Chapter 3

OPERATION

CONTENTS

CONTENTS (continued)

PRINCIPLES OF CONTROL

1. An upper unit (2380) containing the display, power supply, GPIB interface, keyboard and digital processing is combined with a 2382 lower unit which contains the frequency synthesizer and swept receiver. All operations are carried out by using front panel controls or remotely via the GPIB. The controls and input/output connectors are divided basically into the following distinct groups :

Upper unit

SUPPLY ON	Indicating light shows the ON state.
DISPLAY	Control and display of A or B store information. GPIB mode indicator.
FUNCTION/DATA	Keypad, decrement/increment key and rotary control of reference frequency; keypad control of reference level, incremental frequency and span/div.; store and recall of instrument mode settings.

Lower unit

INPUT	100 Hz - 400 MHz, d.c. coupled 50 Ω, 0.5 W max. Overload protected to 50 W.
VERTICAL	Sensitivity controls, dB and VOLTS ranges, decrement/increment key and rotary control of reference level.

HORIZONTAL	Span selection keys; rotary control of sweep span from 10 Hz/DIV to 40 MHz/DIV. Sweep speed, filter bandwidth and video bandwidth control.
MARKERS	Bright dot marker control for amplitude and frequency read-out.
SIGNAL OUTPUTS	Standard 10 MHz calibrator output. Tracking generator output. Probe supply.

2. Individual key functions within these groups are described in ´Front panel control functions´ para. 110 and 111. Four colours have been used for marking front panel keys:

white for first function keys

blue for second function keys (2ND FUNCT key must be pressed first)

green for functions becoming active on pressing the ´PRESET´ key

yellow for alphanumeric and special characters available after the TEXT key is pressed.

INPUTS, OUTPUTS AND INDICATING LIGHTS

Front panel (refer to Fig. 1)

3. [1] SUPPLY ON
A rotary switch applies the a.c. supply voltage to both upper and lower units. A green indicator light shows the ON state. Refer to Chap. 2 (mains voltage selection) for further information.

[2] GPIB (General Purpose Interface Bus)
Indicating lights show the mode in which the instrument is working :

Local	both lights OFF
Remote	REMOTE light ON
Addressed (addressed by controller)...	ADDRESSED light ON

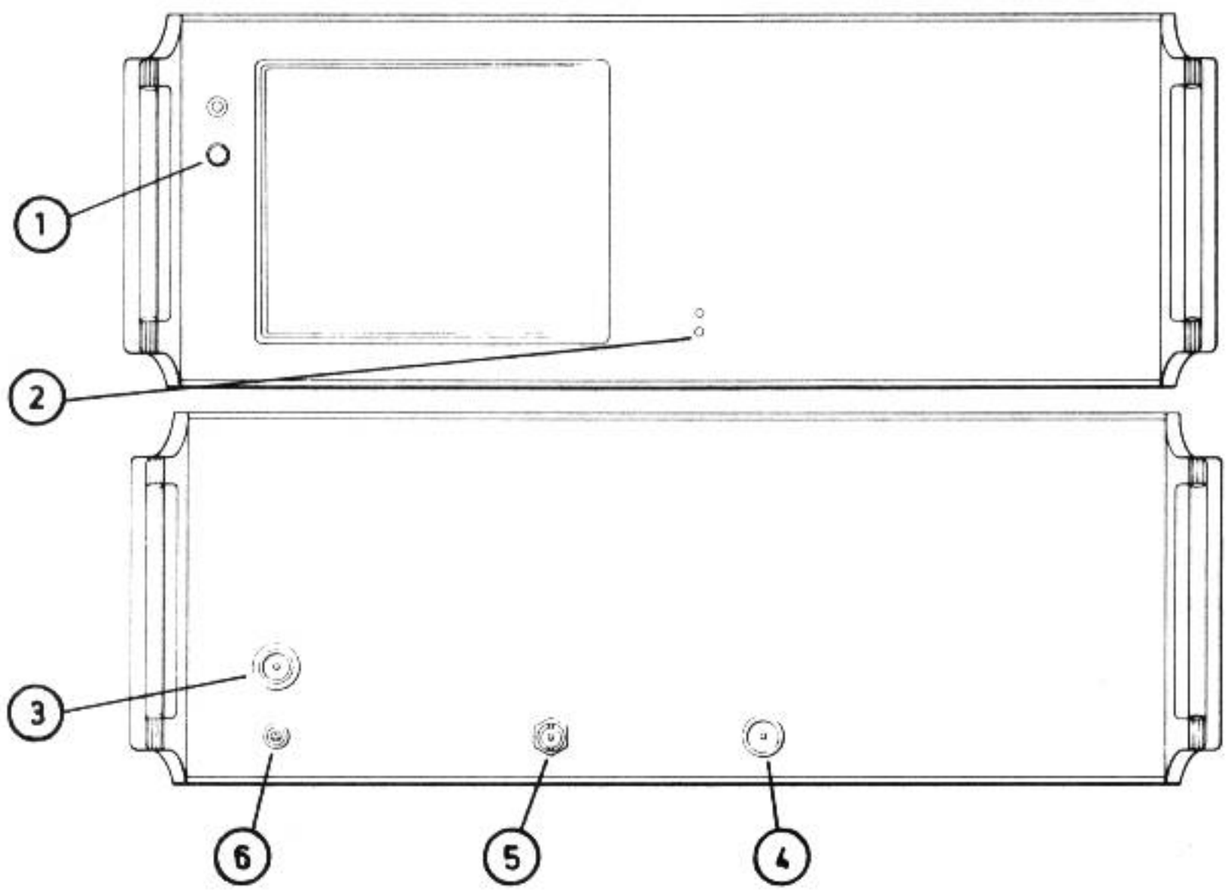

Fig. 1 Front panel inputs, outputs and indicating lights

[3] INPUT 100 Hz - 400 MHz 50 Ω [DC COUPLED] 0.5 W MAX
A type N socket for connection of input signals in the range 100 Hz - 400 MHz. Maximum input level is +27 dBm. Input circuitry is protected against accidental application of overload power up to +47 dBm (50 W) by means of a latching relay. The word 'OVERLOAD' appears on the screen if an input level of +27 dBm is exceeded and if an 'OPTIONS' board is fitted, it can be arranged that an audible warning is emitted. When the overload is no longer present the protective state and the screen annotation can be cleared by pressing the INTMD IDENT button (refer to Front panel control functions - lower unit, para. 111, location [27]). For pulsed RF signals etc. the trip can be overridden (refer to para. 111 location [26]).

[4] TRACKING GENERATOR 50 Ω
A type N socket providing a swept frequency output synchronous with the internally generated input signal (100 Hz - 400 MHz) to within ±1 Hz. Output level from a 50 Ω source is initially -10 dBm, but can be adjusted from -9.7 to -20.3 dBm (refer to Front panel control functions - lower unit, para. 111, location [35]).

[5] STD 10 MHZ OUTPUT -10 dBm
A BNC type socket supplying a nominal 10 MHz square wave calibrator output at a level of -10 dBm from a 50 Ω source.

[6] PROBE
A sub-miniature 3-pin socket providing power for an active probe such as the Zero Loss Probe TK 2374.

Rear panel (refer to Fig. 2)

4. [1] FUSES
Supply input fuses are rated as follows :

230 V, 2.5 A time lag (20 mm x 5 mm cartridge)
110 V, 4 A time lag (20 mm x 5 mm cartridge)

Note ...

The instrument employs double fusing, a fuse in both the live and neutral supply leads.

[2] LINE VOLTS SELECTOR
The selector switch allows the instrument to be set to an appropriate supply voltage. The '230 V' setting covers supply voltages in the range 189 - 264 V and the '110 V' setting supply voltages between 95 - 132 V. Normally the instrument is despatched set for the 230 V supply. If the 110 V setting is to be used the supply fuses must be changed to the appropriate rating.

[3] LINE VOLTS INPUT
Three pin a.c. supply power input connector. The ground pin is internally connected to the chassis. This male connector mates with the female socket fitted to the supply cable (CEE 22 43129-003W).

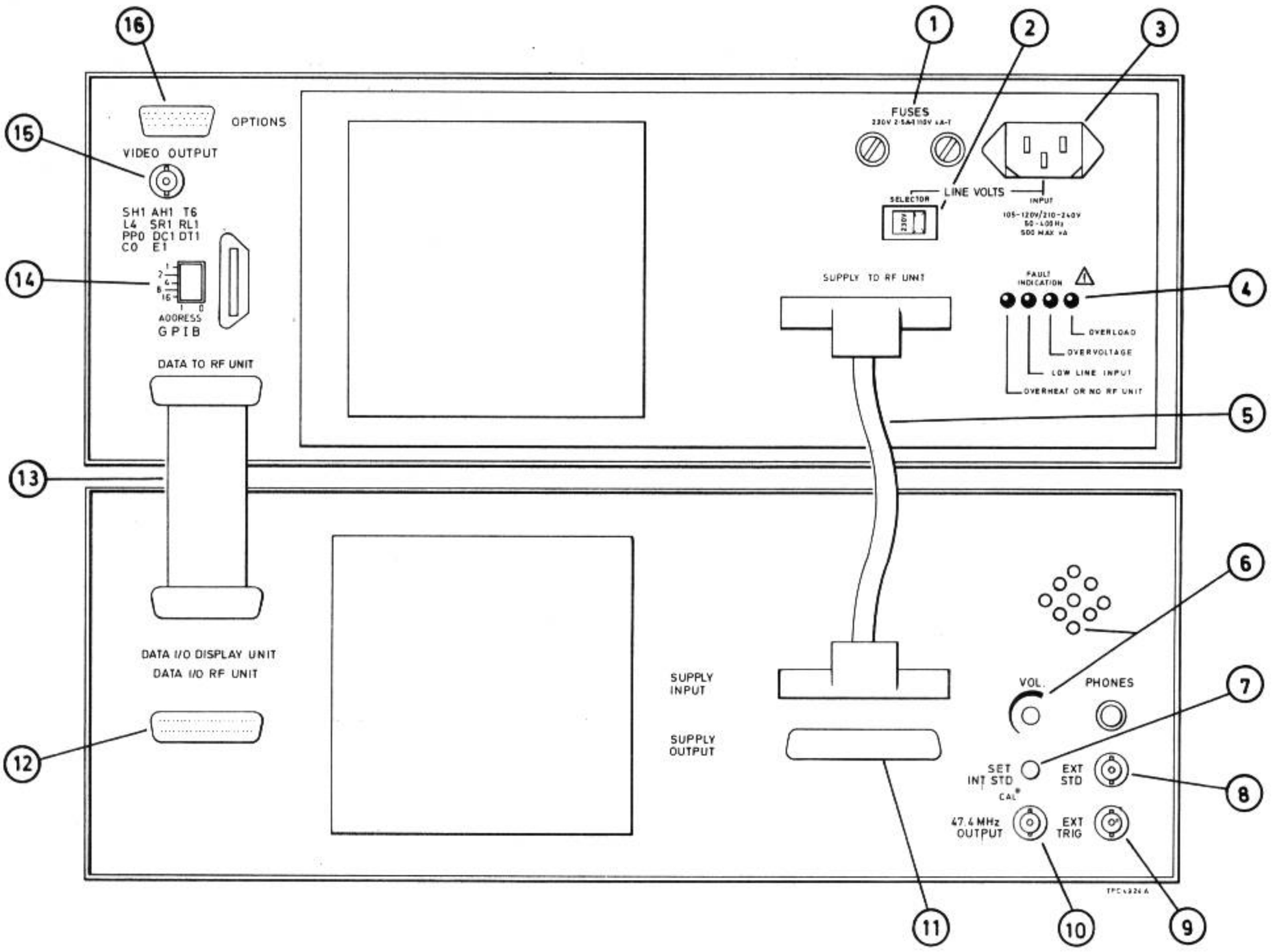

Fig. 2 Rear panel inputs, outputs and interfaces

[4] FAULT INDICATION
Four amber lights provide warnings of overload, over-voltage, low line input voltage and overheat or no RF unit.

(a) Overload Light is ON when the internal power supply has shut down due to excessive load such as a short-circuited output.

(b) Overvoltage Light is ON when there is a supply regulation fault which causes overvoltage.

(c) Low line input voltage Light is ON to indicate there is or has been a low line input voltage or that a line drop-out exceeding 20 ms has occurred.

(d) Overheat or no RF unit Light is ON when the instrument has shut down due to excessive internal temperature rise or if the display unit (2380) has been switched ON without an RF unit connected.

[5] POWER SUPPLY TO RF UNIT and SUPPLY INPUT sockets, cable assembly 43129-991G. This cable and its two 37-pin connectors link the power supply from the upper display unit to the lower RF unit.

[6] VOL, PHONES
Audio monitoring of amplitude or frequency demodulated signals is provided using a loudspeaker fitted to the rear of the RF unit. As an alternative, this jack socket is provided for the use of earphones. The output from loudspeaker and phones is controlled using the adjacent volume control. Selecting AUDIO on the front panel, switches the drive ON and OFF. A 6.35 mm jack plug to BNC lead is available as an optional accessory.

[7] SET INT STD
Normally in the CAL position. When moved off the CAL position this switched preset permits the frequency of the internal standard to be adjusted to a desired accuracy.

[8] EXT STD
A BNC socket is provided to enable an external standard to be connected if required. The internal 10 MHz frequency standard is locked to this signal or the appropriate harmonic of it. The external standard may have a frequency of 1,2,5 or 10 MHz, and a level of -15 dBm to +15 dBm into 50 Ω. The frequency must be within ±1 part in 10^6 for the system to lock.

[9] EXT TRIG
A BNC socket is provided to enable external trigger to be applied to trigger the start of a sweep or to synchronize the display of a demodulated signal when zero span is used. Triggering can be applied over the range 50 mV p-p to 100 V p-p, at frequencies from 10 Hz to 300 kHz. Refer to Trigger Source keys para. 111 location [30].

[10] 47.4 MHZ OUTPUT
The input signal after frequency translation to 47.4 MHz i.f. is connected to this BNC socket as an auxiliary 50 Ω output. The level is nominally 3 dB greater than the r.f. input signal for 0 dB r.f. attenuation, and the bandwidth is approximately 3 MHz.

[11] SUPPLY OUTPUT
This 37-way socket is used to extend the display unit's power supply to a further RF unit if required. The upper unit's supply will power up to two lower units, although only one can be selected at any one time.

[12] DATA I/O RF UNIT
This 25-way socket is used to extend data to and from further RF units if required.

[13] DATA TO RF UNIT and DATA I/O DISPLAY UNIT sockets, cable assembly 43130-082H. This cable and its two 25 pin connectors is used for the transmission of housekeeping and display data between the upper and lower units.

[14] GPIB
All functions (apart from power ON, intensity controls and those related to the second marker) on both units are GPIB controllable via this 24-way socket. Indicator lights on the front panel show whether the instrument is in the 'local', 'remote' or 'remote addressed' modes, and the address slide switch is positioned on the left of the GPIB connector.

The 2380 can be set to talk directly to a GPIB plotter, via this socket, in order to obtain hard copy prints of traces, annotation and graticules.

[15] VIDEO OUTPUT
When Conversion kit 46883-735V is fitted this BNC socket provides the composite monochrome video signal to drive an auxiliary TV display or video plotter.

[16] OPTIONS
When Conversion kit 46883-735V is fitted this 15-way socket provides a pen recorder output comprising two analogue signals and a pen lift drive. It also provides the RGB and sync drives for a video colour monitor.

CRT DISPLAY ANNOTATIONS

5. The display covers an area of 140 mm x 110 mm. The central 100 mm x 90 mm graticule area is used for the graphical display of the measured parameters and consists of ten major divisions horizontally and ten vertically.

6. The top 10 mm of the display is used for the following dedicated information (refer to Fig. 3):

[1] 'A' scale units

[2] 'B' scale units

[3] Text. A caption of up to 38 characters can be input.

[4] RF attenuator in dB and input impedance in ohms.

[5] Tracking generator setting.

[6] When an external standard frequency is in use. Displays 'int std' when internal standard has been adjusted.

[7] The instrument type number

7. Down each side of the graticule, 20 mm strips nine characters wide, are available for the display of an annotation on each major graticule division. 'A' scale annotations are down the left hand side of the display and 'B' scale annotations down the right hand side.

8. Data entry areas towards the top of the graticule are used to display user prompts and standard error messages during normal use e.g. the 'calibrated' condition as shown in Fig. 3, KEY SELECTION NOT VALID, OUT OF RANGE etc. Menus of various types are often displayed superimposed on the trace to assist in the use of a particular function. If the trace interferes with the reading of a menu, it can be faded out using the appropriate intensity control.

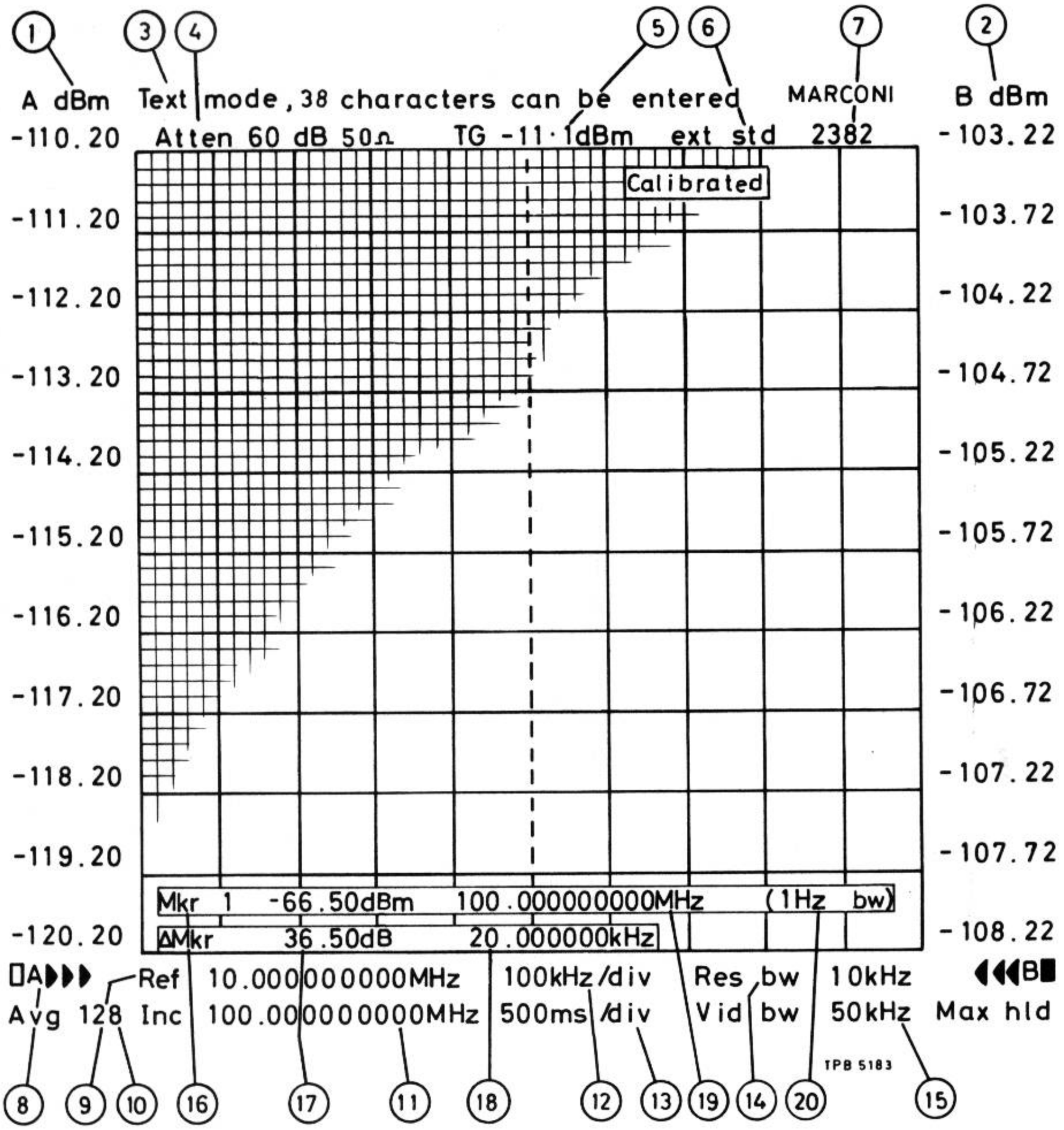

Fig. 3 CRT display annotations

9. The bottom 10 mm of the screen is used for the following dedicated information (refer to Fig. 3):

[8] Whether the display is outlined (□) or infilled (■) and whether the above annotation refers to the 'A' or 'B' displays (indicated by A▶▶▶ or ◀◀◀B).

[9] Reference frequency value.

[10] Number of display A and/or B multiple sweep averages when in VIDEO AVG mode. Alternatively maximum hold (Max hld).

[11] Incremental frequency value

[12] Value of Span/div, Zero span or FM demod *

[13] Value of Time/div

[14] Value of resolution bandwidth

[15] Value of video bandwidth

* ´Zero span´ or ´FM demod´ replaces the Span/div annotation.

10. The bottom 10 mm of the graticule area is shared for the display of the following information (providing the function is in use):

[16] Level of Mkr 1 (in dBm, dBV, dBmV, dBµV, dB, nV, µV, mV or V as appropriate). In METER mode ´Mkr 1´ is replaced by ´Meter´. Also refer to [20] below.

[17] Level difference between two markers in dB (in volts on VOLTS ranges).

[18] Frequency difference between two markers.

[19] Frequency of Mkr 1 (resolution 1 Hz in RES 1 Hz mode - second function of FREQ COUNT).

[20] Marker level can be displayed as the equivalent noise in a 1 Hz bandwidth. The annotation ´(1 Hz bw)´ is displayed in this mode. The annotation ´Freq count´ is displayed when FREQ COUNT mode is in use or ´Res 1 Hz´ when RES 1 HZ mode is in use.

CALIBRATION SEQUENCES

11. When the CAL key is pressed an automatic self-calibration routine is performed to optimize measurement accuracy and cancel any temperature drift. All the resolution filters are adjusted to set their centre frequency and gain, and each step of the r.f. attenuator and overall frequency response is measured and stored for error correction of all subsequent measurements. The sequence takes about 30 seconds and disables the instrument during this time. Subsequent calibration routines are faster, depending on the degree of change since the last calibration occurred. This is an essential operation to perform whenever accurate measurements are to be made (refer to the CAL function para. 110[9]).

OPERATING PROCEDURES

Preparation for use

12. If the two units have been disconnected for ease of transportation, mount the Display unit 2380 above the RF unit 2382 and lock into position using the clips at the front of the unit and the two toggle latches at the back.

13. With reference to Fig. 2 fit the power supply cable assembly 43129-991G [5] and data cable assembly 43130-082H [13].

14. Check that the rear panel supply fuses [1] are correctly rated for the supply in use and that the line volts selector switch [2] is set for the required supply voltage.

15. Fit the supply lead 43129-003W into the power input connector [3], connect to supply and rotate the SUPPLY switch on the upper unit (refer Fig. 1 [1]) until the green indicator light is ON.

Obtaining a display and use of basic controls

16. A full description of all front panel control functions is given in paras. 110 and 111; refer to Fig.31 for their locations.

17. Ensure the INTENSITY controls [1,2 and 3] are set to their mid-position and press the SELECT & PRESET key [36]. Functions becoming active upon operation of this key have green lettering. After a few seconds a display on the c.r.t. should appear. Adjust GRATICULE INTENSITY as required.

Horizontal scale FULL SPAN

18. Adjust INTENSITY ´A´ [1] until a display of noise can be seen. The average level of this noise, approx. -65 dBm, can be determined from the left hand margin annotation of the screen graticule. The SELECT & PRESET key [36] sets the vertical scale to dBm, 10 dB/div. and the horizontal scale to /DIV, 40 MHz/div. The d.c. marker (zero pip) can be seen at the left hand side of the graticule area.

19. Notice that the value of r.f. input attenuation is displayed and that the reference frequency, initially set at 200 MHz, is indicated by a dashed vertical line and marginal annotation. Incremental frequency (initially set at 40 MHz (one tenth of span)), sweep span (40 MHz/div.), sweep time (10 ms/div.) resolution bandwidth (1 MHz) and video bandwidth (11 kHz) are also marginally annotated. Typical c.r.t. display annotations can be found in Fig. 3.

20. The top line of the graticule area is the reference level and this is initially set at 0 dBm. Press the FULL SPAN key [29].

21. Rotate the REF FREQ control [18] and observe that the dashed vertical line on the display can be repositioned over the entire spectral response. In FULL SPAN mode therefore, the reference frequency can be set to any value required over the range zero to 400 MHz, the marginal annotation indicating the actual value of the frequency selected.

22. In order to see a signal display, connect a 50 Ω cable between the STD 10 MHz OUTPUT (Fig. 1 [5] and the INPUT (Fig. 1 [3]). The screen should display vertical bright lines corresponding to the 10 MHz signal and its harmonics. The fundamental can be identified as the largest spectral line a quarter of a division from the left hand side of the screen.

23. Position the dashed vertical line on to the ninth harmonic using the REF FREQ rotary control [18]. The reference frequency annotation indicates that the value of the frequency at this point is approx. 90 MHz (refer to Fig. 4).

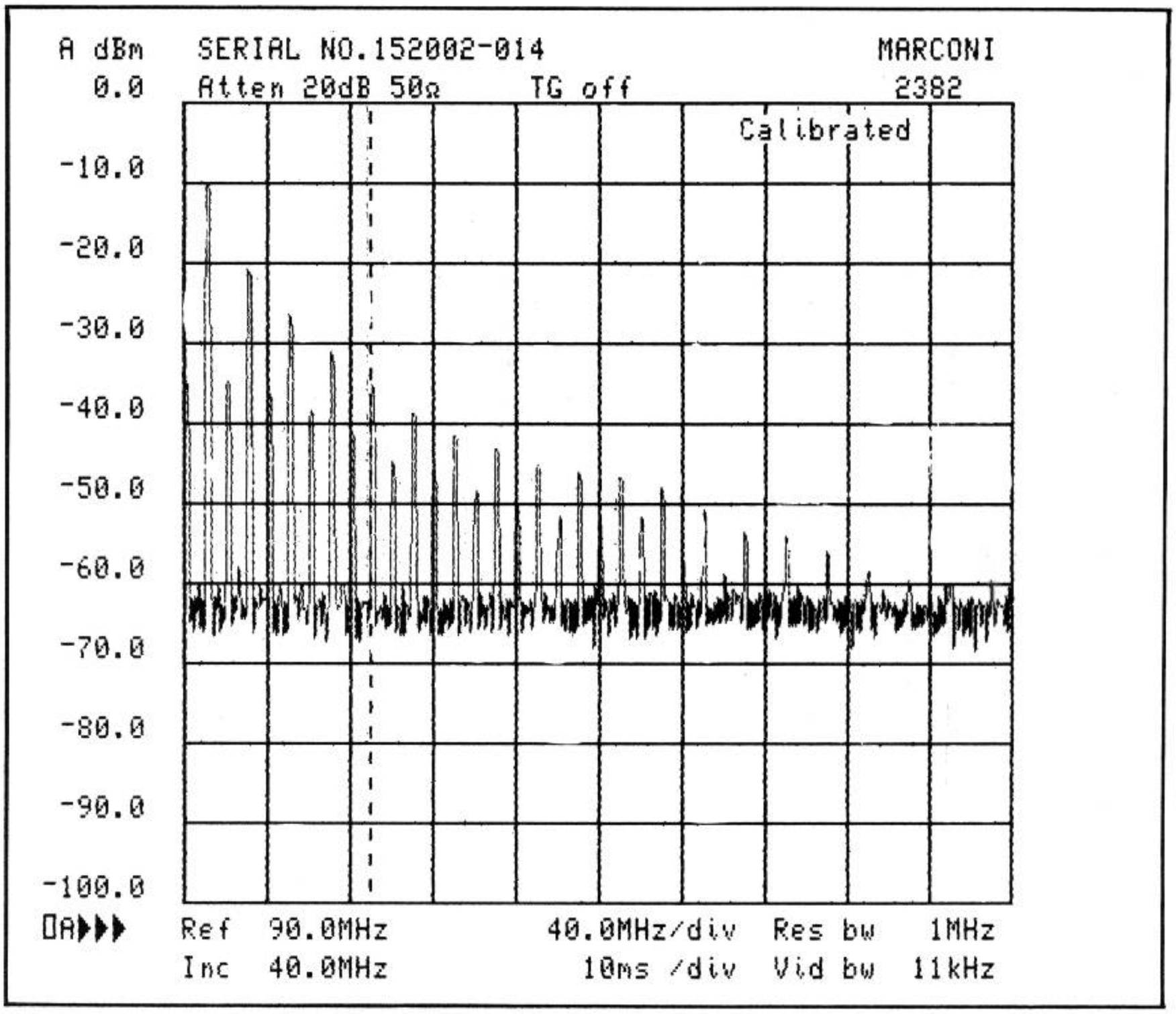

Fig. 4 Frequency spectrum for 10 MHz cal. sig. (FULL SPAN)

Horizontal scale /DIV

24. To obtain a display of say the 10 MHz fundamental at improved resolution, position the dashed line on to the fundamental and press the horizontal scale /DIV control [29]. The dashed vertical line will now appear at the centre of the screen, with the fundamental beneath it, the horizontal scale span/div. filter bandwidth, sweep time and video bandwidth being automatically set to produce a satisfactory display. Although the 10 MHz spectral line will be near the centre of the screen it may not be precisely on the dashed vertical line. This can be achieved either by the use of the REF FREQ rotary control as a fine control or, as the exact frequency is known in this case, by

pressing the REF FREQ key [12] and keying in 10 MHz using the DATA keypad [19] and the MHz terminator [20]. In both cases it is the spectral display which moves, the dashed line remaining stationary. The reference frequency annotation now reads 10 MHz and the height of the fundamental should be one major division down from the top of the graticule area corresponding to -10 dBm.

25. Vary the setting of the SPAN/DIV 'click' control [29] and watch the displayed spectrum adjust to the new conditions. Anticlockwise rotation decreases the Hz/div. At each value of Hz/div. r.f. attenuation, filter bandwidth, sweep time, video bandwidth and their annotations are adjusted automatically, sensitivity remaining unchanged. Notice that incremental frequency takes the same value as the span/div. at each variation of the SPAN/DIV control. If necessary the REF FREQ rotary control can be used to align the peak of the response with the dashed vertical line as the frequency span is reduced, or SIG TRACK [15] can be pressed to do this automatically. (Refer to Fig. 5).

