TIA3100™ Time Interval Analyzer

Operating Manual

General Information
Installation
Operation

Odetics
Precision Time Division

WARRANTY

KODE guarantees this equipment to be free from defects in material and workmanship for 90 days from date of delivery under normal use and service. Equipment that **KODE** sells as a distributor for another manufacturer is covered only by that manufacturer's warranty.

KODE will furnish materials at no charge for installation by Purchaser for any minor repairs which do not require the Purchaser to break the seal on the unit to be repaired. The seal may be broken and repairs made with **KODE's** written approval.

If **KODE**, after discussion with the Purchaser, determines that the equipment should be returned to **KODE** for review and possible repair, the equipment may be shipped prepaid to the Anaheim plant by the Purchaser.

If equipment that has been returned for repair is found to be free from defect and does not in fact meet all specifications, the Purchaser will be billed for check-out time at **KODE's** current out-of-warranty repair fee and for freight to return the unit to the Purchaser.

If the equipment is found to be defective due to a defect in material or workmanship, **KODE** will correct the error to meet the specifications under which the equipment was delivered and ship the equipment back to the Purchaser freight prepaid.

KODE reserves the right to make changes in design at any time without incurring any obligation to install such changes on units previously purchased.

The warranty does not apply to any equipment or portion thereof which shall have been repaired or altered except by the Seller or which has become defective through misuse, mishandling or exposure to environmental conditions which exceed specifications after delivery.

No other warranties expressed or implied shall apply to any equipment sold under this warranty and the foregoing shall constitute the Purchaser's sole rights under the agreed terms of the warranty.

Under no circumstance will **KODE** assume liability for loss, damage or consequential expense arising directly or indirectly from the use of its equipment either separately or in combination with other equipment.

Equipment, subassemblies, printed circuit boards, etc., that are returned for repair after expiration of the original warranty period will be warranted for a period of 30 days from date of receipt by the customer.

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SECTION ONE GENERAL INFORMATION

1.1 INTRODUCTION

This manual provides information pertaining to the installation, operation, testing and adjustment of the **KODE MODEL 3100 TIME INTERVAL ANALYZER [TIA].**

1.2 DESCRIPTION

The **KODE MODEL 3100 TIME INTERVAL ANALYZER** is a general purpose time interval analyzer with specific applications in the design, test and troubleshooting of disc and magnetic tape drives. The **KODE MODEL 3100 TIME INTERVAL ANALYZER** permits the precise evaluation of jitter, peak shift and margin in time dependent data streams (FM, MFM, RLL, etc.).

The instrument is capable of making and recording from 10^0 to 10^{10} measurements, where each measurement is made with a resolution of 0.1 nanosecond. The accumulated measurements are displayed on a CRT as a histogram of number of occurrences versus interval time.

1.3 ACCESSORIES SUPPLIED

Detachable power cord.
Two X1/X10 Scope Probes (See Paragraph 3.7.2.5 for Probe Compansation procedures.

1.4 RECOMMENDED TEST EQUIPMENT

Equipment required to test and service the **KODE MODEL 3100 TIME INTERVAL ANALYZER** is listed in Table 1-1. Other equipment may be substituted if it meets or exceeds the specifications.

TABLE 1-1

RECOMMENDED TEST EQUIPMENT

EQUIPMENT	MFG/MODEL
Service Accessory Kit	NEED NEW #
Frequency Counter	Fluke/1953A
Multimeter	Fluke/8000A
Oscilloscope	TEK/7704
Oscilloscope	TEK/7A26
Oscilloscope Plug-in	TEK/7B85
Oscilloscope Probes (2)	TEK/P6063B
Time Synthesizer	HP/5359A

1.5 SPECIFICATIONS

INPUTS

A and B

Impedance: 1M Ohm, 5pF
Trigger Level: Front Panel Selectable –0.5V to +0.5V (4 mV resolution)
Coupling: DC
Minimum Pulse Width: 5ns

ARM

Impedance: 1K Ohm to GND
Trigger Level: TTL
Trigger Slope:Positive edge (low to high transition)
Minimum Pulse Width: 20ns

ENABLE

Impedance: 22K Ohm to +5V
Trigger Level: TTL
Trigger Slope: Selectable +, – or ±
Minimum Pulse Width: 20ns
Delayed Enable and Gate: Selectable from 1 us to 1 second in 1 us steps

TIME INTERVAL MEASUREMENTS

INTERVAL RANGE

One Source Measurement: 5ns to 440 Ms
Two Source Measurement: 0 to 440 Ms
Full Scale: 4000 X Selected Time Base
Delay Trigger: Extends measurement range to 11 X Full Scale in 1/2 Full Scale steps

AVAILABLE TIME BASES

0.1ns, 0.2ns, 0.5, 1ns, 2ns, 5ns, 10ns, 20ns, 50ns, 0.1us, 0.2us, 0.5us, 1us, 2us, 5us, 10 us

TIME INTERVAL STATISTICS

Summation, Mean, Leading and Trailing Edge Margins
Standard Deviation
Stable and Exponential averaging

SAMPLE SIZE

1 to 9999,
10^4 to 10^{10} in decade steps

MINIMUM TIME BETWEEN MEASUREMENTS

< 1 us

RESOLUTION

± Selected Time Base

CALIBRATION

User invoked, automatic period measurement check of calibration and automatic self-calibration to internal reference frequency standard.

Reference Frequency = 4.096 MHz
Reference Period = 244.1406ns ± 2.4ps, 0°C to 50°C, including 0.5ps per year aging.

1.5 SPECIFICATIONS (Continued)

SINGLE SHOT TIME INTERVAL MEASUREMENT ACCURACY (After Self-Calibration)

± Quantization Error + Quantization Offset
± (Time Base Error X Input Time Interval)
± Jitter ± Trigger Error ± Systematic Error

Quantization Error = Selected Time Base
Quantization Offset = Refer to following Table
Time Base Error = .001% X Selected Time Base
Jitter ≤ 50ps

Trigger Error = $\frac{\text{Input Noise (mv RMS)}}{\text{Input Slew Rate (V/us)}}$

Systematic Error = Self-Calibration Residual Error (At Self-Calibration Temperature ±5°C)

≤ Calibration Self-Check Limits (Over Temperature Range, 10°C to 40°C)

TABLE 1-2 ACCURACY AND CALIBRATION ELEMENTS

PRIMARY TIME BASE	DERIVED TIMES BASES	QUANTIZATION OFFSET	SELF-CALIBRATION RESIDUAL ERROR	CALIBRATION SELF-CHECK LIMITS
100ps	100ps	0ns	10ps	50ps
	200ps			
500ps	500ps	0ns	15ps	250ps
	1ns			
	2ns			
5ns	5ns	1/2 Time Base RMS	150ps	+1.00ns -0.00ns
	10ns			
	20ns			
≥50ns No Self Calibration Performed	≥50ns	1/2 Time Base RMS	500ps	N/A

TIME BASE

External Input: 5 MHz 1 to 10V p-p, 50 Ohms to Ground
Internal Input: Crystal Controlled Oscillator with 0.001% stability and accuracy over operating temperature range

OPERATING TEMPERATURE

10°C to 40°C (50-104°F)

OUTPUTS

PRINTER/PLOTTER: Centronix parallel type
IEEE-488/GPIB INTERFACE
PROBE COMPENSATION: Calibration Signal Monitor output

DIMENSIONS

SIZE: 508mm (20") wide, 190m (7.5") high, 508mm (20") deep

WEIGHT: 18.16 kg (40 lbs)

SECTION TWO INSTALLATION

2.1 INTRODUCTION

This section provides all necessary information to install the **KODE MODEL TIA 3100**. Covered in this section are initial inspection, power requirements, interconnection, storage and repackaging for shipment.

2.2 INITIAL INSPECTION

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the shipment has been checked mechanically and electrically. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, notify **KODE**. Procedures for a quick check of electrical performance are given in Paragraph 3.6.6. If the shipping container is damaged, or the cushioning material shows sign of stress, notify the carrier as well as **KODE**. Keep the shipping material for the carrier's inspection.

2.3 PREPARATION FOR USE

2.3.1 POWER REQUIREMENTS

The **TIA 3100** requires a power source of 110 or 220 VAC. Before switching on the instrument, ensure that the available AC power matches the input requirements listed on the identification plate located on the rear panel of the instrument.

The **TIA 3100** is shipped with a three-wire power cable. When this cable is connected to an appropriate AC power source, this cable connects the chassis to earth ground. When the power cable is not in use, it can be wrapped around the four standoffs (feet) located on the rear panel of the **TIA**.

2.3.2 PROBE COMPENSATION

The **TIA** is shipped with 2 probes. These probes **should be calibrated** per the procedure outlined in Paragraph 3.7.2.5.

2.3.3 INTERCONNECTIONS

2.3.3.1 IEEE-488 INTERFACE BUS

A description of the IEEE-488 bus is not provided in this manual. Information concerning the design and operation of the bus is available in IEEE-488-1978, titled "IEEE Standard Digital Interface for Programmable Instrumentation."

Interconnection data concerning the rear panel IEEE-488 connector is provided in Table 2-1.

A software settable device address "switch" is used for ADDRESS SELECTION of the **TIA 3100**. Instructions for setting and changing the device address are provided in SECTION THREE of this manual.

2.3.3.2 PRINTER/PLOTTER OUTPUT

Interconnection data concerning the rear panel printer connector is provided in Table 2-2.

2.4 STORAGE AND SHIPMENT

2.4.1 ENVIRONMENTAL LIMITATIONS

The instrument should be stored in a clean, dry environment. The following limitations apply to both storage and shipment:

Temperature:	–40°C to +75°C
Humidity:	95% relative
Altitude:	50,000 feet

2.4.2 PACKAGING

The following general instructions should be used for repackaging with commercially available materials.

[1] Wrap the instrument in heavy paper or plastic. (If shipping to KODE Service Department attach a tag indicating the type of service required, return address, model number and full serial number.)

[2] Use a strong shipping container. A double-wall carton made of 250 pound test material is adequate.

[3] Use enough shock-absorbing material (3- to 4- inch layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container.

[4] Seal the shipping container securely.

[5] Mark the shipping container "FRAGILE" to ensure careful handling.

TABLE 2-1

IEEE-488 CONNECTOR Mating Connector Amphennol 57-30240

PIN	LINE
1	DI01
2	DI02
3	DI03
4	DI04
13	DI05
14	DI06
15	DI07
16	DI08
5	EOI
17	REN
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	GND
18	GND

TABLE 2-2

PRINTER/PLOTTER CONNECTOR Mating Connector 3M/3421-7020

PIN	LINE
1	–STROBE
2	DATA 0
3	DATA 1
4	DATA 2
5	DATA 3
6	DATA 4
7	DATA 5
8	DATA 6
9	DATA 7
10	–ACK
11	+BUSY
12	+PE
13	+SEL OUT
14	–AUTO FD
15	–ERROR
16	–INIT
17	–SEL IN
18-25	GROUND

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SECTION THREE OPERATION

3.1 INTRODUCTION

This section provides operating information needed for the **KODE TIA 3100 Time Interval Analyzer.** This section includes a description of all front panel and rear panel controls, connectors, indicators and operating instructions for both the manual and the remote operating mode.

3.2 OPERATING CHARACTERISTICS

3.2.1 GENERAL

The **TIA 3100** measures time intervals from a selected start trigger to a selected stop trigger. Functionally, receipt of a **START** trigger enables clocks of a selected period to increment the state of a previously reset counter. The counter continues to run until subsequently halted by receipt of a **STOP** trigger. Interval time is thus measured in discrete increments of the selected clock period referred to as a Time Base. The **duration** of any one interval is defined by the **state of the counter** upon completion of the interval.

The **modulus** of the counter utilized in the **TIA 3100** is **4000**; thus, for any one interval measurement, there are 4000 possible measurement outcomes. The number of times each possible outcome occurs in a series of measurements is recorded in a multi-channel event counter, specifically a high speed 4000 x 24 bit RAM whose address lines are driven by the parallel outputs of the interval counter. Subsequent to receipt of a **STOP** trigger, that RAM location defined by the state of the interval counter is accessed, its contents incremented by one, and the result rewritten in the accessed location.

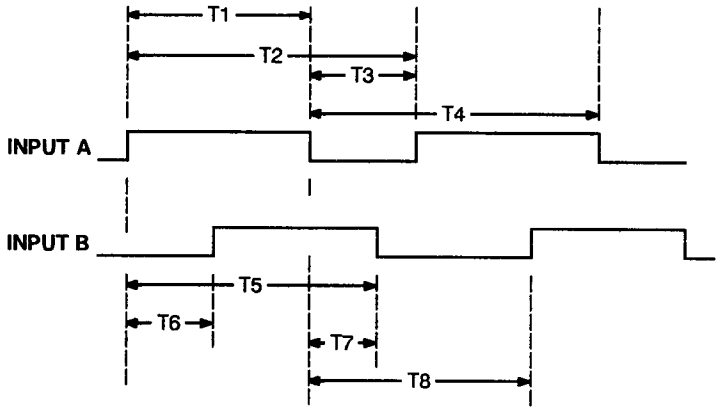
After a selected number of such interval measurements, referred to as the selected **Sample Size,** the numerical content of each location is read out by the system CPU, LOG converted and plotted on the CRT as a function of RAM address. The resultant histogram may then be interpreted as **time interval frequency of occurrence** with respect to incremental interval time.

3.2.2 TRIGGERING POSSIBILITIES

The **TIA 3100** measures time intervals from 5 nanoseconds to 440 milliseconds for a one source measurement. For a one source measurement the input signal must be connected to the **Input A** jack. For a two source measurement using both the **Input A** and **Input B** jacks, the **TIA 3100** measures time intervals from 0 to 440 milliseconds. Refer to Figure 3-1 for a graphic representation of possible measurements.

Upon detection of a **STOP TRIG** the **TIA 3100** performs necessary housekeeping and calculations in a high speed RAM. The result is a binary number representative of the measured interval. At the end of this processing time (approximately 0.5 us), the **TIA 3100** re-arms itself to look for the next **START TRIG.**

Certain combinations of data and data rates can exist where some intervals are never measured or their probability of being measured would depend on the preceding interval(s).



TRIGGER POLARITY		INTERVALS	
START	STOP	A – A	A – B
+	–	T1	T5
+	+	T2	T6
–	–	T4	T7
–	+	T3	T8
+/–	–	T1,T4	T5,T7
+/–	+	T2,T3	T6,T8
+	+/–	T1	T6
–	+/–	T3	T7
+/–	+/–	T1,T3	T6/T7

Figure 3-1. Possible TIA 3100 Measurements

Referring to Figure 3-2, consider the following data:

- Single source measurement (A – A),
- START TRIG +, and
- STOP TRIG –

In this case, all of the long intervals are missed. With the randomizing function enabled, the **TIA 3100** will randomly trigger on the next or second to next available START TRIG, thereby eliminating the otherwise missed intervals.

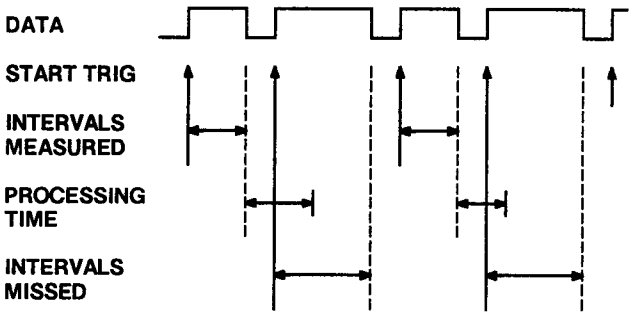


Figure 3-2. Interval Measuring

After the selected number of measurements (the Sample Size) has been completed, the data is plotted on a CRT as a histogram of number of measurements versus interval time.

3.2.3 INPUTS

Four front panel inputs, labeled A, B, ENABLE, EXT ARM are provided. The A and B inputs are high impedance (1M ohm) and may be used with standard X10 probes. The inputs are designed to offer a selectable threshold voltage. This voltage may be set from -0.5 volts to +0.5 volts. When using X10 probes the effective threshold is thus between -5 and +5 volts. See Paragraph 3.4.1.6 for more information.

The ENABLE and EXT ARM inputs require a TTL compatible signal and must be used with X1 probes.

3.2.4 TIME INTERVAL MEASUREMENT RESOLUTION, RANGE, and START DELAY

Functionally, the period of the clock applied to the interval counter, referred to as the measurement Time Base, determines both measurement resolution and range.

Resolution is defined as ± selected time base. Range is 4000 times the selected time base.

The **Measurement Field** may be **delayed** by up to 10 times the **Measurement Range** in 1/2 **Measurement Range** steps using the **Start Delay**. In this case, in response to a **Start Trigger**, the **TIA 3100** first executes the selected delay, and then begins the **time interval** measurement. The resultant is the **sum** of the **delay** and the **interval** between the **end of the delay** and the **Stop Trigger**. This feature has the effect of allowing the measurement of the relatively long intervals while retaining the resolution of a **ten times smaller time base**.

Figure 3-3 illustrates the relationship between the **Start Delay**, **Measurement**, and **Scan Fields** while Table 3-1 summarizes the range of these fields.

TABLE 3-1 MEASUREMENT TIME BASES

TIME BASE	SCAN FIELD	MEASUREMENT FIELD RANGE	MAX START DELAY	MAXIMUM MEASUREMENT
.1 ns	40 ns	400 ns	4 us	4.4 us
.2 ns	80 ns	800 ns	8 us	8.8 us
.5 ns	200 ns	2 us	20 us	23 us
1 ns	400 ns	4 us	40 us	44 us
2 ns	800 ns	8 us	80 us	88 us
5 ns	2 us	20 us	200 us	220 us
10 ns	4 us	40 us	400 us	440 us
20 ns	8 us	80 us	800 us	880 us
50 ns	20 us	200 us	2 ms	2.2 ms
100 ns	40 us	400 us	4 ms	4.4 ms
200 ns	80 us	800 us	8 ms	8.8 ms
500 ns	200 us	2 ms	20 ms	22 ms
1 us	400 us	4 ms	40 ms	44 ms
2 us	800 us	8 ms	80 ms	88 ms
5 us	2 ms	20 ms	200 ms	220 ms
10 us	4 ms	40 ms	400 ms	440 ms

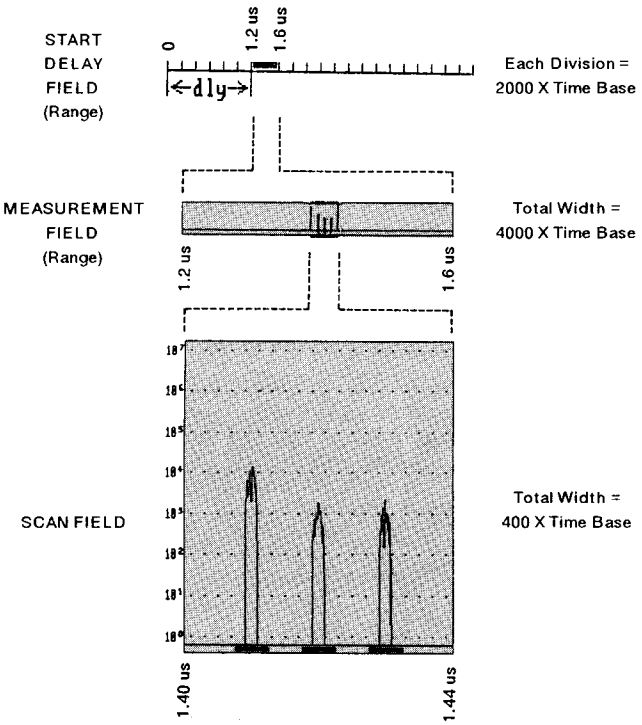
3.2.5 TIME INTERVAL FREQUENCY OF OCCURRENCE RESOLUTION AND DISPLAY RANGE

The number of time interval measurements to be completed prior to event counter readout by the system CPU and subsequent display, is referred to as Sample Size. Sample Size is selected from the front panel and ranges from 1 to 9999 and 10^4 to 10^{10} in decade increments. Frequency of occurrence resolution is determined by the selected Sample Size in a reciprocal relationship. The maximum count associated with any one channel of the event counter RAM is $2^{24} - 1 = 16{,}777{,}215$. Once this count is reached, the further occurrence of time interval events associated with those channels at their maximum count is ignored. However, the occurrence of time interval events associated with RAM channels not yet at maximum, continue to be recorded. The effect of this implementation is to increasingly truncate the peak(s), as the Sample Size is increased from 10^7 to 10^{10} while continuing to display the remainder of 7.2 decades.

3.2.6 ACQUISITION AND DISPLAY MODES

The **TIA 3100** acquires time interval frequency of occurrence data in either of two front panel selectable modes, referred to as single and continuous. Acquisition in the single mode is automatically terminated when the number of interval measurements equals the selected Sample Size. The resultant histogram is then displayed.

Acquisition in the continuous mode is repeated rather than terminated. The contents of the display memory are automatically updated as each new histogram is acquired.



Times shown are for a Time Base of 100 pico seconds.

Figure 3-3. Relationship Between the Start Delay, Measurement, and Scan Fields

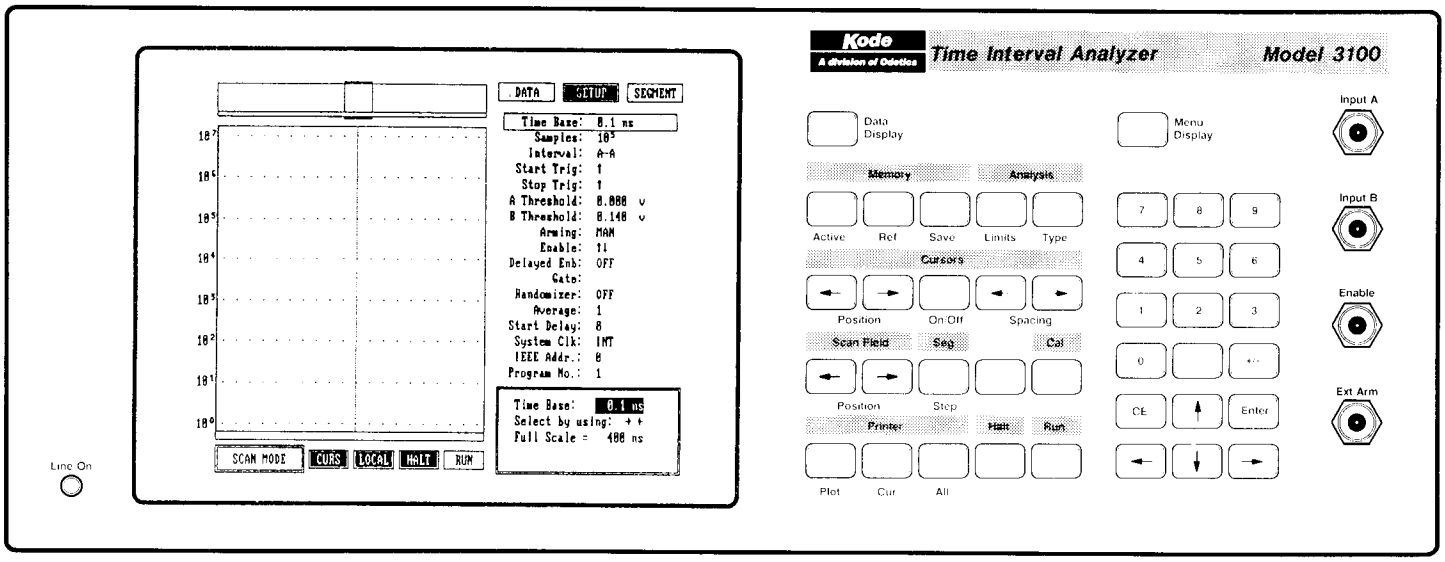
3.3 FRONT PANEL CONTROLS, INDICATORS AND CONNECTORS

For convenient reference, the front and rear panel drawings are illustrated on each page (as applicable) with their respective descriptions.

