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CANBERRA

Model 2040 Coincidence Analyzer

User's Manual

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COINCIDENCE ANALYZER
Model 2040

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Section 1
INTRODUCTION

1.1 COINCIDENCE ANALYZER OPERATION

The Canberra Model 2040 Coincidence Analyzer accepts up to four input signals generated by energy analysis or time discrimination modules. In turn, it produces a logic pulse output when all of the inputs enabled by front-panel switches occur within the resolving time set by front-panel controls; that is, when the leading edges of all selected input logic pulses occur within a time period equal to the "resolving time" selected.

Two resolving time ranges are provided: 0.1 - 1.0 microsecond and 10 - 100 nanoseconds. The 0.1 to 1.0 microsecond range is typically used for energy coincidence analysis; the 10 - 100 nanosecond range is used for timing or simultaneous energy and timing coincidence experiments.

The input signals are positive NIM logic signals such as the +5 volt nominal pulses 0.5 microseconds wide from 2035A, 2036A, and 2037A Timing Single Channel Analyzers. The pulse width is not important since only the leading edge is used by the 2040 Coincidence Analyzer to trigger the internal pulses. The positive or "slow" outputs from the 1427 ARC Timing, the 1428 Constant Fraction Discriminator, and the 2055 Logic Shaper and Delay may also be used as inputs to the 2040.

The 2040 output pulse is a NIM logic pulse, and is produced when all switch-selected input conditions are met. For example, if A and B and ANTI inputs are IN, pulses must be present at A and B and not at ANTI, with the leading edges of A and B within the resolving time of the unit. A truth table for the various inputs is given in Figure 4-3.

1.2 APPLICATIONS

The inputs to the Model 2040 can be any standard NIM logic pulse such as produced by SCAs. A coincidence set up with NaI detectors is shown in Figure 1. The unipolar output pulse from the 2012 Amplifier is processed by a Model 2036A Constant Fraction Timing SCA to produce a standard NIM logic pulse for the 2040 Coincidence unit. In order to properly operate the system a delay curve is obtained in which coincidences are measured as a function of relative delay between the two detectors. The delay controls on each 2036A are used to set relative delay. In the ideal case of no time jitter in either detector, the solid curve in Figure 2 is obtained. However, real detectors will produce the dashed curve, and the minimum resolving time setting is where there is a flat region (indicating all true coincidences are collected). The proper relative delay is then the value for the center of the flat region.

A coincidence circuit in which the spectrum of one detector is collected in an MCA gated by coincidence pulses from the 2040 is shown in Figure 3. The timing signals are derived from Model 2037A Crossover Timing SCAs with bipolar pulses from the 2011 amplifiers. For Canberra ADCs operating in the late coincidence mode the Model 2055 Logic Shaper and Delay may be omitted since only a trigger pulse is required.

The 2040 may also be used in a slow coincidence mode in conjunction with a time-to-amplitude converter such as the Model 2043 Time Analyzer shown in Figure 4. The 2040 coincidence would be used with the RANGE switch set to 0.1 - 1μsec. Care must be used in the arrangement shown to set the relative delays properly, which is done by adjusting 2015A amplifier time constants, 2043 output delay, and 1457 delay amp time constants.