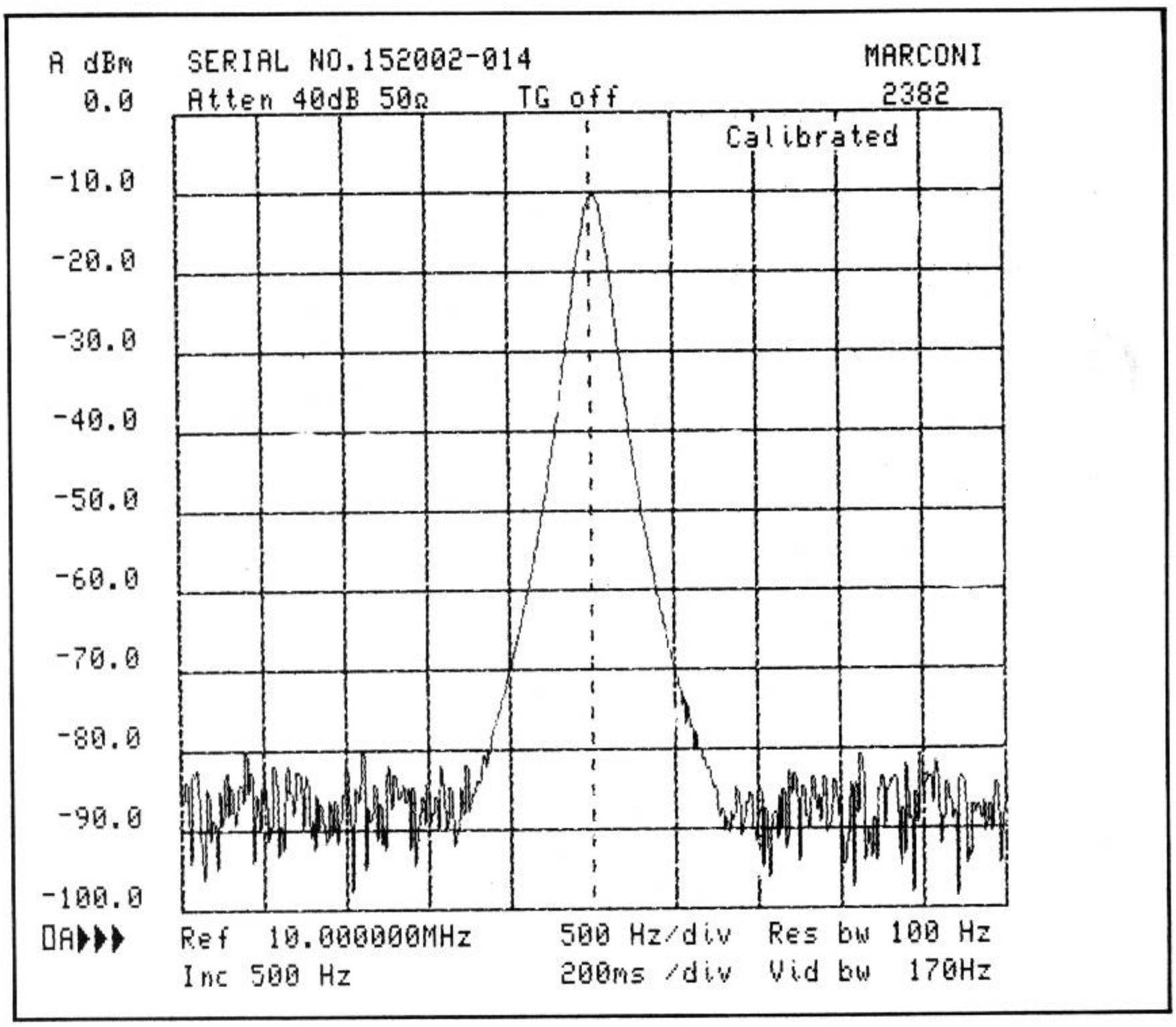

Fig. 5 Fundamental of 10 MHz cal. sig. (/DIV)

26. The smallest value of frequency span possible using this control is 10 Hz/div. To increase the resolution further it is possible to override the 'AUTO' filter bandwidth selection by pressing the FILTER BANDWIDTH ↓ control [33]. At each press the resolution bandwidth becomes progressively smaller

until a minimum of 3 Hz is reached. This is the maximum resolution which can be obtained. The sweep, controlled automatically during this time, is now very slow since narrow filters have long time constants and therefore require long scan times. It is possible to override this ´AUTO´ control by pressing the SWEEP TIME ↑ key [32] for an even slower sweep (maximum 20 s/div.) to ensure the filters respond fully, or the ↓ key for a faster sweep. The faster sweep however is in an uncalibrated condition and the ↓ key would only be used therefore to position the signal at the required reference position more quickly. To indicate this the message ´Calibrated´ is deleted from the top of the screen. At faster sweeps the display shifts to the right and the amplitude is reduced. On a slow sweep, to restart the trace press SWEEP MODE START [31]. Notice the ´read in bright up´ vertical band moving across the screen. This appears whenever the sweep time is longer than 0.1 s/div. and identifies the sweep refresh point. It can be switched off or on as required by pressing 2ND FUNCT then sweep mode START (IDENTIFY REFRESH) [31].* Return the controls to their original positions such that the 10 MHz fundamental is at the centre of the screen and is the reference frequency. Set the span to 10 MHz/div. using either SPAN/DIV rotary control [29], or the SPAN/DIV key [13] together with a keypad and terminator entry.

Reference frequency ↓ or ↑

27. Pressing the REF FREQ ↓ or ↑ key [17] causes a decrease or increase in the reference frequency initially equal to one division of the current display. The actual value of the step is therefore equal to the SPAN/DIV control setting in this instance (10 MHz). Subsequently the value of the ´decrease´ or ´increase´ can be changed using the INC FREQ key [14]. The display moves across the screen and the new reference frequency appears beneath the dashed vertical line, the marginal annotation indicating its value. Return the 10 MHz fundamental to the centre of the screen.

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* NOTE ON ALIASING

The 2382/2380 sampling system digitizes the signal at the i.f. detector. To produce an accurate representation on the display at least two samples between the 0.1 dB points are required and therefore a minimum sampling rate of 10 µs (100 kHz) is necessary at the maximum sweep speeds used.

If a low repetition rate, narrow width pulse train is viewed on a wide bandwidth filter, e.g. 1 MHz or 300 kHz this sampling rate may not satisfy the Nyquist Sampling Criteria and aliasing could result giving spurious shapes to the spectral envelope. If such effects are suspected, reduction of the filter bandwidth to 100 kHz will eliminate the aliasing.

Incremental frequency (INC FREQ)

28. The value of the decrement or increment produced when REF FREQ ↓ or ↑ is pressed may be set using the INC FREQ mode. Press the INC FREQ key [14]. The message ´Inc freq=´ appears in the data entry area of the screen together with instructions for setting INC FREQ to its ´AUTO´ mode or new value. Enter 20 MHz using the DATA keypad and terminator and note the above message has been erased and 20 MHz incremental frequency appears in the marginal annotation area in reverse video. Press the REF FREQ ↑ key and the reference frequency annotation changes to 30 MHz. The 30 MHz component of the 10 MHz signal moves to the dashed vertical line at the centre of the display. Press the REF FREQ ↓ key to return to the 10 MHz reference.

The HORIZ POSN control

29. Initial operation of the SELECT & PRESET key [36] automatically made the HORIZ POSN control [16] active in the centre reference mode and hence in the previous operations the reference frequency has been displayed by the dashed vertical line in the middle of the graticule area. Press the HORIZ POSN key [16]. The screen now displays the 10 MHz signal and dashed vertical line at the right hand side of the graticule area. If HORIZ POSN is pressed again the 10 MHz signal and dashed vertical line are displayed at the left hand side of the graticule area (refer to Fig. 6). Repeated operation of the key moves the 10 MHz signal and dashed vertical line sequentially through each of the three positions in turn. Select the left hand reference position again. At a setting of 10 MHz/div. frequency span the harmonics can be seen adjacent to every vertical graticule line to the right of the reference frequency.

30. Vary the REF FREQ rotary control [18] and observe the change in the reference frequency annotation and how the new reference spectral line moves to the left hand expand point. Return the control to its original position so that the reference frequency is 10 MHz and reset the HORIZ POSN key to the centre reference mode. Set the frequency span to 100 kHz/div. and the incremental frequency to its ´AUTO´ mode. The ´AUTO´ mode is set by pressing INC FREQ and any terminator key e.g. Hz.

Reference level and vertical scale controls

31. Initially the vertical scale control [24] is set to dBm, 10 dB/div. and the REF LEVEL set to 0 dBm automatically by the operation of the SELECT & PRESET key, the A B SELECT control being in the ´A´ state. The top of screen reference level can be changed using the DATA keypad. Press the REF LEVEL key [11] and the message ´A & B Ref level=´ appears in the data entry area of the screen. Enter -15 dB using the keypad, and terminator key and note that almost instantaneously after pressing the terminator key the message is erased and the required reference level of -15 dBm is displayed on the top line of the graticule - the display moving accordingly. Reset the top of screen reference level to 0 dBm using the same procedure.

32. Press the REF LEVEL ↑ key [25] and note that the vertical scale dB/div. remains the same but the top of scale reference level changes to 10 dBm. With this reduction in sensitivity the trace moves down the screen. Repeating this operation using both the REF LEVEL ↓ and ↑ keys shows that the top of scale reference level changes in 10 dB steps above and below zero - the display moving accordingly as the sensitivity is either decreased or increased.

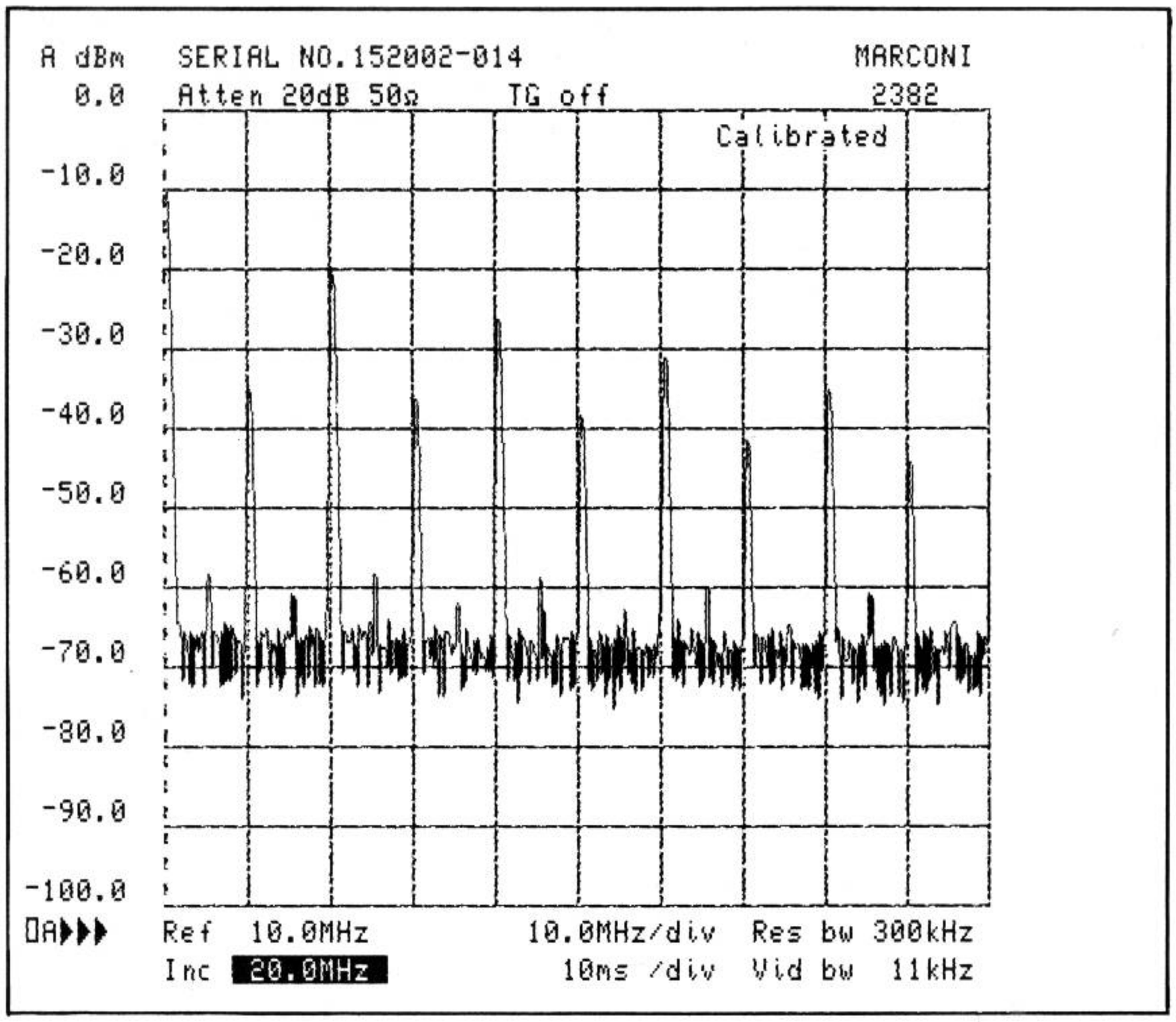


Fig. 6 The left hand reference mode (/DIV)

Making the top of scale reference level -10 dBm sets the peak of the 10 MHz signal at the top of the screen. The 10 dB/div. vertical scale setting gives minimum resolution.

33. Press the 5 dB/div. key to increase the resolution and observe that the top graticule line remains the same and indicates a reference level of -10 dBm but the left margin annotations change such that the bottom of the screen is now -60 dBm. Press the 2 dB/div. key. The top line remains the same again and the bottom of the screen is now -30 dBm. When the 1 dB/div. key is pressed, the reference level is still -10 dBm but the resolution is further increased and the scale annotations have an additional decimal place. Similarly the 0.5 dB/div. scale annotations have two places of decimals. The extent of the scale is -20 dBm on the 1 dB/div. range and -15 dBm on the 0.5 dB/div. range.

Reference level (rotary control)

34. The top of screen reference level can also be changed using the rotary control [25]. This is a fine control however whereas the above set reference level increment keys are coarse controls. Rotate the control anticlockwise. This reduces the sensitivity, reference level increases and the trace moves down the screen. The reference level changes in steps which vary according to the selected vertical scale. For the 10 dB, 5 dB and 2 dB/div. keys the steps are 0.1 dB. For the 1 dB and 0.5 dB/div. keys the steps are 0.01 dB. Rotate the control clockwise and watch the trace moving up the screen in the same way and to the same extent as above. Refer to Fig. 7. The sensitivity increases when the control is moved in this direction and reference level increases. Notice the audible click as the control is rotated. This occurs whenever the 10 dB input attenuator changes.

35. As this control is very sensitive, if the reference level is not an exact number of dB it is easier to round up the scale annotation if necessary by pressing the REF LEVEL key and using the DATA keypad.

36. The above measurements have all been with respect to a reference of one milliwatt (dBm) but the procedures are the same when making measurements with respect to 1 V (dBV), 1 mV (dBmV) or 1 µV (dBµV). Repeat from para. 31 to become familiar with the use of these features. To select dBV press 2ND FUNCT [22] then 5 dB/div. and to select dBmV press 2ND FUNCT then 2 dB/div. etc.

37. Similarly dB can be selected by pressing the 2ND FUNCT then 0.5 dB/div. key but in this case a previously selected reference level (e.g. -10 dBm) is maintained and annotated 0 dB at the top of the scale. The value of each major scale division from zero depends upon the setting of the vertical scale /div. keys and is that number of dB with respect to the chosen reference level. Subsequent changes to the /div. keys cause the picture and graticule annotations to change accordingly so that 0 dB is always at the reference level. The function is used to determine the dB difference between a reference at 0 dB and any other signal.

The marker facilities

38. Display the 10 MHz calibrator signal as explained in the previous paragraphs with PRESET operated and with keys and controls set as follows :

AB SELECT [24]	A
HORIZONTAL SCALE [29]	/DIV
SPAN/DIV [29] or [13]	10 MHz/div.
HORIZ POSN [16]	Centre reference
REF FREQ [12]	50 MHz
REF LEVEL [25]	0 dBm
VERTICAL SCALE [24]	10 dB/div

All other controls unoperated.

39. Set markers A B SELECT key to 'A' and press MKR 1 [34]. A bright dot marker appears on the screen in the position occupied when the key was last selected. Adjust DISPLAY A and graticule intensities for best contrast. Display annotations for this marker can be seen on lines three and four from the bottom of the screen (refer to Fig. 3). They show the number of the marker in use (MKR 1 in this case) and the level and frequency of the signal indicated by it.

40. Press the 1 2 MOVE key. A green light indicates that marker 1 has been selected and the marker dot flashes on the screen for easy identification. Using the markers rotary control move the marker to the left or right over the display. The bright dot follows the outline of the response and the marker annotations change accordingly.

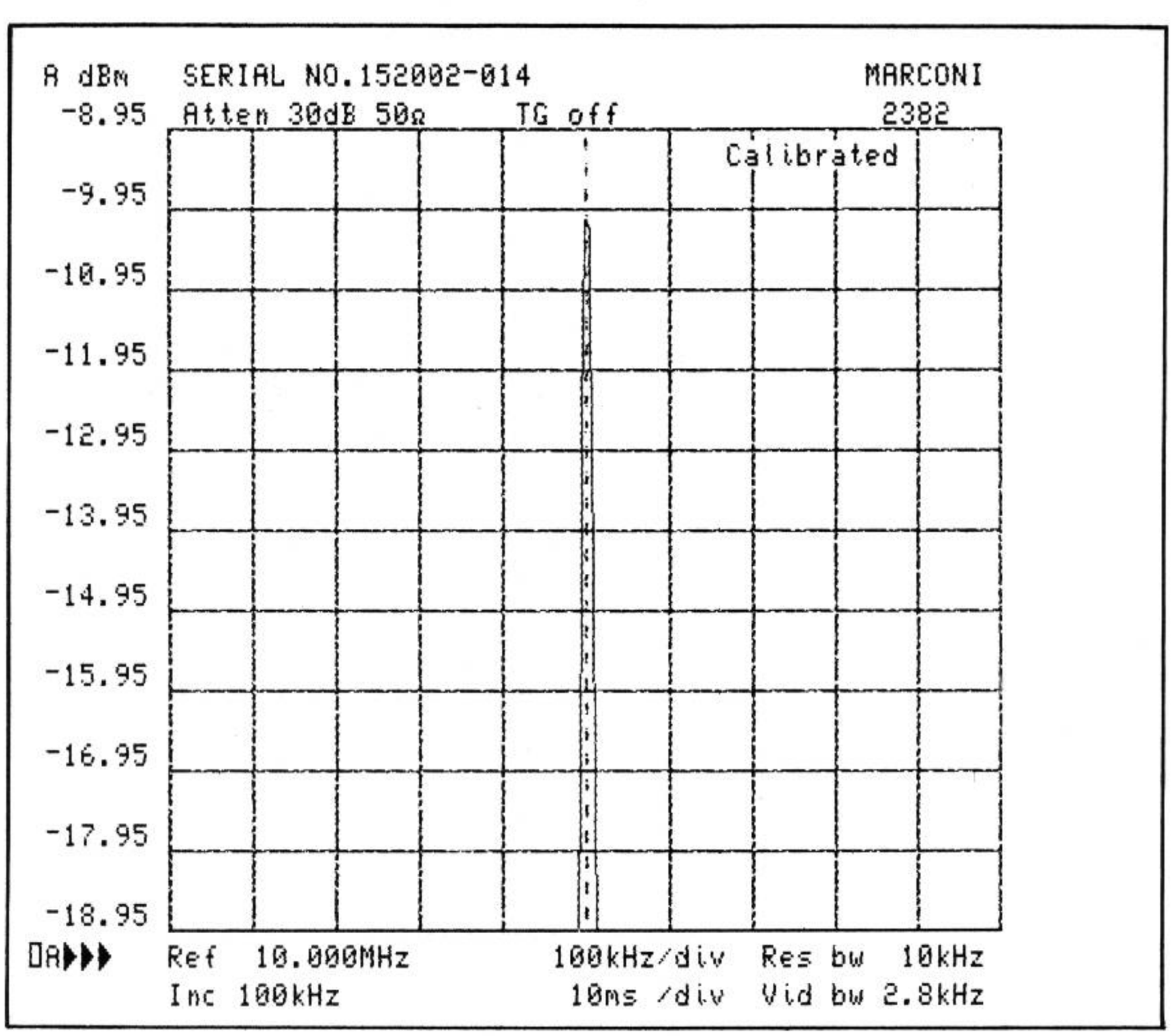


Fig. 7 Reference level - fine control display

41. Position the bright dot on the peak of one of the spectral lines and note the frequency recorded. To enhance the accuracy of the frequency measurement press FREQ COUNT. The annotation 'Freq count' appears at the bottom right hand side of the screen and the frequency is now measured to a resolution of ±10 kHz. Press 2ND FUNCT then FREQ COUNT. The frequency is now measured at ±1 Hz resolution. Refer to Fig. 8. Press the FREQ COUNT key again to cancel the mode.

42. Vary the position of the marker and press PEAK FIND. The bright dot moves to the peak of the largest spectral line currently displayed. Press 2ND FUNC then PEAK FIND (NEXT PEAK) and the bright dot moves to the next largest peak. Repeat as required. Pressing the 1 2 MOVE key again deselects the MOVE mode.

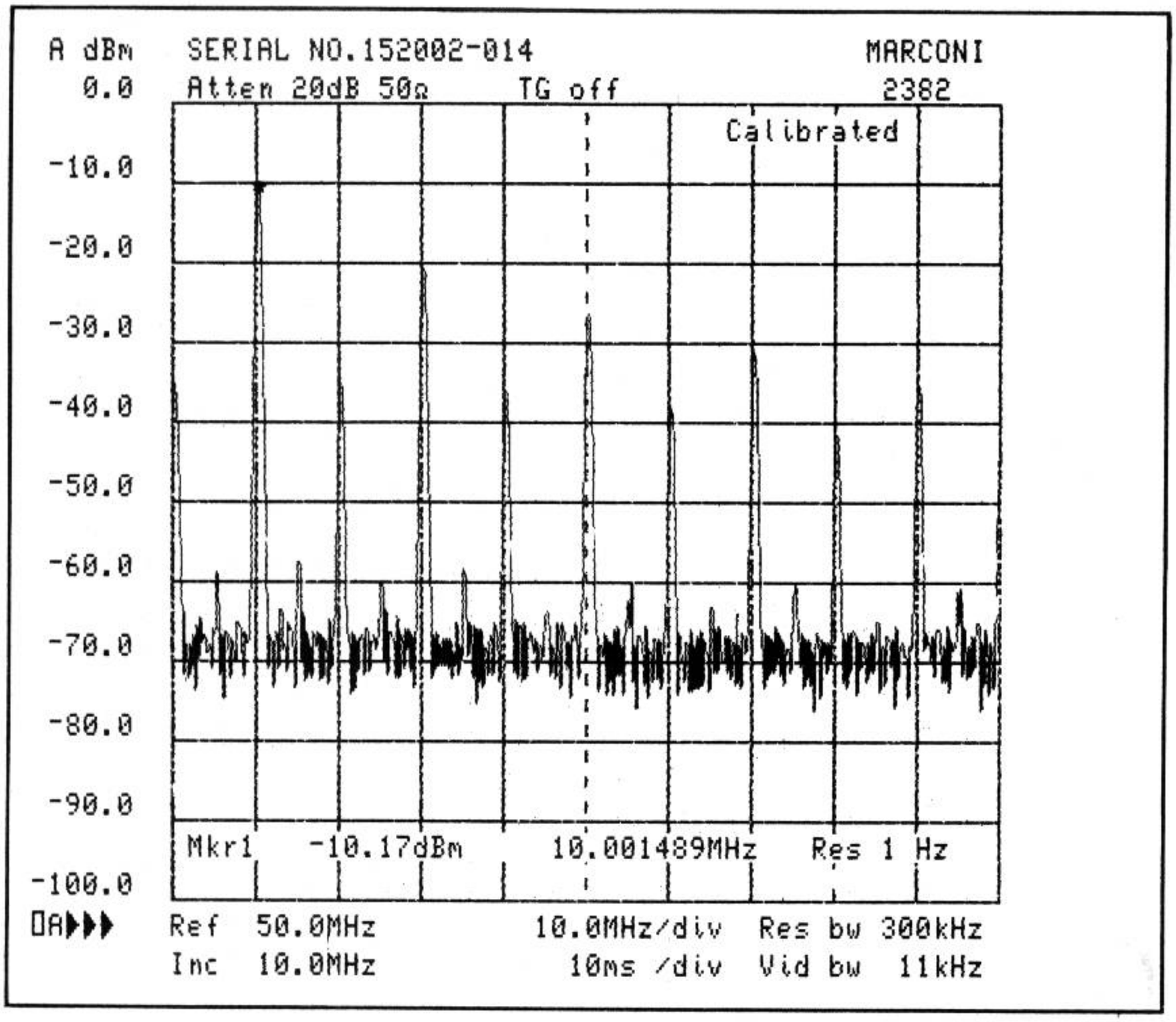


Fig. 8 Frequency measurements at 1 Hz resolution using MKR 1

43. Press the MKR 2 key and set the 1 2 MOVE control to MKR 2. An indicator light shows that MKR 2 is selected and it flashes on the screen for easy identification. Using the rotary control move the dot to a signal peak and note that the screen annotations now show the level and frequency of this marker. In addition the difference in level and the difference in frequency between the two markers is shown (refer to Fig. 9). To avoid the continual movement of the display which may affect measurement accuracy press sweep mode SINGLE ARM. This stores and displays a single sweep and markers can be positioned with greater precision. Alternatively the SAVE A key can be used (refer to para. 49).

44. Switch off marker 2 by pressing the MKR 2 key again and set the 1 2 MOVE control back to MKR 1. Switch back to SWEEP MODE NORM or 'unsave' the A trace.

45. **MKR 1 SETS REF FREQ.** Position marker 1 on to the peak of the 10 MHz spectral line and check that the annotated frequency is approx. 10 MHz. Press the MKR 1 SETS REF FREQ control. The reference frequency is now changed to that specified by the marker and this spectral line and marker now moves to the dashed vertical line at the centre of the screen.

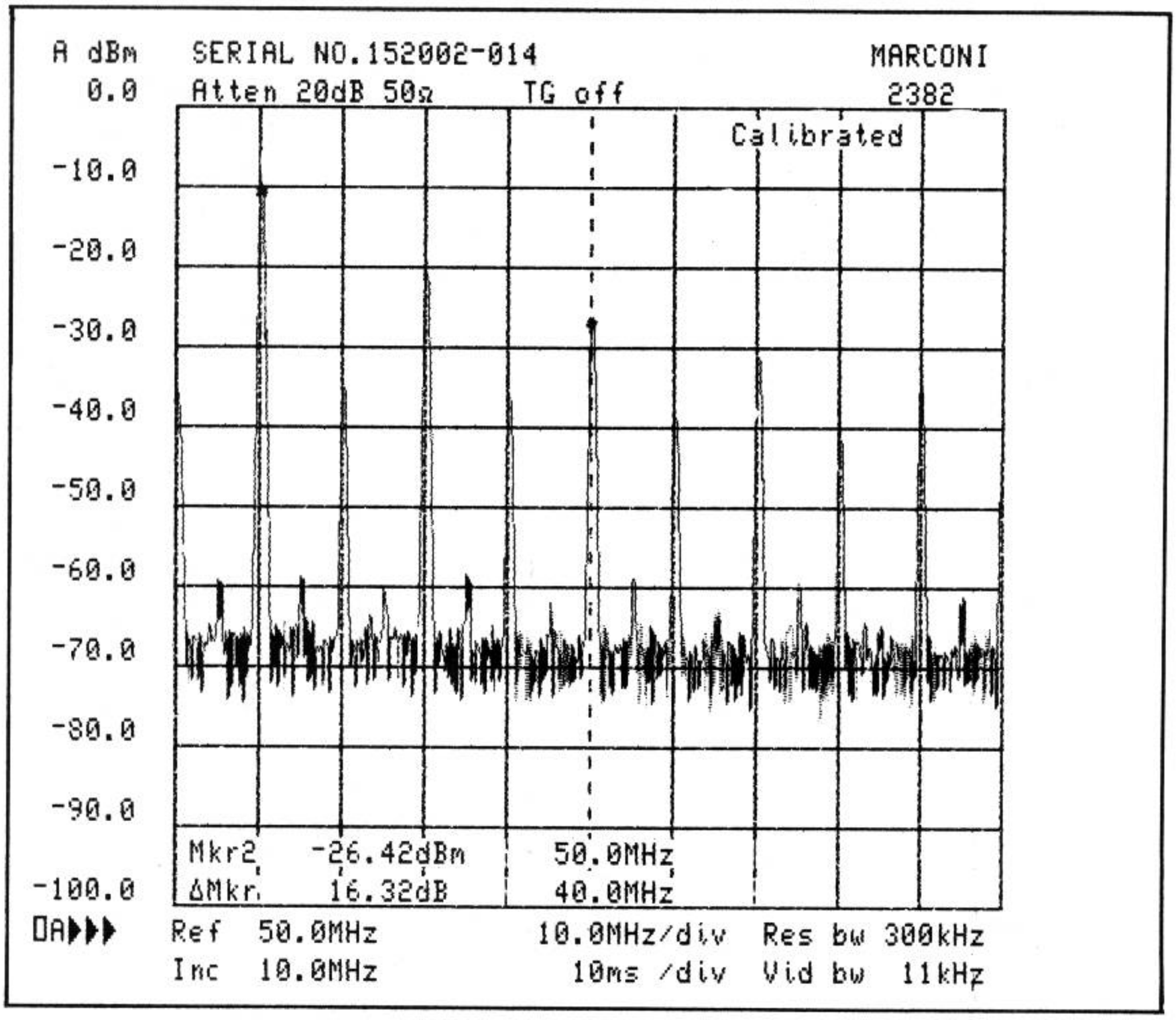


Fig. 9 Measurements using both markers

46. **MKR 1 SETS REF LEVEL.** Pressing this control causes the reference level to change to that level indicated by the marker. The marker and response is therefore automatically repositioned to the top of the screen. Set REF LEVEL to 0 dBm.

47. **MKR 1 SETS INC FREQ.** Using this control the incremental frequency can be set to that indicated by the marker. At present MKR 1 is positioned on the peak of the 10 MHz fundamental, this being the reference frequency displayed at the centre of the screen. Press the MKR 1 SETS INC FREQ key and note that the incremental frequency annotation is now that frequency of MKR 1 in reverse video. This may not be exactly 10 MHz and as the incremental frequency must be exactly 10 MHz for the next exercise, key in this value using INC FREQ. Subsequent operations of REF FREQ ↑ will now move the harmonics of the 10 MHz calibration signal successively to the dashed vertical line for measurement as required - these being themselves spaced at 10 MHz intervals. If INC FREQ is set to 20 MHz and the above procedure repeated, each time the REF FREQ ↑ key is operated the odd harmonics of the calibration signal will move successively to the dashed vertical line - these being spaced at 20 MHz intervals. Pressing the REF FREQ ↓ key successively will return the reference frequency to its original 10 MHz.

48. **ΔF SETS INC FREQ.** This control allows the incremental frequency to be set to the difference frequency between the two markers. Press MKR 2 and set the 1 2 MOVE control to MKR 2. Move marker 2 to the peak of the 20 MHz spectral line and note that the difference frequency annotation is approx. 10 MHz. Press the ΔF SETS INC FREQ key and note that the 'Inc' annotation is now the same as the Δ Mkr frequency annotation. Set the display to a 10 MHz reference frequency and switch off the marker controls. Restore the INC FREQ setting to its AUTO value.

The display B and SAVE facility

49. All the above operations can be repeated using the alternative channel - DISPLAY B [2]. For this exercise set the A B SELECT key [24] and the markers A B SELECT key [34] to 'B' and press VIEW A to de-select the A channel. Press VIEW B and adjust the INTENSITY B control until a display is obtained. Operate the keys as instructed in previous paragraphs using DISPLAY B controls and note that similar results are obtained except that the vertical marginal annotations are now at the right hand side of the screen and the identifier at the bottom right of the display now indicates ◀◀◀B instead of A▶▶▶. The symbol '□' signifies an outlined display. Press 2ND FUNCT then VIEW B to see an infilled one and note the change in marginal annotation (■).

50. Display the fundamental of the 10 MHz calibration signal on the A channel with PRESET operated and with keys and controls set as follows :

A B SELECT [24]	A
HORIZONTAL SCALE [29]	/DIV
SPAN/DIV [29] or [13]	100 kHz/div.
HORIZ POSN [16]	Centre reference
REF FREQ [12]	10 MHz
REF LEVEL [11]	-10 dBm
VERTICAL SCALE [24]	10 dB/div.

All other controls unoperated.

Press the SAVE A control [1] and the display is stored in the digital memory. This can be demonstrated by disconnecting the input signal; the screen continues to show the stored display. Reconnect the input signal and press SAVE A again to de-select the mode and return to a 'live' display.

51. The same signal can now be shown at a different resolution using the DISPLAY B channel. Press VIEW A to de-select the A channel, set the vertical scale A B SELECT to the 'B' position and press VIEW B. Adjust the INTENSITY B control to give a satisfactory picture maintaining the key and control positions as for VIEW A. Press the VERTICAL SCALE 5 dB/div. key to display the peak of the 10 MHz signal only. Now press VIEW A so that both channels are displayed on the screen and can be compared (refer Fig. 10). Setting the A B SELECT control to either A or B allows the vertical scale for that view to be changed. Operating the REF LEVEL controls at this point however, changes the reference level on both displays. If independent control is required, operating 2ND FUNCT then A B SELECT [24] will unlock the reference levels allowing each to be adjusted separately. Under these circumstances the relevant key light flashes, indicating the 'unlocked' condition. Repeating this operation restores the 'locked' condition and the relevant key light ceases to flash. As the horizontal marginal annotations are common to both 'live' displays, both the arrowed annotations A▶▶▶ and ◀◀◀B appear and if horizontal controls such as reference frequency, filter bandwidth or sweep time are adjusted both displays are affected.

