INSTRUCTION MANUAL

MODEL 801
50 MHz PULSE GENERATOR

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SECTION 1
GENERAL DESCRIPTION

1.1 THE MODEL 801

The Model 801 is a 50 MHz general purpose laboratory pulse generator. The instrument gives you full control in primary pulse triggering and shaping plus simultaneous TTL, ECL, $\overline{\text{ECL}}$ and sync pulses. The primary pulse output has controllability in offset and independent rise/fall durations, as well as pulse width, pulse delay and a choice of positive, negative or complementary outputs. The TTL, ECL and $\overline{\text{ECL}}$ are of fixed levels and rise times that are standard for use with compatible devices. The primary pulse has minimum rise and fall times of 7 ns and a maximum of 250 ms.

The output is ±20 volts with 50Ω source impedance which provides ±10 volts into a 50Ω load. Upper and lower pulse levels are fully adjustable through ±20 volts.

External triggering can be set to any point of the rising or trailing edge of the trigger signal. Single pulses or pulse pairs may be triggered; pulse width may be trigger controlled; continuous pulses may be gated and a precise number of pulses may be triggered for a 'burst' output. Manual and external triggering is indicated by an LED on the front panel for rapid visual set of trigger level.

1.2 SPECIFICATIONS

1.2.1 Versatility

Five Simultaneous Pulse Outputs
Fixed level ECL, $\overline{\text{ECL}}$, TTL and sync pulses and a pulse with variable amplitude and variable rise/fall times. Pulses available over a 5 Hz to 50 MHz frequency range (200 ms to 20 ns periods).

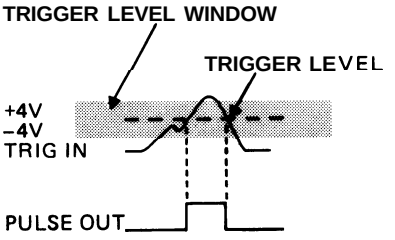
Operational Modes
Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator quiescent until triggered by external signal or front control, then generates one pulse.

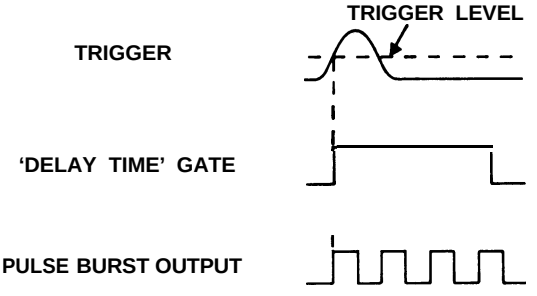
Gated: As triggered mode, except generator oscillates for the duration of the external signal.

Double Pulse: Continuous, trigger and gate, as above, except two pulses for each period. Space between pulses of double pulse controlled by delay control. Double pulse at all outputs except sync.

External Width: External signal at trigger input and trigger level control determine output pulse width and period as shown.



Trigger Burst: External trigger starts internal gate (delay time) for pulse burst (1 to 100 pulse range) as shown.



1.2.2 Pulse Outputs

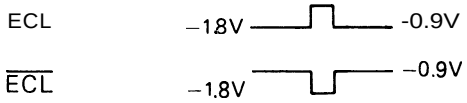
Variable Amplitude Pulse
Upper and lower pulse levels are independently adjustable. Pulse dynamic range is ±20V into an open circuit from the 50Ω source. The pulse is 20V p-p maximum, 1V p-p minimum. Into a 50Ω termination, dynamic range is ±10V, maximum pulse 1OV p-p, minimum pulse 0.5V p-p.

Overshoot and ringing is less than ±(5% of amplitude setting +100 mV) into 50Ω load.

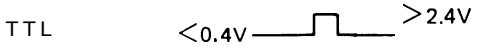
Preshoot is less than ±(5% of amplitude setting +100 mV) into 50Ω load.

Fixed (ECL, $\overline{\text{ECL}}$, TTL) Pulses

Pulse levels for 50Ω loading as shown:



ECL, $\overline{\text{ECL}}$ Transition Time: < 6 ns.



TTL Transition Time: < 10 ns.

