

INSTRUCTION MANUAL

**MODEL 801  
50 MHz PULSE  
GENERATOR**

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# 1

## SECTION

### 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  $\pm 20$  volts with  $50\Omega$  source impedance which provides  $\pm 10$  volts into a  $50\Omega$  load. Upper and lower pulse levels are fully adjustable through  $\pm 20$  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.

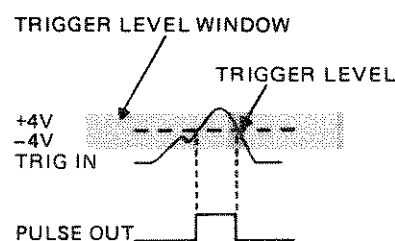
**Triggered:** Generator quiescent until triggered by external signal or front control, then generates one pulse.

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

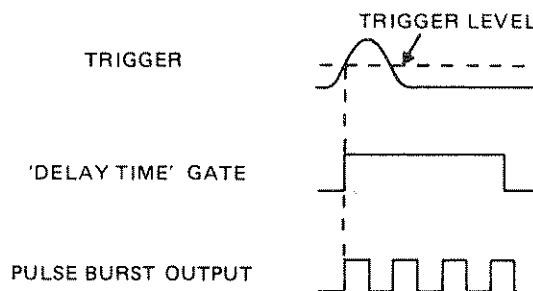
**Double Pulse:** Continuous, trigger and gate, as above, except two pulses for each period. Space between pulses of

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  $\pm 20\text{V}$  into an open circuit from the  $50\Omega$  source. The pulse is 20V p-p maximum, 1V p-p minimum. Into a  $50\Omega$  termination, dynamic range is  $\pm 10\text{V}$ , maximum pulse 10V p-p, minimum pulse 0.5V p-p.


Overshoot and ringing is less than  $\pm(5\%$  of amplitude setting  $+100\text{ mV}$ ) into  $50\Omega$  load.

Preshoot is less than  $\pm(5\%$  of amplitude setting  $+100\text{ mV}$ ) into  $50\Omega$  load.


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

Pulse levels for 50 $\Omega$  loading as shown:

ECL  -1.8V ——— -0.9V

$\overline{\text{ECL}}$   -1.8V ——— -0.9V

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

TTL  <0.4V ——— >2.4V

TTL Transition Time: < 10 ns.

### Sync Pulse

Sync pulse is 0 to at least +1V from a 50 $\Omega$  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  $\pm$ 4% to 2  $\mu$ s period changing to 50  $\pm$ 15% at 20 ns period.

Width jitter is less than 0.1% plus 50 picoseconds.

Sync pulse duty cycle is 50  $\pm$ 4% of pulse period to 2  $\mu$ s period, changing to 50  $\pm$ 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.

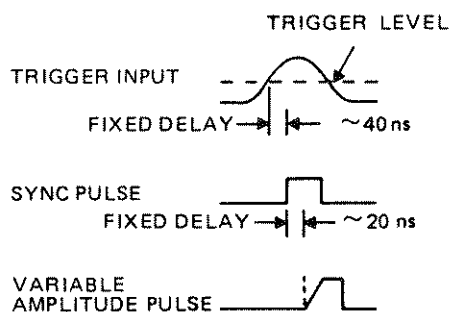
Linearity: For transition greater than 10 ns  $\pm$ 5% between 10 to 90% points on pulse.

### 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  $\pm$ 200 mV p-p to 5 MHz increasing to  $\pm$ 600 mV p-p to 50 MHz (from 50 $\Omega$  source) and a maximum amplitude of  $\pm$ 10V with a minimum width of 10 ns.

Input impedance is approximately 1 k $\Omega$  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  $\pm$ 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 $^{\circ}$ C  $\pm$ 5 $^{\circ}$ C after 1 hour warm-up. Instrument will operate from 0 $^{\circ}$ C to 50 $^{\circ}$ C.

### Dimensions

28.6 cm (11  $\frac{1}{4}$  in.) wide; 13.3 cm (5  $\frac{1}{4}$  in.) high; 29 cm (11  $\frac{1}{4}$  in.) deep.

### Weight

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

### Power

90 to 130V or 180 to 250V; 50 to 400 Hz; 60 watts nominal.

# 2

## SECTION 2

### INSTALLATION

#### 2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

#### 2.2 ELECTRICAL INSTALLATION

##### 2.2.1 Power Connection

###### WARNING

To preclude injury or death due to shock, the third wire earth ground must be continuous to the facility power outlet. Before connecting to the facility power outlet, examine extension cords, autotransformers, etc., between the instrument and the facility power outlet for a continuous earth ground path. The earth ground path can be identified at the plug on the instrument power cord; of the three terminals, the earth ground terminal is the nonmatching shape, usually cylindrical.

###### CAUTION

To prevent damage to the instrument, check for proper match of line and instrument voltage and proper fuse type and rating.

###### NOTE

*Unless otherwise specified at the time of purchase, this instrument was shipped from the factory with the power transformer connected for operation on a 108 to 132 Vac line supply and with a 0.6 amp fuse.*

Conversion to other input voltages requires a change in rear panel fuse-holder voltage card position and fuse according to the following table and procedure.

Card Position	Input Vac	Fuse
100	90 to 110	0.6 amp
120	108 to 132	0.6 amp
220	198 to 242	0.3 amp
240	216 to 264	0.3 amp

1. Open fuse holder cover door and rotate fuse pull to left to remove the fuse.
2. Select operating voltage by orienting the printed circuit board to position the desired voltage on the top left side. Push the board firmly into its module slot.
3. Rotate the fuse-pull back into the normal position and insert the correct fuse into the fuse holder. Close the cover door.
4. Connect the ac line cord to the mating connector at the rear of the unit and the power source.

##### 2.2.2 Signal Connections

Use 3 foot RG58U 50 $\Omega$  shielded cables equipped with female BNC connectors to distribute input and output signals when connecting this instrument to associated equipment.

#### 2.3 ELECTRICAL ACCEPTANCE CHECK

This checkout procedure verifies the generator operation. If a malfunction is found, refer to the Warranty in the front of this manual. A 2 channel oscilloscope and 50 $\Omega$  coax cable are needed for this procedure (see figure 2-1).

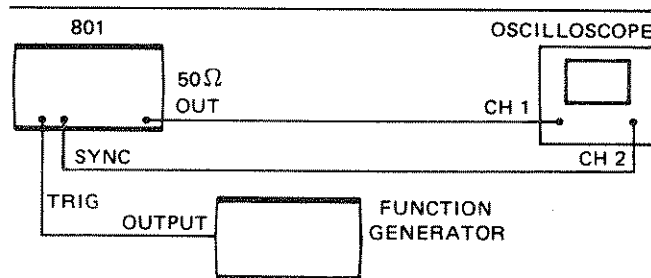


Figure 2-1. Initial Setup

Preset the pulse generator controls by setting the following switches to their white mark:

MODE  
TRIGGER  
PERIOD/RATE  
DELAY  
WIDTH  
OUTPUT  
TRANSITION TIME

Set the following controls to 12 o'clock:

TRIGGER LEVEL  
VARIABLE PERIOD/RATE  
VARIABLE DELAY  
VARIABLE WIDTH  
LOWER LEVEL  
UPPER LEVEL  
TRAILING EDGE  
LEADING EDGE

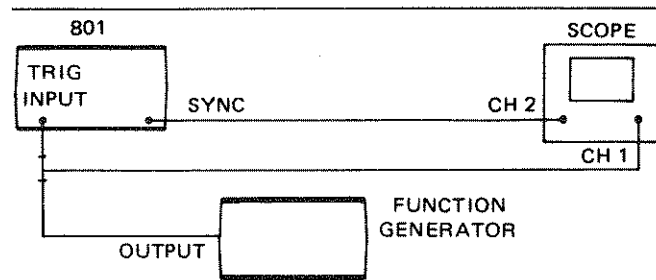


Figure 2-2. Second Setup



Set the function generator to supply a 1 kHz,  $\geq 5V$  triangle wave trigger.