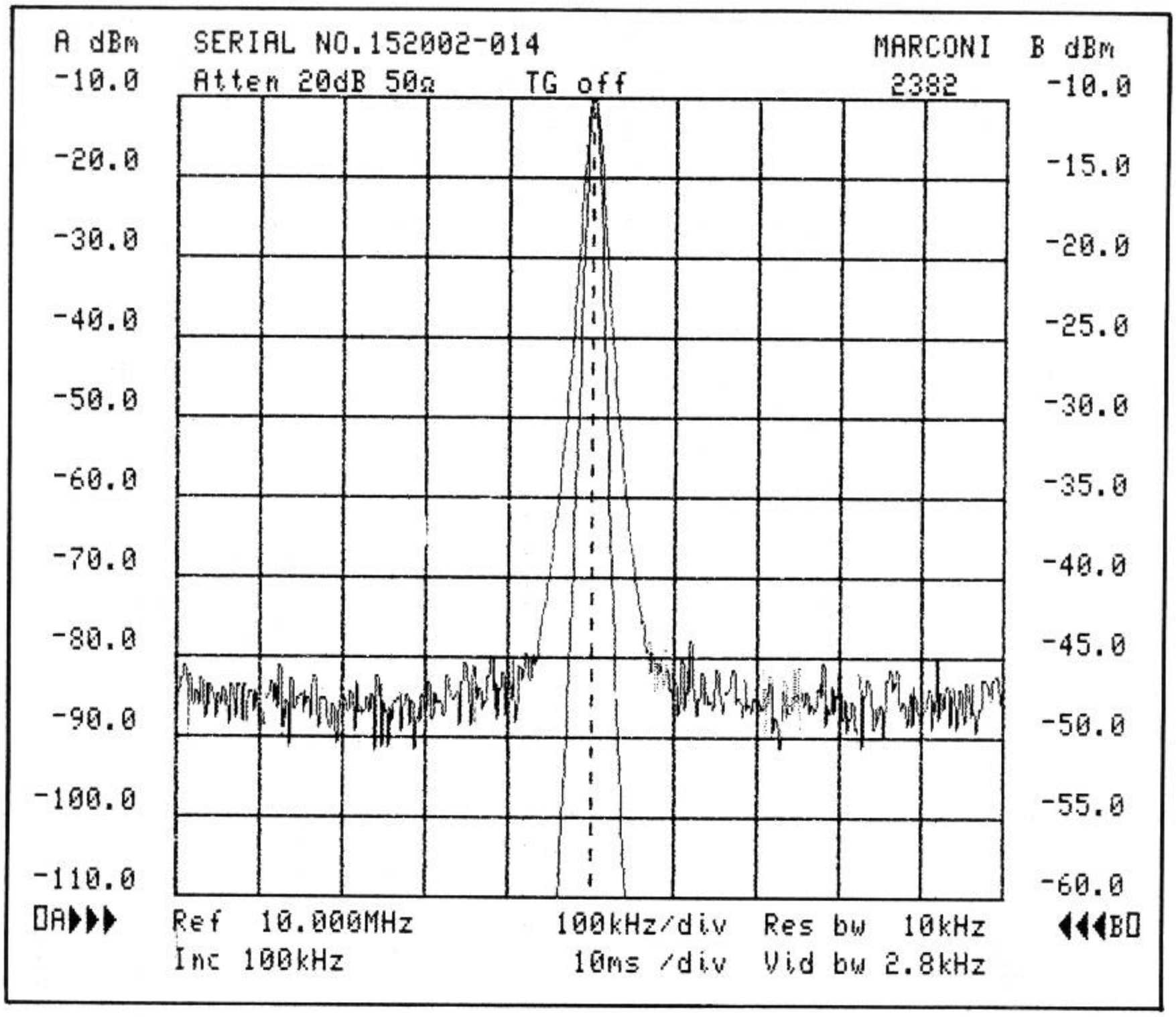


Fig. 10 Two signal display - different resolutions

52. In this situation if SAVE A is pressed a stored display A is shown against a ´live´ display B. Alternatively if SAVE B is pressed a stored display B is shown against a live display ´A´. With SAVE B pressed operate the A B SELECT key [24]. With A B SELECT set at ´B´ vertical scale changes can be made as above but if an attempt is made to adjust horizontal controls such as reference frequency, filter bandwidth, or sweep time the ´A▶▶▶´ annotation disappears and the displayed horizontal marginal annotations remain as they were i.e. those for the ´saved´ trace. Trace B does not change but trace A is displayed in a new position relating to the changed horizontal controls. Switching AB SELECT to ´A´ causes ´A▶▶▶´ to reappear together with the new horizontal marginal annotations. The ´◀◀◀B´ annotation disappears. Switching A B SELECT to ´B´ brings back the stored B display annotations. Return the horizontal controls to their previous positions. Press SAVE B again to de-select the mode and return to a live condition. Display view A and view B as in para. 51.

53. Press SAVE A and SAVE B. Both annotations A▶▶▶ and ◀◀◀B are displayed. Vertical controls can be used but again the horizontal marginal annotations are related to the stored displays. In the example being illustrated these are the same for both displays but this is not always the case and operating AB SELECT to either A or B would display each one independently as required.

If an attempt is now made to adjust reference frequency, filter bandwidth etc. the new values are set into the instrument but not displayed and traces A and B do not change.

54. Press SAVE A and SAVE B keys again to de-select these modes. The displays are now related to the changed horizontal control settings and may require repositioning.

Voltage measurements

55. Display the fundamental of the 10 MHz calibrator signal on the 'A' channel with PRESET operated and with keys and controls set as follows :

AB SELECT [24]	A
HORIZONTAL SCALE [29]	/DIV
SPAN/DIV [29] or [13]	100 kHz/div.
HORIZ POSN	Centre reference
REF FREQ [12]	10 MHz
REF LEVEL [11]	0 dBm
VERTICAL SCALE [24]	10 dB/div.

All other controls unoperated.

56. To measure the voltage at the peak of this signal press the vertical scale VOLTS/DIV key. In this mode the signal is displayed against a linear ten division scale. The bottom graticule line shows zero and the top of scale annotation is 500 mV. This is an 'initial' value - if the voltage ranges have been used previously the top of screen annotation reverts to the value last used. To change the scale range for optimum sensitivity press the REF LEVEL ↓ or ↑ key. The ↑ key increases the top of scale annotation in a 1,2,5 sequence, decreasing the sensitivity of the instrument. The signal therefore appears to decrease in amplitude. Pressing the ↓ key increases the sensitivity in a similar way and the signal appears to increase in amplitude. For optimum sensitivity in this instance select 100 mV full-scale and determine the voltage at the signal peak. This should be approx. 70 mV r.m.s.

57. Notice that rotation of the REF LEVEL rotary control has no effect in this mode.

58. Now press the 2ND FUNCT then VOLTS/DIV keys (LOG). This causes the horizontal lines of the vertical scale to appear in logarithmic form covering a range of two and a half decades. The top of scale annotation initially indicates 1 V and the other major decade boundaries 100 mV and 10 mV progressing towards the bottom of the display. Once again the voltage at the peak of the displayed signal can be assessed (70 mV) and the range can be changed, using the REF LEVEL ↓↑ keys, in a 1,10,100 sequence (refer to Fig. 11). Press SELECT & PRESET to restore the vertical scale to dBm, 10 dB/div.

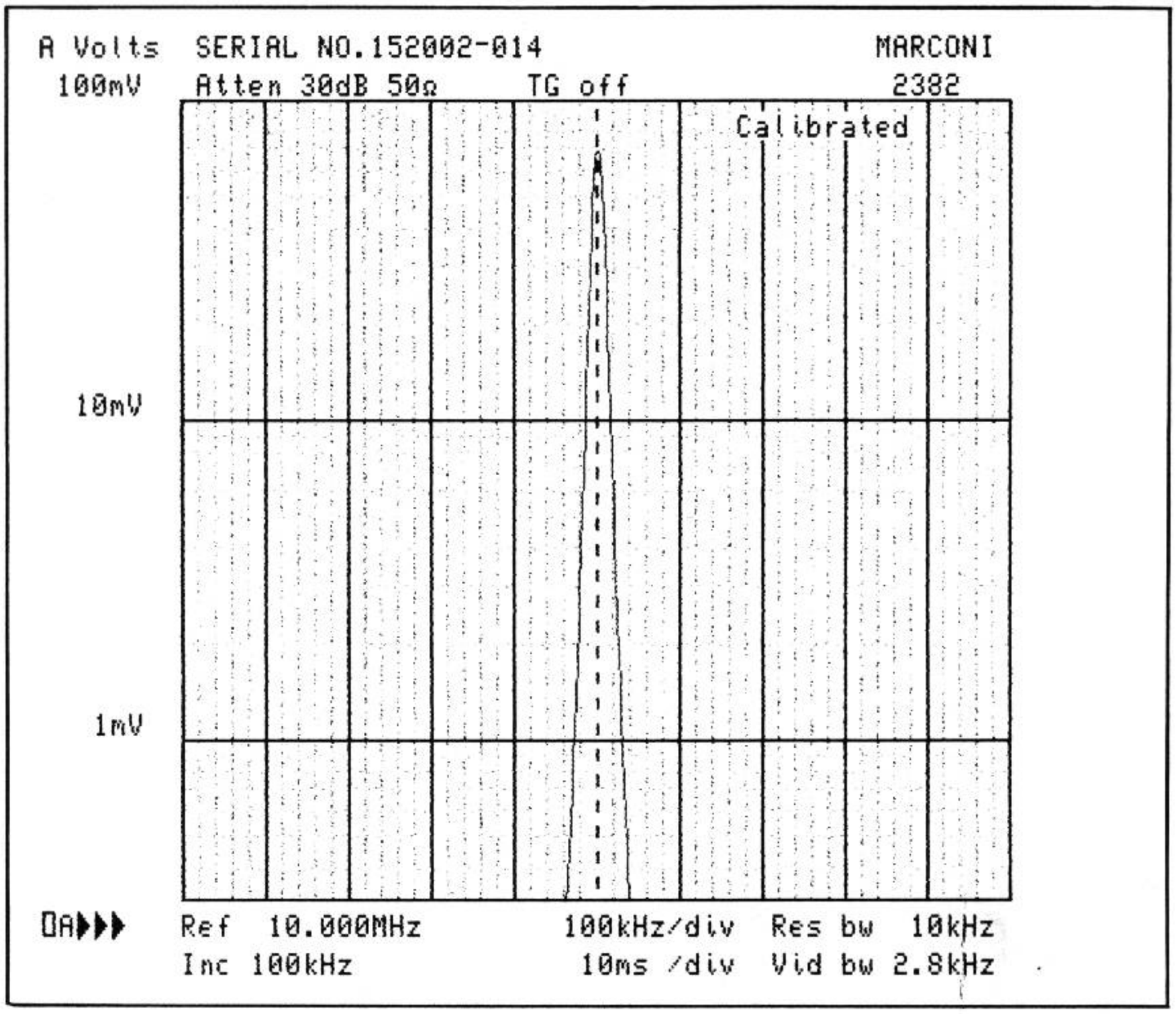


Fig. 11 LOG volts, vertical scale

Horizontal scale LOG control

59. Pressing PRESET in para. 58 displays the 10 MHz calibration signal and its harmonics against a linear 400 MHz horizontal scale. Press horizontal scale LOG [29]. At first press, the logarithmic scale last used appears on the screen. As this is not required in this instance, press the LOG key again.

60. At this second press, the prompt message 'Start freq=' appears near the top of the screen. Using the DATA keypad and terminator, key in 1 MHz. A second prompt message now appears - 'Stop freq='. Enter 1 GHz in the same way. Note the request to enter decade values only.

61. Almost immediately after the terminator for this entry is pressed the prompt messages are erased and a three decade logarithmic scale is displayed horizontally along the bottom of the graticule area starting at 1 MHz and finishing at 1 GHz. The frequency of any spectral line on this display can be determined by inspection of the graticule.

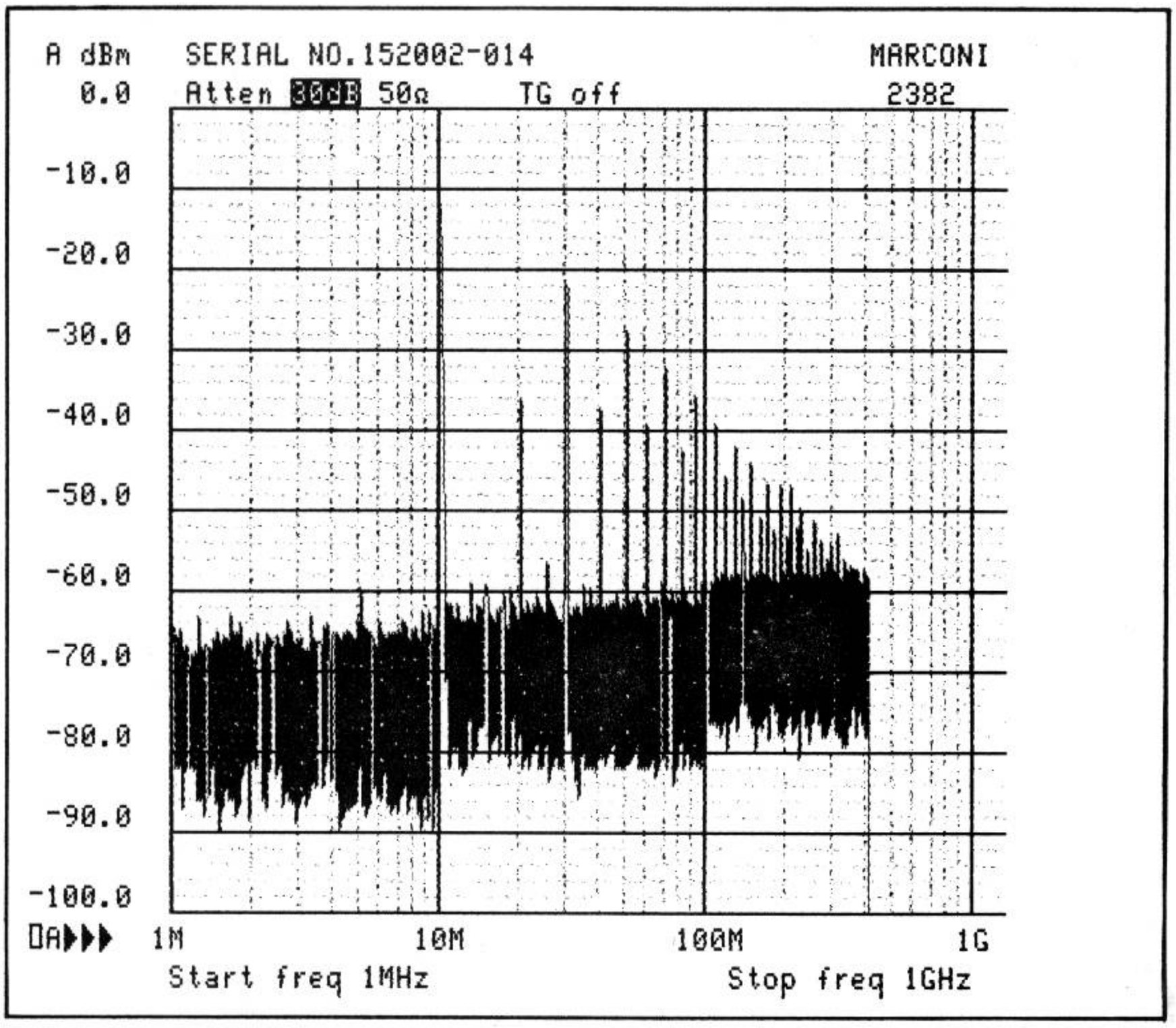


Fig. 12 Logarithmic frequency span

Signal track

62. Using this facility a slowly drifting signal can be automatically maintained at the centre of the display.

63. To demonstrate this and at the same time become familiar with other controls and more involved displays, press PRESET and connect a signal generator to the INPUT of the analyzer. Apply a signal of 30 MHz, amplitude modulated at 1 kHz (or as required e.g. from 1 to 10 kHz) to a depth of approx. 70%. RF output level can be set to approx. -20 dBm.

64. Press REF FREQ key [12] and key in 30 MHz using the DATA keypad [19] and the MHz terminator [20]. Set the SPAN/DIV rotary control to display the 30 MHz carrier at the centre of the screen and to give good separation between the upper and lower sidebands and their distortion products (e.g. 500 Hz/div. as in Fig. 13). Operate the ↓↑ REF LEVEL keys to give optimum sensitivity.

65. Set the markers A B SELECT key to 'A', press MKR 1 and position the marker on the peak of the carrier by pressing PEAK FIND. Press MKR 1 SETS REF FREQ to position the peak of the carrier on the dashed line. Now press SIG TRACK and slowly vary the signal generator carrier frequency. Notice that the carrier peak is maintained on the dashed vertical line and that the reference frequency annotation changes as the carrier frequency varies.

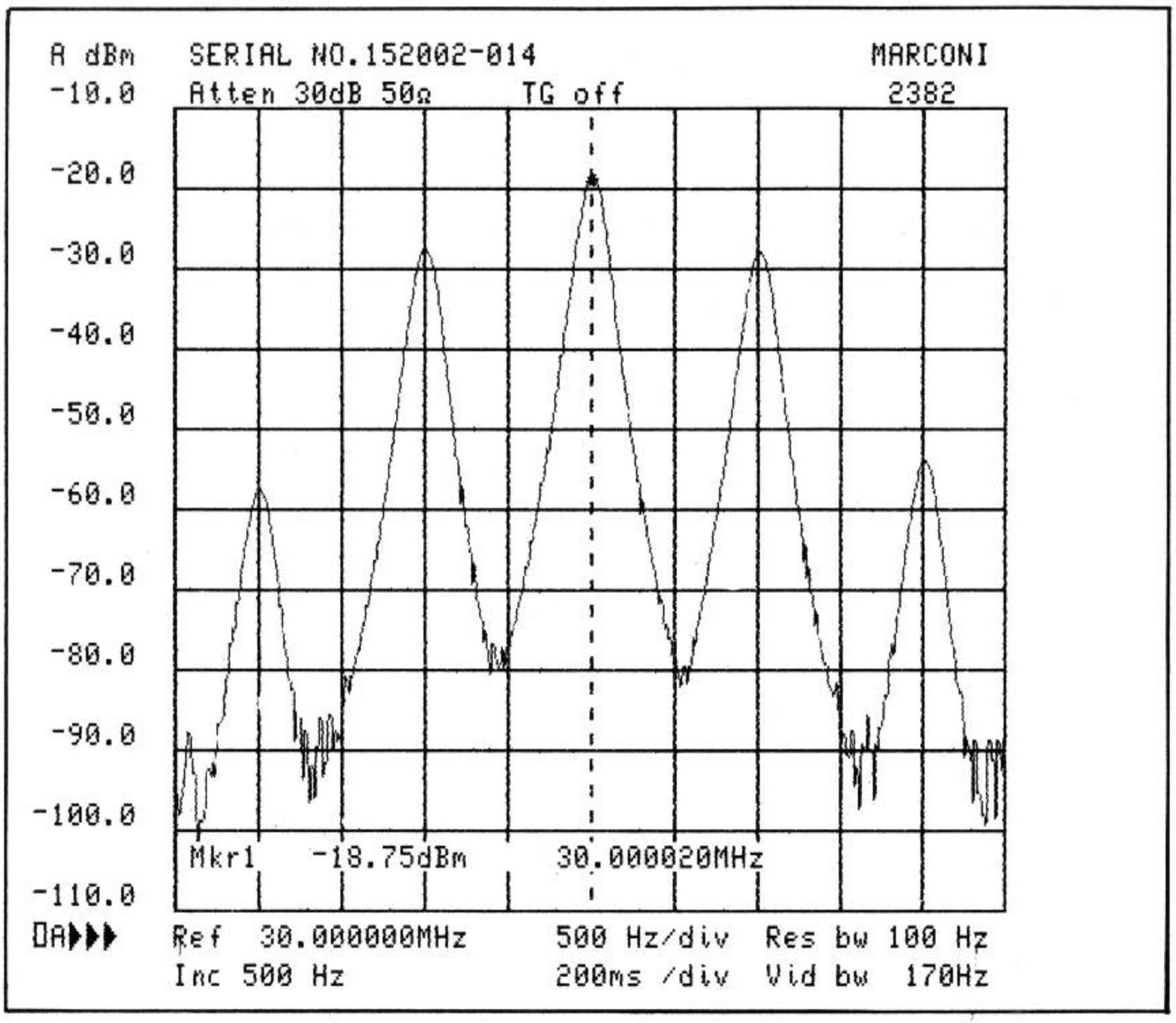


Fig. 13 Frequency spectrum of AM signal

66. Return the signal to 30 MHz and press SIG TRACK again to deselect the mode. Press MKR 1 to clear the marker from the screen.

Zero span

67. Using this control, signals may be amplitude demodulated, the modulating signal appearing against a horizontal time axis.

68. With the signal generator connected and set up as in para. 63 and the 30 MHz carrier and sidebands suitably displayed on the screen press ZERO SPAN. Set the vertical scale to VOLTS/DIV. and operate the ↓↑ REF LEVEL keys for a suitable range. The SWEEP TIME and FILTER BANDWIDTH ↓ and ↑ keys can now be pressed to obtain a satisfactory display (refer to Fig. 14).

69. When the input signal is an unknown amplitude modulated wave the above displays can be used to assess:

a) carrier frequency
b) modulating signal frequency
c) modulation depth
d) modulation distortion

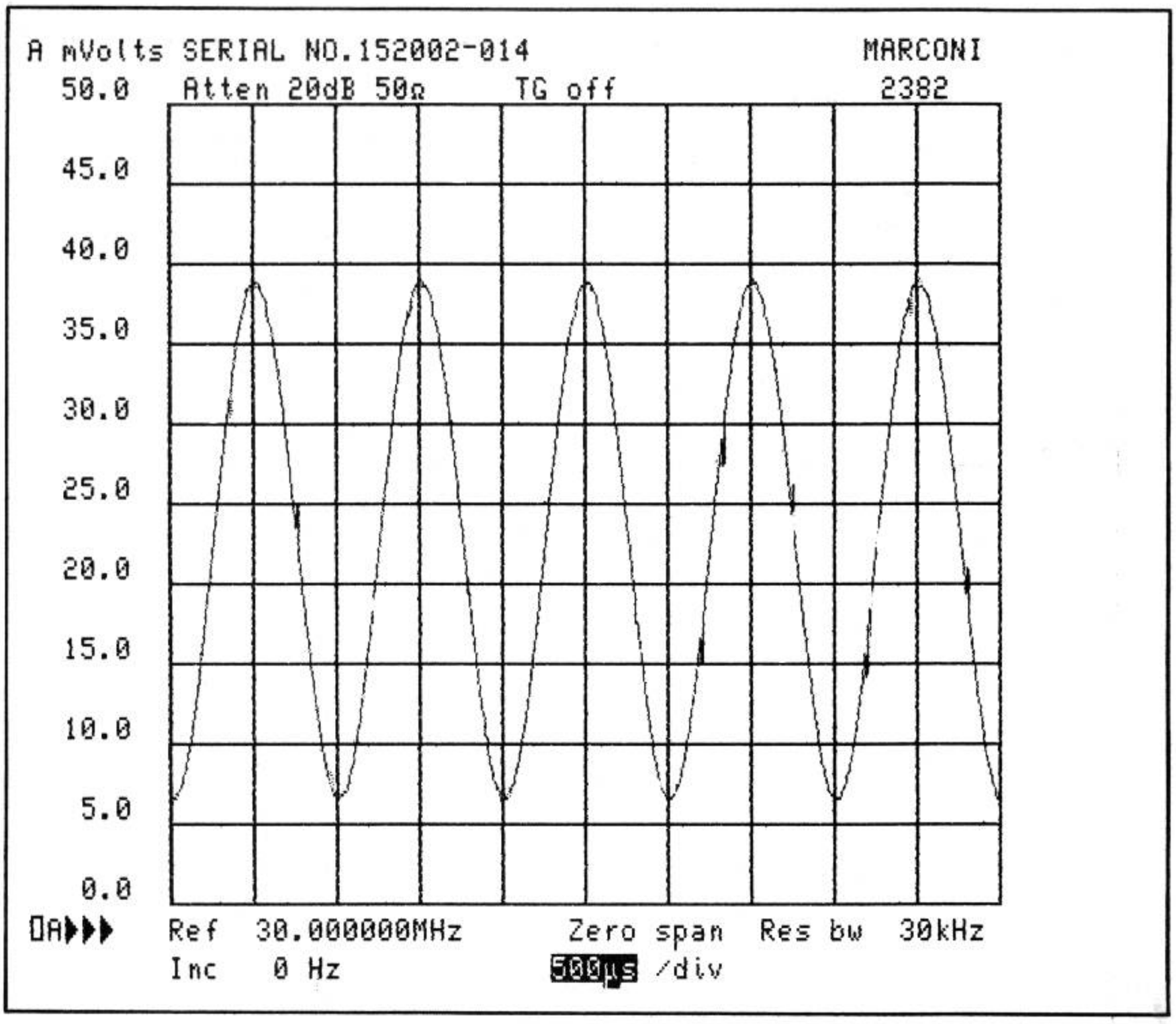


Fig. 14 An amplitude demodulated signal (ZERO SPAN)

70. The VIDEO TRIG mode is automatically selected for this display but external trigger using the EXT TRIG socket on the rear panel and the EXT trigger source key may provide a more satisfactory response. These modes normally provide positive edge triggering. Pressing 2ND FUNCT prior to selecting the trigger source gives negative edge triggering. Press /DIV to display the carrier and sidebands again, and the 10 dB/DIVISION vertical scale key and ↓↑ REF LEVEL to return the display to that set previously in para. 64.

Noise level measurement

71. With the 30 MHz carrier and sidebands suitably displayed, set the markers A B SELECT key to ´A´, press MKR 1 and set 1,2 MOVE to 1 [34]. Using the MOVE rotary control position marker 1 in the noise, well clear of a signal. Press 2ND FUNC then FULL SPAN (NOISE 1 Hz) and the level of the noise normalized to a 1 Hz bandwidth is shown as a marginal annotation on the fourth line from the bottom of the screen (refer Fig. 15).

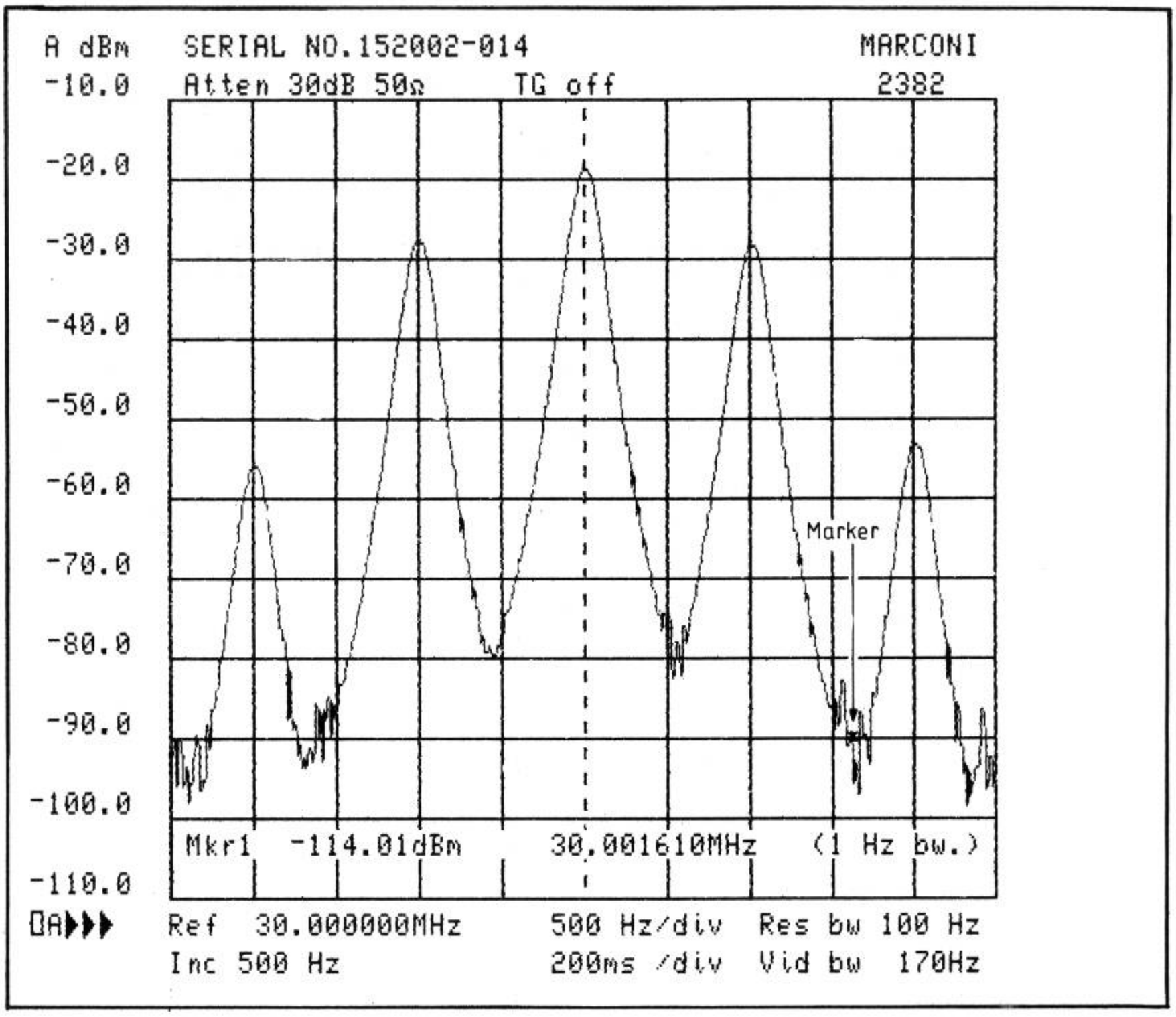


Fig. 15 Noise level measurement

72. If a signal to noise measurement is required, press the 2ND FUNC and FULL SPAN keys again to deselect the NOISE mode and use MKR 1 to measure the power level of the signal concerned.

Low level signal measurement

73. Low level signals near the noise level of the analyzer may be indiscernible from the noise. The amplitude of such signals can be measured by :

a) Increasing the noise filtering by reducing the video bandwidth
b) Video averaging

74. To demonstrate the first method connect the 10 MHz calibration signal to the analyzer INPUT and press the PRESET key. Set REF FREQ to 400 MHz (40th harmonic) and SPAN/DIV to 50 kHz and note that the level of noise is approx. 15 dB peak-to-peak. The 400 MHz harmonic is not visible as it is hidden in the noise. Video bandwidth at this point is approx. 2.8 kHz. Increment SWEEP TIME to approx. 5s/div. and observe that the level of noise has now been reduced to approx. 2 dB peak-to-peak. As the amplitude of the low level signal has not been similarly affected this can now be measured without difficulty. Adjust reference level and vertical scale dB/div. for a satisfactory

display (refer Fig. 16). Video bandwidth under these circumstances is much reduced and is approx. 22 Hz.

