ROHDE&SCHWARZ

EC Certificate of Conformity

(to EMC Directive 89/336/EEC)

CE

This is to certify that

Waveform Synthesizer

ADS

1012.4002.02

(equipment, type, designation)

complies with the provisions of the Directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 89/336/EEC).

This declaration of conformity of the European Communities is the result of an examination carried out by the quality assurance of **ROHDE & SCHWARZ** in accordance with European Standards EN 50081-1 and EN 50082-1, as laid down in Article 10 of the Directive.

ROHDE & SCHWARZ
GmbH & Co. KG

Contents

1.2 General Overview of the Synthesis Capabilities of the ADS

The DUAL ARBITRARY WAVEFORM GENERATOR ADS features two independently programmable digital synthesis channels. Due to its innovative circuit design, the ADS serves both for generating fully-arbitrary waveforms and for digital synthesis of the standard signal waveforms sine and triangle. The ADS thus offers high performance features extending far beyond those of the regular ARB generators.

Specified in detail, the circuit design of the ADS allows you to generate the following signals on both channels:

- arbitrary waveforms (mode ARB) with a length of up to 64-K samples at 12-bit amplitude resolution as sequences of four ARB waveforms which are each 16-K samples long
- sequences of ARBitrary waveforms with individually programmable repetition rate and read clock rate for each signal
- sine wave signals with high spectral purity and fine frequency resolution covering 0.1 Hz to 5 MHz
- triangular wave output signals with high linearity with frequency coverage from 0.1 Hz to 100 kHz
- phase-continuous, internally or externally controlled linear or logarithmic sweeps with high sweep rates
- user-programmable (ARB) sweeps with up to 8191 individual frequencies
- user-programmable phase sweeps.

Special features offered by the ADS are:

Internal or external clock

The synthesis clock of the ADS can be generated by the internal clock generator or can be applied separately for each channel from an external source. With internal clocking of the channel, the signal of the clock generator is available at the respective CLK socket.

Optionally, the ADS can be fitted with the Clock Generator ADS-B1, a high-resolution clock synthesizer.

Triggered operating modes, internal trigger generator

In addition to the continuous generation of periodic signals, the ADS also permits to control the signal curve by an internal, external or manual trigger on both synthesis channels. The trigger source is selected individually for each synthesis channel.

The ADS-internal trigger generator can be individually programmed in period and symmetry with crystal accuracy. It provides a signal that is always available at the TRIGGER connector of the respective synthesizer channel when the internal trigger source is selected, irrespective of which operating MODE is currently selected for this channel.

Easy-to-use editors

For simple, but efficient control, the operation of the ADS is based on a menu-structured concept. This allows you to create and modify ARB signals, composite ARB signal sequences and user-programmable (ARB) sweeps simply and conveniently also using the front-panel keyboard.

Exceptional storage capabilities

The advanced storage management in the ADS permits to have up to 100 different ARB sweeps, ARB signals and composite ARB signal sequences readily stored for one of the two channels for immediate availability to the user.

Another powerful feature available in the ADS is the additional storage medium, the Memory Card. This allows you to archive the complete memory contents and thus create individual and application-specific waveform libraries.

1.3 Digital Synthesis Techniques Used in the ADS

The output signals delivered by the ADS on both channels are produced using digital synthesis techniques.

The signal to be generated is stored in a programmable waveform memory in the form of time-equidistant sampling points of a cycle. The analog output signal is produced by way of digital/analog conversion of the numeric sampling values, which are periodically read from the waveform memory.

Fully-arbitrary signal waveforms can thus be generated by reprogramming of the waveform memory.

The frequency of the generated signal can be adjusted by variation of the synthesis clock. The clock signal can be provided by an internal clock generator or also be fed into the generator by an external clock source.

A digital address generator serves for addressing the waveform memory. The addressing sequence can be influenced by an internal, external or manual trigger signal. Various triggered MODEs can in this way be implemented.

Programmable control of the address generator permits to generate sequences of the signal waveforms stored in various memory areas of the 64-Kpoint waveform memory. Each signal waveform selected in the course of the sequence can be individually programmed as to the number of periods to be output and its read clock.

For spectral forming of the output signal of the D/A converter, optionally one of six analog low-pass filters may be selected.

The series-connected output amplifier provides an output voltage of maximally 10 V_{PP} into 50 Ω.

For setting the level of the output signal, a mechanically switched attenuator (in steps of 6 dB) is provided, functioning in conjunction with an electronic level setter. For non-interrupting level setting, also electronic setting circuits are available as alternative, which can be optionally used for external level control.

Independent of the level setting selected, an adjustable dc offset voltage of up to ± 5 V can be superimposed on the output signal.

1.4 ADS Block Diagram

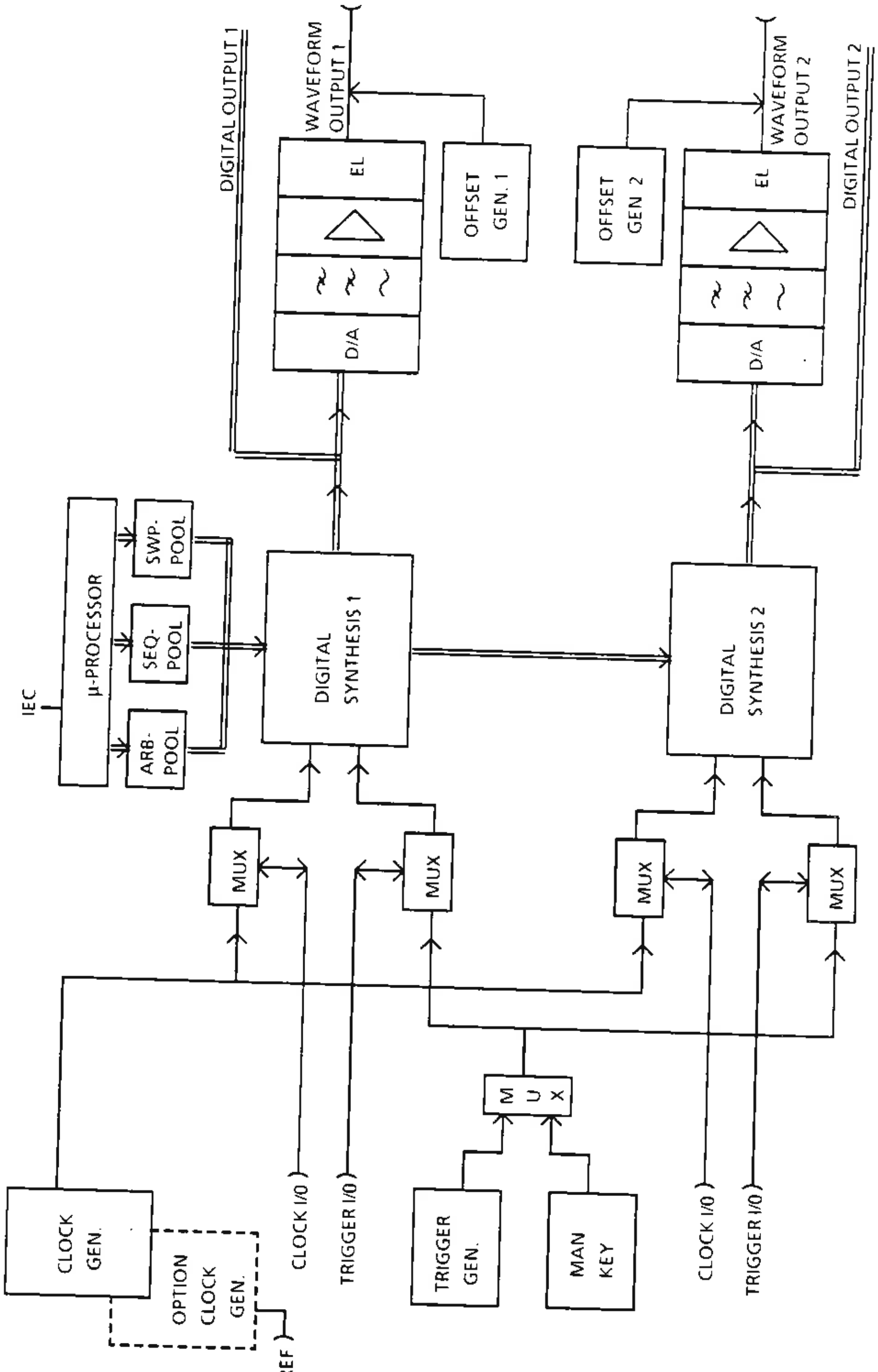


Fig. 1-1

2 Preparations for Use

2.1 Initial Start-up

The DUAL ARBITRARY WAVEFORM GENERATOR ADS is designed for operation from ac supply systems of different nominal voltages.

Prior to starting up the instrument, first make sure that it is set to the correct ac-operating voltage for the respective place of operation. If this is not the case, the ac voltage setting of the ADS must be adjusted correspondingly before start-up. Please refer to Section 2.2 for further information.

Particularly insure that the air vent holes are never covered so that sufficient cooling is always provided.

Also, the DUAL ARBITRARY WAVEFORM GENERATOR ADS is designed for operation at ambient temperatures of 0 to 55 °C.

Moisture condensation should be prevented. Once the instrument has become wet, it must be dried out before it is switched on.

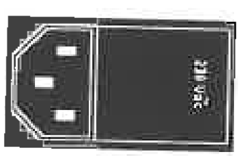
2.2 Power Supply

The ADS can be operated from ac supply voltages of 100 V, 120 V, 220 V and 230 V and line frequencies between 47 and 440 Hz.

Upon delivery, the instrument is factory-set to 220 V.

The required rated voltage for the respective place of operation can be selected easily without opening the instrument:

- Disconnect the power cable.
- Lift off the cover of the voltage selector [22][1] at the rear of the instrument using a screwdriver.



[1] *The figures in square brackets refer to the operating controls of the front panel and rear panel views 3-1 and 3-2.*

- Remove the coding cylinder then accessible and reinsert it such that the required voltage value is visible from outside.
- If required, lift off the fuse holders marked by arrows, insert an appropriate fuse according to the specification given below and reinsert the holder.
- Firmly close the cover.
- Check if the required voltage value can be read outside in the cover window.

Fuses required:

Selected ac voltage	Required type of fuse
100 V	IEC 127-2/3 T4L/250V
120 V	IEC 127-2/3 T4L/250V
220 V	IEC 127-2/3 T2L/250V
230 V	IEC 127-2/3 T2L/250V

Also note the following tolerances for selecting the required ac-operating voltage:

ac voltage	Tolerance	Specified range
100 V	-10% , +15%	90 to 115 V
120 V	-15% , +10%	102 to 132 V
220 V	-15% , +10%	187 to 242 V
230 V	-10% , +15%	207 to 264 V

The pertinent regulations according to VDE or IEC must be observed.

2.3 Rack Mounting

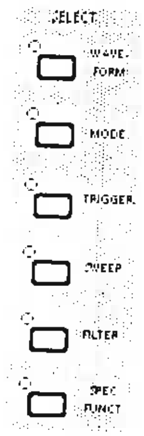
The instrument can be easily fitted into any 19" rack using the Rack Mount Adapter ZZA-94 (order number 396.4905.00). Fitting instructions are included with the adapter.

3 Operating Instructions

3.1 Legend to Front and Rear Panel Views

The front panel of the DUAL ARBITRARY WAVEFORM GENERATOR ADS is clearly arranged in the following function units (cf. Fig. 3-1):

1 Keypad SELECT



The keypad SELECT allows to select the main menus. At the touch of one of the six SELECT keys, the MENU keys are assigned functions. The active functions are always shown in the MENU display [3]. Each SELECT key has an LED to indicate which main menu is currently selected.

Meanings of the individual SELECT keys:

WAVEFORM	SELECT key to access the waveform menu → see Section 3.2.7
MODE	SELECT key to access the operating mode menu → see Section 3.2.4
TRIGGER	SELECT key to access the TRIGGER menu → see Section 3.2.5
SWEEP	SELECT key to access the SWEEP menu in sine or triangular operation → see Section 3.2.11
FILTER	SELECT key to access the FILTER menu for selecting the analog output filters → see Section 3.2.6
SPEC FUNCT	Select key to activate special functions → see Section 3.2.12

2 Display

The current instrument setting is shown in display **2**. The waveform in use, the active operating mode, output level, output frequency, etc. are indicated. Since not all setting parameters can be shown at a time in order to save space, always the function values entered last are indicated in the display.

3 MENU Display

The currently active functions assigned to the menu keys are displayed here. Each of the six display windows is assigned to a menu key.

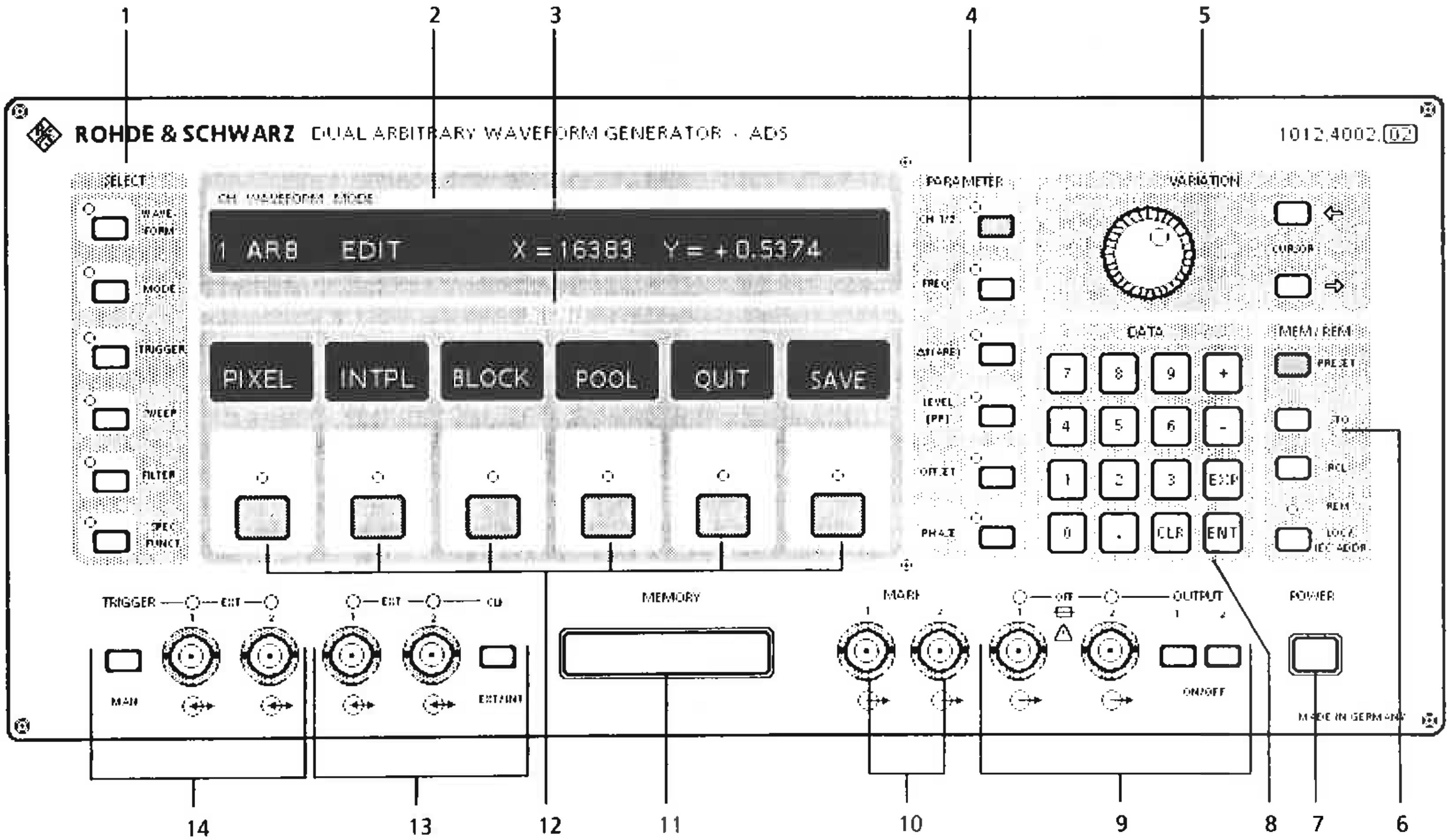
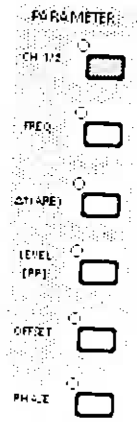


Fig. 3-1 Front panel view

4 Keypad PARAMETER

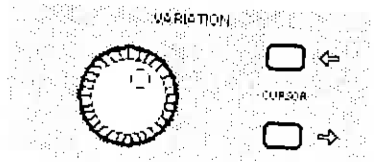


Using the keypad PARAMETER, the most important parameters of the output signal can be selected for display and variation. The LEDs assigned to the input keys indicate that the respective parameter is active and ready for entries.

Meanings of the PARAMETER keys:

CH1/2	Key for channel switchover. By pressing key CH1/2, the channels 1 and 2 can be alternately activated for entries. The number shown on the left of display [2] indicates which channel is active.
FREQ	Key to activate the frequency parameter. This parameter can only be activated in sine and triangular operation (see 3.2.2.3).
ΔT(ARB)	Key to activate the step time ΔT in ARB or SEQ operation.
LEVEL (P-P)	Key to activate the level parameter. The level is displayed in V_{PP} into 50 Ω (see 3.2.2.1).
OFFSET	Key to activate the parameter "dc-offset" (see 3.2.2.2).
PHASE	Key to activate the phase parameter in sine or triangular operation or to synchronize both channels in ARB and SEQ operation (see 3.2.2.5).

5 VARIATION Control Field with Knob and Cursor Keys



The control knob allows for quasi-continuous adjustment of the function value of the active parameter.

The cursor keys can be used to specify which decimal position of the function value is to be varied. The decimal selected for variation is underlined in the display.
→ see Section 3.2.1.3

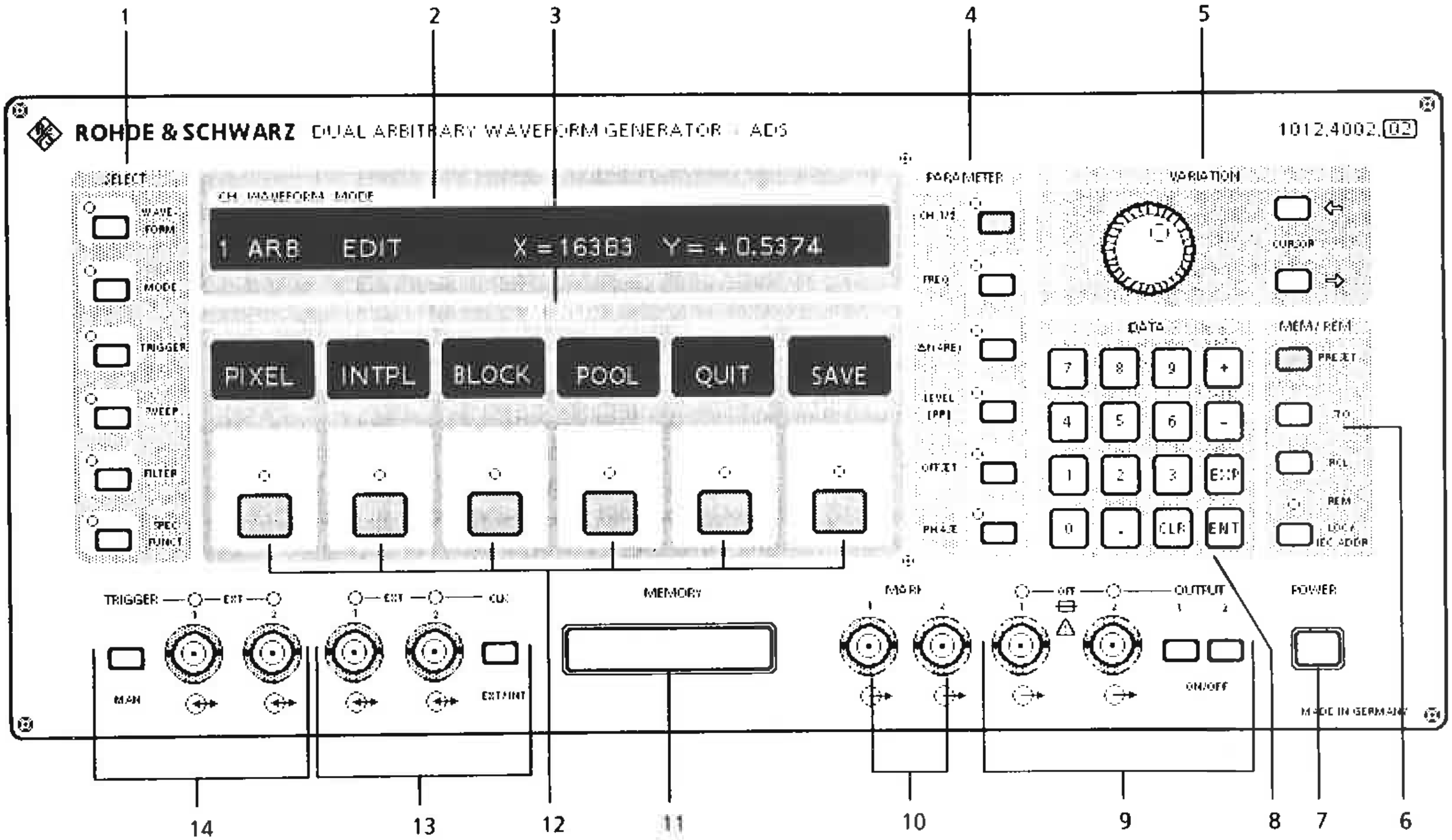
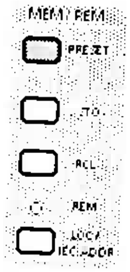


Fig. 3-1 Front panel view

6 Memory / Remote Keys (MEM / REM)



The keys of the Memory / Remote input field have the following functions:

PRESET — Selection of the instrument PRESET state
→ see Section 3.2.1.5

STO — Storing complete front-panel setups
→ see Section 3.2.1.6

RCL — Recalling complete front-panel setups stored in the ADS
→ see Section 3.2.1.6

LOC/IEC ADDR — In REMote state: switchover to LOCal mode
In LOCal state: Activation of IEC bus address
→ see Sections 3.3.1 and 3.3.2

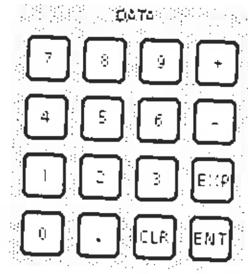
The REM LED indicates that the instrument is set to remote control.

IMPORTANT: If the instrument is set to remote control (REM LED on), entries using the front-panel keyboard can only be made again after the ADS is returned to local control by pressing the LOC key.

7 POWER

Power switch

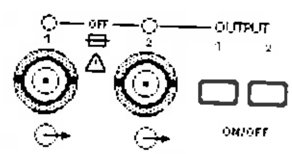
8 DATA Entry Keyboard



Exact numeric function values for the currently active parameter can be entered using the data entry keyboard.

Each input must be acknowledged via the ENT key. A parameter activated for entry is indicated by a lighting LED at the respective entry key in the PARAMETER or MENU keypad.
→ see Section 3.2.1.2

9 OUTPUT



ON/OFF key 1 or 2

Keys for alternate switch-on and switch-off of signal outputs 1 and 2, respectively.

See Section 3.2.12.5 for selection of the internal impedance of the switched-off output.

OFF LED 1 or 2

LED to indicate switch-off state of signal outputs 1 and 2, respectively.

Connectors 1 and 2

Output connectors for channel 1and 2
Output impedance: 50 Ω

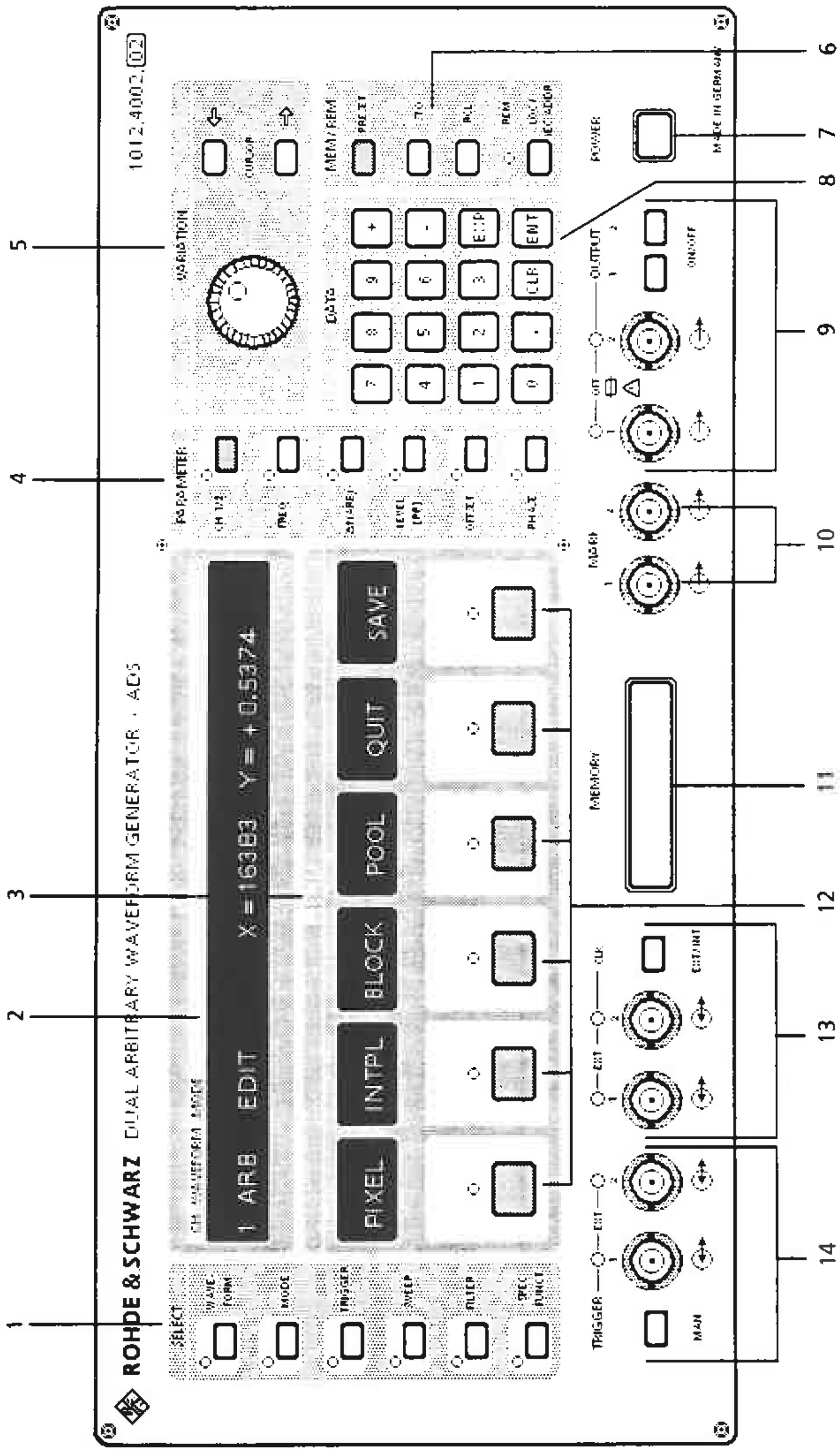
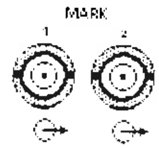


Fig. 3-1 Front panel view

10 MARK 1 or 2



Output connectors for the marker signal of channels 1 and 2, respectively.
Output impedance: 50 Ω
Level: TTL compatible

11 MEMORY

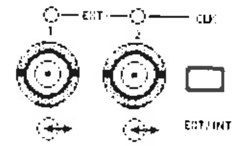
Insert slot for memory card
→ see Section 3.2.12.1

12 Keypad MENU

The keys in keypad MENU are used for selecting functions in the currently active menu.

If a parameter in a menu is selected for subsequent data input, the LED assigned to the respective MENU key lights up.
→ see Section 3.2.2 PARAMETER Entries

13 CLK



Connectors 1 and 2 and EXT LEDs 1 and 2

Female connectors CLK 1and CLK 2 serve as input and output connectors for the internal or an external clock signal of channels 1 and 2, respectively.

For operation with internal clock:
- clock output
- output impedance: 50 Ω
- level: TTL compatible
- EXT LED of CLK 1 or CLK 2 inactive

→ see Section 3.2.3.1

For operation with external clock:
- clock input
- input impedance 50 / 600 Ω
- input comparator threshold 0.2 V
- EXT LED of CLK 1 or CLK 2 active

→ see Sections 3.2.3.3 and 3.2.12.7

EXT/INT key

Key for switching between internal and external clock
→ see Section 3.2.3

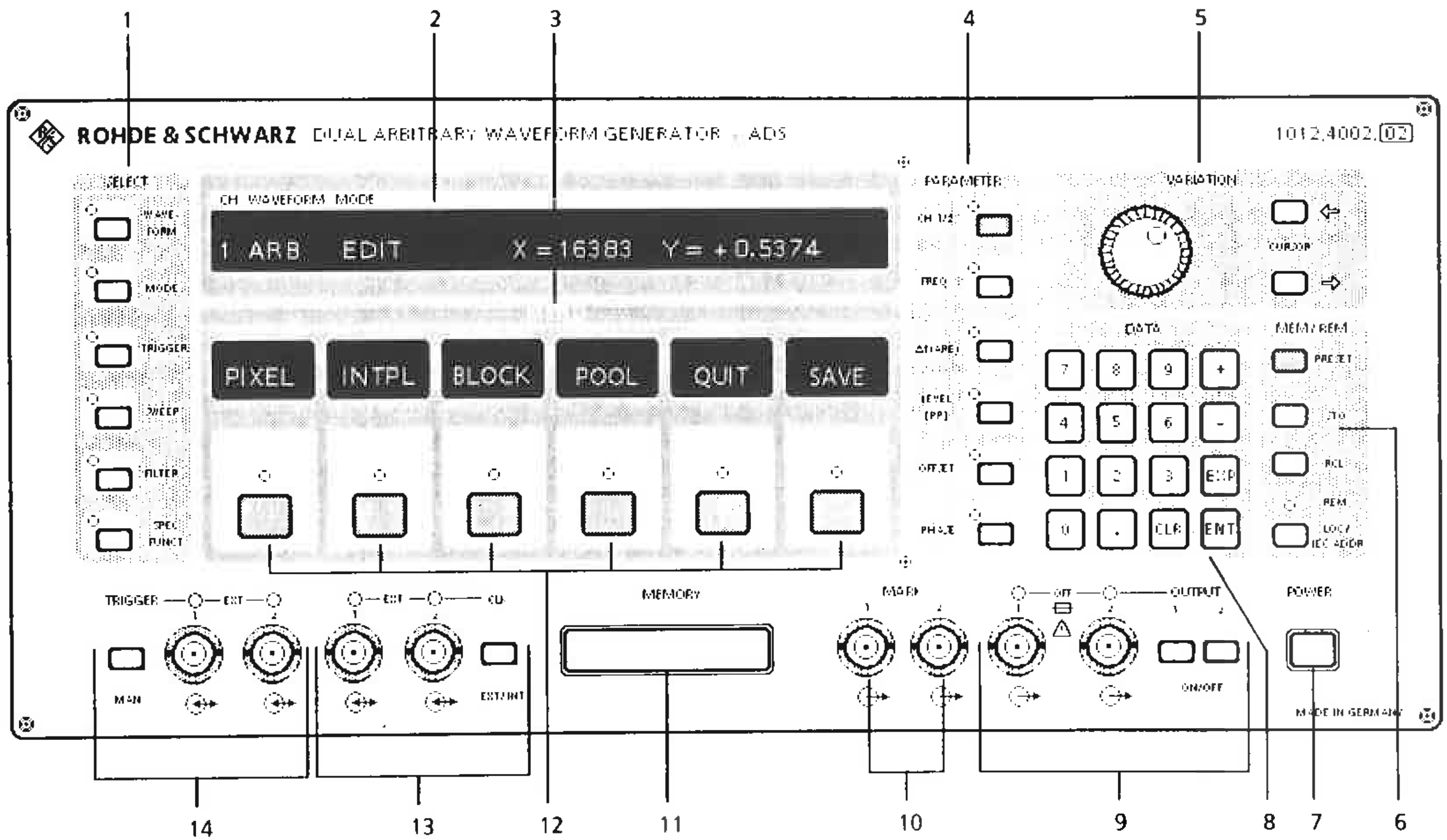
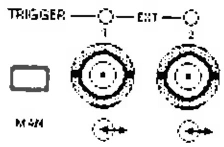


Fig. 3-1 Front panel view



Connectors 1 and 2 and EXT LEDs 1 and 2

Female TRIGGER connectors 1 and 2 serve as input and output connectors for the internal or an external trigger signal of channels 1 and 2, respectively.

TRIGGER : INT, MAN
- output impedance: 50 Ω
- level: TTL compatible
- EXT LED of TRIGGER 1 or TRIGGER 2 inactive

→ see Section 3.2.5.1

TRIGGER : EXT
- trigger input
- input impedance 50 / 600 Ω
- comparator threshold 0.2 V / 2 V
- EXT LED of TRIGGER 1 or TRIGGER 2 active

→ see Section 3.2.5.2

Key MAN

Input key to release a manual trigger signal
→ see Section 3.2.5.3

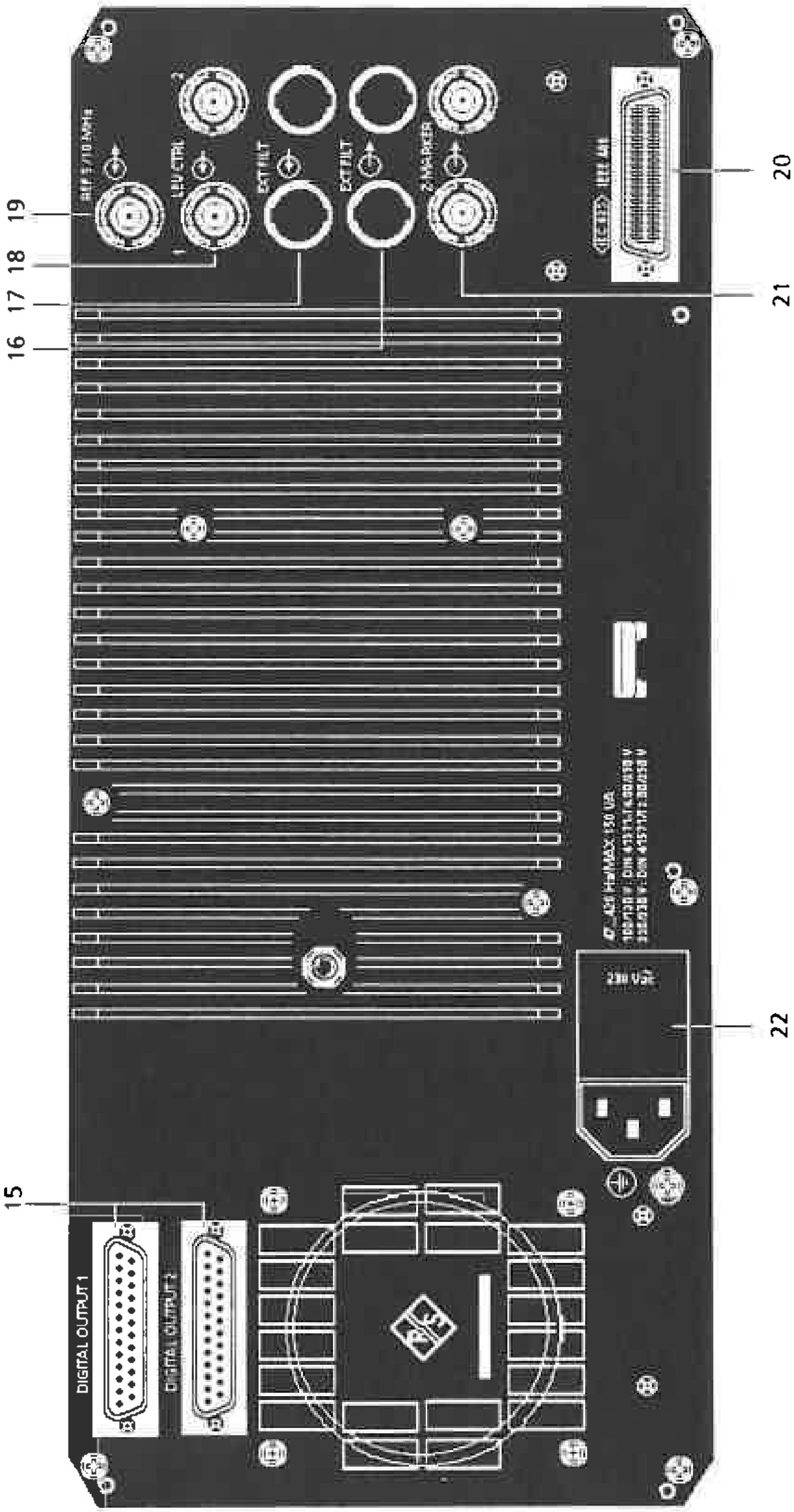
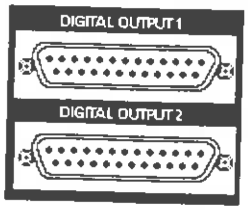


Fig. 3-2 Rear panel view

The following inputs and outputs are provided on the rear panel of the generator (see Fig. 3-2):

15 DIGITAL OUTPUT 1 or 2



Digital WAVEFORM output for channel 1 or 2.

Word width: 12 bit + CLK signal
Level: TTL
Pin assignment → see Section 3.2.13

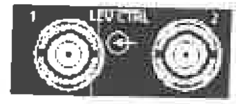
16 EXT. FILT ⊖→ 1 or 2

Opening provided for a BNC connector to connect the input of an external filter for channel 1 or 2.
→ see Section 3.2.6

17 EXT. FILT ⊖← 1 or 2

Opening provided for a BNC connector to connect the output of an external filter for channel 1 or 2.
→ see Section 3.2:6

18 LEV CTRL 1 or 2



Signal input for external control of the output level of channel 1 or 2.

Input impedance: 50 Ω
Input voltage range: -1 to + 1 V
→ see Section 3.2.12.3

19 REF 5 / 10 MHz

Output/ input connector for the internal or an external reference signal.
→ see Section 3.2.12.12

The connector is only provided if the ADS is equipped with option Clock Generator ADS-B1.

Minimal output level: >0.2 V into 50 Ω
Minimal input level: 0.2 V or TTL

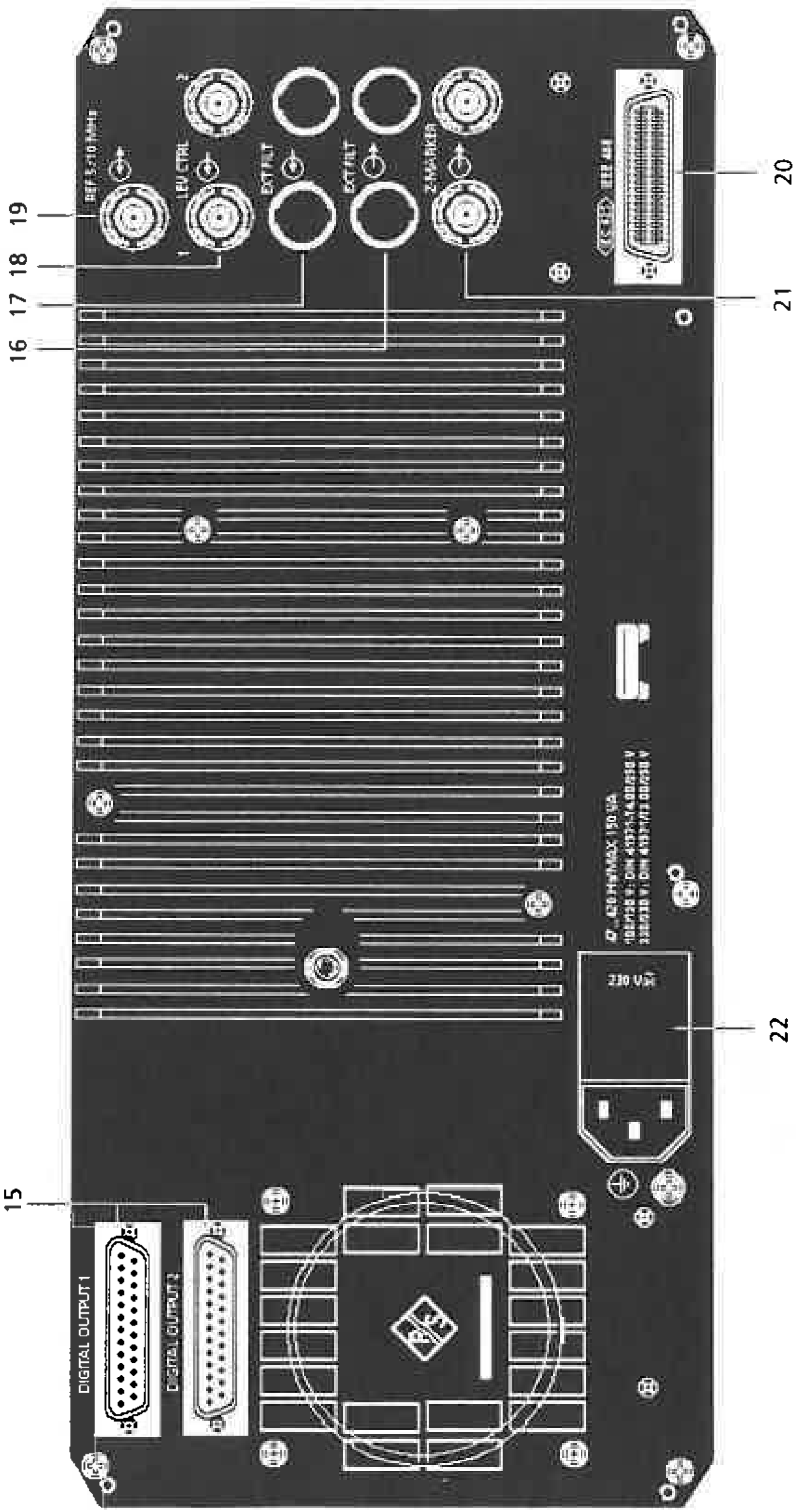
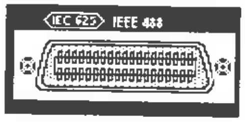


Fig. 3-2 Rear panel view

20 <IEC625> IEEE 488



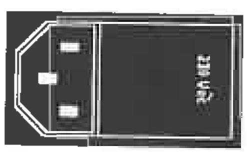
IEC bus female connector in accordance with IEEE 488 <IEC625>.

See Section 3.3 for remote control of the ADS via IEC bus.

21 Z-MARKER 1 or 2

Female output connector Z-MARKER for channel 1 or 2.
→ see Section 3.2.8.5

22 Voltage Selector and AC Supply Connector



See Section 2.2 for setting the correct ac-operating voltage on the instrument.

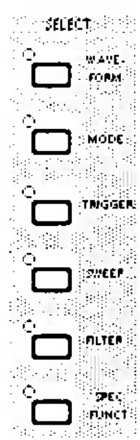
3.2 Manual Operation

3.2.1 General Operational Concept

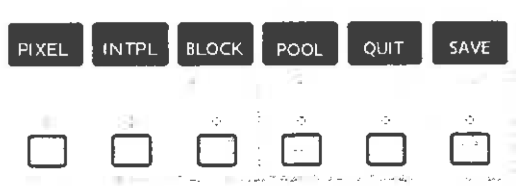
Owing to the menu-assisted operational concept of the DUAL ARBITRARY WAVEFORM GENERATOR ADS, the manifold setting facilities offered by the instrument can be selected conveniently and easily by few distinct input keys.

All entries, except those for the internal clock generator or trigger generator, refer to the channel which is indicated in the display. The key CH1/2 in the PARAMETER keypad allows switching to the other channel. Both channels can be programmed fully independently of each other.

The individual function menus are selected via the SELECT entry keypad [1]. Six main menus are available for selection, each menu is subdivided into further submenus. Each SELECT key has an LED to indicate which menu is currently selected.



The menu functions are indicated in the MENU display [3]. The MENU keypad [12] permits to select the menu functions.



Example:

The WAVEFORM menu is selected by pressing the SELECT key WAVEFORM. The MENU display then reads as follows:

The menu functions available may include selection of an instrument setting, activation of a parameter entry or branching to a submenu.

The function RET (Return) provided in the submenus allows to return to the next higher level in the menu hierarchy.

If more than six menu functions are available for selection in a menu level, the function NEXT is provided in the MENU display to select the additional functions. Again, the function RET can be used to return to the previous menu level.

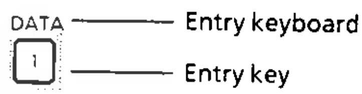
Changing to another function menu is possible at any time by selecting a new main menu via the SELECT keypad [1]. The newly selected main menu is then always activated, irrespective of the menu level of the previous menu.

The most important signal parameters can be easily activated for direct entry using the PARAMETER keypad [4]. In this case, the selected menu level is not abandoned but remains available for further entries. The parameters which are activated for entries are indicated by the LEDs assigned to the respective keys.

The function value of a parameter can be easily changed by numeric input via the DATA entry keyboard [8] or by continuous variation using the rotary knob [5].

