KENWOOD

DB-3545

JITTER ANALYZER

INSTRUCTION MANUAL

KENWOOD CORPORATION

CONTENTS

1. Description and Features

(1) Description

Subjective judgment has conventionally been used in the adjustment, inspection and installation of the optical pickup of CD players, as well as in the adjustment and inspection of the CLV servo system. The operator judged RF (HF) signals by observing the eye on the CRT.

Objective results were available only indirectly through measurement of error rate.

The model DB-3545 is intended for the measurement and analysis, nearly in real time, of the jitter distribution of eye pattern, which provides as a guide for the transmission characteristics of the CD player. The instrument handles jitter as data in relation to time.

Thus the date is absolutely objective, eliminating the errors due to operator's sixth sense and subjective judgment.

(2) Features

1) The distribution of 3T-pit long jitters is collected and displayed in graphics form, continuously in real time.

2) Concurrently with the distribution display, the standard 5-inch CRT displays all information on measurement--the calculation of the distribution area of 3T-pit long jitters and bar graph display of calculated values, go/no-go judgment relative to a reference value, etc.

Thus the operator's eye movement is reduced to a minimum, which enhances measurement efficiency. This feature is ideal for use in the line service department working on optical pickups and servo sysrems, etc.

3) The GP-IB interface permits setup from outside (instead of the analyzer's panel controls) and reading of measurement data to external equipment. Thus the data can be checked by research and engineering departments.

4) The small and light unit is a function-oriented design with easy-to-use panel layout of switches.

2. Specifications

(1) Input section

1) RF input

Input impedance : Input resistance 1MΩ ±5% Parallel capacity : 35±5 pF

Input level range : At gain X1 : 300 mV to 3 Vp-p(with 720 kHz sine wave)

: At gain X10: 60 mV to 30 mV(with 720 kHz sine wave)

※ NOTE : If the input is outside the level range, distortion occurs, giving wrong measurement. Also, such an input is interpreted as absence of input, so that the measurement stop circuit operates and stops the measurement.

2) Maximum input voltage : ±10 V peak

3) Slope selection

Measurement period is switch selectable between rise-to-fall and fall-to-rise.

a) Rise-to-fall mode (ON pit) : Measurement starts at the zero-cross point on the rising edge and ends at the zero-cross point on the falling edge.

b) Fall-to-rise mode (OFF pit) : Measurement starts at the zero-cross point the falling edge and ends at the zero-cross point on the rising edge.

4) Offset input : Offset voltage is applied to the RF-input zero-cross comparator.

Input impedance : 20 kΩ (Typical)

Input range : Within ±1V

(2) Jitter measurement

NOTE : The following specifications apply to the peak input point.

1) Channel pit length and measurement range : 3T, 694±115 (±1/2T)
2) Display resolution : 1 ns
3) CRT's effective display range : ±115 ns (±1/2T)
4) Accuracy of time width central value : ±5 ns (at 1 Vp-p input)

(3) CENT (central value) display

An arbitrary point in the measurement range can be moved to the screen center so that the absolute time is displayed.

1) Number of display digits : 3 digits on CRT
2) Display resolution : 1 ns
3) Display range : ±115 ns relative to 694 ns theoretical central value for 3-pit channel
4) Display accuracy : ±5 ns on theoretical center point (at 1 Vp-p input)

(4) Auto centering

Auto centering automatically pulls the peak point of data to the screen center. With the auto centering, the absolute time at the peak point is displayed as CENT (CRT central value).

Pull-in range : ±115 ns (±1/2T)

(5) Distribution area calculation ("AREA" on display)

The ratio X/Y is calculated in percent, in which X is the total of X input values which are out of the t_1-t_2 range specified by the +WIDTH and -WIDTH values relative to the 694 ns theoretical central value for 3T, and Y is the total of Y input values for the total gate time (694 ±115 ns) for 3T.

1) +WIDTH setting range : 0 to +115 ns
2) -WIDTH setting range : 0 to -115 ns
3) Range of "AREA" value : 0 to 100%
4) Accuracy : Approx.±5%

(6) Area go/no-go judgment (GO/NG on screen)

The "AREA" value is judged to be "go" or "no-go" ("NG" on the screen) relative to the "LIMIT" value.

1) Criteria : Go if AREA < LIMIT

: No-Go if AREA > LIMIT

2) LIMIT setting range : 0 to 100%

(7) Distribution averaging ("AVERAGE" on screen)

This function selects whether the CRT displays distribution data in real time for every cycle period or the average of eight cycle periods.

AVERAGE : ON ..... Real-time display for every cycle period

OFF ..... Display of average of eight cycle periods

(8) MONITOR terminal

This output terminal provides for monitoring the input waveform using an oscilloscope, etc. The oscilloscope must be 1 MΩ or more in input impedance and within 35 pF in capacitance.

Output level

Gain × 1 : The input signal is amplified by approx. 8.5 dB before it is output.

Gain × 10 : The input signal is amplified by approx. 28.5 dB (i.e., 20 dB over that for gain ×1) before it is output.

Output impedance : Approx. 50Ω

(9) SLICE OUT terminal

This terminal provides for monitoring the output of the internal comparator using an oscilloscope, etc.

Output signal of this terminal synchronizes with the ON pit of the input 3T pit signals.

Output level : TTL

Fanout : 1

(11) Power supply section

1) Rated input voltage : 100/117/220/240 V (to be set via power selector on rear panel)

2) Input range : ±5% of rated input voltage

3) Input frequency : 47 to 63 Hz

4) Power consumption : Approx. 45 W (at 100 VAC, 50 Hz)

(12) Operating temperature range : 25° ±10°C

(13) Physical specifications

1) External dimensions (Main body) : 260(W) × 150(H) × 356(D) mm

(Maximum dimensions) : 275(W) × 166(H) × 392(D) mm

2) Weight : Approx. 7.6 kg

3. Principle of Measurement

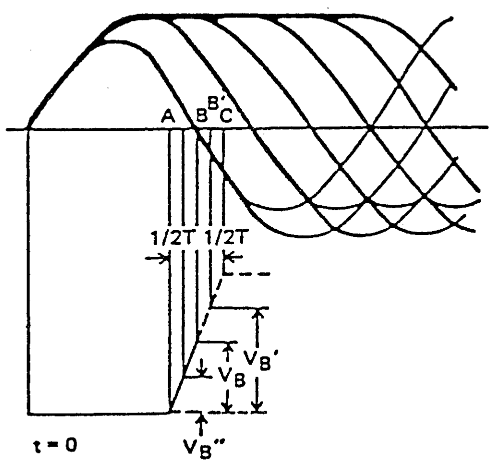


Fig.1 Diagram of Measuring Principle

The model DB-3545 performs measurement in the range of channel pit 3T ±1/2T. When the time 2.5T has elapsed after the waveform selected by the SLOPE button crossed the zero level, the gate of a time-to-voltage converter (TVC) is opened to start integration.

The integration continues until the waveform crosses the zero level a second time. The output voltage for the integration is read by an A/D converter,which represents the time duration in the specified range.

For a waveform that does not cross the zero level a second time within the specified time range, the TVC measurement is terminated at an elapse of 1T after the TVC start time. The data is assumed invalid.

Consider the example of Fig.1. The example uses an RF signal containing channel pits 3T to 11T at random. Suppose an RF signal of 3T has appeared after some number of measurements.

The TVC starts at the time of A = (3 - 0.5) T = 578 ns after the rising zero crossing. At the moment when the TVC stops at the falling zero crossing at point B (say, 694 ns) , the TVC outputs a voltage of VB〔V〕. This VB〔V〕,taken as meaning 649 ns, is converted into a digital value, consequently adding one (+1) to the counter at the memory location for 694 ns. (Actually, however, the TVC is applied with an offset in consideration of linarity.)

Similarly, each time a 3T waveform appears, times are measured for B', B, B",and so on, adding + 1 to each of the counters at memory locations corresponding to VB', VB, VB",etc. When any point between points A and C is counted to 255, the measurement is terminated.

The distribution condition is stored memory as a group of dots: 231 dots along the X-axis and 8 bits = 256 dots along the Y-axis, as shown in Fig.2. The readings of the counter values are recorded in the ratio of 1 ns/dot.

To display the distribution on the CRT, the address counter is operated by software and the corresponding distribution memory value is output as the X-axis value. For reasons of display space, the X value is reduced to a half. The value (256/2 = 128) represents 231 counts at the time of reading from the address counter, so that the width is 694 ns ±115 ns (231 ns).

