Hall A

H-P

MODEL 8013 B

PULSE GENERATOR

OPERATING AND SERVICE MANUAL

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1–1 INTRODUCTION

1–2 The 8013B is an extremely versatile, easy to operate pulse generator with a wide range of applications. It has a variable repetition rate of 0–50 MHz and transition times of < 3.5ns which make it ideal for testing digital logic: HTL, RTL, DTL and most ECL can be tested. The simultaneous positive and negative outputs are useful for testing circuits with both positive and negative power supplies. Format changes from normal to complement can be made at the throw of a switch. without having to re-adjust any pulse parameters. This enables changes from positive to negative logic conventions to be made and 100% duty cycles to be obtained very easily.

1–3 The 8013B has a selectable source impedance which makes impedance matching to the circuit under test very simple. It also has a square wave facility that is independent of width and delay settings and a double pulse facility that is useful for testing device recovery times and making noise immunity measurements.

1–4 The front panel of the 8013B has been carefully designed to provide a logical layout of the controls; horizontal controls for pulse timing parameters, vertical controls for pulse amplitude parameters. Also, compatible pulse settings are guaranteed as long as the pulse delay and pulse width controls are either set to the left of the pulse period control or; if set vertically below the period control, that the delay and width verniers are set counterclockwise of the period vernier. This simple, straightforward design enables pulses to be set up extremely quickly and easily.

1–5 The 8013B will operate in three different modes as follows:

Normal mode: in this mode the internal rate generator determines the repetition rate of the output pulses. The generator can be triggered internally, externally or manually or can be gated. A trigger pulse is generated for each output pulse and the pulse output can be delayed with respect to the trigger output.

RZ mode: in this mode external pulses are applied to the input connector on the 8013B rear panel and these pulses trigger the delay generator directly, completely by-passing the internal rate generator. Thus the internal rate generator can be used separately in this mode to provide trigger pulses that are independent of the RZ output.

External width mode: in this mode external pulses applied to the input socket on the rear panel determine the width and repetition rate of the output pulses. In fact the output is a pulse-shaped version of the external input. The pulse available at the trigger output, being derived from the internal rate generator, is independent of the RZ output.

Table 1–1. Specifications

PULSE CHARACTERISTICS

Transition times: 3.5ns fixed with INT LOAD switched IN. < 5ns fixed with INT LOAD switched OUT.

Overshoot and ringing: < ± 5% of pulse amplitude unless INT LOAD is switched OUT and amplitude reduced to 0.4V – 4V when it may increase to ± 10%.

Preshoot: < ± 5% of pulse amplitude.

Pulse width: < 10ns to 1s in four ranges. Vernier provides continuous adjustment within ranges.

Width jitter: < 0.1% + 50ps on any width setting.

Maximum duty cycle: > 75% from 1 Hz to 10 MHz, decreasing to ⩾ 40% at 50 MHz. Up to 100% in COMPL mode.

Maximum output: with INT LOAD switched IN, output is 5V across 50 ohms, 10V across open circuit. With INT LOAD switched OUT, output is 10V across 50 ohms. Output circuit cannot be damaged by short circuits.

Attenuator: 4-step attenuator reduces output to 0.2V with INT LOAD switched IN, or to 0.4V with INT LOAD switched OUT. Vernier provides continuous adjustment within ranges.

Polarity: dual channel, positive and negative outputs simultaneously.

Output format: normal or complement selectable.

Source impedance: 50 ohms ± 3% shunted by typically 20pF with INT LOAD switched IN. > 50 ohms shunted by typically 20pF with INT LOAD switched OUT.

DC offset: with INT LOAD switched IN, offset is ± 2.5V across 50 ohms and is independent of amplitude settings. With INT LOAD switched OUT, offset is automatically switched off.

Pulse delay: < 35ns to 1s (with respect to trigger output) in four ranges. Vernier provides continuous adjustment within ranges. Min. delay 17ns typical.

Delay jitter: < 0.1% + 50ps on any delay setting.

REPETITION RATE AND TRIGGER

Repetition rate: 1 Hz to 50 MHz in four ranges, continuous adjustment within ranges.

Period jitter: < 0.1% + 50ps on any rate setting.

Square wave: 0.5 Hz to 25 MHz in four ranges. Duty cycle 50% ± 5% up to 1 MHz. At 25 MHz tolerance increases to ± 15%.

Double pulse: up to 25 MHz simulating 50 MHz.

Trigger output: > +1V across 50 ohms, 16ns ± 10ns wide. Suitable for triggering another 8012B/13B.

EXTERNALLY CONTROLLED OPERATION

External Triggering

Repetition rate: 0 to 50 MHz. For square wave output, frequency is divided by 2.

Trigger input: sinewaves > 1.7 p-p (about zero) or pulses > 0.8V either polarity with a width of > 7ns.

Maximum input amplitude: ± 7V.

Delay: 25ns ± 8ns between leading edge of trigger input and trigger output signals.

Input impedance: 50 ohms ± 10%, dc coupled.

Manual: front panel pushbutton for single pulse.

Gating

Synchronous gating: gating signal turns generator on. First trigger output pulse is coincident with leading edge of gate pulse. Last output pulse is always generated with normal width even if the gate pulse ends during the generation of the pulse.

Gate input: dc-coupled; voltage at open connector approx. +1.8V. Shorting current ⩽ 12mA. Input impedance approx. 160Ω.

Table 1–1. Specifications (cont'd)

Gate input signal: voltage > +1.5V or resistor > 1KΩ to ground enables rep. rate generator. Voltage < +0.8V or resistor < 160Ω disables rep. rate generator. Gate input TTL compatible. Maximum input: ± 5V.

External Width and RZ modes

External width: output pulse width determined by the width of the drive input signal. Amplitude selectable. Trigger pulses, produced by the internal rate generator, are independent of the output pulses.

RZ mode: external input signal switched directly to delay generator. Output pulse period determined by period of RZ input signal. Delay, width, amplitude and output formats are selectable. Trigger pulses, produced by internal rate generator, are independent of the output pulses.

Input signal: input impedance 50 ohms, dc coupled. Signal amplitude > +1V, maximum input ± 5V. Width > 7ns.

GENERAL

Operating temperature range: 0°C to 55°C.

Power: 100/120/220/240V +5%, −10%, 48 to 400 Hz, 100 VA max.

Weight: net 4 kg (8.8 lbs); shipping 6.5 kg (14.6 lbs).

Dimensions: 200mm wide, 142mm high, 330mm deep (7.9" x 5.6" x 13").

Accessories: 15179A Adapter frame; rackmount for two units.

1–6 SPECIFICATIONS

1–7 Table 1-1 is a complete list of the Model 8013B critical specifications that are controlled by tolerances. Any changes in specifications due to manufacturing, design, or traceability to the U.S. National Bureau of Standards are included in table 1-1 or on a manual change sheet included with this manual. The manual and manual change sheet (if any) supersede all previous information concerning specifications of the Model 8013B.

1–8 INSTRUMENT AND MANUAL IDENTIFICATION

1–9 Instrument identification by serial number is located on the rear panel. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix, separated by a letter designating the country in which the instrument was manufactured. (A= U.S.A.; G=West Germany; J=Japan; U=United Kingdom.)

1–10 This manual applies to instruments with a serial prefix number as shown on the title page. If changes have been made in the instrument since this manual was printed, a "Manual Changes" supplement supplies with the manual will define these changes. Be sure to record these changes in your manual. Backdating information in Section VII adapts the manual to instruments with serial numbers lower than that shown on the title page. Part numbers for the manual and the microfiche copy of the manual are also shown on the title page.

2–1 INITIAL INSPECTION

2–2 Inspect the instrument and accessories for physical damage and if damage is evident refer to paragraphs 2–5 to 2–8 for the recommended claim procedure and repacking information.

2–3 The 8013B is delivered complete with the following items.

ITEM	HP Stock Number
0.5A fuse for 220/240V operation	2110–0202
1A fuse for 100/120V operation	2110–0007

2–4 The power cord delivered with the 8013B will be one of the following:

2–5 CLAIMS FOR DAMAGE

2–6 If physical damage is evident or if the instrument does not meet specifications when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office. The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

2–7 REPACKING

2–8 If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag showing owner, address, model and serial number and the repair required. The original shipping carton and packing maternal can be re-used but the Hewlett-Packard Sales/Service Office will also provide information and recommendations on materials to be used if the original packing is not available or re-usable.

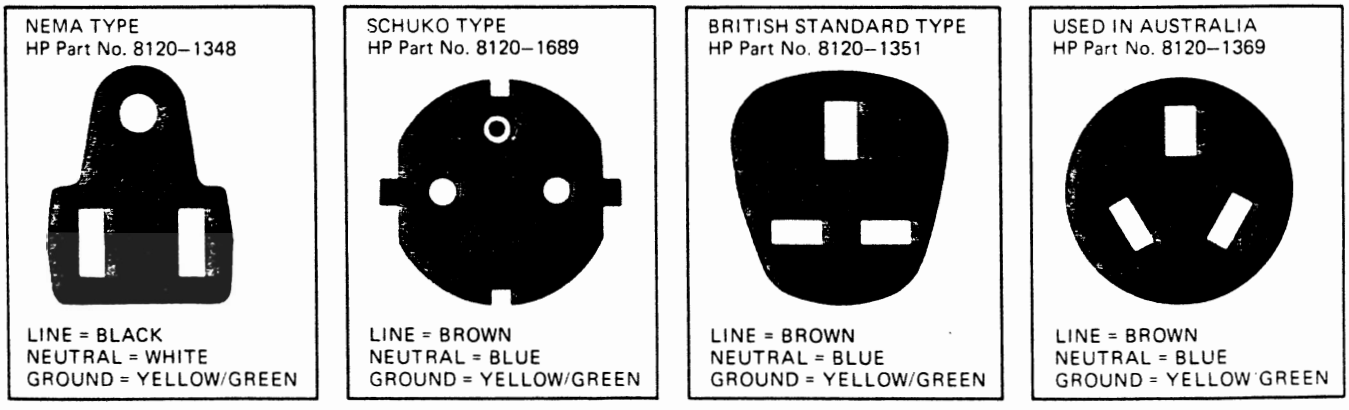


Figure 2–1. Power Cords

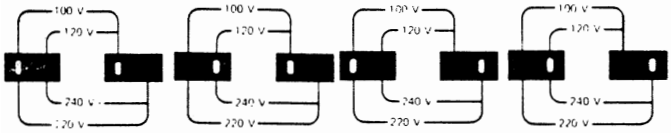
2–9 PREPARATION FOR USE

2–10 Power Cord

2–11 The 3-wire power cable supplied with the 8013B when connected to the appropriate power outlet, grounds the instrument cabinet and panels. To preserve this safety feature when operating the instrument from an outlet without a ground connection use an appropriate adapter and connect the ground lead (green/yellow) to an external ground.

2–12 POWER SOURCE REQUIREMENTS

2–13 The model 8013B will operate from nominal ac line supplies of 100V, 120V, 220V or 240V (–10%, +5%) at 48 Hz to 400 Hz. Two switches on the rear panel allow one of the four voltages to be selected.



100 volts 120 volts 220 volts 240 volts

Figure 2-2. Selector settings for the nominal power line voltages

The power dissipation is 100VA max.

CAUTION

Before applying power to the instrument, check on the rear panel that the 8013B is set in accordance with local supply conditions (see para 2–13). If not, use a screwdriver to change the voltage selector positions. Insert the correct fuse into the fuse holder: 1A for 100/120 V Operation; 0.5A for 220/240 V Operation.

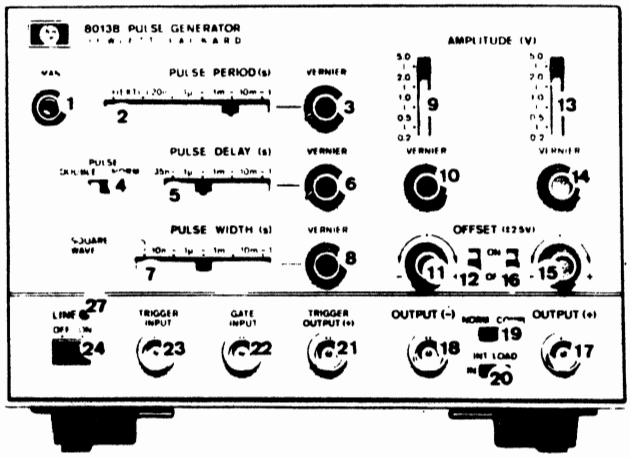
2–14 Connect the power cable to the rear connector.

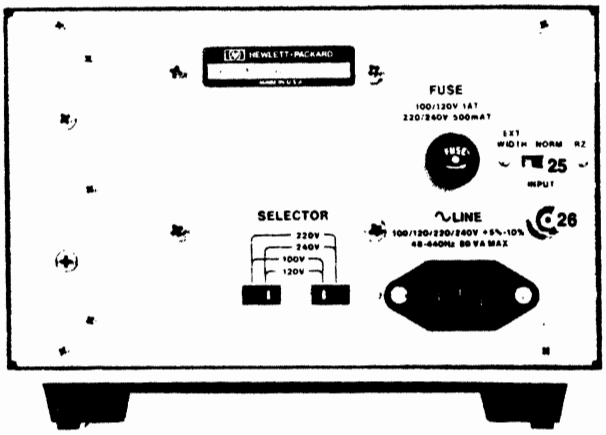
2–15 TEMPERATURE REQUIREMENTS

2–16 The 8013B will operate within specifications when the ambient temperature is between 0°C (32°F) and 55°C (131°F). It can be stored at temperatures between –40°C (–40°F) and 75°C (167°C).

2–17 RACK MOUNTING

2–18 The 8013B can be mounted in a rack using the 15179A Adapter Frame. This frame has space for mounting either one or two 8013B pulse generators alongside each other in a rack.





(1) MAN pushbutton: push to generate single pulses when the RATE switch is set to EXT(+) or EXT(−).

(2) RATE switch: for selecting the range of pulse rate.

