


# Pulse Generator

# Model 8020

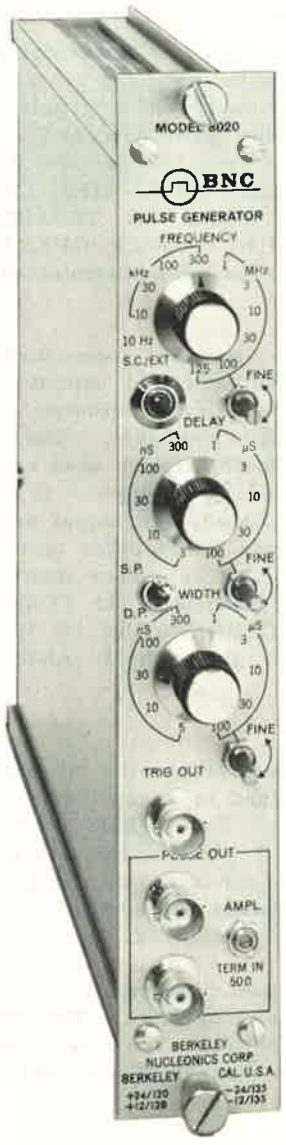
# INSTRUCTION MANUAL

**BERKELEY NUCLEONICS CORPORATION**
1198 Tenth St., Berkeley, California 94710

# INDEX

# SPECIFICATIONS

SECTION 1




REPETITION RATE: a) 0.5 Hz-10 Hz, continuously variable, 3 kHz-125 MHz continuously variable.
b) Ext Trigger, 0-125 MHz.
c) Single Cycle.

DELAY: 0 to 100 μsec, continuously variable.

WIDTH: 3 nsec to 100 μsec, continuously variable.

JITTER: Rep rate, delay or width less than 50 psec or 0.1%, whichever is greater.

DOUBLE PULSE: 6 nsec min. separation. Pulse spacing set by delay controls.

RESOLUTION OF FINE CONTROLS: Less than 0.4%.

TEMPERATURE COEFFICIENT OF FREQUENCY, DELAY OR WIDTH: Less than 0.1%/°C.

DUTY FACTOR: Greater than 50%.

OUTPUT PULSES: Two parallel output connectors providing greater than −32 mA. When terminated in 50 Ω, there are two −0.8 V pulses. (Standard NIM fast logic level.)

RISE TIME: 1 nsec.

FALL TIME: 1.3 nsec.

AMPLITUDE ADJUSTMENT: 10:1 range (from −32 mA to −3.2 mA), continuously variable.

OUTPUT PULSE ABERRATIONS: Baseline or pulse top, less than 5%.

TRIGGER OUT: −0.8 V, 50 Ω, 1 nsec rise time. (Two outputs on front and rear panel.)

EXTERNAL TRIGGER: −0.6 V, 50 Ω. (Rear panel.)

EXT GATE: NIM logic. (−0.6 V to gate on, at rear panel.) Synchronous. Rear panel slide switch provides gated or ungated operation.

AMBIENT TEMPERATURE: 55°C max.

PROTECTION: Open and short circuit proof.

POWER REQUIREMENTS: +24 V, 120 mA, +12 V, 120 mA, −24 V, 135 mA, −12 V, 135 mA.

MECHANICAL: Single width AEC module, 1.35" wide x 8.70" high in accordance with TID-20893 (Rev. 2).

WEIGHT: 2½ lbs., net, 7 lbs. shipping.

# OPERATING INSTRUCTIONS

SECTION 2

## 2.1 INTRODUCTION

The Model 8020 pulse generator is a one nanosecond rise time, 125 MHz pulse generator specifically designed for use with high energy physics instrumentation. However, its broad range of functions is applicable in other areas. It provides two parallel outputs of -16 mA which convert to two -0.8 V pulses terminated into 50 ohms.*

The Model 8020 conforms to the mechanical and electrical specifications for NIM (nuclear instrument modules) set up by AEC report TID-20893, Rev. 3. In order to power this instrument it is necessary to provide ±24 V and ±12 V from an external supply. Berkeley Nucleonics manufactures portable power supplies, the Model AP-1 and Model AP-2, which are designed to provide the necessary power.

## 2.2 FUNCTION OF CONTROLS AND CONNECTORS

FREQUENCY: A twelve-position switch and 25-turn trimming potentiometer provide the range desired. The internal repetition rate is adjustable from 3 kHz to 125 MHz. Below 3 kHz, a range of frequencies from 0.5 to 10 Hz is available by setting the FREQUENCY switch to 10 Hz. In addition a S.C. (single cycle) pushbutton and EXT (external trigger) operation is provided.

DELAY: A ten-position switch and a 25-turn trimming potentiometer provides a continuous delay between PULSE OUT and TRIG OUT from 0 - 100 μsec.

WIDTH: A ten-position switch and 25-turn trimming potentiometer provides a continuous pulse width from 3 nsec to 100 μsec.

S.P./D.P. (Single Pulse / Double Pulse): A front panel toggle provides either a single or double output pulse with each Trigger Out pulse. When this control is in the S.P. (single pulse) position, one output pulse appears with each Trigger Out pulse. When this toggle is in the D.P. (Double Pulse) position, two output pulses appear with each Trigger Out pulse. The first pulse is time coincident with the trigger out and second pulse is separated from the first by the setting of the delay controls.

*This logic level has been adopted by the U.S. AEC committee on nuclear instrument modules. See Standard Nuclear Instrument Modules, Report TID-20893 Rev. 3, available from the U.S. Government Printing Office, Washington, D.C. 20402 for 40 cents.

AMPL. (Amplitude): A front panel mounted trimmer adjusts the output amplitudes over a 10:1 range. Normally it is set at the maximum to provide -16 mA output into each of two 50 ohms output terminations (or 0.8 V at each output when terminated in 50 ohms.)

GATE - ON / OFF: A rear panel slide switch provides gated or ungated operation. When it is in the GATE-OFF position a continuous pulse train appears at the output. When it is in the GATE-ON position a pulse burst will appear at the output connector only during the time that a -0.6 V gate signal appears at the rear panel gate connector.

TRIG OUT (Trigger Out): A connector on both the front and rear panel provides synchronizing pulses in time relation to the output pulse as set by the Delay controls. The Trigger Out pulses are a square wave train whose period is the same as the Frequency clock. THE TRIGGER OUTPUT CABLE MUST BE TERMINATED INTO 50 OHMS FOR PROPER OPERATION. The unused output need not be terminated.

PULSE OUT: Two parallel connectors on the front panel provide identical output pulses. When the AMPL (Amplitude) trimmer is set at maximum, -32 mA is available. The -32 mA divides into two -16 mA outputs when each connector is terminated in 50 ohms. If only one connector is terminated, the output amplitude will be -1.6 V across the 50 ohms termination and the rise time will be slower than 1 nanosecond. IT IS NECESSARY TO TERMINATE BOTH OUTPUT CONNECTORS IN 50 OHMS TO OBTAIN 1 NS RISE TIME AND -0.8 V PULSES.

EXT TRIG (External Trigger): A rear panel connector is provided to accept external synchronizing pulses. The FREQUENCY switch must be in the EXT position for this mode of operation. The input impedance is 50 ohms, and a -0.6 V amplitude pulse with a rise time less than 0.2 μsec is required.

GATE: A rear panel connector is provided to receive the external gate pulse. The input impedance is 50 ohms and -0.6 V is required to gate on the pulses. See GATE-ON/OFF above.

## 2.3 OPERATIONAL CHECK POINTS

If there are any difficulties in obtaining desired operation from the Model 8020, the following check list will be useful.

NO OUTPUT PULSE:

- Is the rear panel GATE - ON/OFF in the proper position? (Set at GATE-OFF for continuous pulse train).
- Is the front panel FREQUENCY switch set correctly?

POOR OUTPUT PULSE SHAPE:

- Are both output connectors terminated in 50 ohms (even if one is not used)?
- Is the output cable 50 ohms characteristic impedance?

ERRATIC TRIGGERING OF OSCILLOSCOPE:

- Is the Trigger Out cable terminated in 50 ohms?
- Does the delay or width duty factor exceed 50%?

ERRATIC EXTERNAL TRIGGER OPERATION:

- Is the external trigger at least -0.6 V in amplitude when connected?
- Is the front panel FREQUENCY switch set at EXT?

DIFFICULTY IN EXTERNAL TRIGGERING AT 125MHz REP RATE:

- Is the Fine Frequency Control set at maximum counter-clockwise position?

