LAB <u>basic</u> HW Tools …

Szerver;
e-Jegyzőkönyv

Internet

IntuiLink.

21
PC/Laptop
GPIB
Controller

**GPIB
address**

- Toolbar <u>add-ins</u> for **Word, Excel** (Scope, DMM, [PS])
- "Waveform Editor" (ARB gen)
- "Data Capture" (Scope)

(USB)

USB/GPIB   82357A

'Data Capture'

Toolbars
(Word, Excel)

"Waveform Editor"

(GPIB)

ARBgen, opt 001

10

ARBgen, opt 001

9. sz mérés:
Analóg
fáziszárt hurok
vizsgálata

7   **22**   **10**   **5**...

Scope   DMM   ARBgen   PS
54622A   34401A   33220A   E3631A

DUT
(device
under test)

Manual **PS**
E3630A

METEX
ME-22T DMM

● ● ●

Agilent (= HP)
**Signal Generator (ESG)
E4430B**

PSG/ESG Signal Generator
Agilent PSG/ESG

19

10. sz mérés:
900 MHz-es
FSK
adatátviteli
berendezés
vizsgálata

PSA/ESA Spectrum Analyzer
Agilent PSA/ESA

18

**Spectrum Analyzer (ESA)
E4411B**
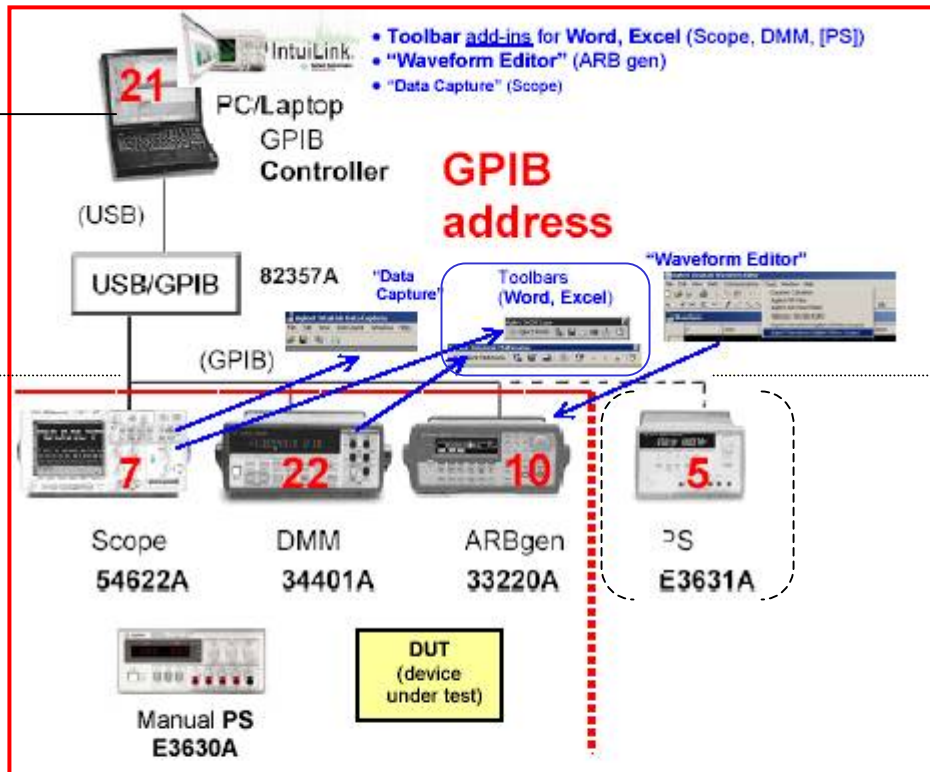
E9340A <u>LogicWave</u> PC Logic Analyzer

34 channels; **100 MHz state** (64k
250 MHz timing (128K) analysis
Connects via **parallel** port
Single-screen user interface
(the most commonly used features,
and the captured data, are
available on one screen)

**Scope
54622D**

7

Interface VISA/SICL Names   Windows PC   USB Cable   GPIB Instruments

Accept DEFAULT settings !!

Blue IO Icon

VISA Name   SICL Name

"GPIB0"   "gpib0"

USB Port

VISA assistant
IO config

82357A   Scope address: 7

ARB address: 10

GPIB Cables

Multimeter address: 22

Logical Unit: 7
Bus address: 21

Note: **VISA** = Virtual Instrumentation Software Architecture
SICL = Standard Instrument Control Library

USB = Universal Serial Bus

GPIB = General Purpose Interface (Instrument) Bus

HP-IB = IEEE488 = IEC625

Graph
Local

Shift
Local

" Go to Local "
II. félév: ESA és ESG is !!

ARBgen Opt. 001: Ext Timebase (@ "Slave Gen")

"Slave Gen"

10 (GPIB)

REF   GEN

REF   GEN

"Slave Gen"

10 MHz In   10 MHz Out
   ±5V   ±1Vpp

**Rear
Panel**

10 MHz In   10 MHz Out
   ±5V   ±1Vpp

42V pk ⚠

Modulation
In

Ext Trig/
FSK / Burst

TTL

42V pk ⚠

Modulation
In

Ext Trig/
FSK / Burst

TTL

/ **REF GEN** Ref **Out** to "Slave Gen" Ref <u>In</u> /

"Slave Gen" is
phase-locked
to **REF GEN**

Connecting a valid signal to the reference frequency input
at the <u>rear</u> <u>panel</u>
<u>automatically</u> sets the instrument to use the external timebase.

No user intervention is required.

Software Defined Radio:

Transmitter

PA

I/Q Modulator

DAC

DAC

DSP

RF VCO

**Freq Domain :
FFT**

Real-Time
Spectrum Analyzer

Oscilloscope

Data Transfer

Logic Analyzer

Trigger

Trigger

**Frequency
Domain**

**Analog Time
Domain**

**Digital Time
Domain**

SpA&RFgen

E4411B

1.5GHz

Agilent
ESA-L Series
Spectrum Analyzers
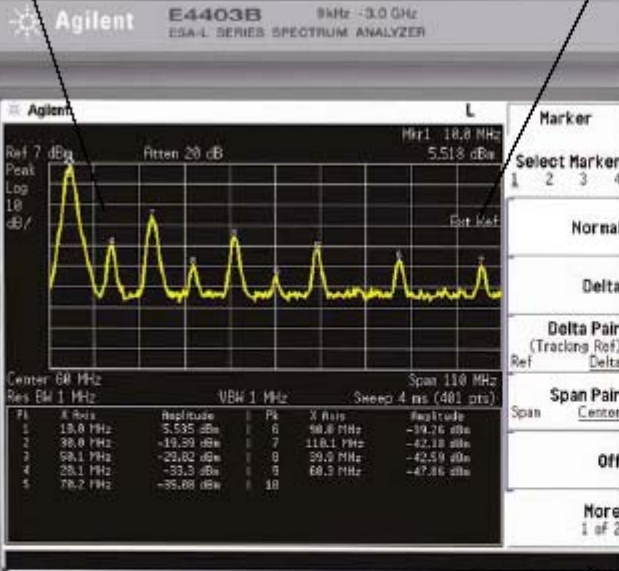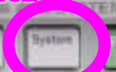
" Go to Local "

(!)

