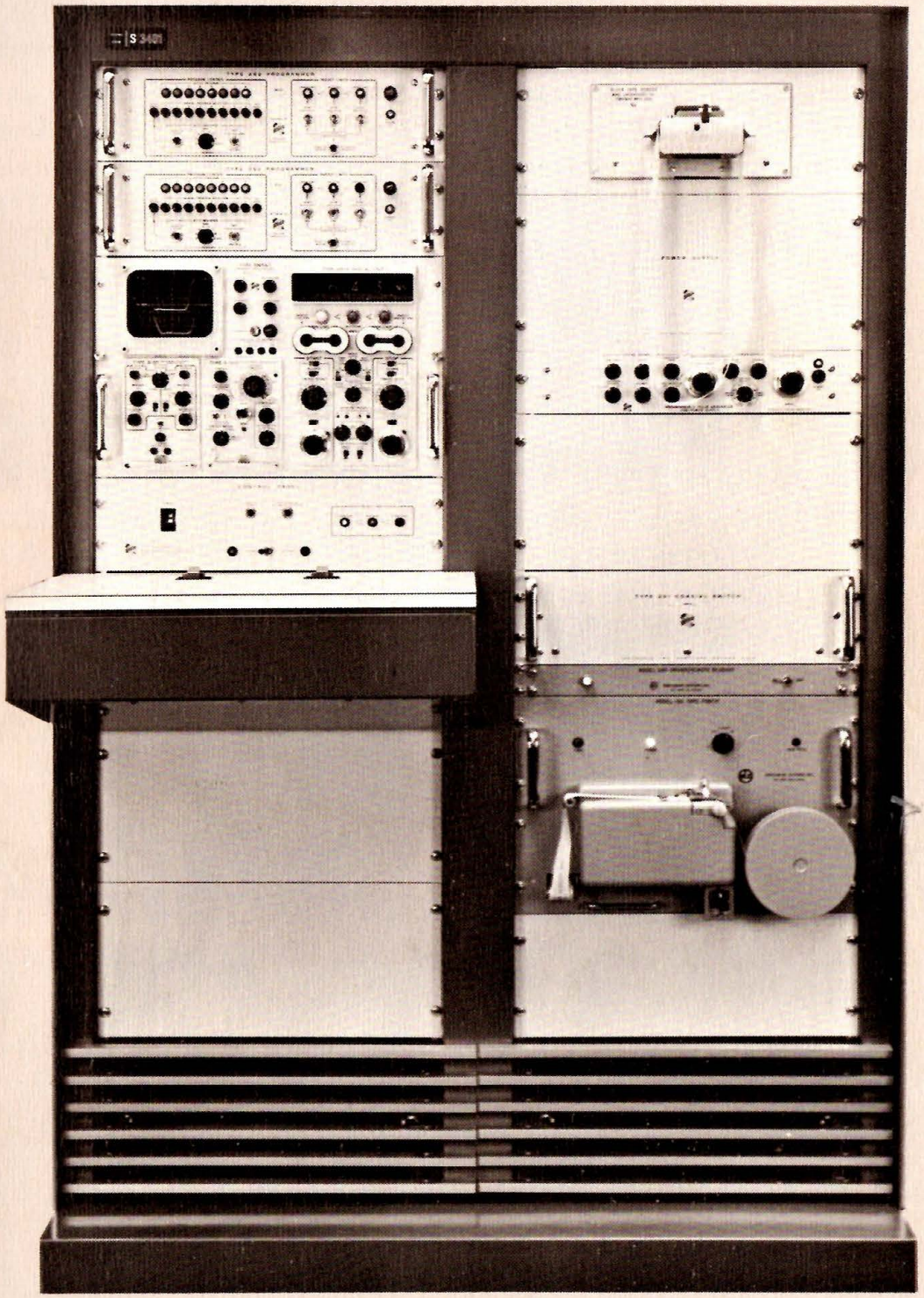
TYPE S-3401
DIGITAL READOUT SYSTEM



TYPE S-3401
DIGITAL READOUT SYSTEM

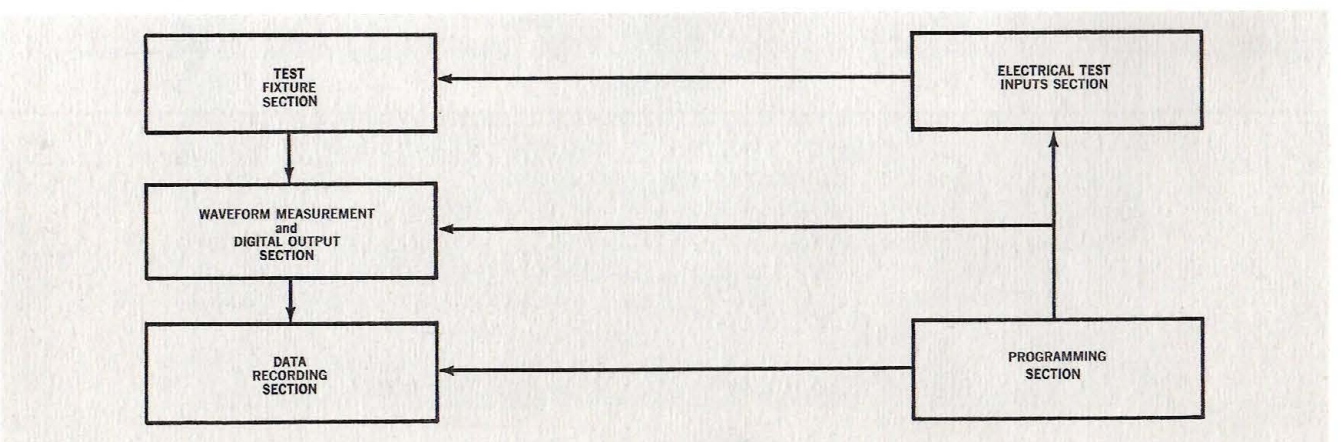
In the Type S-3000 series Digital Systems, Tektronix is offering integral equipment packages designed for semi-automated, dynamic testing of electronic switching devices and computer logic modules.

