

# Model 2145 Time-to-Amplitude Converter/ Single Channel Analyzer

## Features

- Usable time range:  
5 ns to 1 ms
- 15 ranges of Time-to-Amplitude Conversion
- DC coupled for optimum count rate performance
- Built-in Single Channel Analyzer and linear gate
- COINCidence/  
ANTICOINCidence gating inputs
- Selectable output delay and width
- Adjustable STROBE function
- All functions on front panel

## Description

The Model 2145 Time-to-Amplitude Converter/Single Channel Analyzer generates a rectangular output pulse whose peak amplitude is linearly proportional to the time interval between a START and STOP input pulse pair. The built-in Time Single Channel Analyzer (SCA), COINCidence/ANTICOINCidence gating, RESET, STOP INHIBIT features enhance the Model 2145's flexibility for your nuclear timing analysis needs.

The basic Time-to-Amplitude Conversion (TAC) analyzes the time relationships between random events, such as nuclear decay, that occur within a selected interval of time. The Model 2145 is ideal for time of flight, positron lifetime, pulse shape analysis in particle studies, and pulse pair timing in position-sensitive detector systems.

To meet these needs, the Model 2145 offers 15 time ranges from 20 ns to 1 ms, with a jumper-selectable time offset extending the useful range of the two shortest time ranges. The positive unipolar TAC output is essentially flat topped for accurate measurement by an analog-to-digital converter (ADC).

Internal gating prevents a TAC output pulse for overrange START to STOP time differences, STOP inputs received prior to an accepted START, and START or STOP signals received during the converter busy time. The front panel OVERRANGE, VALID CONVERSION and BUSY LEDs simplify setup of the instrument. The COINCidence/ANTICOINCidence gating feature permits prompt (early) gating of a START/STOP pulse pair and is best used to minimize conversion time on unwanted pulses.

The single channel analyzer portion of the Model 2145 operates on the TAC output pulse amplitude, and places equivalent timing restriction on the time spectrum being accumulated. For a selected TIME RANGE, a 0 to 100% time window can be selected with the front panel TIME and  $\Delta$  TIME ten-turn locking-dial potentiometers.

An SCA logic output is produced for every TAC pulse whose peak amplitude falls between the TIME setting and the sum of TIME plus  $\Delta$  TIME settings. A front panel SCA IN/OUT switch lets the TAC output be gated by the SCA output, or be generated normally.

Both the TAC and SCA outputs are simultaneously adjustable in width (internal jumper options for 0.5, 1.0, or 2.5  $\mu$ s) and are synchronous, so timing jitter on the SCA output is essentially non-existent. The front panel DELAY allows selection of the delay between the receipt of a STOP signal and the generation of an output signal.



# Model 2145 Time-to-Amplitude Converter/SCA

Following a valid conversion, the STROBE function allows an external control signal to determine if and when a TAC output is generated. The START and duration set the time window during which a strobe signal will be accepted. They are controlled by the DELAY and CONV READY signals respectively. In the EXT STROBE Mode, the DELAY and CONV READY signals allow minimization of system dead time.

VALID START and VALID STOP outputs represent the time interval from the accepted START or STOP until TAC reset occurs. The front panel STOP INHIBIT adjustment allows rejection of STOP input signals in a range of 1% to 100% of each time range. This is useful for suppressing unwanted inputs in applications such as linear accelerators, and prevents false outputs. A MONITOR OUTput is provided; when its output is true, STOP pulses are inhibited.

The RESET/INHIBIT input permits late anticoincidence gating. It is used to terminate a conversion cycle and prevent subsequent conversions while driven. For example, it can prevent a TAC output based on slow energy analysis.

The VALID START, VALID STOP, SCA, CONV READY, and MONITOR outputs are each internally selectable as positive voltage pulses or negative fast NIM current pulses. Each positive output is source matched with a 50 ohm series resistive termination, preventing ringing on unterminated cables, which can cause multiple counting.

## Specifications

### INPUTS

- **START** – Accepts negative or positive logic signals or levels, internally selected; shipped in negative position. Negative threshold  $-250$  mV; positive threshold  $1$  V; width  $\geq 2$  ns.  $Z_{in} \approx 50 \Omega$ , selectable to  $\approx 1$  k $\Omega$  by removal of internal resistor; dc coupled input protected to  $\pm 10$  V. Leading edge initiates time conversion.
- **STOP** – Input specifications identical to START input. Leading edge terminates time conversion.
- **GATE** – Input specifications identical to START input. Gates TAC output in either COINCidence or ANTICOINCidence mode. GATE must begin  $10$  ns prior to and overlap START input.
- **STROBE** – Input voltage requirements identical to START input; width  $\geq 50$  ns;  $Z_{in} \approx 1$  k $\Omega$  for positive signals,  $50 \Omega$  for negative signals, dc coupled; initiates output pulse when in EXT STROBE mode; must occur in time window set by CONV READY.
- **RESET/INHIBIT** – Input specifications identical to STROBE input; serves as a late anticoincidence input and terminates conversion cycle. The reset period ends at the conclusion of RESET/INHIB or the internal clear time, whichever occurs last.