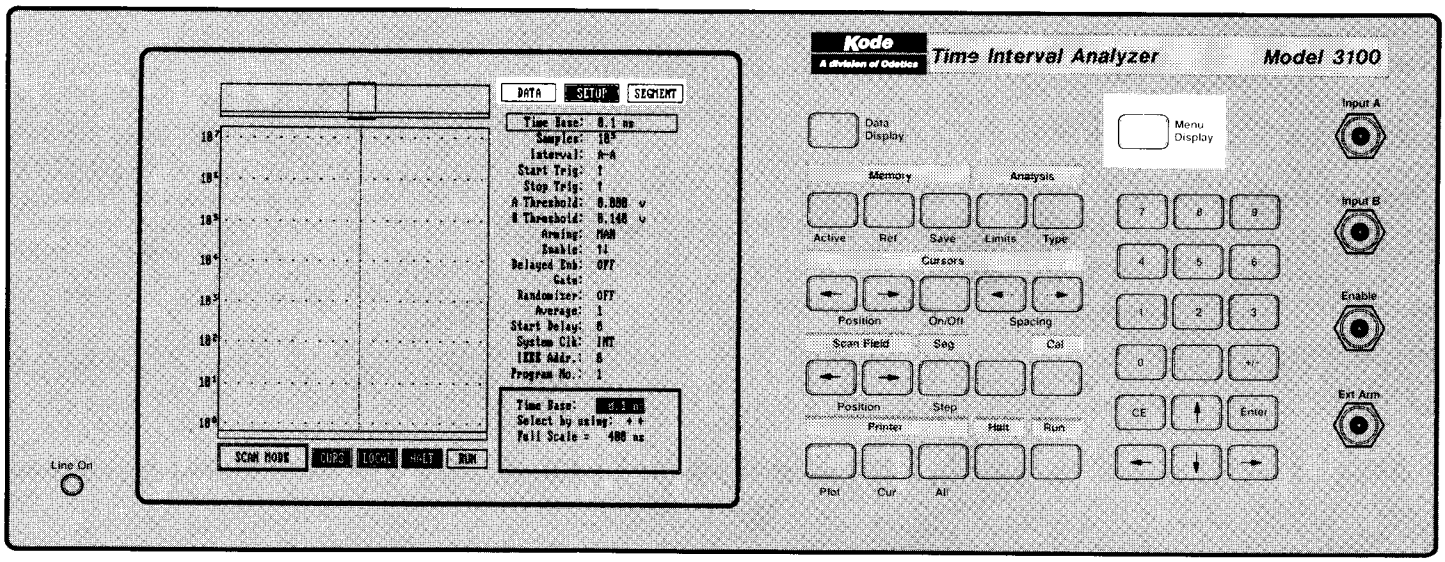
All controls are located on the right half of the front panel. They are grouped into two sets of pushbutton key switches. The left group is for data display selection and operational control. The right group is for set up parameter selection.

The only indicator on the front panel is the AC power Line On indicator located at the bottom left corner.

All feedback to the user from control switch activation is provided on the CRT at either the bottom or to the right of the data display.



3.4 MENU DISPLAY SELECTION



MENU DISPLAY

Sequentially selects one of three menus for presentation to the right of the data display. The selected menu:

- **DATA** [Section 3.4.3],
- **SETUP** [Section 3.4.1], or
- **SEGMENT** [Section 3.4.2]

is highlighted in reverse video.

DATA must be selected to display **Math Analysis** of time interval measurements while **SETUP** and **SEGMENT** must each be selected for setting specific measurement parameters pertinent to the desired time interval measurement. Each of these menus is discussed in the following text.

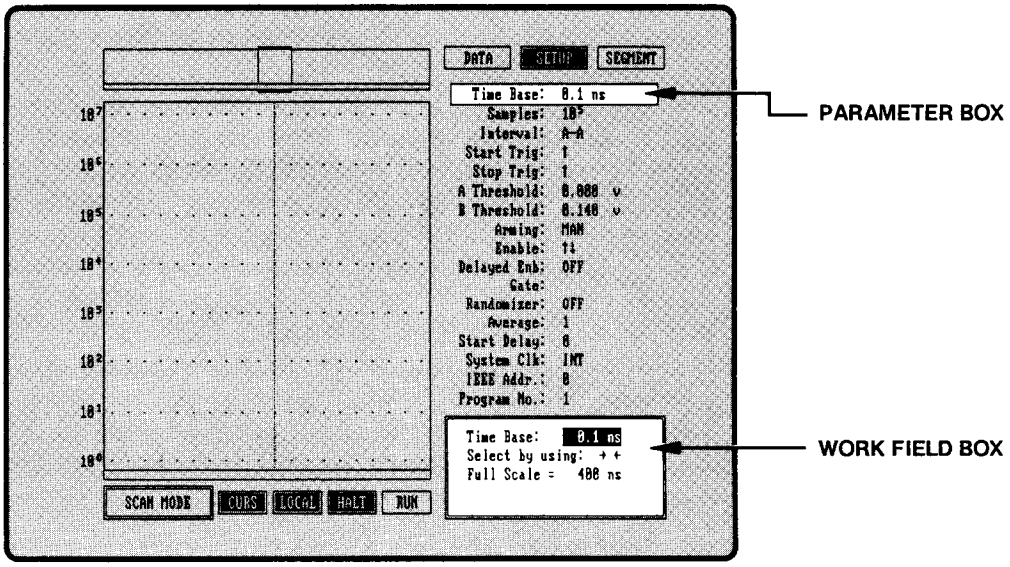
3.4.1 SETUP MENU

The **SETUP** MENU lists 16 individual parameters which must each be setup prior to measurement by the user. The parameters are accessed by use of the UP and DOWN **ARROW** keys. The parameter accessed at any given time is highlighted by a box around the parameter and its current setting.

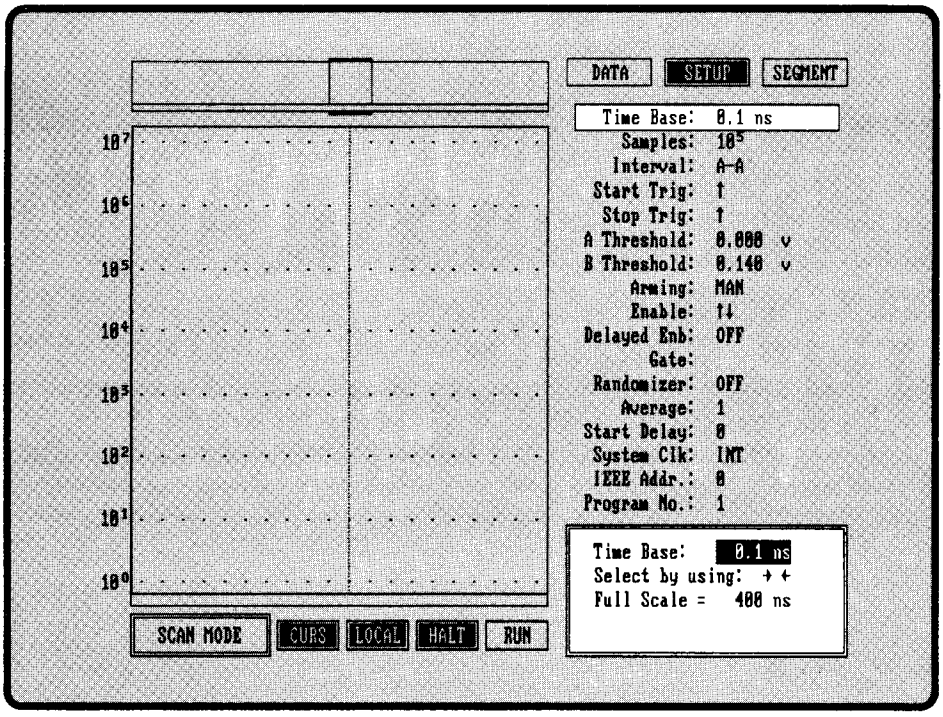
The choice of settings for each parameter is displayed in the work field contained within the box at the bottom of the menu.

Generally, the LEFT and RIGHT **ARROW** keys are used to make the selection. The selected value is highlighted in reverse video and shown in the PARAMETER BOX. The exceptions to LEFT/RIGHT **ARROW** key selection employ prompting messages in the WORK FIELD and also require use of the **ENTER** key to invoke the selection.

Each parameter is discussed in detail below.



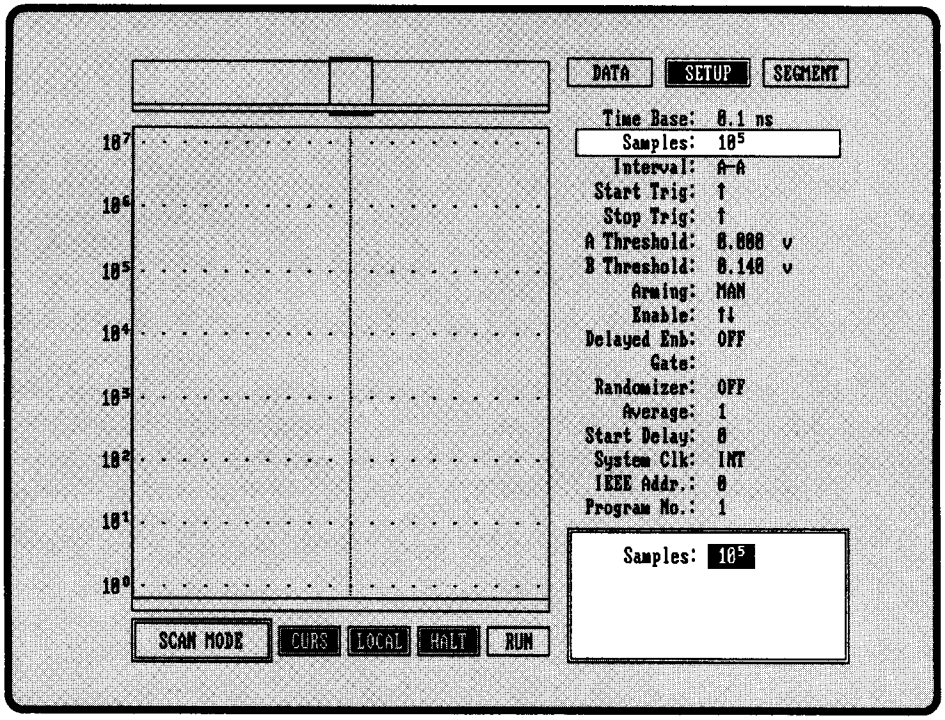
3.4.1.1 TIME BASE



TIME BASE

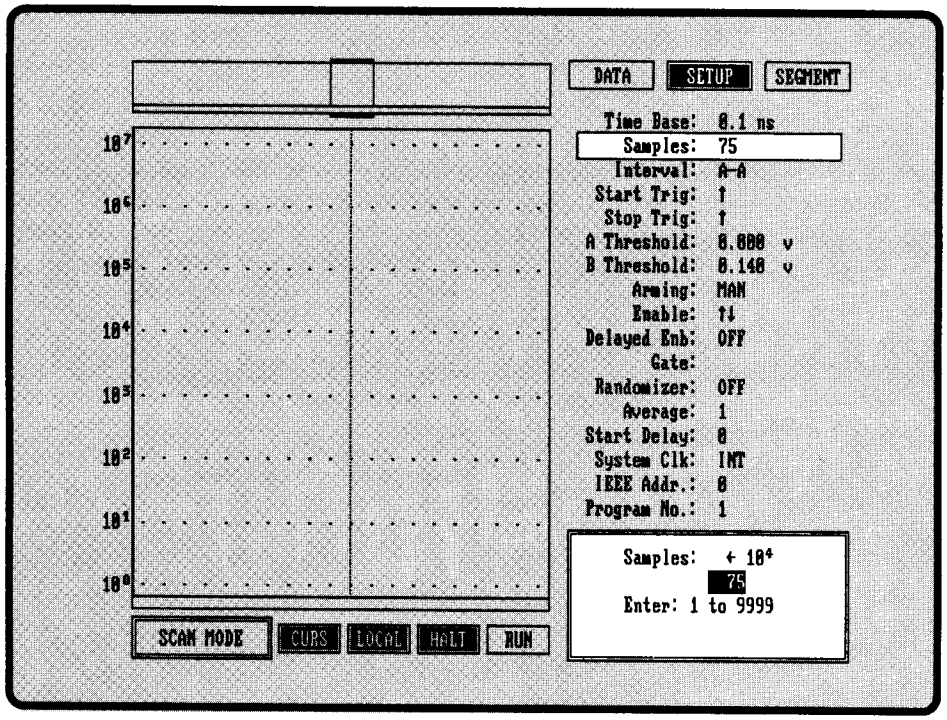
Use LEFT/RIGHT **ARROW** keys to sequentially select any one of the 16 time bases. As each is selected it will appear in reverse video in the WORK FIELD and in the **Time Base** box. Additionally, the resultant full scale time value is indicated in the WORK FIELD.

3.4.1.2 SAMPLES



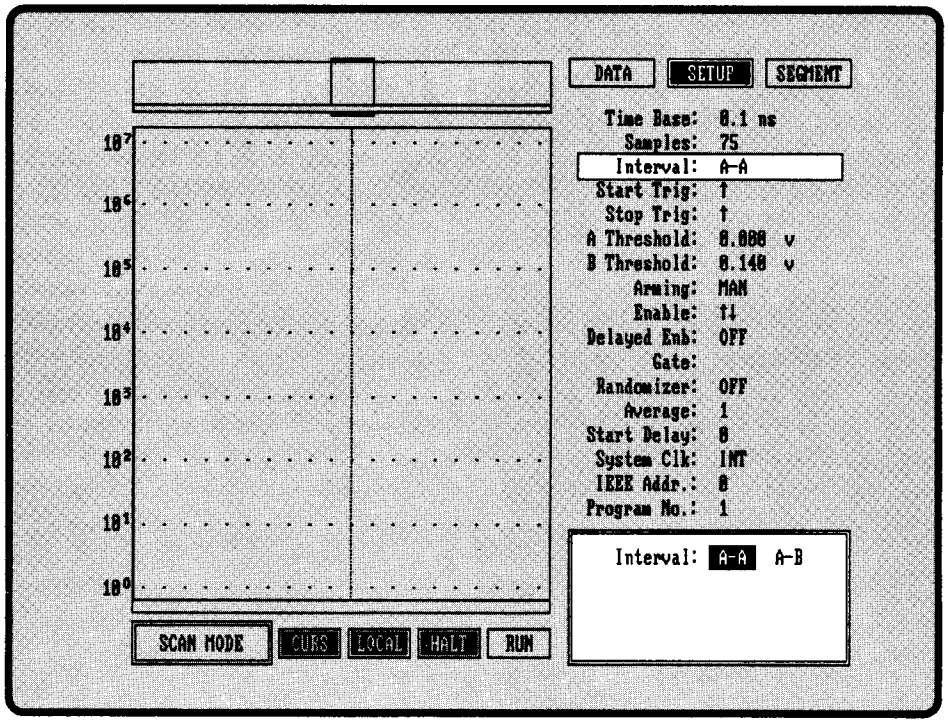
SAMPLES

Use LEFT/RIGHT **ARROW** keys to sequentially select any of the seven sample sizes from 10^4 to 10^{10}. The selection will appear in reverse video in the WORK FIELD and in the **Sample** box.



If less than 10^4 samples are desired, use the LEFT **ARROW** key to select $<10^4$, then using the numeric keys and the **ENTER** key enter a number from 1 to 9999. The resultant selection will appear in reverse video and in the **Sample** box.

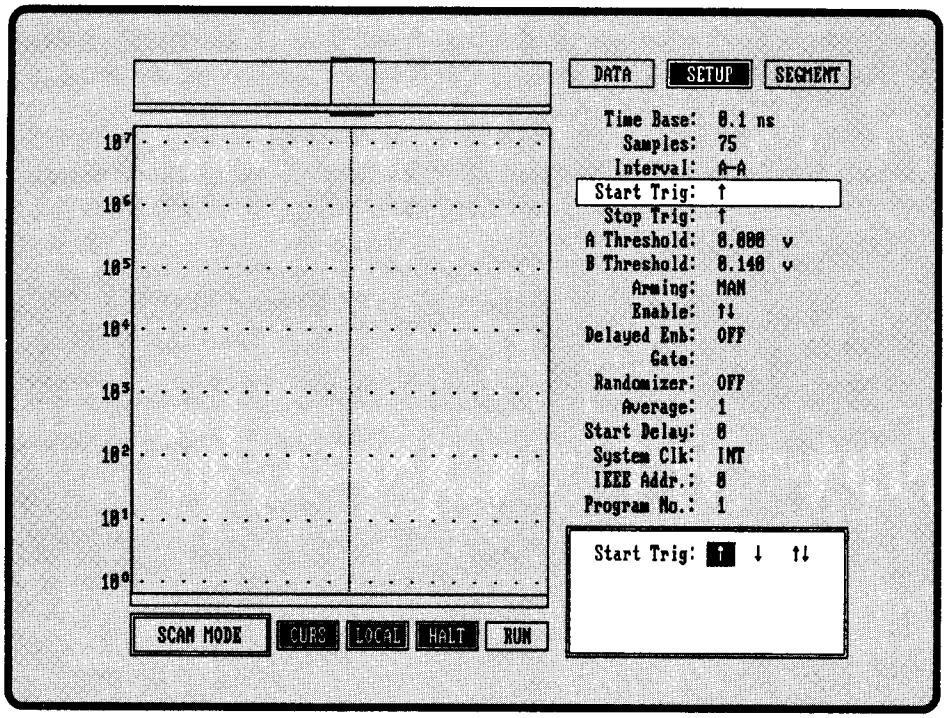
3.4.1.3 INTERVAL



INTERVAL

Use LEFT/RIGHT **ARROW** keys to select **A–A** or **B–B** measurement interval. The selection will appear in reverse video and in the **Interval** box.

3.4.1.4 START TRIGGER



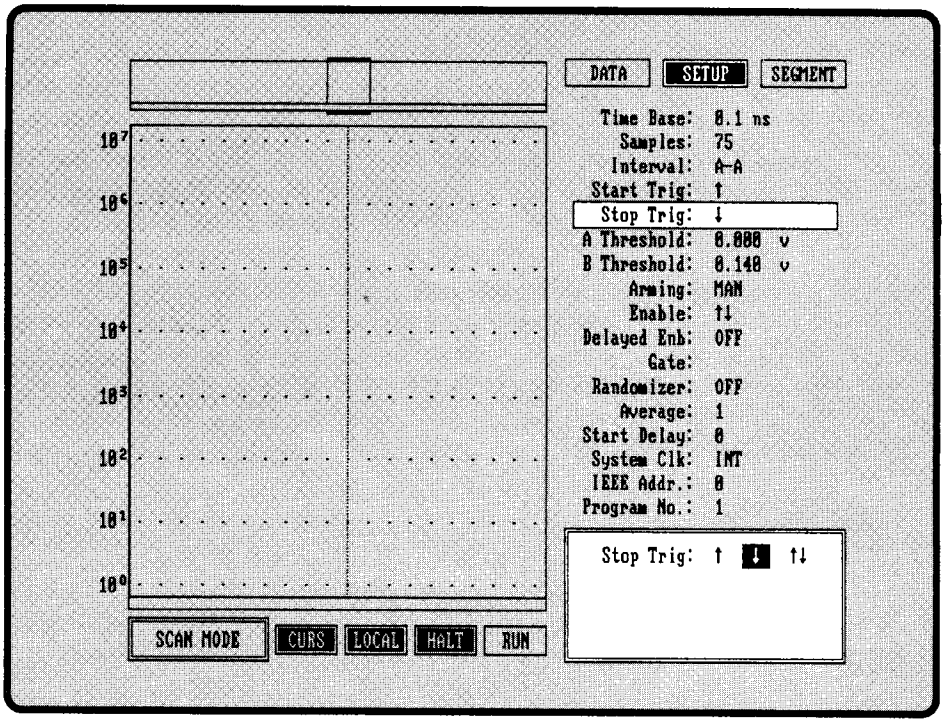
START TRIGGER

Use LEFT/RIGHT **ARROW** keys to select any of the three trigger conditions:

- ↑ - **positive** going edge, or
- ↓ - **negative** going edge, or
- ↑↓ - **both** edges.

The selection will appear in reverse video and in the **Start Trig** box.

3.4.1.5 STOP TRIGGER



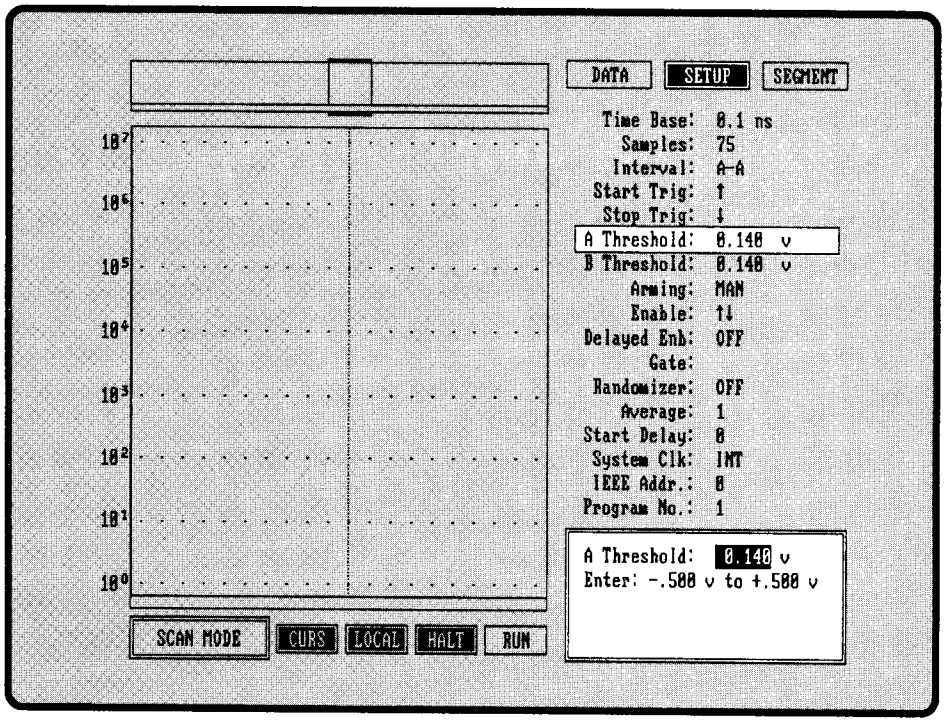
STOP TRIGGER

Use LEFT/RIGHT **ARROW** keys to select any of the three trigger conditions:

↑ - **positive** going edge, or
↓ - **negative** going edge, or
↑↓ - **both** edges.

The selection will appear in reverse video and the **Stop Trig** box.

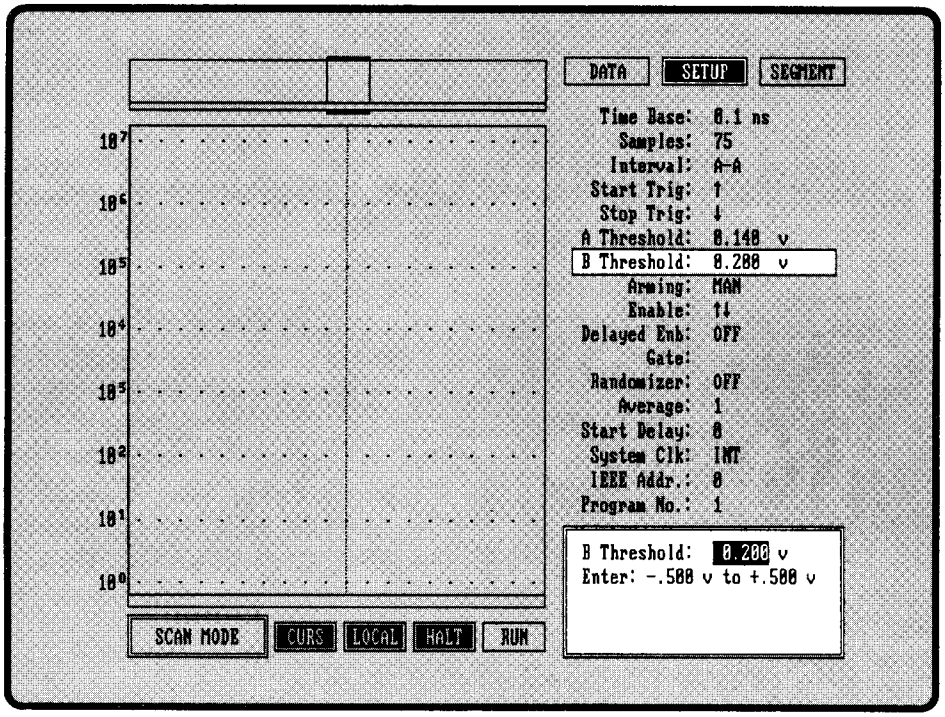
3.4.1.6 A THRESHOLD



A THRESHOLD

Using the **NUMERIC** keys and the **ENTER** key, select a trigger threshold from -0.500 volts to +0.500 volts. The **TIA** will round the selection to the nearest 4 millivolts. The resultant selection will appear in reverse video and in the **A Threshold** box. If a X10 probe is used, the threshold should be set to 1/10 of the desired value at the probe tip.