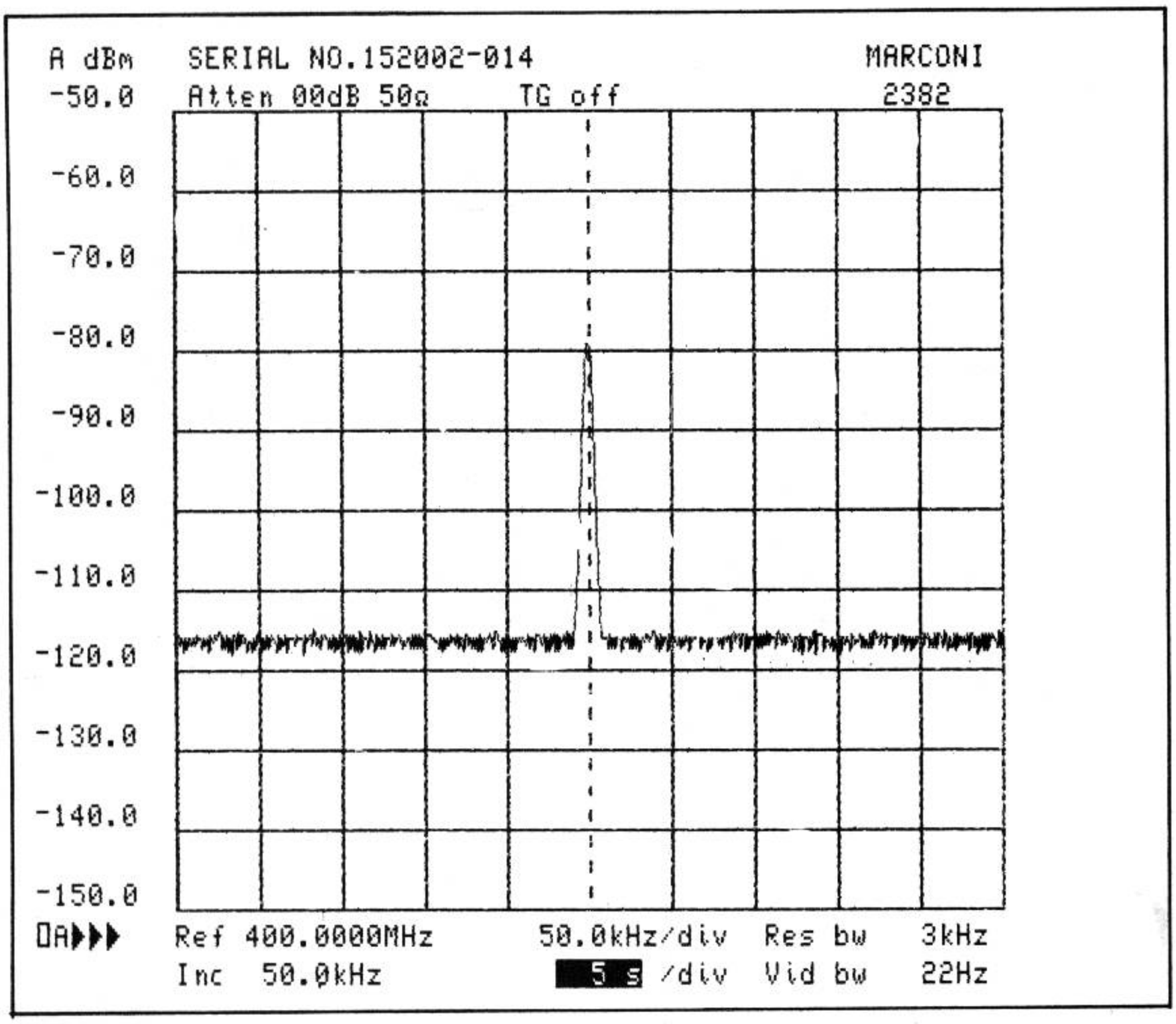


Fig. 16 Low level signal measurement by reducing video bandwidth

75. The above method for measuring low level signals requires a very slow sweep to achieve results. The second method using video averaging allows a more instantaneous display and changes in noise smoothing can be seen almost immediately. Return the analyzer controls to their previous positions so that REF LEVEL is 0 dBm, vertical scale is 10 dB/div. and AUTO FILTER BANDWIDTH, SWEEP TIME and VIDEO BANDWIDTH are selected. Press the display A VIDEO AVG key and full information on the use of this function is displayed on the screen. Using the DATA keypad, key into the instrument the number which gives the required sweeps to be averaged. The higher the number of sweeps the greater the smoothing but the time taken is longer. The maximum number of sweeps possible is 128(2^7). After a keypad entry is made, as the sweeps are completed they are counted and shown at the bottom of the screen. The reduced level of noise is apparent almost immediately and upon completion the low level signal can be seen and measured as required (refer. Fig. 17). If VIDEO AVG has been selected in error it can be cleared by operating DATA key 0, otherwise to eraze a completed or part completed entry, press the VIDEO AVG key again.

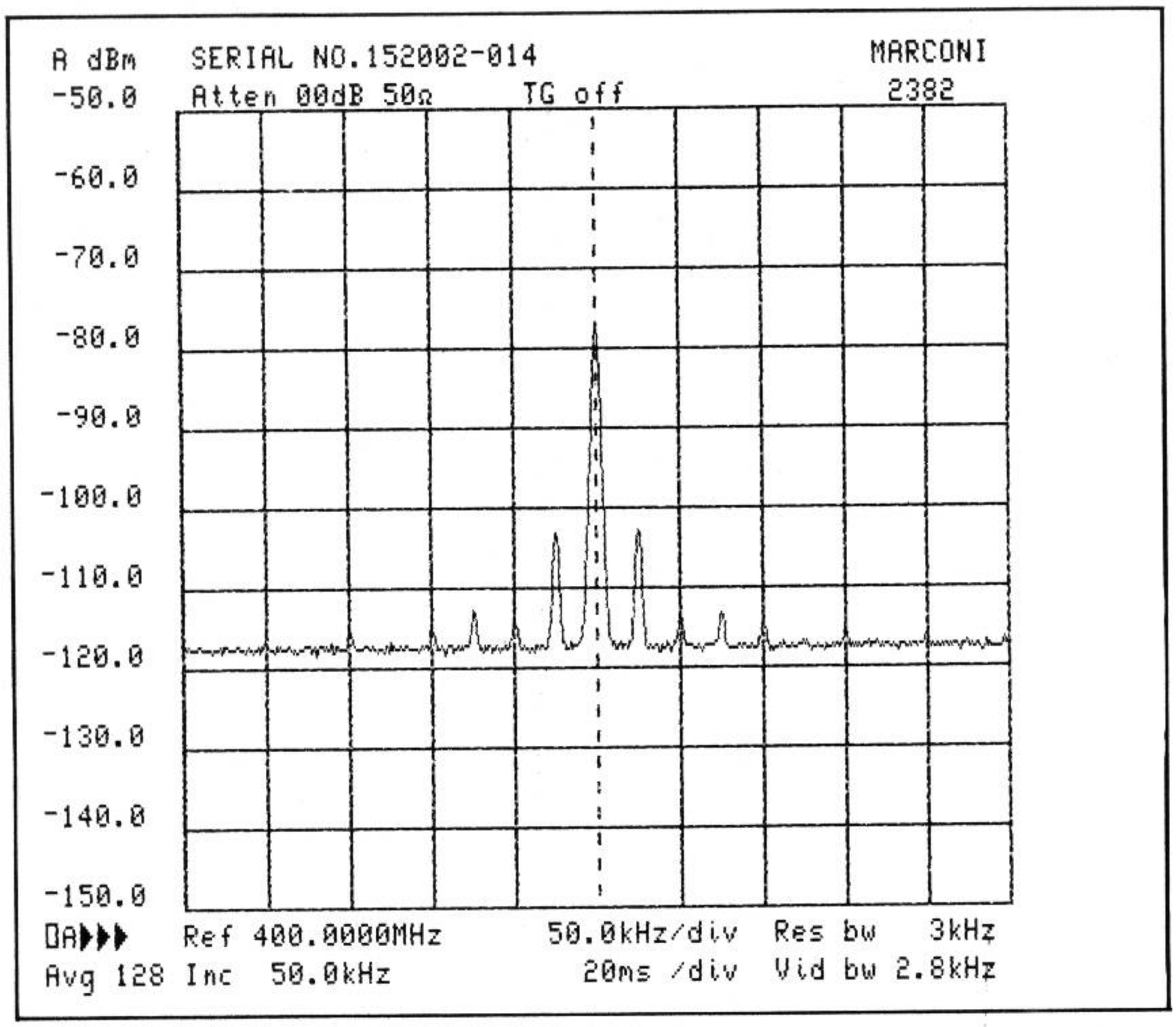


Fig. 17 Low level signal measurement by video averaging

The store/recall function

76. To put the previous control settings or any other settings into store press the STORE key [23], and the screen displays a list of store operations. Press DATA key 1 - the STORE mode, and then the DATA key corresponding to an empty or an unwanted unprotected store location. The current operational status of the instrument is now stored at this memory location and any unprotected data previously held here is overwritten. For identification the chosen location may be annotated by using the TEXT key [10] to add a suitable caption to the required display before performing the ´STORE´ sequence.

77. To verify that the current operational status has been stored, change the display and then press RECALL. Key in the previously selected location using the DATA keypad and the original control status and display is returned to the screen. As an alternative, store the current operational status in location ´1´. Now when the analyzer is switched OFF and then ON again the control settings are displayed at once without the necessity of having to recall them.

78. To protect a stored display, press the STORE key to display the store operations and press DATA key 3. This selects the PROTECT mode and when the data key corresponding to the chosen location is pressed the location is then protected. The only way to overwrite this protected store in the future is to first unprotect it by pressing STORE, DATA key 4 and then the data key corresponding to the location to be unprotected. The normal overwriting procedure described in para. 76 can then be followed.

79. Disconnect the 10 MHz calibration signal from the analyzer INPUT.

Normalize using tracking generator

80. This facility compensates for frequency response errors incurred by the spectrum analyzer connecting cables and test fixtures when measuring the response of a filter, amplifier or other frequency conscious device.

81. Press PRESET and key in the frequency span required by using the SPAN/DIV key [13] and the DATA keypad (1 MHz/div. in this example). Press REF FREQ and key in the centre frequency to be used in the same way (9 MHz). Press TRACK GEN to select the tracking generator and if necessary reset its output level using the 2ND FUNC then REF LEVEL (SET TG) keys and the data keypad; refer to lower unit control [35]. Press NORMALIZE [6]. The annotation ´Connect test fixture Then press NORMALIZE´ appears in the data entry area of the screen. As instructed, connect the test fixture or connecting leads between the TRACKING GENERATOR output (Fig. 1 [4]) and the analyzer INPUT and press NORMALIZE again. The displayed message changes to ´Normalized´ and a single sweep of the screen is executed. A signal should appear which is the frequency response of the unwanted parts of the circuit.

82. Connect the device to be tested into the test fixture. The resulting response is now that for the device only - the effects of the extraneous circuitry being nullified (refer Fig. 18).

Limit mask

83. Using the data keypad, upper and lower limit boundaries can be entered into the ´B´ store to provide a go/no go limit mask. To demonstrate this the displayed frequency response of the filter previously tested in para. 82 can be checked against a limit mask entered in the following way.

84. Maintaining the control settings used above, press VIEW B, set the vertical scale AB SELECT key to B and the front panel controls as for display A. Press VIEW A and VIEW B to clear the displays from the screen. Press 2ND FUNCT then SAVE B keys (MASK). This displays a menu of mask operations on the screen. From this menu, to enter upper limit boundaries, press DATA key 1 and observe that the screen now displays a table into which a maximum of eight levels and eight corresponding frequencies can be inserted. After these have been entered press DATA key 0 to exit back to the mask menu.

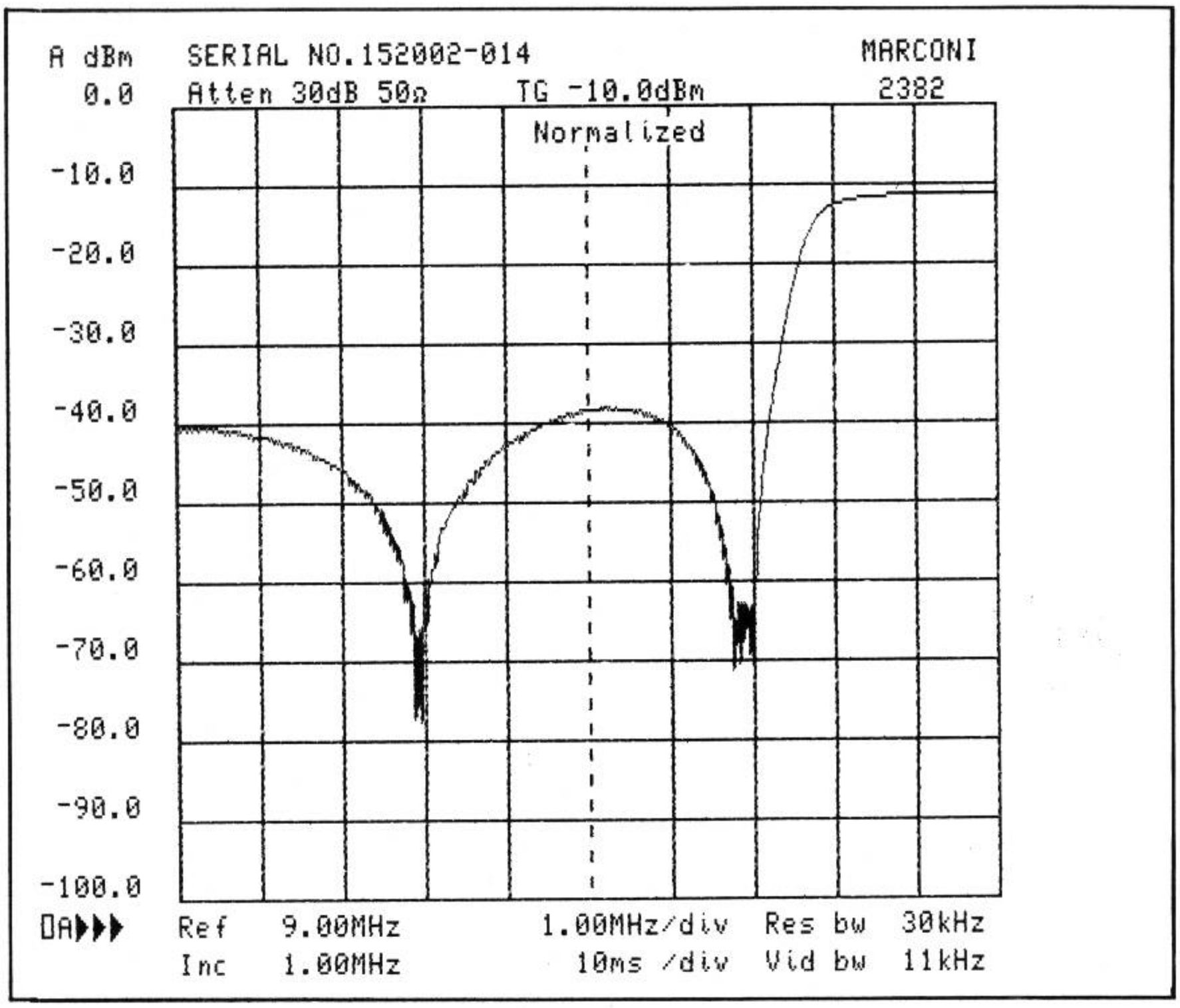


Fig. 18 Frequency response of a filter using NORMALIZE facility

85. For the lower limit boundaries press DATA key 2 and again a maximum of eight levels and eight frequencies can be inserted. As the levels and frequencies are keyed in, the upper and lower profiles of the mask appear on the screen. Exit from the menus and press VIEW A.

86. The frequency response of the filter can now be compared with the go/no limits which are overlaid upon it (refer Fig. 19). Press 2ND FUNCT then VIEW B (INFILL) for an alternative display.

87. Mask values are retained in memory. To modify part of the stored limit profile only, return to the menu by selecting MASK, choose the appropriate entry mode and key in the relevant ordinate changes. Alternatively the DELETE key can be used to remove a setting.

88. Once the mask is set up in this way, it is only necessary to substitute filters of the same type to rapidly check that each performs within specified limits.

89. Disconnect the test fixture and tracking generator signal from the input.

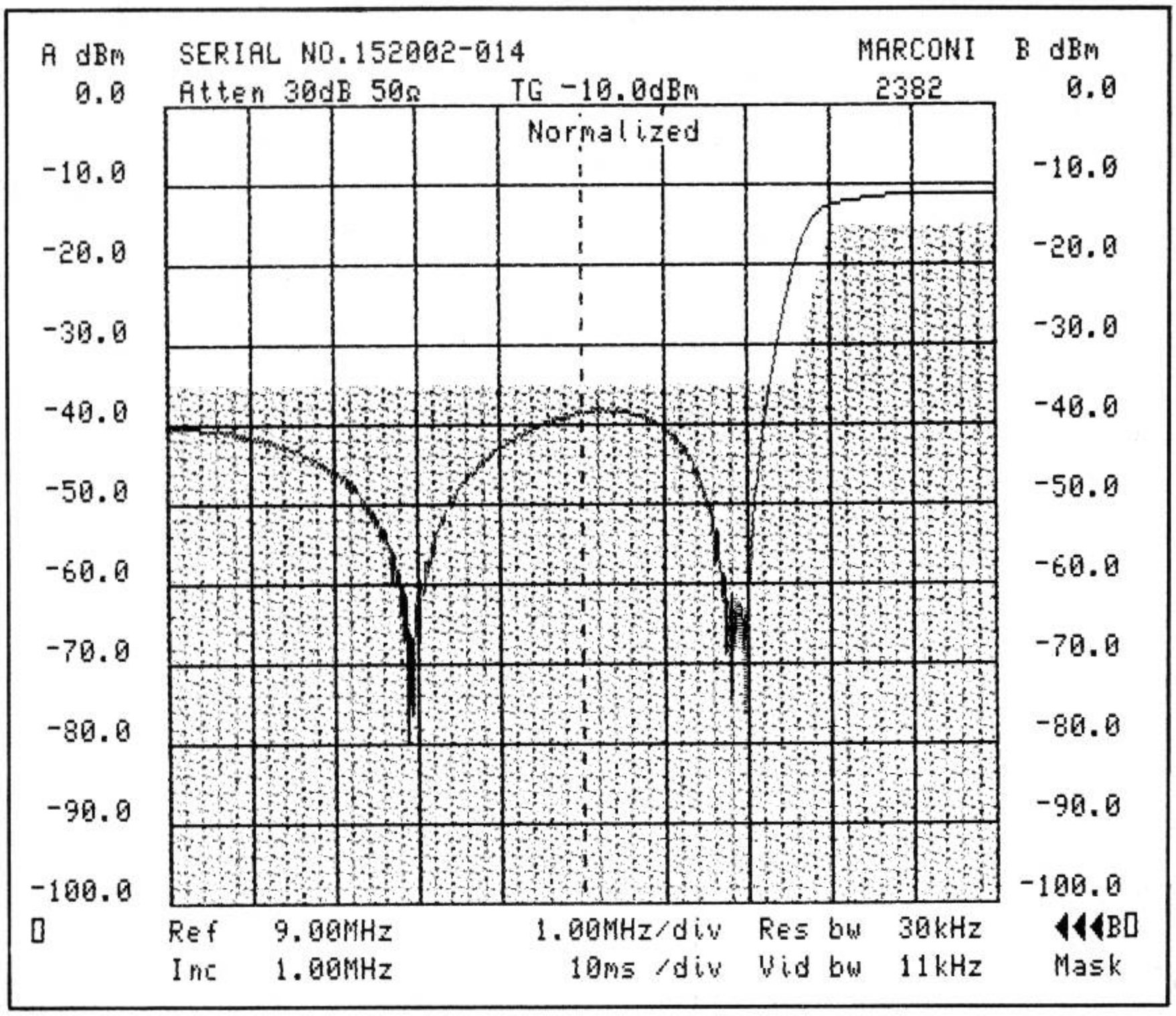


Fig. 19 Filter frequency response with limit mask

External standard input

90. To use this facility, apply a 1,2,5 or 10 MHz ±1 Hz signal at a level of -15 to +15 dBm to the EXT STD BNC socket at the rear of the RF unit. ´Ext std´ is displayed on the screen to show that system lock has been achieved (Fig. 3 [6]).

91. To demonstrate correct functioning, first connect the STD 10 MHz OUTPUT signal (Fig. 1 [5]) to one channel of a dual trace oscilloscope, and the external standard signal to the other channel. If the oscilloscope is triggered by the external standard, the 10 MHz signal will drift across the oscilloscope screen because the two frequencies are not synchronously locked. If the external standard is now also fed to the EXT STD socket on the rear panel of the analyzer, the drift of the 10 MHz signal will cease, showing that system lock has been achieved.

Intermodulation testing

92. With the RF ATTEN [26] set at AUTO and a signal within the measurement range of the analyzer applied, the r.f. input attenuation is set to give the optimum trade-off between low noise and low intermodulation. The r.f. attenuator can be controlled manually however to operate in either a low noise or

low intermodulation mode. Under these circumstances it is possible that the value of attenuation is decremented to such an extent that the mixer input is overloaded. As a result, internally generated distortion products can be displayed which may appear to be input signals. It is necessary to be able to recognize these products and this can be done by pressing the INTMD IDENT key [27]).

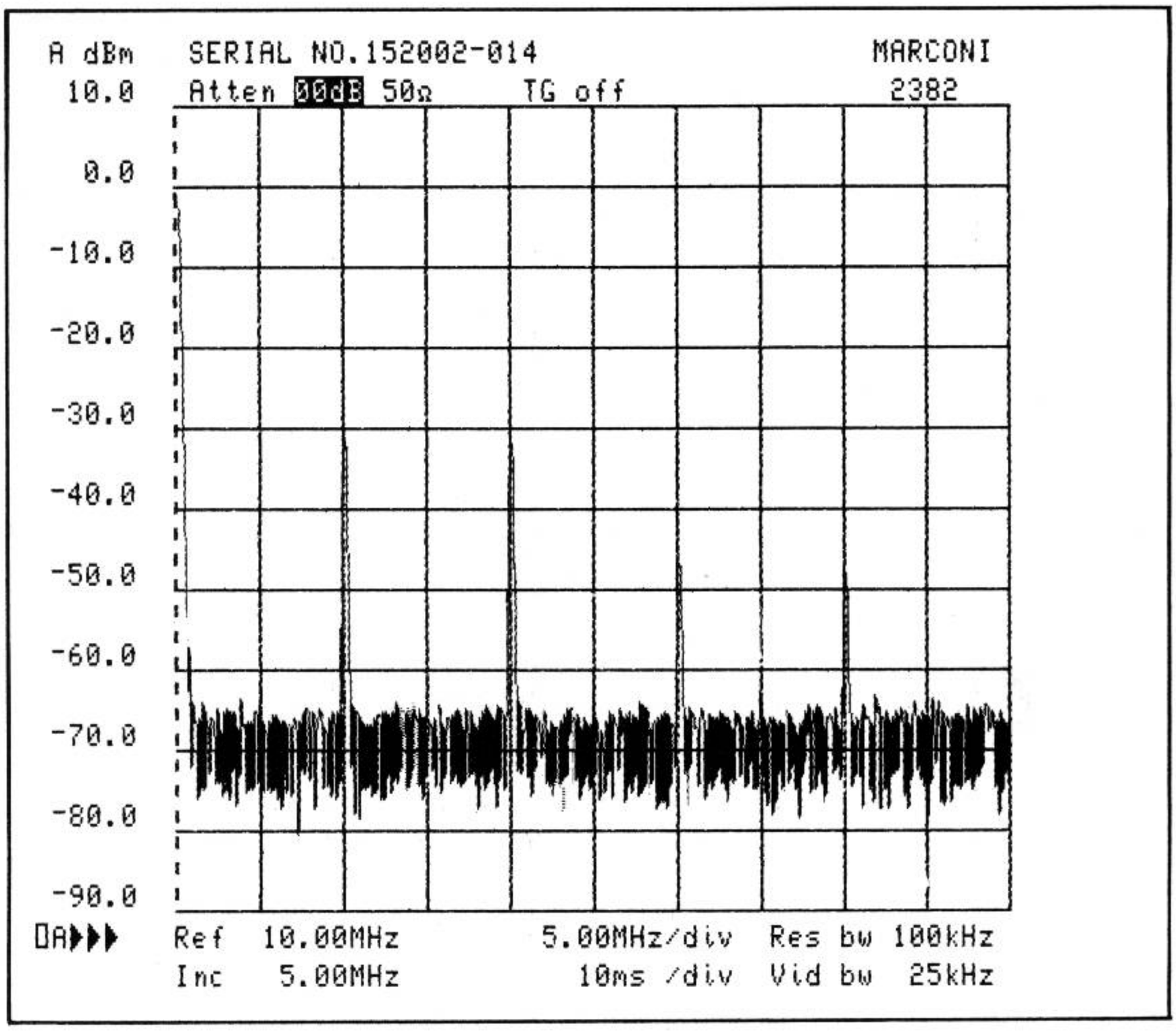


Fig. 20 Internally generated distortion products

93. To demonstrate this, press SELECT & PRESET and set REF FREQ to 10 MHz and REF LEVEL to 10 dBm. Connect a signal generator set to give a sinusoidal output of 10 MHz at +0 dBm to the input of the analyzer. Display the 10 MHz signal at the left hand side of the screen and using the SPAN/DIV control decrease the frequency span to 5 MHz/div. Press the RF ATTEN ↓ control until the attenuator level shown on the screen is 0 dBm.

94. Note the 20 MHz and 30 MHz distortion products (Fig. 20). Setting the INTMD IDENT key repeatedly ON and OFF confirms these signals to be internally generated as their amplitude decreases and increases under these conditions. The amplitude of the fundamental remains almost unchanged. High level input

signals causing distortion products such as these should be attenuated to eliminate this condition. Self generated intermodulation products can also be produced by high level input signals. These can be identified in the same way. Set RF ATTEN to ´AUTO´.

Trace exchange (A ⇔ B)

95. Connect a signal generator set to give a sinusoidal output to the input of the analyzer and display a signal of 100 MHz -10 dBm at the centre of the screen. Ensure that keys and controls are set as follows:

SELECT & PRESET	ON
REF FREQ	100 MHz
SPAN/DIV	10 kHz/div.
REF LEVEL	-10 dBm

Press 2ND FUNCT then VIEW A to ´infill´ the trace and SAVE A to store it. Press VIEW A to delete the trace from the screen.

96. Press VIEW B and key in SPAN/DIV 500 Hz. Amplitude modulate the input signal at a frequency sufficient to show a good separation between the carrier and sidebands at a depth of about 50%. Press 2ND FUNCT then vertical scale A B SELECT to unlock the reference level. Set A B SELECT key to ´B´ and key in a reference level of 0 dBm. Rotate the REF FREQ control to offset the displayed signal by approx. three graticule divisions. Press VIEW A to show both signals on the screen then press the A ⇔ B key noting the change in the display.

97. It will be apparent that the contents of the A and B data stores have been interchanged. Press the VIEW keys alternately to prove the action. Note that the SAVE mode is automatically set when A ⇔ B is pressed before the contents of the stores are interchanged.

Trace arithmetic (A-B→A)

98. To demonstrate the use of this control and experience the display of frequency modulated signals, change the input signal to 20 MHz and set keys and controls as follows:

SELECT & PRESET	ON
REF FREQ	20 MHz
SPAN/DIV	1 kHz/div.
REF LEVEL	0 dBm

Frequency modulate the input signal using a modulating signal of about 400 Hz and a deviation of 3 kHz and adjust the signal generator output to -10 dBm. Press SAVE A and VIEW A to store and delete the trace from the screen.

99. Press VIEW B and vary the deviation on the signal generator slightly to 4 kHz. Press VIEW A to bring back the stored image then press A-B→A. Press VIEW B.

100. The difference between the two displays can now be seen about a centrally placed horizontal axis, annotated 0 dB. By adjusting the signal generator deviation gradually back to 3 kHz this difference is steadily nullified. Press A-B→A again to cancel the function, then press VIEW B and the two displayed signals can be seen to be identical.

101. One use of the A-B→A control therefore would be to match up two independent signal generator outputs. Another would be to compare the response curves of two filters which are almost the same.

FM DEMOD

102. Maintaining the input signal to the analyzer as in para. 98 on the 'A' display, press FILTER BANDWIDTH ↑ repeatedly to give a resolution bandwidth of 10 kHz (10 x Span/div.).

103. Using the REF LEVEL control adjust the display until the signal is at the top of the screen. Press 2ND FUNCT then ZERO SPAN (FM DEMOD). Operate the FILTER BANDWIDTH ↑ key to display the signal at a reasonable amplitude at the centre of the screen (e.g. 3 kHz/div.) then press SWEEP TIME ↓ to show the modulating signal more clearly (e.g. 1 ms/div.). Refer to Fig. 21.

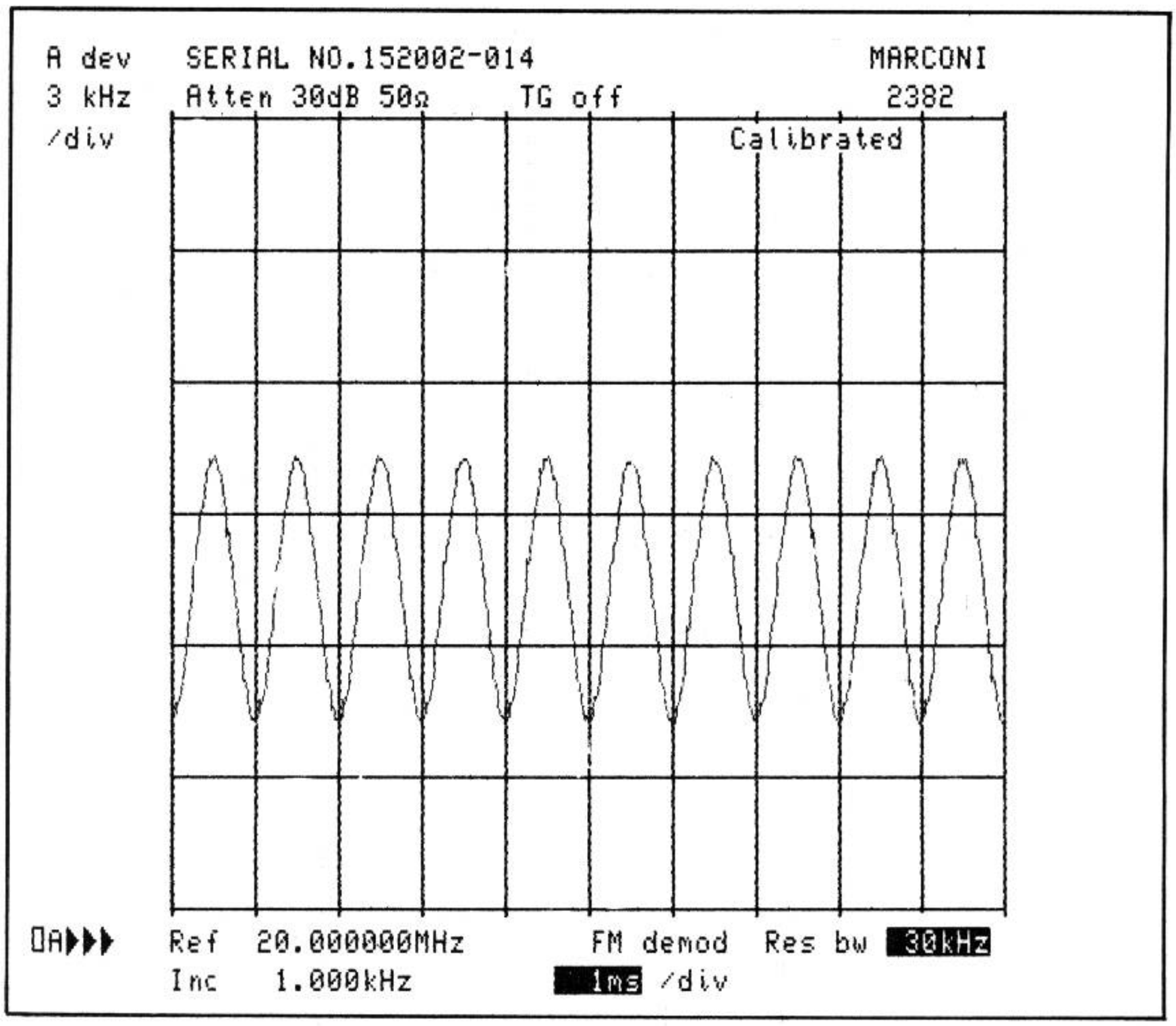


Fig. 21 A frequency demodulated signal (FM DEMOD)

Remote operation

104. The 2382/2380 can be remotely controlled over the GPIB. All functions (apart from power ON, A and B intensity controls, graticule intensity control and those related to the second marker) on both units are controllable via the

24-way socket on the rear panel (refer to Fig. 2 [15]). This socket allows the instrument to be coupled to a suitable GPIB controller.