Perform the steps in table 2-1. Only approximate values are required to verify operation.

Table 2-1. Performance Checkout

Step	Control	Position/Operation	Observation
1	POWER	In	CH 1: A near 0 volt dc level. (LEVEL control is not calibrated.) CH 2: 1.5 volt pulses.
2	LOWER LEVEL	Rotate ccw	Pulse base drops 20V.
3	UPPER LEVEL	Rotate ccw	Pulse upper level drops 20V.
4	UPPER LEVEL	Rotate cw. Make observation; then reposition for good display.	Pulse rises 20V, then rises 20V more while pulling the base up 20V. Base rises to 0V.
5	OUTPUT	COMP, then NORM	Set scope for one or two cycles. Observe the switching of duty time from 1st half cycle to 2nd half cycle.
6	WIDTH	Rotate ccw, then to $10\mu s \parallel 100\mu s$	Duty time changes. (Use scope X 10 magnification to see narrow widths.)
7	WIDTH VARIABLE	Rotate ccw, then to 12 o'clock	Duty time decreases, then increases.
8	TRANSITION TIME	Rotate to $500\text{ ns} \parallel 5\mu s$	Slope of pulse edges increases.
9	LEADING EDGE	Rotate cw, then full ccw	Slope of leading edge decreases, then approaches vertical.
10	TRAILING EDGE	Rotate cw, then full ccw	Slope of trailing edge decreases, then approaches vertical.
11	DELAY	Rotate cw to $10\mu s \parallel 100\mu s$	Pulse position changes within cycle time.
12	DELAY VARIABLE	Rotate ccw, then cw	Pulse position moves to left, then right.
13	PERIOD/RATE VARIABLE	Rotate cw, then to 12 o'clock	Period increases, then decreases.
14	MODE	CONT DBL	Two pulses instead of one.
15	DELAY VARIABLE	Rotate ccw, then cw, but maintain double pulse	Pulse pairs move closer, then further apart.

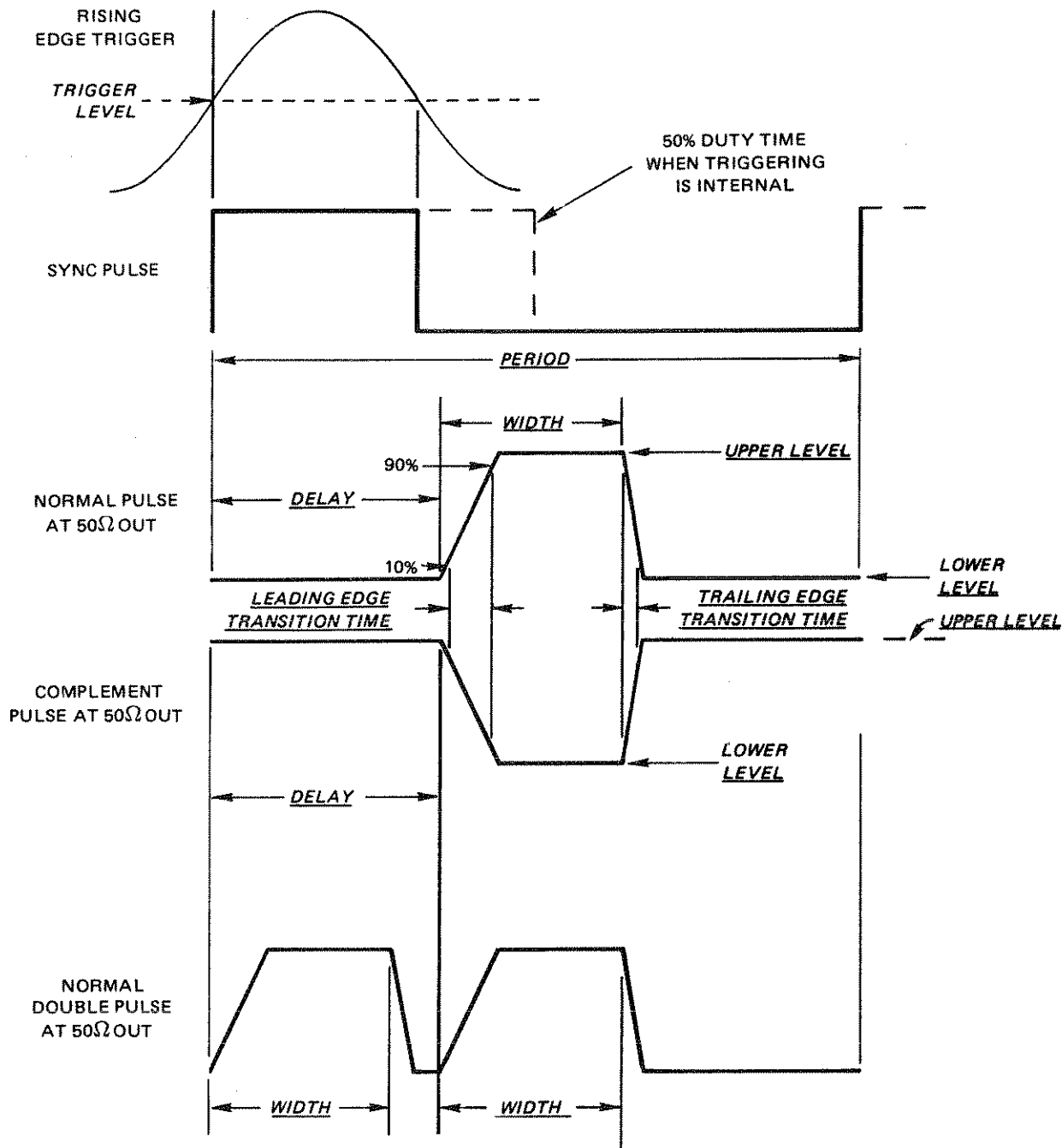
Table 2-1. Performance Checkout (Continued)

Step	Control	Position/Operation	Observation
16	WIDTH VARIABLE	Rotate ccw, then to 12 o'clock, but maintain double pulse	Duty time of each pulse of pulse pair decreases, then increases.
17	MODE	TRIG	Pulse delayed from sync leading edge.
18	MODE	TRIG DBL	Two pulses instead of one.
19	50Ω OUT	Remove cable; place on ECL connector	ECL double pulse output.
20	ECL	Remove cable; place on $\overline{\text{ECL}}$ connector	$\overline{\text{ECL}}$ double pulse output complement of previous output.
21	$\overline{\text{ECL}}$	Remove cable; place on TTL connector	TTL double pulse output.
Change to setup in figure 2-2. Trigger scope on trigger signal.			
22	TRIGGER		Sync rises on trigger falling edge.
23	TRIGGER		Sync rises on trigger rising edge.
24	TRIGGER LEVEL	Rotate cw and ccw, then to white mark	Sync pulse triggers at different levels on triangle trigger signal.
Change to setup in figure 2-1. Set trigger source to 400 Hz.			
25	MODE	GATE	Several pulses from the pulse generator for each gate cycle.
26	MODE	GATE DBL	Two pulses for each one in previous step. (WIDTH VARIABLE may need adjusting.)
27	MODE	EXT WIDTH	— — —
28	TRIGGER LEVEL	Vary level; return to white mark	Pulse width varies.
29	MODE	TRIG BURST	— — —
30	DELAY	100 μs   1 ms	— — —
31	DELAY VARIABLE	Rotate ccw, then cw	Decreases, then increases the number of pulses per trigger cycle.
32	TRIGGER	MAN TRIG	— — —
33	MAN TRIG	Press switch	The pulse set of the previous step for each press of MAN TRIG.