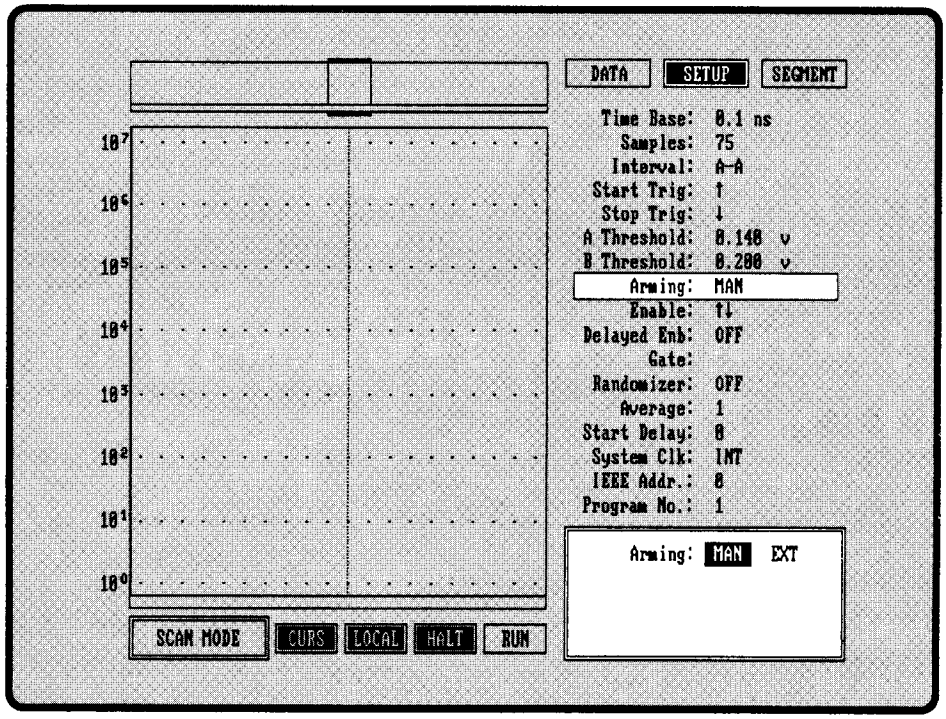
3.4.1.7 B THRESHOLD



B THRESHOLD

Use the same procedure as described for **A Threshold.**

3.4.1.8 ARMING

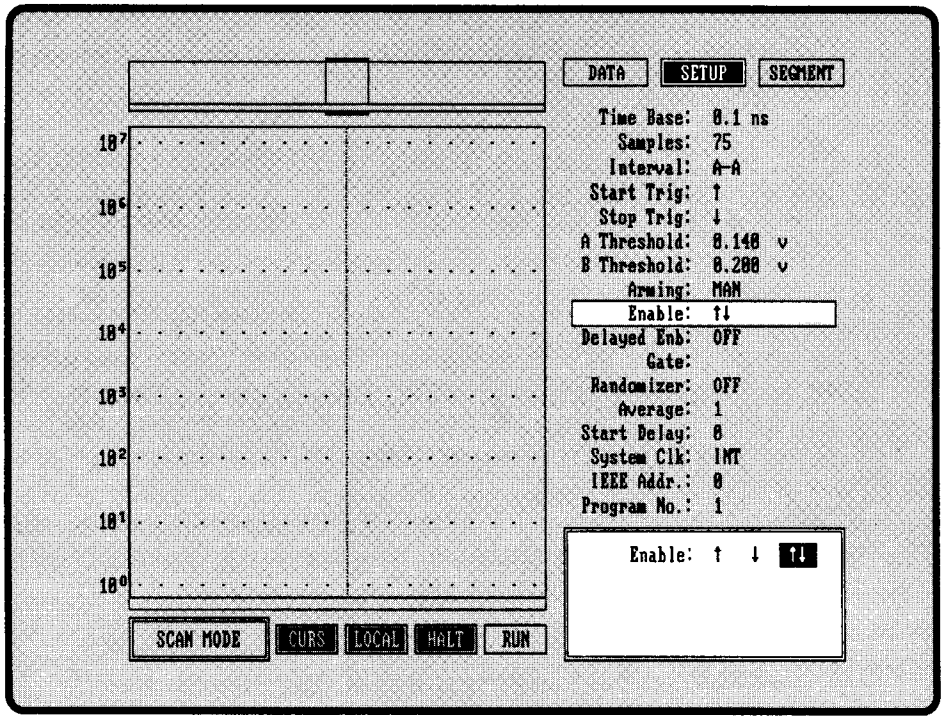


ARMING

Use the LEFT/RIGHT **ARROW** keys to select either **MAN**ual or **EXT**ernal arming. Manual arming uses the RUN key (see Paragraph 3.6.8), while external arming uses the **EXT ARM Input**. The resultant selection will appear in reverse video and in the **Arming** box.

In the **EXT Arming** mode, the unit will start making measurements on the first positive edge of the **EXT ARM** signal following a depression of the **RUN** key.

3.4.1.9 ENABLE



ENABLE

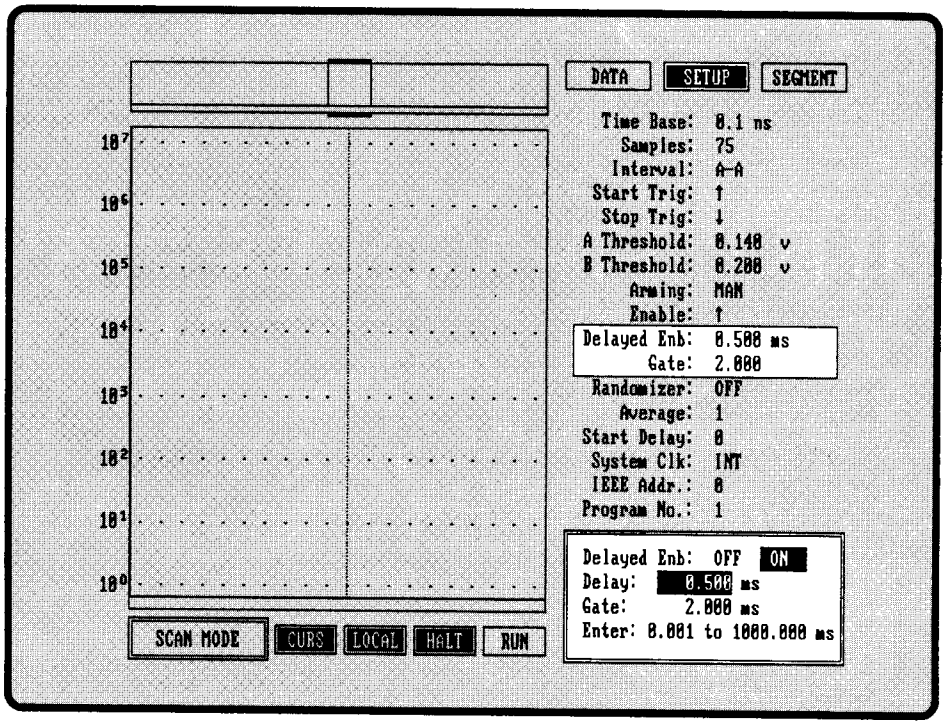
Using the LEFT/RIGHT **ARROW** keys to select any of the three enable conditions:

- ↑ - **positive** levels of the enable signal,
- ↓ - **zero volt** levels of the enable signal, or
- ↑↓ - **continuously.**

The selection will appear in reverse video and in the **Enable** box.

NOTE: If the **Delayed Enable** is ON (see description below) the continuous enable ↑↓ is **not** available as a third selection. Further, the **Delayed Enable** delay will start on a positive or negative going **edge** of the enable signal.

3.4.1.10 DELAYED ENABLE/GATE

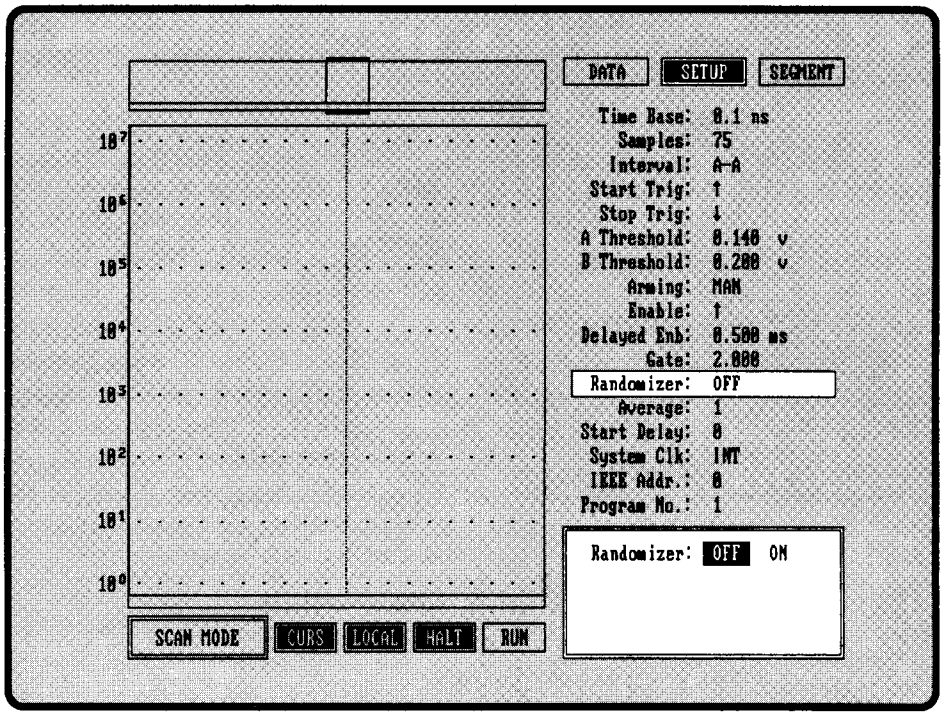


DELAYED ENABLE/GATE

The **Delayed Enable and Gate** must be selected as a **pair**. The **first** parameter is the delay time from the Enable edge as selected under Enable, while the second parameter **(Gate)** is the duration of the **Delayed Enable**. Use the LEFT/RIGHT **ARROW** keys to turn the **Delayed Enable** ON or OFF. The selection will appear in reverse video and in the **Delayed Enable** box.

If ON is selected, then use the **NUMERIC** and **ENTER** keys to select a number from 1us to 1 sec in 1us steps. This selection must be made for both the **Delay** and the **Gate** and will appear in reverse video and in the **Delayed Enable** box.

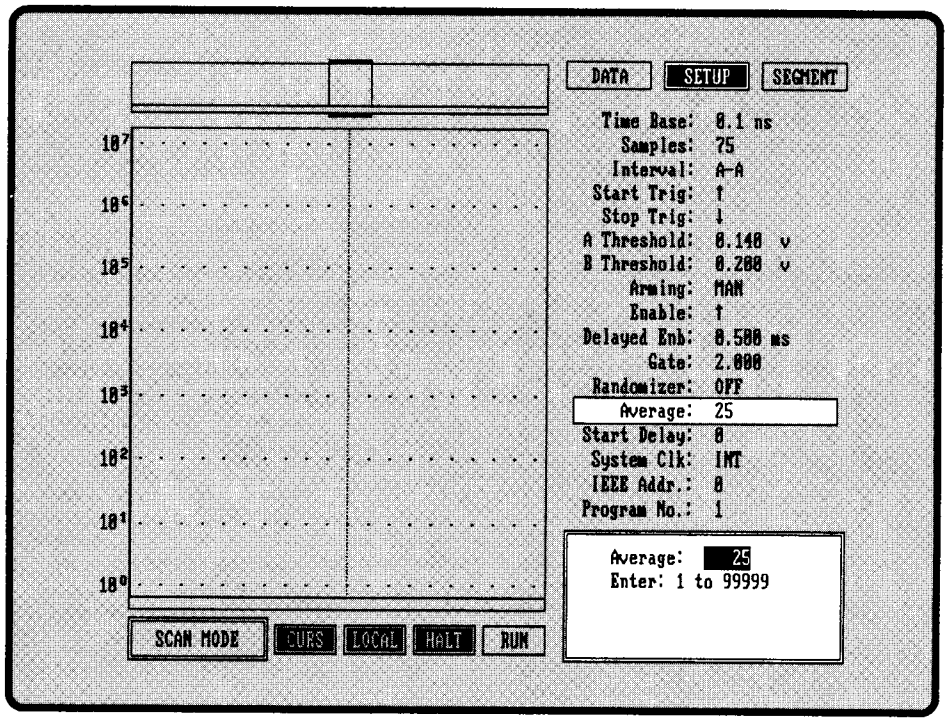
3.4.1.11 RANDOMIZER



RANDOMIZER

Use the LEFT/RIGHT **ARROW** keys to turn the **randomizer** either ON or OFF. The selection will appear in reverse video and in the **Randomizer** box. See Paragraph 3.2.2 for a discussion of the **Randomizer** function.

3.4.1.12 AVERAGE



AVERAGE

Using the **NUMERIC** keys and the **ENTER** key, select a number from **1** to **99999**. The selection will appear in reverse video and in the **Average** box. The selected number is used for **N** in "stable averaging" and **K** in "exponential averaging" as in the following equations:

$$\textbf{STABLE: } A_n = A_{n-1} + \frac{Z_n - A_{n-1}}{n} \Bigg|_{n=1}^{n=N}$$

$$\textbf{EXPONENTIAL: } A_n = A_{n-1} + \frac{Z_n - A_{n-1}}{K}$$

Where:

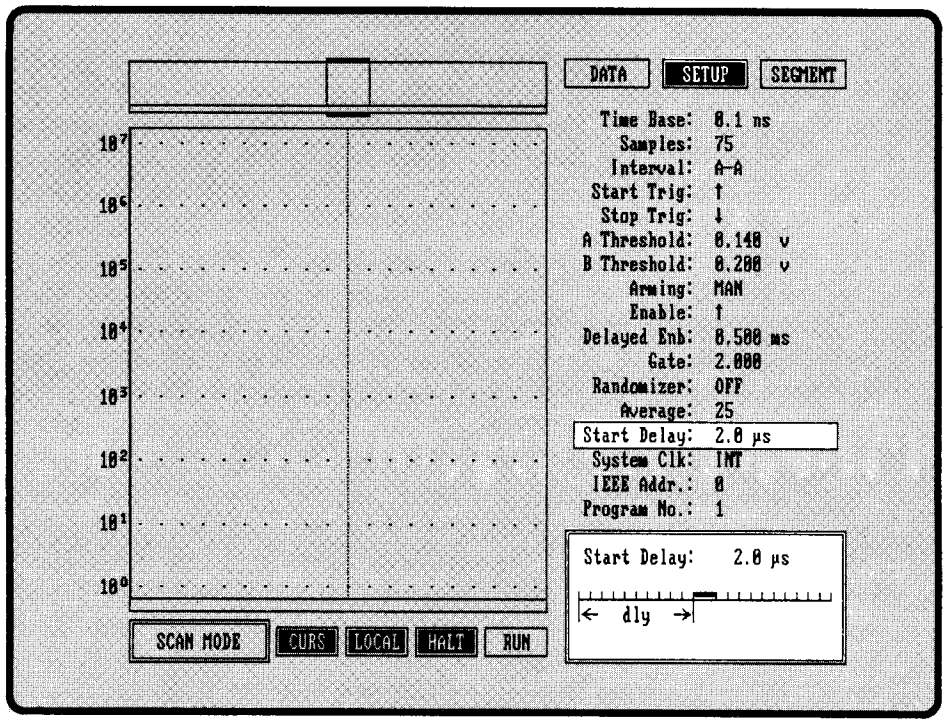
A_n = The current average.

A_{n-1} = The previous average.

Z_n = The current measurement.

See Paragraph 3.6.2.2 for a discussion of the **Averaging** function.

3.4.1.13 START DELAY

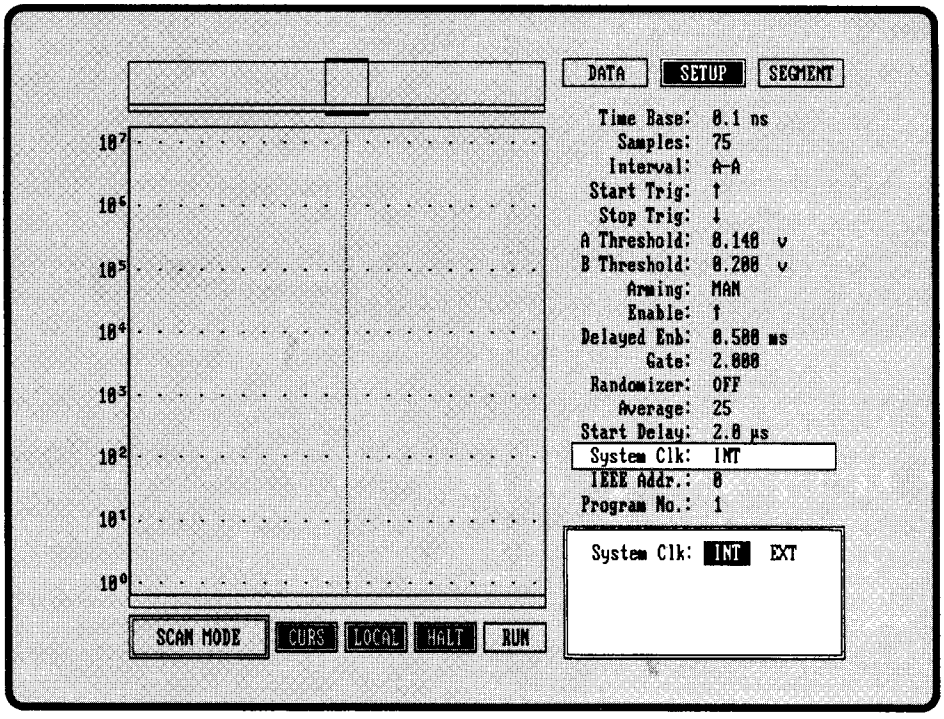


START DELAY

Using the LEFT/RIGHT **ARROW** keys, position the **Start Delay** indicator in the WORK FIELD to the desired delay. The delay may be chosen in increments of one-half the full scale measurement range; i.e., 2,000 times the selected time base. The selected delay is numerically indicated in both the WORK FIELD and the **Start Delay** box.

See Paragraph 3.2.4 for a discussion of the **Start Delay** function.

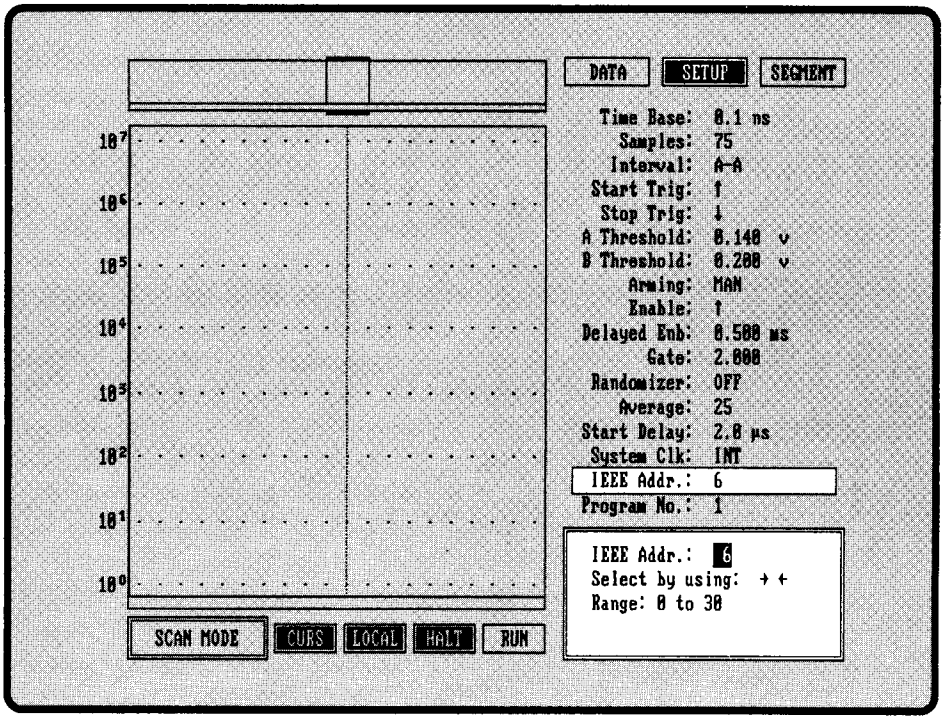
3.4.1.14 SYSTEM CLOCK



SYSTEM CLOCK

Use the LEFT/RIGHT **ARROW** keys to select either an **INT**ernal or **EXT**ernal system clock. The selection will appear in reverse video and in the **System Clock** box. The requirements of the external clock are discussed in Paragraph 1.5 **Time Base Specifications**.

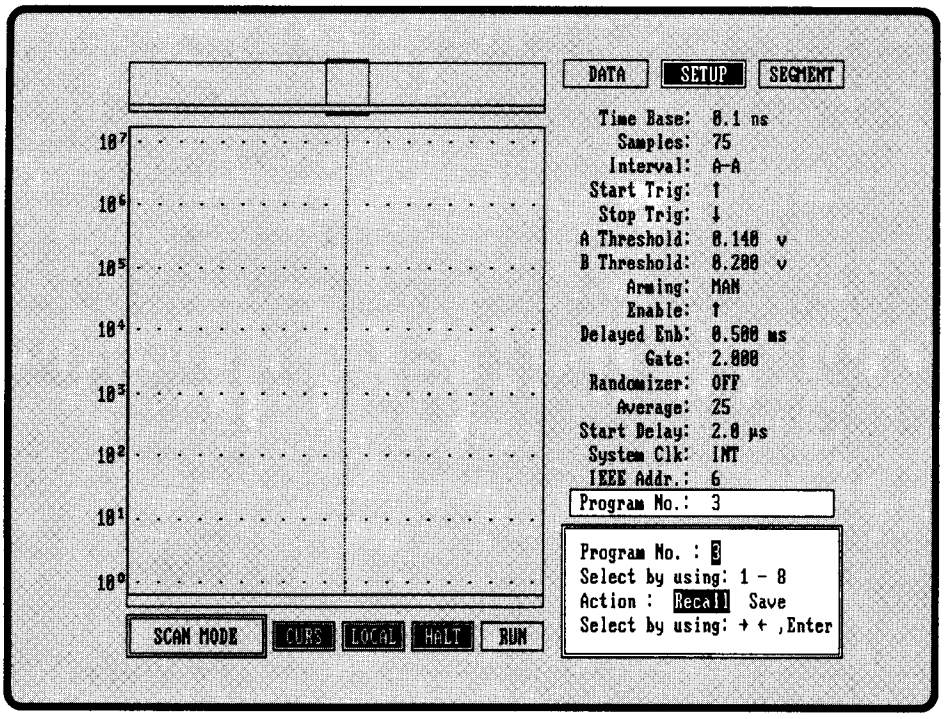
3.4.1.15 IEEE ADDRESS



IEEE ADDRESS

Use the LEFT/RIGHT **ARROW** keys to select a Device Address from **0** to **30.** The selection will appear in reverse video and in the **IEEE Address** box.

3.4.1.16 PROGRAM NO.



PROGRAM NO.