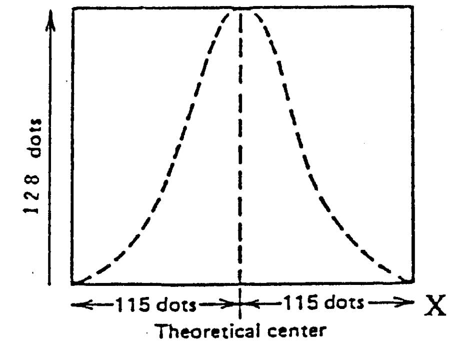


Fig.2 Distribution Memory

3-1. Meaning of "AREA%" value vs. go/no-go judgment/setting

In Fig. 3, the range t_1 to t_2 indicates the gate time set as the "±WIDTH" parameters.

(1) Definition of δ

Letting Y denote the total input, Y' denote the input between t_1 and t_2, and X denote the difference (Y - Y'), then δ is defined by the formula ① below.

Using the value δ , the "AREA%" value is defined by formula ②.

(2) Calculation of "AREA%" value

δ (%) = Y'/Y × 100 ....①

AREA% = 1 - δ (%) = X/Y × 100 ....②

where Y' ≤ Y.

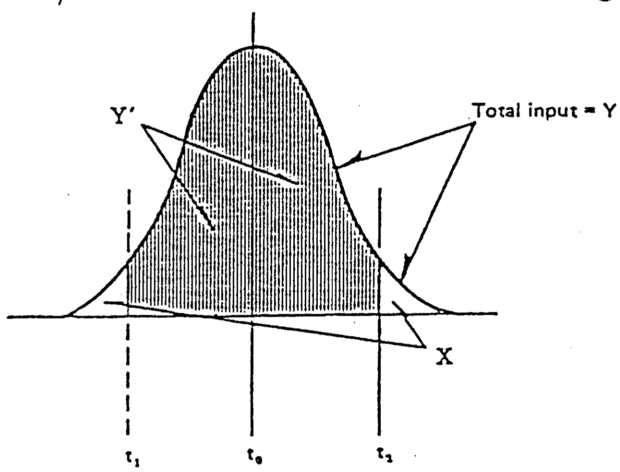


Fig.3

- NOTE : The "AREA%" display and go/no-go judgment are based on the area X. In other words, X = (1 - δ). If this value is smaller than the value set at "LIMIT", the judgment is "go".

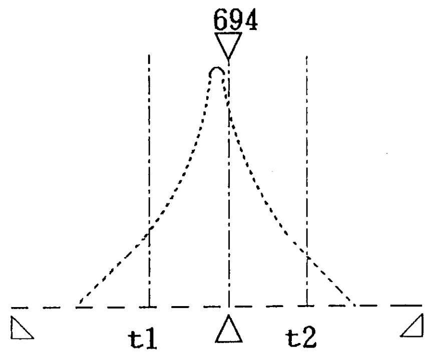
Referring to formula ①, when the jitter (Y) is smaller than the "WIDTH" setting, the "AREA%" display always shows 0%, which gives a "go" judgment.

The arithmetic operations described above are all done by the CPU in the main body, and the results are displayed as digital numbers on the CRT.

3-2. Selection of AREA% Central Value

To calculate the AREA% value in 3.1, either the theoretical central value for 3-pit channel which is 694 ns (see Figure 4) or the maximum value of the currently displayed distribution (see Figure 5) may be selected as t_0 (central value of distribution).

Fig. 4



+WIDTH = 034 ns

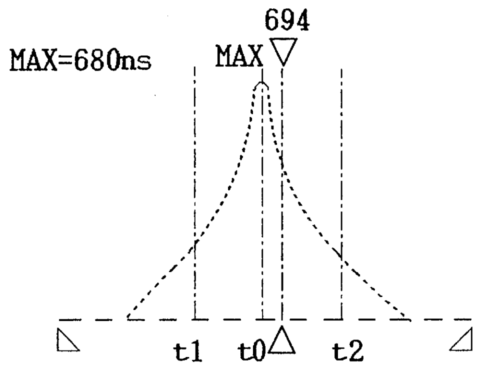
-WIDTH = 034 ns

$$t_0 = 694\text{ns (fixed)}$$

$$t_2 = +\text{WIDTH} + t_0 = 34 + 694 = 728\text{ns}$$

$$t_1 = -\text{WIDTH} + t_0 = -34 + 694 = 660\text{ns}$$

Fig. 5



+WIDTH = 034 ns

-WIDTH = 034 ns

$$t_0 = \text{MAX} = 680\text{ns}$$

$$t_2 = +\text{WIDTH} + \text{MAX} = 34 + 680 = 714\text{ns}$$

$$t_1 = -\text{WIDTH} + \text{MAX} = -34 + 680 = 646\text{ns}$$

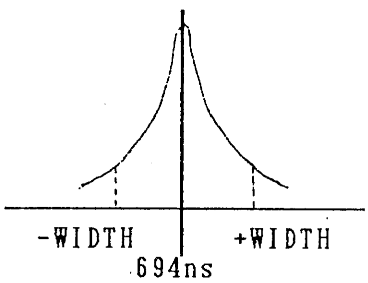
Figure 4 above shows an example which always uses 694 ns as t_0, the central value for AREA% calculation. The AREA% value of an offset signal will thus very due to difference of the amount of data that corresponds to the window (t_1-t_2) even if the ON pit and OFF pit have the same jitter distributions. This allows calculation of the AREA% value including the offset. Figure 5 shows an example which always uses the current maximum point (displayed following MAX =; 680 ns in the above example) as t_0 for the AREA% calculation. This allows the AREA% calculation of jitter width only free from effects of offset.

3-3. How to Use AREA% Value (Relationship to δ value)

As described in the specification, the DB-3545 calculates an AREA% value based on the following definition. (see Figure 6)

$$\text{AREA\%} = \frac{\text{Total number of jitters outside +WIDTH to -WIDTH}}{\text{Total number of jitters in overall period}}$$

The following explains the relationship between the AREA% value and the δ value calculated based on the theory of probability and statistics. Jitters form the normal distribution shown in Figure 7 according to the theory of probability and statistics.

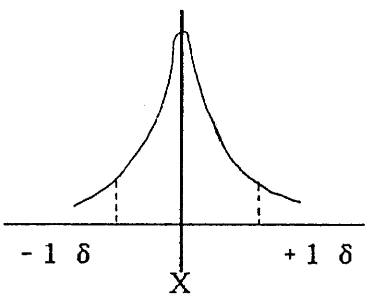


694 ns ... Theoretical 3-T central value

+WIDTH ... Positive (+) deviation from 694 ns

-WIDTH ... Negative (-) deviation from 694 ns

Fig.6 Distribution and AREA% Value



$\bar{X}$ ... Mean value of jitters

δ ... Standard deviation

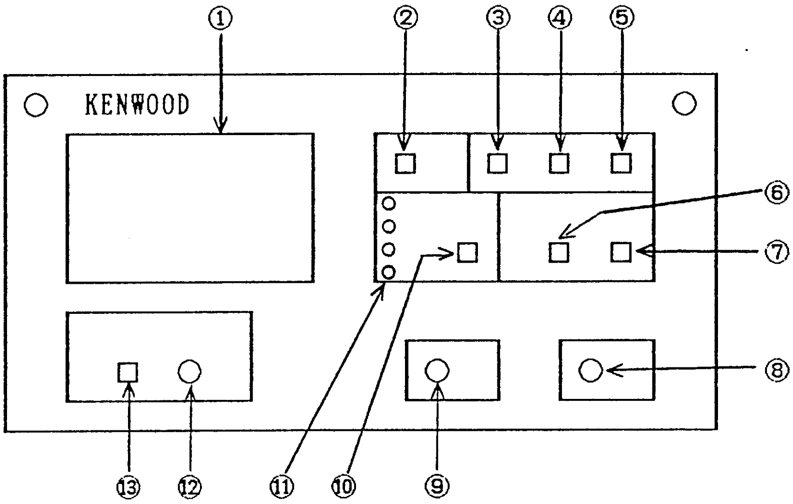
Fig.7 Distribution and Value

"1δ" means that 31.73% of all jitters were out of the period from -1δ to +1δ. This applies to a case, on the DB-3545, where the central value of distribution is 694 ns and +WIDTH and -WIDTH correspond to the value of 1δ.

To be concrete, if the AREA% value is 31.73% (rounded off to 32%) and +WIDTH and -WIDTH correspond to the deviation of ±1, go/no-go judgment is performed based on the AREA% value. In the case that 694 ns is not the central value of distribution, ±WIDTH values can be shifted by the amount of deviation from 694 ns according to the definition of the AREA% value. (However, the maximum shift shall be 694 ±115/2 ns.) For example, if the central value is deviated by +10 ns from 694 ns, it is 694 + 10 = 704 ns. To compensate the AREA% in such a case, add 10 to the ±WIDTH values (i.e., +WIDTH = +WIDTH + 10, -WIDTH = -WIDTH + 10). If t_0 (central value of distribution) is set to the maximum when selecting the AREA% central value in 3.2, this compensation is performed automatically.