Sync Pulse

Sync pulse is 0 to at least +1V from a 50Ω source.

Normal/Complement Control

Normal pulse or its complement is selected. The normally quiescent and active levels are reversed in complement format. This control affects all outputs except sync pulse.

1.2.3 Time Domain

Period

Period range is from less than 20 ns to greater than 200 ms in 7 overlapping ranges.

Period jitter is less than 0.1% plus 50 picoseconds.

Width

Width range is from less than 10 ns to 100 ms in 7 overlapping ranges. Maximum duty cycle is 70% for periods to 200 ns, decreasing to 50% for 20 ns periods. Range switch also has a square wave detent (⊓⊔).

⊓⊔ duty cycle is 50 ±4% to 2 μs period changing to 50 ±15% at 20 ns period.

Width jitter is less than 0.1% plus 50 picoseconds.

Sync pulse duty cycle is 50 ±4% of pulse period to 2 μs period, changing to 50 ±15% at 20 ns period except in trigger and external width modes, in which case it is determined by the trigger signal.

Transition Time

For variable amplitude pulse only. Independently adjustable leading and trailing edges from less than 7 ns (5 ns typical) to 250 ms in 7 overlapping decade ranges (measured from 10 to 90% points). Verniers give 50:1 adjustment on all ranges except 5 ns, which gives 25: 1.

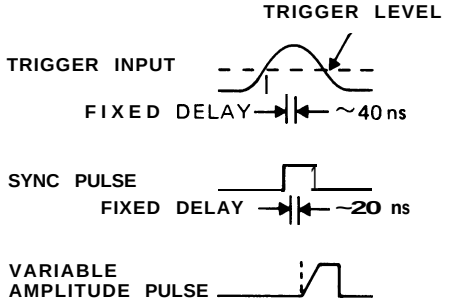
Linearity: For transition greater than 10 ns ±5% between 10 to 90% points on pulse.

Delay

Pulse occurrence can be delayed from less than 10 ns to 100 ms with respect to the sync pulse. Maximum duty cycle is 70% for periods to 200 ns, decreasing to 30% for 20 ns periods.

Delay jitter is less than 0.1% plus 50 picoseconds.

Fixed delay is as shown:



1.2.4 Input Characteristics

External Trigger

The external signal required to trigger the generator has a minimum amplitude of ±200 mV p-p to 5 MHz increasing to ±600 mV p-p to 50 MHz (from 50Ω source) and a maximum amplitude of ±10V with a minimum width of 10 ns.

Input impedance is approximately 1 kΩ in parallel with 22 pF

Triggering is selected to occur at either rising or falling edge of trigger signal; triggering level is adjustable to be between ±4V. An LED lights for approximately 100 ms for each external and manual trigger occurrence accepted.

1.2.5 General

Environmental

Specifications apply at 25°C ±5°C after 1 hour warm-up. Instrument will operate from 0°C to 50°C.

Dimensions

28.8 cm (11.4 in.) wide; 17.3 cm (6.8 in.) high; 29 cm (11.4 in.) deep.

Weight

5.4 kg (12 lb) net; 7.3 kg (16 lb) shipping.

Power

90 to 110V 108 to 132V, 180 to 220V or 216 to 250V; 50 to 400 Hz; 60 watts nominal.

SECTION 3
OPERATION

3.1 **CONTROLS** AND CONNECTORS

The generator controls and connections are shown in figure 3-1 and keyed to the following descriptions.

0 **MODE Switch –** Selects one of the following eight modes.

CONT – Continuous pulses at all output connectors.

TRIG – DC level at all outputs until a suitable trigger appears (see (2), (3)); then one or more pulses occur,depending on mode and control settings.

GATE – DC level at all outputs until a suitable trigger edge appears (see (2), (3)); then pulses occur until the trigger signal transverses the generator trigger level again.

EXT WIDTH – DC level at all outputs until a suitable trigger appears (see (2), (3)); then a pulse occurs which has the duration of the trigger signal.

TRIG BURST – DC level at all outputs until a suitable trigger appears (see (2), (3)) to trigger a gate time (5); then a fixed number of pulses occur as determined by (4) and (5).