Explanation of the Setting Examples

Setting examples will be given in the manual as follows:



Example: Input of digit 4 via DATA entry keyboard

Example: Selection of menu WAVEFORM via keypad SELECT

Example: Selection of a submenu or selection or activation of a parameter shown in the MENU display (i.e. here: selection of the REF submenu)

3.2.1.1 Overview of the ADS Function Menus

The following Figures 3-3 to 3-8 show the individual menu hierarchies:

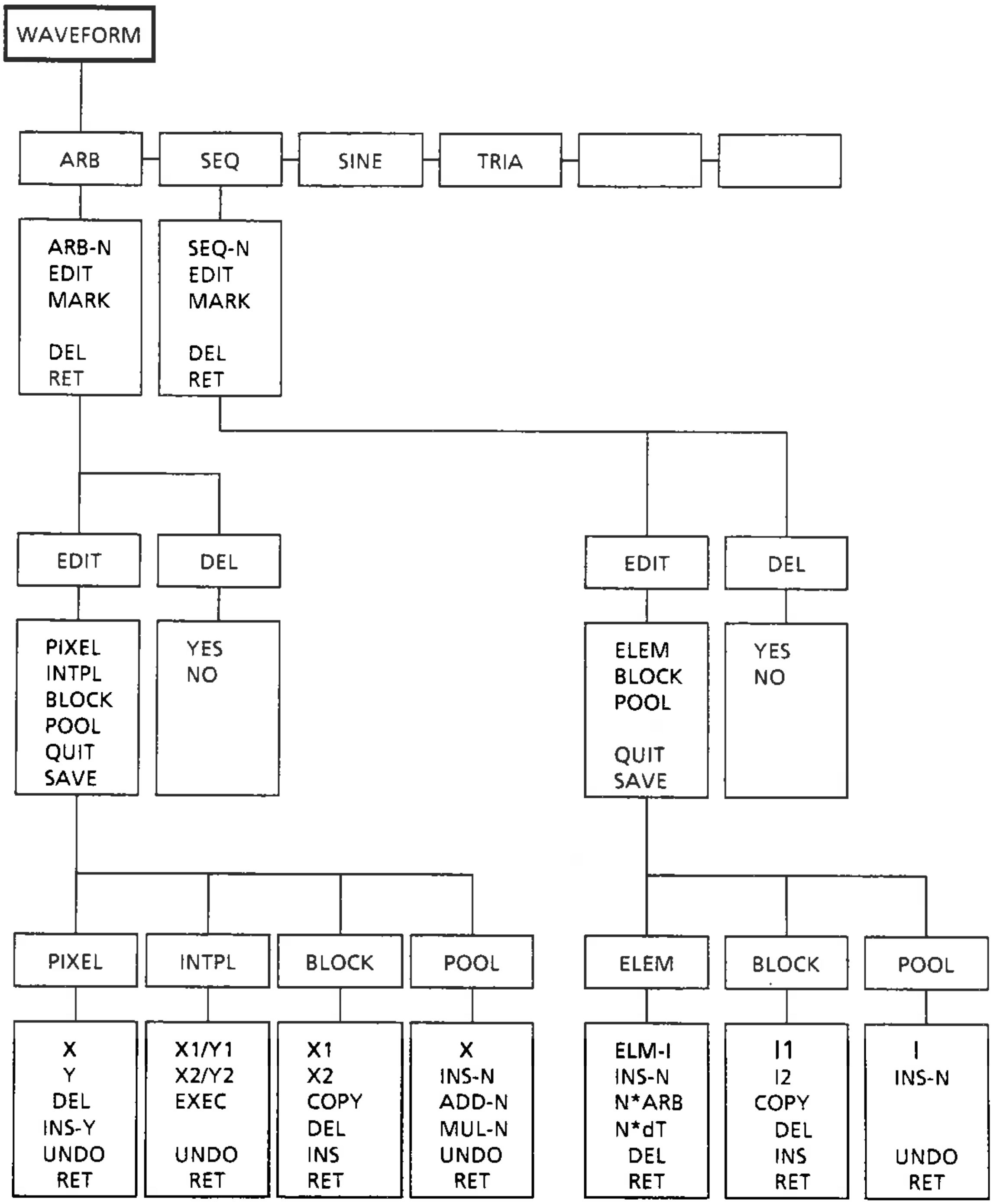


Fig. 3-3 Main menu WAVEFORM with submenus

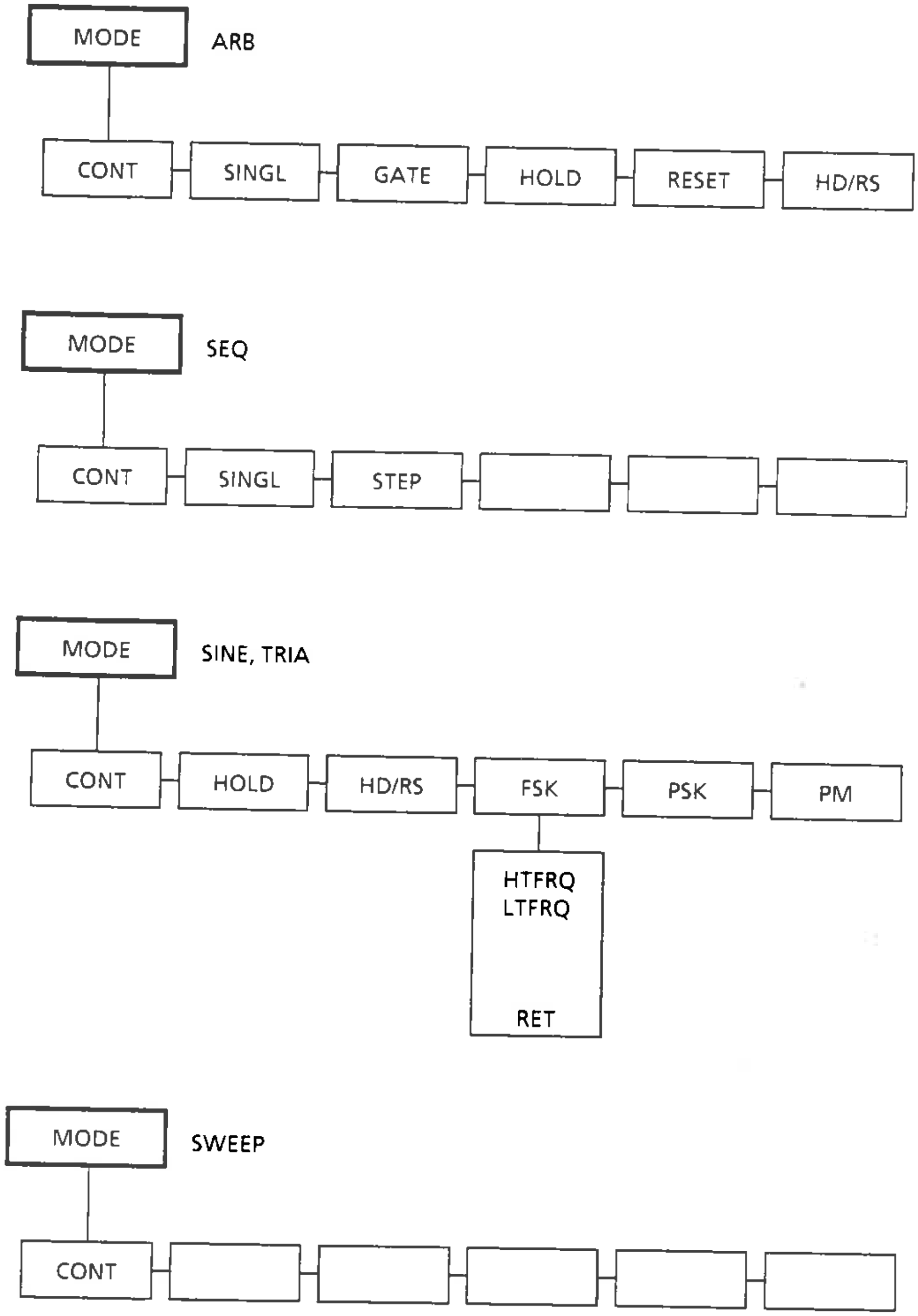


Fig. 3-4 Main menu MODE with submenus

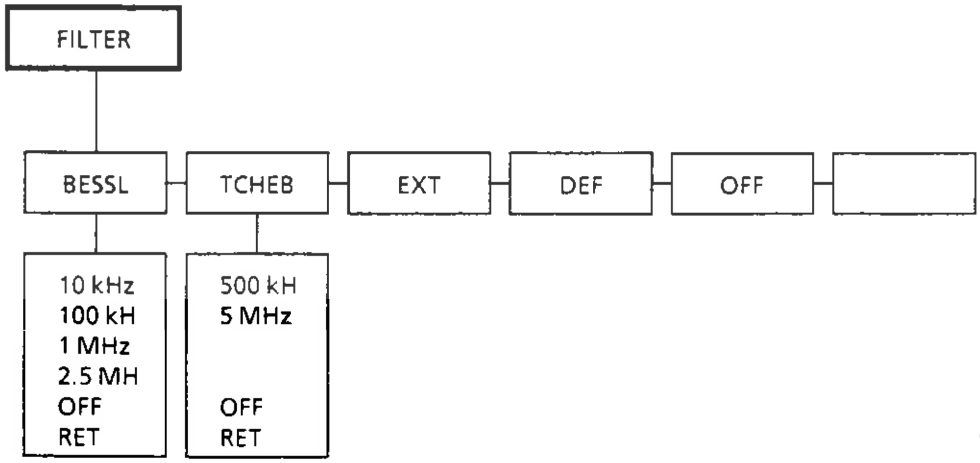


Fig. 3-5 Main menu FILTER with submenus

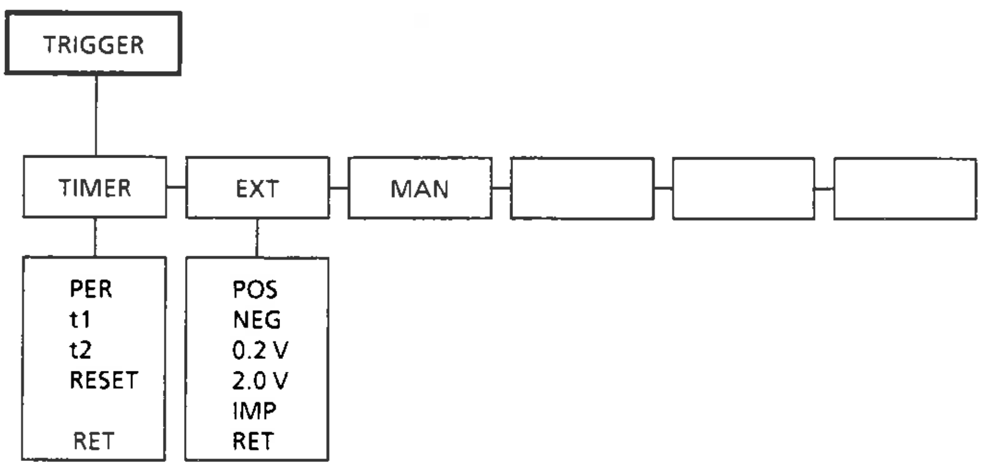


Fig. 3-6 Main menu TRIGGER with submenus

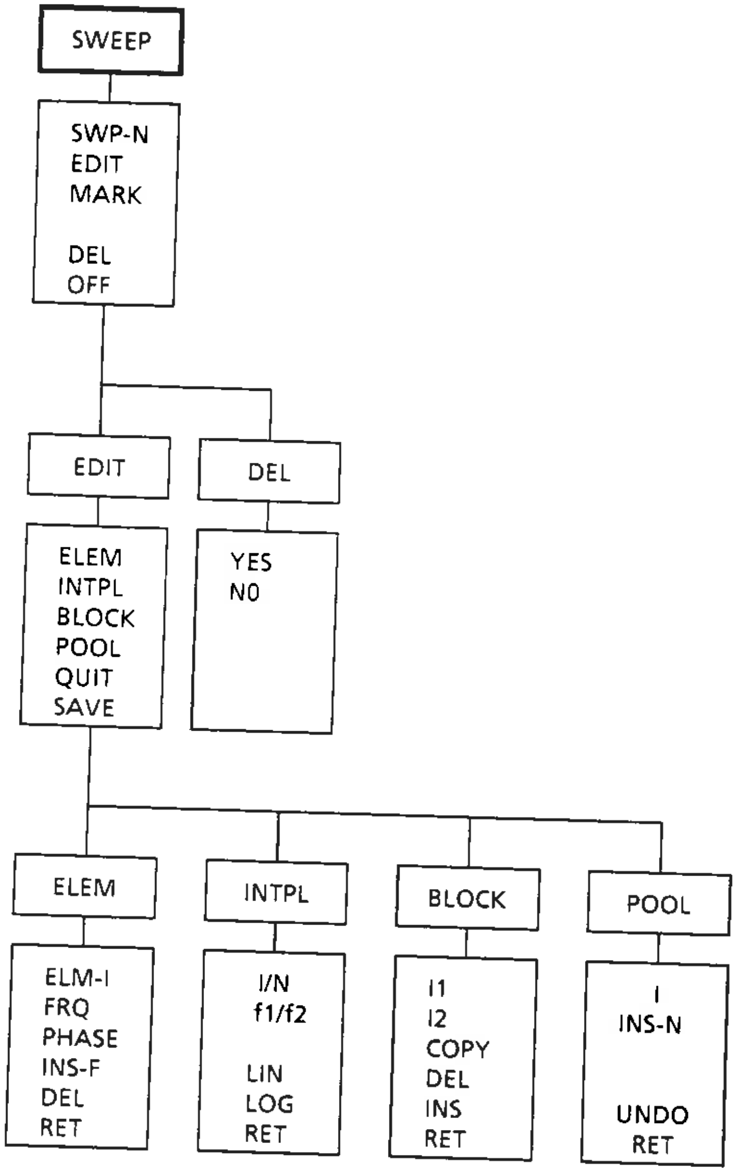


Fig. 3-7 Main menu SWEEP with submenus

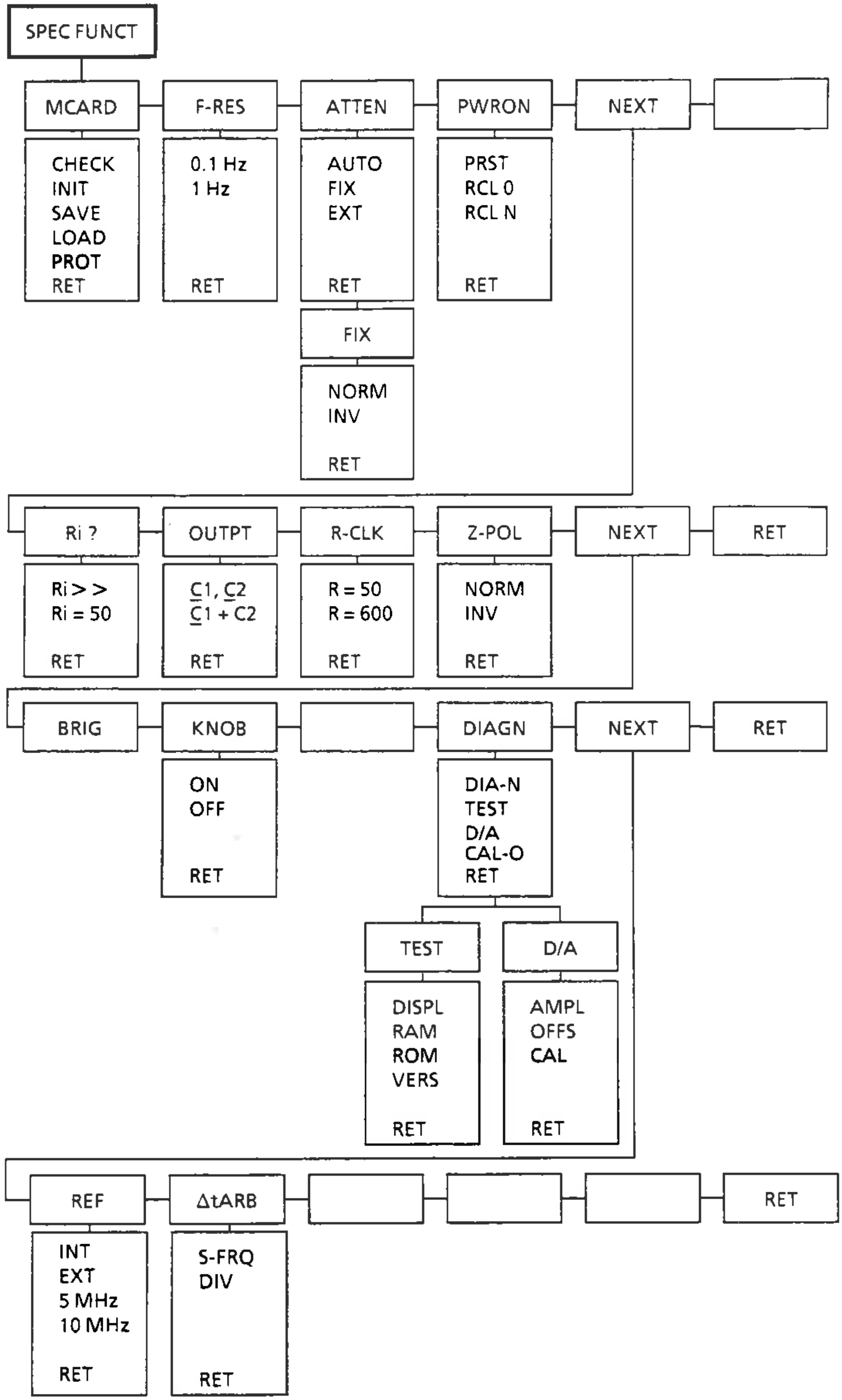
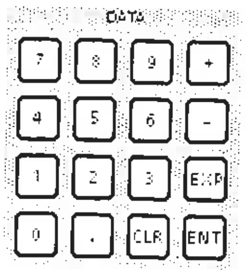


Fig. 3-8 Main menu SPEC FUNCT with submenus

3.2.1.2 Setting Function Values via the DATA Entry Keyboard

The entry keyboard DATA [8] is used to enter exact numeric parameter values.



Meanings of the DATA keys

0 to 9	keys for digit entries
+ /-	keys to enter the polarity sign of mantissa and exponent
EXP	key for subsequent entry of an exponent
.	key to enter a decimal point
CLR	key to clear erroneous inputs
ENT	key to acknowledge an entered value

After a parameter has been activated for entry, the function value currently valid for this parameter is cleared from the display by pressing a digit key, one of the polarity sign keys or the decimal point key. Instead, blanks with underscore characters are displayed. They indicate the maximal number of decimals possible for the next entry - less the already made entry. The blanks are filled by further DATA entries from left to the right.

Note the following for numeric data entries:

- It is not necessary that as many values are input as blanks shown.
- Each entry must be acknowledged by ENT before it is effective on the instrument - after an instrument-internal error check has been performed.
- Erroneous inputs can be cleared using the CLR key.
- When the parameter key is pressed again before the entry is acknowledged by ENT, all previously input values are deleted.

An entry made without exponent (EXP) always refers to the parameter unit currently shown in the display, unless the parameter has no dimension assigned. Generally, this consists of prefix (e.g. Kilo...) and basic unit (e.g. : ...hertz).

Example:

Current setting: 1 SINE CONT FREQ = 10.000kHz

Step	Entry	Resulting display
1	DATA [1]	1 SINE CONT FREQ = 1_______ kHz
2	DATA [.]	1 SINE CONT FREQ = 1.______ kHz
3	DATA [8]	1 SINE CONT FREQ = 1.8_____ kHz
4	DATA [ENT]	1 SINE CONT FREQ = 1.800kHz

After an entry is completed by pressing the key ENT, the generator always selects the unit displayed for the parameters FREQ, LEVEL and TIME such that minimally one and maximally three of zero different positions before the comma are given (floating point representation).

Parameters with setting ranges limited to few decades are always indicated in the respective basic unit (e.g. OFFSET).

Example:

Current unit : kHz

Step	Entry
1	PARAMETER FREQ
2	DATA 1
3	DATA 5
4	DATA 0
5	DATA 0
6	DATA ENT

Value displayed following actuation of the ENT key: 1.500 000 MHz.

Example:

Current unit : MHz

Step	Entry
1	PARAMETER FREQ
2	DATA 0
3	DATA .
4	DATA 0
5	DATA 1
6	DATA ENT

Value displayed following actuation of the ENT key : 10.000 kHz

If a parameter value is input with an exponent (exponent to base 10), the input is always referred to the basic unit (V, s, Hz) irrespective of the previous display.

If an input is terminated without an exponent specified, this is interpreted as EXP = 0.

Example:

Current setting: `1 SINE CONT FREQ = 10.000kHz`

Step	Entry	Resulting display
1	DATA [1]	1 SINE CONT FREQ = 1_______ kHz
2	DATA [EXP]	1 SINE CONT FREQ = 1________ Hz
3	DATA [ENT]	1 SINE CONT FREQ = 1 Hz

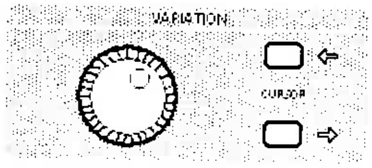
Erroneous inputs

If an entry cannot be executed by the DUAL ARBITRARY WAVEFORM GENERATOR ADS, an error message is output in the display for about 2 seconds after the ENT key has been pressed. The faulty entry can then be corrected.

To restrict the possibilities of erroneous inputs as best as possible, any input keys which are activated but have no logical connection to the active input parameter are ignored (e.g. the key "-" with frequency parameter FREQ).

The parameter selected remains active for further entries even after successful completion of an input, until another parameter is selected or the user exits from the menu level of this parameter.

3.2.1.3 Variation of Function Values Using the Rotary Knob



The control knob [5] allows for quasi-continuous variation of the active parameter.

The cursor shown marks the decimal position of the function value which is to be varied by the rotary knob.

The cursor keys in control field [5] can be used to move this cursor to any of the decimals of the function value. Also, it is posssible to select the positions to the left of the highest decimal of the current value. The selected decimal position is stored and will be automatically set the next time the parameter is activated.

Clockwise rotation of the knob increments the parameter value, counterclockwise rotation decrements it.

An acknowledgement of the input with the ENT function, as is required for value entries via the DATA entry keyboard, is not necessary in this case.

Rotary knob variations violating the permissible value range of the parameter are automatically ignored. Thus, any erroneous inputs by the control knob are inhibited.

3.2.1.4 Switch-on Status

When the DUAL ARBITRARY WAVEFORM GENERATOR ADS is switched on, first the currently set IEC bus address and the fitted options are specified in the display.

After about 5 seconds, the switch-on status is set. This may optionally be:

- the instrument-specific PRESET state,
- a basic instrument state to be defined by the user, or
- the state valid prior to last switch-off.

The special function (SPEC FUNCT) PWRON (see Section 3.2.12.4) can be used to select the switch-on status. Upon delivery, the instrument is factory-set to its PRESET state.

3.2.1.5 The Instrument PRESET State

Actuating the key PRESET in the MEM/REM input field [6] sets both channels of the ADS to a predetermined basic status, characterized by the following settings:

WAVEFORM	SINE	waveform sine
MODE	CONT	continuous mode
TRIGGER	INT	internal trigger source
SWEEP	OFF	sweep off
FILTER	DEF	automatic filter selection
OUTPUT	OFF	signal output deactivated
FREQ	1 kHz	frequency 1 kHz
LEVEL (P-P)	10 mV	signal level 10 mV_{pp}
OFFSET	0 V	dc offset voltage 0 V
CLK	INT	internal clock source

The MENU function keys are assigned to the main menu WAVEFORM.

Parameter FREQ is activated for entry.

The further PRESET settings of the generator are:

TRIGGER,EXT	RISE (0.2 V)	triggering for positive edge, threshold 0.2 V
TRIGGER,INT	PER = 1 µs	internal trigger period 1µs
	T1 = 0.5 µs T2 = 0.5 µs	trigger low time 0.5 µs trigger high time 0.5 µs

The predetermined setting of the ARB waveform is:

ARB-n	0	current ARB waveform: 0
dT	40 ns	step time = 40 ns
MARK	1	marker position = 1

Predetermined settings of waveform SEQ:

SEQ-n	1	current ARB SEQuence 1
dT	40 ns	step time = 40 ns
MARK	1	marker position = 1

Predetermined settings of waveforms SINE und TRIA:

MODE:FSK	HTFRQ = 1 kHz LTFRQ = 1 kHz
MODE:PSK	d φ = 0 degrees

Predetermined settings of the special functions for both channels (see Section 3.2.12):

F-RES	1 Hz	frequency resolution in sine and triangular operation: 1 Hz
ATTEN	AUTO	standard level setting
REF	INT, 10 MHz	10-MHz internal reference frequency (only with built-in option CLOCK GENERATOR ADS-B1)
Ri ?	Ri = 50	internal impedances of connectors OUTPUT with level switched-off : 50 Ω
R-CLK	R = 50	input impedances of female connectors CLK: 50 Ω
OUTPT	C1,C2	separate signal outputs
Z-POL	NORM	Z-Marker: not inverted

3.2.1.6 Storing and Recalling of Instrument Settings (STO, RCL)

Complete front-panel setups can be stored and retrieved via the keys STO and RCL in the MEM/REM input field [6].

The storage area reserved in the instrument for this function has sufficient memory capacity for data of up to 20 complete front-panel setups.

The data are saved in the non-volatile STO/RCL memory and are also retained when the instrument is switched off or in the event of a power failure.

The memoy registers 1 to 20 are provided for storing any front-panel settings. The memory address 0 is reserved for saving the current instrument state.

This current instrument state is always automatically stored and therefore available to the user at any time, i.e. also when the instrument is switched back on after not being used for some time.

For storing or recalling a setup, the STO or RCL key, respectively, is pressed, the required memory address entered and the entry terminated by ENT.

The previous memory contents will be overwritten when a new instrument setting is stored.

Example:

Step	Entry	Result
1	MEM/REM [ ] STO	Storing the current front-panel setup in memory 15
2	DATA [1]	
3	DATA [5]	
4	DATA [ENT]	

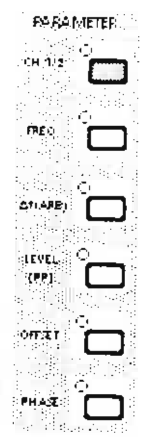
Example:

Step	Entry	Result
1	MEM/REM [ ] RCL	Retrieving instrument setup 17
2	DATA [1]	
3	DATA [7]	
4	DATA [ENT]	

3.2.2 PARAMETER Entries

The following signal parameters are provided in the PARAMETER keypad of the ADS and can be activated for entry of a new function value or for variation by rotary knob at any time:

CH1/2	key for switching between channel 1 and 2
FREQ	frequency for sine and triangular operation
dT(ARB)	step time dT in ARB or SEQ operation
LEVEL [P-P]	signal level in V_{PP} into 50 Ω
OFFSET	dc offset voltage in V into 50 Ω
PHASE	phase between channel 1 and 2 in sine or triangular operation



3.2.2.1 Output Level (LEVEL)

The generator output level is entered as peak-to-peak value into 50-Ω termination. The output level can be set separately for each of the two generator channels.

Basic unit	V
Setting range	0 to 10 V
Readout	Floating point representation
Resolution	4-digit, minimally 0.1 mV

Example:

Step	Entry	Result
1	PARAMETER LEVEL (PP)	Setting a signal level of 10 mV_{PP}
2	DATA 1	
3	DATA 0	
4	DATA EXP	
5	DATA -	
6	DATA 3	
7	DATA ENT	

Display: LEV = 10.0 mV

3.2.2.2 DC Offset (OFFSET)

The dc offset is input in V (DC) into 50-Ω termination. The dc offset can be set separately for each of the two channels, irrespective of the current output level setting.

Basic unit	V
Setting range	-5 V to 5 V
Readout	3-digit, fixed point representation
Resolution	0.01 V

Example:

Step	Entry	Result
1	PARAMETER OFFSET	Setting a dc offset of 500 mV
2	DATA .	
3	DATA 5	
4	DATA ENT	

Display: OFFS = 0.50 V

3.2.2.3 Frequency (FREQ)

The PARAMETER key FREQ activates the frequency parameter.

Note:
Frequency entries can only be made in sine wave or triangular wave operation.

5 MHz is the upper frequency limit for sine wave signals, 100 kHz for triangular wave signals. The frequency resolution can be switched from 1 Hz to 0.1 Hz using the special function F-RES (see Section 3.2.12.2). In this case, the maximally settable frequencies are reduced to 500 kHz for sine signals and to 10 kHz for triangular signals.

Basic unit	Hz
F-RES = 1 Hz: Setting range, sine Setting range, triangle	 1 Hz to 5 MHz 1 Hz to 100 kHz
F-RES = 0.1 Hz: Setting range, sine Setting range, triangle	 0.1 Hz to 500 kHz 0.1 Hz to 10 kHz
Readout	7-digit, floating point representation
Resolution	[0.1] 1 Hz

Example:

Step	Entry	Result
1	PARAMETER FREQ	Setting a frequency of 20 kHz
2	DATA 2	
3	DATA 0	
4	DATA EXP	
5	DATA 3	
6	DATA ENT	

Display: FREQ = 20.000 kHz

3.2.2.4 Period of Read Clock (dT)

In combination with the number of reference points (samples) used for defining the signal waveshape, the parameter dT, representing the period of the read clock in ARB and SEQ operation (step time), defines the frequency of the output signal.

The resolution and the setting range of the parameter dT depend on the optional fitting of the generator. If the ADS is equipped with the option CLOCK GENERATOR ADS-B1, an extended setting range plus a substantially enhanced resolution are offered.

The parameter is activated for entry by pressing the PARAMETER key ΔT. Input values, which cannot be exactly set on account of lacking resolution, are rounded off to the next settable value. The set value, if applicable also rounded off, is read out in the display.

Note:
The parameter dT can only be activated in ARB and SEQ operation.

Basic unit	s
Setting range, standard Setting range, with option	40 ns to 2.5 ms 30 ns to 5.0 ms
Readout	4-digit, floating point representation
Resolution, standard Resolution, with option	40 ns (1 us for dT > 1 ms) 1*10E-4, minimally 10 ps

Example:

Step	Entry	Result
1	PARAMETER ΔT(ARB)	Setting a step time (sample period) of 1.6 ns
2	DATA 1	
3	DATA .	
4	DATA 6	
5	DATA EXP	
6	DATA -	
7	DATA 6	
8	DATA ENT	

Display: dT = 1.600 us

3.2.2.5 PHASE

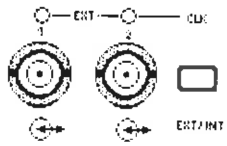
Due to the frequency synthesis techniques applied in the ADS, the phase between the channels 1 and 2 can be precisely set. Pressing the PARAMETER key PHASE in ARB or SEQ operation synchronously resets the signal curves of both channels.

Note the following for programming the phase:

- A fixed phase relationship between the signals of both channels can only be obtained if both channels are controlled by the same clock source. This may be the internal clock generator, the option CLOCK GENERATOR if fitted in the ADS, or also an external clock souorce.
- The phase relation of two sine or triangular signals at identical frequencies is undefined until a phase value is input. In this case, first a phase of 0 degree is set when the PARAMETER key PHASE is pressed.
- Once a phase is defined, it is only valid as long as the frequency setting remains the same. When the frequency for the channels is varied, the phase must be redefined.
- Setting of phase is possible at any time irrespective of the current frequencies set on both channels. However, a fixed phase relationship can only be set for signals having identical frequency or with an integer frequency relation of both channels.
- The phase setting is always referred to the currently active channel. If channel 1 is selected, a setting of - 45 degrees corresponds to a 45-degrees phase lag of channel 1 referred to channel 2.

Basic unit	degree(s)
Setting range	- 180 to + 180 degrees
Readout	4-digit, fixed-point representation
Resolution	0.1 degree

3.2.3 Selection of Clock Source



The system clock of both channels in the ADS can be created by the internal clock generator or also be fed into the instrument by an external clock source. The CLK EXT/INT key [13] is used for switchover of the clock source for the currently active channel. In external clock operation, the CLK EXT LED of the respective channel lights up.

3.2.3.1 Internal Clock Generator

The ADS is as standard equipped with a crystal-referenced clock generator.

The clock period of the internal clock generator is set in ARB and SEQ operation via the parameter dT. Clock periods ranging from 40 ns to 2.5 ms with a minimal resolution of 40 ns can be generated.

In sine or triangular operation, the internal clock generator supplies a fixed clock frequency of nominally 16.777216 MHz. If a frequency resolution of 0.1 Hz is selected using special function F-RES, the clock is reduced by factor 10 to 1.6777216 MHz.

The output signal of the internal clock generator is always available for external applications at the CLK connector of the channel (Ri = 50 Ω, level = TTL compatible), as long as the internal clock generator is selected for the respective channel.

3.2.3.2 Option CLOCK GENERATOR ADS-B1

The ADS may optionally be equipped with the CLOCK GENERATOR option ADS-B1, which replaces the internal clock generator by a high-resolution clock synthesizer. Using this option, read clock periods with a resolution of up to 10 ps can be defined in ARB and SEQ operation.

The setting range coverage is 30 ns to 5 ms.

Again, the clock period is set analogously to the setting of the internal clock generator using the parameter dT.

Selection of reference source and reference frequency (Option ADS-B1)

The clock synthesis of the CLOCK GENERATOR ADS-B1 can optionally be operated with an internal or external reference of 5 MHz or 10 MHz.

The connector REF 5/10 MHz [19] serves as reference output or reference input for the internal or external reference signal.

Using this reference input / output [19], the clock synthesis of the ADS can be locked in phase to an external reference source.

The reference source and the reference frequency are selected in a selection menu, which is accessed with the special function REF (see Section 3.2.12.12).

When operated from an internal reference, the reference signal is available with a level >0.2 V into 50 Ω and a frequency accuracy of 1 * 10E-5 for synchronization of external systems.

The requirements for external reference signals are as follows:

Waveform	Sine or triangle
Level	0.2 to 2 V into 50 Ω or TTL
Frequency accuracy	5 * 10E-5

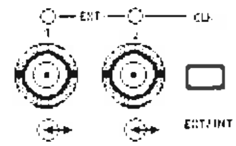
Operating example:

Setting an internal reference with 5 MHz

Step	Entry	Result
1	SELECT SPEC FUNCT	Selection of menu SPEC FUNCT
2	MENU REF	Selection of menu REF
3	MENU INT	Selection of internal reference
4	MENU 5MHz	Selection of reference frequency

3.2.3.3 External Clock

Both channels offered in the ADS can be operated fully independently of each other with an external system clock.



The key CLK EXT/INT permits switching from internal to external clock for the currently active channel, the CLK EXT LED [13] indicating this mode. The external clock is applied via female connectors CLK.

The input impedance of the CLK connectors switched as input may optionally be 50 Ω or 600 Ω. For switching over, the special function R-CLK is available (see section 3.2.12.7).

The frequency range specified for external clock signals is from 0 to 33 MHz. Applying clock signals with frequencies up to 35 MHz is possible, however, without guarantee for the instrument data specified in the Data Sheet.

The CLK input is designed for sine or triangular signals at an amplitude of minimally 200 mV (into 50 Ω or 600 Ω).

The input is automatically protected against overloads. As soon as the voltage exceeds the range of ±6 V, the input connector is dc-decoupled from the internal input stage.

After eliminating the cause of overloading, the input is activated by switching the instrument off and then on again.

3.2.4 Operating MODEs

In addition to the continuous periodic generation of the selected signal waveforms in the mode CONT, the ADS also offers to control the signal generation in both channels - independently of each other - by trigger signals.

The triggered operating modes can be selected by the user in the main menu MODE.

The MODE menu offered is always dependent on which signal waveshape is currently selected.

The modulation modes frequency-shift-keying (FSK), phase-shift-keying (PSK) and pulse modulation, which are available in sine and triangular operation, are also selected via the MODE menu.

The individual MODEs available in the ADS are described in detail in the following sections:

→ 3.2.8.6 ARB MODEs
→ 3.2.9.7 SEQ MODEs
→ 3.2.10.1 MODEs in sine wave and triangular wave operation
→ 3.2.10.2 Modulation modes
→ 3.2.11.6 SWEEP MODEs

3.2.5 Selecting the Trigger Source

The front-panel key TRIGGER in the keypad SELECT calls the main menu for selecting the trigger source. The menu is read out in the MENU display (refer to Fig. 3-6 for a schematic layout of the complete trigger menu):

TIMER	EXT	MAN			

The following three possibilities of triggering are offered:

- TIMER (internal triggering),
- EXTernal triggering, and
- MANual triggering.

The trigger source is selected separately for each channel.

Dependent on which trigger source is selected, the TRIGGER connectors [14] serve as trigger inputs for external trigger signals or as trigger outputs for the internal or manual trigger signal.

3.2.5.1 Programming the Internal Trigger Generator

The ADS is equipped with an internal trigger generator (TIMER), which is available as signal source for triggered operating modes, as internal SWEEP time base or also for external applications.

The following key sequence selects the internal trigger generator as trigger source for the currently active channel:

Step	Entry
1	SELECT TRIGGER
2	MENU TIMER

In internal triggering, the female connectors TRIGGER [14] serve as outputs for the signal of the internal trigger generator.

The output impedance of the trigger output stage is 50 Ω, the level is TTL compatible.

When internal triggering is selected, the trigger generator signal is available irrespective of which operating mode is selected, i.e. also in CONT mode.

Programming the internal trigger generator

The TIMER menu allows the user to set the parameters for the internal trigger generator. This menu is automatically called up when the internal trigger generator is selected:

PER	t1	t2	RESET		RET

Programming of the trigger generator is possible in two ways:

- by entering the LOW and HIGH times of the signal (T1, T2), or
- by entering the period (PER).

The period is calculated using the following formula:

$$PER = T1 + T2$$

T1 and T2 can be set in the range from 0.5 us to 1000 s with a resolution of minimally 0.5 us.

Thus, the minimal period to be set is 1 us, the maximally possible period is 2000 s.

The MENU key RESET permits to reset the trigger signal to its initial state (HIGH). With this performance feature, unneccessary waiting times in particular with long periods can be avoided.

The ratio T1:T2 or T2:T1 must not be greater than 1:6500.

Example:

Programming the internal trigger generator

Step	Entry	Result
1	SELECT TRIGGER	Selection of TRIGGER menu
2	MENU TIMER	Activating the internal trigger generator
3	MENU PER	Activating the parameter period for entry
4	DATA 1	DATA entry
5	DATA EXP	DATA entry
6	DATA -	DATA entry
7	DATA 3	DATA entry
8	DATA ENT	Acknowledging the DATA entries

On completion of all these entries, the internal trigger generator delivers a signal with a period of 1 ms and a HIGH component of 50%. The trigger signal is available at the TRIGGER connector of the respective channel indicated in the display during the above entries.

3.2.5.2 External Triggering

The following key sequence switches the TRIGGER connector of the selected ADS channel as input:

Step	Entry
1	SELECT TRIGGER
2	MENU EXT

The LED TRIGGER EXT assigned to the connector lights. Simultaneously, the TRIGGER EXT menu is called up:

POS | NEG | 0.2V | 2.0V | IMP | RET

The individual MENU keys have the following functions:

POS, NEG:
The menu keys POS and NEG define the polarity, in which the external trigger signal controls the functional sequence of trigger generation. When POS is selected, the non-inverted external signal triggers the sequence. With NEG selected, the sequence is triggered by the inverted external signal.

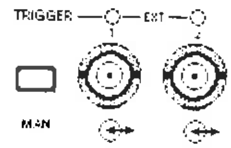
POS is the default setting.

In externally edge-triggered modes, the trigger edge can thus be selected with the POS and NEG function.

0.2V, 2.0V:
The menu keys 0.2 V and 2.0 V are used to set the trigger threshold of the input comparator.

IMP:
The trigger input has an input impedance of either 50 Ω or 600 Ω. The function IMP in the Trigger:EXT menu is used to switch the impedance between these two values.

3.2.5.3 Manual Triggering



The key MAN serves for manual control of the triggered operating modes. The MAN key is activated for the currently selected channel by pressing the key MAN in the TRIGGER menu.

The function of the MAN key depends on which MODE is set. For level-controlled operating modes, the logic state of the trigger signal is changed each time the MAN key is pressed. On the other hand, on each actuation of this key in edge-triggered operating modes a trigger edge is generated.

The trigger signal generated using the MAN key is output via the TRIGGER connector [14], as is also done with the signal from the internal trigger generator.

3.2.6 FILTER Selection

Six analog lowpass filters are offered by the ADS to suppress the interference products (aliasing) occurring in addition to the wanted signal as a result of digital frequency synthesis. The filters can be switched separately for each channel.

The filters are first automatically selected when a new waveform is switched on.

In ARB and ARB SEQ operation, filtering is switched off in the basic status in view of the arbitrary waveform designed.

In sine and triangular operation, special Chebyshev lowpass filters are switched on which are particularly adjusted to the respective operating mode.

The cutoff frequency of the selected filters depends on which frequency resolution is selected.

Specified in detail, the following lowpass filters are available for selection:

Table 3.1

Filter characteristics	Order	Cutoff frequency
Bessel	3	10 kHz 3 dB
Bessel	3	100 kHz 3 dB
Bessel	3	1 MHz 3 dB
Bessel	3	2,5 MHz 3 dB
Chebyshev	7	500 kHz (*)
Chebyshev	7	5 MHz (*)

(*) Modified Chebyshev lowpass filters.
The frequency response shows an increase of about 0.5 dB in the specified cutoff frequency.

To select the FILTER menu, the key FILTER in the SELECT keypad is pressed.

Unless special filters have been selected after switching to a new waveform, the display [2] shows the following readout in ARB and ARB SEQ operation:

FILTER OFF

or in sine or triangular operation:

FILTER DEFAULT.

At the same time, the FILTER menu functions are read out in the MENU display (see Fig. 3-5 for a schematic overview of the complete FILTER menu):

BESSL | TCHEB | EXT | DEF | OFF

The FILTER menu allows the setting of an automatic basic setting with the MENU key DEF (default). The filters required are selected in the submenus TCHEB und BESSL.

Filtering of the output signal can be switched off via the MENU key OFF.

Operating example:

Selecting the 100-kHz Bessel filter

Step	Entry	Result
1	SELECT FILTER	Selection of FILTER main menu
2	MENU BESSL	Selection of submenu "Bessel Filter"
3	MENU 100kH	Selection of 100-kHz Bessel filter

External Filtering, FILTER:EXT

The ADS is now prepared for an external filtering of its output signal using an external, application-specific filter. For this purpose, four openings for BNC connectors are provided on the rear of the instrument to connect external filters.

3.2.7 Selecting the WAVEFORM

The WAVEFORM menu allows to select the signal waveshape. On actuation of the key WAVEFORM in the SELECT keypad [1], the menu functions are read out in the MENU display (see Fig. 3-3 for a schematic layout of the complete WAVEFORM menu):

Four different signal waveforms are available to the user:

ARB	ARBitrary Waveforms Generation of ARB waveforms is described in detail in Section 3.2.8.
SEQ	SEQuences of ARB waveforms see Section 3.2.9
SINE	Sine signals see Section 3.2.10
TRIA	Triangular signals see Section 3.2.10

3.2.8 Generation of Arbitrary Waveforms (WAVEFORM:ARB)

The ADS is capable of generating two mutually independent fully-arbitrary waveforms (ARB) with a length of up to 16384 (16K) points (PIXELs) each and an amplitude resolution of 12 bit[1].

An ARB waveform has a minimum length of 2 pixels.

An easy-to-use editor is offered by the ADS for defining the ARB signals.

In addition to the designing of user-specific waveforms, the ADS can also load sampling values of signals via the standard interfaces (see Section 3.3).

The ARB POOL

Depending on their individual lengths, up to 100 different ARB signals can be defined and stored in the so-called ARB POOL.

This ARB POOL serves as internal waveform memory and can be accessed by both of the ADS channels.

Any of the waveforms saved in the ARB POOL can at any time be called into the working memory of one of the ADS synthesis channels for output, or are available to the user for editing purposes. The POOL addresses (0 to 99) are used to select the waveforms stored under the respective numbers.

[1] It is possible to achieve a length of 64 Kpoints in Sequence mode by switching on 4 ARB waveforms one after the other.

Defining the signal curve

To define the currently required signal curve, normalized amplitude values of reference points (samples) at time-equidistant spacing are entered.

The normalized input range covers the values from - 1 to + 1 and is displayed in the voltage range defined by the parameter LEVEL when the waveform of the signal is output. The complete input range extends from -1.0240 to + 1.0235. Also, the absolute voltage at the generator output depends on the setting of the parameter OFFSET:

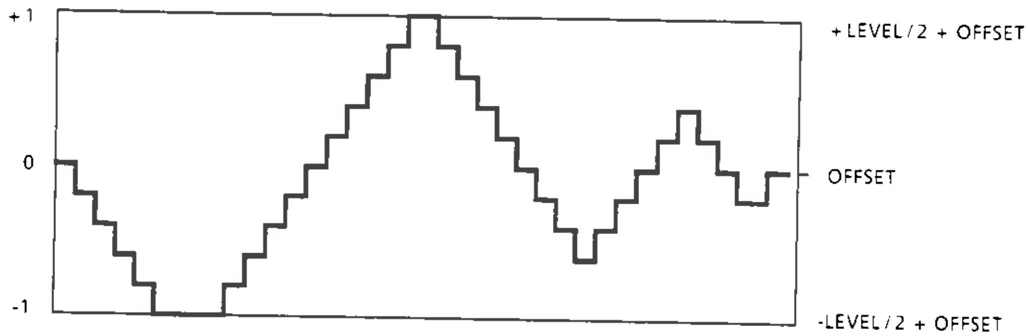


Fig. 3-9

Note:

So as to obtain maximal amplitude accuracy while using the full dynamic range available in the ADS, the signal waveshape should be defined without its direct component and the highest amplitude values should be assigned the input values + 1 and - 1. The required direct component can be superposed on the output signal at any time by a respective setting of the parameter OFFSET irrespective of the signal form.

Defining the signal period

The period of the ARB signal is conditioned by the number of samples S used for defining the signal curve and the period of the read clock dT. This gives:

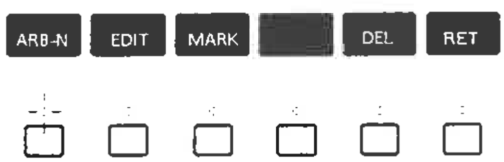
$$T_{arb} = S * dT$$

3.2.8.1 The ARB Menu

When the menu function key ARB is actuated in the main menu WAVEFORM, the ARB waveform designed last is automatically loaded from the ARB POOL and output with the current parameter set.

The display shows the number assigned to the respective ARB waveform, the current operating mode, the length of the ARB waveform and the current period of the read clock:

Simultaneously, the ARB main menu functions are read out in the MENU display:



The LED assigned to the menu key ARB-N lights up, indicating that the parameter ARB-N is activated for DATA input. Thus, any waveform stored in the ARB POOL can be selected for output by entering the memory location at which it was previously stored in the ARB POOL.

The further menu keys are assigned the following functions:

EDIT Key to select the ARB editor. The capabilities of the ARB editor are specified in detail in Section 3.2.8.5.

MARK Parameter key to activate entry of the marker position (see Section 3.2.8.4).

DEL Key to delete an ARB waveform from the ARB POOL (see Section 3.2.8.3).

3.2.8.2 Loading a Waveform from the ARB POOL (ARB-N)

To call a waveform saved in the ARB POOL, the parameter ARB-N of the ARB main menu must be assigned the number N of the memory location where the currently required waveform is stored in the POOL.

The ARB signal can be selected either by entering an exact value via the DATA entry keyboard [8] or by varying the parameter ARB-N using the control knob [5].

Example:

Loading the ARB waveform ARB 15

Step	Entry	Result
1	SELECT WAVEFORM	Selecting the WAVEFORM menu
2	MENU ARB	Selecting the ARB menu
3	MENU ARB-N	Activating the parameter ARB-N to specify the ARB waveform required for output
4	DATA 1	DATA entry
5	DATA 5	DATA entry
6	DATA ENT	Once the entry is acknowledged by ENT, the selected waveform is loaded from the ARB POOL and generated.

3.2.8.3 Deleting an ARB Waveform from the ARB POOL (DEL)

If all the 100 memory locations available in the ARB POOL are occupied or if the memory capacity is fully utilized on account of a variety of "long" ARB signals, any one of the previously stored waveforms must be deleted before a new ARB wave can be defined. (The flexible memory partitioning makes it possible to alternatively delete a stored SEQuence or sweep, thus freeing up memory for the new ARB waveform.)

For this purpose, the function DEL is provided in the ARB main menu.

This function is always relevant for the currently activated and displayed ARB wave. To select any other waveform to be deleted, the parameter ARB-N is used. In order to avoid an unintentional deletion of a waveform, the delete instruction must be acknowledged in a submenu before it is effected.

Example:

Deleting the ARB waveform ARB 76

Step	Entry	Result
1	SELECT WAVE-FORM	Selecting the WAVEFORM menu (*)
2	MENU ARB	Selecting the ARB menu (*)
3	MENU ARB-N	Activating the parameter ARB-N to specify the ARB waveform to be deleted
4	DATA 7	DATA entry
5	DATA 6	DATA entry
6	DATA ENT	Acknowledging DATA entry
7	MENU DEL	Selecting the delete function
8a	MENU YES	Acknowledging the delete instruction - return to the ARB main menu
8b	MENU NO	Abort the delete operation and return to the ARB main menu

(*)Note:

Steps 1 and 2 of the above example serve to select the ARB main menu. However, if one of the ARB submenus is already accessed, the ARB main menu can be reached by actuating the RET keys in the submenus once or several times.

3.2.8.4 Marking Specific Points of a Signal Wave - Z-Marker (MARK)

For each of its two channels, the ADS contains a programmable marker generator used to specifically mark any point of the ARB signal wave.

The signal from the marker generator is output both as TTL-compatible signal via the MARK connectors [10] and as Z-marker via the Z--MARKER outputs [21] on the rear.

Unless a different entry is made, the marker is generated synchronously with the first point of the wave once the ARB wave is activated.

The marker position is determined with the parameter MARK in the ARB main menu.

Z-marker

Whereas the signal available at the MARK connector is only given for general control and synchronization purposes, the Z-marker serves to visually inject the selected marker position on the screen of a connected oscillograph. The Z-marker allows to influence the intensity of the electron beam via the Z control input of the oscillograph.

To adjust the marker amplitude to the specific requirements of the oscillograph, the position of the jumper X8 on the Digital Board Module is changed (see Table 3-2).

Using the special function (SPEC FUNCT) Z-POL the signal from the Z-marker generator can be inverted, thus allowing to switch between blanking and unblanking of the marked wave points.

Table 3-2 shows the possible settings of the Z-marker generator:

Table 3-2

Position X8	Z-POL	Z-MARKER output
1-2	NORM	0 V - 15 V
1-2	INV	0 V - 15 V
2-3	NORM	+ 15 V 0 V
2-3	INV	+ 15 V 0 V

3.2.8.5 The ARB Editor (EDIT)

General

The ARB editor allows to design fully-arbitrary new waveforms or to modify already existing waves.

The ARB editor is called via the menu key EDIT of the ARB main menu. The MENU display then reads as follows:

PIXEL | INTPL | BLOCK | POOL | QUIT | SAVE

All the editing operations are always referred to the currently active ARB waveform.

Modifications to the signal wave are immediately effective on the output signal of the generator, thus allowing the user immediate visual control.

The ARB editor contains 4 submenus (see Fig. 3-3 for a schematic overview of the complete WAVEFORM menu including the ARB editor): PIXEL, INTPL, BLOCK and POOL.

PIXEL

All editing operations concerning the pixel display are comprised in the submenu PIXEL. With the functions offered in this menu, individual points of the ARB wave can be adjusted in amplitude or be delected, and new points can be added in the wave.

INTPL

The menu key INTPL calls an interpolation menu, which allows the user to automatically create straight lines and polygonal lines.