A typical S-3000 system is comprised of a number of equipment units arranged to apply the specified test conditions to a variety of semiconductor devices, to measure their pertinent waveform parameters, and to record the results in digital form. The functional sections of a system include:

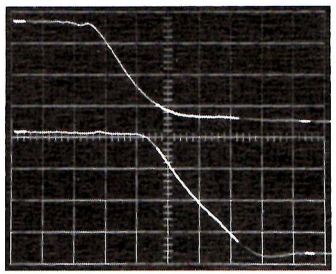
- Waveform measurement and digital conversion
- Test fixture and test circuits
- Electrical test inputs
- Digital data recording
- Programming

Several choices of equipment units and accessory items are available for these functional sections. Numerous combinations can be furnished to provide a wide range of system capabilities. For each set of user requirements a group of complementary units is consolidated into an optimum system configuration. Each system is offered as a complete working entity designed to perform tests and measurements as specified by the purchaser.

FUNCTIONAL BLOCK DIAGRAM OF TYPE S-3401 SYSTEM

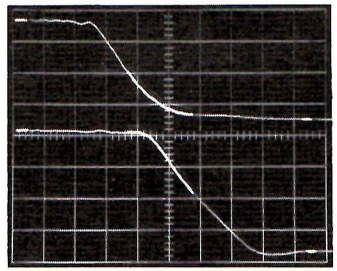


Program 1 013.0 ns



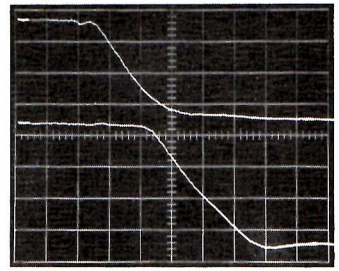
Turn Off Risetime (10% to 90%)

Program 2 009.7 ns



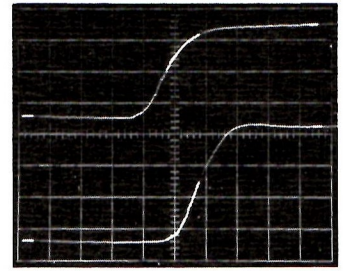
Turn Off Propagation Time (50% to 50%)

Program 5 ~~005.6 ns~~ 076.0 mv



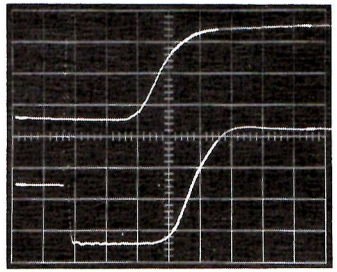
Logic Voltage Amplitude

Program 3 006.5 ns



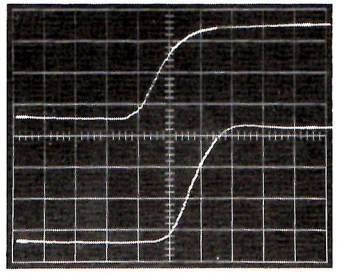
Turn On Propagation Time (50% to 50%)

Program 4 ~~076.0 mv~~ 005.6 ms



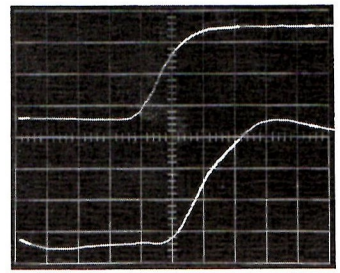
Turn On Falltime (V_1 to V_2)

Program 6 007.8 ns



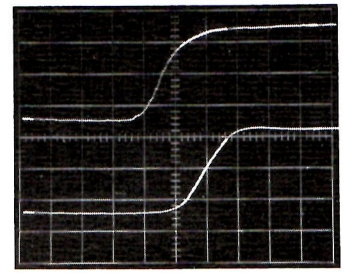
Turn On Falltime (90% to 10%)

Program 13 010.0 ns



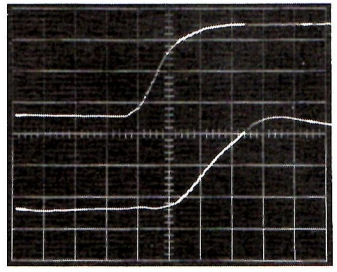
Turn On Falltime (90% to 10%)

Program 10 009.8 ns



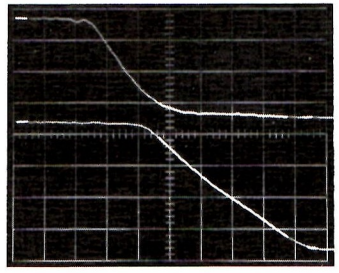
Turn On Falltime (90% to 10%)