Power ON
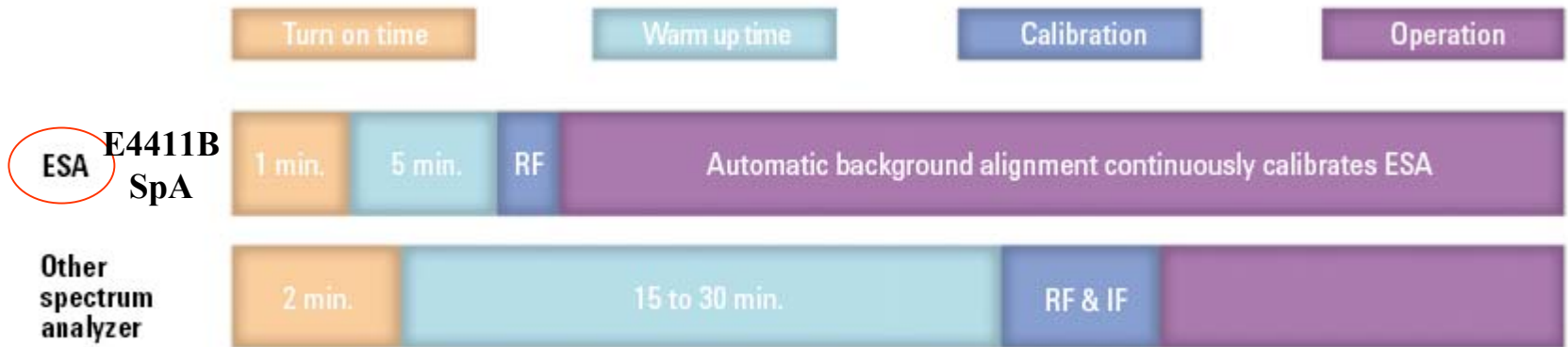
Standby

N
female

CAUTION:

papay@hit.bme.hu

SpA&RFgen

ESA-L Series Basic Express Analyzers

- *Basic Express Analyzer* offers fastest delivery and most favorable price
- Provides basic, quality, general-purpose spectrum analysis for bench top, manufacturing, or service environments
- Speed and accuracy
- Color display and builtin floppy disk drive
- Built-in set of rich measurement features and minimum options

5 Minute warm up time (!)

Most spectrum analyzers take 15 minutes to 1 hour to warm up before the specifications in the data sheet are valid. Not with the ESA. The ESA Series takes only 5 minutes to warm-up so technicians and engineers spend little time waiting for instrument stabilization.

| Turn on time | Warm up time | Calibration | Operation |

ESA **E4411B SpA**

| 1 min. | 5 min. | RF | Automatic background alignment continuously calibrates ESA |

Other spectrum analyzer

| 2 min. | 15 to 30 min. | RF & IF | |

Five minute warm up time with advanced background alignment
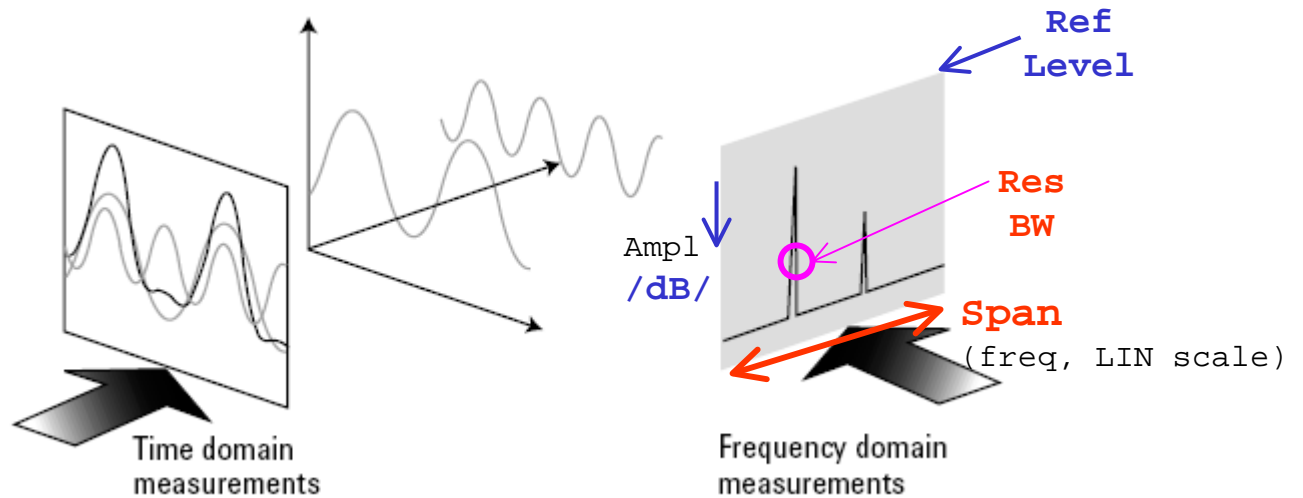
Built-in context sensitive help

The ESA's context sensitive help menus make it very easy to look up front panel, soft key, and hard key information, including its equivalent remote SCPI commands.
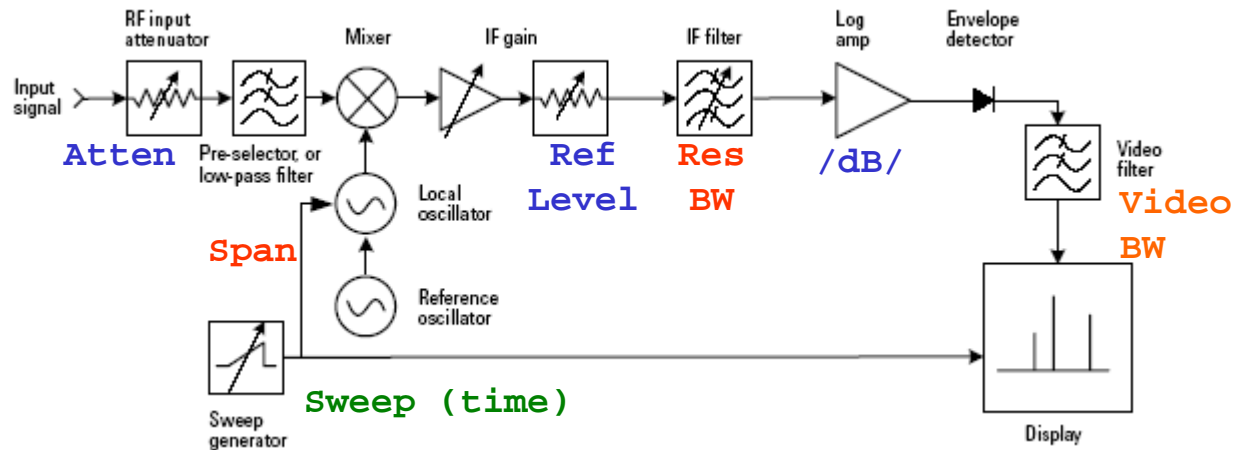
Step 1
Press Help