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NOTE: Underline indicates a front panel controlled 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 occurrence 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 **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 occurrence 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 0V 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 50 $\Omega$  OUT pulses; the LOWER LEVEL/UPPER LEVEL control may need adjusting to observe the 50 $\Omega$  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 ( $\square$ ) is meant to be used in continuous mode. Other modes result in the following default conditions.

Mode Selected	Output
TRIG $\square$	A triggered 10 ns pulse
CONT DBL $\square$	A continuous output of paired 10 ns pulses
TRIG DBL $\square$	A triggered output of paired 10 ns pulses
GATE DBL $\square$	A gated output of paired 10 ns pulses

### 3.2.3 ECL Termination

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

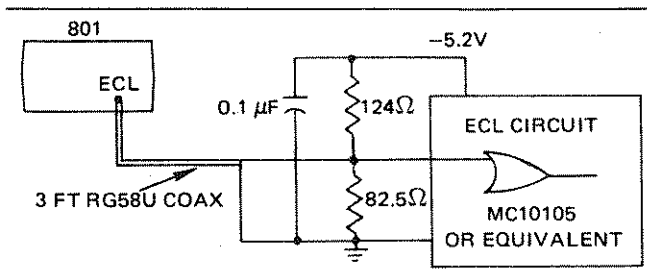


Figure 3-3. ECL Termination

### 3.2.4 Output Terminations

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

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

### 3.2.5 Nonlinear and Reactive Loads

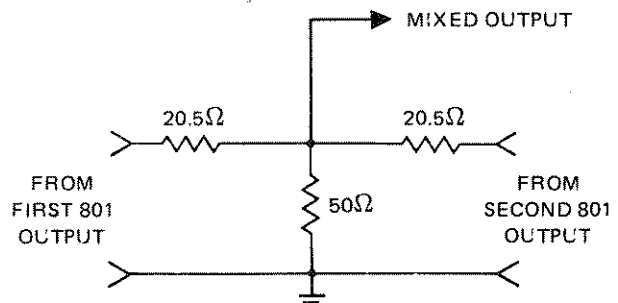
Both nonlinear and reactive loads will cause pulse distortion. Reactive loads driven with fast transitions cause voltage spikes that can damage the 801 output amplifier. If it is necessary to drive reactive loads directly, the instrument must be protected against these voltage spikes.

### 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  $\square$  and TRIGGER LEVEL maximum cw. The output will now be locked to the lower level. Switching the trigger to  $\square$  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

$$t_{\text{observed}}^2 = t_{\text{scope}}^2 + t_{801}^2$$

or

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

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:

$$t_{\text{observed}}^2 = t_{801}^2 + t_{\text{scope}}^2 + t_{\text{c.u.t.}}^2$$

## 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.

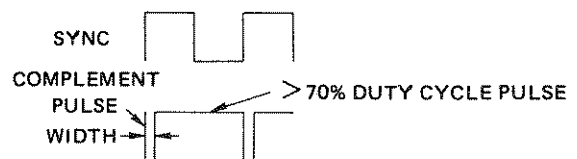


Figure 3-4. Greater Than 70% Duty Cycle Pulse

Control	Operation
Edge Controls and DELAY	Set as desired.
<b>3.3.3 Triggered Pulses</b>	
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
TRIGGER	Set as desired. (Observe TRIG indicator to ensure triggering occurs.)

### 3.3.9 Gated Double Pulses

Set up 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.

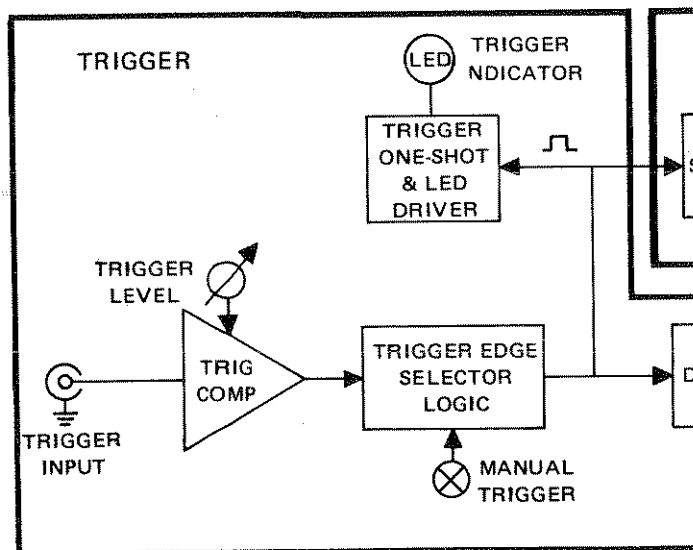
Control	Operation
MODE	GATE DBL
TRIGGER	Set as desired. (Observe TRIG indicator to ensure triggering occurs.)





## SIGNAL MNEMONICS

Signal mnemonics are used in the instrument schematics as well as this and other figures in the manual.



TOG	— TRIG TO OSC GATE
TD	— TRIG TO DELAY
TRF	— TRIG TO RISE/FALL
OD	— OSC TO DELAY
OW	— OSC TO WIDTH
ORF	— OSC TO RISE/FALL
DW	— DELAY TO WIDTH
PPDW	— PULSE PAIR DELAY TO WIDTH
DOG	— DELAY TO OSC GATE
WRF1	— WIDTH TO RISE/FALL 1
WRF2	— WIDTH TO RISE/FALL 2

## NOTE

RISE/FALL (RF) and TRANSITION TIME (TT) are interchangeable.