DIFFICULTY IN OBTAINING 125MHz REP RATE:

- Are the Delay and Width Controls set near minimum so that 50% duty factor is not exceeded?

EXCESSIVE JITTER:

- Check power supply regulation.

INSUFFICENT AMPLITUDE:

- Check setting of AMPL. control.

# CIRCUIT DESCRIPTION



This section of the manual describes the circuits used in the Model 8020. Section 3.1 describes the block diagram and reference is made to Fig. 1. Sections 3.2-3.11 describe the detailed circuits and reference is made to the schematics 8020-1, 8020-2 and 8020-3 at the back of the manual. See Sect. 3.12 for service.

## 3.1 BLOCK DIAGRAM

A block diagram of the Model 8020 is shown in Fig. 1. The clock pulses are generated by either the 3 kHz-125 MHz Multivibrator or the 0.5 Hz-10 Hz Multivibrator. The output of the 3 kHz-125 MHz Multivibrator triggers the Delay One-Shot and also triggers the Trigger Out circuit. The output of 0.5 Hz-10 Hz Multivibrator triggers the External Trigger circuit which in turn triggers the Delay One-Shot and Trigger Out circuit. When either the 0.5 Hz-10 Hz or 3 kHz-125 MHz Multivibrator is operating the other is inhibited.

The External Gate is connected directly to the 3 kHz-125 MHz Multivibrator. When the rear panel gate switch is in the "ON" position, the multivibrator is inhibited until a gating signal appears at the External Gate connector. The multivibrator then generates clock pulses for a period of time equal to the gate pulse width.

The External Trigger circuitry accepts external synchronizing pulses and shapes them to provide a trigger for the Delay One-Shot and the Trigger Out circuit. The 0.5 Hz-10 Hz and 3 kHz-125 MHz Multivibrators are inhibited during External Trigger operation.

The Delay One-Shot generates a pulse whose width is adjustable by the front panel Delay controls. The output of this one-shot passes into the Single/Double Pulse circuitry. If this circuit is set in the Single Pulse mode a trigger pulse is generated coincident with the trailing edge of the delay pulse. If the circuit is set in the Double Pulse mode, an additional trigger pulse appears which is coincident with the leading edge of the delay pulse.

The output of the Single/Double circuitry triggers the Width One-Shot. This one-shot generates a pulse whose width is adjustable by front panel Width controls. The Output Pulse Shaper generates the proper pulse shape to drive the output circuitry. The output circuitry is a current switch which provides a current of -36 mA into the output terminating resistances.

## 3.2 3 kHz-125 MHz MULTIVIBRATOR

Refer to Schematic 8020-1. Transistors Q11-Q18 function as a free-running multivibrator from 3 kHz-125 MHz. The feedback loop for regeneration is from the collector of Q11 through R36 and C18 to the base of Q12. The emitter of Q12 is capacitively coupled to the emitter of Q11. The value of the coupling capacitor C33-C41 sets the frequency range. The base of Q11 is coupled to the collector Q12 through C17 and R35, which completes the feedback loop.

Transistors Q14 and Q15 are constant current sources for the emitters of Q11 and Q12. Transistors Q16 inhibits the multivibrator when the Frequency switch is in the 10 Hz or External/Single Cycle position. Transistor Q13 is connected as an emitter follower to provide +9.3 V to the collectors of Q11 and Q12.

The fine frequency setting of the multivibrator is controlled by adjusting the clamping levels of the collector waveform via D12 and D13. This clamping level is set by the Fine trimmer R58 via Q17, D14, and Q18. The function of D14 and Q18 is to compensate for the temperature coefficient of Q17, D12, and D13.

The output of the multivibrator appears across R33 and R34 and is derived from the collectors of Q11 and Q12 through R45 and R46. These pulses are referred to as clock pulses and drive the bases of Q24 and Q25.

## 3.3 0.5 Hz-10 Hz MULTIVIBRATOR

Refer to Schematic 8020-1. The low frequency multivibrator of 0.5 Hz-10 Hz is provided by transistors Q54-Q58. The feedback loop is from the emitter of Q54 through C28 to the emitter of Q55, and from the collector of Q55 to the base of Q54. The timing capacitor is C28 which receives its charging current from the collector of Q56. The amount of charging current is set by the Fine frequency trimmer, R58, which controls the current through Q57 and Q56. The output of the multivibrator at the collector of Q54 drives the base of Q58. The collector of Q58 provides a trigger to the base of Q1, which is the input to the External Trigger circuit. The description of the operation of this circuit is given next in Section 3.4.

## 3.4 EXTERNAL TRIGGER

Refer to Schematic 8020-1. Transistors Q1-Q6 function to shape an external trigger to provide a clock pulse in place of the free-running multivibrators. Transistors Q1 and Q2 are in a Schmitt Trigger configuration. Transistor Q1 is normally conducting and Q2 is normally non-conducting. This state is reversed when an External Trigger pulse is connected to the base of Q1. Transistor Q3 sets the bias on the base of Q2. Transistors Q4 and Q5 function as a

current switch to increase the gain of the Schmitt Trigger. The current output of Q4 and Q5 appears across R33 and R34 to produce pulses to trigger the bases of Q24 and Q25. Transistor Q6 functions as an inhibit gate for the External Trigger circuit when the Frequency switch is in any position except External or 10 Hz. Transistor Q53 inhibits the external trigger circuit when the gating circuit is operating.

### 3.5 EXTERNAL GATE

Refer to Schematic 8020-1. Transistors Q7-Q10 function to gate off the 3 kHz-125 MHz multivibrator during a period of time an external gate signal is present. Transistors Q7 and Q8 function as a Schmitt Trigger. During the gated mode of operation, Q7 is normally conducting and Q8 is non-conducting. A negative gate at the base of Q7 reverses this state. Transistor Q9 operates as an emitter-follower to provide the bias for the base of Q8. The circuit functions in the following manner:

When the GATE/ON-OFF switch is in the OFF position, the voltage at the base of Q9 is +1.4 V. The voltage at the base of Q8 is +0.85 V. The collector of Q8 is +2.6 V and the emitter of Q10 is +2.0 V. Diode D7 is back-biased and the multivibrator is unaffected by a gate signal.

When the GATE/ON-OFF switch is in the ON position, the voltage at the base of Q9 is +0.2 V which produces a voltage of -0.4 V at the base of Q8. The collector of Q8 is at +6.4 V and the emitter of Q10 is at +5.8 V. This voltage, through diode D7, clamps the collector of Q14 and the multivibrator is inhibited. When a negative gate pulse appears at the base of Q7, these conditions are reversed and the emitter of Q10 shifts to +2.0 V. Diode D7 is back-biased and the multivibrator functions for a period of time equal to the gate pulse width.

### 3.6 DELAY LINE DRIVER & TRIGGER OUT

Refer to Schematic 8020-2. The clock pulses from the frequency multivibrators or external trigger circuit provide complementary signals which drive the bases of Q24 and Q25. Transistors Q24 and Q25 are in a current- switch configuration and their purpose is to both shape the pulses for the Trig Out (Trigger Out) circuits and to drive the Delay One-Shot.

The pulses at the collector of Q24 are delayed for 8 ns through DL-1 and then trigger the bases of Q19 and Q21. Transistors Q19, Q20, Q21, and Q22 function as current switches to provide Trigger Out pulses on both of the front and rear panels. Transistor Q23 is an emitter-follower to provide -2.7 V to the bases of Q19 and Q21.

The bases of Q20 and Q22 are at -2.5 V which is provided by the voltage drop across D19. The output pulses at the collectors of Q20 and Q22 appear at the two TRIG OUT connectors. Diodes D17 and D18 at the collector of Q20 (and diodes D20 and D21 at the collector of Q22) provide a return path to ground if the TRIG OUT connector is not terminated.

The pulses at the collector of Q25 function to trigger the Delay One-Shot. At the collector of Q25 is a shorted delay line DL-2, with a double transit time of 4 nsec. This provides a clipped pulse of approximately 3 ns width at half-height. This pulse is passed through emitter-follower Q26 and then triggers the Delay One-Shot, Q27-Q31.