This feature allows the user to **save** in non-volatile memory, **all** of the **SETUP** and **SEGMENT** parameters, as well as SCAN FIELD and CURSOR location. **Eight** [8] such sets of conditions may be **saved** and **recalled** as follows:

1) Using the **Numeric** keys, SELECT the desired program number from **1** to **8.**
2) The **selection** will appear in both the **Program No.** box and the WORK FIELD.
3) Then, using the LEFT/RIGHT **ARROW** keys, SELECT either

   - **Recall**, or
   - **Save**

   depending upon the action desired.

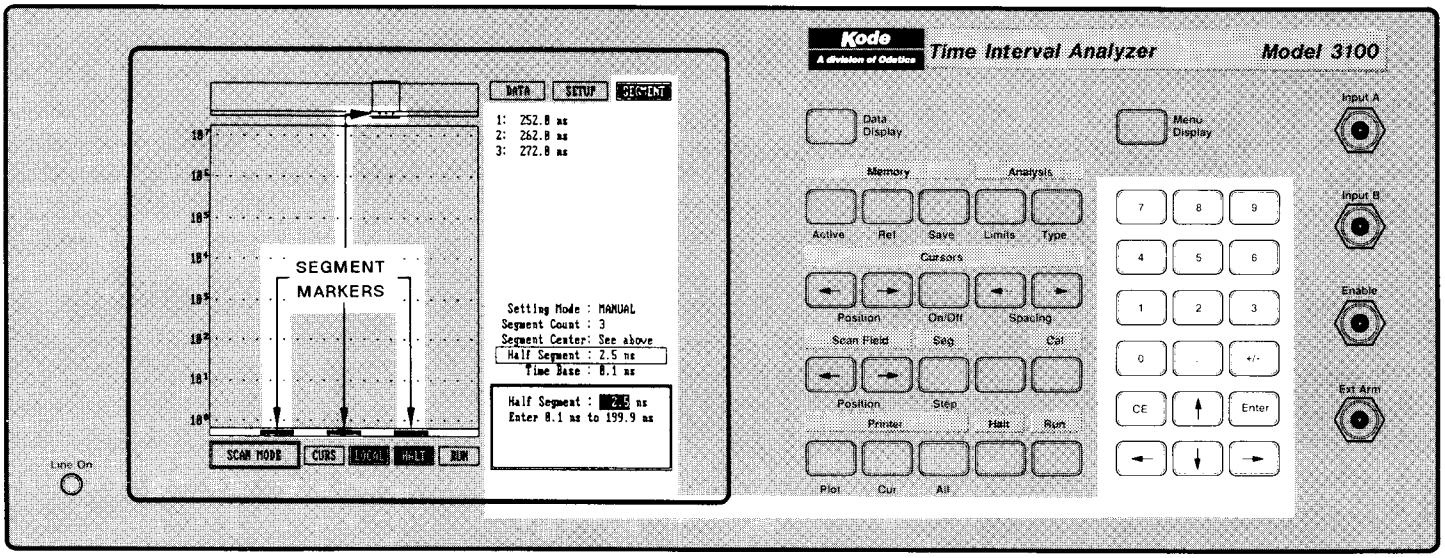
   - If a previously stored program is desired SELECT **Recall**, or
   - If the present set of parameters are to be stored, SELECT **Save.**

4) Finally, PRESS the **Enter** key and the selected action:

   - **Recall**, or
   - **Save**

   will be executed.

3.4.2 SEGMENT MENU



The **SEGMENT** menu provides the means for segmenting the full scale measurement field into a number of segments (data fields). These segments are selected to encompass expected time interval data and are used by the **TIA 3100** as the data fields for math analysis by segment (Refer to Paragraph 3.6.2.1) and the **SIGMA 1** and the **SIGMA 2** data display modes. (Refer to Paragraphs 3.5.2 and 3.5.3.) The selected **SEGMENTS** are shown as **SEGMENT MARKERS** at the bottom of the MEASUREMENT FIELD and the SCAN FIELD.

The **SEGMENT** menu lists 5 individual parameters which must be SET by the user.

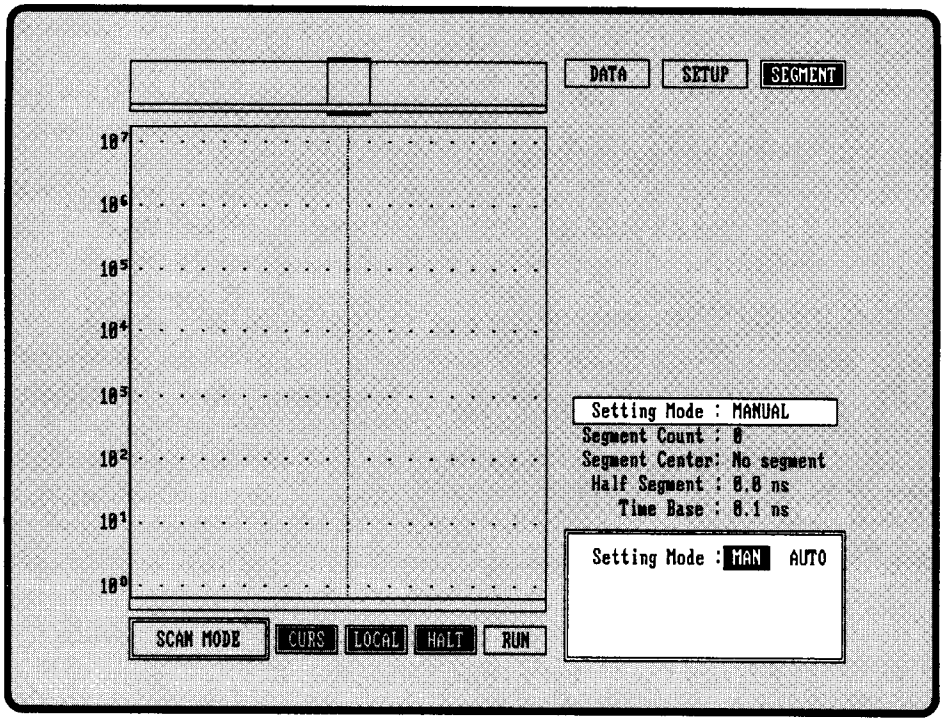
- **SETTING MODE**
- **SEGMENT COUNT**
- **SEGMENT CENTER**
- **HALF SEGMENT**
- **TIME BASE**

The parameters are accessed by use of the UP and DOWN **ARROW** keys. The parameter accessed at any given time is highlighted by a box around the parameter and its current setting.

The choice of settings for each parameter is displayed in the WORK FIELD contained with the box at the bottom of the menu. Generally the LEFT and RIGHT **ARROW** keys are used to make the selection. The selected value is highlighted in reverse video and shown in the PARAMETER box. The exceptions to LEFT and RIGHT **ARROW** key selection employ prompting messages in the WORK FIELD and require use of the **ENTER** key to invoke the selection.

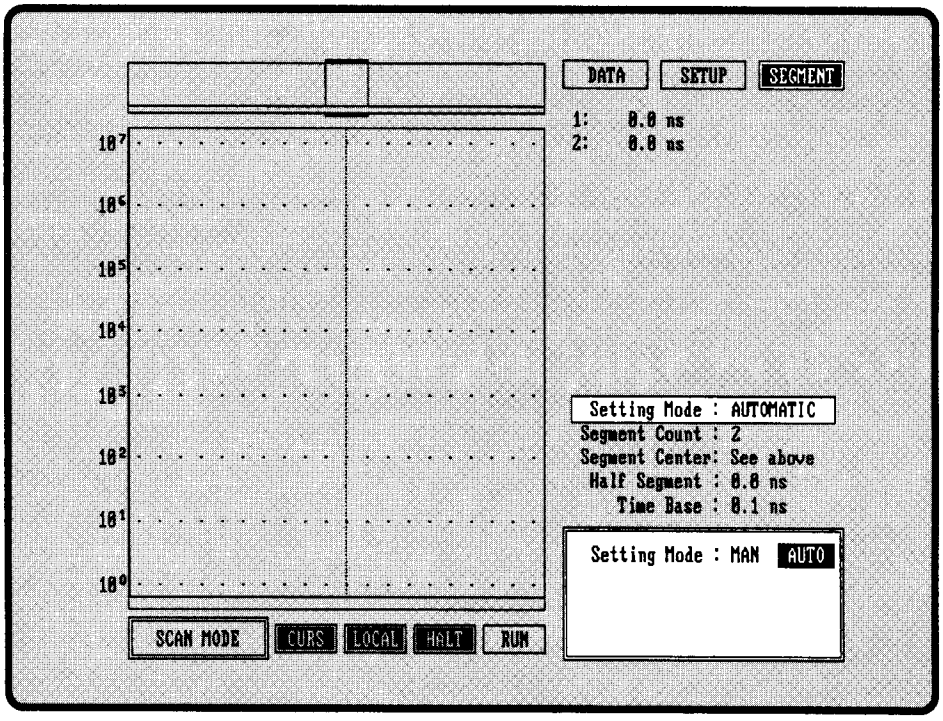
A discussion of each parameter follows.

3.4.2.1 SETTING MODE



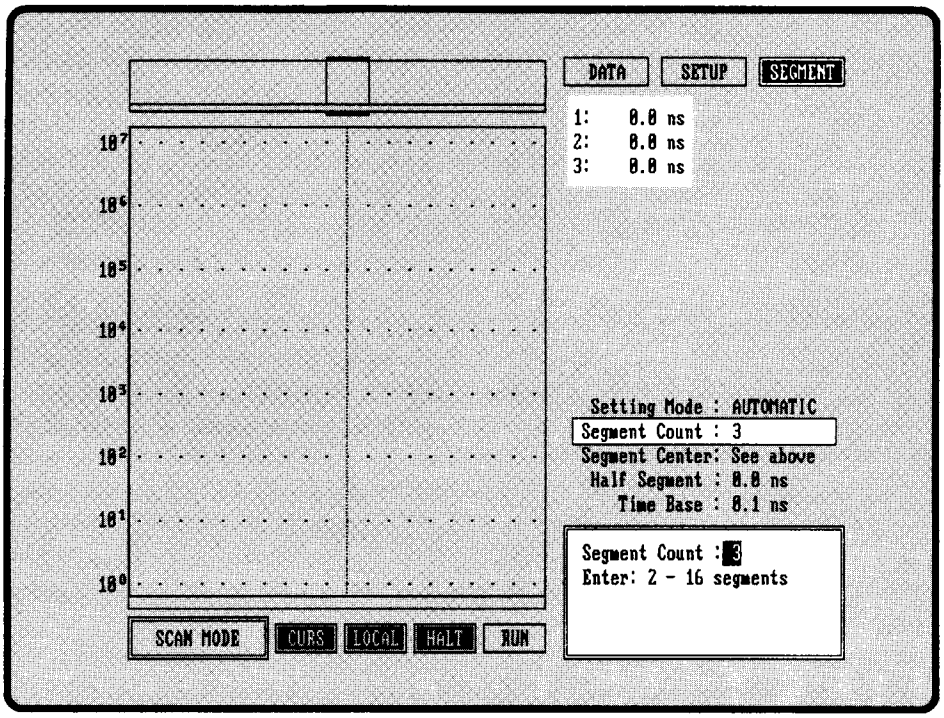
SETTING MODE

Use the LEFT/RIGHT **ARROW** keys to select the **MANUAL** or **AUTOMATIC SETTING MODE.** The selection will appear in reverse video and in the **Segment Mode** box.



If the **AUTOMATIC** mode is selected, the menu will update to include 2 lines for ultimately entering **SEGMENT CENTERS** and will assume **SEGMENT COUNT** of at least 2.

3.4.2.2 SEGMENT COUNT



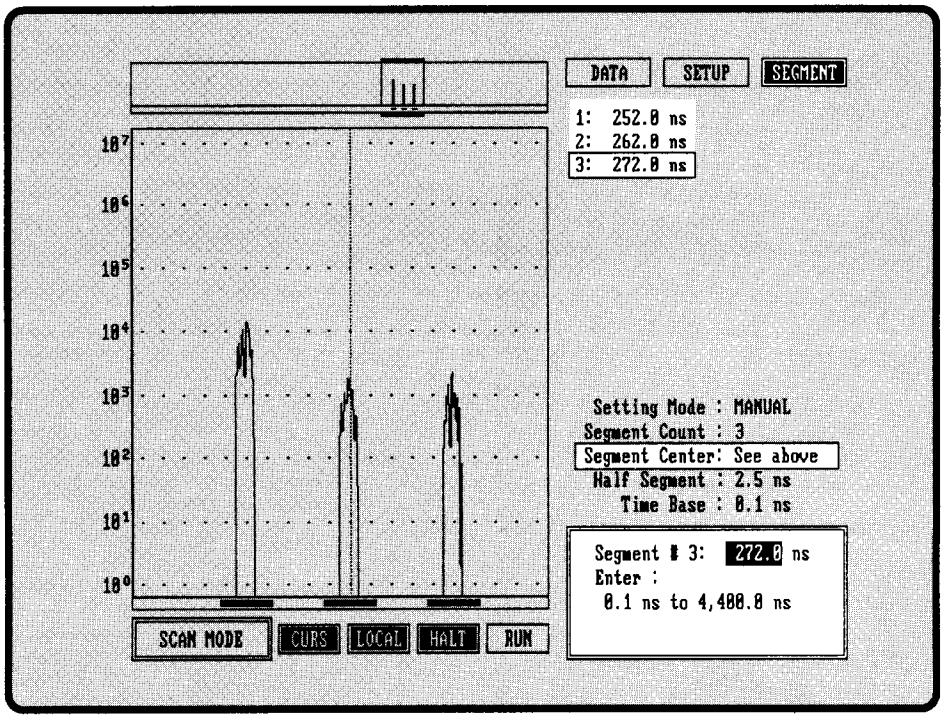
SEGMENT COUNT

Using the **NUMERIC** keys and the **ENTER** key, select a **SEGMENT COUNT** from **0** to **16**. If **0** segments are selected, the

- **segment controlled displays,** and
- **math analysis by segment**

are **inoperative.** The selection will appear in reverse video and the **SEGMENT COUNT** box. In addition, the menu will update to include the selected number of lines for ultimately entering **SEGMENT CENTERS.**

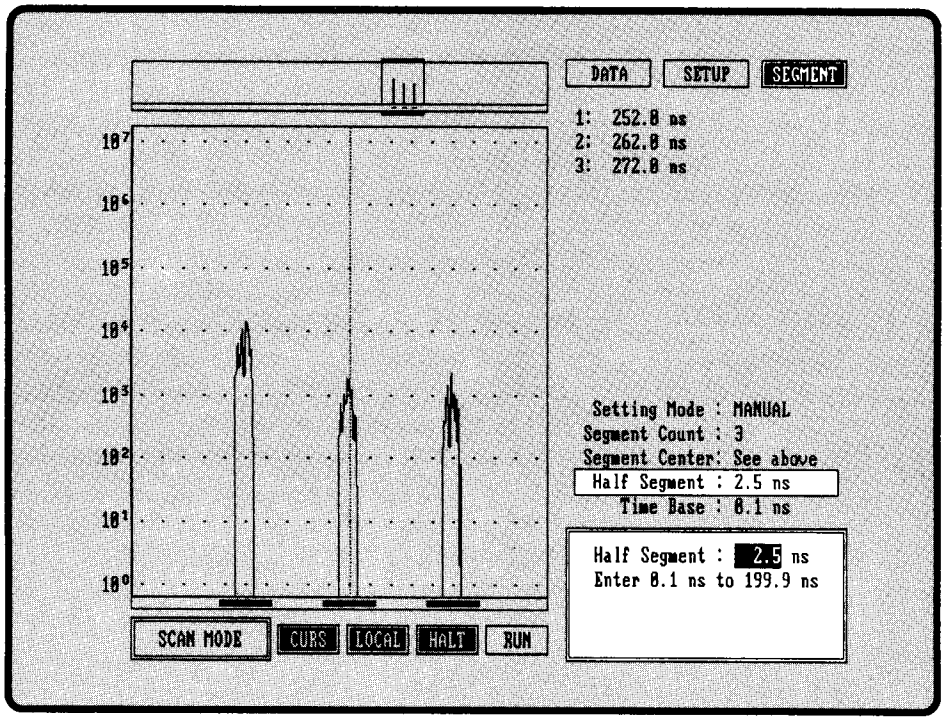
3.4.2.3 SEGMENT CENTER



SEGMENT CENTER

Upon selection of the **SEGMENT CENTER** parameter, the **TIA 3100** will prompt the user to SET the **center value** of **SEGMENT #1**. Use the **NUMERIC** keys to select a value from the indicated range. With each successive entry the **TIA** will advance to the next segment number. To **move** from one segment to the next, without changing the value, use the **ENTER** key only. The selected value will appear in reverse video and adjacent to the segment number.

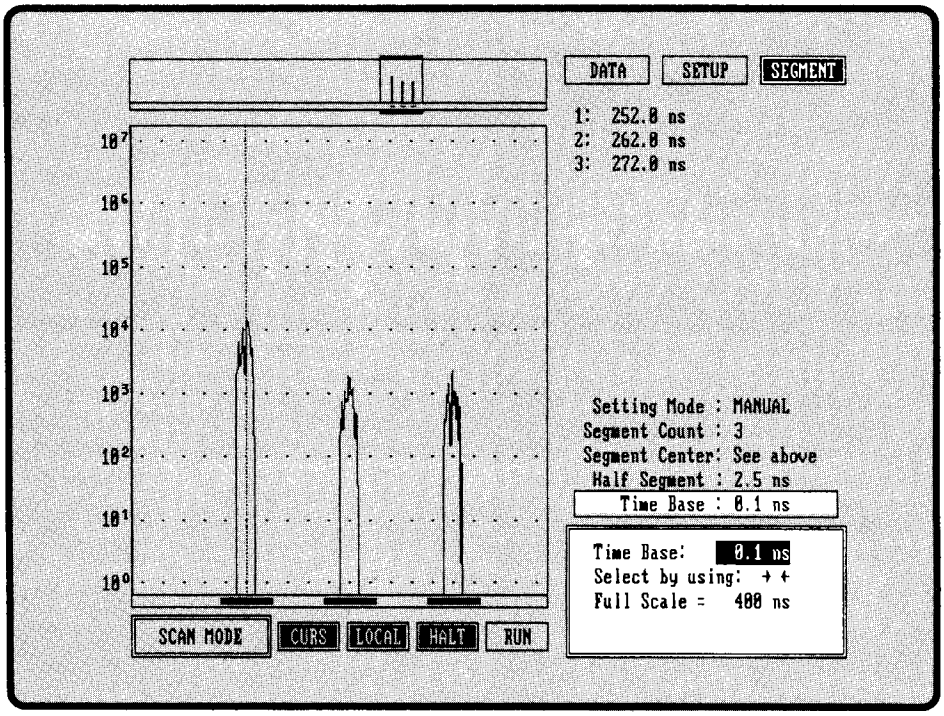
3.4.2.4 HALF SEGMENT



HALF SEGMENT

Using the **NUMERIC** keys and the **ENTER** key, select a **HALF SEGMENT** width within the given range. This range will change if the **TIME BASE** is changed. The selected value will appear in reverse video and the **Half Segment** box. If the value is greater than 1/2 the distance between segments, (ie.,would cause segment overlap), the **TIA 3100** will truncate the segment width to just prevent overlap.

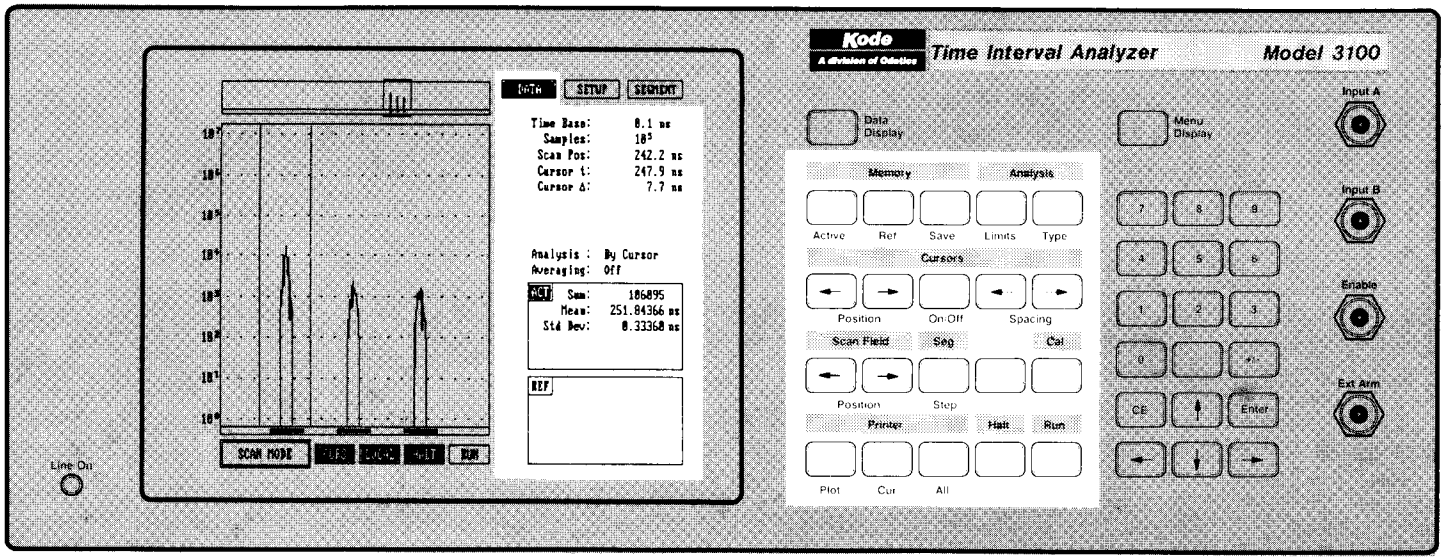
3.4.2.5 TIME BASE



TIME BASE

The **TIME BASE** may be changed in the **SEGMENT** menu as it was in the **SETUP** menu using the LEFT/RIGHT **ARROW** keys to select one of the **16** available time bases. If the selected time base causes any previously selected segments to **merge** or become **less in width** than the resolution afforded by the time base (1 bin), the affected segments will be **flagged** with appropriate messages. Returning to the previous time base will eliminate the error conditions while retaining the previously selected segments.

3.4.3 DATA MENU



The **DATA** menu is normally used **after** completing the selection of **SETUP** and **SEGMENT** parameters. It provides information pertinent to the DATA DISPLAY and **must** be selected to view the results of mathematical analysis.

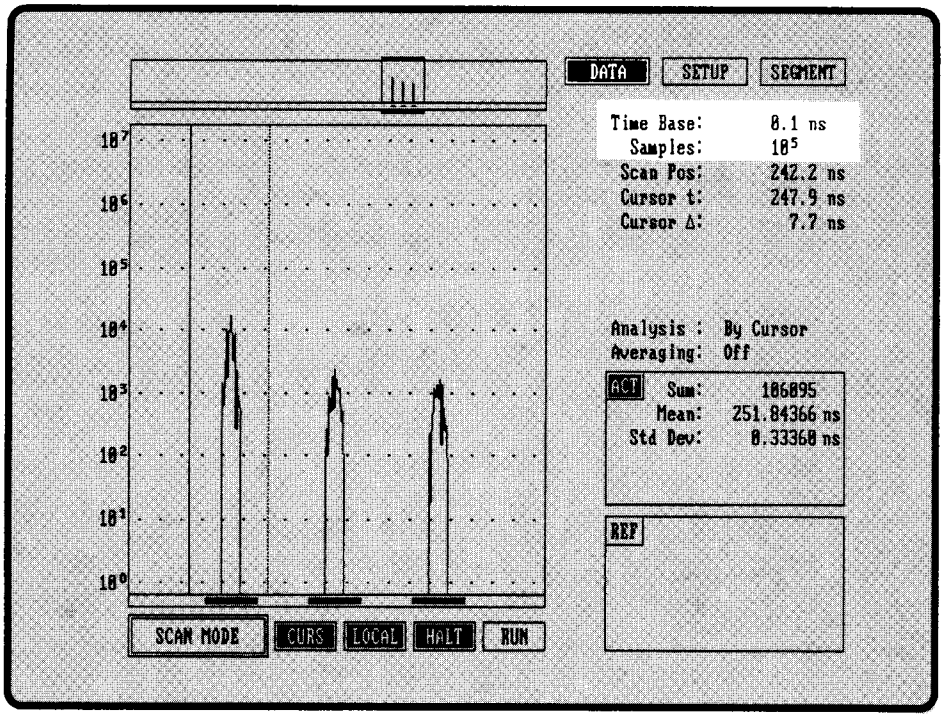
The **DATA** menu displays the status of:

- key **SETUP** parameters,
- the location of the **CURSORS**,
- the location of the **SCAN FIELD,** and
- the **mathematical analysis** results

as discussed in following text.