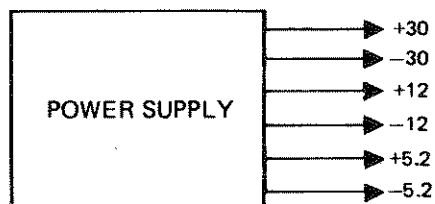
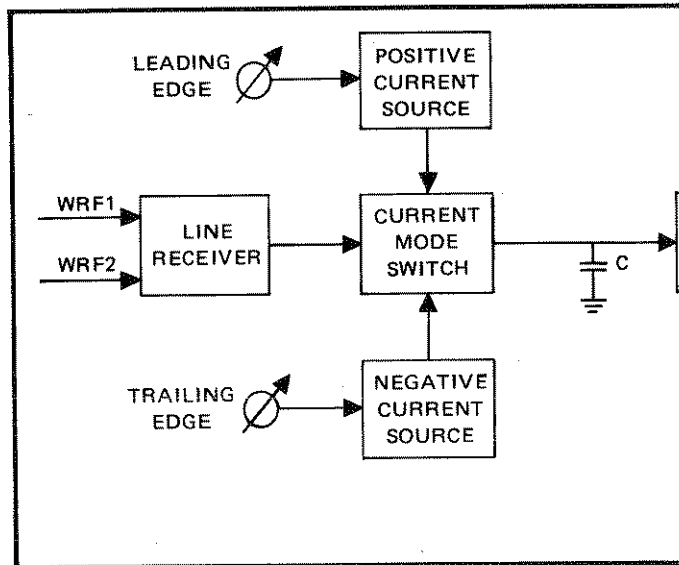
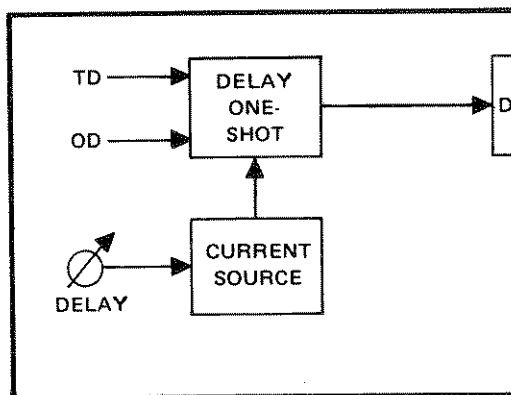


Figure 4-1. Overall Block Diagram



# 4

## SECTION 4

### CIRCUIT DESCRIPTION

#### 4.1 OVERALL BLOCK DIAGRAM

The Model 801 is made up of nine major circuit blocks. They are: trigger circuit, sync circuit, period oscillator, delay one shot, width one shot, transition time control circuit, output amplifier, auxiliary outputs and a power supply (see figure 4-1).

The main circuit board contains the transition time control circuit, output amplifier and power supply. Most circuitry is in the form of discrete components.

The timing board contains all the remaining circuit blocks. They are made of a combination of high speed emitter coupled logic (ECL) and discrete components.

The ECL logic serves a dual purpose. In addition to making up the individual circuits, it couples signals from one block to another. The coupling path depends on the generator mode selected. The mode control switch programs the pulse distribution logic to give the proper path.

#### 4.2 TRIGGER CIRCUIT

The trigger input signal level is compared against a threshold voltage from the trigger level potentiometer ( $-4V$  to  $+4V$ ) by the trigger comparator (figure 4-1). When the level set by the trigger level potentiometer is exceeded, the output of the comparator changes logic states. It will change back to its original state as the threshold voltage is passed a second time in the opposite direction. Hysteresis between the two levels is approximately 100 mV.

The output of the comparator is sent to a logic circuit which selects the leading or trailing edge as the trigger source. The signal at this point is monitored for transitions by an ac coupled 100 ms one shot which drives the LED trigger indicator. Every transition causes the LED to flash on for 100 ms. The manual trigger switch will also cause the trigger indicator to flash. The trigger pulse is then routed by the pulse distribution logic to the other circuit blocks.

#### 4.3 PERIOD OSCILLATOR

The period oscillator is a basic ECL gate multivibrator. A simplified diagram is shown in figure 4-2.

The RC time constant determines the charge and discharge rates for capacitor C and, therefore, the frequency of operation.

Positive feedback via the path through C results in a stable oscillator. Varying resistor R changes the frequency over a 10:1 range. Note that since the charging and discharging currents are equal but opposite, the resulting waveform has a 50% duty cycle.

The oscillator may be gated on and off by the gate amplifier and diode CR. When the output of the gate amplifier is low, diode CR will be reversed biased allowing the oscillator to run. When the output is high, CR pulls the input node A of the gate high, which holds node C low and no oscillation can occur. The output of the oscillator is buffered and routed to other circuitry by the pulse distribution logic.

#### 4.4 SYNC CIRCUIT

The sync selector logic circuit (figure 4-1) selects either the output of the trigger circuit or the oscillator square wave as the sync output. This signal is delayed to compensate for the delay through the output amplifier and then fed to a 50 ohm output driver stage.

#### 4.5 DELAY CIRCUIT

The delay circuit (figure 4-1) consists of an ECL gate and discrete circuit one shot multivibrator. When the delay circuit is triggered, a timing capacitor is discharged by a constant current source until a threshold point is reached. The circuit then resets by rapidly recharging the timing capacitor. The output pulse from the ECL gate has a width proportional to the timing capacitor value and the magnitude of the current source. The pulse distribution logic routes the delay pulse to the other circuitry.

#### 4.6 WIDTH CIRCUIT

The operation of the width one shot and the delay one shot is identical. The width circuit (figure 4-1) accepts triggering information from different sources, however. The width one shot output is connected to the source selection logic circuit. This circuit selects the signal that drives the output amplifier. The oscillator square wave, the trigger circuit output, or the width one shot output may be selected.

The source selection logic drives the auxiliary outputs and also drives the variable transition control circuit located on the main board.

#### 4.7 AUXILIARY OUTPUTS

The auxiliary outputs (figure 4-1) carry the same signal as the 50 ohm output, but the levels and transition times are fixed. The ECL driver feeds signals to the ECL and  $\overline{\text{ECL}}$  outputs and also to an ECL-to-TTL converter. The converter feeds a 50 ohm output driver circuit which provides a TTL level signal into 50 ohms.

#### 4.8 TRANSITION TIME CONTROL CIRCUIT

The transition time control circuit (see figure 4-1) accepts the differential signal from the width one shot in an ECL line receiver and then drives a current mode switch.

The current mode switch connects either the positive or negative current source to capacitor C. The constant current sources form positive and negative going linear ramps which are clamped to a constant level by a bipolar clamp circuit. The current sources are controlled by front panel potentiometers. Changing the current will change the transition time.

The bipolar clamp drives a buffer amplifier for impedance matching which then drives a bipolar clipping circuit. The clipping circuit removes any voltage variations introduced by the clamp circuit and establishes precise amplitude levels.

#### 4.9 OUTPUT AMPLIFIER

The output amplifier accepts the signal from the transition time control circuit, establishes upper and lower pulse levels and delivers it to the 50 ohm load.

An X-Y multiplier is used to give independent upper and lower level controls. The multiplier requires a voltage-to-current converter in the signal path since it works on a differential current splitting technique. The X-Y multiplier controls the magnitude of these currents to establish an output amplitude. The difference between the upper and lower level controls programs the multiplier to produce the required peak-to-peak output signal. The signal is further processed in the preamp circuit. The multiplier output signal is always symmetrical about ground, so a signal proportional to the sum of the upper and lower level controls is added to give the correct dc offset. The preamp output signal upper and lower levels are proportional to the setting of the front panel controls.

The preamp output is further amplified by the output amplifier. The power amplifier power supplies track the mid-point level programmed by the upper and lower level controls. A bipolar clamp limits the supplies when equal upper and lower levels are selected near the output extreme, such as +9.5V and +10.0V.

#### 4.10 MODES OF OPERATION

The major circuit block connections depend on the mode of operation selected. Block diagrams of the major modes and key waveforms are shown in figures 4-3 thru 4-9.