### OUTPUTS

- **TAC** – Provides positive flat topped rectangular unipolar pulse; constant pulse shape independent of TIME RANGE or amplitude; amplitude proportional to accepted START/STOP input pulse time difference; adjustable delay ( $0.5$  to  $10.5 \mu\text{s}$ ) and width ( $0.5$ ,  $1.0$  or  $2.5 \mu\text{s}$ , internally selectable); rise time  $\approx 250$  ns; dc coupled; front panel BNC connector.  $Z_{out} \approx 10 \Omega$  or  $93 \Omega$  internally selectable. Shipped set for  $10 \Omega$  and  $1 \mu\text{s}$  width;  $10$  V full scale into high impedance load.
- **VALID START** (converter busy time) – Provides either TTL-compatible positive voltage pulse with  $T_{rise}$  and  $T_{fall} < 25$  ns, or  $-16$  mA current pulse with  $T_{rise} < 10$  ns; internally selected, shipped in negative position;  $Z_{out} \approx 50 \Omega$ , dc coupled; duration equal to time interval between accepted START input and end of cycle reset time.
- **VALID STOP** – Output pulse specifications identical to VALID START; duration equal to time interval between accepted STOP input signal and end of cycle reset time.
- **SCA** – Output pulse specifications identical to VALID START; leading edge is in time coincidence with, and duration is equal to, TAC output.
- **STOP INHIBIT MONITOR** – Output pulse specifications identical to VALID START; monitors STOP INHIBIT RANGE adjustment.
- **CONVersion READY** – Output pulse specification identical to VALID START. Active from end of DELAY period. Duration set by CONV READY WIDTH control. Range set by internal jumper,  $1$  to  $20 \mu\text{s}$  or  $10$  to  $200 \mu\text{s}$ ; shipped in  $1-20 \mu\text{s}$  position. Indicates period when STROBE input will initiate output pulse.

### FRONT PANEL CONTROLS

- **TIME RANGE** – Three-position rotary switch selects full scale time interval of  $20$ ,  $50$ , or  $100$  ns between accepted START and STOP input pulses.
- **MULTIPLIER** – Five-position rotary switch extends TIME RANGE by  $X1$ ,  $X10$ ,  $X100$ ,  $X1K$  or  $X10K$ .
- **DELAY** – 22-turn screwdriver potentiometer varies TAC output delay time;  $0.5$  to  $10.5 \mu\text{s}$  range, when adjacent toggle switch in VARiable; fixed  $150$  ns relative to STOP input with switch in MINimum. Test point monitors the DELAY time setting.
- **GATE MODE** – Toggle switch selects COINCidence or ANTICOINCidence gating. Time conversion is enabled (COINC) or inhibited (ANTICOINC) upon receipt of a GATE input signal.
- **TIME** – 10-turn locking dial potentiometer selects minimum time of interest from  $0$  to  $100\%$  of selected TIME RANGE.
- $\Delta$  **TIME** – 10-turn locking dial potentiometer selects time window width from  $0$  to  $100\%$  of selected TIME RANGE.
- **SCA IN/OUT** – Toggle switch selects whether TAC output is gated with Time SCA value, or not.
- **STROBE MODE** – Toggle switch selects INTernal or EXTernal strobe operation.
- **CONVersion READY WIDTH** – 22-turn, screwdriver adjustable potentiometer determines time duration during which STROBE input will initiate output pulse; internal jumper selectable for  $1$  to  $20 \mu\text{s}$  or  $10$  to  $200 \mu\text{s}$ , shipped set for  $1$  to  $20 \mu\text{s}$ .
- **STOP INHIBIT** – Toggle switch enables (ON) or disables (OFF) stop inhibit TIME RANGE adjustment.
- **STOP INHIBIT RANGE** – 22-turn potentiometer to reject unwanted STOP input signals from  $1\%$  (minimum  $20$  ns) to  $100\%$  of selected TIME RANGE.