The **NUMERIC**, LEFT/RIGHT **ARROW**, and UP/DOWN **ARROW** keys are inactive when displaying the **DATA** menu.

3.4.3.1 SET UP PARAMETERS



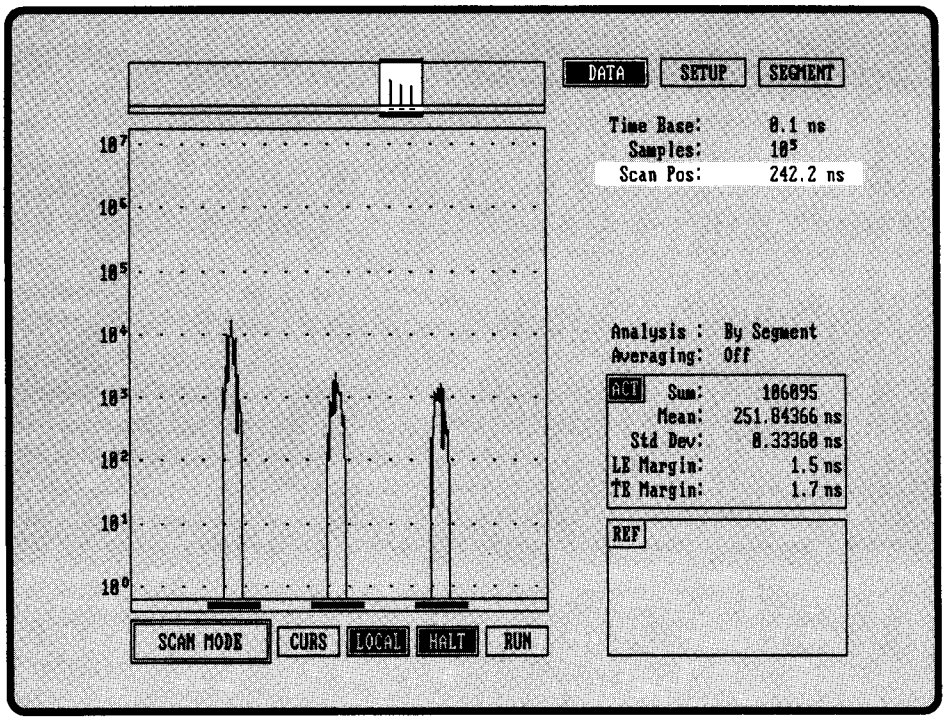
SETUP Parameters

The **two** key **SETUP Parameters:**

- **Time Base**, and
- **Samples (Size)**

are displayed at the top of the **DATA** menu.

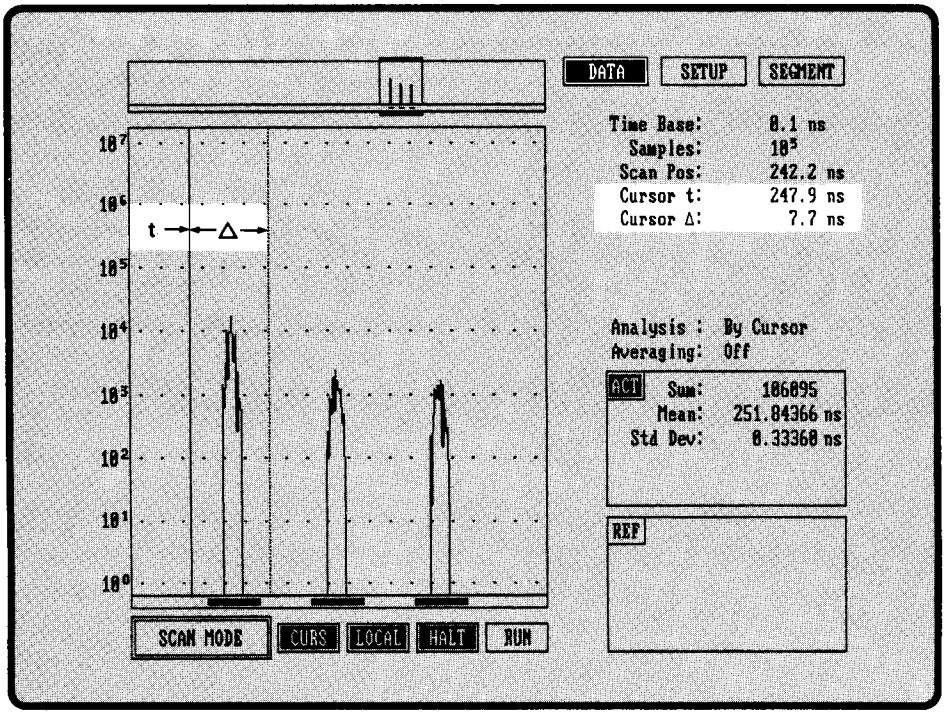
3.4.3.2 SCAN POSITION



SCAN POSITION

The **POSITION** of the left boundary of the **SCAN FIELD** is indicated in **units of time.** The **SCAN FIELD** is represented by the **square box** at the top of the DATA DISPLAY, and may be positioned anywhere within the MEASUREMENT FIELD. See Paragraphs 3.5.1 and 3.6.4 for details.

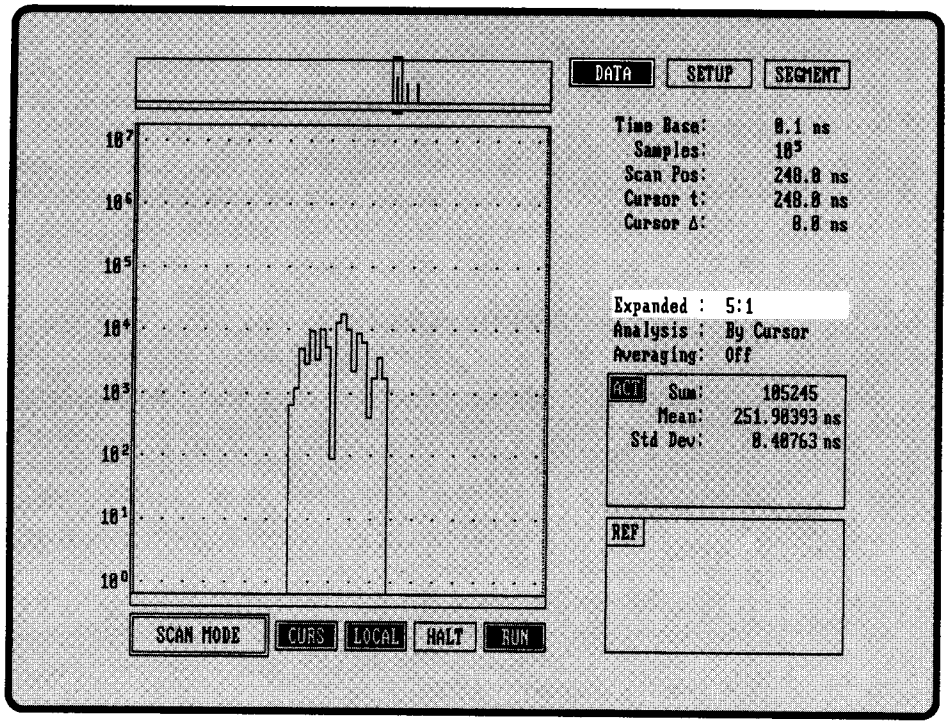
3.4.3.3 CURSOR POSITION



CURSOR POSITION

The position of the **CURSORS** and the spacing between them is indicated in **units of time.** The **solid CURSOR** location is indicated as **CURSOR t,** while the spacing between them is indicated as **CURSOR Δ**. See Paragraph 3.6.3 for more details.

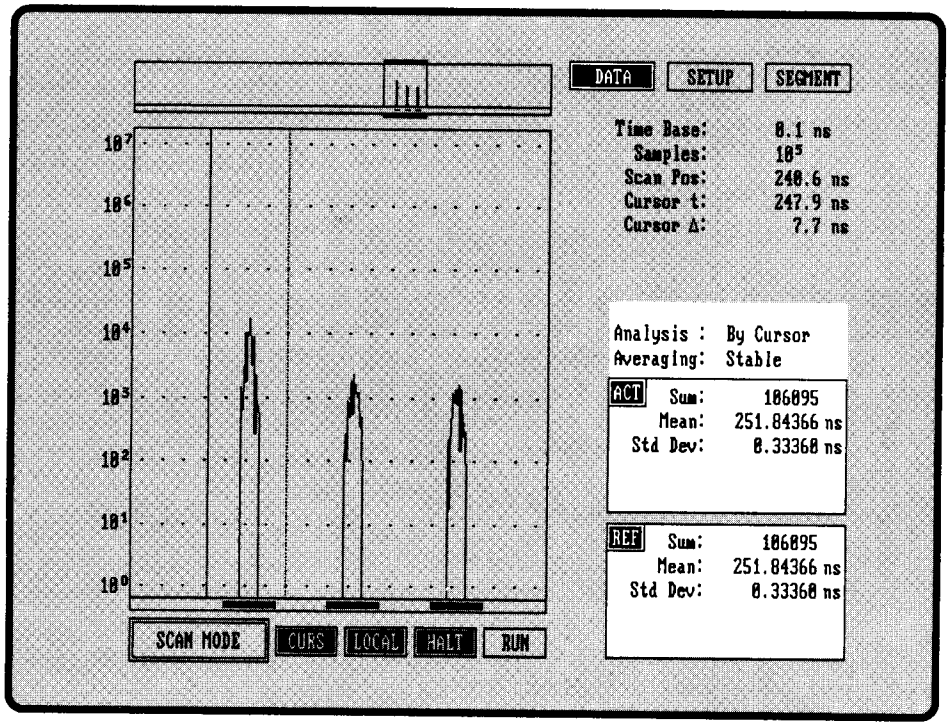
3.4.3.4 EXPANDED DISPLAY



EXPANDED DISPLAY

While in the **DATA** menu, the displayed data can be expanded **2:1** or **5:1** by pressing the **NUMERIC** key **2** or **5**. Pressing the **NUMERIC** key **1** will return the display to normal.

3.4.3.5 MATH ANALYSIS



MATH ANALYSIS

The type of **MATH ANALYSIS** selected:

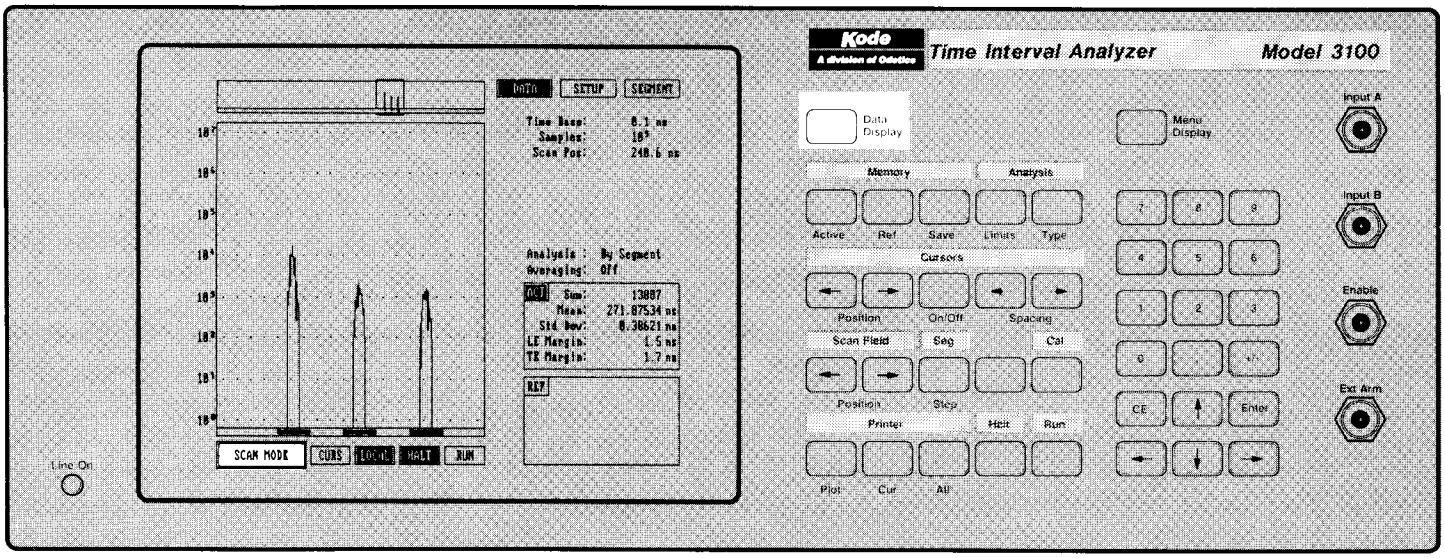
- **SEGMENT** or **CURSOR**, and

the **type** of **AVERAGING:**

- **Off**,
- **Stable**, or
- **Exponential**

and the actual math results for both the **Active (ACT)** and **Reference (REF)** memories are displayed in the lower half of the **DATA** menu. See Paragraph 3.6.2 for more details.

3.5 DATA DISPLAY SELECTION



DATA DISPLAY

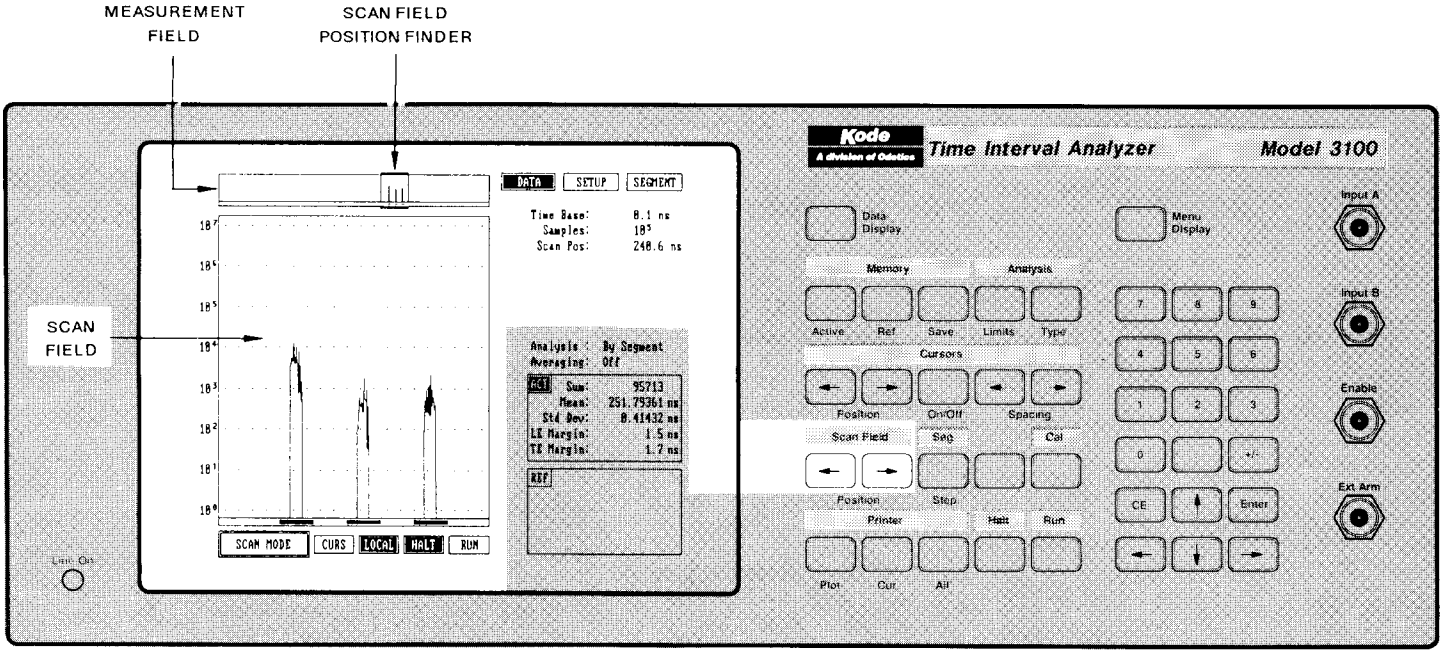
Sequentially selects one of the three **DATA DISPLAY** modes:

- **SCAN**, or
- **SIGMA 1**, or
- **SIGMA 2**

The selected mode influences the nature of data presentation in the DATA DISPLAY area of the CRT and is indicated in the left box at the bottom of the display.

The **SIGMA 1** and **SIGMA 2** modes can be activated only if **SEGMENTS** have been set up in the **SEGMENT** menu.

3.5.1 SCAN MODE

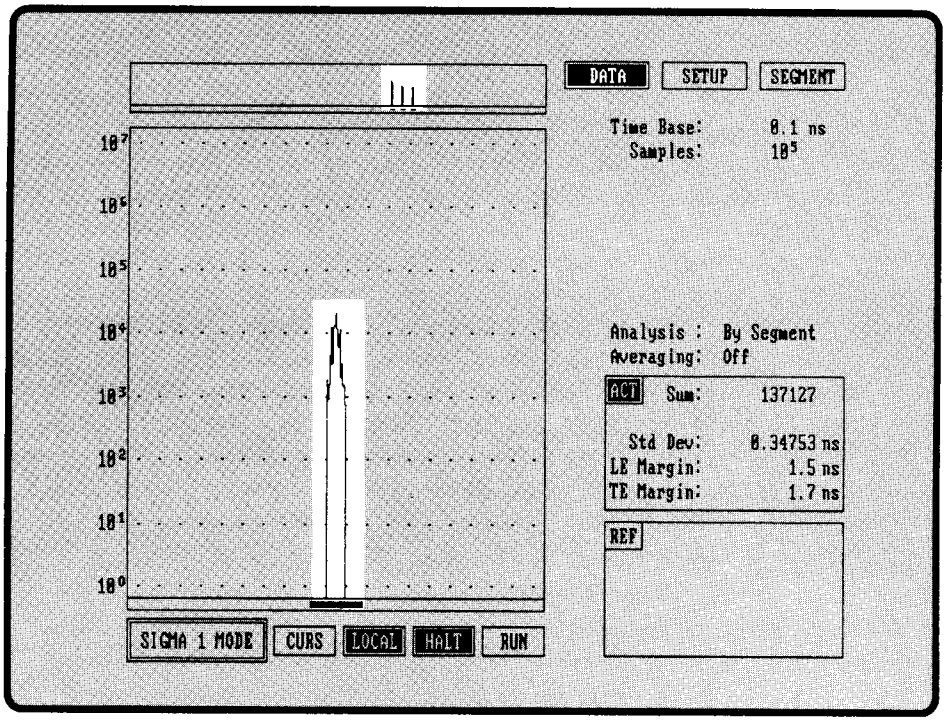


In the **SCAN MODE**, the data contained within the square **SCAN FIELD** position finder in the **MEASUREMENT FIELD**, is presented in expanded form in the main **SCAN FIELD**. The width, or range of the **MEASUREMENT FIELD** is **4000 times** the selected time base, while the width of the **SCAN FIELD** is 400 times the selected time base.

The position of the **SCAN FIELD** can be selected with the **SCAN FIELD POSITION** LEFT/RIGHT **ARROW** keys.

As discussed further below, full use of **Memory**, **Analysis**, **Cursor**, **Segment Step**, and **Printing Functions** are available in the **SCAN** mode.

3.5.2 SIGMA 1 MODE



SIGMA 1 MODE

In the **SIGMA 1 MODE** the data contained within each of the selected segments as seen in the MEASUREMENT FIELD is superimposed and presented as one histogram in the main DATA DISPLAY FIELD.

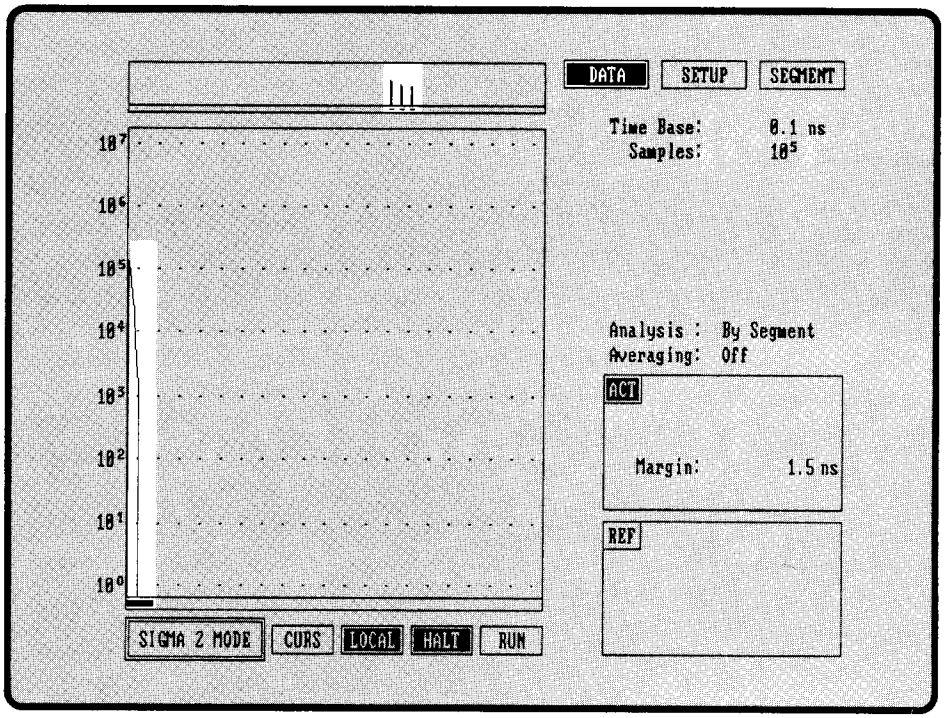
The SCAN FIELD and its position controls as well as the **SEGMENT STEP** are **inoperative in this mode.**

Full use of the **Memory** and **Printing** functions are available in the **SIGMA 1 MODE.**

The **CURSOR** function is limited in the **SIGMA 1 MODE** to provide math measurements between the two cursors only. The absolute location of the cursor is not meaningful and therefore only the cursor spacing is identified on the CRT.

The **Math Analysis** function is limited in that no mean readings are provided.

3.5.3 SIGMA 2 MODE



SIGMA 2 MODE

The **SIGMA 2 MODE** differs from the **SIGMA 1 MODE** in that all data presented in **SIGMA 1** to the **left** of the segment center line is rotated and superimposed on the data to the right of the center line. The resulting histogram displays worst case margin without regard to distribution (**SEGMENT**) location or leading or trailing edge.