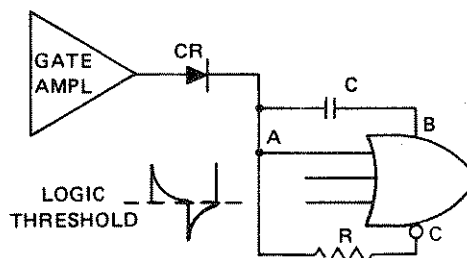


Figure 4-2. Simplified ECL Gate Multivibrator

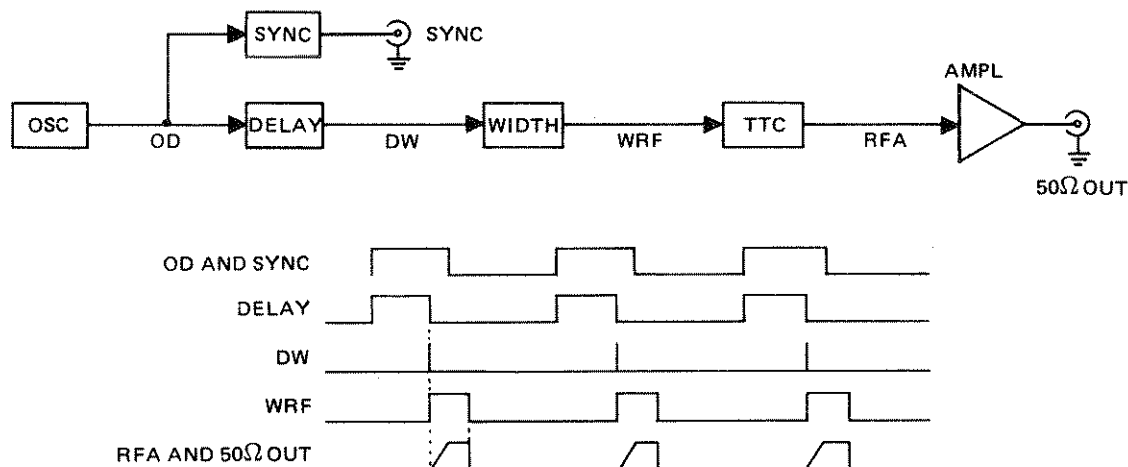


Figure 4-3. Continuous Mode

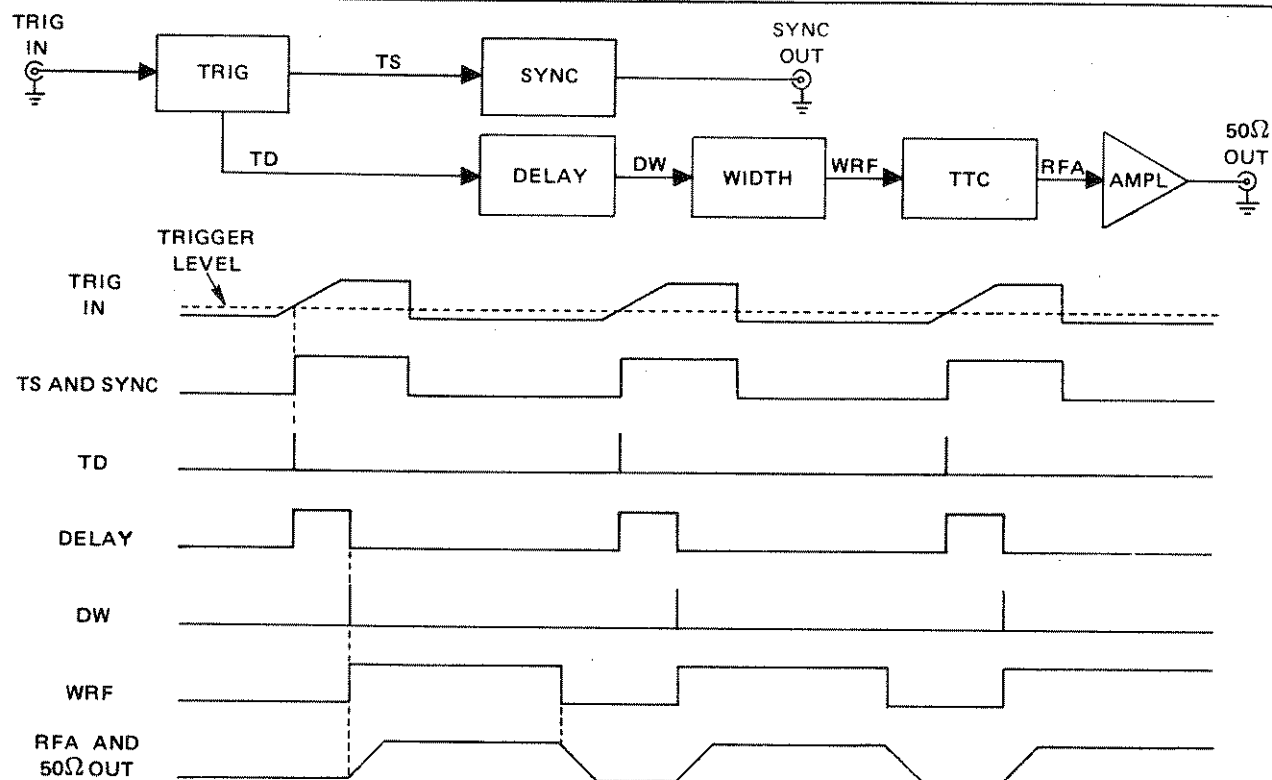


Figure 4-4. Trigger Mode

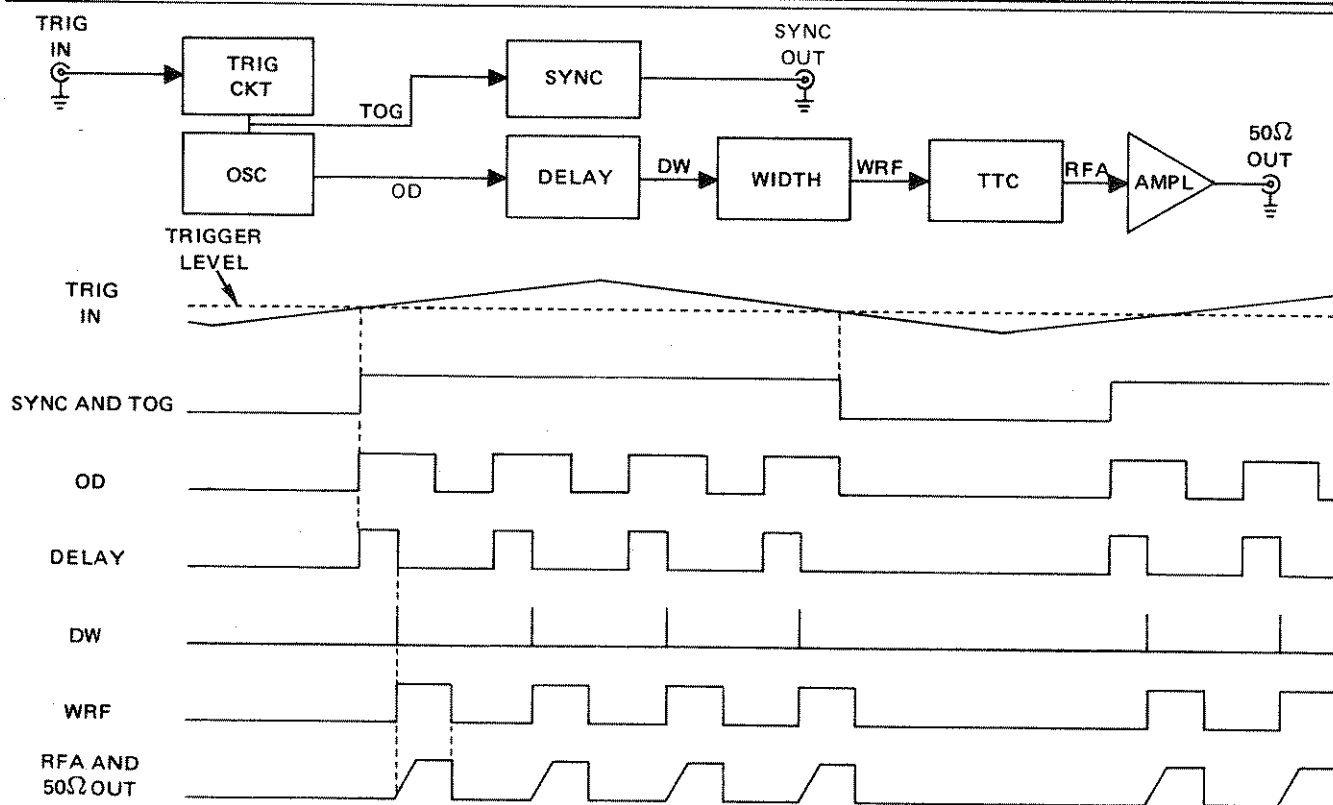


Figure 4-5. Gate Mode

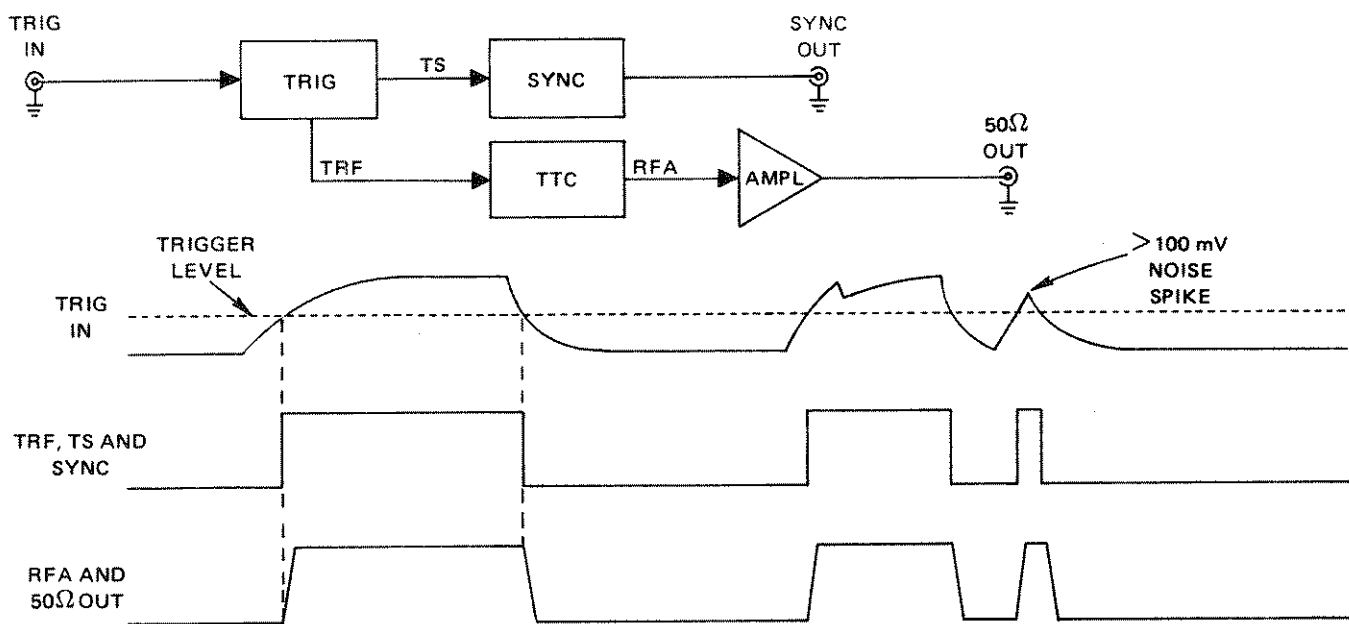


Figure 4-6. External Width

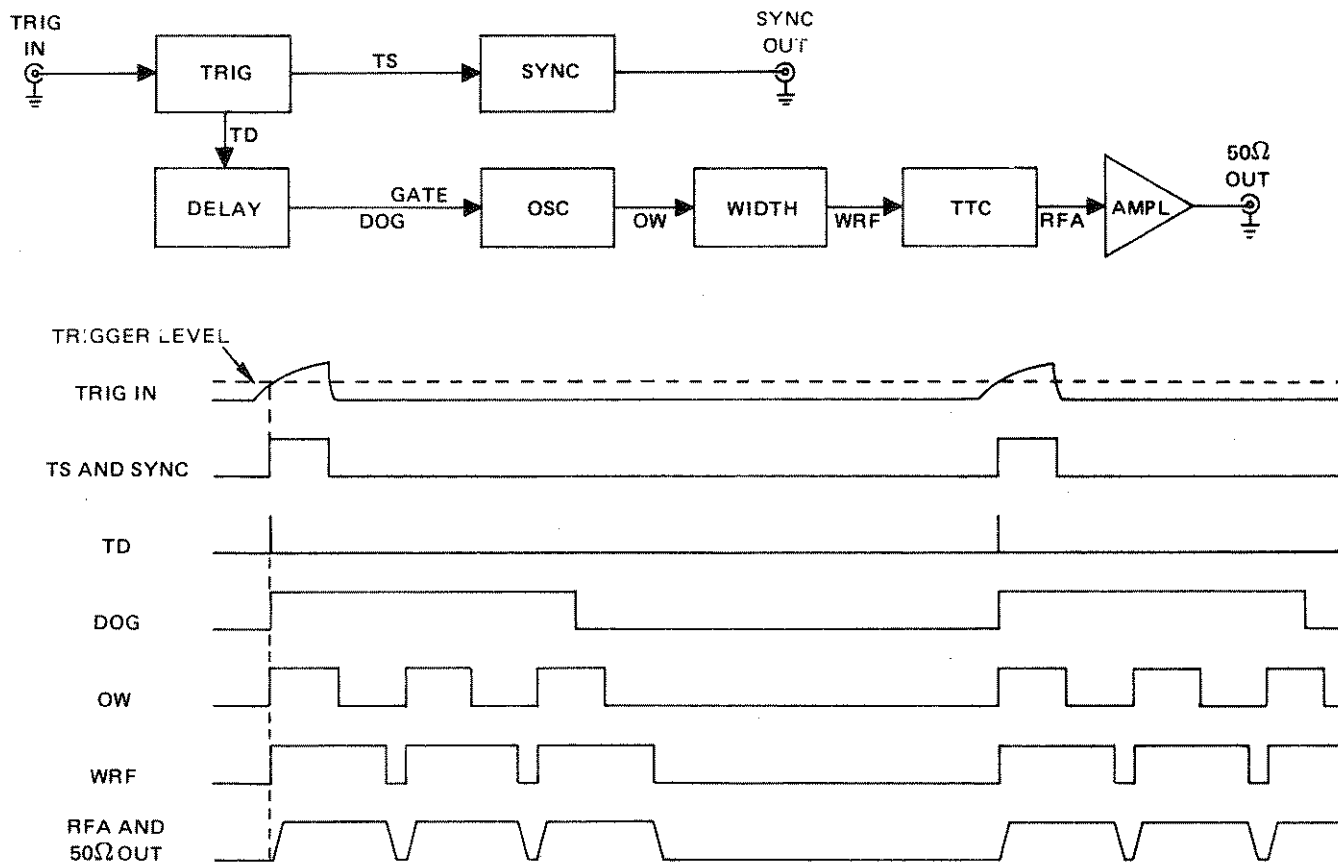


Figure 4-7. Trigger Burst

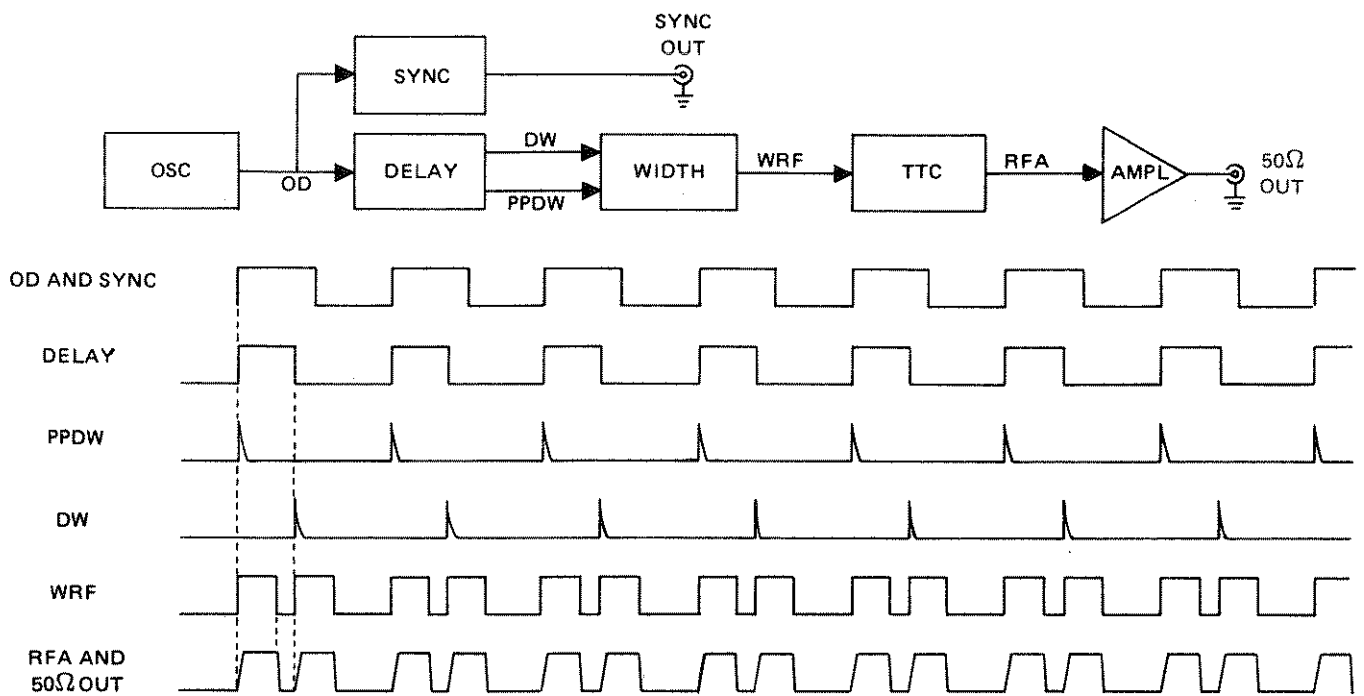


Figure 4-8. Continuous Double Pulse Mode

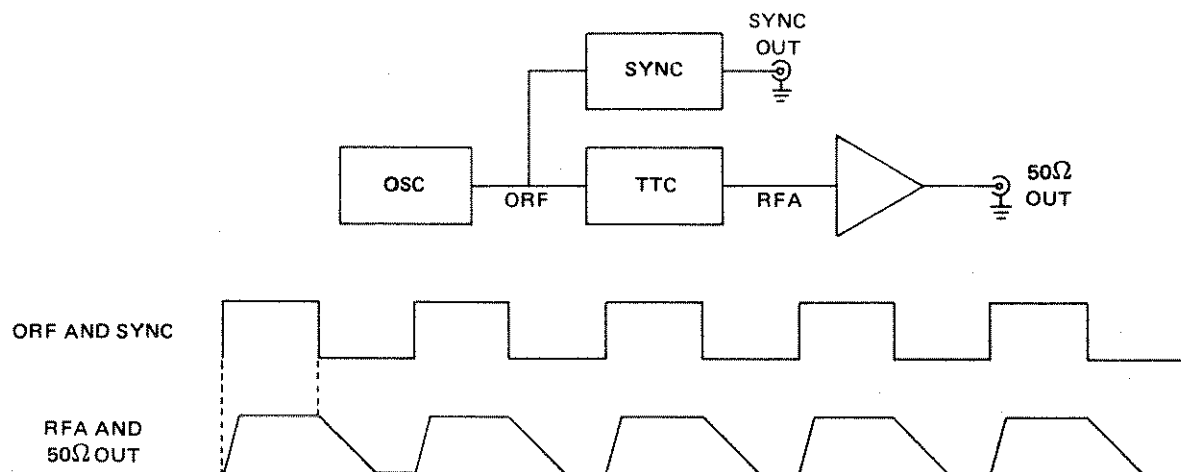


Figure 4-9. Continuous Square Wave Mode

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# 5

