ROHDE&SCHWARZ

Instruments
Division

Operating Manual

TV GENERATOR D/D2-MAC

SGDF

2011.1858.02 Standard Model
2011.1806.XX

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ROHDE&SCHWARZ

ROHDE&SCHWARZ GmbH & Co. KG
W-8000 München 80 · Mühldorfstraße 15 · Postfach 80 14 69
Tel. (089) 41 29-0 · Int. +(49 89) 41 29-0
Telefax (089) 41 29-21 64 · Int. +(49 89) 41 29-21 64
Telex 5 23 703 (rs d) · Teletex 897 487=RSD

ROHDE&SCHWARZ WERK KÖLN Graf-Zeppelin-Straße 18 · Postfach 98 02 60 **W-5000 Köln 90**	Tel. (0 22 03) 49-0 Telefax (0 22 03) 49-308 Telex 8 874 525 (rsk d)
ROHDE&SCHWARZ WERK TEISNACH Kaikenrieder Straße 27 **W-8376 Teisnach**	Tel. (0 99 23) 2 80 Telefax (0 99 23) 2 82 18
ROHDE&SCHWARZ MESSGERÄTEBAU GMBH Riedbachstraße 58 · Postfach 16 52 **W-8940 Memmingen**/Allgäu	Tel. (0 83 31) 108-0 Telefax (0 83 31) 108-254 Telex 54 512 (mbmgn d) Teletex 897 487=RSD
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Yugoslavia	ROHDE&SCHWARZ Repräsentanz Langusova ul. 8 **YU-61000 Ljubljana**	(061) 262671 (061) 262882 39701 (hoja yu)

For other areas
not listed contact:
ROHDE&SCHWARZ GmbH & Co. KG
International Marketing Division 5Z
Postfach 80 14 69
W-8000 München 80
Telefax Int. + (49 89) 41 29 31 15
Telex 52 370 320 (rs d)

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1 Characteristics

The D/D2-MAC TV Generator SGDF supplies a D/D2-MAC baseband signal in line with the "Spécification du système D/D2-MAC/paquet".

Digital storage of vision and sound signals together with the high-precision D/A converter and subsequent signal filtering guarantee high signal quality at 8.5-MHz bandwidth and a converter clock frequency of 20.25 MHz.

31 full-field signals are generated:

- The D/D2-MAC test pattern with possible source identification, EBU colour bars, grid pattern, combined test signal and signals for measuring delay and colour faults in RGB channels,
- the newly specified MAC test signals multiburst, multipulse, horizontal sweep signals for measuring amplitude and group delay,
- the staircase and sawtooth signals required for testing A/D, D/A converters,
- a 50% grey picture without colour and the CCIR ramp signal for measuring the S/N ratio with the Video Noise Meter UPSF2,
- black, white and squarewave signals for measuring of level, streaking and tilt,
- CCIR insertion test signals in MAC and composite format to automatically determine signal distortion with the aid of conventional, external, synchronized video analyzers,
- Field-repetitive sweep signal (0 to 8.5 MHz).
- the sin(x)/x pulse with full bandwidth for checking the group delay and for evaluating the amplitude frequency response on the spectrum analyzer.

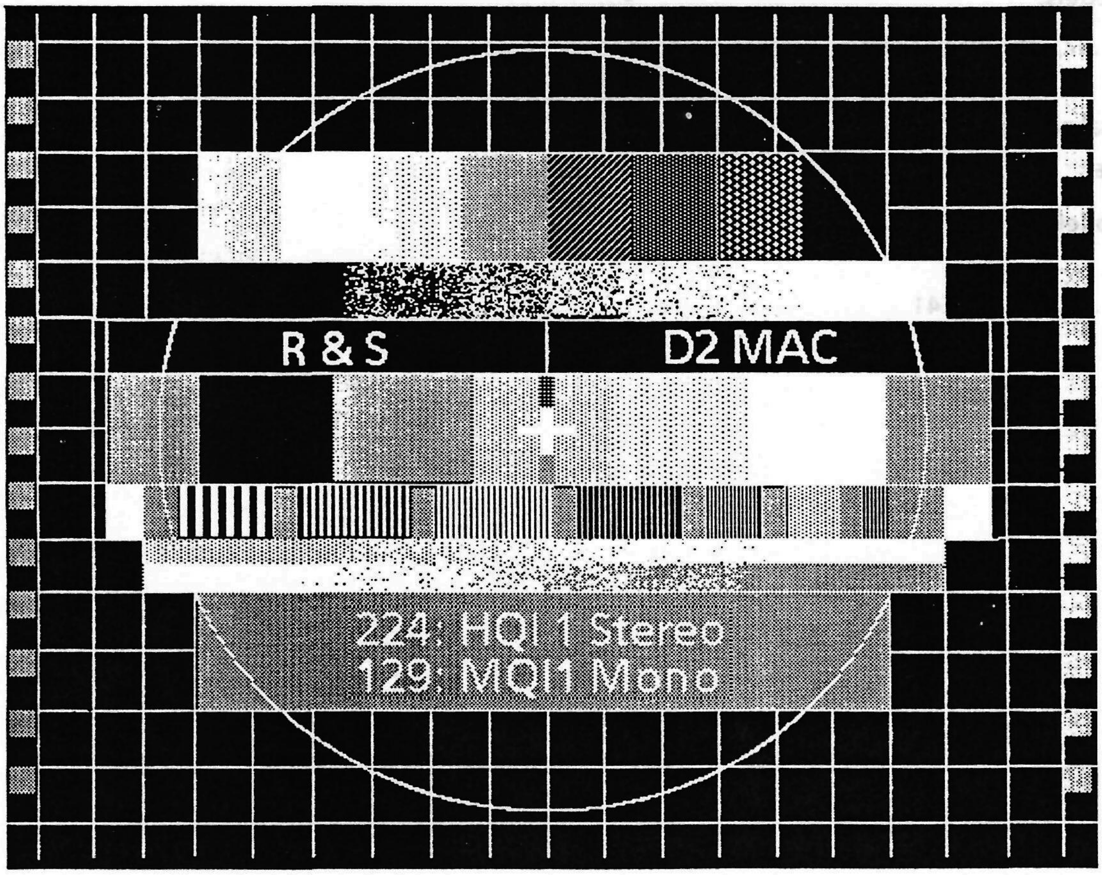


Fig. 1-1 D/D2-MAC Test Pattern

Since the D/D2-MAC signal not only has multiplexed analog components but also includes up to eight sound channels in the baseband, the SGDF also generates duobinary-coded sound and data signals at half the clock rate (D2 → 10.125 MHz). Four different sound configurations may be called up at a simple keystroke (see Tables 1-1 and 1-2).

As a further feature, even sound and data coded in duobinary at the full clock rate (D → 20.25 MHz) can be switched over internally to the D-MAC signal. In this case the number of sound channels is doubled.

Thanks to the variable signal amplitude - which may either be adjusted manually on the front panel or remotely via the IEEE-488/IEC-625 bus - measurements that depend on level such as locking of clock PLLs for decoding the MAC signal may be carried out. Of course, all other generator functions, too, may be controlled via IEEE-488/IEC-625 bus.

Accuracy of the 20,25 MHz crystal oscilator

- Increased crystal accuracy

  $\Delta f/f \leq 3 \times 10^{-7}$

  included in models:

  2011.1806.36, .37, .38, .39, .42, .43

- Standard crystal accuracy

  $\Delta f/f \leq 4 \times 10^{-6}$

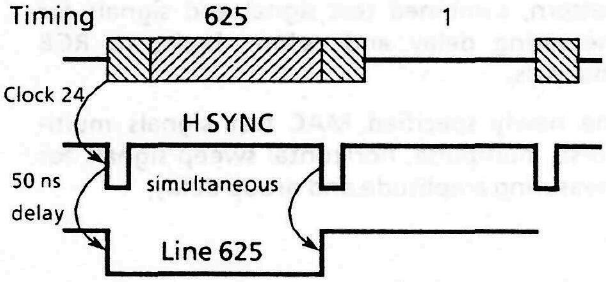
  included in models:

  2011.1858.02
  2011.1806.33, .34, .35, .40, .41

1.1 Clock Generator

A 20.25-MHz crystal oscillator with oven heating is used for producing the control signals and the sampling clock of the signals.

The clock generator also supplies the H sync and the line 625 signals. These two signals have TTL levels at an output impedance of approx. 75 Ω. The H sync signal is a 4.7 µs wide, low pulse in each line. The falling edge of the H sync pulse coincides approximately with clock pulse 24 of the D/D2-MAC signal. Counting is to standard (clock pulse 2 = bit 3 of LSW). The line 625 signal is low during line 625.



These two signals can be used, for instance, to trigger oscilloscopes or to produce clamping signals for external circuits.

1.2 Description

The D/D2-MAC Generator SGDF can be subdivided into the following functional groups as illustrated in Fig. 1-2:

- generator with clock generator
- data signal generator
- video signal generator
- D/A converter with lowpass filter
- processor control with front panel and IEC-625/IEEE-488 bus

1.2.1 Clock Generator

A 20.25-MHz oven-controlled crystal oscillator (OCXO) is used to produce the control signals and the sampling clock for the signals.

1.2.2 Data Signal Generator

In the data signal generator, the complete data signal of the D/D2-MAC signal including line sync words and line 625 is stored in a ROM. The ROM is read out with a period of two frames. As a result, only HQI1 and MQI1 sound signals can be realized, and in line 625 only static data. Four different data sets can be selected using the processor. The bits read out from the ROM at a bit rate of 10.125 Mbit/s are taken to a duo-binary coder which is implemented with the aid of a digital filter as specified in the D/D2-MAC standard.

The generator hardware can output a D-MAC-coded signal. This requires different firmware however.

For contents of line 625 as well as of the different packets of the data burst see section 1.3.

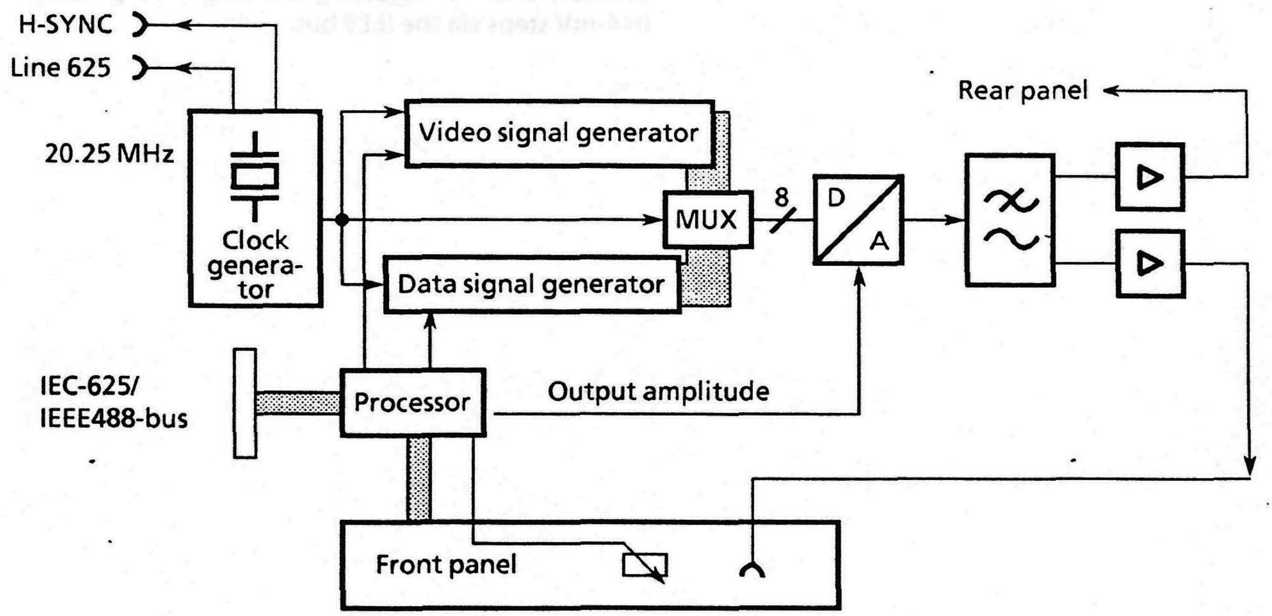


Fig.1.2 Block diagram

1.2.3 Video Signal Generator

The video signal generator operates purely digitally. The coded video signal samples are read from ROMs and are applied to a D/A converter. The colour difference signal and the luminance signal, which are transmitted one after the other, are stored together in one line with 1088 8-bit samples. This has the advantage that any test signals covering the entire video range of a line and pictures with other aspect ratios can be programmed. The total storage capacity is for up to 960 different lines. A higher-order ROM determines the type of signal to be read out in the particular picture line. No special arrangements are required for colour difference signals E_u and E_V, which are output on alternate lines, and different and even very complex signals can be produced with reasonable means. The different video signals can be selected via the processor. Moreover, different test line coding is also possible in even and odd frames.