Program 14 008.0 ns



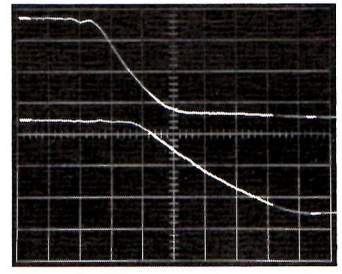
Turn On Falltime (90% to 10%)

Program 11 007.5 ns



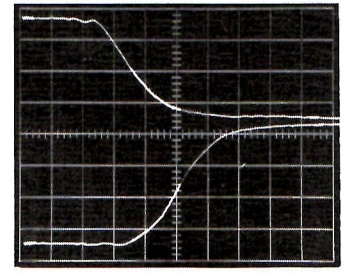
Turn Off Risetime (10% to 90%)

Program 12 019.8 ns



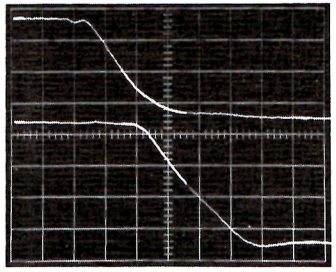
Turn Off Risetime (10% to 90%)

Program 9 018.7 ns



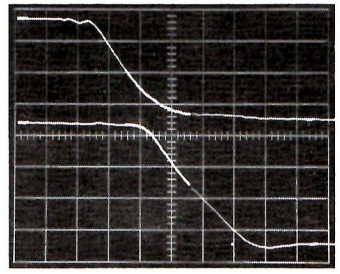
Turn Off Propagation Time (50% to 50%)

Program 7 010.0 ns



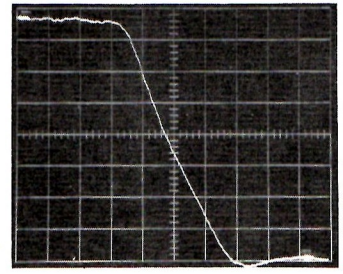
Turn Off Propagation Time (50% to 50%)

Program 8 010.5 ns



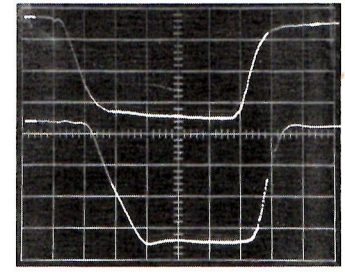
Turn Off Propagation Time (50% to 50%)

Program 15 077.0 mv



Logic Voltage Amplitude

Program 16 074.2 ns



Pulse Width (50% to 50%)

567 CRT DISPLAY

TYPICAL MEASUREMENT PROGRAM FOR MOTOROLA MC-306F 3-INPUT LOGIC GATE INTEGRATED CIRCUIT

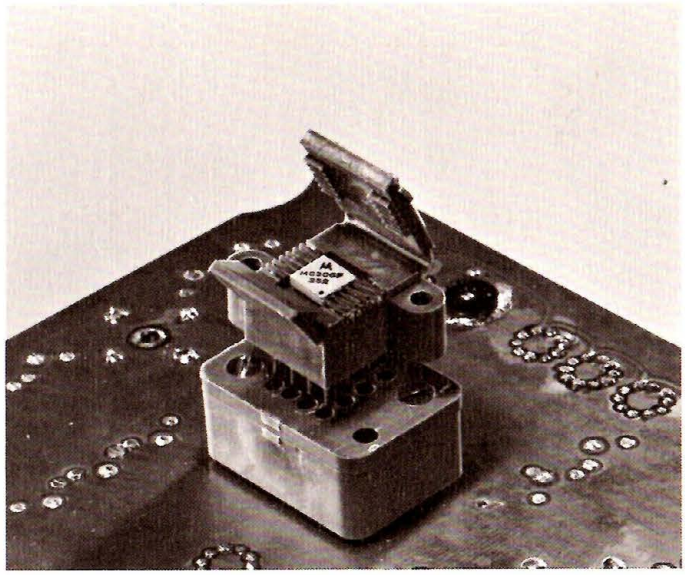
MEASUREMENTS		TEST CONDITIONS					±5% GO, NO-GO LIMITS*	
Program No.	Parameter	Input	Input Logic	Output	Fanout Load	V_{EE}	Lower	Upper
1	Turn Off Risetime (10%-90%)	3	3 ON to OFF 1 and 2 OFF	"Or"	One	−5.2V	12.3 nsec	13.7 nsec
2	Turn Off Propagation Time (50% to 50%)						9.0 nsec	10.0 nsec
5	Logic Voltage Amplitude						71 mv	79 mv
3	Turn On Propagation Time (50% to 50%)		3 OFF to ON 1 and 2 OFF				5.2 nsec	5.8 nsec
4	Turn On Falltime (V_1 to V_2)						5.9 nsec	6.6 nsec
6	Turn On Falltime (90% to 10%)						7.6 nsec	8.4 nsec
13					Four		9.0 nsec	10.0 nsec
10					One	−4.2V	7.3 nsec	8.1 nsec
14					Four		10.0 nsec	11.0 nsec
11	Turn Off Risetime (10% to 90%)		3 ON to OFF 1 and 2 OFF		One plus 47 pf	−5.2V	18.0 nsec	20.0 nsec
12						−4.2V	17.1 nsec	18.9 nsec
9	Turn Off Propagation Time (50% to 50%)			"Nor"	One	−5.2V	7.3 nsec	8.1 nsec
7		1	1 ON to OFF 2 and 3 OFF	"Or"			9.5 nsec	10.5 nsec
8		2	2 ON to OFF 1 and 3 OFF				9.0 nsec	10.0 nsec
15	Logic Voltage Amplitude	3	3 ON to OFF 1 and 2 OFF				71.2 mv	78.8 mv
16	Pulse Width (50% to 50%)						67.5 nsec	74.5 nsec

*Note: Program tapes for the S-3401 System can be prepared which repeat the same tests and measurements several times, each with a different series of limits.

