ADVANTEST®

ADVANTEST CORPORATION

INSTRUCTION MANUAL

TR41301

EXTERNAL KEYBOARD

MANUAL NUMBER 0382 EE 603

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Printed in Japan

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SECTION 1

GENERAL INFORMATION

1-1. GENERAL

When connected to the TR4133 or TR4133A or TR4133B Spectrum Analyzer the TR41301 External Keyboard serves as a function keyboard capable of greatly expanding the functions of the respective analyzers. The TR41301 provides the TR4133/TR4133A/4133B with various marker functions not included in the analyzers, and also enables the various functions to be set by DATA number/unit keyboard operation.

This instruction manual mainly covers those functions enabled by connecting the external keyboard to one of the analyzers. It is recommended that the TR4133/TR4133A/4133B instruction manual be read first before proceeding to use this manual.

TR4133/4133B Spectrum analyzers with serial No. below cannot be connected to this External Keyboard unless ROMs inside the spectrum analyzer are replaced to new ones. If the serial No. of your TR4133/4133B matches the No. below, contact your nearest ADVANTEST representative for the ROM replacement.

Model	Serial No.
TR4133	32540001 to 42540041
TR4133B	32980001 to 42980119

1-2. ACCESSORIES SUPPLIED

	Rating	Q'ty
Instruction manual	E41301	1

1-3. SPECIFICATIONS

(1) Applicable analyzers

TR4133 Spectrum Analyzer

TR4133A Spectrum Analyzer

TR4133B Spectrum Analyzer

(2) TR4133/TR4133A/TR4133B functions enabled by TR41301 connection.

The five digital memories WRITE, A, B, C, and D

INPUT-A display

B A and D A functions (transfer of waveform data between memories)

The following marker functions

- Setting by marker position frequency
- Delta marker
- MARKER CENTER FREQUENCY
- MARKER PEAK SEARCH
- SIGNAL TRACK
- MARKER REFERENCE LEVEL
- NEXT PEAK SEARCH
- NOISE/Hz

SWEEP STOP/START functions

Numerical setting of reference level by DATA keyboard operation

Numerical setting of ATT by DATA keyboard operation

Numerical setting of frequency span by DATA keyboard operation

Numerical setting of center frequency by DATA keyboard operation

1 div. increment/decrement (UP/DOWN) of center frequency

Automatic setting of frequency bands (when setting center frequencies)

Setting the center frequency step size

Setting of display frequency by START-STOP command

FREQ. LOCK (fixing center frequencies by counter)

Display of DISPLAY LINE

Numerical and step setting of functions by DATA keyboard, and COARSE and FINE UP and DOWN keys

Saving and recalling of up to 12 setting conditions

Label function

And the following six advanced functions

- Frequency NEXT-PEAK search
- Occupied bandwidth measurement
- Adjacent channel leak power measurement
- Sweep adapter AFC
- SAME LEVEL MARKER
- Adjacent peak search

(3) General Specifications

Operating environment conditions:

Temperature $0^{\circ}C$ to $40^{\circ}C$,

Relative humidity 85% or less

Power: +5V (Supplied from the TR4133/4133B front panel connector)

Power requirement :

3 VA

Outside dimensions:

Approx. 300(W) x 62(H) x 180(D)mm

Weight: Approx. 1.7 kg or less

MEMO

SECTION 2

PRELIMINARY AND GENERAL PRECAUTIONS

2-1. INTRODUCTION

To ensure that the TR41301 External Keyboard is used correctly and efficiently, be sure to read the following precautions as part of the preliminary preparations before commencing any operations.

2-2. INSPECTION

After taking delivery of the TR41301, check that no damage has been incurred during transportation. If damage has occurred, or if the keyboard fails to function in accordance with the specifications, please contact your nearest Takeda Riken representative.

2-3. PRECAUTIONS WHEN TRANSPORTING THE KEYBOARD ELSEWHERE

If the keyboard is to be transported elsewhere, pack it in the same packaging used when the keyboard was first delivered, or in other equally efficient packaging.

2-4. OPERATING ENVIRONMENT CONDITIONS

(1) Do not use in dusty areas, or in places subject to direct sunlight and/or corrosive fumes. Also ensure that the ambient temperature is between $0^{\circ}C$ and $40^{\circ}C$ and that the humidity is less than 85% RH.

(2) The storage temperature range for the keyboard is $-20^{\circ}C$ to $+60^{\circ}C$. If the keyboard is not to be used for any length of time, wrap it up in a vinyl plastic cover or place it in a carton and store in a cool dry place.

2-5. CONNECTING TO THE TR4133A/4133B ANALYZER

(1) The TR4133/TR4133A/4133B power switch must be OFF before the TR41301 is connected to it.

(2) When making the actual connection, align the plug guide with the socket guide as shown in Figure 2-1, and then push straight in.

(3) When disconnecting the TR41301, hold the plug connection sleeve as shown in Figure 2-2, and pull straight out. Do not pull while holding the cable itself.

2-6. BATTERY LIFE

The TR41301 External Keyboard has been equipped with Lithium back-up batteries capable of maintaining memory contents for at least three years.

If the LOW BTRY ALARM comes on, contact your nearest ADVANTEST representative to have the battery replaced.

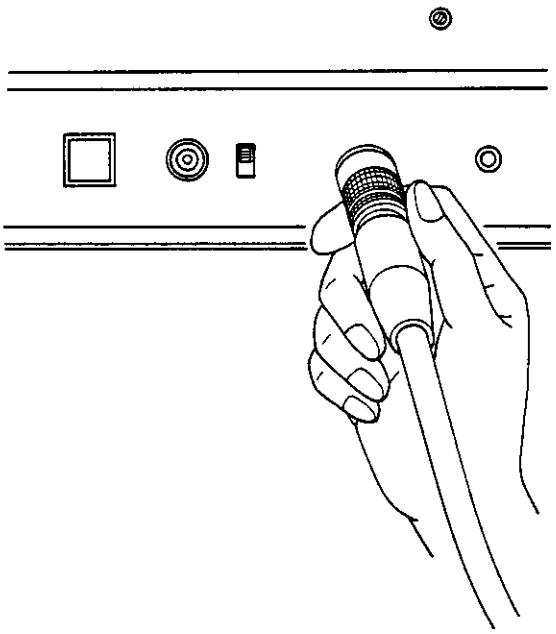


Fig. 2-1 TR41301 connection to TR4133/A/B

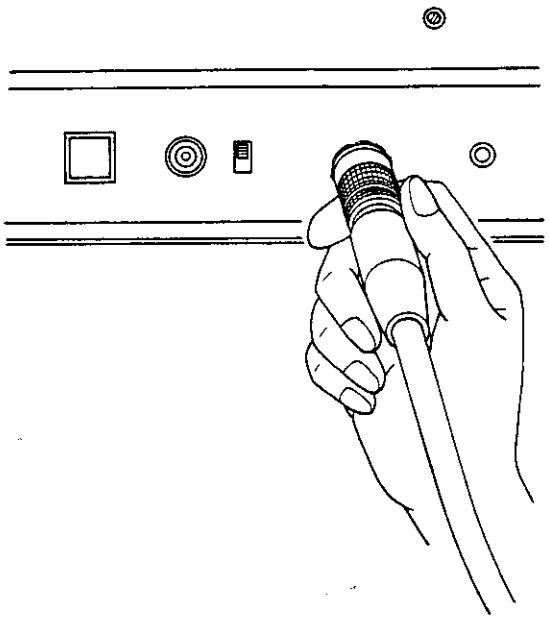


Fig. 2-2 Disconnecting the TR41301 from the TR4133/A/B

MEMO

SECTION 3
OPERATING PROCEDURES

3-1. OUTLINE

After first briefly summarizing the TR4133/4133B operating procedures, this section gives an outline of each key.
Proceed to Section 4 for a more detailed description of each function.

3-1-1. Outline of TR4133/4133B Operations Activated by the External Keyboard

The keyboard key switch functions can be divided into the following three main types.

(1) Direct execution of the relevant function when key is pressed - same as when TR4133/4133B keys are pressed.

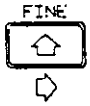
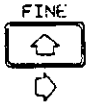
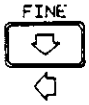
(2) Keys for calling special functions when pressed, and subsequent input and setting of numerical values by Data number/unit keyboard or UP/DOWN key operation. In this case, an abbreviated function name (maximum of six characters) appears in the bottom line of the screen, and the "Data keyboard" set numerical value is shown in the right of that name. These functions are known as "active functions". (See Figure 3-1).

(3) Functions which include elements of both (1) and (2).

Examples: MARKER (NORMAL, DELTA), FREQ LOCK AVERAGE, etc.

3-1-2. Active Functions

Active functions are defined by the following process. The description here uses CENTER FREQ. as an example (see Figure 3-1).

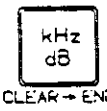
Operator	TR4133/4133B operation and CRT status
(1) Press 	CENTER appears on the bottom line of the CRT screen. The center frequency can then be changed by DATA keyboard and UP/DOWN key operations. This status is maintained until another active function key is pressed.
(2) Press 	The center frequency is increased by 1 div. on the horizontal axis.
Also:	
(3) Press  continuously	After about half a second, the center frequency is increased at a rate of 2 divs. per second (approx). After about two seconds, the center frequency is increased at a rate of 5 divs. per second (approx).
(4) Press 	The center frequency is increased by 1/20 div. on the horizontal axis.
Also:	
(5) Press 	After about half a second, the frequency is increased at a rate of 2 divs. per second (approx). After about two seconds, the frequency is increased at a rate of 5 divs. per second (approx).
(6)  and 	These keys are operated in the same way as the UP keys.
(7) Numerical input by DATA keyboard operation Press 1234	Input numerical value are displayed as "CENTER 1234".
(8) Press 	The number corresponding to the previously pressed key is erased. "CENTER 123"

(9) Press 

The "123" characters are erased, and the center frequency is set to 60 GHz.

Press 

The "123" characters are erased, and the center frequency is set to 123 MHz.

Press 

The "123" characters are erased, and the center frequency is set to 123 kHz.

Note: As a rule, press the "kHz" key when none of the three unit keys are suitable. For example, after setting AVERAGE, SAVE, or RECALL.

Note: If a function key is pressed before pressing the unit key, the input numerical value is cleared.

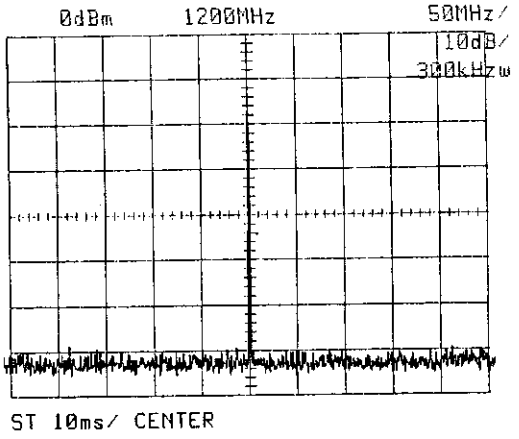
The above may be summarized as follows:

(1) Press the entry function key to be set.

(2) The entry function name code appears on the bottom line of the screen.

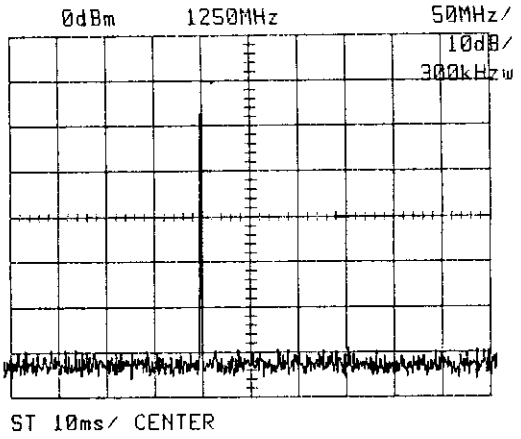
(3) Set the numerical value by UP, DOWN, or DATA keyboard operation.

(1) Press [CENTER FREQ]



Center frequency becomes an active function.

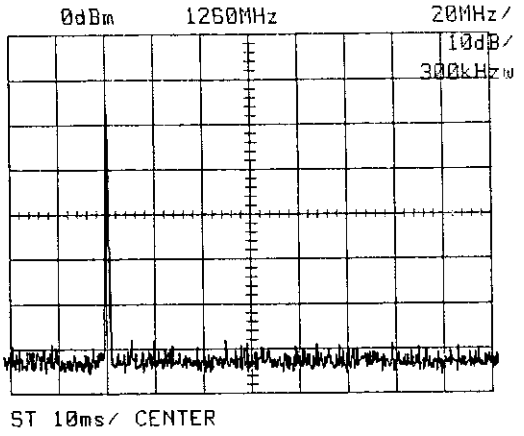
(2) Press [⇧]



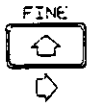
Center frequency is incremented by 1 div.

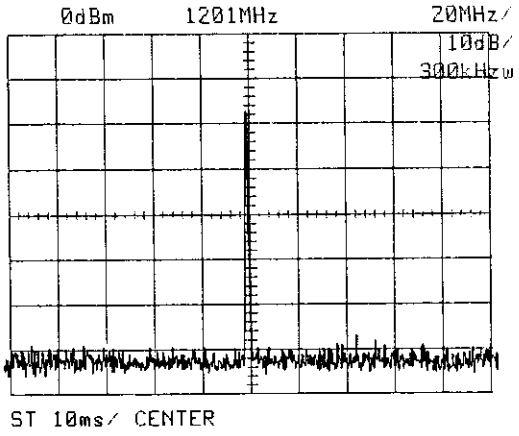
Fig. 3-1 Active function setting

(3) Then press  continuously.



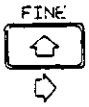
Center frequency is incremented continuously.

(4) Press 

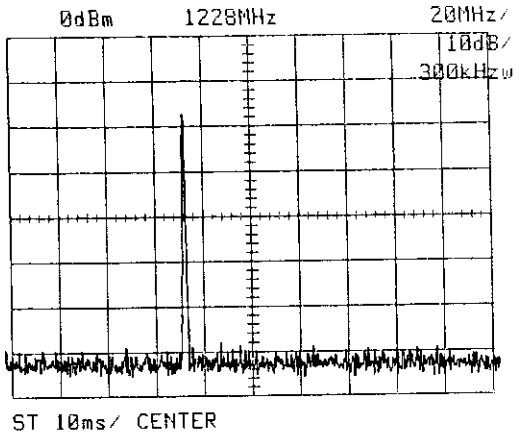


Center frequency is incremented by 1/20 div.

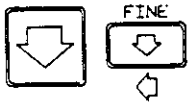
Fig. 3-1 Active function setting (cont'd)

(5) Press 

again



Center frequency is incremented continuously in the same way as in step (3) above.

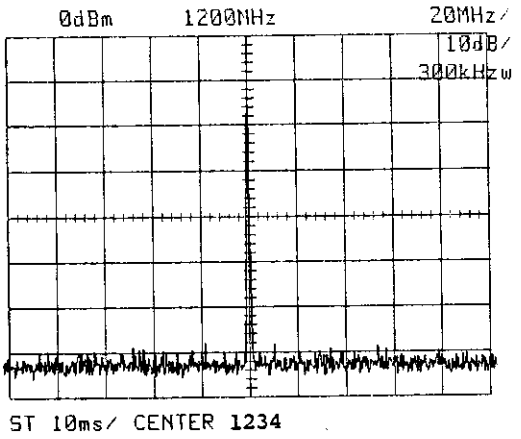
(6) 

Center frequency is decremented in a similar manner as in steps (1) thru (5).

Fig. 3-1 Active function setting (cont'd)

(7) Input of numerical value by DATA keyboard operation.

Example: Press 1, 2, 3, and 4



(8) And then press BACK SP

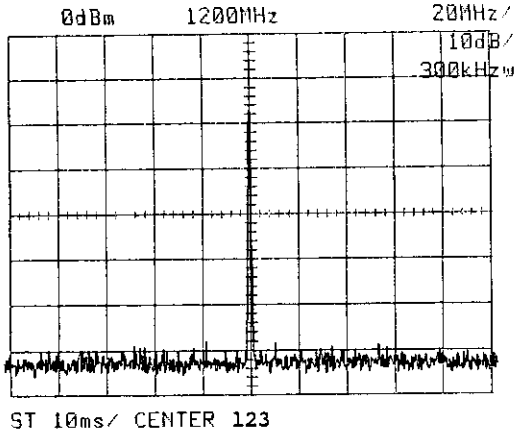


Fig. 3-1 Active function setting (cont'd)

(9) Press [GHz V sec] (INSERT). Although the "123" characters are erased, and the center frequency is interpreted as 123 GHz, this figure exceeds the maximum setting limit of 60 GHz. Therefore, 60 GHz is set as the center frequency.

Press [MHz mV ms] (DELETE). The "123" characters are erased, and the center frequency is set to 123 MHz.

Press [kHz dB] (CLEAR→END). The "123" characters are erased, and the center frequency is set to 123 kHz.

Note: If [CENTER FREQ]* is pressed before [GHz V sec] (INSERT), [MHz mV ms] (DELETE), or [kHz dB] (CLEAR→END) is pressed, the input numerical value is erased as indicated.

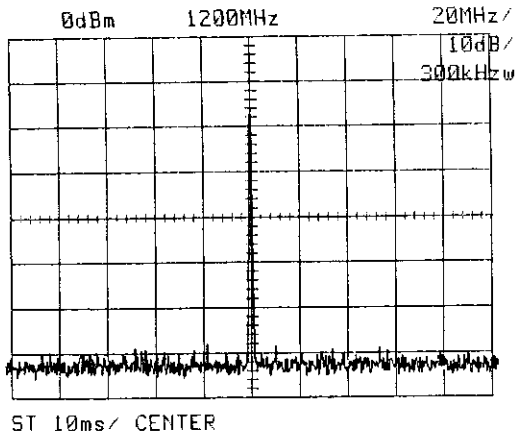


Fig. 3-1 Active function setting (cont'd)

3-2. DESCRIPTION OF INDIVIDUAL KEYS

The numbers enclosed in brackets below are key numbers, and numbers indicated by a ' are SHIFT key functions. See Figure 3-2.

TRACE Section

(1) POSI PEAK

Press this key to switch to POSI PEAK mode, and press a second time to switch to POSI NEGA PEAK mode. POSI NEGA PEAK mode is set when the POWER is first switched on.

(1)' SAMPLE

The A/D converter is switched to random sampling mode.

(2) WRITE

Successive display of input signal response.

(2)' PLOTTER

Plotting of TR4133/B display to external plotters connected via GPIB cable is enabled.

(3) STORE A, B, C, D

The input waveform data at the moment the key is pressed is stored in the respective A, B, C, and D memories. At the same time, the memory is changed to VIEW mode.

(4) VIEW A, B, C, D

Display of the contents of the A, B, C, and D memories.

(5) MAX HOLD A, B, C, D

One of the A, B, C, or D memory contents are compared with the input waveform data of each sweep at each point on the horizontal axis. The larger level is stored in the A, B, C, or D memories.

(6) AVG A, B, C, D (AVERAGE)

Digital averaging is executed in one of the A, B, C, or D memories, and the result then stored in the respective memory. Averaging is stopped by pressing the respective VIEW A, B, C, or D key.

(7) B-A → C

The A memory contents are substracted from the B memory contents, and the difference of level is shown in trace waveform on the CRT screen. The display line indicating the reference for this level difference is also shown on the screen.

(8) INPUT-A → C

The A memory contents are substracted from the input waveform in a manner similar to the subtraction in (7). The meaning of the display line shown on the screen, and the related operation are identical to (7).

(9) B ⇄ A

The A and B memory contents are interchanged.

(9)' INSTR PRESET

Initializes all settings of TR41301 and TR4133/B.

(10) D → A

The A memory contents are transferred to the D memory.

The D memory contents remain unchanged.

MARKER Section

(11) NORMAL (Normal Marker)

When this key is pressed, a marker appears in the center of the frequency axis (at the position of the current active marker when in Δ marker mode), and the mode is changed to NORMAL marker mode.

(11)' OTHER TRACE (Marker → The Other Trace)

When a waveform is shown in dual display mode, the waveform which the marker is to trace is shifted to the other display.

(12) OFF

All marker-related displays are erased from the screen when this key is pressed.

(13) Δ (Delta Marker)

The marker is switched to Δ marker mode when this key is pressed. Although two markers appear, only one of them can move on the frequency axis. The frequency and level differences between the two markers are displayed on the screen. The movable marker is called the active marker, and the other marker is called the reference marker.

(13)' FIXED Δ (Fixed Delta Marker)

The frequency and level of the marker at the moment this key is pressed (active marker when Δ marker) are stored, and the differences from the active marker frequency and level are displayed. Even if the signal input setting is changed, the reference marker data is kept at the same frequency and level, and the differences from the active marker are displayed.

(14) MKR → CF (Marker → Center Frequency)

The frequency of the marker position becomes the center frequency, and the marker is shifted to the center.

(15) PEAK SEARCH (Marker Peak Search)

The marker is shifted to the position of the highest level in the waveform displayed on the screen.

(16) SIG TRACK (Signal Track)

PEAK SEARCH and MARKER → CENTER operations are executed during each sweep (once every approx. 0.8 sec. when less than sweep time 50 msec.), the peak signal being maintained constantly in the center of the screen. This mode is cancelled when the key is pressed a second time.

(17) MKR → REF LVL (MARKER → Reference Level)

The marker position level is set as the reference level. No operation when in LINE mode.

(18) NEXT-PEAK (Next Level Peak Search)

Marker is shifted to the peak of the next highest level after the current marker position.

(19) NOISE/Hz

Marker level is displayed in the equivalent IF band width 1 Hz value. This function can be used only when the level unit is dBm with 10 dB on the vertical axis scale.

(20) SIG IDENT (Signal Identifier)

Function used to determine whether the correct frequency band has been selected when measuring a signal of unknown frequency, the function being used in EXT MIXER mode in the TR4133B. When this key is pressed, a confirmation signal about 3 dB below the signal spectrum appears on the side of the signal spectrum during each sweep. If the frequency difference between the signal spectrum and this confirmation signal is less than 1 MHz, the signal will be measured in the correct frequency band.

(21) SHIFT IF switch

If the frequency of the input signal is the same as the 1st IF frequency (approx. 4 GHz) of this keyboard, the CRT screen base line is raised and the dynamic range is reduced. In this case, press this switch to change the IF frequency and reduce the base line. This switch can only be used when the 0 thru 3.6 GHz band and EXT MIXER (TR4133B) are used.

(22) AFC switch

When the FREQUENCY SPAN/DIV setting is less than 20 kHz, stabilized spectrum analysis is achieved by applying AFC (Automatic Frequency Control) to the measured signal. This function cannot be used, however, for waveforms such as FM modulation signals below 1 kHz and PULSED RF.

(23) CLEAR

Sweeping is reset, and waveforms are erased from the CRT screen.

(24) STOP/START

Sweeping is stopped when this key is pressed, and is then started again from the same position when the key is pressed a second time.

TRIGGER MODE Section

(25) FREE RUN

Sweeping is repeated at the set rate.

(26) LINE

Sweeping is repeated at a rate equal to the line frequency.

(27) VIDEO

Sweeping is commenced at the input signal amplitude in the same way as in an oscilloscope.

(28) SINGLE

Sweeping is commenced each time the STOP/START key is pressed.

MEMORY Section

(29) SAVE

Storage of keyboard settings. These settings can then be recalled by the RECALL key (30).

When the [SAVE], [1] and [kHz dB] keys are pressed, the set conditions are stored in memory 1. The conditions can be recalled by the [RECALL] key described below. There is a total of 12 memories.

(30) RECALL

Recalling of data saved in memory by the [SAVE] key.

When the [RECALL], [1] and [kHz dB] keys are pressed, the measuring conditions saved in memory 1 are retrieved and set in the TR4133/4133B.

(31) (SAVE) LIST

By using the label function outlined in (35), the user can write any desired comment in the contents of each saved memory.

See Item 4-8-5. for further details.

The CRT screen is reverted to the former display when the key is pressed a second time.

(32) f (Function)

Used to call advanced function.*

Example: NEXT PEAK-2 mode is selected by pressing [f], [1], and [kHz dB].

* See Section 4 for further details on the advanced function.

(33) (f) LIST

Display of the contents of the advanced functions incorporated in the TR4133/4133B.

While this display is on the screen, only the f key will function. The former display is restored when the (f) LIST key is pressed a second time.

(34) LOW BATTERY ALARM

This LED comes on if the memory back-up battery voltage drops below a specified value.

KEY FUNCTION Section

(35) LABEL CLEAR

All characters written and displayed on the screen by the label function (36) are cleared when this key is pressed.

(36) LABEL

When this key is pressed, the built-in LED comes on, and a cursor appears on the screen to indicate that label mode has been commenced. Each key on the keyboard panel with a green character inscribed in the bottom left hand corner is then used for input of the corresponding character. When the LABEL key is pressed again, the cursor and LED are switched off, and normal mode is restored.

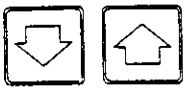
(37) SHIFT

The SHIFT key is pressed to change the function of the next key to that indicated by the yellow characters inscribed at the base of the key.

FUNCTION Section

(38) SPAN/DIV

SPAN/DIV is selected as the external keyboard active function when this key is pressed. See Item 3-1-2. for details on active functions.

When SPAN/DIV is selected, DATA keyboard numerical value measurements, and  step settings are possible.

(39) FULL (FULL SPAN)

The frequency range of the selected frequency band is displayed once when this key is pressed.

The former status is restored when key (38) is pressed.

(40) ZERO (ZERO SPAN)

The sweep frequency width becomes zero when this key is pressed, and the instrument operates as a tuned receiver fixed to the center frequency. The former status is restored by pressing the key a second time.

(41) REF LEVEL (REFERENCE LEVEL)

The reference level active function is selected when this key is pressed.

(42) ATT

The MIN. INPUT ATT active function is selected when this key is pressed.

(43) FREQ CAL.

To measure the frequency accurately when SPAN/DIV is set to 50 kHz thru 50 MHz, calibrate the frequency by pressing this key. When SPAN/DIV is set to a level below 20 kHz, the center frequency is in counter mode.* This function is not required when in counter mode.

* See Subsection 7-3 of the TR4133/4133B Instruction Manual.

(44) FREQ LOCK

Pressing this key when the SPAN is less than 20 kHz results in the current center frequency being stored in memory, and monitoring of that frequency during each sweep to compensate any drift.

In addition, with FREQ LOCK selected as the active function, the fixed frequency can be set to any value. This mode is cancelled when keys (45), (46), (48), (50), and (51) are pressed.

(45) CENTER FREQ (CENTER Frequency)

Selection of the center frequency as the active function.

(46) FREQ BAND

Selection of the FREQUENCY BAND as the active function. The LED on the right hand side of the key goes out, and while it remains off, the FREQUENCY BAND is fixed. Even if the center frequency is set outside the current FREQUENCY BAND range, the center frequency becomes the maximum or minimum value of the FREQUENCY BAND without any change to that BAND.

(47) (FREQUENCY BAND) AUTO

The LED on the left hand side of this key comes on when the key is pressed. And while the LED is on, the FREQ. BAND is set automatically when CENTER FREQ. or FREQ. LOCK is set.

(48) CF STEP SIZE

CENTER FREQ. STEP SIZE is selected as the active function when this key is pressed.

CT STEP SIZE indicates the size of the change in center frequency effected by the UP or DOWN key when the center frequency is set.

(49) (CF STEP SIZE) AUTO

When this key is pressed, the LED located between this key and the CF STEP SIZE key comes on, and the CF STEP SIZE described above under (48) remains the same as SPAN/DIV.

(50) START

The start frequency is selected as the active function when this key is pressed.

(51) STOP

The stop frequency is selected as the active function when this key is pressed.

(52) RBW (Resolution Bandwidth)

The resolution bandwidth is selected as the active function when this key is pressed.

(53) SWEEP TIME

The sweep time is selected as the active function when this key is pressed.

(54) (RBW, SWEEP TIME) AUTO

When this key is pressed, RBW and the sweep time are set automatically according to the SPAN/DIV.

(55) VIDEO BW (Video Filter Bandwidth)

The video bandwidth is selected as the active function when this key is pressed.

Video BW can be set to OFF, 10 kHz, 1 kHz, 100 Hz, and 10 Hz.

DATA Keyboard Section

(This set of keys is covered by the following (56) thru (71)).

(56) GHz, V, sec

Input of data units.

The numerical value set by keys (59) thru (70) is given a unit and then executed.

(57) MHz, mV, ms

Same as (56).

(58) kHz, dB

Same as (56).

As a rule, keys (56) thru (58) do not result in a operation if pressed before setting a numerical value by keys (59) thru (70).

(59) Decimal point [.]

Input of a decimal point when a numerical value is set by keys (60) thru (70).

(60) Sign inversion key [±]

Inversion of the sign of the numerical value set by keys (59) thru (70). The sign can be inverted at any time when a numerical value is being set by ten key operation.

(61)' ZERO CAL

Execution of ZERO CAL.*

* Refer to the TR4133/4133B instruction manual.

(61) thru (70) Numerical value keys.

(65)' dBm

Input of dBm as the level unit.

(66)' dBμ

Input of dBμ as the level unit.

(67)' dBpW

Input of dBpW as the level unit.

(68)' 10 dB/div.

Vertical axis scale set to 10 dB/div.

(69)' 2 dB/div.

Vertical axis scale set to 2 dB/div.

(70)' LINEAR

Vertical axis scale set to LINEAR (voltage V unit).

(71) BACK SP

Deletion of the previous input numerical keyed in by keys (59) thru (70).

(72) FINE DOWN

As a rule, data is decremented at minimum resolution for the respective function. For some functions, continuous operation is executed when this key remains depressed. (Repeat function)

(73) FINE UP

As a rule, data is incremented at minimum resolution for the respective function. For some functions, continuous operation is executed when this key remains depressed. (Repeat function)

(74) COARSE DOWN

Data is decremented at a suitable step rate for each separate function. For some functions, continuous operation is executed when this key remains depressed. (Repeat function)

(75) COARSE UP

Data is incremented at a suitable step rate for each separate function. For some functions, continuous operation is executed when this key remains depressed. (Repeat function)

Note: There is no distinction between COARSE and FINE for some functions.

Other Functions

(76) OFS (OFFSET)

Any desired offset can be set at the reference level when the vertical axis scale is LOG.

(77) DISPLAY LINE ON

The display line is shown on the screen. In "B-A → C" and "INPUT-A → C" modes, the reference line where B=A or INPUT=A is shown.

In other modes, this function serves as the level display line.

(77)' CHAR ON (CHARACTER ON)

Characters cleared from the screen by CHAR OFF (see (78)') are redisplayed.

(78) DISPLAY LINE OFF

The display line shown on the screen by (77) is cleared.

(78)' CHAR OFF

Characters are cleared from the CRT screen.

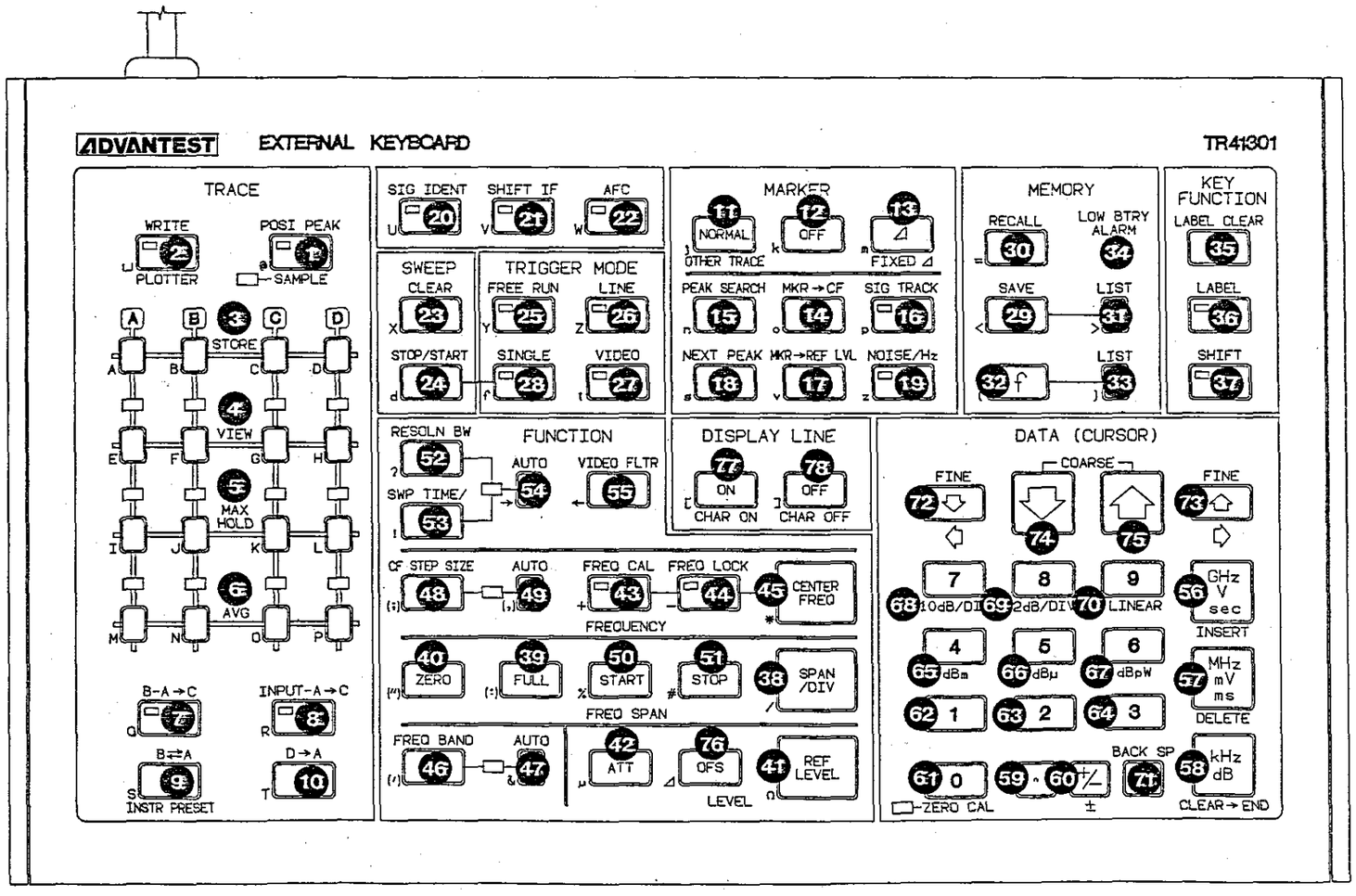


Fig. 3-2 Panel Descriptions

SECTION 4

OPERATING PROCEDURES FOR EACH FUNCTION

4-1. OUTLINE

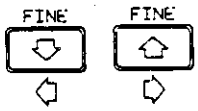
The TR4133/4133B Spectrum Analyzer functions activated by the TR41301 External Keyboard are described below under functional group headings. To explain each function, procedure descriptions with number (1), (2), (3), ... come first, then follow illustrations with corresponding numbers.

4-2. DATA KEYS

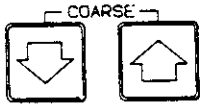
When function settings are to be input by the TR41301, this group of DATA keys is used after pressing the function key to be set. The two types of DATA keys used to meet different requirements are the step keys and "DATA number/unit keyboard".
The relationship between these DATA keys and each function is described in more detail under Subsection 4-3. below.

4-2-1. Step Keys

Data is incremented/decremented by prescribed steps when these keys are pressed.



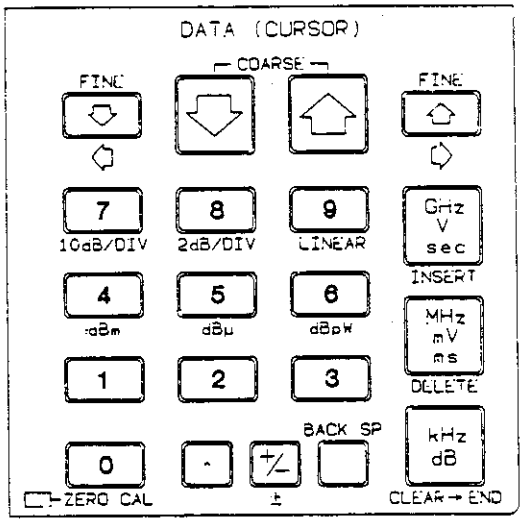
As a rule, data is incremented/decremented at minimum resolution for the respective function. For some functions, continuous operation is executed when this key remains depressed. (Repeat function)



Data is incremented/decremented at a suitable step rate for each separate function. For some functions, continuous operation is executed when this key remains depressed. (Repeat function)

Note: There is no distinction between COARSE and FINE for some functions.

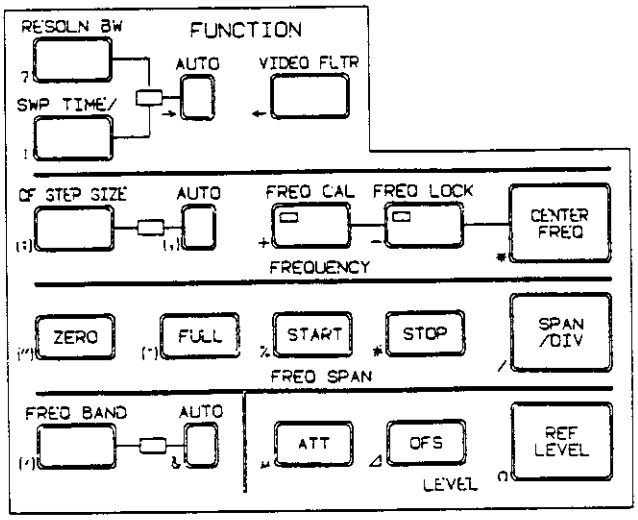
4-2-2. DATA keyboard



Direct input of numerical value data. This data is input to the set data when the relevant unit key is pressed after keying in the set numerical data. If the BACK SP key is pressed while setting the numerical value, the previous input number is deleted.

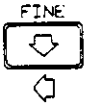
Note:
- When function settings are keyed in by DATA key operation, the setting is not executed until the unit key is pressed.
- "DATA keys" refer to the group of keys shown in the above diagram - the UP and DOWN keys are not included.
- If a unit key not defined for a particular function is pressed (for example, kHz for SWEEP TIME), a buzzer is activated and operation stops. Since the numerical value being set is maintained, simply press the correct unit key to continue.
- When setting numbers which do not take a unit (such as AVERAGE, SAVE, RECALL, FUNCTION), press kHz key.

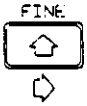
4-3. FUNCTIONS



4-3-1. CENTER FREQ 

(1) This key is used to decide the center frequency. When the key is pressed, the center frequency is selected as the active function. Any value from 0 to 60 GHz may be set. The resolution is 1/20 of the SPAN/DIV, or 1 kHz when SPAN/DIV is less than 20 kHz.

(2) When the 

or 

key is then pressed, the center frequency is decremented or incremented by 1/20th of the SPAN/DIV. If, however, this operation results in the center frequency shifting outside the range of the current frequency band, a buzzer is activated and the center frequency remains unchanged.

When the SPAN/DIV is 50 kHz or 100 kHz in the respective 12.4 thru 28 GHz and 28 thru 60 GHz frequency bands, the center frequency display may be displaced slightly from the display waveform. When measuring the center frequency under these conditions, always make use of FREQ CAL operation.

(3) Press  or  .

(3)-1 If STEP SIZE is in AUTO,
increments/decrements are in SPAN/DIV steps only.

(3)-2 When CF STEP SIZE has been set,
increments/decrements occur in the set steps.

(3)-3 If, as a result of (3)-1 or (3)-2, the center frequency lies outside the range of the current frequency band,

i) a buzzer is activated and the center frequency remains unchanged if "FREQ.BAND" (see 4-3-3.) is in MANUAL, or

ii) the frequency band is set automatically if "FREQ.BAND" is in AUTO.

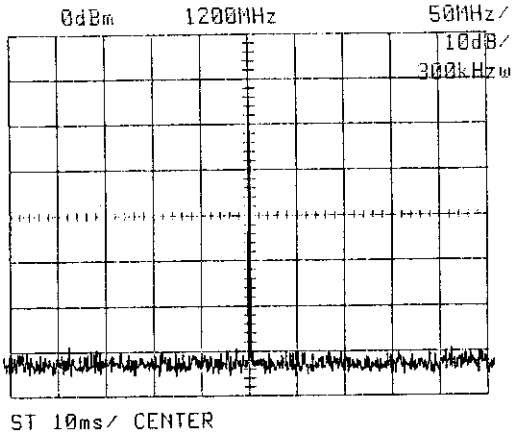
(4) The center frequency to be set can be keyed in directly as a numerical value by DATA key operation. After pressing the relevant DATA keys, press the GHz, MHz, or kHz unit key to set the keyed in frequency.

(5) When the center frequency is set by DATA key operation with SPAN/DIV at a value from 2 MHz to 50 kHz, FREQ CAL is executed one to six times in the processing routine.
With each FREQ CAL operation, the LED lamp built into the FREQ CAL key flashes on and off, each operation taking up to two seconds to be completed.

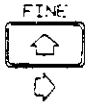
(6) And if the center frequency is set by DATA key operation with a SPAN of 20 kHz or less, or at ZERO SPAN, the operation may take from two to five seconds to be complete.
If the set frequency input signal already exists, the setting operation can be speeded up by switching the AFC ON in advance.

(7) When FREQ BAND is set to AUTO, the most suitable frequency band for the set numerical value is set automatically. When set to MANUAL (where the FREQ BAND AUTO LED is not on) the FREQ BAND is fixed, and the maximum or minimum value of the current FREQ BAND is set.

(1) 



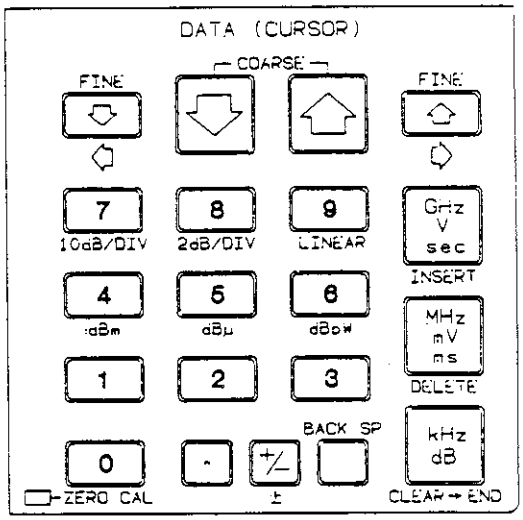
(2) Center frequency is decremented by 1/20 of SPAN/DIV when 

is pressed.
Center frequency is incremented by 1/20 of SPAN/DIV when 

is pressed.

(3) Center frequency is decremented by SPAN/DIV when  is pressed.
Center frequency is incremented by SPAN/DIV when  is pressed.

(4) Setting by DATA key operation



(5) If center frequency is set by DATA key operation when 2 MHz > SPAN/DIV > 50 kHz, FREQ CAL (see the TR4133/B instruction manual) is executed from one to six times during the TR4133/B internal processing. 

Approx. two seconds each time.

(6) & (7) Omitted.

4-3-2. FREQ. LOCK

This function is used to fix the center frequency when SPAN/DIV is less than 20 kHz.

(1) This function does not operate when SPAN/DIV is not less than 20 kHz, or is not ZERO SPAN.

(2) When the FREQ LOCK key is pressed, the built-in LED comes on, and "FRQLOCK" appears in the center right of the screen.

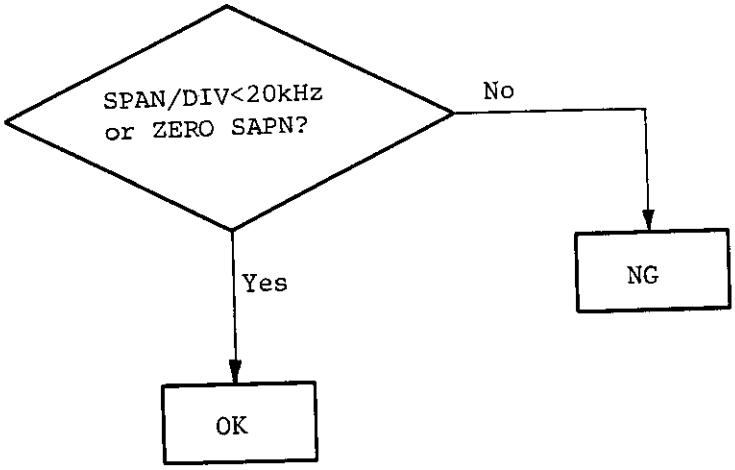
(3) The center frequency in step (2) above is stored in memory, and is adjusted by the built-in counter during each sweep (sweep time of about one second at less than 50 ms/div).

(4) When this function is operated as an active function with "FRLOCK" appearing in the bottom line of the screen, and the numerical value is keyed in by DATA key operation, the center frequency can be set in the same way as CENTER FREQ, and can also be stored and fixed in memory. In this case, too, the center frequency takes some two or three seconds to be fixed and stabilized. (This time interval varies according to various factors such as the length of time after switching the power on, and other previous settings).

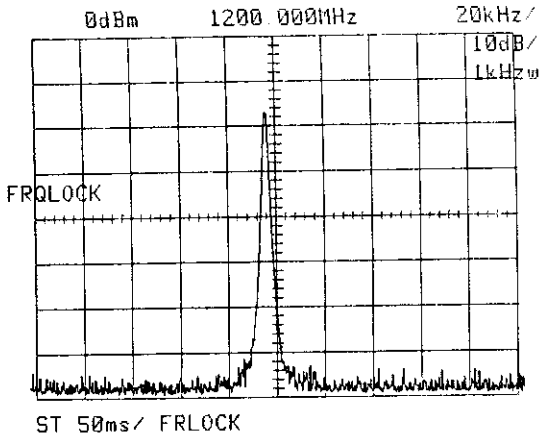
(5) The fixed frequency can be incremented/decremented by pressing the UP or DOWN key.

(6) This mode can be cancelled by pressing the CENTER FREQ, FREQ. BAND, or CF STEP SIZE key.