### 3.7 DELAY ONE-SHOT

Refer to Schematic 8020-2. Transistors Q27, Q28 and Q29 form the regenerative loop for the Delay One-Shot. Before a trigger pulse arrives, the base of Q27 is at .31 V and the base of Q28 is at +.65 V. Transistor Q27 is non-conducting and Q28 is in conduction. A +0.6 V trigger pulse at the base of Q27 starts to reverse this state and the collector of Q27 goes negative. This excursion passes through emitter-follower Q29, through timing capacitors C64-C72, and then to the base of Q28. This pulse cuts off Q28 which causes Q27 to go into full conduction. A quasi-stable state now exists until the timing capacitor charges up through R87 and R82. When the base of Q28 nearly reaches 0 V, Q28 starts to conduct and Q27 starts to cut off. The transistors, by regenerative action, then switch back to their inital states. Transistor Q29 is a low impedance source to rapidly discharge the timing capacitor to its initial state.

The coarse timing period of the quasi-stable state is provided by front panel selection of one of the timing capacitors, C64-C72. The fine timing is obtained by controlling the amplitude of the voltage swing at the collector of Q27 via D25. Diode D25 obtains its clamping level via emitter-follower Q30, emitter-follower Q31, and trimmer R95. Transistor Q31 compensates for the temperature coefficient of Q30 and D25.

The bias of +.65 V at the base of Q28 is obtained from D22 and R82. The bias of +.31 V at the base of Q27 is obtained from D38, R174, and R175.

The +4.5 V collector supply voltage for Q27 and Q28 is obtained from emitter-follower Q51 (on Schematic 8020-3).

The outputs of the Delay One-Shot are two complementary pulses--one at the collector of Q27 and the other at the collector of Q28.

### 3.8 DOUBLE PULSE CIRCUITRY

The two output pulses from the Delay One-Shot drive current-switch Q32 and Q33. At the collectors of Q32 and Q33 are shorted clipping lines which provide bipolar, complementary pulses of about 4 ns width. The positive 4 ns pulses at the collectors of Q32 and Q33 occur at the beginning and end of the Delay One-Shot pulse, respectively. These pulses then pass to a gating circuit which permits either one or both pulses to pass.

If the SINGLE/DOUBLE PULSE toggle is in the SINGLE PULSE position the base of Q34 goes positive through R106. Transistor Q34 conducts and the collector of Q32 is held at nearly 0 V. This shorts out the pulse at the collector of Q32. However, the pulse at the collector of Q33 passes through diode D29, emitter-follower Q36 and then on to trigger the base of Q39. The function of D29 is to bias on Q36 slightly. The negative excursion of the bipolar trigger pulse is below the conduction threshold and does not appear at the emitter of Q36.

If the SINGLE/DOUBLE PULSE toggle is in the Double Pulse position, the base of Q34 is at 0 V and the transistor does not conduct. The trigger pulse at the collector of Q32 then appears at the emitter of Q35 in a similar route as described in the preceding paragraphs. The two trigger pulses then appear at the base of Q39 with a time delay set by the Delay controls to provide a double pulse operation.

### 3.9 WIDTH ONE-SHOT

The Width One-Shot, Q38-Q42, functions in an identical manner to the Delay One-Shot described above in Section 3.7. The output of the Width One-Shot is at the collector of Q38. This pulse is delayed from the TRIG OUT pulse as set by front panel Delay controls and has a width set by front panel Width controls. It is next shaped by the Output Pulse shaper for the output circuitry.

### 3.10 OUTPUT PULSE SHAPER & OUTPUT CIRCUITRY

Transistor Q43 and Q44 are a current-switch which receives the Width One-Shot pulse. The base of Q44 is biased at +3.9 V by divider R170, R159. The positive pulse at the base of Q43 causes a reversal of state and a negative pulse appears at the collector of Q43. This pulse, in turn, switches the output current-switch, Q46 and Q47. A negative pulse appears at the collector of Q47 which passes to the Output connectors. Transistor Q45 is an emitter-follower to provide -2.7 V collector supply voltage for Q43 and Q44.

Transistor Q48 is a constant current supply for the output current-switch Q46 and Q47. The output amplitude is controlled by adjusting the AMPLITUDE trimmer at the base of Q48. This trimmer controls the amount of current being switched into the output load resistance.

Transistor Q49 is an emitter-follower to provide the bias level for the base of Q47. This bias level may be adjusted internally by varying R152, the Output Drive trimmer. This adjustment is adjusted to achieve the best compromise between output rise time and pulse top aberrations.

### 3.11 OTHER CIRCUIT & CONSIDERATIONS

Emitter-follower, Q51 (Schematic 8020-3) provides the +4.5 V supply for the instrument. Note that 20 mA of current for the +4.5 V bus comes from the +24 V supply via R151. Another approximately 20 mA comes from Q51 whose main function is to regulate this bus.

Resistors R141, R156, and R157 (Schematic 8020-3) are provided to nearly equalize the current from all power supply buses for optimum utilization of the NIM power supply.

### 3.12 SERVICE

If service is required on the Model 8020 refer to the schematics for the proper waveforms and voltages. A 50 MHz oscilloscope and a 350 ps sampling oscilloscope is required to properly trouble shoot this instrument.

When circuit tracing it is particularly necessary to observe the 3-4 ns wide trigger pulse has a minimum amplitude of 0.6 V at the inputs of the Delay and Width One-shots (bases of Q27 and Q28).

There is one adjustment trimmer in the Model 8020, R152 which is at the rear of the P. C. board next to the power connector. This trimmer adjusts the bias level on the output current switch. While the output pulse is observed on a sampling oscilloscope adjust the trimmer for the best compromise between the fastest output rise time and minimum pulse top aberrations. The correct setting will provide 1 ns output pulse rise time and pulse top aberrations of less than 5%.

## Abbreviations

| | | | |
|---|---|---|---|
| cer | ceramic | $\mu$H | microhenry |
| comp | composition carbon | $\mu$F | microfarad |
| EMC | electrolytic, metal case | pF | picofarad |
| mic | mica | pos | positions |
| myl | mylar | tan | tantalum |
| k | kilohm | V | working volts DC |
| meg | megohm | var | variable |
| m | milli | W | watts |
| MF | metal film | ww | wirewound |

---------- NOTE ----------

The last number after each part description is the BERKELEY NUCLEONICS part number for reordering.