(3) Rate VERNIER: for continuous adjustment of the repetition rate within the range selected on the RATE switch. Clockwise rotation increases the pulse period (i.e. reduced the rate). In the RZ and EXT WIDTH modes the RATE controls define the frequency of trigger output pulses only.

(4) PULSE DOUBLE/NORMAL switch: in the DOUBLE PULSE position the 8013B delivers two pulses for every trigger pulse – one pulse in phase with the trigger output and one delayed by the amount set on the PULSE DELAY controls. DOUBLE PULSE is not available in the EXT WIDTH mode and is automatically inhibited if selected. In the NORMAL position, for each trigger pulse, the 8013B delivers, from each output, one pulse which is delayed on the trigger pulse by the amount set on the PULSE DELAY controls.

(5) PULSE DELAY switch: for selecting the range of pulse delay with respect to trigger in all modes except SQUARE and EXT WIDTH.

(6) Pulse delay VERNIER: for continuous adjustment of pulse delay within the range selected on the PULSE DELAY switch. Clockwise rotation increases the delay.

(7) PULSE WIDTH switch: for selecting the range of the pulse width required in all modes except SQUARE and EXT WIDTH.

(8) Pulse width VERNIER: for continuous adjustment of pulse width within the range set on the PULSE WIDTH switch.

(9) AMPLITUDE (V) switch: for selecting range of negative (−) output pulse voltage.

(10) AMPLTIUDE VERNIER: for continuous adjustment of negative (−) output voltage within the range selected on the AMPLITUDE switch. Clockwise roation increases the output amplitude.

(11) OFFSET (V) vernier: for adjustment of baseline of pulse OUTPUT (−) over the range of +2.5V to −2.5V.

(12) OFFSET (V) switch: for enabling/disabling the offset VERNIER (−). In the OFF position, the baseline of the pulse OUTPUT (−) is zero volts.

(13) AMPLITUDE (V) switch: for selecting range of positive (+) output pulse voltage.

(14) AMPLITUDE VERNIER: for continuous adjustment of positive (+) output voltage within the range selected on the AMPLITUDE switch. Clockwise rotation increases the output amplitude.

(15) OFFSET (V) vernier: for adjustment of baseline of pulse OUTPUT (+) over the range of +2.5V to −2.5V.

(16) OFFSET (V) switch: for enabling/disabling the offset VERNIER (+). In the OFF position, the baseline of the pulse OUTPUT (+) is zero volts.

(17) OUTPUT (+) connector: BNC connector.

(18) OUTPUT (−) connector: BNC connector.

(19) NORM/COMPL switch: NORM/COMPL reverses the duty cycle of the output; what was the normal output becomes the complement and vice versa.

(20) INT LOAD switch: switches the internal 50 ohm load either IN or OUT. With load OUT, max. amplitude is doubled to 10V.

(21) TRIGGER OUTPUT connector: BNC connector supplies positive trigger output. Trigger output is not related to the input in EXT WIDTH and RZ modes.

(22) GATE INPUT connector: BNC connector to which gate pulses are applied. The pulse output and trigger output are synchronous to the gate signal.

(23) TRIGGER INPUT connector: BNC connector to which trigger pulses are applied when the RATE switch is set to EXT(−) or EXT(+)

(24) LINE ON-OFF switch: press-for-on-press-for-off switch.

(25) EXT WIDTH, NORM, RZ switch: NORM position enables synchronous pulse and trigger output. With rate switch set to EXT+ and this switch set to RZ (delay trigger) or EXT WIDTH (width trigger) the trigger output is asynchronous to signals applied to the INPUT connector

(26) INPUT connector: BNC connector to which RZ or EXT WIDTH trigger pulses are applied. Input disabled when rate switch is set to an internal range.

(27) LINE lamp: glows when LINE ON/OFF switch is ON.

Figure 3–1. 8013B Front and rear panels – Control identification diagram

3–1 GENERAL

3–2 This section gives some general notes on the operation of the 8013B together with operating instructions for each of the operating modes:

NORM operating mode
RZ operating mode
EXT WIDTH operating mode

Full setting up instructions are given for normal internal trigger mode followed by any changes required in the control settings for the following modes. For ease of operation the instructions will refer to Figure 3–1 which shows the controls identified by a reference number in a circle. The same reference numbers are used in the text when each control is mentioned. The control settings shown in Figure 3–1 are the same as the initial settings given for normal internal trigger mode.

3–3 OUTPUT FORMATS

3–4 The 8013B has two pulse outputs: one with positive (17) and one with negative (18) output polarity. The normal/complement output formats can be changed using the NORM/COMPL switch (19) Thus logic convention can be changed without having to re-adjust any of the pulse parameters.

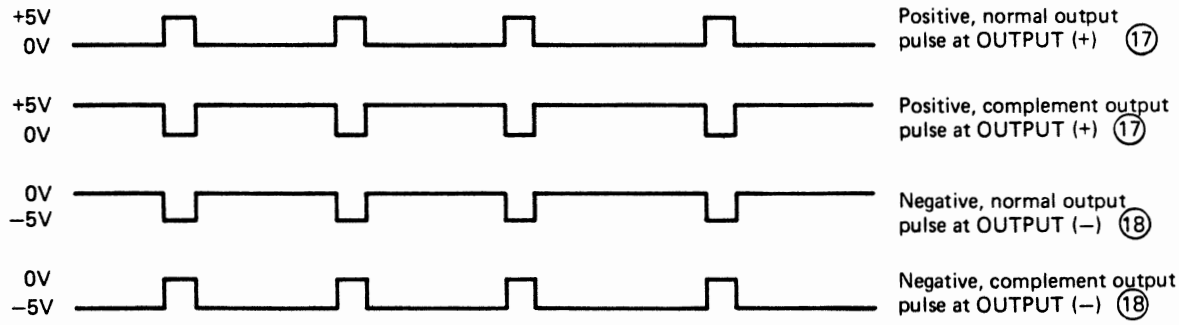


Figure 3–2. Normal/Complement Outputs

3–5 Normal/Complement pulse switching can be used to provide duty cycles of up to 100%.

3–6 INTERNAL 50 OHM LOAD

3–7 The internal 50 ohm load of the 8013B can be switched in or out using the INT LOAD switch (20) . This makes impedance matching to the circuit under test much easier and also provides a maximum pulse amplitude of ± 10V with the load switched out. Note, however, that the DC offset is automatically switched off when the INT LOAD is switched out.

3–8 CONTROL LAYOUT

3–9 The front panel of the 8013B has been carefully designed to provide a logical layout of the controls; horizontal controls for pulse timing parameters, vertical controls for pulse amplitude parameters. Thus a particular pulse can be set up extremely easily and quickly. Also, the pulse period, delay and width controls are designed in such a way that incompatible pulse settings will be noticed immediately (see Figure 3–3).

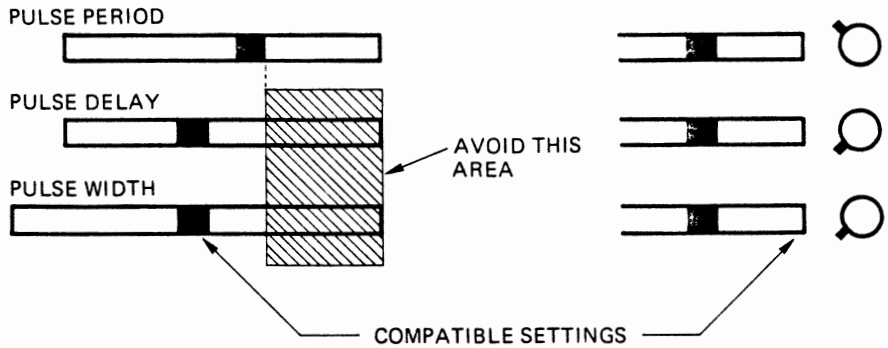


Figure 3–3. Positioning of Controls

3–10 Compatible pulse settings are guaranteed as long as the pulse delay and pulse width controls are either set to the left of the pulse period control or; if set vertically below the period control, that the delay and width verniers are set counter clockwise of the period vernier.

3–11 NORM OPERATING MODE

3–12 There are six ways of operating in the normal mode:

Internal trigger – the repetition rate is determined by the internal rate generator which is internally triggered.

External trigger – the rate generator is disabled and an external signal is used as the trigger source.

Manual trigger – one pulse is produced each time the MAN button is pressed.

Square wave – in each of the above modes a square wave output can be selected (pulse width = pulse period / 2) instead of the variable pulse width output.

Gating – Each of the outputs obtained above (except square wave) can be gated using an external input.

Double pulse – this mode can be selected with any of the above outputs(except square wave). Two pulses are produced for each trigger pulse.

All output pulses are preceded by a trigger pulse at the TRIGGER output connector (21) . In square wave mode the delay between the trigger output and the pulse outputs is fixed at 25 ± 8ns, but in other modes the delay can be varied using the PULSE DELAY (5) and VERNIER (6) controls.

3–13 Internal Trigger

3–14 In this mode the 8013B requires no external signal to produce an output signal. Rate, delay, width, amplitudes etc. are all adjustable from the front panel controls, The initial control settings (also shown in Figure 3–1) are given to assist someone unfamiliar with the operation of the 8013B. The positive and negative pulse outputs (17) and (18) and the TRIGGER OUTPUT (21) should be connected to an oscilloscope using a 50 ohm system (as shown in Figure 3–4). The oscilloscope (an HP 180C mainframe with 1801A and 1821A plug-ins) should be set with the sweep time at 20μs/div and the sensitivity at 2V/div.

PULSE PERIOD (2)	.1m–10m
VERNIER (3)	CCW
PULSE DOUBLE/NORM (4)	NORM
PULSE DELAY (5)	1μ–.1m
VERNIER (6)	CCW
PULSE WIDTH (7)	1μ–.1m
VERNIER (8)	Center
AMPLITUDE (9)	2.0–5.0
VERNIER (10)	CW
OFFSET VERNIER (11)	Center
OFFSET SWITCH (12)	ON
AMPLITUDE (13)	2.0–5.0
VERNIER (14)	CW
OFFSET VERNIER (15)	Center
OFFSET SWITCH (16)	ON
NORM/COMPL (19)	NORM
INT LOAD (20)	IN
Mode selector (25)	NORM
LINE (24)	ON

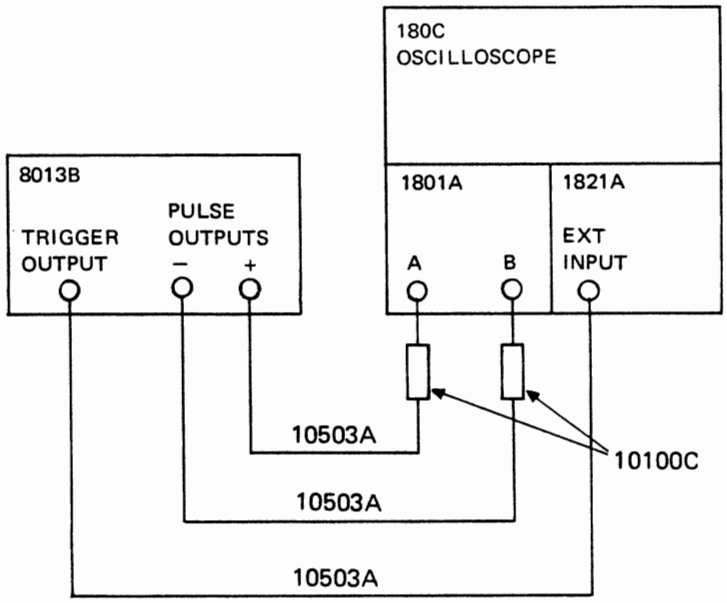


Figure 3–4. Initial control settings and test equipment

3–15 The circuits and controls involved in normal internal trigger mode are shown in Figure 3–5.