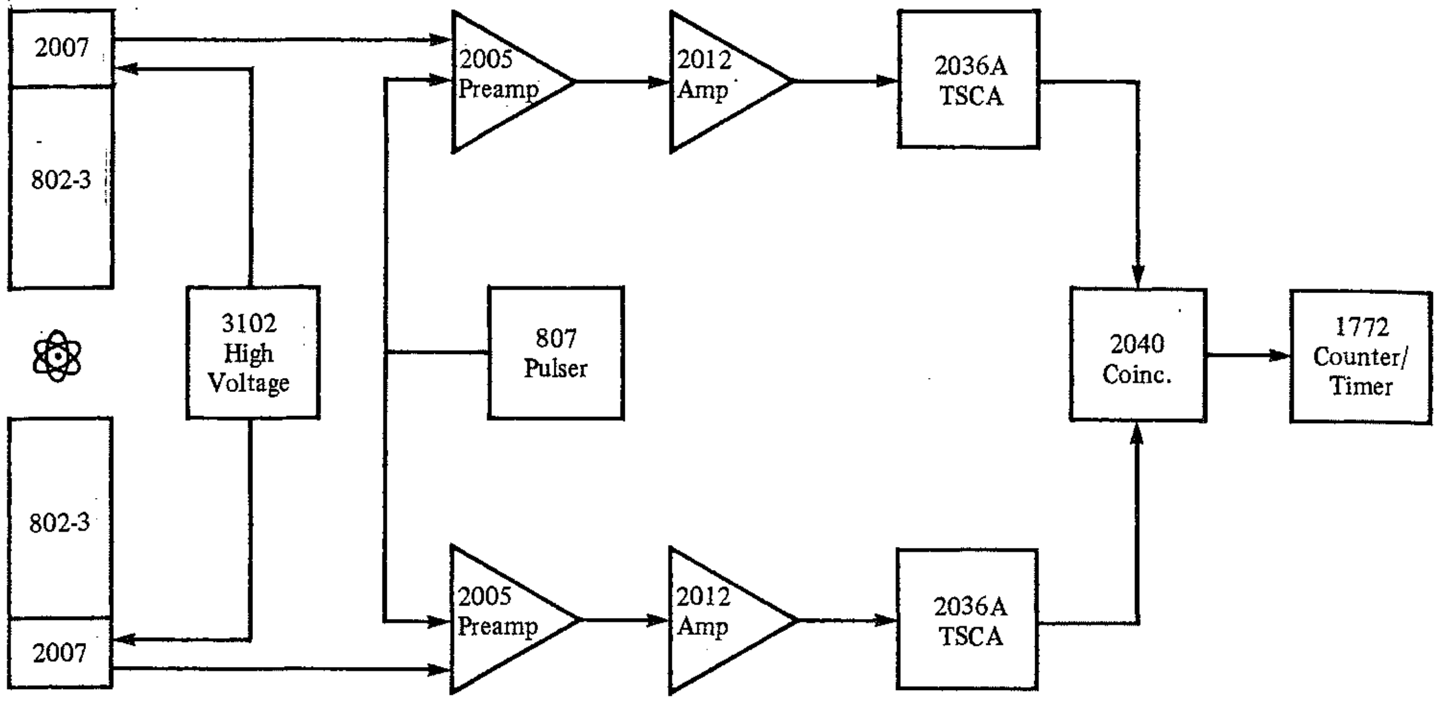


Figure 1. Coincidence Electronics.

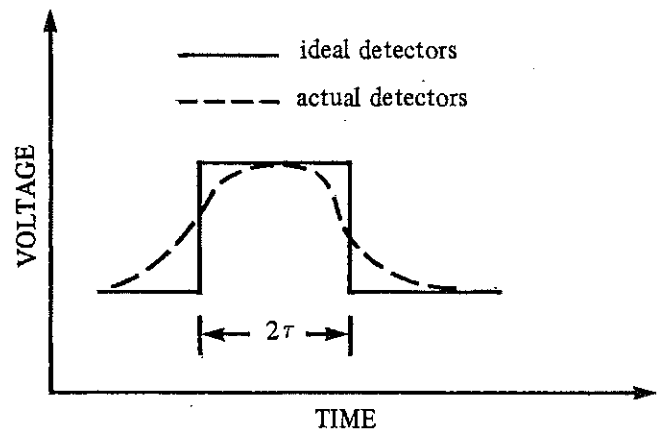


Figure 2. Resolving Time Curve.

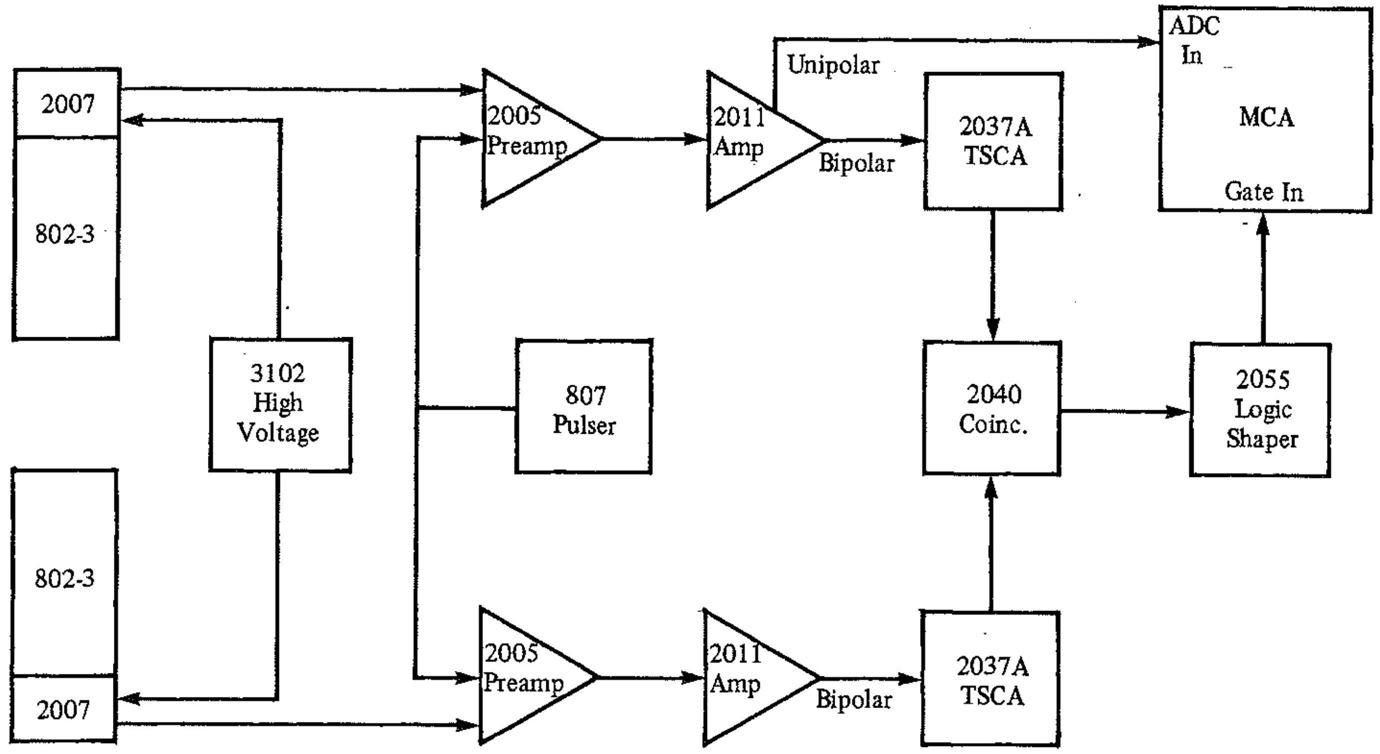


Figure 3. Coincidence Electronics with Crossover Timing.