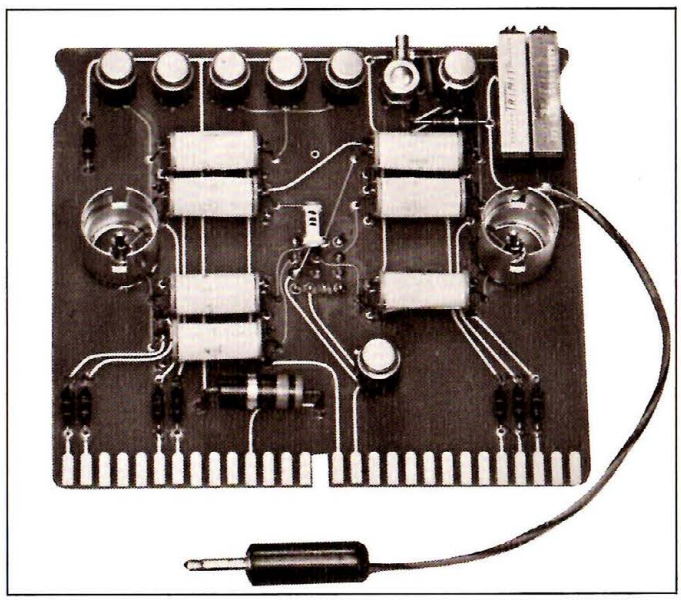
TEST FIXTURE SECTION

The test fixture adapts the system to the device to be tested. It is built up on an etched circuit board which plugs into a terminal strip within the operating shelf. Actual-use circuit environment is simulated by mounting the test circuitry such as bias regulators, input buffers and fanout loads on the board. Input and output scanner switches and sockets for the signal pickup probes are permanently attached and connected. The standardized electrical environment provided by this arrangement assures maximum repeatability of test results.

Each system can be equipped to receive a pair of fixture boards. Manually controlled transfer switching permits operating one fixture while loading the opposite one. Custom wired boards can be supplied in quantity for equipping any desired number of S-3400 systems.



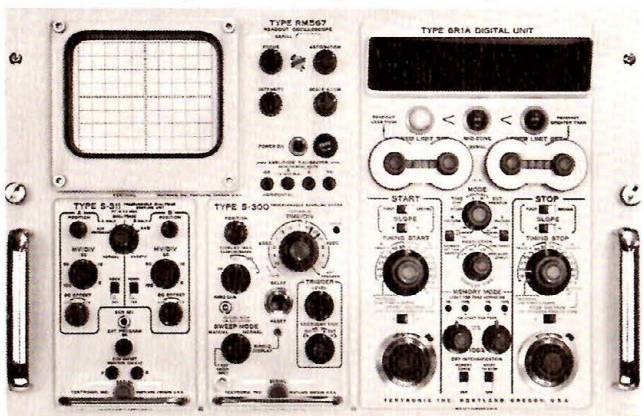
TEST FIXTURE SOCKET AND FLAT-PACK HOLDER



TEST FIXTURE (underside)