4. Controls and Indicators

(1) Front panel



① CRT	:	Displays various pieces of information.
② MODE	:	Pressing this button changes the normal measurement mode to the specification entry mode and vice versa. Refer to the description in Section 5. This button is in normal measurement mode at power ON time.
③ AUTO CENTER	:	Pressing this button brings the peak point to the screen center. Then the "center" position on CRT ① shows the absolute time of the peak point. This button operates alternately.
④ ⑤ SHIFT ◁ ▷		These buttons shift the distribution curve on CRT ① when AUTO CENTER ③ is OFF and MODE ② is in normal measurement mode. Pressing the button ▷ or ◁ moves the distribution curve to the right or left, respectively. The center of the CRT shows the absolute time of the peak point. When MODE ② is set in

specification entry mode, the specification entry is increased by ▷ and decreased by ◁ (but within the range of specification value ; refer to Section 5, "Mode Selection").

⑥ SLOPE : Selects the ON pit or OFF pit measurement of the signal input. When this switch is set to ON (_/‾), measurement is made from the falling to the rising zero crossing; when it is set to OFF(‾_), measurement is made from the rising to the falling zero crossing.

⑦ GAIN : Selects the gain of RF signal input. When set to ON, the input gain of this switch is 10X (300 mVp-p max.); when OFF, it is 1X (3 Vp-p max.).

NOTE : To meet the measurement requirements, the input RF signal is amplified by approx. 8.5 dB at "1X" gain or approx. 28.5 dB (additional +20 dB) at "10X" gain.

⑧ RF INPUT : This is a BNC type connector for receiving external RF signal from a player, etc. The input impedance is 1 MΩ or less at 35 pF, and the maximum input sensitivity is 3 Vp-p. Note that an excessive input may cause damage. The withstand input voltage is 10 Vp-p.

⑨ MONITOR OUTPUT : This is a monitor output terminal for monitoring the input pit signal using an oscilloscope, etc. The level of the internally amplified signal is output here. This level is used as the signal level going to the built-in comparator. This terminal may also be used to check for excessive input level by selecting the appropriate position of GAIN ⑦. Further, the terminal may be used in conjunction with REAR panel OFFSET IN ⑧ and SLICE OUT ⑦ on the rear panel, in order to moni-tor the input signal on an dual-trace oscilloscope.

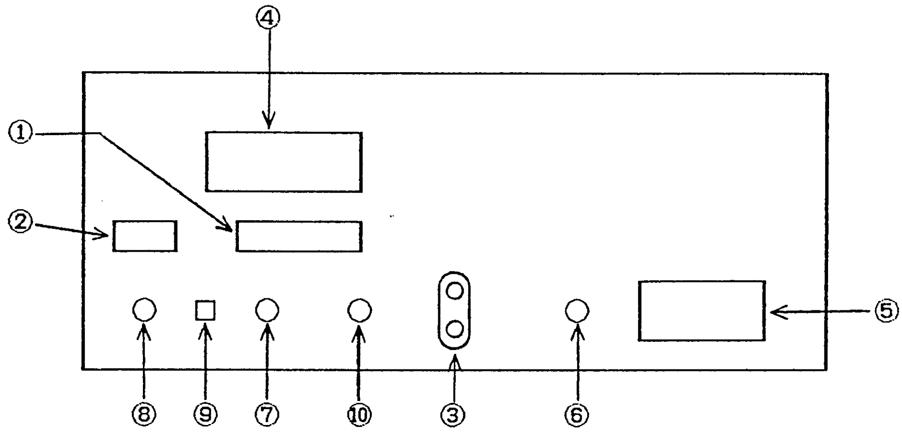
⑩ LCL : Pressing this switch enables local control (from front panel). This switch is disabled if an LLO (local lockout) instruction is sent from a GP-IB controller.

⑪ GP-IB LED : These four LEDs indicate the status of the DB-3545 when it is controlled via a GP-IB.

⑫ POWER LED : Lighting of this LED indicates that the power is connected to the DB-3545.

⑬ POWER SWITCH : Pressing this lock-type pushbutton switch turns on/off the power supply to the DB-3545.

(2) Rear panel



① GP-IB connector : When operating the DB-3545 under a GP-IB controller, this connector should be connected to a piggy-back cable.

Before connecting or disconnecting the piggy-back cable, the power supply to the GP-IB controller must be turned off.

② GP-IB setting switch : This DIP switch consists of eight poles, which are (from left to right) EOI/CR.LF selection, (unused), L.ONLY and address bits 5 to 1.

EOI/CR.LF......This is a delimiter selector. When set to the upper position EOI is selected as the delimiter.

L.ONLY.........When set to the upper position, puts the DB-3545 into the listen only mode. Only the commands A) to H) set with panel switches can be accepted.

Address bits...Used to set the DB-3545 to an address of five binarybits. When set to the upper position, the address bit is ON.

NOTE : This switch must always be set before turning on the DB-3545. A setting made after power ON does not work since the settings given at the power ON time remains effective.

③ Earth terminal board : This board has terminals for rounding the analyzer. The FRAME GND terminal must always be grounded for safety since it is connected to the analyzer case. The center pin of the power connector is also connected to this board. The upper terminal is GND for the internal signal system, and the lower one is GND for the chassis.

④ Power selector : This connector provides a selection of incoming voltage to the analyzer in the range of 100 to 240 V.

NOTE : When changing the voltage, be sure to remove the power plug, then select the correct voltage.

⑤ AC INPUT connector: This connector should be connected with the AC cord furnished.

⑥ FUSE holder : This is an AC input protection fuse of the following rating.........100/117 V, 1 A, glass tube fuse

220/240 V, 0.5 A, glass tube fuse

NOTE : Do not use a fuse of excessive capacity as it may damage the analyzer.

⑦ SLICE OUT : This terminal provides the positive-polarity output of the internal comparator in response to the RF input signal fed to RF INPUT ⑧ on the front panel. The comparator's output is TTL level (fanout=1).

⑧ OFFSET IN : When OFFSET ⑨ is set to VARIABLE, the input level at this terminal provides the comparator level for the RF input. The input range is ±3 V.

⑨ OFFSET : When set to VARIABLE, this switch sets the input comparator level to the level of the input signal sent from OFFSET IN ⑧ ; when set to GND, the switch sets the input comparator level to the GND potential. For ordinary measurement, GND is selected. Note that if this switch is set to VARIBLE and no offset is given to ⑧, no distribution data will be output.

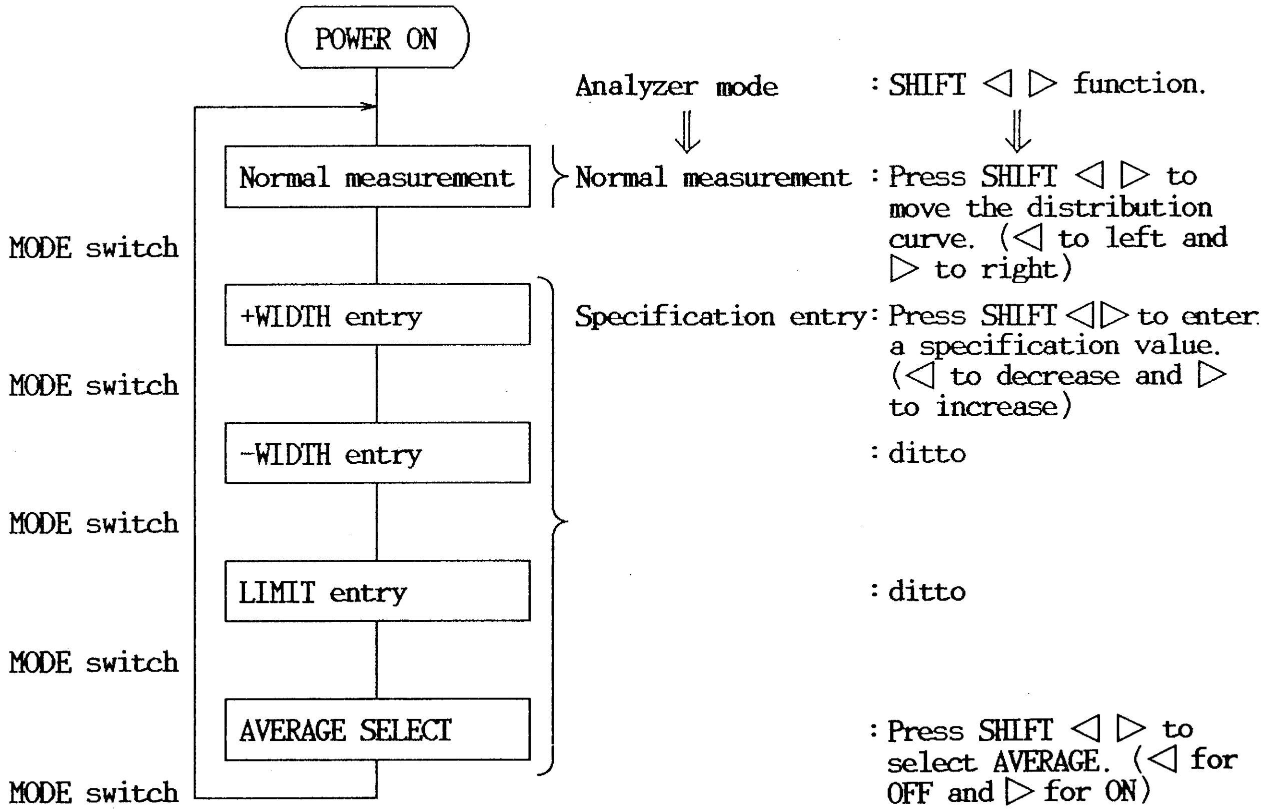
⑩ BRIGHTNESS : This control adjusts the CRT screen brightness. Clockwise rotation increases the brightness.