Step 3
A help screen appears with explanation and equivalent SCPI command (if applicable) for the key pressed

Step 2
Press any key or soft key

Ref Level

Res BW

Ampl **/dB/**

Span (freq, LIN scale)

Time domain measurements

Frequency domain measurements

Time Domain **vs. Frequency** domain: http://www.educatorscorner.com/index.cgi?CONTENT_ID=2489

SuperHet SA: http://www.educatorscorner.com/index.cgi?CONTENT_ID=2491

RF input attenuator — **Atten**

Pre-selector, or low-pass filter

Mixer

Local oscillator

Reference oscillator

IF gain — **Ref Level**

IF filter — **Res BW**

Log amp — **/dB/**

Envelope detector

Video filter — **Video BW**

Span

Sweep generator — **Sweep (time)**

Display

Input signal

Span, **Res BW**: RBW,
Sweep (time): ST

The bandwidth of the IF filter is called the resolution bandwidth (RBW). The sweep time is ST. The measurement speed is Span/ST. Therefore, the time that signal stays in the IF filter passband is: RBW/[Span/ST].
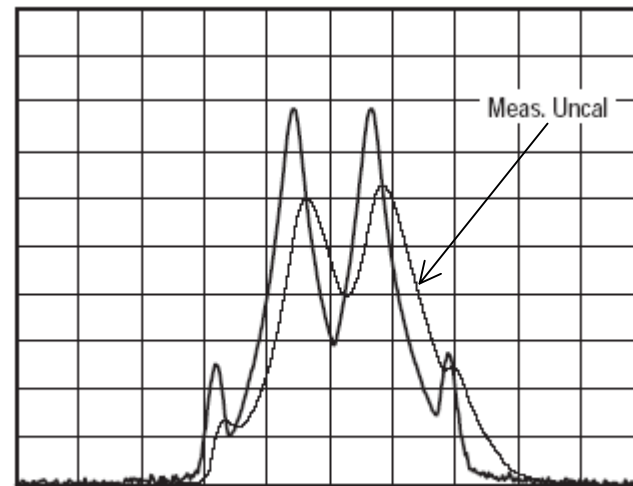
On the other hand, the rise time of a filter is inversely proportional to its bandwidth. That is: Rise Time = k / (RBW), where k is a constant of proportionality.

To assure the output of the filter rise to the correct amplitude we need:

time in passband ≥ rise time: $(RBW)/[(Span)/(ST)] \geq k/(RBW)$

therefore, $ST \geq k(Span)/(RBW)^2$

(Auto Couple ...)

Sweep Time | Retrace Time Between Sweep

1 / Update Rate

Meas. Uncal
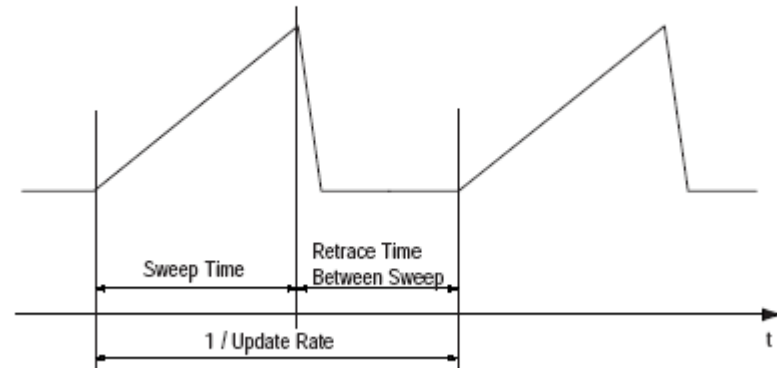
Penalty For Sweeping Too Fast
Is An Uncalibrated Display

Spectrum analyzer display diagram with the following labels:

Ampl (Amplitude section)
- **Ref level** — (1) Ref 5 dBm
- **dB/DIV** — (30) Log 10 dB/
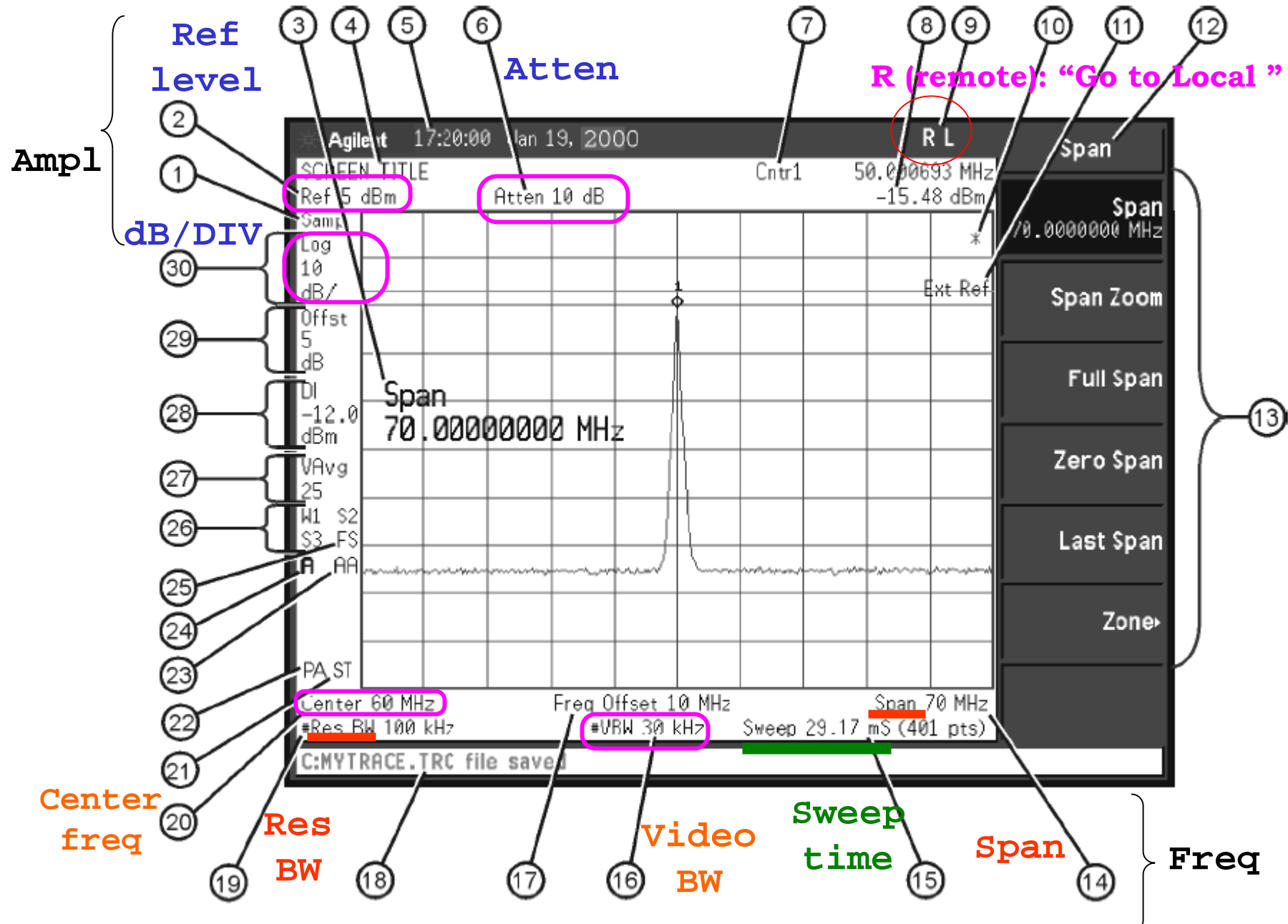
Atten — (6) Atten 10 dB