WAVEFORM MEASUREMENT AND DIGITAL OUTPUT SECTION

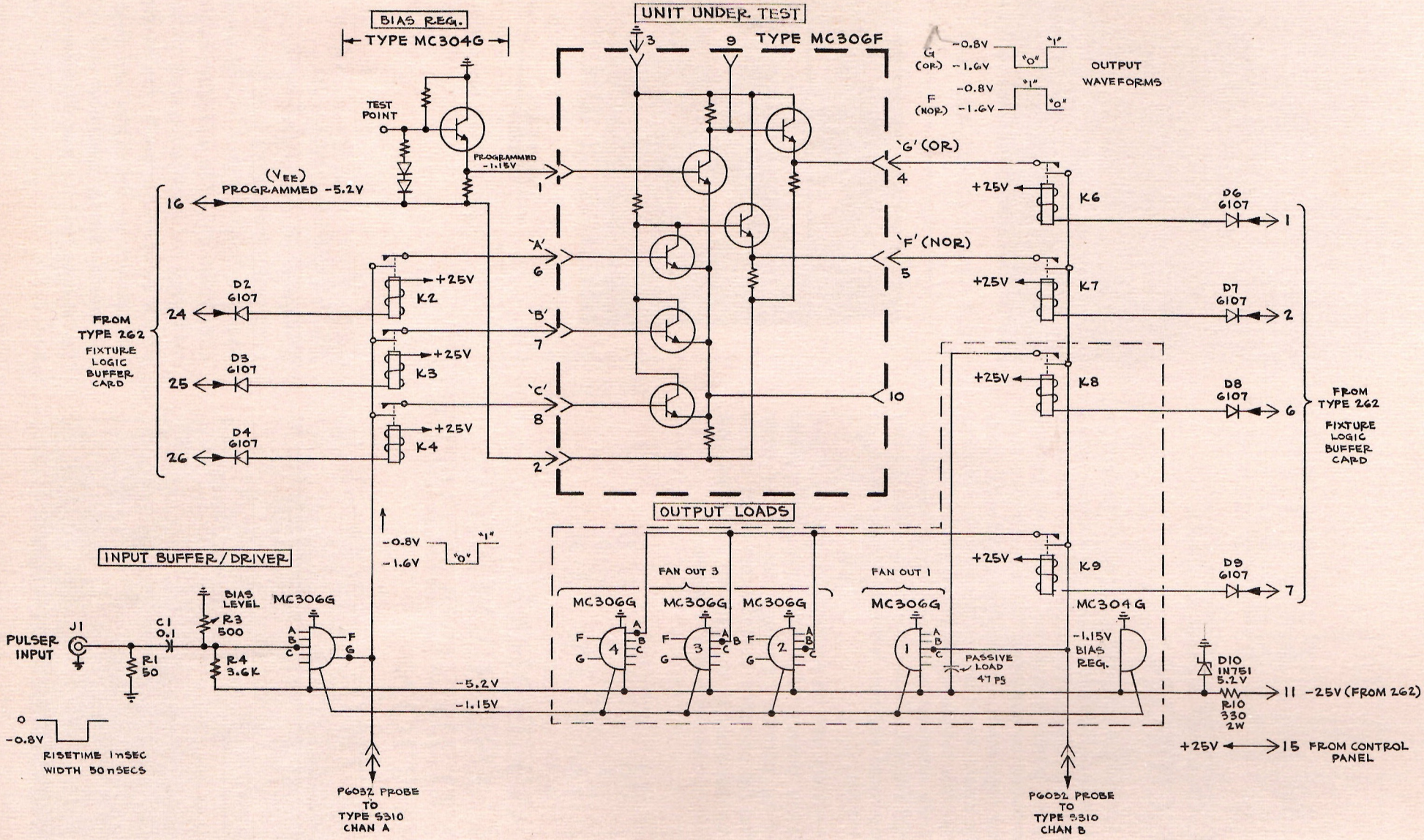
RM567/6R1A/S300/S311



MEASUREMENT METHOD

The waveform measurements are taken by sampling-type signal input and the time base units operating in conjunction with an analog to digital conversion unit. The waveform quantities being measured are displayed in analog form on the crt. The measurement results are displayed in numerical form on the digital unit. These displays are useful during check out and calibration of the system and for performance monitoring in use.

INTEGRATED CIRCUIT TEST FIXTURE



Input and output waveforms are picked up simultaneously from the device under test. The two waveforms are reproduced by a dual-channel sampling system which constructs voltage analog equivalents of the original waveforms on a much slower time scale. The actual measurements are scaled from these analog waveforms. The circuitry which performs the measurement is comprised of dc analog memories, dc voltage dividers, analog voltage comparators and a digital counter.

Signals are presented to the measurement circuitry only during a gated time interval determined by the Time Base Unit. The resulting measurement "window" can be envisioned as a graph in rectangular coordinates with time as the X axis and amplitude as the Y axis. The crt display portrays the relationships of the signals to the measurement window. The time window is made to begin at the correct instant by externally triggering the time base in coincidence with the signal. The duration of the time window is determined by selecting the rate range set in the Time Base Unit. The input signals are brought into the correct relationship with the amplitude scale, or Y axis, of the measurement window by selecting the optimum amplification ratio and adjusting the dc offsets of the dual-trace sampling unit.

For digitizing purposes, the time axis of the window is scanned in 1,000 incremental steps.

A sample of the input signal is taken each 10 μsec and the time window scan is advanced by one increment. Each succeeding sample is taken at an incrementally later time. The result is a voltage analog of the input signal made up of 1,000 steps. Each value represents the instantaneous amplitude of the input signal at a known time within the time window. Waveform timing measurements are made by counting the number of steps between selected points on the waveform along the time axis.

Each waveform parameter measurement requires a start pulse and a stop pulse for gating the digital counter. The gating pulses are generated at programmed pickoff points on the analog waveforms by analog voltage comparators. The comparators are set (programmed) by precision voltage dividers referenced to the dc analog memories.

Amplitude measurements are made in a similar manner except that the amplitude axis is digitized by a different method. Pulses from a crystal controlled clock are gated to the digital counter during the time a linear ramp voltage is rising from the voltage level of one analog memory to the level of the other one.

There are two analog memories for each signal channel. One is referred to as the 0% memory and the other is referred to as the 100% memory. Each is connected to the signal analog waveform during a small fraction of the time window period. Generally the 0% memory is gated to receive and store the baseline level of a waveform. The 100% memory is usually gated to receive and store the upper level of a waveform. Both memory zones can be positioned as desired within the time window to permit placing them to coincide with the desired waveform levels.* The memories have two possible modes of response. They can be set to respond to the average value of the waveform existing during the zone period or they can be set to respond to the peak value that occurs in the zone.