BLOCK

The BLOCK menu contains commands to delete segments of the currently active waveform, multiply them or insert them at other positions.

POOL

The operations offered in the POOL menu permit to insert, add or multiply complete waveforms from the ARB POOL or the Memory Card in the currently active wave.

QUIT

The ARB editor is exited without saving the signal wave, i.e. all the performed editing operations are undone.

Saving edited ARB waveforms (SAVE)

With the function key SAVE, the edited wave is retained instead of the wave previously stored in the ARB POOL and the ARB editor menu is exited.

Auxiliary facilities for editing

To support the editing operations performed, the marker generator of the ADS channel is automatically set, irrespective of the setting currently valid for the parameter MARK. The marker position defined before selection of the ARB editor remains stored and is automatically reset as soon as the ARB editor menu is exited again.

While editing operations are performed, the MARK connectors [10] are exclusively used as output for a SYNC marker generated synchronously with the first point of a signal period. This SYNC marker is provided as an external trigger signal for the oscillograph connected to the ADS to allow the user visual control of the signals.

At the Z-MARKER output [21] on the rear of the instrument, the current cursor position (X) is output as Z-marker. If a segment is marked in the BLOCK editor, two Z-markers are generated: one Z-marker at the starting position of the selected segment (X1), the second at the end position of this segment (X2). Fig. 3-10 shows the test setup recommended for editing.

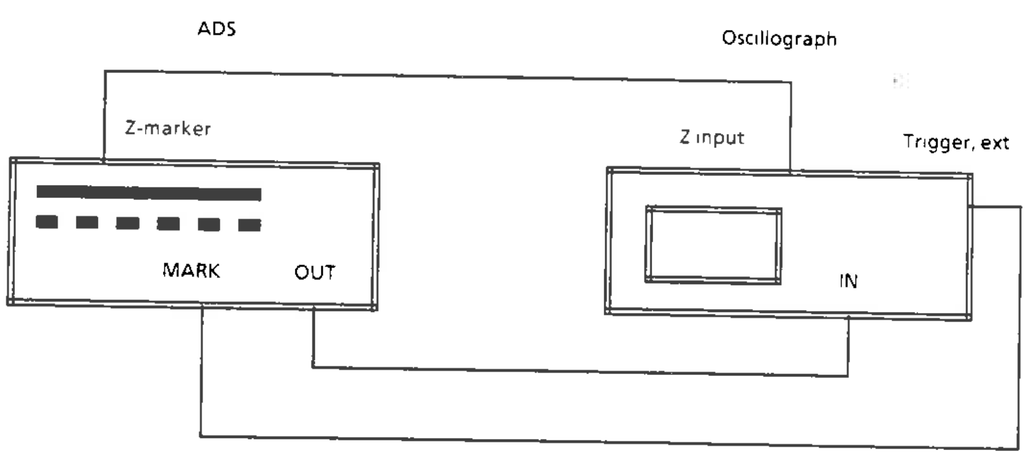


Fig. 3-10

3.2.8.5.1 Editing Specific Points of a Signal Wave (PIXEL)

The editor menu PIXEL can be used to create new ARB signals point by point, to insert new points in an already existing wave, or to delete or modify points of an existing wave.

This menu is accessed by actuating the menu key PIXEL in the ARB EDIT menu. The MENU display then reads as follows:

The meanings of the menu function keys are:

X — Parameter key to enter the cursor position.
Range of values: 1 to 16384

Y — Parameter key to enter the relative amplitude value of the cursor position.
Range of values: -1.0240 to + 1.0235

DEL — Function key to activate the DELete function.

INS-Y — Function key to activate the INSert function.

UNDO — Function key to cancel the editing operation performed last.

3.2.8.5.2 Capabilities of the PIXEL Editor

Adjusting amplitude values

The Y value of the current cursor position X can be adjusted at any time via the DATA entry keyboard or the rotary knob. If the Y value is entered using the DATA entry keyboard [8], the cursor position X is automatically incremented when the ENT key is pressed. This enables complete waveforms to be easily modified.

Inserting new points in a wave (INS-Y)

The INS-Y function is provided to automatically insert new points in a signal wave. The operation is always relevant for the current cursor position X. On actuation of the INS-Y key, the parameter Y is active for entry and the following display appears, for example:

When the data input for the Y value is acknowledged by the ENT key, the new point is inserted at the cursor position X.

The wave point originally located at the insert position as well as all the following points are moved by one position to the right. At the same time, the cursor position is incremented by one count.

The parameter Y remains active, thus allowing entry of an amplitude value of a further point to be inserted. The INS-Y function remains activated until the menu item is left.

Deleting points from the signal wave (DEL)

This is performed analogously to the above insert operation.

To delete the current cursor position, the DEL key is pressed. Simultaneously, all the wave points to the right of the cursor position are shifted left by one position.

The cursor position is maintained so that also the position following the point deleted last can be cleared by pressing the DEL key again.

Creating new ARB signals with the PIXEL editor

The PIXEL editor supports point-by-point generation of new ARB signals by automatically incrementing the cursor position.

After deleting one of the memory locations in the ARB POOL using the DEL function, the PIXEL editor is selected and the cursor position X set to the first point of the newly created waveform (X = 1).

The Y value is entered using the DATA entry keyboard [8] and the data input is then acknowledged with the ENT key. The new point is inserted in the new signal wave and the cursor automatically set to the next position (X = 2). The parameter Y remains activated for entry, so that a further point can be defined for the wave by another data entry. ARB signals can thus be easily and conveniently created point by point, without the user having to specifically enter the cursor position X for each new point.

Extending existing ARB signals

If the cursor position X is moved beyond the defined range, the following is read out for the amplitude value Y:

Y = ----

In this case, the amplitude value can only be entered via the DATA entry keyboard [8]. When the amplitude value Y is entered and the input acknowledged with the ENT key, the existing waveform is automatically extended up to the cursor position X. Points of the wave located between the last defined point and the new cursor position are automatically assigned 0 as Y value.

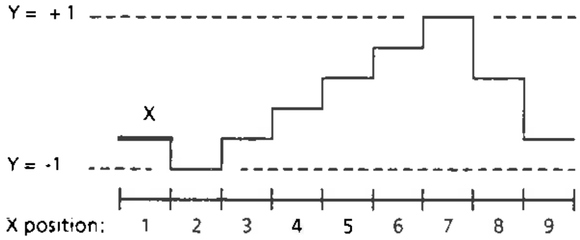
If the Y value is entered using the INS-Y function, the cursor is automatically set to the next position and the parameter Y remains activated for entry.

Possibilities for correction (UNDO)

The UNDO function offered in the EDIT:PIXEL menu permits to cancel the editor operation performed last.

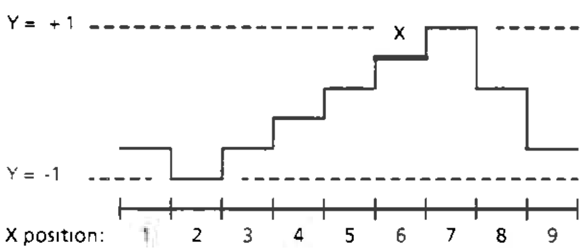
3.2.8.5.3 Examples for the PIXEL Editor

The following ARB waveform is the output signal for the examples given:

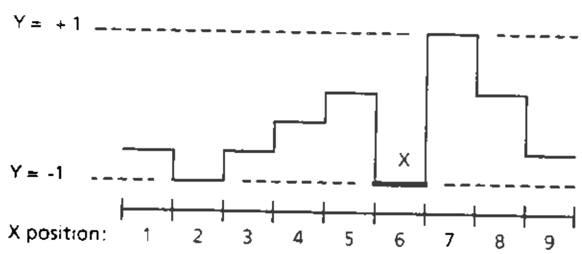


1. Variation of the amplitude value of individual points

Step	Entry	Result
1	MENU X	Shifting the cursor position to the position to be varied. Here: 6
2	DATA 6	
3	DATA ENT	

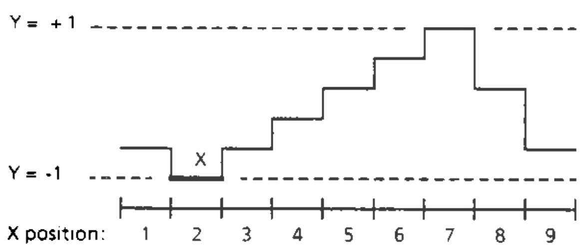


Step	Entry	Result
4	MENU Y	Entering the required amplitude value Y. Here: - 1
5	DATA -	
6	DATA 1	
7	DATA ENT	

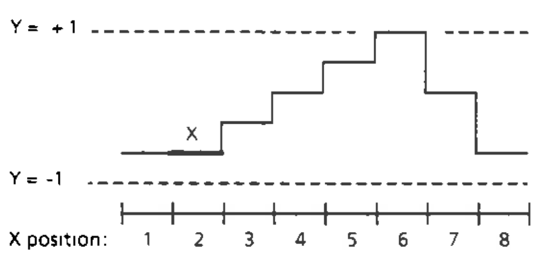


2. Deleting specific points

Step	Entry	Result
1	MENU X	Shifting the cursor position to the position to be deleted. Here: 2
2	DATA 2	
3	DATA ENT	

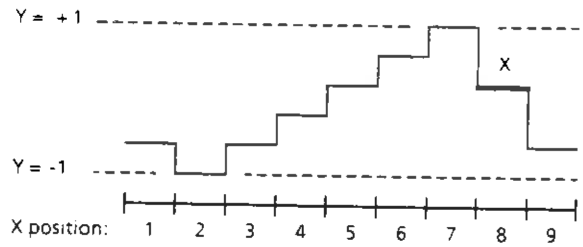


Step	Entry	Result
4	MENU DEL	Deleting the marked point

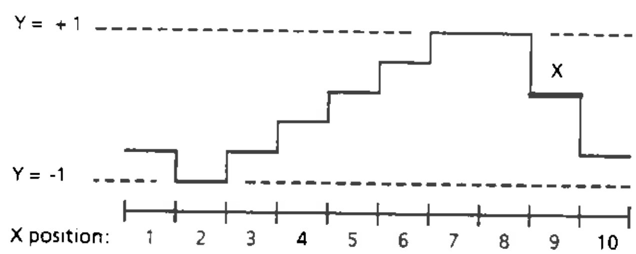


3. Inserting points in the wave

Step	Entry	Result
1	MENU X	Entering the cursor position for the new point to be inserted in the wave. Here: 8
2	DATA 8	
3	DATA ENT	



Step	Entry	Result
4	MENU INS-Y	Entering the amplitude value for the point to be inserted in the wave. Here: + 1
5	DATA 1	
6	DATA ENT	



3.2.8.5.4 Linear Interpolation (INTPL)

The editor menu INTPL allows the user to create straight lines and polygonal lines conveniently and easily.

This menu is accessed from the ARB EDIT menu by actuating the menu function key INTPL:

Meanings of the menu function keys:

X1/Y1 Toggle key to alternately activate either the parameter position (X1) or the parameter amplitude value (Y1) of the starting point of interpolation for entry. The currently active parameter is underlined in the display.

X2/Y2 Toggle key to alternately activate either the parameter position (X2) or the parameter amplitude value (Y2) of the end point of interpolation for entry. The currently active parameter is underlined in the display.

EXEC Function key to execute the interpolation.

UNDO Function key to undo the respectively last interpolation operation.

Functional sequence of the interpolation function

Automatic linear interpolation is initiated in the ADS on actuation of the function key EXEC in the interpolation menu. The starting and the end positions of the required interpolation range as well as the associated amplitude values must have been entered before. After the interpolation is executed, the starting point and the end point of this interpolation range are connected by a straight line.

The values of the interpolation parameters X1, Y1, X2 and Y2 can be exactly entered via the DATA entry keyboard [8] or continuously varied using the rotary knob. When the INTPL menu is selected, the position X1 of the starting point is automatically active for entry.

To allow the user visual control on a connected oscillograph, the start and stop positions are output as Z-markers.

The starting point X1 and the end point X2 of the interpolation range may be set in the already defined wave or also outside. X2 may fall below the value of X1. Erroneous inputs are ignored by the ADS.

Values entered for the amplitude parameter that lie in the already defined wave are immediately effective on the output signal.

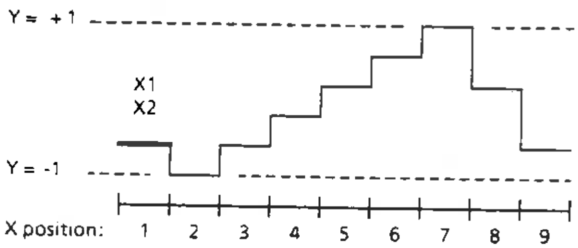
Sections in the existing wave are overwritten by the interpolation. If the starting position is outside the already defined signal wave, all the points between the last wave point and the starting point of the selected interpolation section are automatically assigned the amplitude value 0 once the interpolation is executed.

On completion of the interpolation operation, the starting position X1/Y1 is automatically set to the previous end position X2/Y2 and the parameter X2 activated for entry. This means that only a new end position X2/Y2 is then to be input by the user to further continue interpolation. Thus, curve traces can be created conveniently and easily from straight lines.

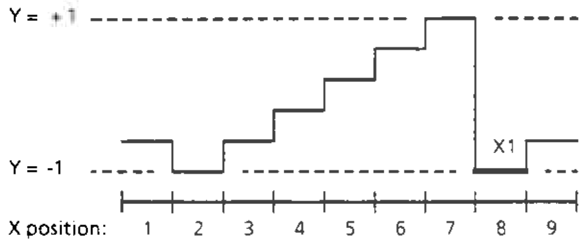
To cancel a currently performed interpolation, the function key UNDO is provided.

3.2.8.5.5 Example for the ARB INTPL Editor

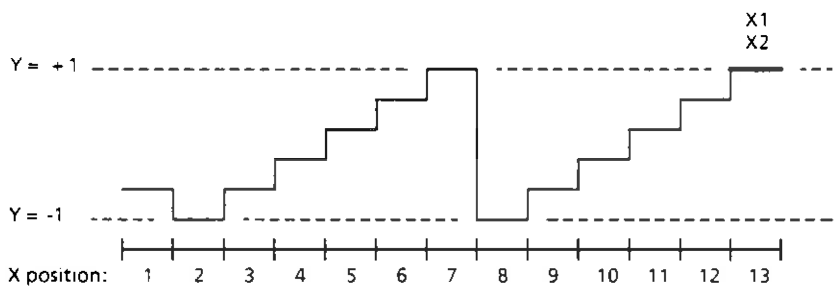
The following ARB waveform is the output signal for the example given:



Step	Entry	Result
1	MENU X1/Y1	Entering the starting position X1, Y1 of the interpolation range Here: X1 = 8, Y1 = -1
2	DATA 8	
3	DATA ENT	
4	MENU X1/Y1	
5	DATA -	
6	DATA 1	
7	DATA ENT	
8	MENU X2/Y2	Entering the end position X2, Y2 of the interpolation range. Here: X2 = 13, Y2 = 1
9	DATA 1	
10	DATA 3	
11	DATA ENT	
12	MENU X2/Y2	
13	DATA 1	
14	DATA ENT	



Step	Entry	Result
15	MENU EXEC	Executing the interpolation function



3.2.8.5.6 Operations with Specific Wave Segments (BLOCK)

The BLOCK editor menu offers functions to delete segments from the currently active ARB wave, to move them or duplicate them at any other positions. With this BLOCK editor, complete ARB signals can be easily modified with few entries.

To access the BLOCK editor menu, the key BLOCK in the ARB editor menu is pressed:

X1	X2	COPY	DEL	INS	RET

Meanings of the menu function keys:

X1 — Menu key to activate the limit value X1 for entry.

X2 — Menu key to activate the limit value X2 for entry.
X2 also marks the position where the contents of the internal editor memory is to be inserted in the curve trace using the INS function.

COPY — Function key to copy the marked segment of the signal wave to the internal editor memory.

DEL — Function key to delete the marked segment.
DEL automatically copies the marked range to the internal editor memory.

INS — Function key to insert the contents of the editor memory starting from position X2.

3.2.8.5.7 Capabilities of the ARB BLOCK Editor

Marking a specific segment of the wave (X1, X2)

On selection of the BLOCK editor, the limit values X1 and X2 are automatically set to the limits of the valid ARB signal and output as Z-markers on a connected oscillograph for visual control of the signal.

X1 and X2 can be exactly entered via the DATA entry keyboard [8] or also continuously varied to any position of the active ARB wave using the rotary knob.

Copying the marked segment into the editor memory (COPY)

When the function key COPY is pressed, a copy of the marked segment is saved in the internal editor memory. As long as this editor memory is not overwritten by further COPY or DEL operations, its contents is available for editing operations.

The COPY and INS functions can be used to insert segments from one ARB waveform into another wave. New ARB waves can thus be designed conveniently and easily from segments of already existing waves.

Deleting the marked segment (DEL)

On actuation of the function key DEL, the marked segment of the ARB signal waveshape is deleted including the limit values. At the same time, a copy of this deleted segment is saved in the internal editor memory. The limit values X1 and X2 are set to the ARB signal position following the segment deleted and X2 is active for entry.

A delete operation currently performed can be cancelled again by actuating the INS key.

Inserting the contents of the editor memory (INS)

When the function key INS is pressed, the current contents of the internal editor memory is inserted in the active ARB waveform starting from position X2. The previous point of the wave located at position X2 and all the following points are moved a distance equal to the length of the inserted segment to the right.

The insert position X2 can be set to any position on the ARB wave or outside. Points between the last point of the ARB wave and the insert position X2 are then automatically assigned the amplitude value 0 when the INS key is pressed.

Once the INS operation is executed, the limit values X1 and X2 are automatically set as limits of the newly inserted segment, so that the INS operation can be easily undone by actuating the DEL key.

The contents of the editor memory is not changed when the INS function is applied.

Relocating segments of the signal wave

If a specific segment of the active ARB signal is to be moved to another location, first a DEL operation is to be carried out.

Once this delete operation is executed, the segment to be moved is saved as copy in the internal editor memory and the insert position X2 is activated for entry.

When the insert position X2 is then entered, the segment currently deleted is reinserted from the editor memory in the wave starting from position X2 on actuation of the INS function key.

Duplicating segments of the signal wave

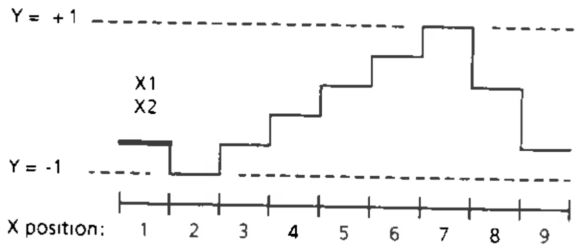
To duplicate a segment of an ARB waveshape, this segment must first be copied into the editor memory using the COPY function.

The contents of the internal editor memory can then be reinserted at any position of the ARB wave or also outside using the INS function. The parameter X2 defines the insert position. In this case, the limit values X1 and X2 are always assigned to the segment inserted last.

If a segment is to be inserted several times, it must be ensured that the insert position X2 is moved by one position to the right before each INS operation.

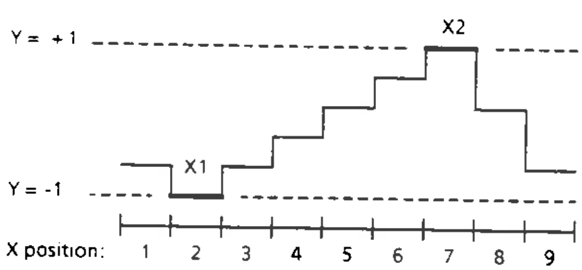
3.2.8.5.8 Examples for the ARB BLOCK Editor

The following ARB waveform is the output signal for the examples given:

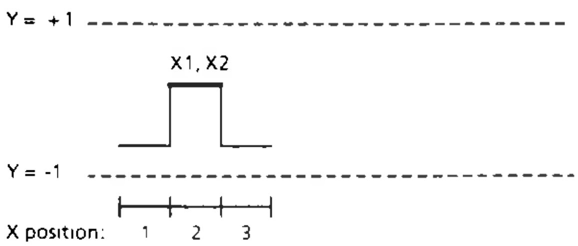


1. Deleting a segment from the signal wave

Step	Entry	Result
1	MENU X1	Entering the limit value X1. Here: X1 = 2
2	DATA 2	
3	DATA ENT	
4	MENU X2	Entering the limit value X2. Here: X2 = 7
5	DATA 7	
6	DATA ENT	

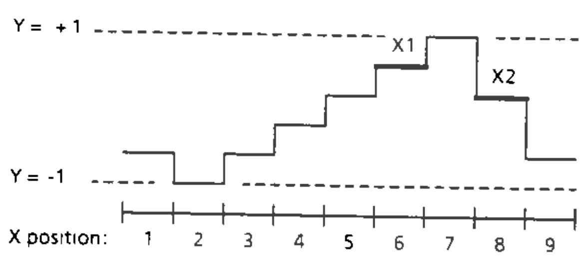


Step	Entry
7	MENU DEL

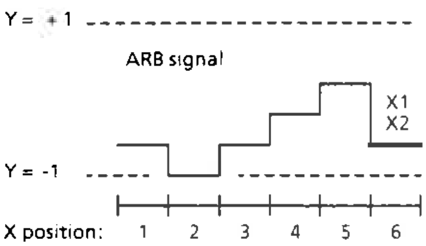


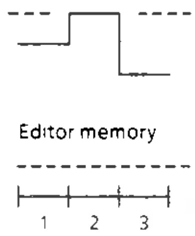
2. Relocating a segment of the signal wave

Step	Entry	Result
1	MENU X1	Entering the limit value X1. Here: X1 = 6
2	DATA 6	
3	DATA ENT	
4	MENU X2	Entering the limit value X2. Here: X2 = 8
5	DATA 8	
6	DATA ENT	

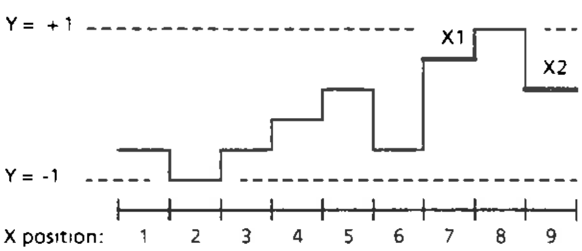


Step	Entry	Result
7	MENU DEL	Deleting the marked segment



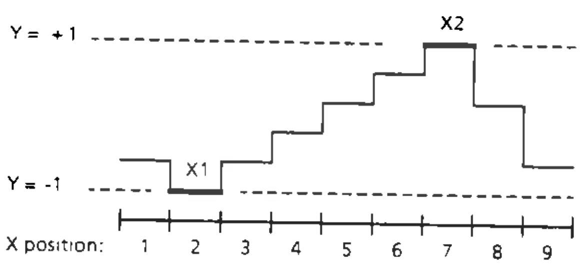


Step	Entry	Result
8	MENU X2	Entering the insert position. Here: 7
9	DATA 7	
10	DATA ENT	
11	MENU INS	Inserting the contents from the editor memory.

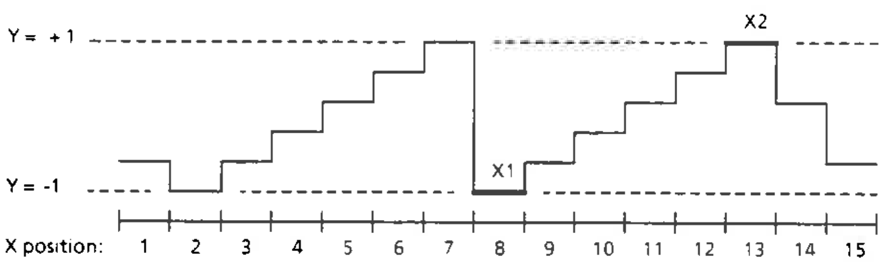


3. Duplicating a segment of the signal wave

Step	Entry	Result
1	MENU X1	Entering the limit value X1. Here: X1 = 2
2	DATA 2	
3	DATA ENT	
4	MENU X2	Entering the limit value X2 Here: X2 = 7
5	DATA 7	
6	DATA ENT	
7	MENU COPY	Copying the marked segment into the editor memory.



Step	Entry	Result
8	MENU X2	Entering the insert position X2. Here: X2 = 8
9	DATA 8	
10	DATA ENT	
11	MENU INS	Inserting the contents from the editor memory



3.2.8.5.9 Combining ARB Signals (POOL)

Using the ARB POOL editor menu, complete ARB waveforms stored in the ARB POOL or on the Memory Card can be inserted at any position in the active ARB signal, be multiplied with it or superposed on it.

To access the POOL editor menu, the function key POOL in the ARB editor menu is pressed:

X	INS-N	ADD-N	MUL-N	UNDO	RET

Meanings of the menu function keys:

X — Parameter key to activate the cursor position X for entry. X marks the position where the waveshape selected from the ARB POOL is to be joined up with the active ARB signal.

INS-N — Menu key to select the insert function. INS-N activates the memory location N of the ARB POOL or the Memory Card[1] for selecting the ARB waveshape to be inserted.

ADD-N — Menu key to select the add function (superposition). As with the INS-N function, ADD-N activates the memory location N of the ARB POOL or the Memory Card[1] for selecting the ARB waveshape to be superposed on the active ARB signal.

MUL-N — Menu key to select the multiply function. Again, MUL-N activates the memory location N of the ARB POOL or the Memory Card[1] for selecting the ARB waveshape to be multiplied with the active ARB signal. Possibility of amplitude modulation.

UNDO — Function key to undo the operation last performed.

[1] Waveforms stored on the Memory Card are accessed using the memory locations N = 100 to 199. If N is selected from the range 100 to 199, the waveform (N-100) on the Memory Card is loaded and inserted into the active ARB waveform. If there is no Memory Card in the insert slot [11], the entry is ignored.
The internal ARB POOL is accessed using the memory locations N = 0 to 99.

3.2.8.5.10 Capabilities of the ARB POOL Editor

Inserting ARB waveshapes from the ARB POOL (INS-N)

The insert function INS of the POOL editor menu can be used to insert waveforms saved in the ARB POOL or stored on the Memory Card[1] in the active ARB signal.

The cursor X marks the position where the waveform selected is inserted. X can be set to any position on the active ARB signal wave or also outside, as long as the sum of resulting points per ARB waveform is not greater than 16384. If the waveform selected is inserted at a position outside the active ARB wave, the points between the end point of the ARB signal and the insert position are automatically assigned the amplitude value 0.

To allow the user visual control of the signal on a connected oscillograph, the cursor position X is output as Z-marker.

The ARB wave to be inserted is selected by pressfing the menu key INS-N. When the memory location N, where the waveform to be inserted is stored in the ARB POOL, is entered and the entry acklowledged, the wave is inserted in the active ARB wave starting from position X.

On completion of this INS-N operation, the cursor position X is set to the first position after the inserted ARB waveform and is active for entry. Complex ARB signals can thus be conveniently and quickly designed from the waveshapes stored in the ARB POOL by successive insert operations.

The waveform inserted last can be deleted again using the UNDO function.

Superposing ARB signals (ADD-N)

The add function ADD-N permits to superpose waves from the ARB POOL on any position of the active ARB signal. A possible application of this ADS feature is the superposition of interfering signals stored in the ARB POOL.

The cursor X marks the starting position from where both signals are superposed. The superposing signal is selected analogously to the INS-N function on actuation of the ADD-N key. When the memory address N, where the waveform to be superposed on the active signal is stored in the ARB POOL, is entered and the entry acknowledged, superposition is effective.

If the length of the overlay waveform exceeds that of the active ARB signal, the portion of the overlay waveform that exceeds the length of the active ARB signal is discarded, leaving the length of the active ARB signal unchanged. If the sum of the amplitude values exceeds the displayable range (-1.0240 to + 1.0235), the maximum value is the limit.

The ADD-N operation performed last can be cancelled again with the UNDO function.

Multiplying ARB signals (MUL-N)

This function MUL-N allows the user to multiply the active ARB signal with a waveshape stored in the ARB POOL at any position X. This feature of the ADS is for example suitable for blanking the active ARB signal by way of multiplication with a square wave function, or for generating mixtures of both signals.

If the length of the waveform to be multiplied exceeds the length of the active signal, the portion of this waveform that exceeds the length of the active signal is discarded, as was done with the ADD-N function. The length of the active ARB signal is left unchanged.

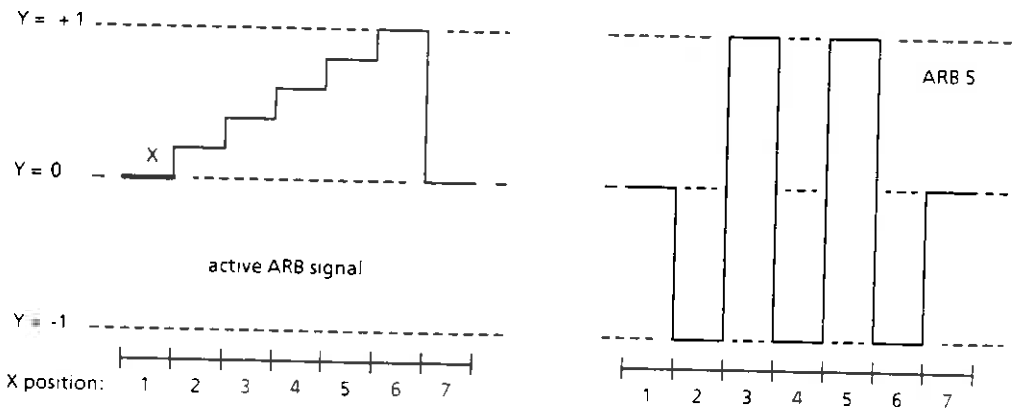
The signal for multiplying is selected by actuating the menu key MUL-N.

Again, the UNDO function is provided to cancel the MUL-N operation performed last.

[1] With regard to accessing waveforms of a Memory Card, see the footnote to 3.2.8.5.9.

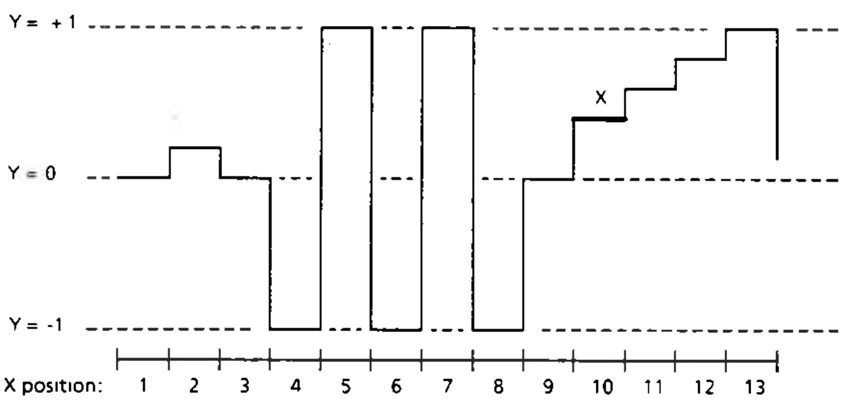
3.2.8.5.11 Examples for the ARB POOL Editor

The examples given in this section to specify the capabilities of the ARB POOL editor are based on the ARB output signals shown.



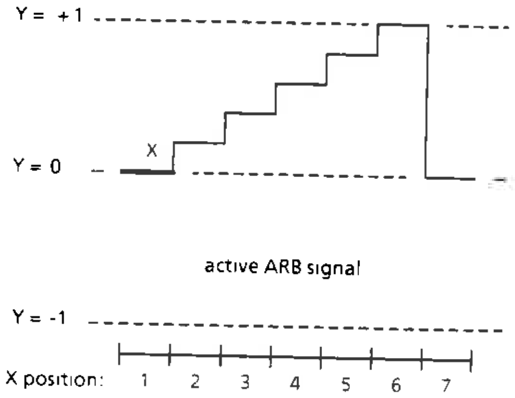
1. Inserting an ARB signal wave

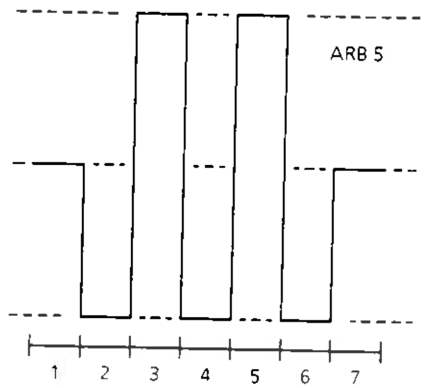
Step	Entry	Result
1	MENU X	Entering the insert position. Here: X = 3
2	DATA 3	
3	DATA ENT	
4	MENU INS-N	Selecting a waveshape from the ARB POOL for insertion. Here: ARB 5
5	DATA 5	
6	DATA ENT	Acknowledging entry. insertion of the selected wave.



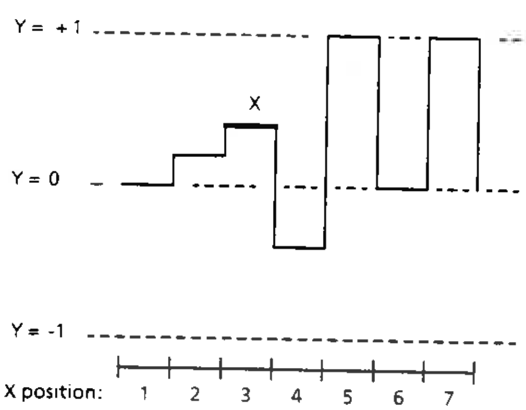
2. Superposing an ARB signal

Output signals:



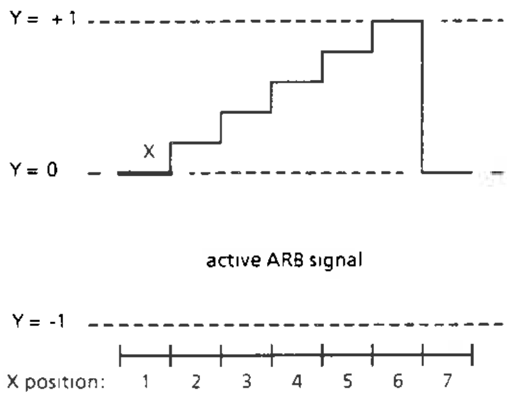


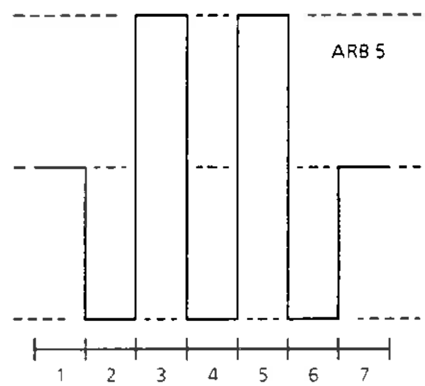
Step	Entry	Result
1	MENU X	Entering the cursor position X where the signal ARB 5 is to be added. Here: X = 3
2	DATA 3	
3	DATA ENT	
4	MENU ADD-N	Selecting the superposing signal from the ARB POOL. Here: ARB 5
5	DATA 5	
6	DATA ENT	Acknowledging entry. Superposition of the selected signal.



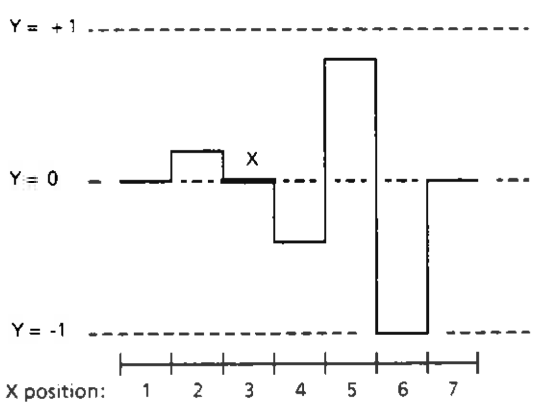
3. Multiplying an ARB signal

Output signals:





Step	Entry	Result
1	MENU X	Entering the cursor position X where the signal ARB 5 is to be multiplied. Here: X = 3
2	DATA 3	
3	DATA ENT	
4	MENU MUL-N	Selecting the signal for multiplying from the ARB POOL. Here: ARB 5
5	DATA 5	
6	DATA ENT	Acknowledging entry. Multiplication of the selected signal.



3.2.8.6 ARB MODEs

In addition to the continuous mode CONT, also five triggered operating MODEs are available in ARB operation of the ADS:

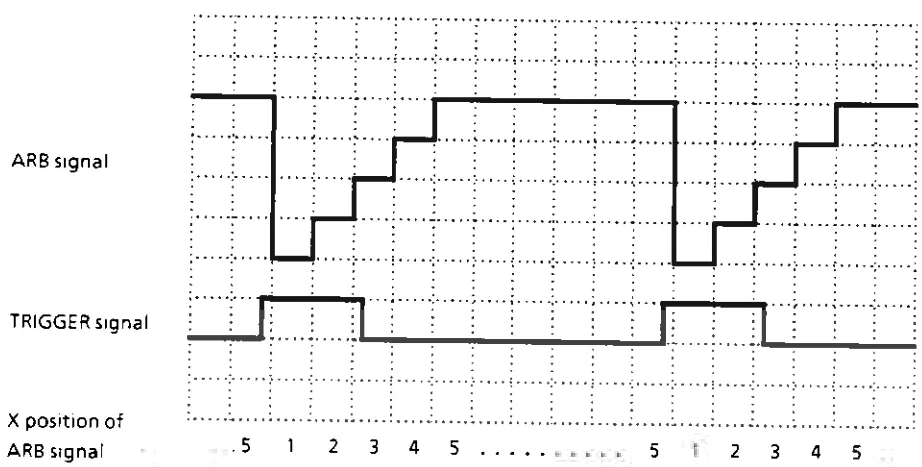
- Single mode (SINGL)
- Gate mode (GATE)
- Reset mode (RESET)
- Hold mode (HOLD)
- Hold/Reset mode (HD/RS)

The operating mode required is selected via the key MODE in keypad SELECT. On actuation of this key, the MODE menu for ARB waveform operation is read out in the MENU display:

The trigger source to control the triggered MODEs is selected from the TRIGGER menu, which is accessed via the key TRIGGER in the keypad SELECT.

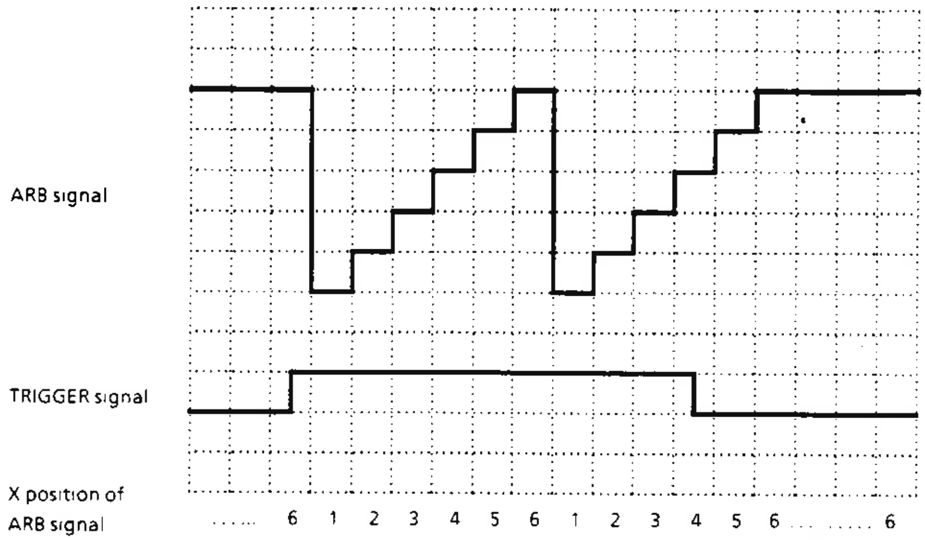
3.2.8.6.1 MODE SINGL

In the operating mode SINGL, each rising edge of the trigger signal initiates the output of a single oscillation of the selected ARB signal. Output of the amplitude values is always stopped at the last position of one full signal cycle, so that the amplitude value of the last point is present at the instrument output until the next rising trigger edge occurs. Trigger edges occurring during a signal cycle are ignored. If manual triggering is selected with the MAN key [14], each actuation generates a rising trigger edge.



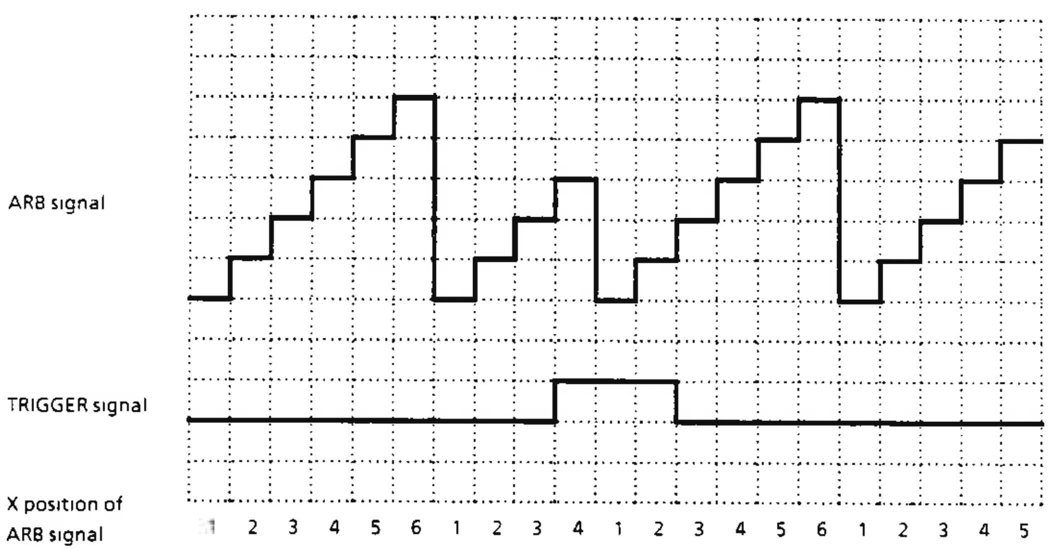
3.2.8.6.2 MODE GATE

In operating mode GATE, the sequence of signal generation is controlled by the logic state of the trigger signal. When the trigger signal changes from HIGH to LOW, output of the amplitude values is stopped as soon as the last value of a signal cycle is reached. Further output of the ARB signal is started again with the next rising trigger edge. With manual triggering, the state of the trigger signal changes each time the MAN key is actuated.



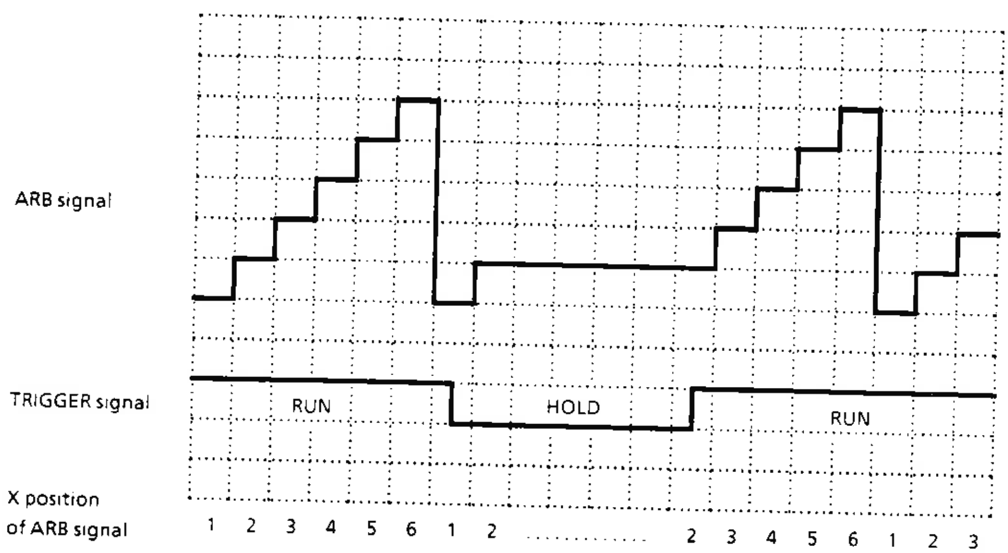
3.2.8.6.3 MODE RESET

When RESET mode is selected, each rising edge of the trigger signal restarts generation of the ARB signal. With manual triggering, a rising trigger edge is generated each time the MAN key is pressed.



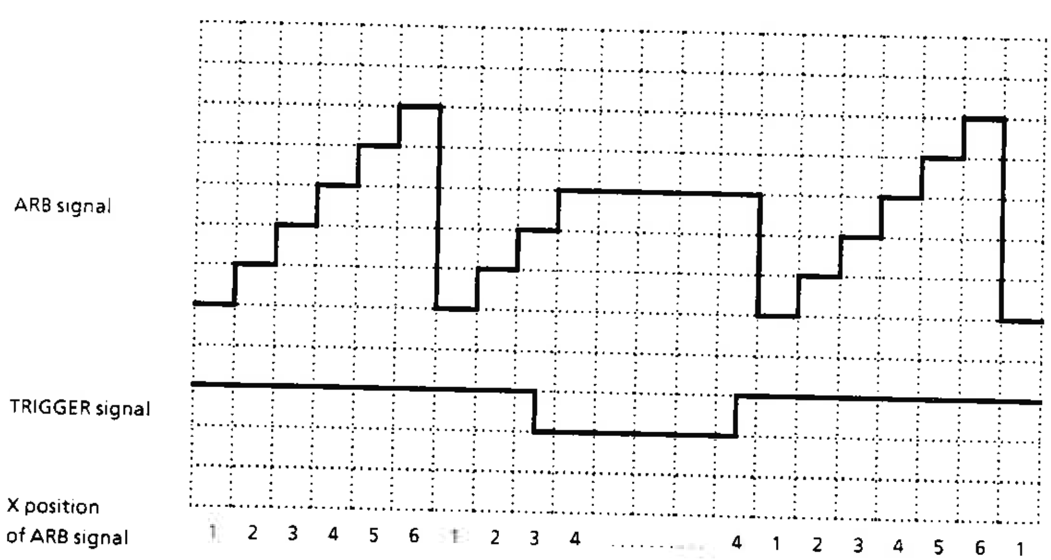
3.2.8.6.4 MODE HOLD

The operating mode HOLD permits to interrupt the output of amplitude values controlled by the logic state of the trigger signal. As long as the trigger signal is HIGH, the amplitude values of the ARB signal are continuously output. When it changes to LOW, output is stopped and the amplitude value of the point generated last is output. The output of the next amplitude value is initiated again as soon as the trigger signal changes back to HIGH. If manual triggering is selected, the state of the trigger signal is changed each time the MAN key is pressed.



3.2.8.6.5 MODE HD/RS

Basically, this hold/reset mode gives the same type of action as the above MODE HOLD. However, in contrast thereto, generation of the ARB cycle is restarted when the trigger signal changes from LOW to HIGH.



3.2.9 Generating ARB Sequences (WAVEFORM:SEQ)

The WAVEFORM:SEQ mode implemented in the ADS allows the user to generate composite signal sequences not to be designed with the usual ARB generators due to the limited waveform memory capacity of these generators. SEQ operation is based on the functioning principle that different ARB waves stored in the ARB POOL can be cyclically output in a sequence individually programmed by the user. This additional capability offered by the ADS to generate each of the ARB signals with an individual repetition rate and at the same time different read clock frequency allows for a broad range of applications so far not available on other ARB generators.

A typical application of the WAVEFORM:SEQ functions is the generation of video test signals, another application is the simulation of rarely occurring signal interferences.

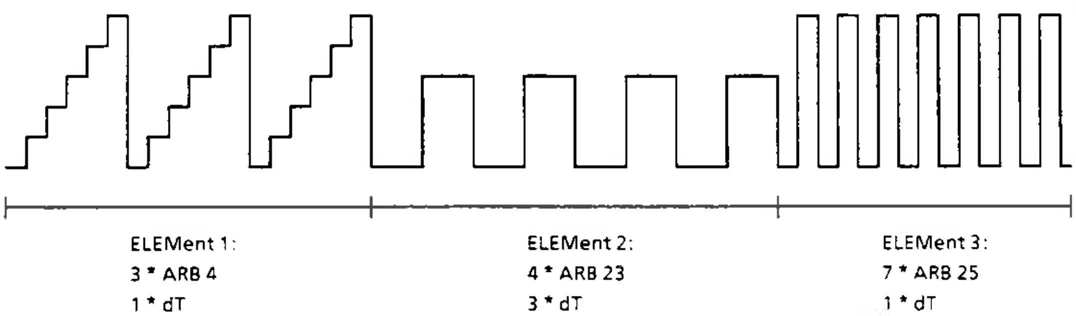
3.2.9.1 Structure of an ARB Sequence

An ARB sequence may contain up to 8191 different sequence elements (ELEM).