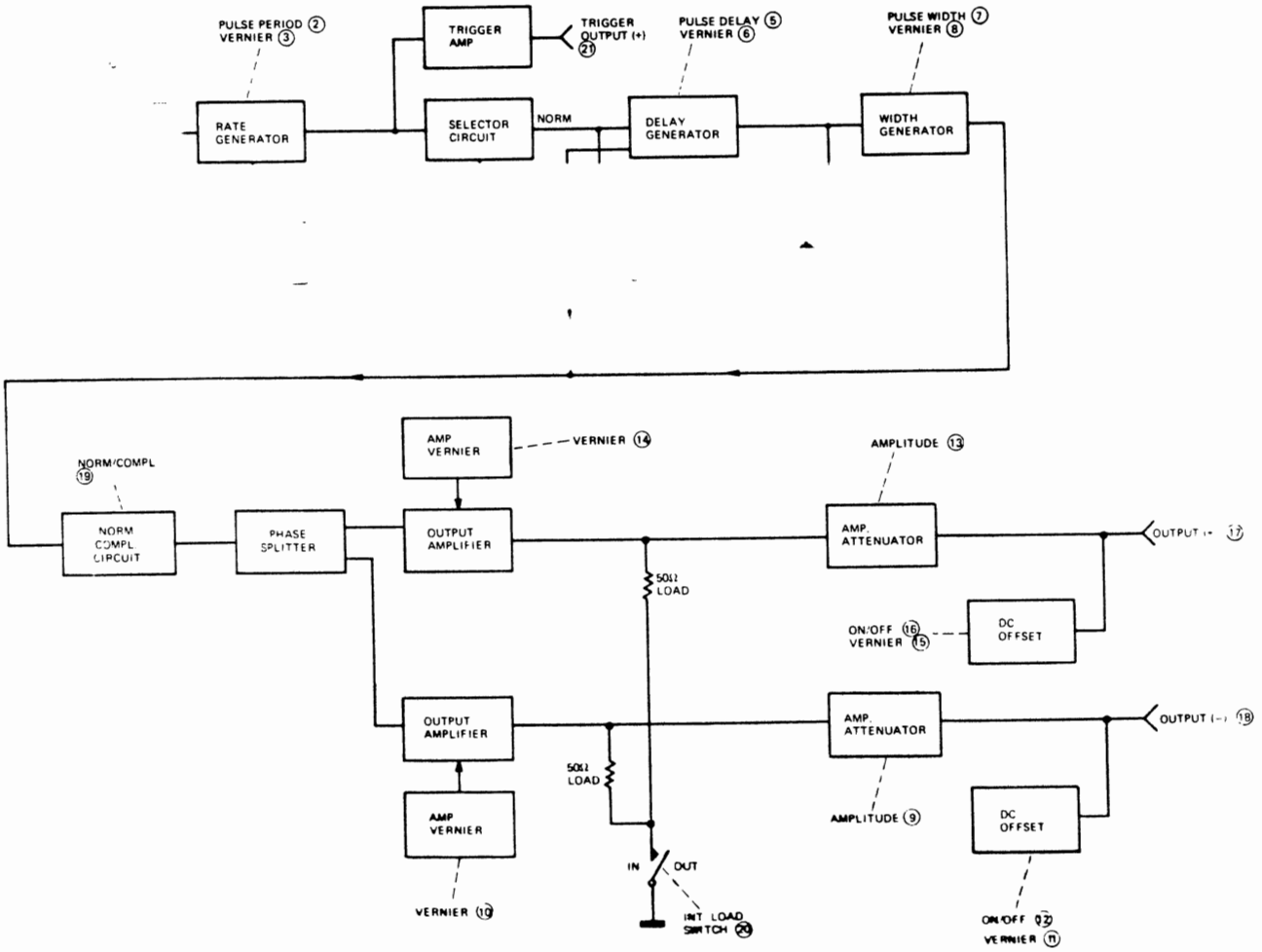


Figure 3–5. Normal internal trigger mode – block diagram

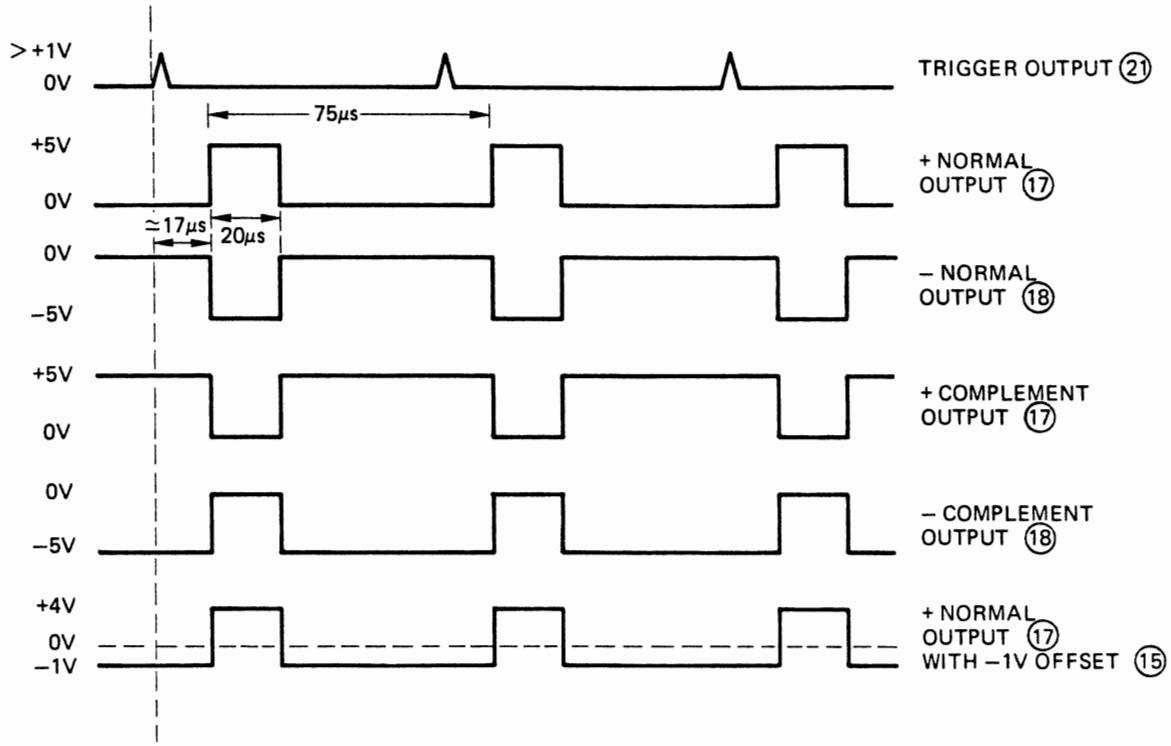


Figure 3–6. Output pulses in normal internal trigger mode

3–16 The output pulses should appear at the pulse OUTPUT (+) (17) and pulse OUTPUT (–) (18) as shown in Figure 3–6 according to the setting of the NORM/COMPL switch (19) and the OFFSET verniers (11) and (15)

3–17 If the INT LOAD switch (20) is set to OUT, the internal 50 ohm loads on each of the output amplifiers are switched out and the amplitude of the output pulses doubles (this can only be done if the 8013B has an external 50 ohm load). All other pulse parameters remain the same.

3–18 External Trigger

3–19 In this mode the repetition rate generator is disabled and each trigger pulse is produced by an external signal which is applied at the TRIGGER INPUT connector (23) . The input signal can be a sinewave of > 1.7V p-p (about zero) or pulses > 0.8V amplitude (positive or negative) and at least 7ns wide. The amplitude must not exceed ± 7V.

a. Set the PULSE PERIOD control (2) to EXT (+) to trigger on the positive going slope of the input or to EXT(–) to trigger on the negative going slope.

b. The pulse delay, width , amplitude, etc. are determined by the front panel controls and can be left at the same settings as for normal internal trigger mode.

3–20 The circuits and controls involved in normal external trigger mode are shown in Figure 3–7.

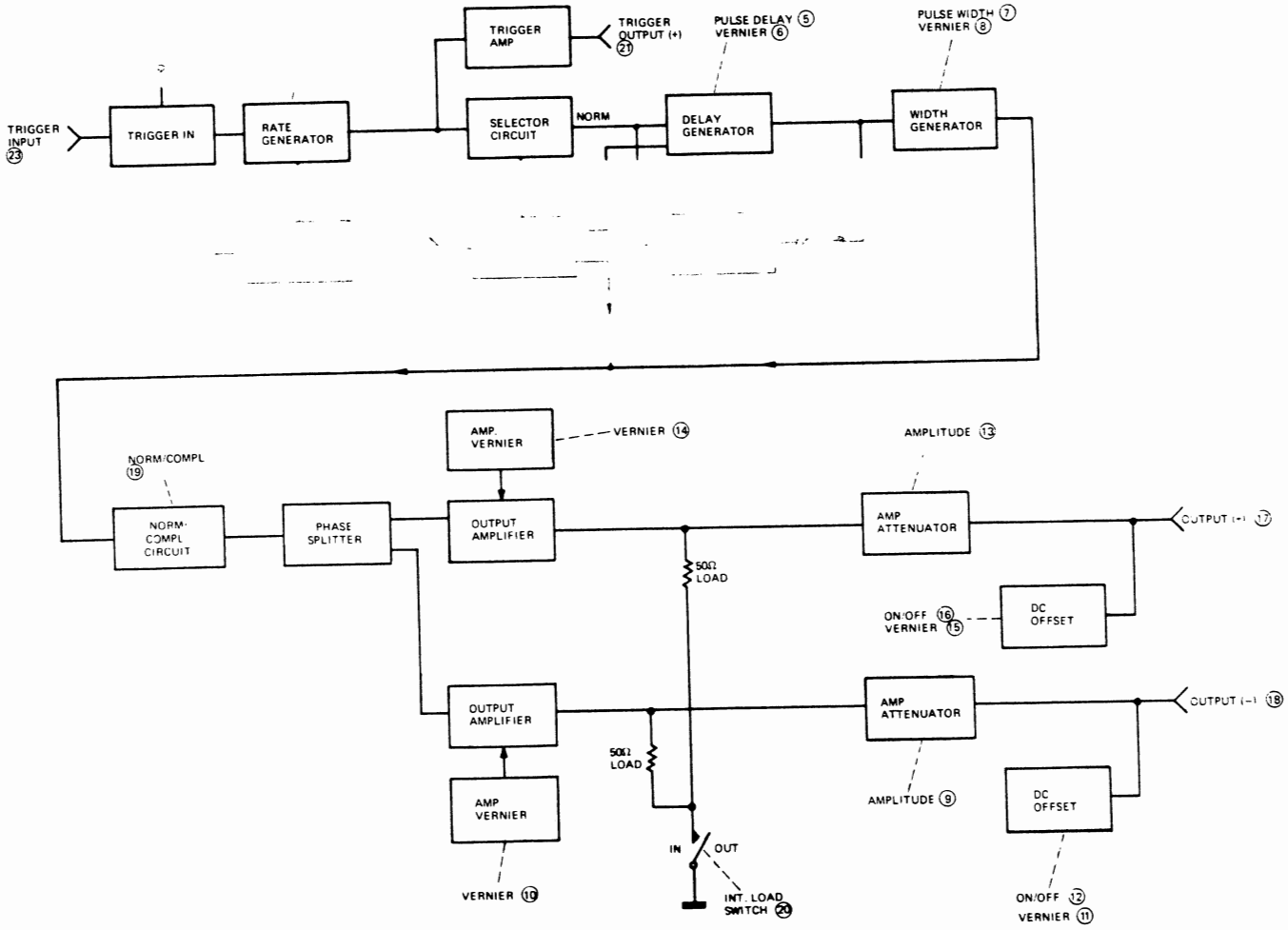


Figure 3–7. Normal external trigger mode – Block diagram

3–21 The output pulses should appear at the TRIGGER OUTPUT (21) and OUTPUT (+) (17) connectors as shown in Figure 3–8, according to the applied trigger and the setting of the PULSE PERIOD control (2) (either EXT+ or EXT–).

3–22 The output pulse parameters and formats can be varied using the controls shown in Figure 3–7.

3–23 Manual Trigger

3–24 In this mode the repetition rate generator is again disabled and each trigger pulse is produced by pressing the MAN button (1) once.

a. Set the PULSE PERIOD control (2) to either EXT(+) or EXT(–).

b. The pulse delay, width, amplitude etc. are determined by the front panel controls and can be left at the same settings as for normal internal trigger mode.

c. Press the MAN button (1) **once** for each output pulse.

3–25 The circuits and controls involved in normal manual trigger operation are shown in Figure 3–9.