105. The analyzer responds to a remote command from the controller in the same way as it does to a local front panel command. Text and both A and B traces can therefore be displayed on the analyzer c.r.t. by remote commands. General programming concepts and procedures are set out in IEEE Standard 488-1978 and IEC Publication 625-1. An introduction to the instrument bus, principles of operation, commands, data transfer etc. is given in 'The GPIB Manual' (H 54811-010P). In addition, the GPIB Operating manual H 52382-900A Vol. 1A, supplied with the instrument, gives full details of GPIB operation (refer to ACCESSORIES in Chap. 1).

106. The 2382/2380 has talker, listener and talk only capabilities. One address is used for talk and listen and is initially set by means of the address switch which is positioned on the rear panel beside the GPIB connector (refer to Fig. 2 [15]). The address is set as the sum of the numbers switched e.g. for address 12, the 8 and 4 switches are pressed to the left and all the others to the right. Addresses 0 to 30 are available; 31 puts the analyzer in talk only. At power up the instrument's internal address register is updated to the setting of this address switch and the address appears on the c.r.t. display if the 2ND FUNCT key and then the LOCAL key are pressed. The status of the instrument's software etc. can be read over the GPIB and also displayed by pressing 2ND FUNCT then RECALL.

107. Capability codes to identify the interface functions applicable to the instrument are marked on the rear panel, just above the GPIB address switch. They are also listed in para. 109 below.

108. Indicating lights on the front panel (Fig. 2 [2]) show when the instrument is under remote operation (REMOTE indicating light ON) and when it is being addressed by the controller (ADDRESSED indicating light ON). Under remote operation all front panel controls except LOCAL are disabled to guard against manual intervention. Pressing the LOCAL key restores manual control under these circumstances, but if the controller sends the local lock-out command the LOCAL key is disabled and to restore local operation a further command GTL - go to local, is necessary.

Available GPIB functions

109. The fundamental communication capabilities provided by the GPIB are as follows :

Source handshake (SH1)	-	complete capability
Acceptor handshake (AH1)	-	complete capability
Talker (T5)	-	basic talker, serial poll, talk only, unaddress if MLA
Listener (L4)	-	basic listener, unaddress if MTA
Service request (SR1)	-	complete capability
Remote/local (RL1)	-	complete capability, when in remote or local lock out, selected groups of keys can be enabled and disabled using commands sent over the bus

Device clear (DC1)	-	complete capability, the instrument adopts its preset state
Device trigger (DT1)	-	complete capability
Parallel poll (PP0)	-	no capability
Controller (C0)	-	no capability
Open collector devices (E1)	-	as opposed to tristate devices.

FRONT PANEL CONTROL FUNCTIONS - 2380

110. A description of the function of each control key can be found by obtaining its location from Fig. 31 and relating it to the relevant part of this paragraph. A list of 'hidden' functions is also provided. Where a group of controls is identified an additional figure shows the keys covered by that particular location. Functions becoming active upon operation of SELECT & PRESET [36] have green lettering on their keys.

Note ...

If a key requiring data entry is pressed in error, the selected function can usually be cleared by pressing the DELETE key [21]. When this does not apply the screen menu gives the information for clearing a function. The INTENSITY controls can be used to fade out the display if necessary while reading the menu.

[1] DISPLAY A

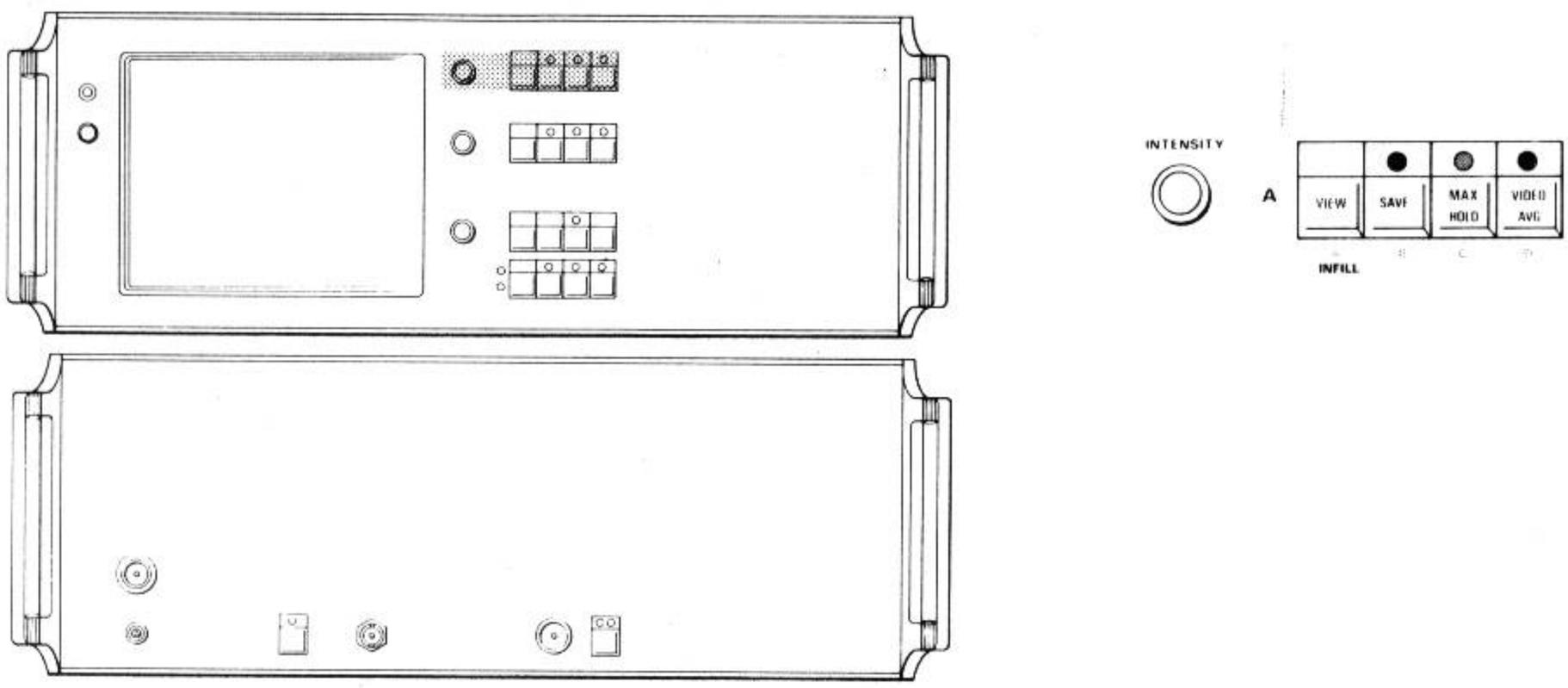


Fig. 22 Display A controls

para. 110 (continued)

VIEW (green letters)
Operation of this control continuously outputs the content of the A display store to the c.r.t. screen. Successive operations cause the function to interchange between the ON and the OFF state.

In the ON state the brightness of the display can be adjusted by means of the adjacent rotary INTENSITY control.

INFILL (2ND FUNCT then VIEW)
When the 2ND FUNCT key is operated followed by the VIEW key the display changes from the normal 'line draw' mode to an 'infill' mode. The 'infill' mode presents information in a histogram type format whereas in the 'line draw' mode, an outline of the trace is displayed on the screen. An infilled or outlined square, as appropriate, is positioned next to the A▶▶▶ annotation. The infill mode cannot be selected on ZERO SPAN or FM DEMOD.

SAVE
Successive operations of this key cause the function to be turned ON and OFF. A green indicator light shows when the SAVE state is operative.
In the ON state the signal is stored in the A channel digital memory. With VIEW A pressed this stored signal is displayed on the screen.

2ND FUNCT then SAVE A
These keys can be used to switch the screen's minor graticule lines OFF and ON.

MAX HOLD
When MAX HOLD is selected the maximum signal level recorded at each memory location is retained and displayed on the screen. Successive operations cause the function to interchange between the ON and OFF states. An amber indicator light shows when the MAX HOLD condition is operative and the annotation 'Max hld' is displayed on the line immediately below 'A▶▶▶'. The MAX HOLD mode is automatically cleared down when video averaging is in use and is not available in ZERO SPAN and FM DEMOD.

VIDEO AVG
Operation of this key prepares for the signal averaging of a number of sweeps related to display A. The message 'A VIDEO AVERAGING' together with information on the use of a data key to select the number of sweeps to be averaged appears in the data entry area of the screen. The data key to be pressed is the exponent of 2 which gives that number of sweeps. For example, if 128 sweeps are to be averaged the digit 7 is keyed in (2^7 = 128).

After a single DATA key is pressed, the screen message is replaced by an annotation at the bottom left hand side of the display stating the number of sweeps to be averaged e.g. Avg. 128. This in turn is quickly replaced by the counted sweeps as they are completed. Upon completion, the total number of sweeps averaged is shown until the mode is cancelled, or a second value is entered. The green indicator light shows only when a keypad digit 1 or greater than 1 has been selected. If a VIDEO AVG key is selected in error, it can be cleared by operating DATA key 0. To eraze a completed, or part completed entry press the VIDEO AVG key again.

para. 110 (continued)

In single sweep mode, repeated operation of the SINGLE ARM key is necessary to achieve the signal average of a set number of sweeps. Operation of the PRESET key sets the number of averages to 1 therefore no averaging occurs. The MAX HOLD mode is automatically cleared down when video averaging is in use.

[2] DISPLAY B

VIEW
INFILL
SAVE
MAX HOLD
VIDEO AV

Functions are the same as those for DISPLAY A, but read 'B' for 'A' where applicable e.g. B display store not A display store. Video averaging and max. hold marginal annotations are now on the right of the display.

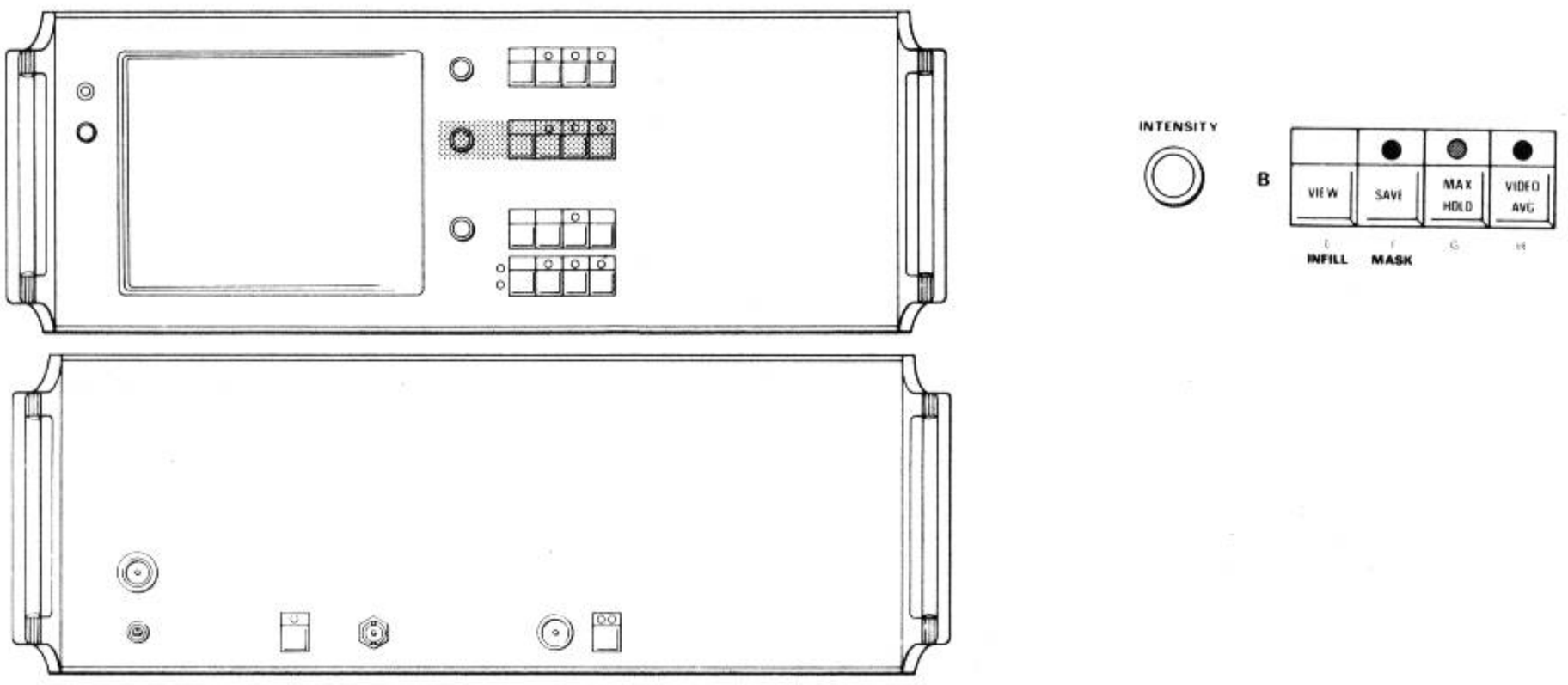


Fig. 23 Display B controls

MASK (2ND FUNCT then SAVE B)
If operation of the 2ND FUNCT key immediately precedes the operation of SAVE, upper and lower limit boundaries can be entered into the B store to provide a go/no go limit mask. A menu of operations first appears on the screen from which it can be seen that by pressing certain DATA keys maximum and minimum levels and frequencies can be entered or cleared to define the limits of the mask. Instructions for entering the mask limits and a screen record of the entries is provided on pressing the relevant DATA keys. Pressing DATA key 0 switches the mode OFF. The limit mask appears on the screen as a bright band between the upper and lower limits when INFILL is not selected or as a pale band when INFILL is selected. In the latter case the display is bright below the lower limit and dark above the upper limit (refer to Operating procedures para. 83).

[3] GRAT (green letters)
Successive operations of this key cause the function to interchange between the ON and the OFF state, permitting the display or suppression of the graticule. In the ON state the brightness of the graticule can

para. 110 (continued)

be adjusted by means of the adjacent rotary GRATICULE INTENSITY control. Pressing 2ND FUNCT and then GRAT suppresses the graticule annotations. Repeating this operation restores the annotations.

Except in the event of an overload, with VIEW A, VIEW B, and GRAT switched OFF, the e.h.t. unit is switched OFF and the screen goes blank.

This may be used in an unscreened environment whilst a sweep is taken and stored. Electro magnetic radiation is reduced to a minimum and very low level signal measurements can be made more accurately. Subsequently the display can be switched on again to observe the reading.

[4] LOCAL
When under GPIB control, but not in 'local lock-out' mode, pressing this key returns the instrument to 'local' control and extinguishes the REMOTE indicator light. In 'local lock-out' mode, the LOCAL key is disabled.

ADDR (2ND FUNCT then LOCAL)
When pressed the instrument's GPIB address is displayed on the screen for two seconds.

[5] GPIB PLOT
This key enables a GPIB plotter to be used via the GPIB socket at the rear of the instrument Fig. 2 [14]. When the key is pressed a menu is displayed listing the DATA keys to be used for further information etc.

DATA key 1 gives a detailed set of instructions on how to set up the instrument and obtain a plot.
DATA key 2 allows a choice of graticules i.e. major, minor, both or none; a choice of A and/or B trace; the annotations required i.e. A display, B display or general.
DATA key 3 allows pen numbers to be allocated for different parts of the display e.g. annotations, major and minor graticule lines etc.
DATA key 4 automatically selects SAVE mode and executes the plot.

Pressing the DELETE key aborts the plot. All menus are automatically deleted during the plot.

OPTIONS (2ND FUNCT then GPIB PLOT)
When these keys are pressed, an options menu is displayed. Standard options which are selected using data keys 1 to 3 are Beeper, Colour palette and Pen plot but these are only available if Conversion kit 46883-735V is fitted. Data key '0' is used to exit from the options mode and return the instrument to its previous setting. When data keys 1 to 3 are pressed a secondary menu is displayed appropriate to the option selected.

The secondary menu for the Beeper option shows that by pressing the respective data keys the beeper can be used to indicate an error, end of sweep or an overload. The selection can be turned ON or OFF by repeated pressings of the data key. To exit from the Beeper option back to the main menu, data key 0 is pressed.
With the colour palette selected there is a choice available between normal and strong colours, for use on a colour monitor. By pressing data key 1 normal colours are selected. This is a restful display suitable for continuous relaxed viewing. The following colours are used.

para. 110 (continued)

Normal colours:

graticule - low luminance white (grey)
markers - high luminance white
A trace
annotations - low luminance red (orange)
text

B trace
annotations - low luminance blue
text
Top and bottom annotations (except text)
- high luminance white or the A or B trace colours if selected.

Data key 2 selects strong colours. This is for lectures or presentations etc. The following colours are used.

Strong colours :-

graticule - high luminance green
markers - high luminance white

A trace
annotations - high luminance red
text
B trace
annotations - high luminance blue
text
Top and bottom annotations (except text)
- high luminance white or the A or B trace colours if selected.

Data key 0 is used to exit back to the main menu.

In the pen plot mode a detailed secondary menu is displayed and using data keys 1 to 5 an X-Y plotter can be controlled via the OPTIONS socket. Facilities have been provided for setting graticule, bottom left, top right; plotting on major, minor or major and minor graticule lines - or without graticule; choice of A, B, or both displays and actual plot execution - initially at 5 V/s but by using the ↓↑ REF FREQ keys plot speed can be increased or decreased in a 1,2,5 sequence from 1 V/s to 200 V/s. The DELETE key is used to abort the plot and data key ´0´ to exit back to main menu. All menus are deleted during plot execution.

[6] NORMALIZE
Used in conjunction with the tracking generator output as the stimulus for passive or active frequency domain network analysis, the ´normalize´ facility compensates for frequency response errors incurred by the spectrum analyzer test fixtures and leads. This permits the frequency response of the unit under test to be displayed with all external errors removed. The function may be selected on vertical scales dB/DIVISION or LOG VOLTS/DIV and horizontal scales FULL SPAN, /DIV, and LOG modes only, for both A and B displays.
First operation of this key causes the message ´Connect test fixture then press NORMALIZE´ to appear in the data entry area of the screen and an amber key light goes ON.

para. 110 (continued)

The next operation of the NORMALIZE key initiates a single sweep of the screen. If the sweep speed is relatively slow the displayed message changes to ´Normalizing´ until the sweep has been executed then ´Normalized´ appears. During normalizing several functions are rendered inoperative e.g. a previously selected vertical scale function, dB/division or volts/div. cannot be changed. If the sweep speed is fast the message ´Normalized´ appears almost instantaneously.
If NORMALIZE is pressed again, the function is cleared down, the amber light goes out, and the instrument is returned to normal operation.

[7] A-B→A
Operation of this control causes the difference in level between the A and B displays to be shown on the A display. This facility is only available therefore on dB amplitude modes and is used for differential measurements (refer to Operating procedures para. 98). With VIEW A, VIEW B, SAVE B and SWEEP MODE NORM selected the screen shows the stored reference image ´B´ superimposed on the live difference display. If the SAVE A function is selected in place of SAVE B the screen shows the live input signal ´B´ superimposed on the live difference display.
Successive operation of this control causes the function to interchange between the ON and OFF states. An amber indicator light shows when the function is ON.

Display with a dB vertical scale

The difference is displayed in dB at the resolution selected for the A display. The horizontal centre line of the display is the difference between the A and B top of screen reference levels in dBs. Thus if the reference levels are the same the centre line is 0 dB with positive differences above and negative differences below this level.

Display with a logarithmic voltage vertical scale

If LOG mode has been selected (2ND FUNCT then VOLTS/DIV) and then A-B→A is pressed the major horizontal lines of the logarithmic graticule are labelled 10, 1 and 0.1 starting at the top of the graticule. A zero difference is displayed on the graticule line annotated 1.

A display on the graticule line annotated 10 indicates that signal A is greater than signal B by 1 unit of voltage (depends on scale selected). A display on graticule line 0.1 indicates that signal A is less than signal B by 1 unit of voltage (log ratio = 10/1 or 1/10 respectively). At the top of the scale the annotation ´A´ scale units is replaced by the annotation ´RATIO´.

[8] A↔B
Operation of this key causes the contents of the A and B data stores to be interchanged. The key is used mainly in conjunction with the A-B→A control and on single sweep displays when neither data store is being updated. If however the key is pressed when either or both sweeps are live then further processing of data from the input store is suspended, SAVE mode automatically set and the contents of the stores are interchanged.
Additionally the A (or B) MAX HOLD & VIDEO AVG functions are made inoperative but an averaged or MAX HOLD trace is maintained if that mode has previously been selected.

para. 110 (continued)

The function is selected and data interchanged each time the key is pressed. An example on the use of this control is given in Operating procedures para. 95.

[9] CAL
When this key is pressed an automatic calibration routine is initiated (refer to para. 11 for further details).

When the control is ON and a calibration routine commences, the message 'Calibrating' is displayed on the screen and a calibrating signal replaces the signal at the receiver input. While the calibrating routines are being carried out the display shows the progress and a 'Bad cal' message is displayed if an error is detected. After the routine is complete the input signal is restored and the messages are cleared from the display.

The green key light shows when the instrument is in a calibrated state and the word 'Calibrated' is displayed at the top of the screen. This light and screen message are OFF when the instrument is in an uncalibrated state.

[10] TEXT (yellow letters)
Operating this key selects the caption mode. In this state most of the keys on the 2380, become alphanumeric entry keys and the Hz terminator a 'space' key, enabling a caption of up to 38 characters to be entered on the top line of the display. A cursor indicates the data entry point and may be non-destructively positioned anywhere along this line using the REF FREQ rotary control. The DELETE key erases the previous character in the caption area and pressing 2ND FUNCT then DELETE erases all characters in the caption area. To obtain lower case characters or the non-numeric alternatives to the keypad symbols, the 2ND FUNCT key must be depressed before the appropriate character key. Whilst in this mode a message 'Enter annotation Press TEXT key to exit' is displayed in the data entry area of the screen. The instrument operational status cannot be changed whilst in the caption mode. A further operation of the TEXT key returns the 2380 keys to their normal operational functions.

SECRET (2ND FUNCT then TEXT)
To prevent unauthorized reading of the frequency to which the instrument is set, when the 2ND FUNCT control key is pressed followed immediately by the TEXT key annotations regarding reference frequency are erased. Frequency annotations can be restored by repeating this operation.

FUNCTION/DATA
[11] REF LEVEL
In the dB/division mode this control changes the top of scale reference level. It is used in conjunction with the DATA keypad and appropriate terminator. Any unterminated keypad entry may be cancelled by operating REF LEVEL again or by repeated operations of the DELETE key.

When the control is pressed the message 'A & B Ref level=' or 'A (or B) Ref level=' appears in the data entry area of the screen. The message appearing depends on the setting of the AB SELECT key and whether it is in locked or unlocked mode. Immediately after a level has been entered and a terminator pressed this message is erased and the required reference level is displayed on the top line of the graticule. Maximum

para. 110 (continued)

reference level is +30 dBm, minimum is -160 dBm and data is displayed to 0.1 or 0.01 dB resolution, depending on the selected vertical scale (refer to location 25).

It should be noted that reference level can also be altered by:-

Vertical scale	REF LEVEL	↓ or ↑
	REF LEVEL	rotary control
Markers	MKR 1 SETS	REF LEVEL

In the linear VOLTS/DIV mode the REF LEVEL key is used in a similar way to set the volts per division scaling in a 1,2,5 sequence.
When the REF LEVEL key is pressed the message ´A & B volts/div.=´ or ´A (or B) volts/div.=´ appears on the screen. The message appearing depends on the setting of the A B SELECT key and whether it is in locked or unlocked mode. The required scaling is keyed in using the keypad and terminators as before. The scaling is displayed on the top line of the graticule after the terminator is pressed; maximum value is 0.5 V/div. minimum is 0.1 µV/div. Voltage scaling can also be changed using the REF LEVEL ↓↑ keys. Providing the keypad entry is acceptable a voltage terminator will force the lower unit into the VOLTS/DIV mode when previously set to dB/DIVISION and similarly a dB terminator will force the lower unit into the dB/DIVISION mode if previously set to VOLTS/DIV. Operation of the REF LEVEL key is ineffective in the LOG VOLTS/DIV mode; the REF LEVEL ↓↑ keys are used for scale changing.

SET TG (2ND FUNCT then REF LEVEL)
This second function of the REF LEVEL key is used to set the output level of the tracking generator and is associated with the TRACK GEN key. Refer to Front Panel Control Functions [35].

[12] REF FREQ
This control is used to change the reference frequency. It is used in conjunction with the DATA keypad and an appropriate terminator to enter a desired reference frequency in the range 0 - 400 MHz to 1 Hz resolution. Any unterminated keypad entry may be cancelled by operating REF FREQ again or by repeated operation of the DELETE key.
When the key is pressed, the message ´Ref freq=´ appears in the data entry area of the screen. Immediately after a frequency has been entered and a terminator pressed, this annotation is erased and the information is transferred to the appropriate margin annotation area.

If the horizontal scale /DIV mode is selected the new reference frequency is moved to the selected left hand, right hand or centre reference point depending on the setting of HORIZ POSN, the display moving accordingly. If however, horizontal scale FULL SPAN is selected then the dashed vertical line on the display is moved to the new reference frequency. Should a frequency be requested that exceeds the range of the lower unit, a message ´Out of range´ is flashed in the display area for two seconds. The reference frequency remains at its previous value.

In the horizontal scale ZERO SPAN mode the synthesizer is adjusted to tune the analyzer to the selected reference frequency. On horizontal scale LOG mode the function is inoperative.

para. 110 (continued)

It should be noted that the value of the reference frequency can also be altered by:

Function/data	SIGNAL TRACK, REF FREQ ↓ or ↑, REF FREQ rotary control.
Markers	MKR 1 SETS REF FREQ.

[13] SPAN/DIV
Whether in the /DIV or FULL SPAN mode the SPAN/DIV key in conjunction with the DATA keypad and appropriate terminator provides an alternative method for selecting the span required to that given by the horizontal scale SPAN/DIV 24 position rotary switch (refer to Front Panel Control Functions [29]. The ranges available are from 10 Hz/div. to 20 MHz/div. in a 1,2,5 ... sequence and 40 MHz/div. The value selected is indicated in the appropriate screen area.

When SPAN/DIV is pressed the message 'Span/div.=' appears in the data entry area of the screen and two seconds after the required span has been entered the message is erased. Any unterminated keypad entry may be cancelled by operating the key again or by repeated operation of the DELETE key.

[14] INC FREQ
This key is used in conjunction with the DATA keypad and appropriate terminator to define the magnitude of the frequency step to be applied to the reference frequency when either the REF FREQ ↓ or ↑ control is pressed. Initially the incremental frequency is set so that this frequency step is one tenth of the frequency span for the FULL and /DIV controls, but the range available is from 1 Hz to 400 MHz. On ZERO SPAN the incremental frequency is set at 0 Hz.

Any unterminated keypad entry may be cancelled by operating INC FREQ again or by repeated operation of the DELETE key.

Pressing the INC FREQ key causes the message 'Inc freq =' to appear in the data entry area of the screen together with brief 'setting up' instructions. After a frequency has been entered and a terminator pressed, this message is erased and the information is transferred to the appropriate margin annotation area. If INC FREQ is followed by any terminator with no numerical value entered the frequency step reverts to its initial or 'auto' value.

It should be noted that the value of the incremental frequency can also be altered by:

Markers	MKR 1 SETS INC FREQ and
ΔF SETS	INC FREQ controls

[15] SIG TRACK
Signals at the centre of the screen can be maintained in this position by pressing the SIG TRACK control even though the identified signal may drift. This mode is an automatic frequency controller, ensuring that the reference frequency of the analyzer is retuned to match the frequency of the input signal. The reference frequency is updated every sweep. Note that in this mode the rate at which the SPAN/DIV rotary control can be operated has been reduced to avoid loss of signal.

para. 110 (continued)

Successive operations of this key cause the function to interchange between the ON and OFF states, an amber indicator light showing when the ON state is selected.

Operation of any of the following keys will automatically clear the function:

Horizontal scale FULL SPAN, LOG, METER, ZERO SPAN, FM DEMOD.

(Examples on the use of this control are given in Operating procedures para. 62).

[16] HORIZ POSN
In the /DIV mode, successive operations of this key cause the reference frequency, indicated by a dashed vertical line, to be positioned at the centre, left hand or right hand side of the screen. The display then expands about the selected position as the frequency span is reduced. Since the reference frequency is unchanged the action of the key shifts the display to the left or right as required.
The HORIZ POSN function is inoperative in the FULL SPAN, LOG, ZERO SPAN, FM DEMOD and METER modes, its former setting being stored so that it can be recalled upon return to the /DIV mode.
When SIG TRACK is operated the function is forced into the centre reference.

[17] REF FREQ ↓ or ↑
Operation of these keys cause the reference frequency to be decremented or incremented in discrete steps. The magnitude of each step is either a value entered via the keypad using the INC FREQ key or a specific 'auto' value related to the horizontal scale FULL SPAN or /DIV controls. For details refer to the INC FREQ key [14] description.

If the horizontal scale /DIV mode is selected the synthesizer moves the new reference frequency to the selected left hand, right hand or centre expand point, the display moving accordingly. If however FULL SPAN is selected then the dashed vertical line is moved on the display to the new reference frequency. In the ZERO SPAN mode the synthesizer is adjusted to tune the analyzer to the selected reference frequency. On LOG mode this function has no meaning. If a frequency is requested that exceeds the range of the lower unit, a message 'Out of range' is flashed in the data entry area of the screen for two seconds. The reference frequency remains at its previous value.

[18] REF FREQ rotary control
Except when in the caption mode (refer to key location [10]) this control increases or decreases the reference frequency, each new value being shown in the annotation area at the bottom of the screen.
If horizontal scale FULL SPAN is selected the dashed vertical reference line is moved on the display to that signal required as the new reference frequency. If however the /DIV mode is selected, providing the sweep speed is 10 ms/div. or faster, the synthesizer moves the required signal to the left hand, right hand or centre expand point - depending on the position of the HORIZ POSN control, the display moving accordingly.
For sweep speeds of 100 ms/div. and slower, in the /DIV mode, the above method becomes too time consuming and therefore when the REF FREQ control is rotated, the dashed reference line is again moved on the display to

para. 110 (continued)

the required signal as in the FULL SPAN mode. Once the line is placed over this signal a new sweep is initiated and the signal is transferred to the selected left hand, right hand or centre expand point after only one sweep. The procedure is considerably quickened by using this method.
In the ZERO SPAN mode the synthesizer is adjusted to tune the analyzer to the selected reference frequency. On LOG mode the function is inoperative.
If a frequency is requested that exceeds the range of the lower unit, a message ´Out of range´ is flashed in the data entry area of the screen for two seconds. The reference frequency remains at its previous value.