One sequence element contains a programmable number of N cycles of a wave stored in the ARB POOL. The number of these ARB cycles N comprised in a sequence element may range from 1 to 65.535.

In addition to the number of ARB periods, an individual expansion factor can be defined for each ELEMent. The expansion factor (N*dT) is always referred to the period of the read clock currently valid for the element and can be adjusted in a range of values from 1 to 65.535.

Example of a sequence comprising three elements:



The SEQ POOL

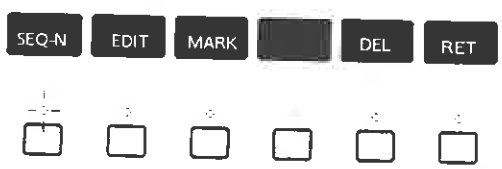
Analogously to the ARB POOL, up to 100 different sequences can be defined and retained in the SEQ POOL. All the ARB sequences stored in the SEQ POOL can be called into the working memory of the ADS for output at any time and are available to the user for editing purposes. The POOL addresses (0 to 99) serve to select the required ARB sequence, which is stored under the respective number in the SEQ POOL.

3.2.9.2 The SEQ Menu

When ARB:SEQ operation is selected on actuation of the menu function key SEQ in the main menu WAVEFORM, always the wave sequence generated last is automatically loaded from the SEQ POOL and output with the current parameter set.

The display shows the number assigned to the sequence, the current MODE, the number of elements contained in the sequence and the currently set period of the read clock dT:

Simultaneously, the SEQ menu functions are read out in the MENU display:



The LED assigned to the menu key SEQ-N lights up, indicating that the parameter SEQ-N is activated for DATA input. Thus, any wave sequences stored in the SEQ POOL can be selected for output.

The function menu keys basically correspond to those of the ARB menu:

SEQ-N — Parameter key to select a sequence in the SEQ POOL.

EDIT — Menu key to select the SEQ editor. Refer to Section 3.2.9.6 for detailed information about the SEQ editor.

MARK — Parameter key to activate the position of the sequence marker for entry (see Section 3.2.9.5).

DEL — Menu key to delete an ARB sequence from the SEQ POOL (see Section 3.2.9.4).

3.2.9.3 Loading a Sequence from the SEQ POOL (SEQ-N)

To call a sequence stored in the SEQ POOL, the parameter SEQ-N of the SEQ menu must be assigned the number N of the memory location where the required sequence is stored. This POOL address can be exactly entered via the DATA entry keyboard [8] or also continuously adjusted with the rotary knob [5].

Example:

Loading sequence 7 from the SEQ POOL

Step	Entry	Result
1	MENU SEQ-N	Activating parameter SEQ-N for entry
2	DATA 7	Entering required address number 7.
3	DATA ENT	Termination of entry by acknowleding with the ENT key.

3.2.9.4 Deleting a Sequence from the SEQ POOL (DEL)

The wave sequence currently displayed can be deleted by actuating the menu key DEL in the SEQ menu. For protection against maloperation, the delete instruction must be acknowledged in a submenu before it is effective.

Example:

Deleting the ARB sequence SEQ 12

Step	Entry	Result
1	MENU SEQ-N	Activating the parameter SEQ-N to specify the ARB sequence to be deleted
2	DATA 1	DATA entry
3	DATA 2	DATA entry
4	DATA ENT	Acknowledging DATA entry
5	MENU DEL	Selecting the delete function
6a	MENU YES	Acknowledging the delete instruction - return to the SEQ main menu
6b	MENU NO	Abort and return to the SEQ menu

3.2.9.5 Marking Specific Elements in the Sequence (MARK)

The ADS contains a programmable sequence marker generator. It can be used to specifically assign a sequence marker to any element of the active wave sequence. The marker remains active during the complete sequence run of the marked element and is output both as TTL-compatible signal via the MARK connector [10] of the respective channel and as Z-marker via the Z-MARKER output [21] of this channel on the rear.

When an ARB sequence is selected, the sequence marker is first generated synchronously with the first element of the sequence. The sequence marker can be programmed using the parameter MARK of the SEQ menu.

3.2.9.6 The Sequence Editor (EDIT)

General

The SEQ editor permits to design fully-arbitrary ARB wave sequences or to modify already existing sequences.

The SEQ editor is structured analogously to the ARB editor described in Section 3.2.8.5. It is selected by pressing the menu key EDIT of the SEQ menu:

ELEM | BLOCK | POOL | | QUIT | SAVE

All editing operations performed are referred to the currently active ARB sequence.

Modifications to the sequence are immediately effective for the output signal of the generator, thus allowing the user immediate visual control.

The SEQ editor contains 3 submenu (see Fig. 3-3 for a schematic overview of the complete WAVEFORM menu including the SEQ editor). These submenus are: ELEM, BLOCK und POOL.

ELEM

The submenu ELEM corresponds to the menu PIXEL of the ARB editor, comprising all the editing operations to be performed with individual ELEMents of the wave sequence. Using the operations offered in this menu, the signal waveform, the repetition rate or the expansion factor of individual elements of the sequence can be varied.

BLOCK

The BLOCK menu contains commands to delete specific segments of the active sequence, to relocate or multiply them.

POOL

The function operations offered in the POOL menu permit to insert complete sequences from the SEQ POOL or from the Memory Card[1)] in the active sequence.

QUIT

The SEQ editor is exited without saving of the signal sequence, i.e. all performed editing operations are undone.

SAVE

Saving edited ARB sequences. With the function key SAVE, the edited sequence is retained in the SEQ POOL instead of the previously stored sequence and the SEQ editor menu is exited.

Auxiliary facilities for editing

While editing operations are performed, the sequence marker generator is automatically set to the sequence element to be edited, irrespective of the setting currently valid for the parameter MARK. As the sequence marker is at the same time output as Z-marker via the Z-MARKER output on the rear, the element to be edited can be unblanked or blanked via the Z-control input of a connected oscillograph, thus allowing the user visual control of the signal.

The marker position defined before selection of the SEQ editor is retained and automatically reset when the editor is exited.

3.2.9.6.1 Editing Individual Sequence Elements (ELEM)

The editor menu ELEM can be used to create new ARB wave sequences element by element, to insert new elements in an already existing sequence, or to delete or modify elements of an existing sequence.

The menu is accessed by actuating the menu key ELEM in the SEQ:EDIT menu:

ELM-I | INS-N | N*ARB | N*dT | DEL | RET

The meanings of the menu keys are:

ELM-I — Parameter key to activate sequence position I (I[th] element) for entry. ELM-I corresponds to the cursor position X of the ARB editor.

INS-N — Menu key to select the INSERT function. At the touch of the key, the number N of the memory location, where the ARB waveform to be inserted as sequence element is stored in the ARB POOL or on a Memory Card[1)], is activated for entry.

N*ARB — Parameter key to activate the repetition factor for the ARB wave, which is selected as sequence element, for entry.

N*dT — Parameter key to activate the expansion factor for the element shown for entry.

DEL — Function key to delete the element shown (sequence position I) from the sequence.

1) Sequences stored on the Memory Card are accessed using the memory locations N = 100 to 199. If N is selected from the range 100 to 199, the sequence (N-100) on the Memory Card is loaded and inserted into the active sequence. If there is no Memory Card in the insert slot [11], the entry is ignored.
The internal SEQ POOL is accessed using the memory locations N = 0 to 99.

3.2.9.6.2 Capabilities of the SEQ ELEM Editor

Creating new ARB sequences

If the user wishes to design a new sequence, first one of the stored sequences will as a rule need to be deleted using the DEL function. After deletion, the element index I is set to the value 1 (sequence position 1).

An ARB waveform is inserted using the INS-N function. After entering the ARB waveform number N of a sequence element using the DATA entry keyboard [8] and then pressing the ENT key, the ARB waveform N is inserted at position I = 1 in the sequence. The element index I is automatically set to the next value. The INS-N function remains active so that additional ARB waveforms can be inserted. Initially, the repetition factor (N∗ARB) and the expansion factor (N∗dT) are set to the default value of 1, they can subsequently be programmed.

Variation of element parameters

To vary the parameters of a sequence element, this element must first be selected from its position in the sequence and be output in the display. The index ELM-I corresponds to the position of the element in the sequence. When activated, the parameters can be varied via the parameter keys N∗ARB or N∗dT either using the DATA entry keyboard [8] or the control knob [5].

If the ARB waveform number needs to be changed, the selected sequence element must first be deleted using the DEL function and then inserted again using the INS-N function and the changed ARB waveform number. It should be noted that the parameters N∗ARB and N∗dT are in the process set to 1 and may possibly need to be adjusted.

Example:

Variation of element parameters

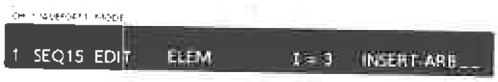
Step	Entry	Result
1	MENU ELM-I	Selecting the fourth element
2	DATA 4	
3	DATA ENT	
4	MENU N*ARB	Programming the repetition factor
5	DATA 3	
6	DATA ENT	
7	MENU N*dT	Programming the expansion factor
8	DATA 2	
9	DATA ENT	

Following this entry, the fourth element of the sequence consists of 3 cycles of the ARB waveform that was previously selected using INS-N. Each cycle of the waveform is expanded by a factor of 2, doubling the read clock period Δt.

Inserting new elements (INS-N)

The INS-N function allows the insertion of new elements in the sequence at sequence position I.

On actuation of the key INS-N, first the ARB signal to be inserted is activated for entry and the following display appears, for example:



When the ARB POOL address or the Memory Card address (see footnote section 3.2.9.6.1) of the desired ARB waveform is entered and the entry acknowledged by ENT, the ARB waveform is inserted as a new element at position I of the sequence. The element that was originally located at position I and all of the following elements are moved to the right by one position. At the same time, position I is automatically set to the next value. The INS-I function remains active, so that by entering an ARB POOL address, a second ARB waveform can be inserted at the new sequence position I (= I_{old} + 1). The repetition factor and the expansion factor of the new element in the sequence are initially set to 1, they can be subsequently edited by the user (see "Variation of element parameters").

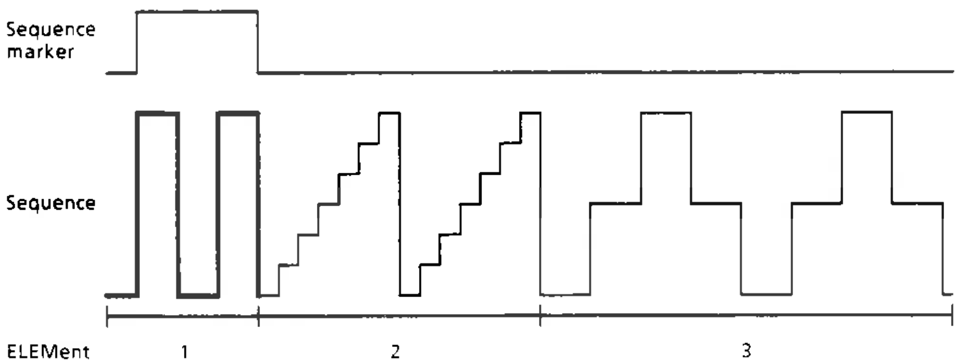
The element just inserted in the sequence can also be cleared again using the DEL key.

Deleting elements from the sequence (DEL)

The function DEL clears the element shown in the display from the sequence. At the same time, all the elements following the wave section deleted are moved to the left by one position. The cursor position is maintained, so that also the next element can be deleted conveniently by striking the DEL key again. Thus, complete sections of a sequence can be deleted easily by pressing the DEL key as often as required.

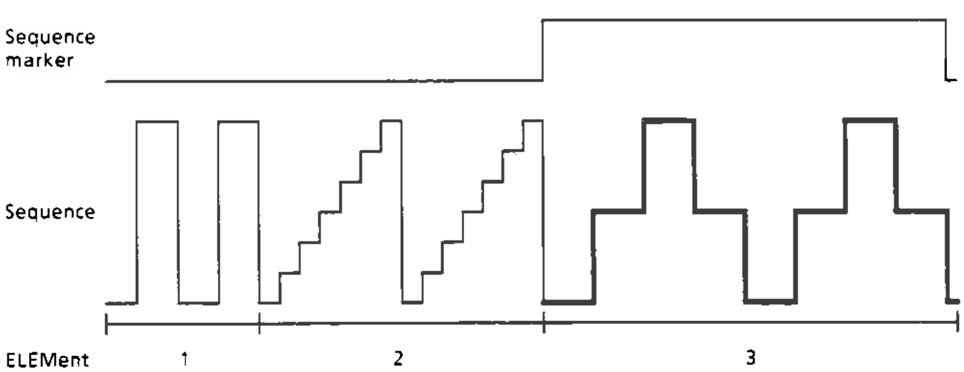
3.2.9.6.3 Examples for the SEQ ELEM Editor

The following ARB sequence composed of three elements is the output signal for the examples given:

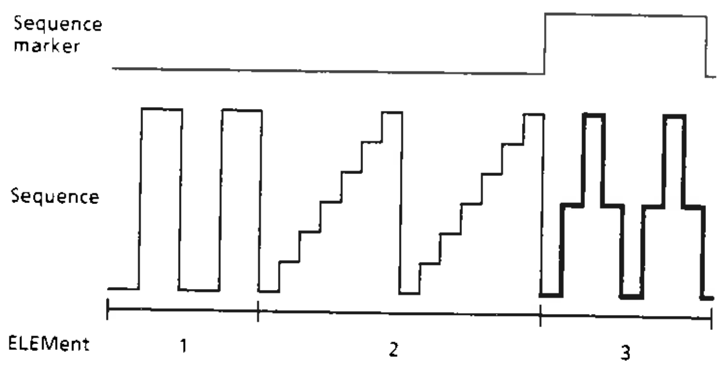


1. Variation of element parameters

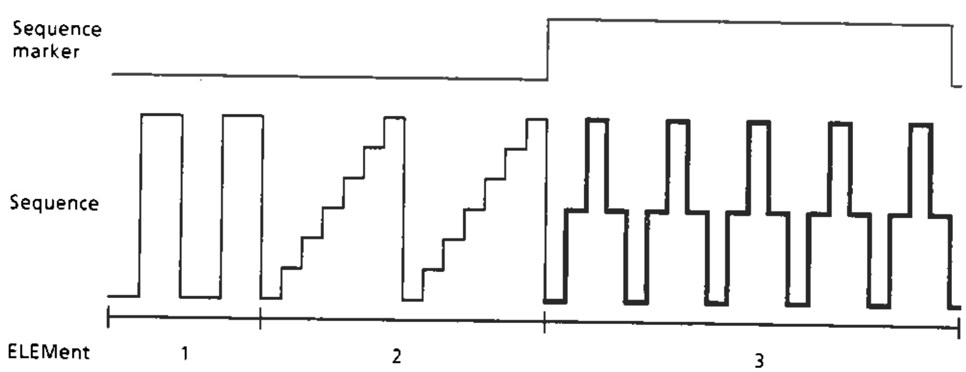
Step	Entry	Result
1	MENU ELM-I	Selecting the element to be modified. Here: element index 3 (position 3)
2	DATA 3	
3	DATA ENT	



Step	Entry	Result
4	MENU N*dT	Variation of the expansion factor of element 3 from 3 to 1
5	DATA 1	
6	DATA ENT	

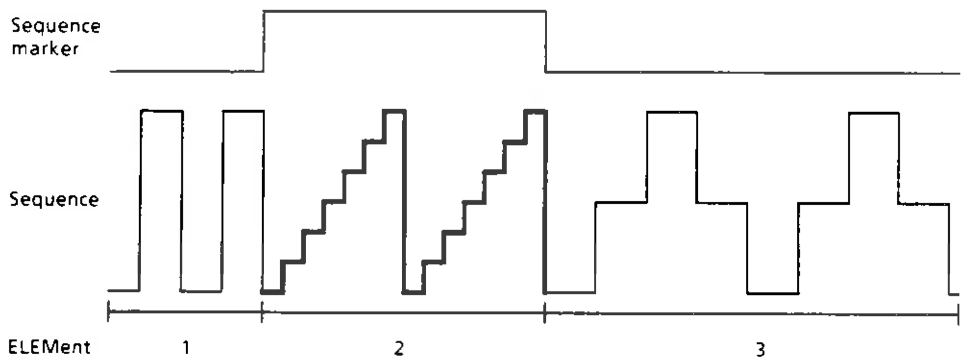


Step	Entry	Result
7	MENU N*ARB	Variation of the repetition factor N*ARB from 2*ARB to 5*ARB
8	DATA 5	
9	DATA ENT	

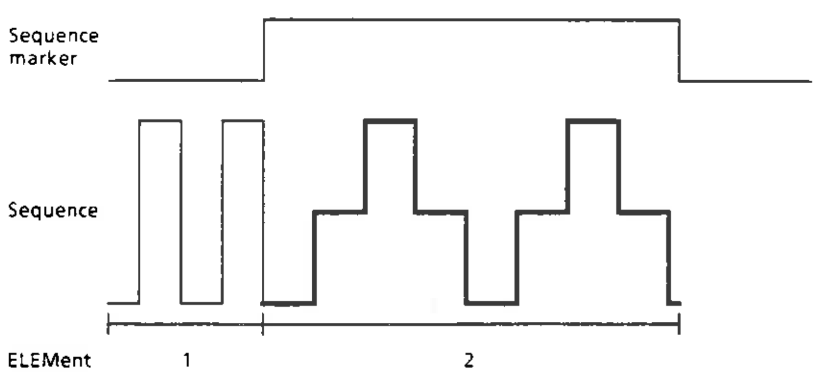


2. Deleting an element

Step	Entry	Result
1	MENU ELM-I	Selecting the element to be deleted. Here: element 2 (position 2)
2	DATA 2	
3	DATA ENT	

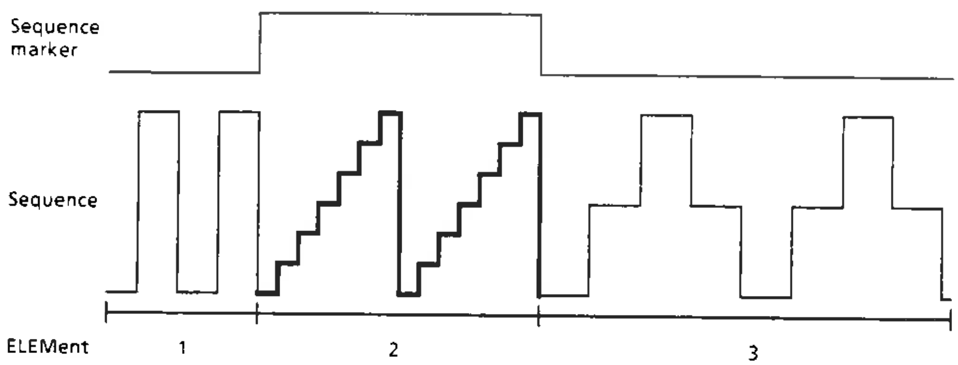


Step	Entry	Result
4	MENU DEL	Deleting the element marked

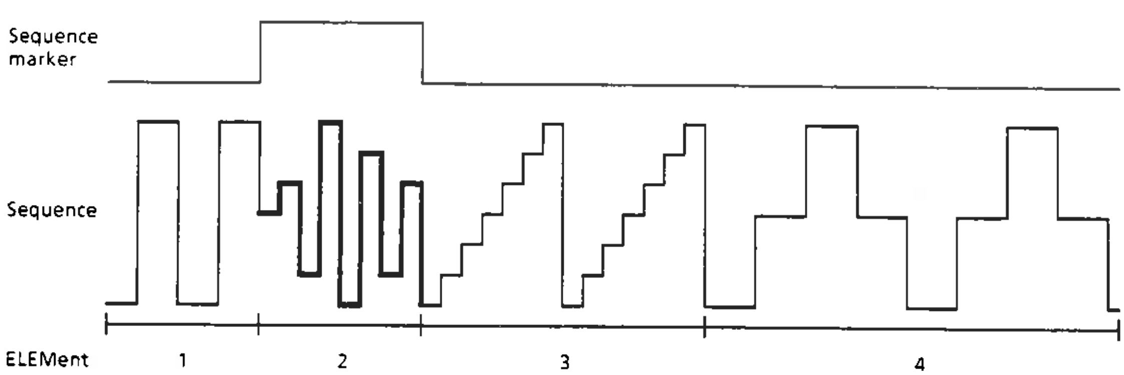


3. Inserting an element

Step	Entry	Result
1	MENU ELM-I	Entering the sequence position where a new element is to be inserted. Here: 2
2	DATA 2	
3	DATA ENT	



Step	Entry	Result
4	MENU INS-N	Inserting ARB waveform ARB 3
5	DATA 3	
6	DATA ENT	



3.2.9.6.4 Operations with Individual Segments of the Wave Sequence (BLOCK)

Analogously to the ARB BLOCK editor, the SEQ BLOCK editor offers functions to delete segments from the currently active ARB sequence, to move them or duplicate them at another position. With this BLOCK editor, complete ARB sequences can be modified easily with few entries.

To access the BLOCK editor menu, the key BLOCK in the SEQ editor menu is actuated:

Meanings of the menu function keys:

I1 — Parameter key to activate the limit value I1 for entry.

I2 — Parameter key to activate the limit value I2 for entry.
I2 also marks the sequence position where the contents of the editor memory is to be inserted in the active sequence.

COPY — Function key to copy the segment defined by the limit values I1 and I2 into the internal editor memory.

DEL — Function key to delete the segment marked. The deleted segment is automatically stored in the ADS editor memory.

INS — Function key to insert the contents of the editor memory in the active sequence starting from position I2.

3.2.9.6.5 Capabilities of the SEQ BLOCK Editor

Marking a segment in the wave sequence (I1, I2)

On selection of the SEQ BLOCK editor, the limit values I1 and I2 are automatically set to the first element of the active ARB sequence.

To mark a segment, I1 and I2 can be exactly entered via the DATA entry keyboard [8] or also continuously varied to any positions on the active ARB sequence using the rotary knob [5]. Each activated limit value is output as Z-marker via the Z-MARKER output of the respectively selected channel.

Copying the marked segment into the editor memory (COPY)

At the touch of function key COPY, a copy of the marked segment is retained in the internal editor memory. As long as this editor memory is not overwritten by further COPY or DEL operations, its contents is available for editing operations.

The COPY and INS functions can be used to insert segments from one ARB sequence in another wave sequence. New ARB sequences can thus be designed conveniently and easily from segments of already existing wave sequences.

Deleting the marked segment (DEL)

On actuation of the function key DEL, the segment marked is deleted from the ARB sequence, including the limit values. At the same time, a copy of the segment deleted is retained in the internal editor memory..The limit values I1 and I2 are set to the sequence position following the deleted wave segment and I2 is active for entry.

A delete operation currently performed can be cancelled by actuating the INS key.

Inserting the contents from the editor memory (INS)

When the function key INS is pressed, the current contents of the internal editor memory is inserted in the active ARB sequence starting from position I2. The element previously set at position I2 and all the following elements are moved to the right by the number of positions as elements inserted.

The insert position I2 can be set to any position in the sequence. To allow to join the contents of the editor memory also at the end of a sequence, the insert position can be additionally set to the position following the last element. Entries beyond this range are ignored.

Once the INS operation is completed, the limit values I1 and I2 are automatically set to the limits of the new segment, so that the INS operation can be easily cancelled again by actuating the DEL key.

The contents of the editor memory is not changed when the INS function is used.

Relocating segments of a sequence

If a specific segment of the active ARB sequence is to be moved to another location, it must first be deleted from its current position using the DEL function. On completion of the delete operation, the segment to be moved is saved as copy in the internal editor memory and the insert position I2 is active for entry.

When the insert position I2 is then entered, the segment currently deleted is reinserted from the editor memory in the sequence starting from position I2 by pressing the INS key.

I2 can be set to any position in the ARB sequence. To allow to move a segment to the end of the wave sequence, also the position following the last element can additionally be set as insert position I2.

Duplicating segments of a sequence

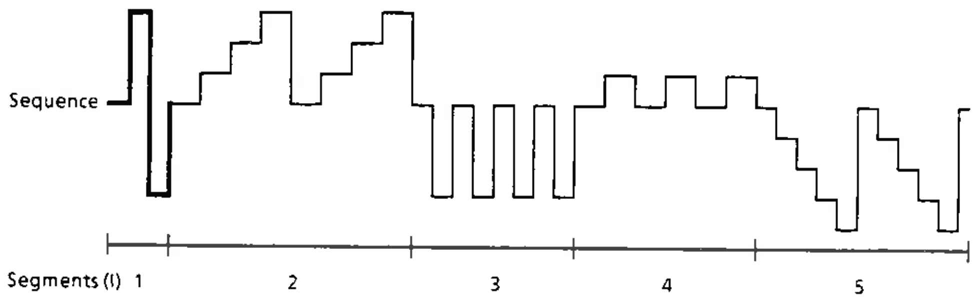
To duplicate a specific segment of an ARB sequence, it must first be copied into the editor memory using the COPY function.

The contents of the internal editor memory can then be reinserted at different positions of the ARB sequence or also at the end of the sequence using the INS function. The parameter I2 defines the insert position. In this case, the limit values I1 and I2 are always assigned to the segment inserted last.

If a segment is to be inserted several times, it must be ensured that the insert position I2 is moved by one position to the right prior to each INS operation.

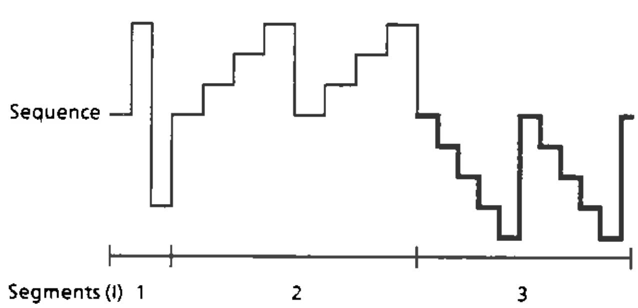
3.2.9.6.6 Examples for the SEQ BLOCK Editor

The following ARB sequence is taken as output signal for the examples for the SEQ BLOCK editor:



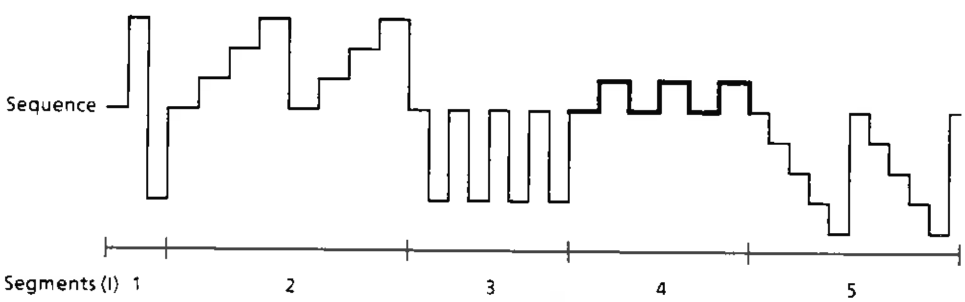
1. Deleting a segment from the wave sequence

Step	Entry	Result
1	MENU I1	Entering the limit value I1. Here: I1 = 3
2	DATA 3	
3	DATA ENT	
4	MENU I2	Entering the limit value I2. Here: I2 = 4
5	DATA 4	
6	DATA ENT	
7	MENU DEL	Deleting the segment marked.



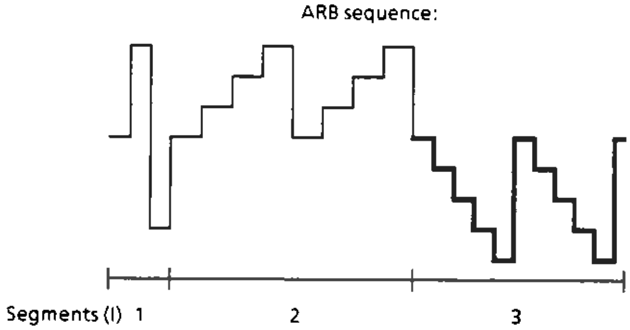
2. Relocating a segment of the wave sequence

Step	Entry	Result
1	MENU I1	Entering the limit value I1. Here: I1 = 3
2	DATA 3	
3	DATA ENT	
4	MENU I2	Entering the limit value I2 Here: I2 = 4
5	DATA 4	
6	DATA ENT	

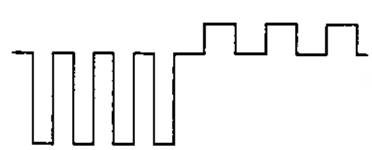


Step	Entry	Result
7	MENU DEL	Deleting the segment marked.

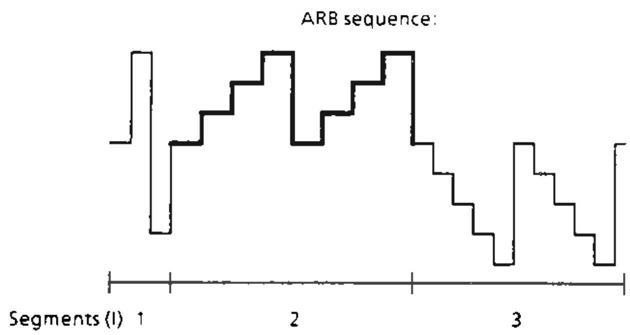
ARB sequence:

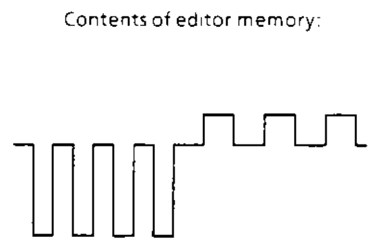


Contents of editor memory:

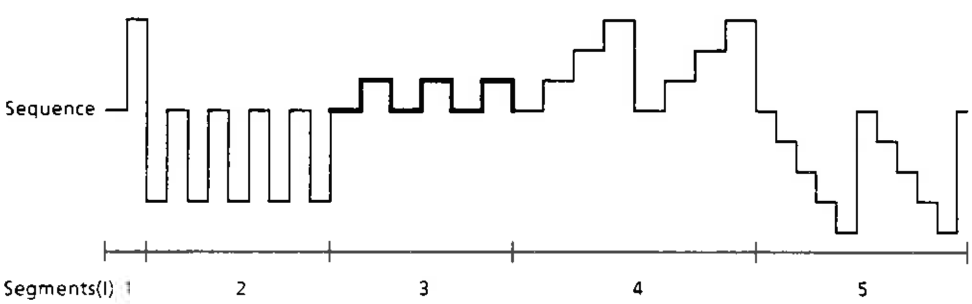


Step	Entry	Result
8	MENU I2	Entering the insert position I2. Here: I2 = 2
9	DATA 2	
10	DATA ENT	





Step	Entry	Result
11	MENU INS	Inserting the segment retained in the internal editor memory.



3.2.9.6.7 Combining ARB Sequences (POOL)

Using the SEQ POOL editor menu, complete ARB sequences retained in the SEQ POOL or stored on a Memory Card can be inserted at any position in the active ARB sequence.

To access the POOL editor menu, the menu key POOL in the SEQ editor menu is pressed:

Meanings of the menu function keys:

I — Parameter key to activate sequence position I for entry. I marks the position where the ARB sequence selected from the SEQ POOL or from the Memory Card is to be inserted in the active sequence.

INS-N — Menu key to select the insert function. INS-N activates the memory location N of the SEQ POOL or the sequence (N-100) on the Memory Card[1)] to select the ARB sequence to be inserted.

UNDO — Function key to undo the editing operation performed last.

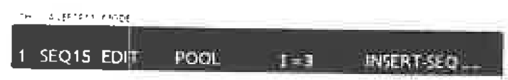
Functional sequence of the editing operation

1. **Defining insert position I**

   On selection of the SEQ POOL editor, the sequence position I where a sequence stored in the SEQ POOL is to be inserted in the valid wave sequence is activated for entry. "I" may be set to any position in the sequence. If a sequence is to be joined at the end of the active sequence, the position following the last sequence position is input as insert position. As editing aid, the sequence marker indicates the currently selected position I.

2. **Selecting the sequence to be inserted**

   The memory location of the sequence to be inserted is activated for entry by pressing the menu key INS-N. The following display appears then, for example:



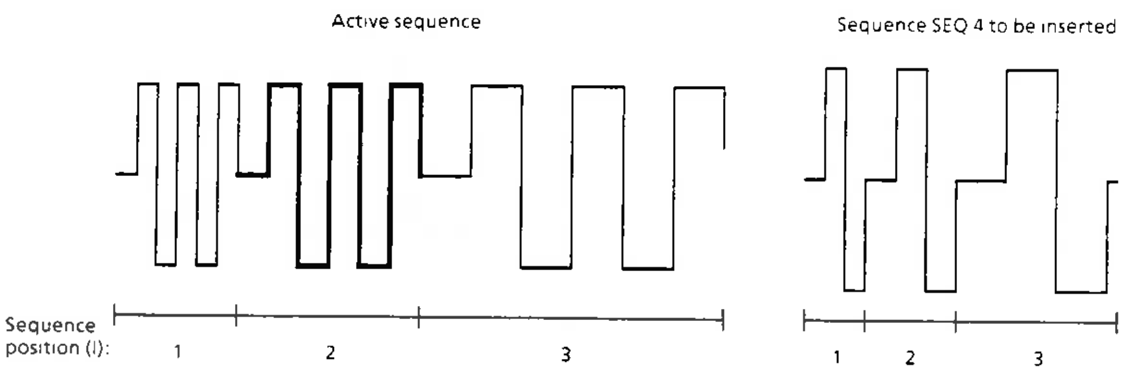
Once the respective memory location, where the sequence to be inserted is stored, is entered and the entry acknowledged by the ENT key of the DATA entry keyboard, the selected sequence is inserted in the active wave sequence starting from position I.

To clear the sequence inserted last again, the UNDO function is provided.

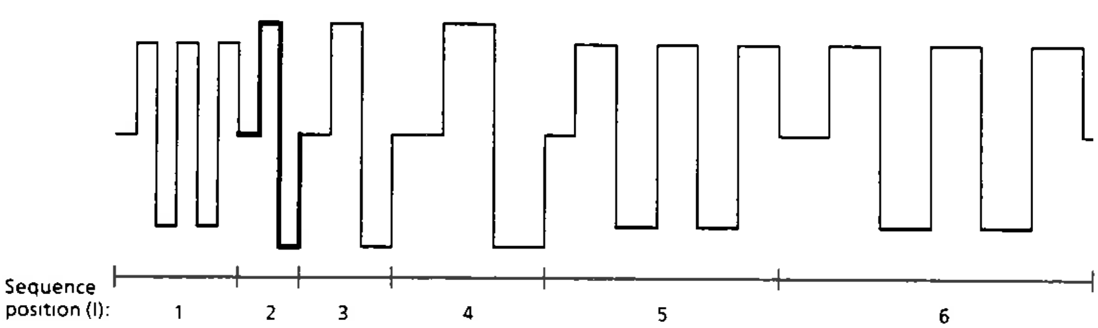
1) If the address N is in the range 0 to 99, the sequence N is selected from internal memory, i.e. taken from the SEQ POOL. If N is selected in the range 100 to 199, the sequence (N-100) is read from the Memory Card. If there is no Memory Card in the insert slot [11], the entry is aborted with no action taking place.

3.2.9.6.8 Example for the SEQ POOL Editor

Step	Entry	Result
1	MENU I	Entering the insert position. Here: I = 2
2	DATA 2	
3	DATA ENT	



Step	Entry	Result
4	MENU INS-N	Selecting the sequence to be inserted. Here: SEQ 4
5	DATA 4	
6	DATA ENT	

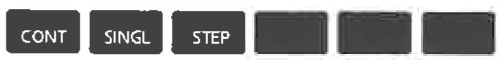


3.2.9.7 SEQ MODEs

In addition to the continuous mode CONT, also two triggered operating MODEs are available in SEQ operation of the ADS:

- Single mode (SINGL)
- Step mode (STEP)

The operating mode required is selected via the key MODE in the keypad SELECT. At the touch of this key, the MODE menu for SEQ operation is read out in the MENU display:



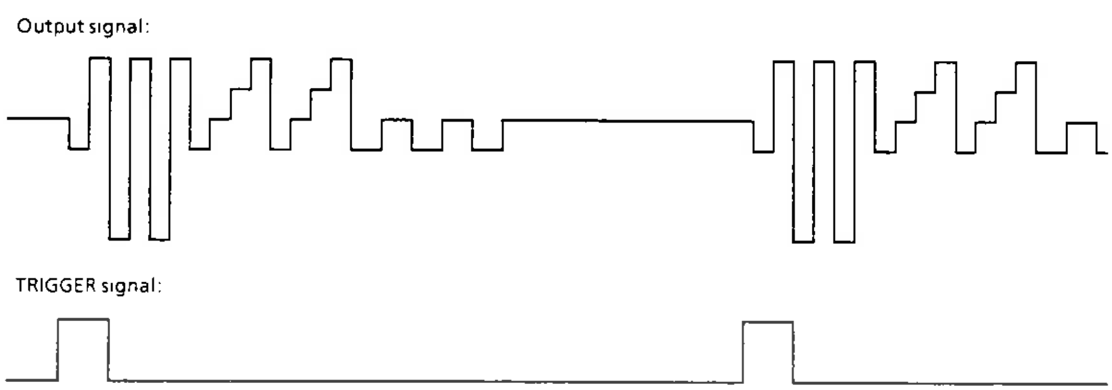
The trigger source to control the triggered MODEs SINGL and STEP is selected from the TRIGGER menu, which is accessed via the key TRIGGER in keypad SELECT.

3.2.9.7.1 MODE SINGL

In this mode, analogously to the ARB SINGL mode, each rising edge of the trigger signal initiates the output of the complete ARB sequence currently selected. Output of the amplitude values is always stopped at the last point of the last element in the sequence. The amplitude value of this last point is present at the output connector of the respective channel until the next rising edge of the trigger occurs.

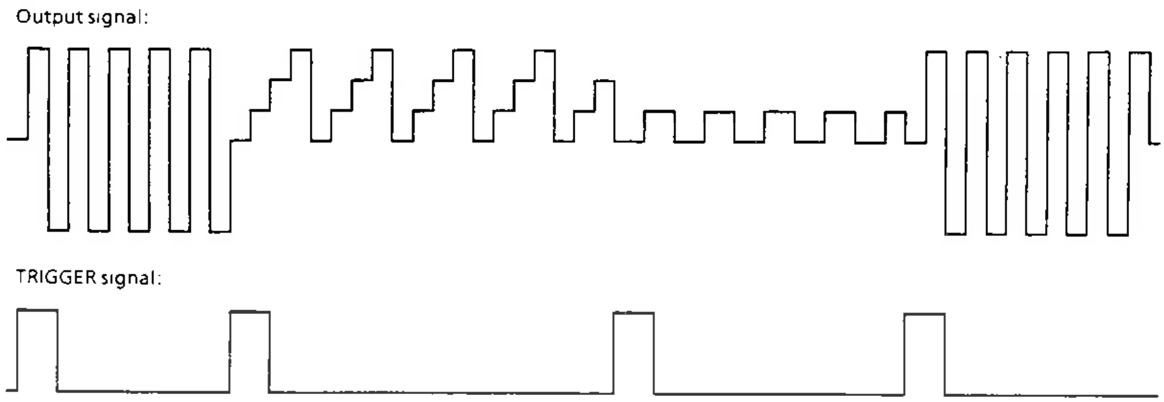
Trigger edges occurring during the wave sequence are ignored.

If manual triggering is selected with the MAN key [14], a rising trigger edge is generated each time the key is hit.



3.2.9.7.2 MODE STEP

When the operating mode STEP is selected, each rising edge of the trigger signal selected initiates a change to the next element of the sequence, irrespective of which repetition rate N*ARB is programmed. Between the trigger edges, the ARB wave of the element is output continuously. The read clock period is set in accordance with the expansion factor programmed for the element. With manual triggering, a change to the next element is initiated each time the MAN key is hit.



3.2.10 Generating Sine and Triangular Wave Signals (WAVEFORM:SINE, WAVEFORM:TRIA)

In addition to the designing of fully-arbitrary waveforms and ARB sequences, the digital synthesis capabilities offered in the ADS also allow the user to generate the standard waveforms sine and triangle.

Sine mode

The sine function is selected via the menu key SINE of the WAVEFORM menu.

The frequency range coverage for sine mode is 1 Hz to 5 MHz with a frequency resolution of 1 Hz. To activate the frequency of the sine signal for entry, the key FREQ in the keypad PARAMETER is actuated. The frequency value can either be exactly entered via the DATA entry keyboard [8] or continuously adjusted with the rotary knob [5].

Frequency changes are effected phase-continuously in the entire frequency range. Using the special function F-RES, a frequency resolution of 0.1 Hz can be set for the frequency range up to 500 kHz.

Sine synthesis is controlled with an internal synthesis clock frequency of 16.777216 MHz (1.6777216 MHz when F-RES = 0.1 Hz). Unless the internal clock source is selected, the clock signal is available as TTL signal at the CLK connector [13] of the respective channel.

For operation with an external clock signal, it must be noted that a deviation of the clock frequency from the nominal value 16.777216 MHz (1.6777216 MHz when F-RES = 0.1 Hz) causes a frequency error in the sine wave signal generated.

In synchronism with the sine signal, a TTL signal is available at the connector MARK [10] for controlling or synchronization purposes.

Triangular mode

The triangular function is selected via the menu key TRIA of the WAVEFORM menu.

The frequency range coverage for triangular operation is 1 Hz to 100 kHz with a frequency resolution of 1 Hz. Analogously to sine mode, the key FREQ in the keypad PARAMETER is pressed to activate the frequency of the triangular signal for entry. The frequency value can be exactly entered via the DATA entry keyboard [8] or continuously adjusted with the rotary knob [5].

Frequency changes are effected phase-continuously in the total frequency range. Using the special function F-RES, a frequency resolution of 0.1 Hz can be set in the frequency range 0.1 Hz to 10 kHz.

Triangular synthesis is controlled like the sine synthesis with an internal synthesis clock frequency of 16.777216 MHz (1.6777216 MHz when F-RES = 0.1 Hz). Unless the internal clock source is selected, the clock signal is avail-able as TTL signal at the CLK connector [13] of the respective channel.

For operation with an external clock signal, it must be noted that a deviation of the clock frequency from the nominal value 16.777216 MHz (1.6777216 MHz when F-RES = 0.1 Hz) causes a frequency error in the triangular signal generated.

In synchronism with the triangular signal, a TTL signal is available at the connector MARK [10] for controlling or synchronization purposes.

3.2.10.1 MODEs in Sine and Triangular Operation

In addition to the continuous mode CONT, also two triggered operating MODEs are available in sine and triangular operation of the ADS:

- Hold mode (HOLD)
- Hold/Reset mode (HD/RS)

The operating mode required is selected via the key MODE in the keypad SELECT. On actuation of this key, the MENU display reads as follows:

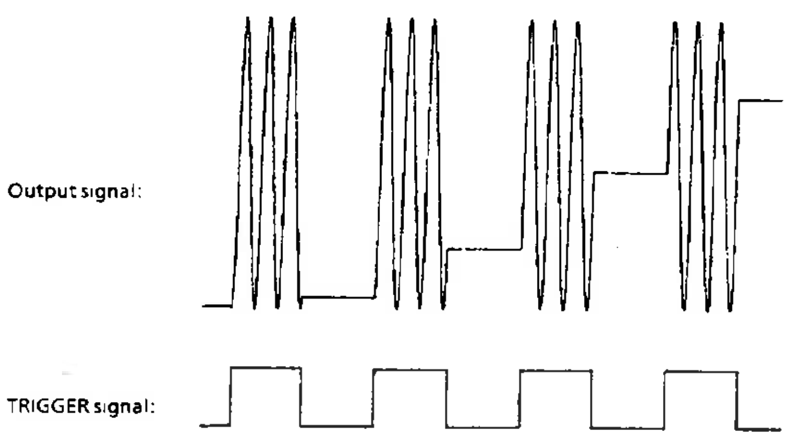
The trigger source to control the triggered MODEs is selected from the TRIGGER menu, which is accessed via the key TRIGGER in the keypad SELECT.

3.2.10.1.1 MODE HOLD (HOLD)

In the operating mode HOLD, the output of the sine or triangular signal is controlled by the logic state of the trigger signal.

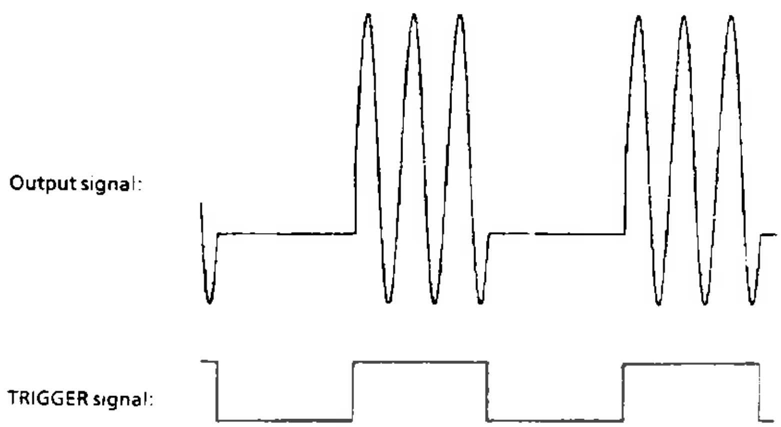
As long as the trigger signal is HIGH, the amplitude values are output continuously. When it changes to LOW, the output of the amplitude values is halted and the amplitude value of the point generated last is continuously output. The output of the next sine wave or triangular wave values is continued phase-continuously as soon as the trigger signal changes to HIGH.

Either the internal trigger generator or an external trigger can be used. Also, the MAN key [14] is provided for manual triggering, when the logic state of the trigger signal is changed each time the MAN key is pressed.



3.2.10.1.2 MODE HD/RS

Basically, the HOLD/RESET mode functions like the HOLD mode.The sine or the triangular signal, respectively, is again controlled by the logic state of the trigger signal, as in HOLD mode. However, in contrast to the HOLD mode, the signal is not output phase-continuously when the rising edge of the trigger occurs, but is always started at the beginning of the signal cycle, i.e. phase zero.



3.2.10.2 Modulation Modes

In sine and triangular operation, the following modulation modes are offered in the ADS:

- Frequency Shift Keying (FSK)
- Phase Shift Keying (PSK)
- Pulse Modulation (PM)

As modulation signal, the signal from the trigger source selected via the TRIGGER menu is used.

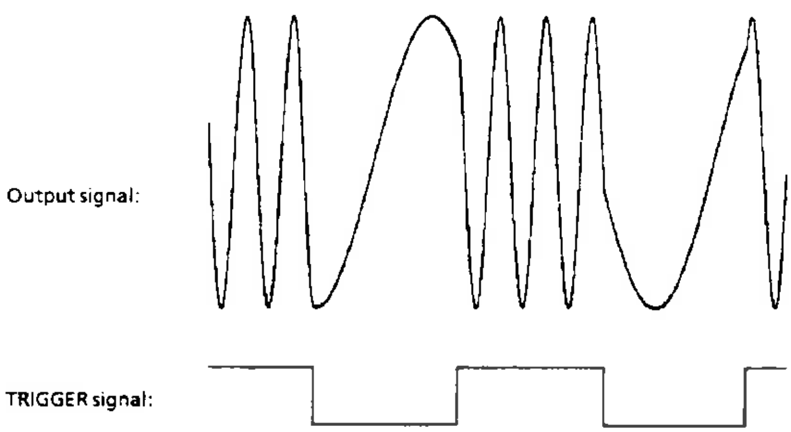
The modulation modes are selected via the menu MODE in sine or triangular operation:

3.2.10.2.1 Frequency Shift Keying (FSK)

The modulation mode FSK is activated using the menu key FSK of the MODE menu when sine or triangular operation is selected.

At the same time, the MENU display shows the FSK menu for entry of the cutoff frequencies HTFRQ and LTFRQ:

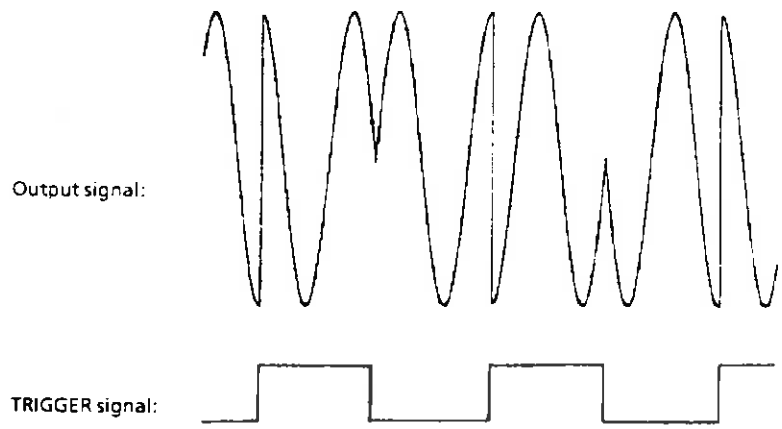
The cutoff frequency values HTFRQ (HIGH TRIGGER FREQUENCY) and LTFRQ (LOW TRIGGER FREQUENCY) may be optionally determined over the entire frequency range available for the respective waveform. Frequency shift keying is always performed phase-continuously, independently of the frequency difference, and is controlled by the logic state of the trigger signal. The frequency LTFRQ is assigned to the LOW state and the frequency HTFRQ to the HIGH state of the trigger signal. If manual triggering is selected, the frequency is changed each time the MAN key [14] is pressed.