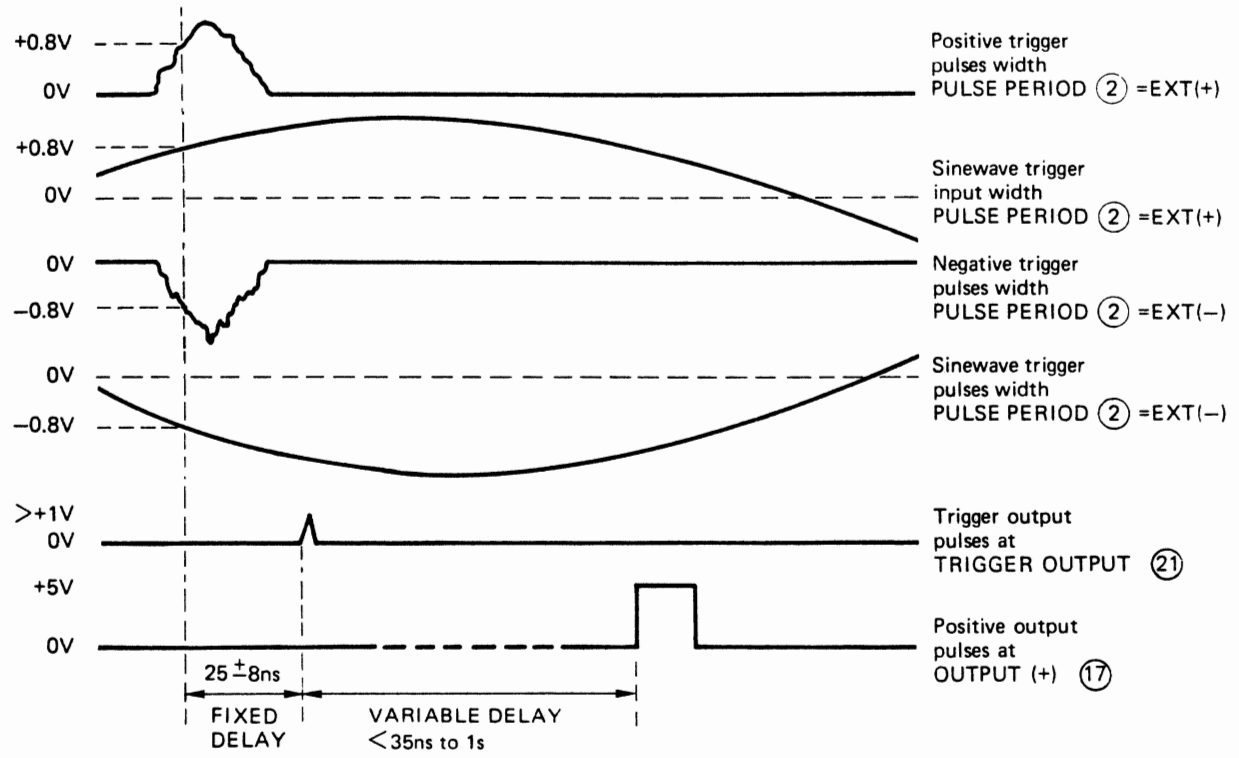


Figure 3–8. Output pulses in normal external trigger mode

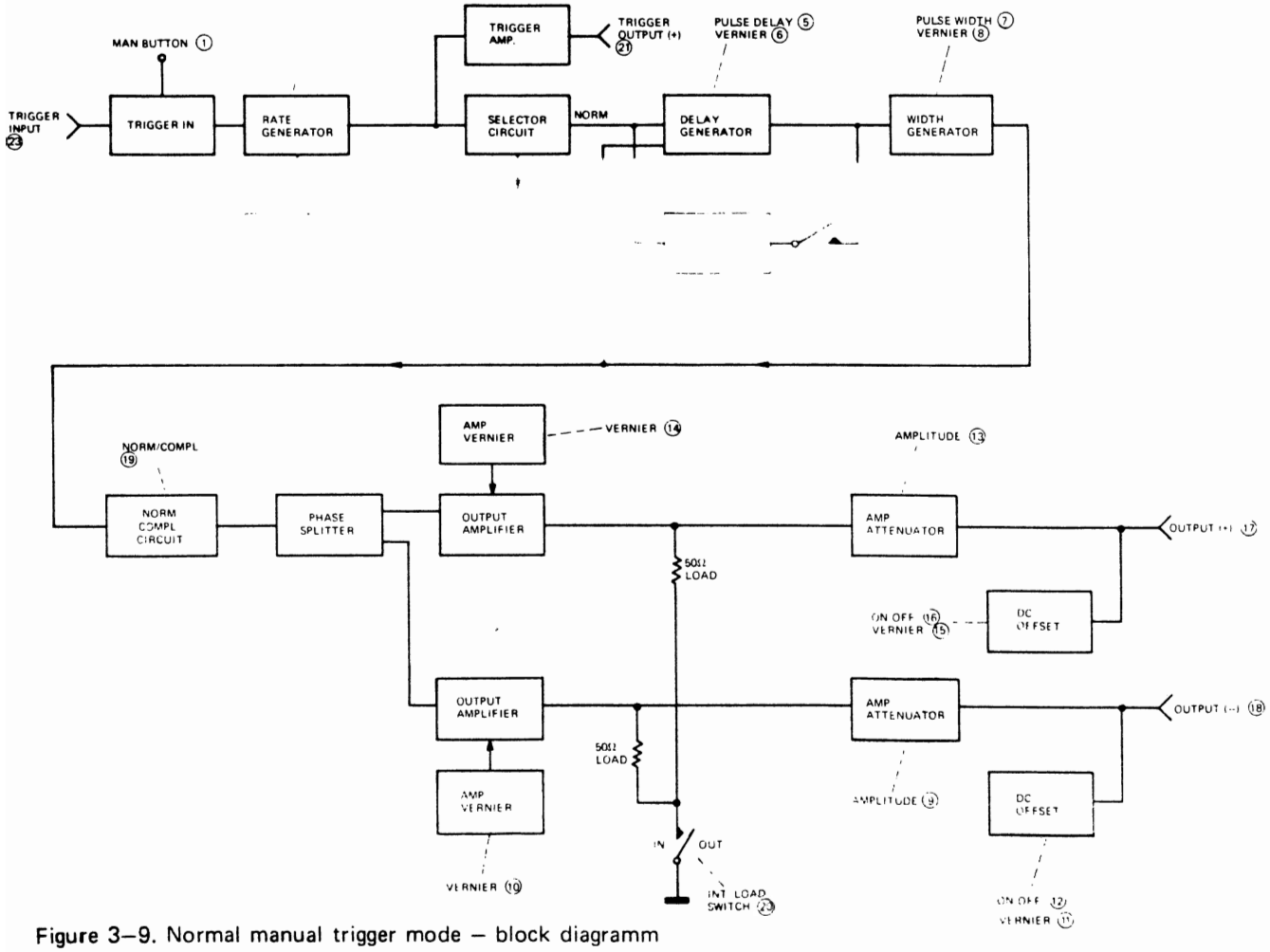


Figure 3–9. Normal manual trigger mode – block diagramm

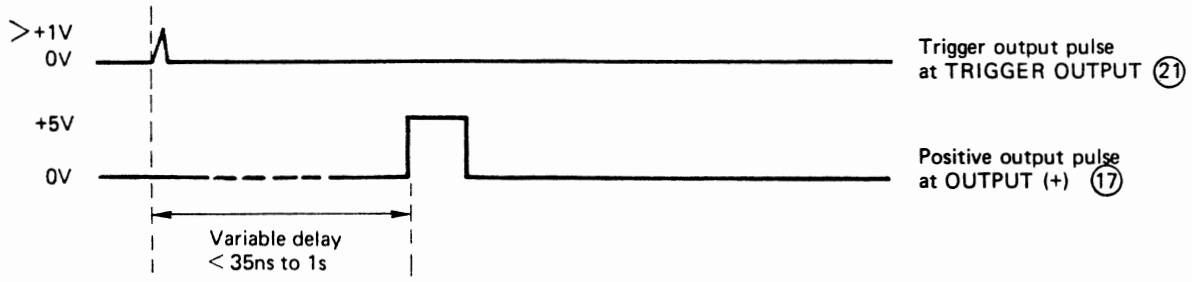


Figure 3–10. Output pulses in normal manual trigger mode

3–26 The output pulses should appear at the TRIGGER OUTPUT (21) and OUTPUT (+) (17) connectors as shown in Figure 3–10.

3–27 The output pulse parameters and formats can be varied using the controls shown in Figure 3–9.

3–28 Square Wave Mode

3–29 In this mode the pulse width is exactly half the pulse period (50% duty cycle). Pulse period, delay amplitude etc. can still be varied using the front panel controls. A square wave output can be selected in any of the preceding operating modes; the following points must, however, be remembered.

a. Output pulse has 50% duty cycle.

b. Output pulse rate is half that of the rate generator (or input trigger pulse).

c. The delay between input trigger pulse and square wave output is fixed.

d. The output pulse is symmetrical above and below the offset level.

e. Square wave output cannot be gated.

3–30 The square wave output can be produced as follows:

a. Set the PULSE PERIOD control (2) to an internal range (as in normal internal trigger mode) or to EXT and apply external trigger pulses at the TRIGGER INPUT connector (23) in order to determine the repetition rate of the output pulses.

b. Set the PULSE WIDTH control (7) to SQUARE WAVE.

c. Set the amplitude etc. of the output pulses as for normal internal trigger mode.

3–31 The circuits and controls involved in square wave mode are shown in Figure 3–11.

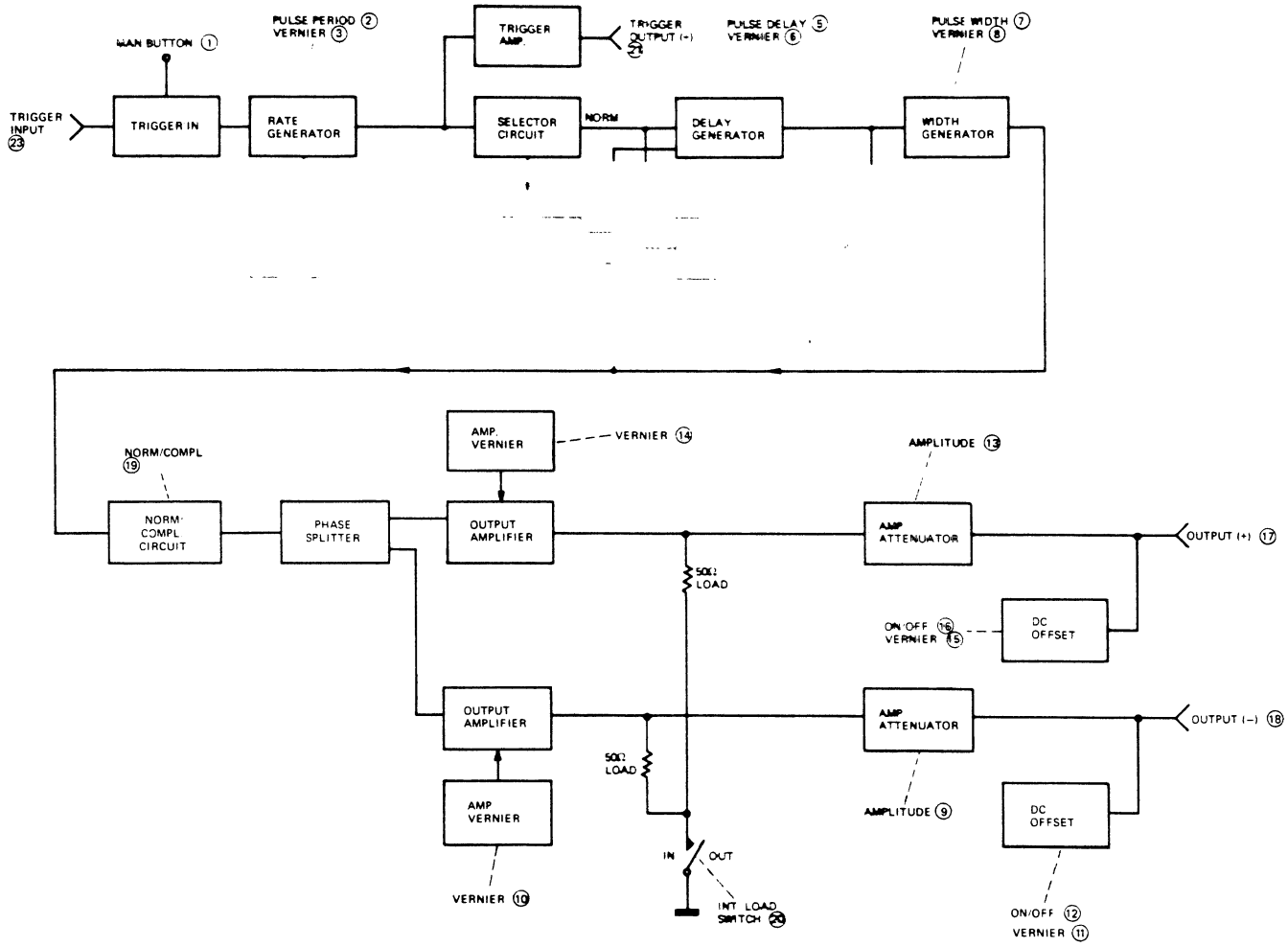


Figure 3–11. Normal square wave mode – block diagram

3–32 The output pulses should appear at the OUTPUT (+) connector (17) as shown in figure 3–12.

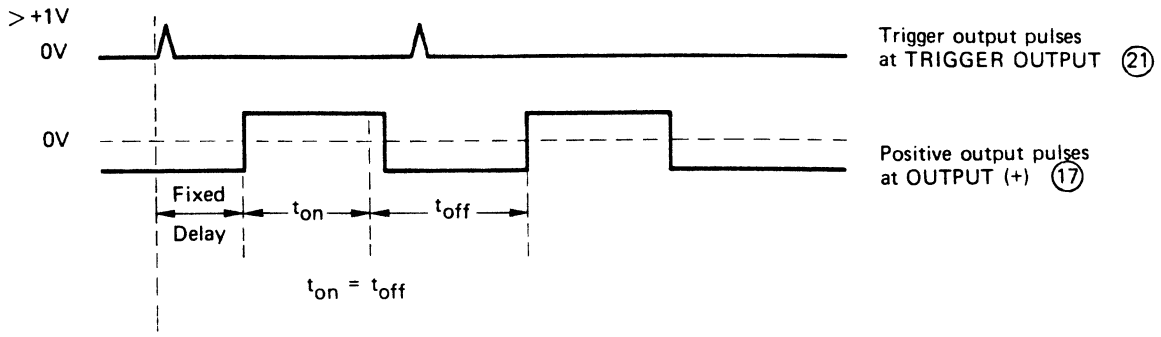


Figure 3–12. Output pulses in square wave mode

3–33 The output pulse can be switched to negative or normal or complement and the offset and amplitude can be varied.

3–34 Gating Mode

3–35 The output pulses obtained in any of the preceding operating modes can be gated by applying an appropriate pulse to the GATE INPUT (22) . If square wave mode is gated, the level of the pulse baseline after the gate has closed depends on the number of pulses during the gate 'on' time (see figure 3–15). The gate input must meet the following requirements:

to enable the rate generator – input voltage > +1.5V or resistor > 1KΩ from gate input to ground.

to disable the rate generator – input voltage < +0.8V or resistor < 160Ω from gate input to ground.

The gate input is TTL compatible and the input voltage must not exceed ± 5V.

3–36 The circuits and controls involved in gate mode are shown in Figure 3–13.

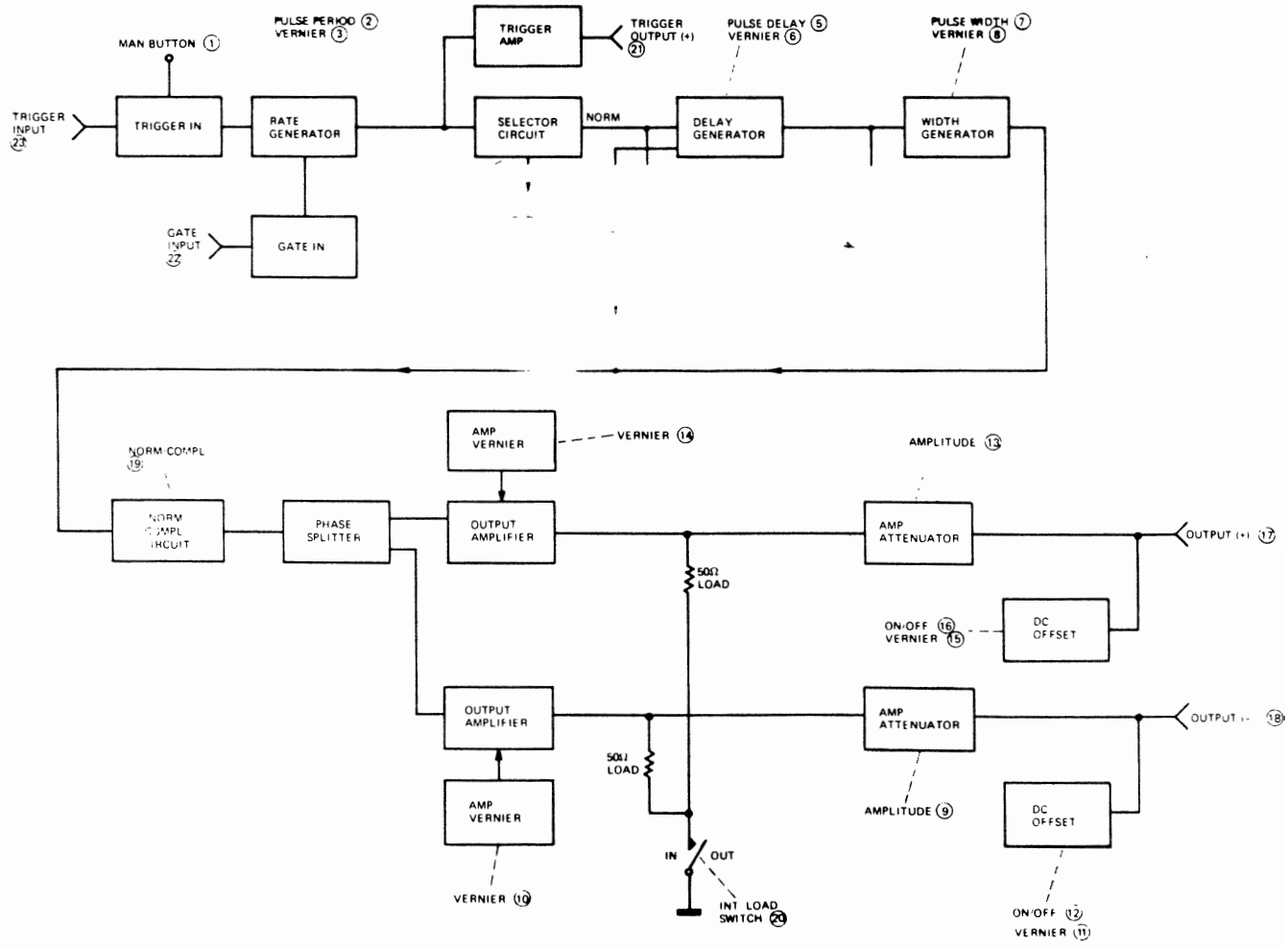


Figure 3–13. Normal gate mode – block diagram

3–37 The output pulses should appear at the TRIGGER OUTPUT (21) and OUTPUT (+) (17) connectors as shown in Figure 3–14.