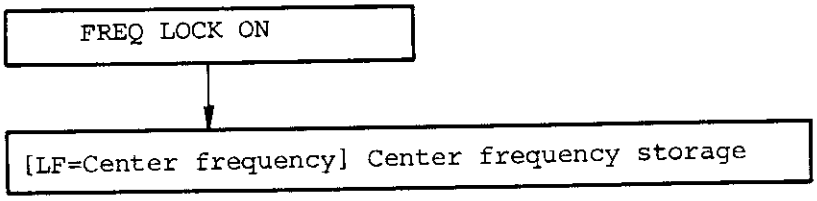
(1) Condition to set FREQ. LOCK to ON,

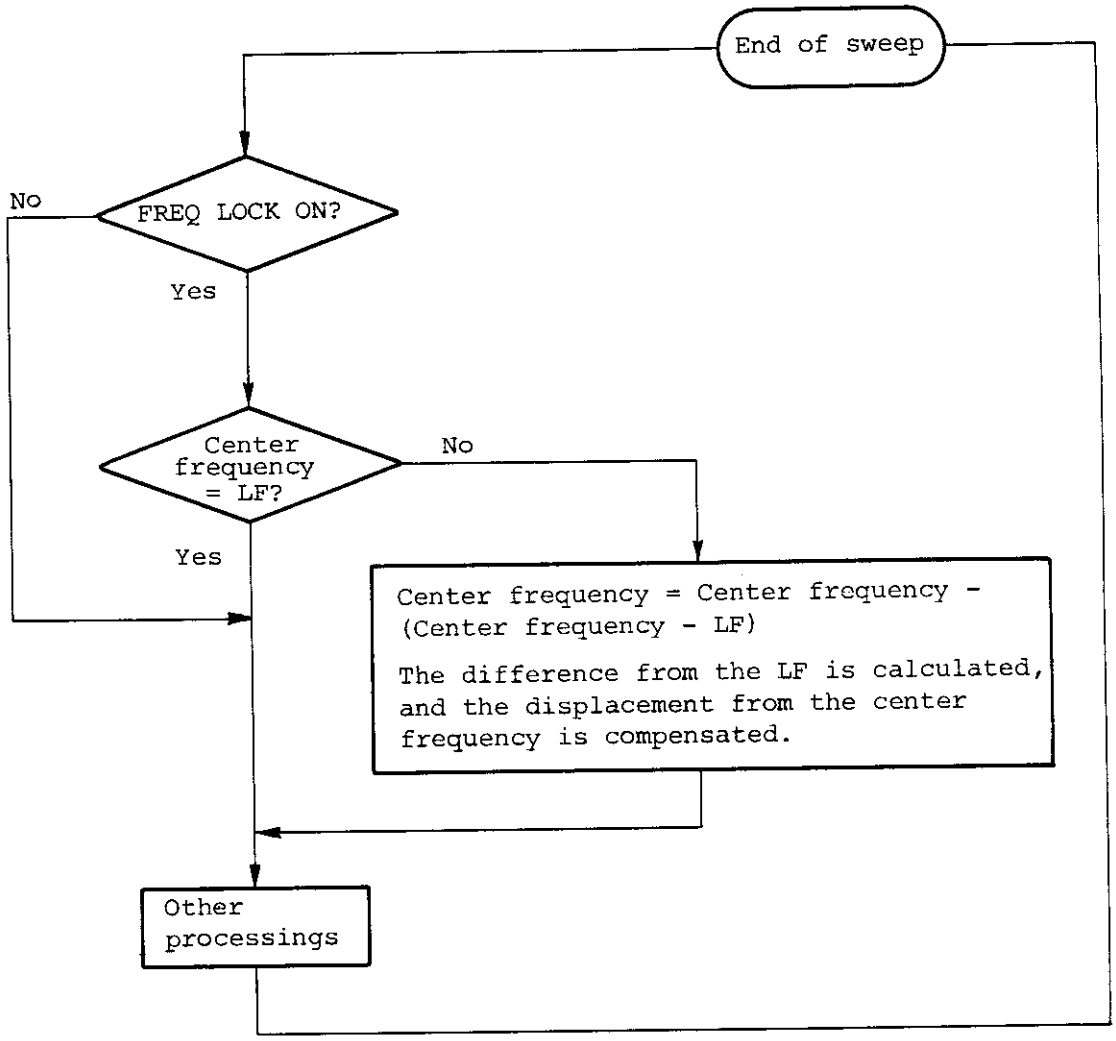


(2)

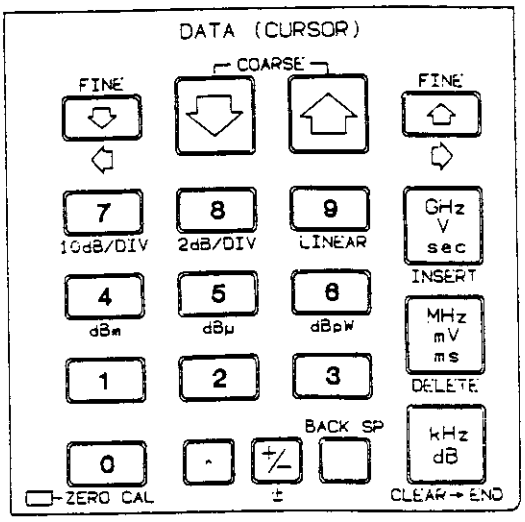


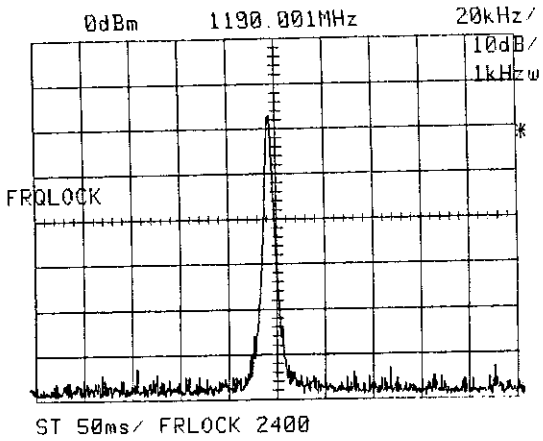
(3)


FREQ LOCK ON
[LF=Center frequency] Center frequency storage


End of sweep
No
FREQ LOCK ON?
Yes
Center frequency = LF?
No
Yes
Center frequency = Center frequency - (Center frequency - LF)
The difference from the LF is calculated, and the displacement from the center frequency is compensated.
Other processings

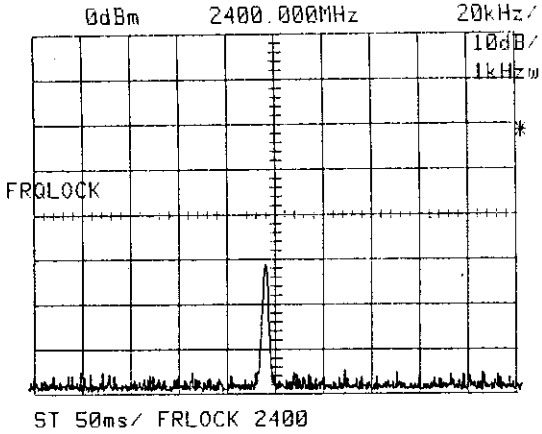
(4) Fixed frequency can be set directly by DATA key operation.



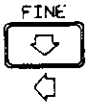


Fixed at set frequency 2 or 3 seconds later.

Set in same way as center frequency.



The fixed frequency is incremented/decremented in 1 kHz steps when 

or 

is pressed.

The fixed frequency is incremented/decremented by SPAN/DIV steps when  or  is pressed.

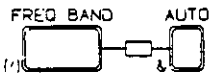
(5) FREQ. LOCK is cancelled when any of the following functions is selected.

4-3-3. FREQ.CAL 

This function is the same as the TR4133/4133B FREQ.CAL function. The FREQ.CAL built-in LED is on during execution of this function. Refer to Item 4-8-2. of the TR4133/4133B instruction manual for further details.

4-3-4. FREQ.BAND (Frequency Band)

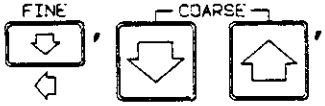
Function used to change the frequency band.

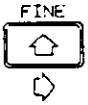


This function operates as the active function. Frequency band AUTO mode is cancelled when the 

key is pressed. When the "kHz" key is pressed after DATA key operation, the frequency band is set as indicated in the following table.

Setting / Analyzer model	1	2	3	4	5	6	7
TR4133	0-0.36	0.01-4	4-12	8-12	12-20	12.4-28	28-60
TR4133B	0-0.36	3.5-7.5	7.2-15.2	10.9-20	12.4-28	28-60	3.5-20

Attempts to set any other values results in a buzzer being activated without any change to the frequency band. The frequency band is increased/decreased one band at a time when 

, , or 

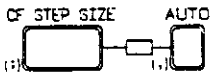
key is pressed.

4-3-5. 

(FREQ. BAND) AUTO

When this key is pressed, the LED on the right hand side of the key comes on, and the mode is switched to frequency band automatic setting mode. If a CENTER FREQ. or FREQ.LOCK numerical value is set by DATA key operation, the most suitable frequency band is selected automatically. And if a center frequency is set outside the FREQ.BAND range when not in AUTO mode, the maximum or minimum value within that band becomes the center frequency.

4-3-6. CF STEP SIZE



(1) This function is used to decide the step size for changes in the center frequency incremented or decremented by using  or  after the active function has been set to 

.

(2) If AUTO is set, the step size becomes the same as the SPAN/DIV, and is set automatically.

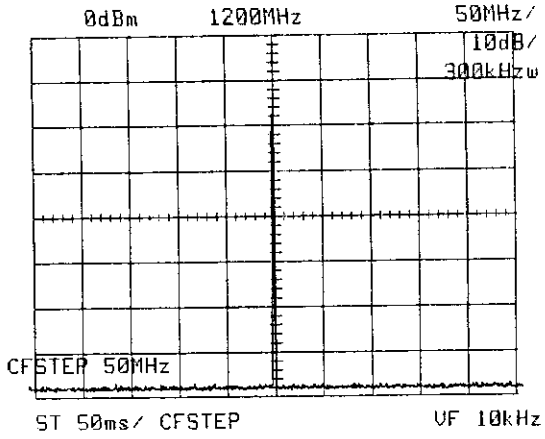
(3) When the SPAN/DIV is greater than 50 kHz, the CF STEP SIZE setting resolution is as shown in the following table. Note that CF STEP SIZE settings are executed after discarding any values set below these center frequency setting resolution values.

TR4133	0-0.36	0.01-4	4-12	8-12	12-20	12.4-28	28-60
CF STEP SIZE resolution	1 kHz	1 kHz	2 kHz	1 kHz	2 kHz	4 kHz	8 kHz

TR4133B	0-0.36	3.5-7.5	7.2-15.2	10.9-20	12.4-28	28-60	3.5-20
CF STEP SIZE resolution	1 kHz	1 kHz	2 kHz	3 kHz	4 kHz	8 kHz	-

(1) When the [CF STEP SIZE] key is pressed,

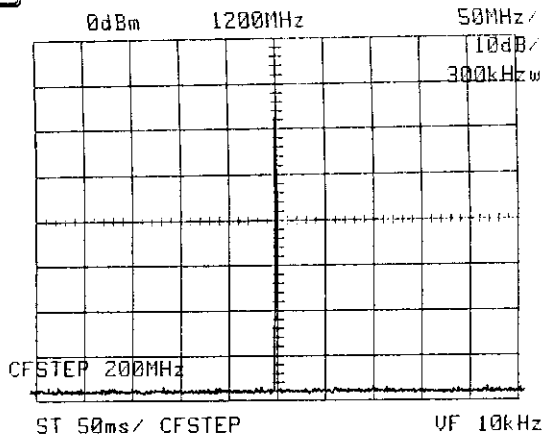
"CFSTEP" is displayed as indicated in the accompanying diagram, and CF STEP SIZE becomes the active function.



(CF STEP SIZE is set to SPAN/DIV when this key is first pressed after the power is switched on or INSTR PRESET is executed. And if CF STEP SIZE is switched to AUTO after being set, and this key is pressed again, the previous CF STEP SIZE is reproduced).

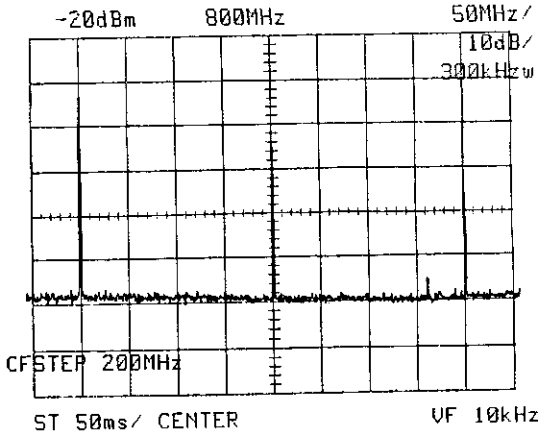
[2] [0] [0]

[MHz mV ms]

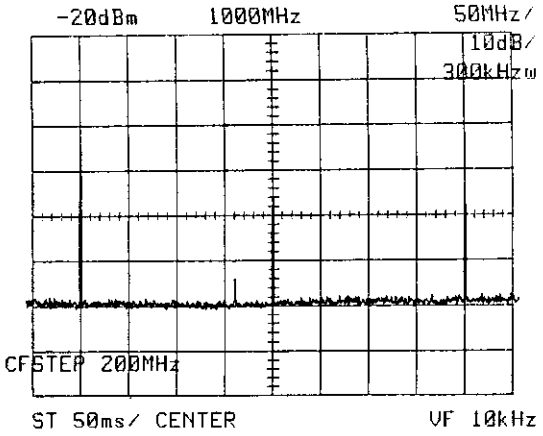


The CF STEP SIZE is set to 200 MHz.

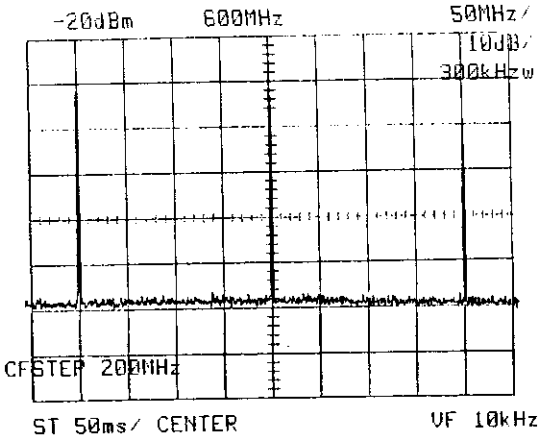
Active function becomes center frequency.

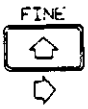


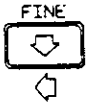
Center frequency is incremented by a single CF STEP size to become 1000 MHz.



Likewise, the center frequency is decremented by 200 MHz.





and 

increment and decrement the center frequency in steps equal to 1/20 of the SPAN/DIV in the same way as when CF STEP SIZE is switched to AUTO.

4-3-7. START & STOP  

This function operates as an active function. The left and right hand edge frequencies of the screen scale can be set.
The TR4133/4133B, however, is only capable of setting the frequency span in 1-2-5 steps, which means that the left and right hand sides of the scale cannot be made to correspond to each other on a one-to-one basis in diverse settings such as START/STOP. This is overcome by displaying a vertical cursor as indicated in figure and displaying the START and STOP frequencies as the cursor frequency. Since the operation of these functions is somewhat complicated, they are described according to the following sequence. The parenthesized numbers in this diagram correspond to the following description text numbers.

******* START Frequency *******

This description commences with the start frequency. The stop frequency operation is symmetrical to the start operation.

Note: • This mode is cancelled when the [CENTER FREQ], [SPAN /DIV] or [FREQ LOCK] key is pressed, and the start and stop frequency displays are erased.

• Since no calibration such as in the CENTER FREQ (4-3-1.) function is executed in the START and STOP functions, the center frequency accuracy is 5 MHz. When a precise setting of the center frequency is required, set the display frequency range by CENTER FREQ and SPAN/DIV keys.

(1) The start frequency is shown on the left hand side of the scale on the CRT screen, and the stop frequency is shown on the right hand side (as indicated in figure when the [START] key is pressed.

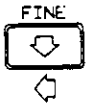
(2) A vertical cursor appears on the screen when the [⇧] key is pressed, as shifts by one division to the right.

Note: The start frequency at the bottom of the left hand scale is the frequency of the cursor position at that time.

(3) When the [FINE ⇧] key is pressed, the vertical cursor appears and is shifted one point to the right.

(4) If the difference between the cursor position frequency and the frequency on the right hand side of the scale (STOP frequency) becomes smaller than SPAN/DIV at this point as a result of Steps (1) and (2) above, SPAN/DIV is immediately reduced by one step, and the center frequency is incremented by 1/2 of the SPAN/DIV change without effecting the STOP frequency (on the right side of the scale). The frequency of the cursor position is thus shifted so as to maintain the same value as before the SPAN/DIV change.

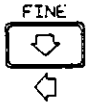
(5) The cursor is shifted one division to the left when the [⇩] key is pressed.

(6) The cursor is shifted one point to the left when the 

key is pressed.

Note: The start frequency display is the cursor position frequency.

(7) If the separation between the cursor and the left hand side of the scale is less than one division, the cursor is shifted to the left.

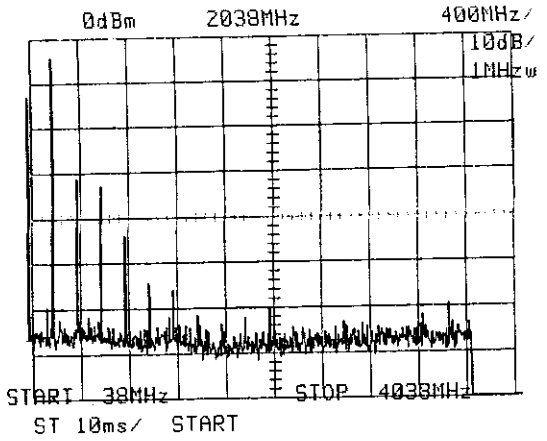
(8) If  and 

are pressed when the cursor is already at the left hand side of the scale, SPAN/DIV is increased by one step, and the center frequency is decremented by 1/2 of the SPAN/DIV change without effecting the STOP frequency (on the right side of the scale). The frequency of the cursor position is thus sifted so as to maintain the same value as before the SPAN/DIV change.

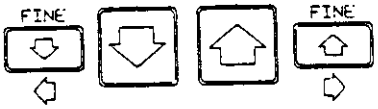
(9) The start frequency can be set directly by DATA key operation. In this case, the cursor is shifted to the most suitable position from the stop frequency and the set numerical value. Operation differs, however, in the following cases.

- If the start frequency is set higher than the stop frequency by mistake, a buzzer is activated, SPAN/DIV is set to 50 kHz, and the set frequency becomes the center frequency. The cursor disappears and the start and stop frequencies indicate the frequencies on the left and right hand sides of the scale. The cursor can be retrieved by repeating steps (2), (3), and (4).
- If the start frequency is set lower than the stop frequency, but outside the FREQ BAND range, a buzzer is activated, and an error message is displayed without the function being executed.

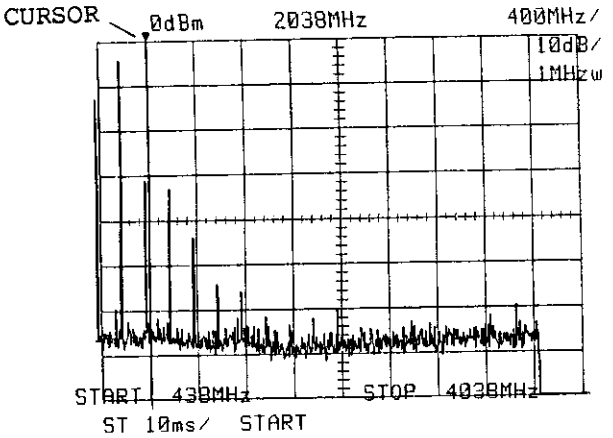
(1) START START/STOP frequency display appears on the screen.



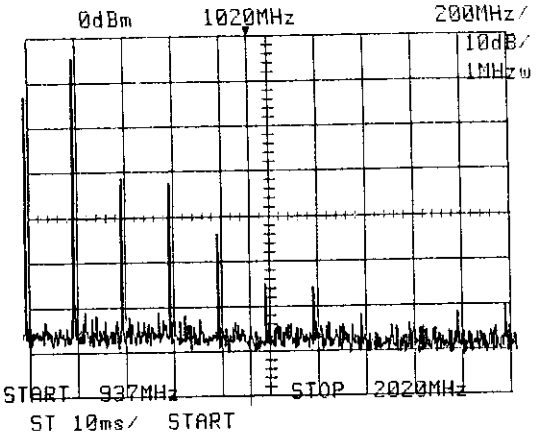
(2) (3) (5) (6)



Cursor is moved left and right as indicated in the accompanying diagram by pressing the UP and DOWN keys.



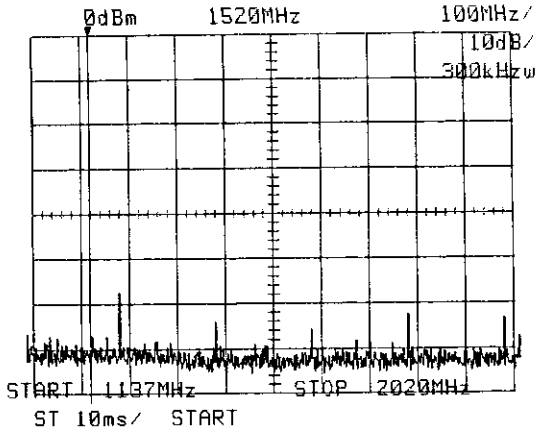
(4) Example



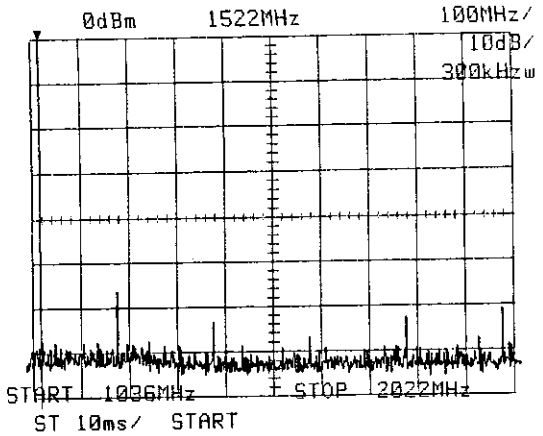
When  is pressed, the cursor frequency becomes 937 + 200 = 1137 MHz.

The separation between the cursor position and the right hand side of the scale is less than 1000 MHz at this time. SPAN/DIV is thus set to 100 MHz, and the cursor is shifted to the 1137 MHz position while maintaining the stop frequency (frequency at right hand side of scale) at 2020 MHz.

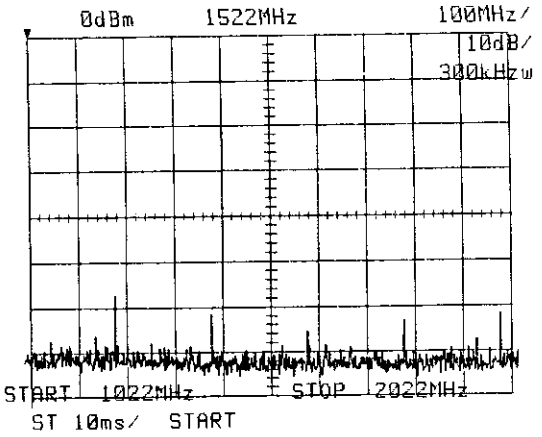
The screen display finally appears as indicated in the following diagram.



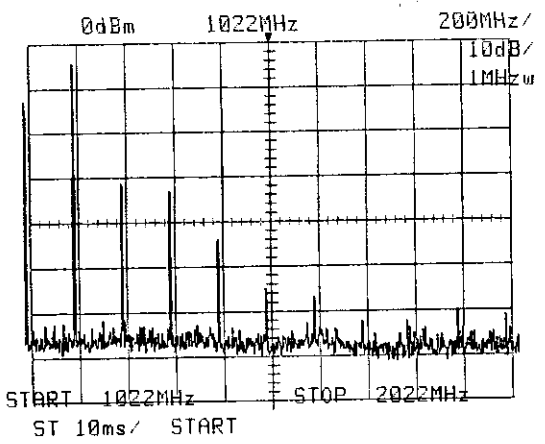
(7)



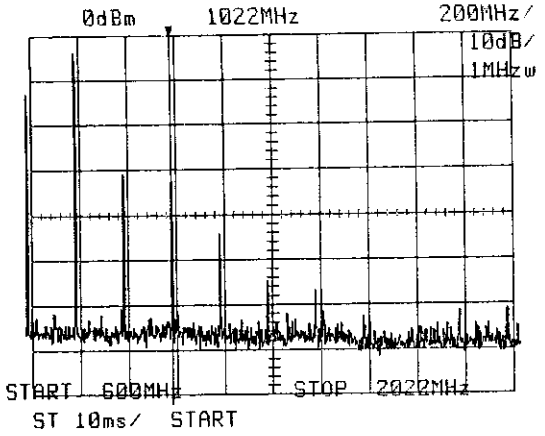
If  is pressed while in the condition indicated in the diagram on the left, the display is changed as indicated below.



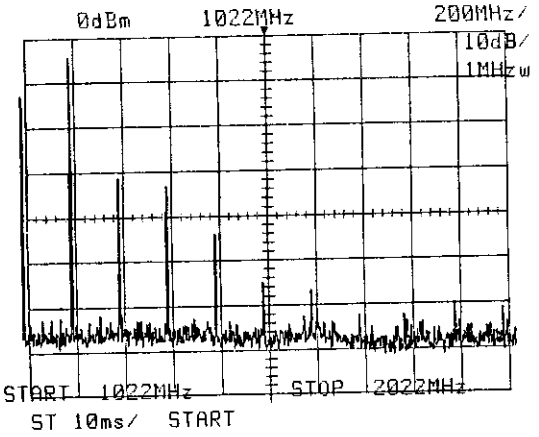
(8) If  is pressed when the cursor is at the left hand side of the scale in step (7), SPAN/DIV is increased by one step without changing the start frequency.



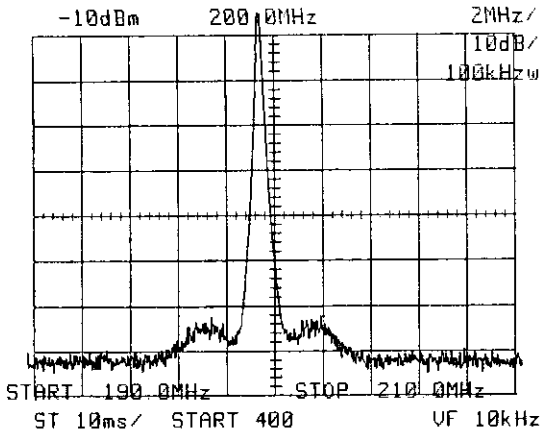
(9) Example showing the start frequency set by DATA key operation.



If [%] [START] [1] [0] [2] [2] [MHz mV ms] are pressed while in the condition indicated in the diagram on the left, the display is changed as indicated below.

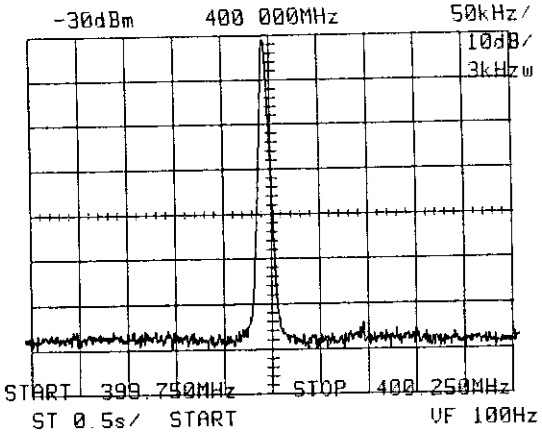


(10) The start frequency has been set higher than the stop frequency.

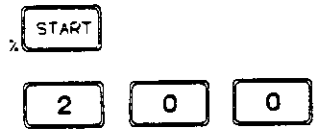


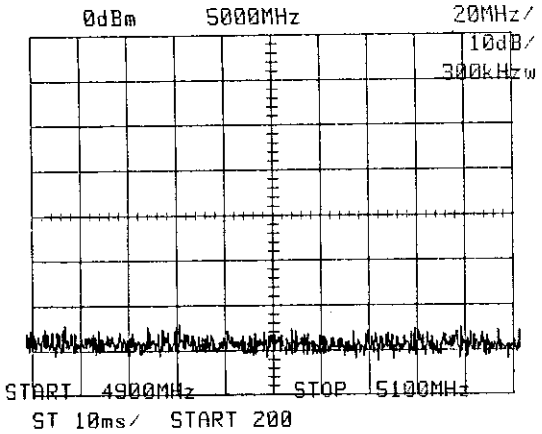
[%] [START] [4] [0] [0] [MHz mV ms]

A buzzer is activated, SPAN/DIV becomes 50 kHz, and the set frequency becomes the center frequency. The cursor disappears.



(11) Example: Set a start frequency of 200 MHz when the TR4133 has been set to the 4 GHz to 8 GHz FREQ. BAND.





A buzzer is activated, and an error message is displayed.

******* STOP Frequency *******

Operations related to the stop frequency are the exact reverse of operations related to the start frequency. These stop related operations are outlined in brief below.

(1) When the [STOP] key is pressed, the start frequency appears at the left hand edge of the scale on the screen, and the stop frequency appears at the right hand edge.

(2) When the [⇩] key is pressed, the vertical cursor appears and is shifted to the left by one division.

(3) When the [FINE ⇩] key is pressed, the vertical cursor appears as shown in Figure 4-19, and is shifted to the left by one point.

Note: The stop frequency in the bottom right hand corner of the scale indicates the frequency of the current cursor position.

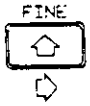
(4) If, as a result of steps (1) and (2), the difference between the cursor position frequency and the frequency at the left hand edge of the scale (start frequency) is smaller than the current SPAN/DIV, this SPAN/DIV is immediately reduced by one step. The center frequency is reduced by 1/2 of the SPAN/DIV change without changing the frequency at the left hand edge of the scale (start frequency), and the cursor is shifted so that the cursor position frequency remains the same as before the SPAN/DIV change.

(5) If the [⇧] key is pressed, the cursor is shifted to the right by one division.

(6) If the [FINE ⇧] key is pressed, the cursor is shifted to the right by one point.

Note: The stop frequency display is the frequency of the cursor position.

(7) If the separation between the cursor and the right hand edge of the scale is less than one division, the cursor is immediately shifted to the right hand edge of the scale.

(8) If  and 

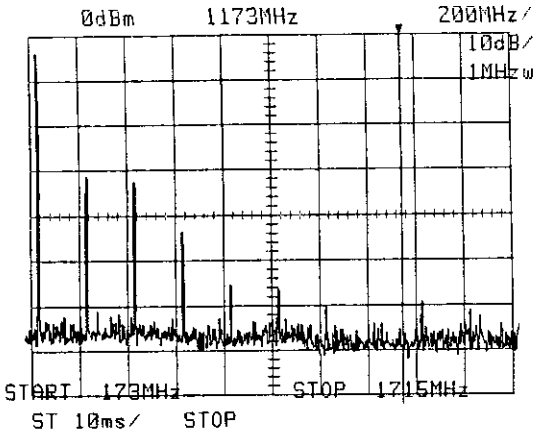
are pressed when the cursor is already located at the right hand edge of the scale, SPAN/DIV is increased by one step, and the center frequency is increased by 1/2 of the SPAN/DIV change without altering the start frequency at the right hand edge of the scale. The cursor is shifted so that the cursor position frequency remains the same as before the SPAN/DIV change.

(9) The stop frequency can be changed directly by DATA key operation. In this case, the cursor is shifted to the most suitable position in respect to the set value and the stop frequency, and SPAN/DIV is set to the most suitable value.

Note: Operation differs in the following cases.

- When the start frequency is set to a value greater than the stop frequency.
  A buzzer is activated, SPAN/DIV is set to 50 kHz, and the set value become the center frequency. The cursor disappears, and both the start and stop frequencies are represented as the frequency at the left hand edge of the scale.
  The cursor reappears if step (2), (3), or (4) is executed.
- When the start frequency is set to a value less than the stop frequency, but the FREQ BAND range is exceeded.
  A buzzer is activated, and an error message is displayed with the setting being executed.

Stop frequency cursor



4-3-8. SPAN/DIV (FREQUENCY SPAN/DIV)

(1) This function operates as an active function.

(2) This function is identical to SPAN/DIV of the analyzer panel. If 

, and are pressed, SPAN/DIV is increased/decreased in 1-2-5 steps one step at a time. There is no distinction between coarse and fine. Settings from a minimum of 2 kHz/div up to a maximum of 400 MHz/div are possible.

(3) SPAN/DIV can be substituted directly by a numerical value by DATA key operation.

(4) If SPAN/DIV key is pressed in Full span mode with a marker activated, the center frequency is set to the marker frequency. Effective use can be made of this function when combined with the marker functions described later in this manual (see Item 4-3-20).

(5) If the span key is pressed during
- MARKER OFF, and
- FULL SPAN

as in step (4), the span and the center frequency are returned to the values immediately prior to switching to FULL SPAN.

(6) As was described in Item 4-3-1, the center frequency resolution differs according to the SPAN/DIV value. Furthermore, the operation involved in setting the center frequency by DATA key also differs according to the SPAN/DIV value.

(7) The (RBW, SWEEP TIME) AUTO mode is not cancelled when these keys are pressed.

4-3-9. FULL (SPAN) [FULL]

This function is identical to the FULL SPAN switch on the analyzer panel.
Refer to Item 4-8-3. of the analyzer instruction manual.

Note: The (RBW, SWEEP TIME) AUTO mode is cancelled when this key is pressed.

4-3-10. ZERO (SPAN) [ZERO]

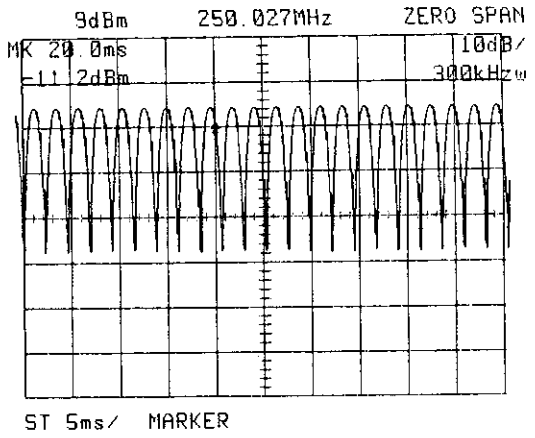
This function is identical to the ZERO (SPAN) switch on the analyzer panel.

(1) Refer to Item 4-8-3. of the analyzer instruction manual.

(2) In ZERO SPAN mode, the center frequency is the value computed by the built-in counter. The operation involved when the center frequency is set by DATA key operation is handled in the same way as when SPAN/DIV is less than 20 kHz/DIV. See Item 4-3-1.

(3) If the [SPAN/DIV] key is pressed during zero span mode, the span and center frequency are reset to the values current immediately prior to setting zero span mode.

(4) The marker frequency displayed in zero span mode represents the sweep time up to the marker from the left hand edge of the screen (see diagram below).
Likewise in Δ marker mode, the sweep time difference between two markers is indicated.



4-3-11. REF. LEVEL [REF LEVEL]

The reference level becomes the active function. Refer to the TR4133/B instruction manual for details on basic items related to the reference level.

(1) The reference level value is increased or decreased by pressing the UP or DOWN key. The step size involved in these changes are listed in Table 4-1 below.

Table 4-1 REF LEVEL step size

	Vertical scale axis		
	10 dB/div	2 dB/div	Linear
COARSE step size	10 dB	1 dB	1-2-5 steps
FINE step size	1 dB	0.25 dB	
Setting range	From +40 dBm to -69.75 dBm		20 V to 100 μV

(2) Direct input of the reference level value is possible by DATA key operation. The sign of the value is set by using the [+/-] key where the sign is inverted each time the key is pressed. The setting is executed when the [kHz dB CLEAR→END] key is pressed after the numerical value has been set by DATA key and [+/-] key operation.

4-3-12. Reference Level Offset (OFS) [OFS]

When the vertical axis is in LOG, any desired offset can be applied to the reference level.

(1) After pressing the OFS key, key in the offset value in the XX.XX format by DATA key operation, and then set the unit by using the [kHz dB CLEAR→END] key. The GHz and MHz keys cannot be used in this case. Since the offset value is in dB units (relative value), the level unit can be dBm, dBμ, or dBpW.

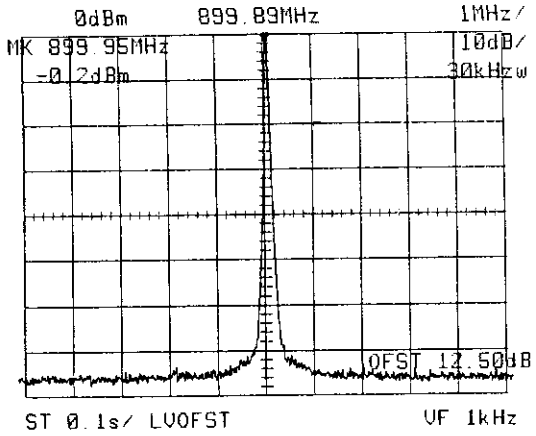
(2) While the offset value is being set,
OFFSET XX.XXdB
appears on the screen.

(3) And the reference level, NORMAL marker level, and display line level are shown with an offset value added to the actual value (or subtracted from the actual value if the sign of the offset value is negative).

(4) To cancel this offset, use the offset function again and set the offset value to zero.

OFS 1 2

• 5 kHz dB



4-3-13. Changing the Level Display Unit

During LOG displays, dBm, dBμ, or dBpW can be selected as the unit of display of reference level, marker, and display line.
Reference level is displayed in the dBm unit when SHIFT and 4 (dBm) are pressed, in the dBμ unit when SHIFT and 5 (dBμ) are pressed, and in the dBpW unit when SHIFT and 6 (dBpW) are pressed.

4-3-14. Changing the Vertical Axis Scale

The vertical scale is normally graduated in logarithmic units at 10 dB/division, but this can be changed to 2 dB/division, and linear.
The vertical scale is switched to 10 dB/division when SHIFT and 7 (10dB/DIV) are pressed, to 2 dB/division when SHIFT and 8 (2dB/DIV) are pressed, and to linear when SHIFT and 9 (LINEAR) are pressed.

4-3-15. ATT (MIN INPUT ATTENUATION)

MIN INPUT ATTENUATOR is selected as the active function. This function is the same as the ATT setting in the TR4133/B analyzers. (Refer to Item 4-8-6. of the TR4133/B instruction manual).
MIN INPUT ATTENUATOR is increased and decreased by the UP and DOWN keys.
Pressing the [kHz dB] key following input of the numerical value enables the setting to be made in the 10 dB unit.

Note: ATT 0 dB can only be set by DATA key operation. The minimum setting possible when using the UP and DOWN keys is 10 dB.

4-3-16. RESOLN BW (RESOLUTION BANDWIDTH) [RESOLN BW]

The TR4133/B resolution bandwidth is set by this function.
In this case, resolution bandwidth is selected as the active function. Refer to Item 4-8-4. of the TR4133/B instruction manual for details of basic items related to the TR4133/B resolution bandwidth.
The bandwidth can be increased or decreased in 1-3 steps from 100 Hz to 1 MHz by pressing the UP or DOWN key.

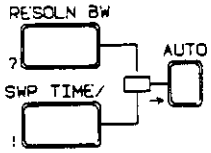
Note:
- The UP and DOWN keys have a repeat function
- There is no distinction between coarse and fine.
- Although direct setting by DATA key operation is possible, the setting can be executed in only in 1-3 step size.
- (RBW, SWEEP TIME) AUTO mode is cancelled when this function is selected.

4-3-17. Sweep Time 

Sweep time is selected as the active function when this key is pressed. Note that (RBW, SWEEP TIME) AUTO mode is cancelled when this function is selected.

Refer to Item 4-8-9. of the TR4133/B instruction manual for details of basic items related to SWEEP TIME/DIV.

Sweep time can be set to values from 5 msec/div. to 10 sec/div. in 1-2-5 steps by UP, DOWN, or ten key operation.

4-3-18. (RBW, SWEEP TIME) AUTO 

When the key is pressed, the LED on the left of the key comes on to indicate (RBW, SWEEP TIME) AUTO mode.

In this mode, the resolution bandwidth (RBW) and sweep time are automatically set to optimum levels according to the SPAN/DIV and VIDEO FILTER values.

This mode is set automatically when the power is switched on, and normally remains set.

Note: If this key is pressed when RBW or SWEEP TIME is the active function, that active function is switched off. The FULL SPAN MARKER function described in Step (4) of Item 4-3-8. above is operated when this AUTO key is pressed, that is, this key is similar to the AUTO key on TR4133 analyzer panel.

4-3-19. VIDEO FILTER 

This function is exactly the same as the video filter function in the TR4133/B analyzers. For further details on this function, refer to Item 4-8-7. of the TR4133/B instruction manual.

(1) Video function is selected as the active function.

(2) Video filter is switched to OFF, 10 kHz, 1 kHz, 100 Hz, or 10 Hz by the UP and DOWN keys.

(3) There is no distinction between coarse and fine in the UP and DOWN key operations.

(4) When in (RBW, SWEEP TIME) AUTO mode, the optimum sweep time is set automatically according to the video filter value.

(5) Although the filter can also be set by DATA key operation, only one of the five steps given in (2) above can be set.

4-3-20. FULL SPAN MARKER Function

Although there is no specific key for this function, it can be operated by combining (in sequence) a number of different other functions as described below. (Also see Item 4-3-18. "AUTO", and Item 4-3-8. "SPAN/DIV").

(1) Set SPAN/DIV to the desired value. (Because of the marker frequency resolution, set to a value of at least 5 MHz/div.) The center frequency can be at any value at this time.

(2) Switch to FULL SPAN (in MULTI BAND if desired).

(3) Switch MARKER on. (Set to NORMAL MARKER). If MARKER is already on, this step can be omitted.

(4) Align the marker with the signal to be measured.

(5) When the SPAN/DIV or (RBW, SWEEP TIME) AUTO key is pressed, SPAN/DIV is switched to the value set in Step (1), and the center frequency becomes the frequency of the marker shifted in Step (4).

Note: At FULL SPAN (400 MHz/div), the marker axis resolution is 400 MHz * 10 div/700 points = approx. 5.7 MHz. Therefore, this becomes the minimum resolution for the frequency setting in Step (5). Hence, if the SPAN/DIV set in Step (1) is too small, the signal found in Step (4) may not appear on the screen during Step (5).

Although this function is operated by following the basic sequence from Step (1) thru Step (5), it is convenient to use each of the marker search functions in Step (4). A number of examples where a marker search function is used in Step (4) are outlined below. The marker function used here is described later in more detail Subsection 4-5.

(4)-1 MARKER PEAK SEARCH

When this function is used here, the signal of maximum level within the selected FREQ. BAND is sought automatically. (If MULTI BAND is set in Step (1), the signal of maximum level within the preselector band is found).

(4)-2 NEXT PEAK SEARCH

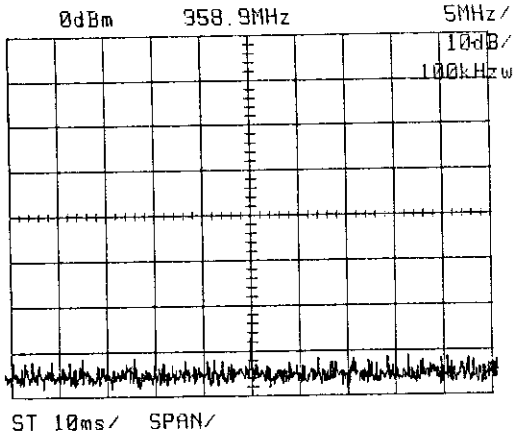
When this function is used here, signals can be sought in level height sequence after the maximum level signal within FREQ. BAND.

(4)-3 NEXT PEAK 2 [f] [1] [kHz dB]

When this function is used here, the high level signals are sought in sequence from the higher (or lower) frequencies from the DISPLAY LINE setting within the selected FREQ. BAND.

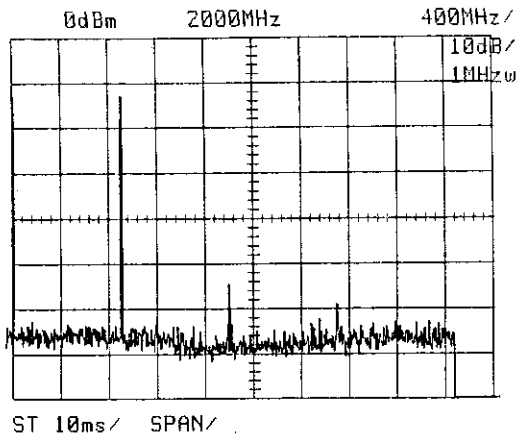
(1) SPAN/DIV setting

[SPAN /DIV] [6 dBμ] [MHz mV ms]



(2) Set to FULL SPAN.

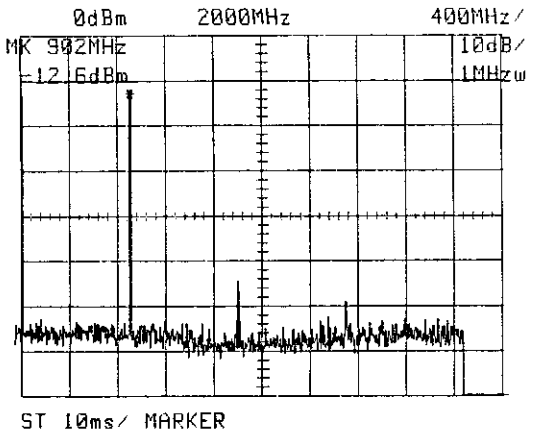
FULL



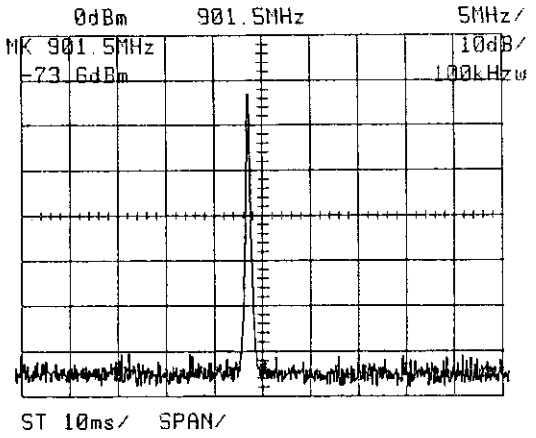
(3) Switch MARKER on.

(4) Shift the marker to the position of the signal or frequency to be set.

NORMAL



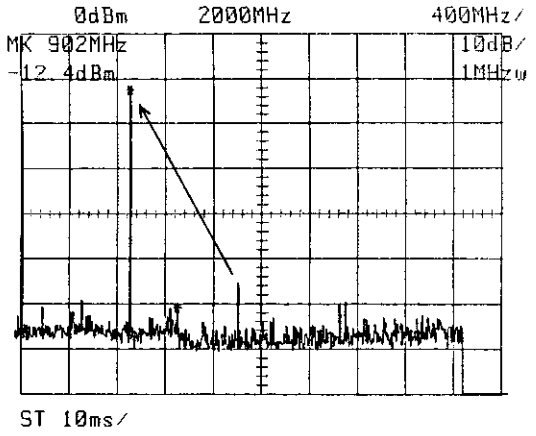
(5) Press the AUTO or SPAN /DIV key.



SPAN/DIV is switched to the value set in Step (1). The marker frequency is Step (4) becomes the center frequency.
The (4)-1 and (4)-3 functions can be used in Step (4).

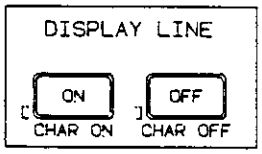
(4)-1 MARKER PEAK SEARCH

PEAK SEARCH



For details on MARKER PEAK SEARCH, NEXT PEAK SEARCH, and NEXT PEAK SEARCH 2, see Section 4-5.

4-4. DISPLAY LINE



4-4-1. Outline

The display line function can be used in two different ways. In one method, the function is used immediately after selection of the B-A→C or INPUT-A→C trace function, while in the other method, the function is used after other functions.
These two methods are described in Items 4-4-2. and 4-4-3. below.

4-4-2. Function Used Immediately After B-A→C or INPUT-A→C Trace Function

(1) When B-A→C or INPUT-A→C trace function is selected in the analyzer, a display line (horizontal cursor) appears on the screen without pressing the DISPLAY LINE-ON key. (See Subsection 4-6. for details on B-A→C and INPUT-A→C).

(2) This display line indicates that B=A when the waveform data is B-A→C, and that INPUT-A→C when INPUT=A. Therefore, the display line level in this case is indicated as DL = 0 dB.

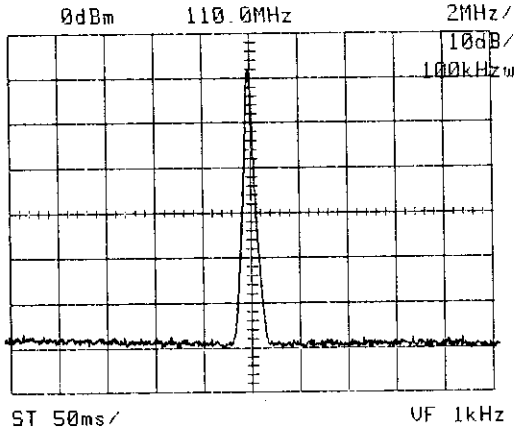
(3) When the [ON] key is pressed, the display line is selected as the active function.
Although this display line can be moved upwards and downwards on the screen by using the UP and DOWN keys, the level remains at DL = 0 dB indicating that the reference line set in Step (2) is 0 dB. The B-A→C and INPUT-A→C waveforms are moved up and down on the screen in accordance with the display line movement.

(4) Position cannot be set by DATA key operation

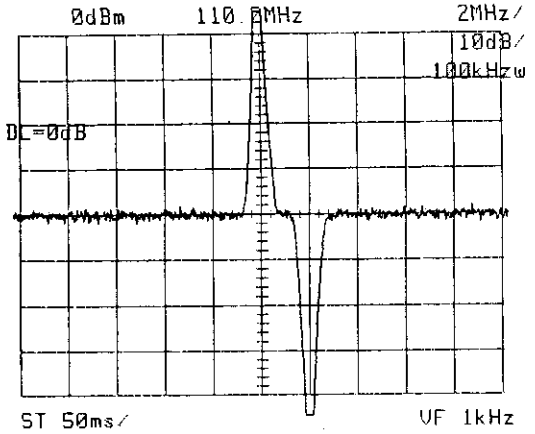
Note: ● The built-in processor takes 0.25 sec to execute arithmetic operations on the B-A→C waveform data and display line movement in Step (3). If Step (3) is repeated while this built-in processor is still processing an operation, a buzzer is sounded and the second Step (3) operation is disregarded. This should be remembered especially when programming via GPIB.