3.2.10.2.2 Phase Shift Keying (PSK)

The menu key PSK of the MODE menu selects the modulation mode PSK in sine or triangular operation of the ADS.

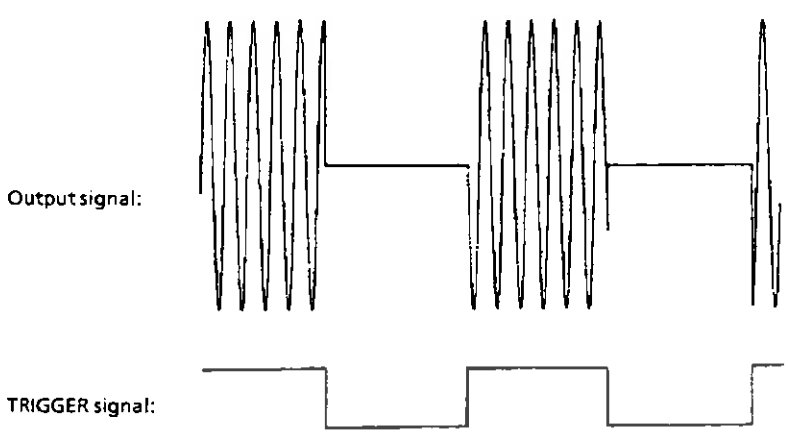
Using the PSK method of modulation, the phase shift dPH of the output signal during the HIGH state of the trigger signal in relation to the LOW state can be set in the range from -180 to + 180 degrees with a resolution of 0.02 degree. With manual triggering, a phase shift is initiated each time the MAN key [14] is pressed.



3.2.10.2.3 Pulse Modulation (PM)

The menu key PM of the MODE menu selects the modulation mode PM in sine or triangular operation of the ADS.

Blanking of the sine or triangular signal is controlled by the logic state of the trigger signal. The output signal is blanked in LOW state of the trigger. If manual triggering is selected, the state of the trigger signal is changed on each actuation of the MAN key [14]. A set DC offset is maintained when the signal is blanked.



3.2.11 SWEEP Operation

In sine and triangular operation, the ADS offers user-programmable digital frequency and phase sweep capabilities (ARB-SWEEP). For each sweep step, both frequency and phase can be individually programmed by the user, so that frequency sweeps, phase sweeps as well as frequency and phase sweeps combined can be performed.

The sweep is controlled by the trigger signal. The step time corresponds to the period of the trigger signal. Switchover to the next sweep step is triggered by the rising edge of the trigger signal.

An easy-to-use SWEEP editor is provided for programming the sweep, which permits to program linear or logarithmic frequency sweep cycles easily with few entries.

The SWEEP POOL

Analogously to the ARB POOL and the SEQ POOL, a SWEEP POOL is provided for storing up to 100 different sweeps.

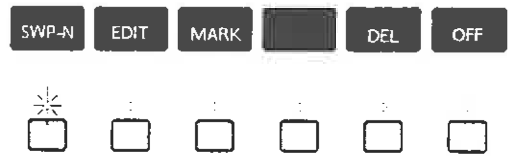
3.2.11.1 The SWEEP Menu

The SWEEP menu is selected via the key SWEEP in the SELECT keypad [1]. It can only be called when sine or triangular operation is selected.

On selection of this SWEEP menu, the sweep programmed last is loaded from the SWEEP POOL and started according to the current trigger setting. Any operating MODEs or modulation modes selected are automatically switched off.

The display indicates the number of the sweep performed, the number of the programmed steps and the currently valid period of the trigger signal:

At the same time, the SWEEP menu functions are read out in the MENU display:



The LED assigned to the menu key SWP-N lights up, indicating that the parameter SWP-N is activated for DATA input. Thus, any sweeps stored in the SWEEP POOL can be selected for output by entering the memory location number of the respective sweep cycle.

The further menu keys are assigned the following functions:

EDIT — Key to select the SWEEP editor. The capabilities of the SWEEP editor are described in detail in Section 3.2.11.5.

MARK — Parameter key to activate entry of the sweep marker position (see Section 3.2.11.4).

DEL — Key to delete a sweep from the SWEEP POOL (see Section 3.2.11.3).

OFF — Key to stop the sweep currently performed. On actuation of the OFF key, the active sweep frequency is continuously output. To restart sweep, the menu key SWP-N is pressed.

3.2.11.2 Loading a Sweep from the SWEEP POOL (SWP-N)

To call a sweep stored in the SWEEP POOL, the parameter SWP-N of the SWEEP menu must be assigned the number N of the memory location where the currently required sweep is retained in the POOL.

The sweep can be selected by entering an exact value via the DATA entry keyboard [8] or by varying the parameter SWP-N using the rotary knob [5].

Example:

Loading the ARB SWEEP SWP 15

Step	Entry	Result
1	MENU SWP-N	Activating parameter SWP-N to specify the sweep required
2	DATA 1	DATA entry
3	DATA 5	DATA entry
4	DATA ENT	Once the entry is acknowledged by ENT, the sweep selected is loaded from the SWEEP POOL and started.

3.2.11.3 Deleting a Sweep from the SWEEP POOL (DEL)

The currently active sweep indicated in the display can be deleted via the menu function key DEL in the SWEEP menu. For protection against maloperation, the delete instruction must be acknowledged in a submenu before it is effective.

Example:

Deleting the sweep SWP 12

Step	Entry	Result
1	MENU SWP-N	Activating parameter SWP-N to specify the sweep to be deleted
2	DATA 1	DATA entry
3	DATA 2	DATA entry
4	DATA ENT	Acknowledging DATA entry
5	MENU DEL	Selecting the delete function
6a	MENU YES	Acknowledging the delete instruction - return to the SWEEP menu
6b	MENU NO	Abort and return to the SWEEP menu

3.2.11.4 Marking Specific Sweep Positions (MARK)

The ADS contains a programmable SWEEP marker generator. It can be used to specifically assign a sweep marker to any position of the active sweep. The marker remains active during the complete sequence of the marked sweep position and is output both as TTL-compatible signal via the MARK connector [10] of the respective channel and as Z-marker via the Z-MARKER output [21] of this channel.

When an ARB sweep is selected from the SWEEP POOL, the sweep marker is first generated synchronously with the first sweep position. The sweep marker can then be programmed using the parameter MARK of the SWEEP menu.

3.2.11.5 The SWEEP Editor (EDIT)

General

The SWEEP editor permits to generate new sweeps or modify already existing sweeps.

The SWEEP editor is selected via the menu key EDIT of the SWEEP menu. The MENU display then reads as follows:

ELEM	INTPL	BLOCK	POOL	QUIT	SAVE

All editing operations performed are referred to the SWEEP currently active.

Modifications to the SWEEP are immediately effective for the output signal of the generator, thus allowing the user immediate visual control.

The SWEEP editor contains 4 submenus (see Fig. 3-7 for a schematic overview of the complete SWEEP menu including the SWEEP editor). These submenus are: ELEM, INTPL, BLOCK and POOL.

ELEM

The submenu ELEM comprises all the editing operations to be performed with individual sweep steps (elements). Using the functions offered in this menu, the phase or the frequency of individual SWEEP steps can be varied, SWEEP steps be deleted or new SWEEP steps inserted.

INTPL

The menu key INTPL calls an interpolation menu, which permits to program linear or logarithmic frequency SWEEPs conveniently and easily.

BLOCK

The BLOCK menu contains commands to delete sections of the currently active SWEEP, multiply them or insert them at another position within the sweep.

POOL

The function operations offered in the POOL menu allow to insert complete SWEEPs stored in the SWEEP POOL or on the Memory Card at any position in the currently active SWEEP.

QUIT

On actuation of the menu key QUIT, the SWEEP editor is exited without saving of the sweep, i.e. all the editing operations performed are undone.

Saving edited SWEEPs (SAVE)

With the function key SAVE, the edited SWEEP is retained instead of the sweep previously stored in the SWEEP POOL and the SWEEP editor menu is exited.

Auxiliary facilities for editing

While the editing operations are performed, the SWEEP marker generator is automatically set to the element to be edited, irrespective of the setting currently valid for the parameter MARK.

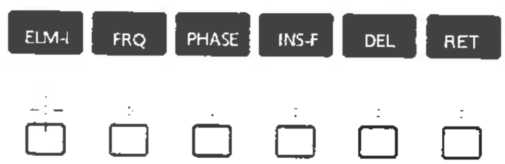
The sweep marker is at the same time output as Z-marker via the Z-MARKER output [21] on the rear, so that the edited element can be unblanked or blanked via the Z-control input of a connected oscillograph, thus allowing the user visual control of the sweep.

The marker position defined before selection of the SEQ editor is retained and automatically reset as soon as the editor is exited.

3.2.11.5.1 Editing Individual SWEEP Steps (ELEM)

The editor menu ELEM can be used to create new ARB SWEEPs element by element, to insert new steps in a SWEEP, or to delete or modify elements of an existing SWEEP.

The menu is accessed by actuating the menu function ELEM in the SWEEP EDIT menu:



The LED assigned to the menu key ELM-I lights up, indicating that the parameter ELM-I is activated for entry.

The meanings of the menu keys are:

ELM-I — Parameter key to enter the SWEEP position. In this case, the index ELM-I corresponds to the position of the element in the sequence.

FRQ — Parameter key to enter the frequency of SWEEP position I. The frequency of individual SWEEP steps can be optionally selected in sine operation in the range from 1 Hz to 5 MHz. For triangular signals, the range is 1 Hz to 100 kHz.

PHASE — Parameter key to enter the phase of SWEEP position I. The phase can be selected in the range from - 180 to + 180 degrees at a resolution of 0.02 degree.

INS-F — Menu key to select the INS-F function for inserting a new frequency SWEEP step.

DEL — Function key to delete SWEEP position I.

3.2.11.5.2 Capabilities of the SWEEP ELEM Editor

Creating new SWEEPs using the SWEEP ELEM editor

In order to create a new SWEEP, first one of the SWEEPs stored will as a rule need to be deleted using the DEL function of the SWEEP main menu. After deletion, the element index is set to the value 1 (SWEEP position 1).

After actuating the menu key FRQ, the individual sweep steps can be entered using the DATA entry keyboard. When the ENT key is actuated, the element index I is automatically set to the next value. The parameter FRQ remains active, so that additional entries can be made. The phase of the individual sweep steps is first set to the default value of 0 degrees. If desired, it can be subsequently programmed.

Variation of element parameters

To vary the parameters of an element, this element must first be selected via its index ELM-I and output in the display. The index ELM-I corresponds to the position of the element in the sequence.

When activated, the parameters can be varied via the parameter keys FRQ or PHASE either using the DATA entry keyboard [8] or the control knob [5].

Example:

Step	Entry	Result
1	MENU ELM-I	Selecting SWEEP position 4
2	DATA 4	
3	DATA ENT	
4	MENU FRQ	Activating the parameter FREQUENCY and entering value 10000 (10 kHz)
5	DATA 1	
6	DATA EXP	
7	DATA 4	
8	DATA ENT	
9	MENU PHASE	Activating the parameter PHASE and entering the value 90 (90 degrees)
10	DATA 9	
11	DATA 0	
12	DATA ENT	

Inserting new SWEEP steps (INS-F)

The INS-F function allows the insertion of new frequency SWEEP steps at the SWEEP position defined via the parameter ELM-I.

On actuation of the key INS-F, the frequency of the SWEEP step to be inserted is activated for entry and the following display appears, for example:

When the frequency value is entered and the entry acknowledged by the ENT key, the new frequency with a phase of 0 degree is inserted in the SWEEP at position I. The element originally located at position I and all the following elements are moved up by one position. Also, the insert position I is incremented by one count.

The INS-F function remains active after the new SWEEP step is inserted, so that complete SWEEP sections can be inserted easily step by step by successive frequency entries without each step position being newly entered. Thus, new sweeps can be easily created.

For correction purposes, the last SWEEP step entered can be deleted using the DEL key.

Deleting elements from the sequence (DEL)

The function DEL clears the position indicated in the display from the SWEEP. At the same time, all the SWEEP steps following the position deleted are moved back by one position. The cursor position is maintained, so that also the next element can be deleted by striking the DEL key again. Thus, complete sections of a sweep can be deleted by pressing the DEL key as often as required.

3.2.11.5.3 Examples for the SWEEP ELEM Editor

1. **Variation of element parameters**

A SWEEP composed of four elements with the following frequency and phase settings is taken as output signal for the example given:

Element index:	1*	2	3	4
Frequency:	1.000 kHz	2.000 kHz	5.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

* The asterisk indicates the current position of the SWEEP marker.

Step	Entry	Result
1	MENU ELM⊣	Selecting the element to be modified. Here: element index 3 (position 3)
2	DATA 3	
3	DATA ENT	

Element index:	1	2	3*	4
Frequency:	1.000 kHz	2.000 kHz	5.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

Step	Entry	Result
4	MENU FRQ	Varying the frequency of SWEEP element 3 from 5 kHz to 7 kHz
5	DATA 7	
6	DATA EXP	
7	DATA 3	
8	DATA ENT	

Element index:	1	2	3*	4
Frequency:	1.000 kHz	2.000 kHz	7.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

Step	Entry	Result
9	MENU PHASE	Varying the phase of the SWEEP element 3 from 0 to 90 degrees
10	DATA 9	
11	DATA 0	
12	DATA ENT	

Element index:	1	2	3*	4
Frequency:	1.000 kHz	2.000 kHz	7.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	90 degrees	0 degree

2. Deleting an element

A SWEEP composed of four elements with the following frequency and phase settings is taken as output signal for the example given:

Element index:	1*	2	3	4
Frequency:	1.000 kHz	2.000 kHz	5.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

* The asterisk shows the current position of the SWEEP Marker.

Step	Entry	Result
1	MENU ELM-I	Selecting the element to be deleted. Here: element 2 (position 2)
2	DATA 2	
3	DATA ENT	

Element index:	1	2*	3	4
Frequency:	1.000 kHz	2.000 kHz	5.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

Step	Entry	Result
4	MENU DEL	Deleting the element marked

Element index:	1	2*	3
Frequency:	1.000 kHz	5.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	0 degree

3. **Inserting a new frequency step (INS-F)**

A SWEEP composed of four elements with the following frequency and phase settings is taken as output signal for the example given:

Element index:	1*	2	3	4
Frequency:	1.000 kHz	2.000 kHz	5.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

* The asterisk shows the current position of the SWEEP marker.

Step	Entry	Result
1	MENU ELM-I	Entering the SWEEP position where the new element is to be inserted. Here: 2
2	DATA 2	
3	DATA ENT	

Element index:	1	2*	3	4
Frequency:	1.000 kHz	2.000 kHz	5.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

Step	Entry	Result
4	MENU INS-F	Inserting an intermediate step of 1.5 kHz
5	DATA 1	
6	DATA .	
7	DATA 5	
8	DATA EXP	
9	DATA 3	
10	DATA ENT	

Element index:	1	2	3*	4	5
Frequency:	1.000 kHz	1.500 kHz	2.000 kHz	5.000 kHz	10.000 kHz
Phase:	0 degree	0 degree	0 degree	0 degree	0 degree

3.2.11.5.4 Programming Linear and Logarithmic SWEEPs (INTPL)

The editor menu INTPL permits to program linear and logarithmic SWEEPs conveniently and easily. After an interpolation range is defined, it can be inserted in the active SWEEP at any position.

The menu is accessed from the SWEEP EDIT menu by actuating the menu key INTPL:

Meanings of the menu function keys:

I/N — Toggle key to alternately activate the insert position I and the number of interpolation steps N for entry.

f1/f2 — Toggle key to alternately activate the cutoff frequencies f1 and f2 of the interpolation range for entry.

LIN — Function key to execute a linear interpolation.

LOG — Function key to execute a logarithmic interpolation.

Functional sequence of the interpolation function

The functional sequence of interpolation takes three steps:

1. **Entering the insert position I and the number of interpolation steps N**

   When the interpolation menu is selected, the insert position I is set to the first position of the active SWEEP and is activated for entry. At the same time, the frequency value defined for this position is indicated.

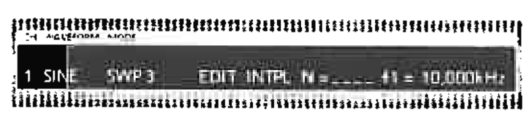
   Example:

   The parameter I can be exactly entered via the DATA entry keyboard [8] or continuously adjusted with the rotary knob [5]. Always the frequency value of this entered position I is displayed.

   "I" can be set to any position in the exisiting SWEEP as well as to the first position following the already defined SWEEP. During the interpolation the SWEEP marker follows the position I, irrespective of the setting valid for parameter MARK.

   The parameter N is activated for entry by pressing the menu key I/N.

   Example:



   The parameter N defines the number of reference values provided for the interpolation. As the interpolation range is inserted, the number of possible interpolation steps - with a total of 8191 SWEEP steps possible - depends on the number already defined.

2. **Entering the cutoff frequency values f1 and f2 of the interpolation range**

In order to perform the interpolation operation, the cutoff frequencies f1 and f2 of the interpolation range required must be defined. Actuation of the menu key f1/f2 activates the frequency f1 for entry. A variation of f1 is immediately effective on the output signal of the generator.

If the frequency of insert position I is to be maintained, the frequency value f2 is activated for entry by pressing the menu key f1/f2 again.

The cutoff frequencies f1 and f2 can be set to any values within the frequency range specified for the respective waveform (sine or triangle).

3. **Executing the interpolation**

Linear or logarithmic interpolation is started via the function keys LIN or LOG, respectively. The calculated range is inserted in the SWEEP starting from position I.

On completion of interpolation, the insert position is automatically set to the last position of the new section, so that a subsequent interpolation could immediately be performed.

3.2.11.5.5 Example for the SWEEP INTPL Editor

A sawtooth sine SWEEP is generated with the following values:

F_{min} = 1 kHz
F_{max} = 100 kHz
TIME/STEP = 1 ms
1 kHz / step

Step	Entry	Result
1	SELECT WAVE-FORM	Selecting the waveform sinus
2	MENU SINE	
3	SELECT SWEEP	Loading and deleting SWEEP 1
4	MENU SWP-N	
5	DATA 1	
6	DATA ENT	
7	MENU DEL	
8	MENU YES	
9	MENU EDIT	Selecting the interpolation menu
10	MENU INTPL	
11	MENU I/N	Entering the interpolation steps for the range 1 kHz to 100 kHz
12	DATA 1	
13	DATA 0	
14	DATA 0	
15	DATA ENT	

Step	Entry	Result
16	MENU f1/f2	Entering the cutoff frequencies
17	DATA 1	
18	DATA EXP	
19	DATA 3	
20	DATA ENT	
21	MENU f1/f2	
22	DATA 1	
23	DATA 0	
24	DATA 0	
25	DATA EXP	
26	DATA 3	
27	DATA ENT	
28	MENU LIN	Executing the interpolation

Step	Entry	Result
29	SELECT TRIGGER	Setting the internal trigger generator
30	MENU TIMER	
31	MENU PER	
32	DATA 1	
33	DATA EXP	
34	DATA -	
35	DATA 3	
36	DATA ENT	

3.2.11.5.6 Operations with Individual SWEEP Sections (BLOCK)

Analogously to the ARB BLOCK editor, the SWEEP BLOCK editor offers functions to delete sections from the currently active SWEEP, to move them or duplicate them at other positions. With this BLOCK editor, complete SWEEPs can be easily varied with few entries.

To access the BLOCK editor menu, the key BLOCK in the SWEEP editor menu is pressed:

Meanings of the menu function keys:

I1 Parameter key to activate the SWEEP limit value I1 for entry.

I2 Parameter key to activate the SWEEP limit value I2 for entry.
I2 also marks the SWEEP position where the contents of the internal editor memory is to be inserted in the SWEEP using the INS function.

COPY Function key to copy the SWEEP section defined by the limit values I1 and I2 into the internal editor memory.

DEL Function key to delete the section marked.

INS Function key to insert the contents of the editor memory in the SWEEP starting from the SWEEP position I2.

3.2.11.5.7 Capabilities of the SWEEP BLOCK Editor

Marking specific SWEEP sections

On selection of the SWEEP BLOCK editor, the limit values I1 and I2 are automatically set to the first position of the currently active SWEEP. The lower limit value, I1, is activated for entry and simultaneously output as SWEEP marker via the Z-MARKER output [21] for visual control of the signal on a connected oscillograph.

I1 and I2 can be activated via the parameter keys I1 and I2 of the BLOCK menu. The limit values required can be entered exactly via the DATA entry keyboard [8] or continuously adjusted with the control knob [5]. The SWEEP marker always indicates the limit value active for entry.

The limit values I1 and I2 can be set to any position in the active SWEEP.

Coyping the marked section into the editor memory (COPY)

When the function key COPY is actuated, a copy of the section marked is stored in the internal editor memory. As long as the editor memory is not overwritten by further COPY or DEL operations, its contents is available for editing.

The COPY and INS functions can be used to insert sections from one SWEEP in another SWEEP. New SWEEPs can thus be designed conveniently and easily from sections of already existing SWEEPs.

Deleting the marked section (DEL)

On actuation of the function key DEL, the marked SWEEP section is deleted from the SWEEP including the limit values. At the same time, a copy of the deleted section is retained in the internal editor memory.

The limit values I1 and I2 are set to the SWEEP position following the section deleted and I2 is active for entry.

A delete operation currently performed can be cancelled using the INS key.

Inserting the contents of the editor memory (INS)

When the function key INS is pressed, the current contents of the internal editor memory is inserted in the active SWEEP starting from position I2. The SWEEP step previously at position I2 and all the following points are moved a number of positions to the right, whereby this number is equal to the number of inserted SWEEP sections.

The insert position I2 can be set to any position in the SWEEP as well as to the position following the last SWEEP position.

Once the INS operation is completed, the limit values I1 and I2 are automatically set to the limits of the new section, so that the INS operation can be easily undone by pressing the key DEL.

The contents in the editor memory is not changed when the INS function is applied.

Relocating SWEEP sections

If a specific section of the active SWEEP is to be moved to another location, first a DEL operation is to be carried out.

Once the delete operation is completed, the section to be moved is retained as copy in the internal editor memory and the insert position I2 is activated for entry.

When the insert position I2 is then entered, the section currently deleted is reinserted from the editor memory in the SWEEP starting from position I2 on actuation of the INS key. I2 can be set to any position in the SWEEP as well as to the position directly following the last SWEEP position.

Duplicating SWEEP sections

To duplicate a section in a SWEEP, the section must first be copied into the editor memory using the COPY function.

The contents of the internal editor memory can then be reinserted at different positions in the SWEEP or joined at the end of the SWEEP using the INS function. The parameter I2 defines the insert position. The limit values I1 and I2 are always assigned to the section inserted last.

If a section is to be inserted several times, it must be ensured that the insert position I2 is moved by one position to the right before each INS operation.

3.2.11.5.8 Examples for the SWEEP BLOCK Editor

1. Deleting a SWEEP section

A SWEEP composed of six elements with the following frequency and phase settings is taken as output signal for the example given:

Element index:	1*	2	3	4	5	6
Frequency:	1 kHz	2 kHz	3 kHz	4 kHz	5 kHz	6 kHz
Phase:	0 degree	0 degree	0 degree	0 degree	0 degree	0 degree

* The asterisk shows the current position of the SWEEP marker.

Step	Entry	Result
1	MENU EDIT	Selecting the SWEEP BLOCK editor. When selected, I1 is active for entry.
2	MENU BLOCK	
3	DATA 3	Entering the limit values. Here: I1 = 3, I2 = 4
4	DATA ENT	
5	MENU I2	
6	DATA 4	
7	DATA ENT	
8	MENU DEL	Deleting the section marked.

Element index:	1	2	3*	4
Frequency:	1 kHz	2 kHz	5 kHz	6 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

2. Relocating a SWEEP section

A SWEEP composed of six elements with the following frequency and phase settings is taken as output signal for the example given:

Element index:	1*	2	3	4	5	6
Frequency:	1 kHz	2 kHz	3 kHz	4 kHz	5 kHz	6 kHz
Phase:	0 degree	0 degree	0 degree	0 degree	0 degree	0 degree

* The asterisk shows the current position of the SWEEP marker.

Step	Entry	Result
1	MENU EDIT	Selecting the SWEEP BLOCK editor. When selected, I1 is active for entry.
2	MENU BLOCK	
3	DATA 3	Entering the limit values. Here: I1 = 3, I2 = 4
4	DATA ENT	
5	MENU I2	
6	DATA 4	
7	DATA ENT	
8	MENU DEL	Deleting the section marked.

Element index:	1	2	3*	4
Frequency:	1 kHz	2 kHz	5 kHz	6 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

Step	Entry	Result
9	MENU I2	Entering insert position I2. Here: I2 = 2
10	DATA 2	
11	DATA ENT	

Element index:	1	2*	3	4
Frequency:	1 kHz	2 kHz	5 kHz	6 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

Step	Entry	Result
12	MENU INS	Reinserting the previously deleted section from the internal editor memory

Element index:	1	2*	3	4	5	6
Frequency:	1 kHz	3 kHz	4 kHz	2 kHz	5 kHz	6 kHz
Phase:	0 degree	0 degree	0 degree	0 degree	0 degree	0 degree

3.2.11.5.9 Combining Individual SWEEPs (POOL)

Using the SWEEP POOL editor, complete SWEEPs retained in the SWEEP POOL or stored on the Memory Card can be inserted at any position in the active SWEEP.

To access the POOL editor menu, the menu key POOL in the SWEEP editor menu is pressed:

Meanings of the menu functin keys:

I — Parameter key to activate the SWEEP position I for entry. I marks the position where one of the SWEEPs retained in the SWEEP POOL or stored on the Memory Card is to be inserted in the active SWEEP.

INS-N — Menu key to select the insert position. INS-N activates the memory location N of the SWEEP POOL or the sweep (N-100) on the Memory Card[1] to select the SWEEP to be inserted.

UNDO — Function key to undo the editing operation last performed.

Functional sequence of the editing operation

1. **Defining insert position I**

   When the SWEEP POOL editor is selected, the SWEEP position I where a SWEEP stored in the SWEEP POOL is to be inserted in the active SWEEP is activated for entry.

   "I" can be set at any position in the SWEEP. If a SWEEP is to be joined at the end of the active SWEEP, the position following the last SWEEP position is entered as insert value I. As editing aid, the SWEEP marker indicates the currently selected position I.

2. **Selecting the SWEEP to be inserted**

   The memory location of the SWEEP to be inserted is activated for entry by pressing the menu key INS-N. The following display appears then, for example:

   Once the respective memory location of the SWEEP POOL, where the SWEEP to be inserted is stored, is entered and entry acknowledged by the ENT key, the selected SWEEP is inserted in the active SWEEP starting from position I.

   To clear the SWEEP inserted last again, the UNDO function is provided.

1) If the address N is in the range 0 to 99, the sweep N is selected from internal memory, i.e. taken from the SWP POOL. If N is selected in the range 100 to 199, the sweep (N-100) is read from the Memory Card. If there is no Memory Card in the insert slot [11], the entry is aborted with no action taking place.

3.2.11.5.10 Example for the SWEEP POOL Editor

A SWEEP composed of four elements with the following frequency and phase settings is taken as output signal for the example given:

SWEEP SWP12 to be inserted is set as follows:

Element index:	1*	2	3	4	1*	2
Frequency:	1 kHz	2 kHz	3 kHz	4 kHz	8 kHz	9kHz
Phase:	0 degree	0 degree	0 degree	0 degree	0 degree	0 degree

* The asterisk shows the current position of the SWEEP marker.

Step	Entry	Result
1	MENU I	Entering the insert position Here: I = 2
2	DATA 2	
3	DATA ENT	

Element index:	1	2*	3	4
Frequency:	1 kHz	2 kHz	3 kHz	4 kHz
Phase:	0 degree	0 degree	0 degree	0 degree

Step	Entry	Result
4	MENU INS-N	Selecting the SWEEP to be inserted. Here: SEQ 12
5	DATA 1	
6	DATA 2	
7	DATA ENT	

Element index:	1	2	3	4*	5	6
Frequency:	1 kHz	8 kHz	9 kHz	2 kHz	3 kHz	4 kHz
Phase:	0 degree	0 degree	0 degree	0 degree	0 degree	0 degree

3.2.11.6 SWEEP MODEs

The MODE menu allows the user manual control of the SWEEP. The SWEEP MODE menu is read out in the MENU display when the key MODE in the SELECT keypad is pressed:

In the mode CONT, the SWEEP is continuously generated in step with the trigger signal selected. The time per SWEEP step is defined by the period of the trigger signal. Triggering can be carried out with the internal trigger generator, using an external trigger source or manually.

3.2.12 Special Functions (SPEC FUNCT)

The ADS menu for selection of the special functions is acessed via the key SPEC FUNCT in the SELECT keypad. It comprises four submenus:

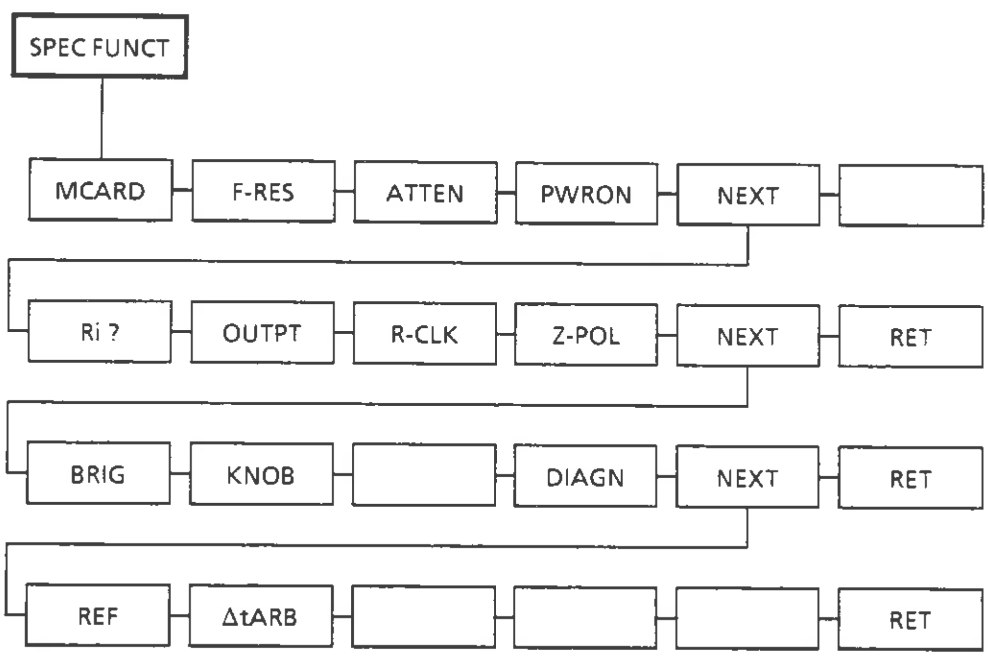


Fig. 3-11

3.2.12.1 Copying the Instrument Memory (MCARD)

The memory card available as accessory for the ADS allows the user to archive the complete internal memory contents. All the POOLs (ARB POOL, SEQ POOL and SWEEP POOL) stored on this memory card can be recalled at any time into the ADS-internal memory together with the complete instrument settings of the STO/RCL memories.

The menu key MCARD calls the MCARD submenu:

Checking the memory card (CHECK)

The function CHECK is provided to verify if the memory card available has already been prepared for use (initialized) in the ADS. In order to avoid that memory cards unknown to the ADS are unintentionally initialized for ADS operation and the data stored on these cards irrevocably lost, it is recommended to check the card with this function before it is initialized with INIT.

Initializing a memory card (INIT)

Using the function INIT, memory cards are initialized for use in the ADS. The memory contents of the memory card is then overwritten. ADS data can only be stored on a memory card, which has been initialized before.

Copying the instrument memory contents on the memory card (SAVE)

Before this operation is started, the memory card must be inserted in the insert slot [11] provided for this purpose. On actuation of the function key SAVE, the complete contents of the ADS memory is saved on the memory card. This does not affect the memory contents of the ADS.

Loading the contents of the memory card into the instrument memory (LOAD)

On actuation of the function key LOAD, the contents saved on the memory card is copied into the instrument memory. The ADS internal memory is in this case completely overwritten.

Activating write-protect (PROT)

Actuating the menu key PROT will write-protect the Memory Card inserted in the insert slot [11]. By actuating the PROT key once more, write-protection is cancelled.

Note:

To prevent data on the Memory Card from possibly being lost, make sure that the Memory Card is not inserted in the insert slot when the instrument is turned on or off.

3.2.12.2 Selecting the Frequency Resolution (F-RES)

The menu key F-RES calls the R-RES submenu:

The special function F-RES can be used to switch over the frequency resolution in sine and triangular wave operation. The switchover is always relevant for the ADS channel currently activated for entry.

In addition to the standard resolution of 1 Hz, an increased resolution of 0.1 Hz is thus available. When the increased resolution in frequency is selected, the upper frequency limit is reduced from 5 MHz to 500 kHz in sine operation and from 100 kHz to 10 kHz in triangular operation.

The function keys 0.1 Hz and 1 Hz are used for switchover.

A resolution of 1 Hz is set when the PRESET key in the MEM/REM keypad [6] is pressed.

3.2.12.3 Selecting the Level Setting (ATTEN)

The menu key ATTEN calls a submenu for selection of the level setting:

AUTO	FIX	EXT			RET

Using this submenu ATTEN, three different modes of level settings can be selected. The level setting selected is always relevant for the ADS channel currently activated for entry.

AUTO

In the default setting AUTO, the level of the output signal is set via an attenuator, which is mechanically switched in steps of 6 dB, in conjunction with an electronic level setter adjustable in 0.1-dB steps (PRESET setting).

Non-interrupting level adjustment (FIX)

On actuation of the function key FIX, the set level of the output signal is further reduced transient-free, i.e. without using the mechanically switching attenuator.

Using this merely electronic level setting, the level interruptions occuring during the switching of the attenuator can be avoided. This transient-free level adjustment permits tests on level-sensitive circuits.

In a range of 20 dB, the level accuracy corresponds to the values specified for the mode AUTO. In the case of further reductions in level, an increased level error must be taken into account. If the level of the output signal is increased beyond the value, which was set when the non-interrupting level adjustment is selected, this generally causes switching of the attenuator. The level thus newly adjusted is automatically taken as reference value for an additional non-interrupting level reduction.

Inverting the output signal (NORM, INV)

In the mode FIX, the output signal can be inverted using the function key INV. Inverting the output signal has no effect on the DC OFFSET setting. Inverting is switched off with the function key NORM.

External level control (EXT)

The level setting of the output signal can be switched over to external level control via the function key EXT. The connector LEV CTRL [18] of the respective channel on the rear of the instrument serves as control input.

The input voltage range specified for the LEV CTRL input is -1 V to + 1 V. The level is set proportionally to the voltage currently applied. An input voltage of -1 V corresponds to the output level set prior to selection of the EXT function. An input voltage of -0.5 V corresponds to a reduction in level of 6 dB.

Positive control voltages invert the output signal, however, without affecting the DC OFFSET setting. An input voltage of + 1 V thus leads to an inverted output signal at the level which was set prior to selection of the EXT function.

The bandwidth of the control input is typically 50 MHz, the input impedance is 50 Ω.

3.2.12.4 Selecting the Switch-on State (PWRON)

The menu key PWRON calls a submenu for selection of the switch-on state of the generator:

In addition to the instrument PRESET status (menu key PRST) described in Section 3.2.1.5, it is also possible to select between the state valid prior to last switch-off (menu key RCL0), which is automatically retained in the STO/RCL memory location 0, or one of the 20 further user-programmable instrument settings retained in the STO/RCL memory locations N = 1 to 20 (menu key RCL N).

On actuation of the PRESET key in the MEM/REM keypad [6], automatically the instrument setting valid prior to the last switch-off (RCL 0) is taken as switch-on status for the ADS.

3.2.12.5 Internal Impedance with Level Switched-off (Ri?)

The output signal of the respective channel can be switched off by actuation of the keys OUTPUT ON/OFF [9]. In switch-off state, the OUTPUT-OFF LED assigned to the channel lights up.

The menu key Ri ? calls a menu for selecting the internal impedance when the signal level is switched off:

Meanings of the menu keys:

Ri>> The signal output is internally dc-decoupled from the output connector when the signal level is switched off.

Ri = 50 The internal impedance of 50 Ω and the set DC-OFFSET are retained in switch-off state (PRESET setting).

3.2.12.6 Addition of the Output Signals (OUTPT)

It is possible using the special function OUTPT to add the output signals of both generator channels and have the summated signal output at output 1. The signal output of the second channel is switched off when this special function is activated. The summated signal is always made of the output signals attenuated by 6 dB plus the DC OFFSETs of channels 1 and 2 attenuated by 6 dB.

The menu key OUTPT calls the submenu for setting the output configuration:

Meanings of the function keys:

C1,C2 Selecting the basic setting (PRESET status).

The output signals of channel 1 and channel 2 are output indepedently of each other via the connectors OUTPUT 1 and OUTPUT 2 [9].

C1 + C2 Activating addition of both output signals and output of the summated signal via the signal OUTPUT 1 [9].

3.2.12.7 Internal Impedance of the CLOCK Input (R-CLK)

The menu key R-CLK calls a submenu for selecting the input impedances of the CLOCK inputs:

The menu keys R = 50 and R = 600 are used for selection. The entry is always relevant for the CLK input of the ADS channel currently active for entry.

The input impedance for external clock signals may be switched between 50 Ω and 600 Ω.

An input impedance of 50 Ω is automatically set for both CLK inputs when the PRESET key in the MEM/REM keypad [6] is pressed. In the case of internal CLOCK, the output impedance of the CLOCK input is 50 Ω irrespective of which input impedance is currently selected.

3.2.12.8 Inverting the Z-MARKER (Z-POL)

Using the special function Z-POL, the Z-marker for switching between blanking and unblanking of the marker position on the screen of a connected oscillograph can be inverted.

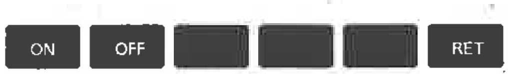
The menu key Z-POL calls the submenu Z-POL:

3.2.12.9 Setting the Brightness of the Display (BRIG)

The special function BRIG allows for variation of the brightness of the ADS vacuum fluorescent display for adjusting to the environmental conditions. The brightness can be adjusted in 11 intensity steps in the range from 0.0 to 1.0. The value 0.0 corresponds to the display switched off, 1.0 represents maximal intensity.

3.2.12.10 Deactivating the Rotary Knob for Variation (KNOB)

The rotary knob for data variation can be deactivated and activated using the special function KNOB. This menu key calls a submenu with the function keys ON and OFF to control the knob function:



The rotary knob is enabled in PRESET status.

3.2.12.11 Diagnostics and Testing (DIAGN)

The ADS features comprehensive diagnostics and testing facilities, allowing for status monitoring and adjusting of the instrument faults detected.

The diagnostics and testing menu is accessed via the menu key DIAGN:

The meanings of the menu keys are:

DIA-N — Parameter key to select the various internal diagnostic points of the generator.

The Tables 3.3, 3.4 and 3.5 give a summary of the individual diagnostic points, indicating typical values and tolerance values.

TEST — Menu key to access a submenu for selection of internal test routines and for display of the instrument firmware version.

D/A — Menu key to access a submenu for output of internal digital / analog converter settings.

CAL-O — Function key to select the internal offset calibration routine.

3.2.12.11.1 Tables of Internal Diagnostic Points

For status monitoring of the instrument, for adjustment purposes as well as for selective trouble-shooting, the dc voltage of the diagnostic points specified in Tables 3.3 to 3.5 can be measured using the internal diagnostics function of the ADS. See also the operating manual chapter 4 "Maintenance and Troubleshooting".

The typical voltage values indicated always refer to the setting and the ADS channel specified.

Table 3-3 Diagnostic points of the Processor Module

DIA-N	Test point	Typical value	Tolerance
1	Backup battery voltage	3.4 V	3.2 to 3.7 V
2	RS-232 clock monitoring	> 0.2 V	> 0.2 V

Table 3-4 Diagnostic points of the Analog Unit channel 1, 2

DIA-N		Test point / setting	Typical value	Tolerance
CH1	CH2			
11	21	Output of Waveform DAC LEVEL [PP] = 10 V ARB full-scale value Y = + 1 ARB full-scale value Y = - 1	 -1.0 V + 1.0 V	 ± 100 mV ± 100 mV
12	22	Output of Chebyshev Filter FILTER:TCHEB, 5 MHZ, LEVEL 10 V ARB full-scale value Y = + 1 ARB full-scale value Y = - 1	 -1.0 V + 1.0 V	 ± 100 mV ± 100 mV
13	23	Output of Bessel Filter FILTER:BESSL, 1 MHZ, LEVEL 10 V ARB full-scale value Y = + 1 ARB full-scale value Y = - 1	 -1.0 V + 1.0 V	 ± 100 mV ± 100 mV
14	24	Output of level setting circuits LEVEL [PP] = 10 V SPEC FUNCT:ATTEN:FIX ARB full-scale value Y = + 1 ARB full-scale value Y = - 1	 -1.0 V + 1.0 V	 ± 100 mV ± 100 mV
15	25	Output Offset-CAL.-DAC	0 V	± 4 V
16	26	Output of Output Stage LEVEL [PP] = 10 V, OFFSET 0 V 50-Ω termination ARB full-scale value Y = + 1 ARB full-scale value Y = - 1	 + 1.25 V - 1.25 V	 ± 100 mV ± 100 mV
17	27	Output of Attenuator LEVEL [PP] = 10 V, OFFSET 0 V 50-Ω termination ARB full-scale value Y = + 1 ARB full-scale value Y = - 1	 + 1.25 V - 1.25 V	 ± 100 mV ± 100 mV
18	28	Output of OFFSET-DAC OFFSET = + 5 V OFFSET = - 5 V	 -4.0 V + 4.0 V	 ± 200 mV ± 200 mV

Table 3-5 Diagnostic points of Clock Generator option ADS-B1

DIA-N	Test point	Typical value	Tolerance
31	Level, reference signal	> 1.5 V	> 1.5 V
32	Tuning voltage, 16.777-MHz Oszillator	2.0 V	1.3 to 2.6 V
33	Tuning voltage, Interpolation Oscillator	----	0.6 to 4.1 V
34	Level, Interpolation Oscillator	> 1.5 V	> 1.5 V
35	Tuning voltage, Main Oscillator	----	0.4 to 4.1 V
36	Option recognition	> 4.7 V	> 4.7 V
37	Level, clock output	> 1.5 V	> 1.5 V
38	Level, 80-kHz reference	< 1.5 V	< 1.5 V

3.2.12.11.2 Internal Test Routines (TEST)

The menu key TEST of the diagnostics menu DIAGN calls a submenu for selection of internal test routines:

DISPL	RAM	ROM	VERS		RET

Meanings of the menu keys:

DISPL Function key to select the test routine for the ADS display.

RAM Function key to select the RAM test.

ROM Function key to select the ROM test.

VERS Menu key for display of the instrument firmware version number.

3.2.12.11.3 Display and Variation of Internal D/A Converter Settings (D/A)

The menu key D/A of the diagnostics menu DIAGN calls a submenu for display and variation of internal digital/ analog converter settings:

AMPL	OFFS	CAL			RET

Direct entry of D/A converter settings makes a fine adjustment of the amplitude and offset settings possible.

Meanings of the menu keys:

AMPL Function key to display and vary the setting of the amplitude reference voltage D/A converter.

OFFS Function key to display and vary the setting of the offset D/A converter.

CAL Function key to display and vary the setting of the offset calibration D/A converter.

The input range for D/A converter settings is 0 to 4095. Table 3-6 shows the standard settings of the AMPL D/A converter and the OFFS D/A converter at typical amplitude and offset values. Varying the parameters LEVEL or OFFSET causes a direct entry to be overwritten and automatically leads to a standard setting. Regardless of the offset setting, the setting of the offset calibration D/A converter remains unchanged.

Table 3-6

D/A	Setting	Value
AMPL	LEVEL [PP] = 10.0 V	4000
	LEVEL [PP] = 7.5 V	3000
	LEVEL [PP] = 5.01 V	2003
OFFS	OFFSET = +5.0 V	0
	OFFSET = +2.5 V	1000
	OFFSET = 0 V	2000
	OFFSET = -2.5 V	3000
	OFFSET = -5.0 V	4000

3.2.12.12 Selecting Reference Source and Reference Frequency (REF)

The menu key REF calls a submenu for selection of the reference source and the reference frequency:

This submenu is only available if the instrument is equipped with the option Clock Generator ADS-B1.

As reference source, the internal reference oscillator of the option or an external reference signal may be selected. The reference frequency can be optionally switched between 5 and 10 MHz.

The meanings of the menu function keys are:

INT — Function key for switching over to the internal reference source.

In the case of operation with the internal reference, the reference signal is available at the connector REF 5/10MHz [19]. The output voltage of the reference signal is specified by > 0.2 V_{rms} into a load impedance of 50 Ω.

EXT — Function key for switching over to an external reference source.

The connector REF 5/10MHz [19] serves as input for the external reference signal. The frequency error of the external reference signal must not exceed the value ±5∗10E-6 of the reference frequency value set.

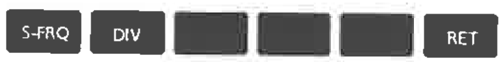
5 MHz — Function key for switching to an internal or external reference frequency of 5 MHz.

10 MHz — Function key for switching to an internal or external reference frequency of 10 MHz.

The setting REF INT, 10 MHz corresponds to the PRESET setting.

3.2.12.13 Direct Setting of the Clock Generator Option (ΔtARB)

Using the menu key ΔtARB, a submenu which enables direct setting of the Clock Generator Option's (ADS-B1) output frequency is called. The function ΔtARB is only available when the option is fitted in the ADS.



Meaning of the menu keys

S-FRQ — Parameter key for entering the output frequency of the clock synthesizer.
Input range: 12.5 to 33.334 MHz
Resolution: 1 kHz

DIV — Parameter key for entering the division factor DIV of the frequency.
Input range: 1 to 65535

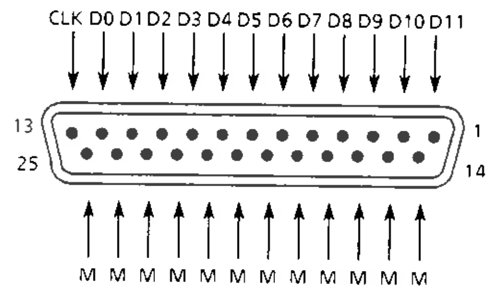
The synthesizer clock period is calculated as follows:

$$\Delta t = \frac{DIV}{S\text{-}FRQ}$$

3.2.13 DIGITAL-OUTPUT Connector

The contents of the addressed memory location of the internal waveform memory is available as 12-bit word at the DIGITAL OUTPUT connector [15], in combination with the synthesis clock. The output level of the signals is TTL-compatible.

Fig. 3-12 shows the pin assignment:



D11 = MSB
D0 = LSB
M = ground

Fig. 3-12

3.3 Remote Control of the Instrument via IEC Bus

The ADS is fitted with an IEC/IEEE bus interface as standard. It corresponds to the standards IEC 625-1 and IEC 625-2 or IEEE 488.1 and IEEE 488.2. The individual commands and their respective designations are clustered basically in accordance with the Standard Commands for Programmable Instruments (SCPI). The specifications given for the individual commands indicate to what extent the commands are covered by the standard. The ADS supports the SCPI version 1990.0.

Fig. 3-13 gives an overview of all IEC bus commands. In a system (e.g. TRIGger) and a subsystem (e.g. LIST), the device-specific commands are listed alphabetically both in Fig. 3-13 and in Section 3.3.5.

3.3.1 Brief Instructions for Simple Applications

1) Connect controller and ADS using the IEC bus cable.
2) Set device address 14.
3) Device settings:

   The first command received via the IEC bus interface sets the ADS to the remote control state. All keys except LOC/IEC ADDR are disabled. The REM (remote) LED lights and the MENU line display is switched off. The key LOC/IEC ADDR can be used to switch the ADS back to local state.

   Reset the device:
   IECOUT 14,"*RST"

   The ADS is in remote status and the REM LED is on.