Percentage pickoff points and amplitude measurements make use of both the 0% and 100% memories. Voltage (amplitude) pickoff points utilize only the 0% memory. When the necessary reference level is not present in the signal waveform, it must be injected into the signal input. Injection is accomplished by momentarily connecting the signal pickup probe to the desired reference voltage level by means of a chopper relay. The relay operation is timed to coincide with the 0% zone.* Measurements can then be made as though the actual signal contained the reference value.

MEASUREMENT CAPABILITIES

1. General types of measurements.

Waveform timing measurements may be taken between two points on the same waveform or from a selected point on the input waveform

*__NOTE:__ When a measurement requires use of a probe chopper relay, the 0% zone must be positioned within the first 10% of the time window.

of a device to a selected point on its output waveform. Each pickoff point can be established independently at a given *percentage* of the waveform amplitude or at a *discrete instantaneous voltage* referred either to ground or to an injected dc reference voltage. All of the following transistor measurements can be taken through use of the pickoffs mentioned:

rise time	turn on time
fall time	turn off time
delay time	pulse width
storage time	

Waveform amplitude measurements may be taken between the two stable states of a switching waveform or from a reference level (ground or dc voltage) to one of the stable states. Logic voltage levels can be measured in this manner while a logic block is being pulsed.

DC voltage measurements can be taken in much the same manner used in taking amplitude measurements. Because the measuring circuits are gated by the time window which is controlled by the Time Base Unit, an external trigger must be applied to simulate the presence of a repetitive signal.

AC and pulse current measurements can be taken by installing current probe transformers in the test circuit. The transformer converts the current to an equivalent voltage which is then connected to the signal input of the dual-channel sampling unit.

2. Measurement ranging:

S-3400 Systems can be equipped with either manual ranging or programmable ranging sampling units. The manual units are the Type 3S76 or Type 3S3 Dual-Channel Sampling Plug-ins combined with the Type 3T77 Sampling Time Base. The programmable units are the Type S-310 or Type S-311 Dual-Channel Sampling Plug-ins used in combination with the S-300 Sampling Time Base. The programmable units are also equipped with front-panel manual controls.

Type S-311 Dual-Channel Sampling Plug-In

The S-311 is a 50-ohm input-impedance unit with internal sampling.

S-311 Programmable Functions:

Amplitude ranging: 40, 80, 160, 400 and 800 mv full-scale calibrated sensitivity. In the S-3401 System these ranges are extended through use of P-6032 Cathode-Follower Probes fitted with 10X attenuator heads. Other attenuators up to 1000X are available. Maximum linear signal range of the probe is ±150 mv (±15 v with 100X attenuator). Input dc resistance of all attenuators is 10 megohms, input capacity of 100X head is 2 pf.

The 50 ohm input impedance of the S-311 permits use of several other optional means of adapting to the characteristics of signal sources:

50-ohm coaxial attenuators.
P6034, 10X; and P6035, 100X resistive divider probes.
P6040/CT-1 current probe.

DC offset: 0 to ±1 v offset, each channel. (See P6032 Probe limitations.)

Mode selection: Channel A only
Channel B only
A + B added
Dual Channel

Probe Choppers: The S-3401 System is equipped with dc reference choppers for the P6032 Probes. Programming facilities are provided in the S-3401 System to operate the choppers on A only, B only, A and B Channels simultaneously, or to turn OFF both sets of choppers.

Risetime response of the S-311 is 0.4 nsec (10% to 90%).

The S-3401 System illustrated is equipped with two pairs of P6032 Probes; one pair for each of

the two test fixtures. A coaxial transfer switch connects either set of probes to the S-311 input.

Type S-310 Dual-Channel Sampling Plug-In

The S-310 is a direct sampling unit equipped with P6038 Sampling Probes. Its performance characteristics are similar to the Type 3S3 (see Tektronix general catalog).

S-310 Programmable Functions:

Amplitude ranging: 40, 80, 160, 400 and 800 mv full-scale calibrated sensitivity. Ranges are extended through use of 10X attenuator heads on the P-6038 Probes.

Maximum linear signal range of the probe is ±3 volts, (±30 volts with 10X attenuator). Input dc resistance with 10X attenuator is 1 megohm, input capacity is 2 pf.

DC offset: 0 to ±0.5 v each channel.

Mode selection: Channel A only
Channel B only
A + B added

Probe Choppers: The System can be equipped with dc reference choppers for the P-6038 Probes. The programming facilities provided in the S-3401 System will operate the choppers on A only, B only, A and B simultaneously, or turn OFF both choppers. Transient response risetime: 0.4 nsec (10% to 90%).

Single test fixture S-3400 Systems only can be equipped with the S-310.

Type S-300 Sampling Time Base Unit

Programmable Functions:

Time base ranging and trigger delay: 10, 20, 50, 100, 200, 500 nsec, and μsec full scale; with trigger delay to 1 μsec. 2, 5, 10, 50 and 100 μsec. full scale; with trigger delay to 100 μsec.

3. Measurement Parameters

The 6R1A Digital Unit can be programmed to take measurements as follows:

Amplitude measurement, A or B Channel, 0% memory to 100% memory.

Time measurement, START & STOP pickoff points as listed.

A or B Channel.

First or second, + or − slope.

% pickoff, set to any point between 0% and 100% memories by selected precision resistors in voltage divider.

Amplitude pickoff, precision voltage divider on fixed voltage which is referred to the 0% memory.