- If a trace function apart from B-A→C and INPUT-A→C is selected, the display line functions according to that described in Item 4-4-3. below even through status set may be as described in Item 4-4-3.
  If B-A→C or INPUT-A→C is then selected again, the display line functions as described in Item 4-4-2.
- If the trace (waveform display) is altered and B-A→C or INPUT-A→C is cancelled, the display line disappears from the screen. If, however, the DISPLAY LINE-ON key has been pressed prior to Step (1), the display line is retained on the screen and the function is altered to that described in Item 4-4-3.

(1), (2) B-A→C or INPUT-A→C selected



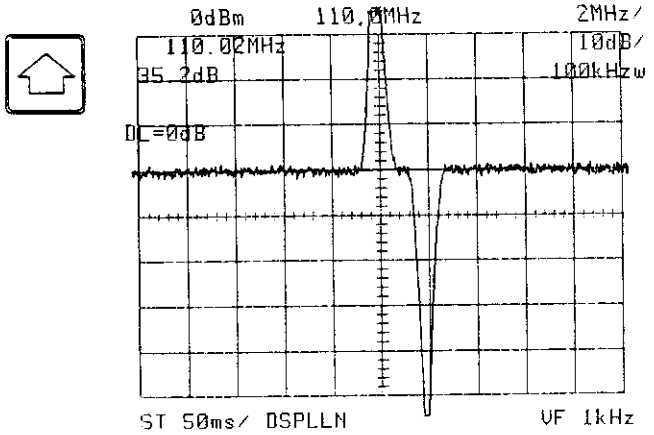
The B-A→C operation is performed, and the resultant waveform is displayed. The display line appears at about the center level of the scale.



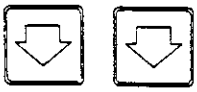
Display line intersection occurs at the point where A = B.

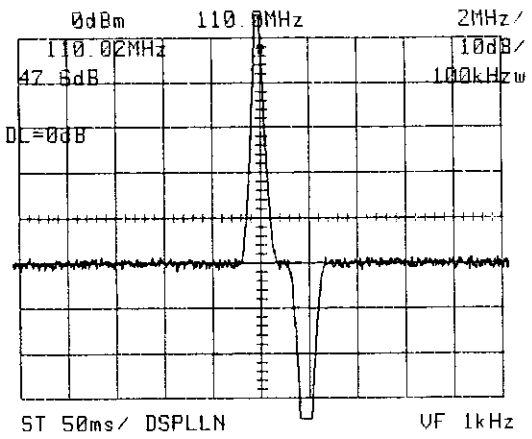
(3) DISPLAY LINE

When the [ON] key is pressed, display line is selected as the active function. This display line can be moved up and down by pressing the [FINE] ↓, [↓], [↑], and [FINE] ↑ keys.

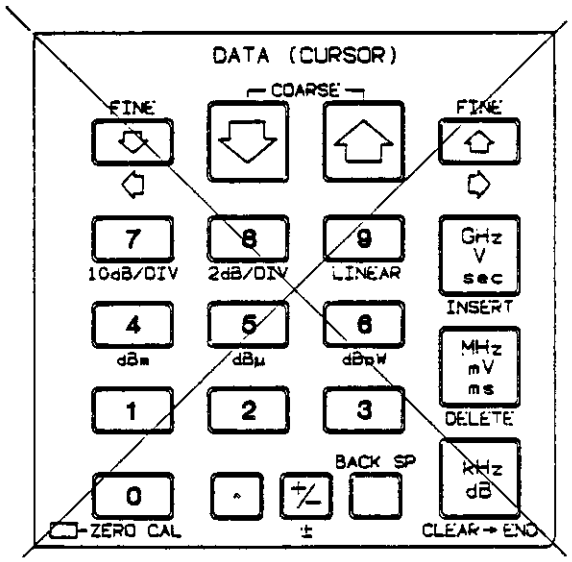


The waveform moves up and down according to the display line movement.



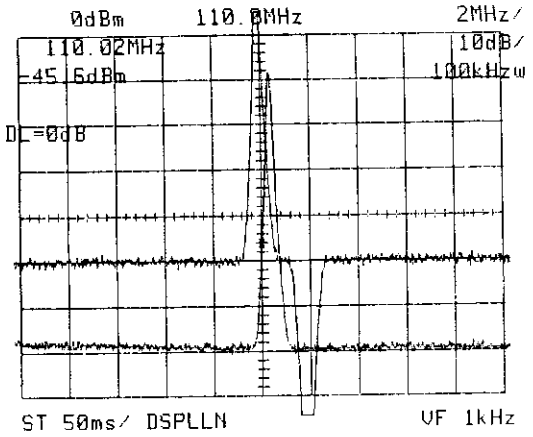


(4) Position cannot be set by DATA key operation.

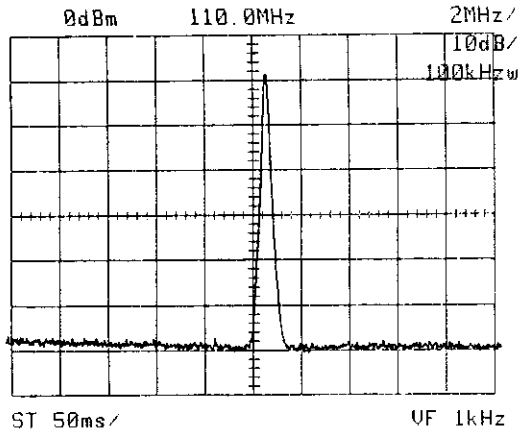


(5) If the B-A→C or INPUT-A→C display is cancelled, the display line display is also erased.

If the WRITE / PLOTTER key is pressed during the status indicated in (3) a dual display, (B-A→C and WRITE) appears on the screen.



If pressed WRITE a second time, a single WRITE display appears.



4-4-3. Condition not Corresponding to the Status in Item 4-4-2. (immediately following selection of trace apart from B-A→C and INPUT-A→C)

(1) The display line (horizontal cursor) appears on the screen when the [ON] key is pressed.

(2) The display line is selected as the active function, and this display line can be moved upwards and downwards on the screen by using the UP and DOWN keys. The step sizes during this operation are listed in Table 4-2 below.

(3) The level at the display line position is shown as as DL = XX dBm on the left hand side of the screen. The unit of this level is changed simultaneously with the changes described in Item 4-3-13, "Changing the level unit".

(4) The display line position can be set directly as a level value by DATA key operation.

(5) As a secondary function of this display line, this function can also be used as the threshold line during NEXT PEAK-2 mode. See Subsection 4-11, "NEXT PEAK-2" for details.

Note: ● If the B-A→C or INPUT-A→C key is pressed while the display line (as described in Item 4-4-2.) is on, the function is changed to that described in Item 4-4-2.

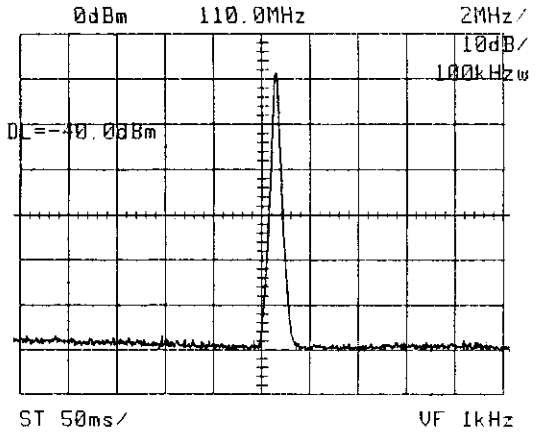
● If INPUT-A→C is displayed while in the condition described in Item 4-4-3, the corresponding waveform is moved up and down in response to movement of the display line. (There is no response, however, with B-A→C key).

Table 4-2 Step size of display line

	10 dB/Div	2 dB/Div
COARSE	10 dB	2.5 dB
FINE	0.4 dB	0.1 dB

(1), (2) DISPLAY LINE [ON]

A display line appears, and can be moved up and down by [FINE] [↓], [↓], [↑], and [FINE] [↑].



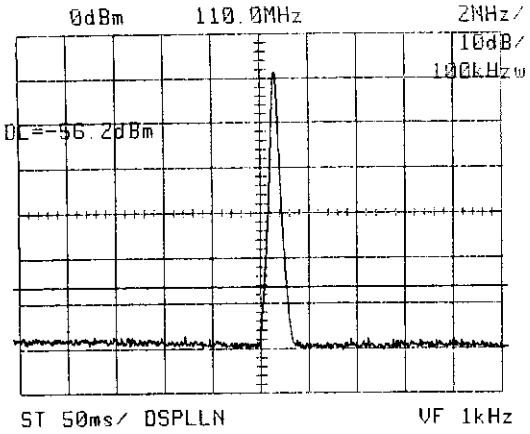
(3) The level unit is the same unit as the reference level and marker.

(4) Setting by DATA key operation is possible.

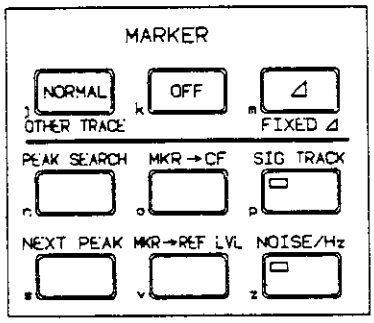
[5] [6] [.] [2]

[+/-] [kHz dB] CLEAR→END

-56.2 dB



4-5. MARKER SECTION



4-5-1. Outline

Use of the marker enables screen waveform data to be read in digital form. In addition, MKR → CF, SIG TRCK, MARK → REF LVL, and other signal inputs can be set.

4-5-2. Normal Maker Mode

(1) When the NORMAL (OTHER TRACE) key is pressed, a marker appears in the center of the frequency axis. The normal marker becomes the active function, and is switched to variable status.

(2) The marker frequency and level appear in the top left hand corner of the screen.

(3) The marker position can be moved up and down by the UP and DOWN keys. The step sizes during this operation are listed below.

	Step size
COARSE	1 Div = 70 point
FINE	1/70 Div = 1 point

The UP and DOWN keys are capable of repeat operation in this case.

(4) The marker can also be shifted directly to the desired frequency by DATA key operation. If, however, a frequency outside the frequency range on the screen is keyed in, the marker is shifted to the right or left hand side of the scale.

(5) If this key is pressed during delta marker mode, delta marker mode is changed to normal marker mode.
In this case, the reference delta marker is erased while the active delta marker remains on the screen.

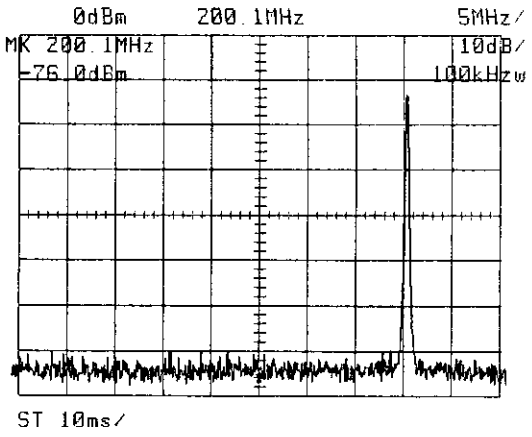
(6) If the TRACE key is pressed when the marker is on, the marker is shifted on the traces.

(7) If the SHIFT and NORMAL (OTHER TRACE) keys are pressed during dual display mode, the marker is shifted from one trace to the other. This also occurs when the delta marker is used.

(8) Although the marker frequency resolution depends on the SPAN/DIV value, it is same as the center frequency resolution. (The delta marker resolution may differ from the center frequency).

(1) The marker appears in the center of the screen when the NORMAL key is pressed.

(2) The marker level and frequency are shown in the top left hand corner of the screen.



(3) 1 DIV.UP (shift to right)

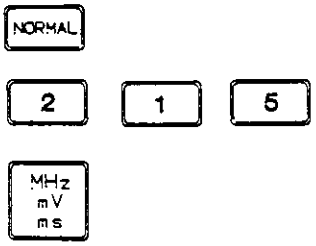
FINE 1 point (1/70) UP.

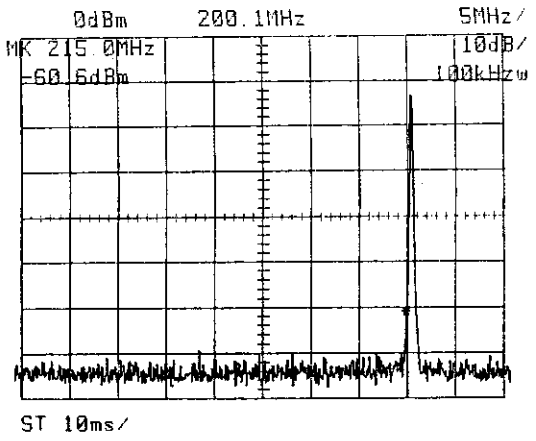
1DIV DOWN

FINE 1 point DOWN

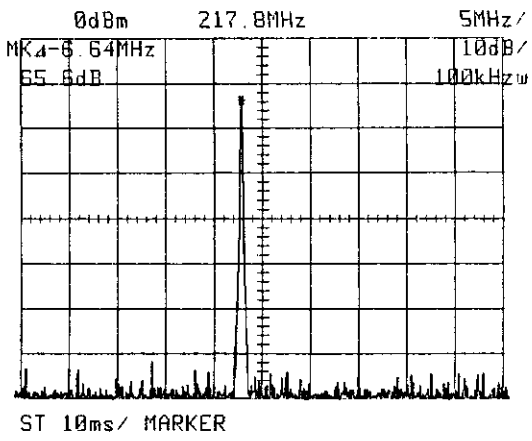
(4) Position can also be set by DATA key operation.

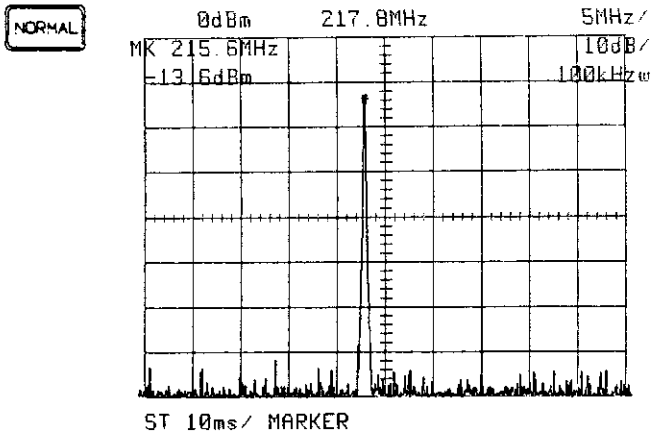
Position is set as shown in the diagram.



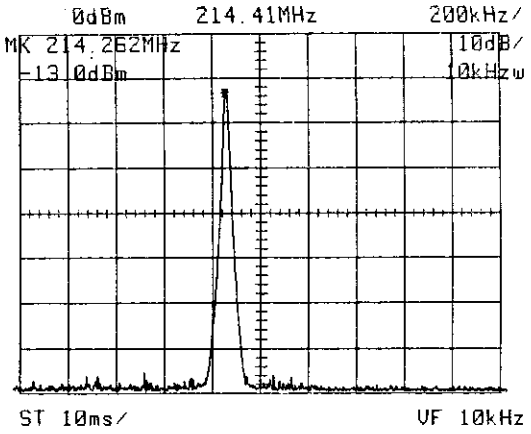


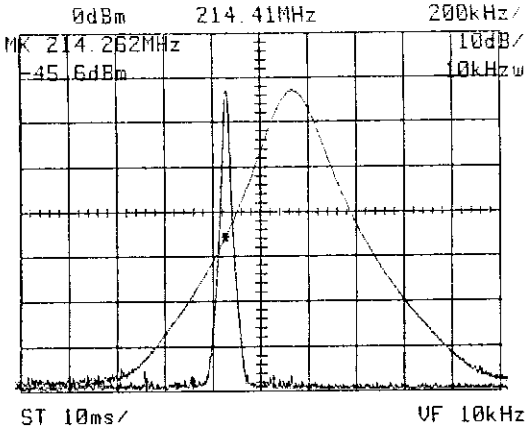
(5) If the NORMAL (OTHER TRACE) key is pressed when a delta marker has been set, the marker is changed to a normal marker.



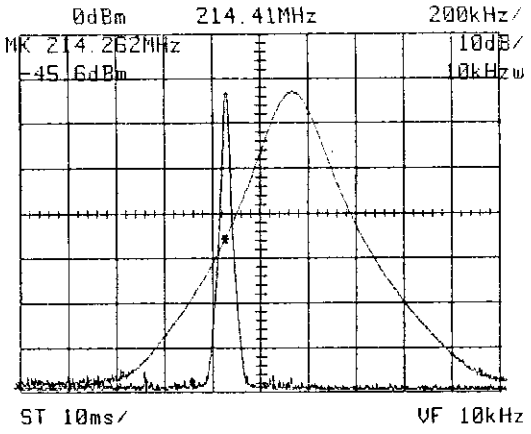


(6) The marker shifted to the other waveform in accordance with trace mode changes.

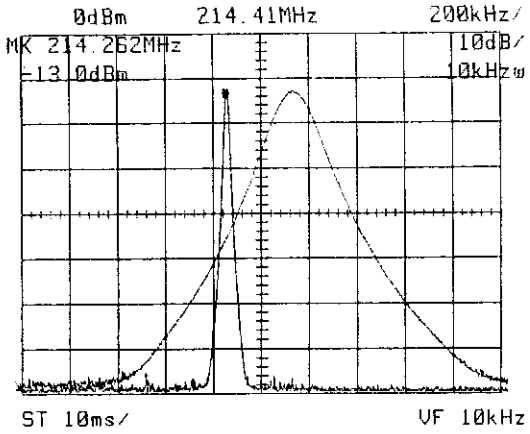




(7)



SHIFT NORMAL
OTHER TRACE



4-5-3. (MARKER) OFF

When the OFF key is pressed, the marker related display disappears from the screen, and the marker related functions (signal track, noise, Hz, etc.) are cancelled.

4-5-4. Delta Marker (Δ)

When the [Δ] key is pressed, two markers are obtained. Only one of these, however, can be moved. (The movable marker is called the active marker, and the non-movable marker is called the reference marker).

Instead of the marker frequency and level shown for normal markers, the frequency and level differences are shown in this case.

Both the active marker and reference marker trace waveforms constantly.

Pressing the [Δ] key results in the changes described in (1)' thru (1)-3 below according to the current conditions.

(1) If the [Δ] marker is pressed after the normal marker has been switched on, the active and reference markers appear at the position of the marker when the key is pressed. (Since both markers appear at the same spot, they appear to be a single marker).

(1)-1 If MARKER is off when the [⊿] key is pressed, the active and reference markers appear at the center of the scale. (Since both markers appear at the same spot, they appear to be a single marker).

(1)-2 If the delta marker is on when the [Δ] key is pressed, and MARKER is the active function, the previous reference marker disappears and reappears at the position of the active marker. (Since both markers appear at the same spot, they appear to be a single marker).

(1)-3 If the delta marker is on when the [Δ] key is pressed, and MARKER is not the active function, MARKER becomes the active function without any change in the reference and active markers.

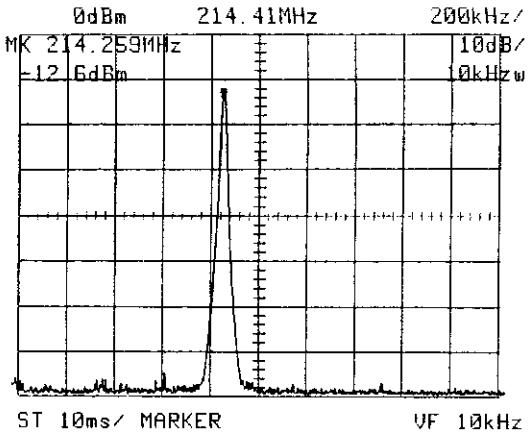
(2) The position of the active marker can be shifted by using the UP and DOWN keys. The step sizes in this case are the same as for normal marker.

(3) The position of the active marker can be set by DATA key operation on the basis of the difference between the reference and active marker frequencies.

(4) Delta marker mode is cancelled when the [NORMAL] key is pressed. Only a single marker remains in the active marker position, this being the normal marker.

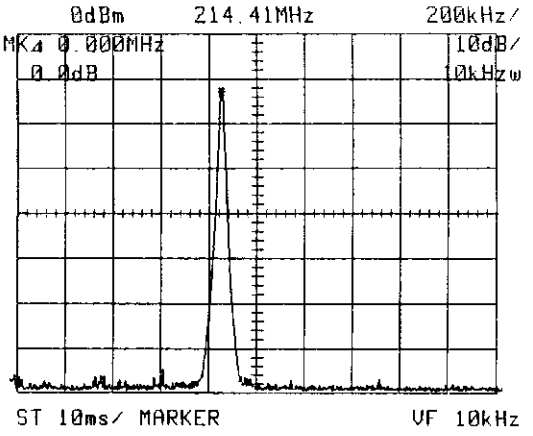
(5) All markers together with the frequency and level displays are cleared when the [OFF] key is pressed.

(1)



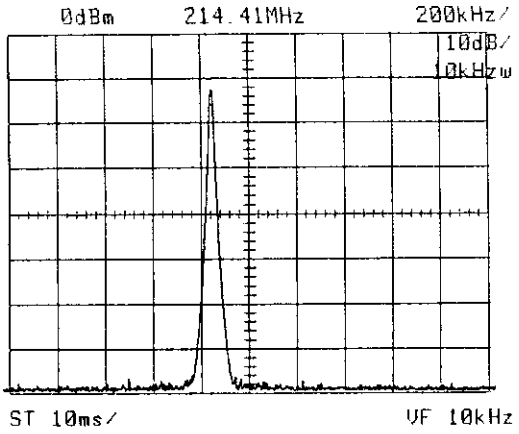
Normal marker

[Δ]



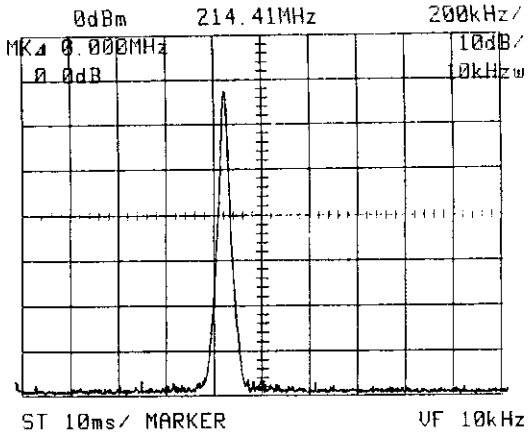
The active and reference markers appear together at the previous normal marker position.

(1)-1



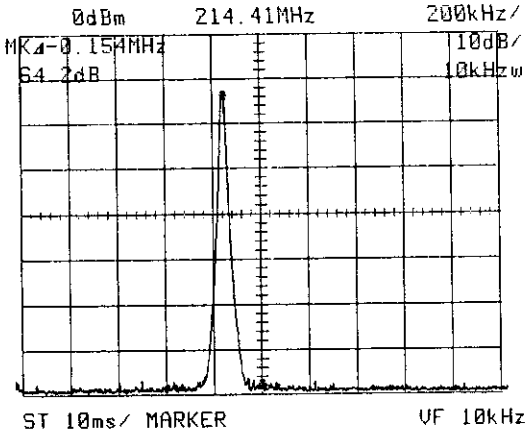
Marker off

Δ



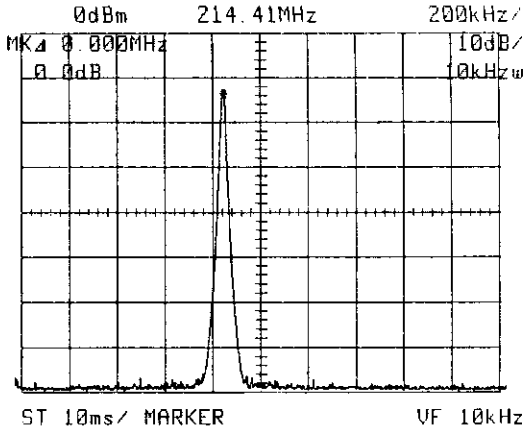
The active and reference markers appear together in the center.

(1)-2



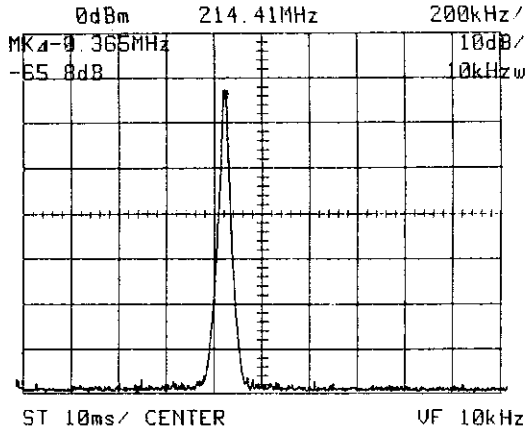
Delta marker mode, with Marker as active function.

Δ

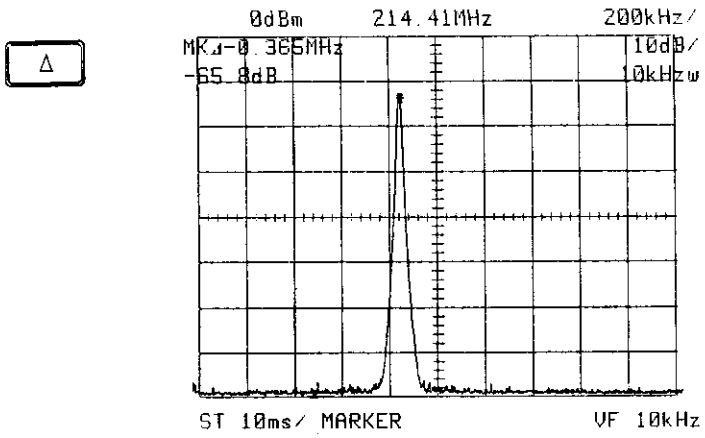


The reference marker is shifted to the active marker position.

(1)-3



Delta marker mode, with active function other than marker.



MARKER becomes the active function.

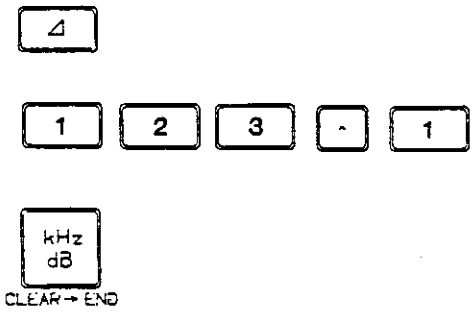
(2) FINE  Active marker shifted one point to the right.

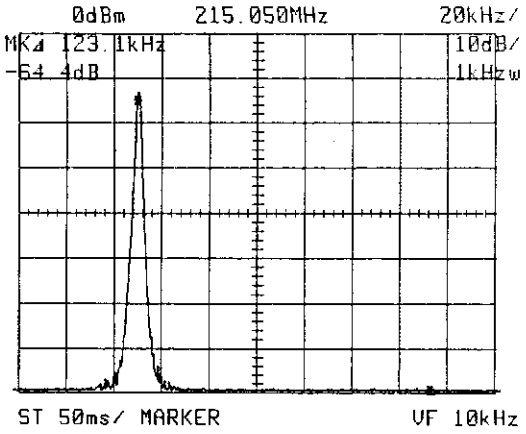
 Active marker shifted one division to the right.

 Active marker shifted one division to the left.

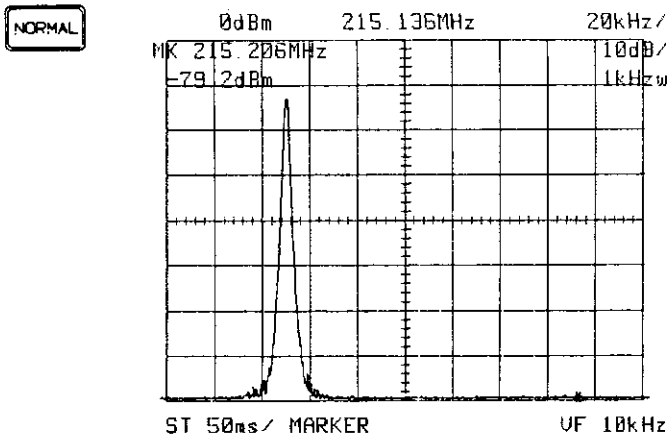
FINE  Active marker shifted one point to the left.

(3) DATA key operation





(4) Normal marker appears at active marker position.



4-5-5. Fixed Delta Marker

The fixed delta marker mode is set by pressing the SHIFT and FIXED Δ keys.

When the above keys are pressed in the indicated order, the frequency and level of the marker at that time (or of the active marker if already in delta marker or fixed delta marker mode) are stored in memory. In addition, the position of the reference marker is fixed, and the frequency and level differences between the reference and active markers are displayed.

Even if the input setting conditions (center frequency, SPAN/DIV, etc.) are changed, the reference marker data is maintained, and the differences from the active marker remain on display.

(1) When the SHIFT and FIXED Δ keys are pressed, one of the following four cases will apply.

(1)-1 Marker is not on.

As in delta marker mode, the reference and active markers both appear together at the center of the scale. In this case, however, the reference marker is fixed and does not trace the waveform. The same applies to the other three cases described below.

(1)-2 Normal marker is on

The reference and active markers both appear together at the position at the moment the two keys are pressed.

(1)-3 Delta marker is on

The previous reference marker is shifted to the position of the active marker frequency. The reference marker frequency and level data stored in memory at this time is the same as the active marker data.

(1)-4 Fixed delta marker mode has been set already

Same as case (1)-3.

(2) The active marker can be moved by using the UP and DOWN keys, and by DATA key operation.

If, however, a setting is made that exceeds the current scale range, the active marker is shifted to either the left or right hand edge of the scale.

(3) The delta marker frequency and level displayed in the top left hand corner of the screen are the result of the following calculations.

Delta marker frequency

= Reference marker frequency - Active marker frequency

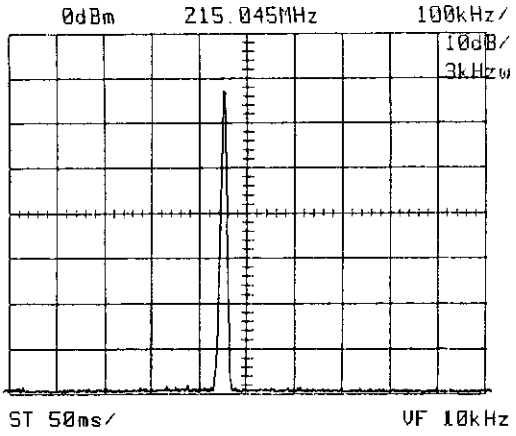
Delta marker level

= Reference marker level - Active marker level

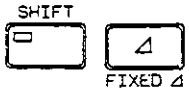
The above reference marker frequency and level values are stored in memory during Step (1), and remain in memory until Step (1) is repeated again (irrespective of changes in the input setting conditions such as center frequency and span/div). Furthermore, the displayed position of the reference marker remains unmoved without waveform tracing.

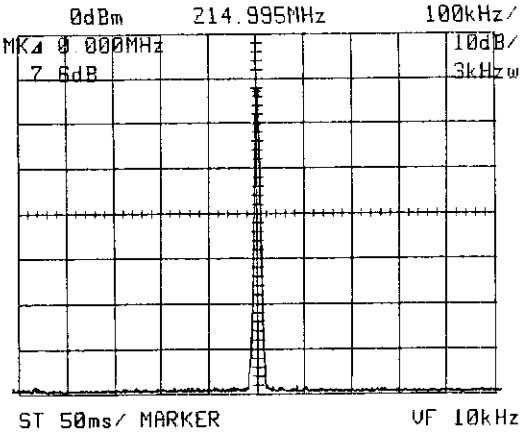
(4) The fixed delta marker level cannot be calculated in vertical axis scale units when that scale is LIN/. In this case, [X] is displayed in the marker level unit.

(1)-1



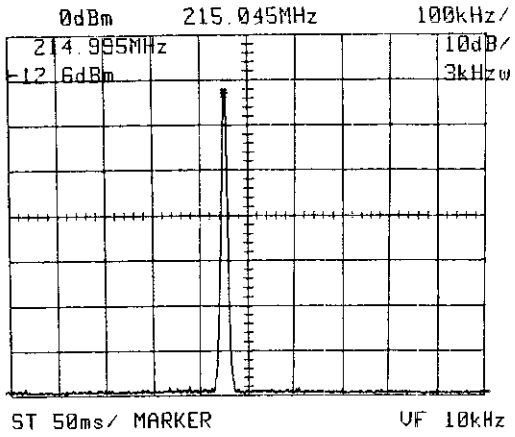
Marker off



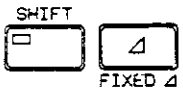


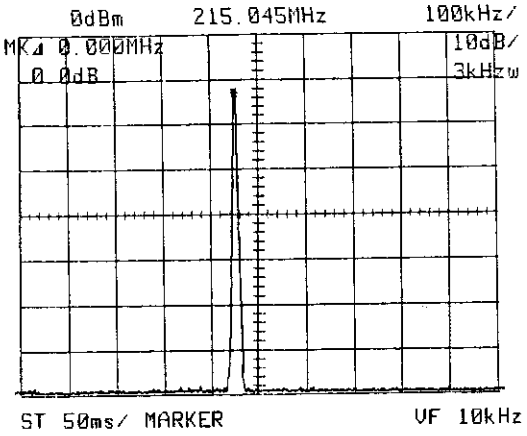
The reference marker does not move.

(1)-2



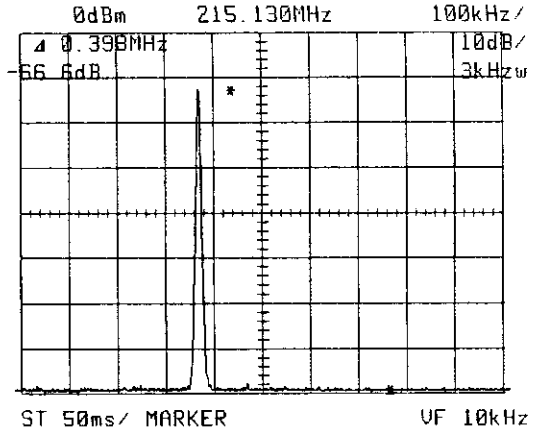
Normal marker mode



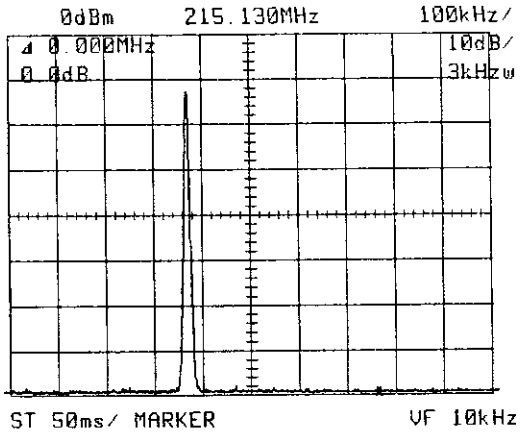


The active and reference markers both appear together at the position of the previous normal marker.

(1)-3



Fixed delta marker mode

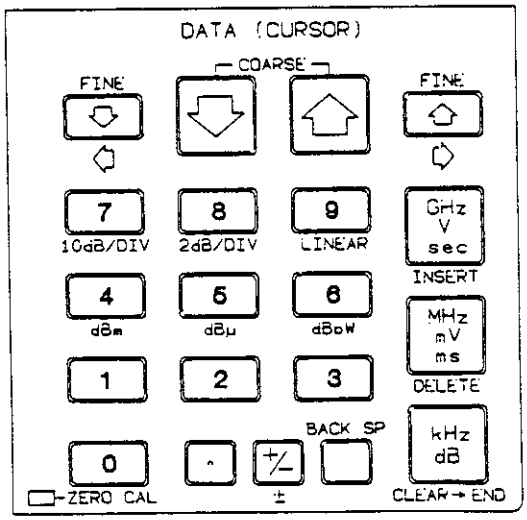


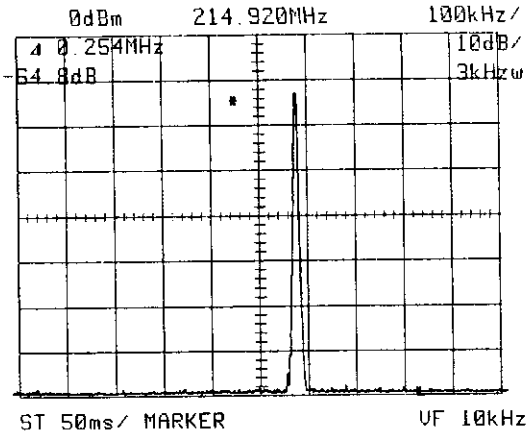
The reference marker is shifted to the active marker position.

(1)-4 Same as (1)-3.

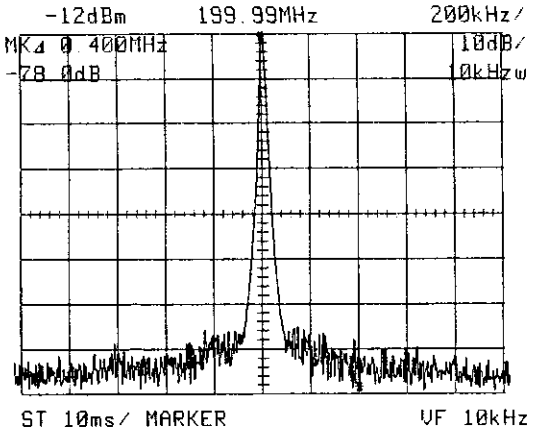
(2) The active marker can be moved by  , and .

However, setting outside the current scale range is not possible.





(3) The reference marker data remains unchanged when the [CENTER FREQ] [SPAN /DIV] and [REF LEVEL] settings are changed.



Reference marker　　Active marker

A MHz　　a MHz

B dBm　　b dBm

Marker data

(a - A) MHz

(b - B) dBm

This is displayed.

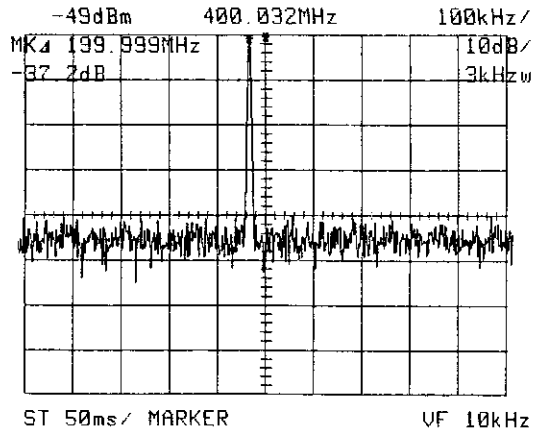
The reference marker screen position and data correspond.

The following conversion is made.

CENTER = 400 MHz

SPAN/DIV = 50 kHz

REF LEVEL = -20 dBm



Reference marker Active marker

A MHz a MHz

B dBm b dBm

Marker data

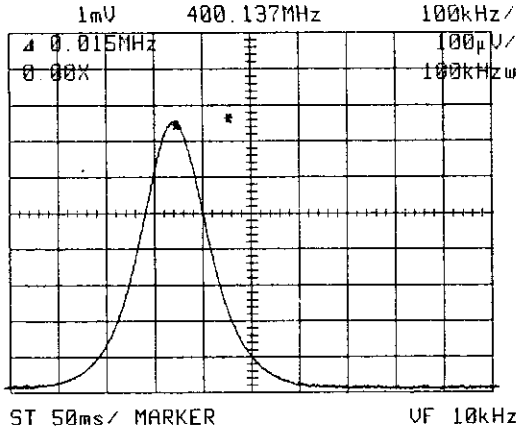
(c - A) MHz:

(d - B) dBm:

This is displayed.

The reference marker screen position and data do not correspond (since the signal input setting has been changed).

(4) If the vertical scale is set to LIN/ during fixed delta marker mode, the unit of the delta marker level display becomes X because delta calculation in Linear mode is not possible.



4-5-6. MRK → CF [MKR→CF]

(1) The marker position when the [MKR→CF] key is pressed while a normal marker is displayed is set to the center frequency.

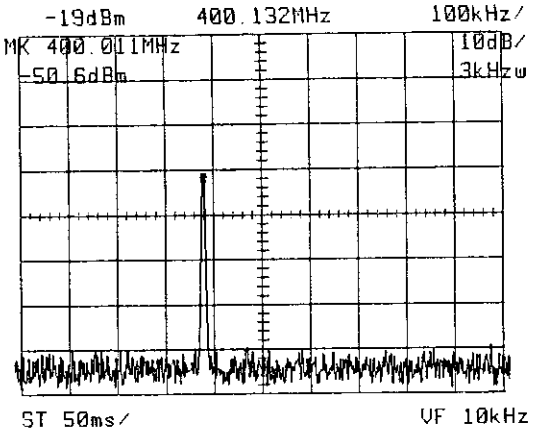
(2) The marker following step (1) is shifted to the scale center.

(3) If steps (1) and (2) are executed in delta marker mode, the marker is replaced by the active marker.

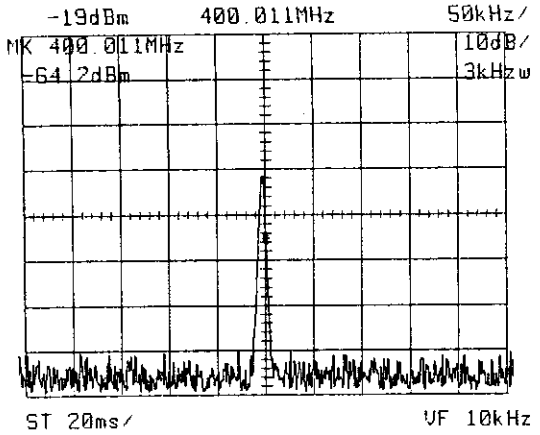
Note: ● Due to the configurational nature of the TR4133/B hardware, the center frequency following steps (1), (2), and (3) may differ slightly from the former marker frequency.

- When the MK → CF operation is executed, the Tuning control on the TR4133/B analyzer panel is set to center frequency change status.

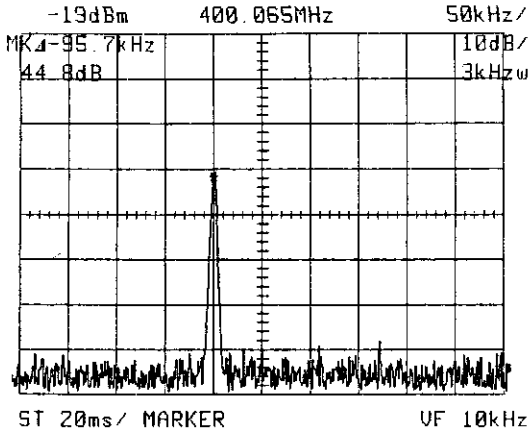
(1) When in normal marker mode



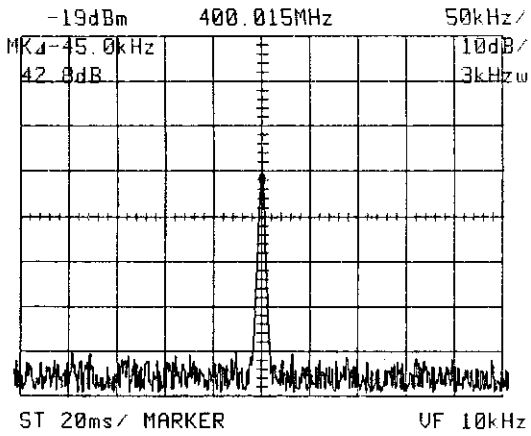
(2)



(3) When in delta marker mode

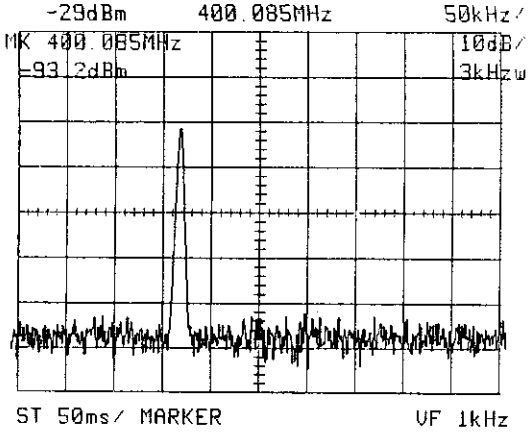


MKR→CF

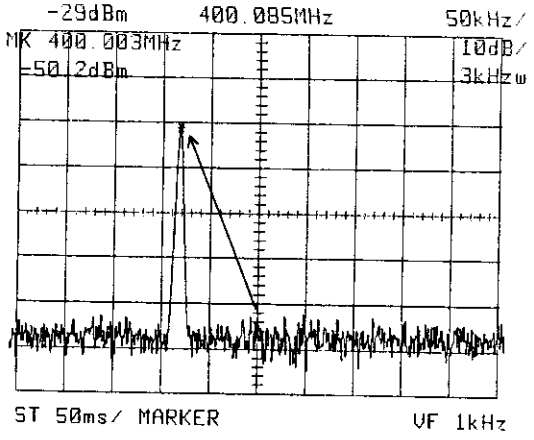


4-5-7. Peak Search

When the PEAK SEARCH key is pressed, the marker is shifted to the peak of the highest level within the scale.



PEAK SEARCH



4-5-8. Signal Track

When the 

key is pressed while a marker is being displayed, the signal track function is switched on. Pressing the key a second time switches the function off. The signal track function is described in further detail below.

(1) While the signal track function is on, SIG TRC is displayed in the center left hand side of the scale. The point of the highest level on the waveform shown on the scale (or on the waveform being traced by marker when in dual display mode) is sought during each sweep (every 0.8 to 1 sec when SWEEP TIME is less than 50 msec/div.), and the center frequency is changed to that point. (Peak search and MK → CENTER operations are executed during each sweep).

(2) If trigger mode is switched to SINGLE while signal track is on, that signal track operation is suspended.

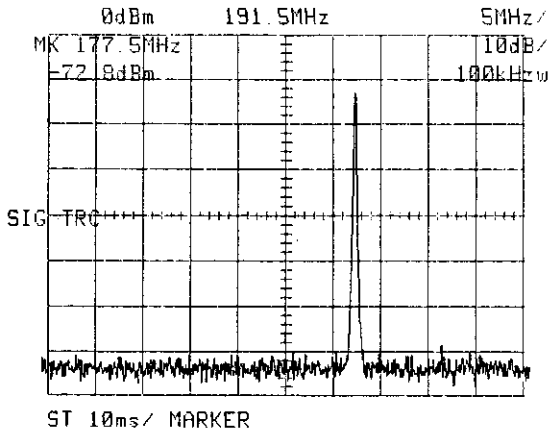
Note: • When the waveform being traced by the marker is not WRITE, signal track fails to operate correctly.

• When SIGNAL TRK is executed, the Tuning control on the TR4133/B analyzer panel is set to center frequency set status.

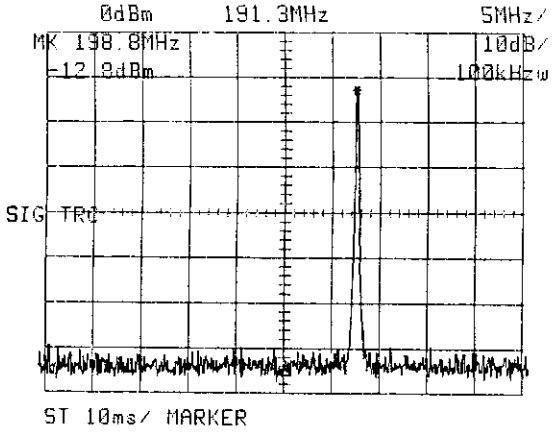
• If the 

key is pressed while the marker is off, the operation is invalid and a buzzer is sounded.

