDTH controls. Refer also to the timing diagram.

With **Pulse** selected the generator produces a single pulse which starts typically 100ns after the positive-going edge of the TRIGGER IN pulse or at each press of the Manual button. The PERIOD and PULSE DELAY controls are inoperative.

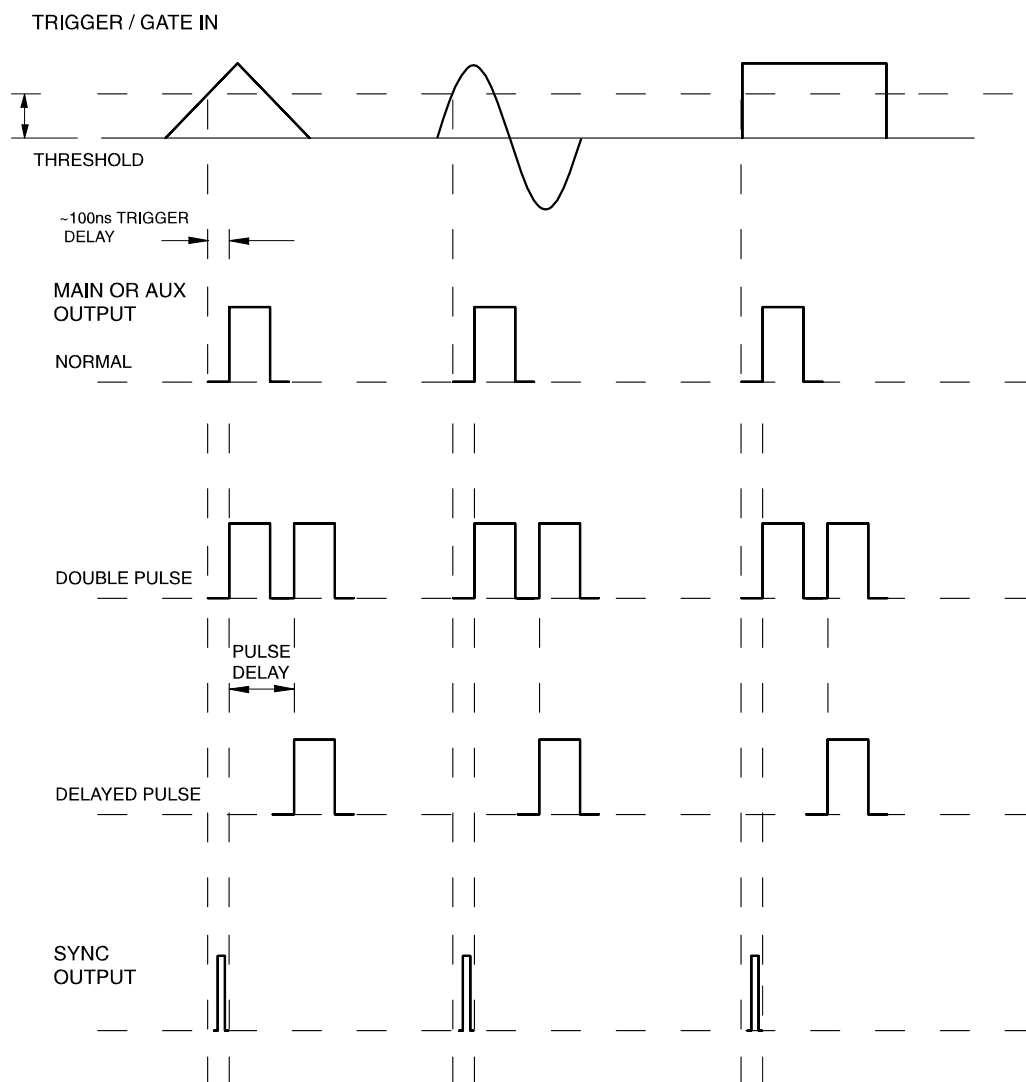
With **Double Pulse** selected the generator produces two pulses for each trigger signal. The first pulse of each pair starts typically 100ns after the positive-going edge of the TRIGGER IN pulse or at each press of the Manual button. The PULSE DELAY controls set the time between the leading edges of the first and second pulse. The PERIOD controls are inoperative.

With **Delayed Pulse** selected the generator produces a single pulse which starts after a delay, set by the PULSE DELAY controls +100ns, from the positive-going edge of the TRIGGER IN pulse or press of Manual. The PERIOD controls are inoperative.