ELECTRICAL TEST INPUTS SECTION

Electrical excitation of the device under test is supplied by dc power supplies and a pulse generator. These units are programmable; permitting rapid set up of test conditions and allowing automatic sequencing of a variety of predetermined test conditions.

The S-320 Programmable Pulse Generator and Power Supply in the S-3401 provides the following outputs:

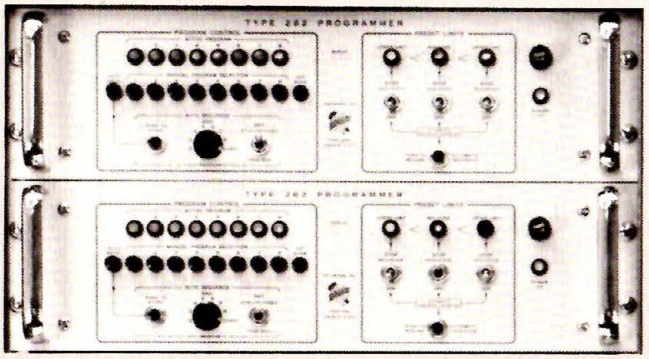
Pulse: 1 nsec risetime, 50-ohm output impedance. Programmable ranges of 5 nsec to 250 nsec pulse width; ±5 v to ±15 v amplitude; 10 kc to 100 kc pps.

DC Voltage: 0 to ±50 v, 200 ma max.

DC Current: 0 to ±300 ma, 20 v max.

Additional or alternative commercial pulse genrators and power supplies are available as required for specific applications.

PROGRAMMING SECTION



The System is programmed by a Tape Block Reader in conjunction with two Tektronix Type 262 Programmers. The Block Reader accepts standard 1-inch, 8-level tape. It reads twelve 8-level code patterns simultaneously, making a contact closure to ground in each hole position. The contacts are connected to program control lines leading to the various programmable units in the System. Each time the Block Reader is sequenced, it advances the tape 12 lines to the next 12-line, 8-level code block. Each 96-bit tape block contains a complete program for making one test and measurement. Series of tests and measurements of any desired number of programs can be stored in tapes.

I. Program Elements

Test Inputs:

DC Voltage supplies.
DC Current supply.
The power supplies are programmable from zero to ±full rated voltage.
Pulse parameters.

Test Fixture Logic:

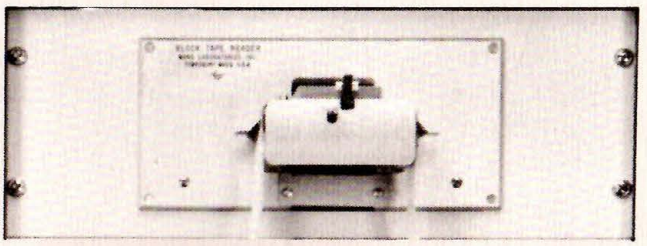
Control lines to the test fixture can be programmed to connect the test inputs, loads, and signal acquisition probes to the designated terminals for setting up specified test and measurement conditions. Capacity and flexibility are provided for testing 16-lead devices.

Measurements:

Signals connected to the probes are processed and presented to the waveform measurement circuits by means of these programmable functions:

Amplitude sensitivity, two channels, 5 ranges each. Establishes amplitude scale.

DC offsets. Center the signal waveforms in the measurement window.



Time base range selection, 13 ranges. Establishes time scale.

Time base trigger delay. Time positions the signals waveforms into the measurement window.

Signal chopper drive. Establishes known baseline reference for voltage measurements and for timing measurements referred to voltage pickoffs.

The waveform measurement and digital section can be programmed for scaling the desired measurements from the analog waveforms presented to it. Programmable functions include:

Type of measurement, Voltage or Time.
Memories, both A & B Channels:
0% and 100% zone positions.
0% mode, average or — peak.
100% mode, average or + peak.
START & STOP timing pickoff points:
A or B Channel.
First or second + or — slope.
Voltage pickoff level.
% pickoff level.

The means of programming the 6R1A to make the desired measurement on the waveforms presented to it is the parameter measurement card:

8 parameter measurement program cards are plugged into each 262 Programmer.

A program card is selected by grounding its enable line with a contact closure in the Tape Block Reader.

The pre-wired program card is connected through a logic circuit card, to the 6R1A, permitting the pre-wired connections and resistors on the card to determine the measurement to be made by the comparators and the counter in the 6R1A Digital Unit.

Limits:

Upper and lower GO, NO-GO limits are coded into the program tape for each measurement. Control lines from the Block Reader are con-

nected to converter circuits which translate the punched tape code into a voltage-level code for the limit comparators in each 262. On each program block, any one of the 16 measurement parameter cards can be selected and any desired limits programmed for comparison with the measurement results. An INHIBIT signal can be transmitted to the program sequencer on any of six GO, NO-GO logic combinations determined by setting three front-panel toggle switches on each 262. A PUSH TO RESUME AUTOMATIC SEQUENCE button cancels the GO, NO-GO inhibit signal.

Decisions:

Program sequencing control is interlocked through an OR gate. The Block Reader is automatically sequenced to the next program unless there is an INHIBIT signal present in the gate. Inhibit signals can be transmitted from four sources:

- GO, NO-GO logic.
- Data recording equipment.
- End of Word Code in the Program Tape.
- Manual stop button.