5. Mode Selection

(1) Mode selector switch

1) Normal operation

The MODE selector switch ② selects the measurement mode and specification entry mode. Each push of this switch changes the current operation to the next one.



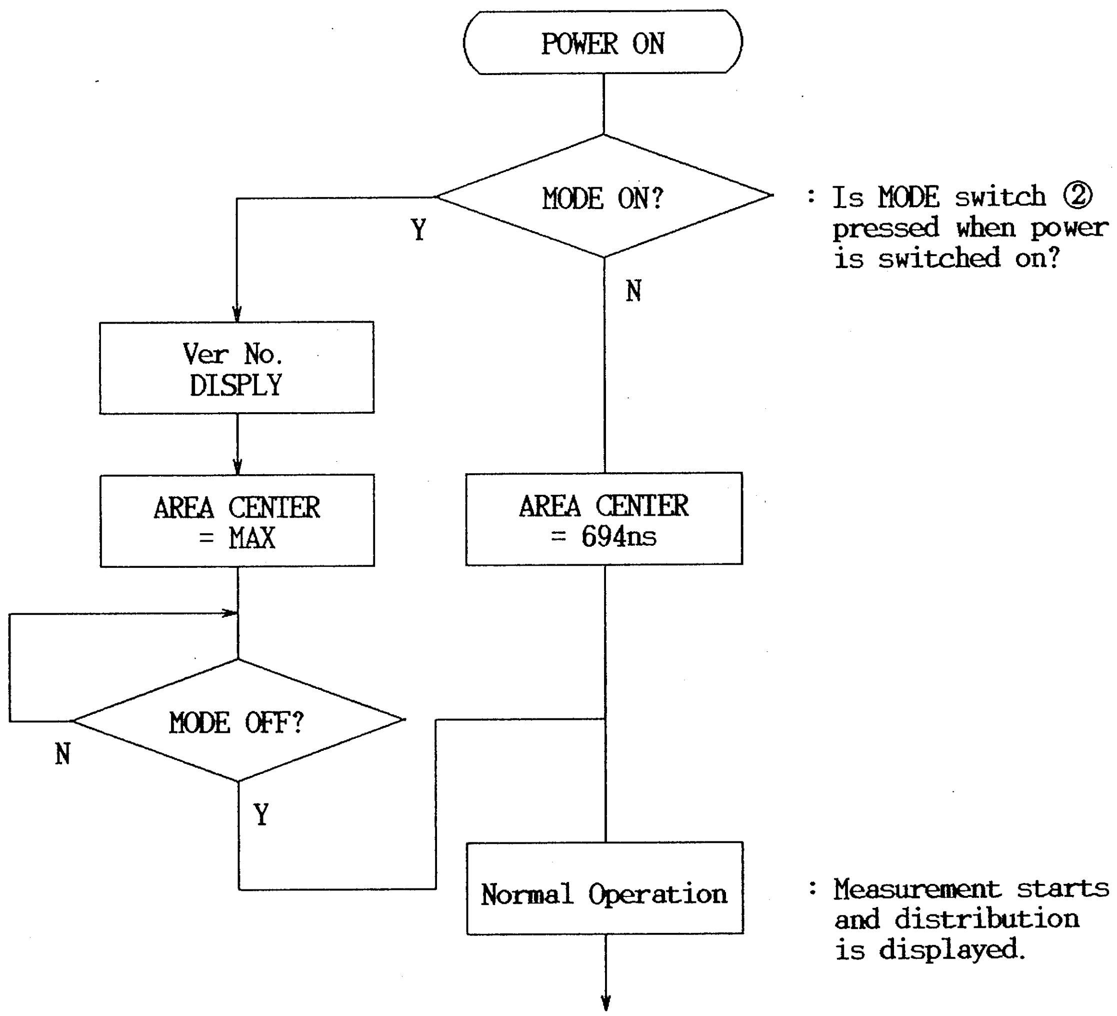
When the analyzer is turned on, the normal measurement mode is set. Then, each push of the MODE switch selects the next operation, from +WID to AVE. Anoter push after AVE puts the analyzer back into the normal measurement mode.

NOTE 1: During specification entry mode, the following switches will not function : ③ AUTO CENTER, ⑥ SLOPE, and ⑦ GAIN.

NOTE 2: Specification values entered here will be stored for approximately 2 weeks. They may disappear if the power is not switched on for 2 weeks or more.

2) How to select area center

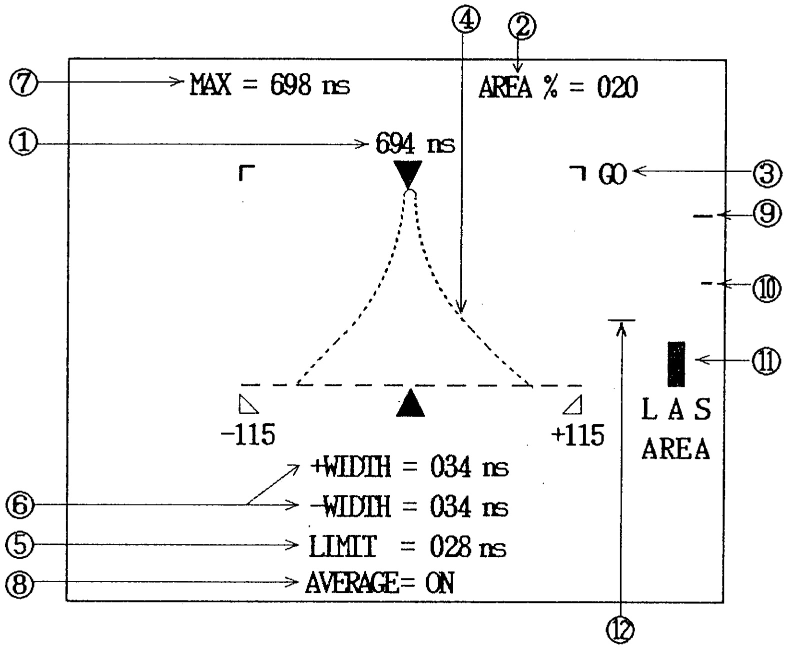
To calculate the AREA% value, either the theoretical central value for 3-pit channel which is 694 ns or the maximum value of the currently displayed distribution may be selected as the central value.



If the DB-3545 power is switched on normally, 694 ns is automatically set as the central value for the AREA% calculation. If the MODE switch ② is pressed when turning on the power, Ver. No. is displayed on the CRT, and the maximum value of distribution is set to the central value for the AREA% calculation. Then, releasing the MODE switch ② starts measurement and displays distribution.

(2) Mode selection and on-screen information

Shown below is an example of items of information displayed during operation of the analyzer.



① CENT : Indicates the absolute time position, in units of ns, of the screen center for the distribution displyed on the CRT.

② AREA% : Indicate the ratio, in percent, of (the total of X inputs received outside the t1-t2 time range enclosed by -WIDHT and +WIDTH (⑥) to (the total of Y inputs received for the whole gate time for 3T).

③ JUDGE (GO/NG) : Displays "GO" if the value indicated at ② is smaller than the value set at ⑤ ; otherwise displays "NG".

④ Jitter distribution : Displays the jitter distribution curve. The Y-axis resolution is 2 inputs per dot or, at full scale, 256 inputs per 123 dots. The X-axis resolution is 1 ns per dot or, at full scale, ±115 ns on both sides of the 694 ns position at the screen center (±115 dots).

⑤ LIMIT : Used to set the go/no-go limit for value indicated at ②. Specifically, the values outside the range determined at ⑥ are put to go/no-go judgment. A "go" judgment is given if the LIMIT setting is larger than the value displayed at ②.