1.2.4 D/A Converter with Lowpass Filter

The 8-bit samples from the video generator and the data generator are multiplexed and applied to a D/A converter. This D/A converter has a linearity of 0.2%.

The amplitude of the output signal is varied by varying the reference voltage of the D/A converter.

The output signal of the D/A converter passes through a sin(x)/x equalizer, a steep-edged Cauer filter and an allpass filter section to the delay equalizer. The signals for the front-panel and rear-panel output are routed through separate output stages, thus ensuring excellent output isolation.

1.2.5 Processor

The operating functions of the SGDF are controlled by a processor system. Due to a battery backup of the RAMs, the SGDF stores the last setting and recalls it, for instance, after a power failure.

The processor also executes the commands from the IEC/IEEE bus. The commands meet IEEE 488.2 standard.

The processor handles switching over the output amplitude from the calibrated mode CAL to the VAR setting voltage determined by the front-panel potentiometer. The processor has also a D/A converter for adjusting the output amplitude in 4-mV steps via the IEEE bus.

1.3 Specifications

1.3.1 Video Signal

Signal data

MAC signal (in position CAL)
Nominal level of luminance and chrominance signals (if not stated otherwise) 1000 mV ± 5 mV

Rectangular pulses, staircases, sawtooth signals nominal ± 5 mV *)

Multiburst frequency response ripple ± 1%
Multipulse frequency response ripple ± 1%

Blackman pulse acc. to CCIR
amplitude nominal ± 7 mV
half-amplitude duration 120 ns ± 7 ns

Rise times acc. to CCIR (Hamming window)
rise time 10 to 90% 105 ns ± 7 ns

Rise times and half-amplitude durations of signals acc. to CCIR Rec 473 in compressed MAC signal

luminance (1.5:1)	133 ns	± 5 ns
	154 ns	± 7 ns
	1.33 µs	± 20 ns
chrominance (3:1)	333 ns	± 15 ns
	667 ns	± 20 ns

Rise times and half-amplitude durations of uncrompressed signals acc. to CCIR Rec 473

luminance	200 ns	± 7 ns
	231 ns	± 10 ns
	2 µs	± 30 ns
chrominance	1 µs	± 20 ns
	2 µs	± 30 ns

Signal-to-noise ratio, rms weighted (ref. to 1 V_{pp})
0.2 to 7.5 MHz ≥ 72 dB measured in 50% grey picture
≥ 68 dB measured at the ramp signal

*) See Annex 1 for nominal values of commonly used signals

1.3.2 Insertion Test Signals

MAC test signals
Each full field contains the test signals acc. to CCIR

MAC	Line/ full line	Description
1a	312/ even	pulse and bar
1b	312/ odd	15 kHz
2a	623/ even	positive ramp
2b	623/ odd	negative ramp
3a	624/ even	reference signal with real component of complex sweep signal (under preparation): polarity-inversion every second full field)
3b	624/ odd	reference signal with imaginary component of complex sweep signal (under preparation: polarity-inversion every second full field)
4	311/ even and odd	multipulse
5	1/ even and odd	staircase
6	313/ even and odd	multiburst

Note:
If requested by the customer, insertion of test signals acc. to CCIR Rec. 473 can be programmed.

1.3.3 Sound and Data Signals

Duobinary-coded D/D2 sound and data signals

basic amplitude	800 mV	± 10 mV
peak-to-peak amplitude	945 mV	± 10 mV

Format of D2-MAC sound and data signals
Content of two subsequent full fields

80 packets (address 224) HQI1stereo
1 BI packet with address 224

20 packets (address 129) MQI1mono
1 BI packet with address 129

2 information packets (address 0)

60 dummy packets (address 1023)

For sound coding of 1st data frame see Table 1-1.

Format of D-MAC sound and data signals
Content of two subsequent full fields:

1st data frame:

80 packets (address 224) HQI1stereo
1 BI packet with address 224

20 packets (address 129) MQI1mono
1 BI packet with address 129

2 information packets (address 0)

60 dummy packets (address 1023)

2nd data frame:

80 packets (address 225) HQI1stereo
1 BI packet with address 225

20 packets (address 130) MQI1mono
1 BI packet with address 130

2 information packets (address 0)

60 dummy packets (address 1023)

For sound coding of 2nd data frame see Table 1-2.

Table 1-1 1st data frame

	Addr.	Coding	Frequency/level (0 dB, 12 dB below full range) left	right	mono
audio 1	224	HQI1s	1 kHz / 0 dB	5 kHz / 0 dB	-
	129	MQI1m	-		0.5 kHz/0 dB
audio 2	224	HQI1s	1 kHz/12dB	off 2)	-
	129	MQI1m	-	-	5 kHz/-3 dB
audio 3	224	HQI1s	off 2)	1 kHz/12dB	-
	129	MQI1m	-	-	0.25 kHz/6 dB
audio 4	224	HQI1s MQI1m	silence 1)	silence 1)	-
	129		-	-	silence 1)

1) scale factor 0 2) scale factor 1

Table 1-2 2nd data frame

	Addr.	Coding	Frequency/level (0 dB, 12 dB below full range) left	right	mono
audio 1	225	HQI1s	5 kHz / 0 dB	1 kHz / 0 dB	-
	130	MQI1m	-	-	7.5 kHz/0 dB
audio 2	225	HQI1s	15kHz/0dB	off 2)	-
	130	MQI1m	-	-	1 kHz/-3 dB
audio 3	225	HQI1s	off 2) -	15 kHz/0dB	-
	130	MQI1m			1 kHz/0 dB
audio 4	225	HQI1s	silence 1)	silence 1)	-
	130	MQI1m	-	-	silence 1)

1) scale factor 0 2) scale factor 1

Table 1-3 Format of line 625

Data output in line 625 as in Table 1-3:

		Number of bits	Contents
LSW	Line sync word	6	to standard
CRI	Clock run in	32	to standard
FSW	Frame sync word	64	to standard
UDT	Unified data and time	5	10101 bin
CHID	Channel identification	16	5A5A hex
SCR	Service configuration reference	8	00 hex
MVSCG	Multiplex and video scrambling control group		
	bei 4/3 aspect ratio (standard)	8	0011 1111 bin
	bei 16/9 aspect ratio (optional)	8	0011 0111 bin
CAFCNT	Conditional access frame count	20	FFFFF hex
	Unallocated	5	11111 bin
	Error control	14	Golay code
RDF	Repeated data frames:		
	5 identical data blocks	5*94	
TDMCTL	Time Division Multiplex Control comprised of:		
	FCNT	8	5A/5B hex
	UDF	1	0 bin
	TDMCID	8	00 hex
	FLN1	10	3FF hex
	LLN1.	10	3FF hex
	FLN2	10	3FF hex
	LLN2	10	3FF hex
	FCP	11	7FF hex
	LCP	11	7FF hex
	LINKS	1	0 binär
		14	Data protection according to BCH-Code

1.3.4 Outputs

D/D2-MAC outputs	1 at the front,	
	1 at the rear,	
	Z_{out} = 75 Ω	
Return loss	0 to 6 MHz	≥ 34 dB
	6 to 10 MHz	≥ 30 dB
TTL outputs	Z_{out} ~ 75 Ω	
H pulse	4.7 µs	± 50 ns
frame-repetitive pulse	line 625	
amplitude into 75 Ω	~1.6 V	
no-load operation	~5 V	

1.3.5 Setting Capabilities

Amplitude control with front-panel potentiometer or via IEC-625/IEEE-488 bus	
control range	-50 to +40%
Data signal switch-off by pressing AUDIO key for	≥ 2 s

1.3.6 IEC-625/IEEE-488-bus Control

IEC/IEEE-bus control

Electrical specifications to IEC-625-1 (IEEE 488-1)

Setting capabilities for:

- video signal
- audio signal
- output amplitude
- switching on/off of sound data signal
- duration of bounce signal
- common commands to IEEE 488-2

2 Operating Instructions

All controls and indicators are arranged in groups according to their function:

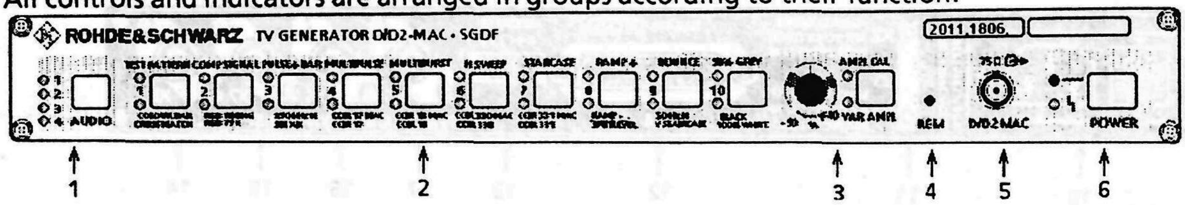
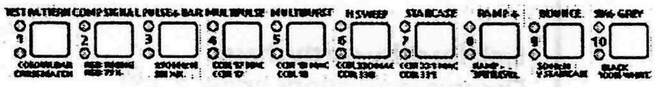
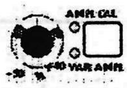
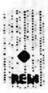
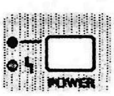


Fig. 2-1 Front view

2.1 Operating Controls

(see Fig. 2-1 Front view)

Ref. No.	Labelling	Function
1		Audio signal selection Data burst off
2	 upper / center / lower 1a = TEST PATTERN 1b = COLOUR BAR 1c = CROSS HATCH 2a = COMB SIGNAL 2b = RGB TIMING 2c = RGB 75 % 3a = PULSE + BAR 3b = 250 kHz 3c = SIN X/X 4a = MULITIPULS 4b = CCIR 17 MAC 4c = CCIR 17 5a = MULTIBURST 5b = CCIR 18 MAC 5c = CCIR 18 6a = H SWEEP 6b = CCIR 330 MAC 6c = CCIR 330 7a = STAIRCASE 7b = CCIR 331 MAC 7c = CCIR 331 8a = RAMP + 8b = RAMP- 8c = SPLITLEVEL 9a = BOUNCE 9b = 50 Hz 9c = V STAIRCASE 10a = 50 % GREY 10b = BLACK 10c = 100 % WHITE	Video signal selection Two more signals are available for adjustments: 0 = grey signal without insertion test lines 31 = field-repetitive sweep signal (see 2.1.2.2)
3		Output level setting Reset function
4		Remote-control indicator LED (yellow) lights for remote control
5		D/D2-MAC signal output 1 V into 75 Ω
6		Power ON key with fuse-blown indicator LED (red)

2.1.1 Rear-panel Connectors

(see Fig. 2-2 Rear panel)