## SECTION CALIBRATION

### 5.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

### 5.2 REQUIRED TEST EQUIPMENT

Voltmeter . . . . . Millivolt dc measurement (0.1% accuracy)  
Oscilloscope, Dual Channel . . . . . 500 MHz bandwidth  
Counter . . . . . 55.0 MHz (0.01% accuracy)  
50 $\Omega$  Load . . . . .  $\pm 0.1\%$  accuracy, 2W  
Function Generator . . . . . 5 kHz  $\wedge$ , 4V p-p

### 5.3 REMOVING GENERATOR COVERS

1. Invert the instrument and remove the four screws in the cover.
2. Turn the instrument upright, remove the top cover, and remove the four screws securing the bottom cover.
3. Replace the top cover and turn the instrument upside down.

#### NOTE

*Remove the cover only when it is necessary to make adjustments or measurements.*

### 5.4 CALIBRATION

After referring to the following preliminary data, perform calibration, as necessary, per table 5-1. If performing partial

calibration, check previous settings and adjustments for applicability. See figures 5-1 and 5-2 for calibration point location.

The completion of these calibration procedures returns the instrument to correct calibration. All limits and tolerances given in these procedures are calibration guides and should not be interpreted as instrument specifications. Instrument specifications are given in section 1 of this manual.