CONT DBL – As for CONT except two pulses occur for each pulse period. Time to second pulse is set by 0

TRIG DBL – As for TRIG except two pulses occur in the one pulse period. Time to second pulse is set" by (5).

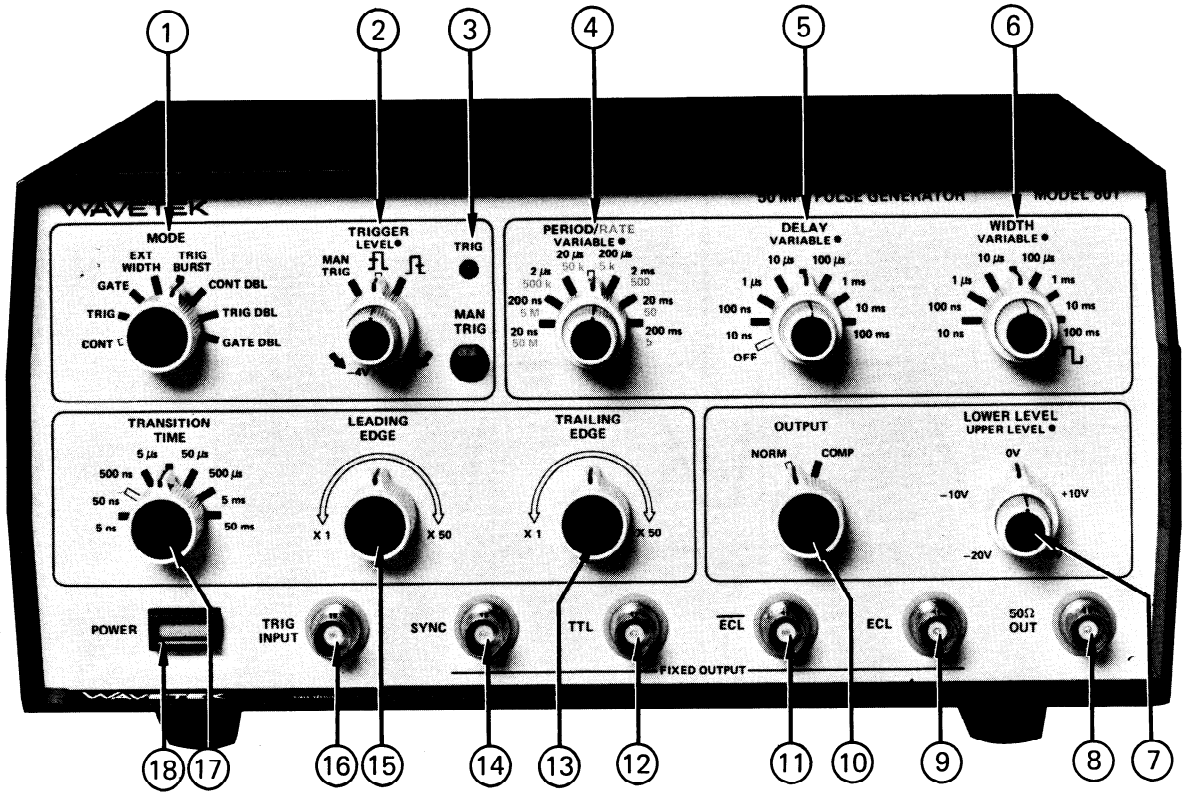
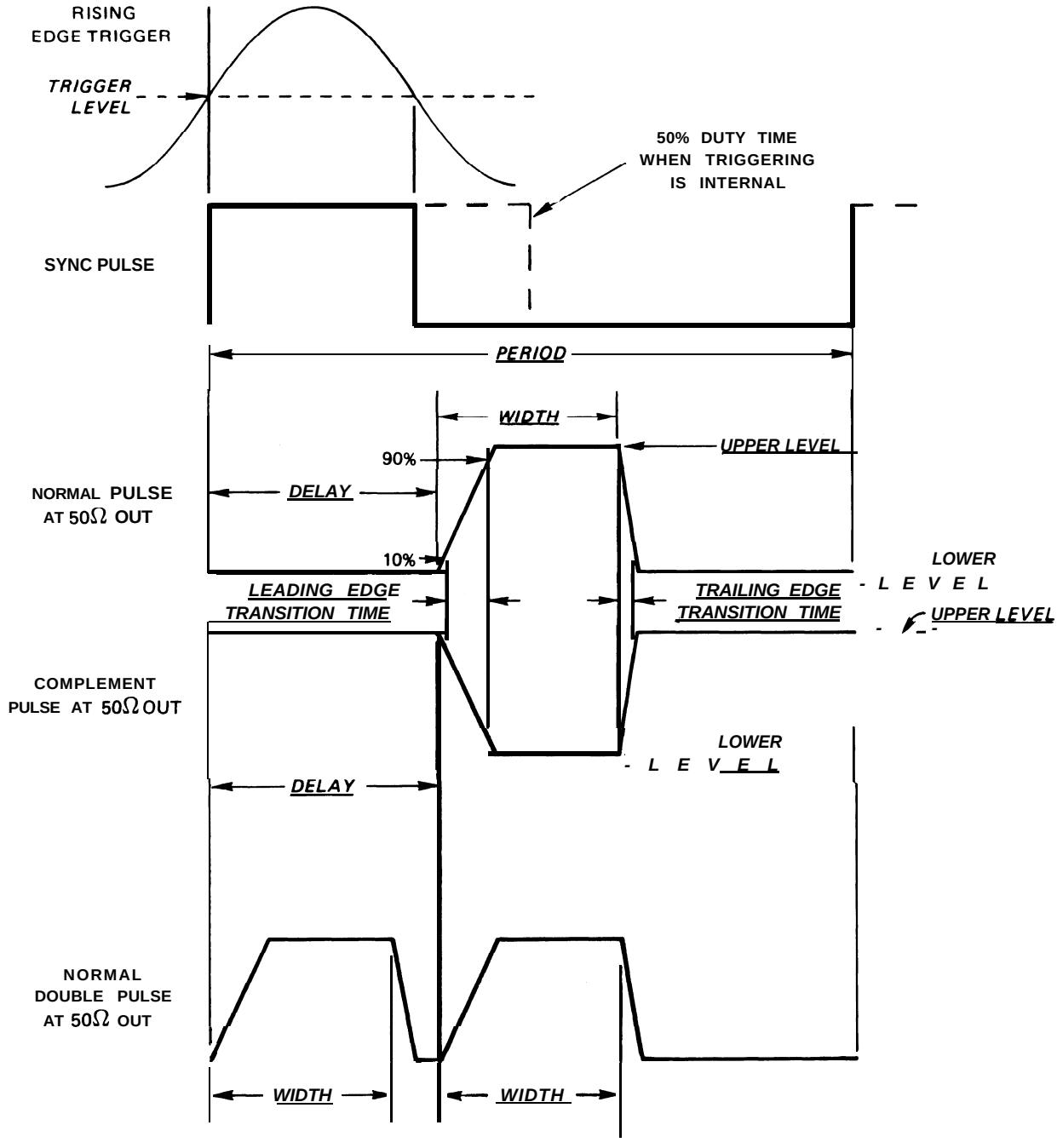