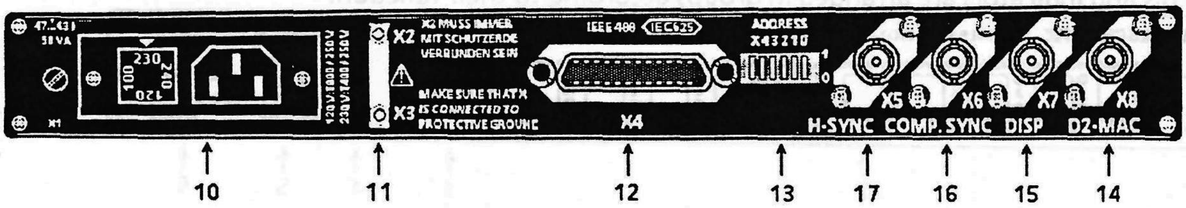
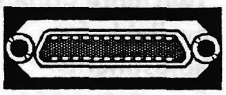
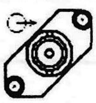
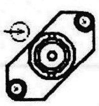
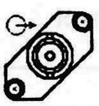
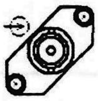


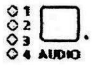
Fig. 2-2 Rear panel

Ref. No.	Labelling	Function
10		AC supply connector with voltage selector and fuse
11	 X2 X3	Link for safty earth/chassis Observe instructions under 2.2.3!
12	 X4	IEC/IEEE bus connector (see section 2.4)
13	 1 0	IEC/IEEE bus address switch (see section 2.4)
14	 X8	D/D2-MAC signal output 1 V into 75 Ω
15	 X7	DISPERSAL D/D2-MAC signal and energy dispersal signal (SGDF versions .34, .35, .38, .39, .41, .43)
16	 X6	Line 625 TTL levels (output impedance approx. 75 Ω)
17	 X5	H sync TTL levels (output impedance approx. 75 Ω)

2.1.2 Controls and Indicators
(see Figs. 2-1 and 2-2)

A key is provided for each setting function. LEDs allocated to the keys indicate the selected function. The functions of the keys and LEDs are described in detail below.

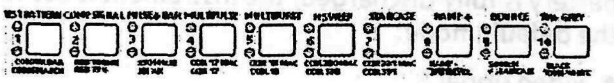
2.1.2.1 AUDIO Key



The front-panel key labelled AUDIO is for setting the audio signal. When this key is pressed, the next *audio signal* is selected. The four LEDs next to the key indicate the type of signal just selected. The specifications for the four sound settings are given in section 1.3.

If the key is pressed for about 2 s, the data signal of the generator is cut off, ie grey level is output during line sync word, sound and data bits and line 625. The LED is blinking to indicate this status which corresponds to the actual audio setting. This mode is switched off by pressing the audio key for a normal period of time.

2.1.2.2 SIGNAL Keypad



This front-panel keypad (1 to 10) is for selecting altogether 30 full-field signals. By pressing one of these keys, the signal specified in the upper label is selected. The upper LED lights. When the key is pressed again, the signal specified below the key is selected and the lower LED lights. A further keystroke selects the signal specified in the second place below the key and in this case both LEDs light. A new signal is selected in the generator synchronous with the beginning of the next frame.

For generator adjustment, the following signals can be generated by pressing key 10 or 5 for about 2 s:

Key	Signal	Description	LED check
10	0	grey level without insertion test lines	no LED on
5	31	field-repetitive sweep signal	upper LED 5 and lower LED 9 on

2.1.2.3 AMPLITUDE Controls

The AMPLITUDE key allows the output signal to be switched from the calibrated output voltage of 1 V_{pp} to a variable value adjustable with the potentiometer. The output signal level can be varied between -6 and +3 dB (0.5 to 1.4 V_{pp}) using the potentiometer. The selected setting is indicated by the two LEDs CAL and VAR. If this key is pressed during switch-on, the initial generator status is restored.

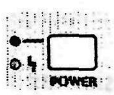
2.1.2.4 REM Indicator

The REM LED lights if the SGDF is in remote-control mode.

2.1.2.5 GENERATOR Output

The generator signal is output at this socket (75 Ω).

2.1.2.6 POWER Key



The POWER key is for switching the instrument on. Before the SGDF is switched on, the preparations for use in section 2.2 must be observed. The green LED indicates that the SGDF is on. The red LED lights if a fuse has blown.

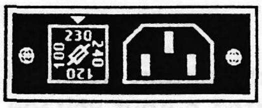
2.2 Preparations for Use

2.2.1 Environmental Conditions

The instrument operates at ambient temperatures between + 5 °C and + 45 °C.

2.2.2 Setting to AC Supply

The instrument is factory-set to 230 V and can thus be operated in an AC supply voltage range from 198 to 253 V. Set the voltage selector to the correct voltage.



For the AC supply voltage range 108 to 138 V, for example, the voltage selector must be set to 120 V and the power fuse on the rear panel be exchanged. To do so, remove the cap from the voltage selector, replace the fuse by one of the values specified on the rear panel and set the selector so that the *arrow* is pointing to the required voltage.

2.2.3 Operation with External Ground

A removable safety earth link is fitted at the rear of the SGDF. This link enables safety earth and chassis to be separated and may only be taken off after the power cable has been disconnected.

To isolate the chassis from safety earth simple unscrew the nuts and remove the metal link.

The chassis and bolt X2 must now be taken to external ground. Otherwise, VDE regulations would be violated and the user would run the risk of contacting line voltage.

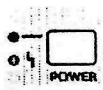
Caution: *With the link removed, the chassis is not connected to the earthing wire of the power cable.*

In the case of large test systems, the chassis may be taken to the system ground. The safety earth link must be refitted immediately if this system ground connection is removed.

2.2.4 Compliance with Radio Protection Mark

In order to comply with the specifications of the radio protection mark, shielded lines must be used for connecting the parallel data interface. The shielding has to be taken to safety earth or to chassis. For detailed pin assignment see drawing in section 2-4.

2.2.5 Switching On



To connect the SGDF to the AC supply, use the power cable supplied with the instrument and connector X1 on the *rear panel*. The SGDF is ready for operation immediately after switch-on. The guaranteed performance data are reached after approx. 10 min. The switched-on status is indicated by a front-panel LED (see Fig. 2-1). The primary fuse is provided on the rear panel. Current limiters are provided instead of secondary fuses.

2.2.5.1 Buffer Memory

The SGDF has a RAM backed up by a lithium battery for storing the current setting. If this battery is fully discharged, the instrument is set to the default mode:

- video signal 1
- audio signal 1
- output level CAL
- bounce time 2 s (duration of bounce signal)
- data signal ON
- initial setting of IEC-625/IEEE-488 parameters (see 2.4.8)

If this setting is also desired in the battery backup mode, the CAL/VAR key must be kept pressed while the instrument is switched on. For instructions on replacing the lithium battery see section 3.2.

2.2.5.2 LED Test

After the SGDF has been switched on, all LEDs with the exception of the red fuse-blown indicator are switched on for approx. 0.5 s.

2.3 Codings

To ensure proper function of the instrument, the coding links on the subassemblies must be inserted as described below. Codings should also be checked if problems are encountered. For most of links, the indicated position is the only one useful, as in the other position the respective signal would be either interrupted for test purposes or taken to chassis.

Suitable software for D505 on the generator board is required for the different codings of X101 and X102 on the processor board.

PROCESSOR BOARD (2011.3021)

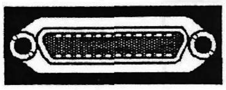
Processor X101	Processor X102	Generator D505	Function
1-2	1-2	2011.3667	all four audio settings D2-MAC
2-3	1-2	2011.3767	audio setting 1 and 2 D2-MAC, audio setting 3 and 4 D-MAC
1-2	2-3	2011.3750	all four audio settings D-MAC
2-3	2-3	---	testing the processor

GENERATOR BOARD (2011.3009)

Link	Position: Normal Operation (factory set)	Position: Testing
X1	1-2	without
X4	1-2	without
X5	1-2	without
X15	1-2	without
X100	1-2	without
X101	1-2	without
X102	1-2	without
X103	1-2	without
X104	1-2	without
X200	1-2	without
X210	1-2	without
X220	1-2	without
X230	1-2	without
X240	1-2	without
X250	1-2	without
X50	without *	with
X300	without *	---
X400	without *	---

* depending on Software

2.4 Remote Control



A controller (eg. PCA2 or PCA5) may be connected to the SGDF via IEC-625/IEEE-488 bus. It is therefore fully sytem-compatible.

IEC bus

The 24-way IEC-625/IEEE-488 connector at the rear of the instrument is standard. The interface complies with standard IEC-625-1 and IEEE-488. In addition, the stipulations of standard IEEE-488.2, which will also be taken over by the IEC commission, have been taken into account. The latter for instance specifies data transmission formats and general commands.

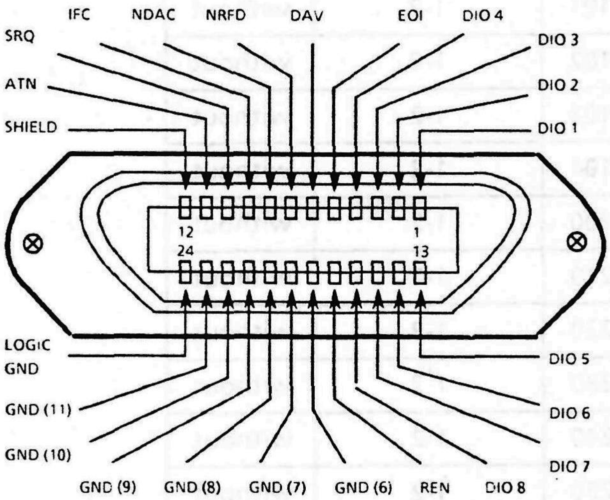


Fig. 2-4 Contact assignment of IEC-bus connector

The standard interface includes three groups of bus lines:

1) **Data bus with 8 lines DIO 1 to DIO 8**
Data transmission is in parallel mode, characters are transmitted in the ISO 7-bit code (ASCII code).

DIO 1 represents the least significant and DIO 8 the most significant bit.

2) **Control bus with 5 lines**
It is for transferring commands:

ATN (attention)
becomes active low during transmission of addresses, universal or addressed commands to the instruments.

REN (remote enable)
for switching the instrument to remote control mode.

SRQ (service request)
in active condition enables an connected instrument to send a service request to the controller.

IFC (interface clear)
is activated by the controller and sets the IEC-bus interfaces of the instruments to a defined output condition.

EOI (end or identify)
identifies the end of a data transmission and is used in parallel poll.

3) **Handshake bus with 3 lines**
It controls timing and data transmission.

NRFD (not ready for data)
Active low on this line signals to the talker/controller that one of the instruments is not ready to accept data.

DAV (data valid)
is activated by the talker/controller shortly after a new data byte has been sent on the data bus.

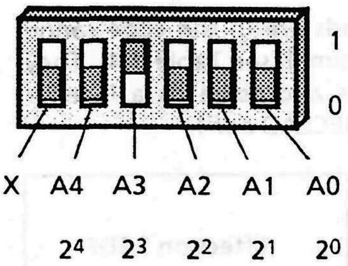
NDAC (no data accepted)
is kept at active low by the connected instrument until the instrument has accepted the data on the bus.

Further information eg. data transmission timing can be seen from the IEC-625-1 standard specifications.

According to IEC-625-1, instruments which are remote controlled via IEC-625/IEEE-488 bus may be provided with different interface functions. See Table 2-1 SGDF interface functions.

2.4.1 Setting the Instrument Address

Address 08 is set in the factory, but the 2-digit instrument address can be changed with the aid of the rear address switch. On switching on, the address is read into the memory with battery backup.



(factory setting)

Note: ***In the upper position, the switch is set to 1.***

The address is the decimal equivalent of bits A0 to A4 of the talker or the listener address. This format is also used in the IEC-bus commands from the controller. Switch X has no function.