1. Unless otherwise noted, all measurements made at the 50 $\Omega$  OUT connector should be terminated into a 50 $\Omega$  ( $\pm 0.1\%$ ) load.
2. Start the calibration by connecting the unit to an ac source and setting the front panel switches as follows:

MODE . . . . . CONT  
TRIGGER . . . . . MAN TRIG  
PERIOD . . . . . 20  $\mu$ s I 200  $\mu$ s  
PERIOD VARIABLE . . . . . Full cw  
DELAY . . . . . OFF  
WIDTH . . . . .  $\sqcap$   
TRANSITION TIME . . . . . 5 ns I 50 ns  
LEADING EDGE . . . . .  $\times 1$   
TRAILING EDGE . . . . .  $\times 1$   
OUTPUT . . . . . NORM  
LOWER LEVEL . . . . . -10V  
UPPER LEVEL . . . . . +10V

3. Allow the unit to warm up at least 30 minutes for final calibration. Keep the instrument covers on to maintain heat. Remove covers only to make adjustments or measurements.

Table 5-1. Calibration Chart

Step	Check	Tester	Cal Points	Control Settings	Adjust	Desired Results	Remarks	
1	Power Supply	Voltmeter	TP1 (J4 Gnd)		R2	+5.2V $\pm$ 20 mV		
2			TP2		R3	−5.2V $\pm$ 20 mV		
3			TP3			+12V $\pm$ 500 mV	If out of tolerance and steps 1 and 2 are OK, troubleshoot power supply	
4			TP4			−12V $\pm$ 500 mV	If out of tolerance and steps 1, 2 and 3 OK, troubleshoot power supply	
5	Output/ Level Adjust- ments	Scope	TP5		R45	Equal + and − peaks		
6			50 $\Omega$ OUT		LOWER LEVEL: −10V	R118	Minimum lower level shift	Use 50 $\Omega$ load at scope. Observe lower level while varying upper level from 0 to −10V.
7					UPPER LEVEL: +10V		Minimum upper level shift	Observe upper level while varying lower level from 0 to +10V.
8							Optimum potentiometer position	Repeat steps 6 and 7, as necessary.
9					UPPER LEVEL: +250 mV on scope LOWER LEVEL: −250 mV on scope	R79	Minimum p-p amplitude change	AC couple scope. Adjust R79 while switching OUTPUT from NORM to COMP.
10					R63	Minimum dc level shift	DC couple scope. Adjust R63 while switching OUTPUT from NORM to COMP.	
11		Voltmeter	TP6		R103	0 $\pm$ 20 mV	Connect P3 to J4.	
12	Tracking Power Supply		+18V Supply Jumper		R195	+16.1 $\pm$ 0.1V		
13			−18V Supply Jumper	R196	−16.1 $\pm$ 0.1V			






Table 5-1. Calibration Chart (Continued)

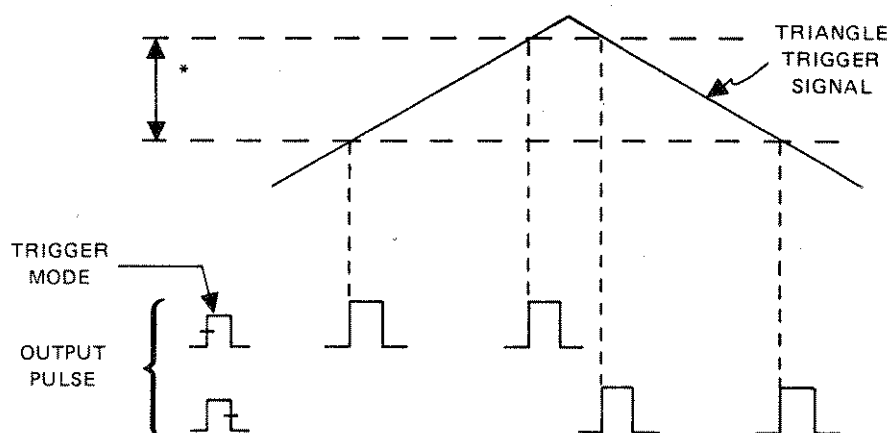
Step	Check	Tester	Cal Points	Control Settings	Adjust	Desired Results	Remarks
14	Output Amplitude Zero Adjustment	Voltmeter	50Ω OUT		R150	0 ±20 mV	Load output with 50Ω. Connect P3 to J3 after adjusting R150.
15	Level Knobs	Scope		LOWER LEVEL: 0V on scope UPPER LEVEL: +5V on scope	LOWER LEVEL knob	LOWER LEVEL knob indicates 0V on panel when 0V on scope	Loosen LOWER LEVEL knob and reposition if necessary. When set correctly, remove UPPER LEVEL knob.
16				LOWER LEVEL: 0V on scope UPPER LEVEL: 0V on scope	UPPER LEVEL knob	Mechanically linked to LOWER LEVEL knob when scope shows 0V	After setting shaft for 0V on scope, replace UPPER LEVEL knob without tightening. Turn knob ccw until mechanical stop starts to pull LOWER LEVEL knob. Tighten setscrew.
17				LOWER LEVEL: 0V UPPER LEVEL: cw until touching LOWER LEVEL knob PERIOD: 10 ms on scope	R116	UPPER LEVEL indicates +10V	
18				LOWER LEVEL: -10V UPPER LEVEL: 0V		Pulse is 0 to -10V on scope	If incorrect, repeat steps 15, 16 and 17.
19				Output Amplitude Response	LOWER LEVEL: -5V on scope UPPER LEVEL: +5V on scope PERIOD: 5 MHz on scope	C48, C72	Best waveform quality with overshoot ≤ ±5%, rise time ≤ 7 ns, fall time ≤ 7 ns

NOTE: Replace bottom cover and turn the instrument right side up.

20	Symmetry	Scope	50Ω OUT	PERIOD: 20 μs I 200 μs PERIOD VARIABLE: full cw	R66	1% symmetry	
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Table 5-1. Calibration Chart (Continued)

Step	Check	Tester	Cal Points	Control Settings	Adjust	Desired Results	Remarks
21	TRIG Indicator	Scope	50 $\Omega$ OUT		R33	TRIG lamp just goes out	
<i>NOTE: Apply a 5 kHz, 4V p-p triangle wave trigger.</i>							
22	TRIG Indicator	Scope	50 $\Omega$ OUT	MODE: TRIG TRIGGER:  WIDTH: 1 $\mu$ s   10 $\mu$ s WIDTH VARIABLE: 12 o'clock	R33	TRIG lamp indicates triggering throughout trigger level range	Trigger scope on SYNC pulse. Observe trigger signal and output pulse as trigger level is varied per figure 5-3.
23				TRIGGER: 			
24	First Period Adjustment	Counter	50 $\Omega$ OUT	MODE: GATE PERIOD: 2 $\mu$ s   20 $\mu$ s PERIOD VARIABLE: full cw WIDTH: 	R54	First cycle = second cycle period No delay of first cycle leading edge from sync	Adjust TRIGGER LEVEL for 3 pulse cycles on the scope. Observe SYNC output on second channel.
25	Frequency			LOWER LEVEL: -10V UPPER LEVEL: +10V MODE: CONT PERIOD: 20 ns   200 ns PERIOD VARIABLE: full ccw	C21	50 (+1, -0) MHz	



\*Vary TRIGGER LEVEL control from 5% thru 95% of trigger signal amplitude. Observe that the TRIG indicator lights for each pulse triggered.

Figure 5-3. Trigger In and Pulse Out