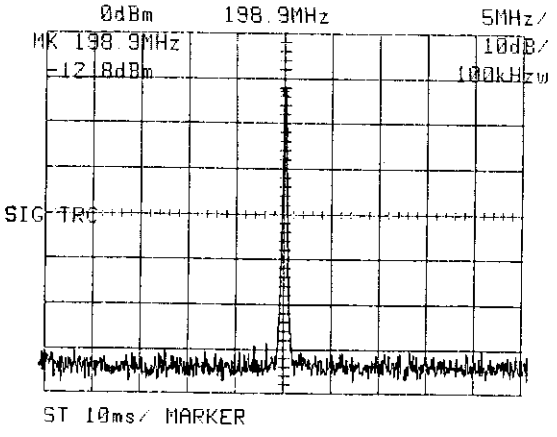
(1)



When the sweep is reached,

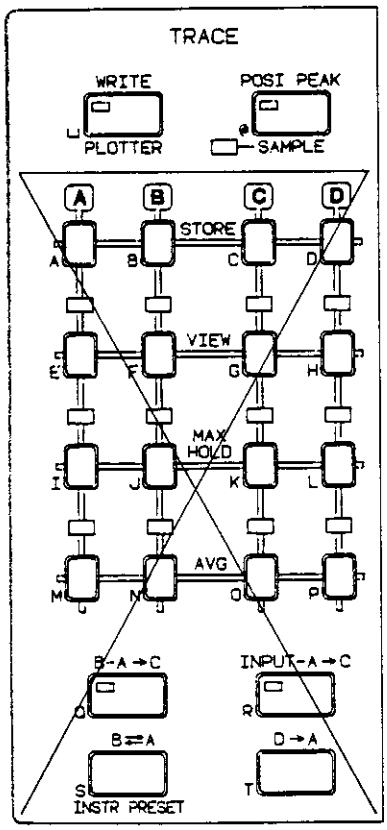


Search for peak, and to CENTER



(3) When the SIG TRACK key is switched on, and SINGLE key is pressed, SIGNAL TRACK is interrupted, and is only executed once by STOP/START.

(4) If a change is made to a trace apart from WRITE while SIG TRACK is on, SIGNAL TRACK fails to operate correctly.



4-5-9. Next Peak

When the NEXT PEAK key is pressed during marker mode, the positive peak values (note 1) of the waveform in the scale (the waveform being traced by marker) are searched for in sequence from the highest peak. Another type of next peak "next peak 2" is available within the advanced functions).

Typical applications are described below.

(1) The waveform is either viewed, or switched to single sweep mode and held (not moved). In waveforms which undergo changes such as the WRITE waveform, peaks cannot be search in the exact level sequence.

(2) Switch NORMAL (OTHER TRACE) or Δ (FIXED Δ) on.

(3) Move the marker to the maximum peak by PEAK SEARCH.

(4) When the NEXT PEAK key is pressed, the marker is shifted to the second largest positive peak. The marker is then shifted to the next largest peak after the current peak each time the NEXT PEAK key is pressed.

(5) Even if the marker is shifted to any desired position in place of Step (2), Steps (2) and (3) can be executed without any problem.

(6) If there are two peaks at the same level, the search proceeds in sequence from the lower frequency.

Note 1. Positive peak values:
All large value points in the vicinity of a particular peak are detected.
Since the display frequencies in the TR4133/B analyzers cover a very wide range, a single point on the horizontal axis can correspond to several MHz (5.7 MHz per point in span of 400 MHz/). Therefore, if certain peaks are not detected by this method, signals may be lost in the waveform.

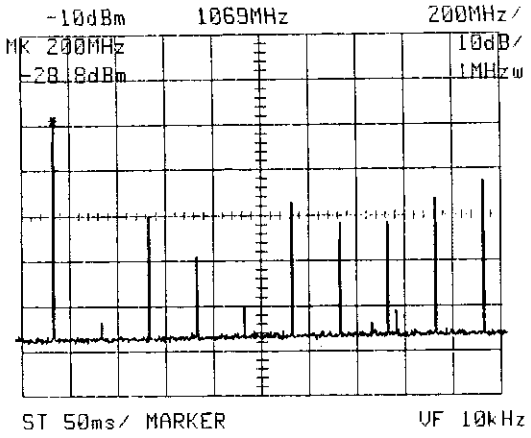
Note 2. Execution of this function requires a relatively long period of time. The operating time is especially long when there are fewer ups and downs in the waveform. (Execution of the horizontal line waveform immediately following initialization takes 48 seconds).
If the NEXT PEAK key is depressed continually, a buzzer is sounded and operation is stopped since the next input is applied during execution of the previous NEXT PEAK operation.

Steps (1) and (2) abbreviated.

(3) PEAK SEARCH

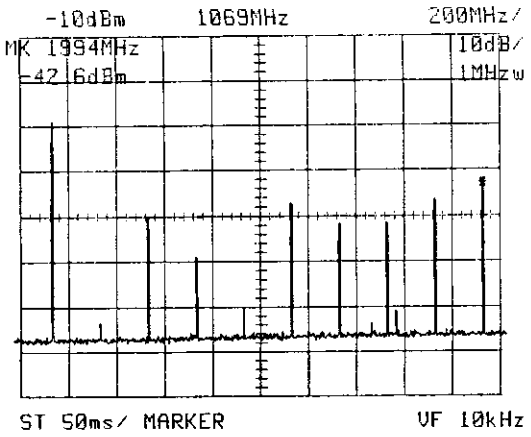
PEAK SEARCH

Marker shifted to peak point.

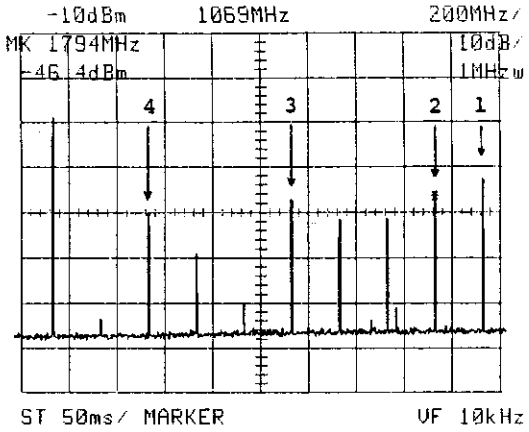


NEXT PEAK

(4) Press once.

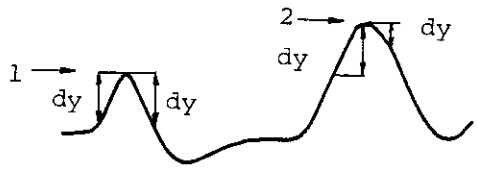


Then pressed a second and third time. This process is repeated.

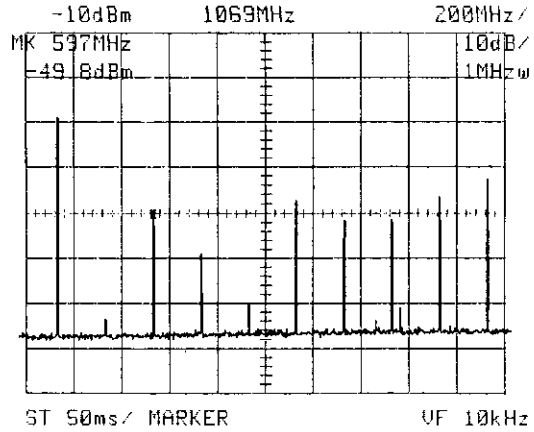


Note: Positive peak values?

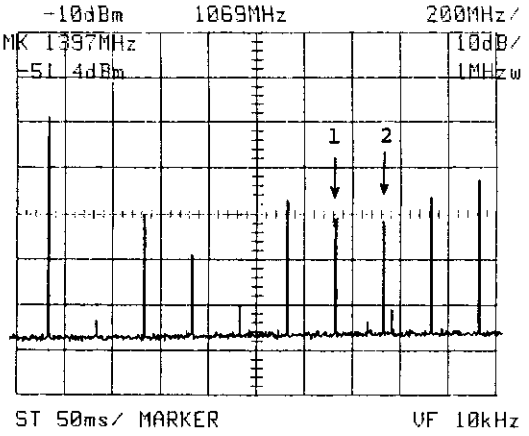
Points higher than surrounding levels. Points indicated by arrows are peaks.



(5) Commence NEXT PEAK SEARCH after moving marker to any desired position.



(6) If there are two peaks at the same level, the search proceeds in sequence from the lower frequency.



4-5-10. Noise/Hz

When the NOISE/Hz key is pressed, the rms value of the noise level normalized in the 1 Hz noise power bandwidth is measured.

(1) This mode functions only when the vertical scale axis is 10 dB/div. and the level unit is dBm. This mode is cancelled automatically if the vertical scale or level unit is changed.

(2) The marker level is displayed on the screen as "XX dBm/Hz". This indicates the noise power per 1 Hz noise power bandwidth. The theory behind the calculation is described below.

1) Find the average of the 16 points both sides of the marker point.

2) Let this average value be A dBm, and let the N to be determined N dBm/Hz.

$N = A - 10 \log(RBW) + (2.5 - 0.8)$

- RBW is the selected resolution bandwidth with an ideal Gaussian filter.
- 2.5 is a constant (dB unit) related to the statistical processing of log compressed average noise.

- 0.8 is obtained by the following expression

  10 log 1.2 = 10 log (a/b) (dB)

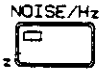
  where a is the noise power bandwidth, and

  b is the spectrum analyzer RBW

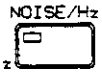
3) To convert the displayed 1 Hz noise power bandwidth into the value of another noise bandwidth, add the following value to the display value.

   10 log (Bandwidth to be converted/1 Hz)

(3) Operations for this mode cannot be executed while still in delta marker mode.

Delta marker mode can be changed to normal marker mode by pressing the 

key.

(4) Pressing the 

key during fixed delta marker mode results in a change to the mode where carrier to noise ratio (C/N) calculations can be executed.

If the fixed delta reference marker is set in advance at the peak of the signal to be measured, and the mode then switched to noise/Hz mode, the signal, the noise power per Hz, and the signal to power ratio (carrier to noise ratio) are displayed as marker levels. In this case, the marker levels are displayed in XX dBc/Hz units.

If the carrier to noise ratio is represented by C_N,

C_N = N - (Reference marker level)

N is the factor determined in step (2), and the reference marker level is the reference marker level stored in memory when the fixed delta marker was on.

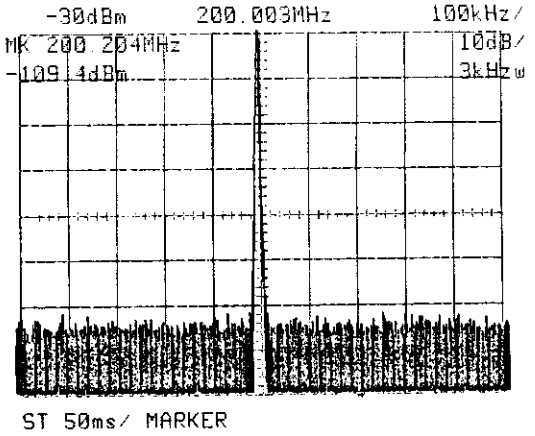
Example 1: Reference marker level is -30 dBm

If the active marker level is -130 dBm/Hz,

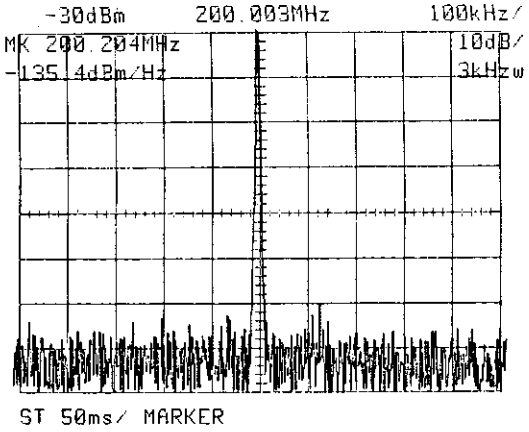
C_N = -130 - (-30) = -130 + 30 = -100 dBc/hz

Example 2: Measurement where signal level is -30 dBm, and noise level is -130 dBm/Hz

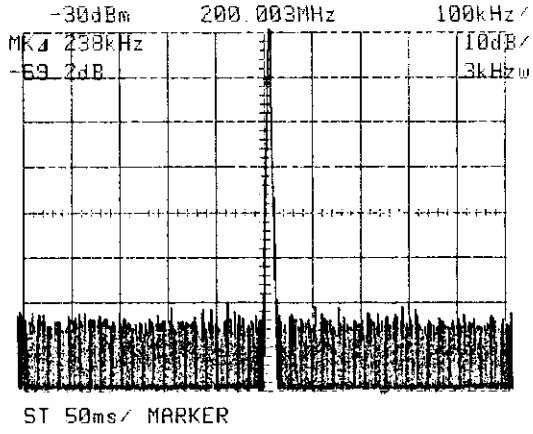
(1) 10 dB/div. (Only when level unit is dBm)

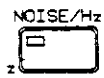


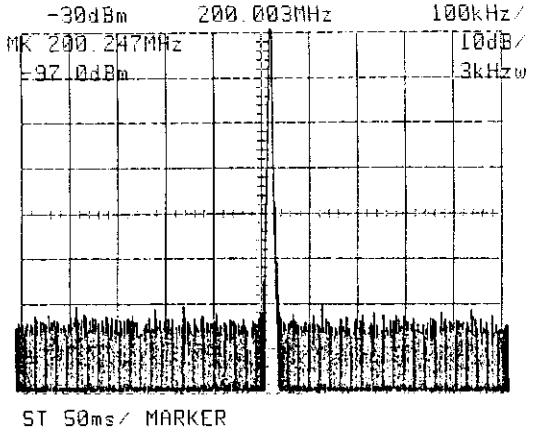
(2) The marker level display when NOISE/Hz is on.



(3) This function cannot be activated in delta marker mode.

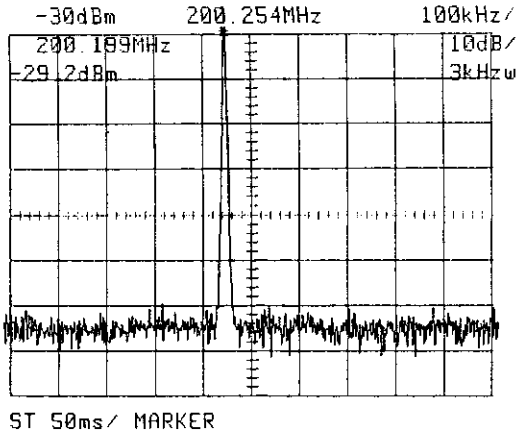




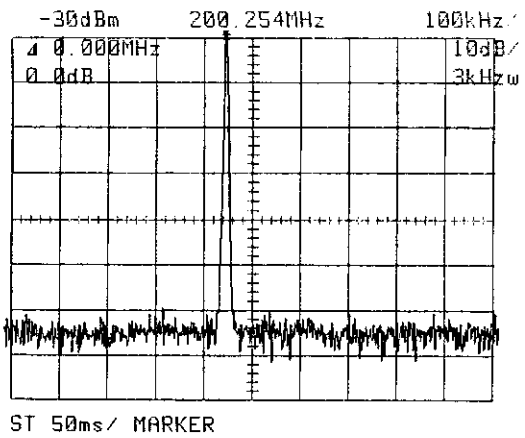


Example 2: dBc/Hz measuring example

1) Align the marker with the peak in normal marker mode.



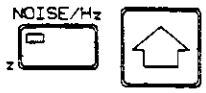
2) Switch the FIXED delta marker on.

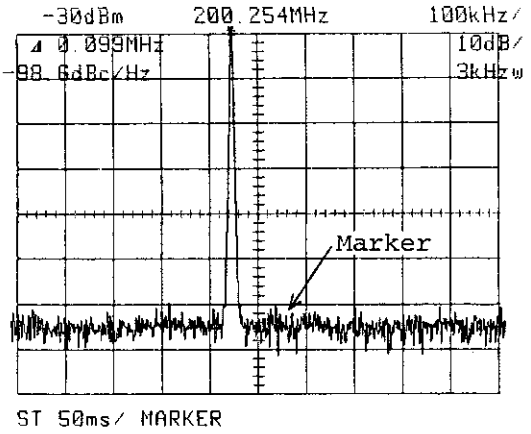


Peak frequency and level are stored in memory.

3) Switch NOISE/Hz on.

Align marker to noise.





Mode is switched to dBc/Hz measuring mode, and the peak frequency and level stored in memory in Step (2) are compared with the active marker noise level, the result being displayed.

4-5-11. Other Trace

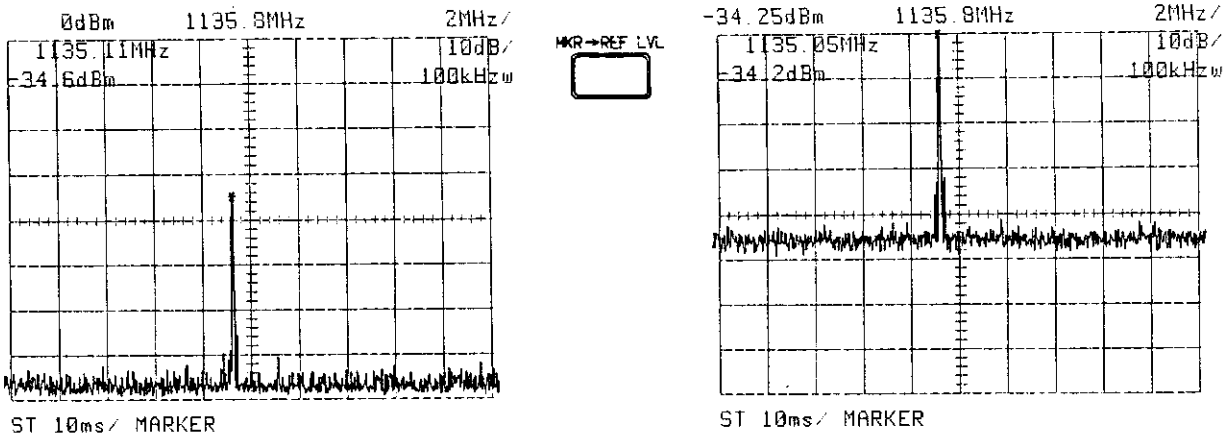
If SHIFT and NORMAL (OTHER TRACE) are pressed during dual trace display mode, the marker is shifted to the other trace (see Item 4-5-2(7)).

4-5-12. MK → REFL MKR→REF LVL

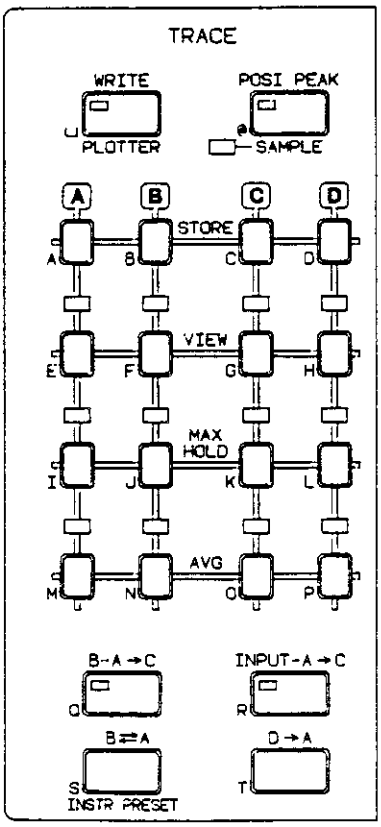
The marker level at the time when MKR→REF LVL is pressed with the marker shown on the screen is replaced by the reference level.
Since the level setting at this time is executed at a resolution of 0.25 dB, it is not possible to combine with other levels at a finer resolution.
This function is not operable when the vertical axis scale is LIN.

Note: 1) There is no response if there is no marker display when this key is pressed.

2) In some cases, execution of this function may take one second.



4-6. TRACE SECTION



4-6-1. Outline

The TR4133/B analyzers contain five screens of digital memories - an input waveform storage memory WRITE, and four computation memories A, B, C, and D.

(1) Any two of the above five memories can be displayed at the same time.

(2) When the TR4133/B is initialized, only the WRITE screen is displayed.

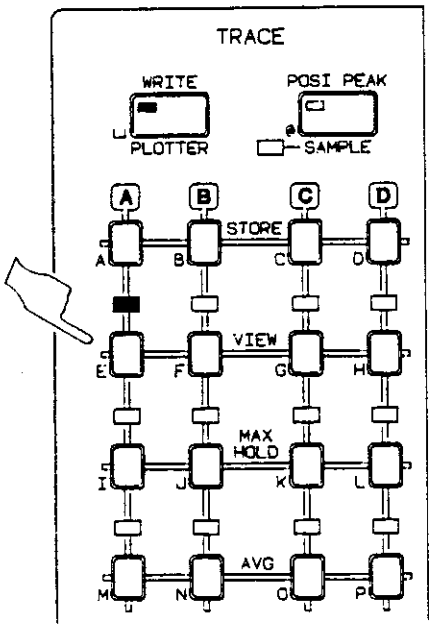
(3) When one of the TRACE section keys is pressed, the corresponding image is displayed.

(4) As a rule, the images corresponding to the last pressed key and the key pressed before that are displayed in dual display mode. Images displayed before the last two keys were pressed are erased in the same sequence that they appeared.
If only one image is desired, press the same key twice.

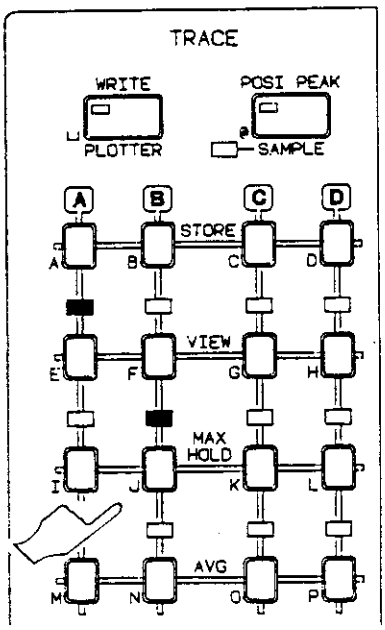
(5) The only exception to the step (4) display is the dynamic operation modes (MAX HOLD, AVERAGE, B-A→C, and INPUT-A→C) where only one image can be displayed at a time.
That is, if a second dynamic operation mode key "B" is pressed during display of the first dynamic operation mode "A", that first mode display disappears.

(6) If a dynamic operation mode is selected while the WRITE waveform is displayed, that WRITE waveform disappears. If the WRITE key is then pressed a second time, both the dynamic operation mode and the WRITE waveform are displayed in dual display mode.

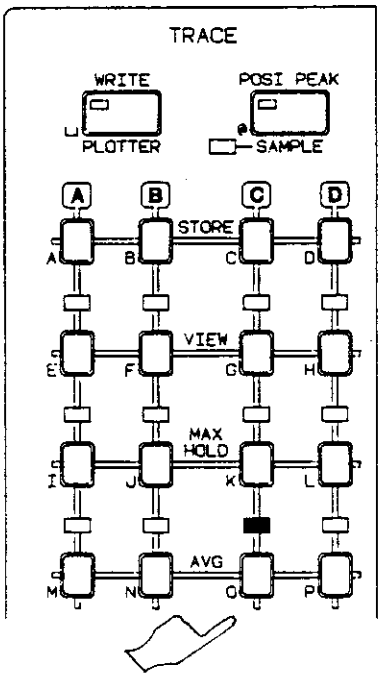
(1)



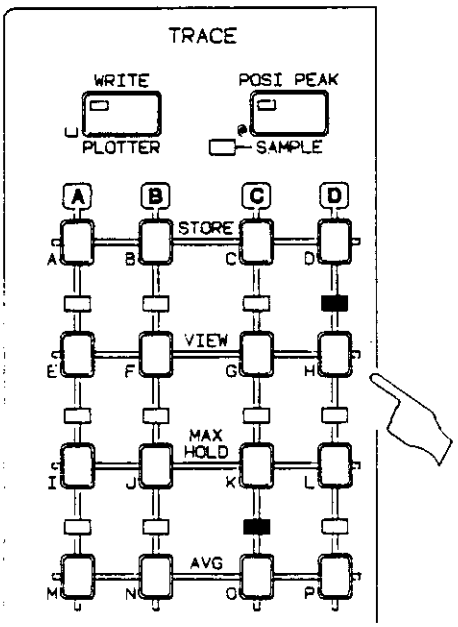
(2)



(3)



(4)



Execute the following operation in the given order

Operation	Results
(1) Press A-VIEW while only WRITE waveform is shown.	(1) Dual display with WRITE and A-VIEW.
(2) Press B-MAX.	(2) WRITE disappears, and A-VIEW and B-MAX are displayed in dual mode.
(3) Press C-AVERAGE.	(3) B-MAX disappears (and since only a single image can be displayed in dynamic operation mode) only C-AVERAGE appears.
(4) Press D-VIEW.	(4) Dual display of D-VIEW and C-AVERAGE.

4-6-2. TRACE Modes that are same as TR4133/B

Apart from the addition of C and D memories to the TR4133/B analyzer memories, the functions and operations related to
WRITE,
each A, B, C, and D STORE,
each A, B, C, and D VIEW, and
each A, B, C, and D MAX HOLD
are exactly the same. And all four memories are of exactly the same priority.
When each VIEW, MAX HOLD, and AVG related mode is selected, the LED for that key comes on to indicate that that mode has been selected (same as the analyzer panel).
A detailed description of these function will not be repeated here. Refer to Item 4-8-8. of the TR4133/B instruction manual.

4-6-3. AVERAGE A, B, C, D

This is basically the same function as the TR4133/B analyzer panel AVERAGE function. Waveform data read during each sweep is averaged after time weighting.
When the A, B, C, or D AVERAGE key is pressed,

(1) Averaging is commenced in the relevant memory in the same way as in the TR4133/B panel. This is the start of the 128 operations referred to below as the setting count.

(2) The average count can be set as the active function. After keying in the desired setting count by DATA key operation, press the kHz key to set the averaging count to 2, 4, 8, 16, 32, 64, or 128. The averaging is reset, and the arithmetic operation is started in accordance to setting count computing equation from zero times.

The operation proceeds to 128 counts if no specific value is set.

The set averaging count appears on the screen in the following format:

3/64

(where 3 is the current averaging count and 64 is the set averaging count).

Active function is off in this case.

To set the averaging count a second time, the AVERAGE key must be pressed again. And if a trace key apart from an averaging key is pressed when averaging is the active function, that active function is switched off.

(3) Averaging is executed in accordance with the following computing equations.

Computations are executed at each point on the frequency axis in the following way.

$$\bar{Y}_n = \frac{n-1}{n} \cdot \bar{Y}_{n-1} + \frac{1}{n} Y_n$$

(when $n = 2, 4, 8, 16, 32, 64$, or 128, and $n < S$) ..... (i)

$$\bar{Y}_n = \frac{2^N-1}{2^N} \cdot \bar{Y}_{n-1} + \frac{1}{2^N} Y_n$$

When N is an integer conforming with the relation $n > 2^N > n/2$ when $n < S$ and is a value from those listed above ..... (ii)

$$\bar{Y}_n = \frac{S-1}{S} \cdot \bar{Y}_{n-1} + \frac{1}{S} Y_n \quad (\text{when } n > 2) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (iii)$$

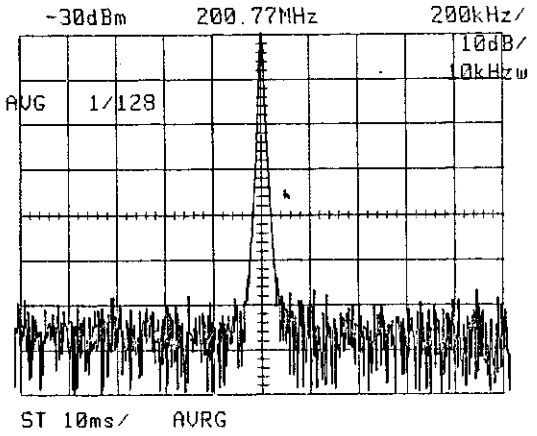
S: Setting constant

$\bar{Y}_n$: The nth item of average data.

Yn: The nth item of input data

If the averaging count exceeds the set count, averaging is continued in accordance with equation (iii), but display of the averaging count in the stop left hand corner of the screen is fixed at "S/S". This status is maintained until another trace key apart from averaging is pressed. In this status, averaging is subjected to time weighting.

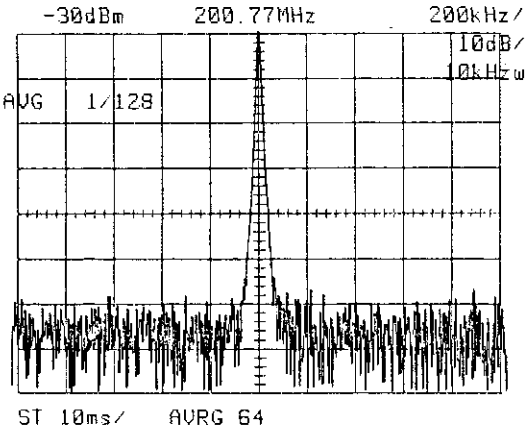
(1) Averaging ON



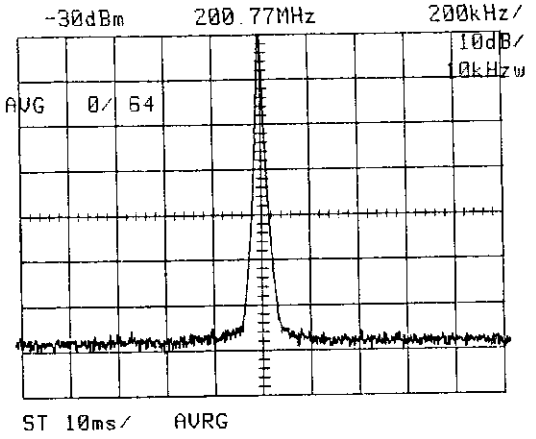
Start of averaging where setting count is 128.

(2) Setting of the averaging count by DATA key operation

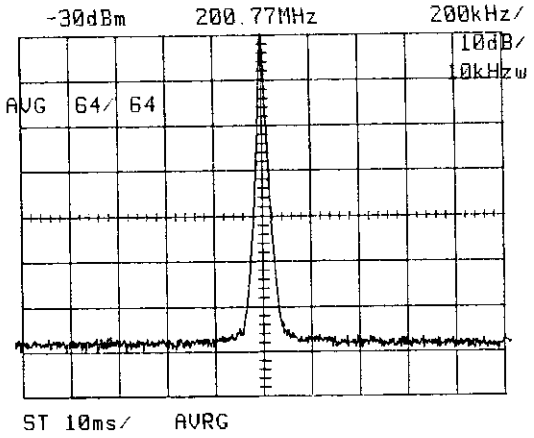
[6] [4]



Averaging is reset, and restarted from zero.



(3) When the count display reaches S/S, the averaging becomes time-weighted averaging, and this new status is maintained.



4-6-4. B-A→C 

(1) When this key is pressed, the key top LED comes on and a horizontal reference line (called the display line in this description) appears on the screen.

(2) The memory A contents are subtracted from the memory B contents, and the results of the operation are stored in memory C as well as being displayed on the screen. In addition, the display line is shown at the level where A = B.

(3) Immediately after this key is pressed, the display line appears at an intermediate level on the screen. And if the display line is moved up or down by setting the active function at that line, the B-A→C waveform can also be moved up or down together with the display line. If the waveform extends beyond the upper and lower edges of the scale, that waveform can be displayed again by moving the display line to a suitable position.
The position of the display line cannot be set by DATA key operation.
Display line operations when B-A→C (or INPUT-A→C) is displayed described in Item 4-4-2.

(4) When the marker is tracing the B-A→C waveform, the marker level represents the B-A→C level difference.

4-6-5. INPUT-A→C 

This function is much the same as the B-A→C function described above. The input waveform (INPUT) replaces the B.

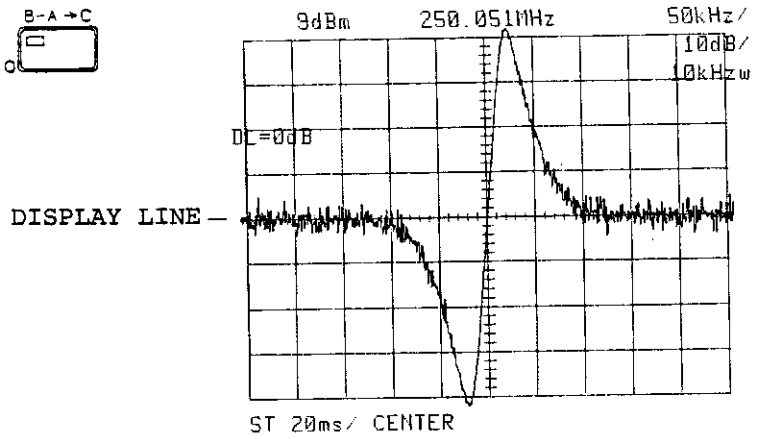
(1) When this key is pressed, the key top LED comes on and a horizontal reference line appears on the screen.

(2) The memory A contents are subtracted from the input waveform contents, and the results of the operation are stored in memory C as well as being displayed on the screen. In addition, the display line is shown at the level where A = input waveform.

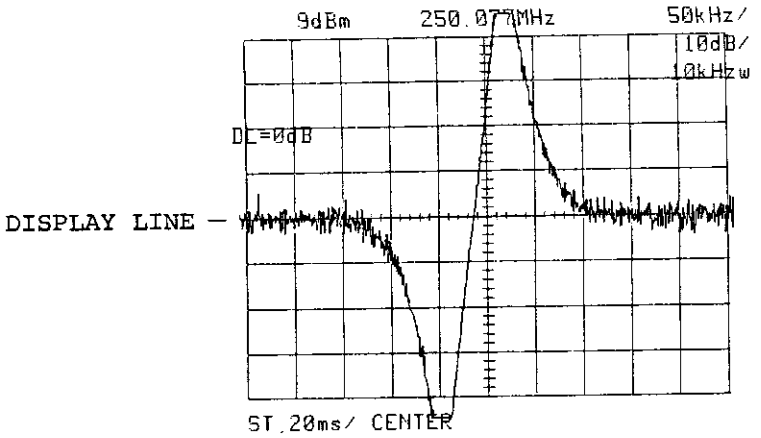
(3) Immediately after this key is pressed, the display line appears at an intermediate level on the screen. And if the display line is moved up or down by setting the active function at that line, the INPUT-A→C waveform can also be moved up or down together with the display line.
If the waveform extends beyond upper and lower edges of the scale, that waveform can be displayed again by moving the display line to a suitable position.
The position of the display line cannot be set by DATA key operation.
Display line operations when INPUT-A→C is displayed described in Item 4-4-2.

(4) When the marker is tracing the INPUT-A→C waveform, the marker level represents the INPUT-A→C level difference.

(1), (2)

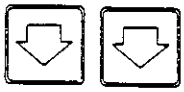


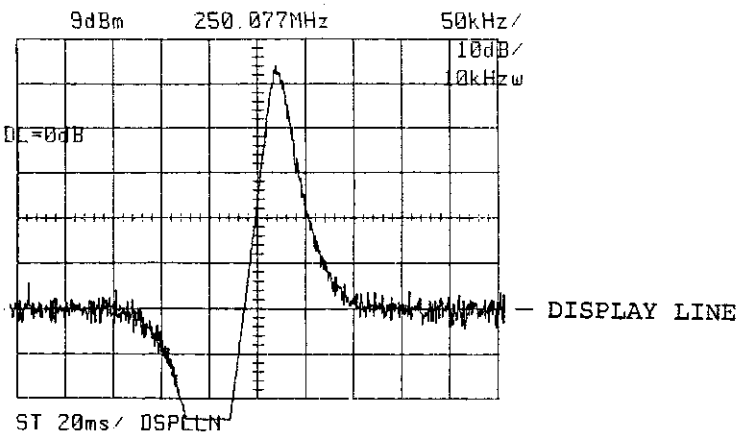
(3)



Waveform extends beyond upper and lower edges.

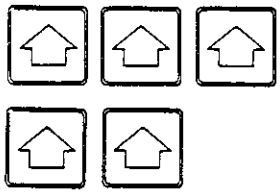
Lower the display line.

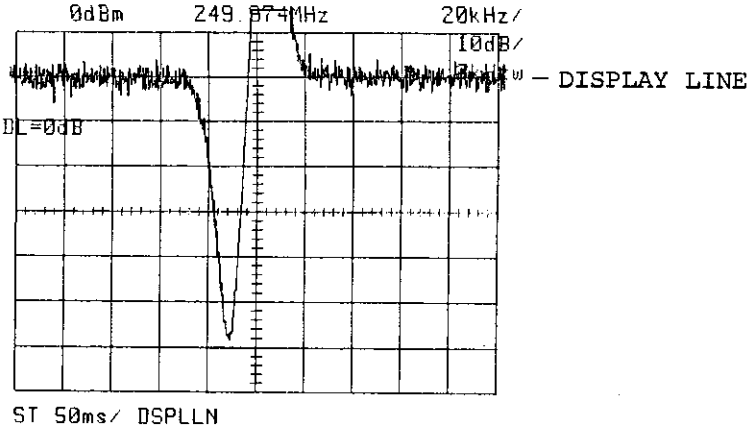




The upper part of the waveform is revealed

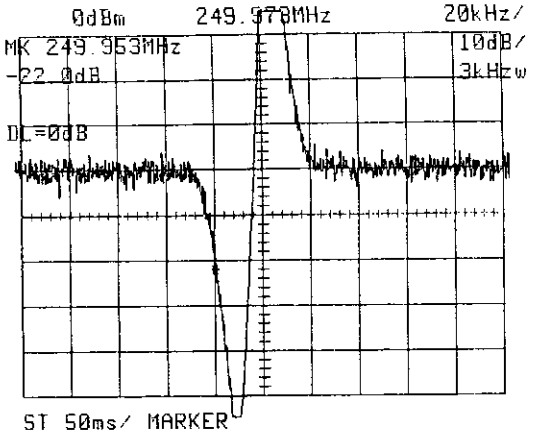
Raise the display line.





The lower part of the waveform is revealed

(4) Marker level display when marker is tracing B-A-C.

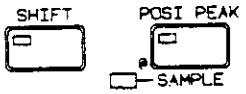


4-6-6. B ↔ A 

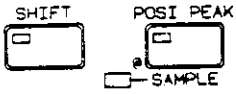
The contents of memories A and B are interchanged. A-VIEW is selected automatically after this.

4-6-7. D → A 

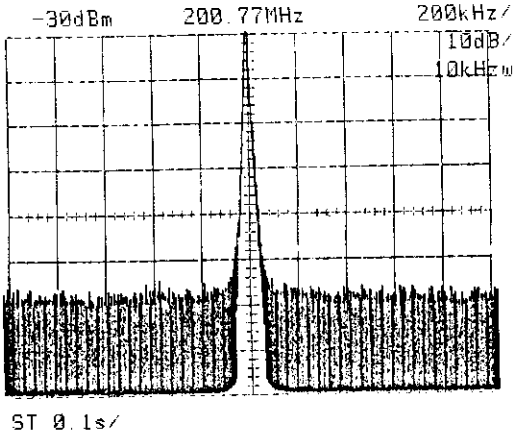
The contents of memory D are transferred to memory A. The D memory contents are retained in memory D.

4-6-8. POSI PEAK/SAMPLE 

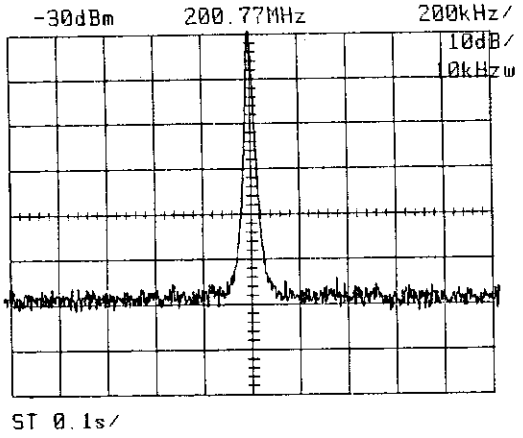
This function is identical to the POSI PEAK function in the TR4133/B analyzer panel.

When 

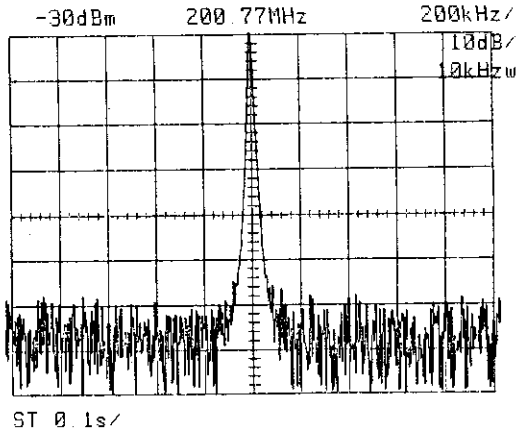
keys are pressed, the LED to the left of the word SAMPLE, the sampling mode of the A/D converter is switched to random sampling mode. The A/D converter sampling modes are set in sequence by this key.



POSI PEAK



SHIFT + SAMPLE



4-6-9. Waveform Data Flow

By combining the D → A, B ↔ A, INPUT-A→C, and B-A→C functions, the waveform data from memory D can undergo a series of arithmetic operations before being stored in memory C. (See Figure 4-1.)

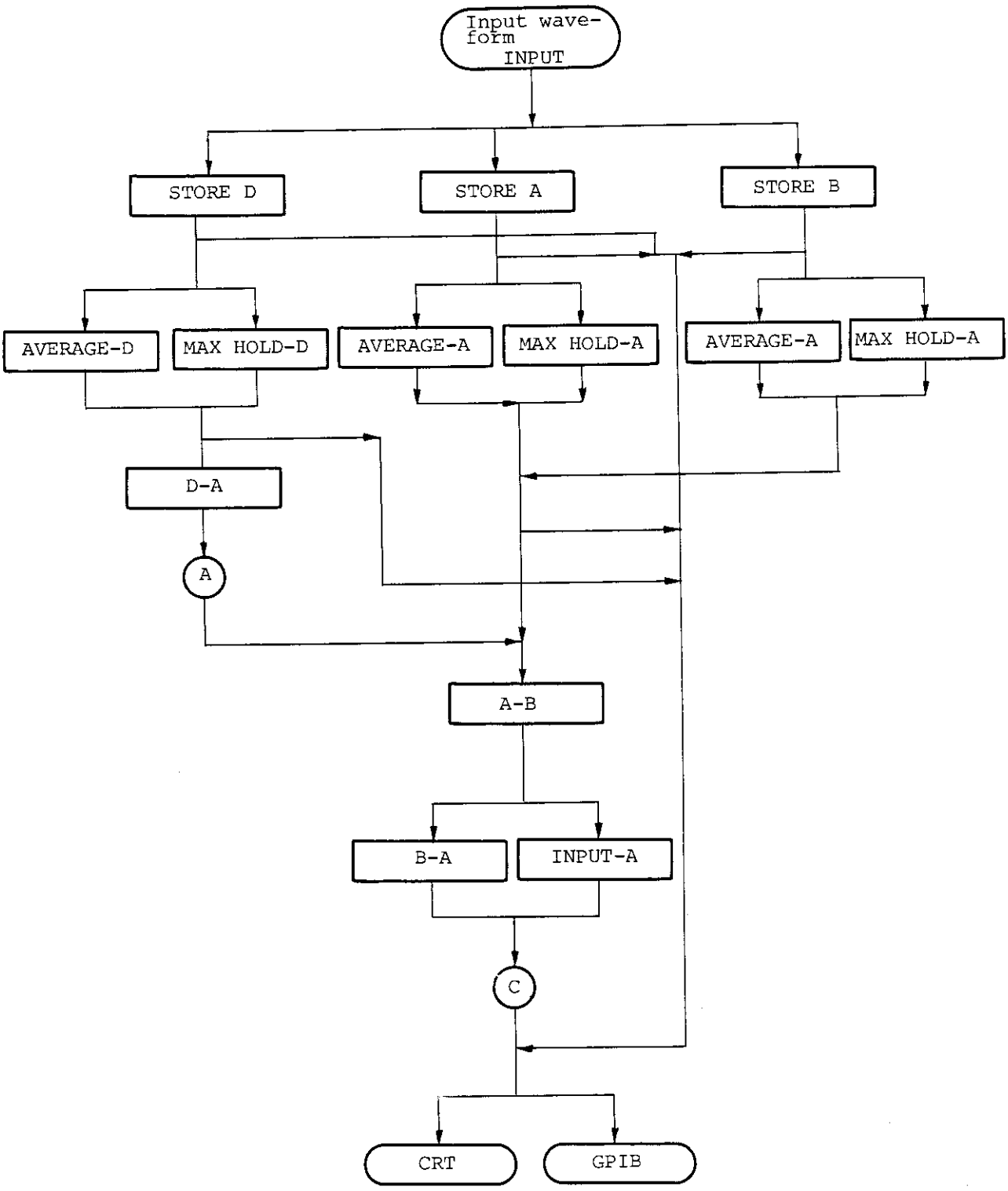
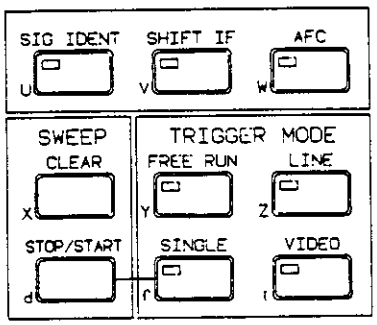


Fig. 4-1 Flow of waveform processing in the TR41301 external keyboard

4-7. SIG IDENT, SHIFT IF, AFC, SWEEP, AND TRIGGER MODE SECTIONS



4-7-1. SIG IDENT (SIGNAL IDENTIFIER)

This key has the same function as the key of the same name on the TR4133/B analyzer panels. Refer to Item 4-8-1. ② of the TR4133/B instruction manual.

4-7-2. SHIFT IF

This key, too, has the same function as the TR4133/B analyzer panels. Refer to Item 4-8-1. ③ of the TR4133/B instruction manual.

4-7-3. AFC

This key, too, has the same function as the TR4133/B analyzer panels. Refer to Item 4-8-2. ⑦ of the TR4133/B instruction manual.

SWEEP SECTION

4-7-4. CLEAR

Sweeping is cleared when this key is pressed, and the WRITE waveform display is erased. There is no change, however, in the contents of the A, B, C, and D memories.

4-7-5. STOP/START 

(1) Sweeping is stopped temporarily when this key is pressed with TRIGGER MODE set to FREE RUN, LINE, or VIDEO, and is started again from the halted position when this key is pressed a second time.

(2) If TRIGGER MODE is set to SINGLE,

(2)-1 sweeping is started when the STOP/START key is pressed.

(2)-2 sweeping is stopped when the STOP/START key is pressed a second time before completion of the sweeping started in (2)-1 above.

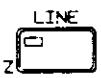
(2)-3 sweeping is started again from the stopped position if the STOP/START key is pressed again. Steps (2)-2 and (2)-3 can be repeated until the sweeping has been completed. If this STOP/START key is pressed after the sweeping has been completed, sweeping is started again as in Step (2)-1.

TRIGGER MODE SECTION

When any of the keys in the TRIGGER MODE section is pressed, the corresponding key-top LED comes on to indicated that the corresponding mode (described below) has been selected. Furthermore, pressing of one of these keys results in "TRGMD" (TRIGGER MODE) being selected as the active function. TRIGGER MODE changes can thus be made by using the UP and DOWN keys. See Item 4-7-10.

4-7-6. FREE RUN 

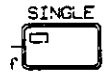
In this mode, sweeping is repeated in preset time cycles (see Item 4-3-17. "Sweep Time").

4-7-7. LINE 

Sweeping is synchronized with power line frequency in this mode.

4-7-8. VIDEO 

In this mode, operation is the same as an oscilloscope. Sweeping is started at the input signal amplitude.

4-7-9. SINGLE 

In this mode, sweeping is executed in accordance with the key position selected in Item 4-7-5.

4-7-10. Change of Trigger Mode with the UP or DOWN Key

When  is pressed with TRGMD set to active function changed by UP and DOWN switching, the TRIGGER MODE switch is changed sequentially in the following manner.

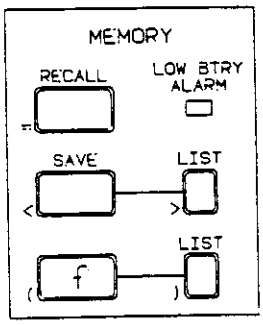
SINGLE → VIDEO → LINE → FREE RUN

And when  is pressed, the TRIGGER MODE switch changes proceed in the following sequence.