R (remote): "Go to Local" — (8)(9) R L

Top of display:
- Agilent 17:20:00 Jan 19, 2000
- (4) SCREEN TITLE
- (7) Cntr1 50.000693 MHz
- -15.48 dBm
- (3) Samp
- (11) Ext Ref

Left side labels:
- (29) Offst 5 dB
- (28) Dl -12.0 dBm
- (27) VAvg 25
- (26) W1 S2 S3 FS
- (25) LA AA
- (22) PA ST

Center of display:
- Span 70.00000000 MHz
- marker 1 (peak)

Bottom of display:
- **Center freq** — (20) Center 60 MHz
- **Res BW** — (19) #Res BW 100 kHz
- Freq Offset 10 MHz
- **Video BW** — (16) #VBW 30 kHz
- **Sweep time** — (15) Sweep 29.17 mS (401 pts)
- **Span** — (14) Span 70 MHz
- (18) C:MYTRACE.TRC file saved

Right side menu (13):
- Span
- Span 70.0000000 MHz
- Span Zoom
- Full Span
- Zero Span
- Last Span
- Zone▶

Freq (12) — frequency menu section

10 MHz peak

Agilent 09:57:21 Sep 5, 2000

Ref 10 dBm   Atten 20 dB
Norm
Log
10
dB/

4 DIV

5 MHz / DIV

Span
50.00000000 MHz

LgAv

W1 S2
S3 FC
AA

Center 30.00 MHz
Res BW 300 kHz   VBW 300 kHz

Active function block   Marker Annotation

Agilent 10:00:41 Sep 5, 2000

Mkr1 10.00 MHz
5.96 dBm

Ref 10 dBm   Atten 20 dB
Norm
Log
10
dB/

Marker
10.000000 MHz
5.96 dBm

LgAv

W1 S2
S3 FC
AA

Center 30.00 MHz
Res BW 300 kHz   VBW 300 kHz   Span 50 MHz   Sweep 1 ms

View/
Trace

Trace (1,2,3) mode:
 clear**W**rite,**S**toreBlank
Trig / Sweep:
 FC: **F**reeRun/**C**ontinuous
AA: **A**uto**A**lign **ON**

IntuiLink
WORD Toolbar

PSA/ESA Spectrum Analyzer
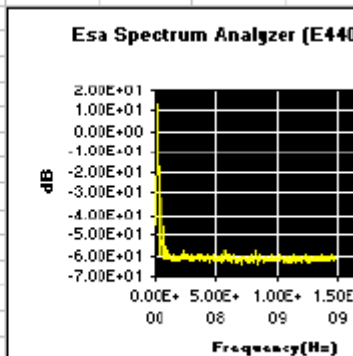
Agilent PSA/ESA
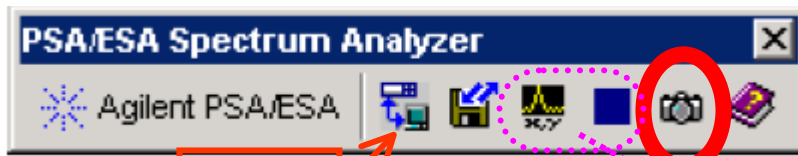
connect

📷 **Get Screen Image** Gets an image of the spectrum analyzer's display and places it in the active worksheet or document.

Get Data Uploads data from the spectrum analyzer to the active worksheet in Excel. Also allows you to obtain repeated measurements.

	A	B	C
1	Frequency	Trace1 (dB)	Attenuation (dB)
2	0.00E+00	-4.50E+01	1.00E+01
3	3.74E+06	-4.20E+01	
4	7.48E+06	-4.00E+01	Center Frequency (Hz)
5	1.12E+07	-3.00E+00	7.50E+08
6	1.50E+07	1.30E+01	
7	1.87E+07	9.00E+00	Date/Time
8	2.24E+07	-5.00E+00	1/17/00 10:54
9	2.62E+07	-2.60E+01	
10	2.99E+07	-4.20E+01	Instrument Model
11	3.37E+07	-4.30E+01	E4401B
12	3.74E+07	-5.90E+01	
13	4.11E+07	-4.80E+01	Instrument Serial Number
14	4.49E+07	-3.30E+01	US00000066
15	4.86E+07	-3.50E+01	
16	5.24E+07	-5.20E+01	Reference Level (dB)
17	5.61E+07	-5.80E+01	0.00E+00

Esa Spectrum Analyzer (E440...)

Get Data

Labels:
☑ Amplitude Units
☑ Attenuation
☑ Center Frequency
☑ Date/Time
☑ Instrument Model
☑ Instrument Serial Number
☑ Reference Level
☑ Resolution BW
☑ Scale Type