2.4.2 Local/Remote Status Change

After switching on, the instrument is always in the local mode (manual control).

If the SGDF is addressed as a listener (in R&S controllers with BASIC commands IECOUT or IECLAD), it changes to the remote mode (remote control) and also remains in this status after the data transfer has been completed.

This status is indicated by the front-panel LED REM.

There are two ways to return to local control:

- The controller sends the addressed command GTL (go to local);
- Pressing a front-panel key. This manual switching capability can be disabled by the controller with the universal command LLO (local lockout).

Switchover from remote to local condition or vice versa will not affect the instrument setup.

Control character	Interface function
SH1	Source handshake, full capability
AH1	Acceptor handshake, full capability
L4	Listener function, full capability unaddressing through MTA
T6	Talker function, full capability, ability to respond to serial poll, unaddressing through MLA
SR1	Service request, full capability
PP0	Parallel poll, no capability
DT0	Device trigger, no capability
RL1	Remote/local switchover, full capability
DC1	Device clear, full capability
C0	Controller function (not available)

Table 2-1 Interface functions

2.4.3 Interface Messages

Interface messages (to IEC-625-1/IEEE-488 standard) are sent to the SGDF on data lines, the ATN line being active (low).

Universal commands

Universal commands are in the code range 10 to 1F hex, 16 to 31 decimal (see Table 2-4). They affect all instruments connected to the bus without any addressing being required.

Command	BASIC command in R&S controllers	Effect on instrument
DCL (Device Clear)	IECDCL	Sets the command processing software to a defined start position. No change of instrument setup.
LLO (Local Lockout)	IECLLO	Front-panel controls disabled.
SPE (Serial Poll Enable)	IECSPE *	Ready for serial poll
SPD (Serial Poll Disable)	IECSPD *	End of serial poll

Table 2-2 Universal commands for SGDF

* The BASIC command 'IECSPL adr,status', which includes commands IECSPE and IECSPD, also reads the instrument status with 'adr' and stores it in the integer variable 'status'.

Addressed Commands

The addressed commands are in the code range 00 to 0F hex, 0 to 15 decimal (see Table 2-4). They only affect instruments addressed as a listener (with BASIC command 'IECLAD adr').

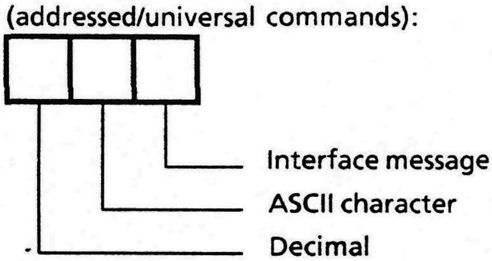
Command	BASIC command in R&S controllers	Effect on SGDF
SDC (Selected Device Clear)	IECSDC	Interrupts processing of received commands and sets the command processing software to a defined start status. No change of instrument setup.
GTL (Go To Local)	IECGTL	IECGTL Change to local mode (manual control)

Table 2-3 Addressed commands

Table 2-4 ASCII/ISO- & IEC-CODE CHART

CONTROL						NUMBERS SYMBOLS				UPPER CASE				LOWER CASE			
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			LISTEN ADDRESSES				TALK ADDRESSES				SECONDARY ADDRESSES OR COMMANDS			

Key for control characters
(addressed/universal commands):



2.4.4 Device Messages

Device messages (to IEC-625-1) are transmitted on data lines, with the ATN line being high ie. not active. The ASCII code (ISO7-bit code) is used for the transmission. (See also Table 2-4).

As can be seen from Table 2-5, device messages may be classified under two different aspects:

Instrument dependency	Direction of transmission to SGDF	from SGDF
Common commands (acc. to standard)	see Table 2-6	see Table 2-7a and 2-7b
Instrument-specific commands (depending on instrument characteristics)	see Table 2-8	see Table 2-9

Table 2-5 Classification of instrument information

In the following text, instrument information received by the SGDF is referred to as 'commands'.

2.4.4.1 Common Commands

These commands are listed in Tables 2-6, 2-7a and 2-7b and concern:

- Commands referring to the service request function and the relevant status and mask registers.
- Commands for instrument identification
- Commands for internal instrument settings
- Commands for polling internal instrument settings

The header of these commands consists of (*) followed by three letters.

Examples:
8 was used as the instrument address (IEC-625/IEEE-488 bus) = factory setting.

1) Basic setting
IECOUT 8, "*RST"

2) Clearing the event status register
IECOUT 8, "*CLS"

3) Switchover to message without header
IECOUT 8, "*HDR 0"

Com-mand	Num. value, range	Description
*RST	---	**Reset** ▸ restores initial status: signal 1; audio 1; amplitude calibrated; bounce time 2 s; data burst on ▸ switches to message with header (same as command *HDR1) ▸ clears output buffer Does not change IEC-625/IEEE-488 interface status, the set IEC-625/IEEE-488 address and the registers of the service request function. A service request message to be served is only reset if it had been issued by a command in the output buffer.
*PSC	0 or 1	**Power on clear flag (Reset upon instrument switch-on)** If 1: Upon switch-on, also the service request enable mask register (SRE) and the event status enable mask register (ESE) are cleared. If 0: The contents of the above registers are retained even if the instrument is switched on and off. This allows a service request on power-on.
*HDR	0 or 1	**Header** If 1: All device-specific messages from the SGDF to the controller are sent with header (not the replies to common commands). If 0: The above messages are sent without Set to 1 also with command *RST.
*OPC	---	**Operation complete** Sets the 0 bit (operation complete) in the event status register if all preceeding commands have been serviced and executed (see section 2.4.8).
*CLS	---	**Clear status** Resets the event status register (ESR) to zero. The mask registers of the service request function (ESE and SRE) remain unchanged.
*ESE	0...255	**Event status enable** The event status enable mask register is set to the indicated value which is interpreted as a decimal number (see section 2.4.5).
*SRE	0...255	**Service request enable** The service request enable mask register is set to the indicated value which is interpreted as decimal number (see section 2.4.5).
*WAI	---	**Wait to continue** Interrupts command processing until all previous commands are executed (see section 2.4.8).

Table 2-6 Common commands to the SGDF

2.4.4.2 Query Messages (Common Commands)

Command	Output message data value		Description
	Digits	Range	
*IDN?	25	alpha-numeric	**Identification Query** The following identification text is sent via the IEC bus in reply to the *IDN? command: **"ROHDE & SCHWARZ,SGDF,0,1.01"** ROHDE & SCHWARZ = manufacturer SGDF = instrument type 0 = reserved for serial number (not used with the SGDF) 1.01 = firmware version (1.01 in the example)
*OPT?	1	alpha-numeric	**Option Query** Sends information on built-in options via the IEC bus. 0: no option built in
*PSC?	1	0 or 1	**Power on Status Clear Query** For readout of status of power on clear flag; see *PSC in Table 2-6
*HDR?	1	0 or 1	**Header Query** For readout of header flag status; see *HDR in Table 2-6
*OPC?	1	1	**Operation Complete Query** The message 1 is entered in the output buffer and bit 4 (message available) set in the status byte provided all commands have been processed and executed (see section 2.4.8)
*ESR?	1...3	0...255	**Event Status Register Query** The contents of the event status register are output in decimal form and the register reset to zero.
*ESE?	3	0...255	**Event Status Enable Query** The contents of the event status mask register are output in digital form.
*STB?	3	0...255	**Status Byte Query** The contents of the status bytes are output in decimal form.
*SRE?	3	0...255	**Service Request Enable Query** The contents of the service request enable mask register are output in decimal form.

Table 2-7a: Common query messages

Command	Output message data value Digits	Range	Description
*TST?	1	0...7 decimal (3 bit)	Self test query A hardware test is carried out in the instrument. If the result is 0, all tested parameters are in order. If faults are found, the decimal equivalent of the following bits is sent: Bit 0: Clock generator faulty Bit 1: ROM error Bit 2: Upon switch-on, no valid setting could be found in the buffer RAM, eg if the lithium battery is flat. In this case replace battery acc. to section 3.2.1. Note that a result is only obtained after completion of the test which takes about 3 s. Set timeout of IEC bus controller accordingly.
*LRN?	max. 68	alpha-numeric	Learn Query The SGDF sends a string consisting of the individual setting commands with parameters which represent the actual instrument status. If this string is buffered and returned to the SGDF unchanged after several settings have been made on the SGDF, the SGDF is reset to the original status prior to the LRN command (this does not apply to flags and registers of common commands). The LRN command should always be sent as a single query message as otherwise the various reply messages cannot be separated.

Table 2-7b Common query messages

2.4.4.3 Device-specific Setting Commands

All front-panel-controlled SGDF functions can also be set via the IEC/IEEE-bus. Setting commands and front panel entries have the same effect.

Table 2-8 shows the setting commands and Table 2-9 the query messages with pertaining replies from the SGDF.

Headers are fully or almost identical with the equivalent key label so that easy-to-read (self-documenting) programs are obtained.

Headers may be shortened by eliminating characters at the end (eg AU instead of AUDIO). The shortest possible form is printed in **Bold** in the table.

Header	Parameter	Perm. units	DEFAULT units	Description
SIGNAL <n>	n: 0...31	---	---	For front-panel signals 1...10 signals top 11...20 signals centre 21...30 signals bottom 31 field-repetitive sweep signal
<n><unit>	n: 1...10	A, B, C	---	Permits the front-panel signals to be selected directly, eg: SIGNAL 3B = Signal 13 (A = top, B = centre, C = bottom)
AUDIO <n>	n: 1...4	---	---	Selecting one of four audio settings, eg: AUDIO 2 = Ton 2
AMPLITUDE **C**ALIBRATED	---	---	---	Setting amplitude to CAL, eg: AMPLITUDE C = CAL position.
AMPLITUDE **V**ARIABLE	---	---	---	Setting amplitude to VAR, eg: AMPLITUDE V = VAR position. Setting via front-panel potentiometer
AMPLITUDE <n> <unit>	0.496...1.416 496...1416 -6.09...3.02 49.6...141.6	**V** **mV** **dB** **P**CT	V	Setting by internal D/A converter. Indication by CAL and VAR LEDs. Setting in 4-mV steps eg: AMPLITUDE 52 PCT = 52% amplitude
BOUNCETIME	0.08...16.000 80...16000	**S** **mS**	S	Duration of change period for bounce signal Setting steps = 80 ms
DATABURST	0...1 **ON** **OF**F			witching the data burst on and off (including line sync word and line 625). The switched-off data burst is signalled by a blinking audio LED. Reinsertion of data burst only with DA1 or DA ON.

Table 2-8: Device-specific setting commands

Examples:

(8 is assumed as IEC/IEEE-bus address of the SGDF)
IECOUT 8, "SIG 4; AU 2"
IECOUT 8, "SIG 5C; AMPL VAR"
IECOUT 8, "AMPL 1.345" ≙ IECOUT 8, "AM 1.345V" ≙ IECOUT 8, "AM 1345 mV"
IECOUT 8, "BOU 4.04" ≙ IECOUT 8, "Bounce 4040 ms"
IECOUT 8, "DATA 0" ≙ IECOUT 8, "DA OFF"

2.4.4.4 Device-specific Query Messages

The shortest possible form is printed in bold.