SINGLE → FREE RUN → LINE → VIDEO

Note: DATA keyboard entry is not allowed.

MEMORY SECTION



4-8. SAVE-RECALL FUNCTION

4-8-1. Outline

This function enables TR4133/B setting conditions to be stored and retrieved in/from memory. A maximum of 12 conditions can be stored at any one time. Storing of setting conditions in memory is referred to as "saving", while retrieving from memory is referred to as "recalling". When the operation described below is executed, the TR4133/B panel setting at that time is saved. Saved data is stored in the TR41301 external keyboard memory (with back-up power supply), and the TR41301 power is supplied from the TR4133/B analyzer. Saved contents can be maintained after the TR4133/B power is switched off. Recall operations depend on the data saved in the keyboard memory. If the TR4133/B frequency and level have not been calibrated at this time, the recalled frequency and level data will not be accurate. When more than one TR4133/B analyzer is used, the recalled analyzer need not be the same as the saved analyzer. (That is, the keyboard may be disconnected after saving certain conditions, and then connected to another analyzer to recall those conditions).
Note that labels, markers, waveforms, and display lines cannot be saved.

4-8-2. Saving Procedure

(1) SAVE is selected as the active function when the [SAVE] key is pressed.

(2) The memory where the data is to be stored is selected by setting a value from 1 to 12 by DATA key operation.

Example: Press [1] and [2] to select memory No. 12.

(3) Commence the actual saving operation by pressing the [kHz dB CLEAR→END] key. This operation takes about 1.5 seconds.

4-8-3. Recalling Procedure

(1) RECALL is selected as the active function when the [RECALL] key is pressed.

(2) Set a value from 1 to 12 by DATA key operation to retrieve the data saved in the previous procedure.

Example: Select memory No. 12 by pressing the [1] and [2] keys.

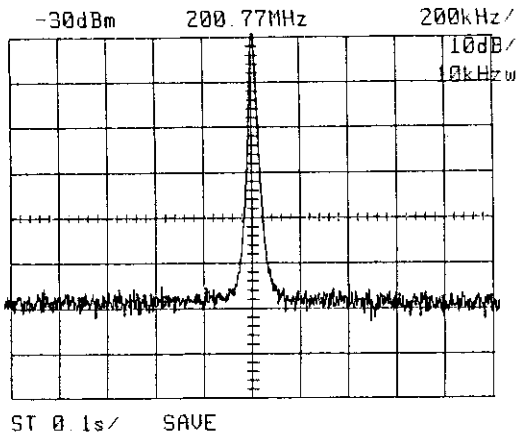
(3) Commence the actual recalling operation by pressing the [kHz dB CLEAR→END] key. This operation takes about 2.5 seconds.

Note: The saving and recalling operation will not proceed in the normal way if any change is made to TR4133/B settings by TR4133/B panel or External Keyboard operation during a saving or recalling operation.

Various functions are displayed in succession during the RECALL mode of operation. The RECALL mode is ended up with the display of "RECALL" in the lower-left area.

Saving Operation Example

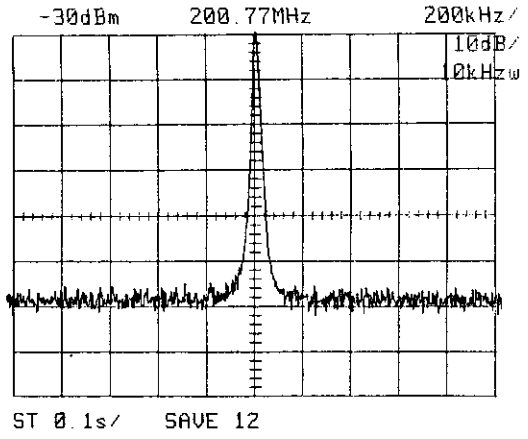
(1) SAVE



SAVE selected as active function.

(2) DATA key operation

Example 1 2



Memory No. 12 is selected.

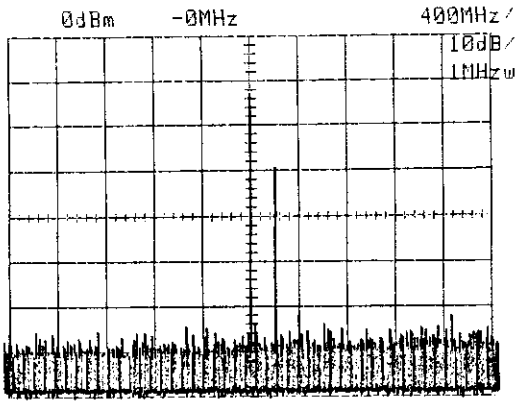
(3) kHz dB
CLEAR→END

The setting conditions at this time are saved in memory No. 12.

Note: This operation is completed in about 1.5 seconds. Do not press any other panel keys during this period.

Recalling Operation Example

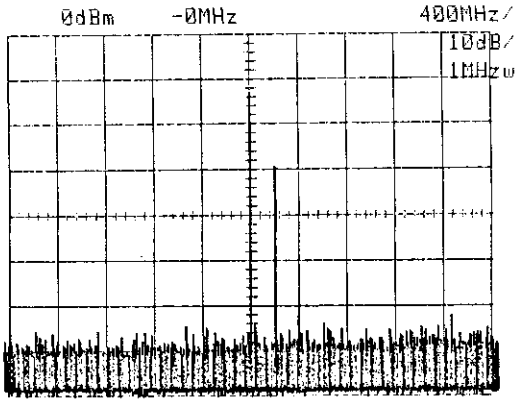
(1) RECALL



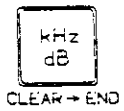
RECALL selected as active function.

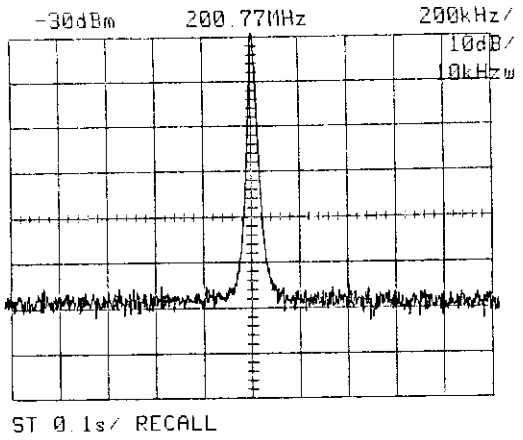
(2) DATA key operation

Example 1 2



Memory No. 12 is selected.

(3) 



The setting conditions are recalled from memory No. 12.

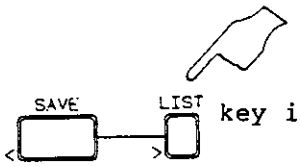
Note: This operation is completed in about 2.5 seconds.
Do not press any other panel keys during this period.

4-8-4. LOW BATTERY Alarm

This LED comes on when the voltage of the memory back-up battery power drops below a specified level. In this case, contact your nearest ADVANTEST representative.

4-8-5. SAVE-LIST

This function permits the user to write and display comments for the contents saved in the saving procedure described above (see Item 4-8-1.) The image displayed on the screen in Step (1) below is called "SAVE-LIST".
The contents of the displayed comments can be edited in any way by the user in Step (2). Suitable comments are inserted on the line corresponding to the memory number where data has been saved, and can subsequently be used as a title for that data. This list is stored in the keyboard memory in the same way as saved data, and can be displayed as described in Step (1).
During the SAVE-LIST display, no other panel keys apart from LABEL and SAVE LIST can be operated.

(1) "SAVE LIST" appears on the screen when the 

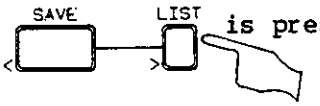
key is pressed. When this operation is first executed after the power is switched on, the screen data has to be transferred from the keyboard, and this takes about two seconds. During this period, panel operations cannot be executed in the TR4133/B or External Keyboard.

(2) Pressing the 

key results in the appearance of a cursor, and activation of a Label function (see Subsection 4-10.) on the screen. The cursor can be moved vertically and horizontally by using the UP and DOWN keys. The green character inscribed in the bottom right hand corner of each key appears at the cursor position on the screen when that key is pressed. Comments of up to 33 characters per line can be inserted on each line within the specified range.

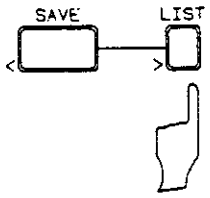
(3) Label mode is cancelled when the 

key is pressed a second time.

(4) If 

is pressed after completing Steps (1), (2), and (3) (or after completing only Step (1)), a buzzer is sounded (like pip, pip, pip, pip,...) for about two seconds to indicate that SAVE - LIST data is being transferred from TR4133/B to keyboard. During this period, panel operations cannot be executed in the TR4133/B or External Keyboard.

(1) When this key is first pressed after switching the power on, the cursor "runs" on the screen and the list contents are displayed in sequence.



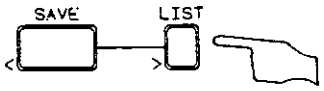

```
      SAVE MEMORY CONTENTS
01: 930MHz BAND  WIDE
02:   "     "    FOR OBW
03:   "     "    FOR ADJEACENT LEAK
04: LINK TO TR4511
05: LINK TO TR5213
06: LINK TO TR5820
07: SPURIOUS CHECK
08: NOIZE/Hz (dBm/Hz) 900MHz
09: NOIZE/Hz (dBC/Hz)   "
10:
11:
12:
```

Save List appears on the screen.

(2) 

The contents in the right hand diagram can be edited and updated when the label function is used. The cursor can be moved within the indicated area by UP and DOWN key operation.

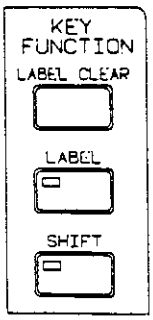
(3) Omitted

(4) 

Buzzer is activated for about 2.5 seconds. List data is transferred from the TR4133/B analyzer to the keyboard during this period.

The screen is subsequently reverted to the former status.

KEY FUNCTION SECTION



4-9. LABEL FUNCTIONS

The green characters at the bottom left hand corner of each key can be written on the screen at any position selected by moving the cursor. Characters written by using the label function can be erased again by the LABEL CLEAR key.

4-9-1. LABEL 

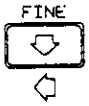
(1) When this key is pressed, the key-top LED comes on, and the cursor appears on the center left hand side of the screen.

(2) Each time a key is then pressed, the green character at the bottom left hand corner of the key appears at the cursor position, and the cursor itself is shifted to the next character position on the right. When the right hand edge of the screen is reached, the cursor is shifted to the left hand end of the next line below.
Note, however, that the UP, DOWN, GHz, MHz, and kHz keys have special functions described in Steps (4) thru (10).

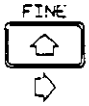
(3) To cancel the label function, press the 

key a second time.

Each key is thus reverted to its normal function.

(4) If the 

key is pressed with LABEL selected as the active function, the cursor is shifted to the left. And if the cursor is already at the left hand edge, it is shifted to the right hand edge of the line above.

(5) Likewise, if the 

key is pressed with LABEL selected as the active function, the cursor is shifted to the right. And if the cursor is already at the right hand edge, it is shifted to the left hand edge of the line below.

(6) If the  key is pressed with LABEL selected as the active function, the cursor is shifted to the next line below. And if the cursor is already at the bottom line, it does not move.

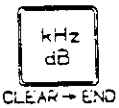
(7) And if the  key is pressed with LABEL selected as the active function, the cursor is shifted to the next line above. But if the cursor is already at the top line, it does not move.

(8) If the 

key is pressed with LABEL selected as the active function, all characters in the label on the line to right of the cursor position are shifted one character to the right, and a blank space for one character is generated at the character position. Any character at the right hand edge of the screen disappears at this time.

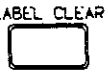
(9) If the 

key is pressed with LABEL selected as the active function, all characters in the label on the line to right of the cursor position are shifted one character to the left, and the character at the cursor position is erased.

(10) If the 

key is pressed with LABEL selected as the active function, all characters in the label on the line to right of the cursor position are erased. To erase an entire line, first shift the cursor to the left hand end of the line before pressing this key.

4-9-2. LABEL CLEAR

When the 

key is pressed, all characters written on the screen by the label function are erased. Note that characters erased by LABEL CLEAR cannot be retrieved. Since this key is located immediately above the LABEL key, take extra care not to press this key by mistake.

4-10. SHIFT FUNCTION 

When this key is pressed, the key-top LED comes on to indicate that the keyboard is in shift key mode where the function inscribed in yellow characters below each key is activated when that key is pressed. Pressing keys with no yellow character inscription has no effect.

The shift key mode is cancelled each time a particular key is pressed after pressing the SHIFT key, and the corresponding key-top LED goes off. Individual key shift functions are described in Items 4-10-1. and 4-10-2.

Table 4-3 List of shift key functions

Key	Shift function name	Section
WRITE	PLOTTER	4-11-1.
B↔A	INSTRE PRESET	4-11-2.
DISPLAY LINE ON	CARACTER ON	4-11-4.
DISPLAY LINE OFF	CARACTER OFF	4-11-3.
POSI PEAK	SAMPLE	4-6-7.
NORMAL MARKER	OTHER TRACE	4-5-1. (8)
Δ MARKER	FIXED Δ MARKER	4-5-4.

Description not repeated in Subsection 4-10.

The following functions are exactly the same as in the TR4133/B, and have been described briefly in Section 2 of this instruction manual.

Table 4-4 List of SHIFT key functions (explained in TR4133/B Instruction Manual)

Key	Shift function name	Initial brief description in this manual	Section
DATA key 4	UNIT dBm	3-2 (64)'	Item 4.8.5 of the TR4133/B instruction manual
DATA key 5	UNIT dBμ	3-2 (65)'	
DATA key 6	UNIT dBpW	3-2 (66)'	
DATA key 7	10 dB/DIV	3-2 (67)'	
DATA key 8	2 dB/DIV	3-2 (68)'	
DATA key 9	LIN/DIV	3-2 (69)'	
DATA key 0	ZERO CAL	3-2 (60)'	Subsection 4.2 of the TR4133/B instruction manual

4-10-1. Plotter Function SHIFT + WRITE (PLOTTER)

Hard copy of the graphs and diagrams displayed on the screen can be obtained by GPIB connection of the TR4133/B analyzer to the ADVANTEST TR9831 or TR9834R X-Y Plotter, or to the Hewlett-Packard HP7470A. With each of these models, the contents (normal screen, waveform only, SAVE-LIST, FUNCTION-LIST etc.) can be set.
When the GHz, MHz, or kHz key is pressed, the plotter commences to make a large, medium, or small size hard copy in accordance with the set mode. Note that there are a number of differences in the hard copy graph layout and symbol shapes etc.

Operating Procedure

(1) When the SHIFT and WRITE (PLOTTER) keys are pressed, the character display shown in Figure 4-2 appears on the screen. (The waveform, scale, etc. remain as before).

```
PLOTTER MODE
 MODE SELECTION
0: ALL
1: WAVE ONLY
2: SAVED LIST
3: ADVANCED FUNCTIN LIST
9: QUIT
CHOSEN:0

TYPE         0;0=TR, 1=HP
PAPER FEED   0;0=OFF, 1=ON
SIZE
GHz: LARGE
MHz: MIDDLE
kHz: SMALL
```

Fig. 4-2 Plotter menu list

(2) The same cursor (_) used in the Label function appears at this time, and can be shifted to the three 0 positions on the screen by pressing the  and/or  key to enable input of a suitable value by DATA key operation. All values are initially set to 0 when the power is switched on and when INSTR PRSET is set. The values thus set are maintained until the power is switched off.

i) If a DATA key is pressed with the cursor located at

CHOSEN:0,

the corresponding mode listed in the following table is selected.

DATA key	Display	Selected mode
0	ALL	Hard copy of normal screen (waveform, characters)
1	WAVE ONLY	Hard copy of waveform only.
2	SAVED LIST	Hard copy of SAVE-LIST (see Item 4-8-5.).
3	ADVANCED FUNCTION LIST	Hard copy of special function list (see Item 4-11-2.).
9	QUIT	Cancel plotter mode.
Others		Buzzer activated, but no operation.

ii) Likewise, if a DATA key is pressed with the cursor located at

TYPE 0;0=TR, 1=HP

the system is set as indicated in the following table to match the selected plotter.

DATA key	Display	Suitable plotter
0	TR	TR9831, TR9834R, or other models based on these plotters.
1	HP	Hewlett-Packard HP7470A or other models based on this plotter.
Others		Buzzer activated, but no operation.

iii) And if a DATA key is pressed with the cursor located at

PAPER FEED 0=OFF, 1=ON

the corresponding mode listed in the following table is selected.

DATA key	Selected mode
0	No paper feed after completion of hard copy.
1	Paper feed after completion of hard copy.
Others	Buzzer activated, but no operation.

The only models capable for paper feed are the TR9834R and equivalent models.

(3) When the "GHz", "MHz", or "kHz" key is pressed, the plotter commences the hard copy in large, medium, or small size according to the settings in Step (2). A hard copy example is outlined in Figure 4-4.

The screen is reverted to the former status (prior to selecting plotter mode).

Since the setting made in Step (2) remains valid as long as no changes are made, any number of copies can be made at the same setting. For every subsequent hard copy, simply press one of the above three keys.

The size of the hard copy differs according to the type of plotter. The sizes for the main models are given below.

Model	Large	Medium	Small
TR9831 TR9834R	Vertical 220 mm Horizontal 240 mm	Vertical 165 mm Horizontal 180 mm	Vertical 110 mm Horizontal 120 mm
HP7470A	Vertical 165 mm Horizontal 190 mm	Vertical 83 mm Horizontal 195 mm	Vertical 41 mm Horizontal 48 mm

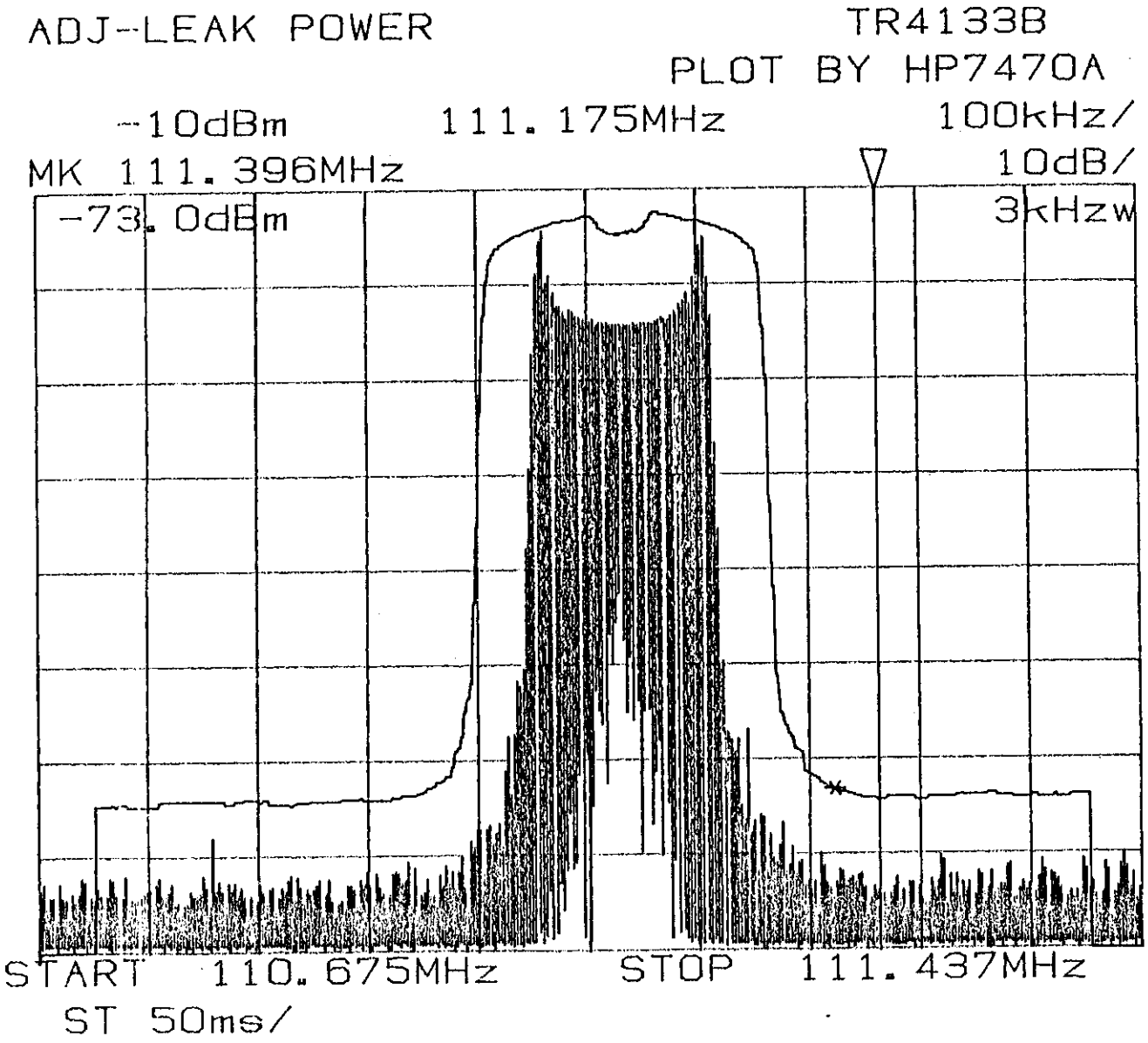


Fig. 4-3 Example of plotter hard copy

(4) Differences between CRT screen and plotted diagrams

i) Characters have a slightly greater vertical height than in the TR4133/B CRT screen, and characters appearing at the top and bottom of the scale are displaced somewhat upwards and downwards respectively.

ii) The label line where the cursor first appears, and the following line, are written in the very top line.

iii) Markers, display lines, start and stop frequency cursors, and the other waveform in a dual screen display can be plotted by exchanging pens.

iv) Hard copy plots also differ slightly from TR4133/B CRT displays in the vertical/horizontal ratio of graphs and the actual sizes.

4-10-2. Instrument Preset (Initialization)

TR4133/B settings can be initialized (reverted to the same status as when the power was switched on). The initialized settings are listed below.

Function	Setting
TRACE	WRITE
A/D SAMPLING MODE	POSI NEGA (+-) PEAK
SWEEP TRIGGER MODE	FREE RUN
SIGNAL IDENT	OFF
SHIFT IF	OFF
AFC	OFF
RESOLUTION BANDWIDTH	1 MHz (AUTO)
SWEEP TIME	10 msec (AUTO)
VIDEO FILTER	OFF
CENTER FREQUENCY	0 MHz
CF STEP SIZE	AUTO
FREQUENCY BAND	0-3, 6 GHz (AUTO)
FREQ CAL, FREQ LOCK	OFF
FREQUENCY SPAN/DIV	400 MHz
START frequency, STOP frequency	OFF

Function	Setting
REFERENCE LEVEL	0 dBm
REFERENCE UNIT	dBm
REFERENCE OFFSET	0 dB
Vertical axis scale	10 dB/DIV
MIN. INPUT ATTENUATOR	10 dB (selected value also reset to 10 dB)
MARKER	OFF
DISPLAY LINE	OFF
LABEL	OFF
SHIFT	OFF

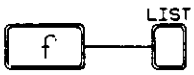
4-10-3. CHARACTER OFF 

Erasure of character displays on the TR4133/B screen. When in plotter mode, however, characters still appear in the plotter menu list (see Figure 4-2) if CHARACTER OFF has been set.
When hard copy is made by plotter, no characters are written in this case.

4-10-4. CHARACTER ON 

Characters erased from the TR4133/B screen by CHARACTER OFF can be retrieved by setting CHARACTER ON.

4-11. ADVANCED FUNCTIONS



The TR4133/B analyzers have been equipped with the following special functions.

Table 4-5 List of advanced functions

No.	Function
1	NEXT PEAK 2 (marker frequency NEXT PEAK search)
2	Occupied frequency band width (OBW)
3	Adjacent channel leak power measurement (ADJ)
4	AFC for Sweep Adapter TR13211 (SA*AFC)
5	Same level marker
6	Adjacent peak search

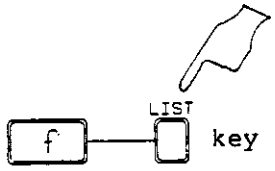
4-11-1. How to Use the Advanced Functions

(1) "FUNCT" (abbreviation for FUNCTION) is selected as the active function when the [f] key is pressed.

(2) Then by DATA key operation, set a value corresponding to one of the functions listed in Table 4-5.

(3) The selected mode is activated when the "kHz" key is pressed (and the corresponding function becomes the active function).

4-11-2. Advanced Function List



The following list appears on the screen when the [f] — [LIST] key is pressed. Since this list indicates the contents of Table 4-5, and whether a ROM has been installed or not, it is convenient for checking special function numbers.

While this list is on display, no other keys can be used.

Pressing the LIST key a second time results in a return to the former status.

ADVANCED FUNCTION CONTENTS

10: NEXT PEAK2

2X: OBW

3X: ADJ-LEAK

40: SA*AFC

50: SAME LEVEL MARKER

60: ADJPK

0: Denotes that this function ROM has been installed.

X: Denotes that this function ROM has not been installed.

4-11-3. NEXT PEAK2 Marker (Frequency NEXT Search)

A display line is set on the screen, and a search is then made in order of frequency for level peaks above that line. This peak search involves a shorter operation time than the regular NEXT PEAK operation.

Operating procedure

Steps (1) and (2) must be executed before calling NEXT PEAK2 mode.

(1) Set the display line to a suitable level.
If this operation is commenced from Step (2) without setting a display line, all positive values within the waveform are sought out in Steps (5) and (6).

(2) Either store the waveform in memory A, B, C, or D, or switch to single sweep mode and hold (keep stationary) the waveform on the screen. In moving waveforms such as WRITE waveforms, it is not possible to make an accurate sequential search.
MAX HOLD and AVERAGE waveforms may be fixed by VIEW. If the waveforms are simply stored, the search will also include unnecessary peaks if the waveform data is not taken in POSI PEAK sampling mode.

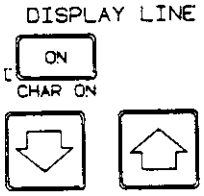
(3) When the [f], [1], and [kHz dB] (CLEAR→END) keys are pressed in that order, the NEXT PEAK2 marker becomes the active function. In this case, the marker appears at the peak of lowest frequency whose level is above the display line.

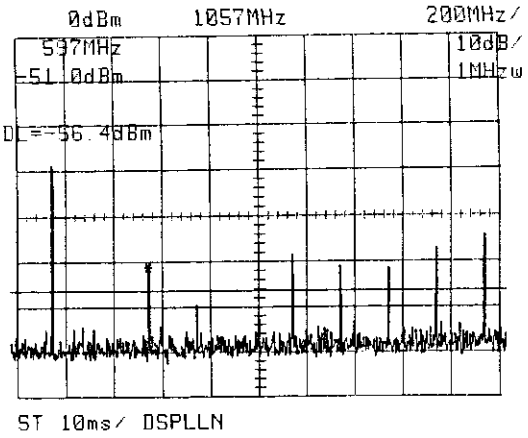
(4) The marker is shifted to the next peak to the right above the display line each time the  key is pressed. And if there are no more peaks to the right of the marker above the display line when the  key is next pressed, a buzzer is activated and the marker remains stationary.

(5) Likewise, the marker is shifted to the next peak to the left above the display line each time the  key is pressed. And if there are no more peaks to the left of the marker above the display line when the  key is next pressed, a buzzer is activated and the marker remains stationary.

(6) To cancel this mode, another active function is selected and the corresponding mode activated.

(1) Set the display line to a suitable value.





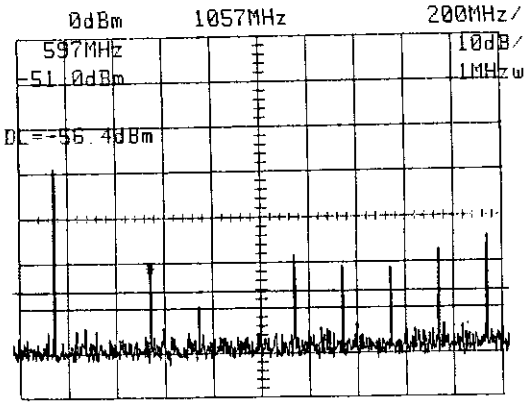
(2) Hold the waveform at a suitable stage.

Example i) Store the WRITE waveform in POSI PEAK.

ii) Switch to VIEW mode after MAX HOLD and AVERAGE.

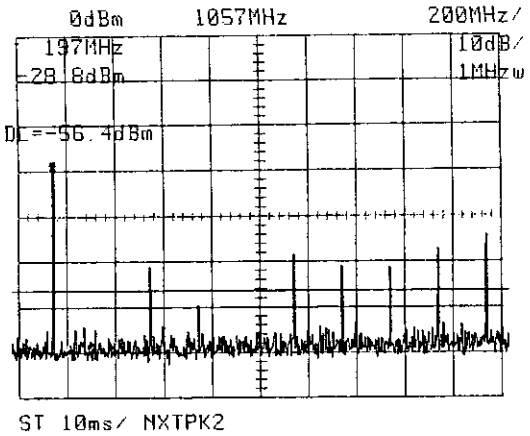
(3) [f] [1]

When advanced function 1 is selected,



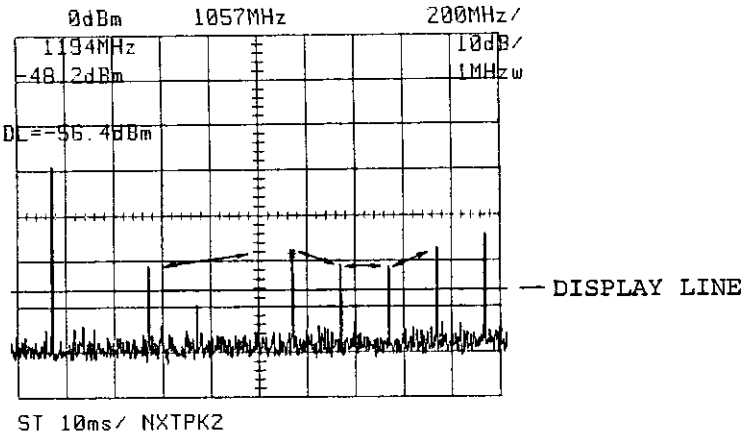
[kHz dB]
CLEAR→END

NEXT PEAK2 marker becomes the active function.



The marker appears at the peak of lowest frequency above the display line.

(4) Use  and  to shift the marker in the manner indicated in the diagram on the right.



4-11-4. Occupied Frequency Bandwidth

The occupied frequency bandwidth is calculated from the waveform data on the TR4133/B screen, and the result is shown as the frequency difference from the Δ marker.
The arithmetic operation is executed in the following way. The occupied frequency bandwidth is the bandwidth of the signal containing 99% of all the power counting from the point of maximum level within a certain frequency range.
Data shown on the TR4133/B screen includes 701 points in respect to the frequency axis. If "Vn" represents the voltage at each point, and "R" the TR4133/B input impedance, the total power "P" on the screen can be determined from the following equation.

$$P = \sum_{n=1}^{701} \frac{Vn^2}{R}$$

where Vn is the voltage at each point on the frequency axis.
If the point where the sum of the power from the left hand edge of the screen is 0.5% of P is the Xth point from the left hand end of the frequency axis, the following equation can be established.

$$0.005P = \sum_{n=1}^{X} \frac{Vn^2}{R}$$

where R is the measuring system impedance

And if the point where the sum of the power from the left hand edge of the screen is 99.5% of P is the Yth point from the left hand end of the frequency axis, the following equation can be established.

$$0.995P = \sum_{n=1}^{Y} \frac{Vn^2}{R}$$

If X and Y are then determined from the above three equations, and the frequency span is represented by "Fs", the occupied frequency bandwidth (OBW) can be obtained from the following equation.

$$OBW = \frac{Fs\ (Y - X)}{701}$$

Note: The occupied frequency bandwidth for signals used in broadcasting and telecommunications is subject to regulations stipulated under the Japanese Radio Law. According to the Law, the occupied frequency bandwidth is defined as,

"The average power radiated at rrequencies in excess of the upper frequency limit and below the lower frequency limit is equal to 0.5% of the total average power radiated by emission, the upper and lower limits indicating the frequency bandwidth ...".

Calculations conforming with this definition are described in this section.

The method for displaying the occupied frequency bandwidth is described below.

(1) Due to memory capacity limitations, occupied frequency bandwidth arithmetic operations cannot be executed together with averaging operations. First check that trace mode has not been set to averaging mode. Trace mode may be set to any other mode except averaging.
And although trace mode may be set in dual display mode, the marker must be tracing the waveform to be measured. In any other case, the marker may be on or off.

(2) Set the virtical axis scale to 10 dB/div.

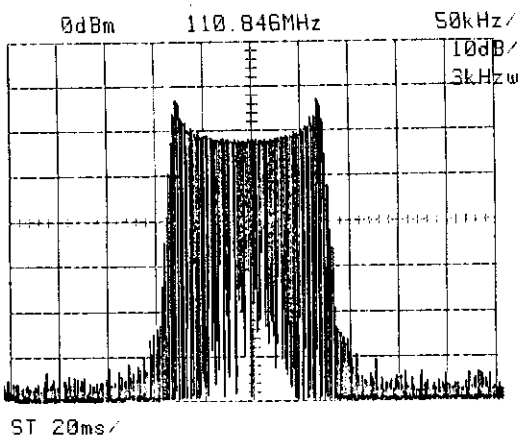
(3) Shift the spectrum signal to be measured to the center of the screen.

(4) Press the [f], [2], and [kHz dB] (CLEAR → END) in that order to commence the occupied frequency bandwidth calculation (operation time of about 0.7 sec.). A buzzer indicates completion of the operation, and two markers (Δ markers) appear at points X and Y described above. The occupied frequency bandwidth is indicated as the difference between the two Δ markers, and the occupied frequency bandwidth (OBW) calculation mode becomes the active function.
If the conditions in (1) and (2) have not been met at this stage, the buzzer is activated and an error message is displayed on the screen without any occupied frequency bandwidth (OBW) calculation being executed.
Successive occupied frequency bandwidth calculations can be executed by repeated pressing of [kHz dB] (CLEAR → END), when already in occupied frequency bandwidth (OBW) calculation mode.
UP, DOWN, and DATA keys are invalid in this case.

(5) It may not be possible to obtain accurate data if the resolution bandwidth (RBW) is less than 1/20 of SPAN/DIV.

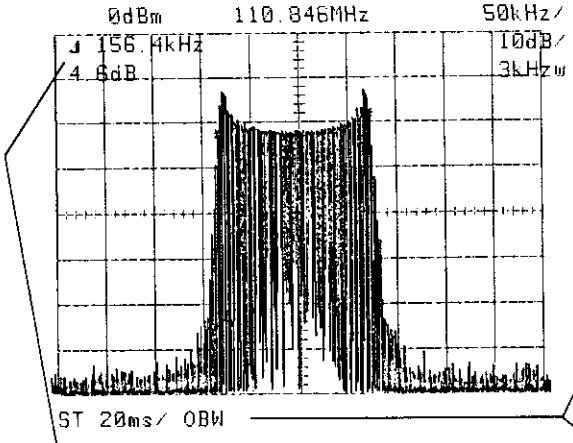
(1) Abbreviated

(2) Check that 10 dB/ has been set, and that the marker is tracing the relevant waveform (where occupied frequency bandwidth is to be measured) if that marker is on.



(3) [f] [2] [kHz dB] CLEAR→END

Approximately 0.7 sec. later,



The occupied frequency bandwidth of the signal is indicated as the Δ marker frequency difference.

Although MARKER is indicated as the active function during occupied frequency bandwidth calculations, this is only temporary.

If [kHz dB] is pressed when occupied frequency bandwidth has already been set as the active function, the arithmetic operation is commenced immediately.

4-11-5. Sweep Adapter AFC

This function is used in conjunction with the TR13211 Sweep Adapter (designed for use with the TR4133/B analyzers). For details on operating procedures, refer to the TR13211 instruction manual.

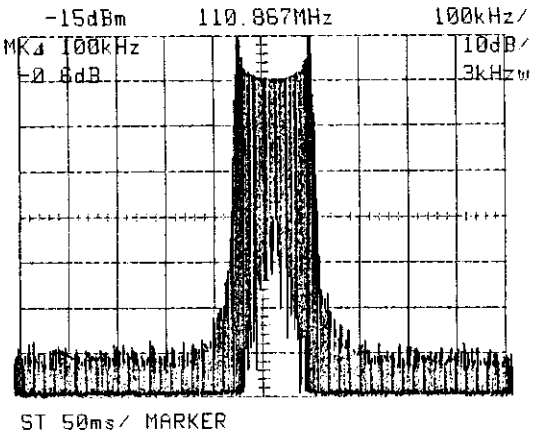
(1) Sweep adapter AFC (abbreviated SA*AFC) is selected as the active function when the [f], [4], and [kHz dB] (CLEAR→END) are pressed in that order.

(2) AFC is switched on irrespective of SPAN/DIV by pressing the "kHz" key after an odd number has been set by numerical key, and is switched off again irrespective of SPAN/DIV by pressing the "kHz" key after an even number has been set by numerical key.

4-11-6. Adjacent Channel Leakage Power Measurement (Note)

Power ratios between the total power "P" of wave form data stored in memoy A, and power in the vicinity of individual points on the frequency axis (total of 701 points, the frequency width being set by Δ marker) are calculated, and after converting the results into dB units, are stored in memory C. These ratios can then be retrieved from this memory for display purposes.

The actual operation procedure is described below.



The total power of the memory A waveform displayed within the scale is expressed in the following way.

$$P = \sum_{i=1}^{701} Pi \quad \ldots\ldots\ldots\ldots \quad (i)$$

where $Pi = Vi^2/R$,

Vi is the voltage at each point, and R is the TR4133/B input impedance (50 ohm)
The Δ marker frequency is

$$\Delta X \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (ii)$$

$P_{ADJ}(x)$ which represents the adjacent channel leakage power at each point on the frequency axis can be expressed in the following way.

$$P_{ADJ}(x) = 10*\log[(\sum_{i=X-\Delta x/2}^{X+\Delta x/2} Pi)/P] \text{ (unit: dB)} \quad \ldots\ldots\ldots \quad (iii)$$

$P_{ADJ}(x)$ is determined for all points from 1 to 701 and is stored in memory C as waveform data. In this case, the following conditions apply.

- The top line of the scale is set when the result obtained by using equation (iii) is 0 dB.
- Likewise, the bottom line of the scale is set when the result is -80 dB.

Note: Adjacent channel leakage power definition
A definition within the narrow band FM system is given in a report by the Japanese Radio Technology Commission of 1985 (March). To quote the definition:-
"The IEC definition as given in IEC Pub. 489-2 refers to that portion of the total transmitted power which subsides within a band of 8.5 kHz between both adjacent channels under certain modulation conditions (1.25 kHz, 60% modulation + 10 dB)".

And according to the same report, this adjacent channel leadkage power must be less than 60 dB in narrow band FM transmitters.
Where the modulation method and frequency band differ, however, the "adjacent channel leakage power" measuring conditions and limits also differ.
In arithmetic operations executed by the External Keyboard, the meaning of adjacent channel leakage power is widened to enable the channel bandwidth (8.5 kHz in the above description) to be set to any value with the leakage value being calculated in the entire frequency bandwidth within the scale.

Operating procedure

(1) Set the vertical axis scale to 10 dB/div.

(2) Hold the desired signal under suitable conditions, obtain the waveform data and store it in memory A.

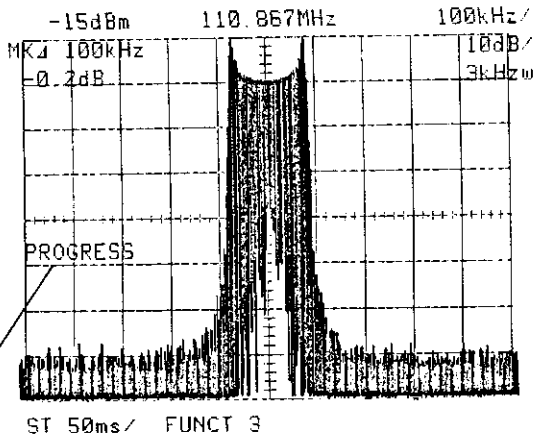
(3) Set the Δ markers. (ΔX setting)

(4) The built-in processor commences the adjacent channel leakage power calculation when the [f], [3], and [kHz dB] (CLEAR→END) keys are pressed in that order.
The buzzer gives a single "pip" sound at the beginning and upon completion of the arithmetic operation.
And while this operation is in progress, the word PROGRESS is displayed on the left hand side of the screen to indicate that the built-in processor is currently executing arithmetic operations.

(5) Upon completion of the arithmetic operations, C VIEW is added to the waveform, and the C memory waveform which indicates the results of the operations is displayed on the screen.
Furthermore, "ADJ-LK" (adjacent channel leakage power) becomes the active function where the relevant arithmetic operations are commenced as soon as the kHz key is pressed.
Since operation (iii) cannot be executed on ΔX/2 within the C waveform between both sides of the scale, the level corresponds with the bottom line of the scale.

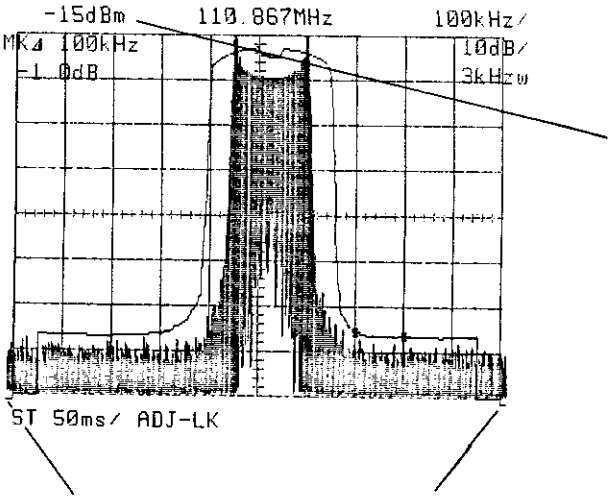
(6) While the marker is tracing waveform C, the marker level represents the power ratio (in dB units) between the total powr of waveform A and the sum of the power components in the vicinity of the marker position frequency (with the relevant frequency range set by Δ marker).
In this case, the marker level can be read directly from the equation (iii) value if the reference level is set to 0 dB by the reference level offset function (see Item 4-3-12).

(1) to (4)



Displayed during execution of arithmetic operations

(1) Vertical axis scale set to 10 dB.
(2) Desired signal displayed under suitable conditions.
(3) Δ marker set.
(4) Adjacent channel leakage power calculation commenced by pressing [f], [3], and [kHz dB] (CLEAR→END).



Calculated results can be read directly from the marker level by setting the reference level to 0 dBm by reference level offset setting.

ΔX/2 for both sides of the scale cannot be calculated

(5) Upon completion of calculations, the results are displayed in waveform C as indicated in the diagram above.

4-11-7. Same Level Marker

With this function, the marker level is stored in memory when "same level marker" is switched on for that marker (the active marker when marker has been set), and the marker is then shifted to a point of the same level on the waveform being traced. Searching in the higher frequency direction is called right hand searching, while searching in the lower frequency direction is called left hand searching. This function is useful in finding the X dB bandwidth of filters etc (especially when controlled by GPIB) by using the TR13211 Sweep Adapter (one of the TR4133/B accessories).

Operating procedure

(1) When the [f], [5], and [kHz dB] keys are pressed with the marker on,

i) the "same level marker" becomes the active function, and SMLVMK is displayed in the bottom center of the screen, and

ii) the marker level at this point (or the active marker level if Δ marker has been set) is stored in memory as the search reference level. This level is called the memory level.

(2) When the  key is then pressed, a search is made for a point of the same level as the memory level, the search being made to the right of the position set in (1) (that is, in the higher frequency direction) as indicated in Figure 4-2. Note, however, that because of quantization errors in the horizontal and vertical axes on the TR4133/B screen, the marker will be shifted to the first point after the memory level has been passed if no point corresponding to the memory level can be found.

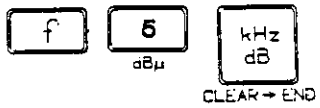
(3) When the  key is pressed, a search is made for a point of the same level as the memory level in the same way as in (2) above, the search being made to the left of the position set in (1) (that is, in the lower frequency direction) as indicated in Figure below.

(4) If the 

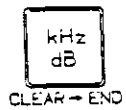
key is pressed when "SMLVMK" is the active function, Step (1) ii) is executed and the memory level is reset.

(5) Steps (2) and (3) are executed repeatedly.

(1) (4)

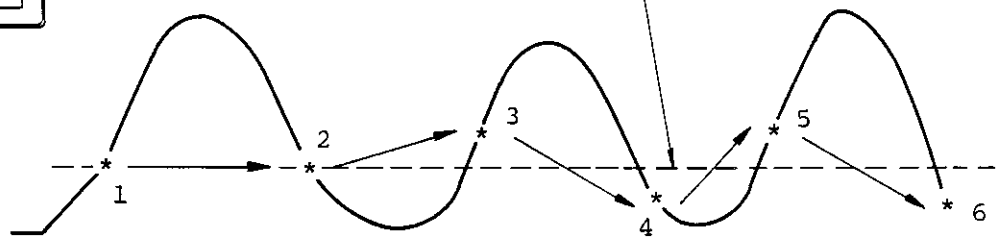


The marker level at this point is stored in memory, and the Steps (2) and (3) arithmetic operation reference levels are used. When "SMLVMK" is the active function:



Level stored in memory in Step (1) or (4). "Memory level"

(2)  right hand searching



Marker is shifted from 1 to 6.

(3) Left hand searching

If the search is started from point 6 in the above diagram, the marker will be shifted from 6 to 1. The memory level is the same in Steps (2) and (3).

4-11-8. Adjacent peak search

The marker is moved from an arbitrary marker point to the maximum peak that is obtainable within an arbitray range (the number of points in the range can be specified arbitrarily).

(1) Set the marker to ON, and move it close to the signal to be searched.

(2) Press [f] [6] [kHz dB] , and the active function will be set in the adjacent peak search mode (ADJPK).
In this state, the marker can also be moved to any desired point by using the [⇩] [⇩] [⇧] [⇧] keys. Marker functions (PEAK SEARCH, NOISE/Hz, etc.) other than the active function can also be used.

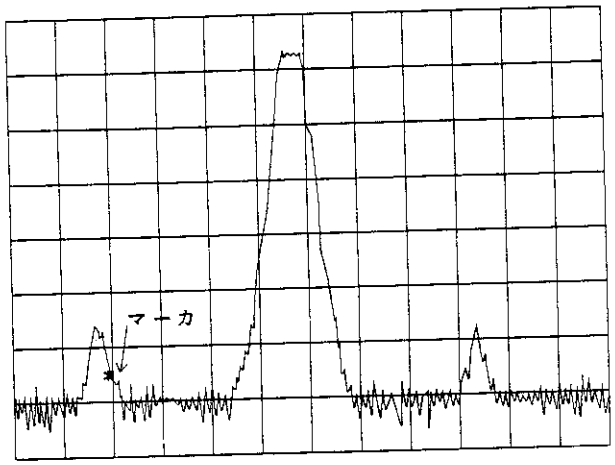
(3) Specify the range to be searched for the peak in terms of the number of points by using the DATA keys, and press the GHz key. One graduation of the display graticule of TR4133/B corresponds to 70 points.
To search for peak within the range of one graduation both before and after the marker, for example, 70 x 2 = 140 points must be searched, and therefore press [1] [4] [0] [GHz V sec] .

(4) Press the kHz key, and the peak will move to the maximum level in the range specified in step (3) above.

(5) The adjacent peak search mode is cancelled when any other active function (CENTER FREQ, etc.) is set.

(6) In step (3), it is also possible to set the range to be searched as a range between the marker and the left end line of the display graticule without using the DATA keys. In this case, move the marker to the desired point and press the MHz key. The range between the marker position and the left end of the display graticule will be set for searching.