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## Capacitors

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C1 | .05 $\mu$F | cer | 100 V | | 110-017 | C37 | .0068 $\mu$F | myl | 600 V | 10% | 114-009 |
| C2 | .05 $\mu$F | cer | 100 V | | 110-017 | C38 | .022 $\mu$F | myl | 100 V | 10% | 114-014 |
| C3 | 10 pF | cer | 1 kV | | 110-002 | C39 | .068 $\mu$F | myl | 100 V | 10% | 114-019 |
| C4 | 180 pF | cer | 1 kV | | 110-007 | C40 | .22 $\mu$F | tan | 35 V | 10% | 122-007 |
| C5 | 180 pF | cer | 1 kV | | 110-007 | C41 | .68 $\mu$F | tan | 35 V | 10% | 122-009 |
| C6 | 180 pF | cer | 1 kV | | 110-007 | C43 | .05 $\mu$F | cer | 100 V | | 110-017 |
| C7 | 180 pF | cer | 1 kV | | 110-007 | C44 | 10 pF | cer | 1 kV | | 110-002 |
| C8 | 5 pF | cer | 1 kV | | 110-001 | C45 | 180 pF | cer | 1 kV | | 110-007 |
| C9 | 180 pF | cer | 1 kV | | 110-007 | C46 | 180 pF | cer | 1 kV | | 110-007 |
| C10 | 5 pF | cer | 1 kV | | 110-001 | C47 | 180 pF | cer | 1 kV | | 110-007 |
| C11 | .05 $\mu$F | cer | 100 V | | 110-017 | C48 | 180 pF | cer | 1 kV | | 110-007 |
| C12 | 180 pF | cer | 1 kV | | 110-007 | C49 | 180 pF | cer | 1 kV | | 110-007 |
| C13 | 180 pF | cer | 1 kV | | 110-007 | C50 | 10 pF | cer | 1 kV | | 110-002 |
| C14 | 180 pF | cer | 1 kV | | 110-007 | C51 | 180 pF | cer | 1 kV | | 110-007 |
| C15 | 5 pF | cer | 1 kV | | 110-001 | C52 | 180 pF | cer | 1 kV | | 110-007 |
| C16 | 180 pF | cer | 1 kV | | 110-007 | C53 | 5 pF | cer | 1 kV | | 110-001 |
| C17 | 100 pF | cer | 1 kV | | 110-006 | C54 | 180 pF | cer | 1 kV | | 110-007 |
| C18 | 100 pF | cer | 1 kV | | 110-006 | C55 | 180 pF | cer | 1 kV | | 110-007 |
| C19 | 2.5-10 pF | var | | | 130-004 | C56 | 180 pF | cer | 1 kV | | 110-007 |
| C20 | 180 pF | cer | 1 kV | | 110-007 | C57 | 180 pF | cer | 1 kV | | 110-007 |
| C21 | 180 pF | cer | 1 kV | | 110-007 | C58 | 180 pF | cer | 1 kV | | 110-007 |
| C22 | 180 pF | cer | 1 kV | | 110-007 | C59 | 180 pF | cer | 1 kV | | 110-007 |
| C23 | 180 pF | cer | 1 kV | | 110-007 | C60 | 180 pF | cer | 1 kV | | 110-007 |
| C24 | 180 pF | cer | 1 kV | | 110-007 | C61 | 25 pF | cer | 1 kV | | 110-003 |
| C25 | 180 pF | cer | 1 kV | | 110-007 | C62 | 10 pF | mic | 500 V | 5% | 112-016 |
| C26 | 180 pF | cer | 1 kV | | 110-007 | C63 | 180 pF | cer | 1 kV | | 110-007 |
| C27 | 180 pF | cer | 1 kV | | 110-007 | C64 | .33 $\mu$F | tan | 35 V | 10% | 122-008 |
| C28 | 25 $\mu$F | elec | 25 V | | 120-005 | C65 | .1 $\mu$F | myl | 100 V | 10% | 114-020 |
| C29 | 180 pF | cer | 1 kV | | 110-007 | C66 | .033 $\mu$F | myl | 100 V | 10% | 114-024 |
| C30 | 180 pF | cer | 1 kV | | 110-007 | C67 | .01 $\mu$F | myl | 400 V | 10% | 114-011 |
| C31 | 180 pF | cer | 1 kV | | 110-007 | C68 | .0033 $\mu$F | myl | 600 V | 10% | 114-005 |
| C33 | 22 pF | mic | 500 V | 5% | 112-001 | C69 | .001 $\mu$F | myl | 600 V | 10% | 114-001 |
| C34 | 100 pF | mic | 500 V | 5% | 112-004 | C70 | 270 pF | mic | 500 V | 5% | 112-009 |
| C35 | 430 pF | mic | 100 V | 5% | 112-012 | C71 | 68 pF | mic | 500 V | 5% | 112-018 |
| C36 | .002 $\mu$F | myl | 600 V | 10% | 114-002 | C72 | 18 pF | mic | 500 V | 5% | 112-017 |

. . . continued

CAPACITORS (continued)

| | | | | | |
|---|---|---|---|---|---|
| C75 | 180 pF | cer | 1 kV | | 110-007 |
| C76 | 180 pF | cer | 1 kV | | 110-007 |
| C77 | 10 pF | cer | 1 kV | | 110-002 |
| C78 | 180 pF | cer | 1 kV | | 110-007 |
| C79 | 180 pF | cer | 1 kV | | 110-007 |
| C80 | 180 pF | cer | 1 kV | | 110-007 |
| C81 | 180 pF | cer | 1 kV | | 110-007 |
| C82 | 10 pF | cer | 1 kV | | 110-002 |
| C83 | 180 pF | cer | 1 kV | | 110-007 |
| C84 | 180 pF | cer | 1 kV | | 110-007 |
| C85 | 10 pF | mic | 500 V | 5% | 112-016 |
| C86 | .33 μF | tan | 35 V | 10% | 122-008 |
| C87 | .1 μF | myl | 100 V | 10% | 114-020 |
| C88 | .033 μF | myl | 100 V | 10% | 114-024 |
| C89 | .01 μF | myl | 400 V | 10% | 114-011 |
| C90 | .0033 μF | myl | 600 V | 10% | 114-005 |
| C91 | .001 μF | myl | 600 V | 10% | 114-001 |
| C92 | 270 pF | mic | 500 V | 5% | 112-009 |
| C93 | 68 pF | mic | 500 V | 5% | 112-018 |
| C94 | 10 pF | mic | 500 V | 5% | 112-016 |
| C96 | 180 pF | cer | 1 kV | | 110-007 |
| C99 | 180 pF | cer | 1 kV | | 110-007 |
| C100 | 180 pF | cer | 1 kV | | 110-007 |
| C101 | 180 pF | cer | 1 kV | | 110-007 |
| C102 | 180 pF | cer | 1 kV | | 110-007 |
| C103 | 5 pF | cer | 1 kV | | 110-001 |
| C104 | .05 μF | cer | 100 V | | 110-017 |
| C105 | 180 pF | cer | 1 kV | | 110-007 |
| C106 | 180 pF | cer | 1 kV | | 110-007 |
| C107 | .05 μF | cer | 100 V | | 110-017 |
| C108 | 20 pF | cer | 1 kV | | 110-018 |
| C109 | 100 μF | elec | 15 V | | 120-007 |
| C110 | 180 pF | cer | 1 kV | | 110-007 |
| C111 | 180 pF | cer | 1 kV | | 110-007 |
| C112 | 50 μF | elec | 25 V | | 120-006 |
| C113 | 50 μF | elec | 25 V | | 120-006 |
| C114 | 50 μF | elec | 25 V | | 120-006 |
| C115 | 50 μF | elec | 25 V | | 120-006 |
| C116 | 180 pF | cer | 1 kV | | 110-007 |
| C117 | 180 pF | cer | 1 kV | | 110-007 |
| C118 | 180 pF | cer | 1 kV | | 110-007 |
| C119 | 180 pF | cer | 1 kV | | 110-007 |
| C120 | 10 pF | cer | 1 kV | | 110-002 |
| C121 | .05 μF | cer | 100 V | | 110-017 |
| C122 | .05 μF | cer | 100 V | | 110-017 |
| C123 | .05 μF | cer | 100 V | | 110-017 |
| C124 | 180 pF | cer | 1 kV | | 110-007 |
| C125 | .05 μF | cer | 100 V | | 110-017 |
| C126 | .05 μF | cer | 100 V | | 110-017 |
| C127 | 180 pF | cer | 1 kV | | 110-007 |
| C128 | .05 μF | cer | 100 V | | 110-017 |
| C129 | 180 pF | cer | 1 kV | | 110-007 |
| C130 | 10 pF | cer | 1 kV | | 110-002 |
| C131 | 10 pF | cer | 1 kV | | 110-002 |
| C132 | 180 pF | cer | 1 kV | | 110-007 |

## Diodes

| | | |
|---|---|---|
| D1 | 1N4154 | 411-003 |
| D2 | 1N4154 | 411-003 |
| D3 | 1N4154 | 411-003 |
| D4 | 1N4154 | 411-003 |
| D5 | 1N4154 | 411-003 |
| D6 | 1N4154 | 411-003 |
| D7 | FH1100 | 415-001 |
| D8 | 1N4154 | 411-003 |
| D9 | 1N4154 | 411-003 |
| D10 | 1N4154 | 411-003 |
| D11 | 1N4154 | 411-003 |
| D12 | FH1100 | 415-001 |
| D13 | FH1100 | 415-001 |
| D14 | 1N4154 | 411-003 |
| D15 | 1N4154 | 411-003 |
| D16 | 1N4154 | 411-003 |
| D17 | 1N4154 | 411-003 |
| D18 | 1N4154 | 411-003 |
| D19 | 1N4154 | 411-003 |
| D20 | 1N4154 | 411-003 |
| D21 | 1N4154 | 411-003 |
| D22 | FH1100 | 415-001 |
| D23 | 1N4154 | 411-003 |
| D24 | 1N4154 | 411-003 |
| D25 | FH1100 | 415-001 |
| D26 | 1N4154 | 411-003 |
| D28 | 1N4154 | 411-003 |
| D29 | 1N4154 | 411-003 |
| D30 | FH1100 | 415-001 |
| D31 | 1N4154 | 411-003 |
| D32 | 1N4154 | 411-003 |
| D33 | FH1100 | 415-001 |
| D34 | 1N4154 | 411-003 |
| D35 | 1N4154 | 411-003 |
| D37 | 1N4154 | 411-003 |
| D40 | 1N5231 | 412-009 |
| D41 | FH1100 | 415-001 |
| D42 | FH1100 | 415-001 |

## Inductors

| | | |
|---|---|---|
| L1 | .33 μH | 310-011 |
| L2 | .22 μH | 310-013 |
| L3 | .22 μH | 310-013 |