⑥ WIDTH : +WIDTH....With the 694 ns theoretical center for 3T taken as the center, used to set upper allowable limit, t2, which is above the center.

Setting range...0 to +115 ns

-WIDTH...Used to set the lower allowable limit, t1, which is under the 694 ns theoretical center for 3T.

Setting range...0 to -115 ns

⑦ MAX Indicates the absolute time in ns for the point having reached count 256

⑧ AVERAGE Determines whether or not to average the distribution displayed at ④.

◁ : ON....Display of average of eight cycle periods.

▷ : OFF...Real-time dispaly for every cycle period.

⑨ AREA 100% scale	A scale of AREA values. Indicates the point of AREA 100%.
⑩ AREA 50% scale	A scale of AREA values. Indicates the point of AREA 50%.
⑪ AREA bar graph display	Displays the AREA% ② in a bar graph. If the JUDGE ③ is GO, the bar graph is displayed white. If it is NG, the center of the bar graph is blank.
⑫ LIMIT scale	A marker is displayed at a point which corresponds to the LIMIT value ⑤ for easy adjustment and so forth.

(3) Notes on conditions of the DB-3545

1) In starting measurement, ensure that RF INPUT ⑧ on the front panel receives input of the level and jitter cycle period within the gain range (see Section 2, (1), 1)) as set with ⑦ GAIN. Otherwise, no distribution curve will be output.

2) When OFFSET ⑨ on the rear panel is set to VARIABLE, be sure to apply OFFSET IN ⑧ with the appropriate input level to the comparator. Otherwise, no distribution curve will be output.

3) When the AVERAGE switch is set to ON, averaging-based operation takes place so the display speed decreases than when the AVERAGE switch is set to OFF. The maximum count of analyses to be averaged does not always reach 255.

4) If the input data is shifted rightward or leftward extremely,the peak may be out of the display range (694 ±115 ns). In such case, the maximum value in the display range may not always reach the 255 times position. The AREA% value cannot also be calculated correctly due to lack of distribution.

5) Two-second interval must be kept between the power on and off, If the power is turned on or off before this interval, the power on reset circuit may not operate, resulting in program mulfunction and disorder, or disorder in the specifications.

6. Operation via GP-IB

(1) Table of GP-IB connector signals

CONTACT	SIGNAL LINE	CONTACT	SIGNAL LINE
1	DIO1	13	DIO5
2	〃2	14	〃6
3	〃3	15	〃7
4	〃4	16	〃8
5	EOI(24)	17	REN(24)
6	DAV	18	GND (6)
7	NRFD	19	〃 (7)
8	NDAC	20	〃 (8)
9	IFC	21	〃 (9)
10	SRQ	22	〃(10)
11	ATN	23	〃(11)
12	SHIELD	24	GND LOGIC

NOTE : the figures in parentheses denote the GND return for the corresponding signals.

(2) GP-IB.

1) Governing standard and subset.

Governing standard : 1EEE-488-1978

Interface functions : SH1, AH1, T6, L3, SR1, DC0, DT0, C0

2) Items to be controlled

The items associated with the DB-3545 that can be controlled with GP-IB are classified into two general groups : the control operation via pushbutton switches on the front panel, and the output of the distribution data stored in the internal memory. The following switches cannot be controlled externally : MODE, SHIFT, BRIGHTNESS, OFFSET, and power switches. It should be noted that as a rule. external control will not work on those which can be known from the data taken in via GP-IB.

3) Outline of GP-IB connector signals

The GP-IB is a byte-serial, bit-parallel interface included in the internationally standardized interface buses for measuring instrument use. The system configuration using the GP-IB interface consists of up to 15 devices (including controllers and measuring instruments) and connecting cables of up to 20 m in total (4 m max. per cable). The maximum transmission speed in the system is 1 Mb/s.

The GP-IB interface is characterized by an asynchronous principle, called the 3-line handshake, which allows a mixture of devices of different transfer speeds within the system. In addition, a piggyback connection method is used in which system devices are linked simply by mounting their connectors one on another.

A handshake sequence is illustrated in the timing chart of Fig.1 and the flow chart of Fig.2.

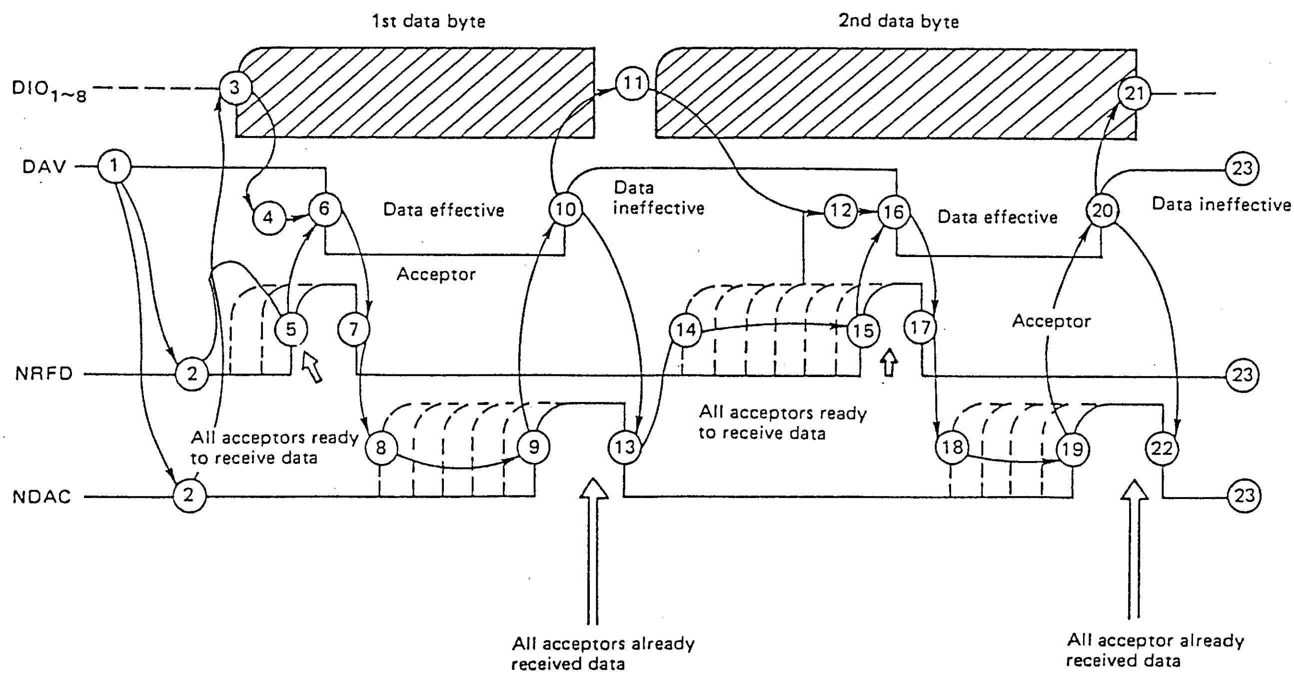


Fig.1 Handshake Sequence Timing Chart.