☑ Make Excel Graph
☑ Include Engineering Units

Start Cell:
H7

☐ Get Repeated Measurements

Repeated Measurements...
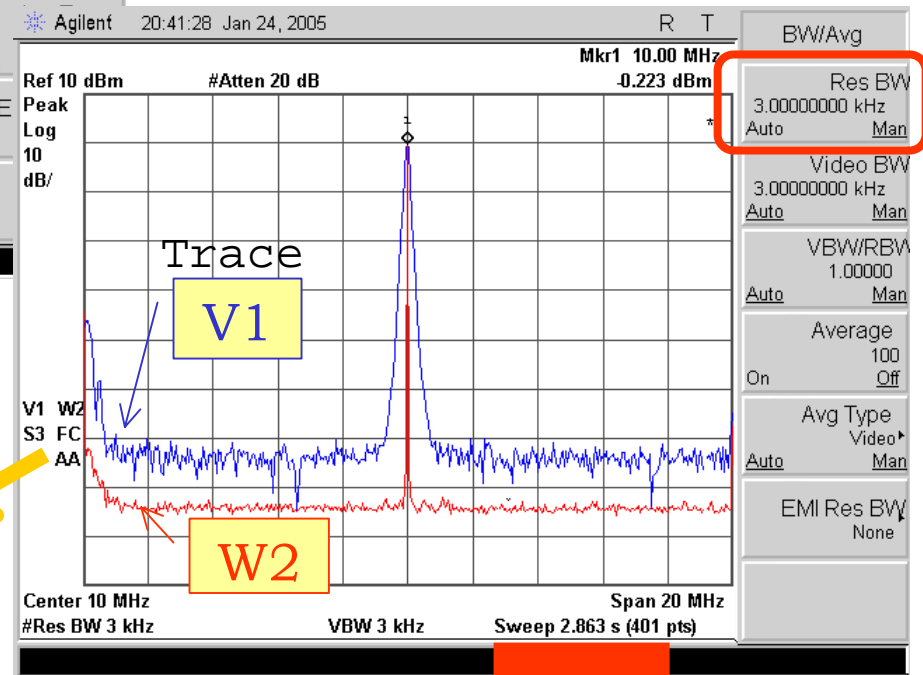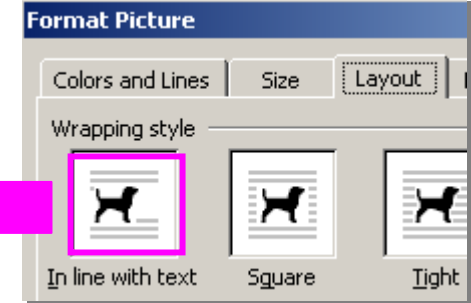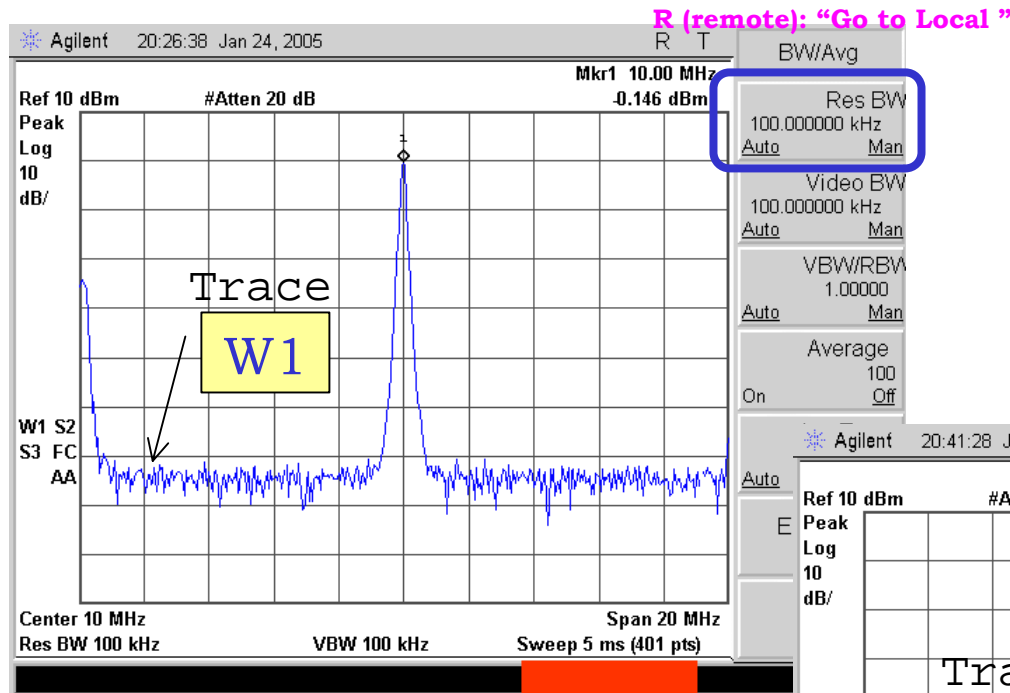
Get Data   Cancel

■ **Stop Repeated Measurements** Stops gathering repeated measurement data from the spectrum analyzer.

📷 **Get Screen Image** Gets an image of the spectrum analyzer's display and places it in the active worksheet or document.
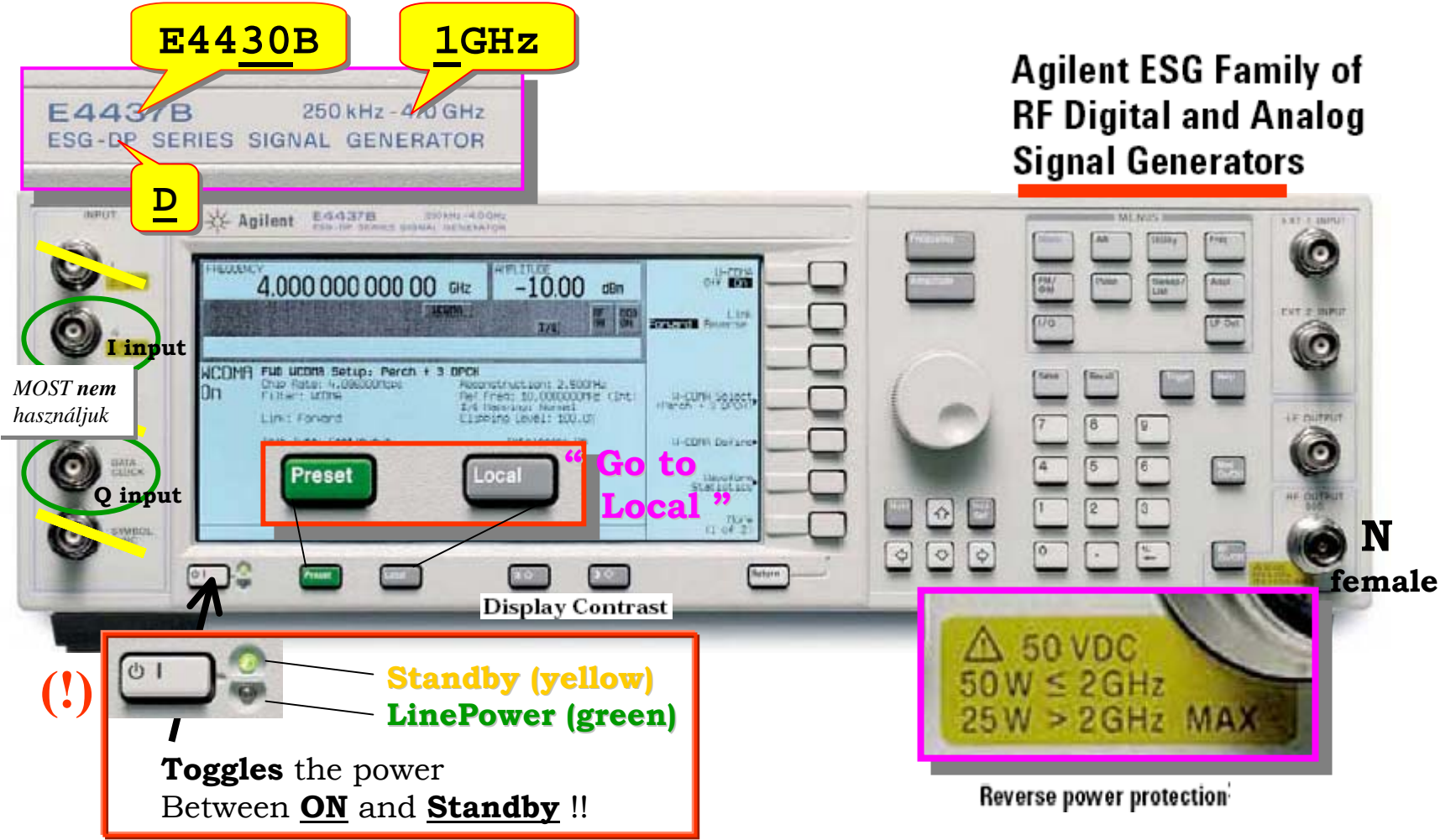
WORD :