## Resistors

| | | | | | |
|---|---|---|---|---|---|
| R1 | 470 k | 1/4 W | comp | 5% | 213-474 |
| R2 | 270 k | 1/4 W | comp | 5% | 213-274 |
| R3 | 10 | 1/4 W | comp | 5% | 213-100 |
| R4 | 1 k | 1/4 W | comp | 5% | 213-102 |
| R5 | 51 | 1/4 W | comp | 5% | 213-510 |
| R6 | 51 | 1/4 W | comp | 5% | 213-510 |
| R7 | 51 | 1/4 W | comp | 5% | 213-510 |
| R8 | 1 k | 1/4 W | comp | 5% | 213-102 |
| R9 | 8.2 k | 1/4 W | comp | 5% | 213-822 |
| R10 | 56 | 1/4 W | comp | 5% | 213-560 |
| R11 | 56 | 1/4 W | comp | 5% | 213-560 |
| R12 | 270 | 1/4 W | comp | 5% | 213-271 |
| R13 | 10 k | 1/4 W | comp | 5% | 213-103 |
| R14 | 240 | 1/4 W | comp | 5% | 213-241 |
| R15 | 51 | 1/4 W | comp | 5% | 213-510 |

. . . continued

RESISTORS (continued)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R16 | 22 k | 1/4 W | comp | 5% | 213-223 | R76 | 510 | 1/4 W | comp | 5% | 213-510 |
| R17 | 15 k | 1/4 W | comp | 5% | 213-153 | R77 | 150 | 1/4 W | comp | 5% | 213-151 |
| R18 | 33 | 1/4 W | comp | 5% | 213-330 | R79 | 51 | 1/4 W | comp | 5% | 213-510 |
| R19 | 51 | 1/4 W | comp | 5% | 213-510 | R80 | 560 | 1/2 W | comp | 5% | 212-561 |
| R20 | 51 | 1/4 W | comp | 5% | 213-510 | R81 | 56 | 1/4 W | comp | 5% | 213-560 |
| R21 | 51 | 1/4 W | comp | 5% | 213-510 | R82 | 2.7 k | 1/4 W | comp | 5% | 213-272 |
| R22 | 1.2 k | 1/4 W | comp | 5% | 213-122 | R83 | 4.7 k | 1/4 W | comp | 5% | 213-472 |
| R23 | 8.2 k | 1/4 W | comp | 5% | 213-822 | R84 | 5.6 k | 1/4 W | comp | 5% | 213-562 |
| R24 | 27 | 1/4 W | comp | 5% | 213-270 | R85 | 10 k | 1/4 W | comp | 5% | 213-103 |
| R25 | 360 | 1/4 W | comp | 5% | 213-361 | R86 | 560 | 1/4 W | comp | 5% | 213-561 |
| R26 | 560 | 1/4 W | comp | 5% | 213-561 | R87 | 1.2 k | 1/2 W | comp | 5% | 212-122 |
| R27 | 8.2 k | 1/4 W | comp | 5% | 213-822 | R88 | 1 k | 1/4 W | comp | 5% | 213-102 |
| R28 | 1.8 k | 1/4 W | comp | 5% | 213-182 | R89 | 390 | 1/4 W | comp | 5% | 213-391 |
| R29 | 270 | 1/4 W | comp | 5% | 213-271 | R90 | 91 | 1/4 W | comp | 5% | 213-910 |
| R30 | 110 | 1/4 W | comp | 5% | 213-111 | R91 | 51 | 1/4 W | comp | 5% | 213-510 |
| R31 | 1.5 k | 1/2 W | comp | 5% | 212-152 | R92 | 4.7 k | 1/4 W | comp | 5% | 213-472 |
| R32 | 6.8 k | 1/4 W | comp | 5% | 213-682 | R93 | 2.2 k | 1/4 W | comp | 5% | 213-222 |
| R33 | 150 | 1/4 W | comp | 5% | 213-151 | R94 | 5.6 k | 1/4 W | comp | 5% | 213-562 |
| R34 | 150 | 1/4 W | comp | 5% | 213-151 | R95 | 1 k | 1 W | trimmer | | 244-017 |
| R35 | 750 | 1/4 W | comp | 5% | 213-751 | R96 | 1 k | 1/4 W | comp | 5% | 213-102 |
| R36 | 750 | 1/4 W | comp | 5% | 213-751 | R98 | 470 | 1/4 W | comp | 5% | 213-471 |
| R37 | 39 | 1/4 W | comp | 5% | 213-390 | R102 | 470 | 1/4 W | comp | 5% | 213-471 |
| R38 | 39 | 1/4 W | comp | 5% | 213-390 | R103 | 51 | 1/4 W | comp | 5% | 213-510 |
| R39 | 470 | 1/4 W | comp | 5% | 213-471 | R104 | 91 | 1/4 W | comp | 5% | 213-910 |
| R40 | 6.8 k | 1/4 W | comp | 5% | 213-682 | R105 | 100 | 1/4 W | comp | 5% | 213-101 |
| R41 | 220 | 1/4 W | comp | 5% | 213-221 | R106 | 10 k | 1/4 W | comp | 5% | 213-103 |
| R42 | 10 k | 1/4 W | comp | 5% | 213-103 | R107 | 4.7 k | 1/4 W | comp | 5% | 213-472 |
| R43 | 1 k | 1/4 W | comp | 5% | 213-102 | R108 | 4.7 k | 1/4 W | comp | 5% | 213-472 |
| R44 | 4.7 k | 1/4 W | comp | 5% | 213-472 | R109 | 51 | 1/4 W | comp | 5% | 213-510 |
| R45 | 22 | 1/4 W | comp | 5% | 213-220 | R110 | 56 | 1/4 W | comp | 5% | 213-560 |
| R46 | 22 | 1/4 W | comp | 5% | 213-220 | R111 | 100 | 1/4 W | comp | 5% | 213-101 |
| R47 | 390 | 1/4 W | comp | 5% | 213-391 | R112 | 33 | 1/4 W | comp | 5% | 213-330 |
| R48 | 470 | 1/4 W | comp | 5% | 213-471 | R113 | 560 | 1/2 W | comp | 5% | 212-561 |
| R49 | 10 k | 1/4 W | comp | 5% | 213-103 | R114 | 56 | 1/4 W | comp | 5% | 213-560 |
| R50 | 15 k | 1/4 W | comp | 5% | 213-153 | R115 | 2.7 k | 1/4 W | comp | 5% | 213-272 |
| R51 | 4.7 k | 1/4 W | comp | 5% | 213-472 | R116 | 15 k | 1/4 W | comp | 5% | 213-153 |
| R52 | 4.7 k | 1/4 W | comp | 5% | 213-472 | R117 | 10 k | 1/4 W | comp | 5% | 213-103 |
| R53 | 1 k | 1/4 W | comp | 5% | 213-102 | R118 | 560 | 1/4 W | comp | 5% | 213-561 |
| R54 | 1.2 k | 1/4 W | comp | 5% | 213-122 | R119 | 5.6 k | 1/4 W | comp | 5% | 213-562 |
| R55 | 39 k | 1/4 W | comp | 5% | 213-393 | R120 | 51 | 1/4 W | comp | 5% | 213-510 |
| R56 | 2.2 k | 1/4 W | comp | 5% | 213-222 | R121 | 1.2 k | 1/2 W | comp | 5% | 212-122 |
| R57 | 1.2 k | 1/4 W | comp | 5% | 213-122 | R122 | 4.7 k | 1/4 W | comp | 5% | 213-472 |
| R58 | 1 k | 1 W | trimmer | | 244-017 | R123 | 2.2 k | 1/4 W | comp | 5% | 213-222 |
| R59 | 820 | 1/4 W | comp | 5% | 213-821 | R124 | 22 k | 1/4 W | comp | 5% | 213-223 |
| R60 | 1.6 k | 1/4 W | comp | 5% | 213-162 | R125 | 1 k | 1/4 W | comp | 5% | 213-102 |
| R61 | 10 k | 1/4 W | comp | 5% | 213-103 | R126 | 1 k | 1 W | trimmer | | 244-017 |
| R62 | 910 | 1/2 W | comp | 5% | 212-911 | R127 | 5.6 k | 1/4 W | comp | 5% | 213-562 |
| R63 | 51 | 1/4 W | comp | 5% | 213-510 | R132 | 3.3 k | 1/4 W | comp | 5% | 213-332 |
| R64 | 51 | 1/4 W | comp | 5% | 213-510 | R133 | 7.5 k | 1/4 W | comp | 5% | 213-752 |
| R65 | 51 | 1/4 W | comp | 5% | 213-510 | R134 | 100 | 1/4 W | comp | 5% | 213-101 |
| R66 | 510 | 1/4 W | comp | 5% | 213-511 | R136 | 33 | 1/4 W | comp | 5% | 213-330 |
| R67 | 100 | 1/4 W | comp | 5% | 213-101 | R137 | 51 | 1/4 W | comp | 5% | 213-510 |
| R68 | 4.7 k | 1/4 W | comp | 5% | 213-472 | R138 | 51 | 1/4 W | comp | 5% | 213-510 |
| R69 | 1 k | 1/4 W | comp | 5% | 213-102 | R139 | 330 | 1/2 W | comp | 5% | 212-331 |
| R70 | 470 | 1/4 W | comp | 5% | 213-471 | R141 | 180 | 2 W | comp | 5% | 210-181 |
| R71 | 15 k | 1/4 W | comp | 5% | 213-153 | R142 | 680 | 1/4 W | comp | 5% | 213-681 |
| R72 | 6.8 k | 1/4 W | comp | 5% | 213-682 | R143 | 1 k | 1 W | trimmer | | 244-017 |
| R73 | 51 | 1/4 W | comp | 5% | 213-510 | R144 | 130 | 1/4 W | comp | 5% | 213-131 |
| R74 | 51 | 1/4 W | comp | 5% | 213-510 | R145 | 3.3 k | 1/4 W | comp | 5% | 213-332 |
| R75 | 51 | 1/4 W | comp | 5% | 213-510 | R146 | 2.4 k | 1/4 W | comp | 5% | 213-242 |