[19] DATA

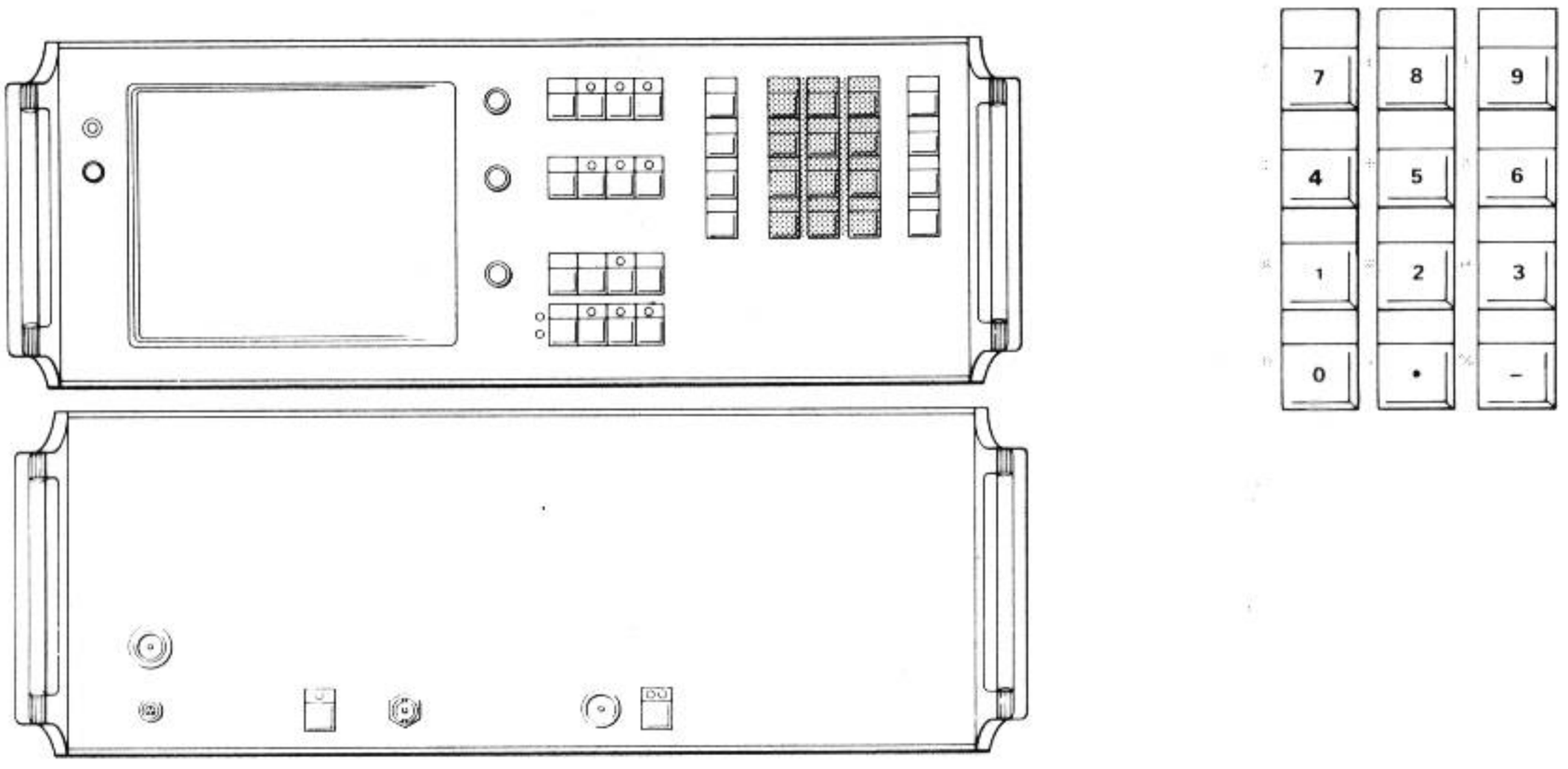


Fig. 24 Data controls

Keys 0 through 9, ´.´ and ´-´ are used in conjunction with instrument controls such as the REF LEVEL, REF FREQ, SPAN/DIV, INC FREQ and terminator keys to enter desired data. Prior to the operation of a terminator ´DELETE´ can be used to delete entries, one at a time, back to and including the initiator. In addition, when used with STORE, RECALL and A or B VIDEO AVG for example, keys 0 through 9 cause a numeric entry and initiate the respective mode. The 0 key is used to exit from a menu selection.

para. 110 (continued)

(20) Terminators GHz/dB, MHz/V, kHz/mV, Hz/µV

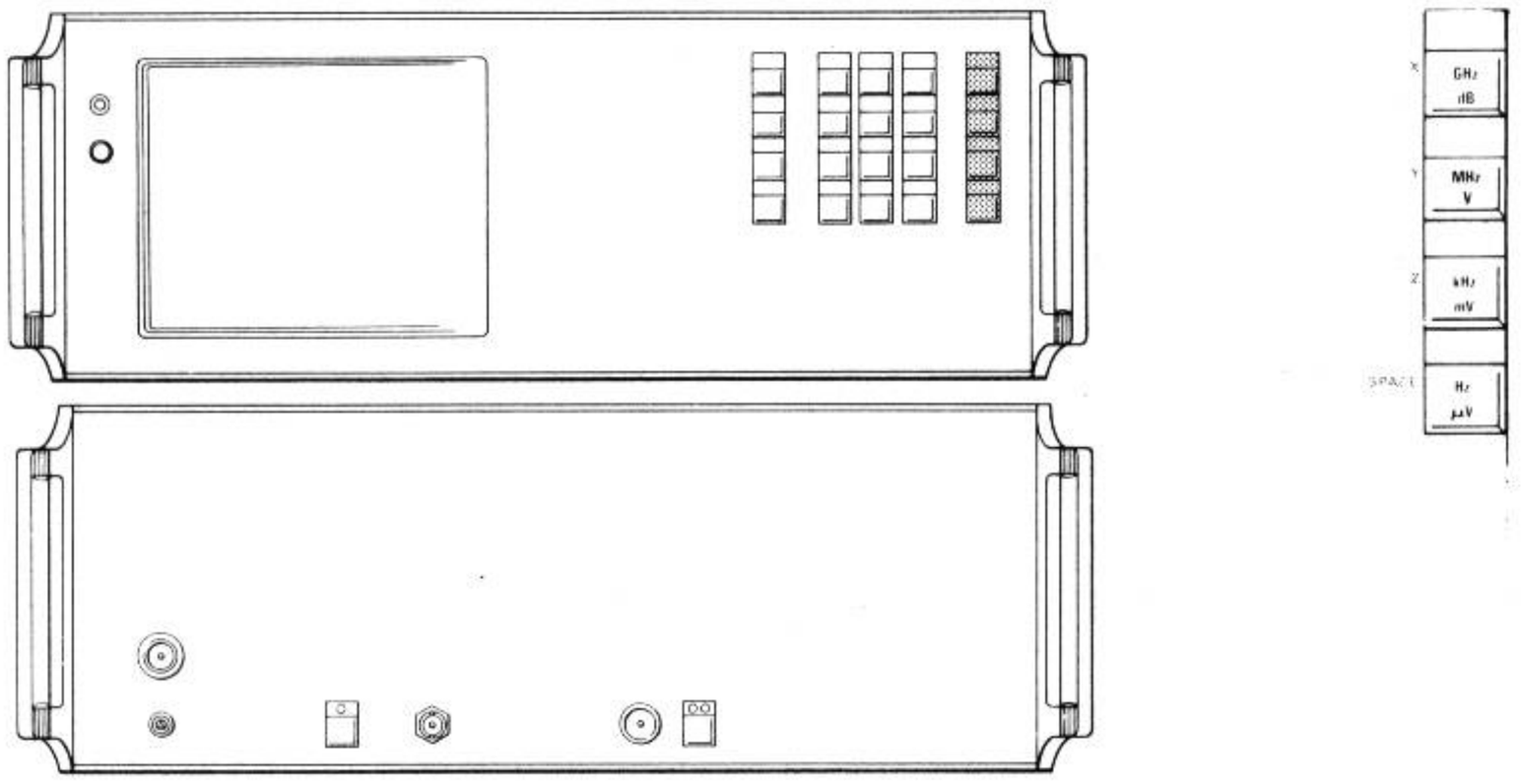


Fig. 25 Terminator controls

These keys are used in conjunction with REF LEVEL, REF FREQ etc. and the DATA keypad. They provide a selection of the units which can be specified, each one acting as a terminator to the entry.

[21] DELETE
This key can be used to delete a function or unterminated data entered in error when using the FUNCTION/DATA keypad.

[22] 2ND FUNCT (coloured blue)
The 2ND FUNCT control allows certain keys a second function. These are printed on the front panel, adjacent to the key, in blue letters. The description of a key's second function, where applicable, is given with that for the key's primary function.
To select a second function the 2ND FUNCT key is pressed, then the required function key. The key light is ON when the 2ND FUNCT key is pressed, and OFF when the second function has been selected. If the second function has been selected in error, it can be cleared by pressing it a second time.

[23] STORE, RECALL
These controls are used in conjunction with the DATA keypad. They permit the storage and recall of nine sets of instrument mode settings. All nine sets are stored in non-volatile memory in the lower unit.
If the STORE key is selected in error, it can be cleared by operating '0' on the DATA keypad.

para. 110 (continued)

STORE
To store the current operational status the STORE key is first pressed and the screen displays a list of STORE OPERATIONS which can be selected using DATA keys 0 to 6. Using these keys, displays can be stored, recalled, protected, unprotected and cleared as required.

Pressing DATA key 1 - STORE MODE, lists the available store locations 1 to 9 and their content. Location 1 is a ´power up´ state and any mode settings saved here will be displayed each time the analyzer is switched ON. Protected stores are identified by an asterisk and these can only be erazed by a deliberate sequence of key operations. Unused locations are designated ´Empty´ and to retain a display - unprotected, it is only necessary to press the DATA key corresponding to an empty location. Alternatively unprotected stored displays can be overwritten by pressing the DATA key corresponding to that stores´ location. For reference purposes, prior to storing, a suitable caption may be added to the display using the TEXT key [10]. This caption will then appear against the chosen location in the list of stores. Failing this, by default, the reference frequency of the stored status is displayed at the chosen location. If a caption has been added, this remains on the screen when PRESET is selected so that it can be used again if necessary. Pressing DATA key 0 returns the display to the ´operations´ menu.
Data key 2 selects the RECALL MODE. Once again the list of locations is displayed and a required display is recalled by pressing the DATA key corresponding to its location in the list. Pressing data key 0 exits from the recall mode back to the store operations menu.

Data key 3 selects the PROTECT MODE. The list of locations is displayed and to protect one of these the DATA key corresponding to that location is pressed. Note that even an empty store can be protected for use at a later date. Data key 0 exits back to the ´operations´ menu.
To unprotect a location data key 4 is first pressed to display the list of store locations in the UNPROTECT MODE, then the DATA key corresponding to the location to be unprotected is pressed. The asterisk adjacent to the location is erazed. The store can now be cleared if necessary by returning to the operations menu (data key 0) and pressing data key 5 (refer below).
Key 5 of the operations list is for the CLEAR MODE. The list of locations is again displayed and subsequently pressing the data key corresponding to a chosen location will empty that store - provided it is unprotected. To clear protected stores they must first be unprotected as detailed in the paragraph above. Return to operations menu by pressing data key 0.
To clear all unprotected stores, display the operations menu and press DATA key 6. DATA key 1 can be pressed to display the list of locations to ascertain that the stores are now empty.

RECALL
Providing the store location is known a display can be recalled more quickly by pressing the RECALL key. The message ´Recall store=´ appears on the screen and subsequently pressing the DATA key corresponding to the required store location produces the display.

para. 110 (continued)

2ND FUNCT then RECALL
This hidden function displays the status of the instrument's software for about ten seconds.

FRONT PANEL CONTROL FUNCTIONS - 2382

111. A description of the function of each control can be found by obtaining its location from Fig. 31 and relating it to the relevant part of this paragraph. A list of hidden functions is also provided. Where a group of controls is identified an additional figure shows the keys covered by that particular location.

Note ...

If a key requiring data entry is pressed in error, the selected function can usually be cleared by pressing the DELETE key [21]. When this does not apply the screen menu gives the information for clearing a function. The INTENSITY controls can be used to fade out the display if necessary while reading the menu.

[24] VERTICAL SCALE

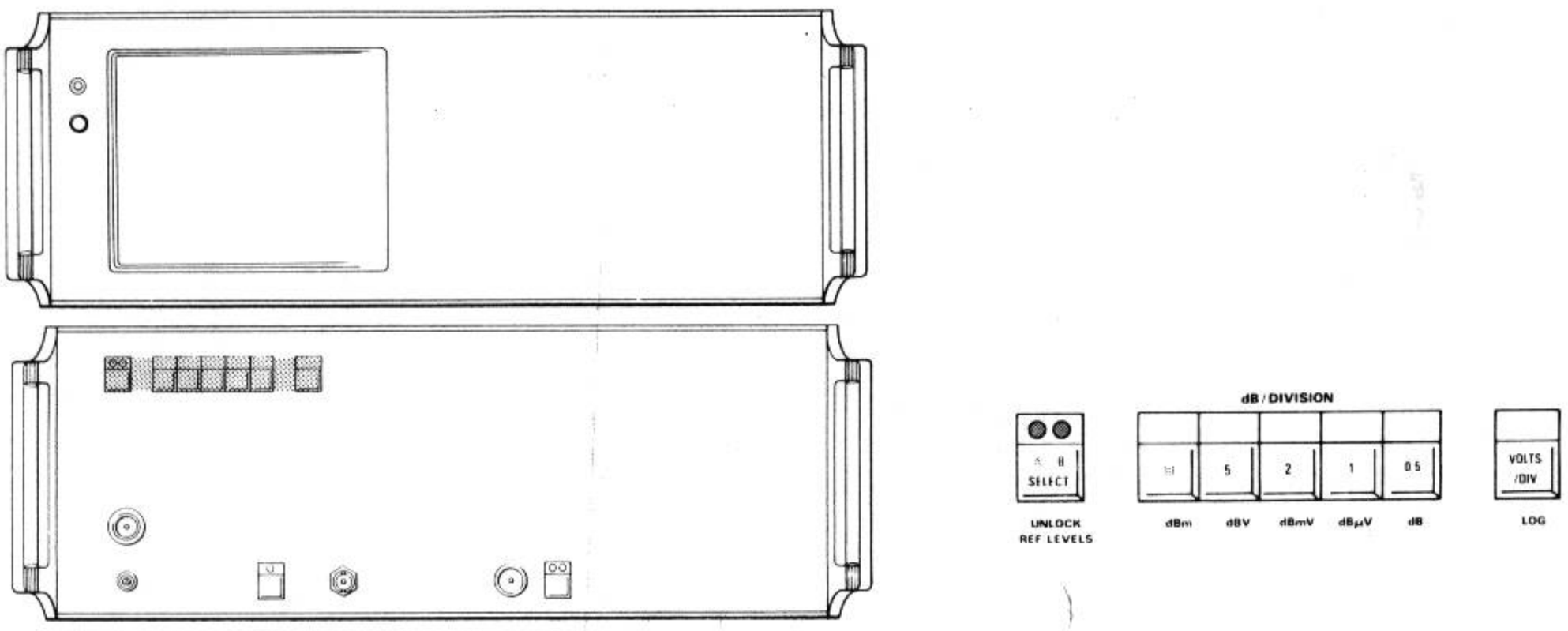


Fig. 26 Vertical scale controls

10 (green figures), 5,2,1,0.5 dB/DIVISION
These keys are used in conjunction with the A B SELECT key to set the appropriate display scale. Operation of any of these controls will cause the vertical scale annotation to change to that number of dB per graticule division. The reference level remains unchanged. For the 10 dB, 5 dB and 2 dB/div. display, the graticule annotation can be set in 0.1 dB increments using the REF LEVEL rotary control [25]. For the 1 dB and 0.5 dB/div. display it can be set in 0.01 dB increments.

2ND FUNCT then 10,5,2,1 or 0.5 dB/DIVISION key
This second function sets the A or B display scale to dBm, dBV, dBmV, dBμV or dB as required. In the latter case the scale annotation is changed

para. 111 (continued)

such that the selected reference level is annotated 0 dB. Subsequent increments or decrements of the reference level, or scale expansion, causes the trace and graticule annotation to change accordingly so as to maintain 0 dB at the chosen dBm reference level.

VOLTS/DIV
This control key is used in conjunction with the A B SELECT key, to select a voltage scale. The ↓↑ REF LEVEL keys or the REF LEVEL key and keypad are used to set the scale to a required voltage range. This is automatically set to 50 mV/div. (500 mV top of scale) after using the PRESET key but usually the range selected is the one last used. In this mode the signal is displayed against a linear ten division scale.

LOG (2ND FUNCT then VOLTS/DIV)
This second function of the VOLTS/DIV key causes the horizontal lines of the scale to appear in logarithmic increments covering a range of two and a half decades. The major graticule lines, indicating decade boundaries, are annotated 1, 10 and 100 in units of voltage dependent upon the setting of the ↓↑ keys.

Graticule compatibility

A and B displays (both 'live'). Where both displays are live and unlocked:

(a) On VOLTS/DIV only two steps of sensitivity difference are possible.

(b) On FM DEMOD (2ND FUNCT then ZERO SPAN) the sensitivity must be the same on both scales.

(c) On ZERO SPAN [AM Demod.] the time axes must be the same but the Y axes can be different (limited to two steps on VOLTS/DIV).

The display is limited to having sweeps with compatible data for the A and B scales.

Displays such as log. volts for the A display and dB/div. for the B display are not possible simultaneously. The following table summarizes the various possibilities and whether the displays are compatible. On ranges where the displays are incompatible the A B SELECT key determines the graticule format and the shared annotations.

TABLE 1 GRATICULE COMPATIBILITY

B display	A Display				
	volts/div.	Log. volts	dB	AM Demod.	FM Demod.
Volts/div.	YES	NO	NO	YES	NO
Log. volts	NO	YES	YES	NO	NO
dB	NO	YES	YES	YES	NO
AM Demod.	YES	NO	YES	YES	NO
FM Demod.	NO	NO	NO	NO	YES

para. 111 (continued)

A and B displays (one or both displays stored). Providing the displays are unlocked there is no limitation on the possible combinations of graticule format.

A B SELECT ('A' coloured green)
Used with the Vertical Scale controls this key permits the independent setting of the vertical scale units for the two displays, VIEW A or VIEW B (the horizontal marginal annotations and vertical reference levels are normally the same for both views). Successive operation of this key causes the function to interchange between the displays, a green indicator light showing the one selected. Annotations A▶▶▶ and ◀◀◀B in the lower corners of the screen are both displayed when VIEW A and VIEW B are 'live'. The state of the control governs whether the A or B display scale units are changed when the appropriate keys are pressed.

When a stored and a live display are viewed together (e.g. SAVE B operated) and horizontal scale controls are changed, the horizontal marginal annotations can differ for views A and B therefore only one annotation A▶▶▶ or ◀◀◀B in the lower corner of the screen is displayed and this indicates which selection has been made. If A is selected and an attempt is made to adjust reference frequency, filter bandwidth, sweep time or any parameters affecting the setting of the lower unit the ◀◀◀B arrowed annotation will disappear and the horizontal marginal annotations will be the ones currently being set into the instrument. View B, if displayed, will not change. Switching AB SELECT to 'B' brings back the stored B display annotations.
When both SAVE A and SAVE B are selected with differing horizontal scale settings, annotation A▶▶▶ or ◀◀◀B indicates the display chosen by the position of the AB SELECT key. Vertical controls can be adjusted as required but if an attempt is made to adjust reference frequency, filter bandwidth, sweep time etc., no visible change takes place. Nevertheless, new horizontal scale conditions are set into the instrument and when SAVE A and/or SAVE B are deselected the horizontal marginal annotations will show these new conditions.

UNLOCK REF LEVELS
If independent setting of the reference levels for the two displays VIEW A and/or VIEW B is required, the 2ND FUNCT key must be operated, followed by the A B SELECT key. Successive operation of the A B SELECT key causes an interchange between the displays, a green flashing indicator light showing the one selected.

[25] REF LEVEL ↓↑ control
dB measurements

When used with the vertical scale dB/DIVISION keys, unless the A B SELECT key is unlocked, this control decrements or increments the reference level and scale annotation for both A and B displays in 10 dB steps. It also suitably adjusts the r.f. attenuators and i.f. gain automatically (when AUTO controls are set). When the A B SELECT key is unlocked the A and B scale annotations can be changed independently.

para. 111 (continued)

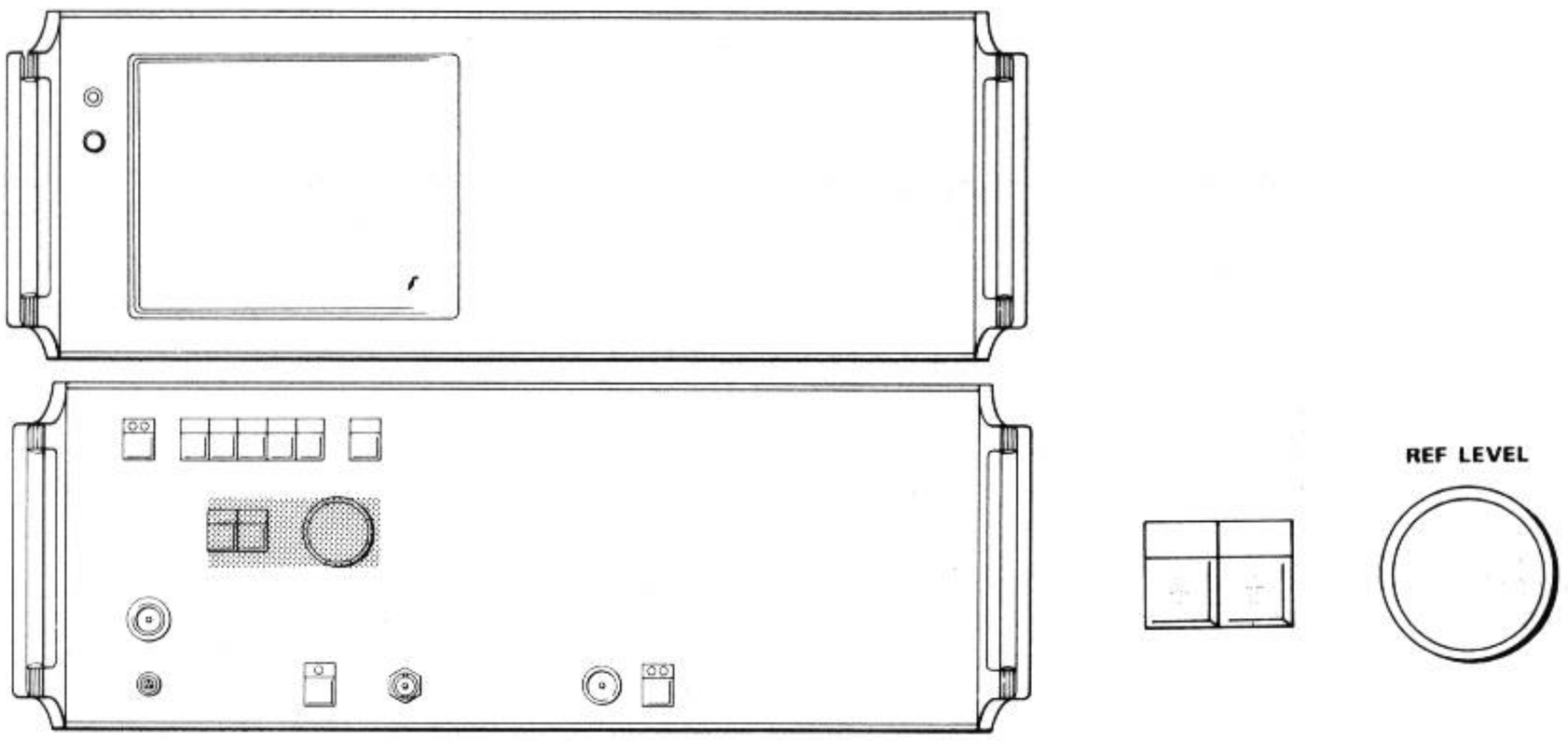


Fig. 27 Reference level controls

Voltage measurements

When used with the vertical scale A B SELECT and VOLTS/DIV keys this control decrements or increments the scale sensitivity in a 1,2,5... sequence. The displayed scale annotation varies from 100 nV/div. up to 500 mV/div. on a 10 division graticule. With both VIEW A and VIEW B displays live and unlocked, difference in sensitivity is limited to two steps. When one (or both) displays is saved sensitivity can be adjusted one step only on each side of the saved setting.

In the 2ND FUNCT then VOLTS/DIV case (LOG), a two and a half decade logarithmic voltage scale is displayed and operation of the ↓↑ control changes the range in a 1,10,100... sequence from nV up through µV and mV to V (min. 100 nV, max. 10 V top of scale).

Overload simulation (2ND FUNCT then REF LEVEL ↑)
This facility is used to demonstrate the operation of overload protection. Pressing these keys simulates the triggering of the overload circuit as if a high level signal had been applied at the input socket. All characteristics of the overload state, as explained in para. 3 [3], are retained, but the function does not test the operation of the latching relay. Press INTMD IDENT [27] to clear.

REF LEVEL rotary control
dB measurements

This control is used as an alternative to the REF LEVEL function/data key or the ↓↑ REF LEVEL keys to change the appropriate top of screen reference level for both the A and B display if the A B SELECT key is locked or for the A or B display if the A B SELECT key is unlocked.

para. 111 (continued)

The steps vary according to the selected vertical scale. For the 0.5 dB and 1 dB/div. cases the steps are 0.01 dB. For 2 dB, 5 dB and 10 dB/div. the steps are 0.1 dB.

[26] RF ATTEN
AUTO (green letters)
In its ON state, shown by a green indicator light, this control automatically sets the r.f. attenuators and i.f. gain for the relevant display selected, in accordance with the REF LEVEL controls, filter bandwidth settings and, when appropriate, the SAVE A and SAVE B keys. Care should be taken in the HORIZONTAL LOG mode however - refer to para. 111 [29] LOG.

↓ and ↑

Operation of these keys cause the setting of the r.f. attenuator to be decremented or incremented in 10 dB steps from 0 dB to 60 dB. Normally to maintain sensitivity a compensating adjustment is automatically made to the i.f. gain but in the VOLTS/DIV mode it may be found that the maximum value of r.f. attenuation available has been reduced to ensure that automatic i.f. compensating gain can be achieved. In the ↓↑ mode, operation of any other front panel control affecting the overall instrument sensitivity changes the i.f. gain and not the r.f. attenuator.

Overload inhibit (2ND FUNCT then RF ATTEN ↑)
Although maximum input level is normally +27 dBm it is possible by pressing the 2ND FUNCT key followed by the RF ATTEN ↓ key, to override the overload trip when measuring signals which have a high peak power but a low mean power. If this is done a reminder that the overload protection is inhibited is displayed on the screen whenever an excessively high power level is detected.

CAUTION

Overriding protection devices can lead to damage and is not a practice to be encouraged. It should only be done when absolutely necessary. Restore the protection by pressing the 2ND FUNCT then RF ATTEN ↑ key again as soon as possible.

[27] INTMD IDENT
The INTMD IDENT key enables any self generated intermodulation or distortion products to be quickly and easily identified. Pressing this key adds 3 dB input attenuation and 3 dB i.f. gain, the overall sensitivity therefore remaining the same. If the display is unaltered when the key is pressed and released then any internally generated intermodulation is insignificant to the measurement. Signals appearing to decrease in amplitude when the key is pressed are intermodulation or distortion products. In fact the signal level remains the same but the noise floor rises by 3 dB.

The facility can only be used on live displays. When the INTMD IDENT key is pressed, a new sweep starts and the initial input attenuation value is displayed and also the message:

'Input level of XXX.XXdBQ gives mixer level of YYY.YYdBQ'

para. 111 (continued)

where Q is the unit currently being displayed (dBm,dBV etc.), and XXX.XX is also the selected reference level being used. In the VOLTS/DIV mode the key is ineffective.

OVERLOAD CLEAR
The INTMD IDENT key may be pressed in an attempt to clear an 'OVERLOAD' annotation on the display. However, in the event of the overload still being present the annotation will be re-established.

[28] VIDEO BANDWIDTH
With AUTO (green letters) pressed, in horizontal scale FULL SPAN or /DIV mode, video bandwidth is set automatically in association with SWEEP TIME. A green light shows when this mode is operative. Manual override is possible by pressing the ↓ or ↑ key, the value of the video bandwidth being displayed on the bottom line of the screen in reverse video.
In the PRESET mode with SWEEP TIME, FILTER BANDWIDTH, and VIDEO BANDWIDTH in the AUTO position and FULL SPAN selected video bandwidth is initially at 11 kHz. In the /DIV mode, bandwidth depends upon the dispersion selected. For both FULL SPAN and /DIV, operation of the ↓ or ↑ key approximately halves or doubles the bandwidth at each press to a minimum of 1 Hz and a maximum of 50 kHz. Video bandwidth controls are ineffective in the ZERO SPAN, FM DEMOD or LOG modes.

[29] HORIZONTAL SCALE

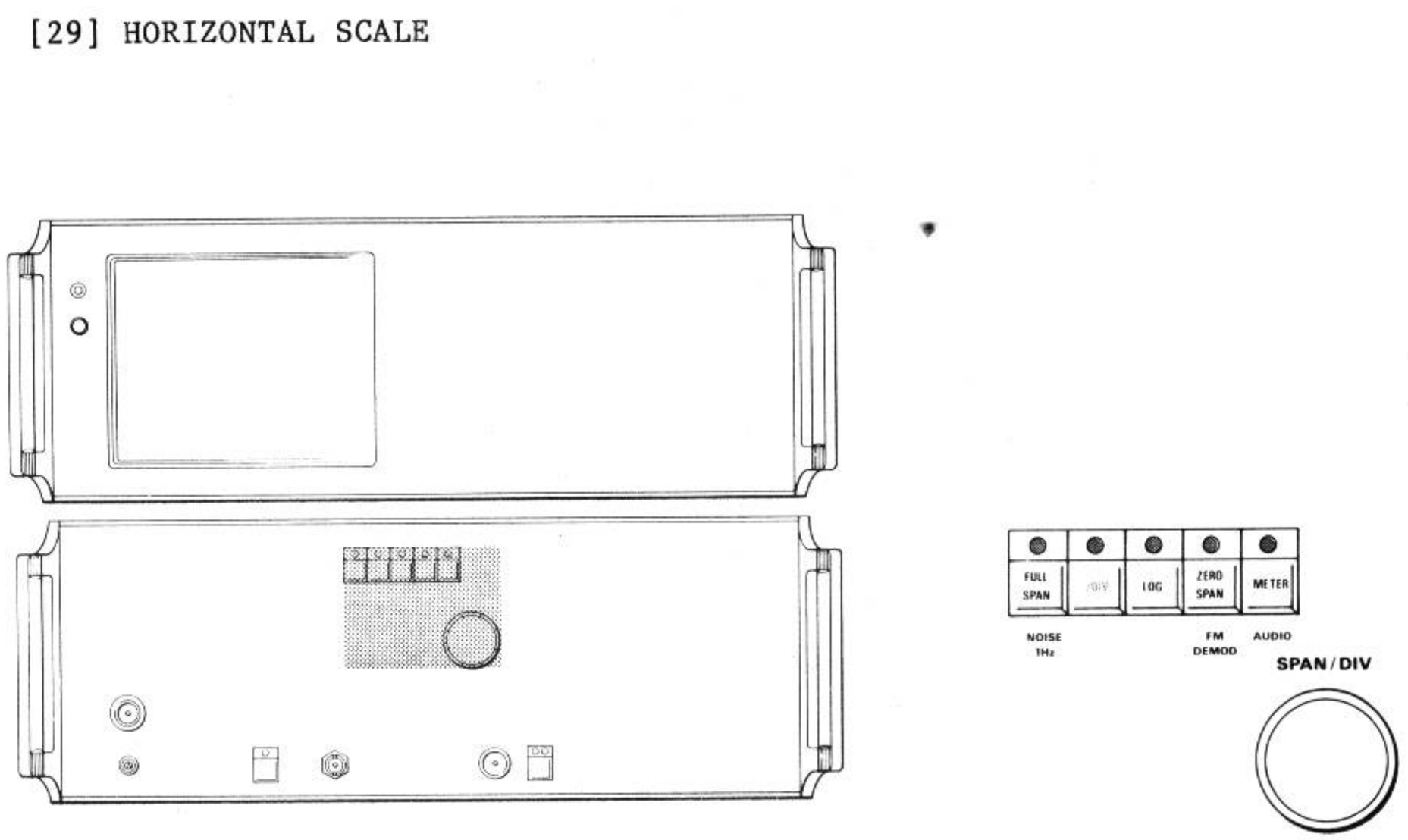


Fig. 28 Horizontal scale controls

para. 111 (continued)

Keys FULL SPAN, /DIV, LOG, ZERO SPAN and METER are mutually exclusive i.e. the operation of any one will not only enable that function and its green indicator light, but will clear down and disable the other functions. The rotary switch control, SPAN/DIV, functions only when the /DIV mode is selected.

FULL SPAN
This control sets the frequency span to the maximum value of 0 to 400 MHz. In this mode the dashed cursor line is positioned at that point on the display appropriate to the current value of the reference frequency. It can be re-positioned over the full display to select any reference frequency required using the REF FREQ rotary control. The screen annotation is updated to read 40 MHz/div. in the appropriate area.