"bal Kutya" ...

Format Picture

Colors and Lines | Size | Layout

Wrapping style

In line with text   Square   Tight

R (remote): "Go to Local "

❋ Agilent   20:26:38 Jan 24, 2005   R T

BW/Avg

Mkr1 10.00 MHz
-0.146 dBm

Ref 10 dBm   #Atten 20 dB
Peak
Log
10
dB/

Res BW
100.000000 kHz
Auto   Man

Video BW
100.000000 kHz
Auto   Man

Trace

W1

VBW/RBW
1.00000
Auto   Man

Average
100
On   Off

W1 S2
S3 FC
AA

Auto

E

Center 10 MHz   Span 20 MHz
Res BW 100 kHz   VBW 100 kHz   Sweep 5 ms (401 pts)

❋ Agilent   20:41:28 Jan 24, 2005   R T

BW/Avg

Mkr1 10.00 MHz
-0.223 dBm

Ref 10 dBm   #Atten 20 dB
Peak
Log
10
dB/

Res BW
3.00000000 kHz
Auto   Man

Video BW
3.00000000 kHz
Auto   Man

Trace

V1

VBW/RBW
1.00000
Auto   Man

Average
100
On   Off

Avg Type
Video
Auto   Man

V1 W2
S3 FC
AA

W2

EMI Res BW
None

Center 10 MHz   Span 20 MHz
#Res BW 3 kHz   VBW 3 kHz   Sweep 2.863 s (401 pts)

View / Trace

Trace (1,2,3) mode:
 View,clear**W**rite,
 StoreBlank,

Trig / Sweep:
 FC: **F**reeRun/**C**ontinuous
AA: **A**uto**A**lign **ON**

papay@hit.bme.hu

SpA&RFgen

E4430B

1GHz

E4437B   250 kHz - 4.0 GHz
ESG-DP SERIES SIGNAL GENERATOR

D

Agilent ESG Family of
RF Digital and Analog
Signal Generators

I input

MOST *nem*
használjuk

Q input

" **Go to
Local** "

N
female

Display Contrast

(!)

Standby (yellow)
LinePower (green)

Toggles the power
Between **ON** and **Standby** !!

⚠ 50 VDC
50 W ≤ 2 GHz
25 W > 2 GHz MAX

Reverse power protection
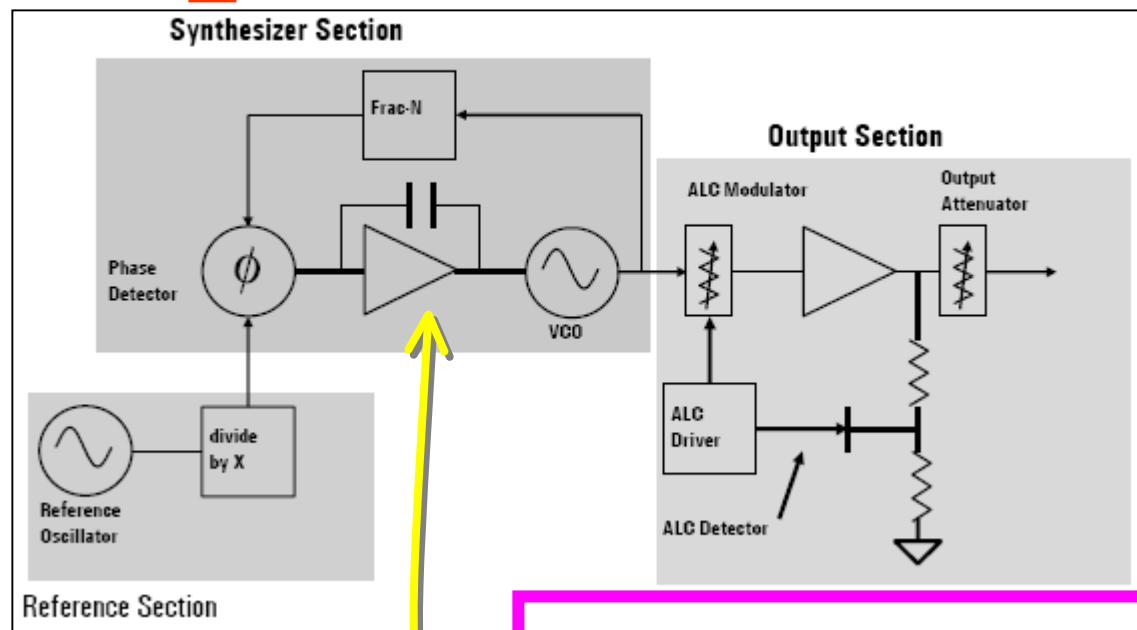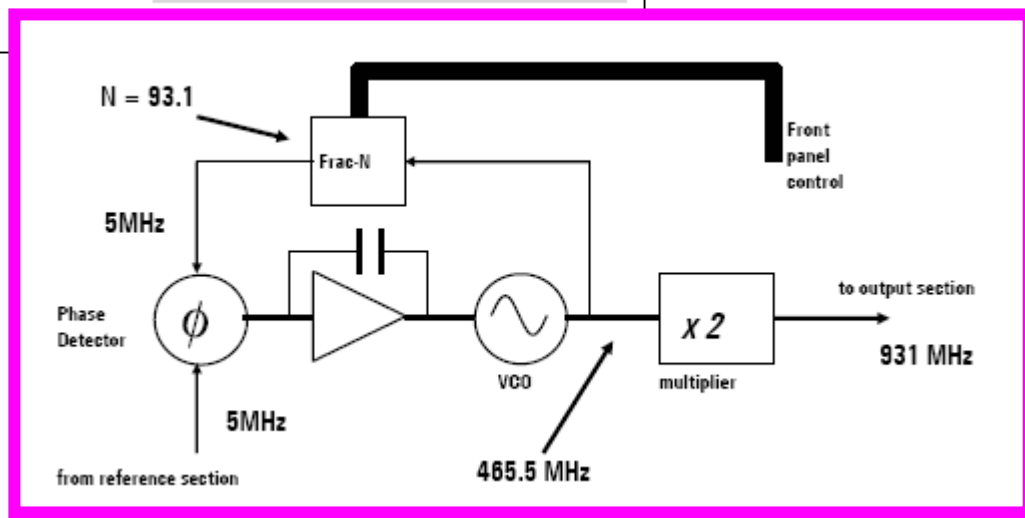
RF CW Block Diagram