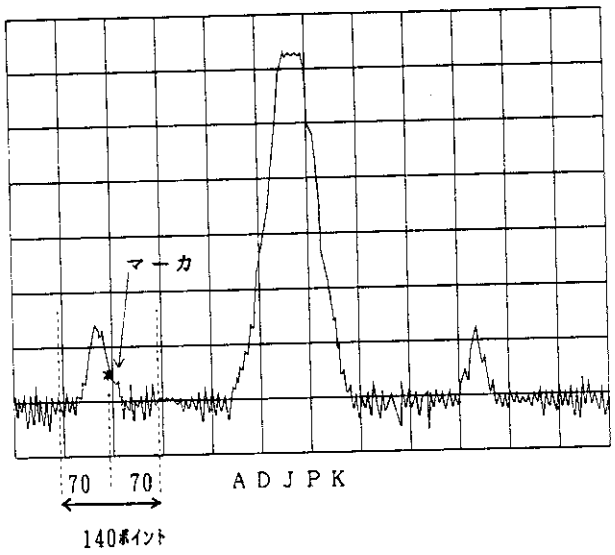
(1) NORMAL



MARKER

(2) f 6 kHz dB

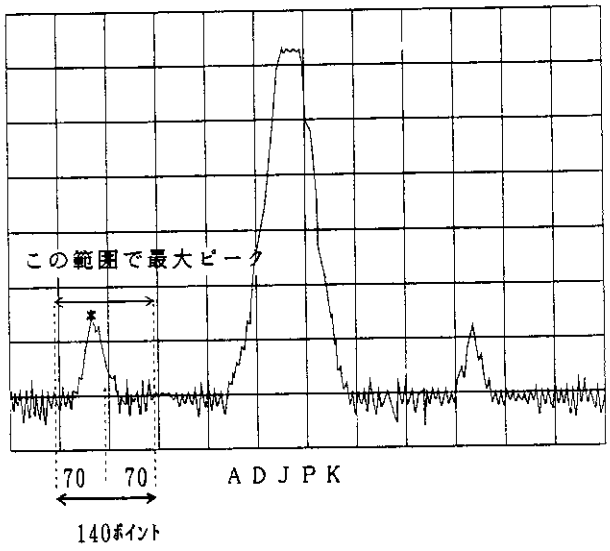
(3) 1 4 0 GHz V sec



ADJPK

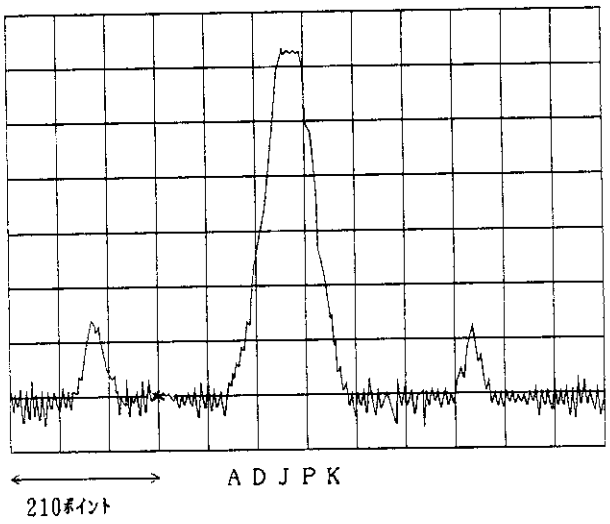
(4) kHz dB

This operation will cause the range of 70 points on both sides of the marker (one graduation on each side) to be searched.

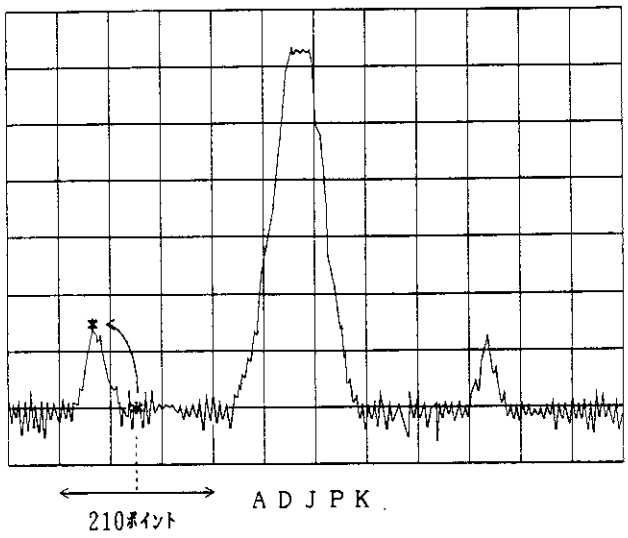


(5) Omitted

(6) If MHz mV ms is pressed instead of using step (3), the range between the marker and the left end of the display graticule is set for searching.



When the [kHz dB] key is pressed, the search is performed over the range set by the above operation, with the marker set at its center position.



SECTION 5
MEASURING PROCEDURES

This section describes the measuring procedures to be followed when using the TR41301 External Keyboard.

5-1. FREQUENCY MEASUREMENTS

5-1-1. Frequency Calibration

Before commencing frequency measurements, let the TR4133/B warm up for 30 minutes after switching the power on. Then after opening the INPUT terminals, press the SHIFT and 0 (ZERO CAL) switches for automatic frequency calibration.

Signal frequencies can be measured by two different methods. The first method involves adjustment of the center frequency, aligning the signal spectrum to be measured in the center of the screen, and reading the center frequency displayed at that time. The other method involves aligning a marker with the spectrum peak and reading the marker frequency. In both methods, measuring error is determined by the frequency setting accuracy. Since this setting accuracy is improved by using a narrower span/div, a narrow span/div should always be used where greater setting accuracy is desired. The center frequency measuring accuracy when executing measurements with span/div in excess of 50 kHz is

$$\pm\{1\ \text{MHz} + (20\%\ \text{of span/div})\}$$

after the FREQ CAL switch is pressed. Pressing this switch results in compensation of frequency error (less than approx. ±20 MHz) in the first local oscillator of the TR4133/B. Since the center frequency display accuracy is greater than ±20 Mhz when span/div is set to 100 MHz/or more, there is no compensatory effect if the FREQ CAL switch is pressed. Therefore, the FREQ CAL switch need not be pressed in this case.

5-1-2. Frequency Measurement Examples

(1) FREQ SPAN [FULL]

(2) MARKER [NORMAL]

(3) Using [FINE ⇩] [⇩] [⇧] and [FINE ⇧] align marker with signal peak to be measured.

> **NOTE**
>
> If the signal to be measured is the maximum level signal on the screen, press the [PEAK SEARCH] key.

(4) [SPAN /DIV] [5] [MHz mV ms] RESOLN BW [AUTO]

(5) Using MARKER [NORMAL] [FINE ⇩] [⇩] [⇧] and [FINE ⇧], align marker with signal peak to be measured (or use the peak search function).

(6) MARKER [MKR→CF]

(7) [SPAN /DIV] [2] [MHz mV ms]

(8) [FREQ CAL]

(9) Using MARKER [NORMAL], [FINE ⇩] [⇩] [⇧] and [FINE ⇧], align marker with signal peak to be measured (or use the peak search function).

(10) MARKER [MKR→CF]

The center frequency displayed at this time is the signal frequency with an accuracy of ±(1 MHz + 400 kHz). That is, ±1.4 MHz (see Figure 5-1).

To further improve the accuracy, proceed with the following setting.

(11) [SPAN /DIV] [5] [0] [kHz dB]

(12) Using MARKER [NORMAL] [FINE] [↓] and [FINE] [↑], align marker with signal peak to be measured (or use the peak search function).

(13) MARKER [MKR→CF]

(14) [SPAN /DIV] [2] [0] [kHz dB] [AFC]

(15) Using MARKER [NORMAL] [FINE] [↓] and [FINE] [↑], align marker with signal peak to be measured (or use the peak search function).

(16) MARKER [MKR→CF]

(17) The center frequency displayed at this time is the measured frequency with an accuracy of ±10 kHz x N (where N is number of harmonics - see Figure 5-2).

For details on harmonics, refer to Subsection 4-8 and Table 4-3 of the TR4133/B instruction manual.

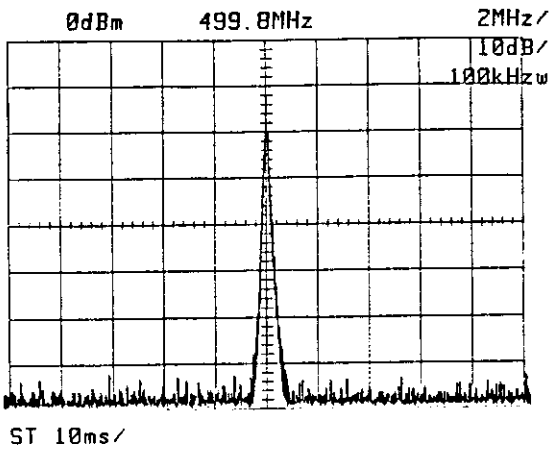


Fig. 5-1 Measurement at 2 MHz/

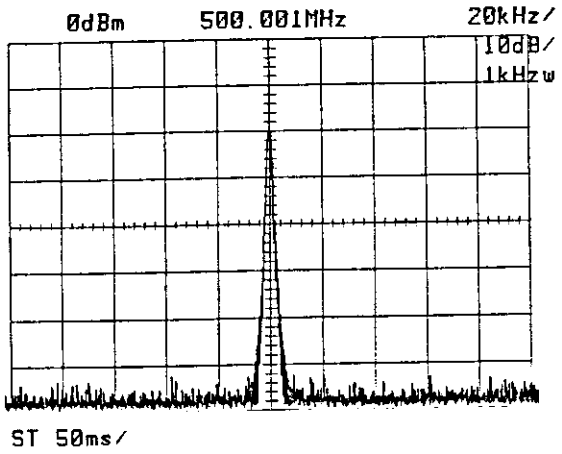


Fig. 5-2 Measurement at 20 kHz/

5-2. LEVEL MEASUREMENT

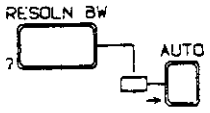
When levels are to be measured, first calibrated the amplitude by using the analyzer calibration signal (200 MHz, -30 dBm). The calibration procedure is described in Subsection 4-4, "Amplitude Calibration" of the TR4133/B instruction manual.

5-2-1. Level Measurements in LOG Mode

(1) Connect the signal to be measured to the INPUT connector.

CAUTION

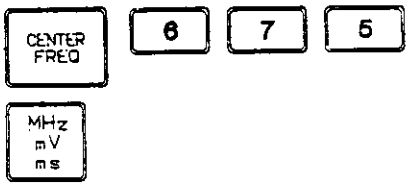
The maximum input levels which can be applied to the analyzer with the input attenuator set to a value greater than 20 dB are +20 dbm, +127 dBμ, +110 dBpW, and 0 Vdc.
Due attention should always be paid to the input signal level. Furthermore, application of an excessive input level to the first mixer may result in mixer saturation and damage which will prevent accurate measurements from being made.
Output reduction due to saturation in the analyzer is specified at less than -1 dB when the first mixer input (signal level input attenuator value) is -10 dBm. And since an input attenuator setting of 0 dB can result in the generation of a large error due to mismatching, accurate measurements can be achieved by setting to velues in excess of 10 dB.

(2) Set 

to AUTO.

(3) 

(4) If the frequency of the signal to be measured is known approximately, set that frequency.



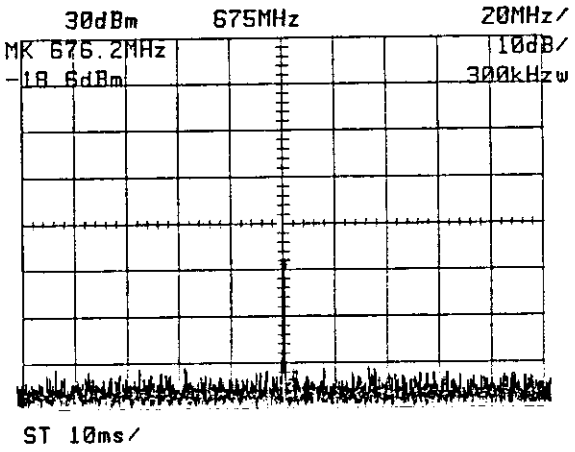
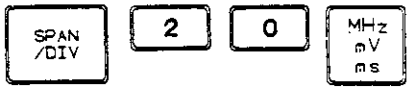
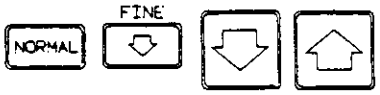


Fig. 5-3 Level measurement

(5) Set the SPAN/DIV to be measured.



(6) Using MARKER 

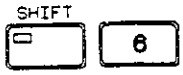
and 

, align marker with signal peak to be measured (or use the PEAK SEARCH function).

(7) Read the signal level from the marker level display.
The level unit can be altered by pressing the following keys.

dBm 

dBμ 

dBpW 

(8) The maximum measuring error in this case is given by the following formula.

Maximum measuring error

= Frequency response ±CAL signal level accuracy (±0.5 dB)
  ± IF GAIN accuracy (±0.5 dB)
  ± Resolution bandwidth switching accuracy (±1 dB)
  ± LOG display accuracy (±1.5 dB)
  ± Marker setting accuracy (±0.2 dB)
  ± INPUT ATT switching error (±1 dB)
  ± Error due to mismatching
= Frequency response ± Error due to mismatching ±4.7 dB (Note)

Among the above error factors, the resolution bandwidth switching accuracy (±1 dB) and the INPUT ATT switching accuracy (±1 dB) become 0 dB if the measurement is made under the same setting conditions as the settings during amplitude calibration (RBW 300 kHz, INPUT ATT 10 dB).

The LOG display accuracy (±1.5 dB) becomes approximately ±0.2 dB if the signal level is measured within ±1 dB of the reference level.

If greater level measurement is desired after considering the above, use the IF replacement method described below.

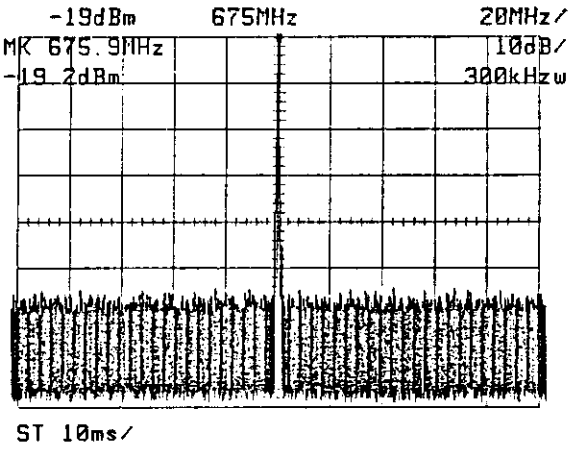


Fig. 5-4 Level measurement by IF replacement

(9) RESOLN BW AUTO

(10) SPAN /DIV 2 0 MHz mV ms

(11) ATT 1 0 kHz dB

(12) Using MARKER NORMAL FINE and FINE, align marker with signal peak (or use the PEAK SEARCH function).

(13) MARKER MKR→REF LVL

(14) Using MARKER NORMAL FINE and FINE, align marker with signal peak (or use the peak search function) and measure the level (see Figure 5-4). The error in this case is

Maximum measuring error

= Frequency response ± Error due to mismatching ±1.4 dB (Note)

Note: The ±1.4 dB and ±4.7 dB in each formula are calculated on the assumption that the error factors all act in the same direction, and thereby represent the worst possible error. In almost all actual cases, however, some of these errors tend to cancel each other out, so the actual error is considerably smaller.

5-2-2. Level Measurement in Linear Mode

(1) 

(2) Using 

and , align marker with signal peak (or use the PEAK SEARCH function) and read the level. (See Figure 5-5).

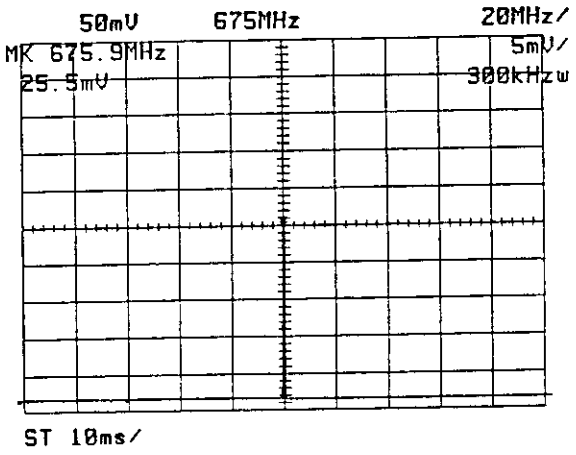


Fig. 5-5 Reading the marker in linear mode

5-3. DISTORTION MEASUREMENT

The measuring limits in distortion measurements are set by distortion generated by the analyzer internal mixer, and by the noise level within the analyzer. Since the TR4133B analyzer has been equipped with a preselector, harmonic distortion in the 3.5 GHz thru 20 GHz range is in excess of 100 dB when a 0 dBm input is applied.

In the 10 MHz thru 3.6 GHz range, the harmonic distortion is in excess of 70 dB in both the TR4133 and TR4133B when a -30 dBm input is applied, and the noise level is less than -118 dBm (at RBW 1 kHz). Hence, when harmonics in excess of 60 dB are measured in this band, the input level of the signal applied to the analyzer's mixer (that is, signal level - input ATT) must be set to a level below -30 dBm.
And since harmonics in excess of 60 dB have to be measured, the noise level must be kept below -90 dBm (-30 dBm -60 dB) by setting RBW to less than 300 kHz and inserting a VIDEO FILTER. If adequate sweep time is not set by this setting, the UNCAL message will appear, and the signal level will drop. Use of a rejection filter (high-pass filter or notch filter) for the fundamental wave is effective in expanding the dynamic range in harmonic distortion measurements. When such filters are inserted between the measured device and the analyzer, the dynamic range is expanded only for the attenuation.
The following filters are availabel from ADVANTEST.

Filter	Frequency band of object communications equipment
MEP-292	26 MHz to 30 MHz
MEP-293	50 MHz to 80 MHz
MEP-294	120 MHz to 190 MHz
MEP-295	335 MHz to 520 MHz

5-3-1. Distortion Measurements in 900 MHz Communications Equipment

Connect up the 900 MHz communications equipment, RF coupler, and a high-pass filter as outlined in Figure 5-6.
Since the maximum permissible input level for the analyzer is +20 dBm with an input attenuator in excess of 20 dB, select a coupler value which ensures that the RF coupler output is less than +20 dBm.

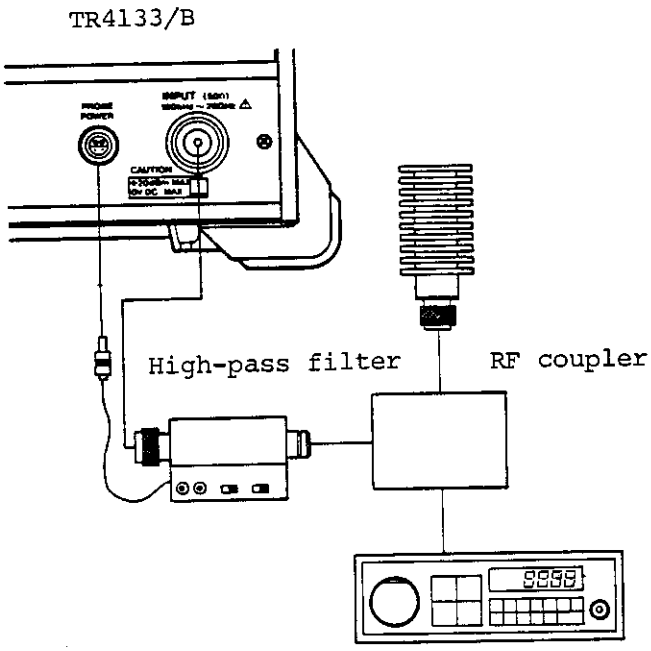


Fig. 5-6 Set up for measuring communications equipment distortion

(1) Switch the high-pass filter FLTR/THRU switch to the THRU position.

(2) Adjust the MIN INPUT ATT to a value which ensures a mixer input signal level (signal level - input ATT value) of less than -10 dBm.

For example, for a signal level of +15 dB, set [ATT] [3] [0] [kHz dB]

(3) [REF LEVEL] [1] [5] [kHz dB]

(4) [CENTER FREQ] [9] [0] [3] [MHz mV ms]

(5) [SPAN /DIV] [5] [0] [MHz mV ms]

(6) [VIDEO FLTR] [1] [0] [kHz dB]

(7) MARKER [PEAK SEARCH]

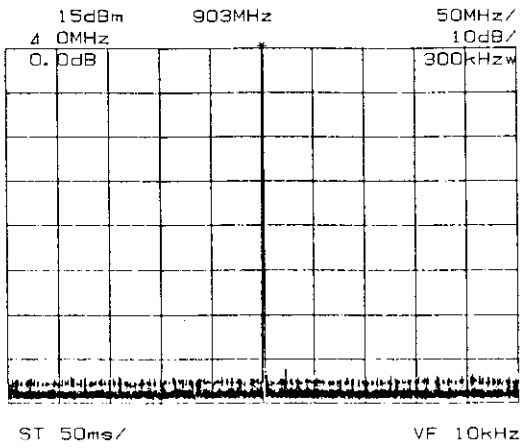


Fig. 5-7 Measurement of fundamental wave level when high-pass filter is set to THRU

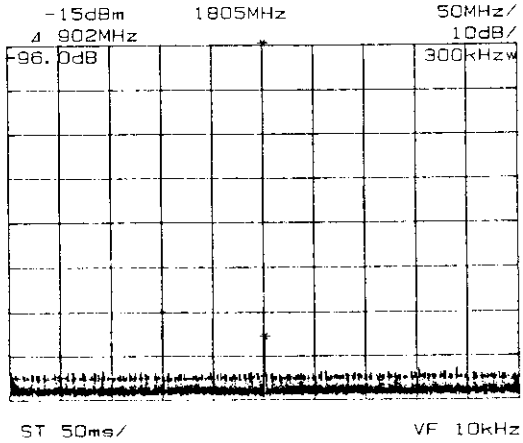


Fig. 5-8 Measurement of second harmonic wave level when high-pass filter is set to FLTR. The level difference between the Δ marker display and the fundamental wave level is measured.

(8) [SHIFT] [Δ FIXED Δ] (See Figure 5-7)

(9) [CENTER FREQ] [1] [8] [0] [6] [MHz mV ms]

(10) Switch the high-pass filter FLTR/THRU switch to the FLTR position. ATT is decreased when the harmonic wave level is low.

(11) [ATT] [0] [kHz dB]

(12) When MARKER [PEAK SEARCH] is pressed, the Δ marker display is shown as a ratio (dB) in respect to the fundamental wave of the second harmonic wave. A value of -95.0 dB is then obtained when the high-pass filter compensation value of 1 dB is added. (See Figure 5-8).

(13) [CENTER FREQ] [2] [7] [0] [9] [MHz mV ms]

(14) And when MARKER PEAK SEARCH is pressed again, the third harmonic wave level can be measured as -97.8 dB.

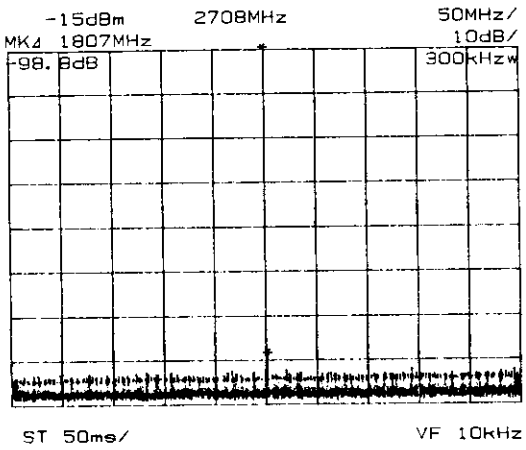


Fig. 5-9 High-pass filter set to FLTR and the third harmonic wave level measured. Level difference between Δ marker and fundamental wave is displayed.

5-4. AM SIGNAL MEASUREMENT

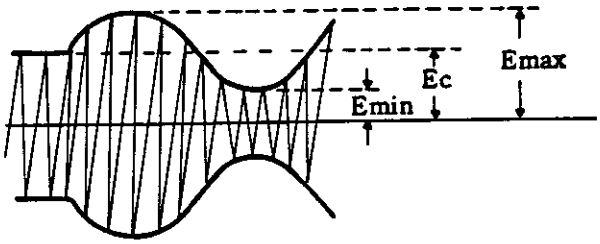
The modulation frequency and modulation index m of AM signals can be measured by spectrum analyzer.

When measuring modulation frequencies, the horizontal axis on the screen can be set to ZERO SPAN mode use as a fixed receiver if the signal modulation frequency is low. Since the demodulated wave appears on the screen in this case, the modulation index m can be determined on the time axis from this waveform (see Figure 5-10 (a)).

And when the modulation frequency is high, the horizontal axis is generally set to SPAN/DIV mode, and the modulation frequency then determined from the difference between the sideband and carrier frequencies on the frequency axis (see Figure 5-10 (b)).

Greater accuracy is attained if measurements are made is LINEAR mode when the modulation index is greater than 10%, and in LOG mode when less than 10%.

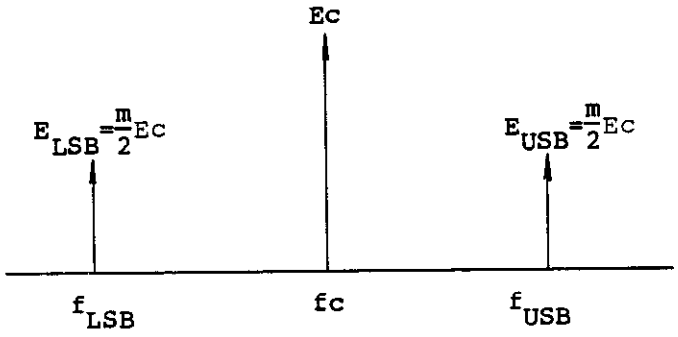
Examples illustrating how AM signal modulation frequency and modulation index are determined are outlined below.



$$m\ (\%) = \frac{Emax - Ec}{Ec} \times 100$$

$$= \frac{Emax - Emin}{Emax + Emin} \times 100$$

(a) ZERO SPAN mode (time axis display)



$$m\ (\%) = \frac{2E_{SB}}{Ec} \times 100$$

(b) SPAN/DIV mode (frequency axis display)

Fig. 5-10 Calculation of AM signal modulation index m on time and frquency axes

5-4-1. AM Signal Measurement when Modulation Frequency is Low and Modulation Index is Large

(1) Connect the AM trasmitter output to the analyzer INPUT connector via an external attenuator if necessary as indicated in Figure 5-11.

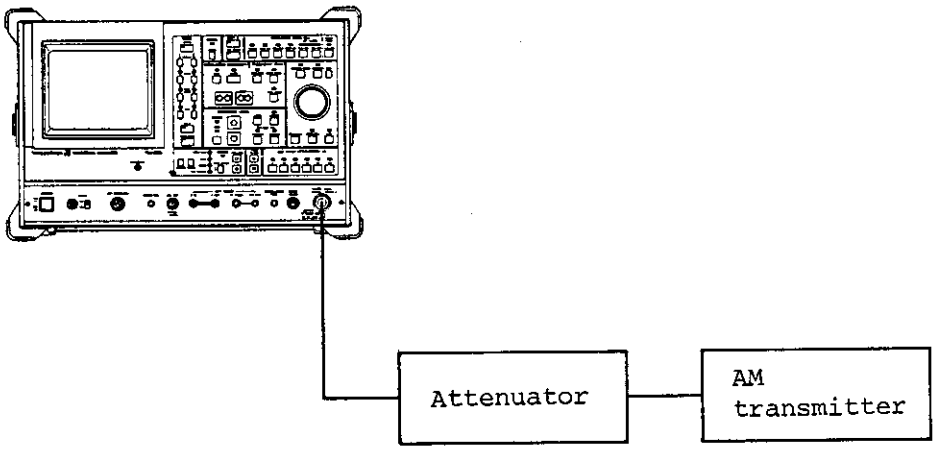


Fig. 5-11 AM signal measuring set-up

(2) Set the frequency of the signal to be measured.

CENTER FREQ [9] [0] [3] [MHz mV ms]

(3) Set RBW to a value at least three times greater than the modulation frequency.

RESOLN BW [1] [0] [0] [kHz dB]

(4) Using MARKER [NORMAL], [FINE] [↓] [↑] and [FINE] [↑], align marker with the peak of the signal to be measured (or use the peak search function).

(5) Using [REF LEVEL], [FINE] [↓] [↑] and [FINE] [↑], align the signal peak to a position close to the reference level on the graticule.

(6) [SHIFT] [9] LINEAR

(7) FREQ SPAN [ZERO]

(8) Using [CENTER FREQ], [FINE] [▽], [▽], [△] and [FINE] [△], adjust the signal level to the highest position on the screen.

(9) TRIGGER MODE [VIDEO]

(10) Set TIME/DIV to a value which is easy to read.

[SWP TIME/] [ ] [5] [MHz mV ms]

(11) Using MARKER [NORMAL], [FINE] [▽], [▽], [△] and [FINE] [△], align the marker with the signal peak.

(12) Using MARKER [Δ], [FINE] [▽], [▽], [△] and [FINE] [△], align the marker with the next signal peak.

(13) Measurements are possible where one cycle from the Δ marker position (see Figure 5-12).

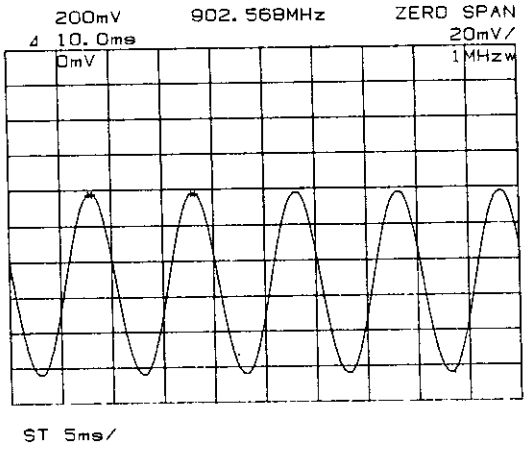
$$fm = \frac{1}{10.0\ (ms)} = 100\ (Hz)$$

(14) Using MARKER [NORMAL], [FINE] [▽], [▽], [△] and [FINE] [△], align the marker with the signal peak. The level at this stage can be read from the displayed marker level.

E max (mV)

(15) Using [FINE] [▽], [▽], [△] and [FINE] [△], align the marker with the minimum value on the waveform, and read the Emin value. The modulation index m(%) can be obtained from the following equation.

$$m = \frac{Emax - Emin}{Emax + Emin}$$



$$fm = \frac{1}{10.0\ (ms)}$$

$$= 100\ (Hz)$$

Fg. 5-12 AM modulation frequency measurement

5-4-2. AM Signal Measurement when Modulation Frequency is High and Modulation Index is Small

(1) Connect the AM transmitter output to the analyzer INPUT onnector via an external attenuator if necessary as indicated in Figure 5-11.

(2) SHIFT, 7 (10dB/DIV), RESOLN BW AUTO

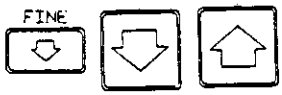
(3) Set SPAN/DIV to a value below the modulation frequency.

SPAN /DIV, 1, 0, kHz dB

(4) Adjust the center frequency to the carrier frequency.

CENTER FREQ, 9, 0, 2, ., 0, 8, 3, MHz mV ms

(5) MARKER PEAK SEARCH, MKR→CF, MKR→REF LVL, Δ

(6) Using 

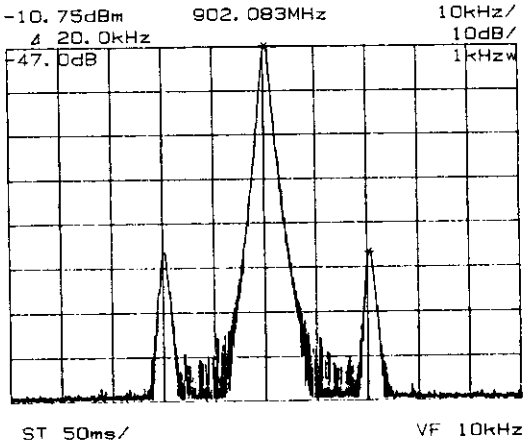
and , align the marker with the sideband signal peak. (See Figure 5-13)

The modulation frequency and modulation index can be obtained from Δ marker frequency and level display.

fm = Δ marker frequency display

$$m = \text{Log}^{-1}\ \frac{(E_{SB} - E_C + 6)}{20} \times 100\%$$

$$= \text{Log}^{-1}\ \frac{(\Delta\text{marker level display} + 6)}{20} \times 100\%$$



fm = 20.0 kHz

$$m = \text{Log}^{-1}\left(\frac{-47 + 6}{20}\right) \times 100$$

$$= 0.89\%$$

Fig. 5-13 AM signal measurment when modulation frequency is high and m is small

The relationship between the modulation index m (%) and the value (dB) obatained by subtracting the carrier level E_C from the sideband level E_{SB} is outlined in Figure 5-14.

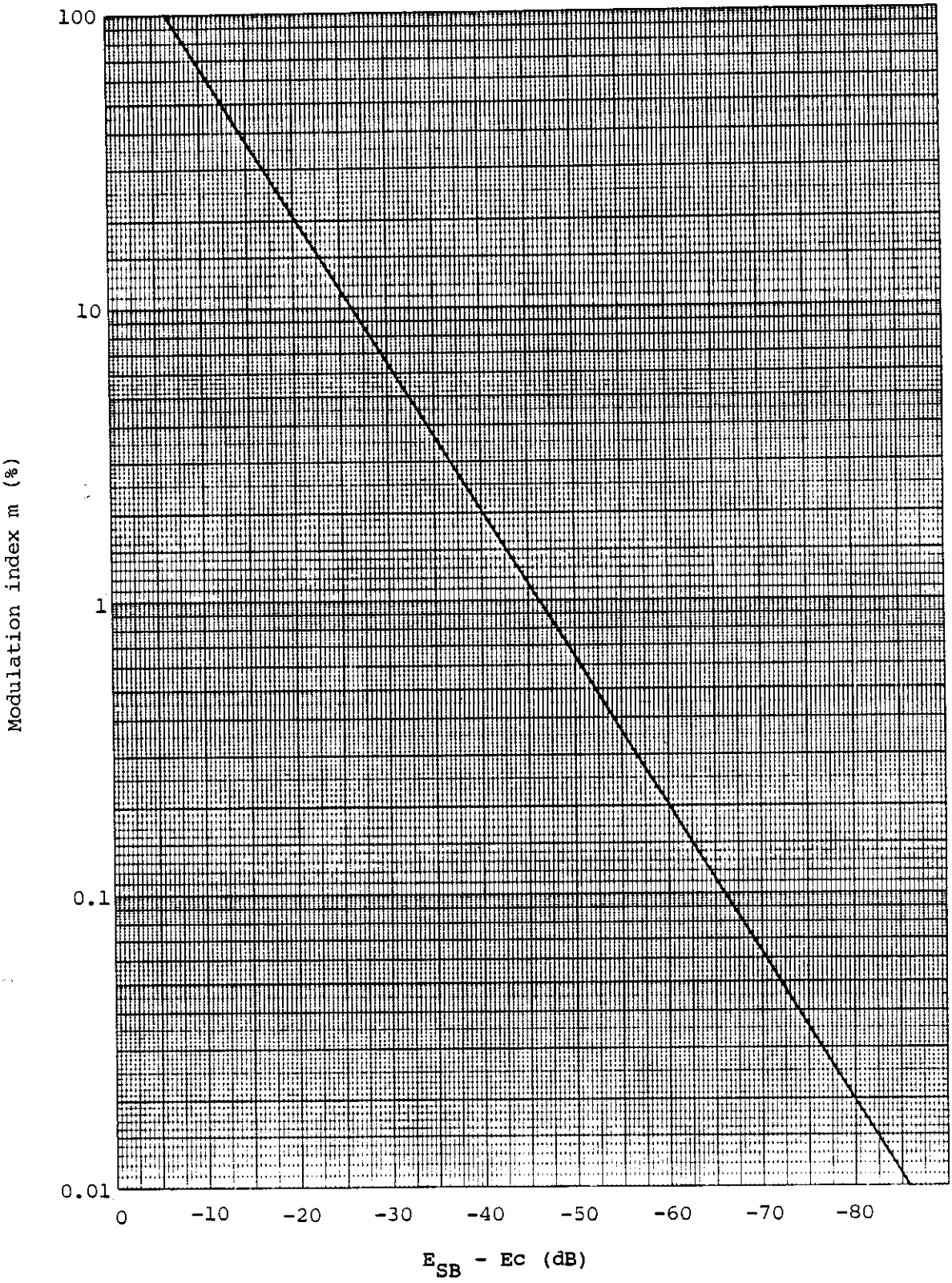


Fig. 5-14 Relationship between modulation index and the difference between the sideband and carrier levels

5-5. FM SIGNAL MEASUREMENT

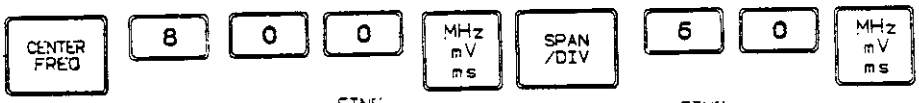
When FM signals are measured by spectrum analyzer, values can be obtained for the modulation index m, the modulation frequency fm, and the peak deviation Δfpeak.

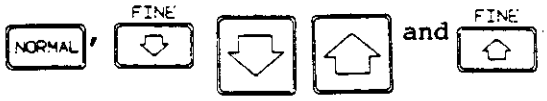
When the modulation frequency is low, the analyzer's horizontal axis is set to ZERO SPAN mode for use as a fixed tuned receiver where the IF filter slope is used for FM demodulation to enable measurement on the time axis.

When the modulation frequency is high, on the other hand, measurments are made on the frequency axis, and the modulation frequency is obtained from the sideband frequency. Examples are outlined below.

5-5-1. FM Signal Measurement when Modulation Frequency is Low

(1) Adjust the signal's carrier frequency to the center frequency.



(2) Using MARKER 

, align marker with the signal peak.

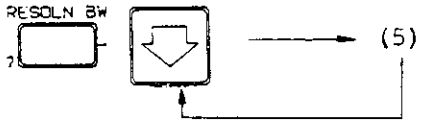
(3) 

(4) FREQ SPAN ZERO

(5) Using 

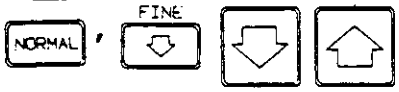
, aadjust the demodulated signal to the highest position on the screen (reference level).

(6) Set RESOLUTION BW to a value at at least three times greater than the modulation frequency, and under conditions where the demodulated signal can be easily seen.

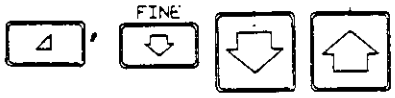


(7) TRIGGER MODE 

(8) Set the sweep time to a value where the waveform is easy to observe.

(9) Using MARKER 

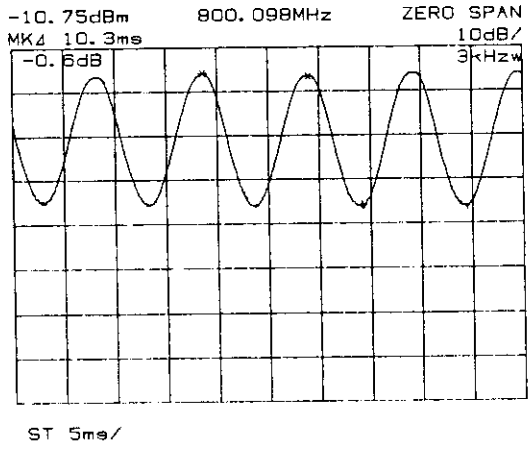
, align marker with the peak of the demodulated signal.

(10) Using MARKER 

, align marker with the next peak of the demodulated signal.

(11) The time difference T(s) between the Δ markers is given as

$$fm = \frac{1}{T(S)} \quad Hz$$



$$fm = \frac{1}{10.3\ (ms)}$$

$$= 97.1\ (Hz)$$

Fig. 5-15 Measurement of FM modulation frequency when modulation frequency is low

5-5-2. FM Signal Measurement when Modulation Frequency is High

(1) SHIFT 7 (10dB/DIV) RESOLN BW AUTO

(2) Set SPAN/DIV to a value below the modulation frequency.

SPAN /DIV 1 0 kHz dB

(3) Set the carrier frequency.

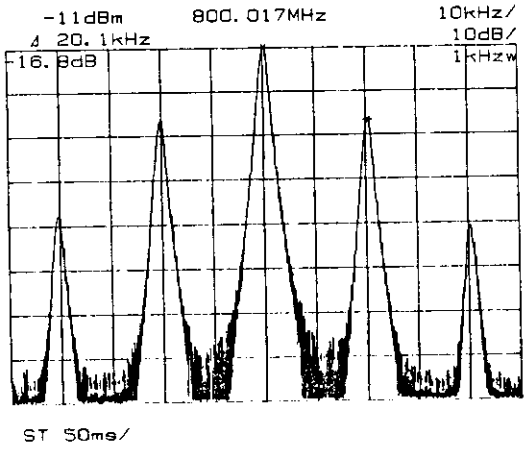
CENTER FREQ 8 0 0 MHz mV ms

(4) Press AFC when waveform appears on the screen.

(5) MARKER PEAK SEARCH MKR→CF MKR→REF LVL Δ

(6) Using FINE ▽ ▽ △ and FINE △, align the marker with the adjacent sideband signal peak. (See Figure 5-16)

(7) The difference in frequency between the Δ markers is the modulation frequency fm.



fm = 20.1 kHz

Fig. 5-16 Measurement of FM modulation frequency when modulation frequency is high

5-5-3. FM Signal Peak Deviation Δfpeak Measurement

Set the resolution bandwidth to the value which includes the main sideband (in excess of five times the modulation frequency). Adjust SPAN/DIV to the peak deviation, and set the value to be measured.

(1) SPAN /DIV — 5 — 0 — kHz dB

(2) CENTER FREQ — 8 — 0 — 0 — MHz mV ms

(3) RESOLN BW — 3 — kHz dB

(4) A — STORE

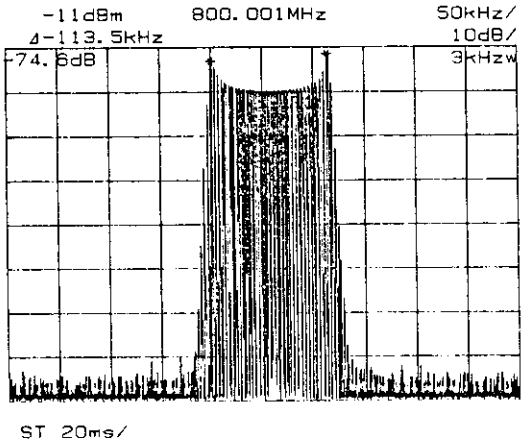
(5) MARKER — PEAK SEARCH — Δ — NEXT PEAK (Figure 5-17)

(6) Find Δfpeak by measuring Δfpeak peak from the marker Δ frequency display.

$$\Delta fpeak = 1/2\ \Delta\ fpeak\ peak$$

The modulation index m can be obtained from the Δfpeak and fm values.

$$m = \frac{\Delta fpeak}{fm}$$



$$\Delta fpeak = \frac{113.5\ kHz}{2}$$

$$= 56.75\ kHz$$

Fig. 5-17 Measurement of FM signal peak deviation

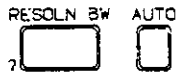
5-5-4. How to Find the FM Modulation Index m when m is Small

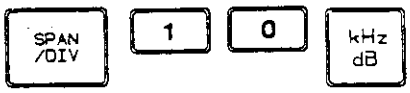
(1) If the FM signal modulation index m is less than about 0.8,

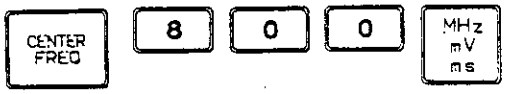
$$m = \frac{2 \times E_{SB}}{E_C}$$

where E_{SB} is the level of the first sideband, and E_C is the carrier level.

(2) Set SPAN/DIV to a value below the modulation frequency, and align the center frequency with the carrier frequency.

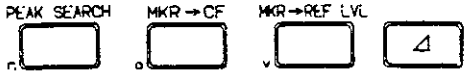
(3) 

(4) 

(5) 

(6) Press 

when waveform appears on the screen.

(7) MARKER 

(8) Using 

and

align the marker with the first sideband signal peak. The modulation index m can thus be obtained from the followig equation if E (dB) represents the Δmarker level display.

$$m = \frac{2 \times E_{SB}}{E_C} = \mathrm{Log}^{-1} \frac{(E_{SB} - E_C + 6)}{20} = \mathrm{Log}^{-1} \frac{(\Delta E + 6)}{20}$$

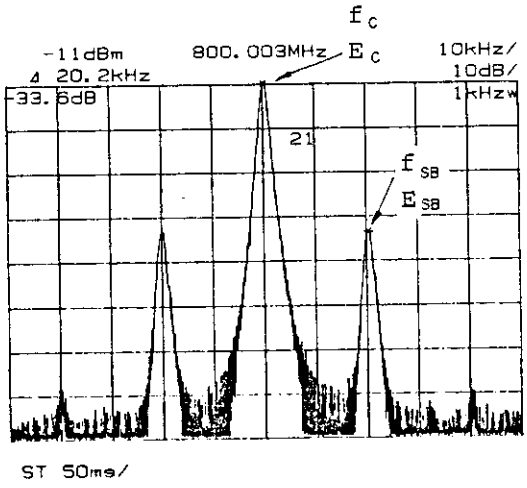
Figure 5-14 in Item 5-4-2 shows the relationship between m and $(E_{SB} - E_C)$ in graphical form.
Note that "m" is represented by % in the figure.

(9) The modulation frequency fm can be obtained from

$$fm = |f_{SB} - f_C|$$

Hence, frequency deviation Δfpeak can be obtained from

$$\Delta fpeak = m \times fm$$



$$m = \text{Log}^{-1}\left(\frac{-33.6 + 6}{20}\right)$$
$$= 4.17\ (\%)$$

Fig. 5-18 FM frequency index measurement ($m \leq 0.8$)

5-6. ELECTRIC FIELD STRENGTH MEASUREMENTS

Spectrum analyzers are the same in principle as electric field strength measuring equipment. An example of measuring the electric field strength by using TR4133/A/B and TR41301 is outlined below.

(1) Connect the antenna to the TR4133A/B INPUT connector (50 ohms). If the antenna impedance is not 50 ohms, match the impedance by using a matching circuit.

(2) Set the center frequency and frequency span to suitable values.

(3) Switch the unit of the reference level at the top of the screen to dBμ by using SHIFT and 6 (dBμ).

(4) Press MARKER NORMAL, and a marker appears on top of screen. Then using FINE ▽ ▽ △ and FINE △, align the marker with the spectrum to be measured.

(5) Read the displayed marker level as ex dBμ.

If Ex (dB): Electric field strength to be found

(1 μV/m = 0 dBμ/m)

He (dB): Effective length of dipole antenna (1 m = 0 dB)

La (dB): Cable loss

Ba (dB): Balun loss

ex = Ex + He - La - Ba

Ex = ex + La - He + Ba

= ex + K

where K is a calibration coefficient. A graph outlining the relationship between frequency and this calibration coefficient is given in Figure 5-19.