   Set sine waveform for channel 1:
   IECOUT 14,":SOUR1:FUNC SIN"

   The digit "1", a so-called numeric suffix, refers the command to channel 1 of the ADS.

   Set 5-kHz frequency for channel 1:
   IECOUT 14,":SOUR1:FREQ 5KHZ"

   Set 1-V level for channel 1:
   IECOUT 14,":SOUR1:VOLT 1V"

4) On actuation of the key LOC/IEC ADDR of keypad MEM/REM [6], the ADS returns to LOCAL state and is ready for manual operation again.

Note:

The time-out value for IEC/IEEE bus operations should be set to at least 2 seconds on the bus controller.

3.3.2 Setting the Device Address

In the LOCAL mode (REM LED off), the IEC bus address can be displayed and adjusted by pressing the key LOC/IEC ADDR. The address remains stored until it is overwritten by a new address input. The address range covers 0 to 30. Additionally, the address can also be adjusted via IEC bus using the command SYSTem:COMMunicate:GPIB:ADDRess.

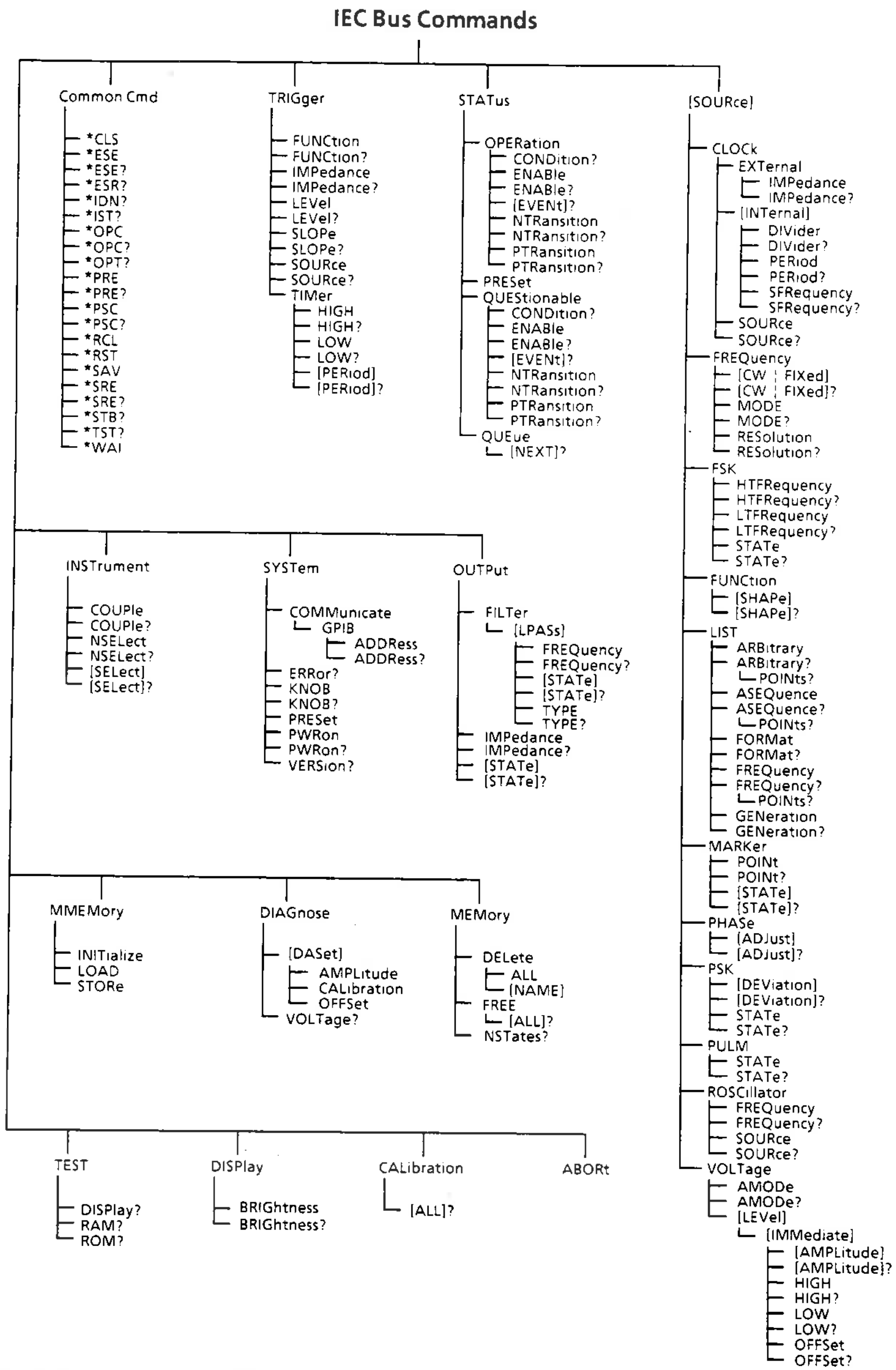


Fig. 3-13 Overview of the IEC bus commands

3.3.3 Common, Device-independent Commands (Common Commands)

Command	Numeric value	Meaning
*CLS	---	**Clear Status** The command clears all Event Registers combined in the status byte as well as all queues except the Output Queue. Subsequently, the device in is operation-complete-status.
*ESE	0 to 255	**Event Status Enable** The command sets the Standard Event Status Enable mask register to the value interpreted as bit pattern.
*OPC	---	**Operation Complete** Sets the OPC event bit (bit 0) in the Event Status Register, when all selected pending device operations have been completed.
*PRE	0 to 65535	**Parallel Poll Register Enable Command** This command permits a parallel poll and sets the individual bits of the Parallel Poll Enable Register.
*PSC	0 or 1	**Power On Status Clear Flag** (reset on power-up) If 1: On power-up of the device, the complete Status Reporting System is reset. If 0: The Status Reporting System is not affected by the turning off and subsequent power-up of the device.
*RCL	0 to 20	**Recall** Recalls a stored device setting from a memory. In memory address 0, the device setting valid prior to last switch-off is stored. This operation does not affect the POOLs.
*RST	---	**Reset** Acts on the device like the PRESET key. Additionally, also the Output Buffer is cleared. The command does not change the status of the IEC bus interface, the set IEC bus address and the mask registers of the Status Reporting System. A current Service Request is only reset if it has been generated by a message in the Output Buffer.
*SAV	1 to 20	**Save** Saves the current device setup in a device-internal memory. The ARB POOL, SEQ POOL and SWEEP POOL are not affected by this operation.
*SRE	0 to 255	**Service Request Enable** Loads the Service Request Enable mask register with the value interpreted as bit mask. Bit 6 is ignored. Each bit set permits the associated event to trigger a Service Request.
*WAI	---	**Wait to Continue** The device waits to execute subsequent commands until all pending selected device operations have been completed and the Operation-Complete-Flag is set TRUE.

Examples:
(An IEC bus address of 14 is assumed for the ADS.)

1) **Basic setting**
   IECOUT14, "*RST"

2) **Saving device setting in memory 15**
   IECOUT14, "*SAV 15"

3) **Recalling device setting from memory 15**
   IECOUT14, "*RCL 15"

3.3.4 Common, Device-independent Data Request Commands (Common Commands)

Command	Output Message	Meaning
*ESE?	0 to 255	**Event Status Enable Query** The contents of the Standard Event Status Enable ESE mask register is given in decimal form.
*ESR?	0 to 255	**Event Status Register Query** The contents of the Standard Event Status Register ESR is given as decimal value and the register then set to zero.
*IDN?	Text	**Identification Query** A text is provided for identification of the device. It is structured as follows: ROHDE&SCHWARZ,ADS,0,1.0 Rohde&Schwarz = manufacturer ADS = model 0 = reserved for serial number (not used) 1.0 = firmware version (example)
*IST?	0 ¦ 1	**Individual Status Query** Reads the individual status IST. This is the status bit sent during a parallel poll function. Using this command, the bit can also be read without parallel poll.
*OPC?	1	**Operation Complete Query** The message "1" is entered in the Output Buffer when all selected pending device operations have been completed.
*OPT?	0 ¦ ADS-B1	**Option Identification Query** The command gives a sequence of characters for identification of the options contained in the device. For the ADS, the option ADS-B1 is defined.
*PRE?	0 to 65535	**Parallel Poll Register Enable Query** This command returns the current contents of the Parallel Poll Enable Register.
*PSC?	0 ¦ 1	**Power On Status Clear Flag Query** This command gives the status of the Power On Status Clear Flag (see Section 3.3.3, *PSC).
*SRE?	0 to 191	**Service Request Enable Query** The bit mask of the Service Request Enable SRE register is given as decimal value. Bit 6 is always zero.
*STB?	0 to 255	**Status Byte Query** The contents of the status byte, including the Master Summary Status Bit, is output as decimal value.
*TST?	Error code	**Self Test Query** The command initiates a self-test in the device. The result is output as decimal value. If no error is detected during self-test routine, the response is 0. The further error codes are summarized in Section 3.3.15.

Example:

Device identification via IEC bus (device address 14)

```
IECTERM 10           (talker terminator "new line")
IECOUT14, "*IDN?"    (identification query)
IECIN14, A$          (receive device response)
PRINT A$             (print out device response)
```

3.3.5 Device-specific Commands

The following sections give all the ADS-specific setting commands. Each command is first indicated in its complete wording, together with the information whether it is supported by the current SCPI standard or not. The shortest possible notation of a command is specified in capitalized letters. The text in square brackets is optional and may be omitted without effect on the command execution (see Section 3.3.8.1). The second and third lines, respectively, indicate the short form of the command, when all possibilities for abbreviation are applied.

The next section decribes the effect of a command. Subsequently, the possible parameters, units and the query form of the command are listed.

The character "#" represents a so-called "numeric suffix" and is always used if a specific functional unit of several similar functional units of a device must be indicated. For example, the number of the channel to which the command applies must be specified in many commands with the dual-channel generator ADS.

If several alternatives are possible for a parameter, they are seperated by a vertical "¦".

The parameter forms <numeric_value>, <NRf>, <NR1>, <NR3>, <Text>, <Boolean> and <Definite Length Arbitrary Block Data> are described in detail in Section 3.3.8.3.

Note:

At least one space should separate a command from the parameter forms.

3.3.5.1 The System :SYSTem

The system :SYSTem comprises the common functions affecting the general device setup.

:SYSTem:COMMunicate:GPIB:ADDRess <numeric_value> **(SCPI)**
:SYST:COMM:GPIB:ADDR <numeric_value>

The command sets the IEC bus address of the ADS, which is valid on termination of the current line. All subsequent commands must be sent to this new address.

<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	none
Query:	**:SYSTem:COMMunicate:GPIB:ADDRess?**
Response:	<NR1>

:SYSTem:ERRor? **(SCPI)**
:SYST:ERR?

The query provides the next entry of the Error Queue of the ADS. The device responds with an error code and a text describing the error, for example:

-131,"Invalid suffix;FREQuency 1000 V".

If the queue is empty, the ADS responds with 0,"No Error". In the case of an overflow of the queue, the last entry is replaced by -350,"Queue overflow".

The queue is deleted when the ADS is switched on, after the command *CLS is given and after the last element is read.

All the error messages are listed in Section 3.3.15.

:SYSTem:KNOB <Boolean> **(not SCPI)**
:SYST:KNOB <Boolean>

The command activates or deactivates the control knob for variation.

<Boolean>:	OFF ¦ ON ¦ 0 ¦ 1
Query:	**:SYSTem:KNOB?**
Response:	0 ¦ 1

:SYSTem:PRESet **(SCPI)**
:SYST:PRES
The command has the same effect as the key PRESET on the ADS front panel. This does not change the state of the IEC bus interface.

:SYSTem:PWRon <value> **(not SCPI)**
:SYST:PWR <value>

The command corresponds to the special function PWRON and decides on the switch-on state of the ADS. Any STO/RCL memory can be automatically selected. The memory location 0 resets the device setup valid prior to the last switch-off. Entering PRESet suppresses selection of the memory, so that the ADS remains in its PRESET status.

<Value>:	-1 to 20 ¦ PRESet
Unit:	none
Query:	**:SYSTem:PWRon?**
Response:	-1 to 20

:SYSTem:VERSion? **(SCPI)**
:SYST:VERS?

The query provides the version number of the implemented SCPI version in the form of YYYY.V. YYYY represents the year and V the revision number.

Response:	1990.0 (example)

3.3.5.2 The System :STATus

The SCPI standard defines further status registers, in addition to the status reporting recommended in the IEEE 488.2 standard. These registers are controlled by the commands of system :STATus. Refer to Section 3.3.7 for detailed information about status reporting.

:STATus:OPERation:CONDition? **(SCPI)**
:STAT:OPER:COND?

The query outputs the contents of the Operation Status Condition Register, which is not destructively read.

Response: 0 to 32767

:STATus:OPERation:ENABle <NRf> **(SCPI)**
:STAT:OPER:ENAB <NRf>

The command sets the Operation Status Enable Register. Using this register, the individual events of the Operation Status Event Register can be selectively enabled for the summary bit in the status byte. "1" on the respective bit position enables the event.

<NRf>	0 to 32767
Unit:	none
Query:	**:STATus:OPERation:ENABle?**
Response:	0 to 32767

:STATus:OPERation[:EVENt] ? **(SCPI)**
:STAT:OPER?

The query outputs the contents of the Operation Status Event Register. In this case, the register is destructively read.

Response: 0 to 32767

:STATus:OPERation:NTRansition <NRf> **(SCPI)**
:STAT:OPER:NTR <NRf>

The command sets the negative edge filter for the operation status. Each 1 in this register (NTRansition) ensures that the corresponding bit in the condition register is monitored for 1 → 0 transitions. If such a transition occurs, the respective bit in the EVENt Register is set.

<NRf>:	0 to 32767
Unit:	none
Query:	**:STATus:OPERation:NTRansition?**
Reponse:	0 to 32767

:STATus:OPERation:PTRansition <NRf> **(SCPI)**
:STAT:OPER:PTR <NRf>

The command sets the positive edge filter for the operation status. Each 1 in this register (PTRansition) ensures that the corresponding bit in the condition register is monitored for 0 → 1 transitions. If such a transition occurs, the respective bit in the EVENt Register is set.

<NRf>:	0 to 32767
Unit:	none
Query:	**:STATus:OPERation:PTRansition?**
Response:	0 to 32767

:STATus:PRESet **(SCPI)**

The command sets the Operation Status Enable Register and the Questionable Status Enable Register to zero, so that all the events are unmasked. The positive edge filters are activated on all bits, the negative edge filters are switched off.

The command has no effect on the event registers, which can be cleared by *CLS. Neither the Event Status Enable (ESE) Register nor the Se- ice Request Enable (SRE) Register are changed.

Parameter: none

:STATus:QUEStionable:CONDition? **(SCPI)**
:STAT:QUES:COND?

This query outputs the contents of the Questionable Status Condition Register, which is not destructively read.

Response: 0 to 32767

:STATus:QUEStionable:ENABle <NRf> **(SCPI)**
:STAT:QUES:ENAB <NRf>

The command sets the Questionable Status Enable Register. Using this register, the individual events of the Questionable Status Register can be selectively enabled for the summary bit in the status byte. "1" on the respective bit position enables the event.

<NRf>	0 to 32767
Unit:	none
Query:	**:STATus:QUEStionable:ENABle?**
Response:	0 to 32767

:STATus:QUEStionable[:EVENt]? **(SCPI)**
:STAT:QUES?

This query outputs the contents of the Questionable Status Event Register. In this case, the register is destructively read.

Response: 0 to 32767

:STATus:QUEStionable:NTRansition <NRf> **(SCPI)**
:STAT:QUES:NTR <NRf>

The command sets the negative edge filter for the Questionable Status. Each 1 in this register (NTRansition) ensures that the corresponding bit in the condition register is monitored for 1 → 0 transitions. If such a transition occurs, the respective bit in the EVENt Register is set.

<NRf>:	0 to 32767
Unit:	none
Query:	**:STATus:QUEStionable:NTRansition?**
Response:	0 to 32767

:STATus:QUEStionable:PTRansition <NRf> **(SCPI)**
:STAT:QUES:PTR <NRf>

The command sets the positive edge filter for the Questionable Status. Each 1 in this register (PTRansition) ensures that the corresponding bit in the condition register is monitored for 0 → 1 transitions. If such a transition occurs, the respective bit in the EVENt Register is set.

<NRf>:	0 to 32767
Unit:	none
Query:	**:STATus:QUEStionable:PTRansition?**
Response:	0 to 32767

:STATus:QUEue [:NEXT] ? **(SCPI)**
:STAT:QUE?

Like the query :SYSTem:ERRor?, this query provides the next entry of the Error Queue of the ADS. The device responds with an error code and a text describing the error, for example:

-131,"Invalid suffix;FREQuency 1000 V".

If the queue is empty, the ADS responds with 0,"No Error". In case of an overflow of the queue, the last entry is replaced by -350,"Queue overflow".

The queue is deleted when the ADS is switched on, after the command *CLS is given and after the last element is read.

All error messages are listed in Section 3.3.15.

3.3.5.3 The System [:SOURce]

The System :SOURce concerns the generation of signals. The node [:SOURce] is optional. If it is omitted, no channel can be entered. In this case, the command is always referred to channel 1, unless another channel is defined as default channel via :INSTrument.

3.3.5.3.1 The Subsystem :CLOCk

[:SOURce#]:CLOCk:EXTernal:IMPedance <numeric_value> **(not SCPI)**
[:SOUR#]:CLOC:EXT:IMP <numeric_value>
:CLOC:EXT:IMP <numeric_value>

The command switches the impedance of the CLK connector, when it has been selected as an input, between 50 Ω and 600 Ω.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ∈ {50 ¦ 600}
Units:	OHM, KOHM
Basic unit:	OHM
Query:	**[:SOURce]:CLOCk:EXTernal:IMPedance?**
Response:	0.50000000E + 2 ¦ 0.60000000E + 3

Note:

If the option ADS-B1 is fitted, the internal signal element timing is generated by a synthesizer with variable frequency and a subsequent divider. In this case, the step time can, instead of being set with [:SOURce]:CLOCk[:INTernal]:PERiod, also be set using both commands [:SOURce]:CLOCk[:INTernal]:DIVider and [:SOURce]:CLOCk[:INTernal]:SFRequency. These two commands are coupled with the command [:SOURce]:CLOCk[:INTernal]:PERiod, i.e. the values from SFRequency and DIVider are effected by PERiod and the value from PERiod is effected by SFRequency and DIVider. If the option ADS-B1 is not installed, the commands SFRequency and DIVider do not exist.

[:SOURce]:CLOCk[:INTernal]:DIVider <numeric_value> **(not SCPI)**
:CLOC:DIV <numeric_value>

The command sets the divider which is used in the generation of the signal element timing. Legal values range from 1 to 65535. The setting applies for both channels. See note above.

<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Query:	**[:SOURce]:CLOCk[:INTernal]:DIVider?**
Response:	<NR3>

[:SOURce]:CLOCk[:INTernal]:PERiod <numeric_value> **(not SCPI)**
:CLOC:PER <numeric_value>

The command sets the step time for ARB waveforms and ARB sequences. The setting applies for both channels. See note above.

<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	NS, US, MS, S
Basic unit:	S
Query:	**[:SOURce]:CLOCk[:INTernal]:PERiod?**
Response:	<NR3>

[:SOURce]:CLOCk[:INTernal]:SFRequency <numeric_value> **(not SCPI)**
:CLOC:SFR <numeric_value>

The command determines the frequency supplied by the synthesizer which is used in the generation of the signal element timing. Legal values range from 12.5 MHz to 33.334 MHz. The setting applies for both channels. See note on preceding page.

<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	HZ, KHZ, MHZ
Basic unit:	HZ
Query:	**[:SOURce]:CLOCk[:INTernal]:SFRequency?**
Response:	<NR3>

[:SOURce#]:CLOCk:SOURce <Text> **(not SCPI)**
[:SOUR#]:CLOC:SOUR <Text>
:CLOC:SOUR <Text>

The command determines whether the clock signal used in clocking out waveforms comes from the ADS internal clock generator or whether it is fed in from an external source.

#:	channel number ∈ {1 ¦ 2}, optional
<Text>:	INTernal ¦ EXTernal
Query:	**[:SOURce]:CLOCk:SOURce?**
Response:	INT ¦ EXT

3.3.5.3.2 The Subsystem :FREQuency

The commands in this subsystem set the basic parameters for the sine and triangular signals.

[:SOURce#]:FREQuency[:CW] <numeric_value> **(SCPI)**
[:SOURce#]:FREQuency[:FIXed] <numeric_value>
[:SOUR#]:FREQ <numeric_value>
:FREQ <numeric_value>

The command sets the frequency for sine and triangular waves in the mode CONT (CW). The operating MODE is not changed.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	HZ, KHZ, MHZ
Basic unit:	HZ
Query:	**[:SOURce#]:FREQuency[:CW]?**
	or
	[:SOURce#]:FREQuency[:FIXed]?
Reponse:	<NR3>

[:SOURce#]:FREQuency:MODE <Text> [,<numeric_value>] **(SCPI)**
[:SOUR#]:FREQ:MODE <Text> [,<numeric_value>]
:FREQ:MODE <Text> [,<numeric_value>]

The command is used to determine for the sine and triangular waves if the ADS generates a signal with constant frequency (CW, FIX) or if a sweep (LIST) is performed. The optional parameter <numeric_value> defines the sweep number. If omitted, the previously entered sweep number is assumed. In the case of CW or FIX, this parameter is ignored. If the current waveform is not sine or triangle, the waveform sine is set.

#:	channel number ∈ [1 ¦ 2], optional
<Text>:	CW ¦ FIXed ¦ LIST
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	none
Query:	**[:SOURce#]:FREQuency:MODE?**
Response:	CW ¦ LIST, <NR3>

[:SOURce#]:FREQency:RESolution <numeric_value> **(not SCPI)**
[:SOUR#]:FREQ:RES <numeric_value>
:FREQ:RES <numeric_value>

The command corresponds to the special function F-RES and is used for switching over the frequency resolution for the waveforms sine and triangle in the mode CONT. The resolution may be set to 1 Hz or 0.1 Hz.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	0.1 ¦ 1 ¦ MINimum ¦ MAXimum ¦ DEFault
Query:	**[:SOURce#]:FREQency:RESolution?**
Response:	0.1 ¦ 1

3.3.5.3.3 The Subsystem :FSK

The subsystem :FSK serves for configuration of the modulation mode FSK (Frequency Shift Keying), when the output signal is blanked between two frequencies.

[:SOURce#]:FSK:HTFRequency <numeric_value> **(not SCPI)**
[:SOUR#]:FSK:HTFR <numeric_value>
:FSK:HTFR <numeric_value>

The command defines the frequency during the high phase of the trigger signal.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	HZ ¦ KHZ ¦ MHZ
Basic unit:	HZ
Query:	**[:SOURce#]:FSK:HTFRequency?**
Response:	<NR3>

[:SOURce#]:FSK:LTFRequency <numeric_value> **(not SCPI)**
[:SOUR#]:FSK:LTFR <numeric_value>
:FSK:LTFR <numeric_value>

The command defines the frequency during the low phase of the trigger signal.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	HZ ¦ KHZ ¦ MHZ
Basic unit:	HZ
Query:	**[:SOURce#]:FSK:LTFRequency?**
Response:	<NR3>

[:SOURce#]:FSK:STATe <Boolean> **(not SCPI)**
[:SOUR#]:FSK:STATe <Boolean>
:FSK:STATe <Boolean>

The command switches the modulation mode FSK on or off.

#:	channel number ∈ [1 ¦ 2], optional
<Boolean>:	OFF ¦ ON ¦ 0 ¦ 1
Query:	**[:SOURce#]:FSK:STATe?**
Response:	0 ¦ 1

3.3.5.3.4 The Subsystem :FUNCtion

The command of this subsystem controls the device to output a specific waveform. In the case of ARBitrary and SEQuence, additionally the number of the waveform can be specified. For SINusoid und TRIangle waveforms, this will be ignored.

[:SOURce#]:FUNCtion[:SHAPe] <Text> [,<numeric_value>] **(not SCPI)**
[:SOUR#]:FUNC <Text> [,<numeric_value>]
:FUNC <Text> [,<numeric_value>]

#:	channel number ∈ [1 ¦ 2], optional
<Text>:	SINusoid ¦ TRIangle ¦ ARBitrary ¦ SEQuence
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Unit:	none
Query:	**[:SOURce#]:FUNCtion[:SHAPe]?**
Response:	<Text> ∈ {SIN ¦ TRI ¦ ARB ¦ SEQ}, <NRf>

3.3.5.3.5 The Subsystem :LIST

This subsystem serves for transmission of ARB waves, sequences and sweeps between controller and device ADS.

[:SOURce]:LIST:ARBitrary# <numeric_value>, ... **(not SCPI)**
:LIST:ARB# <numeric_value>, ...

The command transfers an ARB wave to the ADS. The values transmitted represent the Y values.
The wave values are transmitted sequentially starting from the X position 1. Up to 16384 <numeric_value>'s, separated by commas, may be specified.

#:	number of ARB wave
<numeric_value>:	Y value ∈ {-1.0 to + 1.0}

[:SOURce]:LIST:ARBitrary# <Definite Length Arbitrary Block Data> **(not SCPI)**
:LIST:ARB# <Definite Length Arbitrary Block Data>

The command corresponds to the previous command. However, the ARB wave is transmitted to the ADS in binary format at high speed. The data format <Definite Length Arbitrary Block Data> is described in Section 3.3.8.3.

[:SOURce]:LIST:ARBitrary#? **(not SCPI)**
:LIST:ARB#?

The query transmits an ARB wave to the controller. The data format can previously be defined using the command [:SOURce]:LIST:FORMat.

[:SOURce]:LIST:ARBitrary#:POINts? **(not SCPI)**
:LIST:ARB#:POIN?

The query provides the number of points to be included in the ARB wave.

#:	wave number
Response:	<NR1>

[:SOURce]:LIST:ASEQuence# <sequence element>, ... **(not SCPI)**
LIST:ASEQ# <sequence element>, ...

This command serves for programming sequences in the ADS. A sequence consists of sequence elements. Each element is composed of the three components wave number, repetition factor and time division factor.

The order of wave number, repetition factor and time division factor is predetermined and cannot be modified by the user. Any number of sequence elements, separated by commas, may be specified.

Example:

:LIST:ASEQ23 15,3,1, 28,2,3, 59,5,1

The sequence with number 23 is composed of three elements:

ARB wave 15, executed three times, time division 1
ARB wave 28, executed twice, time division 3
ARB wave 59, executed five times, time division 1

Also, binary data transmission is possible as <Definite Length Arbitrary Block Data>, when the TUPEL order is maintained. Each of the three components is transfered as 2-byte value without polarity sign.

[:SOURce]:LIST:ASEQuence#? **(not SCPI)**
:LIST:ASEQ#?

The query transfers an ARB sequence to the controller. Prior to transmission, the data format can be determined using the command [:SOURce]:LIST:FORMat and is structured as in the previous command.

[:SOURce]:LIST:ASEQuence#:POINts? **(not SCPI)**
:LIST:ASEQ#:POIN?

The query gives the number of elements contained in an ARB sequence.

#:	sequence number
Response:	<NR1>

[:SOURce]:LIST:FORMat <Text> **(not SCPI)**
:LIST:FORMat <Text>

The command determines the format for transmission of lists, which is to be used for the data transmission from the ADS to the controller. For data transmission from the controller to the ADS, the transmission format is automatically determined.

<Text>:	ASCii ¦ BINary
Query:	**[:SOURce]:LIST:FORMat?**
Response:	ASC ¦ BIN

[:SOURce]:LIST:FREQuency# <numeric_value>, ... **(SCPI)**
:LIST:FREQ# <numeric_value>, ...

The command transmits the frequencies pertaining to a sweep to the ADS. The frequencies are transferred sequentially starting from sweep element 1. Any number of <numeric_value>'s, separated by commas, may be specified.

#: sweep number
<numeric_value>: <NRf> ¦ MINimum ¦ MAXimum ¦ DEFault

[:SOURce]:LIST:FREQuency# <Definite Length Arbitrary Block Data> **(SCPI)**
:LIST:FREQ# <Definite Length Arbitrary Block Data>

The command transmits the frequencies pertaining to a sweep to the ADS in binary format. The frequencies are transferred sequentially starting from sweep element 1. The binary format is described in Section 3.3.8.3. Each element specifies a frequency value and requires 4 bytes.

#: sweep number

[:SOURce]:LIST:FREQuency#? **(SCPI)**
:LIST:FREQ#?

The command returns a sweep to the controller. The command format depends on the command definition [:SOURce]:LIST:FORMAT.

[:SOURce]:LIST:FREQuency#:POINts? **(SCPI)**
:LIST:FREQ#:POIN?

The query provides the number of elements contained in a sweep.

#: number of wave
Response: <NR1>

[:SOURce]:LIST:GENeration <Text> **(SCPI)**
:LIST:GEN <Text>

This command is used to determine the sequences for generation of the list system. However, the ADS only supports the mode DSEQuence, as only a linear list processing in sequential order is possible. For the sake of completeness, the command is implemented.

<Text>: DSEQuence
Query: **[:SOURce]:LIST:GENeration?**
Response: DSEQ

3.3.5.3.6 The Subsystem :MARKer

The subsystem :MARKer handles the switching on and off of the markers in the ADS. The command is always effective for the marker assigned to the currently active ADS mode, i.e. the ARB marker in ARB mode, the SEQ marker in SEQ mode and the SWEEP marker in SWEEP mode.

[:SOURce#]:MARKer:POINt <numeric_value> **(SCPI)**
[:SOUR#]:MARK:POIN <numeric_value>
:MARK:POIN <numeric_value>

The command sets the marker to a specific point in an ARB wave, sequence or sweep.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦MAXimum ¦ DEFault
Units:	none
Query:	**[:SOURce#]:MARKer:POINt?**
Response:	<NR3>

[:SOURce#]:MARKer[:STATe] <Boolean> **(SCPI)**
[:SOUR#]:MARK <Boolean>
:MARK <Boolean>

The command switches marking on or off.

#:	channel number ∈ [1 ¦ 2], optional
<Boolean>:	OFF ¦ ON ¦ 0 ¦ 1
Query:	**[:SOURce#]:MARKer[:STATe]?**
Response:	0 ¦ 1

3.3.5.3.7 The Subsystem :PHASe

This subsystem contains one command only. The command is used to synchronize the two channels in the ADS. For the sine and triangular waveforms in the mode CONT, a phase offset can simultaneously be defined. It is set at the point of synchronization and maintained at the same frequency.

[:SOURce#]:PHASe[:ADJust] <numeric_value> **(SCPI)**
:PHAS <numeric_value>

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	RADian, DEGRee
Basic unit:	RADian
Query:	**[:SOURce#]:PHASe[:ADJust]?**
Response:	<NR3>

3.3.5.3.8 The Subsystem :PSK

The subsystem :PSK configures the modulation mode PSK (Phase Shift Keying). In this modulation mode, the phase of the output signal is varied between two values.

[:SOURce#]:PSK[:DEViation] <numeric_value> **(not SCPI)**
[:SOUR#]:PSK <numeric_value>
:PSK <numeric_value>

The command sets the difference in phase for the modulation mode PSK.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦MAXimum ¦ DEFault
Units:	RADian, DEGRee
Basic unit:	RADian
Query:	**[:SOURce#]:PSK[:DEViation]?**
Response:	<NR3>

[:SOURce#]:PSK:STATe <Boolean> **(not SCPI)**
[:SOUR#]:PSK:STATe <Boolean>
:PSK:STATe <Boolean>

The command switches modulation mode PSK on or off.

#:	channel number ∈ [1 ¦ 2], optional
<Boolean>:	OFF ¦ ON ¦ 0 ¦ 1
Query:	**[:SOURce#]:PSK:STATe?**
Response:	0 ¦ 1

3.3.5.3.9 The Subsystem :PULM

In pulse modulation, the amplitude of the output signal is varied between zero and the set level.

[:SOURce#]:PULM:STATe <Boolean> **(SCPI)**
[:SOUR#]:PULM:STATe <Boolean>
:PULM:STATe <Boolean>

The command switches pulse modulation mode on or off.

#:	channel number ∈ [1 ¦ 2], optional
<Boolean>:	OFF ¦ ON ¦ 0 ¦ 1
Query:	**[:SOURce#]:PULM:STATe?**
Response:	0 ¦ 1

3.3.5.3.10 The Subsystem :ROSCillator

The commands available in this subsystem configure the reference frequency option or query its respective state. They are only to be used when the option ADS-B1 is installed.

[:SOURce]:ROSCillator:FREQuency <numeric_value> **(SCPI)**
:ROSC:FREQ <numeric_value>

The command is used to set the reference frequency. 5 MHz or 10 MHz may be selected.

<numeric_value>:	<NRf> ∈ {5E6 ¦ 10E6}
Units:	HZ, KHZ, MHZ
Basic unit:	HZ
Query:	**[:SOURce]:ROSCillator:FREQuency?**
Response:	0.10000000E-8 ¦ 0.50000000E + 7

[:SOURce]:ROSCillator:SOURce <Text> **(SCPI)**
:ROSC:SOUR <Text>

The command determines whether the reference signal is internally generated in the ADS or supplied externally.

<Text>:	INTernal ¦ EXTernal
Query:	**[:SOURce]:ROSCillator:SOURce?**
Response:	INT ¦ EXT

3.3.5.3.11 The Subsystem :VOLTage

This subsystem sets level and offset of the output signal and selects the setting algorithm for the relay-switched attenuator.

[:SOURce#]:VOLTage:AMODe <Text> **(not SCPI)**
[:SOUR#]:VOLT:AMOD <Text>
:VOLT:AMOD <Text>

The command corresponds to the special function ATTEN and sets the operating mode of the relay-switched attenuator.

#:	channel number ∈ [1 ¦ 2], optional
<Text>:	AUTO ¦ FIXed ¦ NORM ¦ INV ¦ EXT
Query:	**[:SOURce#]:VOLTage:AMODe?**
Response:	AUTO ¦ NORM ¦ INV ¦ EXT

[:SOURce#]:VOLTage[:LEVel][:IMMediate][:AMPLitude] <numeric_value> **(SCPI)**
[:SOUR#]:VOLT <numeric_value>
:VOLT <numeric_value>

The command sets the amplitude of the output signal (peak to peak).

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	MV ¦ V ¦ MVPP ¦ VPP
Basic unit:	V
Query:	**[:SOUR#]:VOLT?**
Response:	<NR3>

[:SOURce#]:VOLTage[:LEVel][:IMMediate]:HIGH <numeric_value> **(SCPI)**
[:SOUR#]:VOLT:HIGH <numeric_value>
:VOLT:HIGH <numeric_value>

The command sets the positive peak value of the output signal. Level and offset are adjusted such that the negative peak value is maintained.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	MV ¦ V ¦ MVPP ¦ VPP
Basic unit:	V
Query:	**[:SOUR#]:VOLT:HIGH?**
Response:	<NR3>

[:SOURce#]:VOLTage[:LEVel][:IMMediate]:LOW <numeric_value> **(SCPI)**
[:SOUR#]:VOLT:LOW <numeric_value>
:VOLT:LOW <numeric_value>

The command sets the negative peak value of the output signal. Level and offset are adjusted such that the positive peak value is maintained.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	MV ¦ V ¦ MVPP ¦ VPP
Basic unit:	V
Query:	**[:SOUR#]:VOLT:LOW?**
Response:	<NR3>

[:SOURce#]:VOLTage[:LEVel][:IMMediate]:OFFSet <numeric_value> **(SCPI)**
[:SOUR#]:VOLT:OFFSet <numeric_value>
:VOLT:OFFS <numeric_value>

The command sets the dc offset of the output signal.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	MV ¦ V ¦ MVPP ¦ VPP
Basic unit:	V
Query:	**[:SOUR#]:VOLT:OFFSet?**
Response:	<NR3>

3.3.5.4 The Systems :ABORt and :TRIGger

The following commands are used to select the operating mode for triggering and to configure the trigger system of the ADS. The trigger system consists of an internal trigger generator used for both channels and a changeover switch each to select internal, manual or external triggering. As some functions in the ADS are edge-triggered (e.g. SINGle) while others are level-controlled (e.g. GATE), the generator can be set for low or high state either via the period or also the times.

:ABORt **(SCPI)**

The command resets the internal trigger generator. The generator then starts immediately at the high phase. This command can be used to start the generator in a defined way, which is particularly suitable with long trigger periods.

Parameter:	none
Query:	no

:TRIGger#:FUNCtion <Text> **(not SCPI)**
:TRIG#:FUNC <Text>

This command corresponds to the menu, which is displayed in the MENU display on actuation of the key MODE in the keypad SELECT. It determines the operating mode for triggering and activates the mode. NONE corresponds to the operating mode CONT.

#:	channel number ∈ [1 ¦ 2], optional
<Text>:	NONE ¦ SINGle ¦ GATE ¦ STEP ¦ MRESet ¦ HOLD ¦ HRESet
Query:	**:TRIGger#:FUNCtion?**
Response:	NONE ¦ SING ¦ GATE ¦ STEP ¦ MRES ¦ HOLD ¦ HRES

:TRIGger#:IMPedance <NRf> **(not SCPI)**
:TRIG#:IMP <NRf>

The commands allows to switch the impedance of the external trigger connection between 50 Ω and 600 Ω.

#:	channel number ∈ [1 ¦ 2], optional
<NRf>:	50 ¦ 600
Unit:	OHM, KOHM
Query:	**:TRIGger#:IMPedance?**
Response:	0.60000000E + 3 ¦ 0.50000000E + 2

:TRIGger#:LEVel <NRf> **(SCPI)**
:TRIG#:LEV <NRf>

The command sets the trigger level for external triggering. It may be set to 0.2 V or 2 V.

#:	Channel number ∈ [1 ¦ 2], optional
<NRf>:	0.2 ¦ 2.0
Unit:	UV ¦ MV ¦ V
Query:	**:TRIGger#:LEVel?**
Response:	0.20000000E + 1 ¦ 0.20000000E + 0

:TRIGger#:SLOPe <Text> (SCPI)
:TRIG#:SLOP <Text>

The command sets the trigger edge for external triggering.

#:	channel number ∈ [1 ¦ 2], optional
<Text>:	POSitive ¦ NEGative
Query:	**:TRIGger#:SLOPe?**
Response:	POS ¦ NEG

:TRIGger#:SOURce <Text> (SCPI)
:TRIG#:SOUR <Text>

The command sets the trigger source.

#:	channel number ∈ [1 ¦ 2], optional
<Text>:	TIMer ¦ MANuell ¦ EXTernal
Query:	**:TRIGger#:SOURce?**
Response:	TIM ¦ MAN ¦ EXT

:TRIGger:TIMer:HIGH <numeric value> (not SCPI)
:TRIG:TIM:HIGH <numeric value>

The command sets the duration of high level of the trigger generator. The value for the period is adjusted correspondingly.

<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	US, MS, S
Basic unit:	S
Query:	**:TRIGger:TIMer:HIGH?**
Response:	<NR3>

:TRIGger:TIMer:LOW <numeric_value> (not SCPI)
:TRIG:TIM:LOW <numeric_value>

The command sets the duration of low level of the trigger generator. The value for the period is adjusted correspondingly.

<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	US, MS, S
Basic unit:	S
Query:	**:TRIGger:TIMer:LOW?**
Response:	<NR3>

:TRIGger:TIMer[:PERiod] <numeric_value> (not SCPI)
:TRIG:TIM <numeric_value>

The command sets the period of the internal trigger generator.

<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Units:	US, MS, S
Basic unit:	S
Query:	**:TRIGger:TIMer[:PERiod]?**
Response:	<NR3>

3.3.5.5 The System :OUTPut

The purpose of the OUTPut block is to modify the signal after it has been generated. The block permits selection of various filters, selection of the output impedance and switch-on and switch-off of the outputs (OUTPUT [9]).

:OUTPut#:FILTer[:LPASs]:FREQuency <numeric_value> (not SCPI)
:OUTP#:FILT:FREQ <numeric_value>

The command sets the cutoff frequency of the filter.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	10.0E3 ¦ 100.0E3 ¦ 500.0E3 ¦ 1.0E6 ¦ 2.5E6 ¦ 5.0E6
Unit:	HZ ¦ KHZ ¦ MHZ
Query:	**:OUTPut#:FILTer[:LPASs]:FREQuency?**
Response:	<NR3>

:OUTPut#:FILTer[:LPASs][:STATe] <Boolean> (SCPI)
:OUTPut#:FILT <Boolean>

The command switches the filters on or off.

#:	channel number ∈ [1 ¦ 2], optional
<Boolean>:	OFF ¦ ON ¦ 0 ¦ 1
Query:	**:OUTPut#:FILTer[:LPASs][:STATE]?**
Response:	0 ¦ 1

:OUTPut#:FILTer[:LPASs]:TYPE <Text> (not SCPI)
:OUTPut#:FILT:TYPE <Text>

The command allows to switch the filter characteristic between Bessel and Chebyshev. DEFault activates an automatic: in ARB and SEQ mode, no filter is active; in sine and triangle mode, a suitable Chebyshev filter is switched on depending on the frequency. Additionally, also an external filter can be connected into the signal path.

As not every characteristic is available at any frequency, first the type of filter and subsequently the frequency should be set.

Attention: Selecting a filter characteristic does not automatically activate the filter!

#:	channel number ∈ [1 ¦ 2], optional
<Text>:	BESSel ¦ TCHebychev ¦ DEFault ¦ EXTern
Query:	**:OUTPut#:FILTer[:LPASs]:TYPE?**
Response:	BESS ¦TCH ¦ DEF ¦ EXT

:OUTPut#:IMPedance <numeric_value> **(SCPI)**
:OUTP#:IMP <numeric_value>

The command determines the internal impedance of the output when it is switched off (special function Ri?). The user may select between 50 Ω and high-impedance output.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	50 ¦ MAXimum
Units:	none
Query:	**:OUTPut#:IMPedance?**
Response:	50 ¦ MAX

:OUTPut#[:STATe] <Boolean> **(SCPI)**
:OUTP# <Boolean>

The command switches the output on or off.

#:	channel number ∈ [1 ¦ 2], optional
<Boolean>:	OFF ¦ ON ¦ 0 ¦ 1
Query:	**:OUTPut#[:STATe]?**
Response:	0 ¦ 1

3.3.5.6 The System :CALibration

This system handles the functions for device calibration.

:CALibration[:ALL]? **(SCPI)**
:CAL?

The query initiates an offset calibration in the ADS. When the calibration is successfully completed, the ADS responds with "0". Otherwise, "1" is indicated. Additionally, bit 3 "Device-Dependent Error" is set in the Standard Event Status Register in the case of error. During calibration, bit 0 is set in the Operation Status Register.

Response: 0 ¦ 1

3.3.5.7 The System :MEMory

This system controls the device-internal memory, which includes the recall memories as well as the data POOLs for the modes ARB, SEQ and SWP.

:MEMory:DELete:ALL **(SCPI)**
:MEM:DEL:ALL

The command clears the complete pool with all ARB waves, sequences and sweeps.

Parameter: none
Query: no

:MEMory:DELete[:NAME] <Text> **(not SCPI)**
:MEM:DEL <Text>

The command deletes an ARB wave, sequence or sweep from the pool. The element to be deleted must be indicated as text in inverted commas.

<Text>: "ARB#" ¦ "SEQ#" ¦ "SWP#"
#: element number, e.g. "ARB25"
Query: no

:MEMory:FREE[:ALL]? **(SCPI)**
:MEM:FREE?

The query provides the memory location available in the POOL in byte.

Response: <NR3>
Unit: none

:MEMory:NSTates? **(SCPI)**
:MEM:NST?

The query provides the number of STO/RCL memory addresses available in the device.

Response: 21
Unit: none

3.3.5.8 The System :DISPlay

This system contains a command for setting the brightness of the display. Values from 0.0 to 1.0 may be set. With 0.0, the display is switched off completely, 1.0 is maximal brightness.

:DISPlay:BRIGhtness <numeric_value> **(SCPI)**
:DISP:BRIG <numeric_value>

<numeric_value>: <NRf> ¦ MINimum ¦ MAXimun ¦ DEFault
Unit: none
Query: **:DISPlay:BRIGhtness?**
Response: <NR3>

3.3.5.9 The System :DIAGnose

Implementation of the system :DIAGnose is optional in the standard SCPI. Here, the ADS contains commands for addressing various test points. Some D/A converters can be directly set to check their functions.

:DIAGnose[:DASet]:AMPLitude# <numeric_value> **(not SCPI)**
:DIAG:AMPL#

The command corresponds to the special function D/A-AMPL and sets the amplitude D/A converter to a required value for testing purposes.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Query:	no

:DIAGnose[:DASet]:CALibration# <numeric_value> **(not SCPI)**
:DIAG:CAL# <numeric_value>

The command corresponds to the special function D/A-CAL and sets the offset calibration D/A converter to a required value for testing purposes.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Query:	no

:DIAGnose[:DASet]:OFFSet# <numeric_value> **(not SCPI)**
:DIAG:OFFS# <numeric_value>

The command corresponds to the special function D/A-OFFS and sets the offset D/A converter to a required value for testing purposes.

#:	channel number ∈ [1 ¦ 2], optional
<numeric_value>:	<NRf> ¦ MINimum ¦ MAXimum ¦ DEFault
Query:	no

:DIAGnose:VOLTage#? **(not SCPI)**
:DIAG:VOLT#?

The query returns the voltage value at the respective diagnostic point.

#:	number of diagnostic point
Response:	<NR3>
Unit:	V

3.3.5.10 The System :TEST

Implementation of this system is optional in the standard SCPI. In this system, the ADS contains instructions for different self test routines. Alternatively, RAM and ROM tests can be performed using the command *TST.

:TEST:DISPlay? **(not SCPI)**
:TEST:DISP?

The command corresponds to the special function TEST-DISPL and initiates a display test. The two text lines of the front panel and the LEDs are provided with test patterns, thus allowing a visual function control. Additionally, the hardware of the front panel is checked. If no error is detected, the ADS device responds with "0", otherwise, "1" is output. The test result is also obvious from the Status Reporting System.

Response: 0 ¦ 1

:TEST:RAM? **(not SCPI)**

The command checks the read-write memory in accordance with special function TEST-RAM. The device sends "0" if no error is detected, otherwise "1" is indicated. The Status Reporting System is updated. In the case of specific errors, the ADS is capable of locating the defective memory component. This information can be obtained via the Error Queue.

Response: 0 ¦ 1

:TEST:ROM? **(not SCPI)**

The command checks the ROM of the ADS (special function TEST-ROM) contained in the firmware. Again, the device responds with "0" if no error is detected and with "1" on detection of an error. The Status Reporting System is updated.

Response: 0 ¦ 1

3.3.5.11 The System :MMEMory

The system :MMEMory (for mass memory) operates the memory card, its function corresponding to the special function MCARD.

:MMEMory:INITialize **(not SCPI)**
:MMEM:INIT

The command initializes a memory card for use in the ADS. For this purpose, the size of the card is determined, all memory locations are checked and some data structures are set up. The previous contents of the card is cleared.

Parameter: none

:MMEMory:LOAD **(not SCPI)**
:MMEM:LOAD

The command loads the contents of a memory card in the ADS, when all STO/RCL addresses and the POOLs with all ARB waves, sequences and sweeps are replaced by the respective information on the memory card. The settings stored in the ADS are lost.

Parameter: none

:MMEMory:STORe **(not SCPI)**
:MMEM:STOR

This command is the opposite to the above command, i.e. all data in the STO/RCL memories and the POOLs are saved on the memory card. The data stored on the card so far are lost.

Parameter: none

3.3.5.12 The System :INSTrument

This system defines the cooperation of the two ADS channels. Normally, all commands without channel number are automatically referred to channel 1. If this presetting is not required, it can be varied using the following commands. :INSTrument also determines whether the outputs of the ADS are additively coupled or operated separately.

:INSTrument:COUPle <Text> **(SCPI)**
:INST:COUP <Text>

The command determines whether both channels of the ADS are additively coupled, when the added signal is output via OUTPUT connector [9] of channel 1 (ALL), or operated separately (NONE). This corresponds to the special function OUTPT.

<Text>:	ALL, NONE
Query:	**:INSTrument:COUPle?**
Response:	ALL, NONE

:INSTrument:NSELect <NRf> **(SCPI)**
:INST:NSEL <NRf>

The command determines which of the channels is to be considered as default channel, if setting commands specify no channel number. The channel required is characterized by its number.

<NRf>:	1 ¦ 2
Units:	none
Query:	**:INSTrument:NSELect?**
Response:	1 ¦ 2

:INSTrument[:SELect] <Text> **(SCPI)**
:INST <Text>

The command determines which of the channels is to be considered as default channel, if setting commands specify no channel number. The channel required is characterized by its number.