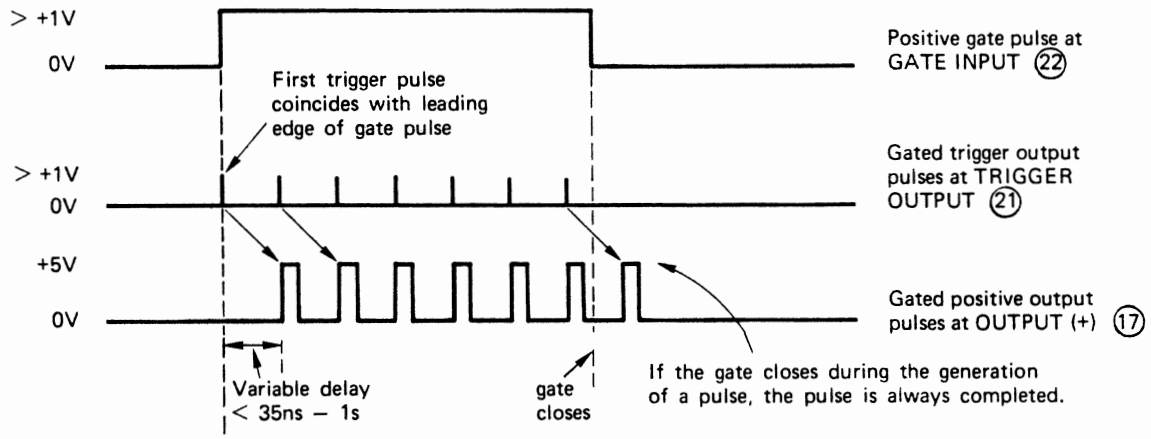
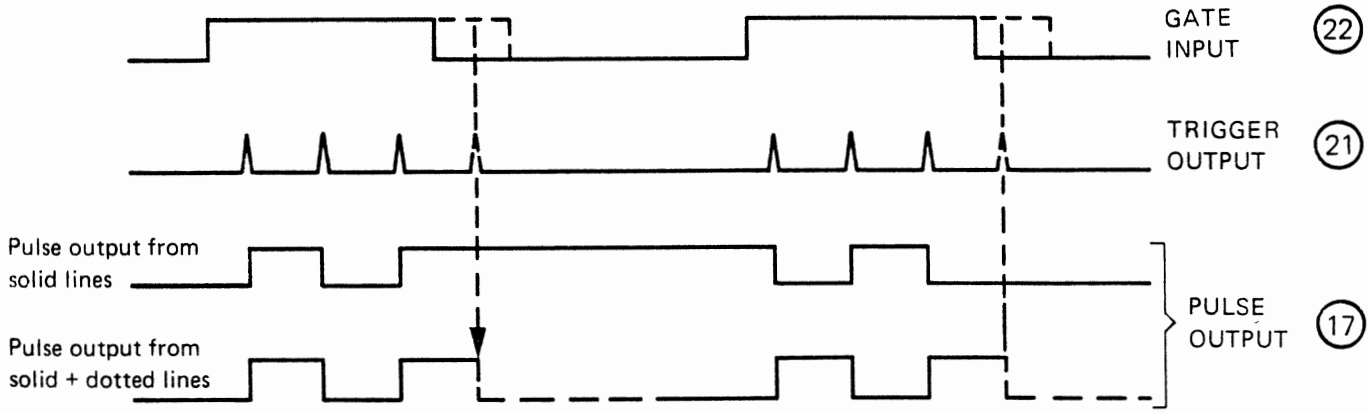


Figure 3–14. Output pulses in gate mode



Note that repetition rate is divided by 2.

Figure 3–15. Gated output in square wave mode

3–38 RZ MODE

3–39 In RZ mode external pulses, applied to the INPUT connector (26) on the 8013B rear panel, trigger the delay generator directly (see figure 3–16) and the shape of the output pulses is determined by the output amplifiers. The output pulses cannot be gated and are independent of the pulses at the TRIGGER OUTPUT connector (21).

3–40 The circuits and controls involved in RZ mode are shown in figure 3–16.

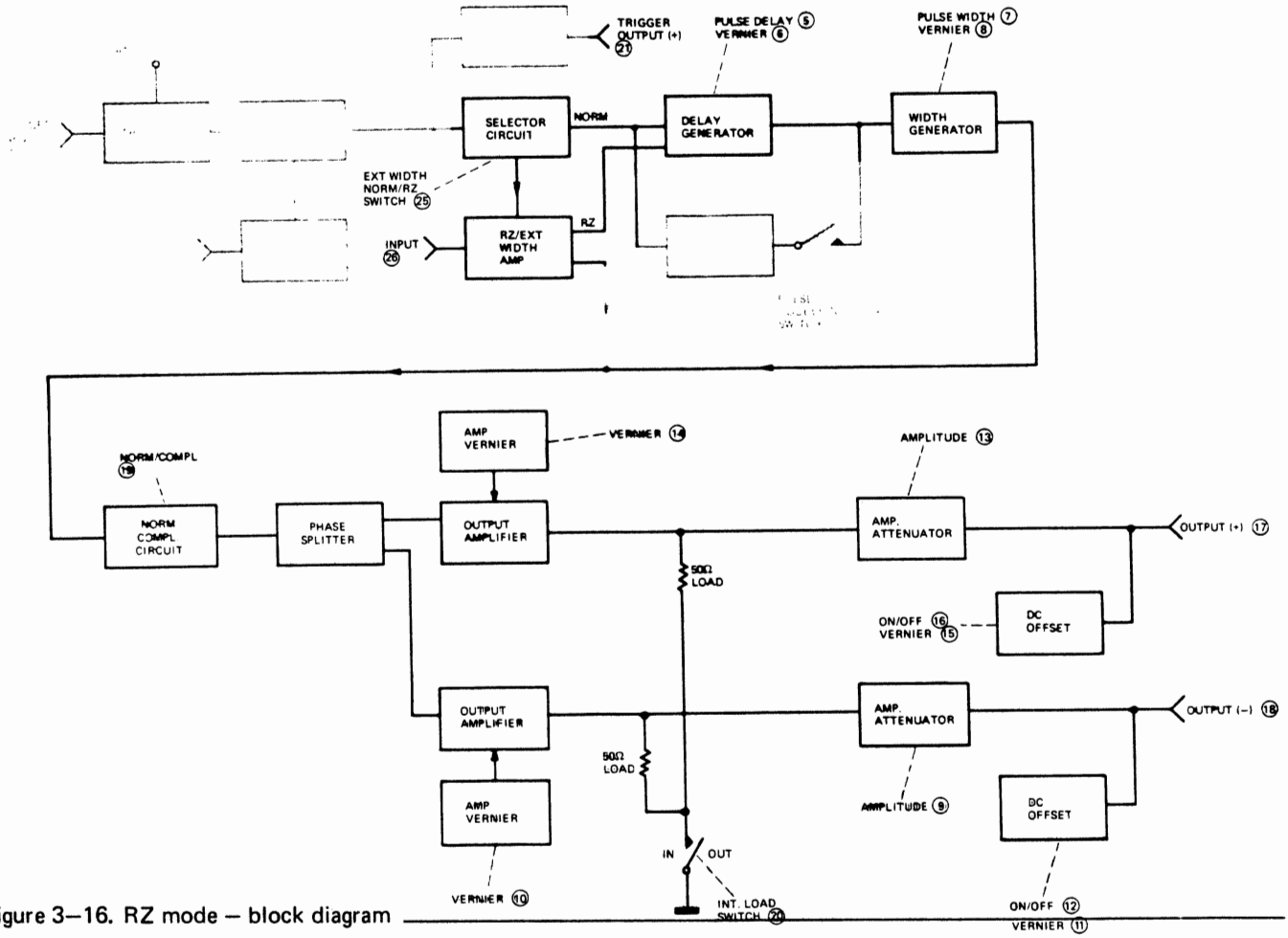


Figure 3–16. RZ mode – block diagram

3–41 The RZ input signal must be > +1V to a maximum of ± 5V in amplitude and must be at least 7ns wide.

3–42 The procedure for obtaining an output in RZ mode is as follows:

a. Connect the external signal to the INPUT connector (26) on the rear panel of the 8013B.

b. Set the Mode Selector switch (25) to RZ.

c. Set the pulse delay, width, amplitude, offset and output format as required.

3–43 The output pulses should appear at the OUTPUT (+) connector (17) as shown in Figure 3–17.

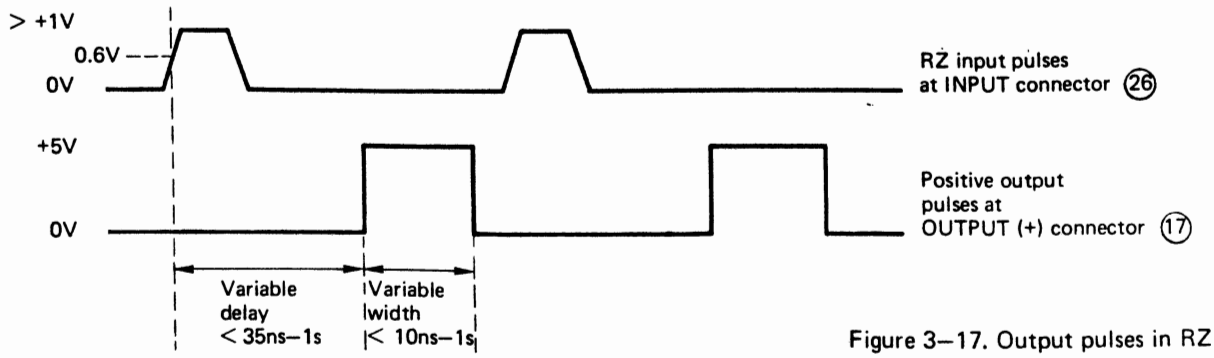


Figure 3–17. Output pulses in RZ mode

3–44 DOUBLE PULSE Mode

3–45 In this mode, the 8013B delivers two output pulses for each trigger pulse. One pulse is in phase with the TRIGGER OUTPUT (21) ; the other pulse is delayed by the time set on the PULSE DELAY controls (5) and (6).

3–46 Double pulse output can be selected in any of the preceding operating modes except square wave. Double pulse output is produced as follows:

a. Set the PULSE DOUBLE/NORM switch (4) to DOUBLE.

b. The remaining pulse parameters and output format can be set as required.

3–47 The circuits and controls involved in double pulse mode are shown in Figure 3–18.

3–48 The trigger and output pulses should appear at the TRIGGER OUTPUT (21) and OUTPUT (+) (17) connectors as shown in Figure 3–19.