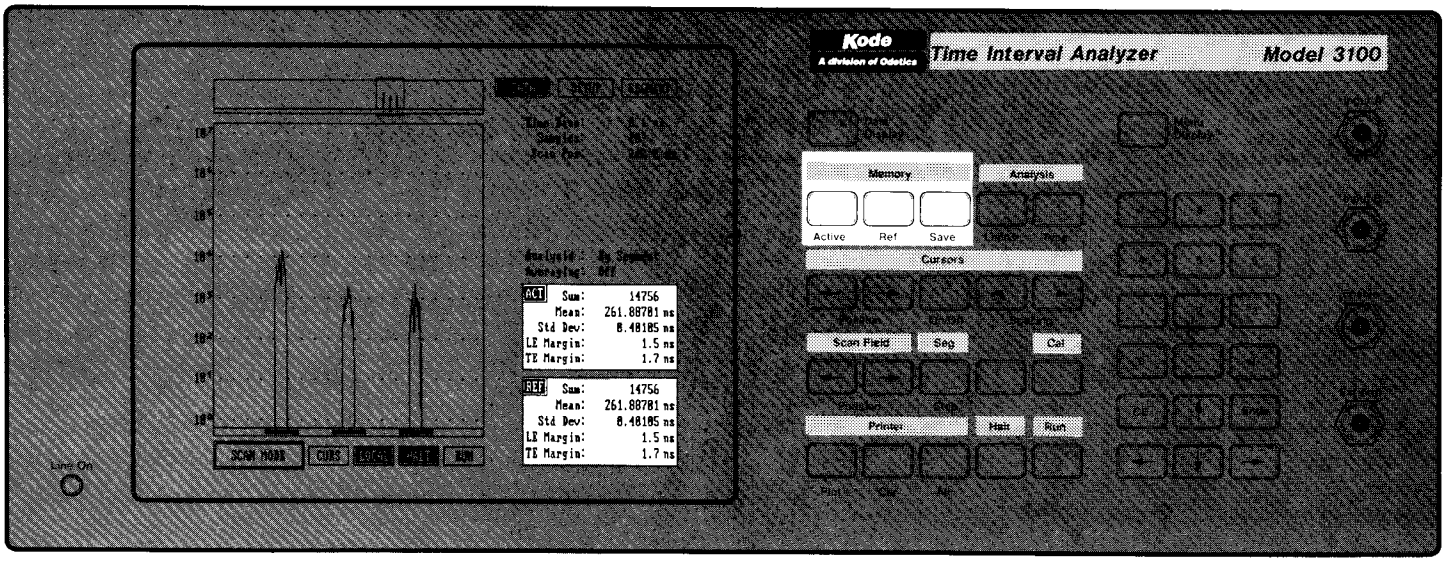
The **SCAN FIELD, SEGMENT STOP** and **CURSOR** functions are inoperative in this mode.

Full use of the **Memory** and **Printing** functions are available in the **SIGMA 2 MODE.**

Math Analysis is limited to margin only.

3.6 OPERATIONAL CONTROLS

3.6.1 MEMORY



The three (3) **Memory Control** switches:

- **Active**,
- **Ref**, and
- **Save**

are used to store data in memory and to selectively display the previously stored data, the current (active) data or both.

3.6.1.1.1 Active

Pressing the alternate action **Active** key will **invoke** or **remove** the **Active Memory** data for histogram and Math Analysis display. Math analysis results from the **Active Memory** are displayed in the top box. If the **TIA** is running in a **continuously updating mode**, the active data displayed will be for the last completed analysis and will continue to update as each analysis is completed until halted.

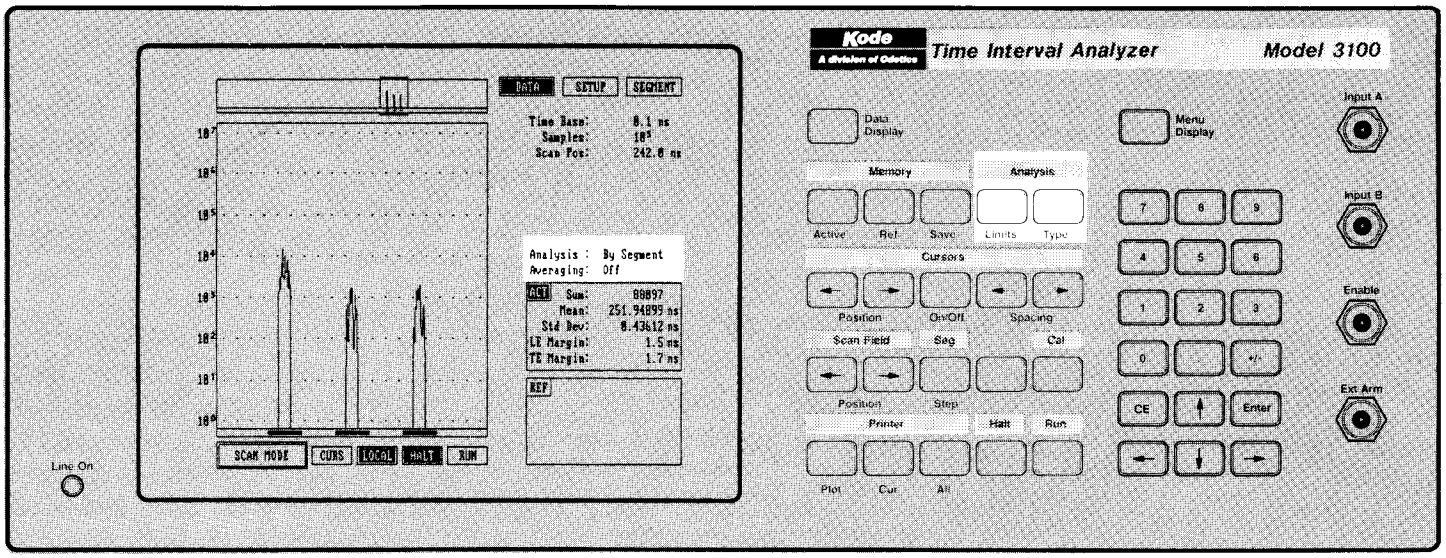
3.6.1.1.2 Ref [Reference]

Pressing the alternate action **Reference** key will invoke or remove the **Reference Memory** data just as described for the **Active** key. The histogram will remain as a static reference for comparison to real time active data controlled by the **Active** key, previously discussed. The math results from the **Reference Memory** are displayed in the bottom box.

3.6.1.1.3 Save

The **Save** key, when pressed, stores the results of the **last completed analysis** in the **Reference** memory.

3.6.2 ANALYSIS



The two **Analysis** control switches:

- **Limits**, and
- **Type**

are used to select the **limits** and **type** of mathematical analysis. The selected choices are displayed just above the **Math Results** boxes.

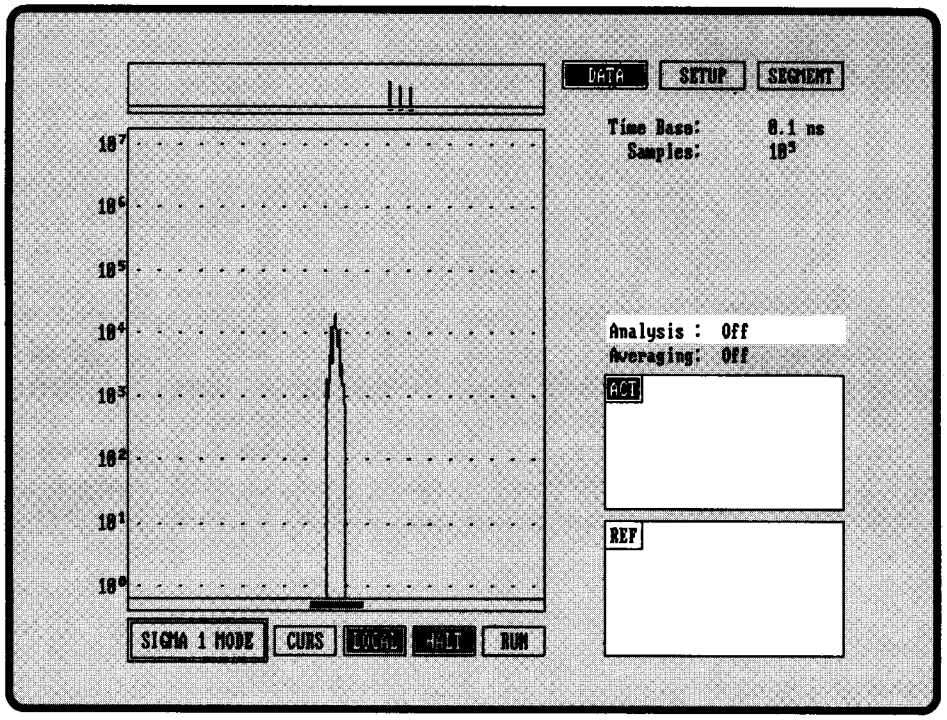
3.6.2.1 LIMITS

Successive activation of the **Limits** switch will **cycle** each of the three different limit ranges over which the math analysis is performed;

- **Off**,
- **by Cursors** and
- **by Segment**.

If the **CURSORS** are not activated, or **no** segments have been set up, then associated **math limits** will not be selectable. For example, if no segments have been defined, but the **CURSORS** are ON, the **Limits** switch will **alternately** select **Off** and **by Cursors**.

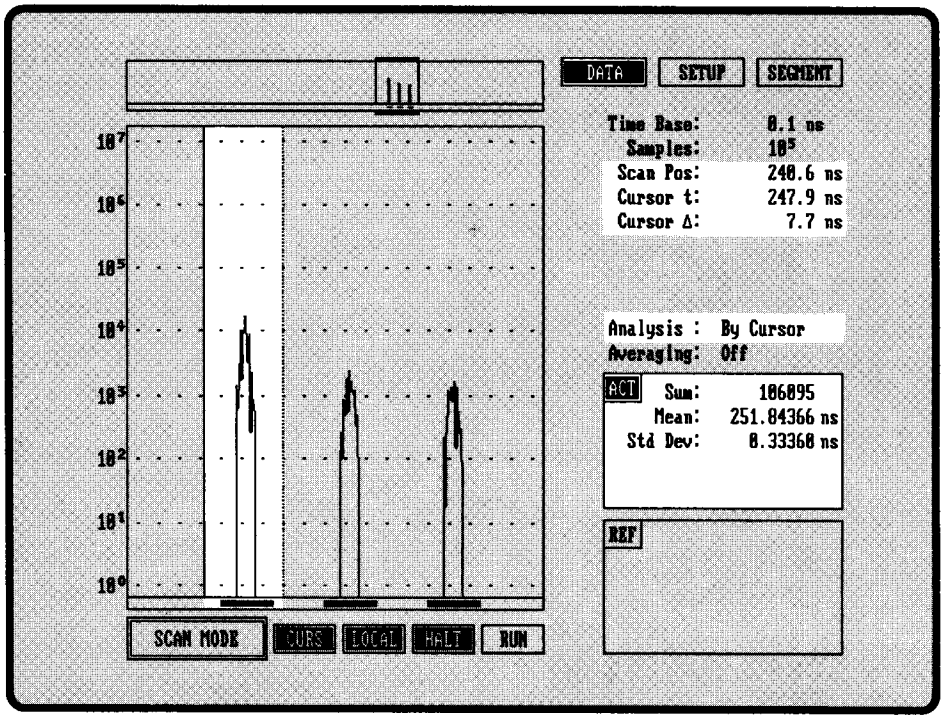
3.6.2.1.1 LIMITS OFF



LIMITS, OFF

When **Off** is selected, **no** math results are displayed for either the **Active** or **Reference** memory.

3.6.2.1.2 LIMITS BY CURSORS



LIMITS, BY CURSORS

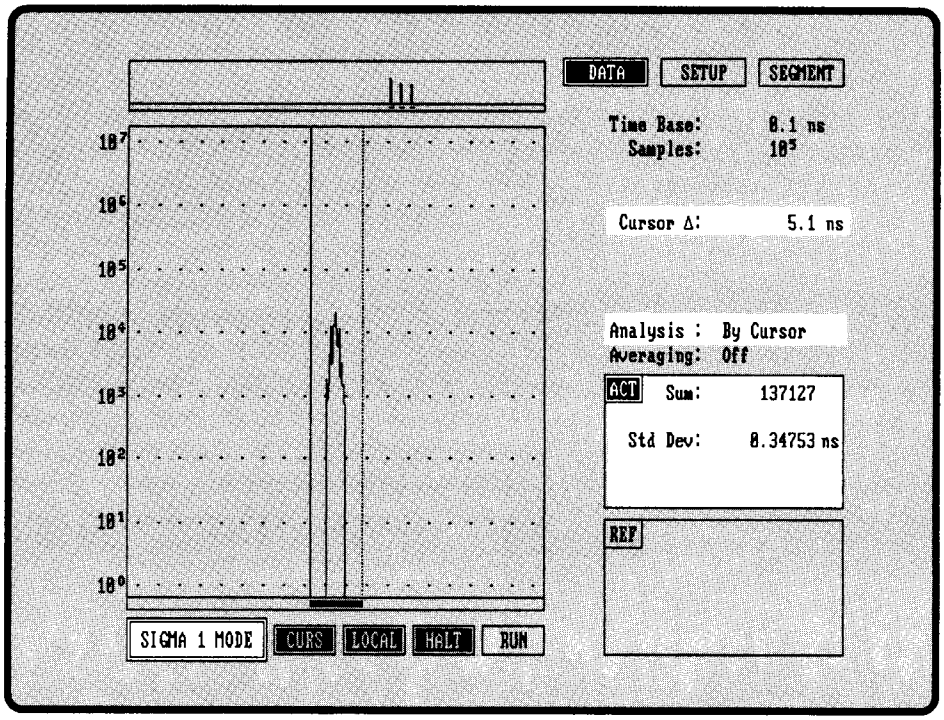
When analysis by **CURSORS** is selected, the math is performed on the data located between the two **CURSORS.**

In the **SCAN MODE**, the **CURSORS** may be placed anywhere within the SCAN FIELD the:

Summation,
Mean, and
Standard Deviation

results will be displayed.

3.6.2.1.3 LIMITS BY CURSORS [SIGMA 1 MODE]

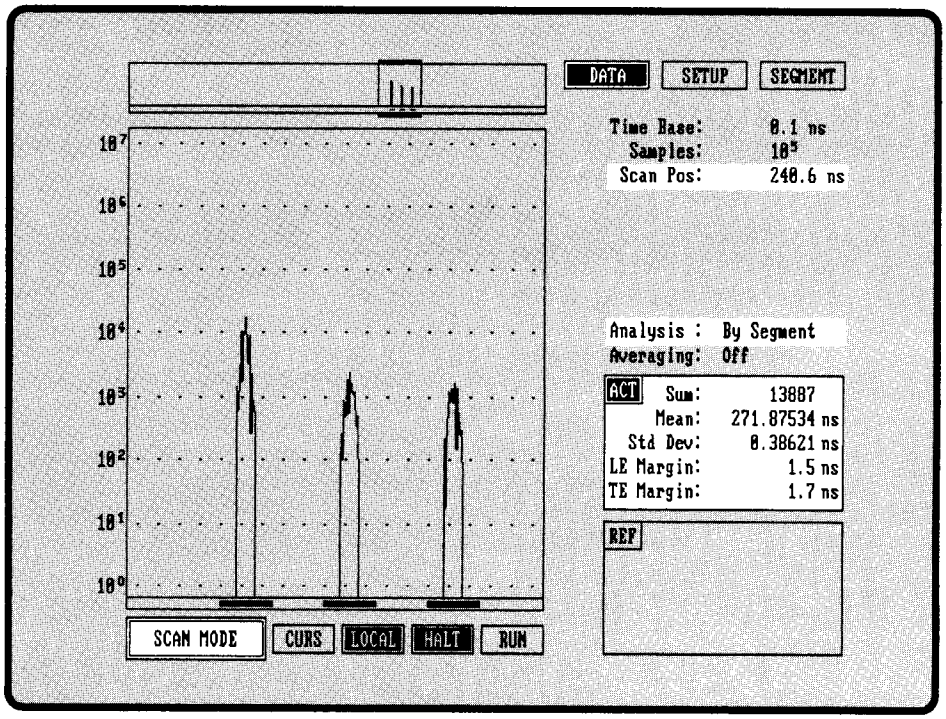


LIMITS, BY CURSORS [SIGMA 1 MODE]

In the **SIGMA 1** mode, the **CURSORS** may be placed only within the segment limits and the math results are limited to Summation and Standard Deviation.

In the **SIGMA 2** mode, math analysis by **CURSORS** is **not allowed.**

3.6.2.1.4 LIMITS BY SEGMENT



LIMITS, BY SEGMENT

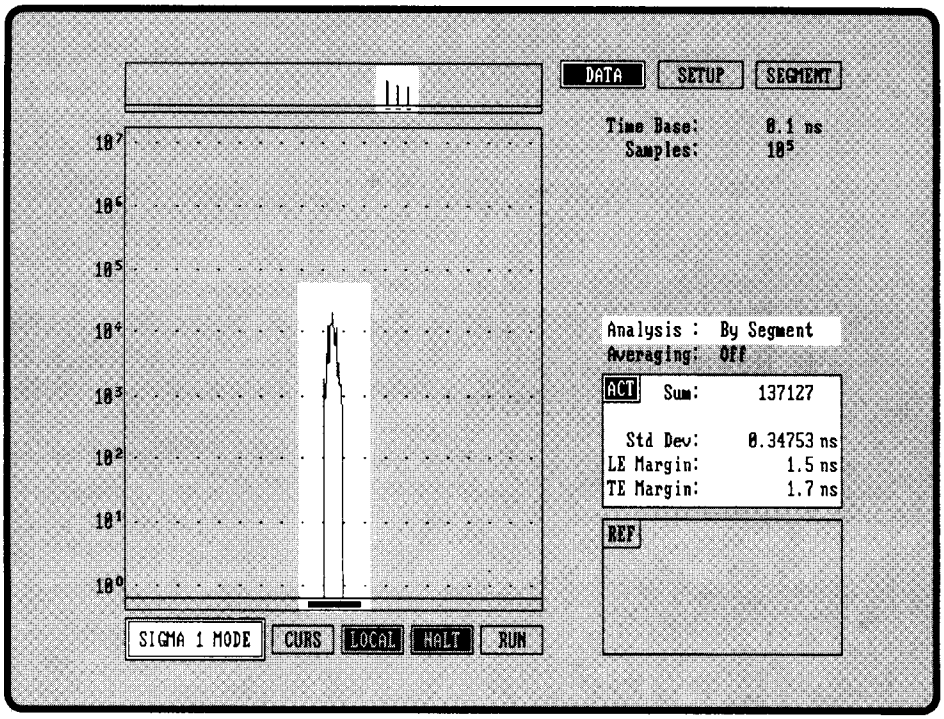
When analysis by **Segment** is selected, the math is performed on the data located within the segment(s) as discussed further below.

In the **SCAN** mode, the analysis includes:

- **Summation,**
- **Mean,**
- **Standard Deviation,**
- **Leading,** and
- **Trailing Edge Margins.**

Edge margin is the time between the leading or trailing edge of the segment and the corresponding edge of the measured data distribution. The analysis is performed only on the **Prime Segment** as indicated by the highlighted segment on both the MEASUREMENT and SCAN fields. The segment assigned **Prime** status may be selected with the **Segment Step** switch as discussed in later text.

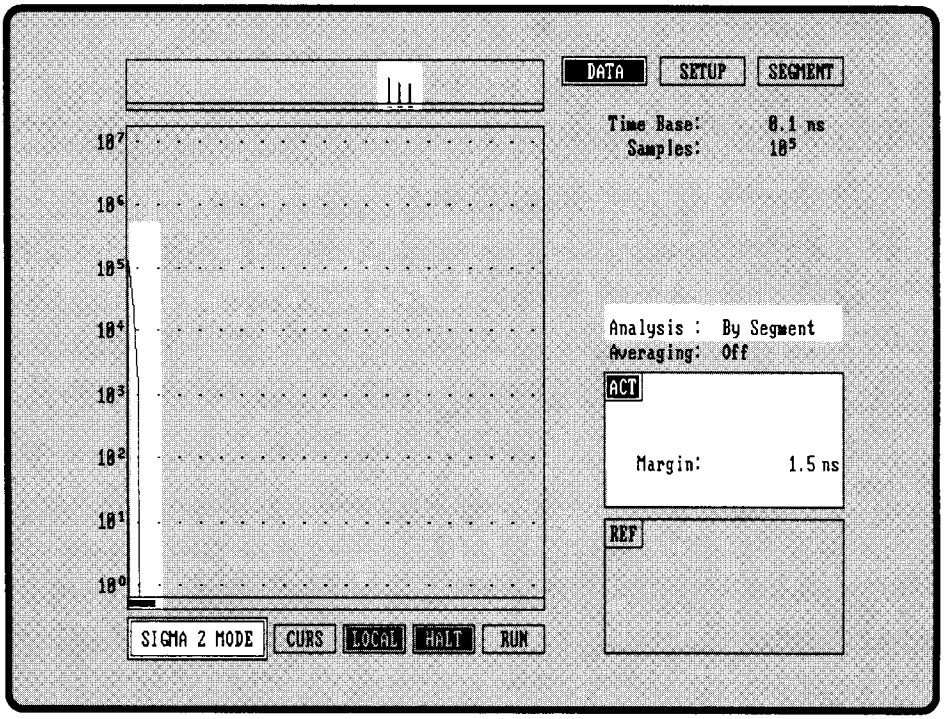
3.6.2.1.5 SIGMA 1 MODE



SIGMA 1 MODE

In the **SIGMA 1** mode, the **Mean** calculation is not performed since all segment distributions are superimposed or overlaid and **mean** is not relevant.

3.6.2.1.6 SIGMA 2 MODE



SIGMA 2 MODE

In the **SIGMA 2** mode, the analysis is **limited** to a single margin calculation.

3.6.2.2 TYPE

Successive activation of the **Type** switch will select **one** of **three Analysis** types:

- **non-averaging (off),**
- **Stable averaging**, or
- **Exponential averaging.**

Averaging may be used to:

- **reduce variance** when analyzing data with random or transient conditions, or
- to **recover coherent signals** buried in noise.

The **TIA** must be **HALTED** to initially select one of the averaging types.

Stable averaging terminates after the selected number of averages **(N)** has been performed while **Exponential averaging** will continue indefinitely, unless stopped by the operator.

Stable averaging is most useful when the characteristics of the signal under analysis are **not changing except for noise** during the measurement process.

Exponential averaging is useful when the characteristics of the signal are **changing significantly** during the averaging process. The value of **K**, selected by the user, is the **decay constant**. As the averaging process continues, old data is discounted more and more, thus giving weight to the new data as it occurs.

Stable:

$$An = A_{n-1} + \frac{Z_n - A_{n-1}}{n} \Bigg|_{n=1}^{n=N}$$

Exponential:

$$An = A_{n-1} + \frac{Z_n - A_{n-1}}{K}$$

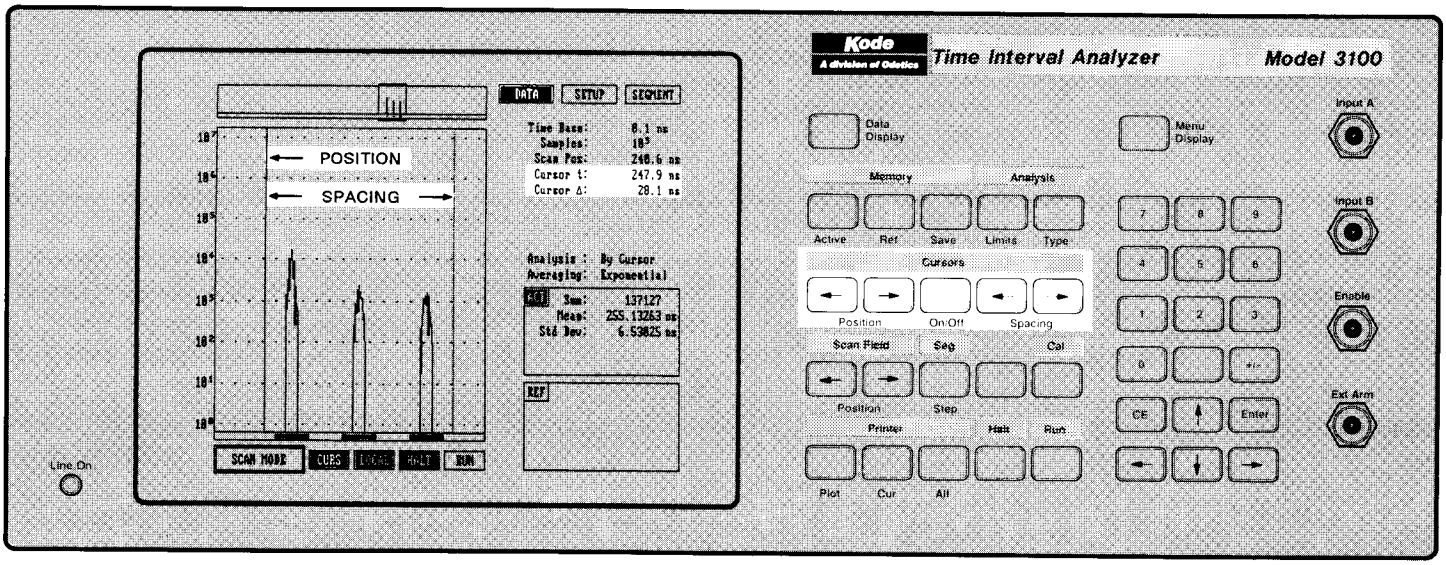
Where: A_n = The current average

A_{n-1} = The previous average

Z_n = The current measurement

N=K = The number of ensembles selected in the **Setup** menu. (See Paragraph 3.4.1.12)

3.6.3 CURSORS



Two vertical lines spanning the **full height** of the DATA DISPLAY are provided to assist the operator in measurements. These lines are called **CURSORS** and may be moved anywhere on the display as discussed below.