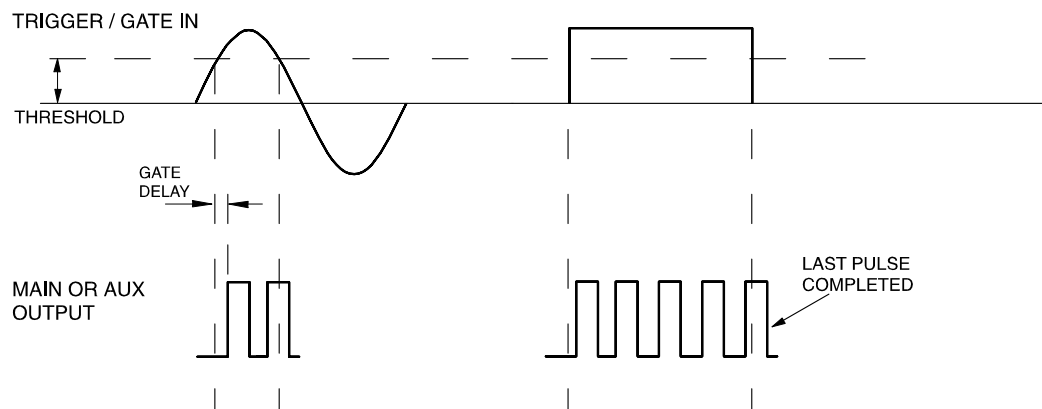
**Triggered Square** mode is not available.



## PULSE TIMINGS IN TRIGGERED MODE



## PULSE TIMINGS IN GATED MODE



## Gated Modes

When Gated is selected on the Run-Triggered-Gated switch the generator produces a train of pulses which starts after a delay from the leading edge of the gating signal. The last pulse is completed (i.e. normal pulse width) when the gating signal ends except for Square mode which is terminated synchronously with the gating signal. The gating signal is derived from either an external signal applied to the TRIGGER/GATE IN socket or by pressing the Manual button. The delay from the leading edge of the gating signal to the first pulse is approximately 20% of the PERIOD range setting plus 80ns; the vernier setting has minimal effect.

The PERIOD, PULSE WIDTH and PULSE DELAY controls set the pulse train parameters in exactly the same way as for Run mode according to which FUNCTION/MODE position is selected. Refer also to the timing diagram.

## COMPLEMENT

The Complement switch inverts both AUX OUT and MAIN OUT. It is most useful in generating jitter-free large mark:space ratio waveforms which cannot be obtained in Normal mode. The "space" instead of the "mark" is determined by the PULSE WIDTH controls in this mode.

## MAIN OUT

The amplitude of MAIN OUT is controlled by the 2-position range switch and the AMPLITUDE control which provides continuously variable adjustment within each range.

The output has a 50Ω source impedance and is designed to operate into a 50Ω load under which condition the two ranges are 50mV to 500mV and 500mV to 5V. Good quality 50Ω coaxial cables should be used. If the cable is not terminated with 50Ω, greater amplitude can be achieved but cable reflections will cause aberrations on the waveform.

## AUX OUT

The AUX OUT provides a TTL/CMOS compatible waveform with the same timings as MAIN OUT. This output occurs approximately 15ns before MAIN OUT.

## SYNC OUT

SYNC OUT provides a TTL/CMOS compatible pulse of typically 30ns duration which occurs approximately 40ns before MAIN OUT in all Pulse modes. In Square mode the SYNC pulse occurs approximately 10ns after the MAIN OUT leading edge.

## TRIGGER/GATE IN

The TRIGGER/GATE IN is the control input for the triggered and gated modes which have already been described. The input is a Schmitt trigger which can handle any wave shape from DC-10MHz with >2V input level.



Do not apply external voltages exceeding  $\pm 10V$ .

## Maintenance

For service repair and calibration please contact your local Tenma distributor or go to [www.tenma.com](http://www.tenma.com)

### Cleaning

If the instrument requires cleaning use a cloth that is only lightly dampened with water or a mild detergent.

**WARNING! TO AVOID ELECTRIC SHOCK, OR DAMAGE TO THE INSTRUMENT, NEVER ALLOW WATER TO GET INSIDE THE CASE. TO AVOID DAMAGE TO THE CASE NEVER CLEAN WITH SOLVENTS.**

### Mains Fuse

The transformer primary is protected by an integral thermal fuse which is not user replaceable. Should a fault develop which causes the thermal fuse to blow, the generator must be returned to the manufacturer or agent for service.

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