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RESISTORS (continued)

| | | | | | |
|---|---|---|---|---|---|
| R147 | 470 | 1 W | comp | 5% | 211-471 |
| R148 | 39 | 1/4 W | comp | 5% | 213-390 |
| R149 | 91 | 1/4 W | comp | 5% | 213-910 |
| R150 | 91 | 1/4 W | comp | 5% | 213-910 |
| R151 | 750 | 1 W | comp | 5% | 211-751 |
| R152 | 10 k | 1 W | trimmer | | 244-013 |
| R153 | 15 k | 1/4 W | comp | 5% | 213-153 |
| R154 | 470 | 1/4 W | comp | 5% | 213-471 |
| R155 | 1.8 k | 1/4 W | comp | 5% | 213-182 |
| R156 | 180 | 2 W | comp | 5% | 210-181 |
| R157 | 180 | 2 W | comp | 5% | 210-181 |
| R158 | 33 | 1/4 W | comp | 5% | 213-330 |
| R159 | 4.7 k | 1/4 W | comp | 5% | 213-472 |
| R160 | 33 | 1/4 W | comp | 5% | 213-330 |
| R161 | 1.8 k | 1/4 W | comp | 5% | 213-182 |
| R162 | 10 k | 1/4 W | comp | 5% | 213-103 |
| R168 | 51 | 1/4 W | comp | 5% | 213-510 |
| R169 | 51 | 1/4 W | comp | 5% | 213-510 |
| R170 | 10 | 1/4 W | comp | 5% | 213-100 |
| R171 | 51 | 1/4 W | comp | 5% | 213-510 |
| R172 | 10 | 1/4 W | comp | 5% | 213-100 |
| R173 | 2.7 k | 1/4 W | comp | 5% | 213-272 |
| R174 | 33 | 1/4 W | comp | 5% | 213-330 |
| R175 | 3.9 k | 1/4 W | comp | 5% | 213-392 |
| R176 | 3.9 k | 1/4 W | comp | 5% | 213-392 |
| R177 | 3.9 k | 1/4 W | comp | 5% | 213-392 |
| R178 | 120 | 1/4 W | comp | 5% | 213-121 |

## Transistors

| | | |
|---|---|---|
| Q1 | 2N5179 | 430-025 |
| Q2 | 2N5179 | 430-025 |
| Q3 | 2N5179 | 430-025 |
| Q4 | 2N5179 | 430-025 |
| Q5 | 2N5179 | 430-025 |
| Q6 | MPS2924 | 430-009 |
| Q7 | 2N5179 | 430-025 |
| Q8 | 2N5179 | 430-025 |
| Q9 | 2N5179 | 430-025 |
| Q10 | 2N5179 | 430-025 |
| Q11 | 2N5179 | 430-025 |
| Q12 | 2N5179 | 430-025 |
| Q13 | MPS6531 | 430-017 |
| Q14 | 2N5179 | 430-025 |
| Q15 | 2N5179 | 430-025 |
| Q16 | MPS2924 | 430-009 |
| Q17 | MPS6531 | 430-017 |
| Q18 | MPS3638 | 430-010 |
| Q19 | 2N5179 | 430-025 |
| Q20 | 2N5179 | 430-025 |
| Q21 | 2N5179 | 430-025 |
| Q22 | 2N5179 | 430-025 |
| Q23 | MPS6534 | 430-018 |
| Q24 | 2N4258 | 430-030 |
| Q25 | 2N4258 | 430-030 |
| Q26 | 2N5179 | 430-025 |
| Q27 | 2N5179 | 430-025 |
| Q28 | 2N5179 | 430-025 |
| Q29 | 2N5179 | 430-025 |
| Q30 | MPS6531 | 430-017 |
| Q31 | MPS3638 | 430-010 |
| Q32 | 2N4258 | 430-030 |
| Q33 | 2N4258 | 430-030 |
| Q34 | 2N5179 | 430-025 |
| Q35 | 2N5179 | 430-025 |
| Q36 | 2N5179 | 430-025 |
| Q37 | 2N5179 | 430-025 |
| Q38 | 2N5179 | 430-025 |
| Q39 | MPS6534 | 430-018 |
| Q40 | 2N5179 | 430-025 |
| Q41 | MPS6531 | 430-017 |
| Q42 | MPS3638 | 430-010 |
| Q43 | 2N4959 | 430-022 |
| Q44 | 2N4959 | 430-022 |
| Q45 | MPS6534 | 430-018 |
| Q46 | 2N5109 | 430-024 |
| Q47 | 2N5109 | 430-024 |
| Q48 | 2N2219 | 430-006 |
| Q49 | MPS6531 | 430-017 |
| Q50 | MPS6531 | 430-017 |
| Q51 | MPS6531 | 430-017 |
| Q52 | MPS6534 | 430-018 |
| Q53 | 2N5179 | 430-025 |
| Q54 | MPS6518 | 430-016 |
| Q55 | MPS6518 | 430-016 |
| Q56 | MPS6518 | 430-016 |
| Q57 | MPS6518 | 430-016 |
| Q58 | MPS2924 | 430-009 |