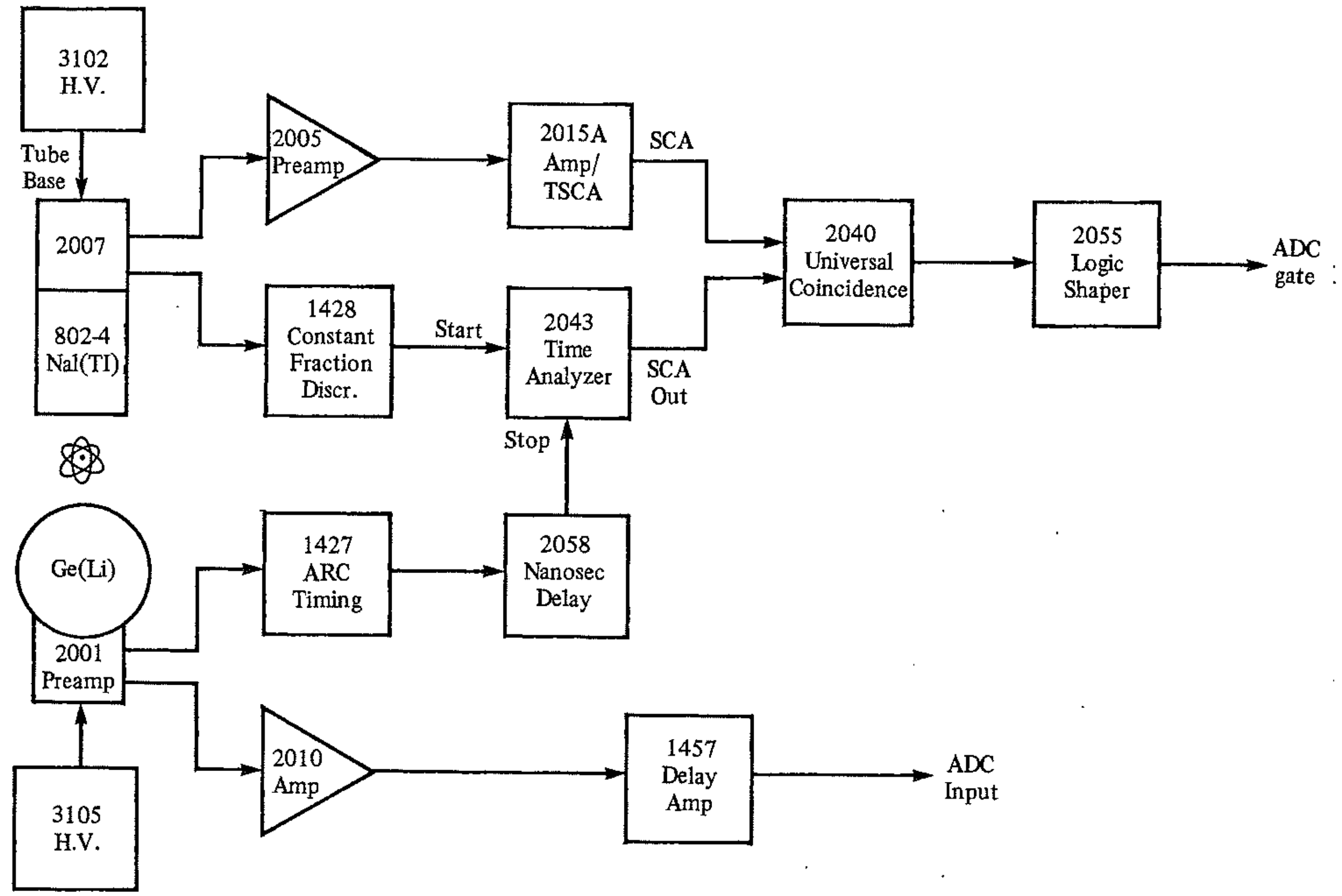


Figure 4. Coincidence Circuit with Time Analyzer.

Section 2
SPECIFICATIONS

2.1 INPUTS

INPUT SIGNALS	Number: up to 4; 3 coincidence and 1 anti-coincidence. Polarity: positive. Amplitude: 4 to 10 volts. Rise Time: 50 nanoseconds, maximum. Duration: 100 nanoseconds, minimum. Impedance: 2.2K ohms shunted by 120pf. Connectors: BNC

2.2 OUTPUTS

OUTPUT SIGNAL	Polarity: positive. Amplitude: 10 volts, nominal. Rise Time: 50 nanoseconds, maximum. Duration: 1 microsecond, nominal. Impedance: 50 ohms, DC coupled. Connector: BNC

2.3 PERFORMANCE

RESOLVING TIME	10 - 100 nanoseconds, and 0.1 - 1.0 microsecond, range-switch and rotary-control selectable.
STABILITY	Better than 5% of setting or 3 nanoseconds, whichever is larger.
LINEARITY	See Figure 3-1.

2.4 CONTROLS

RESOLVING TIME	Front panel potentiometer providing a 10:1 range (within the range set at the RANGE switch).
RANGE	Front panel switch for selecting resolving time ranges of 10 - 100 nanoseconds or 0.1 - microsecond.
A, B, C	Front panel toggle switch to accept (IN) signal applied to adjacent connector for coincidence operation.
ANTI	Front panel toggle switch to accept (IN) signal applied to adjacent connector for anti-coincidence operation.

2.5 POWER REQUIREMENTS	+24V – 35mA -24V – 80mA +12V – 170mA -12V – 12mA
2.6 PHYSICAL	
SIZE	Standard single-width module (1.35 inches wide) (3.38cm) per TID-20893.
WEIGHT	2.8 lbs. (1.26 kg.)

Notes

Section 3
CONTROLS AND CONNECTORS

3.1 GENERAL

The functions of the controls and connectors located on the module are described in this section. It is recommended that this section be read before proceeding with the operation of the module.