Query message	Message sent by SGDF in the talk mode	
	Header	Parameters or number format in default units
SIGNAL?	SIGNAL	0...31
AUDIO?	AUDIO	1...4
AMPLITUDE?	AMPLITUDE	CALIBRATED VARIABLE 0.496...1.416
BOUNCETIME?	BOUNCETIME	0.08...16.00
DATABURST?	DATABURST	0...1

Tabelle 2-9 Device-specific Query Messages

Examples:
IECTERM 10 (Talker delimiter "new line")
IECOUT 8, "*HDR 1; Sig?; Ampl?"
IECIN 8, A$
PRINT A$ ⇒ SIGNAL 25; AMPLITUDE CALIBRATED

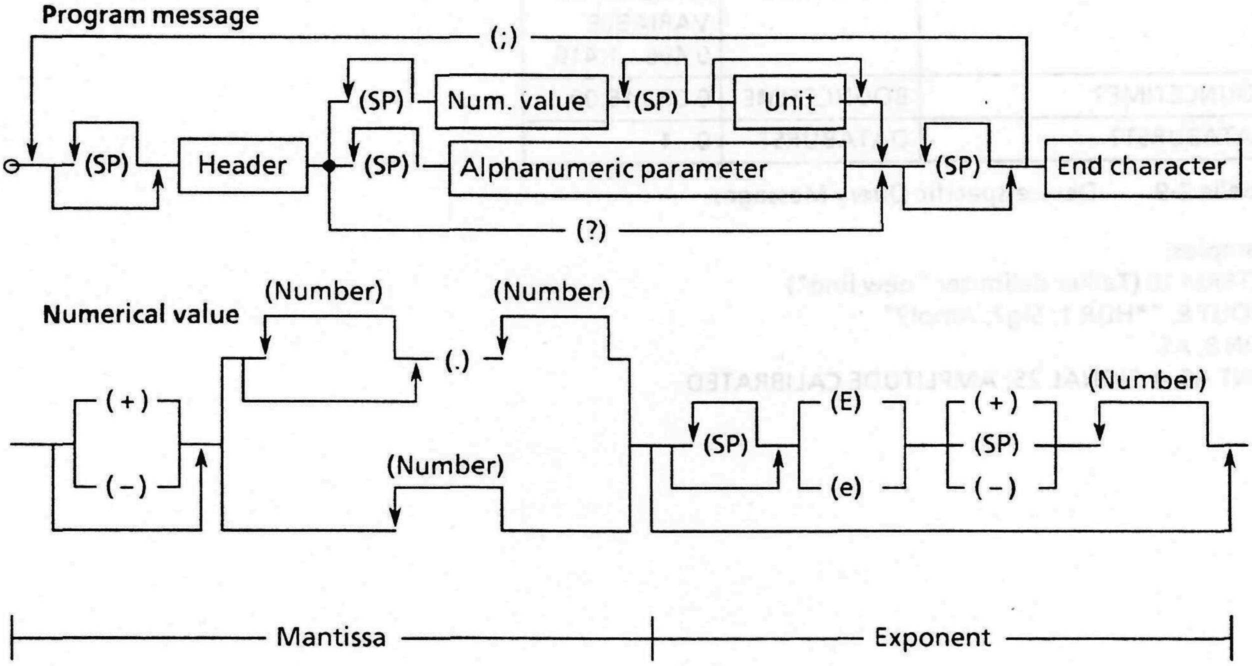
2.4.5 Syntax of Setting Commands and Query Messages (controller-to-device messages)

Fig. 2-5 shows the syntax of a program message. Each message must be terminated by an end marker. Permissible end markers:

- New line (ASCII code decimal 10)
- End (EOI line active) together with:
  > last useful character of message or
  > semicolon (;)
  > ASCII character with code 0 to 32 decimal.

Since a carriage return (ASCII code decimal 13) is permissible as a meaningless filler in front of the end character, also the combination carriage return + new line is permissible.

End characters accepted by the SGDF are standard in all R&S IEC/IEEE-bus controllers.



SP: All characters with the ASCII code 0 to 9 or 11 to 32 decimal, especially space.

Fig. 2-5 Syntax diagram of a program message

Example:

*RTS; SIGNAL 26; AMPL 0.65 V <CR><NL>

New Line

Carrige Return

SIG?; AMPL? <NL>

Since messages are only terminated by an end marker they may take up more than one line on the controller screen. Most IEC/IEEE-bus controllers automatically add an end marker to the text.

A program message may consist of several message units which have to be separated by a semicolon (;).

A unit may consist of the following parts:

- Header and question mark
  Example: SIGNAL?

This combination requests the SGDF to hold the required data ready in an output buffer for transmission on the IEC/IEEE bus as soon as the SGDF is addressed as talker.

Note: *? directly after the header*

- Header and numerical value
  Example: AMPL 61.3E-2

  Header and numerical value must be separated at least by an empty space (space ASCII code 32 decimal). In the case of device-specific messages a unit may be added after the number.

Lower case characters are permissible, they are equivalent to upper case characters. This allows units to be written in their usual form (eg dB) instead of writing them in upper case characters (DB) which is also permissible.

Additional spaces may be added in the following positions:

- before header
- between header and numerical value
- before and after the semicolon (;)
- before the end character.

Header of device-specific commands

The headers are similar or identical to key labels. The result are easy-to-read (self-explanatory) programs.

Headers may be shortened as required by eliminating characters at their end (eg S or SI instead of SIGNAL). The shortest possible forms (bold letters) can be seen from in Tables 2-8 to 2-9.

Numerical value

Only decimal figures with the following notations are permissible:

- with or without sign
  eg: 5, +5, -5
- with or without decimal point, the position of the decimal point being arbitrary
  eg: 1.234, -100.5, .327
- with or without exponent to the base of 10, "E" or "e" being the sign for the exponent
  eg: .451, 451E-3, +4.51e-2
- the exponent may be with or without sign, a space is permissible instead of the sign
  eg: 1.5E + 3, 1.5E-3, 1.5E3
- leading zeros are permissible in mantissa and exponent
  eg: +00015, -01.5E-03
- the length of the mantissa may cover up to 40 numbers without leading zeros. The exponent is limited to two numbers. Exceeding the permissible length in the case of negative exponents causes the number to be rounded to 0, with positive exponents this causes an overflow. Exceeding the permissible length of the mantissa causes positions after the decimal point to be cut otherwise an overflow.

Note: *An exponent on its own (eg: E-3) is not permissible; correct is: 1E-3*

Unit

In the case of device-specific setting commands, a unit may be added directly to the numerical value (eg: 1.38, permissible is also 1.38E3MV). Permissible units are listed in Table 2-8. They may be abbreviated or written in upper case or lower case characters. If no unit is indicated, the pertaining default unit applies.

2.4.6 Syntax of messages sent by the SGDF in the Talker mode (device-to-controller messages)

The SGDF sends messages on the IEC/IEEE bus if:

1) it has been requested by one or several query messages with question mark in one program message to hold data ready in the output buffer.
2) it indicates in the status byte by setting bit 4 (MAV message available) that the requested data are available in the output buffer (see also Section 2.4.7)
3) it has been addressed as talker (BASIC command "IECIN adr, string variable")

It should be noted that query messages are sent immediately before the talker address. If another message is sent in between, the output buffer is cleared.

If the SGDF is addressed as talker immediately after a query message without observing point 2) above, the bus handshake is inhibited until the requested data are made ready (eg about 3 s after command *TST?).

The syntax of the messages sent by the SGDF is similar to that of the messages it received and can be seen in Fig. 2-6.

- New line (ASCII code 10 decimal) together with end (line EOI active) is used to terminate a program message.
- Selection with command "*HDR 0" or "*HDR 1" whether only numerical values (*HDR 0) or header and numerical values (*HDR 1) are sent.

The mode "header and numerical values" is also selected with command
▸ *RST (reset).

The setting "header and numerical values" allows messages sent by the SGDF to be returned unchanged. Thus, any keyboard setting may be read out, stored in the memory and repeated later on via IEC/IEEE bus.

- If the SGDF receives several query messages, it returns several message units, which are separated by a semicolon, in one program message.
- Header and numerical values are always separated by a space.
- Headers are made up of upper case characters and "*".
- For the syntax of numerical values see Fig. 2-6. Only decimal numbers are sent. The specific form of numerical values for each message can be seen in Tables 2-7 and 2-9.
- The messages sent by the SGDF comprise no units. In the case of physical parameters, the numbers are assigned the basic units listed in Table 2-9.

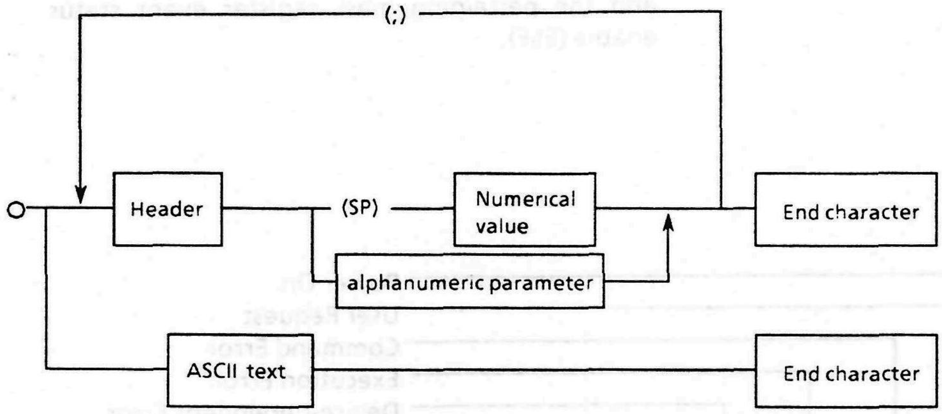
Program example:
(for IEC/IEEE-bus controller PCA; the IEC/IEEE-bus address of the SGDF is assumed to be 8).
Example 1: self-test; simple synchronization procedure

```
5 IECTIME 5000 ............................ timeout = 5 s; test takes about 3 s
10 IECTERM 10 ............................. input delimitor: LF
20 IECOUT 8, "*TST?" ...................... trigger of test function
30 IECIN 8,ST$ ............................ talker addressing and reading of data
40 PRINT "Selbsttest SGDF: ";ST$
```

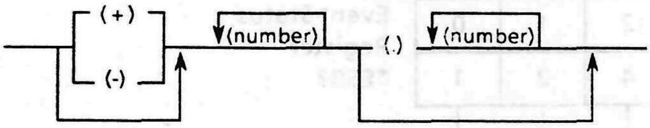
Example 2: identification; message by service request that data are available

```
10 IECTERM 10 ............................. input delimiter: LF
20 ON SRQ GOSUB 100 ....................... with service request branch after line 100
30 IECOUT 8, "*SRE 16; *IDN?" ............. SRQ through MAV bit and identification query
.
.
.
100 REM SERVICE REQUEST ROUTINE
110 IECSPL 8,S% ........................... serial poll
120 IF (S% AND 16) = 0 THEN GOTO 150 ...... service request from SGDF?
130 IECIN 8,ID$                             yes, talker addressing
140 PRINT "Identifikation:"; ID$
150 ON SRQ GOSUB 100
160 RETURN
```

Output message



Numerical value



SP: space (ASCII code 32 decimal)

ASCII text: reply to commands *IDN? and *OPT? (see Table 2-7)

Fig. 2-6 Syntax diagram of messages sent by the SGDF

Example with header:
SIGNAL 22; AMPLITUDE CALIBRATED; BOUNCETIME 4.00 (NL + END)

Example without header:
22; CALIBRATED; 4.00 (NL + END)

2.4.7 Service Request (to IEEE 488.2) and Status Register

The figure below shows status registers and their logical links.

In compliance with the standard, the status byte (STB) and the pertaining mask register (SRE), which are also available in older instruments, are supplemented by the event status register (ESR) and the pertaining mask register event status enable (ESE).