NOISE 1 Hz (2ND FUNCT then FULL SPAN)
On dB vertical scales (dBm, dBV, dBmV, dBμV, dB), FULL SPAN, /DIV and METER only, operation of these keys display the noise normalized to a 1 Hz bandwidth. Convertion to an equivalent level of noise in any other bandwidth can be made using :

$$\text{Equivalent noise} = 10 \log_{10} \frac{(\text{Bandwidth})}{1\ \text{Hz}}\ \text{dB}$$

MKR 1 and 1,2 MOVE functions are automatically activated and marker measurement of the noise is displayed as an amplitude level annotation on the fourth line from the bottom of the screen. The annotation 1 Hz bw is also displayed. Subsequent operation of these keys will clear the noise 1 Hz function. Markers are left to be cleared separately.

/DIV (green letters) and SPAN/DIV rotary switch
When the /DIV mode is selected the horizontal scale Hz/div., filter bandwidth, sweep time and video bandwidth are initially set to produce a satisfactory display. Subsequently the SPAN/DIV 24 position rotary switch is used to select the span required. The value of the span selected is indicated by the displayed annotation in the appropriate screen area. The ranges available are from 10 Hz/div. to 20 MHz/div. in a 1,2,5... sequence and 40 MHz/div. on a 10 division graticule. For each position of the SPAN/DIV rotary switch the dashed vertical line at the centre, left hand or right hand, of the display, depending on the position of the HORIZ POSN key, indicates the current reference frequency.

LOG
When this key is pressed if the instrument is not in LOG mode, the logarithmic scale last used is shown on the screen. Should this scale not be required the LOG key is pressed again. At this second press, or when the instrument is initially in LOG mode when the LOG key is first pressed the prompt message ´Start freq=´ appears at the top of the screen. Note the request to enter decade values only. Using the DATA keypad the desired start frequency and appropriate terminator is now keyed in, and a second prompt message appears, positioned below the first, saying ´Stop freq=´. The stop frequency is now similarly entered. As the terminator for this entry is pressed the prompt messages at the top of the screen are erased, and the bottom two lines of screen annotation are erased. The number of decades of frequency span required (which can range from 1 to 7) are evaluated and appear at the bottom of the screen, the required start and stop frequencies being at

para. 111 (continued)

the left and right hand side of the display respectively. The available range is from 100 Hz to 1 GHz.
The sweep moves through the decades starting at the highest on the right and moving progressively to the lowest on the left, the complete spectrum being shown on the screen. In 'AUTO' modes filter bandwidth is automatically selected at each decade boundary and r.f. attenuation is optimized automatically for each frequency decade.

CAUTION

In AUTO RF ATTEN mode the r.f. attenuator can be switched many times during a sweep and continued sweeps may result in excessive attenuator wear.

The REF FREQ control is in-operative in this mode.

ZERO SPAN
When this key is pressed, initially VIDEO trigger source and 'line draw' are selected and the screen displays the input signal, amplitude demodulated, against a time axis. The Hz/div screen annotation changes to read 'Zero span'. MKR 1 is operative in this mode but only for level measurements. Sweep speed may be varied as required (refer SWEEP TIME controls) and the VERTICAL SCALE controls are used to adjust the amplitude of the display.

FM DEMOD (2ND FUNCT then ZERO SPAN)
This second function of the ZERO SPAN key is used to display frequency demodulated information against a time axis, the vertical scale displaying frequency deviation. It should be noted that FM DEMOD will not function satisfactorily if a.m. is present in the signal being investigated. When the keys are pressed, initially VIDEO trigger source and 'line draw' are selected and the Hz/div screen annotation changes to read 'FM demod.' Marker controls are inoperative. Sweep speed may be varied as required (refer SWEEP TIME controls) and the vertical scale depends on the setting of the filter bandwidth (refer FILTER BANDWIDTH controls).

METER
Operation of this key causes the display to present information about level variation in the form of a vertical 'thermometer' bar type read-out at the centre reference frequency point on the display. The bar will normally be in outline but it may be filled in if 'INFILL' is selected (refer to DISPLAY controls). MKR 1 and 1,2 MOVE are automatically activated and the marker is directed to the peak of the bar. The signal level is displayed on the fourth line from the bottom of the screen in the place normally occupied by the MKR 1 level annotation e.g. Meter -48.22 dBm. Meter mode uses a /DIV type display with centre reference. It can be used on both live and stored displays but the point to which the marker is tuned is live under all conditions. In this mode, sweep is set to SINGLE ARM but further single sweeps may be initiated by pressing any of the SWEEP MODE keys.
Manual adjustment of the 1,2 MOVE control sets the marker at any required point on the display and the meter bar displays the level at that frequency.

para. 111 (continued)

AUDIO (2ND FUNCT then METER)
This operation provides audio monitoring of amplitude demodulated information using either the internal loudspeaker or earphones. A volume control and a jack socket for the phones are located on the rear panel. (Refer to Fig. 2). The VOLTS/DIV vertical scale should be used for optimum audio quality.

[30] TRIGGER CONTROLS
These controls select the desired trigger source both for frequency and time displays. All keys (except AUTO TRIG) are mutually exclusive, successive operations causing the function to interchange between the ON and OFF state. Operation of any of these keys lights its green indicator lamp to show it is in the ON state.

With VIDEO selected the sweep is triggered by the detected envelope of the input signal. With LINE or EXT selected the sweep is triggered from the power line or externally applied signal respectively. The above modes normally provide positive edge triggering. Pressing 2ND FUNCT prior to selecting the trigger source gives negative edge triggering.

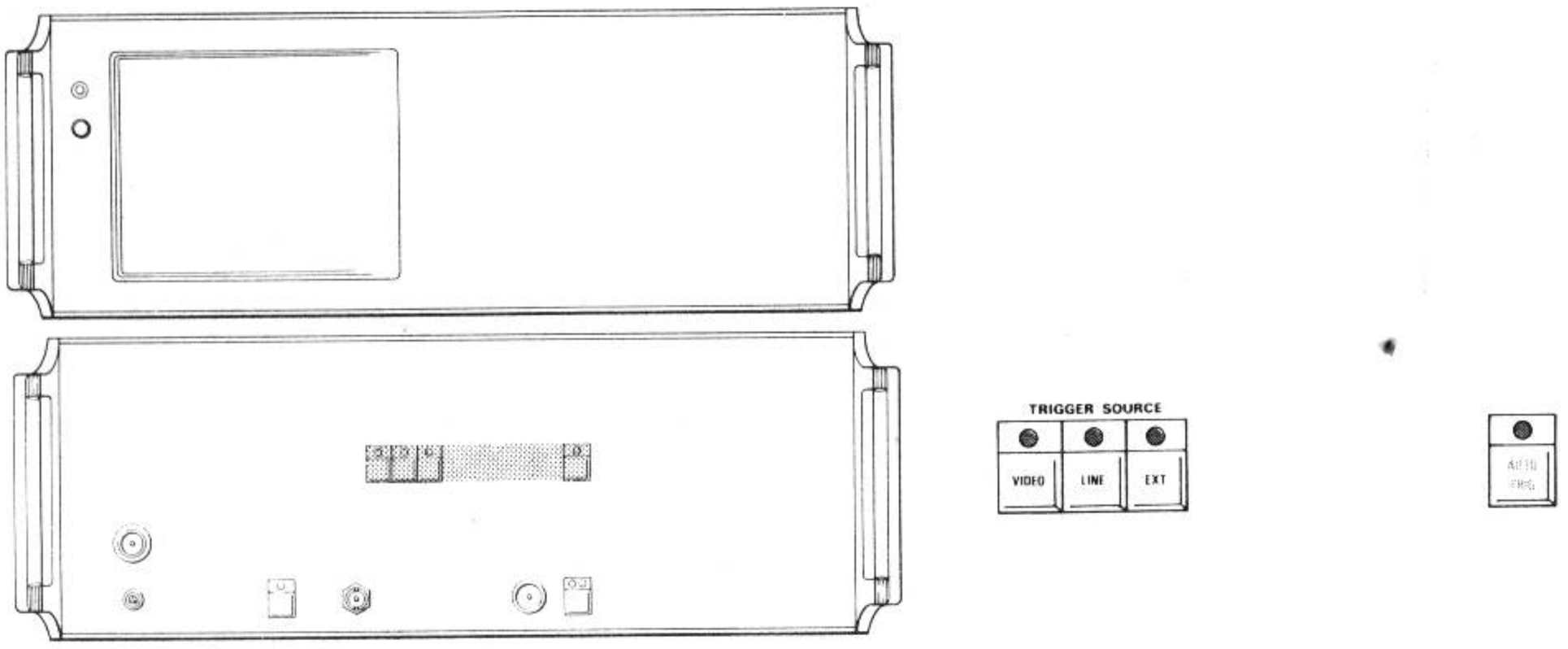


Fig. 29 Trigger controls

AUTO TRIG (green letters)
Operation of this key causes an auto mode circuit to become active whenever the triggering source falls below a certain level or frequency. A sweep therefore runs on trigger if a trigger source is present or free runs if a source is not present. As before the green indicator light shows the function is in the ON state.

para. 111 (continued)

[31] SWEEP MODE
NORM (green letters).
If this key is pressed, any sweep currently in operation will be terminated and the continuous sweep mode will be selected. In this mode, at the end of a sweep the sweep circuit is rearmed such that the next trigger from the selected trigger source will start a further sweep. This process repeats indefinitely.

SINGLE ARM
Pressing the SINGLE ARM key lights the key lamp, terminates any sweep currently in operation and permits the next trigger pulse from the selected trigger source or START key to initiate a single sweep. Each operation of the SINGLE ARM key produces a repetition of the above sequence, the amber indicating light is ON from the time the sweep circuit is armed to the time the sweep has been completed.

START
Operation of this key during a sweep will abort that sweep and initiate a new sweep. If EXT source and AUTO TRIG are selected with no external signal applied, an 'artificial' trigger pulse is provided and the sweep will run immediately on pressing this START key.

IDENTIFY REFRESH (2ND FUNCT then START)
When this mode is selected a 'read in bright-up' vertical band moves across the screen to identify the sweep refresh point whenever the sweep time is longer than 0.1 s/div. Successive operation of these keys cause the function to interchange between the ON and OFF states but it should be noted that the ON state is initiated automatically - refer to SWEEP TIME [32)].

[32] SWEEP TIME
These keys, in conjunction with the horizontal scale FULL SPAN, /DIV or ZERO SPAN control enable the sweep time for the display to be set either automatically when the AUTO key (green letters) is pressed or manually when the ↓ or ↑ key is pressed. The Time /div annotation is displayed on the bottom line of the screen - in reverse video if AUTO is not operational. Increasing sweep time increases noise filtering which automatically reduces the equivalent video bandwidth. This facility may therefore be used to average the noise level on a display for the purpose of identifying low level signals. When the selected sweep time is greater than 0.1 s/div. a bright-up facility is activated. This can be de-selected by pressing the 2ND FUNCT then START keys (IDENTIFY REFRESH).

In the ↓ and ↑ mode, when the sweep time is less than the AUTO value, the message 'Sweep uncal' may be displayed at the top of the display area. This indicates that the sweep through that particular filter is too fast. A green indicator light shows when the AUTO mode is operative.

AUTO (with FULL SPAN)
In this mode, with the AUTO key pressed, sweep time is set at 10 ms/div.

AUTO (with /DIV)
When the AUTO key is pressed the current filter bandwidth and horizontal scale dispersion selection are used and the correct sweep time for the display is produced automatically.

para. 111 (continued)

AUTO (with ZERO SPAN or FM DEMOD)
With the AUTO key pressed the sweep time is set at 10 ms/div.

↓,↑ (with FULL SPAN or /DIV)
On each operation of these keys, the sweep time is decremented or incremented by one step in a 1,2,5 ... sequence, to a minimum of 10 ms/div. or a maximum of 20 s/div.

↓,↑ (with ZERO SPAN or FM DEMOD)
On each operation of these keys, the sweep time is decremented or incremented by one step in a 1,2,5 ... sequence as above, but to a minimum of 5 µs/div. and a maximum of 20 s/div.

[33] FILTER BANDWIDTH
These controls, when pressed, select the resolution filter bandwidth either automatically when the AUTO key (green letters) is pressed or manually when the ↓ or ↑ key is pressed. The bandwidths available range from 3 Hz to 1 MHz in a 1,3,10 ... sequence and the selection made is annotated on the screen - in reverse video if AUTO is not operational (refer Fig. 3). A green indicator light shows when the AUTO mode is operative.
The exact function of each control depends upon the setting of other horizontal scale keys and various combinations of keys and functions are given in more detail below.

AUTO (with FULL SPAN)
In this mode bandwidth is set at 1 MHz

AUTO (with /DIV or METER)
With the AUTO key pressed the optimum filter bandwidth for the current frequency span (SPAN/DIV) is selected automatically. Sweep speed is also automatically selected, providing AUTO SWEEP TIME is pressed.
At the smallest value of frequency span (10 Hz/div.) it is possible to override the AUTO control to obtain even narrower bandwidths down to 3 Hz by pressing the ↓ key.
Overriding AUTO sweep time is also possible to obtain a slower or faster sweep. Under these circumstances however the instrument may be in an uncalibrated condition and a message ´Sweep uncal´ is displayed at the top of the screen.

AUTO (with ZERO SPAN)
In this mode the filter bandwidth in use depends upon the sweep time selected. With AUTO sweep time, bandwidth is 1 kHz.

AUTO (with FM DEMOD)
In this mode the filter bandwidth is 1 kHz and the vertical scale annotation is 100 Hz/div. on a nominal 6 division scale.

AUTO (with LOG)
Filter bandwidth is selected automatically at each decade boundary.

↓,↑ (with FULL SPAN, /DIV or METER)
On each operation of these keys the filter bandwidth is decremented or incremented by one step in a 1,3,10 ... sequence to a minimum of 3 Hz or a maximum of 1 MHz. New sweep times are set up accordingly when AUTO SWEEP TIME is selected.

para. 111 (continued)

↓,↑ (with ZERO SPAN)
The filter bandwidth is decremented or incremented by one step in a 1,3,10 ... sequence within the range 3 Hz to 1 MHz as above.

↓.↑ (with FM DEMOD)
The filter bandwidth is decremented or incremented as for the 'ZERO SPAN' case and in addition the vertical graticule annotation is rescaled in accordance with the selected filter bandwidth from 3 Hz/div. to 300 kHz/div. in a 1,3,10 ... sequence.

↓,↑ (with LOG)
These controls are ineffective in this mode.

[34] MARKERS

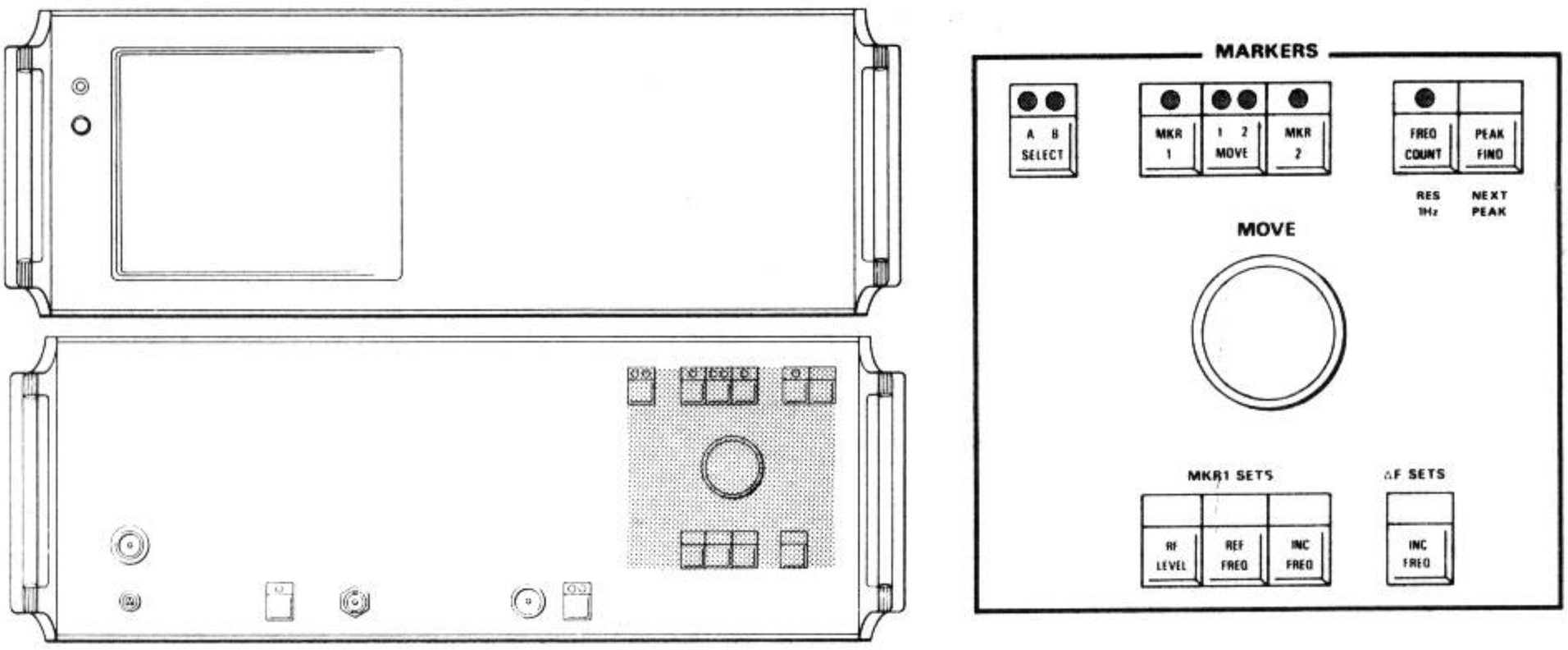


Fig. 30 Marker controls

A B SELECT
This key is used to select the display which is to carry the markers. Successive operation causes the function to interchange between VIEW A AND VIEW B, a green indicator light showing the one selected.

para. 111 (continued)

MKR 1, MKR 2
Successive operation of either of these controls causes the function to interchange between the ON and OFF state, a green indicating light in the key showing the ON state. Normally when the key is pressed, providing INTENSITY is not set too high, a flashing marker appears on the selected display in the same position it occupied when last selected. If however the METER mode is selected the marker is positioned on the top of the bar at the reference frequency. The display to carry the markers is that selected by the MARKERS A B SELECT control.

Annotation of the display is in four zones on each of two lines as follows (refer to Fig. 3):

Zone 1 - line 1 (fourth line from bottom)
Marker identification, Mkr 1, Mkr 2, Meter.

Zone 2
Amplitude level in appropriate units, dB or VOLTS.

Zone 3
Marker frequency (no frequency annotation is given in horizontal scale LOG, ZERO SPAN, and FM DEMOD modes).

Zone 4
The annotation ´1 Hz bw´ is displayed when the NOISE 1 Hz mode (2ND FUNC then FULL SPAN) is in operation; ´Freq count´ when FREQ COUNT mode is in use or ´Res 1 Hz´ when RES 1 Hz (2ND FUNC then FREQ COUNT) mode is in use.

Zone 1 - line 2 (third line from bottom)
The annotation ´Δ Mkr´ is displayed on all occasions when MKR 1 and MKR 2 are operative. It is not displayed when in the METER mode.

Zone 2
The amplitude of the difference in level between the two markers is given when ´Δ Mkr´ is displayed. All dB units (dBm, dBV, dBmV, dBμV) are reduced to a dB annotation.

Zone 3
The frequency difference between the two markers is given when ´Δ Mkr´ is displayed and when frequency is displayed in Zone 3 line 1.

1,2 MOVE and MOVE rotary control
Operation of the 1,2 MOVE key permits the MARKERS MOVE control to move one marker horizontally following the outline of the spectral response. The marker being moved is indicated by one of two green lights on the key and also by that marker flashing on the display.
If only one marker is in use, successive operations of this key will cause the function to interchange between the ON and OFF state.

When both markers are in use successive operations of the key will cause the function to interchange between the two markers and the OFF state, the display being annotated appropriately. At all times the horizontal movement of the marker is limited to the display graticule area.

para. 111 (continued)

FREQ COUNT
Successive operation of this key causes the function to interchange between the ON and OFF states, the green indicator light showing the ON state.

In the ON state this mode permits marker measurement of frequency to a resolution of ±10 kHz on spans greater than 200 kHz/div., ±1 Hz on spans less than 200 Hz/div. and to ±100 Hz for all other spans. Certain restrictions are applicable however - refer to Performance data, Chap. 1. The desired spectral line is identified by placing the displayed marker on it, and providing this position is 20 dB or more out of the noise the frequency at that point is measured and displayed in Zone 3 line 1, as detailed previously. The annotation 'Freq count' appears in Zone 4 line 1 when this function is selected.

RES 1 Hz (2ND FUNCT then FREQ COUNT)
This is similar to the above mode with the exception that the resultant measurement is displayed at 1 Hz resolution. The annotation 'Res 1 Hz' appears in Zone 4 line 1.

PEAK FIND
This mode is operative when the horizontal scale FULL SPAN, /DIV, or LOG keys are in use. Upon selection MKR 1 moves to the peak of the largest spectral line on the currently selected display. If PEAK FIND is pressed when MKR 1 is OFF, then A B SELECT 'A' and MKR 1 are automatically selected. When 2ND FUNC then PEAK FIND are pressed MKR 1 moves to the peak of the next largest spectral line. This feature is repeated for each successive operation of these two keys to a maximum of nine peaks.

MKR 1 SETS - REF LEVEL
This function operates only in the dB modes (dBm, dBV, dBmV, dBµV, dB) when MKR 1 is ON. When the key is pressed the operating reference level is changed to that indicated by the marker and the marker is automatically repositioned to the top of the display. If SIG TRACK mode is operational it must be re-instated after using this function.

MKR 1 SETS - REF FREQ
This key is operative only when MKR 1 is ON and the horizontal scale is set to FULL SPAN or /DIV. When pressed the reference frequency is changed to that frequency indicated by the marker. In the /DIV mode the new reference frequency and marker moves to the selected left hand, right hand or centre reference point, the display moving accordingly. If horizontal scale FULL SPAN is selected, the dashed vertical line is moved on the display to the new reference frequency indicated by the marker.

MKR 1 SETS - INC FREQ
With MKR 1 ON, and horizontal scale FULL SPAN or /DIV selected, when this key is operated the incremental frequency memory is loaded with the value of the frequency of MKR 1. The incremental frequency display annotation is changed accordingly (refer to the INC FREQ control for further information).

ΔF SETS - INC FREQ
Markers 1 and 2 must both be ON in this mode. Operation is similar to that above except that the frequency difference between marker 1 and marker 2 is loaded into the incremental frequency memory.

para. 111 (continued)

[35] TRACK GEN
Operation of this key causes the tracking generator to be switched ON and OFF, a green light showing the ON condition. The output of the tracking generator is initially fixed at -10 dBm the range of frequencies swept being dependent upon the setting of the horizontal scale controls. More usually however, the level would be that set previously by means of the keypad (refer to SET TG). The amber key light is reserved for future offset tracking use.

SET TG
When the 2ND FUNCT key followed by the REF LEVEL key is operated the message 'TG level=' is displayed on the screen and the tracking generator output can be varied from -9.7 dBm to -20.3 dBm in 0.1 dBm intervals using the DATA keypad. The selected output level is displayed on the screen for two seconds after the terminator is pressed. Any unterminated keypad entry may be cancelled by repeated operations of the DELETE key.

Note that even if the tracking generator has not been switched ON, entering a TG level will automatically set it into operation.

[36] SELECT & PRESET (coloured green)
Pressing this key selects that particular lower unit and the following controls become active :

VERTICAL SCALE
AB SELECT in 'A' state, 10 dB/div. AUTO (RF ATTEN),

HORIZONTAL SCALE
/DIV, NORM (SWEEP MODE), IDENTIFY REFRESH, AUTO TRIG, AUTO (FILTER BANDWIDTH)
AUTO (SWEEP TIME), AUTO (VIDEO BANDWIDTH)

DISPLAY
VIEW A (in line draw state), GRAT

FUNCTION/DATA
HORIZ POSN in centre reference state

All other keys are OFF and marker functions are cleared down. The tracking generator although switched OFF remains ready for use at -10 dBm (refer to [35]). Keys becoming active upon operation of SELECT & PRESET have green lettering.

The following 'initial states' are set:

Vertical scale units to dBm

REF LEVEL	0 dBm
REF FREQ	200 MHz
INC FREQ	10% of SPAN
SPAN/DIV	40 MHz/div.

Volts/div. sensitivity to 50 mV/div. (500 mV top of scale)

A green indicating light shows when the SELECT & PRESET key is in its operated state.

TABLE 2 HIDDEN 2ND FUNCTIONS

Hidden function	Location (Fig. 31)	KEYS 2ND FUNCT and:
Minor graticule lines OFF/ON	1	SAVE A
Status information	23	RECALL
Overload simulation	25	REF LEVEL ↑
Overload inhibit	26	RF ATTEN ↑
-ve edge trigger	30	TRIGGER SOURCE

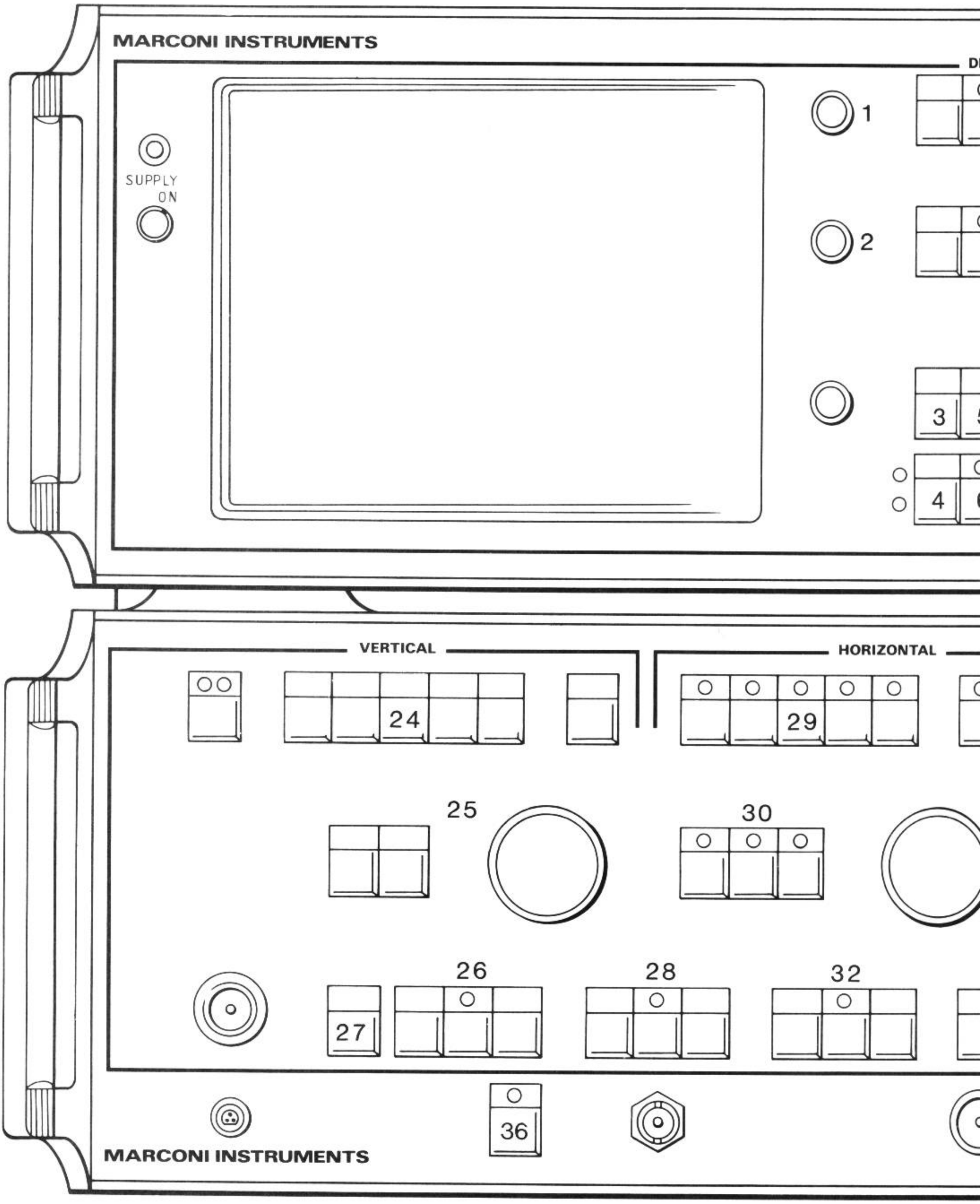
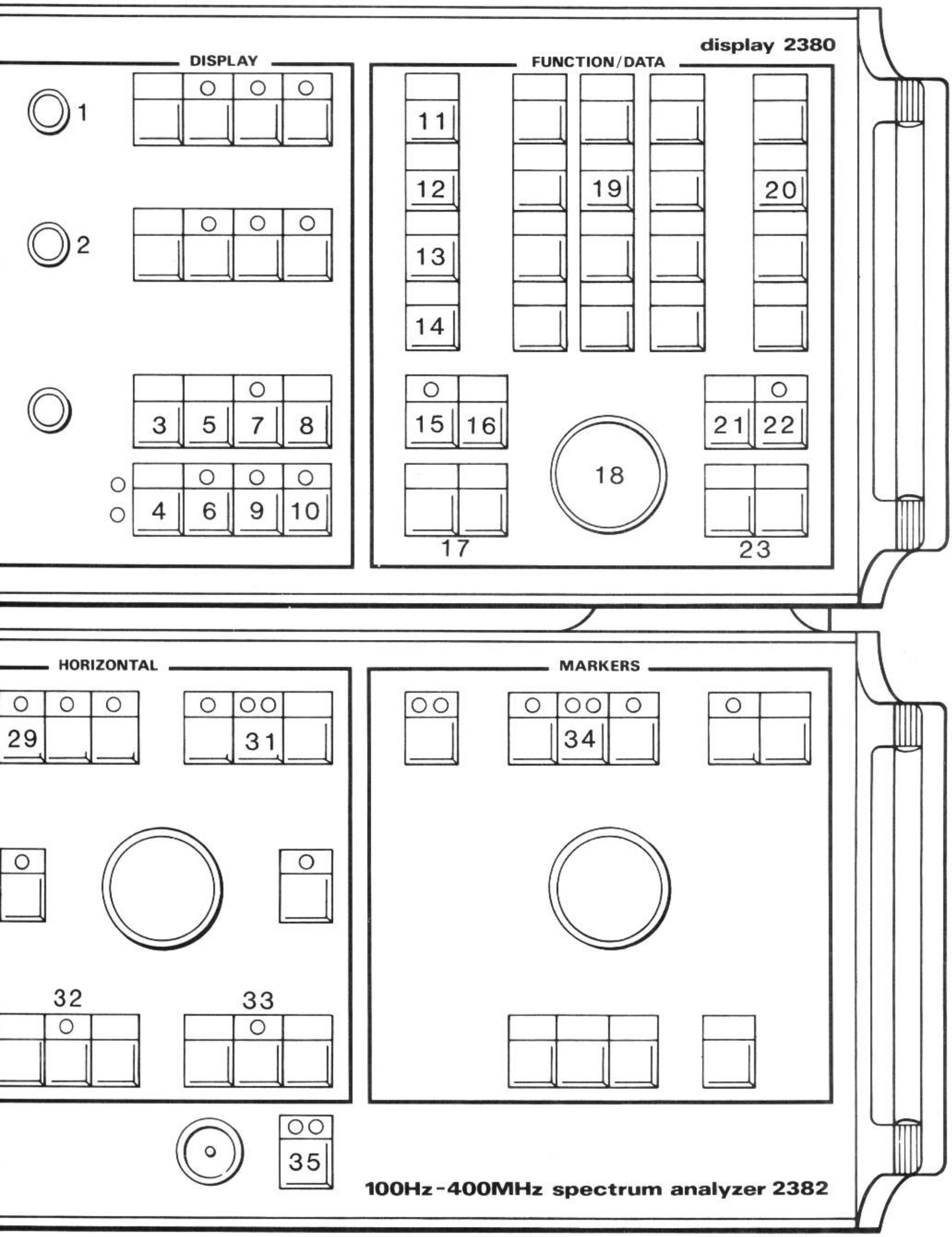


Fig. 31

Fig. 31 Front panel control 1



ont panel control locations.