Data Recording:

The 6R1A and the Tape Punch data recording equipment are interconnected in a control loop. A PRINT COMMAND signal from the 6R1A initiates transfer of data. A DISPLAY HOLD signal from the Tape Intercoupler causes the 6R1A to hold its digital reading until the transfer is complete.

Outputs from the 262 GO, NO-GO logic can be used to transmit a red-ribbon shift code and a skip command to the Tape Intercoupler.

II. Operational Programming

Setting up the S-3401 to make a series of tests and measurements is accomplished by the following steps:

- Install parameter measurement cards in the 262 Programmer.
- Insert program tape in the Block Reader.
- Set system controls.
- Insert test fixture board.
- Plug in device to be tested.
- Push START button.

Automatic sequencing will continue until the End of Test code is read by the Block Reader, or an INHIBIT signal is transmitted by the GO, NO-GO logic.

Manual controls permit the operator to:

- START Automatic Sequence.
- RESUME Automatic Sequence.
- STOP Automatic Sequence.
- CONTINUOUSLY RECYCLE a program.
- ADVANCE the tape one program at a time.

Visual displays for set up and monitoring use include:

- CRT display of waveforms, with trace brightening of memory reference zones and segments being measured.
- 4-place Nixie* numerical display of measurement results and units of measure.
- Parameter measurement card designator lamp.
- GO, NO-GO comparator state lamps.

The test and measurement rate of an S-3401 System is determined by the accumulative time of all the sequential functions. The principal time periods are involved in the following:

- Block Reader advance time.
- Measurement time (two time base sweeps of 1,000 increments).
- Data transfer time.

Maximum sequencing rates in three different modes of operation for signal repetition rates of approx. 100 kc or greater are approximately as follows:

- GO, NO-GO (no data recording):
  360 per minute.
- Full Data recording (20 character/sec. tape punch; no intercoupler data storage):
  120 per minute
- Full Data recording (60 character/sec. tape punch and intercoupler data storage):
  240 per minute
- Full Data recording (110 character/sec. tape punch and intercoupler data storage):
  360 per minute

NO-GO Data recording only:

- Intermediate rate between the above rates determined by the ratio of GO to NO-GO RESULTS.

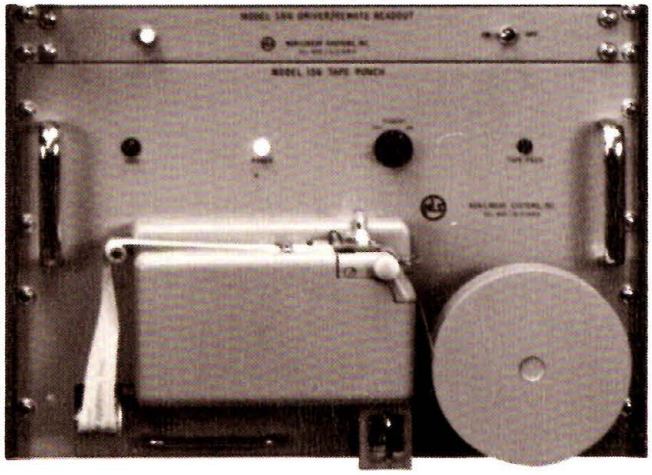
System self-performance evaluation program tapes are furnished for each System. Also, the user can prepare test and measurement program tapes with sections devoted to self checking routines.

The program tape is a standard one-inch, 8-level Mylar† tape. In the preparation of program tapes, each of the 8-level lines in the 12-line blocks is punched as a character. The programming language utilizes all of the possible 256-bit combinations of the 8 levels. A 1-2-2-4 BCD code is used for programming incremental quantities such as power supply voltages.

*Trademark Burroughs Corporation.

†Trademark DuPont Corporation.

DATA RECORDING SECTION



The punched tape data recording section of an S-3400 System is comprised of a standard commercial tape punch and a parallel entry intercoupler unit.

A variety of equipment combinations is available; providing a range of capabilities in speed and flexibility. In general the optimum combination is determined by the user's requirements in terms of recording rate and number of data source elements desired.

Principles of Operation:
On completion of a measurement, the 6R1A Digital Unit transmits a PRINT COMMAND signal to the Tape Intercoupler Unit. This initiates a scanning function in the intercoupler which sequentially reads the logic levels of all the parallel data input lines from the 6R1A; coding the data for the tape punch driver circuits. If the intercoupler is not equipped with storage registers, the scanning rate will be determined by the rate at which the particular punch mechanism can operate. During the scanning period, a DISPLAY HOLD signal from the intercoupler unit inhibits the Block Reader advance and prevents resetting of the 6R1A for another measurement.

If the intercoupler unit is equipped with storage registers, the scanner transfers all of the data from the input lines into storage within a few milliseconds. The 6R1A and the Block Reader are then released and advanced to the next program. Data is read from the storage registers into the punch mechanism concurrently with the programming and execution of the next measurement program.

Multiple input intercoupler units will accept data from a number of sources and feed the data to the tape punch sequentially. Examples of information which can be recorded in this manner include:

Data from the program tape in the Block Reader:
- Identification number.
- Measurement program number

Data from external sources:
- Serial number counter
- Digital time clock.

Tektronix, Inc. / *P.O. BOX 500 • BEAVERTON, OREGON 97005 • Phone: (Area Code 503) Mitchell 4-0161 • Telex: 036-691*
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