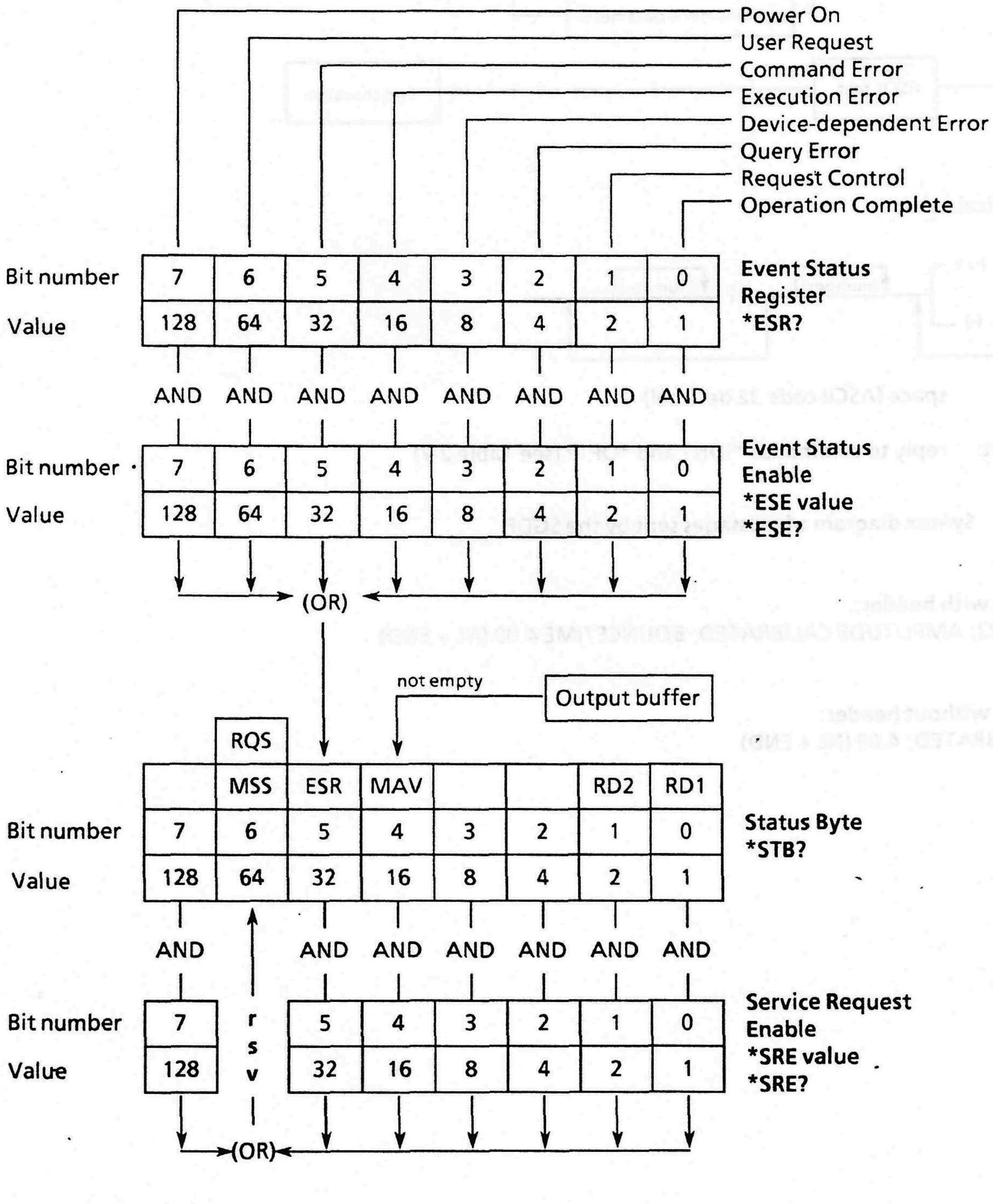


Fig. 2-7 Status register

Table 2-10 Event status registers

Bit number	Description
7	**Power On** Set when the SGDF is switched on or when the power returns after a power failure.
6	**User Request** This bit is set if a key on the SGDF is pressed. With of the mask register set correspondingly, a service request is triggered. This function is very useful for test systems requiring manual and IEC/IEEE-bus control.
5	**Command Error** Set if the analysis of received commands detects a syntax error, including: • general syntax errors • illegal unit • illegal header
4	**Execution Error** Set if during execution of received commands one of the parameter is outside the permissible range
3	Not used in the SGDF.
2	**Query Error** This bit is set: • if the controller wishes to read data from the SGDF without sending a prior query message, • if the data ready in the output buffer of the SGDF are not read out and if a new command is sent to the SGDF instead.
1	**Request Control** Not used in the SGDF.
0	**Operation Complete** This bit ist set with command "*OPC" if all previous commands have been processed and executed.

With certain events (eg error, operation complete) a bit in the event status register (ESR) is set to 1 (see Table 2-10).

These bits remain set until they are erased either by a read-out of the event status register (with command *ESR?) or by the following conditions:

- command *CLS
- switching on the AC supply (the power-on bit is set subsequently)

With the aid of the event status enable mask register (ESE) the user may select the bits in the event status register that set the sum bit ESB (5 bits in the status byte), and this may trigger a service request. The sum bit is therefore only set if at least one bit in the ESR and the respective bit in the ESE is set to 1. The sum bit is automatically erased if the above-mentioned condition becomes invalid, eg if the bits in the ESR have been erased by a read-out of the ESR, or if the ESE has been changed.

The event status enable mask register is written with command "*ESE wert" ("wert" = content in decimal form) and can be read out again with command *ESE?. Upon power on it is set to 0 provided the power on clear flag is 1 (*PSC 1).

It is not changed by other commands or interface messages (DCL, SDC).

It should be noted that the bits of the status register are numbered from 0 to 7 in compliance with IEEE 488.2, whereas bus data lines are labelled DIO1 to DIO8.

The service request enable mask register (SRE), enables the user to determine whether, upon a change of the MAV or ESB bit from 0 to 1, also the RQS bit of the status byte is set and a service request is sent to the controller by activating the SRQ line. Since each bit of the service request enable mask register is allocated to a bit in the status byte, the following possibilities are given:

Content of SRE (dec.)	Bit No. set in SRE	Effect
0	--	No service request
16	4	service request if the MAV bit is set (message in output buffer)
32	5	service request if the ESB bit is set (at least 1 bit in the event status register is set and not masked
48	4 + 5	Service request in both above cases.

The service request enable mask register (SRE) is written with command "*SRE wert" (wert = content in decimal form). It may be read out again with command *SRE?. Upon power up it is set to 0 provided the power on clear flag is 1 and the service request function of the SGDF is inhibited. The SRE mask register is not changed by other commands or interface messages (DCL, SDC).

Several devices may trigger a service request at the same time; the open collector drivers produce an OR function on the SRQ line. In order to identify which device triggered the service request, the controller must read the status bytes of the device. A set RQS bit (bit 6/DIO7) indicates that the device sends a service request.

Bit No.	Bus line	Designation	Description
4	DIO 5	MAV	Message Available Indicates that a message is available for reading in the output buffer. If the output buffer is empty, the bit is 0.
5	DIO 6	ESB	Sum bit of event status register
6	DIO 7	RQS MSS	Request service (read by serial poll) Master Status Summary (read by *STB?)

The status byte of the SGDF can be read in the following way:

- Command "*STB?"
  MSS (master status summary) is transferred as bit 6. MSS is 1 if at least 1 bit is set in the status byte and if the respective bit in the service request enable mask Register (SRE) is set too.

The content of the status byte - including the MSS bit - are output in decimal form. However, it is not possible to identify a set MAV bit in this way. The status byte is not changed by the read-out and a possible service request is not cleared.

- Serial poll
  (with R&S controllers: IECSPL adr, status.)
  The content is transferred in binary form as one byte. RQS (request service) is sent as bit 6. RQS is set if the addressed device has triggered the service request. After this the RQS bit is set to 0 and the service request is made inactive. All other bits of the status byte remain unchanged.

RQS is cleared at the same time as MSS, eg by resetting the service request enable mask register (SRE).

The status byte is cleared:

- by *CLS at the beginning of a program message.
  At the beginning of a program message the output buffer (and thus the MAV bit) is cleared. *CLS cleares the event status register (and thus the ESB bit). This in turn causes the MSS and RQS bits and the service request message to be cleared.

- by processing the entries in the status byte

  With MAV bit set:
  by reading the content of the output buffer (IECIN adr,A$)

  With ESB bit set:
  by reading the event status register (*ESR?).

As a result also the MSS and RQS bits in the status byte and the service request are cleared.

Program example:

In the following program a service request is triggered as soon as an error is detected and the type of error is determined from the event status register. (The example uses the command set of the IEC/IEEE-bus controller PCA; the IEC/IEEE-bus address of the SGDF is assumed to be 8).

```
10   IECTERM 10 ————————————————————————————————— Input delimitor: LF
20   ON SRQ GOSUB 100
30   IECOUT 8, "*CLS; *HDR 0; *ESE 60; *SRE 32"
.                                      ————————————— for service request in case
.                                                    of an error
.
100  REM -----------------------------------------
110  REM  SERVICE REQUEST ROUTINE
120  REM -----------------------------------------
130  IECSPL 8, S%
140  IF (S% AND 64) = 0 THEN GOTO 300 ————————— SRQ not from SGDF?
150  IECOUT 8,"*ESR?" ————————————————————————— read event status
160  IECIN 8,E$                                  register lesen
170  E% =VAL(E$)
180  IF (E% AND 32) <>0 THEN PRINT "COMMAND ERROR"
190  IF (E% AND 16) <>0 THEN PRINT "EXECUTION ERROR"
200  IF (E% AND 8)  <>0 THEN PRINT "DEVICE-DEPENDENT ERROR"
210  IF (E% AND 4)  <>0 THEN PRINT "QUERY ERROR"
220  ON SRQ GOSUB 100
230  RETURN
240  REM -----------------------------------------
300  REM Service request from other device
.
.
380  ON SRQ GOSUB 100
390  RETURN
```

Note: If the status byte is changed while the SRQ routine is processed, a condition for a service request remains so that the SRQ line is reactivated. The result may be that after processing the SRQ routine the controller again detects an SRQ.

2.4.8 Timing of Command Execution and Synchronization

Commands received by the SGDF are first stored in an input buffer which accepts a maximum of 255 characters. After the end character has been received, the programs are executed in the sequence in which they have been received. During this time, the IEC-bus may be used for communication with other instruments.

Note: *Command lines exceeding the input buffer capacity cause errors*

Commands *OPC and *OPC? (operation complete) are used for signalling back the time the execution of the received commands is terminated and the output signal of the SGDF has settled to the new values.

*OPC sets bit 0 in the event status register so that a service request may be triggered if all previous commands are executed.

*OPC? makes the message "1" in the output buffer ready for use and sets bit 4 (MAV) in the status byte if all previous commands have been executed.

This synchronization method is recommended if another unit requiring the settled signal of the SGDF should be requested to start a measurement via IEC/IEEE bus.

After *WAI the SGDF delays the execution of new commands until all previously received commands are completely executed. This specifically prevents an overlapping command execution.This program example shows a simple method for synchronization.

Command *OPC? generates a message as soon as all previous commands have been executed and the SGDF output signal has settled. Since this message should be read into line 30, the bus handshake is stopped until the message is available and the SGDF output signal has settled.

2.4.9 Error Handling

All errors identified by the SGDF in connection with IEC/IEEE bus control are signalled by setting a bit (bit 2, 4 or 5) in the event status register (see Table 2-10). These bits remain set until the event status register is read out or cleared with command *CLS. This complies with IEEE-488.2 and permits triggering of a service request and program-controlled error identification.

Program example:
(The command set of the IEC/IEEE-bus controller PCA is used; the bus address of the SGDF is assumed to be 8).

```
10  ICETERM 10
20  ICEOUT 8, "SIG 12; AMPL 0.65; *OPC?"
30  ICEIN 8,A$: REM A$ no longer used
40  REM From now on signal 12 is available at the SGDF output with an amplitude of 0.65 V. Since
    the signal of the SGDF is only changed if the full field changes and since the output
    amplitude requires a certain time for settling, it may take up to about 120 ms before the
    OPC message is output in line 30.
```

2.4.10 Resetting of Instrument Funcions

The tabel below holds the various commands and events causing a reset of individual instrument functions.