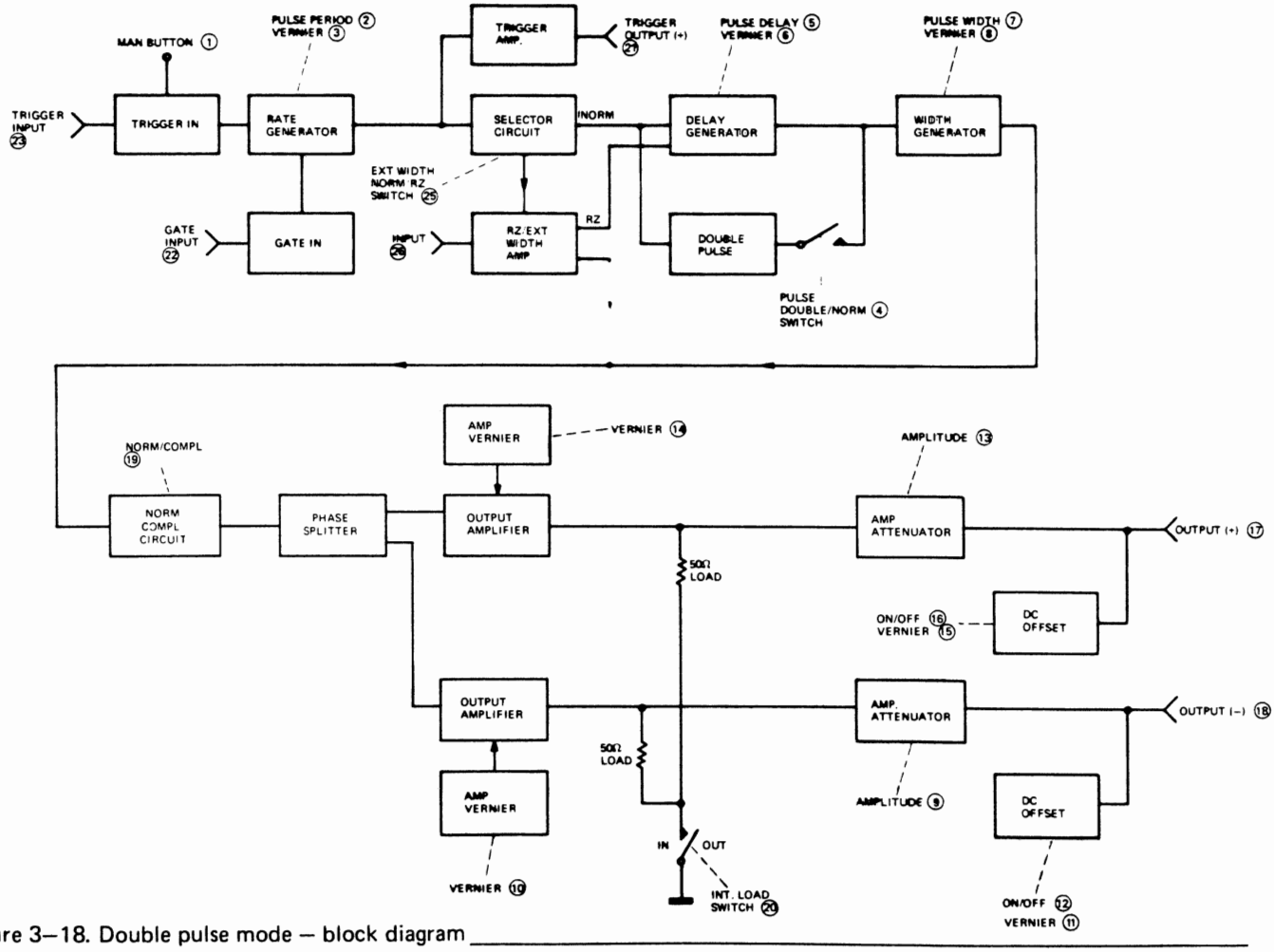


Figure 3–18. Double pulse mode – block diagram

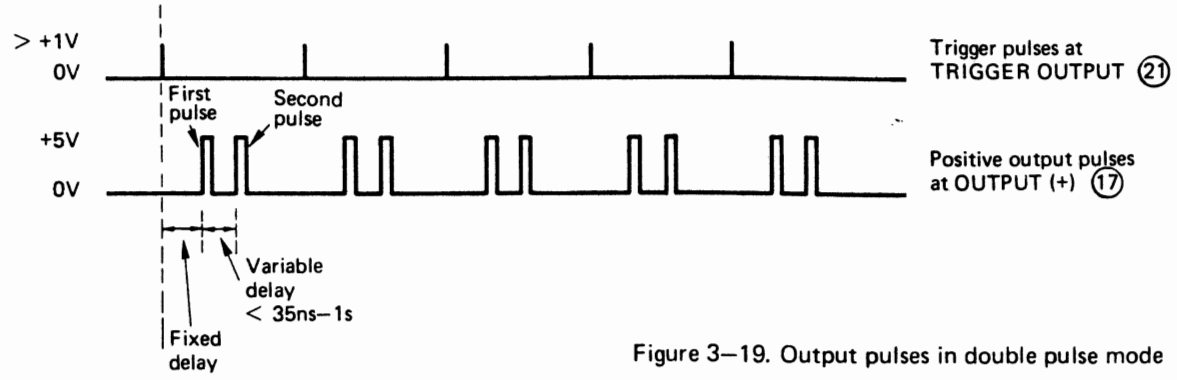


Figure 3–19. Output pulses in double pulse mode

3–49 EXTERNAL WIDTH MODE

3–50 In this mode, external pulses, applied to the INPUT connector (26) on the rear panel, are routed directly to the output amplifiers which are caused to change state at the threshold level of the input signal. Thus the pulse output is a shaped version of the input. It is also independent of the TRIGGER OUTPUT (21).

The external width input signal must be > +1V to a maximum of ± 5V in amplitude and must be at least 7ns wide.

3–51 The circuits and controls involved in external width mode are shown in Figure 3–20.

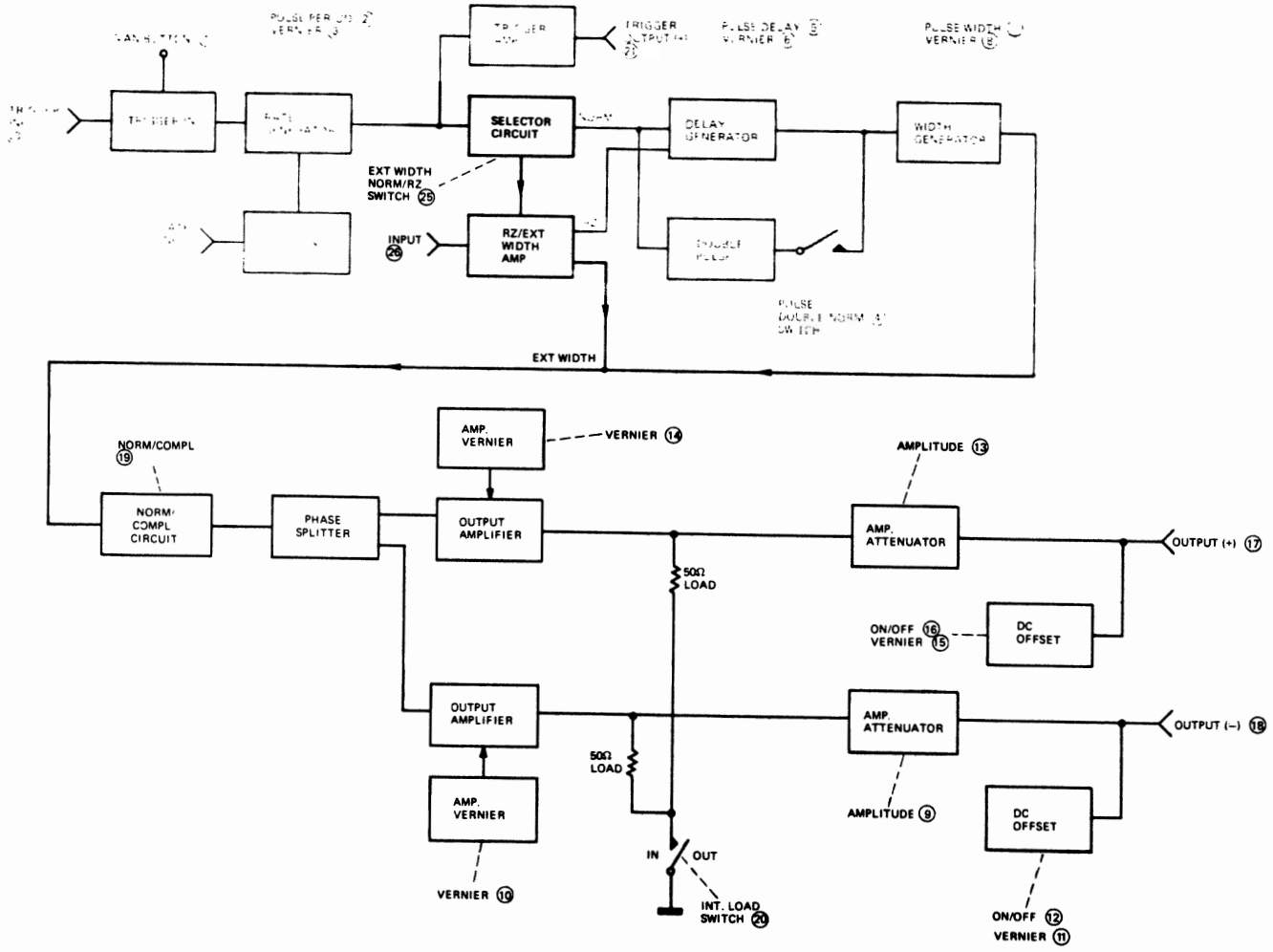


Figure 3–20. External Width mode – block diagram

3–52 The procedure for obtaining an output in external width mode is as follows:

a. Connect the external signal to the INPUT connector (26) on the rear panel of the 8013B.

b. Set the Mode Selector switch (25) to EXT WIDTH.

c. Set the pulse amplitude and output format as required.

3–53 The output pulses should appear at the OUTPUT (+) connector (17) as shown in Figure 3–21.

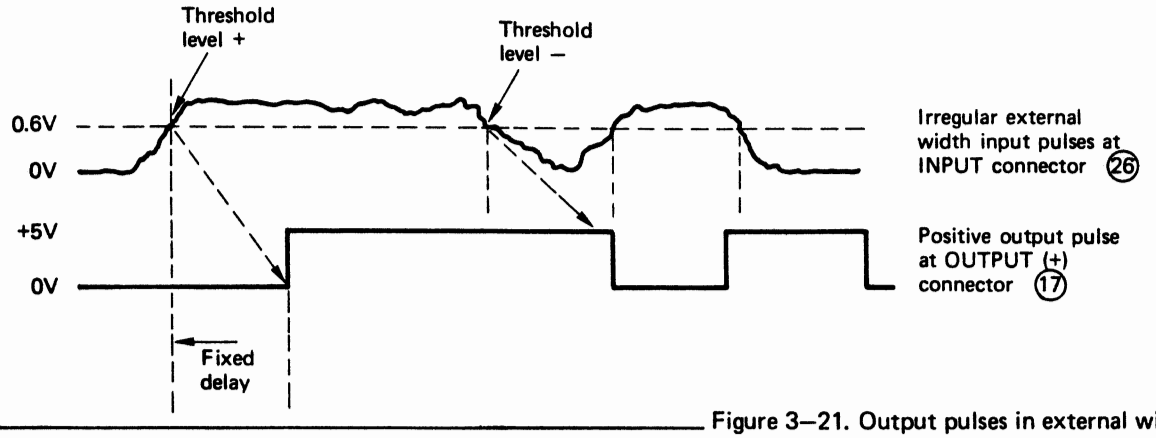


Figure 3–21. Output pulses in external width mode

3–54 ADDITIONAL FACILITIES IN RZ AND EXT WIDTH MODES

3–55 When operating in RZ or EXT WIDTH modes, the internal rate generator is available as an independent clock generator which provides an output at the TRIGGER OUTPUT connector (21) . This output can be triggered internally, externally or manually and can also be gated as in the normal operating mode. If this facility is not required, it can be switched off by setting the PULSE PERIOD control (2) to EXT and disconnecting the TRIGGER INPUT (23) . The circuits and controls involved in this facility are shown in Figure 3–22.