Handshake Flow Chart

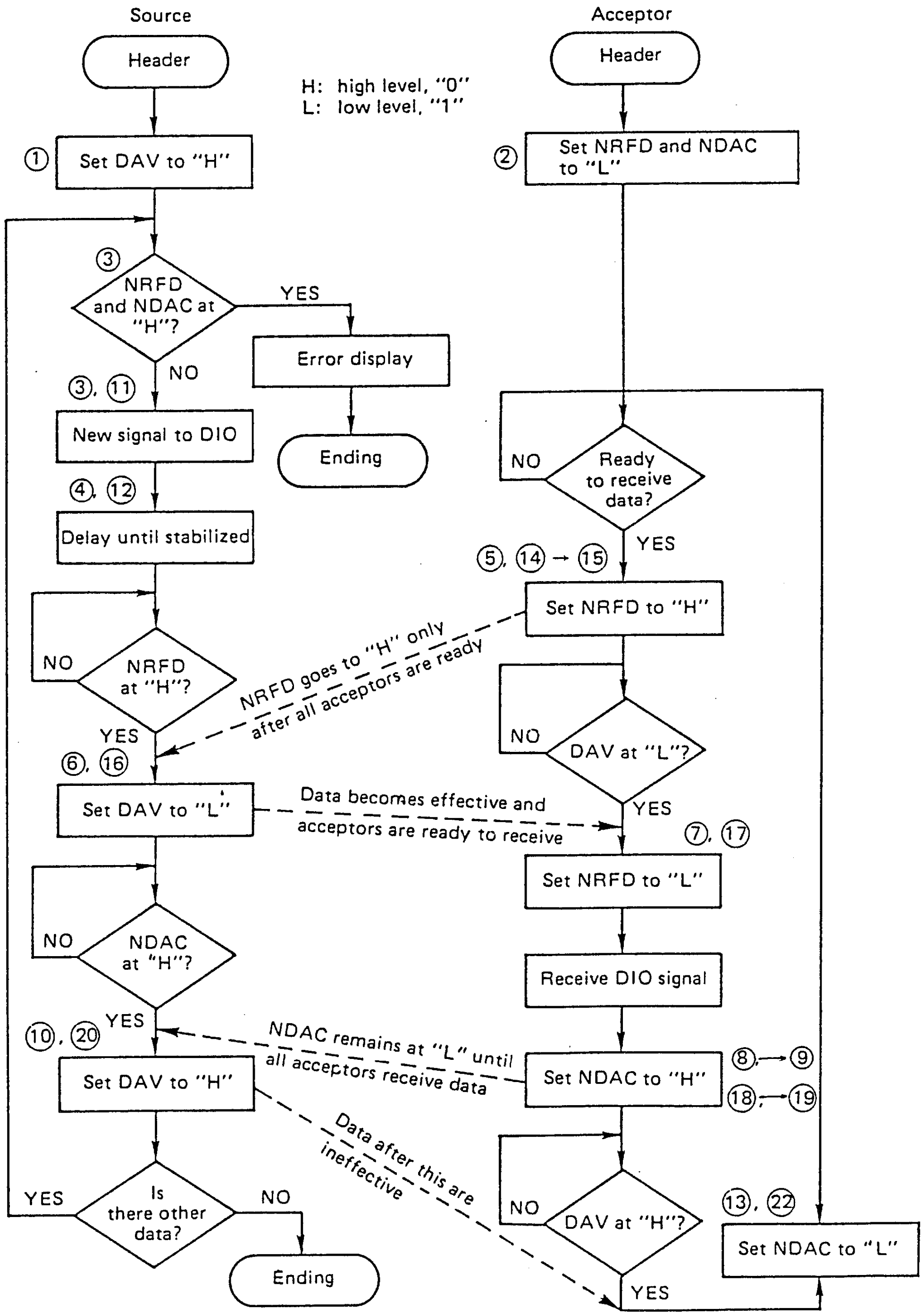


Fig. 2 Handshake Flow Chart (for transfer of data between source and acceptor through handshake sequence.)

4) Concept of device messages

The GP-IB interface system is aimed at transferring messages between devices (e.g., between a controller and a device to be controlled) using interfacce function. While in operation, the device under control can receive and send various types of device messages at different times for different purposes.

According to objectives, these messages are classified into four categories:

(1) Measurement data

Example : Parameter measured by equipment (Input)

(2) Program data

Example : Setting of equipment functions (Input)

(3) Status data

Example : Internal status of equipment (Output)

(4) Display data

Example : Raw data (Input/output)

These four categories of messages differ in format according to message types. Further, messages of the same type may have different formats depending on their purpose of use.

For each type of message, the following events are handled as a single unit : message occurrence, transfer, and interpretation. Each type of message has a header part and an ending part.

Generally, a device message consists of a header, a body (numerals), and an ending (delimiter).

A message unit contains one byte or more of data, and a sequence of data that is sent/received as a unit can be considered a series of message units. Message units can be classified by data fields. Data fields are categorized by the properties of contents of message units. Data fields are indicated by the following characters:

Type and contents of data	Header (alphabet)
Sign and polarity of data Amount of data Exponent indication	Body (numeral)
String delimiter Block delimiter Record delimiter	Ending (delimiter)

(3) Method of controlling the analyzer

1) Setting the panel control functions

The controllers on the analyzer's panel (except for MODE, SHIFT, BRIGHTNESS, OFFSET, and power switch) can be set externally via a GP-IB. Judgment setting is also available externally. In the initial state when the power is turned on, the GP-IB commands are set to ACO , WSO , IGO and SRO. This initial setup is equivalent to the following :

AUTO CENTER = OFF

SLOPE = (ON PIT)

GAIN = × 1

SERVICE REQUEST = OFF

The message unit of this program data consists of the following data fields:

(2 letters) + (1 to 3 numerals) + (CR.LF/EOT)

↑ ↑ ↑

Header Body Ending (delimiter)

The instructions for the panel control functions are described in paragraph 2) below. The panel control functions can be set by sending instructions in ASCII code to the analyzer. Note that the panel setup information cannot be read out.

2) Setting the panel switches, GO/NG specifications and SRQ specifications.

① Panel switches

A) AUTO CENTER : AC0....Equivalent to AUTO CENTER switch OFF

AC1....Equivalent to AUTO CENTER switch ON

B) SLOPE : WS0....Equivalent to SLOPE SW (ON PIT)

WS1....Equivalent to SLOPE SW (OFF PIT)

C) GAIN : IG0....× 1

IG1....× 10

② GO/NG specifications

D) +WIDTH : WP000 ~ 115.......+WIDTH0~+WIDTH 115 ns

E) -WIDTH : WM000 ~ 115.......-WIDTH0~-WIDTH 115 ns

F) LIMIT : LT000 ~ 100.......LIMIT0~LIMIT 100 %

G) MODE SET : MS ....Data setting for D) to F) completed

③ SRQ specifications

H) SRQ ON/OFF : SR0....SRQ OFF

SR1....SRQ ON

I) AVERAGE : Fixed at OFF(No function)

J) SHIFT : No function

3) Sample program for panel switch setting

Given below is an example of panel setting program written in HP BASIC.

```
10 ABORT     7
20 CLEAR     7
30 CLEAR     702 ......Sets the DB-3545 to address 02.
40 REMOTE    702
50 A$ =     "AC 0" ......Sets AUTO CENTER to OFF.
60 OUTPUT    702 ; A$
80 END
```

When setting a specification value of 50 ns for +WIDTH, as an example, "A$" is set to "WP050".

Setting of the WP, WM and LT commands must be followed by MS, data completion command. Then judgment will be made based on that data.

Example.
```
50 A$ = "WP050"
60 OUTPUT 702 ; AS .....50 ns is set for +WIDTH
70 A$ = "MS"
80 OUTPUT 702 ; AS .....Judgment data established
90 END
```

4) Reading out the measurement data

① Commands for measurement data

A) MAX DATA : DM command ... (On-scrren information ⑦) Reads out the absolute time for the point having reached the maximum count.

B) CENT DATA : DC command ... (On-scrren information ①) Reads out the absolute time for the screen center.

C) AREA DATA : AR command ... (On-scrren information ②) Reads out the AREA % value.

D) JUDGE DATA : GN command ... (On-scrren information ③) Reads out the GO-NG data.

E) JITTER DATA: DA command ... (On-scrren information ④) Reads out the jitter distribution for 231 ns, in the order from -115 ns and successively to +115 ns.

② Reading out the MAX, CENT and AREA data

The MAX, CENT and AREA datas that can be read out by the DB-3545 are the absolute time and percent for each distribution, in 3 bytes/data.

(3-digit ASCII data : 694 ± 115 ns, 000 to 100 %)

③ Reading out the JUDGE data

The JUDGE data that can be read out by the DB-3545 is the judgment data for each distribution, in 1 byte/data. (1-digit ASCII data : 30H for GO, 31H for NG)

5) Read-out procedure

Measurement data can be read out from the DB-3545 through the following procedure :

1. Issue a read request to the DB-3545 (command output).
2. After data has internally become ready for the GP-IB bus line, notify the service request (SRQ) issuing controller of data readiness.
3. Read measurement data from the controller.