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Chapter 4-1

BRIEF TECHNICAL DESCRIPTION

CONTENTS

INTRODUCTION

1. The following brief description should be read in conjunction with the appropriate diagrams in this chapter. A detailed description is given in the H 52382-900A Vol. 2 and H 52380-900E Service Manuals.

2. The 2382/2380 Spectrum Analyzer comprises a lower unit (2382) containing r.f. signal processing plus an upper unit (2380) containing the display and power supply. Communication is via a two-way serial 9600 baud 20 mA current loop for housekeeping data and a one-way high speed serial link for the display data. The upper unit's power supply will power up to two lower units with only one selected at any one time. The lower unit is internally wired to be self-addressing and it may be controlled via the front panel or remotely via a single GPIB socket.

CIRCUIT SUMMARY

Signal path, data conversion and tracking generator

3. The 2382 RF unit has an integral tracking generator and forms with Display unit 2380 a swept tuned spectrum analyzer covering the range 100 Hz to 400 MHz. A block schematic of the 2382 is shown in Fig. 1. With reference to

this diagram, the signal to be measured enters via the overload protection circuit. This is a latched change-over relay which is tripped out by any signals over 0.5 W and protects for overloads of up to 50 W. An appropriate annotation is displayed on the screen that this has occurred, and the tripped condition remains until it is cleared by means of a front panel key.

4. The signal is then processed via a conventional up-down multi-stage superheterodyne configuration using a chain of phase coherent oscillators derived by phase locked loop synthesis techniques from the basic 10 MHz reference frequency oscillator. An additional phase coherent oscillator at 47.4 MHz provides the source signal for the tracking generator facility. This signal is frequency translated in a reverse, but otherwise identical, manner to the input signal by means of the second and first local oscillators.

5. The tracking generator signal is amplified by a broad band amplifier and amplitude levelled by an overall a.g.c. loop and is then available for use internally for system calibration via an internal change-over switch, or externally as the stimulus for passive or active frequency domain network analysis.

6. After frequency translation, the input signal is resolved by either a switched bandwidth LC filter, or a switched bandwidth crystal filter, both at 2.6 MHz, depending on the bandwidth required. Bandwidths of 30 Hz and below require the signal to undergo a further down-up frequency translation to 100 kHz to ensure that the filter shape will be sensibly independent of ambient temperature.

7. The translated, filtered input signal is applied to a switched gain logarithmic amplifier system. This switches in extremely accurate attenuator sections to keep the output signal within a 12.8 dB range for an input variation of 89.6 dB. The seven possible values of attenuation needed to achieve this form a 3-bit code to indicate the instantaneous status of this setting. The remaining 12.8 dB of output is detected and A-D converted to an 11-bit word which is processed by a log/lin law PROM and overlapped with the previously mentioned 3-bits of data to form a 13-bit word describing the instantaneous signal level to a resolution of 0.025 dB in a dynamic range of 102.4 dB. A linear data table in the PROM is selected when the 'Volts' display mode is in use.

8. The trigger circuit can select either an internal, external or supply frequency source. The output triggers the sweep start for both frequency and time displays. This facility is essential on the 'Zero Span' mode where the demodulated signal is displayed instead of the frequency spectrum.

9. Finally, the 13-bit word is parallel-to-serial converted and transmitted to the display unit via a single lead at a 2.5 MHz bit rate. A sync out signal is also fed to the upper unit to synchronize the upper unit serial-to-parallel converter.

Microprocessor and control

10. The 2382 front panel controls and the serial link to the 2380 upper unit are serviced via microprocessor interrupt procedures organized by a software Real Time Executive residing in the main program. All system switching, control and flag reads are done via a two-way buffer on the microprocessor bus. In this way, the bus wiring in the receiver area is free from the

continuous data train of pulses on the normal microprocessor bus thus reducing the possibility of interference to the analogue circuits.

Synthesizer

11. This is a major sub-system of the 2382 and comprises three master varactor controlled oscillators (see Fig. 2) whose outputs are offset one from the other by linking them via two slave varactor controlled oscillators in a phase locked loop configuration.

HF master oscillator

12. This covers the range 530 to 938 MHz and is swept for spans of 5 MHz to 400 MHz, or locked at 5 MHz intervals anywhere over this band. Its output is divided by 64 to enable a counter to monitor its frequency.

LF master oscillator

13. This covers the range of 26.9 to 34.1 MHz and can be swept for spans of 50 kHz to 2 MHz or locked at 100 kHz intervals anywhere over this band. Its output is directly counted to monitor its frequency.

HF slave oscillator

14. This oscillator combines with two masters to form a phase locked combination that synthesizes an output frequency range of 498.6 to 906.6 MHz.

Interpolation oscillator

15. This is a very stable free running varactor oscillator covering the range 28.46 to 32.4 MHz. Before being used as the fine offset frequency in the total system, the output is divided by 32 giving an operational range of 124 kHz at an offset frequency of 889 kHz. This oscillator is swept for spans of 100 Hz to 20 kHz and can be set to a final resolution of 1 Hz anywhere over its 124 kHz of range. By counting its output frequency before division, the divided output can be measured to 1 Hz in a counter gate time of 31.25 ms instead of the 1 second gate time required for direct measurement of the output.

LF slave oscillator

16. This oscillator is used to add the output of the interpolation oscillator and the l.f. master oscillator into the other synthesized loop such that the overall system covers the range 502.6 to 902.6 MHz to a resolution of 1 Hz with sweep capability of 100 Hz to 400 MHz spans.

50 MHz VCXO

17. This is a high purity varactor controlled crystal oscillator used, after division, to drive the sampling gates which lock the l.f. and h.f. master oscillators to precise frequencies when they are not being swept. It is locked back to the 10 MHz reference frequency standard (either the internal or the external one, if connected) by means of another sampled feedback loop. The 50 MHz oscillator is also used to provide the time base gate period for the counter.

Control voltages

18. The microprocessor system, in conjunction with variable ratio dividers, a digital-to-analogue converter and a tracking integrator, provide a non-linear ramp. This has a magnitude and shape that will produce a linear frequency sweep from the chosen oscillator over the span and reference frequency currently being used.

19. By means of a further microprocessor controlled D/A converter each of the three controlled oscillators is refreshed with its correct tuning voltage during each sweep retrace, the value being retained during the subsequent sweep.

Signal path, display, pen plot and RGB video

20. The serial data input from the 2382 lower unit (para. 9) at the 2.5 MHz bit rate (see Fig. 3) is converted to 16-bit parallel data in the 2380 Display unit and is subjected to a running digital averaging process to simulate the customary video filter. A normal analogue RC network is inappropriate since, due to the inclusion of the high resolution switched gain logarithmic amplifier, no full range detected analogue signal exists anywhere in the system.

21. Since the final stored picture has a resolution of 500 slots across the displayed frequency span, it is necessary to ensure that any spectral responses less than one slot wide do not get missed or attenuated. The Resolution Stretcher is designed to do this whilst at the same time not exaggerating the noise level, as a simple peak hold circuit would do.

22. The processed data word is now transferred under Direct Memory Access (DMA) control to RAM space dedicated as Input Store or Error Store depending on whether the current sweep is a measurement scan or a calibration scan. The data in these two stores is now selectively subtracted (the data space in the Error Store permits correction over the range 100 Hz to 400 MHz) and loaded into the appropriate dedicated RAM spaces known as A Store and B Store under microprocessor control.

23. Each Display Store shift register contains 500 bytes representing the data for the currently displayed image. These data can be used to produce an infilled display or an outlined display depending on the option selected. On the completion of each horizontal scanning line (one complete recirculation of data in the shift register), the Clock Counter generates a DMA request. This results in a DMA transfer of a single display slot of data from the appropriate Display Store to the appropriate shift register. During this transfer the 16-bit word in the Display Store is added to the 16-bit word in the Shift Latch to arrive at the correct vertical display value and is then subject to the correct hardware multiplication to give the selected scaling factor before the 8 bits appropriate to the selected display range are loaded into the recirculating shift register. The output from the shift register is used to produce a solid (infilled) display or is subjected to further line draw processing to produce an outlined display. The resulting signal is then mixed with the graticule and character symbol data before being applied to the video amplifier and thence to the c.r.t.

24. The frequency graticule data and marker data are similarly refreshed, two bits being used for Graticule brightness information and two bits being used for Steady or Flashing Markers.

25. The c.r.t. controller chip organizes the display drive waveforms and also drives the character generator EPROM to annotate the graticule and display mode status information. The first character of each line is used as a control character and is suppressed, decoded and used to generate the amplitude graticule. Thus the graticule for both axes is under microprocessor control and may draw in any type of ruling to suit the needs of the display.

26. An optional board supplies the drives for the x and y axes of a pen recorder, as well as RGB outputs for use with a colour monitor and a composite video output for a monochrome monitor. A beeper is also included on the board to warn against certain conditions.

Processor and control

27. The 2380 front panel controls are serviced via microprocessor interrupt procedures. Additionally, the processor shares the data and address buses with a DMA controller to allow direct memory access to selected peripherals. Housekeeping data between the processor and the RF unit is conveyed by the 20 mA current loop. The GPIB interface housed in the Display unit allows the spectrum analyzer to form part of a system acting under the direction of a controller.

Power supply

28. Besides powering the Display unit, the power supply can supply one r.f. unit on full power and a second on standby power. The switched mode power supply controller operates in synchronism with the associated r.f. unit's frequency standard. The controller shorts down to provide protection against overload, overvoltage or overheat conditions while rear panel lights illuminate to warn of overvoltage, undervoltage and overload as well as to indicate when no r.f. unit is connected.

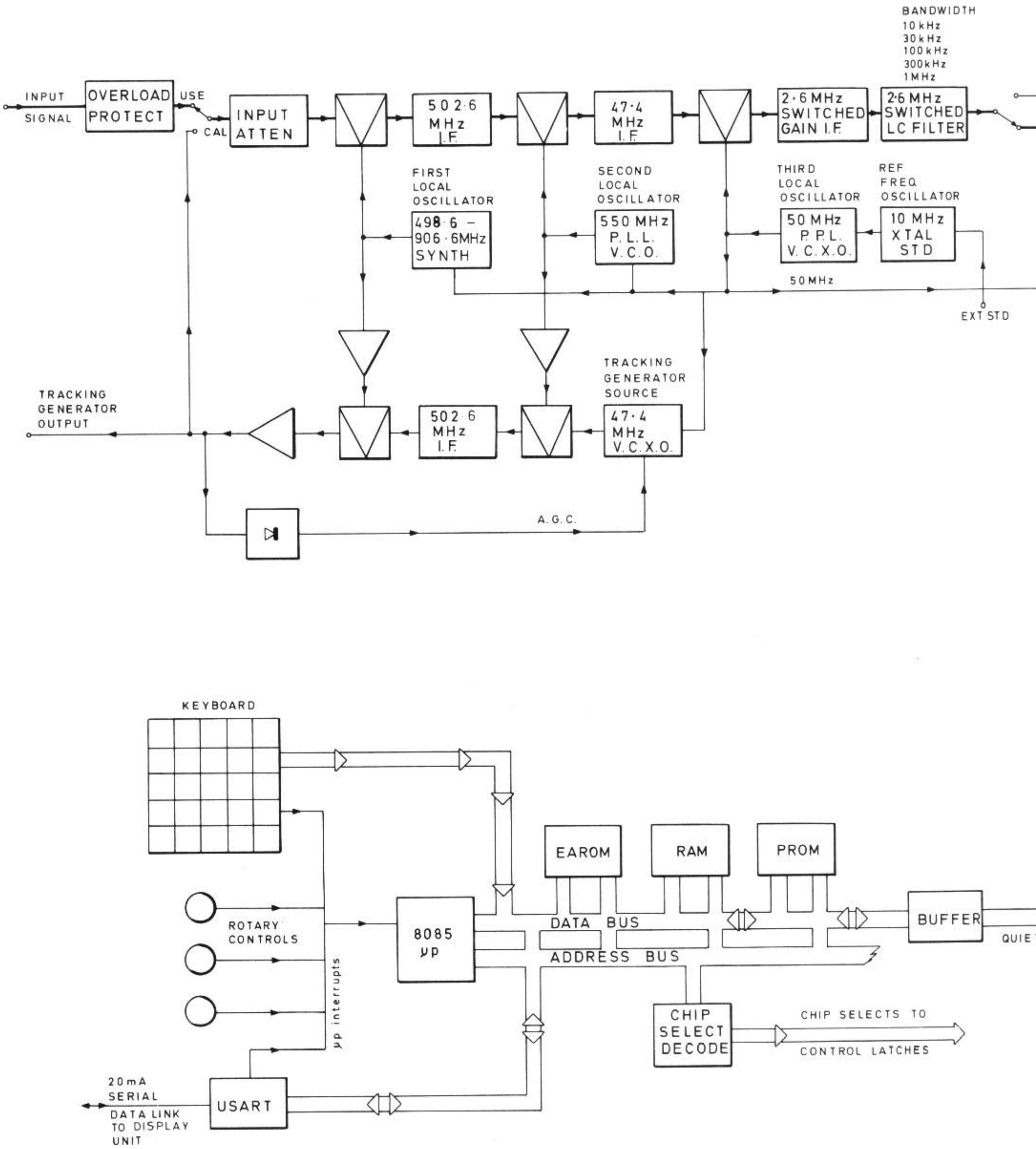

Fig. 1 Block

Fig. 1

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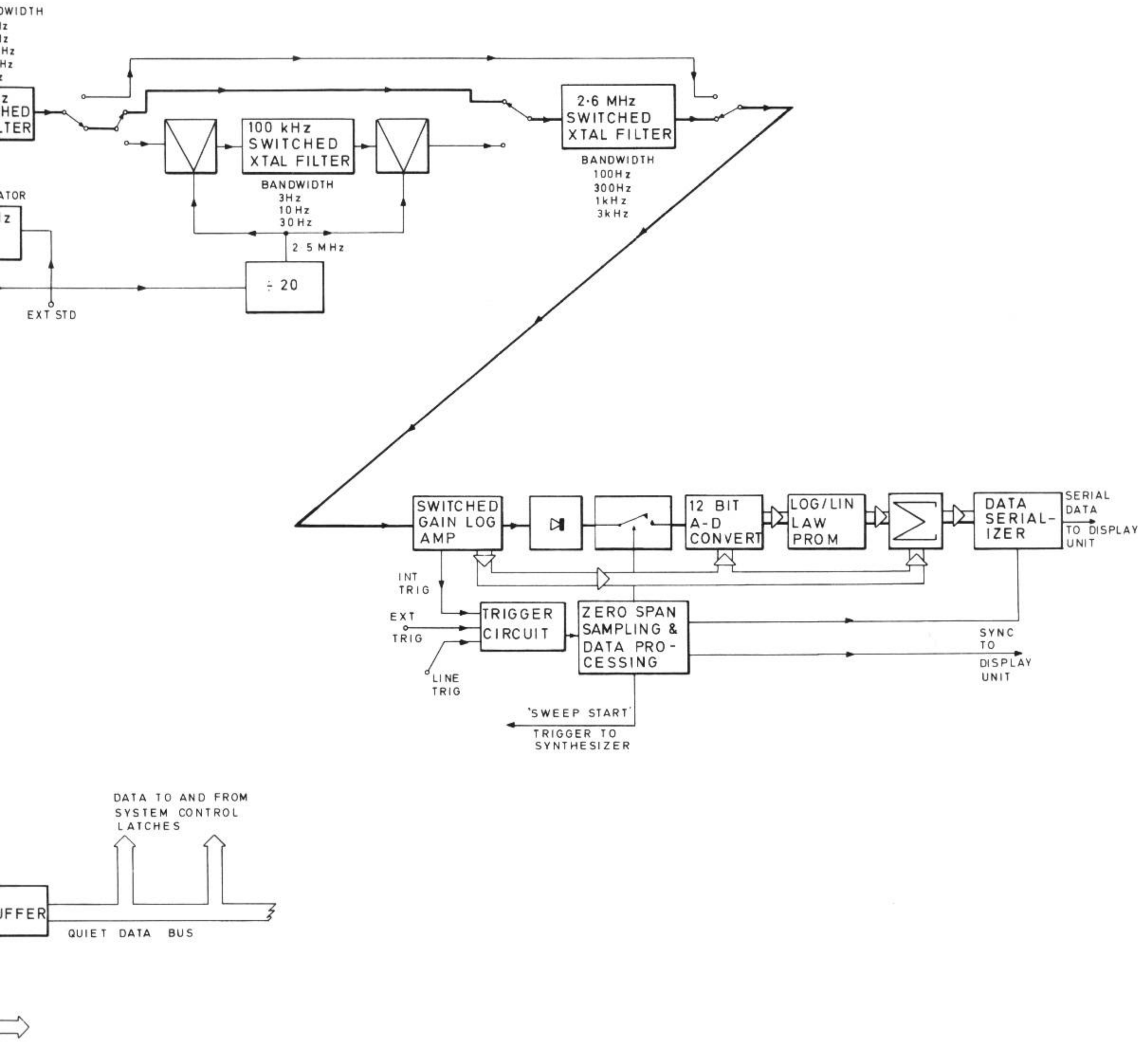

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Block schematic of 2382 system

Fig. 1
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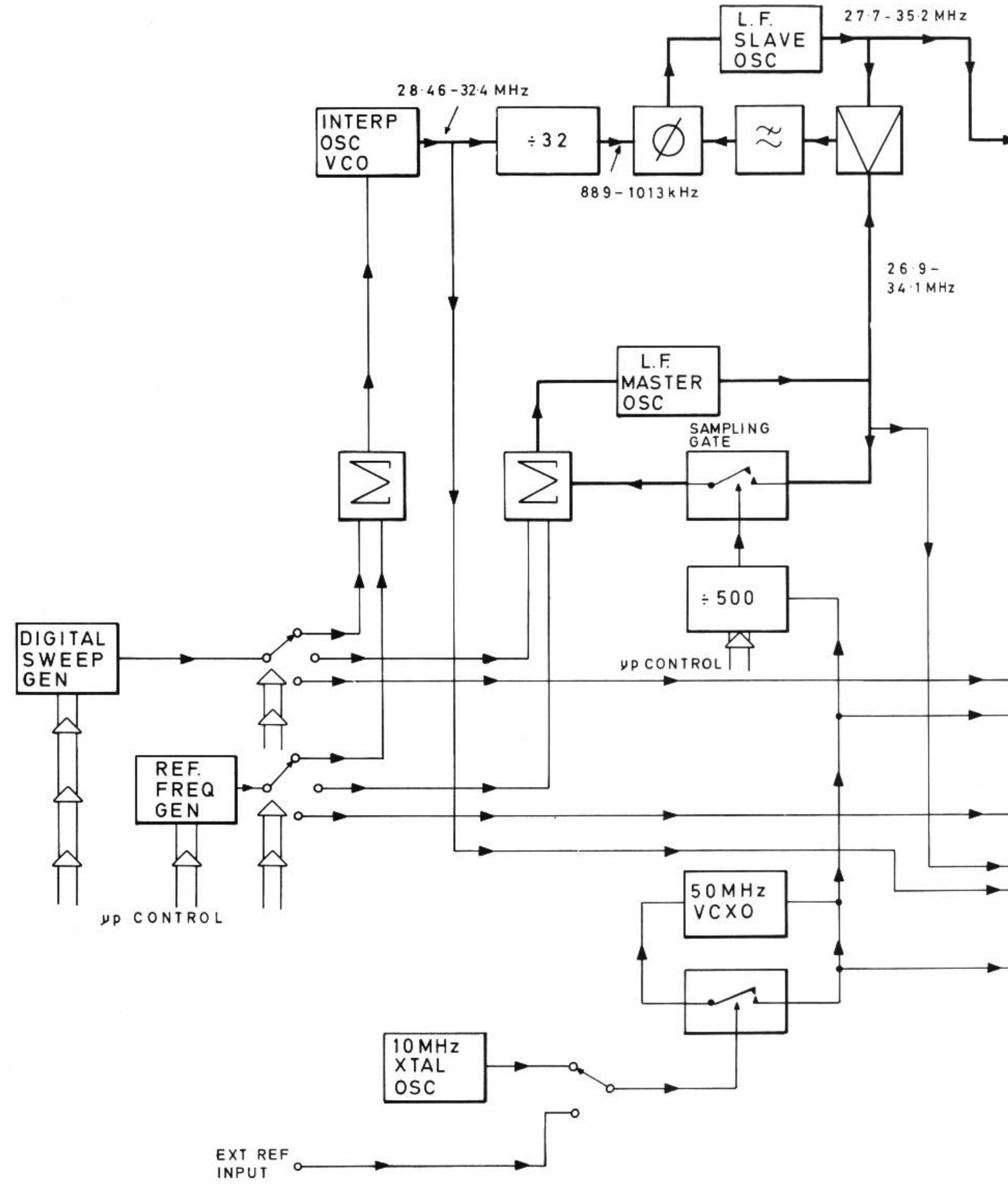

Fig. 2

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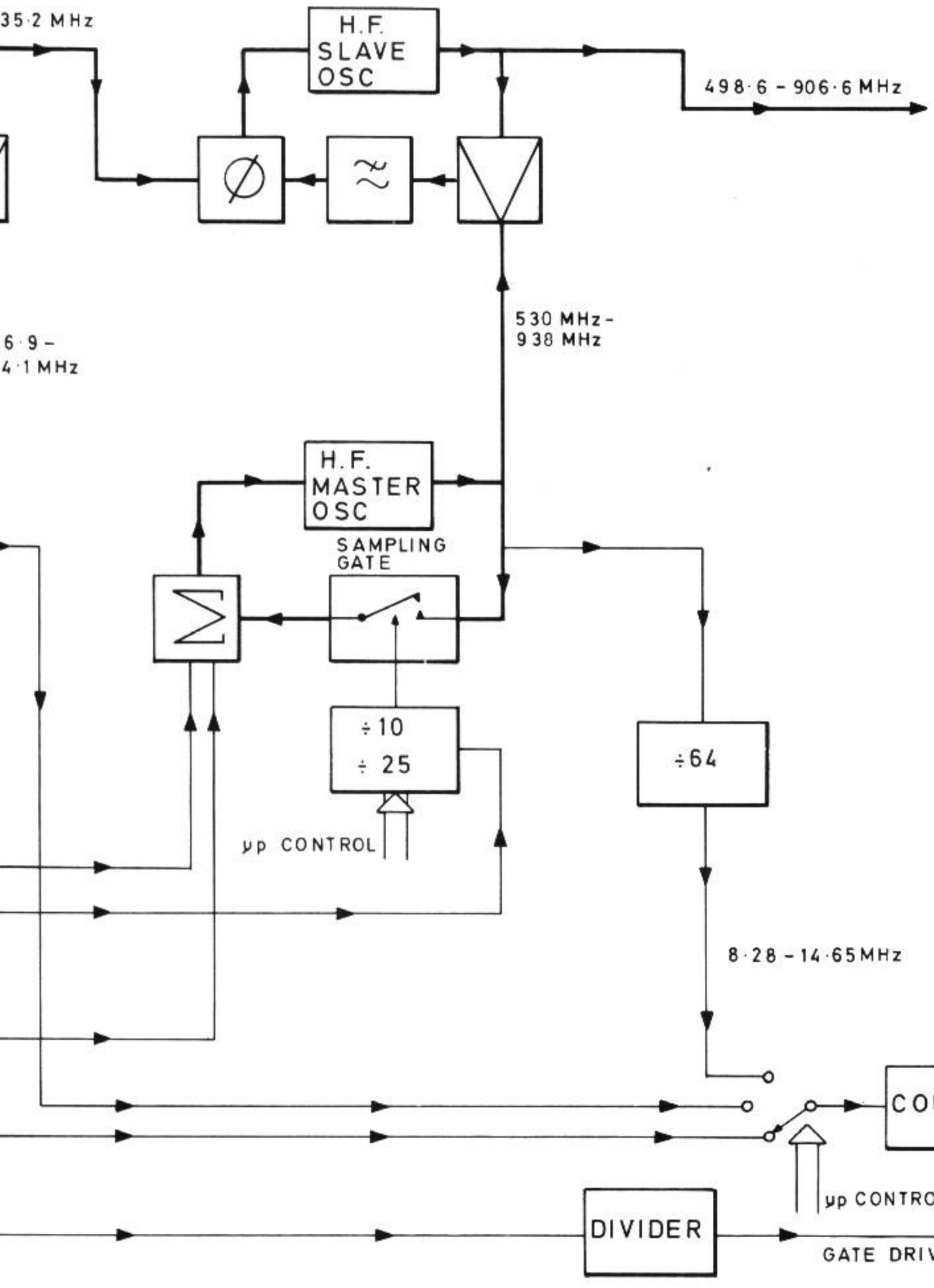
Fig. 2 Block schematic



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chematic of 2382 synthesizer

Fig. 2
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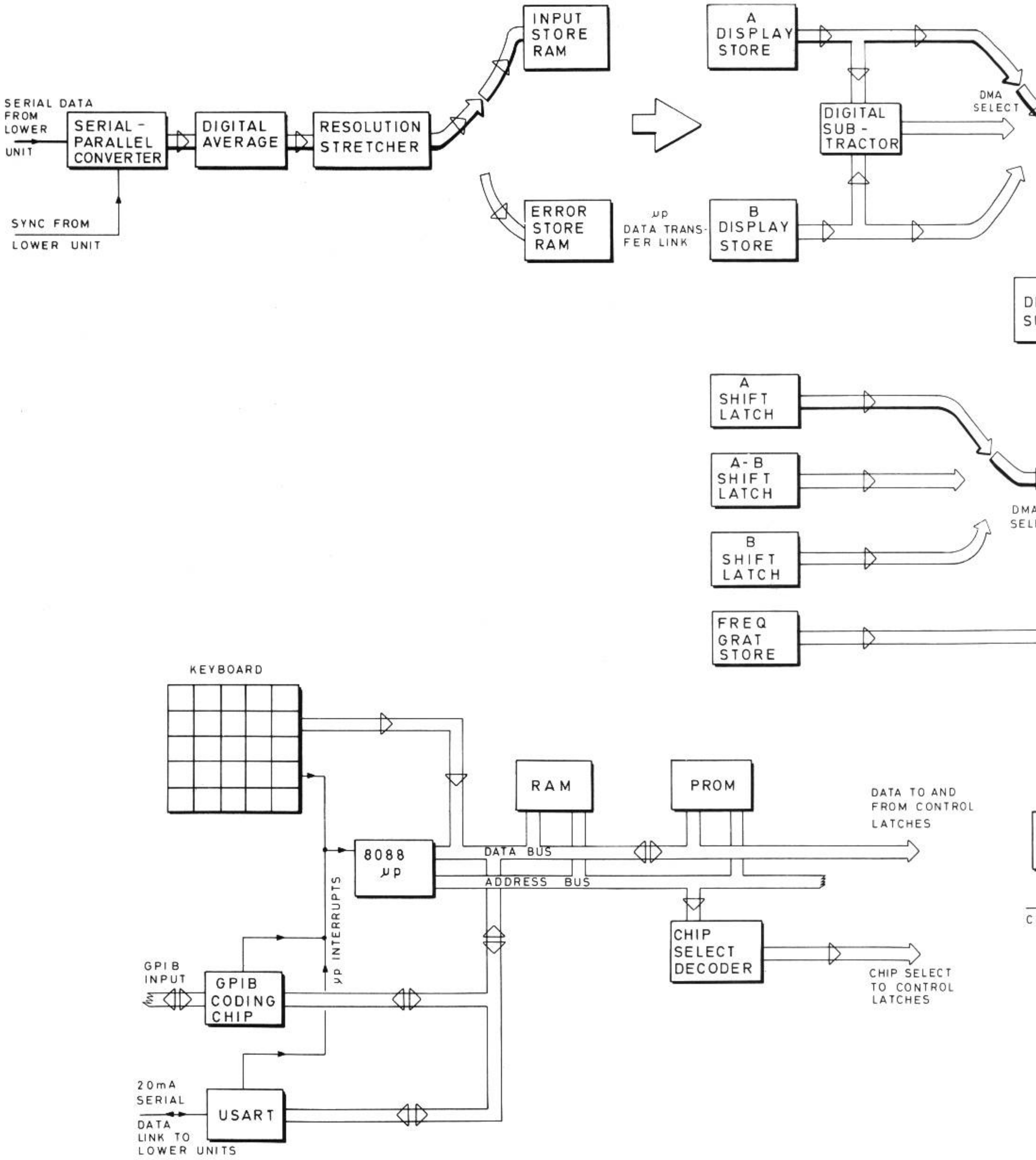

Fig. 3

Fig. 3 Block schemati

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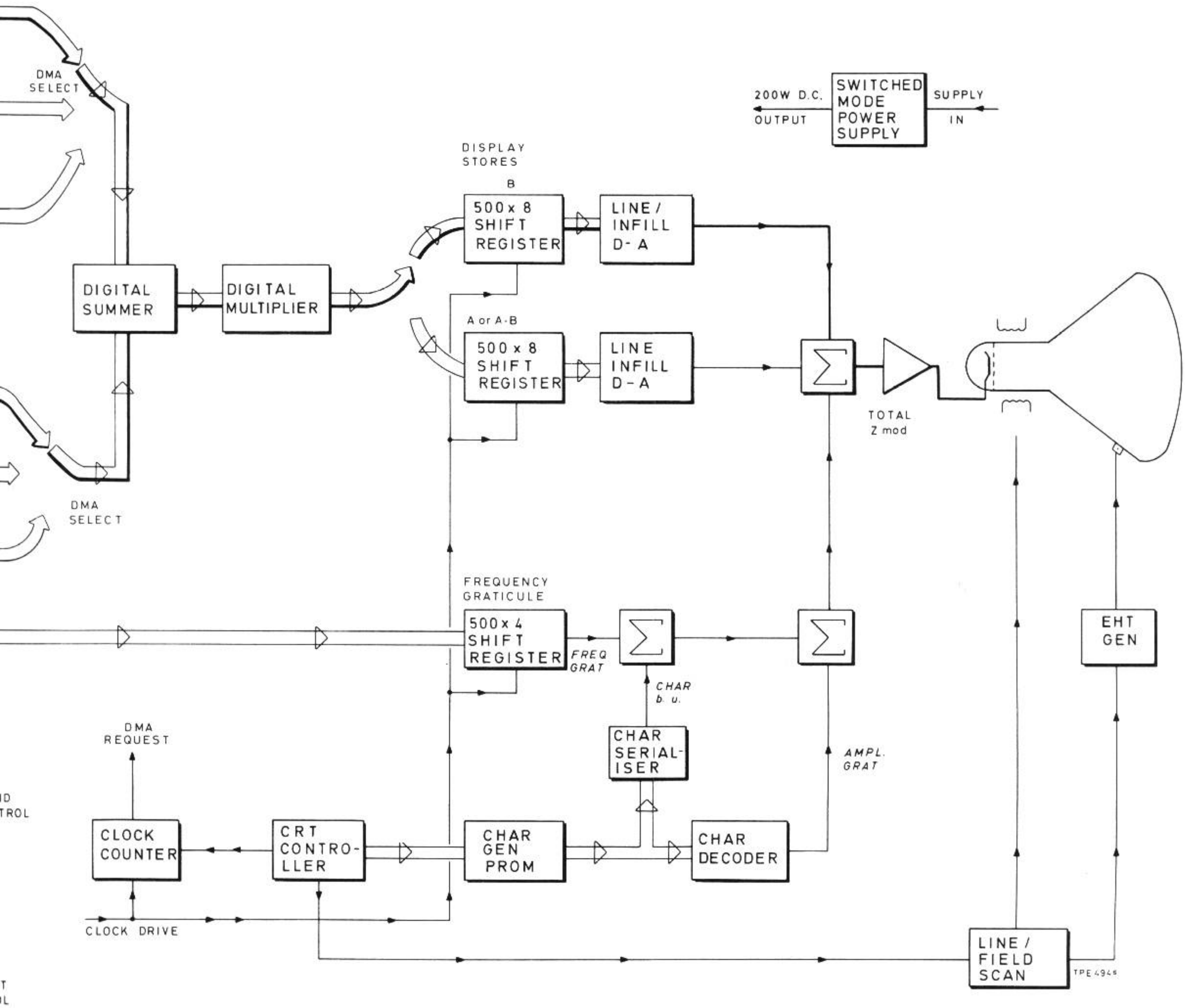

schematic of 2380 system

Fig. 3
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2382/2380

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Printed in England