Figure 3-I . Controls and Connections



NO TE: Underline indicates a front panel con trolled parameter.

Figure 3-2. Pulse Parameters

GATE DBL – As for GATE except two pulses occur for each pulse period. Time to second pulse is set by (5).

(2) TRIGGER Switch – Selects one of three trigger methods: manual, an external trigger signal's rising edge or an external trigger signal's falling edge. The external trigger signal is applied at (16).

LEVEL Control – Inner knob sets acceptance threshold for trigger signal at (16).

(3) MAN TRIG Switch – Supplies a trigger with a duration that equals the time the switch is held down. Output depends on the mode selected (see (1)).

TRIG Indicator – An LED which lights approximately 100 ms for each trigger signal accepted.

(4) PERIOD/RATE Switch – Selects one of seven ranges of pulse period. Calibrated in seconds and hertz.

VARIABLE Control – Varies the pulse period within the range selected by the outer knob. Clockwise increases the pulse period and decreases frequency.

(5) DELAY Switch – Selects one of seven ranges of pulse delay, time to second pulse of double pulses or length of burst, depending on mode setting. OFF position ensures minimum delay.

VARIABLE Control – Varies the delay time within the range selected by the outer knob. Clockwise increases the delay.

(6) WIDTH Switch – Selects one of seven ranges of pulse width or an approximate 50% duty cycle.

VARIABLE Control – Varies the pulse width within the range selected by the outer knob except in ⎍.

(7) LOWER LEVEL Control – Outer knob sets the lower level of the 50Ω OUT pulse, which may be varied from -20 to +20 volts into an open circuit or -10 to +10 volts into a 50Ω termination. Maximum pulse height is 20 volts open circuit.

UPPER LEVEL Control – Inner knob sets the upper level of the 50Ω OUT pulse. Upper level range is identical to that stated for the lower level.

(8) 50Ω OUT Connector – The main output of the generator. Pulses from this output may be controlled in level and transition time as well as frequency and width.

(9) ECL Connector-An output with an emitter-coupled-logic level pulse whose occurence and duration are controllable. Levels are -1.8V quiescent, -0.9V active.

(10) OUTPUT Switch – Selects a normal pulse or its complement which swaps the active and quiescent levels. Affects all outputs, except SYNC,

(11) $\overline{\text{ECL}}$ Connector – An output like the ECL output (9) except active and quiescent levels are reversed.

(12) TTL Connector – An output with a transistor-transistor-logic level pulse whose occurence and duration are controllable. Level is < 0.4V quiescent, > 2.4V active into a 50Ω termination.

(13) TRAILING EDGE Control – Varies the duration of the 50Ω OUT pulse trailing edge. Duration range is set by (17). Clockwise rotation increases edge time. Full cw exceed upper value of the selected range. Trailing edge time is not part of WIDTH time.

(14) SYNC Connector – An output with a pulse of OV to > 0.5V into 50Ω termination and a square wave when the generator is in a continuous mode (see (1)). In other modes, width is determined by the time between initial transition of the trigger signal through the trigger level to the trailing transition.

(15) LEADING EDGE Control – Same as (13) but varies the duration of the leading edge of the 50Ω OUT pulse. Leading edge time is part of WIDTH time.

(16) TRIG INPUT Connector – Accepts an external signal to trigger the generator. Triggers on rising or falling edge of input as determined by (2). See paragraph 1.2.3 for input specifications.

(17) TRANSITION TIME Switch – Selects one of seven ranges for 50Ω OUT pulse rise and fall durations. Actual durations within a range are set by (13) and (15).

(18) POWER Switch – Pulse generator on/off switch.

3.2 NOTES ON OPERATION

Operational modes are described in paragraph 3.1 under the mode switch. The pulse itself may be shaped in width, leading and trailing edge transition times, upper level, lower level, frequency of occurrence (period) and delay with

respect to its sync pulse. These pulse parameters are shown in figure 3-2. Specific setups for each mode are given in paragraph 3.3.

3.2.1 White Marks

When first becoming familiar with the 801, the white mark settings are handy. The white mark settings for the front panel switches will always give a 5k to 50 kHz sync signal when power is on. The same settings will give 50% duty time, TTL, ECL, $\overline{\text{ECL}}$ and 50Ω OUT pulses; the LOWER LEVEL/UPPER LEVEL control may need adjusting to observe the 50Ω OUT on an oscilloscope. Once the output is observed, each control can be adjusted and observed until the desired result is obtained.

3.2.2 Pulse Width, Transition and Delay

Narrow duty cycle pulses require the NORMAL OUTPUT while greater than 70% duty cycle pulses require the COMP OUTPUT setting. Pulse width plus trailing edge time plus delay time settings should not exceed the period time. (See figure 3-2.) The sum of width, trailing edge and delay actually must be somewhat less than period time by an amount that depends upon the period time selected. Therefore, when the sum of the desired width, trailing edge and delay time exceeds 70% of the period time, the pulse should be observed to make sure it is as desired.