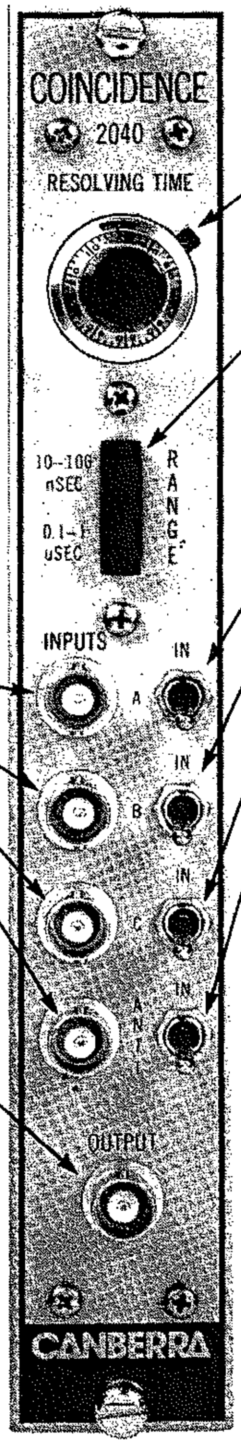


Figure 3-1.

3.2 CONTROLS

RESOLVING TIME CONTROL
This potentiometer selects resolving times within the range set by the RANGE switch.

RANGE SWITCH
This switch determines the resolving time range within which the Model 2040 will operate. There are two positions: 10 - 100 nanoseconds and 0.1 - 1.0 microsecond.

TOGGLE SWITCHES (IN)
These switches are used to select those inputs which will be considered for the coincidence (or anti-coincidence) experiment; all inputs not selected by these switches are ignored; the absence of any input pulse at an input enabled by the toggle switch will inhibit any output from the Model 2040 Coincidence Analyzer.

3.3 CONNECTORS

INPUT CONNECTORS
Connectors A through C are used for coincidence events. If all signals at these connectors (enabled by the corresponding input toggle switches) occur within the resolving time set by the RESOLVING TIME controls, an output signal will occur at the OUTPUT connector. The anti-coincidence input (ANTI) is used to inhibit an output, imposing a NAND condition.

OUTPUT CONNECTOR
A positive 10 volt pulse with a rise time less than 50 nanoseconds and a duration of one microsecond is produced when a coincidence (or anti-coincidence, depending upon the connections made) occurs among the enabled inputs to the Model 2040.

Section 4
OPERATING INSTRUCTIONS

4.1 GENERAL

Since it is impossible to determine exactly how the user will operate his module in a specific experiment, explicit instructions cannot be given. However, if the following general procedures are performed, the user will become as familiar with the operation of the module as is necessary.

4.2 SET UP

1. Insert the Model 2040 Coincidence Analyzer module in an AEC compatible bin such as the Canberra Model 2000.

2. For coincidence operation, connect input signals, which meet the conditions detailed in Section 2.1, to BNC connectors A and B. (See also Section 1.2).

3. Set toggle switches A and B to the IN position.

4. Set the toggle switches associated with input C and ANTI at their out positions (down).

5. Connect the OUTPUT connector to an oscilloscope or to the input of a scaler such as the Canberra Model 1772. Set the sensitivities of the oscilloscope to 5V/cm and 1 microsecond/cm, vertical and horizontal, respectively.

6. Set the RANGE switch to 0.1 - 1 microsecond; set the RESOLVING TIME control to 10 (max.).

4.3 COINCIDENCE CHECKOUT

1. Activate the input signals and observe the OUTPUT signal on the oscilloscope (or observe the scaler beginning to count). If an output cannot be seen, using the oscilloscope check that the inputs are as specified in Section 2.1. An output signal will be generated when the input signals occur within one microsecond of each other.

2. Repeat step 1 with the following input signal combinations:

   a. Input A and Input C.
   b. Input B and Input C.
   c. Inputs A, B, and C.

   Be sure that the IN switch is set for those inputs which are to be enabled (and that they are off for those not enabled).

3. Keeping the set up as in Step 2, reduce the RESOLVING TIME control setting and note that the OUTPUT signal finally disappears.

4. Using two coincidence inputs (A and B, for example) delay one with respect to the other. The following diagrams show how Canberra modules can be used for this test:

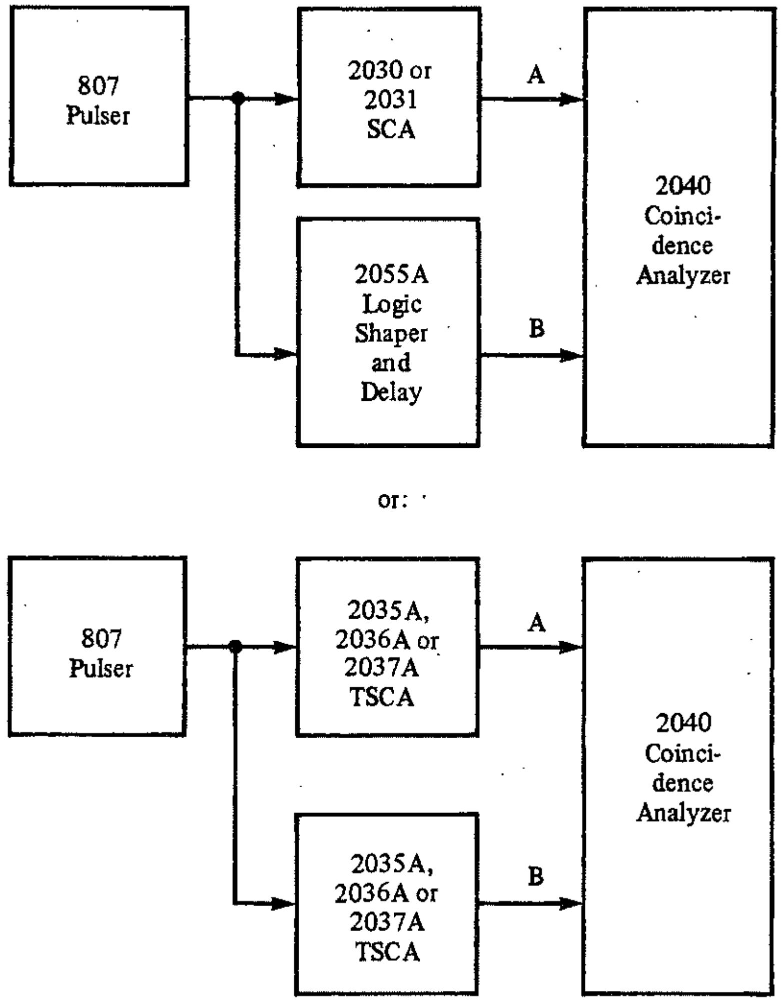


Figure 4-1. * (Use variable delay on one Model 2037A SCA)

5. Check that an output is generated when the input signals occur within the RESOLVING TIME set on the RESOLVING TIME control. Vary the delay and RESOLVING TIME controls and check them at different settings. Refer to Figure 4-2 for a typical linearity/accuracy curve of actual resolving time vs. indicated time.

6. Set all IN switches at their off position (down). Note that the OUTPUT signal disappears.

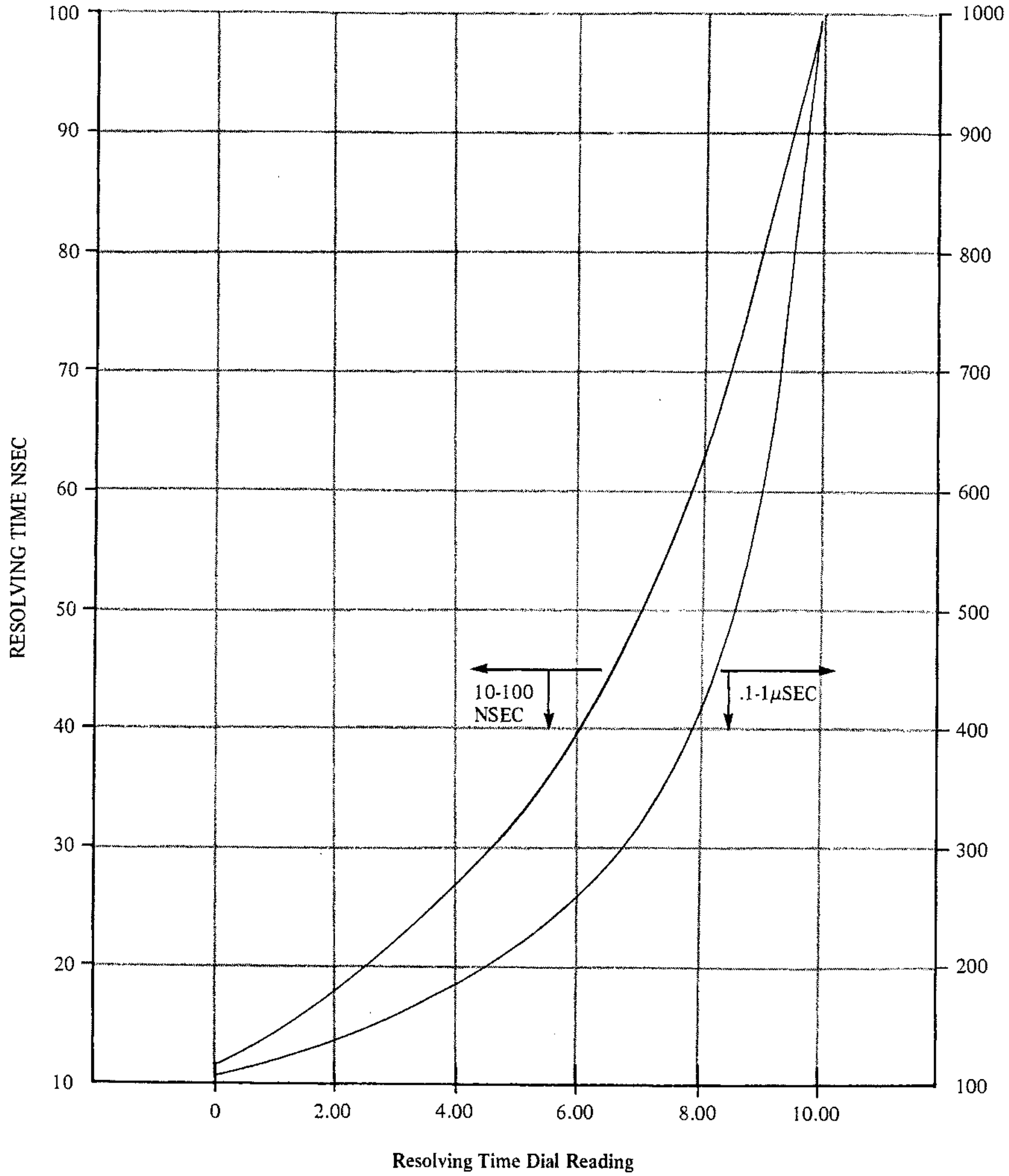


Figure 4-2. Dial Resolving Time vs. Actual Resolving Time.