3.6.3.1 Cursors, On/Off

Toggles the **CURSORS** ON and OFF. **CURSORS** are ON when the **CURS** legend is highlighted in reverse video.

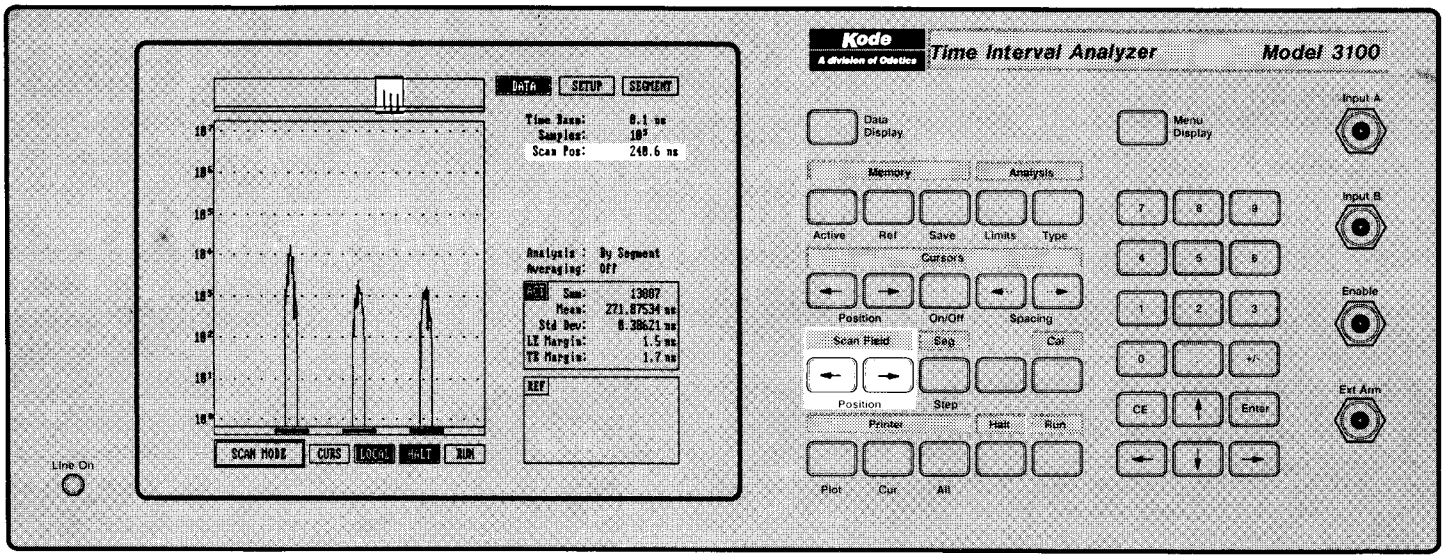
3.6.3.2 Cursors, Position (←, →)

Provided the **CURSORS** are ON, causes the primary **CURSOR** (solid vertical line) and secondary **CURSOR** to move in the indicated direction.

3.6.3.3 Cursors, Spacing (←, →)

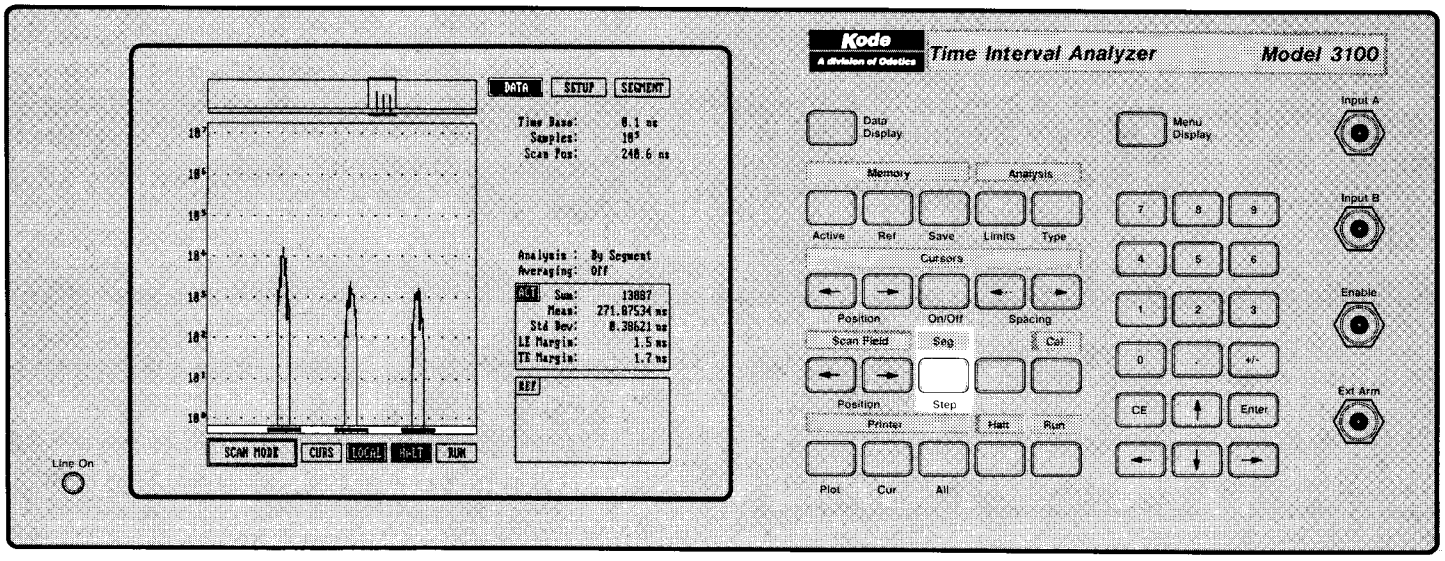
Provided the **CURSORS** are ON, causes the secondary (dashed vertical line) to move in the indicated direction.

3.6.4 SCAN FIELD



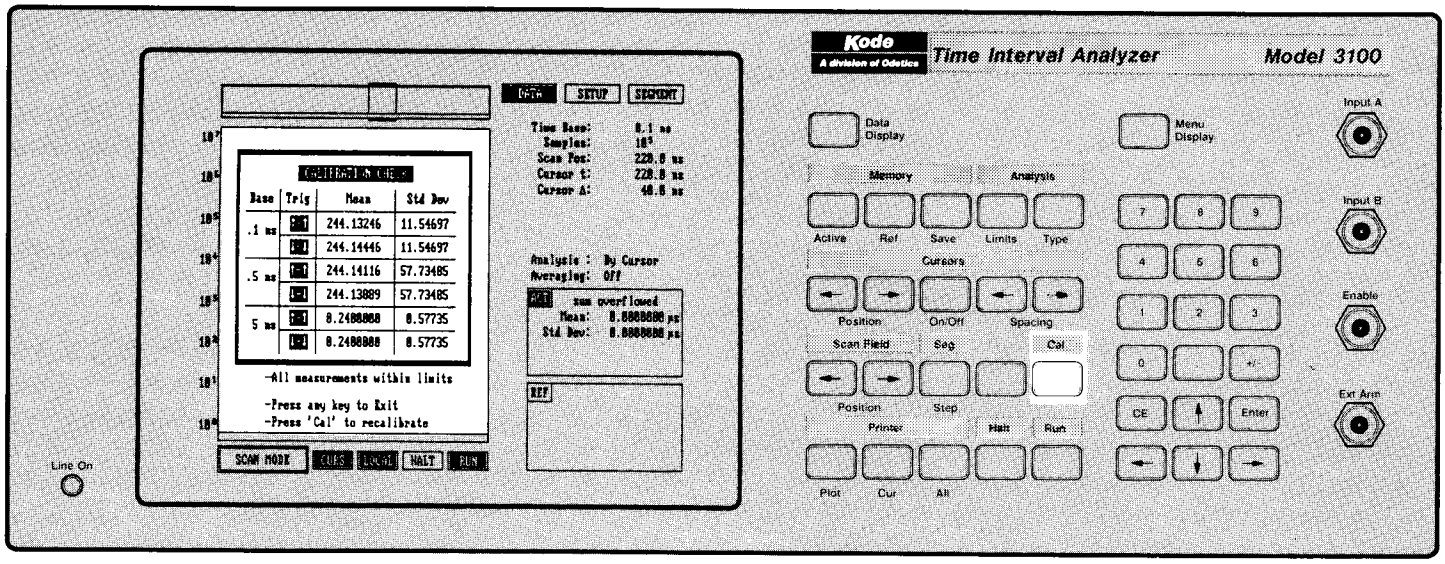
The position of the **SCAN FIELD** is controlled by the LEFT/RIGHT position **ARROW** keys. It may be moved in single increments, equal to the selected **Time Base** by **single** [momentary] pressing of the LEFT/RIGHT **ARROW** keys. **Continuous** activation of the switches will yield an accelerating rate of movement of the **SCAN FIELD** in the selected direction. At the highest rate of movement, the histogram in the **SCAN FIELD** will be blanked, however, the MEASUREMENT FIELD histogram will remain intact.

3.6.5 SEGMENT STEP



The **Prime Segment**, that is, the segment in which **math analysis** is performed in the **Scan Mode**, is sequentially selected with the **Segment Step** switch. The **Prime Segment** is identified by the highlighted video at the bottom of the MEASUREMENT FIELD and the SCAN FIELD. Successive activation of the **Segment Step** switch will cause the SCAN FIELD to move from **left** to **right** across the MEASUREMENT FIELD, one segment at a time. This has the effect of keeping the location of the **Prime Segment** within the SCAN FIELD while moving the data from **right** to **left** through the SCAN FIELD with each successive activation of the switch.

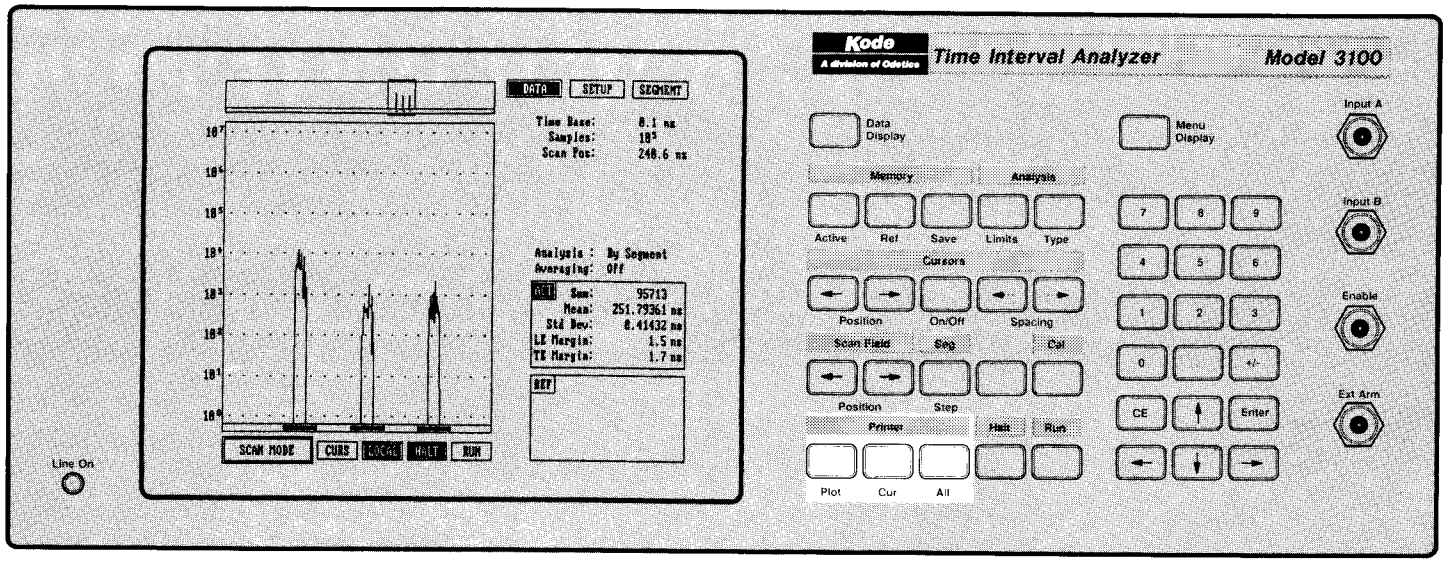
3.6.6 CALIBRATION



Pressing the **CAL** [Calibration] key will initiate an **automatic self check** mode of the operation in the **TIA.** This check takes several seconds. The results of the check are presented on the CRT and indicated as being **in limits** or **out of limits.** Refer to **SECTION 1, Paragraph 1.5 SPECIFICATIONS.** If the results are **all in limits,** pressing any key other than **Cal,** will exit the **Calibration** check mode. Any **out of limits** readings are highlighted by reverse video. If **out of limit** readings are encountered, the **TIA** may be automatically calibrated by pressing the **Cal** key again.

This process will take **several minutes** and may be followed by a **self check** if desired. While in the calibration process, the **RUN** indicator on the CRT will be highlighted. Upon completion, the **HALT** indicator will be active. The **CE [Clear Entry]** key may be used to abort the calibration process. In this case, the previous calibration values stored by the **TIA** will be retained.

3.6.7 PRINTER



The three **Printer** control switches:

- **Plot,**
- **Cur,** and
- **All**

allow a variety of informational dumps to a printer connected to the back panel parallel printer interface. The CE **[Clear Entry]** may be used to abort any Printer function.

3.6.7.1 Plot

Causes the entire CRT display to be plotted on the printer.

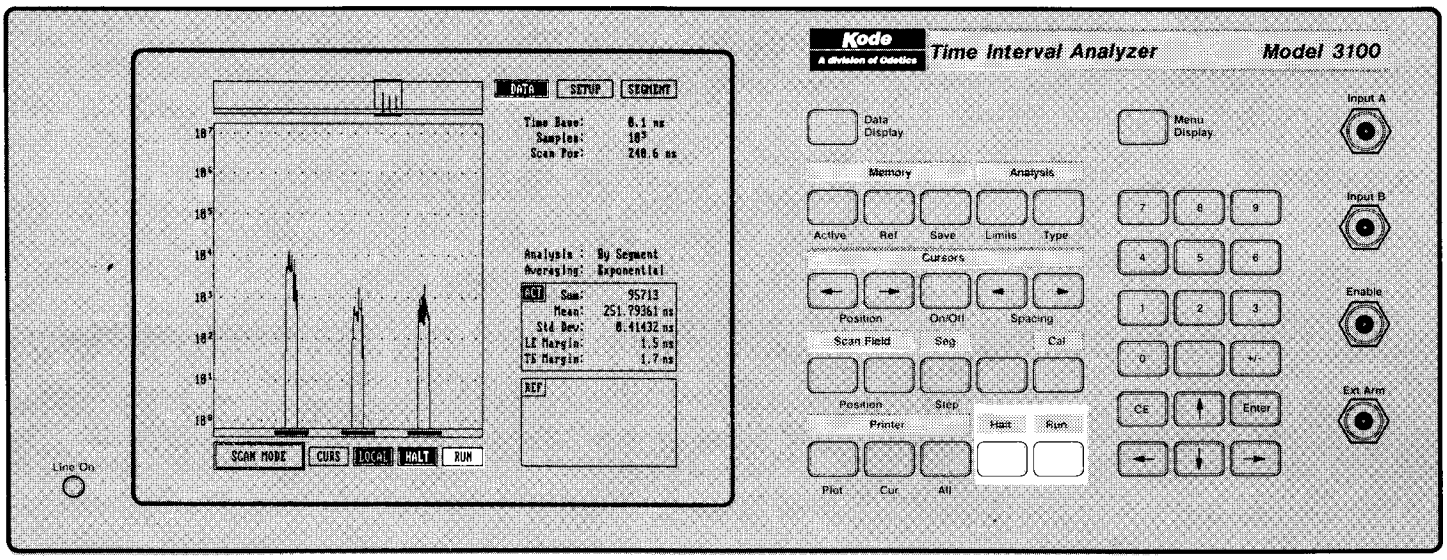
3.6.7.2 Cur

Causes the **Active** and **Reference** memory data bounded by the **CURSORS** to be printed on the printer.

3.6.7.3 All

Causes the entire **Active** and **Reference** memory data to be printed on the printer.

3.6.8 RUN and HALT



The **TIA** is controlled locally by the **Run** and **Halt** switches. These switches **begin** and **end** the **time interval measurement** as called for by the setup parameters as described below.

3.6.8.1 Halt

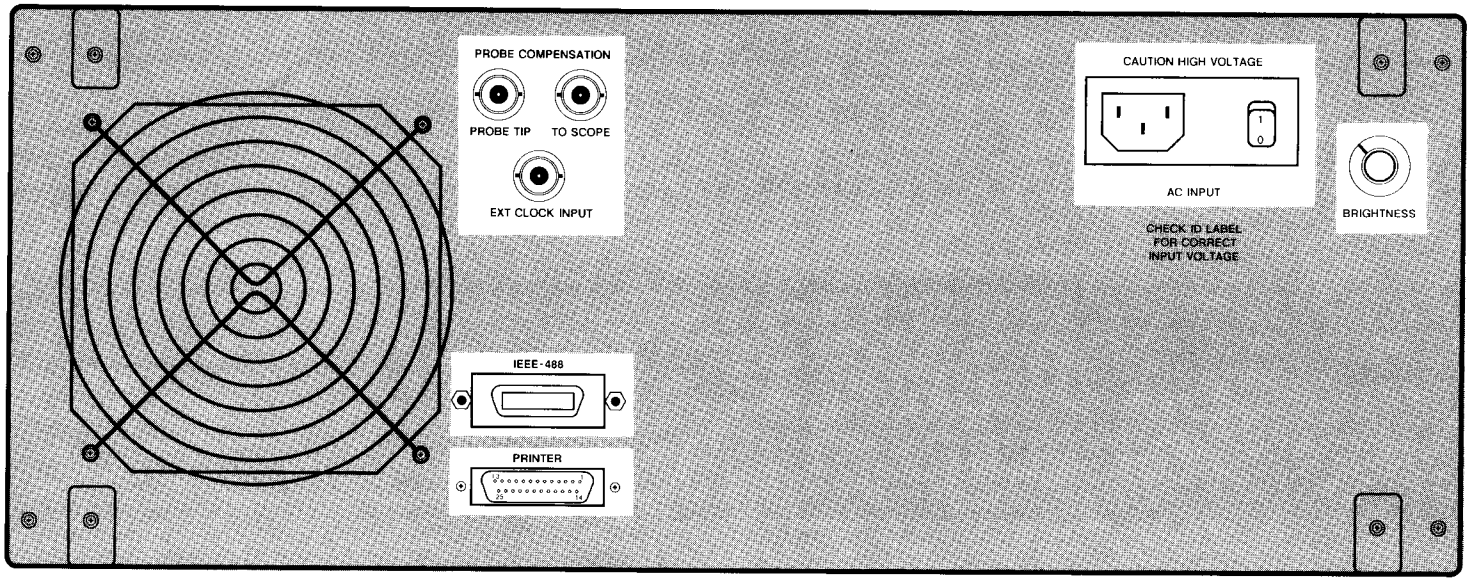
Aborts the current measurement.

3.6.8.2 Run

A momentary (less than 0.5 seconds) pressing of this key causes the **TIA** to start making measurements. During the measurement, the **RUN** indicator at the bottom of the CRT is highlighted. At the completion of an ensemble (selected **Sample Size**), the **Halt** indicator is highlighted.

Pressing this key for **more** than 0.5 seconds causes the **TIA** to **continuously re-arm** itself upon completion of an ensemble until the **Halt** key is pressed.

3.7 REAR PANEL CONTROLS AND INDICATORS



Rear panel controls and connectors are discussed below.

3.7.1 CONTROLS

Two controls are located on the **TIA** rear panel. One control is the **POWER ON/OFF** rocker type switch.

1 = Power ON [Push switch at TOP]
0 = Power OFF [Push switch at BOTTOM]

The other control is the CRT **BRIGHTNESS** control. CLOCKWISE rotation when **viewed from the rear** will **increase** CRT brightness.

3.7.2 CONNECTORS

3.7.2.1 AC INPUT

This three prong connector is intended for use with the AC Power Cord provided with the unit.

3.7.2.2 IEEE-488

Standard IEEE-488 interface connector. (See Table 2-1)

3.7.2.3 PRINTER

Standard parallel printer interface connector. (See Table 2-2)

3.7.2.4 EXTERNAL CLOCK INPUT

BNC connector for the application of an external system clock. (See Paragraph 1.5, Time Base, and Paragraph 3.4.1.14 System Clock)

3.7.2.5 PROBE COMPENSATION

Two BNC connectors are provided for calibrating probes. The connector labeled **PROBE TIP** provides a 1.22 KHz square wave output, while the connector labeled **TO SCOPE** is internally connected, through a buffer, to the signal applied to the front end comparator. See Figure 3-4.

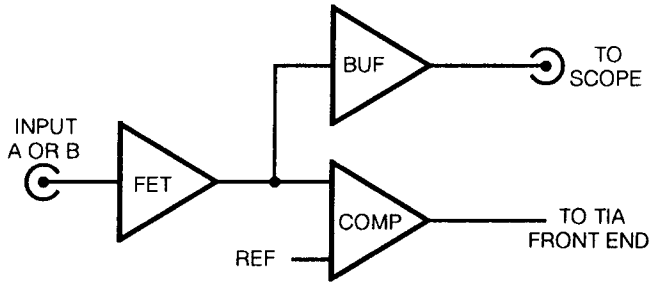


Figure 3-4. Probe Compensation Internal Connection

[1] Connect the tip of the probe to be calibrated to the **PROBE TIP** BNC connector. Connect the BNC end of the probe to be calibrated to the channel to be used, **Input A** or **Input B** BNC connector on the front panel.

[2] Connect a **coaxial** cable **(DO NOT USE A PROBE)** between the **TO SCOPE** BNC connector and an oscilloscope.

[3] Set the oscilloscope controls to accommodate a 1.22 KHz, 1 volt p–p signal with a +3.5 VDC offset.

[4] Adjust the probe for **flat response** of the square wave as seen on the oscilloscope; i.e., adjust for **no overshoot** or **undershoot** of the leading and trailing edges.

3.8 REMOTE PROGRAMMING

The **TIA Interval Analyzer** is equipped with **remote programming** capabilities in accordance with the IEEE-488 "Standard Digital Interface for Programmable Instrumentation."

This section describes the specific capabilities and the device dependent messages used to control the **TIA** via the IEEE-488 bus. Also included, are the output formats for the various output commands.

TABLE 3-2.

INTERFACE SUBSET CAPABILITY

SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T1	Basic Talker Capability
L1	Basic Listener Capability
SR1	Service Request Capability
RL1	Remote/Local Capability
PP0	No Parallel Poll Capability
DT1	Device Trigger Capability [RUN Mode]
C0	No Controller Capability

SRQ - becomes active upon completion of a selected **Sample Size** measurement, completion of a Calibration Check, or completion of the Self-Calibration function.

DT - causes address selected **TIA's** to enter the **RUN** mode.

3.8.1 DEVICE DEPENDANT MESSAGES

The **TIA** always accepts messages coming from the controller, but only responds to them when it is in the **REMOTE** state. It is the responsibility of the IEEE-488 controller to ASSERT **REN [REMOTE ENABLE]** prior to sending messages.

3.8.2 COMMAND MESSAGE TERMINATION

Each command must be terminated with an ASCII:

- "space" **[20 hex]**, or
- "comma" **[2C hex]**, or
- "carriage return" **[0D hex]**, or
- "line-feed" **[0A hex]** character.