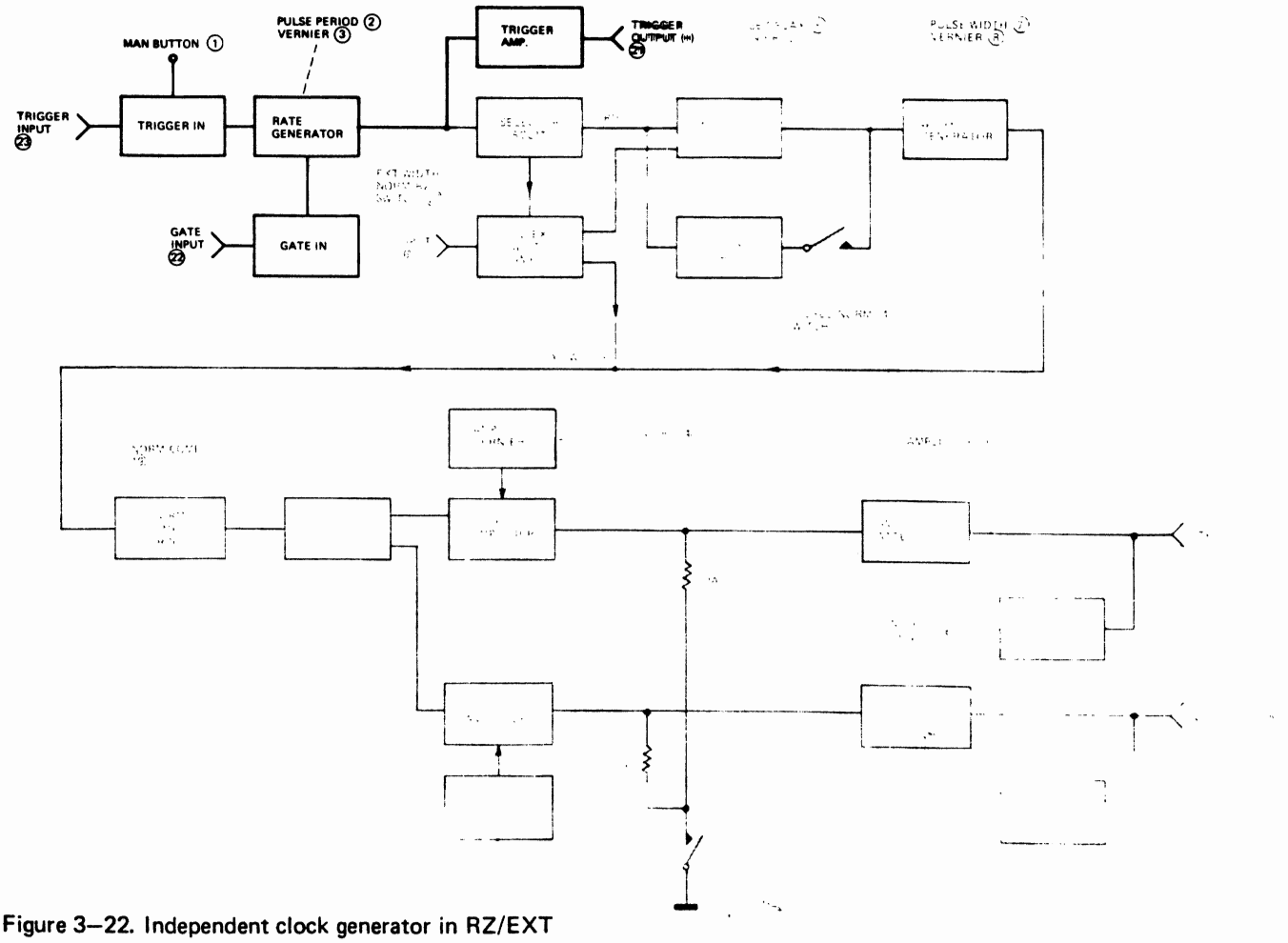


Figure 3–22. Independent clock generator in RZ/EXT WIDTH modes – block diagram

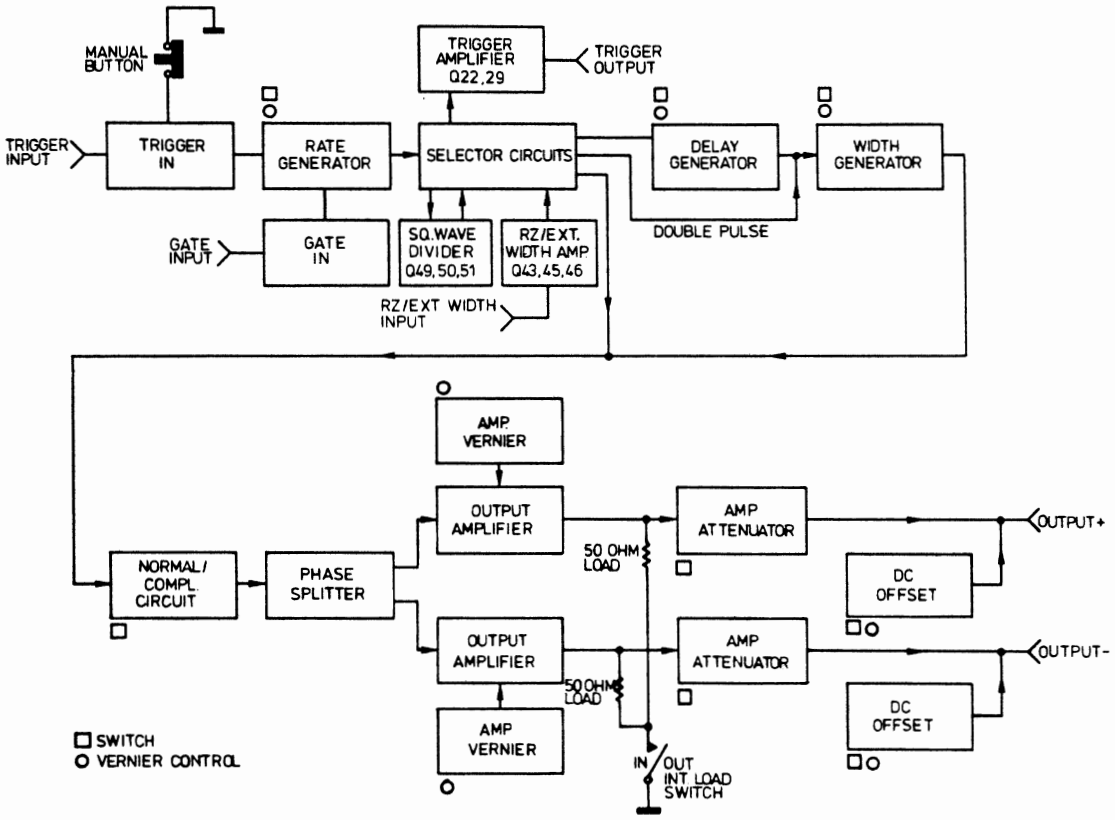


Figure 4–1. 8013B Pulse Generator – Block Diagram

4–1 INTRODUCTION

4–2 A basic block diagram of the 8013B is shown in Figure 4–1 and this diagram should be referred to when reading the following description. The pulse repetition rate is generated either internally by the rate generator, manually using a push-button, or externally by an applied signal. The pulses produced can be gated synchronously by applying an external gating signal to the gate input. The output of the rate generator is fed to the selector circuits and to the trigger amplifier to produce a trigger output.

4–3 The 8013B can be used in one of three modes of operation; Normal mode, RZ mode and External Width mode. In Normal mode the pulses are generated as described above; In RZ mode external signals, applied directly to the delay generator, determine the repetition rate of the output pulses; In External Width mode external signals, applied to the Normal/Complement circuit, determine the width and repetition rate of the output pulses. The mode switching is accomplished by the selector circuits.

4–4 The output of the selector circuits, in Normal and RZ modes is applied to the delay generator which delays the pulses by the amount set on the delay controls.

4–5 In double pulse mode two pulses are produced for each trigger pulse; the normal delayed pulse plus an extra pulse that by-passes the delay generator and is thus not delayed.

4–6 The pulse spikes from the delay generator are applied to the width generator where pulses of defined width are created.

4–7 The output of the width generator or, in External Width mode, the external input signal is applied to a pulse shaper where two complementary signals are generated. These two signals are then applied to the normal/complement circuit.

4–8 The signals are then applied to two variable gain output amplifiers and attenuators. Finally the variable DC offset is added.

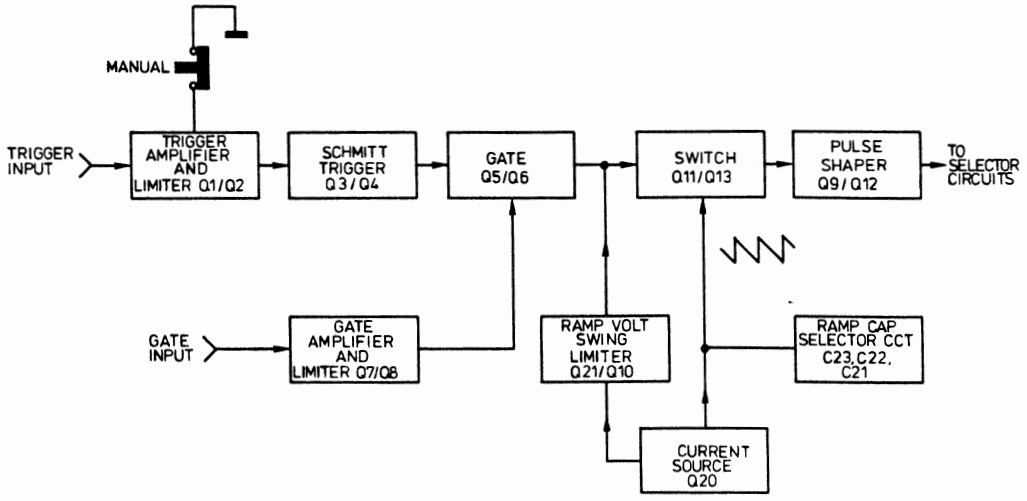


Figure 4–2. Repetition rate generator – block diagram

4–9 REPETITION RATE GENERATOR

4–10 A block diagram of the repetition rate generator is given in figure 4–2 and a full schematic in diagram 1. These diagrams should be referred to when reading the following description.

4–11 The pulse repetition rate is determined;

a. by the internal rate generator
b. externally using an applied signal
c. manually suing a pushbutton.

4–12 Internal Rate Generator

4–13 When the internal rate generator is used, one of four period ranges is selected using the period range switch. In the three slower ranges, ramp capacitors (C23, C22, C21) are selected to provide the required repetition rate, transistors Q17, Q18 and Q19 switch these capacitors in or out. In the fastest range, no ramp capacitor is switched in; the time is determined by preset capacitor C24. In operation the selected capacitor discharges through constant current sink Q20 controlled by the pulse period vernier R1 and the value of the capacitor.

As the voltage at Q20 collector approaches zero, CR17 becomes forward biassed causing Q11 and Q13 to conduct and rapidly recharge the capacitor. The pulse period vernier controls Q21 and Q10 which act as a voltage swing limiter and determine the upper voltage limit to which the ramp capacitor can recharge. When the capacitor has recharged to this limit, Q13 and Q11 cut off thus allowing the discharge cycle to resume. The output from Q11 is applied, via the differentiator network Q28/L3/R35, to the delay generator and the trigger output amplifier.

4–14 External Trigger Operation

4–15 In external trigger mode the rate generator is used as a pulse shaper. Trigger pulses are applied to the differential amplifier Q1/Q2 which in turn switches the Schmitt trigger formed by Q3/Q4. The negative output spikes from the collector of Q4 turn Q5 on and Q13 base rises so that Q13 and Q11 turn on to produce an output pulse.

4–16 Manual Operation

4–17 When the Manual pushbutton is pressed, a negative spike is produced at the collector of Q4 which enables the current switch Q11/Q13. One pulse is produced from Q11 each time the Manual pushbutton is pressed.

4–18 GATING

4–19 Gate signals are applied to the gate amplifier Q8/Q7. Q8, normally 'off' is turned on by the 0V level (off time) of the gate input pulse. Thus Q6 is turned on, the current through Q6 lowers the base voltage of Q13 and so disables the rate generator. When the level of the gate input pulse reaches +1.8V (on time) Q8 turns on and enables the pulse source. Thus output pulses will be produced from the rate generator only during the gate input pulse 'on' time.

4–20 SELECTOR CIRCUITS

4–21 A block diagram of the selector circuits is given in figure 4–3 and is repeated for each mode of operation showing the signal paths used. Figure 4–1, 4–3 and the schematic diagram 2 should be referred to when reading the following description.

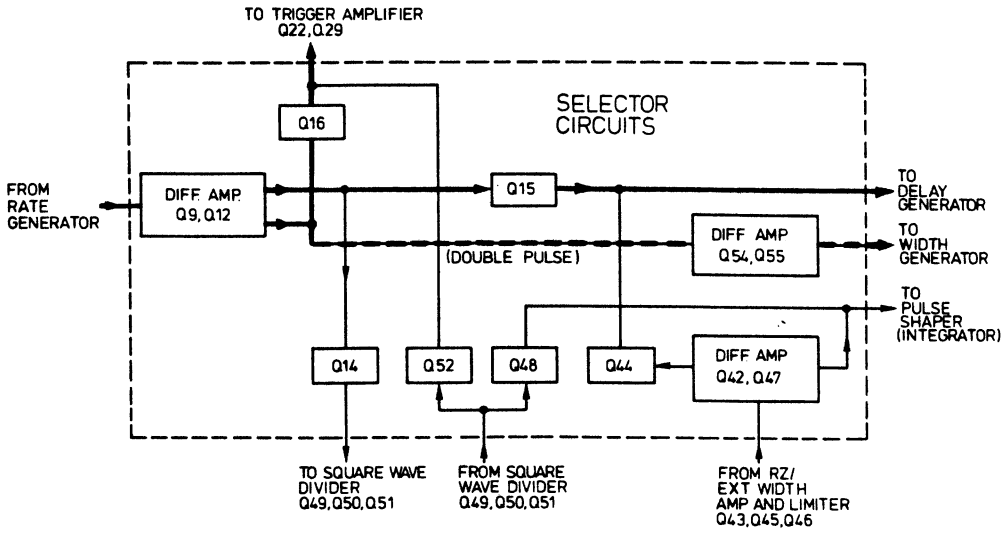


Figure 4–3a. Normal mode (including external trigger and rate mode).

4–22 In Normal mode, the rate generator output is applied to the delay generator via Q15 and to the trigger amplifier via Q16. If double pulse mode is selected, the pulse is also applied to the width generator via differential amplifier Q54/Q55 (see schematic 3).

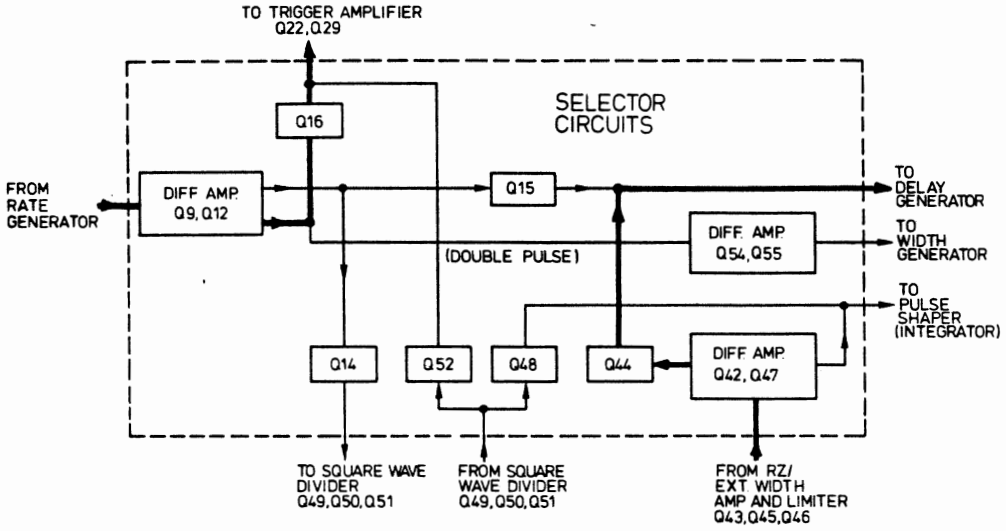


Figure 4–3b. RZ mode

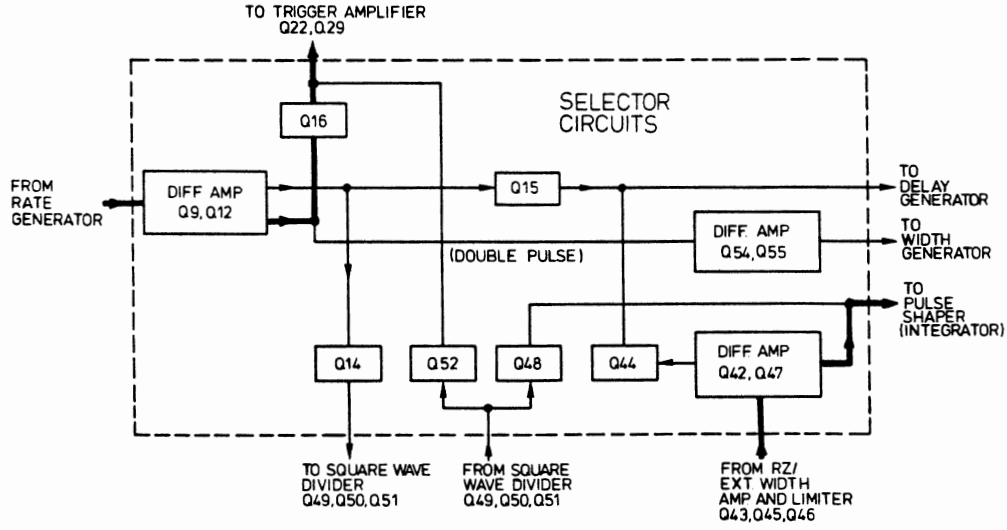


Figure 4–3c. Ext. Width mode

4–23 In RZ mode the rate generator output is only used to generate trigger pulses, via Q16. The RZ input is applied, via Q43, Q46, Q45 to the differential amplifier Q42/Q47 and gate Q44, to the delay generator.