4.4 ANTI-COINCIDENCE

1. Supply a signal to the ANTI connector and one to the INPUT A connector.
2. Set the RESOLVING TIME control at 10.
3. Set the RANGE switch at 0.1 - 1 microsecond.
4. Set the A IN switch at IN.
5. Set the ANTI IN switch at IN.
6. Set all other switches at their off position (down).
7. Observe the OUTPUT. No output pulse will be generated if any input signals on connectors A, B, or C occur in coincidence with the signal at the ANTI connector.
8. Repeat Step 7 utilizing other coincidence inputs. The following truth table will be obtained when operating the Model 2040 Coincidence Analyzer:

INPUT				
SIGNAL				
A	B	C	ANTI	OUTPUT
0	0	0	1	0
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	1	0
1	0	1	1	0
1	1	0	1	0
1	1	1	1	0
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	0	1

* **Figure 4-3.**

* NOTE: It is assumed that a "0" input refers to the corresponding channel that is switched "OUT."

CIRCUIT DESCRIPTION

Each input to the Model 2040 has a differentiator and a one-shot associated with it. The differentiator detects the leading edge of the input pulse and generates a negative spike to trigger the one-shot.

The ANTI input is disabled by holding the buffer transistor (Q13) on, so that an input will not make a trigger spike. The three COINC inputs are disabled by turning off the one-shot input transistor. This also makes the output of the one-shot high so that it can be ANDed with enabled one-shots.

RESOLVING TIME is essentially the width of the one-shots. The last input must be triggered before the first input one-shot times out. (See Timing Diagrams). When the third triggered input one-shot goes high, this makes the input to the Schmitt Trigger made up of Q20, Q21, and Q22 go high and give a TRIG X pulse.

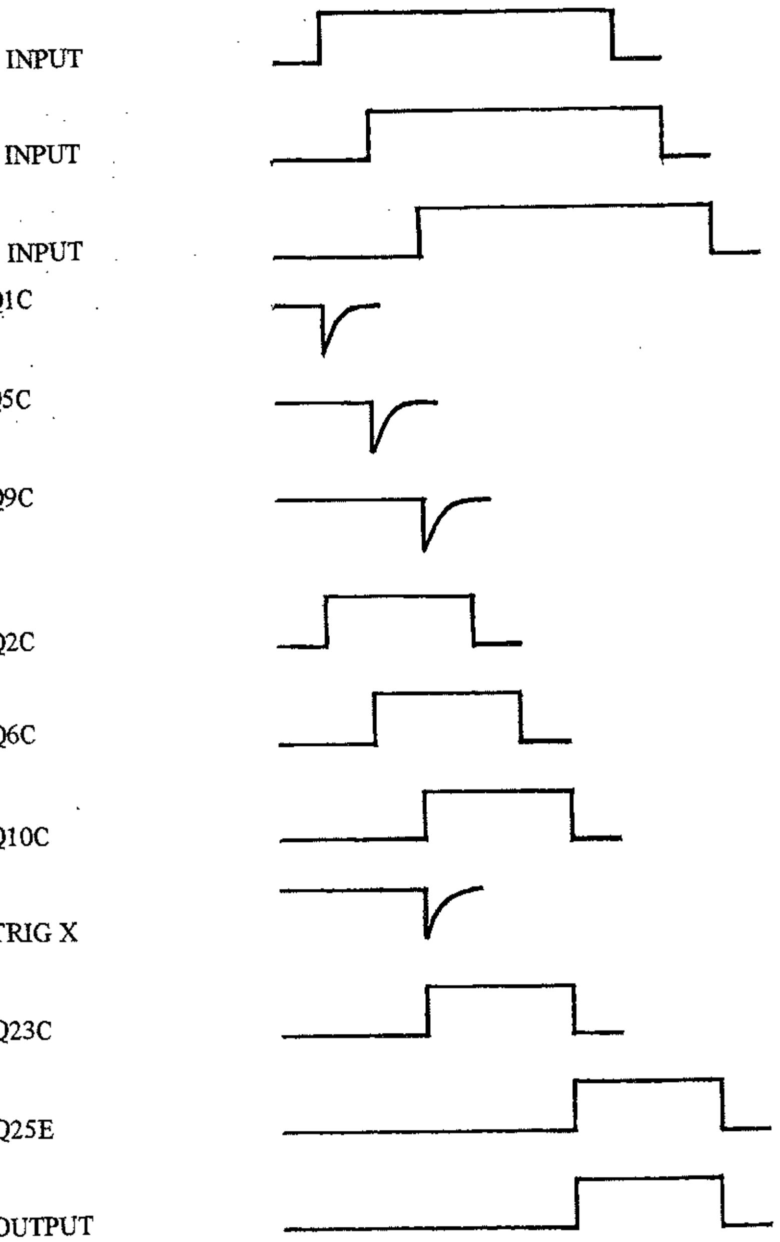
TRIG X triggers the ENABLE ONE-SHOT (Q23, Q24) which in turn triggers the OUTPUT ONE-SHOT (Q25, Q27) to generate an output.

However, if an ANTI input occurs within the resolving time, a TRIG Y will be generated by Schmitt Trigger Q17, Q18 and Q19. This triggers the DISABLE ONE-SHOT (Q30, Q31) and holds the output of the ENABLE ONE-SHOT low to inhibit an output.

Resolving time is varied by the RESOLVING TIME control and the RANGE switch to control the time of each one-shot.