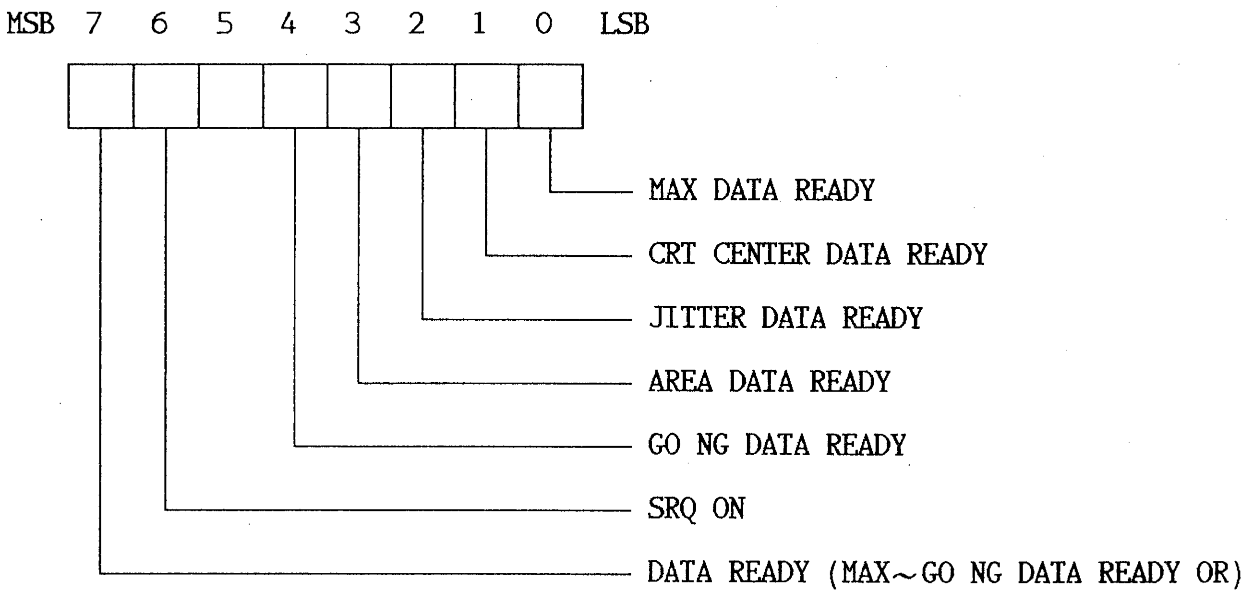
- Data readng conditions :

SRO : SRO .....Service request OFF

SR1 .....Srevice request ON

Interrupt of the DB-3545 uses serial polling. A controller designed for parallel polling must not be used.

Bit allocation for SPOLL is as follows :



• Output data format :

Each data consists of two bytes of BCD. Data is sent three times in ASCII format. (Example : 36H, 39H and 34H, for 694 ns)

(4) Programming example using HP-BASIC (common to MAX, CENT and AREA)

① MAX data read-out :

This function is used for acquiring the MAX data displayed on the CRT via a GP-IB. The data is consists of 3-digit ASCII data of 694 ± 115 ns. Input data is given three times in BCD code from the host controller.

The MAX data on the CRT is read by the following procedure :

1. Set the controller into data read mode.
2. The controller waits for an interrupt. This is done by looking at bit 7 in SPOLL. (At this time, it is recommended to check the ready bits--bits 0 and 7.)
3. The MAX data is acquired. The data consists of 3-digit BCD data (0 to 2).
4. The current measurement finishes with the acquisition of the three-digit data, followed by the next measurement.
5. A reference program (in HP-BASIC) is given on the next page.

```
10     ! +++++++++++++++++++++++++++++++++++++++++
20     ! +      DB3545 CD  JITTER ANALYZER       +
30     ! +      MAX DATA COLLECTION PROG.        +
40     ! +      (DM COMMAND)                     +
50     ! +                      1987 3           +
60     ! +             BY KENWOOD                +
70     ! +++++++++++++++++++++++++++++++++++++++++
80     REM INITIALIZE
90     INTEGER C(107)
100    ASSIGN @Hpib TO 7
110    ASSIGN @Jit TO 702                    ; DB-3545 is set to address 2
120    Hpib=7
130    ABORT @Hpib
140    CLEAR @Hpib
150    REMOTE @Jit
160    ON INTR Hpib GOSUB Service
170    Mask=2
180    ENABLE INTR Hpib;Mask
190 ! +++++++++++++++++++++++++++++++++++++++++++
200 ! +      CONDITION SETTING ROUTINE          +
210 ! +++++++++++++++++++++++++++++++++++++++++++
220 OUTPUT @Jit;"SR1"                        ; SRQ ON
230 OUTPUT @Jit;"AC1"                        ; AUTO CENTER ON
240 Loop:!
250 PRINT "MAX DATA COLLECT NOW!!"
260 Loop1:!
270 OUTPUT @Jit;"DM"                         ; DM command is sent to DB-3545
280 Lwait:IF Dataflg=0 THEN Lwait           ; Wait until data flag = 1
290 Dataflg=0
300 SEND @Hpib;UNT TALK 2 MLA
310 FOR I=0 TO 5
320 ENTER 7 USING "#,B";C(I)
330 Ccc=C(I)-48                              ; MAX data is put into array C(0)-(2)
340 PRINT Ccc,                               ; Compensates for ASCII data (-30)
350 NEXT I                                   ; Displays data on screen
360 PRINT
370 GOTO Loop1
380 Service:!                                ; SRQ interrupt routine
390 S=SPOLL(@Jit)
400 Dataflg=1                                ; Data flag is set to 1
410 ENABLE INTR Hpib;Mask
420 RETURN
430 END
```

② Jitter distribution data read-out :

This function is used for acquiring the jitter distribution displayed on the CRT via a GP-IB. It has an address capacity of 231 dots for the X-axis direction. Dot resolution is 1 ns/dot, so that data for a 231 ns range is acquired with the total of 231 dots. Addresses are given by assigning to 0 the left edge of the screen, 115 to the center, and 231 to the right edge.

Each output data consists of 2-byte binary code. Each data (HI and HO in this order) is converted into ASCII code, until 231 datas x 2, or 462 outputs, are sent out.

(Example. For 5EH : 35H, 3EH
HI LO)

The jitter distribution data on the CRT is read by the following procedure :

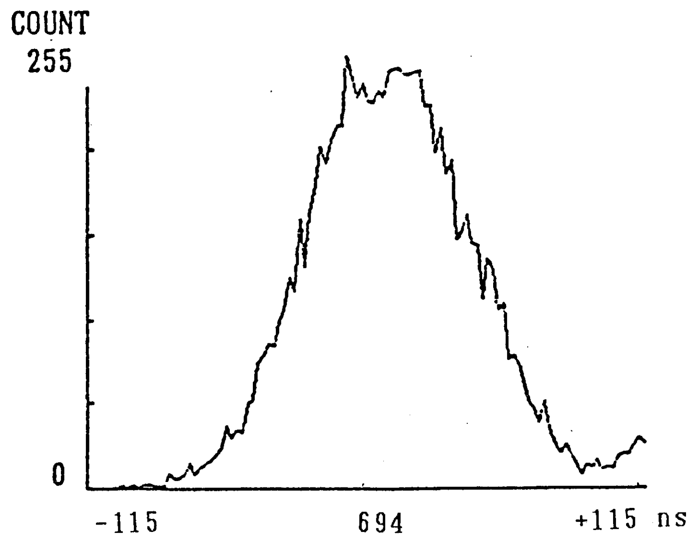
1. Set the controller into data read mode.
2. The controller waits for an interrupt. This is done by looking at bit 7 in SPOLL. (At this time, it is recommended to check the ready bits-- bits 2 and 7.)
3. The distribution data is acquired, The data covers addresses 0 to 230. The data size for one distribution is equivalent to 231 addresses, each address represented by 2 bytes.
4. The current measurement finishes with the acquisition of the distribution data for 231 addresses (462 outputs of BCD data), followed by the next measurement.
5. A reference program is given on the next page.

```
10      ! +++++++++++++++++++++++++++++++++++++++++
20      ! +       DB3545 CD JITTER ANALYZER       +
30      ! +       DATA COLLECTION PROGRAM         +
40      ! +       (DA COMMAND)                    +
50      ! +                       1987  3         +
60      ! +            BY KENWOOD                 +
70      ! +++++++++++++++++++++++++++++++++++++++++
80 Start: !
90      REM INITIALIZE
100     INTEGER C(465)
110     ASSIGN @Hpib TO 7
120     ASSIGN @Jit TO 702                      ; DB-3545 is set to address 2
130     Hpib=7
140     ABORT @Hpib
150     CLEAR @Hpib
160     REMOTE @Jit
170     ON INTR Hpib GOSUB Service
180     Mask=2
190     ENABLE INTR Hpib;Mask
200 ! +++++++++++++++++++++++++++++++++++++++++++
210 ! +       CONDITION SETTING ROUTINE         +
220 ! +++++++++++++++++++++++++++++++++++++++++++
230 OUTPUT @Jit;"SR1"                           ; SRQ ON
240 OUTPUT @Jit;"WS1"
250 OUTPUT @Jit;"AC1"
260 OUTPUT @Jit;"IG0"                           ; AUTO CENTER ON
270 Loop:!
280 PRINT "DATA COLLECT NOW"
290 Loop1:!
300 OUTPUT @Jit;"DA"                            ; DA command is sent to DB-3545.
310 Lwait:IF Dataflg=0 THEN Lwait               ; Wait until data flag = 1.
320 Dataflg=0
330 SEND @Hpib;UNT TALK 2 MLA
340 FOR I=0 TO 463
350 ENTER 7 USING "#,B";C(I)                    ; One data (3 bytes) is entered.
360 Ccc=C(I)-48
370 PRINT "I=",I,Ccc
380 NEXT I                                      ; "461 + 2 outputs" over?
390 PRINT "1 TIME END"
400 LOCAL @Jit
410 WAIT 2
420 GOTO Loop1
430 Service:!                                   ; SRQ interrupt routine
440 S=SPOLL(@Jit)                               ; Jitter data ready check
450 IF BIT(S,2)=0 THEN Data_error               ; Data ready check
460 IF BIT(S,7)=0 THEN No_data
470 Dataflg=1
480 ENABLE INTR Hpib;Mask
490 RETURN
500 Data_error:!                                ; Error comment
510 PRINT "DATA ERROR"
520 GOTO Mend
530 No_data:!
540 PRINT "NO DATA ERROR"
550 Mend:!
560 BEEP
570 END
```