4–24 In Ext. Width mode the rate generator output is only used to generate trigger pulses, via Q16. The Ext. Width input is applied, via Q43, Q46, Q45 to the differential amplifier Q42/Q47 to pulse shaper 3 and the integrator.

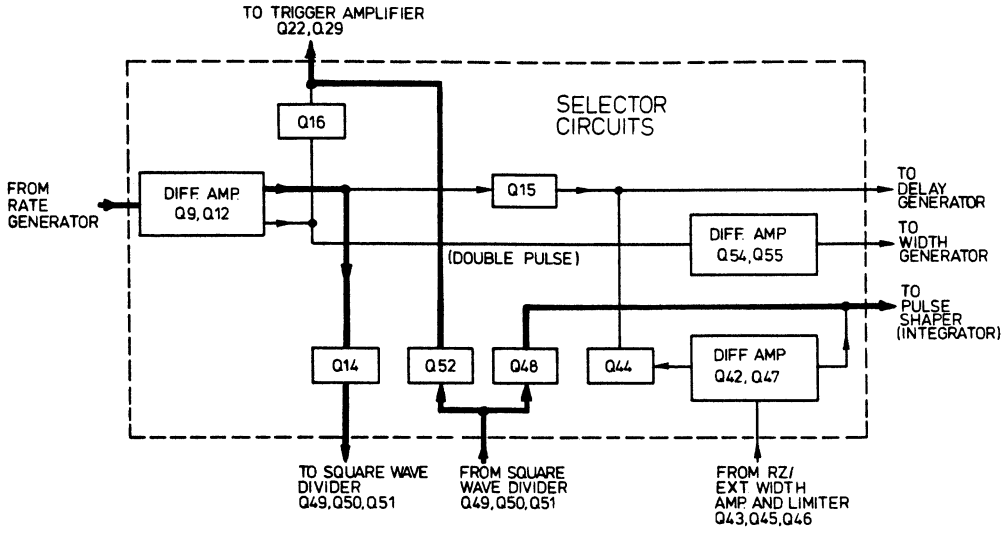


Figure 4–3d. Square wave mode

4–25 In Square wave mode the output of the rate generator is applied, via Q14, to the square wave divider. The output of the divider is applied to the trigger amplifier, via Q52, and pulse shaper 3 and the integrator, via Q48.

4–26 DELAY GENERATOR

4–27 A block diagram of the delay generator is given in figure 4–4 and a full schematic in diagram 3. These diagrams should be referred to when reading the following description.

4–28 The purpose of the delay generator is to delay the pulse source, whether from the internal rate generator, external trigger or from the RZ input, within the range of 35ns to 1s, with respect to the trigger output.

4–29 The current source (Q23), the monostable (Q30/Q31) and the recharge circuit (Q26) are controlled by the width switch so that the delay circuit is inhibited in square wave and external width modes.

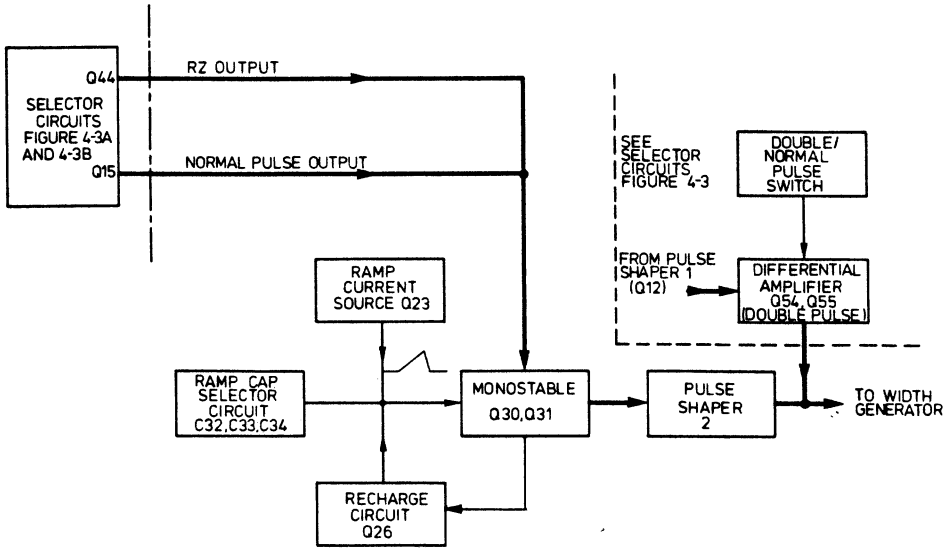


Figure 4–4. Delay generator – block diagram

4–30 Under no-signal conditions, Q31 is off, Q30 is on and Q26 is acting as a sink for the ramp current. Thus the ramp current souce (Q23) cannot charge the ramp capacitors. A positive pulse input signal turns Q31 on and Q30 off, Q26 follows Q30 collector and thus is non-conducting. The selected ramp capacitor is charged by the current source Q23 until a level is reached when Q30 turns on again, which turns Q31 off. Q26 now conducts again and rapidly discharges the selected ramp capacitor. The output from the monostable is a negative spike, coincident with the pulse input, followed by a positive spike which occurs some time later and is used to drive pulse shaper 2. The time between the pairs of spikes is the time taken for the ramp waveform to reach the threshold level of the monostable (Q30/Q31), i.e. the delay time.

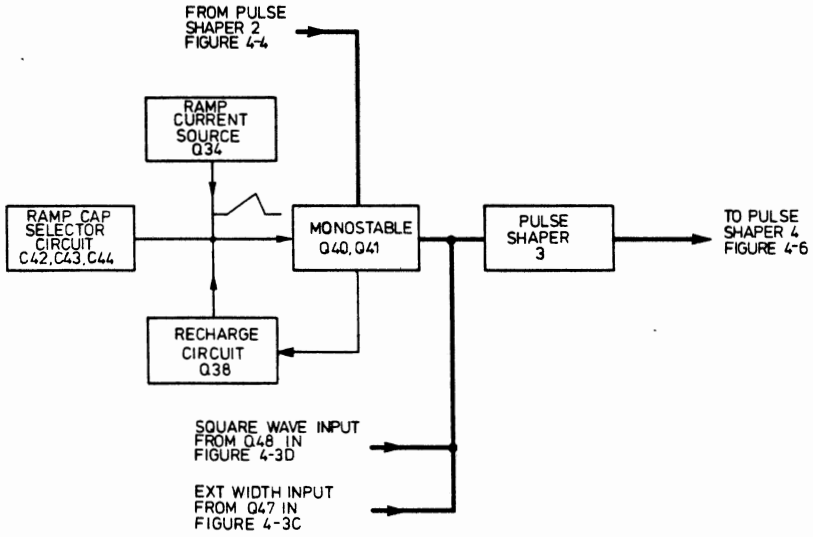


Figure 4–5. Width generator – block diagram

4–31 WIDTH GENERATOR

4–32 A block diagram of the width generator is given in figure 4–5 and a full schematic in diagram 4. These diagrams should be referred to when reading the following description.

4–33 The function of the width generator is to create a pulse of defined width for each positive pulse spike received from the delay generator. The current source (Q34) and the monostable (Q40/Q41) are controlled by the width switch so that the width circuit is inhibited in square wave and external width modes.

4–34 The width generator circuit is identical to the delay generator circuit except for the differentiator on the output (L11); see para. 4–30. The output pulse is applied to pulse shaper 3.

4–35 If square wave or external width modes are being used, the output signals from the selector circuits in figures 4–3c and 4–3d are applied directly to pulse shaper 3 and both the delay and width generators are disabled.

4–36 The two complementary outputs from pulse shaper 3 are then applied to the Normal/Complement circuit.

4–37 OUTPUT AMPLIFIERS

4–38 A block diagram of the output amplifiers is given in figure 4–6 and a full schematic in diagram 5. These diagrams should be referred to when reading the following description.

4–39 The Normal/Complement circuit consists of transistors Q29 to Q32 which are controlled in pairs

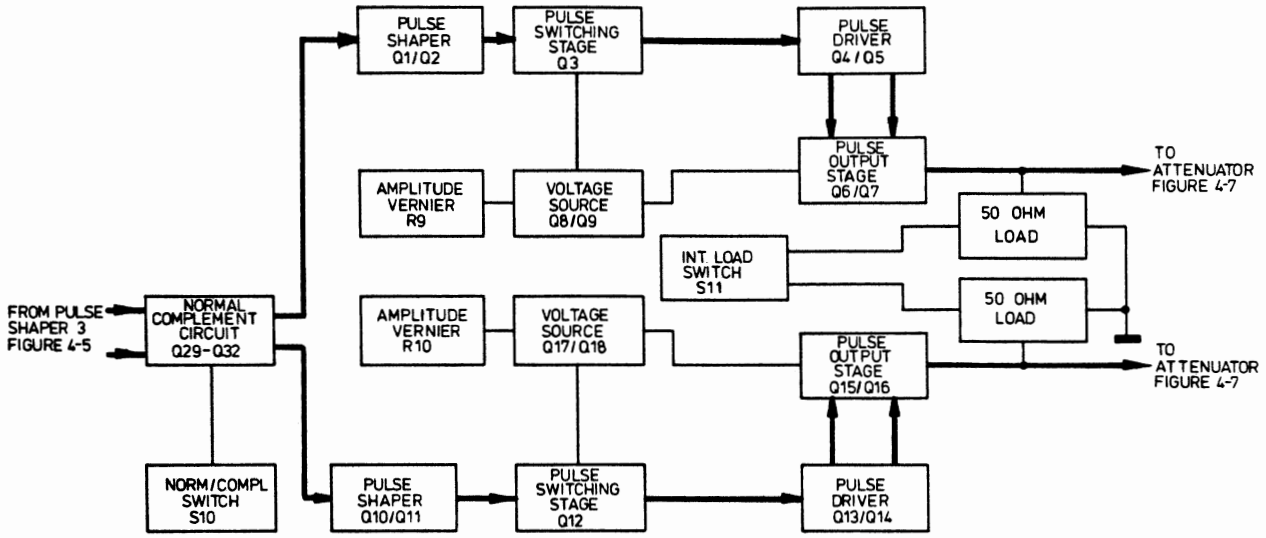


Figure 4–6. Output amplifiers – block diagram

(Q29/Q30 and Q31/Q32) by the NORM/COMPL switch (S10). Either one pair or the other is enabled to transpose the two pulse inputs.

4–40 The two complementary differentiated outputs are applied to pulse shaper Q1/Q2 for the positive channel and pulse shaper Q10/Q11 for the negative channel. The output of Q2 drives the positive output amplifier (Q4 to Q7) via a switching transistor Q3; the output of Q11 drives the negative output amplifier (Q13 to Q16) via a switching transistor Q12.

4–41 Amplitude verniers R9 and R10 determine the potential across the respective voltage sources (Q8/Q9 for the positive channel and Q17/Q18 for the negative channel). This determines the pulse amplitude swing for each channel.

4–42 When the internal load switch S11 is set to the 'in' position, relays K1 and K2 are energized and connect the 50 ohm loads to their repsective outputs.

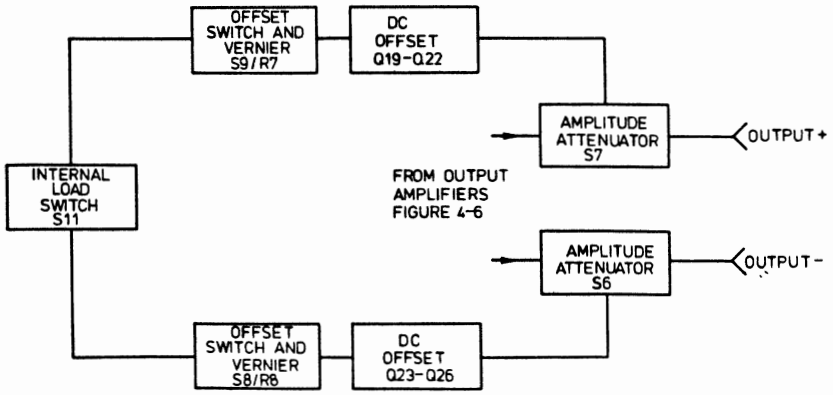


Figure 4–7. Offsets and attenuators – block diagram

4–43 OFFSETS AND ATTENUATORS

4–44 A block diagram of the offsets and attenuators is given in figure 4–7 and a full schematic in diagram 6. These diagrams should be referred to when reading the following description.

4–45 The pulses from the output amplifiers are applied to the two attenuator networks which can reduce the amplitude of each channel from 10V to 0.4V with the 50 ohm load switched out or from 5V to 0.2V with the 50 ohm load switched in.

4–46 The dc offset circuits comprise Q19 to Q22 for the positive channel and Q23 to Q26 for the negative channel. Both circuits operate in the same way and thus only the positive channel is described. Note that the offset is not available when the internal load is switched out.

4–47 When the offset switch (S9) is set to 'off', the vernier (R7) is shorted out. Thus Q19/Q20 and Q21/Q22 are switched off and deliver no current. When the offset switch is set to 'on', clockwise rotation of the vernier increases the output from Q20 and decreases the output from Q22. The output of the amplifier will then be positive. Counterclockwise rotation of the vernier causes the reverse to happen and the amplifier output to become negative.

4–48 POWER SUPPLIES

4–49 The +17V and −17V power supplies are identical series regulated types using IC regulators (U1 and U2) and series pass transistors (Q27 and Q28). Resistors R100 and R104 act as current sensing resistors to enable the regulators to limit the current output.