RF: Radio Frequency
CW: Continuous Wave = **sine**

VCO: Voltage Controlled
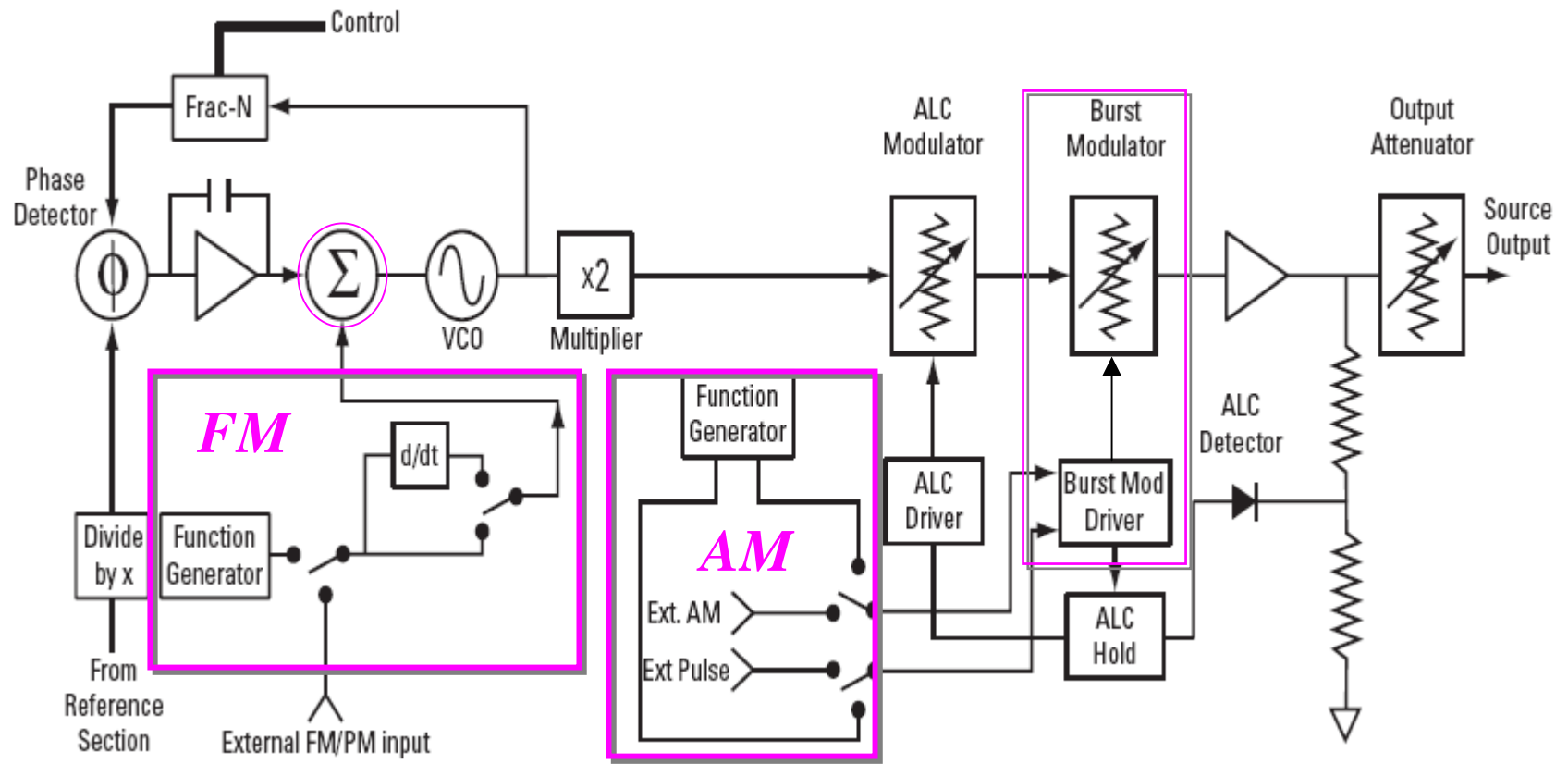　　　　Oscillator
Frac-N: Fractional-N
　　　　　divider
ALC: Automatic Level
　　　　Control

9. sz mérés:
Analóg fáziszárt
hurok (APPL)
vizsgálata
(**nem** Fractional-N PLL)

Signal Generator Block Diagram

**RF OUTPUT
(CW, carrier)**

MENUS

Frequency　(0.01Hz)

Amplitude　(0.02dB)

Mode | AM | Utility | Freq
FM/ΦM | Pulse | Sweep/List | Ampl
I/Q | | | LF Out

Mod signal

Save　Recall　Trigger　Help

EXT 1 INPUT

EXT 2 INPUT

LF OUTPUT

BNC

Mod On/Off

RF OUTPUT 50Ω

N female

Why is an amplitude value of 100 mV displayed as 100.111 ... mV?

"The amplitude resolution of ESG is 0.02 dB."

If we enter **100 mV**, the ESG will perform the following **calculations**:

1. Calculates the power in Watts:
$P = V^2/R$
2. Converts Watts to dBm:
$Pd = 10\log(P) = -6.9897$ dBm
3. Rounds up to the closest even hundredth: Pd = -6.98 dBm
4. Recalculates back to voltage in mV:
$P = 10^{(Pd/10)}$ and
$V = \mathrm{sqr}(P*R)$, therefore **V = 100.111 ... mV**

Hold　↑　Incr Set

7 | 8 | 9
4 | 5 | 6
1 | 2 | 3
0 | . | +/−

←　↓　→

Return

Setting

Tuning

⚠ 50 VDC
10 W ≤ 2 GHz

Output

Power²	Standard
250 kHz to 1 GHz	+13 to −136 dBm

1. Frequency Area

Digital Modulation Annunciators

2. Amplitude Area

3. Softkey Labels

R (remote): "Go to Local"

7. Annunciators

I input

6. Active Entry Area

Q input

5. Text Area

FREQUENCY

AMPLITUDE

R L UNLOCK EXT REF OVEN COLD   ATTEN HOLD UNLEVEL RF OFF MOD OFF
T S SWEEP EXT1 LO EXT2 LO BERT AM FM PULSE ENVL P I/Q ERR

Error: -222, Data out of range; value clipped to lower limit.