# Model 2145 Time-to-Amplitude Converter/SCA

## INTERNAL CONTROLS

- TAC OUTPUT WIDTH – Jumper selects 0.5, 1.0 or 2.5  $\mu$ s output pulse width for both SCA and TAC outputs.
- TAC OUTPUT IMPEDANCE – Jumper selects  $Z_{out} = 10 \Omega$  or  $93 \Omega$ .
- START +/-, STOP +/-, GATE +/-, STROBE +/-, RESET +/-: Jumpers determine input polarity of respective signals.
- VALID START +/-, VALID STOP +/-, SCA +/-, STOP INHIBIT +/-, CONVERSION READY +/-: Jumpers select either positive voltage or negative current-mode outputs for the respective signals.
- CONV READY – Jumper selects 1 to 20  $\mu$ s or 10 to 200  $\mu$ s range.
- OFFSET ON/OFF – Jumper enables (ON) or disables (OFF) output time offset, extending usable range by  $\approx 5$  ns when TIME RANGE is set to 20 ns or 50 ns. Shipped in ON position.
- BIN VOLTAGE – Jumper configures 2145 for Bins with 6 V power supply.

## INDICATORS

- OVERRANGE – Glows red when START/STOP time interval exceeds selected range.
- VALID CONVERSION – Red LED lights when START/STOP time interval and gating produce a TAC output. Not affected by SCA setting.
- BUSY – Bicolor LED is green when TAC is inactive, turns red to indicate significant count rate.

## PERFORMANCE

- TIME RESOLUTION –  $<0.01\%$  of full scale plus 5 ps FWHM.
- TAC DIFFERENTIAL NONLINEARITY – With OFFSET jumper set to ON, typically  $\leq \pm 1\%$  (maximum 2%) from lower limit of useable range to full scale. For 20 ns TIME RANGE, lower limit is 5 ns; for all other TIME RANGES, lower limit is 10 ns or 1% of full scale, whichever is greater.
- TAC INTEGRAL NONLINEARITY – With OFFSET jumper set to ON,  $<\pm 0.1\%$  over useable range, as described in Differential Nonlinearity specification.

- SCA TIME/ $\Delta$  TIME INTEGRAL NONLINEARITY –  $<\pm 0.5\%$  of full scale.
- TAC OUTPUT TEMPERATURE STABILITY –  $0.01\%/^{\circ}\text{C}$  ( $\pm 100$  ppm/ $^{\circ}\text{C}$ ) of full scale, plus  $10$  ps/ $^{\circ}\text{C}$ .
- SCA TIME/ $\Delta$  TIME TEMPERATURE STABILITY –  $>\pm 0.01\%/^{\circ}\text{C}$  ( $\pm 100$  ppm/ $^{\circ}\text{C}$ ) of full scale.
- OUTPUT DELAY/OUTPUT WIDTH TEMPERATURE STABILITY –  $>\pm 0.01\%/^{\circ}\text{C}$  ( $\pm 100$  ppm/ $^{\circ}\text{C}$ ) of full scale.
- TEMPERATURE OPERATING RANGE – 0 to  $50^{\circ}\text{C}$ .
- TAC OUTPUT DROOP –  $<0.015\%/ \mu\text{s}$  of delay from completed conversion to TAC output. Delay time is determined by front panel DELAY setting or external strobe acceptance, or both.
- CONVERTER RESET – 1  $\mu\text{s}$  for X1 and X10 multipliers, 5  $\mu\text{s}$  for X100, 40  $\mu\text{s}$  for X1K and X10K; occurs after TAC output, reset or overrange.
- GATE PEDESTAL – Essentially zero pedestal, factory calibrated.
- SCA OUTPUT TIME WALK – None, with respect to TAC output.
- MINIMUM START TO STOP CONVERSION TIME –  $\approx 2$  ns.
- COUNT RATE CAPABILITY – START, STOP, GATE inputs capable of count rates greater than 25.

## CONNECTORS

- All signal connectors are front panel BNCs.

## POWER REQUIREMENTS MHz

+24 V dc – 70 mA	+12 V dc – 230 mA
-24 V dc – 30 mA	-12 V dc – 290 mA

## PHYSICAL

- SIZE – Standard double-width NIM module 6.85 x 22.12 cm (2.70 x 8.71 in.) per DOE/ER-0457T.
- NET WEIGHT – 1.3 kg (2.8 lb).
- SHIPPING WEIGHT – 2.3 kg (5.0 lb).

## ENVIRONMENTAL

- OPERATING TEMPERATURE – 0 to  $50^{\circ}\text{C}$ .
- OPERATING HUMIDITY – 0 to 80% relative, non-condensing.
- Meets the environmental conditions specified by EN 61010, Installation Category I, Pollution Degree 2.