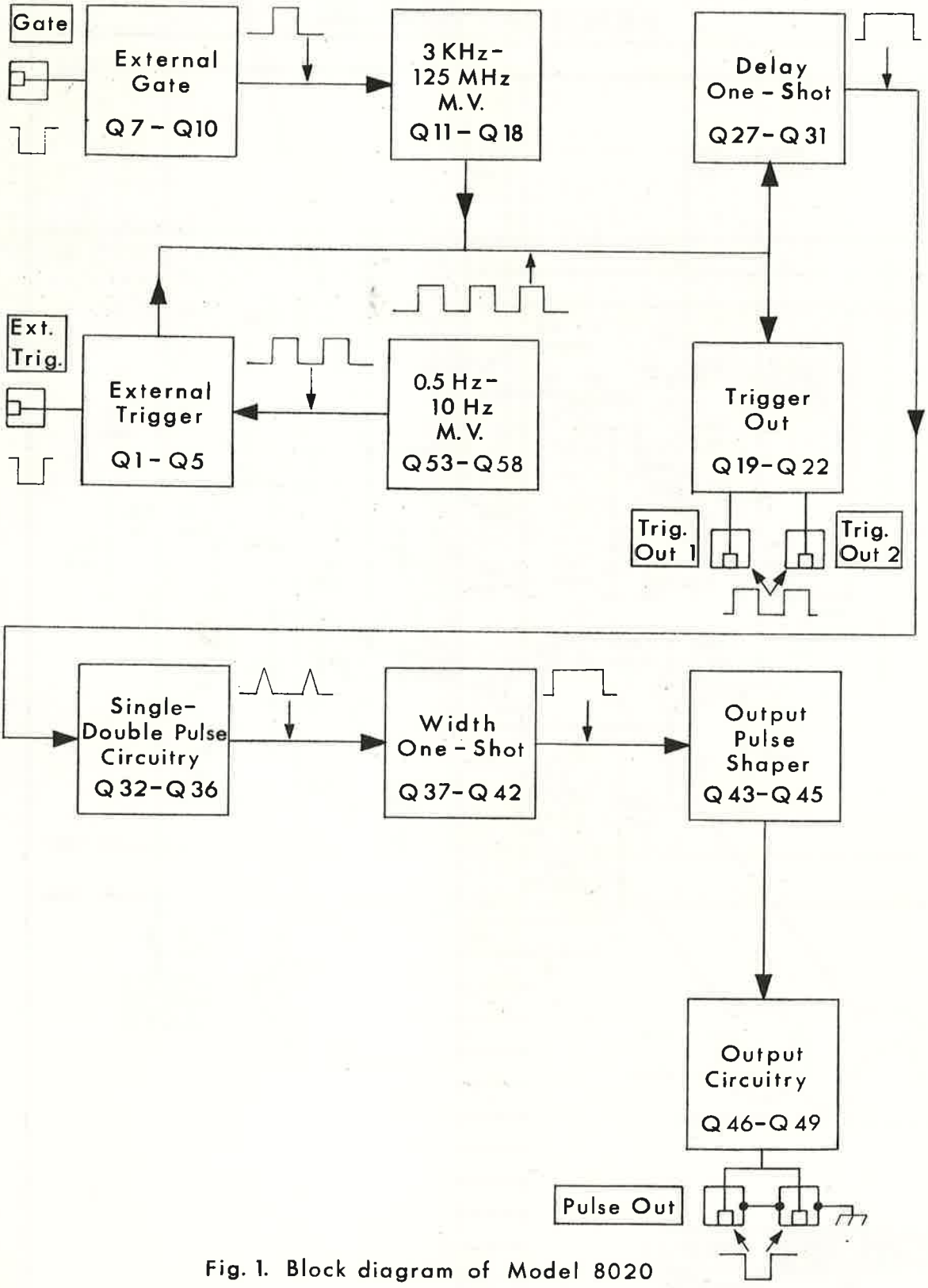


Fig. 1. Block diagram of Model 8020

| REV | DATE | REVISIONS |
|---|---|---|
| A | 9SEP70 | DELETED R165, R166, R167 & D40. |
| B | 7APR78 | CHG'D: R33, R34 TO 150, R60 TO 1.6K, R56 TO 2.2K, R41 TO 220; Q11, Q12, Q14 & Q15 TO 2N5179 |

4.1V / 3.6V

EXT. SCHMITT TRIG.

NOTE: WIDTH DEPENDENT ON INPUT WIDTH OF EXT. TRIGGER

4.1V / 3.6V

>10 Hz INHIBIT

4.5V / 7.3V to 4.0V, VARIABLE

GATE SCHMITT TRIG.

8.3V / 4.5V to 8.0V, VARIABLE

3 KHz–125 MHz M.V.

0.5–10 Hz M.V.

+24V
+12V
+4.5V
-12V
-24V
+9.3V
+0.3V
0.0V
-0.4V

C4 180pF
R10 56
R11 56
C2 .05μF
R4 1K
D1
Q1 2N5179
C5 180
D2
D3
R7 51
C3 10pF
R8 1K
R9 8.2K
Q3 2N5179
R13 10K
R12 270
C6 180pF
Q4 2N5179
Q5 2N5179
Q6 MPS 2924
C7 180pF
R14 240
R15 51
C8 5pF
C9 180pF
D4
R17 15K
Q53 2N5179
R18 33
R16 22K
R19 51
R20 51
D5
D6
Q7 2N5179
Q8 2N5179
C10 5pF
C11 .05μF
R21 51
R22 1.2K
R23 8.2K
R24 27
R25 360
C12 180pF
C132 180pF
R26 560
R27 8.2K
C13 180pF
R28 1.8K
Q9 2N5179
Q10 2N5179
C14 180pF
R29 270
C15 5pF
R30 110
R31 1.5K, ½W
D7 FH-1100
ON
OFF
GATE
C16 180pF
Q13 MPS 6531
R33 150
R34 150
R43 1K
C23 180pF
R44 4.7K
C27 180pF
R50 15K
R45 22
C17 100pF
R46 22
C18 100pF
R35, 750
R36, 750
Q11 2N5179
Q12 2N5179
R32 6.8K
R40 6.8K
C19, 2.5-10pF
R37 39
R38 39
Q14 2N5179
Q15 2N5179
R39 470
R98 470
C21 180pF
C20 180pF
R41 220
Q16 MPS 2924
C22 180pF
R42 10K
R47 390
D8
D9
R48 470
C24 180pF
D10
D11
D12 FH-1100
D13 FH-1100
C25 180pF
R49 10K
C26 180pF
Q17 MPS 6531
D14
Q18 MPS 3638
R51 4.7K
R52 4.7K
R53 1K
Q58 MPS 2924
R59 820
R60 1.6K
TP
R58 1K
FINE FREQ.
R57 1.2K
C29 180pF
R56, 2.2K
C30 180pF
Q57 MPS 6518
C117 180pF
Q56 MPS 6518
C118 180pF
C28 25μF
Q54 MPS 6518
Q55 MPS 6518
C31 180pF
R54 1.2K
R55 39K
+24V
+12V
+4.5V
TO BASE Q24
TO BASE Q25
-12V
-24V
>10Hz INHIBIT LINE
.5–10 Hz DRIVE LINE

RG-174/U
EXT TRIG
-0.6V MIN. REQ'D FOR EXT. TRIGGER

RG-174/U
GATE
-0.6V MIN. REQ'D TO GATE ON

GATE ON: -0.4V
GATE OFF: +0.85V

GATE ON: +5.8V
GATE OFF: +2.0V

NOTES: SEE DRAWING 8020-3

FREQUENCY

| | |
|---|---|
| 125 MHz | C33, 22 pF |
| 100 MHz | C34, 100pF |
| 30 MHz | C35, 430pF |
| 10 MHz | C36, .002 μF |
| 3 MHz | C37, .0068μF |
| 1 MHz | C38, .022μF |
| 300 KHz | C39, .068μF |
| 100 KHz | C40, .22μF |
| 30 KHz | C41, .68μF |
| 10 KHz | |
| 10 Hz | |

R61 10K

0.0V / -12.0V / 4.0V / 1.2V

OBSERVABLE ONLY IN 10 Hz POSITION

BNC BERKELEY NUCLEONICS CORP.
1198 TENTH ST., BERKELEY, CA 94710

SCALE:
APPROVED BY: MB
DRAWN BY JLW

| NO. | DATE | REVISIONS |
|---|---|---|
| A | 9SEP70 | DELETED: R97, R163, R164, R78 & D39. ADDED: R170 & R171. |
| B | 15JUL71 | DEL.: Q52, D23, D24, R169, R83, R84, R85, R86, C54, C55, C121, D26. ADD: R172, R173, R174, C133, D38, R175. CHANGE: R96 TO 1.2K, R94 TO 220Ω. |

DELAY LINE DRIVER & TRIGGER OUT SWITCH

DELAY ONE-SHOT & 6V E.F.

DOUBLE PULSE CIRCUITRY

GATE

NOTE 4

3nS

0.6V MIN

0.0V

4.3V

3.2V

+24V

+12V

+4.5V

+6.0V

-12V

-24V

C119 180pF

R62 910Ω 1/2W

R168 51

C120 10pF

R68 4.7K

R172 10

C48, 180pF

Q24 2N4258

Q25 2N4258

FROM D12

FROM D13

D16

Q26 2N5179

L1 .33μH

C133 180pF

R67 100

R73 220

R173 2.7K

D38 IN270

R174 33

R175 3.9K

+0.31V

8nS DELAY LINE RG-174/U

R64 51

D17 D18

R69 1K

R74 51

D20 D21

R171 51

Q19 2N5179

Q20 2N5179

Q21 2N5179

Q22 2N5179

R63 51

R170 51

C46 180pF

-2.1V

-2.7V

D19

C43 .05μF

C44 25pF

R65 22

C45 180pF

Q23 MPS 6534

-3.3V

R72 6.8K

C50 25pF

R75 22

C51 180pF

R66 510

R70 470

R71 15K

C49 180pF

R76 510

R82 2.7K

C52 180pF

R77 150

R81 56

C122 .05μF

C53 5pF

R79 51

R80 560Ω 1/2W

Q27 2N5179

Q28 2N5179

D22

+0.65V

R88 1K

C56 180pF

R89 390

R90, 91 C57, 180pF

C58, 180pF

Q50 MPS 6531

C59 180pF

R91 51

C123 .05μF

R93 2.2K

Q29 2N5179

Q30 MPS 6531

C60 180pF

C60 180pF

D25 FH-1100

R92 4.7K

C63 180pF

R170 10

C61 25pF

C62 10pF

Q31 MPS 3638

C75 180pF

C76 180pF

R94 220

R95 1K

FINE DELAY

TP

R96 1.2K

R87 1.2K 1/2W

C77 10pF

R103 51

R102 470

R106 10K

R107 4.7K

R108 4.7K

C124 180pF

C79 180pF

D28

C80 180pF

D29

Q32 2N4258

Q33 2N4258

Q35 2N5179

Q36 2N5179

Q34 2N5179

L2 .22μH

L3 .22μH

R104 91Ω

R105 100

C78 180pF

RG-174/U TO Q39 BASE

+6.0V TO Q40

TRIG OUT #1 BACK PANEL

TRIG OUT #2 FRONT PANEL

RG-174/U

NOTE: TRIGGER OUTPUTS MUST BE TERMINATED INTO 50Ω.