Preset   Local

Return

4. Error Message Area

Status message

PSG/ESG Signal Generator

✳ Agilent PSG/ESG
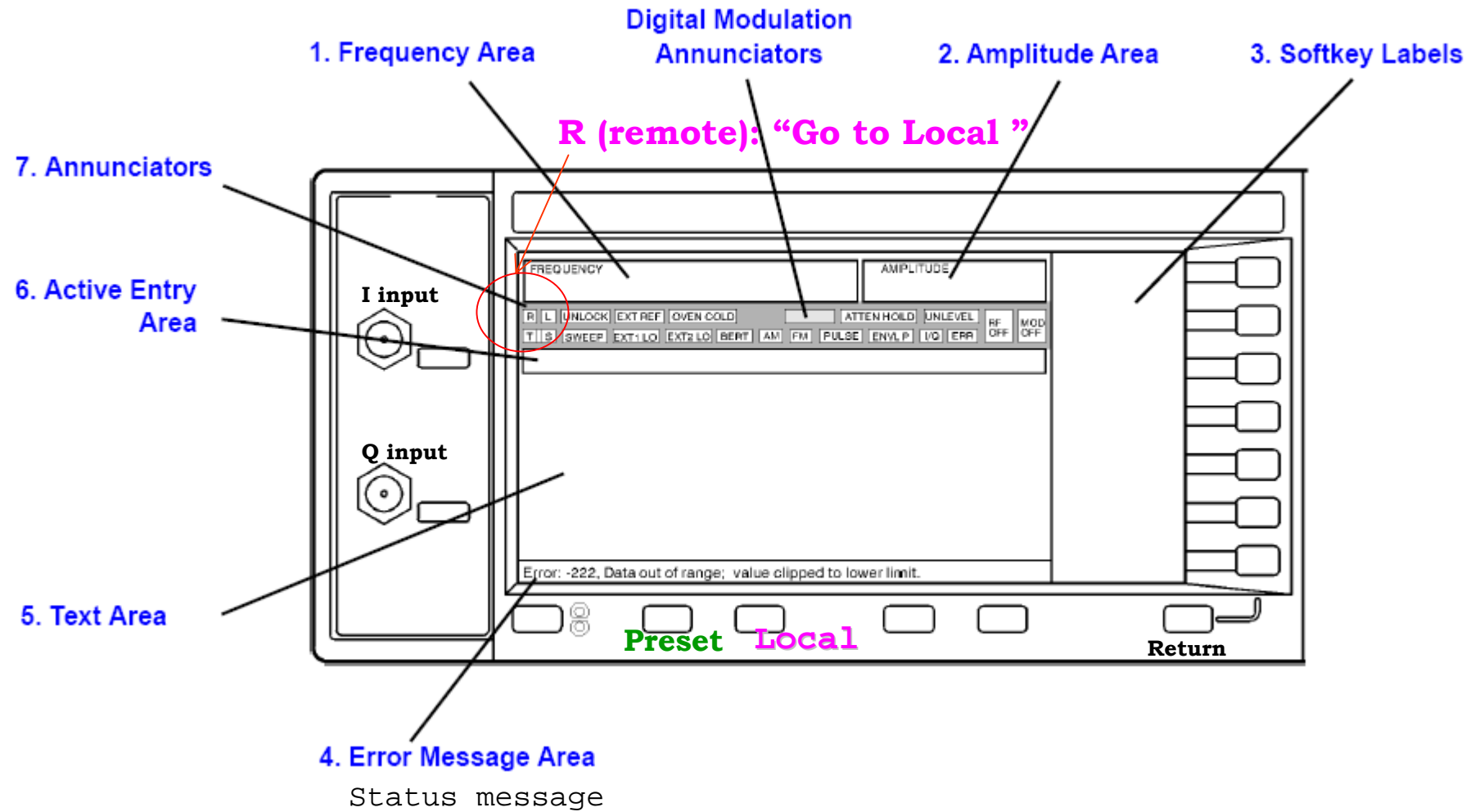
IntuiLink WORD Toolbar

connect

Agilent ESG RF Signal Generator

⚠ Screen Capture Instructions:

1. Press the "Local" key on the ESG.
2. Press the "Trigger" key on the ESG, which will initiate a capture of the screen.
3. Wait until you see the "Bitmap captured" status message on the ESG. (This may take up to 20 seconds.)
4. Click "OK" to complete the capture of the image.

OK   Cancel
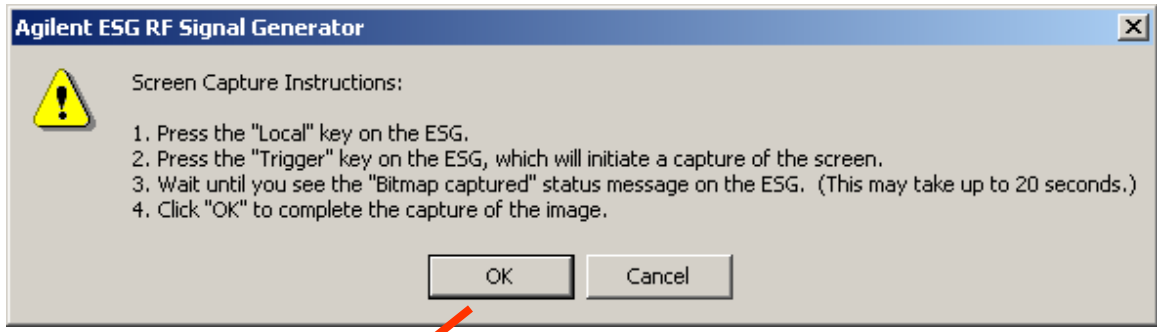
FREQUENCY
10.000 000 00 MHz

AMPLITUDE
-31.20 dBm

AM Path
1 2 WB

L

AM

RF ON   MOD ON

AM
Off **On**

Ampl: **-31.20 dBm**   Incr: 2.00dB

[COUPLE] AM Depth
74.7 %

Modulation Status Information					
Mod	State	Depth/Dev	Source	Rate	Waveform
AM 1	On	74.7%	Internal	50.0000kHz	Sine
AM 2	Off	74.7%	Internal	400.0Hz	Sine
AM WB	Off	0.5V=100%	I Input		
FM 1	Off	1.0000kHz	Internal	400.0Hz	Sine
FM 2	Off	1.0000kHz	Internal	400.0Hz	Sine
ØM 1	Off	0.000rad	Internal	400.0Hz	Sine
ØM 2	Off	0.000rad	Internal	400.0Hz	Sine
LFOut	Off	0.000Vp	IntMod		
Pulse	Off	40.0usec	Internal	80.0usec	Pulse
Burst	Off		Ext1 DC		
I/Q	Off		Ext I/Q		

AM Source▶
(Internal)

AM Rate
50.0000 kHz

AM Waveform▶
(Sine)

AM Depth Couple
Off **On**

Status message

WORD :

"bal Kutya" ...

Format Picture

| Colors and Lines | Size | Layout |

Wrapping style

In line with text   Square   Tight