Event / Effect	Switching on the operating voltage: Power-On-Clear-Flag 0	Power-On-Clear-Flag 1	CAL-VAR key pressed? = MASTER RESET	DCL, SDC (Device Clear, Selected Device Clear)	Commands: *RST	*CLS
Basic instrument setup	--	--	yes	--	yes	--
Zero reset of event status register ESR	yes	yes	yes	--	yes	yes
Zero reset of mask registers ESE and SRE	--	yes	yes	--	--	--
Clearing of output buffer	yes	yes	yes	yes	yes	3)
Clearing of service request	yes	1)	yes	2)	2)	3)
Messages from SGDF: setting "with header"	--	--	yes	--	yes	--
Command processing and reset of input buffer	yes	yes	yes	yes	--	--

1) Yes, but "service request on power on" is possible.
2) Yes, but only if caused by a message in the output buffer.
3) Yes, if *CLS is sent at the beginning of a command line.

Table 2-11 Resetting the instrument functions

3 Maintenance

The SGDF requires no regular maintenance.

Note: *This chapter describes troubleshooting at the module level. For troubleshooting at a deeper level, we recommend the Service Manual with the order number: 2011.2202.24.*

3.1 General Information

3.1.1 Cleaning

It is recommended to use a soft, lint-free duster or a brush for external cleaning. For heavier soiling, meths or mild detergents may be used. Do not use any nitro thinners, acetone etc. since these solvents may damage the front-panel labelling or plastic parts (keys).

3.1.2 Storage

The instrument can be stored at temperatures between -40 and +70°C.
The instrument should be protected against dust if it is stored for a longer period.

3.1.3 Opening and Closing the Instrument

- Switch off the instrument and disconnect the power plug.
- Disconnect all other cables.
- Unscrew the two supporting feet from the rear panel (2 screws each).
- Use a small screwdriver to lift off the upper cover.
- If necessary, unscrew the shielding plate from the process controller (rear PC board) or from the generator (front PC board).

To close the instrument, proceed in reverse order. When sliding on the cover, make sure that it fits tightly in the frame. When screwing down the feet, press the cover to the instrument until it locks in position.

3.1.4 Replacing the Lithium Battery

The SGDF has a RAM which is backed up by a lithium battery. The operating life of this battery depends on how the instrument is used (eg after long storage time at high temperatures). In such cases the battery should be replaced from time to time (once in three years) by one of the same type. To open the instrument, proceed as described in section 3.1.3 and replace the battery properly (solder lugs and use cable ties for fastening).

Caution:

The battery used in the instrument is a high-power lithium cell. It must not be short-circuited or recharged under any circumstances. Do not open used cells and handle them as hazardous waste.

3.2 Checking the Crystal Oscillator

The crystal oscillator of the generator is subject to aging. To maintain the accuracy of 4×10^{-6}, the oscillator should be checked once a year and readjusted, if required. For measuring the clock frequency refer to section 3.3.2.

3.3 Checking the Rated Specifications

Checking the main performance data of the SGDF is described in the following. After replacing components, a new adjustment may be necessary for which the following instruments are required:

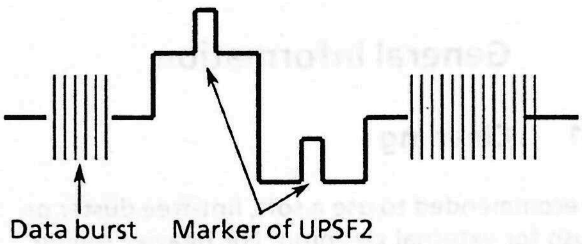
- Video Noise Meter UPSF 2 with
- 200-kHz highpass filter
- 7.5-MHz lowpass filter
- D/D2-MAC weighting filter
- TV Syncer
- TV Digital Oscilloscope ODF
- Frequency counter

3.3.1 Signal Amplitude
(see Fig. 3-1)

The signal amplitude is measured with the aid of the video noise meter which is synchronized with a TV syncer. These instruments are connected as follows:

- The generator signal of of the SGDF is applied to the loop-through filter input of the TV syncer.
- The looped-through signal is applied to the rear test input of the UPSF2.
- The SYNC output of the TV syncer is connected to the sync input of the UPSF2, the loop-through input being terminated. The UPSF2 is set to EXT BLANKING mode.

The reference bar measurement of the UPSF2 allows the amplitude to be measured in reference line 624 of the generator signal. The first sampling point must be set to 21 µs and the second to 29 µs. The readout must be set to mV. At the UPSF2 monitor output, the following signal should now be in line 624:



Readout on the UPSF2 is: **1000 mV ± 5 mV**

If the SGDF is set to VAR, the setting range of the signal amplitude can be checked. It is between **500 mV and 1420 mV**.

The signal amplitude measurement is repeated for the second generator output. The TV Digital Oscilloscope ODF can also be used for these measurements.

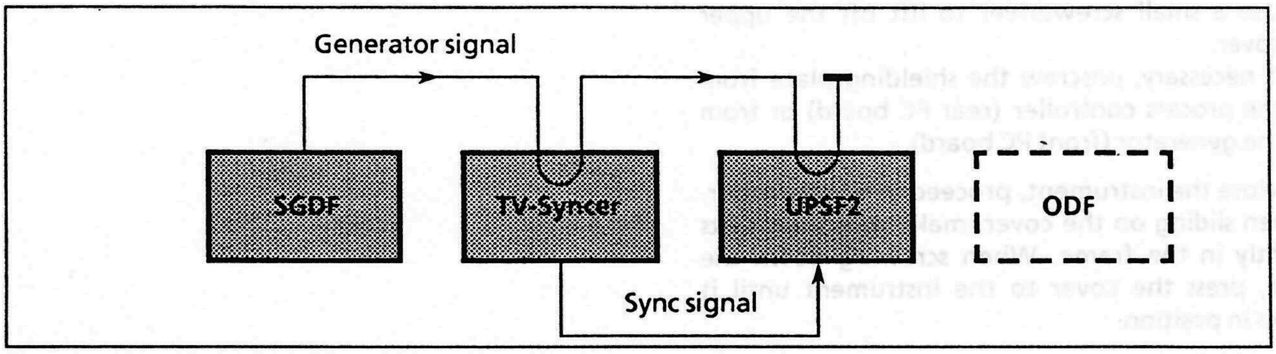


Fig. 3-1 Test setup for measuring the signal amplitude

3.3.2 Clock Frequency

The clock frequency of the SGDF generator section can be measured at the H sync output with the aid of a frequency counter.
The frequency is: **15625 ± 0.062 Hz**

Since this high-precision measurement of such a low frequency is often not possible, the clock frequency can also be measured directly. For this purpose, remove the panelling and the shielding cover from the generator board and measure the clock frequency at connector X30A3.
The frequency is: **20.25 MHz ± 80 Hz**

To measure the clock frequency, allow the instrument to warm up for at least 30 min. Since the crystal is subject to aging, it is recommended to readjust the clock frequency once a year to ensure the accuracy of 4×10^{-6} (see also section 3.3).

3.3.3 Signal Waveform

The signal generation of the SGDF is purely digital, ie the signal is stored in the form of samples and converted to analog form by means of a D/A converter. A fault in the digital generation may affect all signals. A ramp signal is best for checking the performance of the generator, since it runs through all steps of the D/A converter. An oscilloscope externally triggered by the H sync signal is used for checking.

The signal is checked for quality. The ramp rises by 4 mV approximately every 200 ms (resolution 8 bit). Apart from a small ripple caused by the glitches of the D/A converter, the signal should rise or fall monotonically.

The quality of the ramp signal can also be checked by measuring the S/N ratio using the UPSF2. The test setup in section 3.4.1 is required (see also Fig. 3-2), the signal however being applied to the UPSF2 via an external 200-kHz highpass filter, a 7.5-MHz lowpass filter and a D/D2-MAC weighting filter. A full-field S/N ratio measurement should yield the following result (referred to 0.7 V of UPSF2): **>65 dB**

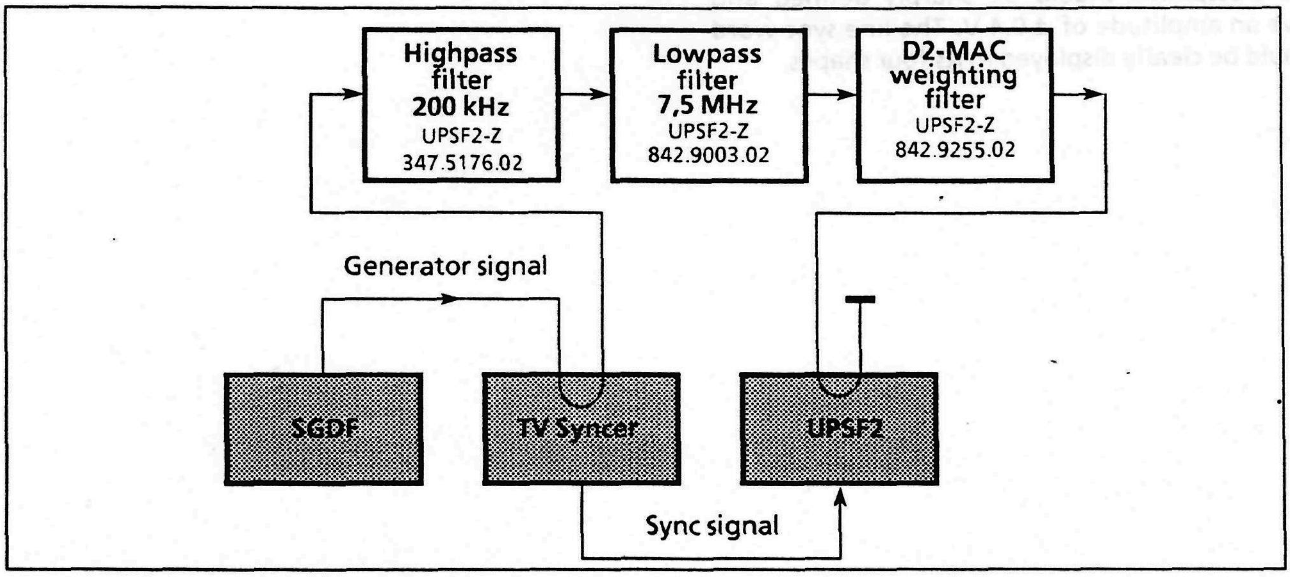


Fig.3-2 Test setup for measuring the S/N ratio

3.3.4 Data Signal

The data signal of the SGDF can only be completely checked with the aid of a decoder. The response of the TV syncer to the SGDF signal is a simple method of checking the data signal. If the sync words in the data signal are all correct, it can be assumed that the data signal from the memory is also correct.

Another possibility of measuring the data signal is checking the eye pattern on an oscilloscope. The oscilloscope is triggered by the H sync pulse of the SGDF and the start of the data burst is observed. The following signal should be displayed:

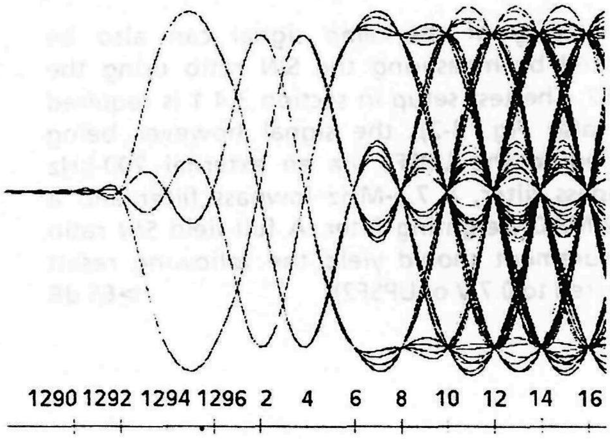
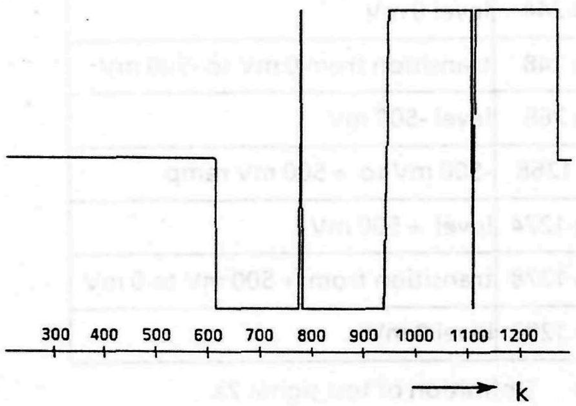


Fig. 3-3 Data signal

The crosspoints should be sharply defined and have an amplitude of ± 0.4 V. The line sync word should be clearly displayed in its four shapes.