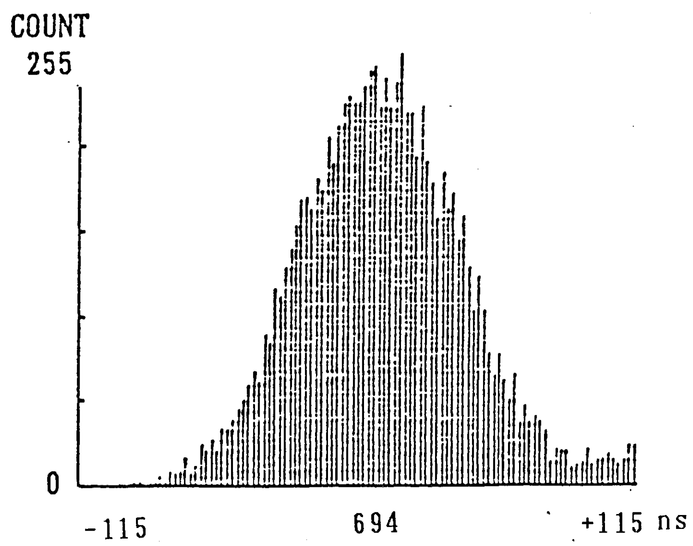
Shown below are examples of the results obtained from this program.

(Contents of array C (I) : Y-axis
Contents of array I : X-axis)

① Sample of continuous dot display



② Sample of bar graph display



(5) Programming example on PC-9801 (using N88 BASIC)

The following shows an example of GP-IB control software, which is compatible to the NEC PC-9801. It has been confirmed that this program operates on the following models:

1. PC-9801F Clock: 8 MHz
2. PC-9801VX21 Clock: 10 MHz

If this program is used on another computer, a part of the program may have to be altered. Carry out first the command test in 1) to make sure that it operates. Then, enter the DC command in 2) and the DA command in 3).

Program Functions

1) Command test: Enter commands directly.

   1. Load the program. (GP-IB address: 2)
   2. Input jitters. → Distribution is displayed.
   3. Key in RUN and press the Return key.
   4. INPUT COMMAND? is displayed on the CRT of the personal computer.
   5. Enter the panel setting commands, etc.

      ⟨Example⟩

      AC1 ↲ : Auto centering ON

      ACΦ ↲ : Auto centering OFF

      IG1 ↲ : Gain = × 10

      IGΦ ↲ : Gain = × 1 gain

      WS1 ↲ : OFF pit slope

      WSΦ ↲ : ON pit slope

      Enter the above commands to make sure that they cause the same results as of manual setting.

   6. Key in STOP to terminate operation.

1) DB-3545 program on PC-9801

Accepts commands (for panel setting etc., excluding data output) when INPUT COMMAND? is displayed in the command test.

2) DC command

Reads the central value data and displays them on the CRT of the personal computer.

1. Load the program.
2. Input jitters. → Distribution is displayed.
3. Key in RUN and press the Return key.
4. CRT central values are displayed on the CRT as follows:

   684

   685

   686

   684

   :

5. Key in STOP to terminate operation.

Procedures for MAX and AREA are the same.

3) DB-3545 program on PC-9801

The DC command reads the jitter central value and displays it in the JT$ position.

```
1000 '
1020 '
1030 '          INTERFACE INITIAL
1040 '
1050     ISET IFC : ISET REN
1070     CMD DELIM=0 : CMD TIMEOUT=5
1100 '
1110     ON SRQ GOSUB *SPOLL1
1120 '
1130 '   INITIAL
1150     KCMD$="AC1" :PRINT@ 2;KCMD$    ; AUTO CENTER ON
1160     KCMD$="IG1" :PRINT@ 2;KCMD$    ; GAIN× 10
1170     KCMD$="WS0" :PRINT@ 2;KCMD$    ; SLOP×
1230 '
1240 '          KEISOKU
1250 '
1260 *JT
1290   INTOK=0 : PRINT@ 2;"DC"         ; "DC" command is sent.
1292 SRQ ON
1295 'PRINT"MAXOUT!!"
1298 PRINT INTOK
1300   IF INTOK<>1 GOTO 1295
1310       LINE INPUT@ 2;JT$           ; 3-digit jitter central value is entered
1320       PRINT JT$                   in JT$ position.
1330       WBYTE &H5F;
1340   GOTO *JT                        ; Next jitter central value is entered.
1350 '
1360 '  WARIKOMI
1370 '
1380 *SPOLL1                           ; Serial poll interruption.
1385 'PRINT"NOW SPOOL"
1390   POLL 2,SB
1392 'PRINT SB
1395    INTOK=1                        ; Poll end flag is set.
                                       ; End of serial poll interruption.
1405 RETURN
1410 '
1420 END
```

4) DA command

Reads the jitter distribution data and displayes them on the CRT of the personal computer.

1. Load the program.
2. Input jitters. → Distribution is displayed.
3. Key in RUN and press the Return key.
4. 2-digit data (14 is expressed as 0104) are displayed in order from the left of the CRT, amounting to 231 addresses ×2 +2 (i.e., control code).

```
00 00 00 ..................................................

          01 07 F4 5D .....................................
                   ↑
        Jitter components

00 00 00 .................................................. 00

    ↓
```

5. Key in STOP to terminate operation.

5) DB-3545 program on PC9801

The DA command reads the jitter distribution and displays it in the JT$ position.

```
1000 '
1020 '
1030 '             INTERFACE INITIAL
1040     DIM JT$(255):DIM JT1$(255)
1050     ISET IFC : ISET REN
1070     CMD DELIM=0 : CMD TIMEOUT=5
1100 '
1110     ON SRQ GOSUB *SPOLL1
1120 '
1130 '   INITIAL
1150     KCMD$="AC0" :PRINT@ 2;KCMD$      ; AUTO (ENTER OFF)
1160     KCMD$="IG1" :PRINT@ 2;KCMD$      ; GAIN × 10
1170     KCMD$="WS0" :PRINT@ 2;KCMD$      : SLOP ×
1230 '
1240 '             KEISOKU
1250 '
1260 *JT
1290   INTOK=0 : PRINT@ 2;"DA"            ; DA command is sent.
1292 SRQ ON                               ; SRQ ON
1295 'PRINT"DA READ!"
1298 'FOR I=0 TO 463
1300   IF INTOK<>1 GOTO 1300
1310 INPUT @2;JT$, JT1$                   ; Data is entered in JT$ position.
1315 PRINT "I=",I
1320       PRINT JT$;JT1$
1325 'NEXT I                              ; Next distribution is read.
1330       WBYTE &H5F;
1340   GOTO *JT
1350 '
1360 '  WARIKOMI                          ; Serial poll interruption.
1370 '
1380 *SPOLL1                              ; Poll
1385  PRINT"NOW SPOOL"
1390   POLL 2,SB                          ; Poll end flag is set.
1392  PRINT SB
1395    INTOK=1                           ; End of serial poll interruption.
1400  'SRQ ON
1405 RETURN
1410 '
1420 END
```

(6) Table of GP-IB commands

Function group	Commands	Function	State of power-on time
PANNEL SW	AC 0 AC 1	AUTO CENTER SW = OFF = ON	○
	WS 0 WS 1	SLOPE SW = OFF (ON PIT) = ON (OFF PIT)	○
	IG 0 IG 1	GAIN = × 1 = × 10	○
GO/NG	WP 000 WP 115	+WIDTH = 000(ns) +WIDTH = 115(ns)	
	WM 000 WP 115	-WIDTH = 000 (ns) -WIDTH = 115 (ns)	
	LT 000 LT 100	LIMIT = 00 (%) LIMIT = 100 (%)	
	MS	MODE SET (data setting established for WP to LT)	
SRQ	SR 0 SR 1	SRQ = OFF SRQ = ON	○
MES.DATA	DM	MAX DATA READ	
	DC	CENTER DATA READ	
	AR	AREA DATA READ	
	GN	JUDGE DATA READ	
	DA	JITTER DATA READ	

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