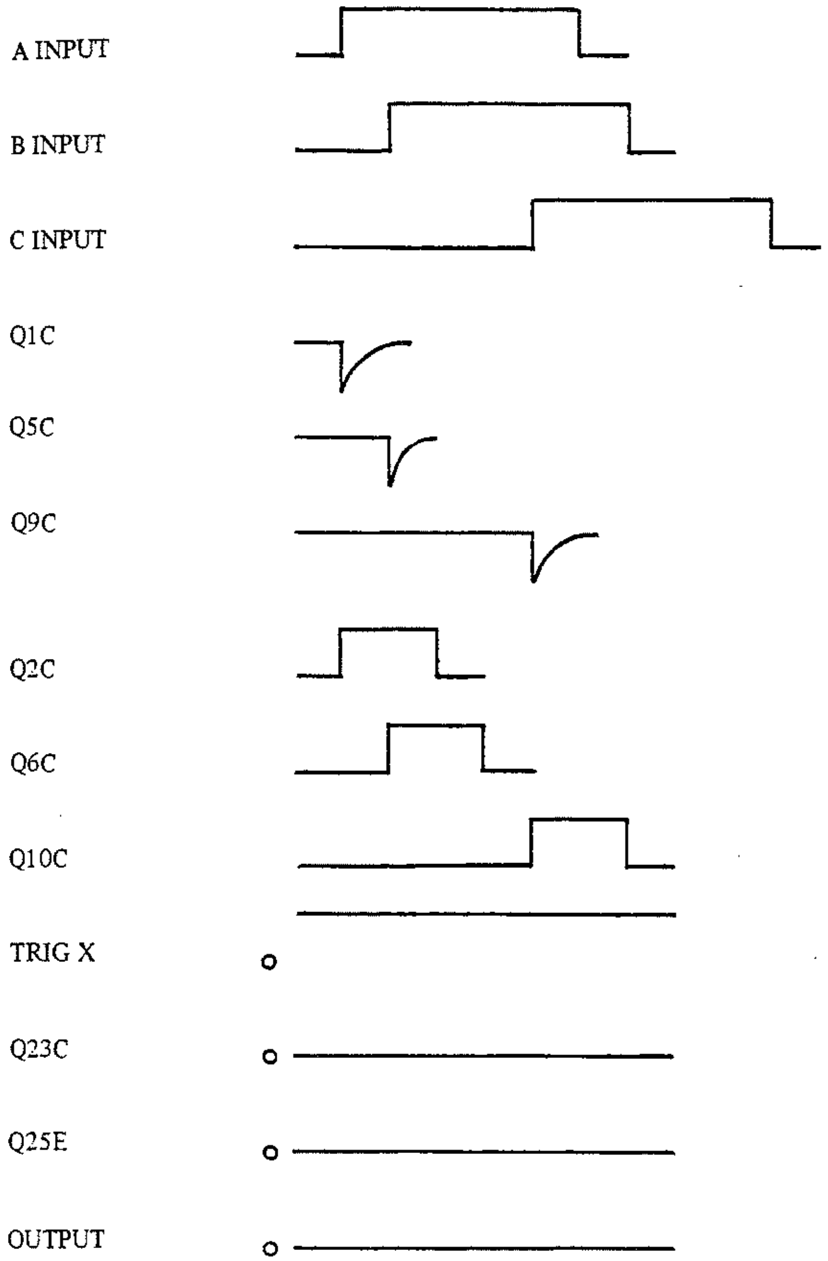
Case 1

3 COINC INPUTS WITHIN RESOLVING TIME



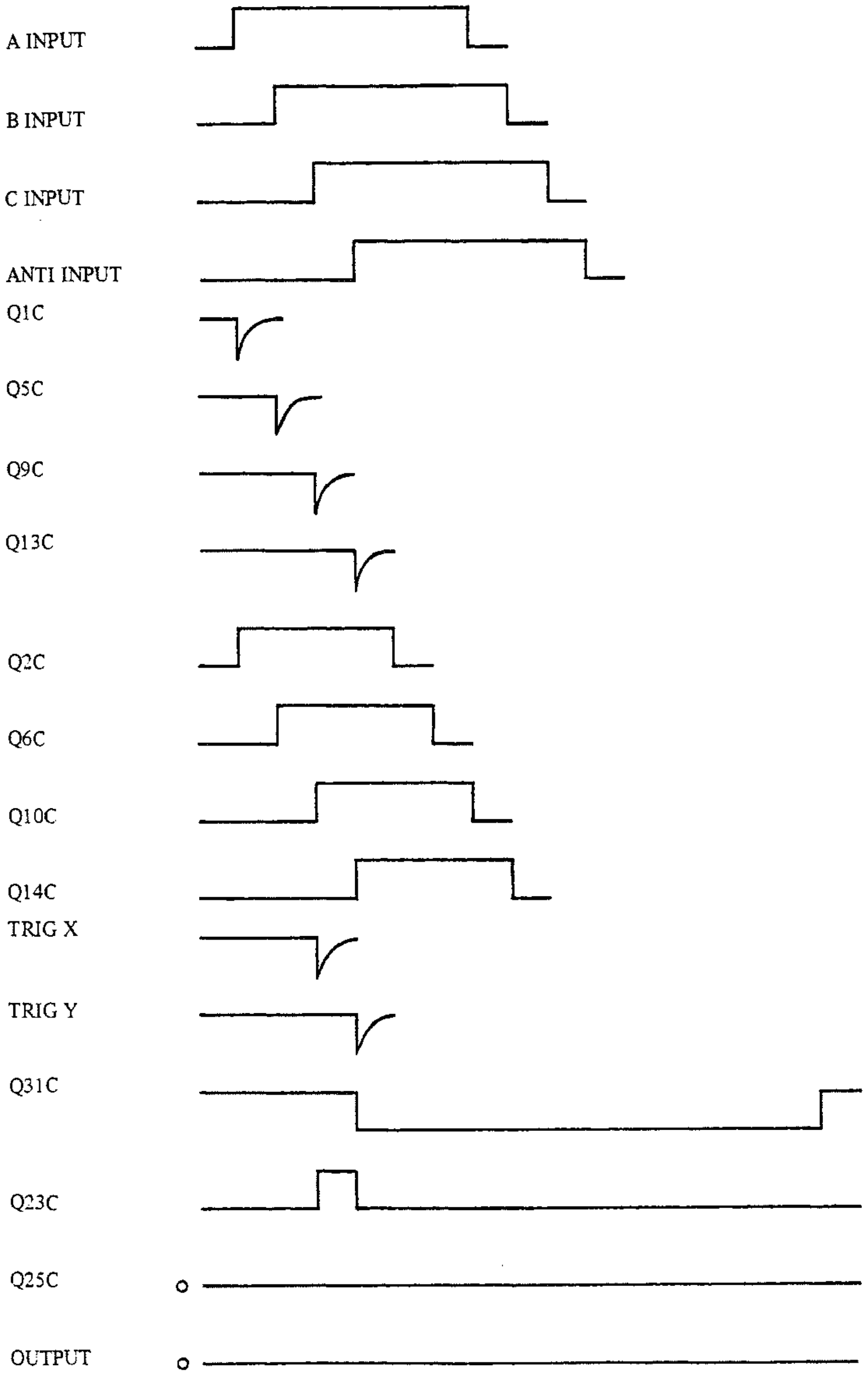
Case 2

3 COINC INPUTS - ONE OUT OF RESOLVING TIME



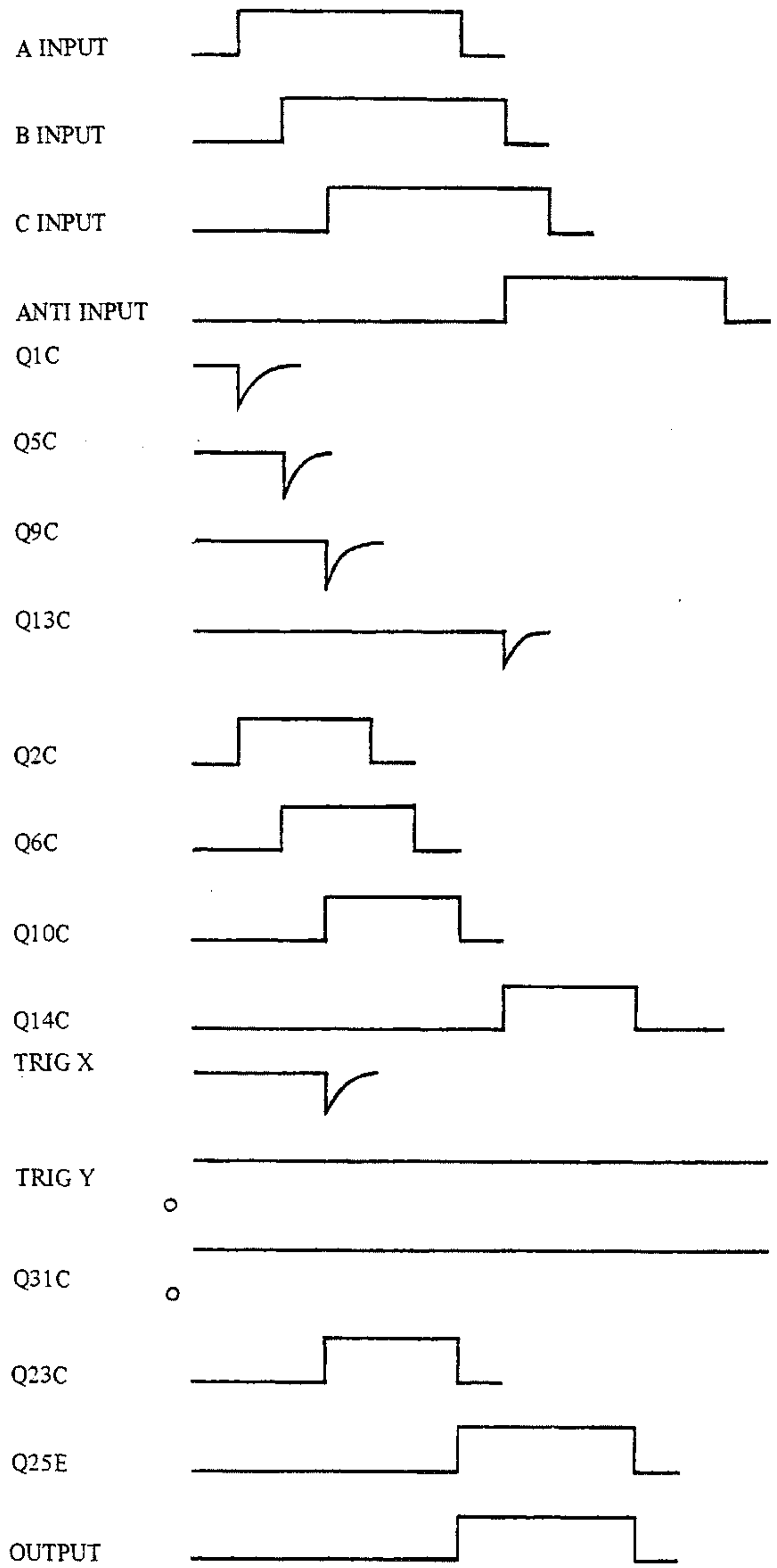
Case 3

3 COINC INPUTS AND ANTI INPUT IN RESOLVING TIME



Case 4

3 COINC INPUTS IN RESOLVING TIME ANTI OUT OF RESOLVING TIME



Notes

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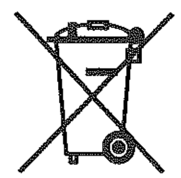

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