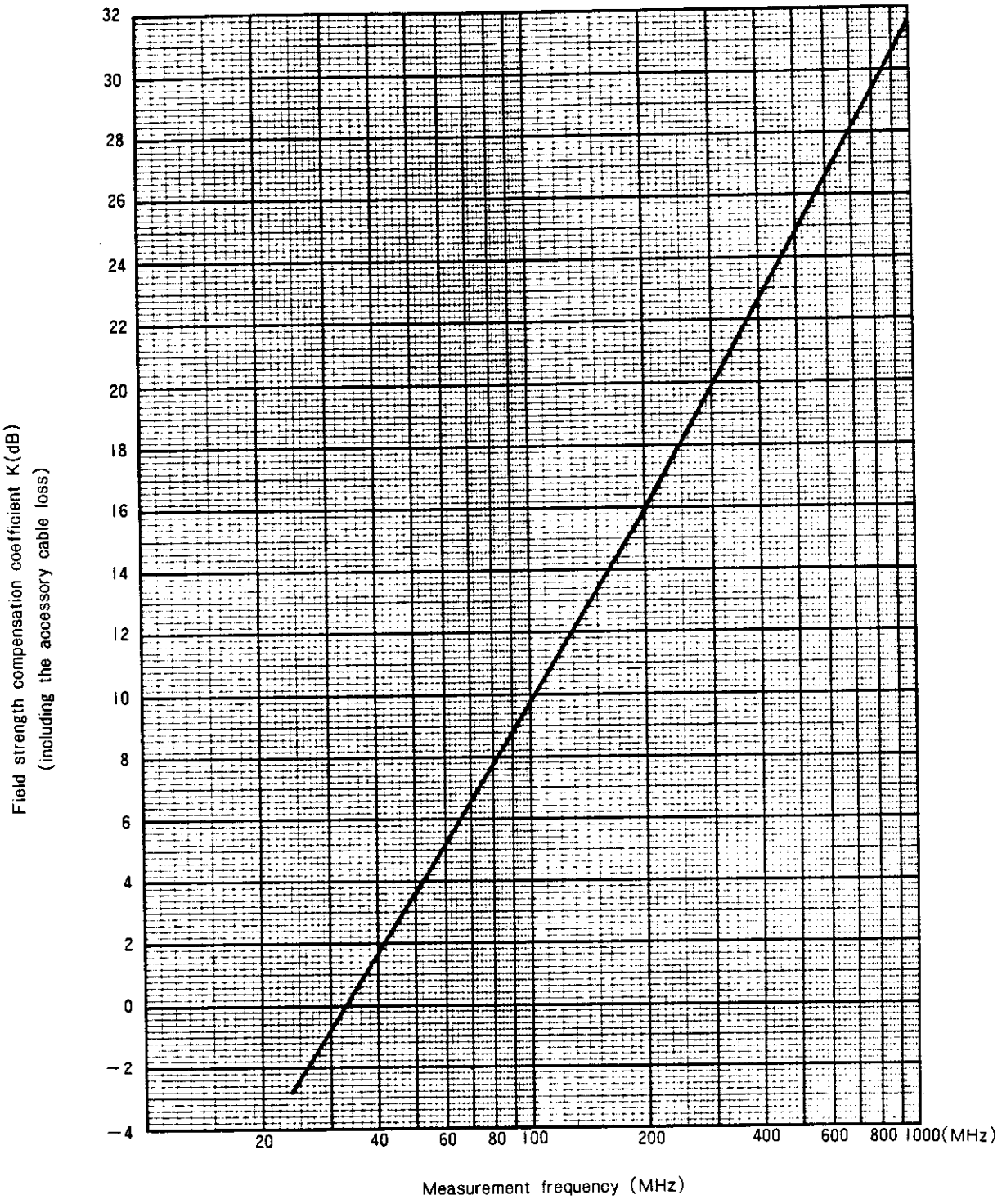


Fig. 5-19 Relationship between frequency and calibration coefficient in electric field strength measurements

5-7. PULSE MODULATED SIGNAL MEASUREMENT

Pulse modulated signals used in radar etc can be measured by spectrum analyzers by using the simple procedure described below.

(1) Pulse repetition frequency (PRF)

(2) Pulse width (τ)

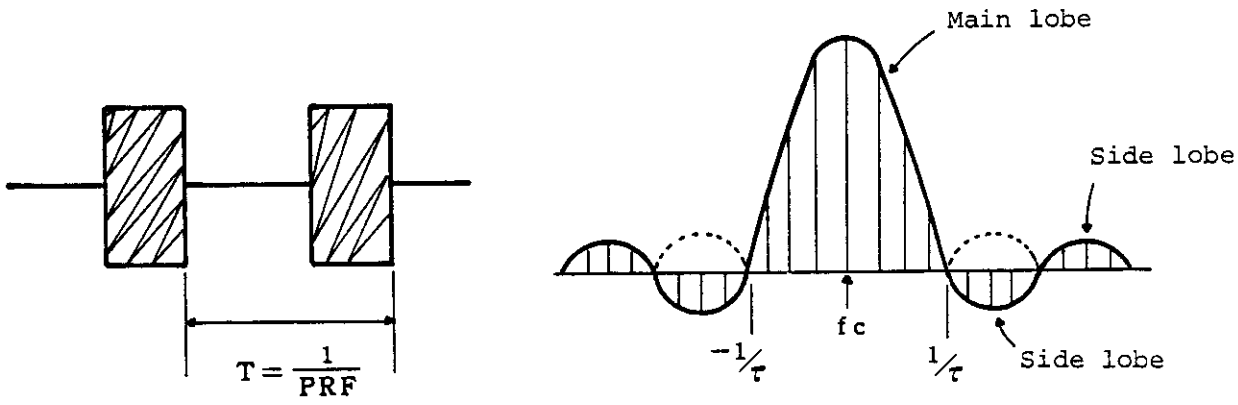
(3) Carrier frequency (fc)

(4) Peak power (P peak)and average power (P ave)

CAUTION

The maximum input level which may be applied to the analyzer is +20 dB, 0 Vdc when MIN INPUT ATTENUATOR is set to 20 dB or higher. Since the peak power of pulse modulated signals in radar etc is very high, make sure the input signal is sufficiently attenuated by coupling etc before applying it to the INPUT connector.

Furthermore, since the analyzer mixer input level is -10 dBm, set the MIN INPUT ATTENUATOR so as to ensure that P peak $\leq$ -10 dBm.



(a) Time axis display (b) Frequency axis display

Fig. 5-20 Representation of pulse modulated signal

To avoid mixer saturation, decrease the MIN INPUT ATTENUATOR setting in 10 dB steps from 50 dB to find the minimum attenuation where the signal level will decrease no further.

5-7-1. Measurement of Pulse Repetition Frequency (PRF)

(1) TRACE [POSI PEAK]

(2) FREQ SPAN [ZERO]

(3) Set the resolution bandwidth to a value sufficiently wider than the pulse repetition frequency.

[RESOLN BW] [1] [0] [0] [kHz dB]

(4) Set the center frequency to the carrier frequency.

[CENTER FREQ] [5] [GHz V sec]

(5) [SWP TIME/] [5] [MHz mV ms]

(6) TRIGGER MODE [SINGLE], SWEEP [STOP/START]

(7) Using MARKER [PEAK SEARCH] [Δ] [FINE ⇩] [⇩] [⇧] and [FINE ⇧], align the marker with the peak of the adjacent signal. (Figure 5-21) The time interval T(ms) between the markers is shown in the Δ marker display, and the pulse repetition frequency (PRF) can be obtained from the following equation.

$$PRF\ (kHz) = 1/T\ (ms)$$

5-7-2. Pulse Width τ and Carrier Frequency Measurements

Pulse width τ can be obtained from the inverse of half the main lobe width or from the inverse of the side lobe width. In this case, set the resolution width within the range specified below to ensure an envelope of sufficient resolution.

$$\text{Pulse repetition frequency (PRF)} \times 1.7 \leqq \text{Resolution bandwidth} \leqq 0.1/\tau$$

Steps (1) thru (7) are the same as Steps (1) thru (7) described in Item 5-7-1. above.

(8) TRIGGER MODE [FREE RUN]

(9) Set SPAN/DIV to a value where the main lobe is clearly shown.

[SPAN /DIV] [1] [0] [MHz mV ms]

(10) Set the REF LEVEL to a value where the signal is easy to observe.

[REF LEVEL] [+/-] [3] [0] [kHz dB]

(11) Set SWEEP TIME to above 70/RPF [Hz] (s/div).

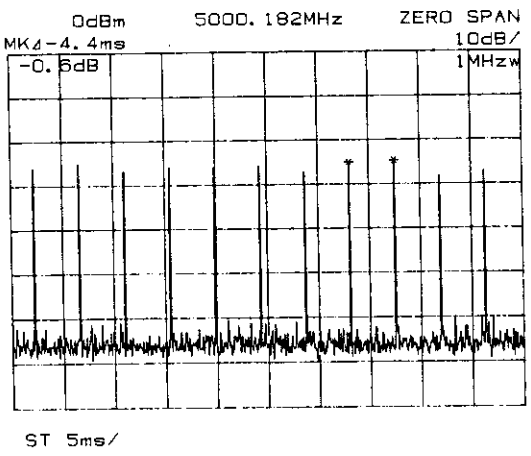
[SWP TIME/] [1] [GHz V sec]

(12) Using MARKER [NORMAL], [FINE] [↓] [↓] [↑] and [FINE] [↑], align the marker with the center of the main lobe. The displayed marker frequency thus becomes the carrier frequency fc, and the measuring accuracy of fc is determined by the pulse width τ. If τ is small, the main lobe is expanded making it difficult to determine the center. To ensure that the center is clearly displayed, SPAN/DIV must be set to a value greater than $1/\tau$. The accuracy of the measured frequency in this case is the same as the accuracy of the center frequency within the set SPAN/DIV. Refer to Subsection 5-1., "Frequency Measurements" in the TR4133/B instruction manual for further details.

(13) Using [FINE] [↓] [↓] [↑] and [FINE] [↑], aligh the marker with the lowest level in the main lobe.

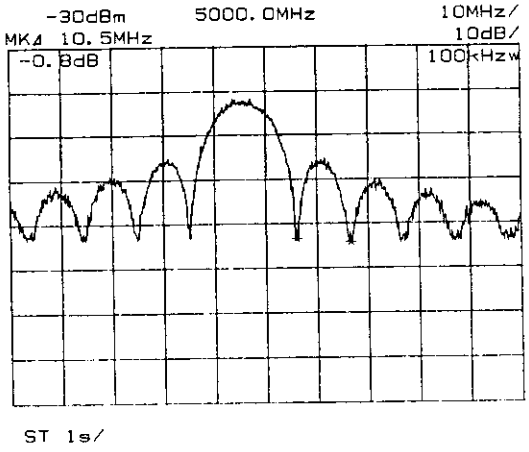
(14) Using [Δ], [FINE] [↓] [↓] [↑] and [FINE] [↑], aligh the marker with the lowest level in the next side lobe. (Figure 5-22)
If the frequency difference between the Δ marker displays is Δf [Hz],

$\tau = 1/\Delta f$ [s]



$$PRF = \frac{1}{4.4\ (ms)} = 227.31$$

Fig. 5-21 RPF measurement



$$I = \frac{1}{10.5 \times 100} = 0.095\mu s$$

Fig. 5-22 τ measurement

5-7-3. Peak Power (P peak) and Average Power (P ave) Measurements

The spectrum analyzer amplitude display is proportional to the resolution bandwidth (RBW) if that bandwidth satisfies the following conditions.

Pulse repetition frequency (PRF) x 1.7 < RBW < 0.2/τ

In this case, the amplitude display is proportional to resolution bandwidth, and the relationship between the actual peak power (P peak dBμ) and amplitude display (P' peak dBμ) is given by the following equation.

$$P\ peak = P'\ peak + \alpha\ (dB)$$
$$\alpha\ (dB) = 20\ log\ (\tau \times 1.5 \times RBW)$$

where α is called the pulse attenuation ratio.
The average power (P ave dBμ) is given by

$$P\ ave = P\ peak \times PRF \times \tau$$

where PRF is the pulse repetition fequency (Hz)

SECTION 6

USE OF EXTERNAL KEYBOARD AND STANDARD TR4133/B FUNCTIONS BY GPIB

6-1. OUTLINE

Like the standard TR4133/B functions, analyzer functions enabled by use of the TR41301 External Keyboard can be activated by external controller via GPIB (refer to Section 6 of the analyzer instruction manual).
Since the GPIB is connected to the TR4133/B analyzer in this case, it (the GPIB) cannot be connected directly to the keyboard.

6-2. GPIB OUTLINE

6-3. SPECIFICATIONS

6-4. GPIB OPERATING PROCEDURES

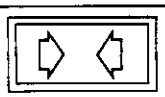
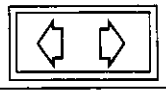
6-5. BLOCK DELIMITER

Since the above four sections are exactly the same as described for the standard TR4133/B analyzer functions, refer to the TR4133/B instruction manual for details.
The complete list of commands for the standard TR4133/B analyzer functions and the external keyboard functions is provided in Table 6-1.

Table 6-1 List of all TR4133/B GPIB commands

Commands indicated by a superscript *1 or *2 are subject to operational restrictions as described in Subsection 6-7.

I. Functions available only by TR4133/B analyzer key operation

Code	Corresponding key	Function description (TR4133/B Instruction Manual)
A0	MIN INPUT ATTENUATOR 0 dB	4-8-6.
A1	MIN INPUT ATTENUATOR 10 dB	4-8-6.
A2	MIN INPUT ATTENUATOR 20 dB	4-8-6.
A3	MIN INPUT ATTENUATOR 30 dB	4-8-6.
A4	MIN INPUT ATTENUATOR 40 dB	4-8-6.
A5	MIN INPUT ATTENUATOR 50 dB	4-8-6.
Frequency band (Figures in brackets refer to TR4133/B) Units in GHz		
B0	0 - 3.6 (0 - 3.6)	4-8-1.
B1	0.01 - 4 (3.5 - 7.5)	4-8-1.
B2	4 - 12 (7.2 - 15.2)	4-8-1.
B3	8 - 12 (10.9 - 20)	4-8-1.
B4	12 - 20 (18 - 28)	4-8-1.
B5	18 - 28 (28 - 60)	4-8-1.
B6	28 - 60 (MULTI BAND 3.5 - 20)	4-8-1.
FA*2	CENTER FREQ	4-8-2. (9)
M1*1	MARKER	4-8-2. (10)
Y0	Counter clockwise rotation of tuning knob	4-8-2. (8)
Y1	Clockwise rotation of tuning knob	4-8-2. (8)
FB	SPAN/DIV	4-8-3. (13)
BW	RBW	4-8-4. (16)
NR		4-8-3, 4-8-4
WD		4-8-3, 4-8-4
FC	(REFL. LEVEL UP, DOWN) FINE COARSE	4-8-5. (18)
LD	(REFL. LEVEL) DOWN	4-8-5. (17)

Code	Corresponding key	Function description (TR4133/B Instruction Manual)
LU	(REFL. LEVEL) UP	4-8-5. (17)
UN	(REFL. LEVEL) UNITS	4-8-5. (21)
LC	(GPIB) LOCAL	3-2. (43)
TR	TRIGGER MODE DOWN	4-8-9. (37)
SR	(SWEEP) START	4-8-9. (37)
TU	(SWEEP TIME) UP	4-8-9. (36)
TD	(SWEEP TIME) DOWN	4-8-9. (36)
VU	(VIDEO FILTER) UP	4-8-7. (24)
VD	(VIDEO FILTER) DOWN	4-8-7. (24)

II. Functions available by external keyboard and analyzer key operation

Code	Corresponding key	Function description (TR4133/B Instruction Manual)
WR*1	WRITE	4-8-8. (25)
SA*1	STORE A	4-8-8. (26)
SB*1	STORE B	4-8-8. (27)
VWA*1	VIEW A	4-8-8. (28)
VWB*1	VIEW B	4-8-8. (29)
MA*1	MAX HOLD A	4-8-8. (30)
MB*1	MAX HOLD B	4-8-8. (31)
AAn*1	AVG A	4-8-8. (32)
ABn*1	AVG B Note: n denotes the average setting count.	4-8-8. (33)
SU*1	B-A→C	4-8-8. (34)
PP	POSI PEAK	4-8-8. (35)
SG	SIG IDENT	4-8-1. (2)
SI	SHIFT IF	4-8-1. (3)
BA	RBW AUTO	4-8-4. (15)
M0	MARKER OFF	4-8-2. (11)
FL*1	FREQ CAL	4-8-2. (6)
ZL*1	ZERO CAL	4-8-2. (5)
ZS	ZERO SRAN	4-8-3. (14)
FS	FULL SPAN	4-8-3. (12)
AF	AFC	4-8-2. (7)
CL	CLEAR	4-8-9. (38)
L1	10 dB/div on vertical axis	4-8-5. (19)
L2	2 dB/div on vertical axis	4-8-5. (20)
LN	Linear (V) vertical axis	4-8-5. (22)

III. Functions available only in external keyboard

Note: There is no command corresponding to the SHIFT key. All shift functions have been made available as commands which can be set directly.

Code	Corresponding key	Function description (TR4133/B Instruction Manual)
SC*1	STORE C	4-6-2.
SD*1	STORE D	4-6-2.
VWC*1	VIEW C	4-6-2.
VWD*1	VIEW D	4-6-2.
MC*1	MAX HOLD C	4-6-2.
MD*1	MAX HOLD D	4-6-2.
ACn*1	AVG C	4-6-3.
ADn*1	AVG D	4-6-3.
SM	(SAMPLING MODE) SAMPLE (SHIFT)	4-6-8.
IA*1	INPUT-A→C	4-6-5.
CA*1	B⇄A	4-6-6.
DA*1	D→A	4-6-7.
T0	FREE RUN	4-7-6.
T1	LINE	4-7-7.
T2	VIDEO	4-7-8.
T3	SINGLE	4-7-9.
SS	SWEEP STOP/START	4-7-5.
MK0*2	MARKER → REFERENCE LEVEL	4-5-12.
MK1*2	FIXED DELTA MARKER (SHIFT)	4-5-5.
M2*2*3	DELTA MARKER	4-5-4.
MK2*2	NOISE/Hz	4-5-10.
M3*3	MARKER → CENTER FREQ.	4-5-6.
MK3*2	NEXT PEAK	4-5-9.
M4*2	PEAK SEARCH	4-5-7.
MK4*2*3	NORMAL MARKER	4-5-2.
M5*2	SIG TRACK	4-5-8.

Code	Corresponding key	Function description (TR4133/B Instruction Manual)
MK5*2	OTHER TRACE	4-5-11.
RB	RESOLN BW	4-3-16.
ST	SWP TIME/	4-3-17.
VF	VIDEO FILTER	4-3-19.
D1*2*3	DISPLAY LINE ON	4-4.
D0*2*3	DISPLAY LINE OFF	4-4.
CF	CENTER FREQ.	4-3-1.
FO	FREQ. LOCK	4-3-2.
CS1	CF STEP SIZE	4-3-6.
CS2	CF STEP SIZE AUTO	4-3-6.
SP	SPAN/DIV	4-3-8.
FT*2	START (frequency)	4-3-7.
FP*2	STOP (frequency)	4-3-7.
B8	FREQ BAND	4-3-4.
B7	FREQ BAND AUTO	4-3-5.
RL	REF LEVEL	4-3-11.
AT	ATT	4-3-15.
LO	LEVEL OFFSET	4-3-12.
FU	FINE UP	4-1.
FD	FINE DOWN	4-1.
CU	COARSE UP	4-1.
CD	COARSE DOWN	4-1.
0	DATA keyboard 0	4-2-2.
1	DATA keyboard 1	4-2-2.
2	DATA keyboard 2	4-2-2.
3	DATA keyboard 3	4-2-2.
4	DATA keyboard 4	4-2-2.
5	DATA keyboard 5	4-2-2.
6	DATA keyboard 6	4-2-2.

Code	Corresponding key	Function description (TR4133/B Instruction Manual)
7	DATA keyboard 7	4-2-2.
8	DATA keyboard 8	4-2-2.
9	DATA keyboard 9	4-2-2.
.	DATA keyboard .	4-2-2.
-	DATA keyboard +/-	4-2-2.
GZ	GHz, V, sec.	4-2-2.
MZ	MHz, mV, ms	4-2-2.
KZ	kHz, dB	4-2-2.
V	GHz, V, sec.	4-2-2.
MV	MHz, mV, ms	4-2-2.
UV	No corresponding key	4-2-2.
S	GHz, V, sec.	4-2-2.
MS	MHz, mV, ms	4-2-2.
DB	kHz, dB	4-2-2.
DM	kHz, dB (dBm)	4-2-2.
DU*2	kHz, dB (dBμ)	4-2-2.
DP	kHz, dB (dBpW)	4-2-2.
U1	(UNIT) dBm (SHIFT)	4-3-13.
U2	(UNIT) dBμ (SHIFT)	4-3-13.
U3	(UNIT) dBpW (SHIFT)	4-3-13.
SV	SAVE	4-8-2.
RC	RECALL	4-8-3.
FN	f	4-9.
LB1	LABEL	4-10-1.
LB2	LABEL CLEAR	4-10-2.
PL	Plotter	4-11-1.
C1	CHARACTER ON	4-11-3.
C0	CHARACTER OFF	4-11-3.
IP	INSTRUMENT PRESET	4-11-2.

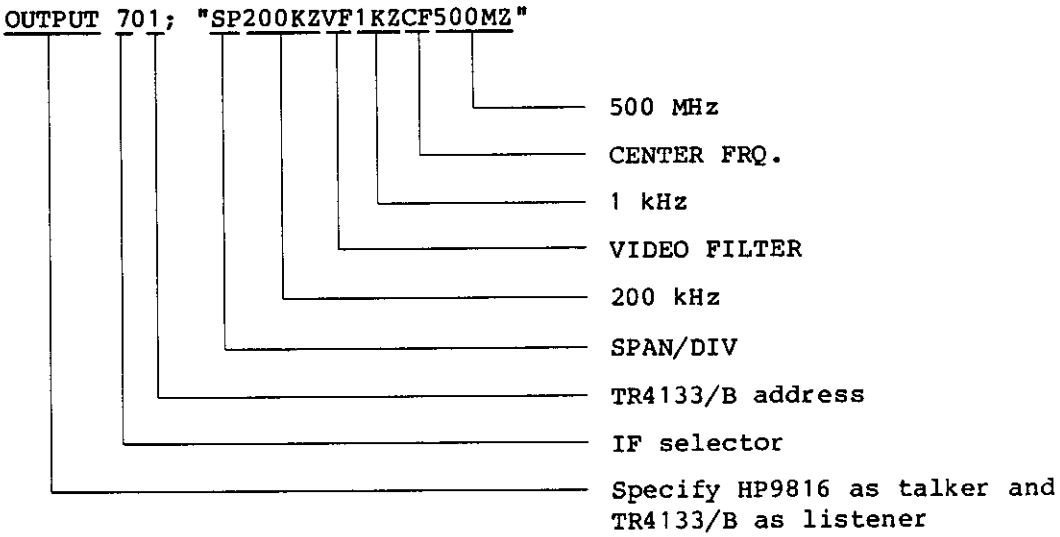
Codes for setting commands which do not correspond to a key or switch

Setting	Code	
Header	HD0 HD1	Header OFF Header ON
Block delimiter	DL0 DL1 DL2 DL3	"CR", "LF" + EOI "LF" EOI "CR", "LF"
Output data	OP OS OM	Output Interrogated Parameter Output Status Byte Output Mode String
Trace data input	IN	Input Trace Data
Service request	S0 S1	Transmission of SRQ No transmission of SRQ

6-6. OUTLINE OF FUNCTION SETTINGS

In this section, an example of a program using the HP9816 Hewlett-Packard Desk Top Computer is described in respect to various function settings.
Actual function settings are described later in Subsection 6.8.

Example 6-1:
Set center frequency to 500 MHz, frequency span to 200 kHz/, and the video filter to 1 kHz.



Generation and execution of the above program results in a
Center Frequency of 500 MHz,
SPAN/DIV of 200 kHz, and
Video filter of 1 kHz
being set in the TR4133/B.
The TR4133/B commands correspond to both the analyzer and external keyboard key functions. When generating the program, proceed to set the commands by pressing keys on both the analyzer panel and external keyboard in the prescribed order.

6-7. PRECAUTIONS IN THE USE OF GPIB COMMANDS

When operating the TR4133/B via GPIB, there are a number of restrictions to be considered in terms of internal processing. In the list of commands in Table 6-1, the relevant commands are indicated by a superscript *1, *2, or *3.

6-7-1. Commands Indicated by *1 in the Command List

If these command codes are followed by another command on the same line, the second command is disregarded.
To ensure correct operation, these commands must always be followed by a carriage return before programming the next command.

Example of incorrect programming:

```
10 OUTPUT 701; "VWAM1"
                  └──Disregarded
```

Example of correct programming:

```
10 OUTPUT 701; "VWA"
20 OUTPUT 701; "M1" .... Results in correct operation
```

6-7-2. Commands Indicated by *2 in the Command List

If another command follows (on the same line) one of these commands under certain conditions, that command will be disregarded, or will not result in correct operation.
As in Item 6-7-1. above, correct operation is ensured by executing a carriage return after each of these commands.
The different conditions for each command are listed in the following table.

<table>
<tr><th>Code</th><th>Conditions plus examples of correct and incorrect operation</th></tr>
<tr><td>FA</td><td>If SPAN/DIV is set to a value of at least 50 kHz and the "FA" command is then keyed in while the LED indicator in the CENTER FREQ. key is on, the center frequency is reset. (This center frequency resetting function is described in Item 4-8-2. of the TR4133/B analyzer instruction manual.)

Example of incorrect programming:
10 OUTPUT 701; "FAY0"
20 OUTPUT 701; "FAY1"
└── Disregarded

Example of correct programming:
10 OUTPUT 701; "FAY0"
20 OUTPUT 701; "FA"
30 OUTPUT 701; "Y1" ... Results in correct operation</td></tr>
<tr><td>M0
MK0
M1
MK1
M2
MK2
M3
MK3
M4
MK4
M5
MK5
D0
D1
FT
FP
GZ
MZ
KZ</td><td>Successive input of commands related to marker, display line, and START/STOP frequency (commands also include UP and DOWN in addition to those listed in the left hand column).

Example of incorrect programming:

10 OUTPUT 701; "M1CUM4"
└── Does not operate correctly

Example of correct programming:

10 OUTPUT 701; "M1"
20 OUTPUT 701; "CU"
30 OUTPUT 701; "M4" ... Results in correct operation

(Since internal processing for marker commands is always complicated, successive commands cannot be received immediately after a marker command.)
(See Subsection 6-8. for details on marker related commands.)

<table><tr><th>Function</th><th>Code</th></tr><tr><td>Marker</td><td>MK4, M2</td></tr><tr><td>Center frequency</td><td>CF</td></tr><tr><td>Center frequency step size</td><td>CS1</td></tr><tr><td>Start frequency</td><td>FT</td></tr><tr><td>Stop frequency</td><td>FP</td></tr><tr><td>Frequency band</td><td>B8</td></tr><tr><td>Save</td><td>SV</td></tr><tr><td>Recall</td><td>RC</td></tr><tr><td>Advanced function</td><td>FN</td></tr><tr><td>Plotter</td><td>PL</td></tr></table></td></tr>
</table>

<table>
<tr><th>Code</th><th>Conditions plus examples of correct and incorrect operation</th></tr>
<tr><td></td><td>The above functions are used to make numerical settings by DATA key operation.

Example of incorrect programming:

10 OUTPUT 701; "CF200MZMK4"
└———Desregarded

Example of correct programming:

10 OUTPUT 701; "CF200MZ"
20 OUTPUT 701; "MK4" ... Results in correct operation</td></tr>
<tr><td>DM

DU

DP</td><td><table><tr><th>Function</th><th>Code</th></tr><tr><td>Reference level
Display line</td><td>RL
D1</td></tr></table>
The above functions are used to make numerical settings by DATA key operation.

Example of incorrect programming:

10 OUTPUT 701; "RL-20DMMK4"
└———Disregarded

Example of correct programming:

10 OUTPUT 701; "RL-20DM"
20 OUTPUT 701; "MK4" ... Results in correct operation</td></tr>
</table>

6-7-3. Precautions when Executing Numerical Settings by Marker and Display Line

Command codes relevant to these precautions are indicated by the *3 superscript in the command list.

i) When marker is OFF,
and the marker position is set numerically by the MK4 (NORMAL marker) command, the command cannot be followed by a numerical value. (In this case, the marker must be turned ON by the MK4 command, and since this involves complicated internal operation the next command cannot be received on the same line.)

Example of incorrect programming:

```
10 OUTPUT 701; "M1"                ! Marker OFF
20 OUTPUT 701; "MK4200MZ"          ! Marker 200 MHz
                    └──── Desregarded
```

Example of correct programming:

```
10 OUTPUT 701; "M1"                ! Marker OFF
20 OUTPUT 701; "MK4"               ! NORMAL marker
30 OUTPUT 701; "200MZ"             ! Marker 200 MHz
or
10 OUTPUT 701; "M0"                ! Marker ON
20 OUTPUT 701; "MK4200MZ"          ! Marker 200 MHz
   (Marker may be turned on prior to input of MK4)
```

ii) If, when not in delta marker mode, the
M2 (delta marker)
command is used to numerically set the position of the delta marker, the command cannot be followed by a numerical value. (In this case, the delta marker must be turned ON by the MK2 command, and since this involves complicated internal operation the next command cannot be received on the same line.)

Example of incorrect programming:

```
10 OUTPUT 701; "MK4"               ! NORMAL marker
20 OUTPUT 701; "M2200MZ"           ! Delta marker 200 MHz
                    └──── Disregarded
```

Example of correct programming:

```
10 OUTPUT 701; "M1"              ! Marker OFF
20 OUTPUT 701; "M2"              ! Delta marker ON
30 OUTPUT 701; "200MZ"           ! Delta marker 200 MHz
```

or

```
10 OUTPUT 701; "M2"              ! Delta marker ON
20 OUTPUT 701; "CF200MHz"        ! Center frequency 200 MHz
30 OUTPUT 701; "M2200MZ"         ! Delta marker 200 MHz
```

(Marker may be turned on prior to input of numerical value)

iii) If, when the display line is OFF, the
D1 (display line ON)
command is used to numerically set the position of the display line, the command cannot be followed by a numerical value. (In this case, the display line must be turned ON by the D1 command, and since this involves complicated internal operation the next command cannot be received on the same line.)

Example of incorrect programming:

```
10 OUTPUT 701; "D0"              ! Display line OFF
20 OUTPUT 701; "D1-30DM"         ! Display line -30 dBm
                   └──── Disregarded
```

Example of correct programming:

```
10 OUTPUT 701; "D1"              ! Display line ON
20 OUTPUT 701; "-30DM"           ! Display line -30 dBm
```

or

```
10 OUTPUT 701; "D1RL-10DM"       ! Display line ON
                                 ! Reference level -10 dBm
20 OUTPUT 701; "D1-30DM"         ! Display line -30 dBm
```

(The display line may be turned on prior to input of numerical value)

6-7-4. Bus Processing for Commands Indicated by *1, *2, and *3

(1) Relationship between controller execution time and TR4133/B execution time

"The time taken for the controller to execute the program is not synchronized with the time taken by the target TR4133/B to execute received commands".

That is,

the following one line of control program

```
10 OUTPUT 701; "ZL"        ! Reception of "ZL" command.
```

means that, "the controller supplies the "ZL" command, and the TR4133/B receives that command". Note that execution of this one line of program by the controller does not mean that execution of "ZERO CAL" by TR4133/B has been completed.

(2) Program flow when a command which requires time to be executed is keyed in

In this case,

```
10 OUTPUT 701: "ZL"        ! Execution time of about 30 seconds
                           ! Upon reception of "ZL" command
20 OUTPUT 701; "MK4"       ! NORMAL marker
```

When the control is about to output the "MK4" command in line 20, the TR4133/B is denied handshake until completion of ZERO CAL.

Once ZERO CAL has been completed, handshake is recommenced and the "MK4" command is received. Note, however, that programming apart from that for TR4133/B is executed between lines 10 and 20.

Other commands which take time to be executed are listed below.

Function name	Normal execution time	Maximum execution time
IP (Instrument Preset)	Approx. 2 sec.	Approx. 2 sec.
ZERO CAL	Approx. 30 sec.	Approx. 40 sec.
Center frequency setting when SPAN/DIV < 2 MHz	Approx. 5 sec.	Approx 12 sec.
NEXT-PEAK	Approx. 1 sec.	Approx. 40 sec.
Marker functions other than Next peak	Approx. 0.3 sec.	Approx. 1 sec.
Occupied frequency band	Approx. 0.8 sec.	Approx. 1 sec.
Adjacent channel leak power	Approx. 2 sec.	Approx. 2 sec.
Plotter	Approx. 80 sec.	Approx. 80 sec.

The plotter is a special case where the GPIB is occupied by the plotter and TR4133/B while the plotter is drawing. Therefore, the controller is stopped temporarily if it attempts to send commands to the TR4133/B and other external equipment.

(3) Actual operational flow between program and other equipment such as the TR4133/B and controller on the GPIB

i) ZERO CAL ("ZL") example

```
Program                          ! C: Controller, TR4133/B
                                 ! T: TR4133/B
                                 ! O: Other target execution
                                 !    contents
                                 !
                                 !
10 OUTPUT 701; "ZL"              ! C: "ZL" command input
   (ZERO CAL command input)      ! T: ZERO CAL commenced
                                 ! T: "ZERO CAL being executed"
                                 ! C: Next command about to be
                                 !    executed immediately.
                                 !
20 BEEP                          ! C: Buzzer activated
30 OUTPUT 702; "XX"              ! C: Command sent to other
                                 !    equipment
                                 !
40 OUTPUT 701; "SP1MZ"           ! T: This command cannot be
                                 !    received until "ZERO
                                 !    CAL" has been completed.
                                 ! C: This command sent upon
                                 !    completion of "ZERO CAL".
50 BEEP                          ! C: This buzzer activated
                                 !    almost concurrently with
                                 !    completion of ZERO CAL.
60 END                           !
```

ii) When plotter is involved

```
10 OUTPUT 701; "PLKZ"          ! T: Start of plotter drawing.
                               !    Size: small
20 BEEP                        ! C: Buzzer activated
                               !    (commands within
                               !    controller executed
                               !    immediately.)
30 OUTPUT 702; "XX"            ! C: Command cannot be sent
                               !    to other equipment since
                               !    bus has been occupied by
                               !    TR4133/B and plotter.
                               !    Processing waits for
                               !    plotter to finish
                               !    drawing.
50 BEEP                        ! C: This buzzer activated
                               !    almost concurrently with
                               !    completion of plotter
                               !    drawing.
60 END                         !
```

"Controller" here is an instrument to operate the devices on the bus. The program flow is not necessarily as above if there exists an interface adapter as GPNET-model 10 by Network Supply between the computer and the GPIB. The controller in this case is the GPNET-model 10.

6-7-5. Necessity for Waiting Time to be Included in the Program

If the precautionary items described in this section have been followed, the TR4133/B commands will operate normally. However, it may be necessary to set suitable "waiting times" in the following cases to ensure that data is read correctly.

(1) When trace data and marker data are to be read by using the "OP" command after changing the signal input setting
If data cannot be read after waiting a sufficiently long period of time (for the waveform to be rewritten for a new setting) after a single sweep, it is possible that the data prior to the setting change has been read.

(2) When trace data and marker data is read by using the "OP" command following a change in trace mode (see Subsection 4-6, "Waveform Display").
A waiting time of approximately 0.5 second is required for the new setting to be executed by the internal processor.

(3) A waiting time of approximately 0.5 second is also required for the command to be executed by the internal processor before input of the next command when the display line is moved up or down in B-A→C or INPUT-A→C mode.

6-7-6. Other Precautions

When more than one command is included on the same line, the final character in a particular command will overlap with the first character of the next command and may be interpreted as a different command.
In this kind of case, correct operation can be achieved by inserting a space ( ) or comma (,) after the end of the preceding command.

Example of incorrect setting:

OUTPUT 701; "ST1SVF10KZ"
Although the intention has been to set sweep time to 1 sec./div and video filter to 10 kHz, the commands are interpreted in the following way:
ST: Sweep time
1 : 1
SV: SAVE
F1: Error generated since no "F" command is used, and no further commands are to be read.

Example of correct setting:
OUTPUT 701; "ST1S VF10KZ"
A space has been inserted between the S and V (a comma may also be used in place of the space).

6-8. EQUIPMENT SETTINGS

6-8-1. Center Frequency Setting CF

The center frequency can be set using the GPIB in a number of different ways. Since each method has its advantages and disavantages, the method most suitable for particular conditions is used.
The same advantages and disadvantages also prevail in manual settings. In addition to methods (1) and (2) below, the center frequency lock function described in Item 6-8-2. can also be used as a setting method.

(1)

Method	Feature	Precautions
Direct numerical value setting by DATA key operation	Setting of correct center frequency at any time	Setting operation takes time when SPAN/DIV is between 50 kHz and 2 MHz.

Program example: Set center frequency to 430 MHz.

```
10 OUTPUT 701; "CF430MZ"
```

Precautions:
When the center frequency and SPAN/DIV settings are to be altered, SPAN/DIV should be changed first. Otherwise, an accurate setting of the center frequency based on SPAN/DIV will not be achieved.

(2)

Method	Feature	Precautions
Change the center frequency stepwise by UP and DOWN keys.	Simplification of programs and the TR4133/B execution time is fast. No problem with accuracy when span is greater than 5 MHz/div.	Not as accurate as direct numerical setting. Considerable frequency displacement when large steps are set by CF STEP SIZE. Not practical for random center frequency settings.

Program example: Increase center frequency one step at a time.

```
Part 1
10 OUTPUT 701; "SP1MZ"          ! Set SPAN/DIV to 1 MHz.  Center
20 OUTPUT 701; "CFCU"           ! frequency increased in steps
                                ! equal to SPAN/DIV (i.e. +1 MHz)

Part 2
10 OUTPUT 701; "CS1200MHz"      ! Set CF STEP SIZE to 200 MHz.
20 OUTPUT 701; "CFCU"           ! Center frequency incremented in
                                ! steps equal to CF STEP SIZE
                                ! (i.e. +200 MHz)
20 OUTPUT 701; "CU"             ! Center frequency incremented by
                                ! additional 200 MHz.
                                (Since center frequency has become
                                the active function, "CF" is no
                                longer needed before the "CU").
```

6-8-2. Center Frequency Lock Function, and the Center Frequency Setting Method Using this Function FO

The center frequency lock function ("FO" command) can be used when SPAN/DIV is less than 20 kHz. Use of this center frequency lock function by GPIB operation is described below under a number of different circumstances.

(1)

Method	Feature	Precautions
Simple input of "FO" command only	Elimination of long term drift in the center frequency. Seizure of FM signals where AFC cannot be applied.	Time required for center frequency to stabilize after input of "FO" command immediately after the center frequency has been changed.

(2)

Method	Feature	Precautions
Input of numerical value of fixed frequency after "FO".	Center frequency set in the same way as setting by "CF", and center frequency subsequently locked.	Time is sometimes required before the center frequency is stabilized after command input.

Example of incorrect setting:

```
10 OUTPUT 701; "FO430MZ"      ! Center frequency locked at
                              ! 430 MHz
20 DIM A(700)                 ! Declaration of 700 arrays
30 OUTPUT 701; "OPAA"         ! Waveform memory A in ASCII
40 FOR I=0 TO 700             ! Sequential output of data to
                              ! array A
50 ENTER 701; A(I)            !
60 NEXT I                     !
70 END                        !
                              Center frequency not always stable
                              at 430 MHz at this stage.
```

Example of correct setting:

```
10 OUTPUT 701; "FO430MZ"      ! Center frequency locked at
                              ! 430 MHz
20 WAIT 3                     ! Wait two or three seconds
                              ! Wait for at least three sweeps to
                              ! be completed if SWEEP TIME is
                              ! less than 0.1 sec.
                              !
30 DIM A(700)                 ! Same as above.
40 OUTPUT 701; "OPAA"         !
50 FOR I=0 TO 700             !
60 ENTER 701; A(I)            !
70 NEXT I                     !
80 END                        !
                              Center frequency stabilized at
                              430 MHz at this stage.
```

6-8-3. Frequency Band Setting B0 - B8

Several different methods are available for setting frequency band by GPIB. Different methods are used under different conditions.

(1) If FREQ BAND is set to AUTO, the optimum frequency band is set automatically for the center frequency set by center frequency setting or center frequency lock function.

```
Example:
10 OUTPUT 701; "SP5MZ"      ! SPAN/DIV 5 MHz
20 OUTPUT 701; "FO430MZ"    ! Center frequency = 430 MHz
                            ! Frequency band is set
                            ! automatically to 0 - 3.6 GHz (or
                            ! 0.01 - 4 GHz).
     :
```

(2) Use of analyzer panel function command code

```
Example:
10 OUTPUT 701; "B0"         ! Set to 0 - 3.6 GHz frequency
                            ! band.
                  "FREQ BAND AUTO" is not cancelled.
```

```
Example:
10 OUTPUT 701; "B8"         ! "FREQ BAND AUTO" cancelled.
```

(3) Use of external keyboard function command code

```
Example:
10 OUTPUT 701; "B81KZ"      ! Set to 0 - 3.6 GHz frequency
                            ! band.
100 OUTPUT 701; "B83KZ"     ! Set to 10.9 - 20 GHz (TR4133/B)
                            ! Frequency band 3
                  "FREQ BAND AUTO" cancelled if
                  frequency band becomes active
                  function.
```

6-8-4. F CAL Method FC

Command common with the corresponding external keyboard FREQ CAL function.

Example:

```
10 OUTPUT 701; "FC"              ! F CAL
                 └──────────── Any command written after this is
                               disregarded.
```

6-8-5. CF Step Size Setting CS

Example:

```
10 OUTPUT 701; "CS200MZ"         ! CF STEP SIZE set to 200 MHz
20 OUTPUT 701; "CFCU"            ! Center frequency incremented
                                 ! 200 MHZ
30 OUTPUT 701; "CU"              ! Center frequency incremented
                                 ! 200 MHz
          :
          :
```

6-8-6. Start and Stop Frequency Settings FT

Although programming by key operations as with other functions is preferrable, this function involves a rather complicated sequence as outlined in Item 4-3-6. If possible, the use of start and stop frequencies in programming by GPIB will avoid possible trouble. If, however, the frequencies are to be used, first thoroughly read Item 4-3-6. before commencing any programming.
Especially when not measuring wide band spectra above 100 MHz, there is little to be gained by using this method.

Example: Measurement on 150 MHz - 250 MHz band

```
10 OUTPUT 701; "CF200MZ"         ! Center Frequency Set
20 OUTPUT 701; "FP250MZ"         ! Frequency Span Set
30 OUTPUT 701; "FT150MZ"         ! Start Stop Set
```

Precautions restart and stop frequency settings

(1) If the FT (start frequency) or FP (stop frequency) command is used to set a numerical value when not in start frequency or stop frequency mode, the FT or FP command cannot be followed by the numerical value nor UP and DOWN (CD, CU, FD, FU).

Example of incorrect setting:

```
10 OUTPUT 701; "IP"          ! Initialization
20 OUTPUT 701; "FT0MZ"       ! Start frequency 0 MHz
                  └──Disregarded
```

Example of correct setting:

```
10 OUTPUT 701; "IP"          !
20 OUTPUT 701; "FT"          !
30 OUTPUT 701; "0MZ"         ! 0 MHz set as start frequency
```

(2) If the FT (start frequency) command is used to set a numerical value with the cursor frequency indicating the stop frequency when in start - stop frequency mode, the FT command cannot be followed by the numerical value nor UP and DOWN (CD, CU, FD, FU). The same applies if start and stop are reversed.

Example of incorrect setting:

```
10 OUTPUT 701; "IP"          !
20 OUTPUT 701; "FT"          !
30 OUTPUT 701; "0MZ"         ! 0 MHz set as start frequency
40 OUTPUT 701; "FP1GZ"       ! Stop frequency 1 GHz. Stop
                             ! frequency simply becomes active
                             ! function.
```

Example of correct setting:

```
10 OUTPUT 701; "IP"          !
20 OUTPUT 701; "FT"          !
30 OUTPUT 701; "0MZ"         !
40 OUTPUT 701; "FP"          ! 1 GHz set as stop frequency
50 OUTPUT 701; "1GZ"         !
```

6-8-7. SPAN/DIV Setting SP

(1) Numerical setting by using the keyboard "SP" command.

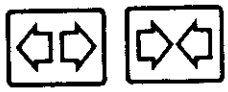
```
Example:
10 OUTPUT 701; "SP100MZ"    ! Span 100 MHz
```

(2) Setting in 1-2-5 steps by using keyboard commands.

```
Example:
10 OUTPUT 701; "SP100MZ"    ! Span 100 MHz
20 OUTPUT 701; "CU"         ! Span incremented by one step to
                            ! 200 MHz.
```

(3) Setting in 1-2-5 steps by using analyzer panel "FB, NR, WD" command.

```
Example:
10 OUTPUT 701; "FB"         ! Span by
```



```
10 OUTPUT 701; "NR"         ! Span decremented one step.
```

Note: If the "SP" command is keyed in during FULL SPAN, the FULL SPAN described in Item 4-3-10. is switched to (FULL SPAN → marker → center frequency) and span setting function.

6-8-8. FULL SPAN Setting FS

```
Example:
10 OUTPUT 701; "FS"
```

6-8-9. ZERO SPAN Setting ZS

The resultant operation when center frequency is set by numerical value is the same as when SPAN/DIV is less than 20 kHz.
This command is common with the analyzer panel.

Example:

```
10 OUTPUT 701; "ZS"              ! Zero span
```

6-8-10. Reference Level (REF LEVEL) Setting RL

(1) Although the reference level can be set in steps by using analyzer panel commands, this method is not very practical. The method is described, however, in the TR4133/B instruction manual.

(2) Numerical setting is possible keyboard command.

Example: Set reference level to -30 dBm

```
10 OUTPUT 701; "RL-30DM"   ! Reference level set to -30 dBm
```

(3) Setting in steps is also possible by keyboard command.

Example: Increment reference level by 1 dB

```
10 OUTPUT 701; "RL-30DM"   ! Reference level set to -30 dBm
20 OUTPUT 701; "FU"        ! Since reference level is active
                           ! function, it is incremented by
                           ! 1 dB by FINE UP.
```

Sign permitted anywhere between RL and DM

May also be KZ. See next item.

6-8-11. Reference Level, Marker Level, and Display Line Level Units DM, DU, DP

The unit for the reference level (and the marker and display line levels) can be set at any time by the analyzer panel UNIT key and by the keyboard SHIFT-4, SHIFT-5, and SHIFT-6 keys. However, since the unit-appending command can also set the unit as indicated in the example in Item 6-8-10. (3), the reference level can be set with a new unit irrespective of the unit involved in the previous setting. Furthermore, settings are also possible with "KZ" (in the same way as in manual operations) in place of "DM, DU, DP".

```
Example: Set reference level to 100 dBμ
10 OUTPUT 701;"RL-30DM"          ! Reference level set to -30 dBm
20 OUTPUT 701; "-10KZ"           ! Reference level set to -10 dBm
30 OUTPUT 701; "100DU"           ! Reference level set to 100 dBμ
                    └──── Unit change
```

6-8-12. Attenuator (MIN. INPUT ATTENUATOR) Setting AT

(1) Direct numerical value setting

```
Example:
10 OUTPUT 701; "AT10DM"     ! Attenuator set to 10 dB
```

(2) Set attenuator to active function, and change by up and down operations.

```
Example:
10 OUTPUT 701; "AT"         ! Attenuator set to active
                            ! function.
20 OUTPUT 701; "CD"         ! Attenuator decremented by one
                            ! step.
30 OUTPUT 701; "CU"         ! Attenuator incremented by one
                            ! step.
          :
```

Only method (1) can be used to set attenuator to 0 dB.
The 1 dB digit is disregarded if set.

6-8-13. Resolution Bandwidth (RBW) Setting RB

(1) Direct numerical value setting

Example:

```
10 OUTPUT 701; "RB10KZ"     ! Resolution bandwidth set to
                            ! 10 kHz.
```

(2) Set resolution bandwidth to active function, and change by up and down operations.

Example:

```
10 OUTPUT 701; "RB"         ! Resolution bandwidth set to
                            ! active function.
20 OUTPUT 701; "CD"         ! Resolution bandwidth decremented
                            ! by one step.
30 OUTPUT 701; "CU"         ! Resolution bandwidth incremented
                            ! by one step.
```

Note: "RESOLN BW/SWP TIME AUTO" is cancelled by input of the "RB" command.

6-8-14. Sweep Time (SWEEP TIME/DIV) Setting ST

(1) Direct numerical value setting

Example:

```
10 OUTPUT 701; "ST10MS"     ! Sweep time set to 10 ms/
```

(2) Set sweep time to active function, and change by up and down operations.

Example:

```
10 OUTPUT 701; "ST"         ! Sweep time set to active
                            ! function.
20 OUTPUT 701; "CD"         ! Sweep time decremented by one
                            ! step.
30 OUTPUT 701; "CU"         ! Sweep time incremented by one
                            ! step.
```

Note: "RESOLN BW/SWP TIME AUTO" is cancelled by input of the "ST" command.

6-8-15. VIDEO FILTER Setting VF

(1) Direct numerical value setting

Example:

```
10 OUTPUT 701; "VF1KZ"      ! VIDEO FILTER set to active
                            ! function, and 1 kHz keyed in.
```

6-8-16. Marker Peak Search M4

After the signal to be measured is displayed within the screen scale by center frequency or frequency span setting, execution of this marker peak search function simplifies the recording of the signal frequency and level data.