<Text>:	CHANNEL1 ¦ CHANNEL2
Query:	**:INSTrument[:SELect]?**
Response:	CHANNEL1 ¦ CHANNEL2

3.3.6 Error Handling via the IEC Bus

All the errors detected during operation of the ADS via IEC bus are indicated to the controller in two ways. First, a specific bit is set in the Event Status Register (ESR, see Section 3.3.7.3), which can initiate a Service Request. Secondly, an entry is made in the Error Queue of the ADS, which can be read using the command :SYSTem:ERRor? (see Section 3.3.5.1).

In addition to an unambiguous error code, the queue also contains an explanatory text and, if required, the critical section of the command that caused the error.

The queue may accept five entries. If it is polled when empty, the ADS gives the response:

0,"No error"

If an overflow occurred in the queue at some point, the last entry is replaced by:

-350,"Queue overflow"

The information given by the device in response to a polling of the Error Queue maximally has 255 characters.

The following events clear the error queue:

- power-up of device
- command *CLS
- reading of last entry

All the error messages of the ADS are listed in Section 3.3.15.

3.3.7 Status Reporting

3.3.7.1 The Status Data Register Model

The register model shown in Fig. 3-14 is one of the essential features of the SCPI Status Reporting System. This model consists of five registers, each register is 16-bit wide. Bit 15, the most significant bit, is zero in all registers so that their contents can be processed by the controller as positive integers.

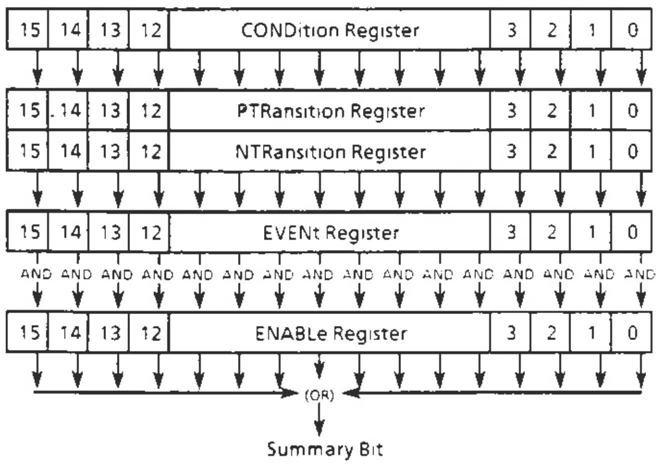


Fig. 3-14 Status Data Register Model

The individual bits of the CONDition register characterize the current state of the ADS device. The information of the CONDition register is transferred to the EVENt register via edge filters for positive (PTRansition) and negative (NTRansition) edges.

Each bit set in the PTRansition register has the effect that a 0 → 1 transition in the CONDition Register sets the respective bit in the EVENt register.

The bits of the EVENt register can also be set by negative bit edges, if the corresponding bits are set in the NTRansition register.

Once an EVENt bit has been set, it remains set (= 1), until the register is read or a *CLS command is received.

The EVENt register is subsequently logically ANDed with the ENABle register. If the result is unequal to zero, the summary bit is set, otherwise it is deleted. The summary bit is joined up with the status byte STB and can trigger a Service Request.

The following possibilities of accessing the registers are given via IEC bus:

- The CONDition register can only be read. In this case, its contents is not changed.
- PTRansition, NTRansition and ENABle registers can be read and written to at any time via IEC bus. When read, their contents is not changed.
- The EVENt register can only be read but not written to. It is destructively read, i.e. the contents is automatically cleared after reading.
- The command *CLS clears all EVENt registers.

Each of the register blocks Questionable Status and Operation Status in the following overview (Fig. 3-15) contain such a system with 5 registers. The summary bit of the Questionable Status Register Block is joined up with bit 3 of the status byte STB, the summary bit of the Operation Status Register Block with bit 7 of status byte STB.

To ensure compatibility with the IEEE 488.2 standard, the Standard Event Status Register ESR and its Enable Register ESE are structured in accordance with this standard. A bit set in the ESR causes the summary bit to be set if the associated bit in the ESE is set. The summary bit is joined up with bit 5 of the status byte STB.

As is the case with all Event Registers, the ESR is cleared when read or using the command *CLS.

3.3.7.2 Structural Overview of the Status Reporting System

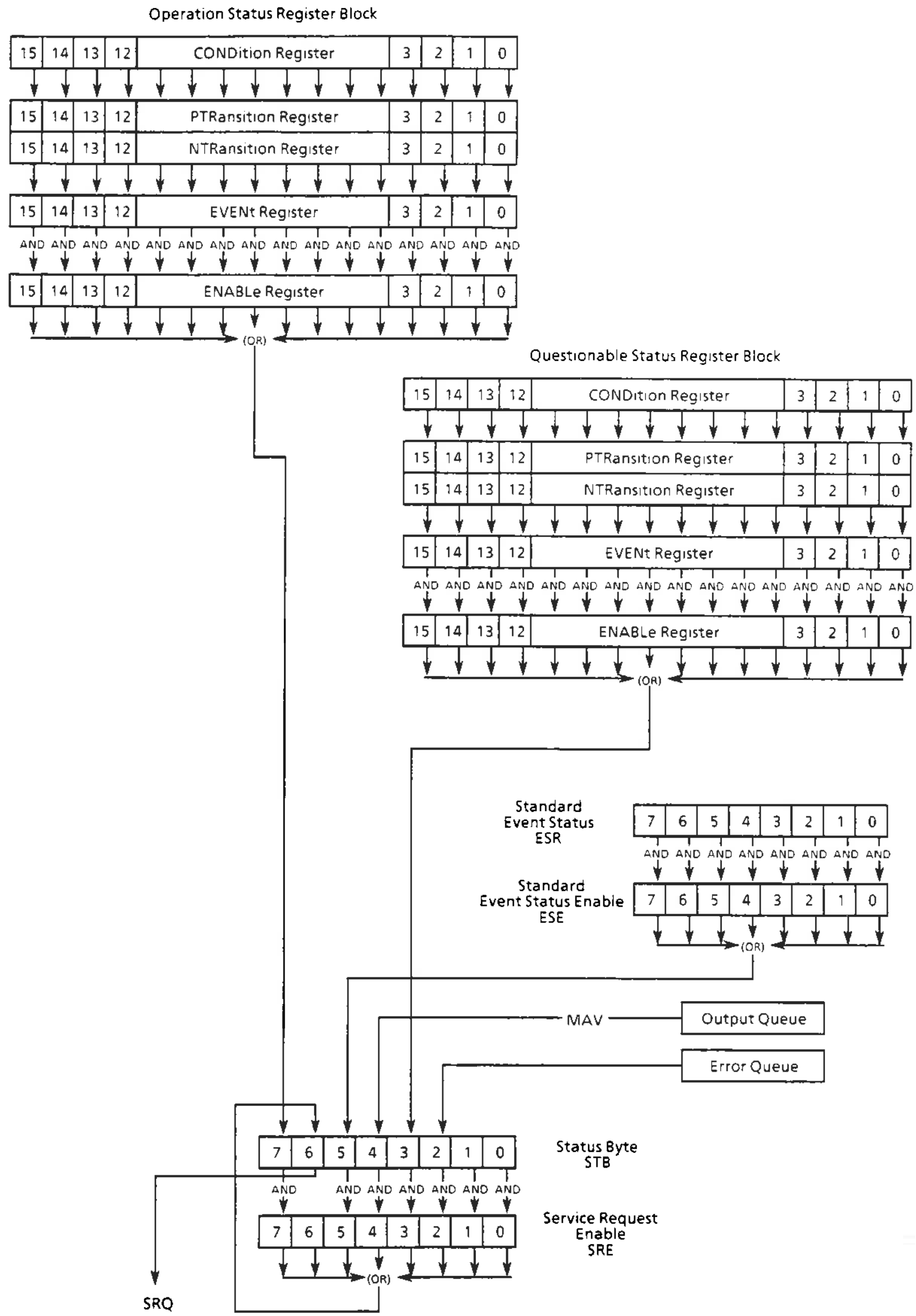


Fig. 3-15 Status Reporting System

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In addition to an unambiguous error code, the queue also contains an explanatory text and, if required, the critical section of the command that caused the error.

The queue may accept five entries. If it is polled when empty, the ADS gives the response:

0,"No error"

If an overflow occurred in the queue at some point, the last entry is replaced by:

-350,"Queue overflow"

The information given by the device in response to a polling of the Error Queue maximally has 255 characters.

The following events clear the error queue:

- power-up of device
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All the error messages of the ADS are listed in Section 3.3.15.

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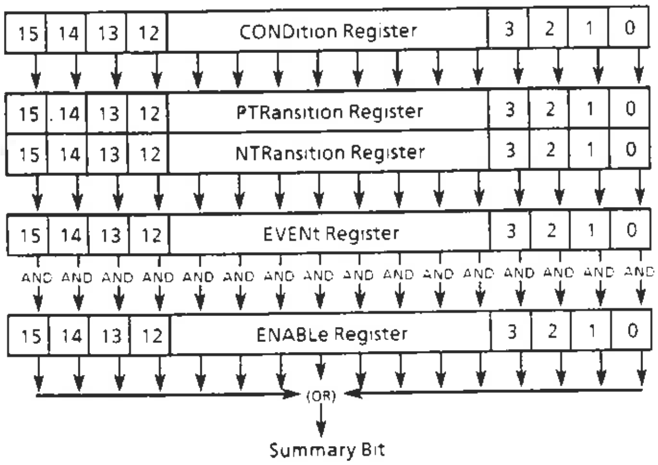

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- The EVENt register can only be read but not written to. It is destructively read, i.e. the contents is automatically cleared after reading.
- The command *CLS clears all EVENt registers.

3.3.7.3 Bit Allocation of the Standard Event Status Register (ESR)

Bit No.	Meaning
7	**Power On** This bit is set when the device is switched on or the power returns following a power failure.
6	**User Request** Set when the LOC / IEC ADDR key is pressed.
5	**Command Error** This bit is set if a syntax error is detected during analysis of a received command line. Section 3.3.15 lists all the errors that cause the bit to be set.
4	**Execution Error** This bit is set if a received command, though syntactically correct, cannot be correctly executed for various other reasons. Section 3.3.15 lists all the errors that cause the bit to be set.
3	**Device-dependent Error** This bit is set if a functional error has occurred during operation. Section 3.3.15 lists all the errors that cause the bit to be set.
2	**Query Error** This bit is set if - an attempt is being made by the controller to read data from the device when no common query has been issued before, or - if the data prepared by the device in the Output Buffer are not read and instead, a new command has been sent to the device.
1	**Request Control** (not implemented in the ADS)
0	**Operation Complete** This bit is set in response to the command *OPC when all the selected pending device operations have been completed.

3.3.7.4 Bit Allocation of the Status Byte STB

Bit No.	Meaning
7	Summary bit of the OPERational Status Register Block
6	**Request Service** This bit is set following generation of a Service Request SRQ. An SRQ is generated if one of the other bits of this register is set in combination with its mask bit in the Service Request Enable Register SRE.
5	**ESB** Summary bit of the Event Status Register
4	**MAV** (Message available) This bit is set if messages are available in the Output Buffer which can be read.
3	Summary bit of the QUEStionable Status Register Block
2	**Error Queue not empty** This bit is set if an entry has been made in the Error Queue.
1	Not implemented in the ADS.
0	Not implemented in the ADS.

3.3.7.5 Bit Allocation of the OPERation Status

Bit No.	Meaning
15	**0** This bit is always set to zero.
0	**CALibrating** This bit is set during offset calibration.

3.3.7.6 Bit Allocation of the QUEStionable Status

Bit No.	Meaning
15	**0** This bit is always set to zero.
14	**Command Warning** This bit indicates that a command ignored one or more parameters.

3.3.8 General Information about the Syntax of the IEC Bus Commands

3.3.8.1 Structure of an IEC Bus Command

Generally, an IEC bus command consists of the header and optionally one or more parameters which are separated by a space. For example:

:SOURce1:VOLTage:LEVel 5mV

is an instruction to the ADS to set a level of 5 mV for channel 1. The character sequence ":SOURce:VOLTage:LEVel" is the header, "5mV" is one parameter. A header consists of one or more so-called "mnemonics", i.e. the individual keywords constituting the command.

For most mnemonics, a long form as well as a short form are available. The shortened form is constituted by the characters indicated in capitals, the long form is the complete word. This means that for example the word "SOURce" is not to be entered in this way, as the ADS ignores upper-case and lower-case representation, but can be input either as SOURCE" or as "SOUR". Abbreviations between the short form and the long form are not permissible and rejected by the device.

Mnemonics indicated in square brackets in the command may be omitted. In combination with the possible short forms, a command can thus be considerably shortened. For example,

[:SOURce#]:VOLTage[:LEVel][:IMMediate][:AMPLitude]

can be shortened to [:SOURce#]:VOLT or even to :VOLT, if no indication of the channel used is made and thus the command referred to the default channel (i.e. channel 1 unless otherwise defined). The full command length must be accepted by the ADS for reasons of compatibility with the SCPI standard.

Several commands can be included in a line, separated by semicolon ";".

3.3.8.2 Processing of the Header Tree

To ensure optimal clarity for the command structure of the ADS, a great number of commands are arranged as combined commands, their individual components separated by colons. The structure of these command combinations is oriented in accordance with the modules of the ADS.

With a suitable setting of the colons, which separate the individual mnemonics of a header, not always the complete path for a command must be entered if several elements of a system are to be varied.

If no colon is set at the beginning of a command, the IEC bus software uses the current node as a starting point. See the following example for better illustration:

The command :SOUR:VOLT:HIGH 1V sets the positive peak value of the output signal to 1 V.To set the negative peak value, the command :SOUR:VOLT:LOW -1V is used.

Both commands can then be combined in one line:

:SOUR:VOLT:HIGH 1V; LOW -1V

Following the semicolon, LOW is indicated without leading colon. In this case, the ADS assumes the characters :SOUR:VOLT as specified. This method can however only be used within a command line, i.e. in BASIC within an IECOUT command.

3.3.8.3 Parameters

In addition to the header as command specification, many commands in the ADS also require additional data to exactly determine the command effect. A command for setting the level, for example, requires the indication of the new level value as additional data information. These so-called parameters are specified following the command header. Depending on which command is used, various forms of parameters are possible which are listed in the specification of the respective command.

<numeric_value>

Here a floating-point number may be entered, as well as the keywords MINimum, MAXimum or DEFault in accordance with the format <NRf>. MINimum sets the minimum value of the parameter, MAXimum the maximally possible value and DEFault the value determined in the PRESET setting.

<NRf>

Here a floating-point number, optionally with polarity sign, decimal point and exponent with polarity sign, may be entered. The device accepts this universal format almost always if numeric value parameters are required. Any exceptions to this are indicated with the respective commands.

<NR1>

This number format covers signed integers. It is used in the ADS in talker mode, if the parameter required uses integers (e.g. with *ESR?).

<NR3>

This floating-point format is a special form of <NRf>. It is used by the ADS in talker mode, if the required parameter has floating-point character (e.g. frequency and level). The mantissa is always ranging between 0.0 and 0.999..., contains a decimal point and is 8-digit long. Always an exponent with polarity sign follows, even if it is zero. This standardized format greatly facilitates computer processing of the device response.

<Text>

Here, a key word is entered as parameter (in the standard IEEE 488.2 denoted as <Character Program Data>). See the following example:

OUTPut#:FILT:TYPE EXTern

The word EXTern is the parameter. Text parameters are separated from the header by a white space and, like the headers, generally have a short form and a long form. The short form, EXT in this case, is constituted of the capitalized characters of the keyword. A text parameter must not be set with a colon after the header, this results in a syntax error.

<Boolean>

Here a Yes/No decision is required. The keywords ON and OFF or a numeric value may be entered. If the value equals zero, it is processed like OFF, if it does not equal zero, it corresponds to the keyword ON.

<Definite Length Arbitrary Block Data>

This is a transmission format for binary data, which fully uses all the 8 data bits. It mainly serves for fast transmission of data blocks between the device and the controller and is structured as follows:

#45168xxxxxxx...

The ASCII character "#" marks the beginning of a data block. The next digit, in this example "4", informs on how many of the following digits indicate the length of the binary block. The real binary data here comprise 5168 bytes, which immediately follow the specification of length.

Binary elements with more than one byte (for example floating point numbers or ARB wave points) are transmitted with the high-order byte first, as required in the IEEE 488.2 standard.

During binary transmission, all terminators and other special characters are ignored by the device until the byte number indicated in the specification of length has been transmitted.

In the case of ARV waves, the individual pixels are transmitted as signed 2-byte integers in a range of values from -2000 (for -1.0) to + 2000 (for + 1.0).

ARB sequences consist of three 2-byte elements with no polarity signs per element, the first indicating the wave number (0 to 99), the second the repetition factor (1 to 65535) and the third the time division factor (1 to 65535).

Sweep sequences consist of 4-byte elements, which directly indicate the frequency in Hz.

3.3.8.4 Queries

Queries are instructions for the ADS to prepare certain information in an Output Buffer, where it can be read by the controller.

All the commands, unless specially indicated, have an additional query form. It allows to determine the current device setting pertaining to the command. A query consists of a command header in long form or in short form and a question mark immediately following without space.

Example:

IECOUT14, ":SOURCE:VOLTAGE?":	query for REM voltage value
IECIN14, A$:	fetch REM voltage value
PRINT A$:	print out REM voltage value

Each time a query is received by the device, the current value of the respective parameter is provided in the Output Buffer.

Generally, the execution of a query has no influence on the setting of the ADS. However, commands like :CALibration or :TEST are expections, as they trigger a calibration or a test routine before the result is output. This will be specially indicated in the command description.

Some general conventions apply for the device response:

- The header of the query itself is not included in the response.
- Numeric values are always output as number, i.e. not as MINimum, MAXimum or DEFault, and always without unit. They always refer to the basic unit indicated in the respective command (V, Hz etc.).
- The values for MINimum, MAXimum and DEFault can be queried with all commands allowing for entries of these keywords. In this case, the query is appended to the respective keyword. For example, the following applies for the frequency in sine operation:

:FREQuency? MINimum	provides the minimum value
:FREQuency? MAXimum	provides the maximum value
:FREQuency? DEFault	provides the preset value

- Truth <Boolean> values are returned as 0 (for OFF) and 1 (for ON).
- Non-numeric parameters <Text> with a long form and a short form are always returned in the short form. For example, the response to :SOURCE:FUNCTION:SHAPE? would be SIN but not SINUSOID.
- For the response from the device, the point in time when the query is issued is relevant but not the point in time when the buffer is read out. Generally, this is of no relevance. However, it may become important with variable parameters like diagnostic points. It is relevant also if first a query for a parameter is issued and in the same line this parameter is varied.

  Exception: In the case of queries for lists such as ARB waves, sequences and sweeps, the information is made available only when the buffer is read.

3.3.9 Interface Messages

The interface messages (defined in accordance with standard IEC 625-1 / IEEE 488) are transmitted to the ADS on the data lines, in which case the Attention line is active (low).

3.3.9.1 Universal Commands

The universal commands have codes between 10 and 1F hexadecimal (see Section 3.3.16, Table 3-7). They are effective for all the participating devices connected to the bus, without these devices being individually addressed before.

Command	BASIC command with R&S Controllers	Effect on the ADS
DCL (Device Clear)	IECDCL	Aborts processing of the currently received commands and sets the command processing software to a defined initial state. The device setting is not changed.
LLO (Local Lockout)	IECLLO	The key LOC/IEC ADDR is disabled.
SPE (Serial Poll Enable)	IECSPE	Ready for serial poll.
SPD (Serial Poll Disable)	IECSPD	End of serial poll.
PPU (Parallel Poll Unconfigure)	IECPPU	End of parallel poll state.

3.3.9.2 Addressed Commands

The addressed commands are in the code range 00...0F hexadecimal (see Section 3.3.16, Table 3-7) and act only on those participating devices, which have been addressed as listeners before.

Command	BASIC command with R&S Controllers	Effect on the ADS
SDC (Selected Device Clear)	IECSDC	Aborts processing of the currently received commands and resets the command processing software to a defined initial state. The device setting is not changed.
GTL (Go to Local)	IECGTL	Change to local status (manual operation of ADS).
PPC (Parallel Poll Configure)	IECPPC	Configures parallel poll response from addressed device (subsequent command required).

3.3.10 Command Processing Sequence and Synchronization

All commands received by the device are first stored in an Input Buffer, which can accomodate a maximum of 2048 characters. Once the terminator has been received, the commands are processed in the sequence in which they were sent. During this time, the IEC bus can be used for communication with other participating devices.

The size of the Input Buffer does not restrict the length of the line. Command lines which exceed the capacity of the buffer are processed in several parts. The bus is occupied during this time.

The commands *OPC und *OPC? (Operation Complete) are used as feedback information indicating the time when processing of the received commands is fully executed and the output signal of the ADS has settled on the new values:

- *OPC sets bit 0 in the Event Status Register and is capable to trigger a Service Request once all selected pending operations have been executed.
- *OPC? always sends back the message "1" in the Output Buffer once all previous commands have been executed.

This method of synchronization is recommended if another device, which requires the settled signal of the ADS, is to be requested to start a measurement via the IEC bus.

Following *WAI, the ADS does not process any new commands until all selected pending operations have been completely executed. Thus, overlapping command execution can be prevented.

Program example:

(The command set of the IEC bus controller PCA is used; the ADS is set to IEC bus address 14.)

```
10 IECTERM 10:            REM input terminator: LF
20 IECOUT 14, "VOLT 5;    FREQ 1KHZ;  *OPC?"
30 IECIN 14, A$:          REM A$ not used further
40 REM The ADS has executed the commands
50 REM in line 20. Its output signal is settled
60 REM and can be used e.g. for further
70 REM measurements.
```

3.3.11 Resetting of Device Functions

The following table summarizes various events and commands which cause a partial resetting of individual device functions.

Event / Effect	Switching on the operating voltage Power On Status Clear 0	Switching on the operating voltage Power On Status Clear 1	DCL, SDC (Device Clear, Selected Device Clear)	*RST oder SYSTem:PRESet	STATus:PRESet	*CLS
Clear STB, ESR	--	yes, 1)	--	--	--	yes
Clear SRE, ESE	--	yes	--	--	--	--
Clear EVENt Register	--	yes	--	--	--	yes
Clear PTRansition, NTRansition und ENABle Registers	--	yes	--	--	yes	--
Clear Output Buffer	--	yes	yes	--	--	--
Reset command processing and Input Buffer	yes	yes	yes	--	--	--
Default device status	2)	2)	--	yes	--	--

1) New "Service Request on Power On" is possible.
2) Yes, if special function PWRON is set to PRESET.

3.3.12 Local/Remote Switchover

The device is always in the local status when switched on (manual operation).

If the ADS is addressed by the controller as a listener (using the IEC commands IECOUT or IECLAD in the case of R&S controllers), it enters the remote status (remote control) in line with the standard and remains in this mode even after data transfer has been completed. The REM LED is continuousy illuminated to indicate remote control status. All controls on the front panel except the LOC/IEC ADDR key are disabled, the menu line is cleared.

There are two possibilities for return to the local status:

- with the addressed command GTL (Go to Local) from the controller.
- by pressing the key LOC/IEC ADDR. Data output from the controller to the ADS should be stopped before pressing the key. Otherwise, the ADS will immediately return to the remote status again. The function of the key LOC/IEC ADDR can be disabled by the controller sending the universal command LLO (Local Lockout).

The other device settings are not modified when switching from "Remote" to "Local" or vice versa.

3.3.13 Interface Functions

According to the IEC 625-1 standard, devices which can be remote-controlled via the IEC bus can be equipped with different interface functions. The following table lists the interface functions valid for the ADS:

Abbreviation	Interface functions
SH1	Source Handshake, full capability
AH1	Acceptor Handshake, full capability
L4	Listener, full capability, unaddress if MTA
T6	Talker, full capability, capability to reply to serial poll, unaddress if MLA
SR1	Service Request, full capability
PP1	Parallel Poll, full capability
RL1	Remote/Local switchover, full capability
DC1	Device Clear, full capability
DT0	Device Trigger, not available
C0	Controller, not available

3.3.14 IEC Bus Connector and Bus Lines

The IEC bus connector [20] is located on the rear panel of the instrument. The ADS is equipped with a 24-contact connector in compliance with the IEEE 488 standard.

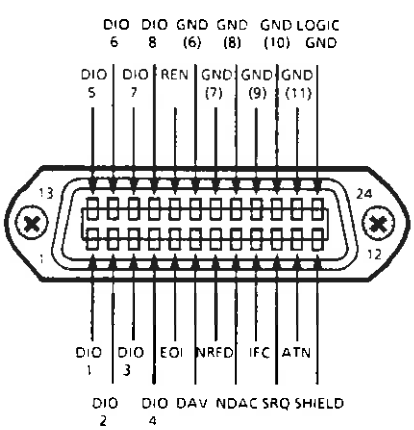


Fig. 3-16 Pin assignment

The standardized interface contains three groups of bus lines:

1) **Data bus** with 8 lines DIO1 to DIO8.

   The data are carried in bit-parallel, byte-serial format across the interface. The characters are transmitted in the ISO-7-bit code (ASCII code). Lists may be partly transmitted in binary form using all 8 signal lines.

   DIO 1 represents the least significant bit and DIO8 the most significant bit.

2) **Control bus** with 5 lines.

   This is used to transmit control functions:

   ATN (Attention)
   becomes active low when addresses, universal commands or addressed commands are transmitted to the connected participating devices.

   REN (Remote Enable)
   is used by the controller to switch the device to the remote status.

   SRQ (Service Request)
   enables a connected participating device to send a Service Request to the controller by activating this line.

   IFC (Interface Clear)
   is activated by the controller to place the IEC interfaces of the connected participating devices in a defined initial status.

   EOI (End or Identify)
   is activated to identify the end of data transfer or when executing a parallel poll sequence.

3) **Handshake bus** with 3 lines.

   The handshake bus is used to control the data transfer sequence between talker and listener:

   NRFD (Not Ready for Data)
   Active Low on this line indicates to the talker/controller that not all participating devices are ready for data transfer.

   DAV (Data Valid)
   The DAV signal is sent by the talker/controller as soon as a new data byte is present on the data bus for processing.

   NDAC (Not Data Accepted)
   The NDAC signal is held at active Low by the participating device until all data present on the data bus are acepted.

Detailed information on the data transfer sequence is available in the IEC 625-1 standard.

3.3.15 List of Error Messages

The following sections give a summary of all the error messages that can be triggered via IEC bus or in local control of the device. Negative error codes are SCPI-specific, positive error codes characterize the device-specific errors.

The left column of the table indicates the error code, the column in the middle the number of the bit which is set in the ESR on occurrence of an error. The error text entered in the Error/Event Queue or shown in the display is in bold print. Below the error text, an explanation to the respective error is given.

3.3.15.1 SCPI-specific Error Messages

Error code	Set ESR bit	**Error text with queue polling** Explanation of error
0	none	**No error** This message is output if no entries are contained in the Error Queue.
-101	5	**Invalid Character** A syntactic element contains a character which is invalid for that type; for example, a header containing an ampersand, "SOURCE&".
-102	5	**Syntax error** An unrecognized command or data type was encountered; for example, a string was received when the device does not accept strings.
-103	5	**Invalid separator** The parser was expecting a separator and encountered an illegal character; for example, the semicolon was omitted after a program message unit.
-104	5	**Data type error** The parser recognized a data element different than one allowed; for example, numeric or string data was expected but block data was encountered.
-112	5	**Program mnemonic too long** The header contains more than twelve characters.
-113	5	**Undefined header** The header is syntactically correct, but it is undefined for the ADS; for example *XYZ is undefined for any device.
-114	5	**Header suffix out of range** Indicates that a nonheader character has been encountered in what the parser expects is a header element.
-123	5	**Exponent too large** The magnitude of the exponent was larger than 32000.
-124	5	**Too many digits** The mantissa of a decimal numeric data element contained more than 255 digits excluding leading zeros.
-128	5	**Numeric data not allowed** A legal numeric data element was received, but the device does not accept one in this position of the header.

Error code	Set ESR bit	Error text with queue polling Explanation of error
-131	5	**Invalid suffix** The suffix is inappropriate for this device.
-134	5	**Suffix too long** The suffix contained more than 12 characters.
-138	5	**Suffix not allowed** A suffix was encountered after a numeric element which does not allow suffixes.
-141	5	**Invalid character data** Either the character data element contains an invalid character or the particular element received is not valid for that header
-144	5	**Character data too long** The character data element contains more than twelve characters.
-148	5	**Character data not allowed** A legal character data element was encountered where prohibited by the device.
-158	5	**String data not allowed** A string data element was encountered but was not allowed by the device at this point in parsing.
-161	5	**Invalid block data** A block data element was expected, but was invalid for some reason; for example, an END message was received before the length was satisfied.
-168	5	**Block data not allowed** A legal block data element was encountered but was not allowed by the device at this point in parsing.
-178	5	**Expression data not allowed** A legal expression data was encountered but was not allowed by the device at this point in parsing.
-200	4	**Execution error** This generic execution error is generated by the device if it is not able to detect a more specific error in its current state.
-222	4	**Data out of range** Indicates that a legal program data element was parsed but could not be executed because the interpreted value was outside the legal range as defined by the device.
-300	3	**Device specific error** This generic device-dependent error is generated by the device if it is not able to detect a more specific error in its current state.
-350	3	**Queue overflow** A specific code entered into the queue in lieu of the code that caused the error. This code indicates that there is no room in the queue and that an error occured but was not recorded. The size of the queue is five.
-400	2	**Query error** General query error not specifically specified.

Error code	Set ESR bit	**Error text with queue polling** Explanation of error
-410	2	**Query INTERRUPTED** Indicates that a condition causing an INTERRUPTED Query error occured; for example, a query followed by DAB or GET before the response was completely sent.
-420	2	**Query UNTERMINATED** Indicates that a condition causing an UNTERMINATED Query error occured; for example, the device was addressed to talk and an incomplete program message was received.
-430	2	**Query DEADLOCKED** Indicates that a condition causing a DEADLOCKED Query error occured; for example, both input buffer and output buffer are full and the device cannot continue.

3.3.15.2 ADS-specific Error Messages

Error code	Set ESR bit	**Error text with queue polling** Explanation of error
147	3	**A/D-Converter not responding** The device is not capable of addressing the diagnostics D/A converter on the processor module.
164	3	**ERROR: This mode is not possible now** An attempt is being made to set an operating mode or a modulation mode, which is not yet possible with the current device setup.
160	none	**Automatic frequency adaptation** Automatic frequency adaptation has been performed. The message is output for example if the ADS is requested to generate a triangular signal but the frequency currently set is too high.
110	3	**ERROR: no free space to insert element** No more free space is available for inserting further elements while editing an ARB wave, a sequence or a sweep.
120	3	**ERROR: editor inactive, function locked** An editing operation has been selected even though no editor is currently active. This error message should normally not occur.
130	3	**ERROR: insert MemoryCard and try again** An attempt is being made to access to a memory card presently not correctly inserted.
131	3	**ERROR: invalid version of MemoryCard** The memory card is not suitable for use in the ADS.
132	3	**ERROR: No ADS / AMS MemoryCard** The memory card does not contain the data structures expected by the ADS. Prior to using it, such a card must be initialized. Caution: all data stored on the card so far will be lost!

Error code	Set ESR bit	Error text with queue polling Explanation of error
133	3	**ERROR: MemoryCard data destroyed** The memory card is recognized as ADS card, but contains only inconsistent data.
134	3	**ERROR: MemoryCard too small** The memory card inserted is too small to accomodate all ADS data. A larger card should be used, or the ARB waves, sequences or sweeps that are no longer needed should be deleted from the ADS POOLs.
135	3	**ERROR: MemoryCard fatal error** An error not further specified by the ADS prevents access to the card.
136	3	**ERROR: MemoryCard write protected** It was attempted to write data to a write-protected MemoryCard.
137	3	**ERROR: MemoryCard contains no data** It was attempted to read data from a blank MemoryCard.
140	3	**ERROR: ROM test failed** Check sum testing of the EPROMs in the firmware failed. Save functioning of the ADS cannot be guaranteed.
141	3	**ERROR: RAM test failed, check RAM1** The buit-in RAM test detected an error in component 1 on the processor card.
142	3	**ERROR: RAM test failed, check RAM2** The buit-in RAM test detected an error in component 2 on the processor card.
143	3	**ERROR: RAM test failed, check RAM34** The buit-in RAM test detected an error in component 34 on the processor card.
144	3	**ERROR: RAM test failed, check RAM35** The buit-in RAM test detected an error in component 35 on the processor card.
145	3	**ERROR: RAM test failed, address error** The buit-in RAM test detected an error in address decoding in or outside of the RAM components.
146	3	**ERROR: Display processor test failed** The ADS initiated a self test of the front panel processor, resulting in a negative response.
150	3	**ERROR: invalid data, STO aborted** The current data set of the ADS is not consistent, storing of the data was therefore not possible. The function PRESET ensures a proper data set again, however, the current setting will be deleted.
151	3	**ERROR: invalid memory, RCL aborted** The contents of the required RCL memory is destroyed, reading of the memory was therefore aborted.

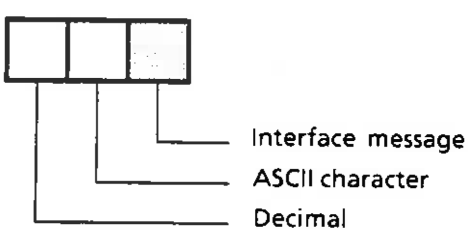
Error code	Set ESR bit	**Error test with queue polling** Explanation of error
100	3	**ERROR: value too small** The value entered last falls below the range of values permissible for the current parameter.
101	3	**ERROR: value too large** The value entered last exceeds the range of values permissible for the current parameter.
161 162	3 3	**ERROR: t2 > t1 * 6500** **ERROR: t1 > t2 * 6500** The trigger times T1 and T2 must not differ by more than factor 6500.

3.3.16 ASCII/ISO and IEC Character Set

Table 3-7

Control characters						Numbers and sp. characters				Upper-case letters				Lower-case letters			
0	NUL		16	DLE		32	SP	48	0	64	@	80	P	96	`	112	p
1	SOH	GTL	17	DC1	LLO	33	!	49	1	65	A	81	Q	97	a	113	q
2	STX		18	DC2		34	"	50	2	66	B	82	R	98	b	114	r
3	ETX		19	DC3		35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	SDC	20	DC4	DCL	36	$	52	4	68	D	84	T	100	d	116	t
5	ENQ	PPC	21	NAK	PPU	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK		22	SYN		38	&	54	6	70	F	86	V	102	f	118	v
7	BEL		23	ETB		39	'	55	7	71	G	87	W	103	g	119	w
8	BS	GET	24	CAN	SPE	40	(	56	8	72	H	88	X	104	h	120	x
9	HT	TCT	25	EM	SPD	41	)	57	9	73	I	89	Y	105	i	121	y
10	LF		26	SUB		42	*	58	:	74	J	90	Z	106	j	122	z
11	VT		27	ESC		43	+	59	;	75	K	91	[	107	k	123	{
12	FF		28	FS		44	,	60	<	76	L	92	\	108	l	124	|
13	CR		29	GS		45	–	61	=	77	M	93	]	109	m	125	}
14	SO		30	RS		46	.	62	>	78	N	94	^	110	n	126	~
15	SI		31	US		47	/	63	? / UNL	79	O	95	–	111	o	127	DEL
Addressed commands			Universal commands			Listener addresses				Talker addresses				Secondary addresses and commands			

Code:



4 Maintenance and Troubleshooting

Note: This section explains troubleshooting until replacement of boards. We recommend to refer to the Service Manual for a more detailed fault diagnosis (ordering code 1012.9756.24).

4.1 Maintenance

Under normal operating conditions, regular maintenance is not required. However, we recommend to check the lithium battery once a year, at least every two years and to clean the front panel and the display, if soiled.

4.1.1 Checking and Replacing the Lithium Battery

A battery-backed CMOS-RAM retains the data of the stored instrument settings, the stored ARB curves and the stored offset calibration settings after switch-off.

The service life of the backup battery typically reaches up to 10 years. Power consumption of the CMOS-RAM and self-discharge of the battery are, however, subject to wide manufacturing tolerances. This may lead to premature discharge of the battery, especially with high ambient temperature.

Checking the battery by means of the internal diagnostics function of the ADS:

- Select diagnostic point 1:

Step	Enter
1	SELECT SPEC FUNCT
2	MENU DIAGN
3	MENU DIA-N
4	DATA 1
5	DATA ENT

- The battery voltage measured by the diagnostics A/D converter is indicated in the display. Battery voltage upon delivery: V_{rated} = 3.67 V, specified limit: battery voltage ≥ = 3.2 V.
- The battery must be replaced, if the voltage drops below the limit.

Replacing the backup battery

When the battery is replaced, all internal instrument settings as well as all ARB curves stored are deleted. These settings and curves have to be programmed again after replacement of the battery. In addition, a new calibration of the residual offset is required (cf. section 4.1.4).

The curves and settings can easily be saved and transferred again into the instrument memory after replacement of the battery using the MemoryCard.

The backup battery is replaced as follows:

- Switch off the instrument
- Remove the feet and remove cover
- Unlock the boards at the bottom of the instrument
- Disconnect the flat cable to the controller board
- Remove the controller board and the top screen cover
- Cut the fixing strip of the battery and solder off the terminals; make sure not to short-circuit the battery
- Solder in a new battery G1 and secure with new fixing strip
- Reassemble the instrument
- The diagnostics function can be used for checking the new battery

4.1.2 Cleaning the Front Panel and the Display

If soiled, clean these units using a soft cloth and a non-alcoholic solvent, e.g. customary rinsing agents (not spirit or petrol).

4.1.3 Replacing the Fuse for the Signal Output

The two signal outputs [9] of the ADS are provided with a replacable fuse on the analog boards. If the fuse burns due to inadmissible operation, replace it with a spare fuse of the same type supplied with the instrument.

For replacing the fuse, proceed as follows:

- Switch off the instrument
- Remove feet and cover
- Unlock the boards at the bottom of the instrument
- Disconnect the coaxial plug-in connectors to the respective analog board
- Remove the analog board from the instrument and remove the screen cover on top of the board (labelling)
- Remove the defective fuse F320 and insert a new fuse
- Reassemble the instrument

4.1.4 Calibrating the Residual Offset

A residual offset at the ADS output can be automatically minimized using the special function DIAGN:CAL-O.

Manual residual offset calibration (without the special function DIAGN:CAL-O):

- Create ARB waveform (zero line):

Step	Entry
1	MEM/REM PRESET
2	SELECT WAVEFORM
3	MENU ARB
4	MENU ARB-N
5	DATA 9
6	DATA 9
7	DATA ENT
8	MENU DEL
9	MENU YES

ARB waveform 99 is deleted.

- ADS settings:

Step	Entry
1 *)	OUTPUT 1 (2)
2 *)	PARAMETER CH 1/2
3	SELECT WAVE FORM
4	MENU ARB
5	MENU ARB-N
6	DATA 9
7	DATA 9
8	DATA ENT
9	PARAMETER LEVEL (PP)
10	DATA 5
11	DATA .
12	DATA 0
13	DATA 0
14	DATA 1
15	DATA ENT

*) select desired channel

- Measure residual offset voltage using diagnostics:

Step	Entry
1	SELECT SPEC FUNCT
2	MENU DIAGN
3	MENU DIA-N
4 *)	DATA 1
5 *)	DATA 6
6	DATA ENT

*) Output of channel 1 output stage. When tesing channel 2, enter 26.

A voltage proportional to the residual offset voltage is shown in the display.

- Minimize the residual offset voltage:

Step	Entry
1	SELECT SPEC FUNCT
2	MENU DIAGN
3	MENU D/A
4	MENU CAL

Vary the CAL D/A converter setting until the residual offset voltage measured using the diagnostics is zero (tolerance ± 1mV).

This setting of the D/A converter should be performed for both channels (1 and 2).

4.2 Function Check (Self-test Routine)

Upon switching on the instrument the internal controller automatically checks the digital instrument functions. Various special functions and a diagnostics function enable more detailed functional checks.

The diagnostics function can be applied for checking various analog voltages on the individual boards. The function of individual, important parts of the circuit can thus be quickly checked by means of a correspondingly selected instrument setting. This diagnostics function is particularly suitable for servicing the instrument and is therefore described in detail in the Service Manual.

4.2.1 Function Test of the Display

Correct functioning of the keyboard/display unit can normally be realized just with switching on the instrument. If the display is to be checked specifically, the internal display test should be called.

Proceed as follows:

Step	Entry
1	SELECT SPEC FUNCT.
2	MENU DIAGN
3	MENU TEST
4	MENU DISPL

The display test is initiated. Each point of the vaccum fluorescence display is activated and all LEDs are controlled.

4.2.2 RAM Test

The static CMOS-RAM on the controller board can be tested using this special function.

Call the RAM test as follows:

Step	Entry
1	SELECT SPEC FUNCT.
2	MENU DIAGN
3	MENU TEST
4	MENU RAM

The result of the RAM test is indicated in the display of the instrument.

4.2.3 ROM Test

The program EPROM on the controller board can be tested using this special function.

Call the ROM test as follows:

Step	Entry
1	SELECT SPEC FUNCT.
2	MENU DIAGN
3	MENU TEST
4	MENU ROM

The result of the ROM test is indicated in the display.

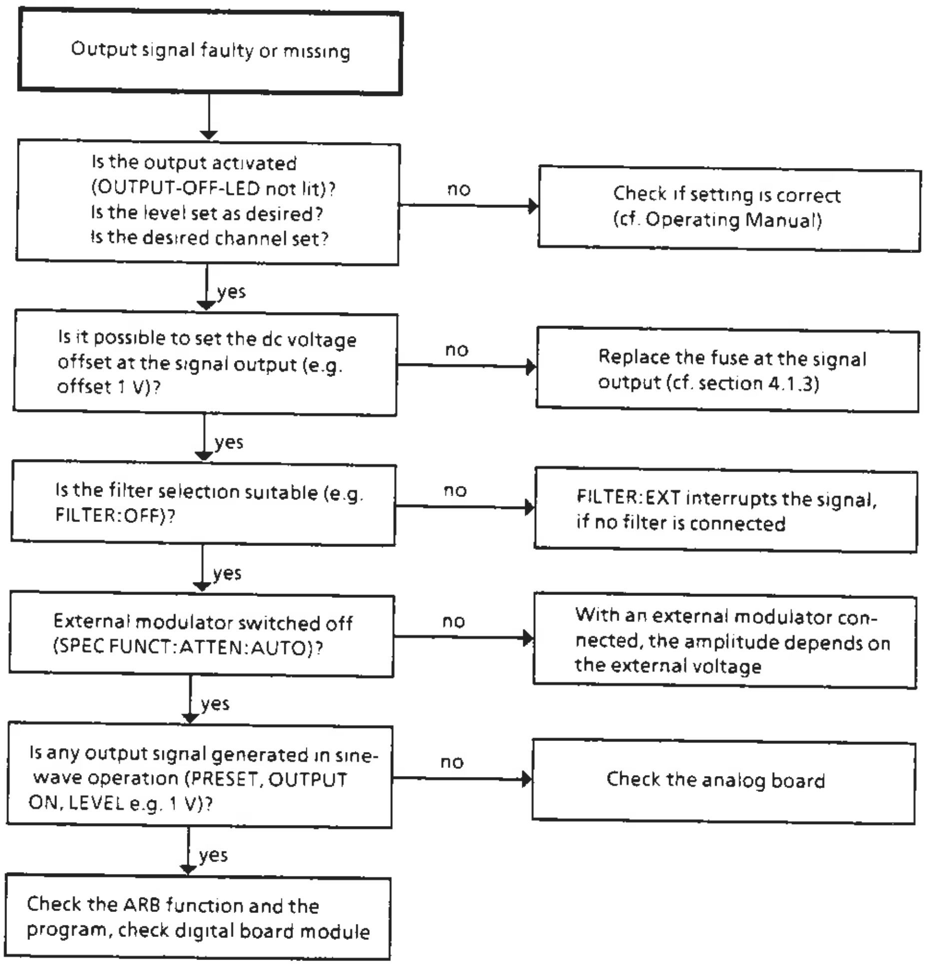
4.3 Troubleshooting

Since the ADS provides various operating modes and is user-programmable, it offers numerous signal waveforms. An instrument error may not be obvious, if unsuitable curve shapes or operating modes were selected.

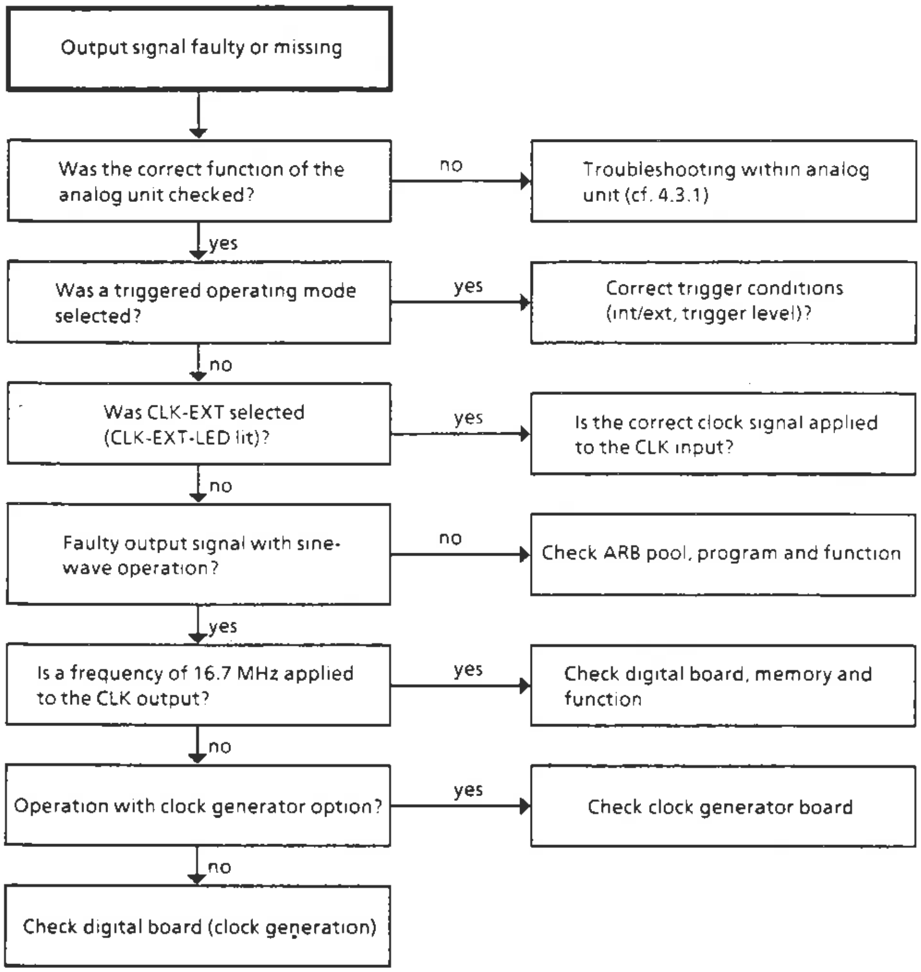
For efficient troubleshooting, it is thus useful to work with simple curves and simple operating modes.

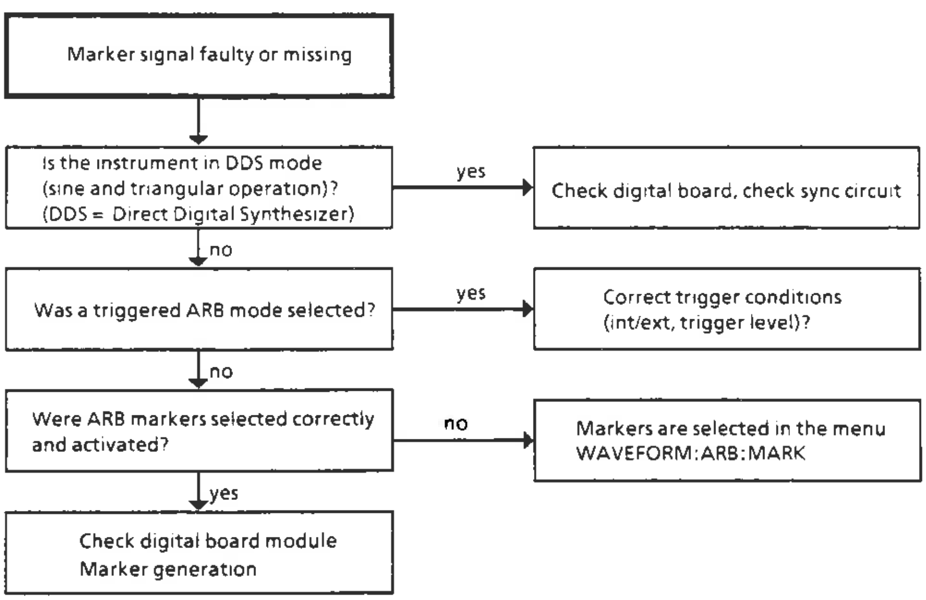
The various instrument functions are realized by boards, thus facilitating troubleshooting by just localizing a defective board. Troubleshooting is even possible within analog boards, if the diagnostics function is used efficiently.