The 50% duty time width setting (⊓) is meant to be used in continuous mode. Other modes result in the following default conditions.

Mode Selected	output
TRIG ⊓	A triggered 10 ns pulse
CONT DBL⊓	A continuous output of paired 10 ns pulses
TRIG DBL⊓	A triggered output of paired 10 ns pulses
GATE DBL⊓	A gated output of paired 10 ns pulses

3.2.3 ECL Termination

Figure 3-3 shows a 5.2/0volt 50Ω ECL termination. Similar 50Ω terminations can be made for ECL circuits with other voltage arrangements.

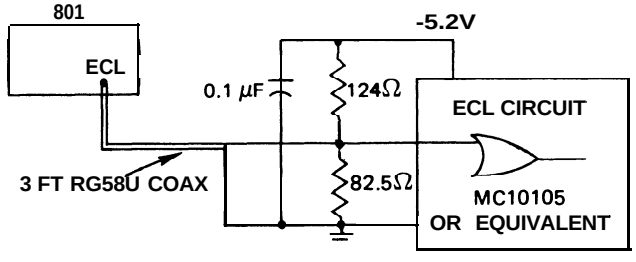


Figure 3-3. ECL Termination

3.2.4 Output Terminations

Only 50Ω RG58U cable should be used to connect the 801 to the circuit under test. A 50Ω 2W load should be used at the circuit end of the cable for maximum pulse fidelity.

The 50Ω terminations should always be used on the SYNC and TTL outputs and 50Ω Thevenin loads should be used on the ECL outputs.

3.2.5 Nonlinear and Reactive Loads

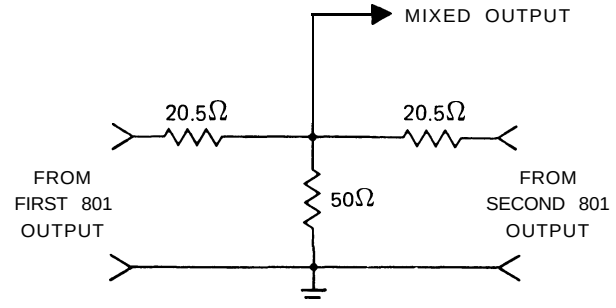
Both nonlinear and reactive loads will cause pulse distortion. Reactive loads driven with fast transitions cause voltage spikes that can damage the 801 output amplifier. If it is necessary to drive reactive loads directly, the instrument must be protected against these voltage spikes.

3.2.6 Duty Cycle

Always use the lowest range possible for both delay and width functions. This will reduce the recovery time of the one-shots and extend the maximum duty cycle of the 801 to its fullest capability.

3.2.7 Output Mixing

The outputs of two 801's may be mixed using the following network.



Maximum output from either generator is limited to 6 volts.

3.2.8 Precise Output Levels

Many times when testing a circuit it is desirable to lock the output of the generator at either the high or low level. A precise measurement of this level may then be obtained using a DVM.

The external width mode is useful for this purpose. Set the MODE to EXT WIDTH, TRIGGER to ⊓ and TRIGGER LEVEL maximum cw. The output will now be locked to the lower level. Switching the trigger to ⊓ will lock it to the upper level.

The OUTPUT NORM/COMP switch could also be used to reverse the upper and lower levels as the trigger edge does, but some error could be introduced by the X-Y multiplier.

3.2.9 Rise Time Measurements

When measuring rise time in a linear device under test, the error induced by the rise time of the testing system must be considered. For example, when observing the 801 rise time on an oscilloscope, 801 rise time is

$$t^2_{observed} = t^2_{scope} + t^2_{801}$$

or

$$t_{801} = \sqrt{t^2_{observed} - t^2_{scope}}$$

That is, the observed rise time must be corrected for by the inherent oscilloscope rise time to determine the actual 801 rise time. Extending the method to include a circuit under test will determine circuit under test rise time:

$$t^2_{observed} = t^2_{801} + t^2_{scope} + t^2_{c.u.t.}$$

3.3 OPERATION

In the following descriptions of operation, observe the pulse on an oscilloscope. When the 50Ω OUT pulse is not desired, disregard leading and trailing edge adjustments. (See figure 3-2 for pulse parameters.)