Example: Obtain frequency and level data on a signal of about 200 MHz.

```
 10 OUTPUT 701; "SP1MZ"          ! Set frequency span to 1 MHz.
 20 OUTPUT 701; "CF200MZ"        ! Center frequency 200 MHz.
 30 WAIT 0.5                     ! Wait 0.5 sec. for sweep end
 40 OUTPUT 701; "SA"             ! Store wave form in memory A
                                 ! A VIEW screen
 50 OUTPUT 0.1                   ! Wait until "SA" completed
 60 OUTPUT 701; "M4"             ! Marker peak search
 70 OUTPUT 701; "OPML"           ! Marker level output command
 80 ENTER 701; L                 ! Marker level acquisition
 90 OUTPUT 701; "OPMF"           ! Marker frequency output command
100 ENTER 701; F                 ! Marker frequency acquisition
          :
          :
```

Note: If the waveform is not stored in memory (see line 40) before input of the "M4" command, the marker level data may undergo a change in lines 60 thru 80. (If the marker is tracing WRITE with trigger mode left in FREE RUN, the waveform data is rewritten in lines 60 thru 80, and as a result, the marker level may be sent to the controller as new waveform data when the line 80 command is received by the TR4133/B.)

6-8-17. NORMAL Marker Setting MK4

The marker position can be set numerically as a frequency (see Item 4-5-1). This function is useful in that it allows the marker position to be set roughly with level data in that vicinity being accepted. See Item 6-7-3. for precautionary notes.

Example of correct setting: Intake of level data in the 430 thru 440 MHz bandwidth.

```
10 OUTPUT 701; "IP"            ! Initialization
20 OUTPUT 701; "SP2MZ"         ! Set frequency span to 2 MHz/
30 OUTPUT 701; "CF435MZ"       ! Center frequency 435 MHz
40 OUTPUT 701; "MK4"           ! NORMAL marker ON
50 OUTPUT 701; "430MZ"         ! Marker 430 MHz
60 DIM L(350)                  ! Declaration of up to 350 array
                               ! variable L(I)
70 FOR I=1 TO 350              ! Frequency 5 DIV = 350 points =
                               ! 10 MHz
80 OUTPUT 701; "OPML"          ! Marker level output command
90 ENTER 701; L                ! Marker level acquisition
100 OUTPUT 701; "FU"           ! marker incremented by 1 point
110 NEXT I                     ! 80, 90, and 100 repeated
                               ! 350 times
          :
```

Note: The marker frequency setting accuracy conforms with the center frequency setting accuracy. Hence, it is practically impossible to obtain the peak of the 200 MHz signal by the following program. (See Marker Peak Search described in Item 6-8-16. above.)

Example of incorrect setting: Intake of frequency and level data of a 200 MHz signal.

```
10 OUTPUT 701; "IP"              ! Initialization
20 OUTPUT 701; "SP10MZ"          ! Set frequency span to 10 MHZ
30 OUTPUT 701; "CF200MZ"         ! Center frequency 200 MHz
40 OUTPUT 701; "MK4"             ! NORMAL marker ON
50 OUTPUT 701; "200MZ"           ! Marker 200 MHz
60 OUTPUT 701; "OPML"            ! Marker level output command
70 ENTER 701; L                  ! Marker level acquisition
80 OUTPUT 701; "OPMF"            ! Marker frequency output command
90 ENTER 701; F                  ! Marker frequency acquisition
          :
```

6-8-18. DELTA Marker Setting M2

The position of the active delta marker can be set as the frequency difference between markers. Use this function after carefully reading the description on the delta marker in Item 4-5-3. Pay special attention to active marker and reference marker changes.

Delta marker setting example 1:
Obtain data in the level difference in the ±60 kHz spurious of a 900 MHz signal for up to 70 points on both sides of the difference.

```
10 OUTPUT 701; "IP"              ! Initialization
20 OUTPUT 701; "PPSP20KZ"        ! POSI PEAK
                                 ! Set frequency span to 20 kHz
30 OUTPUT 701; "CF900MZ"         ! Center frequency 900 MHz
40 WAIT 1                        ! Wait 1 sec. for sweep completed
50 OUTPUT 701; "MK4T3"           ! NORMAL marker ON SINGLE SWEEP
60 OUTPUT 701; "M4"              ! Marker peak search
70 OUTPUT 701; "M2"              ! Delta marker ON
80 OUTPUT 701; "50KZ"            ! Delta marker 50 kHz
90 GOSUB 400                     ! Print output of frequency and
                                 ! level for 35 points from +50 kHz.
100 OUTPUT 701; "-70KZ"          ! Delta marker -70 kHz
110 GOSUB 400                    !
120 END
400 FOR I = 1 TO 70              ! Obtain 70 points of data from
                                 ! starting point (10 kHz range)
                                 !
410 OUTPUT 701; "OPMF"           ! Marker frequency output command
420 ENTER 701; F                 ! Marker frequency acquisition
430 OUTPUT 701; "OPML"           ! Marker level output command
440 ENTER 701; L                 ! Marker level acquisition
450 PRINT "F=";F;"LVL=";L        ! Printing of level and frequency
                                 ! data
460 OUTPUT 701; "FU"             ! Marker incremented by 1 point
470 NEXT I                       ! Repeat 70 thru 110 70 times
480 RETURN
```

Delta marker setting example 2:

Using the NEXT PEAK2 function, measure the peak level differences between the signal and spurious for the same signal used in example 1, and print out the results. Assume that the spurious level is above -50 dBm.

```
 10 thru 60                      Same as in example 1
 80 OUTPUT 701; "D1"             ! Display line ON
 90 OUTPUT 701; "-50DM"          ! Display line set to -50 dBm
100 OUTPUT 701; "FN1KZ"          ! Special function 1 (NEXT PEAK-2)
                                 ! ON
110 GOSUB 200                    !
120 OUTPUT 701; "CUCU"           ! Active marker to +60 kHz spurious
130 GOSUB 200
140 END
```

```
200 OUTPUT 701; "OPMF"           ! Marker frequency output command
210 ENTER 701; F                 ! Marker frequency acquisition
220 OUTPUT 701; "OPML"           ! Marker level output command
230 ENTER 701; L                 ! Marker level acquisition
240 PRINT "F=";F;"LVL=";L        ! Printing of level and frequency
                                 ! data
250 RETURN
```

This subroutine is also used elsewhere.

6-8-19. FIXED Delta Marker Applications MK1

Frequency and level differences between the reference and active markers can be obtained in much the same way as for the delta marker. First carefully read the description of the FIXED delta marker in Item 4-5-4. before making use of this application. Pay special attention to active marker and reference marker changes.

Example: Determine level differences between a 900 MHz signal and its harmonics up to the fourth harmonic.

```
10 thru 50                      Same as in example in Item 6-8-18.
                                ! 900 MHz signal peak search with
                                ! frequency span of 200 kHz/div.
60 GOSOB 200                    ! Print fundamental wave frequency
                                ! and level.
                                ! Use subroutine described in
                                ! previous item.
70 OUTPUT 701; "MK1"            ! FIXED delta marker ON
80 OUTPUT 701; "T0"             ! Return to FREE RUN
90 OUTPUT 701; "CF1.1GZ"        ! Center frequency 1.8 GHz
100 GOSUB 300                   !
110 OUTPUT 701; "CF2.7GZ"       ! Center frequency 2.7 GHz
120 GOSUB 300                   !
130 OUTPUT 701; "CF3.6GZ"       ! Center frequency 3.6 GHz
140 GOSUB 300                   !
150 END                         !
300 WAIT .5                     ! Wait 0.5 second
                                ! Wait for WRITE waveform to be
                                ! rewritten by new setting.
310 OUTPUT 701; "T3"            ! To SINGLE SWEEP
320 OUTPUT 701; "M4"            ! Marker peak search
330 GOSUB 200                   ! Obtain level difference between
                                ! reference and active markers
340 RETURN
```

Note: Use subroutines 200 thru 250 used in previous Item.

6-8-20. Signal Track Application M5

Frequency and level data can be obtained easily from signals of unknown frequency.

Example: Obtain frequency and level data for the maximum level of a signal within the 12 thru 20 GHz frequency band.

```
10 OUTPUT 701; "IP"            ! Initialization
20 OUTPUT 701; "B4"            ! Set to 12 - 20 GHz frequency band
30 OUTPUT 701; "SP5MZ"         ! After first setting span to 5 MHz
40 OUTPUT 701; "FS"            ! Set to FULL SPAN
                               ! (in preparation for the
                               ! subsequent FULL SPAN, marker
                               ! function)
50 OUTPUT 701; "M4"            ! Marker peak search
60 OUTPUT 701; "SP"            ! FULL SPAN marker function
                               ! Set to 5 MHz span
                               ! Center frequency is set to the
                               ! line 50 marker frequency.
70 OUTPUT 701; "M5"            ! SIGNAL TRACK ON
80 WAIT 1.5                    ! Wait 1.5 seconds
90 OUTPUT 701; "NRNR"          ! Span decrement by 2 steps
100 WAIT 1.5                   ! Wait 1.5 seconds
110 OUTPUT 701; "NRNRM5"       ! Span decrement by 2 steps to
                               ! final span of 200 kHz
                               ! SIGNAL TRACK OFF
120 GOSUB 300                  ! Subroutine in previous item
                               ! Frequency and level data of
                               ! signal found in FULL span on
                               ! line 50 is obtained in 200 kHz
                               ! span.
130 END
```

Note: Programming from line 300 is the same as in the previous item.

6-8-21. MKR → Reference Level Application MK0

Example: Obtain the level of a 900 MHz signal.
After shifting the marker to the signal peak by marker peak search, align the signal peak with the reference level using this function and obtain the signal level by using marker peak search again.

```
10 thru 50                      Same as in Item 6-8-17. (After
                                finding the 900 MHz signal at span
                                of 200 kHz/ and setting to SINGLE
                                SWEEP, shift the marker to the
                                signal peak by marker peak search.)
60 OUTPUT 701; "T0"             ! Return to FREE RUN
70 OUTPUT 701; "MK0"            ! MKR → Reference level
80 WAIT 1                       ! Wait for waveform to be rewritten
                                ! in the above setting.
90 OUTPUT 701; "T3"             !
100 OUTPUT 701; "M4"            ! Marker peak serach
110 GOSUB 200                   ! Subroutine described in
                                ! Item 6-8-18.
120 END                         ! Display of marker frequency and
                                ! level
```

6-8-22. Use of NEXT PEAK MK3

Always set sampling mode to POSI PEAK. And although another method involves execution of NEXT PEAK after obtaining waveform data in MAX HOLD or AVERAGE, execute a single peak search before executing NEXT PEAK.

Example: Obtain the frequency and level data in sequence from the highest to the sixth highest level within the 150 MHz thru 250 MHz band.

```
10 OUTPUT 701; "IP"              ! Initialization
20 OUTPUT 701; "PP"              ! Set sampling mode to POSI PEAK
30 OUTPUT 701; "SP10MZCF200MZ"   ! Set span to 10 MHz and center
                                 ! frequency to 200 MHz.
40 WAIT 0.1                      ! Wait 0.1 second
50 OUTPUT 701; "SA"              ! Store waveform data in memory A
                                 ! in the above setting
60 OUTPUT 701; "M4"              ! Marker peak search
70 GOSUB 200                     ! Same subroutine as in
                                 ! Item 6-8-18.
80 FOR I = 1 TO 6                !
90 OUTPUT 701; "MK3"             ! NEXT PEAK
100 GOSUB 200                    ! Obtain marker data
110 NEXT I                       ! Repeat lines 80 thru 100 six
                                 ! times.
120 END
```

Note: Programming from line 200 is the same as in Item 6-8-18.

6-8-23. Setting the Averaging Count AA

Example: Set averaging to 64 times.

```
10 OUTPUT 701; "AA64KZ"
                  └──This may be omitted.
```

Since averaging in the TR4133/B is a "time weighted averaging" as described in Section 4, there is no termination. Therefore, the waveform data may be taken once the set averaging count has been exceeded.

The progress averaging count can be determined by one of three different methods.

i) Compute the sweep end service request at the averaging start.

ii) Start averaging after executing a SINGLE SWEEP, key in a SWEEP START command (SR) for the set averaging count (or more), then obtain the waveform data.

iii) Set up the wait time sufficient for the average execution before obtaining the waveform data.

6-8-24. Trigger Mode Setting

The TR4133/B trigger mode can be set by command code corresponding to the keyboard panel keys.

Command code	Trigger mode
T0	FREE RUN
T1	LINE
T2	VIDEO
T3	SINGLE

Code	SWEEP
CL	CLEAR
SR	START
SS	STOP/START

When the TR4133/B is activated via GPIB, this trigger mode setting is useful in programming by application of (SWEEP) CLEAR and SINGLE (SWEEP) functions. This is especially effective in obtaining signal frequency and level data by using a marker (see Items 6-8-15 and 6-8-16).

Example: Measure a 900 MHz signal at span 5 kHz/ and video filter 100 Hz. Obtain and display the peak frequency and level data as the marker data.

```
10 OUTPUT 701; "IP"            ! Initialization
20 OUTPUT 701; "SP5KZ"         ! Span 5 kHz/
30 OUTPUT 701; "CF900Mz"       ! Center frequency 900 MHz
40 OUTPUT 701; "VF0.1KZ"       ! Video filter 100 Hz, and sweep
                               ! time 5 s/div.
50 OUTPUT 701; "T4"            ! SINGLE SWEEP
60 OUTPUT 701; "CL"            ! Waveform CLEAR
70 OUTPUT 701; "SR"            ! Sweep start
80 WAIT 50.5                   ! (Sweep time/div) x 10 + x =
                               ! 50.5 sec.
                               ! Wait for rewriting of waveform
                               ! in setting up to line 40.
90 OUTPUT 701; "M4"            ! Marker peak search
100 GOSUB 200                  ! Obtain marker data.
110 DIM A(700)                 ! Place WRITE memory waveform data
                               ! in array A(I).
120 OUTPUT 701; "OPTAW"        !
```

```
130 FOR I=1 TO 700                !
140 ENTER 700;A(I)                !
150 NEXT I                        !
160 END
```

Note: Programming from line 200 is the same as in Item 6-8-18.

Comment:
Since waveform is cleared and sweeping started in line 60, it is better to wait for the waveform to be rewritten in the settings up to line 50 for a single sweep time. In the case of long sweep times, this permits a reduction in the program execution time.

6-8-25. Use of the SAVE and RECALL Functions SV RC

These functions cannot be used when the keyboard is not connected to the TR4133/B. Any attempt to call these functions with the keyboard disconnected from the TR4133/B results in cessation of communications between the TR4133/B and controller. In this case, the TR4133/B power supplied must be switched off and on again.

Example:

```
10 OUTPUT 701; "SV1KZ"          ! Store the various settings in
                                ! the keyboard memory.
20 OUTPUT 701; "RC1KZ"          ! Retrieve the above settings.
```

6-8-26. Use of LABEL LB1, LB2

After the switching to label mode by the LB1 command, the characters to be displayed as a label are selected in ASCII code and keyed in enclosed between ? marks (?xx?).

Example:

```
10 OUTPUT 701; "LB1"              ! LABEL ON
20 OUTPUT 701; "?PULSED RF-1?"    ! Section enclosed between ? marks
                                  ! (ASCII characters) are displayed
                                  ! as label.
30 OUTPUT 701; "FU"               ! Treated as ordinary if not
                                  ! enclosed between ? marks.
                                  ! Since in label mode at this time,
                                  ! cursor is shifted one character
                                  ! to the right.
          :
100 OUTPUT 701; "LB1"             ! LABEL OFF
                                  ! Label mode is not cancelled
                                  ! without this input.
110 OUTPUT 701; "LB2"             ! LABEL CLEAR
```

6-9. SHIFT FUNCTION SETTINGS

Keyboard SHIFT function settings made via GPIB all involve direct called commands. Hence, there are no commands corresponding to the SHIFT key.

6-9-1. ZERO CAL ZL

Like the F CAL function, ZERO CAL is a command common with the corresponding analyzer function. (Although ZERO CAL is a keyboard SHIFT key function, there is no command corresponding to the SHIFT key. Direct called commands have been made available for all the SHIFT key functions).
Execution takes about 30 seconds. If there is no continuous operation by GPIB for relatively long periods of time (in excess of 30 minutes), there is no need to execute "ZL" within the program. Where execution is required, see Item 6-7-4 (2). Completion of ZERO CAL results in the same initialization as "IP".

Example:

```
10 OUTPUT 701; "ZL"              ! ZERO CAL
20 OUTPUT 701; "IP"              ! Initialization
                 └──── No meaning
```

6-9-2. IP (Initialization)

All settings of TR4133/B and TR41301 is initialized.

Example:

```
10 OUTPUT 701; "IP"
```

6-9-3. Use of Plotter GPIB PL

Plotter mode is set by using the "PL" command. Plotter drawing is started by input of the same command code as in manual key operation. Once the plotter mode settings have been made, they do not need to be reset again unless a change is required. Drawing is commenced immediately by the "GZ, MZ, KZ" commands according to the selected settings.

Example: Draw a normal display at "medium" size in a model HP-7470A Plotter.

```
100 OUTPUT 701; "PL"          ! Set to plotter mode.
100 OUTPUT 701; "CD1"         ! Cursor down
                              ! HP-7470A plotter designation
120 OUTPUT 701; "MZ"          ! Start drawing in "medium" size.
          :
          :
500 OUTPUT 701; "PL"          ! Set to plotter mode.
120 OUTPUT 701; "GZ"          ! Start drawing at "large" size at
                              ! same settings as above.
```

WARNING

If plotter drawing is executed manually with the GPIB still connected to the controller, the driver of equipment connected to the GPIB may be damaged.

6-9-4. Sampling Mode Setting SM, PP

Example:

```
100 OUTPUT 701; "SM"          ! Set to random sampling mode.
200 OUTPUT 701; "PP"          ! Set to POSI PEAK mode if
                              ! previously POSI NEGA PEAK mode.
210 OUTPUT 701; "PP"          ! Set to POSI NEGA PEAK mode.
```

6-9-5. Marker OTHER TRACE MK5

When in dual display mode, the marker can be switched from one trace to the other by using this command.

```
Example:
100 OUTPUT 701; "VWC"          ! C VIEW (C memory display)
110 OUTPUT 701; "VWD"          ! Set to D VIEW (D memory display)
                               ! dual display
120 OUTPUT 701; "MK5"          ! Marker shifted to C memory
```

6-9-6. CHARACTER ON-OFF (Character Display ON-OFF) D1, D0

```
Example:
100 OUTPUT 701; "D1"           ! Character display ON
110 OUTPUT 701; "D0"           ! Character display OFF
```

6-9-7. Changing the Vertical Axis Scale L1, L2, LN

Setting by command common to the corresponding analyzer function (see the following example).

```
Example:
100 OUTPUT 701; "L2"           ! 2 dB/div
110 OUTPUT 701; "LN"           ! LINEAR
120 OUTPUT 701; "L1"           ! 10 dB/div
```

6-9-8. Changes in Level Unit

When the vertical axis scale is in LOG display, three separate levels can be selected. Each of these involves one of the following commands.

```
Example:
100 OUTPUT 701; "DM"           ! dBm
110 OUTPUT 701; "DU"           ! dBμ
120 OUTPUT 701; "DP"           ! dBpW
```

6-10. SETTING OF ADVANCED FUNCTIONS FN

Unlike the SHIFT functions, the special functions can be set by input of commands (by "FN" command) corresponding to the same key used in manual settings.
Each function is described separately below.

6-10-1. Use of NEXT PEAK2

Set sampling mode to POSI PEAK. Another method involves execution of NEXT PEAK after obtaining waveform data in MAX HOLD or AVERAGE.

Example: Measure a signal in the 150 MHz thru 250 MHz band.

```
 10 OUTPUT 701; "IP"              ! Initialization
 20 OUTPUT 701; "PP"              ! POSI PEAK mode
 30 OUTPUT 701; "SP10MZCF200MZ"   ! Set span to 10 MHz and center
                                  ! frequency to 200 MHz.
 40 WAIT 0.1                      ! Wait 0.1 sec. at above setting.
 50 OUTPUT 701; "MA"              ! MAX HOLD
 60 WAIT 2                        ! Wait 2 seconds for MAX HOLD.
 70 OUTPUT 701; "VWA"             ! Freeze the trace.
 80 OUTPUT 701; "D1"              ! Display line ON
 90 OUTPUT 701; "-60DM"           ! Set display line to -60 dBm.
100 OUTPUT 701; "FN1KZ"           ! Advanced function 1=NEXT PEAK-2
                                  ! ON
                                  ! Shift marker to NEXT PEAK-2 start
                                  ! point in this band
110 GOSUB 200                     ! Subroutine described in
                                  ! Item 6-8-18.
                                  ! Obtain marker data.
120 FOR I=1 TO 6                  !
130 OUTPUT 701; "CU"              ! NEXT PEAK2 UP
140 GOSUB 200                     ! Obtain marker data.
150 NEXT I                        ! Repeat lines 130 thru 150 six
                                  ! times.
160 END
```

6-10-2. Use of Occupied Frequency Bandwidth (OBW) FN1KZ

Since the occupied frequency bandwidth result is obtained as a delta marker frequency, use the "OPMF" command to accept the occupied frequency bandwidth data.

Example: Measure the occupied frequency bandwidth for a 1.2 GHz signal.

```
10 OUTPUT 701; "IP"              ! Initialization
20 OUTPUT 701; "SP20KZCF1.2GZ"   ! Set span to 20 kHz/ and center
                                 ! frequency to 1.2 GHz.
                                 ! Wait 0.1 sec. at above setting.
50 OUTPUT 701; "SA"              ! Store waveform data in memory A.
60 OUTPUT 701; "FN1KZ"           ! Advanced function 1
                                 ! Occupied frequency bandwidth
                                 ! calculation start
70 GOSUB 200                     ! See Item 6-8-18.
                                 ! Obtain marker frequency and
                                 ! level data.
80 END
```

Note: Programming from line 200 is the same as in Item 6-8-18.

6-10-3. Setting and Operation by GPIB for Adjacent Channel Leak Power, SWEEP ADAPTER AFC, and Other Advanced Functions

Like NEXT PEAK-2 and occupied frequency bandwidth, these settings can be made by input (by "FN" command) of commands corresponding to the same keys used for the manual settings.

6-11. OUTPUT OF SET DATA

The TR4133/B is capable of output of the following function data to the GPIB controller.

Center frequency
SPAN/DIV
Reference level
Resolution bandwidth
Sweep time
Video filter
Marker frequency
Marker level
Trace data
Frequency band
Level offset
Display line level

The "OP" command (Output Interrogated Parameter) is used for output of set data. The "OP" command is followed by output of the code of the required parameter (set data) to the TR4133/B.
Function parameter codes are listed in Tables 6-2 and 6-3.

Table 6-2 "OP" parameter codes

Code	Output parameter
CF	Center frequency
IG	IF GAIN
MF	Marker frequency
ML	Marker level
RB	Resolution bandwidth
RL	Reference level
SP	SPAN/DIV
ST	Sweep time
VF	VIDEO FILTER

Table 6-3 Designated codes for trace data

Code	Input/output data	Type of data
TAA	A memory trace data	ASCII code
TAB	B memory trace data	
TAC	C memory trace data	
TAD	D memory trace data	
TAW	WRITE memory trace data	
TBA	A memory trace data	Binary code
TBB	B memory trace data	
TBC	D memory trace data	
TBD	C memory trace data	
TBW	WRITE memory trace data	

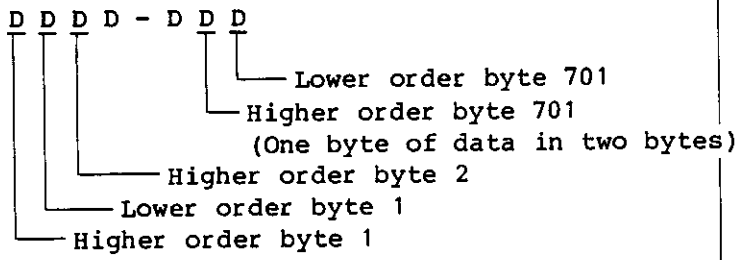
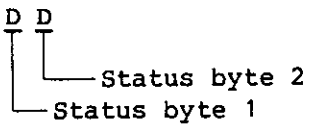
6-11-1. Format of Output Data

The format of the output data obtained by "OP" command is outlined in Table 6-4.

Table 6-4 Output data format

Output data setting code	Format	Output byte count (excluding block delimiter)
OP (excluding trace data)	HH␣DDDDDDDD.DD E±D CRLF └Block delimiter └Data exponential └Data mantissa section └Data sign (positive: space "␣", negative: "-") └Header (See Table 6-5.)	17
OP trace data	• For ASCII outputs DDDD CRLF └Block delimiter └Trace data (for one point)	4

Table 6-4 Output data format (Cont'd)

Output data setting code	Format	Output byte count (excluding block delimiter)
OP trace data	• For binary output  Note: EOI is appended to the final byte of data as a delimiter. CRLF is not used.	1402
OS	 Note: EOI is appended to the final byte of data as a delimiter. CRLF is not used.	2
OM	Note: EOI is appended to the final byte of data as a delimiter. CRLF is not used.	11

Since the total number of bytes for all output data apart from trace data is 17, the array declaration must include at least 17 bytes for input of data as a character string variable from the controller.
The output data header indicates the type of data (see Table 6-5 for a list).
The header is turned off and no output is obtained when the "HD0" command is used, and is turned on for data output when the "HD1" command is used.

Table 6-5 Relationship between output data and headers

Type of output data			Header
CENTER FREQUENCY			CF
SPAN/DIV			SP
REFERENCE LEVEL	dBm		DM
	dBμ		DU
	dBpW		DP
	LINEAR		LV
SWEEP TIME/DIV			ST
RESOLUTION BANDWIDTH			RB
VIDEO FILTER			VF
IF GAIN			IG
MARKER	FREQUENCY		MF
	LEVEL	dBm	MM
		dBμ	MU
		dBpW	MP
		LINEAR	ML

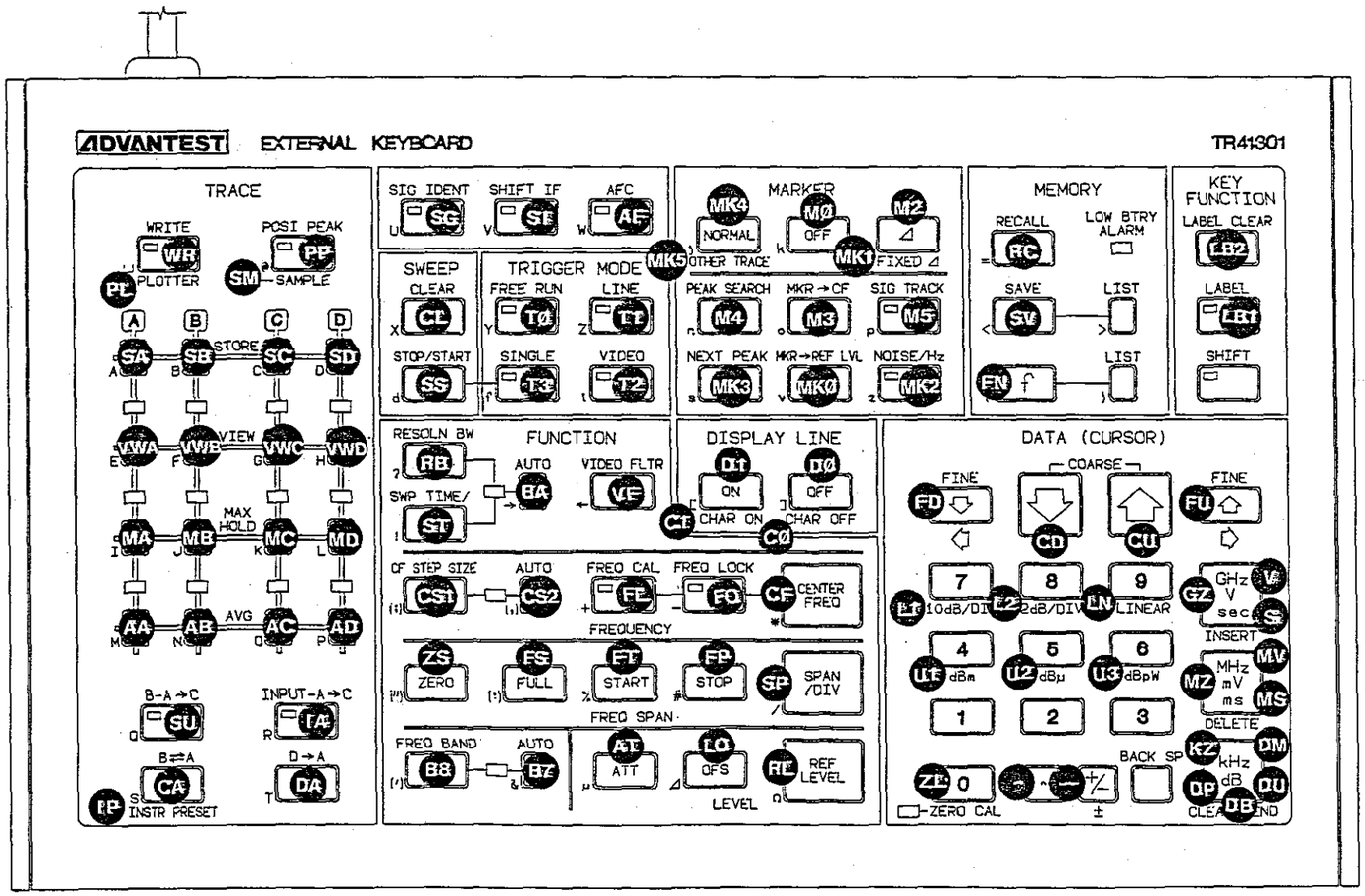


Fig. 6-1 GPIB codes associated with front panel

SECTION 7

PRINCIPLES OF OPERATION

The External keyboard block diagram is outlined in Figure 7-1.

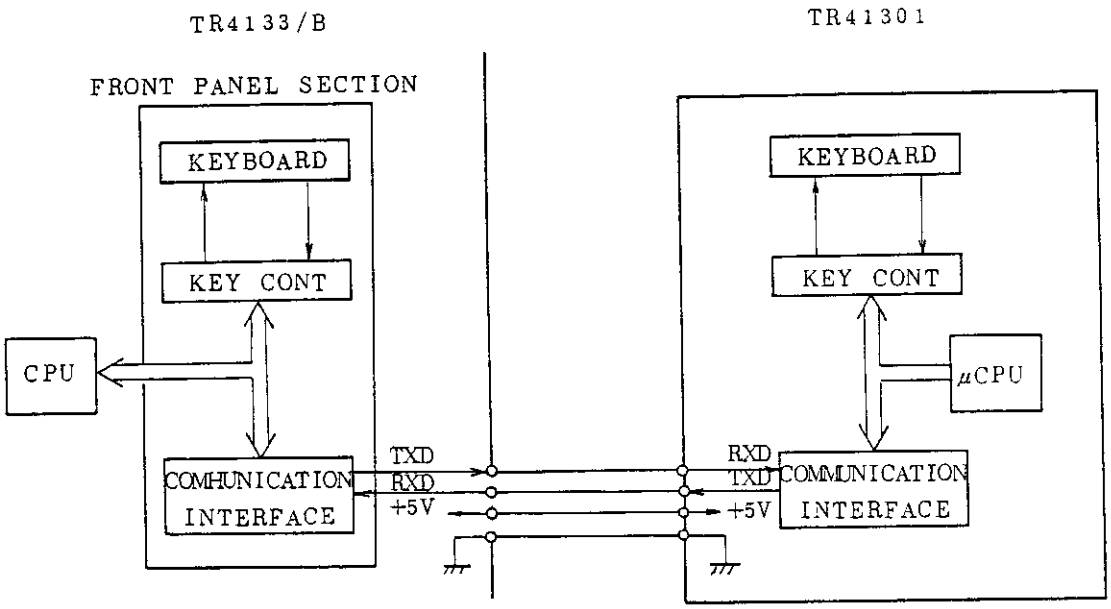


Fig. 7-1 TR41301 block diagram

Transfer of signals between the keyboard and TR4133/B involves conversion of CPU 8-bit data into serial data and transmission via two signal lines. The data transfer rate in this case is about 2.4K baud.

MEMO

SECTION 8

TROUBLESHOOTING

Figure 8-1 shows the troubleshooting flowchart for TR41301.

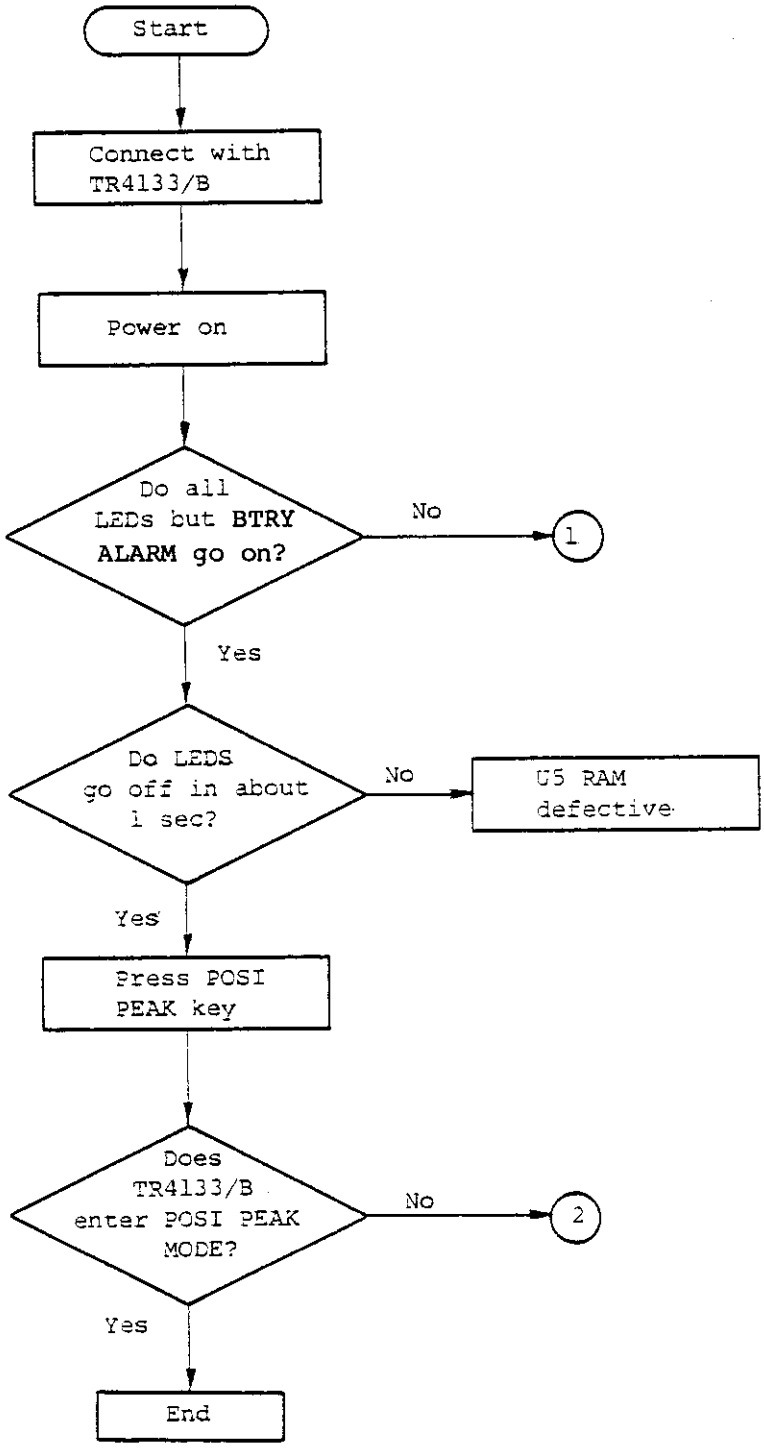


Fig. 8-1 Troubleshooting flowchart

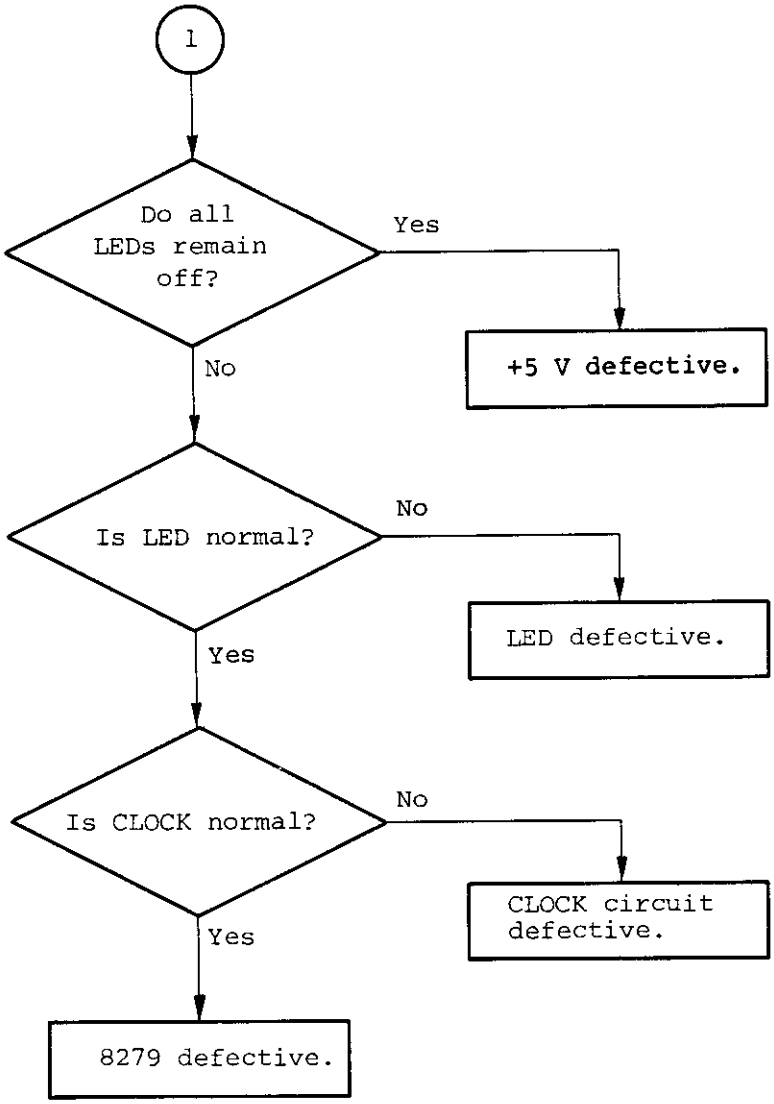


Fig. 8-1 Troubleshooting flowchart (Cont'd)

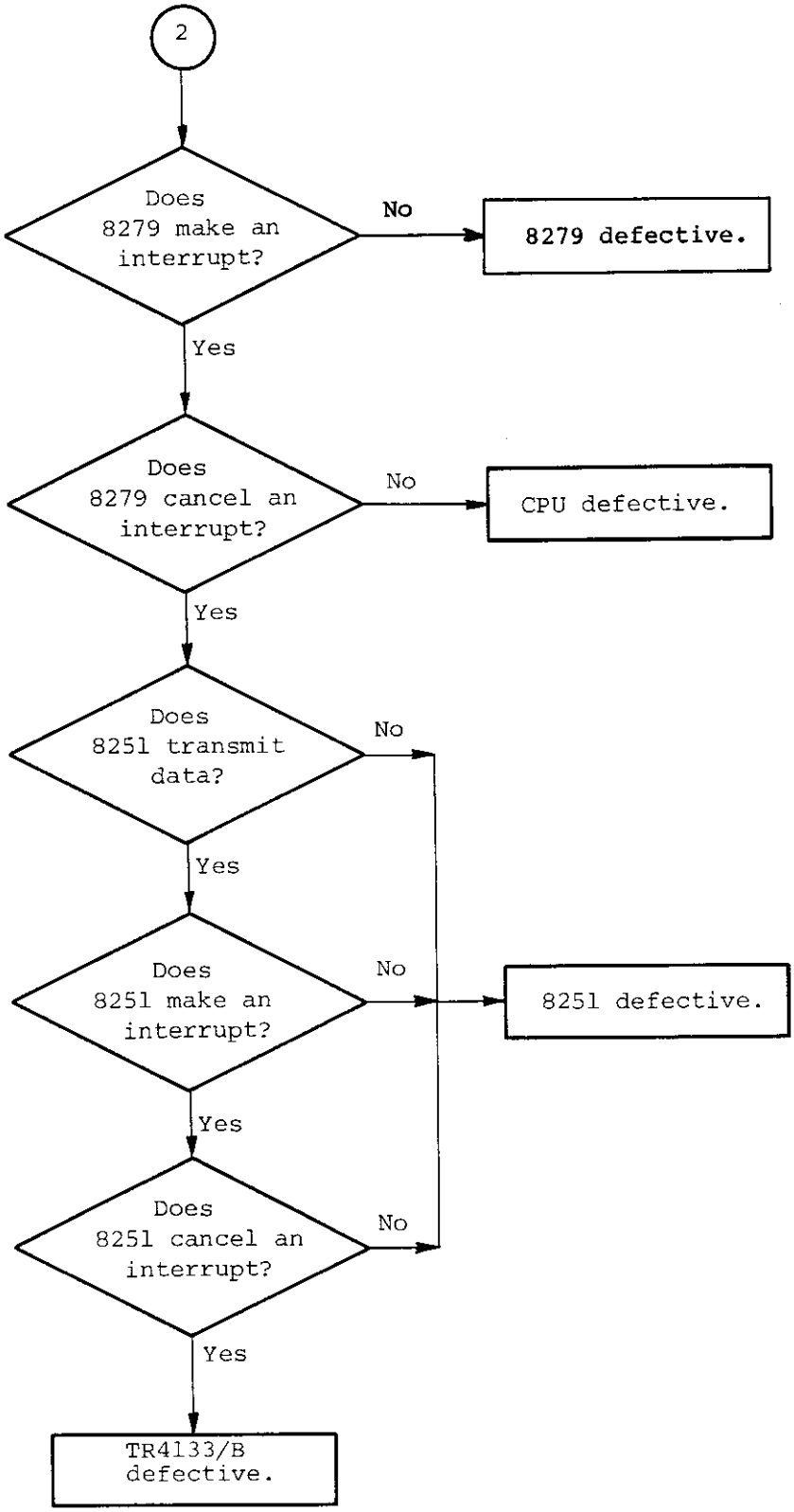


Fig. 8-1 Troubleshooting flowchart (Cont'd)

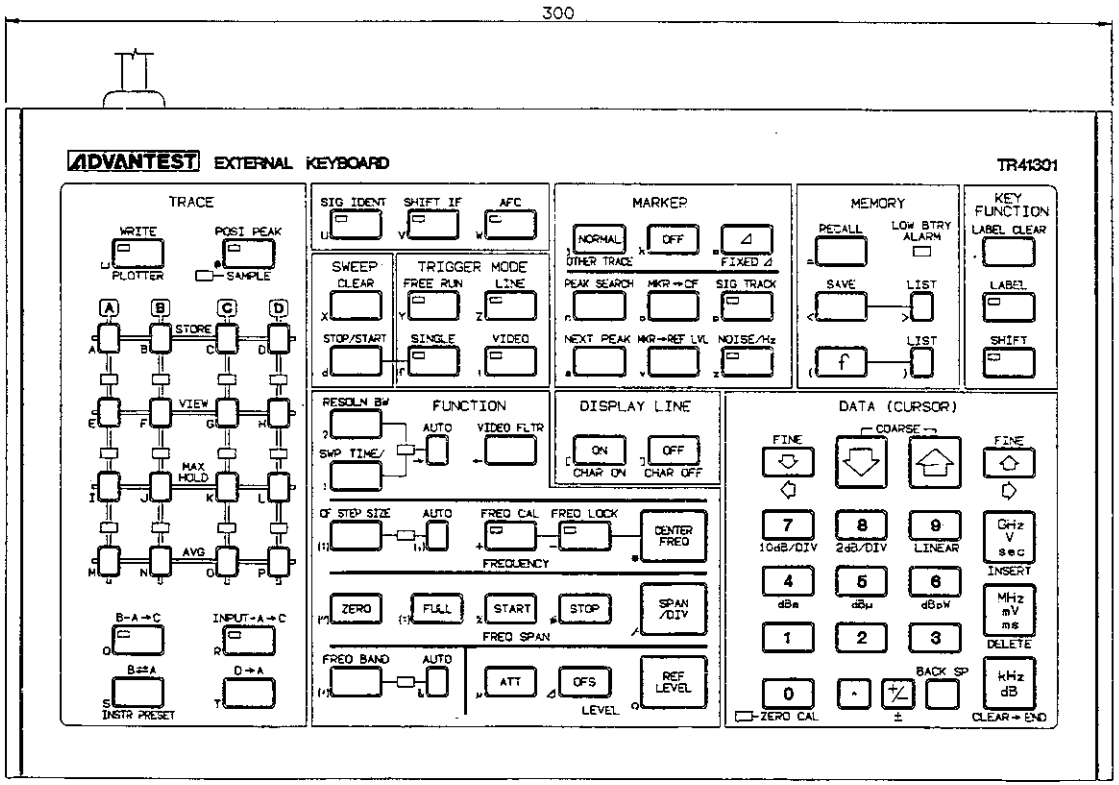
MEMO

APPENDIX

List of TR4133/B error messages

Message	Description	Counter measure
F ADJ ERR	Center frequency setting cannot be executed within the prescribed time.	Possible defective counter or other device
CNT ERR	Counter failed to operate.	Possible defective counter or other device
FOR START STOP, PRESS "SPAN/DIV"	START or STOP key pressed during ZERO/SPAN or FULL/ SPAN.	Press the SPAN/DIV key.
PRESS F-BAND OR MARKER	SPAN/DIV or AUTO key pressed during MULTI BAND (TR4133 B only).	Press the F-BAND key and select a frequency band, or press the MARKER key and set a shift frequency.
PLOTTER HANDSHAKE ERROR	GPIB not properly connected between plotter and TR4133/B.	Make sure the GPIB connection between plotter and TR4133/B is correct.
NO F-LOCK WHEN SPAN/ >50 kHz	Frequency lock key pressed when SPAN/ >50 kHz.	Frequency lock operates only when SPAN/ <20 kHz.
INVALID DATA, IGNORED!	Input of invalid data	Key correct data
HP PLOT ROM ERR	ROM for the Hewlett-Packard plotter has not been included.	Graphs cannot be drawn on the Hewlett-Packard plotter.
OBW ROM ERR	Occupied frequency bandwidth ROM has not been included.	Occupied frequency bandwidth operations cannot be executed. (Option)
ADJ LEAK ROM ERR	The adjacent channel leakage current ROM is not installed.	The adjacent channel leakage currrent cannot be calculated.
CANNOT OFST	An attempt is made to execute a level offset when the vertical axis scale is LIN.	Change the vertical axis scale to 10 dB/ or 2 dB/.
SET Δ MK!	The delta marker is not set when calculating the adjacent channel leakage current.	Set an appropriate value in the delta marker.
SET Δ MK BUT 0	The delta marker value is 0 when calculating the adjacent channel leakage current.	Set an appropriate value (other than 0) in the delta marker.

TR41301 INDEX



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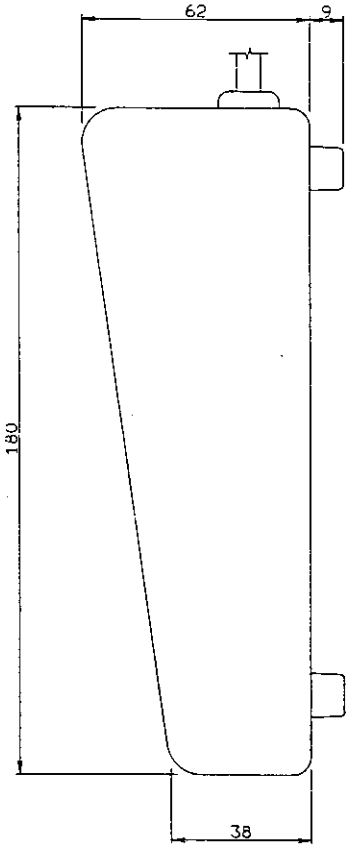
FRONT VIEW



SIDE VIEW

TR41301
EXTERNAL VIEW

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