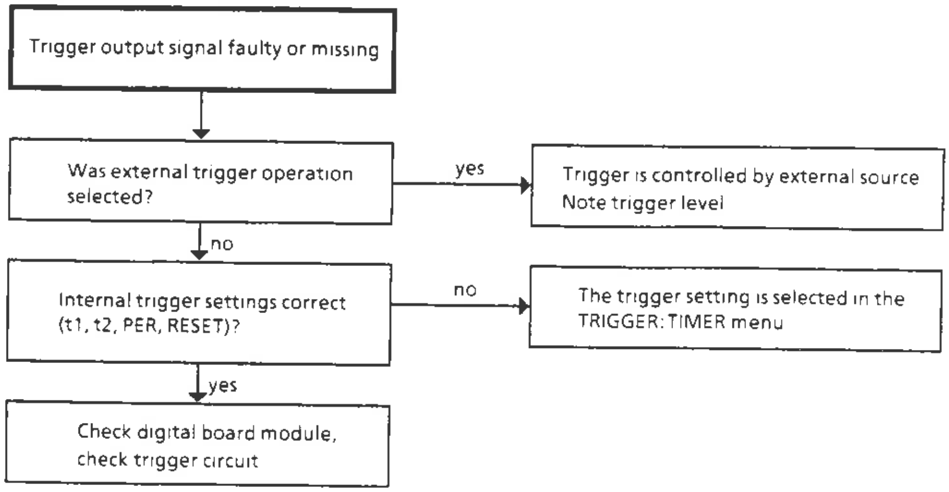
4.3.1 Troubleshooting Aid for the Analog Unit



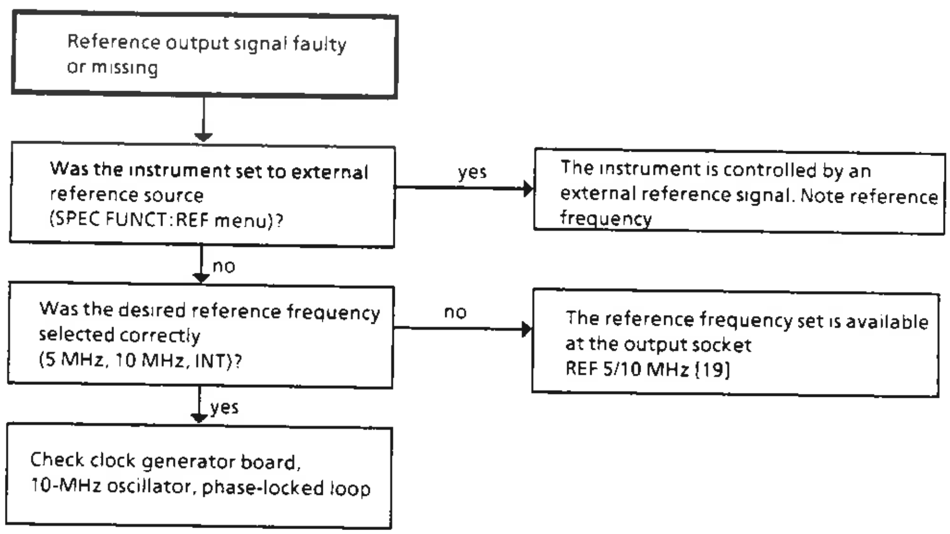
4.3.2 Troubleshooting Aid for the Digital Unit







4.3.3 Troubleshooting Aid for the Clock Generator (Option ADS-B1)



4.3.4 Survey of Diagnostic Points

Efficient troubleshooting is even possible within analog boards by means of the diagnostics A/D converter of the ADS.

This A/D converter is applied to various analog test points of the instrument via a multiplexer. A fault can thus be quickly determined with a suitable instrument setting. The internal diagnostics function also allows for comfortable adjustment of the instrument.

The following diagnostic points can be selected via the SPEC FUNCT:DIAGN menu. The subsequent table informs about the measuring voltages to be expected.

List of the ADS diagnostic points:

Diagnostics number DIA-N	Board	Function	Permissible display range
0	--	Diagnostics function off	± 10 mV
1	Controller (A7)	Voltage of CMOS-RAM backup battery	3.2 to 3.7 V
2	"	Control of RS-232 clock	>0.2 V
3	"	X-output (not used yet)	0 to 3.3 V
4	"	Diagnostics A/D converter (open input)	± 10 mV
5	"	Diagnostics A/D converter (input to controller ground)	± 0.5 mV
11	Analog board Channel 1 (A5)	Output of Waveform DAC	± 1 V
12	"	Output of Chebyshev Filter	± 1 V
13	"	Output of Bessel Filter	+ 1 V
14	"	Output of Modulator	± 1 V
15	"	Output of Offset-CAL-DAC	± 4 V
16	"	Output of Output Stage	± 4 V
17	"	Signal Output (MAIN OUT)	± 4 V
18	"	Output of OFFSET-DAC	± 4 V
21	Analog board Channel 2 (A9)	Output of Waveform DAC	± 1 V
22	"	Output of Chebyshev Filter	± 1 V
23	"	Output of Bessel Filter	± 1 V
24	"	Output of Modulator	± 1 V
25	"	Output of Offset-CAL-DAC	± 4 V
26	"	Output of Output Stage	± 4 V
27	"	Signal Output (MAIN OUT)	± 4 V
28	"	Output of OFFSET-DAC	± 4 V
31	Clock Generator Option (A4)	Level control, Reference Frequency	> 1.5 V
32	"	Tuning voltage 16.7/25-MHz loop	1.3 to 2.6 V
33	"	Tuning voltage 10.000 to 10.008 MHz Loop	0.6 to 4.1 V
34	"	Level control 10.000 to 10.008 MHz Oscillator	> 1.5 V
35	"	Tuning voltage 100 to 200 MHz Loop	0.4 to 4.1 V
36	"	Option Recognition	> 4.7 V
37	"	Level control VAR/FIX output	> 1.5 V
38	"	Level control 80 kHz reference frequency	< 1.5 V

4.4 Replacement of Boards

The instrument functions of the ADS are systematically divided by means of the individual boards. Thus, all digital functional blocks for one channel are realized on one single board. All analog functional blocks are also realized on a single board. A clock generator is optionally provided, containing a complete synthesizer for fine adjustment of the ADS clock-pulse rate on one single board.

The individual boards have digital interfaces to the internal control. The interdependence between specified data and the supply voltage of the boards is negligibly small.

Thus, when replacing individual pre-adjusted boards, subsequent adjustment of the complete instrument is not required.

5 Checking the Specifications

5.1 Measuring Equipment and Auxiliary Aids

Item	o Type of device, required specs. ● Recommended R&S device	Type	Order No.	Application
1	o Frequency counter Range >100 MHz			5.2.2.1 5.2.2.2 5.2.2.3.1 5.2.2.3.2 5.2.2.3.3 5.2.3.1 5.2.3.6.2
2	● DC voltage power supply 0 to 35 V	NGT 35	191.2019.02	5.2.6.1
3	o RMS voltmeter 10 Hz to 30 MHz ● RMS Voltmeter	URE 3	350 5315.03	5.2.2.3.1 5.2.3.2.1 5.2.3.2.2 5.2.3.5
4	o DC voltmeter ● Digital Multimeter 1 µV to 1200 V	UDS 5	349.1510.02	5.2.3.3.1 5.2.3.3.2
5	o Sinewave generator ● Signal Generator 10 Hz to 140 MHz	SMK	348.0010.03	5.2.2.3.2 5.2.2.3.3
6	o Distortion meter ● Audio Analyzer	UPA	372.6014.03	5.2.3.4.1
7	o Oscilloscope with probe DC to 100 MHz			5.2.2.1 5.2.2.2 5.2.2.3.2 5.2.2.3.3 5.2.3.1 5.2.3.6.1 5.2.3.6.3 5.2.3.6.4 5.2.4.1.1 5.2.4.1.2 5.2.4.1.3 5.2.4.2.1 5.2.4.2.2 5.2.4.3.1 5.2.4.3.2 5.2.5.1 5.2.6.2
8	● Feed-through termination 50 Ω	RAD 50	844.9352.02	5.2.2.3.1 5.2.3.2.1 5.2.3.2.2 5.2.3.3.1 5.2.3.3.2 5.2.3.4.1 5.2.3.4.2 5.2.3.5 5.2.3.6.1 5.2.3.6.3 5.2.3.6.4 5.2.4.1.1 5.2.4.1.2 5.2.4.1.3 5.2.4.2.1 5.2.4.2.2 5.2.4.3.1 5.2.4.3.2 5.2.5.1
9	● Spectrum Analyzer 100 Hz to 2 GHz	FSA	804.8010.52	5.2.3.4.2 5.2.3.5 5.2.6.2
10	o Clock generator with TTL output ● Function generator	AFGU	377.5000.02	5.2.3.6.3 5.2.3.6.4 5.2.4.2.2

5.2 Test Procedure

The specifications should be checked after the instrument has warmed up (approx. 45 minutes) and been calibrated (SPEC FUNCT:DIAGN:CAL-O).

5.2.1 Testing the Displays and Keypads

To test the keypads, input the entries described in section 3.2. The displays [2] und [3] should agree with the figures included in that section.

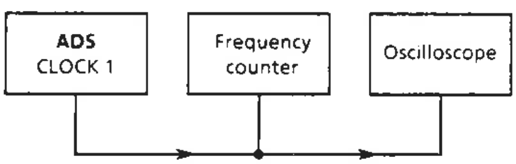
A display test is invoked using the special function DIAGN:TEST:DISPL.

5.2.2 Testing the Clock Oscillators

If the clock generator option ADS-B1 is installed, it is not necessary to perform test steps 5.2.2.1 and 5.2.2.2.

5.2.2.1 Testing the 16.777 MHz Clock Oscillator (CH1)

Test setup



ADS settings

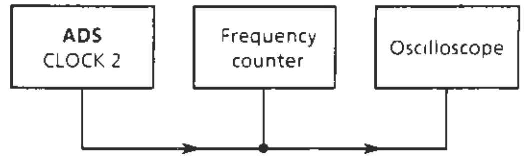
- PRESET

Test

Measure frequency and level (CLOCK1), compare with values listed in test report.

5.2.2.2 Testing the 25 MHz Clock Oscillator (CH2)

Test setup



ADS settings

- PRESET
- CH2
- WAVEFORM
- ARB
- Δt (ARB) = 40 ns

Test

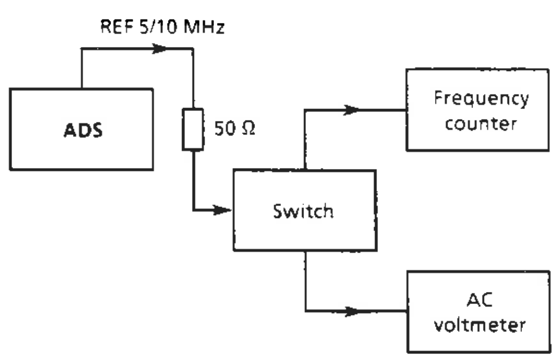
Measure frequency and level (CLOCK2), compare with values listed in test report.

5.2.2.3 Testing the Reference and Clock Frequencies (Option ADS-B1)

Perform the test steps 5.2.2.3.1 and 5.2.2.3.2 only when the clock generator option ADS-B1 is installed.

5.2.2.3.1 Testing the Internal 5 MHz/10 MHz Reference Frequency

Test setup



ADS settings

- PRESET

Test

Measure frequency and level (REF 5/10 MHz), compare with values listed in test report.

ADS settings

- SPEC FUNCT
- REF
- 5 MHz

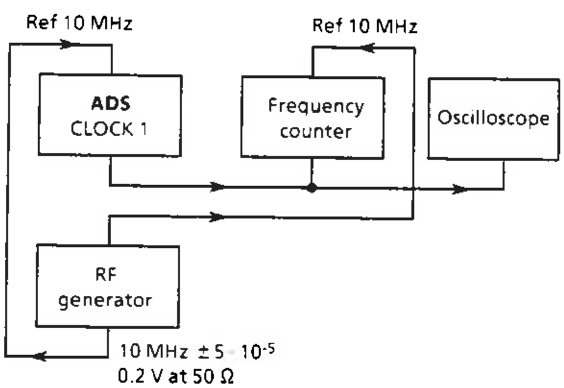
Test

Measure frequency and level (REF 5/10 MHz), compare with values listed in test report.

5.2.2.3.2 Testing the Clock Synthesizer

1. REF EXT, 10 MHz, CH1

Test setup



ADS settings

- PRESET
- SPEC FUNCT
- REF
- EXT
- WAVEFORM
- ARB

RF generator settings

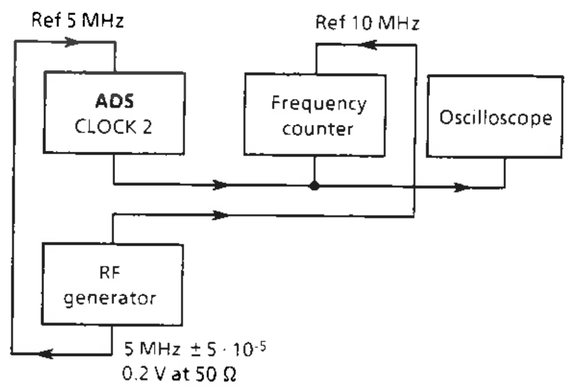
- 0.2 V at 50 Ω
- 10.000500 MHz (10 MHz + $5 \cdot 10^{-5}$)

Test

Measure frequency and level (CLOCK1), compare with values listed in test report.

2. REF EXT, 5 MHz, CH2

Test setup



ADS settings

- PRESET
- CH2
- SPEC FUNCT
- REF
- EXT
- 5 MHz
- WAVEFORM
- ARB
- Δt (ARB) = 80 ns

RF generator settings

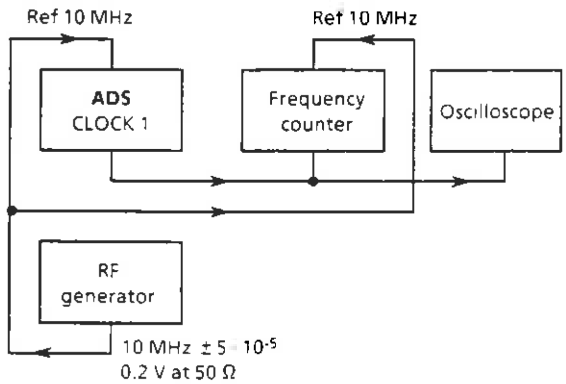
- 4.999750 MHz (5 MHz - $5 \cdot 10^{-5}$)
- 0.2 V at 50 Ω

Test

Measure frequency (CLOCK2), compare with values listed in test report.

5.2.2.3.3 Testing the 16.777216 MHz Oscillator (REF EXT, 10 MHz, CH1)

Test setup



ADS settings

- PRESET
- SPEC FUNCT
- REF
- EXT

1. 10.000500 MHz

RF generator settings

- 0.2 V at 50 Ω
- 10.000500 MHz (10 MHz + 5 · 10^{-5})

Test

Measure frequency and level (CLOCK1), compare with values listed in test report.

2. 9.999500 MHz

RF generator settings

- 9.999500 MHz (10 MHz - 5 · 10^{-5})

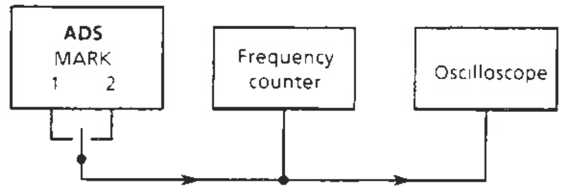
Test

Measure frequency (CLOCK1), compare with values listed in test report.

5.2.3 Sinewave Mode

5.2.3.1 Test Frequency Accuracy (CH1, CH2)

Test setup



1. Resolution 1 Hz

ADS settings

- PRESET
- CH1/2 *)
- FREQ = 5 MHz

*) Switches to channel 2. Press only when testing channel 2.

Test

Measure frequency and level (MARK1; MARK2), compare with values listed in test report.

2. Resolution 0.1 Hz

ADS settings

- PRESET
- CH1/2 *)
- SPEC FUNCT
- F-RES
- 0.1Hz
- FREQ = 500 kHz

*) Switches to channel 2. Press only when testing channel 2.

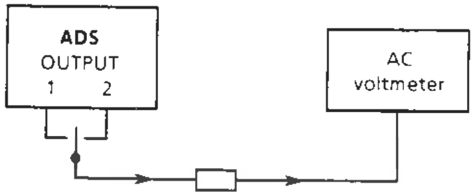
Test

Measure frequency (MARK1; MARK2), compare with values listed in test report.

5.2.3.2 Testing Output Level

5.2.3.2.1 Testing the Calibrated Attenuator

Test setup



1. ATTEN:NORM

ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON

*) Switches to channel 2. Press only when testing channel 2.

Test

Measure voltages at the levels listed in table 5-1 and determine the deviation. Compare the maximum deviation with values listed in test report.

2. ATTEN:FIX

ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- SPEC FUNCT
- ATTEN
- FIX

*) Switches to channel 2. Press only when testing channel 2.

Test

Measure voltages at the levels listed in table 5-2 and determine the deviation. Compare the maximum deviation with values listed in test report.

Table 5-1

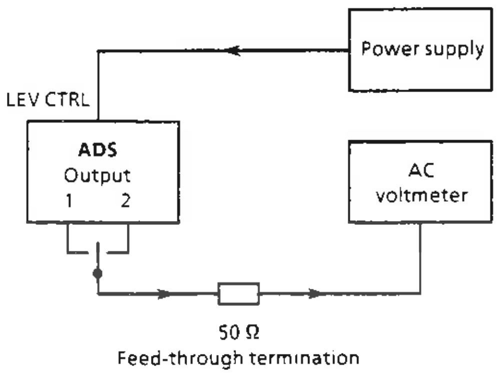
Set level	Measured level V_2	Nominal level V_1	Deviation V in dB
10 V (reference)	$V_2 = V_0 =$		0 dB
5.01 V	$V_2 =$	$V_1 = 0.501 \cdot V_0 =$	
50 mV	$V_2 =$	$V_1 = 0.005 \cdot V_0 =$	
25 mV	$V_2 =$	$V_1 = 0.0025 \cdot V_0 =$	
Error V/dB = 20 log V_2/V_1			max. deviation:

Table 5-2

Set level	Measured level V_2	Nominal level V_1	Deviation V in dB
10 V (Bezug)	$V_2 = V_0 =$		0 dB
6.59 V	$V_2 =$	$V_1 = 0.659 \cdot U_0 =$	
3.18 V	$V_2 =$	$V_1 = 0.318 \cdot U_0 =$	
1.00 V	$V_2 =$	$V_1 = 0.100 \cdot U_0 =$	
Error V/dB = 20 log V_2/V_1			max. deviation:

3. **ATTEN:EXT (External Level Control)**

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- SPEC FUNCT
- ATTEN
- EXT

*) Switches to channel 2. Press only when testing channel 2.

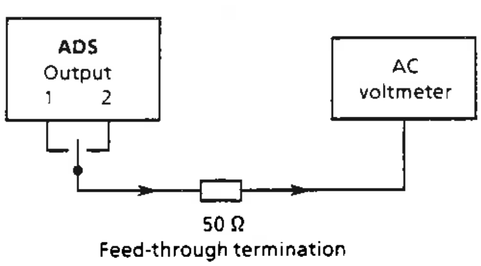
Test

Measure output level using the following DC voltages and compare with the test report.

- + 1 V
- - 1 V
- 0 V

5.2.3.2.2 Frequency Response of Output Level (CH1, CH2)

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- FREQ = 20 Hz to 5 MHz

*) Switches to channel 2. Press only when testing channel 2.

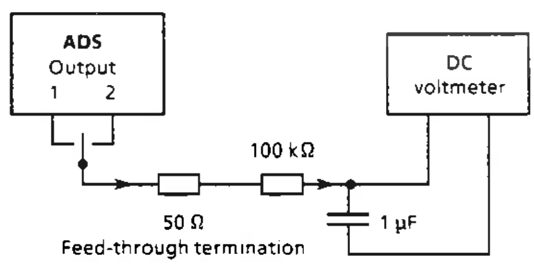
Test

Vary the frequency on the ADS and measure the output level with an AC voltmeter. Compare the maximum deviation from the nominal level with values in test report.

5.2.3.3 Testing the Offset Voltage

5.2.3.3.1 Residual DC Offset Voltage (CH1, CH2)

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- FREQ = 100 kHz

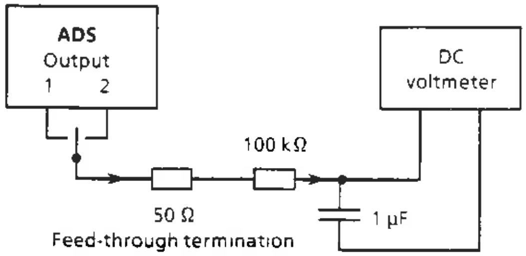
*) Switches to channel 2. Press only when testing channel 2.

Test

Measure the DC voltage and compare with values in test report.

5.2.3.3.2 DC Offset Voltage

Test setup



ADS settings

- PRESET
- CH1/2 *)
- FREQ = 100 kHz
- OUTPUT ON

*) Switches to channel 2. Press only when testing channel 2.

Test

Note the DC voltage on the DC voltmeter at the following ADS settings.

ADS setting

- OFFSET = -110 mV

ADS setting

- OFFSET = -120 mV

ADS setting

- LEVEL = 10 V
- OFFSET = +5 V

ADS setting

- OFFSET = -5 V

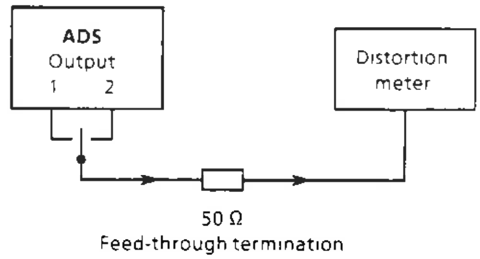
Test

Compare the noted DC voltages with values in test report.

5.2.3.4 Testing the Waveform (CH1, CH2)

5.2.3.4.1 Distortion Factor (THD)

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- FREQ = 20 Hz to 100 kHz

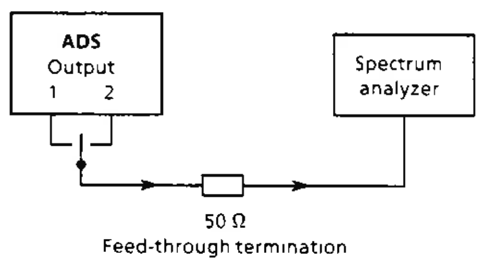
*) Switches to channel 2. Press only when testing channel 2.

Test

Compare the distortion factor with value in test report.

5.2.3.4.2 Harmonic und Nonharmonic Spurious Signals (CH1, CH2)

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 1 V
- OUTPUT ON
- FREQ = 100 kHz to 5 MHz

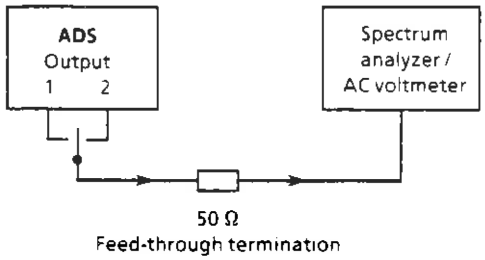
*) Switches to channel 2. Press only when testing channel 2.

Test

Compare the levels of harmonic and nonharmonic spurious signals with values in test report.

5.2.3.5 Testing the Filter (CH1, CH2)

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON

*) Switches to channel 2. Press only when testing channel 2.

1. 10 kHz Filter

ADS settings

- FREQ = 10 kHz

Measure and use as reference level.

ADS settings

- FILTER
- BESSL
- 10 kHz

Test

Compare difference between reference level and level with above filter against values in test report.

2. 100 kHz Filter

ADS settings

- FREQ = 100 kHz

Measure and use as reference level.

ADS settings

- FILTER
- BESSL
- 100 kH

Test

Compare difference between reference level and level with above filter against values in test report.

3. 1 MHz Filter

ADS settings

- FREQ = 1 MHz

Measure and use as reference level.

ADS settings

- FILTER
- BESSL
- 1 MHz

Test

Compare difference between reference level and level with above filter against values in test report.

4. 2.5 MHz Filter

ADS settings

- FREQ = 2.5 MHz

Measure and use as reference level.

ADS settings

- FILTER
- BESSL
- 2.5 MH

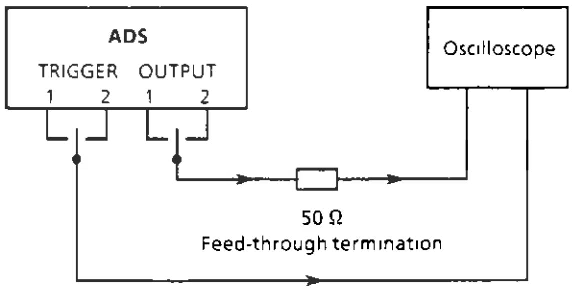
Test

Compare difference between reference level and level with above filter against values in test report.

5.2.3.6 Testing Operating and Trigger Modes

5.2.3.6.1 Hold/Reset (Internal Trigger)

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- MODE
- HD/RS
- TRIGGER
- TIMER
- PER = 2.5 ms

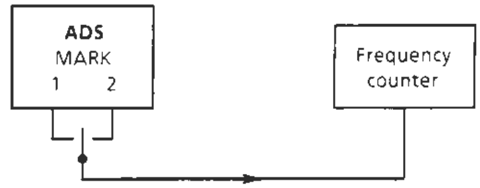
*) Switches to channel 2. Press only when testing channel 2.

Test

When the trigger signal is high, the output signal is continuously generated. When the trigger signal switches to low, the amplitude value of the ouput signal is held at the level present when the switch takes place. With the next rising edge of the trigger signal the ouput signal is reset and a new cycle begins. Check the levels of the trigger signal and compare with values in test report.

5.2.3.6.2 FSK (Manual Trigger)

Test setup



ADS settings

- PRESET
- CH1/2 *)
- MODE
- FSK
- LTFRQ = 1 MHz
- HTFRQ = 2 MHz
- TRIGGER
- MAN

*) Switches to channel 2. Press only when testing channel 2.

Test

Measure the frequency and compare with values in test report.

ADS settings

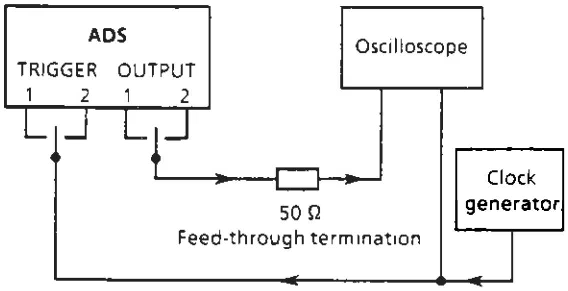
Press the MAN key.

Test

Measure the frequency and compare with values in test report.

5.2.3.6.3 PSK (External Trigger, 2 V Threshold, POS)

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- MODE
- PSK
- Δφ = 90°
- TRIGGER
- EXT
- POS
- 2.0 V

*) Switches to channel 2. Press only when testing channel 2.

Clock generator settings

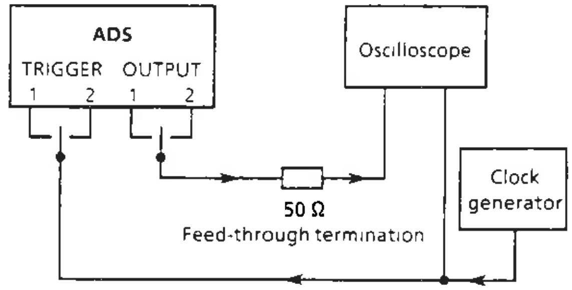
- Frequency 1 kHz
- Level TTL

Test

The phase shift of the output signal should equal 90°.

5.2.3.6.4 PM (External Trigger, 0 V Threshold, NEG)

Test setup



ADS settings

- PRESET
- CH1/2 *)
- FREQ = 10 kHz
- LEVEL = 10 V
- OUTPUT ON
- MODE
- PM
- TRIGGER
- EXT
- 0.2 V
- NEG

*) Switches to channel 2. Press only when testing channel 2.

Clock generator settings

- Sine
- Frequency 1 kHz
- Level 0.5 V

Test

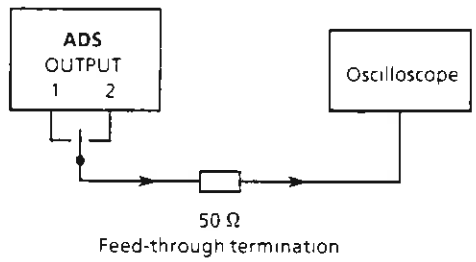
The amplitude of the output signal should switch between 0 V and 10 V.

5.2.4 ARB Operation

5.2.4.1 Testing the Waveform

5.2.4.1.1 Square-wave: Pulse Slope

Test setup



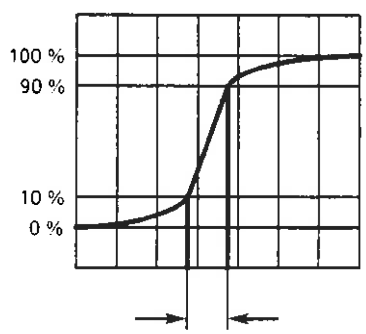
ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- ARB
- DEL
- YES
- EDIT
- PIXEL
- Y
- 1
- ENT
- -1
- ENT
- RET
- SAVE

*) Switches to channel 2. Press only when testing channel 2.

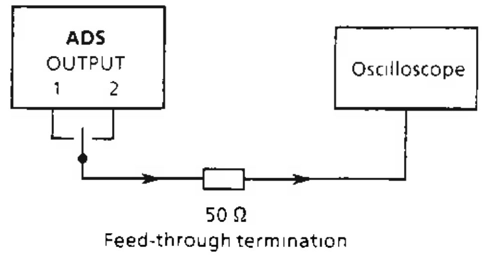
Test

Measure the rise time from 10% to 90% and the fall time from 90% to10%.



5.2.4.1.2 Square-wave: Overshoots

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- ARB

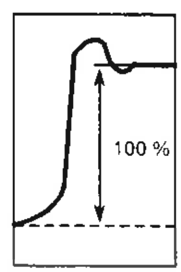
*) Switches to channel 2. Press only when testing channel 2.

Oscilloscope settings

- 2 V/Div
- 20 ns/Div
- DC

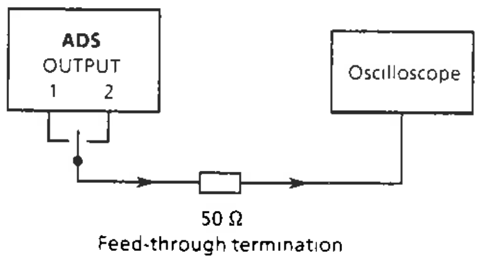
Test

Any overshoots must be ≤5% of the square-wave's amplitude.



5.2.4.1.3 Triangular Waveform: Continuity Test

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- ARB
- 1
- ENT
- DEL
- YES
- EDIT
- INTPL
- X1/Y1
- -1
- ENT
- X2/Y2
- 8192
- ENT
- X2/Y2
- 1
- ENT
- EXEC
- 16384
- ENT
- X2/Y2
- -1
- ENT
- EXEC
- RET
- SAVE

*) Switches to channel 2. Press only when testing channel 2.

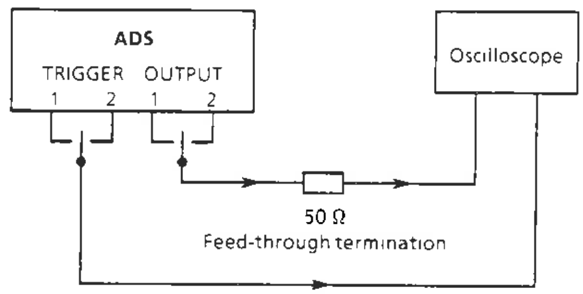
Test

Check for monotonous operation of the triangular waveform.

5.2.4.2 Operating Modes

5.2.4.2.1 Single

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- ARB
- 1
- ENT
- TRIGGER
- TIMER
- PER = 1 ms
- MODE
- SINGL

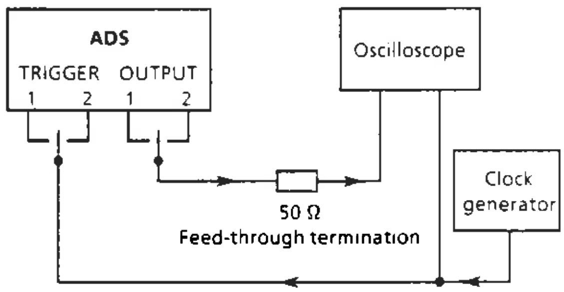
*) Switches to channel 2. Press only when testing channel 2.

Test

The programmed triangular waveform is started with the rising edge of the trigger signal. The amplitude of the last point of the triangular waveform (-1) is maintained until the next rising edge of the trigger signal occurs.

5.2.4.2.2 Gate

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- ARB
- 1
- ENT
- TRIGGER
- EXT
- MODE
- GATE

*) Switches to channel 2. Press only when testing channel 2.

ADS settings

- Frequency 1 kHz
- Level 2.5 V

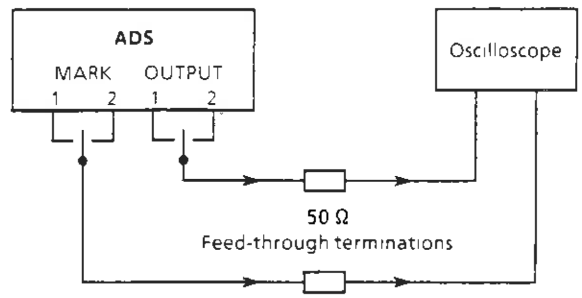
Test

Observe the signal on the oscilloscope, check for correct trigger functionality.

5.2.4.3 Testing of Marker Settings

5.2.4.3.1 Marker Output MARK

Test setup



ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- ARB
- Δt (ARB) = 100 ns
- ARB-N
- 2
- ENT
- DEL
- YES
- EDIT
- INTPL
- X1/Y1 = -1
- ENT
- X2/Y2 = 10
- ENT
- X2/Y2 = + 1
- ENT
- EXEC
- RET
- SAVE
- MARK = 1 to 10

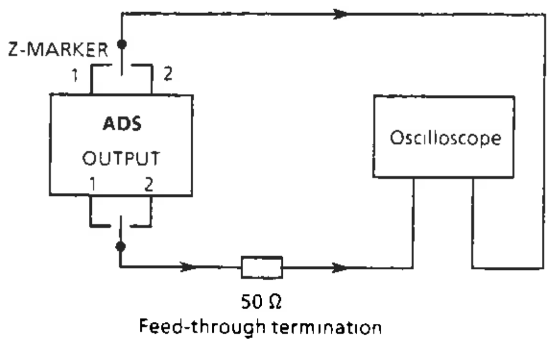
*) Switches to channel 2. Press only when testing channel 2.

Test

Check for agreement between ramp position and marker.

5.2.4.3.2 Marker Output Z-MARKER

Test setup



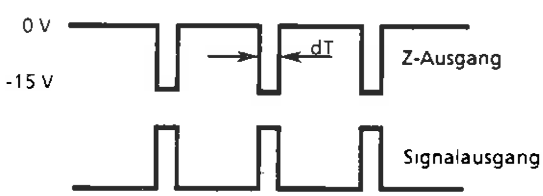
ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- ARB
- 3
- ENT
- Δt (ARB) = 100 ns
- DEL
- YES
- EDIT
- PIXEL
- Y
- 1
- ENT
- RET
- INTPL
- 2
- ENT
- X1/Y1 = 0
- ENT
- X2/Y2 = 10
- ENT
- X2/Y2 = 0
- ENT
- EXEC
- RET
- SAVE

*) Switches to channel 2. Press only when testing channel 2.

Test

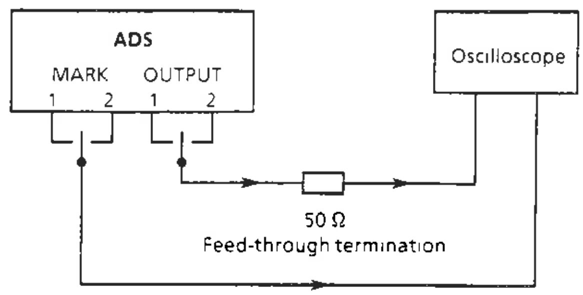
Check the oscilloscope for agreement between the signal output and the Z-marker output.



5.2.5 ARB Sequence Operation

5.2.5.1 Testing Sequence Mode Functionality

Test setup



ADS settings

- PRESET
- LEVEL = 10 V
- OUTPUT ON
- CH1/2 *)
- ARB
- 4
- ENT
- DEL
- YES
- EDIT
- INTPL
- X1/Y1 = -1
- ENT
- X2/Y2 = 10
- ENT
- X2/Y2 = + 1
- ENT
- EXEC
- 20
- ENT
- X2/Y2 = -1
- ENT
- EXEC
- RET
- SAVE
- 5
- ENT
- DEL
- YES
- EDIT
- INTPL
- X1/Y1 = -1
- ENT
- X2/Y2 = 20
- ENT
- X2/Y2 = + 1
- ENT
- EXEC
- 40
- ENT
- X2/Y2 = -1
- ENT
- EXEC
- RET
- SAVE
- WAVEFORM
- SEQ
- DEL
- YES
- EDIT
- ELEM
- INS-N = 4
- ENT
- 5
- ENT
- ELM-I = 1
- ENT
- N*dT = 2
- ENT
- RET
- SAVE

*) Switches to channel 2. Press only when testing channel 2.

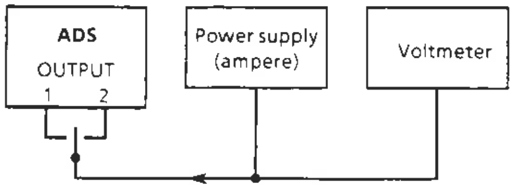
Test

A continuous sequence of triangular waveforms should be visible, with two consecutive periods measuring 40 ns each, and the next 2 periods measuring 80 ns each.

5.2.6 Testing the Signal Output

5.2.6.1 Overvoltage Protection

Test setup



ADS settings

- PRESET
- OUTPUT ON
- CH1/2 *)

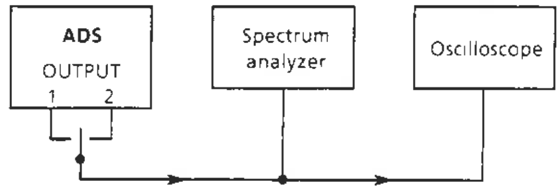
*) Switches to channel 2. Press only when testing channel 2.

Test

Increase the DC voltage at the power supply and, on the power supply, observe the current flowing into the output of the ADS. The overvoltage protection of the selected channel is activated and the output is disconnected (current flow is interrupted) when the DC voltage is between 15V and 18V. The only way to activate the output again is to remove the overvoltage and to power cycle the ADS. Simply pressing the OUTPUT ON/OFF key does not cause the output of the selected channel to be switched on again.

5.2.6.2 Level OFF

Test setup



Spectrum analyzer: AC coupled
Oscilloscope: DC coupled

ADS settings

- PRESET
- CH1/2 *)
- LEVEL = 10 V
- OUTPUT ON
- FREQ = 5 MHz
- OFFSET = + 5 V

*) Switches to channel 2. Press only when testing channel 2.

Test

Note the level indicated on the spectrum analyzer and the DC voltage indicated on the oscilloscope.

Press the ON/OFF key. The DC voltage indicated on the oscilloscope should remain unchanged. Again note the level indicated on the spectrum analyzer, check that the suppression agrees with values in the test report.

5.3 Test Report

ROHDE & SCHWARZ
DUAL ARBITRARY WAVEFORM GENERATOR ADS
Order No. 1012.4002.02

Date: ....

Name: ....

Serial No.: ....

Item No.	Characteristic	Measurement in section	Minimum	Actual	Maximum	Unit
1	Testing the displays and keypads	5.2.1	---	yes/no	---	---
2	Testing the 16.777216 MHz clock oscillator, CH1, 23 °C ± 5 °C, 1 month old	5.2.2.1				
	16.777216 MHz		16.776531		16.777901	MHz
	H level		2.5		---	V
	L level		---		0.8	V
3	Testing the 25 MHz clock oscillator, CH2, 23 °C ± 5 °C, 1 month old	5.2.2.2				
	25.000000 MHz		24.998979		25.001020	MHz
	H level		2.5		---	V
	L level		---		0.8	V
4	5 MHz/10 MHz reference frequency, internal, 23 °C ± 5 °C, 1 month old	5.2.2.3.1				
	10.000000 MHz		9.999650		10.000350	MHz
	5.000000 MHz		4.999825		5.000175	MHz
	Output level		0.2		---	V_{rms}
5	Clock synthesizer	5.2.2.3.2				
	1. REF EXT, 10 MHz					
	25.001250 MHz		25.001250		25.001250	MHz
	H level		2.5		---	V
	L level		---		0.8	V
6	Clock synthesizer	5.2.2.3.2				
	2. REF EXT, 5 MHz					
	12.499375 MHz		12.499375		12.499375	MHz
	H level		2.5		---	V
	L level		---		0.8	V

Item No.	Characteristic	Measurement in section	Minimum	Actual	Maximum	Unit
7	16.777216 MHz oscillator (REF EXT, 10 MHz, CH1)	5.2.2.3.3				
	1. 16.777216 MHz		16.777216		16.777216	MHz
	H level		2.5		---	V
	L level		---		0.8	V
	2. 16.777216 MHz		16.777216		16.777216	MHz

CHANNEL 1

Item No.	Characteristic	Measurement in section	Minimum	Actual	Maximum	Unit
8	Frequency accuracy 23 °C ± 5 °C, 1 month old	5.2.3.1				
	1. 5 MHz		4.999825		5.000175	MHz
	H level		2.5		---	V
	L level		---		0.8	V
	2. 500 kHz		499.982		500.017	kHz
9	Calibrated attenuator	5.2.3.2.1				
	1. ATTEN:NORM					
	max. deviation		-0.2		0.2	dB
	2. ATTEN:FIX					
	max.deviation		-0.2		0.2	dB
	3. ATTEN:EXT					
	+ 1 V		3.4		3.7	V_{rms}
	-1 V		3.4		3.7	V_{rms}
	0 V		0.00		0.05	V_{rms}
10	Frequency response of output level	5.2.3.2.2				
	20 Hz to 100 kHz		---		0.1	dB
	100 kHz to 5 MHz		---		0.5	dB
11	Residual DC offset	5.2.3.3.1	-120		120	mV
12	DC offset voltage	5.2.3.3.2				
	-110 mV		-132		-88	mV
	-120 mV		-142		-98	mV
	+ 5 V		4.78		5.22	V
	-5 V		-5.22		-4.78	V

Item No.	Characteristic	Measurement in section	Minimum	Actual	Maximum	Unit
13	Distortion factor (THD)	5.2.3.4.1				
	20 Hz to 100 kHz		---		-60	dB
14	Harmonic / nonharmonic spurious signals	5.2.3.4.2				
	100 kHz to 2 MHz		---		-60	dB
	2 MHz to 5 MHz		---		-50	dB
15	Filter	5.2.3.5				
	1. 10 kHz		-3.5		-2.5	dB
	2. 100 kHz		-3.5		-2.5	dB
	3. 1 MHz		-3.5		-2.5	dB
	4. 2.5 MHz		-3.9		-2.9	dB
16	Hold/Reset (internal trigger)	5.2.3.6.1	---	yes/no	---	---
	H level		2.5		---	V
	L level		---		0.8	V
17	FSK (manual trigger) 23 °C ± 5 °C, 1 month old	5.2.3.6.2				
	1 MHz with ADS-B1		0.999965		1.000035	MHz
	without ADS-B1		0.999950		1.000050	MHz
	2 MHz with ADS-B1		1.999930		2.000070	MHz
	without ADS-B1		1.999900		2.000100	MHz
18	PSK (ext. trigger, 2 V, POS)	5.2.3.6.3	---	yes/no	---	---
19	PM (ext. trigger, 0 V, NEG)	5.2.3.6.4	---	yes/no	---	---
20	Square-wave: pulse slope	5.2.4.1.1				
	Rise time		---		10	ns
	Fall time		---		10	ns
21	Square-wave: overshoot	5.2.4.1.2	---		5	%
22	Tri. waveform: continuity	5.2.4.1.3	---	yes/no	---	---
23	Mode: Single	5.2.4.2.1	---	yes/no	---	---
24	Mode: Gate	5.2.4.2.2	---	yes/no	---	---
25	Marker output MARK	5.2.4.3.1	---	yes/no	---	---
26	Marker output Z-MARKER	5.2.4.3.2	---	yes/no	---	---
29	Sequence mode functionality	5.2.5.1	---	yes/no	---	---

Item No.	Characteristic	Measurement in section	Minimum	Actual	Maximum	Unit
30	Overvoltage protection	5.2.6.1	---	yes/no	---	---
31	Level OFF Difference ON/OFF	5.2.6.2	---		-80	dB

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32	Frequency accuracy 23 °C ± 5 °C, 1 month old	5.2.3.1				
	1. 5 MHz		4.999825		5.000175	MHz
	H level		2.5		---	V
	L level		---		0.8	V
	2. 500 kHz		499.982		500.017	kHz
33	Calibrated attenuator	5.2.3.2.1				
	1. ATTEN:NORM					
	max. deviation		-0.2		0.2	dB
	2. ATTEN:FIX					
	max. deviation		-0.2		0.2	dB
	3. ATTEN:EXT					
	+ 1 V		3.4		3.7	V_{rms}
	-1 V		3.4		3.7	V_{rms}
	0 V		0.00		0.05	V_{rms}
34	Frequency response of output level	5.2.3.2.2				
	20 Hz to 100 kHz		---		0.1	dB
	100 kHz to 5 MHz		---		0.5	dB
35	Residual DC offset	5.2.3.3.1	-120		120	mV
36	DC offset voltage	5.2.3.3.2				
	-110 mV		-132		-88	mV
	-120 mV		-142		-98	mV
	+ 5 V		4.78		5.22	V
	-5 V		-5.22		-4.78	V
37	Distortion factor (THD)	5.2.3.4.1				
	20 Hz to 100 kHz		---		-60	dB

Item No.	Characteristic	Measurement in section	Minimum	Actual	Maximum	Unit
38	Harmonic / nonharmonic spurious signals	5.2.3.4.2				
	100 kHz to 2 MHz		---		-60	dB
	2 MHz to 5 MHz		---		-50	dB
39	Filter	5.2.3.5				
	1. 10 kHz		-3.5		-2.5	dB
	2. 100 kHz		-3.5		-2.5	dB
	3. 1 MHz		-3.5		-2.5	dB
	4. 2.5 MHz		-3.9		-2.9	dB
40	Hold/Reset (internal trigger)	5.2.3.6.1	---	yes/no	---	---
	H level		2.5		---	V
	L level		---		0.8	V
41	FSK (manual trigger) 23 °C ± 5 °C, 1 month old	5.2.3.6.2				
	1 MHz with ADS-B1		0.999965		1.000035	MHz
	without ADS-B1		0.999950		1.000050	MHz
	2 MHz with ADS-B1		1.999930		2.000075	MHz
	without ADS-B1		1.999900		2.000100	MHz
42	PSK (ext. trigger, 2 V, POS)	5.2.3.6.3	---	yes/no	---	---
43	PM (ext. trigger, 0 V, NEG)	5.2.3.6.4	---	yes/no	---	---
44	Square-wave: pulse slope	5.2.4.1.1				
	Rise time		---		10	ns
	Fall time		---		10	ns
45	Square-wave: overshoot	5.2.4.1.2	---		5	%
46	Tri. waveform: continuity	5.2.4.1.3	---	yes/no	---	---
47	Mode: Single	5.2.4.2.1	---	yes/no	---	---
48	Mode: Gate	5.2.4.2.2	---	yes/no	---	---
49	Marker output MARK	5.2.4.3.1	---	yes/no	---	---
50	Marker ouput Z-MARKER	5.2.4.3.2	---	yes/no	---	---
51	Sequence mode functionality	5.2.5.1	---	yes/no	---	---