3.3.1 Continuous Pulses

Set the controls as follows for continuous pulse output.

Control	Operation
MODE	CONT
OUTPUT	NORM (or COMP if inverted pulse is desired)
All Other Controls	Set as desired. DELAY is constrained to be less than PERIOD-(WIDTH +TRAILING EDGE). If a large pulse WIDTH is desired but cannot be obtained, refer to paragraph 3.3.2.

3.3.2 Continuous Wide Duty Cycle Pulses

Follow this setup for pulses greater than those that can be obtained in paragraph 3.3.1. The "pulse" that appears to be positive going is referred to as the > 70% pulse.

Control	Operation
MODE	CONT
OUTPUT	COMP
PERIOD/RATE and Level Controls	Set as desired.
WIDTH	Set to desired lower level time (see figure 3-4). The > 70% pulse will start WIDTH time after SYNC leading edge with DELAY OFF.

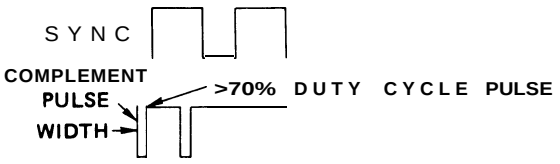


Figure 3-4. Greater Than 70% Duty Cycle Pulse

Control	Operation
Edge Controls and DELAY	Set as desired.

3.3.3 Triggered Pulses

Set up as in paragraph 3.3.1. If triggering with an external signal, connect the trigger source to TRIG INPUT. Ensure that the trigger rate is slower than the pulse rate.

Control	Operation
MODE	TRIG
TRIGGER	Set as desired. (Observe TRIG indicator to ensure triggering occurs.)

3.3.4 Gated Pulses

Set up as in paragraph 3.3.1. If gating with an external signal, connect the gate source to TRIG INPUT. Set the gate pulse width to allow the number of pulses desired. Reset the controls as follows.

Control	Operation
MODE	GATE
TRIGGER	Set as desired. (Observe TRIG indicator to ensure triggering occurs.)

3.3.5 Pulses With Width Controlled Externally

Connect the trigger source to TRIG INPUT and set the controls as follows.

Control	Operation
MODE	EXT WIDTH
TRIGGER	Set as desired. (Observe TRIG indicator to ensure triggering occurs.)
Edge Controls and Output Controls	Set as desired.

3.3.6 Triggered Burst of Pulses

In triggered burst mode, the trigger initiates a gate pulse, controlled by the DELAY control, which gates the output pulses. Set the controls as follows.

Control	Operation
MODE	TRIG BURST
TRIGGER	Set as desired. (Observe TRIG indicator to ensure triggering occurs.)
PERIOD, WIDTH, Edge Controls and Output Controls	Set as desired.
DELAY	Set to the total period time of the number of pulses desired in the burst.
TRIG INPUT	Set input trigger period to greater than the DELAY time.

NOTE

Trigger Period > Delay Time > Pulse Period

3.3.7 Continuous Double Pulses

For continuous double pulses, set the controls as follows.

Control	Operation
MODE	CONT DBL
OUTPUT	NORM (or COMP if inverted pulse is desired)
WIDTH	Set as desired.
DELAY	Set for desired width between double pulses.
PERIOD/RATE	Set for sum of WIDTH + DELAY + time desired between successive double pulses.
Edge Controls and Level Controls	Set as desired.

3.3.8 Triggered Double Pulses

Set up as in paragraph 3.3.7. If triggering with an external signal, connect the trigger source to TRIG INPUT. Reset the controls as follows.

Control	Operation
MODE	TRIG DBL
Control	**Operation**
TRIGGER	Set as desired. (Observe TRIG indicator to ensure triggering occurs.)

3.3.9 Gated Double Pulses

Setup as in paragraph **3.3.7.** If gated with an external signal, connect the gate source to TRIG INPUT. Set the gate pulse width to allow the number of pulses desired. Reset the controls as follows.

Control	Operation
MODE	GATE DBL
TRIGGER	Set as desired. (Observe TRIG indicator to ensure triggering occurs.)