3.8.3 KEY SWITCH COMMANDS

See Figure 3-5 for KEY SWITCH command row/column **[Krc]** assignments.

3.8.4 OUTPUT COMMANDS

1] **ADQ :** Outputs **A**ctive memory data as **D**ecimal numbers.

2] **ALQ :** Outputs **A**ctive memory data as **L**ogrithmic numbers.

3] **RDQ :** Outputs **R**eference memory data as **D**ecimal numbers.

4] **RLQ :** Outputs **R**eference memory data as **L**ogrithmic number.

5] **MAQ :** Outputs **M**ath **A**nalysis information.

6] **SDQ :** Outputs **S**tatus of **D**ata menu.

7] **SUQ :** Outputs **S**tatus of Set**U**p menu.

8] **SMQ :** Outputs **S**tatus of Seg**M**ent menu.

9] **CAQ :** Outputs summary results of **CA**libration check.

3.8.5 CURSORS AND SCAN FIELD MOVE COMMANDS

1] **FLnnn.** : Positions the solid **CURSOR** to one of 400 positions along the **X** axis. **"0"** is the left most position and **399** is the right most position.

2] **FRnnn.** : Positions the dotted **CURSOR** to one of 400 positions along the **X** axis. **"0"** is the left most position and **399** is the right most position.

3] **FSnnnn.** : Positions the beginning of the **SCAN FIELD**, see Paragraph 3.2.6. The range is **"0"** to **3600**.

3.8.6 MISCELLANEOUS COMMANDS

1] **H** : Display **H**ome command. Selects the **SCAN** mode and the **DATA** menu. Positions the **Parameter Box** to the **Time Base** parameter.

2] **RDL** : Loads data in to the **R**eference memory. The **RDL** command must be followed by **D**ecimal data in the exact format listed in Paragraph 3.8.7.3. [2].

3.8.7 COMMAND RESPONSES

3.8.7.1 ADQ COMMAND RESPONSE

1] **Active memory is Empty.**

```
ACTIVE MEMORY:<LF>
TIME BASE=nnnxs<LF>
SAMPLE SIZE=nnnnnn<LF>
NO DATA<LF>
END OF DEC DATA<LF*>
```

2] **The TIA is making measurements [RUN is selected].**

```
ACTIVE MEMORY:<LF>
TIME BASE=nnnxs<LF>
SAMPLE SIZE=nnnnnn<LF>
DATA NOT READY<LF>
END OF DEC DATA<LF*>
```

3] **Active Memory contains non-zero data.**

```
ACTIVE MEMORY:<LF>
TIME BASE=nnnxs<LF>
SAMPLE SIZE=nnnnnn<LF>
nnnn.nnnns nnnnnnnn<LF>
        .
        .
        .
nnnn.nnnns nnnnnnnn<LF>
END OF DEC DATA<LF*>
```

Where: n = a single digit **0-9**, a SPACE, or an ASTERISK (*)
<LF> = Line Feed
<LF*> = Line Feed with the EOI Line **ACTIVE**

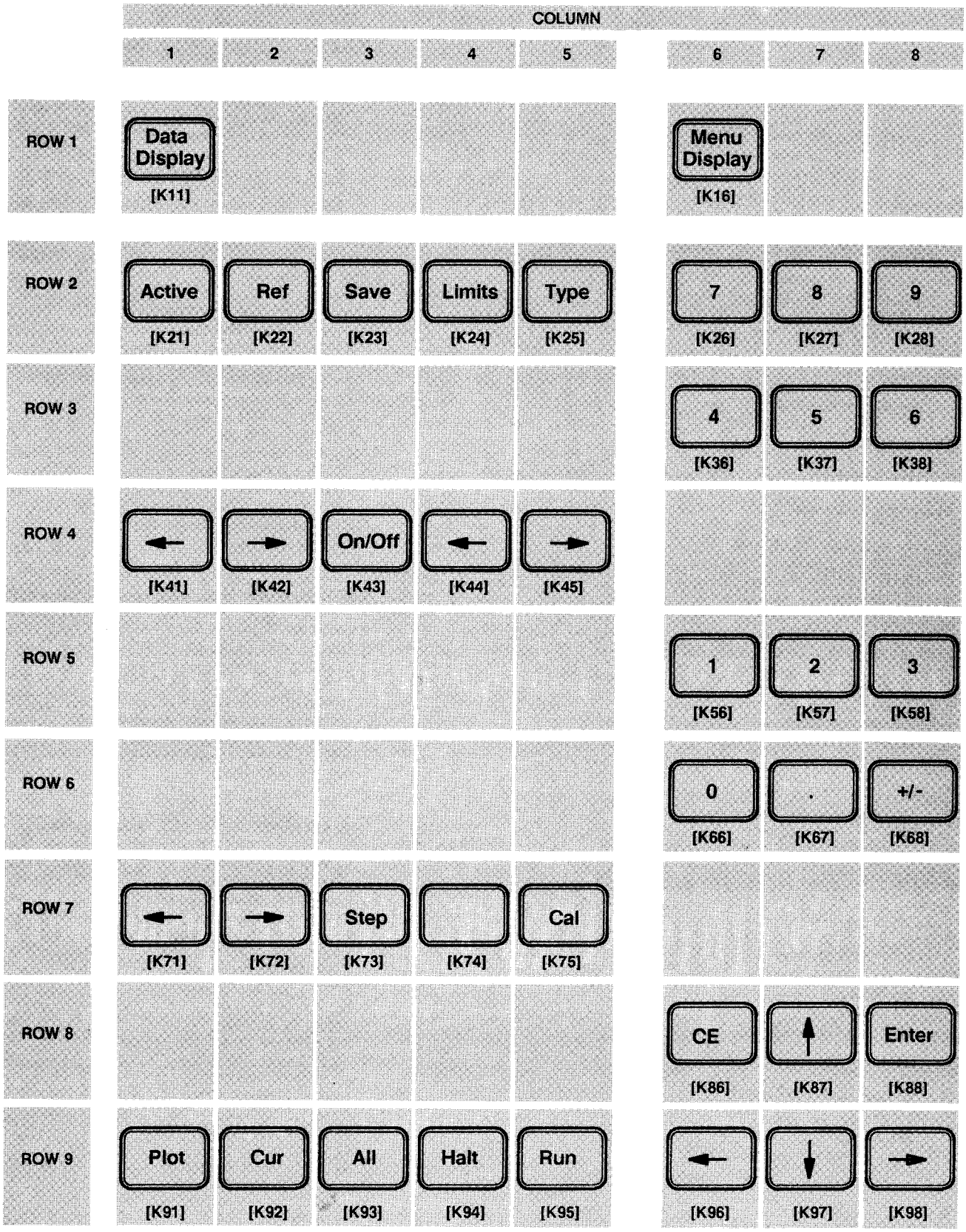


Figure 3-5. Key Switch Command Assignments

3.8.7.2 ALQ COMMAND RESPONSE

1] Active memory is Empty.

```
ACTIVE MEMORY:<LF>
TIME BASE=nnnns<LF>
SAMPLE SIZE=nnnnnn<LF>
NO DATA<LF>
END OF LOG DATA<LF*>
```

2] The TIA is making measurements [RUN is selected].

```
ACTIVE MEMORY:<LF>
TIME BASE=nnnns<LF>
SAMPLE SIZE=nnnnnn<LF>
DATA NOT READY<LF>
END OF LOG DATA<LF*>
```

3] Active Memory contains non-zero data.

```
ACTIVE MEMORY:<LF>
TIME BASE=nnnns<LF>
SAMPLE SIZE=nnnnnn<LF>
nnnn.nnnns nnnnnnnn<LF>
        .
        .
        .
nnnn.nnnns nnnnnnnn<LF>
END OF LOG DATA<LF*>
```

3.8.7.3 RDQ COMMAND RESPONSES

1] Reference memory is Empty.

```
REFERENCE MEMORY:<LF>
TIME BASE=nnnxs<LF>
SAMPLE SIZE=nnnnnn<LF>
NO DATA<LF>
END OF DEC DATA<LF*>
```

2] Reference Memory contains non-zero data.

```
REFERENCE MEMORY:<LF>
TIME BASE=nnnxs<LF>
SAMPLE SIZE=nnnnnn<LF>
nnnn.nnnns nnnnnnnn<LF>
        .
        .
        .
nnnn.nnnns nnnnnnnn<LF>
END OF DEC DATA<LF*>
```

3.8.7.4 RLQ COMMAND RESPONSES

1] Reference memory is Empty.

```
REFERENCE MEMORY:<LF>
TIME BASE=nnnxs<LF>
SAMPLE SIZE=nnnnnn<LF>
NO DATA<LF>
END OF LOG DATA<LF*>
```

2] Reference Memory contains non-zero data.

```
REFERENCE MEMORY:<LF>
TIME BASE=nnnxs<LF>
SAMPLE SIZE=nnnnnn<LF>
nnnn.nnnns nnnnnnnn<LF>
        .
        .
        .
nnnn.nnnns nnnnnnnn<LF>
END OF LOG DATA<LF*>
```

3.8.7.5 MAQ COMMAND RESPONSE

1] Analysis is Off

```
MATH ANALYSIS IS OFF<LF>
END OF DATA<LF*>
```

2] Analysis is by CURSORS.

```
MATH ANALYSIS IS BY CURSORS<LF>
ACTIVE MEMORY:<LF>
SUM=nnnnnnnnnn<LF>
MEAN=nnnn.nnnnnnn xs<LF>
STD DEV=nnnn.nnnnnnn xs<LF>
REFERENCE MEMORY:<LF>
SUM=nnnnnnnnnn<LF>
MEAN=nnnn.nnnnnnn xs<LF>
STD DEV=nnnn.nnnnnnn xs<LF>
END OF DATA<LF*>
```

3] Analysis is by Segment.

```
MATH ANALYSIS IS BY SEGMENT<LF>
ACTIVE MEMORY:<LF>
SUM=nnnnnnnnnn<lf>
MEAN=nnnn.nnnnnnn xs<LF>
STD DEV=nnnn.nnnnnnn xs<LF>
LE MARGIN=nnnn.nnn xs<LF>
TE MARGIN=nnnn.nnn xs<LF>
REFERENCE MEMORY:<LF>
SUM=nnnnnnnnnn<LF>
MEAN=nnnn.nnnnnnn xs<LF>
STD DEV=nnnn.nnnnnnn xs<LF>
LE MARGIN=nnnn.nnn xs<LF>
TE MARGIN=nnnn.nnn xs<LF>
END OF DATA<LF*>
```

3.8.7.6 SDQ COMMAND RESPONSE

1]

```
DATA STATUS<LF>
TIME BASE=nnnns<LF>
SAMPLE SIZE=nnnnnn<LF>
SCAN POS=nnnn.nnn xs<LF>
CURSOR T=nnnn.nnn xs<LF>
CURSOR DELTA=nnnn.nnn xs<LF>
ANALYSIS= nn nnnnnnn<LF>
AVERAGING=nnnnnnnnnnn<LF>
END OF DATA<LF*>
```

3.8.7.7 SUQ COMMAND RESPONSE

1]

```
SETUP STATUS:<LF>
TIME BASE=nnnnS<LF>
SAMPLE SIZE=nnnnnn<LF>
INTERVAL= nnn<LF>
START TRIGGER= zzz<LF>
STOP TRIGGER= zzz<LF>
A THRESHOLD= n.nnn v<LF>
B THRESHOLD= n.nnn v<LF>
ARMING= ???<LF>
ENABLE= ???<LF>
DELAYED ENB=nnnn.nnn xs<LF>
GATE=nnnn.nnn xs<LF>
RANDOMIZER= ???<LF>
AVERAGE=nnnnn<LF>
START DELAY=nn.n<LF>
SYSTEM CLK= ???[LF>
IEEE ADDR=nn<LF>
PROGRAM NO.=n<LF>
END OF DATA<LF*>
```

3.8.7.8 SMQ COMMAND RESPONSE

1] **Segments are not defined.**

```
SEGMENT STATUS:<LF>
SETTING MODE=??????????<LF>
SEGMENT COUNT= 0<LF>
HALF SEGMENT=  0.0   ns<LF>
TIME BASE=nnnns<LF>
END OF DATA<LF*>
```

2] **Segments are defined.**

```
SEGMENT STATUS:<LF>
SETTING MODE=??????????<LF>
SEGMENT COUNT= nn<LF>
SEGMENT CENTER #nn nnnn.nnn ns<LF>
        .
        .
        .
        .
SEGMENT CENTER #nn nnnn.nnn ns<LF>
HALF SEGMENT=nnn.nnn xs<LF>
TIME BASE=nnnns<LF>
END OF DATA<LF*>
```

3.8.7.9 CAQ COMMAND RESPONSE

1]
```
CALIBRATION VALUES OUT OF LIMITS<LF>
END OF DATA<LF*>
```

2]
```
CALIBRATION VALUES WITHIN LIMITS<LF>
END OF DATA<LF*>
```

> **NOTE**
>
> **The CAQ COMMAND RESPONSE only replies if a Calibration Check has been performed since the last Power-On.**

Where:

n	=	a single digit **0-9**, SPACE, or an ASTERISK (*)
x	=	m, u, or n
z	=	POS, NEG, +/–
?	=	alpha character [e.g.,ON, OFF, INT, EXT, MANUAL, AUTOMATIC]
<LF>	=	Line Feed
<LF*>	=	Line Feed with the EOI Line **ACTIVE**

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ADDENDUM TO TIA-3100 OPERATORS MANUAL

ENHANCED GPIB OPERATIONS

REV. G AND H FIRMWARE

MARCH,1990

INTRODUCTION

This addendum to the Time Interval Analyzer Mdel 3100 (TIA-3100) Operating Manual describes several new GPIB commands that have been added in Revisions G and H of the operating firmware. These new commands improve the transfer rate characteristics and functionality of the TIA-3100's GPIB interface.

Rev. G equipped units include some of the advanced GPIB features to be described while Rev. H includes those in Rev. G plus some additional commands. Since Rev. H succeeded Rev. G in so short a time, units equipped with Rev G can be upgraded to Rev. H at no charge by contacting Odetics PTD. Units equipped with Rev. A though F can be upgraded in the field for a nominal charge or at no charge in connection with a factory calibration.

All TIA-3100's present a brief firmware Rev. level message at power up via a reverse video window that appears on the CRT subsequent to the application of power. Rev. G and H equipped units will display the message "REVISION H (or G)" in this window.

REV. G COMMANDS, GENERAL DESCRIPTION

DATA TRANSFER

Previous revisions of the TIA-3100 firmware (Rev. A through F) provided only for the complete dump of memory data. Since the TIA-3100 can accumulate counts in each of 4000 Time Base "bins", the time to transfer the entire contents of the memory in previous revisions was sometimes prohibitively long. Even though the TIA-3100 suppresses output of zero content bins, transfer times of several seconds were sometimes required.

In contrast, Rev H now provides for the selective transfer of memory data using new range start and end commands in conjunction with a new memory output command to transfer the contents of only those bins bounded by the specified range start and end limits.

In addition, Rev. H also provides for the selective transfer of memory data of those bins falling within the range bounded by the currently selected Memory Segment, assuming that one or more segments have been defined via the Memory Segment Menu.

DATA TRANSFER (CONTINUED)

The above data transfer commands utilize a three byte per bin binary transfer format. Bin time identifiers are not sent. The data must therefore be parsed into a bin format after transfer. Depending on the application this binary data may be used directly or may be converted by the host into some other format such as ASCII.

The advantage of this binary transfer format is speed. Where-as previously, 20 ASCII bytes were needed to characterize the contents of each bin, this new format requires only three bytes; a six fold reduction in the amount of data to transfer. In addition, the TIA-3100 can transfer this binary formatted data about 20% faster than the ASCII equivalent.

STATUS

In previous revisions the host could not access the data ready status of the TIA-3100 directly. Instead, the data ready status was communicated only as part of an actual request to transfer data. Rev. H now incorporates a separate command to query the TIA-3100's status independent of the actual transfer command. Use of this command should make the timely scheduling of data transfers easier and more reliable.

REV. H COMMANDS, GENERAL DESCRIPTION

SETUP

In previous versions, setup of the TIA-3100 required the transmittal of numerous discrete "K" commands simulating front panel key depressions. While this approach was easy to learn and use, the time required fort the TIA-3100 to process and act upon each command was prohibitive in some critical applications.

With the advent of Rev. H, two new setup commands have been added that permit the user to set multiple Setup Menu and Segment Menu parameters directly, each with a single command.

DISPLAY UPDATE DISABLE/ENABLE

To further improve the response time of the TIA-3100 to setup commands, a command has been added that permits the user to enable or disable the display of new setup data. This command has a significant effect on command processing because the time required to update the display is large compared to other command processing times. Typically, command response times should improve by 250 ms to 500 ms per command

REV. G COMMAND SYNTAX

DATA TRANSTER

COMMAND	DESCRIPTION	EXAMPLE
RSnnnxS	Set **R**ange **S**tart to nnnx Seconds	
REnnnxS	Set **R**ange **E**nd to nnnx Seconds	
	where: nnnx = free form time entry in seconds	nnnx = .000000234 = 0.000000234 = 23.4e-8 = 234n = 0.234u
ABQ	Outputs **A**ctive memory data as a sequence of **B**inary numbers. - start = integer specified in RSnnnxS - end = integer specified in REnnnxS - output format = three bytes per bin, binary count data from $00\ 00\ 00_H$ to $7F\ FF\ FF_H$ - output FF FF FF if start>end	Assumed TIA-3100 Settings Time Base = 100 ps Example RS Command Arguments RS = 50 ns RS = 60 ns ABQ Command Processing Selected Bins Calculation # Bins = $\frac{(60 - 50)ns}{100ps} = 100$ Command Response: Bins / Data 50.0 ns bin XXXXX 50.1 ns bin XXXXX . . 59.9 ns bin XXXXX 60.0 ns bin XXXXX

DATA TRANSTER (CONTINUED)

COMMAND	DESCRIPTION	EXAMPLE
ASnnn	Outputs **A**ctive **S**egment data as a Binary number - nnn = Segment Number - output format = three bytes per bin, binary count data from 00 00 00_H to 7F FF FF_H - output FF FF FF if specified segment number is not defined.	Assumed TIA-3100 Settings Time Base = 0.5ns Segments: .. 1. 200 ns 2. 300 ns 3. 400 ns Half Segment Width: .....20 ns Example AS Command Argument nnn = 003 TIA-3100 Command Processing Selected Bins Calculation $\#Bins = \frac{2 \times 20\ ns}{.5\ ns} = 80$ Start Bin = (400 - 20) ns = 380 ns Command Response Bins / Xfer Data 380.0 ns bin XXXXX 380.5 ns bin XXXXX . . 419.5 ns bin XXXXX 420.0 ns bin XXXXX

STATUS

COMMAND	DESCRIPTION
SRQ	Outputs **S**tatus of data, **R**eady or not Ready If data is not available, following message is sent MEASUREMENT DATA STATUS<LF> NO DATA<LF> END OF DATA<LF> If data is available, following message is sent MEASUREMENT DATA STATUS<LF> DATA READY<LF> END OF DATA<LF>

REV. H COMMAND SYNTAX

DIRECT SETUP MENU PARAMETER SELECT

COMMAND	FUNCTION	PARAMETER	DESCRIPTION
DST X_1; X_2; .....X_{14};X_{15}; Notes: 1. Trailing semi-colon delimiters mandatory following each parameter position 2. Two consecutive semi-colons (i.e. ;;) signifies no change to current setting	Select Setup Menu Parameters	Time Base	X_1 = xx xx = 1, 2, ...16 where: 1 = 100ps, 2 = 200ps ..16 = 10µs
		Sample Size	X_2 = 1Exx or xxxx 1Exx = 10^{xx} where: 4 ≤ xx ≤ 10 or xxxx where: 1 ≤ xxxx ≤ 9999
		Interval	X_3 = A or B A = A - A B = A - B
		Start Trigger	X_4 = + or - or T + = Rising Edge - = Falling Edge T = Transition Independent of Polarity
		Stop Trigger	X_5 = + or - or T + = Rising Edge - = Falling Edge T = Transition Independent of Polarity
		A Threshold	X_6 = sxxx s = + or - 0 ≤ nnn ≤ 500 (mv)
		B Threshold	X_7 = sxxx s = + or - 0 ≤ nnn ≤ 500 (mv)
		Arm	X_8 = E or M E = External M = Manual
		EnablePolarity	X_9 = + or - or N + = High True - = Low True N = None, Always Enabled & Delayed Enable Off
		Enable Delay	X_{10} = xxxxxx or 0 where: 1 ≤ xxxxxx ≤ 999999 (µs) 0 = Delayed Enable Off
		Enable Gate	X_{11} = xxxxxx or 0 where: 1 ≤ xxxxxx ≤ 999999 (µs) 0 = Delayed Enable Off
		Randomizer	X_{12} = 0 or 1 where: 0 = Off 1 = On
		Number of Averages	X_{13} = xxxxx where: 2 ≤ xxxxx ≤ 99999
		Start Delay	X_{14} = xx where: xx = Delay Time Increment (0 - 20, each increment = 1/2 Full Scale)
		System Clock	X_{15} = 0 or 1 where: 0 = Internal 1 = External

DIRECT SEGMENT MENU PARAMETER SELECT

COMMAND	FUNCTION	PARAMETER	DESCRIPTION
If X_1 = M DSG X_1; X_2 .....X_m; or If X_1 = A DSG X_1; X_2; .....X_7; Notes: 1. Trailing semi-colon delimiters mandatory following each parameter position 2. Two consecutive semicolons (i.e. ;;) signifies no change to current setting	Select Segment Menu Parameter Select Manual or Auto Mode based on value of X_1 parameter.	Select Mode	X_1 = A or M where: M = Manual A = Auto Note If X_1 = M, X_2 parameter specifies total number of segments for manual selection. Number of segments included in this command must then equal X_2. Total number of parameters included in command given by $m = 4 + (X_2 - 1)$ If X_1 = A, X_2 parameter specifies total number of segments for automatic calculation. Only 1st two segment centers should be sent
For X_1 = M DSG X_1; X_2;.....X_m;	Select Segment Parameters in Manual Segment Mode	Number of Segments	X_2 = xx where: 0 = No segments (Clear all segments) 1 ≤ xx ≤ 16 = Number of segments
		Segment Units	X_3 = uu where: uu = us or ms or ns
		1st Segment Center	X_4 = xxx.x where: xxx.x = 4 digit floating point number
		nth Segment Center	X_{4+n-1} = xxx.x where: xxx.x = 4 digit floating point number n = Number sent in "Select Number Segments" parameter X_2
		Half Segment Units	X_{5+n-1} = uu where: uu = us or ms n = Number sent in "Select Number of Segments" parameter X_2
		Half Segment Value	X_{6+n-1} = xxx.x where: xxx.x = 4 digit floating point number n = Number sent in "Select Number ofSegments" parameter X_2
For X_1 = A DSG X_1; X_2; .....X_7;	Select Segment Parameters in Auto Seg. Mode	Number of Segments	X_2 = xx where: 0 = No segments (Clear all segments) 1 ≤ xx ≤ 16 = Number of segments
		Segment Units	X_3 = uu where: uu = us or ms or ns
		1st Segment Center	X_4 = xxx.x where: xxx.x = 4 digit floating point number
		2nd Segment Center	X_5 = xxx.x where: xxx.x = 4 digit floating point number
		Half Segment Units	X_6 = uu where: uu = ns or us or ms
		Half Segment Value	X_7 = xxx.x where: xxx.x = 4 digit floating point number

DISPLAY

COMMAND	FUNCTION	PARAMETER	DESCRIPTION
DDU x	Set Display Update Mode	Display Update	x = 0 or 1 0 = Disable Display Update 1 = Enable Display Update

UPGRADE POLICY

Odetics Precision Time Div. routinely upgrades 3100's with the latest in firmware at no charge whenever units are returned to our factory for calibration or other customer service needs. For information regarding upgrade, interested customers are advised to contact their local Odetics PTD manufacturers representative or to contact the Odetics Precision Time Div. directly.

USERS COMMENTS INVITED

While Odetics PTD has made every effort to address our customers most pressing concerns in this revision, we are always receptive to any comments or additional suggestions from the TIA-3100 user community. Please address all comments and suggestions to:

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