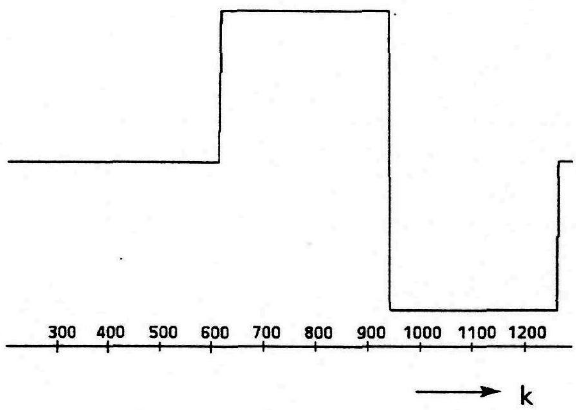
Annex



Test signal 1a, even frame

k =	
255 to 612	level 0 mV
612 to 616	transition from 0 mV to -500 mV
616 to 773	level -500 mV
773 to 779	pulse (base -500 mV; peak + 500 mV)
779 to 936	level -500 mV
936 to 940	transition from -500 mV to + 500 mV
940 to 1097	level + 500 mV
1097 to 1103	pulse (base + 500 mV, peak-500 mV)
1103 to 1260	level + 500 mV
1260 to 1264	transition from + 500 mV to 0 mV
1264 to 1292	level0 mV

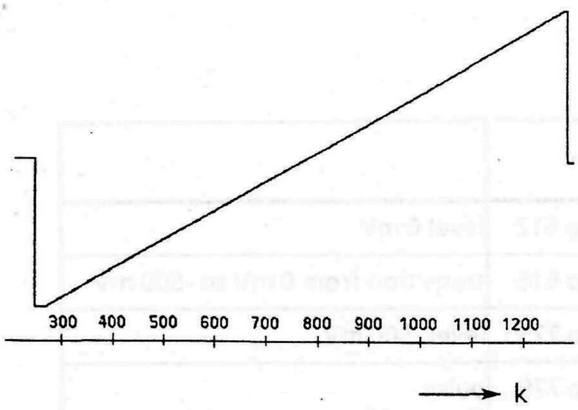
Table 1a Definition of signal 1a, even frames



Test signal 1b, odd frame

k =	
255 to 612	level 0 mV
612 to 616	transition from 0 to + 500 mV
616 to 936	level + 500 mV
936 to 940	transition from + 500 mV to -500 mV
940 to 1260	level -500 mV
1260 to 1264	transition from -500 mV to 0 mV
1264 to 1292	level 0 mV

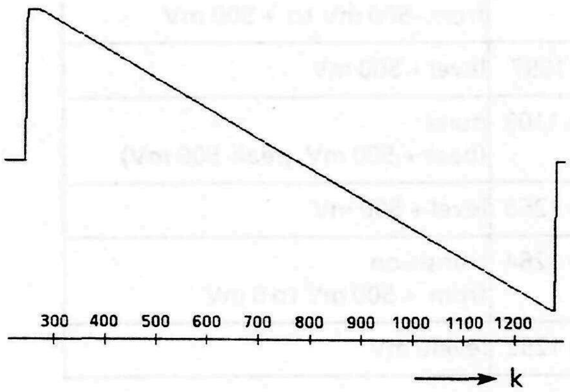
Table 1b Definition of signal 1b, odd frames



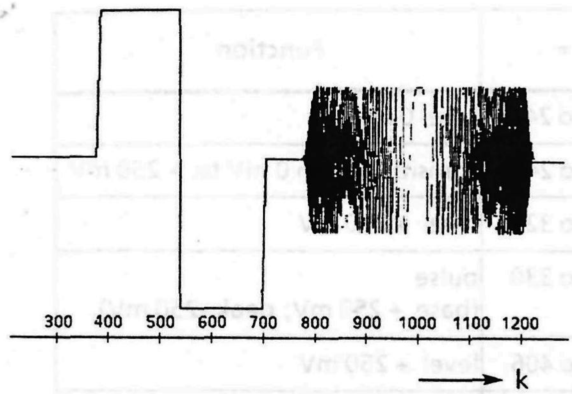
Test signal 2a even frame

k =	
225 to 244	level 0 mV
244 to 248	transition from 0 mV to -500 mV
248 to 268	level -500 mV
268 to 1268	-500 mV to + 500 mV ramp
1268 to 1274	level + 500 mV
1274 to 1278	transition from + 500 mV to 0 mV
1278 to 1292	level 0 mV

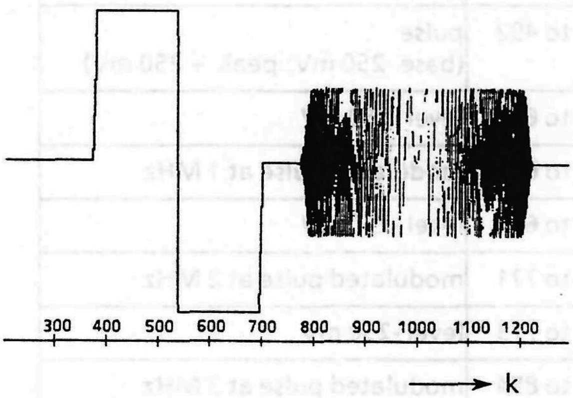
Table 2a Definition of test signal 2a



Testsignal 2b Timing, see test signal 2a, but inverted level



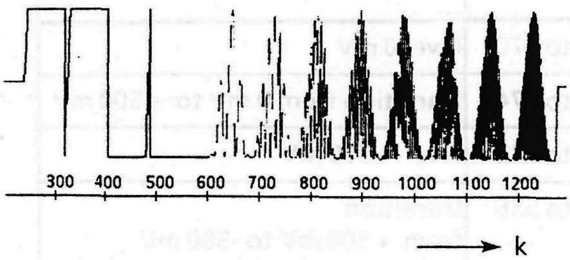
Test signal 3a



Test signal 3b

k =	Function
255 to 370	level 0 mV
370 to 374	transition from 0 mV to + 500 mV
374 to 532	level + 500 mV
532 to 536	transition from + 500 mV to -500 mV
536 to 694	level -500 mV
694 to 698	transition from -500 mV to 0 mV
698 to 739	level 0 mV
739 to 1251	komplex wobbulation of amplitude ± 250 mV (real part in even frames, imaginary part in odd frames)
1251 to 1292	level 0 mV

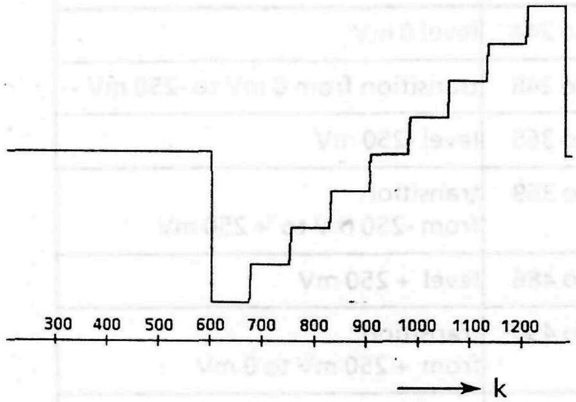
Table 3 Definition of signals 3a and 3 b



Test signal 4

k =	Function
225 to 244	level 0 mV
244 to 248	transition from 0 mV to + 250 mV
248 to 324	level + 250 mV
324 to 330	pulse (base + 250 mV; peak -250 mV)
330 to 406	level + 250 mV
406 to 410	transition from + 250 mV to -250 mV
410 to 486	level -250 mV
486 to 492	pulse (base -250 mV; peak + 250 mV)
492 to 607	level -250 mV
607 to 688	modulated pulse at 1 MHz
688 to 690	level -250 mV
690 to 771	modulated pulse at 2 MHz
771 to 773	level -250 mV
773 to 854	modulated pulse at 3 MHz
854 to 856	level -250mV
856 to 937	modulated pulse at 4 MHz
937 to 939	level -250 mV
939 to 1020	modulated pulse at 5 MHz
1020 to 1022	level -250 mV
1022 to 1103	modulated pulse at 6 MHz
1103 to 1105	level -250 mV
1105 to 1186	modulated pulse at 7 MHz
1186 to 1188	level -250 mV
1188 to 1269	modulated pulse at 8 MHz
1269 to 1274	level -250 mV
1274 to 1278	transition from -250 mV to 0 mV
1278 to 1292	level 0 mV

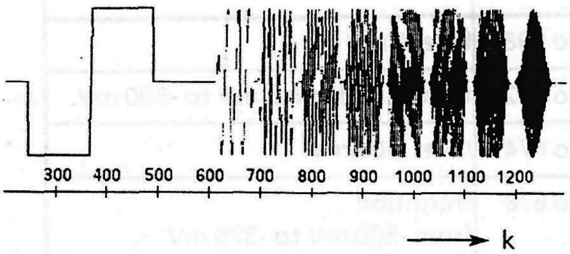
Table 4 Definition of signal 4



Test signal 5

k =	Function
225 to 598	level 0 mV
598 to 602	transition from 0 mV to -500 mV
602 to 674	level -500 mV
674 to 678	transition from -500 mV to -375 mV
678 to 749	level -375 mV
749 to 753	transition from -375 mV to -250 mV
753 to 824	level -250 mV
824 to 828	transition from -250 mV to -125 mV
828 to 899	level -125 mV
899 to 903	transition from -125 mV to 0 mV
903 to 974	level 0 mV
974 to 978	transition from 0 mV to + 125 mV
978 to 1049	level + 125 mV
1049 to 1053	transition from + 125...250 mV
1053 to 1124	level + 250 mV
1124 to 1128	transition from + 250...375 mV
1128 to 1199	level + 375 mV
1199 to 1203	transition from + 375...500 mV
1203 to 1274	level + 500 mV
1274 to 1278	transition from + 500 mV to 0 mV
1278 to 1292	level 0 mV

Table 5 Definition of signal 5



Test signal 6

k =	Function
225 to 244	level 0 mV
244 to 248	transition from 0 mV to -250 mV
248 to 365	level -250 mV
365 to 369	transition from -250 mV to + 250 mV
369 to 486	level + 250 mV
486 to 490	transition from + 250 mV to 0 mV
490 to 607	level 0 mV
607 to 688	burst 1 MHz
688 to 690	level 0 mV
690 to 771	burst 2 MHz
771 to 773	level 0 mV
773 to 854	burst 3 MHz
854 to 856	level 0 mV
856 to 937	burst 4 MHz
937 to 939	level 0 mV
939 to 1020	burst 5 MHz
1020 to 1022	level 0 mV
1022 to 1103	burst 6 MHz
1103 to 1105	level 0 mV
1105 to 1186	burst 7 MHz
1186 to 1188	level 0 mV
1188 to1269	burst 8 MHz
1269 to 1292	level 0 mV

Table 6: Definition of signal 6