0.0V

-0.8V

+0.65V to -1.9V VARIABLE

DOUBLE PULSE MODE ONLY 0.6V MIN 0.0V

4nS

NOTE 4

4nS

0.6V MIN 0.0V

$T_R$ = 2nS

DOUBLE PULSE

SINGLE PULSE

DELAY

| | |
|---|---|
| C64, .33μF | 100 μS |
| C65, .1μF | 30 μS |
| C66, .033μF | 10 μS |
| C67, .01μF | 3 μS |
| C68, .0033μF | 1 μS |
| C69, .001μF | 300 nS |
| C70, 270pF | 100 nS |
| C71, 68pF | 30 nS |
| C72, 18pF | 10 nS |
| | 5 nS |

NOTES: SEE DRAWING 8020-3

| NO. | DATE | REVISIONS |
|---|---|---|
| B | 15JUL71 | CHANGE: D22 TO IN4154. |
| C | 12OCT71 | CHANGE: DELAY SWITCH TO 2-POLE 10-POSITION. |
| D | 7APR78 | CHG'D: DL-2 TO L1, .33μH, DL-3 & DL-4 TO L2 & L3, .22μH; R104 TO 91Ω, R153 TO 15K |

BNC BERKELEY NUCLEONICS CORP. 1198 TENTH ST., BERKELEY, CA 94710

SCALE:

DATE: 20 MAR 70

APPROVED BY: MB

DRAWN BY JLW

REVISED 12 OCT 71

PULSE GENERATOR MODEL 8020

DELAY & DOUBLE PULSE

DRAWING NUMBER 8020-2D

| NO. | DATE | REVISIONS |
|---|---|---|
| F | 7APR78 | CHG'D: Q39 TO Q37, Q43 & Q44 TO 2N4959; R139 TO 330, R153 TO 15K, R170 TO R178; +3.9V TO +3.7V |
| | | |

| NO. | DATE | REVISIONS |
|---|---|---|
| A | 9SEP70 | DELETED: R124, R161, R162 & D36. |
| B | 15JUL71 | DEL.: R111, R116, R117, R118, R119, R171, R146, D34. ADD: R176, R177, D39, D40, D41, D42. CHANGE: R125 to 1.2K, R127 to 220. |
| C | 12OCT71 | CHANGE: WIDTH SWITCH TO 2-POLE, 10 POS. |
| D | 16NOV71 | DEL.: D37, C117. CHANGE R139 TO 270, R159 TO 560. ADD R170. C132. |
| E | 14DEC71 | CHANGE C94 to 18pf |

WIDTH ONE-SHOT

OUTPUT PULSE SHAPER

OUTPUT CIRCUITRY

4.4V
3.3V
-2.0V
-2.8V
+24V
+12V
+4.5V
+6.0V
-12V
-24V
4nS
0.6V
0.0V
C81 180pF
R110 150
R114 56
R115 2.7K
C125 .05μF
R123 2.2K
R120 51
R177 3.9K
Q37 2N5179
Q38 2N5179
D39 IN270
DRIVE FROM Q35 & 36
RG-174U
0.31V
+0.65V
R109 51
R176 3.9K
R112 33
C82 10pF
R113 560, ½W
D30
C85 10pF
R121 1.2K, ½W
Q41 MPS6531
D33 FH-1100
C96 180pF
R122 4.7K
Q40 2N5179
C99 180pF
Q42 MPS3638
C100 180pF
R127 220
R126 1K
TP
FINE WIDTH
R125 1.2K
R139 330, ½W
R141 180, 2W
C130 10pF
R169 51
C103 5pF
R138 51
C126 .05μF
R178 120
Q43 2N4959
Q44 2N4959
+3.7V
R160 33
R159 560
C131 5pF
R137, 56
R158 33
R136 33
R132 3.3K
C101 180pF
Q45 MPS6534
R133 7.5K
R134 180
C102 180pF
R142 620
-2.6V
AMPLITUDE
R143 1K
C104 .05μF
C105 180pF
R144 150
R145 1K
C106 180pF
D40 IN5231
5.1V
R147 430 1W
Q51 MPS 6531
4.5V EMITTER FOLLOWER
C107 .05μF
R151 750, 1W
C127 180pF
C114 50μF 25V
C115 50μF, 25V
R152 10K
OUTPUT DRIVE
R153 15K
C111 180pF
Q49 MPS6531
D35
R154 470
Q46 2N5109
Q47 2N5109
C132 180pF
C110 180pF
R148 39
C108 20pF
SEE SYMBOL 3
Q48 2N2219
R149 91
C109 100μF, 16V
R150 91
D41 FH1100
D42 FH1100
R155 1.8K
R156 180, 2W
R157 180, 2W
C113 50μF, 25V
C112 50μF, 25V
C128 .05μF
C129 180pF
0.0V
-0.8V
OUTPUT
MUST BE TERMINATED INTO 50Ω
AMP 202515-3
+24V 28
-24V 29
+12V 16
-12V 17
GND
+0.65V
+0.65V to -1.9V VARIABLE

| | | |
|---|---|---|
| C86, .33μF | ○—\|\|—○ | 100 μS |
| C87, .1μF | ○—\|\|—○ | 30 μS |
| C88, .033μF | ○—\|\|—○ | 10 μS |
| C89, .01μF | ○—\|\|—○ | 3 μS |
| C90, .0033μF | ○—\|\|—○ | 1 μS |
| C91, .001μF | ○—\|\|—○ | 300 nS |
| C92, 270pF | ○—\|\|—○ | 100 nS |
| C93, 68pF | ○—\|\|—○ | 30 nS |
| C94, 18pF | ○—\|\|—○ | 10 nS |
| | ○ ○ | 5 nS |

WIDTH

NOTES:
1. ALL DIODES ARE IN4154, UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ¼ WATT, UNLESS OTHEWISE NOTED.
3. REF. DRAWING 8020-2: DL-2.3 + 4 ARE CLIPPING LINES WITH A TWO-WAY (2T) DELAY OF 4 NS.
4. TRIGGERING WAVEFORMS ARE OBSERVED ON A SAMPLING SCOPE WITH 350 pSEC RISE TIME.
5. DC VOLTAGES MEASURED WITH FREQUENCY AT EXT.

SYMBOLS:
1. TP DESIGNATES TIE POINTS.
2. SYMBOL ▷ DESIGNATES COMPONENT IS PHYSICALLY CLOSE TO CIRCUITRY SHOWN.
3. ⊘ IS A SINGLE APERTURE FERRITE
4. ⊘⊘ IS A MULTIPLE APERTURE FERRITE
5. ⊖ COAXIAL LINE.
6. INDICATES TRANSISTOR CASE IS TIED TO COLLECTOR EXTERNALLY.
7. ⚠ INDICATES COMPONENT IS ON PRINTED CIRCUIT SIDE OF BOARD.

BNC BERKELEY NUCLEONICS CORP.
1198 TENTH ST., BERKELEY, CA 94710

| SCALE: | APPROVED BY: | DRAWN BY: JLW |
|---|---|---|
| DATE: 20MAR70 | MB | REVISED 14 DEC 71 |

PULSE GENERATOR MODEL 8020

WIDTH & OUTPUT — DRAWING NUMBER 8020-3F